Accounting and Billing of Wireless Internet Services in the Third Generation Networks

Päivi Kallio[1], Giovanni Cortese[2], Roberto Tiella[2], Alessandro Zorer[2]

[1]VTT Electronics, Kaitoväylä 1, 90571 Oulu, Finland
Tel. :+358 400 963 214
Fax: +358 8 551 2320
eMail: paivi.kallio@vtt.fi

[2]Sodalia S.p.A, Via Valentina Zambra n.1, 38100 Trento, Italy
Tel.;+39 0461 316111
Fax: +39 0461 316663
eMail: {cortese,tiella,zorer}@sodalia.it

Abstract. The development of the wireless Internet market and its structure is driven by differing industry fundamentals and the revenue derived from content and content-related services is expected to increase significantly for all actors within the wireless industry. Providing flexible and scalable accounting and billing systems will be essential for success when offering wireless services to end customers. The wireless service providers have difficulties in billing their customers due to their inability to associate customer transactions with network usage, correlate data from multiple sources and flexibly support the emerging billing models. In this paper an accounting and billing model for the two wireless services is presented. The evaluation of the services proved that the number of roles and partners in the wireless services is huge and that solutions like accounting agents and billing mediation servers are needed for tracking customer transactions and directing the accounting and billing between the partners.

Keywords: Accounting, billing, wireless, Internet

1. Introduction

Differing industry fundamentals have been driving the development of the wireless Internet market and its structure in Europe, USA and Japan. In Europe the air interface standards are uniform, the network quality is good and messaging is highly used and fixed-line Internet relatively highly used.

The revenue derived from content and content-related services is expected to increase significantly for all actors within both the wireless and Internet Protocol (IP) industries, and, therefore, a well-formulated business model will give a competitive advantage over the other wireless companies [1]. The increased number of actors in the wireless value chain is faced with the following challenges:

- A growing complexity of interoperability among providers' service elements.
- Settling revenue throughout the value chain should be manageable and software

driven.

- The absence of industry standards for interfacing all the involved service elements.
- The unique character of General Packet Radio Service (GPRS) infrastructure requires a new accounting and billing model.

Accounting is according to the definition:
" ... the process of keeping track of a user's activity while accessing the network resources, including the amount of time spent in the network, the services accessed while there and the amount of data transferred during the session. Accounting data is used for trend analysis, capacity planning, billing, auditing and cost allocation." [3]

The providers of wireless services cannot currently effectively bill their customers for the wireless services due to their inability to:

- Associate customer transactions and network usage in real-time;
- Correlate data from multiple sources, such as network usage events, transactions and content purchases;
- Flexibly support emerging billing models

The aim of this research is to develop an accounting and billing model for the wireless services by researching the literature and evaluating two wireless services that are under development for the Third Generation (3G) networks. The first service is a trading service for banks and brokers, and the other is a multi-player game. In this paper the roles of the companies in the wireless business are handled first, then the requirements of accounting and billing in wireless services and, finally, an accounting and billing model for the two case-example services is presented.

2. The Roles of the Companies in a Wireless Business and their Billing Roles

In a wireless business all companies can play several roles and communicate directly with each other in spite of their role. Several categorizations of the company's roles in the wireless business exist, and as many speculations about its future roles. The possible roles of the wireless companies ([5],[2]) are presented in Table 1 :

Table 1. Roles of the companies in a wireless business

Role	Description
Content Provider (CP)	Develops original content for various distribution channels or aggregate content that others have created.
Network Operator (NO)	Sells network capacity to consumers via service providers enabling the use of services
Technology Provider	Produces mobile-enabled devices, application platforms and components and storage technologies and basic operating environments.
Application Service Pro-	Provides remote hosting, services, maintenance and upgrades of applications and thus enable businesses to contact their custom-

vider (ASP)	ers via a mobile channel.
Service Provider	Sells mobile telecommunications services to the subscribers and takes care of the billing, customer relationships and marketing.
Customer	Uses services defined by the service architecture

In the case-example services, multiple providers are involved in the value chain, supplying part of the end-to-end service delivered to the final customer. Each of the partners in the value chain should be paid for the part of service provided.

The following Figure describes the transaction flows for billing to the final customer and for revenue settlement between the service providers.

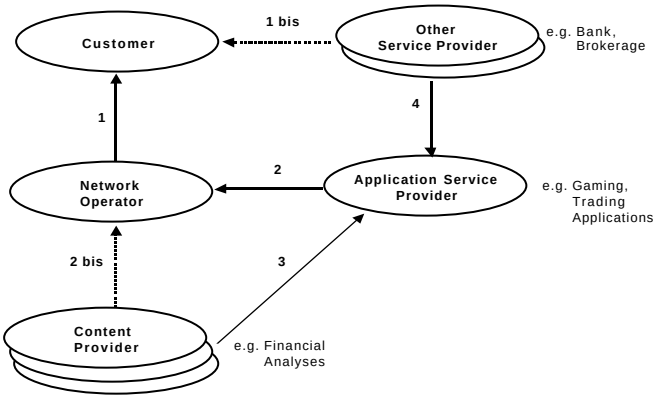

Figure 1. Billing roles of the companies in the case-example services

In relationship 1 (Figure 1), the NO is likely to 'interface' with the customer for invoicing since they already have a contract. The bill provided to the final customer includes fees for network access and usage, and fees for service usage. The revenue provided to the CP (2 bis) refers to the content provided directly or through the application service provider's applications. So far, the NOs have determined the functionality of the services, and the operators, who want to gain a customer base without deploying the infrastructure, have acquired many service operators.

The billing of the customer could be based on:

- Monthly fees to access the service
- Initial download of the service and download of additional services
- Links to service-based fashion/retail websites

In relationship 2, interconnection and settlement agreements between the ASP and the NO should be considered for revenue sharing. The revenue provided to the ASP may refer to the entire charge for the value-added service or only the ASP service.

The content providers sell their content to portals and service providers. The critical success factors for the CPs are whether or not they are producing high-quality content and their knowledge of the control of mobile user interfaces. Aggregating and

repackaging content will probably be one of the main sources of revenue for content providers. The content providers charge for their services based on the content.

Additional sources of revenue for the actors in the 3G- field are:

- Advertising
- % of revenues of service providers
- % of data download/airtime revenue
- Standard or premium usage rates paid by the end user
- Flat rate or as part of bigger service
- License revenues for software developers
- Service revenues for operators, integrators and software developers to enable the wireless corporate Local Area Network (LAN)

The density and duration of the service usage sessions will be completely dependent on the service and will vary from 60 seconds (location-based entertainment) to 40 minutes [8] (games).

3. Requirements of Accounting and Billing in Wireless Services

The billing includes invoicing, rating and discounting, and network data management [4]. In this research billing is handled mainly from the aspect of invoicing. The aim of billing is to provide a correct bill and, if there is a billing problem, resolve it quickly. [6] The requirements of the accounting and billing in wireless services include:

1. The ability to collect, exchange and reconcile *billing data from multiple sources*. The end-user service involves services provided by many providers and at least one of the providers will be responsible for end-user billing. This may be the network provider in some business models, but not always.
2. *Support for a variety of billing schemes*, like content or volume. For the billing, the following are foreseen possibilities:
   - Flat rate where the user subscribes a contract, which gives the customer unlimited access to the service. Flat rate is often combined with some form of usage-based tariff scheme.
   - Usage-Based, that can be based on time, volume, transaction or content and on a combination of different rating attributes, such as Quality of Service (QoS), time (e.g. prime-time vs. off-peak) and location.
3. *Batch and Real-Time Support.*

   The following major phases are foreseen in the processing chain:
   - Data collection that generates raw accounting data from network element/ application server
   - Aggregation and correlation of multiple sources of data. This involves generating call and service data records for all the 'service components' within a service usage instance.
   - Rating by using contract data.
   - Billing that includes applying discount policies for a service, generating an invoice to the customer and generating revenue sharing data to the third-party providers involved.

The above steps can be performed in batch, involving transfer and processing of large blocks of data. Alternatively, they can be performed on an event basis (real-time). Real-time processing for some or all of the steps can only be for improving the timeliness of the billing process, or, in some cases, to achieve a specific functionality. This requires feedback from the billing processing chain to the application or infrastructure services

4. *Open Interfaces*
   A set of selected resources that contribute to the end-user service has to be equipped with an accounting 'agent' that is able to exchange data through public, open interfaces that are related to the service. When the service is web- or WAP-based, it is likely that the agent is a generic agent based on interpretation of the web/WAP server logging.
5. *Dynamic configuration*
   The accounting agent must support all the above behaviours and be remotely configurable from a properly authorized software entity, and should be able to select the appropriate behaviour at run-time.

4. Accounting and Billing in the Case-Example Services

The fundamental question for the wireless services is "What to bill and how to account?". As the volumes of data being filtered by mediation devices increases, the key to an effective billing system is scalability. The players in the wireless service area must think carefully about the complexities of the service delivery channel and balance the requirements for accounting and billing simplicity and clarity for the customer [7]. In the case-example services, the network operator is assumed to be the interface and thus to have the billing relationship with the customer.

4.1 Objectives of the Accounting and Billing in the Case-Example Services

The main goal of accounting and billing in the case-example services is to define the functionalities and Application Programming Interfaces (APIs) needed to develop an end-to-end mobile service charging solution for value-added and content services, and to propose an architectural framework where this solution can be implemented. Other goals of accounting and billing in the case-example services are:

1. Demonstrate the dynamic configuration of the behaviour of accounting agents attached to the service elements.
2. Demonstrate the ability to collect and correlate usage data from multiple sources driven by the end-to-end view of the service. The sources of income are very different in terms of the role played within the service, and with respect to the level of support provided to the accounting and billing process.
3. Support multiple rating schemes. The different events coming from the user can be paid for differently and this type of logic can be flexibly defined in the business model.
4. Support real-time billing, from event collection to transaction/volume rating, in order to support the prepaid charging model or service usage checks.

5. Provide data for supporting different business models. Whenever feasible in the service, the advertising model could also be supported. In practice this means that the customer could be provided with advertisements for discounts or free service, while the advertiser pays the fees.

The solution encompasses data collection from all the relevant service elements of the multiple service providers via accounting agents, data mediation and analysis, end-to-end service rating and revenue sharing. API exported to billing [4] is standard compliant in order to use any billing product for constructing the invoice.

4.2 Main Components of the Billing Chain

This section describes the major components of the billing chain used in the case-example services. It is assumed that all the parties involved in the supply chain allow access to their service elements in order to collect the raw usage data needed to perform the rating and billing functions.

Typically, not all the service elements need to be interfaced in order to collect usage data related to data and value-added services. For example, in the network part of GPRS/UMTS access services it is necessary to receive data from the Gateway GPRS Support Node (GGSN) and extract information about the connectivity between the mobile terminal and the IP network, and, from the authentication server, to correlate information about the mobile terminal equipment and IP Address assigned to the session.

The level of support provided to the accounting process by the different service elements varies considerably. Some kinds, such as network nodes, are able to provide raw usage records in a standard format, while some others - such as Wireless Application Protocol (WAP) and web servers - don't care about accounting and thus do not provide any standard or vendor-specific usage records. For the latter, some kind of application function, here named Accounting Agent, should be provided in order to extract usage data from sources such as log files and database tables. Accounting and billing components receive data from the relevant service elements that co-operate in providing the end-to-end service to the final customer.

The following Figure 2 illustrates a logical view of the architecture of the billing chain, providing the main components and their relationships (the interfaces are numbered).

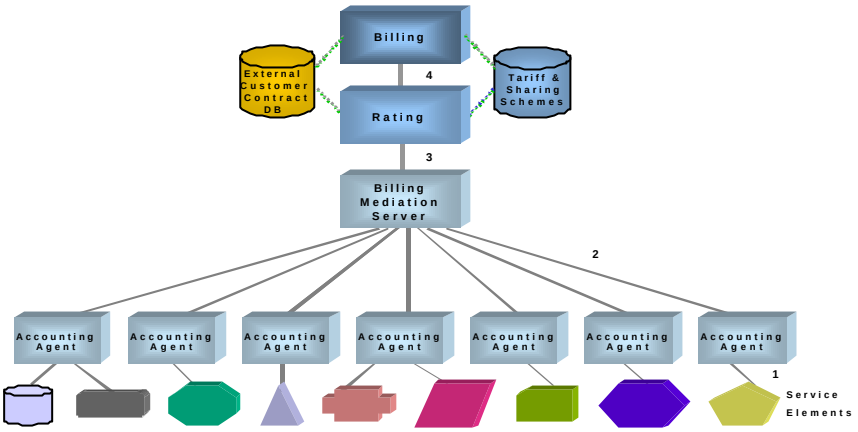

Figure 2. Logical Architecture of the Billing Chain

It is important to be noted that Interface 1 (between Service Element and Accounting Agent) and/or Interface 2 (between Accounting Agent and Billing Mediation Server) introduces some critical security issues when they are located between the boundaries of different Providers. Mature technologies, such as PKI infrastructure provides the basic instruments in order to face of the problem, providing the needed security to all the involved parties.

4.2.1 Accounting Agents

Accounting agents are attached to all the relevant service elements in order to collect raw usage data (interface 1 in Figure 2). To achieve better performance and reduce management traffic overhead, it is better to run accounting agents close to service elements.

The management function performed by accounting agents depends on the type of application/ network node interfaced. It provides the following functions:

- Acts as an interface for the service elements supporting multiple protocols
- Converts raw usage data from multiple source data formats to a set of standard detail records [4]
- Filters, validates and aggregates raw usage data extracted from the source service elements
- Translates usage detail records to a common eXtensible Markup Language (XML) syntax, possibly an encoded format [9].
- Acts as an interface for the billing mediation server on an event basis or in batch mode to provide usage detail records
- Provides feedback to service elements in a prepaid or service usage check

The accounting agent need to interface a variety of usage data sources and to provide collected data encoded into different output formats. Furthermore, it is it should be extensible in order to support new data source types and output formats in the future. To achieve such goals without introducing heavy-weighted platform, for the case-example services an architectural framework has been adopted, that allowed the

Accounting Agent to be designed as a set of pluggable modules that could be assembled at runtime and remotely managed and configured.

4.2.2 Billing Mediation Server

The billing mediation server receives all the usage detail records from accounting agents distributed over the network (interface 2 in Figure 2).

It should be able to receive usage data on an event basis or in batch mode. Communication between the mediation server and the agent could be asynchronous for receiving single events, for example using Java Messaging Service (JMS), or scheduled for collecting massive usage data The ability to receive asynchronous messages is needed in order to support the prepaid charging model or service usage checks.

An application protocol should be used to guarantee the correct and complete transfer of the usage data. The billing mediation server also provides some elaboration of usage data, such as aggregation of records coming from different sources, filtering of duplicated records and synchronization.

4.2.3 Rating

The rating engine receives all the usage detail records from the billing mediation server (interface 3 in Figure 2) in standard formats and correlates them on an end-to-end service generating records related to the entire service to be billed. The customer services are rated according to tariff schemes, and support multiple options such as volume, content, time, service and combinations thereof.

The service usage records are correlated to the contract data in order to rate customer services according to the subscribed contracts. Deny of Service notifications are sent back to Billing Mediation Server that dispatch them to the proper Service Element by means of the related Account Agent.

All the elaboration functions, like record correlation, aggregation, rating, and verification, should be configurable. The flexibility in defining and modifying these steps is fundamental to meet the requirements in terms of complexity and time-to-market of today's Wireless Internet Services. One of the most promising and established technology for this purpose, adopted in the case-example services, is rule languages and engines. In the billing domain rule technology allows to easily define through configuration and maintain all the business logic that performs correlation and rating functions.

The rated service usage record is exported to billing on an event basis or in batch mode. Two types of service usage records can be exported: records related to the final customer usage of the service and records aggregated to the partner service provider. In the latter, only the portion of the service (e.g. content) owned by the partner is taken into account.

4.2.4 Billing

Billing applies pricing and discounting polices to the received service usage records (interface 4 in Figure 2) by generating an invoice to the final customer. It also generates revenue sharing data to third-party providers, only including details of the their

portion of service. The billing function takes into account the pricing and discounting schemes configured in the billing system.

4.3 Service 1 - A Multi-player Game

Service 1 is a multi-player game that is known as the “Labyrinth Game”. It is an arcade game where multiple players move in a big labyrinth or dungeon and complete a mission. The client side is implemented using MIDP (Java MIDlets) and a GPRS/UMTS (Universal Mobile Telecommunications System) connection is used on terminal side clients, while on the server side J2EE (Java 2, Enterprise Edition) is used. The user can download the game "on the air" through a serial cable or infrared connection.

4.3.1 Billing Roles in Service 1

Figure 2 shows the billing roles of Service 1. The user of Service 1 pays for access to the service and for playing it for a certain time. The NO delivers the invoice to the customer and receives the fees, part of which is afterwards paid to the other partners for revenue sharing.

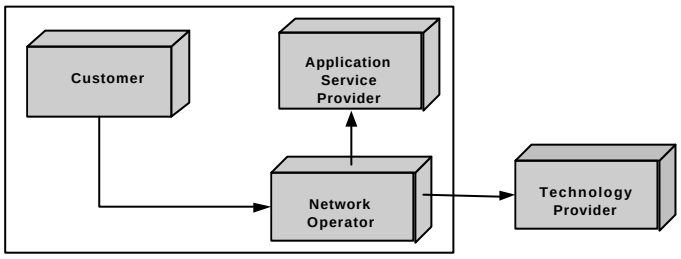

Figure 3. Billing roles in Service 1.

The billing of Service 1 takes place according to the number of bits transferred, but it could also be based on different kinds of packages.

4.3.2 Accounting and Billing-Scenario for Service 1

As depicted in Figure 3, in Service 1 the accounting agents can be attached to:

- A GPRS backbone network for collecting usage data in order to evaluate the network service usage in terms of data volume/time;
- An authentication server for collecting accounting records in order to correlate the IP address information to the subscriber;
- A gaming server for collecting value-added service usage data in order to charge for the service per-transaction.

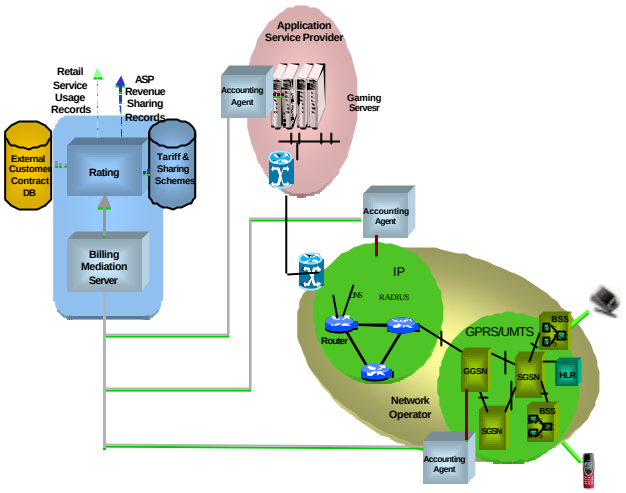

Figure 4. The Billing Context of Service 1

The service components Rating and Billing Mediation Server collect the usage data and correlate the usage records as explained in section 4.2.

After all the collection, filtering/validation, correlation and rating phases, the service accounting records are aggregated for the different roles:

- To bill the final customer;
- To define incoming revenue of the network operator and
- To define the revenue sharing fees for the application service provider.

4.4 Service 2 – A Trading Solution

Service 2 is a trading solution that provides

- Easy and precise online stock exchange information
- A complete set of advanced analysis tools and
- Real-time, direct, electronic trading

for professional traders and serious Internet investors. It is a service for Direct Access Trading (DAT) on the major European and North American exchanges from one professional, effective and reliable platform that is fully functional for operations throughout the entire world.

4.4.1 Billing Relationships in Service 2

As in Service 1, the NO delivers the invoice to the customer and receives the fees, part of which is afterwards paid to the other partners for revenue sharing. The customer of Service 2 has to be a customer of a bank and subscribed to the service as a

bank customer. The service connection is transparently carried out with the service provider. In the Service 2, performance and reliability are the most important quality requirements. The NOs share revenue by paying the application service, service and content providers. Figure 4 illustrates the billing relationships of Service 2.

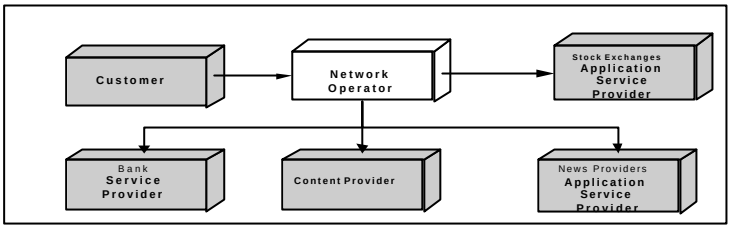

Figure 5. Billing roles in Service 2.

The price of Service 2 is based on:

1. The subscriptions for software functionalities.
2. Exchanges fees - from how many exchanges do they want to receive the quotes.
3. Trading fees.
4. Content fees, such as financial news or financial analysis.

The main revenue streams for Service 2 are licensed per year, with a changeable cost based on the number of functions enabled by the license and trading fee.

4.4.2 Accounting and Billing Scenario for Service 2

As depicted in Figure 5, in Service 2 the accounting agents could be attached to:

- A GPRS backbone network for collecting usage data in order to evaluate the network service usage in terms of data volume/time;
- A server for collecting accounting records in order to correlate the IP Address information to the subscriber;
- Servers of ASP and other service providers for collecting value-added service usage data in order to charge for the service per transaction and per content .

After collection, filtering, correlation and rating, the service accounting records are aggregated:

- To bill the final customer (retail model);
- To define the incoming revenue of the network operator and other SP and
- To define the revenue sharing fees for the ASP, CP and other SP.

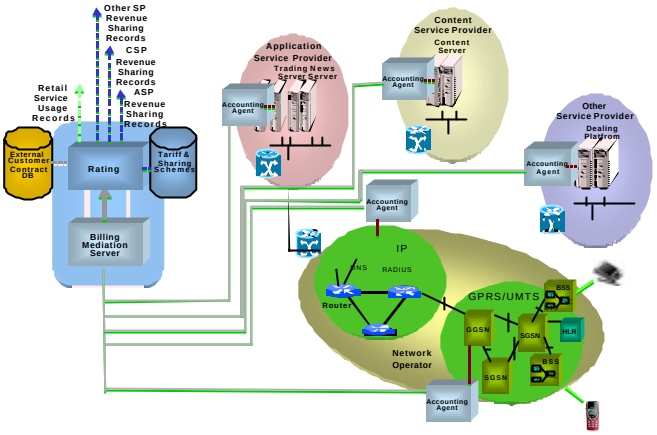

Figure 6. The Billing Context of Service 2

4.5 Implementation of the Components in the Future

In the implementation of the illustrated case-example services it is assumed that the network operator works as the provider of the billing services to the final customer and accounts for the sharing of revenues with the Internet service providers and/or content providers.

The components can be used to implement advanced billing models in a complex value-chain that provides wireless data and value-added services. For these services, it could be demonstrated how an entity, acting as a provider of billing services, is able to collect, correlate and rate the end-to-end service for the final customer and the different parties involved. The provider of these billing services could be the wireless network service provider, some other party involved in the supply-chain - such as a bank - or a party not involved in delivering the service.

5. Conclusions

Providing flexible and scalable accounting and billing systems will be essential for success in the wireless services of the 3G-networks. The increased number of partners in the wireless value chain causes difficulties when defining the division of income between the partners, and the wireless service providers typically also have difficulties in billing their customers due to their inability to:

- Associate customer transactions and network usage in real-time;
- Correlate data from multiple sources and
- Flexibly support emerging billing models

The wireless services require defined needs models for accounting and billing, and methods of putting them into practice. In this paper an accounting and billing model for the two wireless services was presented. The evaluation of the services proved that the number of roles and partners in the wireless services is huge and some kind of solution needs to be defined for tracking the customer transactions and directing the accounting and billing information between several partners. In the billing chain of

the case-example services, four main components were used: rating, billing, billing mediation server and accounting agent. We regard these as the most important parts of the wireless billing chain of the future. The presented billing and accounting model will be technically implemented in the future as a real-case service, as it was presented in this paper.

6. Acknowledgements

This work was done in the Wise (Wireless Internet Service Engineering) project funded by the European Union and the participating five European companies and three research institutes.

7. References

[1] Afuah, A.; Tucci, C.L., 2001. Internet Business Models and Strategies. McGraw et Hill, New York, USA. ISBN 0-07-239724-1. 358 p.

[2] Durlacher, 2000. UMTS Report, an Investment Perspective. 146 p.

[3] Internet.com, 2002.Webopedia. On-line at: http://www.webopedia.com/TERM/A/AAA.html

[4] Ipdr.org, 2002. Network Data Management -Usage (NDM-U) For IP-Based Services; Version 3.1. On-line at: http://www.ipdr.org/documents/NDM-U_3.1.pdf. 100 p.

[5] Lymysalo, M. ,2000. Evolution of Mobile Electronic Commerce- Opportunities for One-to-one Marketing. VTT Information Technology. Research Report TTE1-2000-31. 88 p.

[6] TMForum, 2000. Process Invoicing and Collections (Telecom Operations Map- version 2.1). On-line at: http://www.tmforum.org/clickmap/tomv2.1/pr5.htm

[7] UMTS Forum, 2000a. Enabling UMTS/ Third Generation Services and Applications. 72 p.

[8] UMTS Forum, 2000b. Shaping the Mobile Multimedia Future- An Extended Vision from the UMTS Forum. On-line at: http://www.umts-forum.org/reports/report10.pdf. 113 p.

[9] IETF, 1995. RFC 1832, XDR: External Data Representation Standard, August 1995.