TRANSWITCH®

*Engines for Global Connectivity*

communicator

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## From the President

The current Public Switched Telephone Network (PSTN) is based on circuit switching concept and has evolved over the last 100 years to its current state where it is the foundation of voice communication (and circuit-switched data communication) today. This foundation is now being challenged by new technology from the world of data networking. A number of industry analysts now believe that in the future, packet switching technology will be the choice for voice networks and not circuit switching. This transition will not take place overnight - it will be gradual.

The fundamental drivers behind this

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## The Future is Today: Major Trends in Data and Telecommunications

As the global leader in VLSI solutions for multi-service access and transport applications, TranSwitch is committed to monitoring and understanding significant technology and business trends in semiconductor, networking, and service environments. This knowledge is central to our business, as TranSwitch's VLSI solutions are fundamental enablers for next generation communications systems, networks, and services. We must prepare ourselves for these future changes by envisioning them now.

Timely solutions require intelligent monitoring of market dynamics, and TranSwitch sees seven networking trends as being especially important. Technology continues to be a primary catalyst for change, and four of the seven trends are technology focused: wireless communication, optical networking, end-to-end Internet Protocol (IP) networking, and broadband access. Completing the seven are two areas that are economic - carrier interoperation and global infrastructure build-out - and one that represents the confluence of technological, economic, and social changes: the Internet's World Wide Web (WWW). In this article, we present a short sketch of each of these trends and describe some of their implications for TranSwitch.

**Wireless Communication**

Today, wireless and wireline networks provide what are essentially complementary and non-overlapping services, with the former used almost exclusively for untethered voice communication. Although most new cell phones come equipped with data capability, lack of bandwidth to support fast Internet communications is a major obstacle to the use of cellular devices for data applications. A major technology challenge lies in managing the radio transmission to provide packet- or cell-based dynamic bandwidth capabilities. A number of broadband wireless solutions have been proposed, but broad market penetration and adoption have yet to be achieved.

A second challenge to the widespread use of mobile Internet communications lies in developing the means to display WWW information once it is accessed. One solution can be found in the Wireless Access Protocol (WAP) that prescribes how to build Web pages and transmit them to cell

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willingness to change are (a) the possible reduction in operating cost, and (b) the possibility of offering enhanced services.

Analysts estimate that by the year 2005, data will consume 95% of all available bandwidth in the U.S.A. This means that, by that time, data network economics of scale will make it highly advantageous in terms of cost of operation to eliminate the separate voice network.

In addition to the cost savings from the convergence of voice and data in the same network, packet telephony should facilitate applications or services which are difficult or impossible to offer when voice and data ride on separate networks.

A number of equipment vendors are now offering carrier-class packet telephony solutions with required functionality, reliability, and operations/management features. The intent of these products is to have seamless interoperability with the current PSTN and at the same time, facilitate the development and introduction of new and innovative services.

TranSwitch Corporation has a long history of being able to predict market and technology trends and field products to match the emerging applications. I.P. telephony is no exception. We now have a number of products for this end market. In fact, our CUBIT and ASPEN products are emerging as the technology of choice for the switching substrate in I.P. telephony applications.

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phones. However, the result is limited display capability, and, exacerbated by cumbersome keyboard entry functions, many applications are not yet feasible. Advances in micro-display technology will be critical to achieving a usable, high-bandwidth mobile Internet.

**Optical Networking**

There is little dispute that optical fiber transport provides the highest quality, most cost-effective medium for very high bandwidth transport. The penultimate challenge here is to transmit and switch end-to-end across the network without leaving the optical domain. While dense wavelength division multiplexing (DWDM) greatly augments optical network transport capacity today, end-to-end costs are increased by the numerous optical-electrical conversions required for switching and, at the interface, by connections to the non-optical portions of the transport network.

Optical switching and other high-bandwidth optical technologies are currently cost-effective only in the core of the network, where tremendous volumes of data and services are transported. Closer to the edge of the network, these technologies are cost prohibitive for all but the largest customers or metropolitan areas. Until optical switching to the service node is less expensive, the challenge is to define and design a cost-effective optical core that seamlessly interfaces with mixed media access networks.

**End-to-End IP Networking**

Conformance to clearly defined protocols is essential for cost-effective end-to-end networks. A generally accepted vision of the future is that end-to-end IP networking will be the protocol used in all-optical networks. Practically, this is based on the efficiency of IP for data traffic - which is surpassing voice traffic in volume- and on the premise that dedicated IP systems and networks will be whole cost optimal. As a result, the entire network is so cost-effective that, even when IP is not the most efficient way to transmit a particular service, the loss of efficiency for that service is insignificant.

The use of IP as the primary service protocol in a carrier grade network gives rise to quality of service (QOS) issues that were not anticipated in the original definition of IP, a scheme that was then optimized for delay-insensitive data traffic. A variety of IP modifications are now addressing this issue, with multi-protocol label switching (MPLS) being particularly promising.

A second transitional issue regarding IP networks is that, until penetration reaches 100 percent, these networks need to interwork with non-IP networks to provide reliable end-to-end connectivity at the bandwidths required for IP services.

**Broadband Access**

Given that service traffic drives demand for backbone network facilities, soon to be flush with DWDM bandwidth, the question of how to get the service to the customer is critical. This comes down to bandwidth requirements in the “last mile” - the final connection between service providers and service users. The quality of service - in terms of speed and functionality - experienced by end users will improve dramatically only when bandwidth at the fringes of the network becomes significantly greater than it is today.

Among the approaches that have been proposed to provide the necessary level of service bandwidth are optical fiber, cable, broadband wireless, fixed wireless, and multiple variations of DSL (digital subscriber loop) technology. All of these technologies are presently under some degree of deployment, but quality, performance, and economic tradeoffs have meant that there is not yet one clear winner.

**Carrier Interoperation**

Bolstered by an increasingly strong economy and by government deregulation, new networks are being built at breakneck speed, not only in industrialized countries, but also

throughout the entire world. In fact, the telecommunications infrastructure has been acknowledged to be a fundament factor in economic growth, quality of education, and global competitiveness. Therefore, the race to connect as many businesses and end-customers as possible continues, as service providers compete on the basis of coverage (number of subscribers reached) and value (more services at lower cost).

An immediate byproduct of global network proliferation has been increased complexity of interconnections and interoperability among networks. Not all networks succeed, and the more successful operators will acquire the less successful ones. The interoperability and interworking issues are magnified in this case, as the merging of networks creates the need to offer a full service suite across both the original and the acquired networks, even when they may have been built at different times with different technologies and architectures. Many new networks deploy a single protocol technology throughout, creating all-ATM or all-IP networks for example, and these must operate with older mixed-protocol networks. The requirement for seamless end-to-end value-added service creates an even greater challenge at the network gateway, as compared to simply handing off basic traffic between two unrelated service networks. In an extension of the Second Law of Thermodynamics, all pure protocol networks tend to become multi-protocol networks over time.

**Global Infrastructure Build-out**

As the global infrastructure expands for economic and social reasons, an interesting consequence is the patchwork build-out of the networks. In industrialized countries, this protocol quilt is driven by the need to differentiate. In developing countries, it is driven by the fact that build-out tends to be patchwork because networks in large cities were built long before those in the more remote areas. So, while remote regions do not have extensive telecommunications services, it often happens that networks in outlying areas are more modern than their urban predecessors. Indeed, because of the time it takes to deploy extensive networks, many segments have already become obsolete by the time build-out is complete.

A second consequence of network build-out is that the most modern network architectures are usually deployed in developing countries. Starting with a clean slate, without the need to maintain an aging but highly utilized legacy infrastructure, means that interoperability issues can be avoided in initial deployment. Therefore, optical metropolitan and backbone systems are readily deployed, in combination with wireless for voice access (and, more and more, for low speed data access). Higher-level interoperability issues remain, however, because of the immediate need to interface with other international or neighboring networks, and because of the inevitable need to add new unforeseen services and technologies to the network.

**The Internet and the World Wide Web**

The Internet and WWW are global social phenomena that are changing the way people work, live, and think. The ability to connect to and share information from almost anywhere at almost any time is changing the way that people communicate and the way that business is conducted. For example, e-mail is fast becoming the preferred mode of communication, not only in corporate environments, but also in small businesses and homes, with the use of wireless phones, PDAs, and pagers becoming quite common. In fact, the appetite of end users for high-speed and high-bandwidth appears insatiable. As growth rates for data traffic continue to exceed those for voice traffic and cellular access to the Internet becomes more pervasive, the need to extend broadband access to desktops, laptops, palmtops, and network appliances will become even greater.

The WWW has changed the way people communicate, and it has also changed their expectations. The richness of information that is readily available - together with freedom from the communication barriers posed by differences in time and location - makes Internet users impatient with anything less than instant response from a 24x7 network.

**With an eye to the future**

Technology trends show much progress toward delivering multi-functional services throughout a global network at very low cost. The common objective that underlies all these trends is the need to deliver substantially more bandwidth through a universal infrastructure that provides broadband access at low cost per bit to people everywhere.

From TranSwitch's perspective, the key factors that weave these seven trends together are the need for bandwidth in the network — especially, broadband access; the need for interoperability among protocols, networks, and services; and the unparalleled and unpredictable rate of change.

This demand has tremendous implications for all enabling technologies - services, systems, networks, terminals, semiconductors, and protocols - and for the industry leaders like TranSwitch that develop these technologies. Our response has been to focus on delivering the most complete line of VLSI solutions for multi-service access and transport applications, and on integrating the core attributes of programmability, multi-protocol functionality, systems knowledge, and world-class design support.

Future issues of communicator will further explore networking trends and the ways in which TranSwitch is leveraging its in-depth understanding of how protocols interact, how multiple protocols can be handled simultaneously, and how service distribution and access networks can be built efficiently.

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# TranSwitch Corporation Acquires Alacrity Communications, Inc.

TranSwitch Corporation has acquired Alacrity Communications, Inc. which specializes in the development and marketing of high-capacity VLSI switching devices for telecommunications and data communications applications. Alacrity has developed a high performance VLSI product line called MMIP™ which can be used to configure high-capacity switching platforms for switching ATM, I.P. and TDM based traffic.

"With this acquisition, TranSwitch gains access to Alacrity's highly innovative VLSI technology for integrated data, voice, and video switching and traffic management. In combination with our *CellBus®* and SONET/SDH technology, TranSwitch now has the key VLSI solutions for applications in equipment needed to configure the next generation network infrastructures," said Dr. Santanu Das, TranSwitch's Chairman and CEO.

Integration of Alacrity's high-speed switching technology into TranSwitch's ATM/I.P. product line will deliver a seamless path for capacity expansion of TranSwitch's patented *CellBus®* architecture. *CellBus®* -based devices, such as CUBIT-3™ and ASPEN™, are widely deployed in multi-service access systems worldwide, and the extension of this technology, with the MMIP™, will further enable cost-effective system architectures to address increasing service capacity requirements. "We welcome Alacrity to our team and look forward to expanding our development efforts and technology capabilities with the talent pool available within Alacrity," concluded Dr. Das.

"TranSwitch's market presence, along with its complementary technologies, makes this a great opportunity for Alacrity to realize the market potential of our existing high-speed cell switching technology and its planned extensions," stated Dr. Zheng Liu, Vice President and CTO of Alacrity.

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# TranSwitch President and CEO Awarded Ernst & Young LLP Entrepreneur of the Year Award

Dr. Santanu Das, President and CEO of TranSwitch Corporation recently won the Ernst & Young Entrepreneur of the Year Award for Southwest Connecticut / New York Hudson Valley in the Telecommunications category. Dr. Das received the award in recognition of his vision, innovation and accomplishments in establishing and sustaining a successful and growing business.

Dr. Das "accepted this very prestigious award on behalf of the TranSwitch employees and Dr. Steward Flaschen, TranSwitch's former Chairman of the Board who passed away this past year. This is a very special award for me and TranSwitch," said Dr. Santanu Das, President and CEO of TranSwitch. "I am very grateful to all TranSwitch employees who have worked so hard to establish this company as a leader in the communications IC (integrated circuit) space. The men and women who comprise the TranSwitch team have propelled us into a leadership position by the power of their ideas and the strength of their commitment and for this I salute them and extend my personal gratitude."

Dr. Das was selected from a group of distinguished nominees by an elite, blue-ribbon panel of judges composed of business and civic leaders, academicians, as well as prior year award winners. Dr. Das is now eligible to compete for the national Entrepreneur of the Year Award at Ernst & Young's Entrepreneur of the Year International Conference to be held in Palm Springs, California, November 9-12, 2000.

Dr. Das has been President and Chief Executive Officer of TranSwitch since its inception in 1988, and in 1997 he also became the Chairman of the Board of Directors. Dr. Das has led the company to a strong financial performance since its Initial Public Offering in 1995. The Company has seen sequential revenue growth and profitability for the past several years and has established itself as a leading innovator of high-speed semiconductor solutions for three fast-growing communications end markets, namely; the Worldwide Public Network Infrastructure, the Internet Infrastructure, and the Corporate Wide Area Networks.

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