This article provides internetworking design and implementation information and helps you identify and implement practical internetworking strategies that are both flexible and scalable.

This article was developed to assist professionals preparing for Cisco Certified Internetwork Expert (CCIE) candidacy, though it is a valuable resource for all internetworking professionals. It is designed for use in conjunction with other Cisco manuals or as a standalone reference. You may find it helpful to refer to the Internetworking Case Studies, which provides case studies and examples of the network design strategies described in this article.

Contents

Internetworking Design Basics

Internetworking-the communication between two or more networks-encompasses every aspect of connecting computers together. Internetworks have grown to support vastly disparate end-system communication requirements. An internetwork requires many protocols and features to permit scalability and manageability without constant manual intervention. Large internetworks can consist of the following three distinct components:

- Campus networks, which consist of locally connected users in a building or group of buildings
- Wide-area networks (WANs), which connect campuses together
- Remote connections, which link branch offices and single users (mobile users and/or telecommuters) to a local campus or the Internet

The following articles provide information about internetworking design basics:

- Introduction
- Internetworking Design Basics

Designing various internetworks

Designing an internetwork can be a challenging task. An internetwork that consists of only 50 meshed routing nodes can pose complex problems that lead to unpredictable results. Attempting to optimize internetworks that feature thousands of nodes can pose even more complex problems.

Despite improvements in equipment performance and media capabilities, internetwork design is becoming more difficult. The trend is toward increasingly complex environments involving multiple media, multiple protocols, and interconnection to networks outside any single organization's dominion of control. Carefully designing internetworks can reduce the hardships associated with growth as a networking environment evolves.

The following articles provide information about designing various internetworks:

- Designing Large-Scale IP Internetworks
- Designing SRB Internetworks
- Designing SDLC, SDLLC, and QLLC Internetworks
- Designing APPN Internetworks
- Designing DLSw+ Internetworks
- Designing ATM Internetworks
- Designing Packet Service Internetworks
- Designing DDR Internetworks
- Designing ISDN Internetworks
- Designing Switched LAN Internetworks
- Designing Internetworks for Multimedia

Network Enhancements

In network management, functions such as security, monitoring, control, allocation, deployment, coordination and planning are executed. Network management is governed by a large number of protocols that exist for its support, including SNMP, CMIP, WBEM, Common Information Model, Java Management Extensions, Transaction Language 1, and Netconf.

The following articles provide information about enhancing a network:

- Increasing Security on IP Networks
- Integrating Enhanced IGRP into Existing Networks
- Reducing SAP Traffic in Novell IPX Networks
- STUN for Front-End Processors
- Multicasting in IP and AppleTalk Networks
- Using ISDN Effectively in Multiprotocol Networks
- Broadcasts in Switched LAN Internetworks
- SNA Host Configuration for SRB Networks
- SNA Host Configuration for SDLC Networks

IP Routing Concepts

IP Routing is an umbrella term for the set of protocols that determine the path that data follows in order to travel across multiple networks from its source to its destination. Data is routed from its source to its destination through a series of routers, and across multiple networks. The IP Routing protocols enable routers to build up a forwarding table that correlates final destinations with next hop addresses.

Following articles provide information about diferrent IP routing concepts:

- RIP and OSPF Redistribution
- Dial-on-Demand Routing
- Scaling Dial-on-Demand Routing
- Using HSRP for Fault-Tolerant IP Routing

UDP Broadcast Flooding

A broadcast is a data packet that is destined for multiple hosts. Broadcasts can occur at the data link layer and the network layer. Data-link broadcasts are sent to all hosts attached to a particular physical network. Network layer broadcasts are sent to all hosts attached to a particular logical network. The Transmission Control Protocol/Internet Protocol (TCP/IP) supports the following types of broadcast packets:

- All ones-By setting the broadcast address to all ones (255.255.255.255), all hosts on the network receive the broadcast.
- Network-By setting the broadcast address to a specific network number in the network portion of the IP address and setting all ones in the host portion of the broadcast address, all hosts on the specified network receive the broadcast. For example, when a broadcast packet is sent with the broadcast address of 131.108.255.255, all hosts on network number 131.108 receive the broadcast.
- Subnet-By setting the broadcast address to a specific network number and a specific subnet number, all hosts on the specified subnet receive the broadcast. For example, when a broadcast packet is set with the broadcast address of 131.108.4.255, all hosts on subnet 4 of network 131.108 receive the broadcast.

The following article provides information about UDP Broadcast Flooding:

- UDP Broadcast Flooding

Large-Scale H.323 Network Design for Service Providers

In today's highly competitive communications industry, service providers must find new ways to increase revenue and leverage their existing network infrastructure. Many service providers have already deployed networks consisting of Cisco solutions to provide data services to their subscribers. For them, packet telephony is a readily deployable, value-added, revenue-generating application that leverages the Cisco technology's data-handling capabilities.

The following article provides information about Large-Scale H.323 Network Design for Service Providers:

- Large-Scale H.323 Network Design for Service Providers

LAN Switching

Today's local-area networks (LANs) are becoming increasingly congested and overburdened. In addition to an ever-growing population of network users, several factors have combined to stress the capabilities of traditional LANs:

- Faster CPUs-In the mid-1980s, the most common desktop workstation was a PC. At the time, most PCs could execute 1 million instructions per second (MIPS). Today, workstations with 50 to 75 MIPS of processing power are common, and I/O speeds have increased accordingly. Two modern engineering workstations on the same LAN can easily saturate it.

- Faster operating systems-Until recently, operating system design had constrained network access. Of the three most common desktop operating systems (DOS/Windows, the UNIX operating system, and the Mac OS), only the UNIX operating system could multitask. Multitasking allows users to initiate simultaneous network transactions. With the release of Windows 95, which reflected a redesign of DOS/Windows that included multitasking, PC users could increase their demands for network resources.
- Network-intensive applications-Use of client-server applications, such as Network File System (NFS), LAN Manager, NetWare, and World Wide Web is increasing. Client-server applications allow administrators to centralize information, thus making it easy to maintain and protect. Client-server applications free users from the burden of maintaining information and the cost of providing enough hard disk space to store it. Given the cost benefit of client-server applications, such applications are likely to become even more widely used in the future.

The following article provides information about LAN Switching:

- LAN Switching

Subnetting an IP Address Space

The following article provides a partial listing of a Class B area intended to be divided into approximately 500 Open Shortest Path First (OSPF) areas. For the purposes of this example, the network is assumed to be a Class B network with the address 150.100.0.0:

- Subnetting an IP Address Space

IBM Serial Link Implementation Notes

Half-duplex and full-duplex serial links can often be confusing. One reason for the confusion is that there are several different contexts in which these two terms are used. These contexts include asynchronous line implementations, IBM Systems Network Architecture (SNA)-specific implementations, and data communications equipment (DCE) implementations.

The following article clarify some common misconceptions and points of confusion associated with half-duplex, full-duplex, and multipoint connections:

- IBM Serial Link Implementation Notes

References and Recommended Reading

The following article provides a list of reference books for further reading on internetworking design:

- References and Recommended Reading