Alternative Architectures in the Network Management

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Abstract: **Network Management is needed to control and optimize the operation of the network and to respond to changing user requirements. Management includes the initialization, monitoring and modification of the network functions. In order to perform management, special functions are needed. To distinguish these functions from the normal network functions, this work includes the terms "management functions" and "primary functions".**

Management functions may be performed explicitly by human operators, but also automatically by dedicated soft- and hardware modules. In case human operators are responsible for network management, most management functions will be performed from a limited number of remote locations. In case management functions are performed automatically, it is possible to distribute the hard- and software modules that implement these functions over the various systems in the network.

This work explains how management functions can be designed together with primary functions. It also discuses, that it may not always be possible to design all management functions before the start of the operational phase. The alternative is: after the start of the operational phase the designer may decide to add the remaining management functions by developing new generation of network systems.

I. INTRODUCTION

Architectures for network management enable the designers to discuss management functions at a high level of abstraction and guide the design of management protocols and services. In this work it is assumed that architectures consist of: a set of architectural concepts; rules that tell how to use these concepts and models for designing a specific class of systems.

All current management architectures, notably the ISO, ITU-T and the IETF architectures, have been developed after the design of the network functions have been completed. Such approach indicates a specific conceptual view of the role of the management functions and invites to apply different architectural concepts for the design of management functions. This work proposes an alternative approach, in which no principle distinction is made between the management requirements and the requirements of primary functions. Both sets of requirements can be integrated into one set of requirements and elaborated in a single design process, which uses one architectural model.

To demonstrate that both kind of functions can be expressed in the architectural concepts and rules as used by the OSI – Reference model, tree models are developed – model of distributed management architecture, model of centralized management architecture and model of hybrid management architecture. A set of new definitions according to new architectures are also presented.

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II. OSI MANAGEMENT, TMN MANAGEMENT AND INTERNET MANAGEMENT

The origin of OSI management can be found in ISO, most of the work is performed in collaboration with the ITU-T. The standards that results from this cooperation are published by both organizations without technical differences. Within the ITU-T, the OSI management recommendations are published as part of the X.700 series.

The first standard that describes OSI - management, is the *OSI Reference Model* [1]. This standard identifies OSI management as an important working area and provides initial definitions. The first outcome that presents the development of OSI management was the *OSI Management Framework* [2]. Later it was decided to produce an additional standard, which was called the *Systems Management Overview* [3]. These standards provide the basis for OSI management (Figure 1).

Title	ISO/IEC	ITU-T	Year
OSI Management Framework	7498/4	X.700	1989
OSI Systems management Overview	10040	X.701	1992

Fig. 1: The basis of OSI Management

The term TMN is introduced by the ITU-T as an abbreviation for Telecommunications Management Network. The concept of a TMN is defined by Recommendation M.30210 [4].

According to M.3010 "a TMN is conceptually a separate network that interfaces a telecommunications network at several different points". The relationship between TMN and the telecommunications network that is managed is shown on Figure 2.

According to this figure, the interface points between the TMN and the telecommunications network are formed by Transmission Systems and Exchanges. They are connected via Data communication network to one or more Operations systems. The Operations systems perform most of the management functions; these functions may be carried out by human operators but also automatically. It is possible that a single management function will be performed by multiple Operations systems. In this case the Data communication network is used to exchange information between the operations systems.

In the second half of the past decade the Internet grew to a size that management of the Internet could no longer be provided on an ad hoc basis: a structured and standardized approach to Internet management was required.

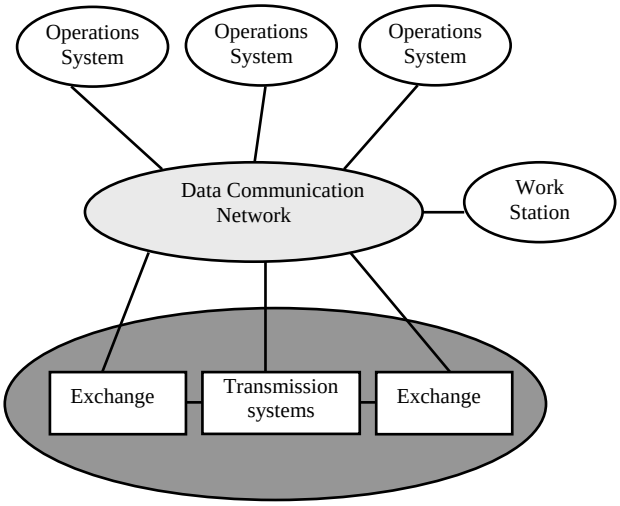

Fig. 2: General relationship of a TMN to a telecommunication network

SNMP (Simple Network Management Protocol)[5] is a further development of SGMP (Simple Gateway Management Protocol). SGMP was aimed at management of Intermediate Systems – Gateways. Because SGMP appeared to be a success, it was decided to extend its scope and include management of End System. To reflect this change, the protocol was renamed into SNMP.

It is important to say that no special standards have been defined for the Internet Management architecture; only protocols and MIBs have been standardized.

The main goal of the future enhancement of the Internet Management architecture are:

- All systems connected to the network should be manageable with SNMP;
- The cost of adding network management to existing systems should be minimal;
- It should be relatively easy to extend the management capabilities of existing systems;
- Network management must be robust.

III. An Alternative Management Architecture Models

The management architectures that where presented above can be characterized by the fact that they only consider management functions, and not the primary functions that should be managed. In this part of the work an alternative architecture will be presented that shows how primary functions should be extended with management functions. The view that management functions should be seen as extensions to the primary functions, implies that it should be possible to define both kind of functions in terms of a single set of architectural concepts and rules. Here we decided to use the concepts and rules of the OSI Reference model.

The main contribution of this work are the models that show how to apply these concepts and rules to explain the case that management is performed from one or more remote locations.

A service management architecture

In this section several models will be presented that show how existing services can be extended to include service management.

Figure 3 shows the part of the service design process. During the early design cycles the focus will be on the development of primary service functions. During the later design cycles the extension to include service management will be performed.

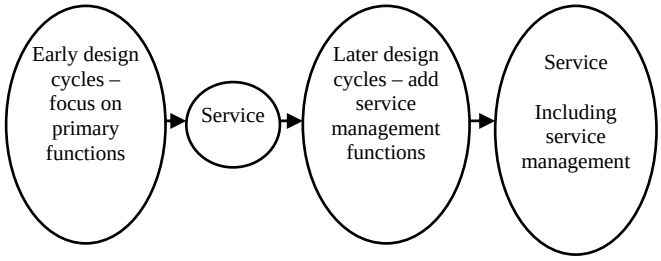

Fig. 3: Extending a service to include service management

Figure 4 shows the service model that guides the design of the primary functions. The model includes a service provider, a number of users and the SAPs (Service Access Points). Every SAP represents common parts of the communication between the user and the service provider. The *P* at each SAP indicates, that only the execution of Primary service is supported.

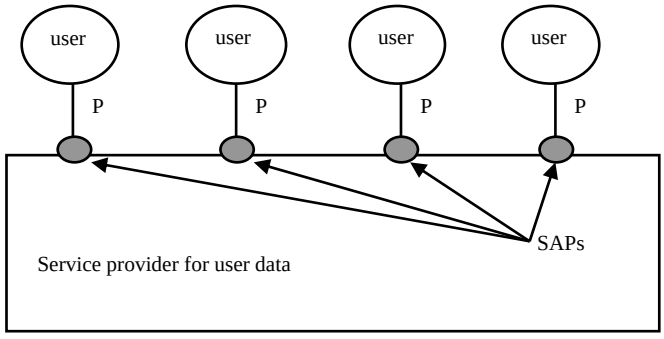

Fig. 4: Model of the design of primary functions

The addition of service management has consequences for the interaction between users and provider. This implies that the behaviour of the provider, as well the behavior of user ha-ve to be adapted. The models of this behavior should not be presented in this work.

IV. A Model for Distributed Service Management

The idea of the equal distribution of service management is to give all service users same set of service management fa-

cilities. A potential problem associated with this approach is, that interference between managing users can not be avoided. For reducing this problem, some restrictions upon a set of service management interactions should be set. One possible solution is shown on Figure 5.

In this model all SAPs support the same set of service management interactions (*M*). In fact the model is equal to the model that is shown on Fig. 4. – addition and equal distribution of service management does not modify the structure of the initial model.

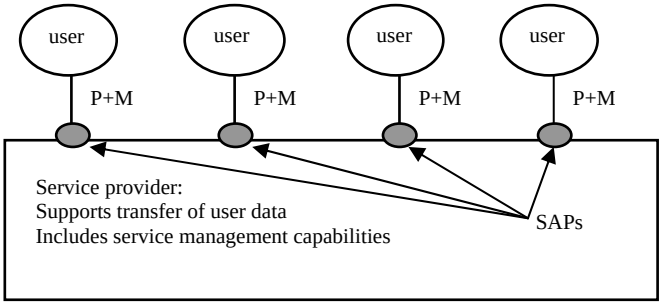

Fig. 5: Model of distributed service management

The result of service management addition is the change of user and provider behavior. This change must be reflected in the service definition as follows:

- Existing service primitives may be extended with special service management parameters;
- Special service management primitives may be defi-ned;
- The relationship between service primitives may be modified.

The extension of the service parameters may include parameters such as QoS negotiation, connection speed, needed recourse etc.

One example for new service primitive may be *ErrorReport* which primitive can include parameters such as *cause* for the error.

The relationship between the service primitives can be modified in order to add or to reject some functionality by examining any service.

It is important to note, that the changes of the service primitives and service parameters should not be intended for user data transport. This implies that these primitives:

- need not include address and user data parameters;
- need not be defined of a similar type of primitive at another SAP.

V. A Model for Centralized Service Management

The choice between distributed and centralized service management should be make by the designer and follows from the user requirements. The centralized approach is followed in case requirements exists that service management interactions should be confined to a single location. The purpose of such a requirement may be to prevent unauthorized service management access or to avoid the interference that may occur in case of multiple managing users. Centralized service management implies that all management interactions should be executed at one single SAP. This may be an existing SAP or a new service management SAP.

The model for centralized service management is presented in Figure 6.

One of the SAPs supports service management functions. This support is indicated with the letter M. The P+ in the square brackets indicates that this SAP may, but not need to support primary interactions.

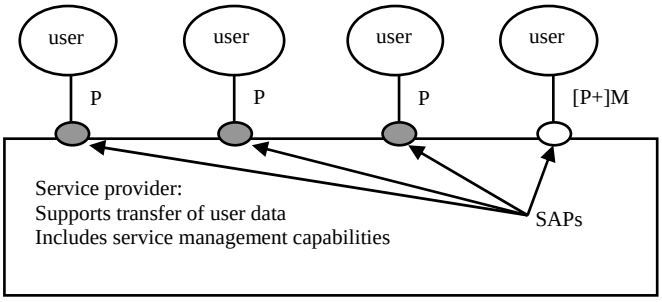

Fig. 6: Model of centralized service management

The impact on the service design definition in case of centralized service management is similar to the distributed service management discussed above. The main difference is the implementation of *Special service management SAP*. In this case the normal user SAPs leave unchanged and an additional SAP is proposed. Through this SAP the service manager may be connected to the provider. This might be an existing user which becomes ‘super user’ or an extra manager. In case of ‘super user’ the SAP may be divided in two parts - normal data SAP and special service management SAP (Figure 7).

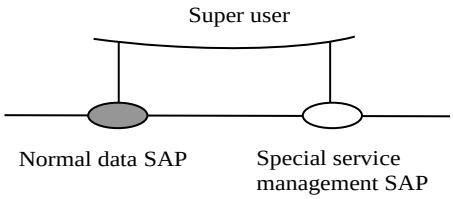

Fig. 7: Connecting the ‘Super user’ to the service provider

The second possibility is to connect a Service manager through special service management SAP. The service manager may not perform primary interactions and only management interactions.

VI. A Model for Hybrid Service Management

Distributed service management has, just as centralized service management, certain advantages and disadvantages:

- Distributed service management allows users to take immediate action in case they experience problems with

the service provider or in case they change their demand. Distributed service management it may be difficult to avoid interference in case different users want to initiate conflicting management actions. The potential weak point in this type of service management might be security;

- With centralized service management it is much easier to avoid conflicting management actions and to guarantee a high level of security. The problem in this case is, that user who experience problems should always contact the service manager. This might be impossible in some problem cases;

The idea behind hybrid service management is to combine the advantages ant avoid the disadvantages of both approaches, mentioned above. This can be accomplished by introducing different sets of service management interactions. In the hybrid service management approach all users get service management capabilities, but only one (or some) user gets more capabilities then other.

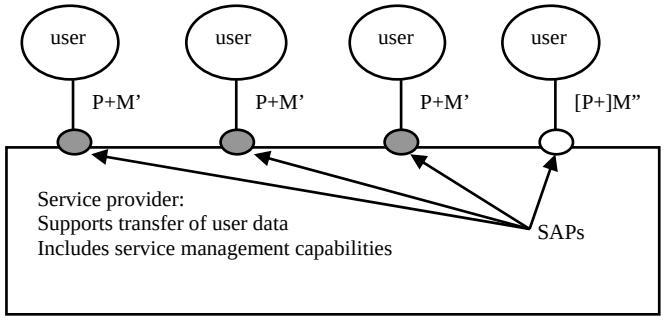

Fig. 8: Model of hybrid service management

As shown on Figure 8, the existence of two sets of service management interactions (M' and M") is suggested. It may be possible to define more than two sets – for example M'_1, M'_2 and so on. That means – different users may get different management interactions capabilities.

For example, in case of large public network, it may be advisable to define tree different sets:

- One set of service management interactions that may be only executed by a single central service manager. This manager may belong to the organization that owns the public network. The set of interaction may include operations on adding or removing users, adding or removing management services etc.;
- Another set of service management interactions that may only be executed by a small number of network users which become service managers. Each company that is connected to the public network may have their own service manager. The set of the service manager interactions will be smaller than the previous set and limited to the company. The service manager may for instance create or remove group addresses for use within the company.
- The set of service management interactions that may be executed at all remaining SAPs. This set may include for instance reachability tests.

The addition of hybrid service management involves the same changes to the service definitions as discussed in the previous section.

VII. CONCLUSIONS

In addition to service management concept other approaches may be performed. The authors propose the following concepts:

- protocol management concept;
- remote element management concept;

These concepts will be discussed by the authors in their future works.

It is important to say that every one of these concept should correspond to the specifics of the managed networks and of the managed services.

The service management concept involves implementation of new service primitives or service functions. These service primitives may carry primary service information that is encapsulated in an ordinary management operation command or vice versa. This may depend on the specific application or service to be applied.

In order to find the most secure architecture it is important to define the appropriate type of service management and, in case of centralized or hybrid management, the user who will be responsible to the functionality of the whole network. Which type of services will be allocated to the other user in the network is also decisive parameter of the network functionality.

All this concluding remarks give a wide area for further research and architecture design of networks with integrated primary functions and management functions.

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