Comparing a CMCC to the IBM 3745/3746, 3172, and OSA

Currently, the key solutions in use to connect your network to an IBM S/390 mainframe are the IBM 3745/3746 FEP, the IBM 3172 Interconnect Controller, the IBM Open Systems Adapters (OSAs), or a Cisco router with a CMCC. A Cisco router can directly replace an IBM 3172 without any loss of function, and it will improve performance and availability. In many cases, you can use a Cisco router with a CMCC as a higher-performance, lower-cost alternative to a FEP. However, some functions might still require a FEP.

This chapter compares the functions provided by provided by a Cisco channel-attached router to the following IBM platforms:

- IBM 3745/3746 FEP
- IBM 3172 Interconnect Controller
- IBM OSA

The chapter ends with a summary comparison of the CMCC and the IBM channel connectivity solutions.

IBM 3745/3746 FEP

Historically, IBM's primary solution for mainframe access has been the FEP. The FEP offers a great deal of functionality for subarea networks and legacy protocols. However, only the largest networks use most of the functionality provided by the FEP; most small networks use only a subset of this functionality. In addition, networks are changing rapidly and the typical enterprise network now supports a multitude of protocols, LANs, WANs, and device types. High-performance substitutes, such as LANs, high-speed serial lines, and Frame Relay have replaced low-speed serial lines. The FEP has not kept up with the requirements of today's enterprise networks so other networking gear is required to augment or replace the FEPs. If you are considering replacing some or all of your FEPs, first determine which functions your FEP is providing today so that you do not lose any of these functions as you move forward to CMCC.

FEPs have the following key functions in today's networks:

- *SNA session routing*—SNA session routing is required in environments with multiple data centers or Advanced Communications Function (ACF)/VTAM application hosts and a high volume of cross-domain SNA traffic. SNA session routing can be important in environments with distributed AS/400s.
- *SNA COS*—SNA COS allows prioritization of SNA traffic between the FEPs and the mainframes and is important in environments with SNA backbones. SNA COS is less important in environments that have consolidated the FEPs in the data center. In this case, either there is no FEP-to-FEP traffic, or the FEPs are connected at the data center over high-speed LANs that do not have bandwidth contention problems. However, some networks take advantage of Link Services Prioritization (LSPRI), which provides transmission priority based on COS for outbound traffic (for example, FEP to cluster controller).

- *Serial line concentration*—FEPs can concentrate large numbers of low-speed (9.6-kbps) serial lines. However, as networks migrate to high-speed WAN backbones, the need for high-density, low-speed serial connectivity decreases.
- *Switched SDLC*—Some enterprises rely on switched SDLC to support transient SNA connections to small branch offices or to provide switched network backup. As SDLC is being replaced by multiprotocol data links, switched SDLC requirements are diminishing. In place of SDLC, protocols such as Integrated Services Digital Network (ISDN), Point-to-Point Protocol (PPP), and Serial Line Interface Protocol (SLIP) are being used to provide multiprotocol or IP-switched line support.
- *SNA boundary network node (BNN) function*—FEPs provide an SNA BNN function, which includes polling, converting from local addresses to SNA addresses, and converting exchange identification (XID). In the absence of remote FEPs, local FEPs can perform these functions. In the absence of any FEPs, ACF/VTAM can perform most of these functions.
- *SNA Network Interconnection (SNI)*—Many enterprises use FEPs for SNI to allow independent SNA networks to communicate. There are other alternatives, such as the SNASw border node function and electronic data exchange over the Internet; however, any change on one side requires a change on the other side, so this migration will be a slow one.
- *SSCP takeover*—With this facility, if an owning VTAM goes down, another VTAM can assume ownership of those resources without disrupting any existing application sessions. The NCP plays a role in allowing this takeover.
- *Extended recovery facility (XRF)*—The XRF is a program that allows one VTAM application to take over for another. The XRF code in the NCP plays a key role in supporting this capability.
- *X.25 support*—X.25 Interconnection allows the NCP to act as an X.25 packet switch. NCP Packet Switching Interface (NPSI) allows the NCP to connect to other resources over X.25 networks. X.25 Interconnection supports both SNA and non-SNA devices. For non-SNA (Asynchronous and Binary Synchronous Communications Protocol) devices, it supports conversion to SNA.
- *Specialized program products that support custom or older applications*—Network Routing Facility (NRF) provides routing inside the NCP without VTAM participation. An emulation program allows the IBM 3745 to connect to Basic Telecommunications Access Method (BTAM) in an IBM mainframe.
- *Legacy protocols*—The FEP supports program products, such as Non-SNA Interconnection (NSI) for Bisynch conversion, Airline Line Control Interconnection (ALCI) for airline line control protocol transport, and Network Terminal Option (NTO) for synchronous conversion. You can install these products in the FEP to handle non-SNA protocols. Legacy protocols are older protocols that are declining in usage.

FEPs such as IBM 3745/3746 hardware support IBM NCP software to provide network control and routing for SNA subarea networks. The IBM 3745/3746 supports high-speed attachments for IP/HPR flows, such as 155–Mbps ATM, Primary Rate Interface (PRI) ISDN, and ESCON MPC+.

Using the Cisco Channel-Attached Router as a FEP Alternative

The Cisco channel-attached router can be used as an alternative to the IBM 3745/3746 FEP. The Cisco router and CMCC combination focuses on the key features that most IBM customers use, such as mainframe channel attachment for both SNA and TCP, SNA routing, SNA COS, and access to SDLC- and LAN-attached resources.

Looking at the key FEP functions identified in the previous section, the Cisco IOS Software and the CMCC offer a way to address most of the key FEP functions while providing a higher-performing, multipurpose channel gateway. For functions not addressed by the CMCC, one or more FEPs still may be required.

SNA Session Routing

The Cisco IOS Software supports native APPN routing through the SNASw feature, and with DLUR it can support native SNA routing for legacy 3270 traffic in an SNASw network. In many environments, SNASw is the logical progression from subarea SNA. SNASw is more dynamic and less labor-intensive to maintain than a subarea network, and it extends the number of SNA network addressable units (NAU) beyond the 64,000 limit per subarea SNA domain.

SNA COS

The SNASw feature also preserves SNA COS for both APPC and legacy 3270 traffic. If the Cisco SNASw feature is installed only in central site DLSw+ routers, it provides outbound prioritization based on COS, similar to LSPRI in the FEP. In a multiprotocol environment, Cisco queuing algorithms such as Custom Queuing can be used to reserve bandwidth for SNA traffic over DLSw+ (DLSw+ supports LU and SAP prioritization). SNASw EE supports SNA COS to IP type of service (ToS) mapping (SNA transmission priority to IP precedence mapping) for both inbound and outbound traffic in a bidirectional fashion between an EE-enabled S/390 host and an SNASw EE router, allowing the service policy agent within CS/390 to enforce QoS policies.

Serial Line Concentration

The Cisco 3600 Series router supports up to 54 serial lines, or 36 serial lines plus one LAN. The Cisco 7200 Series router supports 48 serial lines and one LAN, which can be Fast Ethernet. Either the Cisco 3600 or the Cisco 7200 Series router is a good solution for low-speed SDLC serial line concentration. The MultiChannel Interface Processor (MIP) card is the best solution for high-speed serial concentration when the remote branches have routers and connect over 56- or 64-kbps lines or ISDN Basic Rate Interface (BRI). The Cisco 7500 Series router MIP card supports two channelized T1/E1s or two PRI ISDN lines, supporting up to 48 56-kbps or 64-kbps remote sites per card. You can install multiple MIP cards in a Cisco 7500 Series router. If your current network is pure SNA and your FEPs connect 200 or more low-speed (19.2 kbps or below) serial lines, the branches are too small to justify a router. Although a packet-switched service such as X.25 or Frame Relay is not an option, the FEP still may be the most cost-effective solution.

Switched SDLC

The Cisco IOS Software transports multiprotocol traffic, including SNA, over switched services. However, it does not support dial-out to switched SDLC devices. (Dial-in requires that you code **sdlc role prim-xid-poll** on the appropriate serial interface.)

SNA BNN Functions

The Cisco IOS Software can reduce mainframe cycles by providing several boundary functions such as remote polling, group poll support, and DSPU concentration. Using SNASw and DLUR, Cisco routers can provide many functions provided by a FEP.

Autonomous Network Connection

SNI connections require a FEP in at least one of the connecting networks. The Cisco IOS Software allows connection to an SNI gateway, but it does not provide SNI gateway functionality, as shown in the following examples:

- If the inter-enterprise connection uses back-to-back SNI gateways, at least one FEP is required in each independent SNA network.
- If the inter-enterprise connection can be an adjacent SNI configuration, one network can keep a FEP to provide the SNI gateway function, and the attaching network can replace FEPs with CIPs. The downside to this alternative is that certain topology changes in one network (for example, adding a new subarea node) might require changes in the other network.

- If the inter-enterprise connected hosts are APPN-enabled, they can eliminate SNI connections using APPN border node support (either extended or peripheral). APPN border node allows networks with different NETIDs to establish CP-to-CP sessions with each other (SNASw does not play any role in host-to-host border node connections). Cisco routers and multilayer switches can also provide IP transport between hosts that implement extended border node HPR/IP EE support, or they can provide DLSw+ SNA WAN transport for bridged LLC traffic from non-HPR/IP (EE) border node connections between hosts.

Casual connection can be used, eliminating the FEP requirements for one network. This connection supports primary LU (application) initiated sessions only.

SSCP Takeover

The SNASw DLUR feature of the Cisco IOS Software fully supports the SSCP takeover facility.

XRF

This product requires an NCP. There is no channel-attached router equivalent.

X.25 Support

The Cisco IOS Software can be configured as an X.25 packet switch and supports transport of SNA over an X.25 backbone. However, there is no comparable function to provide asynchronous or bisynchronous conversion to SNA. (The CMCC does support the TN3270 Server, which provides conversion from TN3270 to SNA.)

Specialized Program Products that Support Custom or Older Applications

There is no function comparable to NRF in the Cisco IOS Software. There is no feature comparable to the FEP in the Cisco IOS Software.

Legacy Protocols

Although the Cisco IOS Software can duplicate some special protocols supported by the FEP, such as asynchronous and bisynchronous tunneling, comparable protocol support (that is, conversion to SNA) is not provided. (The CMCC does support the TN3270 Server, which provides conversion from TN3270 to SNA.)

Benefits of Using a Cisco 7000 or 7500 Series Router with a CMCC

A Cisco channel-attached router with a CMCC offers additional features that are not available in an IBM 3745. These features include:

- *Multipurpose*—The CMCC provides a state-of-the art, high-performance solution for mainframe connectivity for access not only to SNA applications but to TCP/IP applications as well. As networks begin to offer intranet and Internet services, tying the mainframe into TCP/IP networks with features such as TN3270 Server enables you to leverage your mainframe investment. The NCP's support of TCP/IP is limited.
- *Higher speed*—The CMCC offers a tenfold improvement in performance over an IBM 3745 model 200 for SNA, and even larger for TCP/IP. Many networks have reached capacity for their existing IBM 3745s. Instead of investing more money in older technology, organizations are migrating to multifunction channel solutions.
- *Connectivity*—The FEP has limited connectivity. It does not support Fiber Distributed Data Interface (FDDI), ATM, LANE, Fast Ethernet, Switched Multimegabit Data Service (SMDS), T3, or even Ethernet (for SNA). (The IBM 3746 900 expansion frame supports Ethernet with an imbedded 8229 translational bridge.)
- *Lower cost*—The CMCC in a Cisco 7500 Series router can save your organization money because there is no recurring licensing fee, and the resale value of the IBM 3745 often pays for the CMCC. In leasing environments, the payback period is 18 to 24 months.

In summary, the Cisco 7500 Series router in conjunction with a CMCC offers many benefits such as speed, connectivity, and flexibility to an IBM enterprise network. By minimizing the number of FEPs required in a network, the CMCC offers a means to reduce network costs while improving performance. However, some FEPs still may be required for the following:

- SNI connections to other enterprises or divisions
- Bisynchronous, asynchronous, or ALC conversion
- Specialized functions, such as an emulation program, XRF, or NRF

IBM 3172 Interconnect Controller

The IBM 3172 Interconnect Controller, introduced in the late 1980s, was IBM's premier solution for LAN-to-mainframe connectivity. The IBM 3172 was essentially a rugged PS/2 server that was based on a Micro Channel Architecture (MCA) bus. The IBM 3172 supported both TCP/IP and SNA traffic to the host. It supported a limited number of LAN and WAN connections.

The IBM 3172 is no longer sold by IBM, but there is a large installed base of the devices worldwide. Therefore, this discussion will focus on the reasons to replace existing IBM 3172s with a CMCC solution.

Through software options, the IBM 3172 offers a variety of different capabilities. Its native support is a basic kernel operating environment called Interconnect Controller Program (ICP), which provides functionality similar to that provided by a CMCC operating in IP Datagram mode (albeit with a different channel protocol used). The IBM 3172 offers three other options that require the OS/2 operating system: TCP/IP Offload, SNA Communications Program, and Multiprotocol Extensions. The TCP/IP Offload option is similar to that offered on the CMCC. However, because of the limited processing capability of the platform and the fact that the Offload option is provided on top of a generic OS/2 operating system, the total throughput of this option was always very low. The SNA Communications Program provides support for SNA traffic across the channel and is analogous to the SNA support on the CMCC. The Multiprotocol Extensions option provides TCP/IP Offload plus all of the features of the IBM Route Expander software. Route Expander provides basic routing and WAN connectivity.

The IBM 3172 platform supports both ESCON and parallel channels. It offers Token Ring, Ethernet, and FDDI LAN connectivity and a variety of different WAN interfaces. However, the platform only supports five slots for connectivity.

The IBM 3172 was a capable LAN-to-mainframe connectivity device in its time. However, the hardware has not kept pace with the evolution in processors, memory, or bus architecture. The software options provided on top of OS/2 (a defunct operating system) did not provide the overall throughput and stability required in today's enterprise environments.

The CMCC is a very effective and complete replacement for the IBM 3172. The connectivity options offered on a Cisco channel-attached router far exceed those offered on the IBM 3172. The Cisco IOS Software offers many more advanced capabilities—DLSw+, SNASw, and QoS, to name just a few. A channel-attached Cisco 7000 Series router with CMCC can provides many times the throughput of a single IBM 3172. Finally, the CMCC supports all of the capabilities of the IBM 3172 (plus the TN3270 Server) and can be introduced with few changes to the host definitions.

IBM OSA

The OSA is an integrated communications adapter for S/390, ESCON-based mainframes that provides for direct attachment to Ethernet, Fast Ethernet, Token Ring, FDDI, and ATM networks. IBM previously released two versions of the OSA: OSA1, a two-card set that included two Intel 486 processors running channel offload software; and OSA2, a single-card replacement for the OSA1. The OSA2 eliminated the channel offload software offered on the OSA1.

The OSA-Express is the third iteration of OSA. With the availability of IBM's high-speed OSA-Express, customers are questioning when it is appropriate to use the OSA-Express, and when to use the CMCC.

The following sections describe the OSA-Express, the problems that the OSA-Express solves, and the problems it does not solve.

What Is the OSA-Express?

The OSA-Express is a network interface card (NIC) for the mainframe. It provides Gigabit Ethernet, Fast Ethernet, Ethernet, and ATM access to the LAN. The OSA-Express is important for many reasons:

- It takes advantage of new hardware architectures and operating system features to provide high-speed TCP/IP access to the mainframe.
- It removes most of the bottlenecks associated with older channel protocols and allows access into an OS/390 that is similar to access in any open systems UNIX or Windows workstation complex.
- For TCP/IP access, it removes the requirement for a channel-attached controller, such as the FEP or the CMCC.

Compared to the older OSA cards, the OSA-Express utilizes some of the following technologies:

- *Self Timed Interface (STI) bus*—The STI bus is the main data bus for the mainframe CPUs. It operates at 333 MBps. The OSA cards are directly attached to this bus in a chained fashion so there are two paths between any OSA card and the processors.
- *Queued Direct Input Output (QDIO) subsystem*—QDIO allows the OSA-Express to communicate on the STIs without the limitations of the ESCON or bus and tag channel protocols by removing the 17-MB limitation of the ESCON channel architecture.
- *Direct Memory Access (DMA) Protocol*—The CS/390 TCP/IP stack accesses the data in the OSA-Express buffers directly, without multiple data copies.
- *IP Assist features*—The OSA-Express offloads some of the processing from the mainframe TCP/IP stack, including MAC handling, packet filtering, IP multicast, and maintenance of the IP address table.
- *Configuration through the mainframe TCP/IP stack*—When you use the OSA-Express only for TCP/IP, the OSA-Express is automatically configured from information provided by the mainframe TCP/IP stack. This feature removes one of the limitations with the older OSA cards. You must still use the OSA Support Facility (OSA/SF) to configure SNA protocols and ATM cards.
- *Manageability*—The newest versions of OS/390 provide RMF and SNMP management of the OSA-Express.

When to Use the OSA-Express

The OSA-Express is becoming the method of choice for connecting the S/390 to a TCP/IP network. The OSA-Express architecture removes the limitations of the channel protocols and places the S/390 on the same plane as the large UNIX servers. By using QDIO to the STI bus, the Gigabit Ethernet and Fast Ethernet cards have direct access to the 333-MBps CPU buses. The OSA-Express is considerably faster than the current ESCON technology.

By rewriting the TCP/IP stack to use the DMA protocol against the OSA buffers, IBM has eliminated many of the buffer copies, which results in better throughput and reduced CPU resource consumption. IBM reduced the amount of configuration that is required for TCP/IP pass-through by loading the parameters from the TCP/IP profiles dataset, which eliminates the need to use the OS/2 or Windows-based OSA/SF facility.

The OSA-Express supports the Service Policy Server in S/390. The OSA-Express has four output queues, each of which is associated with a ToS. Application data is prioritized by the Service Policy Server, and data is queued in by priority. ToS bits are set and read by the Cisco network, providing end-to-end QoS.

In general, use the OSA-Express for high-speed TCP/IP access and use a Cisco network to gain the greatest advantages from the OSA-Express.

However, not all customers will benefit from the OSA-Express. To benefit from the OSA-Express, your system must meet the following requirements:

- *IBM mainframe*—You must be using an IBM mainframe. The OSA-Express is not supported on non-IBM hardware.
- *Mainframe must be Generation 5 or later*—The OSA-Express is not supported on IBM processors prior to Generation 5. The Generation 5 mainframes became available in 1998.
- *OS/390 Version 2, Release 7 or later*—The operating system must be Version 2, Release 7 or later. QDIO, which enables the OSA-Express performance, was introduced in Version 2, Release 7.
- *IBM CS/390 TCP/IP stack*—You must be using the IBM TCP/IP stack.
- *TCP/IP access*—The QDIO and DMA improvements in the OSA-Express are for TCP/IP traffic only. SNA traffic is supported as long as it is through SNASw or APPN/HPR/IP. Legacy SNA traffic support is provided on the lower-speed OSA-Express cards, but it does not use QDIO and DMA and represents an expensive use of a valuable ESCON card cage slot.

Use the OSA Express as a high-speed channel into the mainframe. OSA-Express is not a router or a switch, and you must connect the OSA-Express to the network through a router or a switch. OSA-Express is a good choice for accessing the TN3270 Server application on the mainframe and for high-speed FTP traffic and for HPR/IP traffic.

When Not to Use the OSA-Express

In addition to supporting high-speed TCP/IP access through Gigabit Ethernet and Fast Ethernet interfaces, the OSA-Express supports lower-speed LAN interfaces, such as 4-Mbps Token Ring, 10-Mbps Ethernet, Fast Ethernet, and ATM. OSA-Express supports native SNA traffic in the same manner as the OSA2 card. When used in the OSA-Express, the lower-speed interface cards run at wire speed, which is not true of these same interface cards in the OSA2.

Even at wire-speed, OSA cards do not represent a good use of valuable mainframe real estate for SNA traffic. The OSA cards are placed in a slot in the card cage on the mainframe. This card cage has a limited number of slots that you can use to connect a limited number of devices. You can use a slot in the card cage for either ESCON or OSA connectivity. A single slot can support four ESCON ports. The maximum theoretical throughput of these four ports is 68 MBps (4 x 17 MBps).

If you use this same slot for a Gigabit Ethernet OSA-Express, the maximum theoretical throughput is close to 120 MB, which is a good tradeoff. If this same slot were used for a 10-Mbps Ethernet OSA card, the throughput would be less than 1.5 MBps, which is not a good tradeoff. The same reasoning applies to the Fast Ethernet versions of the OSA-Express.

In these situations, you should use a router to aggregate WAN connections and to send aggregated data through a CIP or CPA.

To enable SNA support, you must use OSA/SF, an OS/2 and Microsoft Windows-based graphical configuration tool. (OSA/SF also has a 3270-style REXX interface.) The chief complaint of customers is that using the OSA/SF is cumbersome.

When to Use a CMCC

You should use a CMCC in the following situations:

- *Non-IBM mainframes*—Use the CMCC with any mainframe that supports the ESCON or bus and tag channel protocols, which is 100 percent of all IBM and PCM boxes. The OSA-Express is not an option for non-IBM mainframes.
- *Older mainframes prior to Generation 5*—Use the CMCC on the approximately 60 percent of mainframes that do not support the OSA-Express.

- *Older operating system releases prior to Version 2, Release 7*—Use the CMCC with any currently supported operating system release.
- *Aggregation of TCP/IP and SNA traffic*—The CMCC is an efficient use of the I/O card cage resources. Use the interface cards in the router to aggregate WAN traffic and to efficiently transport the combined traffic across the ESCON or bus and tag channel.
- *Offload processing*—Use the dedicated CPU and memory of the CMCC to offload processing from both the router and the mainframe. You can use the TN3270 Server application to offload the protocol conversion duties from the mainframe. You can also use the TCP/IP Offload function to offset the inefficiencies associated with the mainframe TCP/IP stack in older releases (Version 2, Release 4 and earlier).

Why You Should Use the OSA-Express with a Cisco Network

You should use the OSA-Express when your environment allows you to do so. The OSA-Express provides high-speed TCP/IP access to the mainframe; however, it functions only as a network interface. The OSA-Express does not provide routing or switching, so it is dependent on the external network to perform routing and switching.

This section describes the advantages of using a Cisco network in front of the OSA-Express. A Cisco network adds value to the OSA-Express in the following four major areas:

- Jumbo frame support
- End-to-end QoS
- Load balancing through MNLB features
- Redundancy

Jumbo Frame Support

A Jumbo Ethernet frame is 8992 bytes and is typically referred to as a 9-KB frame. A normal Ethernet frame is 1492 bytes and is typically referred to as 1500 bytes. Using the Jumbo Ethernet frame can result in significant increases in throughput (up to 75 percent) for bulk data transfers, such as file transfers or storage backups. To use Jumbo frames, all network devices between the servers must support the larger frame size.

One benefit of using a Cisco switched network with the OSA-Express is that the Gigabit Ethernet interfaces on the Catalyst 6500 switches support Jumbo Ethernet frames. The Gigabit Ethernet interface card supported by the OSA-Express also supports Gigabit Ethernet interface cards on other IBM servers, such as the RS/6000, which also supports Jumbo Ethernet frames.

End-to-End QoS

The Service Policy System of the OS/390 operating system allows you to prioritize application traffic by application name, time of day, origin, destination address pairs, and so on. The Workload Manager uses this information to prioritize dispatching applications. The OSA-Express also uses this information to prioritize outbound traffic. The OSA-Express uses one inbound traffic queue and four outbound traffic queues. The outbound traffic queues are associated with the four TCP/IP ToS precedence settings.

In conjunction with the Service Policy System, the S/390 can prioritize application performance, as well as outbound traffic.

Cisco and IBM have conducted interoperability tests. These tests prove that a Cisco network recognizes the prioritization of traffic from the OSA-Express and enforces this priority end to end through the network. The Cisco network uses features such as WFQ, Custom Queuing, Priority Queuing, and WRED to enforce the prioritization of the application traffic.

Note: In Cisco routers, WFQ is on by default on serial interfaces at speeds up to T1/E1 rates, which means you do not need to do anything extra to support the end-to-end prioritization of application traffic.

Load Balancing

Cisco and IBM have conducted testing that proves that a Cisco network can make load-balancing decisions based on information from the IBM Workload Manager. Using the MNLB feature of Cisco LocalDirector, the Cisco network can direct traffic to one or more OSA-Express adapters based upon the capability of the connected mainframe LPARs to conduct work.

Testing was conducted using a Cisco workload agent, which communicates with the IBM Workload Manager to set a metric value for each connected interface. The Cisco LocalDirector uses this information to route traffic to the connected OSA-Express adapters or CMCC cards.

Redundancy

One of the greatest differentiators for the IBM mainframe environment is its unrivalled availability. IBM mainframe environments are known for 99.99 percent availability, which equates to less than 15 minutes of downtime per year. If you are going to have an application server with this type of uptime characteristic, you want to attach it to a network with the same reliability.

Testing conducted by IBM and Cisco has shown that you can design networks to eliminate any single point of failure in the network and in the application server complex. During testing, which used both CMCCs and OSA cards, the following scenarios were created and the application availability results noted:

- *CPU failure*—Application traffic was rerouted to another server in the complex
- *LPAR failure*—Application traffic was rerouted to another server in the complex
- *Router failure*—Application traffic was rerouted through another router in the network
- *OSA failure*—Application traffic was rerouted through another OSA to the application VIPA address
- *CMCC failure*—Application traffic was rerouted through another CMCC to the application VIPA address

Summary of CMCC and IBM Channel Controllers

There are three main IBM solutions that attach the mainframe to the enterprise network—the 3745/3746 FEP, the 3172 Interconnect Controller, and the OSA. These products span generations of networking technology.

The IBM 3745/3746 FEP is the oldest, most mature IBM mainframe channel connectivity device. Groomed and enhanced over a period of more than a decade, the FEP has a great deal of functionality for SNA networks. Some of the features it provides cannot be provided by a CMCC or any other channel device—SNI, for example. However, the majority of SNA and TCP/IP traffic can very effectively and easily be supported on the CMCC. Enterprises should evaluate their needs carefully. The goal should be to keep and maintain only the smallest number of FEPs required to do FEP-specific functionality. The rest of the SNA and TCP/IP traffic will be better served by gaining access to the mainframe via a CMCC.

The IBM 3172 Interconnect Controller was a very effective LAN-to-mainframe connectivity device in the late 1980s and early 1990s. However, it has failed to keep up with technology and is no longer even sold by IBM. In many environments, the IBM 3172 cannot support the level of traffic required in enterprises today. The CMCC is a complete, cost-effective, and high-throughput replacement this device.

The OSA-Express is the latest generation of the NICs for the mainframe. The OSA-Express provides up to Gigabit Ethernet TCP/IP access to the mainframe. When you have the option to use this technology, you should do so. You also should use a Cisco network to interface to the OSA-Express card to the advantage of Jumbo frame support, end-to-end QoS, load balancing, and redundancy.

Many situations exist in which you cannot or should not use the OSA-Express. These situations include the use of non-IBM mainframes, older IBM mainframes, older operating system releases, and the need to aggregate SNA and TCP/IP traffic. In these instances, the CMCC remains the most beneficial means of providing high-speed access into the mainframe.