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Multiple Networks, One Access

The past few years have seen the rapid rise of the Internet to become a second universal network alongside the telephone network. Already the Internet traffic (measured in bits) exceeds that of the telephone network. Network operators are responding by making large investments in data networks and by looking for synergy opportunities through converging the networks. Futhermore, as competition increases, not only within a certain kind of network but also across heterogeneous networks, offering converged voice/data services is seen as a means to increase market share. However, even though data has overtaken voice traffic, voice services are still the main revenue source for carriers and should therefore not be disrupted by convergence. As the cost of bit transport in backbone networks continues to drop, the access represents an increasing part of a carrier's overall investment. It is of cardinal interest to maximise the return on this investment by turning today's access (the telephone line) into a single high-bandwidth line for voice, data and video services. This coincides with the interests of network users, who are best served by a single point of access to a converged set of services which use the full capabilities of the underlying networks. The paper explores the implications of these trends on the evolution of access, services and the networks themselves.

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Introduction

The past few years have seen the rapid rise of the Internet to become a second universal network alongside the telephone network. Already the Internet traffic (measured in bits) exceeds that of the telephone network, and this trend looks set to continue. However, even though data has overtaken voice traffic, voice services are still the main revenue source for carriers, estimated at between 80% and 90% of the total. For this reason data network operators and equipment suppliers are increasingly focusing on the provision of voice services over data networks. Traditional network operators are responding to this trend by making large investments in data networks and by looking for synergy opportunities through network convergence. Futhermore, as competition intensifies, not only within one kind of network but also across heterogeneous networks, operators are looking for differentiating factors to increase market share.

A second trend is the dramatic drop in the cost of bit transport in backbone networks, fuelled by technology innovations and giving rise to the 'Death of Distance'. Distance-independent charges are of course well-known to Internet users, but are increasingly becoming a fact of life in the PSTN as well, where long-distance tariffs are being slashed and distance-dependent tariff structures are drastically simplified or even eliminated. This has been recognized by the Voice-over-IP community, where a large degree of consensus exists that the window of opportunity for rate arbitrage is rapidly closing. Cheap telephony with reduced quality voice will not justify widespread deployment of voice-over-IP. As tariffs become comparable, as well as low in absolute terms, users will demand at least today's voice quality and convenience. Competition will therefore shift from price wars to service differentiation. Users will be attracted by converged voice and data services which increase convenience in their daily communication and which save time and effort. Carriers offering this will be rewarded with increased income from services and additional call minutes, as well as with increased customer loyalty or 'stickiness' in Internet terminology. In fact, services may be given away free for increasing stickiness of other services[1].

As the cost of bit transport in backbone networks continues to drop, the access represents an increasing part of a carrier's overall investment. It is therefore of cardinal interest to carriers to maximise the return on this investment by turning today's access (the telephone line) into a single high-bandwidth line for voice, data and video services. This coincides with the interests of network users, who are best served by a single point of access to a set of converged voice-data services which use the full capabilities of the underlying networks. On the other hand, users generally will neither know nor care how the various media streams comprising the services they are using are transported in the network; for example, by time division multiplexing (TDM), Internet protocol (IP) and/or asynchronous transmission mode (ATM). Service and access convergence will therefore happen much faster than convergence of the networks themselves.

Service Convergence

Service providers of all types are seeking solutions for delivering high-profit, differentiated voice and data services. The incumbent carriers, however, have an additional concern. They already have huge amounts

invested in traditional TDM switching, an investment that cannot be cast aside simply for the sake of new technology. Incumbent carriers realise that to remain successful, they must somehow preserve the best of their existing networks, while simultaneously adopting newer technologies to, in the first instance, support data services. In other words, they must find a way to leverage their existing circuit-switched investment through interworking and combination with packet-based data networks.

Emerging carriers, while seeking newer packet-based technologies, clearly understand that their networks must be capable of interfacing with the existing public switched telephone network. Another key concern for these new carriers is determining which of the thousands of features available through today's networks their customers will need. These new service providers, must look for ways to construct their networks that allows them to provide their customers access to the rest of the world while at the same time delivering all of the services and features that their customer base has come to rely upon.

Both incumbent and new carriers need a strategy that offers an economical path to ubiquitous service delivery and growth. To address competitive pressures and achieve their long-term goals, service providers require networking solutions that:

- allow for the rapid introduction of new competitive features;
- extend the revenue-generating life of existing networks;
- provide a cost-effective way of bridging their TDM and ATM/IP domains;
- take advantage of the existing line-side revenue producing features;
- deliver a future-proof solution; and
- operate in a multi-vendor environment.

For the service provider, one of the primary drivers for network evolution is revenue generation, whether from new or existing streams. The packet-based networks of the twenty-first century, capable of combining voice and data traffic, will enable a new set of services that could not be supported by the existing TDM circuit switched networks alone, for example:

- *Single-Stage Dialling Voice-over-IP (VoIP)*: Dial an IP call with a simple access code;
- *Virtual Private Networking*: Provides business customers with cost-effective, secure private networks using shared network resources;
- I*P-based Centrex*: Creates mixed VoIP and wireline Centrex groups;
- *Voice over DSL*: Delivers multi-line presence using a single copper pair;
- *Unified Messaging*: Retrieves both voice mail and e-mail from either PC or telephone;
- *E-Mail Notification and Voice Delivery*: Notifies users over the telephone when they have received e-mail, and receives messages over the telephone;
- *Subscriber Controlled Input*: Allows subscribers to conveniently change their telephony feature usage profile over the Web whenever and as often as they like;
- *Click to Dial*: Web pages with *call-me* buttons allow surfers to trigger a PSTN call setup over the Web;
- *IP Call Conference*: Set up a large telephone conference through the Web and receive notification of who is currently speaking;
- *Web Service Subscription*: Select a subscriber service over the Web and receive it immediately;
- *Voice/Data Collaboration Service*: Allows colleagues in different locations to collaborate on document/presentation development while communicating in real-time;
- *Multimedia Conversations*: School students discussing homework assignments, teenagers discussing (digital) pictures taken at yesterday's party;
- *Multimedia Call Centres*: New multimedia centric call centres allowing an end user to see a product and talk to a customer service representative over a single connection;
- *On-line Billing*: Check current call charges over the Web;
- *High-bit rate Internet Access*: Via xDSL; and
- *Remote Access Services*: Provides dial-in access offering for corporate accounts.

The major impact of any network solution on a service provider's bottom line is not the underlying technology, but rather the flexibility to deliver such network services. Solutions that support differentiated and innovative services, allow for the rapid introduction of new services and, most importantly, enable interoperability with the existing public voice network. What should be pointed out here is the different ways in which services have been provided in voice and in data networks. In the traditional voice-telephony networks, services and features are 'inside'—part of the network itself—usually implemented in a proprietary manner by the equipment vendor and owned by the network operator. This is the case irrespective of whether the service logic is implemented in the telephone switches themselves or in centralised computers (as in intelligent networks). In universal data networks (Internet), the services are 'outside'—implemented in computers (servers) at the edge of the network—based on industry standard (open) platforms, and most frequently not owned by the network operator but by independent service providers. This paradigm, with its promise of fast feature delivery and the ability to capitalise on the creativity of thousands of independent service suppliers, will also be applicable to future converged voice-data services. Traditional voice switches will therefore make use of commercial platform technology to allow client-server access to the large base of voice services, thus avoiding extremely costly re-implementation and preserving the stability and performance which is the hallmark of the telephone network. The same approach can make these voice services and features available in other networks, (for example, voice-over-IP) with the following advantages:

- supports today's complete telephony feature set,
- permits the fast introduction of new revenue generating features,
- provides for differentiated features,
- carrier-class, highly reliable, feature-rich solution,
- supports feature interworking,
- offers open interfaces
- provides cost-effective TDM to packet network integration, and
- provides TDM features to IP and ATM access devices.

Access Convergence

Although the access area has seen tremendous development over past years, it is still the case that for most

residential users and small businesses access to both voice and data services is via the telephone access line, not least because of the enormous embedded base of such lines, making wholesale replacement by other technologies very costly. Carriers must therefore be offered means to squeeze the most additional revenue out of this huge investment and to offer competitive high-speed access to data services. Here the various forms of digital subscriber loop (DSL) technologies come into their own.

xDSL solutions require, as the network prerequisite, copper twisted-pair cables and thus offer incumbent operators a good way of upgrading their network towards higher bandwidths. Universal asymmetric digital subscriber line (UDSL), symmetric digital subscriber line (SDSL), and asymmetric digital subscriber line (ADSL) need no upgrade of the copper networks at all, but only equipment at the central office and at the customer premises. The plain old telephony system (POTS) and some integrated services digital network (ISDN) traffic can be transmitted together with the broadband signals using frequency-division multiplexing. At the customer premises either a network termination or a PC card has to be installed. Additionally ADSL needs a splitter for separation of POTS and xDSL signals. UDSL (also known as G.lite) is well suited for residential mass market due to its splitterless nature, which allows installation at customer premises without truck roll out. SDSL is intended for upgrading ISDN lines.

At the central office side a digital subscriber line access multiplexer (DSLAM) is used which contains the modems and a concentrator to reduce bandwidth needed within the core data network. Looking at stand-alone systems, for every subscriber who wants to have broadband service, the copper cable from the main distribution frame has to be connected to a splitter to be able to add the broadband signal and has then to be rerouted to its narrowband line card. This requires skilled personnel as well as additional infrastructure and space for splitters and broadband equipment. The alternative to a stand-alone DSLAM is a switch-integrated xDSL line card which offers narrowband telephone service and broadband xDSL service at the same time. No external splitter is required. Offering broadband service to a subscriber now only requires the exchange of a line card. As xDSL is mainly intended for an upgrade of existing telephony networks, such a solution with minimum impact with respect to mechanical rearrangements, service interruption and introduction of new management procedures and systems has clear advantages.

The benefits of an integrated voice/data access are obvious:

- It provides the basis for converged voice/data services, by providing parallel access to PSTN and data networks, as well as interworking between them. Service convergence is enhanced by integrated authentication, operations, administration and maintenance (OAM) and billing.
- It is fast and flexible, permitting services to be changed without the need to change the access, thus providing a short time-to-market for new services. Additionally, it offers the subscriber unrestricted choice between circuit-switched and/or packet-based services.
- It is economical, as it provides for the reuse of existing highly reliable infrastructure and, with suitable design, minimised installation costs through plug and play provisioning.

Conclusion

Network convergence comprises many aspects. It has been argued here that service and access convergence will occur much faster than network convergence, as the former provides most utility to the end user and most revenue opportunities to the network operators. Backbone network convergence will most likely occur over a much longer time frame, as its benefits are not directly visible to the end user. For the network operators, on the other hand, long-distance traffic accounts for a declining proportion of revenue. Expansion in the backbone network will therefore be justified by the demand for new data services with rapidly increasing bandwidth demand, rather than the early replacement of the voice network infrastructure. Both of course will continue to profit from the continuing advances in transport technology such as wave division multiplexing. This leads to the conclusion that he network of the future will be a network of cost-optimised heterogeneous networks with full interworking capabilities, providing users with a rich, seamless set of converged voice/data services via a common access.

Reference

1 TOLLI, DOMINICK (AT&T). Presentation given at the 'Voice on the Net' conference, Las Vegas, 13–16 April, 1999.

Biography

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Dr. Hoogendoorn studied Electrical Engineering and Computer Science at the University of Stellenbosch, South Africa, Stanford University, United States of America, and the University of Cambridge, United Kingdom. He joined Siemens in 1987 after serving as Chairman of the Computer Science Department at the University of Witwatersrand in South Africa. He holds a variety of patents for his work on the architecture of switching systems. Dr. Hoogendoorn is currently Senior Vice-President responsible for Systems Engineering, Carrier Switching Networks, in the Information and Communication Networks division of Siemens AG.