Network Management Detailed Operations Map

GB908

Evaluation Version 1.0 *March 1999*

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This document was developed by TeleManagement Forum in order to help service and network providers communicate their needs for industry agreements to support process automation. It is intended for use by the members of TM Forum and other organizations that TM Forum believes can help achieve its members' goal of automated service and network management. It serves as one of the starting points for TM Forum work programs directed at solving specific process automation problems. Additional supporting, detailed documentation will be added to this document, as it becomes available. Direct inquiries to the TM Forum office:

1201 Mt. Kemble Avenue
Morristown, NJ 07960 USA
Tel No. +1 973 425 1900
Fax No. +1 973 425 1515

TM Forum Web Page www.tmforum.org

Document Life Cycle

The Network Management Detailed Operations Map is being issued as Evaluation Version 1.0. The TeleManagement Forum ("TM Forum") expects to update it to reflect comments from implementation experience, as well as to reflect additional member comment and public comment. The Network Management Detailed Operations Map is a companion document to the TM Forum Telecom Operations Map.

The purpose of an Evaluation Version is to encourage input based on experiences of members and the public as they begin to use the document. Following the Evaluation Period, documents that are seen to deliver value are candidates for formal approval by the TM Forum. All documents approved by the TM Forum (as well as those previously approved by NMF) undergo a formal review and approval process.

This document will continue under formal change control. Supporting work will be added to this document or issued as further companion documents to the TM Forum Telecom Operations Map. A document of this type is a "living document," capturing and communicating current knowledge and practices. Further inputs will be made because of detailed work ongoing in the TM Forum and the industry.

Individuals or companies who are not members of the TM Forum are encouraged to provide comments on this document. However, in order for their comments to be considered, a signed waiver must be on file with TM Forum pertaining to intellectual property rights. To obtain this form, please contact the TM Forum.

Document History

Version	Date	Purpose
Version 0.1	1/97	Initial draft for input to Miami meeting
Version 0.2	4/97	Updated draft for input to Long Beach meeting
Version 0.3a	5/97	Abbreviated draft for Telecom Operations Map team comment
Version 0.4	6/97	Draft reflecting initial Telecom Operations Map team input
Version 0.4b	7/97	Input to Paris meeting
Version 0.4c	9/97	Incorporating Paris action input
Version 0.4d	9/97	Incorporating UK discussion
Version 0.5	9/97	Incorporating comments on sections 1-3, updates to all other
Version 0.6	10/97	Incorporating updates from the London meeting
Version 0.7e	11/97	Interim update from the Montreal meeting

Version 0.7f	11/97	Incorporating informal comment round with members
Version 0.7	11/97	Version for formal comment by NMF members
Version 0.8	2/98	Post Miami comment resolutions applied
Version 0.9	3/98	Update for consistency with the high-level TOM and draft available to members
Evaluation Version 1.0	3/99	Updated for validation of input/output diagrams, reformatting and editing. Evaluation Version 1.0 released to public for comment

Time Stamp

This document can be considered valid until December 31, 1999, at which time it may be superceded with a final approved version or extended in its current form.

Acknowledgments

To create a document such as this requires two types of people: those willing to describe how they do business (or would like to do business in the future) and those willing to ask the questions and document the results. Special thanks to the following Service Providers and Network Operators who shared their views on "what it means to deliver services through integrated management systems:"

Some of the Operators interviewed:

- Mark Adams, Graham Dye and Bob Belcher of Mercury
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In addition, the following team of people devoted most of a spring and summer to conduct interviews, to evaluate and document the results and to provide additional input:

Contributors

- Menno van den Burg, PTT Telecom, Netherlands
- Mike Kelly, Nortel, UK
- Anne Bennett, CrossKeys, Canada
- Lucia Marchisio, CSELT, Italy
- David Milham, BT, UK
- Salah Aidarous, NEC, USA
- Masayoshi Ejiri, Fujitsu, Japan
- Paul Foster, CiTR Pty Ltd, Australia

- Madhoo Soodan, BT, UK
- Peter Huckett, TTC, UK
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Bruce Murrill, TM Forum Project Leader

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TeleManagement Forum

References

1. A Service Management Business Process Model, NMF, GB901, 1995
2. SMART TMN™ Telecom Operations Map, NMF, GB910, Evaluation Version 1.0, October 1998
3. SMART TMN™ Technology Integration Map, NMF, GB909, Issue 1, April, 1998
4. ITU-T TMN Recommendation M.3400 (TMN Management Functions, ITU-T, 4/97), M.3010 (Principles for a telecommunication management network, ITU-T), M.3200 (TMN Management Services, ITU-T, 1996) and Related Recommendations
5. Bellcore GR-2869, Generic Requirements for Operations Based Telecommunications Management Network (TMN) Architecture

Table of Contents

Table of Figures

Preface

TeleManagement Forum recognized the need to provide a framework to achieve automated flow-through between service management and the network element. The Network Management Detailed Operations Map (NM Detailed Operations Map) is the result of a 1997 TeleManagement Forum initiative to build upon previous work by identifying and describing network management processes and the interfaces with service management processes. This document and its input to the Telecom Operations Map extends the Telecom Operations Map blueprint to include the network management processes layer.

For Service Providers, the NM Detailed Operations Map expands the politically neutral reference point provided in the Telecom Operations Map. This view is important as they consider internal process reengineering needs, partnerships, alliances, and general working agreements with other providers. For suppliers, it outlines potential boundaries of software components, and the required functions, inputs, and outputs that must be supported by products.

The NM Detailed Operations Map consists of:

- Description of the business drivers, simple business relationships reference model and a quick overview of the Telecom Operations Map framework.
- Description of network management processes, functions, relationships, and a view of the high level process and triggers.
- Discussion of issues related to deployment of these capabilities, including considerations for procurement.
- High level review of process automation needs.
- Common glossary of terms and identification of relevant reference materials.
- Detailed information of the principles and procedures for delivering the required capabilities.
- Analysis of partitioning between generic network management and sub-network management capabilities.

Expectations for Future Additions

The Network Management Detailed Operations Map is a living document and member expectations for continued development of the map are high. Expectations for 1999 updates to the Network Management Detailed Operations Map document or separately issued documents include:

- Updates for stronger consistency between the Telecom Operations Map and the Network Management Detailed Operations Map, including update of input/output diagrams.
- Definition of unique needs or specific considerations for varying technologies, e.g., IP Services, Mobile/Wireless.
- Assessment and update for comments from members and wider industry.
- Assessment and update for changes indicated by lessons learned as a result of Catalyst and Fast Track implementation experience.

TeleManagement Forum

The TeleManagement Forum is an international non-profit organization serving the communications industry. Its mission is to help service providers and network operators automate their business processes in a cost- and time-effective way. Specifically, the work of the TM Forum includes:

- establishing operational guidance on the shape of business processes
- agreeing on information that needs to flow from one function to another
- identifying a realistic systems environment to support the interconnection of operational support systems
- enabling the development of a market and real products for automating telecom operations processes

TM Forum makes use of international and regional standards when available, and provides input to standards bodies whenever new technical work is done.

The members of TM Forum include service providers, network operators and suppliers of equipment and software to the communications industry. With that combination of buyers and suppliers of operational support systems, TM Forum is able to achieve results in a pragmatic way that leads to product offerings (from member companies) as well as paper specifications.

TM Forum Approach Defined

The TM Forum approach is a holistic, business-driven approach to achieving OSS integration by building on the TMN model (the Telecommunications Management Network model produced by ITU-T). The goal of TM Forum is to make it possible for service providers and operators to provide services efficiently, using Commercial Off-the-Shelf (COTS) software as much as possible – to become 'Smooth Operators' in the best sense of the word.

To that end, TM Forum provides investment direction as well as development specifications needed to produce management systems. It addresses the problem of business process automation and OSS integration in a holistic and pragmatic way. Specifically, TM Forum brings three essential elements to bear on the TMN layered model:

A business process-driven approach. The TM Forum approach starts from the premise that Service Provider and Network Operators need to automate their business processes, which means information needs to flow from end-to-end across many different systems. Only when a process is understood and the linkages are clear is it possible to apply standards in a way that delivers business value.

Technology-independent agreements. Business agreements about what information will flow between and within processes must be kept independent of the protocols used to implement those agreements. The approach documents all agreements in technology-neutral form, so that the same agreement can be implemented in multiple technologies as they continue to evolve.

Products, not just paper. A main premise of is that paper standards are not sufficient to solve business problems. Products, not paper, are the end goal, provided documentation is produced to support the replications of industry agreements across multiple vendors' products.

Components of the TM Forum Approach

In order to address all three of these principles, the TM Forum approach consists of multiple components as shown in Figure P.1:

High-level direction – a sense of 'which way is west' to enable service providers and suppliers to make basic investment decisions about their business processes and technology choices. This direction takes the form of the **Telecom Operations Map** and companion documents, like the Network Management Detailed Operations Map, as well as the **Technology Integration Map.**

Specific agreements – precise requirements and the specifications of what information is to be exchanged between any two processes or systems, provided in technology-neutral form and accessible through the **Central Information Facility**. In addition, specifications for technology integration points are provided.

Catalyst projects – an environment in which to promote the integration of existing products, and to gain development experience to test the precepts of the 'Maps' and the viability of specific information agreements.

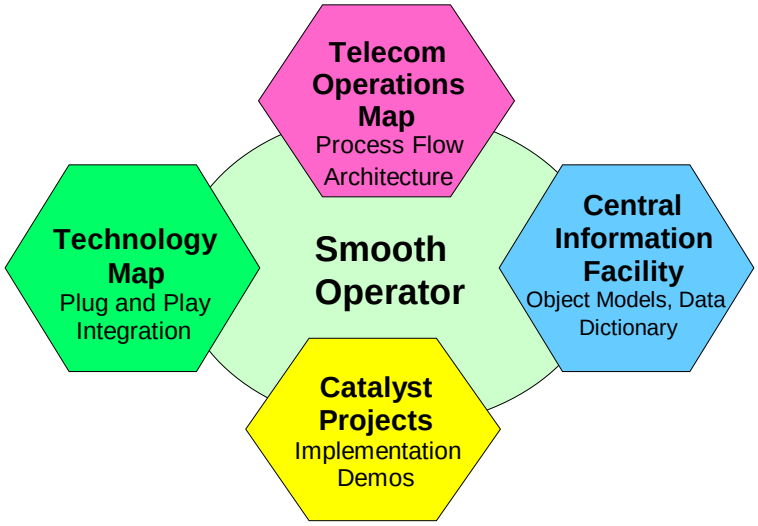

Figure P.1: TM Forum approach to OSS Integration

For more information on the components, see the Telecom Operations Map, other TM Forum documentation available on the TM Forum Web site.

Chapter 1 – Document Objectives

Objectives of this document

Service Providers faced with ever increasing competition continue to see the value of well-automated operation processes. They are struggling to move from a manual-intensive, inconsistent, inflexible environment to one that provides significant improvement in service quality, cost and time to market. They also see the need to do business electronically with trading partners, suppliers, wholesale and retail customers.

The leading focus of the TeleManagement Forum's mission is to enable end-to-end process automation of communications services operations processes. The Network Management Detailed Operations Map, as a companion document to the Telecom Operations Map, adds to the framework for accomplishing this mission.

The TM Forum Network Management Program team produced this document initially as a consensus tool for discussion and agreement with Service Providers and Network Operators. The outcome of those discussions enabled revision and update of early drafts to reflect the common view of a number of organizations. The focus of the Telecom Operations Map document, and its companion documents, are on the business processes used by Service Providers, the linkages between these processes, the identification of interfaces, and the use of customer, network or service information by multiple processes. The objectives of the NM Detailed Operations Map are to continue the progress made in establishing:

- An 'industry owned' common business process model
- The definition of the industry view of the processes and functions needed to effectively carry out Network Management, within a broader service delivery environment
- Agreement on the basic information required to perform each function.
- An industry vision, to suppliers of Network Management systems and software, of the environment within which their products will need to operate and interoperate
- Enabling focused work to be carried out in TM Forum teams to define detailed agreement of information (process) flows, agreements, implementations and products

- Relating business needs to available or required standards

The result is that products designed within this framework enable service providers and network operators to procure network management solutions that automate and integrate better into their environment. This will enable the cost benefits of management automation and process harmonization. Furthermore, a common industry view on processes and data will facilitate operator-to-operator and operator-to-supplier process flow-through, which is essential for rapid service provisioning and problem handling in a competitive global environment.

Define Common Terminology

This document also provides the definition of common terms concerning communications services processes and the functions performed within each process. Common terminology makes it easier for Service Providers to negotiate with customers, 3rd party suppliers and other Service Providers.

Consensus Tool

The TM Forum produced this document initially as a consensus tool for discussion and agreement among Service Providers and Network Operators. Its broad consensus of support continues to grow. The map enables:

- Focused work to be carried out in TM Forum teams to define detailed business requirements, information agreements (exchanges between applications or systems) and to review those outputs for consistency
- Relating business needs to available or required standards
- Equipment suppliers, applications builders and integrators to build management systems by combining 3rd party and in-house developments

The anticipated result is that the products purchased by Service Providers and Network Operators for operational management of their networks and services will integrate better into their environment, enabling the cost benefits of end-to-end automation. Furthermore, a common industry view on processes and data will facilitate operator-to-operator and operator-to-supplier process interconnection, which is essential for rapid service provisioning and problem handling in a competitive global environment.

Using This Document

The document is not intended to be prescriptive about how the tasks are carried out; how a Provider or Operator is organized; or how the tasks are identified in any one organization. This document is not intended to be a specification.

Rather, it is a snapshot of industry views, which will progress with time and with further understanding and analysis. It is not intended to be too detailed, more a directional statement for the industry that can be enhanced. Thus, it cannot be the subject of supplier conformance statements. It is expected to be the starting point of detailed work that will lead to an integrated set of specifications that will provide real benefit to both suppliers and procurers in enhancing industry capability.

The purpose of this document is to continue to set a vision for the communications services industry for competing successfully through the implementation of process driven approaches to operations management. This includes ensuring good linkage among all vital operations support systems concerned with service delivery.

Intended Audience

The Network Management Detailed Operations Map aims at a wide audience of communications services specialists. Primarily, it is aimed at decision makers who need to know and input to the common business process model used to enable communications operations automation in a cost efficient way. The document or model supports, and is consistent with, many efforts underway in the industry supporting this automation goal.

For experienced communications professionals the NM Detailed Operations Map proves to be intuitive -- a strong, common model of communications operations processes.

The NM Detailed Operations Map is also aimed at designers and integrators of operational management systems software and equipment suppliers, who benefit from understanding how management processes and applications need to work together to deliver business benefit to Service Providers.

Furthermore, it continues to give providers and suppliers a common model for discussing complex business needs. This is becoming more necessary as operators move from developing their own operations systems software, to a more procurement and systems integration approach. This move away from developing internally is to react to market forces that are driving down systems and operational costs and time to market for new services.

The document should interest Service and Network Provider business process re-engineering, operations, and procurement staffs for:

- Understanding the common business process model being used to drive automation
- Getting involved in providing inputs, priorities and requirements

It should also be of keen interest to suppliers of management applications, management systems, and networking equipment, who need to understand the deployment environment for their products and solutions.

Relationship to Standardization Activities

Much of the management infrastructure upon which systems will be built is expected to be based on standard interfaces. Relating business needs to available, or necessary standards is a primary goal of the TM Forum in promoting a standards-based approach to communications management. Where applicable, the TM Forum uses industry standards in its work to promote the acceptance of standards and to minimize redundant work. People active in management standardization (in the broadest sense) will find the document useful in setting a top down, customer centric context of how management specifications need to work together.

This document uses, as its guiding principle, the TM Forum Telecom Operations Map (Reference 2). Use is made of terms and concepts from other documents, especially ITU-T M.3400 (Reference 4) and the related Bellcore GR-2869 (Reference 5).

Terms and Definitions

Customer

In this document, the term Customer refers to the recipient of one or more services from one or more Service Providers.

Service Provider

In this document, the term Service Provider refers to companies who provide communications services as a business. Service Providers may operate networks, or they may simply integrate the services of Other Providers (who operate networks) in order to deliver a total service to their customers.

Providing communications services to any one end-customer may involve multiple Service Providers, where one provider may "sub-contract" with Other Providers to fulfill the customer's needs. When necessary to account for this relationship, the term Service Provider is used in this document to describe the company responsible to provide service to an end-customer. The term Other

Provider is used to denote companies which have a sub-contractual responsibility.

Network Operator

In this document, the term Network Operator refers to an organization that operates a communications infrastructure. A Network Operator may also be a Service Provider.

Supplier

In this document, the term Supplier refers to an individual or organization that provides operations and/or network products and services to a Service Provider or Network Operator. These products could include communications equipment, computing platforms, or management applications software.

End-to-End Process Flow

TM Forum uses the term 'end-to-end process flow' to include all processes and functions (shown in layers on the process map), and the sequence of all activities required to accomplish a task from initial inputs to required outputs. TM Forum uses flow-through to mean automation across an interface or set of interfaces.

For term and acronym definitions not explained within this document, please refer to the TeleManagement Forum Glossary. The TeleManagement Forum Glossary can be found through the TM Forum web site.

Chapter 2 – The TMN Model

The telecommunications industry has embraced the Telecommunications Management Network (TMN) model as a way to think logically about how the business of a service provider is managed. The TMN model consists of four layers, usually arranged in a triangle or pyramid, with business management at the apex, service management the second layer, network management the third layer, and element management at the bottom. The idea is that management decisions at each layer are different but interrelated. For example, detailed information is needed to keep a switch operating (at the element management layer), but only a subset of that information is needed to keep the network operating (e.g. is the switch operating at full capacity). Working from the top down, each layer imposes requirements on the layer below. Working from the bottom up, each layer provides a capability to the layer above.

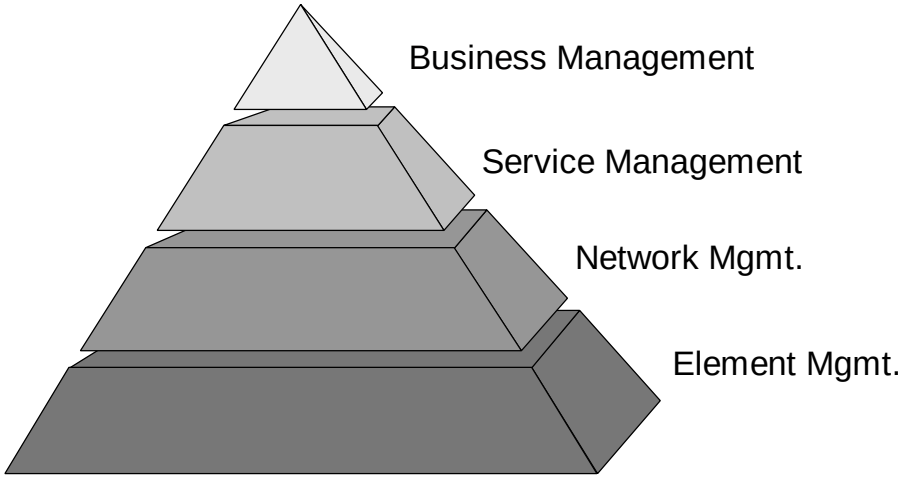

Figure 2.1: Basic TMN Model

The TMN model is simple, although its implementation is complex. The sheer number of standards now available that address the various interfaces between management systems sometimes makes it difficult to see and appreciate the big picture. These ITU-T standards are mainly concentrated in the element management and network management layers. They have been developed from the bottom up, making it difficult to apply the standards as part of a business case. It is also difficult to have a customer centric focus.

Chapter 3 – Business Drivers

The Business Challenge

The communications services industry is rapidly changing with new rules, new competitors, new customers, and unprecedented demands. Service Providers worldwide all face similar challenges, risks, and struggles to remain profitable in the face of more competition, falling market share, and price pressures. As the Providers face these challenges, their suppliers must find innovative ways to deliver value or they may also go out of business.

The Importance of Service

The core of a communications services provider is service. The key objectives are 'more for less' -- faster service introduction, improved quality of service at a lower cost. These objectives can only be achieved through automation of customer care and operational support processes, and a strong automated linkage between the management of customer service offerings and the underlying networking assets. Both the level of customer service provided and the level of automation in the current environment of almost all Service Providers is much lower than expectation and lower than what providers need to remain competitive. Many Service Providers are now actively engaged in re-engineering their business processes for maximum efficiency and effectiveness.

Some Service Providers also choose to operate their own network infrastructure, while others choose to outsource this segment of their business. The effective exploitation of this network infrastructure, whether directly operated or outsourced, is an integral part of the service delivery chain and directly influences the service quality and cost perceived by the end customer.

The processes for the management of this network infrastructure are the focus of this document.

Linking Objectives and Requirements

Making a link between communications business objectives and the requirements typically stated for operational management systems is a challenge. Systematic process models are an essential source of solutions to

this challenge. They can be used to positively influence a service provider's organization in many ways such as:

- Simplifying internal communications and communications with suppliers or other outside parties
- Revealing the way the organization performs, particularly from a customer point of view
- Identifying process and functional interfaces, particularly all points of contact of the process and its customers
- Identifying control points and critical performance metrics
- Targeting productivity and quality improvements
- Providing a framework to assess automation opportunities
- Allowing less experienced staff to be quickly effective, and so on.

Operational management systems and 3rd party applications, becoming available in the market place today, are maturing in terms of their ability to support these business process models and needs.

Business Process Models

The use of systematic business process models makes it easier to evaluate and improve the processes themselves. Employing business process modeling techniques contributes to the goals and profitability of Service Providers. Using the same modeling techniques for business development and information system development brings noticeable efficiency improvements and removes barriers within those organizations and across cooperative, inter-organizational projects.

Service Providers that use systematic business process modeling to manage and improve their businesses have a much greater chance of success in today's marketplace.

Chapter 4 - Business Relationship Reference Model and Telecom Operations Map

Business Relationship Reference Model

The relevant business relationships for this simple Business Reference Model in Figure 4.1 are between:

- Service Providers
- Service Customers and Service Providers
- Service Providers and their Suppliers

Service Providers face very different regulatory pressures and their approaches to competitive threats will continue to be quite distinct. In general, Service Providers share three characteristics. Service Providers are:

- heavily dependent upon effective management of information and communications networks to stay competitive
- adopting a service oriented approach to the way they run their business and their networks
- automating their service and network management processes, sometimes undertaking a complete re-engineering of the way they do business.

Standardizing Process Interfaces

The Business Reference Model shown in Figure 4.1 illustrates the principal points of contact between Service Providers, their customers, and their suppliers. A wide range of automation opportunities exists among the business roles and relationships shown. Each has a specific business objective dictating the level and type of management information exchanged, the robustness required of the management interface, and the priority with which industry agreements are pursued in the area concerned.

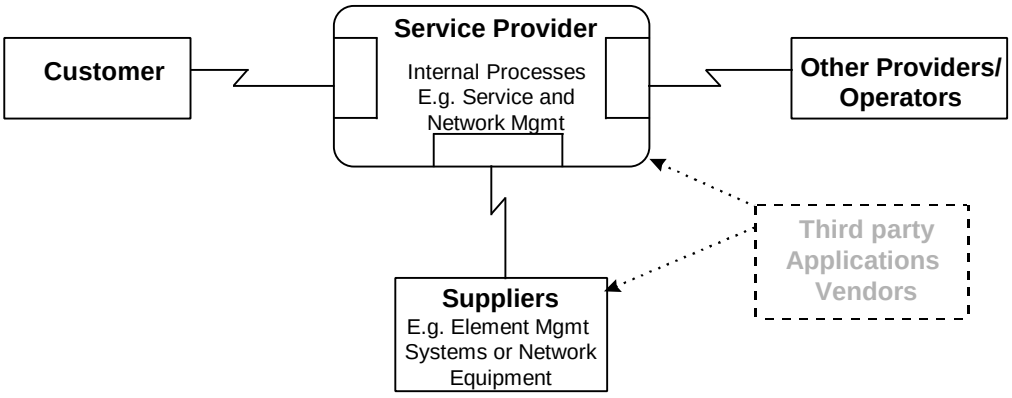

Figure 4.1: The Business Reference Model

Management Value Chain

These process interfaces are part of the 'management value chain' from the customer, through service management to network management, and subsequently to the externally sourced suppliers' equipment, supplying the communications service. This chain may also include other Service Providers (or network operators) in delivering the end to end service.

Supplier Interfaces

The interfaces to suppliers and other providers/operators are external. These are initially 'procurement' interfaces, but after deployment, they become much more a part of the internal operation. The suppliers of these products or services need to ensure that their management systems directly support the service provider's business processes to ensure the most efficient service delivery. The interfaces are likely to be points at which different applications vendors' software need to be able to exchange information.

Network Management Relationships

The following interactions impact Network Management processes and directly drive the need for interface specifications in the form of information agreements that may need to be automated:

Interactions with Service Management

This is one of the primary relationships for Network Management and acts as the main source of requests for information and actions to execute tasks. Service Management is responsible for managing the customers' perspective for each individual service provided, normally against some type of contractual agreement. Thus, its purpose is to 'act on behalf of the customer' for interactions with Network Management.

Interactions with Suppliers or with Supplier-provided Equipment

Most traditional Service Providers own and operate networks in order to deliver their services. Certainly, the service delivery chain will always include at least one Provider which takes on this Network Operator role. For these Provider/Operators, the network operations task is an internal business function rather than a point of external interface. However, since most Service Providers do not manufacture their own network equipment, they are reliant on the equipment suppliers, from whom they procure, to help them achieve their automation goals. The ability for devices to be configured in a common way, for example, or to provide alarm or performance data using common formats and terms, is critical to achieving the full benefits of service and network management automation. To get the most from automation efforts, procured equipment must be able to receive and act on common high-level instructions, and deliver performance and usage-related information in a common way, that meets the Providers' requirements.

Interaction with Customers

Most Service Providers see a need for automated management links with their Customers, at least with some types of Customers, and/or for some types of services. These interactions occur mainly with Service Management, which act as a proxy for the customers' needs to Network Management.

Interactions with Other Providers

World-wide alliances and regulatory actions are generating increasing volumes of interactions between Service Providers. Today, these often involve manual intervention, representing an unacceptable cost and often significantly degrading service quality to the Customer.

Some of the interactions between Providers may be similar in content to the interactions between a Provider and a Customer. However, it is likely that the volumes of transactions, the level of detail required, and the speed with which information needs to be exchanged between Providers will dictate substantially different implementation agreements.

Note:

The use of Service Management here refers to both the Service Development and Operations Processes, Customer Care Processes and Customer Interface Management Processes.

Telecom Operations Map Overview

The Telecom Operations Map (Reference 2) identifies a number of operations management processes covering Customer Care, Service Management and Network Management. For completeness and ease of reference Figure 4.2 from that document is reproduced here. The Telecom Operations Map provides a high level view of processes in operation management. The NM Detailed Operations Map focuses on a more detailed breakdown of the Network Management processes.

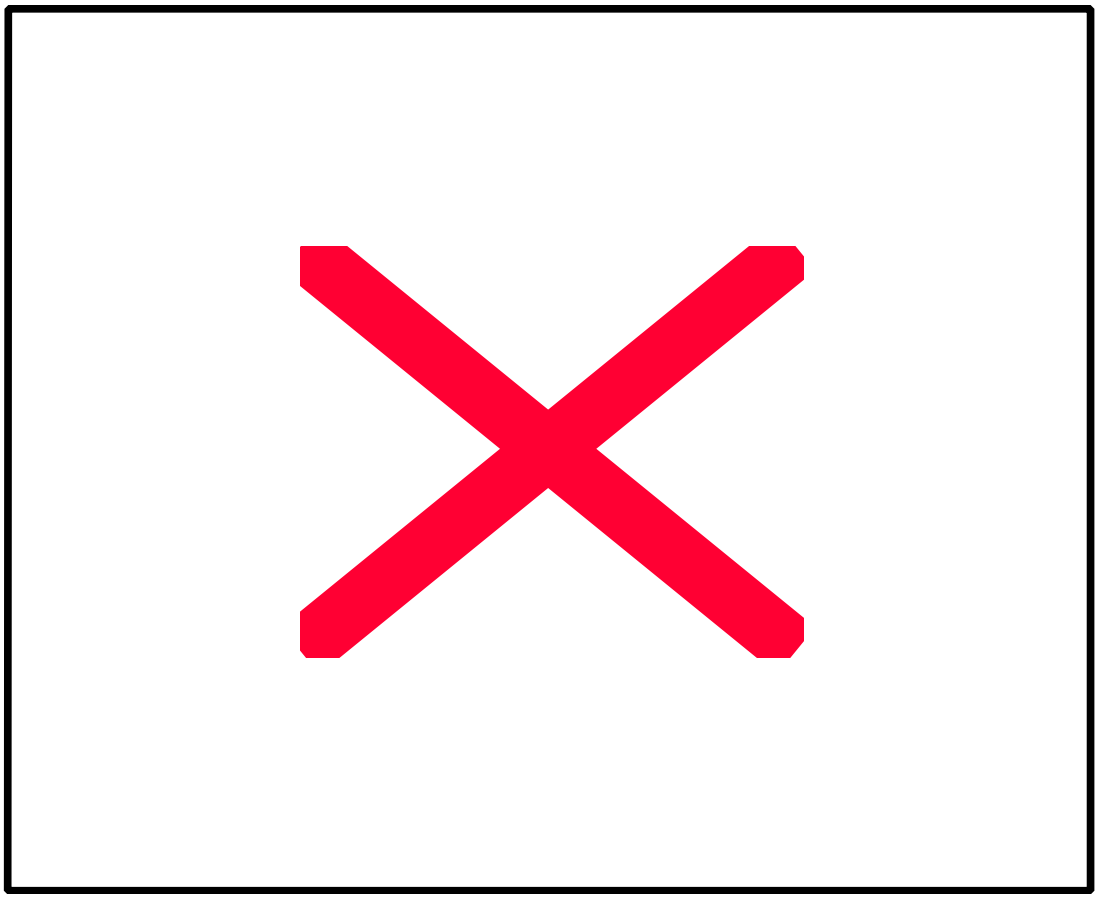

Figure 4.2: Static Business Process Model

This Telecom Operations Map can be applied to any communications service, e.g., wireline, wireless, packet based, etc. The Telecom Operations Map uses the layers of the TMN model as core business processes, but divides the service management layer into 2 parts: Customer Care and Service Development and Operations. In the simplest sense the division reflects differences between processes triggered by individual customer needs from those applied to a group of customers subscribed to a single service or service family. It also reflects the accountability for direct customer contact handling in Customer Care processes.

Depending on the provider, Customer Interface Management may be managed within the individual Customer Care sub-process or, in combination across one or more of the Customer Care sub-processes. For this reason, Customer Interface Management is separately delineated.

The NM Detailed Operations Map relates each of the high level Network Management Processes, identified in the lower layers of the diagram, to a series of component functions (arranged in function set groups). It then identifies relationships and information flows between them. It should be realized that the physical implementation of the management systems might not reflect this strict segmentation between service and network management systems. Providers and Operators will make their own decisions, on the location, within their management environment, of applications that interoperate using the agreed information flows according to their own business judgement.

Chapter 5 - Network Management Processes and Functions

Introduction

In this section, Network Management processes are identified and each process is mapped onto its component functions. The modeling of the Network Management processes and functions is based on the following considerations:

- Top-down decomposition of Service Management needs to guide the structuring of processes and to identify the supporting functions within Function Set Groups (as defined in ITU-T M.3400 - Ref. 3).
- Positioning of the Network Management processes and functions within a layered management architecture, as described by the TMN Logical Layered Architecture (Ref. 4, ITU-T M.3010).

Network Management processes, and the process flows that link these, have been derived from discussions and interviews with business planning and operational staff in a number of Service Providers. They represent a business-oriented (top-down) view of the structure of the Network Management Layer. The Function Set Groups are drawn from standards (see Reference 4) and reflect a structure and terminology which may also be familiar to operations and planning staff.

Annex C provides a mapping between the defined processes and the Function Set Groups (and their underlying component Function Sets) relevant to the operation of each process. Annex D shows how the high level processes can be decomposed to sub-processes and provides a view on how processes and sub-processes relate to Function Set Groups and Function Sets.

More information on the links with the TMN architecture is attached as Annex A.

Processes and Functions

The relationship between processes and functions is illustrated in Figure 5.1

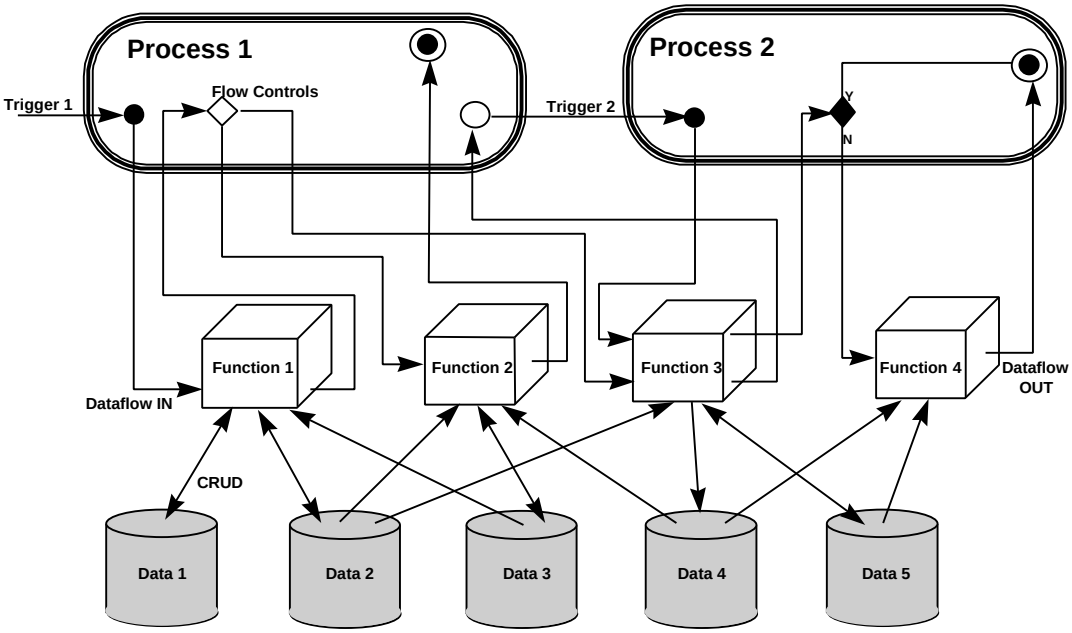

Figure 5.1: Relationship between Processes, Functions and Data

Key: CRUD = Create, Read, Update, Delete

Processes describe the flow of activities to solve a particular business problem, or part of it. At early analysis stages for processes, the means of availability and how the data flows are not significant. Whether or not data is handed over or accessed in a central database is not addressed. However, processes are concerned with the triggers that set them into action.

A function is a unit of processing (either initiated by humans or through an automated action) with specific, well-defined inputs and outputs. For functions (unlike processes) the data is essential because the function is described as a unit of processing together with its associated data inputs and outputs. As used in this framework, functions tend to be dedicated to a single purpose and highly granular.

A process will typically make use of activities in a number of functions. Multiple processes may employ a given function. Thus, there is in principle a many-to-many mapping between process and function. Annex D shows examples of how the high level processes in this document might be decomposed into sub-processes, which may be linked together in 'work strings' (for instance by using workflow engines). It is recognized though that each NO or SP may perform this decomposition in a different way.

Based on TMN standards (see Reference 4), functions with related or complementary capabilities are grouped into Function Set Groups, which then provide operational support to individual processes. It is envisioned that agreement is possible on the high-level processes and the standardized Function Set Groups, without constraining the way in which these are mapped through the intermediate work strings and sub-processes. This maintains the flexibility of application and implementation of this work in individual organizations, and

provides harmonization of the underlying functional support and the broad process structure in which these are used.

A function can be considered as a mechanistic reaction to specific inputs, and is thus relatively straightforward to automate. Whereas a process is a reaction to one or more triggers with the application of business rules, and can therefore be more complex to automate. By structuring processes, functions and data (see figure 5.1), their relationships can become clearer.

This function-oriented perspective for understanding the content of processes supports the "top-down" analysis of processes, by identifying likely target functional capabilities which the processes will employ in carrying out their role. The overall analysis and design of individual process areas (using techniques such as UML for information models) will be handled within TM Forum by individual Working Groups, using the Telecom Operations Map as a common backdrop for their work.

Methodology for Developing Business Processes

Initially, an analysis of the business activities, functions and information flows is needed to guide the structuring of the overall operational environment into major processes, and to identify the contents and linkages between these.

The following steps can be distinguished for the development of business processes:

- Identify Actors. Actors are the external parties providing triggers to the business area to be modeled. What is considered external will depend on what is to be modeled. Furthermore, external parties not providing triggers are not called actors.
- Describe the different Roles each actor can perform.
- Identify Triggers. Each actor in a certain role can provide and receive several triggers.
- Identify reaction to triggers. What sequence of activities (flow-through) will take place in response to the trigger?
- Grouping of activities/functions. All reactions to all triggers can be grouped together in sets of activities. These sets are called the business processes.

Processes are distinguished within a management layer (such as Network Management) because they represent a major area of operational responsibility, and provide a clean separation of concerns between individual processes. In terms of TMN management layers, process flows occur vertically, from the Network Management Layer up to the Service, or down to Network Element

Management Layers, as well as within the Network Management Layer itself. Indeed, the process flows to support the Service Management Layer are one of the primary drivers in this top-down approach to delivering business benefit. Another issue to recognize is that the dynamics of the lifecycle of each of these Layers is likely to be very different and the implications need to be well understood. A discussion of these issues can be found in Annex B.

Overview of Processes, Functions and Data Areas

An overview of Process, Function Set Group and Data Area names are presented here. The Processes, plus the Function Set Groups and Data they use, are described in more detail in below. (see also Reference 4 for the standardized definitions).

The Function Set Groups and Data Areas are those identified as belonging to the Network Management Layer, but can be used by the processes within other layers, where this is appropriate. For example, Network Configuration functions may be used directly by the Service Configuration Process, for service configuration. These relationships are important for a complete view of the requirements placed on the functions.

Figure 5.2 shows the high-level structure of Network Management processes, the supporting Function Set Groups, and the data areas on which these depend. The processes are those already identified in the lower layer of the earlier TMN Figure 4.2. Figure 5.3 positions Network Management operations within TMN. As an example, Network Provisioning might make use of a number of the Function Set Groups, such as Provisioning for the actual choice and set-up of network paths, and testing to validate that these are usable. Data concerning Topologies and Network Configurations may then be involved in supporting those functions (More detail is provided in subsequent diagrams).

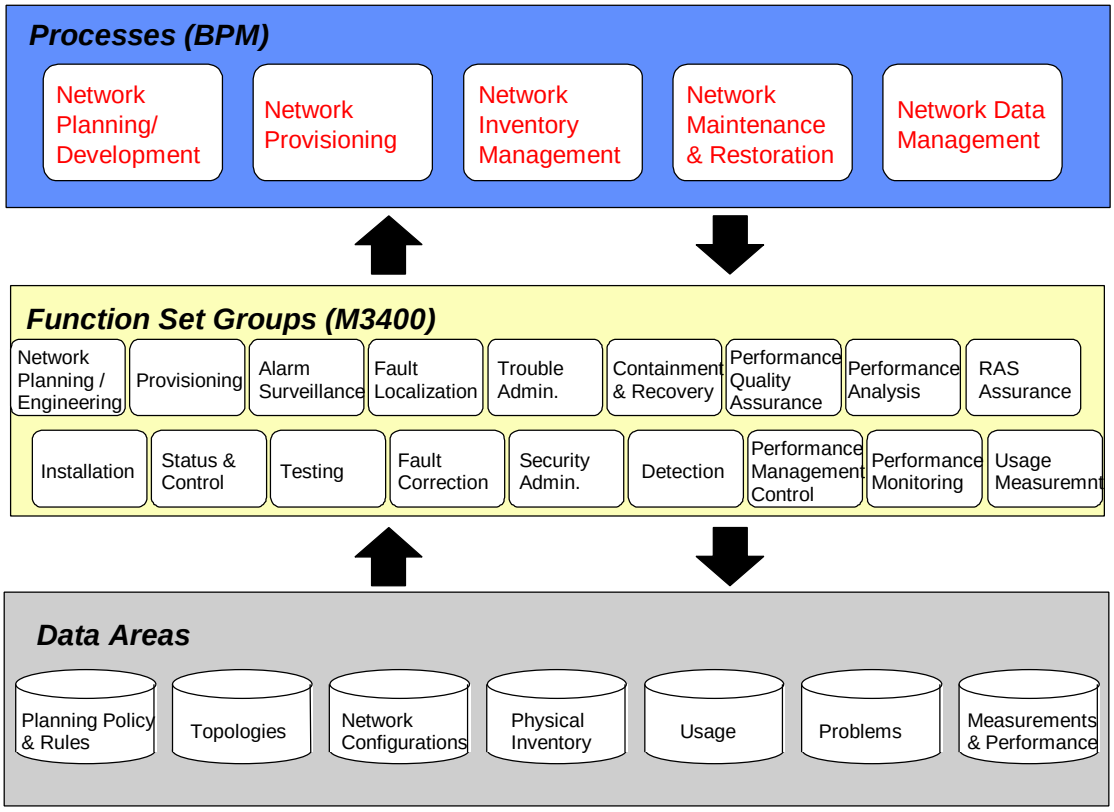

Figure 5.2: Processes, Function Set Groups and Data Areas Used in This Document

Key: RAS = Reliability, Availability and Survivability

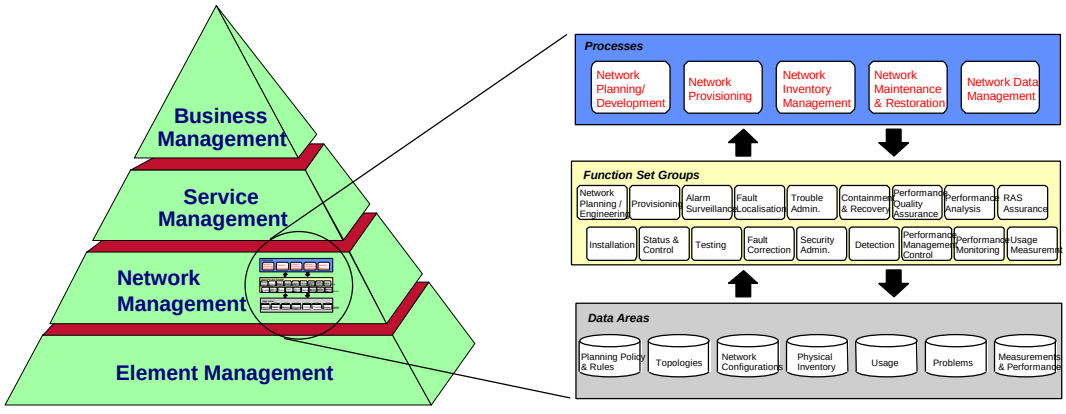

Figure 5.3: Positioning the Network Management Detailed Operations Map within TMN

High Level Processes

The processes shown in Figure 5.2 are described in more detail in this section. Each process description is supported by a process input/output diagram that illustrates the linkages between the process and other parts of overall operations. These processes are likely to be implemented in a typical Provider environment for a specific domain of network operation. This is so that where networks are layered or partitioned for technical or commercial reasons, a process area may be used several times to deal with the different components involved.

For example, managing mobile services could involve management of a mobile network which itself makes use of several fixed network domains (possibly provided by different network operators). Network management in such an environment may involve invoking Network Provisioning separately for each network domain to support configuration of an overall mobile service. This would imply that the Network Provisioning process might be used several times in different ways to achieve the necessary Network Management in support of the service concerned. To accommodate this kind of situation, the processes described here should be recognized as potentially layered in the same way that communications networks and services can be layered.

The process input/output diagrams (reproduced from the Telecom Operations Map, Reference 2) and shown here consist of a process box in which the process tasks or responsibilities are listed. The set of input and output information flows identifies significant interactions between the process area concerned and other parts of the operation. The flow arrows are labeled with the nature of the interaction, and the process or entity with which they interact at their termination.

In the diagrams, only triggers (i.e. interactions which control the process operation) are included, and not other data flows which may exist (since there may be several ways of exchanging information between processes). Triggers, which interact outside of the Network Management Layer, are explicitly indicated. Triggers may be initiated from:

- Service Management, where these NM processes provide support for the Service Management flows (e.g. Service Problem Resolution triggering Network Maintenance & Restoration)
- Within the Network Management layer, in response to needs (triggers) concerned specifically with Network Management (e.g. Network Planning detects the need to re-deploy network resources to deal with, say, a local network overload)
- Externally supplied (but owned, leased or otherwise contracted) equipment or networks (i.e. from the underlying Element/Sub-Network Management)

In addition, the structure of Figure 5.2 is reproduced for each process area, with the Function Set Groups which are involved in supporting that process area. Relevant data areas are highlighted by showing the boxes concerned using white background, rather than gray. Refer to Annex C for textual detail.

Annex D shows both examples of process flows at one more level of detail, and identifies an initial series of sub-processes. (For other processes, this next level of detail will be added as, and when, member resources allow). More detailed analysis is expected to be the subject for individual working teams, constituted of TM Forum members who have business need for open agreement of those information flows. It is likely that as analysis work continues, the need to update this initial process model and the relevant standards (e.g. M3400) will become apparent. For instance, some common agreements on human resource management methods (e.g., Workforce Management), or logistics management will probably be required.

It should be noted that the material provided in this section and in Annex D is intended to provide examples of the way that the processes might operate, and should not be regarded either as exhaustive or normative.

Network Planning & Development

Process Description

This process is responsible for the definition of rules for network planning, installation and maintenance, application of new technology and supplier strategy, development and acceptance of new network types, and description of standard network configurations for operational use.

Also, this process is responsible for designing the network capability to meet a specified service or need at the desired cost and for ensuring that the network can be properly installed, monitored, controlled and billed. The process is also responsible for ensuring that enough network capacity will be available to meet the forecasted demand. Based on the required network capacity, orders are issued to suppliers or other network operators (ONOs) for site preparation and installation orders are issued to the Network Inventory Management or a 3rd party Network Constructor (work orders). A design of the logical network configuration is provided to Network Provisioning.

Input triggers

- new service description from Service Planning & Development
- new network technology from Supplier
- capacity plan from Service Planning & Development
- capacity request from Network Provisioning, Inventory Management and Maintenance & Restoration

Output triggers

- orders to Suppliers and/or ONOs
- work orders to Network Inventory Management or a Network Constructor
- configuration requirements to Network Provisioning
- performance goals to Network Data Management
- maintenance rules to Network Maintenance & Restoration
- work orders to Network Inventory Management
- deployment plans to Service Planning & Development

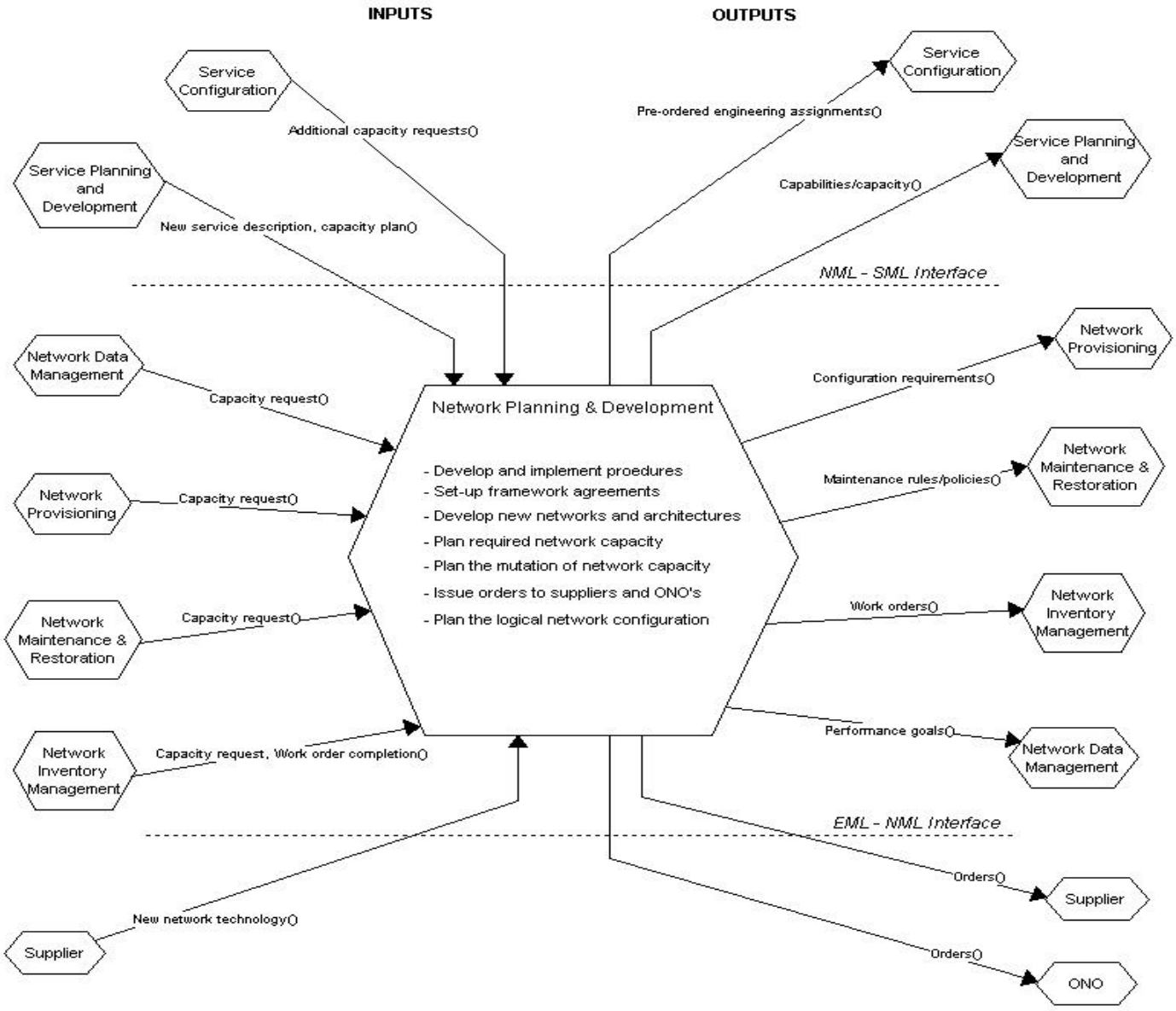

Figure 5.4: Network Planning & Development Process, Including Input and Output Triggers

Output data (i.e. data generated within this process)

- purchasing, installation, performance and maintenance rules, including standard network configurations (for example SDH rings) and routing restrictions/requirements
- network capabilities (including performance goals)
- planned network capacity
- planned logical network configuration
- deployment plans

Process responsibilities

- develop and implement procedures
- set-up framework agreements with suppliers
- develop new networks and architectures, determine network capabilities, based on network technology and architecture
- plan required network capacity
- plan the mutation of network capacity (including destruction of obsolete networks)
- issue orders to suppliers and ONOs
- plan the logical network configuration
- plan the required physical site facilities

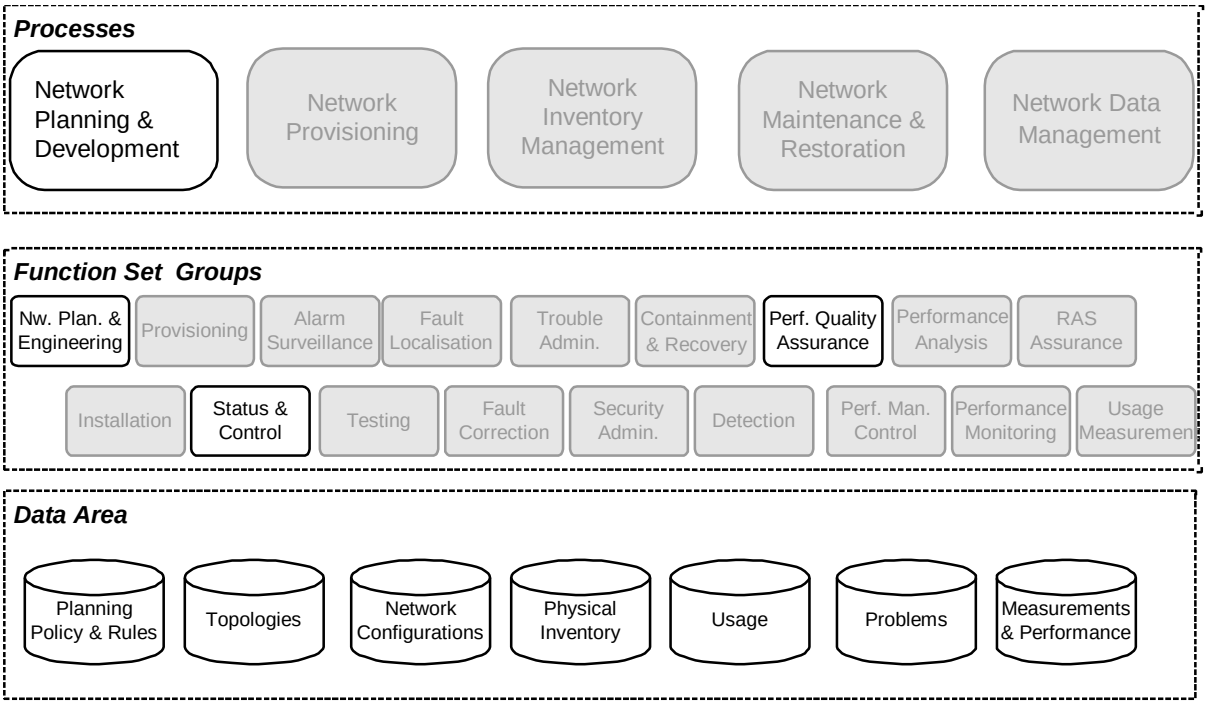

Figure 5.5: Functional Groups and Data Areas for the Network Planning & Development Process

Network Provisioning

Process Description

This process is responsible for the configuration of the network to ensure that network capacity is ready for provisioning of services. It carries out network provisioning, as required, to fulfill specific service requests, and configuration changes to address network problems. The process must assign and administer identifiers for provisioned resources, and make them available to other processes.

Note that the routine provisioning of specific instances of a customer service (especially 'simple' services such as POTS) may not normally involve Network Provisioning but may be handled directly by Service Provisioning from a pre-configured set.

Input Triggers

- network capacity available from Network Inventory
- configuration requirements from Network Planning & Development
- network provisioning request from Service Configuration (to support a new request for service)
- configuration request from Network Maintenance

Output Triggers

- network capacity request to Network Planning
- network configuration ready (including identifier if successful), to Service Configuration
- work order to Network Inventory Management (if any physical work is necessary)
- start monitoring request to Network Data Management
- network configuration request to lower-level management

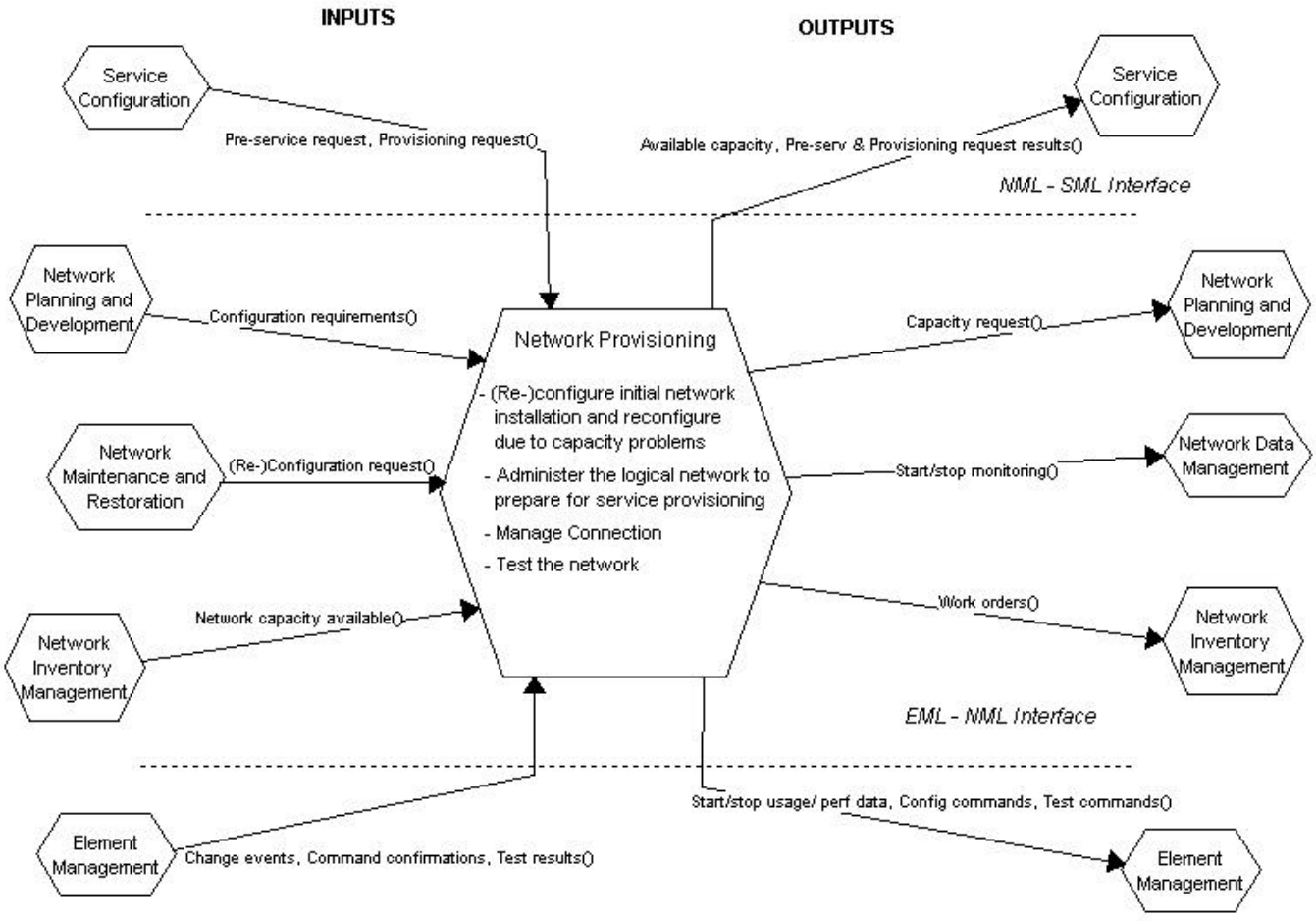

Figure 5.6: Network Provisioning Process, Including Input and Output Triggers

Output data (i.e. data generated within this process)

- installed logical network configuration
- network identifiers and associations with services supported

Process responsibilities

- (re-)configuration of the network
- administration of logical networks
- assignment of identifiers
- testing the network to ensure operational readiness

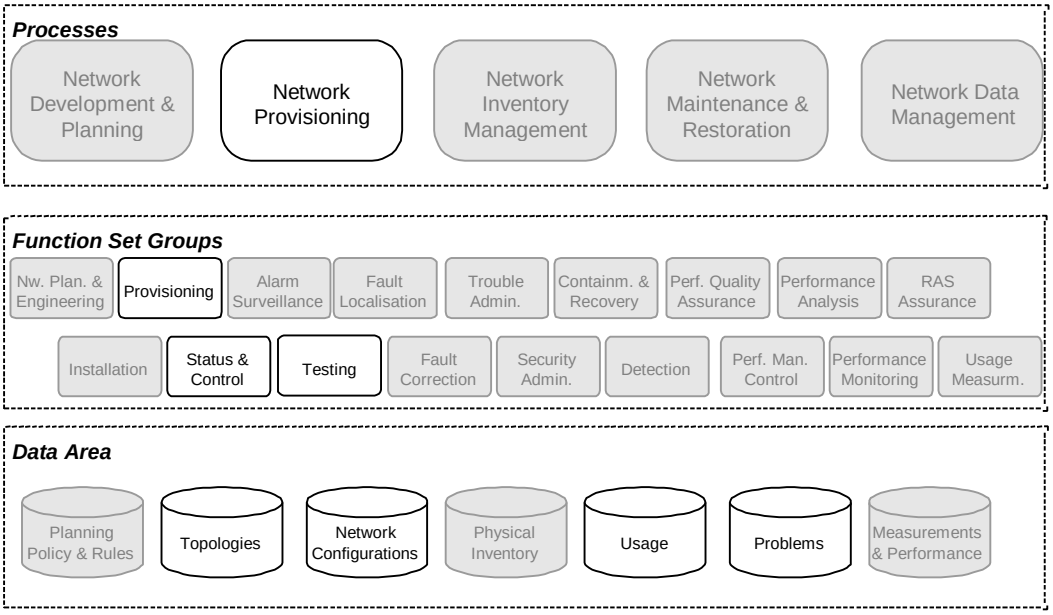

Figure 5.7: Functional Groups and Data Areas for the Network Provisioning Process

Network Inventory Management

Process Description

This process is responsible for anything to do with physical equipment and the administration of this equipment. The process is involved in the installation and acceptance of equipment, with the physical configuration of the network, but also with handling of spare parts and the repair process. Software and hardware upgrades are also the responsibility of this process.

Input Triggers

- work order from Network Planning and/or Network Provisioning
- change notification from Element Manager
- work order(start/stop/cancel) from Network Maintenance & Restoration
- start monitoring request to Network Data Management
- new/spare/repair part available from Supplier
- equipment problems/updates from Supplier

Output Triggers

- maintenance scheduled / ready to Network Maintenance & Restoration
- network capacity available to Network Provisioning
- request to Network Planning for equipment (new or spares) orders
- notifications/orders/returns to Suppliers
- capacity ready indication to Service Marketing

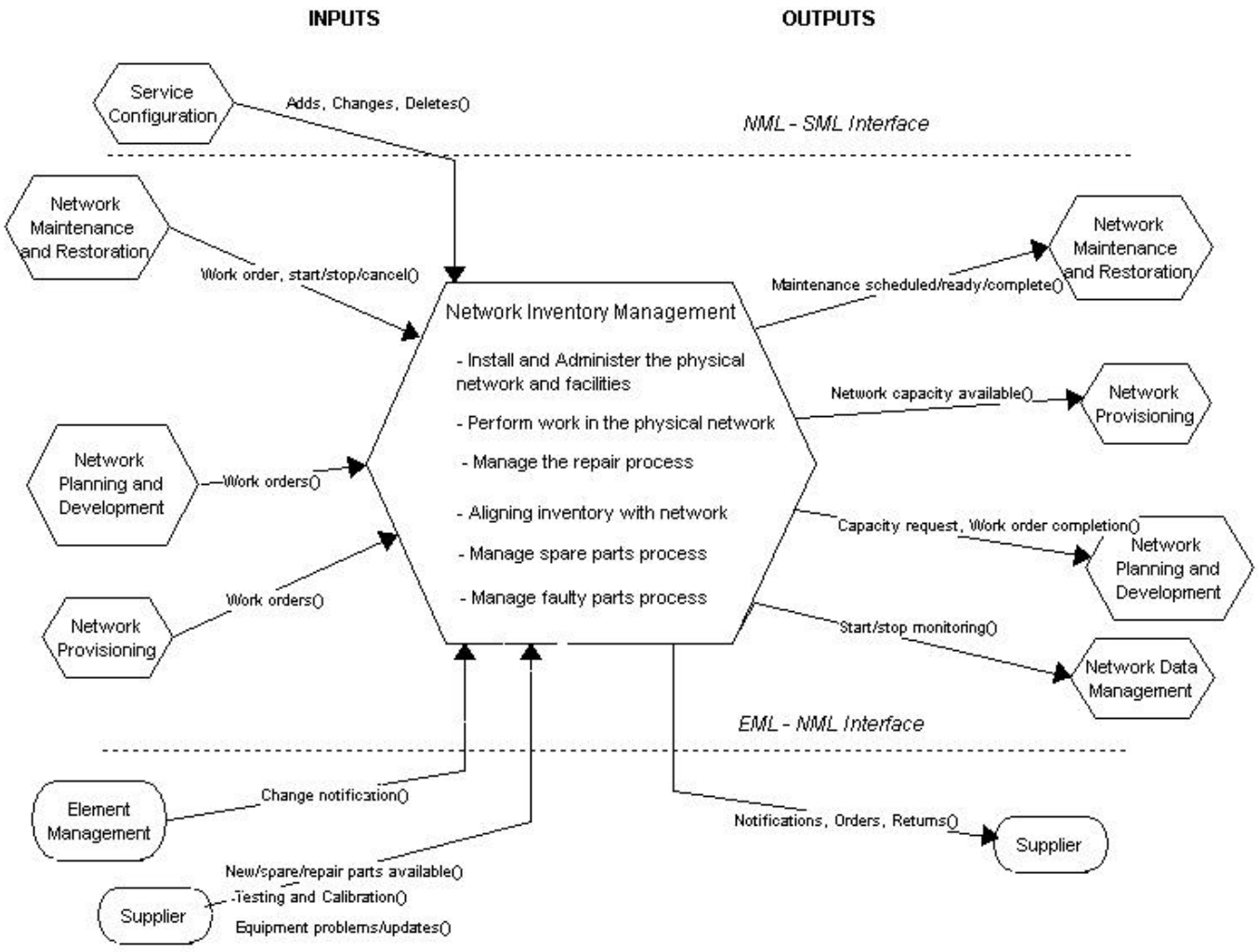

Figure 5.8: Network Inventory Management Process, Including Input and Output Triggers

Output data (i.e. data generated within this process)

- physical network data
- maintenance schedule
- inventory / repair information

Process responsibilities

- installation and administration of physical network
- performing work in the network
- managing the repair process
- responsibilities for alignment of inventory information with actual network

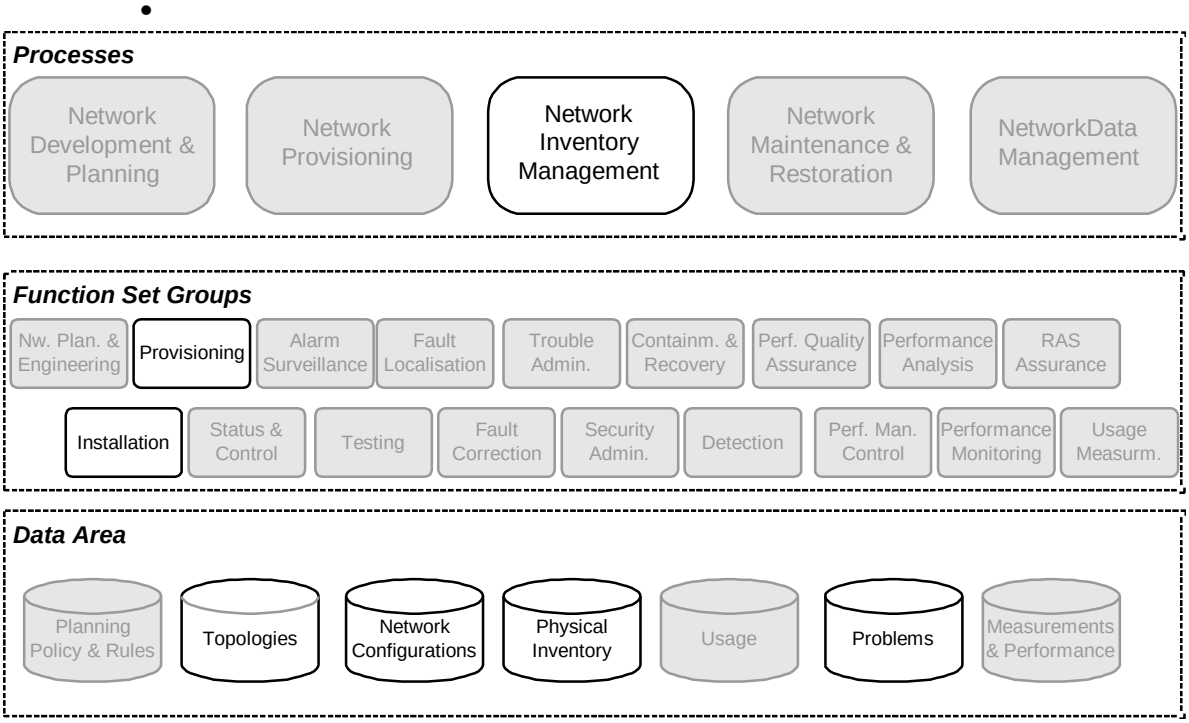

Figure 5.9: Functional Groups and Data Areas for the Network Inventory Management Process

Network Maintenance & Restoration

Process Description

This process is responsible for maintaining the operational quality of the network, in accordance with the required network performance goals. Network maintenance activities can be preventative (such as scheduled routine maintenance) or corrective. Corrective maintenance can be in response to faults or to indications that problems may be developing (proactive). This process initiates tests, does analysis to determine the cause and impact of problems, and notifies Service Management of possible effects on quality. The process can issue requests for corrective actions.

Input Triggers

- maintenance rules/policies from Service Problem Resolution/Quality Management
- element faults/events from Element Managers
- regular/preventative maintenance requirements from Network Planning
- maintenance activity start/complete from Network Inventory Management
- performance degradation indication from Network Data Management

Output Triggers

- work order (start/stop/cancel) to Network Inventory Management
- configuration and restoration requests to Network Provisioning
- service or SLA affecting network problem and resolution notification to Service Problem Resolution
- service or SLA affecting network maintenance activity to Service Problem Resolution
- capacity request to Network Planning & Development

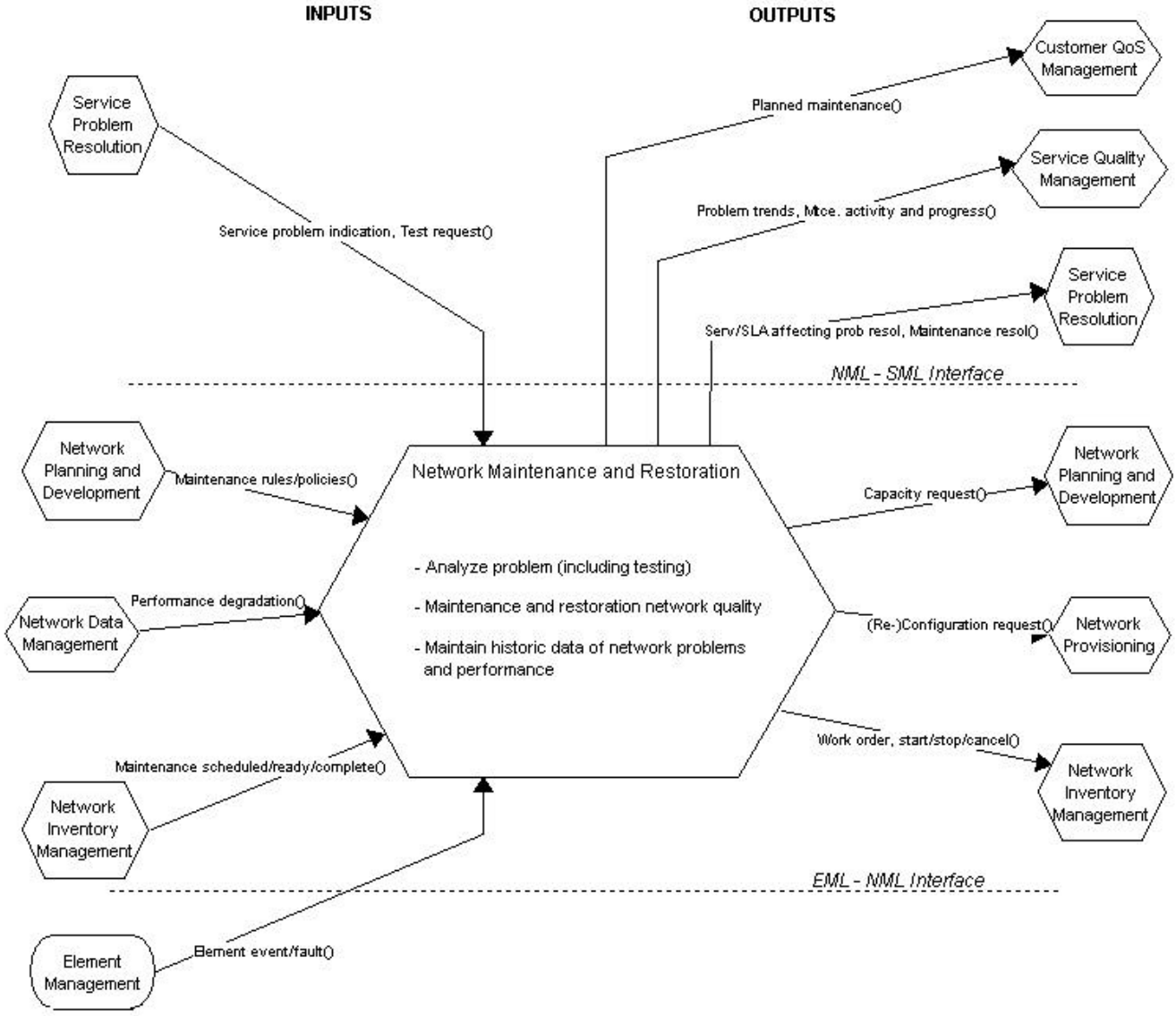

Figure 5.10: Network Maintenance & Restoration Process, Including Input and Output Triggers

Output data (i.e. data generated within this process)

- historic data on network problems, testing and maintenance

Process responsibilities

- problem analysis (including testing)
- network quality maintenance and restoration
- maintain historic data of network problems and performance

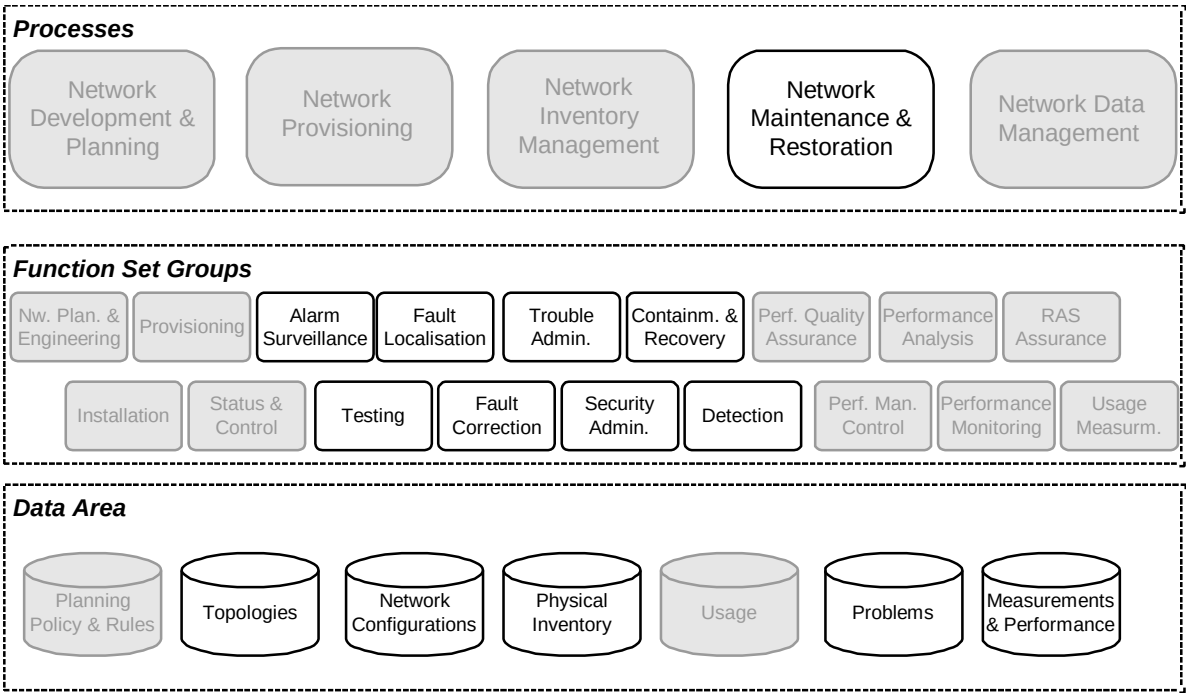

Figure 5.11: Functional Groups and Data Areas for the Network Maintenance & Restoration Process

Network Data Management

Process Description

This process is responsible for the collection of usage data and events primarily for the purpose of network performance and traffic analysis and optimization. This data may also be an input to Billing (Rating and Discounting) processes at the Service Management Layer.

The process must provide sufficient and relevant information to verify compliance/non-compliance to Service Level Agreements. However, the Service Level Agreements are not known at the NML. This process must ensure that the Network Performance goals are tracked, and that notification is provided when they are not met (e.g., threshold exceeded, and performance degradation). This includes information on capacity, utilization and traffic. In some cases, changes in traffic conditions may trigger changes to the network (via Network Provisioning) for the purpose of traffic control such as call gapping in case of network congestion. Reduced levels of network capacity can result in requests to Network Planning for more resources.

Input Triggers

- performance goals from Network Planning and Development
- usage/ performance data request from Service Quality Management or Rating/ Discounting, may be handled by periodic collection and reporting
- start monitoring request from Network Provisioning and/or Network Inventory
- change in network element configuration

Output Triggers

- performance degradation notification to Network Maintenance
- service quality degradation notification to Service Problem Resolution
- usage information to Service Management Layer for Billing
- capacity request to Network Planning and Development
- network changes (including start/stop monitoring) for traffic control to the Element Manager
- Update of network management system database

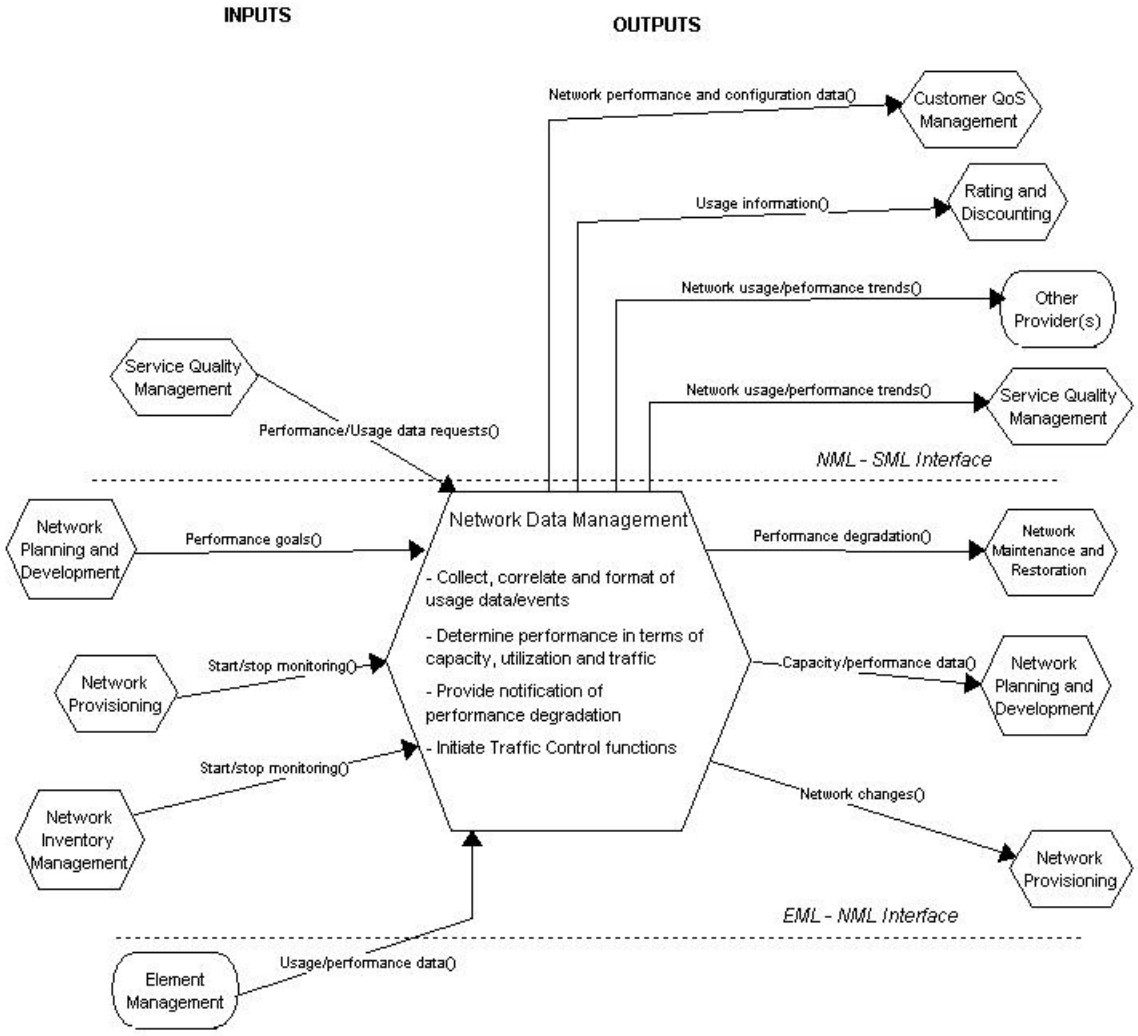

Figure 5.12: Network Data Management Process, Including Input and Output Triggers

Output data (i.e. data generated within this process)

- usage/ performance data
- historical performance and traffic analysis

Process responsibilities

- collection, correlation and formatting of usage data and events
- determining Network Performance in terms of capacity, utilization and traffic
- providing notification of performance degradation
- implementation of Traffic Control functions

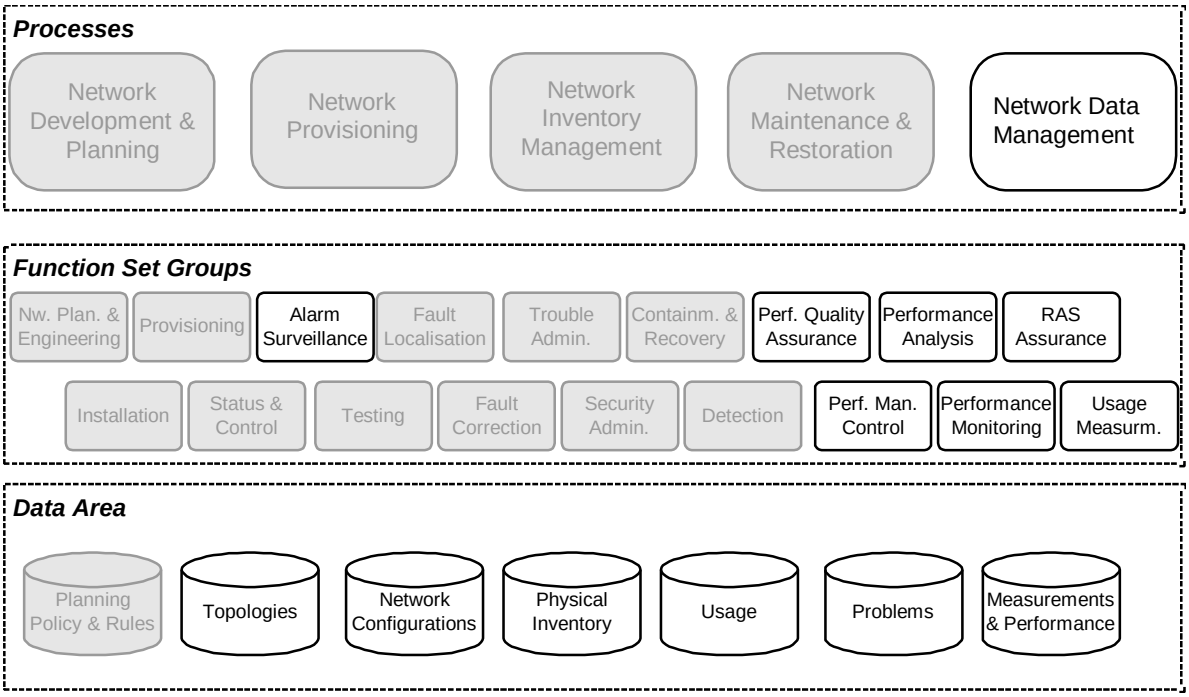

Figure 5.13: Functional Groups and Data Areas for the Network Data Management Process

Chapter 6 – Deploying Network Management Solutions

Technical Boundaries

This section examines the impact of interaction with particular network technologies on management solution structure. It is often advantageous to establish a technical boundary to separate those Network Management capabilities that are network technology dependent, from those that are common or generic to the broader operation of an Operator. The key benefits of defining such a boundary are:

For the Service Provider:

- Minimizes the impact of introducing new network technologies on the Network Management Layer (NML) and above layers, hence lowering systems costs and speeding up introduction of new network technologies. For instance, existing generic applications can be applied to the management of new technologies.
- Reduces the cost of the technology-dependent components and the capabilities these offer, since vendors are free to innovate below the boundary, and can generate higher volume business for their solutions. Providers should be free to purchase only the functionality (applications) they need.
- Allows the higher level functionality (i.e. above the boundary) to be procured more competitively resulting in the potential to create a market for the generic applications.
- Promotes a more structured management solution with potential for increased flexibility and easier evolution for new services and management capabilities.

For the Vendors:

- Increases the value of their offerings (i.e. greater functionality) by allowing inclusion of appropriate higher-level management capabilities accessed in an agreed way across the technology-dependent boundary.
- Improves potential for growth in their market size due to greater functionality and faster take up by SPs.

- Improves potential for new revenue through the enhanced functionality of their network equipment or software support.
- Provides increased “headroom” for the development of management capabilities and innovative solutions within the envelope of the offered technology. A common structure allows the vendor to focus on the applications structure as well as functionality, and to more clearly target and price manage solutions for given Operator needs. Incumbent needs may be very different to new operators.
- Improves the efficiency of systems integration among vendor application products, enabling a vendor ‘value chain’ to operate more effectively.

Relationship with the Telecom Operations Map

The functional areas addressed in this document can be encapsulated as blocks of functionality within the Telecom Operations Map framework. The scope of the chosen functional blocks can reflect the distinction between generic and technology-specific management indicated above. The functional blocks shown in Figure 6.1 have been chosen, on this basis, i.e., to distinguish Network Management capabilities associated with Element Managers (at the node level) and Sub-Network Manager(s) (for some managed network area or domain). Note that this is only one possible structuring. Procurement by Service Providers of managed network technology is often based on a combination of Element Management and some aspects of Network Management packaged into this type of Sub-Network Management. This allows the managed Sub-Network domain to be accessed as a network area, rather than just a series of individual network nodes. The Sub-Network might be defined:

- on the basis that it employs a particular network technology (e.g. SDH or ATM), with its associated management, and is procured as a package;
- on the basis of geographical partitioning;
- because specific areas of management functionality are supported; and
- on many other criteria for defining the Sub-Network boundaries.

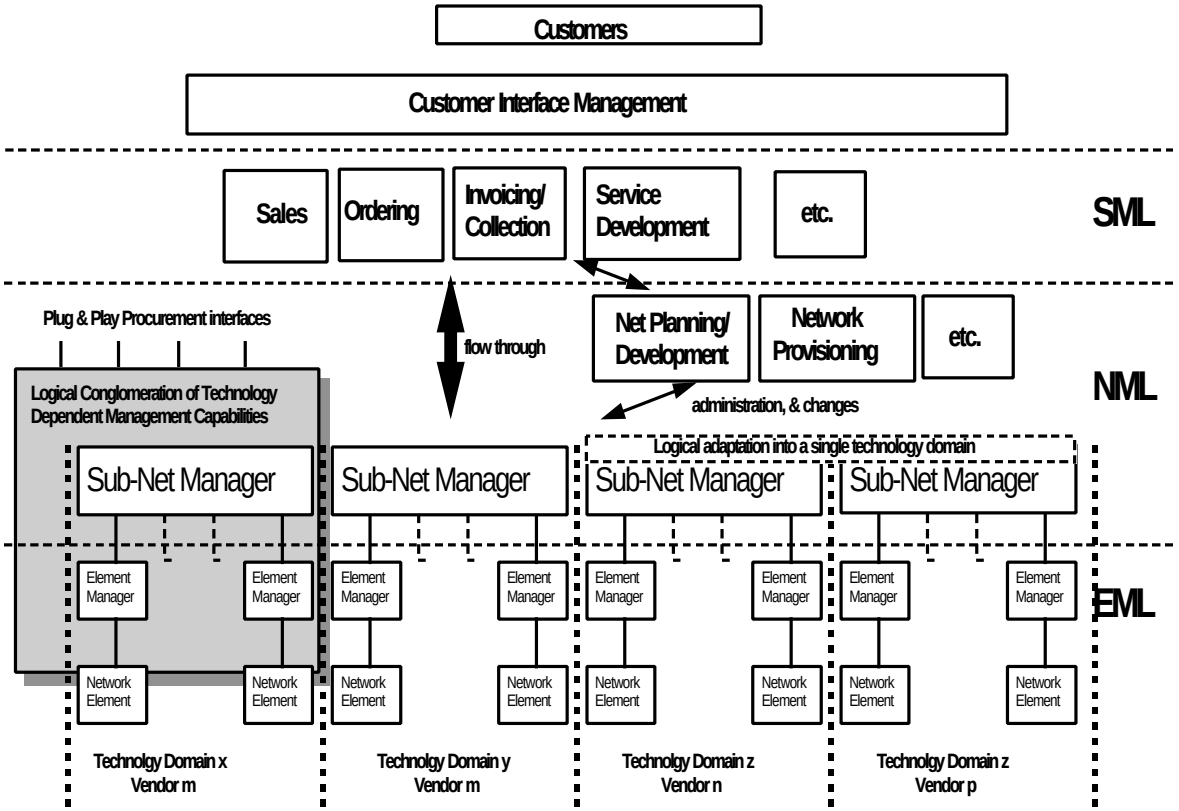

Figure 6.1: Structuring the Network Management Layer

This document does not attempt to distinguish explicitly the Sub-Network Manager functionality and Element Manager functionality. In practice, the balance between these aspects will be determined by the deployment constraints imposed by the procurer administration and the internal design constraints of the technology. Consequently, the distribution of functionality may vary significantly from one implementation to another.

Factors for Distribution of Functionality

The factors influencing distribution of functionality are illustrated by the following examples:

Constraints in the design of network technology

- Aggregation of performance and usage data may best be done at the nodal level in order to minimize the volumes of data flows transferred to higher-level management.
- The design/routing of PVCs must by its nature be performed from a central place, before fanning out to the lower level tasks which are performed at the nodal level.
- Detailed configuration functions may best be performed at the nodal level in order to provide a fully assured configuration mechanism and to minimize data duplication.
- Mapping of network-oriented to node-oriented resource choices (e.g. network routings mapped to equipment port choices) may be optimally handled in different ways for each type of technology and for each separate implementation of the same technology. This can lead to different distributions of functionality within each technology domain to support similar capabilities presented at the boundary to higher-level management.

Constraints at the time of deployment

- State of the computing infrastructure (e.g. processing capability) upon which the management solution is deployed.
- Physical computing architecture adopted by the SP. For example, presentation of management services through standard and open interfaces from a central place may be preferred in order to minimize the cost of supporting protocol stacks and to minimize the impact on evolution of the computing infrastructure.
- Degree of adaptation required due to shortfalls or overlaps in functionality.
- Segmentation needs of the administration; physical (geographical domains) or logical (customer groups, product groups etc.).
- Nature of interfaces to network elements and element management systems and their degree of standardization.
- The processing, capacity, and scalability of software involved.
- The capabilities of the data network used for communication to and from the Network Elements and Element Management Systems (e.g., speeds, protocols, and standards).
- The SP organization and business needs/policies, e.g., the way that trouble resolution and escalation should be handled.

Key Criteria for Partitioning Functionality

The main criteria applied to the partitioning of functionality is that the function is:

- Logically related to the other functions chosen, in support of some overall management feature or capability. This is the major area of linkage with the Telecom Operations Map, since the processes and process flows identified in the Telecom Operations Map are used to identify which functions are logically related and should be considered together.
- Specific to a technology Sub-Network or is considered to require a significant degree of knowledge about the internals of the network technologies.

A description of the detailed functionality identified on this basis within the Network Management Layer, and in the supporting Sub-Network Management, is provided in Appendix 1. This represents a view based on the perspective of a specific TM Forum member and has not been ratified by other members. It is provided only as an indication of a possible structuring that addresses the partitioning between generic Network and Sub-Network Management. Further analysis of this concept is likely, as part of the ongoing work group activities and findings will be published as available.

Chapter 7 - Evaluation of Process Automation Needs

In this section, each process is reviewed in terms of the likelihood of requiring industry-common interfaces to be developed. This information is very preliminary and subjective in nature, having been gleaned from comments made during the interview process on NML process needs. It has not been subjected to any sort of formal "vote" or consensus process. In the final analysis, service providers will determine where they need industry agreements based on the magnitude of inefficiencies caused by manual interactions or lack of common terms. These inefficiencies can be manifested as excessive errors, protracted process intervals, or the inability to respond quickly to new market opportunities.

Network Development Process

Process Name	Mechanized SML or EML Interface Required?	Repetitive functions?	High value to automate?	Industry agreements desired?
Network Development	No	Yes, but low intensity and high degrees of customization	No	No

NOTE: for clarity, the Development and Planning processes have been shown separately in this section.

This process requires information on policies and design rules to be exchanged between network operators and their suppliers. It is a highly interactive process and is not easily automated since each network development comes with its own set of unique characteristics. In some cases, the result is to amend or extend the detailed processes and functions in other areas to accommodate the effective introduction of new services and technologies.

This process is the entry point for the Service Management lifecycle.

Network Planning Process

Process Name	Mechanized SML or EML Interface Required?	Repetitive functions?	High value to automate?	Industry agreements desired?
Network Planning	SML Possibly EML Mechanization of the work order activity	Yes, but low intensity	SML: No EML: May be important to get required quality and integrity of data	No for internal works order Yes for external (Works) Order possibly using EDI

This process takes capacity plans and capacity requests to generate the specific orders for the provision, configuration and construction of equipment. These ordering interfaces can be automated to improve effectiveness of the processes. Internal works orders are likely to be automated by some local proprietary interfaces such as a work scheduler or project-planning tool. External orders to suppliers are the traditional domain of Electronic Data Interchange (EDI), and, more recently, engineering ordering processes (e.g. CALS).

This process supports the Service and Network Management lifecycles.

Network Provisioning Process

Process Name	Mechanized SML or EML Interface Required?	Repetitive functions?	High value to automate?	Industry agreements desired?
Network Provisioning	Yes for both interfaces	Yes	Yes	Yes for the logical configuration of the EML. For Physical configuration it may be required

This process takes configuration requests from Customer Care and Service Management Processes as well as from other NML processes. The result of Provisioning is to provide the data for the logical configuration of the Network Element through the EML, or for a request to the Network Inventory for physical configurations. For the former, automation based upon industry agreements is essential. For the latter, the automation of the interface may be a local issue. However, if the Network Inventory is run by a separate organization, then automation based upon industry agreements will be desirable.

This Process is an essential support component of the Customer Care Ordering Process and the Service Management Service Configuration Process.

Network Inventory Management Process

Process Name	Mechanized SML /EML Interface Required?	Repetitive functions?	High value to automate?	Industry agreements desired?
Network Inventory Management	EML : Yes	Yes, but may involve equipment-specific operations	Some functions	Yes for configuration interfaces that reflect physical inventory changes

The Network Inventory Management Process supports a number of Network Level Processes that need to be automatically updated to track the physical state of the network inventory across an EML interface. The process is an essential part of the Network Management lifecycle and supports those Service Management and Customer Care lifecycles that require physical changes to the network.

The execution of the physical work is carried out by Workforce Management (see Annex D) and will need an automated interface that may not be based upon industry agreements.

Network Maintenance and Restoration Process

Process Name	Mechanized SML or EML Interface Required?	Repetitive functions?	High value to automate?	Industry agreements desired?
Network Maintenance and Restoration	Yes, for both	Yes, but may involve equipment-specific operations	Most Functions	Yes, for Network Element Alarms, problem reports to Service Management, and for work orders to 3rd party maintainers.

The Maintenance and Restoration Process strongly impacts a customer's perception of service quality. The rapid and accurate handling of problem reports and alarms, their subsequent diagnosis, and restoration require the accurate processing of large numbers of events. This process is essential to support the Network Management, Service Management, and Customer Care lifecycles.

Network Data Management Process

Process Name	Mechanized SML or EML Interface Required?	Repetitive functions?	High value to automate?	Industry agreements desired?
Network Data Management	EML Yes SML Yes	Yes	High value for specific monitored data which drive performance reporting in support of SLAs High value for usage measurements to lower costs and improve integrity	EML Yes SML Yes

The Data Management Process has two distinct aspects:

Usage measurement for Billing

- For this aspect, the need is to collect, collate and correlate large volumes of data and move them efficiently to systems that can carry out rating and billing. The data transfer needs high level of integrity and audibility.

Monitoring of network traffic and performance conditions

- This aspect is crucial as network degradation usually precedes network failure. Detection and raising of problems at this stage can improve customer perception of service quality.

It is also essential to the Network Planning and Development processes, since it gives early warning of exhaustion of network capacity. The process is essential to support the Network Management, Service Management, and Customer Care lifecycles.

Chapter 8 – Glossary of Terms and Acronyms

ATM	Asynchronous Transfer Mode
BPM	Business Process Model
EM	Element Management
EML	Element Management Layer
ITU	International Telecommunications Union
ITU-T	ITU - Telecommunications Sector
NE	Network Element
NEM	Network Element Management
NM	Network Management
NML	Network Management Layer
NMP	TM Forum Network Management Program
NO	Network Operator
OLO	Other Licensed Operator
OMT	Object Modeling Technique
ONO	Other Network Operator
SDH	Synchronous Digital Hierarchy
SLA	Service Level Agreement
SM	Service Management
SML	Service Management Layer
SP	Service Provider
TMN	Telecommunications Management Network
TOM	Telecom Operations Map
UML	Unified Modeling Language

ANNEX A: TMN and Role of Network Management

TMN (Telecommunications Management Network) represents a series of architectural and interfacing agreements focused on an infrastructure for managing telecom networks and services, including planning, installation, provisioning, operation, maintenance and administration. The TMN is defined by the ITU-T, the international body responsible for specifying telecommunications standards. A TMN provides management functions for communications networks and services and offers communications between itself and the communications networks, services and other TMNs. In this context, a communications network is assumed to consist of both digital and analogue communications equipment and associated support equipment. A communications service in this context consists of a range of capabilities provided to customers.

Within the TMN layered management architecture (see Fig A.1), the Network Management Layer is an important integration layer between the Element Management Layer and the Service Management Layer. Its basic function is to bring together information from the Element Management systems which support it, and then integrate, correlate and in many cases summarize that information, in order to pass on the relevant information to Service Management Systems. That information will generally relate to the characteristics of the network technologies involved but should describe an end to end view that is consistent across the (multiple) technologies which may support a customer service. In the reverse direction the Network Management Layer will receive information from the Service Management Layer, process it and then pass on relevant commands and data to the appropriate Element Management System(s).

However, the Network Management layer is more than just a mediator between the EML and SML. The Network Management layer has its own responsibilities; for example, network provisioning and network fault management. The important issue is that management responsibility will be placed at a level where adequate information is present, instead of shifting all responsibilities to the SML. For example if a non service-affecting network failure occurs, i.e., breakdown of one leg of an SDH ring, the Network Management layer may handle the failure without notifying the SML.

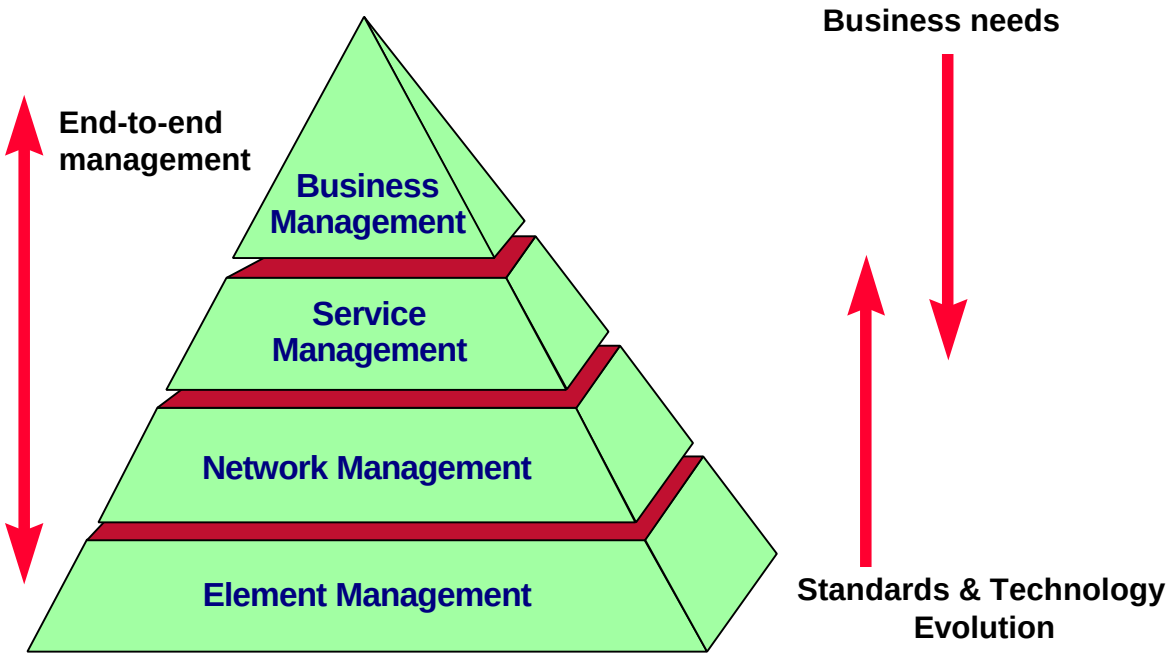

Figure A-1: The TMN Layered Management Architecture

There has been a good deal of valuable attention given in ITU-T and elsewhere to "higher-level" management. Much of the work completed so far by Standardization and other bodies is reflected in Recommendations, Standards and Implementation agreements which describe aspects of the Element Management Layer, with work now progressing quickly toward the Network Management Layer. Much of this crucial work can be characterized as defining the 'instrumentation' of the equipment to be managed, rather than defining automated management information process flows to achieve integrated management of services for a customer. TM Forum has done a considerable amount of analysis of the Service Management Layer, to try to understand and document the business needs of Service Providers and Network Operators. These needs are currently being analyzed and detailed specifications of information flows are being produced. The knowledge gained from this activity, as well as further direct input from TM Forum members, will be applied in determining which activities at the NML need to be progressed. Work is already underway in many areas to document requirements, to develop detailed process and information flows and, subsequently specifications, and/or implementations, that support Service Management. These information flows may be between SML and NML, NML and EML or wholly within the NML.

It is TM Forum's intent, and procedural starting point, to use and apply agreed standards in this process, where they exist and meet business needs.

ANNEX B: Service Related Lifecycles

As noted earlier, many Providers are reengineering their business processes. A common approach is to identify a set of service related lifecycles. In general, the essential lifecycle is the Service Management lifecycle, from initial identification and definition of a service, through planning and development, deployment, ongoing operation and finally phasing out that service, as this will drive the other lifecycles. While there can be many combinations in how a particular company will segment and name their particular processes and methods, the overall lifecycle will generally contain many of the same steps. Figures B.2 gives a typical view.

Each step in a service lifecycle has consequences throughout the management (TMN) framework, with consequential activities required at Business, Service (Customer Care), Network and Element Management layers. It should be noted though that many of the steps are not currently subjects for standardization, as they represent essential competitive differentiators for the Provider. However, in order to be able to procure cost-effective management systems, rather than develop proprietary software, Providers are realizing that some commonality of approach is required. This common approach can be used across management systems in their own environment, as well as between the management systems of their partners and customers. Both equipment and software suppliers, also recognize that there is advantage in the ability to easily integrate products to this environment. Thus, the main emphasis of this document is driven from the Service Operation and Monitoring aspects of Service Management. The commonality of approach is acceptable and beneficial to the industry, rather than some of the more value added areas, which are likely to be proprietary at this time.

The following sub-section identifies the typical lifecycles that have been identified and discusses some differences in their characteristics.

The Customer Care Lifecycle

The customer care processes in the top row of Figure 4.2 (see Section 4) forms a lifecycle driven by the provision of a specific instance of a customer service. There are likely to be many customers, many different services, and a dynamic need to add, delete, or change services. This implies the need to support high transaction rates in the Service Providers' Customer Care systems (but not necessarily in each individual customer's management system). It also implies relatively low data volumes per transaction, high transactional integrity, and low levels of manual intervention to save costs.

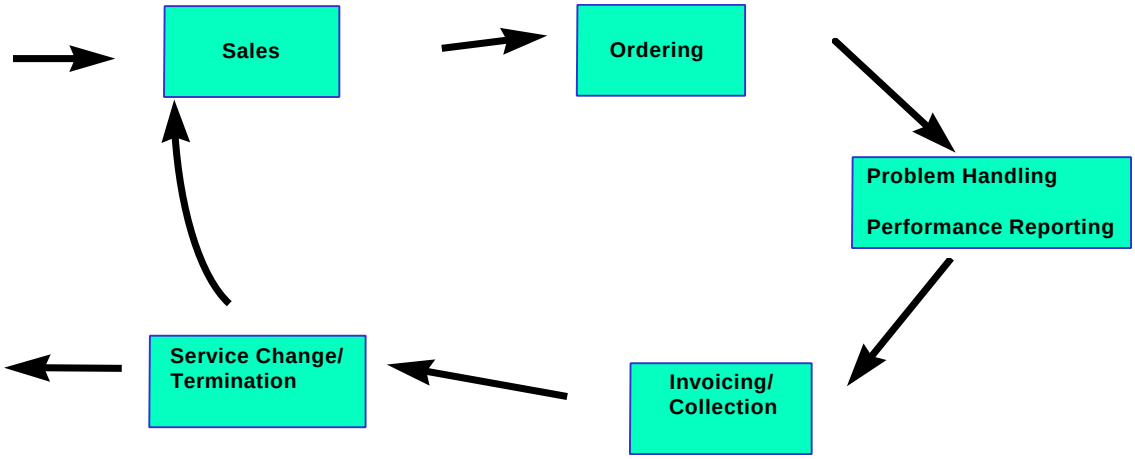

Figure B.1: The Customer Care Lifecycle

The Service Management Lifecycle

The Service Management processes in the middle row of the overall process model form a longer periodicity lifecycle driven by the introduction, modification, and withdrawal of different service products (or 'classes' of service). This lifecycle involves creating the specific policies, rules, process, and data templates used to configure and select service products the Customer Care process can utilize.

While there can be many combinations in how a particular company will segment and name their particular processes and methods, the overall lifecycle will generally contain many of the same steps. Figure B.2 gives a typical view.

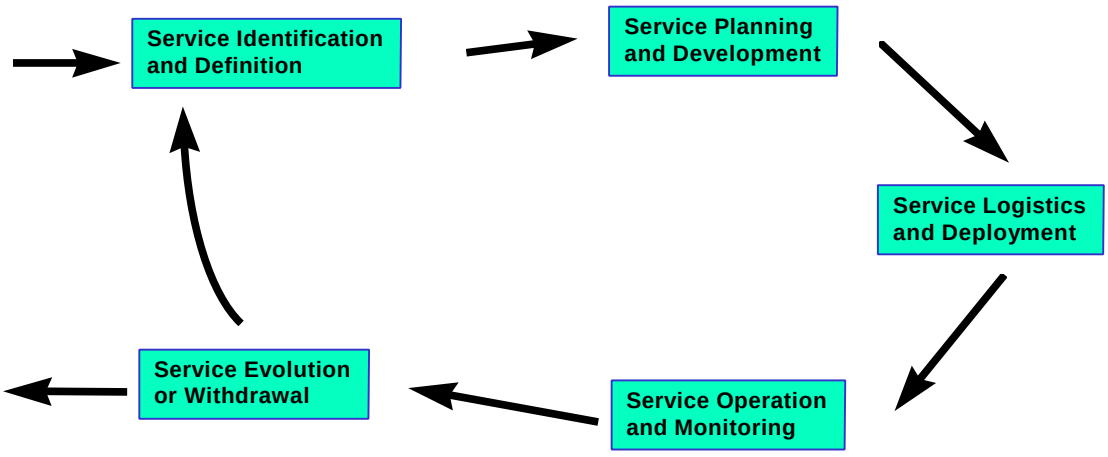

Figure B.2: Typical Service Management Lifecycle

The Network Management Lifecycle

The Network Management processes form the lower layer of processes in the overall Service Management Telecom Operations Map and have to respond to and support both the Customer Care process lifecycle and the Service Management Lifecycle.

In addition to responding to these two process lifecycles, the building of the network infrastructure introduces additional lifecycles comprising the cycle of planning and building of the network for expansion of capacity, which has a relatively long periodicity, and the cycle of technology evolution which involves technology change-out whilst ensuring service continuity.

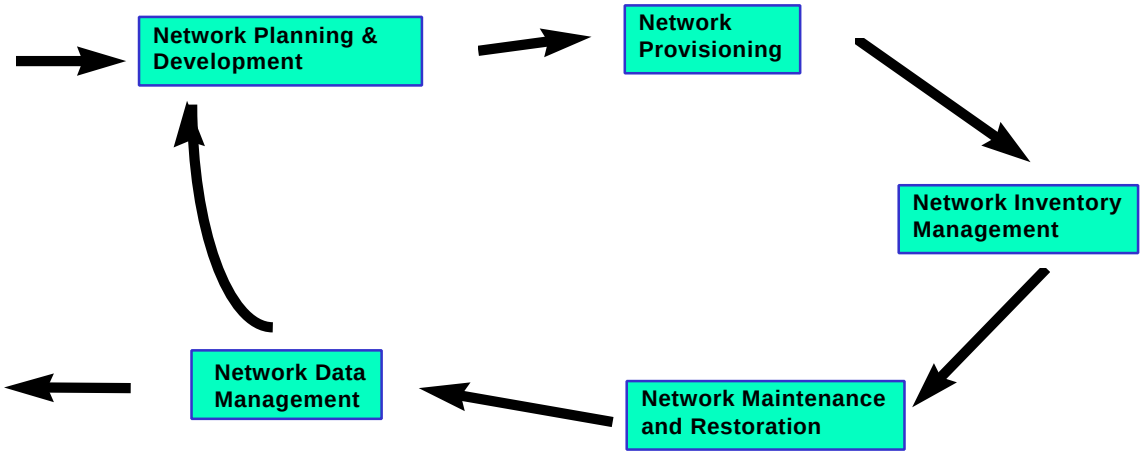

Figure B.3: The Network Management Lifecycle

Whilst many of the planning processes can be largely manual, some of the steps are amenable to automation because they involve the creation of large amounts of data. This has to be internally consistent, and has to be introduced into the operational network in a relatively short interval of time, maintaining a high degree of integrity during the process. The monitoring and maintenance processes may involve the processing of high volumes of small transactions.

Integration of Network Management systems into the Provider's environment is one of the main issues the industry needs to address. Until recently, real-time operational management was limited to the Element Management Layer, i.e. more or less stand-alone alarm and configuration boxes, with much proprietary internal development within the Network Operator to 'glue' important aspects (e.g. alarm monitoring) together. However, moving to the NML, Network Management systems have to support the business processes of the network operator. Inter-operability problems arise because the network management processes are complex, since all of these lifecycles have to be resolved, integrated, and supported.

Interfacing and/or support problems arise in the following areas:

- Deficiencies in life cycle support. Network management systems currently tend to only support the operational phase of network management.
- Inter-operability problems with different network technologies and equipment from multiple vendors.
- Inter-operability problems towards other TMN layers. For example, topology of the network (physical location of NE's, cable management, and logical connectivity) is not supported, and the link towards Service Management is not present.

- Partitioning of, ownership of, and support for network data. Different vendor (element or sub-network management) systems tend to build in assumptions about who owns specific data and who may access or change it. Different Operators choose to manage data in their own environments in different ways and many of their own systems make similar assumptions on location and ownership.

Lifecycle Interaction

The following diagram shows how these three lifecycles interact.

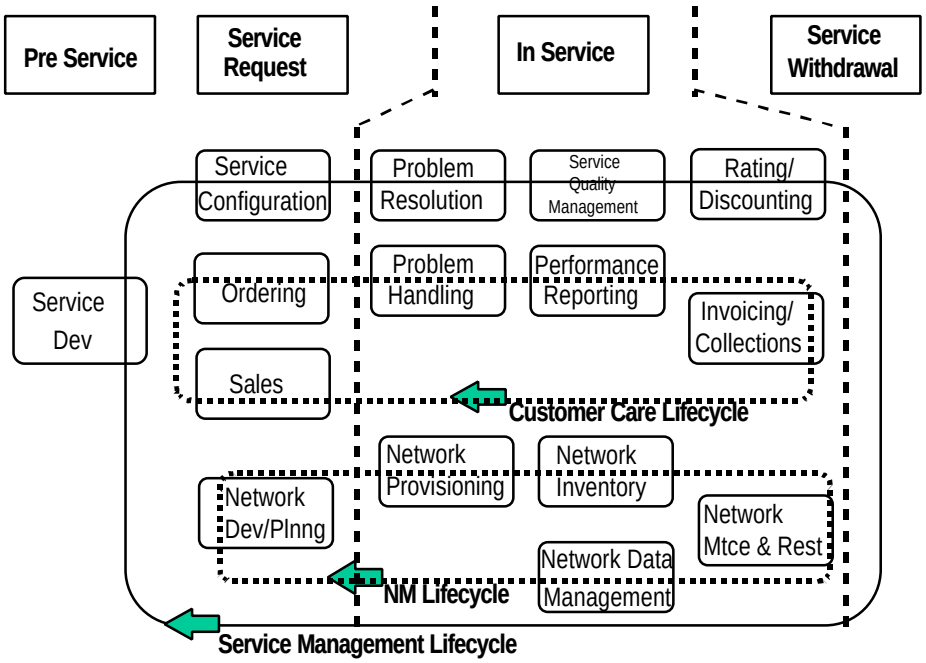

Figure B.4: Telecom Operations Map Lifecycle Relationships

ANNEX C: M.3400 Functions Applicable to the NM Detailed Operations Map

The M.3400 Function Set Groups encompass TMN Function Sets from all TMN layers. In this section for each of the relevant Functions Set Groups the relevant Function Sets are listed (i.e., those applicable at the NML).

	Network Planning & Development	**Network Inventory Management**	**Network Provisioning**	**Network Maintenance & Restoration**	**Network Data Management**
Configuration					
Network Planning and Engineering	· Infrastructure planning (BML) · Network infrastructure design · Access infrastructure design · Facility infrastructure design · Routing design				
Installation		· Procurement (BML) · Management of installation (BML) · Network installation administration · Material management · Scheduling and dispatch administration of installation force			

	Network Planning & Development	Network Inventory Management	Network Provisioning	Network Maintenance & Restoration	Network Data Management
Configuration					
Provisioning		· NE(s) administration (EML) · NE(s) database management (EML) · NE(s) inventory notification (EML) · NE(s) inventory query (EML) · Manage pending changes in NE(s) (EML)	· Network resource selection and assignment · Interexchange circuit design · Access circuit design · Leased circuit design · Facility design · Manage pending network change · Network connection management · Circuit inventory notification · Circuit inventory query · NE(s) path design (EML) · NE(s) resource selection and assignment (EML)		
Status and Control	· Network RAS goal setting (BML)		· Message handling systems network status · Leased circuit network status · Transport network status · NE(s) status and control (EML)		

	Network Planning & Development	**Network Inventory Management**	**Network Provisioning**	**Network Maintenance & Restoration**	**Network Data Management**
Fault					
Reliability, Availability and Survivability Quality Assurance					· Network outage reporting
Alarm Surveillance				· Network fault event analysis, including correlation and filtering · Alarm status modification · Alarm reporting (EML) · Alarm summary (EML)	· Alarm correlation and filtering (EML)
Testing				· Circuit selection, test correlation and fault location · Selection of test suite · Test access network control and recovery · Test circuit configuration (EML)	
Fault Localization				· Network fault localization	
Fault Correction				· Management of repair process (BML) · Scheduling and dispatch administration of repair force	
Trouble Administration				· Trouble ticket administration	
Security					
Detection				· Internal traffic and activity pattern analysis · Network security alarm · Software intrusion audit	

	Network Planning & Development	Network Inventory Management	Network Provisioning	Network Maintenance & Restoration	Network Data Management
Security					
Containment and Recovery				· Network intrusion recovery · Administration of network revocation list · Protected storage of network configuration data · Severing internal connections	
Security Administration				· Testing of audit trail mechanism · Admin of internal authentication · Admin of internal access control · Admin of internal certification · Admin of internal encryption and keys · Network audit trail management · Network security alarm management	

	Network Planning & Development	**Network Inventory Management**	**Network Provisioning**	**Network Maintenance & Restoration**	**Network Data Management**
Performance					
Performance Quality Assurance	· QoS performance goal setting (BML) · Network performance goal setting (BML)				· Network performance assessment
Performance Monitoring					· Network performance monitoring event correlation and filtering · Data aggregation and trending · Circuit-specific data collection · Traffic status (EML) · Traffic performance monitoring
Performance Management Control					· Traffic Control · Traffic administration (EML) · Performance administration (EML)
Performance Analysis					· Recommendations for performance improvement (BML) · Traffic exception analysis · Traffic capacity analysis · Network performance characterization
Accounting					·
Usage Measurement	Planning of usage measurement process (BML)				· Network usage correlation · Usage short-term storage · Usage long-term storage

ANNEX D: Expansion of High Level Business Processes

This annex should be considered "informative." It describes how the high level processes presented in Section 5 are expanded into sub-processes. These sub-processes support the high-level processes and have been derived from discussions with business planning and operational staff in a number of Service Providers. They represent the way providers describe daily tasks they perform, or would ideally like to perform, in managing integrated networks to support automated management of services, delivered to their customers.

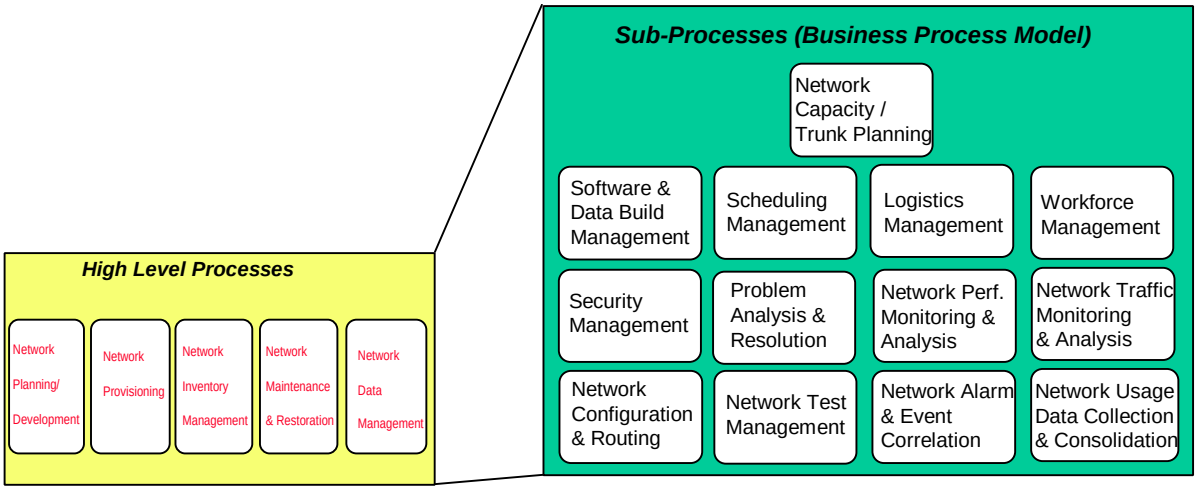

Figure D.1: High-Level Business Processes and Sub-Processes

Figure D.1 shows the five high-level network management business processes and thirteen sub-processes. Note that additional sub-processes may be added as knowledge increases through analysis of this area. This is a slightly different view from that described in current standards, but it should be noted that neither view is wholly right or wrong, nor is either fully complete. Both views are necessary if the objective is to be achieved. The difficult task is to map the process view onto the wealth of available standards that can be used, and to deliver the business benefits through tangible products that can be deployed. In doing that, further requirements will be identified that will influence future standards.

As a first step, the need to understand the relationship of processes and sub-processes with Function Set Groups and Function Sets is useful. The diagram

below (Figure D.2) helps to position them, but does not describe the Function Set Groups or Function Sets in detail (see Reference 4 for more detail).

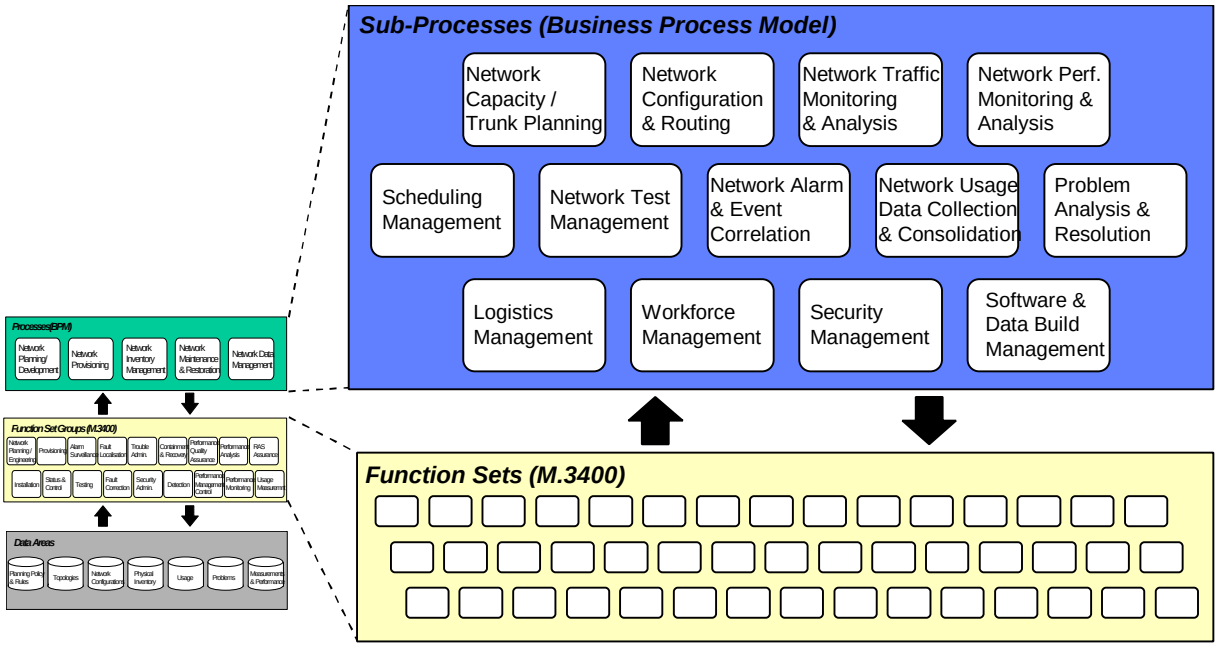

Figure D.2: Relationship Between Processes and Functions

Each process or sub-process will be composed of all or part of the different Function Set Groups or Function Sets, perhaps as a linked workflow, to achieve its objectives. Figure D.3 shows 2 examples of these linked workflow, described later in section D.1, and how these might be used.

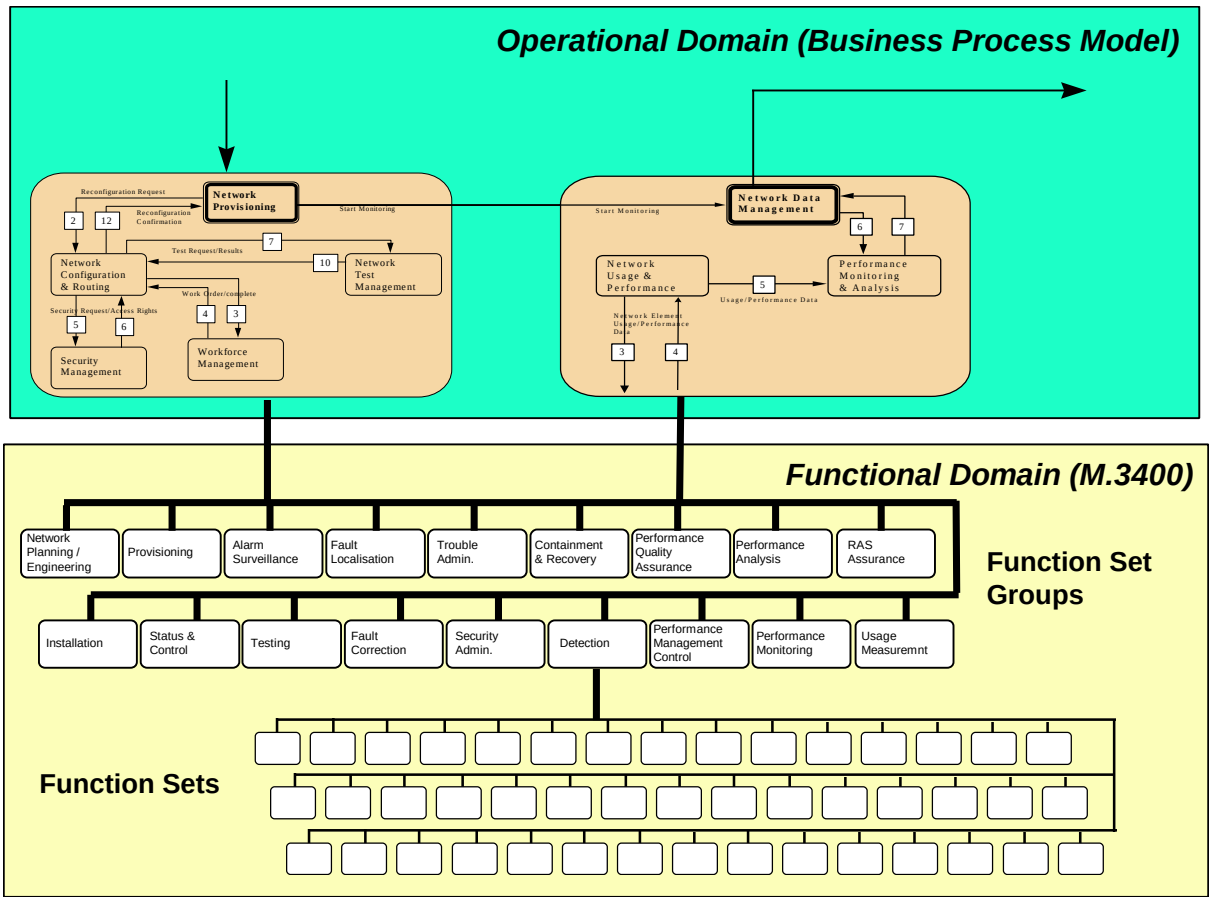

Figure D.3: Process Usage of Function

This Annex will outline some process automation examples that address areas identified to be of common need in the industry and of higher priority. The examples are not exhaustive, but will give a view to industry players of which capabilities could be tackled first, as part of an industry effort. Initially it can be seen that each high level process maps to several sub-processes and that each sub-process maps to several high level processes, creating many-to-many relationships. Figures D.4 - D.8 show the mappings of each high level process to the relevant sub-process(es). Note, that at this point no attempt is made to map the processes to the functions, and that the figures are only addressing a subset of the overall functionality, and should be read as illustrative only.

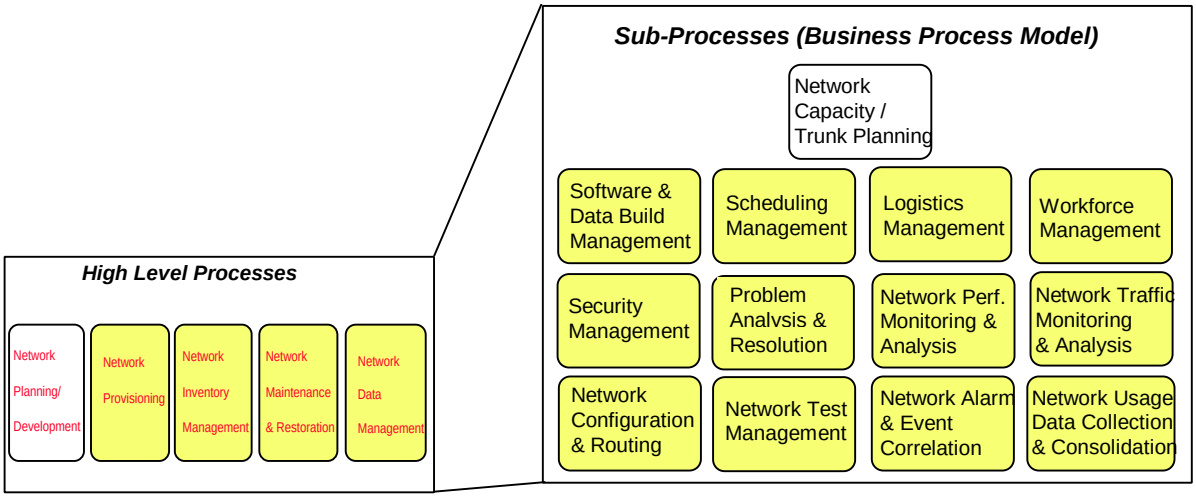

Figure D.4: Mapping of Network Development & Planning with Sub-processes

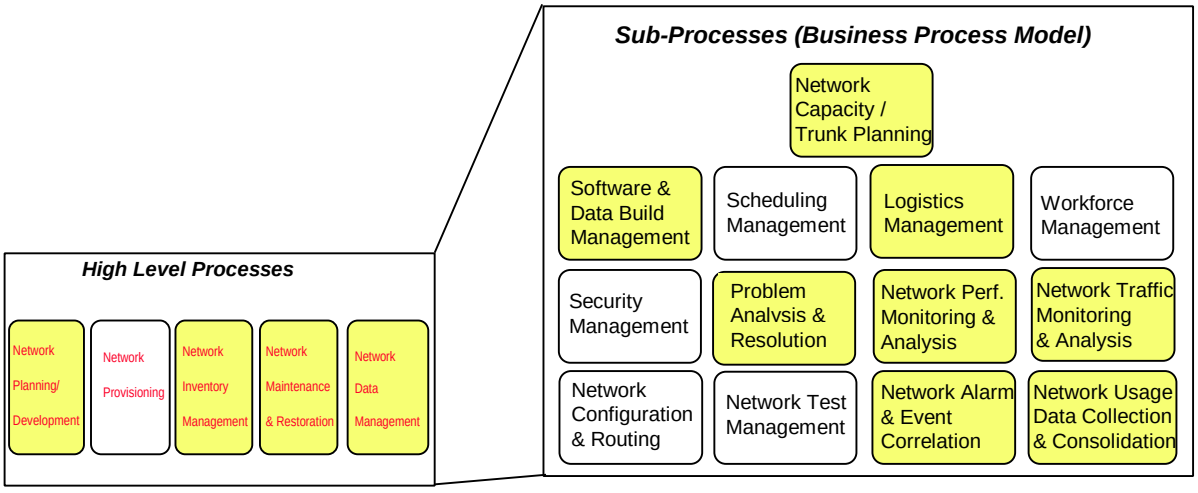

Figure D.5: Mapping of Network Provisioning with Sub-processes

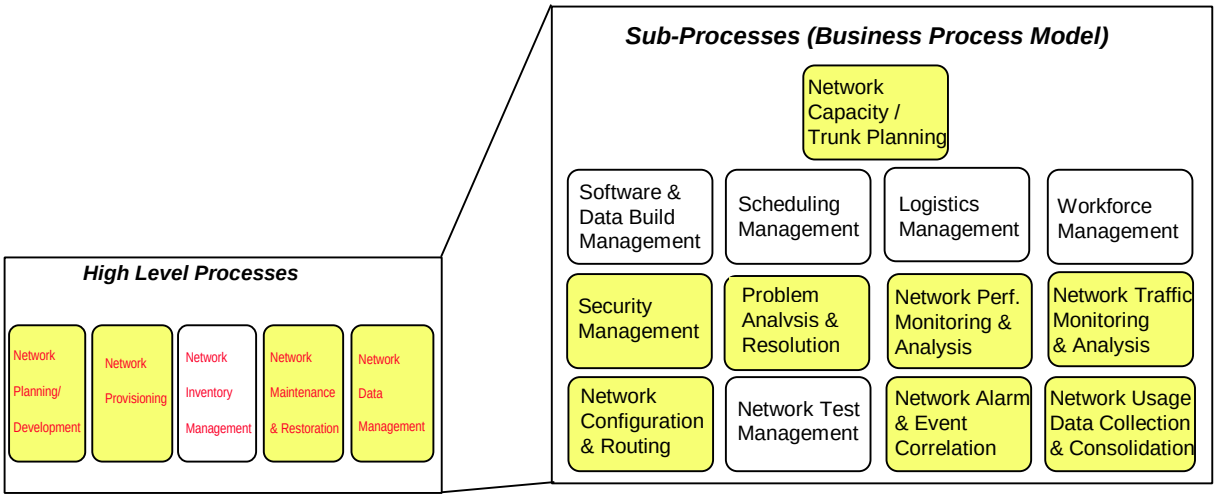

Figure D.6: Mapping of Network Inventory Management with Sub-processes

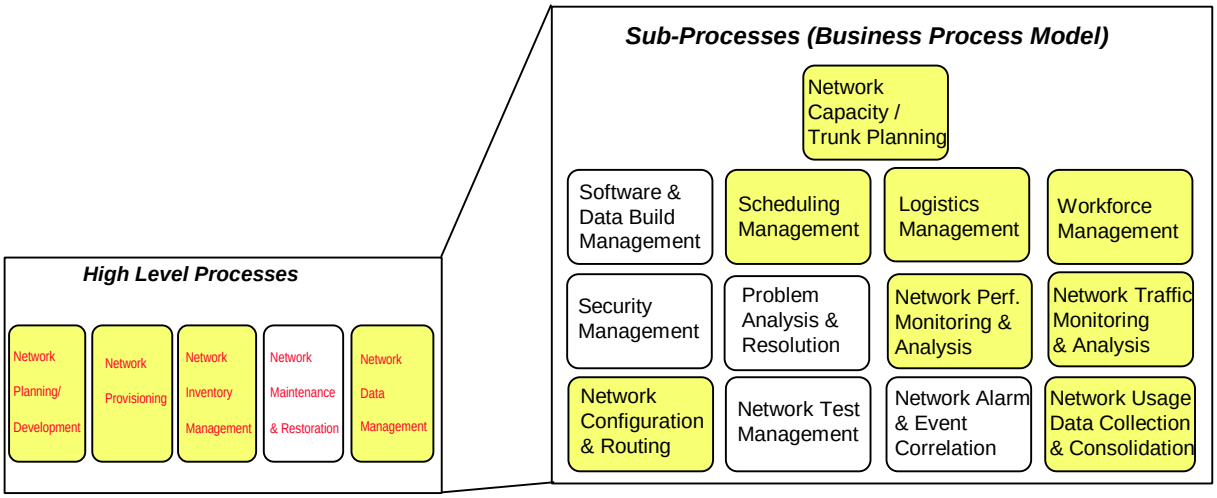

Figure D.7: Mapping of Network Maintenance & Restoration with Sub-processes

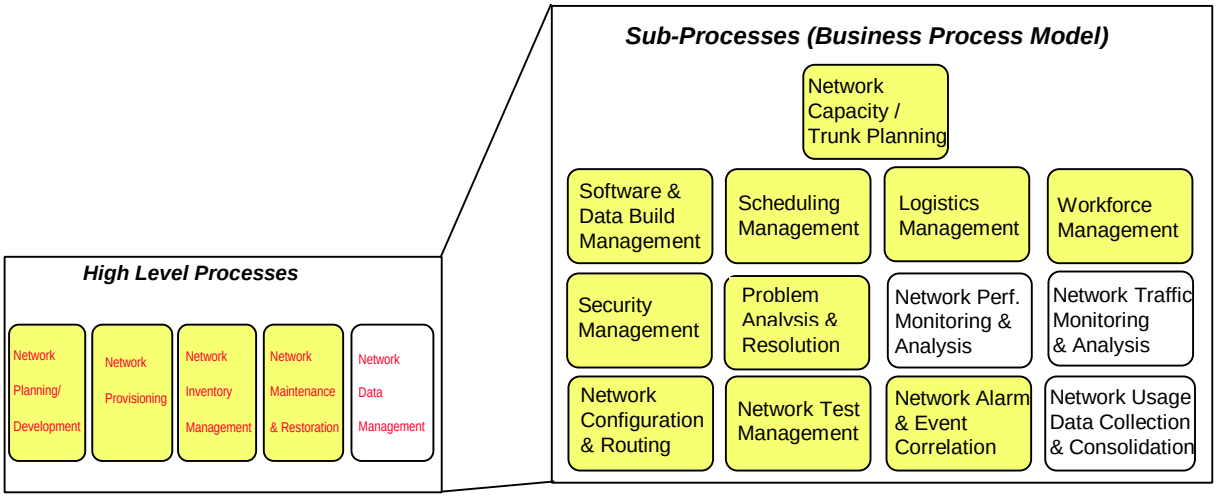

Figure D.8: Mapping of Network Data Management & Control with Sub-processes

Business Process Mapping Examples

This section shows two examples in which the flow of information between the sub-processes is depicted. Although they were chosen arbitrarily, they demonstrate the insight gained through the expansion of high level processes. The figures show the flow between TMN Layers and between those sub-processes supporting the high-level business process. The shaded area in each Figure shows those sub-processes that make up the high level process.

This method of representation facilitates rapid understanding and insight into process functionality. Assuming sub-processes like those shown will be available as reusable software objects, quick development of and re-design of processes will be possible.

Network Provisioning Process Example

This example assumes that a new service is being provisioned and that the necessary network construction has already taken place. The numbers in Figure D.9 show, as an example, the sequence of operations starting with a network provisioning request [1] from the Service Configuration process within the Service Management Layer and finishing with the configuration result [13]. Then it shows the start monitoring [14] messages sent to the Service Configuration and Network Data Management processes respectively.

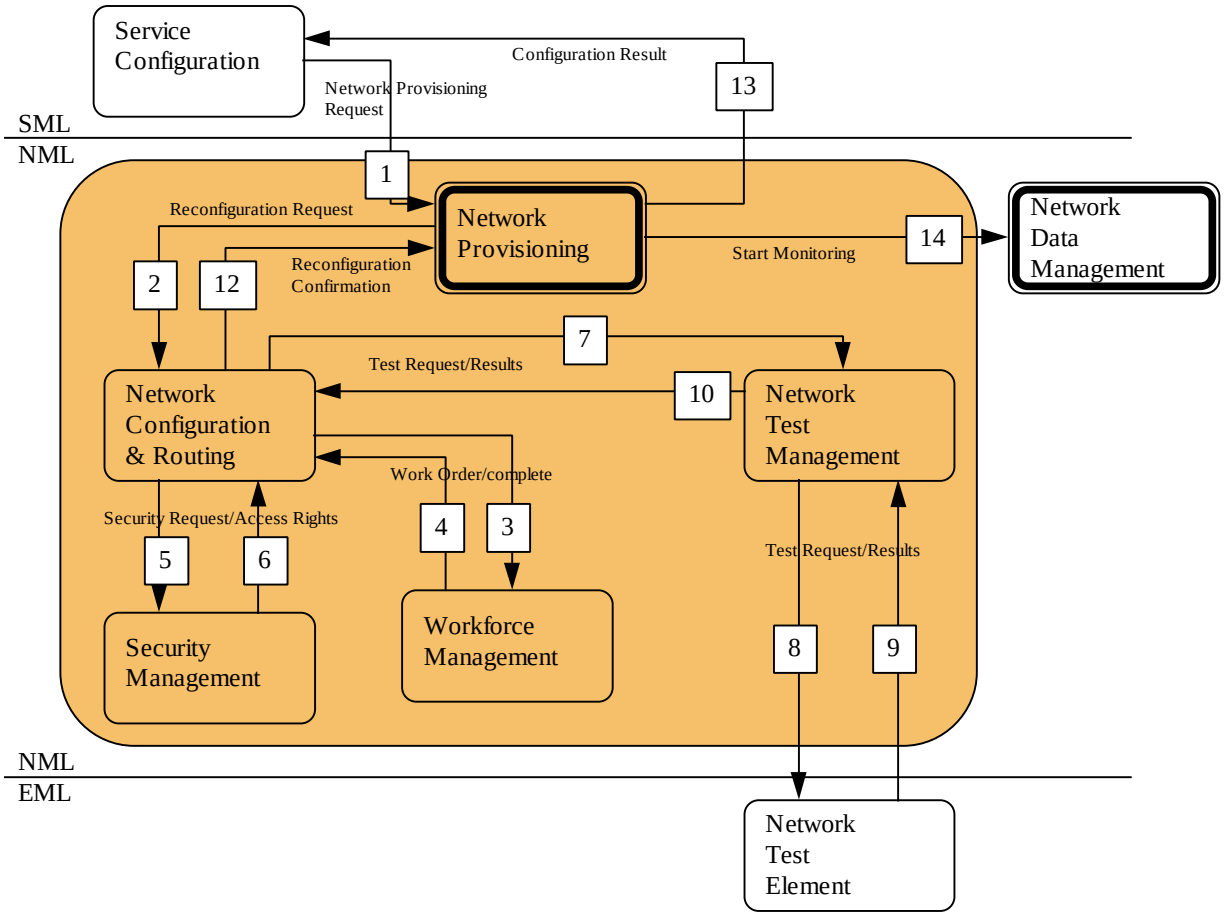

Figure D.9: Process Flow for Network Provisioning

Network Data Management Process Example

This example assumes a new service has been provisioned and has triggered Network Data Management to start its function. Further, it shows that Network Data Management has discovered an out-of-spec condition and has notified the Service Problem Resolution process.

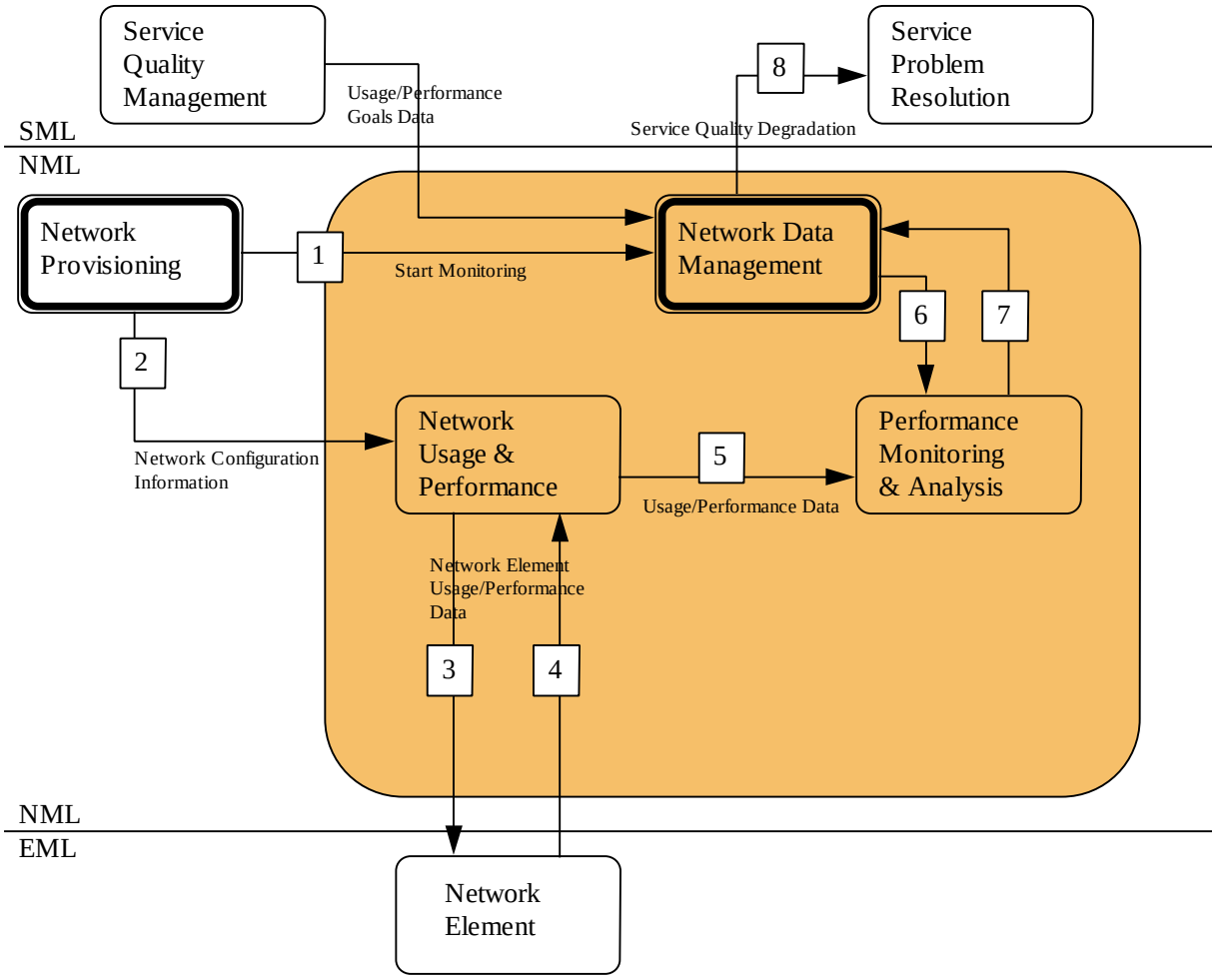

Figure D.10: Process Flow for Network Data Management

Detailed Descriptions of Sub-Processes

Although each sub-process has many triggers and data flows, in the examples shown above, only those triggers and data flows pertinent to the high level process are shown. This section shows a more detailed view of inputs, outputs and responsibilities of three of the sub-processes used in section D.1. This can be seen by comparing the subset of inputs & outputs shown above with those shown in the figures below.

Performance Monitoring and Analysis Sub-process

Managing/Servicing individual NLA's with the Service Management Layer

This sub-process is responsible for managing, processing and analyzing network and NE statistical information, to determine and track network performance, providing Network Performance Assessment. It is also responsible for the gathering of network performance data needed by the Service Management Layer to track Service Level Agreements. Mapping of the SLA to the network level has been called a Network Level Agreement (NLA).

Inputs:

- Receives Network Performance and QoS performance goals from Network Planning and the Service/Business Layer processes. This would include performance requirements, thresholds for degradation notification, and organization/scheduling information such as, which reports are done daily, which are done monthly, and so forth.
- Receives Network QoS threshold events, including error Threshold events, from Network Alarm/Event Correlation and assessing immediate or potential impact on NLA's.
- Receives statistical data, which may include Call Detail Records for switched services, from the Network Usage Data sub-process, in order to track resource and connection QoS and utilization.
- Receives network test data from Network Test Management, used to characterize performance; such as, baselining and Network/QoS assessment.
- Receives network outage information from Alarm/Event Correlation in order to track resource/connection availability, MTBF, MTTR. Receives traffic violations from Traffic Monitoring
- Requests network inventory and topology data from the Network Inventory Management process, to analyze performance data.

Functions:

- Performs trending of historical information to predict future performance and provide proactive maintenance recommendations.
- Maintains historical view of network performance information.

Outputs

- A historical view of Network Performance analysis. Outputs Capacity and Traffic analysis to Business Layer (Forecasting and Planning)
- Network performance degradation notifications to Network Maintenance and Restoration.

- Outputs NLA violations to the Service Management Layer.
- Outputs network domain performance statistics to Service Performance Reporting.
- Requests additional performance data from Network Data Collection and/or Network Test Management based on the need for proactive maintenance of suspect resources.
- Identifies the need for changes in network capacity to Network Planning.

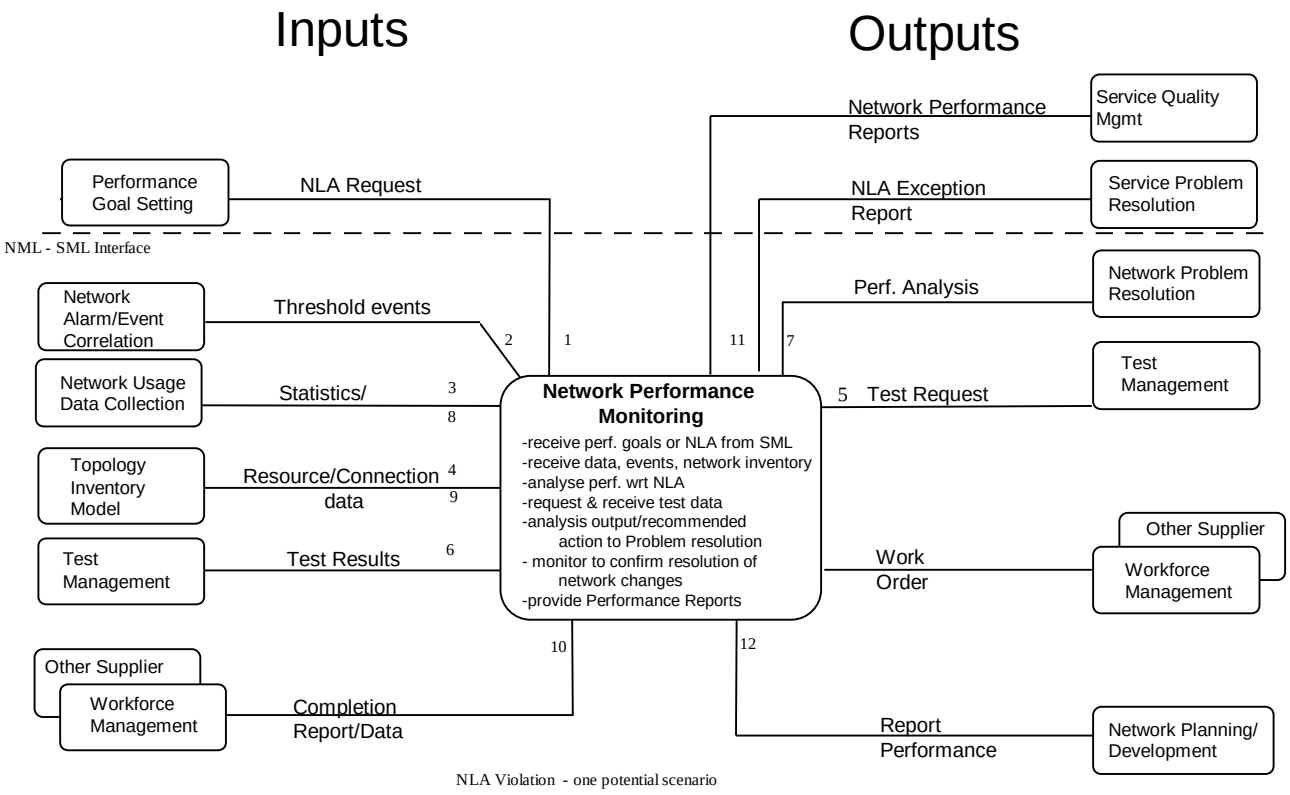

Figure D.11: Network Performance Monitoring

Network Test Management Sub-process

This sub-process is responsible for verifying the operational usability of individual or connected network components, which may be supporting a service, and determining causes of faults. It manages all aspects of the testing process, determining the appropriate tests that will be run, depending on path and equipment characteristics, controlling the tests, collating, and comparing the results against predetermined limits or norms. It provides traceability and audibility against all actions.

Inputs:

- Receives test request commands from Network Configuration and Routing for pre 'in-service' components and Network Problem Resolution for 'in-service' components.
- Receives test request commands from Network Performance Monitoring & Analysis for performance problems, Network Problem Resolution for network failures, and from Scheduling Management for routine testing.
- Receives network and element configuration details.
- Receives test results from Element Management Systems.
- Receives circuit ID information from test requester.

Functions:

- Maintains suite of suitable test suites and expected test results.
- Maintains a database of test resources.
- Identifies explicit components to be tested.
- Manages the application of different tests to differing equipment and paths.
- Identifies if test will be destructive (to existing traffic) or not and gives suitable warning.
- Runs Scheduled routine tests as requested.
- Compares test results with expected result and assigns the pass/fail/indeterminate.
- Maintains log of test and result.

Outputs:

- Requests configuration details from appropriate network databases.
- Requests Element Management Systems run tests.
- Reports 'completion' to Scheduling Management and 'fails' to Network Problem Resolution.
- Outputs results to Network Configuration and Routing for pre 'in-service' components
- Outputs results to Network Problem Analysis & Resolution or to Network Performance & Monitoring for 'in-service' components.

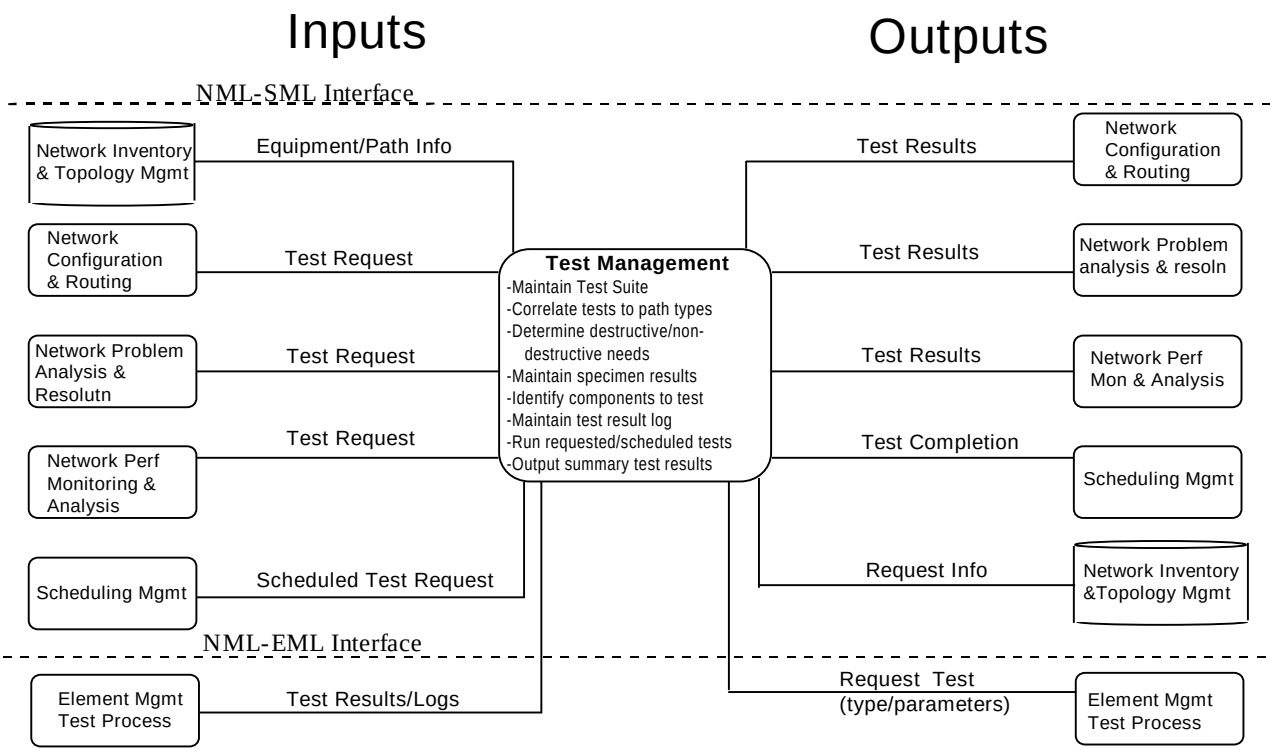

Figure D.12: Network Test Management

Network Configuration & Routing Sub-process

This sub-process installs the initial logical configuration of the network after network construction. Furthermore, this process designs and installs network re-configurations in the operational network. In the design process, business rules for the utilization of the network are applied. In the design, the reconfiguration requests from different sources (high level processes an sub-processes) are coordinated. This sub-process is also responsible for the alignment of the configuration as stored in the network management and administrative systems with the real network configuration.

Inputs:

- Initial configuration design of a newly constructed network from the Network Capacity/Trunk Planning process.
- Requests for reservation and configuration of standard network capacity from the Service Configuration process.
- Reconfiguration requests:
  - From the Network Capacity/Trunk Planning sub-process, when network integrity might be compromised by third party activity.
  - -from the Service Configuration process when a service request cannot be implemented from the available network inventory. In this

case, the Network Configuration & Routing sub-process will investigate if capacity can be obtained by reconfiguration.

- From the Problem Analysis & Resolution sub-process when a structural network problem can be resolved by network reconfiguration.
- From the Logistics Management sub-process when network construction requires reconfiguration of the network, because the operational network is jeopardized by the construction activities.
- From the Network Capacity/Trunk Planning sub-process when reconfiguration is required to link the new network to the existing network.

Functions:

- Reserves and configures standard network capacity.
- Responsible for network re-configuration.
- Installs initial network configuration and subsequent network reconfigurations. Issues work orders when physical actions are required for network reconfiguration.
- Keeps actual network configuration synchronized with network configuration information stored in network management and administrative systems.
- Maintains routing and connectivity tables.
- Applies business rules for network utilization.
- Co-ordinates re-configuration requests.

Outputs:

- Notification to the Service Configuration process about installed standard capacity.
- Notification to other processes about pending re-configurations:
- To the initial requester of the reconfiguration.
- To affected processes; such as, the Network Performance Monitoring & Analysis, Network Traffic Monitoring & Analysis, Network Alarm & Event Correlation, Network Usage Data Collection & Consolidation, and Network Capacity/Trunk Planning sub-processes.
- Work order information to the Workforce Management process.

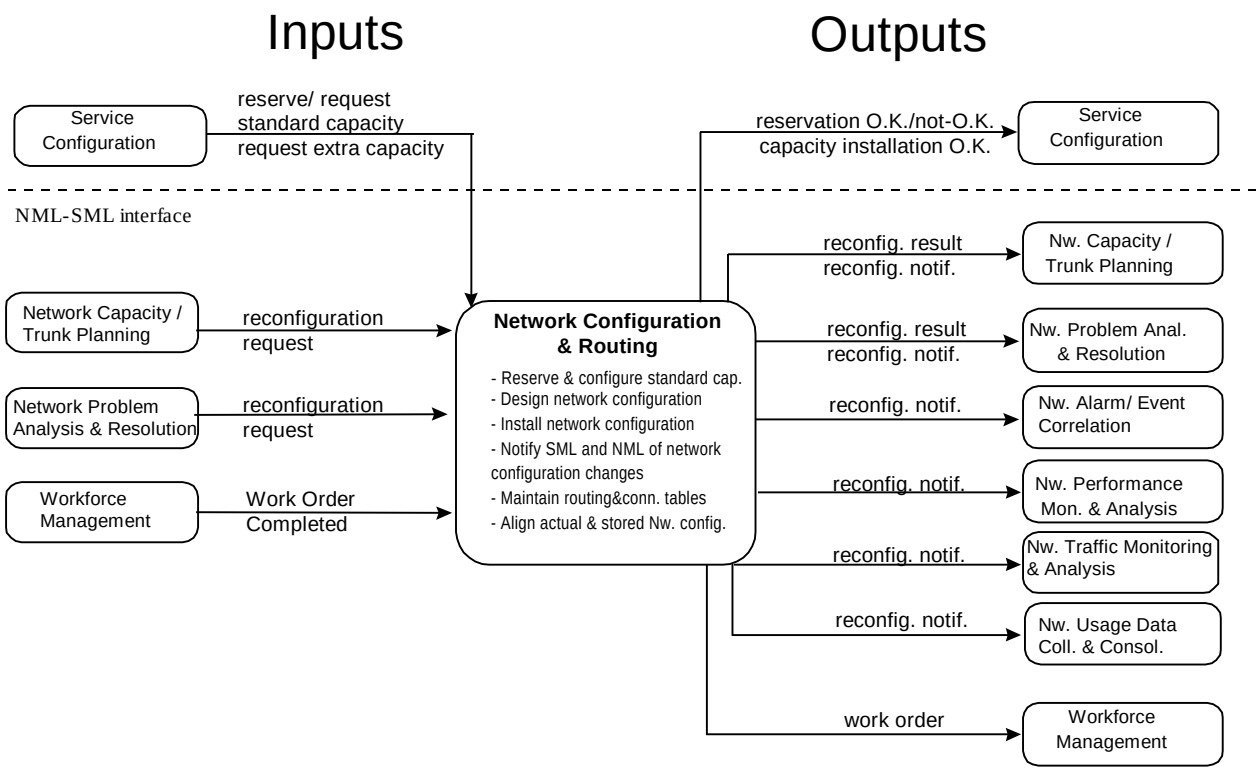

Figure D.13: Network Configuration and Routing

Appendix

Partitioning of Function Set Groups (M3400) and Data Areas into Generic and Sub-Network Function Set Groups, Data Areas and Generic Sub-Network Interfaces

Patent Declaration: TM FORUM has been informed by one of its members that the member has been granted a US patent and has other patent applications pending which may, in the members' opinion, be of interest in connection with the attached material.

The Member has issued the following statement pertaining to US patent 5 640 505 and European patent application 95930663.0:

TM FORUM has been informed that a US patent and a European patent application belonging to an TM FORUM member are relevant to the material contained in the member's contribution into the NM Detailed Operations Map. Subsequently, TM Forum received written confirmation that the member will grant licenses with fair and reasonable conditions.

The invention protected by the US patent and a European patent application relates to the construction of the operational support structure from a set of domains. In the invention, each domain is formed from at least one computer and domains include:

- a domain for managing customer handling system,
- a domain for managing individual technologies,
- a domain for managing network operations.

The TM FORUM member considers the functional groups, data areas and interfaces defined in the NM Detailed Operations Map, including the partitioning in Appendix 1, can be implemented without using the invention protected by the US patent and the European patent application. Again, the member has provided a letter that licenses will be granted on fair and reasonable terms and conditions.

Members' comments are invited and will be shared with other members upon request.

TM FORUM issues the foregoing under the provisions of the TM FORUM Agreement on Intellectual Property. TM FORUM takes no position on the statements made by member or on the validity or applicability of the patents and patent applications held by member.

Note: The declaration was made against an earlier draft of this document. If the material in this document is formally accepted by TM Forum members, TM Forum will seek further clarification from the member that this declaration applies to any formally published material prior to actual publication.

Introduction

Traditionally Element Management level within the TMN Architecture has been used as the boundary for containing the technology specific management capabilities whilst giving a generic view of the network to the higher management layers (e.g., NML, SML etc.). Such a boundary is adequate for managing individual technologies but leaves much of the integration across technologies to be undertaken by the Service Providers/Network Operators. Increasingly Service Providers/Network Operators seek solutions from the Equipment Suppliers in the form of complete Sub-Networks. Such Sub-Networks may consist of a range of technologies (Routers, Switches, etc. in an IP network) from multiple vendors. The Telecom Operations Map discusses mutual benefits, to the various players in the communications industry, and the partitioning Network Management Layer into Generic and Sub-Network specific components and providing 'plug and play' type interfaces at the Sub-Network level. Currently, there is no industry wide agreement on such a partitioning.

To facilitate productive discussion between the Service Providers/Network Operators and Equipment Suppliers, this Appendix proposes to complement the main body of the TMF Telecom Operations Map. Specifically, this is related to the partitioning of the Network Management Function Set Groups and Data Areas into their Generic and Technology related counter parts. The Appendix also identifies the essential plug and play set of interfaces between the Sub-Network Management and higher layer Processes/Functions Set Groups.

Partitioning and Interfaces proposed in this annex are based on BT's Tile Architecture (as this architecture is specifically based on management of Technology Domains). As such the TMF Telecom Operations Map team considers the titles given to the partitioned Function Set Groups and Data Areas to be proprietary and tentative. However, the team's objective remains to agree on the terminology or a modification of the terminology(where possible aligned with existing terminology used in the International Standards) following formal review and assessment for enhancement to the TMF Telecom Operations Map. Once the terminology is agreed, the appropriate architectural changes will be reflected in the main body of the TMF Telecom Operations Map in a future release of the document.

Partitioning of Function Set Groups

This section provides the partitioning of Function Set Groups as identified in the main body of the NMF Telecom Operations Map into their Generic and Sub-Network specific counterparts.

Function Set Groups (M3400)	**Partitioned Function Set Groups (Titles are proprietary, based on BT Tile Architecture)**	
	Generic Function Set Groups	**Technology Domain Related (i.e. Sub-Network) Function Set Groups**
Network Planning & Engineering	() Network Modeling (ii) Network Design (iii) Physical Network Element Planning	Capacity Planning
Provisioning		Capacity Assignment
Status and Control	Network Build Management	(i) Network Configuration (ii) Maintain Equipment Build levels and upgrade plans (iii) Software and Data Build Management

Function Set Groups (M3400)	**Partitioned Function Set Groups (Titles are proprietary, based on BT Tile Architecture)**	
	Generic Function Set Groups	**Technology Domain Related (i.e. Sub-Network) Function Set Groups**
Installation	() Equipment Movement Management () Supplier Interaction Management (iii) Job Control – Network Build (iv) Scheduling (v) Workforce Management	Commission Equipment into Operation
Alarm Surveillance	() Network Problem Correlation (ii) Scheduling and Routine Management	Technology Problem Correlation
Testing		Technology Test Management
Fault Localization	Network Route Cause Location	Technology and Physical Root Cause Analysis
Trouble Ticket Administration	() Job Control (Trouble Ticket)	

Function Set Groups (M3400)	**Partitioned Function Set Groups (Titles are proprietary based on BT Tile Architecture)**	
	Generic Function Set Groups	**Technology Domain Related (i.e. Sub-Network) Function Set Groups**
Fault Correction	(i) Network Restoration Analysis () Equipment Movement Management ( ) Supplier Interaction Management (iv) Workforce Management	(i) Technology Restoration Analysis (ii) Network Configuration (iii) Commission Equipment into Operation
Reliability, Availability, and Survivability Quality Assurance	Reliability, Availability, and Survivability Quality Assurance	
Performance Monitoring		(i) Network Element Monitoring (ii) Capacity Utilization Monitoring
Performance Analysis	Network Usage Analysis	Technology and Equipment Performance Analysis
Performance Management Control		Network Configuration

Function Set Groups (M3400)	**Partitioned Function Set Groups (Titles are proprietary based on BT Tile Architecture)**	
	Generic Function Set Groups	**Technology Domain Related (i.e. Sub-Network) Function Set Groups**
Performance Quality Assurance	Performance Quality Assurance	
Usage Measurements		Network Usage Data Collection & Consolidation
Detection		(i) Access Security (ii) Capacity Utilization Monitoring
Containment and Recovery		Software and Data Build Management
Security Administration	Network Security Management	Access Security

Partitioning of Data Areas

Currently there are no defined standards for data that needs to be shared by various Function Set Groups. The NM Detailed Operations Map has recognized

the need for identifying such data areas as identified in the main body of the document. The following table suggests suitable partitioning of these data areas into generic and technology dependent sets. It also identifies some additional data areas that are not currently identified in the NM Detailed Operations Map but are relevant.

Data Areas	**Partitioned Data Areas**	
	Generic Data Areas	**Technology Domain Related (i.e. Sub-Network) Data Areas**
Planning Policy & Rules		Planning Policy and Rules
Topologies	Network Topologies	(i) Technology Topologies (ii) Physical Topologies
Network Configurations		Network Configurations
Physical Inventory	Spares and Buffer Stock Inventories	Physical Inventory
Usage	Usage Long Term	Usage Short Term
Problems	Network Problems	(i) Network Configuration Problems (ii) Inventory Faults
Measurements & Performance		Measurements & Performance
	Build Orders	
	Serving Points	
	Trouble Tickets	

NM Function Set Groups and Data Areas (Generic)

This section provides a brief description of each of the Function Set Groups and Data Areas at the Generic Level.

Function Groups (Generic)

Network Modeling - Network Modeling will create and maintain models of network configurations and topologies to examine the effect of potential changes. These are in response to requests for new or re-optimized network designs. It will apply a set of pre-defined rules, using available network usage data, to simulate changes and analyze the effect on existing or proposed network resources.

Network design - Network Design is the function which develops the plans, policies & rules and network designs (creating, amending and deleting nodes and links) to meet the future demands on the network for network changes, rearrangement or new products and services. This function, whilst involving a

high degree of manual activities, will be supported by expert systems to enable "what if" scenarios to be developed and modeled by the Network Modeling function based on the actual current network configuration. This function will provide the Capacity Assignment function with the assignment rules and the Capacity Planning function with planning rules.

Network Usage Analysis - Network Usage Analysis function processes all the usage data collected by the Network Usage Data Collection function and held in the Measurements and Performance (Traffic) data store. It performs arithmetic and statistical calculations for report purposes and formats data for recording against the required measurements of traffic usage It performs trend analysis on the traffic data and compares historical and predicted future levels against the threshold details. This will enable early identification or predictions of problems before they become service affecting. Problems (including potential problems) are recorded in the Network Problems data store and notified to Job Control (Trouble Ticket) for tracking of the resolution. Quality levels will be measured in real time to enable action to be taken immediately when service levels fall, or are predicted to fall, below pre-defined limits. Where, because of an identified problem, additional data or collection on a different periodicity is required, this function will notify Network Usage Data Collection of the data requirements.

Network Problem Correlation - The Network Problem Correlation function will provide one of the most powerful tools in the identification of faults and traffic problems in the network. It will take problem reports from the Network Problems data store. This will have been populated from three primary sources:

- from the network via Technology Root Cause Location, where some level of correlation will already have been performed;
- from the Network Usage Analysis function; and via exception, from the customer via Product Problem Analysis.

Network Root Cause Analysis - The Network Root Cause Location function uses information obtained by the Network Problem Correlation function to identify the location of the fault in terms of logical component or the cause of a traffic problem. Network Root Cause Location will use fault histories from the Network Problems data store and expert systems technology to deduce the most likely cause of the problem or location of the fault. The introduction of modern technology into all parts of the network should also enable in-built diagnostics to be invoked to help with the location of faults. A Trouble Ticket will be created and will contain all relevant details of the fault. Having identified the logical component that is faulty, a request will be made to the Physical Root Cause Location function to identify the faulty piece of equipment.

Network Restoration Analysis - The Network Restoration Analysis function determines the options available to restore service taking into account the availability of network capacity, equipment and the workforce to complete any tasks. With remote configuration capabilities, the first option will normally be to invoke a reconfiguration rather than to repair the fault. This will allow fault repair to be non-urgent lower priority tasks. Network Restoration Analysis will also propose solutions to resolve network problems which are traffic or usage related,

caused by demands placed on the network by customers or by a fault in the network. This will involve all network resources that are traffic related, e.g. switches, routes, signaling paths, and service control points. In the future with bandwidth on demand, additional measurements and controls will be required to deal with the utilization of bandwidth.

Equipment Movement Management - The Equipment Movement Management function is responsible for the automatic tracking and stock control of all equipment (Network and CPE). Restocking of supply points (vans, local stocks etc.) will be automatically initiated including delivery to specific pick-up points and homes for staff working from home. All equipment will be bar coded to enable it to be located and tracked. This function will be linked to supplier delivery processes to allow Just In Time (JIT) ordering.

Requests for equipment to support a business process will require the location of the pick up point or the delivery mechanism to be specified to ensure that activities required are scheduled along with the other tasks.

Supplier Interaction Management - Manages flow of information to and from equipment suppliers:

- Availability and Capability of new technologies
- Compatibility's
- Network Plans and Configurations
- Build Orders and Delivery Plans

Job Control - The primary functions of Job Control is to interleave automated tasks with manual tasks. The inter-relationships of different jobs will mean that one Job Control function may invoke another one to initiate another job (e.g., the order control may instigate a planning job as a result of a shortage of capacity).

Physical Network Element Planning - establishes the method of meeting the capacity demand either by purchase, moving of surplus capacity or the repair of faulty elements.

Network Build Management - Maintains the overall build levels of the network and ensures that changes made within individual sub-networks will not jeopardize the overall compatibility across the rest of the network.

Scheduling & Routine Maintenance - The Routine Maintenance Management function covers the creation, maintenance, and operation of a schedule of routine maintenance activities carried out on a periodic basis on Network Equipment, including: Software and Data Audits, producing backups of the software and data, and routine testing of equipment.

Network Security Management - Monitors and Analyses security violation (unauthorized/fraudulent use) of network.

Workforce Management - Identifies appropriate skills levels, availability of resources, allocation of work, and monitoring work progress.

Data Areas (Generic)

Network Topologies - The Network Topology Data Area provides a logical view across the entire network to enable coordinated planning and building of the Network. This data area enables a view to be taken which is independent of the technologies and platforms. It also provides a high level view of the capacity of the network. Network Topology information is mainly created by the planning processes where this high level view of the network is required

Build Orders - Build Order data documents network and configuration changes necessary to implement designs as defined in the Network Configuration data area. A Build Order may both draw on resources and ultimately provide capacity as defined in the Physical Inventory data area. Build Orders may initiate Jobs as defined in the Work Management data area. A Build Order may specify a modification to a Network Topology Element as defined in the Network Topology data area.

Serving Points - Network Serving Point describes the Network Serving Areas for individual service types. The Network Serving Points data area contains information about the Network Points (NSP) themselves and the information, which is required to support them. The concept of NSPs is essential in allowing the design of Customer Service Solutions across different Sub-networks, as they represent the points of entry and exit from the different Comprehensive Network Serving Point information and will enable rapid service provision.

Spare and Buffer Stock inventories - holds details and location of spares and Buffer stock inventories.

Network Problems - Describes problems that have been reported against overall Network Configurations (e.g., end-to-end circuits). Problem reports have originated from the network and/or customers. The information includes problem correlation details and diagnosis. A problem is a perceived malfunction, i.e.. it may indicate that a failure has occurred in a Network Component but the actual cause of the failure may be elsewhere. Several problem reports may be related to a single fault. For example, a cable break may raise a number of alarms including signaling errors and loss of cable pressure. The root cause location process uses this information to localize the fault.

Trouble Tickets - Records the progress of a fault report, from inception to clear, following localization of a problem to an equipment item. Correlation functions may use this information to inhibit analysis of subsequent related problem reports. Customer contact functions may use the information to advise customers of anticipated restoration times. Also included in this data are the tasks required to complete the clear. The tasks are described in terms of activities, dependencies between activities, and plans and time-scales. Further information

is held which describes job performance, e.g., planned and actual times, costs, etc.

Sub-Network (Technology Related) Function Set Groups, Data Areas, and Interfaces

Sub-Network Function Set Groups

This section describes the functional set groups encapsulated within the Sub-Network Management.

Capacity Planning - This function:

- Forecasts the future capacity requirements based on current demands and utilization of the resources within the sub-network.
- Enables new capacity to be planned and brought into operational status in a controlled way within pre-defined thresholds and rules.

Capacity Assignment - This function:

- Determines network resources (VCs, VPs etc.) required for a PVC;
- Produces initial design/s of PVC/s (including alternative options if required);
- Reserves, assigns or releases the network resources (e.g., VCs and VPs that are needed to make up a PVC).

Network Configuration - is invoked by Capacity Assignment. It will also ensure that the necessary configuration is effected within the network elements, which includes bandwidth controls, ABR, CBR etc.

Capacity Utilization Monitoring - collects information about utilization of logical network elements and identifies potential shortages and under utilization for input to the Capacity Planning function.

Technology Problem Correlation - identifies faults and traffic problems (or potential problems) in the sub-network and associates the related problems and passes them to Root Cause Analysis.

Technology and Physical Root Cause Analysis - identifies the sub-network component or components (Physical or Logical) that are faulty or most likely to be faulty or the cause of a traffic problem.

It also provides access to detailed views of the Technology Topologies, Sub-Network Configurations, and physical Equipment (e.g., Racks, Shelves, Slide in units, etc.) that are planned and installed within its domain.

Technology Restoration Analysis - determines options available within the sub-network to restore service taking into account the availability of network component capacity. Chooses the optimum option and restores the service and escalates if unable to restore.

Technology Test Management - provides the automated testing and diagnostic capabilities to allow a component part of the network (e.g. a Virtual Circuit or an individual functional block on the ATM switch). This is for the component part to be tested for correct operation or to diagnose a problem.

Network Element Monitoring - This function will:

- monitor status of individual network components
- receive, filter and standardize the format of the reports from the network
- hold a secure log of these reports
- provide capability for clearing the contents of the above logs
- provide capability for resetting and interrogation of alarm conditions received from the network

Technology and Equipment Performance Analysis - These functions process measurements and performance data and will:

- conduct trend analysis
- compare historical and predicted levels against thresholds
- identify/predict problems before they become service affecting.
- measure Quality levels in real time.

Network Usage Data Collection and Consolidation - deals with data collection and assembly of all usage information for use by Billing, Performance & Usage Analysis. The aim is to be able to record all or selected events (billing, performance etc.) of usage of network configuration instances both effective and ineffective. Additionally this function will need to collect other non-usage data, such as, customer configuration of services.

Commission Equipment into Operation - commissioning planned or replacement equipment and bringing it into operational use in a controlled way.

Maintain Equipment Build Levels and Upgrade Plans - This function will:

- maintain a record of new equipment planned to be introduced into the network and ensures compatibility
- ensure that when new/replacement equipment is introduced it is compatible with the existing build levels
- maintain the inventory data and reconcile in-service inventory with the Network Plans

Software and Data Build Management - provides remote/automatic capabilities for:

- producing backups for the software and data that is required for correct functioning of the network elements and the sub-network
- ability to check the integrity and accuracy of software and data against corruption or virus infection etc.
- restore software and data to a known state
- enhance/upgrade software and data

Access Security - refers to the ability to:

- install 'Sub-Network/Element Managers' in way as not to contravene the security of the networks or other systems forming the overall 'Management Network'.
- authenticate each transaction
- maintain an audit trail of all or selected transactions to a sufficient level of detail (e.g., date/time, origin, authentication signature, details of transaction and responses) to allow audits to be carried out for fraud and illegal access.
- identify illegal or fraudulent accesses to the sub-network manager

Sub-Network Data Areas

In addition to the functions, the conglomeration of Sub-Network/Element managers will also host the following data areas:

Planning Policy and Rules - This data areas identifies the policy and rules for:

- allocation of network resources for capacity planning
- optimization of the network based on utilization

Technology Topologies - describes the inter-connectivity of Nodes, Routes, Links, and Capacity for technology types. Technology Topologies are essentially logical maps of the network for technology types. Also includes navigation

information e.g. Switching and Routing details, to show how traffic may be routed within a technology type.

Physical Topologies - describes information about the structure of the network at a physical level, e.g., Plug-in Units, Racks, Shelves etc.

Network Configurations - This data area is concerned with individual instances of network configurations (e.g. a PVC) and the component parts that comprise them. This area is primarily concerned with logical connectivity rather than physical equipment items and transmission media.

Physical Inventory - The Inventory Data Area holds information on physical equipment (inventory items and stock) and describes all instances (historical, current and planned) of inventory items that are required to support the providing Network Configuration instances. This includes information about software programs which are used to run network functions and documentation required for operational use. For ATM networks much of the master inventory data area may be the network itself where it can be interrogated on-line.

Usage - Usage data provides details about an instance of use of network configurations (e.g. a PVC). Usage data includes:

- an aggregate view of usage events (billing, performance, traffic etc.) and will include: start date/time, stop date/time, originating network end point, terminating end point, volume of data transferred, effective bandwidth, utilization factor etc.
- sampling/selection of detailed parameters (e.g. a view of CBR or ABR, cells originating/terminating from/on a particular network end point, etc.)

Network Configuration Problems - Within a particular technology type and the subsequent diagnosis. This type of Problem Report would describe problems associated with particular Network Configurations (e.g. a PVC), Network Connection or Network Component (e.g. transmission errors occurring in a specific SDH Add/Drop Multiplexor). The problem description would include the restoration priority, anticipated/actual restoration times, and details of knock-on effects caused by the service restoration (e.g. short break in transmission caused by switching to an auxiliary circuit). The information includes problem correlation details and subsequent diagnosis.

Inventory Faults - Describes faults that have been diagnosed to individual equipment items. This information may be created following diagnosis and localization of problem reports. The Data Area includes the fault history for that equipment item.

Measurements and Performance - Measurement is the specification of what to measure and how, together with the associated results. Performance is the analysis of measurement results. These data areas describe measurements made against:

Traffic - Describes the volume of traffic and the conclusions drawn regarding trends and patterns. Some traffic measures may be an aggregate view of the Usage data.

Network Configurations - (e.g. a PVC) Within a particular technology type, and the derived performance level or pattern for that instance. Information in this Data Area includes planned/predicted service breaks and performance related events (e.g. switching between two SDH multiplex regenerator sections).

Inventory - Describes measurements made against individual equipment items and the derived performance levels or patterns.

Sub-Network Generic Interfaces

This section gives a description of the technical interfaces that need to be made visible to the higher level (i.e. technology independent) processes/functional areas.

Key to the symbols used for the interfaces:

- data flow received by the sub network manager
- data flow initiated by the sub-network manager
- data flow may be initiated from either direction
- interactive dialogue

Note 1 - In addition to the responses shown, any of the transactions may return a failure message with a reason for failure.

Note 2 - Interfaces are grouped in terms of higher level Processes or Function Set Groups where the latter is shown in {brackets}. These groupings will be further refined as the TM FORUM Business Model evolves.

With Customer Care, and Service/Product Development & Maintenance Processes

Order Handling and Service Configuration

No.	Initiating data flow	Response data flow	Sub-Network Function	Remarks
Prov.1	*Ò determine network configuration designs e.g. PVCs (including alternative options)*	design options and properties of each option	Capacity Assignment	
Prov.2	Ò as Prov.1 and earmark network capacity	as Prov.1	Capacity Assignment	
Prov.3	Ò confirm earmarked capacity and configure network	confirmation	Capacity Assignment	
Prov.4	Ò release earmarked network capacity	confirmation	Capacity Assignment	

Prov.5	Ò request product test	test results	Performance Analysis	
Prov.6	Ò initiate usage and measurement recording for network configuration instance	confirmation	Performance Analysis	

Problem Handling and Service Problem Resolution

No.	Initiating Data flow	Response Data flow	Sub-Network Function	Remarks
Prob.1	⇨ forward network configuration instance problem details	confirmation	Root Cause Location	
Prob.2	Ñ forward network configuration instance problem updates & clear	confirmation	Root Cause Location	
Prob.3	Ñ forward network configuration instance performance details	confirmation	Performance Analysis	
Prob.4	➲ Request network configuration instance problem details	problem details of network configuration instance	Root Cause Location	
Prob.5	Ò request product test	Test Results	Performance Analysis	as Prov.4

Invoicing and Collection

No.	Initiating Data flow	Response Data flow	Sub-Network Function	Remarks
Bill.1	ò request collection of network configuration instance usage data	Bulk xfr of network configuration instance usage data	Network Usage and Billing data collection	
Bill.2	ò clear network configuration instance usage data	confirmation	Network Usage and Billing data collection	
Bill.3	ò Configure Global Billing parameters (e.g. tariff rates)	confirmation	Network Usage and Billing data collection	

With Network Management Processes/Functions (Generic)

Network Planning/Development and Network Provisioning

No.	Initiating Data flow	Response Data flow	Sub-Network Function	Remarks
NM.1	ò Request network configurations details	details of network configurations	Capacity Planning	
NM.2	ò Network configurations and capacity forecasts	Confirmation	Capacity Planning	
NM.3	ò instigate capacity plan	capacity shortfall predictions	Capacity Planning	
NM.4	ó install, commission, accept/reject software build	Dialogue	Software and Data Management	
NM.5	ò Update Network Build status	Confirmation	Capacity Planning	
M.6	ñ Report changes in Network Build status (auto discovery)	Confimation	Capacity Planning	

Network Inventory Management

NM.7	ò Add new inventory and capacity	Confirmation	Physical Network Element Planning	

Network Maintenance & Restoration, and Network Data Management

NM.7	ñ forward problem details	confirmation	Root Cause Location	as Prob.1
NM.8	ô forward correlated problem report	confirmation	Root Cause Location	
NM.9	ò perform tests	test results	Root Cause Location	
NM.10	ò Request network configuration	details of network configurations	Root Cause Location	
NM.11	ó drill down/up from network configuration to equipment details	details of network configurations, equipment details etc.	Root Cause Location	
NM.12	ô forward problem updates & clear	confirmation	Root Cause Location	as Prob.2
NM.13	ò determine/select service restoration options	restoration options	Root Cause Location	similar to Prov.1
NM.14	ò restore service	confirmation	Root Cause Location	similar to Prov.2 & Prov.3
NM.15	ò Back up software and data	confirmation	Software and data management	
NM.16	ò Audit software and data	audit results	Software and data management	
NM.17	ò define routine maintenance tasks	confirmation	Scheduling and Routine Maintenance	

NM.18	ò collect routine maintenance results	routine maintenance results	Scheduling and Routine Maintenance	

Network Data Management, { Usage Measurement}, { Performance Monitoring}, and {Performance Control}

NM.19	ò specify measurements and performance requirements	confirmation	Performance Analysis	
NM.20	ò forward measurement results and performance data	measurement results and performance data	Performance Analysis	
NM.21	ò apply traffic/bandwidth controls	confirmation	Network Configuration	
NM.22	ò specify network usage data requirements	confirmation	Network Usage and Billing data collection	
NM.23	ò forward network usage data	Network Usage Data	Network Usage and Billing data collection	
NM.24	ò reset network usage data	confirmation	Network Usage and Billing data collection	

{Security Administration}

No.	**Initiating Data flow**	**Response Data flow**	**Sub-Network Function**	**Remarks**
Access.1	ò set user access privileges	confirmation	Access Security	
Access.2	ñ notification of illegal access attempt	confirmation	Access Security	
Access.3	ò notification of planned visit	confirmation	Access Security	
Access.4	ñ notification of arrival and departure of authorized personnel	confirmation	Access Security	
Access.5	ò forward transaction log	transaction log	Access Security	
Access.6	ò reset transaction log	confirmation	Access Security	