A process-driven methodological approach for the design of telecommunications management systems

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Abstract

Until recently, monopolistic network operators considered resolving service and network management from a systems viewpoint. Due to deregulation, the customer becomes central and there is a need to consider management as an activity transversal to all the business units of the company. The issue needs to be considered first from a business viewpoint and only then from a systems viewpoint. Moreover, there is a general need of increasing the quality of IT systems. Therefore, new methods are required for the realization of management solutions.

This paper proposes a methodological approach for the specification, design and implementation of management systems in this renewed telecommunications industry context. The application of the method first identifies and defines the business processes and specifies the information models, which contain data manipulated by these processes. The obtained results are inputs for system design whose outputs are in turn software and hardware entities that make up the management system.

Keywords: TMN, Management processes, Information model, Information Technology

1 Introduction

The design of a management architecture for a public network operator is always an ambitious challenge. The steps that lead to an effective definition of a TMN which combines legacy and new systems are important and the path is not straightforward.

The new situation in telecommunications imposes a drastic evolution of the organization, and of the way networks and services are operated. The needs of increasing productivity and of a better consideration of the customer lead all Telcos to work and think differently. New approaches are required to define the IT systems. In fact, there is a need to move from a system view of TMN to a TMN business view taking into consideration the customer requirements. The keyword is not system, “but business process” that will lead in turn to a system at the implementation step.

Therefore a methodology is required that is able to provide a continuous support for the specification, design and implementation of a TMN in the new telecommunications context.

The problem has several dimensions:

- A functional dimension, i.e., being able to understand and clearly express the requirements identified within the operational processes, which activities to automate, and how and when to automate them.
- A technical dimension that has a strong impact on the quality of the information system. There is a need to clearly and unambiguously specify the necessary applications, the information model and the interfaces to implement. This issue is very important internally in order to plan the evolution of tools, and of course also externally for communicating with suppliers.
- An economic dimension: by clearly identifying the needs, expressing and planning them unambiguously, decisions are taken with better visibility of stakes and risks. Moreover, the standardized description of the activities to automate enables identifying the reusable components.

Information technology and object oriented methodologies [OOD, OMT, Objectory, UML] provide steps, and models and notations at each step to build an application or a system. However, they are far from being complete when dealing with management systems.

Standards organizations are providing many useful inputs but not an integrated solution. ITU-T provides a list of management functions [M.3400] that may be implemented in a management system and information models that represent the resources to be managed [M.3100]. Moreover ITU-T M.3010 defines the TMN functional architecture that represents a management system at an abstract level. These inputs may be considered as important ingredients for building a management system.

The TeleManagement Forum (TMF) with its Operational Map [TOM] identifies management processes at a very high level without defining how to specify them and how to translate them at a system level.

Based on the above results, our proposal consists in defining a methodology that enables building a management system starting from the processes that describe the management activities within the company and ending with the management systems that will implement and run these processes. Care has been taken to reuse as much as possible the work done within the different management working groups of the company (Telecom Argentina) in order to follow an approach which is evolutionary and not revolutionary.

The paper is organized as follows.

The second section explains the context of Telecom Argentina (TA) with regards to TMN. The third section emphasizes the overall view of our proposed methodology for the specification, design and implementation of management systems based on a process oriented approach. The fourth section illustrates the methodology with an example. Finally, conclusions and some issues for future work are discussed in the fifth section.

2 TA TMN context

Telecom Argentina (TA) as a public network operator, is already engaged in all phases of management of its networks and services, with the weight of legacy technologies and systems, but also with the large experience it has acquired through the course of time

and with its trained personal. The common problem is how to achieve the implementation of IT systems that can integrate the new management functions that are needed in a multi-vendor legacy environment.

TA is a POTS operator created in 1990 trough a privatization process of the former public administration ENTEL held by the Argentine government. The previous operator has been divided in various entities, one for POTS service in the northern part of the country (TA, Telecom Argentina), one for the POTS service in the southern part (Telefonica de Argentina), one for the international services (Telintar), etc. Therefore, TA has inherited legacy technologies and legacy systems from Entel.

During the first years of its existence, TA was engaged in building new lines, developing new services and restructuring the company. At that time, the priority was "volume". Currently, the challenge is more "Quality of Service", in terms of rapidity of intervention, of service deployment and restoration, etc. Since the context has changed, the objectives and the tools have to evolve too.

To achieve these goals, the company is engaged in two directions: first develop service and network management solutions starting with the processes of the company, and second restructure the Technical Information System.

The first step in restructuring the TMN of TA was to establish clear and solid bases, i.e., to achieve a Network Element Management Layer which allows building the higher level management systems required for the company. The first problem faced is to perform this task in an already operating network. The objective and the context were not so simple, but already known and basically controlled.

The basis is established on the following concepts:

- Concentration of O&M activities
- Access control management to the equipment
- Deployment of standard solutions, i.e., off-the-shelf platforms, basically from the equipment vendor.
- Open platform for the upper level interface, i.e., interoperable platforms.

Many questions then arose that need to be considered:

- How to analyze and design the future management systems?
- How to plan the evolution of these systems?

Software engineering methods, techniques and tools provide part of the answer. However the main problem is still how to specify the functional needs and how to obtain the management architecture and system from these specifications.

3 The methodology

3.1 Process modeling

Since TA follows a process-driven management approach, and even more in depth for technical activities of maintenance and management, specification work has started with TA's most critical processes in order to reuse as much as possible already obtained results.

The fist step consisted in defining a method and the associated conceptual tools so that most designers could use them therefore leading to uniformity in the produced specifications. The methods should be end-to-end from requirements to implementation.

To build our method, we have first studied the existing results and the documents available from the different international working groups. The first problem faced was the large amount of recommendations and standards already published. All the information tends to be partial, and very general. It does not provide support to start from requirements that lead to the specification of system functionalities.

Faced with all these information sources, the need was a user guide that benefits from already produced information.

The first source was TM Forum. As the objective was to find a path from our (TA) operational processes to an IT architecture we needed to explicitate the relationship between our own mode of operation, Telecommunications Operation MAP (TOM) processes offered by TMF and TMN functions. The first task was to interconnect the data supplied by TOM with the management functions identified by M3400. M.3400 functions were mapped into TOM processes. This provided a first level of structuring of the TOM processes and identified the functional blocks, thus resulting in the necessary framework to carry out step 1 to produce the functional model. M.3400 functions were very important to us since they enabled a standardized translation of the activities of a TA operational process by undergoing a mapping exercise between M3400 and our mode of operation. When a TA process activity didn't have its counterpart in M.3400, additional management functions were prescribed. This enabled defining an appropriate

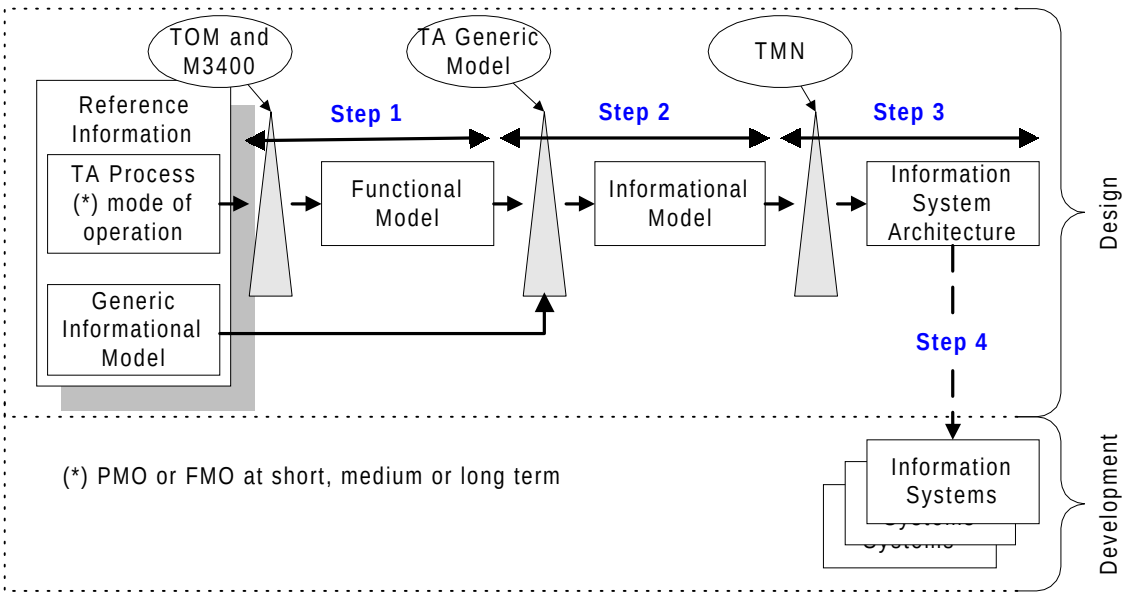

Figure 1: Overall Methodology

filter that translated TA operational processes into TOM processes and into corresponding M.3400 management functions. The result of this **first step** of the methodology is the functional model. Figure 1 shows the overall methodology with the different steps noted 1., 2., 3 and 4.

Table 1. shows a small subset of the mapping table that translated TA processes into TOM processes and TMN functions. Each function is numbered so that they can be

uniquely identified on a process diagram. Note that the example presented below is not complete.

Area [TOM]	TOM Processes	TMN Functions	TA Activities
1. Customer Care Processes	1. Sales	1. Management of sales process	
		2. Service feature definition marketing	
		3. Customer identification	
		4. Customer need identification	
		5. External relations (legal, stockholders, regulators, public relations)	
	2. Order handling	1. Request for service	Service request
		2. Purchase authorization	
		3. Purchase verification	
		4. Service status administration	Information about the designed solution
		5. Directory address determination	
		6. Arrangement of installation with customer	
		7. Security screening	
2. Service Development and Operation Processes	1. Service Planning / Development	1. Customer service planning	
		2. Solution proposal	
		3. Customer service feature definition	
	2. Service Configuration	1. Access route determination	Technical feasibility analysis
		2. Leased circuit route determination	technical feasibility analysis
		3. Priority service restoration	request availability of resources
		4. Capacity assignment	Elaborate the detailed plan of service constriction
		5. Service activation	Transmit work order
		6. Administration of the state of the Service	Configuration of the service; activation of the service

Table 1: Subset of the mapping between TOM processes, TA mode of operation and M.3400 functions.

3.2 Information modeling

The **second step** of the methodology consists in relating the information model of the TA process (i.e., the data manipulated by the process) with a generic network model. This step enables translating the operational process information model into an information which is a specialization of a generic information model.

The following sections explain the necessity and goals of an information model and detail the different rules that were applied to obtain the generic information model for TA.

3.2.1 Necessity and goals of a management information model

The processes identified in the previous step manipulate objects that represent the resources to be managed.

Therefore there is a need of an information model for the representation of all the resources (e.g., networks, services) A methodological approach is required in the definition of this information model that leads to an *unified* management of complex and heterogeneous networks and services.

What's the starting point for the identification of resources to be managed?

ITU-T recommendation G.805 [G.805] provides a widely accepted definition of the *generic* functional architecture of transport networks. With G.805, all generic resources of complex transport networks are identified for advanced configuration management functionality.

The architectural components in G.805 are:

- *Transport or connectivity entities* (Trail, network connection, subnetwork connection and link connection),
- *Topological entities* (Layer network, subnetwork, link, access group),
- *Transport processing entities* (Adaptation function, Trail termination function),
- *Reference points*, these are the inputs and outputs of transport entities (trail termination point, connection termination point).

Control and management interfaces to resources identified in G.805 are created by means of managed objects that act as if they were real resources. Each functional unit has a software module attached to it that acts like an agent for that functionality, and makes the functionality visible in a management system.

The information model is an intelligent organization of managed object behavior. Managed object behavior provides the specific control and management interfaces for the transport function.

3.2.2 Main characteristics of an information model

The main characteristics of an information model are the following:

- It must model **all resources identified in recommendation G.805**. These resources are the common resources found in any telecommunication network.
- It must **structure** the information: An information model should describe the way in which information is structured. Structuring the model leads to a consistent set of entities and relationships (among these entities) that model the problem. Also, the amount of information that must be managed for complex network configurations requires undertaking a structured approach.
- It must be **generic** to model any service, network or network element. In fact many entities in communications and information networks share common characteristics. Genericity enables to maximize commonality and minimize implementation efforts.
- It must be **object oriented** based. Such an approach integrates Informational / Behavioral / Computational aspects of each network resource.
- It must be **implementation independent**.
- It must be capable of modeling both networks and services.

- It must be **exhaustive** in order to handle any configuration.
- It must be **simple and understandable** in order to easily refine and instantiate it for a particular configuration.
- It should be applicable to any management level where decisions may be made.
- It should support the five management functional areas, namely configuration, fault, security, performance and accounting, i.e. it should provide services to these areas.

These objectives lead to the definition of an ***object oriented***, ***generic***, *and* ***structured*** information model that is compliant with standards, in particular ***G.805***. Then, this model must be specialized for the modeling of each specific network or service (transmission, switching, signaling, etc).

In fact, generic models proposed by standardization bodies are dialects that implement the same *G.805 principles*:

- ITU-T *M.3100* [M.3100] is a generic network information model based on G.805 principles that focuses on the *modeling of network elements*.
- ETSI *GOM* [GOM] is a generic network information model based on G.805 concepts that puts emphasis on the *modeling of networks*.
- *OMNIPOINT* [NMF] defined by NMForum is a generic information model that does not apply the G.805 principles. It focuses more on the enterprise or corporate network than the telecommunication network and also emphasizes the services provided by these types of networks.

The generic model for Telecom Argentina is therefore based on G.805, M.3100 GOM, OMNIPOINT and SMFs (Systems Management Functions).
G.805, M.3100 and GOM are used to identify and model resources, while SMFs are used to model services. Among the SMFs of paramount importance, we can find the object management function [X.730], the state management function [X.731], attributes for representing relationships function [X.732], Alarm Reporting Function [X.733], Event Report Management Function [X.734] and Log Control Function [X.735].

The obtained generic model can then be specialized and eventually enriched when applied to a given technology.

3.3 Functional and Information models

With both the functional and information models, which are the first analysis level, it is possible to point out if the current management applications used within the company are appropriate or not. These models enable us to have a clear and structured vision of the necessary information system, which is mandatory for the automation of the process.

By comparing this vision to the current situation, the deviation may be evaluated and then the necessary transitions to reach the target situation may be defined.

The interpretation will be different according to the analyzed process (current process, target process at short, medium or long term). Since the methodology applies to any process, starting with the current process and ending with the target process enables us to guide the evolution of management systems, to plan the development and to come up with a set of actions to improve and optimize the processes.

3.4 Information system modeling

The goal of the **third step** of the methodology is to determine the system architecture by using the standards recommendations and particularly the TMN functional architecture. At TA this step has not yet been fully covered but our short-term objective is to finish it so as to dispose of a permanent guide covering from requirement captures all the way through to implementation.

Furthermore, this phase allows the definition of the general systems architecture, and thus identifies and specifies the projects. The **fourth step** of the method is the economical and technical feasibility study of each proposal, to take the specific decision of how to implement the solution designed before.

4 Case study

In this section, the proposed methodology is applied to a TA service provisioning process.

The work starts with a general description of the process without specifying the specific service to be provisioned. Then including the particularities of the managed services validates the work.

The analysis is sequential, starting with the process and following step by step the sequence of activities and the information flows. Figure 2 shows the mapping of the process onto the TOM model, enriched by the specific management functions used by the process (e.g., 221, 222, 224). It is possible to add on the same graph, the tools/systems currently used to implement the process. This enables to analyze the current implementation state of the process and the degree and quality of automation. The work performed on the detailed process diagrams enables identifying with a high degree of accuracy the managed objects and the information flows, and also detailing the management functions that have been activated; this leads to a complete knowledge of the information system implementation for this process. In the following diagram, the functions numbers (e.g., 221, 222, 224) indicate the entries of the mapping table between TOM and TMN functions that enable describing the activities developed in this part of the service provisioning process. Similarly the current architecture of the technical information System may be described by indicating the used computer systems.

The detailed work is not presented in this paper due to the complexity of the result, which consists of a large amount of information.

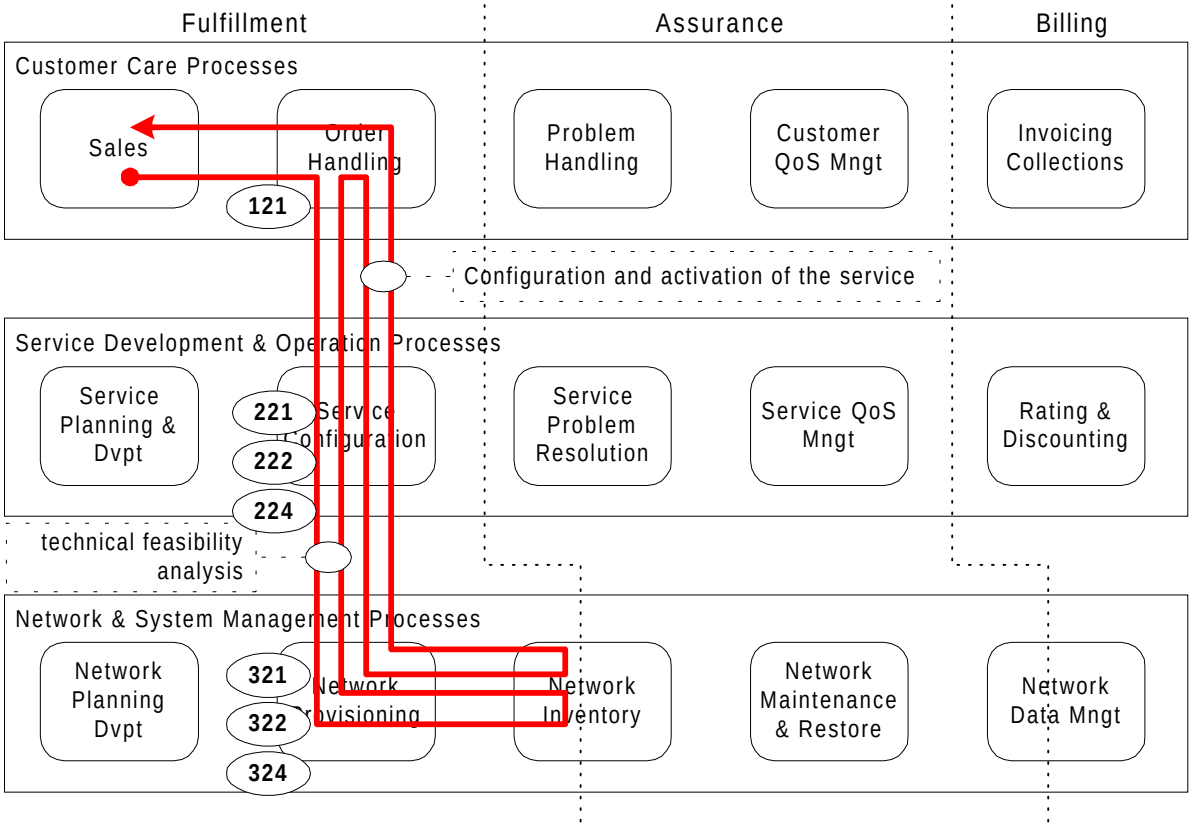

Figure 2: Process diagram for Telecom Argentina Fullfilment Process

An interesting result of this study has been the capability to put in order an important quantity of information conveyed by the process-driven analysis, and to present it in a structured and standardized way.

Two groups have done the work, each handling a specific business unit of the company, but with coordination among these groups. The defined method and filters led to a coherent specification by both groups.

The next step is to apply the proposed method to all major processes and critical services of the company in order to establish an exhaustive mapping between processes and IT information system. For each process there is a need to define its necessary management functions, the process information model and its current automation and implementation state. This first view of the current technical architecture will be used as a starting point for the elaboration of the IT system evolution plan. This elaboration requires the definition of the target architecture. Therefore the same analysis will take place for the target processes, and the transition plans from the current to the target situations will be elaborated. The evaluated plan will enable the directors of the company to make decisions based on a clear vision of the evolutions, priorities and budget.

The objective of improving information quality is reached by clearly and accurately structuring this information. This is required to avoid launching projects not properly defined and specified (“non matured” ideas) properly and therefore subject to drift and overcharge.

The second objective of providing precise specifications to telecommunications suppliers will be reached by using commercial specification tools that support well known software engineering methods such as UML [UML].

5 Conclusion

In this paper, we have presented our proposed methodological approach for the specification, design and implementation of telecommunications management systems. Our main contribution has been to structure all available information from the company and from the management standards (ITU-T, ETSI, TM Forum) to provide a continuous support for building management systems. The outputs of the different steps of our methodology may be directly given as inputs to commercially available tools to produce unambiguous specifications based on standard notations (e.g., UML, GDMO [GDMO], GRM [GRM], etc.). This overall work improves the communication within the company with different groups involved in the process of definition of the IT systems and with decision-makers so as to present to them the systems evolution plan. This improvement applies and externally with suppliers of management systems, specifying unambiguously the precise requirements that should lead to the provision of management systems that are operable, portable, interoperable, scalable and open, and that perfectly match the needs of the Telco. In other words, this work leads to the improvement of the *Quality* of the IT system.

6 Acknowledgement

The authors are grateful to Professor Simon Znaty, from ENST Bretagne, for his pertinent remarks and advice.

References

[G.805] ITU-T Rec. G.805, “Generic functional architecture of transport networks”, 1995.

[GDMO] ITU-T X.722, “Guidelines for the Definition of Managed Objects”, 1993.

[GOM] I-ETS 300-653, Generic managed object class library for the network level view, 1996.

[GRM] ITU-T X.725, “General Relationship Model”, 1995.

[M.3010] ITU-T Rec. M.3010, “Principles for a Telecommunication Management Network”, 1996.

[M.3100] ITU-T Rec. M.3100, “Generic Network Information Model”, 1995

[M.3400] ITU-T Rec. M.3400, “TMN Management Functions”, 1997.

[NMF] NMForum. "Discovering OMNIPoint", Prentice Hall, 1993.

[TOM] TeleManagement Forum, “TeleManagement Operational Map”, 1998.

[UML] G. Booch, J. Rumbaugh, I. Jacobson, “The Unified Modeling Language User Guide”, Addison-Wesley, 1998.

[X.730] ITU-T Rec. X.730, “Object Management Function”, 1993.

[X.731] ITU-T Rec. X.731, “State Management Function”, 1993.

[X.732] ITU-T Rec. X.732, “Attributes for representing relationships Function”, 1993.

[X.733] ITU-T Rec. X.733, “Alarm Reporting Function”, 1993.

[X.734] ITU-T Rec. X.734, “Event Report Management Function”, 1993.

[X.735] ITU-T Rec. X.735, “Log Control Function”, 93.