The global trend of deregulation and competition in the telecommunication industry has increased the urgency for the industry to reexamine the fundamental business model and technology framework. The requirements for new services to be offered at lower cost are forcing telcos to streamline the business processes and optimize technology strategy. These requirements have resulted in the telco business process reengineering (BPR). The software development suppliers, as one of the key players of the telco BPR, are facing increased challenges to provide a technology framework to deliver solutions to meet today's new business requirements and objectives.

1.1 CHALLENGE TO TELCO SOFTWARE DEVELOPMENT

The challenges facing today's software practitioners include:

- The understanding of the requirements for telco business process reengineering
- The multiple technology environment
- The technology integration
- The control of the process

First, we need to understand the fundamental driving forces of the business process reengineering. The global deregulation and competition has forced every telco to fundamentally rethink the way they do their business and particularly the way they deal with their customers. Many newcomers into the telco market operate in a much leaner and efficient manner, they use more off-the-shelf IT technology and products to deliver more customer management functions as a means to gain market share. Retail customers require more sophisticated and cheaper service and product offerings. Wholesale customers require much easier access to the existing telecommunication infrastructure and customer network management functions. The business customers require easier electronic access to their service information and they require more value-add from the service providers to increase the value of their own product and service offers (e.g., e-commerce) to their customers. These driving forces have challenged the industry to rethink the functionality of the management solutions and the software development processes.
Second, the emergence of multiple network technologies and IT technologies has created a much diversified software development environment. We are forced to deal with the reality that we have many different ways to do the same tasks and indeed people have built many systems and components using different technologies. We have different frameworks to design the systems, different tools to build software, and different systems to interact. We have to live with different levels of maturity of the technology we use to build solutions. Under these circumstances, the temptation of playing with newest technology and search for perfect solutions is so strong, we sometimes forget the business problems we are supposedly to solve. The business desire to avoid expensive process reengineering and the urge to reengineer technical solutions is sometimes so hard to reconcile.

Third, the consequences of the multiple technology environment have created the challenge to build integrated solutions to business problems. In addition to the technology contributions the IT industry has brought to the telco industry, it also opened a Pandora’s box and brought a curse to this industry by propagating the technology wars into the telco management solutions domain. The emergence of IT technologies is very random and the amount of time required for their maturity to support commercial operations is uncontrollable. This sense of not being in control is not helping people who are charged with responsibility to build long-term business solutions, as these responsibilities require a planned release of functionality and orderly enhancement and migration strategy. Whereas many of us may have accepted the notion of the right technology for right problem domains, it is still too hard to practice it in the real world.

Fourth, no software development management process exists to support business process reengineering. On the one hand we curse the existence of legacy systems as the integration with them is so difficult; on the other hand, we really have no processes in place to guarantee that the software we develop today will not be legacy systems tomorrow. There are processes to manage the individual projects which build pieces of the business solutions. Yet which direction these collection of projects will lead us to is unclear and random. The real challenge to the software practitioners is to manage the business solution development life cycle. Although we cannot dictate the solution architecture for tomorrow’s business problems, we have enough processes in place to anticipate the future need and to make tomorrow’s software development tasks easier.

Finally, the real challenge facing the software professionals in the time of business process reengineering is not to have to do the next business process reengineering. Instead, the solution development for the business problems is implemented as a constant evolution and process improvement.

The foremost question we ask is then, what are the most appropriate technology frameworks in which we can develop applications? What are the frameworks we can use to implement our long-term business objectives and what are the processes leading us to the management software solutions?

1.2 TMN DEVELOPMENT

One of the main initiatives of the BPR in the management solutions arena is the TMN development. The Telecommunications Management Network (TMN) is the most comprehensive framework to manage all aspects of telecommunications, from equipment to customers and from network to services. It defines the business objectives of the telecommunication management, and it encompasses a broad range of management functions and operations required to support telecom businesses.

Yet, TMN is not a technology framework. Although it defines certain technology components in the element management area, it does not equate itself to a management technology. Instead, it defines multiple viewpoints of the telecommunication management:
It defines the business objectives of the management solutions.

It provides a reference framework for creating more functions and management applications.

It defines principles of management architecture and solutions.

It provides partitions of management tasks into multiple domains and multiple functional areas.

It provides an abstraction view of management process models and information models.

It defines an instantiated computing architecture to support communications and interoperability at the network and element management level.

A misconception in a segment of the industry is to equate TMN to a technology, specifically, to equate TMN to OSI technology. While OSI is a technology useful to the management of telecommunication equipment, it covers only a small portion of the management framework and provides only one of the functions—to achieve the protocol level interconnection. A large part of TMN framework, particularly in the area of integrated software architecture, has not mandated any specific technology as its choice of implementation. It is up to the technology and solution creators to decide the most appropriate technology strategies to implement TMN.

This is indeed the direction taken by many technology creators and TMN solution providers such as:

- Telecommunication Information Network Architecture Consortium (TINA-C)
- TeleManagement Forum (TMF, formerly Network Management Forum)
- Object Management Group (OMG) Telecom Task Force

TINA-C has defined a Service Architecture [92] and Network Resource Architecture [95] which are instantiations of TMN service and network management functions. These architectures are supported by a Distributed Processing Environment (DPE) [96], a computational environment supporting distributed processing and application development.

TMF defined a Telecom Operations Map (TOM) [99] which instantiates the TMN management functions with a set of well-defined business processes and object models known as the SmartTMN [2]. This map is also supported by a computational environment defined as the Technology Integration Map (TIM) [100]. The telecom operations map provides TMN solution developers with an industry agreement on business processes and information flow-through, and the technology integration map provides them with a guide for management technology procurement, development roadmap, and conformance.

OMG’s Telecom Task Force defined a CORBA-based architecture to support OSI-based network management functions [91]. This architecture supports most TMN network management concepts and operations. The task force worked closely with TMF and X/Open Group to define CORBA/OSI interworking gateway to facilitate the introduction of CORBA technology into TMN management domains [102]. OMG’s Business Objects work also targets the definitions of business processes and objects for implementing TMN functions.

In addition to reinforcing the view that TMN is a framework of telecommunication management rather than a technology, these initiatives represent challenges to TMN development. These industrial programs have manifested the fact that TMN’s future relies on the technology instantiations to produce solution architectures. Otherwise, TMN will always remain a set of principles of telecommunication management, useful only as a reference model for verifying business objectives.
The first technical challenge to TMN is the use of the IT technology to enable the development and deployment of its functions. One of the strong requirements of telco BPR is to define a TMN computational architecture for deploying management functions in a much more distributed and large scale networks. This requirement exists in both network management functions and service management functions. The network management solutions have to be deployed to manage nation-wide or global networks with multiple technologies and ever increasing network resources. The service management solutions have to support a widely distributed, highly dynamic, and increasingly diversified service deployment scenarios. With the focus of TMN management shifting more toward the end customer management, the highly scalable solutions are sought to support on-line customer access to, and service interaction with TMN systems through a very wide range of access mechanisms. There does not exist any defined technology framework in TMN to satisfy these requirements. New technology strategies have to be defined to create these solutions.

The second technical challenge to TMN is to avoid turning BPR into a sequence of expensive R&D projects and TMN development into a technology play. Instead, the TMN development requires a strong business focus and disciplined management process. The introduction of IT technologies into TMN has created almost infinite number of ways to achieve the same results. Many of the industry’s TMN development exercises failed because we embark on a search for a perfect solution. In many cases we end up with a sequence of (new) technology evaluations rather than an instantiation of solution suitable for our business objectives. The IT technology and products emerge with a much quicker pace than the business requirements. We must understand that the business solution architecture needs almost certainly to out-live a specific technology, no matter how hot the technology.

The third technical challenge is to provide an integrated TMN solution framework. TMN defined an integrated management framework with different viewpoints at different levels of abstraction. This has created difficulty and confusion to the TMN solution development. The vertical management layers were easily and wrongly mapped into totally isolated software architectures and platforms among which no processes and information are flowing through. The conceptual separation of horizontal management functions was interpreted literally to create vertical application stovepipes which are very hard to integrate. With the emergence of more and more network technologies and management technologies, the industry will end up with more specific functional pieces of software (such as SNMP-based element manager for a vendor’s ATM switches, or OSI-based network manager for another vendor’s SDH networks) but no integration strategy to put them together to form business solutions. Even though some of these components exist in some standard technologies, they still do not equate to business solutions. The reality is that many of them are in proprietary technologies and were never designed to interact with each other! The challenge to the industry is to define integrated architectures so that these components can be used to form business solutions. Based on this architecture, the integrated management applications can be developed and these applications will combine the functions of the network equipment, value-added services, and customer care to deliver the customer services and to achieve the customer satisfaction.

The fourth challenge is how TMN will evolve and mature with new technologies. Telco industry will forever be in a state that business solutions are supported by a large range of technologies with different levels of sophistication and maturity. The development will always face the following issues:

- how to interact with existing legacy systems
- how to deal with multiple new technologies
- how to manage the overall life cycle of the solution development aimed to reduce the chance of building legacy systems
It is the responsibility of the software practitioners of TMN development to manage this evolution process. We need to clearly understand that in this process, we cannot break from the past and nor can we dictate the future. In our solution development, we have to interact with the legacy systems by, say, using object wrappers. Also we have to be prepared that the components we are building now will in the future be replaced or adapted to the future solutions. A good software practice is, for instance, to specify fully the functionality of the components and the external behaviors of the interface, and at the same time, to define the minimum requirements for integration by designing very generic and simple interfaces. The specifications should not only include computational specifications (information and functional specifications and programs) but also include the proper documentations. One of the less attractive attributes of a legacy system is that over time it evolves but the evolutionary interfaces and functionality is not documented well. Therefore it becomes more and more difficult to interface with other newer systems. One of the biggest weaknesses with business life cycle management is the lack of good (and standard) documentation processes. To develop and manage this process should be treated as the integral part of the TMN solution management.

### 1.3 TMN STANDARDS DEVELOPMENT

The challenge to TMN development also exists in the standards area. If we examine the TMN standards development so far, we could categories them into:

- **Frameworks and architecture** such as management frameworks and transport architecture.
- **Interoperability** such as management functions (SMF) [77], [78], communication (SMC), and information (SMI)
- **Specification of operations** such as a large quantity of specifications and object models defined by using the Guidelines for the Definition of Managed Objects (GDMO). These are usually very complex and detailed.

Let’s examine how the standards can help us develop TMN solutions for business problems. The first type of standards defines concepts and principles. These are important to guide us to the overall solution architecture and the style of the technology selection, such as client/server technology or distributed object-oriented technology. However, there are no clear definitions of conformance to the overall architecture, nor is it necessary. People are entitled to and will implement TMN principles using different approaches.

The interoperability standards help us to build basic plumbing infrastructure to exchange information. These are so far largely useful at the element level. Since the highest value of the TMN business solutions exists in the high levels (end-to-end network functions, service and customer management, business applications), the technical and business innovation at the protocol level is a nonstrategic issue. It makes sense that we use standard protocol to exchange information at the element level.

The operational standards are problematic. There are a large quantity of TMN standards defining how to do a thing in a TMN way such as managing connections, reporting faults, managing lease lines, etc. These standards are overloaded. They intend to guide people to implement specific management functions in commonly accepted ways, i.e., they are object specifications of systems or components. On the other hand, they are always meant to be interface specifications for interoperability purposes. That is, two operation systems implementing the same standard specification are meant to interoperate.

In software engineering practice, these two roles impose hugely different requirements on the way objects are modeled. A specification of a system always requires a detailed object analysis and object definition. A specification for an interoperability purpose is always more
effective if it is simple and abstract. The results of many TMN specifications are that they may just be detailed enough as specifications for operational systems, but they are too complex to be interface specifications for application level interoperability.

This leaves a major gap in the standards that there are very few, if any, specifications designed for application integration. People complain about the complexity of TMN standards, because they have to implement the whole complex and detailed specifications to claim conformance—for the purpose of interworking or integration.

In order for TMN to become a management framework for applications to interact, interwork, and to grow in a building block fashion, the standards have to be simplified. The value of a standard specification facilitating interworking between functional components is far greater than a standard defining operational details of a component.

1.4 THE PURPOSE OF THIS BOOK

This book deals with the technical challenges of building integrated TMN solutions in a multiple technology environment. It provides the principles and processes one could adopt to deal with this complex issue. Each chapter deals with a different aspect of this theme.

The integrated TMN solutions have strong and urgent business requirements. These requirements dictate our business objectives. They provide reasons why we need business process reengineering. They provide strong input into the process of defining integrated solution architecture. Clear understanding of these requirements at any stage of the solution development process is crucial for us to stay focused.

The introduction of IT technology into telco industry, in particular, the distributed object-oriented technology has greatly enhanced the strength of the integrated TMN solutions to answer today’s business challenges. However, this has also introduced a significant degree of complexity in the technical solutions and the management of TMN development. Before we adopt the distributed technologies, we have to be convinced that strong business requirements do exist for adopting these technologies. We must have a firm understanding of the complexities and difficulties we will face in adopting these technologies.

Migration from centralized development environment to the distributed environment requires a fundamental paradigm shift and an appreciation of a wide range of new design principles and models. To avoid the risks of our solution development efforts turning into expensive R&D exercises, we need to be prepared for this paradigm shift and understand this sometimes painful migration process. We need stay focused to the business requirements and have a clear strategy of dealing with the emergence of new technologies, new standards, and new and somewhat immature products.

The notion of the right technology for the right problem domain is gaining more support in the industry. This reflects the maturity of the industry toward new IT technologies. This notion asserts that it is the business problems and challenges caused by deregulation and competition that drive the progression of the TMN solution development process. Technologies are important but they are only the means to achieve the business objectives. This paradigm shift is crucial as it helps to achieve the following goals:

- TMN development becomes more customer solution focused.
- Development efforts are more result oriented, rather than technology indulgence and experiments.
- Solution development processes are more concerned with end-to-end needs.
- Software practitioners are more concerned with integrating different technologies rather than constantly picking the best technology.

These have helped us focus to develop integrated solutions and avoid technology wars.
Sec. 1.4 • The Purpose of This Book

The technology integration has presented us with some new challenges. First, we need to understand the purpose of the integration. The ISO and ITU-T standards movement in the past decades has a very strong focus on interoperability. However, the TMN solution development requires more than interoperability. It requires an environment for application interworking and component-based application development. Second, we need to understand different integration strategies for different requirements. Third, we need to define an integration framework which consists of a well-defined business process model and information model, i.e., we need to know and be able to describe our business better before we build management solutions. To face the challenge from a deregulated market place, we need to define a strong customer-oriented view of TMN. Traditionally, TMN defined service providers’ or equipment vendors’ view of the telecommunication management. This should be complemented by a customer focused view, centered on the management of customers’ service interactions with their service providers.

This book is not about building telco operation systems. It is not about how to build a TMN fault management system or VOD service. It is about establishing management processes and development principles that will lead to an integrated environment for new and existing operation systems.

This book is not about building CORBA or OSI solutions. Although CORBA is used throughout the book as an example of distributed object-oriented technology, and it is indeed becoming the strong technology choice for the telco industry among others, very few principles and processes discussed in this book are dependent on the choice of CORBA as the underlying technology. Indeed all the principles and processes discussed in this book are about how to build long-term business solutions that out-live the individual technologies used in the solutions. We will demonstrate that the rapid emergence of IT technologies and their adoption in the telco industry does provide a serious challenge to the life cycle management of our solutions. The divergence of technology is now so strong that every functions can be supported by a large number (and still growing) of technologies and products. This reality simply means that the notion of best technology does not exist. We cannot advise anyone (we doubt if anyone can) what is the best technology for the future of TMN development, and it is very irresponsible for us to do so. However, the principles and processes do exist which can help one manage the process of solution development, technology selection and migration. This will be the focus of the book, and this will be the area to which we hopefully add value.