

## Management of IP Connectivity Service Over WDM Networks

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

### 1. Introduction

Today's efforts in the telecom industry and the research community are characterised by the need of conceiving architectures and defining strategies to introduce Quality of Service (QoS) into the packetised networks and especially into the Internet protocols. Representative illustrations of the work in the field are the numerous studies and standardisation activities on the Integrated Services (IntServ) [1] and Differentiated Services (DiffServ) [2] models. In addition, and independently, WDM technology has reached levels of maturity that makes it the most efficient and effective solution for the deployment of terabit transport networks [3], [4], [5], [11] and [12]. As a reasonable projection, it seems that these two technologies will converge to offer a universal, reliable and ultra-fast solution.

Telecommunications stakeholders are moving to a new generation of packet-based networks, on which service convergence is promising. Such a multi-service network can be decomposed in network stratum, each one acting as a server and providing support to the layer above (the client). 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 raises the possibility to reduce the complexity of Network Management and Control, enable IP routers to interface directly to WDM equipment by eliminating ATM and SDH [6]. However, this is the final step in an evolutionary path. The challenge of deploying these networks relies on innovative solutions in the Network Management and Control fields, as well as on a coherent strategy on how to migrate the existing network and management infrastructure.

The equipment in these networks will be based on different technologies. This situation creates an environment where different network element management systems coexist, each specific for their technology, causing a "smoke-stack" network management environment with separate technology domains to the service providers. For example, the TDM voice network and its Operation Systems (OS) can be regarded as one domain, while an ATM data network and its related OSs can be regarded 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 growing networks. Thus the definition of management domains is driven by the mix of technologies, vendors, and business needs present in 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.

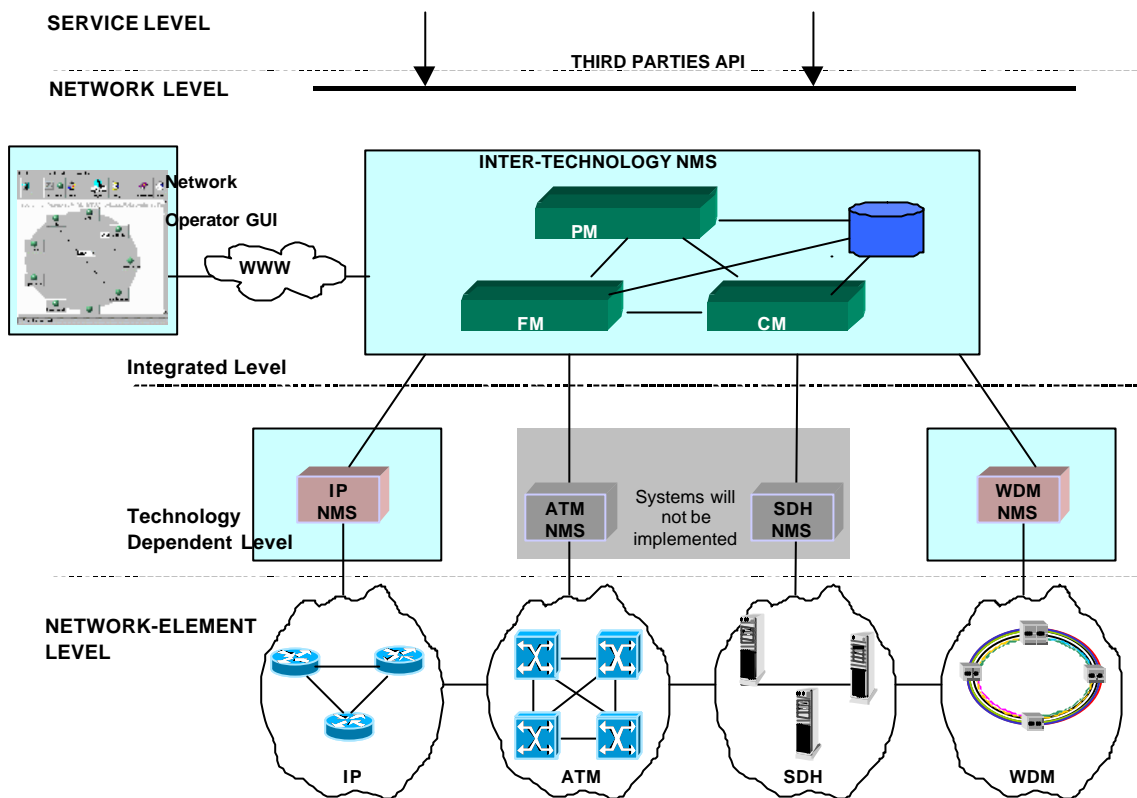
The WINMAN project will design, develop and deploy integrated management systems in the evolutionary scenario towards IP directly over WDM networks. WINMAN proposes management solutions for areas, which have not being covered so far in terms of specification and implementation:

- open management systems for IP and WDM networks exporting a published northbound interface
- Integrated management systems for end-to-end IP services on WDM networks with QoS guarantees.

## **2. System 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 further, 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 with an open interface 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 in that case is transparent to the components of the WINMAN solution. The components do not have knowledge on the location of the other components, whether they are co-located on the same node or running on a node thousands of kilometres away. The maximum degree of distribution is to have one node for every management component. These concepts are depicted in the figure 1.

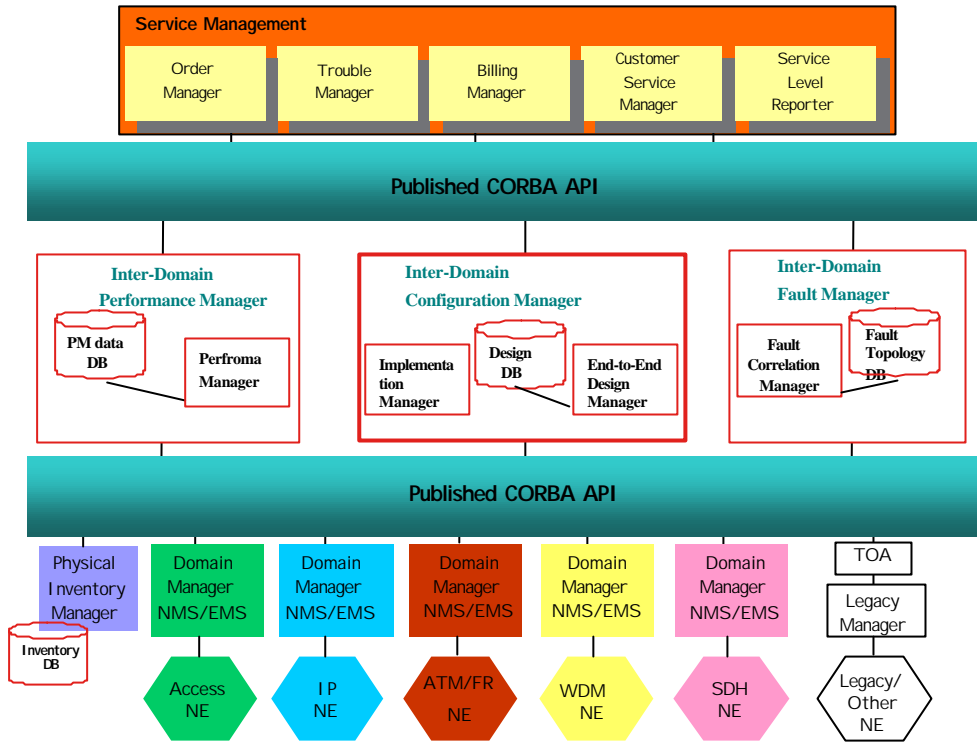


**Figure 1: WINMAN Management Architecture**

All components of the inter-domain management systems are required to publish a standard CORBA API to eliminate pair-wise interfaces. When the standard API cannot be met, a Technology Object Adapter (TOA) is developed such that this interface can be met without changing the core applications. This isolates pair-wise interfaces to an adaptation process that translates requests and responses from the external interface protocol into the published CORBA API. This mechanism can also be used to interface to legacy and non-compliant systems.

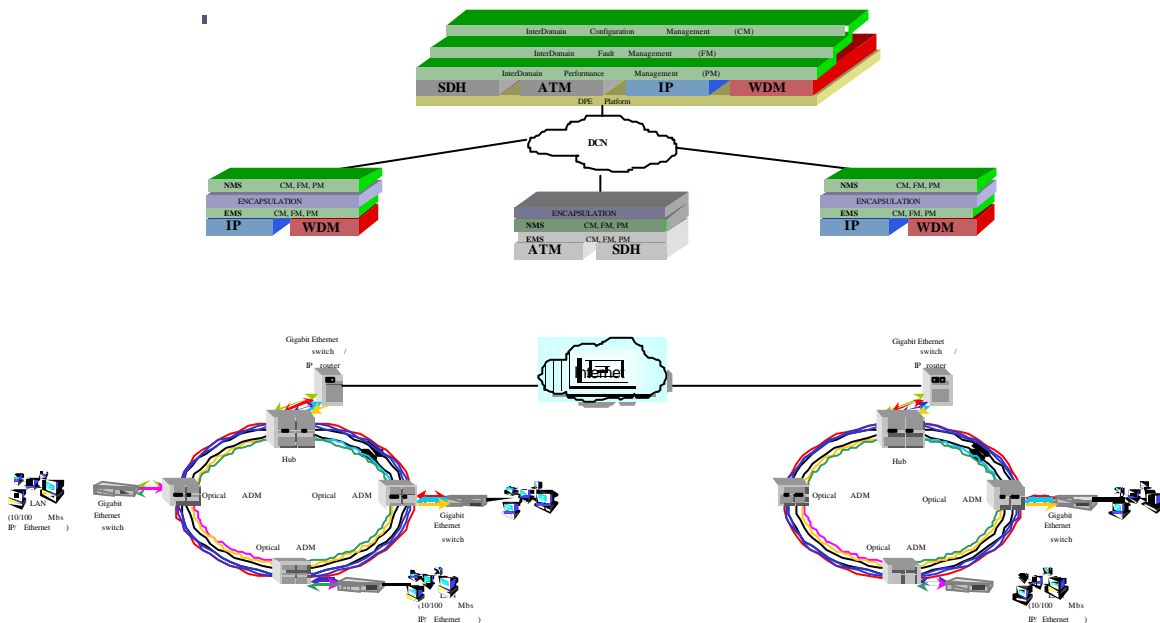
A fundamental part of the architecture is the information database of all the physical and logical network configuration data needed to manage the network. This database can be viewed as a large directory with open, standard interfaces. WINMAN will make use of Common Information Model - Directory Enabled Networks (CIM-DEN) models [8].

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.



**Figure 2: WINMAN System Architecture**

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. A possible instance of this trial configuration is depicted in figure 3.



**Figure 3: WINMAN Trials Reference Configuration Scenario**

### 3. 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.

The proposed architecture and enterprise model of the initial WINMAN specifications makes possible the development, provision and validation of a novel Integrated Network Management architecture for future IP networks.

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