Value-Based Billing in a 3G IP Services Environment

Conor Ryan, Dr. William Donnelly,
Eamonn de Leastar, James Cloney.
Telecommunications Software & Systems Group (TSSG)
Waterford Institute of Technology
Waterford, Ireland
Ph: +353 51 302900
Fax: +353 51 302901
Email: {cryan, wdonnelly, edeleastar, jcloney}@tssg.org
Web: http://www.tssg.org

ABSTRACT

The proliferation of IP-based services has resulted in a paradigm shift away from traditional flat-rat, single service billing to content and usage based billing for composed service sets. The Information Societies Technology (IST) FORM project has prototyped an accounting and billing solution for IP-based telecommunications services. A key element of the solution is the IPDR Network Data Management – Usage specification. This paper presents the FORM development of a federated accounting and billing solution for inter-enterprise IP-based service billing and accounting.

Keywords: Bundled Service, IPDR, Federated IP Billing and Accounting, QoS, Discounting, Interoperability.

1. INTRODUCTION

To survive in the rapidly expanding and changing IP-based services market, service providers need to develop new and dynamic billing and accounting solutions. The traditional flat rate, monthly service subscription models with fixed costs are no longer valid for today's service market. It is widely accepted amongst consumers and providers that accounting and billing for emerging 3G services will be content and usage based.

The widespread and continued usage of the flat rate model has been attributed to the fact that most existing service providers have spawned from the telco-based world where they have been accustomed to distance and time based billing. It's the comfort zone [1]. However, in an IP world, geography is irrelevant. Distance based billing just doesn't work. Time-based billing further discourages the usage of IP-based services. Also, until recently, service providers were locked into the ubiquitous flat-rate business model by their fear that consumers will not pay for content when they could get it, or something similar elsewhere for free. This view is further enhanced by the decline in the fortunes of .com companies. However, the experience from other industries (such as the travel industry) has shown that it is the high cost of travelling that prevents people from travelling more frequently and that profitability can increase as prices decrease, through increased consumption.

Telecommunications service providers explain their resistance to introducing more dynamic charging models (usage, value, service, application or transaction based charging) by pointing to the absence of sophisticated billing and accounting systems. The proliferation of consumers Quality of Service (QoS) expectations has also highlighted severe inadequacies with the service providers flat-rate business models. When a mobile call is dropped, is the non-receipt of a discount because the provider will not give one or the provider's billing system does not possess the functionality to do so? The latter explanation is more probable. Alternatively, if one considers a simple comparison of the two models whereby, in the traditional model a consumer requests the download of a film 300 megabytes in size, but the actual download required 333 megabytes because of some re-transmission issues. The provider can only charge for 300 megabytes and hence has lost revenue on 33 megabytes while also failing to provide a quality service (perhaps because of a fault with the network provider). In a content-based model the consumer is charged for the film not the megabytes i.e. the film download cost is €19.99.

Just as important as determining the value of content, is the question of how content-derived revenues / charges should be settled between the various facets of the provisioning chain; network providers, content providers, service providers, portals, hosting companies, last-mile ISPs, advertisers, distributors, intermediary providers etc. Usage details must be delivered by each of the constituent entities, compiled, rated, discounted, billed and finally the money collected has to be settled back to the entities that exist at the various points in the chain. These factors along with the inherent complexities of new 3G services, place demands on innovative IP billing and accounting systems which cannot even be compared to the requirements of traditional flat-rate systems for 2G and older services.

System interoperability challenges have been a significant obstacle to value-based billing. The usefulness of a state-of-the-art, IP compatible billing and accounting system is limited if it is unable to interact with existing billing/accounting systems, in a standard way, across diverse networks. Service providers have found that the complexity of having to maintain custom integrations in order to facilitate communication between diverse software systems has seriously detracted from the profits that can be made from a value-based approach to billing [1]. These challenges, along with those of usage data exchange between the various entities in the provisioning chain, have brought about the evolution of a federated accounting model. A federated accounting system supports the intra and inter domain communication between the different hardware and software components that facilitate service provision. The 'Accounting and Billing' team within the FORM [2] project, comprised of the TSSG and Fraunhofer FOKUS, have identified the ability to perform automated federated accounting as the key element to maintaining the profits that can be generated from value-based billing for IP services. The crux of any such automated federated accounting system is the need for a standard means of representing/transferring the accounting information between entities. Once a data exchange standard is in place, the situation is significantly altered, as providers are freed from the extensive costs of custom integration, since they can assume that the software packages will automatically communicate. This presents a plug and play type scenario, where value-based billing for content becomes a profitable and an almost routine exercise for the service provider allowing them to focus on their core competency – new service generation and delivery.

2. IP SERVICE ACCOUNTING AND BILLING

By using IP to build telecom services, carriers and providers can for the first time establish tiers or grades of service and create variable pricing to reflect real marketplace conditions. INSIGHT's research suggests that at least for the next few years, billing for these new IP-based services will be an element of a convergent billing operation [3]. IP revenues are generated by rating IPDRs, which are similar to the traditional telecommunication's Call Detail Record (CDR) of circuit switched billing. However, the IPDR extends the fields and functions of the CDR to monitor a broader range of parameters encompassing; Session Length, Packets, Transaction, Content, Service Level Agreements (SLAs), Resource Name, QoS Level, etc. It is perceived that the converged bill of today (your telecomm operator bill) will evolve, in the near future, to a new paradigm of real-time, usage-based, value-based, content-based or session-based billing in an all IP packet network. This evolution is required to meet the rapidly changing requirements of the providers, the customers and the legal bodies governing the freedom of information in the new billing and accounting environment. To rapidly deliver the next generation of complex IP telecommunications services, providers are finding that they need to collaboratively establish service provision chains. Billing for these services will require that accounting records be exchanged between the various providers. These records must retain a sufficient level of granularity of information to facilitate performance analysis, real-time cross selling, churn management, real-time fraud detection and other historical accounting data analysis techniques. These requirements, combined with new customer expectations for real-time billing, online bill querying and analysis, automated self-provisioning/subscription and service activation along with QoS dependant discounting, emphasise the huge billing and accounting challenges that providers will face.

FORM: These requirements were identified in the Market Analysis and Requirements Acquisition phase of the FORM project. The crucial element of a federated accounting system is the manner in which accounting information is passed between provider domains while maintaining support for the peripheral provider activities and customer/legal requirements mentioned previously. The system requires a standardised, structured, yet adaptable record format for the exchange of detailed accounting information. Several record formats including Service Detail Records (SDRs) [4], CDRs, Charge Detail Records (ChDRs), the ETSI TIPHON Open Settlement Protocol (OSP) [5] and the Internet Protocol Detail Record (IPDR) were researched. The FORM 'Accounting and Billing' team adopted the IPDR.org's Network Data Management – Usage (NDM-U) [6] (v2.6) specification as the underlying standard to support the ubiquitous transfer of usage details between the various entities in the service provision chain. The NDM-U specification is a usage-based billing standard for IP services (effectively an interface that allows technology to be shared across systems) that provides a means of accounting for transactions such as content delivery. For the sake of flexibility, at a time when services are evolving rapidly, the IPDR has chosen an XML based standard and is currently experimenting with version 3.0 of its specification. However, the team identified that the NDM-U (v2.6) portrays a narrow focus on the area of charge inclusion and that there is a much wider business scenario that needs to be addressed by any such standard.

The FORM federated accounting system supports value-based customer billing and value-chain entity settlement for IP based services. The system also introduces the concepts of context-based billing whereby multiple registered/subscribed users can use the same physical device and yet be billed separately, while also supporting three-phase service charge discounting.

Federated Accounting: The FORM project has adopted an Inter Enterprise Service Provider (IESP) process model. This model was generated in conjunction with the Service Fulfilment Assurance and Billing (FAB) processes defined by the Telemanagent Forum's (TMF's) Telecom Operations Map (TOM) [7] and the Telecommunication Information Networking Architecture (TINA) [8] Services Architecture. The FORM federated accounting system focuses on supporting the Billing process of the FAB process breakdown, while also addressing many of the requirements driving the evolution of Value-Based Billing in a 3G IP Services Environment.

The ability to provide co-operative working environments between organisations is a crucial prerequisite for the provision of next generation IP services. The IESP has been identified as a possible entity that could offer enterprise management services to collaborating organisations. The IESP offers management services that enable businesses to form and dissolve service provision collaborations in a highly automated fashion. This paper is concerned with the billing and accounting activities supported by the IESP. These activities must cater for a wide variety of customer needs and the requirements of the various entities that constitute the service provision chain. The system must be able to cater for customer charging while instantaneously supporting revenue settlement with each of the entities involved in the provision of the service being charged for. It is envisaged that some of the pioneering operators may assume this IESP role, turning their vast experience and size into a marketable commodity that they can package and sell to smaller service providers. The creation of such a collaborative environment, where content providers, network providers, ISPs, ASPs and general service providers, will lead the introduction of composed service sets or bundled services. These bundled services will be marketed as a single service and equivalently will generate a single customer charge for any use of the service. There are many infrastructure and integration complexities that are quite apparent in such a bundled services environment, and billing/accounting represents one of the major challenges.

The IPDR Organisation: The IPDR (www.ipdr.org) organisation is an industrial consortium. It was founded by some of the prominent vendors providing management solutions for IP-based networks. Members include Hewlett-Packard, Oracle, Portal, Sun, AT&T, Amdocs, Compaq, XACCT, Aptis, Andersen Consulting, CableData, Clarent, Narus, Savera, and TeleStrategies. The primary objective of the IPDR organisation is to define the essential attributes of information exchange between network elements and services, OSSs (Operation Support Systems) and BSSs (Business Support Systems). This specification provides the foundation for the development of open, carrier-grade support systems that enable next-generation networks and services to operate efficiently and cost effectively. The IPDR organisation and the FORM project have adopted the core functional roles and interfaces of the TMF's TOM for the specification of interfaces between OSSs and BSSs. The specific goals of the IPDR organisation that fulfil the FORM federated accounting system requirements are to:

- Define an open, flexible record format (the IPDR structure) for exchanging usage information.
- Define essential parameters that can be used to define a service or network usage.
- Provide an extension mechanism so network and service elements, and support systems can exchange optional usage metrics for a particular service.

The idea central to the IPDR initiative is similar to that of the CDR, which is a record of system events and is widely used in the telephony world. A CDR is produced every time a user makes a call. Among other information, a CDR contains the start and end times of calls, and the identification of the calling and called parties. This information is then used by a billing system to create accounting records that support bill preparation and subsequent analysis. The IPDR is the corresponding record for IP-based networks. The IPDR organisation has produced the NDM-U specification for the detail record that tracks network and service usage and facilitates Value-Based Billing for IP-based services. The specification also provides a major part of the architecture for the measurement of IP-based transactions, and the identification of network resource usage, which is an important step towards a scaleable billing mechanism.

It is worthwhile to note that although the acronym IPDR includes IP (Internet Protocol), IPDR specifications and record structure are not proposed exclusively for IP-based networks and services. Both the specification and the record structure are fairly generic and sufficiently flexible to support exchange of usage information for other types of networks and services.

The NDM-U specification focuses on providing a framework for a standard mechanism to exchange usage data between systems. The XML record structure and service definitions provide a means to begin representing service usage information in a consistent, self-describing, human readable format. These structures called IPDRs allow for the creation of documents by one system in a format that can be understood and easily used by another. An IPDR Document, which is also the unit of information exchange, contains one or multiple IPDRs. It must also be noted that syntax-wise, all IPDR Documents are XML instance documents. The adoption of XML in the NDM-U was another important factor in the selection of the IPDR as the accounting record format for the FORM federated accounting system, as XML is widely being adopted as a tool for representing business data in a technology-neutral and platform independent manner. The existence of an IPDR Doc master schema and Service Specific schemas further support the adoption of the IPDR as the standard means for usage information exchange within a federated accounting system.

3. THE FORM FEDERATED ACCOUNTING SYSTEM

The FORM billing team have adopted the NDM-U specification in the design of the IESP federated accounting system. In this business model the IESP fulfils the role of a service broker. The IESP negotiates Service Level Specifications (SLSs) with various Third Party Providers (TPPs) for their respective services. The IESP then negotiates SLAs with Inter Enterprise Service Customers (IESCs) based on these SLSs. Various other groups in the FORM project have been working on the automation of these Fulfilment processes. These agreements detail resources, QoS level parameters, accounting information, customer/provider information etc. Once an IESC has subscribed to an IESP service they are authorised to use that service. The various TPPs that support the actual service provision depends on the correlation between the IESC requirements and the TPP's ability to meet those requirements as specified in an SLS. When an IESC has completed a service usage, each of the constituent TPPs in the service provision chain is responsible for the instantaneous delivery of IPDRs to the IESP for near real-time rating and billing. Each of the TPPs has the option of performing their own rating or outsourcing their rating to the IESP. The accounting information that the IESP requires to fuel charging schemes and algorithms is embedded in the SLS for the provider and SLA for the customer. The IESP rates the IPDRs for settlement with the TPP and also for charging the IESC. The basic business principle of the IESP broker model is that it agrees a rate for service provision with a provider and then agrees a higher rate for service usage with the customer and generates revenue with the difference. Another adaptation of this business principal is that the TPP simply outsource it's rating and billing to the IESP and that the IESP charges the TPP for each usage of it's accounting service. The FORM federated accounting system has initially adopted the IESP broker model as depicted in Figure 1.

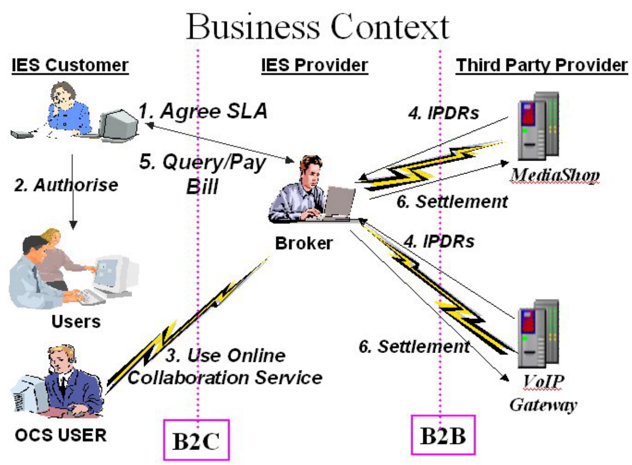

Figure 1. FORM IESP Business Context

This diagram illustrates the inter-domain interactions required to provide and bill for an Online Collaboration Service (OCS). The OCS represents a bundled service used to validate the federated accounting system. The service encompasses the simultaneous, cohesive delivery of a MediaShop (Upload/Download Content) and a VoIP service. This service was trialled under the scenario of two doctors remotely uploading/viewing x-ray images using the MediaShop service while simultaneously discussing same via a VoIP call. The OCS is marketed and billed to the user, as a single service. The MediaShop and VoIP TPPs are aware that their respective services are cooperating in an OCS usage, however, the IESP is responsible for coordinating the provision of the constituent services within a single OCS accounting usage/session. The actions in Figure 1 can be summarised as follows:

The initial activity is the agreement of an SLS for the MediaShop and VoIP services between the respective TPPs and the IESP. Once this pre-requisite has been fulfilled:

1. The IESP negotiates an SLA for the OCS with the subscribed IESC.
2. The IESC organisation can then disperse User Ids and Passwords for the service to various individuals within the organisation.
3. An authorised user initiates an OCS usage through the IESP Broker.
4. When the usage is terminated, the TPPs mediate and send IPDRs to the IESP Broker, where they are aggregated and rated (against accounting information extracted from the IESC SLA) for a single customer charge and individually rated (against accounting information extracted from the TPPs SLSs) for settlement with each of the TPPs.

5. The IESP Broker presents a periodic, electronic Bill for services to the IESC via a web browser. The IESC can submit queries regarding the OCS usage to the IESP Broker. The IESC pays the IESP Broker.
6. The IESP Broker settles with the TPPs for the usages of their respective services by IESCs within the relevant Billing period.

The single customer charge is greater than the sum of the settlements passed to the respective TPPs and the difference represents the consideration retained by the IESP Broker.

Figure 2 illustrates the process flows between and internal to, the various entities depicted in Figure 1. The federated accounting management processes and activities that this paper targets are described in the context of the FAB (Fulfilment, Assurance, and Billing) of TOM (Telecom Operation Map) [7]. The figure is based on an original version of a Service Billing Process Flow Instance from the TOM. Various aspects of the FORM federated accounting system have been added for clarity. In Figure 2, 'Bills' refer to Customer Bills and 'Invoices' refer to Settlement Invoices.

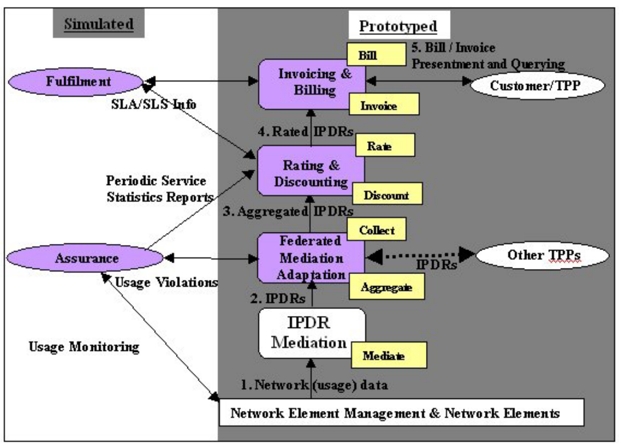

Figure 2: Federated Accounting Process Flows

The activities in Fulfilment process depicted above include subscription; SLA and SLS negotiation. The federated accounting system exploits this information to populate an OCS charging scheme for the IESC charge calculation and for the TPP settlement calculation. The different QoS and per unit rating parameters extracted from the SLA/SLS are merged with the actual usage data extracted from the IPDRs/Assurance Reports to calculate a charge/settlement and the related discounts (if any). The Assurance process activities include per usage and periodic monitoring of TPPs services. The federated accounting system uses the outputs of the Assurance process to perform QoS related discounting. It should be noted from the diagram that outputs from both the Fulfilment and Assurance processes were simulated in trials of the federated accounting system as the focus of the system is the Billing process.

The Billing process relies upon the federated accounting system to translate network data from the various TPPs that occur in a service provision chain, into customer and TPP settlement charges. The FORM federated accounting system utilised in the aforementioned trials, constitutes several components as depicted in Figure 3.

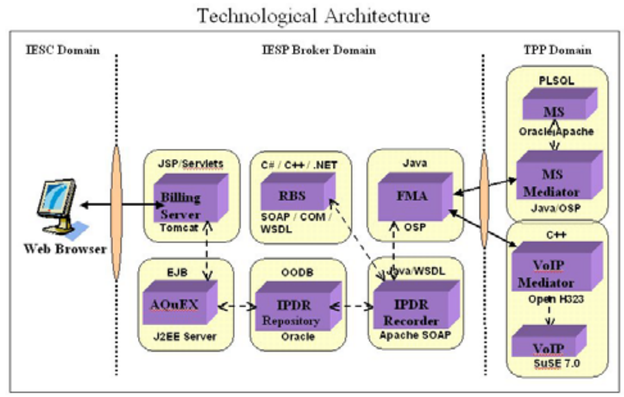

Figure 3: Federated Accounting Technological Architecture

The MediaShop (MS) service and MS mediator developed by FOKUS and the VoIP service and VoIP mediator developed by the TSSG, both reside in the TPP domain. Theoretically each of these providers would negotiate an SLS for their respective services with the IESP, however for trial purposes this activity was simulated through the generation of spreadsheet based settlement/discounting schemes. The MS and VoIP providers are responsible for delivering IPDRs across the interdomain reference point between the IESP and TPP domains.

The IESP Federated Mediation Adapter (FMA) developed by FOKUS extends a contract that is invoked at this reference point. The FMA is then responsible for identifying whether or not IPDRs are related to a stand-alone service delivery or if the IPDR represents usage data from a bundled service. Participation in a bundled service is indicated by comparing a *BundledSessionID* generated at service initiation with the IPDRDoc *doc_id*. The *BundledSessionID* is passed to the FMA and the Relevant TPPs at service set-up, the TPPs then use this *BundledSessionID* as the doc_id for the IPDRDoc that contains all IPDRs related to the service usage within the bundled service session. The FMA is also passed information relating to the number of IPDRDocs that a bundled service should generate i.e. the number of constituent TPP services. When the appropriate number of IPDRDocs for a bundled service has been received, the FMA aggregates the IPDRs from each of the IPDRDocs into a single IPDRDoc that is passed to the IPDRRecorder. The IPDRRecorder notifies the Rating Bureau Service (RBS) that these records require rating and stores the IPDRDoc in the IPDR Repository. The RBS then pulls/requests the IPDRDoc from the IPDRRecorder, which retrieves and passes it to the RBS. The RBS then rates each of the constituent IPDRs against their respective Charging/Settlement Schemes and SLAs/SLSs.

The IPDR schema does not include any element in which to insert charge/settlement details that have been calculated by the RBS. Hence, a Charge Element (CE) extension to the schema was generated. Several options for the inclusion of payment details within the customisable elements (Service Consumer (SC), Service Element (SE), Usage Element (UE)) of the schema were evaluated, but their inherent customisability disqualified them, as a payment information structure, by its nature, requires a rigid structure to support Bill/Invoice generation. A sample IPDR CE instance with the proposed structure is shown in Figure 4.

```xml
<CE>
    <CostBase type="Content" unit="file">Mad Max</CostBase>
    <Provider>
        <Settlement currency="€" unitrate="13.50">12.15</Settlement>
        <!--  The  Costbase * unitrate - the Discount Value -->
        <Discount>
            <Value>1.35</Value>
            <Parameter type="Periodic">MeanAvailibility</Parameter>
            <!-- SLA Parameter of 99.995% MeanAvailibility was violated -->
            <!--hence a 10% discount (1.35€) applies -->
        </Discount>
        <SLSID>TPP01566</SLSID>
    </Provider>
    <Custmer>
        <Charge currency="€" unitrate="15">9.90</Charge>
        <!-- The file Unitrate - the Discount Value -->
        <Discount>
            <Value>5.1</Value>
            <Parameter type="Periodic">MeanAvailibility</Parameter>
            <!-- From Settlement - 1.35€ -->
            <Parameter type="Incentive">Introductory</Parameter>
            <!-- A 3 month Introductory Discount of 25% (of 15) 3.75 -->
        </Discount>
        <SLAID>IESC030456</SLAID>
    </Custmer>
    <RateTime>2002-04-08T14:15:10Z</RateTime>
</CE>
```

Figure 4: Charge Element Instance

This instance (unrelated to the previous OCS scenario) represents the CE of an IPDR generated by rating data extracted from the Usage Element of the same IPDR. The CE has a common entry for the *CostBase* and individual entries for the Customer Charge and Content Provider Settlement. The CE contains detailed discount information for potential inclusion in a bill and to support various analysis queries etc. The SLS/SLA ID identifies the source of related discount/rating parameters.

Rating Bureau Service: The RBS is the core component of the federated accounting architecture. The purpose of the RBS is to convert the measurement of usage data represented in an IPDR instance, into realistic end-charges for the service consumer (IESC) and settlement charges for the providers (TPPs). This is achieved by massaging information extracted from IPDRs, SLAs, SLSs and QoS reports with pre-defined charging schemes for specific services. A major objective of the RBS is to provide the flexibility required to ensure new services can be deployed rapidly by supporting the rapid definition and integration of alternative rating schemes/strategies. This was achieved by building a solution directly related to the world of financial planning and accounting – spreadsheet based charging schemes. Spreadsheets facilitate the application of a familiar toolset and accounting procedures while supporting the ready composition of what-if scenarios and projections. The charging schemes used in the various trials of the federated accounting system were built in Microsoft Excel worksheets. This facilitated graphical displays of the rating process during demonstrations of the system. However, in a production performance environment Excel is not a viable option. Even though it exposes a sophisticated API, it is not intended to be operated in a "server" mode (essentially unattended). However, as Excel is a de-facto standard, there are a number of alternatives. RBS has trialled several of these components, and they have proved effective and efficient, clearly demonstrating the viability of this approach.

Current RBS charging schemes for the VoIP and MS services, incorporate three-phase discounting. The primary discounting phase occurs during the initial rating cycle, immediately after an IPDR has been created and delivered to the IPDR Recorder. The initial discounting phase compares various QoS parameters in the charging scheme (extracted from an SLS) with the actual parameters in an IPDR for a service usage. These parameters indicate if a TPPs service provision achieved the QoS level agreed in the SLS for that service. An example might be the maximum *MeanPacketLoss* parameter for a VoIP service. If the maximum value is exceeded, this results in a QoS violation and the related discount detailed in the SLS are applied to the settlement charge. This discount is then propagated to the customer charge as the customers SLA is based on the aforementioned SLS. Hence, if the customer charge for the VoIP usage should have been 1€, the IESP cut is 20% (20c) and the TPP settlement would then have been 80c. The effect of a 50% QoS violation discount results in the customer paying 60c, the IESP retains 20c and the offending TPP receives 40c (50% of the original amount). The important factor here is that the customer benefits and the IESP maintains its consideration amount.

Secondary and tertiary phase discounting occur during the periodic/billing rating cycle e.g. weekly, monthly, quarterly etc. Secondary discounting is concerned with discounting for periodic type QoS parameters including *MeanAvailability* of service etc. The actual parameters for the service are extracted from periodic service monitoring reports (simulated) delivered to the RBS from the Assurance process. The relevant parameters are compared with SLS values and discounted in a similar manner to the primary discounting phase. Tertiary discounting supports the application of volume based, incentive or tailored discounts. The relevant information is extracted from an SLA and applied through a charging scheme. An example might be a 10% discount on all service usage charges each month for the first 3 months subscription to a service. Each of the three discounting techniques use a percentage discounting strategy whereby a QoS violation or tertiary discount results in a percentage reduction on the original charge. It should also be highlighted that near real-time viewing of a service charge will only expose primary usage-based discounting and that periodic and incentive/volume based secondary and tertiary discounts are not exposed until the actual periodic bill is produced. Real-time or pre-paid rating would obviously not incorporate all three phases of discounting.

Context-based billing is another feature of the RBS facilitated through the use of the IPDR. This functionality supports each service usage being charged to a context (person, project, department etc.) as opposed to a physical device (phone line, IP address, device ID etc.). This feature is supported in an IESP environment as each service usage is authenticated and authorised centrally (by the IESP Fulfilment process), thus allowing a single user to have several contexts e.g. an accountant may have a separate context for each of his/her clients. Each time the accountant uses a service e.g. VoIP, MediaShop, IPFax etc. they do so under the relevant client's context. Each context may possibly be identified through a service device by entering a different Personal Identification Number (PIN) combination. The service provider then inserts this PIN in the *ContextID* Tag in the Usage Element of an IPDR. This *ContextID* may be ignored during rating but provides an essential grouping field for a billing system. The *ContextID* entry then allows the accountant to run a query on their online bill through the Billing Service (Figure 3) to group and total charges by Context, hence providing precise valuable input for their own bill to their client. If the accountants billing system were IPDR compatible they could possibly request the billing information in XML IPDR format and input it directly into their own billing system.

The RBS Application was developed using Microsoft COM components hosted in COM+. COM+ is an application server that provides management facilities to the hosted application.. COM+ controls the activation and destruction of a component, the pooling of an individual component for more efficient client connections, and also the clustering of applications in a distributed environment to encourage scalability. The further use of Web Services Description Language (WSDL) [9] to describe the RBS application allowed it to be deployed as a Web Service, which in turn provides an interface point for other accounting components to exchange information in a seamless manner. As rating is only one component within the overall accounting process it is important that it exists within a workflow environment. With the use of ebXML [10] and IBM's Web Services Flow Language (WSFL) [11] the RBS can be integrated into an existing service delivery chain. One of the main drivers for this kind of solution is the evolution of business processes. Managers look to integrated business solutions taking account of the life cycle management, physical distribution of activities and the speed of response to changing circumstances. Managers require applications that are easier to maintain, evolve and posses a greater degree of compatibility between their systems and those of their partners and customers.

Web Services: Web services are defined as loosely coupled applications that can be exposed as services and easily consumed by other applications using Internet standard technologies (WSDL, UDDI, XML, SOAP). Web services are URL addressable resources that exchange information and execute automatically without human intervention. Web services provide a simple, flexible, standards based model for binding applications in the provision of bundled services. Bundled services can be easily assembled from locally developed services or externally available services, irrespective of the platform, development language or object model used to implement any of the constituent services or applications. In this manner the IESP and supporting TPPs assembling and reassembling Web services can configure dynamic FAB processes. The new Web services architecture could enable an IESP to build a service grid, enabling TPPs to plug into required utilities such as directories for the discovery of new services, rating, billing, payment, monitoring and performance auditing and security services.

The Universal Description, Discovery and Integration (UDDI) [12] specification is a cornerstone of the Web services solution. A common analogy used for UDDI is a 'phone book for Web services.' It has business names, business mailing addresses, contact names, contact phone numbers, Web services offered by businesses, addresses of Web services, meta-data describing the "interfaces" of Web services, etc. An IESP is an obvious candidate for hosting a UDDI registry. There are a number of ways to publish your business and services to UDDI. All UDDI Operators (HP, IBM, SAP, Microsoft etc.) provide a web site to which you can point your browser and use to add your businesses, services, and service addresses. You can also use more specific applications that can run on your local computer and can access the UDDI registry over the Internet using Simple Open Access Protocol (SOAP) [13] XML messages. Programs can register themselves with minimal human intervention using SOAP/XML messages and one of the freely-available client-side Java, Visual Basic, C#, or COM API's for accessing UDDI registries.

4. CONCLUSION

Traditional service providers are aggressively pursuing new market opportunities as integrated broadband service providers, offering IP telephony, high speed Internet access, digital video, video-on-demand and other 3G services. To capitalise on the surge in market demand for 3G broadband services, and to compete in a marketplace of converging technologies, TPPs will need end-to-end, pre-integrated, next generation, flexible, Operation Support Systems (OSSs) to support their changing business and pricing models. The principal operational challenges exposed by this new paradigm are the ability to efficiently develop and activate complex new service offerings, the ability to manage the reliability and quality of these service offerings, and the ability to model new pricing plans that more effectively capture the true value of the content consumed/service delivered. These TPP challenges are heavily based on the automation of OSS activities including service subscription, service mediation, service accounting, single bill provision and the ability to dynamically add more and more services to their product mix.

At the operations level, as the network infrastructure gradually evolves from being dominated by 'circuit switched' to 'packet switched' network elements, providers need to realign their OSSs to handle a vast array of 3G IP based services. They also need to address the associated complexity of hybrid networks and the integration of their existing legacy OSS/Billing systems with next generation CRM and billing systems.

This paper has described the use of the IPDR.org's NDM-U for IP-Based Services specification as the underlying standard to support the ubiquitous transfer of usage details between the various entities in a 3G IP service provision chain. The IPDR provides a solid foundation upon which the FORM Billing team has built a federated accounting and billing solution for inter-enterprise 3G IP-based service billing and accounting. However, the use of the IPDR in the federated accounting and billing system has an associated drawback. The problem concerns that of the large overheads associated with XML IPDRDocs. XML encapsulates an abundance of tags for entries such as name of field, field content, ending the field; the name of fields and subsequent tag names can often consume more resources than the contents of the field itself. However, Version 3.0 of the NDM-U specification addresses the compact encoding of the IPDRDoc. This encoding, based on the External Data Representation (XDR) Standard [14], is defined to address the operational efficiency of the NDM-U protocol in the dimensions of storage, transmission time, and processing overhead [15].

The widespread adoption of XML schemas provides a powerful agreed format for describing the structure of XML documents. Thus when a new service is to be introduced into the rating & billing process, the first step is to compose a Schema for IPDR instance documents generated by usage of the service. This schema can then be deployed within the components to enable them to comprehensively validate these instances when generated. The schemas can also be deployed effectively to "shape" the charging algorithms, serving as a type of template for their structure.

REFERENCES

[1] Simon Chapman, "Going-out-of-business model", PBI Media Billing Magazine, Issue 14: July 2001.
[2] FORM project (www.ist-form.org).
[3] The Insight Research Corporation, "IP Billing: Moving Beyond Telecom's Time/Distance Billing Model", July 1999.
[4] Bandwidth 2000, An Information Infrastructure for Bandwidth Trading, Ten Telecom http://www.ten-telecom.org/
[5] ETSI TS 101 321 V2.1.1, Telecommunications and Internet Protocol Harmonization Over Networks (TIPHON); Open Settlement Protocol (OSP) for Inter-Domain pricing, authorization, and usage exchange, August 2000.
[6] Network Data Management – Usage (NDM-U) For IP-based Service, Version 2.6, June 2001, IPDR Organisation (www.ipdr.org).
[7] Telecom Operations Map - GB910, TeleManagement FORUM, March 2000, Version 2.1.
[8] Telecommunications Information Networking Architecture (TINA), consortium (www.tinac.com), 2000.
[9] Web Services Description Language (WSDL), Version 1.1, March 2001,W3C (www.w3.org).
[10] ebXML (www.ebxml.org).
[11] Web Services Flow Language (WSFL), Version 1.0, May 2001, IBM Software Group.
[12] Universal Description, Discovery and Integration (UDDI), (www.uddi.org).
[13] Simple Open Access Protocol (SOAP), Version 1.1, May 2000, W3C (www.w3.org).
[14] External Data Representation (XDR), August 1995, IETF RFC1832 (www.ietf.org).
[15] Network Data Management – Usage (NDM-U) For IP-based Service, Version 3.0, November 2001, IPDR Organisation (www.ipdr.org).