Networking Basics Course

A summary of the material needed for a HTM technician in the field.

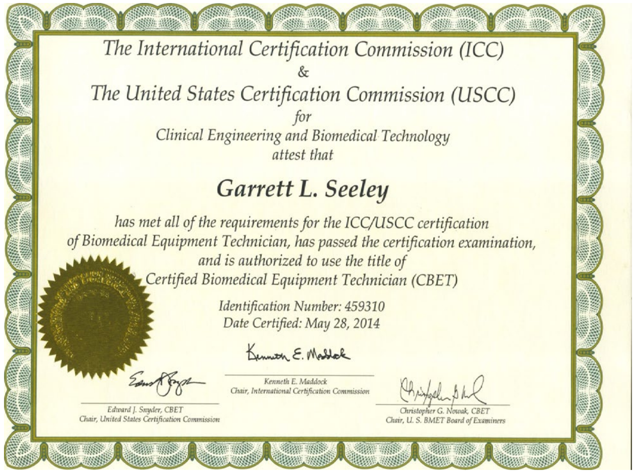
We will cover

- Introduction of Presenter
- Basics of why we use networks
- WINS / Name Driven Networking
- TCP and the Internet Protocol
- Subnetting and Port Forwarding
- Wireless and Troubleshooting

Introductions - Who Am I?

Garrett Seeley - Associate Professor
Biomedical Equipment Technology, Texas State Technical College - since 2008

- Master of Science in Information Systems
  - Texas A&M University - Central Texas, Killeen, Texas
- Bachelor of Applied Science and Technology in Biomedical Electronics
  - Thomas Edison State College, Tenton, New Jersey
- Medical Equipment Repairer 35G/91A
  - United State Army Medical Equipment and Optics School



The International Certification Commission (ICC)
&
The United States Certification Commission (USCC)
for
Clinical Engineering and Biomedical Technology
attest that

Garrett L. Seeley

has met all of the requirements for the ICC/USCC certification of Biomedical Equipment Technician, has passed the certification examination, and is authorized to use the title of Certified Biomedical Equipment Technician (CBET)

Identification Number: 459310
Date Certified: May 28, 2014

Kenneth E. Maddock

Edward J. Snyder, CBET
Chair, United States Certification Commission

Kenneth E. Maddock
Chair, International Certification Commission

Christopher G. Nowak, CBET
Chair, U. S. BMET Board of Examiners

- Certifications
  - CBET
  - A+ IT technician
  - Network+ Certified

Who is TSTC?

- A technical school chain ran by the State of Texas
  - 10 campuses statewide - 2 for Biomedical Equipment
  - Regionally Accredited as a 2 year college (SACS)
  - TSTC Waco is on the old John B Connally Airbase
  - Waco has On Site Housing.
  - 18k Average tuition costs for a degree (in state)
  - Visit us on the web ! https://www.tstc.edu/

Introductions - The BET Department at TSTC

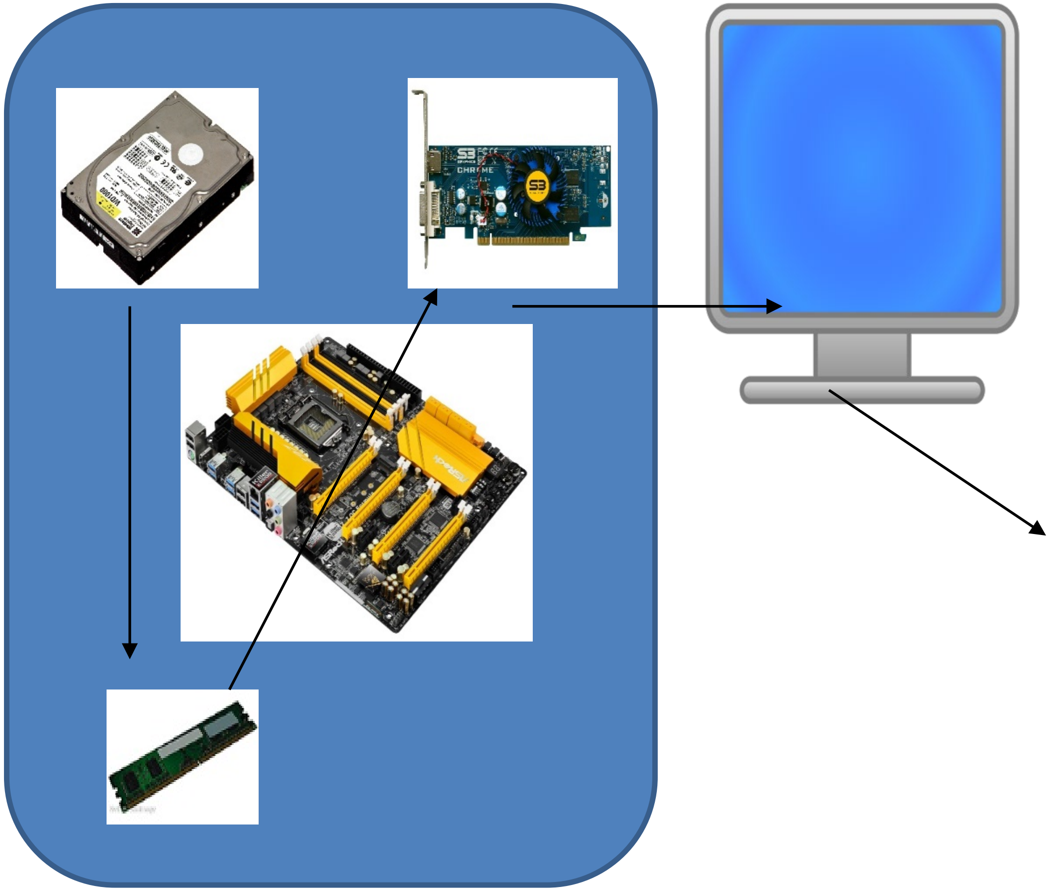
Our program data:

- Waco offers 2 degrees - Biomedical Equipment Technology and Medical Imaging Systems. Each is a separate 2 year Associates of Applied Science - 60 credits. Taken concurrently = 2.5 years for 2 AAS degrees.
- The system graduates about 70 BET students per year, Waco Biomedical Equipment Technology graduates about 50 students per year
- There is no waiting list to enroll. There are no requirements to enter.
- Completion of students is increasing, around 50%, Placement is over 90%
- BET program has over 3 million dollars of actual hospital equipment to learn on - project based learning using job tasks to instruct.

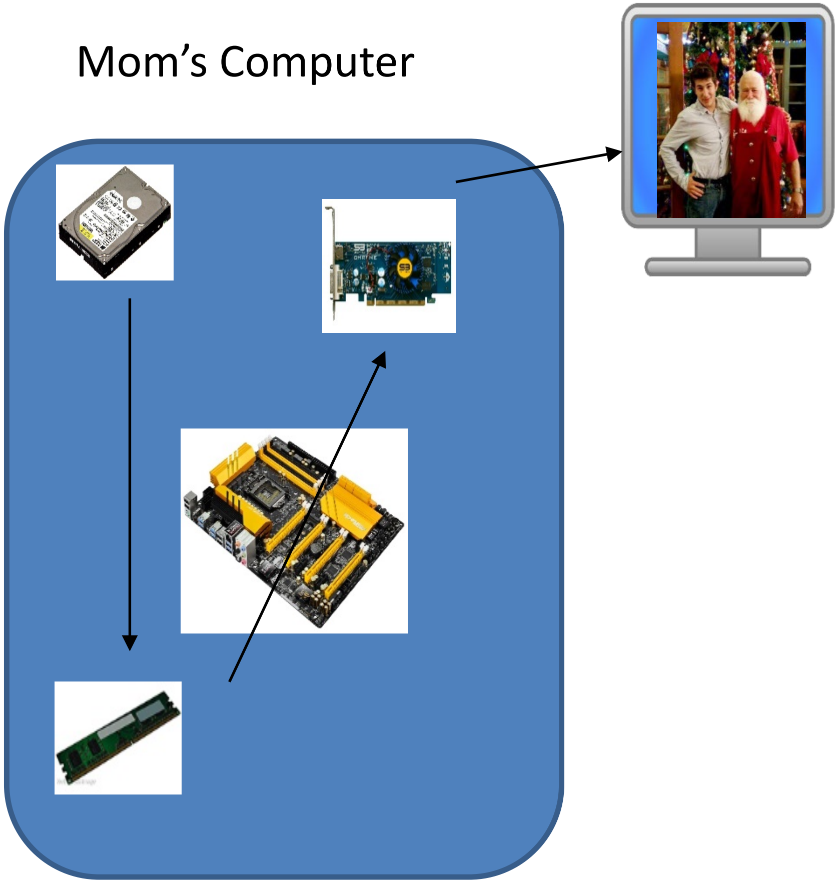
https://waco.tstc.edu/programs/BiomedicalEquipmentTechnology

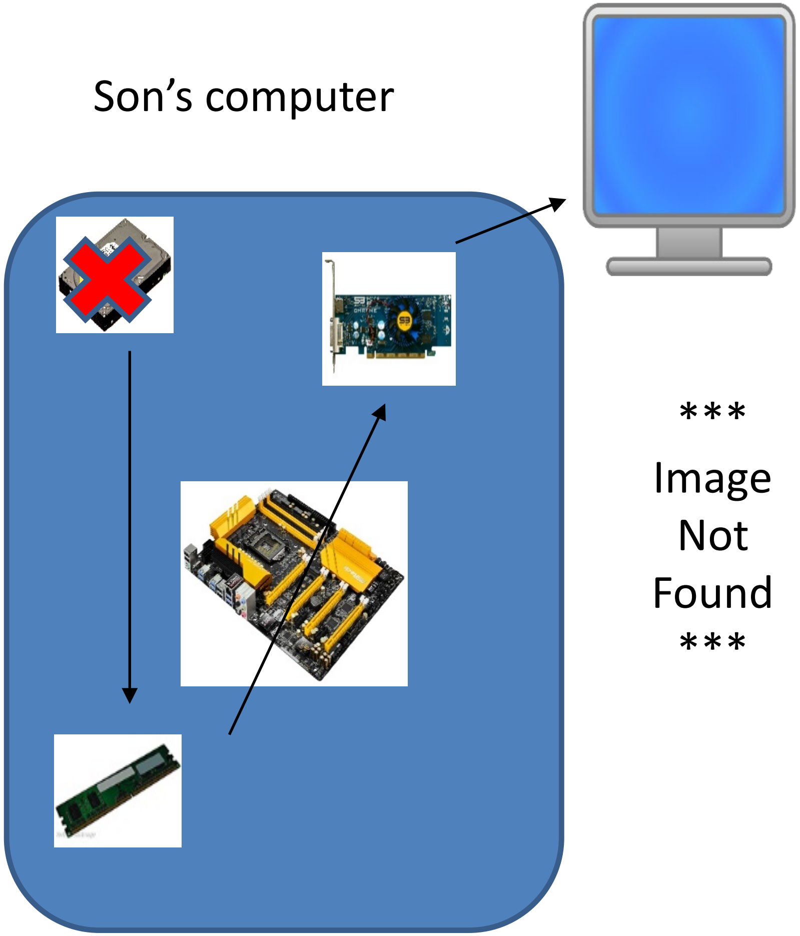
Why Do We Use A Network?

Using a computer – Recall that…



But what if someone else wants to see a picture that is on Mom's computer?


Mom's Computer


Son's computer

***

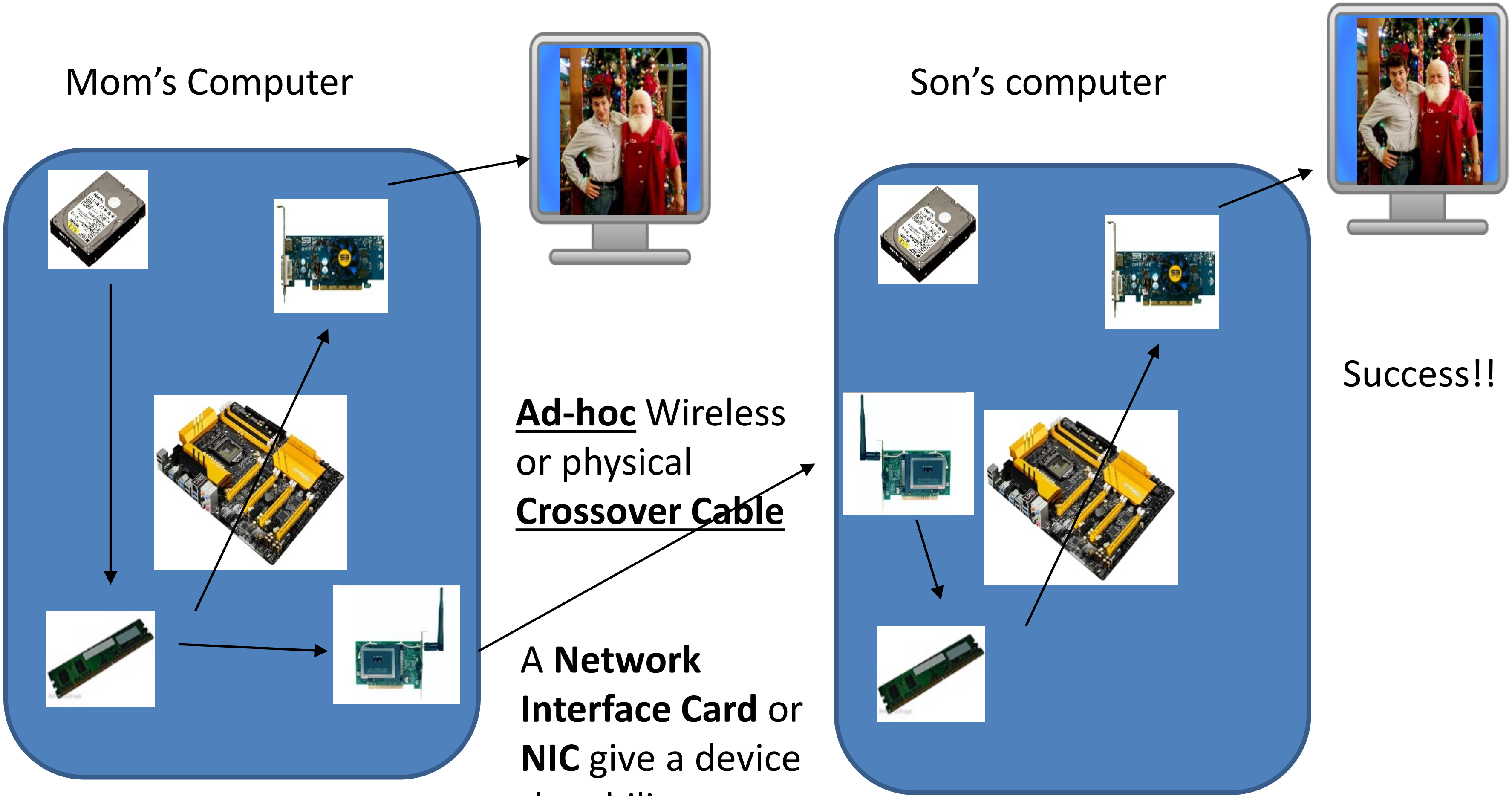
Image

Not

Found

***

Lets Add a Network Interface Card



Mom’s Computer

Son’s computer

Ad-hoc Wireless or physical **Crossover Cable**

Success!!

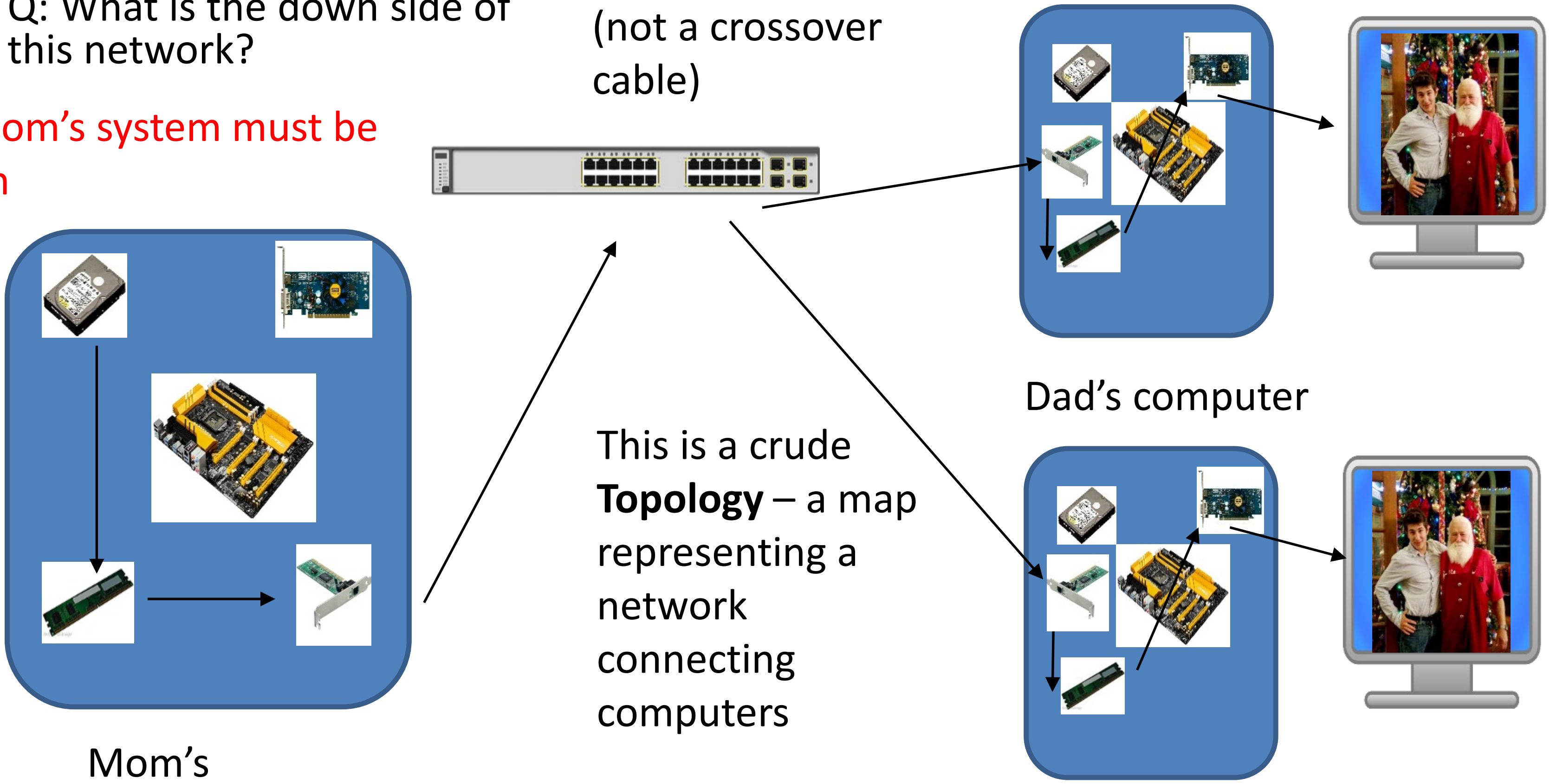
A **Network Interface Card** or **NIC** give a device the ability to use a network

What if another person wants access to my files? Build a bigger network.

Basic Peer-to-Peer Networking

- Use a **Switch** (or a **Hub**) to connect all machines directly.
- Q: What is the down side of this network?

Mom's system must be on



A **Switch** – connected by standard cabling (not a crossover cable)

Son's computer

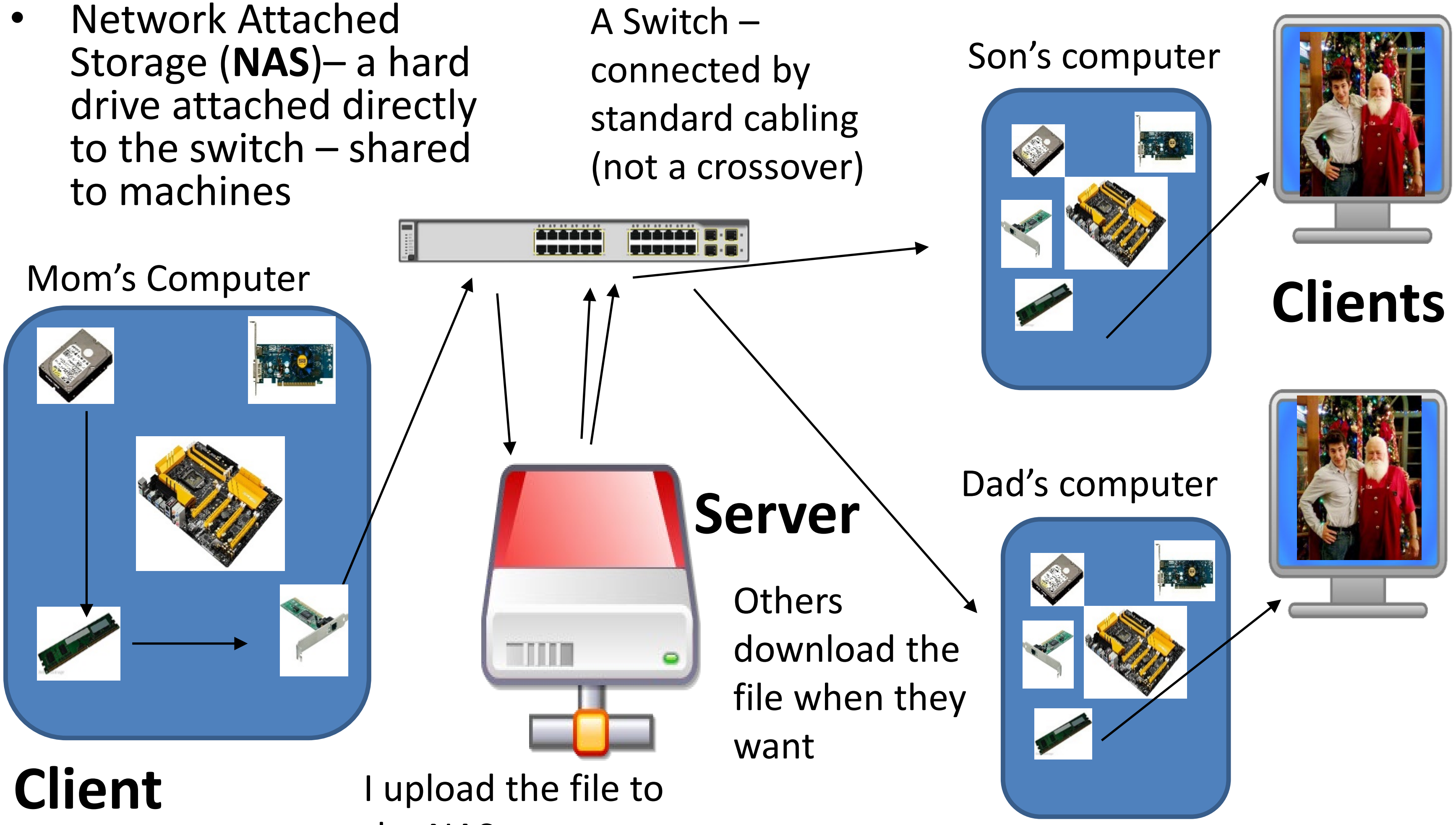
Dad's computer

This is a crude **Topology** – a map representing a network connecting computers

Mom's Computer

Lets fix the down side and share a NAS
Basic Client - Server Networking

- Network Attached Storage (**NAS**)– a hard drive attached directly to the switch – shared to machines



A Switch – connected by standard cabling (not a crossover)

Son's computer

Clients

Mom's Computer

Server

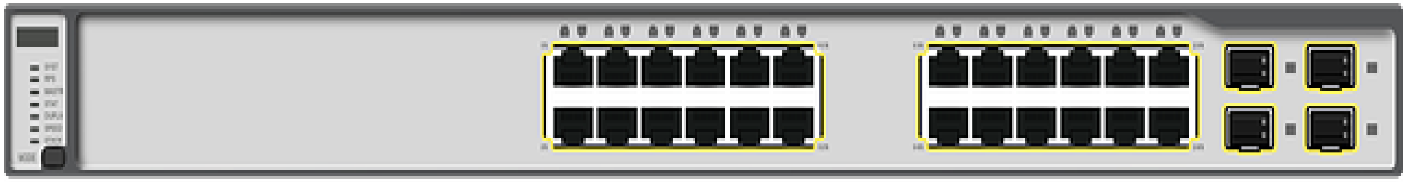
Dad's computer

Others download the file when they want

Client

I upload the file to the NAS

What do we need to make the network?

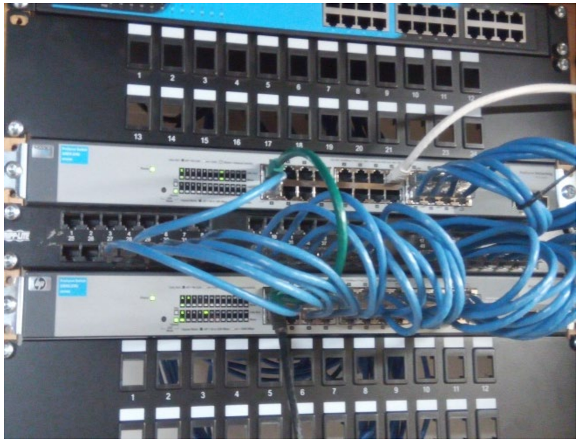


- A Switch provides the **backbone** – a connection between clients and servers that all devices use to communicate to each other. A backbone may have multiple switches or other hardware in it. It is the main path for data on a local network. **Switches** work as repeaters and sorters, copying the messages and sending them ONLY to the device that needs it. It knows the device using a **MAC address** (a Local ONLY address). This is also called the **Physical Address**. It is not adjustable. It works on **Layer 2** of the **OSI model**

What do we need to make a network?

Ethernet connections (802.3)– provides the connection to the backbone/switch. These connectors use a **bandwidth** – the amount of data that we can send at one time. A bit is a “1” or a “0”. We send Millions of bits per second (**Mbps**).

Cabling (LAN) Info:
Copper wiring – 10/100/1000baseT.
Base = **baseband** (digital signals)
The first number lists the speed in Mbps
The **T** means twisted pair cable, listed in Categories (Cat)
10Mbps = **Cat 3**, 100Mbps = **Cat 5e**, 1000Mbps = **Cat 6**, - all look the same!
We can use Fiber Cabling – for 10 or 100 Gbps networks. This is 10gbaseFx (up to 10000 times faster than copper!)



What do we need for wireless?

Wireless connections (802.11) – Uses a radio to transfer information to and from a client without using any wiring. It is still measured in Bandwidth but the radio frequency is important . There is a security concern as well.

Wireless (WLAN) Info:
Requires an Access Point (AP) to act as the backbone.
Uses a Radio transmission cover 2.4Ghz and 5Ghz bands
Uses channels – can only operate a limited number in the same area. 2.4Ghz can operate channels 1 - 11 (actually 3) 5Ghz can operate
Transmits in 11, 54, 300 Mbps, 1.7, and now 3.4 Gbps. These are the B, G, N, AC, and AX transmission speeds
Must be secured (encrypted) or it is easy for hackers to "listen in" to the transmission.

What else do we need?

We will need the computers and servers to build our network

For example:

<u>NAS</u> – Network Attached Storage – A server with a hard drive that shares its resources over the network.

Now… how do we set up a network?

Actually, that is another part of the slide show.

But first… any Questions?

How Do We Set Up Networks?

Seriously, its not as hard as people think.

Here is why networks aren't that hard

- You are already used to one. – I'll prove it to you!!!
- Why does this work?

254 – 867 – 4885

Area Code

City Code

Individual Number

Q: Why don't we all have the same number?

A: Because everyone's phone would ring at the same time

Q: Well, what's wrong with that?

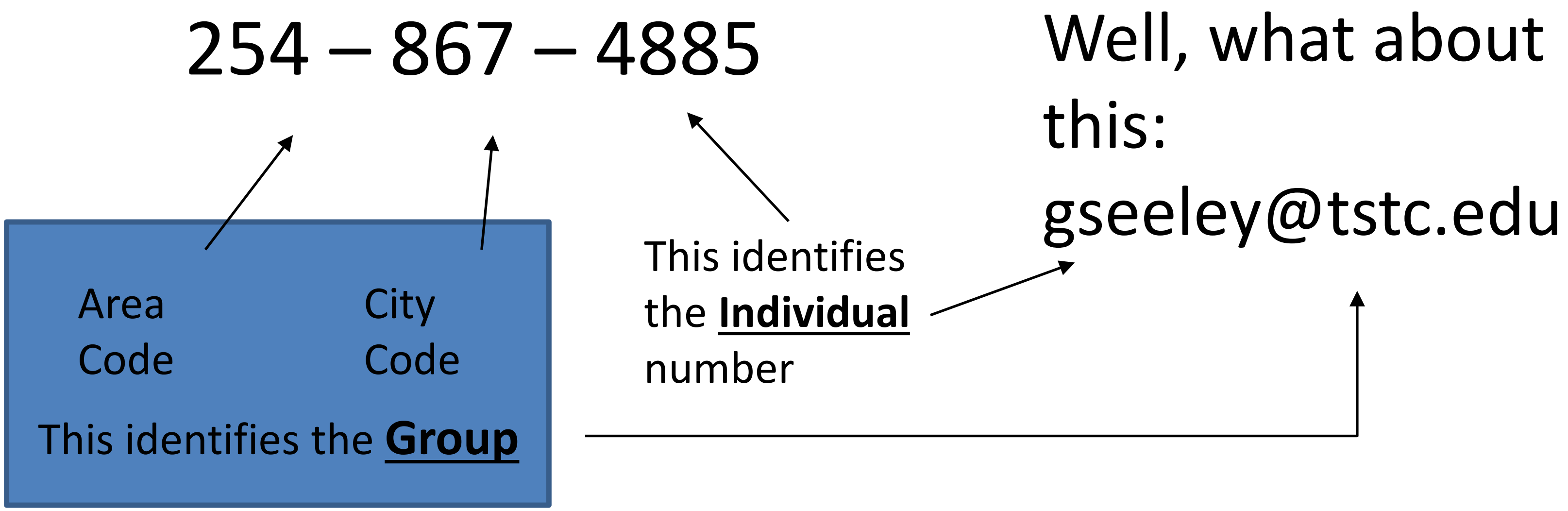
A: It would upset everyone to have all phones ringing at the same time

This is why we are all not named "Bob", but it would be easier to remember everyone's name if we all had the same one.

Well, how does that apply to networking?

The phone system is a network

It does what all networks do – It identifies a group and identifies an individual



254 – 867 – 4885

Area Code

City Code

This identifies the **Group**

This identifies the **Individual** number

Well, what about this:

gseeley@tstc.edu

Ok, again, how does this apply to networking?

- All networks **identify the group** of devices (Clients, servers, computers, switches routers, printers). They identify them as one whole group. This is usually with either a name for the group or a number for the group.
- All networks **identify each individua**l in the group with a unique name or number.

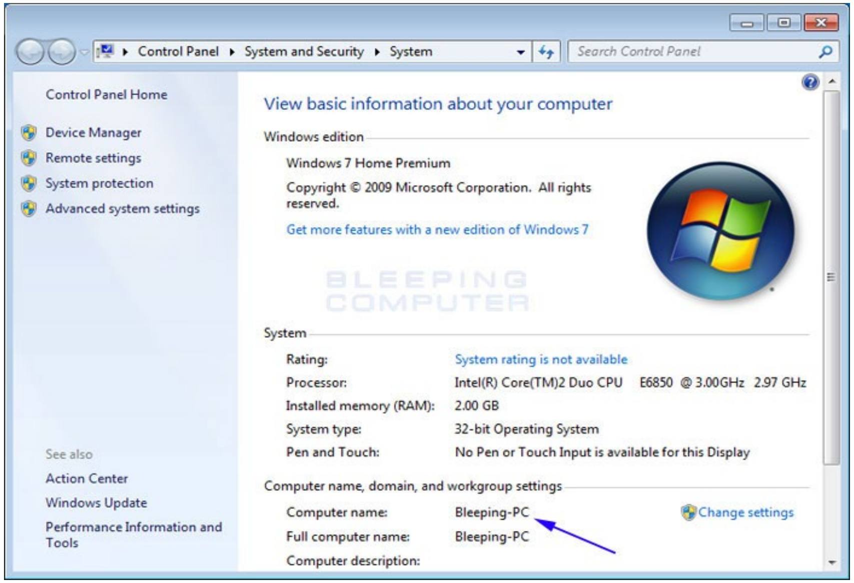
There are different ways to network – they are called **Protocols**

- A **Protocol** is way to network machines – Think of it like speaking a language

Let's look at **WINS** protocol, **W**indows **I**nternet **N**aming **S**ystem; Also called **Samba** – (in Linux) , and **Appletalk** in Mac Systems (all the same)

The first network we will study is WINS

- WINS uses a group name – called a "**Workgroup**"
- WINS uses a individual name - called a "**Computer Name**" or "Host Name"



View basic information about your computer

Windows edition

Windows 7 Home Premium

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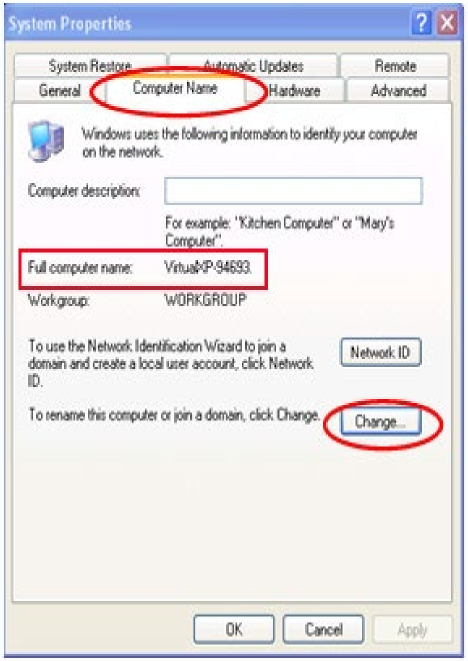
Get more features with a new edition of Windows 7

System

Rating: System rating is not available
Processor: Intel(R) Core(TM)2 Duo CPU E6850 @ 3.00GHz 2.97 GHz
Installed memory (RAM): 2.00 GB
System type: 32-bit Operating System
Pen and Touch: No Pen or Touch Input is available for this Display

Computer name, domain, and workgroup settings

Computer name: Bleeping-PC
Full computer name: Bleeping-PC
Computer description:



Windows uses the following information to identify your computer on the network.

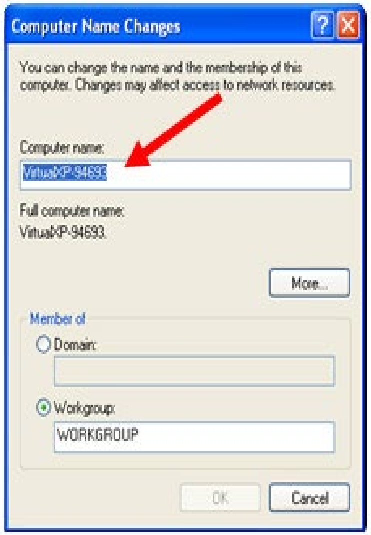
Computer description:

For example: "Kitchen Computer" or "Mary's Computer".

Full computer name: VirtualXP-94693
Workgroup: WORKGROUP

To use the Network Identification Wizard to join a domain and create a local user account, click Network ID.

To rename this computer or join a domain, click Change.



You can change the name and the membership of this computer. Changes may affect access to network resources.

Computer name: VirtualXP-94693

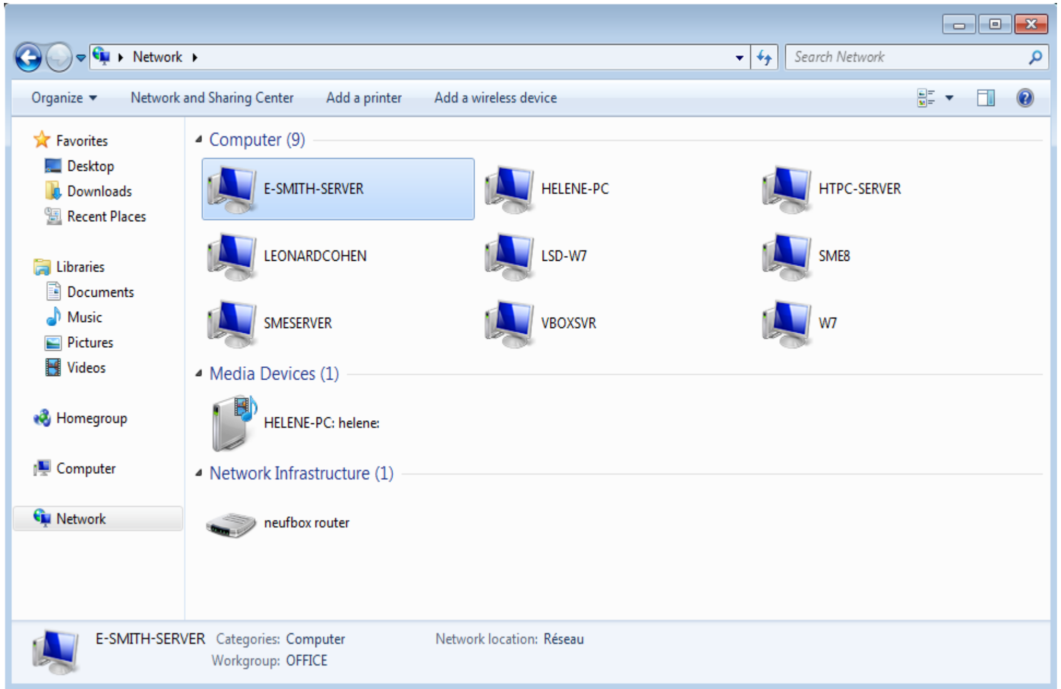
Full computer name:
VirtualXP-94693

Member of
○ Domain:
● Workgroup: WORKGROUP

What does WINS do for me?

I can share files, folders, drives, printers, and other devices if we are in the same workgroup.

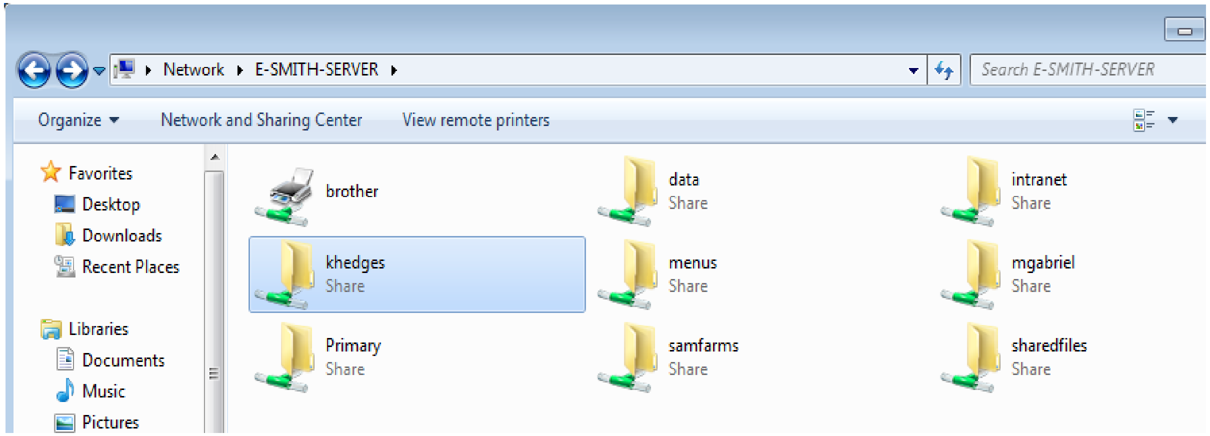
We call this a simple file share.



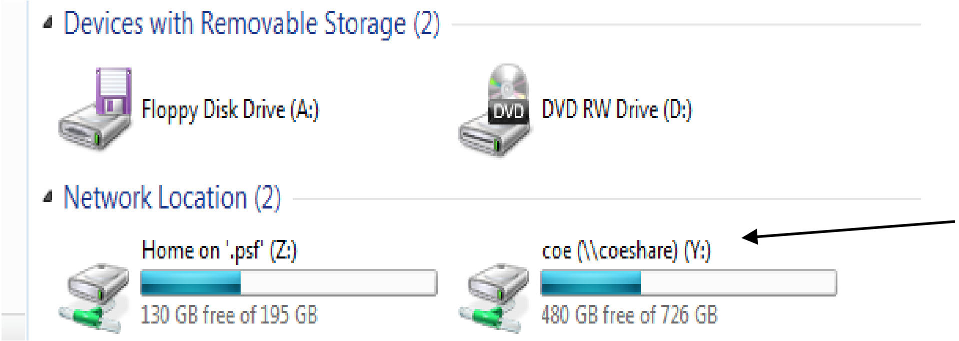
E-SMITH-SERVER Categories: Computer
Workgroup: OFFICE
Network location: Réseau

WINS shares folders and resources

These are folders under the “E-SMITH-SERVER” share

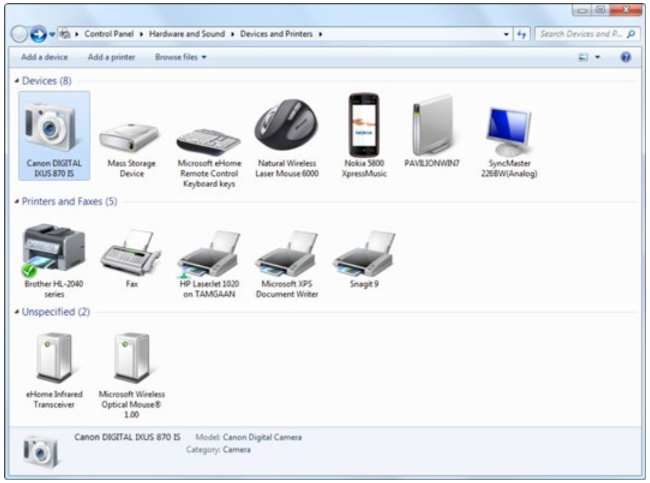


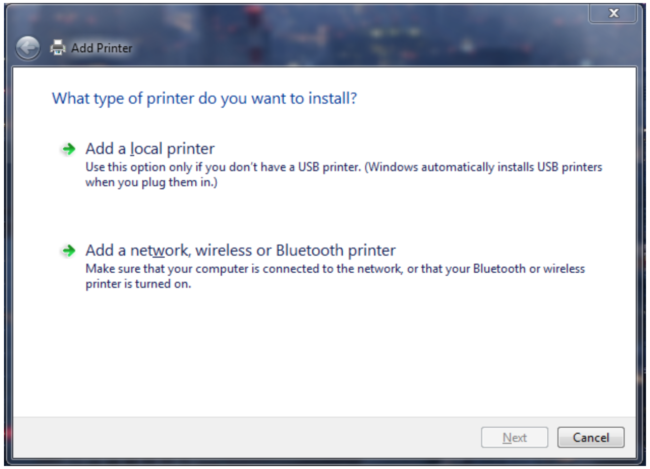
This is what it looks like when you attach one of the folders under the “**Map a drive**” option (Windows 7) or “Add a network location” (Windows 10) in “Computer” file system in Windows



A NAS looks like this

WINS also shares devices like printers

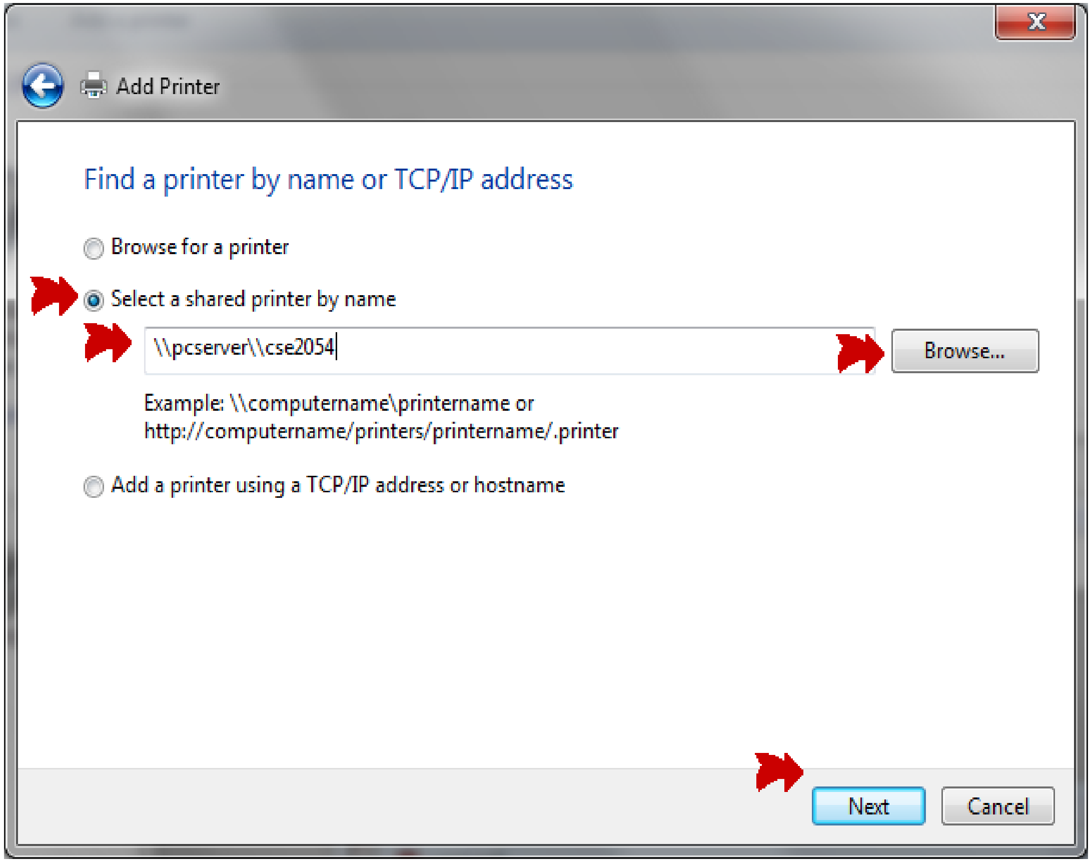

Control Panel ▸ Hardware and Sound ▸ Devices and Printers ▸
Search Devices and P...
Add a device
Add a printer
Browse files ▾
Devices (8)
Canon DIGITAL IXUS 870 IS
Mass Storage Device
Microsoft eHome Remote Control Keyboard keys
Natural Wireless Laser Mouse 6000
Nokia 5800 XpressMusic
PAVILIONWIN7
SyncMaster 226BW(Analog)
Printers and Faxes (5)
Brother HL-2040 series
Fax
HP LaserJet 1020 on TAMGAAN
Microsoft XPS Document Writer
Snagit 9
Unspecified (2)
eHome Infrared Transceiver
Microsoft Wireless Optical Mouse® 1.00
Canon DIGITAL IXUS 870 IS
Model: Canon Digital Camera
Category: Camera



Add Printer

What type of printer do you want to install?

- Add a local printer
  Use this option only if you don't have a USB printer. (Windows automatically installs USB printers when you plug them in.)
- Add a network, wireless or Bluetooth printer
  Make sure that your computer is connected to the network, or that your Bluetooth or wireless printer is turned on.



Add Printer

Find a printer by name or TCP/IP address

○ Browse for a printer

● Select a shared printer by name

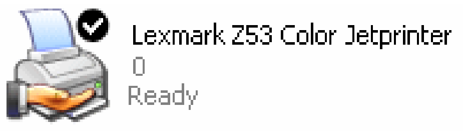
\\pcserver\\cse2054

Example: \\computername\printername or
http://computername/printers/printername/.printer

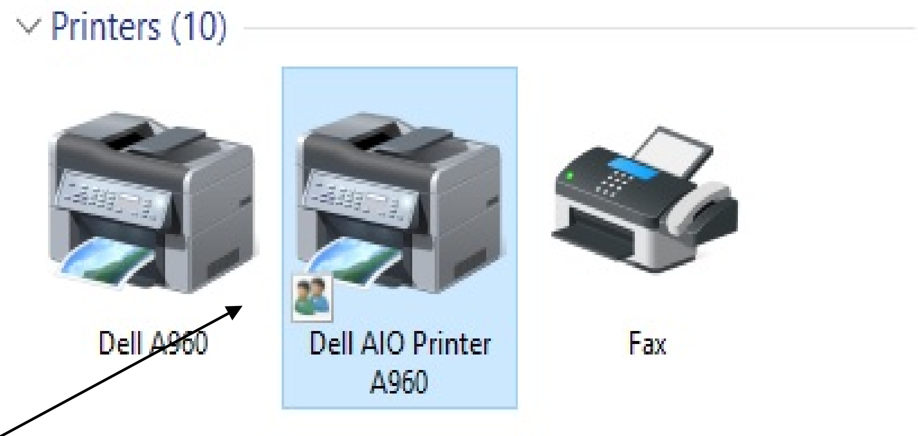
○ Add a printer using a TCP/IP address or hostname

This is what shared devices look like

- Shared printer icon from Windows XP



Lexmark Z53 Color Jetprinter
0
Ready



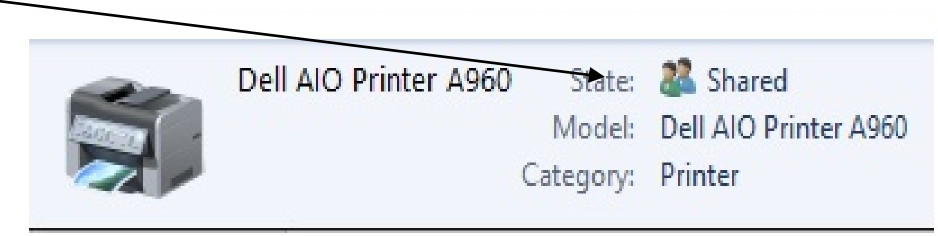
Printers (10)

Dell A960

Dell AIO Printer A960

Fax

Shared printers in Windows 7 and 10



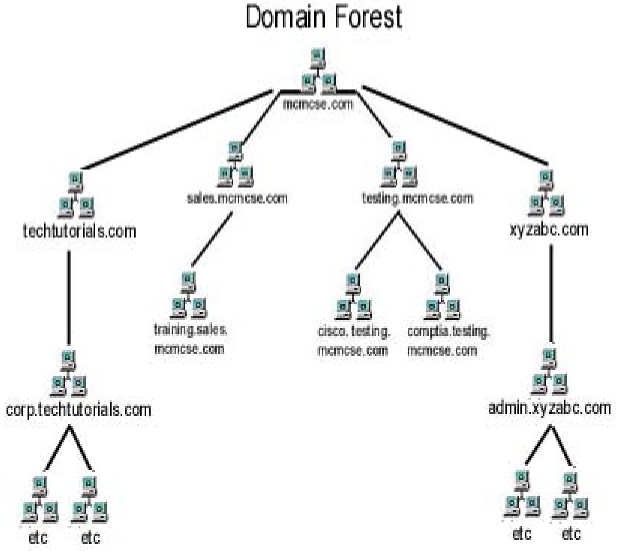
Dell AIO Printer A960

State: Shared
Model: Dell AIO Printer A960
Category: Printer

WINS is similar to business grade networks

- It is similar to Active Directory, but do not confuse the two.
- Active Directory uses a login server and controls which users have access to devices and clients.

In active directory, all computers are under a structure called a “forest”. Only certain users can log into specific machines. The group of machines a user can access is called a “tree” (used as a workgroup). This is actually how most businesses are set up.



Understanding Active Directory

- There are permissions set to a login, a machine, and a domain (a workgroup of machines)
  - Here is the easiest way to understand it – A login with its password verifies the user is **authentic** and **authorized** to use these host names on this domain.
  - These settings are held in a server called the "Active Directory"
- Uses two main security concepts – Authentication and Authorization
  - User name and password assures the user is who they say they are
    - Authentication (Login) security is "**Something you have, Something you know, Something you are**"
    - Authorization security is "This login can do this with these things"

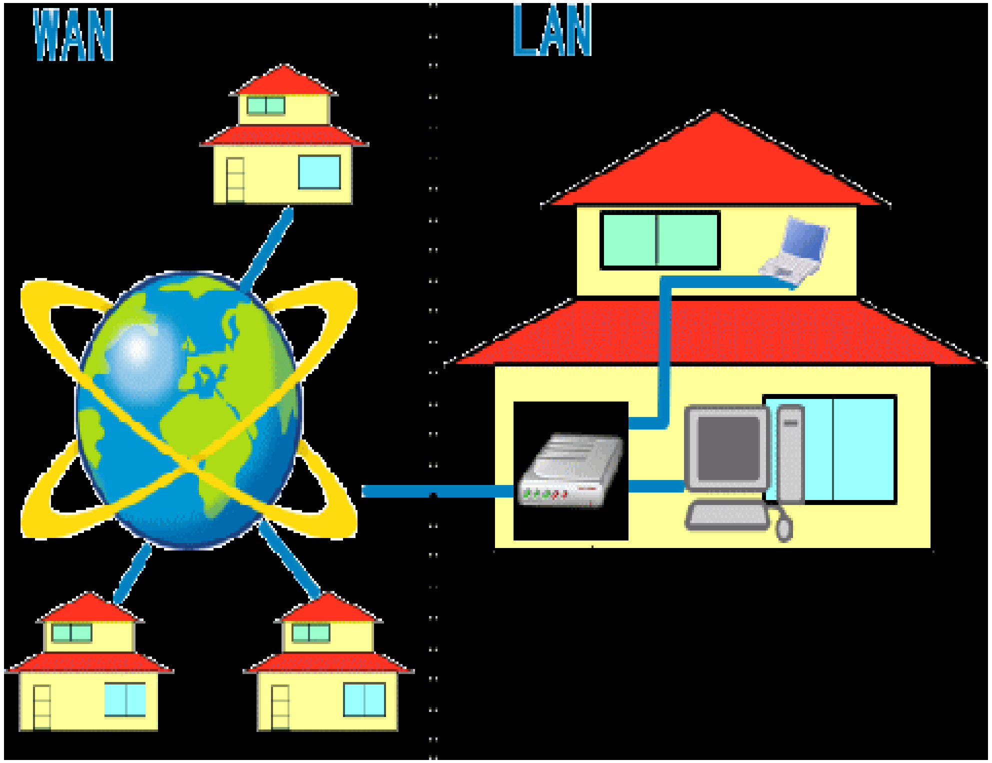
WINS is used along side of the Internet

Its odd, but Name-Driven networking is for Local traffic (**LAN**-Local Area Network) connections only. The **Internet** is called a Wide Area Network (**WAN**)

Remember Protocols?

WINS does not affect any other protocol. It works along side them.

It is a LAN Only network protocol – does not give Internet access



Well, what do we need to get my WINS network to the internet?

- Short answer? More slide show.
- The Internet uses a different protocol, the TCP/IP protocol. Remember a protocol is like using a different language
- There are a whole new set of set-up instructions, hardware, and commands used.

Any Questions???

TCP/IP Networking

What is it and how to I make it work?

(FYI: we are going to study IPv4. IPv6 is easier if you know IPv4)

Most people have seen IP's used

They just didn't know it.

- IP's are used on web pages to access the internet.
- They are used for both local (Local area network – **LAN**) and Internet (Wide Area Network – **WAN**) networking
- We use something called DHCP to set the IP for you automatically. You did not need to know it.
  - This is a "Lease" the IP is only good for 2 to 12 hours.
  - It is only good on that network, or that wireless access point
  - Its what we call **Dynamic** IP Addressing – it changes.

MSN.com - Windows Internet Explorer
http://www.msn.com/
MSN.com - Web Snapshot
msn
Extreme Roller Coasters
Think 0-128 mph in less than four seconds
GEICO

Its automatic, why do I need to know it?

Because we can’t always use TCP/IP in DHCP mode. Sometimes the IP has to stay permanent

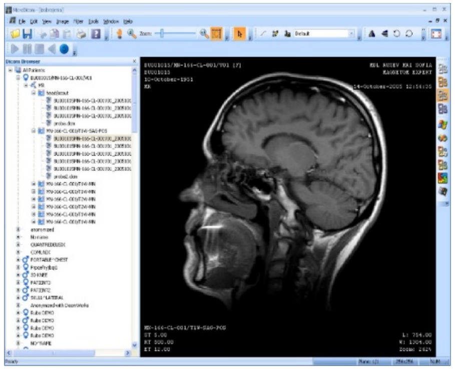
- What if you need to always be at the same IP for a program or a service to work?
- What if I need to get IP or web information from your machine?
- What if you need to use a specific IP for security settings (such as required in DICOM, HL7, ECG streaming) such as in Patient Monitoring?

In these cases, we can’t use automatic setting. We need **Static IP** Addressing – **<u>the IP will not change</u>**

We use Static TCP/IP in Hospitals.

Static IP's are mainly used on:

- Patient Monitors
- Medical Imaging Systems
- The Servers receiving all this data
- DICOM Workstations



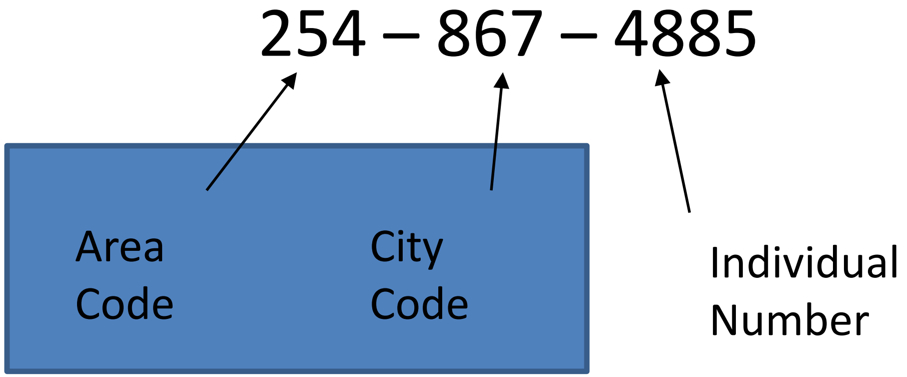
Where is it no so important to use Static IP?

Things that use WINS or Active Directory –
Electronic Medical Records (**EMR**)
Workstations only (Servers need Static IP)

How do we set it up? Recall WINS

TCP/IP is like a phone number

- It has a group Identifier part and a individual part



254 – 867 – 4885

Area Code

City Code

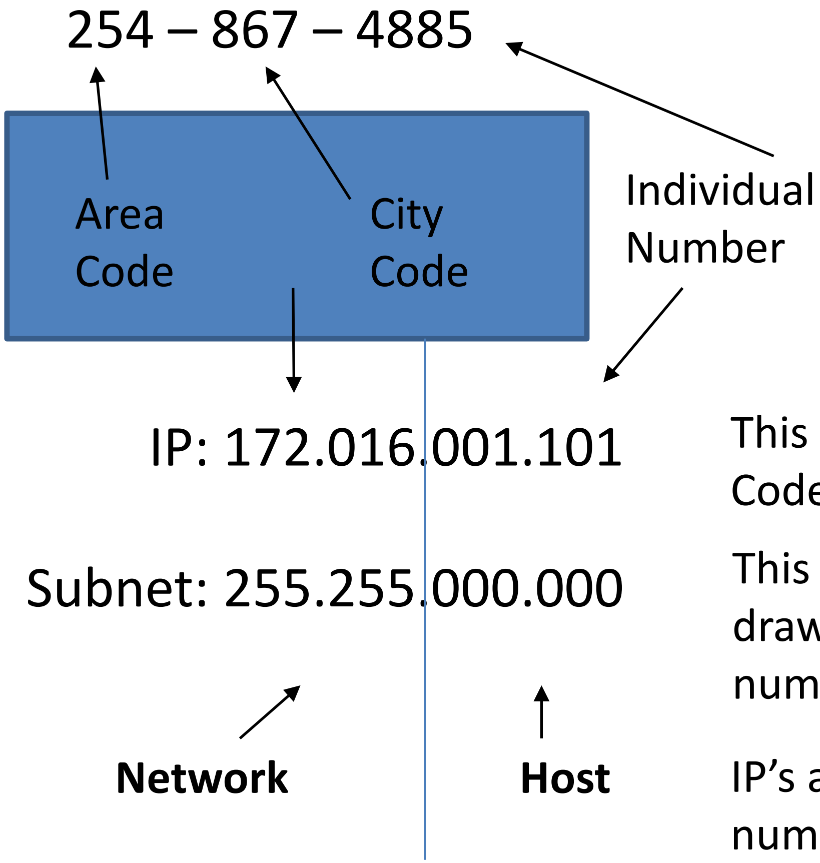
Individual Number

- Remember that phone would ring at the same time if we had the same number. Therefore, we need to have a Unique Individual part of the number.

- We want to talk within our group, therefore we need the same group part of the number

TCP/IP Uses Numbers

- TCP/IP is like a phone number - It uses 2 pai



254 – 867 – 4885

Area Code

City Code

Individual Number

IP: 172.016.001.101

Subnet: 255.255.000.000

Network

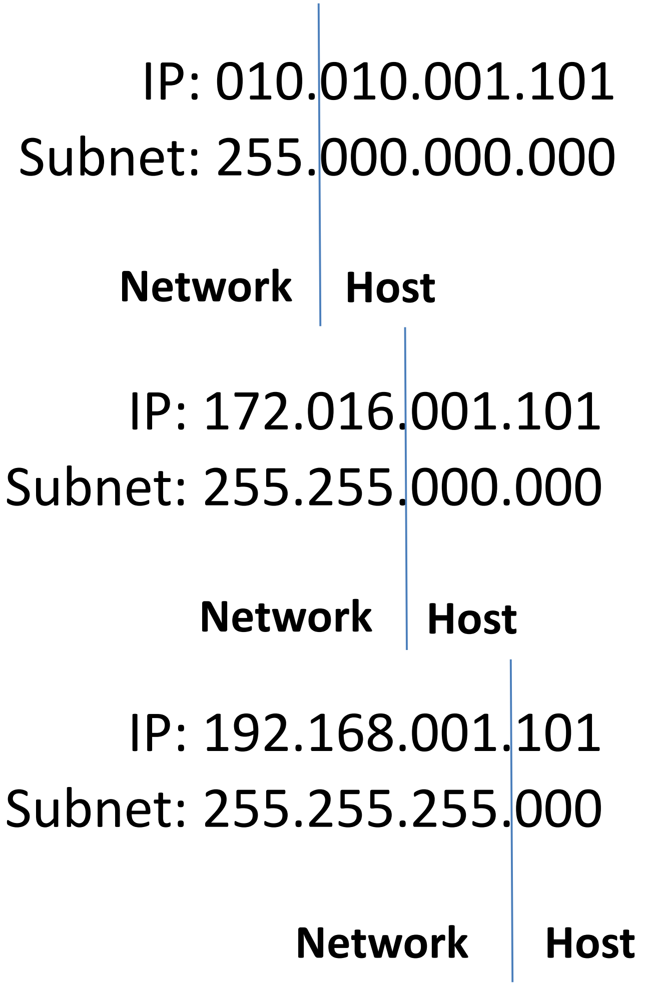
Host

This is the IP number. It tells you the **Network** (Area Code) number AND the **Host** (Individual) number

This is the Subnet number. It tells you the where to draw the line between the host and network numbers. Simply draw a line after the Last “255”

IP’s are listed in 4 groups of numbers. These numbers, called **Octets** are between 000 and 255 for both the IP and subnet.

Lets Talk about drawing lines – here are common ones



IP: 010.|010.001.101
Subnet: 255.|000.000.000

Network | Host

IP: 172.016.|001.101
Subnet: 255.255.|000.000

Network | Host

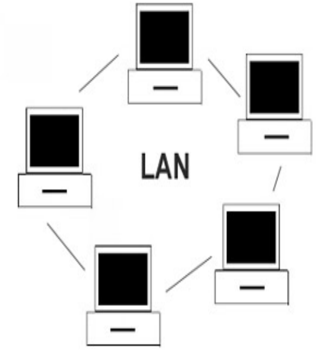
IP: 192.168.001.|101
Subnet: 255.255.255.|000

Network | Host

To understand an IP network:

1. Write down both the **IP** and **subnet** for a network – TCP/IP needs both
2. Draw a line after the last "255" in the subnet. The subnet separates the network number from the host number.
3. All machines must have the **same network number** to work
4. All machines must have a **unique host number.**

Classful networks – Local Area Networks (LAN)



IP: 010.010.001.101
Subnet: 255.000.000.000

Network **Host**

IP: 172.016.001.101
Subnet: 255.255.000.000

Network **Host**

IP: 192.168.001.101
Subnet: 255.255.255.000

Network **Host**

Class A – Large Networks – up to 16.7 Million computers

Class B – Midsized Networks – up to 65 Thousand computers

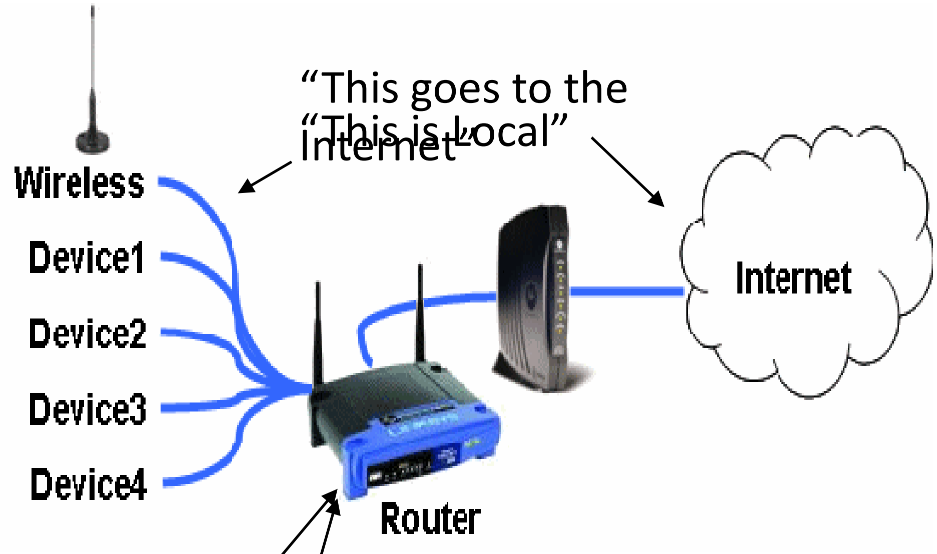
Class C – Small / Residential Networks – up to 255 computers

- These are common networks used in the Hospital IT environment. They follow the "Classful" rules.
- These IP's do not appear on the Internet
- Routers (and switches) know this is local traffic only.
- IT compliance is Voluntary

Classless networks - Wide Area Networks (WAN)

“The Real Internet”

- If there is a different number used for an IP, the IP is probably (this is voluntary) a real internet address. The router can easily tell “this has to leave the network and go to the Internet Service Provider (**ISP**)”
- This is the job of a **Router**.
- Routers act as **Gateways**, connecting networks to the internet.



“This goes to the Internet”

“This is Local”

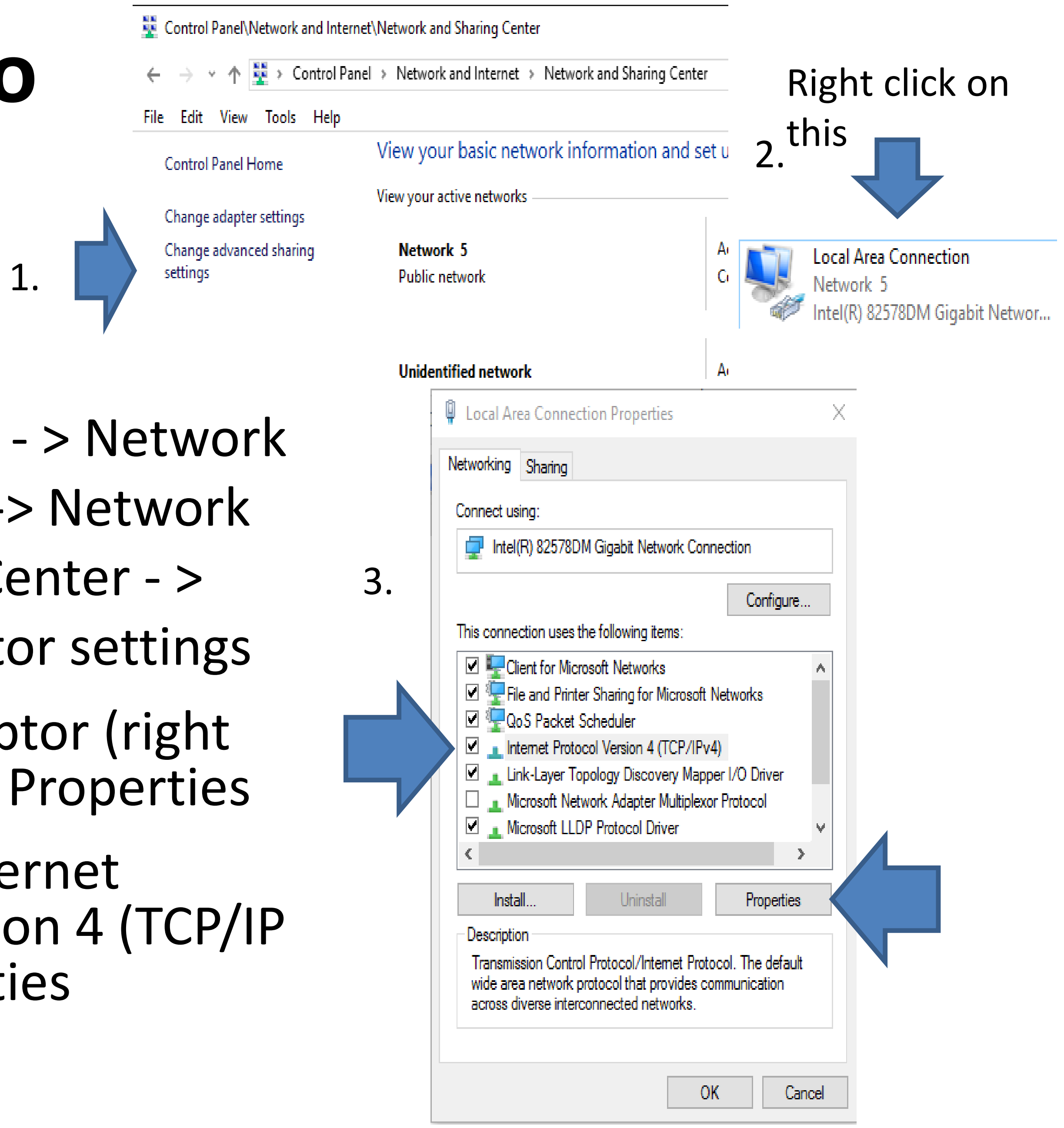
IP: 192.168.0.105?

IP: 216.58.218.164?

Set this into Windows

Select:

1. Control Panel - > Network and Internet -> Network and Sharing Center - > Change adaptor settings
2. Network Adaptor (right click on it) - > Properties
3. Highlight “Internet Protocol version 4 (TCP/IP v4) -> Properties



1.

Control Panel\Network and Internet\Network and Sharing Center

Control Panel › Network and Internet › Network and Sharing Center

File Edit View Tools Help

Control Panel Home

Change adapter settings

Change advanced sharing settings

View your basic network information and set u

View your active networks

Network 5
Public network

Unidentified network

2. Right click on this

Local Area Connection
Network 5
Intel(R) 82578DM Gigabit Networ...

3.

Local Area Connection Properties

Networking | Sharing

Connect using:

Intel(R) 82578DM Gigabit Network Connection

Configure...

This connection uses the following items:

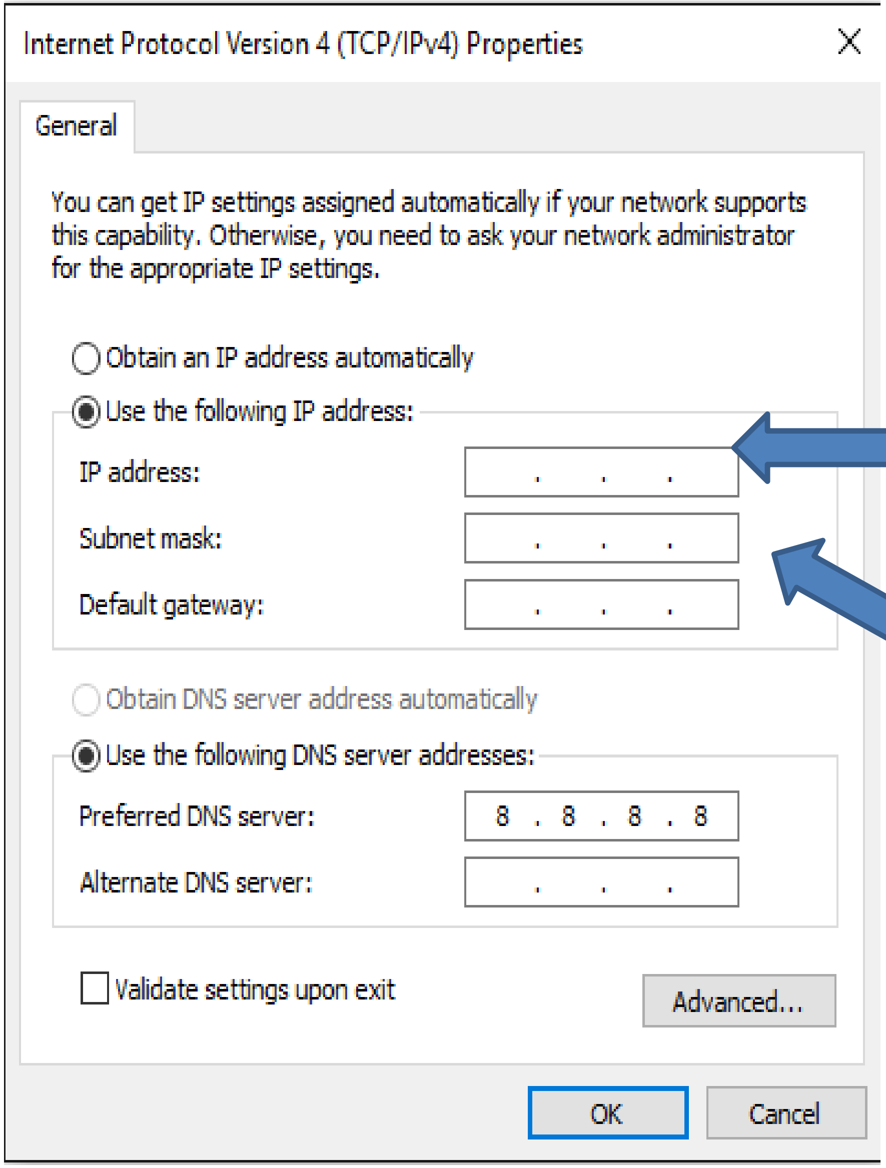
- ☑ Client for Microsoft Networks
- ☑ File and Printer Sharing for Microsoft Networks
- ☑ QoS Packet Scheduler
- ☑ Internet Protocol Version 4 (TCP/IPv4)
- ☑ Link-Layer Topology Discovery Mapper I/O Driver
- ☐ Microsoft Network Adapter Multiplexor Protocol
- ☑ Microsoft LLDP Protocol Driver

Install... | Uninstall | Properties

Description

Transmission Control Protocol/Internet Protocol. The default wide area network protocol that provides communication across diverse interconnected networks.

OK | Cancel



Internet Protocol Version 4 (TCP/IPv4) Properties

General

You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.

○ Obtain an IP address automatically

● Use the following IP address:

IP address: . . .

Subnet mask: . . .

Default gateway: . . .

○ Obtain DNS server address automatically

● Use the following DNS server addresses:

Preferred DNS server: 8 . 8 . 8 . 8

Alternate DNS server: . . .

□ Validate settings upon exit

That brings up the menu to set in the IP info

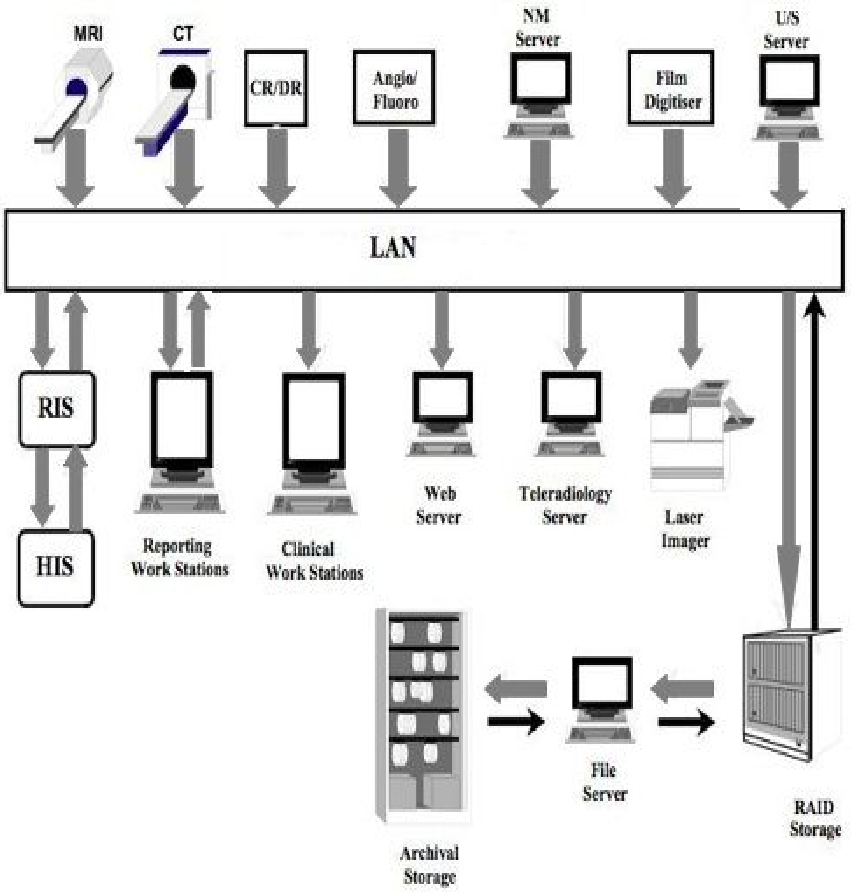
Set **your IP address** in this area.

- Must work with the LAN IP's (Network)
- Must be unique (Host)

For the **Subnet**, keep it simple.

- Use the same **subnet as** the router and **other machines** on the network
- Keep in mind that this tells your machine which IP part is network and which is host.

So, is IP and Subnet it for the settings?... No



Well, yes and no. That is it for settings on the LAN side of TCP/IP.

Let's say we have IP's and subnets set. This is what a LAN may look like.

If all of these are talking to each other... that's great!

Now we need to tell the machine how to access the internet (if needed).

What happens when this replaces the file server?

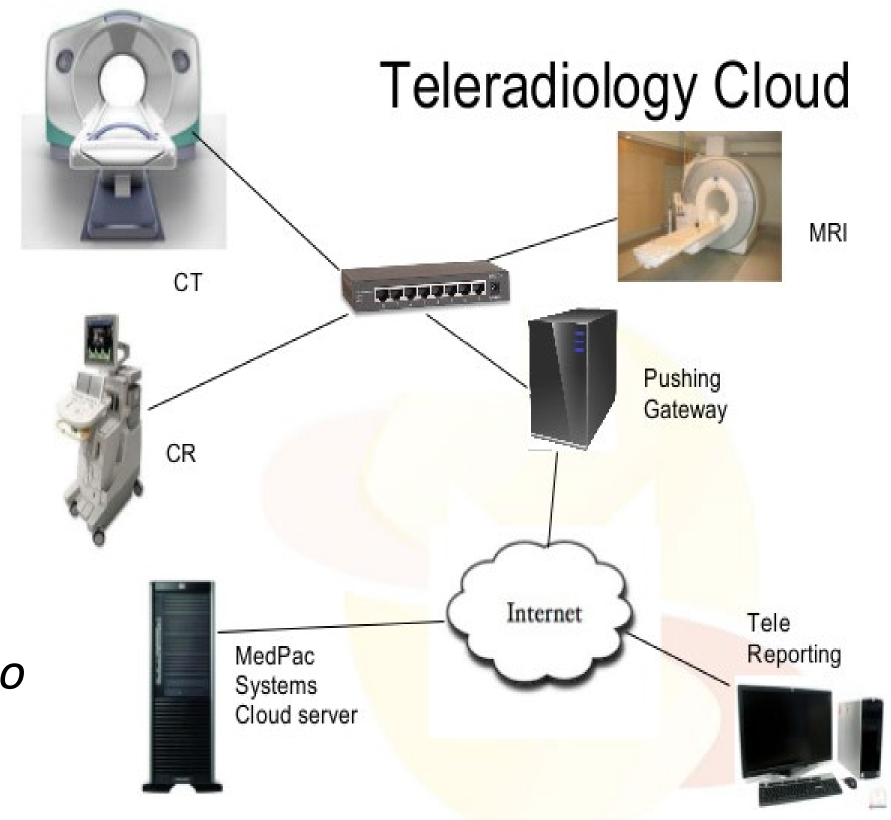
This is a simple diagram of a web deployed PACS server. It is hosted by a remote company for the hospital.

The medical imaging devices called "**Modalities**" have to send to a remote server through a gateway.

A **Gateway** is a server that connects 2 different networks. (HIS to WAN)

*The **Gateway** is the way off your LAN and to the Internet*

This is a very popular setting. We use the Internet in a lot of different places..



But wait, there’s more, (unless you want to memorize IP numbers)

Former Webmaster at BET / MIT Club

Studied at Texas State Technical College Waco, Texas

Lives in Waco, Texas

Kenneth Wilson with Jacob Cantley and 18 others.
January 26 · Cortaro, AZ, United States ·

For all of my biomed friends that are unaware of upcoming events. I've been before and recommend it to all.

Think about websites. We go to https://www.facebook.com , but the computer thinks https://31.13.80.49.

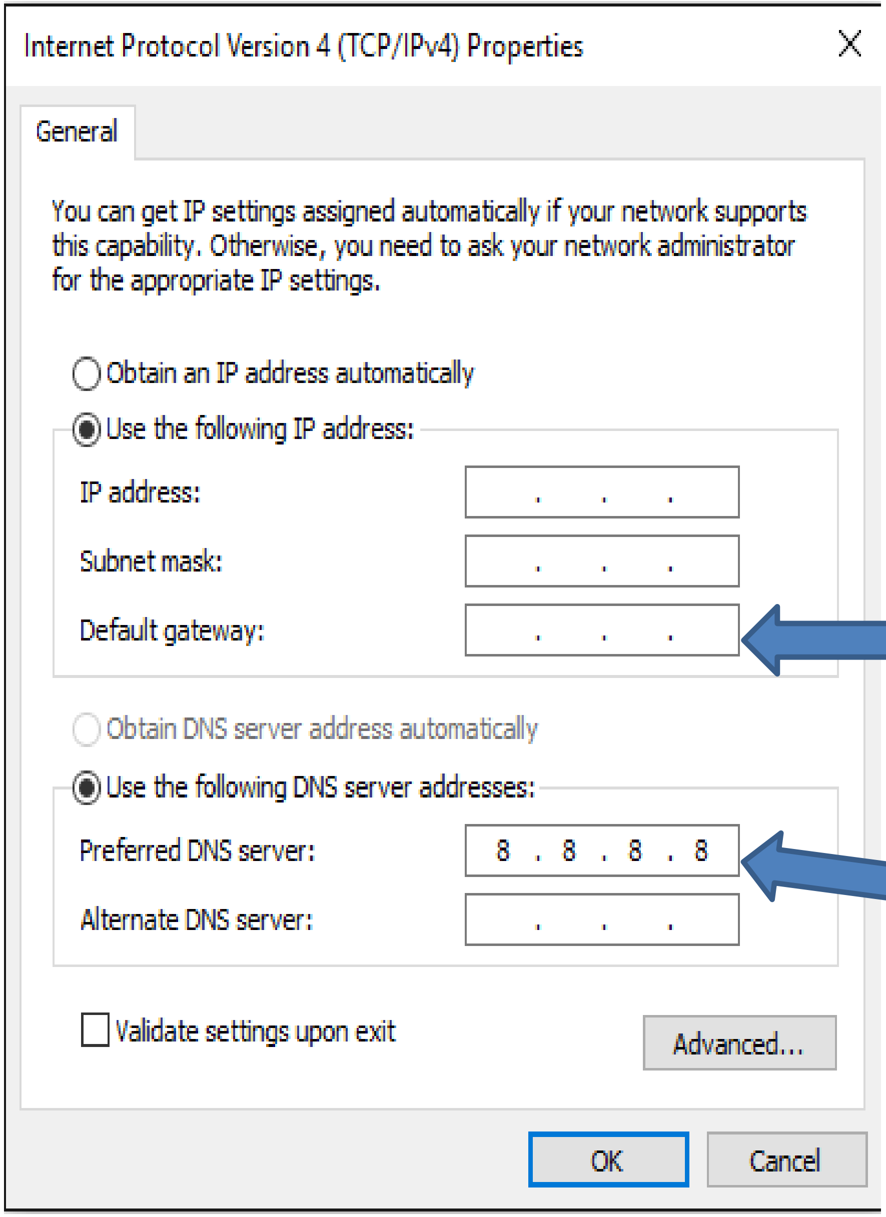
How does it know which “number to dial” when given a name? It usually goes through a web service.

The Domain Name Service (**DNS**) is the internet’s phone book. It gives us the number when given a name

DNS = the Internet IP phonebook

When a router is given a name ,E.g. http://www.facebook.com, the machine actually needs a number to go to the web page. It asks the router (or a server) for the IP number for the name (http://www.facebook.com). The DNS service looks up what it knows. If it does not know, it asks the router it connects to. Eventually, a router or server knows (http://www.facebook.com = http://31.13.80.49) this information is returned to your web browser. Then the web browser goes to http://31.13.80.49 and ends up on Facebook

All of that so that we can share our feelings on silly cat picture. Well… Ok… It does more.



Internet Protocol Version 4 (TCP/IPv4) Properties

General

You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.

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● Use the following IP address:

IP address: . . .

Subnet mask: . . .

Default gateway: . . .

○ Obtain DNS server address automatically

● Use the following DNS server addresses:

Preferred DNS server: 8 . 8 . 8 . 8

Alternate DNS server: . . .

□ Validate settings upon exit

That brings us back to this menu

The **Gateway** needs to be the one machine that everyone in the LAN goes through to get to the internet.

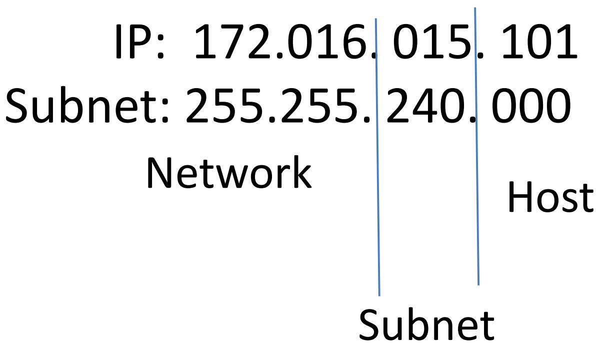
- Usually we use the router IP here.

The **DNS** is the router or server that will give all internet IP numbers to the computer (one at a time as needed).

- When in doubt, use the router IP here as well.

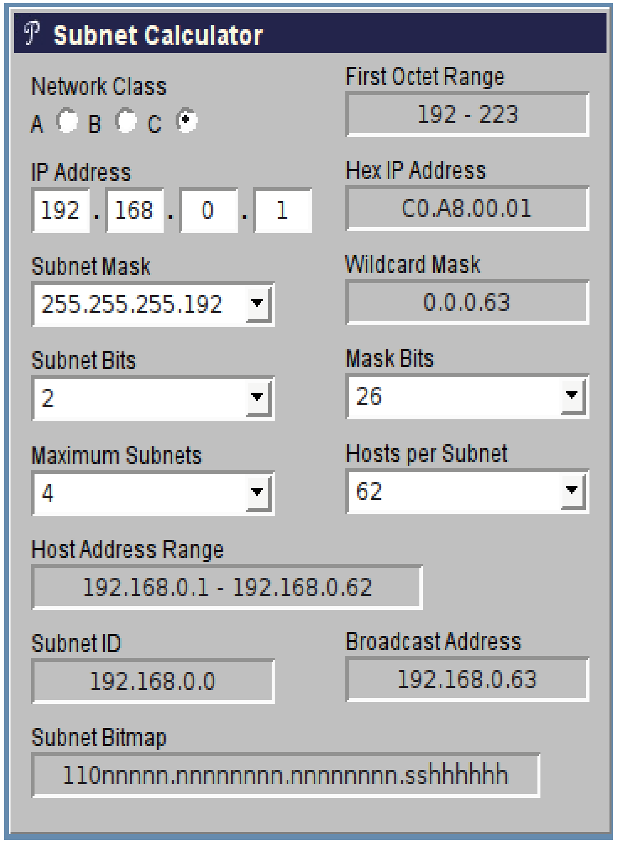
What to do if I see “Weird things”

- IP’s can get complicated. There is actually an entire 4-year degree around making IPs work (Network Admin)
- Sometimes Admins use different subnets. E.g. Subnet: 255.255.240.0
  – If you see this, what they are doing here is extending the hosts to more than the last octet.


IP: 172.016. 015. 101
Subnet: 255.255. 240. 000
Network
Host
Subnet

The easy answer is to ask IT or experienced BET’s for help when you see this!

Use a Subnet Calculator - http://www.subnet-calculator.com/


Subnet Calculator

Network Class: A ○ B ○ C ●

First Octet Range: 192 - 223

IP Address: 192 . 168 . 0 . 1

Hex IP Address: C0.A8.00.01

Subnet Mask: 255.255.255.192

Wildcard Mask: 0.0.0.63

Subnet Bits: 2

Mask Bits: 26

Maximum Subnets: 4

Hosts per Subnet: 62

Host Address Range: 192.168.0.1 - 192.168.0.62

Subnet ID: 192.168.0.0

Broadcast Address: 192.168.0.63

Subnet Bitmap: 110nnnnn.nnnnnnnn.nnnnnnnn.sshhhhhh

WOW. That’s deep! Do we need to continue?

- No, not really. That’s the basics and for those that need a break, let’s have an intermission.
- We’re half way through. There is more slide show.
- When we come back, We will do:
  - Subnetting, VPN, Port Forwarding
  - Wireless Networking

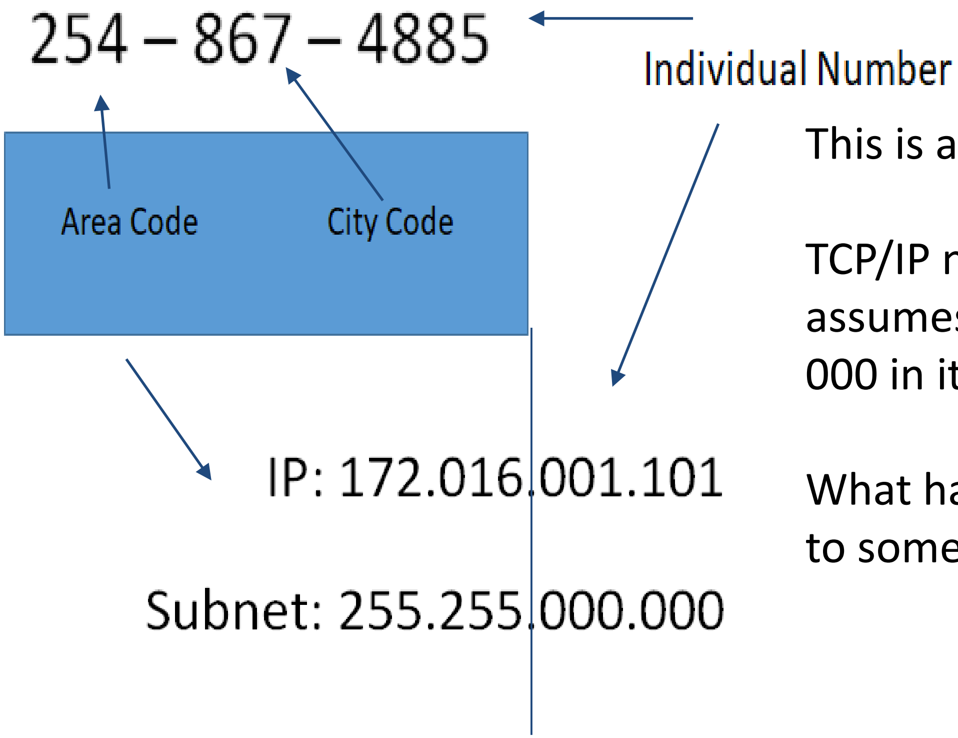
Any Questions???

Subnetting, VLANs, and Port Forwarding

How we segment and secure networks

Subnetting isn’t unusual, it is just traffic control

- TCP/IP is like a phone number



254 – 867 – 4885

Individual Number

Area Code

City Code

IP: 172.016.001.101

Subnet: 255.255.000.000

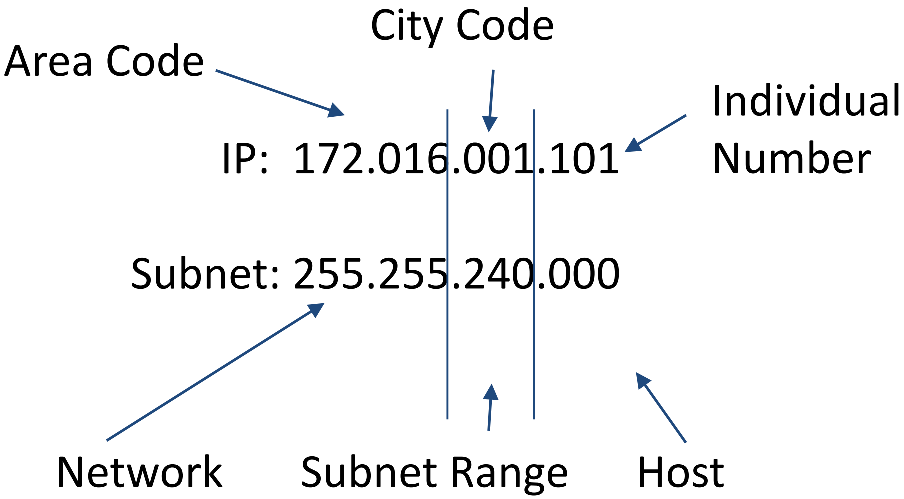
This is a simple model for basic

TCP/IP numbers using a class B network. It assumes the Subnet always has either a 255 or a 000 in its numbers.

What happens when the Subnet numbers change to something like 255.255.240.000 ?

Subnetting Traffic into different ranges

In the case of a Subnet 255:254:000:000, the subnet number 254 becomes the like the city code. Is a city code always local? Is it always long distance? Sometimes.



City Code

Area Code

Individual Number

IP: 172.016.001.101

Subnet: 255.255.240.000

Network

Subnet Range

Host

In this case, the **Network** numbers separate all networks

The **Host** give all machines a unique number in their Subnet

However, the **Subnet** itself breaks up the bigger network into smaller networks.

What are the ranges? Well… its Binary

I mean the subnet is a length of 1’s and 0’s. All IP’s are. For a Class B network, the Subnet Mask numbers are as follows:

Number of sub - networks	That number in Binary is:	Subnet bits (-1 and flip it)	Subnet Mask (In Decimal)	Mask Bits	Number of hosts per subnet
2	0000 0010	1000 0000	255.255.128.000	/17	32766
4	0000 0100	1100 0000	255.255.192.000	/18	16382
8	0000 1000	1110 0000	255.255.224.000	/19	8190
16	0001 0000	1111 0000	255.255.240.000	/20	4094
32	0010 0000	1111 1000	255.255.248.000	/21	2048

https://www.pantz.org/software/tcpip/subnetchart.html

And it continues on….

What are “Mask Bits”?

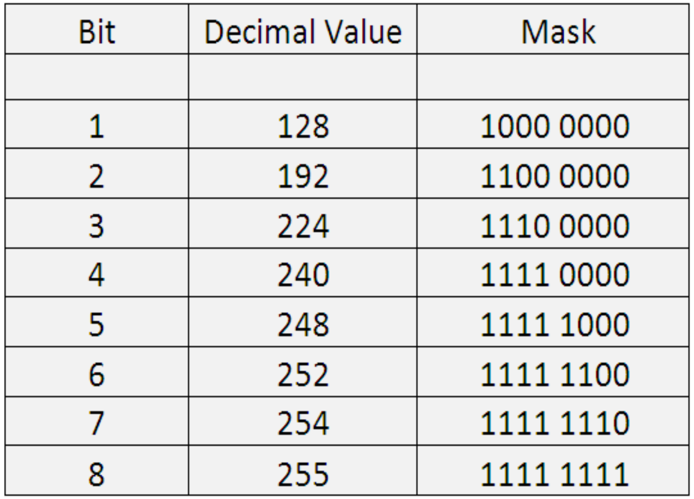
Well, subnets are all 1’s and zeros. Remember when I said a subnet with 16 sub networks in binary is 1111 0000, which is 16 -1 = 15 in binary 0000 1111 and then flipped to 1111 0000, that is the 3rd octet.

The subnet actually is 255.255.240.000.

This means the actual number is

1111 1111. 1111 1111. 1111 | 0000. 0000 0000

Network | Host



Bit	Decimal Value	Mask
1	128	1000 0000
2	192	1100 0000
3	224	1110 0000
4	240	1111 0000
5	248	1111 1000
6	252	1111 1100
7	254	1111 1110
8	255	1111 1111

I bet you see the line for the network now. How many 1’s are there? 8 + 8 + 4 = 20. There are 20 bits

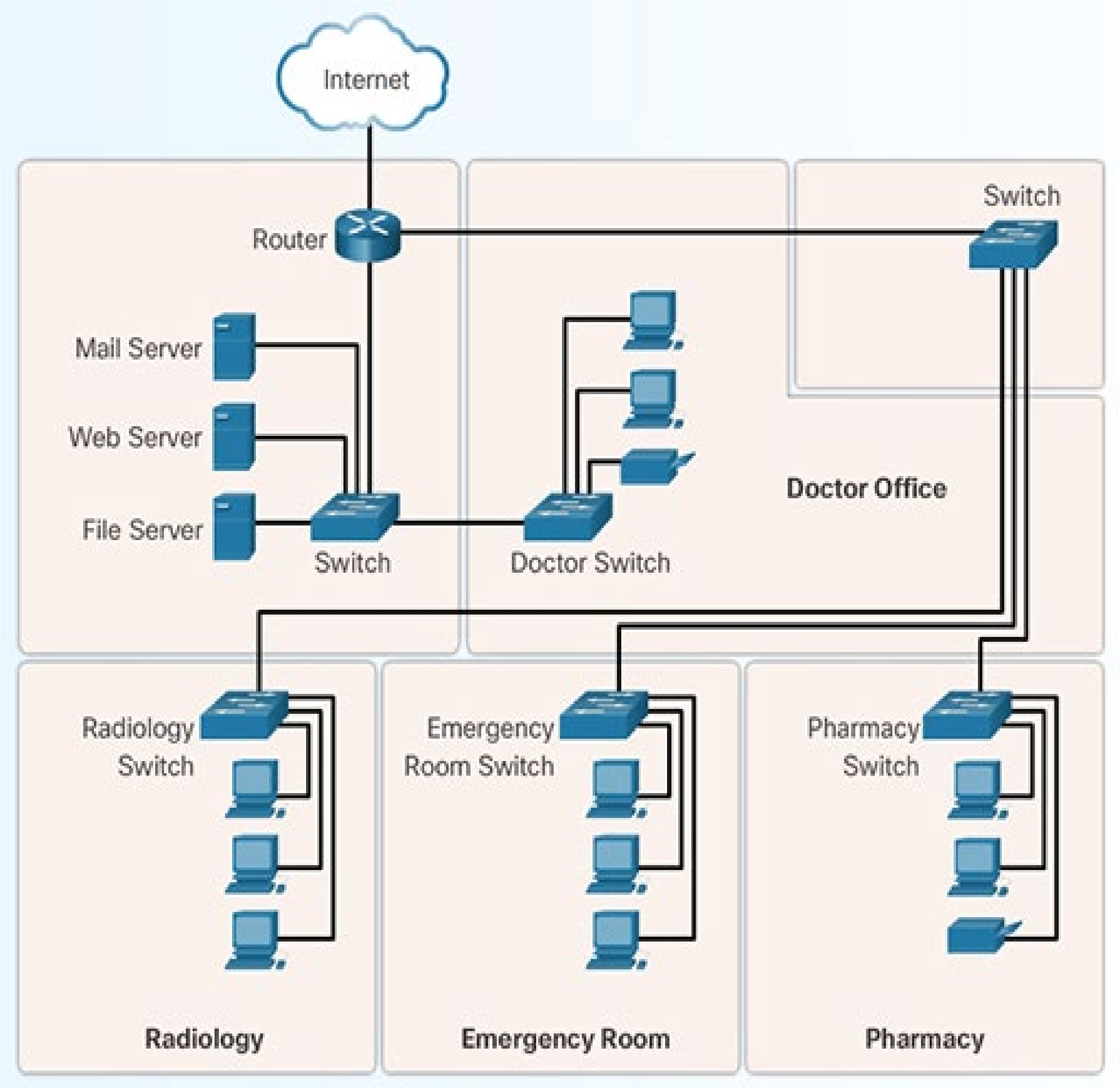
If I represent that in a short hand called **Mask bits**, that is a ***/20***

Why this is done:

We set up a hospital to run as smaller subnetted areas

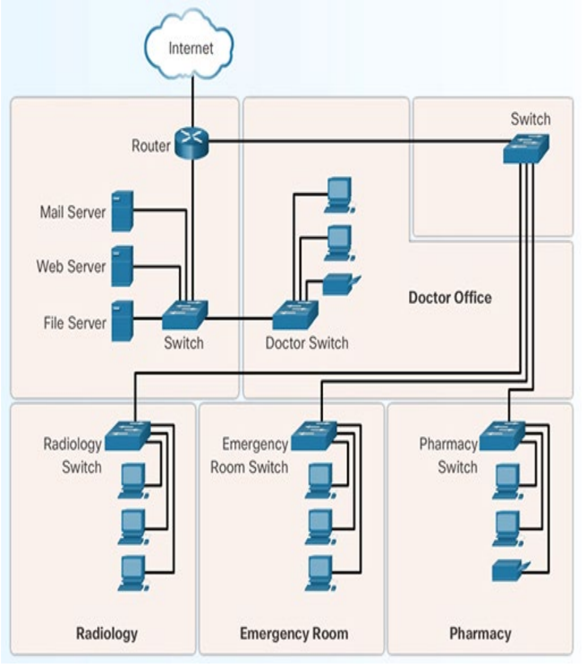
Each Box is a separate network.

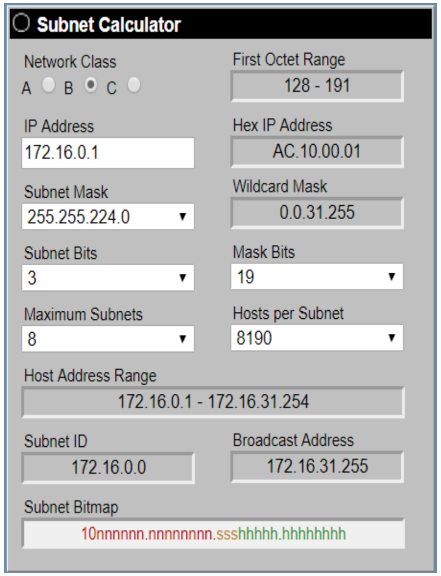
There are 6 subnets What type of numbers do we need?



For Example - Subnet with a /19 network

We need 6 networks, but we can’t do that in the numbering scheme.. We have to use a larger network then and leave the extra numbers for future growth. Use the online subnet calculator to make this easier. http://www.subnet-calculator.com/





Subnet Calculator

Network Class A ○ B ● C ○

First Octet Range: 128 - 191

IP Address: 172.16.0.1

Hex IP Address: AC.10.00.01

Subnet Mask: 255.255.224.0

Wildcard Mask: 0.0.31.255

Subnet Bits: 3

Mask Bits: 19

Maximum Subnets: 8

Hosts per Subnet: 8190

Host Address Range: 172.16.0.1 - 172.16.31.254

Subnet ID: 172.16.0.0

Broadcast Address: 172.16.31.255

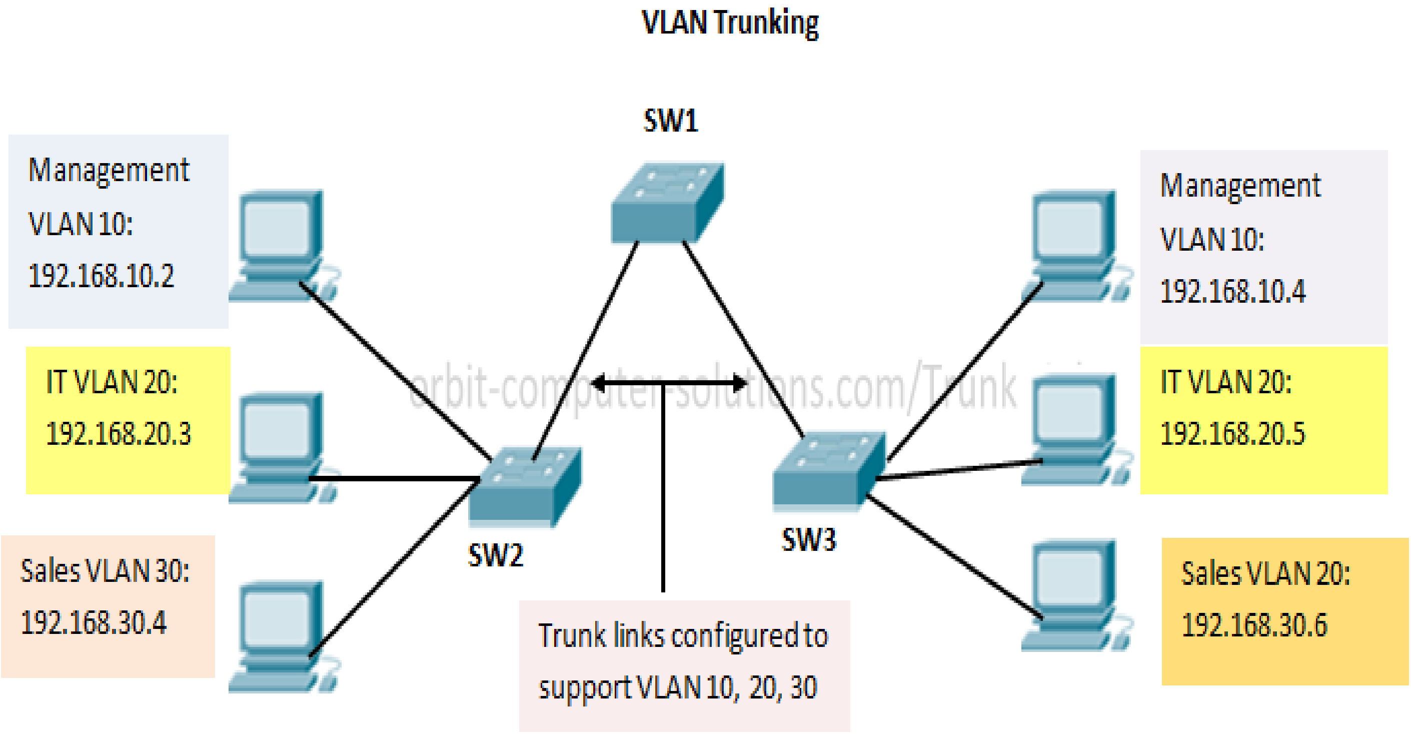
Subnet Bitmap: 10nnnnnn.nnnnnnnn.ssshhhhh.hhhhhhhh

Our IP range is anything between 172.016.000.001 to 172.16.031.255 is in the same network and can talk to each other without needing a router.

Our Subnet needs to be 255.255.224.0
It handles 8 sub-networks of 8190 hosts per network.

VLAN - What is this? (Virtual Local Area Network)

There is only 2 things you need to know about VLAN #1 - It is replacing switches and cabling. #2 - You need a programmable switch to do it. **VLAN is mainly for switches!**



VLAN Trunking

SW1

Management VLAN 10: 192.168.10.2

IT VLAN 20: 192.168.20.3

Sales VLAN 30: 192.168.30.4

SW2

SW3

Management VLAN 10: 192.168.10.4

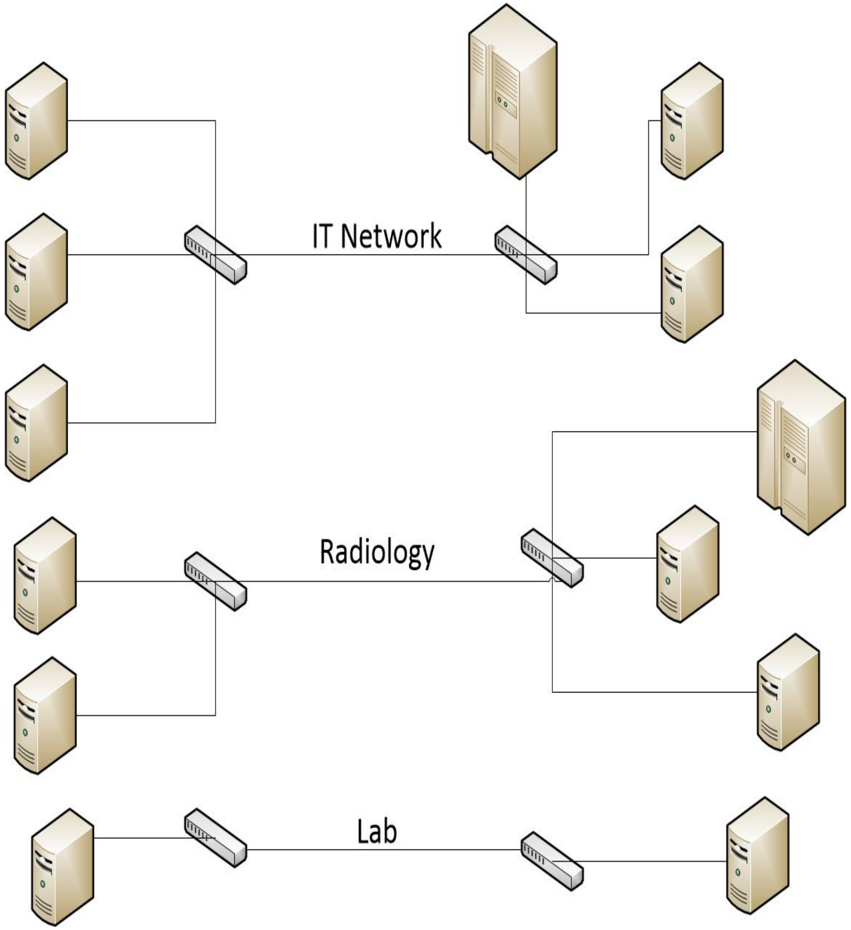
IT VLAN 20: 192.168.20.5

Sales VLAN 20: 192.168.30.6

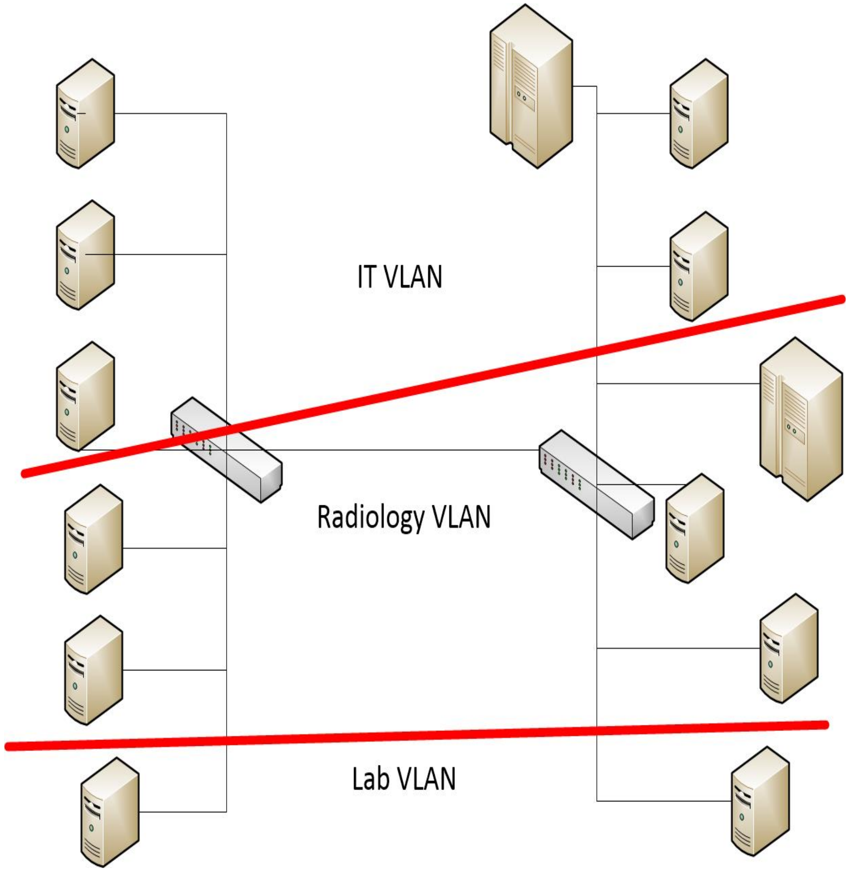
Trunk links configured to support VLAN 10, 20, 30

Virtual Local Area Networks - Before and After

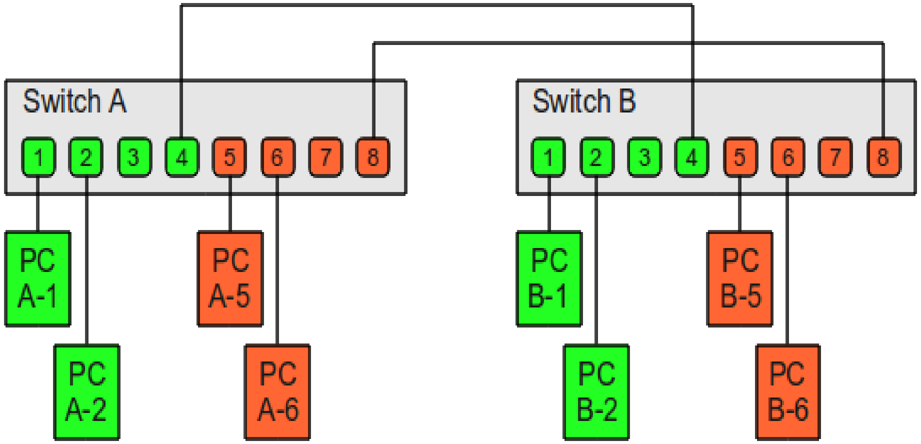
Before VLAN



With VLANs



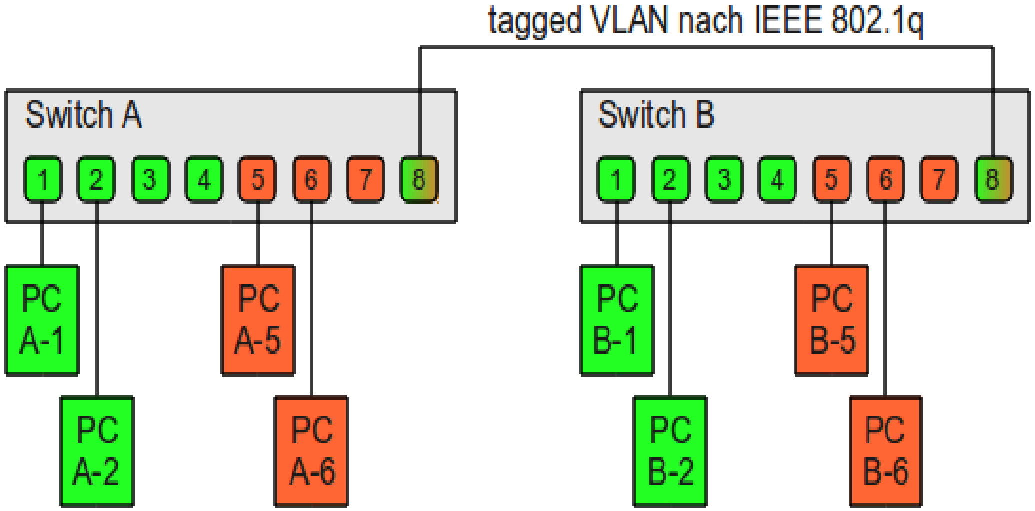
VLAN terms



Tagging- We put a header in front of the data and say "this is for VLAN 10" or " this is for VLAN 20"

Untagging - Data that is not given a header

Trunk - One line is tagged and left as a trunk to share data for both VLAN's - this reduces cabling. (CISCO Term)



https://www.thomas-krenn.com/en/wiki/VLAN_Basics
and
https://www.youtube.com/watch?v=aBOzFa6ioLw

What is port forwarding?

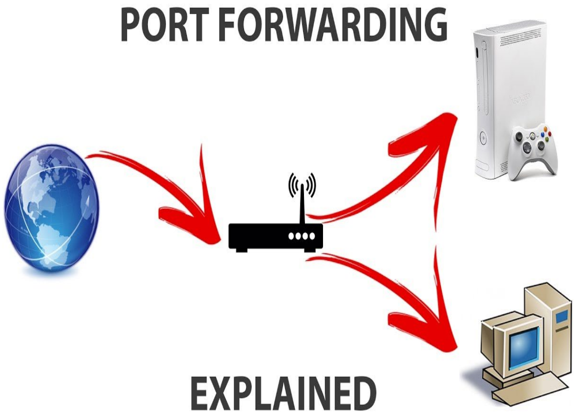
Port forwarding is sending a communication **from the outside** of a router **in** to the network. This is different from a communication that starts inside the network, this will come from the internet (outside the network). To understand this, we have to start with a port. A **port** is a location of software on a computer.

We use ports to tell what the traffic is and which software it needs.

SSH - Secure Shell - Port 22
Telnet - Port 23
SImple Mail Transfer Protocol - Port 25
DNS - Domain Name Service - Port 53
Hypertext (HTTP or Web) - Port 80
Secure HTTP (Https) - Port 443

File Transfer Protocol (FTP) Port 20, 21
DICOM - Ports 104, 2221, 11112, 3321
WINS and NetBIOS - Ports 135, 137-139
Medical Device Com. - Port 6464
https://en.wikipedia.org/wiki/List_of_TCP_and_UDP_port_numbers

Communication enters or leaves by a Port



It is a **Software Port**, not a physical Port

- This is the job of the router.
  - It either blocks the communication (default setting) or it sends the message to the right IP inside the network
- We tell it how to forward the information from outside to inside
  - Who needs what port information

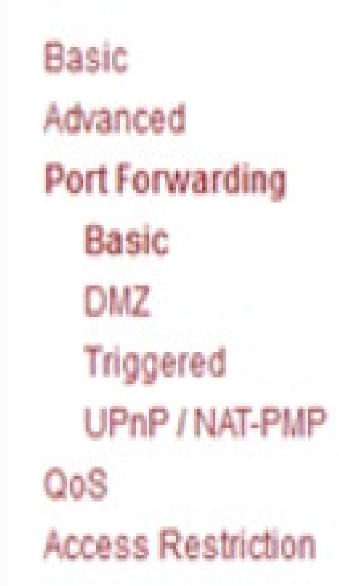
This is needed for older routers and gaming systems, like an XBox. And for any **Hospital VPN**

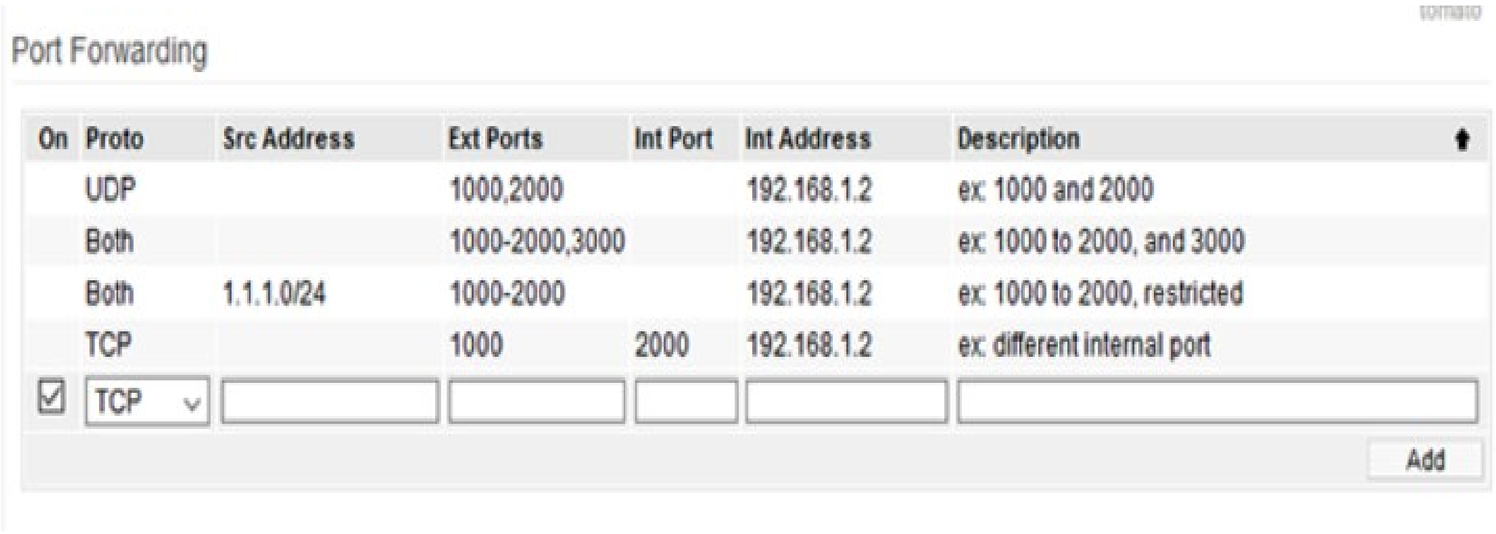
****Note**** People **outside your LAN** <u>do not use the IP of the machine</u> they are trying to reach. They use the **Router IP** instead.

Setting up port forwarding

Its different for each router,

- Look for the port forwarding part of the router
- Set up a basic port forward to an internal IP.
- Tell the machine the External Port and the Internal IP.
- Tell it if the communication TCP , UDP, or both





Port Forwarding

On	Proto	Src Address	Ext Ports	Int Port	Int Address	Description
	UDP		1000,2000		192.168.1.2	ex: 1000 and 2000
	Both		1000-2000,3000		192.168.1.2	ex: 1000 to 2000, and 3000
	Both	1.1.1.0/24	1000-2000		192.168.1.2	ex: 1000 to 2000, restricted
	TCP		1000	2000	192.168.1.2	ex: different internal port
☑	TCP					

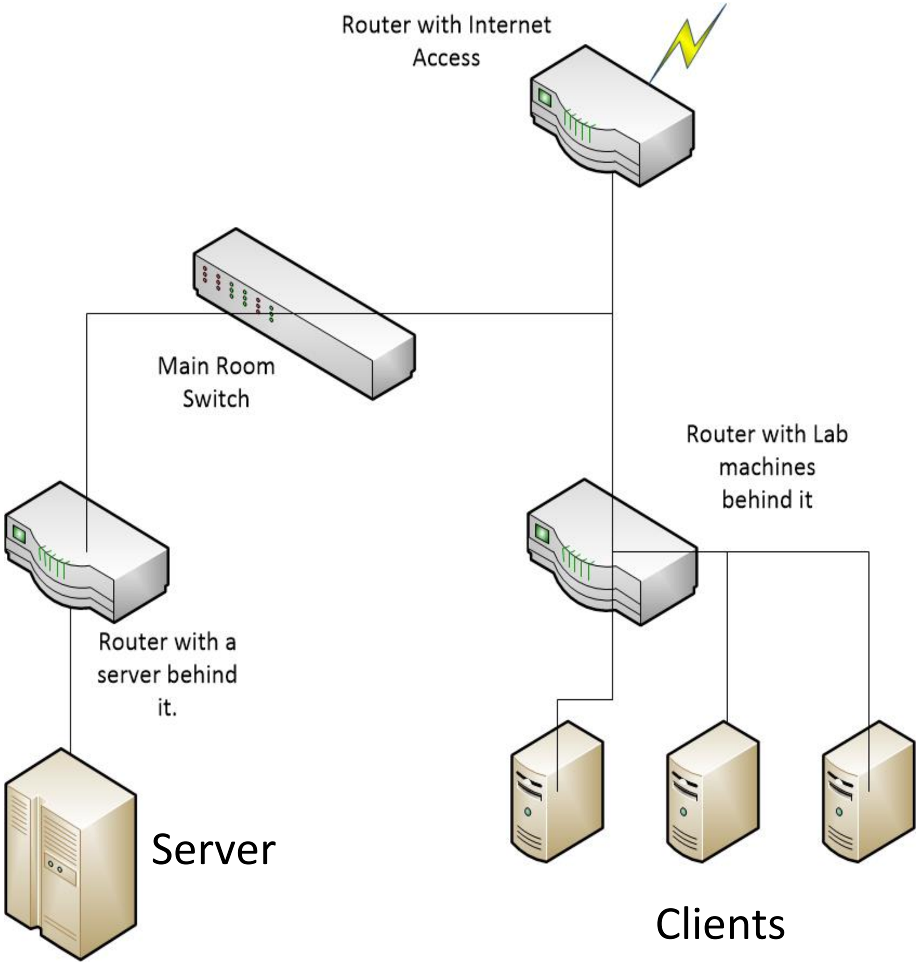
Do not use DMZ unless you have to.

What is the end goal of Port Forwarding?

To set up a lab like this:

The trick here is to get a signal to the server from behind a different router. The number scheme will be very different.

- Use different subnets to separate the networks into 3 subnets
- Forward requests to the server through its router - use the router external IP


Router with Internet Access
Main Room Switch
Router with Lab machines behind it
Router with a server behind it.
Server
Clients

Bringing it all together

Try to set up 3 personal labs at home to learn this.

- Set up a IP using a Subnetted IP . Manually set the IP's.
- Given a Programmable Switch that has basic VLAN settings, make a VLAN and show that there is a separation of the traffic.
- Given a router, place a server behind a router and connect it to your VLAN. Use port forwarding to sent a signal from the clients on a different LAN to your Server

You will need:

2 Computers
3 Routers
A Home network

I suggest a Linksys WRT54G loaded with DDWRT or Tomato Software

Basic TCP/ IP DOS commands Toolkit

1.Ping	Used to verify a TCP/IP connection between your machine and another. It is the most common command Example: **ping 192.168.1.100**
2.Ipconfig	Used to show the current running IP settings. **Example - ipconfig/all**
3.MAC	The Physical Address used by switches to connect machines via a LAN - **only visible via ipconfig/all**
4.Tracert	Used to count the number of routers between your machine and another. Example: **tracert** www.google.com
5.Arp	Used to see the other machines your machine has seen broadcast data on the network. Over time, shows who is on the LAN with you. **Example: arp -a**
6.Netstat	Used to see which machines are talking to your over the network. It can tell which program (PID) is using the connection. **Example: netstat -a -n –o**
7.Nslookup	Used to see a real IP given a computer name. It also checks to see if the DNS is running. **Example: nslookup** www.google.com
8.Telnet or **SSH**	Used to access the command line of a system remotely. SSH is an encrypted version of telnet. **Example: telnet -o 192.168.1.1**
9.FTP	Used to transfer large files over the Internet. There is no size limit to the file transferred. **Example:** ftp 192.168.1.1 Most common **commands are: get, put, open, close, quit**

Let’s have a brief pause for questions

We only have one more section to go!

Nearly There!!

But, we need to cover wireless next.

How to use Wireless Networks

We’re just replacing cables.

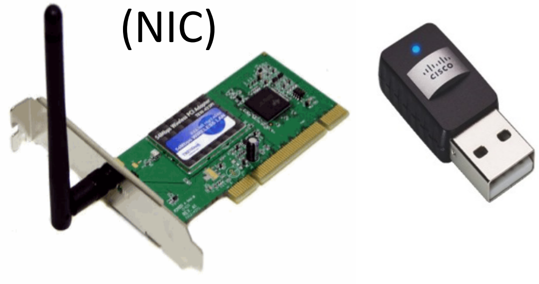
First thing to know about wireless

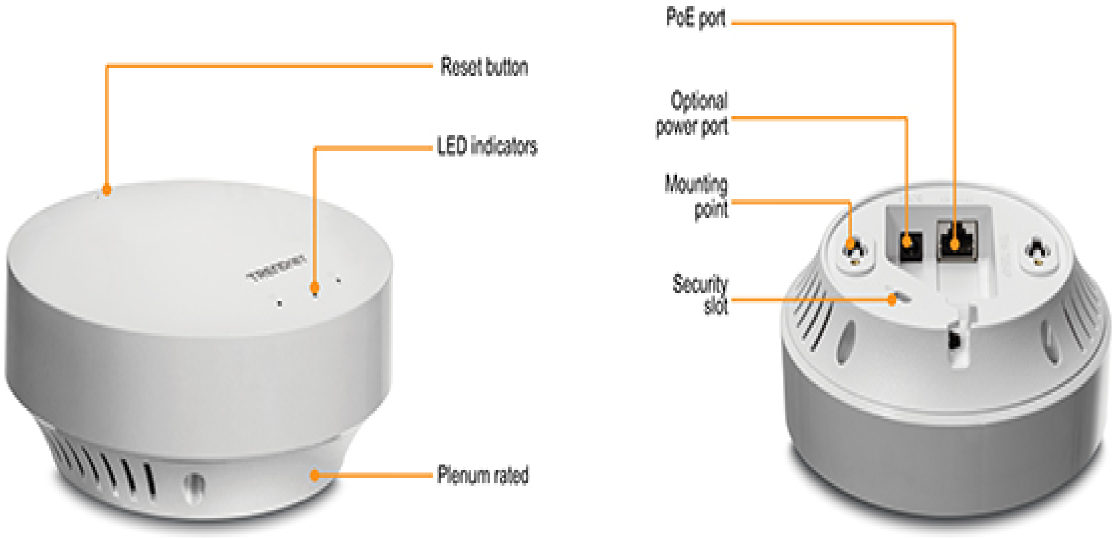
- It uses TCP/IP and WINS
  - The main point of wireless is not to replace the protocols we mentioned before. Wireless networking just replaces the Cabling
  - Wireless uses a radio transmitter to connect devices instead of a cable. Anyone can hear the conversation. This is why we use encryption
  - Wireless is affected by noise and other wireless systems

What hardware do we need?

Wireless Router

Wireless adaptors (NIC)



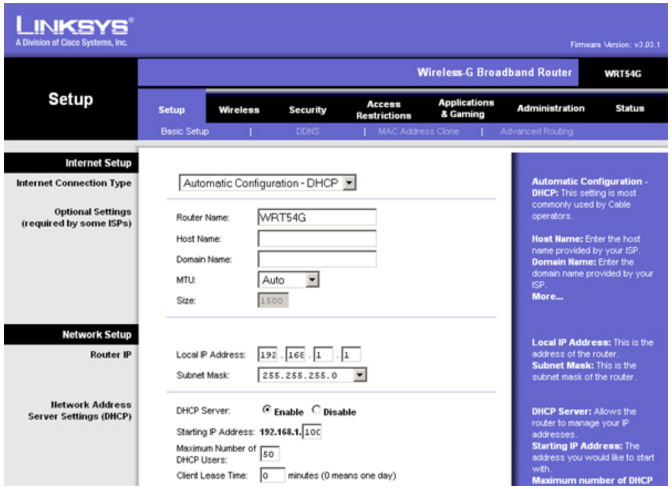


Wireless Access point

You have to use a wireless adaptor. This can be a card, a USB adaptor, or built in wireless cards. It has to work with the wireless **Access Point (AP)** (usually a wireless router). This adaptor shows up as a separate NIC.

What settings do we use?

Configure the wireless router or access point using a web page for the router. You have to connect directly to the router



Internet Setup

Internet Connection Type: Automatic Configuration - DHCP

Optional Settings (required by some ISPs)

Router Name: WRT54G
Host Name:
Domain Name:
MTU: Auto
Size: 1500

Network Setup

Router IP

Local IP Address: 192 . 168 . 1 . 1
Subnet Mask: 255.255.255.0

Network Address Server Settings (DHCP)

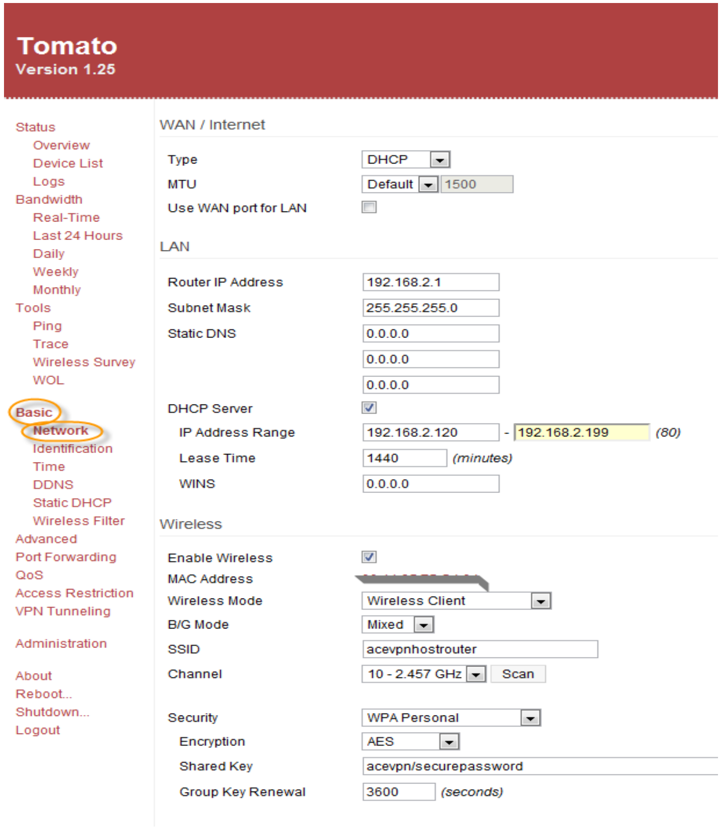
DHCP Server: ● Enable ○ Disable
Starting IP Address: 192.168.1.100
Maximum Number of DHCP Users: 50
Client Lease Time: 0 minutes (0 means one day)

Automatic Configuration - DHCP: This setting is most commonly used by Cable operators.

Host Name: Enter the host name provided by your ISP.
Domain Name: Enter the domain name provided by your ISP.
More...

Local IP Address: This is the address of the router.
Subnet Mask: This is the subnet mask of the router.

DHCP Server: Allows the router to manage your IP addresses.
Starting IP Address: The address you would like to start with.
Maximum number of DHCP



WAN / Internet

Type: DHCP
MTU: Default 1500
Use WAN port for LAN: □

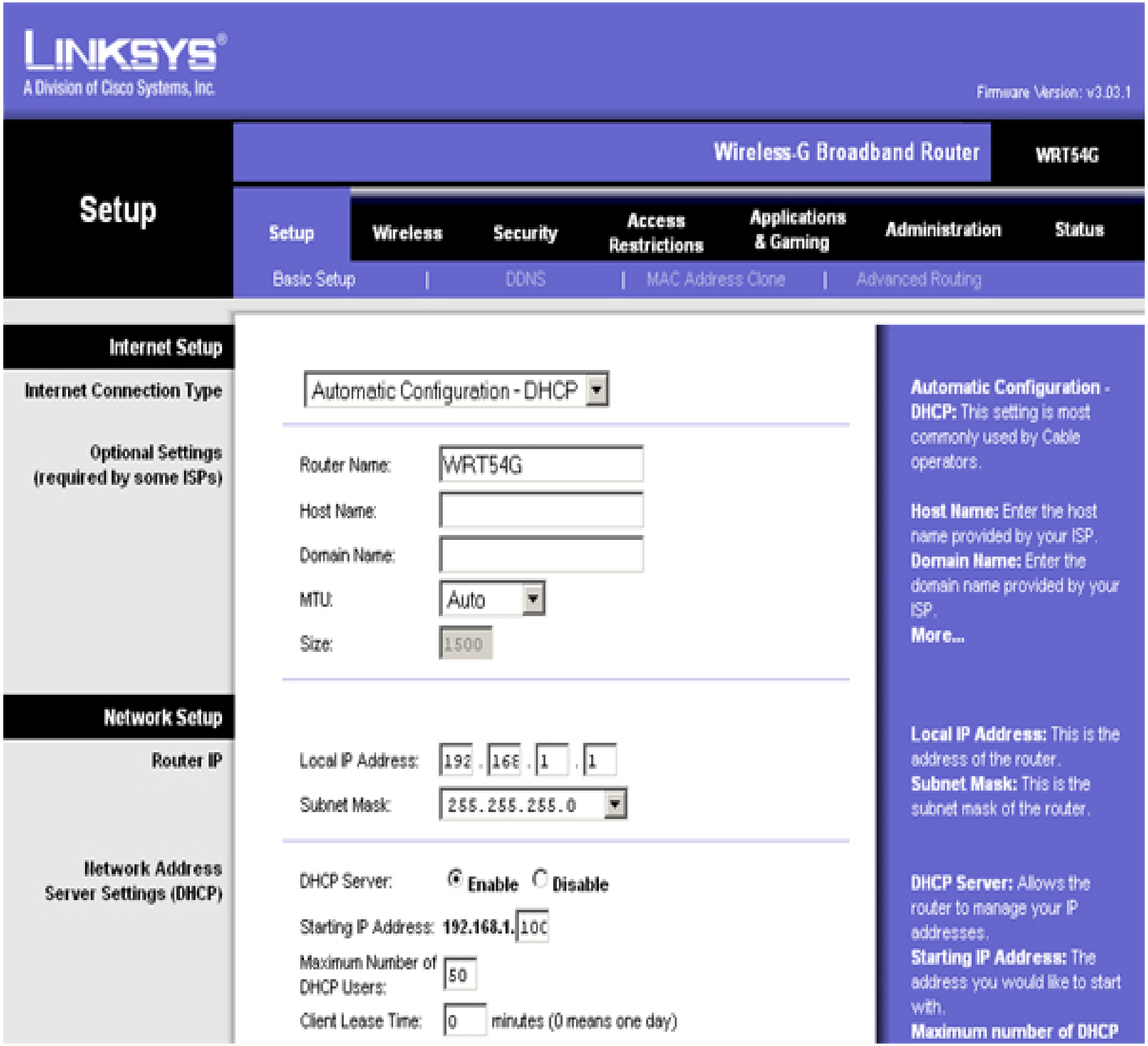
LAN

Router IP Address: 192.168.2.1
Subnet Mask: 255.255.255.0
Static DNS: 0.0.0.0
0.0.0.0
0.0.0.0
DHCP Server: ☑
IP Address Range: 192.168.2.120 - 192.168.2.199 (80)
Lease Time: 1440 (minutes)
WINS: 0.0.0.0

Wireless

Enable Wireless: ☑
MAC Address: [redacted]
Wireless Mode: Wireless Client
B/G Mode: Mixed
SSID: acevpnhostrouter
Channel: 10 - 2.457 GHz Scan

Security: WPA Personal
Encryption: AES
Shared Key: acevpn/securepassword
Group Key Renewal: 3600 (seconds)


LINKSYS®
A Division of Cisco Systems, Inc.
Firmware Version: v3.03.1
Wireless-G Broadband Router
WRT54G
Setup
Setup
Wireless
Security
Access Restrictions
Applications & Gaming
Administration
Status
Basic Setup | DDNS | MAC Address Clone | Advanced Routing

Internet Setup

Internet Connection Type: Automatic Configuration - DHCP

Optional Settings (required by some ISPs)

Router Name: WRT54G
Host Name:
Domain Name:
MTU: Auto
Size: 1500

Network Setup

Router IP

Local IP Address: 192 . 168 . 1 . 1
Subnet Mask: 255.255.255.0

Network Address Server Settings (DHCP)

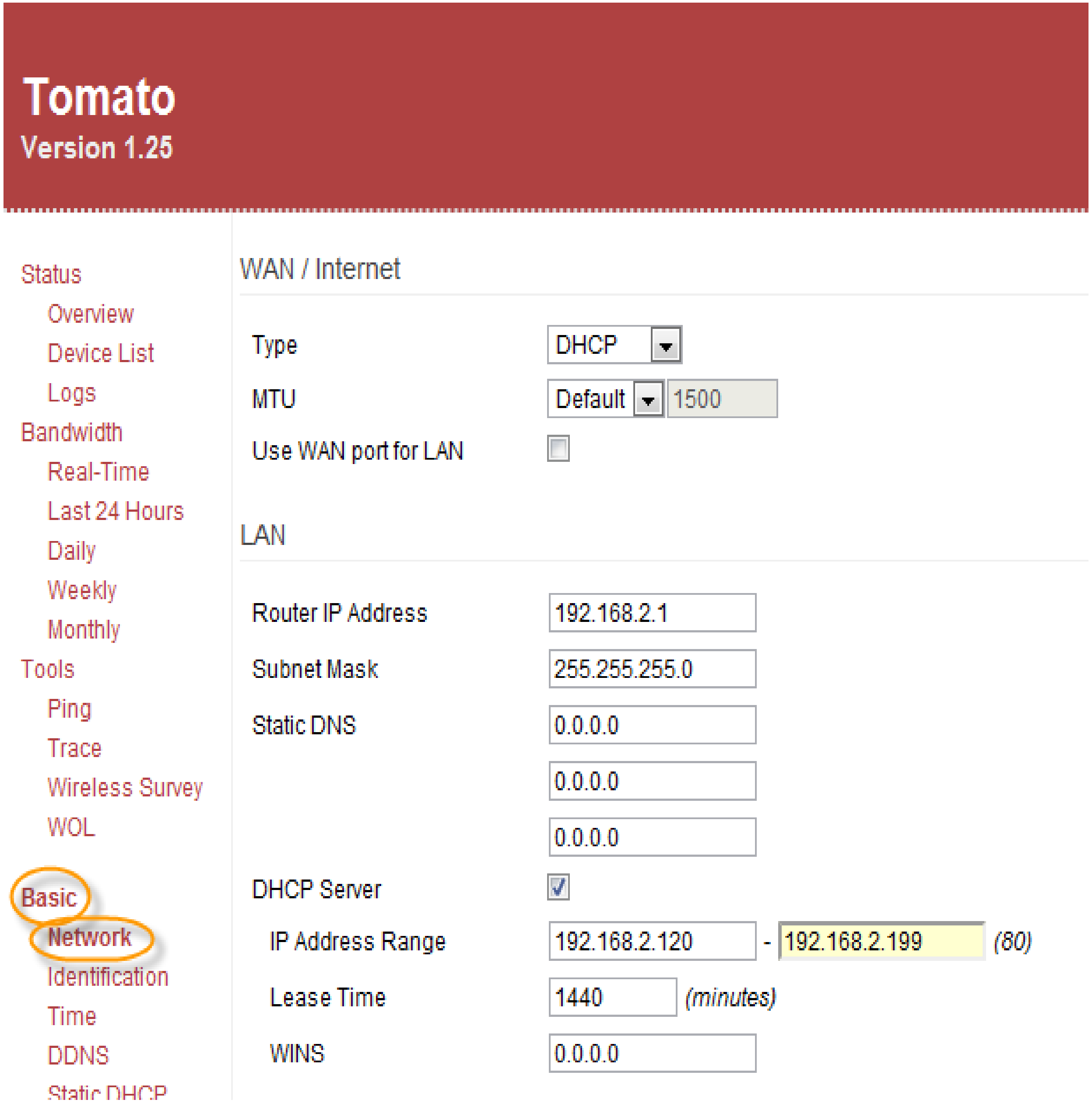
DHCP Server: ● Enable ○ Disable
Starting IP Address: 192.168.1.100
Maximum Number of DHCP Users: 50
Client Lease Time: 0 minutes (0 means one day)

Automatic Configuration - DHCP: This setting is most commonly used by Cable operators.

Host Name: Enter the host name provided by your ISP.
Domain Name: Enter the domain name provided by your ISP.
More...

Local IP Address: This is the address of the router.
Subnet Mask: This is the subnet mask of the router.

DHCP Server: Allows the router to manage your IP addresses.
Starting IP Address: The address you would like to start with.
Maximum number of DHCP



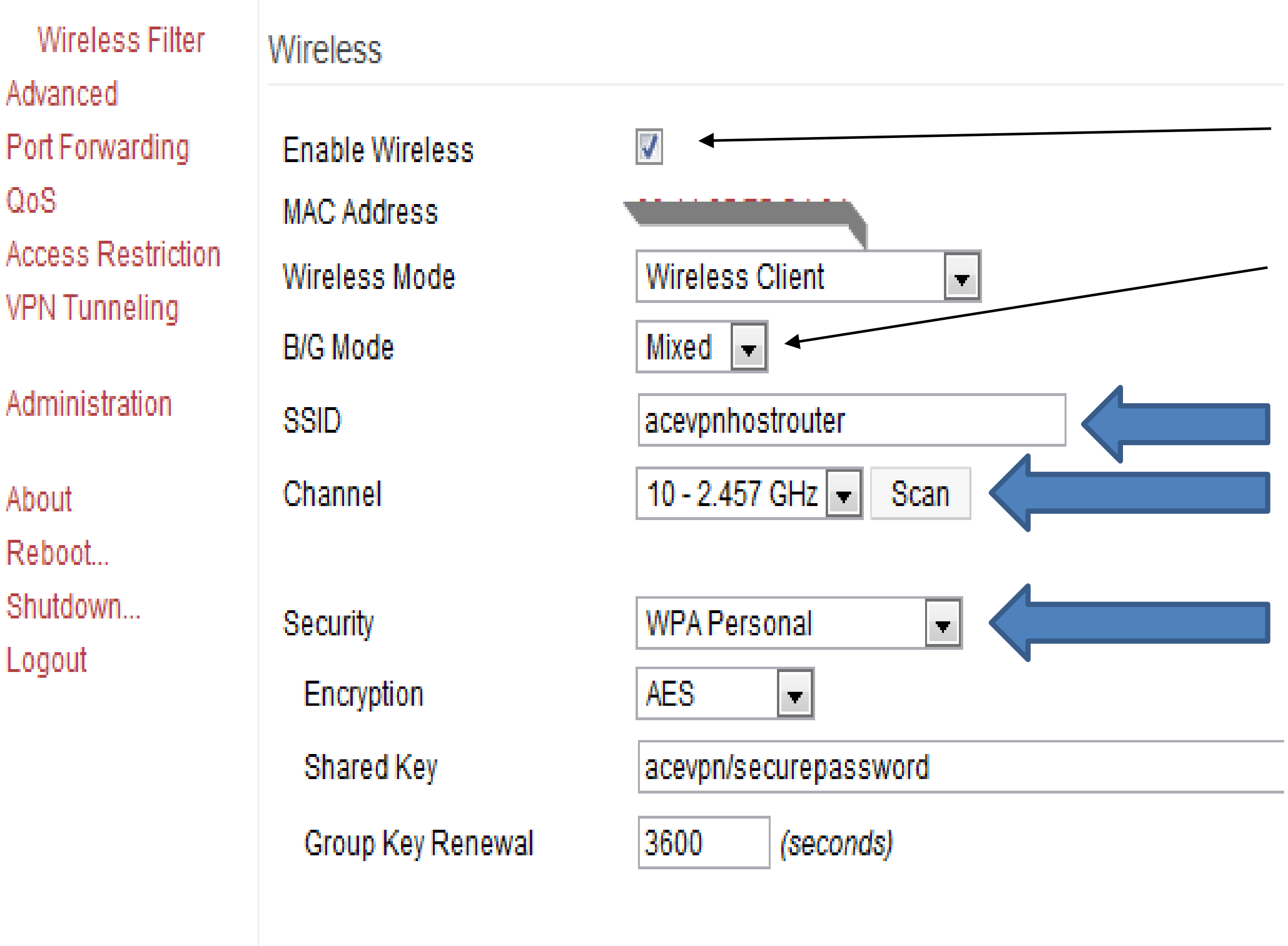
WAN / Internet

Type	DHCP
MTU	Default 1500
Use WAN port for LAN	□

LAN

Router IP Address	192.168.2.1
Subnet Mask	255.255.255.0
Static DNS	0.0.0.0
	0.0.0.0
	0.0.0.0
DHCP Server	☑
IP Address Range	192.168.2.120 - 192.168.2.199 *(80)*
Lease Time	1440 *(minutes)*
WINS	0.0.0.0

What are the settings for Wireless?



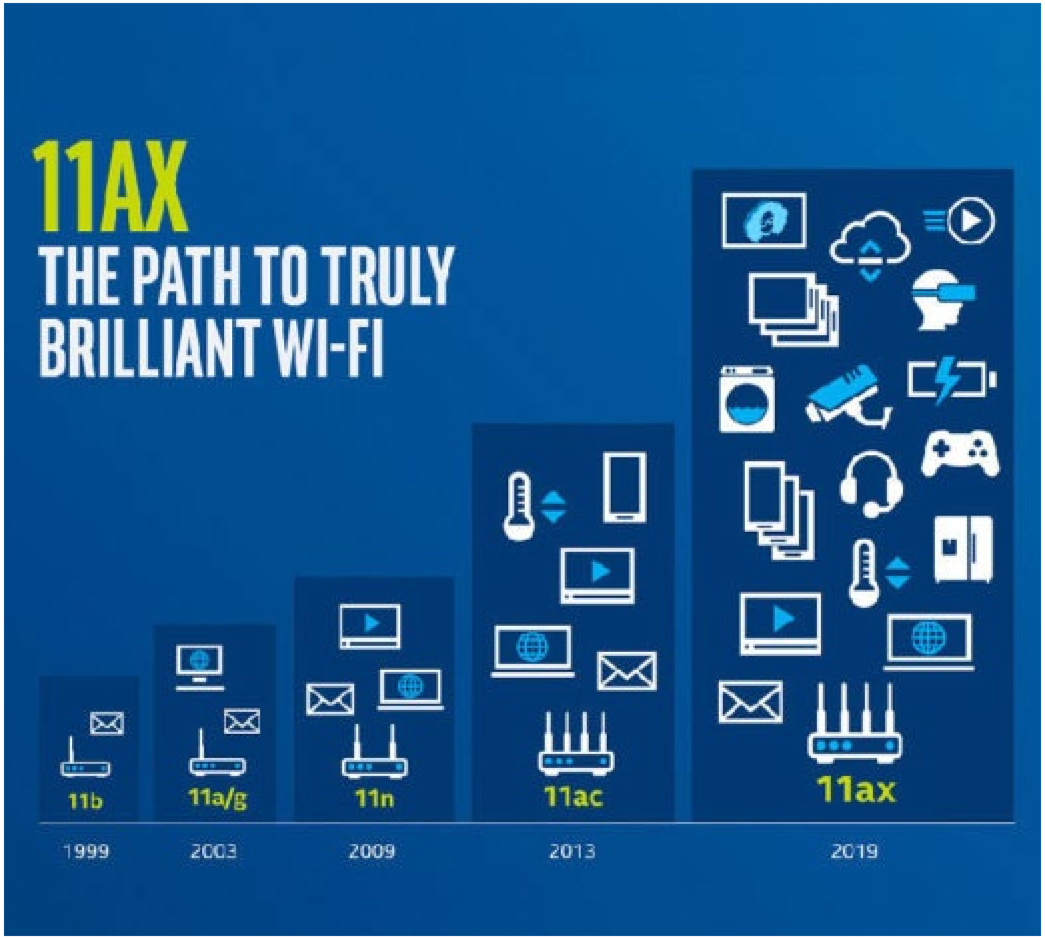
Wireless

Enable Wireless	☑
MAC Address	[redacted]
Wireless Mode	Wireless Client
B/G Mode	Mixed
SSID	acevpnhostrouter
Channel	10 - 2.457 GHz
Security	WPA Personal
Encryption	AES
Shared Key	acevpn/securepassword
Group Key Renewal	3600 *(seconds)*

This setting turns on the radio and selects what speed to use B,G,N, AC, AX, or mixed

The most important settings are the SSID, the Channel, and the Security

What is B,G,N, AC, or AX mode



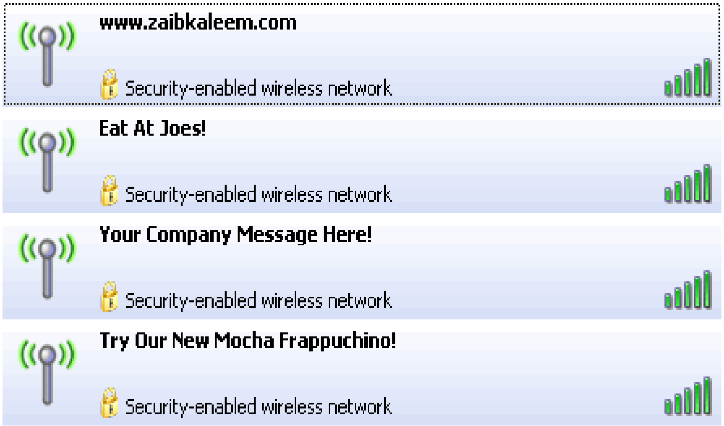
It is the speed of the network

Mode	Speed	Freq
B	11Mbps	2.4Ghz
G	54Mbps	2.4Ghz
N	300Mbps	2.4 and 5 Ghz
AC	1.7 to 3.5 Gbps	5 Ghz
AX	3.4 to 14 Gbps	1, 2.4, 5, 6 Ghz
Mixed	Whatever the client says they can do	

SSID = the Name of the broadcast (AP)

Set the SSID so that people see the name of the access point

- This does not have to be broadcast.
- If it is set to **“not broadcast**”, people see this…
- … they have to add the name of the SSID to join the network – this is a crude password approach.

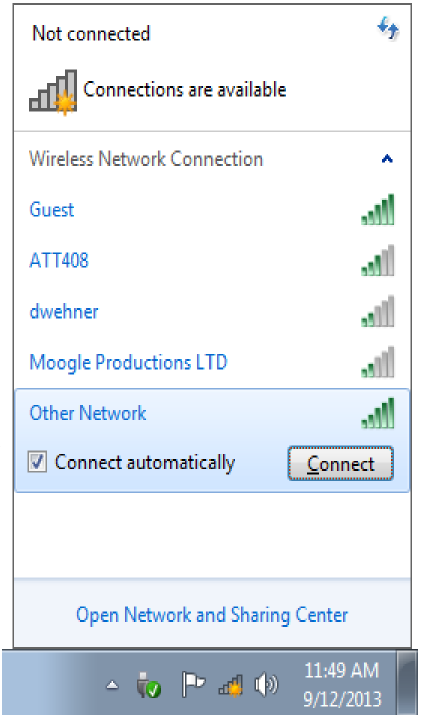


www.zaibkaleem.com
Security-enabled wireless network

Eat At Joes!
Security-enabled wireless network

Your Company Message Here!
Security-enabled wireless network

Try Our New Mocha Frappuchino!
Security-enabled wireless network



Not connected

Connections are available

Wireless Network Connection

Guest

ATT408

dwehner

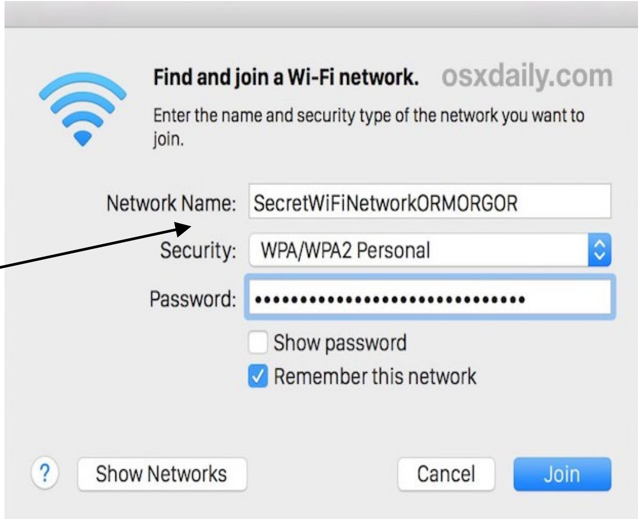
Moogle Productions LTD

Other Network

☑ Connect automatically

Open Network and Sharing Center

11:49 AM
9/12/2013



Find and join a Wi-Fi network. osxdaily.com

Enter the name and security type of the network you want to join.

Network Name: SecretWiFiNetworkORMORGOR

Security: WPA/WPA2 Personal

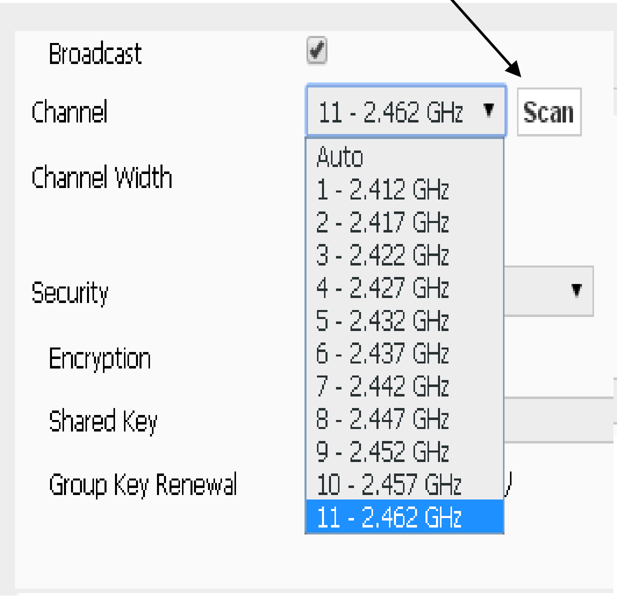
Password: ••••••••••••••••••••••••••••••

□ Show password

☑ Remember this network

Find an open channel

- Make sure you choose one not being used!
- Do a “Site Scan” It gives results like this.



Broadcast ☑

Channel 11 - 2.462 GHz ▾ Scan

Channel Width

Security ▾

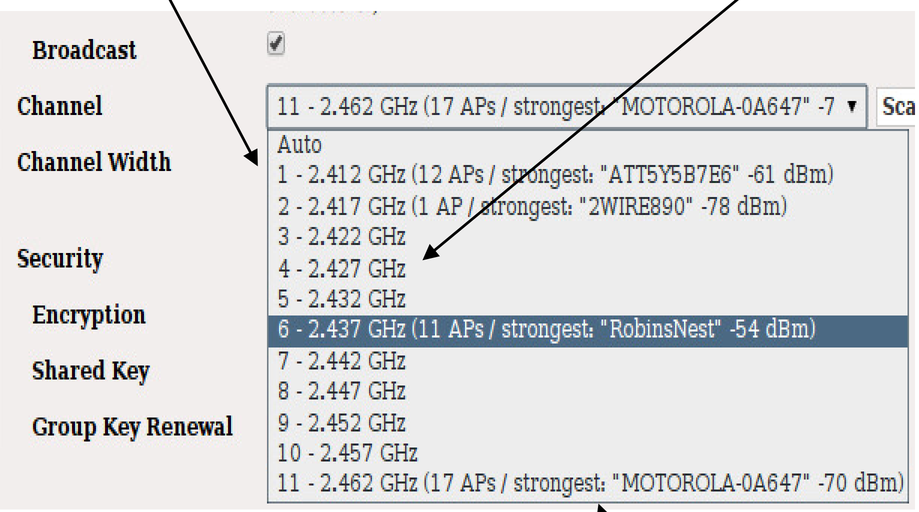
Encryption

Shared Key

Group Key Renewal

Auto
1 - 2.412 GHz
2 - 2.417 GHz
3 - 2.422 GHz
4 - 2.427 GHz
5 - 2.432 GHz
6 - 2.437 GHz
7 - 2.442 GHz
8 - 2.447 GHz
9 - 2.452 GHz
10 - 2.457 GHz
11 - 2.462 GHz

This is a open channel



Broadcast ☑

Channel 11 - 2.462 GHz (17 APs / strongest: "MOTOROLA-0A647" -7 ▾ Sca

Channel Width

Security

Encryption

Shared Key

Group Key Renewal

Auto
1 - 2.412 GHz (12 APs / strongest: "ATT5Y5B7E6" -61 dBm)
2 - 2.417 GHz (1 AP / strongest: "2WIRE890" -78 dBm)
3 - 2.422 GHz
4 - 2.427 GHz
5 - 2.432 GHz
6 - 2.437 GHz (11 APs / strongest: "RobinsNest" -54 dBm)
7 - 2.442 GHz
8 - 2.447 GHz
9 - 2.452 GHz
10 - 2.457 GHz
11 - 2.462 GHz (17 APs / strongest: "MOTOROLA-0A647" -70 dBm)

This Channel is being used

Keep in mind channel overlap

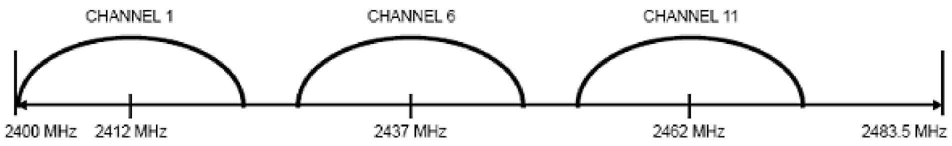


Figure 141—North American channel selection—non-overlapping

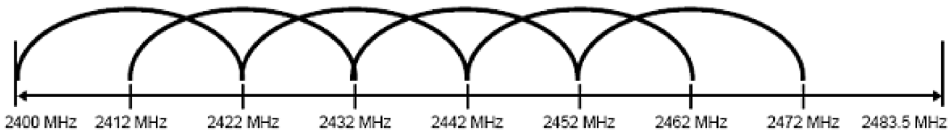
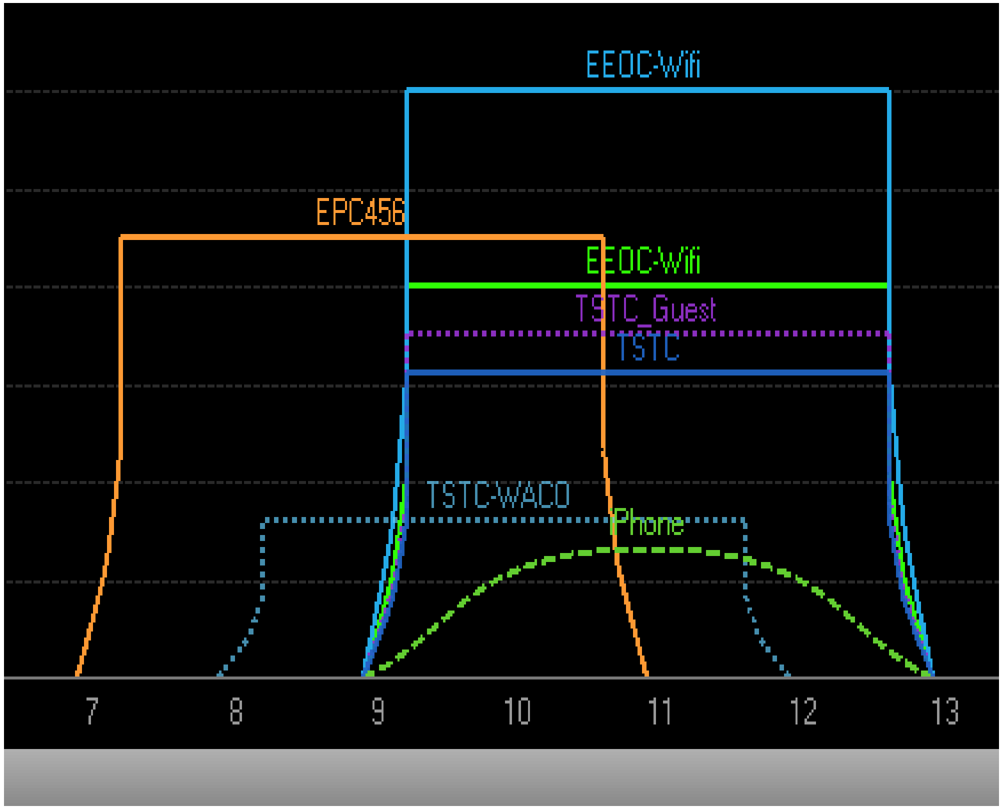
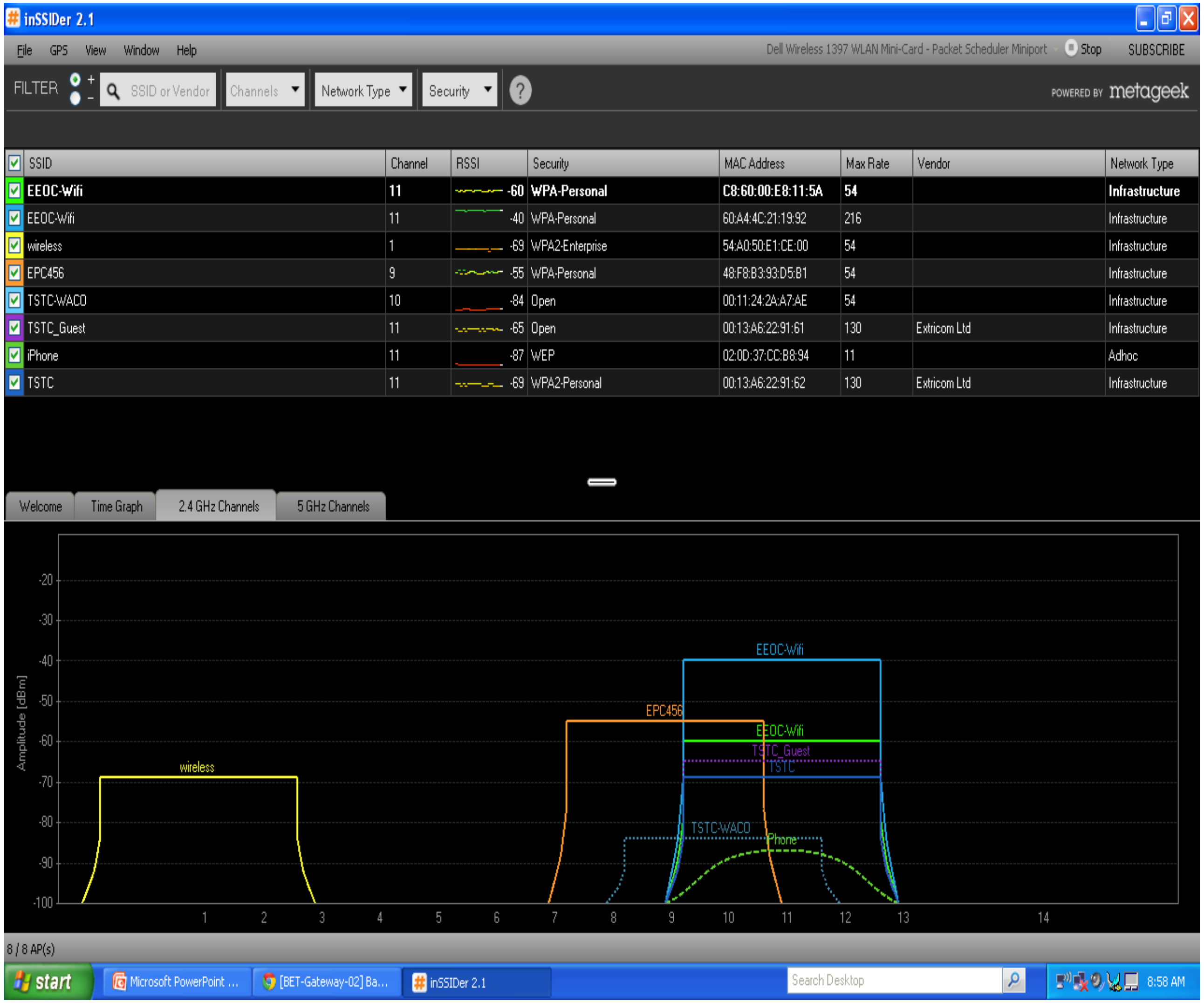


Figure 142—North American channel selection—overlapping



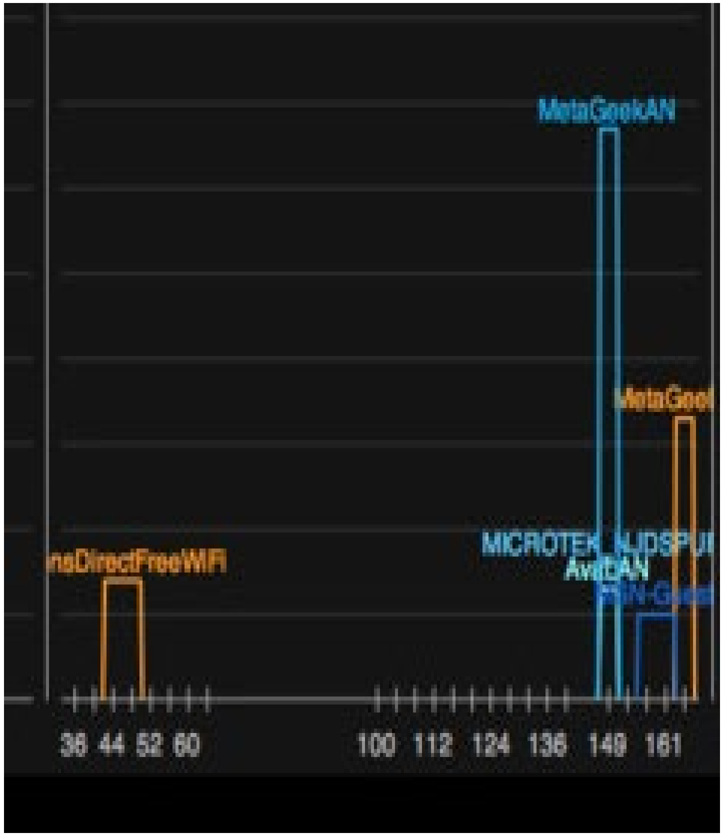
2.4 Ghz channels have 12 channels 1 through 11, but most interfere with each other. In application, we only have 3 channels. 1, 6, and 11

This is a 3rd party program to scan SSID’s

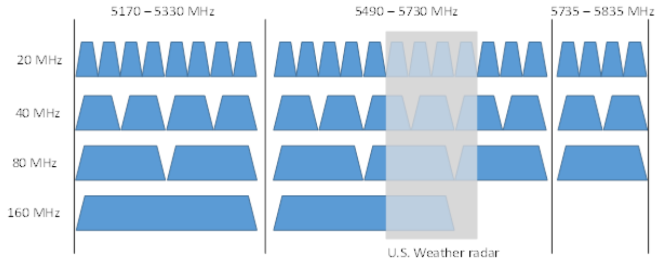


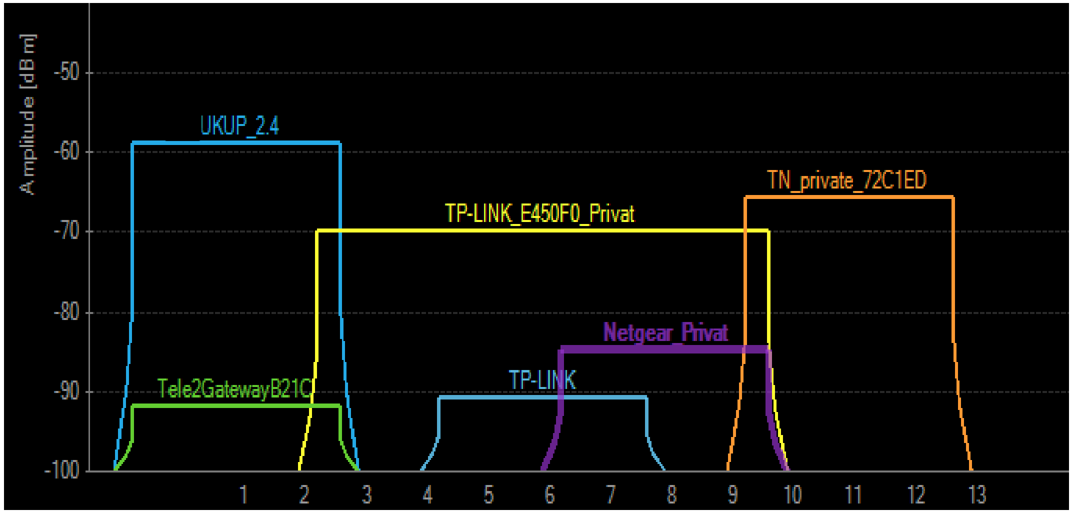
☑ SSID	Channel	RSSI	Security	MAC Address	Max Rate	Vendor	Network Type
☑ **EEOC-Wifi**	**11**	**-60**	**WPA-Personal**	**C8:60:00:E8:11:5A**	**54**		**Infrastructure**
☑ EEOC-Wifi	11	-40	WPA-Personal	60:A4:4C:21:19:92	216		Infrastructure
☑ wireless	1	-69	WPA2-Enterprise	54:A0:50:E1:CE:00	54		Infrastructure
☑ EPC456	9	-55	WPA-Personal	48:F8:B3:93:D5:B1	54		Infrastructure
☑ TSTC-WACO	10	-84	Open	00:11:24:2A:A7:AE	54		Infrastructure
☑ TSTC_Guest	11	-65	Open	00:13:A6:22:91:61	130	Extricom Ltd	Infrastructure
☑ iPhone	11	-87	WEP	02:0D:37:CC:B8:94	11		Adhoc
☑ TSTC	11	-69	WPA2-Personal	00:13:A6:22:91:62	130	Extricom Ltd	Infrastructure

InSSIDer shows stuff like this 5 GHz band.



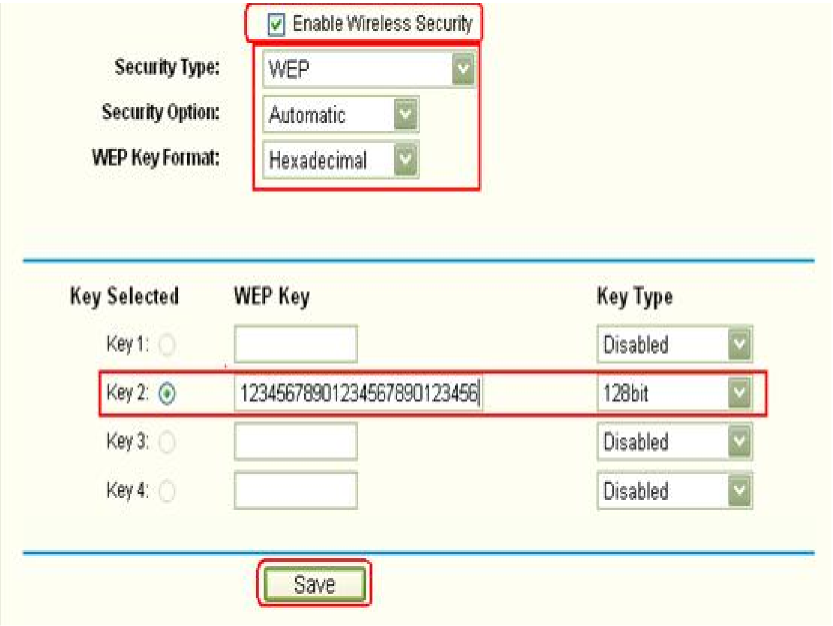
.. Or this Dual Band N broadcasting SSID. See how congested the 2.4 GHz frequencies get?





Use security settings to encrypt

- When mentioning security, think "Encryption"
  - There are 3 basic types:
    - WEP –Uses a Hex Key password
    - WPA – TKIP Encryption
    - WPA2 – a beefier version of WPA – Uses AES encryption
    - WPA and WPA2 both **use passphrases**



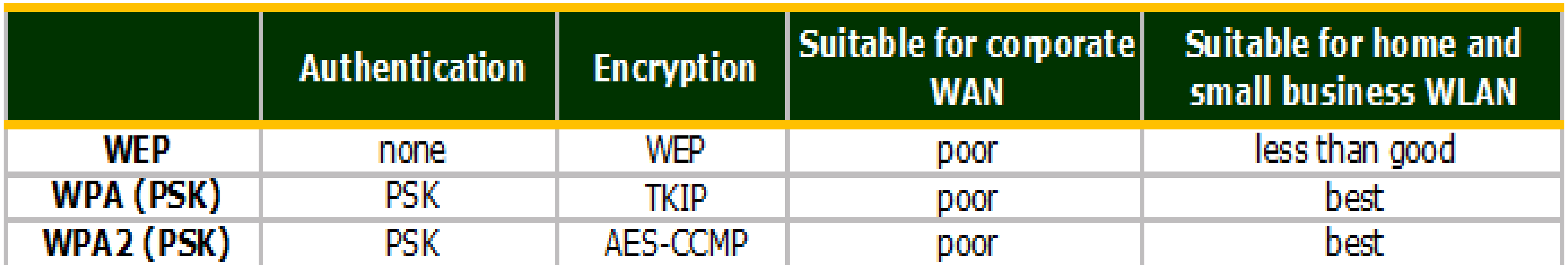
☑ Enable Wireless Security

Security Type: WEP

Security Option: Automatic

WEP Key Format: Hexadecimal

Key Selected	WEP Key	Key Type
Key 1: ○		Disabled
Key 2: ●	12345678901234567890123456	128bit
Key 3: ○		Disabled
Key 4: ○		Disabled

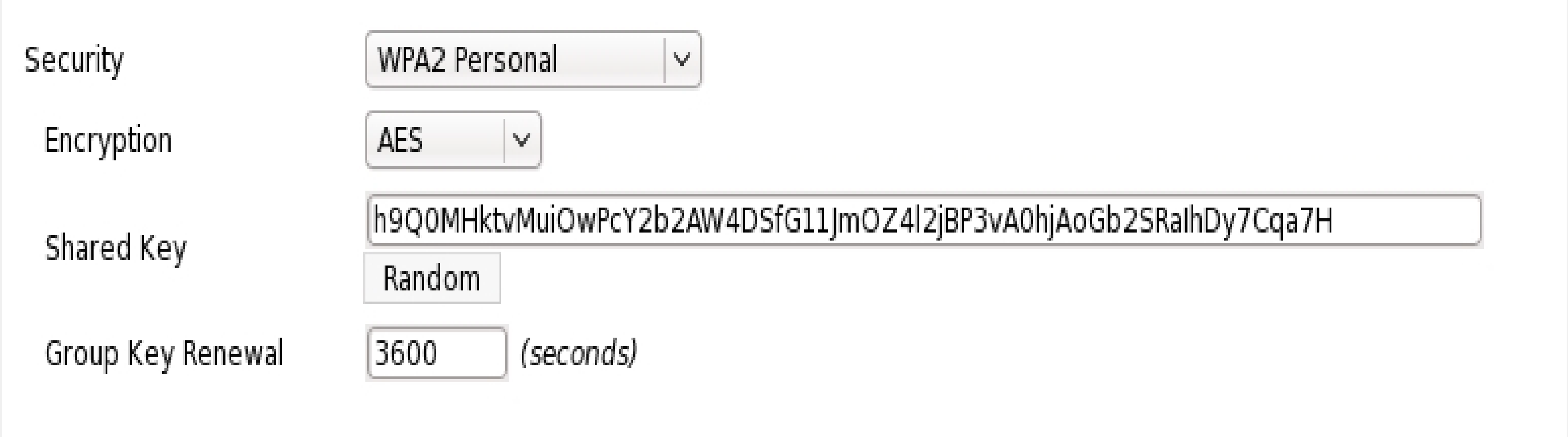


	Authentication	Encryption	Suitable for corporate WAN	Suitable for home and small business WLAN
WEP	none	WEP	poor	less than good
WPA (PSK)	PSK	TKIP	poor	best
WPA2 (PSK)	PSK	AES-CCMP	poor	best

Set the security to what you prefer

It is a give and take between “more accessible” and “hard to crack”

- Use **WEP**, **WPA** personal or **WPA2** personal. WPA / WPA2 means it tries both.
- Encryption: **TKIP** is older but more accepted. **AES** is stronger. TKIP/AES means it tries both
- The **Shared Key** needs to be a strong password
- The **Key renewal** forces the system to drop the existing key and shifts to a new encryption



Security: WPA2 Personal

Encryption: AES

Shared Key: h9Q0MHktvMuiOwPcY2b2AW4DSfG11JmOZ4l2jBP3vA0hjAoGb2SRalhDy7Cqa7H

Group Key Renewal: 3600 *(seconds)*

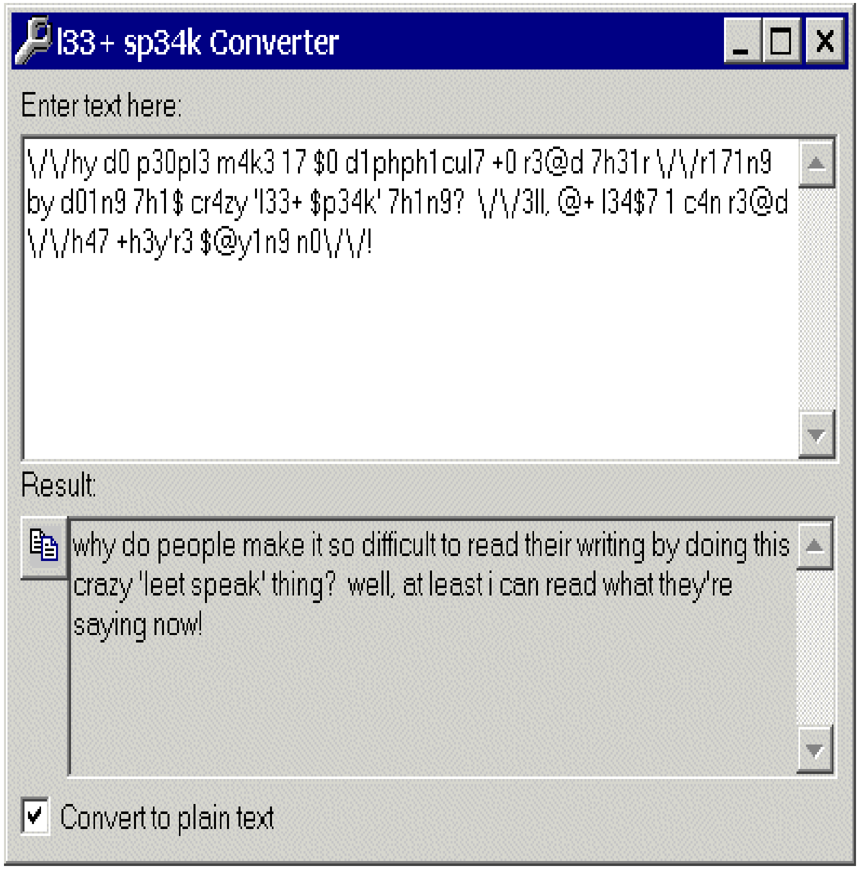
Security is only as strong as the password

Use “Strong Passwords”

- At least 8 characters in length
- Use upper and lower case letters
- Use at least one number
- Use at least one special character

I suggest “leet speak” replace vowels with these characters and “text speak” common words, Capitol the 1st letter.

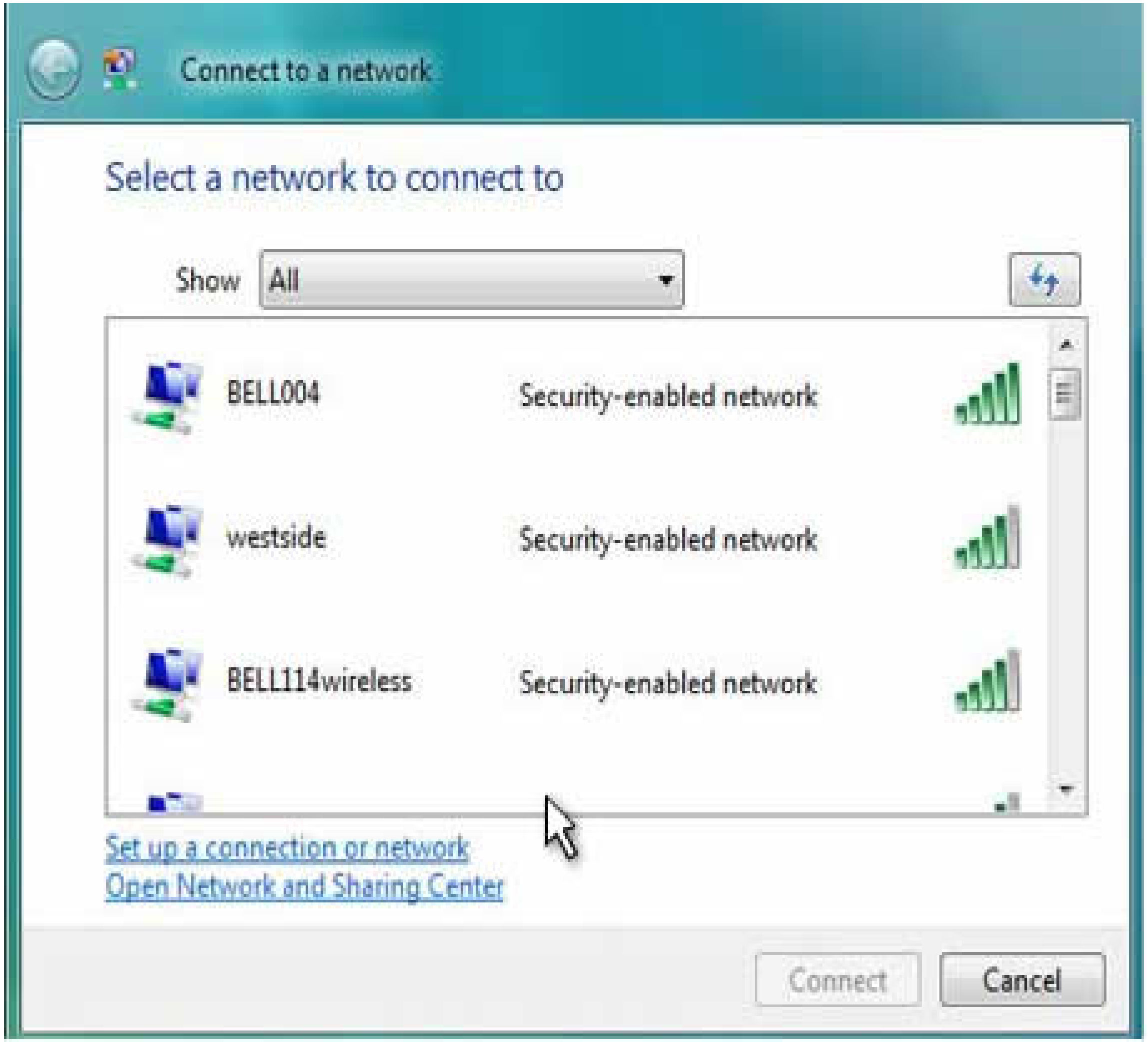
“You will not crack this” becomes uW1llN0tCr@ckTh1s



```
\/\/hy d0 p30pl3 m4k3 17 $0 d1phph1cul7 +0 r3@d 7h31r \/\/r171n9
by d01n9 7h1$ cr4zy 'l33+ $p34k' 7h1n9?  \/\/3ll, @+ l34$7 1 c4n r3@d
\/\/h47 +h3y'r3 $@y1n9 n0\/\/!
```

```
why do people make it so difficult to read their writing by doing this
crazy 'leet speak' thing?  well, at least i can read what they're
saying now!
```

That's It, you should be able to access the Wireless network.



Connect to a network

Select a network to connect to

Show All

BELL004	Security-enabled network
westside	Security-enabled network
BELL114wireless	Security-enabled network

Set up a connection or network
Open Network and Sharing Center
Connect
Cancel

Final Questions???

We reviewed

- The basics of networking
- How to set up WINS
- Setup and use of TCP/IP
- Advanced Subnetting
- Port Forwarding
- VPN usage
- Wireless Networking Setup