Basic Router Configuration

Jirasak Sittigorn
Internetworking Standards & Technologies
Department of Computer Engineering, Faculty of Engineering
King Mongkut's Institute of Technology Ladkrabang

Cisco Networking Academy®
Mind Wide Open™

Network Addressing

- Protocols
- Port Address
- IPv4 Address
- MAC Address
- Message Delivery

Basic Router Configuration

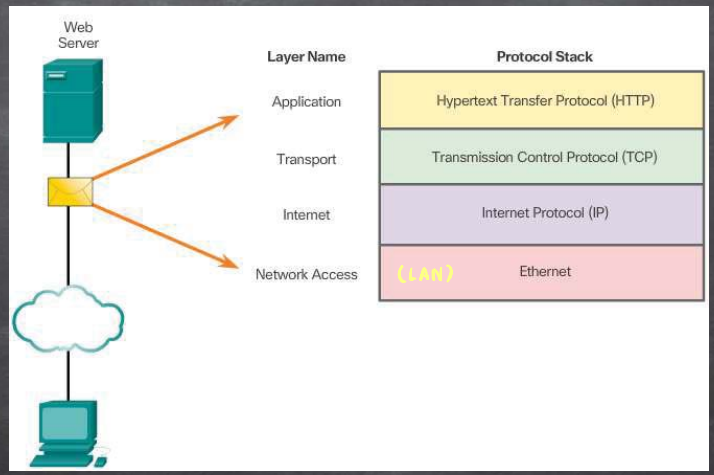
- Cisco IOS
- Accessing a Cisco IOS Device
- Navigating the IOS
- The Command Structure
- Getting Basic

Network Protocols

1. The role of protocols
2. How the message is formatted or structured
3. The process by which networking devices share information about pathways with other networks
4. How and when error and system messages are passed between devices
5. The setup and termination of data transfer sessions

Protocol Interaction

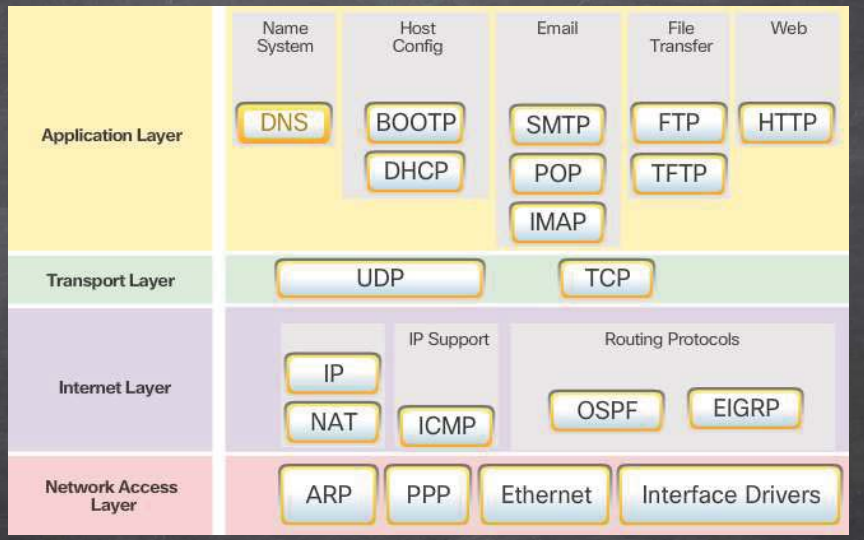
- Interaction of protocols in communication between a web server and web client.



Protocol Suites and Industry Standards

Layer Name	TCP/IP	ISO	AppleTalk	Novell Netware
Application	HTTP DNS DHCP FTP	ACSE ROSE TRSE SESE	AFP	NDS
Transport	TCP UDP	TP0 TP1 TP2 TP3 TP4	ATP AEP NBP RTMP	SPX
Internet	IPv4 IPv6 ICMPv4 ICMPv6	CONP/CMNS CLNP/CLNS	AARP	IPX
Network Access	Ethernet PPP Frame Relay ATM WLAN			

TCP/IP Protocol Suite



Port Address

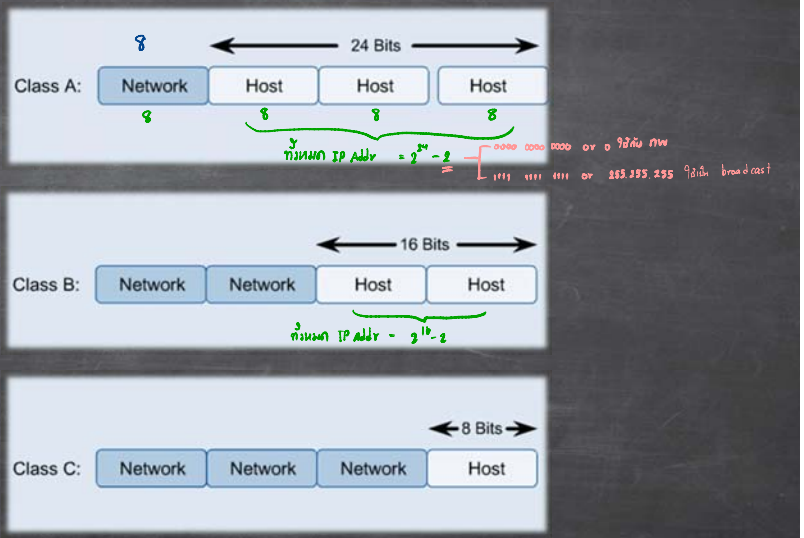
- Handy way for computers and users to keep track of which port belongs to what program
- Ports are numbered from 0 to 65,535
  - The Internet Assigned Numbers Authority (IANA) decided to reserve the first 1024 port numbers (i.e., 0 to 1023) for requesting entities.
  - Ports 1024 - 49,151 : registered port numbers
  - Ports 49,152 - 65,535 : dynamic or private port numbers
- General ways to use port number for source and destination
  - Well-known port numbers -> usually for destination port
  - Ramdomly generate -> for source port

well known Ports

Logical Addresses : IP address (IPv4)

- IP Classes:
  - class A, B, C , D, E →
- Class selection
  - Max. number of workstations required
- Each network
  - Must have a unique logical name (domain name)
  - Ex. www.ce.kmitl.ac.th is 161.246.4.119
- Each node or computer
  - Must have a unique host part of IP address

Logical Addresses : IP address (IPv4)



Logical Addresses : IP address (IPv4)

IP Address Class	High-OrderBits	First Octet Address Range	Number of Bits in theNetwork Address
Class A	0	0 - 127*	8
Class B	10	128 - 191	16
Class C	110	192 - 223	24
Class D	1110	224 - 239	28

Address Class	Number of Networks	Number of Hosts per Network
A	126*	16,777,216
B	16,384	65,535
C	2,097,152	254
D (Multicast)	N/A	N/A

Logical Addresses : IP address (IPv4)

IP Address Classes

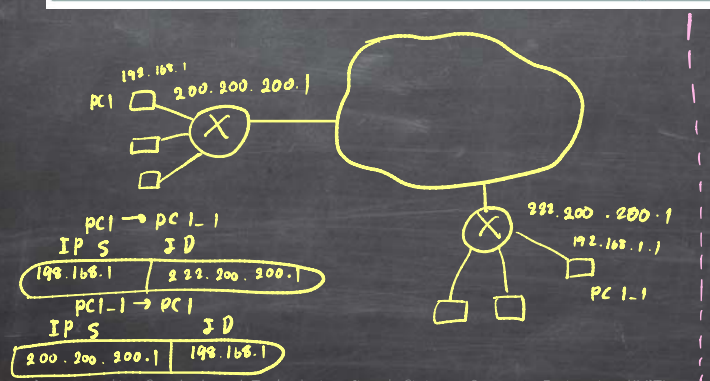
Address Class	1st octet range (decimal)	1st octet bits (green bits do not change)	Network(N) and Host(H) parts of address	Default subnet mask (decimal and binary)	Number of possible networks and hosts per network
A	1-127**	00000000-01111111	N.H.H.H	255.0.0.0	128 nets (2^7) 16,777,214 hosts per net (2^24-2)
B	128-191	10000000-10111111	N.N.H.H	255.255.0.0	16,384 nets (2^14) 65,534 hosts per net (2^16-2)
C	192-223	11000000-11011111	N.N.N.H	255.255.255.0	2,097,150 nets (2^21) 254 hosts per net (2^8-2)
D	224-239	11100000-11101111	NA (multicast)		
E	240-255	11110000-11111111	NA (experimental)		

** All zeros (0) and all ones (1) are invalid hosts addresses.

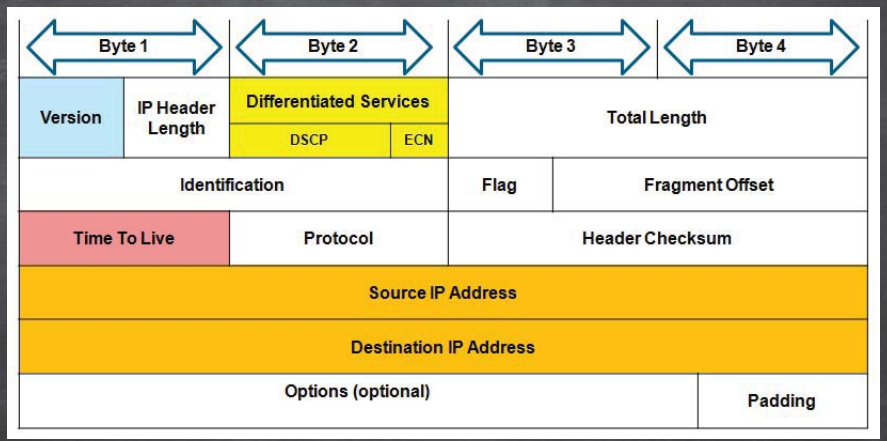
Logical Addresses : IP address (IPv4)

- **Private addressing**

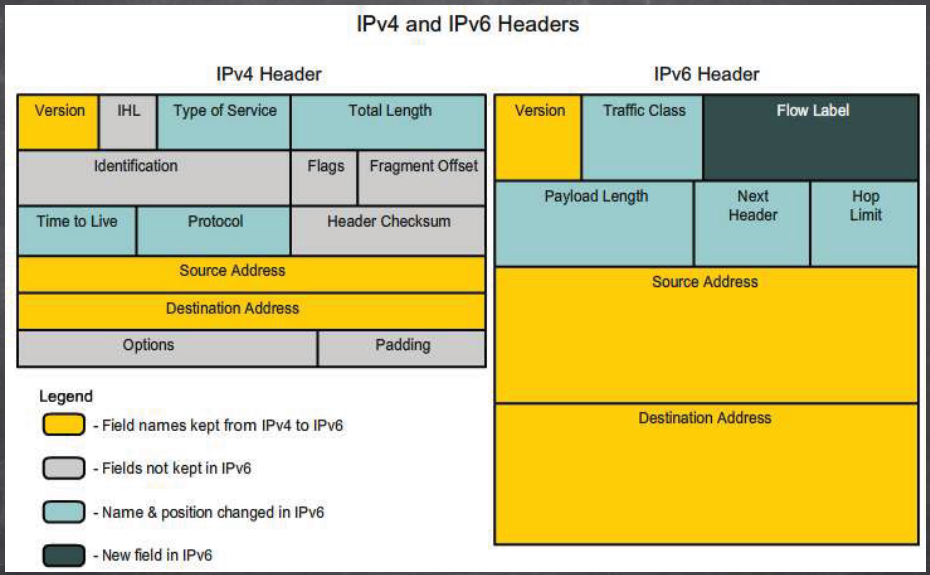
Class	RFC 1918 Internal Address Range	CIDR Prefix
A	10.0.0.0 - 10.255.255.255	10.0.0.0/8
B	172.16.0.0 - 172.31.255.255	172.16.0.0/12
C	192.168.0.0 - 192.168.255.255	192.168.0.0/16



Logical Addresses : IP address (IPv4)



Logical Addresses : IP address



Physical Addresses : MAC Address

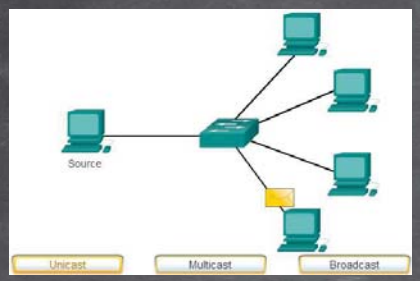
มี 6 byte

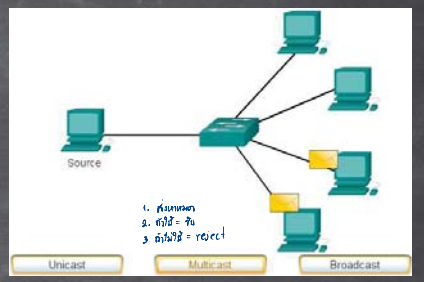
- An Ethernet MAC address is a **48-bit binary** value expressed as **12 hexadecimal** digits (4 bits per hexadecimal digit).
- Hexadecimal is used to represent Ethernet MAC addresses and IP Version 6 addresses.
  - Hexadecimal is a base sixteen system using the numbers 0 to 9 and the letters A to F.
  - It is easier to express a value as a single hexadecimal digit than as four binary bits.
  - Hexadecimal is usually represented in text by the value preceded by 0x (E.g., 0x73).

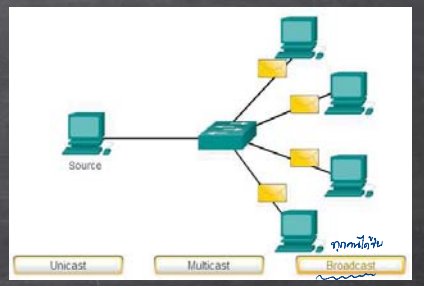
Physical Addresses : MAC Address

- MAC addresses were created to identify the actual source and destination.
  - The MAC address rules are established by IEEE.
  - The IEEE assigns the vendor a **3-byte** (24-bit) code, called the Organizationally Unique Identifier (OUI).
- IEEE requires a vendor to follow two simple rules:
  - All MAC addresses assigned to a NIC or other Ethernet device must use that vendor's assigned OUI as the first 3 bytes.
  - All MAC addresses with the same OUI must be assigned a unique value in the last **3 bytes.**

Message Delivery

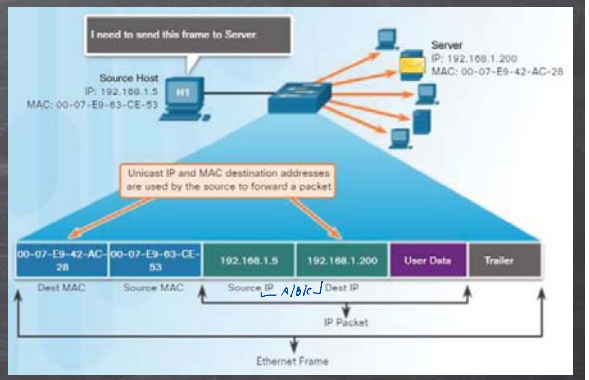






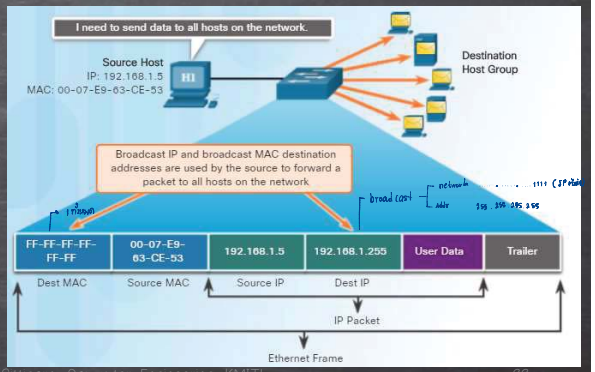
Unicast MAC Address

- A unicast MAC address is the unique address used when a frame is sent from a single transmitting device to a single destination device.
- For a unicast packet to be sent and received, a destination IP address must be in the IP packet header and a corresponding destination MAC address must also be present in the Ethernet frame header.



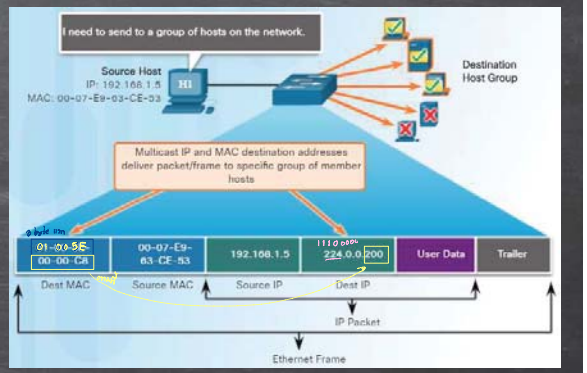
Broadcast MAC Address

- Many network protocols, such as DHCP and ARP, use broadcasts.
- A broadcast packet contains a destination IPv4 address that has all ones (1s) in the host portion indicating that all hosts on that local network will receive and process the packet.
- When the IPv4 broadcast packet is encapsulated in the Ethernet frame, the destination MAC address is the broadcast MAC address of FF-FF-FF-FF-FF-FF in hexadecimal (48 ones in binary).



Multicast MAC Address

- Multicast addresses allow a source device to send a packet to a group of devices.
- Devices in a multicast group are assigned a multicast group IP address in the range of 224.0.0.0 to 239.255.255.255 (IPv6 multicast addresses begin with FF00::/8).
- The multicast IP address requires a corresponding multicast MAC address that begins with 01-00-5E in hexadecimal.



MAC Address Representations

- Use the `ipconfig /all` command on a Windows host to identify the MAC address of an Ethernet adapter. On a MAC or Linux host, the **ifconfig** command is used.
- Depending on the device and the operating system, you will see various representations of MAC addresses.

Cisco IOS

- Operating Systems

Shell: The user interface that allows users to request specific tasks from the computer. These requests can be made either through the CLI or GUI interfaces.

Kernel: Communicates between the hardware and software of a computer and manages how hardware resources are used to meet software requirements.

Hardware: The physical part of a computer including underlying electronics.

Cisco IOS

- Purpose of OS
  - PC operating systems enable a user to:
    - Use a mouse to make selections and run programs.
    - Enter text and text-based commands.
    - View output on a monitor.
  - Cisco IOS enables a network technician to:
    - Use a keyboard to run CLI-based network programs.
    - Use a keyboard to enter text and text-based commands.
    - View output on a monitor.
  - All networking devices come with a default IOS.
  - It is possible to upgrade the IOS version or feature set.

Cisco IOS

- Cisco Internetwork Operating System (IOS)
  - Collection of network operating systems used on Cisco devices
- Location of the Cisco IOS
- IOS Functions

Cisco IOS

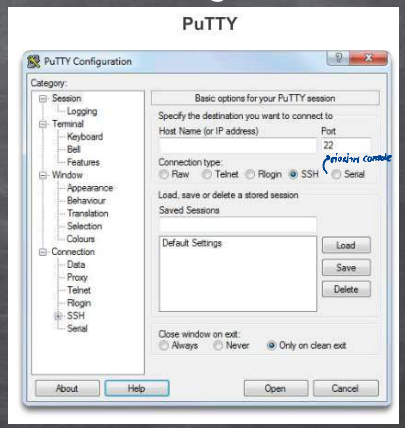
- Router & Switch Boot Sequence
  - POST
  - Run boot loader software
  - Boot loader does low-level CPU initialization
  - Boot loader initializes the flash filesystem
  - Boot loader locates and loads a default IOS operating system software image into memory and hands control of the switch over to the IOS.

Accessing a Cisco IOS Device

- Console port
- Telnet
- Secure Shell (SSH)
- Aux Port

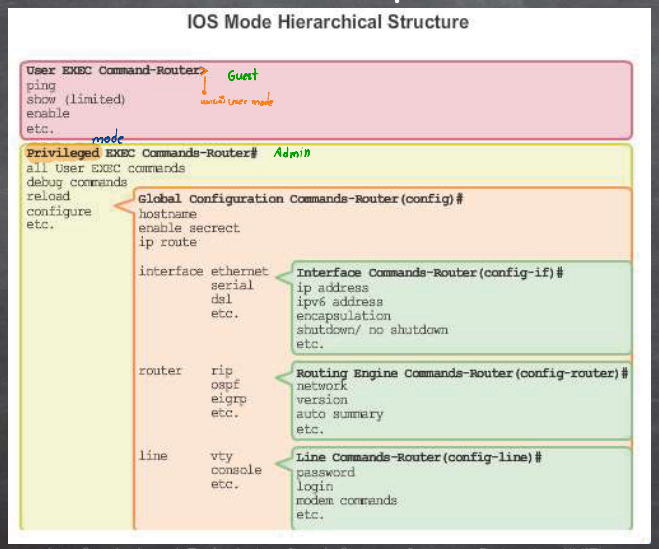
Accessing a Cisco IOS Device

- Terminal Emulation Programs
  - Software available for connecting to a networking device
    - PuTTY
    - Tera Term
    - SecureCRT
    - HyperTerminal
    - OS X Terminal



Navigating the IOS

- Cisco IOS Modes of Operation



Navigating the IOS

- Primary Modes

User EXEC Mode

Limited examination of router.
Remote access.

```
Switch>
Router>
```

The **User EXEC** mode allows only a limited number of basic monitoring commands and is often referred to as view-only mode.

The **Privileged EXEC** mode, by default, allows all monitoring commands, as well as execution of configuration and management commands.

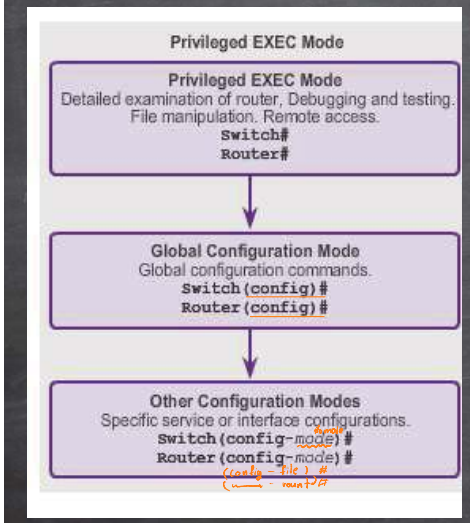
Privileged EXEC Mode

Detailed examination of router. Debugging and testing. File manipulation. Remote access.

```
Switch#
Router#
```

Navigating the IOS

- Global Configuration Mode and Submodes



IOS Prompt Structure

```
Router>ping 192.168.10.5

Router#show running-config

Router(config)#Interface FastEthernet 0/0

Router(config-if)#ip address 192.168.10.1 255.255.255.0
```

The prompt changes to denote the current CLI mode.

```
Switch>ping 192.168.10.9

Switch#show running-config

Switch(config)#Interface FastEthernet 0/1

Switch(config-if)#Description connection to WEST LAN4
```


Navigating the IOS

- Navigating between IOS Modes

```
Router con0 is now available.

Press RETURN to get started.

User Access Verification
Password:
Router>
Router>enable
Password:
Router#
Router#disable
Router>
Router>exit
```

User-Mode Prompt

Privileged-Mode

User-Mode Prompt

Router

Navigating the IOS

- Navigating between IOS Modes

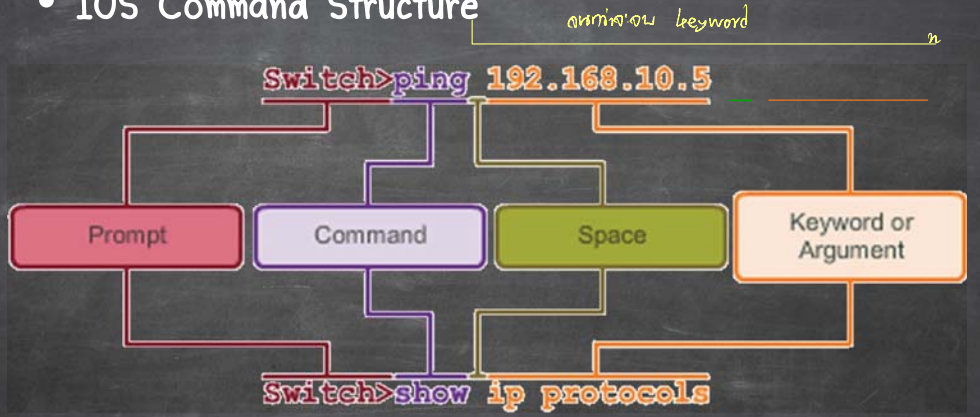
```
Switch>enable
Switch#configure terminal
Enter configuration commands, one per line.
End with CNTL/Z.
Switch(config)#interface vlan 1
Switch(config-if)#exit
Switch(config)#exit
Switch#
```

```
Switch#configure terminal
Enter configuration commands, one per line.
End with CNTL/Z.
Switch(config)#vlan 1
Switch(config-vlan)#end
Switch#
```

```
Switch#configure terminal
Enter configuration commands, one per line.
End with CNTL/Z.
Switch(config)#line vty 0 4
Switch(config-line)#interface fastethernet 0/1
Switch(config-if)#end
Switch#
```

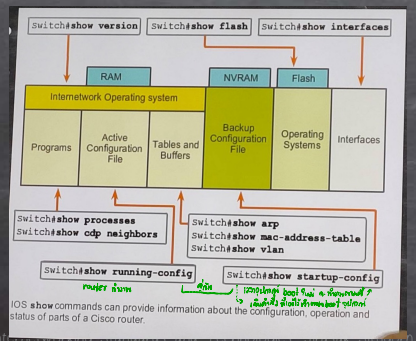

The Command Structure

- IOS Command Structure



The Command Structure

- Context Sensitive Help
- Command Syntax Check พิมพ์ผิด command จะแจ้งผล
- Hot Keys and Shortcuts TAB CTR, C-A, C-Z, ↑, ↓, C-3-6 ออกจากโหมด C-C
- IOS Examination Commands (?)



คำสั่ง show

The Command Structure

- The show version Command

```
Router#show version
Cisco IOS Software, C1900 Software (C1900-UNIVERSALK9-M), Version
15.2(4)M1, RELEASE SOFTWARE (fc1)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2012 by Cisco Systems, Inc.
Compiled Thu 26-Jul-12 19:34 by prod_rel_team

ROM: System Bootstrap, Version 15.0(1r)M15, RELEASE SOFTWARE (fc1)

cisco1941 uptime is 41 minutes
System returned to ROM by power-on
System image file is ""flash0:c1900-universalk9-mz.SPA.152-
4.M1.bin""
Last reload type: Normal Reload
Last reload reason: power-on



This product contains cryptographic features and is subject to
United
States and local country laws governing import, export, transfer
and
use. Delivery of Cisco cryptographic products does not imply
third-party authority to import, export, distribute or use
encryption.
```

Router#show version

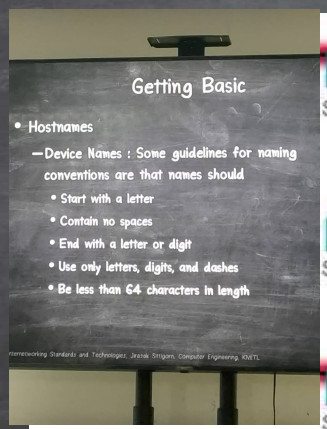
Getting Basic

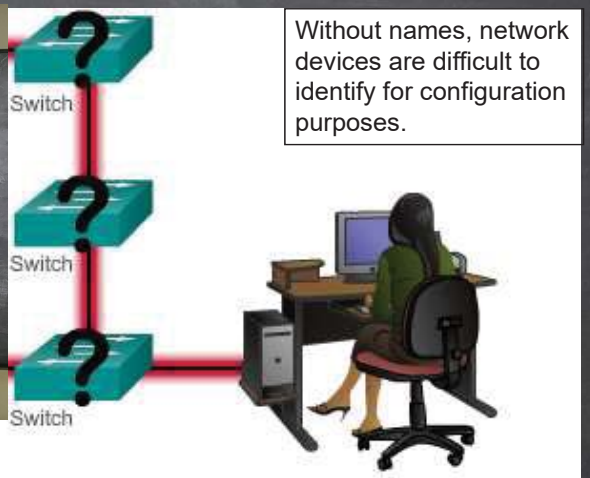
เวลาติดตั้งอุปกรณ์ ตั้งทำดังนี้

1. Hostnames
2. Limiting Access to Device Configurations ตั้ง user / password เพื่อเข้าใช้งาน
3. Addressing Devices ที่อยู่ addr
4. Verifying Connectivity → ที่เช่า config ลูกน้อง, config ถูก เชื่อมต่อกันได้ไหม ← ก็จะมาอยู่ Reboot
5. Saving Configurations

Getting Basic

- Hostnames

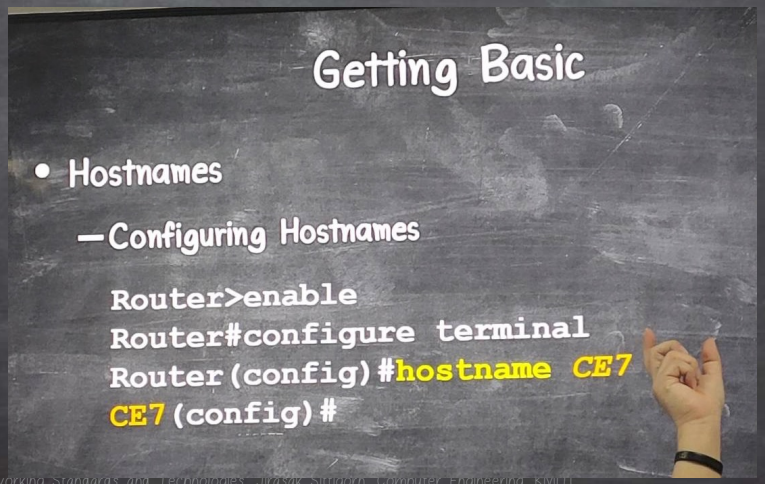




Without names, network devices are difficult to identify for configuration purposes.

Getting Basic

- Hostnames
  - Configuring Hostnames



Getting Basic

- Limiting Access to Device Configurations
  - Banner Messages
  - Securing Device Access
    - Enable password
    - Enable secret
    - Console password → ของ console
    - VTY password ก็คือเวลาทำงาน remote เข้ามา
    - Encrypting Password Display

Getting Basic

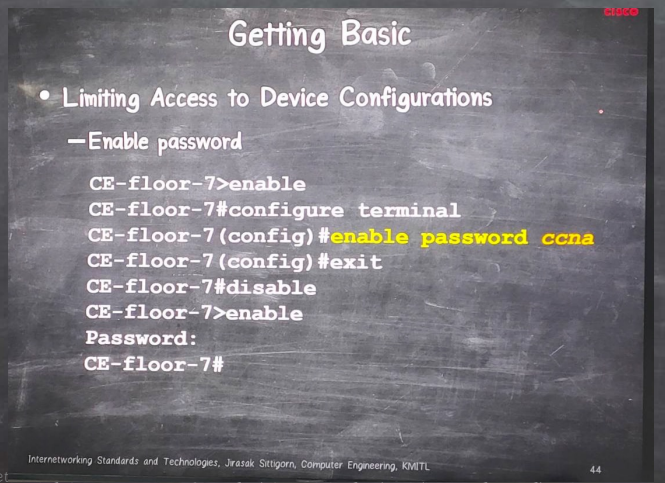
- Limiting Access to Device Configurations
  - Banner Messages
    - important part of the legal process in the event that someone is prosecuted for breaking into a device
    - wording that implies that a login is "welcome" or "invited" is not appropriate
    - often used for legal notification because it is displayed to all connected terminals

ตั้งชื่อ banner เพราะอยู่ mode....

```
CE-floor-7(config)#banner motd # This is a secure system.
Authorized Access ONLY!!! #
CE-floor-7(config)#exit
CE-floor-7#disable
CE-floor-7>exit
```

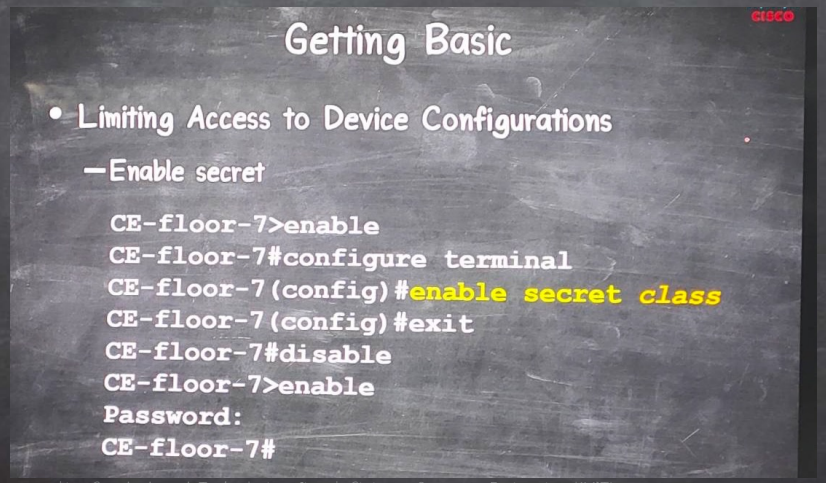

Getting Basic

- Limiting Access to Device Configurations
  - Enable password



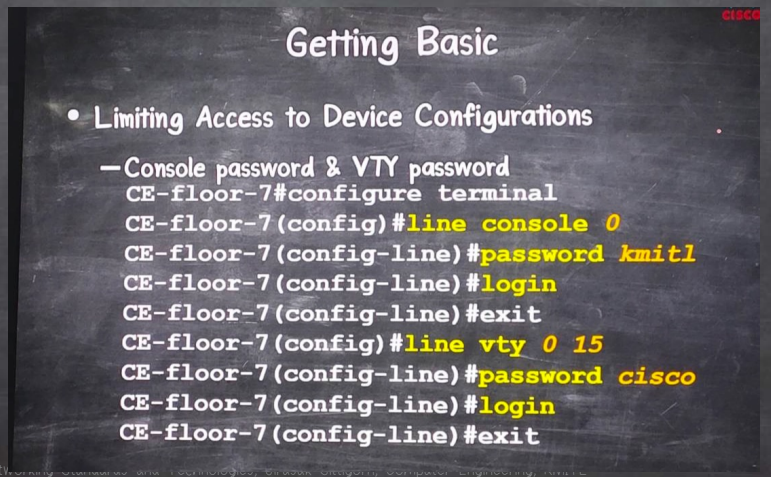
Getting Basic

- Limiting Access to Device Configurations
  - Enable secret



Getting Basic

- Limiting Access to Device Configurations
  - Console password & VTY password



Getting Basic

- Limiting Access to Device Configurations
  - Encrypting Password Display
    - prevents passwords from showing up as plain text when viewing the configuration
    - purpose of this command is to keep unauthorized individuals from viewing passwords in the configuration file
    - once applied, removing the encryption service does not reverse the encryption

ไม่อยากให้เห็น password ใช้คำสั่งนี้

```
CE-floor-7#show running-config
Building configuration...
...
no service password-encryption
!
hostname CE-floor-7!
!
!
!
enable secret 5 $1$mERr$9cTjUIEqNGurQiFU.ZeCi1
enable password ccna
!
!
!
line con 0
 password kmitl
 login
!
line aux 0
!
line vty 0 4
 password cisco
 login
line vty 5 15
 password cisco
 login
!
!
!
end
```

```
CE-floor-7(config)#service password-encryption
CE-floor-7(config)#exit

CE-floor-7#show running-config
Building configuration...
...
service password-encryption
!
hostname CE-floor-7
!
!
!
enable secret 5 $1$mERr$9cTjUIEqNGurQiFU.ZeCi1
enable password 7 08224F4008
!
!
!
line con 0
 password 7 082A41471D15
 login
!
line aux 0
!
line vty 0 4
 password 7 0822455D0A16
 login
line vty 5 15
 password 7 0822455D0A16
 login
!
!
!
end
```

Getting Basic

- Addressing Devices
  - Select an interface to configure
    - Physical interfaces / Loopback interfaces

```
Router(config)#interface type port
Router(config)#interface type slot/port
Router(config)#interface type slot/sublot/port
```

ไม่มี IP คือ mac — ชนิด Interface

    - Switch virtual interfaces (SVIs)

```
Switch(config)#interface vlan number
```

ตัวเลข

เรียก IP ขึ้นมาก่อน

  - Set the IP address of an interface

```
Router(config-if)#ip address ip_address subnet_mask
Router(config-if)#no shutdown
```

→ เหมือนกดเปิดเครื่อง

ปิด Interface เปิดขึ้นมา

#no IP ADD ยกเลิก IP

Getting Basic

- Verifying Connectivity

```
Router#show running-config
Router#show startup-config
Router#show ip route
Router#show interfaces
Router#show ip interface
Router#show ip interface brief
Router#traceroute
Router#ping
PC>ping
PC>tracert
PC>route print
PC>nslookup
```

show ip route ดู routing table

show interface ทั้งหมด

traceroute เส้นทางเดินไหน ปลายทาง here

ping ดูว่าติดต่อกันได้มั้ย

tracert กดอาจต้องมีไฟล์บอกเส้นทาง ปลาย IP ไหนบ้าง (เปิดความปลอดภัยด้วย + เชื่อว่า ไฟล์ในเครื่อง)

route print ใช้ดู routing ใน pc

nslookup ทำเมื่อ request Domain name

Getting Basic

- Saving Configurations

```
Router#copy running-config startup-config
```

IOS Command Line Interface

```
Press RETURN to get started.

This is a secure system. Authorized Access ONLY!!!

User Access Verification

Password:

CE-floor-7>enable
Password:
CE-floor-7#show startup-config
startup-config is not present
CE-floor-7#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
CE-floor-7#
```

IOS Command Line Interface

```
CE-floor-7#show startup-config
startup-config is not present
CE-floor-7#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
CE-floor-7#show startup-config
Using 733 bytes
!
version 12.2
no service timestamps log datetime msec
no service timestamps debug datetime msec
service password-encryption
!
hostname CE-floor-7
!
!
!
enable secret 5 $1$mERr$9cTjUIEqNGurQiFU.ZeCi1
enable password 7 00224F4000
!
!
!
!
!
!
ip cef
no ipv6 cef
!
 --More--
```


Questions and Answers