

**Sun City Summerlin Computer Club
Seminar**

**Home Networking Basics
Wired and Wireless
What's New?**

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This 1½-hour seminar will cover basic networking concepts, discuss equipment and software needed to set up a simple wireless home local area network, connect to the Internet and share files and printers between two or more PCs. We'll also keep some time open to answer your networking questions.

This seminar's target audience is users who are pretty comfortable with their PC and Windows and want to move up to taking better advantage of having multiple PCs.

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Where to Find the Seminar Materials

- **Sun City Summer Computer Club Website:**
 - <http://www.scscclclub/smnr>
- **Acrobat file of these slides and notes**
 - http://www.scscclclub/smnr/home_networking_basics_2021.pdf

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Go to the “Seminar Handouts” page on the Club web site using the link above. Look in the Internet and Networking section.

Find the link to this “Networking, Home, Basic ” presentation, which is saved as an Adobe Acrobat PDF file.

Click the link to open the PDF document.

From there, you can print the document by clicking on the printer icon or you can save it to your hard disk by clicking the diskette icon.

Seminar Agenda

- **Basic Concepts and Terminology**
- **Wireless Networking Concepts and Hardware**
- **Las Vegas Internet Services**
- **Helpful Web Site Links**
- **Demo - Setting Up a Wireless Network**
- **Key Network Protocols and Services**
- **Shared Files and Printers**
- **Connecting to Network Printers**
- **WiFi Direct Networking**
- **Open Q and A**

**Home Networking Basics
Wired and Wireless**

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Our goal in this presentation is to cover many of the basic concepts of home networking. After that, we'll get session attendees up and running on a simple, secure home network that mixes wired and wireless connections.

Basic Concepts

- **Networks allow computers and devices to communicate.**
- **Why Have a Home Network?**
 - PCs & devices can share: files, printers, Internet connection.
 - PCs and devices can *back up* each other's data.
- **Simple Home Networks are easy to set up.**
 - Network cables, router or switch.
 - Enable client / server software configuration.
- **Wireless networking uses 2.4, 5 and 6 GHz radio spectrum.**
- **Speeds have steadily improved ...**
 - 54 Mbits per second (802.11g – rare these days)
(up to) 150, 300, 450, 600 & 900 Mbits per second (802.11n),
(up to) 1.3 Gbits per second (802.11ac)
 - (up to) 11 Gbits per second (802.11ax) (1 – 7 GHz spectrum)
 - (up to) 40 Gbits per second (802.11ay) (60 GHz spectrum)

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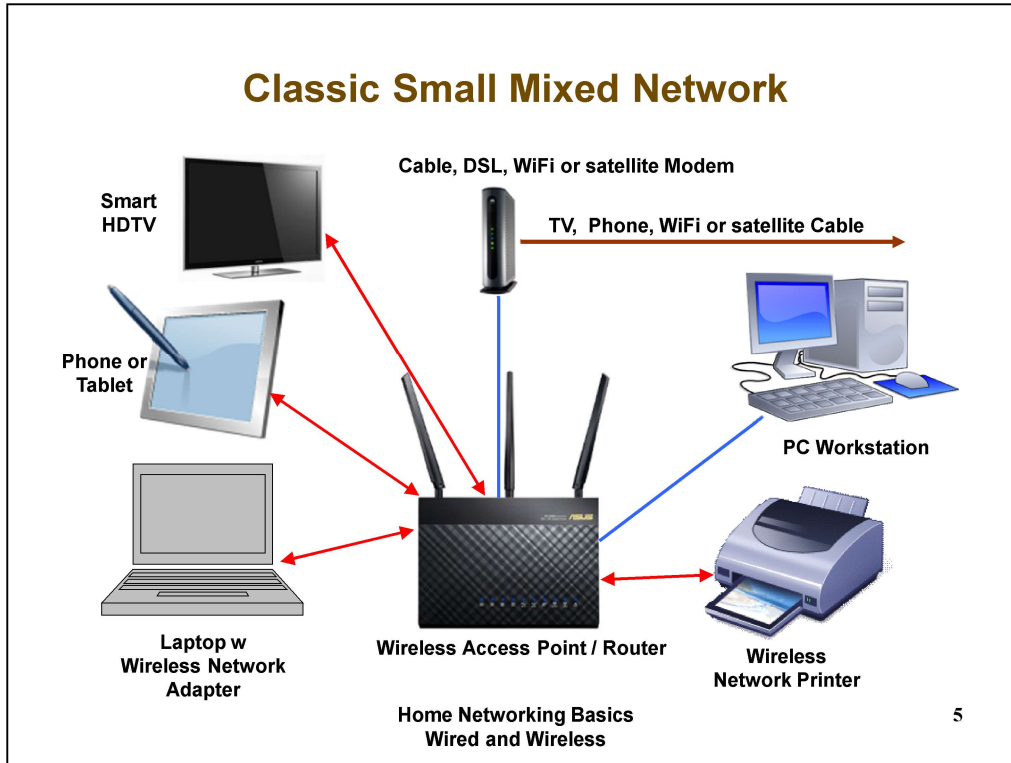
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Networking is the process of connecting two or more computers together so that they can communicate with one another. Networks can also communicate with other networks, making possible vast interlinked sets of computers.

Our focus is on relatively simple home networks of two up to a few PCs, connected to each other using Ethernet cables and wireless connections. Using a simple network of this type allows the connected PCs to share printers and files and also, if you have a wide-band Internet connection, such as DSL or Cox cable, to share that connection as well. This permits all PCs on the net to concurrently access the Internet via the high-speed connection.

As we will see in the following discussion, simple mixed (wired and wireless) home networks are easy to set up. You DO need some equipment and you need to configure some software to get it all to work, but generally, once a network is set up, it needs little if any additional tinkering, at least until you add another PC or change some other aspect of the configuration.

Wireless networking uses a “hub and spoke” topology. There is a central switching point, the Wireless Access Point / Router (WAP) that all the other remote nodes communicate with. Each remote node sends and receives via its own attached or built-in Wireless Network Adapter (WNA).



Above is the archetypical simple mixed wired and wireless network configuration diagram.

We have one or more PC workstations connected by Ethernet cables to an integrated Wireless Access Point / Router. The router provides high speed connections between each of the other Ethernet “wired” devices connected to it. The “wired” links can run at 100 million, 1 billion or even 10 billion bits per second.

We also have a laptop computer, a tablet and a network printer connected by wireless links to the same WAP / router. The wireless link may run at (up to) either 54 million bits per second, 150 million bits per second, 300 million bits per second and higher, all the way 1.9 billion bits per second. However, due to distance, obstacles and interference, it may run much slower.

In addition to its routing firmware, the router may also contain Internet firewall firmware and DNS server features.

The router is connected by Ethernet cable to a cable, satellite or DSL modem.

The cable, DSL , WiFi or satellite modem is connected to a TV or satellite coaxial cable, a WiFi antenna or to the DSL telephone jack, which provides the connection to the external Internet.

We will look at each of these components in more detail in following slides.

Wired Networking Hardware (1)

- **Ethernet Network Interface Card / Chip (NIC)**
 - Usually on motherboard of a device (PC, laptop, tablet, TV, ...)
 - Every NIC has a unique 6 byte (48 bit) physical address.
 - In Windows, try IPCONFIG /ALL in Command prompt to see yours.
- **Ethernet Cable - Category 5e (up to 1 Gbit) or 6 (up to 10 Gbits)**
 - Costs about \$1 per foot retail for short cables.
 - 8 wires inside (4 twisted pairs) with shielding in cable.
 - Use RJ45 multi-line telephone jacks as connectors.
- **Ethernet Switch**
 - Usually 4 Ethernet ports + a WAN port or Uplink port.
 - Also comes in 8, 16 or 24 ports.
 - Newer switches are auto-sensing – any port can be the “uplink”.
 - One switch can connect to another switch.
 - Often a switch is built into a Router or Wireless Access Point (WAP).



Network interface cards (NICs) mount inside a PC or may be integrated as chips onto a motherboard. They provide the hardware send / receive / control interfaces to an Ethernet cable. Almost all NICs now support speeds of 10, 100, 1000 million (and higher) bits per second. The NIC automatically senses what speed the rest of the network is running and chooses the corresponding speed. The newest generation of NICs can run at 1 billion bits per second (gigabit Ethernet) or higher, but such speeds may be overkill for home networks today unless you want to stream video to your TV.

Ethernet cables come in three common speed ratings: Category 5 for 10/100 Megabit, Category 5e for 1 Gigabit and Category 6 for 10+ Gigabit. The cables are shielded, with 4 twisted pairs inside, and have 8-pin RJ 45 snap-in jacks at each end. Ethernet cables can be up to 330 feet (100 meters) long.

A hub or switch is a simple interconnection device that has sockets for RJ 45 connectors from Ethernet cables. A hub is an older, “dumb” device that takes every message it receives and sends it to every other device connected to it. A switch looks at the target NIC address in each message and only sends the message out the Ethernet port that the target NIC is plugged into. A hub or switch also acts as an amplifier, so that two PCs can effectively be 600 feet apart if the hub / switch is centered between two long cables.

Wired Networking Hardware (2)

- **Ethernet Router / Wireless Access Point**
 - Provides basic switch functionality.
 - Provides dynamic IP address (DHCP) services.
 - Provides Network Address Translation (isolates internal LAN network from Internet).
 - May also provide wireless network support
Handles 802.11b,g,n,ac,ax,ay wireless protocols.
- **Cable, DSL or Satellite Modem**
 - Ethernet to Cable, Phone or satellite converter.
 - Has to be activated with your Internet Service Provider (provide the MAC address)



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Routers are switches with a much higher level of intelligence. Routers have built in functions to dynamically assign “private” IP addresses from a specified range (DHCP). The router also performs transparent mapping of these private IP addresses into a single “public” IP address assigned by the cable or DSL Internet Service Provider. This makes your entire in-house network look like a single PC to the outside world. Routers may also include firewall functionality. Firewalls effectively block incoming TCP/IP connections from all but a handful of standard, “safe” ports. This keeps out hackers.

With either Cox cable, satellite broadband or Embarq DSL, whether running a wired, wireless or mixed network, you must have a router in place to allow more than one PC to simultaneously access the Internet. These ISPs only allow one physical connection, i.e. a single IP address, to their network from a given connection point.

A cable or DSL modem converts Ethernet messaging signals to signals compatible with either your cable TV wiring or your special DSL telephone wiring. Cox cable uses two reserved digital channels for the incoming and outgoing message signals. DSL uses specially tuned phone wiring to allow the high speed signals.

Both cable and DSL are asymmetric. On Cox, incoming messages travel at about 6 Megabits per second; outgoing messages travel at 512 Kilobits per second.

A new form of Fiber DSL (FIOS) currently can deliver 15 Million bits/sec, but isn’t offered in Las Vegas.

Wireless Networking Hardware

PC Card Wireless Network Adapter

- Remote wireless connection.
- Wireless now built into most cell phones, laptops & tablets. Try to get ac support



USB Wireless Network Adapter

- Remote wireless connection.
- Newest “n” and “ac” models are very small
- USB ax adapters very scarce



A Wireless Access Point / Router combines the features of the router and the central 802.11b, 802.11g, 802.11g+ (MIMO) or 802.11n wireless transmitter receiver. It provides the central hub of a wireless network.

Wireless network adapters are attached to a PC or laptop and provide the remote ends of a wireless network. Adapters come in several configurations: PCI cards (for desktops), PC cards (for laptops), USB (very flexible). On most new laptops, the Wireless network Adapter is built in and controlled by an on/off switch.

Powerline Networking Hardware

- Uses your household wiring.
- Speeds from 80 M-bits to 2000 M-bits. (1000 M-bits per port)
- Plug in one near your router and connect an Ethernet cable to it.
- Plug in the second in a remote room (say by your TV) and connect an Ethernet cable from it to your TV, Blu-ray player or cable / satellite receiver.
- Great for streaming audio/video, extending wireless network.
- See the following web page:
<https://www.amazon.com/AV2000-Powerline-Pass-Thru-Gigabit-PLA5456BBKIT/dp/B01MTNKNPZ/>



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Powerline network adapters allow you to use your household's electrical wiring to create a remote Ethernet wired connection in a different part of the home than your computer room.

You can buy a pair of adapters (or more). Plug an adapter into a wall socket and then connect an Ethernet cable from your router to it.

In the remote room, plug in the second power line adapter and connect an Ethernet cable from it to an Ethernet device, like a PC, a Blu-ray player or even another wireless access point.

The newest models of power line adapters have speeds up to 1000 M-bits per second. This is excellent for streaming Internet audio and video, like from NetFlix or Hulu.

Power line networking can perform much better than wireless, because it isn't subject to radio interference.

High Speed Internet Service in LV

- **Cox Cable (fiber coaxial cable hybrid)**
 - Speeds from 10 Mbps to 940 Mbps
- **CenturyLink DSL (fiber / DSL hybrid)**
 - Speeds from 10 Mbps to 40 Mbps (SCS); 940 Mbps (fiber, new developments)
- **Hughes Net (satellite) – subsidiary of Echostar**
 - <http://www.hughesnet.com/>
 - 25 Mbps - various data limits: 10, 20, 30 or 50 Gbytes/mo
 - Target market is rural communities
- **Cellular Data Hot Spots - uses a 4g cellular hot spot**
 - <http://sprint.com>
- **5G Home Internet (Coming in 2021 / 2022) AT&T, Verizon, T-Mobile**
 - <https://www.verizonwireless.com/5g/home/>
- **LEO Satellite Internet Service (Coming in 2021 / 2022)**
 - SpaceX, Amazon, others launching large arrays of satellites.
 - <https://www.cnn.com/2021/04/15/spacexs-starlink-early-users-review-service-internet-speed-price.html>

Networking Web Links

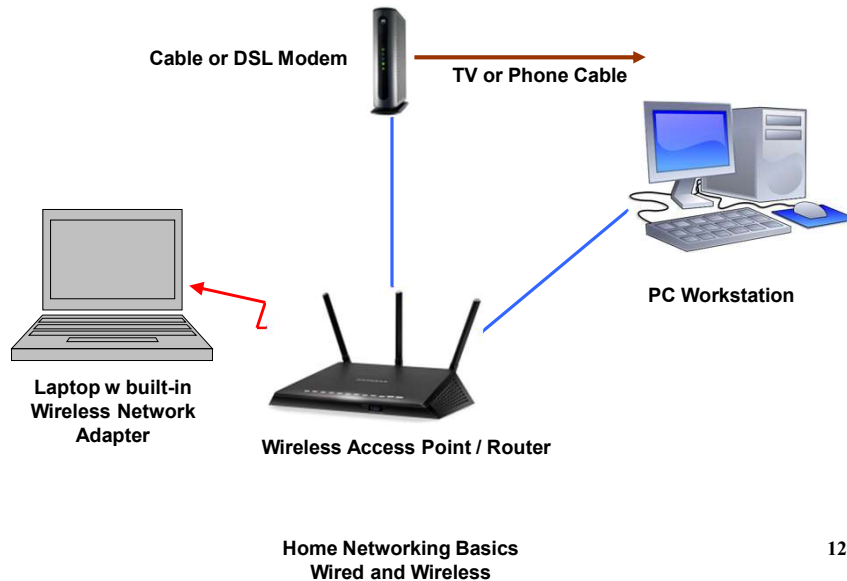
- <http://www.linksys.com>
- <http://www.netgear.com/>
- <http://www.dlink.com/>
- <http://www.belkin.com/>
- <https://www.asus.com/us/>
- <http://windowshelp.microsoft.com/Windows/en-US/networking.msp#>
- <http://www.microsoft.com/windowsxp/using/networking/default.msp#>
- <http://www.pcmag.com/article2/0,4149,1277020,00.asp>
- Windows Help and Support (Networking and the Web)

The above hyperlinks go to the major home networking equipment vendors' web sites. All these vendors provide a wealth of technical information.

There is also a link to the Microsoft home networking site, which again has much useful information.

Finally, the Windows Help systems have extensive information on networking which is worth reading for more information.

Demo – Two PC Wired / Wireless Network



Above is a simplified two PC mixed wired and wireless network configuration diagram, a simpler version of what we reviewed above.

This is the configuration we will now set up in the demo.

There is some simple hardware cabling to do.

The rest is software and system configuration.

Demo – Setting Up a Two-PC LAN (1)

- Read the vendor instructions – **TWICE!**
- On newer PCs and laptops, Ethernet NICs are already installed or built in. Most laptops also have built in 802.11n or ac.
- Plug in an Ethernet cable from PC to WAP/Router.
- Plug in an Ethernet cable from Cable/DSL modem to WAP/Router's WAN port.
- Power cycle both the Cable/DSL modem and the WAP/Router.

There's not much to comment on here. Just follow the steps.

It's important to power cycle both the Cable/Satellite/DSL modem and the WAP/Router so they will discover each other correctly. For best results, power on the modem first, wait until it has established its Internet connection, then plug in the WAP/Router.

Demo – Setting Up a Wireless Router

- **Configure the Wireless Access Point using the setup program provided by the vendor. The setup may be a series of web pages built into the router. If so, use your web browser to connect.**
 - SSID (change it from the default – e.g. “SCSCC300N”).
 - Administrator access password (change it from the default).
 - **Strongly Recommended - configure WPA2, WPA, (or WEP) security on the router (see notes). WPA2 is best security. WEP very weak.**
- **Using your browser, connect to the WAP / Router to re-check its configuration.**
- **Install any required network adapter drivers on the wireless PC(s).**
- **As needed, plug in the Wireless PC card or USB adapter or turn on your laptop’s wireless network subsystem.**
- **Windows should automatically discover the wireless access point and run a wizard to let you join the wireless LAN.**

Router vendors may provide a setup software tool to allow you to configure the WAP / Router from a wired connection. This setup tool does basic configuration. On newer routers, the setup may be entirely browser-based. The setup will automatically start when you first start up your web browser. Security caution ... Outside hackers know all the vendors’ defaults. To be secure, it’s important to change the SSID from the vendor’s default (e.g. “Linksys”) to some custom value that only you know. For example: “I_BURT_T”. Also change the vendor’s default administrator access password (e.g. “admin” or “password”) to something more difficult to crack. For example: “I7i0B9t5T”. You may want to turn off SSID broadcasting to make your wireless LAN [mostly] invisible to outsiders unless they already know your SSID.

Once the WAP / router is set up, you should reboot your PC to get a dynamic (DHCP) IP address from the new router. It usually will be in the 192.168.x.y range (x and y vary by vendor). For Mac Airports, the addresses are in the 10.0.x.y range.

Next, use your web browser to connect to the WAP / router at the vendor’s designated IP address (192.168.1.1 for Linksys). The WAP / router will have a built in mini web server with configuration screens to allow you to fine tune and adjust advanced settings. Login using your new administrator password.

Finally, to secure your wireless network from outside hackers, configure encryption to use WPA or WPA2 (recommended) or 128 bit WEP (if your wireless devices don’t support WPA) security. Once security has been enabled, any PC that wants to connect to this access point must be configured with the WPA private shared key or one of the generated WEP security keys. So write down the WPA shared key and/or a few of the four WEP keys generated. When joining the wireless LAN on the remote laptop or device, you may need to set the mode (WPA, WPA2 or WEP) and you will have to enter a valid WPA, WPA2 or WEP key to communicate successfully.

Demo – Setting Up a Two-PC LAN (3)

- **Set up the LAN Connection on each PC (use Wizard)**
 - In Windows 10, go to **This PC > Properties**
 - Specify a Workgroup name and PC name.
Don't use defaults: "MSHOME" or "WORKGROUP"!
 - On Windows 7 / 8 / 10, avoid "HomeGroups" if other PCs are not also Windows 7 / 8 / 10.
 - As of Win 10 V1903, HomeGroups are no longer supported.
- **Check and adjust LAN Connection's Settings.**
 - Use Control Panel's Network Connections applet.
 - Go back to check and refine Wizard's settings.
 - If needed, enable the Windows Firewall.

Sample Workgroup name: "BURT_HOME_WG".

Windows networking is based on the NetBIOS protocol, which is not routable (it can't access the public Internet), so you need to ensure the network is using "NetBIOS over TCP/IP" option. This option is set in the TCP/IP properties dialog or by the Network Setup Wizard.

It's important to enable the Windows 7, 8 or 10 Firewall at least temporarily to protect your PC while you are doing the setups. Otherwise a virus, worm or Trojan Horse might sneak in the back door. Later on, you can consider installing a more robust software firewall like Zone Alarm, Comodo, Kerio or Norton.

Demo – Setting Up a Two-PC LAN (4)

- **Reboot both PCs to ensure all software & settings are clean.**
- **Check PCs can “see” each other (Use “My Network Places”).**
- **Try your Internet connection from both PCs.**

If everything is working, you can feel proud of yourself.

If not, recheck the various steps and read the vendor’s setup guide again.

TCP/IP Name / Address Services

- **Domain Name Services (DNS)**
 - Resolves Internet host names like AOL.COM to IP addresses (e.g. 172.20.148.50)
 - Experiment with PING command.
 - Cox.Net DNS servers at: 68.111.16.30 and 68.111.16.25.
 - OpenDNS servers at: 208.67.222.222 and 208.67.220.220.
- **Dynamic Host Configuration Protocol (DHCP)**
 - Your router's built-in IP address server automatically assigns a dynamic IP address to requesting PCs.
 - IP address is "leased" to a PC or device for a set length of time (e.g. 4, 8, 12 or 24 hours). A PC or device can "renew" the lease.
 - Commonly, your *router* will assign IP addresses (192.168.x.y) to PCs on your internal network.

Domain Name Services (DNS) servers are special computers on the public Internet that convert readable domain names to IP addresses. ISPs like Cox.net, Earthlink.net, AT&T.net all have their own DNS servers. These DNS servers themselves form a network along with the main domain name registration services, such as Network Solutions and GoDaddy. These DNS servers regularly synchronize with each other so that most requests to resolve a domain name can be processed by a nearby DNS server. OpenDNS is a free, public DNS service that you can configure your PC or router to use. Normally on Windows, you can just let Windows TCP/IP automatically find the nearest DNS server.

Dynamic Host Configuration Protocol (DHCP) is a service that dynamically assigns IP addresses to network computers (PCs, routers, printers, other devices). Each such IP address is leased to the requesting PC for a set length of time, such as 6 or 24 hours. A computer can renew or release its lease. Windows requests a new lease each time it boots up. The DHCP server has a defined "pool" of addresses it can lease out. For your local router, typical IP addresses in the pool will range from: 192.168.1.100 to 192.168.1.199 – i.e. 100 addresses out of a possible 255. The others are reserved for permanent static assignment to devices like print or database servers. Note that IP address series starting with 192.168.x.y and 10.0.x.y are "special". Those addresses cannot be directly accessed from computers outside your private LAN. The router uses Network Address Translation (NAT) to transparently route traffic between computers on your private LAN and external computers on the public Internet.

Key Windows Local Networking Services

- **Client For Microsoft Networks**
 - Allows a PC to connect to shared files and printers on another networked PC in the same Work Group.
 - Required to connect to other network printers and shared folders.
- **File and Printer Sharing for Microsoft Networks**
 - Allows a PC to share its own printers and files with other networked PCs and devices in the same Work Group.
 - Required to allow other PCs and devices to connect to this PC's network printers and shared folders.

The Client for Microsoft Networks service is the core service that allows a Windows PC to access shared files and printers on other PCs on the same Workgroup/Homegroup on a LAN. Originally known as MS-Net or NetBIOS, this service allows a PC to “map” a logical drive to a shared folder on another PC. It also allows a PC to “add” a logical printer that physically resides on another PC.

File and Printer Sharing for Microsoft Networks is the core service that allows a Windows PC to share its printers and file folders with other PCs on the same Workgroup on a LAN. Printer shares are defined in the Control panel / Printer applet. File folder shares are defined using the Windows Explorer’s “Share As” function. Each shared folder is given a “Share Name” and other properties of the share are set. Important Note ... the underlying file folder’s access control properties must be consistent with those of the share. Otherwise remote users will not be able to access the folder, even though they can connect to the share.

A particular PC may be set up as just a client, just a file and print server or as both. For a small network, it’s generally most effective to have each PC operate as both a client and a server. Each PC can then function as a backup server for the other.

Shared Files and Printers Demo

- **Create some file folder and local printer “shares”.**
 - Windows Explorer folder “Sharing” menu.
 - Make them accessible by “Everyone”.
 - Printers and Faxes applet “Share as”.
- **Connect to those “shares” from the other PC.**
 - Windows Explorer Tools > Map function (\\pcname\sharename).
 - Creates a logical drive letter that points to a remote folder.
 - Control Panel “Add Printer” function (network printer).
- **Disconnecting from a “shared folder”**
 - Right click on the logical drive.
 - Click Disconnect.

In Windows Explorer, to share a folder, right click on it and then click Properties and then the Sharing tab. Click the “Share” button. Specify the share’s name and who will be granted access to it (normally everyone).

To share a printer, go to the “Printers and Faxes” applet, right click on the printer and click “Share”. Give the printer share a name.

In Windows Explorer or in My Computer, to connect a logical drive to a share on another PC, click the Tools menu, then Map or click the “Map” link in the toolbar. Choose a free drive letter and then type in or browse to the desired Share. The syntax is \\<pc name>\<share name>. You may need to enter credentials if you don’t have an account on the PC advertising the share.

To add a shared network printer, go to the “printers and Faxes” applet and click “add printer”. Indicate the desired printer is a network printer. Type in or browse to the desired network shared printer. The syntax is: \\<pc name>\<printer name>. Note – a network print server is also accessed in this way; to Windows, it looks like a PC with a shared printer.

To disconnect from a shared folder, go to My Computer, right click on the drive letter, and then click “Disconnect”.

To detach from a network printer, go to the “Printers and Faxes” applet, right click on the printer and then click Delete.

Installing Network Printers Demo

- **Network printers may be wired or wireless.**
 - A network printer has built-in network print server software.
 - Good practice to configure the network printer with a “static” IP address so it won’t change if router or printer is reset.
 - Newer printers advertise themselves via “Bon Jour” or UPnP service (uses connection by name, rather than IP address).
 - Important! You may need to install a printer driver if your Windows system doesn’t already have it.
- **Start in Windows Control Panel’s Devices and Printers applet**
 - Click “Add Printer”
 - In dialog that appears, click “Network printer”
 - Windows will search the network for network printers and display a list.
 - Select the network printer you wish to connect to.
 - Windows will complete the installation.
- **Deleting a network printer.**
 - Right click the printer’s icon and then select Remove Device.

WiFi Direct Networking

- New standard for connecting two or more “certified” devices *without* a wireless access point / router.
 - <http://www.wi-fi.org/discover-wi-fi/wi-fi-direct>
 - http://en.wikipedia.org/wiki/Wi-Fi_Direct
 - Standard is managed by the WiFi Alliance
- Devices form an ad-hoc “peer to peer” network.
 - Secure connections automated (WPS, NFC or Bluetooth)
 - Useful for synchronizing contacts & calendars
 - Devices can print directly to a Wifi Direct printer
 - Can be used to facilitate streaming (e.g. Chromecast).
- Look for the “WiFi CERTIFIED” logo:
 - Cell phones
 - Tablets
 - Laptops
- Caution – WiFi of any kind uses lots of battery power



Open Workshop / Q and A

**Your Networking
Problems and Questions**

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