TELECOMMUNICATION SERVICE MANAGEMENT

QINZHENG KONG, GRAHAM CHEN, AND GLENN HOLLIMAN

Abstract—**The development of standard platform approaches to the management of telecommunication services is emerging as a key focal point for business re-engineering in the telecommunication industry.**

This paper examines the directions in which telecommunication service management is evolving and discusses the general requirements for a TMN management platform architecture. Strategic directions and technical choices are also discussed.

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1 INTRODUCTION

The telecommunication industry is currently experiencing considerable change in its business environment. The combined efforts of the telecommunication and computer industry has resulted in considerable growth in communication and data service offerings, which in turn has reduced the gap between telecommunication services and MIS applications. The demand for more services, and the integration of these services, is increasing rapidly.

This trend has put enormous pressure on the existing telecommunication industry's business environment. It has forced the industry to adjust its IT strategy to be more service oriented and to employ new technologies to provide support for:

- integrated services
- interoperability with different Telcos
- a consistent data model
- management of customer service network.

The need to support these new requirements has resulted in most major players in the telecommunication industry's embarking on significant business re-engineering initiatives. The aim of this business re-engineering is to re-organize the industry's structure to be more service oriented and to push forward the boundaries of technology to provide a new platform for the migration of legacy MIS systems.

The need to provide more communication and data services to the customers and the demand to embrace new management technology for this business re-engineering has manifested itself in shift in focus from TMN [1,2] network management to its service and business management components. It is clear that the task of providing a service management component in telecommunication's IT management strategy has become fundamental to the process of business re-engineering and gaining an industrial competitive edge.

This paper discusses the requirements for a TMN service management platform, demonstrates the limitations of existing management platforms in providing the support for the service management infrastructure, and proposes new directions and technology choices for future management platforms.

2 TELECOMMUNICATION MANAGEMENT NETWORK

A TMN is a management architecture framework which provides an environment for interfacing a telecommunication network with computer systems to provide different management functions at several different levels. The framework allows the management of business information between different components (operations systems, communication equipment, network and computer systems) and provides control of service operations and information flow.

Figure 1 depicts the architecture of TMN.

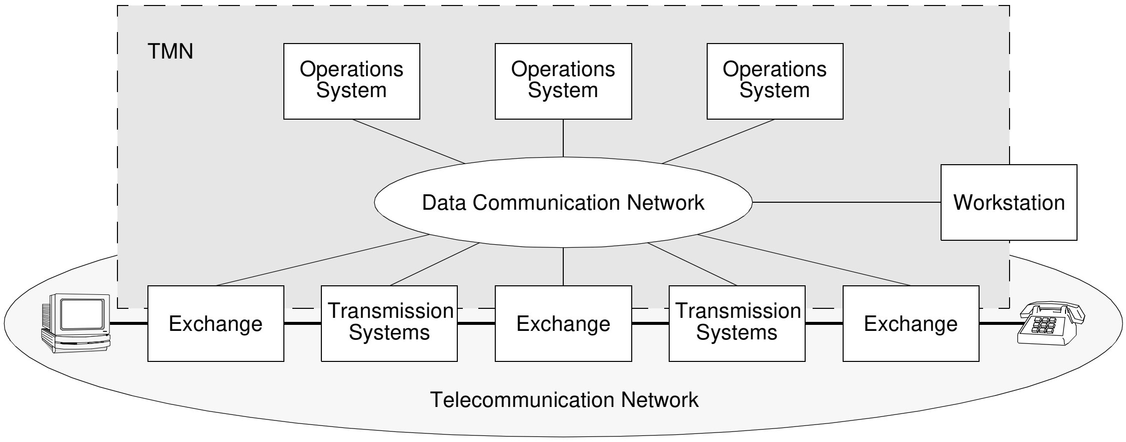

Figure 1: Relationship of TMN and Telecommunication Network

The objective of the TMN is to provide a framework for telecommunication management. Its architecture offers five management functions:

- Performance management
- Fault management
- Configuration management
- Accounting management
- Security management.

The TMN architecture partitions management problems into five domains:

- Element Layer
- Element Management Layer
- Network Management Layer
- Service Management Layer
- Business Management Layer.

These domains form a functional management hierarchy.

Each management function has different semantics in different layers. The relationship of the five TMN management functions and the five abstract management layers can be illustrated by Figure 2.

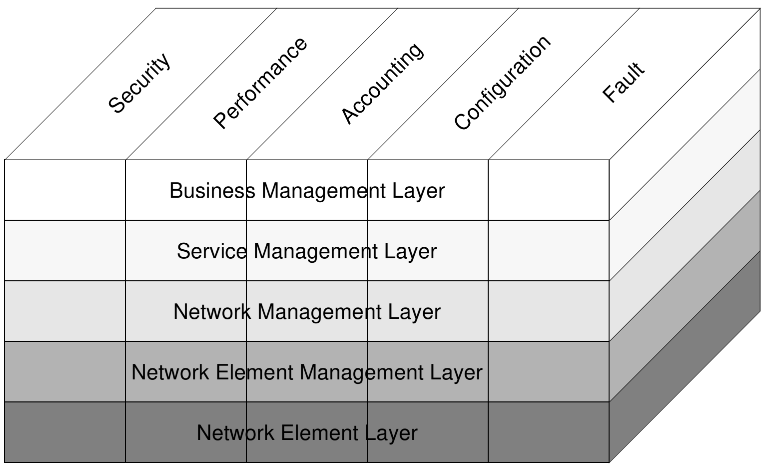

Figure 2: Management Layers and Management Functions

3 SERVICE MANAGEMENT

The TMN service management layer addresses an important area of the telecommunication management space. The service management layer plays the following roles as shown in Figure 3:

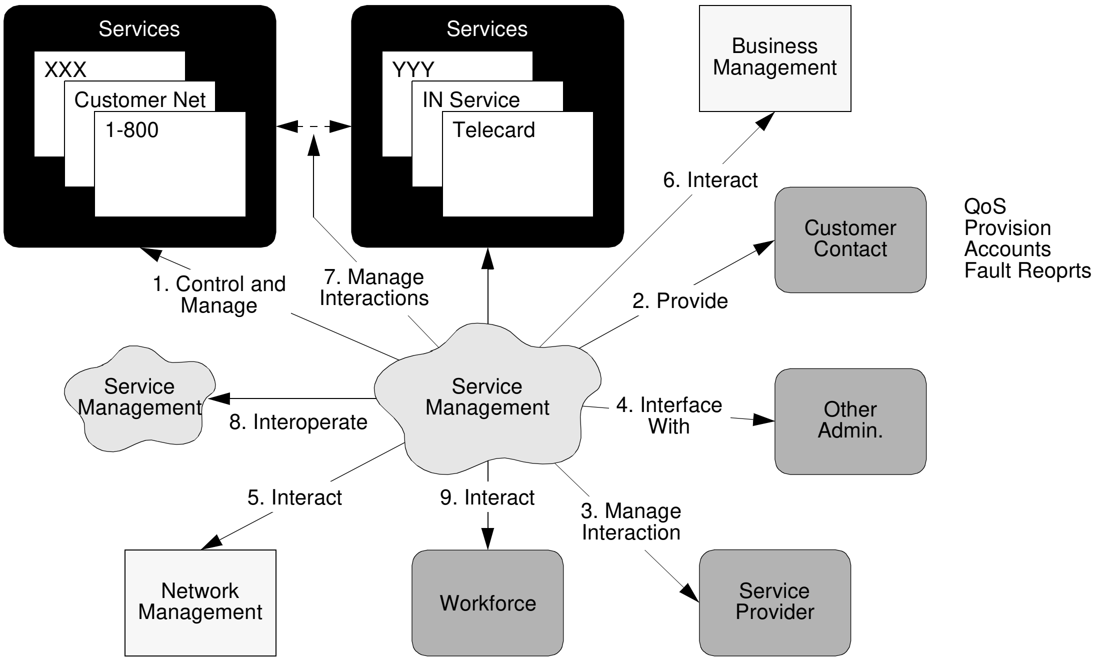

Figure 3: Service Management

1. It controls and manages a range of customer oriented services as provided by telecommunication operators, such as telecard services, 1-800 services and customer network services.
2. It provides a customer contact for all services transactions including provision and cessation of services, accounts, quality of service (QoS), fault reporting and billing.
3. It manages interactions with service providers.
4. It interfaces with other administrations and/or recognized private operating agencies.
5. It manages interactions with the underlying network management layer.
6. It interacts with the business management layer.
7. It manages service related data and service management information.
8. It manages interactions between services.
9. It provides support for workforce management and the integration between workforce and computerised processes.

The management functions in service management have a different orientation and broad scope when compared with those in network or systems management. All five TMN management functions have an extended meaning in the service management layer.

Fault management, for example, has extended its scope from managing faults in the network and its elements to managing faults in services. It is more concerned with the restoration of a service to its subscribers within a time-frame set by contractual agreement.

4 NETWORK MANAGEMENT PLATFORMS

Current technologies provide the functionality to manage the lower layers of the TMN architecture. Network management platforms, such as HP OpenView, provide the capability to exchange management information between different application entities. Early management platforms supported a peer-to-peer communication paradigm with a proprietary interface and often require that the management applications are within the same management domain and use the same management protocol. Recently, management platform features have been extended to support a standard Application Program Interface (for example X/Open XOM&XMP API) and provide automatic connection management and location transparency. The HP OpenView range of products, for instance, provide a Graphic User Interface (GUI) for easy application development, an X/Open API for software portability, location transparency through Post Master Daemon (P.M.D) and Local Registration File (L.R.F), and event management services. OpenView supports multiple underlying communication protocols, such as CMIP and SNMP. It also supports management functions required to manage network elements and networks.

An example of using OpenView in network management applications is demonstrated in Figure 4. If an Agent is either a CMIP Agent or a SNMP Agent, a Manager can talk to it directly through OpenView DM platform using XMP API. For those proprietary Agents, an Adaptor can be built which communicates with the Manager using CMIP/SNMP protocol and converts the requests to the proprietary Agent protocol. A management application program can play both manager role and agent role, which allows an management application managing other managers.

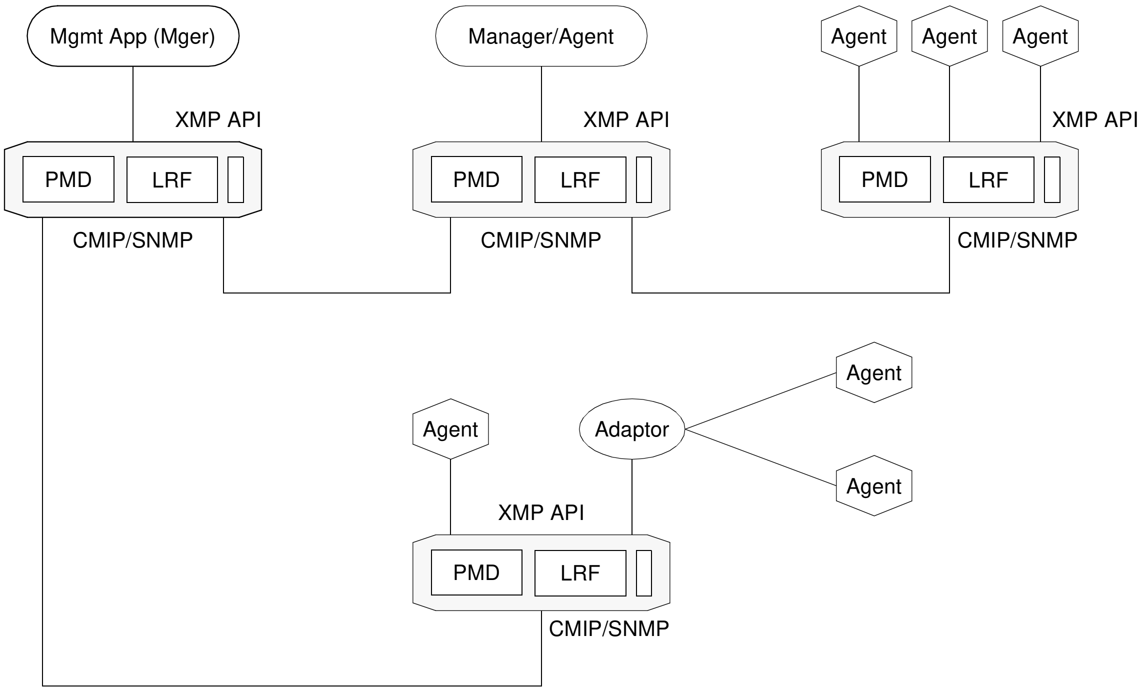

Figure 4: OpenView in Network Management

Recently, there is a strong paradigm shift in the telecommunication industry to re-adjust its IT strategy to be more user oriented and service oriented. In other words, it is more important to align its business perception with the user perception. The telecommunication industry provides a range of services rather than simply providing functions to manage networks and elements.

This paradigm shift places strong emphasis on two issues. Firstly, the nature of telecommunication business requires management at a higher level. The following questions should be addressed:

- How a service is provided to subscribers?
- What management functions are required to provide the quality of service agreed to in the service provisioning contracts?
- How to define the information model that preserves a unified and consistent view for users of different services?
- How a service is implemented and managed?
- How to manage services across different telecommunication authorities which most certainly have different service provisioning systems, tariff policies and business environment, administration, and technological framework? In other words, how to achieve interoperability at a higher level.

Secondly, the trend of software development requires that applications, including management applications, are implemented within an open distributed environment.

These issues have added new requirements and challenge to the existing network management technology framework. In turn, the existing network management platform technology needs to be enhanced to serve the service management tasks.

5 REQUIREMENTS FOR SERVICE MANAGEMENT PLATFORM

The rapid growth of the global computer and telecommunication networks has increased the demand for more distributed and large scale network and systems management applications. Management applications are expected to manage geographically dispersed networks and services with very complex heterogeneous computer and telecommunication resources and to achieve consistent, reliable and transparent access and update to these resources. A crucial issue for the industry is to employ new technologies to guarantee that the global network of resources can be shared and managed by applications in a consistent and efficient manner.

The increased demand to manage large scale distributed telecommunication services applications in a heterogeneous environment has not been met due to the limitations of the existing systems management technology. The current models of network and systems management (OSI or SNMP) are not designed for meeting today's management requirements. New models are being sought by different technology development bodies such as official and industry standards bodies as well as industrial consortia.

In a general terms, the new model must meet the following requirements for the management systems to manage today's telecommunication service applications. These requirements can be grouped into:

Common requirements for distributed platform

- Distribution—telecommunication applications are geographically distributed. Hence, the management applications should also be distributed. This requires the management platform to support highly distributed management applications by providing distributed environment and distributed services.
- Scalability—ever increasing size of resources, information, services and networks to be managed has required the management platform to be scalable.
- Heterogeneity—the extremely diversified types of resources and computer systems in the management domain requires the management platform to handle heterogeneous systems.
- Common Services—some distributed services are common to many distributed applications. A platform which supports these common services will greatly reduce the complexity of application development.

Special requirements for service management platform

- Consistency—data consistency is a very important issue in distributed telecommunication service management applications. The service management platform needs to have the ability to support a consistent data model.
- Service Integration Support—The provision of support for service integration is a new issue for management platforms. Service management functions are required so new services can be easily introduced and managed, and existing services can be integrated.
- Interoperability—Inter-operate with different business domains and administrative authorities with different enterprise policies, business focuses, underlying technological framework and organizational infrastructure.

All these factors have greatly increased the complexity of today's distributed applications and have also increased the complexity of management functions for such applications.

To face this new challenge, both the standards bodies and the industry are looking in new directions to provide a more powerful technology framework to meet these requirements.

6 THE SHIFT TO THE NEW PARADIGM

The sub-committee 21 of the International Standards Organization (ISO) is the official standards body which initiated and executed the Open Systems Interconnection (OSI) program. This committee is responsible for defining network and systems management framework including the management architecture, information modelling, and communication protocols. Most management platforms support this framework and claim conformance to this architecture. Recently, the committee has progressed to evolve the OSI program to embrace the requirements of distributed service applications and management applications. In particular, the requirement to provide interoperability at the application services level is gaining more importance than at the protocol level. Also, a framework encompassing various existing technologies to provide support for distributed applications is a major industry requirement.

Based on this assessment, the SC21 has decided that the OSI program will make a major shift from *Open Systems Interconnection* to *Open Distributed Processing*. This change of directions is represented by the following characteristics:

- The programme shifts the emphasis to providing a framework for defining distributed applications and application integration, so that interoperability can be achieved at the application level.
- The programme will move from low level open protocol development to high level open distributed services development.
- The programme will move from the peer-to-peer based, service element end-point interconnection paradigm to the distributed object based environment.
- The communication paradigm is more service request broker oriented, based on the remote procedure call, rather than the association based peer-to-peer paradigm.

As a consequence of this shift, the OSI Open Distributed Processing [3] reference model will be the next major focus of the OSI program. The ODP reference model has currently been adopted by many industry groups and consortia such as OMG and TINA-C [4,5]. A new sub-project named Open Distributed Management Architecture [6] has also been created within the OSI program as part of this shift.

Although the work was initiated in a standards forum, it reflects the real industry needs. In the HP OpenView Forum in 1994 and 1995 for instance, users were stating strongly the requirements for functionality to manage large, heterogeneous and highly distributed information systems. There were major requirements for distributed object technology to manage applications and services and to achieve high level systems integration and interoperability.

7 TMN MANAGEMENT PLATFORM AND ITS FEATURES

Rapid technology development has introduced many new mechanisms into the system and service management business. These new mechanisms provide basic support for the development of service applications, and at the same time they also introduce new challenges to the whole IT industry.

The demand for having an open and distributed TMN management platform comes from many different areas of the industry. The requirements of such a platform is to provide an environment in which new customer services can be easily added to the system without the need to deal with complex system specific details and to permit the management application to efficiently and effectively manage the system. ODP and ODMA discussed above can be used as the guidelines for a TMN management platform.

To meet the requirement specified in Section 5, a TMN Management Platform should consist of the following major components:

- Distributed Platform—basic infrastructure to support distribution, which includes:
  - platform support for distributed services and management functions
  - protocol support for different communication and interoperability protocols.
- Distributed Services and Management Functions—common services and functions required for distributed management applications. Examples of such services are:
  - Transaction Service,
  - Relationship Service,
  - Trading Service,
  - Directory Service,
  - Naming Service.
- Underlying Communication Protocols and Interoperability Protocols, for example:
  - Network management protocols, such as CMIP and SNMP
  - Directory service protocol, X.500
  - Massage handling protocols, such as X.400 and SMTP
  - Other protocols, such as DCE and TCP/IP.
- Object Management Tool Kit, which may include:
  - Object Editor

– GDMO compiler
– Automatic Agent Generator
– Test Generator and System Simulator

The relationship between the different components of the TMN Platform is illustrated in Figure 5.

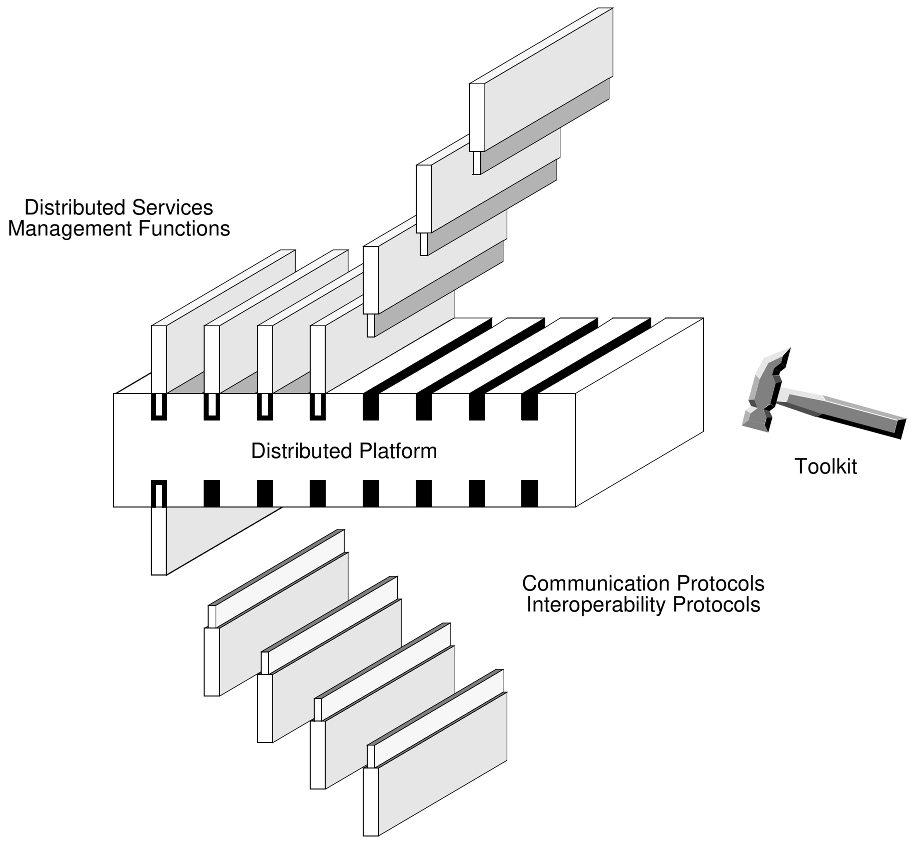

Figure 5: TMN Management Platform

The TMN Management Platform provides the following basic features and characteristics:

- It provides a distributed environment in which interoperability between heterogeneous applications can be achieved. Many system details, such as the topology of the network, the routing to peer application programs, the location of different components in the system, the underlying communication mechanism and protocols, should be transparent to user applications.
- The Object concept is important in distributed systems. The benefit of the distributed object model is that objects or blocks of objects form the natural boundary for distribution. Also the services offered by the object blocks provide natural support for distributed applications and the seamless integration between platform services and management applications built on top of platforms. Each system service can be specified as an object and used as a building block. Using these building blocks, the system can be scaled according to the user's requirements to provide powerful functionality and to achieve best performance. The distributed object model also provides a sound basis for the implementation of the service request broker.
- Different object services in a distributed environment are located in different places. A service directory should be supported by the platform to provide dynamic registration of object services and provide mapping between an object service name and its location.
- Object Modelling should be supported not only in the network management level but also in the service management level. Service management object definitions and service management functions need to be specified using abstract object definition languages, such as GDMO, IDL or ODL (an object definition language proposed by TINA-C).

In addition to the features specified above, it is important that the platform can support application integration and provide basic infrastructure for different distributed services. Extra features can be provided by adding Distributed Services as building blocks. For example:

- The specification of relationships between different management objects, especially between network management objects and service management objects, can be supported by adding an Object Relationship Service. This is important for managing interactions between the network management layer and the service management layer.
- In a fully open and highly distributed system, the synchronization among different activities/operations within applications is sometimes of crucial importance. This can be supported by adding a Transaction Service to provide the business and service level transactional control.
- Built-in security can also added to the distributed management platform since security is one of the major concerns in many open distributed applications.
- A Trading Service will add resource discovery capabilities to the platform.

All these features are important to the industrial needs for a highly extensible platform. Such a platform will not only offer a large range of distributed services, but also allow easy third-party service extensions to provide more diversified functionality or to increase the capacity to manage more objects or agent systems.

For example, object building blocks can be defined on top of the existing object services to provide more service specialization. Using the transaction service example, it is possible for a special agent representing shared resources to further specify object service interfaces to achieve specialized commitment semantics. These new object services are provided as a natural service extension to the existing set of object services in a *plug and play* manner.

The framework proposed by various standards and standards groups, such as ODP, TINA-C and ODMA, points out the right direction towards an open and distributed TMN management platform.

8 SERVICE MANAGEMENT PLATFORM

A Telecommunication Service Management Platform can be build on top of the TMN Management Platform. A Service Management Platform is illustrated in Figure 6. It may contain three layers:

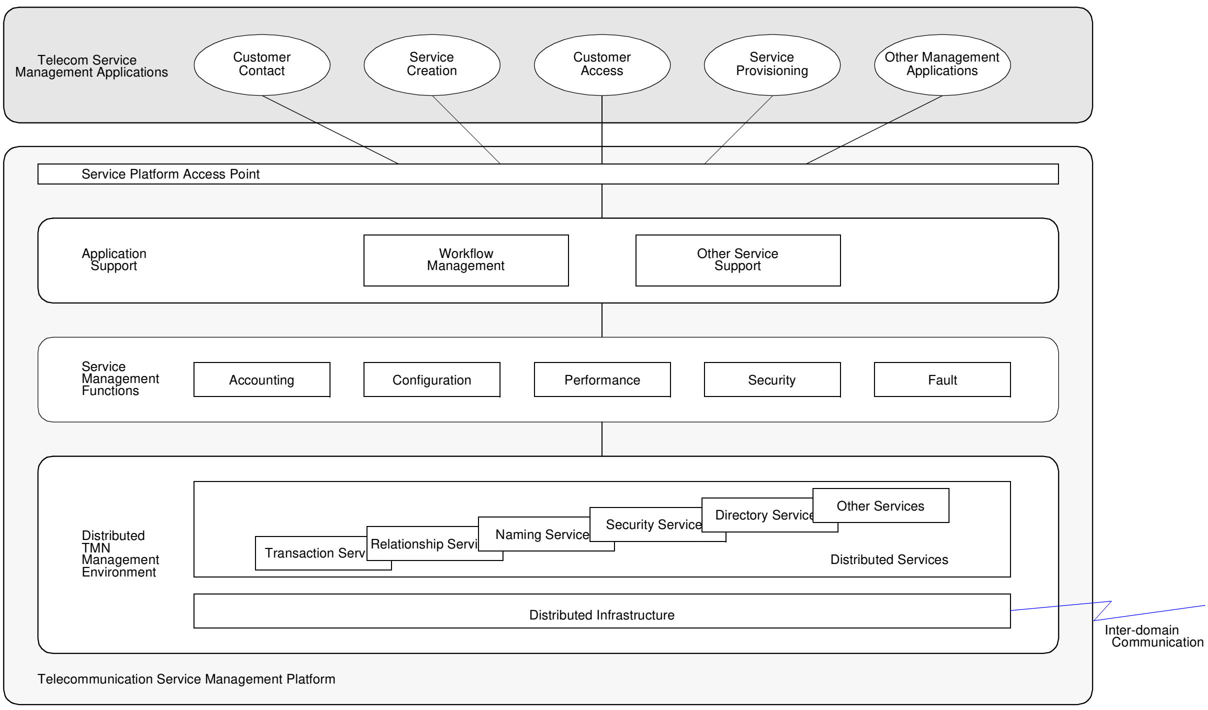

Figure 6: Telecommunication Service Management Platform

- *TMN Management Platform*—which, as described in the previous section, provides the basic support for general network and system management applications. It consists of Distributed Infrastructure, Distributed Services, and basic Network and System Management Services, such as CMIS and SMF.
  It is important that this base platform provides environment support for application integration and interoperability between different business domains.
- *Network and Service Management Functions*—which support telecommunication network and service management functions defined in TMN, such as fault management and accounting management functions. The provision of support for service integration is a new issue for existing management platforms. Service management functions are required so new services can be easily introduced and managed, and existing services can be integrated.
- *Application Support*—which provides a set of facilities useful for development of service applications. For example:
  - Transactional workflow management system—to provide process control and automated actions in Telecommunication Service Provisioning and other activities.
  - Query facility—to allow different Telecommunication Service users and Management Entities to query the status of the network and to find out service related information.
  - Service Design tools—to map the service designer's solution into network solutions. This may be implemented as a workflow management application and may involve interactions with query facilities.

The major task of the Service Management Platform is to support the development of specialized telecommunication service management components and integrate these components with existing network management platforms, such as HP OpenView, which provide the basic support for OSI SMF functions and TMN FCAPS functions. Telecommunication Service Management Applications can be built on top of the Service Management Platform.

9 CONCLUSION

Existing management platforms, such as HP OpenView, can be used for Telecommunication Network Management and Network Element Management. The result of a CiTR R&D Telecommunication Service Management project, as summarized in this paper, indicates that new Telecommunication Service Management components need to be defined and built in order to provide TMN service management functionality. These components need to be integrated with existing network management platforms.

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