An Integrated Approach for the Management of IP connectivity over WDM transport networks

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Abstract

This paper outlines the work being carried out in WINMAN, an ongoing European RTD project, whose aim is to offer an integrated network management solution for the provisioning and maintenance of end-to-end IP connectivity services derived from Service Level Agreements (SLAs) over hybrid transport networks (ATM, SDH and WDM). WINMAN consists of an open, distributed, and scalable management architecture supporting multi-vendor, multi-technology environments and evolutionary scenarios from hybrid IP/ATM/SDH/WDM towards genuine IP over WDM networks.

Keywords:

Integrated / Distributed Network Management, CORBA, TMN, IP, ATM, SDH, WDM.

1 Introduction

Current trends in the telecom industry and the research community are focused upon conceiving architectures and defining strategies to introduce Quality of Service (QoS) into packet-based networks and especially into the Internet protocols. Representative illustrations of the work undergoing in this field are the numerous studies and standardisation activities on the Integrated Services (IntServ) [1] and Differentiated Services (DiffServ) [2] concepts. In parallel to these evolutions, WDM technology has reached adequate levels of maturity, prevailing as the most efficient and effective solution for the deployment of terabit transport networks [3], [4], [5]. As a reasonable projection, it seems that these two technologies will converge to offer a universal, reliable and ultra-fast solution for future demanding services. Telecommunications stakeholders are rapidly moving to a new generation of packet-based multi-service networks. Such a multi-service network can be functionally decomposed into a number of network strata [8], each acting as a server and providing support to the above layers (client layers). Today's transport networks are primarily based on ATM and SDH technologies. Some operators started deploying WDM technology for bandwidth capacity extension between network nodes by means of point-to-point connections. The emergence of IP over Optical Networks concept raises the possibility to reduce the complexity of network architecture, enabling IP routers to interface directly with WDM equipment by eliminating the ATM and SDH layers [6]. However, this is the final step in an evolutionary path. The challenge of deploying these networks must account for innovative solutions in the Network Management and Control Planes, as well as for a coherent strategy on how to migrate the existing network and management infrastructure. The equipment in these networks will be based on diverse technologies. This situation, where different network element management systems coexist, each pertinent to a different underlying technology, leads to a "smoke-stack" network management environment with separate technology domains to the service providers. For example, the TDM voice network and its Operation System (OS) can be viewed as one domain, while an ATM data network and its related OSs can be considered as another domain [7]. The network management situation is further complicated by multi-vendor support within

a single technology domain (e.g. SDH, ATM), and service providers need to partition the management of their rapidly growing networks.

Thus the definition of management domains is driven by the mix of technologies, vendors, and business requirements within the given service provider environment. Lack of integration and sheer complexity of the tools themselves have become a barrier for the development of new applications as well as the exchange and sharing of data captured by these individual network management and provisioning tools. The WINMAN project aims to design, develop and deploy integrated management systems in the evolutionary scenario towards IP directly over WDM networks. WINMAN proposes management solutions for areas, which have not being covered so far in terms of specification and implementation:

- Open management systems for IP and WDM networks exporting a published northbound interface towards Service Management Systems.
- Integrated management systems for end-to-end IP services on WDM networks with QoS guarantees.

The goal is to offer an integrated network management architecture, which is technology neutral and capable of providing managed end-to-end IP connectivity derived from Service Level Agreements (SLAs). The specific characteristics defining the scope of the WINMAN solution in relationship to this objective are described in the sequel.

2 WINMAN Business Reference Model

2.1.1 Business Roles

Business entities, which are considered users and producers of services in today's information market, may play different business roles. The following types of business roles were identified as having some kind of interaction, either directly or not, with the WINMAN system:

- Customers and end-users:
  - Customers are legal persons, humans or companies, which have contracts with Value Added Service Providers (VASPs) about the right to use telecommunications services and the obligations to pay for this right and the usage of these services according to the tariffs.
  - End-users are entities, which interact with the VASPs to obtain the effect of the service. End users may be humans, or an automated piece of application software.

  This is the only business role consuming services, not trying to make profit out of them. Examples include Virtual Private Network (VPN), Multimedia / Voice over IP (MoIP / VoIP) end-users and customers.

- Value Added Service Providers (VASPs) , whose role is oriented towards customer management and value adding. Customers buy services from VASPs, which act as retailer of telecommunications services, providing other services than connectivity. Examples include VPN and VoIP SPs.

- Network Service Providers acting both as Network Provider and Network Management Provider. Their role is to support VASPs to provide their services, acting basically as managed connectivity providers. They provide an interface to VASPs, which enable them to request connections between arbitrary end-points in the global network. Network Providers are responsible for managing resources involved on service and network provision, thus providing connectivity services. The services offered by the Management Service Providers aim at fulfilling the management needs of their customer organisations, such as VASPs and business customers.

One should note that these business roles acts as user and provider towards other business roles, for example, a VASP provides services to customers - the provider role - but uses services from Network Service Providers, playing the user role. Several business relationships can be established among the different roles. Several roles can be performed by a single business entity – the actor or player or stakeholder, at the same time. For example, a player in the Network Service Provider role can also be in the role of a VASP. This is the case for companies who own their own transport network and want to make revenue in the new markets, for example, an incumbent telecom operator.

The following actors could be defined:

- Incumbent/traditional telecommunications providers that were used to be called PNOs: these players have an incumbent position in the market, since they have extended fixed network infrastructure, both in the local loop (copper) and in the backbone all over the country. The can play multiple roles in once, such as the roles of Network Service Provider and VASP.
- Competitive/new entrant telecommunications providers: these providers are new entrants following the market deregulation and are competitive to the above. They usually don't have extended network infrastructure in the local loop and build their backbone on top of the incumbent ones. They use the local loop either by the unbundling deregulation procedure or by owning licenses in the Wireless Local Loop. They gradually build their own backbone network. Examples of such carriers are the Internet Service Providers, who extend their activities in the telephony and other services.

2.1.2 Business Model Relationships

This section describes the relationships among the various roles identified. The following picture shows the key roles and their interdependencies.

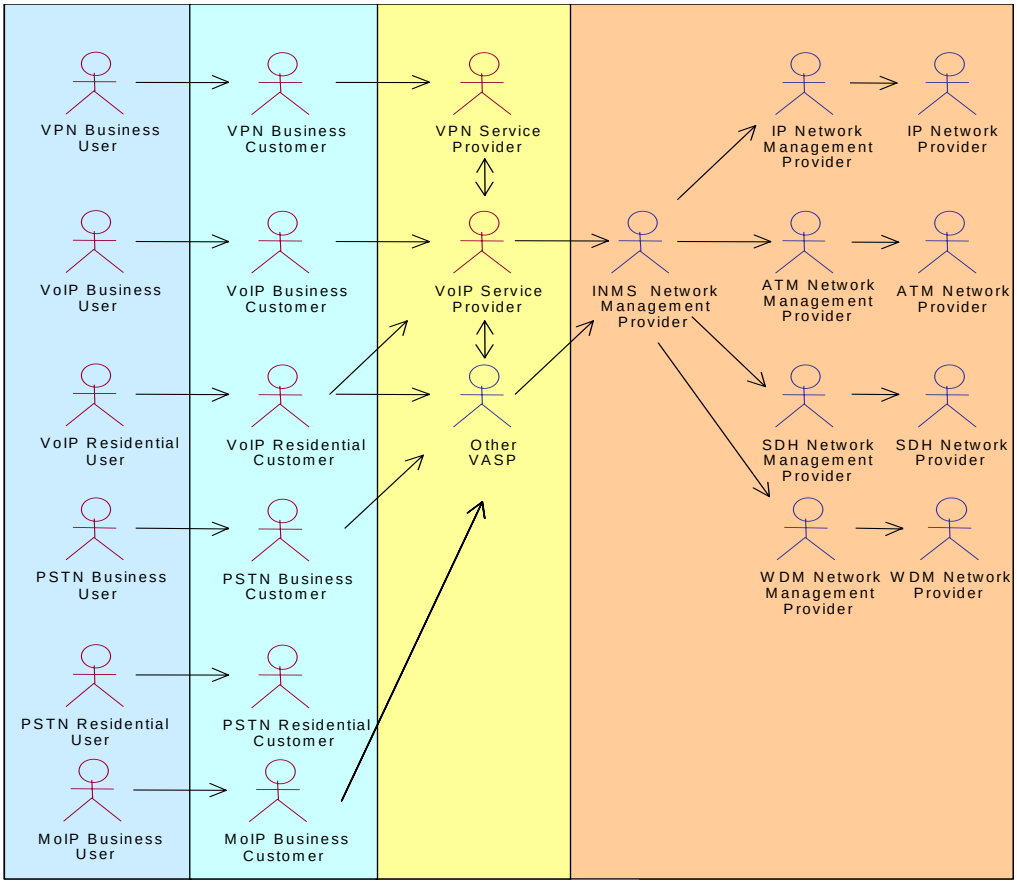

Figure 1: WINMAN Business Environment

The different roles are placed in Figure 1 in a vertical positioning according to the identification of role played, as identified in the previous sections, i.e. Customers/End Users, Value Added Service Providers and Network Service Providers. In this context the different Customers/End users are presented in shades of blue, VASPs in yellow and Network Service Providers in orange. Note the central role that the Inter-domain Network Management System (INMS) takes in this figure.

3 WINMAN architecture

The WINMAN management systems will be designed by applying mainly Open Distributed Processing (ODP) principles taking also into consideration the Telecommunications Management Network (TMN) framework. The TMN architecture structures the management complexity by layering the management applications, defining a common data model, enabling re-use of management data, and specifying system interfaces. ODP goes one step beyond, enabling the design of management applications that are independent of distribution, the underlying infrastructure and management protocols.

The project is implementing an Inter-Domain Network Management System (INMS) for Configuration, Fault and Performance Management and separate Network Management Systems for IP and WDM technologies. The INMS has open interfaces to the Service Management and the Network Management Systems of the different domains (WDM, IP, ATM, and SDH) complemented with a GUI. These open interfaces will support applications from different users (e.g. third parties that want to manage by themselves the capacity that they hire from a transport network operator), and will run in a multi-vendor environment.

The components of the WINMAN systems can be distributed over a number of nodes connected by the Data Communication Network. The components have a published interface, over which they can request and send information. The degree of distribution is thus transparent to the components of the WINMAN solution. The components do not have knowledge of the location of the other components, whether they are collocated on the same node, or running on a physically distant node. The maximum degree of distribution is to have one node for every management component. These concepts are depicted in Figure 2.

A fundamental part of the architecture is the information database of all the physical and logical network configuration data needed to manage the network. This database can be viewed as a large directory with open, standard interfaces.
In the INMS architecture, each application building block will provide well-defined functionality via open interfaces encapsulating the different network elements, thereby logically decoupling the high level applications from the physical infrastructure. Thus GDMO, CMIP, and SNMP interfaces will be transparent to the building blocks.

Furthermore the architecture defines the functionality of each building block as well as open interfaces encapsulating the different network elements and thereby, logically decoupling the high level applications from the physical infrastructure.

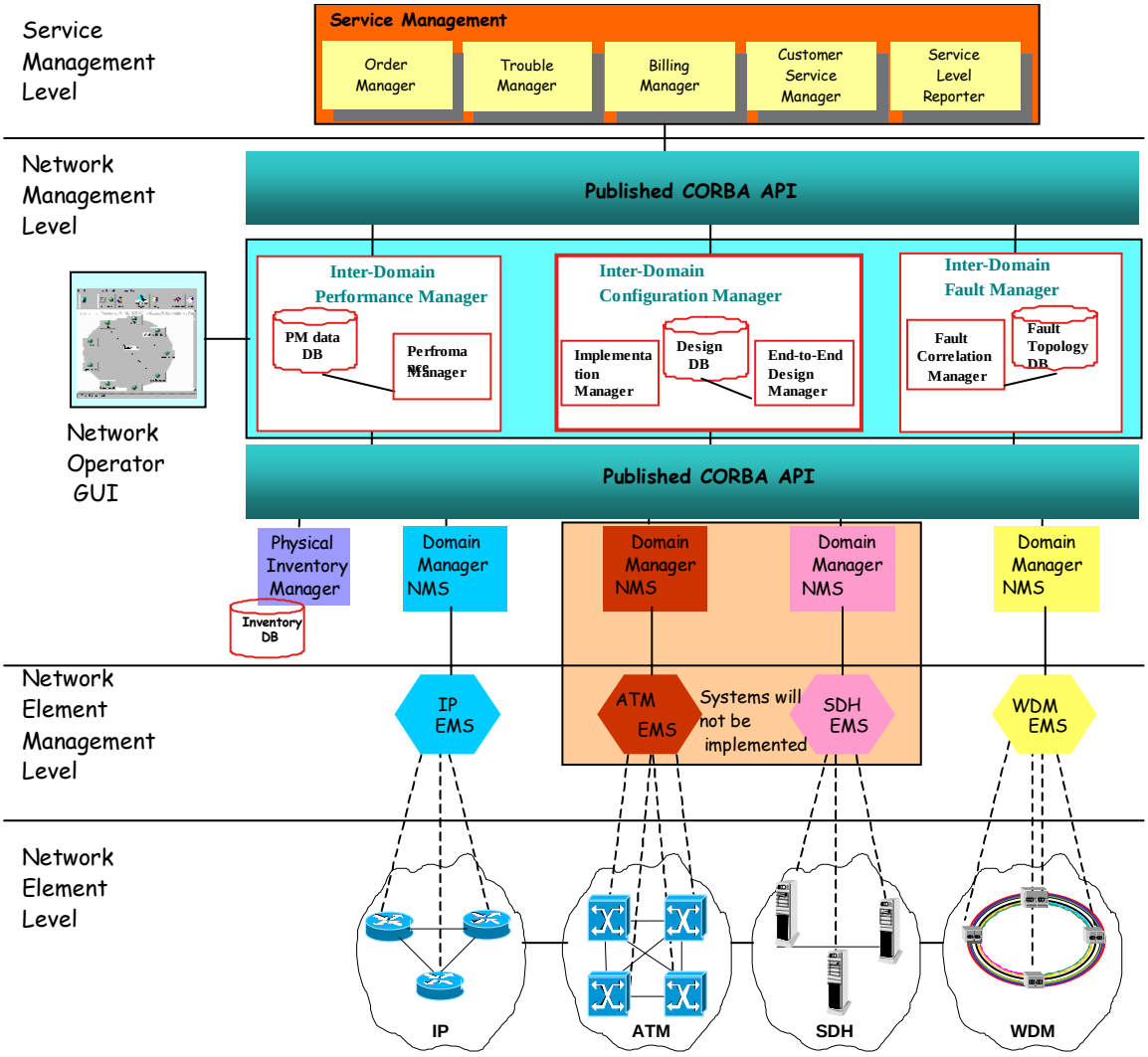

Figure 2: WINMAN Architecture

WINMAN takes into account the following initially identified functional requirements for each of the three management functional areas:

Configuration Management

The Configuration Management application enables single point access to provisioning tasks and to end-to-end views of connections and their underlying infrastructure (down to the physical layer) and facilities, independent of domain. Identified functions are to:

- Discover network resources and topology
- Maintain an inventory of all the network resources with their status and hierarchical relationship
- Handle service requests from the Service Management for the configuration of the requested transport service
- Notify the Service Management about service state (pending, in-effect) changes
- Configure the end-to-end connections and services across different technology domains, taking into account the interworking between the routing on the IP and the WDM layers
- Present an end-to-end view of the services giving the logical hierarchy of all transmission sections constituting the end-to-end connection
- Provide updates to the Fault and Performance Manager reflecting the changes in the network configuration and new services

Fault Management

The Fault Management application collects information about faults across different technological domains and determines the root cause domain responsible for the fault. Identified functions are to:

- Interface with network management systems and receive alarms depicting domain fault manager's view of the service affecting root cause
- Interface with the Inter-Domain topology database to obtain network topology information.
- Keep an inventory of user-defined correlation rules
- Maintain a fault topology database, which contains the alarm status of the network resources and services
- Quickly correlate faults between optical and client layers
- Quick localise faults
- Design management rules for the multi-layer survivability aspects (avoidance of conflicting actions, protection and restoration, service differentiation)

Performance Management

The Performance Management application collects data from the different technological domains and processes it in order to assess the performance of the network resources and the usage of the resources. Based on these assessment results the operator is able to perform pro-active management of transport capacity across their multi-layer network and is able to perform pro-active management in order to prevent faults affecting the service in the network. Identified functions are to:

- Set threshold crossing alerts on the available route capacity between any two-service locations for all provided transport services/facilities,
- Set threshold crossing alerts on the equipment capacity,
- Handle notifications of capacity threshold crossings,
- Obtain periodic and on-demand reports of the monitored capacity (traffic load)
- Use the obtained traffic monitoring data for identifying hot spots in the network and take measures to prevent network congestion

4 Conclusions

This paper gives an overview of the IST Project WINMAN whose main task is to develop and validate an open and flexible integrated management of IP over WDM networks. The project will contribute to the establishment and operation of worldwide IP over WDM networks. The trials envisaged in the WINMAN project would demonstrate inter-connectivity across a worldwide network management infrastructure in a multi-provider and multi-domain environment. During its two-year and a half life span, the WINMAN project will develop and validate innovative solutions in the field of integrated management of IP over WDM networks.

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[1] http://www.winman.org

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