The Regulator and the IP Network Cloud: Regulatory Challenges Arising from Network Evolution

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By

Dr. Richard Downes
Sales Director
Mexico, Central America and the Caribbean Region

Detecon Inc.
10700 Parkridge Blvd, Suite 100
Reston VA 20191, USA
Fixed: +1 305 228-8881
Mobile: +1 305 903-8287
E-mail: Richard.downes@deteconusa.comom
Website: www.deteconusa.com

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Detecon Inc.

A.J. Seymour provides those of us who live along the shores of the Caribbean with an image most relevant for today's topic. This Guyanese poet and literary pioneer penned in 1944 what has been called the first truly West Indian poem: "Over Guiana, Clouds." Through its verses, Seymour evokes images of clouds that

" …on their pilgrimage they go
And weave themselves strange pagan
arabesques
Or subtle unimaginable shapes
Before they pass on to another land."

Just as Seymour suggests that clouds remind "mankind below of its place in the order of things,"[1] the images of clouds that spring incessantly from today's modern network diagrams remind us of the complexity and indeed mystery inherent in the technological processes that are transporting our messages, like Seymour's mysterious clouds "on to another land." Transmissions from gateways disappear into network clouds only to reappear nearly instantaneously, properly routed to appointed destination.

Today I will concentrate on one type of network cloud--the Internet Protocol or IP cloud--and the implications of the data transfers that take place within that IP cloud. The technical descriptions of this process of transmission through the IP cloud need not detract us here, but we are consumed with its implications. Indeed, network planners, service providers,

[1] Nicolas Laughlin, review of Collected Poems, 1934–1989, by A.J. Seymour, at www.triste-le-roi.blogspot.com/seymour_poems.html.

telephone users, and even regulators are all being touched one way or another by the implications of this IP cloud. This paper offers a quick overview of the status of the use of the Internet Protocol to deliver voice-oriented services and what recent developments mean for the regulatory authority in terms of its own mandate and organizational concept.

The IP Transport Mechanism

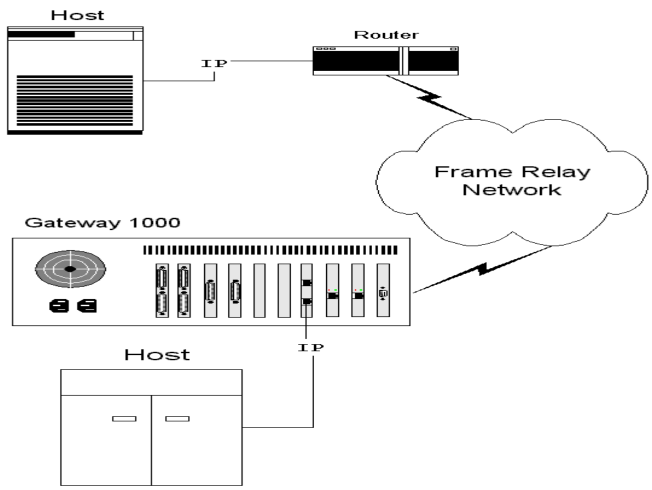
The Internet Protocol (IP) is a set of rules defining a specific method for the transmission of digital "blocks [or packets] of data from sources to destinations, where destinations are hosts identified by fixed length addresses."[2] IP defines and routes packets of data with appropriate headers and texts through various interconnected networks to arrive a determined destination. It provides packet routing, fragmentation and re-assembly of the data at the destination point under "best effort" promises. IP is not the only option for the transmission of data, for example two other data transmission technologies commonly used are the Integrated Services Digital Network (ISDN) which offers the capability to transmit large amounts of data across networks and Asynchronous Transfer Mode (ATM) which was designed to be a single high speed data networking solution for all types of applications. ATM is used primarily today for backbone data networks - driven primarily by telecommunications network operators. In 1988 the International Telecommunications Union (ITU) created the Frame Relay protocol to serve as an underlying data transmission scheme. Frame Relay is widely used in enterprise and network applications such as point-to-point broadband bearers carrying IP traffic. IP gained popularity as a data transmission protocol with the development of the Internet and emergence of the World Wide Web, where it is commonly used in combination with the Transmission Control Protocol, or TCP. The

[2] U.S. Department of Defense, Defense Advanced Research Projects Agency, "Internet Protocol: DARPA Internet Protocol Specification, Oct. 1981, www.ietf.org/fc/fc0791.txt.

Internet's enabling of a global user community linking hundreds of millions of users through TCP/IP has lead to IP becoming a ubiquitous element to a broad variety of applications.

Networks deliver IP data packets across a variety of physical links, including Ethernet, serial lines, Token Ring LANs, ATM, Frame Relay, and ISDN. Figure One diagrams the network where Frame Relay is used to deliver IP traffic.

Figure One
Delivery of IP traffic Using Frame Relay[3]

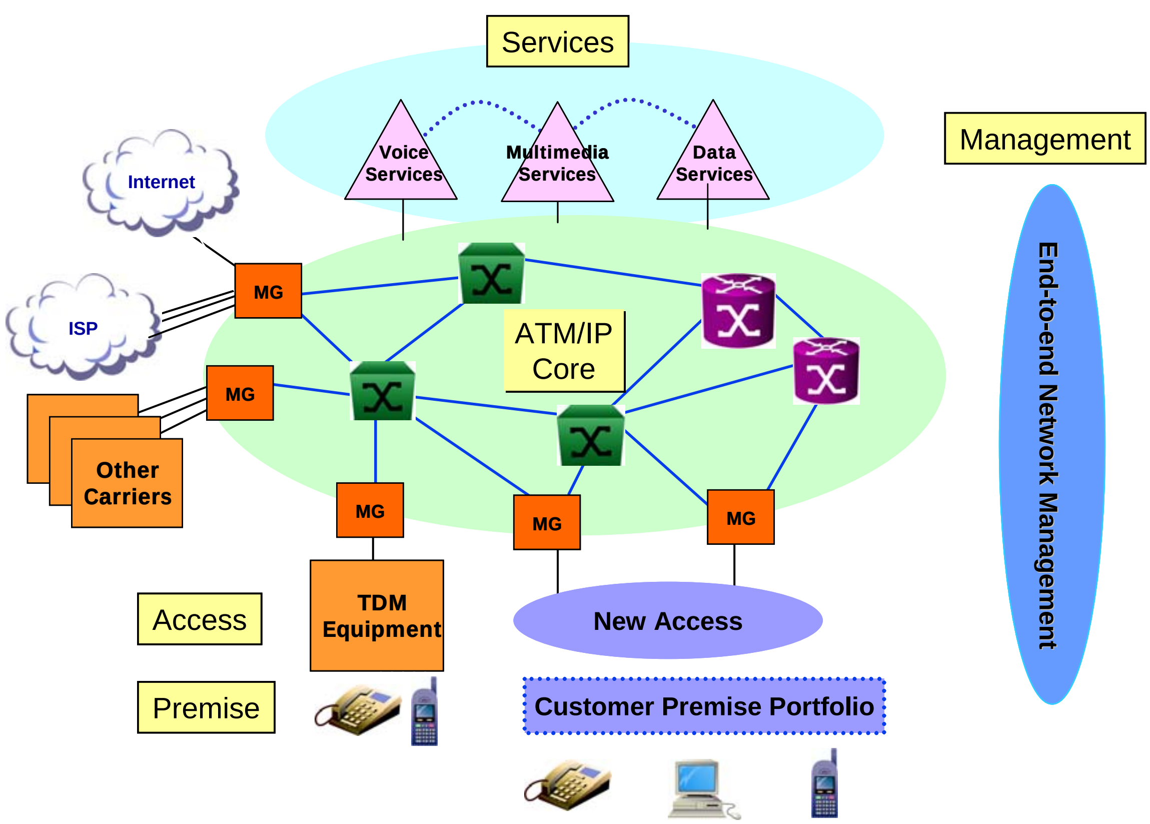


Whilst using various and diverse underlying transmission link technologies to support and carry IP traffic, the telecommunications community is developing an "all-IP network architecture" that employs IP for the end-to-end transport of all user and signaling data. Such networks allow for the combination of voice and data on one physical network, or combination of networks, to significantly reduce capital and operating costs for network operators and service providers. Most industry analysts position IP as the fundamental building block of multi-media convergence. They envision a convergence between IP and telecommunications networks, such as the Public Switched Telephone Network (PSTN), as providing the impetus for widespread feasibility and adoption of emerging applications,

[3] www.jbmelectronics.com/product/atm-9.htm

including universal messaging, multimedia conferencing, electronic commerce, and on-demand audio/video distribution.[4] However, the extensive capital investment level and set of technical issues yet to be fully resolved that is required to replace, convert, or upgrade existing wireline and wireless networks to full IP capability and interoperability means that the full commercial implementation of all-IP networks by telecommunications network operators is still in the future, while beta testing and trial deployments are conducted. However, many network operators already are beginning to phase-in the migration to all-IP networks. Figure Two depicts a next generation network with either all-IP or ATM cores.

Figure Two
Advanced Generation Network with Either IP or ATM Core[5]



[4] See Wayne Zeuch (Vice Chairman, Standards Committee T1), "Signaling for Voice over IP: Requirements and Standards," Presentation, CITEL/PCCI, Brasilia, Brazil, Nov 4-6, 2002.

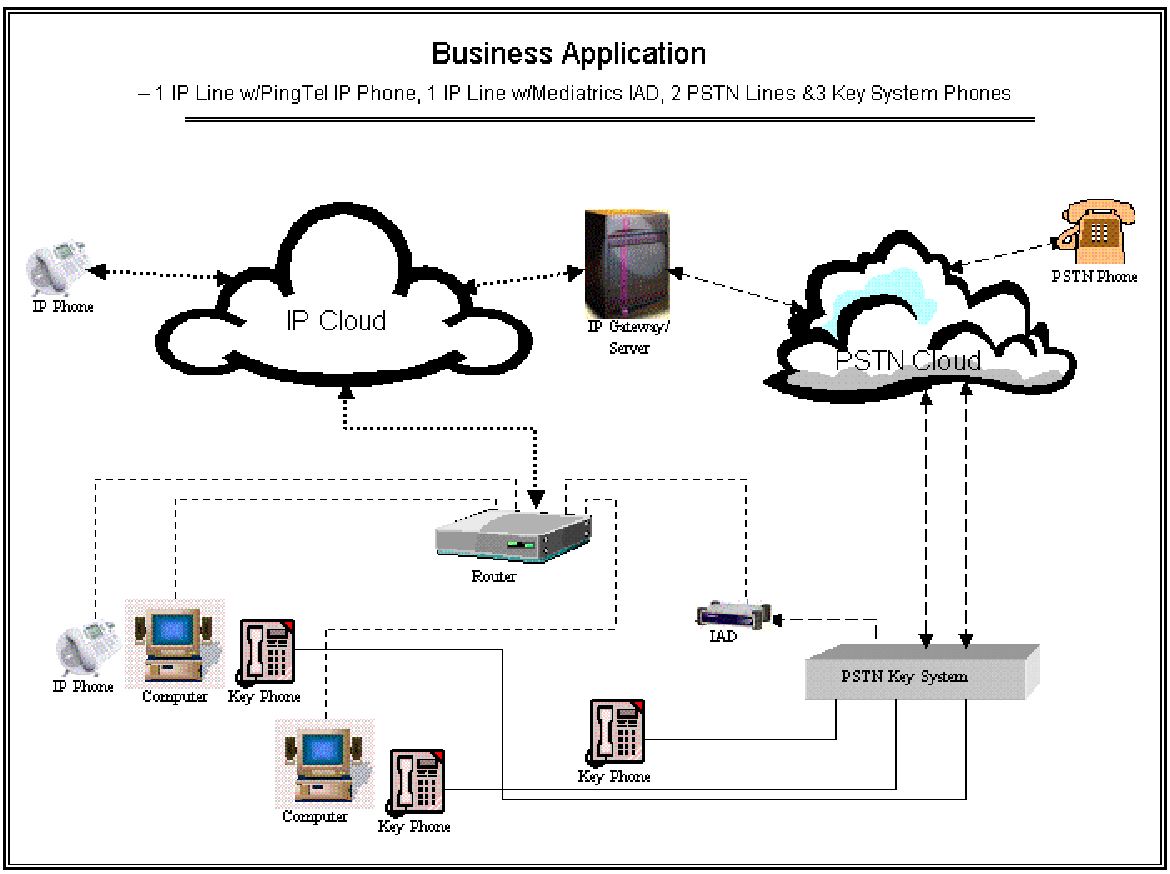
[5] Inter-American Telecommunications Commission, PCCI, Delegation of Canada, "Next Generation Networks - Standards Overview, May 2002, PCI/Doc. 1478/02, p. 3.

Even though we have not yet arrived at the age of the all-IP network, the capability to use IP as a means of transmitting voice as digitized and packetized data has existed since the mid-1990s and adoption rate of this method is growing by leaps and bounds. In fact, the economic advantages of packet voice are revolutionizing the architecture principles at both the access and core network levels - moving networks away from their previous circuit-switched nature and towards packet. The rising prominence of packet voice, and especially packet voice using IP, is being manifested in a variety of applications. Only some of these applications are currently visible in the public sphere. However since many packet voice services depend upon one type of interconnection access or another to the traditionally regulated Public Switched Telephone Network (PSTN), they have presented significant challenges for the regulatory community--hence the issue: how does the regulatory community act with respect to what goes into and comes out of that IP network cloud.

IP-Based Applications

Network and equipment providers, and even some user groups, are beginning to utilize IP as a means of providing traditional voice services through IP-based PBXs, Centrexes, Virtual Private Networks, and international and domestic long distance trunks. Under the general rubric of VoIP (Voice over Internet Protocol), these players are using IP to carry voice calls and faxes over corporate intranets and the Internet. VoIP codes analog voice or fax into a digitized data stream that can be transported by IP packets. New technologies such as VoIP are being used on corporate enterprise networks, allowing companies to communicate to office locations around the world over the Internet or dedicated data links and bypassing the local, long distance, and international telephony operators and carriers. Companies and consumers that use VoIP technologies thus can avoid paying traditional telephony long distance charges, which may result in significant savings to the user and significant revenue loss to the telephony operators and carriers, because they avoid paying call-based telephony charges. Established long distance carriers, such as ITXC, are also using IP technology--usually completely transparent to the customers because of the inherent efficiency of packet-based transmission compared to circuit-based transmission methods. Figure Three diagrams a Voice over IP network and its interaction with the PTSN. VoIP is not without its technical challenges, not the least of which is the coordination requirements of different standards-developing organizations: working from the

Figure Three
Voice Over IP Network Diagram[6]



telecommunications perspective (the ITU) on the one side and from the Internet perspective

[6] http://www.covoda.com/voip_network_diagram%20Page.htm.

(the Internet Engineering Task Force IETF) on the other. While the ITU is a rigidly structured formal international organization, the IETF is quite the opposite. True to the innovative nature of the Internet community, the IETF is an organic self-organized group of contributors, with no set membership policies that allows anyone who registers to attend their meetings. IETF contributors are able to make contributions to the technical development and evolution of the Internet and associated technologies, e.g., the protocols including IP, on an equal peer basis.

On the performance side, the wide business deployment of VoIP services is still hindered by quality of service, or performance, of the IP networks over which the VoIP packets are transported. When public networks are involved, such as the Internet, this currently often leads to a lower quality of voice when carried over IP, particularly higher delay and "jitter" (delayed arrival of packets transiting the network.)[7] As most modern packet networks are engineered for "best effort" data transportation and not specifically for voice traffic there is a clear challenge to achieve PSTN equivalent Quality of Service (QoS). Packet networks designed for "best effort" data traffic allow the network to introduce variable delay to individual packets. Packets can also arrive out of order, and needing to be rearranged by the destination host. Delays in voice data packets of more than 100ms can result in a perceptible reduction in voice quality. Further, compressing the voice data stream (to reduce the data bandwidth needs) can also reduce the quality of the voice, which can result in a tradeoff between QoS and bandwidth. The development of advanced voice coding algorithms, priority-based packet networks, advanced networking equipment, and other innovations has solved many of the QoS issues related to VoIP, allowing voice over packet to

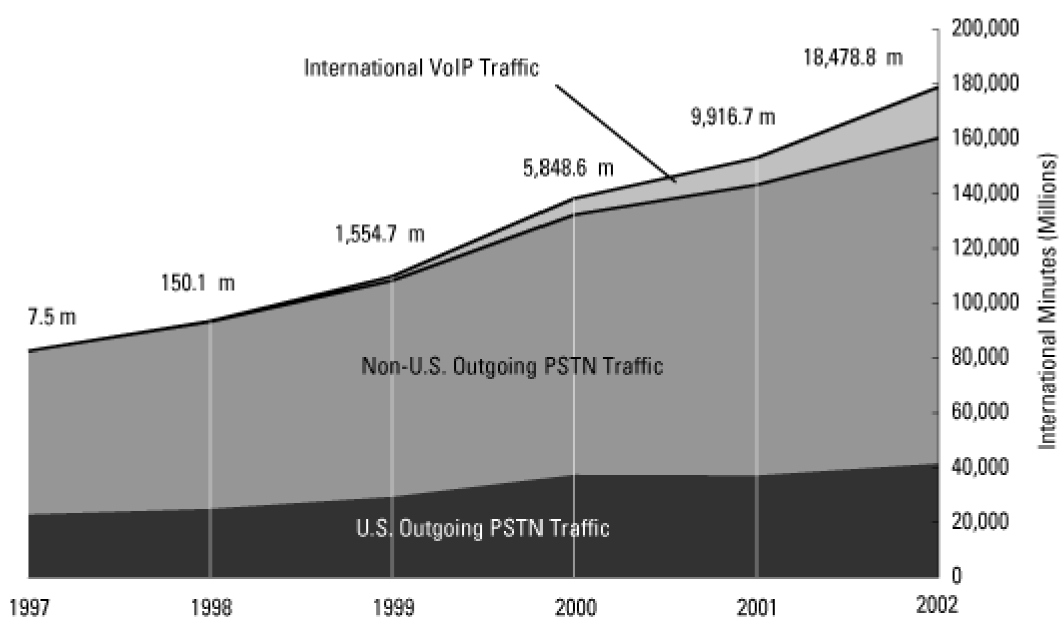
[7] International Telecommunications Union, Dr. Charles M. Sarraf, “”IP Telephony Technical Issues,” Document IP Tel/9-E, Geneva, October 8-10, 2001.
http://www.itu.int/ITU-D/e-strategy/internet/iptelephony/Seminars/2ndEGM/documents/technical/IPTel-9.pdf

be deployed in many networks, often imperceptibly to the users. However many technical issues concerning accounting, billing, charging, roaming, etc., remain open. Although these issues are receiving significant attention and solutions are being announced commercially on almost a daily basis.

Domestic and International Long Distance

Concurrent with the arrival of technical and commercial solutions, the use of VoIP is gaining steam, although packet networks still carry only a small fraction of domestic and international long distance calls. A report from the consulting firm TeleGeography 2003 estimated that the market share of global traffic rose to 10 percent in 2002 from 6 percent the previous year. Other analysts and VoIP equipment vendors predict that VoIP traffic within Europe will grown substantially through 2006 and then sustain respectable growth rates thereafter. On a more global basis, TeleGeography 2003 estimates that Voip accounted for 18 billion minutes of IP transmitted phone calls, up from 9.9 billion minutes in 2001.

Figure Four
Global VOIP Traffic, 1997-2002



Notes: Voice-over-IP (VoIP) traffic includes all cross-border voice calls carried on IP networks but terminated on public switched telephone networks; PC-to-PC communications and private network traffic are excluded. PSTN traffic includes circuit-switched voice and fax traffic carried on traditional international facilities as well as international simple resale (ISR) facilities. Figures for 2002 are estimated. Source: TeleGeography research

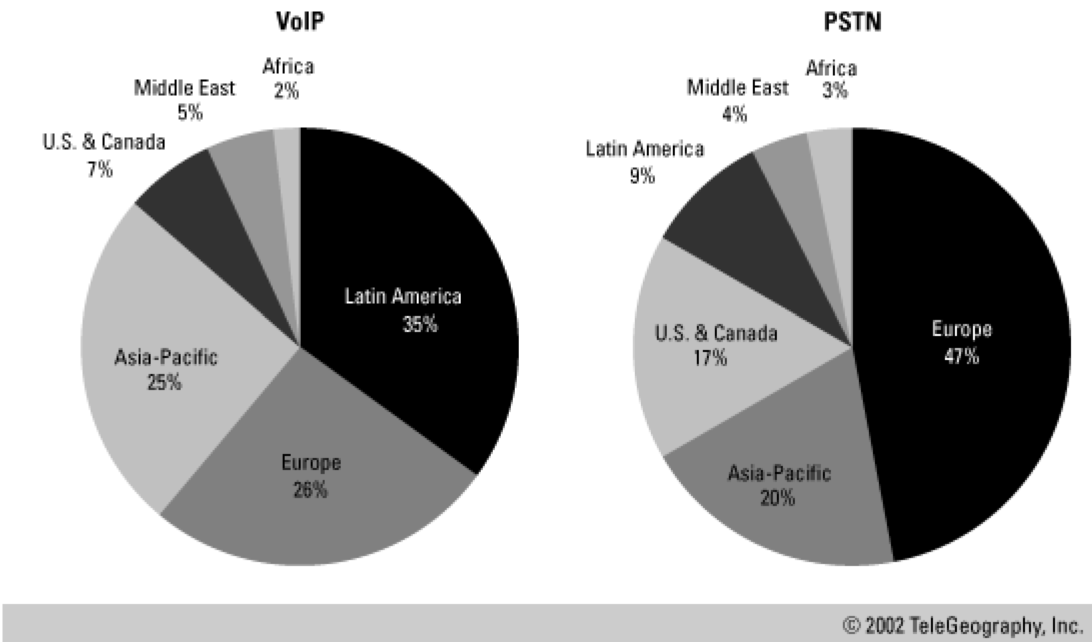
Voice over IP is particularly attractive in the developing world where the lack of market opening and low cost communications alternatives have promoted its use through internet cafes and other Personal Computer to Personal Computer linkages. This is challenging the market position of established telephone operators and other with long distance licenses that depend upon equal terms of market access to remain competitive. According to the International Telecommunications Union (ITU),

> Internet telephony means lower prices for consumers and big challenges for telecom operators ... Price and cost savings are driving the market. In countries where the telephone network is developing, Internet telephony is particularly attractive. China has gone all out to develop Internet-based services. It's less interesting for companies to do this in countries where the phone network is already well-developed -like Germany for example.

An ITU survey noted that the call from the United States to Australia over a net-based service to be half the cost of a call over a traditional network. It also noted that calls from the Untied States to China would drop in costs from 59 cents a minute to 21 cents. Estimates by TeleGeography point out that the majority of IP telephony minutes originate in or are destined to the developing world.

Voice over IP has also become the default method for domestic carriers in the United States and elsewhere to offer reduced rate domestic long distance services. In the United States, Vonage Digital Voice offers unlimited calls anywhere within the United States and Canada. The Vonage service is enabled via any broadband Internet connection (DSL, cable modem) that the customer has access to for $39.99 a month, plus a one-time $29.99 activation fee. The company announced on September 1st that it had reached a customer base of 40,000. Other VoIP-based service providers such as iConnectHere, Go2call, and Net2Phone offer rates as low 1.2 cents per minute within the United States and 5.9 cents per

Figure Five
VOIP and PTSN Minutes for Cross Board Calls, 2002



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minute from the United States to Italy utilizing VoIP. While hardly challenging the impact of 60 million Verizon customers, VoIP subscribers are demonstrating the appeal of packet-based voice. The VoIP solution is also receiving trade association support in the regulatory arena from the "VON [Voice on Network] Coalition," which is "actively advocate the viewpoint that the IP Telephony industry should remain as free of governmental regulations as possible, and to educate its members on regulatory and policy issues of business importance." The VON coalition, which counts among its members Microsoft, Intel and VoIP carrier advocate Puliver.com, seeks to:

- Educate regulators, legislators and media worldwide about voice on the net opportunities, technologies, products, benefits, and practices;

- Recommend action on regulation and legislation that affects the interests of the voice on the net industry;

- Provide a forum for discussion by the members of the voice on the net industry, to educate on important legal and regulatory policy issues and encourage the exchange of ideas.[8]

From the carrier perspective, Voice over IP telephony offers distinct advantages depending, of course, upon the carrier's competitive position in the market. It allows long-distance wholesalers and VoIP-centric carriers the opportunity to enhance company value by not having to pay interconnect charges for calls. They also gain the benefits of greater bandwidth efficiency, since an IP telephone call requires about 6-8 Kbps throughput on a shared basis while a switched telephony call takes up 64 Kbps on a dedicated basis. IP telephony also offers the opportunity for enhanced service opportunities, including: IP multicast conferencing, learning applications, phone directories, and even "voice web browsing" (voice interaction with a web page by speaking commands). Presumably to take advantage of such incentives, the Chilean operator Chilesat (with a mere one percent of the local telephone business) recently announced investments for US$ 25 million to foster fixed telephony through IP networks. Their objective is to gain a 20 percent market share by 2004 by building upon the advantages of an all-IP network.

Virtual Private Networks

VoIP can also leverage IP-based Virtual Private Networks (VPNs). These consist of routing and switching facilities using a number of virtual links of dedicated capacity between the nodes. These links may be provided by the corporation itself or obtained through leasing

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[8] www.con.org/info.asp

capacity from operators or by outsourcing. On corporate premises, VPNs can be provided through traditional and Wireless LANs as well to provide seamless services beyond the boundaries of the corporate network to senior executives, "road warriors," field engineers, and home workers accessing the corporate network across the Internet. A growing number of full or part time employees access corporate-based applications and services using VPNs across the Internet from their homes. The employees require access to the full secure functionality, enabled by VPN access to corporate resources, regardless of location or country. When accessing remotely using VPNs, employees commonly gain access to their corporate network by using a VPN software client application on their PC. They can originate and terminate calls over that access, as well as participate in conference calls, web-assisted calls and video conferencing.

IP-based VPN service provision is a fast growing market with AT&T, Infonet, Equant and MCI/UUNet – all emerging as market leaders on the world scene, and a number of national and regional players also offering these services. Providers offer services either commingled with the public Internet platform, or through managed IP platforms (which are usually ATM based).

The IP PBX

IP is also revolutionizing the private branch exchange (PBX). Callers using the IP PBX make use of its ability to map telephone numbers to IP addresses--typically other VoIP clients. A VoIP session is established between one company's PBX and the other party's IP host, allowing the exchange of packets of data--including voice packets.

According to the Dell’Oro Group, shipments of IP PBXs increased in the second quarter of 2003 rose to 1.8 million lines. The sale of IP PBXs is a growing segment for enterprise voice communications, even though the overall market for this sector has remained flat. IP PBXs are also most popular option for operating IP telephones over corporate data networks, as nearly two thirds of IP terminals purchased are those designed to operate on PBX systems. Cisco Systems is strongly committed to the IP-based PBXs, having delivered over two million IP-enabled terminals. These provide voice, unified messaging, and contact center systems, replacing the standard office phone.

The Implications for Regulators of These Developments

Fundamental changes are occurring in the global regulatory arena because of the explosive growth of IP-related services, especially Voice over IP. The structure of the regulator itself is shifting, as the convergence of voice and data communications and delivery mechanisms is forcing the regulator to assume wider responsibilities than just that of supervising telephone and broadcasting services. Increasing, the regulator is being confronted with issues related to Internet connectivity and other IP-related access and service issues. These issues include numbering and addressing schemes that have become critical areas because of the volume of users and their special needs related to IP addresses and the convergence of Internet and telephony. Also important are a host of fundamental regulatory issues raised by the disruptive nature of the new IP-related technology and enabled business models--including the state's role in setting fair and balanced competitive rules for both IP-based and non-IP based services regarding interconnection, taxation, and licensing.

Numbering and addressing

The plethora of additional devices enabling voice and data communications has important implications for the global numbering and addressing schemes. As IP-based systems allow the convergence of voice and data, as well as the use of voice over non-traditional access lines, additional numbers and new numbering and addressing schemes become essential elements of the expansion in capabilities. The fundamental question here is whether the availability of innovative IP telephony services will lead to merely a substitution of one type of service for another or to a significant incremental number of lines per household. Voice over IP-base service providers in the United States offer second lines within a local calling area that permit a distant customer to call within that rate area without paying long distance charges. Mass adoption of this practice might accelerate number pool exhaustion. On the other hand, one company that is offering IP-based telephony (over cable modems) reports that 86 percent of the local RBOC's customers are interested in substituting their current service for the IP-based service, presumably maintaining the same number in the process.

On a larger scale, the rise in the number of IP devices on the Internet is already leading to a serious crisis in the number of unique public IP addresses available, prompting a shift from Internet Protocol Version 4 (IPv4) to the next generation Internet Protocol Version 6 (IPv6). The IPv6 Forum reports that the exhaustion of public Internet addresses is forcing major corporations to resort to a less desirable Network Address Translation technology to satisfy its addressing requirements. IPv6 increases the IP address field size in the packet header from 32 bits to 128 bits and thereby increases the number of unique addresses possible to a nearly incomprehensible amount of 10 to the 38th power. Its introduction is not without controversy, as the Director of the ITU's Telecommunications Standards Bureau recently pointed out,[9] but its gradual implementation is expected to ease the pressure on IP address demands, to permit the simpler auto-configuration of addresses, and allow for continued expansion of IP-based services via the Internet.

As with IP addresses, the convergence of IP-based voice and data services is forcing rethinking concerning the format for addressing communications. With only a traditional

[9] Houlin Zhao, "The ITU and Ipv6," Global Ipv6 Summit, Beijing, China, April 3-4, 2003, www.ipv6.net.cn/pdf%20ipv6/4.03/AM/2-zhao%20houling.pdf

telephone number, IP-based network elements can have difficulty uniquely identifying users and services via the Internet and subscribers have difficulty indicating their preferences for incoming communications. In cooperation with the ITU, the Internet Engineering Task Force has developed a common numbering protocol known as ENUM, designed to map contemporary E.164 numbers (the traditional telephone numbering scheme) into Uniform Resource Identifiers (URIs). These URIs will make it possible to use E.164 numbers to provide calling users with a variety of address capabilities, including those used for phone, fax, and e-mail, by which the called user can be contacted. Not only does this enable the recipient of the communication to tailor the ways in which they are contacted through a single number, it also allows callers to terminate calls to IP address-based networks. ENUM responds to the need to access a subscriber on an IP address-based network from the PSTN by providing a global numbering/addressing scheme across both PSTN and IP address-based networks.

. Under ENUM, the user will only have to enter telephone numbers: digits will be inverted and converted to the DNS-scheme via a conversion program. Contact information can be easily amended, added to, and updated without changing the number used for access. There is no target date for the implementation of ENUM, but trials are underway and pending issues are being worked out.[10] The ENUM Forum has suggested that the implementation process be guided by the following attributes:

- There should be a short implementation timeframe
- Government oversight should be as light as possible
- Competition should be viable at all levels

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[10] See "**Global Implementation of ENUM, "**– APT/ITU Workshop on ENUM and IDN, 25-26 August 2003 – www.aptsec.org/seminar/meeting-2003/workshop/enum/.

- All interfaces should be based on open industry standards and best practices and that they be stable, interoperable and uniform between the registrar and registry(ies)
- Intellectual Property owned by contracting authority for easy movement from one entity to successor
- The cost for procurement and operational cost should be minimal[11]

Leveling the Competitive Field for IP and Traditional Telephony

Aside from adapting to the IP-related addressing issues, regulators are also forced to contend with fundamental conflicts regarding provisioning of IP based services between legacy providers. Regulators have in general assumed two radically different postures according to the degree of market opening experienced within the regulator's domestic scenario. In those nations where market liberalization has already begun to transform the communications sector, IP-related services have thus far largely escaped regulation. Pressured by lobbying efforts from manufacturers of IP-enabled equipment, free speech and consumer advocates, and Internet activists, these governments have for the most part been reluctant to impose regulatory restrictions on IP-based access or services. On the other hand, countries where state or private monopolies continue to flourish remain dedicated to branding IP-related telephony as illegal and are seeking to restrict and control access. These countries are concerned about revenue lost to traditional (and licensed) telecommunications operators and advocate making IP telephony subject to international accounting rates. They seek to impose their position domestically through a variety of methods intended to restrict, limit, or otherwise control IP-based services. And to-date, such attempts have been met with questionable degrees of success.

The importance of a prudent and constructive approach to these challenges by both the regulator and policy maker cannot be overemphasized. In this era of disruptive and

[11] Gary Richenaker, Telcordia Technologies, and Steve Lind, AT&T, "ENUM Forum Contribution, " June 13, 2003. www.enumf.org/documents/gen/ GEN0068R2_Chair_Revised_Tier1_Proposed_Outline.doc

revolutionary technology advances, there is a concomitant need for constructive and functional legal frameworks and supporting policies that ensure maximum advantages accrue to the citizens and the state itself. There is no one formula for all situations, and many national formulas appear to be shifting over time. The United States Federal Communications Commission has historically declined to regulate Internet-based services, including IP telephony, determining it to be an ”information” service and not a “telecommunications” service. However, the increasing viability of VoIP as an alternative to traditional circuit-switched services may push it squarely on the FCC’s regulatory docket. In the United Kingdom, as in other countries, the regulatory effort focuses on the services provided, as opposed to the access technologies. The Office of Telecommunications judges that VoIP services should be regulated as public telephony only if it is not offered as an adjunct to traditional PSTN service and if

- The service is marketed as a substitute for traditional Public Switched Telecommunication Network (PSTN) voice services; or
- The service appears to the customer to be a substitute for public voice telephony; or
- The service provides the customer’s sole means of access to the traditional circuit switched PSTN.

Concluding Comments

This brief review has examined the nature of IP technology and services that are enabled by the IP network cloud, as intriguing, one would hope, as the clouds over Guyana that A.J. Seymour admired so many years ago. It is difficult to project with certainty where all of these IP clouds are taking us--just as difficult, perhaps as it was in Mr. Seymour’s days to predict the destiny or longevity of the flows of billowing images from his land into neighboring terrain. We at Detecon stand ready to aid in the evaluation of that process from the regulators viewpoint and help chart a course that will lead to a solution that distills the very best solution from these IP clouds for current and future users of this infinitely enabling technology.

About the author

Dr. Richard Downes is the Sales Director for Mexico, Central America and the Caribbean Region for Detecon Inc., a global leader in telecommunications, advanced engineering and Information Technology strategy consulting. He previously served as the Director for Latin America and the Caribbean for 3G Americas and the Universal Wireless Communications Consortium (UWCC), where he advocated the GSM-based evolution to advanced wireless services. He was also heavily engaged in advancing international roaming and in the dialogue on regional telecommunications issues in the Inter-American Telecommunications Commission (CITEL) and in various national-level debates on wireless standards in the region.

A native of Bangor, Maine, Dr. Downes is a retired U.S. Air Force officer and a member of three generations of family members dedicated to the telephone industry. He earned a Bachelor of Science degree from the U.S. Air Force Academy and a doctorate in History of Latin America from the University of Texas at Austin.