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A Model of Quality Service Management for Information Systems

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Resumo

No contexto actual de competitividade das empresas, torna-se essencial para a sobrevivência das mesmas a aplicação de metodologias que contribuam para o incremento dos níveis de eficiência e eficácia dos processos internos. Nas empresas das áreas das tecnologias de informação (TI) e em particular na área de desenvolvimento e manutenção de Software, muitas vezes são negligenciados os processos de gestão interna quer de desenvolvimento quer de manutenção das aplicações ao longo do seu ciclo de vida.

Para endereçar estas questões de primordial importância na indústria das TI, têm vindo a ser desenvolvidos alguns *Frameworks* e referenciais normativos que permitem implementar soluções para gestão da qualidade de serviço das TI e das respectivas infra-estruturas. Esta Dissertação propõe-se aprofundar e estudar a aplicação das diferentes *Frameworks* e Normativos no âmbito da Qualidade no Processo de Desenvolvimento e Manutenção de Software, e no Serviço e Gestão das Infra-estruturas de apoio, procedendo ao enquadramento das mesmas nos problemas decorrentes nesta área. Alguns dos *Frameworks* e Normativos a serem estudados, incluem: CMMI, Personal Software Process (PSP), ISO/IEC15504 (SPICE), ITIL, ISSO/IEC 20000, ISO/IEC 12207, ISO/IEC 9126, ISO 14598, ISSO/IEC 27001, ISO/IEC 17799 e CobiT.

Após a descrição de cada uma das normas, com os seus pontos fortes e fracos, será feita uma caracterização e levantamento de funcionalidades para uma solução tecnológica de suporte com recurso a estas metodologias, bem como se efectuará a aplicação prática destas metodologias num caso de estudo real, no qual serão identificadas métricas e características no âmbito dos

processos de desenvolvimento de tal ferramenta de suporte, sendo elaborado um Modelo de Gestão da Qualidade do Serviço utilizando estes Frameworks e Normativos no desenvolvimento e implementação de um Sistema de Informação.

Palavras-Chave

CMMI, Personal Software Process (PSP), ISO/IEC15504 (SPICE), ITIL, ISO/IEC 12207, ISO/IEC 9126, ISO 14598, ISO/IEC 17799, ISO/IEC 20000, ISO/IEC 27001, CobiT, IT Frameworks.

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Abstract

In today's companies, it is essential for their survival the application of methodologies that increment the levels of efficiency and effectiveness of their internal processes. In Information Technology (IT) companies and in particular, IT companies that develop and maintain their own Software programs, many times their internal management processes are neglected when developing and maintaining their applications, throughout the application's lifecycle.

To address these questions of primordial importance for IT companies, a set of Frameworks and Standards have been developed, trying to drive solutions for the management of Service Quality in IT and their infrastructure. This Dissertation proposes to study the application of the different Frameworks and Standards related to Quality in the process of development and maintenance of computer Software, as well as Service and Management of their Infrastructures, referring to the recurring problems in this area. Some of the Frameworks and Standards to be studied here are: CMMI, Personal Software Process (PSP), ISO/IEC15504 (SPICE), ITIL, ISO/IEC 20000, ISO/IEC 12207, ISO/IEC 9126, ISO 14598, ISO/IEC 27001, ISO/IEC 17799 and CobiT.

After describing each of these Standards and Frameworks, with their pros and cons, it will be made a characterization and evaluation of functionalities for a technological offer supporting these methodologies, as well as a practical application of these methodologies in a real case study, in which there will be identified metrics and characteristics regarding the development processes of such Support tool. A Model of Quality Service Management using these Standards and Frameworks in the development and implementing of an Information System will also be proposed and implemented.

Keywords

CMMI, Personal Software Process (PSP), ISO/IEC15504 (SPICE), ITIL, ISO/IEC 12207, ISO/IEC 9126, ISO 14598, ISO/IEC 17799, ISO/IEC 20000, ISO/IEC 27001, CobiT, IT Frameworks.

1. Introduction

1.1 Context

In order to understand the existence of so many Standards and Frameworks in this specific area of IT, we first must identify the recurring problems in IT development and the Quality flaws that arise from problems in the early stages of the development processes, which will be reflected in the final product. A good way to start is to study the existing Standards and Frameworks, which will permit to address problems that many times are not visible to the manager, alerting the manager to their awareness and impact to the final product.

Some of the most common errors in IT development and management can be mitigated applying these standards. Problems derived from insufficient testing, unavailable or incomplete product documentation, absence of planning the sequencing of operations, no time management techniques for the programmers and their teams, considering product packaging and product support and so many other issues that should be considered for product Quality improvement and how Quality is perceived by the client.

The IT manager must understand how these Standards and Frameworks overlap and complement with each other, in order to take advantage of their guidelines and solve the problems they are trying to address.

1.2 Problem

The working environment for the case study is an ERP developing department, with the present solution for Client Support consisting in an ad-hoc Client support E-mail, with no control over resolution time, occurring lost requests for change, redundancy of e-mail reading (all product

areas had to read all e-mails, because not all e-mails had a clear indication of what area the problem referred to). This represented a terrible inefficiency in valuable support team's time.

The absence of a standard point of entry, with a set of required characteristics (form fields) when outlining a request also leaded to incomplete requests, which implied a reply answer from the support team demanding a more detailed request for change.

The objective consists in establishing a robust and consistent Support platform in an IT department. The case study presented illustrates a web support platform developed considering the Frameworks' and Standards' best practices. A more detailed description of the problem will be detailed in Chapter 3.

1.3 Methodology

The approach taken during the execution of this Dissertation was focused in assimilate and gather all the pertinent and actualized information regarding the state of the art of Quality Service Management. This approach resembles the Action Research methodology [48, Page 2], as it is "grounded in practical action, aimed at solving an immediate problem situation while carefully informing theory".

This methodology ideal domain considers an environment [48, page 7] where the "researcher is actively involved"; "the knowledge obtained can be immediately applied" and "the research is a process linking theory and practice". All these 3 premises are present. The Action Research has 5 identifiable phases:

- Diagnosing
- Action planning
- Action taking

- Evaluating
- Specifying learning

After a thorough diagnosing of the several existing Standards and Frameworks, a group of these Standards and Frameworks were selected (the Action planning phase) and included in this Dissertation. Some may argue this selection, but I believe the selected Standards and Frameworks cover a wide area of information for those who have interest in this very interesting area of IT.

The different Standards and Frameworks are presented in a top-down approach, considering the related and more detailed associated Frameworks next to the preceding and more generic Framework. An example may be CMMI - Capability Maturity Model Integration as a more "Top" approach, and ISO 15504 SPICE as a more detailed associated Framework. (This structured approach is better reflected in the Annex).

All of these Standards and Frameworks overlap and complement each other. By presenting all of these Frameworks and Standards together, will permit the reader to have a clearer view of what exists and what can be useful in each situation or business goal.

After having described and consolidated the included Frameworks, the sum up of those guidelines and best practices will be applied to a real case study (the Action taking phase), clearly identifying which Framework or Standard (or both) is being used in the specific process.

The first step is drawing the As-Is Process for the analyzed problem, permitting a clear view of the status of the process and visually identifying how the process should be implemented, permitting a To-Be schema. Using the core Frameworks and Standards as good practices references, a new Client support process will be designed.

The second step is the operational implementation of the new process design into a functional platform. The full integration/implementation of the core Frameworks and Standards is not an objective in the development and implementation of the To-Be Support Platform we will use as a case study.

Finally, an assertion (the Evaluation phase) of the obtained results is executed and the reuse of this information is applied as feedback for process reengineering and process improvement (the Specifying learning phase).

1.4 Dissertation Structure

The dissertation follows a logic sequence in the presentation of the Frameworks and Standards. A related Framework or Standard will be presented next to the main Framework that preceded it. In Chapter 2 (IT Frameworks), a description of the main goals and approaches taken by each of the Standards and IT Frameworks will be presented.

IT Frameworks like CMMI, ITIL or CobiT that are focused on internal process improvements will be detailed and how these frameworks integrate with some of the most recognized ISO Standards, like ISO/IEC 15504 (SPICE), ISO 20000, ISO 9126, ISO 12207 or ISO/IEC 17799.

Chapter 2 begins to describe CMMI - Capability Maturity Model Integration, one of the world's most recognised IT Framework. CMMI focuses in providing a structured approach for the software development, defining a support structure in which a software project can be organized and developed. The described CMMI will be CMMI for Development version 1.2, the first constellation of CMMI. A description of CMMI origins, CMMI levels, as well as CMMI requirements for appraisals like SCAMPI is presented.

ISO/IEC15504 Software Process Improvement and Capability dEtermination (SPICE) follows, as the ISO's (which is prominently a European organization) offer of a Process Improvement standard, which is aligned with CMMI (an American Framework). ISO/IEC15504 is an approach for the assessment of processes, aligned with the capability levels (continual approach) presented by CMMI. It is used usually as a benchmark tool as it permits to quantify business processes.

Next Information Technology Infrastructure Library (ITIL) is presented, as it is an essential Framework that describes a set of processes for the management of IT. Because it is a framework, ITIL does not describe in great detail how any particular process should be implemented. ITIL comprises a set of several books, but the scope of this dissertation will focus only on the Service Support and Service Delivery books. A description of ITIL origins and what is expected to happen in ITIL is also presented.

Finally, the last Framework to be presented is CobiT - Control Objectives for Information and related Technology. CobiT is a business focused, process-oriented, controls-based and measurement-driven Framework. It provides essentially a set of control objectives, following the principle of providing the information that the enterprise requires to achieve its objectives. CobiT is commonly associated with internal control and audit firms, as it is aligned with the 2002's Sarbanes-Oxley act (SOX).

In Chapter 3, a description of the problem and the needs that need to be fulfilled are presented. The Product and Services GIAF, the Process layout As-Is, the goals to be achieved and the metrics used to quantify the success of a Client Support Process. The Request for Change characteristics are also detailed for the Request for Change template, by integrating the Support Team's feedback for their needs in terms of Request for Change information, as well as embedding the good practices of the mentioned Frameworks.

In Chapter 4, a proposed solution and process redesign (Process layout To-Be) is detailed. This Client Support Process will be redesigned and used as a use-case, fitting good practices of parts of some of the core Frameworks and Standards presented in Chapter 2. The ITIL/CMMI/CobiT frameworks will be fitted for the specific problem, accordingly. The Process Improvement approach ISO/IEC 15504 SPICE will also have a strong presence, especially with the involvement and feedback from Clients (stakeholders).

In Chapter 5, a Prototype Implementation for the Support Platform is detailed, separated in two different perspectives:

- Service Support Platform - Client's Side
- Service Support Platform - Support Team's Side

Alongside with the description of the Support Platform, the several embedded Frameworks and Standards are indicated where their use is appropriate. In Chapter 6, a critic Evaluation using a structured approach through the answering of key questions and the answering of specific questions for both a Goals-oriented Evaluation as well as a Process-oriented Evaluation of the new Support Platform.

In Chapter 7, Conclusions and further Developments, the operational and process gains are discussed, as the results and the number of Requests for Change gain critical mass for a thorough and significant analysis. As the information consolidates and feedback from Clients and Users is obtained, the opportunity arises for the reuse of this knowledge. It will be presented how the results can be used to continuously improve the Support Platform and subsequently the Service Support process.

At the end of the Dissertation, a References listing, a Glossary/Acronyms and an Annex, which contains all of the detailed Frameworks and associated Standards that were studied for this dissertation are presented.

2. IT Frameworks

A good way to start is to know the different Standards and Frameworks that exist and are available to the IT manager, knowing what good advices and practices they have to offer, so that the IT manager can perform the best possible decisions based on the appropriate best practices. In this Chapter, a description of several main Standards and Frameworks will be presented and resumed. They will be presented in a top down approach, meaning that a generic Framework will be followed by the more detailed associated Framework, and then again by a more generic (not directly related) Framework.

This chapter will present the structure of the main IT Frameworks, like CMMI, ITIL, CobiT, ISO 15504 (SPICE), as well as some IT Standards, like ISO/IEC 12207, ISO/IEC 9126, ISO 20000, ISO 14598 and ISO/IEC 17799.

The analysis of the Frameworks begins with Capability Maturity Model Integration (CMMI), which is a commonly recognised standard focused in process improvement, based in two different approaches, continual or staged process improvements.

Let's begin with one of the main Frameworks recognised throughout the world as one of the milestones in IT management and process improvement, CMMI - Capability Maturity Model Integration.

2.1 Capability Maturity Model Integration (CMMI)

CMMI (Capability Maturity Model Integration) is a Framework. A Framework, by definition is "a structure supporting or containing something". In software development, a Framework is a

defined support structure in which another software project can be organized and developed. CMMI considered 4 different models directed to different domains, supporting the process improvements of those specific areas. The models were:

- CMMI-SE (Systems Engineering)
- CMMI-SW (Software Engineering)
- CMMI-IPPD (Integrated Product and Process Development)
- CMMI-SS (Supplier Sourcing)

CMMI has evolved and is currently undergoing a different structural approach. CMMI now includes the concept of CMMI "constellations." A constellation is a set of CMMI components designed to meet the needs of a specific area of interest. A constellation can produce one or more related CMMI models and related appraisal and training materials. CMMI for Development is the first of these constellations [1].

The prior CMMI-SE/SW (Systems Engineering and Software Engineering) Version 1.1 as well as CMMI-IPPD (Integrated Product and Process Development) are now superseded to Version 1.2 CMMI for Development (CMMI-DEV), to truly reflect the comprehensive integration of these bodies of knowledge and the application of the model within the organizations. CMMI-SS (Supplier Sourcing) was removed.

There are still available some CMM models, like P-CMM (People CMM) and SA-CMM (Software Acquisition CMM). P-CMM (People CMM) shares the same philosophy as the CMMI-SW, but applied to Human Resources in order to continuously improve the ability of software organizations to attract, develop, motivate, organize, and retain the talent needed to steadily improve their software development capability. SA-CMM (Software Acquisition), aims to organizations that acquire solutions such as hardware, software, services, and systems. This Dissertation will only focus in the CMMI models.

2.1.1 *CMMI Levels*

As it is described in CMMI-DEV [6, Part 1, Chapter 3], CMMI supports two improvement paths. One path enables organizations to incrementally improve processes corresponding to an individual Process area[1] (or process areas) selected by the organization. The other path enables organizations to improve a set of related processes by incrementally addressing successive sets of process areas.

These two improvement paths are associated with two representations:

- Continuous representation, for which CMMI uses the term "capability level."
- Staged representation, for which CMMI uses the term "maturity level."

The concept of levels is the same on both representations.

Levels are used in CMMI to describe an evolutionary path recommended for an organization that wants to improve the processes it uses to develop and maintain its products and services. Levels can also be the outcome of the rating activity of appraisals. The most used method to grant a CMMI level to an organization is through SCAMPI (Standard CMMI Appraisal Method for Process Improvement). Figure 1 illustrates the difference between stage and continuous representations.

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[1] Process area is a cluster of related best practices in an area, which when implemented collectively, satisfy a set of goals considered important for making significant improvement in that area [6, Preface].
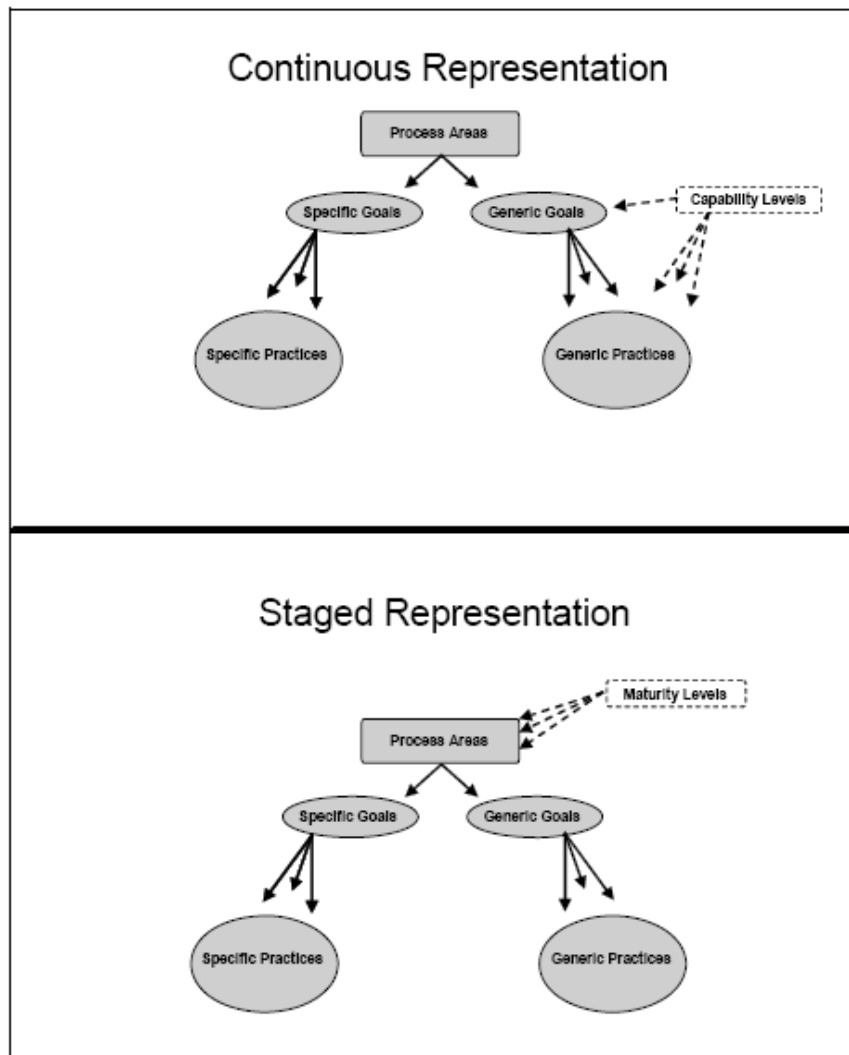
Source: CMMI-DEV Version 1.2 Part 1, Chapter 3

Figure 1 - CMMI Continuous and Staged Representations

The capability/maturity dimensions of CMMI are used for benchmarking and appraisal activities, as well as guidance to an organization's improvement efforts.

Capability levels, which belong to a continuous representation, apply to an organization's process improvement achievement in individual process areas. These levels are a mean for

incrementally improving the processes corresponding to a given process area. There are six capability levels, numbered 0 through 5.

Maturity levels, which belong to a staged representation, apply to an organization's process improvement achievement across multiple process areas. These levels are a means of predicting the general outcomes of the next project undertaken. There are five maturity levels, numbered 1 through 5. Table 1 illustrates the alignment between the two representations.

Levels	Continuous Representation Capability Levels	Staged Representation Maturity Levels
Level 0	Incomplete	N/A
Level 1	Performed	Initial
Level 2	Managed	Managed
Level 3	Defined	Defined
Level 4	Quantitatively Managed	Quantitatively Managed
Level 5	Optimizing	Optimizing

Source: CMMI-DEV Version 1.2 Part 1, Chapter 3

Table 1 - CMMI Capability and Maturity Levels

Each level has a set of specific practices/recommendations that should be implemented in order to achieve the desired level. Level 2 through 5 represent the same on both representations. A short description of the continuous representation follows:

Capability Level 0: Incomplete

An "incomplete process" is a process that either is not performed or partially performed.

Capability Level 1: Performed

A performed process is a process that satisfies the specific goals of the process area. But they can be lost over time if they are not institutionalized.

Capability Level 2: Managed

A managed process is a performed process that has the basic infrastructure in place to support the process. It is monitored, controlled, and reviewed and evaluated.

Capability Level 3: Defined

A defined process is a managed process that is tailored from the organization's set of standard processes. A critical distinction between capability levels 2 and 3 is the scope of standards, process descriptions, and procedures. Process descriptions and procedures are tailored from the organization's set of standard processes to suit a particular project or organizational unit.

Capability Level 4: Quantitatively Managed

A quantitatively managed process is a defined process that is controlled using statistical and other quantitative techniques. Quantitative objectives for quality and process performance are established and used as criteria in managing the process.

Capability Level 5: Optimizing

An optimizing process is a quantitatively managed process that is improved based on an understanding of the common causes of variation inherent in the process. The focus of an optimizing process is on continually improving the range of process performance through both incremental and innovative improvements.

A short description of the staged representation levels follows:

Maturity Level 1: Initial

At maturity level 1, processes are usually ad hoc and chaotic. The organization usually does not provide a stable environment to support the processes. Success in these organizations depends on the competence and heroics of the people in the organization and not on the use of proven processes.

Maturity Level 2: Managed

At maturity level 2, the projects of the organization have ensured that processes are planned and executed in accordance with policy.

Maturity Level 3: Defined

At maturity level 3, processes are well characterized and understood, and are described in standards, procedures, tools, and methods.

Maturity Level 4: Quantitatively Managed

At maturity level 4, the organization and projects establish quantitative objectives for quality and process performance and use them as criteria in managing processes.

Maturity Level 5: Optimizing

At maturity level 5, an organization continually improves its processes based on a quantitative understanding of the common causes of variation inherent in processes.

As referred early, levels 2 through 5 represent the same on both representations. All these descriptions of the levels are more detailed in CMMI-DEV version 1.2 [6, Part1, Chapter 3].

2.1.2 *CMMI Appraisals (SCAMPI)*

The Standard CMMI Appraisal Method for Process Improvement (SCAMPI) appraisal methods are the generally accepted methods used for conducting appraisals using CMMI models [8]. The SCAMPI family of appraisals includes Class A, B, and C appraisal methods. SCAMPI A is the most rigorous method and the only method that can result in a rating. SCAMPI B provides options in model scope, but the characterization of practices is fixed to one scale and is performed on implemented practices. SCAMPI C provides a wide range of options, including

characterization of planned approaches to process implementation according to a scale defined by the user [6, Part 1, Chapter 5].

Appraisals of organizations using a CMMI model must conform to the requirements defined in the Appraisal Requirements for CMMI (ARC) v 1.2 document [7]. In short, this ARC document details step by step sets of activities to achieve the selected goals. ARC permits setting the frame of activities to define the responsibilities of the sponsor and the team leader, as well as point the method to document, plan and prepare for the appraisal. It also sets the requirements of the appraisal to collect, consolidate and validate data. How to set the rating, and finally, reporting the results.

But lets detail further what is SCAMPI A. SCAMPI A satisfies the Appraisal Requirements for CMMI (ARC) v1.2 and is a Class A appraisal method. The SCAMPI A method has the following primary objectives:

- Provide a common, integrated appraisal method capable of supporting appraisals in the context of internal process improvement, supplier selection, and process monitoring
- Provide an efficient appraisal method capable of being implemented within reasonable performance constraints

As an ARC Class A method, SCAMPI A is a benchmarking-oriented method suitable for generating ratings. SCAMPI A appraisals can be performed in three modes of usage:

- Internal Process Improvement
- Supplier Selection
- Process Monitoring

While many of the SCAMPI A features are common across all usage modes (e.g., identification of strengths, weaknesses, and ratings), there are differences in motivation and intent that can result in some expected method differences in these usage modes. Performing appraisals efficiently involves minimizing the use of resources and the impact on appraisal teams and appraised organizations, while maintaining the essential method characteristics that ensure the high degree of accuracy required for an effective benchmarking, regardless of the mode of usage [8, Chapter 1, Page 17].

The first thing to do in SCAMPI is to prepare and plan for appraisal. The team leader and the appraisal sponsor should analyze the requirements. The team leader will collect information and help the appraisal sponsor match appraisal objectives with their business objectives. The next step is to document the results of appraisal planning including the requirements, agreements, estimates, risks, method tailoring, and practical considerations.

The business needs for process improvement drive the requirements for the conduct of any given appraisal and generally include one or more of three closely related factors:

- Reducing costs
- Improving quality
- Decreasing time to market

The appraisal team leader must establish high-level cost and schedule constraints to determine which process areas and organizational entities are to be included to ensure feasibility. The appraisal team leader is also responsible for keeping the appraisal sponsor informed of risk management activities so that, if needed, timely sponsor intervention is possible to ensure the achievement of appraisal objectives.

After appraisal requirements have been documented, constraints are understood and the appraisal plan is defined, the team must be selected and prepared. The minimum acceptable

team size for a SCAMPI A appraisal is four people (including the appraisal team leader). All team members must have previously completed the SEI-licensed Introduction to CMMI course.

After the team is selected and all the data collection is planned, the appraisal may now be conducted and the model practices implemented. The findings will be validated and the appraisal output results generated. With this output, the capability (or maturity) level attained for each process area within the scope of the appraisal will be depicted.

The appraisal results will be delivered to the sponsor and to the appraised organizational unit. The appraisal results are intended to support decision making, and should be delivered in a way that promotes appropriate actions. Whether the appraisal was conducted for internal process improvement, supplier selection, or process monitoring purposes, the delivery of results (ADS – Appraisal Disclosure Statement) should facilitate the actions that will be driven by the information and utilized for subsequent reports and follow-up actions.

In short, what are the benefits of using CMMI? The answer is that CMMI best practices improve organizations by enabling to do the following:

- More explicitly link their management and engineering activities to their business objectives
- Expand their visibility into their product life cycle and engineering activities to ensure that their products and services meet customer expectations
- Incorporate lessons learned from additional areas of best practice, like risk management
- Implement more robust high-maturity practices and levels
- Address additional organizational functions critical to their products and services
- More fully comply with relevant ISO standards, like ISO/IEC 15504 (SPICE)

A more detailed explanation of CMMI is presented in Annex A.1, as well as a derivation of the SW-CMM is available in Annex A.2, applicable to small programming teams or individual programmers to accomplish continuous improvements called Personal Software Process.

In the next subsection, the CMMI's associated ISO standard, ISO/IEC 15504 (SPICE) will be presented.

2.2 ISO/IEC15504 Software Process Improvement and Capability dEtermination (SPICE)

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. ISO/IEC 15504 SPICE (Software Process Improvement and Capability dEtermination) is a framework that provides a structured approach for the assessment of processes. ISO/IEC 15504 consists of the following parts, under the general title Information Technology - Process Assessment:

- Part 1: Concepts and vocabulary [16], provides a general introduction to the concepts of process assessment and a glossary
- Part 2: Performing an assessment [17, 17a], sets out the minimum requirements for performing an assessment that ensure consistency and repeatability of the ratings
- Part 3: Guidance on performing an assessment [18], provides guidance for interpreting the requirements for performing an assessment
- Part 4: Guidance on use for process improvement and process capability determination [19], identifies process assessment as an activity that can be performed either as part of a process improvement initiative or as part of a capability determination approach

▪ Part 5: An exemplar Process Assessment Model [20], contains an exemplar Process Assessment Model

ISO/IEC 15504 integrates smoothly in the continuous approach made by CMMI-DEV Version 1.2, but proper harmonization work should be considered [17b]. This permits a synchronized process assessment (ISO/IEC 15504) with the CMMI appraisals structure, like SCAMPI. A schematic of process assessment relationship follows in Figure 2.

Source: ISO/IEC 15504 - Part 1 [16]

Figure 2 - ISO/IEC 15504 Process Assessment Relationship

In Part 2 of ISO/IEC 15504, the measurement framework is detailed on how to perform an assessment. The requirements for the Processes Reference and Assessment Models are set, and finally, the conformity of the process assessment is verified.

Process assessment, as defined in ISO/IEC 15504, is based on a two dimensional model containing a process dimension and a capability dimension. The process dimension is provided by an external Process Reference Model, which defines a set of processes characterized by statements of process purpose and process outcomes. The capability dimension consists of a measurement framework comprising six process capability levels and their associated process attributes [17, Introduction].

As referred, the ISO/IEC 15504 capability dimension and the process capability levels match the continuous representation we have seen in CMMI-DEV [6]. These two dimensions, provided by the Process Reference Model and the Measurement Framework will give origin to the Process Assessment Model, used as reference to the Assessment Process.

The Assessment Process contains at least five specified activities: planning, data collection, data validation, process attribute rating, and reporting. An assessment is carried out by assessing selected processes (using Process reference models) against the Process Assessment Model chosen for the assessment [16]. Figure 3 gives a schematic view of ISO/IEC 15504 normative elements.
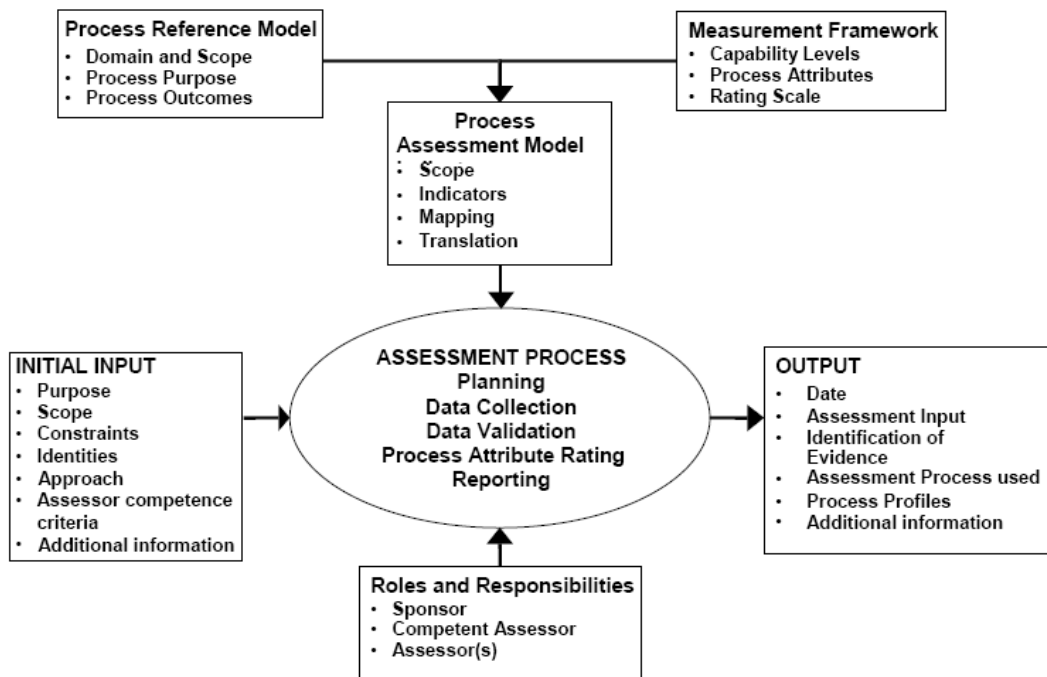
Source: ISO/IEC 15504 - Part 2 [17]

Figure 3 - ISO/IEC 15504 Normative Elements

The sponsor will have the responsibilities and the authority to make sure that the adequate resources and competencies are made available in order to perform a conformant assessment. The assessment results will normally be used as a basis for developing an improvement plan or determining capability and associated risks as appropriate.

The competent assessor is responsible for ensuring that the assessment achieves its purpose and that it is conformant with the requirements of ISO/IEC 15504 Part 2. It is therefore imperative that the competent assessor selects an appropriate documented assessment process based on the Process Assessment Model(s). The rating activities are performed solely by the competent assessor and assessors [18].

The initial assessment input must include at a minimum, an assessment purpose; the identity of the sponsor of the assessment and the sponsor's relationship to the organizational unit being assessed; the assessment scope, approach and constraints; a criteria for competence of the assessor who is responsible for the assessment; clear role definitions for the assessment team; and additional information to support process improvements and capability determination [18].

The output information which is pertinent to the assessment and will support understanding of the output assessment shall be compiled and included in the assessment record for retention by the sponsor. The assessment output is intended to support understanding of the assessment results and facilitate activities such as benchmarking and third party verification (ex: by comparing Capability levels).

Each capability level has a set of process attributes that are evaluated and rated when an assessment process is performed and a capability is determined. The higher the level, more processes must be achieved. The set of processes to be evaluated are set in the scope of the assessment. Each process is rated following these values:

- ▪ N - Not achieved (0 to 15 % achievement)

- P - Partially achieved (15 % to 50 % achievement)
- L - Largely achieved (50 % to 85 % achievement)
- F - Fully achieved (85 % to 100 % achievement)

Table 2 will give an easy understanding of which processes must be satisfied for each capability level. The key idea is simple. All of the process attributes at lower levels must be rated as "Fully Achieved" while those at the level can be rated as "Largely Achieved" or "Fully Achieved".

Scale	Process Attributes	Rating
Level 0	Process Performance	Partially Achieved
Level 1	Process Performance	Largely or Fully Achieved
Level 2	Process Performance	Fully Achieved
	Performance Management	Largely or Fully Achieved
	Work Product Management	Largely or Fully Achieved
Level 3	Process Performance	Fully Achieved
	Performance Management	Fully Achieved
	Work Product Management	Fully Achieved
	Process Definition	Largely or Fully Achieved
	Process Deployment	Largely or Fully Achieved
Level 4	Process Performance	Fully Achieved
	Performance Management	Fully Achieved
	Work Product Management	Fully Achieved
	Process Definition	Fully Achieved
	Process Deployment	Fully Achieved
	Process Measurement	Largely or Fully Achieved
	Process Control	Largely or Fully Achieved

Scale	Process Attributes	Rating
Level 5	Process Performance	Fully Achieved
	Performance Management	Fully Achieved
	Work Product Management	Fully Achieved
	Process Definition	Fully Achieved
	Process Deployment	Fully Achieved
	Process Measurement	Fully Achieved
	Process Control	Fully Achieved
	Process Innovation	Largely or Fully Achieved
	Process Optimization	Largely or Fully Achieved

Source: ISO/IEC 15504 - Part 3 [18]

Table 2 - ISO/IEC 15504 Process Attributes ratings for Capability Levels

An assessment process must be exemplarily documented so that all of the comprising activities can be detailed and replicated. Data required for evaluating the processes within the scope of the assessment must be collected in a systematic manner. The strategy and techniques for the selection, collection, analysis of data and justification of the ratings must be explicitly identified and demonstrable by the assessment team. Each process identified in the assessment scope is assessed on the basis of objective evidence [18].

This data collection and detailing will permit an easier data validation and process attribute rating (the activities seen on the Assessment Process), leading to the final Assessment Process activity, the Reporting. The Reporting must document that the assessment was performed according to the requirements, and for each assessor, records to prove their participation should be included. The sponsor approves those records and provides feedback from the assessment as a means to improve the assessment process.

In the following section, another essential and worldwide recognised Framework will be presented, the Information Technology Infrastructure Library (ITIL).

2.3 Information Technology Infrastructure Library (ITIL)

Information Technology Infrastructure Library (ITIL) has been around for 20 years, but interest has only increased in the last six years. ITIL is becoming the next big thing in Information Technology. This section will describe the origin of ITIL, who controls the ITIL contents and what is the key message to learn from this Framework. Throughout this section, it will be important to remember that ITIL describes a framework of processes for the management of IT. Because it is a framework, ITIL does not describe in great detail how any particular process should be implemented.

Version 2 of ITIL was initially released in mid 2000. The present day version 2 contains just 10 books, as pieces of a puzzle that complement (and overlap) each other:

- Service Support
- Service Delivery
- Business Perspective (Volumes I & II)
- ICT Infrastructure Management
- Applications Management
- Security Management
- Planning and Implementation
- Software Asset Management
- ITIL - Small Scale Implementation

Two of these books, Service Support and Service Delivery, are the heart of ITIL and the focus of the present drive for ITIL adoption. Only these two books will be detailed in this Dissertation. Service Support covers a set of core processes (Figure 4), more focused on Customer satisfaction and problem resolutions. They will be detailed in sub-section 2.4.1.
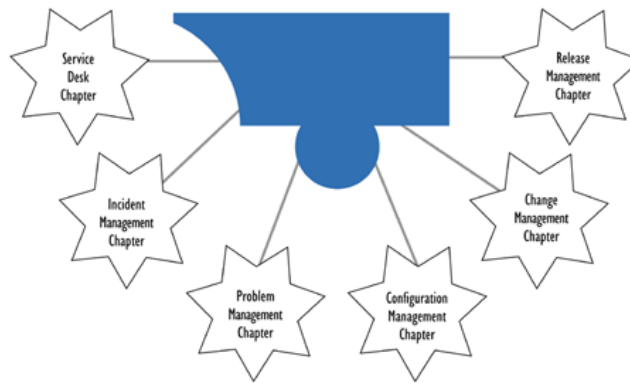
Source: ITIL Service Support Version 2 [21]

Figure 4 - ITIL Service Support coverage

Service Delivery covers a different array of core processes (Figure 5), more focused on level of service. These processes will be detailed in sub-section 2.4.2.
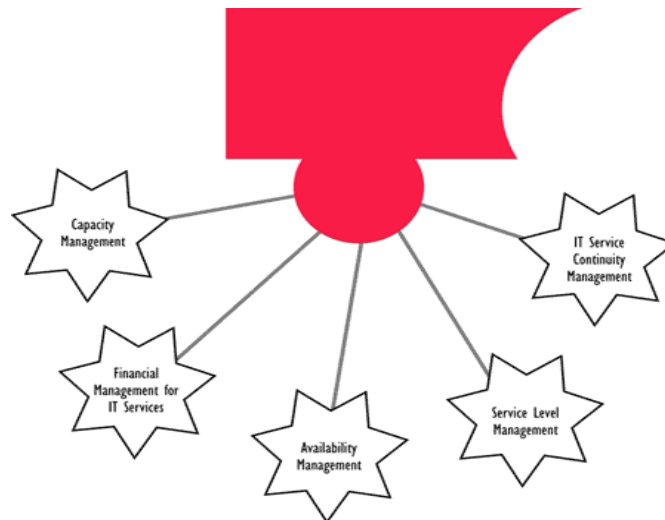
Source: ITIL Service Delivery Version 2 [22]

Figure 5 - ITIL Service Delivery coverage

2.3.1 *ITIL Service Support*

ITIL Service Support, also known as the blue book, defines a set of core processes to be addressed. Each one of these processes has their specific goal. These processes are centred on the relationships between the IT organisation and their Customers. Service Delivery is partially concerned with setting up agreements and monitoring the targets within these agreements. Meanwhile, on the operational level, the Service Support processes can be viewed as delivering service as laid down in these agreements [22]. This ITIL book addresses the following processes:

- Configuration Management
- Service Desk
- Incident Management
- Problem Management
- Change Management
- Release Management

Service Support refers to the need for Configuration management, Change management, Incident Management, Problem Management and Release Management processes to be integrated. For example, the process of releasing components to the live environment (the domain of Release Management) is also an issue for Configuration Management and Change Management whilst the Service Desk is primarily responsible for liaison between IT providers and the Users of services [21, Chapter 2]. Let us begin with the first Process, Configuration Management.

Configuration Management

Configuration Management intends to provide information on the IT infrastructure to all other processes and IT Management, enabling control of the infrastructure by monitoring and

maintaining information on all the resources needed to deliver services, as well as Configuration Items (CIs) status, history and relationships. In ITIL Service Support Version 2 [21], Configuration Management is defined as "The process of identifying and defining Configuration Items in a system, recording and reporting the status of Configuration Items and Requests for Change, and verifying the completeness and correctness of Configuration Items". To accomplish these objectives, a set of tasks must be executed and registered. The essential tasks referred in this process are:

- Identification and naming
- Management information
- Verification
- Control
- Status Accounting

All these tasks permit a well defined Configuration Item and must be registered in a Configuration Management Database (CMDB), a database which contains all relevant details of each Configuration Item (CI) and details of the important relationships between CIs. A Configuration Item is an item needed to deliver a service, uniquely identifiable, that can be subject to change and so it can be managed. A Configuration Item must have a category, defined relationships, a set of attributes and a status.

Service Desk

The Service Desk is the single point of contact between service providers and the users, on a day-to-day basis. It is also a focal point for reporting incidents and making service requests. As such, the Service Desk has an obligation to keep users informed of service events, actions and opportunities that are likely to impact their ability to pursue their day-to-day activities [21]. Service Desk intends to be the primary point of call for all questions, requests, complaints and

remarks, as well as restore the service as quickly as possible in order to support business activities.

All incidents (defined as an unexpected disruption to agreed service) life-cycle should be managed by Service Desk by coordinating a resolution and generating all associated incident reports and communications, in order to promote an effective, reusable and permanent resolution. Priority is determined by business impact and urgency. The correct assessment of priorities enables the deployment of manpower and other resources to the best interest of the customer (ex: Escalating an incident up in the management chain or horizontally to a different specialist group).

Incident Management

Incident Management tries to ensure that the best possible levels of service quality and availability are maintained according to Service Level Agreements (SLAs), restoring normal service as quickly as possible whilst minimizing the adverse impact on business operations. One possible solution is providing a Work-Around, avoiding an Incident or a Problem. Service requests, although not being a failure in the IT infrastructure, are treated as Incidents.

Problems are considered as all the unknown root cause of one or more incidents. Known error is considered as condition that exists after the successful diagnosis of the root cause of a problem when it is confirmed that a Configuration Item (CI) is at fault. If not properly controlled, a change may introduce new incidents, so a way of tracking back is required. It is therefore recommended that the incident records should be held on the same Configuration Management Database (CMDB) as the Problem, Known error and Change records.

The Incident life-cycle has 4 steps:

- Accept service event, register and consult the CMDB

- Classification
- Solve
- Closure

Incident Management implies proactive reporting and daily reviews of individual Incident and Problem status against service levels. Weekly and monthly management reviews should be a standard procedure.

Problem Management

The Problem Management process requires the accurate and comprehensive recording of Incidents (in the CMDB) in order to identify effectively and efficiently the cause of the incidents and trends. Problem Management intends to stabilize IT services by preventing incidents and problems through the removal of the root causes. Problem Management is dedicated in preventing the recurrence of incidents related to errors and minimizing the consequences derived from those incidents.

Through the inputs present in the Configuration Management Database (Incident details, configuration details and defined workarounds), the desired outputs can be defined and detailed. Requests for change are often. Problem management process updates problem records including workarounds and/or solutions for known errors, integrating those solutions with the Incident Management process, as well as making these solutions available to the Service Desk.

Problem Control makes the identification, classification, assigns resources and investigates in order to establish known errors. The identified errors are controlled and recorded in the CMDB. The error is assessed and a resolution (normally a Request for Change - RfC) is proposed. Reporting is also a key element in Problem Management.

Change Management

Changes arise as a result of Problems, but many Changes can come from proactively seeking business benefits such as reducing costs or improving services [21, Chapter 8.1]. Change Management objective is to implement approved changes efficiently, cost-effectively and with minimal risk to the existing and to the new IT infrastructure. Only approved changes are made, risk and cost minimized.

It is generally accepted that Change Management and Configuration management are best planned and implemented concurrently. Changes undergo a Change Advisory Board (CAB), which is a group of people who can give expert advice to Change Management on the implementation of Changes. This Board is likely to be made up of representatives from all areas within IT and representatives from business units [21].

Change Management is also responsible by Filtering Changes and managing the Change Process and Changes, while chairing the CAB and reviewing management information. The Change Management process has defined 3 categories of impact of Changes, which defines a different approval workflow. The categories are:

- Category 1 - Little impact on current services. The Change Manager is entitled to authorize the Request for Change
- Category 2 - Clear impact on services. The Request for Change must be discussed in the Change Advisory Board. The Change Manager requests advice on authorization and planning
- Category 3 - Significant impact on the services and the business. Considerable manpower and/or resources needed. The Request for Change will have to be submitted to the board level (CAB/EC – Change Advisory Board / Executive Committee)

All changes must have a back out plan always possible and a priority setting defined. The Change Management process has 4 priority levels:

- Urgent - Change necessary now (otherwise severe business impact)
- High - Change needed as soon as possible (potentially damaging)
- Medium - Change will solve irritating errors or missing functionality (can be scheduled)
- Low - Change leads to minor improvements

The Change Management Process has the following steps:

- Request for a Change
- Registration and Classification in the CMDB
- Monitoring and Planning
- Approval (CAB / EC)
- Building & Testing
- Authorize Implementation (CAB / EC)
- Implementation
- Evaluation (PIR - Process Implementation Review)

Changes can be scheduled, following a defined Forward Schedule of Changes (FSC), that contains details of all the Changes approved for implementation and their proposed implementation dates.

Release Management

Release Management takes a holistic view of a Change to an IT service and should ensure that all aspects of a Release, both technical and-non-technical, are considered together [21, Chapter 9.1]. Release Management tries to safeguard all software and related items and ensure that only

tested / corrected version of authorized software/hardware is in use. The motto is "Right software and Hardware at the right time and the right place".

In order to accomplish this goal, a set of tasks must be executed. The release policies must be clearly defined and a Definitive Software Library (DSL) and a Definitive Hardware Storage (DHS) created. A Definitive Software Library stores reliable versions of software in a single logical location. However, software may be physically stored at different locations (Ex: Licenses and CDs in a vault). A Definitive Hardware Storage is an area set aside for the secure storage of definitive hardware spares.

Release Management is responsible for the distribution of Software and the associated Configuration Items (CIs), managing and overseeing the build of software releases. Software audits are also under the scope of Release Management process, using the information in the CMDB. Releases are also done under the control of the Change Management process. Release Management is the only process which creates its own policy. There are several Release Policies:

- Release Unit
- Full / Package / Delta Releases
- Numbering
- Frequency
- Emergency Change

Back out plans should always be considered. The Release Management process is oriented to a more operational Software control and distribution. It works closely with two other processes; Change Management (control perspective) and Configuration Management (control and administration).

2.3.2 *ITIL Service Delivery*

ITIL Service Delivery is also known as the red book. As said before, Service Delivery is partially concerned with setting up agreements and monitoring the targets within these agreements. ITIL Service Delivery intends to integrate a set of processes oriented in the maintenance of agreed levels of service. It comprises 5 core processes:

- Availability Management
- IT Services Continuity Management
- Capacity Management
- IT Financial Management
- Service Level Management

Lets further detail on what each of this processes are focused and how they integrate and complement with each other.

Availability Management

Availability Management is concerned with the design, implementation, measurement and management of IT services to ensure the stated business requirements for availability are consistently met [22, Chapter 2.5]. Availability Management predicts, plans for and manages the availability of services by ensuring that all services are underpinned by sufficient, reliable and properly maintained CIs, and where CIs are not supported internally there are appropriate contractual agreements with third party suppliers to ensure the services. Changes are proposed to prevent future loss of service availability so that IT organizations can be certain of delivering the levels of availability agreed with customers in SLAs.

All aspects of availability are considered and managed in this process (Reliability, Maintainability, Redundancy and Serviceability). Maintainability is considered as Maintenance

done internally and Serviceability as Maintenance done by external entities. Availability Information is stored in an Availability Database (ADB). This information is used to create the Availability Plan. SLAs provide an input to this process.

An IT service is considered not available to a customer if the functions that customer requires at a particular location cannot be used although the agreed conditions under which the IT service is supplied are being met. In order to clearly quantify availability of services, the following metrics are used:

- MTTR: Mean Time to Repair (Downtime) - Time period that elapses between the detection of an Incident and it's Restoration. Includes: Incident, Detection, Diagnosis, Repair, Recovery and Restoration
- MTTF: Mean Time To Failure (Uptime) - Time period that elapses between Restoration and a new Incident
- MTBF: Mean Time Between Failures - Time period that elapses between two incidents. (MTTR + MTTF)

For an easier understanding, Figure 6 follows.
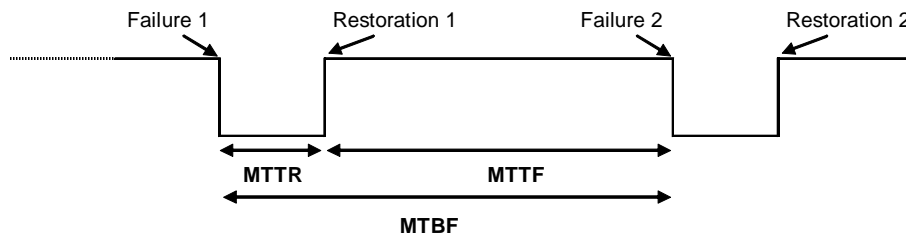
Figure 6 - ITIL Availability Metrics

In this manner, levels of availability can be clearly agreed with customers in Service Level Agreements (SLAs).

IT Services Continuity Management

IT Service Continuity Management is concerned with managing an organisation's ability to continue to provide a pre-determined and agreed level of IT Services to support the minimum business requirements following an interruption to the business [22, Chapter 2.4]. Due to increasing Business dependency on IT, IT Service Continuity Management plans ahead in order to reduce costs and time of recovery, adding value to the customer and guaranteeing survival of the Business.

The planning consists mainly in a Business Impact Analysis, analysing Risks through the value of assets, threats and vulnerabilities. Risk Management acts through the use of countermeasures and planning for potential disasters. Risk Analysis has strong influence on the Computer Risk Analysis and Management Methodology (CRAMM), which is based on the ISO/IEC 17799.

This analysis permits the elaboration of a Contingency Plan, which assists in a fast, controlled recovery. Wide but controlled access to the Contents of the plan should be given, including Administration, Infrastructure and staff. Options of course (including Cold & Hot Start) must be clearly defined and tested regularly, without impacting the live service.

A Cold start or gradual recovery is applicable to organisations that do not need immediate restoration of business processes and can function for a period of up to 72 hours, or longer, without a re-establishment of full IT facilities. This may include the provision of empty accommodation fully equipped with power, environmental controls and local network cabling infrastructure, telecommunications connections, and available in a disaster situation for an organisation to install its own computer equipment.

A Hot Start (or immediate recovery) option provide for the immediate restoration of services following any irrecoverable incident. Hot stand-by typically referred to availability of services

within a short timescale such as 2 or 4 hours whereas immediate recovery implies the instant availability of services.

A contingency plan has 7 Sections:

- Administration
- The IT Infrastructure
- IT Infrastructure management & Operating procedures
- Personnel
- Security
- Contingency site
- Return to normal

Every contingency plan should be tested under realistic circumstances and reviewed initially every 6 to 12 months and after each disaster. The action should protect any live services first. Changes to the plan must pass the Change Advisory Board (CAB).

Capacity Management

Capacity Management tries do find the correct balance between the right, cost justifiable, capacity of IT resources such that the Service Levels agreed with the business are achieved at the right time. It comprises three sub-processes [22, Chapter 6.2]:

- Business Capacity Management - The focus of this sub-process is ensuring that the future business requirements for IT Services are considered, planned and implemented in a timely fashion
- Service Capacity Management - The focus of this sub-process is the management of the performance of the live, operational IT Services used by the Customers

■ Resource Capacity Management - The focus in this sub-process is the management of the individual components of the IT Infrastructure

Each of the sub-processes carry out many of the same activities, but each sub-process has a very different focus. Business Capacity Management is focused on the current and future business requirements, while Service Capacity Management is focused on the delivery of the existing services that support the business and Resource Capacity Management is focused on the technology that underpins all the service provision [22, Chapter 6.2].

A corporate Capacity Management process ensures that the entire organisation's Capacity requirements are catered for. Success in Capacity Management is dependent on a number of factors [22, Chapter 6.6]:

■ Accurate business forecasts

■ Knowledge of IT strategy and plans, and that the plans are accurate

■ An understanding of current and future technologies

■ An ability to demonstrate cost-effectiveness

■ Interaction with other effective Service Management processes

■ An ability to plan and implement the appropriate IT Capacity to match business needs

These factors are aligned with a set of core management activities, which are:

■ Predicting Customer demands of Resources

■ Demand Management

■ Workload Management

■ Performance Management

■ Capacity Planning

■ Defining Thresholds and Monitoring

Performance Management data populates the Capacity Database (CDB), which contains all metrics and useful information used to create a Capacity Management Plan. Application Sizing estimates the resource requirements to support a proposed application change to ensure that it meets its required service levels. This information is obtained through modelling and simulations:

- Trend Analysis
- Analytical Modelling
- Simulation Modelling
- Baseline Models

Modelling permits to answer the "What If…" questions. Data for Modelling usually comes from the Capacity Database (CDB).

IT Financial Management

IT Financial Management is the sound stewardship of the monetary resources of the organization. It supports the organization in planning and executing its business objectives and requires consistent application throughout the organization to achieve maximum efficiency and minimum conflict [22, Chapter 5.1.2]. Financial Management has 3 main processes:

- Budgeting: The process of predicting and controlling the spending of money within the enterprise and consists of periodic negotiation cycle to set budgets (usually annual) and the day-to-day monitoring of the current budgets. Has key influence on strategic and tactical plans.
- IT Accounting: The set of processes that enable the IT organization to fully account for the way its money is spent (particularly the ability to identify costs by customer, by service, by activity).

- Charging: The set of processes required to bill a customer for the services applied to them. To achieve this requires sound IT Accounting, to a level of detail determined by the requirements of the analysis, billing, and reporting procedures.

Costing is a must in ITIL. There are different costing types, like fixed (unaffected by the level of usage); variable (varying according to the level of usage); direct (usage specific to one service); indirect or overhead (usage not specific to one service); Capital (not diminished by usage) and revenue or running (diminish with usage). Input cost units recommended by ITIL:

- Equipment Cost Units (ECU)
- Organization Cost Units (OCU)
- Transfer Cost Units (TCU)
- Accommodation (buildings) Cost Units (ACU)
- Software Cost Units (SCU)

IT Financial Management must define charging and pricing policies, in close communication with the Financial Department. It can define a No Charging policy (IT treated as support centre); a Notional Charging (IT treated as cost centre) or Actual Charging (money is actually transferred between bank accounts). When charging, a pricing policy must also be defined. A Recovery of Costs policy means IT is treated as a service centre; a Cost Price Plus policy means IT is treated as a profit centre (but with small margins) and Market Prices policy means IT is treated as a profit centre.

Support and Cost centres use "soft charging" in which no money changes hands. Service and profit centres usually use "hard costing" in which money is transferred between bank accounts. Profit centres focus on the value of the IT service to the customer, because since there is a real money exchange, quality of service tends to be evaluated in a more thorough manner by the Customer.

Service Level Management

The goal for Service Level Management (SLM) is to maintain and improve IT Service quality, through a constant cycle of agreeing, monitoring and reporting upon IT Service achievements and instigation of actions to eradicate poor service - in line with business or cost justification. Through these methods, a better relationship between IT and its Customers can be developed [22, Chapter 4.1.2].

A set of tasks must be executed in order to correctly perform a quality Service Level Management. A Service Catalogue should be created. A Service Catalogue should list all of the services being provided, a summary of their characteristics (specification sheet) and details of the Customers and maintainers of each item. Service Level Requirements must be established, serving as a pro-forma that can be used as a starting point for all Service Level Agreements (SLAs).

Customer Relationship Management should incorporate Service Improvement Programs, so that Service Quality Plans can be specified (following the defined SLAs for that Customer) and monitored, reviewed and reported to management.

Ideally contracts are based on targets in the Service Level Agreement (SLA). Service Level Agreements must set minimum requirements in a clear and concise manner. They should always include defined:

- Period
- Service Description
- Throughput
- Availability
- Response Times
- Signature

Other possible clauses that should be considered when defining a SLA are:

- Contingency arrangements
- Review procedures
- Change procedures
- Support services
- Customer responsibilities
- Housekeeping
- Inputs and Outputs
- Changes

As said before, SLAs must be monitored and reviewed regularly in order to monitor if service is being delivered to specification and review if service specification is still appropriate.

2.3.3 *ITIL Evolution*

The current IT Infrastructure Library (ITIL), version 2, was released in 2000. It is a process-based practice of 10 books and the globally accepted best practice framework for ITSMF (IT Service Management Forum). With the expected 2007 ITIL Version 3, ITIL Version 3 becomes a service lifecycle-based practice incorporating the best of V1 and V2 and tested current best practice. Five lifecycle titles will form the core of ITIL practice, instead of Version's 2 two core books, Service Delivery and Service Support [25, 25a, 25b, 25c]:

- Service Strategy
- Service Design
- Service Transition
- Service Operation

▪ Continual Service Improvement

The Core is supported by an Introduction and Key Element Guides along with multiple topic specific complementary guides and an integrated service lifecycle model including service, organisational, process and technology maps. This part of ITIL Version 3 will be launched in Spring 2007. A schematic approach of the new core books is presented in Figure 7.

Source: ITIL Refresh News 1st Edition [25]

Figure 7 - ITIL package Version 3

The UK's Office of Government Commerce (OGC) continues to own the core guidance and the ITIL brand, but they have passed responsibility for stewardship to ITSMF International (IT Service Management Forum), which is a international ITIL user group.

Following the success and recognition of the ITIL framework, a British Standard (BS) was created and aligned with ITIL:

- BS15000-1 (Specification for service management)
- BS15000-2 (Code of practice for service management)

Facing the huge success and recognition of UK's BS15000, the International Organization for Standardization (ISO) has decided to launch in 2005 an international version of BS15000, ISO20000. In order to adequate the British Standard to an international audience, some small modifications were made regarding the format and structure, consistency of parts 1 and 2, objectives alignment, and terms and text harmonization. ISO 20000 is detailed in Annex A.5.

Another important Framework, CobiT, is presented in the next section.

2.4 CobiT - Control Objectives for Information and related Technology

The CobiT framework is "business focused, process-oriented, controls-based and measurement-driven". It provides essentially a set of control objectives, following the principle of providing "the information that the enterprise requires to achieve its objectives, what the enterprise needs to manage, and what control IT resources should be used, through a structured set of processes in order to deliver the required information services" [41, CobiT Framework, page 11].

The information needs to conform to some control criteria, which CobiT refers to as "business requirements for information" [41, CobiT Framework, page 11]. There are seven defined criteria [41, CobiT Framework, page 11]:

- Effectiveness deals with information being relevant and pertinent to the business process as well as being delivered in a timely, correct, consistent and usable manner

- Efficiency concerns the provision of information through the optimal (most productive and economical) use of resources

- Confidentiality concerns the protection of sensitive information from unauthorised disclosure

- Integrity relates to the accuracy and completeness of information as well as to its validity in accordance with business values and expectations

- Availability relates to information being available when required by the business process now and in the future. It also concerns the safeguarding of necessary resources and associated capabilities

- Compliance deals with complying with those laws, regulations and contractual arrangements to which the business process is subject, like, externally imposed business criteria, as well as internal policies

- Reliability relates to the provision of appropriate information for management to operate the entity and exercise its fiduciary and governance responsibilities

These criteria should integrate the IT Processes. To govern IT effectively, it is important to appreciate the activities and risks within IT that need to be managed. CobiT defines IT activities in a generic process model within four domains [41, CobiT Framework, pages 13-14]:

- Plan and Organize, which "[…]covers strategy and tactics, and concerns the identification of the way IT can best contribute to the achievement of the business objectives"

- Acquire and Implement focus on which "[…] IT solutions need to be identified, developed or acquired, as well as implemented and integrated into the business process"

- Deliver and Support focuses with the "[…] actual delivery of required services, which includes service delivery, management of security and continuity, service support for users, management of data and the operational facilities"
- Monitor and Evaluate "[…] addresses performance management, monitoring of internal control, regulatory compliance and providing governance"

These four domains sum up 34 main processes. Processes need controls. Each of CobiT's IT processes has a high-level control objective and a number of detailed control objectives. As a whole, they are the characteristics of a well-managed process. CobiT's control objectives are the "[…] minimum requirements for effective control of each IT process." [41, CobiT Framework, page 14]. The enterprise's system of internal controls impacts IT at three levels [41, CobiT Framework, page 15]:

- Executive management level, where "[…] business objectives are set, policies are established and decisions are made […]"
- Business process level. "Most business processes are automated and integrated with IT application systems, resulting in many of the controls at this level being automated as well. These controls are known as application controls"
- IT service activities. "The controls applied to all IT service activities are known as IT general controls"

General controls are those controls embedded in IT processes and services. Examples include [41, CobiT Framework, page 15]:

- Systems development
- Change management
- Security
- Computer operations

Controls embedded in business process applications are commonly referred to as application controls. Examples include [41, CobiT Framework, page 16]:

- Completeness
- Accuracy
- Validity
- Authorisation
- Segregation of duties

A basic need for every enterprise is to understand the status of its own IT systems and to decide what level of management and control the enterprise should provide. CobiT is a measurement driven framework. CobiT deals with this need of quantification through the use of 0-5 maturity models (as seen in the CMMI [7, 8, 9 and 10] and ISO 15504 SPICE [16, 17, 18, 19 and 20]). Figure 8 shows a schematic representation of CobiT's maturity models.
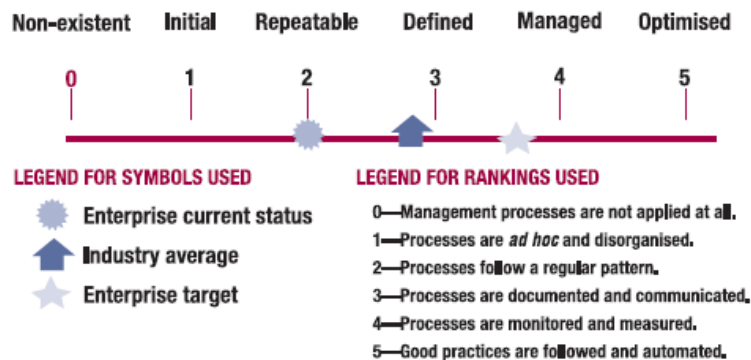
Source: CobiT 4.0 [41, page 18]

Figure 8 - CobiT's Maturity Models graphic representation

A properly implemented control environment is attained when all three aspects of maturity (capability, performance and control) have been addressed. Improving maturity reduces risk and improves efficiency, leading to fewer errors, more predictable processes and a cost-efficient use of resources. To summarise, IT resources are managed by IT processes to achieve IT goals that

respond to the business requirements [41, CobiT Framework, page 20]. This is the basic principle of the CobiT framework, as illustrated by the overall CobiT Framework in Figure 9.
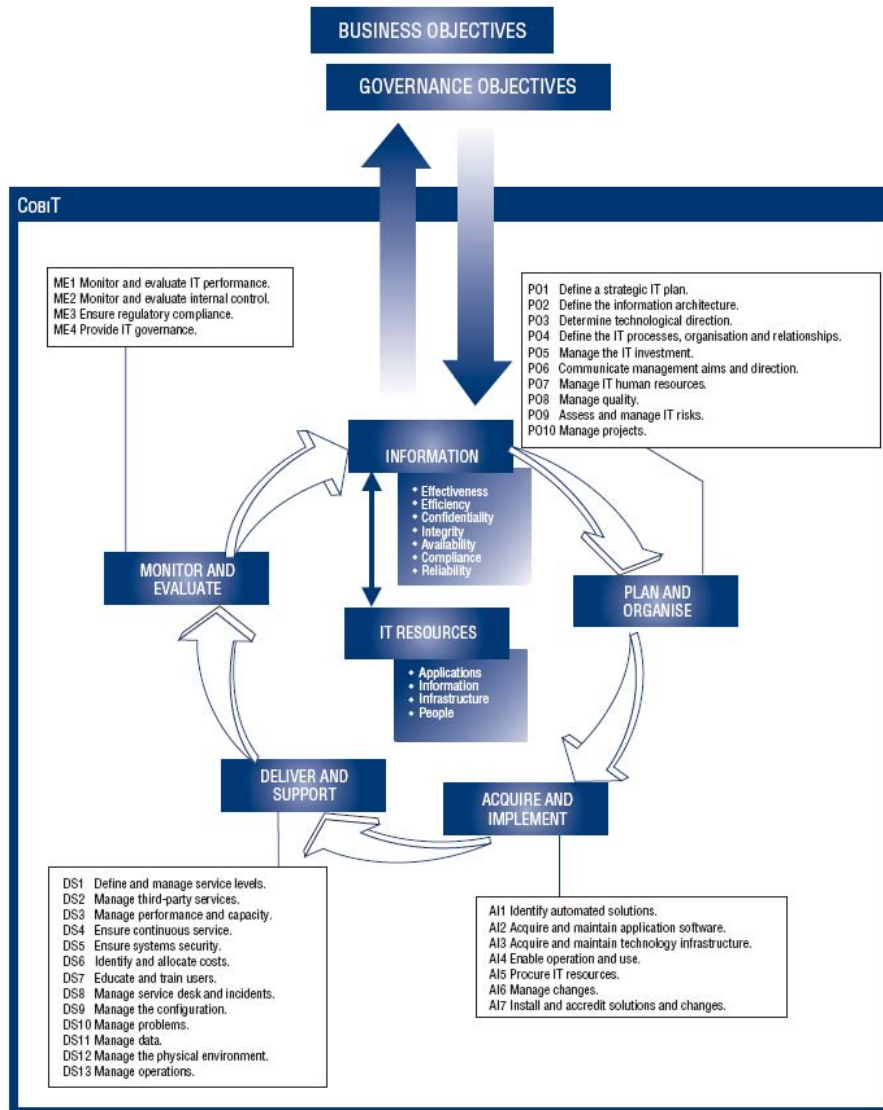
Source: CobiT 4.0 [41, page 24]

Figure 9 - Overall CobiT's Framework

Each one of the processes series (ME, PO, AI and DS) shown in Figure 9 is covered by CobiT in 4 sections, as follows [41, CobiT Framework, page 27]:

- Section 1 contains a process description summarising the process objectives, with the high-level control objective represented in a waterfall
- Section 2 contains the detailed control objectives for the process
- Section 3 contains the process inputs and outputs, RACI chart (RACI - Responsible, Accountable, Consulted and/or Informed), goals and metrics
- Section 4 contains the maturity model for the process

Considering the scope of this dissertation, the detail of each section will not be presented in this chapter. CobiT is usually associated with internal control policies and audit firms, as it is aligned with the 2002's Sarbanes-Oxley act (SOX) from the United States.

In the next chapter, Problem Description, an explanation of the problem used as a case study and the representation of the processes As-Is to be analysed are presented.

3. Problem Description

Service Support is an essential activity to all Enterprises and especially those whose core business is providing professional and specialized services, as well as providing ERP solutions. The case study which will be presented focuses in improving a Client Service Support.

The working environment is a Software department that develops an Enterprise Resource Planning (ERP) software solution called "Gestão Integrada Administrativa e Financeira" (GIAF), that translated is something like Integrated Financial and Administrative Management. A proper support channel should exist instead of an ad-hoc, phone based and/or e-mail solution.

It is important for the reader a better understanding and knowledge of what is the ERP GIAF and what services are provided by this IT department and by association, what Support services are provided.

3.1 Product and Services GIAF

The ERP GIAF is oriented to the Small and Medium size Businesses (SMBs) range. It has an established client volume of more than 200 installations, from Banking to Public Sector to Education. This wide variety of different clients and their different goals leaded to a multitude of variant versions and specific developments.

The ERP GIAF is developed in Oracle Forms and can be installed in a Server/Client configuration or Web distributed. The ERP GIAF is structured in three main functional areas in the core product:

- Logistics - The Logistics module is an operational area focused in inventory management and has 3 applicational modules:

  ➤ GA - Provisions Management, focused in the acquisitions of raw materials and services

  ➤ GC - Commercial Management, focused in providing support in the commercial activities, like sales

  ➤ GS - Stocks Management, focused in providing proper control over stocks, inventorying and inventory costing

- Finance - The Finance module is a transactional oriented module, oriented in fast operational invoicing and financial management and has 8 applicational modules:

  ➤ GB - Banks Management, focused in providing proper management over bank accounts and permitting conciliations between payments/receivements and the bank's total amounts

  ➤ GT - Third-Party Management, focused in providing support for all Clients-Suppliers profile and discounts associated to their profile

  ➤ CT - Accounting is focused in invoice registering in the system

  ➤ CX - Cash in Hand is focused in proper Cash in Hand management, useful for retail companies

  ➤ FRC - Invoice Receivements and Conference, is focused in the receivements of invoices and materials, and matching it with the buying order

  ➤ IM - Assets is focused in managing tangible and intangible assets, as well as their depreciation

  ➤ OR - Budgeting is focused in all budgeting activities by either the private or Public sector (especially important in the Public sector)

  ➤ CP - Plan Control is focused in controlling expenses from the Public sector against the year's budget

- Human Resources - The Human Resources module is oriented to payroll processing and payment and has 5 applicational modules:
    - PV - Payments and Staff is focused in payroll processing and payment
    - HR - Human Resources Management is focused in staff formation and evaluation
    - BS - Social Balance is a mandatory information requested by government authorities, which is processed in this module
    - ADSE - Public Administration Disease Support is a Public sector oriented module focused in this parallel and autonomous social security system for civil servants
    - BDAP - Public Administration Database is a Public sector oriented module focused in integrating the budgeting and purchase orders information inserted in the GIAF, connecting with the authorised suppliers of the Public Administration

Beside the core modules, another optional module oriented for Employee Self Service (ESS) is also available, having full integration with the ERP GIAF. It is called MyGIAF and it is a web platform (Java technology). An example of what are the functionalities of this module is that permits employees registering their own vacations through a web browser, integrating this information directly into the HR module shown before.

Another add-on available for GIAF Clients, is integrating a Business Intelligence Tool like Oracle's Business Intelligence Discoverer as a reporting tool. This tool permits on-the-fly reporting to the final Users, giving them the autonomy to create their own reports without any help from a database technician.

It uses an abstraction layer over the GIAF's database schema, so that the final user can understand the underlying content of the database's tables. A schematic of these applicational modules is presented in figure 10.
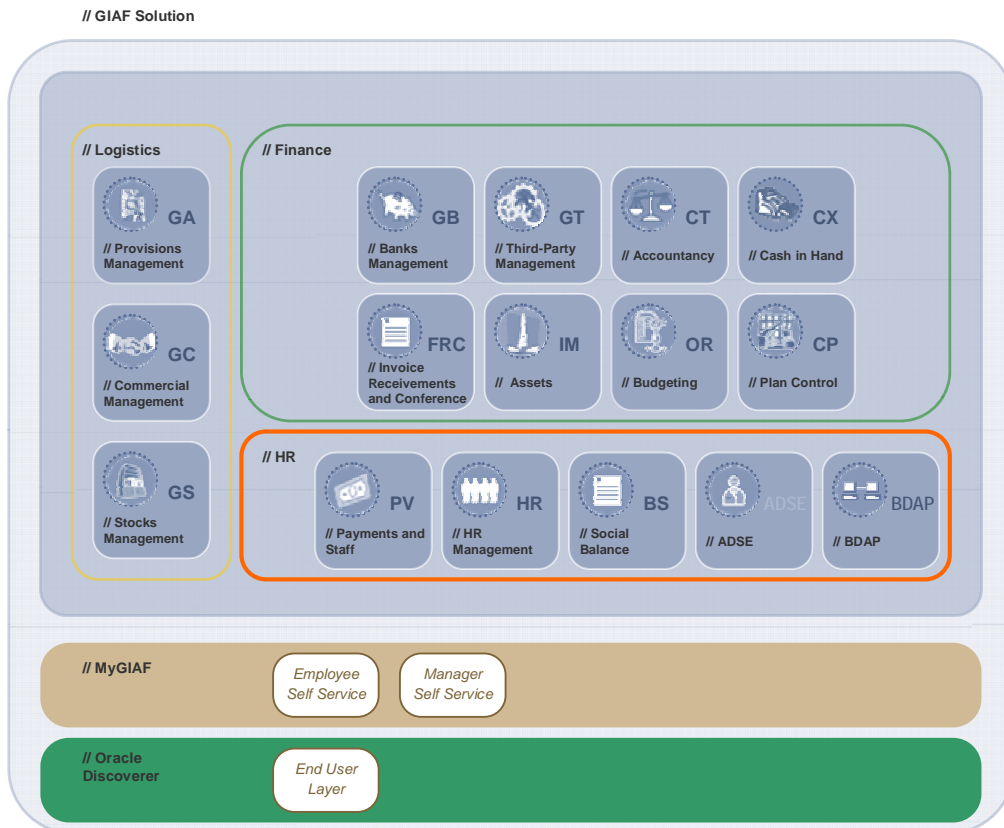
Figure 10 - GIAF Product offering

Beside the products, the GIAF department also has training and education consultants that can be contracted. In order to understand the way the Support Process is being processed, an assessment must be executed in order to fully understand the state of the Process As-Is. It will be presented in the next sub-section.

3.2 Process As-Is

The status of the As-Is Process would fit CMMI's [6] maturity level 1. A control of the number of requests for help, problem solving or counselling does not exist. And the amount of time each

request takes since it arrives until a permanent resolution is presented is not quantified. That represents a terrible loss of information, not permitting proper service management and not ascertaining if agreed Service Level Agreements (SLAs) are being attained.

Requests for Change are received in a common e-mailbox, an e-mailbox which the team of service support all have access. The staff from each of the three areas (LG - Logistics, FI - Finance and HR - Human Resources) had to read most of the e-mails, because sometimes the client did not correctly indicate to which area the request refers to, in order to correctly allocate the request to the proper area specialists.

A severe management problem occurred with the requests incoming by phone. Some older clients had the direct phone number of some key members of the helpdesk. This caused a stressful working environment with phones ringing constantly and did not permit a correct treatment of the ongoing requests, due to constant interruptions.

Another problem comes from the fact that some requests involve specific developments in the ERP. These kinds of requests are processed in a different way, generating a File for Development in a support application, which is budgeted and presented to management by senior service support staff. This separation from the standard service request often originates "lost" service requests that generated File for Development, because no information is registered in the original request on the status of the File for Development (Under Appreciation, Approved and Rejected).

This process cannot be quantified and measured, nor the sequence of activities and roles of the resources are clearly defined. The process As-Is can be represented schematically as follows in Figure 11.
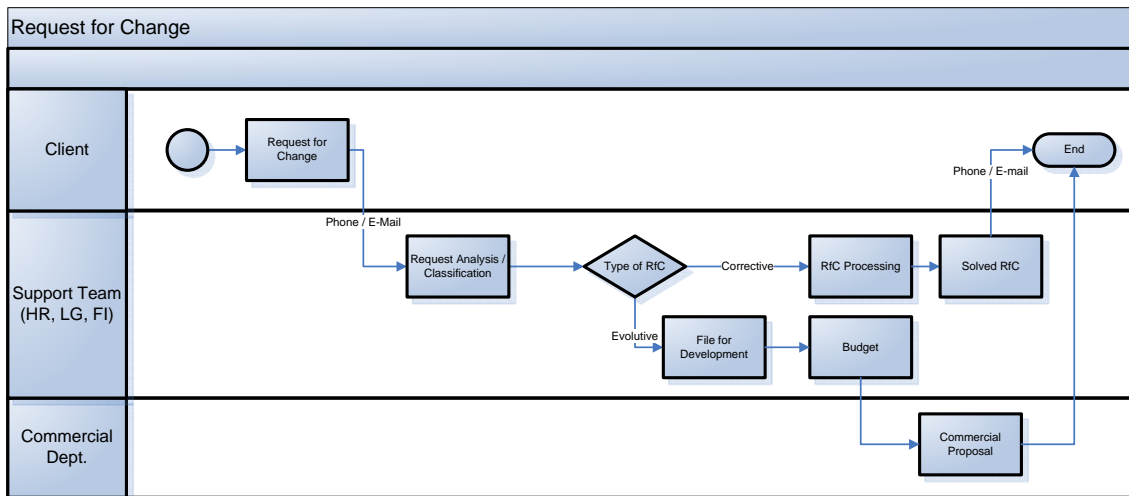
Figure 11 - Service Support Process As-Is

The anarchic way this process was being handled was not sustainable. If a process is not measurable, it is not controllable. As referred in ISO 15504-2 SPICE [17] "The process control attribute is a measure of the extent to which the process is quantitatively managed to produce a process that is stable, capable, and predictable within defined limits.".

A set of points to be achieved in order to solve this deficiency must be considered, so that a new improved service support process can be outlined. The use of a tool should be considered as a support in order to permit a fluent process workflow, as well as permitting a measurable and quantifiable process. An audit trail should be possible (aligning with the CobiT framework [41]), in order to back track the Requests for Change (RfC, as seen in ITIL Service Support [21]) and pinpoint the status of RfCs if asked by Clients or Customers [2] .

Statistics and resolution time must be contemplated, in order to ascertain if agreed Service Level Agreements are within the contractual conditions. A communication Support platform that broadens the interactivity between Clients and the Support team and leads the Support to a well defined process altogether. The next subsection presents a set of metrics and characteristics to be included in the proposed solution.

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[2] Customer (ITIL definition) - A business manager authorized to negotiate with the IT supplier on behalf of the business. Typically someone who has responsibility for the cost of the service, either directly through charging or indirectly in terms of demonstrable business need. Sometimes Customer may have the same meaning as Client (External entity).

3.3 Metrics and Characteristics

The total lack of process metrics detected in the As-Is Process, urges the need for process quantification. For a correct analysis of Service Level Agreements, a set of metrics and characteristics (Request for Change status, etc) should be defined and considered when outlining a new solution. The main focus is the response time for the Requests for Change and defining a template of the required information needed for an effective response to the Requests for Change. After a careful analysis and discussion with the core members from the Support Team, a template was defined.

The Requests for Change statistics metrics should be oriented in order to provide information if Service Level Agreements are being complied. So measurement is essential for a factual and not empirical assessment [47]. In order to identify any bottleneck in the process, intermediate steps time count should be considered. The number of Requests for Change in a time period by Client and associated status is obviously contemplated. The Process segment metrics considered can then be represented by the following table:

Segment Id	Process Segment	Description
1-2	Register / Processing	Average Time passed between Register of the Request for Change and The Support Team assignation
2-3	Processing / Confirmation	Average Time passed between the Support Team assignation and the proposed Request for Change solution
3-4	Confirmation / Closure	Average Time passed between the proposed solution and acceptance and Closure by the Client
1-3	Register / Confirmation	Average Overall time passed between Register and the first Proposed Solution
1-4	Register / Closure	Average Overall time passed between Register and Client acceptance and Closure

Table 3 - Service Support Platform - Process Segment metrics

The Requests for Change characteristics must include mandatory fields in order to provide the Support Team the necessary information. The mandatory fields should be:

- Product Identification (Ex: ERP GIAF, MyGIAF, Oracle Discoverer, etc)
  - Functional Module (Ex: Finance, Logistics, Human Resources, Access Platform, Others)

- Subject of the Request for Change
- Description
- Urgency Level
  - Information Request
  - Error with no significant impact
  - Error with significant impact
  - System Halted

Other optional fields are also available, as file attachments for better detailing of the Request for Change, and User identification of the Request for Change. A description of a possible solution and the tool that supports it is detailed in the next Chapter.

4. Proposed Solution

The proposed solution to improve this process is redesigning the way the support activities are being processed, and defining criteria points to redirect the Requests for Change, permitting load balancing. A support tool must be developed in order to fulfill these new process requirements. The strategy for designing the new process and subsequently the new platform that supports the new process is based in the principle of passing the responsibility for inserting and detailing the Requests for Change to the Clients' side.

After the way the Process was being processed is understood, it is time to focus on what should be considered when outlining the new Process To-Be. It will be presented in the next sub-section.

4.1 Process To-Be

The Process To-Be does not necessarily disrupt with the prior Process As-Is. This approach accelerates the time necessary for acceptance within the Support Team. The Process To-Be bases itself in a structured approach supported by a Support Platform as a nuclear centre piece.

The phone option for Clients should be discontinued and e-mail should be kept only as a support/backup option to the new platform. This approach permits to layout a new support process, based in a central platform to be developed. An urgency grading level should be defined for the Request for Change by the Client (0), permitting better management of the Requests for Change by the Process Manager. A macro-schema for the new Support Process is shown in Figure 12.
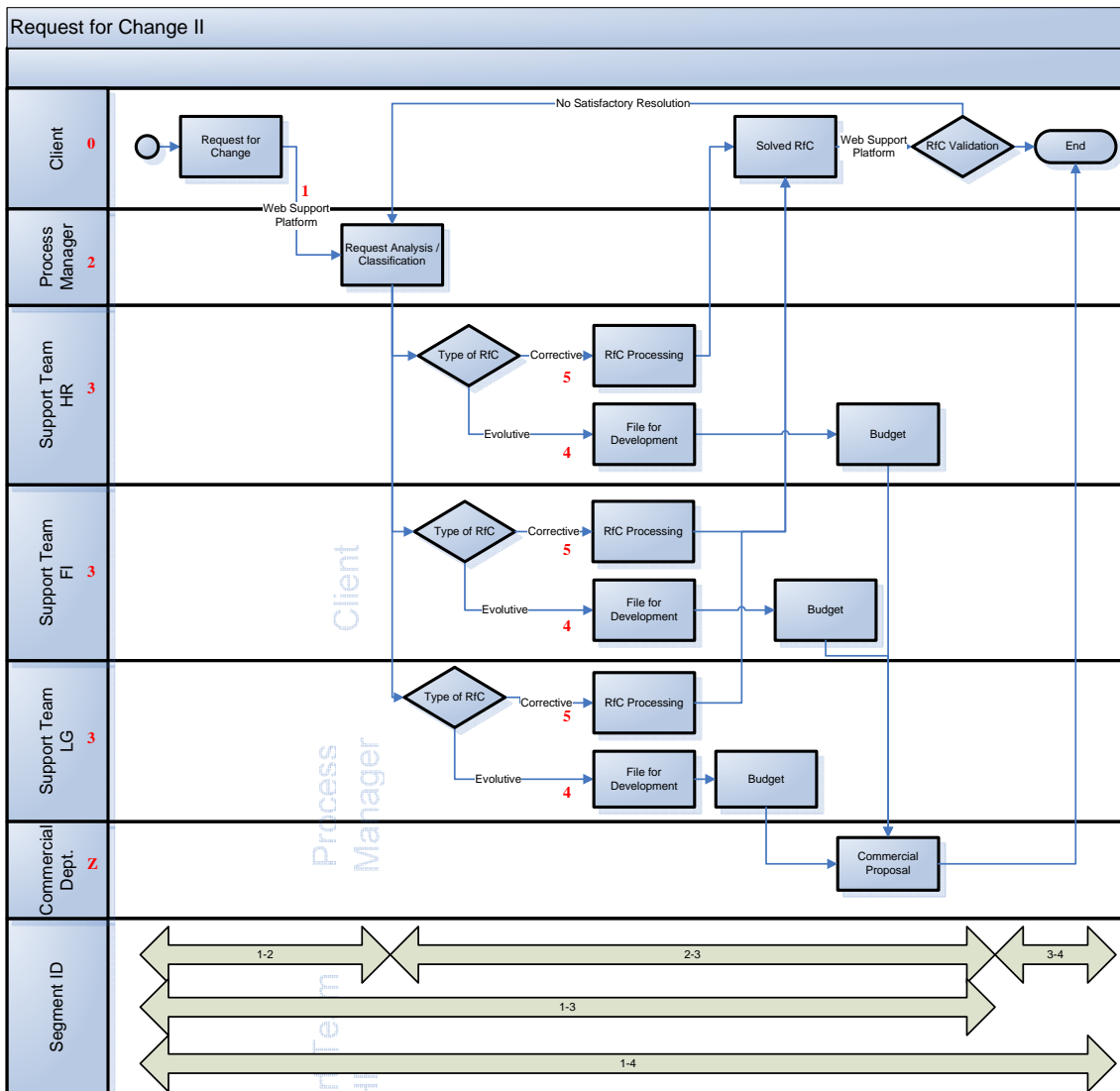
Figure 12 - Service Support Process To-Be

The key addition is the development of the Support Platform (1), known as "GIAF Suporte" and the presence of a Process Manager (2), which has the task of attributing the Requests for Change to the leader of each functional area (3). The leader can then delegate to the members of their area, where each Request is analysed and separated into two categories:

- Evolutive → File for Development (4)
- Corrective → Normal Request for Change processing (5)

The Clients will have a set of fields when filling the Request for Change in the support platform, that permit the Process Manager a faster and more accurate Requests for Change distribution, considering the area (FI, HR and LG), as well as the urgency grade attributed by the Client. The pool of resources is now segmented by each specialized area, having area leaders that can also delegate Requests for Change to the elements of their team. An analysis of the Requests is done and the Requests separated into Evolutive or Corrective Requests. ITIL Service Support [21, Chapter 10.1] mentions what type of tools could be used as support tools, saying "…They generally fall into one of the two following categories:

- Configuration Management Database & Help Desk; traditional Help Desk tools without separate databases and modules for the Service Management processes
- Integrated Service Management tools comprising modern client-server-based tools, with or without a knowledge database"

4.2 Planned Process Workflow

The new Support platform falls into the second category but with the variant of being web-based. Using a standard Process outlining chart, the Inputs and Outputs became clearer. Table 4 describes the planned Process To-Be workflow in a structured approach.

0	Responsible:	External Client		Function:	n/a
Inserting a Request for Change and validating if proper resolution is presented	*Input*	**Systems**	"GIAF Suporte" Platform or E-Mail		
		Documents	Request for Change for Validation / Confirmation or Commercial Proposal		
	Description	The Client inserts the initial Request for Change in the Web Support Platform "GIAF Suporte" in a defined template and is notified when a proposed solution is presented. The Client then must Validate and Confirm if the Request for Change had a satisfactory resolution, closing the Request for Change or returning it, restarting the process. In case of an Evolutive Request, a Commercial Proposal is received.			
	Output	**Systems**	"GIAF Suporte" Platform		
		Documents	Initial Request for Change		
1	Responsible:	Service Support Manager		Function:	Service Support availability
Web Service Support Platform "GIAF Suporte"	*Input*	**Systems**	"GIAF Suporte" Platform		
		Documents	Initial Request for Change		
	Description	The Service Support Platform "GIAF Suporte" has Java technology and has two user profiles: • Clients' Side • Support Team's Side It has embedded a template for Request for Change, Urgency levels and permits load balancing of RfCs between the Support Team as well as a centralized RfCs repository, storage and statistics.			
	Output	**Systems**	"GIAF Suporte" Platform or E-mail		
		Documents	Notifications		
2	Responsible:	Service Support Manager		Function:	Requests for Change Analysis
Distributing and load Balancing of Requests for Change	*Input*	**Systems**	"GIAF Suporte" Platform		
		Documents	Requests for Change		
	Description	The Service Support Manager coordinates and distributes the Requests for Change based in urgency, functional area and work load.			
	Output	**Systems**	"GIAF Suporte" Platform		
		Documents	Requests for Change		

3	Responsible:	Support Team (FI, LG, HR)		Function:	Requests for Change Processing
Requests for Change Processing	**Input**	**Systems**	"GIAF Suporte" Platform		
		Documents	Requests for Change		
	Description	The Requests for Change have been distributed by the Service Support Manager to the Support Team functional area leader. The functional area leader makes an assessment if the Request for Change is a Corrective Request (5) or an Evolutive (4) one. The Corrective are distributed subsequently to the other Support Team elements. The Evolutive ones are budgeted and sent to the Commercial department.			
	Output	**Systems**	"GIAF Suporte" Platform		
		Documents	Requests for Change for Validation / Confirmation or Budgets		
Z	Responsible:	Commercial Department		Function:	Commercial Proposals
Commercial Proposal elaboration	**Input**	**Systems**	"GIAF Suporte" Platform + E-Mail		
		Documents	Budgets		
	Description	The Commercial Department receives the budgets from the Support Team leaders and prepares a Commercial Proposal for the Client. The Request for Change that generated the budget is closed.			
	Output	**Systems**	E-Mail or Registered Letter		
		Documents	Commercial Proposal		

Table 4 - Service Support Planned Process To-Be Workflow

In the next Chapter, the new Support platform will be detailed and aligned with some of the Frameworks and Standards studied previously in earlier sections.

5. Prototype Implementation

5.1 The Support Platform

The new Support Platform was carefully planned and considered the best practices described earlier, incorporating each of the corresponding specialities covered by the respective Frameworks and Standards. The Support Platform (1) is web based, and will use a Secure Sockets Layer (SSL) communications protocol, aligning with ISO/IEC 17799 Information Technology - Security Techniques - Code of Practice for Information Security Management [40] good practices. Figure 13 shows the Support Platform entry page.

Source: http://giafsuporte.indra.pt

Figure 13 - Service Support Platform - Portal

Depending on each user's profiles, the user can access different areas, separated in a Clients' side and a Support Team's side.

5.1.1 *Service Support Platform - Client's Side*

Ideally, each Client should have only one representative with access to the support platform, in order to filter the Requests for change and avoiding any chance of duplicate requests. When this is not possible due to the Client's internal organisation, a message is clearly given when attributing new passwords to the support platform that a strict control of the Client's Requests insertion, is the Client's responsibility and that failure in their control (ex: duplicates, poor detailing, etc) may lower the overall Requests for Change processing rate. The distribution was executed through the use of a newsletter specially crafted with a dynamically created username and password insertion, and an e-mail to key users for every Client was sent.

After a successful Login, the Client's user is presented with Messages (6) informing of updates and alterations to the ongoing Requests, as suggested in ITIL Service Support [21, Chapter 8.8] "Automatic generation of management and trend information relating to Changes".

Figure 14 - Service Support Platform - Messages

The Requests for Change insertion (7) in the Support Platform is designed in order to segment the Requests, permitting an easier separation of the Requests by the Process Manager to the area (FI, HR and LG) leaders. As we can see in Figure 15, there are 3 fields with List of values (12, 13 and 15), permitting a standard classification of the Request for Change. The used fields for classification are:

- Product (12)
  - GIAF
  - MyGIAF
  - Oracle BI Discoverer

- Module (13), indicating each of the functional areas:
  - Finance

> ➢ Logistics

> ➢ Human Resources

> ➢ ERP Platform Access

- Urgency (15), as suggested in ITIL Service Support [21, Chapter 5B] has in this case 4 defined levels:

> ➢ Information Request

> ➢ Error with no significant impact

> ➢ Error with significant impact

> ➢ System Halted

Source: http://giafsuporte.indra.pt

Figure 15 - Service Support Platform - Inserting a Request for Change

The Support platform also has an available Description (14) field for detailing the Request for Change and an optional attaching functionality (16) for files (like error print screens or logs). The Support platform will automatically generate a unique Request for Change Id Number

when the RfC is saved (17) as suggested in ITIL Service Support [21, Chapter 5C] "The following data should be recorded during the Incident life-cycle:

- Unique reference number
- Incident classification
- Date/time recorded
- Name/id of the person and/or group recording the Incident
- Name/department/phone/location of User calling
- Call-back method (telephone, mail etc.)
- Description of symptoms
- Category (often a main category and a subcategory)
- Impact/urgency/priority
- Incident status (active, waiting, closed etc.)
- Related Configuration Item
- Support group/person to which the Incident is allocated
- Related Problem/Known Error
- Resolution date and time
- Closure category
- Closure date and time"

On the Client's side of the Support platform, there are also another set of functionalities, as seen in Figure 14 (numbers 8, 9, 10, 11). Numbers 8 and 9 permit searching for Requests for Change or sets of Requests for Change by status and between dates. Accessing a centralised repository of Requests, as suggested by ITIL Service Support [21, Chapter 5.4], allows integrated information and elimination of lost or incorrect incidents and service requests.

Clients also have the option for inserting Suggestions (10), providing a valued input for process improvement, as referred in CMMI [6, Requirements Development SP3.5] "[…] adequacy and

completeness of requirements by developing product representations […]" "[…] and by obtaining feedback about them from relevant stakeholders.".

In option 11 (Figure 16), Users can modify their personal profile and define what e-mail notifications they prefer (18 for any alteration on the Request for Change and 19 alerting for the Request for Change closure on the Support side).

Figure 16 - Service Support Platform - User Preferences

This form of notification is in close alignment with CMMI Version 1.2 [6, Chapter GP 2.7], "Identify and Involve Relevant Stakeholders", referring the communication practice as important "[...] to establish and maintain the expected involvement of stakeholders during the execution of the process.". ITIL Service Support also refers this point, suggesting [21, Chapter 5.6.1]: "Outputs will be:

- Updated details of Incidents
- […]
- Notice to Customers when an Incident has been resolved"

This practice permits the Client being informed on the solution process of his Request for Change. The next subsection will take us to the Support Team's Side.

5.1.2 *Service Support Platform - Support Team's Side*

The Service Support Platform - Support Team's Side access the same initial front-end as the Client's Side. The difference is based in different user profiles, permitting a different access to the platform's functionalities. The profile that is presented here as a case study for the Support Team's Side has full Administrator features.

Figure 17 represents the output of option 20 as a support panel, where users can preview a list of all open and not assigned Requests for Change in the northeast square, as well as Requests for Change that have been attributed to the user (southwest square). The northwest square informs the user of any new attribution as well as any new addition to the ongoing Requests for Change, which are presented in the southeast square.

Figure 17 - Service Support Platform- Support User Panel

In option 21, Requests Consult is very similar to the option 8 seen on the Client's Side, permitting searching for Requests for Change or sets of Requests for Change by status and between dates, as well as by Request ID and Client, as we can see in figure 18.

Figure 18 - Service Support Platform - Request Consultation

In option 22, we will see a very important functionality of the Support Platform, the Request for Change Management Panel. This option permits the assigning of Requests for Change to the members of the Support Team, as defined in the process outlined in figure 12, by the Process Manager (option 2) or by Team Support Area responsible (option 3). This capability from the Support Platform is accordingly to ITIL Service Support [21, Chapter 5.8.1]. In Figure 19 we can see the Request for Change assignment panel.

The assignment panel is divided in two parts. In the upper section the Process Manager can see the unassigned Requests for Change, analyse their content and assign to a Support Team member. In the lower section the Process Manager can see the Requests for Change assigned to a selected member of the Support Team.

Source: http://giafsuporte.indra.pt

Figure 19 - Service Support Platform - Request for Change assignment

An important functionality, often not considered when designing a Support Platform, is the existence of a Suggestion Box, available in option 23. This functionality is aligned with CMMI [6, Requirements Development SP3.5] as referred earlier. The suggestion box also permit giving feedback on the suggestions received, allowing a more narrowing Client - Support Team relationship.

This narrowing relationship also opens the door for more commercial opportunities, which is always one primordial objective of every business. Figure 20 shows us the Support Platform - Suggestion Box.

Figure 20 - Service Support Platform - Suggestion Box

Option 24 leads the user to the Statistics panel. This is a very important functionality, which permits proper control of the Requests for Change by the Process Manager and permits control over agreed Service Level Agreements compliance. The importance of this topic is referred in ITIL Service Delivery [22, Chapter 2.1], referring "Service Level Management (SLM) is the hinge for Service Support and Service Delivery. It cannot function in isolation as it relies on the existence and effective and efficient working of other processes. A Service Level Agreement without underpinning support processes is useless,[…]".

In figure 21 Support Platform - Request for Change Statistics we can see the statistics results for the Client "FEUP" in a defined period, as well as the statistics results for each of the segments defined in Table 3:

- 1-2 Register / Processing

- 2-3 Processing / Confirmation
- 3-4 Confirmation / Closure
- 1-3 Register / Confirmation
- 1-4 Register / Closure

Figure 21 - Service Support Platform - Request for Change Statistics

In option 25, the Process Manager (which is a Support Platform Administrator) can create new Clients (Figure 22) and new Users (Figure 23) for accessing the Support Platform, as well as creating Clients groups, so that the commercial teams can access the platform and be kept informed over their Client's Requests for Change.

Although this functionality is not referred directly by ITIL, the Business Perspective mentioned in ITIL Service Delivery [22, Appendix E], referrers the incorporation of some good Practices, through Support Platform functional capabilities "[…] three of which are specifically relevant to

the delivery of Information System services, namely: contract facilitation, contract monitoring, and relationship building.".

These three mentioned functionalities are controllable through the Suggestion Box/Information Request; Statistics/Client Grouping and Client involvement and resolution feedback on Request for Change solving.

Source: http://giafsuporte.indra.pt
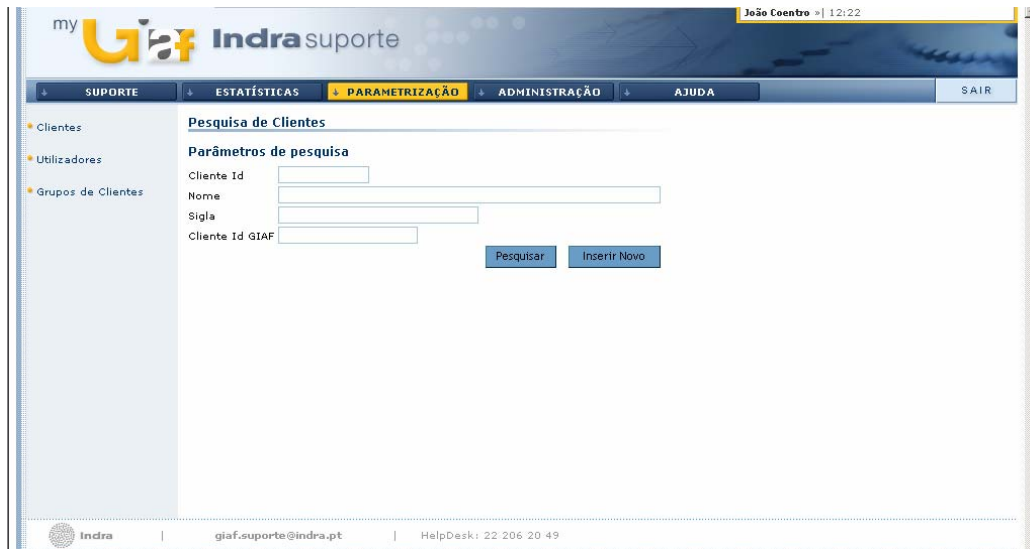
Figure 22 - Service Support Platform - Clients Creation/Consultation

Figure 23 - Service Support Platform - Users Creation/Consultation

Just as important as laying out the functionalities for the Support Platform, the database structure designing for the integrated Information and Support System must consider and integrate some good practices. It is a Star-schema database, oriented for operational performance that permits the calculation of the defined metrics and includes all of the desired characteristics.

Following the Enron scandal, the Sarbanes Oxley Act (SOX) implied that proper action in Companies' Internal Control should be executed. CobiT, presented in Section 2.9 integrates these Good Practices. The Good Practices integrated in the Support Platform concerned audit trail. Who did what and when. As we can see in Figure 24, all of the input records have database columns referring to:

- 26 - User who created the original Record
- 27 - Date of creation of the original Record

- 28 - User who altered the original Record
- 29 - Date of alteration of the original Record
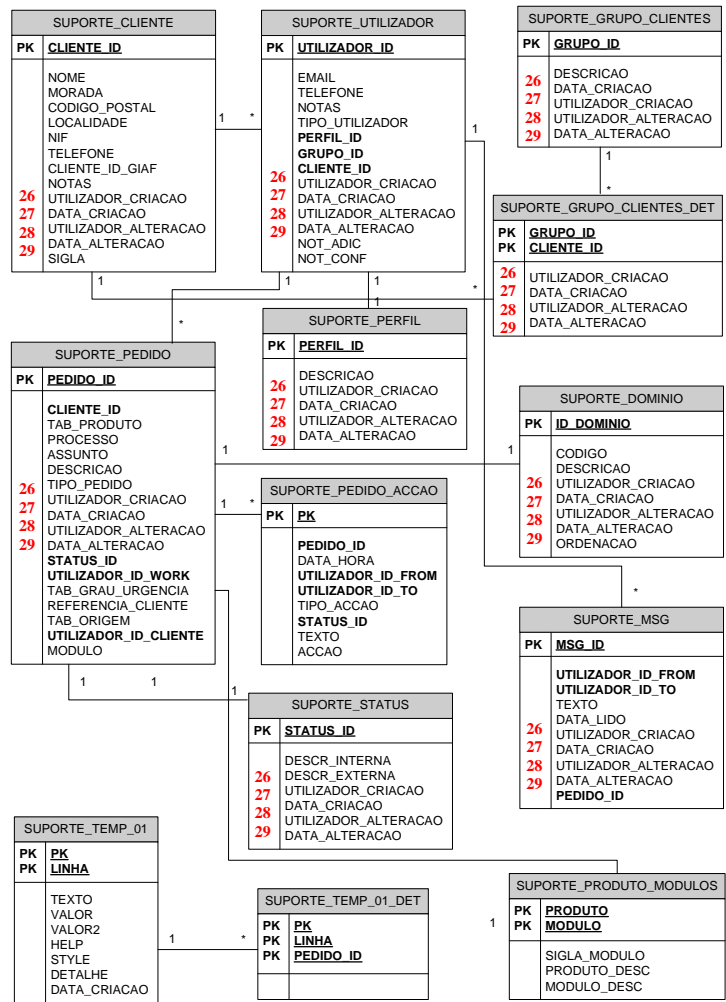
Figure 24 - Service Support Platform - Database Table Diagram

In CobiT [41, Chapter AI7.10, Page 98] refers at some point that the Support System should "Establish control procedures to ensure timely and correct distribution and update of approved

configuration items. This involves integrity controls; segregation of duties among those who build, test and operate; and adequate audit trails of all actions.".

Another recommendation from CobiT [41, Chapter DS10.2, Page 140] is fully integrated with ITIL's Service Support [22], recommending that "The problem management system should provide for adequate audit trail facilities that allow tracking, analysing and determining the root cause of all reported problems considering:

- All associated configuration items
- Outstanding problems and incidents
- Known and suspected errors"

The overall concept of the Database design has considered the overlapping good practices from CMMI [5, 6, 7, 8, 9, 10], ITIL [21, 22] and CobiT [41, 44]. In the next chapter, an evaluation over the new Support Platform will be presented.

6. Evaluation

6.1 Evaluation Key Questions

The need for a Support Platform has become evident on the course of the previous chapters. The pertinent question is to assert if the new Support Platform has fulfilled the planned objectives. When performing a program evaluation, a few key questions [49] should be considered:

- What kind of information is needed to enlighten the intended audiences, (its inputs, activities and outputs), the customers or clients who experience the program, strengths and weaknesses of the program and benefits to customers
- From what sources should the information be collected, for example employees, customers or the program itself
- How can that information be collected in a reasonable fashion, for example questionnaires, interviews, Program generated results or observing customers/ employees
- What resources are available to collect the information

As well as these key questions, there are four levels of evaluation information that can be gathered from clients, including getting their:

- Reactions and feelings (feelings are often poor indicators that your service made lasting impact)
- Learning (enhanced attitudes, perceptions or knowledge)
- Changes in skills (applied the learning to enhance behaviours)
- Effectiveness (improved performance because of enhanced behaviours)

Using the To-Be process outlined in the previous chapter for illustration, we can start to answer these key questions. The Input is the Request for Change, the activities sequencing are defined in Figure 12, and the Output will be the solved Requests for Change. Using the program itself has the source of information (it is a repository of RfCs), we can observe a total of more than 5.000 RfCs inserted since the Support platform has become available for customers.

This volume of Requests for Change is already a ground breaking success, since there was no repository prior to the new Support Platform. The metrics characteristics generated by the program allow the Process Manager, which is the responsible for data recollection, corroborate the decisions for SLAs compliance. These represent a huge evolution for customers (that have their SLAs complied), as well as an organization improvement for the Support Teams (employees).

The four levels of evaluation mentioned before also provide a good degree of comfort in the perception of success of the Support Platform. Reactions and feelings transmitted by customers are very positive. And the perception that customers use the Support Platform as a preferred channel of communication is a good indicator. The effectiveness due to standardized Requests for Change (due to the use of standard forms of RfCs) translated in improved performance in resolution time and overall customer satisfaction.

Alongside with these key questions, the evaluation can be focused as a Goals-Based Evaluation, a Process-Based Evaluation or both. Goal-Based evaluations are evaluating the extent to which programs are meeting predetermined goals or objectives. Process-Based evaluations are geared to fully understanding how a program works.

6.1.1 *Goals-Based Evaluation*

The focus of the evaluation will be in determining if the goals have been attained, as well as a process performance assessment. By answering a few key questions with the available information and feedback, a critic evaluation is performed. Questions to consider when designing a Goals-Based evaluation is analyzing if the goals were reached by answering the following questions [49]:

- How were the program goals established?
- What is the status of the program's progress toward achieving the goals?
- Do personnel have adequate resources (equipment, facilities, etc.) to achieve the goals?
- Should any goals be added or removed? Why?
- How should goals be established in the future?

The Program goals were established considering the absence of a structured process for Requests for change resolution. The ERP GIAF's department Team leader defined the goals with the Process Manager in process definition reunions, defining the main goal as providing a structured Support Platform that work as RfCs repository, permitting SLAs compliance control.

The program succeeded in achieving its goals, and the positive impact is increasing as more and more customers use the Support Platform as the primary point of entry for Requests for Change. The Support Teams make use of prior solutions in the RfCs repository, making use of the IT infrastructure and optimizing resources.

In terms of new goals, the focus is still in further enhancing the Service Support Platform. Enhancements like better Request for Change search engine, better User Interface, improved KPIs in the Statistics and new security mechanisms. The goal of increasing the commercial approach in the new Support Platform is still in study. New goals will be thought in a team

effort (IT Department Director, Process Manager and Support Team Leaders), as they were initially, incorporating the good practices presented earlier.

6.1.2 *Process-Based Evaluation*

For the Process-Based evaluation, there are numerous questions that might be addressed. The following questions were selected by carefully considering what is important to know about the program. The answers to these questions will be the method to understand and examine the processes in this program [49]:

- What is required of employees in order to deliver the services?
- How do customers come into the program?
- What is required of customers?
- What is the general process that customers go through with the program?
- What do customers consider to be strengths of the program?
- What does staff consider to be strengths of the program?
- What do employees and/or customers recommend to improve the program?

With the in depth knowledge of the ERP GIAF, the specialized Support Teams makes use of the RfCs repository of solutions in the Support Platform, speeding up the resolutions, translating in better service and SLAs compliance. This improved the overall standardized responses for RfCs, since they can be reutilized for other elements, and this awareness improved the quality of the responses.

Having the Support Platform ready, the process of informing the customers of the availability went smoothly, through the use of a newsletter specially crafted with a dynamically created e-mail with a username and password inserted, which was sent to key users for each Client. With this access in hand customers need only to fill-in the form fields for the Request for Change.

The feedback from formal (Suggestion Box) and informal (meetings / telephone) channels from Customers (only key users from each Client) has confirmed the success of the new Support Platform. This feedback is also used as input for process tune-up and improvement. Both Customers and Support Teams transmitted more confidence in RfCs resolution and follow-up, as a permanent record of inputs and complements of information to the RfCs is now possible.

In terms of the process itself, there are not direct suggestions for improvement from both Customers and Support Teams. The suggestions are focused in small form structure alteration of the Request for Change template and more available categorizations of the pull down options of the form, permitting an even more detailed specialization of the RfCs.

In the next chapter, a discussion over the accomplishments of the new Support Platform will be presented.

7. Conclusions and further Developments

In an ever more competitive market due to globalization, the use of Frameworks and Standards are tools Software companies alike use to differentiate themselves and increase overall Product and Services Quality. An effort was made in the attempt to give the actual state and the future evolutions of the main Standards and Frameworks.

In this Dissertation, the focus was on Service Support. As a result from the implementation of the new Service Support Platform, the quality of the working environment revealed a clear improvement due to the use of the new Support platform, with no more continued phone ringing, reducing stress levels which ultimately reflected in an increasing productivity.

This is mentioned in ITIL Service Support [21, Chapter 4.4.12], referring "Organisations may use 'call rate reduction' as a direct business benefit of introducing a Service Desk. However although call rates may drop initially upon the introduction of a Service Desk because of the improved service, they will typically start to rise again thereafter. This effect is due to improved Customer confidence, and will result in Customers using the Service Desk, not only for reporting Incidents, but also for advice and guidance and other support activities. This cycle should be carefully and continually monitored."

This effect was verified in the new Support Platform, not in terms of "phone ringing", but in a verified increase of Requests for Change in the Information Request category. Another key improvement from the use of a Service Support platform is the integrated Requests for Change database. This integrated database allows the Process Manager to quantify the number of Requests for Change, by Client, Urgency, in a defined time period. This numbers can be confronted with the agreed Service Level Agreements and proper action can be executed.

The compliance of Service Level Agreements leads to Client's satisfaction, which gives continuity to the commercial relation and permits the opportunity for new business. This is paramount nowadays, the retention and continuity of the established Clients.

As referred in ITIL Service Support [21, Chapter 4.10.1], to achieve the Critical success factors and "introduce and maintain a successful Service Desk, it is essential that:

- Business needs are understood
- Customer requirements are understood
- Investment is made in training for Customers, support teams and Service Desk staff
- Service objectives, goals and deliverables are clearly defined
- Service levels are practical, agreed, and regularly reviewed
- The benefits are accepted by the business"

All of these critical success factors were considered and achieved with the new Service Support Platform. The new Service Support Platform has an average of 10 Requests for Change every working day, totalling already more than 5.000 Requests for Change. The success of the Service Support Platform gave the opportunity to include this solution to the portfolio of "sellable" solutions for new and existing Clients of Indra Sistemas Portugal.

The project used several concepts and components from the main Frameworks presented here like CMMI [5, 6, 7, 8, 9, 10], ITIL [21, 22] and CobiT [41, 44]. The course of this project and this dissertation did not intend a full implementation for certification of the several Standards and Frameworks presented. The resources, costs and time required for a proper implementation for certification, like a SCAMPI type A appraisal for CMMI, ITIL's Service Support and Service Delivery, CobiT or the several ISOs should not be taken lightly. Full commitment of the stakeholders should be a premise.

The information contained in the integrated database is already being used to further enhance the Service Support Platform. Enhancements like better Request for Change search engine, better User Interface, improved KPIs in the Statistics and new security mechanisms. The importance of proper feedback from Clients and the Support Team, permit incorporating these improvements in the Platform and is essential to keep momentum. This is accordingly to the CMMI's [6] concept of continuous Process Improvement.

The increased control over Evolutive (File for Development) and Corrective Requests for Change permitted a more effective follow-up from the commercial teams, translated in a shorter response time for the File for Development budgeting proposals.

Due to the difficulty in obtaining the Standards and Frameworks and the length of some, this Dissertation took a little more time than expected. The excerpts and emphasis from these Standards and Frameworks were selected based in the author's understanding of their principal components, keeping in mind the scope of this Dissertation. Readers from this Dissertation should try to obtain the original documentation if their objective is a full implementation of these Standards.

In the Annex are detailed presentations of the presented Frameworks of Chapter 2, as well a few more related Standards, following a logical sequence of presentation and how they are related. CMMI is related to Personal Software Process and ISO 15504 (SPICE). ITIL is directly related to ISO/IEC 20000 Service Management, which is very focused in Process redesign. ISO/IEC 12207 is focused in Software Life Cycle Processes.

ISO/IEC 9126-1 is focused in Product Quality, paramount these days, which in turn is closely related to ISO/IEC 14598 Software Product Evaluation (now ISO/IEC 25000: SQuaRE). ISO/IEC 27001and ISO/IEC 17799 focuses in Information Security, another key element in the Information Technologies. And for roundup, CobiT focused in Control Objectives for Information and related Technology. All these frameworks complement each other.

It is desired that the readers of this Dissertation can now have a better understanding of the references in IT good practices for IT management and development, and that this Dissertation can stimulate the interest for further study in these Standards and Frameworks as they see fit after this introductory Dissertation on the subject.

The study here presented permitted the author a decomposition of the several "pieces of the puzzle", understanding how these pieces match and overlap over each other, definitely permitting seeing the "bigger picture" on what IT Service Management can be and how it should be implemented. The use and study of all these Frameworks and Standards as guidelines has definitely increased the overall quality of this Service Support Platform.

References

[1]   Carnegie Mellon University Software Engineering Institute; Link:
        http://www.sei.cmu.edu/cmmi/faq/grp07-faq.html, last accessed: 05-12-2006

[2]   Deming, W. Edwards; Out of the Crisis; MIT Press; 1982

[3]   Crosby, Philip B.; Quality is Free: The Art of Making Quality Certain; McGraw Hill;
        1979

[4]   Juran, Joseph M.; Juran Institute; Link: www.juran.com; last accessed: 06-12-2006

[5]   Carnegie Mellon University Software Engineering Institute; The Capability Maturity
        Model: Guidelines for Improving the Software Process; Addison-Wesley Professional;
        1995

[6]   Carnegie Mellon University Software Engineering Institute; Capability Maturity Model
        Integration for Development Version 1.2; CMU/SEI; August 2006

[7]   Carnegie Mellon University Software Engineering Institute; Appraisal Requirements for
        CMMI Version 1.2; CMU/SEI; August 2006

[8]   Carnegie Mellon University Software Engineering Institute; Standard CMMI Appraisal
        Method for Process Improvement (SCAMPI) A: Method Definition Document Version
        1.2; CMU/SEI; August 2006

[9]   Ahern, Dennis M.; Clouse, Aaron: Turner, Richard; CMMI Distilled. A Practical
        Introduction to Integrated Process Improvement, 2nd Edition; Addison Wesley; 2003;
        ISBN: 0-321-18613-3

[10]   Chrissis, Mary Beth; Konrad, Mike; Shrum, Sandy; CMMI: Guidelines for Process
        Integration and Product Improvement; Addison Wesley; 2003; ISBN: 0-321-15496-7

[11]   Humphrey, Watts S.; Introduction to the Personal Software Process; Addison-Wesley;
        1997

[12]   Humphrey, Watts S.; PSP: A Self-Improvement Process for Software Engineers;
        Addison-Wesley; 2005; ISBN: 0321305493

[13]   Humphrey, Watts S.; Winning with Software: An Executive Strategy, Addison-Wesley; December 2001

[14]   Humphrey, Watts S.; Managing Technical People - Innovation, Teamwork and Software Process; Addison-Wesley; 1997

[15]   Humphrey, Watts S.; A Discipline for Software Engineering; Addison-Wesley; 1995

[15a]   Humphrey, Watts S.; Software Process Improvement - A Personal View: How it Started and Where it is Going; Software Process: Improvement and Practice 12 May/June, Pages 223-227; 2007

[16]   International Organization for Standardization (ISO); ISO/IEC 15504-1 - Information technology - Process assessment, Part 1: Concepts and vocabulary, First Edition; ISO/IEC; 2004

[17]   International Organization for Standardization (ISO); ISO/IEC 15504-2 - Information technology - Process assessment, Part 2: Performing an assessment, First Edition; ISO/IEC; 2003

[17a]   International Organization for Standardization (ISO); ISO/IEC 15504-2 - Information technology - Process assessment, Part 2: Performing an assessment, Technical Corrigendum 1; ISO/IEC; 2004

[17b]   P. Rout, Terence; Tuffley, Angela; Harmonizing ISO/IEC 15504 and CMMI; Software Process: Improvement and Practice 12 July/August, Pages 361-371; Link: www.interscience.wiley.com; 2007

[18]   International Organization for Standardization (ISO); ISO/IEC 15504-3 - Information technology - Process assessment, Part 3: Guidance on performing an assessment, First Edition; ISO/IEC; 2004

[19]   International Organization for Standardization (ISO); ISO/IEC 15504-4 - Information technology - Process assessment, Part 4: Guidance on use for process improvement and process capability determination, Final Draft; ISO/IEC; 2004

[20]   International Organization for Standardization (ISO); ISO/IEC 15504-5 - Information technology - Process assessment, Part 5: An exemplar Process Assessment Model, Final Draft; ISO/IEC; 2005

[21]   Office of Government Commerce (OGC); ITIL - Service Support Version 2; The Stationary Office (TSO); 2000

[22]   Office of Government Commerce (OGC); ITIL - Service Delivery Version 2; The Stationary Office (TSO); 2000

[23]   Ball, Eugene S.; ITIL: What it is and why you should care (White Paper); Link: www.globalknowledge.com last accessed: 03-01-2007; 2005

[24]   Marquis, Hank; ITIL Version 3 - What it means to you (White Paper); Link: www.globalknowledge.com last accessed: 03-01-2007; 2006

[25]   The Stationery Office (TSO); ITIL Refresh News - 1st Edition; The Stationery Office (TSO); Autumn 2006

[25a]   The Stationery Office (TSO); ITIL Refresh News - 2nd Edition; The Stationery Office (TSO); January 2007

[25b]   The Stationery Office (TSO); ITIL Refresh News - 3rd Edition; The Stationery Office (TSO); May 2007

[25c]   The Stationery Office (TSO); ITIL Refresh News - 4th Edition; The Stationery Office (TSO); October 2007

[26]   International Organization for Standardization (ISO); ISO/IEC 12207 - Information technology - Software Life Cycle Processes, First Edition; ISO/IEC; 1995

[27]   International Organization for Standardization (ISO); ISO/IEC 20000 Information technology - Service management Part 1: Specification, First Edition; ISO/IEC; 2005

[28]   International Organization for Standardization (ISO); ISO/IEC 20000 Information technology - Service management Part 2: Code of Practice, First Edition; ISO/IEC; 2005

[29]   International Organization for Standardization (ISO); ISO 9126-1 Software engineering - Product quality Part 1: Quality model, First Edition; ISO/IEC; 2001

[30]   International Organization for Standardization (ISO); ISO 9126-2 Software engineering - Product quality Part 2: External metrics, First Edition; ISO/IEC;

[31]   International Organization for Standardization (ISO); ISO 9126-3 Software engineering - Product quality Part 3: Internal metrics, First Edition; ISO/IEC;

[32]   International Organization for Standardization (ISO); ISO 9126-4 Software engineering - Product quality Part 4: Quality in use metrics, First Edition; ISO/IEC;

[33]   International Organization for Standardization (ISO); ISO 14598-1 Information technology - Software product evaluation Part 1: General overview, First Edition; ISO/IEC; 1999

[34]   International Organization for Standardization (ISO); ISO 14598-2 Information technology - Software product evaluation Part 2: Planning and management, First Edition; ISO/IEC; 2000

[35]   International Organization for Standardization (ISO); ISO 14598-3 Information technology - Software product evaluation Part 3: Process for developers, First Edition; ISO/IEC; 2000

[36]   International Organization for Standardization (ISO); ISO 14598-4 Information technology - Software product evaluation Part 4: Process for acquirers, First Edition; ISO/IEC; 1999

[37]   International Organization for Standardization (ISO); ISO 14598-5 Information technology - Software product evaluation Part 5: Process for evaluators, First Edition; ISO/IEC; 1998

[38]   International Organization for Standardization (ISO); ISO 14598-6 Information technology - Software product evaluation Part 6: Documentation of evaluation modules, First Edition; ISO/IEC; 2001

[39]   International Organization for Standardization (ISO); ISO/IEC 27001 Information technology - Security techniques - Information security management systems - Requirements, First Edition; ISO/IEC; 2005

[40]   International Organization for Standardization (ISO); ISO/IEC 17799 Information Technology - Security Techniques - Code of Practice for Information Security Management, Second Edition; ISO/IEC; 2005

[41]   IT Governance Institute; CobiT 4.0, 4th Edition; ISACA; 2005; Link: www.isaca.org last accessed: 23-01-2007

[42] Azuma, Motoei; SquaRE - The next generation of the ISO/IEC 9126 and 14598 international standards series on software product quality, White Paper; Presented in European Software Control and Metrics - Escom; 2001; Link: http://www.sqi.gu.edu.au/sc7-mirror/Publications.html last accessed: 23-01-2007

[43] IT Governance Institute; CobiT 4.1, 4th Edition; ISACA; 2007; Link: www.isaca.org last accessed: 08-10-2007

[44] Curtis, Bill; Integrating CMMI with CobiT and ITIL; Borland; 2005

[45] Tuttle, Brad; D. Vandervelde, Scott; An empirical examination of CobiT as an internal control framework for information technology ; International Journal of Accounting Information Systems, Volume 8, Issue 4, Pages 240-263; December 2007

[46] Dayan, Rony; Evans, Stephen; Knowledge Management your way to CMMI; Journal of Knowledge Management, Volume: 10, Issue: 1, Pages 69-80; 2006

[47] Lott, Christopher M.; Technology Trends Survey: Measurement Support in Software Engineering Environments; International Journal of Software Engineering and Knowledge Engineering , Volume: 4, Issue: 3; September 1994

[48] Baskerville, Richard L.; Investigating Information Systems with Action Research; Communications of the Association for Information Systems, Volume 2, Article 19; October 1999

[49] McNamara, Carter; Basic Guide to Program Evaluation; 2008; Link: http://www.managementhelp.org/evaluatn/fnl_eval.htm; last accessed: 21-07-2008

Glossary / Acronyms

A –

Acceptance Criteria	The criteria that a product or product component must satisfy to be accepted by a user, customer, or other authorized entity
Appraisal	In the CMMI Product Suite, an examination of one or more processes by a trained team of professionals using an appraisal reference model as the basis for determining, at a minimum, what are their strengths and weaknesses. (See also Assessment and Capability Evaluation)
Assessment	An appraisal that an organization does internally for the purposes of process improvement. The word assessment is also used in an everyday English sense (e.g. Risk Assessment). (See also Appraisal and Capability Evaluation)

B –

Benchmarking	A process used in management, and particularly strategic management, in which companies evaluate various aspects of their business processes in relation to best practice, usually within their own industry
Business Objectives	Senior management developed strategies designed to ensure an organization's continued existence and enhance its profitability, market share, and other factors influencing the organization's success. Such objectives may include reducing the number of change requests during a system's integration phase, reducing

development cycle time, increasing the number of errors found in a product's first or second phase of development, and reducing the number of customer-reported defects, when applied to systems engineering activities

C –

Capability Evaluation	An appraisal by a trained team of professionals used as a discriminator to select suppliers, to monitor suppliers against the contract, or to determine and enforce incentives. Evaluations are used to gain insight into the process capability of a supplier organization and are intended to help decision makers make better acquisition decisions, improve subcontractor performance, and provide insight to a purchasing organization. (See also Appraisal and Assessment)
Capability Level	Achievement of process improvement within an individual process area. A capability level is defined by the appropriate specific and generic practices for a process area. (See also Maturity Level and Process Area)
Capability Maturity Model	A model that contains the essential elements of effective processes for one or more disciplines and describes an evolutionary improvement path from ad hoc, immature processes to disciplined, mature processes with improved quality and effectiveness
Category	Classification of a group of Configuration Items, Change documents or Problems
Change Advisory Board	A group of people who can give expert advice to Change Management on the implementation of Changes. This board is likely to be made up of representatives from all areas within IT and representatives from business units

Carnegie Mellon University	Carnegie Mellon University is a global research university and is associated to the SEI - Software Engineering Institute. CMMI is sponsored by the U.S. Department of Defense
Configuration item (CI)	Component of an infrastructure – or an item, such as a Request for Change, associated with an infrastructure. Configuration Items may vary widely in complexity, size and type, from an entire system (including all hardware, software and documentation) to a single module or a minor hardware component
Continuous Representation	A capability maturity model structure wherein capability levels provide a recommended order for approaching process improvement within each specified process area
Customer (ITIL)	A business manager authorized to negotiate with the IT supplier on behalf of the business. Typically someone who has responsibility for the cost of the service, either directly through charging or indirectly in terms of demonstrable business need

D –

Dashboard	A tool for setting expectations for an organisation at each level and continuous monitoring of the performance against set targets
Defined Process	A managed process that is tailored from the organization's set of standard processes according to the organization's tailoring guidelines; has a maintained process description; and contributes work products, measures, and other process improvement information to the organizational process assets
Document	A collection of data, regardless of the medium on which it is recorded, that generally has permanence and can be read by humans or machines. So, documents include both paper and electronic documents

DSL	Definitive Software Library (Reliable versions of software centralised in a single logical location. However, software may be physically stored at different locations.)

E –

Employee Self Service	Employee self-service (ESS) is an increasingly prevalent trend in human resources management that allows an employee to handle many job-related tasks that otherwise would have fallen to management or administrative staff

I –

IEC	International Electrotechnical Commission
Incident	Unexpected disruption to agreed service. Often equal to the extent to which an Incident leads to distortion of agreed or expected service levels
ISO	International Organization for Standardization

K –

Known Error	An Incident or Problem for which the root cause is known and for which a temporary Work-around or a permanent alternative has been identified
KPI	Key Performance Indicators

L –

Lifecycle	A series of states, connected by allowable transitions.

M –

Maturity Level	Degree of process improvement across a predefined set of process areas in which all goals in the set are attained. (See also Capability Level and Process Area)
Metric	Measurable element of a service process or function
MTTR	Mean Time to Repair (Downtime) - Time period that elapses between the detection of an Incident and it's Restoration. Includes: Incident, Detection, Diagnosis, Repair, Recovery and Restoration
MTTF	Mean Time to Failure (Uptime) - Time period that elapses between Restoration and a new Incident
MTBF	Mean Time Between Failures - Time period that elapses between two incidents. (MTTR + MTTF)

O –

OLA	Operational Level Agreement
Organization	An administrative structure in which people collectively manage one or more projects as a whole, and whose projects share a senior manager and operate under the same policies

P –

Priority	Sequence in which an Incident or Problem needs to be resolved, based on impact and urgency
Process area (CMMI)	Is a cluster of related best practices in an area, which when implemented collectively, satisfy a set of goals considered important for making significant improvement in that area

Process	A connected series of actions, activities, Changes etc, performed by agents with the intent of satisfying a purpose or achieving a goal

R –

RACI chart	Chart that identifies who is Responsible, Accountable, Consulted and/or Informed
Request for Change (RfC)	Form, or screen, used to record details of a request for a Change to any CI within an infrastructure or to procedures and items associated with the infrastructure
Resolution	Action that will resolve an Incident. This may be a Work-around
Risk	The potential that a given threat will exploit vulnerabilities of an asset or group of assets to cause loss and/or damage to the assets. It usually is measured by a combination of impact and probability of occurrence.
Risk Management	An organized, analytic process to identify what might cause harm or loss (identify risks); to assess and quantify the identified risks; and to develop and, if needed, implement an appropriate approach to prevent or handle causes of risk that could result in significant harm or loss

S –

SEI	Software Engineering Institute is associated to CMU - Carnegie Mellon University
SOX	Sarbanes-Oxley
Service Level Agreement	A written agreement between a service provider and Customer(s) that documents agreed service levels for a service.

Service Level Management	The process of defining, agreeing, documenting and managing the levels of customer IT service, that are required and cost justified
Secure Sockets Layer	Cryptographic protocol that provide secure communications on the Internet
SMB	Small and Medium Business. The EU has started to standardize the concept. Its current definition categorizes companies with fewer than 50 employees as small and those with fewer than 250 as medium.
Sub-Process	A process that is part of a larger process. A sub-process can be decomposed into sub-processes and/or process elements. (See also Process)
System	An integrated composite that consists of one or more of the processes, hardware, software, facilities and people, that provides a capability to satisfy a stated need or objective

T –

Tailoring	Tailoring a process makes, alters, or adapts the process description for a particular end. For example, a project establishes its defined process by tailoring from the organization's set of standard processes to meet the objectives, constraints, and environment of the project

U –

Urgency	Measure of the business criticality of an Incident or Problem based on the impact and on the business needs of the Customer
User	The person who uses the services on a day-to-day basis

W –

Work-around   Method of avoiding an Incident or Problem, either from a temporary fix or from a technique that means the Client is not reliant on a particular aspect of a service that is known to have a problem

Note:

The definitions displayed in this Glossary were selected from ITIL's Service Delivery Glossary [22]; ITIL's Service Support Glossary [21]; CobiT [41, 44] and CMMI for Development Version 1.2 [6].

ANNEX - Detailed IT Frameworks

A.1 Capability Maturity Model Integration (CMMI)

CMMI (Capability Maturity Model Integration) is a Framework. A Framework, by definition is "a structure supporting or containing something". In software development, a Framework is a defined support structure in which another software project can be organized and developed. CMMI considered 4 different models directed to different domains, supporting the process improvements of those specific areas. The models were:

- CMMI-SE (Systems Engineering)
- CMMI-SW (Software Engineering)
- CMMI-IPPD (Integrated Product and Process Development)
- CMMI-SS (Supplier Sourcing)

CMMI has evolved and is currently undergoing a different structural approach. CMMI now includes the concept of CMMI "constellations." A constellation is a set of CMMI components designed to meet the needs of a specific area of interest. A constellation can produce one or more related CMMI models and related appraisal and training materials. CMMI for Development is the first of these constellations [1].

The prior CMMI-SE/SW (Systems Engineering and Software Engineering) Version 1.1 as well as CMMI-IPPD (Integrated Product and Process Development) are now superseded to Version 1.2 CMMI for Development (CMMI-DEV), to truly reflect the comprehensive integration of these bodies of knowledge and the application of the model within the organizations. CMMI-SS (Supplier Sourcing) was removed.

There are still available some CMM models, like P-CMM (People CMM) and SA-CMM (Software Acquisition CMM). P-CMM (People CMM) shares the same philosophy as the CMMI-SW, but applied to Human Resources in order to continuously improve the ability of

software organizations to attract, develop, motivate, organize, and retain the talent needed to steadily improve their software development capability. SA-CMM (Software Acquisition), aims to organizations that acquire solutions such as hardware, software, services, and systems. This Dissertation will only focus in the CMMI models.

But let us begin with the origins of CMMI, before detailing the CMMI structured approach.

A.1.1 *CMMI Origins*

CMMI evolved from CMM (Capability Maturity Model), a process improvement approach developed by SEI (Software Engineering Institute), which is operated by Carnegie Mellon University. Since 1984, the Carnegie Mellon Software Engineering Institute (SEI) has served as a USA funded research and development centre, funded by the Department of Defense (DoD). CMMI also has a strong support from the NDIA (National Defense Industrial Association).

CMM absorbed the process improvement and Quality principles presented by Deming [2], Crosby [3] and Juran [4] in the 80's. In 1987 SEI released a short description of a process maturity structure and also maturity inquiry by Humphrey. After 4 years of experience with the process maturity structure, SEI evolved this structure to CMM for Software. In February 1993, SEI released CMM version 1.1 as the result of the recommendations of the Software community. In 1995 the SEI created the first CMM designed for software organizations and published it in a book, *The Capability Maturity Model: Guidelines for Improving the Software Process* [5]. Other CMM models were also developed.

The CMM Integration project was formed to sort out the problem of using multiple CMMs. The CMMI Product Team's initial mission was to combine three source models:

1. The Capability Maturity Model for Software (SW-CMM) v2.0 draft C

2. The Systems Engineering Capability Model (SE-CMM)

3. The Integrated Product Development Capability Maturity Model (IPD-CMM) v0.98

The combination of these models into a single improvement framework was intended for use by organizations in their pursuit of enterprise-wide process improvement [6]. The result was CMMI Version 1.02 in 2000. Hence, CMMI is a result of the evolution of the SW-CMM, the SE-CMM, and the IPD-CMM modules. In 2002, CMMI Version 1.1 was released, and since then this improvement framework has been broaden to other areas of interest. Recently CMMI Version 1.2 was released, the first "constellation", which aggregates and synchronizes the scopes of CMMI-SE/SW as well as CMMI-IPPD (as described early).

In 2007 are expected two more "Constellations", CCMI for Acquisition Version 1.2 and CMMI for Services Version 1.2.

A.1.2 *CMMI Levels*

As it is described in CMMI-DEV [6, Part 1, Chapter 3], CMMI supports two improvement paths. One path enables organizations to incrementally improve processes corresponding to an individual Process area[1] (or process areas) selected by the organization. The other path enables organizations to improve a set of related processes by incrementally addressing successive sets of process areas.

These two improvement paths are associated with two representations:

- Continuous representation, for which CMMI uses the term "capability level."
- Staged representation, for which CMMI uses the term "maturity level."

The concept of levels is the same on both representations.

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[1] Process area is a cluster of related best practices in an area, which when implemented collectively, satisfy a set of goals considered important for making significant improvement in that area [6, Preface].

Levels are used in CMMI to describe an evolutionary path recommended for an organization that wants to improve the processes it uses to develop and maintain its products and services. Levels can also be the outcome of the rating activity of appraisals. The most used method to grant a CMMI level to an organization is through SCAMPI (Standard CMMI Appraisal Method for Process Improvement). Figure A.1 illustrates the difference between stage and continuous representations.
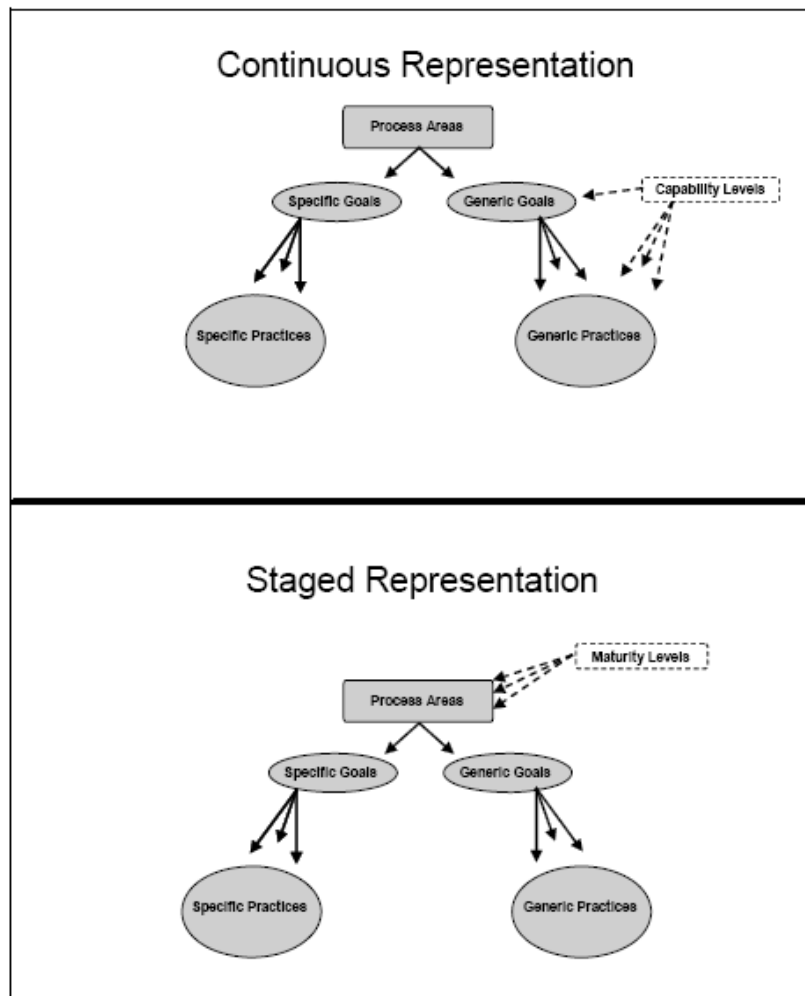
Source: CMMI-DEV Version 1.2 Part 1, Chapter 3

Figure A.1 - CMMI Continuous and Staged Representations

The capability/maturity dimensions of CMMI are used for benchmarking and appraisal activities, as well as guidance to an organization's improvement efforts.

Capability levels, which belong to a continuous representation, apply to an organization's process improvement achievement in individual process areas. These levels are a mean for incrementally improving the processes corresponding to a given process area. There are six capability levels, numbered 0 through 5.

Maturity levels, which belong to a staged representation, apply to an organization's process improvement achievement across multiple process areas. These levels are a means of predicting the general outcomes of the next project undertaken. There are five maturity levels, numbered 1 through 5. Table 1 illustrates the alignment between the two representations.

Levels	Continuous Representation Capability Levels	Staged Representation Maturity Levels
Level 0	Incomplete	N/A
Level 1	Performed	Initial
Level 2	Managed	Managed
Level 3	Defined	Defined
Level 4	Quantitatively Managed	Quantitatively Managed
Level 5	Optimizing	Optimizing

Source: CMMI-DEV Version 1.2 Part 1, Chapter 3

Table A.1 - CMMI Capability and Maturity Levels

Each level has a set of specific practices/recommendations that should be implemented in order to achieve the desired level. Level 2 through 5 represent the same on both representations. A short description of the continuous representation follows:

Capability Level 0: Incomplete

An "incomplete process" is a process that either is not performed or partially performed.

Capability Level 1: Performed

A performed process is a process that satisfies the specific goals of the process area. But they can be lost over time if they are not institutionalized.

Capability Level 2: Managed

A managed process is a performed process that has the basic infrastructure in place to support the process. It is monitored, controlled, and reviewed and evaluated.

Capability Level 3: Defined

A defined process is a managed process that is tailored from the organization's set of standard processes. A critical distinction between capability levels 2 and 3 is the scope of standards, process descriptions, and procedures. Process descriptions and procedures are tailored from the organization's set of standard processes to suit a particular project or organizational unit.

Capability Level 4: Quantitatively Managed

A quantitatively managed process is a defined process that is controlled using statistical and other quantitative techniques. Quantitative objectives for quality and process performance are established and used as criteria in managing the process.

Capability Level 5: Optimizing

An optimizing process is a quantitatively managed process that is improved based on an understanding of the common causes of variation inherent in the process. The focus of an optimizing process is on continually improving the range of process performance through both incremental and innovative improvements.

A short description of the staged representation levels follows:

Maturity Level 1: Initial

At maturity level 1, processes are usually ad hoc and chaotic. The organization usually does not provide a stable environment to support the processes. Success in these organizations depends on the competence and heroics of the people in the organization and not on the use of proven processes.

Maturity Level 2: Managed

At maturity level 2, the projects of the organization have ensured that processes are planned and executed in accordance with policy.

Maturity Level 3: Defined

At maturity level 3, processes are well characterized and understood, and are described in standards, procedures, tools, and methods.

Maturity Level 4: Quantitatively Managed

At maturity level 4, the organization and projects establish quantitative objectives for quality and process performance and use them as criteria in managing processes.

Maturity Level 5: Optimizing

At maturity level 5, an organization continually improves its processes based on a quantitative understanding of the common causes of variation inherent in processes.

As referred early, levels 2 through 5 represent the same on both representations. All these descriptions of the levels are more detailed in CMMI-DEV version 1.2 [6, Part1, Chapter 3].

A.1.3 *CMMI Appraisals (SCAMPI)*

The Standard CMMI Appraisal Method for Process Improvement (SCAMPI) appraisal methods are the generally accepted methods used for conducting appraisals using CMMI models [8]. The SCAMPI family of appraisals includes Class A, B, and C appraisal methods. SCAMPI A is the most rigorous method and the only method that can result in a rating. SCAMPI B provides options in model scope, but the characterization of practices is fixed to one scale and is performed on implemented practices. SCAMPI C provides a wide range of options, including characterization of planned approaches to process implementation according to a scale defined by the user [6, Part 1, Chapter 5].

Appraisals of organizations using a CMMI model must conform to the requirements defined in the Appraisal Requirements for CMMI (ARC) v 1.2 document [7]. In short, this ARC document details step by step sets of activities to achieve the selected goals. ARC permits setting the frame of activities to define the responsibilities of the sponsor and the team leader, as well as point the method to document, plan and prepare for the appraisal. It also sets the requirements of the appraisal to collect, consolidate and validate data. How to set the rating, and finally, reporting the results.

But lets detail further what is SCAMPI A. SCAMPI A satisfies the Appraisal Requirements for CMMI (ARC) v1.2 and is a Class A appraisal method. The SCAMPI A method has the following primary objectives:

- Provide a common, integrated appraisal method capable of supporting appraisals in the context of internal process improvement, supplier selection, and process monitoring
- Provide an efficient appraisal method capable of being implemented within reasonable performance constraints

As an ARC Class A method, SCAMPI A is a benchmarking-oriented method suitable for generating ratings. SCAMPI A appraisals can be performed in three modes of usage:

- Internal Process Improvement
- Supplier Selection
- Process Monitoring

While many of the SCAMPI A features are common across all usage modes (e.g., identification of strengths, weaknesses, and ratings), there are differences in motivation and intent that can result in some expected method differences in these usage modes. Performing appraisals efficiently involves minimizing the use of resources and the impact on appraisal teams and appraised organizations, while maintaining the essential method characteristics that ensure the high degree of accuracy required for an effective benchmarking, regardless of the mode of usage [8, Chapter 1, Page 17].

The first thing to do in SCAMPI is to prepare and plan for appraisal. The team leader and the appraisal sponsor should analyze the requirements. The team leader will collect information and help the appraisal sponsor match appraisal objectives with their business objectives. The next step is to document the results of appraisal planning including the requirements, agreements, estimates, risks, method tailoring, and practical considerations.

The business needs for process improvement drive the requirements for the conduct of any given appraisal and generally include one or more of three closely related factors:

- Reducing costs
- Improving quality
- Decreasing time to market

The appraisal team leader must establish high-level cost and schedule constraints to determine which process areas and organizational entities are to be included to ensure feasibility. The appraisal team leader is also responsible for keeping the appraisal sponsor informed of risk management activities so that, if needed, timely sponsor intervention is possible to ensure the achievement of appraisal objectives.

After appraisal requirements have been documented, constraints are understood and the appraisal plan is defined, the team must be selected and prepared. The minimum acceptable team size for a SCAMPI A appraisal is four people (including the appraisal team leader). All team members must have previously completed the SEI-licensed Introduction to CMMI course.

After the team is selected and all the data collection is planned, the appraisal may now be conducted and the model practices implemented. The findings will be validated and the appraisal output results generated. With this output, the capability (or maturity) level attained for each process area within the scope of the appraisal will be depicted.

The appraisal results will be delivered to the sponsor and to the appraised organizational unit. The appraisal results are intended to support decision making, and should be delivered in a way that promotes appropriate actions. Whether the appraisal was conducted for internal process improvement, supplier selection, or process monitoring purposes, the delivery of results (ADS – Appraisal Disclosure Statement) should facilitate the actions that will be driven by the information and utilized for subsequent reports and follow-up actions.

In short, what are the benefits of using CMMI? The answer is that CMMI best practices improve organizations by enabling to do the following:

- More explicitly link their management and engineering activities to their business objectives

- Expand their visibility into their product life cycle and engineering activities to ensure that their products and services meet customer expectations
- Incorporate lessons learned from additional areas of best practice, like risk management
- Implement more robust high-maturity practices and levels
- Address additional organizational functions critical to their products and services
- More fully comply with relevant ISO standards, like ISO/IEC 15504 (SPICE)

Next a derivation of the SW-CMM will be presented, applied to small programming teams or individual programmers to accomplish continuous improvements. It is called Personal Software Process.

A.2 Personal Software Process (PSP)

By some accounts, more than half of all software projects are significantly late and over budget, and nearly a quarter of them are cancelled without ever being completed. Although developers recognize that unrealistic schedules, inadequate resources, and unstable requirements are often to blame for such failures, few know how to solve these problems. PSP tries to address this issue.

A.2.1 *PSP Origins*

PSP (Personal Process Software) was created by Watts S Humphrey [11], also known as "the father of software quality", and provided the vision and early leadership for the original Capability Maturity Model (CMM). PSP presents a disciplined process for software engineers and anyone else involved in software development. This process includes defect management, comprehensive planning, and precise project tracking and reporting, and it is focused on programmers and small teams of developers.

Watts used as a model SW-CMM (Capability Maturity Model for Software), which is oriented to process improvement. The difference is that while SW-CMM is focused on improving the organizations processes, PSP focuses on the individual programmer, helping him promote improvements in his developing processes, increasing product quality. The programmer can establish for himself more effective and realistic deadlines, lowering costs.

PSP attains his objectives by defining specific forms for each phase of a project, like planning, development, and reporting. These forms aid the programmer in defining a more effective time management and sequencing of activities, and permits the programmer to see where he is making mistakes, and whether if his planning was exact and thorough.

A.2.2 *PSP Maturity Levels*

PSP was created to be used following seven maturity levels, in which new practices of Software engineering are introduced for each level [12]. These levels are grouped two by two, based on their focus. The more basic levels are:

PSP0 and PSP0.1 - The Baseline Process

The first group is dedicated to personal improvement and is called Baseline Process. It comprises levels PSP0 and PSP0.1, which set a guiding line for obtaining data on current processes. These levels intend to give an individual performance boost through the use of metrics and standardized reports. Time, defects and size are all basic metrics for the PSP model. Time and defects metrics are introduced on PSP0 and size on PSP0.1. More metrics are used on the upper levels.

PSP1 and PSP1.1 - The Personal Planning Process

On the second group, the Personal Planning Process, tries do address and motivate the programmer to achieve a better project planning. These levels are focused on helping the programmer in his personal work planning. PSP1 dedicates in establishing ways for a reliable estimate of the size of activities, as well as setting a standard format for the data recollection entries. PSP1.1 comes with a form for tasks planning and another one to accompany the execution of the project. The group main goal is help execute the defined planning. For an early identification of possible setbacks, PSP defines a very detailed step by step execution list so that the programmer can have a more effective control of his part on the project. PSP uses the concept of earned value as metric of the programmers' part in the project.

PSP2 and PSP2.1 - Personal Quality Management

The third group of levels is focused on Personal Quality Management: PSP2 and PSP2.1.These two levels are oriented to the personal Quality management. In level PSP2, code and project reviewing become a part of the programmers' daily processes. Objectives must be set either for reviewing the code or reviewing the project and data must be gathered to assert and evaluate the used process. Project reviewing uses the pre-defined form "Design Review Checklist", and this form orients reviewing Software programming projects and must be modified depending on the software language used.

When reviewing the code, the used form is "Code Review Checklist", in which the programmer must collect data for all the programming languages used.

PSP2.1 helps the programmer reducing the number of defects in the project phase of the Software, improving overall product Quality. To orient the programmer, four templates are used, all based in object oriented programming. The programmer may adapt these models for other types of programming.

PSP3 - Cyclic Personal Process

The top level of PSP, PSP3 Cyclic Personal Process exists with the purpose of scaling bigger projects. It is oriented in helping the programmer deal with more complex and with an increased number of code lines. The approach is to divide the bigger project in sets of smaller projects in which PSP2.1 is applied to each subset. Smaller projects are easier for the programmer to manage, in this operational level. By using this approach, the programmer may in the long run gain the sensitivity to narrow his time expectations, permitting overall more reliable and precise project planning, within time limits and with increased product Quality.

Although this approach is more focused on object oriented programming, the key points and methodologies may be adapted to suit other programming types. Some argue that the main down point for the PSP approach is that is oriented to quantitatively programming (number of code lines produced for programmer a day, like Java or C++), but not well suited for rapid application development (RAD) environments like Lotus Notes/Domino as lines of code are reduced. PSP stresses investing in design time and review time, relative to the actual coding time. It's big on writing down the times spent on these stages, so that you have actual quantities to see and from which to get metrics. And these quantity metrics may be compared.

Overall, the introduction of using quantity metrics may have an effect on productivity, as well to give managers operational time and feedback from the programmers, which on the long run will permit accurate planning and project return value.
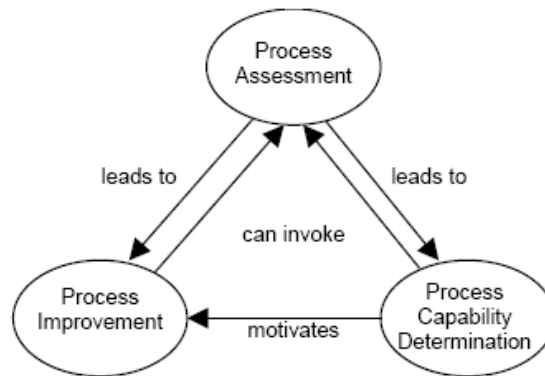
A standard with huge recognition nowadays, which is commonly associated with CMMI is ISO/IEC 15504 (SPICE). It will be presented in the next section.

A.3 ISO/IEC15504 Software Process Improvement and Capability dEtermination (SPICE)

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. ISO/IEC 15504 SPICE (Software Process Improvement and Capability dEtermination) is a framework that provides a structured approach for the assessment of processes. ISO/IEC 15504 consists of the following parts, under the general title Information Technology - Process Assessment:

- Part 1: Concepts and vocabulary [16], provides a general introduction to the concepts of process assessment and a glossary
- Part 2: Performing an assessment [17, 17a], sets out the minimum requirements for performing an assessment that ensure consistency and repeatability of the ratings
- Part 3: Guidance on performing an assessment [18], provides guidance for interpreting the requirements for performing an assessment
- Part 4: Guidance on use for process improvement and process capability determination [19], identifies process assessment as an activity that can be performed either as part of a process improvement initiative or as part of a capability determination approach
- Part 5: An exemplar Process Assessment Model [20], contains an exemplar Process Assessment Model

ISO/IEC 15504 integrates smoothly in the continuous approach made by CMMI-DEV Version 1.2, but proper harmonization work should be considered [17b]. This permits a synchronized process assessment (ISO/IEC 15504) with the CMMI appraisals structure, like SCAMPI. A schematic of process assessment relationship follows in Figure 2.

Source: ISO/IEC 15504 - Part 1 [16]

Figure A.2 - ISO/IEC 15504 Process Assessment Relationship

In Part 2 of ISO/IEC 15504, the measurement framework is detailed on how to perform an assessment. The requirements for the Processes Reference and Assessment Models are set, and finally, the conformity of the process assessment is verified.

Process assessment, as defined in ISO/IEC 15504, is based on a two dimensional model containing a process dimension and a capability dimension. The process dimension is provided by an external Process Reference Model, which defines a set of processes characterized by statements of process purpose and process outcomes. The capability dimension consists of a measurement framework comprising six process capability levels and their associated process attributes [17, Introduction].

As referred, the ISO/IEC 15504 capability dimension and the process capability levels match the continuous representation we have seen in CMMI-DEV [6]. These two dimensions, provided by the Process Reference Model and the Measurement Framework will give origin to the Process Assessment Model, used as reference to the Assessment Process.

The Assessment Process contains at least five specified activities: planning, data collection, data validation, process attribute rating, and reporting. An assessment is carried out by assessing

selected processes (using Process reference models) against the Process Assessment Model chosen for the assessment [16]. Figure A.3 gives a schematic view of ISO/IEC 15504 normative elements.
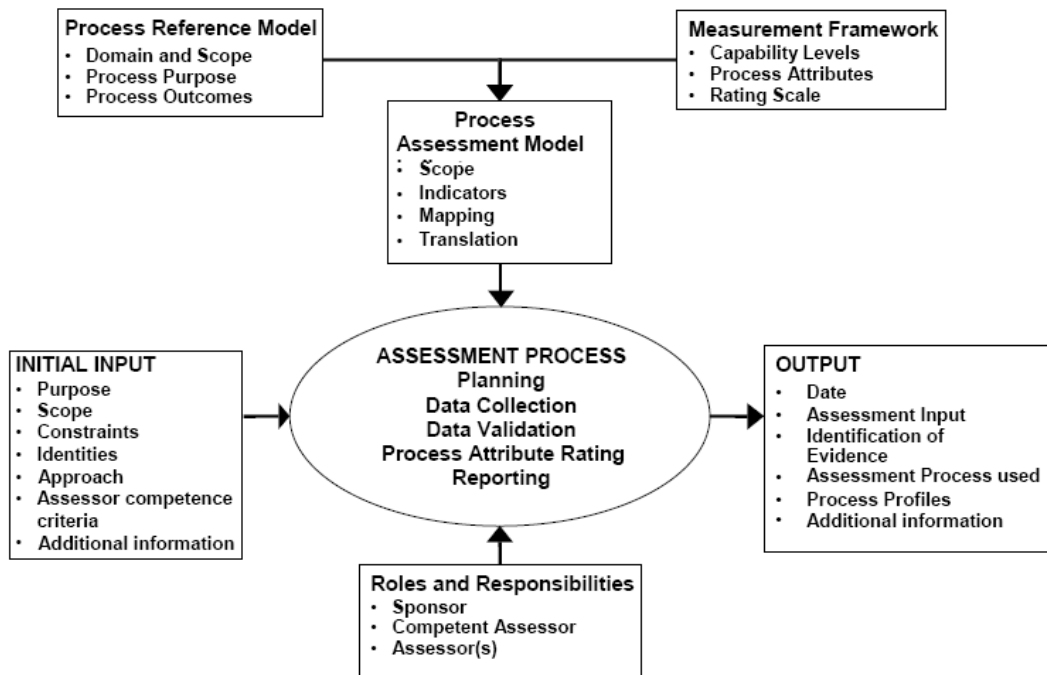
Source: ISO/IEC 15504 - Part 2 [17]

Figure A.3 - ISO/IEC 15504 Normative Elements

The sponsor will have the responsibilities and the authority to make sure that the adequate resources and competencies are made available in order to perform a conformant assessment. The assessment results will normally be used as a basis for developing an improvement plan or determining capability and associated risks as appropriate.

The competent assessor is responsible for ensuring that the assessment achieves its purpose and that it is conformant with the requirements of ISO/IEC 15504 Part 2. It is therefore imperative that the competent assessor selects an appropriate documented assessment process based on the

Process Assessment Model(s). The rating activities are performed solely by the competent assessor and assessors [18].

The initial assessment input must include at a minimum, an assessment purpose; the identity of the sponsor of the assessment and the sponsor's relationship to the organizational unit being assessed; the assessment scope, approach and constraints; a criteria for competence of the assessor who is responsible for the assessment; clear role definitions for the assessment team; and additional information to support process improvements and capability determination [18].

The output information which is pertinent to the assessment and will support understanding of the output assessment shall be compiled and included in the assessment record for retention by the sponsor. The assessment output is intended to support understanding of the assessment results and facilitate activities such as benchmarking and third party verification (ex: by comparing Capability levels).

Each capability level has a set of process attributes that are evaluated and rated when an assessment process is performed and a capability is determined. The higher the level, more processes must be achieved. The set of processes to be evaluated are set in the scope of the assessment. Each process is rated following these values:

- N - Not achieved (0 to 15 % achievement)
- P - Partially achieved (15 % to 50 % achievement)
- L - Largely achieved (50 % to 85 % achievement)
- F - Fully achieved (85 % to 100 % achievement)

Table 2 will give an easy understanding of which processes must be satisfied for each capability level. The key idea is simple. All of the process attributes at lower levels must be rated as "Fully Achieved" while those at the level can be rated as "Largely Achieved" or "Fully Achieved".

Scale	Process Attributes	Rating
Level 0	Process Performance	Partially Achieved
Level 1	Process Performance	Largely or Fully Achieved
Level 2	Process Performance	Fully Achieved
	Performance Management	Largely or Fully Achieved
	Work Product Management	Largely or Fully Achieved
Level 3	Process Performance	Fully Achieved
	Performance Management	Fully Achieved
	Work Product Management	Fully Achieved
	Process Definition	Largely or Fully Achieved
	Process Deployment	Largely or Fully Achieved
Level 4	Process Performance	Fully Achieved
	Performance Management	Fully Achieved
	Work Product Management	Fully Achieved
	Process Definition	Fully Achieved
	Process Deployment	Fully Achieved
	Process Measurement	Largely or Fully Achieved
	Process Control	Largely or Fully Achieved
Level 5	Process Performance	Fully Achieved
	Performance Management	Fully Achieved
	Work Product Management	Fully Achieved
	Process Definition	Fully Achieved
	Process Deployment	Fully Achieved
	Process Measurement	Fully Achieved
	Process Control	Fully Achieved
	Process Innovation	Largely or Fully Achieved
	Process Optimization	Largely or Fully Achieved

Source: ISO/IEC 15504 - Part 3 [18]

Table A.2 - ISO/IEC 15504 Process Attributes ratings for Capability Levels

An assessment process must be exemplarily documented so that all of the comprising activities can be detailed and replicated. Data required for evaluating the processes within the scope of the assessment must be collected in a systematic manner. The strategy and techniques for the selection, collection, analysis of data and justification of the ratings must be explicitly identified and demonstrable by the assessment team. Each process identified in the assessment scope is assessed on the basis of objective evidence [18].

This data collection and detailing will permit an easier data validation and process attribute rating (the activities seen on the Assessment Process), leading to the final Assessment Process activity, the Reporting. The Reporting must document that the assessment was performed according to the requirements, and for each assessor, records to prove their participation should be included. The sponsor approves those records and provides feedback from the assessment as a means to improve the assessment process.

In the following section, another essential and worldwide recognised Framework will be presented, the Information Technology Infrastructure Library (ITIL).

A.4 Information Technology Infrastructure Library (ITIL)

Information Technology Infrastructure Library (ITIL) has been around for 20 years, but interest has only increased in the last six years. ITIL is becoming the next big thing in Information Technology. This section will describe the origin of ITIL, who controls the ITIL contents and what is the key message to learn from this Framework. Throughout this section, it will be important to remember that ITIL describes a framework of processes for the management of IT. Because it is a framework, ITIL does not describe in great detail how any particular process should be implemented.

A.4.1 *ITIL Origins*

ITIL started in the late 1980s when the British Central Computer and Telecommunication Agency (CCTA), now called the Office of Government Commerce (OGC), made a decision that there should be a better way for Information Technology to function. The CCTA commissioned a study group to develop a new approach to managing Information Technology. From this group came Version 1 of ITIL, and was called GITIM, Government Information Technology Infrastructure Management. Version 1 of ITIL was a great deal different from the present-day version. Part of this difference is due to the gradual maturing of ITIL and changes in the Information Technology industry. Between the development of Version 1 and the year 2001, the number of documents (books) used within ITIL grew to more than 32 [21, 22, 23].

In the year 2000, Microsoft used ITIL as the basis for development of their proprietary Microsoft Operations Framework (MOF). The year 2000 also saw the CCTA merge into the Office of Government Commence (OGC). Version 2 of ITIL was initially released in mid 2000. The present day version 2 contains just 10 books, as pieces of a puzzle that complement (and overlap) each other:

- Service Support
- Service Delivery
- Business Perspective (Volumes I & II)
- ICT Infrastructure Management
- Applications Management
- Security Management
- Planning and Implementation
- Software Asset Management
- ITIL - Small Scale Implementation

Two of these books, Service Support and Service Delivery, are the heart of ITIL and the focus of the present drive for ITIL adoption. Only these two books will be detailed in this Dissertation. Service Support covers a set of core processes (Figure A.4), more focused on Customer satisfaction and problem resolutions. They will be detailed in sub-section 1.4.2.
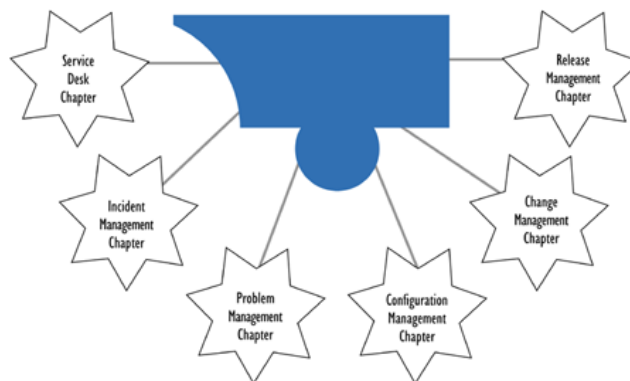
Source: ITIL Service Support Version 2 [21]

Figure A.4 - ITIL Service Support coverage

Service Delivery covers a different array of core processes (Figure A.5), more focused on level of service. These processes will be detailed in sub-section 1.4.3.
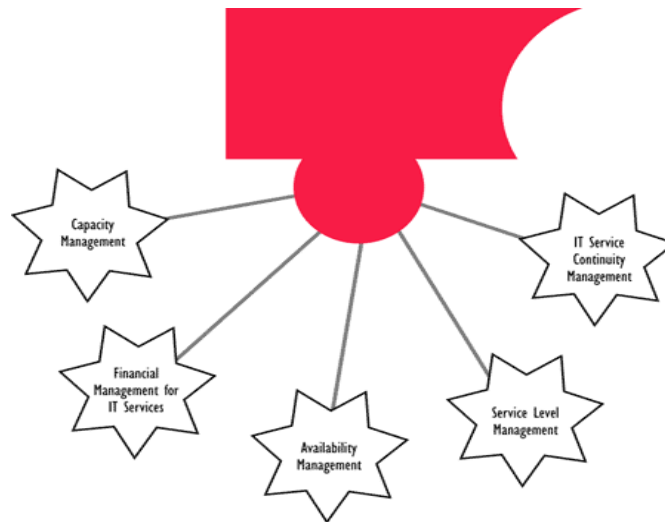
Source: ITIL Service Delivery Version 2 [22]

Figure A.5 - ITIL Service Delivery coverage

A.4.2 *ITIL Service Support*

ITIL Service Support, also known as the blue book, defines a set of core processes to be addressed. Each one of these processes has their specific goal. These processes are centred on the relationships between the IT organisation and their Customers. Service Delivery is partially concerned with setting up agreements and monitoring the targets within these agreements. Meanwhile, on the operational level, the Service Support processes can be viewed as delivering service as laid down in these agreements [22]. This ITIL book addresses the following processes:

- Configuration Management
- Service Desk
- Incident Management
- Problem Management

- Change Management
- Release Management

Service Support refers to the need for Configuration management, Change management, Incident Management, Problem Management and Release Management processes to be integrated. For example, the process of releasing components to the live environment (the domain of Release Management) is also an issue for Configuration Management and Change Management whilst the Service Desk is primarily responsible for liaison between IT providers and the Users of services [21, Chapter 2]. Let us begin with the first Process, Configuration Management.

Configuration Management

Configuration Management intends to provide information on the IT infrastructure to all other processes and IT Management, enabling control of the infrastructure by monitoring and maintaining information on all the resources needed to deliver services, as well as Configuration Items (CIs) status, history and relationships. In ITIL Service Support Version 2 [21], Configuration Management is defined as "The process of identifying and defining Configuration Items in a system, recording and reporting the status of Configuration Items and Requests for Change, and verifying the completeness and correctness of Configuration Items". To accomplish these objectives, a set of tasks must be executed and registered. The essential tasks referred in this process are:

- Identification and naming
- Management information
- Verification
- Control
- Status Accounting

All these tasks permit a well defined Configuration Item and must be registered in a Configuration Management Database (CMDB), a database which contains all relevant details of each Configuration Item (CI) and details of the important relationships between CIs. A Configuration Item is an item needed to deliver a service, uniquely identifiable, that can be subject to change and so it can be managed. A Configuration Item must have a category, defined relationships, a set of attributes and a status.

Service Desk

The Service Desk is the single point of contact between service providers and the users, on a day-to-day basis. It is also a focal point for reporting incidents and making service requests. As such, the Service Desk has an obligation to keep users informed of service events, actions and opportunities that are likely to impact their ability to pursue their day-to-day activities [21]. Service Desk intends to be the primary point of call for all questions, requests, complaints and remarks, as well as restore the service as quickly as possible in order to support business activities.

All incidents (defined as an unexpected disruption to agreed service) life-cycle should be managed by Service Desk by coordinating a resolution and generating all associated incident reports and communications, in order to promote an effective, reusable and permanent resolution. Priority is determined by business impact and urgency. The correct assessment of priorities enables the deployment of manpower and other resources to the best interest of the customer (ex: Escalating an incident up in the management chain or horizontally to a different specialist group).

Incident Management

Incident Management tries to ensure that the best possible levels of service quality and availability are maintained according to Service Level Agreements (SLAs), restoring normal

service as quickly as possible whilst minimizing the adverse impact on business operations. One possible solution is providing a Work-Around, avoiding an Incident or a Problem. Service requests, although not being a failure in the IT infrastructure, are treated as Incidents.

Problems are considered as all the unknown root cause of one or more incidents. Known error is considered as condition that exists after the successful diagnosis of the root cause of a problem when it is confirmed that a Configuration Item (CI) is at fault. If not properly controlled, a change may introduce new incidents, so a way of tracking back is required. It is therefore recommended that the incident records should be held on the same Configuration Management Database (CMDB) as the Problem, Known error and Change records.

The Incident life-cycle has 4 steps:

- Accept service event, register and consult the CMDB
- Classification
- Solve
- Closure

Incident Management implies proactive reporting and daily reviews of individual Incident and Problem status against service levels. Weekly and monthly management reviews should be a standard procedure.

Problem Management

The Problem Management process requires the accurate and comprehensive recording of Incidents (in the CMDB) in order to identify effectively and efficiently the cause of the incidents and trends. Problem Management intends to stabilize IT services by preventing incidents and problems through the removal of the root causes. Problem Management is

dedicated in preventing the recurrence of incidents related to errors and minimizing the consequences derived from those incidents.

Through the inputs present in the Configuration Management Database (Incident details, configuration details and defined workarounds), the desired outputs can be defined and detailed. Requests for change are often. Problem management process updates problem records including workarounds and/or solutions for known errors, integrating those solutions with the Incident Management process, as well as making these solutions available to the Service Desk.

Problem Control makes the identification, classification, assigns resources and investigates in order to establish known errors. The identified errors are controlled and recorded in the CMDB. The error is assessed and a resolution (normally a Request for Change - RfC) is proposed. Reporting is also a key element in Problem Management.

Change Management

Changes arise as a result of Problems, but many Changes can come from proactively seeking business benefits such as reducing costs or improving services [21, Chapter 8.1]. Change Management objective is to implement approved changes efficiently, cost-effectively and with minimal risk to the existing and to the new IT infrastructure. Only approved changes are made, risk and cost minimized.

It is generally accepted that Change Management and Configuration management are best planned and implemented concurrently. Changes undergo a Change Advisory Board (CAB), which is a group of people who can give expert advice to Change Management on the implementation of Changes. This Board is likely to be made up of representatives from all areas within IT and representatives from business units [21].

Change Management is also responsible by Filtering Changes and managing the Change Process and Changes, while chairing the CAB and reviewing management information. The Change Management process has defined 3 categories of impact of Changes, which defines a different approval workflow. The categories are:

- Category 1 - Little impact on current services. The Change Manager is entitled to authorize the Request for Change
- Category 2 - Clear impact on services. The Request for Change must be discussed in the Change Advisory Board. The Change Manager requests advice on authorization and planning
- Category 3 - Significant impact on the services and the business. Considerable manpower and/or resources needed. The Request for Change will have to be submitted to the board level (CAB/EC – Change Advisory Board / Executive Committee)

All changes must have a back out plan always possible and a priority setting defined. The Change Management process has 4 priority levels:

- Urgent - Change necessary now (otherwise severe business impact)
- High - Change needed as soon as possible (potentially damaging)
- Medium - Change will solve irritating errors or missing functionality (can be scheduled)
- Low - Change leads to minor improvements

The Change Management Process has the following steps:

- Request for a Change
- Registration and Classification in the CMDB
- Monitoring and Planning

- Approval (CAB / EC)
- Building & Testing
- Authorize Implementation (CAB / EC)
- Implementation
- Evaluation (PIR - Process Implementation Review)

Changes can be scheduled, following a defined Forward Schedule of Changes (FSC), that contains details of all the Changes approved for implementation and their proposed implementation dates.

Release Management

Release Management takes a holistic view of a Change to an IT service and should ensure that all aspects of a Release, both technical and-non-technical, are considered together [21, Chapter 9.1]. Release Management tries to safeguard all software and related items and ensure that only tested / corrected version of authorized software/hardware is in use. The motto is "Right software and Hardware at the right time and the right place".

In order to accomplish this goal, a set of tasks must be executed. The release policies must be clearly defined and a Definitive Software Library (DSL) and a Definitive Hardware Storage (DHS) created. A Definitive Software Library stores reliable versions of software in a single logical location. However, software may be physically stored at different locations (Ex: Licenses and CDs in a vault). A Definitive Hardware Storage is an area set aside for the secure storage of definitive hardware spares.

Release Management is responsible for the distribution of Software and the associated Configuration Items (CIs), managing and overseeing the build of software releases. Software audits are also under the scope of Release Management process, using the information in the CMDB. Releases are also done under the control of the Change Management process. Release

Management is the only process which creates its own policy. There are several Release Policies:

- Release Unit
- Full / Package / Delta Releases
- Numbering
- Frequency
- Emergency Change

Back out plans should always be considered. The Release Management process is oriented to a more operational Software control and distribution. It works closely with two other processes; Change Management (control perspective) and Configuration Management (control and administration).

A.4.3 *ITIL Service Delivery*

ITIL Service Delivery is also known as the red book. As said before, Service Delivery is partially concerned with setting up agreements and monitoring the targets within these agreements. ITIL Service Delivery intends to integrate a set of processes oriented in the maintenance of agreed levels of service. It comprises 5 core processes:

- Availability Management
- IT Services Continuity Management
- Capacity Management
- IT Financial Management
- Service Level Management

Lets further detail on what each of this processes are focused and how they integrate and complement with each other.

Availability Management

Availability Management is concerned with the design, implementation, measurement and management of IT services to ensure the stated business requirements for availability are consistently met [22, Chapter 2.5]. Availability Management predicts, plans for and manages the availability of services by ensuring that all services are underpinned by sufficient, reliable and properly maintained CIs, and where CIs are not supported internally there are appropriate contractual agreements with third party suppliers to ensure the services. Changes are proposed to prevent future loss of service availability so that IT organizations can be certain of delivering the levels of availability agreed with customers in SLAs.

All aspects of availability are considered and managed in this process (Reliability, Maintainability, Redundancy and Serviceability). Maintainability is considered as Maintenance done internally and Serviceability as Maintenance done by external entities. Availability Information is stored in an Availability Database (ADB). This information is used to create the Availability Plan. SLAs provide an input to this process.

An IT service is considered not available to a customer if the functions that customer requires at a particular location cannot be used although the agreed conditions under which the IT service is supplied are being met. In order to clearly quantify availability of services, the following metrics are used:

- MTTR: Mean Time to Repair (Downtime) - Time period that elapses between the detection of an Incident and it's Restoration. Includes: Incident, Detection, Diagnosis, Repair, Recovery and Restoration

- MTTF: Mean Time To Failure (Uptime) - Time period that elapses between Restoration and a new Incident
- MTBF: Mean Time Between Failures - Time period that elapses between two incidents. (MTTR + MTTF)
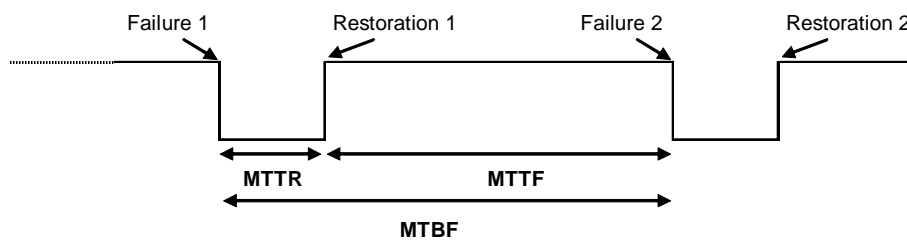
For an easier understanding, Figure A.6 follows.

Figure A.6 - ITIL Availability Metrics

In this manner, levels of availability can be clearly agreed with customers in Service Level Agreements (SLAs).

IT Services Continuity Management

IT Service Continuity Management is concerned with managing an organisation's ability to continue to provide a pre-determined and agreed level of IT Services to support the minimum business requirements following an interruption to the business [22, Chapter 2.4]. Due to increasing Business dependency on IT, IT Service Continuity Management plans ahead in order to reduce costs and time of recovery, adding value to the customer and guaranteeing survival of the Business.

The planning consists mainly in a Business Impact Analysis, analysing Risks through the value of assets, threats and vulnerabilities. Risk Management acts through the use of countermeasures

and planning for potential disasters. Risk Analysis has strong influence on the Computer Risk Analysis and Management Methodology (CRAMM), which is based on the ISO/IEC 17799.

This analysis permits the elaboration of a Contingency Plan, which assists in a fast, controlled recovery. Wide but controlled access to the Contents of the plan should be given, including Administration, Infrastructure and staff. Options of course (including Cold & Hot Start) must be clearly defined and tested regularly, without impacting the live service.

A Cold start or gradual recovery is applicable to organisations that do not need immediate restoration of business processes and can function for a period of up to 72 hours, or longer, without a re-establishment of full IT facilities. This may include the provision of empty accommodation fully equipped with power, environmental controls and local network cabling infrastructure, telecommunications connections, and available in a disaster situation for an organisation to install its own computer equipment.

A Hot Start (or immediate recovery) option provide for the immediate restoration of services following any irrecoverable incident. Hot stand-by typically referred to availability of services within a short timescale such as 2 or 4 hours whereas immediate recovery implies the instant availability of services.

A contingency plan has 7 Sections:

- Administration
- The IT Infrastructure
- IT Infrastructure management & Operating procedures
- Personnel
- Security
- Contingency site
- Return to normal

Every contingency plan should be tested under realistic circumstances and reviewed initially every 6 to 12 months and after each disaster. The action should protect any live services first. Changes to the plan must pass the Change Advisory Board (CAB).

Capacity Management

Capacity Management tries do find the correct balance between the right, cost justifiable, capacity of IT resources such that the Service Levels agreed with the business are achieved at the right time. It comprises three sub-processes [22, Chapter 6.2]:

- Business Capacity Management - The focus of this sub-process is ensuring that the future business requirements for IT Services are considered, planned and implemented in a timely fashion
- Service Capacity Management - The focus of this sub-process is the management of the performance of the live, operational IT Services used by the Customers
- Resource Capacity Management - The focus in this sub-process is the management of the individual components of the IT Infrastructure

Each of the sub-processes carry out many of the same activities, but each sub-process has a very different focus. Business Capacity Management is focused on the current and future business requirements, while Service Capacity Management is focused on the delivery of the existing services that support the business and Resource Capacity Management is focused on the technology that underpins all the service provision [22, Chapter 6.2].

A corporate Capacity Management process ensures that the entire organisation's Capacity requirements are catered for. Success in Capacity Management is dependent on a number of factors [22, Chapter 6.6]:

- Accurate business forecasts

- Knowledge of IT strategy and plans, and that the plans are accurate

- An understanding of current and future technologies

- An ability to demonstrate cost-effectiveness

- Interaction with other effective Service Management processes

- An ability to plan and implement the appropriate IT Capacity to match business needs

These factors are aligned with a set of core management activities, which are:

- Predicting Customer demands of Resources

- Demand Management

- Workload Management

- Performance Management

- Capacity Planning

- Defining Thresholds and Monitoring

Performance Management data populates the Capacity Database (CDB), which contains all metrics and useful information used to create a Capacity Management Plan. Application Sizing estimates the resource requirements to support a proposed application change to ensure that it meets its required service levels. This information is obtained through modelling and simulations:

- Trend Analysis

- Analytical Modelling

- Simulation Modelling

- Baseline Models

Modelling permits to answer the "What If…" questions. Data for Modelling usually comes from the Capacity Database (CDB).

IT Financial Management

IT Financial Management is the sound stewardship of the monetary resources of the organization. It supports the organization in planning and executing its business objectives and requires consistent application throughout the organization to achieve maximum efficiency and minimum conflict [22, Chapter 5.1.2]. Financial Management has 3 main processes:

- Budgeting: The process of predicting and controlling the spending of money within the enterprise and consists of periodic negotiation cycle to set budgets (usually annual) and the day-to-day monitoring of the current budgets. Has key influence on strategic and tactical plans.
- IT Accounting: The set of processes that enable the IT organization to fully account for the way its money is spent (particularly the ability to identify costs by customer, by service, by activity).
- Charging: The set of processes required to bill a customer for the services applied to them. To achieve this requires sound IT Accounting, to a level of detail determined by the requirements of the analysis, billing, and reporting procedures.

Costing is a must in ITIL. There are different costing types, like fixed (unaffected by the level of usage); variable (varying according to the level of usage); direct (usage specific to one service); indirect or overhead (usage not specific to one service); Capital (not diminished by usage) and revenue or running (diminish with usage). Input cost units recommended by ITIL:

- Equipment Cost Units (ECU)
- Organization Cost Units (OCU)
- Transfer Cost Units (TCU)

- Accommodation (buildings) Cost Units (ACU)
- Software Cost Units (SCU)

IT Financial Management must define charging and pricing policies, in close communication with the Financial Department. It can define a No Charging policy (IT treated as support centre); a Notional Charging (IT treated as cost centre) or Actual Charging (money is actually transferred between bank accounts). When charging, a pricing policy must also be defined. A Recovery of Costs policy means IT is treated as a service centre; a Cost Price Plus policy means IT is treated as a profit centre (but with small margins) and Market Prices policy means IT is treated as a profit centre.

Support and Cost centres use "soft charging" in which no money changes hands. Service and profit centres usually use "hard costing" in which money is transferred between bank accounts. Profit centres focus on the value of the IT service to the customer, because since there is a real money exchange, quality of service tends to be evaluated in a more thorough manner by the Customer.

Service Level Management

The goal for Service Level Management (SLM) is to maintain and improve IT Service quality, through a constant cycle of agreeing, monitoring and reporting upon IT Service achievements and instigation of actions to eradicate poor service - in line with business or cost justification. Through these methods, a better relationship between IT and its Customers can be developed [22, Chapter 4.1.2].

A set of tasks must be executed in order to correctly perform a quality Service Level Management. A Service Catalogue should be created. A Service Catalogue should list all of the services being provided, a summary of their characteristics (specification sheet) and details of the Customers and maintainers of each item. Service Level Requirements must be established,

serving as a pro-forma that can be used as a starting point for all Service Level Agreements (SLAs).

Customer Relationship Management should incorporate Service Improvement Programs, so that Service Quality Plans can be specified (following the defined SLAs for that Customer) and monitored, reviewed and reported to management.

Ideally contracts are based on targets in the Service Level Agreement (SLA). Service Level Agreements must set minimum requirements in a clear and concise manner. They should always include defined:

- Period
- Service Description
- Throughput
- Availability
- Response Times
- Signature

Other possible clauses that should be considered when defining a SLA are:

- Contingency arrangements
- Review procedures
- Change procedures
- Support services
- Customer responsibilities
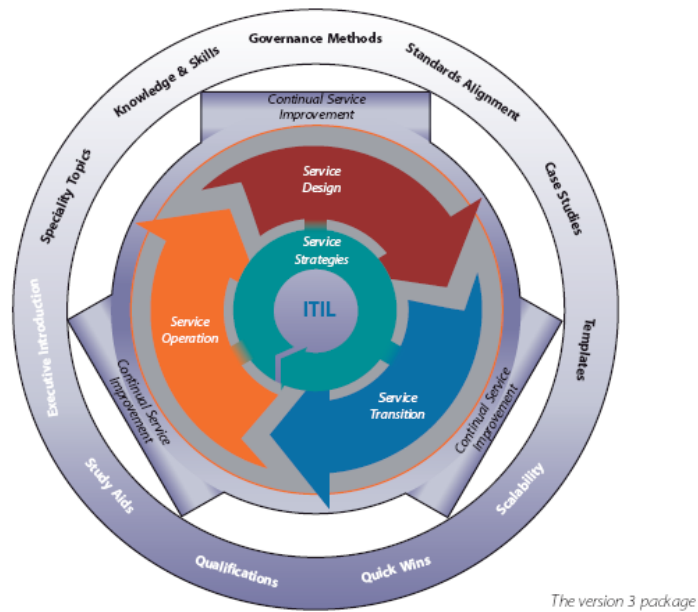- Housekeeping
- Inputs and Outputs
- Changes

As said before, SLAs must be monitored and reviewed regularly in order to monitor if service is being delivered to specification and review if service specification is still appropriate.

A.4.4 *ITIL Evolution*

The current IT Infrastructure Library (ITIL), version 2, was released in 2000. It is a process-based practice of 10 books and the globally accepted best practice framework for ITSMF (IT Service Management Forum). With the expected 2007 ITIL Version 3, ITIL Version 3 becomes a service lifecycle-based practice incorporating the best of V1 and V2 and tested current best practice. Five lifecycle titles will form the core of ITIL practice, instead of Version's 2 two core books, Service Delivery and Service Support [25, 25a, 25b, 25c]:

- Service Strategy
- Service Design
- Service Transition
- Service Operation
- Continual Service Improvement

The Core is supported by an Introduction and Key Element Guides along with multiple topic specific complementary guides and an integrated service lifecycle model including service, organisational, process and technology maps. This part of ITIL Version 3 will be launched in Spring 2007. A schematic approach of the new core books is presented in Figure A.7.

Source: ITIL Refresh News 1st Edition [25]

Figure A.7 - ITIL package Version 3

The UK's Office of Government Commerce (OGC) continues to own the core guidance and the ITIL brand, but they have passed responsibility for stewardship to ITSMF International (IT Service Management Forum), which is a international ITIL user group.

Following the success and recognition of the ITIL framework, a British Standard (BS) was created and aligned with ITIL:

- BS15000-1 (Specification for service management)
- BS15000-2 (Code of practice for service management)

Facing the huge success and recognition of UK's BS15000, the International Organization for Standardization (ISO) has decided to launch in 2005 an international version of BS15000, ISO20000. In order to adequate the British Standard to an international audience, some small

modifications were made regarding the format and structure, consistency of parts 1 and 2, objectives alignment, and terms and text harmonization. ISO 20000 will be presented in the next section.

## A.5 ISO/IEC 20000 Information Technology - Service Management

ISO/IEC 20000 follows the same structure of UK's BS15000. ISO/IEC 20000 Part 1 - Specification, focuses in defining the requirements for a service provider to deliver managed services of an acceptable quality for its customers. ISO/IEC 20000 Part 2 - Code of Practice takes the form of guidance and recommendations.

When defining the requirements to provide a management system, policies and a framework to enable the effective management and implementation of all IT services should be included. Management responsibility, documentation requirements clearly defined, and competence, awareness and training for the staff to perform their role effectively are also required [27].

All of the service management processes within the context of the organization's business and customers' requirements should follow the PDCA (Plan-Do-Check-Act) cycle:

- Plan service management (Plan)
- Implement service management and provide the services (Do)
- Monitoring, measuring and reviewing (Check)
- Continual improvement (Act)

ISO/IEC 20000 follows this approach. Figure A.8 shows a broader picture of the methodology used.
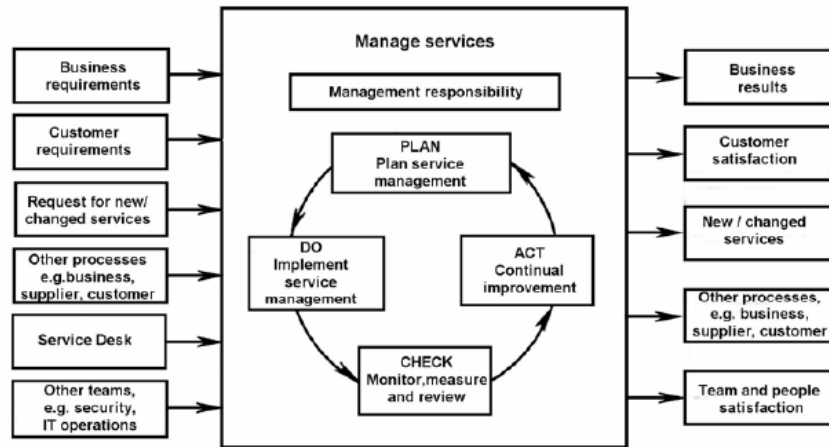
Figure A.8 - ISO/IEC 20000 PDCA's Methodology for service management processes

The inputs shown in Figure A.8 are aligned with the processes we have seen in ITIL Service Delivery and Service Support. The Requests for Change (RfC) shall include adequate funding and resources to make the changes needed. Customer requirements should be clearly defined in Service Level Agreements (SLAs) and business requirements and goals analyzed closely so that a Change Advisory Board (CAB) can authorize a configuration and change management plan.

ISO 20000 describes a mindset of topics and tasks for the main processes [28], like:

- Service delivery processes - focuses in the Service level management (SLM) process and supporting service agreements. Service continuity and availability management/strategy as well as budgeting, accounting and reporting, are all comprised in the service delivery process. Security risk assessment practices, controls and policy are also under the scope of the delivery process.

- Relationship processes - focuses in Business relationship management (like customer satisfaction measurement) and Supplier management, including contract definition, management and dispute management.

- Resolution processes - focuses in primarily defining a background and framing of an incident, defining priorities and workarounds. Incident and Problem management main concerns are tracking and escalation of incidents, keeping records of known errors and performing a clear communication with the customer, while resolving the problem.

- Control processes - focuses in change management (closing and reviewing the Requests for Change - RfC, as well as planning and implementing those changes) and configuration management, with a strong focus in item life-cycle, identification, verification and audit.

- Release process - focus in managing the release policy and roll-out planning, either being a release of acquired software throughout an organization, or in-house developed software, including product documentation, distribution and installation. Post release is also part of the release process.

As we can see, there is a one-to-one relationship with these processes and the core processes described in the ITIL framework. A complementary ISO standard is ISO/IEC 12207, which focuses in product life-cycle, and can perfectly integrate the ISO 20000 Release processes when acquired or in-house developed software are the selected option. Although ISO/IEC 12207 is not exclusively oriented to in-house developed software, the concepts are better understood if this is the case or if at least a development component is present.

A.6 ISO/IEC 12207 Information Technology - Software Life Cycle Processes

ISO/IEC 12207 Information Technology - Software Life Cycle Processes is an international standard focused in the life cycle of software starting in the conceptualization of ideas through retirement, and consists of processes for acquiring and supplying software products and services. In addition, the framework provides for controlling and improving these processes [26].

This international standard describes the architecture of the software life cycle processes but does not specify the details of how to implement or perform the activities and tasks included in the processes. This International Standard groups the activities that may be performed during the life cycle of software into five primary processes, eight supporting processes, and four organizational processes. Each life cycle process is divided into a set of activities; each activity is further divided into a set of tasks [26, Chapter 4].

As said before, the primary life cycle processes consist of five processes that serve primary parties during the life cycle of software:

- Acquisition process, consisting of 5 activities, Initiation; Request-for-Proposal preparation; Contract preparation and update; Supplier monitoring; Acceptance and completion
- Supply process, consisting of 7 activities, Initiation; Preparation of response; Contract; Planning; Execution and control; Review and evaluation; Delivery and completion
- Development process, consisting of 13 activities, Process implementation; System requirements analysis; System architectural design; Software requirements analysis; Software architectural design; Software detailed design; Software coding and

testing; Software integration; Software qualification testing; System integration; System qualification testing; Software installation; Software acceptance support.

- Operation process, consisting of 4 activities, Process implementation; Operational testing; System operation; User support

- Maintenance process, consisting of 6 activities, Process implementation; Problem and modification analysis; Modification implementation; Maintenance review/acceptance; Migration; Software retirement

The activities and tasks in a primary process are the responsibility of the organization initiating and performing those processes. The organization must ensure that the process is in existence and functional. The supporting life cycle processes consist of eight processes. A supporting process supports another process as an integral part with a distinct purpose and contributes to the success and quality of the software project. It consists of:

- Documentation process, consisting of 4 activities, Process implementation; Design and development; Production; Maintenance

- Configuration management process, consisting of 6 activities, Process implementation; Configuration identification; Configuration control; Configuration status accounting; Configuration evaluation; Release management and delivery

- Quality assurance process, consisting of 4 activities; Process implementation; Product assurance; Process assurance; Assurance of quality systems

- Verification process, consisting of 2 activities, Process implementation; Verification

- Validation process, consisting of 2 activities, Process implementation; Verification

- Joint review process, consisting of 3 activities, Process implementation; Project management reviews; Technical reviews

- Audit process, consisting of 2 activities, Process implementation; Audit

- Problem resolution process, consisting of 2 activities, Process implementation; Problem resolution

The organizational life cycle processes consist of four processes. They are employed by an organization to establish and implement an underlying structure made up of associated life cycle processes and personnel and continuously improve the structure and processes.

- Management process, consisting of 5 activities, Initiation and scope definition; Planning; Execution and control; Review and evaluation; Closure
- Infrastructure process, consisting of 3 activities, Process implementation; Establishment of the infrastructure; Maintenance of the infrastructure
- Improvement process, consisting of 3 activities, Process establishment; Process assessment; Process improvement
- Training process, consisting of 3 activities, Process implementation; Training material development; Training plan implementation.

Adding to this core processes with their respective activities, a tailoring process can be performed in order to best suit an organization's software project needs, filtering some of the presented processes and activities. This tailoring process has 4 activities, Identifying project environment; Soliciting inputs; Selecting processes, activities, and tasks; Documenting tailoring decisions and rationale.

The result of the software project can be evaluated through the use of ISO/IEC 9126 Software engineering - Product quality and ISO/IEC 14598 Information technology - Software product evaluation. They will be presented in the next section.

A.7 ISO/IEC 9126-1 Software Engineering - Product Quality / ISO/IEC 14598 Information Technology - Software Product Evaluation → ISO/IEC 25000: SQuaRE

The ISO/IEC 9126-1 Software Engineering - Product Quality and ISO/IEC 14598 Information Technology - Software Product Evaluation are intended for use in conjunction. The ISO/IEC 9126-1 series defines a general purpose quality model, quality characteristics and gives examples of metrics. The ISO/IEC 14598 series gives an overview of software product evaluation processes and provides guidance and requirements for evaluation [33, Chapter 5]. ISO 9126-1 standard is divided into four parts which address, respectively, the following subjects:

- Part 1 Quality model [29]
- Part 2 External Metrics [30]
- Part 3 Internal Metrics [31]
- Part 4 Quality in use metrics [32]

ISO/IEC 14598 is divided in 6 parts, covering the following subjects:

- Part 1 General Overview [33]
- Part 2 Planning and management [34]
- Part 3 Process for developers [35]
- Part 4 Process for acquirers [36]
- Part 5 Process for evaluators [37]
- Part 6 Documentation of evaluation modules [38]

The Quality Model for Internal and External Quality established in the first part of the standard, ISO 9126-1 [29], classifies software quality in a structured set of factors, as follows:

- Functionality - A set of attributes that bear on the existence of a set of functions and their specified properties. The functions are those that satisfy stated or implied needs. The sub-characteristics are:
  - ➢ Suitability
  - ➢ Accuracy
  - ➢ Interoperability
  - ➢ Security

- Reliability - A set of attributes that bear on the capability of software to maintain its level of performance under stated conditions for a stated period of time. The sub-characteristics are:
  - ➢ Maturity
  - ➢ Recoverability
  - ➢ Fault Tolerance

- Usability - A set of attributes that bear on the effort needed for use, and on the individual assessment of such use, by a stated or implied set of users. The sub-characteristics are:
  - ➢ Learnability
  - ➢ Understandability
  - ➢ Operability
  - ➢ Attractiveness

- Efficiency - A set of attributes that bear on the relationship between the level of performance of the software and the amount of resources used, under stated conditions. The sub-characteristics are:
  - ➢ Time Behaviour
  - ➢ Resource Behaviour

- Maintainability - A set of attributes that bear on the effort needed to make specified modifications. The sub-characteristics are:
  - Stability
  - Analysability
  - Changeability
  - Testability

- Portability - A set of attributes that bear on the ability of software to be transferred from one environment to another. The sub-characteristics are:
  - Installability
  - Co-existence
  - Replaceability
  - Adaptability

The sub-characteristic Compliance is not listed above and applies to all characteristics. Each quality sub-characteristic (as adaptability) is further divided into attributes. An attribute is an entity which can be verified or measured in the software product. Attributes are not defined in the standard, as they vary between different software products. The Quality Model for Quality in Use, focus in the user's perception of quality. Quality in Use has 4 main characteristics:

- Effectiveness
- Productivity
- Safety
- Satisfaction

Measuring is normally required at all three levels, as meeting criteria for Internal measures is not usually sufficient to ensure achievement of criteria for External measures, and meeting criteria for External measures of sub-characteristics is not usually sufficient to ensure achieving

criteria for Quality in Use [29, Chapter 7]. ISO/IEC 9126 leaves up to each organization the task of specifying precisely its own model. This may be done, for example, by specifying target values for quality metrics which evaluates the degree of presence of quality attributes.

Internal metrics are those which do not rely on software execution (static measures). External metrics are applicable to running software. And Quality in Use metrics is only available when the final product is used in real conditions. Ideally, the internal quality determines the external quality and this one determines the results of quality in use.
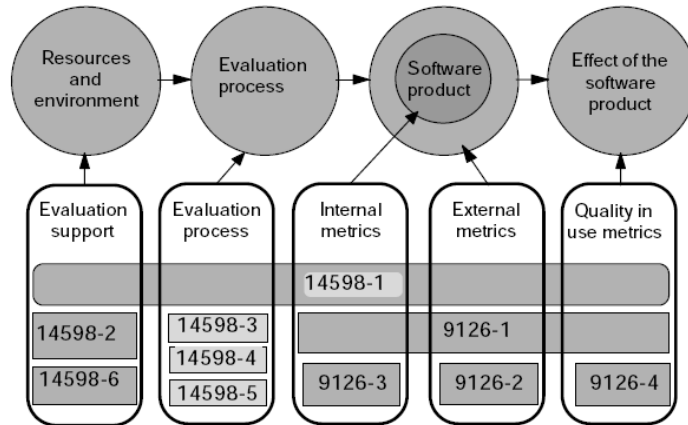
ISO/IEC 14598 Software Product Evaluation series of standards give methods for measurement, assessment and evaluation of software product quality. The evaluation process has 4 main steps:

- Establish evaluation requirements
- Specify the evaluation
- Design the evaluation
- Execute the evaluation

The evaluation requirements should take into account what are the objectives of the evaluation. If the objectives are identifying problems so that they can be rectified; or to compare the quality of a product with alternative products or against predefined requirements (which may include certification).

While establishing the evaluation requirements, the IT manager should select the characteristics and metrics defined in ISO/IEC 9126 for the specific case, in order to decide on the acceptance of the product; decide when to release the product; compare the product with competitive products; select a product from among alternative products; assess both positive and negative effect of a product when it is used or decide when to enhance or replace the appraised product [33, Chapter 7.1.1].

The execution of the evaluation implies taking measures, and the result is values on the scales of the metrics. In the rating step, the measured value is compared with predetermined criteria and a set of rated levels are summarised. The measured results are positioned within the levels and the IT manager must decide if the results are in the acceptable levels or not, and make a managerial decision considering other aspects such as time and cost. A schematic perspective of how ISO/IEC 9126 and ISO/IEC 14598 work together can be seen in Figure A.9.

Source: ISO/IEC 9126-1 Part 1 [29]

Figure A.9 - Relationship between ISO/IEC 9126-1 and ISO/IEC 14598

ISO/IEC 9126 and ISO/IEC 14598 will be overseen by the project SQuaRE (Software Product Quality Requirements and Evaluation), ISO 25000:2005, which follows the same general concepts. There are two important aspects:

- Product aspect
- Process aspect in the field of software quality assurance

SQuaRE focuses on the product side [42].

As important as ISO/IEC 9126 Part 4 - Quality in use metrics is the way Software products interact with each other (different Software products), by not creating security breach in an

Information System. ISO/IEC 27001 Information Technology - Security Techniques - Information Security Management Systems - Requirements and ISO/IEC 17799 Information Technology - Security Techniques - Code of Practice for Information Security Management will be presented in the next section.

A.8 ISO/IEC 27001 Information Technology - Security Techniques - Information Security Management Systems - Requirements / ISO/IEC 17799 Information Technology - Security Techniques - Code of Practice for Information Security Management

ISO/IEC 27001 Information Technology - Security Techniques - Information Security Management Systems - Requirements specifies the requirements for the ISO/IEC 17799 Information Technology - Security Techniques - Code of Practice for Information Security Management, so the correct approach is to use both in conjunction.

ISO/IEC 27001 defines Information Security Management System (ISMS) general requirements, through the definition of guidelines for the establishment and management of the ISMS. While maintaining the ISMS, ISO/IEC 27001 indicates what documentation requirements must be considered, and what control of documents and records should be performed. Management must be committed in all the process, so that the proper provision of resources is supplied [39].

An audit program must be planned, taking into consideration the status and importance of the processes and areas to be audited, as well as the results of previous audits. The audit criteria, scope, frequency and methods are defined based on the requirements defined by ISO/IEC 27001. Management review of the ISMS must consider the information gathered by these audits, in order to ensure that ISMS continual improvement and corrective/preventive actions are performed.

Like other ISOs, ISO/IEC 27001 also follows a PDCA (Plan-Do-Check-Act) methodology. A schematic of the workflow follows.
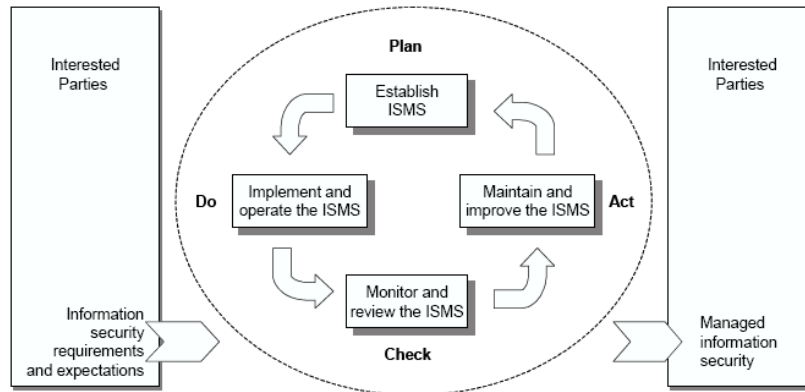
Figure A.10 - ISO/IEC 27001 PDCA Model applied to ISMS Processes

After the requirements are clearly defined by ISO/IEC 27001, ISO's 17799 Code of practice focus in the application of the ISMS. The current standard is a revision of the version published in 2000, which was a word-for-word copy of the British Standard BS 7799-1:1999. The 2005 version of the standard contains the following eleven main sections [40]:

- Security policy, where a information security policy document is defined and reviewed by the management
- Organization of information security, through management commitment and interdepartmental coordination. Information security responsibility allocation and the authorisation process is defined in this section
- Asset management, by performing an Asset inventory of all the important items, and information classification/labelling
- Human resources security, by a thorough screening of the applicants and clearly defined roles, responsibilities and restrictions
- Physical and environmental security, through security perimeters and physical restricted access

- Communications and operations management, through a complete documentation of the procedures and segregation of duties

- Access control, where control rules and rights for each user or group of users are clearly stated

- Information systems acquisition, development and maintenance, where identified requirements of a Information systems acquisition are justified, agreed, and documented

- Information security incident management based in formal event reporting and escalation procedures allowing timely corrective action to be taken

- Business continuity management, ensuring timely resumption of essential operations

- Compliance, focusing in avoiding breaches of any law, statutory, regulatory or contractual obligations, and of any security requirements

Within each section, information security control objectives are specified and a range of controls are outlined that are generally regarded as best practice means of achieving those objectives. For each of the controls, implementation guidance is provided [40].

ISO/IEC 17799:2005 will be renamed to ISO/IEC 27002 in the future. The 27000 series of standards is now reserved for information security matters.

The last section, Compliance, brings us to the following Framework, CobiT - Control Objectives for Information and related Technology, since this Framework is closely aligned with internal control and compliance to audit objectives.

A.9 CobiT - Control Objectives for Information and related Technology

The CobiT framework is "business focused, process-oriented, controls-based and measurement-driven". It provides essentially a set of control objectives, following the principle of providing "the information that the enterprise requires to achieve its objectives, what the enterprise needs to manage, and what control IT resources should be used, through a structured set of processes in order to deliver the required information services" [41, CobiT Framework, page 11].

The information needs to conform to some control criteria, which CobiT refers to as "business requirements for information" [41, CobiT Framework, page 11]. There are seven defined criteria [41, CobiT Framework, page 11]:

- Effectiveness deals with information being relevant and pertinent to the business process as well as being delivered in a timely, correct, consistent and usable manner

- Efficiency concerns the provision of information through the optimal (most productive and economical) use of resources

- Confidentiality concerns the protection of sensitive information from unauthorised disclosure

- Integrity relates to the accuracy and completeness of information as well as to its validity in accordance with business values and expectations

- Availability relates to information being available when required by the business process now and in the future. It also concerns the safeguarding of necessary resources and associated capabilities

- Compliance deals with complying with those laws, regulations and contractual arrangements to which the business process is subject, like, externally imposed business criteria, as well as internal policies

- Reliability relates to the provision of appropriate information for management to operate the entity and exercise its fiduciary and governance responsibilities

These criteria should integrate the IT Processes. To govern IT effectively, it is important to appreciate the activities and risks within IT that need to be managed. CobiT defines IT activities in a generic process model within four domains [41, CobiT Framework, pages 13-14]:

- Plan and Organize, which "[…]covers strategy and tactics, and concerns the identification of the way IT can best contribute to the achievement of the business objectives"
- Acquire and Implement focus on which "[…] IT solutions need to be identified, developed or acquired, as well as implemented and integrated into the business process"
- Deliver and Support focuses with the "[…] actual delivery of required services, which includes service delivery, management of security and continuity, service support for users, management of data and the operational facilities"
- Monitor and Evaluate "[…] addresses performance management, monitoring of internal control, regulatory compliance and providing governance"

These four domains sum up 34 main processes. Processes need controls. Each of CobiT's IT processes has a high-level control objective and a number of detailed control objectives. As a whole, they are the characteristics of a well-managed process. CobiT's control objectives are the "[…] minimum requirements for effective control of each IT process." [41, CobiT Framework, page 14]. The enterprise's system of internal controls impacts IT at three levels [41, CobiT Framework, page 15]:

- Executive management level, where "[…] business objectives are set, policies are established and decisions are made […]"

- Business process level. "Most business processes are automated and integrated with IT application systems, resulting in many of the controls at this level being automated as well. These controls are known as application controls"
- IT service activities. "The controls applied to all IT service activities are known as IT general controls"

General controls are those controls embedded in IT processes and services. Examples include [41, CobiT Framework, page 15]:

- Systems development
- Change management
- Security
- Computer operations

Controls embedded in business process applications are commonly referred to as application controls. Examples include [41, CobiT Framework, page 16]:

- Completeness
- Accuracy
- Validity
- Authorisation
- Segregation of duties

A basic need for every enterprise is to understand the status of its own IT systems and to decide what level of management and control the enterprise should provide. CobiT is a measurement driven framework. CobiT deals with this need of quantification through the use of 0-5 maturity models (as seen in the CMMI [7, 8, 9 and 10] and ISO 15504 SPICE [16, 17, 18, 19 and 20]). Figure A.11 shows a schematic representation of CobiT's maturity models.
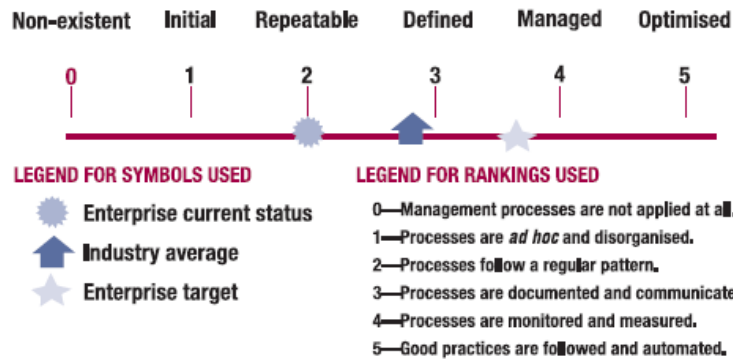
Source: CobiT 4.0 [41, page 18]

Figure A.11 - CobiT's Maturity Models graphic representation

A properly implemented control environment is attained when all three aspects of maturity (capability, performance and control) have been addressed. Improving maturity reduces risk and improves efficiency, leading to fewer errors, more predictable processes and a cost-efficient use of resources. To summarise, IT resources are managed by IT processes to achieve IT goals that respond to the business requirements [41, CobiT Framework, page 20]. This is the basic principle of the CobiT framework, as illustrated by the overall CobiT Framework in Figure A.12.
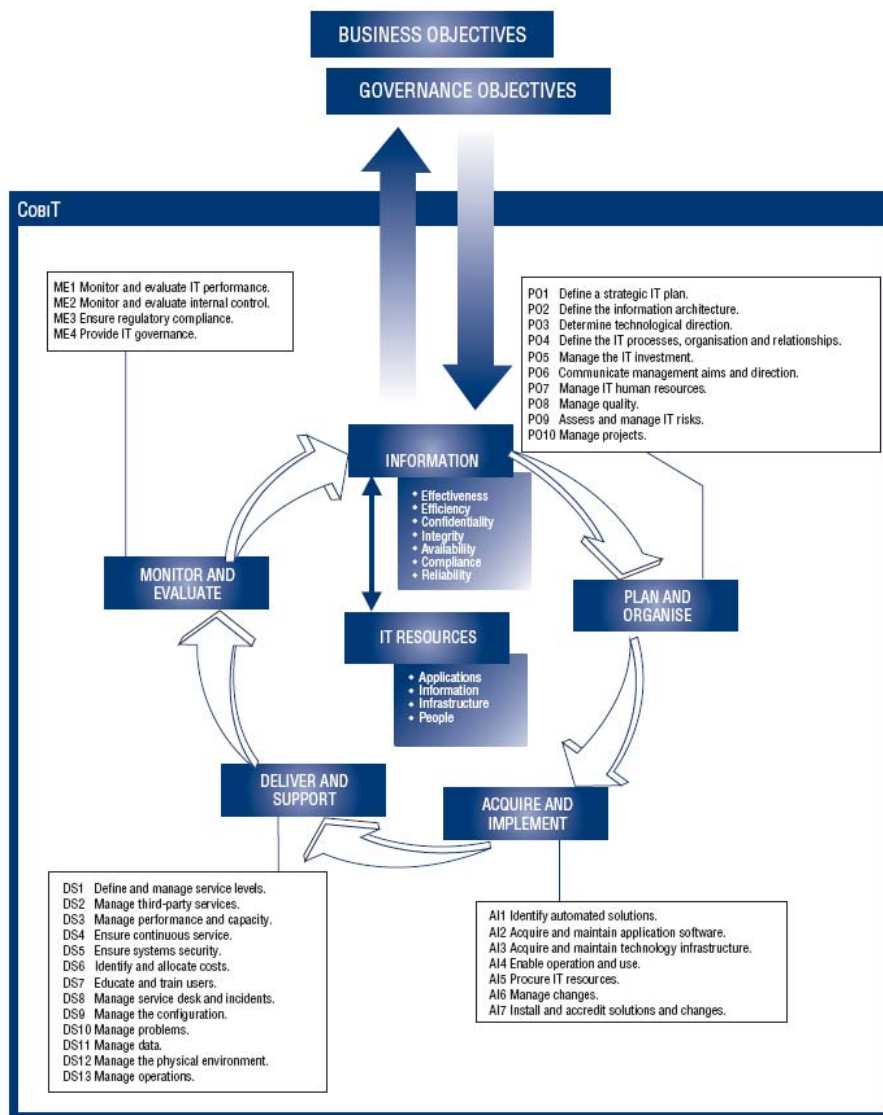
Figure A.12 - Overall CobiT's Framework

Each one of the processes series (ME, PO, AI and DS) shown in Figure A.12 is covered by CobiT in 4 sections, as follows [41, CobiT Framework, page 27]:

- Section 1 contains a process description summarising the process objectives, with the high-level control objective represented in a waterfall
- Section 2 contains the detailed control objectives for the process
- Section 3 contains the process inputs and outputs, RACI chart (RACI - Responsible, Accountable, Consulted and/or Informed), goals and metrics
- Section 4 contains the maturity model for the process

Considering the scope of this dissertation, the detail of each section will not be presented in this chapter. CobiT is usually associated with internal control policies and audit firms, as it is aligned with the 2002's Sarbanes-Oxley act (SOX) from the United States.