A Model for Value-added Internet Service Provisioning

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Abstract: Today's Internet represents a multi-provider environment as a basis for global service delivery with a set of services, business roles, and strategies. The integration of data and telecommunication, especially for multimedia services, requires Quality-of-Service (QoS) for the transport of data. Furthermore, it demands a value-added Internet with communication and network services as well as charging functions between entities and services. This paper defines business roles and their responsibilities as well as business strategies, communication policies, and interacting roles and services. A fully defined business process as part of a business model and independent from technology is used to illustrate value-added Internet service provisioning.

1. INTRODUCTION

Due to the fast growing Internet and the global extent of Internet access even for regular home users, existing business models have changed and new ones arisen. New E-Commerce applications and services offer a wide spectrum of possibilities to do business electronically. Due to available bandwidth and powerful hardware, recently the idea arose to use the Internet infrastructure for an integration of data and telecommunication to entertain customers with multimedia data and services like video streams or teleconferencing.

A crucial point for the transfer of high-quality data is the fact that traffic congestion occurs in the Internet, which makes reliable transmission of delay-sensitive data difficult or even impossible. High-quality Internet applications or services are very susceptible to delayed delivery of data packets, since their quality strongly depends on reliable network parameters like data throughput, bandwidth, and latency. Unfortunately, packet forwarding in today's Internet works on a best-

effort base, which results in poor quality for multiplexed audio or video streams, especially when network congestion occurs. One solution to overcome this problem is the introduction of a multi-service-level Internet, which offers different service levels and the desired Quality-of-Service (QoS) for certain high-quality data transfer. This necessitates the reservation of network resources based on pricing models 0. Within the CATI project (Charging and Accounting Technologies for the Internet) enabling technologies were designed to implement charging and accounting of Internet services based on the reservation of network resources 0.

Figure 1. Multi-provider business scenario

Economic incentives for providing high-quality end-to-end communication imply the development and usage of E-Commerce services that contribute an added value to the service provisioning over IP infrastructure. Interacting and cooperating business roles are required to perform service delivery based on pre-defined policies.

Figure 1 shows a business scenario with an end-customer electronically connected to an E-Commerce Service Provider (ESP) that represents a merchant offering information (in form of both physical and non-tangible goods) and services over the Internet. The clouds in between symbolize the network domain with the underlying network infrastructure of the network providers. These network providers carry different roles and provide several value-added services while transferring data from sender to receiver. Thus, they are called Internet Service Provider (ISP). There may be one or several ISPs involved in the scenario, depending on the network fragmentation of the ISPs and the geographical distances between end-customer and ESP.

If the end-customer (or one of her communication agents that is responsible for communication-related tasks) decides to make use of one of the ESP's offered goods or services, different steps need to be performed before. Service parameters and policies need to be negotiated among business entities before the connection to the ESP can be established and maintained. Possible applications of such a scenario

include IP telephony, teleconferencing, data backups, the transmission of financial feeds, and the transfer of video or audio on demand (VoD, AoD).

This paper is organized as follows. Based on the multi-provider scenario, Section 2 defines business roles and relationships. It defines a set of differentiated services and discusses controlling business policies and their use to the Internet services market. Section 3 describes the overall charging process between different roles for the delivered services. Section 4 contains a fully defined business process showing the temporal coherence between business roles and services. Finally, Section 5 summarizes the paper, draws conclusions, and outlooks on future work.

2. ROLES, SERVICES, AND POLICIES

The growing deployment of E-Commerce applications and the convergence of data and telecommunication make the introduction of proper business models and well-defined business processes indispensable. Applying business models in the technical area of telecommunication require a set of mechanisms being available for performing charging and billing functionality, especially for QoS-based end-to-end communication. This section includes a description of business roles and defines the corresponding services they provide but also their underlying strategies and policies.

2.1 Roles

A role in a role model is characterized by a certain functionality and scope of duties. Roles in business and technical environments have the advantage to logically separate the business model and define what tasks and resources are used by them and what responsibilities the different roles take. L.G. Lawrence [0] defines a role as "... mainly a definition of a job at the lowest level of granularity used in the organization. According to the business concerned it may be in a position description, establishment position statement or other term which addresses what must be done by the occupant of that job regardless of who that person is". A role can inherit purely technical as well as administrative functions. Furthermore, the concept of roles is advantageous for the security, quality, and resource management. Securing data and managing resources can be based on role-access relationships where certain business entities are assigned to roles with restricted functionality.

We want to focus on the roles of ESP, ISP, end-customer, and Customer Premises Network (CPN) knowing that there are more than just these few and that these roles are not limited to the interface but to the quality of the service they provide [0]. An instance of a role will interact and communicate with another instance of a role in order to provide a service. Additionally, one business entity can fulfil the tasks of several roles and thus adopt these roles. One example is Akamai [0] that takes the role of both ISP and ESP by providing access networks and content.

The role of an **E-Commerce Service Provider (ESP)** symbolizes a merchant within the business relationship with an end-customer. The ESP offers products, contents, and services online via the World Wide Web (WWW) to every Internet user in the world and represents the seller of goods. Within the following, “goods” are considered a general term for any kind of product, content, of service that is offered or sold electronically on the Internet.

The role of an **end-customer** symbolizes a customer at the end point of a communication connection with the ESP. The end-customer can get online information about the offered goods within the ESP’s catalogue and may choose electronically by clicking on certain items. The end-customer can even compare prices of different sellers and thus find the optimal product or service concerning quality and price. It is also possible that end-customers are affiliated to a **Customer Premises Network (CPN)**, e.g., a LAN of an enterprise or a university that groups end-customers and establishes the connection to the Access ISP. A CPN represents a group of users in terms of a common policy and conceals individual end-customers from the Access ISP.

The role of an Internet Service Provider (ISP) is divided into the roles of Access ISP and Core ISP according to their scope of network provider duties and the range of hardware and software equipment. Access ISPs support local access to internal or external networks and provide Internet connection between end-customers, be it directly or through a CPN. Many Core ISPs increase the reach of Access ISPs to a global extent and form the backbone of the Internet. They handle the data transport interconnecting multiple Access ISPs. There might be none or more than one instance of a Core ISP involved in a communication connection between end-customer and ESP. It depends on the connectivity of the ISPs and the geographical distance of end-customer and ESP. In case there is only one instance of an ISP involved between end-customer and ESP, it takes the role of both Access ISP and Core ISP. Thus, the role of Access ISP and Core ISP may be physically inherent in one business entity.

2.2 Service Model

Figure 2a shows a service model with the previously defined roles of the end-customer, ESP, and ISP in form of ovals. The model abstracts from the technical solution where the end-customer is connected to an ESP via the IP infrastructure of an Access ISP. Instead, the service model is based on the business relationship between end-customer and ESP including different services that are provided on top of the IP infrastructure of the ISP. The end-customer uses the E-Commerce Service, offered by the ESP, as an interface for further value-added service provisioning. This E-commerce service comprises the offer of products, content, and services that are offered online by the ESP (e.g., furniture, CDs, online books or magazines, audio-on-demand, video-on-demand, Internet games).

Figure 2a also implies the possibility for the end-customer to directly use the IP infrastructure offered by the ISP in order to communicate over the TCP/IP-based infrastructure. This might be useful to up or download data onto or from a file server with no extra services and without any time restrictions for the communication. Ordering an E-Commerce service from the ESP gives the end-customer a wide range of accompanying value-added services that can be recombined and added to increase the value of the E-Commerce service.

Figure 2a. Service model including roles and services

Figure 2b. Service model extended by the feedback mechanism of the charging system

The module **Other Services** combines services such as security service, synchronization service, charging service, etc. **Access Service** is offered to end-customers to connect to the Internet via ISP platform. Service functionality comprises among others access control, charging and billing, logging in and out. An Access ISP holds the position of the closest ISP to end-customer and ESP, which is a special role since access conditions are individually and contractually fixed. Access conditions determine the kind of connection such as its bandwidth, availability, or security measures, but also pricing models for the Internet access. Since these conditions are fixed on a contractual base in form of Service Level Agreements (SLA) 0, they have to be kept otherwise reimbursements have to be settled to compensate the failure. Internet access implies global connectivity with a local connection to the Access ISP, and thus, the price of a local phone call.

Transport Service provided by the role of the ISPs is of fundamental importance for the quality of the delivered communication services. Data needs to be carried reliably from one end point to another. Packet forwarding on today's Internet works on a best-effort basis, which means that single packets are transmitted independently from each other from sender to receiver as fast as possible. However, transmitting video or audio frames with good quality requires a type of network connection with a certain guaranteed bandwidth or maximum delay. A video or audio stream is delay-sensitive which requires timeliness of packet delivery and only allows small variations in the transfer rate due to buffering mechanisms. The service quality of the stream depends on the delay between every

transmitted frame where the frame size varies depending on the amount of changes in the picture. Thus, the transfer rate varies from frame to frame. A video conference on the other hand is rate-sensitive and needs to constantly transmit frames of the same size. Providing a high-quality video conference stream requires a guaranteed bandwidth with a certain constant data transport rate θ . One solution for ISPs to provide reliable transport services according to the required QoS of the E-Commerce service is to firstly classify traffic into different service classes and, secondly, to treat data packets differently depending on the service class and the according price θ . Consequently, the quality of an E-Commerce service depends on many factors, but mainly on the quality of the underlying transport service.

Reservation Service can be provided by ISPs in order to reserve network resources for data transport but also by the ESP to reserve an E-Commerce service. The reservation service negotiates and stipulates service conditions for the E-Commerce service and network parameters for the transport service (including Internet access). Depending on the requirements for the E-Commerce service, the end-customer chooses the desired QoS for the transport service by selecting the appropriate QoS parameters (e.g., bandwidth, latency, loss rates), which in turn affect the price. Three different kinds of service reservation can be distinguished:

1. An immediate short-term reservation where the end-customer reserves a service immediately for one period no longer than the default (e.g. 30 seconds).
2. An immediate long-term reservation where the end-customer reserves a service immediately for a period longer than the default (e.g. several minutes).
3. A reservation in advance where the end-customer reserves a service that will be delivered in the future.

2.1 Strategies and Policies

As described implicitly by the previous two sections, strategies and policies inherently form a major constituent for roles to enable a structured interaction. Note that strategy at this point defines the set of business rules for establishing, controlling, and operating service provisioning. This terminology applied here is addressed to the higher layer, termed business layer. The technical management of communication networks, in particular with respect to policies, determines all details in a given communications layer to allow for the automated decision on, e.g., access rights, security levels, performance issues, or service quality. Therefore, a policy based on economic incentives within the communications layers is a means for business management strategies and business cases.

Interaction between different ISPs is based on a federal approach, where entities are widely self-dependent and responsible for their service delivery, but where the Access ISP has a special role as the point of contact for the end-customer in order to technically set up an E-Commerce service. To be able to implement such an approach in the Internet, a set of communication means is essential, basically driven

by the Internet and its protocols as well as existing management means. SLAs form such crucial technical means to implement a business process depending on an ISP strategy. They are applied between business entities in general, ISPs as well as end-customers, to negotiate business conditions on a contractual basis. They define a.o. a service control policy that regulates objectives and responsibilities for the service delivery under a given business process.

Considering the economic dimensions of strategies and policies, the approach to charge for communication services is an essential constituent for a business process. Therefore, the charging of services (as described in Section 3) needs to be supported by appropriate technology. In addition, the performance in economic terms of the service delivery between service providers shall be based on a “win-win” strategy, which implies service delivery and financial compensation until the service has finished or failed. This implies fair business relationships among providers, since no financial losses result from service failures. The effects of such a strategy, backed by SLAs, policies, and network management functionality will be illustrated by a particular business process (cf. Section 4). The process is applied specifically onto three different Internet technologies to argue that the strategy as well as instances of policy sets are independent from the underlying technology.

3. CHARGING COMMUNICATIONS

A commercialized Internet requires a variety of communication services (as illustrated in Section 2.2) which encompass technical ones as well as economic ones. While the functionality of technical services includes IP packet delivery, reliability and error control, or security features, economic services focus on feedback information from service usage to optimize the revenue of E-Commerce services.

Based on the scenario of Figure 1, a charging approach within a business process requires a system interface for a commercial information transfer between ESPs and ISPs in order to optimize business strategies. Optimizing service provisioning requires accounting of services on a timely basis. Traditionally, this accounting has been performed on longer time-scales, nowadays a short-term is envisioned. This leads to the necessity to map these technically accounted information onto a financial dimension in a similar time-scale. Therefore, a charge calculation function will become the major tool for optimizing business strategies and revenues, since soft real-time charging provides important feedback for service providers. This may allow ESPs to select an optimal provider for IP services at a given time. Potentially, an in-operation communication could be switched dynamically, however, technical restrictions have to be considered closely before practical solutions will be available. A similar concept is applicable to all service provider roles as defined above, where cash flow and further economic factors are to be optimized.

As depicted in Figure 2b, the charging system represents that component in the described service model of Figure 2a, which performs mapping tasks from technically accounted parameters of an IP infrastructure and its usage by end-customers onto financial values required to provide feedback signals to both ESPs and ISPs. However, technical parameters need to be completed by QoS information directed to the ESP in case a content sensitive data transport service has failed, e.g., a file backup. However, QoS information directed to the ESP is required to cancel the E-Commerce service and its charges if content sensitive data has been damaged.

A charging system and its communications facilities ⁰ requires a clear differentiation of tasks and functions to be implemented for the network. Within the Internet, an initial step to organize those tasks has been performed ⁰ and they offer the necessary functionality to perform economically- as well as technically-driven control and optimization functions. The charging tasks with the customer billing (termed billing) and the subsequent payment (termed payment) can be embraced and modeled in a clearing phase (cf. Section 4), which basically compensates effort and expenses ⁴³.

3.1 Billing

Billing can be considered a service itself, which could be outsourced from the service providers' core business. Billing implies the process of collecting all relevant information from a charge calculation function and accumulating it onto the customer's bill. The bill summarizes all charges to a final amount that the customer needs to pay either per service or on a regular base (e.g. monthly, weekly).

The ESP bills the end-customer for the ordered product, the delivered service (including reservation), or the provided digital content. Access and Core ISPs bill a.o. for Internet Access⁴⁴, transport, and reservation services, and especially the charge for the transport service depends on the applied pricing model, including QoS value specifications. The price for these provided services may consist fully or partially of the following three basic components: (1) an access charge for the network access, (2) a one-time connection charge for the connection setup, and (3) a usage charge based on time, volume, or QoS for the provided service. Accordingly, the charge covers used network resources and the maintenance of the network infrastructure. Usage-based pricing schemes are applied to charge the customer for the actual amount of used network resources ⁰. It could even be possible that the

⁴³ As denoted in Section 3.2, clearing can also be done in advance, especially if the service customer is unknown to the service provider.

⁴⁴ In case of a direct dial-in connection between the ESP and the end-customer, no Internet Access service is required and the transport service is charged as a direct phone call from the end-customer to the ESP.

transport charge is shared proportionately between the ESP and the end-customer, e.g., collect calls where the callee pays.

Final prices for E-Commerce, Internet access, and transport service sometimes include an optional charge for their reservation. Figure 3 illustrates the coherence between the different services and the billing for their delivery. Horizontally listed, there is the E-Commerce service on top of the Internet access service and the underlying transport service. Reservations for all these services can be made independently from each other. Billing can be performed separately for the horizontally listed services with or without charges for the reservation service.

E-Commerce Service	Reservation Service	Billing
Internet Access Service		
Transport Service		

Figure 3. Coherence of different services with billing

With classical billing, customers receive a monthly bill with a list of charges for the claimed goods. The scheme can be applied in a single-provider environment with a classic business relationship between the merchant and the customer. Different billing schemes have to be applied in a multi-provider environment (cf. Figure 1) where the service performance depends on the cooperation of multiple entities.

Edge billing is a scheme applicable for billing transport and reservation services along a path of ISPs. Charges from every ISP are added to one final bill. The end-customer or the ESP (or both) pays the total amount to the Access ISP, which deducts its share and passes the rest on to the next ISP along the path. The next ISP also deducts only its share and forwards the rest. This process continues along the paths until the end of network connection. Certainly, bilateral agreements between neighboring ISPs would perform better in terms of effort, but asymmetrical traffic flows and quite drastically changing traffic volumes over time require a flexible solution to short-term service setups. A centralized billing model consists of several bills that are passed directly from the ISPs to the end-customer, which results in a complex situation for the end-customer. A hybrid model is a combination of both edge billing and centralized billing. Other billing schemes comprise clearing centers to perform the clearing between involved entities 0.

3.2 Payment

The payment process is a well-defined scheme, which stipulates how money is exchanged between customer and service provider. In case an end-customer wants to remain anonymously (e.g. using a public phone), payments are made in advance (pre-paid). E-Commerce services where the end-customer is known to at least one service provider (e.g. calling from a stationary phone) the payment process is executed afterwards (post-paid). Figure 4 shows our developed model for classifying payment mechanisms according to anonymous or registered end-customers.

Figure 4. Classification of payment mechanisms

The tree structure shows peculiarities for both anonymous pre-paid and registered post-paid payments. Credit and debit cards as well as regular accounts are used for conventional payments where the customer has a registered bank account. Cash and pre-paid cards (e.g., telephone cards) are anonymous means of payment – well known today. Digital money is just a logical representation of monetary units and is also used anonymously, whereas pre-paid accounts are used with a pseudonym where the service availability depends on the current account balance.

4. BUSINESS PROCESS

This section describes the business process derived from the E-Commerce scenario of Figure 1 where an end-customer requests an E-Commerce service from an ESP. This includes the demand for any of the previously mentioned additional services. The flow of this business process is restricted to only the operative sequence of steps and phases without specifying any strategies for negotiating service parameters or taking market situations into consideration. The business process is part of a business model 0 and it shows the different coherent phases and their correlation with the previously identified roles and services 0. Furthermore, these phases are mapped onto Internet protocol architectures such as best-effort Internet, IntServ, and DiffServ resulting in approaches to solve tasks of these phases

(cf. Figure 6). The business process contains four different but coherent phases: (1) contracting phase, (2) reservation phase, (3) service phase, and (4) clearing phase.

The initial **contracting phase** is run through only once to introduce the business partners to each other on a contractual base for further cooperation and service provisioning. Initially, the end-customer logs in with a service provider - be it an ESP or ISP - to request a service. If the end-customer is already known to the service provider, meaning a contract exists already, the contracting phase is skipped.

Figure 5 shows the business process in form of a flow chart, where the clouds show sub-phases of the four coherent phases and the rhombuses symbolize “forks in the road” that decide which way the process leads. Attached to the clouds are the roles in the gray boxes that represent the involved actors of that sub-phase. After the contracting phase is run through, the business process leads into the **reservation phase** where different services and their parameters are negotiated. The end-customer logs in with the service provider again to actually reserve a service.

In an optional specific information phase the end-customer gets customer specific information about the short-term market situation, e.g., price tender, network traffic, or comparison with other service providers. If no service has been previously reserved the service parameters have to be negotiated among the business entities within the negotiation phase. As mentioned in Section 2.2, services can be reserved immediately for a short term, immediately for a longer term, or in advance. It is important to note that the negotiation phase for the Integrated Services Internet (IntServ) runs differently from the one for the Differentiated Services Internet (DiffServ). IntServ supports the negotiation of service parameters based on single end-to-end flows whereas DiffServ traffic is based on the notion of aggregated flows with fixed numbers of service levels which requires longer termed service negotiation on a per IP packet-basis.

Figure 5. Entire business process including reservation, service, and clearing phase

In the subsequent **service phase**, the performance of the requested services takes place. If no immediate service is desired the end-customer logs out. Of course, the end-customer can log out at any point during the whole business process. If an immediate service is desired by a registered end-customer the actual service is performed within the duty phase. However, if the end-customer decided to remain anonymous, pre-paid payments have to be made within the pre-paid payment phase before the service is performed. If another immediate service is desired the business process loops back into the specific information phase to rerun the reservation phase. Again, this loop is very short termed (e.g., 30 seconds) and flow based in case of IntServ and longer termed (e.g., whole service duration) in case of DiffServ.

		best effort	Intserv	Diffserv
reservation phase	service previously reserved	not possible	check for existing or reserved flow	check DSCP usage of microflows at border router
	negotiation phase	nonnegotiation	RSVP messages btw. ESP & end-customer	res. requests btw. bandwidth brokers
service phase	pre-paid payment phase	no payment since no resources are reserved	pre-paid payments within IP packets for a certain period of time (e.g. 10 minutes)	
	duty phase	IP packet routing with no priorities	IP packets with flow labeling	IP packets with DSCP marked for PHB
	another Immediate service	possible anytime with no guarantee	new RSVP message (default 30 seconds)	similar DSCP marking scheme for packets of a microflow
clearing phase	charging and billing phase	no charges	charges for single flows with same flow label	charges for counted IP packets per DSCP
	account-base payment phase	nopayment	adding identified charges to a customer bill	

Figure 6. Phases of the business process mapped onto different architectures

The final **clearing phase** includes charging, billing, and payment for the delivered service with account-based post-paid payments if the end-customer is registered. The charging and billing phase comprises the accumulation of user specific information to calculate the final price for the service and also the subsequent sending of the bill. Post-paid payments are made within the account-based payment phase for example with credit card, debit card, or regular money transfer. A final, optional customer support phase concludes the business process where the service provider has the chance to get any feedback from the end-customer concerning the performance of the service.

Figure 6 compares a best-effort Internet with the IntServ and DiffServ framework and how they could technically support tasks within some exemplary sub-phases and decision points. It illustrates how best-effort does not foresee any resource reservation or service differentiation. IntServ approaches with RSVP as a signaling protocol are based on single flows, whereas DiffServ handles aggregated flows with guaranteed per-hop behaviors (PHB) for packets with similar DiffServ

Code Point (DSCP). The negotiation within DiffServ is handled by Bandwidth Brokers (BB) of different DiffServ domains [1]. A micro-flow is a single instance of an application-to-application flow of packets identified by source and destination address, protocol id, and source port.

1. CONCLUSIONS AND FUTURE WORK

Business entities and their roles and responsibilities determine basic components of a business process, which is developed for a future value-added Internet. A clear separation of these players, a concise definition of the services they offer, and a characterization of their interactions and mechanisms allow the definition of open business processes. This openness is essential for tomorrow's markets in the Internet, covering charging and accounting for products, contents, and services using network resources. On a network level it is the transport service that implements reliable QoS-based end-to-end communication with different service levels. The usage of the Internet as a platform for electronic business requires a higher level of abstraction with well-defined business processes and business models including special cooperating roles and services based on appropriate policies.

Within the previously shown multi-provider scenario, it is especially the clearing process with clearing, billing, and payment for delivered services that is crucial for the economic success of an E-Commerce application. It must remain open, whether the pure transport-related charging and its corresponding billing will be valid for every single service in the Internet. Regularly changing Internet technologies and a broad variety of service providers and customers with different single demands and expectations complicate development and use of generic business processes and require an exact differentiation of E-Commerce scenarios. However, the business process as demonstrated in Figure 5 made a step towards an integration of E-Commerce and service delivery through the introduction of contractual agreements, charging mechanisms, billing, and payment. Also, the potential of having business processes handy, of having efficient technology in place, and of having simulation experiences available for charging and accounting issues in the Internet provides the basis for experimentation as well as long-term collection of experiences. Although the INDEX project collected first results [2], various questions need further investigations: the applicability of various pricing models [3], its dependencies on business models, and applicability of fine-grained and scalable accounting tools.

The business process clearly distinguished pre-paid payments from account-based payments for the settlement of services. Clearing is part of the economic policy that regulates financial compensation of services. The policy considers registered as well as anonymous end-customers, but prefers account-based payments in case of service failures, when pre-paid payments have been made already.

Account-based payments are advantageous, since clearing is performed on a pay-per-use base where only the actual received service is paid after service delivery.

Furthermore, future work needs to be done in embedding the technological know-how into economic models and business. Figure 6 shows basic approaches how to map the phases of the business process onto technological Internet architectures but more work is required to further develop these ideas. Reservation of network resources could be performed by using intelligent agents as bandwidth brokers. Dynamic usage-based pricing models are designed and need to be operated. Payment methods are still lacking trust for many electronic business applications. The handling of anonymous service customers should be the focus of investigations for QoS-based end-to-end service provisioning in a value-added Internet. The growing number of mobile Internet users and new mobile Internet technology is a clear indication for changing expectations of today's service markets.

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