THE ADAPTABLE TMN MANAGEMENT ARCHITECTURE WITH OTHER OBJECT-BASED MANAGEMENT REQUESTS PLATFORMS

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Abstract Over the last decade, the heterogeneous corporate network has been considered as the basic network service plan of various countries. The globalized heterogeneous corporate network is essential for network providers to provide various communication services, and for customers to acquire their various communication demands. In these cases, to manage such complicated heterogeneous corporate network, it is needed some efficient integrated management scheme.

Telecommunications management network (TMN) is a standardized network management framework for heterogeneous corporate networks. Also, asynchronous transfer mode (ATM) switches are constructed as main public backbone nodes. In this paper, we introduce implemental TMN element management layer (EML) management platform for ATM switches, which are developed by Electronics and Telecommunications Research Institute (ETRI). TMN EML manager workstation also plays a role of TMN NML agent and other agents for heterogeneous management domains, such as common object request broker architecture (CORBA) interface definition language (IDL) based management environment.

Keywords: TMN, CMIP, ATM, Management, Manager, Agent, NMS, MO, MIB, CORBA, Interoperability.

1. INTRODUCTION

Until recent times, most of distributed network elements of any involved network components from multiple vendors need to be controlled with its own

proprietary management pattern. Network components and network management systems were designed specifically for each particular telecommunication equipment and service requests. Thus, it resulted a number of inter-working problems and limited integration of network management functionality. With the growth of complexity in contemporary telecommunication networks, today's trends of the worldwide telecommunication networks are integrated, distributed and heterogeneously combined. Distributed telecommunication environment needs distributed applications that include open system interconnection architecture. To control cost effectively and to make integrated network management practically, we need the one of appropriate integrated network management concepts, such as TMN, SNMP and CORBA based management. Network components are redesigned as generic object oriented information model. Telecommunication management network (TMN) [1] is a framework for the management of telecommunication networks and services of heterogeneous information management targets. The basic concept behind the TMN is to provide an organized network structure to achieve the interconnection of various types of communication infra and network elements (NE) with standardized protocols and interfaces.

On the other hand, ATM technology provides the flexibility that is needed for realizing broadband telecommunications networks. High-speed transmission systems should be expected to offer bandwidth flexibility and heterogeneous traffic accommodation. Thus, ATM architecture is predicted to become a next generation switching technology. Actually, the ATM network is being an infrastructure that will support future broadband and multimedia telecommunication service networks in Korea. Electronics and telecommunications research institute (ETRI) has developed ATM switch and TMN element layer manager/agent system for ATM switches [2]. The TMN based ATM management system, ATM TMN, will communicate with switch's agent using Q3 interface. Management aspects of the ATM switch and network are represented managed objects (MO) through guidelines for definitions of managed object (GDMO) definitions. The management operation interfaces are specified by common management information service/protocol (CMIS/P). To develop commercial TMN management system for ATM switches and network, a real implementation methodology is needed. Standards and some forum (ITU-T, ATM Forum, ETSI, GR, NMF, etc) are currently studying principles for the TMN. But, they are generally confined to information modeling and essential management application function (MAF) specifications. To realize them, we have to design implementation schemes: F interface or gateway architecture between Non-TMN environment (i.e., GUI, Manager console, Operation and Maintenance Processor of ATM switch) and TMN environment (TMN internal manager process). Each of TMN MAF is construction of MO processes as the UNIX processes or threads. CMIP

handling mechanism, management information base (MIB) handling functions, application programming interfaces (API) for communication protocols and stepwise functional flow of TMN CMIP MAF scenarios are also needed [3].

Furthermore, we can expect another types of higher layered management domains, such as SNMP management domain, CORBA based domain which are located in network, service and business management layer. Thus, we have to develop agent system for those different domains of management into TMN element management system (EMS). The agent process for different domains play the role of gateway functionality which allow for the migration of information models between different domains of management technology [4]. This paper describes layered architecture of TMN management system based on EML, EL layers. The management system of TMN EML layer also plays the roles of agent system for heterogeneous management domains. In this paper they will be also described. The TMN MAF scenarios will be also described through the TMN multi-node connection management.

2. FUNCTIONAL STRUCTURE OF TMN EMS & ANOTHER AGENT FOR HETEROGENEOUS MANAGEMENT REQUESTS

The TMN EML layer management system is built in the UNIX based workstation. To support TMN management of ATM NEs, the number of workstations should be one or more. It is fully associated with workstation performance. The major factors of system performance are a number of MOs, a number of MO instances, invoked MAF concerned with process or thread, the execution size of MAF scenarios, a number of concurrently invoked MO processes, etc. The basic structure of TMN EMS system and agents are shown in Figure 1.

The EMS system plays the role of mediation device in TMN architecture; it must provide an agent role to its NMS manager and a manager role to its NE agent(s) at the same time. To satisfy more sophisticated network management requirements, the EMS must be able to handle the management requests from other management clients using different management protocols such as CORBA based management requests. As shown in Figure 1, an EMS manager consists of the manager main process, management application functions (MAF) which operate management scenarios: CN MAF (Connection), CF MAF (Configuration), FT MAF (Alarm & Fault), AC MAF (Account), SC MAF (Security), PF MAF (Performance). And, also communication protocol stacks and some of handling software blocks and graphic user interface through F interface are included. The EMS block manages several NE agents based on element management view, which represents ATM switches, and has an interface

channel to a NMS agent and manager. The NML agent of network management view represents the abstraction of ATM network which is composed of the ATM switches and the network-to-network interface (NNI) links between them. – see section 3.

Figure 1. Structure of TMN EMS & Another Agent

An EMS management service is performed through basic and extended MAF scenarios for configuration, connection, fault, account, security and additional connection services, internally. The basic MAF operates functions associated with UNIX system, and the extended MAF provides TMN based scenario processing functions. A gateway function takes charge of interface messages between MAFs and other applications. The gateway function distributes all incoming requests (from GUI, CORBA Agent) into the proper extended MAF through basic MAF, and handles outgoing results and notifications. The NML agent receives NMS requests and dispatches messages into the EMS main process through a gateway. An Information Conversion Function (ICF) is used to bridge between NMS agent and EMS manager. It is quite different between the MO sets of the EML layer and the

NML layer. The ICF converts and propagates NMS requests to the EMS manager and EMS notifications to the NMS manager. - It performs the mediation functionality. The ICF also decouples (assembles) NMS requests into (from) EMS requests (responses) due to the difference between network view and element view. When the NMS manager makes management requests for the NMS agent, the manager checks the scope of subnetwork, which is affected by the request. To do this, the manager looks up EMS management domain, and determines which EMSs are in the proper scope.

Based on management requirements, the NMS manager may send the same or different requests (UNI and NNI, NNI and NNI, NNI and UNI) to the selected EMS through synchronous or asynchronous binding way. The EML Manager main process inspects the requests, and dispatches the request to appropriate MO worker (process or thread). The MO workers may perform the request or forward the request to the agent in TMN NE layer. In another words, the EMS manager receives the request, it forwards the request to one of basic MAFs, which in turn create an instance of a MAF and the instance invokes management request to NE agents. The results from NE agents are collected in the EMS manager and manipulated with network view information in the NMS agent via the ICF.

TMN EML manager workstation can also play a role of agent for another objected based management domain such as CORBA based network management. CORBA was conceived by Object Managed Group (OMG) with the purpose of making easier to exchange distributed information regardless of the system environment and location. For example, Telecommunications Information Networking Architecture (TINA) and service management systems of telecommunications network provider in Korea are also have basic management scheme with CORBA request/response architecture. There are some possible approaches to join CORBA/TMN environments. One of approaches is using F-interface through IDL/Human Machine Interface (HMI) mapping. In this case, there is no need object-to-object and service-to-service mapping between them. In this case, however, many of unwanted and non-standard additional processing steps are required. Another approach is direct method from/to CORBA to/from TMN environments. A point of excellence of this approach is that all of processing flows represented with objects and object services completely. But, in this case it is very difficult to find out the interoperable features between CORBA and TMN. A detail discussion will be described in section 4) in this paper.

3. TMN BASED MAF SCENARIO FOR MULTI-NODE CONNECTION MANAGEMENT

The information model used to implement the EMS is based on TINA, HAN/B-ISDN and ITU-T documents [6][7]. Figure 2. shows the MO relationships in the EMS which manages multiple NE agents of ATM switches and the trunk link between them. MO set that is used by the connection (CN) MAF is as follow [8]:

Figure 2. Managed Object Models of ATM Agents for CN MAF

- o subnetwork represents a partition of a network
- o subnetworkConnection represents connection among end points of a subnetwork
- o nwCTP describes an end point of subnetworkConnection or linkConnection
- o edge binds nwCTP to subnetworkConnection dynamically
- o topologicalLink shows subnetworkConnection topology
- o linkConnection represents a virtual connection in topologicalLink
- o ITP stands for an end point of topologicalLink

The CN MAF includes end-to-end connection management and experimental results based on operation performed. The experimental system consists of 4 ATM NE agents, each of which is executed on a workstation, an EMS manager and a NMS agent are also executed on another workstation. The EMS and the NE agents were implemented on SPARC workstation with distributed processing environment. In order to establish an ATM end-to-end connection, the NMS manager issues M-ACTION request to the one of NMS agents with connection information such as calling party number, called party number and ATM traffic descriptors. When MO instance of a top-level subnetwork in the NMS agent receives the M-ACTION request for end-to-end connection, it starts searching the distinguished physical locations of subscribers. The NMS agent searches which NE serves calling and/or called subscriber.

It is determined by routing information which is located in each of the NMS agents. Then it issues a M-GET request to the corresponding NE agent via ICF and EMS manager. The NMS agent issues a local getting request to

the ICF using proprietary IPC. Then the ICF forwards the request to the EMS manager. The EMS manager generates an M-GET request to the proper NE agent. The responses containing user location are returned to the NMS agent through the reverse steps. After the MO instance of a top-level subnetwork receives the M-GET response, it begins to search a possible and efficient path from originating NE to destination NE which are confined to single EMS boundary. The routing information is stored in MIB of the NMS agent in association with pre-configuration. Then the NMS agent sends connect M-ACTION request to each NE included in the selected path. The request is transferred with the same case of the M-GET procedure. This procedure is illustrated in Figure 3. The scenario is described with four ATM NEs. This operation could be implemented in parallel or in sequence.

4. INTEROPERATION WITH OTHER OBJECT-BASED MANAGEMENT ENVIRONMENTS

Figure 3. Multi-node Connection Management Scenario for ATM NEs

As well known, CORBA allows object-oriented communication between applications, which are distributed across networks. CORBA provides not only point-to-point object-oriented communications between management applications, but also provides the domain independent object bus for distributed communications applications. CORBA is more general-purposed

than TMN CMIS/P architecture. Thus, we could expect that there are many network providers to require network management system that has the interoperability with CORBA based architecture. In fact, a few number of network providers in Korea have a plan to develop CORBA based management system in service management layer for their reliable communication services successfully. It requires a gateway system, which has the interoperability with CORBA, based management domain which are not necessary based on the TMN CMIP management domain. This is major reason that why we try to build CORBA/CMIP gateway architecture into the TMN EMS system, as described in Fig 1. The gateway process (CORBA Agent, Server Object) has to ready for the heterogeneous management requests with CORBA interface definition language (IDL) specifications [10]. In GDMO, ASN.1 and Template can be mapped into IDL specification through syntactic mapping table. And other possible mapping stacks are shown in Figure 4.

Figure 4. Possible equivalence between CORBA and TMN

In case of the CMIS/P behavior, it is need to be semantic translated. As it were, we need mapping of MO, attribute, ASN.1, and translation of actions and behaviors. During the scoped operations on the managed object, gateway gives the attribute IDs as plain string. The OIDs for given attributes are looked up in the translation information, together with the types of the attributes. Data type of abstract syntax notation (ASN.1) will be matched with CORBA IDL definitions generally. Sometimes, during the specification translation, parts of ASN.1 cannot be represented in IDL. In these cases, some omissions or mismatches are remedied during translation of the values that pass through the CORBA agent in run time. The logical position of CORBA agent is shown in Figure 1. The CORBA agent server forwards all client requests to the TMN EMS main process with form of TMN CMIS/P or operator's commands. We are specifying an algorithm for the translation of IDL specifications into GDMO definitions. The translation algorithm has flows to pick up represented GDMO managed object from IDL interfaces.

For every managed object class template, a primary IDL interface is defined which supports the operations on the managed object. CORBA based management application services will be mapped into access scheme to a managed objects in CORBA agent. The MAF behaviors of TMN are totally transparent to the IDL based CMIS services. A CORBA object service can be mapped to TMN CMIS/P management services. Table 1. shows the possible mapping interface between CMIS based management services and CORBA services.

Beyond above, there are some possible approaches for the construction of CORBA/CMIP gateway framework. Among them, we will describe internal CORBA structure.

CMIS based Management Service	OMG CORBA Object Service
MO FSM (Finite State Machine)	Life Cycle Service
Event Notification Service	Event + Property Service
Naming Service	Naming + Property Service
MO Filtering	Property Service
Repository	Repository Service

Table 1. A possible mapping interface between CMIS and CORBA services

All of internal interfaces are constructed with object request broker (ORB) as object bus. Its overall structure is shown in Figure 5.

Figure 5. TMN architecture with internal CORBA

TMN EMS system distributes each of management scenarios as job-based MAF process. Each MAF process has client stub and communicates with each other through ORB bus of CORBA via server that is located in CORBA/CMIP gateway process. The CORBA server performs TMN EMS manager main process as well as the role of CORBA server object. This approach makes use of the gateway concept between domains and requires the translation of GDMO semantics and existing CMISE functionality into IDL definitions. Such an IDL interface is abstracted from the information model

semantics level but offers only the required functionality by the management applications, with IDL specified object classes and operations concerned with GDMO specifications. In GDMO, ASN.1 and template can be mapped into IDL specification through syntactic mapping table. In case of the CMIS/P behavior, it is need to be semantic translated. The mapping is then made with the GDMO exhaustive model of the managed entity. This approach offers a way to encapsulate TMN CMIS/P components to be used in CORBA environment. Sometimes, however, during the specification translation, parts of ASN.1 cannot be represented in IDL. In these cases, some omissions or mismatches are remedied during translation of the values that pass through the CORBA/CMIP gateway in run time. It remains to be heavily studied.

5. CONCLUSION

In this paper, we introduced possible development structure of TMN EMS management platform for ATM NEs and network. We, mainly, described the functional framework of TMN EML management system. The MO based management application is announced through multi-node connection management of ATM network. To develop the effective TMN EMS, proposed TMN EMS architecture operates management application function (MAF)s are operated with task-oriented separated MAF processes in distributed environment. Thus, MAF's roles are also layered and categorized into F,C,A,P,S,CN based MAF processes. These are very useful to separate the manager's role into CMIP message handling and MO information handling to give flexibility and extensibility. This structure also enables that TMN EMS could be constructed to adapt other heterogeneous management platform such as CORBA based management environments. In front of EMS main manager process, we can build gateway architecture to serve CORBA based management requests, cost effectively. We are defining and developing detail gateway framework in front of TMN EMS. Designing and developing the effective mapping and translation of MOs and management applications are also topics to be heavily studied.

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