Multi-Tenant Internet Services

New Solutions Tap a Ready Market

In the competitive arena created by the Telecommunications Act of 1996, both new and incumbent network service providers are aggressively positioning to deliver high-speed, high value data services to multi-tenant properties. There are many names associated with these services: "lit buildings," "cyber buildings," "smart buildings," and "multi-tenant services," to name a few. Regardless of the label, service providers are centered on leveraging new technologies and an attractive business model to add strategically important, revenue generating data services to their portfolios.

The value proposition extends to a very broad audience. With the growing popularity of Web-based marketing, e-commerce, and partner extranets, even the smallest business requires an Internet presence to be a competitive market player. For building tenants - particularly small-business customers - access to high-speed, business-quality data service on the day they move into a building is a compelling advantage.

Property owners realize the benefits of increased occupancy and higher rental rates as they deliver premium communications services for their buildings. Service providers see benefits not just from delivering service to more customers, but also by capturing an exclusive set of network users whose requirements for bandwidth and value-added services will grow over time. It is a high-growth, highly profitable proposition with tremendous economies of scale that can be focused on a captive user base.

An important set of market enablers have come together to create this opportunity. First is an expanded list of access technologies, including fiber, coax, copper and wireless, now available to deliver bulk access bandwidth to a building. Second, these multi-tenant buildings can be easily wired for data services based on extremely cost effective Ethernet and also Digital Subscriber Loop (DSL) technologies.

And finally, the last critical piece is now in place with a new generation of QoS-capable IP router, notably Xedia's Access Point, which provides the advanced connectivity, bandwidth control, and scale needed to deliver IP services with explicit Service Level Agreements (SLAs) to individual tenants.

A READY-MADE MARKET OPPORTUNITY

There are many traditional and emerging players, including Competitive Local Exchange Carriers (CLECs), Incumbent Local Exchange Carriers (ILECs), and specialized integrators developing strategies to capitalize on the opportunity of the Internet. For these providers, multi-tenant facilities represent an important new horizon - an untapped community of residential, commercial, university, hotel, and convention center customers that need high-speed, high quality IP/Internet services.

Users in these environments have traditionally been underserved, largely due to the high cost of delivering low-speed (and therefore low-revenue) services to one tenant at a time. With few options available, tenants were forced to independently purchase and manage their own Internet access installations. They were typically restricted to either low-speed dial access or very high-cost, specially provisioned dedicated circuits.

Now, however, the booming market for Internet connectivity and networked business applications is driving the need for more bandwidth and better services to even the smallest business or residential tenant.

Analysts estimate that there are currently 20 million to 25 million multi-dwelling units (MDUs), including residential apartments, condominiums, and townhouses in the U.S. alone. This large base of residential units presents an opportunity for delivering services to families and individuals who increasingly tap into the Internet for shopping, travel, banking, financial, news and other services. Forrester Research believes that there will be more than $1 billion spent on home networks by 2002.

In the commercial sector, there are roughly 750,000 business property units to be served. Add to these a large base of hotels, convention centers and business-park or university campuses, and the opportunity becomes even more compelling. The value proposition for each is simple:

Small and medium-sized businesses: Even the smallest business today requires a Web presence to be perceived as a competitive market player. However many small firms cannot spare the time and resources to stretch beyond their core business requirements. They rarely have the benefit of an on-site system administrator, let alone an information technology (IT) manager. These business tenants will benefit greatly from access to ready-made high-speed networking facilities. They are also likely candidates for additional outsourcing services such as Web hosting, e-commerce, and other applications that are beyond their expertise yet critical to their business success.

Hotels and convention centers: Hotel chains are highly motivated to differentiate their properties in order to capture high-margin business travelers. By providing in-room Internet access services, they can win the loyalty of a large mobile workforce. Once the infrastructure is in place, these hotels can drive further profitability by including other high-speed, high-value business services in their portfolio.

Universities: Universities are looking for ways to cost-effectively deliver Internet access to faculty and students. A key challenge in this environment is to ensure that faculty members are not squeezed out of bandwidth needed for academic and administrative applications by students consuming network access to browse the Web. Multi-user services that can be cost-allocated or charged back to different departments or users will provide the ability to not only control cost but also improve service across the campus.

TABLE 1. Riding the IP Services Wave

Once high quality Internet access is in place, service providers can develop new sources of revenue from tenants hungry for more bandwidth and value-added services that improve their ability to compete in a global marketplace. The following is a closer look at some of the enhanced multi-tenant services that can be offered.	
Business-quality Internet access	Local providers can provision high-speed dedicated access to individual building tenants. Some providers will offer differentiated classes of service with corresponding graduated prices.
Web hosting	Providers can host the tenant's Web server in their data centers for a monthly fee that might include the Internet connection, security, management, access to Web authoring tools, and customer control of site content.
E-commerce	E-commerce represents an important opportunity for large and small businesses. Business tenants will be able to scale their business more rapidly and more cost effectively by outsourcing some or all elements of an e-commerce solution, such as transaction processing and credit card verification services.
Application hosting	An emerging class of "Application Service Providers" (ASPs) provide outsourcing solutions for businesses that want to be relieved of application support, licensing, version management and other software burdens. Network providers are filling this role by hosting client/server applications at their service point of presence (PoP). International Data Corporation expects the application service provider market to grow to more than $2 billion by 2003.
Intranet/extranet services	In these network outsourcing solutions, providers use a combination of application hosting, secure tunneling protocols and IPSec encryption to host a customer's intranet or business extranet.
News and other content services	Business tenants can subscribe to news and other content services via their service provider.
Employee training and multicast video services	As with application hosting, network providers can host training programs and daily/weekly video presentations for their customers. IP multicast technology is an important tool for cost effectively sending information to multiple remote recipients.

A NEW MODEL EMERGES

THE BUSINESS PROPOSITION

So why is the time right? For starters, the economics are compelling. In the simplest case, a sampling of local access tariffs across the U.S. shows that the cost of a T1 circuit is about 2.5 times that of a single 56/64-Kbps leased line, yet the T1 circuit delivers 24 times more bandwidth. With a high-density multi-tenant property, it becomes very cost effective to provision a single high-speed circuit rather than many separate low-speed links for individual users. As a result, a service provider who purchases a single T1 can sell access to 24 customers at discounted rates and still make money while the customers enjoy substantial savings. Add to this the opportunity of delivering value-added data services, and the revenue win is hard to ignore.

For property owners, advertising a building as "Internet-ready" brings a competitive edge that can result in higher occupancy rates and higher revenue per square foot. Owners also receive additional revenue from their share of monthly service fees, granted in exchange for exclusive access rights to a property.

Another important market dynamic is the emergence of property owners and real estate management groups that are empowered to negotiate exclusive communications access rights on behalf of many properties.

The good news for service providers is that these property owners represent a single point of contact for marketing services into a multi-tenant facility. The owners in many respects serve as an extension to the service provider's sales team by promoting Internet access and other services to tenants as they move into the building. They in turn typically receive a "commission" on the sale.

It's important to note that while property owners act as marketing partners to the service provider, it is the service provider who provisions and bills for the service. This model avoids situations in which a property owner might be held responsible for service disruptions, thus relieving them from disputes with tenants who might hold back rent if a network commitment is not met.

THE TECHNOLOGY PIECES

Competition within the telecommunications industry has created many options for delivering high-speed access to a multi-tenant facility. While each technology has unique advantages with respect to distance, terrain, and ease of deployment, the net result is that service providers can readily deliver broadband access to buildings new and old.

At the same time, more choices exist for distributing data services within a building. For example, Ethernet switching provides a robust distribution network for buildings that are pre-wired with Category 5 cabling. For buildings without Category 5 cabling, DSL technology can be used over existing copper (telephone) wiring.

With the local access and building infrastructure in place, the breakthrough technology now enabling best cost delivery of multi-tenant services is IP Quality of Service (QoS). IP QoS allows providers to cost effectively provision a high speed local access "pipe" among many tenants, delivering a full suite of IP data services with service visibility and control.

THE CHANGING OF THE QOS GUARD

In provisioning a multi-tenant service, a key objective is to serve as many individual customers as possible over a single shared access link - without compromising quality of service.

Early shared service attempts were based on technologies such as Time Division Multiplexing (TDM) and Asynchronous Transfer Mode (ATM). IP QoS has emerged from the experience gained as those strategies have proven to be either inefficient or too costly and complex.

EARLY QOS STRATEGIES – FROM TDM TO ATM

In a TDM network, a specific amount of bandwidth must be dedicated to each TDM channel, with each channel typically serving an individual tenant. If one tenant wants 64Kbps service and another wants 128Kbps service, then 192Kbps of aggregate bandwidth must be dedicated to the building. There is no possibility for sharing unused bandwidth and no opportunity to over-subscribe the access link.

ATM solutions are more efficient than TDM, but they are also more costly and complex. Efficiencies can be gained by leveraging the statistical multiplexing nature of ATM's Variable Bit Rate (VBR) service. However, in order to guarantee a level of service, an ATM Virtual Circuit must be provisioned to each tenant. Many service providers have found that virtual circuit configuration and management tends to be complex and not particularly scalable.

In addition, because data services are based on IP packets, it is at some point necessary to translate from the service definitions of the ATM world into the service needs of the IP world. This is also relatively complex, uncharted territory.

And finally, ATM has been criticized for consuming a roughly 15 percent bandwidth overhead due to its packet structure. More overhead is generated as data traffic is converted in and out of ATM cells. Bandwidth efficiency therefore suffers in data environments that don't require ATM's more specialized service characteristics.

ENTER IP QOS

While packet switching has long been acknowledged as a more efficient and therefore more cost effective solution than circuit switching for data applications, IP networks have traditionally delivered a best effort service. In a shared access environment, users have been subjected to a free-for-all conflict in which any one user or tenant could consume the bandwidth of all other users. IP network administrators have compensated by over-provisioning aggregate bandwidth, but they have done so without visibility and with no control over how existing bandwidth was being used.

IP QoS has emerged as the critical enabling technology for building IP networks capable of discrete and explicit service level guarantees. With QoS, the network administrator can establish and enforce specific bandwidth policies while gaining the visibility needed to actively manage cost and quality of service. This heightened level of control allows the administrator to adjust bandwidth levels so just the right amount of bandwidth is delivered to the right users when and where they need it.

Class-Based Queuing (CBQ) is the most notable example of an IP QoS technology capable of the flexibility, scale, and bandwidth control needed to deliver IP services within a multi-tenant structure. Xedia Corporation's Access Point routers incorporate the first commercial implementation of CBQ, allowing service providers to dynamically assign, enforce, and monitor the amount of bandwidth available to individual building tenants.

CBQ guarantees that a tenant's committed capacity is always available; but when that committed bandwidth is not fully used, the extra capacity is available to others who may need to burst higher than their committed service rates. This is a flexible and efficient mechanism for controlling bandwidth over-subscription, allowing the provider to manage total bandwidth cost while ensuring that service level guarantees are met. With the bandwidth control, efficiency and scale enabled by CBQ, service providers can now cost effectively deliver business quality IP services across their multi-tenant properties.

WHERE TO START?

THE BASIC ARCHITECTURE

The delivery architecture of a multi-tenant service is the same, regardless of the underlying technologies employed. The physical layer network includes two basic elements: the high speed local access to a building and the in-building network responsible for distributing data services to tenants. The IP service layer provides the network intelligence needed to deliver the value-added IP/Internet services with guarantees that match tenant business needs.

THE PHYSICAL NETWORK

There are a variety of local access options available to serve a building, including SONET, broadband wireless, cable, and DSL. Service rates typically range from N x T1 (multiples of 1.54 Mbps) to full rate T3 (45Mbps). Some providers, such as the 38GHz wireless and SONET vendors, already support OC3 access facilities.

TABLE 2. Local Access Options

Technology	Possible Deployment Scenarios
Wireless	In new markets without existing terrestrial infrastructure, providers can quickly and easily build out an access network. No rights of way are required.
SONET	In markets where high-speed, redundant fiber rings are already running to multi-tenant office buildings, providers can capitalize on the built-in redundancy of this technology, currently specified to scale to 2.4 Gbps. For new construction, providers installing SONET build in scalability to very high speeds for about the same construction costs as installing a less scalable copper infrastructure.
xDSL	Is easily deployed using existing twisted-pair copper wiring infrastructure, with no new construction required. New providers can lease facilities from incumbents.
Coaxial cable TV	The existing infrastructure is limited in its connectivity to commercial sites, but is a strong network option in residential markets for broadband applications.

Deciding which technology to deploy within a building hinges mainly on the building's wiring scheme. Recent trials in this area have shown that both xDSL and Ethernet are viable building distribution technologies. Depending on the quality of the copper in the building, xDSL might be the right choice. If the building is already wired with Category 5 cabling, Ethernet would be a good consideration.

TABLE 3. In-building Service Distribution

	SDSL	Ethernet
Wiring Requirements	existing telco grade copper	Category 5 copper or fiber
Security Considerations	provides physical point-to-point security via a discrete DSL modem to DSLAM connection	a shared access, broadcast media requiring VLAN or VPN support for secure tenant services
Distance Limitations	extends to 11,000 feet at T1 speeds over 24-AWG copper	Category 5 copper supports 100 meters without added repeaters
Data Rate Restrictions	1.544Mbps maximum upstream and downstream; single tenant is limited to 1.544Mbps maximum	100Mbps maximum, Gigabit Ethernet migration; Granular allocation up to the segment maximum

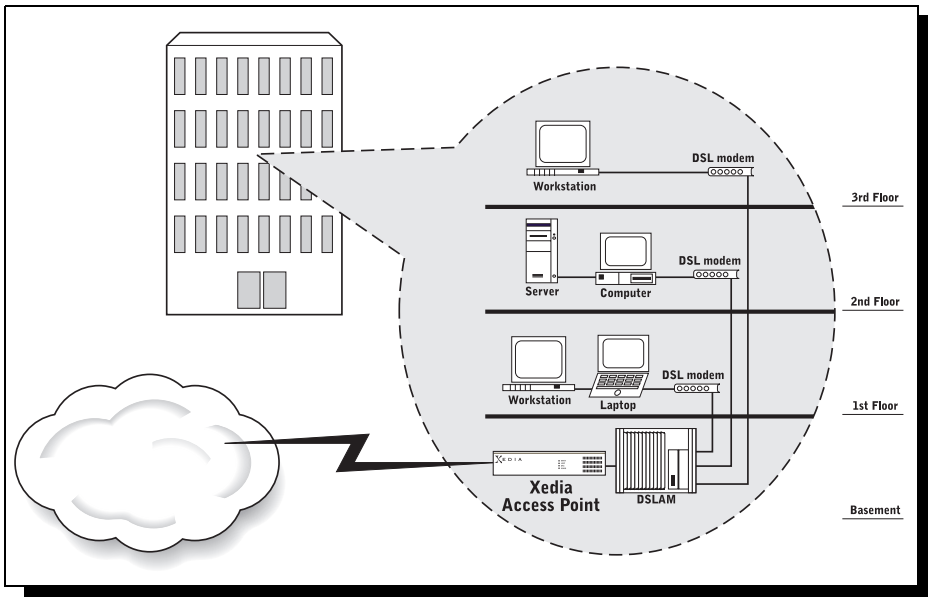

FIGURE 1. For buildings not yet wired with Category 5 copper and/or fiber, xDSL can provide high bandwidth rates over the existing copper phone line infrastructure. xDSL is also physically secure supporting a discrete physical link between a tenant's DSL modem and the DSLAM. Symmetric DSL (SDSL) is emerging as the most likely multi-tenant services candidate.

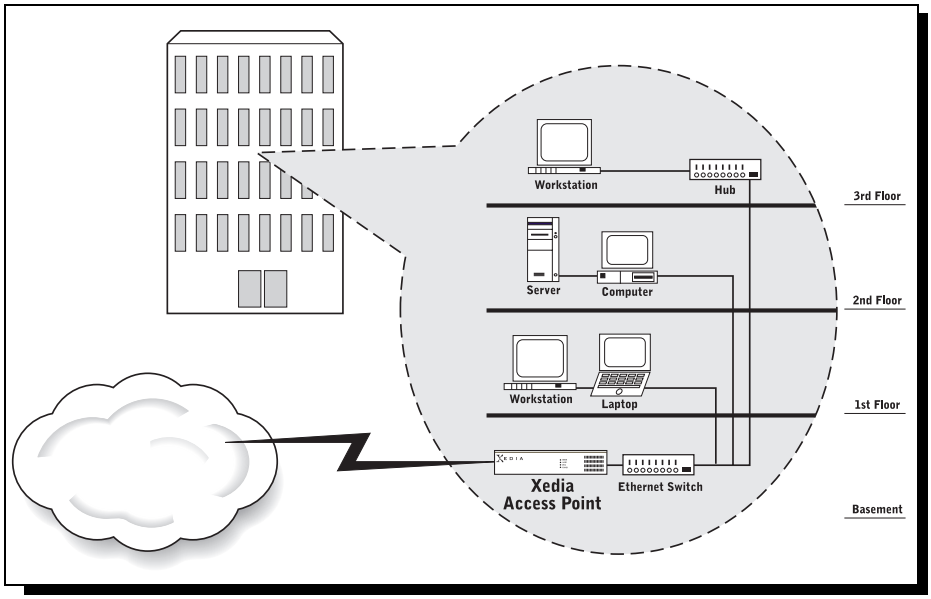

FIGURE 2. Many newer buildings have been pre-wired with Category 5 copper, allowing Ethernet-based distribution of IP services. With Ethernet, bandwidth to any tenant can be allocated with extreme granularity up to and including the physical speed of the segment. Security issues must be addressed with an overlay of virtual local-area network (VLAN) technology or a virtual private network (VPN) solution.

THE IP SERVICE LAYER

IP services must be implemented through a high performance, QoS-capable Internet access router. The router is typically deployed in a building basement at the demarcation point between the local access link and the in-building distribution network. Critical elements of the solution include advanced BGP4-capable IP routing, diverse WAN access options, and explicit QoS control enabling the service provider to achieve:

- Flexible provisioning and delivery of Internet/IP access services
- Best cost utilization of expensive high speed network resources
- The ability to meet explicit service level commitments
- Simple migration to new value-added IP services

It is important to note that traditional multi-protocol routers, which provide solid IP routing features, have been designed for single enterprise sites; they do not scale to meet the needs of a multi-tenant property. While their first generation bandwidth priority mechanisms have evolved to deliver better service levels, bandwidth management policies can only be applied to a small group of users or applications. It is also common to experience performance degradation when bandwidth management or access control is applied.

The multi-tenant IP services router must support robust, Internet-certified routing to ensure a reliable, high performance connection from the building to the service provider. More importantly, QoS services must scale across a large number of tenants, with the assurance of sustained high performance for each tenant as traffic is forwarded to the Internet. It is also critical that the routing platform constantly monitor and measure actual performance to ensure tenant service level requirements are satisfied. And finally, it must be possible to easily provision bandwidth so that each individual tenant receives the service they need.

Xedia's Access Point platform is the first in a new generation of QoS-enabled IP/Internet access routers. Access Point combines world class IP routing, bandwidth QoS, VPN tunneling and encryption, firewall protection, and service level management in a single highly integrated IP services platform. With its demonstrated leadership in performance, scalability and ease of use, Access Point is used in many business Internet services including multi-tenant, Virtual Private Networks, Web hosting, and business Internet access.

Access Point's robust IP routing services have been certified in the most demanding IP service networks in the industry. Its advanced security features are critical to the deployment of major VPN services in the industry. And its leadership IP QoS capability has proven to be the solution needed to now deploy multi-tenant IP services.

CBQ: THE QOS OF CHOICE

CBQ is the foundation of Access Point's QoS capabilities. CBQ is an open, non-proprietary technology that allows flexible partitioning of an IP access link to meet the specific service needs of many IP users. Explicit rate control is applied to user traffic flows, which are identified by information contained within the IP packet header.

Because CBQ allows network providers to allocate, optimize, and monitor bandwidth distribution, it enables them to monitor service levels and charge for usage at a very granular per customer level.

The pioneers in developing CBQ were Sally Floyd and Van Jacobsen of Lawrence Berkeley Labs. By leveraging the inherent flow control mechanisms in standards-based TCP/IP, Floyd and Van Jacobsen developed CBQ to enforce minimum bandwidth guarantees for IP traffic flows. CBQ was also designed for optimal bandwidth efficiency using a bandwidth borrowing mechanism that allows the controlled over-subscription of access links. Similar to the concept of bursting above a committed information rate in Frame Relay networks, user traffic streams can burst above their committed rate when excess network capacity is available.

Important advantages of CBQ include:

- Explicit rate control means customer service level agreements can be met
- Bandwidth borrowing enables lowest cost bandwidth efficiency
- Software-based provisioning eases service deployment to many tenants
- Automated service provisioning for large scale environments using "AutoClass"
- Detailed per-user statistics enable SLA monitoring and charge-back services
- Simple SNMP-enabled integration into back office billing and provisioning systems

SIMPLE, ROBUST SERVICE PROVISIONING AND MANAGEMENT

Bandwidth provisioning under CBQ is extremely flexible and granular. Through a software interface, bandwidth can be provisioned in exact amounts to each tenant. With this degree of control, customer SLAs can be built around discrete service levels that are committed to an individual tenant.

For example, some tenants may require only 56Kbps bandwidth while others require 256Kbps of upstream bandwidth and 512Kbps downstream. Tenants also may want a more premium service that allows them to burst above their committed rate when idle bandwidth is available. As any tenant's bandwidth requirements change, it is

a simple software provisioning exercise to modify their service plan.

Tools such as AutoClass simplify bandwidth provisioning by automating the configuration process for a large number of users with common bandwidth profiles. For example, the building administrator could allocate 128Kbps of bandwidth to each of a large number of tenants by globally applying a single bandwidth policy to a list or a range of tenant IP addresses.

At an even more granular level, a tenant's specific applications can be granted higher priority or given greater bandwidth borrowing privileges than other applications. CBQ will recognize different traffic streams based on their IP header information, and will automatically handle them according to the service levels that have been established.

Access Point's CBQ further allows tenants to manage their own bandwidth via a simple Web-browser interface. For example, out of the 1Mbps of bandwidth that Tenant A is guaranteed, they would like to allocate 56Kbps to E-mail traffic, 256Kbps to Web-traffic and another 256Kbps to transaction processing. This level of control can be administered locally, allowing a tenant to monitor and adjust bandwidth priorities in their own deterministic manner.

Access Point's CBQ also provides the additional—and mandatory—benefits of monitoring and measuring IP network traffic. With this information at hand, a network administrator can easily monitor service levels, adjust bandwidth policies to meet changing tenant needs, and also bill for the usage of IP services.

With this strong combination of features, it is easy to see why CBQ has become the technology of choice for implementing QoS in demanding IP service networks.

Conclusion

The market climate, business model and technology options have aligned; service providers are beginning to capitalize on the rapidly growing multi-tenant arena. Property owners have a window of opportunity to capture market share by luring tenants with the global services afforded by the Internet. Service providers have an immediate opportunity with many long-term advantages in developing new sources of revenue with a portfolio of multi-tenant services.

The technology pieces are in place. High speed local access and in-building distribution solutions exist. The final critical piece is IP QoS, allowing providers to deliver differentiated services equally well to apartment dwellers and to more demanding business tenants.

With its leading-edge IP routing, QoS control, and service management features, Access Point is the ideal solution for delivering IP services to multi-tenant buildings. With millions of potential customers demanding IP services, the time has come for providers to add these value-added offerings to their service portfolios.

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