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On Value Elements of Service Control Functionality

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Abstract

Several experts in Telecom Finland presently believe that in ten years time most voice telephony will be mobile and fixed network would be mostly based on multimedia services (hypertext, stereo, video, digital television and virtual reality). To support a wide range of mobile and multimedia services in a future B-ISDN network the distribution of service control functions between the terminals, servers and the network nodes is a major question. To satisfy broadband mobile and multimedia service needs the networks should support much more distributed operations. In this paper the control functions are analyzed from the service value point of view. The change of value distribution of services is presented and the location of corresponding control functions is discussed.

Keywords

Telecommunications services, control functions, customer value, value added services

1 INTRODUCTION

This work is partly based on previous studies on value creation in value added telecommunications services (Takala et. al. 1995) and distribution of call processing model for multimedia services (Martikainen et.al. 1995). Let us first consider the basic concepts of value and control functions.

The concept of customer value is used in microeconomics, consumer behavior, marketing, and strategic management. Porter defines customer value as the amount buyers are willing to pay

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for what a firm provides them (Porter 1985). Moreover, he defines a concept of actual value or cumulative value that is the actual impact of the product on customer value. In microeconomic theory the concepts of total value and marginal value are used. A necessary condition for all the definitions of customer value is that the customer should perceive it.

We shall here consider the revealed customer value which is defined as a sum of money the customer reveals (by buying or telling) to be willing to pay for the service. If the value is revealed by buying, the price is the revealed customer value, and it is assumed to be close to what customer is ready to pay. If the value is not expressed by actions but with questionnaires, it is assumed that the customer does not distort his or her true preferences. The service may offer more value to customers than what they reveal, but due to competitive situation, uncertainties, or a desire to get a lower price, they can express a lower value.

By a call we mean the use of one or more connections set up between users and / or services. A call process is the set of activities used in processing a call attempt. The set of functions used in call processing are called call control functions, and their representation is called the call processing model. Since there are also call independent functions controlling the network behavior, e.g. the handover functions used in mobile networks, we shall use the following general definition (ISCP 1993): the control functions (CF) are designed to support distributed processing of information with the goal of controlling different network resources in order to provide telecommunication services to customers. We shall use the following control function classes, which will be specified in detail later in this paper: service control, mobility control, resource control, call control and bearer control.

In (Takala et. al. 1995) the value elements or attributes of an intelligent network service were mapped on the network functionalities called as features. In this paper we consider the value attributes of voice telephony, data services and multimedia services and map them on the presented control function classes. By so doing we are able to demonstrate the change in control function value and discuss the corresponding location of control functions.

2 FOUR IDEAL VALUE CREATION ROLES

In this chapter four ideal value creation roles for products are presented. These roles are a basis for subsequent analysis for control functions as creators of value.

Substance products are direct inputs to value creation. In telecommunications information, also called as content, is such a substance. Substance provision is often attributed to the content providers role. Also telecom operators when rendering directory or voice services are providing substance for their customer's value creation.

Tool products are transformers of substance in value creation. A word processor is such a tool. These kind of products are not the main line of operator's business. Still, some individual services such as mail client interfaces provide such substance handling.

Medium products are the mediators between different actors. These conveyors or vehicles facilitate interaction of other value creation agents. Thereby they facilitate specialisation and more efficient task division. Telecommunications sector is rich with such products. All connection products beginning from calls are in this value creation role. Message delivery and voice mail, or premium rate and freephone are medium products as well.

Environment products provide the environment for value creation. Enterprise networks, or virtual private networks are such products. They integrate the whole value creation by providing common service elements to all media and tools that utilize the environment. They also bring all participants of value creation "under the same roof" and thereby make the value creation more efficient. Service providers and telecom operators provide necessary environments for medium type telecom services, including service creation, distribution, management and accounting.

3 VALUE CREATION MODEL OF CONTROL FUNCTIONS

The network control functions accomplish the activities that form a successful service transaction in the network. Thereby these activities are the "atoms" of value creation. The control functions operate on three layers, network, call, and service layers.

Mobility control function operates on the network layer, and it thus creates value environmentally. It is active continuously keeping the terminal in contact to network. The contact is achieved by maintaining the terminal's location information. Other network layer functions such traffic routing and flow control are often autonomous. The network layer has the most indirect role in the value creation and is thus the most difficult to quantify. The value is created when a call or activation of service takes place. It is thus dependent on each customer's mobility, but also intensity of call value creation and service value creation. In addition customers may value the latent value creation, "being reachable", just without counting the actual number of calls received.

Call control and bearer control form the call layer. They have a medium-type value creation role consequentially. Call control frames a conceptual channel between two actors in the network. It accomplishes this by establishing an end-to-end communication configuration. Bearer control supports a call by allocating network transmission resources with one or several connections. Bearer control is subordinate to call control, a user accesses bearer control only through the frame of call control. In relation to call control, bearer control is in fact a substance provider, it provides the call with the substance of mediation, the connection and transmission capacity. The mediating layer is built on top of the network layer, for example, it utilizes ever present access of terminals when establishing a call. The call layer's value creation lays on the intensity of interaction between the actors of the call, and on the extent of value created during that interaction. This interaction can be also service value creation.

The service layer comprises service and resource control functions. These functions create value according the logic of the service, which can be of any value creation role. Service control realizes the service logic, maintains session and user interaction, and invokes service elements when desired. Resource control supports service control by allocating the different special network resources such as bridges, compressions/decompressions and synchronisations to services when they are needed. The service layer utilizes both the environmental layers and mediating layers. The service layer has the most direct role in the value creation of the three levels. Only the content elements of service have more "inherent" and therefore immediate value effect. The service layer creates value depending on the extent of the service interaction and its fit for customer's needs.

In must be also concluded that all control functions manage and integrate the value creation process. If they are analyzed as one coherent control package, they form a value creating entity of environmental type. The value creation role is not a universal quality, but is rather determined in relation to some beneficiary of the value creation.

4 MULTIMEDIA AS NEW SERVICE

Multimedia service is a service in which the interchanged information consists of more than one type (e.g. video, data, voice, graphics). The single information type communications are service components of multimedia. Multimedia services may offer several virtual connections, one virtual connection for each service component. Each of the virtual connections may have particular QoS (Quality of Service) attribute value.

The service provision mechanisms would become in the future different from those of today. The need for efficient resource control and service interlinkage drive the distributed control of the service provision. Let us consider the actors involved in multimedia services (Martikainen et.al. 1995).

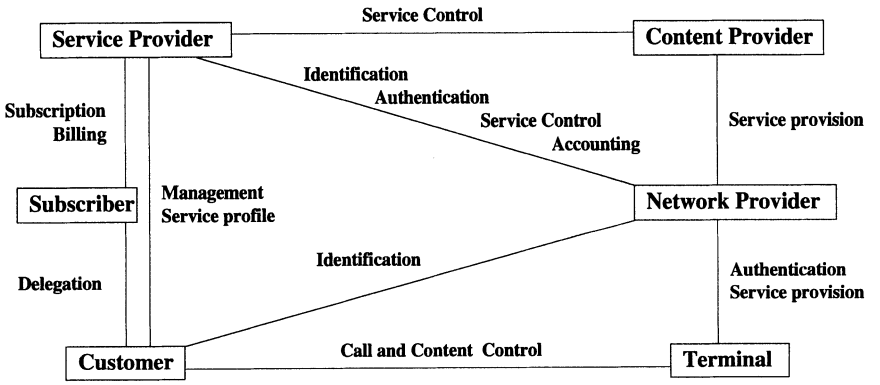

Figure 1 Multimedia service provision model.

The subscriber subscribes to and pays for services offered by one or more service providers on behalf of the real user of the services (customer). It is possible that the customer and the subscriber are the same person. Also various subscribers could be linked to the same customer.

The terminal can be available for the use by many users and provides a level of service that is customized to the user. Therefore each customer must be identified when accessing to the network. The content control allows the customer to influence the content of the service. The customer can manipulate on-line the quality of the receiving service component by the modification of QoS parameters during the connection life time. Different multimedia services may require a service negotiation by the involved terminal to check if they can serve the same type of multimedia service or not.

The network provider provides standardized network services including security access to the network, individual connection links for a session and management of the service provider directory. The main function of a service provider is to design the interface for the customer. This includes the customer registration and identification, easy to use graphical interface, management of customer service profiles and billing/charging for the service. It performs also the session management function and end-to end service control. Service provider is responsible for agreements with network provider on network usage.

The primary function of a content provider is the storage and playback of multimedia content. For interactive services, it controls the playback content based on direct real-time interactions with the customer. This control may require access to and interaction with the network provided by the service provider.

5 SERVICE PROVISION AS A VALUE CREATING SYSTEM

Each value creating activity is originated by some provider of the activity and benefits some subject perceiving value in that activity. In this context value creation can be modeled as a directed relation with the provider as the "source" and the customer as the "target". This relation has been described in the theories of value network (Takala et. al. 1995) and value chain (Porter 1985). In centralized service provision there is one single provider of the service creating activities. When a service is provided in a distributed manner, the number of value creating actors increases, and there are several relations between the actors. Each of these relations can be separately analyzed in terms of the function or functions that one actor represent for another. The multimedia service provision system is analyzed here in the context of these customer-provider relations. Each of the relations is also typified to represent some ideal value creation role.

The actors are presented here as successive layers. The figure structure (Fig. 2) illustrates a few properties of the value creating system. Firstly, customer accesses content "through" other layers. This means that the system utilizes the services of each layer. Secondly, the end-residing narrow actors are the primary value creators, the mediating middle actors support the end-residing actors and thus create value indirectly. Each wider actor contributes to narrower actors above or below. The network provider provides environment to all other actors, and creates value most indirectly. The service provider utilizes network and provides a media for content providers offerings. Likewise, the terminal depends on network and provides access services to customer. Thirdly, the actors of same size are kind of counterparts. Customer matches content provider, both are primary creators of value. They must speak the same language, which is here natural language. Terminal matches service provider, both provide a number of services that act as tools or media. Also they must speak the same language, which is in this case some protocols and standards like hypertext transfer protocol, or mpeg2 video compression standard. Fourthly, each wider actor is also an integrating environment for a number of narrower actors above or below. As an additional remark, terminal extends to network layer in case of terminal mobility, where the terminal participates also to call-unbound value creation.

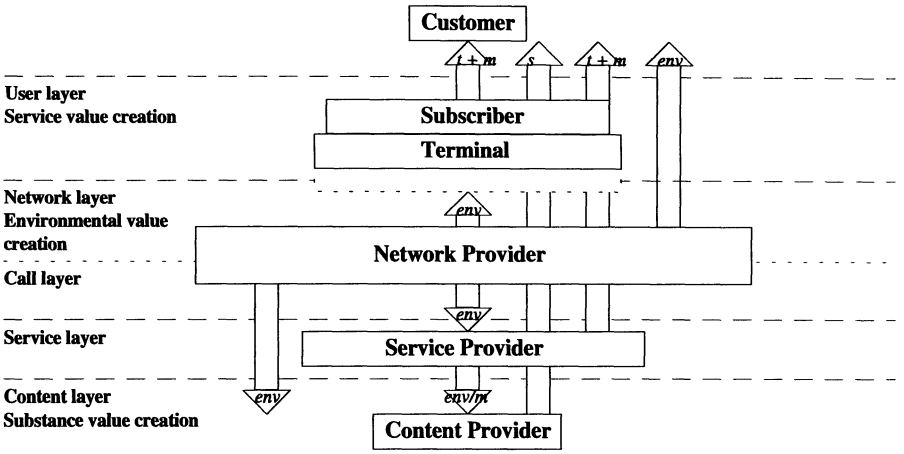

Figure 2 Service provision as a value creation system

6 CALL PROCESSING MODEL

6.1 Control function classes

In the mobile and multimedia services new control functions have been proposed. They are not necessarily user controlled or call related, but they control network and service behavior depending on how they are triggered. We shall group the control functions as follows.

The Call Control Function (CCF) is responsible for the establishment of an end-to-end communication configuration for users without allocating expensive network resources. No transit switches are involved in the Call Control. The Bearer Control Function (BCF) is responsible for establishing connections with the requested bandwidths. All transit switches have to be involved in the Bearer Control. The separation of Call and Bearer Control leads to the separation of Call Control Access Function (CCAF) and Bearer Control Access Function (BCAF).

The Call Control Function and the Service Control Function (SCF) have been explicitly modeled in the Intelligent Network (IN) distributed functional plane architecture (Q.1204 1993), where the trigger event detection is centralized in the Basic Call State Model in Call Control Function and the corresponding signaling interactions with Service Control Function are managed by Service Switching Function (SSF). The triggering mechanism provides the separation of the IN additional network functions from the basic functions.

In mobile systems terminal mobility means the possibility to access services at anytime and anywhere. It implies terminal access control including terminal paging and terminal authentication for the authorization of the right to establish the bearer connection. For this Mobility Control Function (MCF) two new IN functional entities have been introduced: Terminal Access Control Function (TACF) and Terminal Access Control Agent Function

(TACAF). Personal mobility allows the identified customer to access services from any terminal. Several identification mechanisms can be used, e.g. manual PIN entry, biometric identification and smart card based identification (Craven et. al. 1995).

Service profiles for service portability must be handled according to customer requests. Such non-call and non-bearer control includes terminal contation updating, customer registration, and service profile interrogation/modification. For this control Service Access Control Function (SACF) and Service Access Control Agent Function (SACAF) functional entities have been introduced.

In multimedia services a multimedia call model should support the ability to have several connections of the same or different types between any parties involved in a call. It has been widely agreed that future signaling protocols should support Call Control and Bearer Control separation (ISCP 1993).

Future multimedia services will require the allocation and on-line modification of special resources such as both hardware devices and software entities providing functions such as compression, decompression, synchronization, security, multiparty branching and others. To control these specialized resources an additional Resource Control Function (RCF) can be defined and the corresponding protocol was proposed in (Tohme' et. al 1995) and (Hellemans et.al. 1995).

So, we have defined the control function classes for service control, mobility control, resource control, call control and bearer control (Fig. 3) and considered agent functions proposed for them.

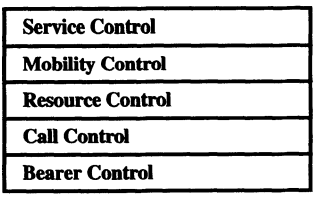

Figure 3 Control function classes

6.2 Control function triggering

The activation of control functions can be separated from the actual control functions by introducing trigger agents (Martikainen et.al. 1995). The trigger agents can be considered as control function stubs separated from the actual control function bodies. Let us group trigger agent types against control function classes. From the examples in the previous chapter we can introduce the following trigger types:

- *Terminal access activated triggering* (TAT) - access rights to the network which can be in the terminal or in the network elements.
- *QoS activated triggering* (QAT) based on monitoring the service or bearer connection quality. Examples of this are

- mobile location updating and handovers,
- multimedia connection rerouting in case of degrading QoS.

• *Service component activated triggering* (SCAT) based on activating/deactivating or synchronizing new service components with needed resource, e.g.
- involvement of decompression resources in case of new service component stream,
- synchronization of video and audio components.

• *Service identifier activated triggering* (SIAT) based on the given service identifier (number), such as IN services with given service identifier (e.g. freephone with 0800).

• *User interaction activated triggering* (UIAT) providing control activated by user, such as
- Calling card and voice services,
- Universal Personal Telephony (UPT).

• *Service activated triggering* (SAT) controlled by the service logic in terminals or network nodes. For example the multimedia service uses another service as its part e.g. to open new window and to display there video segment from some other server.

Each trigger type may communicate with the corresponding control functions:

- Service Control Function (SCF): SAT, TAT,
- Mobility Control Function (MCF): QAT, SAT, TAT
- Resource Control Function (RCF): SCAT, QAT
- Call Control Function (CCF): SIAT, UIAT, SCAT
- Bearer Control Function (BCF): SCAT, QAT

The above control functions provide signaling message interfaces for the triggers (Fig. 4). The SCF interface can be based on INAP operations (Q.1218 1993) and the MCF interface can be based on GSM Handover procedures (ETSI 1994).

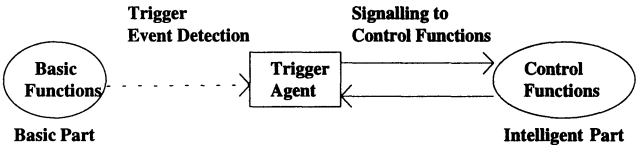

Figure 4 Trigger agent

Trigger agents are mediators between the basic and additional (intelligent) functions in the network. Network architecture specification describes how trigger agents and control functions are distributed in network entities (Martikainen et.al. 1995). There may be Mediation Points in the network which provide the control function signaling interfaces to trigger agents outside the teleoperator management domain and quarantee the separation of operator controlled network from user or service provider controlled network parts (Heinmiller et.al. 1995).

7 VALUE BASED ANALYSIS OF CONTROL FUNCTIONS

Let us now consider how customer value elements can be realized by the control functions service control (S), mobility control (M), resource control (R), call control (C) and bearer control (B). In this chapter three major service classes are analyzed: voice telephony, data services and multimedia services.

7.1 Voice telephony

In our voice telephony example we present the value elements of value added GSM-service with data and advanced switching (centrex) properties.

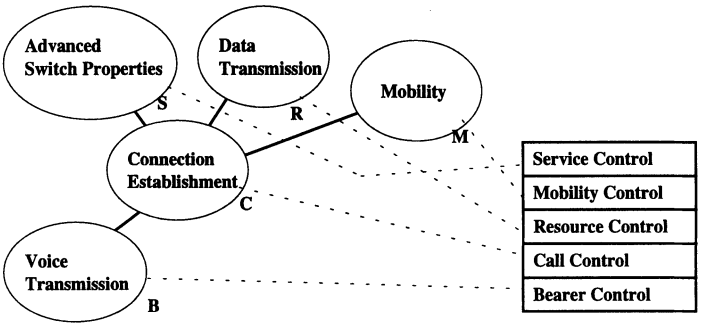

Figure 5 The value elements of voice telephony mapped to control function classes

Figure 5. illuminates, how control functions creates value by supporting direct value creating. The bearer control allocates transmission capacity. In this way it supports both transmission and connection. In also helps to maintain a certain level of quality of service (QoS). The call control creates the service transaction, a frame for call and service. The mobility control adds a new value element by enabling terminal mobility. The resource control makes it possible to use data connection over GSM. The service control activates the value added services requested and manages their provision logic.

7.2 Data service

The Datanet value added data service by Telecom Finland for corporate users is a LAN-interconnection service based on flexible branching equipment and internet routers. The corporate virtual networks are created by managing the channel allocation in the branching equipment level and the routing tables in the router level.

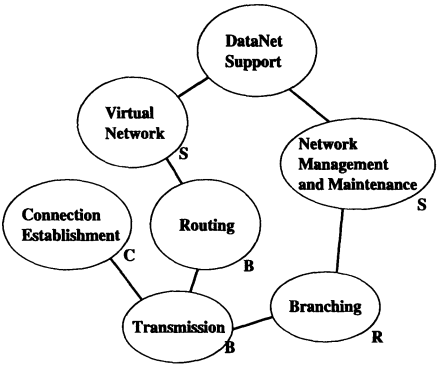

Figure 6 The value elements of data

In distinction to voice, the data service connection establishment is virtual, and branching and routing has a distinctive value role in resource control and a bearer control. The virtual network creates an environment where call control and bearer control are realized in a higher level. The "DataNet support" and the "management & maintenance" create value by maintaining the telecom network service level and guaranteeing a certain quality of service. Different maintenance levels are also used in differentiating the service pricing. They are not anyhow realized by the control functions of the network itself.

7.3 Multimedia

The multimedia service analyzed here is an Internet based broadband service which provides multimedia contents to users having a corporate ATM access. The service has been piloted in Telecom Finland during 1995.

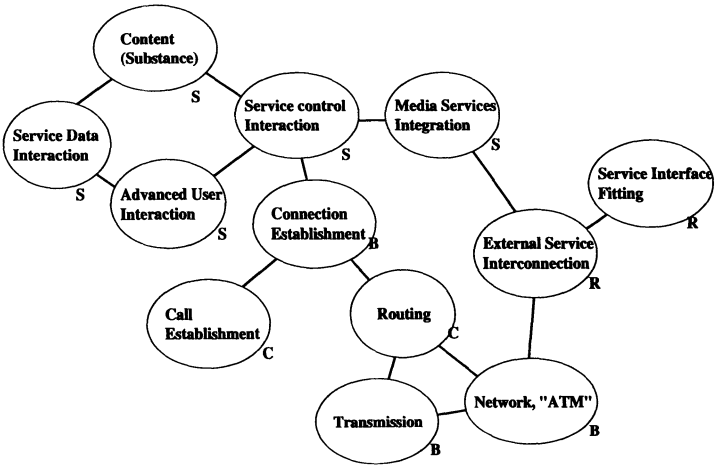

Figure 7 The value elements of multimedia

In multimedia the basic network control functions are data network functions. Service control interaction level can be either broadcast, semi on demand, or on demand. The external services interconnection is accomplished by service control functions that collect external subservice provision under one integrating control service. A mediaoffice type service provides the service interaction functions. The mediaoffice relies on flexible bearer control spanning new connections and efficient resource control guaranteeing the quality of service. The call control is demonstrated in call establishment, that separates the transaction management from connection management. In addition to point-to-point connections also multipoint and broadcast connections may be used.

The platforms of multimedia, which means e.g. the mediaoffice and the service resource allocation logic create value environmentally. Then the external services interconnection, routing, transmission, connection and service control interaction mediate between the service providers and the user. The service elements bring additionally tool and substance value creation to the service, which are not present in the voice and data cases.

8 LOCATION OF CONTROL

The demands on the performance of control functions are clearly on rise. Most dominatingly, service complexity and bearer capacity demands of multimedia and video shift more value creation to service control. The optimization of bearer capacity on demand based on the needed QoS poses also new needs for advanced bearer and connection control. The complexity of services necessitates the previously almost nonexistent resource control. The increasing demand for both personal and terminal mobility must also be answered. The need for call control is more stable, and it's share of value creation is therefore diminishing. There are several factors that drive the distributed implementation of control functions. First is the rapid increase in control function performance demands. Second is the service complexity and the need to activate control from several value elements. The performance demands can be answered in a more managed way, when the performance requirements of each function can be addressed separately.

The value creation has been in telecommunications traditionally concentrated in environment and medium type roles. In future mobile and broadband multimedia services also the substance and tools such as various information provision or voice recognition are increasingly provided by the services

Multimedia marks also a sharp increase in service interface functional requirements. These requirements are clearly on service level of control functions. The service and resource functions that are tools of the data stream transformation, are most naturally positioned to terminal and server, close to the user of the tools and the content databases. The integrating, service provider dependent parts are then found in a service node. The mobility is an environmental function, therefore it must be realized in the whole network intelligence, not some specific location, though the location databases can be centralized.

If we use the trigger-agent and control function distribution model (Fig. 4) we can say that the agent parts of the control functions reside in terminals, service switching points and servers, and are thus distributed. The control function bodies responding to agents and providing the

service logic which controls the network may be independent of the location of the trigger-agents and may reside in servers controlling a number of resources. Thus the control function bodies can also be centralized. So, we can conclude that the value elements of services may specify the importance and functionality of corresponding control functions, but it is helpful to divide the location of these control functions into user or service oriented parts (trigger agents) and system oriented parts (control function bodies). This means that the trigger agents as user and service specific parts are more dependent on user choices and more subject to change than the control functions themselves.

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