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End-to-End Telecom Billing

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Abstract

This thesis defines an end-to-end billing process model. The processes in the model can be mapped to the TMN(Telecommunications Management Network) model which is based on an international telecommunications management standard. We have identified two interfaces in this billing process model. Part 1 of this thesis provides a protocol-independent design of the UAI(Usage Accounting interface) between the service provider and the network provider. Part 2 of this thesis provides information modeling of the UMI(Usage Metering Interface) between the network provider and the equipment provider. This interface is applied to the B-ICI(Broadband ISDN Inter-Carrier Interface) environment.

1. Introduction

The billing system is one of the most complicated systems maintained by telecommunication service providers(SPs). The service providers may need to interface with network providers(NPs) and equipment providers(EPs). So far, most service providers have independently designed their own proprietary schemes in finding the most efficient and cost-effective solution to billing administration processes. Most of the efforts are geared towards complete automation of both internal billing components within the service provider itself and also external billing interfaces that it offers to the customers. Since there is no common interface design approach adopted by service providers, end-to-end billing automation is not possible. Some of the billing interfaces need to be standardized as soon as possible, especially when the service provider, the network operator and the equipment supplier may come from different countries due to the recent worldwide deregulation in the telecommunications industry.

In NMF(Network Management Forum), the SMART(Service Management Automation and Reengineering Team) Billing team currently calls for solutions on the following 4 interfaces between:

- SP and NP (Usage Accounting Interface)
- NP and EP (Usage Metering Interface)
- SP and SP (joint implementation agreements) and
- SP and Customer (Invoice interface)[1].

In this paper, I propose end-to-end billing process model and design Usage Accounting Interface between SP and NP and Usage Metering Interface between NP and EP. A SP may interface with many NPs, SPs, and Customers. For example, a billing SP may need to collect usage information from a wireline carrier and a wireless carrier(national or even international level). Similarly an equipment provider may make switch equipment for different types of carriers(e.g. FR, ATM, SMDS). Thus there is an urgent necessity of having uniform interfaces for both.

2. End-to-End Billing Process Model

To design end-to-end billing process model, we need to examine a billing system in the real world environment and identify all the crucial processes. An example real billing system is illustrated in Figure 1.

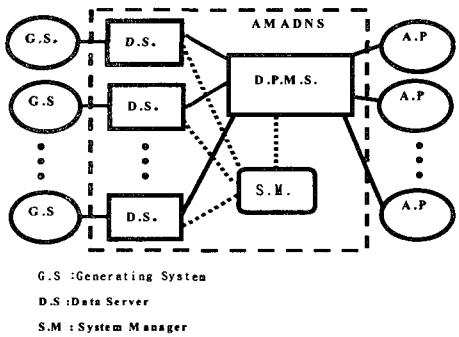

Figure 1. An Examle Billing System in real world

This billing system is based on the Bellcore standard, which is used by practically all the telecommunications carriers in the United States[2]. It shows how the AMA(Automatic Message Accounting) data flow from Generating System to Application Systems. AMA is the

process of measuring and accounting for the use of network resources by customers and carriers. Raw AMA data are generated by Generating System which is switch or Service Control Points(SCP). The raw AMA data are transferred to Data Server. Data Server may serve multiple Generating Systems. They may be implemented internal or external to a Generating System. The Data Server then transfers the AMA records to the Data Processing and Management System(DPMS) which has the whole network level of view. Thus, DPMS collects, correlates and processes the AMA records according to the requirements specific to the Application Systems in order to create so called correlated AMA records. Correlated AMA records are forwarded to the Application Systems. Application Systems are the end systems that need to obtain, use, and process correlated AMA records according to their own needs. These Application Systems may include Billing Systems, Fraud Detection Systems, Marketing Systems, etc. The scope of this paper is only on billing. In the billing system, there are two entities, Revenue Accounting Office(RAO) and Invoice office. RAO has some rating and discounting rules to be applied to the correlated AMA records that do not reflect money value. Then RAO creates charge records reflecting money value and sends the charge records to invoice office. Invoice office deals with customers such as sending invoices, receiving payments, and negotiating billing complaints etc.

Based on the real example of the billing System, we design the end-to-end billing process model. The figure 2 illustrates the end-to-end billing process model.

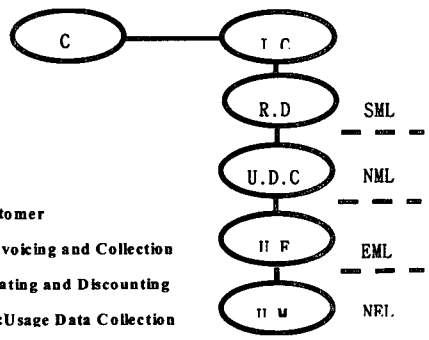

Figure 2. End-to-End Billing Process Model

The Customer Billing process is used to receive invoices, send payments, make billing inquiries, request for billing modifications, etc[3]. The customer process corresponds to customer organization. The Invoicing and Collection process provides the interface with the Customer process. It creates invoices, receives the payments, responds to the billing inquiries from the customer, etc. Its functions correspond to those of invoice office in the real world environment. The Rating and discounting process applies the appropriate rates on the usage records that do not reflect any money value. Its functions correspond to those of RAO(Revenue Accounting Office) in the real world. Normally the invoice office and the RAO reside in the service provider's domain. Thus the invoice process and the rating and discounting process belongs to the Service Management Level(SML) in TMN model. The Usage Data Collection process collects and correlates the usage data and processes them according to specific Application Systems requirements, in this case, the Billing System requirements. This process sits in the Network Management Layer(NML) of TMN because it has the network management level of view. The Usage Formatting process formats the raw AMA data passed by the Usage Metering process. It follows certain formatting rules specified by the higher layer. This process belongs to the Element Management Layer(EML) of TMN because it has some management capabilities over the switch which normally contains usage metering functions. Most likely the Usage Data Collecting process and the formatting process belong to network provider's domain. The Usage Metering process collects raw AMA data and passes them to the next higher layer. Its functions correspond to those of generating systems in the real world environment. This process belongs to the Network Element Layer(NEL) of TMN. Thus this process belongs to the equipment provider's domain.

3. Usage Accounting Interface (UAI)

The interface between the SP and the NP involves the interactions of computer software systems instead of telecommunication hardware equipments. Computer software systems, or processes, interact with each other using communication protocols such as CMIP, FTAM, RDA, FTP, and CORBA. In the telecommunication industry, there is lack of a consensus as to which communication protocol should be used at the interface between the NP and the SP, although there is a growing trend to use CORBA of OMG(Object Management Group) which supports distribution transparency for peer-to-peer communication. For the reason of the lack of consensus, we want to design the interface between the NP and the SP in a protocol independent manner.

To design an abstract interface, firstly, we have to define information objects in the universe of discourse between SP and NP. Secondly, we need to design interface types, which are a set of related interface operations[4,5].

The Object Definition Language(ODL) of TINA-C provides a protocol independent notation to specify interface types[6]. In addition, the quasi-GDMO+GRM (Guideline of Definition of Managed Objects+General Relationship Model) of TINA-C provides a protocol independent notation to specify information model[7].

3.1. Information Model for UAI

In the information model for UAI, there are four information

objects - Network Management-level Accountable(NM_A), Usage Accounting Record (UAR), Usage Accounting Record-subtype(UARn), Record Format Definition(RFD). These objects are illustrated in figure 3.

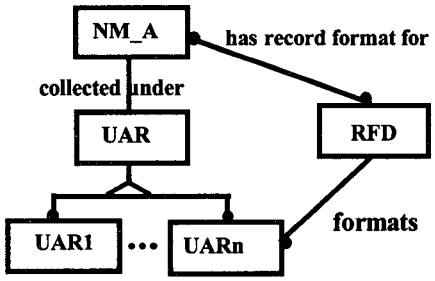

Figure 3. Information Model for UAI

When a customer subscribes a service, NP creates the corresponding NM_A object, which represents the account or the subscribed telecom service for the customer at the Network Management level. Whenever the customer has a usage activity over the subscribed service, the NP collects (receives) raw usage data from EPs, and processes (correlates, aggregates, expands, reduces) them according to the processing algorithm information described in NM_A object.

After processing, NP creates and attaches UARn subtype objects, which represents the processed usage data information for the specific subscribed service. The UAR information object is defined for the generic service as a superclass which is a place holder for the potential subtypes across various service technologies such as Frame Relay, ATM, Cell Relay. Thus, the UARn subtypes are inherited from the UAR object and only the object instances of UARn subtypes are instantiated[5]. The UARn object is formatted according to the information of a RFD object, which contains the formatting information such as what must/may appear in the UARn object. After formatting, the UARn object is ready to be sent to SPs.

3.2. Interface Types for UAI

I have defined five interface types between SP and NP. Each interface type is a set of related interface operations.

Usage_Inquiry type supports SPs remote inquiry of UARn subtype objects. For example, GetUAR operation supports the retrieval of the whole or part of a UARn subtype object. Usage_Notification type delivers UARn to SP. For example, UAR_Notify operation is used to deliver UARn to SP. Usage_Configuration type supports configuration of NM_A objects for SP. For example, NM_ACreate operation is used to create a NM_A object when a customer starts to subscribe a new service. Usage_Configuration_notify type is used to deliver configuration notification to SP. For example, NM_ASuspendNotify operation is used to send a suspend notification when NP initiates to suspend a NM_A object because of the underlying network failure, performance degradation, etc. RFD_Configuration type supports the configuration of RFD object for SP. For example, RFDModify operation is used to modify the contents of a RFD object if necessary.

4. Usage Metering Interface (UMI)

The treatment of the UMI is quite different from the UAI because it involves primarily hardware equipment's, which can understand at most one communication protocol. Today telecom industry has agreed on the use of CMIP as a default protocol for telecom equipments. Thus, unlike the UAI, the UMI emphasizes solely on information modeling. I design the information model to collect the usage information for B-ICI(Broadband ISDN Inter-Carrier Interface) environment with using the generic management objects defined in X.742[9,10]. Thus, it is necessary to briefly introduce the B-ICI and X.742 documents.

ATM forum proposes the B-ICI documents which specify how public carriers can be interconnected to carry traffic for technology-independent multiservice (FR, SMDS, ATM) using ATM backbone[11,12]. It has two phases in which PVC-based services are first supported and SVC-based services. It defines usage measurement requirements, e.g., what and how usage information should be collected. X.742 is titled as Systems Management: Usage Metering Functions for Accounting Purposes. It provides generic management objects for usage metering, e.g., Meter, MeterControl objects. And it provides a template to derive usage information specific to a service type using potential accountable events e.g., registration, request, accept, complete, bulk, interruption, and corresponding.

4.1. Information Model for UMI

A point-to-point PVC has at least two ends at which usage measurements can be taken such as BICI, UNI, FRS-UNI, SNI etc. The recordingIF object represents a recording interface where usage measurements are taken for one or more PVC's. The icPVC object is used to represent an inter-carrier PVC at a recording interface. It has the attributes, which tell connection identification for the icPVC, carriers identification, supported service type etc. On each PVC connection we can install usage metering device which can be represented by the pvcMeter object. The pvcMeter object keeps measuring usage information and reporting the measured usage information according to the information in the pvcMControl object to the NP, which hires the switch. The pvcMControl object is used to control one or more pvcMeters. For example it starts, stops, suspends and resumes metering devices which is represented by pvcMeter. These information objects are most likely implemented in a switching system. These information objects are illustrated in figure 4.

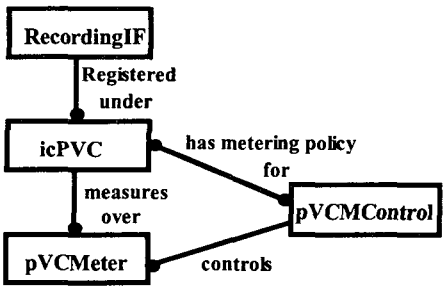

Figure 4. Information Model for UMI

X.742 provides a template to derive usage information specific to a service type using potential accountable events e.g., registration, request, accept, complete, bulk, interruption, and corresponding. The Register event represents the detection of the requester by the service provider. The Request event represents any form of input generated by the requester such as dialed number, feature activation code. The Accept event represents any resulting response to a previous request. The Complete event represents the completion of the provided service such as the remote end clearing. The Bulk event represents non-event related usage measurement, such as the volume usage over a given period on a PVC. However, X.742 doesn't give the specific contents in each event for a service. In this paper, I specify all the specific contents in each event for Frame Relay Service, Cell Relay Service, and Switched Virtual Circuit service[13]. The example of detailed contents of accountable events for SVC service are illustrated below:

```
SVC_Reg ::= SEQUENCE {
callingPartyNumber [0] NumericString,
aESA               [1] NumericString OPTIONAL,
defaultUNIAddress [2] NumericString OPTIONAL,
chargeablePartyNum [3] NumericString OPTION}
SVC_Req ::= SEQUENCE{
CalledPartyNumber [0] NumericString,
aESA               [1] NumericString OPTIONAL,
broadbandBearerCapabili [2] BroadBandBearerCapability,
qOSClassForward    [3] QOSClass OPTIONAL,
qOSClassBackward   [4] QOSClass OPTIONAL,
forwardTrafficDescriptor[5] ForwardTrafficDescriptor,
                   ...}
SVC_Acc ::= SEQUENCE{ ...}
SVC_Comp ::= SEQUENCE{ ...}
SVC_Bulk ::= SEQUENCE{ ...}
```

5. Conclusion

In this paper, I have presented an end-to-end Billing Process Model, which corresponds to the ITU's TMN model. I have defined two billing interfaces which requires prompt standardization to facilitate end-to-end billing automation. The first interface is the UAI between the SP and the NP. And the second interface is the UMI between the NP and the EP.

There are two more future works: The Billing processes interact with other processes in the TMN model. Although this paper addresses the interfaces among the billing processes, we should also address the interfaces between the billing processes and other processes such as TT, OR, PR etc,. Once the interface types have been designed, we need to develop a management integration to integrate the management processes in a distributed environment. One possible method is to use CORBA to implement the management integration.

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