



Basic Router Configuration

Jirasak Sittigorn

Internetworking Standards & Technologies

Department of Computer Engineering, Faculty of Engineering
King Mongkut's Institute of Technology Ladkrabang

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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

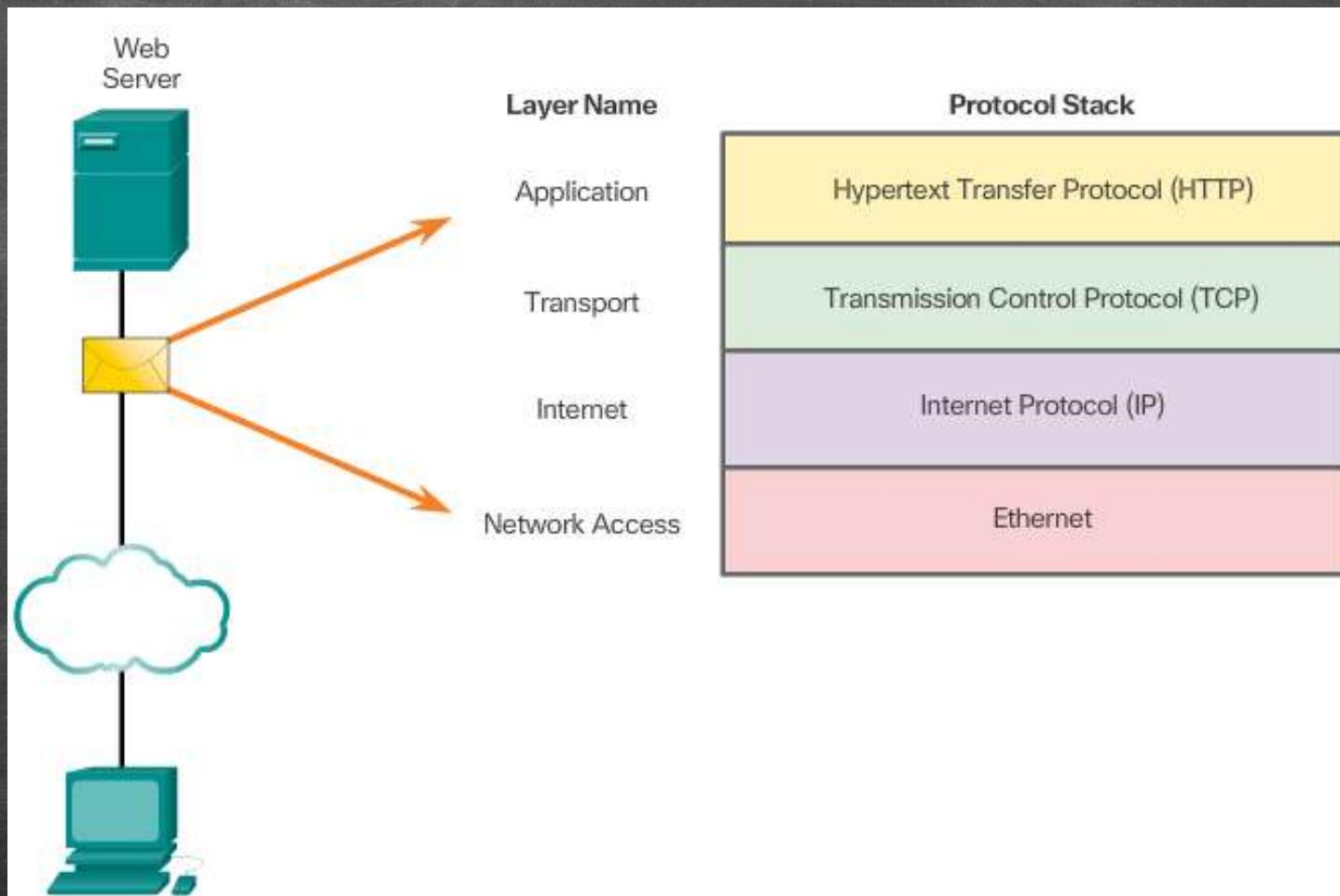
Getting Basic

Network Protocols

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

Protocol Interaction

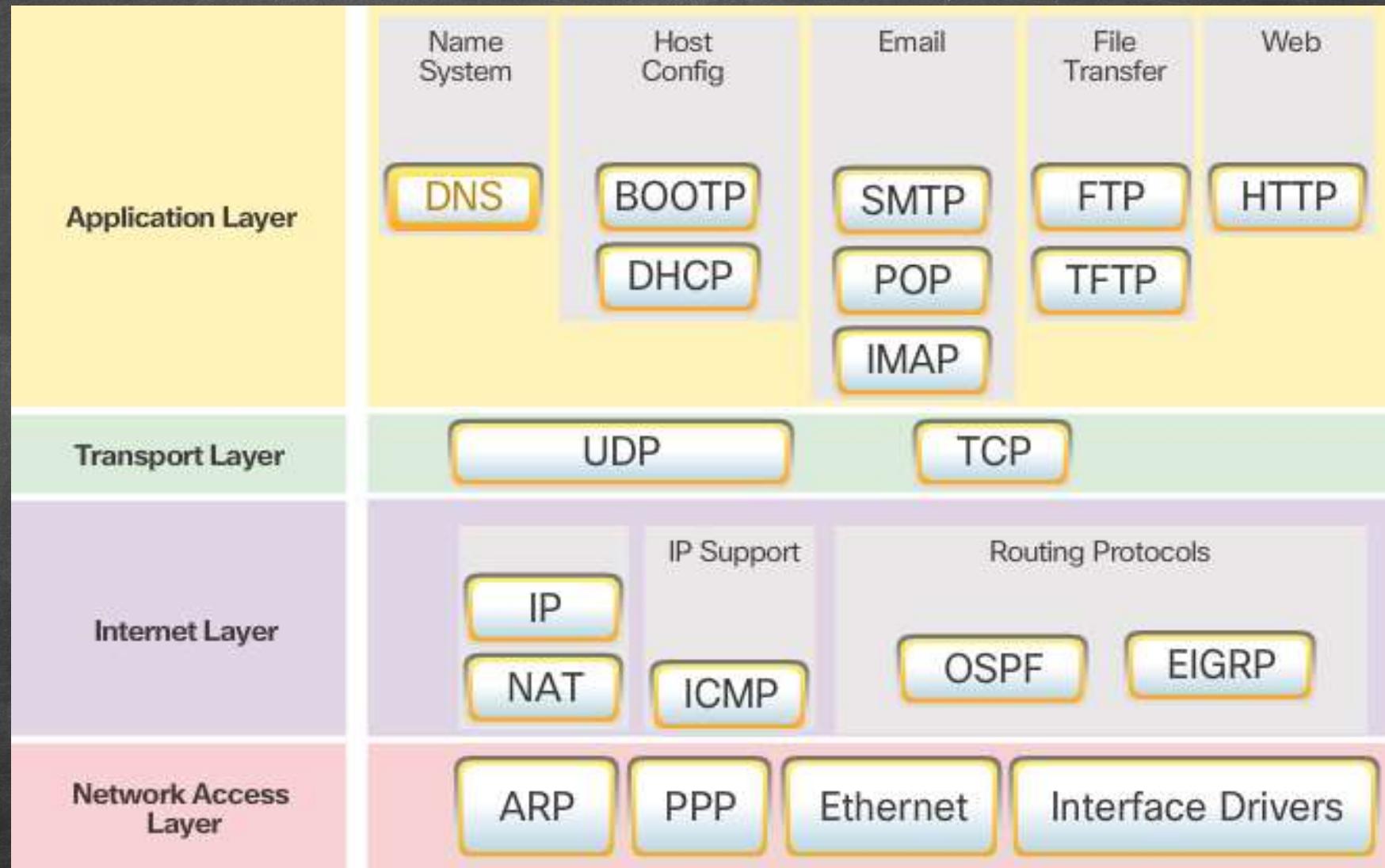
- Interaction of protocols in communication between a web server and web client.



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
 - Randomly generate -> for source port

well known Ports

0	tcp Reserved	51	tcp IMP Logical Address Maintenance	95	tcp MIT ML Device	121	tcp Encore Expedited Remote Pro.Coll.	152	tcp Background File Transfer Program
0	wdp Reserved	52	tcp XNS Time Protocol	96	tcp Micro Focus Cobol	121	wdp Encore Expedited Remote Pro.Coll.	152	wdp Background File Transfer Program
1	tcp TCP Port Service Multiplexer	52	wdp XNS Time Protocol	97	tcp any private terminal link	122	tcp SMAKYNET	153	tcp SCMP
2	tcp Management Utility	53	wdp Domain Name Server	97	wdp any private terminal link	122	wdp SMAKYNET	153	wdp SCMP
3	tcp Compression Process	54	tcp XNS Clearinghouse	98	tcp Kerberos	123	tcp Network Time Protocol	154	tcp NETSC
5	tcp Remote Job Entry	54	wdp XNS Clearinghouse	99	tcp SU MIT Telnet Gateway	123	wdp Network Time Protocol	154	wdp NETSC
7	tcp Echo	55	tcp ISI Graphics Language	100	tcp DNSIX Secure Attribute Token Map	124	tcp ANSA REX Trader	155	tcp NETSC
7	wdp Echo	56	wdp ISI Graphics Language	11	tcp MIT Dover Spooler	124	wdp ANSA REX Trader	155	wdp NETSC
9	tcp Discard	56	tcp XNS Authentication	12	tcp Network Printing Protocol	125	tcp Locus PC-Interface Net Map Ser	156	tcp SQL Service
9	wdp Discard	57	wdp XNS Authentication	12	wdp Network Printing Protocol	126	tcp Unlays Utility Logn	157	tcp KNET VM Command Message
11	tcp Active Users	57	tcp any private terminal access	13	tcp Device Control Protocol	126	wdp Unlays Utility Logn	157	Protocol
11	wdp Active Users	57	wdp any private terminal access	13	wdp Device Control Protocol	127	tcp Locus PC-Interface Comm Server	158	top PCMail Server
13	tcp Daytime	58	tcp XNS Mail	14	tcp Tivoli Object Dispatcher	128	tcp GSS X License Verification	159	top NSS-Routing
13	wdp Daytime	58	wdp XNS Mail	14	wdp Tivoli Object Dispatcher	129	wdp GSS X License Verification	159	wdp SCMP-TRAPS
17	tcp Quote of the Day	59	tcp any private file service	15	tcp SUPDUP	129	tcp Password Generator Protocol	160	wdp SCMP-TRAPS
17	wdp Quote of the Day	59	wdp any private file service	15	wdp SUPDUP	129	wdp Password Generator Protocol	160	wdp SNMP
18	tcp RWP write	60	tcp Unassigned	16	tcp DIXIE Protocol Specification	130	tcp disco FMATIVE	161	wdp SNMP-TRAP
18	wdp RWP write	60	wdp Unassigned	17	tcp Swift Remote Virtual File Protocol	130	wdp disco FMATIVE	162	tcp CMIP TCP Manager
19	tcp Message Send Protocol	61	tcp KI MAIL	17	wdp Swift Remote Virtual File Protocol	131	tcp disco TMATIVE	163	wdp CMIP TCP Manager
19	wdp Message Send Protocol	61	wdp KI MAIL	18	tcp TAC News	131	wdp disco TMATIVE	163	tcp CMIP TCP Agent
11	tcp Character Generator	62	tcp ACA Services	19	wdp TAC News	132	tcp disco SYSMAINT	164	wdp CMIP TCP Agent
11	wdp Character Generator	64	tcp Communications Integrator (CI)	20	tcp Metagram Relay	132	wdp disco SYSMAINT	164	tcp Xerox
20	tcp File Transfer [Default Data]	65	tcp TACACS-Database Service	21	wdp Metagram Relay	133	tcp Statistics Service	165	wdp Xerox
21	tcp File Transfer [Control]	66	tcp Oracle SQL-NET	100	[unauthorized use]	133	wdp Statistics Service	165	top Status Systems
22	tcp Telnet	67	tcp Bootstrap Protocol Server	101	tcp KIC Host Name Server	134	tcp INGRES-NET Service	166	wdp Status Systems
24	tcp any private telnet system	68	wdp Bootstrap Protocol Client	101	wdp KIC Host Name Server	135	tcp Location Service	167	top KAMP
24	wdp any private telnet system	69	tcp Trivial File Transfer	102	tcp ISO-TSAP Class 0	136	tcp PROFILE Naming System	167	wdp KAMP
25	tcp Simple Mail Transfer	70	tcp Copher	102	wdp ISO-TSAP Class 0	137	tcp NETBIOS Name Service	168	top RSVD
27	tcp NSW User System FE	71	tcp Remote Job Service	103	tcp Generic Point-to-Point Trans Net	137	wdp NETBIOS Name Service	168	wdp RSVD 161 wdp SEND
27	wdp NSW User System FE	71	wdp Remote Job Service	103	wdp Generic Point-to-Point Trans Net	137	tcp NETBIOS Datagram Service	169	tcp Network PostScript
29	tcp MSG ICP	72	tcp Remote Job Service	104	tcp ACR-NEMA Digital Imag. & Comm.	138	wdp NETBIOS Datagram Service	169	wdp Network PostScript
29	wdp MSG ICP	72	wdp Remote Job Service	300	tcp Mailbox Name NameServer	139	tcp NETBIOS Session Service	170	top Network Innovations Multiplex
31	tcp MSG Authentication	73	tcp Remote Job Service	105	wdp Mailbox Name NameServer	139	wdp NETBIOS Session Service	171	wdp Network Innovations Multiplex
31	wdp MSG Authentication	73	wdp Remote Job Service	105	tcp 3COM-TSMUX	140	tcp EMFIS Data Service	172	top Network Innovations CL 1
33	tcp Display Support Protocol	73	tcp Remote Job Service	106	wdp 3COM-TSMUX	140	wdp EMFIS Data Service	172	wdp Network Innovations CL 1
33	wdp Display Support Protocol	74	wdp Remote Job Service	106	tcp Password Server	141	tcp EMFIS Control Service	173	tcp Xplex
35	tcp any private printer server	74	tcp Remote Job Service	107	tcp Remote Telnet Service	141	wdp EMFIS Control Service	173	wdp Xplex
35	wdp any private printer server	74	wdp Remote Job Service	108	tcp SMA Gateway Access Server	142	tcp Britton-Lee IDM	174	tcp MAIL.Q
37	tcp Tels	75	tcp any private dial out service	109	tcp Post Office Protocol - Version 2	142	wdp Britton-Lee IDM	174	wdp MAIL.Q
37	wdp Tels	75	wdp any private dial out service	110	tcp Post Office Protocol - Version 3	143	tcp Interactive Mail Access Protocol	175	tcp VMNET
38	tcp Route Access Protocol	76	tcp Distributed External Object Store	111	tcp SUN Remote Procedure Call	v2	tcp VMNET	175	wdp VMNET
38	wdp Route Access Protocol	76	wdp Distributed External Object Store	111	wdp SUN Remote Procedure Call	144	tcp News	176	tcp GENRAD-MUX
39	wdp Resource Location Protocol	77	tcp any private RJE service	112	tcp McIDAS Data Transmission Protocol	144	wdp News	176	wdp GENRAD-MUX
41	tcp Graphics	77	wdp any private RJE service	113	tcp Authentication Service	145	tcp UAC Protocol	177	wdp X Display Manager Control
41	wdp Graphics	78	tcp vettcp	114	tcp Audio News Multicast	145	wdp UAC Protocol	177	Protocol
42	wdp Host Name Server	78	wdp vettcp	114	wdp Audio News Multicast	146	tcp ISO-IP0	178	top Novell Window Server
43	tcp Who Is	79	tcp Finger	115	tcp Simple File Transfer Protocol	146	wdp ISO-IP0	178	wdp Novell Window Server
44	tcp MPM FLAGS Protocol	80	tcp World Wide Web HTTP	115	wdp Simple File Transfer Protocol	147	tcp ISO-IP	179	top Border Gateway Protocol
45	tcp Message Processing Module [recv]	80	wdp World Wide Web HTTP	116	tcp ANSA REX Notify	147	wdp ISO-IP	179	top Intergraph
46	tcp MPM [default send]	91	tcp HOSTS2 Name Server	116	wdp ANSA REX Notify	148	tcp CRONUS-SUPPORT	180	wdp Intergraph
47	tcp KI FTP	91	wdp HOSTS2 Name Server	117	tcp UUCP Path Service	148	wdp CRONUS-SUPPORT	180	
47	wdp KI FTP	92	tcp XFER Utility	118	tcp SQL Services	149	tcp AED 512 Emulation Service	181	
48	tcp Digital Audit Daemon	92	wdp XFER Utility	118	wdp SQL Services	149	wdp AED 512 Emulation Service	181	
48	wdp Digital Audit Daemon	93	tcp MIT ML Device	119	tcp Network News Transfer Protocol	150	tcp SQL-NET	182	
49	tcp Login Host Protocol	93	wdp MIT ML Device	120	wdp CFDP/TKT	150	wdp SQL-NET	182	
50	tcp Remote Mail Checking Protocol	94	tcp Common Trace Facility	120	wdp CFDP/TKT	151	tcp HEIMS	182	
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CISCO

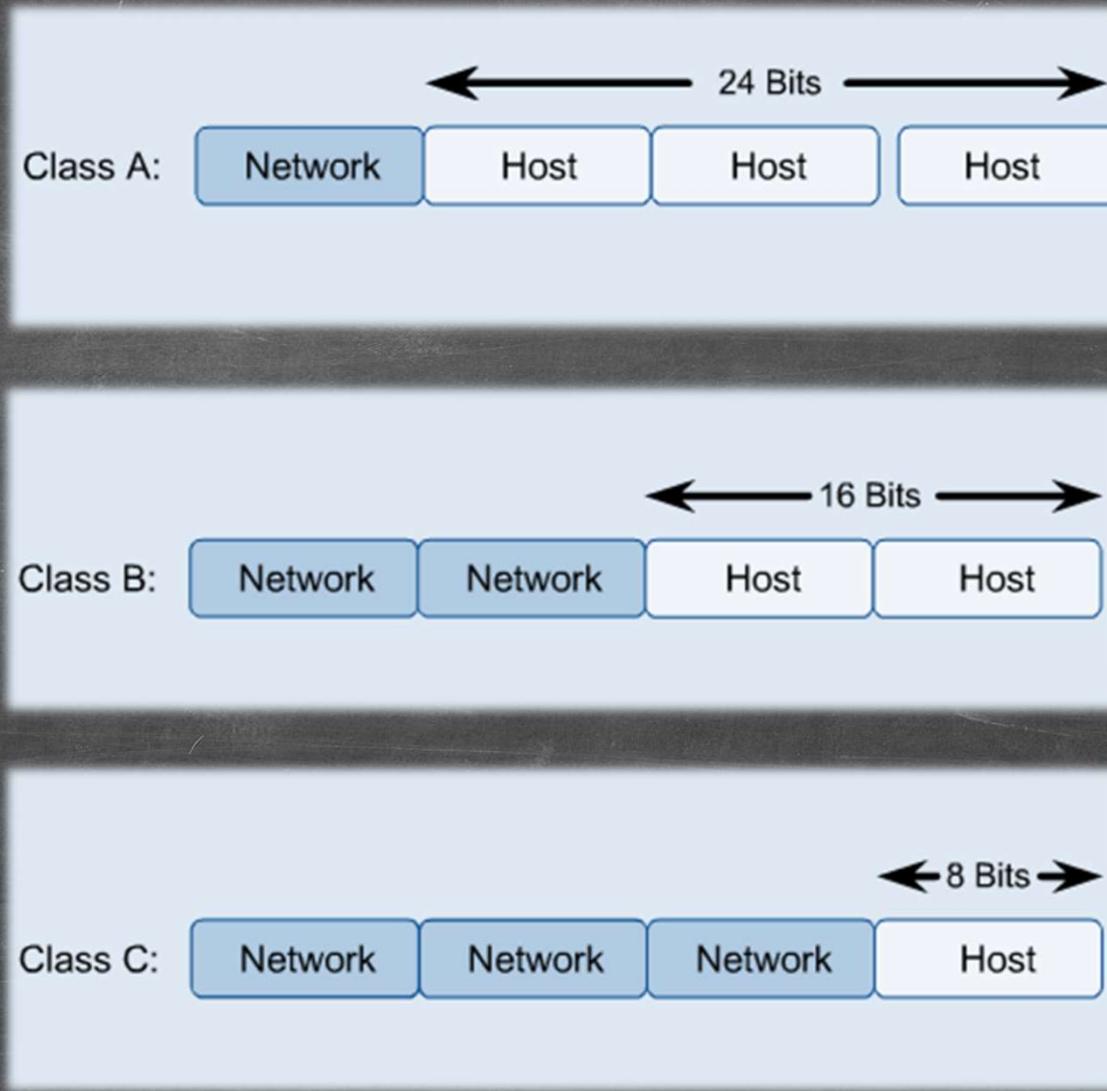
101	tcp Unify	206	tcp AppleTalk Unused	Proto	402	tcp Genie Protocol	433
101	udp Unify	207	tcp Trivial Authenticated Mail Protocol	377	402	udp Genie Protocol	434
102	tcp Unlays Audit SITP	207	tcp Trivial Authenticated Mail Protocol	377	403	tcp decap	435
102	udp Unlays Audit SITP	210	tcp ANSI Z39.50	378	403	udp decap	436
103	tcp OCBinder	210	tcp ANSI Z39.50	378	404	tcp nacd	436
103	udp OCBinder	211	tcp Texas Instruments 914C G Terminal	379	404	udp nacd	437
104	tcp OCServer	211	tcp Texas Instruments 914C G Terminal	379	405	tcp nacd	437
104	udp OCServer	212	udp ATEXSSIR	380	405	udp nacd	438
105	tcp Remote-KIS	213	tcp IPX	380	406	tcp Interactive Mail Support Protocol	439
105	udp Remote-KIS 196	213	udp IPX	381	406	udp Interactive Mail Support Protocol	439
Protocol	tcp KIS Protocol	214	tcp VM PWSCS	381	407	tcp Thubaku	439
107	tcp Application Communication	214	udp VM PWSCS	382	408	tcp Prospero Resource Manager Sys.	440
Interface	tcp Application Communication	215	tcp Indigo Solutions	382	409	tcp Prospero Resource Manager Node	441
107	udp Application Communication	215	udp Indigo Solutions	383	410	udp DECLdring Remote Debug	442
Interface	tcp Application Communication	216	tcp Access Technology License Server	383	411	tcp Remote NT Protocol	443
108	tcp File Five's MUMPS	217	tcp dBASE Unix	384	411	udp Remote NT Protocol	444
108	udp File Five's MUMPS	217	udp dBASE Unix	384	412	tcp Trap Convention Port	445
109	tcp Queued File Transport	218	tcp Netik Message Posting Protocol	385	412	udp Trap Convention Port	446
110	tcp Gateway Access Control Protocol	218	udp Netik Message Posting Protocol	385	413	tcp SNSP	446
110	udp Gateway Access Control Protocol	219	tcp Unlays ARPs	386	413	udp SNSP	447
111	tcp Prospero Directory Service	219	udp Unlays ARPs	386	414	tcp InfoSeek	447
112	tcp OSU Network Monitoring System	220	tcp Interactive Mail Access Protocol	386	414	udp InfoSeek	448
112	udp OSU Network Monitoring System	v3	tcp Berkley rlogind with SPX auth	387	415	tcp BNet	448
113	tcp Spider Remote Monitoring Protocol	221	udp Berkley rlogind with SPX auth	387	415	udp BNet	449
113	udp Spider Remote Monitoring	221	tcp Berkley rlogind with SPX auth	387	416	tcp Silverplatter	449
Protocol	tcp Internet Relay Chat Protocol	222	tcp Berkley rlogind with SPX auth	387	416	udp Silverplatter	450
114	tcp DNSIX Network Level Module	222	tcp Certificate Distribution Center	388	417	tcp Ormax	
115	tcp DNSIX Session Mgt Module Audit	223	tcp Certificate Distribution Center	388	417	udp Ormax	
Audit	tcp DNSIX Session Mgt Module Audit	243	tcp Survey Measurement	389	418	tcp Hyper-G	
Radio	tcp DNSIX Session Mgt Module Audit	243	tcp Survey Measurement	389	419	tcp AriaI	
117	tcp Directory Location Service	245	tcp LINK	390	420	udp SMPIE	
117	udp Directory Location Service	245	tcp Display Systems Protocol 3270	390	421	tcp AriaI	
118	tcp Directory Location Service Monitor	246	udp Display Systems Protocol 3270	391	422	tcp AriaI	
118	udp Directory Location Service	246	tcp Prospero Data Access Protocol	391	423	tcp IBM Operations Planning and	
Monitor	tcp SMUX	344	tcp Perf Analysis Workbench	392	423	Control Start	
119	udp SMUX	345	udp Perf Analysis Workbench	392	424	tcp IBM Operations Planning and	
200	tcp IBM System Resource Controller	346	tcp Zebra server	393	424	Control Track	
200	udp IBM System Resource Controller	347	tcp Fehren Server	393	425	tcp ICAD	
201	tcp AppleTalk Routing Maintenance	348	tcp Cabletron Management Protocol	394	426	tcp snortdip	
201	udp AppleTalk Routing Maintenance	348	udp Cabletron Management Protocol	394	426	udp snortdip	
202	tcp AppleTalk Name Binding	371	tcp Clearcase	395	427	tcp Server Location	
202	udp AppleTalk Name Binding	371	udp Clearcase	395	427	udp Server Location	
203	tcp AppleTalk Unused	372	tcp Unix Listerv	396	428	tcp OCS_CMU	
203	udp AppleTalk Unused	372	udp Unix Listerv	396	428	udp OCS_CMU	
204	tcp AppleTalk Echo	373	tcp Legent Corporation	397	429	tcp OCS_AMU	
204	udp AppleTalk Echo	373	udp Legent Corporation	397	429	udp OCS_AMU	
205	tcp AppleTalk Unused	374	tcp Legent Corporation	398	430	tcp UTMPSD	
205	udp AppleTalk Unused	374	udp Legent Corporation	398	430	udp UTMPSD	
206	tcp AppleTalk Zone Information	375	tcp Hesiod	399	431	tcp UTMPCD	
206	udp AppleTalk Zone Information	375	tcp Hesiod	399	431	udp UTMPCD	
207	tcp AppleTalk Unused	376	tcp Avigna Envoy Network Inquiry	400	432	tcp IASD	
207	udp AppleTalk Unused	376	tcp Workstation Solutions	400	432	udp IASD	
208	tcp AppleTalk Unused	376	tcp Workstation Solutions	401	433	tcp KNSP	
	Proto	376	tcp Avigna Envoy Network Inquiry	401	433	udp KNSP	

451	top Cray Network Semaphore server	544	top krend-kshell	Server	Client	773	top submit
451	udp Cray Network Semaphore server	544	udp krend-kshell	730	tcp IBM NetView DM 6000	773	udp notify
452	top Cray SFS config server	545	top applepcavr	send	tcp	774	top rpassword
452	udp Cray SFS config server	545	udp applepcavr	730	udp IBM NetView DM 6000	774	udp account_dbd
453	top CreativeServer	550	top nov-who	send	tcp	775	top extorb
453	udp CreativeServer	550	udp nov-who	545	udp	775	udp account_tramed
454	top ContentServer	555	top def	731	tcp IBM NetView DM 6000	776	top wpages
454	udp ContentServer	555	udp def	receive	tcp	776	udp wpages
455	top CreativePartner	556	top rfc server	731	udp IBM NetView DM 6000	776	top wpages
455	udp CreativePartner	556	udp rfc server	receive	tcp	780	top wpages
456	top nacos-top	557	top openvms-syspc	741	top netGW	780	udp wpages
456	udp nacos-udp	557	udp openvms-syspc	741	udp netGW	786	top Concert
457	top scalpel	558	top SDNSKMP	742	top Network based Rev. Cont. Sys.	786	udp Concert
458	top apple quick this	558	udp SDNSKMP	742	udp Network based Rev. Cont. Sys.	900	top valve_dammon
459	top apple quick this	559	top TEEDTAP	744	top Flexible License Manager	900	udp valve_dammon
459	udp apple quick this	559	udp TEEDTAP	744	udp Flexible License Manager	901	top device
460	top strok	560	top recordford	747	top Fujitsu Device Control	901	udp device
460	udp strok	560	udp recordford	747	udp Fujitsu Device Control	906	top AccessBuilder
512	top remote process execution	560	udp recordford 561	748	top Russell Info Sci Calendar	906	udp AccessBuilder
512	udp used by mail system to notify	562	top chroot-chshell	Manager	Manager	916	top Central Point Software-xtrinsic
users		562	udp chroot-chshell	749	udp Russell Info Sci Calendar	916	udp Central Point Software-xtrinsic
513	top remote login a la telnet;	564	top plan 9 file service	749	top kerberos administration	917	top waitrd
513	udp maintains data bases showing	564	udp plan 9 file service	750	top rfile	917	udp waitrd
who's		565	top whoami	750	udp loadav	918	top busboy
514	top like exec, but automatic	565	udp whoami	751	top pump	918	udp paperp
514	udp cydog	570	top demon-meter	751	udp pump 752	919	top garcon
515	top spooler	570	udp demon-meter	753	top rip	919	udp Appliance
517	top talk	571	top ulemon-meter	753	udp rip	919	top paprouter
518	top walk	571	udp ulemon-meter	754	top tail-send	1000	top codlock
519	top uniclife	600	top Sun IPC server	754	udp tail-send	1000	udp codlock
519	udp uniclife	600	udp Sun IPC server	758	top nlogin		
520	top extended file name server	607	top rps	758	udp nlogin		
520	udp local routing process (on site)	607	udp rps	759	top con		
525	top theserver	608	top Cray Unified Resource Manager	760	top rs		
525	udp theserver	608	udp Cray Unified Resource Manager	761	top rrs		
526	top novdate	608	top Sender-Initiated Unsolicited File Transfer	761	udp rrs		
526	udp novdate	609	top quoted	762	top quoted		
530	top rpc	609	udp quoted-trap	762	udp quoted		
530	udp rpc	610	top quoted-local	763	top cyclesserv		
531	top chat	610	udp quoted-local	763	udp cyclesserv		
531	udp chat	611	top rproxy-grid	764	top ovarsv		
532	top readnews	611	udp rproxy-grid	764	udp ovarsv		
532	udp readnews	634	top gload	765	top webster		
533	top for emergency broadcasts	634	udp gload	765	udp webster		
533	udp for emergency broadcasts	634	top phonebook	767	top phonebook		
534	top Aperus Technologies Load Determination	636	top rdp	767	udp phonebook		
534	udp Aperus Technologies Load Determination	636	udp rdp	769	top vid		
540	top uscp	636	top doon Id Software	769	udp vid		
541	top uscp-login	704	top entlog copy server daemon	770	top codlock		
541	udp uscp-login	704	udp entlog copy server daemon	770	udp codlock		
543	top klogn	701	top EntrustManager	771	top rip		
543	udp klogn	721	top IBM NetView DM 6000	771	udp rip		
543	top Client	721	tcp IBM NetView DM 6000	772	top cyclesserv2		
		721	udp IBM NetView DM 6000	772	udp cyclesserv2		

Logical Addresses : IP address (IPv4)

- IP Classes:
 - class A, B, C
- 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-Order Bits	First Octet Address Range	Number of Bits in the Network 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)		

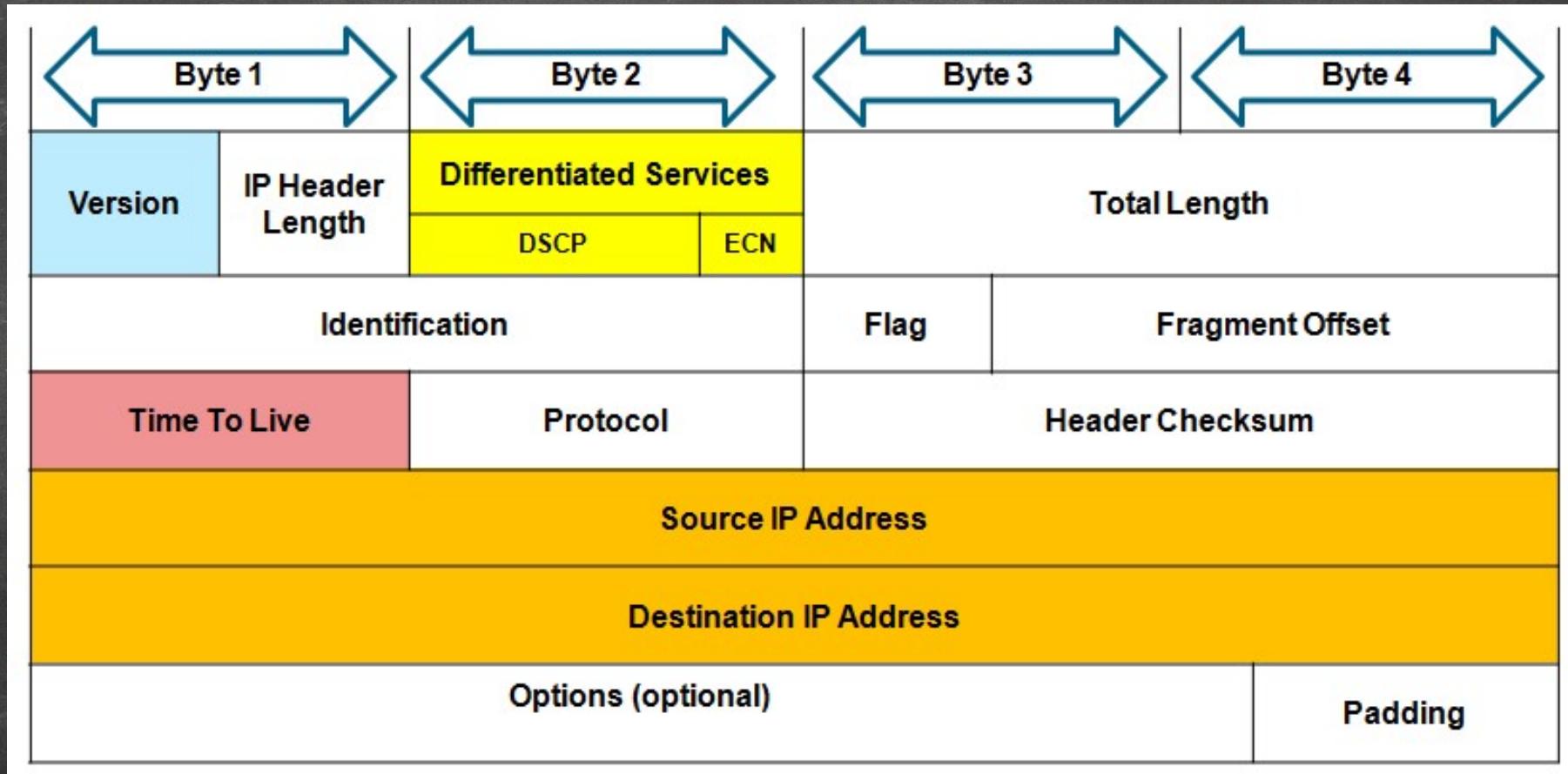
** All zeros (0) and all ones (1) are invalid hosts addresses.

Logical Addresses : IP address (IPv4)

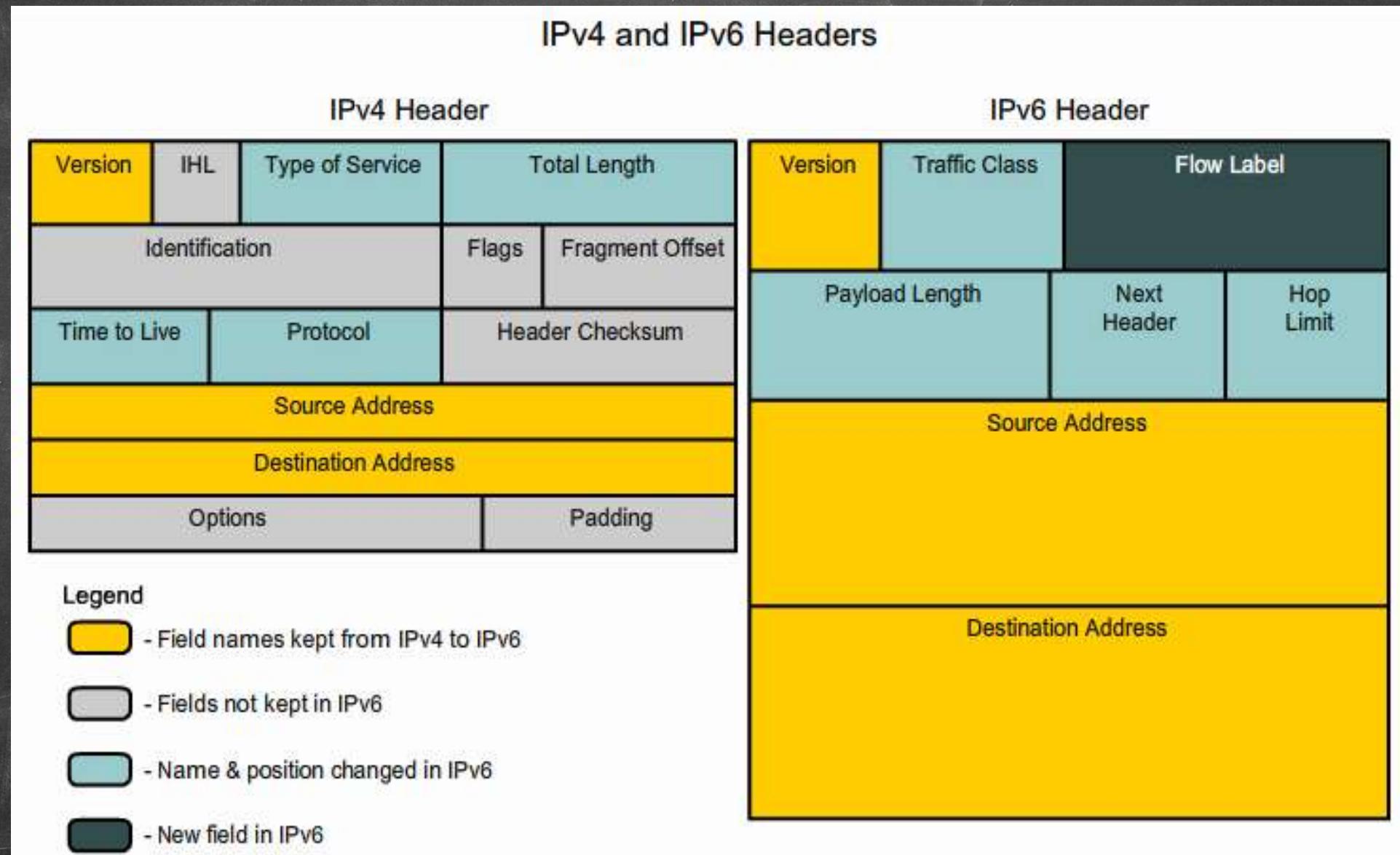
- Private addressing

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



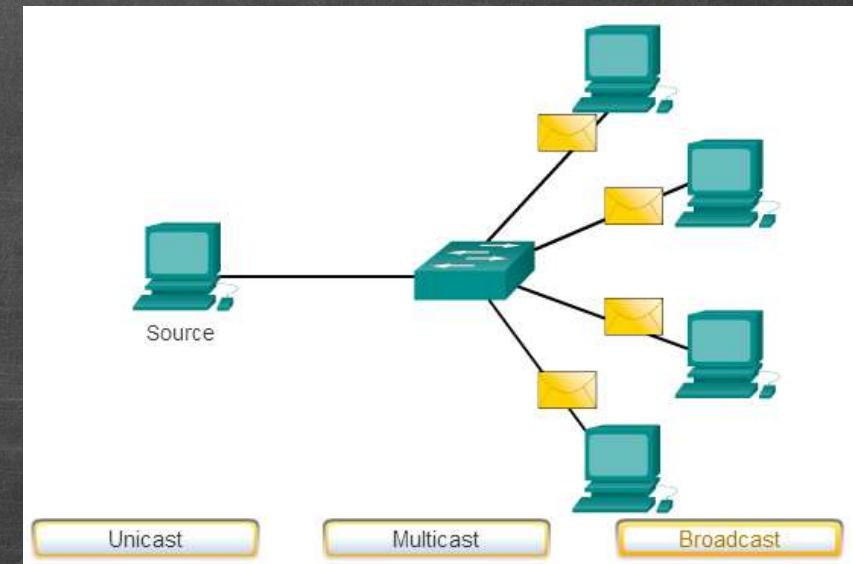
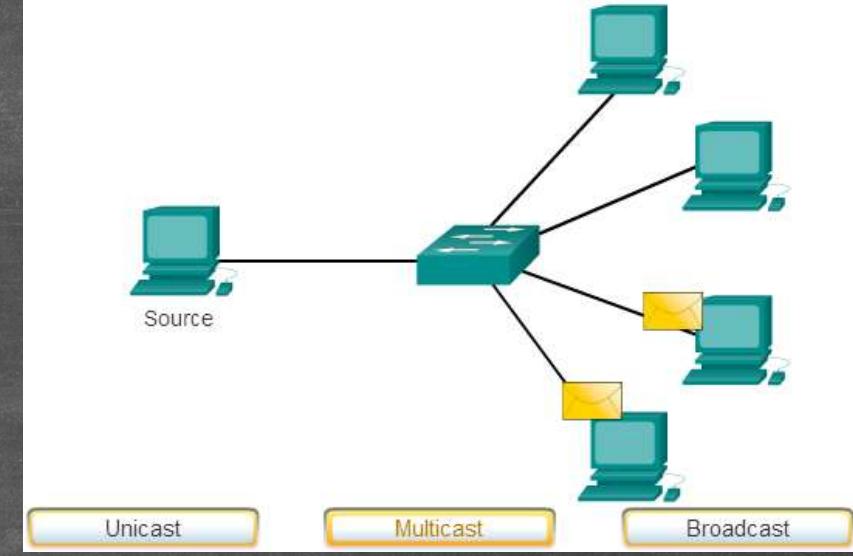
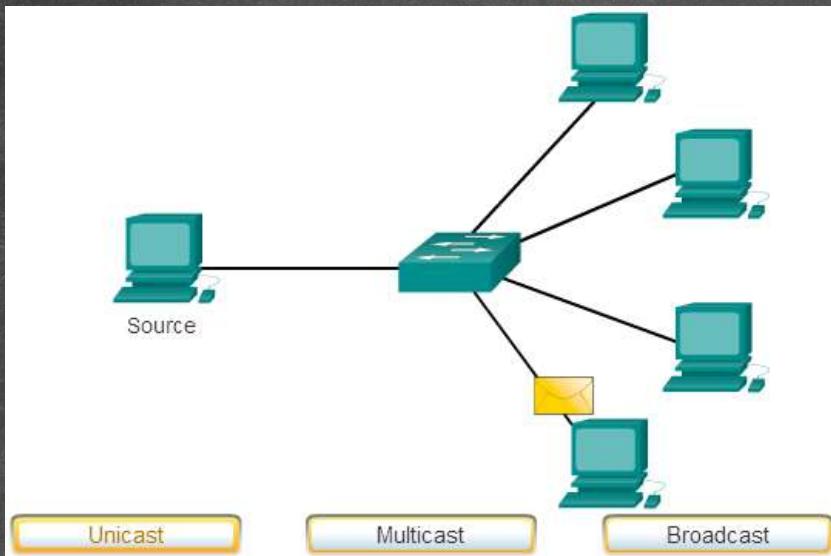
Physical Addresses : MAC Address

- 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

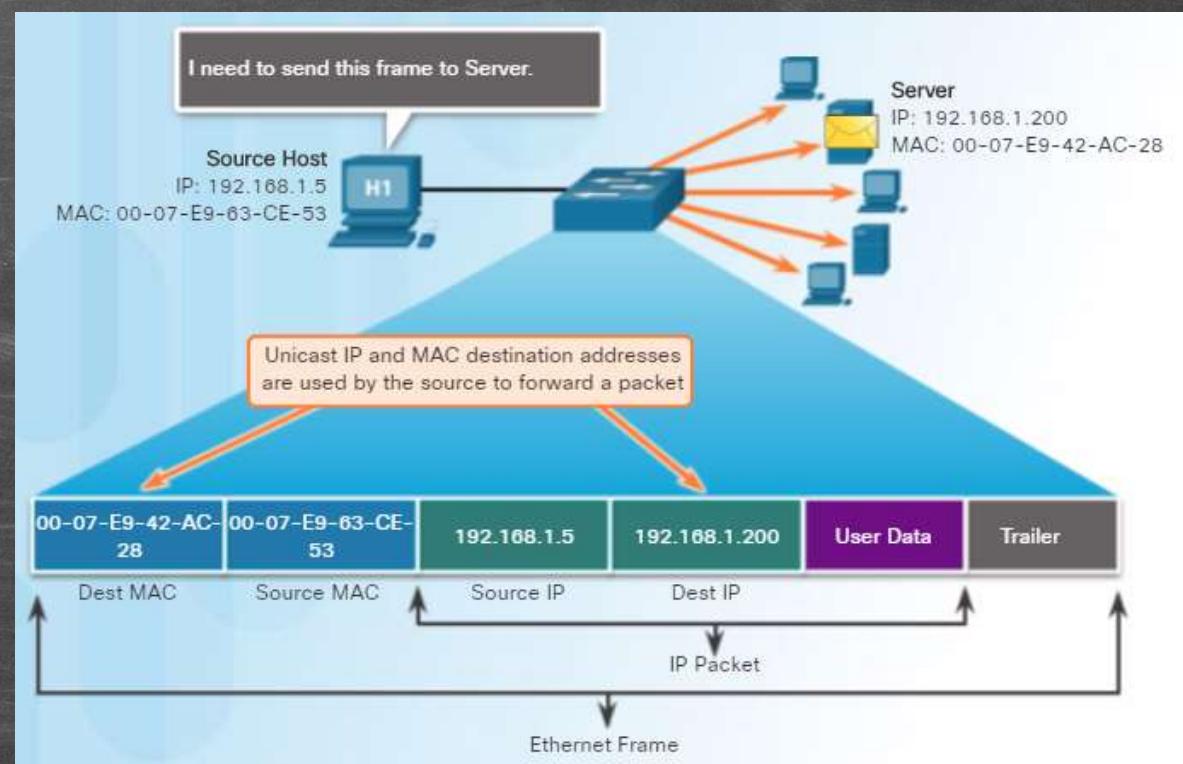
- MAC addresses were created to identify the actual source and destination.
 - The MAC address rules are established by IEEE.
 - The IEEE assigns the vendor a 3-byte (24-bit) code, called the Organizationally Unique Identifier (OUI).
- IEEE requires a vendor to follow two simple rules:
 - All MAC addresses 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



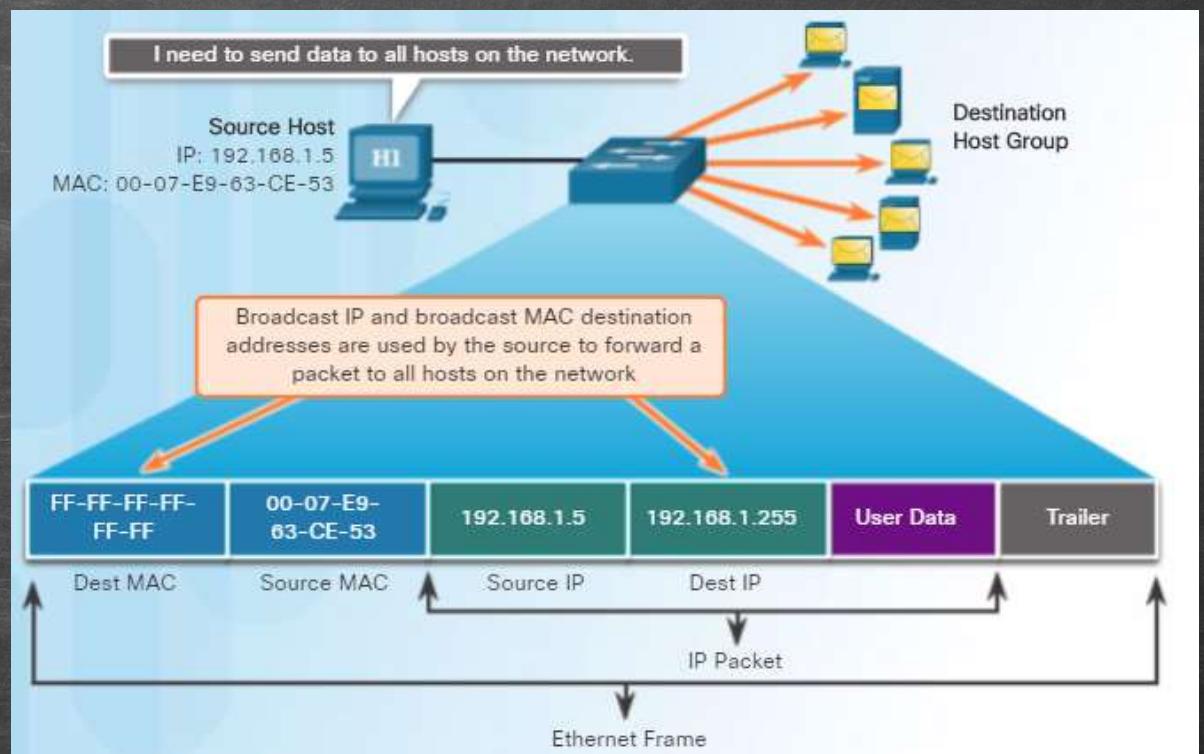
Unicast MAC Address

- 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.



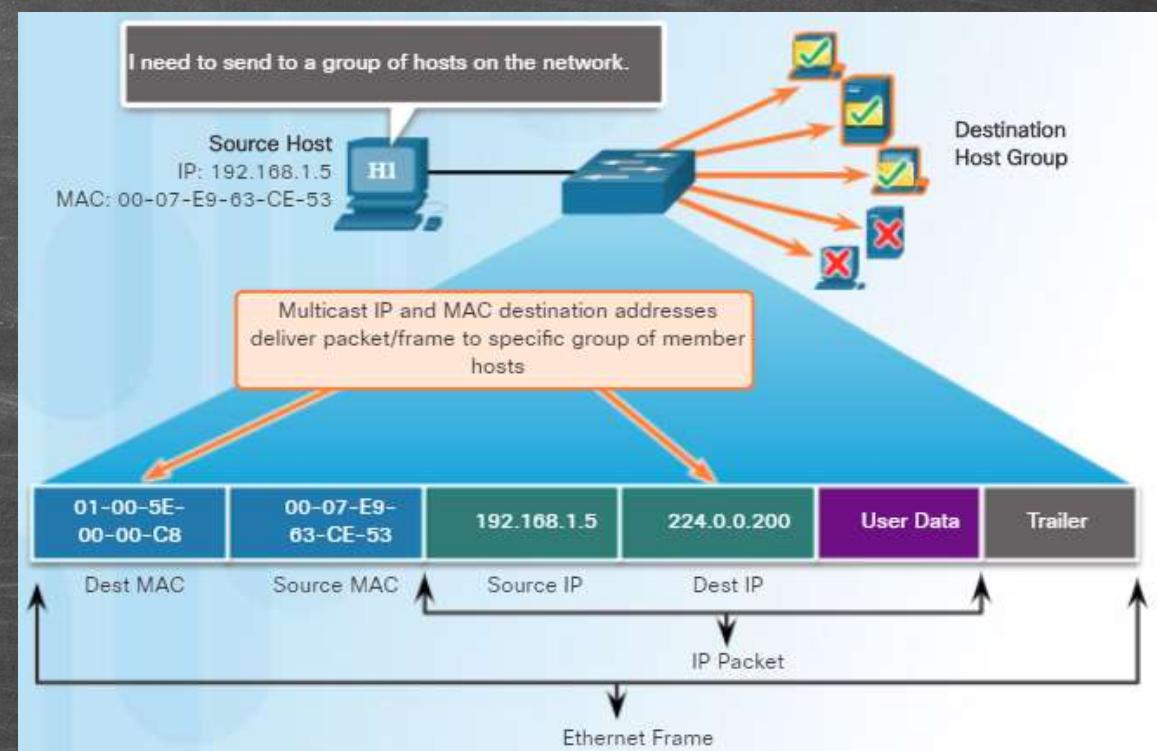
Broadcast MAC Address

- 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.

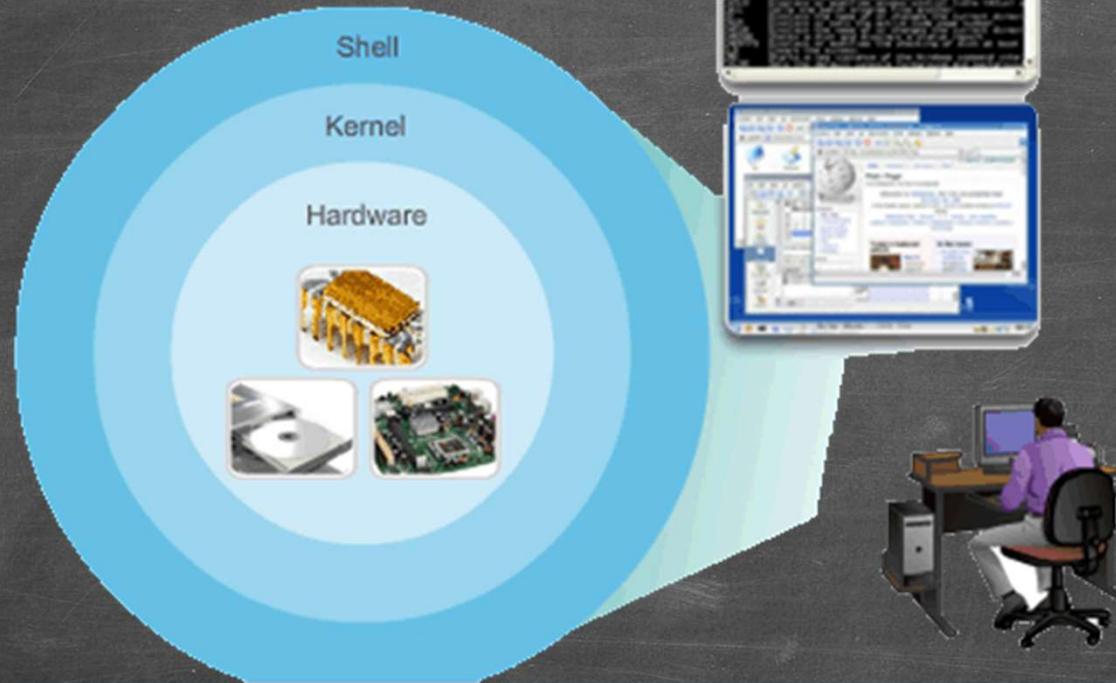


MAC Address Representations

- 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.

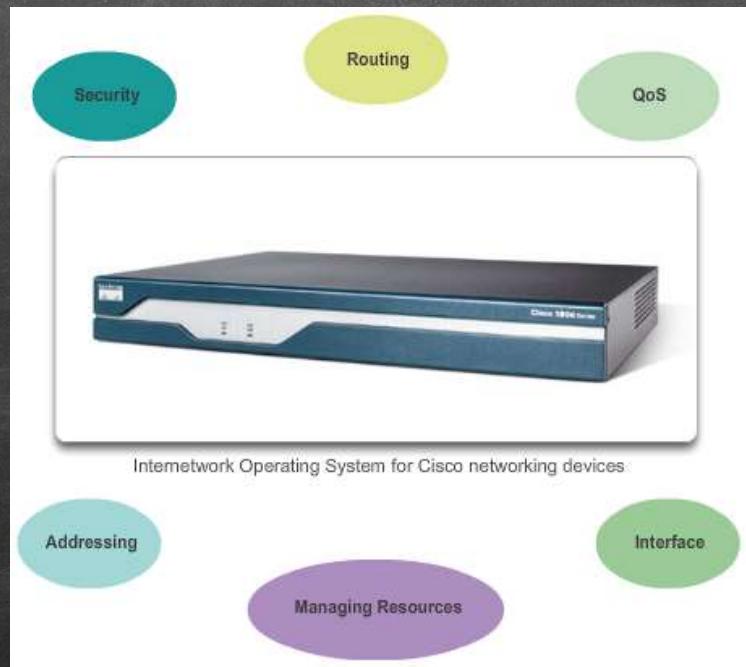
Hardware: The physical part of a computer including underlying electronics.

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.

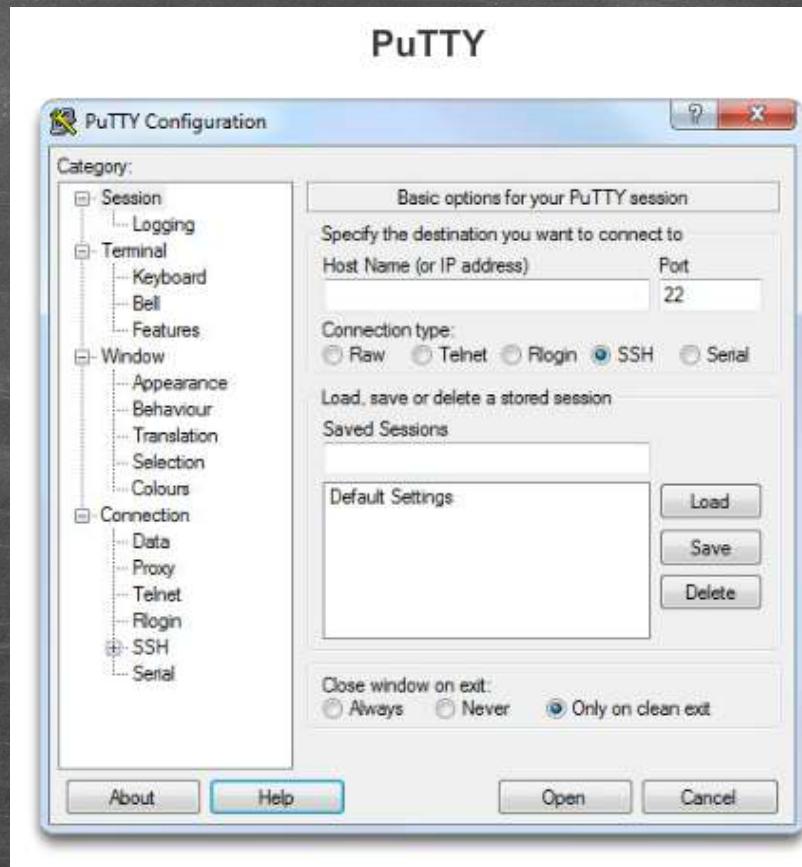
Accessing a Cisco IOS Device

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



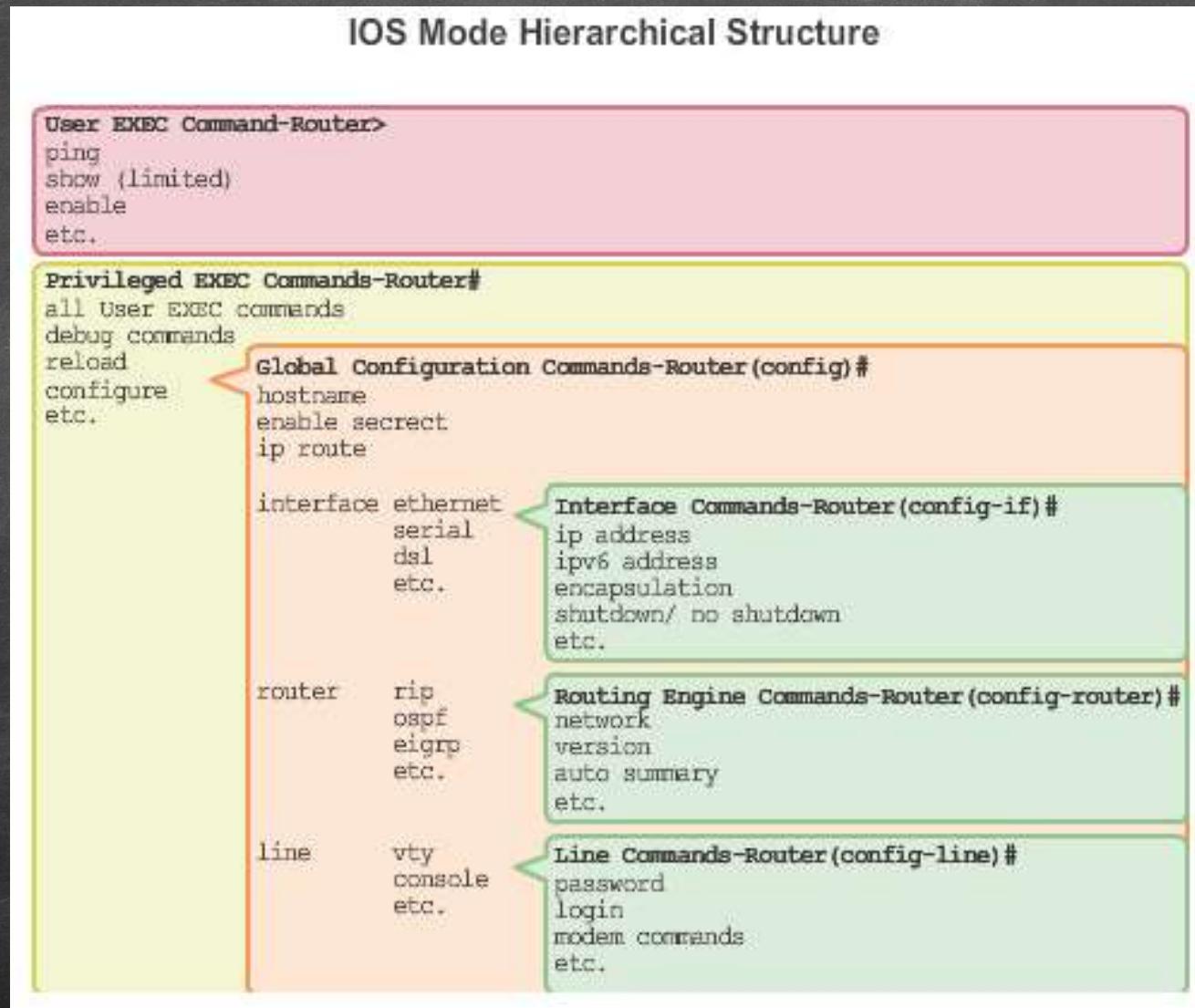
Accessing a Cisco IOS Device

- 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.



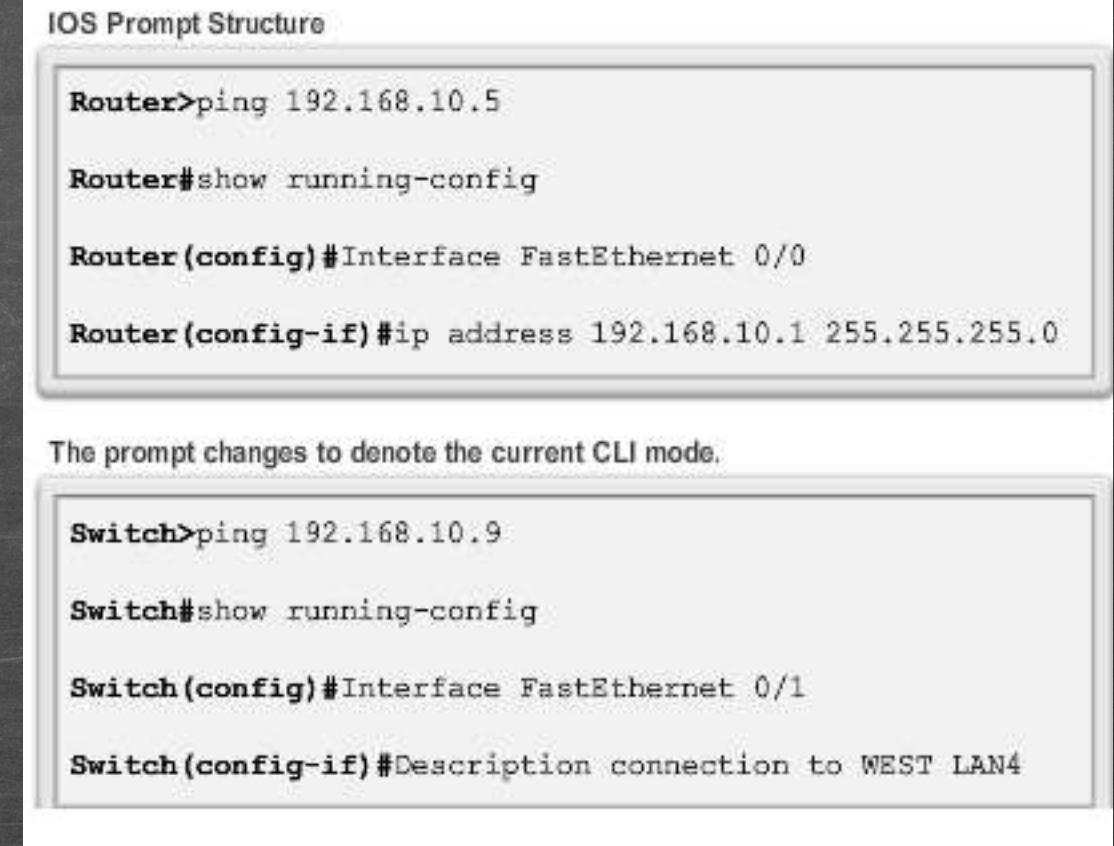
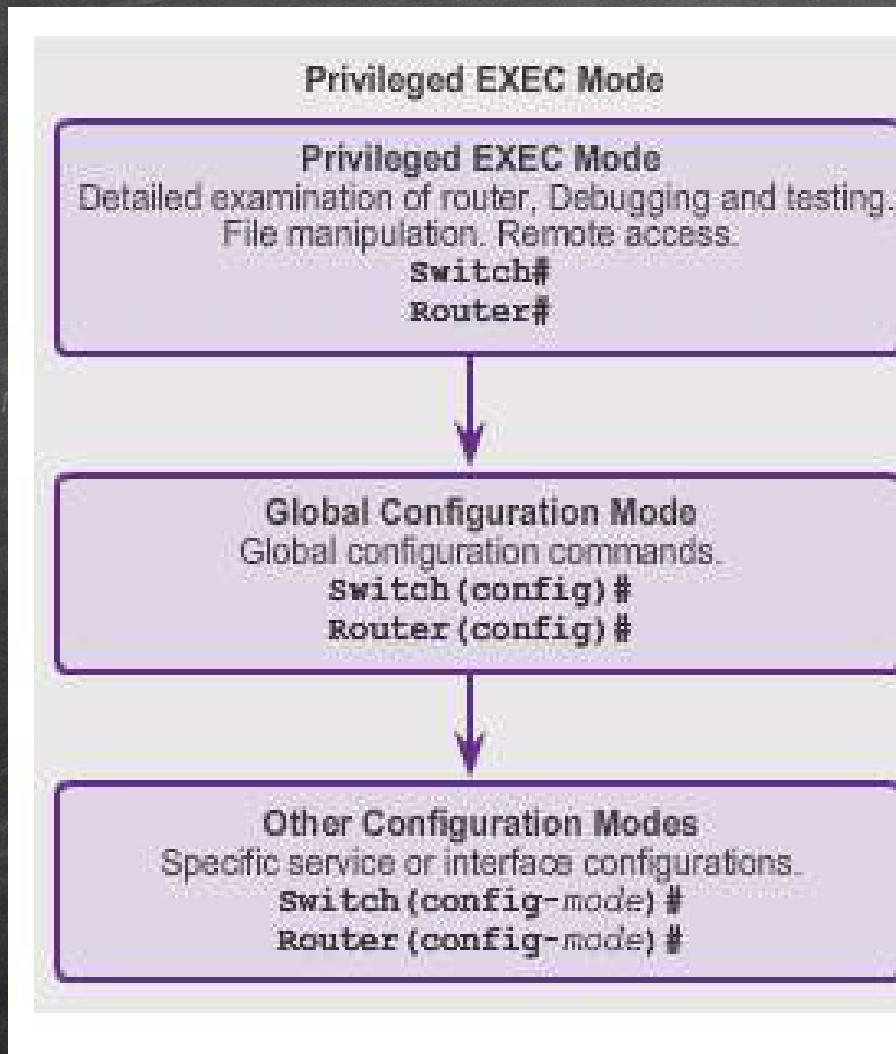
Privileged EXEC Mode

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

```
switch#  
Router#
```

Navigating the IOS

• Global Configuration Mode and Submodes



Navigating the IOS

- Navigating between IOS Modes

```
Router con0 is now available.
```

```
Press RETURN to get started.
```

```
User Access Verification
```

```
Password:
```

```
Router>
```

User-Mode Prompt

```
Router>enable
```

```
Password:
```

```
Router#
```

Privileged-Mode

```
Router#disable
```

```
Router>
```

User-Mode Prompt

```
Router>exit
```

Router

Navigating the IOS

- Navigating between IOS Modes

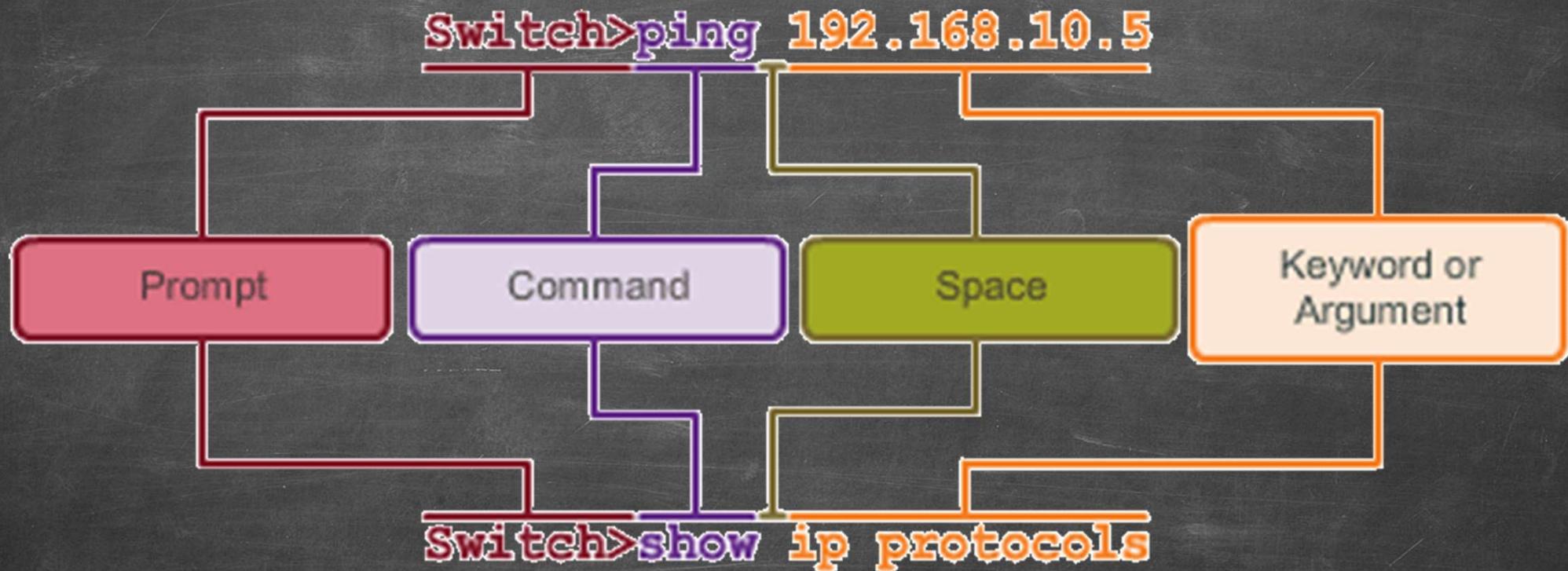
```
switch>enable  
switch#configure terminal  
Enter configuration commands, one per line.  
End with CNTL/Z.  
switch(config)#interface vlan 1  
switch(config-if)#exit  
switch(config)#exit  
switch#
```

```
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
- Hot Keys and Shortcuts
- IOS Examination Commands

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.

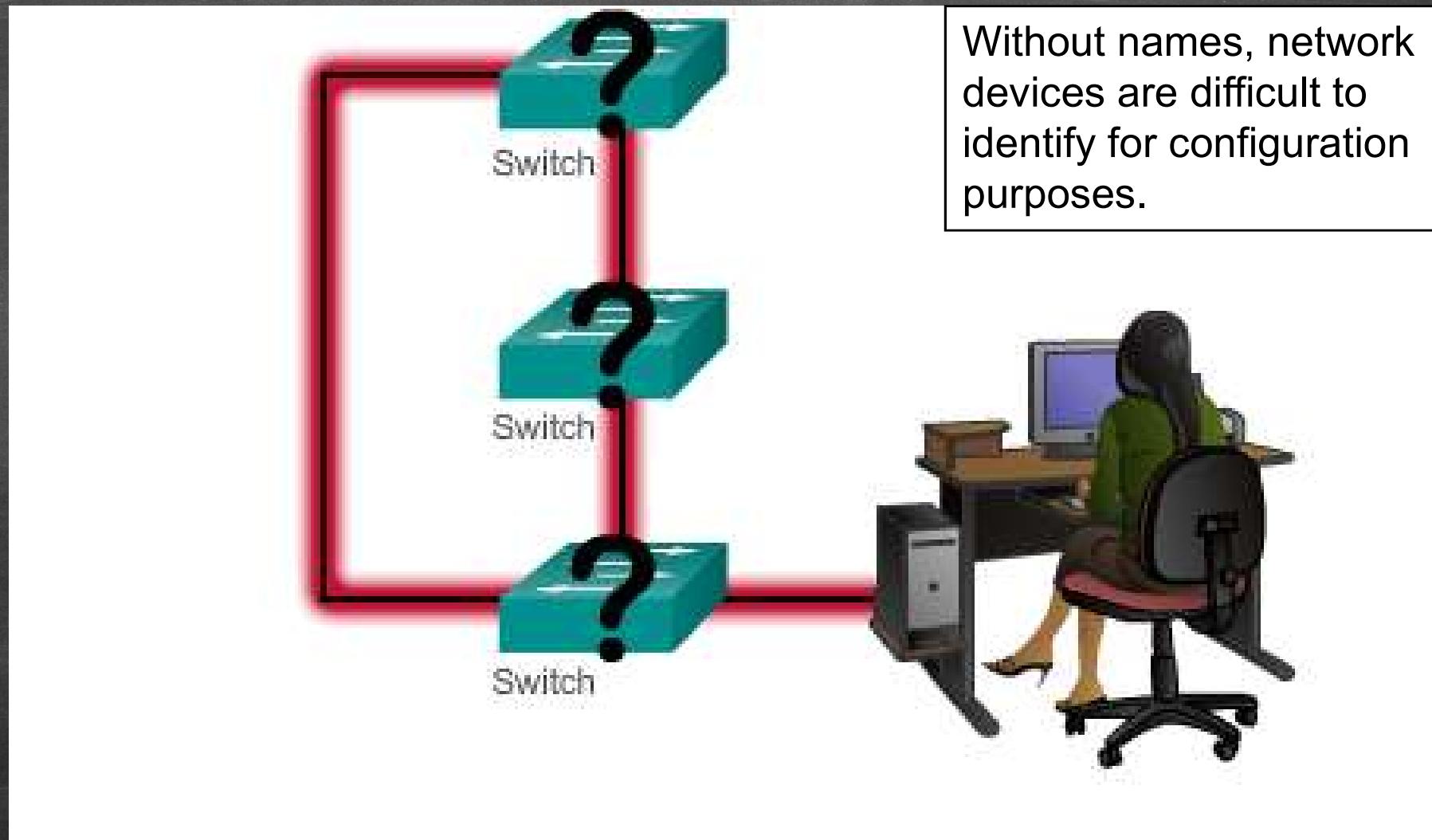
Router#show version
```

Getting Basic

- Hostnames
- Limiting Access to Device Configurations
- Addressing Devices
- Verifying Connectivity
- Saving Configurations

Getting Basic

- Hostnames



Getting Basic

- Hostnames
 - Configuring Hostnames

Getting Basic

- Limiting Access to Device Configurations
 - Banner Messages
 - Securing Device Access
 - Enable password
 - Enable secret
 - Console password
 - VTY password
 - 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

```
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

```
CE-floor-7#show running-config
Building configuration...
...
no service password-encryption
!
hostname CE-floor-7!
!
!
!
enable secret 5 $1$mERr$9cTjUIEqNGurQiFU.ZeC1
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.ZeC1
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
```

- Switch virtual interfaces (SVIs)

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

- Set the IP address of an interface

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

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>**tradcere**

PC>**route print**

PC>**nslookup**

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.ZeCiI
enable password 7 08224F4008
!
!
!
!
ip cef
no ipv6 cef
!
--More--
```

Questions and Answers

