Baudouin Boreux

# The Need for Inter-Domain Management to Control the Network of the Future

***The current (r)evolution in the network utilisation from voice to data, from circuit switching to packet switching affects the design of the whole network and creates a number of challenges for established operators as well as a number of opportunities for new entrants. This revolution in the network directly impacts the domain of network management. The new data technologies need to be integrated in the current management infrastructure and in the telecommunications management network (TMN) architecture. Technical issues are not the whole story as process considerations are at least as important. Many different network technologies need to converge at some higher level to allow coordinated and integrated service management, customer care and billing.***

***This paper proposes a vision for addressing the challenges the operators face in integrating these multiple technologies: how key drivers in the operators' environment force them move the implementation of an inter-domain management (IDM) function above the specific technological domains like synchronous digital hierarchy (SDH), voice switching, asynchronous transfer mode (ATM), Internet protocol (IP)). The paper explains how the inter-domain management function interfaces with other key domains like accounting management or operaions domains.***

***Ultimately, the purpose is and remains to be able to offer to customers a wide range of network services with a minimum of complexity and a maximum of comfort while enabling the operator to use its infrastructure to the highest efficiency possible.***

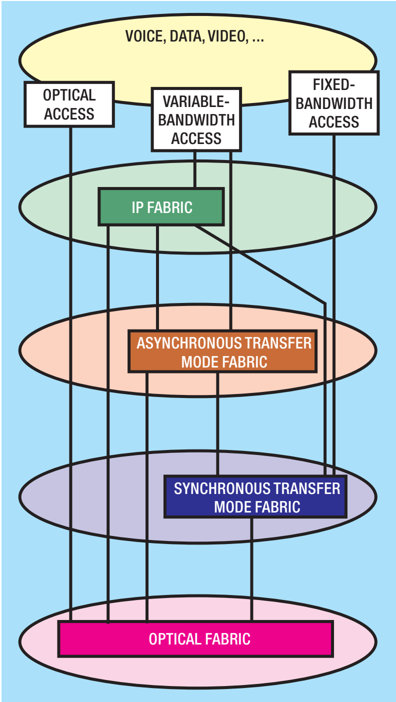



*Figure 1—Multi-technology 'network of networks'*

## Environment

In this current period of tremendous growth and changes in the telecommunications domain, the evolution and strategies of telecommunications operators are influenced by the main following factors.

- The *regulatory environment* at worldwide, European or country based levels that forces service providers to conform to rules and standards. Examples are the obligation for all operators to offer local number portability capabilities or the complex information regulating the unbundling problem.
- The *evolution of the operators themselves* in their current financial or partnership structures. Mergers, acquisitions, joint ventures heavily impact the way operators evolve and very often create new opportunities in unexplored domains.
- The *competitive pressure* which forces the operator to work on three main dimensions critical to its survival: (1) the control of the cost, (2) the quality of the service provided to the customers, (3) the generation of revenues in current services but more and more in new innovative services.
- The *growing complexity of the technologies* used in the network and the combinations that exist among the new technologies or between the new technologies and the older ones that will remain used for economical reasons. Plesiochronous digital hierarchy (PDH), synchronous digital hierarchy (SDH), asynchronous transfer mode (ATM), Internet protocol (IP), optical, and frame relay technologies will still co-exist for many years. Figure 1 provides examples of the combination of some types of possible technologies.
- *Change in relationship between operator and end customer.* The relationship between service providers and their customers is also evolving. Using software technologies (web technologies, intelligent networks capabilities), customers receive more direct access to the network resources

**Baudouin Boreux:**
Lucent Technologies Network Systems Belgium
Rue des Deux Gares, 84
B-1070 Brussels, Belgium
Tel: +32 2 556 7217
Fax: +32 2 556 7512
E-mail: bboreux@lucent.com

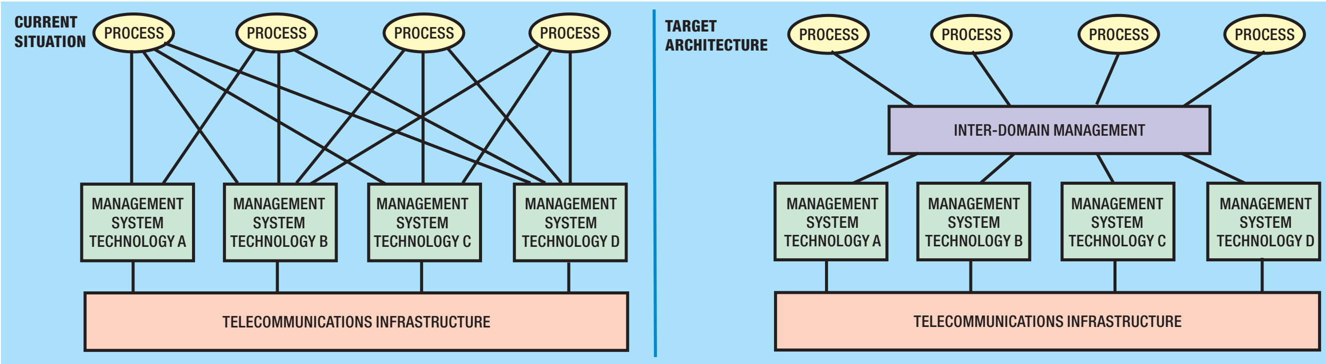



*Figure 2—Present versus future mode of operations*

they buy from service providers both from a service assurance and resource provisioning standpoint.

In order to face these forces, operators have traditionally organised around three main domains:

- The *accounting domain* involves all the activities relating to the collection of billing information, the generation of invoices, the account receivable domain and all other activities relating to revenue collection and recognition.
- The *operations management domain* provides the skills and tools to design and implement all the processes that manage the services inherent to the life of an operator: customer contact platform, service provisioning, service assurance, planning and capacity management, etc. All these processes are progressively automated in order to provide efficiency gains and reduce redundancy. This domain contains the functions generally performed by enterprise resource planning (ERP) platforms.
- The *network management domain* is directly linked to the infrastructure itself, which has traditionally been handled on a technology-by-technology basis mainly for historical and organisational reasons.

## Need for a New Concept

The technology evolution (Figure 1), as well as the need for operators to optimise their operations through completely automated service assurance and flowthrough provisioning processes, make it absolutely necessary to have the relationship between the operations management (ERP) and network management domains as technology independent as possible. Both from an organisational, efficiency and flexibility standpoint, service providers need the network management domain to offer a standard interface to the two other domains whatever technologies these services are implemented on (Figure 2). These considerations force the creation of an additional layer on top of the network management domain. This layer is called the *inter-domain management* layer**.**

## Inter-Domain Management Architecture

The inter-domain management is a management system by which the physical and logical elements of a circuit can be linked as follows:

- to allow the service provider to create a single database which houses current, logical and physical, service/circuit/network design data such that they can make this data available on a near-real-time basis to those fault, performance and traffic management systems they choose to deploy;
- to allow the service provider to design and implement services in a completely automated manner using flowthrough technology;
- to permit the correlation of logical and physical network data, thus yielding a complete end-to-end service/circuit design for those services/circuits which traverse the service providers' hybrid network;
- to allow the service provider to obtain current network data for a given circuit's composition such that maintenance activities can be effected in an expeditious and cost-effective manner;
- allow the service provider physically to display the end-to-end service subscriber's service/network on a near-real-time basis for the purpose of effecting customer service management; and
- to allow the service provider proactively to perform logical capacity management through the establishment of thresholds that when exceeded, result in the automatic creation of an exception report/notice. This capability can be provided as part of the solution itself or it can be provided through the use of an off-line capability which makes use of the data resident within the database proposed.

Figure 3 positions the inter-domain management layer in the global network management structure, in the middle between the domain specific technologies and the service management layer which contains the functions indicated before as the accounting management and operations management functions.

The inter-domain management (IDM) system consists of the following three applications (Figure 3):

- *inter-domain configuration manager*,
- *inter-domain fault manager*, and
- *inter-domain capacity manager*.

### Inter-domain configuration manager

The configuration management function is split into the design and the implementation phases which are the key steps in the service activation process. In order for the configuration manager to know the logical structure it is dealing with (Figure 1), it needs a reliable repository of information documenting the logical structure currently in use. This database is called the *logical tree database*. The 'tree' maintains pointers to the domain management systems (this includes the inventory management system) that contain the details of the relevant section capturing the hierarchical relationship.

An example of the logical tree documented in the logical tree

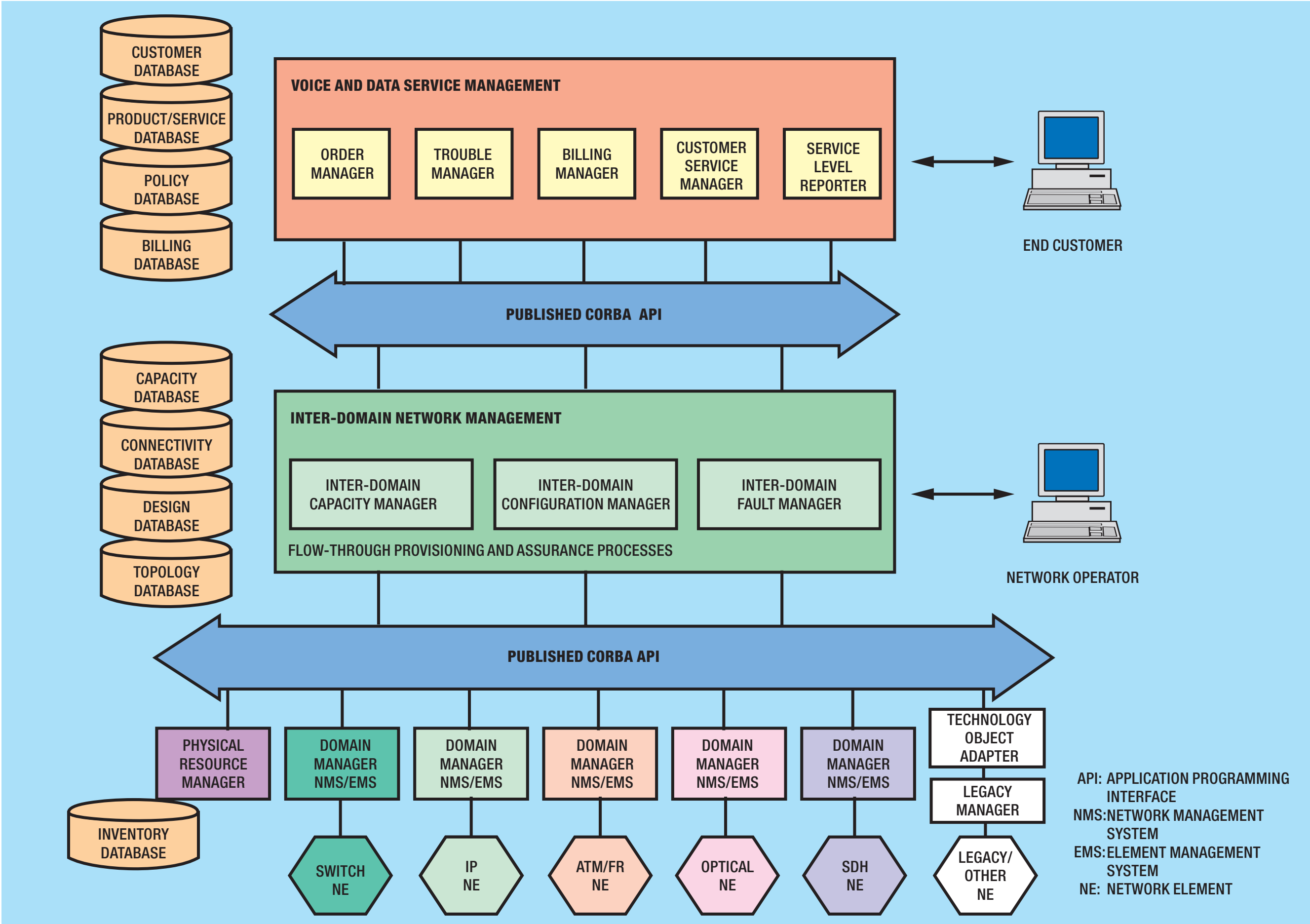



*Figure 3—Global network management structure*

database is provided in Figure 4. This figure presents an example of a network implementing a combination of SDH and ATM technologies between two locations. For purposes of simplification, only a portion of the network has been shown. The top part of the figure presents the physical implementation and the bottom part indicates the corresponding logical implementation in the tree database with the pointer between the various logical or physical elements.

The configuration manager is based on two modules:

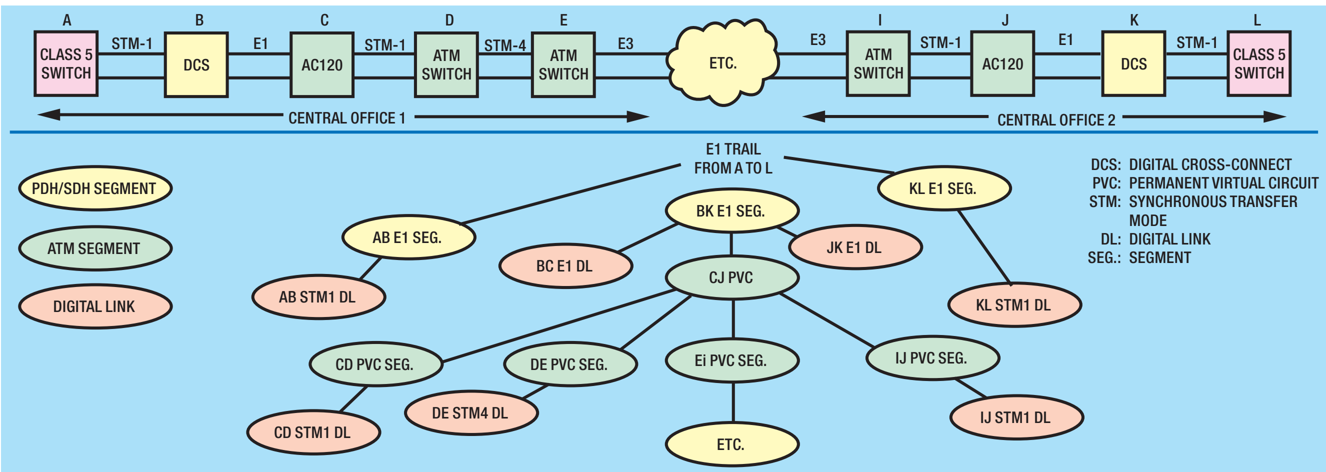
- the logical tree manager module, and
- the provisioning manager module.

***Inter-domain logical tree manager***

The inter-domain logical tree manager provides and maintains a detailed end-to-end view of planned and provisioned transport services and facilities. Its main functions are:

- create and manage an end-to-end service design view and logical hierarchy of facilities supporting the service;
- store the information regarding leased facilities;
- maintain the status of the circuit (pending, implemented, in-effect);
- receive data from the end-to-end design manager and implementation manager;
- service requests for viewing the trail hierarchy information; and

*Figure 4 : Sample trail hierarchy*



- notify configuration manager the status of changes to the trail's status so that the configuration manager can forward the changes to the 'subscribers' (for example, fault manager).

***Inter-domain provisioning manager***
This module has the task of supporting seamless provisioning of services/ facilities across different technologies as well as multiple domains. It consists of two modules: the design management and implementation management modules.

The design management module:

- performs end-to-end service design across one or more domains of the same or different technology;
- manages inter-domain resources;
- services all requests to create, modify and disconnect intra-domain and inter-domain designs;
- upon successful completion, returns a unique circuit identifier to the order manager, if one has not been provided;
- submits 'pending' designs to the logical tree manager to store in the connectivity database;
- requests port assignments and cable link designs from the physical inventory manager;
- requests and coordinates detailed intra-domain service design from domain management systems; and
- provides sub-activities for high-level design, physical layout, and low-level design.

The implementation management function:

- services all implementation and 'in-effect' requests—intra-domain and inter-domain;
- accesses pending designs from the configuration manager;
- correlates and coordinates implementation and 'in-effect' activities among domain management systems;
- requests trail implementation and 'in-effect' information from domain management systems;
- notifies the physical inventory manager to update cable link and other equipment to 'in-effect' status;
- requests the logical tree manager to update the trail identification status to 'in-effect'; and
- provides sub-activities for implement and in-effect.

**Inter-domain fault manager**
The inter-domain fault manager collects faults across multiple technologies and domains and determines the root cause domain responsible for the fault. In particular the following functions are supported:

- Creation and management of a network topology database suitable for inter-domain fault correlation.
- Interface with the inter-domain configuration manager to request network information, subscribe to receive updates to the network information, receive network information and create/update the network topology database and finally process network topology information requests from the correlation manager. If the information is not available from the topology database, it requests it from the inter-domain configuration manager.
- Use a correlation management function to:

  —interface with domain fault management systems and receive alarms depicting the domain fault manager's view of the service affecting root cause,
  —apply the user-defined correlation rules and network topology information to domain root-cause alarms to determine the actual root-cause problem domain,
  —correlate the root-cause fault with the effected circuit identification,
  —interface with the trouble ticket manager to create a trouble ticket for the root cause fault,
  —notify all domains about the root-cause domain,
  —optionally receive requests to create trouble tickets on behalf of domain managers for their non-service affecting faults,
  —notify the domain manager about the status of their trouble ticket requests along with the trouble ticket identification, and
  —service request from the customer service manager for an out-of-service circuit list.

**Inter-domain capacity manager**
The inter-domain capacity manager enables service providers to perform proactive management of transport capacity across their networks consisting of several technologies. The capacity manager enables providers:

- to interface to the configuration manager to get periodic updates of the new pending and 'in-effect' digital links, facilities, and services;
- to interface to the inventory manager to get spare equipment/ ports on network elements for a given service type;
- to provide user-settable threshold crossing alerts on the available service capacity as a percentage of the total between any two service locations over all possible facilities as well as per facility bases;
- to set user-settable threshold crossing alerts on the equipment capacity (that is, number of available slots of a particular kind, etc.);
- to provide pending versus implemented views of the capacity (that is, available bandwidth) on any given date between two service locations or specified facilities;
- to obtain 'what if' view of the capacity between two service locations (that is, if additional facilities are added between two nodes that provide transport between A and Z); and
- to provide notification to the users of capacity threshold crossings; and
- to provide periodic and on-demand reports of the monitored capacity.

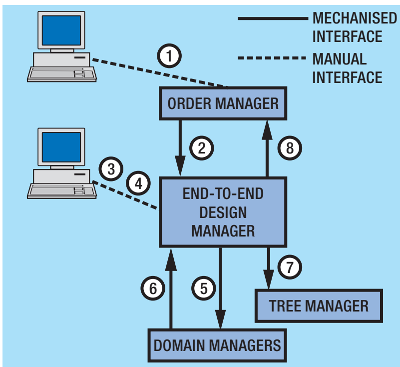
## Operational Examples

This scenario illustrates a generic procedure required to fulfil the provisioning request issued by a customer for one of the transport services. It is assumed that the order manager controls the overall execution of the request. The request from the order management perspective is broken down into two steps:

- service design, and
- service implementation.

***Service design flow steps (Figure 5)***
1 The customer specifies the transport service required. The

*Figure 5—Provisioning flow: design*



order manager captures the request in the form of a service order and initiates the appropriate provisioning task model.
2 The order manager sends a design request to the end-to-end design manager. The request includes the service identifier (that is, circuit identification), service end points (A, Z), type of service, route requirements (for example, avoidance criteria, protection, etc.), required bandwidth, etc.
3 The end-to-end design manager constructs (manually or automatically) a high-level design, at the domain level, from the 'A' to 'Z' ends of the circuit by specifying end-point equipment, inter-domain links and involved elements.
4 The user approves the high-level design, if not automated, and requests detail domain designs (that is, 'low-level' designs).
5 The end-to-end design manager parses the high-level design and distributes the low-level design requests to the appropriate domain management systems (for example, physical inventory manager, ATM, SDH).
6 Each domain management system forwards the completed design to the end-to-end design manager, including parent facilities supporting the design within the domain.
7. The end-to-end design manager forwards the completed service design to the logical tree manager to be included in the hierarchy and flagged as pending.
8. The end-to-end design manager notifies the order manager of design completion.

***Service implementation flow steps (Figure 6):***

1 The order manager sends an implementation request to the implementation manager. Data includes service identifier (that is, circuit identification) for the approved design.
2 The implementation manager retrieves the detail design from the view manager.
3 The implementation manager parses the design and schedules the distribution of the low-level implementation requests to the appropriate domain management systems.
4 Each domain management system sends an implementation completion message to the implementation manager.

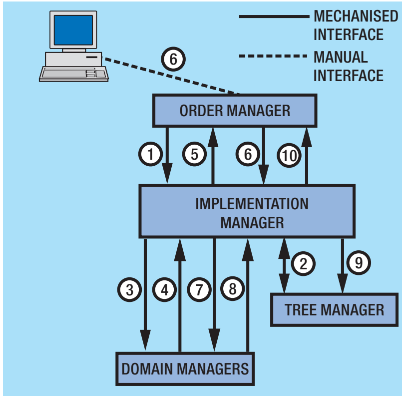



*Figure 6—Provisioning flow: implementation*

5 Upon completion of all individual domain implementations, the implementation manager notifies the order manager.
6 The order manager sends an 'in-effect' request to the implementation manager after all testing activities have been completed.
7 The implementation manager parses the design and schedules the distribution of the low-level 'in-effect' requests to the appropriate domain management systems.
8 Each domain management system sends 'in-effect' completion messages to the implementation manager.
9 Upon completion by all domain management systems, the implementation manager notifies the logical tree manager to update the trail identification status to 'in-effect' and the physical inventory manager to update the physical inventory used to 'in-effect'.
10 The implementation manager notifies the order manager of 'in-effect' completion.

## Conclusion

This paper highlights the operational and business requirements imposed on operators that force them to consider and implement tools allowing service assurance and provisioning capabilities across technology domains. Investments made at operations (ERP) and accounting domains need to rely on technologies in the network management domains that are domain independent. Inter-domain is a powerful concept that is designed to 'hide' the technology dependency to the above software layer and provide the necessary level of abstraction to be able to isolate the investments made at different levels.

The fast-changing environment in the emerging data technologies constitutes a challenge for the emergence of the IDM concept. However, it makes no doubt that such a concept will have to be implemented to cope with the complexity of the network infrastructure. It will require all the power and flexibility of the current software technologies to be successfully implemented in a short time.

## Bibliography


1. Bagga, Yudhveer S.; and Chaudhury, Arati. Communications Software Management Systems (CSMS) Inter-Domain Solution Architecture. Internal Lucent publication, 28 May 1999.
2. Miller, Philip. Communications Software Transport Management System Solution—Market Requirements. Internal Lucent publication, 17 April 1999.


## Biography


**Baudouin Boreux**
Lucent Technologies


Baudouin Boreux is Business Director in the Communications Software division, Lucent Technologies, for the Europe, Middle East and Africa region. His organisation is responsible for the bid management, product marketing and delivery support of network management products. He has worked in the telecommunications industry since 1987, when he graduated from Louvain-la-Neuve university with a Bachelor's Degree in Telecommunications. While working for Lucent, he also earned a Master in Business and Administration from the same university, In the early 1980s, he was involved in the architecture and systems engineering activities for major network management projects in the EMEA region. He was involved in the specification of complex network management structures involving switching and transmission management systems for both PDH and SDH technologies.