"Conversion Box" Utilizes Modular Approach and IndustryPacks to Link Telecommunications Switches and Billing Systems

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Modern telecommunications networks incorporate a complex mix of proprietary and standard communication protocols in call routing and billing systems. This complexity presents special challenges for engineers charged with the enhancement or modernization of a system. The implications of addressing mixed protocol systems can best be understood by first reviewing two specialized definitions in the telecommunications industry: switch and provisioning.

Switch Compatibility is Essential

A switch is a bank of integrated computers responsible for routing calls through the intricate weave of wire, fiber optic and satellite routes that make up the telecommunications infrastructure. Further, the switch also collects information on each call -- the station used to place the call, the number called, when the call began and when it ended. This information is recorded on every switch along a call's route. For example, a phone call from Detroit, Michigan to Lakeland, Florida, is first routed to a local switch in Detroit. The local switch then routes the call to a switch on a trunk line. The trunk line switch routes the call to another switch on the trunk line near Lakeland. That switch sends the call to a local switch, which in turn routes it to the destination. Each of these switches must be able to communicate with one another, and each holds call information that must be collected and transmitted to a billing system in order to present coherent statements to carriers and consumers.

Older switches periodically download call information to a storage device (such as a tape). Newer switches send it via a high speed modem to a host computer in response to requests from the billing application. In order to maintain compatibility with older switches, the newer switches still utilize proprietary formats based upon tape drive requirements and low level wire protocols for the transmission of call data. These formats and protocols vary with each switch manufacturer and even between switch models, although many of the new switches now use standard well-defined protocols (X.25, FTP, and OSI) for transaction data.

In the telecommunications industry, provisioning refers to the maintenance, and modernization of switches. Switches are complex devices and expensive devices. As a result, it is not practical to change switches each time the company adjusts another aspect of its operations. While they have been modified with a high speed modem to send information directly to the host billing computers, many still employ proprietary protocols when transmitting the information. Many Regional Bell Operating Companies (RBOCs) have connected older switches to a Wide Area Network (WAN) and the X.25 protocol in order to complete the link with the maintenance systems.

Most new billing systems are configured to receive transaction data via standard protocols. As a result, firms installing new billing systems are faced with the choice of modifying or replacing older switches that employ proprietary protocols. Recently however, a different alternative was developed for a national telecommunications company.

The Conversion Box Approach

Instead of replacing switches, a conversion box approach has been implemented (Figure 1). The conversion box is an embedded application, that is an application that utilizes a specialized computer as a "black box" link between two dissimilar devices or systems, in this case the switch and billing system host computer. It accepts data from the switch using the proprietary protocol and converts it to standard protocols – X.25, FTP, and OSI – to send the data to the billing host.

Several important design criteria drove the development of the conversion box. First, off-the-shelf hardware and software components were used whenever possible. With only six months to complete the entire project, development efforts needed to be focused on the application software. No time was available to reinvent ancillary components. Also, the design employed modular components to simplify maintenance of the delivered system, and increase its flexibility. The conversion box was also designed to be very reliable, with a mean time between failure of components measured in years. Finally, the conversion box also includes built-in redundancy of some components

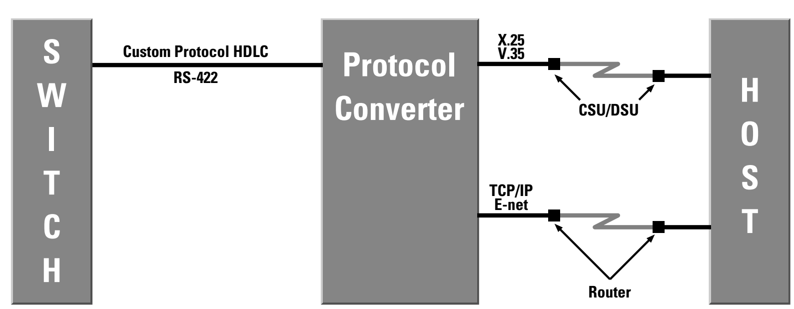

Figure 1. System Design

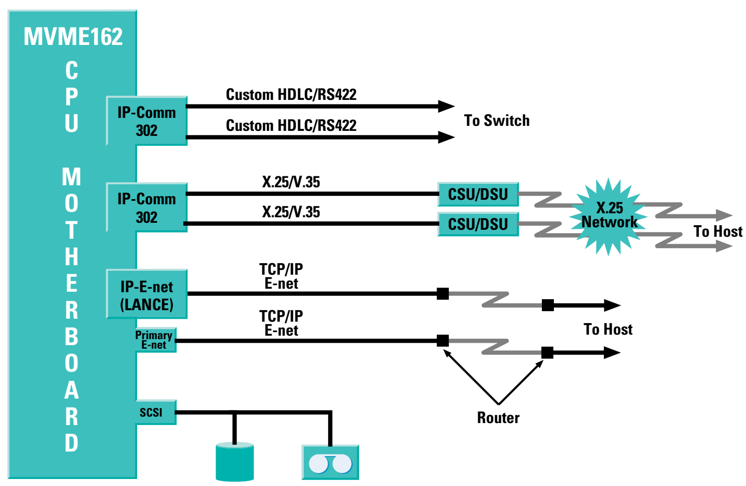

Figure 2. Hardware Detail

as a extra safeguard against failures. Utilizing the redundancy, the conversion box is designed to adjust and continue to operate if other components in the system fail, such as a modem or network connection.

Hardware Overview

An overview of the hardware (Figure 2) begins with the I/O for the conversion box. The conversion box is linked to the switch by twin synchronous serial lines. The conversion box receives commands from and sends data to the billing system by two X.25 synchronous serial lines and two Ethernet cables. The X.25 synchronous lines employ a high speed modem, a DSU/CSU. This configuration provides redundancy not only by the number of lines but also by type of line. Also, duplication allows the conversion box to communicate directly with the billing system on a WAN, utilizing the X.25 protocol or directly connected on a LAN via TCP/IP and FTP.

The I/O lines are linked to a Motorola MVME162 CPU board via three SBS GreenSpring IndustryPacks (IPs): an IP-Comm 302 for the serial lines from the switch; an IP-Comm 302 connects the X.25 synchronous lines to the billing system; an IP-Ethernet (LANCE) for the Ethernet cables. IndustryPacks, each about the size of a business card, perform related groups of input/output functions, including most standard communication interfaces. The IP-Comm 302 places a Motorola MC68302 communications processor on a single IndustryPack. The IP-Ethernet uses the industry standard AMD LANCE chipset compatibility with a wide range of real-time operating systems.

Up to four IndustryPacks snap into the Motorola MVME162. An open specification defines the IndustryPack mechanical, electrical and timing interfaces to the MVME162 board. In this application the IndustryPacks met the requirement for proven, off-the-shelf components that provide the CPU board with its serial, X.25 and Ethernet communications capabilities. This is much simpler and more reliable than modifications to the CPU board or design of a custom CPU board. The other major hardware components are a SCSI hard drive and a tape drive. The use of IndustryPacks provided all the functionality mounted on a single MVME162, which resulted in a single slot, high density solution.

The Protocol Layers

Hardware is the lowest, physical layer in protocols. The other layers of the protocols used in the conversion box are listed in the chart below.

In addition to the protocols detailed above, OSI is becoming widely accepted as the standard for international telecommunications systems. When implemented, everything down from the transport layer will be OSI, and OSI will be used on the Ethernet or the X.25 lines. On the Ethernet lines, the OSI protocol goes down to the physical layer. On the X.25 serial lines, the OSI protocol will sit on top of the X.25 Packet level. The application level of OSI protocols to be used in future systems are FTAM and CMIP. FTAM is the OSI equivalent of FTP. CMIP is used for managing objects, and it is going to be used to manage switches in the telecommunications industry. Again, the modular approach minimizes the effort required to upgrade the conversion box to OSI.

Software Employs Layered, Modular Approach

The software is also layered. At the lowest level are the device drivers for the IP-Comm 302s and the IP-Ethernet. The next level contains the pSOSystem Real Time Operating System, its STREAMS environment and the protocol stacks. There are protocol stacks for OSI, X.25, and TCP/IP. The application software resides on the top layer.

Two other points should be made about the software. The application and operating system are booted from the hard drive. This approach is less expensive then utilizing Read Only Memory (ROM) or Flash Memory, plus it has the benefit of being more flexible. Updates to the operating system and application can be installed via Ethernet or tape to the conversion box.

Following the data through the system helps to illustrate the interaction of the hardware and software components. The call information begins at the switch. It is received by an IP-Comm 302, which passes it to the CPU board and the application software. The application software manages the conversion of the protocol

Layer	Switch	X.25/DSU/CSU	Ethernet
Transport	Not Applicable	Application	TCP and FTP
Network	Custom	X.25 Packet	TCP and IP
Data Link	SDLC, HDLC	LAP-B	IP (Internet Protocol)
Physical	Serial	V.35 serial	Ethernet

and its layers from the switch and stores the converted data to the SCSI drive. When the billing system calls for data, the commands are received through the IP-Comm 302, or the IP-Ethernet. These devices transfer the commands to the applications software, which responds by retrieving the data from the disk. It is then sent via the IndustryPacks and from there to the connected billing system.

The device drivers and other related software which manage the passage of the data through the hardware and software layers were developed by Highlander Engineering of Lakeland, Florida.

System Proven Reliability in Rigorous Testing

The conversion box and its components have proven to be very reliable and adaptable. During extensive testing a number of scenarios were constructed. In one situation, a modem was disabled. The system compensated by employing the second line. When the disabled modem was brought back on-line, the system again reacted and began using the modem again.

The modular IndustryPacks are integral to the flexibility of the conversion box, which protects the telecommunications company's investment. Should conditions change, and a larger number of lines are required, all that is required is the replacement of the IP-Comm 302 with an IP-Comm 360 (which implements the Motorola MC68360 communications processor). Costly changes to basic design or the CPU board are avoided. Also, as the IndustryPacks are low cost devices, the equipment investment required to make the change is minimal. Other major changes, such as the introduction of the ISDN protocol can be accomplished by the minor replacement of an IndustryPack. By incorporating a modular, off-the-shelf component strategy, the conversion box protects existing investments in the telecommunication infrastructure, without presenting any obstacles to its enhancement.

SBS GreenSpring Modular I/O can be found on the Web at:
www.greenspring.com

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VITA 19-199x, BusNet– BusNet enables multiple CPU boards (and/or intelligent controller boards) to communicate across a backplane as if it were an Ethernet network. BusNet permits system configurations consisting of UNIX, real-time or mixed UNIX/real-time computing nodes to exist within one single chassis. A copy of the BusNet draft standard is available from the VITA office. A task group ballot for BusNet was completed on May 23, 1997 and VITA 19 has been moved to the ANSI canvass process. Contact John Rynearson, Techical Director, VITA (techdir@vita.com) if you wish to ballot this standard. A copy of the Busnet specification is available on VITA's web site.

VITA 23-1997, VMEbus for Physics Applications– Many particle physic labs use VME as the basis for experiment control. The purpose of this effort is to come up with a set of recommended practices to encourage commonality. This effort is being sponsored by VIPA — the VME International Physics Association. Contact Bob Downing, Fermi, rwd@fnal.gov, or Chris Parkman, CERN, chris_parkman@cern.ch, for more information regarding this effort. The last task group ballot met the VSO's 75/75 rule and VITA 23 has been moved to the ANSI process. If you would like to participate in the ANSI ballot of this standard, please contact John Rynearson <techdir@vita.com> or Cheryl Cook <cheryl@vita.com> at VITA.

VITA 25-1997, VISION– At the July 1996 meeting in Ottawa, Jim Pangburn of Fermi National Accelerator Laboratories presented a proposal for an object based I/O software interface for the VMEbus. To build consensus for this effort Jim asked and was granted study group status. At the September 1996 VSO meeting, task group status was granted when CERN, Lecroy, and Fermi indicated that they would sponsor this effort. A draft specification is available on the VITA web site. The group has completed a successful task group ballot and VITA 25 has been moved to the ANSI canvass process. Contact John Rynearson, VITA, <techdir@vita.com> or Cheryl Cook, VITA, <cheryl@vita.com> if you want to participate in the ANSI ballot.

VSO TASK GROUP ACTIVITIES

Standards within the VSO are developed in task groups. The formation of a task group requires at least three companies that are VITA members and the proposed work must fit within the defined scope of VITA's accreditation with ANSI. Non VITA members may serve on task groups with the approval of the chair and the task group. The following draft specifications are being developed by their respective task groups within the VSO.

VITA 1.2-199x, High Availability VME (H. A. VME), Draft 0.2, Nov. 9, 1995. – This work is a result of the work started as VMEbus System Level Live Insertion. At the Orlando VSO meeting in March 1995 a special meeting was held to discuss High Availability VMEbus (H.A. VME) requirements. The purpose of this group is to develop a standard based on VME64 and VME64 Extensions that provides Scaleable Fault Management and Dynamic Configuration in Live Systems. Issues to be addressed include: fault detection, fault isolation, fault repair, and live insertion. It was realized that not all applications require all the features and that scalability is an important issue. During the November 1996 VSO meeting, Lou Francz, Dialogic, proposed that a separate standard addressing live insertion be developed using much of the work already done for H.A.VME. He argued that this standard could be completed in a short period of time and would address current market needs. The membership agreed and a task group to develop a live insertion specification (see VITA 1.4) for VME64x was formed.

VITA 1.4-199x, Live Insertion for VME64x– This effort is an outgrowth of the VITA 1.2, High Availability task group. Lou Francz is task group chair and a draft specification for VITA 1.4 is available from the VITA office. Contact Lou Francz at franczl@dialogic.com for more information on this specification.

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