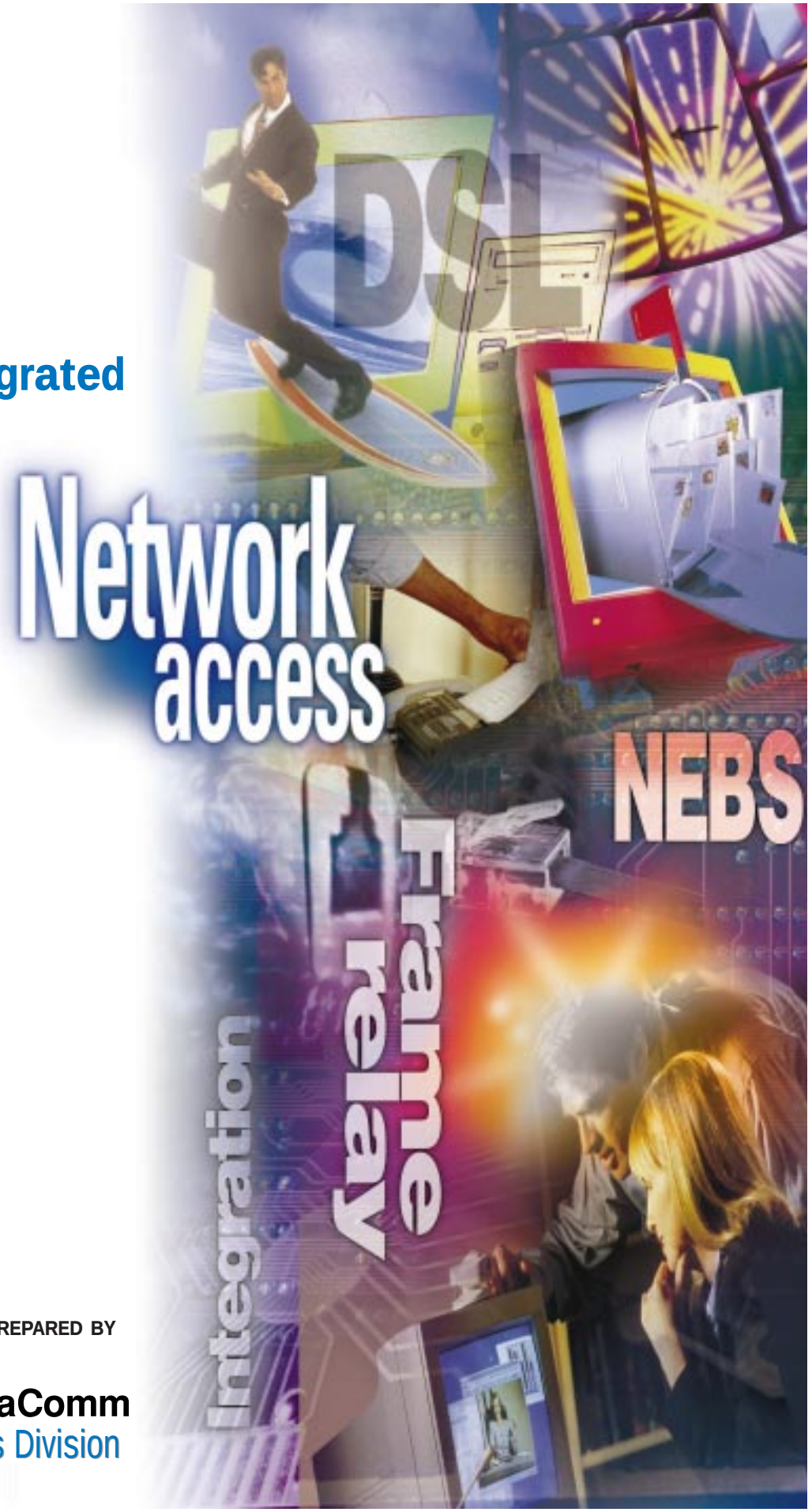
CSU / DSU

Non-Integrated
vs. Router-Integrated



A Briefing Document Prepared by

General DataComm
Network Access Division

General DataComm
Network Access Division

TABLE OF CONTENTS

INTRODUCTION

High-speed, LAN-attached applications continue to rise, generating an increasing need for cost-effective WAN access for intranet and internet access implementation. Routed networking is today the most widely implemented network solution for organizations of all types. Digital circuits operating at speeds from 56Kbps (DDS service) to 1.544Mbps (T1 and Fractional T1 services) to T3 (45 Mbps or 28 T1's) provide the WAN infrastructure that interconnects the routers located at each location served by the network.

The traditional approach to terminating DDS, T1/FT1 and T3 circuits at each location is to use a standalone or high density rack mounted Channel Service Unit/Data Service Unit (CSU/DSU). "Line-by-line" CSU/DSUs and CSU/DSUs providing integrated T1 access are mature products, and are available with enhancements such as SNMP management, direct Ethernet connections, and dial restoral features.

In addition to traditional standalone CSU/DSU solutions, routers with an integral CSU/DSU are available. Integrated CSU/DSU functionality initially might appear to be a good choice, i.e., having one integrated unit instead of two functional units may provide certain reliability advantages.

It might be thought that having the CSU/DSU integrated into the router will:

- Provide a lower cost than comparable separate CSU/DSU devices
- Eliminate a potential point of failure in the network, namely, the cabling required to connect an external CSU/DSU to a router
- Save rack space at a central site, and reduce two boxes to one at remote sites

However, while these benefits appear good, there are other factors that require consideration.

This management briefing will discuss that, depending on the application, integrated approaches do not necessarily save money or eliminate points of failure.

In addition, this briefing will outline valuable features available only in non-integrated CSU/DSUs.

COMPARING BASIC CAPABILITIES

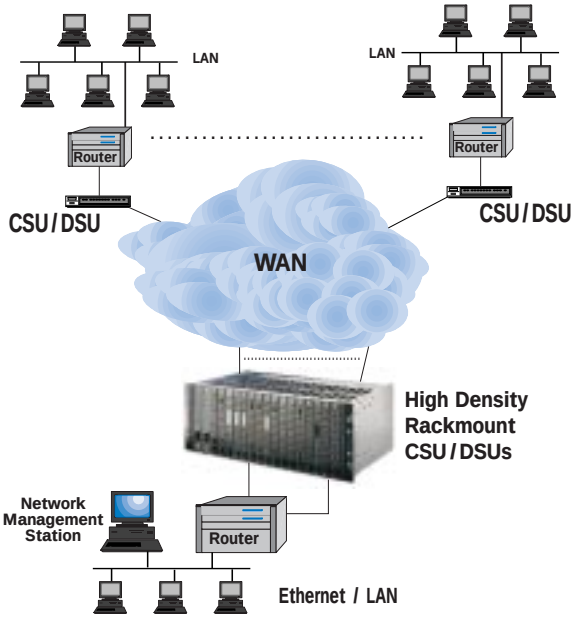


Figure 1 — Typical WAN Configuration with Standalone CSU/DSUs

Figure 1 shows a basic T1 network access arrangement using traditional non-integrated CSU/DSUs at both the remote and central sites.

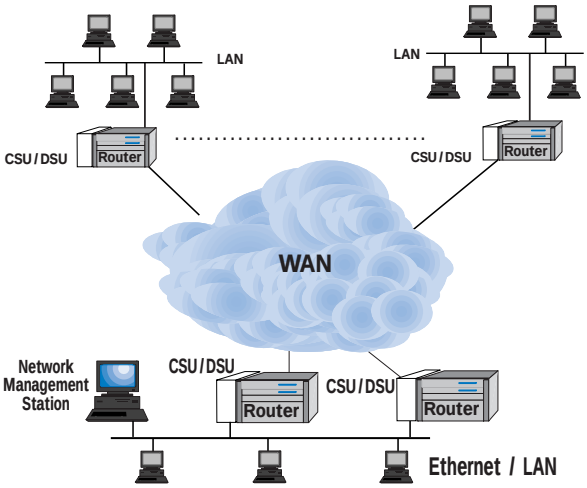


Figure 2 — WAN with Integrated Routers and Integrated CSU/DSUs

The network depicted in Figure 1 can be viewed as either being traditional point-to-point DDS/T1 networking or as frame relay.

Figure 2 shows the same T1 access objective achieved with integral CSU/DSUs. At first glance, it seems that the router with integral CSU/DSU approach is simpler to install and should be more cost effective. However, another look at both approaches shows that this may not be the case.

Cost Savings Proponents of router-integrated T1 CSU/DSUs argue that the internal units are less costly to purchase than separate, external CSU/DSUs. Typically, however, depending on feature content, the list prices of an internal unit and a standalone managed external unit are very similar. When the capabilities of the router integrated CSU/DSU are investigated and compared against those of the standalone CSU/DSU, additional diagnostics and testing features will be found with the standalone CSU/DSU having better troubleshooting capabilities for the same price or lower.

Therefore, if cost is the primary issue, external non-managed CSU/DSUs may be the lowest cost option.

In many cases integral T1 DSU router ports are simply DSX type device. This means that an external Telco-provided demarcation device such as a CSU or CSU/Smart Jack must be installed. Such a device introduces an additional fault point in the network and requires customer provided AC power.

If a standalone CSU/DSU device is deployed, the Telco-provided product and associated costs are eliminated, allowing the user to directly connect to the T1 circuit.

External units offer more complete diagnostics and remote management features, providing long term operating cost savings by reducing the need to dispatch technicians to remote sites.

External CSU/DSUs offer significant line cost savings by the use of efficient multiplexing. Examples of CSU/DSU features that provide the opportunity of increased network savings are multi-port CSU/DSUs that may be used to support inter-office PBX networking and secure and non-secure routed data paths. Examples of these applications are discussed later in this paper.

Points of Failure Because integral CSU/DSUs eliminate the need for a cable between the WAN port of the router and the CSU/DSU (DTE interface), a potential point of failure may have been eliminated. This may be true if cables were prone to failure which typically they are not.

However, the non-integrated solution also provides relief from a single point of failure. Should a problem occur in a router with integral CSU/DSU — much more likely than a cable failure — on-site troubleshooting to determine which internal component has failed will be necessary. If the results of the testing are in any way inconclusive or ambiguous, replacing the entire router may appear to be needed, when in fact the problem actually may be a network service problem, easily identified by an external CSU/DSU.

If diagnostic testing capabilities of an integral CSU/DSU were deemed comparable to those of a non-integrated CSU/DSU then the integral CSU/DSU solution would provide a superior solution. However, this is not the case by design. Many non-integrated CSU/DSUs offer superior fault isolation through comprehensive line and BERT diagnostic testing. This briefing concludes that troubleshooting the rare cable failure and its repair, is much easier and far less disruptive to the network operation than troubleshooting and replacing of a router, or the integral CSU installed in the router.

Space Saving For central site rack mounting of large numbers of WAN links, the initial size of the router(s) with integral CSU/DSUs takes up much more real estate than that of a high density CSU/DSU shelf. For example, two CSU/DSUs using GDC's SpectraComm 2000 shelf require only 1.75" (44.45 mm) of rack height, and up to 16 CSU/DSU units can be housed in the SpectraComm 5000 shelf which is only 7" high (180 mm).

Power Savings Savings of power is not usually a benefit put forth by the proponents of integral CSU/DSUs. Why? Routers are designed for environmentally controlled computer rooms. Routers typically exhaust a considerable amount of heat consuming a high amount of BTUs. When a CSU/DSU is placed inside a router it becomes part of the power consumption equation.

Routers are typically AC powered with backup power (if supplied) provided via generator. Commercial power interruption of a router with integral CSU/DSU affects the WAN connection as well as the integral LAN. Redundant power supply modules may not be an option of many low-to-medium end routers. Lack of commercial power is a major point of failure to a router with integral CSU/DSU.

Many standalone and all rackmount CSU/DSUs manufactured by GDC offer dual power options (AC and DC). Redundant power supply modules are available on all SpectraComm and Universal Access System products.

All GDC CSU/DSUs, standalone as well as rackmount, use six watts or less of power. GDC CSU/DSU shelves do not use fans and due to the very low power budget design dissipate heat. Air conditioned environments are not needed.

NEBS (Network Equipment Building Standards) NEBS compliancy is a requirement when sharing telco Central Office space, but many aspects of NEBS are beneficial to premise installations. Very few routers with integral CSU/DSUs can pass the stringent NEBS tests, and therefore, are not allowed to be installed in the Central Office.

Applicable NEBS benefits include fire safety, electrical hazard and shock protection, lightning protection and power line isolation.

Costly repairs and network disasters can be greatly reduced by the use of an external CSU/DSU. For example, if an integral DSU is utilized, a lightning strike of power surge on the network would travel directly into the router and conceivably pass to the LAN, which may be connected to PCs and other LAN devices. As a result, all attached users and equipment are put at risk. However, by using GDC's CSU/DSUs which protect against hazardous line transients including power lines and transmission lines, the risk is eliminated.

VALUE ADDED

Most standalone CSU/DSUs offer additional capabilities typically not provided by integral CSU/DSU offerings. These include:

- DSL Services
- Multiport Capability
- Drop-and-Insert Capability
- Upgradeable
- Portable
- Demarcation of Service Point
- Variable Line Equalization / Buildouts
- Automatic Service Rate Selection
- Service Line Isolation / Protection

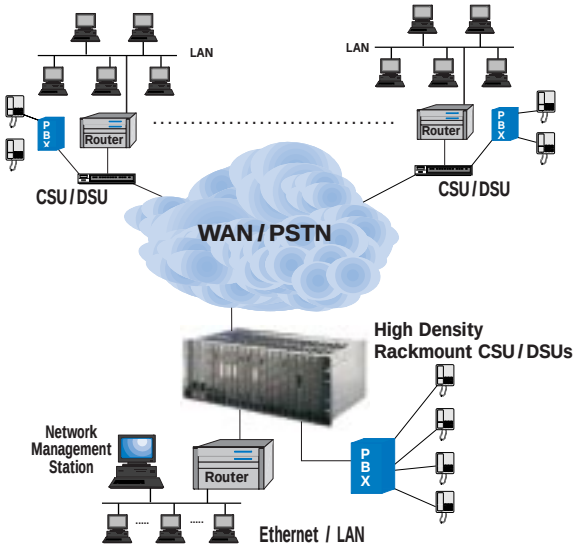


Figure 3 — PBX and Router Sharing Single T1 Access with "Drop-and-Insert" CSU/DSU

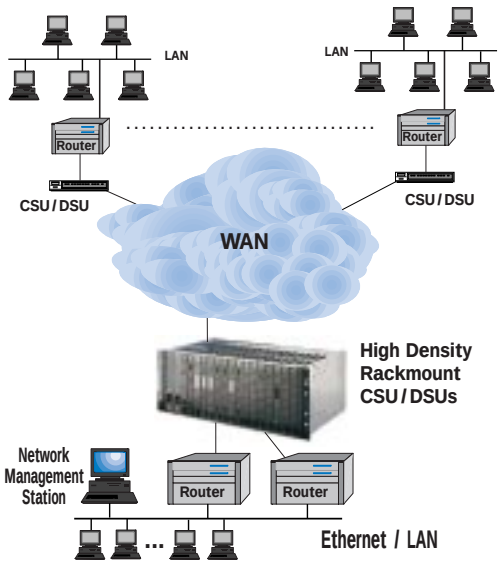


Figure 4 — Dual Routers Sharing Single T1 Access with "Drop-and Insert" CSU/DSU

Depending upon the application, these capabilities can be critical to the resiliency, manageability, and cost-effectiveness of a network; and any one of them can make a strong case for a non-integrated as opposed to a router-integrated approach.

Unlike integrated T1 CSU/DSUs, non-integrated T1 CSU/DSUs support multiple ports and/or drop-and-insert capabilities. The advantage of this is far greater applications flexibility — assuming incremental T1 channel capacity is available. For example, as shown in Figure 3, users can easily add via drop-and-insert an additional application, such as voice from a PBX, saving the cost of a separate new T1 circuit.

DSL Services The ILEC's competitors, known as the CLECs, are emerging and offering comparable T1 replacement services such as DSL. These services provide an external NTU device which connects conventional WAN traffic to DSL. An integral CSU/DSU within a router prevents customers from leveraging this future cost savings, which is predicted to dominate service markets for years to come.

Multiport Capability allows individual DS0 channels (56/64Kbps) of a T1 to be segmented to support a legacy application. This can be an effective way of eliminating the cost of an analog leased line between corporate headquarters and a regional facility.

The ability to support multiple applications over a simple T1 without adding multiplexing equipment allows maximum use of the T1 line and saves on multiple line costs. Only a non-integrated solution has this capability.

Many non-integrated T1 access devices support up to four separate data terminal equipment (DTE) ports with standard physical interfaces such as V.35, EIA-530/422, and EIA/TIA-232-E. This capability can be in addition to the drop-and-insert capability and can be used to support an additional application, such as a PBX, via a DSX-1 interface port. The DSX-1 port also allows the standalone unit to act as a CSU, thus supporting applications where CSU-only functions are required. Figure 4 shows a dual router application – again a single T1 access circuit is shared to reduce network costs.

Drop-and-Insert Capability allows a T1 circuit to be groomed into two or more "channels" each comprising a selected number of DS0s. For example, the data network could be assigned 512Kbps (8 DS0s) and a PBX assigned the remaining 1024 kbps (16 DS0s) for voice. This mapping or DS0s would eliminate the need for two separate circuits; one for data and one for voice.

If two circuits were required to meet the total bandwidth requirement, network diversity could be implemented for the data network (or the voice network), without having to purchase additional circuits.

Drop-and-insert can also be used to split a T1 circuit between two routers, each being assigned a fractional T1 circuit speed, for example, 1,024Kbps (16 DS0s) and 512Kbps (8 DS0s) respectively. This accommodates situations where secure server access has to be provided for internet access, but the firewall is not required (or desired) on the organization's intranet.

Upgradeable Unlike an integrated CSU/DSU that is limited to its basic functionality, a non-integrated CSU/DSU can easily be upgraded to support drop-and-

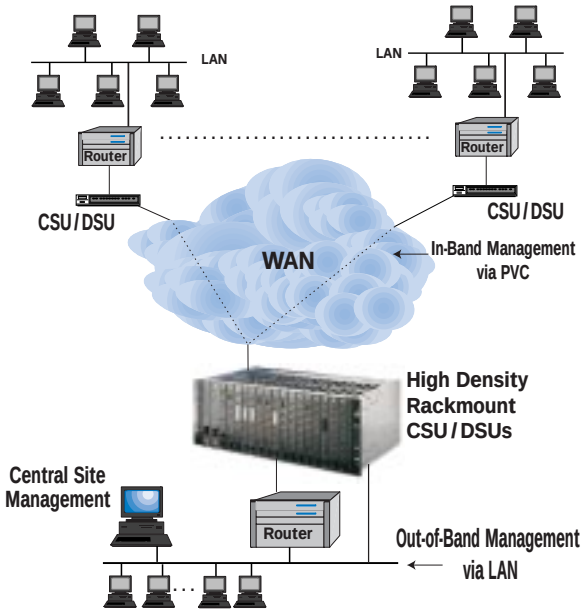


Figure 5 — Centralized, In-Band and Out-of-Band Management

insert and/or multiport features. In this way, non-integrated access greatly increases the flexibility to accommodate network change and growth and match the best router and best access features to the application.

Portable A non-integrated CSU/DSU, whether directly or indirectly LAN connected, can be easily relocated. A non-integrated unit can also be used with any manufacturer's router and also within non-routed applications in the same T1 network.

DIAGNOSTIC TESTING

Fault Insolation and Troubleshooting With an integral CSU/DSU, fault isolation troubleshooting can be difficult. Should the router at the central site fail, the network administrator cannot immediately isolate the problem as to an integral CSU/DSU failure, a T1 line failure, or a network failure. If the router at the remote site fails the network manager will probably have to dispatch a technician to test the router or at the very least contact the telco to check the T1 circuit.

In contrast, as illustrated in Figure 5, a non-integrated solution can include a LAN-connected, out-of-band management path to the CSU/DSU at the central site and an in-band management path at the remote site.

Consequently, if the central site router fails, the condition of the central site CSU/DSU and router — and the router DTE connection and corresponding leads can be determined via a LAN-attached Network Manager. If the remote router fails, the condition of the remote router and CSU/DSU can be determined directly from the central site.

If the circuit fails, management communications can be maintained to the remote CSU/DSU via the switched network using a collocated analog modem. The necessary T1 line diagnostic tests can be run without the need to contact the telco, further reducing the cost of ownership for the standalone solution.

Comprehensive Diagnostic Loopback Testing

As figure 6 shows, in fractional T1 and multiport applications, loop-back testing at the channel level is essential for isolating problems within the T1 24 DS0 channel bundle. However, most router-integrated CSU/DSUs support only full T1 payload loopbacks, while

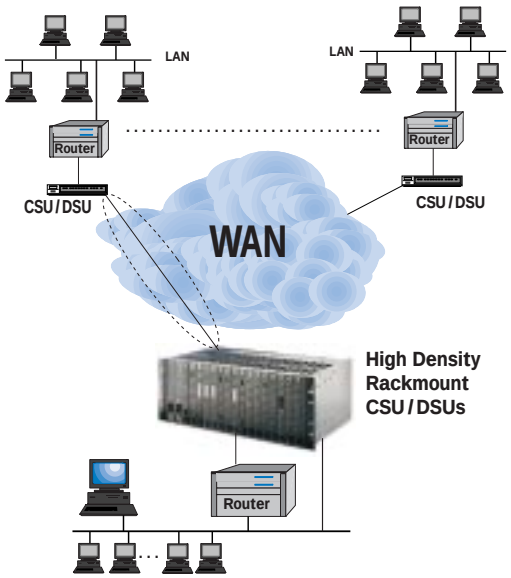


Figure 6 — Channel Loopback Testing

non-integrated CSU/DSUs support non-intrusive channel loopback tests that do not interfere with data passing through other channels.

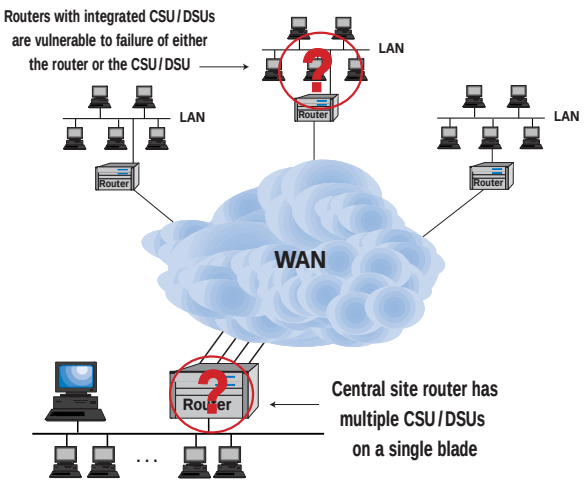


Figure 7 — Single Point of Failure Risk

Line Monitoring Break-in line monitoring and testing are standard T1 CSU/DSU features that allow a technician to break into the T1 path to monitor the condition of the circuit and corresponding T1 channels, as well as to trouble shoot by sending specific test transmit/receive signals.

Break-in line monitoring and testing is done using external test equipment without disturbing the data flow via a convenient front panel connector on the CSU/DSU. Most integrated CSU/DSUs do not have this feature. When they do, the break-in connector is inconveniently located at the back of the router lost among all the cables.

SINGLE POINT OF FAILURE

Router vendors argue that the integrated approach allows easier installation and integrating the CSU/DSU in the router eliminates two sources of possible failure: either the separate CSU/DSU itself or the associated cabling. Consider that the CSU/DSU is still an active component of the network and should failure occur as stated earlier, the network disruption in servicing an integrated router is much greater than that created by servicing a non-integrated CSU/DSU.

Integrated CSU/DSUs do not have comparable mean-time-between-failure (MTBF) ratios to that of the teleco-standard CSU/DSUs,which are typically expressed in hundreds of years. The most likely points of failure are the local loop or the router itself, with its complicated software and integral hardware components. Strong diagnostic capabilities as described in the previous paragraphs cannot be considered an option; they are a “must have” item. If a router with an CSU/DSU fails (Figure 7), the integral CSU/DSU functionality will be lost — or at best significantly diminished — potentially crippling any ability to troubleshoot the network.

FRAME RELAY APPLICATIONS

A major portion of installed data networks consist of routed frame relay. Frame relay networks offer many obvious benefits, including an economic advantage over multiple point-to-point networks.

With frame relay, optimum network design requires good knowledge of the traffic volumes actually being carried. If a frame relay network is over-designed, much of the economic advantage will be lost. If the network is under-specified the network response times during busy periods will become unacceptable, resulting in loss of productivity, not to mention complaints from users.

In addition, due to the bursty nature of LAN-to-LAN traffic, it may be difficult without actual monitoring of the traffic, to know whether poor response times are the result of congestion in the carriers network or the result of under-sized (i.e. under specified) frame relay circuits, or the result of server response times.

The solution to these potential problems is the Frame Relay Probe or “Frame-Aware” CSU/DSU which can provide real-time network traffic information and network status information. Frame Relay analysis capabilities found within routers are not enough.

Frame Probe For example, GDC's ***innovx***™ Frame Relay Probe provides both the probe and the CSU/DSU functionalities in one unit providing valuable information on:

- Network Availability
- PVC Availability
- Network Delay
- PVC Throughput
- End-to-End Frame Loss
- Forward and Backward Explicit Congestion Notifications (FECNs and BECNs)
- Discard Eligibility (DE) Frames
- Local Management Interface (LMI) Statistics (Timeouts and No Responses)
- Bandwidth Utilization
- Committed Information Rate (CIR) Utilization.

Data can be retrieved from each ***innovx*** unit via the web and can be stored in a PC network management station. Using either Innovx Frame Manager software or industry available network management software such as Concord's Network Health; weekly, monthly, quarterly and yearly trend analysis and data reporting is readily available.

CONCLUSION

DDS, T1 or T3 access, a necessity when high speed LAN-based applications require WAN access, can be achieved either with an integrated or non-integrated CSU/DSU. For many networks, however, T1/T3 access is best implemented by separating the router and CSU/DSU functions due to the following cost and benefit considerations:

- Equivalent prices for comparable integrated and non-integrated solutions translate to no significant savings on equipment costs when you choose a non-integrated approach. As a matter of fact, very low priced stand-alone T1 CSU/DSUs are readily available to provide access where price is the major consideration.
- Unexpected costs can surface when settling for an integrated approach in terms of maintenance, line costs, and the cost of troubleshooting and repair.
- A non-integrated approach offers feature richness, such as superior fault isolation, comprehensive diagnostic testing, multiport and drop-and-insert functionality, portability, relief from single point of failure and increased resiliency, manageability, and cost-effectiveness of a network.
- Non-integrated access greatly increases the ability to accommodate network change and growth and can allow better flexibility when matching the best router and best access features to the application.
- Frame probes with integrated CSU/DSU offers the best of both worlds. It features a superior diagnostic capability coupled with sophisticated monitoring of frame relay SLAs.

GDC SOLUTIONS

GDC can give you the flexibility to choose from a wide variety of non-integrated approaches.

GDC products for DDS and T1 access include:

- The ***innovx*** family of Frame Relay Probes with integral CSU/DSUs provide the best networking solution for frame relay networks, comprehensive network monitoring and network management. (Unlike many Frame Relay Probes, a dedicated management workstation is not required.)
- The SpectraComm 2000 offers a low-density, NEBS compliant shelf solution for integrating local and wide area data networks. Equipped with dual power supplies and a variety of plug-in cards, the SC 2000 serves as a versatile shelf system that supports many network services. For redundancy, the SC 2000 can support AC or DC power.
- The RA 1000 offers the flexibility of housing a single Spectracomm card in a common housing using AC power for remote access solutions.
- The SpectraComm 5000 Series is for NEBS compliant SNMP-managed integrated T1 Access with SNMP management. It can support from a 202 T card up to a T3 access card all in the same shelf. The SpectraComm 553 is for T1/FT1 line-by-line access with SNMP management.
- The DeskTop Series of CSU/DSUs is for non-SNMP network management alternatives.

ACRONYMS

BECN - Backward Explicit Congestion Notification

CIR - Committed Information Rate

CLEC - Competitive Local Exchange Carrier

CSU - Channel Service Unit

DACS - Digital Access and Cross-Connect System

DCE - Data Communications Equipment

DE - Discard Eligibility

DSE - Data Set Emulator

DSL - Digital Subscriber Line

DSX-1 - Digital Signal Cross-Connect Level 1

DS0 - Data Signal, Level Zero

DTE - Data Terminal Equipment

FECN - Forward Explicit Congestion Notification

ILEC - Incumbent Local Exchange Carrier

LAN - Local Area Network

LMI - Local Management Interface

LTU - Line Termination Unit

MTBF - Mean Time Between Failure

NMS – Network Management System

NTU - Network Terminating Unit

PBX - Private Branch eXchange

PVC - Permanent Virtual Circuit

SNA - Systems Network Architecture

SNMP - Simple Network Management Protocol.

WAN - Wide Area Network

World Headquarters
Middlebury, Connecticut USA 06762-1299 • Tel: 1-203-574-1118 • Fax: 1-203-758-9468 • 1-203-758-9518 (GDC International) • www.gdc.com

Network Access Division
To locate the Network Access representative or Distributor nearest you, call: 800-523-1737 • For 24-hour delivery, call 1-800-435-8064 • www.gdc.com/connections

U.S. Government Sales Tel: 703-658-4052 Fax: 703-658-4058

Subsidiaries
Canada Tel: 905-415-0705 Fax: 905-415-9316 • France Tel: 33-1-47-62-62-00 Fax: 33-1-47-62-96-96 • Japan Tel: 81-3-5473-7890 Fax: 81-3-5473-7895
Mexico Tel: 52-5-645-2238 Fax: 52-5-645-5976 • Russia Tel: 7-812-325-1085 Fax: 7-812-325-1086
United Kingdom Tel: 44-1189-774868 Fax: 44-1189-774871

International Regional Offices
Asia Singapore Tel: 65-735-2123 Fax: 65-735-6889 Hong Kong Tel: 852-2526-5511 Fax: 852-2525-9944 China Tel: 86-10-6621-1815 Fax: 86-10-6621-1814
Canada Calgary Tel: 403-730-8880 Montreal Tel: 514-336-5454 Fax: 514-335-2160 Ottawa Tel: 613-234-4005 Fax: 613-234-4685
Vancouver Tel: 604-430-5772 Fax 604-435-8181
Europe/Middle East/Africa Austria Tel: 43-1-599-99-675 Fax: 43-1-599-99-678 Belgium Tel: 32-2-529-5848 Fax: 32-2-529-5911
Italy Tel: 39-06-3987-0265 Fax: 39-06-3987-0287
Latin America Brazil Tel: 55-11-535-0232 Fax: 55-11-542-0547 Miami, Florida Tel: 1-954-733-8501 Fax: 1-954-733-8119

Printed in the USA G4581A-800EO