TranSwitch®

Silicon Solutions Integrating Communications Worldwide

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From the President

In today's complex and rapidly evolving telecommunications environment, the potential exists for a complete reordering of the key equipment and service providers. So how do ISPs, LECs, CLECs, IXCs and datacom carriers, as well as their equipment suppliers, navigate this challenging time and still prosper?

We believe the answer is twofold. First, the carrier and equipment manufacturer must collaborate to build highly flexible networks that can accommodate different mixes of traffic, and can grow and adapt to changing needs with only software upgrades.

Second, the service providers must find ways to bundle services in ways that solve the total customer communication problems of their customers.

At TranSwitch, we design, manufacture, and supply VLSI devices whose applications span the full

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DSL Technology Shifts Carriers to the Passing Lane for Internet Access

By Dan Upp

The explosive growth of the Internet is the single most important factor influencing global networking today. With over 40 million users and demand increasing at a rate of nearly 20 percent per month, the Internet accounts for the bulk of new data traffic, particularly in local exchanges. Dealing with this phenomenal growth and determining how to profit from it is one of the most pressing problems of telephone operating companies. Today's standard access methods for public and Wide Area Networks (WANs) using dial-up modems are inadequate to the task of delivering data at higher speeds. The use of Digital Subscriber Loop (DSL) technologies offers one of the best network access options for public carriers.

The Information Highway Traffic Backup

Over the past five years the number of Internet users has increased dramatically from a relative few to tens of millions of subscribers. At the same time the type of customers and their patterns of use have changed. Improved Web browser tools allow an unsophisticated user to access information anywhere in the world quickly and easily. An on-line data base in New Zealand is as accessible as one in the New York Public Library. Commerce over the Internet is a reality and other commercial applications are challenging the TV shopping channels.

But from the viewpoint of telephone operating companies, this is not nirvana. Most of the net access traffic handled by dial-up links (via modem) is routed to local telephone numbers and kept busy for a much longer time than normal telephone calls. Since telephone switches are generally dimensioned according to heuristic rules based on a century of observing voice call statistics, these net access calls end up being handled poorly. Voice calls average three minutes and

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spectrum of the information infrastructure, from local loop and ISP installations to very high-speed SONET/SDH backbones.

It is our belief that a more flexible and adaptable network will have to evolve to allow cost-effective delivery of new and expanded services. Key to this new network architecture are smart and programmable VLSI devices which we call "connectivity engines." These engines are RISC-based silicon building blocks that our customers, the equipment suppliers, can package into a wide variety of communications products. Connectivity engines can then be programmed to realize an adaptive, reconfigurable network.

We don't pretend to know what services and standards will become dominant in the next several years. But we can help our customer be better prepared for the changes that will inevitably come. By using suites of programmable cores (connectivity engines), equipment suppliers and information carriers, can accommodate the "flavor of the month." Such flexibility allows them to transport information regardless of whether it is packaged as cells, packets, or continuous bit streams. After all, the physical layer standards for most protocols are already well defined. Why not make higher level abstractions programmable? In this way, the investment in the physical layer is retained, while simultaneously creating an adaptable architecture.

Customized bundled services is the second survival tactic. Finding ways to solve a customer's total communication needs is likely to be the most important aspect for success in the coming years. Once the carriers' marketing groups figure out what products their customers are looking for, they will realize that they need a configurable, multi-service network architecture based upon programmable platforms. These platforms will be based on VLSI chip sets, such as CUBIT, and other programmable products that TranSwitch offers.

Customized services can be created for individual customers by programming these platforms. The software modules in these platforms can be used to configure and quickly adapt the network to respond to customer needs. Thus, reconfigurable software system and programmable VLSI devices will be key to creating the multi-service network of the future.

It is a particularly turbulent time in the information age. However, with chaos, there is also opportunity. Clearly, there are ways to capitalize on this opportunity. ❖

Santanu Das

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the average subscriber has only a few conversations per day. Network management is performed on a statistical basis to accommodate a predetermined number of simultaneous calls. If a call attempt occurs when all resources are in use, that call is blocked. The objective is to maintain an acceptably low blocking probability under peak traffic conditions (for example on Mother's Day) while keeping capital costs as low as possible.

Since holding times for dial-up Internet access calls now average nearly an hour, this situation can wreak havoc on office performance. Completion rates on both new voice calls and modem access attempts drop substantially below acceptable limits when a large number of long-holding-time calls are received. Furthermore, the operating companies generate no revenue from local calls unless they are routed to an Internet Service Provider (ISP) owned by the company. Carriers can provide connections to the Internet but find they enjoy little benefit.

The DSL Solution

Besides seeking to resolve the Internet traffic dilemma, operating companies are also in search of new revenue opportunities, especially those that could take advantage of their existing copper loop infrastructure. Meanwhile cable companies are beginning to offer both data access and voice telephony to subscribers, presenting a direct threat to carrier revenues. From the telco viewpoint the best emerging solution to address both call congestion and new profit generation employs a variety of Digital Subscriber Loop technologies. Using DSL, carriers will be able to offer higher speed data and Internet access to their customers. This will increase customer satisfaction and serve to keep excess traffic out of central office voice switches, restoring performance to desirable levels. Of course, carriers will have to figure out how to charge for high-speed data access.

Some DSL implementations, such as ADSL, use data-over-voice technology. With dial-up modem access, modem signals occupy the voice spectrum, preventing any other use of the copper access loop. In ADSL data signals occupy spectrum space well above the voice range. This makes it possible to transport voice and high speed data over the same copper pair to the same subscriber. Conventional voice service continues over the existing wires with no change. Lifeline services are unaffected by the ADSL overlay.

At each end of the subscriber loop installation of a passive splitter device allows DSL signal access as illustrated in Figure 1. The function of the splitter is to enable voice signals to pass through while allowing the higher frequency DSL signals to be added at the office end or removed at the subscriber end. This keeps the high frequency signals out of the switch and the ringing voltage out of the DSL modem. The loop simultaneously carries two independent signals with DSL modems, better serving both customers and service providers. The primary customer benefit is higher access speed ranging from

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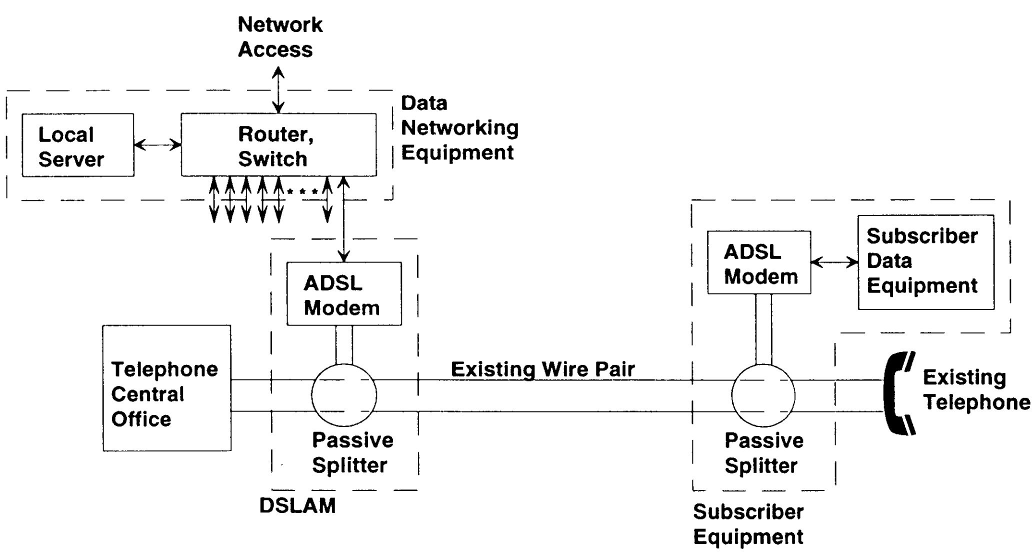
128 kb/s to 50 Mb/s. Available speeds decrease with increasing loop length with short loops supporting the highest speeds.

The benefits of DSL for public carriers are twofold. The first advantage is realized by rerouting the dial-up modem access traffic away from the switch to relieve the switch saturation problem. While this benefit alone might justify the investment in DSL technology, there's more. The terminal modem end is contained within operating company equipment instead of at the destination of a dial-up modem link. This creates opportunities for carriers to offer value-added services that did not previously exist. Telcos can easily add highly targeted services for a local market segment or even tailored to specific customers. Targeted advertising and local news dissemination are the most obvious applications beyond basic net access, but one can expect many more services to be developed in the future.

Figure 1. Installation of a Typical Digital Subscriber Loop System



Implementation of DSL Systems

Three elements are involved in introducing DSL technology into the local copper plant - the subscriber's equipment, the telco Digital Subscriber Access Loop Multiplexer (DSLAM), and data networking equipment. At the subscriber premises, installation of a magnetic passive splitter device permits connection of the xDSL modem while keeping existing telephone service intact. Digital information from the subscriber's data equipment, such as a personal computer, is transmitted by the xDSL modem using carrier frequencies above the voice range. Depending on subscriber end requirements a wide range of device interconnections is possible, including a direct link into a PC or video codec or into a local network.

At the carrier termination point xDSL technology will be installed on a number of incoming copper pair lines. The point of termination may be located in a central office building, in remote access equipment in an environmentally-controlled vault, or in outside plant equipment. In each case the first element in the system is the magnetic passive splitter, which separates the xDSL modem signals from the voice path into the switching or remote concentration systems. Local connections to the xDSL modem are made first to the splitter output and then from the xDSL modem into data networking equipment.

Many xDSL modems will be terminated in a DSLAM system. DSLAM systems will range in size from remote concentrators serving tens or hundreds of users up to larger central-office-based systems with more subscribers and support for more services. The xDSL modem may transport data in the form of either ATM cells or packets depending on application and customer requirements. In each case the modem input/output connection into data networking equipment allows for a variety of connections between multiple sources or servers and individual subscribers. Interconnectivity can be defined according to subscriber service needs and operating company strategies. The major advantage of xDSL technology over dial-up access can now be seen more clearly. Since the termination point for the xDSL modem is located inside the carrier's plant, every ATM cell or packet passes through telco equipment. This creates opportunities for new service definition and easy monitoring for billing or data collection purposes.

Example of DSLAM Architecture

The requirements for justifying installation of a DSLAM system are typical of public network equipment: low cost, high reliability, easy maintenance, and application flexibility. A representative structure for a remote concentrator is a simple system with a bus-based architecture in a backplane.

Several xDSL line cards plug into a bus in the backplane along

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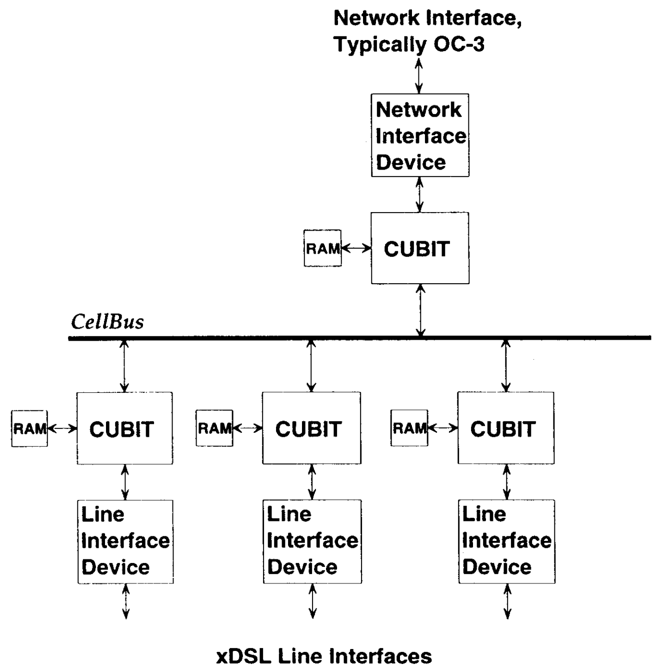
with one or more network uplink cards. In a concentrator, information is transferred only between the cards connected to the lines and the network uplink. Whether the lines are transporting ATM cells or IP packets, the role of the remote system is simply one of transmitting information from lines to network links. No internal line-to-line switching is needed, normally a requirement in public network equipment operation. This simplifies the system and keeps costs as low as possible. More sophisticated systems can also support line-to-line connections or even a complete routing function, but the majority of the market, particularly for residential and small business applications, will opt for the lowest cost service.

As an example of currently available DSLAM technology, the TranSwitch *CellBus* architecture is designed specifically to serve the DSLAM remote access application market. Its central feature is a 32-bit-wide backplane bus capable of supporting either ATM cell or packet transfers between attached cards. Standard operation of the system allows for cell or packet transfers between either line and network cards or line-to-line cards. The system is designed to use low voltage, low power Gunning Transceiver Logic (GTL) for bus interface and support up to one gigabit per second of net information transfer, more than sufficient speed for DSLAM remote applications. *CellBus* standardization is currently in progress, with the first efforts being led by the VME Industry Trade Association (VITA).

CellBus is physically configured as a 37-line parallel bus which executes the basic switching functions by interconnecting a number of interface devices and allowing cell routing among them. CUBIT is a first-generation VLSI device for implementing these parallel bus systems. As shown in Figure 2 a

Figure 2. The *CellBus*-CUBIT DSLAM Architecture



CellBus system is built by connecting several CUBITs over the basic bus architecture. Each CUBIT device, together with a small connected SRAM, forms a complete section of a switch. All of the basic switching functions of translation, routing, and cell buffering are contained in each CUBIT/SRAM combination. Multi-port switching systems can be formed by connecting multiple CUBITs over a *CellBus.*

Virtual Circuit call control is accomplished by entering the routing and translation information into the CUBIT/SRAM. Once this information is entered into the control system, no further action is required for the duration of the session. Incoming ATM cells are routed autonomously by the CUBITs over the *CellBus* according to the programmed Virtual Circuit paths.

No other components are needed to build a basic ATM switching system besides the CUBIT/SRAM units and an external clock. No glue logic, bus transceivers or other specialized functions are needed. The resulting architecture is suitable for a wide range of applications covering lines with a variety of speeds and many different types of interfaces.

Conclusions

The growth in the number of Internet users and the demand for higher Internet access speeds is expected to only increase over the next several years. DSL technologies executed in DSLAM architectures show the greatest promise of delivering higher access speeds and providing a new source of service revenues for public carriers while avoiding central office line saturation. The *CellBus* system from TranSwitch provides a readily available platform for DSLAM implementation. The CUBIT and more advanced products now in development can provide a powerful, cost effective vehicle for the move to DSLAM technology now and in the future. ❖

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List of TranSwitch Products

Product Name	Product Number	Product Description
Asynchronous VLSI Devices		
ART/ARTE	TXC-02020/21	Advanced DS3/STS-1 Line Interface Device
DS3F	TXC-03401	DS3 Framer Device
DS3LIM-SN	TXC-20153	DS3/STS-1 Line Interface Module
E123MUX	TXC03361	E1/E2/E3 Mux/Demux Device
E3LIM	TXC-20163	E3 Line Interface Module
E2/E3F	TXC-03701	8- 34-Mbit/s Framer Device
HDLC	TXC-05101	HDLC Controller Device
JT2F	TXC-03702	6-Mbit/s Framer Device
M12	TXC-03375	DS2/DS1 Mux/Demux Device
M13E	TXC-03303	DS3/DS1 Mux/Demux Device
MRT	TXC-02050	6- 8- 34-Mbit/s Line Interface Device
QDS1F	TXC-03102	Quad DS1 Framer Device
QE1F	TXC-03104	Quad E1 Framer Device
QT1F-*Plus*	TXC-03103	Quad T1 Framer-*Plus* Device
XBERT	TXC-06125	Bit Error Rate Generator/Receiver Device
SONET/SDH Synchronous VLSI Devices		
ADMA-E1	TXC-04002	2-Mbit/s to TU-12 Async Mapper-Desync Device
ADMA-T1/T1P	TXC-04001/11	1.544 Mbit/s to VT1.5/TU-11 Async Mapper-Desync Device
L3M	TXC-03452	SDH/SONET Level 3 Mapper Device
L4M	TXC-03456	SDH/SONET Level 4 Mapper Device
QE1M	TXC-04252	Quad E1 Mapper Device
QT1M	TXC-04251	Quad T1 Mapper Device
SOT-1/SOT-1E	TXC-03001/11	SONET STS-1 Overhead Terminator Device
SOT-3	TXC-03003	STM-1/STS-3/STS-3c Overhead Terminator Device
SYN155/155C	TXC-02301/02	155-Mbit/s Synchronizer Device
ATM (Asynchronous Transfer Mode) VLSI Devices		
ALI-25C/25T	TXC-07125/225	ATM 25-Mbit/s Line Interface Controller Device/Transceiver Device
CDB	TXC-05150	ATM Cell Delineation Block Device
CUBIT	TXC-05801	ATM *CellBus* Switch Device
SALI-25C	TXC-07625	Six ATM 25-Mbit/s Interface Controllers Device
SARA-R	TXC-05601	ATM/SMDS Reassembly Controller Device
SARA-S	TXC-05501	ATM/SMDS Segmentation Controller Device
SARA-2	TXC-05551	ATM Segmentation and Reassembly Device

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