OpenCon Systems, Inc.

WORLDWIDE COMMUNICATIONS SOLUTIONS

White Paper
On
The TMN Gateway

Telecommunication Growing Pains

Today's telecommunication industry is undergoing rapid changes being fueled by the Telecommunication Deregulation Act and increased convergence between industries. This has led to explosive growth in the telecommunication market and has heightened competition by introducing new entrants in the service provider and equipment manufacturer sectors.

Until a few years ago, the need for inter-operability between different vendors' equipment and management systems was limited. Now, to meet the increasing demands for newer services and higher bandwidth at lower costs, service providers purchase equipment from multiple vendors. Due to the differences in the management interfaces supported by the network elements the service providers can no longer manage their network from a single management system.

Traditional telecommunication equipment suppliers support TL1 management interfaces in their equipment and a few support CMIP interfaces in their equipment. Newer equipment suppliers, whose equipment was originally targeted for the data communications market (such as ATM vendors), support SNMP interfaces in their equipment. Thus service providers who buy equipment from the traditional equipment suppliers and new entrants to this market need to manage their networks using TL1, CMIP and SNMP. Other prevalent management technologies include CORBA, EDI and many other legacy protocols such as TBOS and E2A.

The convergence of telecommunications and enterprise networks is another factor that introduces the need to provide seamless interfaces and inter-connectivity between diverse management systems.

One way to overcome the inter-operability and connectivity issue will be to support a standards-based (OSI) common information model interface in the equipment. This approach is typically costly and requires changes to the software that resides in the existing products. Another approach is to provide an external interface that delivers a single view to the management systems while preserving the information model and the communication protocol used by the equipment. This second approach appears to be the desired solution by many of the telecommunication management and equipment vendors. OpenCon Systems' (OCS) TMN Gateway (TMN GW) product uses this second approach to offer a solution for management inter-operability.

OpenCon Systems' TMN GW provides inter-operability and inter-connectivity between diverse management interfaces. This is done by information mapping of management information from one protocol to another. It provides translation capabilities between CMISE, CORBA, SNMP, TL1 or proprietary based information systems, allowing network management from a single system. TMN GW uses a CORBA based architecture that allows any CORBA applications to be integrated without changes in the applications, as long as they use a standard CORBA interface. In addition, the OCS TMN GW's generic architectural design allows it to offer inter-operability and connectivity between applications that reside on any two adjacent layers of the TMN Network. Features like these make TMN Gateway an ideal solution for mixed network deployments and heterogeneous environments.

Bridging the Management Islands

The service provider dilemma of multiple management interfaces and the need for the integration of these interfaces is undeniable. However, service providers will not change their current business technology until "the pain of change is less than the pain of staying the same." The OCS TMN GW eases "the pain of change" by providing a management bridge for service providers from where they are today to where they would like to be in the future.

This section describes the TMN GW product that provides translation capabilities between CMISE, CORBA, SNMP or TL1 based information systems. The TMN GW provides inter-operability between systems supporting diverse management interfaces allowing them to managed from a single management

interface and thereby supporting the convergence of telecom and enterprise network and service management.

The Telecommunication Management Network (TMN) consists of a layered architecture where each layer uses the services offered by the layer below and provides services to the layer above. The TMN network is divided into five layers namely the Element Layer, Element Management Layer, Network Management Layer, Service Management Layer and Business Management Layer. At the element layer, many network elements offer a variety of services such as Transport, Access and Switching. At the EML level, many types of managers exist depending on the elements they manage and the protocols the elements support. Similarly the higher layer applications use a variety of schemes to communicate with the lower layers to use their services. As the TMN standards evolve to provide a common management scheme, it is important to support the existing management scheme since it is more expensive and not practical to rewrite the entire network management applications. The network management products today support the standards based management protocols while the earlier products use more proprietary protocols. TMN GW is aimed at providing information mapping between management applications that use disparate protocols and it can be used between any two layers of TMN model.

The TMN GW supports many of the management interfaces that are supported widely in the current Telecommunication Network. *Figure 1* illustrates the interfaces supported by the TMN GW. The TMN GW provides information and protocol translation from one management interface to the other. The translation is performed based on a rules based inference engine. In order to enable communication between a managing entity and the managed entity using different protocols, the TMN GW can be deployed between them with appropriate interfaces. In order to customize the solution the users shall specify the translation rules between the protocols and in some complex cases write some specific behavioral functions. The translation rules basically consists of protocol mapping between the two entities, behavioral mappings from one protocol to the other and the information mapping rules that enable translation from one information representation to the other. Due to its generic architectural design, the TMN GW product is able to offer inter-operability and connectivity between applications that reside on any two adjacent layers of the TMN Network.

Figure 1: TMN GW Interfaces

The TMN GW product consists of a communication subsystem and TMN GW Core subsystem. The communication subsystem consists of interface adapters where each adapter supports a specific management protocol such as CMISE, TL1 or SNMP. Each of the adapters can perform either a manager role or an agent role depending on how it is deployed. The adapters that are currently supported are TL1, CMISE, and IDL. The TL1 adapter enables communication with Network elements that support TL1 for

management purposes. IDL adapter enables communication with Management applications that use IDL interface to communicate with agents. The CMISE adapter enables communication with CMISE based manager or agents.

The information mapping between one protocol to another takes place in TMN GW Core subsystem. The TMN GW Core subsystem accepts translation rules from the user to construct the Translation Mapping engine. In its simplest form, the rules could be sufficient enough to construct a complete Translation Mapping engine when there is a one to one mapping that exists between protocols and information. In more complex cases where no appropriate mapping exists from one protocol to another, the customer may have to develop some special modules to facilitate the translation. These customized modules can be invoked via user hooks provided by the Core Subsystem.

The TMN GW is both scalable and distributed. Hence it can be deployed either on the same workstation where the management applications are executed or it can be executed on a separate workstation. Also, if a small network needs to be managed it can also be deployed in a Windows NT environment. The adapters are modular and independent of each other. This enables the customer to mix and match the communications interfaces that are needed. For example, if TL1 to CMISE translation is needed only a TL1 adapter and a CMISE adapter will need to be used.

Deployment Chameleon

The OCS TMN Gateway can be deployed between management entities that use diverse protocols providing inter-operability in management applications. The deployment scenarios below illustrate how the TMN GW can be used to allow seamless connectivity between diverse management systems in a TMN network.

CMISE Manager and TL1 Agent

Consider a network where a CMISE based Manager is used to manage network elements that support TL1. The TMN GW can be deployed as illustrated in to enable communication between the CMISE Manager and the TL1 Agent. In this deployment the CMISE adapter will be used to interface with the CMISE Manager and the TL1 adapter will be used to interface with the NE. The CMISE adapter will perform CMISE agent functionality and the TL1 adapter will perform TL1 manager functionality. The TMN GW Core Subsystem will perform most of the translations such as mapping between services, generic translations for alarm, PM reporting etc. Any deviations from the default translations offered by the TMN GW can be specified via the Translation Rules and the TMN GW can perform translations based on these rules.

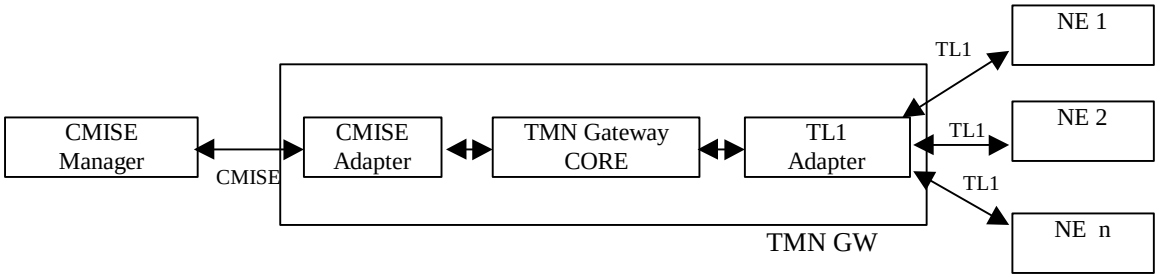

Figure 2: CMISE/TL1 Architecture

CMISE Manager and SNMP Agent

Consider a network where a CMISE based Manager is used to manage network elements that support SNMP. The TMN GW can be deployed as illustrated in Figure 3 to enable communication between the CMISE Manager and the SNMP Agent. In this deployment the CMISE adapter will be used to interface with the CMISE Manager and the SNMP adapter will be used to interface with the NE. The CMISE adapter will perform CMISE agent functionality and the SNMP adapter will perform SNMP manager functionality. As specified before the TMN GW will perform necessary translations between the CMISE information model and the SNMP MIB to enable the communication between the two.

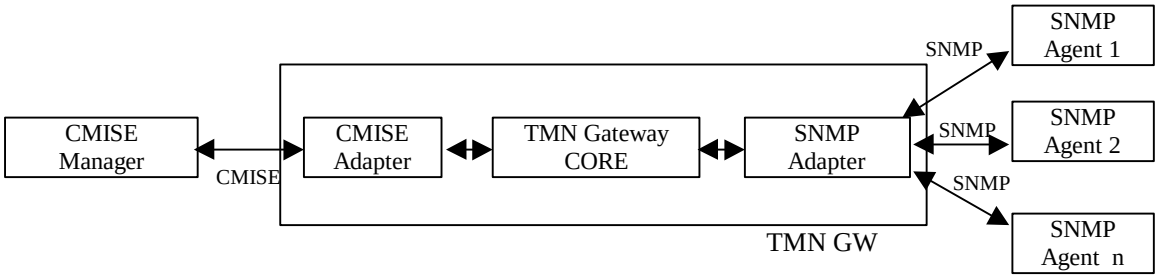

Figure 3: CMISE/SNMP Architecture

NML Application and EMS

Let us assume a Network Management application (example Path Management) has a CORBA interface and wishes to communicate with an Element Manager supporting the CMISE interface. The TMN GW can be used to achieve communication between them. Figure 4 illustrates the deployment for this configuration. In this case, the IDL adapter will be used to interface with the NML application while the CMISE adapter will be used to interface with the EMS. TMN GW will do the translation between IDL specifications and CMISE information model.

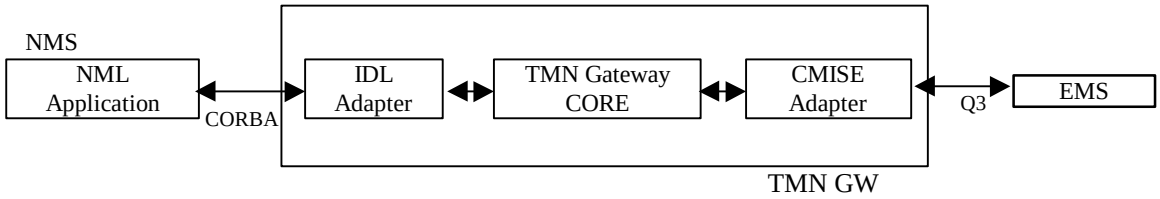

Figure 4: NMS/EMS Architecture

Service Management Applications

The TMN GW can also be deployed at the service management layer where multiple interfaces are involved in providing information to the service management application. For example, for LNP SOA applications, the request order can be created using proprietary, Web, or CORBA interfaces and the information is exchanged with NPAC using the CMISE interface. The TMN GW can be deployed between the Service Order Entry user interface and NPAC as illustrated in Figure 5.

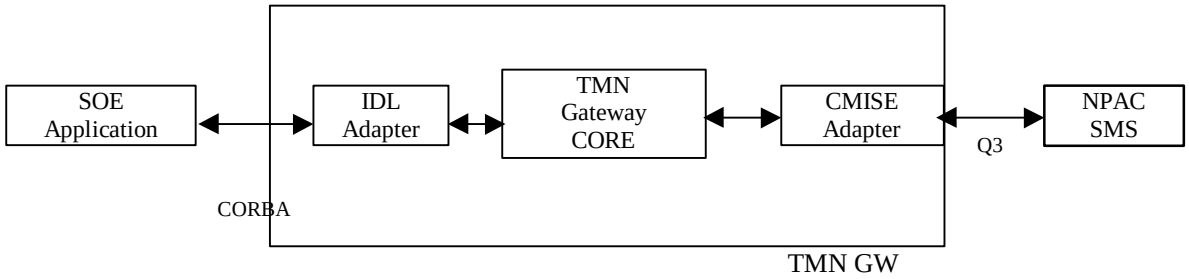

Figure 5: Service Management Application Architecture

Mixed Network Environment with Multi-Protocol Agent/Manager Applications

The TMN GW can be deployed in a mixed network environment. Consider a network with Network Elements supporting TL1 and CMISE Agents. If an element manager uses the CORBA interface and it needs to manage TL1 and CMISE NEs then the TMN GW can be used to enable communication between them. The TMN GW maintains associations and routing tables between the manager and the corresponding agents. Hence it is possible for TMN GW to identify the proper protocol interface when communicating with the NEs and provide proper translation when the requests are received from the manager. Figure 6 illustrates this configuration.

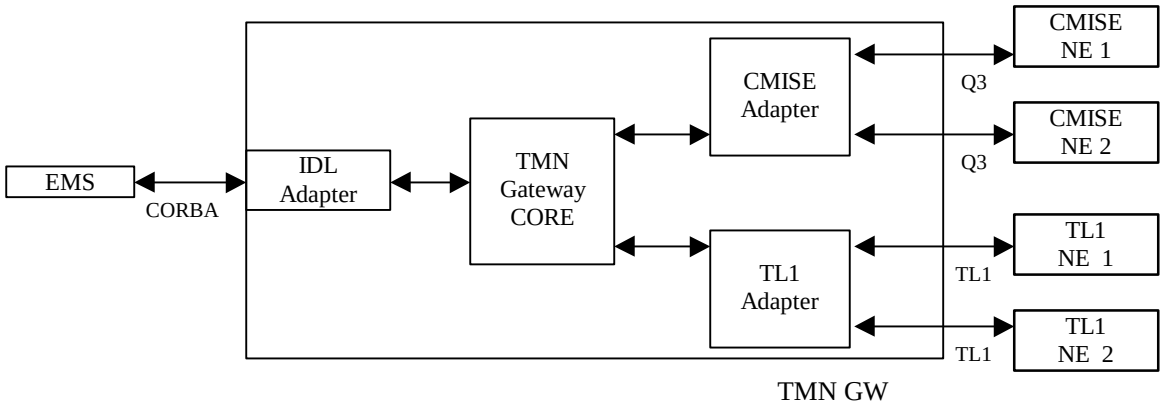

Figure 6: Multi-Protocol Architecture

Adaptive Design for an Ever Changing World

The OCS TMN Gateway provides a basic platform and all the necessary components that can be used to quickly build a system to provide a seamless connection between managers and agents that do not support a common management interface. In order to achieve connectivity between diverse management interfaces, the TMN GW uses a rules based inference engine where the rules can be specified to provide the mapping information from one protocol to another. The TMN GW comes with the default mapping rules between any two protocols for a given information model. However some level of customization work has to be done before new managers and agents can be successfully bonded. In addition to the definition of these mapping rules, customized translation routines may have to be written using the hooks provided by the Translation Mapping engine to accommodate the instances where the translation rules cannot be easily defined using the translation syntax rules.

The high level architecture of the OCS TMN GW is illustrated in Figure 7. The OCS TMN GW has two major subsystems:

- **Communication Interface Subsystem**
- **TMN Gateway Core Subsystem**

The communication interface modules are protocol dependent and facilitate information transfer between external management entities and the TMN GW. The TMN GW Core Subsystem contains the Information Mapping modules.

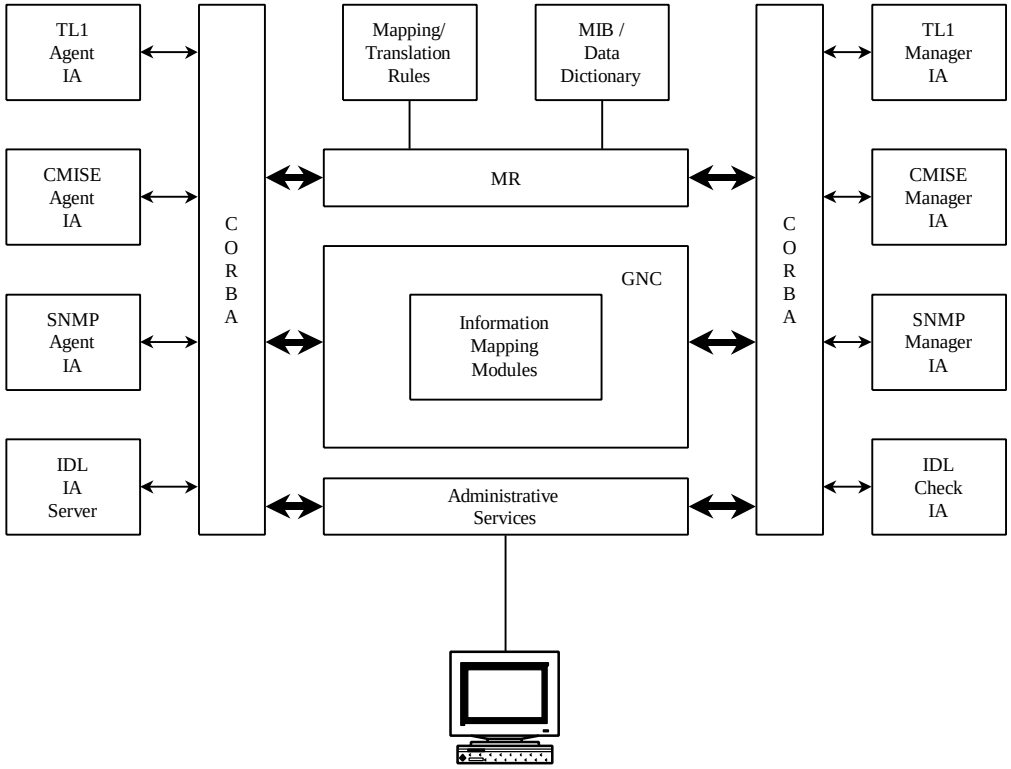

Figure 7: TMN Gateway High Level Architecture

The Mediation module maps requests and responses between different communication protocols (for example, TL1 ENT-EQPT is mapped to CMIP M_CREATE request). The Data Translation module translates information received from one management interface to an equivalent representation of the same information in another management domain. The architecture of the OCS TMN Gateway is modular and not all components need to be included to build an operational gateway. For example, when gateway functionality is required between CMIP managers and TL1 agents, the SNMP communication interface modules are not needed.

Communication is the Key

The Communication Interface Subsystem consists of Interface Adapters (IA) for various protocols such as CMIP, TL1 and SNMP. Each interface adapter consists of a manager adapter and agent adapter. The manager adapter performs manager functions and interfaces with agents externally while the agent adapter performs agent functions and interfaces with managers externally. The reason for the separation between Manager and Agent communication interface adapters is due to differences in the functions performed by these two entities. For example, a CMIP manager can only issue M_CREATE, M_GET and M_SET requests whereas a CMIP agent cannot issue these requests. Similar differences exist between SNMP and TL1 managers and agents.

The communication interface adapters handle all aspects of establishing, maintaining and releasing communication links with the external management entities. In the case of the CMIP interface adapter, this would involve establishing and releasing associations with peer entities. Once the communication links are established, the interface adapters act as an intermediary to forward the requests/responses between

external management entities and the mediation module. The interface adapters use CORBA to communicate with the TMN GW Core subsystem for forwarding various requests and responses. The Interface Adapters use the Metadata Repository (MR) to access various protocol specific information models to construct and forward messages to the external entities as well as with the TMN GW Core subsystem.

The CMIP communication interface module handles all association management functions such as association establishment, release and aborts. This module also handles all security-related functions such as construction and validation of access control information. The mediation module and CMIP communication interface module share a common table, which defines the mapping between a logical name for each external management entity and the corresponding physical address.

The SNMP communication interface module handles all interactions with the external SNMP management entities. This module also handles all security-related functions to validate the incoming SNMP requests/responses. The main function of this module is to construct the SNMP PDU for outgoing messages and parse the incoming SNMP PDUs and forward them to the mediation module.

The TL1 communication interface module handles TL1 parser/formatter functions. This module includes a generic parser/formatter module that can be easily adapted to support any TL1 message set by loading appropriate TL1 data dictionaries. This module also handles activation, termination and validation of TL1 user sessions.

Hard-Core Intelligence

The Core subsystem consists of the Generic Nerve Center (GNC), Metadata Repository services and administrative services. The main function of the OCS TMN GW Core Subsystem is to transform management information from one format to another. This subsystem handles two types of management information. The first type of management information is externally generated and the second type of management information is locally generated. Externally generated management information originates and terminates in the external management entities. Due to incompatibilities in the information models supported by the external management entities, the OCS TMN GW sometimes may have to locally generate this information to satisfy the requests that originate from the external management entities.

Transformation of management information from one format to another is accomplished in two steps. The first step involves mapping the received request/response from one management domain to one or more request/responses in another management domain. The second step involves translation of the data types and values in the message. In the case of locally generated management information, the first step is not necessary. Translation of message formats is performed by the Translation Mapping engine, which is driven by pre-defined translation rules or in some cases customized translation routines.

The TMN Gateway Core Subsystem maintains a log of all errors encountered within the Gateway. The log verbosity level can be configured to record all or combinations of critical, major, minor or informational type errors. The logs can be examined from the Administrative User Interface (AUI).

The Gateway Nerve Center consists of a Mediation module and a Data Translation module. The Mediation module maps requests and responses from one management interface to one or more requests and responses in another management interface. For example, the mediation module can map a scoped M_GET request received from an external CMIP manager into one or more SNMP GetRequest, GetNextRequest or GetBulkRequest messages and forward them to another external SNMP agent. The Mediation module performs the mapping based on protocol mapping rules stored in the Metadata Repository. The Mediation module uses MR services for this purpose.

The main component of the Data Translation module is the Translation Mapping engine. Application specific and vendor specific translation rules drive the Translation Mapping engine. Application specific rules are rules that define how to perform translation of data within one particular application domain.

Examples of application domains are SONET network element management, ATM network element management, Trouble Administration and PIC/CARE. The application specific translation rules cover three main areas:

1) The rules for mapping between the external representation of managed objects and attributes to internal managed objects and attributes

2) Rules for translation of data types and values associated with the external representation of attributes to an internal representation

3) Special processing rules that define actions to be taken when operations on inter-dependent objects are performed. Vendor specific translation rules can be used to over-ride or enhance the general rules defined for the application domain to which the vendor's management entity belongs. The Translation Mapping engine uses MR services to retrieve the translation rules from the MR.

The Metadata Repository stores all information pertaining to each of the management interfaces and the translation rules needed by the GNC. For example, the MR stores the TL1 data dictionary for the TL1 interface and the CMISE information model for the CMISE interface. The MR module offers services to access protocol specific information to the management interfaces. The MR module also offers services to access the translation rules to GNC.

The Administrative Services module provides the interface to configuration files. This includes facilities for configuring log levels, start/stop logs and features. The functionality for software download, switching to a new generic and retrieval of version information is also provided through the administrative services interface.

Convergence At Last

Entering the new millenium the companies that can seemlessly integrate their networks and their clients networks will reap huge rewards. The OCS TMN GW provides this integration for service providers, management and hardware vendors and system integrators. The OCS TMN GW is so flexible it can be used by basically everyone in the business of integrating networks and services. Growing up so fast is always hard to do, but now the communications industry can smoothly make that transition from adolesence to adulthood.