IP BUSINESS INFRASTRUCTURE

WHITEPAPER

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SECTION I

IP SERVICES MARKET CHALLENGE OVERVIEW

1.1 The Changing Environment

The twin forces of privatization and globalization are sweeping across the face of telecommunications around the globe, changing the industry radically. Yet perhaps the most disruptive force at work in carrier markets has been the explosive growth of the Internet. From companies building fiber backbones underseas to those that are rolling out multi-megabit wireless access technology in metropolitan areas—regardless of where they are and what their business model will be—every carrier in the 21st century telecommunications marketplace is investing heavily to build an infrastructure to meet the growing demands of Internet traffic.

In order to make the transition to the new packet-based communications world of the Internet, carriers around the globe are investing in a new generation of back-office business and operations support systems (BSS/OSSes) that can measure, rate, and charge for new packet-based services. One of the key elements in these new back-offices will be the next-generation business infrastructure that can scale with the explosive growth in traffic, as well as assimilate new emerging technologies and standards. XACCT Technologies has already staked out some impressive wins in this arena, and INSIGHT thinks it is a company to watch.

1.2 Need for Next Generation Back Office Solutions

Efficient management and operation of new Internet protocol (IP)-based networks requires new standards-based integrated BSS/OSSes in the service provider's back office. The BSS/OSSes must manage multi-vendor, multi-layered, multi-technology networks from the local network element level to the global service level. They must be very robust, but also very flexible, enabling the rapid deployment and change of new services by the service providers and by the customers themselves.

BSS/OSSes have been around for years in the circuit-switched world to help service providers manage, measure and bill for calls. However, these "legacy" OSSes have not been able to easily adopt to packet-based IP services. Service providers found that the problem with legacy systems was that they typically were not designed to be very modular in function or in architecture. Changes in one part of the system typically had major impacts across the entire system. The legacy systems were not flexible enough within themselves to adjust to new business processes, new work center tasks, or new services. Unfortunately, the BSS/OSSes were built around stand-alone work centers. When the work centers were restructured, the BSS/OSSes could not adapt easily. Since the work centers were stand-alone enterprises (as were the OSS systems that served them), service provider data such as customer records needed to be typed into each system. Keeping duplicate copies synchronized was extremely difficult and costly.

Frustrated with the architectural limitations of their legacy BSS/OSSes, service providers came to realize that while their investments in legacy systems over the years made them extremely feature-rich and optimized to support their specific needs, they could not readily be modified without enormous cost and time. Service providers have realized that a more practical and cost-effective approach to solving their information system needs is to use their legacy systems as "building blocks" together with newer software components. In this way, service providers can build an integrated software business infrastructure to meet their new and evolving business needs.

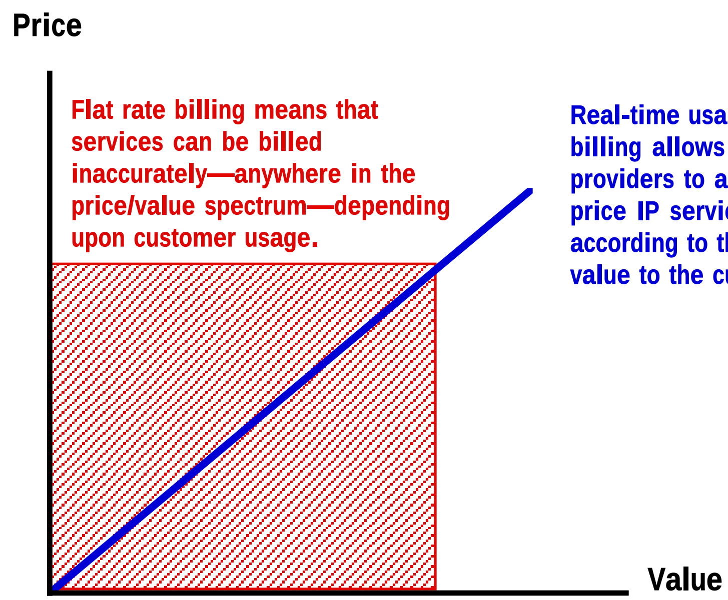
1.3 Value-Based Pricing

At least equally important to making certain that the support infrastructure is available for these new IP-based applications is making sure that it also enables service providers to price their services based on:

- The **cost** to the service provider; and
- The **value** to the customer.

The traditional model for billing used by Internet service providers (ISPs) today is based on a flat monthly rate for unlimited access for consumers and a flat monthly fee for a certain amount of bandwidth for business customers. While the flat rate model offers convenience and simplicity to the service provider and customer alike, the model is inflexible and often unfair in distributing the costs-of-service among customers. As IP-based services increase in number and complexity, sticking with a flat rate billing model may mean big trouble for service providers. Figure I-1 summarizes the problem with flat rate billing.

Figure I-1 Flat Rate vs. Usage-Based Billing



It may take some time before customers are accustomed to paying for certain IP services on a usage-based basis. In the meantime, for those already committed as IP providers, voice over IP (VoIP) and Internet fax can be sold as usage-based services today. This is because the end customers are used to paying for these services on a usage-basis in a circuit-switched world. Some business models may continue to support a low quality IP voice on a best-effort basis, where the service provider doesn't offer a quality of service (QoS) agreement, since the service is "free" or part of the ISP's flat rate plan.

SECTION II
BUSINESS AND OPERATIONS SUPPORT SYSTEMS FOR IP NETWORKS: OVERVIEW

2.1 Business Support Systems

The classical business functions of allocating resources (people, time, money, and capital) to customer needs (markets) via products and services must be integrated with the notion of a data architecture that supports the business enterprise functions. The information systems technology must provide a cost-effective means for a set of interfaces or an architecture to interconnect the diverse subsystems to support the business. The business support systems deployed today will have an impact on all areas of business in the future. Company personnel need to understand the BSSes from the vantage of product and service offerings, marketing, sales & support, and financial issues.

The new IP networks being developed and built today will be used for diverse customer needs, not just for a single homogeneous need, such as switched voice services. It is critical that the business support systems used to support IP services be able to track and manage these methods in real time. The systems must provide the following capabilities:

- Authorize users;
- Create new services and pricing plans;
- Bill for diverse services; and
- Provide accurate network and service usage information.

The crucial distinction is perhaps not between flat rate and usage-based billing, but between real-time and non-real-time usage measurement. Real-time network usage measurement and reporting allows the following benefits:

- A **single interface** from a measurement platform to multiple BSS applications;

- More accurate and more **timely billing cycles** and collections;

- Allowing **network usage profile development** in BSS applications, as a basis for analyzing information about end-user characteristics;

- Using the profiles to conduct **customer relationship management**, allowing a service provider to better serve individual customers;

- Analyzing network usage data to find more competitive tariff structures, which allows **customer churn reduction**;

- Enables measurement of **quality of service (QoS)** for billing, including service level agreement (SLA) management;

- **Network monitoring** to ensure the quality of the network;

- **Provisioning** pre-paid services;

- **Risk avoidance**, such as through real-time detection of fraud and monitoring credit levels; and

- Building a **business model** to profitably rate and bill IP services.

With real-time network usage measurement and reporting, if the carrier wants to bill for IP services at a flat rate, they can do so—while still gaining all the other benefits of the network usage statistics.

2.2 Methods of Billing IP-Based Services

Currently, IP-based services are billed mainly according to the following traditional methods:

- Flat rate services, usually billed monthly;
- Timed sessions;
- Pay-per-transaction, usually billed via credit cards; and
- Pre-payment for a certain quantity of services.

There is no single correct way to bill for IP services in general, but there are several good choices depending on the type of service (shown in Table II-1). For most IP billing methods, the key goal is to match the billing increment with the content or service value to the customer. Since the actual bandwidth is becoming more plentiful, the transport costs are only one small consideration of the proper value. Only a marginal cost can be assessed for transmission.

Table II-1 Types of Billing for IP-Based Services

	Flat/ Monthly	By the Packet	Disk Space	CPU Usage	Session Time	Service Level	Content Value	Trans- action	Skill Level
Web Surfing	X								
Sending E-Mail	X								
Receiving E-Mail	X								
Internet Telephony					X	X			
Internet Chat	X								
Network News	X								
Personal Web Pages			X	X					
Content Hotel			X				X	X	
Directory Service	X			X			X	X	
Online Gaming					X		X	X	X
Personal Finance Services	X				X	X	X	X	
Information Services	X		X	X	X	X	X	X	
Internet Fax		X			X	X		X	
Audio Conferencing					X	X	X		
Video Conferencing					X	X	X		
Online Training				X	X	X	X	X	
Website Hosting	X		X	X		X		X	
Virtual Private Networks	X				X	X			
Multimedia Telephony	X		X	X	X	X	X	X	
Unified Messaging	X		X	X	X	X	X	X	

Certain services lend themselves to specific types of usage measurement for billing purposes. Basic e-mail accounts and Internet access are generally billed at a **flat rate per month** for unlimited usage. Web site hosting could be billed by **disk space** or **central processing unit (CPU) usage**. The CPU usage billing method measures the number of hits or transactions received at a Web site and how much of the CPU is utilized in this process.

Internet telephony follows traditional circuit-switched telephony for its model for rating and pricing, usually being billed by **session length.** Unified messaging can be billed in many different ways. Customers who only want to retrieve messages should contract for a larger mailbox with more disk space for voice, e-mail or fax messages. This service would be priced by the **amount of disk space** leased versus **transactions processed**, or number of messages retrieved.

Customers using a virtual private network (VPN) service will pay for a higher **service level** which provides them with dedicated bandwidth, as well as security features. This service is more expensive than the flat monthly fee charged for basic Internet connections.

Online gaming can use some unusual methods of billing. For example, an online European fighter pilot game requires the customer to purchase additional bullets to stay in the game. More skillful players require fewer bullets to stay in or win the game. Thus, the customer is billed according to bullet usage—which is based on **skill level**.

2.3 The Mediation Platform

What should be immediately apparent from Table II-1 is that in order to have the flexibility to provision IP services and price them based on the most appropriate criteria, an accurate means of gathering the necessary network usage data is essential. **Mediation** is the process of taking network element outputs and converting them into billable events. As defined by IPDR.org, "a mediation system provides a single interface to BSS systems that provides all network usage data as well as a single service elements provisioning. In terms of usage collection, the goal of the mediation system is to capture all usage information required by the BSS systems, and export it within the temporal requirements. Thus, the mediation system must, in some way, determine the devices at the service element layer and interface with that infrastructure to extract the relevant usage information. The second mediation goal is to pass provisioning information from the BSS, to the network elements."

Historically, billing mediation evolved to deal with the environment of the earlier telecommunications standards, IT and data communications requirements as they existed in the 1960s, 1970s and 1980s. Billing mediation provided the following advantages for service providers:

- Relieved mainframe-based bill rendering systems from needing to interface to multiple vendor network elements;
- Could store network event data locally, such as in the central office, rather than transporting it all to a data center;
- Could store large amounts of data from network elements, allowing them to fulfill their primary purposes better by freeing up resources; and
- Data cleansing, sorting, and filtering.

The primary drivers for IP-based mediation are much the same. The processing system needs to be able to combine usage statistics to create single billable Internet usage records, similar to the Call Detail Records (CDRs) used in the circuit-switched world. However, the flexible, highly distributed nature of IP business infrastructure is much different than the older, centralized telephony approach, as further examined in Sections III and IV.

SECTION III

KEYS TO AN IP BUSINESS INFRASTRUCTURE

3.1 Platform Keys to Success

What should service providers be looking for in a next generation IP business infrastructure platform? Several major considerations are:

- Functionality;
- Real-time Performance;
- Standards Compliance;
- Interoperability;
- Customizability; and
- Scaleability.

The IP business infrastructure needs to allow distributed management, processing and plug-ins to a large number of BSS/OSS applications.

3.1.1 Functionality

For the IP business infrastructure—in order to support service providers' business systems and the network management systems—a good platform needs to be able to gather data on multiple levels of the OSI Seven Layer model. The platform needs to be able to gather information from multiple sources, since the information required for compiling a single event may require information from multiple network elements. Finally, the platform for supplying these applications with data needs to be robust.

3.1.2 Real-time Performance

While not required to produce a monthly bill, real-time data is needed to feed many applications independent of the bill rendering system. This is perhaps the biggest driver of the mediation market. It increases the need for a mediation and distribution function to feed the real-time sensitive applications in a timely manner. Many of these needs revolve around the need for Authentication, Authorization and Accounting (AAA), just to process individual requests for service. Clearly, new IP services require more real-time processing of data for AAA, fraud, pre-paid billing, credit-limited billing, etc.

3.1.3 Standards Compliance

Currently, one of the most crucial specifications in the mediation world is the Internet Protocol Detail Record (IPDR) format. IPDR is an extensible markup language (XML)-based record format for exchanging IP resource and service usage information:

- From IP network and service elements to any support system that uses this data (OSS, BSS, etc.); and
- Between such support systems.

The various companies involved in the IPDR.org Initiative, a working group intending to eventually present IPDR to selected standards bodies to be approved, have already defined scenarios for how mediation systems can compile an IPDR format for application services, VoIP, and e-mail services.

Though it is important for service providers to use billing mediation vendors who are thoroughly conversant with the IPDR format, the value of vendors' mediation products is more directly related to how many network elements can be gathered from and how efficiently the platforms allow network data to be sorted and used by multiple applications.

3.1.4 Interoperability

With the trend towards enterprise-wide BSS/OSSes that must supply all the functionality required to support a service while adapting to ever-changing business models, single vendors no longer have the expertise to deliver a complete solution. Systems integrators assemble a solution by blending hardware, software, and functional expertise from several sources. Once deployed, it is essential that the mediation platform be able to gather data from a wide variety of network elements and provide workflow management in between a wide variety of BSS applications.

3.1.5 Customizability

The preference of service providers is to always have as much raw data available as they can afford. The act of aggregation and data reduction throws away potentially useful information, especially since customer usage data is useful for non-billing activities (including overall customer relationship management). In reality, the cost of not reducing data often overwhelms the service providers' ability to pay, so that mediation systems should be programmable by the service provider with regard to how data is reduced. Then the service provider can change the rules as the needs of their operations evolve.

3.1.6 Scaleability

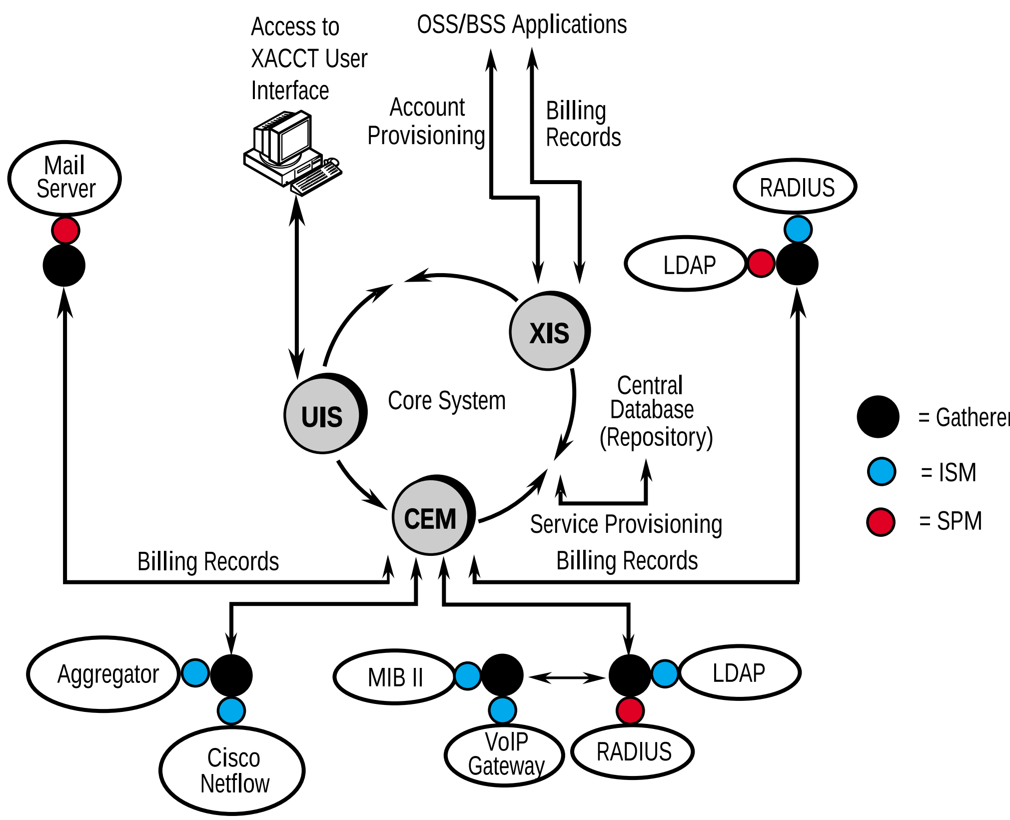
IP business infrastructures must be able to handle much more data in much more diverse ways than the legacy circuit-switched network. New systems must be able to start small and be inexpensive to deploy, then grow as new services are defined and old services are migrated to new network infrastructures. This means that system scaleability— allowing partitioning, distribution, and replication within the infrastructure—is a requirement. Systems scale by enabling deployment of additional processing modules, allowing the efficient handling of an increasing number of users and managed network objects.

3.2 XACCT's Fit Into the IP Business Infrastructure

XACCT is focused on the problem of how to transform the raw data of an IP network into actionable business objects (or software constructs) based upon a user-configurable set of policies or rules. XACCTusage captures the IP session and transaction information produced by the individual network elements, and with its real-time enhancement process, transforms this raw data into meaningful business information.

XACCTusage utilizes a variety of device-specific, as well as general purpose, software agents called information source modules (ISMs). These software modules capture, filter, aggregate, correlate, and merge data collected from a wide range of network elements. The ISMs and the other components comprise a distributed software architecture that allows XACCTusage to capture information from all areas of the network—from the physical layer to the application layer. Figure III-1 shows the general network architecture of XACCTusage.

Figure III-1 XACCTusage Architecture



Note: Central Event Manager (CEM); User Interface Server (UIS); XACCT Interface Server (XIS); Service Provisioning Module (SPM)

Information sources used for IP service usage measurement, such as the ones examined by XACCTusage, include:

- The network session data from the log file of a mail, Web, or proxy server;

- The logging facility of a firewall;
- The IDs of participants in a network from domain name servers;
- Lightweight Directory Access Protocol (LDAP) information from databases and directory services;
- A traffic statistics table on a router; and
- An authentication server's query interface, providing information on user log-ins.

Both the company (XACCT) and its product (XACCTusage) address the key criteria for success for a next-generation IP business infrastructure, as shown in Table III-1.

Table III-1 XACCT's Strengths in Providing Mediation for the IP Business Infrastructure

Criteria for Success	XACCT's Strengths
Functionality	• XACCTusage allows service providers to feed multiple BSS/OSSes with data collected and aggregated from the network. • XACCTusage allows customers the ability to "self-provision" services, such as e-mail, Web, FTP, etc.
Real-time Performance	• Distributed architecture of XACCT eliminates bottlenecks in its data flow model. The system can be easily scaled by adding more processing modules. • XACCTusage can be configured to only send the data that business rules say the downstream application really wants; the other data will not be sent across the communications backplane.
Standards-Compliant	• XACCT is very active in prominent industry forums: the Internet Engineering Task Force (IETF), Global Billing Association, ASP Consortium, and the IPDR Initiative. • XACCTusage can meet IPDR and other industry standards such as Automatic Message Accounting (AMA) and AMA Data Networking System (AMADNS).
Interoperability	• XACCT partners with 30–40 Systems Integration (SI) firms. They train the SI on the XACCTusage system, then allow the SI to build and maintain the system. • Many partnerships with Convergent Bill Rendering Providers such as Saville, Solect, Kenan, Portal Software, Infocomm (rating), Geneva, Daleen, and Cable Data. • About 70–100 vendor elements are already hard wired for optimum performance. • A general agent uses standards (e.g., SNMP) to collect information from thousands of network and service elements.
Customizability	• XACCT can build customized agents in 4 to 6 weeks. • Users can control the amount of data stored and the type of data received.
Scaleability	• Gatherers use ISMs to collect from multiple data sources. Multiple data collection ability of gatherers allows scaleability. • Local caches supplement robust centralized database.

XACCT counts about some 50 customers worldwide; about half have usage-based services in various stages of deployment. Perhaps the most impressive win that XACCT has chalked up is Broadwing, the combination of IXC Communications and Cincinnati Bell. XACCT announced that XACCTusage would be integrated into Broadwing's IP network to support the eClass IP VPN services suite. XACCTusage will allow Broadwing to provide customers with usage-based billing, while giving Broadwing the ability to deliver smart customer relationship management for IP services. Broadwing had the following requirements for its mediation platform:

- Be able to bill on a metered basis for IP services such as IP VPNs and voice over IP;
- Be able to accommodate existing data feeds (e.g., from Cisco Netflow);
- Ability to conduct network-wide traffic flow analysis;
- Ability to work across TCP/IP, asynchronous transfer mode (ATM), and frame relay networks;
- Interface with Kenan's Arbor billing system; and
- Support data services.

XACCT's solution met these requirements, and the solution stood out from the pack with its ability to support existing data feeds like Netflow or SNMP. XACCT's win was all the more impressive considering the competition from the heavyweights—Lucent, Nortel, HP and Cisco—as well as other top-notch billing mediation vendors—AceComm, Narus, and EHPT. This major victory will give the company additional credibility in the eyes of the many service providers interested in providing IP services.

SECTION IV

APPROACHES TO IP BUSINESS INFRASTRUCTURE PLATFORMS AND ARCHITECTURES

4.1 Overview

IP services can be provided over different network architectures (e.g., wireline or wireless) for different media (e.g., voice, data, video, or multimedia). The mediation function performs differently based upon the architecture, media, and service. In this section, approaches are considered for the following three markets:

- Voice over packet;
- Wireless data; and
- Cable applications (e.g., integrated cable modem, video, and voice services).

4.2 Voice over Packet

Wireline long distance service providers are interested in providing voice over packet services. At present, voice over packet can be accomplished by a wide variety of architectures and protocols. These include:

- Voice over frame relay;
- Voice over ATM; and
- Voice over IP.

The battle between ATM versus IP-based voice is raging now. IP proponents note that its ubiquity and simplicity make it the obvious choice. Still, many VoIP customers want all the quality and guaranteed delivery associated with the circuit network. To service the customers willing to pay for a quality VoIP service, some type of monitor for quality and other parameters will be needed. Proponents of ATM believe that ATM's QoS capabilities cannot be matched by throwing bandwidth and

QoS patches on IP standards. In the end, the availability of a billing record standard such as IPDR might be the differentiator between the two.

Figure IV-1 shows a sample voice over DSL local access architecture and its feeds into operations support systems, as implemented by Jetstream Communications, a voice over DSL gateway and integrated access device (IAD) supplier. Information is gathered from (and provisioning instructions are sent to) the DSL access multiplexer (DSLAM), various network elements in the packet network, and the gateway to the public switched telecommunications network (PSTN).

Figure IV-1 Voice over DSL Connections to OSSes (ATM, Frame Relay Architecture)

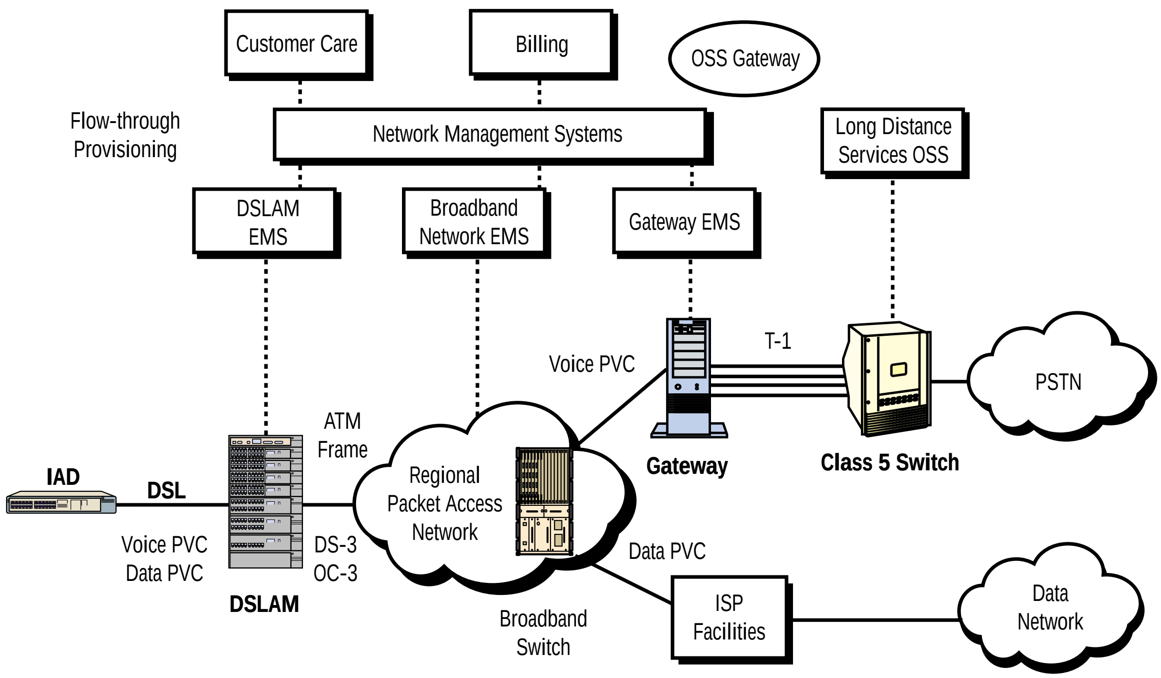
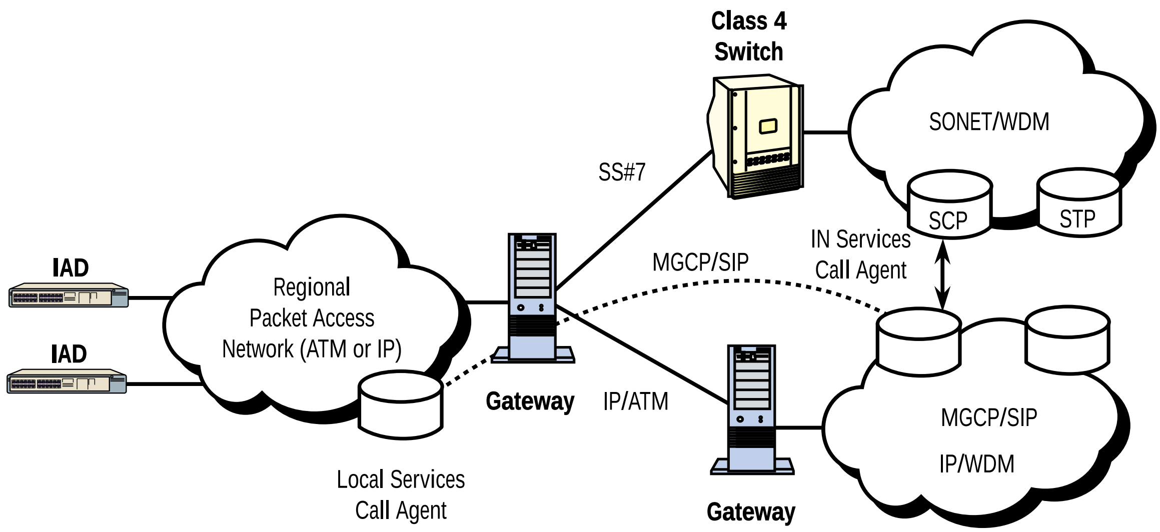


Figure IV-2 shows Tollbridge's IP local architecture for voice over DSL using the media gateway control protocol (MGCP) and Session Initiation Protocol (SIP) for call control.

Figure IV-2 Voice over DSL Architecture (IP using MGCP/SIP)



Despite the relatively complicated nature of the different types of architectures, the actual base data that needs to be gathered by the mediation system in a VoIP scenario is fairly straightforward. Some of the key attributes that need to be captured in a VoIP scenario include:

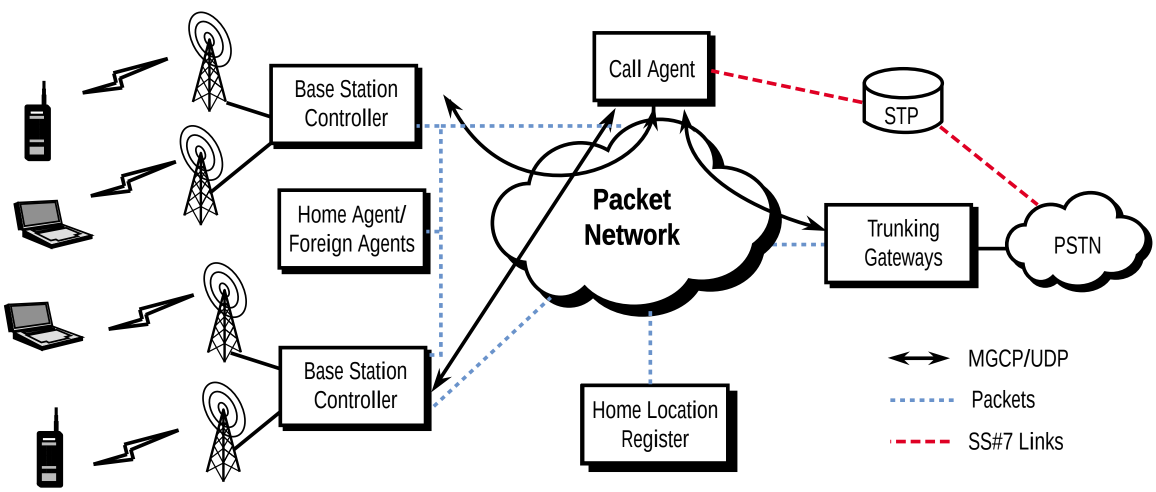
- The identity of the participants (source and destination IP addresses);
- The time of the call's initiation and completion;
- Call progress indicators (that may measure quality of service levels, etc.); and
- Reasons for disconnection.

Optionally, many other elements of the call can be gathered, such as the type of media being transmitted, the type of codec being used, and the identification of a supplementary service (call waiting, call forwarding, etc.) A good solution from a billing mediation vendor would allow the efficient gathering of all call detail information within the service provider's chosen voice over packet architecture. XACCT is building specialized ISMs to gather information from voice over IP network elements such as gateways and gatekeepers.

4.3 Wireless Data

Wireless service providers, especially as third generation (3G) wireless rolls out, will want to take advantage of packet switching capabilities to reduce their access cost and provide enhanced services. There are a number of methods emerging to add packetization to existing and new wireless networks. Figure IV-3 shows a proposed Telcordia 3G end-to-end packet architecture with links to the PSTN.

Figure IV-3 Third Generation End-to-End Packet Architecture



Large 3G data transport capacities can be used for data services, and potentially for backhaul as well. Data services, followed by VoP, will drive the need for additional billing mediation in the wireless market. Currently, short messaging service (SMS)-type services are billed by the message. Internet access enabled by Wireless Access Protocol (WAP) will eventually be based on usage, potentially counting the number of data packets sent. As most Internet services tend to be asymmetric in their traffic patterns, rating may require separation of data sent from data received with higher rate structures for downstream traffic. Rating could also vary by traffic load, time-of-day, etc.

The call and event data generated by the network elements of the next generation wireless network, is required for a number of telecom management activities including:

- The billing of home subscribers, either directly or via service providers, for network utilization charges;
- The settlement of accounts for traffic carried or services performed by fixed network and other operators;
- The settlement of accounts with other wireless carriers for roaming traffic via the transferred account procedure;
- Statistical analysis of service usage;
- Real-time fraud management; and
- As historical evidence in dealing with customer service and billing complaints.

Specialized data collected in wireless mediation includes International Mobile Subscriber Identity and Electronic Serial Number (cellular phone ID) information, the ingress point of the user, and the home location ID. Call data record generation and contents should be flexible and unnecessary redundancy in data should be avoided.

The 3G Partnership Project (3GPP) is already looking at how IP networking can be used within 3G and General Packet Radio Service (GPRS) data streams to carry voice and video in addition to data services. The actual business support systems are outside the scope of 3GPP, but the interfaces to these systems is taken into account. 3GPP represents many of the major wireless telecommunications organizations, including the European Telecommunications Standards Institute (ETSI), the Universal Wireless Communications Consortium (UWCC), the Global System for Mobile (GSM) Association, and the Universal Mobile Telecommunications System (UMTS) Forum.

For GPRS networks, 3GPP has defined a Charging Gateway Functionality (CGF), which provides a mechanism to generate and transfer CDRs from the Serving GPRS Support Node (SGSN) and Gateway GPRS Support Node (GGSN) nodes to the network operator’s chosen billing systems. The CGF may also perform the consolidation of CDRs, pre-processing of CDR fields, filtering of unrequired CDR fields, and adding of operator-defined fields for specific billing systems.

XACCT’s platform replaces the need for the CGF in mobile data networks, and solves the “billing-for-content” dilemma. XACCTusage can read the data from the GPRS Tunneling Protocol (GTP)'s Ga interface, along with 80 other protocols and formats. XACCTusage takes real-time feeds of CDRs from the SGSN and GGSN to decrease the amount of intermediate storage of raw IP content accounting records (from the Web server, probe, Netflow, etc.), before these get enhanced with location and user-ID information known only by the SGSN and GGSN. The resultant accounting records contain "content" information (i.e., application, time1, time2, volume, QoS, user-ID, and user-location). The user-ID and user-location parameters are taken from the SGSN and GGSN, whereas the application, time, volume and QoS parameters are taken from IP equipment and the related software. Since these records can only be created in near-real-time—before they reach the database, which is a 5,000 records/sec bottleneck)—service providers can implement billing prepayment and billing-for-content architectures.

4.4 Cable

In the past year, cable operators have shifted their marketing efforts to selling new services to their existing customer base, rather than selling the same service (i.e., cable TV) to new consumers. Cable operators are now selling multimedia services, digital video, video-on-demand, telephony, and high-speed data services. To feed the desire for increased speed, the cable TV companies have begun offering cable modem service in many locations.

XACCT's integration of its system into a Chinese cable service provider's network provides an excellent example of a good way to deliver and bill for convergent cable IP services. (The operator is henceforth referenced under the pseudonym XU.) The goal of implementation was to make each transaction usage-sensitive, where the subscriber's account is debited based on the volume of content used. Customers are charged a flat monthly fee, which is based primarily on the equipment leased to the customer and the number of e-mail accounts provisioned. Additional fees include a charge for Web content, metered and rated by volume, a usage-sensitive fee for outgoing e-mails, typically based on a rating of file attachments and charged by categorized volume (e.g., large or small), and fees for e-mail sent outside the local domain.

Table IV-1 summarizes the major requirements of XACCT's implementation at XU. Granted, many domestic operators might be unwilling to bill in some of the ways that XU does, but they would at least have that option with a good mediation platform.

Table IV-1 Major Requirements of XACCT's Cable Mediation Implementation at XU

Requirement	Features
XU Control	• Service provider control over all business management functions, providing a direct accounting mechanism for all subscriber activity, while maintain distribution and scaleability.
High Automation	• Automated subscriber access to the network, facilitated by nearly real-time access to user account balance information. The service can be automatically be shut off when the subscriber's balances drop below zero. • Automatic commands to change the user service level for the cable modem service.
Accuracy	• Associating subscribers' media access control addresses for their separate cable modem, set-top box, and PC equipment. • Categorizing usage information from e-mail servers based on destination DNS addresses and the e-mails' sizes.
Functionality	• Allowing efficient usage of scarce upstream bandwidth by only periodically sending information summaries to the provider's data center. • Continues to operate during system and service link outages.

To ensure the accuracy of subscriber data, the registration process is carefully defined. When a new subscriber signs up and pre-pays for the service, they are issued a DOCSIS cable modem, set-top box, and optionally a scanner. Using the barcode on the cable modem, the MAC address is scanned and the unit registered to the customer. The subscriber then chooses one or more e-mail address(es). This information is sent to the server hosted at XU's operations center, where the subscriber account information is created. Cisco Network Registrar customer profiles are stored in LDAP directories.

XIS stores this data and creates a registry entry based on the cable modem MAC address. A code indicating the end-user's company is also added at this time. Later, when the subscriber uses the service, data terminal equipment (DTE) devices attached by the subscriber to the cable modem will be added to the registry as XACCTusage scans the dynamic host configuration protocol (DHCP) server at each organization's point-ofpresence. XIS also allows subscriber provisioning based on the code information found in the registry. If a subscriber decides to cancel the service, they simply return the cable modem. The registry entry of the account is marked for deletion and the account deactivated, though the account is not physically removed from the database to preserve the integrity of the data.

As usage sensitive events are metered and transformed into normalized XACCT Detail Records (XDRs), they are summarized and periodically uploaded to XU's central system, where they are passed directly to the BSS for real-time rating and account management. Sample methods for rating network usage include:

- **E-mail usage based on the domain names of the recipient —** If the sender is foo@beijing.cool.net, and the recipient is bar@beijing.cool.net, there is no charge for the intra-domain event. If the recipient is bar@shanghai.cool.net, then the transaction is categorized and assigned the appropriate rating code for inter-domain e-mail. If the recipient is bar@whatever.com, then the message must be forwarded to the operation center's e-mail server, appropriately categorized, and rated as extra-domain e-mail.

- **Web content based on URLs** — Web content is loaded into proxy cache servers from the operations center to each POP. The download process includes a registry, or list of URLs. When usage information is received from the proxy server's log, the URL root is extracted and compared with the current list of free URLs. If there is a match, then there is no charge to the subscriber (e.g., no usage event is created). If there is no match, then the access is chargeable based on the volume of bytes downloaded. To determine the subscriber, the IP address contained in the proxy log is matched with IP addresses leased by the DHCP server. The log also contains the subscriber's DTE MAC address. It is this information that is inserted by XACCTusage into the XDR record.

SECTION V
BUSINESS INFRASTRUCTURE MARKET FORECAST

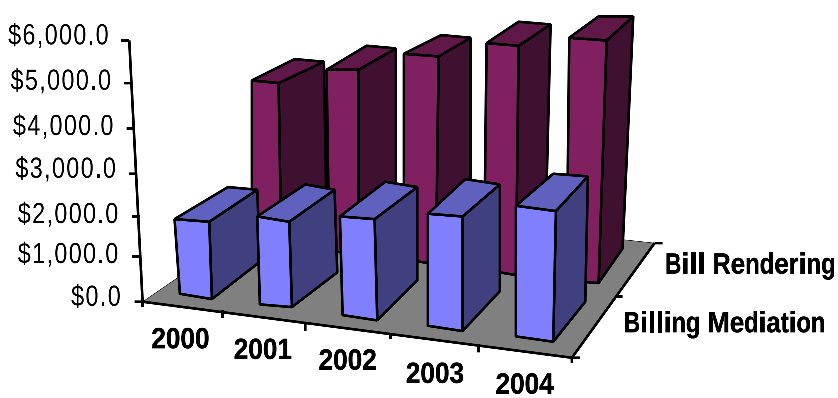
5.1 The Billing Mediation Market

Definitions of the systems considered in Figure V-1 are:

- Billing Rendering — Includes systems supporting the rating, taxing, discounting and aggregation of billing/usage data, and the formatting, rendering and presentment of a bill to a customer.

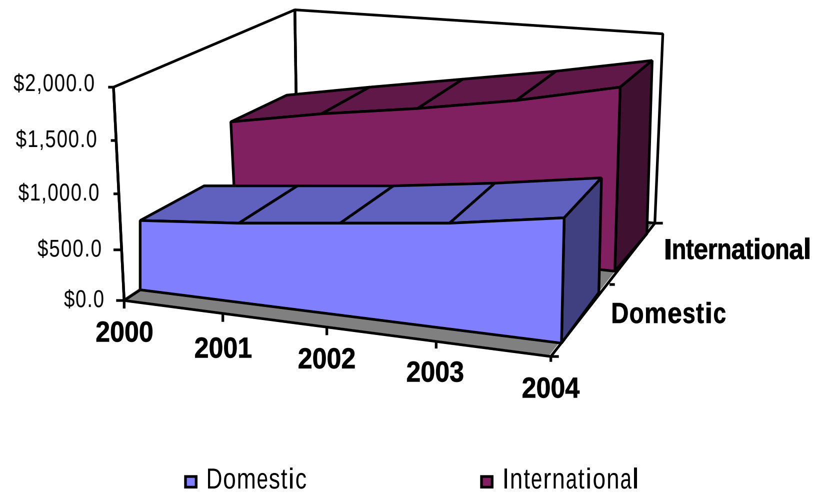
- Bill Mediation — Includes all systems associated with billing usage data collection from network element and sorting, filtering and otherwise preparing the data for bill rendering. This would include generating a CDR or IPDR in the appropriate format. All systems that perform mediation functions, whether they are co-located with the network elements or reside in the data center.

Figure V-1 Worldwide Billing Rendering & Mediation Markets, 2000-2004 ($Millions)



The growth rates for the domestic vs. international mediation market are shown in Figure V-2.

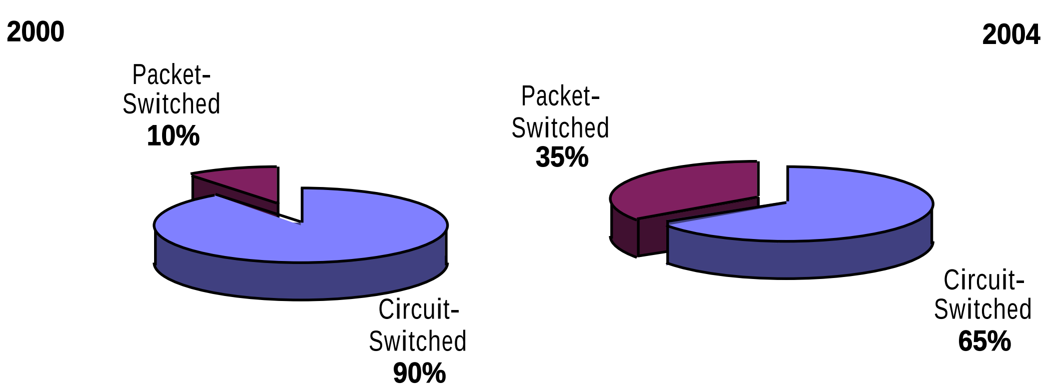
Figure V-2 Mediation Market, Domestic vs. International, 2000-2004 ($Millions)



5.2 The Mediation Market for IP Services

It is IP-based mediation that is the major reason that the total mediation market is growing at such healthy rates, as shown in Figure V-3. The compelling economics of an IP-based system is what will eventually move all carriers to adopt an IP-based model. The problem for incumbent operators will be to offer the new services, whether circuit- or packet-based, while constrained by their tremendous investment in legacy billing systems. Many will choose a strategy of migration. New services will be migrated to a new billing platform, and custom software will be employed to produce a unified bill from the legacy and new billing system.

Figure V-3 Worldwide Billing Mediation Market, Circuit vs. Packet, 2000 and 2004



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