

Florida Institute of Technology
Department of Electrical and Computer Engineering
ECE 4561 Computer Communications
Design Project

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Goal

Design a small business network consisting of a private LAN with 3 subnets, connected to the Internet. Both inexpensive and expensive alternatives are provided to cater to different scale installations and to demonstrate the differences between enterprise-class devices and SMB (small & medium business) -class devices.

Network Specification

Planned IP configuration:

- 192.168.1.0 subnet
 - Will contain one gateway router, one gigabit backbone switch, one general purpose server, one 100 megabit subnet switch, one wireless access point, and one printer/scanner/copier device.
 - Will service "Network A" consisting of up to 248 additional servers/clients.
 - Switch IP is 192.168.1.4, access point IP is 192.168.1.5, printer IP is 192.168.1.6, client IPs are 192.168.1.7 through 192.168.1.254.
- 192.168.2.0 subnet
 - Will contain one 100 megabit subnet switch, one wireless access point, and one printer/scanner/copier device.
 - Will service "Network B" consisting of up to 251 additional servers/clients.
 - Switch IP is 192.168.2.4, access point IP is 192.168.2.5, printer IP is 192.168.2.6, client IPs are 192.168.2.1 through 192.168.2.3 and 192.168.2.7 through 192.168.2.254.
- 192.168.3.0 subnet
 - Will contain one 100 megabit subnet switch, one wireless access point, and one printer/scanner/copier device.
 - Will service "Network C" consisting of up to 251 additional servers/clients.
 - Switch IP is 192.168.3.4, access point IP is 192.168.3.5, printer IP is 192.168.3.6, client IPs are 192.168.3.1 through 192.168.3.3 and 192.168.3.7 through 192.168.3.254.

Subnet mask for clients:

- 255.255.252.0
- Allows for communication among the three internal networks.

Gateway Router:

- 192.168.1.1 (internal IP address)
- 123.123.123.123 (external Internet IP address – specified by ISP)
- Will perform NAT (network address translation) for clients and servers that need to send or receive data from the Internet.
- Will perform packet forwarding for port 80 requests to the internal web server.
- Will block undesired external traffic from coming into the internal network (firewall).

DHCP / Web / Email / File Server:

- 192.168.1.3 (internal IP address)
- Services DHCP requests from clients and assigns IP based on MAC (improved security)
- Serves web pages for internal use and also the external business site.
- Runs Microsoft Exchange Server or Kerio MailServer for business email
- Provides common file storage area for quick access.

Equipment Suggestions

DHCP / Web / Email / File Server:

- Expensive: Dell PowerEdge 6800 Advanced server solution (\$24,000)
Includes Windows 2003 server software with 25 concurrent access licenses
Includes dual gigabit Ethernet interfaces, 73GB dual 10,000 RPM SCSI hard drives, 4GB of memory, and dual Intel Xeon dual core 3.16 GHz processors.
- Inexpensive: Dell PowerEdge 2800 Base server solution (\$1,599)
Does not include any operating system. Sun Solaris 10 for x86 or Red Hat Enterprise Linux would be good contenders for an inexpensive platform.
Includes dual 100 Mbps Ethernet interfaces, 73GB single 10,000 RPM SCSI hard drive, 1GB of memory, and single Intel Xeon 2.8 GHz processor.

Backbone Switch:

- Expensive: Cisco Catalyst Express 500G-12TC (8 + 4 port gigabit, \$1468)
- Inexpensive: Dell PowerConnect 2708 (8 port gigabit, web-managed, \$160)
- Will concentrate the three subnet switches so gigabit speed is helpful to have.

Subnet Switches:

- Expensive: Cisco Catalyst 2960-24TT (24 port 10/100 + dual gigabit, \$959)
- Inexpensive: Dell PowerConnect 2324 (24 port 10/100 + dual gigabit, \$180)
- 100 megabit is a good value compromise since 24-port gigabit switches are expensive.

Router:

- Expensive: Cisco 2851-AC-IP (\$5009)
- Inexpensive: Nortel Passport 2430 (\$550)

Wireless Access Points

- Expensive: Cisco Aironet 1240AG access point (\$610)
Supports A/G/B wireless standards with speeds up to 108 Mbps (Note: the switch that the wireless access device is connected to only offers up to 100 Mbps bandwidth).
- Inexpensive: Netgear WG602 access point (\$70)
Supports G/B wireless standards with speeds up to 54 Mbps.

Multifunction Printer Devices

- Expensive: HP Color Laserjet 4730 multifunction printer series (\$4999+)
- Inexpensive: HP Color Laserjet 2800 all-in-one series with 10/100 network jack (\$699+)

Cabling

- Generic Cat5e (\$0.06 per foot for standard to \$0.25 per foot for plenum)
Plenum cable is fire-resistant for usage in ventilation areas
- RJ45 terminators (\$0.25 each)

Inexpensive cost estimate: \$5,150 + cabling & installation costs

Expensive cost estimate: \$50,200 + cabling & installation costs

For a typical small or medium business, the inexpensive network option should be more than sufficient. In circumstances where there are a very large number of client computers or very large amounts of data being transferred from node to node, it may be worthwhile to consider upgrading some components to enterprise-level equipment tending toward the expensive option.

Functionality:

Internet Communication

If the company has one public IP address, the router can provide network address translation so that all client computer can access the Internet simultaneously without licensing additional addresses. If the company leases three class C address blocks, then the subnets could be changed to externally-accessible ones like 200.200.1.0, 200.200.2.0, 200.200.3.0 for example and the router will properly redirect incoming packets to the proper subnet. The less expensive option, and the most common for small business, is the single public IP address since leasing blocks of addresses can be costly. The type of connection common for small businesses is usually DSL or T1 since both offer decent upload speeds as well as download, which is important if there will be a public web site hosted on the company network. T1 speed is 1.544 Mbps and usually DSL can also be ordered for that speed. The main difference is that T1 offers guaranteed quality of service and bandwidth at a higher monthly cost.

Internal Communication

The wired clients on the internal company subnets can communicate with each other via their 100 Mbps connections which are concentrated at the subnet switch that has 1000 Mbps uplink to the backbone switch where the router is attached. Wireless clients connect via the wireless access points and will communicate anywhere from 1 Mbps to 108 Mbps depending on the quality of the wireless connection and the type of interfacing hardware purchased. IP requests that fall outside the range of the subnet mask will be forwarded to the gateway (in this case the router) so that they can be sent through the ISP to the Internet. The subnet switches use MAC addressing to determine whether frames should be sent higher-up to the backbone switch on the uplink port or if they should be sent to a regular downlink port. The backbone switch also uses MAC addressing to determine whether the frame should be sent to the network A switch, network B switch, network C switch, the central server, or the router.

Capacity

The equipment specified above will support up to 22 wired clients and 24 wireless clients in each subnet which should be fine for a small business, but if more wired client connections are needed the 24 port subnet switches could be changed to 48 port switches. If more wireless client connections are required additional wireless access points could be purchased and connected to the subnet switches. If more than 46 wired clients are required per subnet, an additional switch could be purchased for each subnet so that 6 ports will be used on the backbone switch instead of 3. For expandability beyond that, a larger gigabit backbone switch should be purchased.

Central Server

The general purpose DHCP, Web, Email, and File server that is specified in this design is typical of most small / medium business networks. For very small businesses, which may not want to invest in a special server just for these tasks, a router which includes DHCP functionality can be purchased but it must be able to handle multiple subnets (most off-the-shelf Internet routers only support one subnet). Having a dedicated server for web pages and file storage is a good idea because it doesn't place high network load on any particular client system and also offers a measure of protection in case the web server is compromised by a virus or denial-of-service attack. A centralized mail server allows for cool features like distribution lists, attachment virus protection, room reservations, meeting scheduling, and contact information.

Product Information Web Links

Dell PowerEdge 6800 series server:

http://www1.us.dell.com/content/products/features.aspx/pedge_6800?c=us&cs=04&l=en&s=bsd

Dell PowerEdge 2800 series server:

http://www1.us.dell.com/content/products/features.aspx/pedge_2800?c=us&cs=04&l=en&s=bsd

Dell PowerConnect 2708 switch:

http://www1.us.dell.com/content/products/productdetails.aspx/pwcnt_2708?c=us&cs=555&l=en&s=biz

Dell PowerConnect 2324 switch:

http://www1.us.dell.com/content/products/productdetails.aspx/pwcnt_2324?c=us&cs=65&l=en&s=biz

Cisco Catalyst Express 500G-12TC switch:

http://www.tribecaexpress.com/cisco_catalyst_express_500_series_switches.htm

Cisco Catalyst 2960-24TT switch:

http://www.tribecaexpress.com/cisco_catalyst_2960_series_switches.htm

Cisco 2851-AC-IP router:

http://www.tribecaexpress.com/cisco_2800.htm

Nortel Passport 2430 Router:

http://products.nortel.com/go/product_content.jsp?segId=0&parId=0&prod_id=26380&locale=en-US

Cisco Aironet 1240AG access point:

http://www.cisco.com/en/US/products/ps6521/products_data_sheet0900aecd8031c844.html

Netgear WG602 access point:

<http://www.netgear.com/products/details/WG602.php>

HP Laserjet 4730 series multifunction printer:

http://h10010.www1.hp.com/wwpc/us/en/sm/WF05a/18972-238444-410635-12004-410635-468688.html?jumpid=reg_R1002_USEN

HP Laserjet 2800 series all-in-one printer:

http://h10010.www1.hp.com/wwpc/us/en/sm/WF05a/18972-238444-410635-12004-f51-445194.html?jumpid=reg_R1002_USEN

Schematic

