INTEGRATING CORBA AND TMN ENVIRONMENTS

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Abstract—**A TMN (Telecommunication Management Network) is a management architecture framework which provides an environment for interfacing a telecommunication network with computer systems in order to provide different management functions at several different levels. The ITU-T X.700 series of standards (also known as OSI network and systems management standards) are developed to manage networks and network elements in a TMN environment. Many efforts have been made to define managed objects and develop management platforms for telecommunication network management.**

However, less effort has been made for telecommunication service management. OSI based network management is not particularly suitable for service management. New technologies are required.

CORBA technology, on the other hand, provides a distributed object computing environment. It provides a basic framework for distributed object management and is capable of supporting global multivendor networks. Its distributed nature, object orientation, and the ability to handle complex objects makes it a candidate technology for telecommunication service management.

It is important that these two technologies can be made to work together to provide an integrated telecommunication service and network management environment.

This paper discusses different strategies for interfacing CORBA and the OSI based TMN environments.

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1 TELECOMMUNICATION SERVICE CHARACTERISTICS

In telecommunications, a service is a set of capabilities provided to clients by the communication companies (Telcos). Examples include teleconference, telecard, and voice mail.

Compared with network elements, telecommunication services have the following characteristics:

- Service is distributed while network element is not.
- Services are implemented on top of network elements.
- There are always fewer services than network elements.
- Services are heterogeneous while network elements are not.
- Services are more complex than network elements. In many cases, services involve people as part of the process.
- Services are more dynamic while network elements are more stable. New services often need to be created, implemented and deployed rapidly.

Figure 1 depicts a scenario of telecommunication service management activities and the characteristics.

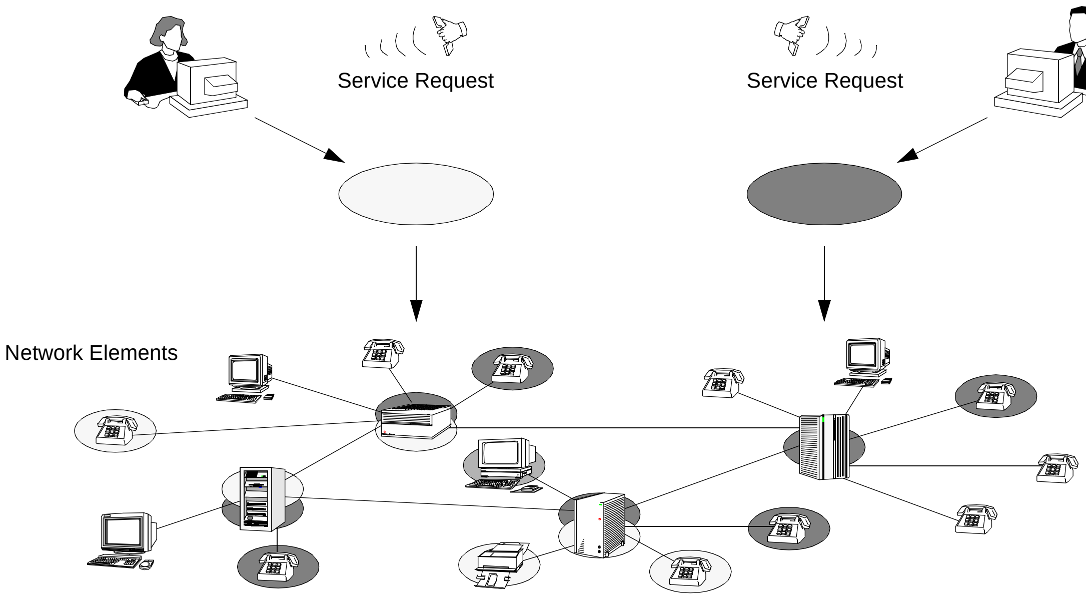

Figure 1: The Characteristics of Telecommunication Services

2 SERVICE MANAGEMENT

The management functions in service management have a different orientation and broader scope than those in network management. Service management is concerned with service related issues as illustrated in Figure 2. Service management activities include:

- how is a service 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 is a service 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?
- how to manage service related work force and task flow?
- what is the relationship between service management and network management?

OSI based TMN network management is designed to manage large numbers of well-defined simple objects. This may not be sufficient to provide a complete solution for service management. For example, the current object modelling facilities (such as GDMO) are not sufficient to model service objects and service management functions. In order to cope with rapid service changes and interoperability requirements between different business domains at a service application level, new technologies are required.

Figure 2 shows the detailed service management activities as defined by ITU-T.

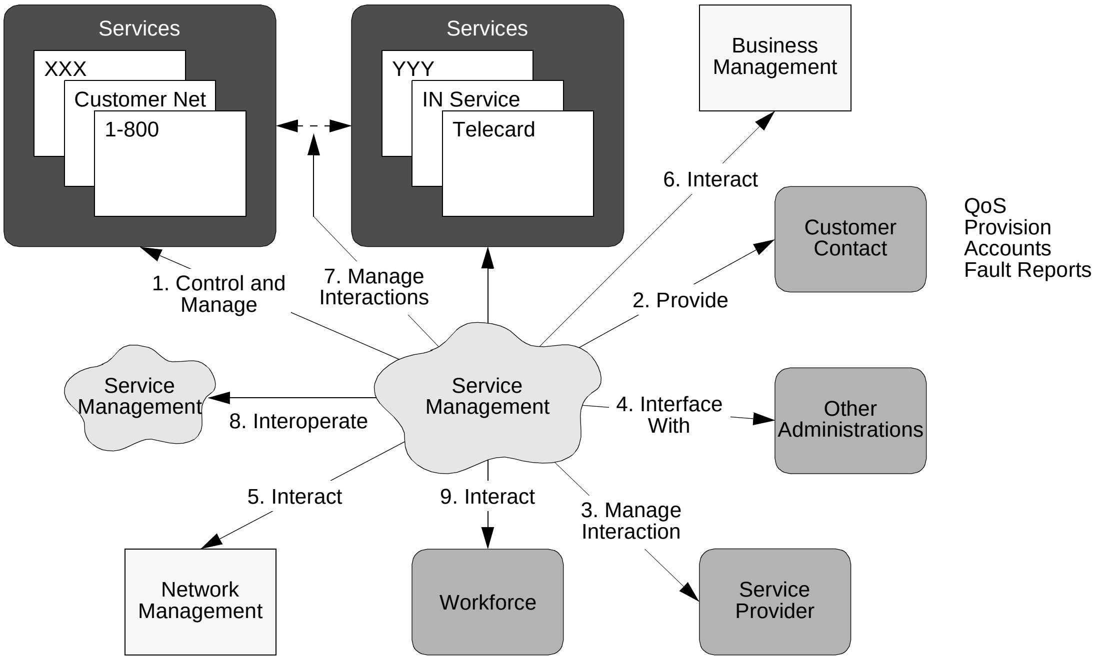

Figure 2: Service Management

3 SERVICE MANAGEMENT REQUIREMENTS

Service management applications are designed to manage geographically dispersed services with very complex heterogeneous computer and telecommunication resources. The management process aims to achieve consistent, reliable and transparent access and modifications of these resources. It is crucial for the industry 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. Telcos distinguish themselves from other Telcos by their service offerings and management.

Major requirements for service management include:

- *distribution*—Telecommunication services are geographically distributed. Hence their management should also be distributed.
- *scalability*—The 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, computer systems and human processes in the management domain require the support for heterogeneous systems.
- *consistency*—Data consistency is crucial to Telcos' business success and it must be achieved in distributed service management.
- *service integration support*—Service management functions are required so that new services can be easily introduced and managed, and existing services can be integrated.
- *interoperability*—Different business domains and administrative authorities must interoperate to achieve integrated service management. These management domains normally have different enterprise policies, business focuses, underlying technological frameworks and organisational infrastructures.

4 CORBA FOR TMN SERVICE MANAGEMENT

TMN networks contain large numbers of relatively simple objects. OSI based TMN network management technology is suitable for managing network objects and network element objects. These objects model the real network elements, and network topology and hierarchy. They are relatively simple in the sense that objects normally do not have complicated operations and relationships. GDMO is a suitable tool to specify these objects and their operations, behaviour and notifications. CMIS/CMIP is used to define communication services and protocols between different entities responsible for implementation and invocation of objects. Most operations performed on these objects are simple operations and are normally performed on a group of objects determined by filter and scope conditions.

On the other hand, TMN services are normally modelled by relatively small numbers of very complex objects. These objects represent a high-level abstraction of the network, relationships of network components, and computerised services supported by the network. For instance, a teleconference service may have a small number of instances representing distributed service offerings and management components. It is however, supported by a large number of underlying elements, network and various management information systems. Access to a teleconference service may invoke very complex functions including accounting, security, performance, interoperability, and quality of services.

Given these parameters and management features, TMN services are difficult to model with GDMO facilities and difficult to implement using OSI network management architecture. CORBA technology offers a better alternative for modelling these complex service objects for TMN service management.

CORBA supports an environment for definition, transportation, implementation and invocation of objects, and requests to access their functions. It also supports the separation and distribution of object implementations from their definitions so that service objects can be quickly designed, implemented, deployed and managed by the environment. The Interface Definition Language (IDL) offers facilities to specify complex operations for objects and generic interfaces to invoke these operations.

All these features make CORBA technology a good candidate for an environment to implement TMN service offerings and service management.

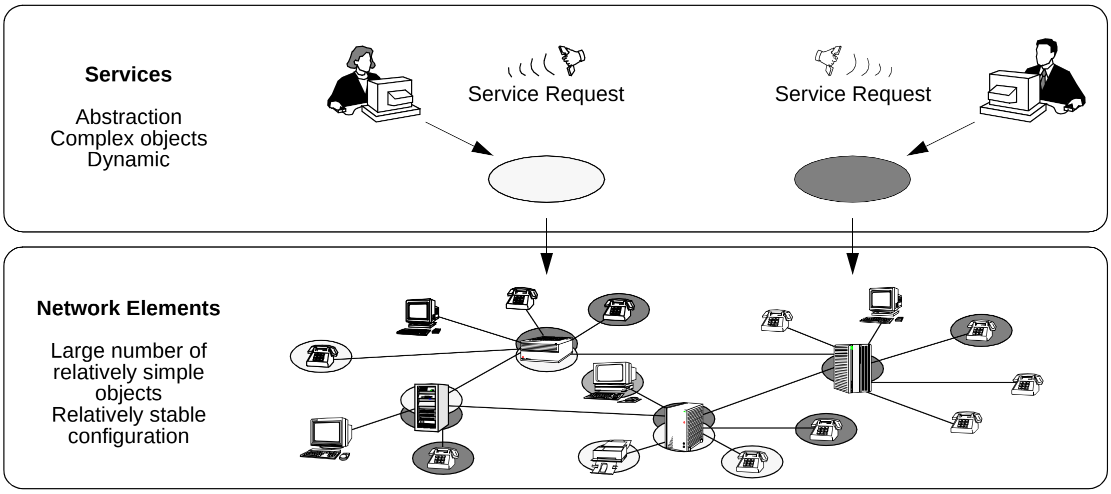

Figure 3: Service Management Activities

5 INTEGRATION OF CORBA AND TMN

Although CORBA is a desirable candidate for implementing TMN services and service management, it is not suitable for managing TMN networks and elements for the following reasons:

- In TMN network management, the network topology and distribution of resources are relatively stable. This means that the feature of transparent handling of distribution of objects provided by CORBA will in many cases present not benefits but overheads.
- The OSI manager-agent communication model is well suited for managing large quantities of network and element objects which are not highly distributed and dynamically reconfigurable. The communication between managers and agents using established connections is more effective than using a request broker.
- Given the network object hierarchy, it is very ineffective for CORBA to model filtered and scoped operations.
- Finally, it is not warranted to replace a large segment of technology (TMN network management) using another technology which is not obviously superior in the domain.

It follows that the best approach is to combine CORBA and TMN network management to provide an integrated network and service management solution.

The major problem of integrating CORBA and OSI based TMN network management is object modelling. These different technologies use very different approaches to model the managed objects:

- In OSI network management, a set of management objects are defined using GDMO; data types used in objects are defined in ASN.1. There is also a set of system management functions defined in the OSI standards.
- CORBA has its own object modelling technique. Its objects are defined in CORBA IDL (Interface Definition Language). A set of object services are also defined in the Common Object Services Specification (COSS).

To integrate CORBA and TMN is to integrate these two different object models, the related management operations and functions, and the underlying communication protocols as illustrated in Figure 4:

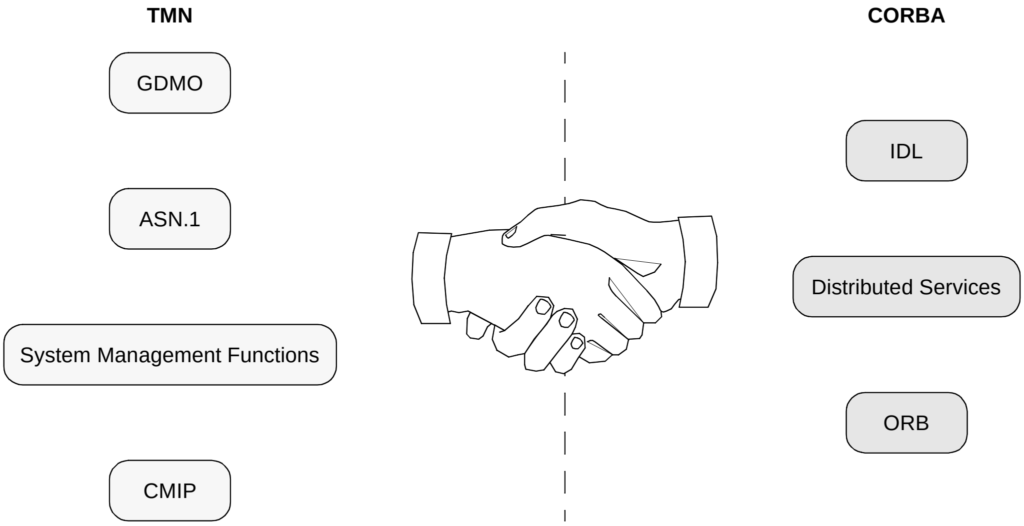

Figure 4: Object Model Integration

Three approaches can be used for the CORBA and TMN integration. These approaches are:

- the gateway approach
- the value-added approach
- the abstract object mapping approach.

5.1 GDMO- IDL GATEWAY

One way of interfacing CORBA and OSI based TMN is to build a gateway between the CORBA environment and the OSI network management environment. One scenario is to develop agents in OSI environment (in which GDMO objects are defined and the CMIP communication protocol is used) and develop managers in CORBA environment (in which object definitions are based on CORBA IDL and the ORB is used as the communication mechanism).

To be able to conduct communications between a manager and an agent, agreement must be made at two levels:

- At the object definition level, each GDMO object needs to have a mapping in IDL. This mapping includes the object definition (such as attribute types and values), operations that can be performed on the object (such as get, set, create, delete, action), notifications the object may issue, and possibly the behaviours of the object.
- At the communication protocol level, messages or requests sent by a manager using protocols supported by the ORB need to be translated into CMIP before being passed to the agent. Messages or responses sent by the agent using CMIP need to be translated back to the protocols supported by the ORB before being passed to the manager.

There is a one-to-one mapping between GDMO objects and IDL objects. There is also a one-to-one mapping between GDMO operations and IDL object invocation methods, as illustrated in Figure 5.

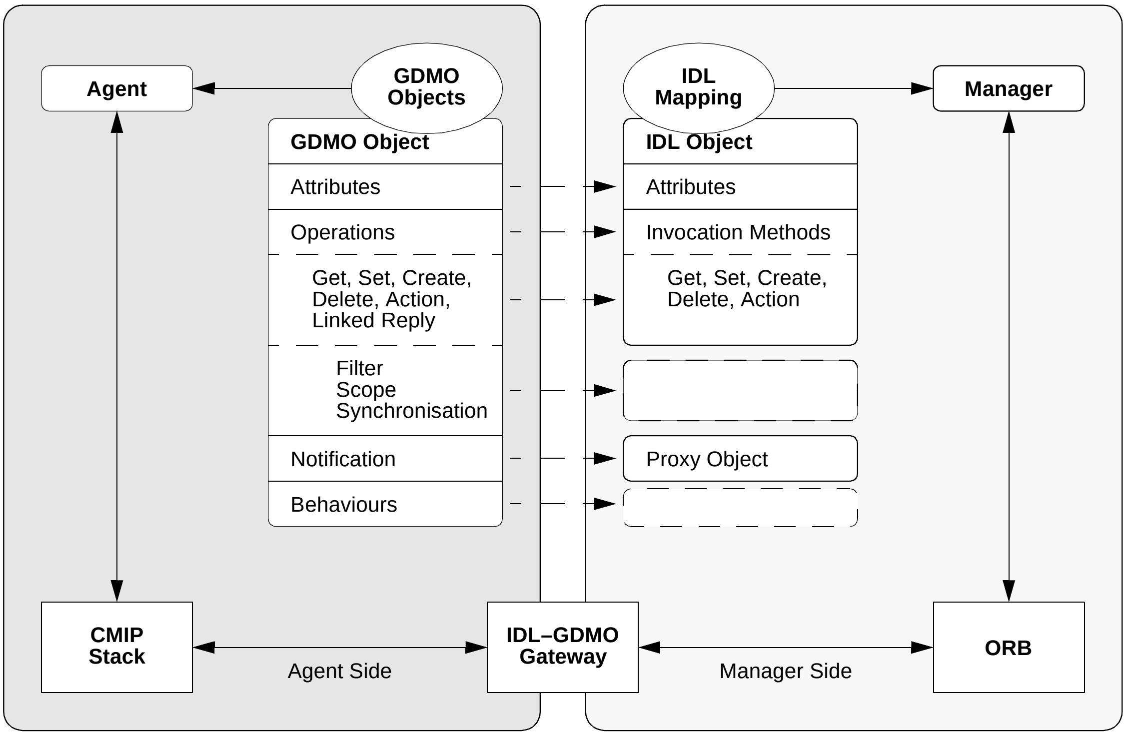

Figure 5: One-to-one Mapping between GDMO Objects and IDL Objects

It is possible to generate IDL objects automatically from original OSI GDMO definitions. These will help to develop an ORB-CMIP gateway (some NMF projects have taken this approach).

Problems with this approach include the handling of specific operations, such as get operations with filter, scope, and synchronisation conditions, and the handling of linked replies and notifications. CORBA does not support well the concept of filtering and scoping, and needs to introduce proxy objects for notifications.

Since the mapping between GDMO objects and IDL objects is a simple one-to-one mapping, it does not add any value to the existing network management world. In fact, this approach loses advantages of both CORBA and CMIP. For example, the flexible object management capability in CORBA, and the powerful filtering and scoping in CMIP, are both compromised.

5.2 VALUE-ADDED OBJECT METHODS

A Value-added approach supports one-to-one mapping between GDMO objects and CORBA IDL objects. Instead of having one-to-one mapping between GDMO object operations and IDL object methods, this approach allows different methods to be defined for each IDL object. In other words, extra value can be added by allowing user-defined methods. Figure 6 illustrates the object mapping using value added approach.

One example of the value-added method is to reboot a router. Instead of defining a simple reboot method, a time signature can be added so that the operator can request to reboot the router at a certain time, for example midnight.

Compared to the simple gateway approach described in Section 5.1, this approach is more powerful and flexible.

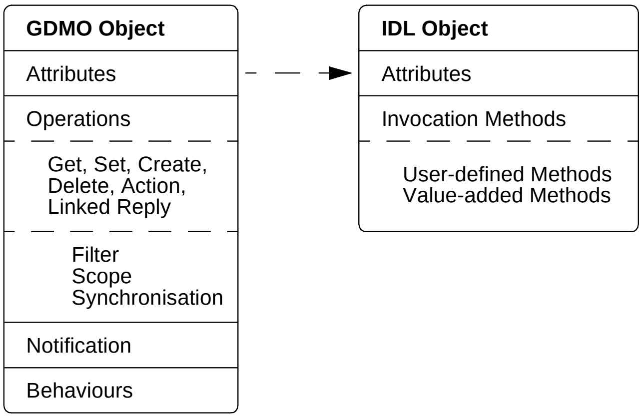

Figure 6: Value-Added Approach

5.3 ABSTRACT OBJECT MAPPINGS

The third approach is to introduce a set of CORBA objects at the appropriate level of the management hierarchy as illustrated in Figure 7. A group of GDMO objects can be mapped onto a single CORBA object at a higher level. A set of methods can be defined for each CORBA object.

For example, a set of service objects can be defined using CORBA IDL. These services are implemented on top of a set of GDMO network element objects. The relationship between the IDL service objects and the GDMO network element objects can be specified. These relationships can be recorded for later references.

Requests on a CORBA object are mapped onto a set of operations performed on a set of GDMO objects according to the relationship between them. For example, a service activation request can be mapped onto a set of configuration or creation operations on the set of network element objects involved.

Events occurred on a GDMO object can be reflected at the CORBA object level. For example, when an alarm is generated by a network element, according to the relationship records, it can be determined which services are affected to what level. This allows service level management tasks to be performed, such as to inform service customers about the degradation of quality of the service.

CORBA and CMIP can be used together to manage telecommunication networks and services. For example, the OSI CMIP based communication protocol can be used for network management related communications between a manager and an agent. The CORBA communication protocol can be used for service management related communications when service objects are defined in CORBA IDL.

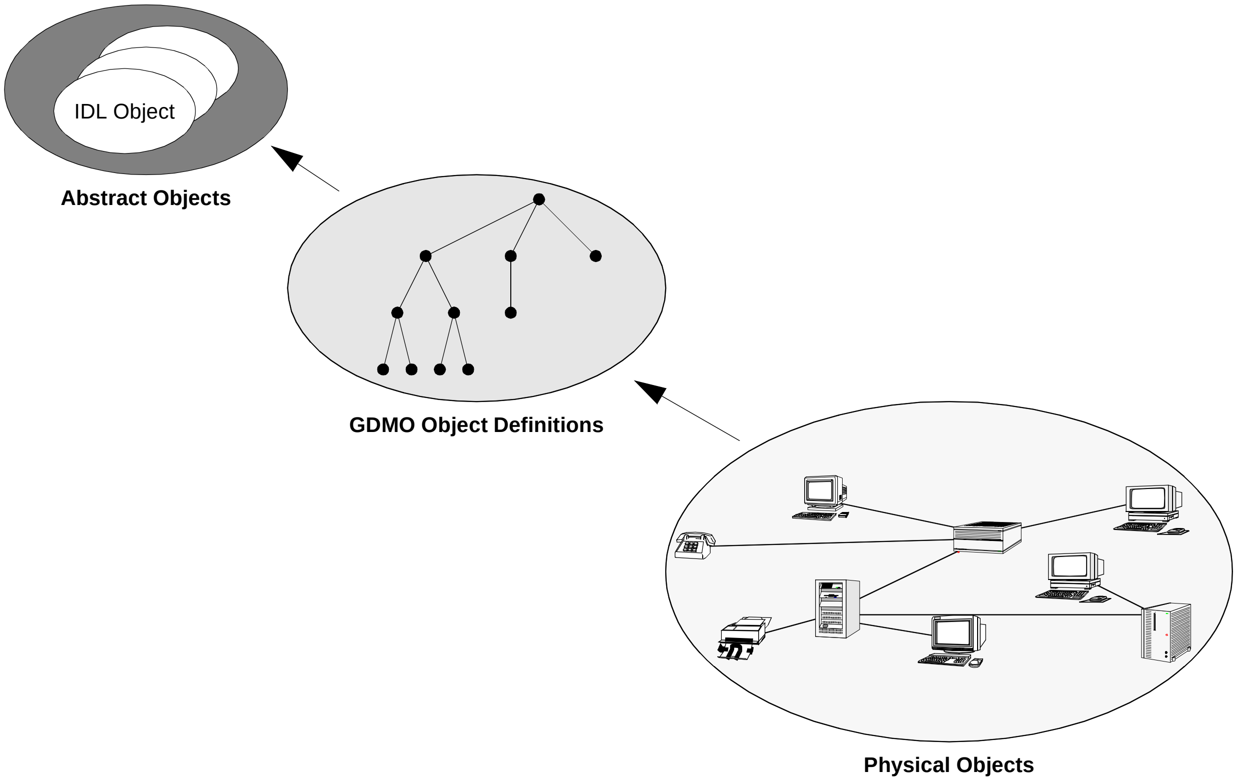

Figure 7: Abstract Object Modelling

This approach achieves the integration of the two management domains (service management and network management) as illustrated in Figure 8:

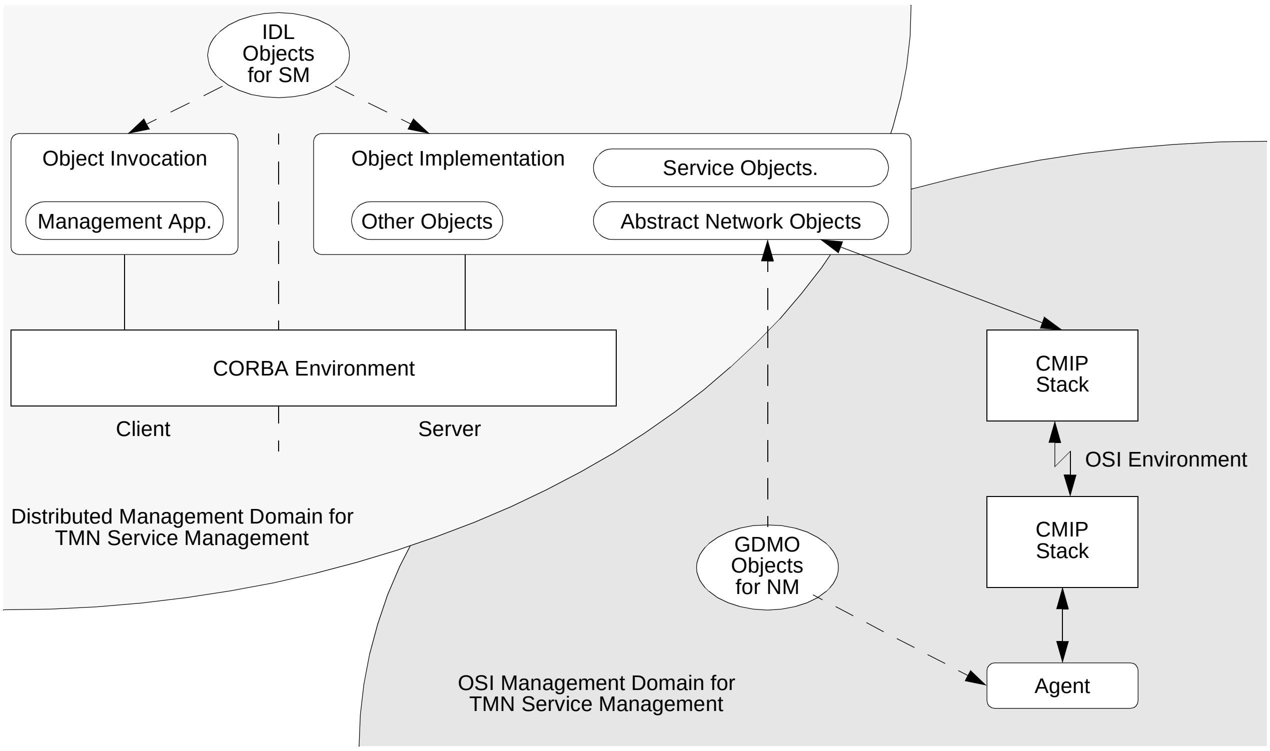

Figure 8: Integrated Management Environment

The distributed management domain for TMN service management is based on the CORBA environment. It consists of

- The CORBA environment as the basic support for distributed object management activities
- CORBA services to provide extra support
- CORBA object definitions (in IDL/ODL)
- Service object implementation for telecommunication service management
- Network object implementation as the integration point to the OSI network management environment
- Relationship service for object mappings
- Other objects as required.

The OSI management domain for TMN network management is based on the OSI network management environment. It consists of

- The OSI environment as the basic support for TMN network management activities. It is capable of handling large number of managed objects
- The XOM/XMP API for accessing the CMIP stack
- GDMO objects defined in DMI (Definition of Management Information) and GMI (Generic Management Information) standards

The abstract object mapping approach has the following characteristics:

- Object mapping.
  This approach is not based on one-to-one mappings between GDMO objects and CORBA objects. GDMO operations, such as get operations with filter and scope conditions, are not simulated in the CORBA environment.
  The approach makes the best use of both CORBA and CMIP technology by using CORBA for service management and CMIP for network management. The integration between service management and network management is supported by representing high level network management entities using CORBA objects and defining relationships between CORBA objects and network objects.
- Service objects.
  High level TMN service objects have not yet been defined by industry and standards bodies. These objects play an important role in achieving service level interoperability, and standard specifications are required. The TINA consortium is currently working on the definition of service objects for the telecommunication industry. Once they are specified, they can be represented as CORBA objects.
- Object mapping tools.
  A set of tools can be developed to allow application developers to specify the relationships between different objects.
- Relationship service.
  The CORBA object relationship service cannot be directly used to support mappings between GDMO objects and CORBA objects as, it defines relationships between CORBA objects only. However, it plays an important role in supporting integration between network management and service management.
  The interoperability between service management domains can be supported by the CORBA environment using its interoperability mechanism.

6 SUMMARY

OSI based TMN network management is used in many existing telecommunication network management applications. It is well defined and sufficient to perform network management functions. But it is not suitable for service management.

CORBA technology provides a distributed object computing environment and can meet the requirements for service management.

The desirable solution is to combine these two environments to achieve an integrated management solution for TMN network and service management.

A number of approaches can be used to provide integrated CORBA and TMN environment for telecommunication service and network management.

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