INSTITUT FÜR INFORMATIK
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Diplomarbeit

Development of an Operation Support Concept for CDTM-IT as a Case Study of Managing Small IT-Infrastructures in Dynamic Environments

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München, den 02. Nov 2007

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(Unterschrift des Kandidaten)

The Center for Digital Technology and Management (CDTM) is a joint institute of TUM and LMU, maintaining a widely independent IT infrastructure inside the MWN. A number of services essential for daily CDTM operations (Firewall, E-Mail, www, wiki, VPN, Intranet-Portal, MS Active Directory, File, Print, Workstations, ...) is being provided and maintained on institute-owned servers. The CDTM infrastructure is administrated and maintained by the CDTM IT task force, comprised of CDTM students and led by one scientific assistant of CDTM. A majority of CDTM students is only actively involved in task force work for 6-9 months, after that most students are neither available nor reachable due to studying abroad. Over the last five years, an infrastructure has developed that is mainly characterized by quick, undocumented introduction of new services. Only in the last two and a half years, an effort was made to move over to functions and services that are more clearly defined and supported. Documentation is existing, but neither are there formal definitions of processes, nor do clear responsibilities exist. Know-how in the task force is present mainly in the minds of a small number of members and would be lost when these people leave CDTM

This paper is concerned with the creation of an operation support concept for CDTM IT as an example for IT organizations in highly dynamic environments. Principles of ITIL/ISO20000 and related frameworks will be regarded and assessed regarding their applicability. Various aspects of IT management come into play and must be considered, and due to the specific properties of the chosen exemplary environment, organizational and staff-related factors must be regarded closely. Measures to create a possible transition into a stable state are developed and compared, for example outsourcing of services or a restructuring of the IT task force. If conditions allow, the end result of this work should provide a basis to CDTM for a stable, effective provisioning of its IT services.

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1 Introduction

Information technology has found its place in nearly every aspect of society, business and education. We surf the World Wide Web on a daily basis, we use email and instant messaging to communicate, we synchronize our personal address books to servers, and we research sources stored in digital libraries. In short: we use a wide variety of interconnected services on a regular basis and we do this while taking the infrastructure behind the functionality for granted. There is a host of infrastructural components that provide the services, including networks, servers and software. Managing these components effectively and efficiently to ensure a level of quality that the users expect, concerning features like stability, security, and privacy, has after a long struggle been accepted even by business managers as being non-trivial. This by now has led to a growing awareness and widespread implementation of IT Service Management (ITSM). The demands that ITSM has to face are manifold and differ greatly, depending on the sector, the line of business and, not least, on the size of the IT organization. Meeting these demands successfully is a never-ending, continually evolving challenge, especially for small organizations in dynamic environments.

1.1 Motivation and Objective

In recent years, more and more organizations start to strive towards a well defined and thoroughly structured IT management, becoming aware of rising expenditures in their IT sectors on the one hand, realizing the impact information technology has on their business on the other. Mostly this development has taken place in big companies and enterprises largely owing to the higher impact of IT spending on a big scale, but also stemming from the fact that small companies do not eagerly assign resources to ventures that do not yield immediate, tangible results. Although structuring or reevaluating the IT environment does not have this property, it is apparent that it pays off in the long term to place the IT environment's management of even a small company onto a solid foundation. The threshold to embracing the big concepts for ITSM without being scared by processes or four-letter acronyms may be comparatively high, but a stable basis enables the IT management not only to keep in step with the evolution of the infrastructure but also to control and steer the growth of their IT and the quality of its services.

To minimize the effort needed to gain from a structured IT the use of a framework suggests itself. IT management efforts in the business world have induced the development of several frameworks for managing IT, each providing a special focus or approach. For large organizations, the best-known and most used framework is ITIL, the Infrastructure Library (introduced in 2.1). For small environments, there have been very few dedicated approaches

to creating a framework. ”ITIL Small Scale-Implementation”, the most prominent of these approaches has been published in [OGC 06], which can be seen as a guideline on how to shrink ITIL to fit small environments. This approach, however well accepted its ancestry may be, has not been given much attention concerning evaluation and scientific analysis.[1]

No matter which framework or approach to managing IT is used, it assumes stability concerning a certain set of conditions. Examples for such parameters are the size of IT staff, a certain minimum IT budget and an upper limit to the rate of changes per time. Of course, from the IT personnel's perspective these parameters have outrageous values at any fixed point in time. There is never enough staff, always a meager budget and ever too many required changes. When listening to business managers the perspective is different: too many expensive IT people use too much budget and keep disapproving necessary changes. Nevertheless, it is the resulting haggling for resources itself that constitutes a stabilizing component for the parameter's values. Still, without demanding certain limits on these values, there is a very small chance of successfully creating a framework that deals generically with ”any IT environment”. However, should environments that cannot guarantee the parameter limits set by the well-used frameworks not be able to derive a benefit from them? Even if they cannot plainly apply the rules and processes given in the frameworks, a certain benefit is to be expected.

The Center for Digital Technology and Management (CDTM), described in the following sections, is a fitting example of the abovementioned no-guarantee environments, as will become clear in the description of the scenario below. This diploma thesis was conceived to provide the IT management of the CDTM with a tailored operation support concept to manage its IT infrastructure in the dynamic conditions extant there. In creating such a concept, there is a chance of gaining an insight into the applicability of ITIL as an IT management framework in such dynamic environments in general. An overview of the approach used to meet these goals is given after a description of the scenario and a more detailed view of the requirements that are to be met.

1.2 The Scenario

To understand the scenario that this document is embedded in this section will introduce CDTM itself, then describe the history of the CDTM IT environment, and finally outline the special dynamics that underlie the management of IT at CDTM. Before engaging in these, it is at first helpful to give a list of entities that occur in the field of CDTM IT, so explanations of abbreviations and names do not break the flow later on[2]. The following entities and terms will occur more or less frequently in this document:

- The Ludwig-Maximilians-Universität (LMU), founded in 1472 and moved from Ingolstadt to Munich in 1826, is one of Germany's elite universities, teaching natural, cultural and social sciences as well as humanities and medicine. Five professors from

[1] An introduction to ITIL, ITILSS and their application in this thesis is given in chapter 2.
[2] The abbreviations can also be found in the glossary for quick reference

LMU support CDTM, coming from business administration (four board members) and computer science. More information can be found at [LMU 07].

- The Technische Universität München (TUM), founded in 1868, is Munich's second university. TUM chairs are taking part in CDTM with also five professors from the departments of electrical engineering (two professors) and computer science (three board members). More information on TUM is found at [TUM 07].
- The Elitenetzwerk Bayern (Bavarian Elite Network / ENB) is a program created by the federal state of Bavaria. It is "aimed at providing excellent education and research opportunities for approx. 2,000 gifted students and 120 new-generation post-graduates per year"[ENB 07] and supports selected study programs by providing funds and in some cases necessary infrastructure.
- The CDTM itself is described below; to define entities it suffices at this point to see the CDTM as a self-organized educational institution that belongs to both LMU and TUM and is a member of the ENB.
- The "Board of Professors at CDTM" consists of ten professors from several departments and institutes of both universities. These professors support CDTM and share a common interest in technology management in this specific setting.
- The "Scientific Directors" of CDTM (SDs) are the executive directors at CDTM, meeting regularly, being the board's contact persons for the students, backing projects and ventures as well as supporting and representing CDTM to the outside world. The SDs are two Professors of the board in semiannual overlapping rotation, usually one each from the LMU and from the TU. Each professor is SD for one year and each semester one of the two hands over the position to a fellow board member, thus avoiding breaks in communication and management while letting each participating organization have its due representation while bearing its share of responsibility.
- Scientific assistants who pursue their doctorate at CDTM while taking care of education and organization are currently known as "Center Assistants" (CAs) – formerly called Teaching Assistants (TA) – and form the "management team" of CDTM. The six CAs make all decisions at CDTM that do not require authorization by the SDs or the CDTM Board. The absence of a formal head of CDTM has various reasons that will not be discussed in this paper. In effect, the assistants have a very high degree of freedom in operational and strategic issues.
- The Leibniz Rechenzentrum (LRZ) belongs to the "Bavarian Academy of Sciences and Humanities" and is the provider of computing, network, backup/archiving and general IT services for the scientific and academic communities in Munich. In computing, it operates the HLRB II, one of the three big supercomputing centers in Germany, currently in the top 10 list of supercomputing according to [LRZ 07a]. The LRZ provides the educational institutions of Munich with internet access and network services via the "Münchner Wissenschaftsnetz" (MWN, Munich Scientific Network) and supplies 4,500 Terabytes of archiving space as well as services like large-format plotters, workstation systems, software etc. For CDTM the LRZ is the main service provider and given the "support of education"-character of most LRZ-services the re-

lation is only partly to be seen as a customer/provider relationship. More information about LRZ can be found at [LRZ 07b].

- The IT at CDTM is managed and maintained by the CDTM IT Taskforce (ITTF), in turn led by a Center Assistant responsible for the ITTF (IT CA). Both are described in detail in the following sections.
- The "Rechnerbetriebsgruppe der Informatik der TU München"(TUM-RBG) is the IT staff of the TUM's institute of computer science, providing support for some pieces of CDTM hardware that were procured via TUM-RBG. There are no definitive contracts, service levels or similar but relations between TUM-RBG and CDTM personnel are very good.

All of these entities have shaped CDTM IT and will still have their share of influence in the future.

1.2.1 CDTM - The Center for Digital Technology and Management

The Center for Digital Technology and Management was founded in 1998 as a joint initiative of LMU and TUM in cooperation with the Massachusetts Institute of Technology (MIT). It was conceived as an elite study program focusing on technology management and designed to be completed in parallel to the normal studies. CDTM started with classes of fifteen to twenty students each year for 1998 and 1999 but gained reputation so quickly that it had to start selecting twenty to twenty-five students each semester from a host of applicants in 2000. Although applications are encouraged for students from any course of studies, most applicants have business administration, computer science and electrical engineering as their main subject. Runners-up include math, "Media Informatics" and several business-oriented study programs like economic geography. In the earlier years of CDTM, students finished the program with a "Certificate in Technology Management" after four semesters. In 2004, the CDTM program "Technology Management" was incorporated into the ENB (see above) as one of the first fifteen programs supported by the Bavarian state as elite study programs. This involved changing the certificate in Technology Management into the "Honors Degree in Technology Management" that now is awarded by the host universities LMU and TUM to accompany the normal degree, such as Diploma and Master's degrees, at the end of the main course of studies.[3]

The CDTM study program consists of a set of core courses that every student has to enroll in and a number of elective courses and workshops that can be combined to reach a certain number of credits to complete the program. Courses range widely in the interdisciplinary areas found between development, engineering, management, and business ethics, and involve innovative technologies, entrepreneurship, management and soft skills. Many courses are supported – some even taught – by well-known industry partners such as BMW, A.T. Kearney, Siemens and Vodafone, which ensures proximity to the cutting edge of technology and enables students to get an inside perspective on possible future employers. The

[3] further information can be fount at [CDTM 07]

main CDTM curriculum guides the students through a semester of gaining research skills, practicing presentations and writing a trend report, followed by a semester of managing product development and a semester of consulting a company or a startup. Students are to spend a term abroad during their time at CDTM, which usually is done in the third or fourth semester. Academic partnerships have been built up to renowned universities like UC Berkeley, CMU and MIT (USA), Waseda University (Japan) and ENST Paris (France). A limited number of students are financially supported during their stay abroad, selected using an internal application procedure.

CDTM is supported and steered by the professors of the board, meeting once a semester. The Scientific Directors officially and externally represent the program and they act for the Board in daily operations at CDTM. They make the strategically important, high-profile decisions, aided and advised by the CAs. The other CDTM board members are consulted in matters encompassing their fields of work. All professors supporting CDTM are available for CDTM students in a mentoring scheme, even though they are among the more highly sought-after personalities in their fields. Additionally, the SDs are also the main contact for students of CDTM, being available for any issue relating to CDTM that is out of the assistants' scope or that a student rather wishes to address to an SD. All board professors react very positively to any request of a CDTM student relating to their normal field of work or research. This includes supporting students with letters of recommendation. In addition, many third parties are usually not prone to devote time to requests made by students unknown to them – or even to trust these students, especially when high-profile industries with restrictive information policies are involved. The CDTM professors often help by lending importance to students' approaches and requests directed there.

With the management team being free in all day to day business decisions, the SDs are only consulted in matters that absolutely require their attention or intervention. Still they often leave such matters to the CAs, for there is traditionally a very high level of trust in the management team based on former experience. Recently, there has been a full exchange of personnel in the group of assistants in a very short time. Added to that, the older assistants were deep in the final phase of their dissertations. These circumstances impeded an effective knowledge transfer so only the most essential knowledge and management information could be transferred. To impart all of the background information that the older assistants had gained through shared experience in setting up the CDTM program would have taken more time and effort than was available. As a result, it is a simple fact that the currently prevailing experience level in CDTM organizational matters is not the same as it was with the old team of assistants. In addition, the experiences in managing CDTM shared by the new assistants are of a completely different nature. Against this background, it stands to discussion if the described strong trust in the management team's capabilities is still justified. It is, however, not in the scope of this document to evaluate these factors' ramifications. The description of this situation, however, falls under the necessity to attempt at an exhaustive description of sources for high dynamics, since this setup is a catalyst for unstructured or unchecked change because there is often no higher authority that strictly monitors strategic decisions.

Financing CDTM is one of the central concerns of the managing team. The program is only partly financed by grants from the ENB by funding three research assistants. One CA is

funded by LMU; other assistants are financed using funds from joint projects in different fields. These externally financed assistants are usually only funded for a year or two, so they spend a significant amount of time on acquiring subsequent funding of their position. Traditionally – due to most of the assistants being management-oriented – the assistant responsible for the IT at CDTM is assigned one of these externally funded positions. To handle CDTM accounts, expenses and the masses of red tape dominating university liaisons, one professor assigned a member of his chair to be at CDTM three days a week without consideration. All other personnel (between three and six student assistants) and most of day-to-day expenses like office supplies etc. have to be covered by sponsorship through companies or by donations. To cover this, all CDTM assistants spend part of their time acquiring new projects and project partners. In addition, sponsors pay for submitting tasks and projects to courses such as "Managing Product Development", knowing the quality of results they can expect from CDTM. Still, funds are never sufficient, as they never are in the educational environment. Considering the managerial character of the assistants' tasks and taking into account the – as a side effect of leading edge technology management – mostly business-driven orientation research fields of the assistants the IT usually stands at the end of the queue when funds are assigned. This circumstance has been one of the key factors in shaping the history of CDTM IT.

1.2.2 CDTM IT - A Small History

The IT field in all its aspects at the Center for Digital Technology and Management has a long and varied history. This becomes most apparent when viewing the number and complexity of services and machines at CDTM, but it is also reflected in the organizational structures of the IT taskforce. In the following paragraphs, the necessary essentials of both aspects will be covered for understanding some of the reasoning later on. This section intentionally does not describe the current state or size of the infrastructure because a large part of chapter 3 is dedicated to this task.

Services and Machines When CDTM was founded, the only hardware were a small number of standalone PCs using a shared internet connection, but soon a project was launched to develop "MyCDTM", a system to manage students, grades, courses, etc. which was to be the first custom system in use on the first server of CDTM. Students designed and programmed the Lotus Domino[4]-based system that was to be connected to the Lotus infrastructure at a chair of TUM's institute of computer science. Incidentally, this connection never happened, which is a first hint at the change frequency and dynamics at CDTM pointed out in the following section. The size of the IT infrastructure at CDTM grew continually over the years, reaching first the "**desktop server**" stage when setting up an MS Windows domain to enable personalized logins and roaming profiles instead of the cumbersome but easy-maintainable "user" and "admin" logins on each PC.

After that stage CDTM moved to another area of TUM and the LRZ allowed CDTM to put it's (by then four) servers into the local LRZ server room onto a plain desk. That stage could

[4]A groupware solution by IBM, see `http://www.ibm.com/software/lotus`

be called "**growing up**", also because server security became an active concern of the IT leaders for the first time. The major implication of this was finally *not* everyone knowing administrative passwords.

This desk in the server room filled quickly with more servers so more tables were put in and stacked on top of each other to accommodate the ten to fifteen servers (including project machines) that accumulated in this "**unchecked growth**" stage. At about this time students' efforts led to a donation by Siemens Business Services, consisting of some ten Compaq servers and five full-height 19" racks. The servers were rather old but regarding performance, they were still a lot stronger than the existing machines.

This event marks the beginning of the "**getting organized**" stage when many measures were taken to clear up, consolidate, optimize and secure the systems. This point in time (February 2005) was also when approximately the current number of machines and services was reached. During this stage a change in IT leadership took place, but before covering this most recent event a description of the organizational history is needed.

Organization The organizational structure and head count of the IT taskforce underwent – in general – the same stages. In the first stage, almost everyone deemed capable of "not breaking" things was entrusted with the administrative password that enabled full access to the single server as well as all the clients. The "IT Taskforce" itself was not yet existing and all scientific assistants, no matter how experienced in administration, worked with the administrative accounts all the time (simply out of convenience), resulting in the predictable chaos concerning stability and security.

This had an end when some students with experience and knowledge in Windows administration joined CDTM. One of the assistants was given responsibility for the IT infrastructure and the IT Taskforce was founded with the most IT capable students of CDTM, heralding the next stage (growing up). Still, at this time there was no organized recruiting of taskforce members, whoever wanted to contribute and was able to do so simply joined the group and started working on IT.

With changes in CDTM organization, the recruiting efforts for new students were adjusted so that each semester the IT taskforce was joined by at least two students with a compulsory stay (in any of the taskforces at CDTM, not only IT) of one full semester. The group grew to a maximum of 15 members, capitalizing from a high motivational lock-in of older students. These "oldies" were actively taking part in CDTM IT for many reasons. For some it offered many ways of learning new things, for some there were attractive privileges like being allowed to run their personal project server at CDTM, still others stayed for the community effect that was emphasized by the IT leader through CDTM-sponsored extracurricular events for IT members only. This tremendous size of the group and thus the huge amount of available work force was the main driving power behind the growth stage of the IT. Services, servers and projects were sometimes created on a weekly basis with task force meetings held bi-weekly to keep everyone informed.

In 2004, the taskforce was reorganized into subgroups focusing on special areas of IT and being responsible to support these areas for CDTM users. Areas were e.g. "Windows Client",

”Windows Server”, ”Linux Server and Network” and ”MyCDTM”. Most members joined more than one subgroup, according to their expertise and available time. This splitting of responsibilities was introduced because the bi-weekly meetings exceeded sensible timeframes and most topics would be discussed in small expert-groups off meeting anyway. Obviously, this change correlates to the transition into the next stage (getting organized) in the course of which several highly trained taskforce members finished their CDTM studies and thus left the group, effectively draining CDTM IT of a part of its ”brain ware” and expertise. As has been stated above, this stage endured until the recent change in IT leadership.

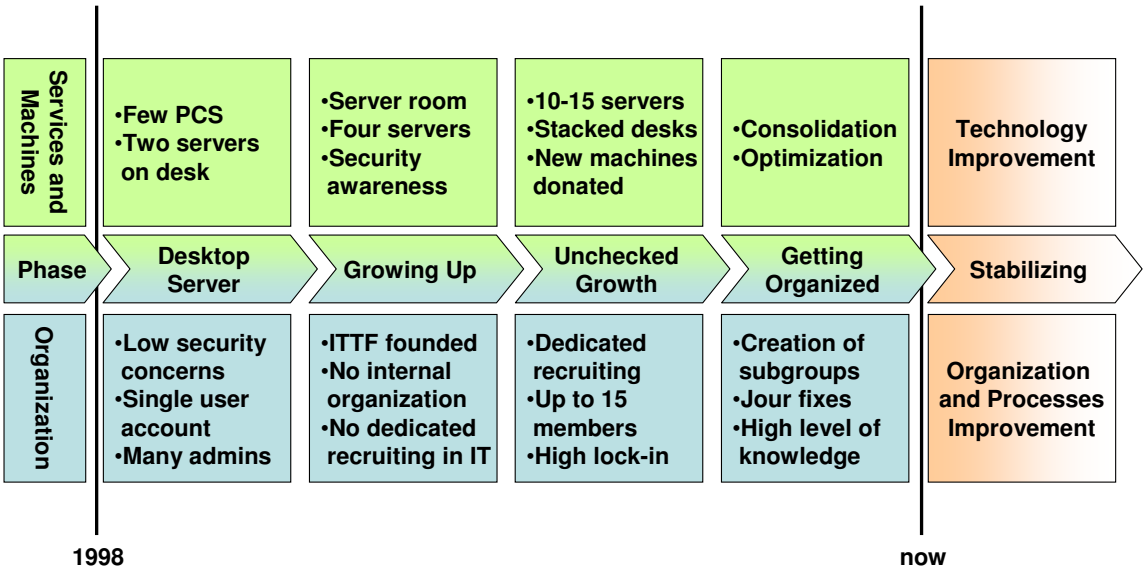

Figure 1.1: The Phases of CDTM IT

As summarized by the diagram in figure 1.1, comparing the two aspects has shown the parallel nature and similar direction of developments in the phases mentioned above. The twice-mentioned change in leadership at a late point in the most recent stage was not drastic in its implementation as a personnel change, but very drastic in the character of leadership. Greatly oversimplifying for sake of brevity, one could call the change a switch from ”someone driving IT” to ”someone detachedly managing IT”. Given the extant culture of carefree, technically oriented people in CDTM IT, this led the situation into a kind of undefined state. Since that time, there have been wide-reaching changes in the management and the organizational structure of the IT Taskforce, and a small number of significant modifications in the infrastructure, the latter being mostly of far-reaching impact. These alterations are only partly reflected in this thesis as they were mostly only in the planning phase when work on this document was started. As far as possible, however, the changes have been kept in the author’s field-of-view when designing and proposing actions and processes, even though they are not included in the description of the status quo in section 3.1. In the cases where they were effectively taken into account, they will of course be mentioned and explained in necessary detail.

Seeing this history of CDTM IT one can already envisage one of the goals of this work, which is to enable the IT taskforce management to use the remnants of the momentum

created in the ”getting organized” stage to lead the CDTM IT into the next ”era”, a phase of stability. To have a future, CDTM IT will, after years of build-up, need to be revised and re-evaluated and there is a need for a future-proof concept to maintain and manage this IT infrastructure in the face of all the dynamic factors prevalent at CDTM IT.

1.2.3 The Special Dynamics of CDTM IT

Now that the general surrounding conditions have been described, it is possible to name and elaborate a number of the factors that make the term ”dynamic environment” very appropriate in this setting. It is obvious that an IT environment that has no change rate whatsoever should be called ”stagnant” and has a high probability of running into problems in the future. However, that basic, necessary change rate incorporates e.g. upgrading systems to new versions, replacing products when warranty, licenses or support become unavailable. Enlarging or redesigning systems due to growth in company size is also included there. These factors come under the heading of system maintenance that is usually covered by standardized actions and is supported and simplified by software and hardware vendors as part of their business. Of course, these changes also apply to CDTM, so the word ”dynamic” in this context does not refer to these, but rather to the events and influences that introduce a certain element of surprise to the IT organization at CDTM. Even though in many environments there are events and influences that are unforeseeable, the character of normal day-to-day work at CDTM provokes a high number of requirements that simply cannot be anticipated. On the other hand, it has also happened that the need for a special new system or software installation was known for a long time beforehand but simply not communicated to CDTM IT. The influences are listed below in no special order, following that there will be an attempt at categorizing or grouping the factors.

- As has been stated in section 1.2.1 above, CDTM decided **against establishing a fixed hierarchy** or organizational structure to promote flexibility on the one hand, to maximize the use of funded positions for teaching on the other. A dynamic resulting from exactly this **managerial flexibility** is evidently a higher rate of change in IT matters. For example, if the management team decides on creating a new course format in which various teams each create their own web service, then IT resources are necessary for hosting the services; if, after just one semester, the course format is abandoned then suddenly the capacities are usable again (without prior notice of course). With CDTM IT being a factually no-budget effort, this dynamic is a strong challenge. In a highly organized institute, there will never be a course format with high background requirements for just one semester if the resources are not available beforehand.
- The **focus of CDTM core courses changes from semester to semester**, as does the character of projects and project organization. Focal points for CDTM core courses have included ”Generation 50 Plus”, ”Mobile Applications for the Soccer World Championship 2006” and ”Smart Dust” (the latter handling nanotechnology). This means that during some semesters there are projects that need no IT resources at all, in some semesters there is a need for several new servers and services, such as SMS-Gateways, map-servers etc.. The focus of the semester may be set a long time before

the beginning of the semester but there is usually no way to prepare the IT for specific requirements.

- One of the integral features of the CDTM core courses constitutes an influence that provokes a high frequency of low-response-time change requests. The core courses have project work as a strong component and are strictly team-oriented. Due to the **highly innovative character of work in CDTM courses** the requirements put forward by the teams, or even the types of requirement, cannot be anticipated before they occur. Requirements can be simply a machine to run a service on but could also cover complex services like the aforementioned inbound-SMS-Gateways and a fully separate WLAN infrastructure for location-based products. It happens very seldom that the responsible assistant for the course denies a team the resource that they need for their concept, acting in confidence that CDTM IT can provide.
- The new management team (after the full switch mentioned in section 1.2.1) has a very different perspective on CDTM's IT environment. Not having used the system during its evolving stages, there is no real insight to the system as a whole. This sometimes leads to **strategic decisions without a real perception of the workload involved**. Small changes as seen from the management team's perspective can influence big areas of the full system, introducing dynamics into integral parts of the system. An example for such a decision is a current project that is set to replace a custom-built intranet system (with code fully owned by CDTM) by an external solution for mainly aesthetic and documentation reasons. This was done after only preliminary evaluation without thoroughly checking the workload implied in integration with CDTM's user directories, mail system and so on. As of now, the new system must even be customized in integral parts to be usable as needed, locking in several taskforce members for almost all of their available time.
- The student members of the IT taskforce are still CDTM students, which implies that they follow their normal course of studies and also can not neglect their CDTM curriculum. The effect of that is a high difficulty for CDTM IT in obtaining output from the **already overloaded students**, especially since membership in one of the taskforces at CDTM is mandatory but reprimands for lack of participation are not known of. Fortunately, commitment in the IT taskforce is rather high, in some semesters even exceptionally so; still, the IT CA has a hard time in finding common time slots for general IT meetings or workshops and, as is usually the case, the first tasks to be dropped when time is short are documentation and knowledge transfer. It is clear for everyone concerned that this is not a good thing in the long run but as has been said by a former taskforce member: "missing documentation does not call a cell phone, but CAs do" (if a request they think important is not answered or fulfilled).
- CDTM students **only have to stay in taskforces for one semester**, usually their first CDTM semester. After that – in most taskforces – they phase in the new students in a short meeting or workshop and then they usually are consulted by the new students if referred to them by the taskforce leader (i.e. the responsible CA) refers them or if the situation demands. This procedure would be doomed to failure in the IT taskforce because a full phase-in of new members would need a full semester due to the size and high complexity of the system. Still, members can not be forced to stay longer,

so knowledge transfer usually happens on-the-fly during issue treatment or rather not at all. Thus it is a fact that the high frequency and throughput of people in CDTM IT inhibits a buildup in stability concerning organization and knowledge [5]

- The IT taskforce has **no official staff** aside from the IT CA. There is a student assistant from time to time but the change frequency in these positions is usually even higher than for normal task force members. This situation implies that the knowledge about the system and its features resides mostly with the IT CA and with the few students who are committed and feel responsible for the running of the IT. This compounds the fluctuations for person-hours available to CDTM IT, a dynamic stemming in part from the organizational structure, in part from the workload on CAs and students.

All these influencing factors can be grouped under headings according to their perceived origin and character. A relation between origin and character of causal factors cannot usually be assumed, but incidentally, there is a correlation between the two features at CDTM, i.e. factors that share a common origin tend to have the same character. The groups chosen here are listed below, table 1.1 shows the mapping of factors to groups.

- **Preconditions / Character of CDTM** – The character of CDTM itself is one of a study program that focuses on managing innovative and emerging technologies and only recruits select students with high levels of knowledge and motivation to keep innovation levels up. In turn, high innovation levels induce and imply modes of operation that inhibit stability and promote flexibility as a necessary feature of all operational aspects. Factors originating here apply to CDTM IT transitively (i.e. through courses or through assistants; CDTM IT perceives the effects, but not the factors themselves). Effects are usually not easily countered but can be ameliorated through work on the interface between the assistants/users and the IT taskforce. A problem here is also that high time pressure on all people concerned makes it difficult to mobilize and motivate the ”customer side” to make the effort, especially since there are no contracts and no perceived ”immediate tangible benefit”.

- **IT Awareness of Staff and Users / Perceptions** – An important feature of any IT environment is how IT is perceived by the users. Are IT services simply a commodity that can be demanded at any time and to any extent? Is IT service a ”dear good” that is not carelessly drawn on? At CDTM, there are two distinct groups of people with different viewpoints. The assistants[6] see the IT mostly as a ”free service that works”, to the extent that a kind of panic ensued when a short service interruption occurred and suddenly the term ”outsourcing” was heard a lot. The working quality and commitment of IT taskforce students is usually so high that this view is understandable, because most of the IT work is done invisibly to the users. The second group of people consists of the (non-IT) students at CDTM. For them, the IT is just a big thing in the background that provides services necessary for their work at CDTM; unfortunately, they seldom even know about all the services available to them, also because the CAs do not inform them actively about the IT. Mostly they never even get a glimpse at

[5] Transitively, the infrastructure also loses stability because sometimes service redundancies are built up due to missing knowledge

[6] Not *all* assistants, of course. We have to generalize.

the complexity and size of the system and do not know about the possibilities the IT can offer them. Members of this group only approach the IT taskforce if they have a problem (login, mail etc.) or if a CA sent them with a specific inquiry. Dynamics arising from this group of factors can only be countered by information policy and by changing the perception of all non-IT people at CDTM. This is too big a task for this thesis and its resulting concept but pointers to possible solutions will be given at special key points in the following chapters (when the interfaces between users and services are handled).

- **Internal structure of CDTM IT / Internals** – The third group of factors originates from inside the IT taskforce and its organization as well as structure. This includes the organizational structure (sub teams, hierarchies, responsibilities), but also the mode of working in CDTM IT itself (method of work assignment, existent processes, documentation). From the perspective of a structured IT concept and strategy, factors stemming from this group usually constitute *unnecessary* dynamics and can be addressed by reorganization and by definition (and following, of course) of processes and procedures. There may be unchangeable factors, like the time students spend in the taskforce or the non-existence of fixed working IT staff but these do not only originate in CDTM IT so they must be accepted as a precondition and be dealt with accordingly. Of course, a concept cannot force the CDTM IT to reorganize and shackle students to the servers just as it cannot force the management team to hire a full-time administrator but there will be proposed improvements that are easy to implement if the necessary ”political motivation” can be mustered.

Factor	Preconditions	Perceptions	Internals
Missing Hierarchy and Managerial Flexibility	yes	no	no
Focus change each semester	yes	no	no
Innovative character of courses	yes	yes	no
Inconsiderate strategic changes	no	yes	no
Workload of TF students	yes	no	yes
Taskforce member throughput issues	yes	no	yes
No fixed IT staff	yes	no	yes

Table 1.1: Grouping of Factors for Dynamics

All the aforementioned factors together effectuate an exceedingly high level of dynamics in CDTM IT. The pieces of inline evaluation in the lists and the grouping given above make clear that the dynamics at CDTM do not come under the term ”chaos” but are rather a bundle of distinguished streams of driving changes, all having a reason and a direction, some even having a purpose. In this realization lies the basis for the assumption that the dynamics at CDTM IT can be tamed and are in fact manageable.

A number of the factors listed in the groups above can be addressed by a proper operation support concept. However, as has been hinted at there are factors the adverse effects of which cannot be lightened by measures available to the CDTM IT taskforce or IT management alone. These factors must rather be finally addressed by the CDTM staff organization and the CDTM community as a whole; in these cases, the IT taskforce can support the

improvements by providing tools or better interfaces to the users.

1.3 Requirements

The evident high level of dynamics creates a very special environment to work in and provides a unique background for creating an operation support concept. This uniqueness creates a set of requirements that are to be fulfilled by the concept itself while the novelty of the situation – using ITSM in small, dynamic environments – provides requirements on the meta-level. The latter concern not only the concept but also the view on the process of concept creation as well as the special properties of the concept as an ITSM entity.

1.3.1 Concept Features

The most widespread cause for failure of any concept, handbook or process in a real environment is a reluctance to accept and adopt. People often position themselves against management measures that are imposed onto them from above. This resistance can happen instinctively and even subconsciously, but usually it arises for a large number of conscious reasons that are well known to people dealing with such situations professionally. Reasons include for example the fear of losing employment because optimized processes need less people. Another reason stems from concerns about changes in competencies and responsibilities that can be regarded averse from a personal standpoint. If the affected people – let us call them ”future users” – have an influence on the development of a process or concept, this resistance can be reduced to a minimum. In this scenario, however, there are very few persons in the group of ”future users” (usually even none), because the students who work with the concept are mostly not at CDTM yet. Fortunately, seen from the new students' point of view, the concept is already in place and constitutes common practice; this eliminates the factor of a concept being forced onto them and lowers the requirement's dimension considerably, cutting away some sensitive aspects centered on individuals and dealing with personalities.

A big part of the following requirements stems from the fact that students usually are not in the IT taskforce for very long while they still constitute the major workforce. Other requirements are caused by the high level of engagement and the high workload that is all part of the scenario. All requirements have in common that they are generally related to the described high level of dynamics. The following is an itemization of the main feature-related requirements that will be checked after the creation of the concept.

Pushing the button – the aforementioned challenges notwithstanding, to be accepted into the daily work life any concept or handbook must do more than just ”be a good handbook” by covering the processes, the documentation and so on. It must also ”push the red button”, i.e. it must address, even promise to solve, the problems and challenges that the people using it are themselves facing. It must not be perceived as extra work and effort but it must be actually attractive to the user to be accepted. This can be achieved in a lot of ways,

sometimes it is a simple design question for the output (pretty, intuitive and quick-to-grasp) and in other situations it is crucial that processes can be adapted to changing situations quickly and easily (especially for process owners)

Low barrier of entry to usage – it must be very easy to just use part of the concept (ideally just one small process for one instance of usage) without having to read a lot of dry, boring matter like role descriptions or terminology definitions. To make this possible it is necessary to use a style and wording that is easy to understand for non-native speakers on the one hand, for people without deep a priori-knowledge on the other. In addition, the entities, roles and so on must be named in a very intuitive fashion so misunderstandings are next to impossible. A low barrier to single usage has mainly two advantages, the lesser one being that older students who return after a term abroad or who help out during a project can easily get up to date on changes in the necessary projects and can quickly get into areas unknown to them. The greater advantage is that new students and people not belonging to the IT taskforce can contribute work effort without needing to be taught and schooled much, especially if only work of an assembly-line character is required that needs only a low level of necessary expertise and that has no stability or security implications.

Lowering effort of entry into workforce – this requirement is already partly addressed by the ”low barrier” requirement above. There is more to this, though, just as the aforementioned is no subset of this point. The central issue aimed at in this item is found at a higher scope, namely the concept as a whole, than the first, which mainly applies to single usage items. Lowering the entry effort into the workforce is something that lets new students get productive a lot earlier in their time in CDTM IT. The concept should not only constitute something that needs to be read, learned and followed to the letter. It should also be something that introduces the new students to the system as well as to the old students by providing a kind of interactive phase-in

Story-telling character – again, there is a certain amount of overlap between this requirement and the previous two. The crucial point here is in the structural properties of the concept. When taken on its own and as a whole, the concept – or rather ”handbook” in this perspective – should be readable like a fiction book. What does that mean? A fiction book can be read front to back without having to skip forward for checking up on necessary information and without having to skip back for finding forgotten data. Ideally, the handbook is created in a way that ensures no forward dependencies and that chooses terms so intuitively that they need not be looked up after having been defined properly. This would also mean that the book is structured didactically, like a schoolbook, maybe having an introductory section explaining how to read it most effectively. Of course, making a concept into an interesting read is not fully possible but steps can be taken to get close

Low-effort maintenance – in this specific scenario and environment work and time are at a premium. This implies that the maintenance of the concept itself, also including adaptation work as response to environment changes, must be very easy and straightforward.

Much can be done in this respect if for example the role concept is designed to be flexible enough so even in case of big changes in the scenario it needs next to no change except new assignments of roles to people or groups. Not enabling easy adaptation and maintenance of the concept itself would result in a growing gap between reality and the concept, negating its very purpose. The next items will touch and address this challenge, too

Inclusion of concept maintenance – how to maintain the handbook constitutes a process in itself, so it is only logical to include this process inside the concept. This makes everyone who familiarizes themselves with the concept aware of the necessity of maintenance and the proper procedure thereof, creating the possibility of a controlled dynamic in the handbook and provoking questions e.g. about recursive properties. It needs to be seen how deeply recursive change processes will get during the creation of the concept

Extensibility – in an environment as highly dynamic as this one there will not only be changes to existing parts of the concept but there will be new processes, new systems, new tools. Consequently, easy extensibility of the existing handbook is mandatory. This can be achieved by providing templates for all entities, be it processes, checklists, or documents. It could also be possible to use paradigms found in object-oriented programming like inheritance, instantiation or implementation to make expanding the handbook easier.

Template-character of output – It is probable that this work can neither fully cover all areas of ITIL processes applicable at CDTM, nor solve all CDTM IT challenges, simply for reasons of time and space. For this reason, the output created in this work must have a certain template character on a large scale. In essence, it should be possible to minimize the effort needed for creation of handbook chapters and concept areas for issues not previously covered. This can be achieved by making the initial set of documents understandable and readable on the one hand, by giving meta-information on the other. It will be seen if it is prudent to incorporate this meta-information into the concept itself or if this should be a separate thing, only to be used in the event of a large-scale extension.

Accessibility – To be usable, all necessary information must be accessible ”instantly” and easily. This means that if someone needs for their work some information given in the concept, they must be able to access this information quickly from outside of CDTM as well as from the inside with no need for special software and without overdue complexity in authorization. The need for accessibility has a large influence on the choice of medium to be used for the concept.

Consistency in formal features – to enable a proper completion of the above requirements a consistency in the formal features of the concept is necessary. This does not imply a certain medium to be used, such as a wiki or a collection of OpenOffice documents, but it rather aims at a defined format for a process or task description. One must keep in mind

all the influence that other requirements exert here, as for example the requirement of extensibility that for optimal fulfillment would require a set of very generic forms to be simply filled out according to a process. A compromise in that respect would be some kind of templating character. If this requirement is handled effectively, most of the others should become a little less hard to address.

1.3.2 ITIL Applicability

A completely different viewpoint is needed when observing the concept creation itself, including its variables and the accompanying decisions. As has been said, the situation at CDTM is not one of the standard cases for ITIL applicability. While creating an operation support concept several activities help in shedding light on the question at hand. One is the task of chapter 5 that tries to map the CDTM requirements to ITSM/ITIL. If this step fails there is apparently no easy way of applying ITSM here and the created concept must rely on basic best practices and customized solutions. If the mapping succeeds then another activity comes into play. In reflecting on the decisions made during the creation of the handbook there is a chance of estimating the value of ITIL in environments as dynamic as this one. It will of course not be possible to give an exhaustive answer but it may be possible for this thesis to provide a certain set of tips, guidelines or estimations as to how much merit there is in implementing ITSM in small, dynamic environments.

1.4 Procedure

With motivation, scenario and requirements taken care of, the only task left to complete this introduction is to outline the further procedural model of this thesis. As figure 1.2 illustrates there will be a two-sided approach to creating a concept. Before embarking on the actual efforts, there is first chapter 2 introducing ITIL to round off the necessary preliminary information. The following chapter 3 describes and analyzes the status quo in the scenario, providing the basis for both of the approaches shown in the diagram. One approach, covered in chapter 4, is covering the classical approach to managing an IT organization, focusing on technology, i.e. the hardware, the software, the services and so on. This aspect forms the first part of the concept. The classical approach is then complemented by the second approach in chapter 5, that takes the organizational and process perspective into focus, describing the interconnections between CDTM and CDTM IT and applying an ITSM process approach to complete the concept.

Finally in chapter 6, a conclusion will be drawn, recapturing the requirements given above and analyzing if they have been addressed in the two concept approaches, thus wrapping up the whole procedure before giving an outlook on possible future possibilities and developments. The concept created in chapters 4 and 5 will be delivered to CDTM in the form of a handbook that is also included – in adapted form – in this document as Appendix A.

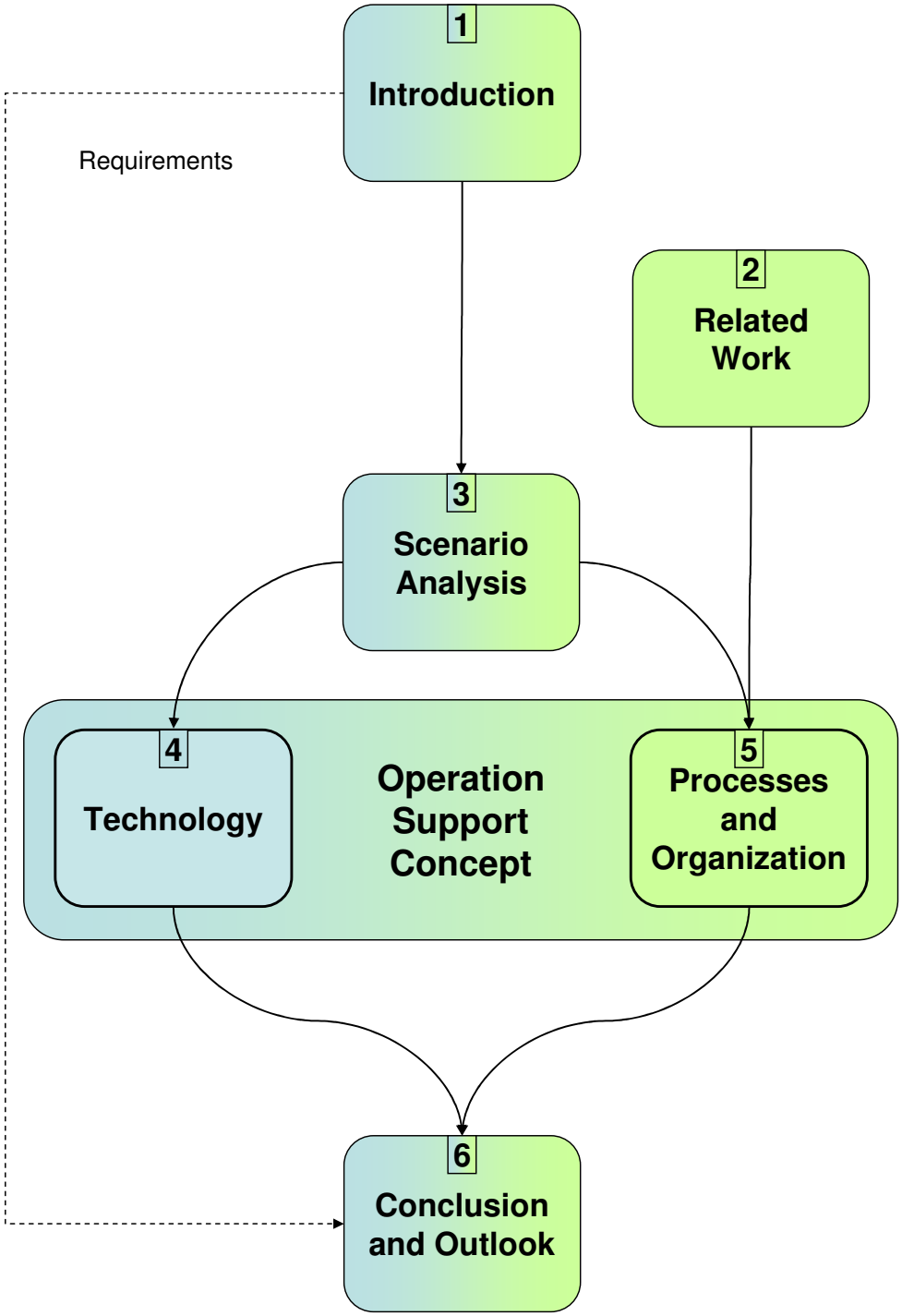

Figure 1.2: The Procedure Model of the Thesis

2 Related Work

Since this paper is bound to create an operation support concept, it is impossible not to touch on the management side of providing IT services. In current times, this in turn cannot be done without taking into account the widespread movement of ITSM, IT Service Management, in IT-providing businesses all over the globe. There are several approaches to ITSM to be found, and since the concept resulting from this document will include ITSM concepts, it is necessary to outline some of the general ideas used.

2.1 The IT Infrastructure Library

The framework for ITSM that is most widely used at the time, even having become a *de facto*-standard, is the IT Infrastructure Library, ITIL for short. As the name states, it is a set of books that was first developed in the late 1980's, consisting of ten core books and thirty complementary books and covering no only IT management, but also connected areas like business continuity management. In 2003, the IT Infrastructure Library has been reorganized and reengineered, and the core processes needed for delivering and supporting services have been pulled together into two books, called "Service Support" ([OGC 03b]) and "Service Delivery"([OGC 03a]), published by TSO for the Office of Government Commerce of the United Kingdom. These two publications are augmented by three more books, covering "The Business Perspective", "ICT Infrastructure Management", and "Application Management". These five areas of service management overlap and augment each other, and together with other, complementary books, they are structured as shown in figure 2.1.

ITIL is not a publication telling the IT services manager "how to do it". Rather, it is a public domain, best practice framework, giving information about what to keep in mind, and giving guidance as to how to go about implementing the core ITIL processes given in Service Support and Service Delivery as the mainstay of ITIL. These core processes described there include "Incident Management", "Problem Management", "Configuration Management", "Change Management", and "Release Management" in Service Support, "Service Level Management", "Financial Management for IT Services", "Capacity Management", "IT Service Continuity Management", and "Availability Management" in Service Delivery. These ten core processes all interconnect on many levels and augment each other to optimize the benefits created by ITSM implementation through ITIL. The publications are completed by surrounding information about recommended software tools, about a possible order of implementation, and a chapter about the relations between processes.

Since ITIL is aimed at all IT organizations and does not concern itself with the area of business supported or with the size of the IT organization, all the processes and information

Figure 2.1: Structure of the ITIL Guidance, taken from [Rudd 04]

given in these books is rather generalized and is seen by some readers as not explicit enough regarding the definition of processes, but this only fits the aim that ITIL has, providing the most widely applicable guidance to implementing IT service management with a quality approach.

2.2 ITIL Small Scale

Since the mainstream IT Infrastructure Library strives for such a wide applicability, it cannot address special needs of niche cases in IT service in its standard books. A special niche, however, is the area of small IT organizations. Every organization starts off small, and even small organizations can benefit greatly from implementing best practices in IT from the start. Additionally, and naturally, the number of small IT organizations in existence is considerably larger than the count of very large IT organizations. These facts prompted the creation and publication of ”ITIL Practices in small IT Units” in 1995, another book by the OGC, which was after the revamping of mainstream ITIL, the follow-up book was also updated and published under the title ”ITIL Small-scale implementation”.

As is stated in [OGC 06, p.1], the purpose of the book is ”to reacquaint IT organisations both

large and small with how the implementation of ITIL best practices can be scaled to meet the constraints facing almost any IT organisation today". It aims at explaining why and how smaller organizations are different, and at offering "ideas and techniques that might help smaller ITSM organisations to improve the quality of the service they deliver to their customers and users". Since all the ITIL processes are so closely interwoven, the book does not try to give help in leaving out some processes, but rather gives guidance at how to scale down all of ITIL to fit a small organization. In the structure shown in figure 2.1, the book covers the whole "bridge" dominating the center of the figure.

For reasons that can only be guessed at, there are very few publications to be found, scientific or commercial, that concern themselves with a small-scale application of ITIL or with the usage of "ITIL Small-scale implementation" in practice. Possible reasons are primarily the character of ITIL itself, and covering a set of guidance interpretations or the following of these is not necessarily of interest. On another perspective, small IT organizations are usually on high workload anyway, and taking it into their hands to implement ITSM along the ITIL Small-scale guidelines leaves no time to reflect or document the "meta-process" involved. Nevertheless, if ITIL Small-scale can be applied in this scenario, an interesting facet of the abovementioned niche will have been illustrated.

2.3 Others

Beside ITIL, there are a number of different frameworks that concern themselves with the management of IT services and with the connections between IT management and the business perspective of leading and controlling an organization. COBIT – Control Objectives for Information and related Technology – is a framework that takes the top-down approach, starting from a large-scale managerial perspective and focusing on "IT Governance" [Inst 05]. Furthermore, there is eTOM[1], originating from and focusing on the management of telecommunication infrastructures. ITIL is the only framework that focuses on processes to provide IT services while not regarding the business perspective as paramount to all matters, but still keeping it in mind. This makes ITIL able to be used in conjunction with the above, business-centered frameworks and its focus on provision of IT services makes it the framework of choice for this paper.

2.4 Summary

Now that the relevant frameworks have been introduced in a way that illustrates their importance for this document, the preliminary information about the general scenario and about the current efforts in business surrounding the topic is complete. The following chapters of this paper will describe and assess the scenario in detail, then improve on the technology aspect of the IT organization at CDTM and then, in chapter 5, an approach at improving on the organizational, the process-oriented, generally: the ITSM perspective will be taken.

[1] `http://www.tmforum.org/TechnicalPrograms/eTOM/1647/Home.html`

In the course of this, there will be an effort at implementing ITIL Small-scale in the current scenario, offering the abovementioned illustration of the niche of small *and extremely dynamic* organizations.

3 Scenario Analysis

For the creation of an operation support concept, it is necessary to have essential information about the scenario. This basic information must be collected in as much detail as necessary, but must not be analyzed at a resolution so high as to be overloaded and thus jeopardizing an unbiased outcome. This chapter devotes a section to an extensive, but not exhaustive, description of the system's status quo, aiming at familiarizing the reader with the currently existing IT environment to an extent that enables relating to the concept's creation and the motives for decisions made later. This description is then followed by an assessment of the situation, trying to evaluate system aspects with regard to interdependencies, criticality and importance of services and machines. Part of the assessment is also the estimation of value and impact of the organizational and process structure currently in place. The chapter is concluded by a summary that combines the other two sections in short form and attempts to plot a course for the concept creation and in some respect for CDTM IT.

3.1 Description of the Status Quo

This first part of the chapter describes the state of the IT organization during the beginning phase of work on this paper. Due to the highly dynamic environment and the changes introduced by the new IT lead, there is a certain level of uncertainty involved in fixing the point in time that this status quo relates to. The most accurate statement possible places this status quo around mid-2007.

3.1.1 Utility and Network Infrastructure

At CDTM, utilities like AC power, LAN, telephone connection etc. are provided by TUM and LRZ and are charged at a flat rate so there are no monetary concerns regarding e.g. power consumption. Environmental concerns are existent but will not be addressed here. In general, the provisioning of utilities to the offices and student working rooms is well proportioned even for extensive use of IT devices. Concerning the CDTM server room there are a number of facts to bear in mind while discussing and planning necessary changes in CDTM server infrastructure. The CDTM server room has never been planned or laid out as a server room but is rather an LRZ communications equipment room that the CDTM is allowed by courtesy of the LRZ to use as a server room. When this agreement was established, the CDTM had three servers in use that were sitting on one standard desk. By now, CDTM has a whole range of server hardware in operation inside this room; including not only the servers mentioned above but also an additional number of servers that were set

up for CDTM projects and for CDTM affiliates. By now, most of the room is filled by six full-height 19" racks that are stuffed with old machines; additional machines are placed on the floor along the wall. Several years of unhindered growth took place with increased use of AC power and increased heat generation only taken into account marginally. Availability of LAN outlets evidently poses no big problem in a time of cheaply and readily available multi-port mini-switches. The following paragraphs will discuss in turn each utility necessary for CDTM IT, mostly focused on the server room and only treating the rest of the offices if necessary.

Utilities Temperature control has become one of the biggest issues in CDTM IT, not only in summer but also during warmer winter weeks, with ambient server room temperature peaking between 35 and 40 degrees centigrade. Mostly due to the dedication of a small number of students, heat-induced service interruption only happened once, affecting one central service for a period of four hours. Ad-hoc measures taken by enterprising taskforce-members were the acquisition of a small mobile A/C unit of 900W cooling power and a jury-rigged thermal insulation of the window against sunlight and external heat. Additionally, some uncritical machines were moved out of the server room and into other locked rooms of CDTM in the hottest period of the year. Following a long and arduous discussion between the IT taskforce, the assistants and TUM facility services, the scientific directors at CDTM persuaded TUM facility services to install additional air conditioning units. This took place in late spring of 2006. Due to a preservation order in effect for the building, an efficient solution using fixed A/C units was not possible, so two mobile units of 2.1kW cooling power each were installed instead. These are venting their excess heat into the building's ventilation system, which strongly limits their cooling efficiency. Consequently, room temperature peaks still reach over 30 degrees centigrade, lowest measured values are at 22 degrees.

The other affected utility, namely AC power, in the CDTM server room is ample, although the limits of possible power consumption inside this one room can only be estimated due to there being at least three A/C circuits, each hooked up differently to the building's utility power. Some outlets are labeled "EDV[1]" and thus dedicated and of appropriate dimension for use with IT equipment; some are simply hooked up to the same circuit breaker as the ceiling light. The CDTM IT Taskforce has made an effort to distribute power consumption over all available outlets and until now, there was no overloading of circuits by CDTM. There are three UPS units in use, one of which is about 18 months old and in good service. The other two units were part of a donation by Siemens Business Services and are Compaq R3000-H units with battery packs produced in 1999 and 2001, so they are factually only used for surge-protection and buffering of very-short-time power outages, trusting in the high quality of utility power at TUM. A 90-second power outage on some outlets of the room in 2005 was buffered without any server failures. The total power consumption can only be guessed at, although one of the bigger servers was load-measured before installation and was found consuming 950 watts when under medium-to-heavy load.

The combined AC power/ temperature control situation, being one of the most critical stress

[1] Elektronische Datenverarbeitung - IT Accessories

factors in CDTM IT, will have considerable influence on the choice of possible change strategies.

Physical Network The physical part of the local area network at CDTM is a low-level configuration element that essentially never changes, excepting host additions and removals. Student laptops join and leave the network on a daily basis and are handled by DHCP inside the strategy. Still it is also an environment of mixed responsibilities and capabilities. We must differentiate here between the physical LAN infrastructure and the logical LAN organization concerning VLANs. Even though VLANs are actually a software feature they virtually (and from CDTM's perspective absolutely) separate LAN segments in just the same way as physical separation would do and thus they are covered here in the hardware overview. The logical network structure, including subnets and network security, will be covered in the following section.

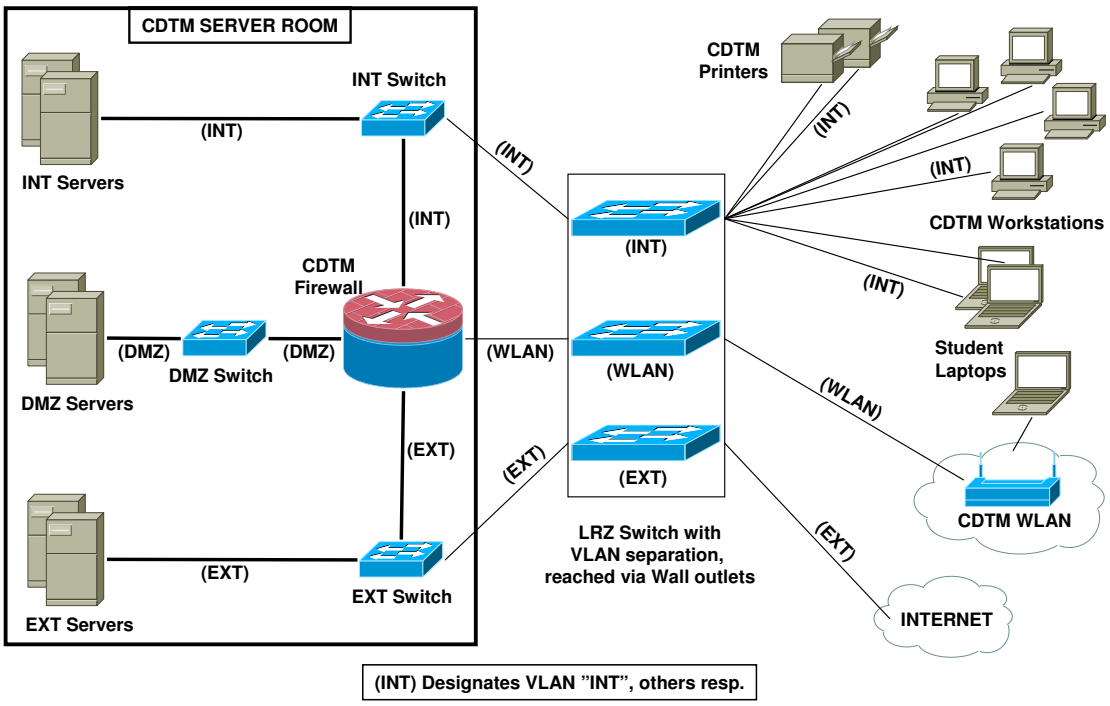

Figure 3.1: CDTM physical network diagram

The largest part of the physical network infrastructure (actually, the floor-wide "utility" part, i.e. the actual cables in walls and cable ducts) are maintained by the LRZ, as are the central floor switches. The LRZ-owned switches and patch panels for enabling and disabling LAN outlets in the CDTM rooms are located in a locked rack inside the common LRZ/CDTM server room and CDTM IT has no direct control over them. Changes in LAN outlet status and floor switch configuration must be applied for with the LRZ and are approved or denied complying with the regulations and capabilities applying to the LRZ network infrastructure. As figure 3.1 shows, the LRZ-provided CDTM network is physically a simple star-shaped network with the LRZ switches at the center and the LAN outlets as connection endpoints. It is important to note and keep in mind that the CDTM server room only has four standard

100Mbit/s office LAN outlets and no special role or priority in the LRZ-based LAN whatsoever. Of the four wall outlets three are each patched into one of the virtual LANs mentioned below, one is still unconnected. The wall outlets mark the boundary of the LRZ-managed part of the physical network. If counting hosts (PCs, servers, printers), CDTM IT has added between one and three rings of network devices to the star, depending on the room observed. Only in some of the assistants' offices and in the big seminar room there are devices that connect to a wall outlet directly, in all other rooms there are mini-switches to enlarge the number of available LAN endpoints. In the server room, three of the seven racks are fed by LAN lines cascading over two switches each.

CDTM has access to three distinct VLANs provided by LRZ, which are considered physically independent (see above). One is the "external" LRZ network, which is fully exposed to the outside world, except for very few ports blocked from the outside for the whole MWN. There are four connection endpoints to this VLAN in rooms openly available to CDTM members and visitors, all of which are visibly marked as "external" and "unsecured outside line". The only other wall outlet of this network is in the server room and connects to a mini-switch extending the VLAN to the two CDTM firewalls and to a number of servers that CDTM IT has no direct control over (privately owned, project-specific servers). Another VLAN represents the CDTM internal network, which is not routed outside of the CDTM floor and thus fully protected. Most wall outlets are patched into this network. The final LRZ-provided segment includes three LRZ-provided and LRZ-managed WLAN access points and terminates at the CDTM firewall, providing IEEE 802.11b shared wireless access inside the CDTM rooms. There is a LAN segment that is essentially invisible to LRZ, this being the CDTM DMZ, that follows security guidelines for demilitarized zones. It exists solely between the CDTM firewalls and has no VLAN tag or wall outlet assigned. The CDTM firewalls have one interface in each of these networks, controlling traffic and access between them.

3.1.2 Logical Network structure

Seen from the logical perspective, the CDTM network reflects the physical segments in its organization and then distinguishes further inside the internal network. The VLANs have the CDTM firewalls as a single point of connection, allowing for full IT task force control over network security and traffic between the networks. The CDTM firewall configuration designates four security zones, these being the LRZ outside network, the WLAN, the DMZ, and the internal network (each zone is described in turn below). There is only one way to reach the internal network directly from another zone, which is the OpenVPN service described in section 3.1.5 below.

There is a band of official, external IP addresses reserved by LRZ for CDTM, used for the externally available CDTM services and managed by ITTF. For virtual transparency of the DMZ, this band is also used for DMZ hosts (see below). There is a DHCP server running in the external VLAN, but this DHCP server provides IP addresses not belonging to CDTM and it is managed by the LRZ for a different institute in the MWN. This VLAN, however, contains the standard gateway for all outbound traffic, so in non-technical language this is simply "the internet" for CDTM.

The VLAN for the CDTM WLAN represents a ”walled garden” infrastructure[2] and has its own, private and non-routed IP band. The CDTM firewall acts as a DHCP server and gateway for clients that connect to the WLAN and then enables a secure VPN connection into the CDTM internal network for users in possession of OpenVPN credentials.

The CDTM DMZ is a high-security environment for CDTM services that must be available from the inside as well as from the outside of CDTM. Examples for such services include the CDTM web site, the intranet application, mailboxes and the revision control system. As mentioned above, the DMZ uses the same address band as the external network, with the firewalls accepting all packets for DMZ IP addresses and routing traffic accordingly. As is mandatory in these circumstances, the network security settings follow a deny-by-default strategy, with each combination of IP address, port and protocol needing a specific setting allowing traffic from a single security zone.

The internal CDTM network is home to student workstations, internal Windows servers, printers, students' laptops, staff machines and OpenVPN clients. No machine in this network is available directly from the outside; one single web page for requesting password resets is provided to the outside via a high-security reverse-proxy service inside the DMZ. All outbound traffic is masqueraded and filtered; the only outbound service forbidden is BitTorrent (a common file sharing application), which is fully throttled by default after its use was determined as cause for occasional excessive network load. This network is fully transparent for all members, acting as one single, switched LAN segment. The IP address band used in the internal network is theoretically divided into several subnets, a setting that is not yet enforced in the network setup, but which is held in reserve in case it becomes necessary.

The IP address mask used in the internal CDTM right now is /22, or 255.255.252.0, with the two last bits of the third octet being used for designating four non-enforced subnets. One of these subnets is used for servers, printers and network equipment; one is reserved for trusted clients like staff laptops, student workstations and privileged clients; the third subnet is the dynamic DHCP range, serving known as well as unknown clients; the last range is still reserved for further use. Each subnet is again strictly divided into ranges according to client location or trust level. The rules for these ranges are set down in the DHCP server configuration and documented in the IT wiki but are not enforced to keep administrative complexity on acceptable levels.

3.1.3 The Hardware

The main characteristic of the hardware situation at CDTM is the age of the hardware, some machines being 7 or more years old. Here, the servers and clients are described in turn, listing also the operating system they run on.

[2] A setup in which the users can only connect freely to other garden visitors but have to use a ”gate”, in this case the CDTM VPN service, to use services outside the garden, such as e.g. browsing the World Wide Web.

Servers

Over the years a rather large number of servers have accumulated considering the small size of CDTM as an institution. Why there is such a large number of servers will be explained in 3.2.2. Each machine hosts between one and ten services, depending on machine performance and service criticality. Some services were repeatedly moved between machines to take into account the poor performance of the existing, outdated machines as well as to eliminate and avoid SPOFs on the hardware side – mainly taking into account the lack of funding for new hardware or for service contracts. Table 3.1 lists all production servers at CDTM as of December 2006. The distribution of services onto these machines is discussed below in more detail.

Server Name	Age	Operating System	CPU	RAM	Package
ATCDTM1	n/a	W2K Srv.	VMWare	192M	VM
ATCDTMDC	5 yrs	W2K Srv.	Athlon-1400	512M	Tower-PC
Calvin	7 yrs	W2K Prof.	P-133	128M	Tower-PC
Copperfield	4 yrs	W2K3	2xP3-1100	2G	Tower-PC
Dumbledore	5 yrs	debian	2xP2-450	384M	ProLiant 1850R
Dumbo	1,5 yrs	W2K3	P4HT-3000	1G	19”’-Rackmount
Fang	5 yrs	debian(SE)	2xP2-400	384M	ProLiant 1850R
Fawkes	5 yrs	debian	2xP3-500	512M	ProLiant 1850R
Fluffy	4 yrs	debian(SE)	Duron-1200	512M	Tower-PC
Fuchur	5 yrs	debian(SE)	P2-450	512M	ProLiant 1850R
Gandalf	5 yrs	W2K3 Srv.	2xP3-500	512M	ProLiant 1850R
Harrypotter	1,5 yrs	W2K3 Srv.	Duron-1600	512M	Desktop-PC
Merlin	5 yrs	debian	4xP3-550	1.25G	ProLiant 5500R
Musicbox	4 yrs	WinXP Prof.	P4-1333	256M	Desktop-PC
Radagast	5 yrs	debian	2xP3-500	512M	ProLiant 5500R
Rincewind	5 yrs	debian	4xP3-550	1G	ProLiant 5500R
Saruman	n/a	W2K3 Srv.	VMWare	384M	VM
Smaug	7 yrs	debian(SE)	P2-400	256M	Tower-PC
Webtools	6 yrs	debian	P3-500	384M	Tower-PC
Whatsup	5 yrs	debian	P3-600	128M	Tower-PC

Table 3.1: List of Servers

Clients

The CDTM students have access to eight PCs in the CDTM offices. These PCs are mostly three- to four-year-old DELL Optiplex GX-150/GX-260 (mostly Pentium III, 256MB) running Microsoft Windows 2000, Microsoft Office XP and various client programs. Additionally there is a two-year-old DELL Inspiron 8600 Laptop (Centrino, 512MB) running Windows XP SP2 for presentations as well as one more DELL PC as described above for administrative aides. Finally, there are two four-year-old Siemens Celsius 400 (Pentium II, 256MB) Workstations running Ubuntu Linux 6.10.

3.1.4 The Software

A wide variety of software is in use at CDTM to support the institute's operations. For a long time there was no real policy concerning which software to use, neither for the assistants' personal laptops nor for student-available client PCs nor for servers. Assistants' laptops, although officially supplied by CDTM, have always been considered to be each assistant's personal matter as the personal need for special tools and local administrator rights combined with preference for certain software products would have made supporting the machines too big a task to handle.

CDTM workstations were not actively managed for a long time as they constitute a "donated lease" from the Leibniz-Rechenzentrum and came pre-installed with Windows 2000 Professional. There had been only one account on each machine so software was installed freely and – unfortunately – often unthinkingly. This only changed little with the set-up of a Microsoft Windows Domain with unprivileged user-accounts, as the administrative accounts were too widely known. In the last two years, efforts have been made by IT taskforce members to define a set of software products (and an installation procedure) for CDTM workstations. Focus of these efforts has been the selection of free and open source alternatives to expensive software products wherever possible, taking into account feature-richness, security and stability. On CDTM servers, there is a largely structured set of software in use. In addition, the frequency of change in software used on the servers is, as could be expected, much lower.

Server Software

On CDTM servers, there was historically a mix of operating systems (three Microsoft Windows Server versions, three Linux distributions including debian Linux 2.1/"slink" from 1999) in use that has been unified to Windows 2003 Enterprise Server and debian Linux 3.0/"sarge". By performing this unification, the taskforce has reduced the basic administrative effort to a minimum that is involved in keeping the servers supplied with current security patches. With the release of debian Linux 4.0/"etch" a soft migration of the servers to debian etch has been taken into consideration. The use of Windows Server System's Enterprise edition was decided "to be on the safe side" due to uncertainties regarding hardware support and operating system capabilities. A migration to the standard version of Microsoft Windows Server 2003 is in consideration, mainly due to licensing and monetary concerns. Patches and updates to the servers' operating system are applied manually by the IT taskforce as automatic updates potentially disrupt services not directly provided by the operating system [3].

The fact that the servers' software set is a lot more structured than one found on the clients stems mostly from the abovementioned efforts of senior IT taskforce members to unify the server landscape. Not to be underestimated are the effects of keeping the servers' administration passwords known to a much smaller group of people and of the higher uncertainty barrier for inexperienced "password-aware" users regarding installation of software

[3] for possible effects, see the historical case of Microsoft Windows NT 4 Service Pack 6a at `http://support.microsoft.com/kb/245678/EN-US/`

on Linux servers. The latter shows especially in the fact that on Windows Servers at CDTM – having the same user interface as an end-user's machine – there have been several unauthorized ad-hoc installations of unevaluated software by non-IT CDTM assistants resulting in security and stability issues, while Linux servers have been completely left alone.

Task/Service	Software on Linux	Software on Windows
Administrative Access	SSH	Terminal Server
DNS	bind	Active Directory
Monitoring	Munin Node	SNMP Agent
Print Service	CUPS	Windows Print Service
Web Server	Apache 2	IIS 6
Web Authentication	LDAPS	Windows native

Table 3.2: List of Generic Server Software

The server software products in use for certain generic tasks right now are listed in table 3.2. Additionally the servers run several software products that are listed by task/service in table 3.3 and table 3.4. These are separate tables for Linux and Windows to emphasize the service count and the type of service each OS is providing at CDTM. The choice of software was mostly influenced by the availability of pre-packaged software, i.e. packages included in the debian distribution and service components delivered with Windows itself. The reason for this lies in the necessary amount of maintenance work. Security patches for pre-packaged software are usually included in the update process of the OS, which had been a main reason for choosing debian as Linux distribution at CDTM. To illustrate this fact the "maintenance" column is included in the two tables ("manual" updates are usually due to used plug-ins due to customization done by CDTM).

Task/Service	Software Product	Maintenance
Authentication for other services	Active Directory LDAP	OS
File Server	Windows File Service	OS
Legacy Intranet	Lotus Domino	manual
Mail Distribution Lists	Lotus Domino	manual
User Store/Administration	Active Directory	OS

Table 3.3: List of Special Server Software (Windows)

Client Software

As mentioned above, the client machines that are available for CDTM students have historically been installed on Windows 2000 Professional. Upgrading these machines to Windows XP has been talked about frequently but has not been officially planned due to lack of resources (licenses as well as personnel). Some of the machines have been re-installed for varying reasons, some after being compromised, some due to hardware failures and some as a necessary maintenance action. Most of the machines by now have two parallel Windows

Task/Service	Software Product	Maintenance
Blog Aggregation	Planet	manual
Blogs	blosxom	OS
Blogs (mail-in)	mnemosyne	manual
Database Server	MySQL	OS
DHCP	dhcpd	OS
Firewall	iptables/pyroman	OS
Gallery	Gallery v2	manual
Intranet System	TEMPLE(on Tomcat)	manual
Monitoring	Nagios	OS
Mail Boxes (IMAPS)	Courier	OS
Mail Routing	Postfix	OS
Mail Virus Scan	ClamAV	OS
Mailing Lists	Enemies-of-Carlotta	manual
Project Management	Trac	OS
Reverse Proxying	Apache mod-proxy	OS
Spam Filtering	amavis-d	OS
Statistics Monitoring	Munin	OS
Version Control	SVN	OS
Video Surveillance	motion	OS
Virtualization	VMWare Server	manual
VPN	OpenVPN	manual
Web Application Server	Apache Tomcat	OS
Web Content Management	TYPO3	manual
Wiki	moinmoin	manual

Table 3.4: List of Special Server Software (Linux)

2000 systems installed, as an attempt to unify the clients' software set (see below). Updates and patches to the CDTM workstations are done on an ad-hoc basis by IT taskforce staff using the Windows Update web site. Automatic updates have been disabled after a faulty Microsoft patch disrupted administration of several core systems (see footnote regarding server software).

The two available Linux clients are PCs that were donated by Siemens at the end of a joint project. As the two machines did not match necessary requirements to run Windows 2000 or higher with acceptable performance, a taskforce member who is proficient in Linux administration installed Ubuntu Linux 5.10 on them and configured the systems for Kerberos authentication against the CDTM Active Directory. Available software on the Linux clients is limited to OpenOffice.org, Mozilla Firefox/Thunderbird and Lyx [4] on a standard gnome desktop. The Linux clients will not be further discussed in this section because they are not officially provided and supported but are rather seen as an as-is offer. In addition, their usage is limited to the small number of Linux-favoring people at CDTM who in this field can mostly support themselves.

[4] LaTeX authoring

The standard Windows clients at CDTM show very diverse patterns of installed software. In the first incarnation of clients, when the administrative passwords were widely known, a lot of third-party software was installed on the clients as needed. When reinstallation of some PCs became necessary the IT taskforce decided to partition the hard drives of the machines so that two Windows installations could be booted, one of them as a "standard CDTM domain client", the other as a "Workgroup installation for projects". The former would have a strict set of software available for all users that would be easy to maintain and update, the latter would have internet access, would not be controlled concerning software installations, but it would have no access whatsoever to the official Windows domain of CDTM. The partition containing the workgroup installation is saved as an image for reverting to a blank installation after finishing a project. This system of dividing the standard clients from the very flexibility-needing project- and programming-use of the PCs was only kept up for about one year, after which a project-leading assistant got hold of an administrative password and started installing software into several domain-specific installations. This effectively ended the use of the project installations, which have been lying idle for long enough to not warrant attention or support any more, so they were removed from most boot PC's menus.

Table 3.5 gives the (semi-)official standard software set that is found on every machine. Table 3.6 lists the special software products that are officially installed on single PCs and the reason for the installation. The host of other software on the client PCs at CDTM is neither official nor supported and will not be listed here since there is no piece of software in that category that is needed for CDTM operations.

Software	Version	Category
Adobe Reader	5.0/6.0	PDF viewing
ConText	0.97	Text Editor
the GIMP	2.0	Image Editing
IrfanView	3.94	Image Viewing&Editing
Lyx	1.3.6	Tex authoring
Microsoft Office	XP(2002/10)	Office Software
Mozilla Firefox	1.0	Internet
Mozilla Thunderbird	1.0	Mail
UltimateZip	2.1	Zip
Spacemonger	1.4	administrative

Table 3.5: List of Generic Client Software

License Status

The question of licensing with regard to software is something that was always kept in mind by the IT task force and the official software provided by the ITTF is covered by licenses from various sources. Most OS licenses are supplied by the hardware manufacturer as OEM software. Exceptions are CDTM Windows servers, which are run on licenses from the "Microsoft Developer Network Academic Alliance" (MSDN/AA) program. The CDTM is not part of this program itself, but some assistants and many IT task force students are members

Software	Category	Reason for Installation
Adobe Acrobat	PDF Generation	administrative aide's use
Adobe Indesign	desktop publishing	administrative aide's use
Ahead Nero	CD writing	multi I/O PC
Dymo Labelwriter	Printing/Office	administrative aide's use
Eclipse	Software Development	course projects
Lotus Notes Client	Groupware	Legacy Administration
Microsoft Vistual Studio	Software Development	course projects
Pagemaker	desktop publishing	administrative aide's use
Ulead Video Studio	Video Editing	periphery PC

Table 3.6: List of Special Client Software

of institutes that take part in MSDN/AA and these persons provided the academic licenses. Since these licenses cover academic use and only exempt commercial use, the use of these licenses at CDTM is considered legal. Nevertheless, obtaining sponsorship or funding for official, non-academic licenses for CDTM server should be considered, especially since these licenses officially expire when a student finishes his main course of studies and counting on a "newer" student to sponsor one of the software keys provided to him can turn out to be too close for comfort.

The single-installation software running on official workstations and provided by ITTF is covered by licenses owned by the assistants or by CDTM in general or by OEM licenses included in hardware purchases, such as CD writing software. The host of "renegade" program installations may or may not be covered by licenses and since that software is not supported or endorsed by ITTF, it will usually be removed from workstations on discovery if the software is not free and legitimacy of the installation is not proven.

Server software running on Windows servers is almost exclusively provided with the operating system and thus included in its license. All other products are either free or are provided by hardware manufacturers. The software deployed on Linux servers is all either included in the debian Linux distribution or available as open source, so licensing is effectively no concern in this area, especially since the debian project only includes fully free software in the distribution, even excluding Mozilla Firefox because of some small non-free parts.

3.1.5 Services

Following is an alphabetical listing describing the services currently provided and maintained at CDTM. Prioritization or criticality grading is deliberately not done here, but follows later in section 3.2.2 on page 58. For each service, the server machine hosting the service is named in brackets after the service name. Concluding each entry is an overview of the services' complexity concerning the administrative effort needed, the workload put on the IT taskforce (in terms of time) and the requirements with regard to hardware resources.

Active Directory [Gandalf] In this context, ”the Active Directory” is a synonym for CDTM’s Windows Active Directory domain setup and for authentication at CDTM. There always has been a Windows domain in use at CDTM. Starting with Windows NT 4.0 and a small set of non-personalized logins the system was first upgraded to Windows 2000 Active Directory with personalized workstation logon. In the most recent incarnation there is a fully Active Directory-integrated domain served by a Windows 2003 Enterprise Server System, providing a dedicated DNS zone, LDAP single-login authentication, and roaming user profiles. This necessitates the administration of settings for roaming user profiles on workstations as well as settings for access to different printers and file shares, which are all managed in the Active Directory by a small subgroup of IT taskforce students.

The Active Directory at CDTM is not used for storing or managing users’ personal data (addresses, contact data and suchlike) because all personal data is held and managed in the MyCDTM system (see below). There is, however, usage of the ”department” field of the Active Directory user object as a filter for access to certain services, e.g. only users with ”wiki” in the department field are able to access the CDTM wiki website. Inside the Active Directory, there is a well-designed, rigidly followed structure of organizational units (OU). This structure enables the use of group policies for enforcing OU-specific settings such as logon scripts and password complexity rules. It separates Active Directory Administrators, Groups, CDTM staff, CDTM students, temporary accounts and Windows domain computers, each of which is again subdivided to provide a sensible and easy way of manipulating and administrating subsets of entities.

The ”realm” of the Active Directory concerning anything aside from authentication is the ”local Windows world at CDTM” only. Effectively this means that no services (excepting authentication to some services) depend or rely upon the Active Directory to function. To give an example, the DNS domain representing the internal Windows world at CDTM is only visible from inside the CDTM local area network so there is no external window of visibility on the Windows infrastructure at CDTM. Reversing the perspective, this dictates that no externally available service resides in the Windows infrastructure. This rule has been set up for several reasons, the foremost being security, but also to enable the widespread use of open source software without needing to check for compatibility with Microsoft standards. Especially some concerns regarding security through administrative diligence could not be allayed after evaluating a Windows-centered structure using a test bed installation with IIS as web server, SQL Server for databases and Exchange for mail routing and storage.

Concerning user authentication, which is the only feature of the Active Directory used outside the Windows environment, CDTM IT for a long time had been striving to achieve the functionality of a single logon (not single sign-on, though). At times, a single person had up to five different user name and password combinations, leading to a very high support load simply due to users’ confusion. With the availability of Windows Server 2003, the Windows LDAP-service interface became fully standard-compliant, enabling the use of Active Directory as a central LDAP authentication server. By now, the Active Directory’s LDAP service at CDTM is the central user authentication point, validating user logins and passwords for multiple web-based services. Due to several challenges inherent in using MS-LDAP over Windows-provided SSL, all authentication requests are secured by ”stunnel”, a tunneling service using OpenSSL encryption.

The administrative complexity of this service is low, especially with the Active Directory being administrated using the well-known Windows GUI. In addition, the effort that has already been put into planning and set-up of the structure lowers complexity. The configuration and set-up of stunnel is well documented and straightforward. The resource requirements for providing the basic Active Directory services are also very low. Running on the already described hardware of Gandalf (see table 3.1) there are no performance issues whatsoever; the current equipment is fully adequate despite its age (hardware failures notwithstanding).

Admin-SVN [Webtools] There is an SVN[5] service running on Webtools that contains a central version of text-based configuration data, safekeeping the configuration of several important Linux services. This data includes for example the DHCP, routing and firewall configuration files of Smaug and Fuchur, so the central firewall system can be restored with new machines without rebuilding configuration files from scratch. Authentication for this service is set up manually so that only ”certified” administrators can commit changes but all ITTF members can read the most recent versions of the files.

SVN is a debian package and thus has no need for manual updates; the load of SVN on the server itself is extremely low, using resources only during the extremely short intervals of actual use by an administrator.

Application Tool [Webtools] Students who apply for acceptance to CDTM do so using the CDTM application tool, a Java-based web application served by an Apache Tomcat service. This tool replaced an application on the legacy intranet system that was built using Lotus Domino. Now, it constitutes the only resource hog on the server it runs on, showing evidence of memory leaks and causing multiple Tomcat service-restarts a week in times of high load. A small company founded by CDTM students is building an add-on service for the application tool that will take a big part of the load off the server in the future, although there are some concerns regarding privacy and personal data of students collected and used by a third party.

The administrative complexity of the application tool itself is not a concern of the IT task force since it is internally managed by the ”recruiting ” task force and the assigned CA. The aberrant behavior and the bug fixes that are frequently submitted by the programmers on short notice create a highly complex and work-intensive support effort that is made more difficult by the total absence of documentation regarding the tool. The load put on the server, compared to the function of the tool, is extreme; memory consumption often exceeds the available hardware resources.

Blogs [Merlin] There is a small number of blogs at CDTM, none of them personal blogs but rather part community effort, part administrative information tool. One of the blogs is the CDTM kitchen blog that is authored by anonymous members and is used to remind users of the CDTM kitchen of proper behavior and conduct when using community resources. Two

[5] `http://subversion.tigris.org`, a replacement for CVS

other blogs are configured to receive their content via e-mail; one of them is used by the IT task force to keep each other up to date on configuration changes, the other receives error notifications from the monitoring systems and provides these via RSS to subscribing task force members.

There is next to no load put on the servers by the blogs, the engines they use are open source and included in debian Linux. The only contact that administrators have with these blogs is when a nonstandard mail produces a hiccup in the mail-in functionality of the two blogs filled by mail.

DHCP [Fuchur/Smaug] Clients at CDTM – including VPN clients, WLAN clients, and LAN clients – get their TCP/IP configuration via DHCP, the Dynamic Host Configuration Protocol. For serving configuration data, the task force has configured two servers, Smaug and Fuchur, to act as load balancing and failover solution. A failover solution was deemed necessary in an environment where every client and printer is configured via this protocol, since a crash of the DHCP server means the network is essentially dead after the timeout of DHCP leases. Some network configuration details have been mentioned in section 3.1.2, and DHCP is configured along these general configuration rules. The DHCP configuration is well structured and has been documented inside the configuration files for direct reference.

DHCP as a network service at CDTM produces next to no load on its servers, since traffic is very low in a setting like this, where the short-term turnover of clients is low. The administrative effort that is needed to maintain this service is limited to maintaining the small number of fixed addresses in case of removal, addition, or MAC-address[6] changes, happening only a few times a year.

DNS [Fuchur/Smaug/Gandalf/LRZ/ATCDTMDC] DNS as an important network service is provided by several machines at CDTM. The DHCP configuration configures clients to use the main CDTM DNS servers, Fuchur and Smaug, with the LRZ DNS servers as fallback solution. This gives CDTM IT first-line control over DNS while still keeping the clients able to work in case the DNS service on CDTM servers fail completely. Since there is a project underway to move most entries into the LRZ DNS servers, the two main DNS servers at CDTM primarily act as DNS caches (secondary servers). The only exception from this is Gandalf, which needs to be the authoritative DNS server for the Active Directory DNS zone, ”internal.cdtm.de”, to ensure proper functioning of the Windows domain. Student Workstations use Gandalf as DNS server to enable dynamic updates inside the domain. Still, DHCP clients do not need to contact the server directly, using Fuchur and Smaug instead via a delegation in the DNS data.

Managing the DNS entries – aside from the system maintenance that is, again, included in the machines upkeep – is done via an LRZ web site when changing entries in the zone cdtm.de and done via Windows GUI when managing internal.cdtm.de. Due to the included on-line help, this keeps administrative effort and needed expertise to a minimum. Except for

[6]MAC: Medium Access Control. The MAC address is an (ideally) unique identifier for every piece of Ethernet equipment

the delegation entry for the internal zone, the DNS server configuration has been unchanged for a long time, can be considered extremely stable and thus a no-effort service. Zone- and server-management together are a light or medium load for CDTM IT. DNS as a system component has (for decades) been constantly optimized in performance as well as security and can thus be considered a nominal-load task for a machine.

DMZ [Fuchur/Smaug] The DMZ's character and functionality have already been described in sections 3.1.2, so there is no need to go into detail here. The DMZ as a service is provided to CDTM people for secure placement of servers that need to be accessible from the outside without the hassle of configuring local firewalling.

The "server load" that the CDTM DMZ produces is evident in the CDTM firewalls as the one contact point to other zones. However, since routing and filtering is handled by the highly optimized Linux kernel including iptables, the load is negligible. The time and effort needed for maintenance and administration of the DMZ is much lower than would first be guessed, for a student wrote a tool (called "Pyroman", and now available as a debian package) to easily and securely configure iptables-based firewalls. This tool minimizes the effort needed to set up rules for newly connected DMZ hosts and additionally includes a fail-safe mechanism to prevent erroneous configuration. Summed up, the amount of work resulting from running the DMZ can be seen at medium level.

File [Dumbo] File service at CDTM is provided by a Windows server because the overwhelming majority of clients is running Windows, and other operating systems like Mac OS and Linux are able to access Windows file shares without problems. Furthermore, NTFS is one of the few file systems that enables direct access control down to file level using single entries for groups and users, while most stable Linux file systems only model access for user/group/everyone. The server offers some general shares for everyone (holding public data and media), for single users (the home drives), and for some smaller groups (office staff, management team and course-related groups). On most shares, access is controlled by share permissions instead of file permissions for ease of configuration (ruling out inheritance and so on). On the public data share, there are subfolders that have specific folder permissions but do not propagate these permissions to their contents; examples for such folders are the task force-specific folders as well as folders holding course content that is writeable by CAs and readable by everyone.

Administration of the file service is very easy with the well-known Windows GUI and the simple rules in place here. Allowing access to a specific share or folder usually only involves adding a user to an Active Directory group and having the user log off an on again to refresh their session. Consequently, administrative load is close to nonexistent. Regarding the hardware, the file server has enough storage capacity available even for the long term, and CPU as well as RAM are strong enough to master even strong usage peaks.

Firewall [Fuchur/Smaug] The firewalls' function has been described in some detail in sections 3.1.1 and 3.1.2; summed up, the CDTM firewalls are the central point of network routing and security at CDTM, separating and controlling four network zones and enabling

secure provision of services throughout CDTM and for external users. The hardware of the Firewalls is rather old and not covered by warranty, which is why there is a setup of two redundant firewalls, working in a failover configuration using ”heartbeat”, a standard Linux high-availability component. To take the level of security to the next level, the machines have been locked down using NSA SELinux[7], a step that was initiated by a very Linux-proficient IT member. Since SELinux has a higher administrative complexity, script-wrappers were created to encase SELinux actions in well-known command structures, thus enabling SELinux-unaware administrators to work with the system efficiently and securely. ”Pyroman”, another helper-tool created especially for this setup, has been described under the heading ”DMZ” above.

Workload is usually not created by the firewalls themselves, but rather by services depending on the firewalls. Still, the important, even critical role as a network security nerve center, combined with the other services running on these two machines (DNS, DHCP, Heartbeat), make regular system checks into a mandatory, regular task, and effort needed for the firewalls (additionally to work needed by dependant services) can be categorized as medium.

Gallery [Radagast] Currently underway is a project that replaces the public share’s folder structure that holds students’ pictures of CDTM events. The target of this migration is a web-based gallery system[8] that allows for authentication using the CDTM login and thus is securely available from inside and outside CDTM. In addition to students’ pictures, this system can hold other data provided by the assistants, such as CDTM’s marketing material and posters created for course teams in earlier semesters.

Administrative load is created only very occasionally by this system. Most security fixes that are provided for Gallery as software apply to public galleries without forced login. In this scenario, security updates can be performed less often, for example during normal OS-update cycles, especially since every action in the gallery is recorded and can be traced in case of a security breach. The load on the server is also normal for a dynamic, PHP-based website and can be considered nominal when using current hardware.

Intranet (TEMPLE) [Merlin] The current intranet system is a Java-based web application that was created in a long-term project, with two CDTM students leading 8-10 programmers from the computer science department of TUM. This project was established to replace the legacy intranet system running on CDTM’s Lotus Domino server (see below) for all things concerning the management of courses and operations and succeeded in doing so. The system contains student contact data, grades, course information, course schedule, and mail forwarding addresses. The mail server uses the systems database for live lookup of mail forwards, CDTM students and assistants use it for course organization and grading, while all CDTM people (including alumni) use the system as reference for addresses and phone numbers. There are evaluations afoot for selecting still another, ready-built system as a successor for this tool, since the assistants did not force the programmers to provide

[7] Security-Enhanced Linux, `http://www.nsa.gov/selinux`
[8] http://gallery.sourceforge.net

enough documentation to make a straightforward system extension possible (and thus the programmers did not do so), consequently exacerbating the creation of new features.

Administrative work concerning this system is limited to creating users and groups at the beginning of a new semester and to supporting users in case of problems. Most problems are simple usage issues or password resets and the remaining requests are usually security-relevant and can be managed by manually altering records in the underlying database. Updates to the system are very infrequent and introduced on an as-needed basis. Since the system is login-only and not public, there are few security concerns to be considered. The load on the server is minimal, even in times of heavy use, since the application was built using a web-application kick-start framework that by design optimizes performance while enhancing security[9].

KitchenCam [Whatsup] The Kitchen Cam has been installed after the CDTM kitchen had been messed up badly several times, with no one feeling responsible. The choice was either to lock the kitchen or to make sure the culprits could be identified. Since a sponsored IP camera was just freed up by a student project, some ITTF members installed the camera in the kitchen and installed motion capture software on the monitoring machine, complete with time-triggered cleanup and disk space savers. Access is limited to the office staff, so this setup complies with surveillance regulations. The system has proven its efficiency in identifying miscreants as well as created deterring effect simply by its presence.

The administrative effort of the kitchen cam is actually nonexistent, since the system was set up with automatic cleanup and intelligent crash-recovery especially to create no workload at all, and since access is restricted to very few people, i.e. few people can repair it, but also few people can break it. The machine load that is produced by the camera is rather low as long as there is no motion detected. Whenever motion is detected, however, the ”Whatsup” machine has to render a movie file from all captured frames and compress this file on the fly. This creates considerable load, starting with the beginning of the detected motion and sometimes continuing for several minutes after motion ceases.

Legacy Intranet [ATCDTMDC] The legacy intranet system, already been mentioned in the introduction, has been in place for over seven years now and it gave the CDTM Intranet its name, ”MyCDTM”, which is and will be used for every successor to the system. It is a suite of applications built to run on Lotus Domino and has been an integral component in running CDTM operations in the past. When TEMPLE was introduced, the system and machine were renamed to ”OldMy” to enable distinction. The OldMy system should actually have been retired for over two years now, the reason being on the one hand that IBM retired Lotus' academic licensing program on acquiring the company and this put the system into a legal gray area. On the other hand, TEMPLE as a replacement has already been in place for a time, replacing most of the functionality. The only central task that is still run on the Domino system is the routing of mails to distribution lists by using Domino groups, described below. This function is so deeply rooted inside CDTM processes that a shutdown of the system – or crash for that matter – at the current time would create a kind of chaos.

[9] http://appfuse.org

There have been large efforts on the ITTF side to migrate the functionality into the TEMPLE system that already has most needed capabilities, but all to no avail, since the management team did not decide on a definitive list of groups to migrate, however much pressed. When the mail group functionality is migrated, the system can be archived and shut down.

Mail [Fluffy/Fang/Radagast/ATCDTMDC] SMTP mail at CDTM is one of the central communication methods, and important information is almost exclusively communicated by e-mail. This is reflected in the number of existing sub-services that are related to mail. The sub-services are listed below, the load and effort induced is handled at the end of the list, even if almost all of these sub-services can be changed or retired singly. This is because at CDTM, e-mail is seen as a single service by students as well as staff.

- **Outbound SMTPS and Routing [Fluffy/Fang]** - Mails can be transferred freely inside the MWN and from the inside to the internet. However, often the destination servers perform various checks of connecting hosts against various rules for avoiding e-mail spam; many relaying servers especially check the DNS system for the IP address of the sending host. To enable CDTM users' client PCs (that do not have DNS entries) sending mails to the outside, the CDTM mail servers allow the sending of mails via SMTP from the inside of CDTM; from the outside sending is allowed only on SMTPS after authentication by the client. Allowing routing transparently from the inside can make the CDTM server be seen as an infected host if there is a spamming PC inside the CDTM network, but this risk is taken after due consideration of many involved factors.

- **Inbound SMTP and Forwarding [Fluffy/Fang]** - The MWN does not allow the connected institutions' mail server to be available from outside the MWN, the TCP port 25 – the standard SMTP port – is blocked by the LRZ firewalls. This is done for security and anti-spam reasons. There are a small number of departments, including the computer science departments of both universities, that are allowed to receive mails from the outside, but many restrictions apply when requesting such a privilege from LRZ. Receiving mails on the secured port 465 is allowed, though, since spammers usually shun the effort needed to use these servers effectively. For all non-privileged entities, the LRZ is providing big central mail gateways that act as receiving server to the outside, scanning the inbound messages for viruses and automatically relaying the messages to the internal mail servers of the receiving organization. To establish this setup without need for special routing rules on the mail gateways, a special setup of the world-wide DNS entries of type MX[10] is used.

  In this way, all mail for the internet domain "cdtm.de" is delivered to the CDTM mail servers, Fang and Fluffy. These servers handle all incoming mail differently according to recipient. For mailboxes, distribution lists, mailing lists (see below), and a small number of special addresses, the mails are simply rerouted. If the recipient address matches one of a number of patterns for user mail addresses (like "firstname"."lastname"@cdtm.de), then the user-specific external forwarding-address is looked up from the intranet database and the mail is routed to the user. This for-

[10] Mail Exchanger

warding system is in use for current students as well as alumni, staff and CDTM instructors.

- **Mailboxes [Radagast]** There are a small number of mailboxes available at CDTM that can be accessed using an IMAPS (secured IMAP) connection. This service is not open to all CDTM users for many reasons, including legal restrictions and workload issues. The existing mailboxes are for CDTM-specific use by some staff members on the one hand, for IT-specific use on the other. The service is not officially supported, being of low impact to CDTM in general.

- **Distribution Lists [ATCDTMDC]** - At CDTM, the extensive use of distribution lists, i.e. centrally managed lists of recipients reachable under a common e-mail address, dates back to the central role of the Lotus Domino system. Lotus Domino provides mailing ”groups” transparently and out of the box, including cascading of groups with elimination of loops as well as double transmits in case of multiple group membership. At this time, the feature of distribution lists is the only feature still in use on the legacy system, since no equally functioning solution has been found to move the sub-service to.

- **Mailing Lists [Fluffy/Fang]** - As opposed to distribution lists, mailing lists are by default not centrally managed but users can subscribe and unsubscribe to the lists. Additionally, often only members of the list may send messages to the list, discouraging the spamming of such lists. CDTM uses ”Enemies of Carlotta”[11](EOC) as a mailing list server, because for example Mailman and Majordomo as the most widespread systems create a very high administrative load, while EOC provides all the essential features including moderated and managed lists.

- **Spam filtering [Fluffy/Fang]** All mail received by the CDTM mail servers is filtered for spam automatically using the debian-package ”amavis-d”; messages suspected of being spam are tagged with ”[CDTM-Spamfilter]” in the subject-line. Since all mails that have distribution lists as recipient pass the central mail hub Fluffy/Fang twice, and would thus be tagged twice, the package has been customized by a student to not ”double-tag” messages.

The mail system as a whole has been set up on two load-balanced servers that also are configured to be each others failover system. The monitoring of these machines shows that their load seldom surpasses medium levels. In normal use, the administrative effort for the mail system is extremely low, especially because the system has been set up to run transparently, efficiently, and with only a minimum of administrative intervention. Support cases usually are limited to textual changes like forwarding addresses or renaming of users who got married recently. Distribution and mailing lists can be managed by CDTM staff, and mailboxes experience only light use. In summary, the mail system induces a low to medium administration effort, being designed and constructed efficiently, considering circumstances and history.

[11] `http://liw.iki.fi/liw/eoc`

Munin [Webtools] As one of the monitoring tools at CDTM, Munin records statistical data about the components of all connected systems. It is plug in oriented and thus can monitor many different features of a system. Munin creates a web page giving graphs for several intervals as well as statistical data like mean and extreme values. There is also a possibility of defining gauges to highlight systems visually that reach critical values in any category, so Munin not only functions as a monitoring tool, but also enables a long-term, proactive strategy through capacity management. Figure 3.2 shows the Munin graphs of memory usage, CPU usage and load[12] for the "Webtools" machine for the last year, nicely demonstrating this effect. In April 2007, Webtools was upgraded with a high amount of RAM and the CPU usage graph shows that at this time CPU usage for swapping memory ("iowait") dropped dramatically, as did the load factor as a good (inverse) indicator for machine responsiveness. Consequently, from a user's perspective Webtools has finally started running smoothly.

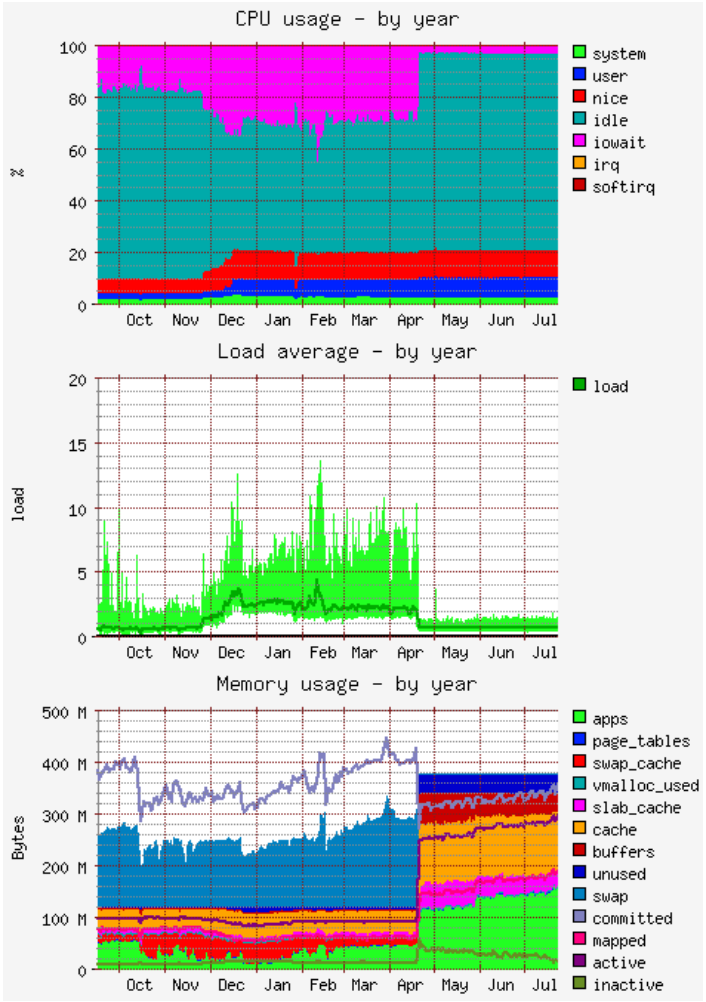

Figure 3.2: Munin Graphs of for Webtools' RAM, CPU and load by year

The amount of work created by Munin itself is not large, but the tasks involved can be complex. Action is only necessary when adding or removing a machine to Munin, but for

[12] meaning the number of processes waiting to be scheduled at time of measurement

performing an addition for example, the administrator in charge has to manually edit the Munin configuration files, install the debian package for a Munin ”client” on the machine to be monitored, adapt the firewall settings to allow Munin traffic, and finally test the setup. Since Webtools resides in the DMZ, the firewall settings must be changed for all new hosts due to the deny-by-default setup in the DMZ. The load of Munin put on the server is high, but periodic. Munin collects data and builds graphs regularly every 5 minutes, fully loading the CPU for about 30 seconds on each run. A more sophisticated, load-saving scenario could be set up, but that would double or triple not only the workload, but also the complexity of tasks.

MySQL [various servers] On all machines at CDTM, MySQL is used as database server without exceptions. The reason for this choice lies in the combination of readymade security fixes in form of debian updates on the one hand, and the ease of administration using e.g. phpMyAdmin[13] on the other, augmented by the various advantages of open source software. At this time, every machine providing services that depend on a relational database is running a local MySQL server that is only reachable from the machine itself. This was done to reduce complexity, to eliminate a database server as a single point of failure for many services, and to keep possible security breaches contained to as few services as possible.

Administrators usually do not interact with the database servers directly, because most applications only need an account on the database to perform all needed actions. The administrative load is kept to a minimum by having the debian project include security fixes and by managing the data itself using phpMyAdmin as well-known web interface with low complexity. The load on servers is usually very low, since CDTM has no large databases, so needed information is cached at most times, using up only memory resources.

Nagios [Whatsup] As the second monitoring tool for CDTM IT, Nagios[14] takes over the reactive monitoring part by alerting the IT task force by mail whenever services become unreachable. In addition to sending out notifications, Nagios provides a small web page for displaying the status of all monitored systems and services and records uptimes and downtimes of network services by regularly connecting on the assorted ports of a server (as opposed to Munin, which gathers internal data inside the target system and display it centrally). The version of Nagios in use at CDTM is 1.4, with the current version being 3.0, so Nagios at CDTM is very much outdated, but still serves its purpose. The Nagios status display at CDTM is not only provided via HTTP but has also been configured to show on a flat screen display that is mounted on the wall in the CDTM hallway and which is attached to the Whatsup machine directly. This provides a direct feedback to people at CDTM, eliminating client-side troubleshooting if a needed service is down.

Administrative tasks needed by Nagios follow the same pattern as the ones for Munin; as long as no machine is added or removed, work is not needed at all (security patches can again be disregarded for debian packages like Nagios). When a machine or a service is added to the monitoring, though, there is a high amount of straightforward, but still sophisticated

[13] `http://www.phpmyadmin.net`
[14] `http://www.nagios.org`

action involved, displaying need for qualified administrators. The load on the monitoring machine itself is very close to zero, since all work involved in the system for monitoring and recording service connectivity can be done using operating system-provided, highly efficient functions.

Planet [Merlin] Two years ago, a student installed an instance of "Planet"[15] on a CDTM server to aggregate some students' and alumni's blogs for creating a community page that keeps interested people informed about the CDTM people-space. Participation fluctuated between five and thirteen blogs and "Planet CDTM" has a small, but constant readership.

Planet itself is updated by debian package again, creating no effort there. Managing submissions is as easy as entering or removing a line in a configuration file, happening about three to four times a year, so administrative effort is minimal. The load on the server is so low as to be negligible, Planet's actions consisting of fetching RSS feeds from blogs and aggregating new entries into it's cache.

Print [Gandalf] For all Windows clients, be it student workstations, be it personal laptops, the print service is provided by Gandalf, the Active Directory domain controller. The printers themselves have been configured to allow access only from a small number of machines, namely the monitoring machines (Webtools/Whatsup), one staff laptop running Mac OS, and Gandalf as print server. Together with the single logon at CDTM, this enables full control over who can print and who can manage print jobs on the printers at CDTM. Additionally, a Windows Server provides the appropriate drivers for printers it shares, making printer connections a hassle-free commodity for most users.

Printing for Linux clients is provided by a CUPS[16] server on Whatsup, providing the same level of access to users but not being officially supported by the IT task force, since modern Linux distributions are able to connect to a Windows print server without problems. Table 3.7 lists the printers available at CDTM and who can access them.

Model	Allowed Users	Placement
HP LaserJet 2200	Everyone	Student study room
HP LaserJet 2300	Project group, CDTM staff	Project Office
HP LaserJet 2420	CDTM staff	CDTM hallway
HP Color LaserJet 4700	CDTM staff, ITTF	CDTM hallway
QMS Magicolor 2+	CDTM staff, selected users	CDTM hallway

Table 3.7: List of Available Printers

Material consumed by printers, such as paper and toner, is replaced by office staff and assistants. Still, the Nagios system monitors the printers via SNMP and shows a warning message on the display in the hallway if toner or paper is low. The effort that ITTF puts into printing at CDTM is small, including only infrequently necessary troubleshooting and

[15] `http://www.planetplanet.org`
[16] Common Unix Printing System

the basic work needed for setting up a new printer. The load factor created on Gandalf is fluctuating strongly, peaks being just before course sessions, when handouts need to be printed en masse. Still, the load is limited by the speed of the printers as a bottleneck, and since the number of printers connected to Gandalf is rather small, the only perceivable load effect happens if all printers are in use with jobs requiring high spooling effort.

PWChangeWeb [Saruman/VM] The only web service powered by Microsoft Internet Information Server is the password change toolbox that utilizes Active Server Pages and Visual Basic scripts to enable a change of users' central CDTM password via a secured web site. Additionally, IT taskforce members can reset users' passwords administratively, automatically sending the password to a given e-mail address. Another function enables the creation of users and organizational units from an uploaded tabular file. The site providing the service has been built by a former IT task force student and can easily be extended in functionality to support other Active-Directory-related tasks if resources become available.

The Windows Server System containing the web site is exclusive to that tool to lower implications of a security breach. This means that load on this system is essentially nonexistent, a fact that prompted the migration of the tool into a virtual machine, thus eliminating the need for extra hardware. Nevertheless, it has the same need for attention concerning updates as all the other Windows servers, even more so because it is the only Windows system reachable from the outside (via Webtools' reverse proxy described below). On the other hand, administrative attention is not necessary for the tool itself (as long as it is not extended), since it has been thoroughly tested and documented before deployment. The system as a whole ranks very low in administrative effort and – due to being a virtual machine – medium in server load.

ReverseProxy [Webtools] To secure the password change tool, Webtools as one of the DMZ servers was chosen to act as reverse proxy, accepting clients' requests for Saruman from the outside and then imitating them as a client connecting to Saruman directly. This ensures that no direct browser request reaches Saruman, disabling several security issues occurring on IIS as a server platform. Additionally, this set up allows for very restrictive firewall rules, Webtools being the only non-internal host able to access Saruman on the network level. After Webtools' reverse proxy functionality had been enabled, other uses for the service came up. By now, there are several more DMZ- and a few internal pages being made available in a highly secured way (https and login-only), with all of these pages being static and thus posing no security risks.

The load on Webtools itself is rather low, since there is no logic needed. The only work done is the rewriting and routing of network traffic and since Linux as an operating system is optimized for network tasks, there is no perceivable effect on performance of the server. The administrative effort used for the reverse proxy functionality itself is essentially included in Webtools' system maintenance, with extra effort only needed in case of new pages to be included.

Student Workstations The student workstations described in section 3.1.3 are available to students 24/7, as are all resources (not only regarding IT) at CDTM. Since their configuration regarding hardware as well as software has been described in the above sections, only a small recapitulation is needed here.

The two Linux PCs have been installed on low-grade, old Siemens hardware and are not officially supported and maintained. Linux-proficient IT students usually include the systems in the sessions for upgrading the Linux servers, but are not required doing so. The systems include single logon via Kerberos and provide software for basic tasks such as mail, web and document authoring.

The remaining workstations are running Windows 2000 Professional on medium-grade DELL hardware. Single logon is included natively in the CDTM Windows domain environment. The PCs provide all software necessary for CDTM student tasks, including the Microsoft Office suite, a WYSIWYG LaTeXeditor, different web browsers, media playing and authoring software, and miscellaneous tools. All software provided by ITTF is also supported and maintained. Software products not provided by the task force are not supported and are removed if illegal, insecure or inappropriate.

A comparatively high amount of administrative effort is needed for the workstations. The Linux workstations, being unsupported, only need attention in case of hardware failure and even then, priority is very low. The Windows PCs, however, require frequent updates (at least once a month) not only for the operating system, but also for various other proprietary software products, with automatic updates for Microsoft products being disabled for reasons explained above. This alone makes the student workstations one of the higher-load services provided by CDTM IT. Complexity of administration is rather low, though, because of the high familiarity of students with the Windows GUI. Hardware requirements and performance are included in the service and do not warrant special attention here.

SVN [Dumbledore] CDTM uses SVN (see Admin-SVN above) as protected repository for all data in need of versioning, including data from projects like TEMPLE (i.e. source code and documentation) as well as all kinds of data related to students' course projects, such as reports' LaTeX sources, the projects' program code and delivered presentations. A former ITTF member created some PHP scripts to be used offline for creating new repositories together with new Trac project spaces (see below); additional repositories are created manually when needed. Authentication of users is provided by Active Directory integration, while access is controlled locally through Apache configuration files and is configured via the mentioned PHP scripts.

SVN is a standard debian package, so security and functionality updates are provided transparently with patching of the OS. Creating a repository is a simple, well-documented task and deleting or archiving a repository is limited to simple file system operations. All tasks relating to data inside the repositories can be performed by users configured to access them, so ITTF is free of any obligations in that respect. As has been said for the Admin-SVN service, the load on the server is minimal concerning memory and CPU use and occurs only directly during usage, anyway. In opposition to that, there is the factor of disk space to care about. Since SVN is able to version binary content as well, and thus gives no warnings con-

cerning disk usage when binary files are committed, students and single CAs have started indiscriminately versioning binary files such as compiled programs and PDF documents. This has led to exceedingly high disk space usage by certain repositories on Dumbledore and thus to a stronger need for monitoring and administrative intervention, increasing the perceived load on ITTF.

Trac [Dumbledore] Trac[17] is an open sourced, web based project management tool written in Python, that includes a wiki-based group site, an SVN repository browser, an issue tracker, and a plug-in interface for enhancing functionality. Trac comes with a scriptable administrative command-line interface for automation, a feature that was important for the decision to use it for CDTM courses and projects. As has been mentioned in the SVN description above, a student used the command-line interface to enable script-based creation and administration of Trac projects in conjunction with their respective SVN repositories. These scripts take away the need for administrators to familiarize themselves with the administrative interfaces of SVN and Trac, considerably lowering the service's administration complexity.

The administrative effort for Trac is limited to using the admin-scripts and solving small incidents regarding access control. Load on the server is medium, Trac being essentially a dynamic web site built from scripts. The currently used, very old hardware is able to provide the system with acceptable performance.

VMWare [Rincewind] Since VMWare, Inc. released the free product "VMWare Server", efforts have been made to move services into virtual machines to save on hardware and thus to lower heat creation while optimizing machine usage. The first service to be run on a virtual machine was the domain controller of the legacy windows domain (its services were used for some time after the domain had been retired), the other productive service is the password change tool described above. VMWare was first evaluated on a Microsoft Windows host, but it was quickly found that every "Microsoft patch day" required a reboot of the host, thus including reboots of all virtual machines. After reinstalling the host using Linux, rebooting a guest became only necessary on large kernel updates on the host. Virtualization of hardware creates a host of opportunities for CDTM IT and will be an object of attention later on.

Administration of a VMWare host is neither more difficult nor more taxing than that of any other basic Linux host. Standard OS updates are provided by debian, updates of the VMWare system are provided on a regular basis and if they do not address any critical security issues, they can be installed at the administrator's leisure. The VMWare host's web interface provides information as well as quick startup and shutdown of machines without the need for designated client software, further easing administration from any machine able to reach the host. A VMWare host that is used for productively used guest machines should not have any additional service running, so load can be fully controlled by VMWare and distributed between the guests without "outside" interference in form of resource usage.

[17] `http://trac.edgewall.org`

Machine load for VMWare thus can be called ”unlimited”, or ”full machine”, even if the momentary load is not very high at any given time.

VPN [Fuchur/Smaug failover] For accessing internal services from the outside and from the wireless network at CDTM, there is a highly secure VPN service running on the firewalls. The software used for this is OpenVPN [18], chosen for ready availability of clients for all major operating systems as well as for the higher security compared to e.g. VPN over PPTP. Additionally, configuring selective routing of packets becomes possible, being an important issue because if Windows users connect via PPTP their default gateway becomes changed and all their traffic goes through CDTM, including traffic created by non-educational-use, posing a problem with LRZ policies. Monitoring showed that there are always a minimum number of current users, signifying a high acceptance of the service.

OpenVPN comes as a debian package and includes utilities for key creation and so on. Using these utilities, a student created CDTM-specific scripts, firstly to create keys for all Active-Directory users not currently in possession of a valid key, and secondly to provide a web site to distribute keys to users on successful CDTM login. This simplified the administration of the service by several orders of magnitude. The whole effort is actually limited to triggering the key-generation scripts each semester and to debugging faulty client installations, most frequently on Mac OS machines. The load on the server is low to medium, depending on the concurrent user count.

Web-Tools [Webtools] For easing the administration of the CDTM environment, some small web-based tools have been programmed by ITTF. These include a tool for managing the internal legacy-DNS entries still present on ATCDTM1, ATCDTMDC, Fuchur and Smaug, a tool for managing subscriptions to the mailing list service and the abovementioned tool for distributing OpenVPN keys. All of these tools are available on Webtools form the inside as well as the outside; access and authentication function along the same lines as they do for the Admin-SVN service.

Load created by these tools can be considered nonexistent. These tools are used only a small number of times each year and even during use are very ”resource-friendly”. Since their inception they have never needed maintenance and will only do so if the services accessed by each of them change, so the administrative effort is calculated into the affected services and here counts as ”none”.

Wiki [Merlin] When the IT taskforce installed a small wiki system on Webtools for evaluation purposes in spring of 2004, acceptance of the tool by the assistants was so high that the system quickly became a central productive tool for CDTM. The load created by the engine used at that time was so great that there were prompt efforts to move the content of the wiki into a different engine on a more potent server. By now, the wiki is used for a high percentage of course-relevant information and an additional module has been installed to display course sessions and deadlines in a calendar view to give easy access to the general

[18] `http://openvpn.net`

CDTM schedule. The wiki-engine used[19] is capable of running several distinct wiki webs in one installation. This feature was used to create the IT wiki, central information storage for the IT taskforce, and provided special security configurations were used to secure access to the CDTM wiki webs, so it became possible to store sensitive configuration information inside the IT wiki and in specially secured pages in the normal CDTM wiki.

With the used engine being another debian-provided package, the IT task force does not face any workload for updating or patching the wiki especially. Some actions inside the wiki are restricted to administrators, such as moving, deleting or renaming pages, because the link structure of a wiki can be severely influenced by these actions. Except for these actions, there is also no administrative effort involved, for the idea of a wiki is the managing of content by the user community. The load on the server has been minimized by running the wiki in a special mode (fastcgi), so even heavy use does not affect performance of the machine overmuch.

WLAN [LRZ-APs] Students with wireless-enabled laptops have the opportunity of connecting to the CDTM network via the WLAN as described towards the end of section 3.1.1. The access points are maintained and controlled by LRZ, but the IP configuration of clients is provided by CDTM DHCP servers and the VLAN holding the access points is one of the legal clients for the VPN service described above. Since the introduction of OpenVPN, the WEP encryption that had been the common denominator for all client systems was turned off, because the walled-garden philosophy of the CDTM WLAN made wireless encryption superfluous if already requiring full OpenVPN encryption for any CDTM-internal traffic.

CDTM administrators are exposed to the WLAN itself only when debugging OpenVPN connections of WLAN users. If there is a real problem with the WLAN itself, users are advised to use the amply available LAN cables and LRZ is informed about the problem. The load on CDTM systems is next to none since all services usable via WLAN are VPN and DHCP and with users still connecting, only via a different medium, these services would not have lower load without the WLAN.

WWW [Fawkes] For outward representation, CDTM uses mainly its web site. This site had been based on a custom-built content management system that rendered static html from submitted content. After acceptance into the ENB, a redesign of the site was started and some dynamic content management systems were evaluated, TYPO3 [20] making the grade, at that point in version 3. The redesign included the spin-off web sites of courses like ”Trend Seminar”, ”MPD”, and ”e-lab”, creating sub-designs based on the same template, effectively creating something like a corporate identity or style guide for CDTM. All of the work necessary for these actions was done by people in a sub-group of ITTF responsible for web sites.

After the launch of the new design, the ”Web and Publishing” taskforce was created and the responsible CA requested administration access for the TYPO3 installation to enable

[19] Python-based Moinmoin, `http://moinmoin.wikiwikiweb.de`
[20] `http://typo3.org`

installation of TYPO3 modules, plug ins and templates on short notice. The CA received this access on the condition that ITTF would deny responsibility for the TYPO3 system and only care for the Linux server underneath. The TYPO3 system was then moved to a dedicated server to minimize impact of TYPO3 configuration errors or security breaches.

Since TYPO3 is running on a dedicated machine, load is not an issue now. If the machine should be moved to e.g. a virtual machine, then load must be analyzed and resources may possibly need to be throttled or limited on the virtual host to disable resource hogging by TYPO3. Concerning disk space, the web site does have its issues, since every access is logged not only using the Apache web server log, but also inside the TYPO3 database; additional, identical logging is done using an external statistics provider configured using the TYPO3 CDTM template. The work needed to clean up log files from time to time is the only ITTF work needed in addition to the general maintenance of the Linux machine below TYPO3.

3.1.6 Existing Documentation

In all of the long lifetime of the CDTM IT infrastructure, there has never been a system handbook of any sort. The task to create such a handbook was often given to ITTF in the earlier stages of CDTM IT history[21], but caring for the system itself took up all the available time resources of ITTF people, since keeping all services running had a higher perceived priority than documenting it. Documentation of performed work, insofar as documentation was created, happened on the fly while performing tasks; documentation of facts such as strategies arrived at in discussions, e.g. for IP address bands, was written down after the respective team sessions. At that time, all documents thus created were stored in an open-for-all folder on the public share of the file server.

Much changed in respect of documentation culture with the introduction of the IT wiki, since it made available an easy, quick way do create structured documentation while performing the associated tasks. This is why the host of available documentation at CDTM has either been created in the IT wiki, or moved there after the setup of the wiki. The documentation base in the wiki is far from extensive and while not including everything necessary to understand the system, it still includes a large share of the information necessary to maintain the system. Added to that are meeting minutes, to-do-lists and organizational documentation. The wiki had been rather unstructured in the beginning, with structure only visible in its link-graph. After a short time, however, some students started to use ”folder separation by page name” (a singular feature of the used wiki engine) to introduce structure into the pages, while this task was still feasible regarding the number of pages and links[22]. The initially created structure is shown in figure 3.3 and it has been followed in general until now, with most of the exceptions created in the last few months.

The area called ”Documentation” is intended to be useable as a reference section for any current information about the system and the infrastructure. The meaning of documentation here is not encompassing contact information, meeting minutes, organizational matters, or

[21] For a description of stages, see section 1.2.2 in the introductory chapter
[22] Shortly thereafter, this approach was also adopted by the general CDTM wiki

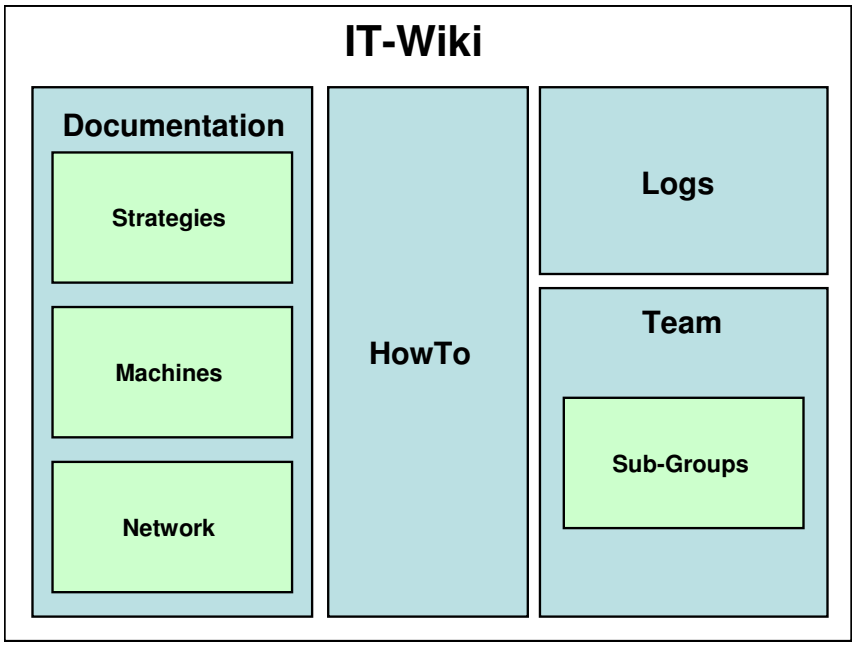

Figure 3.3: Structure of the IT Wiki

how-to descriptions for processes. It rather has a subfolder for strategies concerning IT, one for a template-based document about every existing machine, and one for information relating to the CDTM network, e.g. lists of known MAC addresses.

Another big area of the IT wiki is the ”HowTo” folder, which holds systematic instructions for a number of tasks that are not trivial and that occur at infrequent intervals, so there is a low possibility of someone with experience in this task being available. Tasks covered include for example the administrative process of the mail-in blogs, the setting up of LDAP authentication for an Apache web server and the configuration of server-based backup.

The final folders are reserved for logs, i.e. the step-by-step documentation of big activities such as migration of a service to a new machine, and for team pages, i.e. pages listing members of project teams as well as pages for other organizational information.

Aside from the information found in the wiki, there is little more documentation present concerning CDTM IT. There are some documents of varying age still in a folder on the public drive, but by now the folder has been secured and these documents are of low importance, containing work-in-progress and outdated data.

3.1.7 Distribution of Know-How

Since only a comparatively small amount of information has been fixed in written form, most of it must be there in the collective minds of the task force members. Incidentally, ”IT knowledge” has traditionally been an amorphous thing at CDTM, not to be found as

discreet units of information but rather as a quality of the task force in general, surviving the changes in personnel by older member's teaching and assimilation of knowledge by new members. Consequently, all the knowledge present – apart from the information described in the previous section – is in the heads of current members, and thus very volatile. With some students leaving who have been active in the task force for their full four-semester stay at CDTM, the entity "IT know-how at CDTM" can even be considered "endangered", if there are no high-level IT people joining the IT taskforce in the close future.

3.1.8 Organizational Structure

As has already been described in the introductory chapter, there is no strict, distinct hierarchy at CDTM in general. Since this paper is concerned with the IT task force as a unit, only the organization inside the ITTF and its interfaces to the rest of concerned entities will be discussed. In addition, it will be necessary to regard not only the current situation, but also the situation as it was before the change in IT lead, since there are still students who are shaped in their behavior and perspective by the previous stage in IT history. This twofold perspective will be necessary through the remaining subsections describing the status quo. Since these will handle the communication structure inside and the focal points concerning work of the task force, the organizational structure (as in "Org-Chart") is the only organizational aspect that is discussed here.

Traditionally, the assistant responsible for the IT task force did not assume a strict, hierarchical leader role but was rather "primus inter pares", leading strategy development and taking his share in the task force's workload. The IT CA represented the ITTF toward the CDTM staff and CDTM it toward LRZ and other external entities, filtering requests by staff as well as transparently applying top-down guidelines and decisions to the work of task force students. Even high-impact decisions were sometimes driven and even concluded by task force students, but still required "ratification" by the IT CA. In this way, students had a very high sense of responsibility and power, to be exerted as long as general strategy was followed and as long as the students were able to justify their decisions' reasons in a clear, comprehensible manner. It is hard to say if it was a prerogative or a consequence, but at that time, the IT task force outwardly displayed a sort of group consciousness that went along with a strong group-identity. Maybe because of this factor, many ex-task force CDTM alumni were still available as knowledge resource and in emergencies even as helping hands.

Concerning the task force's interfaces, a similar semi-hierarchical structure was used. With the IT CA being the contact point for assistants, few requests reached the students (i.e. the "workers") without being filtered and even these few were not executed without consulting the IT CA. External relationships, e.g. to the LRZ or other providers, were also handled in this way, so the students could work on their current tasks. The students regarded the IT taskforce as a single entity while still knowing which student was a member, thus contacting any task force member for any request or error in the secure knowledge that the issue would be handled as soon as possible.

Since the change in IT lead has occurred, there has been the introduction of a strong hierarchy and a big change in the role of IT CA. The new perception of the CA role in IT is

centered on managing the task force top-down, emphasizing absolute decision power on the CA side and direct task assignment on an individual basis instead of the previous system of students taking up tasks based on the aforementioned motivational factors. The hierarchy inside the task force is usually two-tiered (CA and students) but for bigger projects, the CA assigns project leaders who are held fully responsible for the project's progress and who have to report regularly. A ”hiwi” (assistant student worker) was recruited for the IT task-force to perform the basic administrative tasks, such as operating system updates, software maintenance and so on. Over the course of a few weeks, this person was given tasks like a normal CDTM student and even put in charge of one-person projects like the evaluation of a software system, leaving no time for the tasks originally designated for them. Additionally, the notion that students usually work for the task force only during their first semester was included in the management concept by adapting the communication structure (see below). All this results in a much higher perceived personal workload of task force members and thus in a tendency to refer any request to the CA as the only person able to assign resources.

Relations to people outside the ITTF are still mostly handled by the IT CA, but in some project cases, they fall into the responsibility of the assigned project lead. This means that all communication between project ”customer” and the task force is take care of by the assigned student while decisions are still authoritatively made by the CA. CDTM students have stopped contacting task force members and use the distribution list of the full task force instead. With the task force members feeling overloaded (see above), this often leads to every recipient waiting for someone else to take up the issue or rather for the CA to assign the issue to someone.

3.1.9 Communication Structure

One of the major changes introduced by the new IT CA was a complete change in communication structure inside the IT task force. In previous times, several distribution lists were used, centered on knowledge and responsibility areas such as ”Windows-Server”, ”Windows-Client”, ”Linux-Server”, and ”Network”. Additionally, there was a list named ”IT-Strategy” with members being all task force members with a high level of experience ”in the field”. In general, being included on one of these lists meant being member of a corresponding sub-group of ITTF. All of these sub-groups and distribution lists included the IT CA, who was in this way able to monitor internal communications, to stay informed in all areas, and to stop flame-wars in their conception, all at the same time. A list called ”IT-All” was used for broadcast-style communication inside the task force, including the information about general IT meetings, which happened regularly about every four weeks to keep everyone up to date. Since detailed discussions about small matters quickly become contra productive in large groups, each sub-group held its own meetings, presenting the results in the big jour fixes and getting the approval of the CA.

The above communication structure evolved with the large growth of the IT task force. Since member acquisition rates dropped a little in recent times and thus sub-group sizes were two to three members, the new IT lead retired the concept of sub-groups and instead created the list ”it-active”, including the first-semester students and a fraction of the other members of the former ”IT-All” group. The ”IT-Strategy” list and group were deemed ”self-appointed”

and deleted or disbanded, respectively. Students and alumni not included in the ”it-active” group have been directed by mail to put all their knowledge about CDTM IT matters into the IT wiki, and since then are only contacted on an as-needed basis. Regular IT meetings are now also held in a distinctly different fashion. Project leaders are asked to hold PowerPoint-presentations and some tasks are assigned, but no general status or information is communicated. Communication about all tasks is required to be point-to-point, i.e. between he CA and the task assignee, so essentially the only point of control and information is the IT CA.

3.1.10 Currently Applied Work-Processes

As already stated in section 3.1.6 above, there is no system handbook or written set of rules to abide by while taking part in CDTM IT work. There is, however, a mode of conduct present. In practice, every new student is shown by the older ITTF members what guidelines there are, and in this way, the proper behavior is conveyed even without being pinned down in written form. Additionally, there are a number of – sometimes small – tasks that, while not having been defined in strict processes, are still being done in the same fashion every time. Both the mode of conduct and the small processes are viewed in turn below, while the big CDTM processes are merely brushed, since they are discussed more thoroughly in chapter 5.

The ”mode of conduct” is a set of behavioral rules that are only ”lived” rather than defined. Until now, there has been no attempt at formulating these rules, but actually, they correspond to the manner in which ”sensible” administration is conducted. This means instinctively adhering to directives like the following:

- When changing critical systems, follow the four-eye principle.
- Do not change things you do not understand.
- Make sure you are always able to roll back your last changes quickly.
- Never change a functioning system without communicating changes to involved people beforehand.
- Always document large actions so they can be reviewed if needed.

In a group structure like the one existing before the organizational changes described above, the behavior just outlined was inherent in the task force community’s culture. In the new hierarchy, this cannot be taken for granted, so these rules need to be conveyed to the students in a different way to ensure the same stability and work quality.

For the small processes in place, there has been an implicit transfer of how they work by old and new members working on them jointly. With the creation of the IT wiki, the steps needed to fulfill some of these tasks have been written down in how-to form. This makes quick reference possible and enables a kind of quality control by people not taking part in these processes, since using a detached view makes them able to spot mistakes or glitches in the documents. As has been said during the description of the situation concerning doc-

umentation, only a small number of task descriptions was written down, centering on the tasks that occur infrequently to buffer loss of knowledge by older members leaving ITTF.

The big IT-related CDTM processes have a number of small, recurring, component tasks that get their share of coverage in the latter category. An example for this is the recurring CDTM-wide process of getting the new students going into their time at CDTM. There is a how-to document for one IT sub-task, which describes how to use the web based Active Directory Toolbox for creation of user accounts. That process is used for creating all person records for a full class of students including their organizational unit all in one go, and thus saves much effort while ensuring quality. Still, this does not prevent the big process from having its flaws in design or execution. In the above example, the management team more often than not neglects to inform the IT task force when all user data needed by IT is available, resulting in last minute action when – or usually after – the new students need their accounts and mail forwards for the first time. Additionally, the data delivered to the task force often includes erroneous datasets, especially concerning first and last names of students having a foreign origin, sometimes severely fouling up mail addresses as well as account names. This shows that the big CDTM processes that concern the IT taskforce in central ways must be either brought under control or need at least clean, controlled interfaced to ITTF.

3.1.11 Focal Points of CDTM IT

CDTM IT has certain targets or aims that are considered central. In a way, one could see this as the answer to the question ”what is the CDTM IT task force considered to be there for”. This perception changes over time and from different perspectives, but some issues are always seen as responsibilities of ITTF. Some of these are recurring at certain intervals, some of them are considered continuous. The continuous aims are similar to the ones that every group of people managing and maintaining an IT environment has and can be summed up under the header ”keep all users able to work”. They include the keeping alive of services and systems as well as supporting the users who have problems. One can dig deeper and consider monitoring, updating, proactive management as well as answering e-mails, teaching students in IT use and so on. These tasks are all included in the continuous focal points and they are generally handled by ITTF. The focal points representing recurring issues are more specific to the environment and include e.g. the need to prepare the environment for a new batch of students each semester, a process undefined until now and thus regularly producing stress loads. Many central points of CDTM IT as seen from a higher vantage point are described in chapter 5, since they can be mapped into the main CDTM processes and are of no big importance until then.

3.2 Assessment of the Situation

With the above status quo as a basis, an assessment of the current situation can now be attempted. In assessing the situation, this section will only name opportunities, challenges, or problems that are induced by the details of the situation described above. The attempt at

finding solutions to problems and giving recommendations about existent opportunities is made in the later chapters. This section only estimates the situation in terms of its stability, criticality and some other aspects relevant to IT management in this setting, grouping aspects of the above section in appropriate categories.

3.2.1 Hardware, Software and Licenses

In grouping the assessment of hardware, and software including licenses, the facets that concern contracts and are liable to produce cost are drawn together. In addition, these factors form the basis of the IT environment's functionality, since without the hardware and software there would be no service provision and probably no IT task force. First assessed will be the situation concerning client hardware, followed by server hardware and analyzing the software and license status finish up this category.

Client Hardware

The client hardware available at CDTM consists of the student workstations, the two Linux clients and one presentation laptop. All of the hardware in use is essentially sufficient for the tasks they are used for right now, running Windows 2000 as operating system. If the clients should be upgraded to Windows XP, only about half of them are able to make this switch without hardware upgrades, some would even need substantial, expensive upgrades. A possible switch to the most recent version of the Microsoft Office suite would aggravate this situation massively.

An upgrade of the existing hardware is quite difficult and expensive due to the proprietary character of DELL workstations. Additionally, the PCs at CDTM all have exceeded their respective warranty periods, so – coupled with the systems being proprietary –every single hardware failure can lead to a permanent loss of a system. This fact can turn hardware-upgrades into unnecessary investments.

Server Hardware

As is easily visible in table 3.1, only a very small part of the server hardware at CDTM can be called "current". The average age is about four and a half years, and all machines are outside any warranty and support. A high share of the servers is based on Compaq ProLiant professional server hardware. In case of a single hardware component failure (like a drive, memory bank or redundant CPU), these systems are still able to go on running and some components, such as the drives of a RAID array, can even be replaced by spare parts with the system still running. However, the few spare parts for the machines that are still available on the market are extremely expensive and the number of those items in CDTM storage is low, consisting of salvaged (read "not new") parts from similar machines. Since these servers are the more powerful at CDTM, they host the more critical services. Consequently, with no replacement machines available and scarcity of spare parts, it is not too bold to compare the

possibility of a bigger hardware failure (like the failure of two drives from a single hardware array at the same time) to the proverbial ”Sword of Damocles” for CDTM IT.

The remainder of the machines, i.e. the non-Compaq boxes, is almost exclusively composed of simple, custom-built client PCs in tower cases. These have never had service contracts and do not offer hardware monitoring capabilities. They are maintained only on demand, meaning on failure. A small number of critical machines, such as for example Smaug (the second firewall) and Fluffy (the mail server), do have more than one physical hard drive and are using a Linux-based software RAID for redundancy of the system disk. Since the standard hard drives used in these machines are cheaply available, there is less of a problem in these machines. The exception to the converted client PCs is Dumbo, the file server, having been custom-built out of mainly server grade components by a CDTM student. This machine is the only one that is largely hassle-free in terms of hardware maintenance, since its hardware provides management capabilities and all components are standardized and readily available.

Compounding the problems with the Compaq hardware named above is simply the count of servers and the implied output of heat. There is the simple relation of more machines meaning more heat created, but also this special situation shows an aspect of Moore’s law in a very hands-on way: today, the raw computing power present at CDTM can theoretically be provided by a single, big machine. This machine would use less than 5 percent of energy and thus create less than 5 percent of heat. Of course, it is not possible to run all services on one machine because computing power is rarely the only resource needed, but still the age of the machines and their power/heat/performance inefficiency is a big factor for the temperature issue in the CDTM server room.

In summary, the server hardware at CDTM is in desperate need of renewal and upgrading. Many issues and a lot of psychological stress can be subtracted from the scenario if something is done in this direction. Various approaches exist, some of them discussed and evaluated in the following chapters.

Software and Licenses

The description of the software situation in section 3.1.4 above already gave a rather detailed insight to the situation. The software setup on the servers is well structured and strongly controlled by the IT taskforce since the administrative passwords for servers have been separated from ones of the clients. The servers’ software situation is very stable and only changed after due consideration of need and of alternatives. The clients, as far as they under ITTF control, have certain standard software installed, but there are still many ”wild” installations of software not endorsed or supported by the task force. This creates an incalculable level of dynamics that should be brought under control, since interference between software products is possible and an unofficial piece of software interfering with the stability of critical standard software should be avoided to guarantee the availability of the CDTM student workstations.

Licensing of software has always been treated as important at CDTM, but was still done more on an as-needed basis, i.e. not proactively planned but rather spontaneously. There

are currently no really actual licensing issues excepting the grey zone of the Lotus Domino server that is being ramped down, but there have been close calls when a software package was installed that seemed ”available” but was already installed on some different machine with the connected license. For the future, a proper license management should be put in place, recording information like e.g. the machine a license is in use on. Naturally, this will produce workload but this workload exists in every properly managed IT environment and coping with it is imperative in avoiding legal issues. Since the only officially CDTM-registered Windows licenses are the ones the workstations and assistants' laptops run on, all other licenses being students' MSDN/AA licenses, an investment that is definitely necessary is the purchasing of CDTM-registered licenses. These are needed for the few remaining Windows clients used in projects and for all Windows Servers in use at CDTM. With the clients in need of an upgrade not only of Windows but also of some other software like Microsoft Office, an investment to this effect can be foreseen and should be included in CDTM's financial planning.

3.2.2 Services and Machines

Compared to the size of CDTM as an institution, there is a very large number of services in use. Regarding the number of services and compared to other IT environments, there is a disproportionately large number of servers being maintained at CDTM. The reasons for this are not obvious right away but can easily be deduced from the facts about hardware and services outlined above. With hardware being old, slow and out of warranty cycles the possibility of crashes is not to be underestimated. To counteract that by eliminating and avoiding SPOFs on the hardware side, some services were repeatedly moved between machines. Amplifying the motivation for service moves was the knowledge about the lack of funding for strong hardware or for service contracts. Finally, rearranging of services was called for when some new service was instantiated that was deemed too performance-hungry or too questionable concerning security to be run on the same machine as other critical services. In most of these cases, uncritical or low-load services were consolidated to free up hardware. The distribution of services on machines at the time is given in the service list 3.1.5. To assess the situation concerning the machine/service configuration, there will now be an analysis of the inter-service dependencies, followed by the then possible view on service criticalities. Combined with the service/machine correlation, this allows a statement about the criticality of machines and including the overview of hardware given before this concludes the service/machine state of affairs' evaluation.

Inter-Service Dependencies

Since the environment at CDTM has grown steadily over time, every new service has been set up with the features and integration possibilities of the then existing systems and services in mind. This may lead to a seamless user experience, but sometimes it implies a closer coupling of systems and thus introduces a higher interdependency-level between the services involved. Still, an aim was kept on low overall system complexity, so new dependencies to until then standalone services were kept to a minimum. However, one dependency was

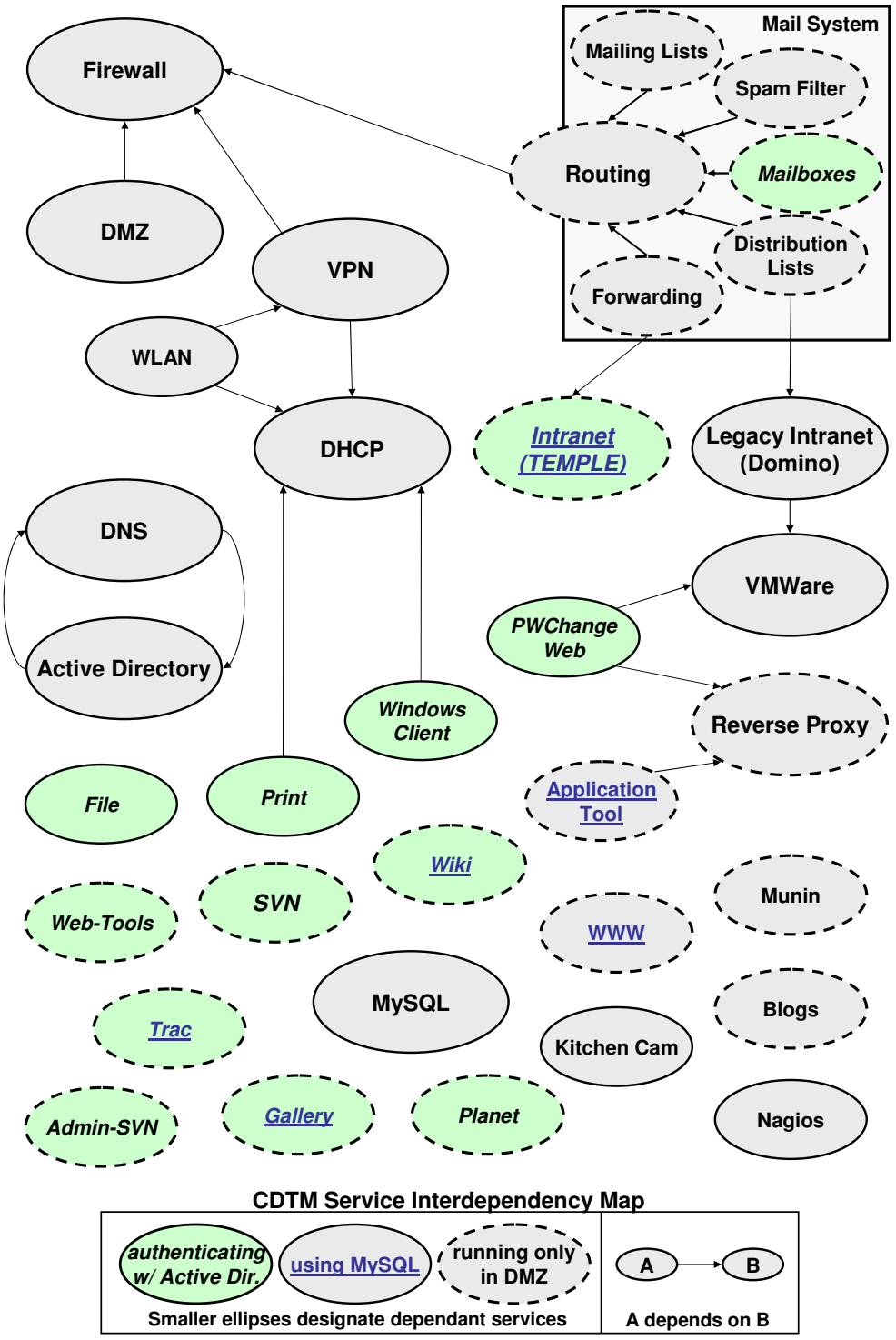

Figure 3.4: Service Interdependencies

deliberately introduced, this being the connection needed for authenticating users of various systems against the Active Directory via LDAP. Additionally, there are innate dependencies, resulting from the system layout and including all network-based dependencies between

systems and for example DHCP, DNS and the firewalls. Figure 3.4 (found at the end of this chapter) gives an illustration of dependencies between services at CDTM. The connections in the graph are labeled with additional information according to the type of dependency, since bindings can be optional (e.g. for look-up purposes) or mandatory (e.g. necessary for login).

Service Criticality

Every service can be labeled with a certain criticality level, stemming from mainly two components. The first component is the level of importance that the users, more specifically the CDTM management team, ascribe to the service and its availability. The listed interdependencies combine with the understanding of the IT task force to give "IT Perspective" as second component criticality, in which the business perspective takes the background and dependencies weigh much more. The higher of the two factors gives a measure of overall service criticality. A possible third component of the overall criticality level is the productivity-enhancing community-effect of services, but since it is not possible to put an exact criticality value on that, the term criticality in this context refers only to relevancy regarding the central operations of CDTM. The assistants' opinion was collected in personal

Service	Assistant	IT Perspective	Effective
Application Tool	extreme	low	extreme
Blogs	very low	medium	medium
File	high	medium	high
Gallery	low	low	low
Kitchen Cam	very low	low	low
Intranet	very high	very high	very high
Mail Routing	extreme	extreme	extreme
Mail Forwarding	extreme	high	extreme
Mailboxes	low	medium	medium
Mail Distribution Lists	extreme	medium	extreme
Mailing Lists	low	medium	medium
Planet	low	low	low
Print	very high	low	high
PWChangeWeb	very low	high	high
CDTM Worstations	medium	medium	medium
SVN	medium	low	medium
Trac	medium	low	medium
VPN	low	high	high
Wiki	very high	very high	very high
WLAN	low	low	low
WWW	extreme	low	extreme

Table 3.8: Criticalities of CDTM services, showing criticality attributed by assistant, criticality induced by service interdependencies, and resulting overall criticality

interviews and has been unfiltered and not been interpreted before use in table 3.8. Since

assistants fall into the ”user” category and the IT CA cannot be counted as a normal assistant, the back-end services that are transparent (or unknown) to the CAs are listed on their own in table 3.9. All the resulting criticalities given are apparent before the background of the accumulated information given above. Numerical values were avoided mainly because there is no possible mathematical formula to grasp the subjective values given by the different assistants. A value of ”extreme” designates essential services with next to no allowable downtime[23].

Service	Criticality		Service	Criticality
Active Directory	extreme		Mail Spam Filtering	low
Admin-SVN	high		Munin	medium
DHCP	very high		MySQL	extreme
DNS	extreme		Nagios	high
DMZ	extreme		Reverse Proxy	high
Firewall	extreme		VMWare	extreme
Legacy Intranet	very high		Web-Tools	low

Table 3.9: Criticalities of CDTM services unknown or transparent to assistants, criticality given by IT perspective only

Machine Criticality

Machine	Criticality		Machine	Criticality
ATCDTM1	very low		Gandalf	extreme
ATCDTMDC	extreme		Merlin	very high
Dumbledore	medium		Radagast	medium
Dumbo	high		Rincewind	extreme
Fang	extreme		Saruman	high
Fawkes	extreme		Smaug	extreme
Fluffy	extreme		Webtools	extreme
Fuchur	extreme		Whatsup	high

Table 3.10: Criticalities of Machines at CDTM

Now that services have been assigned an effective criticality, the distribution of services on servers transposes this information into a criticality evaluation of physical machines at CDTM. In this evaluation, one must count VMWare hosts as the sum of all virtual machines plus the host itself, since the host is a SPOF for all services contained therein. Table 3.10 alphabetically lists the machines with their criticalities and explicitly shows the SPOF-reducing service distribution that has been described above. Thirteen out of 16 machines have a criticality of ”high” or more, with essential services spread over all available machines. Two machines are used for consolidation of low to medium services and the only

[23] the only exception here is the Application Tool that is valued ”extreme” during application phases, but ”very low” during normal operations

”very low”-criticality machine is one that is being phased out in a current project. Recapitulating the fact that all machines aside from the file server are not only out of their warranty timeframe, but also over their MTBF, the situation of the CDTM IT environment concerning stability is put into a different light, whatever appearances may show.

3.2.3 Documentation and Processes

This category covers two of the debatably most important factors of any IT management scenario. Incidentally and interestingly, neither of these factors enjoys a high level of coverage in CDTM IT. Still, there is a certain level of documentation and there are processes that are not necessary defined or documented, but that are practiced.

Documentation

Even if the state of the documentation does reflect neither the size nor the complexity of the IT environment at CDTM, there still is a substantial amount of information to be found if one knows where to look. A significant part of knowledge is stored in the IT wiki, while much information is found inserted into in-line comments of configuration files. In spite of all the written documentation in place, there is still a very high percentage of system configuration information remaining undocumented in written form. The reason for this is the very rigidly defined structure of the systems, enabling experienced administrators to understand a system by simply browsing the configuration locations that are standard for the respective system. It further helps that there has been no customization of configuration locations and no obfuscating of settings, the latter of which is often inadvertently done by using e.g. compressed syntax of settings or overmuch custom scripting of standard processes. Nevertheless, this enables only *experienced* administrators to understand the system in this way, most inexperienced task force members find this situation, exasperating and annoying or simply elitist, even though it simply originates from of lack of time on the part of the members setting up the system.

In a setting like the present one, there is the question to be answered if the present documentation is valuable for the running of CDTM IT or if it would be better to discard the document stock and do a re-documentation of the system from scratch paired with a reevaluation of the system as a whole. The present documentation is very current in some areas, rather outdated in others. There is a definite need for a consolidation and re-sorting of the documented information, but in general, it is advisable to keep the existing knowledge. A re-evaluation of the system is actually in progress in parallel to the creation of this paper, so it is of no concern here.

Processes

While no properly defined processes in a strict ITSM sense exist in CDTM IT, many procedures have been documented and are followed that affect daily IT work at CDTM. IN addition, there are administration guidelines and rules that are followed implicitly and that

have been transferred through member generations by teaching and word-of-mouth. Nevertheless, since the organizational structure has changed and especially this kind of teaching and knowledge progression is inhibited now, a survival of this knowledge cannot be taken for granted. Additionally, the lack of processes seen when looking at the big picture is one of the big creators of dynamics in CDTM IT. The psychological stress as well as some resource shortages that originate from there could be well alleviated by the introduction of processes that are not only properly defined in their procedurals but also in their roles and responsibilities as well as their scheduling properties. The greater share of the existing procedural documentation and knowledge is of high value in the creation of such processes and must be kept intact even at high cost.

3.2.4 Organization and Communication

With the abovementioned changes in the organizational structure, a completely new setting has been created concerning motivation and responsibility. To cope with these changes, a very high CA-side effort regarding management of resources and people is needed that was implicitly taken care of by the whole task force before the change. Seeing the organizational structure of CDTM as a whole, a strong entrepreneurial, start-up character is evident. Thus, it seems unwise to introduce a rigidly fixed hierarchy in a sub-group of CDTM, especially after the previous group structure showed a high output of quality IT work and students showed a feeling of responsibility for the environment. If the rigid organizational structure is to be kept, then it must be supported by a strong model of communication, reporting and related measures. The big challenge that this setup has to face is the task of motivating the students to do work for CDTM in the face of losing the IT community spirit. Other Incentives need to be given, but it is hard to imagine what possibilities there are aside from monetary incentives that are ruled out by the missing budget.

The changes in communication inside CDTM IT have done their share in moving the task force away from being a unit towards becoming a group of single people executing specially assigned tasks. The fact that most tasks are assigned to single students by personal e-mail makes it very hard for students to know what is generally going on in the task force and to stay informed which projects are taking place. The introduction of centrally controlled communication can only be called counterproductive, since the students from older task force generations simply circumvented this by communicating directly, excluding the IT CA from their internal information flow and essentially breaking the model being imposed upon them. It is advisable to rethink the communication model inside the ITTF and to regain the trust and confidence of task force members it would be wise to include them and their knowledge in its design stage, ensuring students' identification with the communication groups.

3.2.5 Estimated Workload

In order to give recommendations and proposals for measures like downsizing and reorganization, it is necessary to estimate the actual load that the task force is currently facing.

Since projects are changing quickly and can always be changed and shifted, their load is not included in the estimation. The time needed for hardware maintenance can also not be estimated but only guessed at, and because there are no service contracts at all for the existing hardware this guess places the load between 2 and 40 hours per semester, with a strongly diminishing probability towards the higher loads. In contrast to the two component loads just named, it is rather easy to estimate the workload that is created by maintenance, by system updates and by some essential processes or procedures.

A survey has been conducted with the more experienced task force members as target group, and the results were used in a short-format overview of the CDTM IT in 2006. The information givrn in [Gies 06] places the general workload at 1-2 hours a week for maintenance and support plus 2-5 hours per semester for scheduled updates, processes, and projects. Weekly maintenance effort is evenly distributed (4:4:5:4) between clients, servers, infrastructure and user support, while the effort per semester occurs on special occasions (beginning of semester, start of special events and courses) or at longer intervals, e.g. monthly updates on a ”Microsoft patch-day”. This workload is actually very much lower than perceived by most persons, including the ones doing the actual work, but this has shown to stem from the big chunk of project-related workload that CDTM requests place on the IT task force. This load does not fall under the term system maintenance but rather under the heading of system adaptation and reconfiguration. The latter category can unfortunately also not be estimated since it fluctuates strongly. Extreme values have been close to none as well as up to 40 person-hours a week for all of the task force combined.

It can be safely assumed that the introduction of proper procedures, processes and communication structures, especially for the interfaces of CDTM IT and the rest of CDTM, reduces the project- and issue-related workload of CDMT IT to a minimum. Then, the maintenance part described above would be the only constant workload and more time becomes freed up for improving the IT environment and for optimizing stability and performance.

3.2.6 Combined Assessment

The view on the status quo illuminates a setting characterized not only by a high count of services and machines, but also by a high level of interconnectedness and complexity. In contrast, when combining the assessment of the categories above, one finds the environment to be more structured and standardized than would be expected in such a setting. There also is a higher level of stability than a superficial examination would suggest. However, both of these properties are not innate to the setup, but rather represent examples for the results of the tremendous amounts of effort put into the environment by previous generations of IT students. Again, the setting itself when seen from a purely factional point of view would not merit this kind of attention from unpaid students without any pressure put on them. Releasing the constructive energy needed to drive the efforts was apparently achieved through the strong group spirit and community structure inside the CDTM IT task force, inducing a feeling of responsibility in its members. The current mode of management for the ITTF, introduced with a change in IT leadership, inadvertently works against this community spirit in favor of a strict, hierarchical organization and thus creates a need for new ways of motivating students to put in effort for maintaining and improving the environment.

The infrastructural component of CDTM IT is most strongly formed by the chronic lack of budget that combines with a high business-criticality of many services to result in a large number of machines, reducing the impact of hardware failures on the old machines characterizing the hardware picture at CDTM. With most machines having a low load and thus not even approaching optimal efficiency, this setup creates a disproportionate amount of heat compared to a setting that consolidates services to run on a smaller number of servers that are more efficiently used. By investing in new hardware or in service contracts for the existing machines, it would be possible to alleviate the effects of that situation.

In addition to the focused perspective given by regarding the above factor categories on their own, there are effects of the interaction between areas to be seen. Some are obvious, even causally trivial effects like the number of machines directly influencing the workload needed for maintenance, but of far greater impact are hidden effects, since they are usually only perceived by their results. Only partly hidden in this scenario (they are easily uncovered at a closer look) are the connections between the various organizational aspects – meaning communication structure, mode of management and so on – and the system's stability. Stability here directly relates to the level of constant maintenance, in turn influenced by the combined effect of perceived workload-level and low motivation of the students performing the maintenance. Since the organizational changes have taken place not long ago, the ramifications only become visible only now and it is still possible to counteract them.

Hidden deeper in the interactions between factors is an effect that strongly influences many of the aspects and that could even create its own feedback loop with a disastrous outcome. The effect has its origin in the lack of defined processes and especially interfaces for ITTF, which combines with the high dynamics in the scenario to produce a disproportionate event-based workload. This event-based effort consists of one-time activities that are never identical but usually very similar and it represents the overwhelming share of person-hours put into CDTM IT, but is in itself neither calculated or planned for, nor assessed or documented. Because of the missing perception of the workload and the resulting ignorance in planning – and this is where the possible feedback loop comes in – IT students are assigned projects and tasks that fill their time even without the event-based work. The only measure preventing the loop is the implicit lowering of the assigned project's priority that is done by the students whenever dynamic events occur that require their time. Compounding the resource issue, the repetitiveness and similarity of these dynamically occurring one-time activities seldom comes into perspective because of the missing documentation. The result of the whole effect is that CDTM IT spends a huge amount of resources on activities that could be structured and standardized, if only the effort could be made of analyzing these actions and their surrounding factors. Nevertheless, since that would require resources that are bound by just these actions, there seems to be a vicious circle in place that only needs to be broken to greatly lower stress effects in CDTM IT.

3.3 Summary

The Scenario at CDTM IT is not at all typical for an organization that small. Concerning size and complexity, it is rather reminiscent of the IT of a small to medium business that

has evolved over time and looks back on quite a long history. As an entity managing IT, the IT task force is treated as a free provider of IT service and support. Internally it is a group of students doing honorary work, led by a staff member having managerial responsibility. These factors alone make the situation of CDTM IT a singular one. Added to that is a high level of dynamics that originates from special features of CDTM as an educational institution on the leading edge of technology and management, creating a setup to be managed that is probably unique in its requirements as well as its features.

Decisions made over time due to a large number of factors resulted in the current, rather oversized server landscape. Services were added to the portfolio frequently, only in the later stages being adjusted to the existing environment; before that, services were spawning very much unchecked. During consolidation phases, service interdependencies developed, especially through introducing a single logon scheme using the CDTM Active Directory. At present, there is a complex map of services in place. Most services run on outdated hardware that unfortunately has to be loaded inefficiently and so creates temperature issues during summer. Workstations are available and in need of much attention, since they are individually installed and maintained.

Traditionally, all CDTM people who are not part of the IT task force see the task force as an IT competence center, available for all questions and issues. CDTM staff gives requests for new services and systems just as they would to an external provider of free services without reflecting ITTF as being part of CDTM. Additionally, projects and courses create a highly dynamic load factor with a wildly fluctuating amount of needed support and administrative help.

With students being in the IT task force more or less by choice (students have to spend one term in a task force of their choice at CDTM), the task force is composed of people doing essentially honorary work for the CDTM community. Dedicated and motivated students have always been active for more than a semester, but with recent management changes, they have been actively phased out by the IT CA after their first term. Before the management change, there was a structure of topic-based sub-groups, while now there is a strictly top-down hierarchical structure with a point-to-point communication scheme centered on the CA.

Concerning IT management, the situation at CDTM is, and has always been, such that planning and managing the IT environment was – and could only be – done on the side and if resources permitted. In effect, only a very small part of the IT-related work is structured using processes, roles and clear definitions. The greater part of effort in the scenario as it is now is interrupt-driven, i.e. controlled by events, and only few tasks are procedurally defined. The only ameliorating factor is an effective culture of administrative diligence through work rules that was established in the past, but this is jeopardized now by current circumstance.

For many of the challenges and issues that have been found in the assessment, counteraction through a variety of measures is very feasible. This paper will strive in an attempt at that in the following chapters, first outlining measures that concern themselves with the infrastructure and the services at CDTM, concentrating on this classical focus of IT operations, in chapter 4. Following that is an exploration of adapting and implementing the ITIL

Small Scale framework introduced in the previous chapter, balancing the scales between the classical IT operations model and the ITSM perspective of chapter 5.

4 Concept Part I: The Technology Aspect

With the status quo given and the an assessment performed, it becomes obvious that there are several options available to CDTM IT's management for improving the quality and manageability of the CDTM IT infrastructure. These options can be separated logically into two complexes, here called the classical perspective and the ITSM perspective. The classical way of coping with the present challenges is to review the infrastructure, the services and the tools used, and then improve on all that. This is done in this chapter. The ITSM perspective, covered in chapter 5, first puts all these aspects into the background, and concentrates on the processes, on the organization, and on communication. When these features have been reviewed on the background of the infrastructure et al., the organization and the management processes can be optimized, enabling a higher effectiveness and transparency in the IT organization.

The classical aspects concerning the infrastructure, i.e. the infrastructure layout and the hardware, are covered at the beginning of this chapter, spanning sections 4.1 until 4.3. They are followed by the measures that are available concerning services, covered by sections 4.4 through 4.6. The aspect of tools is covered last, being treated in sections 4.7 and 4.8, closing with the description a tool family that bridges the gap between the classical and the ITSM view. Each measure that is described will be assigned a value at the end of the section describing it, with values not given numerically, but ranging from "impossible" to "mandatory" via the levels of "very low", "low ", "medium", "high", and "very high". In section 4.9 the results of this evaluation are compared and used to assess the basic effort needed to stabilize the scenario and then – if possible – to recommend a feasible combination of these options to be considered in creating the concept and in implementing it.

4.1 Infrastructure Layout

The layout of the CDTM infrastructure as it is right now – meaning the organization of the network, the placement of services in the different zones and the physical placement of servers, workstations and LAN outlets – was conceived by a group of ITTF students experienced in system administration and design and dedicated to improving CDTM IT. Now that the current setup has been in place for a few years, it is possible to improve on that layout with an aim on easing administration and improving stability while compounding the level of security for critical services.

4.1.1 Network Layout

At this time there are the three zones mentioned in 3.1.1 with a division of these zones by the CDTM firewalls. The DMZ still includes machines that do not host services critical to CDTM as well as student's machines used for personal projects. A number of personal and project machines are placed in the external network and are thus fully exposed to attacks from the outside. The placement of all these machines has been decided after due analysis but there is still a possibility of badly administrated project machines compromising the security of the DMZ. To remedy this situation, a **fourth zone** could be introduced that functions as a kind of "**safe playground**" (SPG for short) for temporary boxes and project machines. The DMZ then optimally only holds essential CDTM machines and services administrated and monitored by the ITTF[1]. The new zone would still be firewalled like the DMZ but due to the separation between DMZ and SPG, some features and actions are possible that would require significant effort to realize in the current setup. For the SPG, these features can include the following:

- Restrictions on opening ports to the outside would be loosened, needing only a simple request instead of justification for each port
- Filtering network traffic of the SPG by default creates a safe area for project boxes that are administrated by non-specialists, eliminating the security-checks needed for project-boxes in the DMZ now
- The SPG can get a different IP-address for masqueraded traffic to the outside. This ensures that essential CDTM services are still accessible even if the network provider blocks the SPG-address for conspicuous behavior
- In case of corruption inside the SPG it can easily be cut off (possibly even with a "red button") without affecting essential operations
- No need for UPS capacity for machines in this zone, reserving expensive UPS capacity for important machines and lowering cost of operation
- In case of A/C failure the machines of this zone can be shut down without further notice, taking away the need to select machines manually in case of error while evading a possible ban on personal or project boxes at CDTM
- Possibility of putting Windows machines in an externally reachable position without exposing them to attacks. Until now, running Windows inside the DMZ is strongly discouraged for security reasons; in the SPG, this restriction is unnecessary.
- By recommending local firewall software on SPG resident machines there is no need for caring about the integrity of single machines inside the SPG
- The SPG can be easily controlled concerning network traffic using QoS[2]-Parameters due to having it's own interface on the firewall. In the current setup, QoS would have to be configured by machine or by IP, being much too complex for effective use.

[1] exceptions could possibly be made for machines with a change rate of nigh zero that have been thoroughly tested and approved by the ITTF

[2] Quality of Service

Initially, all that is needed is an additional network interface on the firewall and the analogous duplication of the configuration present for the DMZ. The main effects on administrative work done by the IT Taskforce are all positive while introducing only a marginal amount of extra effort and complexity. The most important effects are:

- An extremely high stability concerning changes inside the DMZ. There should be only system updates and well-planned, controlled system changes in the DMZ
- No hassle any more with project machines. These boxes represent 85-95% of the administrative effort concerning the DMZ. Moving them to the SPG almost completely shifts the workload to the machine owner
- Less complexity of decision in case of infrastructure failures. The SPG need not be considered if power or A/C failure occurs, priority of CDTM essential services is ensured because every service in the DMZ can be considered important enough if not explicitly defined otherwise
- An effectively lower number of machines to care about. IN the current setup the ITTF still takes care of project boxes up to a certain extent. The amount of work put into these can now be reduced to consulting work for the owners of the machines
- For security reasons, there is no Active Directory-based authentication in the SPG, massively enhancing the security against password sniffing by infected project machines

This recommended change in the infrastructure layout is again an example of a high work/-gain ratio and should be considered and evaluated thoroughly by CDTM IT.

4.1.2 Client Landscape

In case of new workstations being obtained (a change that has been planned for some time), there are several **possibilities of using the old workstation hardware** which suffices for many tasks but should not be used for any critical purpose. At CDTM, machines with special software are often needed for students who need to program for projects or who must design and layout PR material. These tasks have traditionally been done on the student workstations, installing the software as needed, without taking care of licensing, redundant installations, disk space and so on. In step with the hardware and software management directives mentioned in the above sections, this behavior should cease completely. Still, these tasks must be done, so the teams who need the special software should be provided with the means of accessing and using it. The old workstation hardware can well be installed with Windows XP and the special software and then be put into the server room without Interface devices, only to be used via Remote Desktop client. This ensures only one person using the software at the same time while being easy to keep in sync with a proper software and release management. Extensive use by single persons or long idle times can be managed easily by Active Directory Group Policies. Another way of using the boxes is for providing project hardware that can be put into the SPG or used off-site. In any case, there is no need to strive for a high availability and ultimate stability of these machines, so the use of old hardware is not an issue.

A way of simplifying administration while enhancing security is the **introduction of administrative PCs**. There already is a secure Linux machine in place for the creation of VPN certificates and for accessing DMZ servers securely which can easily be extended and further secured to represent a single point of administration for the DMZ, which would be made very much easier by introduction of the SPG. In addition to this Linux-based machine, it is possible to place a remote-only Windows machine at CDTM that has all the necessary tools for the administration of the CDTM Windows environment and is restricted to Windows administrators only, in contrast to ITTF admin students using any CDTM student machine for administration.

The above recommendations only represent a subset of possible changes in infrastructure layout that can be applied to ease administration greatly and they have been chosen for being the most effective ones with regard to effort involved as well as for being the least probable to induce further high-impact changes. Belonging into this group and concerning the abovementioned ”physical placement of servers” is the topic of hardware virtualization, but the impact and applicability of this concept is such that it is discussed as an option in its own section below.

4.1.3 Value

Option	Benefit	Costs	Value
Safe Playground as network Zone	network and service security is enhanced and critical services can be encapsulated (more see above: 4.1.1)	new network hardware for firewalls, medium effort, high diligence needed	**high**
Using old workstation hardware for special software	more stability of standard workstations, low-priority software on separate machines	new hardware needed to get old workstations in the first place	**high**
Introduction of administrative PCs	Dedicated, secure administrative machines, less need for hardening workstations, no administrative software needed on workstations	Hardware must be freed or acquired	**high**
Overall value			**high**
Remark	remark: more feasible in the long term, given the shortage of resources		

Table 4.1: Value of infrastructure layout changes

The changes in the layout of the infrastructure that are described above, are each of high value with mostly low effort and cost involved. Table 4.1 summarizes the options with their values and costs, resulting in an overall value of ”high”, providing great benefits, but taking a high amount of planning for a successful implementation. Additionally, the availability of hardware is assumed for all measures, an assumption that is currently not fulfilled but that fulfillment must be aimed at in the future to ensure stability in any case.

4.2 Serviced Hardware

One of the biggest hassles in running a stable IT environment is the servicing and maintenance of hardware, especially if the hardware landscape is as heterogeneous as the one at CDTM. Maintaining hardware includes a whole host of vectors to be handled; there are spare parts to be ordered and stored, conditions of components to be monitored, new hardware must be planned and purchased and the list goes on. Usually, the hardware landscape of a small environment is rather easy to manage and has a bearable rate of change. Again, the dynamics at CDTM combined with the disproportionate size of the CDTM infrastructure elevate this task to a big factor in maintaining stability and in providing the necessary services efficiently. There are options available to lower the effort needed at CDTM (such as hardware virtualization, covered in subsection 4.4), but there always remains a certain minimum effort when hardware has either exceeded the time of its service contract or was built from single components and must be maintained by the ITTF itself.

4.2.1 Hardware Acquisition

To minimize the basic effort needed the recommendation must be made to CDTM to face the expenses and buy **new hardware with long-term service contracts** (or create service partnerships with e.g. the TUM-RBG) so that in case of a hardware failure there are guaranteed response times and service hours. This is of special importance if the current members of the ITTF do not include a person capable of performing proper servicing of diverse hardware. Until recently, such persons were always available but at present there is no taskforce member proficient enough in hardware-maintenance to service the more complex machines themselves and usually older ITTF-members are reactivated and asked for help in case of bigger failures. In the future, even low-impact hardware like the CDTM student workstations and student printers should be obtained in a way that minimizes effort later on. For workstations, this implies – aside from long-term hardware service contracts – the orientation along concepts created for bigger enterprises like the **Stable Image Platform** Program (SIPP) or even vPro[3] for enabling easy rollout of operating systems and software. Such concepts may be designed for environments of several thousand units but the essence of the abovementioned concepts is something that can be achieved by keeping them in mind while planning for and most of all when purchasing additional hardware.

4.2.2 Managed Clients

A possibility of absolutely minimizing the effort of maintenance on workstations would be procuring new hardware not only with a service contract, but with a **client management contract** as well. LRZ offers these services but the implications of using this service are manifold and disruptive to key features of CDTM IT. On LRZ-managed workstations users *must* use a user account provided by LRZ. Such a user account cannot be used to access the CDTM file server or printers, also the CDTM web services cannot be configured to

[3] see [Inte 07b] and [Inte 07a] for more information

authenticate against the LRZ Active Directory. Furthermore, CDTM has students who are not official LMU and TU students; these students do not have access to an LRZ user account. LRZ workstations must be placed in a specific network address range that is not available in the current CDTM configuration. The list goes on; so in the end, using LRZ-managed workstations would imply a full redesign of CDTM IT, forfeiting single login, jeopardizing the use of CDTM mailboxes, disrupting the network structure, forcing CDTM to buy LRZ file space and more. Finally and in any case, the cost of managed workstations is not covered by any budget at CDTM so this option should be disregarded fully.

4.2.3 Value

Option	Benefit	Costs	Value
Purchasing new server hardware with service contracts	severely lowering administrative complexity, taking hardware problems out of the equation	high monetary cost (must be faced), medium administrative effort	**mandatory**
Acquiring new workstations according to SIPP	possibility of automatic OS/software deployment, stable platform, relieving current, obsolete hardware, freeing up hardware for measures given in 4.1	medium monetary cost, some administrative effort for effective use	**high**
Acquiring LRZ-managed workstations	absolutely minimizing effort created by workstation administration	medium monetary cost, severe problems concerning accounts, no special software, very little control about setup	**impossible**
Overall value			**mandatory**
Remark	workstations: long term, servers: *as soon as possible*, managed workstations are disregarded from here on		

Table 4.2: Value of serviced hardware

If the situation concerning the hardware age of the servers currently running were any better, the value of this measure would be set to ”high”, but since there is currently *no* server with an active hardware service contract, and a vast majority of servers is very old, new hardware is mandatory for stabilizing the server infrastructure at CDTM.

4.3 Server Relocation

Figuratively speaking, temperature control is the ”bane” of the ITTF in the warmer months of the year. A course of action that quickly comes to mind is the relocation of the servers into a more suitable, properly air-conditioned room outside of CDTM, and this thought has been openly voiced by non-ITTF people at CDTM for some time. However, advocating this measure without proper forethought underestimates the measures that are necessary to be taken before the move of even a single server can take place. This section will list these measures, try to identify possible blocking conditions, and then weigh up the positive and negative effects.

4.3.1 Necessary Technical Measures

To relocate any CDTM server there are several technical topics to be taken into account. In the worst case, there is a very high administrative effort to put in before any relocation is possible, whereas in the best case relocation can be quite effortless for single machines. For relocation of CDTM servers specifically, the following list itemizes some essential infrastructural factors of the new location as well as the challenges to face before relocation can begin. Factors are:

- There must be at least the same level of availability concerning uninterrupted power supply, air-conditioning and network connectivity (network outlet availability as opposed to the bandwidth mentioned below) as there is at CDTM
- The network connection between CDTM and the new location must have the bandwidth necessary for the services running off-site to be available without a decrease in performance or quality
- Physical access to the machines must be possible on short notice in case of necessary hardware servicing either by ITTF members or – in case of hardware with a service contract – by external service technicians
- Access to the user interface of the machines (input devices and monitor) is advantageous, either via KVM-over-IP or physically.

Challenging tasks to be fulfilled:

- To relocate a machine, its hardware must be very stable and fail-safe (in terms of existing CDTM hardware, this reads as ”new”), the more so with rising distance to CDTM, ideally the hardware would be redundant. This is necessary because immediate access without any delay is seldom possible at remote sites not under CDTM control. Also, if a hardware failure interrupts service availability for a longer timespan than it would do at CDTM itself, relocation is actually counter-productive for stability and availability improvement
- If direct access to the hardware’s interface devices is not possible, the relocated machines need to be outfitted with remote-access hardware (known under names like

”Remote Lights-Out Management” because no physical presence in the server room is necessary and the lights stay out) to access the interface and the power supply of the machines

- The network connectivity must be set up according to the zones existing at CDTM, i.e. either the VLANs provided by LRZ must be extended to the new location or a user-transparent – and thus complex – setup of tunneling, encryption and routing must be not only put in place but also maintained later
- Special monitoring must be set up to account for the new factors in stability, such as the connection to the remote site and the momentary conditions of its environment. High import must be placed on the life-signs of the remote CDTM-hardware to enable proactive maintenance on a scheduled and communicated basis
- A communication structure must be set up so that CDTM IT is always informed about the conditions at the remote location, for example in case of planned maintenance windows or infrastructure failures. This is quite easily achieved if the remote location is an official collocation provider with service levels, following the normal provider/customer relationship. If the provision of space, power, and network at the new location is only an expression of goodwill – e.g. between institutes – then informing CDTM about every technical hiccup at their site might not come natural to the remote site’s staff, especially in case of an emergency threatening their own systems.

This list of items makes clear that relocation of CDTM machines is non-trivial, even though it only lists the necessities in the case of relocation as an option not being blocked by violation of a greater constraint extant in the situation.

4.3.2 Constraints

In addition to the challenges and necessities above, and inherent in this scenario, some constraints have a potential of being showstoppers for relocation. There are scenarios in which some of them are not effective or can be countered; in other scenarios, they culminate their effects. For each constraint, one or more scenarios will be used to describe the constraint’s effects.

- **Financing Hardware** - Without question, the biggest constraint is the nonexistence of a designated IT budget at CDTM. The effects of this on relocation are numerous, most importantly it affects one of the listed challenges, namely the choice of hardware to be relocated. There is currently no hardware at CDTM that would comply with the features needed, so new hardware would have to be purchased. For a long time, a one-time funding has been announced for CDTM IT but it remains to be seen if the funds are sufficient for the many points of need. After all, new servers are needed all round and possibly some of the new machines carry services that are eligible for relocation. This constraint is effective in all applicable scenarios, only excepting the very improbable event of obtaining a room that is very close to CDTM with CDTM staff having 24/7-access to it.

- **Financing New Room** - Another constraint induced by the factor described above is that there is neither money available to rent a different room nor for renting rack space in a collocation center. Even the LRZ charges for housing servers, being not expensive compared to outside firms but with prices still substantially exceeding CDTM IT spending thresholds. A possibility for CDTM to negate this constraint would be to try getting available rack space in the server room of an affiliated institute, thus eliminating the need to pay rent but introducing challenges mentioned above, such as access to the room and the building of communication structures.
- **LRZ Network Policy** - The physical network of CDTM is provided by the LRZ and is subject to fixed policies. Before relocating to a site that is not part of the MWN, it needs to be checked if it is allowed to host the specific service outside of LRZ jurisdiction. In addition, there are problems when relocating services that are only available CDTM-internally because the network is structured using VLAN tagging and it cannot be assumed that VLANs are extendable to outside CDTM. If considering tunneling as an option for extending the network, there may be harsh restrictions for enabling permanent tunnels to the outside world. The LRZ network policy is another constraint that cannot be circumvented in any scenario.
- **Security, Stability and Trust** - Almost all CDTM services make use of the central credentials of the users for single login purposes. This implies that any external entity housing CDTM servers must implicitly be trusted to honor the privacy and stability of CDTM's network. That includes not compromising the security by viewing or analyzing network traffic as well as not impeding the network's performance by treating other network components preferentially compared with CDTM's. If a certain level of professionalism cannot be expected due to the nature of the entity housing the machines, there is also the possibility of compromising CDTM network security by simply patching a wrong LAN outlet (for whatever reasons). This constraint can be countered in scenarios that include a high level of network separation, such as getting a whole, locked rack with separate LRZ network outlets. This would be possible in a room that belongs to an institute inside the MWN.
- **Privacy** - If a relocated machine provides a CDTM service that in any way includes the grading process or student's personal data, there are regulations to be followed that originate in the German privacy and educational laws. These laws prescribe a minimum level of privacy for students that *must* be enforced and violations are covered by harsh penalties, up to and including jail sentences. For example, no student's grades may be accessible by any person except the student and the appropriate educational staff. This fact implies that a very high level of trust must be given between CDTM and the owner of the off-site location if sensitive data is stored on an off-site server. There are essentially the same counter-measure possibilities as for the previous constraint.

For these constraints, being the most important ones, some scenarios are instantly and obviously impossible. Some other scenarios can effectively be used to relocate CDTM servers, mostly relying on housing inside the MWN. However, none of the possible scenarios eliminates the challenges listed at the beginning of this section, so there is still a high amount of workload when relocating servers.

4.3.3 Value

Option	Benefit	Costs	Value
Relocating servers to off-site server rooms	counteracting the server room temperature problem	extreme administrative effort, new hardware needed	**mandatory**
Overall value			**low**
Remark	An extremely high number of constraints apply. This option can be applied temporarily in single scenarios only		

Table 4.3: Value of server relocation

Relocating servers to rooms outside the CDTM network is a feasible option, but it is hindered by implying a high workload for each server and by needing a big amount of preparatory work. The main reason to relocate servers is the temperature-control issue in the CDTM server room, but given the fact that relocation needs new server hardware, these new machines can be used in other ways to minimize heat output. Examples include virtualization to reduce the number of physical, heat-producing machines (see above) on the one hand and simply replacing the old, ineffective machines by new, efficient ones on the other. The negative consequences of housing servers off-site are manifold and include the need for more monitoring and more security as well as the inclusion of another entity (such as a different institute) into the equation, along with a need to respect and possibly incorporate their policies and structures. The only detour to avoid this would be to pay for a collocation service and at CDTM that is out of the question. In effect, the value of this option must be placed at ”low” and would be very low but for the possibility of alleviating the time-criticality of moving services to virtualization hosts by temporarily setting up the virtualization hosts off-site until moving is finished, thus keeping the new heat-creating hosts out of the server room.

4.4 Virtualization

As described in chapter 3, one of the big challenges in CDTM IT is the general ”hardware issue”, including not only the age and low power of the machines, but also the excess heat generated in the scenario. A rather obvious way to better the situation would be to reduce the number of machines running at CDTM, and since VMWare Server as virtualization software is available free, the merit of moving to virtual hardware must be evaluated. Since the choice of operating system is done on a per-service basis, ”Xen” [4] as a linux-based virtualization solution is out of the question because it can not run Windows as a guest system and this places unbearable restrictions on decision making in this scenario.

There are already two servers at CDTM running VMWare, ”Rincewind” hosting two productive machines and ”Copperfield” as a temporary machine used for testing and evaluation.

[4] `http://xen.xensource.com/`

These machines are currently the only ones having sufficient performance for virtualization, and both of them cannot run more than two virtual machines simultaneously without noticeable changes in reaction time. Consequently, Virtualization can only be contemplated if new machines with a high CPU count and large amounts of system memory are acquired. Information about hardware service given in section 4.2 and the infrastructure layout changes outlined in 4.1 should both be taken into account when purchasing and placement of machines is planned.

To find the level of benefit offered by hardware virtualization, it is first necessary to identify the services that are viable for use in virtual machines. When a list of services is found, a concept about how to set up the virtualized machines can be outlined and then the new setup can be compared to the status quo in terms of value for CDTM IT.

4.4.1 VM-Ready Services

To select services that can be run in guest machines on a VMWare host, it is necessary to view a number of factors, most of which describe not a fixed feature of a system but rather behavioral aspects. These must be measured over a time span and analyzed accordingly to ensure a sensible decision. Therefore, an exhaustive list of services to be moved cannot be given in the scope of this thesis, but an informed estimation can be made. The following are the prime criteria among the information that needs to be collected before a decision can be made; ”behavioral” factors are listed first.

- **Disk Usage** - Putting a service onto an already running machine does not usually use up a large amount of disk space, at least if the service does not belong in the fields of storage or multimedia. When moving a service into its own virtual machine, however, there is a full instance of an operating system to be stored with each machine, which can amount to multiple gigabytes of data in case of a Windows 2003 Server System. Even for Linux-based guest systems, there is a minimum of 4GB of disk usage for a full guest machine to use it efficiently, i.e. to keep log files for a sensible time span and have a proper amount of swap space as well as necessary caches for regular tasks like system updates. In consequence, it may be prudent to consolidate services of low priority or of close relation into a single guest machine to save space.
- **CPU Usage/Thread Count** - Since in most situations many guest machines have to share a single CPU, the load put on the virtual CPU must be examined. Some services, like a web server for example, only use a single thread on their virtual CPU (and only during actual use at that). Other services, like the graphing component of Munin, regularly consume all available CPU power for short intervals. Other services, e.g. web applications like TEMPLE or the application tool, have a high frequency of maintenance work that is automatically done by the application server, preventing the machine from being swapped out and always consuming CPU power. Seeing these facts shows that it must be evaluated for each service if the CPU usage pattern fits a shared CPU, or if the service may prove to be a ”resource hog” that aggressively draws performance from other machines. If the host machines has a large number of CPUs (or CPU cores), the configuration of the guest machines must be made to fit the

services and the performance needed in the configuration scenario.

- **RAM Usage** - Most contemporary services are optimized for using as little RAM as is necessary for delivering the desired performance. On the other hand, most Operating Systems try to make use of every byte of RAM they can get, and performance increases strongly with the addition of more RAM (up to a point, which depends on the OS' flavor). Consequently, the same situation that has been described for disk space prevails for RAM: putting each service into its own machine uses up large amounts of the host systems memory. Because this is a known relationship, virtualization software vendors invest large efforts into counteracting that, mostly by clever techniques for swapping unused guest memory out of the memory and onto the hard disk. Since this swapping happens transparently for the guest machine, there is only impact on the guest's performance in the moment that the guest increases its internal amount of allocated memory, resulting in short spells of (sometimes strong) performance loss when working with a guest. If one allocates more memory to the guest machines than is physically available – a standard procedure in virtualization –, this can let the overall performance drop extremely in high-load situations of multiple guests, so RAM usage must also be measures statistically over a longer time to prevent nasty surprises after a move to virtual hardware.

- **LAN Usage** - A VMWare host does not make its network interfaces available to the virtual machines directly. The administrator creates virtual interfaces that either are available in the virtual system only or are mapped to physical adapters, using preconfigured parameters for several different usage scenarios. This implies that every network packet that needs to be delivered to a guest system traverses the physical host's adapter and its network stack; after that, it is routed to the virtual adapter, where the guest operating system picks it up and processes it again. This overhead in itself is of course again minimized by the host's virtualization drivers, but in case of a guest running services that work with a high network packet count and load the adverse effect in performance created by this procedure becomes more than measurable. In addition to the above, when having n virtual machines sharing a physical network interface, the effective bandwidth available to a single guest system is an n-th of the bandwidth available to the mapped adapter on the host. Depending on the network load situation before a possible virtualization of a service (in this scenario a fully switched 100Mbit/s connection for each machine), this may not be a stopping factor but it can severely influence the performance of multiple services during load peaks of a single one. The effect that LAN usage can have on a virtual machine host is often underestimated, so LAN traffic must be monitored on the source machines before a possible move.

- **Security** - The first aspect that does not represent behavior of a service that is evaluated for possible virtualization is the situation concerning security. With the current network security concept in place, it is not possible to mix machines belonging to different zones (internal, external, DMZ) on a single VMWare host. This is because the VMWare host is a single machine and a single machine must not be connected to multiple zones at the same time if it is not a firewall. During first talks about virtualization, this fact led to the idea of moving the firewalls into virtual machines, which

was quickly dropped due to security reasons because free virtualization software was not deemed trustworthy enough to rely on it for network security of the complete institution. On the same grounds, one must evaluate the security level and ”hardness” of a service scheduled for virtualization, for a single compromised service can potentially combine with a possible VMWare zero-day exploit to give full access to all virtual machines and thus to extremely critical data.

- **Stability** - When using a single hardware for multiple critical machines, there is an extremely high impact on all included services in case of a hardware failure. In essence, the VMWare host machine becomes a SPOF for a large number of services and thus it must be outfitted with redundant hardware and must be able to make use of all possible crash-prevention and crash-recovery mechanisms. Backups of virtual machines need to be planned and executed with an eye on network load, disk load and backup space. If multiple machines can be obtained, it may be necessary to cluster critical services like the Active Directory, or to make them highly available in another way and thus eliminate the VMWare host as a SPOF.
- **Updates** - Relying on a single hardware machine to run multiple guest machines has effects that are seldom though of beforehand. One big effect is a necessity of planned reboots of *all* guest machines in case of the host needing updates of either the virtualization software or updates of the underlying operating system that require a reboot. This rules out Windows as a host system right from the beginning, because in this scenario it is not at all feasible to shut down several critical services just because the OS-integrated internet browser on the host requires an update including a reboot. Still, even Linux – and VMWare server, too – need a reboot-requesting update time and again, so it is necessary to choose services for virtualization that enable planned downtimes.

The monitoring of CPU, RAM, Disk and LAN usage on CDTM machines has already been in place for a long time. Using Munin as a statistics monitoring tool, the task force evaluates the load of machines and tries to plan accordingly, as much as is possible in the scenario. A good example for the results of that planning are shown in the description of the Munin service in section 3.1.5. This makes a planning for virtualization possible with a much shorter ramp-up time, especially when the first step of using virtualization consists of moving full boxes into the virtual world instead of moving single services that are not monitored for their usage parameters right now.

Concerning security, the situation at CDTM shows two different pictures, one in the DMZ and one internally. The DMZ has only Linux machines that have been installed and configured to be as secure as possible, so a breach in one of these machines is extremely unlikely. On the internal front, there is a mix of Windows and Linux machines, so the situation looks rather more complicated, but since the internal network is very strongly protected by two firewalls, and since there has never been a security breach in the internal network, the whole subject resolves into an also rather easy situation. Stability must be decided on a service-by-service basis and the only ”CDTM-wide” statement that can be given about that now is that when moving whole machines, the backup is taken care of by each machine itself and the amount of data backed up is very low, thanks to incremental backups sent to the LRZ backup robots. If multiple host machines are available, the criterion regarding reboots-on-

update can to some extent incorporated into a scheme of grouping services onto VMWare hosts. Groups of services that represent a dependency chain or one important service and multiple services depending on it can be put together on a host, thus making sure that the dependant services are restarted when the service they depend on is down and they could not be used anyway.

The analysis concerning service selection must itself be done by the persons working on virtualization, because not only is it simply out of scope for this work, but these people are also best informed about the special features of the most current version of the virtualization software. Additionally, they get a better feeling of the services themselves and can build documentation and knowledge in this way.

4.4.2 Concept Outline

Because of the scale of a full analysis, this concept outline describes a scenario that is not necessarily the one to go with, while it still seems feasible from the perspective of this paper's author. The description and explanation given below is thus far from complete and shall only serve as a pointer for improving the stability, performance and temperature situation at CDTM. Figure 4.1 illustrates the setup described and reasoned below.

Any virtualization setup that really addresses the CDTM IT situation concerning hardware and server room needs a substantial investment in hardware first. To find out the number and size of needed machines, the analysis described above must be done in full for each service and necessary requirements must be added up. In the internal network zone, there are the monitoring services, the Active Directory, the password change web site, the File and the Print service. Monitoring services should not be placed in virtual machines not only to ensure accurate measurements of response times and availabilities, but also to inform the administrators if a VMWare host is down, which is not possible if the monitoring goes down with it. Microsoft does not recommend running an Active Directory domain controller in a virtual environment of any brand, not even Microsoft Virtual Server. The password change web site already is running in a virtual machine, the print service is provided by the Active Directory server without any issues whatsoever, and the file service is simply too big concerning LAN and disk usage to be eligible for a move into a virtual machine. This shows that new virtualization hardware in the internal network of so little influence that this outline can safely ignore it.

Since there are no official CDTM hosts in the external network (excepting the firewalls), there is only the DMZ left to consider. Due to the high number of services in the DMZ, and due to the high average business criticality of these services, there is not only a need for redundancy but also a need for high performance if a larger number of services or machines are to be made virtual. A cautious estimation shows a need for two at least four-way servers with 6GB RAM or more, each having three network interfaces plus remote management capabilities and each equipped with fast 3.5" hard drives of high capacity for optimal disk performance (reasons for these features become clear below). This may seem a very expensive scenario, but it is possible to retire at least six and possibly even more machines in this way, while putting out only a fraction of heat created now due to new, power-effective

components.

An important feature for big virtualization machines is the ability to monitor and to manage the machine remotely via an interface that is separate from the network available to the host's operating system. This interface does not need to be a LAN interface; it can also be a dial-in option or an external box providing the hardware's user interface (keyboard, video, and mouse) to the administrators, which becomes necessary to service the machine in case of failure of any network component between the virtual machines and the clients. This must be said to emphasize the fact that the VMWare host is as important as all guest machines together and then some more. If the interface also provides health information about the system (like network packet statistics, hardware temperature and memory condition), proactive management and early-warning mechanisms for hardware problems become possible.

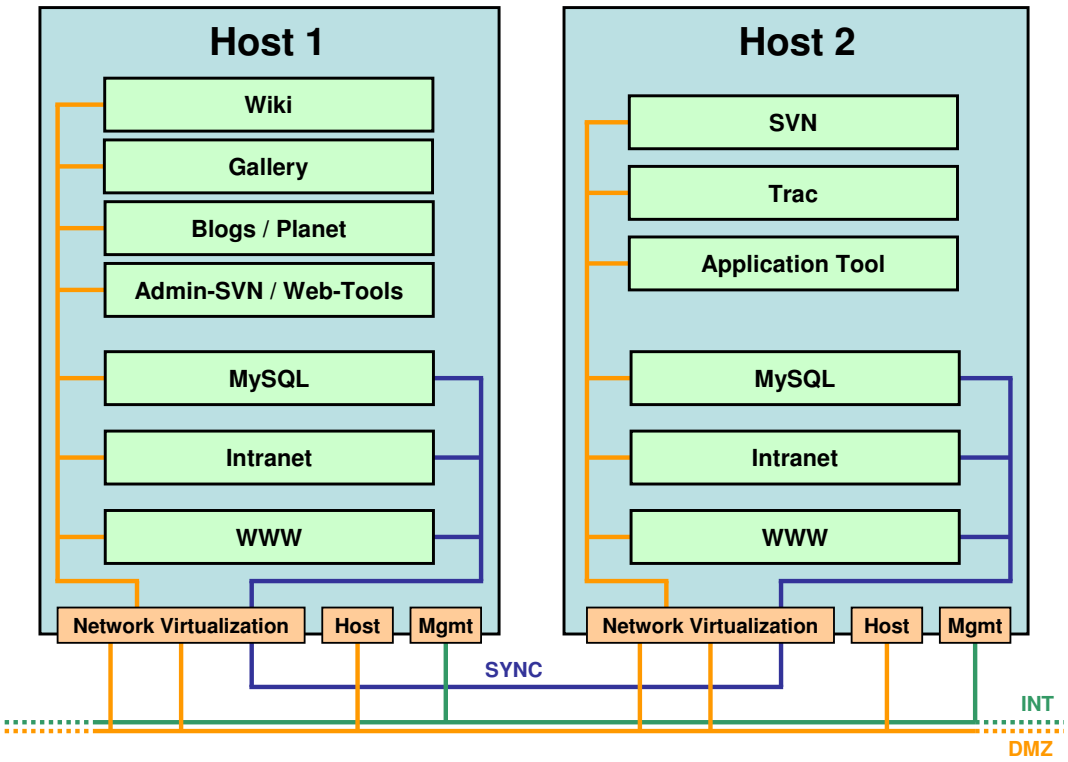

Figure 4.1: DMZ Virtualization Schema

The main reason for having two separate VMWare hosts is that a number of services in the DMZ can well be moved to virtual machines regarding most of the above criteria, but some services are so business-critical to CDTM that a SPOF in form of a single piece of hardware running more than one of these cannot be tolerated. To counteract this, critical machines are mirrored between the two virtualization hosts and a fail-over mechanism using heartbeat and file synchronization (as it is provided by Linux out-of-the-box) is used to provide availability of critical services in case of a hardware failure. Since this raises the load on both hosts

without providing benefit, only the most critical services should be mirrored. Many services in the DMZ use a MySQL server for data storage, but having a MySQL server in each virtual machine would be a veritable waste of RAM and CPU. Since MySQL scales rather well with machine power, it is recommended to consolidate the DMZ MySQL databases onto a big server that provides fast database service to all machines in the DMZ. This machine would then be unquestionably ”ultra-critical” because such a high number of services depend on it and thus it *must* be one of the mirrored services.

To ensure availability of connectivity in all situations, three network interfaces are needed on the two servers. One is used with a dedicated crosslink cable for mirroring and clustering, optimizing performance in this respect while not using any external resources. The second interface is used for mapping the guest system's network adapters to the CDTM DMZ, easing management of connections. The third interface is not used by VMWare but only by the host's operating system. This ensures connectivity and serviceability if one of the virtual machines floods the second adapter and thus endangers administrative capability. Using the host-only interface, an administrator can easily shut down selected virtual machines without affecting the other services. A possible use for a fourth interface (a large share of machines on the market feature four on-board LAN interfaces) can be used as a second interface for grouping the guest systems to lower the possibility of a faulty cable or switch port becoming a multi-service SPOF.

As the schema in figure 4.1shows, quite a number of services can be optimized and consolidated while still maintaining availability and stability. Many pieces of old hardware can be shut down and a high amount of excess heat is avoided. This leads to lower power consumption of A/C units and can lower overall power consumption of the CDTM server room by up to 50%.

4.4.3 Value

Option	Benefit	Costs	Value
Virtualization of services	counteracting the server room temperature problem, lowering hardware count, optimizing resource usage	very high monetary cost because new hardware is needed, medium effort for moving, mirroring needed for eliminating SPOF	**very high**
Overall value			**very high**
Remark	The high monetary cost is a one-time expense and actually lowers the expense required for the new hardware named in 4.2 above.		

Table 4.4: Value of server virtualization

Using a setup such as the one described above, a large amount of stress created by the innate properties of the environment can be ameliorated. Availability and stability of critical services can be maintained, if not raised. The heat creation and power consumption issues can

be heavily counteracted, if not solved. Of course, there is no such thing as a free lunch, and the monetary investment needed for an effective setup is very high. Since the investment is a one-time only expense and the benefits are extraordinary, there may be a good probability of raising the funds for virtualization. Virtualization as an improvement option can be combined with many other options, and it even makes some of them more feasible. In consequence, the value of this option must be set to ”very high”.

4.5 Downsizing

The CDTM IT infrastructure has grown over several years. Even though the growth has been in some ways quite organic, at any time there were still some dedicated members of ITTF around who acted as ”gardeners”, making sure that a number of ideas and rules were followed. Tools were developed and documentation written to ensure a proper fit of new systems and services into the existing system. It cannot be said if this behavior stopped the infrastructure from collapsing through uncontrolled growth or if it actually encouraged expansion by making it too easy. The question now is if this growth was too much and if there are services (and thus, machines) that are obsolete and actually not used, only creating administrative load without offering benefit to CDTM operations.

If there are such services, several actions are possible to reduce the amount of either workload or responsibility that the ITTF is facing. A service can be completely shut down and its data archived. In that case, all the benefits that it provides are also lost. The next level is demoting the service to a lower level of support. This means that the service is only supported and maintained if no critical issues at all are at hand. The next nuance of change would be stopping support for the service. This implies that whenever the service is interrupted, ITTF still takes care of the problem, but with lowest priority. This greatly lowers workload and responsibility but may produce adverse side effects, like a service ”starving” because users stop using it completely after it was down for a certain time or like a raised level in messages from users because a service considered low-key is down. The latter would show that the service concerned may not be of economic or educational benefit and does not directly promote research or student productivity but that it rather encourages the student’s community and additionally gives students a way of enhancing the quality of ”the CDTM experience”. A possible accompanying measure of the two latter alternatives could be used (if realizing the infrastructural changes outlined in section 4.1) by moving the services into the SPG zone and thereby symbolically showing a dissociation from the service that can help building a tolerance against the service’s downtimes in the minds of ITTF members as well as students.

4.5.1 Low Impact Services

A full analysis for finding out the impact and importance of each service would take a long time and much work, starting with questionnaires aimed at different target groups (students, assistants, IT people), then analyzing the data and cross-examining it with reference to infor-

mation about service interdependencies and other technological aspects, and finally extrapolating a rating for each service. Of course, this would go beyond the scope of this thesis, so this section will take the short cut of ”informed and educated estimation by an insider” that has shown to be a good approximation with regard to the result of processes similar to the one above. The following paragraphs of this section alphabetically list the services that are not integral to CDTM's normal operation and give a rating for each along with a justification of the classification. Ratings are named after the recommended action and can be ”keep”, ”demote”, ”unsupported”, and ”retire”, a quick reference to their meaning is given in Table 4.5. A quick overview (grouped by rating) of the combination service/rating/explanation is given in Table 4.6.

Recommendation	Meaning
Keep	The service is kept as it is and fully supported. Possibilities of service levels are still open but a retirement should be out of the question
Demote	The service is demoted in its service levels. This implies that there is some support for the service, but there are no guaranteed response times in case of service failure and there is no priority whatsoever given to answering user's requests in a certain time. If performance requirements allow, these services can be grouped on a single server (maybe even a single old server) to ensure that in case of hardware failure only demoted services are affected
Unsupported	This service is not officially supported by ITTF. If outages occur, there is no reason for ITTF to take care or repair. If resources are available, ITTF may or may not devote them to repairing or maintaining the service. When taking the service out of support, ITTF can try to find a student who is willing to maintain and support the service as voluntary work. For all services that are taken out of support it is advisable to use an old server (and put it into the SPG, see above) and to take that machine out of official monitoring, thus taking it out of the ITTF focus.
Retire	The service is fully retired and it's data archived. The users of this service must be informed beforehand with enough time to archive any personal data or migrate any used functionality. Before any future reactivation of the service, there must be a person (or person group) dedicating themselves to propagating, advertising, and in the first period to maintaining the service.

Table 4.5: Downsizing Levels and Actions

- **Blogs** – unsupported – The blogs running on Merlin have a very low usage rate, the IT blogs recently get only hits by automated readers (”planets” etc.). This justifies moving this service into the ”unsupported” category.

- **Gallery** – keep – If used properly, the gallery service provides many benefits over the file share it replaced, first among those the possibility to access the pictures from anywhere without having to use the VPN service. Additionally, it enhances the build-up of the community spirit between students. It also provides the means to distribute graphical material to students with history and search capabilities.
- **Kitchen Cam** – demote – The Kitchen Cam realizes its effect simply through its existence and there have already been outages of several weeks without anyone noticing. On the other hand, there have been times when it was successfully used to identify miscreants. The combination of these two factors naturally leads to the service being demoted to low support level so it is available as much as possible but does not take precedence over any operations-related service.
- **Mailboxes** – keep – The mailbox server at CDTM only holds a single-digit number of mailboxes, so the number of affected users is very small. There are, however, the mailboxes for the office staff on the box and these are used extensively and daily. This qualifies the server to be supported by the ITTF, but the importance of the server should be set at a lower level than for other services that affect more users. It must be taken into account, though, that the servicing of any mail-related machine is to be done quickly to avoid delay notifications being sent to originating mail servers.
- **Password Change Tool** – keep – The impact of the password change tool already mentioned in section 4.7 in terms of CDTM operations and productivity may be low, but the administrative work saved for ITTF more than balances the support work for the tool.
- **Planet** – demote – The CDTM Planet service has a certain number of regular readers and a certain number of casual readers. Retiring the service would deprive the community of a means to keep in touch, but the impact of retirement is not big enough to warrant full support. If the service usage should decrease significantly it could even be further demoted to ”unsupported”.

The following paragraphs list services that have been mentioned – albeit in unofficial situations – by some CDTM staff members as services they perceive to be not necessary or not obviously used. This inclusion is done to give reference information in case these discussions come up again.

- **VPN** – keep – Even though the VPN service has a distinct amount of administrative work and support involved, it enables many other services and enhances the security of the CDTM network. Without the OpenVPN service, for example, to keep supporting all clients connecting to OpenVPN now, the CDTM WLAN would have to be switched to WEP encryption, which has been proven not secure. Furthermore, there would be no access to the file shares and all other internal services from off-site locations, greatly enlarging the volume of data sent by email throughout CDTM operations.
- **WLAN** – keep – The opinion has been voiced that WLAN administration at CDTM could be handed over to the LRZ. Following this course of action would imply fully opening the internal network to all clients connecting to the LRZ WLANs via the LRZ VPN service, jeopardizing the security of the whole CDTM network.

- **Workstations** – keep – No matter how many people are of the personal opinion that ”everyone has their own laptop nowadays”, usage analysis of the workstations shows that during the semester there are several times each week when there is no workstation available. In addition, even if everyone has their own laptop, they do not carry it around all the time and they do not all have the software available for CDTM student work. Actually, one finds that each semester there is a group of students who prefer using the CDTM workstations to working on their private laptop for various reasons, including the availability of preconfigured printers and the single login features.

Service	Pro	Contra	Recommendation
Gallery	better features than the alternatives, strengthens community	-	keep
Mailboxes	users include key personnel	low user count	keep
Password Change Tool	high impact for ITTF	needs Microsoft IIS	keep
Kitchen Cam	large effect present through existence of service alone	low importance	demote
Planet	strengthens community	community only	demote
Blogs	strengthens community, some ITTF usage	very low usage	unsupported
VPN	stronger security than WEP for WLAN, easy usage, access data from home	-	keep
WLAN	high usage, low administrative load	needs VPN service to be feasibly workable	keep
Workstations	high usage, special software provided to students	service produces administrative load for updates etc.	keep

Table 4.6: Rating of Services for Downsizing

4.5.2 Value

The management option of downsizing the IT infrastructure is very effective if it is applied not in a binary, black-and-white fashion but gradually. The difference between the two is visible in 4.7. The above sections outline four different courses of action, depending on the service’s import and impact. The association between service and action given here and summarized in table 4.6 is of course not authoritative, but it should be taken as a starting point for a decisional discussion. Because no other options are influenced or needed and a

Option	Benefit	Costs	Value
Retiring low-impact services	lightly lowering administrative effort, saving a small amount of hardware	severely curtailing community effects with unknown outcome	**very low**
Adjusting support levels for services according to criticality	heavily lowering administrative effort, impacting only low-criticality services	less hardware saved	**high**
Overall value			**high**
Remark	the greatest benefit can be reached by combining the grading of support with e.g. the creation of a ”safe playground” as described in 4.1		

Table 4.7: Value of downsizing the Infrastructure

positive effect on the number of services and machines to be maintained by CDTM ITTF is evident, the value of this option is set to ”high”.

4.6 Outsourcing

The usage of outsourcing to save effort and money has taken a big hold on IT in the business world. Companies ”concentrate on their core competencies” and decide to save money by paying a third party for services that were handled in-house until then. The main reason why outsourcing is so big in the IT world is simply that most businesses *use* IT *for* their business, but only a small number of firms see IT as *part of their business*. Depending on the amount of planning, strategy, and technical knowledge used in deciding about outsourcing, the results of this course of action vary wildly. Many companies are very pleased with the results of IT outsourcing; but just as many firms follow the ”in-sourcing” path after a period of using outsourced IT, not having evaluated all the effects that come with outsourced IT. The way back to an in-house IT staff is not easy, especially since IT staff – and thus IT knowledge – usually leaves the company (one way or the other) when IT is outsourced. Outsourcing for CDTM IT is an interesting matter that should not be decided lightly but should rather get the same level of attention to detail that it deserves in big enterprises, to not only avoid any traps and pitfalls, but also for the learning effect experienced by the involved CDTM people.

The scope of this document does not cover a full analysis of all factors related to outsourcing, so this section understands itself as a preliminary analysis and as a basis for deciding on the necessity of a full analysis. In the special setting of CDTM being an institute inside the MWN during a time showing a proliferation of free, web-based services, there are not only the classical outsourcing options available that produce monetary costs, but there is also a big supply of free services available, partly provided by big, external companies like Google

and Yahoo, partly supplied by the LRZ for MWN-connected institutions.

The choice of services to be outsourced may not be an easy one but it can be done methodically by categorizing services due to their properties concerning different aspects like security, privacy, cost, and so on. For CDTM, there are certain constraints in effect that make the choices a lot easier. As is said in the section about constraints for server relocation above (section 4.3.2), there is no fixed IT budget for CDTM. Outsourcing, though, usually involves a cost factor through the involved service contracts. These circumstances create one simple question: ”Is the cost for the outsourced service lower than the cost for running the service ourselves?”. Answering the question is not so easy, though. What is the cost for CDTM to run a service in-house? The hardware existing now is essentially ”free”. The workforce is not paid. On the other hand, maybe one can count the time that the IT-CA devotes to a special service as a cost. In addition, if new hardware is needed to run a service effectively and with certain stability then this cost can be set against the cost for outsourcing, simply because both alternatives represent means to the same end.

Before starting any calculations, however, it must be checked if a service is allowed to run ”externally” and if it is technically possible without introducing a huge administrative load due to security and stability, similar to the checks named in section 4.3.2. The following is a list of services that would greatly lessen the workload of CDTM IT if they could be outsourced, along with short explorations into the technical and legal feasibility. Just as has been done for the option of downsizing above, there will be a categorization of services, but in this case a binary decision is better suited, so there will only be a distinction between ”possible” and ”impossible”.

4.6.1 Using Non-Free External Services

There is a number of services that are not possible to get provided for free because they are inherently too complex or generally too much in need of customization before they can be used in any environment. This section evaluates the possibilities for CDTM of outsourcing these services, according to the rules and assumptions given above. Services that are usually non-free, but that are provided by the LRZ free-of-charge to connected institutions, will be discussed in section (4.6.2) below; these include mail-forward, mailboxes, DHCP, and DNS so these will not be touched upon here.

Feasibility Assessment

As mentioned above, the first step of the analysis is to assess the feasibility of outsourcing a service, i.e. the legal restrictions, effects on other configuration items and other technological implications.

- **File Service** – impossible – Putting all the sensitive data stored on CDTM’s file server to off-site file storage (i.e. to an external, non-LRZ provider) with a level of security in storage and transmission that CDTM can afford is definitely against all legal regulations placed upon an academic institution in Germany. Using LRZ-provided file

space is possible, since the LRZ provides cheap file space for institutions inside the MWN, but there are further effects of using that service. Users must have LRZ accounts to use the file space, which is not the case for all CDTM persons. It is possible to create new users at LRZ for the file space, but this would mean forfeiting the single login and making users remember passwords additional to the ones they have already. Additionally, CDTM workstations have roaming user profiles that – depending on the account – transfer several megabytes of data over the network on each logon and logoff. This is now done internally inside one LAN segment. If CDTM would use LRZ file space, this data would travel several miles, impeding performance and putting load on networks shared with other institutions.

- **Firewalling** – possible with reservation – CDTM's firewall setup is non-trivial and cannot be handled by the free LRZ firewalling solutions available now. However, the LRZ is in the pilot testing phase for a new firewall solution by Cisco that enables the users (i.e. the administrators of the using institute) to fully control the traffic on up to five interfaces. This firewall solution is placed on a physical module for each customer. These modules are located in a central networking rack of the LRZ and are administrated remotely via a secured web interface. The professional and redundant setup of this solution would be very advantageous for CDTM IT because it eliminates administrative effort not only for the two hardware machines that run the redundant CDTM firewall but also for their operating systems including security measures. The pricing of this solution by LRZ has not been decided on yet; it may be free, it may be expensive. This is why the option of using LRZ-provided firewalling has been placed in this section instead of section (4.6.2) below and it is one reason for the reservations. Another reason is that the exact feature-set of the solution is not available yet and it is still possible that there are missing features. Additionally, the feasibility of the product's use for CDTM could be hampered by concerning infrastructure changes; the new hardware would be secure, but off-site, and this may create a need for additional LRZ-provided VLAN tags.

- **Printing** – impossible – The LRZ provides printing services for institutions connected to the MWN at acceptable prices, but as with file service, there are restrictions concerning network connectivity and account management that would make a full redesign of the CDTM network inevitable. With CDTM itself providing print service, there are possibilities to improve on the service experience that are still unused as of now, such as for example integrated print quota management and personal print queues.

- **WWW** – possible – The web site of CDTM (www.cdtm.de) and its sub-pages (mpd.cdtm.de, elab.cdtm.de, trend.cdtm.de) are run on a rather simple TYPO3 system and do not contain any sensitive information. TYPO3-hosting is a commodity service by now and many providers are on the market, effectively lowering cost for the consumer. At CDTM, however, there are several plug-ins and modules of TYPO3 in use that may pose small challenges before outsourcing can be done, but these challenges can be easily overcome by simple strategic decisions. The biggest change for the users, i.e. the ones maintaining content, when outsourcing the WWW service is that external TYPO3 hosting companies do not usually give support for TYPO3 if the customer

has ”admin” access, so administrative access to TYPO3 must be curtailed for CDTM staff.

Budget/Cost

Now that the services that are feasible for non-free outsourcing from a technical and legal standpoint have been identified, an attempt at answering the cost-question can be made. Depending on the answers for each ”outsourcing-possible” service, a value for outsourcing as an option can be given.

A quick price check using the World Wide Web shows the price range for hosting TYPO3 in Germany as being upwards of 15 Euros per month. Querying the CDTM management has returned a willingness (or ability) to pay much less, especially if admin access is to be revoked. Consequently, outsourcing the web sites is not possible. Improving performance and failure resistance can be achieved by other measures like e.g. virtualization.

The new LRZ firewall solution has no price tag attached yet. The low budget for CDTM IT is paired with a high reluctance of CDTM to spend on ”transparent” services, i.e. services that do not openly show a direct benefit to the staff or for the operations of CDTM. It can be assumed that if there will be a price tag, it will be too high, even counting the avoided cost for eventual new CDTM-owned firewall hardware. If the MWN-connected entities will be offered the service free of charge, then it will fall under the use of free services and in this case, the technical issues mentioned above represent the only possible showstopper.

Result

It has clearly been shown that all services that would be eligible for outsourcing are either technically bound to the CDTM infrastructure in too many ways or are simply too expensive for the extremely limited IT budget of CDTM. The simple consequence is to value this option as ”impossible” . Potential reservations because of the unavailable price of LRZ’s new firewalling solution have been shown as being superfluous.

4.6.2 Using Free External Services

An option that is in some way related to outsourcing is the use of external services that are offered free of charge. The Leibniz-Rechenzentrum offers many IT-related services free of charge for members of the MWN, representing a ”completely trustworthy free service-provider”, something that would be impossible without the government-funding the LRZ receives. For many services not provided by LRZ there are free providers to be found on the web, usually financed by online advertising, in some cases financed by companies like Google or Yahoo. This section first examines the LRZ-provided services for their technical feasibility concerning CDTM use, most importantly, it checks for the workload needed and effects implied when moving usage to a service of LRZ. Then other (i.e. non-LRZ) gra-

Service	Feasibility	Costs	Result
File Service	Disruption of Windows Domain, strong legal constraints as to outsourcing partner, high security risks, strong privacy concerns	cheap with LRZ, but high administrative overhead at CDTM	**impossible**
Firewall	possible with LRZ-provided Cisco hardware if features permit the number of zones and features needed	monetary cost is undefined yet, migration effort may be very large	**(possible)**
Print Service	full redesign of CDTM network necessary to fit LRZ print service requirements, other providers have too complicated requirements and too low security for CDTM	monetary cost at LRZ acceptable, effort needed is too large	**impossible**
WWW	Feasible with external TYPO3-hosting, strong restrictions regarding administrative access	too expensive, especially if combination of support by provider and administrative access by CDTM is required	**impossible**
Overall			**impossible**
Remark	LRZ firewalling should be evaluated as soon as the service is defined and available, if pricing are acceptable		

Table 4.8: Result of Service Assessment for Non-Free Outsourcing

tuitous services are evaluated, at first on general terms and regarding common aspects and then some single services are evaluated specifically, if necessary and feasible.

Free Services Provided by LRZ

As the central service provider for Munich's scientific community, the LRZ provides many basic IT services on a level that is sufficient for the daily needs of most departments and institutions. Some institutes and departments, mainly from technical sciences, need a higher level of complexity or deeper control over the services than is provided by the customer interfaces of LRZ, and these organizations usually have their own IT department run the service for them internally. From the beginning of CDTM, there was a high need for flexibility and the ability to apply changes above all quickly. This led to most services being run in-house in an ad-hoc manner, as has been mentioned in the IT-historical overview in 1.2.2.

Also mentioned has been the effort to create a stable, structured environment and the level of success in that respect. Now that some services have reached a defined state with a low change rate, and since the LRZ has changed its service portfolio in the meantime, it is now possible to reevaluate LRZ services for usability by CDTM.

CDTM IT services that are stable enough and that the LRZ provides at no cost include mailboxes, mail forwarding, DHCP, and DNS[5]. The overwhelming negative effects (concerning LRZ user accounts and CDTM users) that were named when outsourcing was discussed above still apply to **mailboxes and mail forwarding**. There is no need to discuss these in detail, especially since each of the two services may be stable at CDTM but each as one property that stands against a migration to the appropriate LRZ service. The mailbox count at CDTM is simply too low for falling into the regulations of LRZ, because a certain volume of usage is needed to justify the basic workload for LRZ staff. The mail forwarding at CDTM is simply too complex in its connection to other CDTM systems so the effects of using the LRZ service would be too far-reaching.

For using the – already running – **DHCP** service of the LRZ, CDTM would have to restructure its network completely and change a high number of policies regarding network security and the DMZ. These effects alone would already rule out using the LRZ DHCP servers for client configuration, without even counting the sophisticated DHCP configuration at CDTM that provides distinct addresses and configurations for several groups of network equipment, like printers, student laptops, CDTM workstations and assistant's PCs.

Regarding the **DNS** service there are only very small challenges to face when switching to LRZ DNS. In fact, there is already a project in progress for migrating all the possible DNS entries into the LRZ DNS system via the web-interface available for users of LRZ DNS. This interface lowers the possibility of errors during configuration and provides a rollback feature in case any errors happen against all probability. Not all CDTM-relevant DNS entries can be moved, because there is a Microsoft Windows Active Directory in place at CDTM that includes a dynamic DNS system with Active Directory-specific authentication measures for updates. For security reasons, the LRZ DNS system does not allow dynamic updates from arbitrary Windows clients, so there is a special DNS zone "internal.cdtm.de" especially for the Windows domain that is then also used for special services that must not be accessible or even visible from the outside. As is easily seen, the LRZ DNS services may not dramatically lower administrative workload but they lower the possibility of administrative errors and enhance performance, availability and stability due to the DNS service being a very important part of the LRZ network and thus being constantly maintained, optimized and monitored by LRZ staff. In addition, there is a lower impact if the CDTM-owned DNS servers fail because the main zone "cdtm.de" is still served by LRZ and only internal services and the Windows domain operation would be affected.

Table 4.9 sums up the situation for usage of LRZ-provided services at CDTM. From the table, the reasons become clear for valuing this option as "very low"

[5]Firewalling may be free in the future and has been discussed in 4.6.1

Service	Pro	Contra	Result
Mailboxes and Forwarding	marginally lowering administrative effort needed for mail	extreme threshold for migration due to complexity of service and LRZ restrictions	**impossible**
DHCP	marginal savings in effort, increasing resilience due to serviced hardware	full restructuring of network needed	**impossible**
DNS	lightly lowered administrative effort, very high stability due to high-quality service provider, intuitive web-interface	small amount of loss of control over DNS zones, some restrictions and regulations apply	**possible**
Remark	a project for implementing LRZ DNS usage has already been started		

Table 4.9: Outsourcing Using Free Services by LRZ

Other Services and Providers

Apart from LRZ, there are a large number of providers of free services, almost all of these web-based. Several times, people have proposed using these services for CDTM as a replacement for internally hosted services. Some factors, however, are seldom taken into account because some characteristics of these services are often overlooked.

The one simple thing that is overlooked most often is that almost all of the available services (examples see table 4.10) are centered on end-users and limited to strictly personal use. This is in most cases explicitly stated in their EULA[6] and does not include educational use. This small fact rules out many services for CDTM use from a legal standpoint. Services that are expressly allowed for use in scenarios like this invariably include passages in the attached license agreements that fall in the categories given below.

An even bigger issue that is often overlooked is the whole complex of factors around privacy, security and intellectual property. If CDTM (as a legal entity) should for example decide to put the CDTM gallery into a flickr account as photosets then a high amount of rights are transferred or granted to Yahoo, including the right to republish the image material without consent and without attribution to the originator. Additionally, Yahoo reserves the right to delete or hide images deemed ”inappropriate” by an algorithm or by Yahoo staff. Furthermore, by uploading images to flickr they are *published worldwide*, legally equivalent to publishing in a newspaper and thus falling under regulations of German law that touch on inalienable rights of persons depicted. Effectively, each depicted person must be asked for their consent to publishing these pictures if the person is prominently visible in the picture. If the Gallery is protected using a CDTM login, these regulations have much smaller effects, resulting in the removal of single pictures on depicted person’s request. More aspects of the

[6]End User License Agreement

license agreements are influencing this factor complex, but these examples should suffice to make the point.

The biggest factor from an IT and service-delivery point of view is simply stability. No free service on the web is offered with a guarantee of stability, availability or even a guarantee of informing the users before retiring the service. As a real-world example, Google lost mail boxes in an incident in late 2006, according to an e-mail sent to a technical weblog (see [Arri 06]). The fact that guarantees are simply not given is not acceptable if a service is essential to CDTM and if service quality aspects like especially stability are to be improved or at least kept at bearable levels while lowering cost.

Service	Provider	URL	Issue Types
Gallery	Yahoo	`www.flickr.com`	privacy, features, legal
Gallery	Google	`www.picasa.com`	privacy, features, legal
Mail Relay	Google	`www.google.com/a/edu/`	stability, security, legal
Mailboxes	Google	`www.gmail.com`	privacy, stability, legal
Person Directory	Plaxo	`www.plaxo.com`	privacy, stability, pricing, features
Person Directory	Xing/OpenBC	`www.xing.com`	privacy, security, features
Overall value			**impossible**
Remark	The issues of free external services are generally unacceptable for CDTM operations		

Table 4.10: External, Free. Non-LRZ Services and Their Issues

Concerning free services from other, web-based providers there is a saying that sums the situation up pretty well: ”there ain’t no such thing as a free lunch”. If a service is free then the payment is usually not monetary but given in terms of lower stability or loss of privacy and security. This price can not be paid by CDTM, especially due to being a governmentally subsidized institution. Thus, using external providers of free services as outsourcing partners is impossible, for reasons summarized in table4.10.

Result

With DNS already being switched and mailboxes, mail forward, and DHCP not being eligible for migration to LRZ, the use of free LRZ services in the current situation can only be valued as ”very low”. Nevertheless, the LRZ service portfolio should be consulted every time a CDTM service reaches a certain stability level (regarding changes) or loses complexity to an extent that qualifies the service for ”free LRZ outsourcing”.

The value of using other free services, however advantageous that may seem on first sight,

Outsourcing Provider	Benefit	Costs	Value
LRZ	high stability and quality rating, high security and privacy	strict regulations, high barriers for migration	**very low**
Others	ease of use, no need to apply for usage, few administrative restrictions (inside feature set)	limited feature set, low privacy, untrusted, no guaranteed level of stability,...	**impossible**
Overall value			**impossible**
Remark	the one service of LRZ that is feasible to use is being implemented, thus the whole section is rated "impossible"		

Table 4.11: Value of outsourcing by using free external services

must be set to "impossible" due to mostly legal secondary effects, but also because they simply do not create the necessary benefit for operating CDTM IT. The impossibility of official CDTM use notwithstanding, the available portfolio of services is incredibly diverse and the CDTM student and alumni communities can profit largely from these services and special group and community features they provide. If a high percentage of users registers with some of these services, then CDTM-specific groups can be created there and a networking effect is possible that may very well strengthen the CDTM experience for everyone involved. There already are such effects evident on portals like Xing/OpenBC (`http://www.xing.com`) and LastFM (`http://www.last.fm/group/cdtm`).

4.6.3 Value

Combining the evaluation of the two areas of outsourcing is quite trivial. The only outsourceable service is being moved to the LRZ, and since both, free and non-free services are impossible to outsource, the whole aspect of outsourcing is valued at "impossible".

4.7 Easing Administration Tasks

A whole category of small, but nevertheless quite beneficial, measures can be subsumed under the heading of "Easing Administration Tasks". These measures all share the lessening of administrator's load as their central aim. For some of them, a high one-time effort is needed, but some rate quite high on the gain per effort scale.

4.7.1 Tools and Interfaces

An aspect that is in some measure already taken into account by the ITTF is the possibility to ease the administration work by introducing automation and easy-to-use **tools for recurring tasks**. A good example for this is the resetting of user passwords. Until mid-2006, the "Windows Server" subgroup of the ITTF had to reset passwords administratively on user's request. In a small project assigned to him and rewarded by ECTS credits, a student programmed a small web site (four pages and two scripts) that eases three tasks. A user can request a password reset (the password is mailed to their saved forwarding address), users can change their password securely via web and finally any ITTF member can use their normal account to reset a certain user's password and have the password sent to a specified address. The page was also designed to be extensible so further Windows- or Active Directory-related tasks can be incorporated later[7]. This small web application eliminates a whole host of problems, complexity and workload from the three named tasks, among them the necessity of a specific subgroup answering the request (by taking Windows server Terminal Desktop access and needed knowledge about the Active Directory out of the equation). It also enforces the password strength policy, enables users to change their CDTM-wide password without using a physical CDTM workstation and more. This example shows how high the rate of gain related to effort can be when using customized automation.

There are quite a number of tasks that are either automatable or can be simplified greatly by **creating new interfaces** for them. One of the most complex systems with the highest impact in case of administration errors is the CDTM firewall, administratively including the DMZ. Configuration of the DMZ and firewall rules using standard Linux commands like "iptables" is very complex and error-prone, even for users proficient in using a Linux shell (i.e. not experienced system administrators). Due to this fact, a CDTM student who is active in the open source community has created a debian Linux package called "pyroman" that provides a human-readable script interface for iptables-rules. Still, to use this tool without reservations one must feel comfortable in a Linux/Unix shell environment and one must know about interfaces, ports and such. Creating a secure, error-preventing web interface for that would ease administration very much, especially in semesters when there is no Linux-proficient ITTF member. Admittedly, to build a web interface for this that also displays the current configuration in a not only human-readable, but also "user-readable" way would constitute more than a small project but there are still ways to reward this effort, e.g. in form of a bachelor thesis or a programming/security certificate for a CS student.

4.7.2 Updating and Monitoring

Another desirable tool would introduce a **semi-automated update of the Linux servers** at CDTM by a mixture of scripting, mailing and maybe a secured web interface for selecting packages to be updated and for starting the update remotely. To achieve this, a central machine can collect the available updates from connected Linux machines and then

[7] Addendum: as of September 2007, another task has been automated and incorporated into the portal, namely the creation of a list of user accounts given in a CSV(list of character-separated values) inside a new Active Directory Organizational Unit, useful for creating a new class of students in one single activity.

provide update information to scheduled scripts on these machines after administrator approval, mimicking the functionality of Windows Server Update Services mentioned below. Updates that usually are not triggered without proper cautionary action or that require a system restart, such as Linux kernel-updates, can then still be done manually[8].

A **well-structured monitoring** can take some stress factors out of system maintenance as it is done at CDTM right now. Hardware and systems maintenance is usually done in "interrupt-controlled" fashion, i.e. everyone keeps working as if oblivious of the systems that provide the services and in case of an error normal work is interrupted and the error is handled in any which way. This philosophy adds to the dynamics described in 1.2.3 earlier. When reviewing events in the history of CDTM IT it is fairly easy to make out the periods in which self-motivated students dedicated themselves to using the existing monitoring information for keeping the systems stable. This shows that the monitoring information necessary for proactive maintenance is being generated and recorded (as has been listed in section 3.1.5) but not properly used due to time constraints and motivation issues. To ease the administration of the whole system and make proactive work easier a small system can be built – e.g. using standard tools like log file analyzers – that inform the ITTF about the system monitoring status concisely and in a readable way. There are software solutions that provide exactly these features, like HP OpenView, IBM Tivoli etc, but these software packages are built for big enterprises, are very expensive and need dedicated servers as well as full-time staff to operate effectively. The special situation of having a disproportionate infrastructure size and no dedicated staff creates a very special monitoring scenario, providing another possible subject for interesting student research or student implementation work. The fact, however, that human interaction can never be completely removed from monitoring must be conveyed to CDTM IT management or proactive work will stay at a barely perceptible level.

Another possible measure for lowering administrative load is the introduction of **Windows Server Update Services** (WSUS, see [Micr 07b]) and Windows Deployment Services[9] (WDS, see [Micr 07a]) to enable easy installation and upgrade of clients. The Microsoft Active Directory can be used to roll out patches of non-Microsoft software, which eases administration of student workstations further, especially taking into account the extant low frequency of applying Windows updates and client software updates at CDTM. For using WSUS locally, the LRZ is maintaining a WSUS server in its network that provides tested and LRZ-approved patches and allows the connected institutions to use it as an upstream server, thus lowering complexity of that service by taking care of all the testing usually needed before applying patches downstream. Aside from providing a simple and fast way of installing standard clients, using WDS enables CDTM IT to keep track of OS licenses already used and makes tracking of a certain license to a special machine a lot easier, especially if combined with the stable hardware platform concepts named in section 4.2 above. Introducing these systems and concepts may increase the complexity of Windows Server administration, but it also introduces interesting administrative tasks that may be more attractive for students than applying the same patches to tens of workstations like an assembly line worker. It also goes a fair step of the way to getting the same task done with minimum

[8] Manual updates implying a restart are especially easy to do remotely when using virtualization (see 4.4)
[9] the successor of Remote Installation Service (RIS)

effort on the time scale, time being at a premium in CDTM IT work.

4.7.3 Value

Method	Benefit	Costs	Value
Create and use tools for recurring tasks	complex, recurring tasks are done faster when they are automated, high tool quality ensures high work quality and avoids human errors	tools must be extremely well documented to be adaptable to a changing environment, also they must be adaptable as well as be adapted to stay current	**very high**
Create new administrative interfaces	apart from automation, intuitive interfaces for complex tools can lower error rates and speed up tasks	creation of tools needs effort, same diligence as with above tools applies	**high**
Semi-automated update of Linux servers	the most critical services keep a stable and secure base, time needed for updates is massively lowered	tool must be installed, maintained and maybe even programmed if not available	**high**
Well-structured monitoring	ITTF is close to the pulse of the envirionment and can proactively maintain the systems and services, stability can be guaranteed to an extent	High threshold to overcome for making people do tedious, boring tasks like log-checking	**very high**
Windows Server Update Services / Windows Deployment Services	Updates for all Windows Servers and Clients are centrally managed, deployed and triggered, all Windows systems gain much in stability	a strong machine with Microsoft IIS is needed for WSUS, service must be installed and maintained	**high**
Overall value			**very high**
Remark	many of these measures already have a basis to build on and need only little effort to get off the ground		

Table 4.12: Value of Methods to Ease Administration Tasks

Easing the administration tasks takes much load off the IT task force members, thus enabling them to take part in much more interesting projects. This does not only raise morale levels, but also make ITTF more attractive for new students and can help making people stay longer than one semester in the ITTF. Therefore, implementing this option would not only save time and effort, but can also improve the IT task force's situation on the team-level.

4.8 Use of a Workflow Management System

It is obvious that any IT environment involves a significant number of recurring tasks, however regularly, that are mandatory to be fulfilled. There are also a number of processes in place, if properly defined or not, that must be followed to ensure safety, system security and stability as well as work quality. In an environment where the only constant staff is the management (that is burdened with many other tasks as well) and the normal staying time for working IT members is six months, there is a high difficulty for the workers in becoming familiar with the processes and necessary scheduled tasks. This is especially the case for CDTM students, who always have many other responsibilities as well. As has been hinted at in the requirements section (1.3), the handbook can be written in a way to enable fast learning and quick reference, but reality is seldom close to the ideal case and people do not have the time to (or simply do not) read the handbook in full. At other times, the section used for quick reference may be out of date or simply too easy to be misinterpreted by the person assigned and at those times, error probability rises quickly.

4.8.1 Usable Aspects

A tool category that can help in this situation is the family of workflow management tools. On the one hand, they are useful to manage long-term workflows and well-defined processes, an aspect which is not in the focus of this chapter, but rather of the following one, and will be treated in section 5.3.5. On the other hand, such systems can counteract the challenges just described by **triggering and initiating tasks** that need to be started either on a regular basis, no matter in what intervals, be it each day, week, month or even semester. Additionally, a workflow management tool can be used to **submit and record the requests made by users** that constitute the start of a still undefined process, like the creation of new project web sites. Using a workflow management system for this not only enables the keeping of a history of requests that is helpful in analyzing the situation for more sensible proactive planning, but it also familiarizes the users with the interface of the tool. This implies that when the processes relating to the request are defined and integrated into the tool in the future, the definitions in the system only need to be fleshed out and the interface for the requestor will only change minimally.

If such a system is put in use for reaping the benefits just described, the choice of which software to use is very critical, since the user familiarization only becomes manifest if the tool does not change when starting the implementation of larger-scale processes. There are quite a number of workflow management software systems available on the market, some document-centered, some process- or even business-centered. Many commercial systems include graphical process modeling tools that are easy to use and learn, a feature that may not be critical for the one-step (start/do/finish) processes implied above, but that becomes a big factor in keeping the system scalable to large processes, especially if the system will be used for managing non-IT processes at CDTM. Generally, all the systems show a high correlation between delivered features and price. Which system is best suited, or if it is even

better to implement the processes using standard languages (like BPML, XPDL or YAWL[10]) and run them using an open source workflow engine can not be said at this point. Before evaluating any software, there is much to be done in terms of analysis and design, which would go too far for this document. It is possible, though, to give some preliminary analysis and thought about the topic, and this will be done in section 5.3.5 below as well.

4.8.2 Value

Usage	Benefit	Costs	Value
Triggering recurring tasks	lowered rate of incidents relating to failure of starting recurring (especially low-frequency) tasks, possibility of sending reminders at appropriate times, tracking person performing each task recurrence	effort for setting up and controlling the schedules, due diligence in designing as well as in performing the tasks implemented with the system	**very high**
Submitting and recording requests	enables forecasting and resource planning, unified interface for requests, possible familiarization of requestors with interface for later "full" use of system	effort needed to analyze the recorded data, translating data into future system changes	**high**
Overall value			**medium**
Remark	the cost mentioned in this table is additional to the setup cost for the system. Additional constraints apply (see text), thus the lower overall value		

Table 4.13: Value of a Workflow Management System for Task Initiation and Recording

In general terms, the value of a workflow management system for CDTM IT can clearly not yet be quantified. The benefit created by automatic triggers for recurring tasks and for tracking requests and their history is not to be underestimated, though, and is summarized in table 4.13. However, there is a large amount of work involved in analyzing the tool landscape, then choosing, installing, configuring and not least maintaining a workflow management system. This effort is only justified if the full extent of the system's functionality is used, so a definitive valuing can only be done in section 5.3.5. Nevertheless, if a system can be found that is easy to install and scales down well, then even a usage for only the benefits named above becomes possible, so in the classical, infrastructural context here, the value of this measure is set at "medium".

[10]Business Process Modeling Language, XML Process Definition Language, Yet Another Workflow Language

4.9 Value Comparison

The above sections illuminate the classical perspective on IT, bound to infrastructure, services and tools, with regard to the situation at CDTM. With the above options evaluated, it becomes apparent that following the classical perspective can provide a remedy for many issues and challenges faced by CDTM IT today. Table 4.14 gives an overview of the ratings of the evaluated options, sorted by value rating. Ratings cover the available spectrum with six of eight options being rated medium or higher. The fact that almost any measure that is not blocked by legal or budget issues is rated high, very high or mandatory sheds an interesting light on the state of the infrastructure in place at CDTM. This section summarizes the ratings, recapitulates some of the reasons and attempts a short comparison. A recommended mix of using the options is given in the summary following this section.

The only option to have been rated impossible is ”Outsourcing”, mainly having gotten this rating due to budget restrictions and due to legal concerns. The subsection of outsourcing that concerns itself with using LRZ-provided free services is rated very low due to the character of services concerned, but must be kept under observation as circumstances change. The low rating of server relocation stems from the effects and aspects surrounding the running of servers remotely in a ”foreign realm”.

Using a workflow system solely for aspects pertaining to the classical perspective on improving CDTM IT has been rated ”medium” because, even though the benefits would be considerable, there is the notion of breaking a fly on the wheel, since a workflow management system can do so much more . Since workflow management is very much related to the concept of processes and roles, this option is explored more deeply in the next chapter, where processes are handled.

A high impact rating is given to the option of downsizing the environment, but this is not to be taken too generally, since a sensible approach must be taken and the term ”downsize” in this case relates less to the size of the environment, but rather to the effort needed for administrating the system. Understood like this, an application of ”downsizing” can produce very valuable effects in this scenario. A further ”high”-valued option is the reworking of the infrastructure layout by e.g. creating a fourth security zone. This complex of measures can greatly increase security and stability, but only unfolds that at a relatively high one-time effort.

Virtualization of hardware and the effective easing of administration tasks have a very high positive impact if they are implemented, both boosting stability and availability as well as taking care of some major issues at CDTM. Virtualization does that by relieving part of the headache-inducing hardware situation. Because in itself it needs new hardware (though is needs less than replacing a high number of machines would), the only possible showstopper for this option would be if funds cannot be raised. Easing administration tasks takes load off the IT task force and can have beneficial effects of the motivational and the social perspective of CDTM IT that unfortunately cannot be estimated or measured at this time.

”Hardware Service” as the only mandatory measure is unfortunately the most expensive one when seen from the monetary side, but on the other hand, these expenses are needed only

very infrequently and CDTM IT has spent next to no money in recent years, so chances are good for acquiring the funding necessary for this option. The benefits to be reaped from switching to hardware that includes service contracts are huge, and benefit the whole of CDTM operations by improving stability and by removing one of the biggest challenges from the playing field of CDTM IT. A most intriguing fact about this measure is that, if implemented, it actually intensifies the positive effects of most other measures to be taken.

Option	Benefit	Costs	Rating
Hardware Service	severely lowering administrative complexity, relief from hardware issues, stable basis for infrastructure	high monetary cost, plannable because one-time investment for each piece of hardware	mandatory
Easing Administration Tasks	avoiding errors, saving on effort, thus higher stability and quality	effort for creating and maintaining tools must be taken into account, high level of necessary diligence	very high
Virtualization	Counteracting the server room temperature problem, lowering hardware count, optimizing resource usage	high monetary cost if ”serviced hardware” option is not followed, mirroring needed for eliminating SPOF	very high
Downsizing	lowering administrative effort, adverse effects only on uncritical services, combination with ”Infrastructure Layout” amplifies positive effects	only the effort needed for reorganizing services	high
Infrastructure Layout	enhanced stability, higher security, lower administrative effort	some machines must be freed, new hardware is needed in the network	high
Use of a Workflow System	lower incident rate, enables forecasting	medium maintenance effort and unknown software cost	medium
Server Relocation	counteracting temperature issues	extreme administrative effort, new hardware needed	low
Outsourcing	medium savings in administrative effort	extreme effects on infrastructure, complete redesign and rebuild needed	impossible

Table 4.14: Rating Overview for Improvement Options

4.10 A Recommended Mix

To optimize the benefit of these options in order to raise levels of stability, security and effectiveness in several facets of CDTM IT, the most feasible and best suited combination, a ”recommended mix”, must be found.

Each of the options given in the previous sections of this chapter has its own benefits and costs, as listed in table 4.14. Cross-over effects and influences between options have already been hinted at in the previous section, and the most prominent and rather obvious one is the fact that an acquisition of hardware that is backed by service contracts greatly improves benefits of other measures. Virtualization of hardware benefits from that because one of the biggest cost factors of virtualization is taken care of, but the influence works both ways. If hardware virtualization is used, then fewer machines need to be replaced and more can be retired, easing the barriers for serviced hardware and freeing up funds for other measures. Acquiring new hardware also frees up older hardware for use in easing administration tasks and in implementing beneficial changes in infrastructure layout.

Other effects exist even with the low-valued options. The relocation of servers can be used to temporarily place new machines off-site and then move services over to these machines one by one without a stress factor in the timeframe. When all designated services have been moved and the source machine (or rather machines) has been shut down, then the virtualization hosts can be taken back to CDTM. This counteracts the temperature situation while taking a large amount of possible stress out of the activities created by virtualization of servers, thus heightening the probability of error-free implementation of the virtualization option. More effects exist but need not be detailed here.

A combination that is suited well to counter the issues existent at CDTM while minimizing the challenges to face is based on a core component: the acquisition of new hardware for servers as well as workstations. Building on that, most of the high-benefit options can be realized, only disregarding outsourcing and the option of introducing a workflow management system, which is fully independent in this context while it shows a strong involvement in other areas of the next chapter. The following list gives a possible course of actions that is feasible to undertake in the near future, all under the pretext that funding becomes available. The steps are not necessary to be followed chronologically in the exact order given, many can also be followed in parallel, depending on available resources. Although some dependencies between steps exist, they should be obvious enough to not warrant listing here.

- implement **changes in infrastructure** by creating the ”safe playground”
- **acquire new server hardware** necessary for virtualization, if possible include more machines for replacing old ones
- **set up the virtualization hosts off-site**, best inside the MWN with a DMZ VLAN extension to the new location
- prepare a **definitive client software set**
- start **moving services to virtual machine**, include the services *Wiki*, *Intranet*, *www* first and create a central *central, redundant MySQL server*

- **acquire new workstation hardware** according to the SIPP principle, set up Windows Deployment Services
- **move remaining services** between remaining machines according to the **downsizing** option, freeing up as many machines as possible
- **shut down freed servers** that the services were moved from
- **move virtualization hosts back to CDTM** to remove adverse affect of relocation without worsening temperature situation
- **document the infrastructure!** This can be done beforehand, but is feasible during the steps given here
- according to the new documentation and setup, **create new interfaces and tools** to effectively operate and administrate the systems and services

Using a course of actions such as this, a very high benefit can be gained. Using current resources, and stopping all other projects for implementing this setup, an estimated timeframe for realization of the options above is on the scale of eight to fifteen months without counting documentation effort for the current environment and for planning and implementing new tools and interfaces. This seems a short time, considering the size and complexity of the environment, but it is not to be underestimated that none the steps above is really involving creative effort. On the contrary, the main part of the efforts lies in installing basic software on new hardware and in moving services around between machines.

4.11 Summary

This chapter has shown explicitly that very strong improvements of the situation are possible when keeping with the perspective of classical management of IT, focusing on improving the areas of infrastructure, services and tools. The possible measures in these areas have been described and explored in this chapter and their value for CDTM IT has been estimated and compared. Finally, a course of actions has been recommended that optimizes the benefits gleaned from the described options.

While the benefits of the above options are very large and can be reasonably realized with only moderate costs, they do not represent a long-term benefit in themselves. What these options do not encompass is a long-term guarantee of stability and efficiency. As has been discovered throughout the business world, the classical, technologically focused perspective must be augmented by a process-driven, organizationally focused component to fully develop its potential in heightening stability, security, effectiveness, in short: the quality of an IT organization. Especially in the face of all the dynamics at CDTM and considering the extremely short intervals between each full work-force turnover, there must be a stabilization of knowledge and expertise, covering not only the transfer of know how from one generation to the next, but also ensuring the survival of knowledge through times of less personnel and of less penetration of knowledge through task force members. Additionally, the environment's stability – and in essence, even its quality – does not stem from the ex-

tant knowledge exclusively. If knowledge is present but no one knows how it applies in the specific context, the benefits are minimal.

The systems' properties and configuration must be described, the essential responsibilities and liabilities documented, and the most effective and secure way of working with the systems must be described concerning general rules and specific lists of action items. These necessities prevail for the long-term stability of any IT environment, anywhere, which is a reason why ways of coping with these necessities have been adopted as "best practice" in the business world and are summed up under the term IT Service Management. As has been exhaustively displayed in the introductory chapter, the scenario here is far removed from a standard business environment, so a critical evaluation is in order before adopting any of the already established best practices from the business world. The next chapter explores the organizational aspects and the process perspective of the CDTM IT organization and attempts drawing a benefit for CDTM IT from the ITIL best practice framework introduced in chapter 2.

5 Concept Part II: Processes and the Organization

The technological improvements of the previous chapter have been described as resulting from the classical perspective as opposed to the ITSM perspective. Of course, the ITSM perspective does not disregard technological aspects of an IT organization. Rather, they form one of the focus areas of IT service management. Some frameworks, for example the Microsoft Operations Framework [1], divide ITSM into the three aspects of ”People”, ”Process”, and ”Technology”. With the technological aspect covered in the previous chapter, the focus of this chapter is on the other two areas, although there will be a slight shift in nomenclature from ”People” to ”Organization”. This results from the features of the scenario described in chapter 1, especially from the constrictions created by its ”no fixed staff, no fixed organization” character.

In order to make permanent the benefits that the technological measures of chapter 4 offer, there is a need to change the deep structure of IT operations at CDTM. In the current situation, the dynamics that are inherent in having CDTM as a ”customer” to manage IT for are amplified by organizational factors inside the IT task force and by the changes made in recent times, described in chapter 3. Since the dynamics that are originating from basic CDTM culture cannot – and, in some cases, to keep just this culture alive, must not – be counteracted, an effort must be made to dispel the amplifying factors inside the CDTM IT organization. By creating organizational stability, by establishing a customer-focused mentality, and by implementing measures for continuous improvement, much can be done in this respect.

However, the scope of this document is much too small to encompass a full outline of CDTM IT’s path to these goals. Still, it is possible to give some recommendations about necessary changes in the organizational structure of the IT organization and in the mode of management applied to the IT task force. Some of these recommendations are not only applicable to the ITTF but they would also create general benefits for CDTM if they were allowed to ”spill over” into other taskforces or even CDTM operations in general. In addition to these recommendations, this paper attempts to create the cornerstones for a handbook to be used by CDTM IT in day-to-day operations. In combination with following the recommendations to be given, usage of this handbook can establish a baseline of stability in the IT organization.

Before recommending changes and before applying ITSM to create a handbook, the IT organizations placement in the general CDTM organization is considered in a set of surrounding factors for these measures in section 5.1. This includes lining out the critical

[1] `http://www.microsoft.com/MOF/`

IT-related processes at CDTM and naming the critical success factors regarding acceptance of the measures on the one hand, regarding the handbook's features on the other. In view of these conditions, it is possible for section 5.2 to list some recommended changes in the organization of CDTM IT or CDTM in general that compound the benefits reachable through the measures outlined in chapter 4. These recommendations concern only the people and the IT organization, while taking no special interest in the benefits of processes for the IT organization. The third section of this chapter (5.3) will then start an attempt at applying a process-driven ITSM-approach to CDTM IT for generating improvements in the third area of ITSM, the process level. The framework that is used in the attempt is the small-scale implementation of the IT Infrastructure library that has been introduced in chapter 2. A summary of possible measures and benefits closes out the chapter in 5.4.

5.1 Surrounding Factors

While viewing the technological aspects of CDTM IT in the previous chapter, there were very few interfaces to be found between the technology at CDTM IT and external environments. When viewing the organizational and process-related aspects of CDTM IT, there are a far greater number of connections to entities outside the IT organization itself. The IT task force is embedded in the general CDTM organization, comprised of a large number of students, the management team, the office team, and the CDTM board of directors.

The CDTM is a grown organization with a number of processes involved in running its operations. Some of these processes are either dependent on the IT task force's work for their progress or are intrinsically connected to CDTM IT. This group of business processes should be a focal point for the efforts of ITTF in order to stabilize CDTM's IT-related operations in general. These processes are introduced in 5.1.1.

For all changes, no matter if they are introduced through one of the recommendations or through applying ITSM processes, there is a need for active acceptance by all of the aforementioned person groups that are involved in or affected by the change. Most resistances that these changes have to face originate subconsciously and they are seldom spoken aloud. This is why section 5.1.2 tries to counteract these resistances proactively by naming critical success factors relating to the "people" aspect at CDTM.

In order for a handbook to be not only usable and applicable, but also to be used and updated, there are some critical success factors to be covered in its conception as well as in its implementation. A strong example for such a factor is the complex of decisions concerning the format and maintenance of the handbook. Section 5.1.3 describes and explores these factors.

5.1.1 Critical IT-Related Processes at CDTM

In every environment, no matter if it is a business or an educational institution, there are a number of processes present that are lived and practiced, even if sometimes the involved

people do not reflect on that or even do not realize it. CDTM is no exception to this rule and there even is a stronger share of non-reflected following of processes, simply because the management team is small and very closely coupled, and thus inherently proficient in self-regulation and non-authoritative delegation. As far as the identified processes are closely related or dependent on the IT task force's support, they are listed here.

Starting Off the New Semester

In every organization, there is a process for getting new members started up, be it employees in a company or students at an institute. At CDTM, some 20 students join each semester, and a Kickoff structure has been established to get them started. First, there is a so-called "pre-Kickoff", where the new students get their access badges for CDTM rooms and where they sign all the necessary legal papers. Following one or two weeks after that is the Kick-off weekend, an event that is a mix between workshop and social occasion, ringing in the semester proper for the new students. At the Kickoff-weekend, task force affiliations are chosen and the first social bonds are created in the new class.

For an efficient proceeding of the kick off structure, the communication structures for easily reaching the new class should already be in place before the pre-Kickoff. To the staff, this essentially means that the new students should be reachable by their CDTM-e-mail-addresses of the form "firstname.lastname@cdtm.de" and collectively by a distribution list of standardized format according to their generation. However, there is the problem that has already been outlined in section 5.2.4 (handling responsibilities), that the process for creation of the necessary accounts is not triggered early enough by a responsible entity. This has a higher impact than can be directly seen from the requirements named just above, because these requirements (i.e. only the new class' being reachable) are only the ones reflected by the CAs. A lot more is expected without mention, including the students being able to apply for course participation, the new class' being included in the distribution list covering the "active classes" of CDTM and the students' being able to use the wiki and VPN services. Not only is all this not communicated, but – as described above– also the data required for performing the large number of necessary tasks is often not provided. When the features are not available at pre-Kickoff, the ITTF is usually scolded by some staff member with the saying "But that was obvious to me!" showing the attitude towards the IT task force.

The Kickoff procedure is strongly IT-dependent and with all factors prevalent at CDTM, an extremely high potential of stress is involved. The process of getting a new class started up is already controlled from the organizational side and is reviewed by assistants concerning the educational aspects and the scheduling, but there is no standardization whatsoever concerning the IT part of the process, neither in the IT task force itself, nor on the organizational side concerning the interfaces to ITTF.

The Student Application Process

One of the most central events in the CDTM schedule is the application phase, in which students apply for acceptance into CDTM. The importance of this process is obvious; what would CDTM be without new students? Organizationally, this process has many aspects, including the planning and implementing of recruiting events and informational sessions at CDTM as well as visits during general lectures at other institutes to inform students about the opportunities offered by CDTM. Additionally, the process covers designing, printing and distribution of posters, flyers and other promotional material.

To apply for CDTM, students fill out an online application. This application was first realized as a web-enabled Lotus Domino database and strongly intertwined with the legacy intranet system by using the same login mechanism and user store. Then, a student created a java-based web application simply named ”Application Tool”, which is listed as a service in section 3.1.5 and is the central tool for rating and accepting or denying student’s applications. In recent times, a start-up named CVEX [2]was launched by some students, centering on a web-based tool for letting users create their curriculum vitae. This application was integrated into the process by letting applicants first create their CV in CVEX and then importing it into the Application Tool. All this was done without consulting with the IT task force, so a big part of the application process’ ”digital manifestation” is unknown and not transparent for ITTF. Still, the IT task force must support the process, since the complete application traffic goes through ”Webtools”, a CDTM server. In addition, the e-mail address ”application@cdtm.de” is routed through CDTM systems to a distribution list containing the office team, and the main link to reach the Application Tool is found on the CDTM web site, maintained also by ITTF.

The application process has been called ”the lifeblood of CDTM” by past staff members, and it really is extremely critical for CDTM operations. The dependency on CDTM IT is also very high, but the IT task force is kept out of the information pipeline. Staff and developers only contact the task force when a bug fix or feature change is to be placed on the Webtools server and usually the change is marked and viewed as ”extremely urgent”, interrupting all other tasks for the person who is assigned the Application-Tool-activity. Due to the missing transparency of the tool, some of these changes have even introduced errors, in one instance crashing the whole system and causing several hours of work for ITTF.

Student and Course Projects

Since a high percentage of work at CDTM is project-based, and most of these projects concern themselves with digital products or services, there is a high amount of project-related support required from the IT task force. Three course formats – ”Trend Seminar”, ”MPD” and ”e-lab” – regularly require the setting up of so-called ”Project Spaces”, meaning the combination of a Trac project management tool instance, an SVN repository and a WEBDAV[3]-enabled directory including domain mappings for a project website. In addition to

[2] `http://www.cvex.de`
[3] See glossary entry 6.4

these courses, there are several projects each semester that require singular activities and new services, extreme cases even need separate server hardware and special support for installation and configuration of services.

Since all of these projects require a certain amount of IT support, this aspect of CDTM's educational portfolio is very closely coupled to CDTM IT. For the generic and recurring tasks, a set of scripts has been created (described in the "Trac" paragraph of section 3.1.5) that greatly reduce the workload needed for creating the standard set of tools for the three abovementioned courses. Apart from this small procedural, there is no strictly defined interface between users and CDTM IT for requesting all the single-shot activities needed to get special projects off the ground, even though the actual tasks themselves do not differ very much from each other.

Communications

A mainstay of CDTM operations, of CDTM culture, and of the CDTM way of working itself is quick and uncomplicated communication, because that facilitates fast feedback and easy exchange of ideas. As a fast and ubiquitous method for such a type of communication, e-mail is the main information channel at CDTM. It is regarded as fast and reliable, while enabling archived communication in groups. The management team uses e-mail for all communication regarding CDTM matters, no matter if its character is trivial or essential. Consequently, all services listed in section 3.1.5 under the heading of "Mail" are indeed critical for CDTM operations.

A fact that is generally not realized today is that SMTP mail does not give any guarantees regarding delivery and regarding transfer time. Even though e-mail transfer today is virtually instantaneous compared to "snail mail", many factors can create delays on the transfer path. Delays can be incidental, like the ones caused by momentary overloading of a relay (alas, mostly due to spam), or can even be deliberate, like e.g. delays due to greylisting[4]. Since CDTM IT cannot guarantee service parameters that are not implemented by the appropriate standards, some of the demands that crop up in this environment must be argued down regularly. Nevertheless, e-mail as a critical process feature in all CDTM matters is so important that the IT task force regards it as one of its strongest focal points, though there are still no definitive management processes and monitoring guidelines defined for ensuring the highest possible availability.

Summary

The process descriptions that are given in this section hint at the importance of the IT organization to central CDTM operations. Since flawlessly working IT services are usually seen as a commodity, this importance is not realized by most involved parties until an error occurs. This circumstance is very noticeable at CDTM and unfortunately, a change of this situation is not very probable. Since one can not rely on a continuity in awareness about IT services

[4]More information see `http://www.greylisting.org/` and `http://en.wikipedia.org/wiki/Greylisting`

Process	Core Points
Starting off the new semester	• communication structure is set up • students must be able to apply for course participation • students must be able to use the Wiki and VPN services • process is strongly IT dependent • frequent coordination and communication problems in the past
Student Application Process	• web-based "Application Tool" (see 3.1.5) • changes by external party • process not transparent for ITTF • integration of third-party tool • extreme criticality during application phase
Student and Course Projects	• high percentage of project-based work at CDTM • standard set of tools constitutes "Project Space" • very closely coupled to ITTF
Communications	• quick and uncomplicated communication is essential at CDTM • e-mail is the main information channel • already strong focus point of IT

Table 5.1: Summary of critical IT-related CDTM processes

at CDTM, it is not only important to keep the criticality of core services such as e-mail in mind when talking about any kind of change in CDTM IT, but raising IT awareness and transparency of IT operations towards the CDTM user community is also recommendable.

5.1.2 Critical Success Factors - People

A factor that is often disregarded when managing an IT environment using the classical perspective is that there are not only configuration items, but also people affected by every action, by every change in the IT organization. The big ITSM frameworks, first and foremost the IT Infrastructure Library, take this into account by emphasizing customer satisfaction as a key performance indicator for IT organizations. In the special setting of CDTM with no definitive distinction between customer and service provider, a closer feedback loop is present concerning the customer satisfaction factors that are directly and overtly visible. Such are for example response and quality of IT support as well as stability of the services as

seen from a user perspective, which can sometimes differ from the IT perspective more than marginally. The close feedback loop, the personal acquaintance of IT task force members with all students and the fact that each task force member is a user depending on the services themselves keeps the customer perspective in the focus of CDTM IT already.

Nevertheless, a user group that is more detached from the IT task force than the normal students are is the management team of CDTM. The current group of assistants – aside from the IT CA, of course – takes a very detached view on IT as a CDTM operation and tries to fortify its position as customer using free commodity services. Since the management team is the central entity deciding on strategic issues, which often strongly affect IT operations, there is a need to counteract either the removing of the management team from IT or the satisfaction-related effects thereof. For CDTM IT, this results in critical success factors that are subsumed into the two categories below. The listed factors address views of the assistants that have never been openly voiced or communicated to CDTM IT, but that rather surfaced tentatively in discussions preparing IT decisions, in discussions inside the management team (”leaked” to ITTF), and in private communication when meeting socially. Consequently, the list is far from complete, since there is always a subconscious factor involved in subjective views. Furthermore, the high level of dynamics at CDTM results in an ever-changing situation and thus there may be new factors cropping up or other factors disappearing at any time.

Information Flow

The most critical factor influencing the management team’s perspective on IT is a well-regulated information flow. Until now, the assistants and users were only informed in case of planned, long-term downtimes or if an issue with a service could not be cleared after a certain time, sometimes a few hours, sometimes days. This, together with the CAs’ seeing the IT services as a full responsibility of the IT task force, leads to all problems reflecting on ITTF, no matter if the problem originates inside CDTM IT or if e.g. the network link to the LRZ is interrupted. The only remedy for this situation is to inform the management team as soon as possible and as fully as possible.

The **selection of information** to be sent to the management team is an important matter, since an information overload is as bad as giving too little information. In the one extreme, too much technical information put into infrequent messages, an overload can lead to misunderstandings. The other extreme, very frequent messages giving information of little immediate importance to the recipient, lead to messages being disregarded as noise, having the same effect in the end as not sending any messages at all would have. Consequently, finding – and continuously adjusting – the balance is of great importance when regulating information flow to the management team. The list below gives some pointers as to what features are important in this respect. Information that pertains to transparency of the IT organization is not listed here, but below in a special section.

- The management team must be in the information pipeline for scheduled downtimes right from the beginning of downtime planning.
- In case of system or service failures, the management team must be the first to be

informed that the issue has been detected and that work is in progress, giving an estimated time needed for a solution.

- If resolving an issue takes longer than anticipated, corresponding information must be sent to the management team directly.
- After an issue has been resolved, the affected users must be informed that the respective service is back up and the reason for the issue must be given in a way understandable to the user (this is especially important since most assistants at the time are purely focused on business administration).
- A change in the environment that is visible to the users in any way must be communicated not only when it is done, but already when the time of change has been fixed.

The above pointers are of course not exhaustive, but provide a good starting point for the task of implementing and regulating information flow. That they mostly concern themselves with information flow to the management team should not distract from the fact that informing the users in general is also paramount for continuing satisfaction on the user side. For the reasons mentioned at the beginning of this section, informing the students can be done in a more lax manner, i.e. if an issue arises and is resolved quickly, then the students need not be informed about the start and end of resolving the issue.

Informing the student community in such a manner would only lead to an information overload of the ”too many messages” category, since already the basic CDTM communications produce a high count of e-mails in students' inboxes, and to make sure important ITTF messages are read instead of deleted unread, the IT-related mail volume for students should remain low. It is an option to use the Mailing List service described in 3.1.5 for all the low-level IT information, so users can subscribe to the list if they like to stay informed on that level.

The main result of an optimized information flow is a higher trust in ITTF as an organization, because the work that ITTF performs is visible to the users. Additionally, it will lead to a higher level of personal identification with ITTF on the user side, resulting not only in seeing the IT task force as a part of CDTM instead of a service provider, but also in a higher level of understanding, giving moral support instead of demanding performance.

Transparency

The fact that the IT environment at CDTM is large and complex considering the size of the organization leads to a low level of transparency for the users. CDTM IT is seen as a big, complicated thing that they do not understand. Consequently, the IT task force is treated to a high number of requests and inquiries about services and systems, and it is seen as a small, closed group of people (not ”group of co-eds” in this case) responsible for all things IT. This situation is obviously disadvantageous, since the complexity of the infrastructure is easily overestimated from the perspective of the user and since the closed-group image discourages a fully open communication. If more information about the environment and the organizational workings inside ITTF were given to the users, the number of requests

and inquiries would be reduced by their amount pertaining to information that is essentially obvious and easy to understand, but that is not available to all students.

A higher level of transparency can also help against the situation that people who are eager to learn about technology and IT management keep away from CDTM IT, discouraged by the ”apparent” complexity. This means that on the one hand interaction between ITTF and the other students is lowered, on the other hand it follows that the students do not learn as much at CDTM as they could or as they want, which goes against the educational, and in part the interdisciplinary, goal and aim of CDTM.

Finally, a higher level of transparency can lead to a better picture of CDTM IT in the minds of all users. This is because having information about the systems and their interoperations, not only inside CDTM but also with e.g. LRZ systems, helps in understanding that only a small part of the already low number of issues and downtimes is actually related to responsibilities of CDTM IT. Consequently, the high stability of CDTM-internal services can be appreciated and improvements for the users made by CDTM IT are more visible than before.

Involvement into IT

With the assistants removing themselves from all things IT, it becomes more and more difficult to keep the ties between ITTF and the other task forces without implementing defined interfaces and roles. This measure was unnecessary in the past, not because of the lower complexity or size of the IT organization, but due to the close communication and coupling inside CDTM. Given the number of task forces, workgroups and teams at CDTM, there would be at least ten to fifteen new interfaces needed. Designing and implementing such a high number of interfaces, compared to size of the CDTM organization, would create an extreme overhead not only in workload, but also in communication and organization, and thus is to be avoided.

The alternative to creating interfaces is to **reinstitute the involvement of other entities into IT processes** and vice versa. This does not necessary mean that other people have to do IT work. It simply means that IT issues are not added to other task force’s proceedings as an afterthought, as it is done now in some cases, but that the IT task force is informed early on when a process needing ITTF support in its later stages is started in a different task force. On the other side, IT should inform the other task forces about new features and new services before they become available so the other task forces can evaluate their benefit up front. Additionally, ITTF can inform the other task forces about changes that have back end ramifications for other task forces and their communication to CDTM IT, like e.g. changes in the registration process for temporary users.

Concerning the management team, it can be very profitable to include the CAs in IT processes, not only for the reasons of transparency and information flow that are mentioned above, but also to reestablish IT in the management team as the CDTM core function that is factually is. This involvement in processes is already in place for the creation of project spaces mentioned under the headings of ”SVN” and ”Trac” in 3.1.5, where new project space requests must be signed of by the CA handling the connected project. Other aspects

of CDTM IT can be handled by assistants, even if the assigned CA has no IT knowledge whatsoever. An example is the approval of changes in the workstations' software set after review of the reasons' documentation, a task that in ITSM is usually assigned to the change manager. For CDTM IT, it could well pay off to examine its processes and roles to see if other assistants aside from the IT CA can be "recruited" for ITTF tasks. This not only enhances penetration of IT into the management team's minds but also enables a possible fallback for the IT CAs roles in case of vacation, sick leave, or emergency.

The effects of interweaving ITTF and the other entities of CDTM are various. They not only enhance relations between the groups, they also remove the need for overly complicated interfaces between CDTM sub-entities. Additional benefits are a higher redundancy of functions in IT management and a higher IT awareness of CDTM staff. Not following this option means that the CDTM IT task force moves further into becoming a semi-official service provider, without any budget, staff, or reimbursement, but with all the responsibilities and liabilities implied.

Summary

Taking care of the issues that are not consciously reflected by the CAs may have a big beneficial effect, since these issues greatly affect IT-related decisions of the management team without conscious knowledge of that influence. Subconscious issues can be countered by a special information policy that sets unclear perception of IT aspects straight, without directly addressing the team members with "you see this wrong" but rather by openly demonstrating the true situation at every corner. In addition, a higher level of transparency can lead to more trust in CDTM IT. This would for example prevent a planned reboot of a machine that was not communicated to the management team beforehand (simply as being of low import or interest to them), from being counted as an unplanned downtime, resulting in a higher perceived stability if such information is made available.

Table 5.2 summarizes the core points of the abovementioned critical success factors. There surely are more factors inherent in the scenario, but they will become apparent when implementing processes and when following the recommendations given below. Only then, an estimation of their importance be performed and a course of action to ensure their fulfillment can be devised.

5.1.3 Critical Success Factors - Handbook

As there are critical success factors related to the people aspect, there are others pertaining to the handbook itself. These are of no less importance than the factors just described, though there direct, tangible impact is much smaller. This should not distract from their importance, since disregarding these factors will bring extreme repercussions in the long term. If the handbook that represents the actual basis of work at CDTM is not used according to its critical success factors, the benefits created by its implementation will diminish and, if counteraction is not taken then, they probably will even be negated.

Factor	Core Points
Information Flow	• Almost no information flow present now • Information selection is extremely important • Informing students differently from management team is necessary • Possibly utilize mailing list service • Results in higher trust and empathy towards ITTF. • Results in higher visibility to the users
Transparency	• CDTM IT seen as big, complicated, incomprehensible • High number of requests and inquiries • Seen as small, closed group • Prospective members are discouraged by visible complexity • Higher transparency can improve picture of CDTM in all minds
Involvement into IT	• Assistants are removing themselves from IT-related processes • Need for many defined interfaces if not counteracted • Alternative: reinstitute cross-involvement • Enhance cross-communication • Include CAs in IT processes • Evaluate possible role-sharing • Various beneficial effects

Table 5.2: Summary of people-related critical success factors

Handbook Maintenance

The handbook (as part of the concept) created with this work is to be used ”in production” to run CDTM IT. It is imperative to realize and to convey that this concept is not a fire-and-forget solution that is put in place and remains static ever after. It should rather be a living object that grows and changes with CDTM IT itself and with the requirements and work areas that CDTM IT faces. In a more standard environment, there usually is a role or even a person wholly responsible for managing, reviewing, and updating the ITSM processes. At CDTM, there is no constant staff available for this role, no one the role could officially (that is, hierarchically) report to and on top of that the high level of dynamics implies that the role would take up a significant amount of one persons' available time. Therefore, to ensure a proper maintenance of the concept, the maintenance procedure itself should be a part of the handbook itself, and is a mandatory read for all new members of CDTM IT. This shifts the maintenance workload over to the people using the concept who are closer to the action itself and who can therefore better judge a process's applicability and quality.

There are several options available for achieving proper handbook maintenance. One of

these is a **regular review of the concept at the beginning of each semester** by teams composed of old and new members of the ITTF. This would have the additional effects of showing the ropes to the new ones, of building the communication and community between old and new members and not least of having the concept regarded by ”fresh minds” regularly. Additionally, the full concept would be reviewed regularly, making sure that there is no obsolete or unnecessary information left over from retiring services or similar actions during the preceding semester. The maintenance of the handbook in this option could be constricted to the beginning of a semester, or can be scheduled at the beginning of the semester to take place parallel to normal operations. Only enabling handbook changes at the beginning of a semester has the positive effect of not taking up effort during normal operations, when the support effort for students can be high. This is countered by the adverse effect created by necessary changes that crop up during normal work and have to be redundantly documented for inclusion in the handbook at the beginning of the next review period. If changes during the semester are allowed, this allows for changes to be slowly and thoroughly worked into the concept over time, but if the support load during the semester is higher than anticipated, then changes may take a long time to be incorporated and could even be lost, resulting in an outdated part of the handbook.

Another option for maintenance is to update processes only when they are found to be inaccurate or outdated during their use. This option could be labeled ”**as needed**”, and is by far the option with the lowest workload produced for handbook maintenance itself. The downside of following this option is the problem that seldom used processes can become outdated rather easily and – more importantly – that obsolete or unused material is never purged from the handbook at all, resulting in a bloated, partly stale document. In essence, this mode of maintenance is used in the current IT Wiki, and practice shows that the danger of storing obsolete information is to be taken seriously.

A third option for handbook maintenance relies on a **specific person responsible for maintaining the handbook** and nothing else. It has been mentioned above that there is no fixed personnel available for this task, but the structure of the IT task force allows for another way of making this maintenance mode possible. If enough new students are recruited in a semester, one of them can be assigned the role of ”handbook maintainer”. The only task of this person would then be to check the handbook for necessary changes as well as going around the ITTF and around CDTM, consulting everyone in possession of knowledge about the processes in the handbook if the documentation is still up to date and correct. Since this task can be anything from lightweight to gargantuan, depending on the approach used to perform it, the can be adjusted in its mode of operations. If the task turns out to be very lightweight, the role can be augmented by assigning more tasks to the person or by expanding the role to extend the concept as well as maintain it. Alternatively, the role can be stretched out to two, three, or four semesters, incorporating the duty of introducing the successor into the task and of documenting this facet of the role as well.

Since each mode of maintenance has its advantages and its challenges, certainly a mix of these options optimizes the situation. Due to the uncertain mode of recruiting new members for the task force, the third option can be ruled out, no matter how high its attractiveness when focusing on high-quality handbook maintenance. **A mix of the first two options** could be implemented to minimize workload during the semester while keeping the handbook up

Option	Core Points
Regular review (generally)	• Regular review at the beginning of each semester • Build community and communication in ITTF (+) • Handbook reviewed by fresh minds (+) • Full concept reviewed (+) • No obsolete or unnecessary data possible (+)
Regular review with lock	• No extra effort during semester(+) • Phases of redundant documentation(-) • High short-time load (o)
Regular review without lock	• Slow and thorough incorporation of changes (+) • Changes may take longer time (-) • Changes may be lost in extreme cases (-)
As needed	• Items are updated if found outdated during use • Lowest overall workload (+) • Seldom used processes can become outdated (-) • Obsolete material is never purged (-)
Dedicated Role	• One specific person responsible for maintenance • Check handbook for changes, consult knowledge owners • Only task of the person makes task reliable (+) • Can be adjusted in load (+) • Can be augmented by additional facets (+) • Role can cover multiple semesters if person available (+) • ITTF can not count on resource availability (- -)
Possible Mix	• Short review once a semester • Processes used in last semester are ”current”, updated ”as needed” • Remaining processes selected into work queue for semester • Changes in ”current” processes small and easy/quick to implement (+) • Minimizes workload during semester (+) • High effectiveness in keeping handbook up to date (+) • New students are phased in (+) • No process outdated by more than one semester (+) • No stale information (+) • Regular semester-review phase has low workload (+) • Can be handed over by semester to ”handbook maintainer” role (+)
Legend	• *(+ +),(+),(o),(-),(- -): positive/negative effect of aspect* • *no value designation indicates description information*

Table 5.3: Possible modes of handbook maintenance

to date and while phasing in the new students. To achieve this, the handbook is reviewed once a semester, phasing in the new students. Processes that have been unused for a long time are selected into a work queue, which is checked over the semester for changes and obsoleteness. Processes that have been used at least once in the preceding semester are regarded current and changes in these can be documented ”as needed” during the semester, if resources allow, or are submitted for review in the next semester. This mode of maintenance ensures that the ”as needed”-changes during the semester have a high probability of being small and easy to implement, since no process can be out of date more than one semester. Seldom used processes do not clog the handbook, since they are weeded out each semester, and the regular maintenance review periods are kept on a low work-intensity by scheduling the checks and changes for the semester. If resources allow, all the necessary changes found during the review phase can be handed over to a ”handbook maintainer” as described in the third option, but there is no essential need to rely on availability of people for the role. Table 5.3 summarizes the options and gives a quick overview of the mix just described.

The mode, and thus the process, of maintaining the handbook must be decided upon by the assistant managing the IT task force and should then be properly defined and finally placed into the handbook itself to ensure not only that the process is followed but also that it is reviewed as regularly as all other processes.

Format of the Handbook

An official ”handbook” for operating an IT environment must give the notion of being a proper, official ”document”, including a kind of versioning and given importance by frequent reference to it. This keeps alive the connotations of the handbook being serious and authoritative, which is necessary for not turning into a collection of disorganized paper slips over time. The frequent reference and the versioning are also useful to emphasize the ”living” character of the document to prevent it from becoming a stale archive of obsolete information. It is not easy to find the balance between an authoritative document that is protected from too easy change on the one hand, and a living handbook, that changes with the environment in a timely fashion, on the other. On top of that, once it has been found, keeping this balance is crucial to a stable running of CDTM IT. To make keeping the balance as easy as possible, it is necessary to find a format that not only supports easy changes in parts of the handbook, but also allows for easy versioning and, very importantly, allows for creation of a printed version of the handbook to give to new students to read.

Since much of the information pertaining to CDTM IT is already stored in the IT Wiki, the **use of a Wiki system** for the handbook suggests itself. The advantages are obvious: a wiki does versioning, it tracks the authors of changes, it is quickly and easily accessible from any PC with a web browser, it allows editing of rich text, it works with attachments, and the feature list goes on, depending on the specific software package used. On the downside, it has some serious disadvantages that have show-stopping potential for use as storage for official documentation. The overwhelming majority of wiki software packages rely on a web server to function and do not provide the option of creating an offline version of the data. This is a crucial property needed for handbook storage, since a specific case when the handbook is needed is a downtime of the web server. Additionally, for holding a stable

documentation, the mode of editing allowed by a wiki is too easy and too quick, as an item of the handbook should not be changeable at a whim. In a wiki system, much of the editing is done on a micro-change basis with a high number of save actions in between, and usually there is only one editor at a time. Multiple persons should be allowed to work on a change before it is committed to the authoritative handbook store. To summarize the problem: a wiki does not encourage or require conscious, well thought-out editing. In addition to that, a wiki does not have enough of the aforementioned ”official document” character because it is seen by most people as fleeting information due to its provisioning for quick editing and deleting. These aspects all lead to the same conclusion, that a wiki should not be used as handbook storage.

The psychological factor of encouraging conscious editing and committing of changes by multiple persons is covered by one of the systems already in place at CDTM: **the SVN service**. SVN (short for ”Subversion”, see 3.1.5) as a successor to CVS (the ”Concurrent Versioning System”) is used most often for the versioning of program code in software projects. Its properties relating to the storage of a handbook are as follows:

- Contrary to CVS, it is also able to **handle binary files effectively**, only saving changed parts of these files instead of saving each version as a distinct file. This counteracts the extremely high usage of disk space when versioning binary files like images, PDF files, or documents saved in the proprietary formats of various software tools like office suites or vector drawing programs.
- An SVN repository is first off **designed to be used offline**, checking out a working copy and updating or committing as needed. This provides the mentioned offline version of the handbook for use in case of system failures or if the users in need of the handbook are offline themselves.
- For on-line use, there are **many add-on packages** for SVN that provide a web interface for navigating the repository in its current state while allowing access to previous versions of the contained files.
- An SVN repository is essentially an image of a sub-tree of local file system, a form of organizing documents with which every computer user is **already familiar**.
- Searching a file system sub-tree is done by all current client and server operating systems natively, so a **full-text search of the handbook is always possible**.
- SVN provides means for the **inclusion of meta-information** in the repository, allowing for an additional vector for implementing categorization and for storing document state information if necessary.
- **Access control is easily managed** on the system level with a high possible granularity and a low minimum granularity.

The above list illustrates that SVN, as a system created for versioning as its central function, is the prime choice for storing and versioning of the handbook. The feature first listed – the effective handling of binary files – is the pivoting point for the decision to use SVN, since it leaves the choice of file format completely open, enabling the highest possible flexibility in this respect. Additionally, the flexible granularity of access control enables different

strategies concerning the mode of editing, from allowing full access to the whole ITTF down to only allowing the IT CA to commit changes, a recommendable set-up if the IT-CA is not very deeply involved in day-to-day operations.

With the versioning aspect of the handbook format covered, the question of an optimal **choice of document type** is still open. There are two basic operations to consider. One is editing the handbook's items; the other is reading them for using the handbook in operations. The importance of being able to read the items from any PC rules out many proprietary software packages, for example office software suites like Microsoft Office or OpenOffice.Org, since these products are not necessarily available on every system or even on every operating system flavor. Editing items using formats natively available on all operating systems and machines restricts choices unnecessarily, essentially to plain text format. However, there is no necessity of using the same format for editing and reading. Rather, there are distinct advantages of using different formats for the two tasks.

For **cross-platform reading**, a format that has established itself widely for a long time is Adobe PDF (standing for "Portable Document Format"). PDF files can be created quickly and easily from any other document format through freely available software and can then be read on any platform using a wide variety of reader software. Changing an Adobe PDF document, on the other hand, is possible, but can only be done comfortably by using expensive, proprietary software. Since the items of the handbook should have a very low change rate and a high read count, using PDF as a reading format for the handbook is feasible with creating a new PDF file with each new item version. This addresses another challenge inherent in using the same format for editing and reading, e.g. by enabling a differentiation between "draft/change" versions and "release" versions of items through editing the drafts in the source format and creating a new PDF on release. This draft/release cycle ensures that no intermediate version of an item is inadvertently used, which is possible when using the same format. In the SVN repository, the PDF versions can also be put into a separate subdirectory, allowing for access control – so only the IT-CA can commit a new release of an item – as well as creating an easily printable version of the handbook by checking out only this subdirectory from SVN.

For **creating and editing** the items of the handbook, a format must be chosen so that every member of the task force has access to the program and so that there is no too steep learning curve for using the software. If there is no learning curve at all, there is again the possibility of too casual editing, if it is too steep then the resistance to maintaining the documentation becomes very strong. The cost factor rules out the established, big process modeling tools. It may be possible to use the features of a workflow management system if such a system is implemented at CDTM (the possible uses for such systems are given in 4.8 as well as 5.3.5). Since this is only a rather remote possibility, standard tools not centered on processes etc. must be taken into consideration.

Since reading the editing format from everywhere is not necessary, there are the standard office software suites available to use. Microsoft Office has the advantage that every CDTM student is familiar with its usage and the disadvantages of being not free and not available on Linux, for many students restricting the use of Microsoft Office to CDTM student workstations. The competing software suite, OpenOffice.Org, is available free and on all client platforms. Additionally, it is installed on all CDTM workstations and thus available to stu-

dents not owning a PC. The downside of using OpenOffice.Org is that the familiarity with the interface is lower and that some features, like the formatting of tables in the word processing component, are not as mature (or just not as intuitively usable) as they are in their non-free counterpart.

The final choice of document type is to be made by CDTM management, because there are license questions to be answered and because there is policy involved which is not object of this paper. As a recommendation, there can be given the combination of Adobe PDF for reading and OpenOffice.Org, in combination with other open source software if necessary, for editing documents, since there will be no predictable cost or licensing issues with this combination in the future and since the needed software is already installed on most CDTM machines.

Summary

Factor	Core Points
Maintenance mode	• Possibilities listen in table 5.2 • Optimized mix described (regular short review and work queue)
Choice of versioning	• Wiki not recommended • SVN recommended, since: – Capable of handling binary content – Designed for offline-use – Variety of add-on modules – CDTM users are familiar with it – Can include arbitrary meta-information – Easy access control
Document type for reading	• Must allow cross-platform access • Reader must be free, but have high market penetration • Should allow intuitive draft/release cycle • Adobe PDF recommended
Document type for creating and editing	• Program should be free • Cross-platform availability is strong advantage • Usability/familiarity must be high to prevent resistance • Should be future-safe in license and format • Augmented standard office software suites recommended • Decision must be made by CDTM IT management

Table 5.4: Summary of handbook-related critical success factors

The core points of the critical success factors with regard to the handbook are summarized in Table 5.4. Since the handbook itself represents one of the critical success factors for the operation support concept, the importance of the abovementioned factors must be rated much higher.

5.1.4 Summary

The IT organization at CDTM has been operating as ”a team apart” for a long time, which has augmented the challenges created by the dynamics of the scenario. This section has shown that the work of the IT task force is crucial for the running of CDTM's business processes and more than just the technical perspective described in chapter 4 needs to be addressed for creating and keeping a stable IT organization for the future of CDTM.

5.2 Recommendations

The first aspect of approaching the processes and the organization of CDTM IT covers recommendations that can be given when taking the scenario analysis from chapter 3 as background. As has been done in the complementary list of measures in the previous chapter, each measure will be assigned a value, if possible, and these values will be compared and summarized when finishing the section.

5.2.1 License Management and Software

A proper software and license management is needed to ensure legality of server and client operations at CDTM. Most servers may run on open source software but there still are some other pieces of software in use that in some cases follow very specific licensing terms. The term ”software management” as it is used here implies a set of topics to be taken care of, even influencing security management for clients. Some of the topics may be put into the handbook as processes, such as the process of deploying a new version of any piece of software. Other topics, like the definition of a set of standard software to be used, are influenced by external variables such as CDTM policy (what tool is used for producing papers at CDTM, LaTeX or Microsoft Word ?) and cannot be simply decided upon by CDTM IT or by this thesis. Thus, these topics will be put into the abovementioned recommendation sheet if they are covered in this work.

Some topics result in reasonable recommendations to CDTM IT management at once and without further analysis. These include the **migration of the student workstations** from Windows 2000 to Windows XP and the upgrade of Microsoft Office from version XP to version 2007 simply because the current setup is nearing the end of its support lifecycle. Mainstream support for Office XP ended in July 2006, Windows XP transitioned to extended support in 2005 as given on [Micr 05a] and [Micr 05b]. The current workstation hardware may need minimal hardware upgrades (RAM only) for supporting the new versions but is then still sufficient for normal student work. In the case of new hardware being

purchased there will be no possible capacity issue because there are *very* few workstation models available that do not support the combination XP/2007.

There is not really a choice when divining the value of license management in the scenario. For legal reasons, this is mandatory. Software management is here used in a sense that closely relates to the ITSM process of Release Management, but at this moment is to be seen on a much smaller scale, only incorporating the creation maintenance of a set of standard software on CDTM workstations. This is to ensure that all users can create documents according to CDTM policies and standards and does not yet include a fully-fledged software library or other far-reaching measures. The value of software management in this sense is also mandatory at CDTM, especially since some software installations on CDTM workstations have been identified as problems, creating a large number of incidents over time.

5.2.2 Knowledge Management

Knowledge management is a field that has received much attention all over the business world for a long time. Many times the loss of knowledge has cost organizations dearly while the realization of knowledge has created huge benefits. Even a superficial survey of existing publications and other available information on the subject quickly shows that exploring this improvement aspect in deep is out of the scope of this document by a large factor. Still, with all the dynamic aspects of the scenario, especially the high throughput of ITTF members, this topic is of high impact for CDTM IT, so this section will try to cover as much ground as possible in recommending some steps to make use of knowledge management either in the IT task force or at CDTM in general. Ideally applied, knowledge management not only makes sure existing knowledge is documented or catalogued, but it also keeps track of knowledge that is needed, gained and that is lost (preferably *before* it is lost).

Since here we are concerned with CDTM's IT environment only, we will concentrate on IT knowledge here, even though the same thoughts and procedures may apply for any area of knowledge. Main consumers of IT knowledge in the scenario are course-related projects and the IT taskforce, which accepts not only IT-savvy students, but also encourages interested students from other disciplines to join the task force and learn about IT. Other students showing high levels in IT-related knowledge take part in the CDTM program but do not want to join ITTF because they rather devote their time to gaining interdisciplinary experience and because they also "do enough IT work in CDTM projects and outside CDTM". These students may still be willing to help and to teach IT knowledge on the side, especially if they were rewarded for that with CDTM credits. Consequently, it should generally pay off not to concentrate on ITTF for management of IT knowledge, but rather to try evaluating the IT knowledge available at in of CDTM. After all, the knowledge management model of the ITTF could serve as an example for all other areas of operations of the institution.

Although there has never been a dedicated knowledge management in place in CDTM IT and although there were only contained, ad-hoc attempts at securing and transferring knowledge, there have always been some students at CDTM who dedicated their time to ITTF for

more than one semester and who tried to pass on their knowledge to their successors. With recent management changes the work and essential communication in the taskforce has been restricted to the current semester's "active" students only, thus essentially shutting off the open communication that took place before without providing a replacement, enhancing the need for preservation of existing knowledge for future generations of CDTM IT students. The term "documentation" here includes several distinct tasks. After existing knowledge is discovered and identified, a profile of existing versus missing knowledge must be built to deal with the challenges created by missing expertise. The next task is then to ensure the integrity of the existing knowledge for the future, either by fixing it into written or drawn documentation or by creating models for transporting all the existing knowledge through teaching. The final, continuous task is then to introduce a system or process for monitoring the development of the knowledge base. This task enables proactive measures for prevention of information loss, meaning survival of essential expertise, as well as easing the planning for future knowledge build-up.

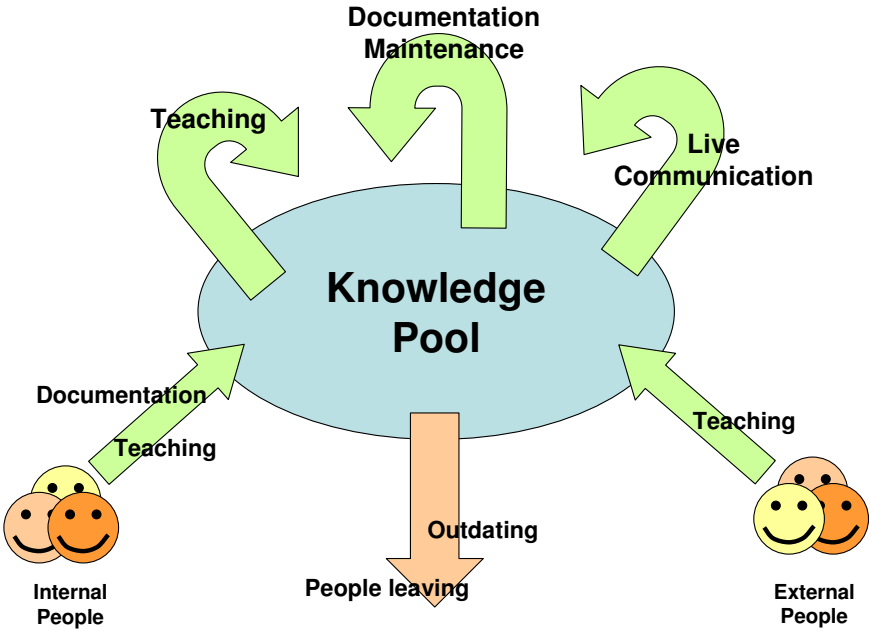

Figure 5.1: Knowledge flows to be monitored and controlled by Knowledge Management

Discovery

The discovery and identification of knowledge is a prerequisite for all other tasks, so it must be embarked on first. In most scenarios, in most groups of people, there is a tremendous amount of latent knowledge and expertise to be tapped if only it was known it existed. CDTM selects high-level students for an elite program, so there is an even higher average level of knowledge to be expected there. There are several ways to go about discovering knowledge; if one wants to cover all CDTM people in the search for expertise, the big challenge is doing this in a way that does not meet too heavy resistance. Inside ITTF, it could be possible to make all members document their knowledge and their expertise by assigning

it this as a mandatory action to each person. In the whole of CDTM, however, this task is much more difficult. Resistance is to be expected for various reasons, most importantly time-constraints, but also priority issues concerning tasks without tangible personal benefit and fear of additional workload if abilities become known[5].

Ways to gather the necessary information are manifold and include questionnaires, workshops, screenings and so on. In this scenario, a way must be found to counter the resistance described above or ideally, a query method is found that negates the resistance by design. In the future, it may be possible make it mandatory for people to provide a set of skills in their CDTM intranet profile or in a separate skill list on acceptance to CDTM, thus building up something like internal yellow pages on the fly. This would be resistance-immune because after a few semesters it is a simple requirement for everyone at CDTM that people experience as a feature of CDTM life and there is simply no alternative.

Viewing the results of the above investigations from a different perspective also gives information about specific knowledge that is not present but that is still needed for an efficient running of CDTM IT. Being informed of knowledge not present at CDTM allows for proactive, more efficient planning of IT tasks, because necessary knowledge can be gained by training existing task force members or – if time allows – by favoring people with this knowledge in next semester's recruiting phase. If these options are not available, it should be possible to buy-in the labor from outside or (temporarily or on a per-task basis) to acquire a person from the IT staff of a supporting institute who has the necessary knowledge.

Preservation

The logical next step after knowledge identification and discovery, and thus the next task, is the preservation of the existing expertise. Each of the two approaches given above (writing down and teaching) constitutes a high long-term amount of effort for all people concerned. The decision that is to be done by CDTM management is choosing between the two approaches according to the factors they perceive to be more important. It has to be kept in mind that the two approaches are only valid for the knowledge and expertise itself. Knowledge management always involves meta-knowledge, like the "knowing what we know" information set that has the knowledge categories and items that are to be handled by knowledge management. It is imperative to make that meta-information available in written form.

If all possible information is recorded in written form, this makes the knowledge available to every future reader with the necessary capability of understanding its content. There is, however the effort of documentation maintenance to be considered, which directly is proportional to how dynamic the recorded information is. Examples for very stable information are log files and meeting minutes; dynamic information is any knowledge that is subject to frequent review and changes regularly to adjust to outside events, such as a description of an evolving process. Neglecting the maintenance of such dynamic knowledge inevitably leads

[5]Unfortunately, in current times a "community" like the one CDTM was based upon in the beginning, more and more is seen as something to gain from and not something into which to provide

to stale, useless information after any longer time span. The big beneficial effect, however, is the long-term availability of knowledge.

Teaching

While reducing written information to reference material and fact sheets, the in itself very dynamic method of keeping knowledge present by teaching also has strong positive and negative aspects. On the ”pro” side stand the direct link between theory and practice, the direct feedback and verification of the applied knowledge, the more efficient transfer between student generations by replacing the write/read/comprehend model with explanation and feedback, and the very quick and ready availability of the information present. On the ”contra” side, there are several big problems to overcome. The biggest on is information loss, created by unused or unexamined knowledge, by knowledgeable students leaving CDTM prematurely, or by ”deterioration”, meaning students forgetting information due to the high amount of input faced when following at least two study programs at once. Other problems include information degradation (by insufficient teaching or understanding), loss of meta-information (forgetting that someone has a special ability or knowledge), and challenges in supervising and monitoring the knowledge transfer and quality. It remains to be decided by CDTM IT management if the pros or cons are stronger in this aspect.

Teaching IT knowledge does not have to be restricted to the IT taskforce. There are considerable benefits to be expected from conveying IT-related abilities to all interested students, since enlarging the available pool of knowledge opens some possibilities to enhance IT service levels. If motivation is possible, IT-proficient (and maybe even tested) students can handle first level support, alike to a living, walking FAQ and help system without maintenance, thus lightening the support load on IT students. In addition, students schooled in IT knowledge are less prone to make inadvertent mistakes, especially security-relevant mistakes. ITTF members who take over the teaching of IT basics can be rewarded for their efforts with CDTM credits, providing the motivation for teaching IT topics.

Until now, there has been a temporal blend of these two approaches in use in the ITTF. First there was very much information conveyed only by teaching, which was feasible due to the size of the task force and the close communication between its members. Over time, and with the complexity of the environment growing quickly, there first was a bigger need for fixed reference information like the abovementioned fact sheets. Following that, the task force diminished in size and because of the high weight on teaching as a transfer method the knowledge was concentrated into the heads of few members and thus writing down the knowledge to prevent loss became more and more important, initiating the use of the IT wiki as information container. A recommendation for the future can only be to continue adjusting the blend between written, oral, and didactic transfer, letting the amount of available time, resources and student’s abilities provide the recipe for the mix.

Meta-Knowledge

When the means of survival for knowledge are defined, it becomes necessary to embark on the continuous task of monitoring – and thus essentially ”managing”– the stock of knowledge, mostly boiling down to maintenance of meta-knowledge. Meta-knowledge represents everything that a knowledge management itself needs to function, including the lists of knowledge areas and of knowledge items. Maintaining it involves surveying the distribution of knowledge, meaning to know where each item is to be found. Finding a certain piece of needed information becomes especially interesting when following the above recommendation, because in that case current and non-stale knowledge fluctuates between the minds of students and written documents. The task of monitoring, surveying, and maintaining knowledge is not an easy task, especially in this dynamic scenario, and must be planned and structured accordingly. A fact that cannot be negated is that there definitely is a certain workload involved, but this amount of work is dwarfed by the amount of work (or money) needed to reacquire lost knowledge.

Value

The necessity of knowledge management is present in every environment. However, at CDTM there is a heightened need for a structured knowledge management due to the high level of dynamics described in 1.2.3. Some small efforts in this direction are already made, but these are by far not sufficient, so the introduction of a thorough management of knowledge is to be considered ”mandatory”.

5.2.3 Staffing and Personnel

No matter how much automation and self-supervision is built into a system, there always remain some usually quite simple tasks that need to be performed by human interaction. At CDTM, it is hard to find students who are willing to perform the necessary ”assembly line tasks” like applying windows updates to CDTM workstations or like manually migrating data from one system to the other during a project. These tasks are also mostly considered too low-key for warranting the attention and valuable time of an assistant, so in effect, they are done by some student who is dedicated enough to sacrifice his time for the tedious task at hand. In the past, some have considered and expressed that behavior as ”stupid”, but without these dedicated students, CDTM IT would not have reached the level of stability it has now.

Since one cannot count on having dedicated students available in every semester, it would be an extreme advantage to have a person responsible for tasks of above character on a regular and steady basis. There are several possibilities to acquire such a person in this scenario. From time to time, there has been a **working student helping CDTM IT**, but never for a period longer than four months and never with an overlapping successor to enable knowledge transfer, to extremely suboptimal overall benefit, obviously. The working students were also sometimes used for nontrivial tasks like software evaluation and customization, so that the

tedious standard tasks remained open. The only way to utilize the availability of working students properly is a two-fold approach. Step one, to create a to-do-list that the student strictly adheres to, following a schedule when necessary, as in updating clients for example. Step two, in case of an IT working-student leaving CDTM, to free up the budget for getting the replacement in early to enable knowledge-transfer. This approach favors long-term working-student contracts and helps increase the quality of work delivered.

Another approach would be trying to get approval for **funding of a part-time position** for an IT administrator. The overwhelming majority of institutes that run their own infrastructure have at least one staff member dedicated to administration and maintenance, and very few those organizations have a comparable level of complexity, not to mention dynamics, in their IT environment. The situation at CDTM (in conjunction with the prevalent opinions in the management team) unfortunately dictates that any human resource budget that becomes available is used for either new assistants or for working-students dedicated to supporting CDTM courses and operations, so this approach has a fairly low probability of being followed.

A final approach that can be used is to go for a **support agreement with another institution**, preferably one of the chairs represented on the CDTM board of directors. Such an agreement is actually feasible and comes into easy reach if one of the director's institute has some open resources in their IT staff time planning. The big downside, however, is that such an agreement must be free of charge for CDTM and in these cases priorities of the working staff lie with their own chair instead of with CDTM. That can imply work on CDTM issues being less thorough, response time for CDTM issues being much higher, and cessation of work for CDTM IT if the workload peaks in the partner institution's IT field. Additionally, the working staff may want to impress their own rules, strategies and processes on CDTM IT to simplify work for them, effectively limiting the freedom of decision in CDTM IT itself. The above factors show that this approach may seem profitable on first sight, but carries some burden with it that is not easy to bear.

When regarding all of these approaches with respect to the budget issues and the management situation, there is a low probability of staff being hired for CDTM IT. The IT-CA should try to put in their weight at management discussions to try for going a step in this direction, because the ratio of effect over cost is tremendous due to students being free for interesting, strategic tasks that improve CDTM IT and due to higher stability and security through maintenance done by the ”new” staff. This recommendation is valued ”very high” for these reasons.

5.2.4 Taskforce Responsibilities

There are very few definite operational responsibilities defined at CDTM with the team being small and flexible enough to work as a unit. This leads to effective and flexible work for day-to-day business but a side effect is that regularly occurring processes are often not initiated without a triggering event. An example process that was neglected repeatedly is the proactive creation of new student's user accounts, mail forwards and so on. On these occasions, the management team usually asked ITTF if the new students already had their

Method	Core Points
Working Student	• Short term only • Big issues for knowledge transfer
Acquire funds for part-time staff	• No IT budget • Funds are usually prioritized for non-IT measures • IT-CA is organizationally seen as ”IT”, but is overloaded
Support contract with other institution	• Preferably with connected institution • Some open resources exist • No budget, must be free • Loyalties lie with staff’s own place of work • Possible need to adapt to foreign policies, strategies, or rules

Table 5.5: Overview of methods for acquiring staff

mail addresses, only to find that the new accounts had not been requested by anyone yet. The triggering event in that case was the need for contacting the new students, and starting the process of user creation at that late time was followed by high-pressure work on the IT side, having to get missing user data from the office team, correcting spelling mistakes on the fly, and testing accounts only quickly. This chain of events is a manifestation of the dynamics described in the introductory chapter and it just goes to show that the above happened not once, but several times in a row.

Is it the responsibility of an overloaded IT taskforce or an overloaded IT-CA to initiate the process of account creation or should the initiation of that task actually be part of the general CDTM process of ”new semester kick-off”? If the latter is the case, then the ”Recruiting Taskforce”, that handles all the events around the new student batches each semester, should have the task of initiating the process as soon as all necessary information is obtained, at the latest this should be done about two weeks before the first mail contact using cdtm.de-addresses is necessary. If the former should be the case then this fact should be documented officially and a process must me defined, including the obtainment the user data until a certain time.

The above example shows that in certain cases, there is a strict necessity for defined responsibilities in order to reach a needed stability and to enable proactive, timely action to prevent hectic, stressful work on the IT side. At CDTM IT, these responsibilities should be identified, defined and assigned to a certain person or person group. If the responsibility for a process is assigned to a single person, the process gains a higher importance in the mindset of the assignee and this will raise the probability of timely process initiation. The CAs already have a high workload, so assigning whole processes to them is not really feasible. Instead, the CAs can be assigned the task of initiating, controlling and supervising a process. Thus, the responsibility for timely action is still at the desk of the CA, but the carrying out

of the actual work involved can be done by any ”resource” available to the CA. Following this course of action would greatly de-stress IT-related people during high-load times, as it would also improve processing time of standard processes of CDTM.

If this aspect of restructuring CDTM (IT) is combined with the use of a workflow management system (see sections 4.8 and 5.3.5), the positive effects can be maximized and there is a guarantee of no scheduled process being overlooked since such a system allows for delegation of responsibilities in case of assignees being or becoming unavailable. Additionally, such systems use roles to assign process instances to, giving the possibility to assign a process to ”any CA” and have it accepted by someone without having to go soliciting in order to find a CA feeling responsible. Even without a workflow management system, the task of assigning definitive responsibilities for CDTM business processes that are connected to IT is of such importance that this recommendation’s value is ”mandatory”.

5.2.5 Recruiting of Task Force Members

Recruiting new members for all task forces at CDTM is done during the kick-off weekend, an event where all students of the new semester get together with most of the CAs and some older students to get to know each other in workshops and social events. Each task force introduces their field of work and activity and students then list preferences for task forces they want to join. As has already been said in section 5.2.2, there is a significant number of IT-capable students not joining ITTF because they already do enough IT work on the side and want to learn more about different topics at CDTM, a fact that is absolutely understandable. Still, an IT environment that is as complex as the one at CDTM requires a certain minimum level of expertise to be present in the group, so a significant part of the task force members must show a certain level of knowledge. Consequentially, an inflow of capable students must be maintained in some way.

One possible approach in this respect is a **partial ”decoupling”** of the ITTF from the other task forces in such a way that there are still the two to five new ”official” members each semester on the one hand, but so that all IT resources of the new students are tapped on the other hand. To achieve this, a mandatory questionnaire can be handed out to new students, in a simple form, containing ”what I know about IT” on one side, ”what I want to learn in IT” on the other. This can also be incorporated into the Intranet system or in or a different portal, and can include other, non-IT related areas of expertise, akin to for example Xing/OpenBC (see 4.6.2). Since the course of studies is named ”Technology Management”, a certain minimum knowledge of technology should be strived for anyway; so why not let non-technical students learn IT from the technical ones? This would facilitate knowledge transfer and make sure that fallback-resources for ITTF in times of personnel shortage become available. This is an especially when the general CDTM recruiting process did not yield a minimum number of IT-proficient students for a semester.

Another possible approach would be a **forced recruiting** of capable people. This may have to go along with the same measure for all other task forces to keep people from objecting and from trying to extract themselves by only committing an alibi amount of effort into the task force and thus passively hindering instead of actively furthering task force activities.

If all mappings of new students to groups were handled authoritatively, it would take only two to three semesters to reach an effective ”it has always been this way” state, reducing the adverse effects just named. Nevertheless, this approach can only tap a part of the available IT knowledge and does not include an easy way to establish a teaching of IT knowledge to interested students. Additionally, this approach does not take measures against semesters low in IT proficiency, i.e. when the CDTM application review and interview phase did not turn out enough people with IT knowledge to keep the necessary expertise level in CDTM IT.

Still another approach can make sure that there are enough IT-proficient students by **modifying the CDTM recruitment policy** to include enough IT-knowledgeable students in the new class by default. When taking a different point of view, it is possible to advance students of extreme IT-related proficiency in the CDTM recruitment ranking to keep a very high knowledge level while not focusing on the IT head count and thus not taking in ”substandard” students in favor of the IT task force. The latter view was taken by the old group of assistants, who succeeded in creating a very high profile of IT knowledge in the task force, having the side effect of raising the environment's complexity and making knowledge transfer to the following, less-proficient students more difficult.

Option	Core Points
Partial decoupling	• Use all IT knowledge at CDTM • Needs knowledge management • Strengthens interdisciplinary factor of CDTM • Can augment other processes
Forced recruiting	• Produces resistance if only done in ITTF • May lower task force efficiency • Problems when few IT-proficient people are available
Modifying CDTM recruitment policy	• Making sure that each generation has a minimum IT knowledge level • May lower overall average grade of accepted students (image-question)

Table 5.6: Overview of options for changes in recruitment

In summary, a mix of the three approaches is very advisable. During recruiting for CDTM, applicants having high IT knowledge should be tagged to see if it is possible to attain a high level of IT proficiency without watering down interdisciplinary quality and entrepreneurial spirit. IT knowledge should be surveyed for all students in a semester, including the level of IT learning interest to provide another channel of learning for interested students as well as to have an overview of knowledge ready in case any project or task force finds itself in need of special knowledge. A forced assignment of students to task forces can be efficient, but could also prove extremely counterproductive, because all taskforce would have to be

affected. Generally, a reevaluation of the recruitment procedures – either for task force membership or for CDTM in general – is advisable and its value is set to ”high”.

5.2.6 Value Comparison and Summary

Option	Benefit	Costs	Rating
License Management and Software	License management is legally necessary, software organization is very recommendable	liceses are a monetary cost that can impossibly be circumvented, medium administrative workload for software organization	mandatory
Knowledge management	Loss of knowledge can not be allowed in an environment as complex as this, the benefit can be named ”survival”	medium to high workload, lower average load if widened to CDTM instead of IT only	mandatory
Staffing and Personnel	Higher motivation of students, no assembly-line work for task force members, safe knowledge	steady monetary cost, budget needs to be found	very high
Assigning responsibilities	Avoidance of misunderstandings, lowering rate of scheduling-related incidents	medium, one-time cost for definition and clearing up; low, regular workload for maintenance	mandatory
Recruiting for Task Force	Stable proficiency and knowledge levels, stable work force count	low to medium workload, depending on mix used	high

Table 5.7: Rating Overview for Recommendations

As table 5.7 shows, all recommendations have at least a value of ”high”, three of five are even mandatory, which can be used for gauging the prevalent general need for changes in organizational and process matters at CDTM. When recapitulating these recommendations, there is an apparent relation to some ITSM processes. As an example, release management covers much of the content of section 5.2.1, and as a best practice process it even surpasses the benefits of all possible measures listed there. However, these recommendations do not only require changes in the IT organization but also a very high level of cooperation on the business operations of CDTM, which are in some cases influenced by them. This, together with the focus of this paper being solely the IT organization, is the reason for these issues being addressed in these recommendations, and not in the following application of ITSM.

5.3 Applying ITSM Processes

This third and final part of this chapter strives in an attempt to apply ITSM processes to the scenario. As a framework, the ITIL small-scale implementation is chosen and will be revisited shortly. Then the two sides will be aligned in compact form, and the scope of application will be chosen to fit the timeframe of this diploma thesis. Then the chosen scope will be applied and some interesting parts of the application explained.

5.3.1 ITIL SS Revisited

The description of critical processes given in section 5.1.1 above strove to concentrate on the operational or business perspective of CDTM. If a framework fails to cover even a small part of the business process perspective of this environment, and thus needs creative customization in itself instead of only a scale down, it is not able to help the situation at CDTM. This is because in this scenario, it is extremely inefficient and thus impossible to first build know how about a framework for its customization and then implement it including a big amount of information and procedure relating to the customization itself. Optimally, knowledge about the framework itself is not necessary at all for using one of its implementations and only minimal familiarity with the framework is necessary to further an implementation. Of course, this optimal situation is unattainable, but it should be the point on the horizon to aim at.

The framework that has established itself as a *de facto* standard in a large part of the business world is the **IT Infrastructure Library**, already introduced in chapter 2. ITIL is a process-driven approach to IT Service Management and strives to cover the full perspective of IT in a business environment. Also introduced was the small-scale implementation of ITIL, providing a way to apply the mainstream ITIL best practices to small IT organizations. Now that the environment has been analyzed thoroughly and the classical perspective of managing IT organizations from the technology side has been exhausted, a match between CDTM IT and this publication suggests itself, but has to be explored before it can be applied.

5.3.2 Matching CDTM IT and ITIL Small-Scale

To align CDTM IT and the ITIL small-scale implementation, it first needs to be checked if the two sides do match sufficiently. To do this, the ITIL small-scale perspective is placed beside the described situation. Then the key statements of the book concerning what it is conceptually dealing with are compared to the scenario, and, following that, the needs CDTM IT are checked for coverage by ITIL small-scale suggested roles.

Does ITIL Small-scale target CDTM?

To check if CDTM is in the target group of organizations for small-scale ITIL, a preliminary check needs to be done to see to what extent the preliminary assumptions for applying small-

scale ITIL given in the publication are met. The book names six exemplary "**constrained circumstances**" that many organizations have to work within, mentioning that it would be unlikely for an organization to be subject to only one such constraint. Indeed, of the named five constraints, all apply at CDTM, with only one of them to a small extent, all others strongly or even to the extreme. Also, the book focuses on two target groups, "organisations delivering IT services with limited fiscal resource", and "IT organisations with a low ratio of IT staff to customers". It views these as separate situations, but both apply in this scenario at the same time, an event that is not touched upon there.

In addition to the constraints, there is a list of features attributed to small IT environments in a "**village and city perspective**", including aspects like a formal vs. informal culture and quick vs. slow communication. Of these features, a significant percentage does match CDTM, some even spot-on, e.g. in the section "Relying on individuals" that states the inevitability of "reliance on one person to know things and be the local expert". Also the facets "Limited Knowledge" and "Understanding of the Business" are close to CDTM's reality. In conjunction with the scenario analysis given in chapter 3, an especially striking sentence is to be found in small-scale ITIL's section 1.6.1, covering high organisation costs: "relatively more consultancy will be required (although if funds for consultancy are not available this would result in lower service levels being delivered)". The juxtaposition of this citation on one side and the service levels provided by CDTM IT on the other against the no-budget background gives an insight to the effort put in by the IT task force's members. "Per capita complexity" is the final facet given, showing one of the very few pointers to ITIL being usable in a non-business setting while pointing at one of CDTM's special circumstances: "Many small IT organisations, for example, those supporting scientific or research organisations, have a customer requirement that is highly complex and extremely dynamic".

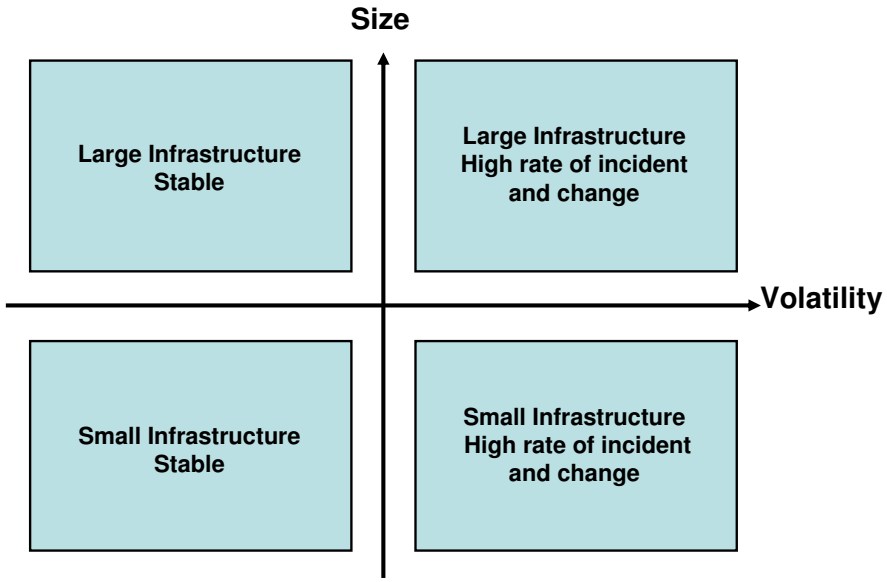

Figure 5.2: Categorizing small IT organizations according to small-scale ITIL

The OGC book categorizes IT organizations by **infrastructure size and volatility** as in figure 5.2, emphasizing its focus on the lower right quadrant, defined by the combination

of a small infrastructure and a high rate of incident and change. Since the ”volatility” in IT at CDTM does not lie so much in the rate of incidents and changes, but rather stems from the special organizational characteristics of CDTM and ITTF as organizations, CDTM IT is quite difficult to place in the diagram, especially since there is no exact scaling of the dimensions given. The text that relates to the diagram helps in this respect by placing the top right quadrant into the focus of mainstream ITIL guidance and by outlining the stability level extant for environments placed in the two left quadrants. The diagram is considered by the text to be complete considering small IT organizations, so CDTM IT must consequently belong in the remaining quadrant, with the special dynamics and features of CDTM representing a third dimension to the diagram that is not covered in the book due to its low occurrence rate. In general, CDTM conforms to enough of the assumptions given in [OGC 06] to warrant the conclusion that CDTM is in the target group of organizations for ITIL small-scale.

In summary, CDTM conforms to enough of the assumptions given in [OGC 06] to warrant an attempt at applying the small-scale implementation of the IT Infrastructure Library to the CDTM IT organization and at reaping a benefit for CDTM IT and thus for CDTM in general.

Does CDTM benefit from ITIL Small-scale?

Since CDTM is in the ITIL small-scale target group, there only remains to be seen if ITIL small-scale covers the needs of CDTM related to IT-supported business processes. As becomes clear in sections 5.1.1 and 5.2.6, there is a strong benefit to be achieved by adapting and changing the organizational and process-relates aspects of the IT organization, but also of CDTM in general. ITIL small-scale lists a number of suggested roles to be developed, widely covering the ITIL processes, but not demanding the same big effort in staffing and hierarchical organization. Each role is checked against CDTM IT in turn to find out if ITIL matches CDTM needs. The match is gauged by ”measure of ITIL role needed/measure of CDTM need covered”. A match of ”full” means the full ITIL role matches the full respective need of CDTM, ”[less than full]/full” means that the role is covering more than CDTM needs, ”full/[less than full]” indicates that the full role does not cover the CDTM need in this area, designating ITIL to be unusable in this area of need.

The first role, **Proactive Problem and Availability Management**, is a forward-looking role that relies on the IT staff’s closeness to the business in small organizations to manage problems proactively. The future-oriented approach needed there is also used to cover availability management; to quote [OGC 06, p.44]: ”In fact, good Availability Management can be said to be reflected by the absence of availability problems, within acceptable cost limits, of course”. Since the only availability issues at CDTM have resulted from technical problems that a proactive problem management would have identified in time to prevent incidents, the match for this role is ”full”.

The second ITIL Small-scale role is **Incident Management and Service Desk**, containing the applicable ITIL functions. Since CDTM is small and there is a rather low incident rate combined with a very direct and familiar communication between ITTF members and users,

the closest thing to a service desk was the general IT mail distribution list. There also never was any incident management present. Even though there are obstacles to overcome, like the challenges inherent in a part-time service desk, CDTM IT would derive a large benefit from both functions, so the match is ”full”.

The suggested role of **Configuration, Change and Release Management** follows the recommendation of [OGC 03b, Annex A] in combining the three service support processes. Especially appealing is the downscaling guidance for configuration and change management. The release management process, though intrinsically followed in the scenario, would benefit from a certain level of formalization. Since a need for all three processes has become evident in the course of this paper, the match here is also ”full”.

As for **Finance and Resource Capacity Management**, there is the challenge of CDTM IT not having a budget, not now and not in the near future. This rules out the usage of the finance management for the organization and leaves resource management as an applicable process, although the missing budget does put severe challenges in this process, too. Since already a small part of the role – the applicable part of capacity management – already covers all of the area applicable for CDTM, the measure of matching is ”small/full”.

The needs of CDTM for application of the role **IT Services Continuity Management** are effectively nonexistent. Every disaster that affects CDTM IT greatly affects CDTM in general, so the general business continuity management is used for CDTM IT in case of a disaster. This setup is possible especially because CDTM is such a small organization and since ”none” of the ITIL small-scale role is needed to cover the full extent of IT continuity, the match is ”none/full”.

Service Level Management, Business and Service Capacity Management, Charging and Relationship Management as the sixth and final ITIL small-scale role finds only a medium level of applicability in CDTM IT. The aspects of service level management and relationship management do find application in the function of the IT-CA, while application of the capacity management part is inhibited by budget constraints, as it has been for the fourth role. The ”charging” aspect of this role does not apply at all, since there is no charge for any service offered by CDTM IT. Again, less than the full ITIL role covers all of CDTM’s needs, so the match value here is medium/full.

Table 5.8 lists the matching in a summarized form. Since every match has a ”full” on the CDTM side, it follows that all needs of CDTM IT as an IT organization can be addressed by the IT Infrastructure Library when scaled down according to the ”ITIL Small-scale implementation” publication, completing the match.

Summary

Both directions of the relation between ITIL Small-scale and CDTM IT do provide a match between the two sides. The needs that CDTM IT feels can all be addressed sufficiently according to the publication’s statements, and the frameworks lists a target group that encompasses CDTM, even if CDTM is hard to place exactly in the set of vectors given. Secure in the knowledge that an attempt at applying the principles of ITSM to CDTM IT via ITIL

Role	Match ITIL/CDTM	Details
Proactive Problem and Availability Mgmt	full	• Problem mgmt very advisable • Availability mgmt useful, but not critical
Incident Mgmt and Service Desk	full	• Deeper incident mgmt unknown until now • Service desk now represented by distribution list
Configuration, Change, and Release Mgmt	full	• Configuration mgmt is very advisable, rudimentarily in place now • Change mgmt is very valuable, informally in place now • Release mgmt is valuable, but not critical
Finance and Resource Capacity Mgmt	small/full	• Financing mgmt not needed since no budget available • Resource capacity mgmt impeded by missing budget
IT Services Continuity Mgmt	none/full	• included in business continuity mgmt
Service Level Mgmt, B&S Capacity Mgmt, Charging, Relationship Mgmt	medium/full	• Service level mgmt valuable, but problematic. See [OGC 06, p.50] • Business and service capacity mgmt hindered by missing budget • Charging not applicable • Relationship mgmt done by IT-CA
Legend	*The match is gauged by "measure of ITIL role needed/measure of CDTM need covered". See first paragraph of 5.3.2*	

Table 5.8: Match of ITIL Small-scale suggested roles to CDTM IT

small-scale will not be futile in all probability, the next task here is to restrict the scope of application.

5.3.3 Scope of ITSM in this Thesis

A full implementation of all ITIL aspects found to be applicable in the above section is by design impossible in the scenario of an ITIL-immature organization. According to

[OGC 03b, Annex 7A], even the planning process for setting up one single function will take at least three to six months, given appropriate funding. This is an estimate given for the standard ITIL framework, and thus does not include the effort needed for scaling down the functions needed in the context of [OGC 06]. Consequently, the scope of ITIL application in this scenario must be severely restricted, and even the selected aspects cannot be planned or implemented in full. However, they can be outlined and a direction for CDTM IT to aim at can be pointed out. The handbook attached to this document (Appendix A) represents a seed of an ITIL-oriented operations handbook that can – and hopefully, will – be fleshed out and expanded to raise the ITSM- related maturity of CDTM IT.

Since all listed ITIL small-scale roles cover a full area of needs in CDTM IT, the selection of roles to be introduced need only be based on the needs of CDTM and not on any measure of coverage or match. The role including the ITIL processes most valuable to CDTM is the third role, ”Configuration, Change, and Release Management”, described in [OGC 06, p.47]. This function is the basis for many other processes and roles, such as problem, availability, and capacity management, among others, a property of this combined function described in [OGC 03b] as well as in [OGC 06]. Additional roles and functions would be of great benefit to CDTM IT and CDTM in general, primarily the incident management and service desk role. This exemplary role may not be as critical due to the small size of the organization, the low incident count, and not least the quick and easy communication between all CDTM members, but it would still provide large benefits by providing data for a proactive problem management. A possible order of implementation of ITIL small-scale roles will be part of the outlook in chapter 6.

A planning of the selected role alone is a task that is simply too big in scale to be covered here. In any case, there would be a very low probability of success if the role was not planned and designed in conjunction with all affected CDTM personnel and with the full support of the IT task force during the creation. Since a strong commitment to the implementation of all ITIL processes is crucial for successful implementation, according to [OGC 03b] and [OGC 03a], the best chances of success are created through a planning effort by the affected people themselves, especially in a dynamic setting with no financial ties between management and work force. Nevertheless, there is a certain level of ITIL-related knowledge needed to find the right way to go, and since the workload of the IT task force members and management is and has always been high, this document aims at giving a bearing for the course needed to glean benefits from ITIL in the CDTM setting.

The ITIL Small-scale publication also gives a recommended starting point to small organizations for implementing ITSM that is said to be ”useful to immature ITSM initiatives” [OGC 06, p.53], called ”Vital ITIL”. This section of the book names the service catalogue, incident management, and configuration management as a starting point, calling the three ”core useful ideas”. Configuration management is covered in the selected role and will be the first priority in implementation, while the term incident management used in the book aims at a single point of contact and at a recorded incident history first. Both of these are present at CDTM in a very informal way, i.e. in form of a distribution list and a dedicated mailbox that is member of the list and archives all messages. However, there is neither analysis of the messages for creating an FAQ document nor cross-reference to solve future incidents easily. The service catalog mentioned in the book can easily be created out of

section 3.1.5 of this paper. This shows that concerning ”Vital ITIL”, CDTM already has a baseline of provisioning in place and can benefit from using them in ITSM right away.

With the scope of ITIL application lined out, the core of the selected role can be described now in the way it is needed for CDTM. As stated above, release management is uncritical in stabilizing the scenario and thus will not be covered in the scope. A strong focus will be on configuration management and a light focus on change management. The following sections will describe the roles and tools needed and outline the processes to implement, concentrating on motivation and explanation, while the item descriptions themselves can be found in appendix A.

5.3.4 ITSM Application: Roles

In the aforementioned, and already cited, annex A of the ITIL Service Support book, there is a statement about the roles needed for implementing the function of change, configuration and release management: ”The roles within the function should include *Configuration Manager*, *Asset Manager*, *Change Manager*, *Change administrator*, *Release Manager* and relevant *Change Advisory Board(s)*.”[6] In small-scale ITIL, there is an understandable effort made towards combining roles, since ”In most cases, the number of identified roles within ITSM will be more than the number of people in the [IT] organisation.” [OGC 06, p.43]. This is definitely the case at CDTM, for the following list of available ”staff” for IT shows an effective number of two, if optimized possibly three persons available, all of them less than full-time.

- The IT task force students do not stay long enough to count as fixed staff and can at most share one role between them, because of knowledge and time constraints on the one hand and being the working IT staff on the other. Thus, they count as one person in this respect.
- The IT CA is the only assistant assigned to IT itself, counting as one person, maybe less than one full person (for IT) due to other obligations.
- The remaining assistants all are assigned other task forces at CDTM and, like the IT CA, have other obligations in education and research, which is a reason for the fact that in terms of ”management commitment”, they show a high level of commitment – provided there is absolutely no workload whatsoever created to be done by themselves. Thus, they do not count for CDTM IT as an available resource.
- The office team, consisting of a part-time administrative employee and two working students, can be used for simple administrative tasks if workload is minimal

In order to implement the roles needed in the selected function when using mainstream ITIL, this number of persons has to cover six roles, averaging two to three roles per person. Of course, the tasks included in the execution of these roles still must be taken care of, but due to the lowered complexity and shortened communication, this is possible in combined roles.

[6] Since the term ”change administrator does not appear elsewhere in [OGC 03b], it is assumed here to be equivalent to the ”change builder” role in mainstream change management.

Combining Roles

To combine the roles in this scenario it is necessary to assess possibilities of offloading tasks to other parts of CDTM on the one hand, to check for possible optimizations of processes on the other. In small-scale ITIL, the function is reduced to one single role, called the ”greater change” role. It is said to be ”the back-room job forming the foundation of ITSM, generating and maintaining the accurate basic data without which ITSM cannot perform effectively” [OGC 06, p.47]. Essentially, this is what is already done by the IT CA supported by the ITTF member students, if only in an undefined and unstructured manner. This suggests taking the greater change role as a basis for the above assessment.

The greater change role does not have to be fulfilled by one person, so **offloading some tasks** would be possible. The administrative part of the asset management could be offloaded to the office team, since all orders are placed through them and all mail and all deliveries reach CDTM through their office. If the office team's workload allows for a consistent application of asset management procedures, there is a considerable amount of effort taken off the IT task force – after taking an inventory of IT assets and initializing the asset database (see 5.3.5), done by the IT task force, of course. Another responsibility that can be offloaded is the management of software licenses, which can be done by any member of CDTM staff. Offloading this responsibility would not only reduce load on the IT CA, but also introduce an external control factor, if the responsibility is taken serious by the assigned person.

With the high workload already present for the IT CA, a **split-off of responsibilities to task force members** could be advantageous to the situation. Since the students in the IT task force are the ones who perform administrative tasks, support tasks, and work in IT projects, they are already the ones fulfilling the tasks covered by the ”change administrator” role in mainstream ITIL change management. The set of tasks attributed to this role needs not to be transferred to the IT CA, rather the role of change administrator should be fulfilled by a member of the task force. Because the change builder role is not meant to be a single person but rather depends on the configuration items to be changed, there is only a need to educate the students so every student can fulfill the role satisfactorily in the field of his or her technical expertise.

The ”relevant change advisory boards” (CABs) are not formally present in such a close-knit group as it is present at CDTM. Nevertheless, since every IT member is also a direct member of CDTM business, and since the IT CA is a member of the staff who is deeply aware of the business strategy of CDTM, any group of knowledgeable IT students together with the IT CA informally convening to discuss a change of any configuration **already constitutes a CAB in function**. The missing formality does not negate the positive effect of the rule present at CDTM: ”never change anything without discussing it with the IT CA first”. It would only be a small effort of taking meeting minutes and documenting them in the form of CAB reports to move from the current situation to a defined CAB culture. Additionally, CAB meetings including top-level business management representatives already exist in form of reports from the IT CA to the management team in regular operational meetings. There is no CAB emergency committee, since the organization is small and the IT CA is the top authority, widely empowered to make emergency decisions without consulting other CAs and also able to reach all technological knowledge-owners quickly through home and

mobile phone.

The now remaining singular, fixed roles can be **combined and fulfilled by the IT CA**. They include the roles of change manager, configuration manager, Release manager and to some extent the role of asset manager. Asset management is not an IT function per se and is already mostly taken care of by the office team, so the only part of the role relevant here is the representation of IT towards hardware and software vendors, which is done transparently by the IT CA already. Release management has been removed from the scope of this document above, and the tasks of this function are to a basic extent already handled by the IT CA at present. The final roles of change manager and configuration manager can be combined in the ITIL small-scale sense to represent a part of the ”greater change” role described.

The roles textually described above are summarized in table 5.9 and result in responsibilities for the persons who are assigned one of the roles. The following section describes these responsibilities, lending meaning to the terms used here.

Role	Possible assignment
Configuration Manager, Change Manager	IT CA, using adapted tasks, processes and responsibilities
Release Manager	not implemented in the scope of this paper, would be also IT CA
Asset Manager	Representative: IT CA, administrative: office team, if possible. If offloading is not possible, postpone implementation
Change Administrator / Change Builder	IT students, according to technical expertise
Change Advisory Boards	already informally present, dynamically convening as needed, regular reports in place, only formalization needed

Table 5.9: Distribution of roles for ”greater change” function

Resulting Roles and Responsibilities

A small set of applicable roles is resulting from the analysis above, and this set is then constricted by the scope of this paper. The functions that are not considered here pertain to the roles of Asset Manager and Release Manager. The resulting roles are adapted according to the analysis above (in 5.3.4). This results in the roles of *Configuration and Change Manager* (represented by the IT CA), the *Change Administrator* (dynamically assigned from the group of IT task force students) and the *relevant Change Advisory Boards* (already informally in place). The according responsibilities are listed here:

- **Configuration and Change Manager**:
  - Generally: Adapt and implement the ITIL change and configuration management functions
  - Identify configuration items (CI) to be managed and controlled
  - Provide the central integration point for the business, the IT task force and third parties
  - Ensure consistency and accuracy of the CMDB (including the Service Catalogue) and the DSL (see 5.3.5)with regard to the actual state of the infrastructure
  - Organize regular audits of processes, systems and services against stored data, implement corrective action
  - Ensure the avoidance of uncontrolled changes
  - Regularly provide information about the state of CDTM IT to the management team
  - Promote ITSM generally at CDTM, raising awareness and strengthening management commitment as well as ITTF commitment to ITSM processes
  - Ensure familiarity with ITSM of all involved persons by taking care of training and education about the ITSM functions in place
  - Guide strategy and policy as well as system design to minimize number of variants and system complexity
  - Investigate major problems and identify remedial actions
- **Change Administrator**:
  - Implement agreed changes showing due diligence
  - Agree on back-out plans before implementation in live systems
  - Plan and coordinate testing of changes
  - Plan and coordinate review of changes after specified time
  - Document actions included or linked in RFC document
- **Change Advisory Boards**:
  - be reachable in emergencies for personal expertise
  - keep user perspective

These lists of responsibilities result from the tasks and functions attributed to the ”greater change” function in ITSM. These responsibilities are also used in the handbook to describe the roles for freshly joining members. It becomes apparent from the lists that the change administrator role is comparatively small in its responsibilities and workload, which is consistent with its assignment to floating IT task force members according to the technical knowledge needed for each change.

5.3.5 ITSM Application: Tools

Then the tools must be named (not necessarily SW tools but categories maybe since the concept is not yet implemented The above selection of ITIL functions and roles results in a set of tools needed for an effective ITSM implementation. The tools named by the ITIL publications as needed for configuration and change management are the Configuration Management Database (CMDB) and the Definitive Software Library (DSL), augmented for change management with functions pertaining to workflow and communication. The small-scale implementation takes into account the small size and low availability of resources in small organizations and gives the Service Catalogue as a starting point for instantiating a CMDB for organizations with immature ITSM processes. Even though the ITSM process of Incident Management and the Service Desk Role have not been included in the scope of this concept, the following lists an incident reporting and management tool. This is because of the possible extreme benefits to be derived from its use in all ITSM areas.

Asset Database

For the function of asset management, there needs to be an asset database in place. The information placed here will be linked from the CMDB if a configuration item represents a physical asset registered in the asset database. As stated in 5.3.4, the asset database will be initialized by CDTM IT, but for various reasons, the data will be managed and controlled by the office team. The asset database can be another wiki-instance on the machine that also hosts the CMDB, but the special form and tool must be decided by the CDTM IT manager together with the office team. This is because the impact on the office team can not be assessed here and it is well possible that the database will be used to manage more than just the IT-related assets. Consequently, the asset database is not deeply covered here and is also not included in the handbook in appendix A.

Configuration Management Database - CMDB

The most essential tool for all ITSM processes is the Configuration Management Database, holding all relevant information about the configuration items, i.e. the systems and services to be managed. In ITIL small-scale, a service catalogue is recommended as a starting point for the CMDB, describing the services provided by the IT organization in a fashion that is understandable by the end users. For CDTM, a subset of section 3.1.5 of this document can easily be used by the CDTM IT task force in conjunction with some normal users to construct this service catalogue.

Nevertheless, the infrastructure of systems and services at CDTM is so disproportionately complex and large compared to the size of the organization, so more information should be collected and recorded. As described in section 3.1.6, much information has been collected in the IT Wiki that must first be audited against the current state of the system and can then be used to seed the future CMDB. Additionally, the CMDB is used in ITSM to store at least RFC entries (Request For Change), Problem Reports, and Change Records.

Since CDTM IT has no budget available to buy professional ITSM software, and – maybe more importantly – has no staff to administrate a fully fledged solution, a software product must be found to cover most of the features of a professional solution while being free, easy to administrate and while having a very easy to learn interface. This task seems impossible at first sight, but since CDTM IT already stores much information in the IT Wiki, all students are familiar with the usage of the software. In addition, the engine used ("MoinMoin", see 3.1.5) records a history of changes, provides fine-grained access control, is free and uses proven technology with very few components, lowering failure probability. However, since the IT-Wiki is part of the CDTM wiki-Farm (a moinmoin-term designating connected wikis on the same server), it is not recommended for security, stability, and procedural reasons, to use the IT-Wiki itself as a CMDB tool. Instead, a new instance of moinmoin should be set up as CMDB for CDTM, running on a dedicated hardware to maximize reliability in case of system failures.

As initial data load, the information now residing in the IT Wiki can be checked and moved into the CMDB, augmented by the service catalogue and by some authoritative, versioned templates for new items. Additionally, there must be processes defined of how to handle a change in the CMDB structure, for example a new template version for a certain type of configuration item. Finally, the system running the wiki-based CMDB must be backed up off-site using the LRZ backup service. When a certain level of ITSM maturity has been reached in CDTM IT and funds or free professional tools become available, a migration to such a tool might be advisable, but it is not advisable to take the whole way from the current state to using a professional CMDB-tool in one single step.

Definitive Software Library - DSL

A further tool that is helpful in establishing an effective configuration management is the Definitive Software Library, described in [OGC 03b], that holds all packages of software that are in use and that have configuration items representing them in the CMDB, for example an item representing a single installed instance of a software product. Since CDTM is such a small environment, and software installation was done on a rather ad-hoc basis in the past, there is nothing even resembling a definitive software library in place at CDTM. There is, however, a secured subdirectory on the file server holding a large share of the software installed on machines. This software store is not managed and largely unsorted, though, only adding to the confusion when trying to find a certain piece of software to reinstall or upgrade a PC.

The introduction of a DSL would go hand in hand with the introduction of a proper license management, which has already been suggested in section 5.2.1. The scope of this paper does not allow for an analysis and an implementation plan regarding a DSL, but implementation is strongly recommended to strengthen the effect of the CMDB by enabling the hassle-free management of software configuration items.

Workflow Management Systems

As already mentioned in section 4.8, outlining the use of workflow management systems to initiate or trigger recurring tasks and to possibly send reminders on excess task duration, these systems have originally been created to manage full-blown processes. Here, ”process”, or ”workflow” for that matter, refers to a larger scale course of actions undertaken by a number of people or roles. The duration of such processes does not need to be long, but workflows that usually run over longer time spans enjoy a greater benefit from the use of a workflow management system than processes based on only one activity.

Regarding the tasks and processes related to ITSM, a workflow management system would ensure the execution of processes to the letter by guiding the user through each step interactively. In addition, scheduled tasks can be triggered automatically by such a system, eliminating the possibility of missing these tasks or of hurried action at the last minute while promoting proactive work by informing the affected parties at an early time. In the special setting at CDTM, a workflow system would even have some more positive aspects, especially if the CAs are using the system not only as process initiators, but also as activity assignees. If a process is stalled because it is waiting for feedback, necessary action, or crucial information from a CA, then the system regularly reminds the user (or role) who needs to take action and it is not possible to scold or blame the ITTF for a delay that it is not responsible for, as has been done in the past. If the usage of the workflow system would be extended to all of CDTM, it would be possible to handle the work assignments of students via the system, giving reminders at the proper time and documenting workflow actions (like paper hand-ins) with proper time-stamps. Actions like ”inform students about grades” could be triggered as soon as all preliminaries (e.g. ”all single grades submitted by graders”) are fulfilled, resulting in many improvements, such as faster throughput time, a higher awareness of the processes at CDTM (also process refinement through awareness during process definition) and a more transparent view on workload involved.

The following paragraphs list the preliminary actions needed before a workflow management system can be implemented, then lists the factors that may be impeding the implementation, and finally summarizes the value of usage.

Necessary Preliminary Actions Workflow management systems are based on well-defined processes. Without exact information about a process, a piece of software can of course not support the execution of the process. De facto, there may be processes in place at CDTM (see section 3.1.10) but they very much lack a proper definition, much less have they been properly identified. In consequence, a high amount of effort must be put into identifying, defining, and modeling these processes before being able to introduce them to a workflow management system. As has been hinted at above, the confrontation with this task will make the involved people more aware of the processes they are modeling and possible catches or problems of the processes will show up, enabling an improvement of the process at hand. Possible redundancies of processes and actions may also be discovered and eliminated at this stage. After a number of processes and the roles involved (which may be to some extent different from the ones created in this paper) have been established, it is possible to be aware of the feature set that a workflow management system must provide.

Then there are more aspects to be taken into account, like the steepness of the learning curve for system users, the stability, the possibility of versioning long-term processes during runtime and more.

Factors Impeding Implementation Depending on the feature-set required of a workflow management system, it is possible that only a commercial solution can provide the necessary performance. If this should be the case, there is the omnipresent lack of budget that could prevent the implementation of such a system at CDTM. Disregarding that, there are some more hurdles to jump before strictly enforced and automatically guided processes can be successful at CDTM. The description of the scenario in section 1.2 has explained the organizational structure and the freedom of the management team to decide freely about strategies applied at CDTM, including IT matters. The past has shown that the natural resilience of human beings to being supervised and controlled is present in the management team, so a corresponding resistance to a workflow system that enables exactly that is to be expected. A possible amelioration of this situation may be provided by the benefit the CAs see in a workflow system supporting their own, management team-internal processes.

With workload in the ITTF and system complexity being as high as they are, there must be a very high benefit delivered by a workflow system to counter the additional workload created by its installation, administration, support, and maintenance. It is well possible that there is a need for an additional (maybe virtual) machine and that a definitive and authoritative user and role directory must be set up, for example. The ramifications of this can be deep and far-reaching, so the relation between workload saved and effort needed should actually be cautiously evaluated before or during the preliminary actions discussed in the previous section. The business-oriented assistants at CDTM may be able to help with their experience in cost/benefit, TCO, and ROI calculations.

Even if the use of the system is restricted to ITTF only, it is possible that the necessary effort for learning and training on the user-side as well as on the process-definition side is too high for the system to have real value. It must be kept in mind that the scenario at hand has a strong dynamic component that may be weakened by defining strict processes and adhering to them but the dynamic component also brings factors into the equation that can invalidate the very idea from which the workflow system was conceived. As of now, it is unclear which path is the prudent one to take but it is definitely a recommendation for CDTM to look into this possibility and to do so with due thoroughness.

Value While the use of a workflow system has a high amount of preliminary action needed before it creates a benefit, this benefit can boost productivity and effectiveness of many processes throughout CDTM. Since this option affects not just the IT task force, but CDTM as a whole, and since it needs a high amount of preparatory discussion with the management team, this paper will not develop this option further and therefore, a workflow management system will not be listed in the handbook.

5.3.6 ITSM Application: Procedures

The remaining aspect of ITSM still to be discussed at this point is the procedural aspect. Since the small-scale implementation book is only a guideline to how a scaling down of ITIL might work, it does not state how exactly to go about scaling down. This is only understandable, since no two IT organizations are the same and the differences multiply with diminishing organization scale. Nevertheless, the character of small-scale ITIL and mainstream ITIL together create an amount of effort for thoroughly designing the core ITIL function that is out of the scope of any one paper by a factor. When regarding the ITSM roles selected for implementation (configuration management and change management) in the scenario, there are a very small number of standard procedures defined in the ITIL documentation. There are, of course, guidelines as to the usage of a CMDB or as to the responsibilities attributed to the ITSM roles and so on, but procedures, being as organization-specific as can be, are to be defined by the ITSM-implementing organization.

In this document, there will only be a sketched adaptation of the core, generic change procedure in this document, to be provided in the handbook. As has already been stated in section 5.3.3 above, the highest benefit is to be expected if the people who are affected by the handbook and involved in its use take part in the creation of the handbook, especially the procedures.

The basic change management procedure described in [OGC 03b, sec.8.3] is very generic and fits almost any organization as well as any possible change. Adapting this procedure for CDTM IT includes a merging of the tasks assigned to ”Change Manager” and ”Configuration Manager” as well as the ones assigned to the ”Change Builder” and ”Independent Tester”. The latter has to be done since there are no resources for an independent testing of changes at CDTM. To counterbalance that in terms of work quality and system stability, there is the four-eye principle in place for changes that may affect the stability of critical systems. Figure 5.3 shows an adapted flowchart of the procedure as it can be used at CDTM. This flowchart is also attached to the appropriate procedural description in the handbook. The count of activities in the procedure is reduced from twenty-two to twelve, and although the resulting activities are more complex in themselves, they cut out much effort in terms of communication and control flow. Concerning the timescale of the single instances of this procedure, there is a reduction by a large factor because due to the close communication between task force members and the small size of the organization, the relevant CABs meet on a basis that in mainstream ITIL is reserved for the CAB emergency committees.

In general, the procedures originating from the ITIL publications can be scaled down quite far for usage in CDTM IT; but this task must be done by the people who are directly involved in day to day business and who have a direct, unfiltered viewpoint on the current user perspective and the business processes as they are at the time. With the dynamics prevalent in the scenario, this task is definitely not in the scope of a paper handling CDTM from afar.

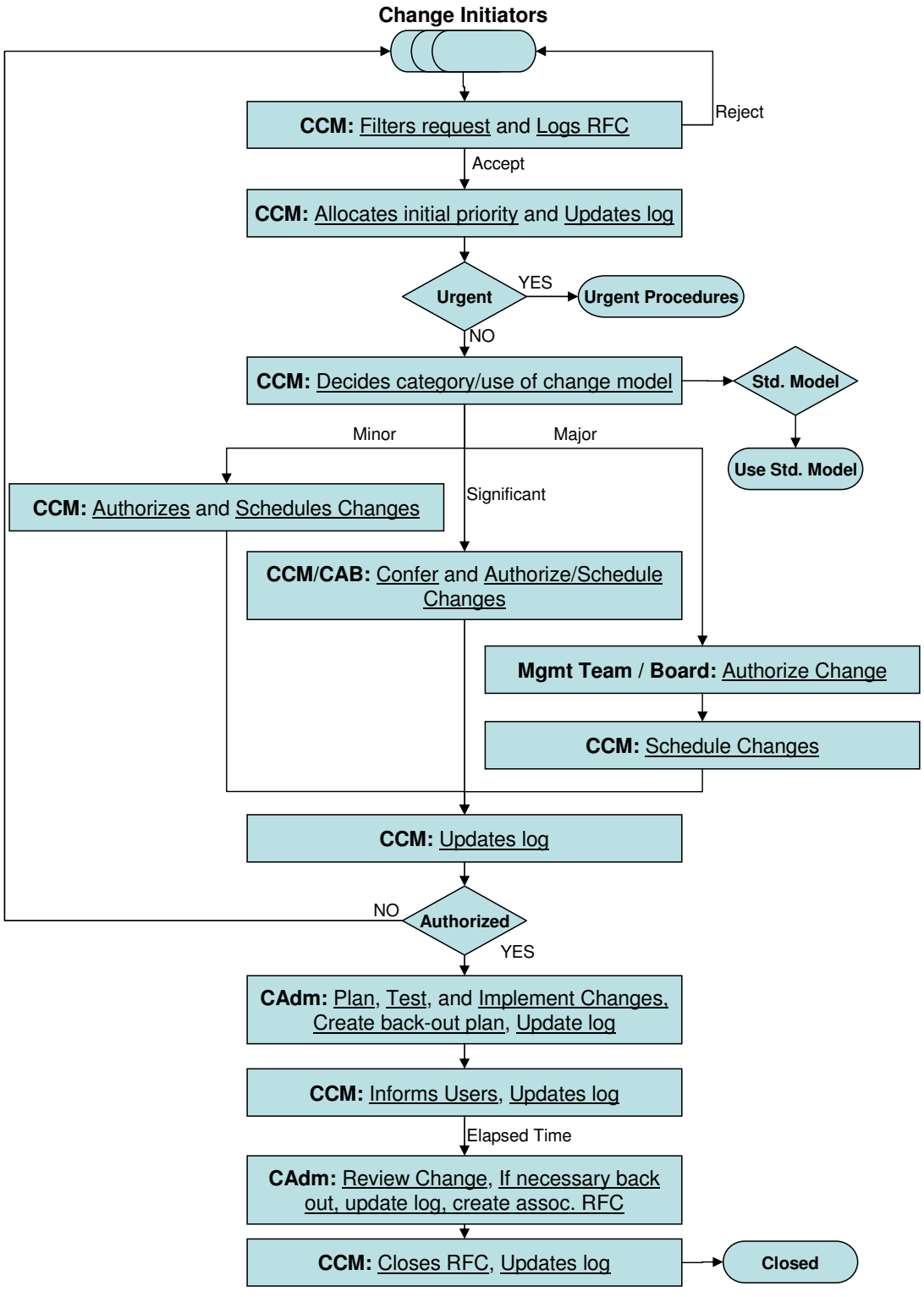

Figure 5.3: Adapted Change Management Procedure

5.3.7 The Handbook: Is ITIL Enough?

The intention of creating the handbook that CDTM will receive is for it to be used by the CDTM IT task force in daily operations, and especially it should be given to new task force members for breaking them in and for familiarizing them with the way of working in CDTM IT. With only the information created in the above application of ITSM to the CDTM organization, the latter will not have the desired effect, since a small amount of basic ITIL knowledge is still needed to fully grasp the meaning of the rather abstract, ITIL-way of seeing ITSM.

To ameliorate this fact, the handbook will contain more so-called ”roles” that are essentially only labels for certain groups of people at CDTM, like for example ”CA” or ”student”. This is done to embed familiar terms into the ITSM-perspective used, and aims at familiarizing the reader with the ITSM perspective without the need for unnecessary abstraction. Additionally, there will be procedures given for updating the handbook itself to make sure this task can be performed without errors in applying the generic change management procedure. Some more information about the diversions from ITSM present in the handbook is given in the appendix but not included in the delivered handbook.

5.3.8 ITSM Process Application - Summarized

The application of ITSM in this scenario creates a tremendous amount of benefits, even if only a subset of ITSM processes is implemented. Naturally, the interconnectedness of all ITIL core processes leads to a lower effectiveness of ITSM processes, but even so, a structuring of CDTM IT helps greatly in achieving stability and effectiveness for CDTM IT operations. Since the scope of this document can not cover a full assessment of the core ITIL processes, a selection has been made using the small-scale implementation approach to using ITIL and the resulting roles, tools and procedures have been described. The results are delivered to CDTM in form of a handbook skeleton that should be fleshed out by CDTM IT while implementing the processes described to create the highest level of gain.

5.4 Summary

After the first part of the concept handled the classical perspective of IT management, handling the technology aspect, the second part concerns itself with optimizing the organization and the IT processes at CDTM. This chapter has first displayed the importance of IT operations for the main CDTM business processes and then named some critical success factors regarding the people in the organization, since the human factor is often overlooked. Then the critical success factors for the handbook that is to be delivered to CDTM IT have been described, covering the maintenance aspect as well as the possible choices of document type and format to be used. With this, all required basic information was covered to complete the general picture needed for working on the ITSM approach to CDTM IT.

The second part of this chapter was devoted to recommendations that are possible to be given and to be implemented on the grounds of the basic picture just created. These recommendations were each given a value considering their effects not only on CDTM IT, but also on CDTM in general. After comparing the values of these options finished this part of the chapter, the application of ITSM processes to CDTM IT was evaluated along the guidance of the ITIL small-scale implementation introduced earlier. To evaluate this application, a match between ITIL small-scale and CDTM IT was devised, and then the scope of ITSM application in this document was restricted to fit into a diploma thesis. The roles, tools, and procedures needed to implement the selected ITSM functions were described and partly analyzed, and finally some changes to the handbook were announced and shortly explained.

In effect, it has been shown that extensive benefit in stabilizing and structuring the CDTM IT organization can be derived from optimizing the organization itself as well as the processes, tools, and procedures that are used in CDTM IT operations. Not only are their certain measures and projects that can be recommended to raise the intrinsic stability, but there is also a huge effect to be gleaned from using an ITSM framework such as ITIL to sleek down IT operations and lower workload while raising effectiveness. As has been stated in the introduction of this chapter, the measures listed in this chapter augment the technological measures of chapter 4 and together, the measures of these two chapters form a concept that can help the IT organization to reach the next stage of CDTM IT history (see section 1.2.2).

6 Conclusion and Outlook

In order to create an operation support concept for CDTM IT, the two previous chapters have addressed first the classical perspective, handling technology in form of services and infrastructure, and then secondly the ITSM perspective, covering the organization itself and its processes. As a basis for these two perspectives, an extensive analysis and assessment of the scenario from an IT perspective was performed.

The two perspectives and the measures derived from analyzing them, together with the handbook represented in appendix A, form a concept for CDTM IT that can be applied to stabilize the environment in many respects. Additionally, it enables the CDTM IT management to lead the IT organization itself into a state that makes the task of keeping up the stable state possible and manageable. Now it remains for this chapter to critically examine the concept and the handbook with regard to their fulfillment of the requirements for the concept stated in the introduction's section 1.3. After that, there will be an evaluation of the paper's result considering ITIL and its applicability for scenarios like the present one, followed by a summary and an outlook on what the future may have in store for the concept, as well as for CDTM IT.

6.1 Evaluation of the Resulting Concept

There were several requirements given in the introductory chapter that the result of the work documented above now has to stand up against to be rightfully called useful and to be considered a success. The requirements are covered here in the same order they were stated in the introduction.

- **Pushing the button** - Surmounting the objective aspects of correctness, usability, and format is the necessity to appeal to the people who must use the handbook and concept. Since there is little to be achieved regarding "pretty design" in the tools and processes selected for the scope of this paper, an effort has been placed in making the product as usable as possible, for example by using already known software like the moinmoin wiki engine as tool. Additionally, the lessening of workload has been emphasized repeatedly in this document, and since this is one of the major stress issues in CDTM IT, this requirement is met to the best possible extent.
- **Low barrier of entry to usage** - The Handbook has been augmented by additional pseudo-roles that will probably never change as long as CDTM does not completely change its organizational structure, an event that would create so much need for change that these few roles do not weigh very much. This augmentation, beside others,

makes the handbook more understandable for new students and hides the dry, abstract ITSM roles behind the mask of known terms and names. This dramatically lowers the barrier to entry for using the concept, easing the way for the student's acceptance of the handbook – and the concept in turn.

- **Lowering effort of entry into workforce** - A mandatory familiarization with the handbook at the beginning of a student's "ITTF career" introduces the new member to the principles used and the processes in place while giving an overview of the roles and hierarchies in place. If the service catalog is included in the handbook, a new task force member shows a high level of familiarity with the system right away, contrary to the situation now, where sometimes ITTF-students are "surprised" by a request pertaining to a service or system they did not know existed. Student break-in is thus considerably eased.

- **Story-telling character** - This requirement stated that the handbook should be readable from beginning to end without any forward references. Since the handbook first states generic information that needs no knowledge at all, then describes the roles existing in the organization followed by the tools used, and finally embarks on a description of processes – the item-category with the most references –, this requirement is met.

- **Low-effort maintenance** - The procedures for maintenance of the handbook are described in the handbook itself, and as the first processes at that. They are not yet realized as change models, because the change management procedure itself is not as fixed as it should be due to the remoteness of perspective that this paper necessarily must keep in place to stay objective. The non-handbook aspects of the concept, like the choice of software for the CMDB, have been handled as to minimize the additional workload for their maintenance at CDTM, succeeding in fulfilling the requirement.

- **Inclusion of concept maintenance** - As just stated, this requirement's fulfillment was used to heighten the level of success for the previous requirement.

- **Extensibility** - The scope of this paper has restricted the amount of roles, tools and procedures to implement in the course of this work, so there is still much to be done. Even if the selected roles and functions have been fully implemented, the tools and roles needed for the implementation of ITSM in order to reach a higher maturity in the organization have already been outlined and can be implemented as resources allow. Cautious estimates using the timeframes given in the annexes of [OGC 03b] show that there will be no shortage of possible ITSM-based improvements at CDTM IT for the next several years.

- **Template-character of output** - In ITIL, there is no such thing as a template for implementation of a function, a process, or a role. Insofar as tools, documents, and ways of working are concerned, the concept created here does have a template character, but the implementation of ITIL must be done using a hands-on approach – by design.

- **Accessibility** - There has been the recommendation to put the tools needed for ITSM on a separate machine to enable accessibility even when critical machines and services are down, serving the perspective of "keeping it accessible". As for the ease of

access, there are no tools needed apart from the software that comes with every modern operating system: a web browser, and a reader for documents of the PDF format. Additionally, a printed handbook is easy to obtain and store in case of a full power outage throughout CDTM for longer than the UPS systems hold. It is hard to get more accessibility without very drastic measures.

- **Consistency in formal features** - In the handbook, there are templates for each item category that must strictly be followed. In addition, there is a recommendation to create a procedure item to be used in case a template gets elevated to its next version. This makes the handbook fulfill this requirement fully. As for the other types of data created, there is no possibility to ensure the format of the document in the scope of this paper, since the systems chosen for data storage are on the one hand very flexible concerning data formats, on the other hand they have not been installed yet and thus cannot be influenced. It is recommended to define fixed formats for example for the configuration item entries in the CMDB before installation of the system, which is feasible since the software is already used for the IT Wiki and can be used for designing, testing, and evaluation the necessary forms.

When reviewing the above list, it is shown that all requirements to the concept that were set up in the introduction were fully met by the concept together with the handbook. The level of success reached by using the concept is now only influenced by the performance of the IT CA and the management team in the task of implementing the concept inside the organization. It is to be hoped that the necessary management commitment can be found and that resources can be mobilized to implement the concept thoroughly and with due diligence.

6.2 Applicability of ITIL/SS in small, dynamic Environments

It has been shown in section 5.3.2 that CDTM does not exactly fit the statements that the ITIL Small-scale implementation book makes about its target group of organizations. In figure 6.1(copied from section 5.3.2 above), CDTM would belong somewhere in the lower right quadrant, but since volatility in the accompanying ITIL text is measured mostly by incident count, CDTM would count as very stable, which it definitely is not, as has been exhaustively proven in the above. It seems to be the case that ITIL Small-scale is aware of environments like this, as can be interpreted from the following quote: ”Many small IT organisations, for example, those supporting scientific or research organisations, have a customer requirement that is highly complex and extremely dynamic” [OGC 06, p.12]. Aside from that quote, however, the book keeps silent about organizations that have such a highly dynamic character.

CDTM itself is a scientific organization, with CDTM IT embedded in that. It follows that an application of ITIL in environments such as CDTM’s is not covered by the book and that the subject of this paper is really rather novel matter in this respect. The interesting revelation that emerges from this circumstance is that the special characteristic of the current

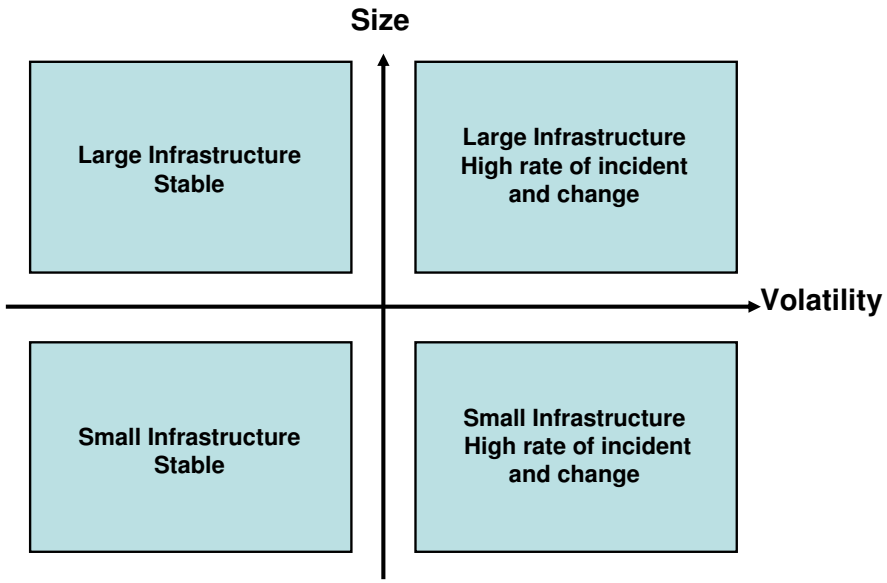

Figure 6.1: Categorizing small IT organizations according to small-scale ITIL

scenario does not stem from a dynamic inside the IT organization, but rather originates from dynamics inside the serviced organization. If figure 6.1 would be expanded into the third dimension, labeling the third axis ”intrinsic dynamics in serviced organization” for example, then CDTM is found in the lower left quadrant, but with a high value in the third dimension.

Consequently, the question of ITIL-applicability gets a different flavor. This paper shows by successfully applying the guidance delivered by small-scale ITIL that the abovementioned spatial quadrant, ”lower left, high”, being the home of the CDTM IT organization, could be fully addressed by the book. This application is not specific to such dynamic environments, but rather stems from the mainstream ITIL’s capabilities of adapting to any environment, owing to the input into the best-practice framework from organizations using ITSM. If the third dimension of figure 6.1 is viewed for all quadrants, it can be assumed that the intrinsic adaptability of the IT Infrastructure library can cope with such dynamics in environments of any size and with any volatility. It is even a possibility that this aspect of ITIL’s properties will be overtly stated in the next iteration of the publication series.

6.3 Summary

In the course of this paper, a small and dynamic IT organization servicing a highly dynamic organization on the edge of high technology and research has been analyzed, assessed and then been provided with a threefold concept to improving and stabilizing its operations. The three components of the operation support concept are covering all aspects of IT management present at CDTM. The measures outlined in chapter 4 cover the technological perspective, the measures given in chapter 5 apply to the organization and the process and include the development of the third part, the handbook, given in appendix A. The handbook is to be seen as a seed for the definitive documentation of IT operations at CDTM,

augmented by the introduction of a CMDB to start an ITSM implementation by creating and empowering the role of configuration and change manager.

During the development of the measures listed, it has been found that the maxim of ITIL, interpreted here as being applicable to any IT organization regardless of size and line of business, also applies for implementing ITSM via ITIL in IT organizations in highly dynamic businesses. Another key learning gleaned from working on this document is that a small size of an IT organization and short communication paths inside the organization do not lessen the amount of effort and diligence needed for the planning and design of ITIL functions in the environment. This learning was gained mainly through realizing the – surprisingly large – amount of restrictions needed to stay in the scope of a diploma thesis, considering the mentioned factors.

6.4 Outlook

It cannot be emphasized enough that an application of the concept represented by this paper will provide very high benefits to CDTM IT concerning not only stability and effectiveness, but also regarding future-safe operations under the conditions present in the organization. The probability of this concept being applied successfully at CDTM depends on too many variables to be estimated here. Of these factors, the level of management commitment is the predominant one, a preliminary requirement for successful ITIL implementation that is stated in the publications several times to emphasize its importance. More factors include the workload amount for the IT CA that does not pertain to managing the IT task force itself, but is related to courses, administrative tasks and other CDTM operational business. Of course, this workload can be lowered if the management commitment in the management team is high enough, but even if the management team fully supports the ITSM ambitions of ITTF, the load put on the IT CA will be very high for some months. The needed effort will lessen when the first basic implementation phase has been finished and students are proficient enough in ITSL matters to take some load off the IT CA.

The implementation of ITSM processes is never very quick or very easy, since it involves an application of a set of guidelines to an organization instead of only following a set of given steps. This fact must not be forgotten when implementing the concept at CDTM. If motivation is coupled with perseverance and diligence, then carrying out the application of this document's resulting principles to CDTM IT will in itself generate a process-awareness in all people involved. This, in turn, can lead to application of this awareness, these process-principles, to the business processes of CDTM, creating not only synergetic effects, but also providing CDTM in general with the same flavor of benefits that ITSM provides for CDTM IT. If a workflow management system is introduced for CDTM IT, then – after a time – there will be a considerable number of "ex-ITTF" students familiar with the interface, the principles, and the benefits. This implies a higher probability of success if the system is expanded for usage in standard CDTM processes, enabling more transparency, shorter run-times of processes, closer coupling of people involved in the same tasks, and a clear definition of responsibilities.

In organizations as small as CDTM, tools used for implementing and supporting ITSM processes in the IT task force can be used to the benefit of the whole organization. For CDTM, using the asset database for more than just IT-related assets can be very attractive, lessening the number of needed user-interfaces and lowering the amount of paper that needs to be archived. The benefit of using a workflow management system has been described already. When – or if – the incident management process and the service desk role are implemented for CDTM IT, then the tools used for submitting, recording, and managing IT incidents can be extended to suit the purposes of other teams in CDTM. To the office team, for example, such a tool would introduce not only the benefits of reporting and controlling, but also the whole service-idea to this highly influential operational area of CDTM.

Considering the position of CDTM as a study program concerning itself with the management of technology, one has to wonder if this field of research and education should not also encompass IT Service Management as a part of the area between digital technology and management. The term ”technology management” in its commonly accepted meaning not only concerns itself with how to manage the creation, inception, and development of technology, but also with its most effective uses and future trends in technology. After all, successfully managed technology is not about the bits and bytes. It is about creating a user experience, about enabling and prolonging user satisfaction. This is where the principles of ITSM can be used and applied by the whole of CDTM in a broader and more general sense to improve further on new technology, to add a new facet to future business efforts, and so to gain a new edge in technology management.

A The Handbook

This appendix represents the seed for the handbook that is to be delivered to CDTM to help in stabilizing the IT organization after its long time of growth. The form is chosen to fit into this document, and CDTM is to get the handbook in the format decided by CDTM management according to 5.1.3.

The Items themselves, e.g. the roles, are not numbered in the version provided to CDTM, since reference is given finally by name of role, tool, or procedure. In this appendix, however, numbering is included to keep with the document's structure. For the same reason, the order of roles, tools, and procedures in the forwarded document is only of minor importance, while here the order is grouped and in groups alphabetical. Additionally, this included version is printed on both sides of the paper to conserver space and paper, while the delivered version will have singled-out items.

Information not present in the forwarded handbook version will be enclosed in rules like this text.

A.1 General Information

This handbook aligns the procedures of CDTM along the ”ITIL small-scale implementation” published by TSO for the OGC. It adheres to a subset or the suggested roles suggested in [OGC 06, chap 4], covering suggested role 3, ”Configuration, Change and Release Management”, while role 2 is touched upon in the Tools section.

The first instance in each of the following sections is a description of how to read the section’s items and can be used as template for new items by replacing the text in square brackets.

Text in italics, like *role* or *Handbook Manager*, refers to other items in the handbook.

This information must be compiled and inserted jointly by all members of the ITTF **The information given above must be completed by ITTF before productive use of the handbook!**

A.1.1 Escalation Chart

The chart below graphically shows the escalation paths resulting from the *role* descriptions. This is created to enable quick reference and must be checked and updated whenever a role is created, changed, or deleted. An arrow from role A to role B indicates that if role A is not reachable, role B can take over its responsibilities in emergencies. Labels on connections indicate conditions.

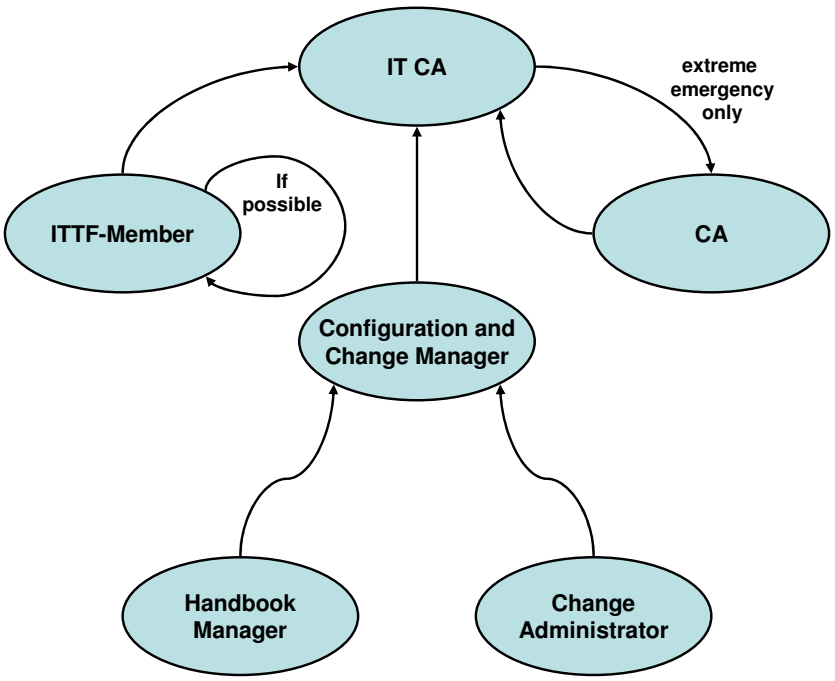

Figure A.1: Escalation Chart

Figure must be updated and attached if initial handbook has differences **The information given above must be completed by ITTF before productive use of the handbook!**

A.1.2 Administration Rules

List the administration rules. Examples:

- Four-eye-principle
- Always have a fallback option
- In Windows administration, only use your personalized administrative accounts ”[name]_adm”
- ...

This list must be compiled and inserted jointly by all members of the ITTF **The information given above must be completed by ITTF before productive use of the handbook!**

A.1.3 Dependency Lists

The lists in this section of the handbook give the interconnections between items. This is of high importance for integrity of the handbook's structure and these lists need to be checked and updated every time an item changes. To keep this task easy, the lists consist of copies of the respective data of the items.

Lists of the following items are available:

- Privileges to instantiate
- Procedure connections
- Procedures for a role
- Procedures for a tool
- Tools for a role

These lists must be compiled and updated jointly by all members of the ITTF **The information given above must be completed by ITTF before productive use of the handbook!**

A.1.3.1 List of initiation privileges

This list shows all the "*role* may initiate *procedure*" relations.

- *Configuration and Change Manager*
  - All change-related processes
  - *Change Management Procedure*
  - *Item Create/Change/Delete*
- *CA*
  - *Change Management Procedure*
- *IT CA*
  - *Change Management Procedure*
- *ITTF Member*
  - *Change Management Procedure*

This list must be compiled and updated jointly by all members of the ITTF **The information given above must be completed by ITTF before productive use of the handbook!**

A.1.3.2 List of procedure connections

This list shows all the ”*procedure A* has *procedure B* in its connected-procedures list” relations.

- *Change Management Procedure*
  - All change related procedures!
- *Item Create/Change/Delete*
  - *Change Management Procedure*

This list must be compiled and updated jointly by all members of the ITTF **The information given above must be completed by ITTF before productive use of the handbook!**

A.1.3.3 List of procedures for role

This list shows all the ”*role* is involved in *procedure*” relations.

- *Change Administrator*
  - *Change Management Procedure*
- *Change Advisory Board*
  - *Change Management Procedure*
- *Configuration and Change Manager*
  - *Change Management Procedure*
  - *Item Create/Change/Delete*
- *Handbook Manager*
  - *Item Create/Change/Delete*

This list must be compiled and updated jointly by all members of the ITTF. It is included for quick reference. **The information given above must be completed by ITTF before productive use of the handbook!**

A.1.3.4 List of procedures for tools

This list shows all the ”*tool* is used in *procedure*” relations. Must be checked and updated when:

- CMDB
  - *Change Management Procedure*

This list must be compiled and updated jointly by all members of the ITTF **The information given above must be completed by ITTF before productive use of the handbook!**

A.1.3.5 List of tools used by role

This list shows all the ”*role* usee *tool*” relations. It shows the tools that the member of a role must be familiar with to work efficiently.

- *Change Administrator*
  - *CMDB*
  - Handbook Repository
- *Configuration and Change Manager*
  - CMDB
- *Handbook Manager*
  - Handbook Repository

This list must be compiled and updated jointly by all members of the ITTF **The information given above must be completed by ITTF before productive use of the handbook!**

A.2 Roles

This section describes the roles used in this handbook. Suggestions are given as to the person or persons best suited for fulfilling the role as seen from an ITSM perspective. Assignment of roles to people is to be reviewed on a per-semester basis to ensure applicability of the handbook.

The following is a list of defined roles, including date of creation, date of last change and status (active, retired). The list must be updated on every creation or deletion.

- [Role Name] - Template/Description (2007-10-25/2007-10-26/active)
- ITSM: Configuration and Change Manager (2007-10-25/2007-10-26/active)
- ITSM: Change Administrator (2007-10-25/2007-10-26/active)
- ITSM: Change Advisory Board (2007-10-25/2007-10-26/active)
- Handbook: Handbook Manager (2007-10-25/2007-10-26/active)
- CDTM: CA - Center Assistant (2007-10-25/2007-10-26/active)
- CDTM: External User (2007-10-25/2007-10-26/active)
- CDTM: IT CA (2007-10-25/2007-10-26/active)
- CDTM: ITTF Member (2007-10-25/2007-10-26/active)
- CDTM: Student (2007-10-25/2007-10-26/active)

A.2.1 [Role Name]

[A short description of the role, should be one sentence].

Role name	[Role Name]
Responsibilities	[• list • of • responsibilities]
Knowledge needed	[What knowledge is needed to fulfill this role? What capabilities must a prospective role owner provide?]
Estimated Workload	[Estimated load for fulfillment in person-hours per week or month, only ITSM-relevant workload is meant here.]
Suggested Assignee	[CDTM personality (like ”office team member”) or *role* best suited for fulfilling this role. The *Handbook Manager* role may best be fulfilled by the *IT Services manager*, but can also be assigned to an *ITTF member*,*CA*, or *Student*]
Procedures involved in	[The procedures (in italics, if in this handbook) that the role is directly involved in.]
Privileges	[What are people in this role allowed to do? Includes Procedures they may instantiate as well as arbitrary privileges worth naming]
Escalate to	[What *role* can step in for the current owner of this role in case of emergency]

Table A.1: [Role Name] Overview

[Long text description of the role, giving details not seen in the overview and making the reader understand what the role is all about. Using ITSM terms is recommended, but information on source should be given]

A.2.2 ITSM: Configuration and Change Manager

This role covers the ITIL roles of Configuration Manager and Change Manager, controlling and designing all configuration items managed by CDTM IT.

Role name	Configuration and Change Manager
Responsibilities	• Generally: Adapt and implement the ITIL change and configuration management functions • see below for more information
Knowledge needed	• Basic knowledge of ITSM procedures Change Management and Configuration Management. • Familiarity with the tools needed • Full familiarity with the CDTM IT Operation Support Concept • ...
Estimated Workload	can vary greatly, probably is at least 5-10 hrs/week
Suggested Assignee	*IT CA*, can also be other *CA*
Procedures involved in	*Change Management Procedure*, *New Project Machine*, all Change-related procedures
Privileges	Full privileges pertaining to the change-related processes. Full privileges concerning configuration management
Escalate to	*IT-CA*

Table A.2: Configuration and Change Manager Overview

This role combines the ITIL roles of Change Manager and Configuration Manager along the lines of ITIL small scale. The person filling this role has full responsibility for the Change Management and the Configuration Management Processes. Detailed responsibilities are listed below.

- Generally: Adapt and implement the ITIL change and configuration management functions
- Identify configuration items (CI) to be managed and controlled
- Provide the central integration point for the business, the IT task force and third parties
- Ensure consistency and accuracy of the CMDB (including the Service Catalogue) and the DSL (see 5.3.5)with regard to the actual state of the infrastructure
- Organize regular audits of procedures, systems and services against stored data, implement corrective action
- Ensure the avoidance of uncontrolled changes

- Regularly provide information about the state of CDTM IT to the management team
- Promote ITSM generally at CDTM, raising awareness and strengthening management commitment as well as ITTF commitment to ITSM procedures
- Ensure familiarity with ITSM of all involved persons by taking care of training and education about the ITSM functions in place
- Guide strategy and policy as well as system design to minimize number of variants and system complexity
- Investigate major problems and identify remedial actions

This central role must be adapted to the current situation at CDTM and fleshed out in its description by ITTF.

The information given above must be completed by ITTF before productive use of the handbook!

A.2.3 ITSM: Change Administrator

This role covers the ITIL roles of Configuration Manager and Change Manager, controlling and designing all configuration items managed by CDTM IT.

Role name	Change Administrator
Responsibilities	• Implement agreed changes showing due diligence • Agree on back-out plans before implementation in live systems • Plan and coordinate testing of changes • Plan and coordinate review of changes after specified time • Document actions included or linked in RFC document
Knowledge needed	Capabilities to perform the necessary tasks, familiarity with the ITSM tools
Estimated Workload	(not applicable, since task-based)
Suggested Assignee	*ITTF Member*, *IT-CA*
Procedures involved in	All change-related procedures.
Privileges	Since the change administrator is only used for executing changes, there are no soecial privileges necessary
Escalate to	*Configuration and Change Manager*

Table A.3: Change Administrator Overview

The Change Administrator role is held by the person planning, administering, testing, and reviewing the change to the configuration items. In case of changes for the handbook, this **must** be the *Handbook Manager*.

This rule should be described again by a current member of ITTF after familiarization with the concept to ensure it is understandable by new students

The information given above must be completed by ITTF before productive use of the handbook!

A.2.4 ITSM: Change Advisory Board

The CAB is a group of people conferring and deciding about changes.

Role name	Change Advisory Board
Responsibilities	• be reachable in emergencies for personal expertise • keep user perspective • critically review and decide about RFCs • ...
Knowledge needed	Familiarity with the concept, basic familiarity with ITSM processes, technical expertise in matters at hand
Estimated Workload	A single CAB itself has no mentionable workload. The personal workload of an *ITTF Member* sitting in on a CAB meeting rises with the number of areas of personal expertise
Suggested Assignee	*IT-CA*, *CA*, *ITTF member*, *Student*
Procedures involved in	All Change-related Processes
Privileges	decide about the authorization and prioritization of changes
Escalate to	

Table A.4: Change Advisory Board Overview

An ITTF Member should fill this description after familiarization with the concept to make it intuitively understandable by new students

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The information given above must be completed by ITTF before productive use of the handbook!

A.2.5 Handbook: Handbook Manager

This is the person responsible for managing this handbook and the only person allowed to do so.

Role name	Handbook Manager
Responsibilities	• Take care of this handbook • Follow the regulations created by CDTM IT management for maintaining the handbook • ...
Knowledge needed	Familiarity with the tools needed to create and edit items in this handbook, understanding of the procedures needed for the tasks
Estimated Workload	The workload depends on the mode of maintenance in use. Must be decided upon, see 5.1.3
Suggested Assignee	An *ITTF member*, a *CA*, the *Configuration and Change Manager*, or the *IT CA*
Procedures involved in	*Item Create/Change/Delete*
Privileges	The person filling this role is allowed to edit the handbook, following the necessary procedures
Escalate to	*Configuration and Change Manager*

Table A.5: Handbook Manager Overview

The *Handbook Manager* is responsible and accountable for the handbook itself, ensuring its correctness, actuality and consistency.

This rule is included in the handbook to enable easy, understandable maintenance and clear responsibilities.

The information given above must be completed by ITTF before productive use of the handbook!

A.2.6 CDTM: CA

A scientific assistant at CDTM.

Role name	[Role Name]
Responsibilities	See *Student* plus • filtering and relaying student's requests to ITTF • ...
Knowledge needed	see *Student*, plus more information about the organization itself
Estimated Workload	for IT in general: none, except for the taking part in procedures as customer contact
Suggested Assignee	(not applicable)
Procedures involved in	
Privileges	Allowed to access special file shares, can request changes in access structure, role can be used to allow starting of procedures that are based on change models, like requests for project sites etc.
Escalate to	*IT CA*, if in function of procedure starter or contact person, no recursion

Table A.6: [Role Name] Overview

The scientific assistants of CDTM are the "influential" part of the user base. If an assistant has an itch, it must be scratched, in one way or another. One assistant is usually assigned the role of *IT CA*.

This rule is included in the handbook to intuitively show the new students what the layout of the organization is, and the role is needed for some special procedures.

The information given above must be completed by ITTF before productive use of the handbook!

A.2.7 CDTM: External User

A user of CDTM systems and services who is not officially part of CDTM.

Role name	External User
Responsibilities	• Adhere to CDTM system usage regulations • Keep credentials safe • ...
Knowledge needed	No knowledge is needed except the capabilities necessary for sensible use of CDTM systems
Estimated Workload	none
Suggested Assignee	(not applicable)
Procedures involved in	
Privileges	Use CDTM systems, submit incidents via CDTM members
Escalate to	(not applicable)

Table A.7: External User Overview

All external personnel who use CDTM systems, such as external lecturers or students doing project work for assistants have this role.

This rule is included in the handbook to keep the handbook intuitive and to enable interaction of processes with external persons.

The information given above must be completed by ITTF before productive use of the handbook!

A.2.8 CDTM: IT CA

The center assistant in charge of the IT task force.

Role name	IT CA
Responsibilities	• Leading the IT task force organizationally • Monitor members' satisfaction and motivation • Organize task force meetings • ...
Knowledge needed	Full knowledge of the task force's responsibilities, its organization, and its procedures. Competencies in leading people. Sufficient knowledge in administration and processes to take over any role in ITTF after short break-in
Estimated Workload	If not combined with any other role, the workload depends on the duties assigned to the CA for CDTM operations and can span from ten hrs/week on the low end, limited upwards by dedication only
Suggested Assignee	must be a *CA*, and capable of fulfilling the role]
Procedures involved in	The IT CA themselves have no procedural privileges without taking on other roles, the IT CA is only an organizational role for escalation purposes in this case.
Privileges	Full administrative privileges in the task force, can assign tasks to any *ITTF member*, can assign incidents to members, ... (when new roles, such as "Incident Manager", are created, this must be updated, privileges must be moved to the new role if applicable)
Escalate to	*CA*, only in extreme emergencies

Table A.8: IT CA Overview

The IT CA is the CDTM person organizationally responsible for the IT task force. This person does not necessarily have roles like *Configuration and Change Manager*, they may simply be the hierarchical head of ITTF. Still, they must be capable of fulfilling any function in CDTM IT.

This rule is included in the handbook to help the new members find out about CDTM IT personalities, roles, responsibilities, privileges and so on.

The information given above must be completed by ITTF before productive use of the handbook!

A.2.9 CDTM: ITTF Member

A member of CDTM IT task force, actively taking part in IT operations.

Role name	ITTF Member
Responsibilities	• Take part in IT operations of CDTM • Follow CDTM IT administration guidelines • Actively monitor systems during use • Take part in at least one ITTF project • ...
Knowledge needed	No knowledge at all is needed to join ITTF. A member is trained and assigned tasks according to their proficiency to maximize the learning effect while keeping with standards of work quality and due diligence.
Estimated Workload	Workload for a task force member can vary according to tasks and roles taken. It can average as little as 1-2hrs/week over the semester, but is only limited upwards by the student's commitment
Suggested Assignee	Any *Student* or *CA* can become a member of the ITTF
Procedures involved in	An ITTF member is not involved in any procedures now. They need to take up a specific role to be involved, e.g. by becomíng a *Change Administrator* for a single change
Privileges	Any ITTF Member can issue RFCs to the *Configuration and Change Manager*, only ITTF members can take up spcial IT roles, in the system, ITTF members have access to passwords etc.
Escalate to	Other *ITTF member*s or the*IT CA*

Table A.9: ITTF Member Overview

The ITTF Member role is held by all students and assistants who actively take part in CDTM IT operations, maintenance, administration and strategy.

This rule is included in the handbook to help the new members find out about their responsibilities, privileges and so on.

The information given above must be completed by ITTF before productive use of the handbook!

A.2.10 CDTM: Student

A CDTM student, the biggest user group at CDTM.

Role name	Student
Responsibilities	• Follow CDTM IT regulations • Keep password safe and regularly change it • ...
Knowledge needed	No Knowledge specific to managing or maintaining IT services or systems is needed, basic capabilities in using CDTM systems are assumed to be present.
Estimated Workload	none
Suggested Assignee	(not applicable)
Procedures involved in	
Privileges	no specific IT privileges
Escalate to	

Table A.10: Student Overview

The CDTM *Students* are the main user group at CDTM. They use the services and communicate incidents to CDTM IT. Even if they have no direct influence on CDTM IT strategy, the way they perceive the systems and services reflects on CDTM IT as a whole.

This rule is included in the handbook not only to make the handbook intuitive, but also to be already available when processes like e.g. incident management are implemented.

A.3 Tools

This part of the handbook describes the tools to be used at CDTM procedures described in the handbook as well as for other IT-internal tasks and processes.

The following is a list of defined tools, including date of creation, date of last change and status (active, retired). The list must be updated on every creation or deletion.

- [Tool Name] - Template/Description (2007-10-25/2007-10-26/active)
- Asset Database (2007-10-25/2007-10-26/active)
- Configuration Management Database - CMDB (2007-10-25/2007-10-26/active)
- Trouble Ticket System (2007-10-25/2007-10-26/active)

A.3.1 [Tool Name]

[A short description of the tool, should be one sentence but still descriptive for the tool]

Tool name	[Tool Name]
Software product	[The name of the software product used for the tool]
Software version	[The product's version that is used in production]
Tool used for	[• Principal • use of • the tool • at CDTM]
Additional uses	[Possible uses of the tool (according to its feature set) that are not implemented at CDTM at this time]
Benefits	[What benefits does the tool provide to CDTM business operations?]

Table A.11: [Tool Name] Overview

[Long text description of the tool, giving details not seen in the overview and making the reader understand what the tool is all about. Additionally, describe benefits in more detail, if applicable.]

A.3.2 Asset Database

The Asset Database is the central storage for information on physical IT assets.

Tool name	Asset Database
Software product	[To be decided on]
Software version	[To be decided on]
Tool used for	• Storing information about physical assets of CDTM IT • Controlling asset flow • Recording informatino linking asset items to configuration items and events • ...
Additional uses	[depending on the software product]
Benefits	There must always be information available about what physical assets are existing, where these assets are located, when they were acquired and more. This enables a precise forward planning for acquisition and support

Table A.12: Asset Database Overview

The asset database is used by the office team to record CDTM IT assets, possibly even all CDTM assets, and used by ITTF as a definitve, externally controlled information base

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The data given above is only to be seen as recommendation, CDTM IT management still must decide on details.

The information given above must be completed by ITTF before productive use of the handbook!

A.3.3 Configuration Management Database (CMDB)

The Configuration Management Database is the central storage for all configuration items, RFC's, and other ITSM-related information.

Tool name	Configuration Management Database
Software product	Moinmoin Wiki
Software version	1.4
Tool used for	Storing information about • configuration items (CIs) • RFC's • Problems • ...
Additional uses	The CMDB can be used for many purposes, see [OGC 03b] for more information
Benefits	The CMDB is essential in enabling ITSM processes to work efficiently

Table A.13: Configuration Management Database Overview

This description should be filled out by CDTM ITTF and then cross-checked by an ITIL-proficient person to make sure the meaning of the CMDB is fully understood and documented for CDTM

The data given above is only to be seen as recommendation, CDTM IT management still must decide on details.

The information given above must be completed by ITTF before productive use of the handbook!

A.3.4 Trouble Ticket System

The trouble ticket system is the main inbound pipe for user requests and incidents.

Tool name	Trouble Ticket System
Software product	OTRS
Software version	2.1
Tool used for	• giving users a single point of contact to the IT task force • recording and analyzing user requests and incidents • providing users with an FAQ • ...
Additional uses	Other teams and functions of CDTM can also use this tool for their purposes to improve service quality
Benefits	Users get a single point of contact, requests are tracked so no request stays unanswered, analysis of incidents shows problems in CDTM IT, ...

Table A.14: Trouble Ticket System Overview

This description should be filled out by CDTM ITTF and then cross-checked by an ITIL-proficient person to make sure the meaning of the CMDB is fully understood and documented for CDTM

The data given above is only to be seen as recommendation, CDTM IT management still must decide on implementation of a trouble ticket system.

The information given above must be completed by ITTF before productive use of the handbook!

A.4 Procedures

The Procedures

This section lists the procedures that have been defined for CDTM IT. These includes generic procedures, like the *Change Management Procedure* described below, as well as change models and other procedures. New categories of procedures will be needed when new ITSM processes are implemented.

The following is a list of defined procedures, including date of creation, date of last change and status (active, retired). The list must be updated on every creation or deletion.

- [Procedure Name] - Template/Description (2007-10-25/2007-10-26/active)
- Generic: Change Management Procedure (2007-10-25/2007-10-26/active)
- Handbook: Item Create/Change/Delete (2007-10-25/2007-10-26/active)

This section purposely has a low coverage in content, since an effect of creating the procedural descriptions is a rethinking of the underlying course of actions. In the CDTM scenario, it is very important for the involved persons to create this content themselves while being supervised in order to learn the ITSM perspective on the work they already do, as opposed to getting a procedure forced onto them which they do not understand.

The next procedures to be defined should include procedures facilitating the phase-in of new members into the IT task force.

A.4.1 [Procedure Name]

[A short description of the procedure, should be one sentence but still describe the purpose]

Procedure name	[Procedure Name]
ITSM area involved	[List the ITSM areas involved, like e.g. *Change Management*]
Roles involved	[The names of *roles* involved in this procedure. If a needed role is not in this handbook, create it or describe it thoroughly in the description below]
Allowed Initiators	[What other *procedures*,*roles*, or people, are allowed to initiate this procedure?]
Connected Procedures	[What procedures are connected to this procedure, i.e. which *procedures* initiate this one and which *procedures* are initiated by this one. Note: not all *procedures* that are allowed initiators must initiate this procedure]
Tools Used	[Which *tools* are used by this procedure, if not in this handbook, describe below in textual description or create "Tool" item]
Estimated Workload	[Estimate the workload in person-hours needed to run through an instance of this procedure without interruptions]
Purpose	[What was the procedure created for, in short terms (overview)]
Benefits	[What benefits does the procedure provide to CDTM business operations?]
Attached Files	[List diagrams, pictures, files attached to this description]

Table A.15: [Procedure Name] Overview

[Long text description of the procedure, giving details about the procedure's purpose, benefits and history. Include a procedural description in the form best suited (may be a bullet list of actions, may be graphical, or even a listing). If use of different tools necessary, attach source files as necessary and possible]

This rule is included in the handbook to intuitively show the new students what the layout of the organization is, and the role is needed for some special procedures.

The information given above must be completed by ITTF before productive use of the handbook!

A.4.2 Generic: Change Management Procedure

All changes should follow this basic procedure.

Procedure name	Change Management Procedure
ITSM area involved	Change Management, Configuration Management
Roles involved	*Configuration and Change Manager*, *Change Administrator*, *Change Advisory Board*, change initiators
Allowed Initiators	*CA*,*IT CA*, *ITTF Member*, *Configuration and Change Manager*
Connected Procedures	All change-related procedures
Tools Used	*CMDB*
Estimated Workload	(workload is determined by the change in question)
Purpose	This is the standard change management procedure for CDTM IT to follow an adapted ITIL guidance for Change Management
Benefits	Enable changes along ITSM guidelines
Attached Files	Flowchart(Powerpoint)

Table A.16: Change Management Procedure Overview

This procedure has been adapted from the mainstream ITIL change management procedure as described in 5.3.6. The flowchart is re-used here.

This information should be augmented by the IT members before use.

The information given above must be completed by ITTF before productive use of the handbook!

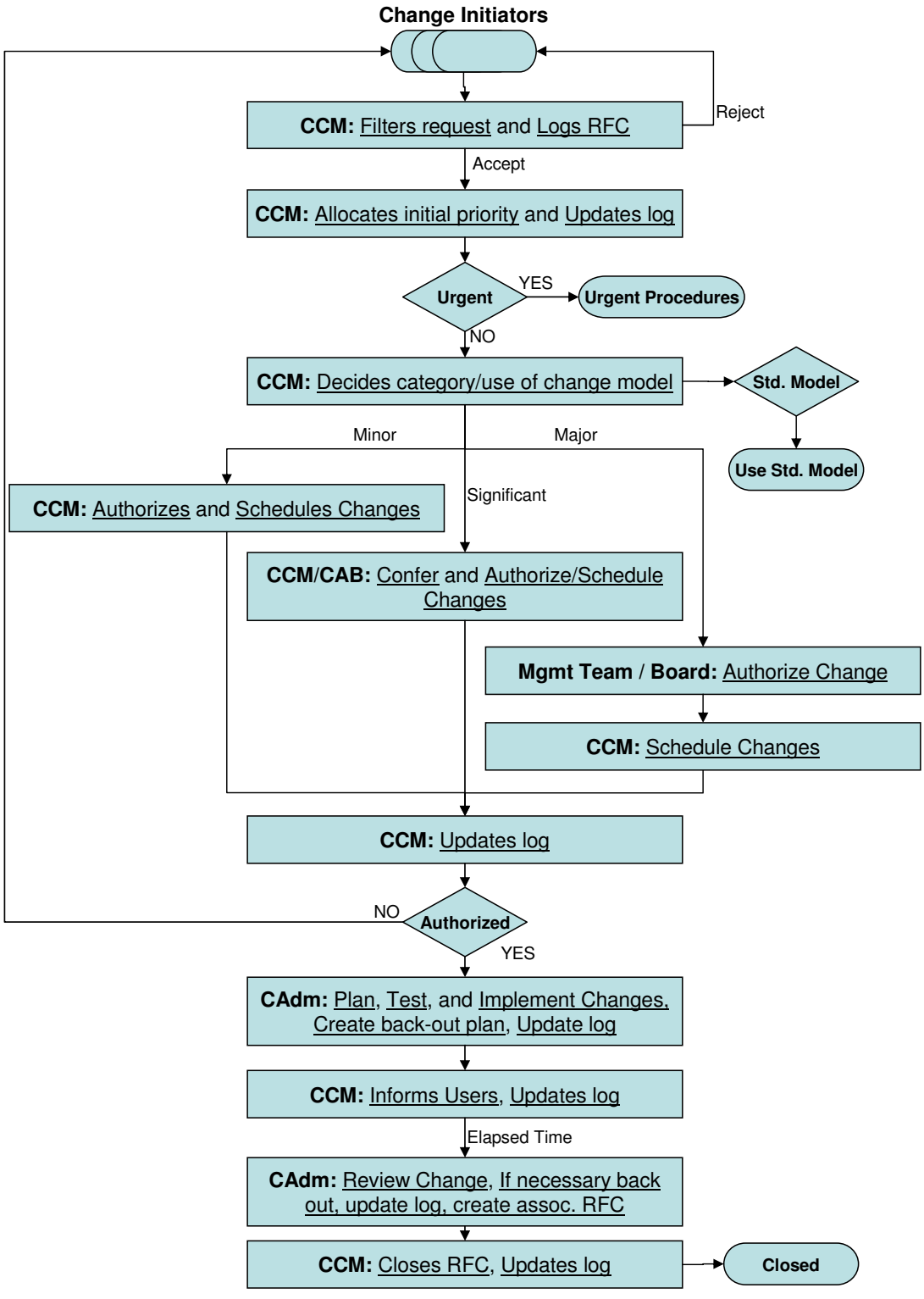

Figure A.2: Adapted Change Management Procedure

A.4.3 Handbook: Item Create/Change/Delete

This procedure describes the special points to consider when creating, changing or deleting an item in this handbook.

Procedure name	Item Create/Change/Delete
ITSM area involved	*Handbook Maintenance*
Roles involved	*Handbook Manager*, *Configuration and Change Manager*
Allowed Initiators	*Configuration and Change Manager*, *Handbook Manager*
Connected Procedures	*Change Management Procedure*
Tools Used	Handbook Repository
Estimated Workload	The workload is strongly dependent on the change rate in the handbook and on the mode of handbook maintenance in place
Purpose	This procedure is a change model, modifying the standard change management procedure of CDTM IT to enable quick, easy, but still high quality changes to this handbook
Benefits	The use of this procedure keeps changes in the handbook under control while still allowing timely changes
Attached Files	

Table A.17: Item Create/Change/Delete Overview

When creating, changing and deleting items in this handbook, several rules must be followed. In general, the Change Management Procedure is to be followed, with the following changes:

- It is assumed that the RFC is created with all information needed for a direct change of the handbook, eliminating the need for back-out planning and such
- The procedure can only be initiated by the *Configuration and Change Manager*. this ensures that only one channel of input is used and the entity filtering the change requests is informed and capable.
- The role of ”Change Administrator” in the standard change management procedure is fulfilled by the *Handbook Manager* and no one else. This ensures consistency of the handbook.
- There is no need for authorization of a change, since only the *Configuration and Change Manager* can initiate this procedure. Also, no report to a CAB is necessary
- The main effort needed to be performed by the Handbook Manager is the checking of all dependencies. This involves the following (requested action on item is given in braces):

  - (Change) all other items using, used by, or involved in the changed item, to be found in the dependency lists in the handbook
  - (Delete) If other items are affected, these items must have been identified beforehand, changed accordingly in the scope of the same RFC and a full list of changed items must be documented
  - (Delete) If any item is affected that was not included in the same change, the changes are not to be performed, but must be reevaluated and resubmitted
  - (Create/Delete) All lists, especially the lists of items at the beginning of a category, must be updated
- Before the procedure is finished, all dependant information, especially the dependency lists, **must** be updated
- (Create/Change/Delete) The printed form of the handbook is to be updated to be available in case of system failures

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This procedure may still need to be changed and adapted by the CDTM management when implementing ITSM processes.

The information given above must be completed by ITTF before productive use of the handbook!

Glossary

CA See *Center Assistant*

CDTM see *Center for Digital Technology and Management*

Center Assistant The scientific assistants at CDTM are called ”center assistant”, after a renaming from the term ”teaching assistant” to allow distinction from working students, who were also titled ”teaching assistant”.

Center for Digital Technology and Management The CDTM is one of the elite study programs that are member of the ENB and is described in chapter 1

DMZ ”...a demilitarized zone (DMZ), more appropriately known as demarcation zone or perimeter network, is a physical or logical subnetwork that contains an organization’s external services to a larger, untrusted network, usually the Internet.” See
`http://en.wikipedia.org/wiki/Demilitarized_zone_(computing)`

Elitenetzwerk Bayern The *Bavarian Elite Network* is an organization furthering elite studies in the German state of Bavaria. For more information, see
`http://www.elitenetzwerk-bayern.de`

ENB See *Elitenetzwerk Bayern*

IEEE 802.11b ”IEEE 802.11 is a set of standards for wireless local area network (WLAN) computer communication, developed by the IEEE LAN/MAN Standards Committee (IEEE 802) in the 5 GHz and 2.4 GHz public spectrum bands.” See
`http://en.wikipedia.org/wiki/IEEE_802.11`

IMAP The *Internet Message Access Protocol* is an application layer Internet protocol that allows a local client to access e-mail on a remote server. See
`http://en.wikipedia.org/wiki/IMAP`

IT CA The *CA* responsible for leading the IT task force at CDTM

Leibniz Rechenzentrum The Leibniz Rechenzentrum is a central provider for IT related services to the scientific community in Munich. For more information, see `http://www.lrz-muenchen.de`

LMU The **Ludwig-Maximilians-Universität** in Munich. For more information, see `http://www.lmu.de`

LRZ See *Leibniz Rechenzentrum*

Management Team The team of assistants at CDTM as a group is called ”management team”

MTBF The *Mean time between failures* (MTBF) is the mean (average) time between failures of a system, and is often attributed to the 'useful life' of the device”, see `http://en.wikipedia.org/wiki/MTBF`

Scientific Directors A special role for two members of the board of CDTM each semester, explained in section 1.2.

SD See *Scientific Directors*.

SPOF A *Single Point of Failure* is a system or component that disables multiple services/systems if a failure occurs

TUM The **Technische Universität München**. For more information, see `http://www.tum.de`

WEBDAV WEBDAV is a standard protocol to access file resources via HTTP and can be used to map e.g. a web site's file directory directly as a network drive, enabling live editing.

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