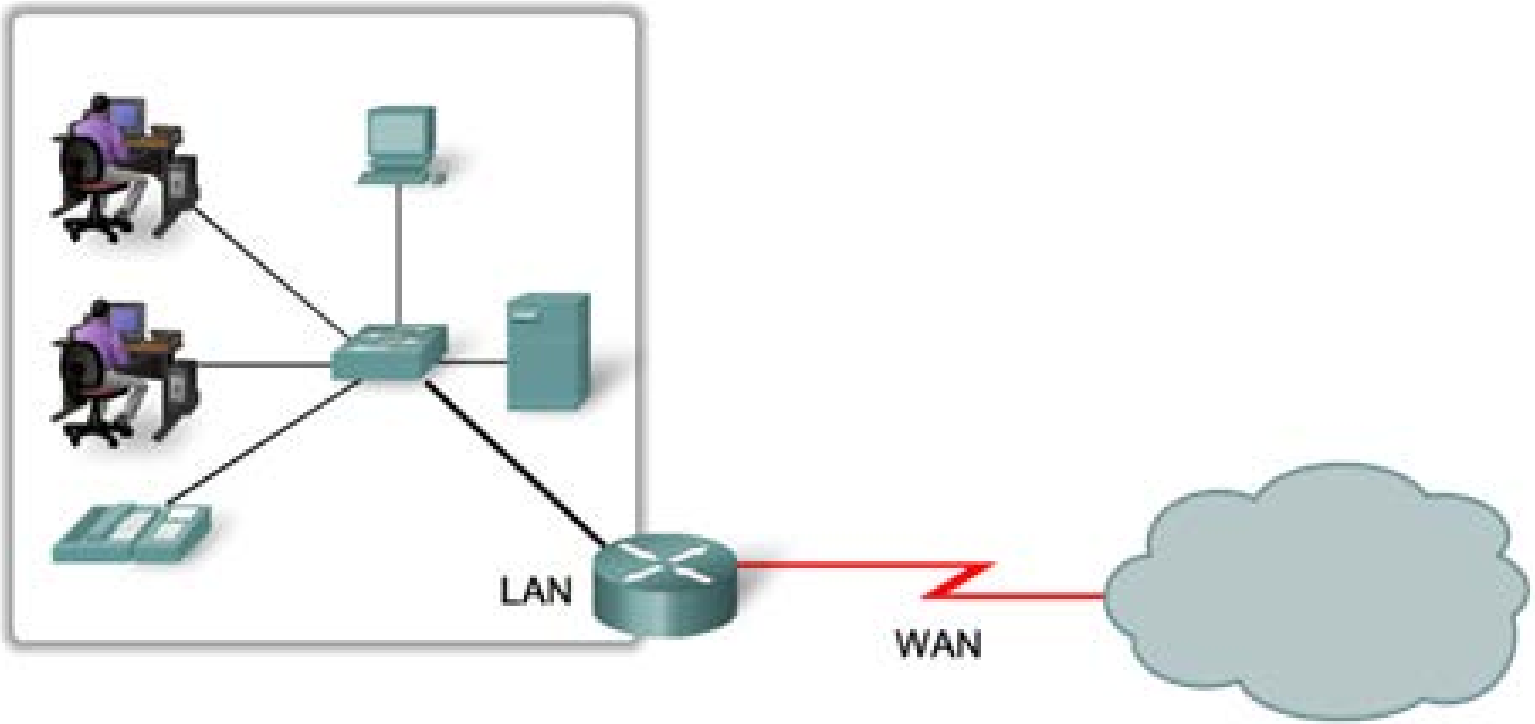
# Chapter 11: Networks

# Small Network

A small network can comprise a few users, one router, one switch.
A Typical Small Network Topology looks like this:



# Device Selection

Factors affecing selection of intermediate devices for a small network:

- Costs of devices – depends on budget of company
- Number of ports needed
- Speed of device – higher speed more expensive
- Expandability of devices
- Manageability of devices – ease of maintenance and troubleshooting

# IP Addressing Scheme

- An IP addressing scheme should be planned, documented and maintained.
- Examples of devices that will be part of the IP design:
  - End devices for users
  - Servers and peripherals
  - Hosts that are accessible from the Internet
  - Intermediary devices
- Planned IP schemes help the administrator:
  - Track devices and troubleshoot
  - Control access to resources

# Redundancy in a Small Network

- Redundancy helps to eliminate single points of failure.
- Improves the reliability of the network.
- But incurs more costs

Redundancy means having more equipment than needed, for standby use during emergencies.

For instance, a company can have a server for operation, and another server on standby.

# Design Considerations for a Small Network

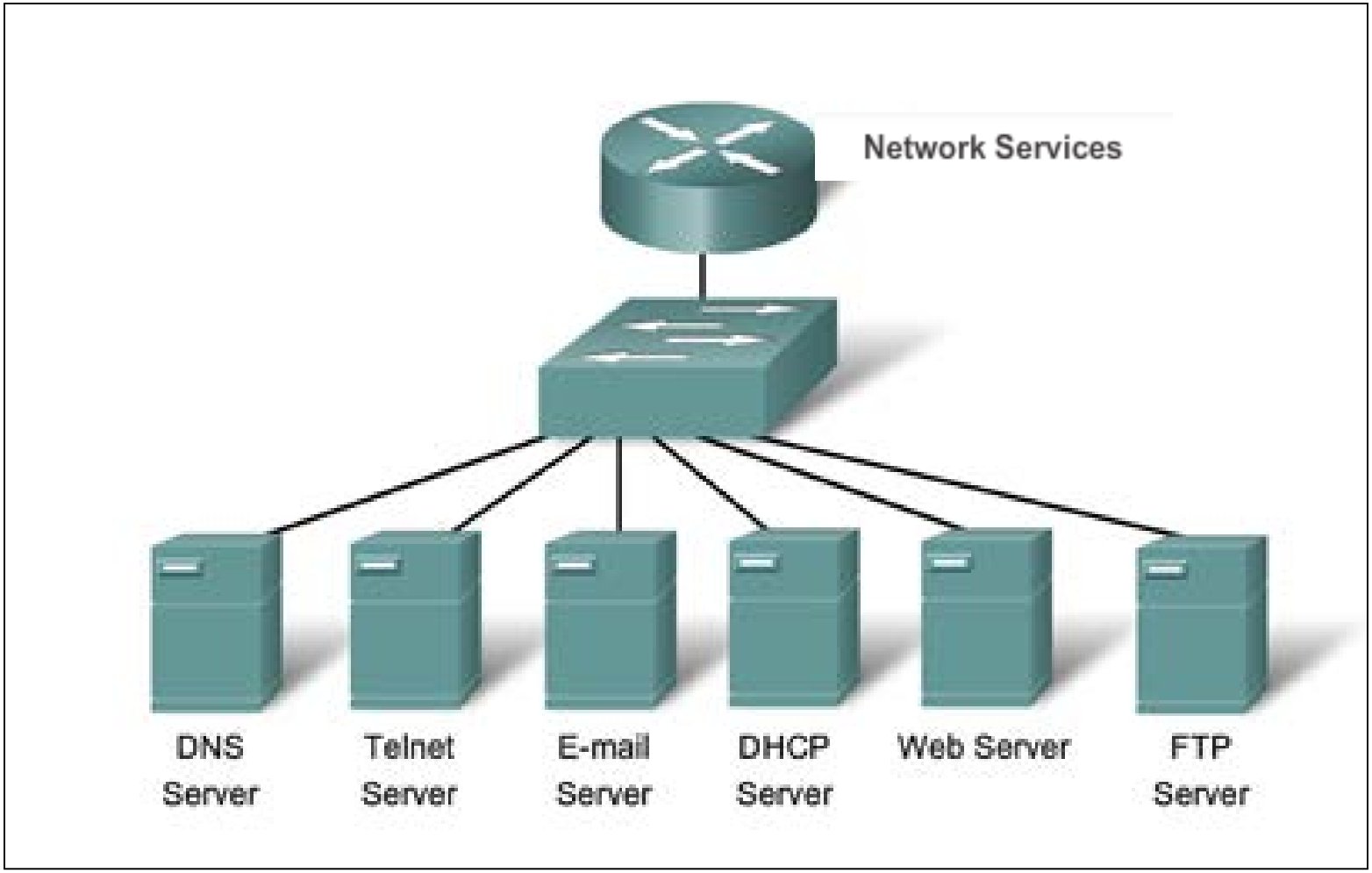
- The following should be included in the network design:
  - Secure file and mail servers in a centralized location.
  - Protection of location by physical and logical security measures.
  - Redundancy

# Common Applications in a Small Network

**Network-Aware Applications** – Software programs that are used to communicate over the network.

**Application Layer Services** – Programs that interface with the network and prepare the data for transfer.

# Common Protocols in a Small Network



# Common Protocols in a Small Network

**Network Protocols Define:**

- Processes on either end of a communication session.
- Types of messages.
- Syntax of the messages.
- Meaning of informational fields.
- How messages are sent and the expected response.
- Interaction with the next lower layer.

# Real-Time Applications for a Small Network

Real-time applications require planning and dedicated services to ensure priority delivery of voice and video traffic.

- **Infrastructure** – Needs to be evaluated to ensure it will support proposed real time applications.
- **VoIP (Voice over IP)** – Is implemented in organizations that still use traditional telephones.
- **IP telephony** – The IP phone itself performs voice-to-IP conversion**.**
- **Real-time Video Protocols** – Use Time Transport Protocol (RTP) and Real-Time Transport Control Protocol (RTCP).

# Larger Network

**Important considerations when growing to a larger network:**

- **Documentation** – Keep a record of the Physical and logical topology.
- **Device inventory** – List of devices that use or comprise the network.
- **Budget** – Itemized IT expense items, including the amount of money allocated to equipment purchase for that fiscal year.
- **Traffic Analysis** – Protocols, applications, and services and their respective traffic requirements should be documented.

# Protocol Analysis of a Small Network

There are softwares for protocol analysis. Information gathered can be used to  make decisions on how to manage traffic more efficiently.

Network administrators can obtain information of employee application utilization. These information will be useful for tracking network utilization and traffic flow requirements.

# Threats to Network Security

When network security is weak or non-existant, it can be attacked by external elements. Some threats are:

- Information Theft
- Data loss
- Data manipulation
- Identity theft
- Disruption of service

# Physical Security

**Four classes of physical threats are:**

- **Hardware threats** – Physical damage to servers, routers, switches, cabling plant, and workstations
- **Environmental threats** – Temperature extremes (too hot or too cold) or humidity extremes (too wet or too dry)
- **Electrical threats** – Voltage spikes, insufficient supply voltage (brownouts), unconditioned power (noise), and total power loss
- **Maintenance threats** – Poor handling of key electrical components (electrostatic discharge), lack of critical spare parts, poor cabling, and poor labeling

# Types of Security Vulnerabilities

**Types of Security Weaknesses:**

- Technological
- Configuration
- Security policy

# Viruses, Worms and Trojan Horses

- **Virus** – Malicious software that is attached to another program to execute a particular unwanted function on a workstation.
- **Trojan horse** – An entire application written to look like something else, when in fact it is an attack tool.
- **Worms** – Worms are self-contained programs that attack a system and try to exploit a specific vulnerability in the target. The worm copies its program from the attacking host to the newly exploited system to begin the cycle again.

# Network Attacks

- Internet queries
- Ping sweeps
- Port scans
- Packet sniffers

# Access Attacks

- Attackers can implement password hacking using brute-force attacks, trojan horse programs, packet sniffer and port redirection.

(a **brute-force attack** consists of an attacker trying many words or phrases, with the hope of eventually guessing correctly.

# Denial of Service Attacks (DoS)

**DoS Attack**

| Resource overloads | Malformed data |
|---|---|
| Disk space, bandwidth, buffers | Oversized packets such as ping of death |
| Ping floods such as smurf | Overlapping packet such as winuke |
| Packet storms such as UDP bombs and fraggle | Unhandled data such as teardrop |

- DoS attacks prevent authorized personnel from using a service. It causes a system to use up its resources.

# Backup, Upgrade, Update, and Patch

Antivirus software can detect most viruses and many Trojan horse applications and prevent them from spreading in the network.

- Keep current with the latest versions of antivirus software.
- Install updated security patches.

# Protect Against Network Attacks

**Authentication, Authorization, and Accounting (AAA, or "triple A")**

- **Authentication** – Users and administrators must prove their identity. Authentication can be established using username and password combinations, challenge and response questions, token cards, and other methods.
- **Authorization** – Determines which resources the user can access and the operations that the user is allowed to perform.
- **Accounting** – Records what the user accessed, the amount of time the resource is accessed, and any changes made.

# Firewalls

A Firewall resides between two or more networks. It controls traffic and helps prevent unauthorized access.

Methods used are:

- Packet Filtering
- Application Filtering
- URL Filtering
- Stateful Packet Inspection (SPI) – Incoming packets must be legitimate responses to requests from internal hosts.

# Endpoint Security

- Common endpoints are laptops, desktops, servers, smart phones, and tablets.
- Employees must follow the companies documented security policies to secure their devices.
- Policies often include the use of anti-virus software and host intrusion prevention.

# Introduction to Securing Devices

- Part of network security is securing devices, including end devices and intermediate devices.
- Default usernames and passwords should be changed immediately.
- Access to system resources should be restricted to only the individuals that are authorized to use those resources.
- Any unnecessary services and applications should be turned off and uninstalled, when possible.
- Update with security patches as they become available.

# Passwords

## Weak and Strong Passwords

| Weak Password | Why it is weak |
|---|---|
| secret | Simple dictionary password |
| smith | Mother's maiden name |
| toyota | Make of car |
| bob1967 | Name and birthday of user |
| Blueleaf23 | Simple words and numbers |

| Strong Password | Why it is strong |
|---|---|
| b67n42d39c | Combines alphanumeric characters |
| 12^h u4@1p7 | Combines alphanumeric characters, symbols and also includes a space |

# Basic Security Practices

- Encrypt passwords.
- Require minimum length passwords.
- Block brute force attacks.
- Use Banner Message.
- Set EXEC timeout.
- Enable SSH (secure shell)

**Securing Devices**

```
Router(config)#service password-encryption
Router(config)#security password min-length 8
Router(config)#login block-for 120 attempts 3 within 60
Router(config)#line vty 0 4
Router(config-vty)#exec-timeout 10
Router(config-vty)#end
Router#show running-config
-more-
!
line vty 0 4
 password 7 03095A0F034F38435B49150A1819
 exec-timeout 10
 login
```

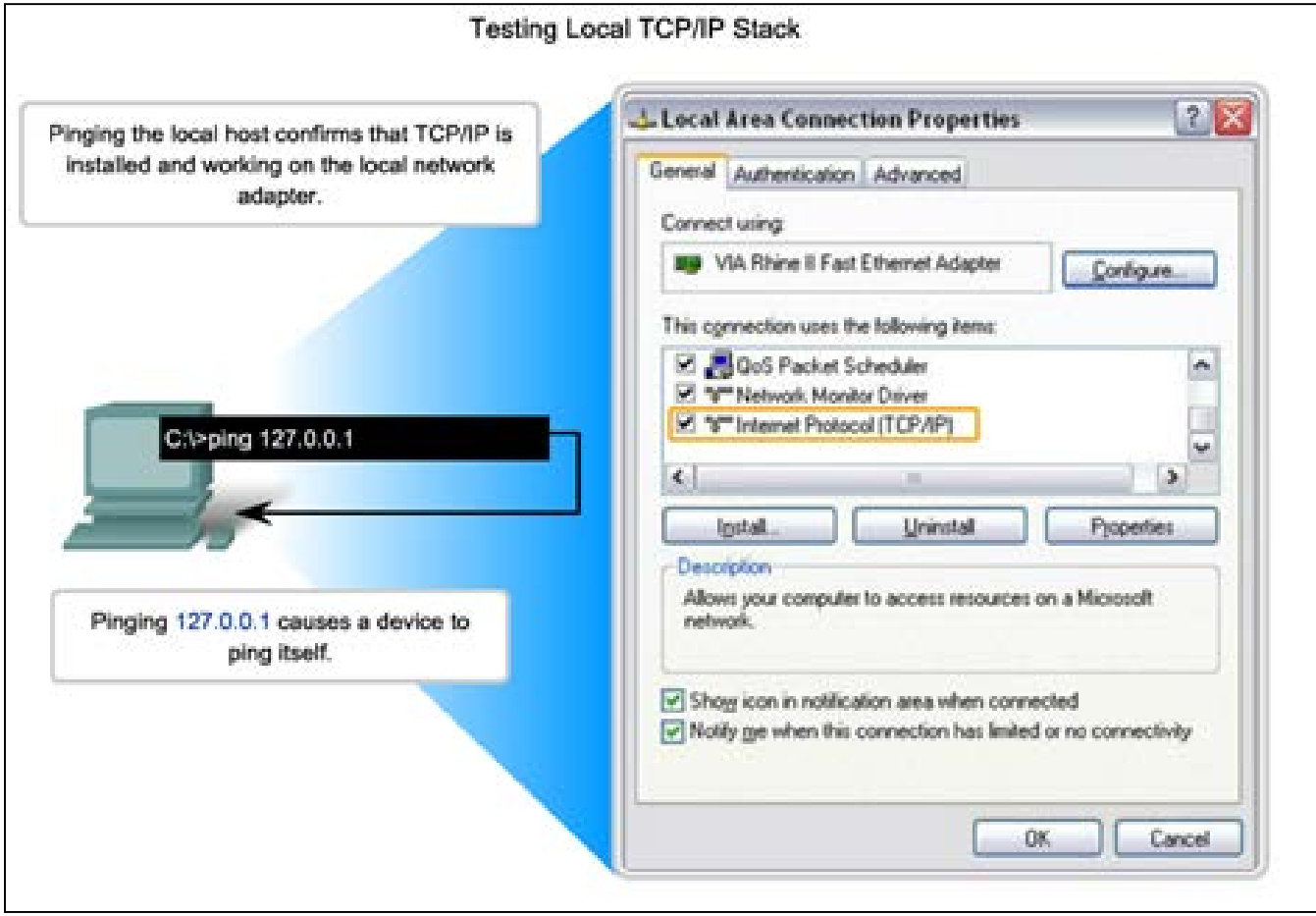
# Enable SSH


```
R1# conf t
R1(config)# ip domain-name span.com
R1(config)# crypto key generate rsa general-keys modulus 1024
The name for the keys will be: R1.span.com
% The key modulus size is 1024 bits
% Generating 1024 bit RSA keys, keys will be non-exportable...[OK]
R1(config)#
*Dec 13 16:19:12.079: %SSH-5-ENABLED: SSH 1.99 has been enabled
R1(config)# username Bob secret cisco
R1(config)# line vty 0 4
R1(config-line)# login local
R1(config-line)# transport input ssh
R1(config-line)# exit
```

Step 1: Configure the IP domain name.
Step 2: Generate one-way secret keys.
Step 3: Verify or create a local database entry.
Step 4: Enable VTY inbound SSH sessions.

# Interpreting ICMP Messages

- **!** – indicates receipt of an ICMP echo reply message
- **.** – indicates a time expired while waiting for an ICMP echo reply message
- **U** – an ICMP unreachable message was received



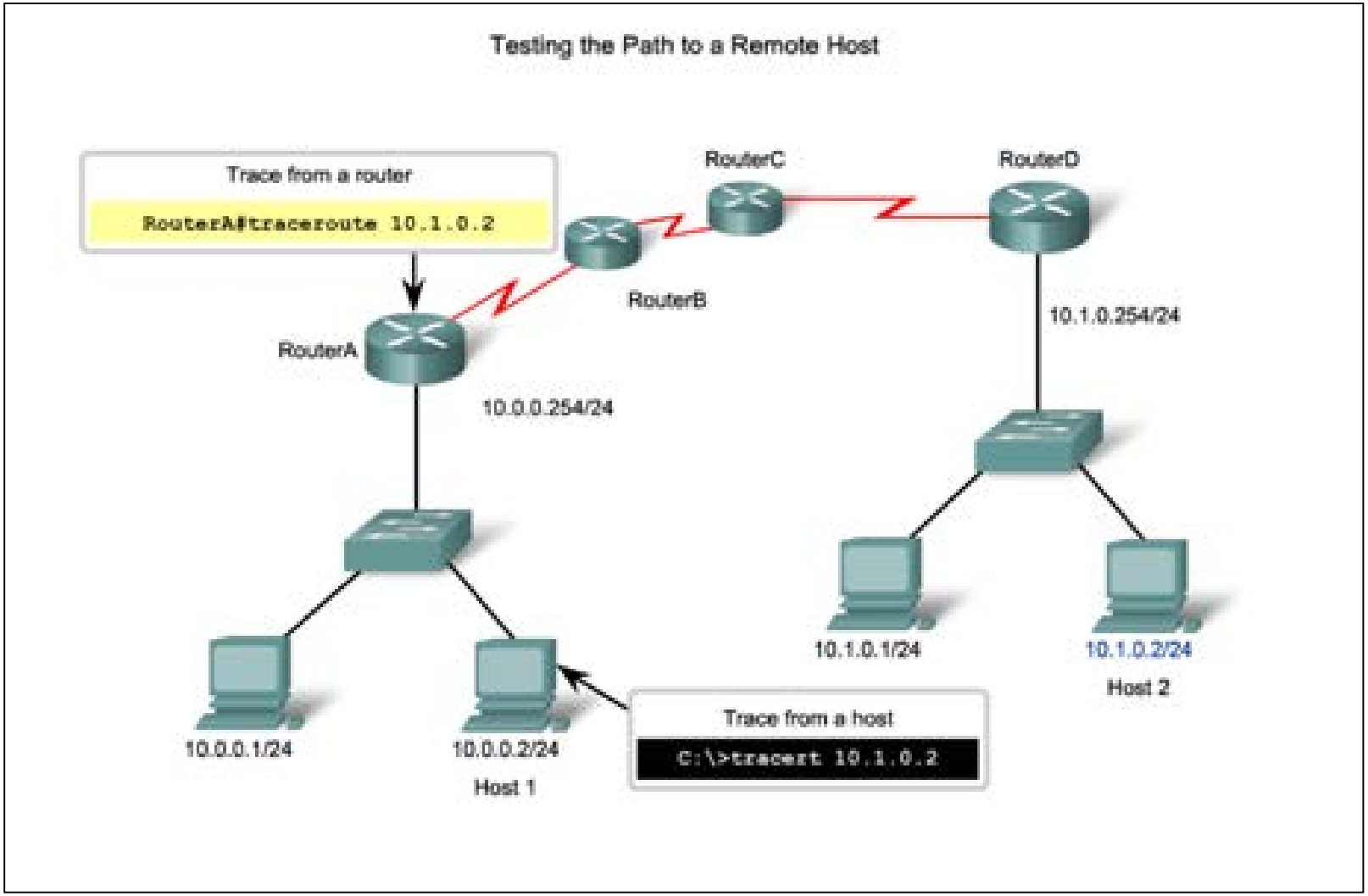
# Leveraging Extended Ping

The Cisco IOS offers an "extended" mode of the **`ping`** command:

- R2# **`ping`**
- Protocol [ip]:
- Target IP address: **192.168.10.1**
- Repeat count [5]:
- Datagram size [100]:
- Timeout in seconds [2]:
- Extended commands [n]: **y**
- Source address or interface: **10.1.1.1**
- Type of service [0]:

Tracert

# Interpreting Tracert Messages



# Common Show Commands Revisited

The status of nearly every process or function of the router can be displayed using a **`show`** command.

Frequently used show commands:

- **`show running-config`**
- **`show interfaces`**
- **`show arp`**
- **`show ip route`**
- **`show protocols`**
- **`show version`**

Show Commands

# Viewing Router Settings With Show Version

**Cisco IOS Version**

**System Bootstrap**

**Cisco IOS Image**

**CPU and RAM**

**Number and Type of Physical Interfaces**

**Amount of NVRAM**

**Amount of Flash**

**Configuration Register**

```
Router#show version
Cisco Internetwork Operating System Software
IOS(tm)2500 Software (C2500-I-L),Version 12.0(17a),RELEASE
SOFTWARE (fc1)
Copyright (c)1986-2002 by cisco Systems,Inc.
Compiled Mon 11-Feb-02 05:55 by kellythw
image text-base:0x00001000
ROM:system Bootstrap,Version 11.0(10c),SOFTWARE
BOOTFLASH :3000 Bootstrap Software (IGS-BOOT-R),Version
11.0(10c),RELEASE SOFTWARE(fc1)
System image file is "flash:c2500-i-l.120-17a.bin"
cisco 2500 (68030 processor(revision N) With 2048K/2048K
bytes of memory.
processor bord ID 08860060,with hardware revision 00000000
Bridging software.
X.25 software,version 3.0.0.
1 Ethernet/IEEE 802.3 interface(s)
2 Serial network interface(s)

32K bytes of non-volatile Configuration memory.

8192K bytes of processor board system flash (Read ONLY)

Configuration register is 0x2102
Router#_
```

Show Commands

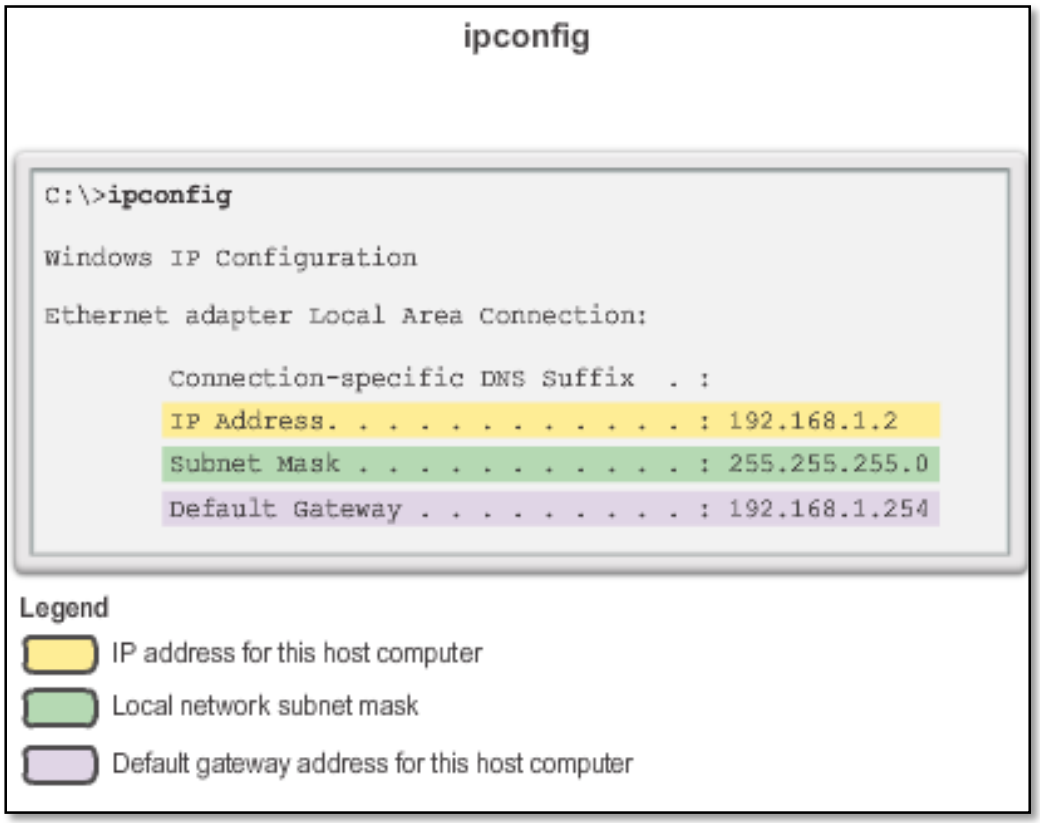
# Viewing Switch Settings With Show Version

## show version Command

```
Switch#show version
Cisco IOS Software, C2960 Software (C2960-LANBASE-M), Version 12.2(25)SEE2,
RELEASE SOFTWARE (fc1)
Copyright (c) 1986-2006 by Cisco Systems, Inc.
Compiled Fri 28-Jul-06 04:33 by yenanh
Image text-base: 0x00003000, data-base: 0x00AA2F34

ROM: Bootstrap program is C2960 boot loader
BOOTLDR: C2960 Boot Loader (C2960-HBOOT-M) Version 12.2(25r)SEE1, RELEASE
SOFTWARE (fc1)

Switch uptime is 2 minutes
System returned to ROM by power-on
System image file is "flash:c2960-lanbase-mz.122-25.SEE2/c2960-lanbase-
mz.122-25.SEE2.bin"

cisco WS-C2960-24TT-L (PowerPC405) processor (revision B0) with 61440K/4088K
bytes of memory.
Processor board ID FOC1107Z9ZN
Last reset from power-on
1 Virtual Ethernet interface
```

# `ipconfig` Command Options

- **`ipconfig`** – Displays ip address, subnet mask, default gateway.
- **`ipconfig /all`** – Also displays MAC address.
- **`ipconfig /displaydns`** – Displays all cached dns entries in a Windows system.



# show cdp neighbors Command Options

**show cdp neighbors** command provides information about each directly connected CDP neighbor device.

```
R3#show cdp neighbors
Capability Codes: R - Router, T - Trans Bridge, B - Source Route Bridge
                  S - Switch, H - Host, I - IGMP, r - Repeater, P - Phone

Device ID        Local Intrfce     Holdtme    Capability  Platform  Port ID
S3               Fas 0/0            151         S I       WS-C2950  Fas 0/6
R2               Ser 0/0/1          125          R        1841      Ser 0/0/1

R3#show cdp neighbors detail

Device ID: R2
Entry address(es):
  IP address : 192.168.1.2
Platform: Cisco 1841,  Capabilities: Router Switch IGMP
Interface: Serial0/0/1,  Port ID (outgoing port): Serial0/0/1
Holdtime : 161 sec

Version :
```

Host and IOS Commands

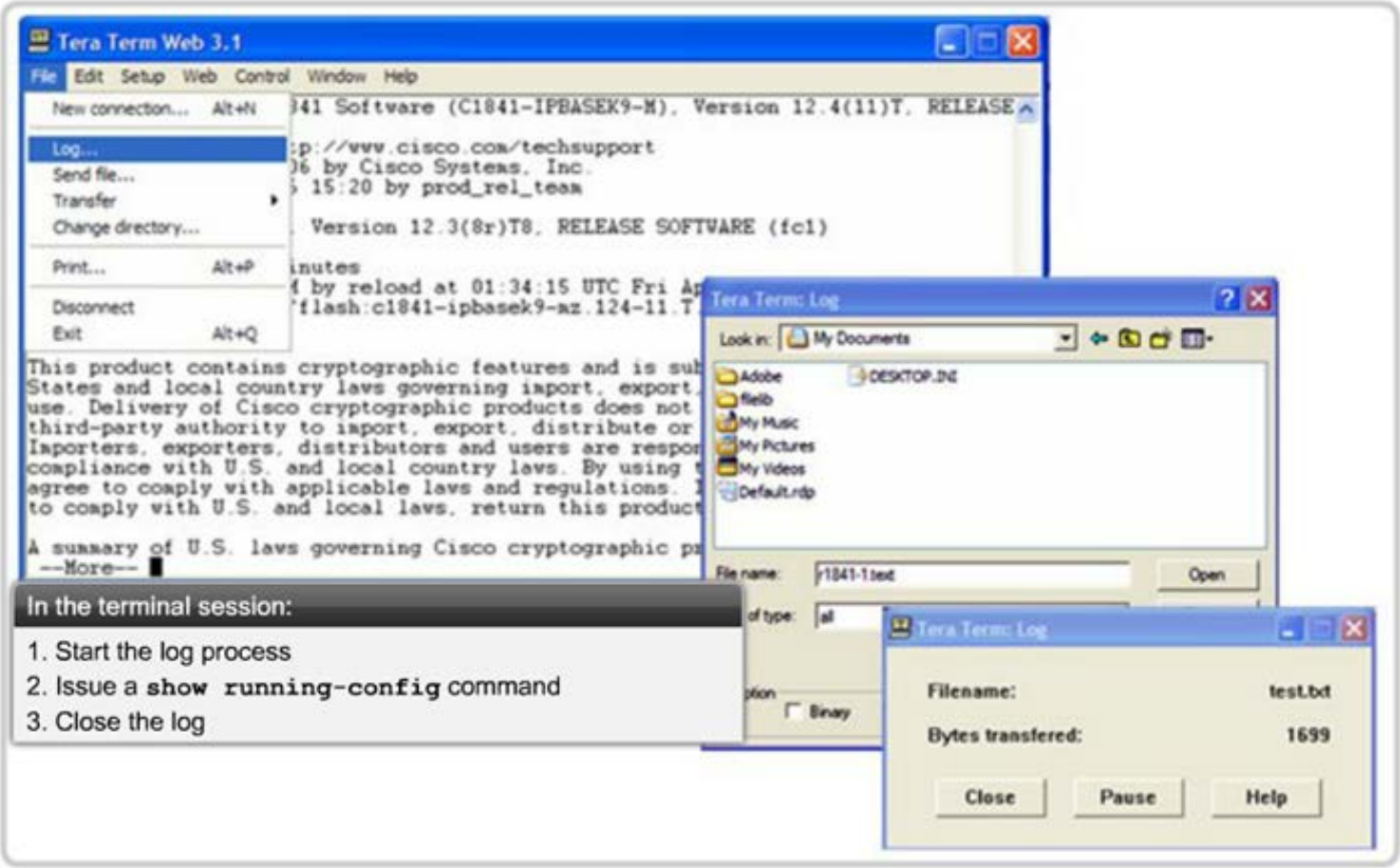
# Using `show ip interface brief` Command

**`show ip interface brief`** command - used to verify the status of all network interfaces on a router or a switch.

```
Router1#show ip interface brief
Interface              IP-Address        OK?   Method   Status                 Protocol
FastEthernet0/0        192.168.254.254   YES   NVRAM    up                     up
FastEthernet0/1/0      unassigned        YES   unset    down                   down
Serial0/0/0            172.16.0.254      YES   NVRAM    up                     up
Serial0/0/1            unassigned        YES   unset    administratively down  down
==========================================================================================
Router1#ping 192.168.254.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.254.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/4 ms
==========================================================================================
Router1#traceroute 192.168.0.1
Type escape sequence to abort.
Tracing the route to 192.168.0.1
  1 172.16.0.253 8 msec 4 msec 8 msec
  2 10.0.0.254 16 msec 16 msec 8 msec
  3 192.168.0.1 16 msec * 20 msec
```

# Backup and Restore Using Text Files

**Saving to a Text File in Tera Term**



# Backup and Restore Using TFTP

- Configuration files can be stored on a Trivial File Transfer Protocol (TFTP) server.
- copy running-config tftp – Save running configuration to a tftp server.
- **copy startup-config tftp** – Save startup configuration to a tftp server.

```
Router#copy running-config tftp
Remote host []? 131.108.2.155
Name of configuration file to write[tokyo-config]?tokyo.2
Write file tokyo.2 to 131.108.2.155? [confirm]
Writing tokyo.2 !!!!!! [OK]
```

# Using USB Interfaces on a Cisco Router

- USB flash drive must be formatted in a FAT16 format.
- Can hold multiple copies of the Cisco IOS and multiple router configurations.
- Allows administrator to easily move configurations from router to router.

# Backup and Restore Using USB

**Backup to USB Drive**

```
R1#copy running-config usbflash0:/   ()
Destination filename [running-config]? R1-Config
5024 bytes copied in 0.736 secs (6826 bytes/sec)
```

Copying to USB flash drive, and no file pre-exists

```
R1#copy running-config usbflash0:/
Destination filename [running-config]? R1-Config
%Warning:There is a file already existing with this name
Do you want to over write? [confirm]
5024 bytes copied in 1.796 secs (2797 bytes/sec)
```

Copying to USB flash drive, and the same configuration file already exists on the drive.

Integrated Router

# Multi-function Device

**Multi-function Device**

- Incorporates a switch, router, and wireless access point.
- Provides routing, switching and wireless connectivity.
- Linksys wireless routers, are simple in design and used in home networks

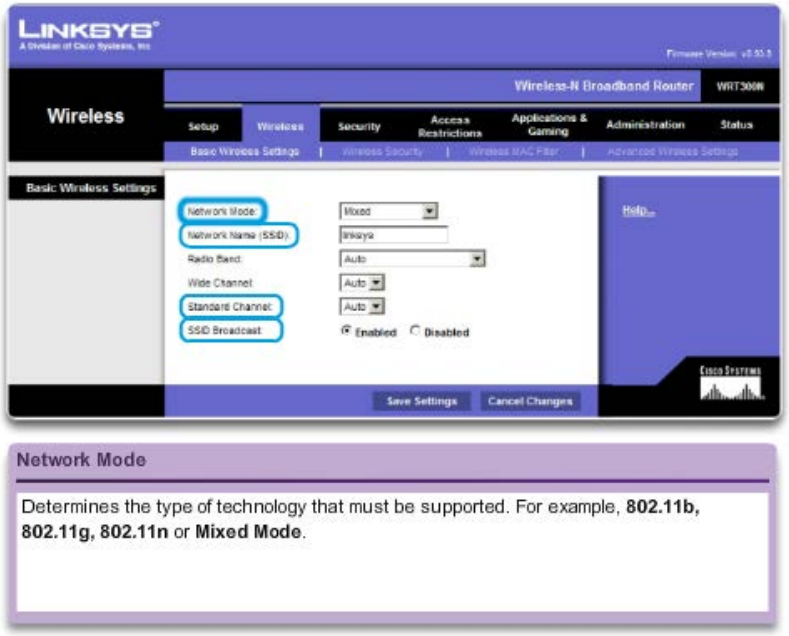
**Cisco Integrated Services Router (ISR)** product family offers a wide range of products, designed for small office to larger networks.

Integrated Router

# Wireless Capability

- **Wireless Mode –** Most integrated wireless routers support 802.11b, 802.11g and 802.11n.
- **Service Set Identifier (SSID) –** Case-sensitive, alpha-numeric name for your home wireless network.
- **Wireless Channel –** RF spectrum can be divided up into channels.

**Linksys Wireless Settings**



Integrated Router

# Basic Security of Wireless

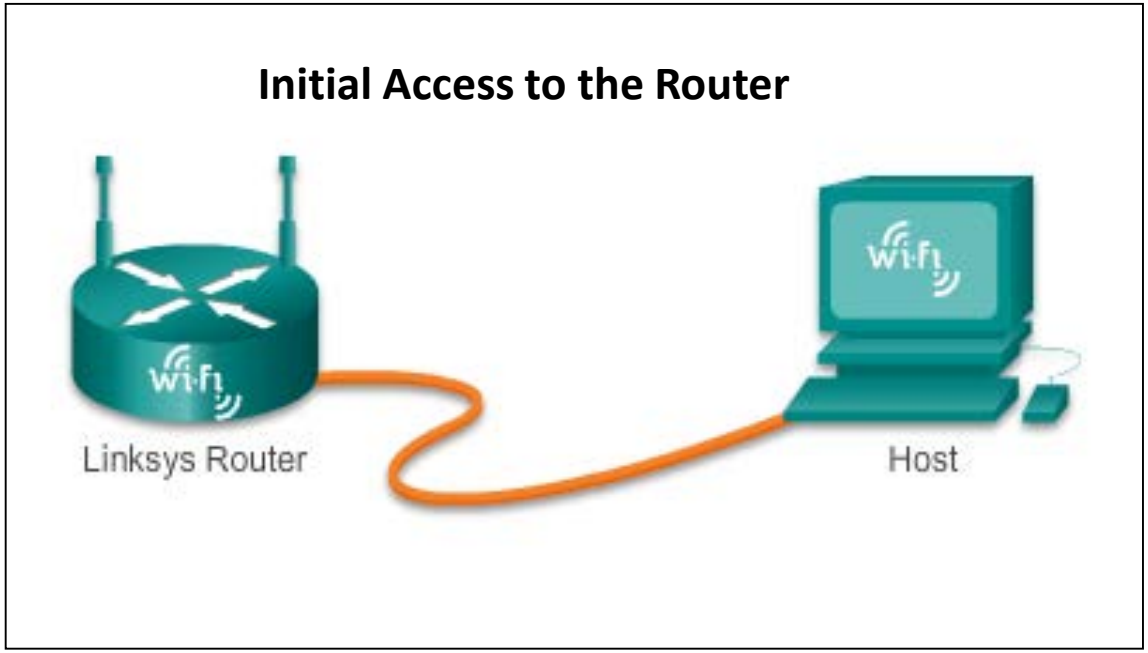
- Change default values
- Disable SSID broadcasting
- Configure Encryption using WEP or WPA
- **Wired Equivalency Protocol (WEP)** - Uses pre-configured keys to encrypt and decrypt data. Every wireless device allowed to access the network must have the same WEP key entered.
- **Wi-Fi Protected Access (WPA) –** Also uses encryption keys from 64 bits up to 256 bits. New keys are generated each time a connection is established with the AP; therefore, more secure.

# Configuring the Integrated Router

**Step 1** - Access the router by cabling a computer to one of the router's LAN Ethernet ports.

**Step 2** - The connecting device will automatically obtain IP addressing information from Integrated Router.

**Step 3** - Change default username and password and the default Linksys IP address for security purposes.



Integrated Router

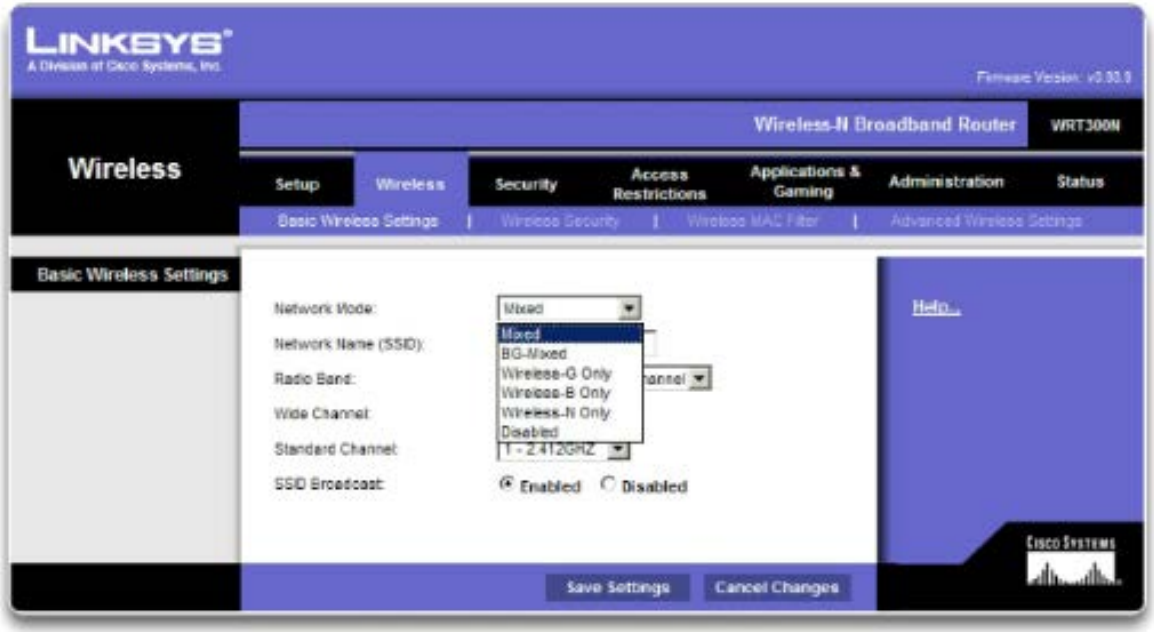
# Enabling Wireless

**Step 1** - Configure the wireless mode

**Step 2** - Configure the SSID

**Step 3** - Configure RF channel

**Step 4** - Configure any desired security encryption



# Configure a Wireless Client

- The wireless client configuration settings must match that of the wireless router.
  - SSID
  - Security Settings
  - Channel
- Wireless client software can be integrated into the device operating system or stand alone, downloadable, wireless utility software.