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On Designing a Distributed Management System with Reliability

Hwa–Sun Song — *Department of Electrical Engineering*
Sang–Yeol Joo — *Department of Statistics*
Kangwon National University, Chunchon 200–701, Korea

Nam–Ho Kim — *Department of Electrical Engineering*
Young–Jun Chung — *Department of Computer Science*
Kangwon National University, Chunchon 200–701, Korea

Abstract. This paper discusses some problems of the TMN–based architecture of integrated network management systems and presents a CORBA–based architecture of distributed network management system with reliability, which maintains location transparency of distributed managed objects and provides an interoperability among heterogeneous networks and systems.

In this paper, the proposed distributed management system model has been applied to the TMN based management systems and then considered for qualitative evaluation of system performance. Two different types of implementation models have been proposed: one is a system using a CORBA gateway and the other is a pure CORBA system, which maps all managed objects into CORBA objects. The characteristics of two system model have been compared in the respect of system implementation

Key Words : *Distributed management system, TMN based management systems, CORBA gateway, CORBA system .*

1. INTRODUCTION

The planning and design of network operations, administration, maintenance, and provisioning, should aim at the real–time management capabilities in terms of the integrated management information base, standard operations and management commands, open system interface, persistent network services, network environments and traffic controls, and so on, which are based upon TMN recommended

by ITU–T. ITU–R has started the standardization activities of telecommunication network management based on TMN.

The telecommunication network management system should include the functional areas of network management, management, terminal (e.g. end-users) management, as well as complicated functional capabilities of their management analysis and design. In such environments, the distribution of management messages, traffics, and management functions is essential in the planning and design stage of telecommunication network management system, which will act as a core factor of its system performance.

In general, the telecommunication network management system will be designed and implemented based upon TMN. However, since the architecture of TMN is a centralized layered architecture, it cannot provide the distribution capabilities of functional loads and will results in the lack and isolation of management functions and interoperability between management information.

In this paper, we will present an optimal architecture of a distributed telecommunication network management system with reliability, based upon CORBA, which adapts the strong points of the TMN architecture and provides better distribution capabilities of system management when compared with those of existing network management systems.

2. INTEGRATED NETWORK MANAGEMENT SYSTEM

A network management system has developed for its own applications with mutual association with international standards. The TMN of ITU-T has been defined for management of telecommunication transmission and switching system, the OSI system management has been developed for management of OSI system resources, IETF SNMP is for internet management. Besides OSF and TINA (Telecommunication Information Networking Architecture) has introduced their own management frameworks as called as DME and TINA, respectively. In this section, we will discuss an integrated management system for tele–communication that is based on TMN.

2.1 TMN (TELECOMMUNICATION MANAGEMENT NETWORK)

TMN is a separate network for telecommunication management, which makes interconnections of communication devices and operation systems with a standard interface, and management information will be exchanged through the interface. The architectures of TMN is well-defined in ITU-T M.3000 series recommendations. TMN defines three basic architectures which can be considered when planning and designing a TMN – physical architecture, functional architecture, and information architecture. The physical architecture describes realizable interfaces and implementation of physical components that make up the TMN and their physical configurations. The functional architecture describes the definition of functional blocks and reference points, and the distribution of their functionality that a TMN can

implement. The information architecture, based upon an object oriented concept, describes the creation of managed objects and interactions between objects. In particular, TMN uses the server/client concepts of the OSI information architecture and recommends an interaction protocol of CMIP/CMIS for information exchange.

2.2 INTER–DOMAIN OPERATION IN THE INTEGRATED NETWORK MANAGEMENT SYSTEM

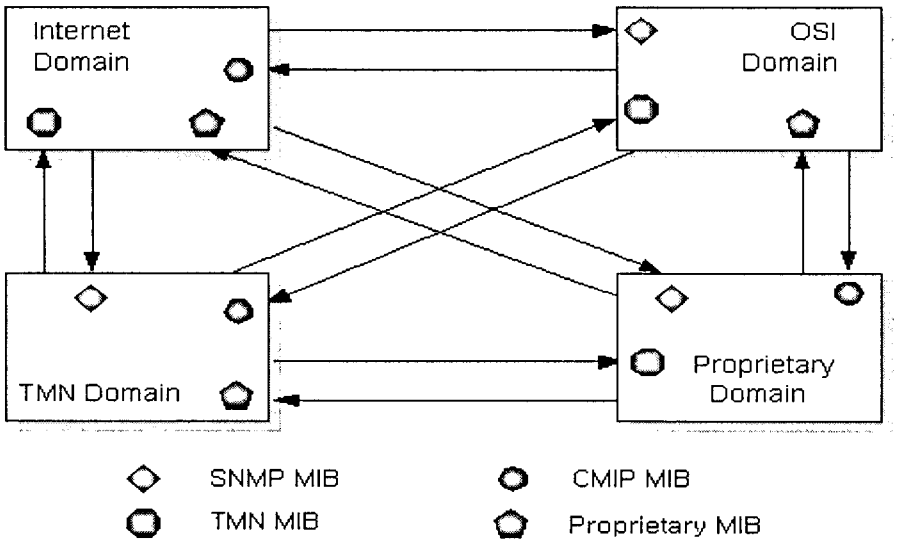

Figure 1: Inter–domain MIB translation in an integrated network management system

Typically an integrated network management system should provide a management architecture, which a network manager has capabilities to manage all telecommunication resources without any special knowledge. In other words, since an integrated network management system consists of many different management systems in the heterogeneous networks, a system manager can easily access management information without knowing the structure of MIB and protocol. Thus, when management information crosses from a domain to another domain, a mediation function is required for MIB translation, so that a manager can access the information in its own management domain (Figure 1).

2.3 LAYERED ARCHITECTURE OF AN INTEGRATED NETWORK MANAGEMENT SYSTEM

Using TMN, an example of an integrated management system can be depicted as shown in Figure 3. In Figure3, NMS0 is a primary network management system, which can directly and indirectly manage all networks. NMS0 can directly access local managers, NMS1 and NMS2, through Q3 interfaces, using the manager-to-manage communication. In this case, NMS1 and NMS2 play roles as agents of NMS0. NMS1 manages a local manager NMS3 and mediation devices, MD0 and MD1, where NMS3 is an agent of NMS1. Finally NMS3, MD1 and MD2, which are managers located at the lower layer, directly manage their own managed objects and reports management information to NMS1.

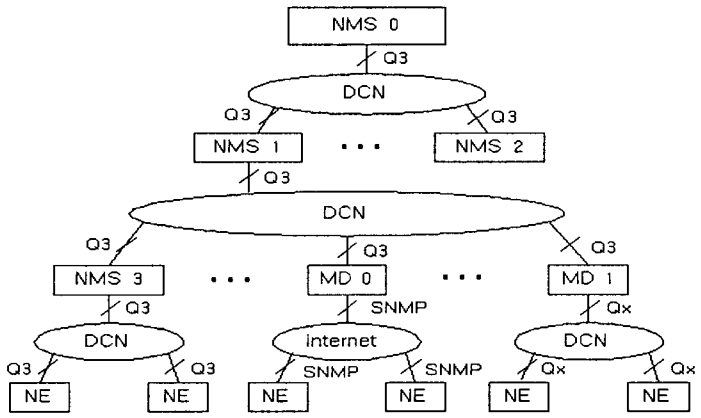

Figure 2: A layered architecture of an integrated network management system

This architecture has some drawbacks: When some failures at the middle layer of this system occurs, there are some difficulties in transferring management information from the lower–layer manager to the upper layer manage. In addition, since management information increases, traffic congestion can arise at the upper-layer manager. As a result, the TMN–based integrated management system cannot provide appropriate distribution capabilities.

3. PROPOSED DISTRIBUTED NETWORK MANAGEMENT SYSTEM

A distributed network management system requires a distribution management framework to efficiently integrate heterogeneous networks. Some standard architecture such as SNMP for Internet management, CMIP for OSI management and TMN

has been defined for network integration. Also some middle-wares such as NMF OMNIPoint, OSF DME, and OMG CORBA have been developed for distribution management systems. In this paper, we proposed a CORBA-based distributed management systems, which provides distribution capabilities with maintaining TMN capabilities.

3.1 CORBA

The Common Object Request Broker Architecture (CORBA) is a standard middle-ware, defined by the Object Management Group (OMG), to provide a common architectural framework for object-oriented applications. CORBA allows users to access to information transparently even though they don't know the knowledge of hardware and software platform. Through the Object Request Broker (ORB), CORBA provides information transparency among distributed objects, supports object-based distributed functions, and also provides interoperability among various applications on different computing system in heterogeneous distributed networks environments.

A manager can transparently invoke a interaction method on a managed objects server. The ORB intercept the call and find an object which can implement the request, and pass its parameters with invoke of its method, and return the results. The manager can retrieve the management information without knowing the object location, the agent-side programming language, operating system and so on.

Using the CORBA, a architectural block diagram for a distributed integrated network management system can be depicted as Figure 5.

In Figure 5, the insertion of a new domain networks into a management system only requires translation of the new domain MIB specifications and interaction between two domains.

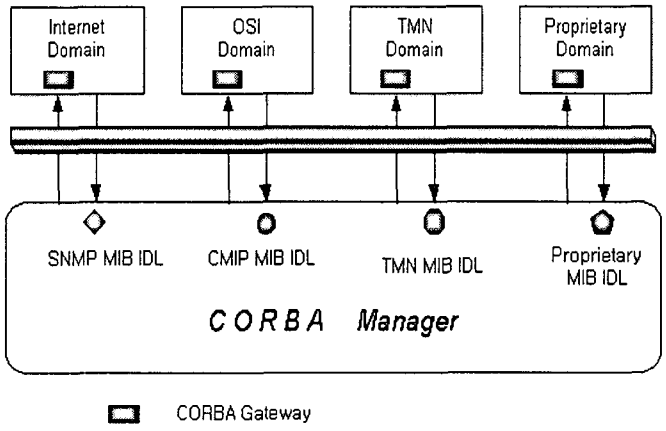

Figure 3: A CORBA framework of the integrated network management system

3.2 A STRUCTURE OF CORBA BASED DISTRIBUTED NETWORK MANAGEMENT SYSTEM

Figure 4 shows an architecture of a distributed network management system in which the TMN based–integrated network management system (Figure 2) is applied to the CORBA domain. In the proposed system, local manager systems (NMS0, NMS1, NMS2, NMS3) and mediation devices (MD0, MD1), which are hierarchically deployed in TMN, are installed distributely among using the ORB. In this case the local manager still maintains the existing TMN characteristics. Each local manger collects information from local managed objects, analyses them, and stores the results into the MIB. The stored management information and management functions can be shared among CORBA ORBs by the manager–to–manage communication.

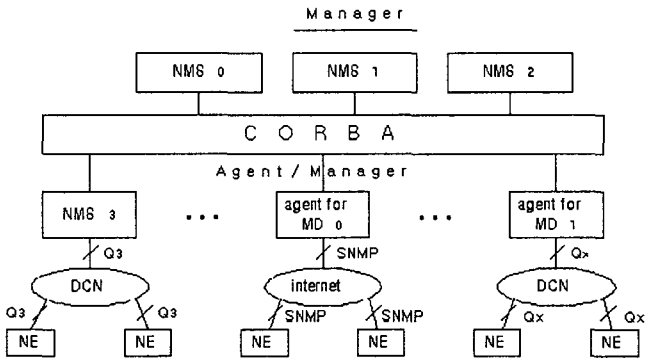

Figure 4: A architecture of CORBA–based distributed network management system

Table 1. Characteristics between layered TMN and Distributed TMN

	Layered TMN	Distributed TMN
1. Interface between NMS'	Q3	CORBA ORB
2. Traffic management	Congestion occurs in higher layer	Traffic will be distributed
3. Control method	Regional control	Distributed functional control
4. Control	Centralized	Distributed
5. Reliability	Weak in failure and survivability	Strong in survivability

The characteristics between layered TMN and Distributed TMN can be summarizes as shown in Table 1.

The proposed distributed–network management system model has the following advantages ;

1. The proposed management system avoids using centralized management functions of TMN and utilizes the peer–to–peer manager–to–manage communication. Thus the management information traffic can be evenly distributed

and eliminate problems caused by the traffic congestion and enhance system performance.

2. The proposed model can convert the existing management system from the regional distribution to a pure distributed systems. Such changes can increase system efficiency and support specialized management functions.

3. The conversion from a centralized system to a distributed system prevents from the isolation of management functions for the lower layer since management information can be continuously shared among local management systems.

4. The allowance of duplicated management functions among local manager systems provides the fault-tolerant capabilities for manager failure and provides more reliable network management capability.

4. IMPLEMENTATION SCHEMES FOR CORBA BASED-DISTRIBUTED MANAGEMENT SYSTEM

In this section, the proposed CORBA-based distributed management system can be implemented by using two different styles as shown in Figures 5 and 6. In Figure 5, a local manager has two management functions. one is manager/agent function which the existing system has and the other is a gateway function, the capability of which provides CORBA manger to recognize management messages. Thus the CORBA manager does not need to keep individual management information base of managed objects and maintain the IDL translation of managed objects.

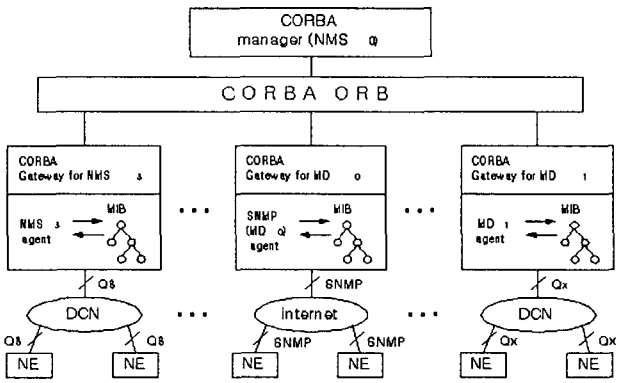

Figure 5: A distributed management system using a CORBA Gateway

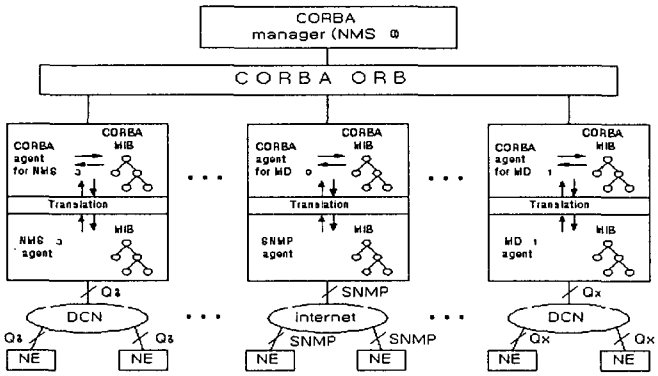

Figure 6: A CORBA–based distributed management system using MIB conversion

In Figure 6, local manages have the agent functions for high–level system manager and a mediation functions for the lower–layered managed objects. In other word, a local manger maintain individual MIB, in which management information is collected from managed objects and stored into MIB and the MIB will be mapped into the agent MIB by the CORBA object translation devices.

Table 2. Comparisons of characteristics between CORBA gateway scheme and MIB conversion scheme

	Gateway	MIB conversion
1. Managed object	TMN Managed objects	CORBA managed objects
2. Driven method	Gateway	Direct Driven
3. Conversion	Message conversion	Object conversion
4. Implementation	Simple	Complex
5. Delay	Mapping delay	None
6. Development period	Short–time	Long–time
7. Cost	Less Expensive	Expensive

Compared to two cases (Table 2), the former (Figure 5) provides a local manager with CORBA gateway capability, in which the manager can perform its own management function of managed systems by only using message translation , without MIB translation of managed objects. Accordingly the system implementation and maintenance are easy and simple since system changes can be done by the IDL mapping of managed objects. However, this approach provides a drawback due to long mapping delay of managed object when the network size increases. Thus this is not good for permanent solutions. The second (Figure 6) provides a pure CORBA–based distributed network management system, in which all MIB information in existing systems should be mapped into CORBA managed objects. Thus this approach

cannot provide good scalability in the short-term and requires implementation complexity and the high expense. However, since all managed objects and functions are based upon CORBA facilities, the system will provide full distribution capabilities of CORBA and future oriented distributed network management system.

6. CONCLUSIONS

This paper discusses problems of TMN-based network management system that is widely used in telecommunication management systems. Then this paper presents a CORBA based distributed network management system to improve the pitfalls, in which maintains location transparency, and interoperability on the different machine in the heterogeneous networks. Also in the paper, two different implementation approaches to build a CORBA based distributed management system are presented and then their comparisons are discussed. Figure 5 can maintain the TMN capabilities and also provide distributed management capabilities. Figure 6 is the pure CORBA based distributed management system and good for the permanent approach. The system implementation can varies dependently upon the characteristics of the distributed management system environment. The two approaches can be used selectively according to system requirements.

ACKNOWLEDGEMENT

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