Networking Summary

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OSI REFERENCE MODEL LAYERS

Layer	Packet is a	Provides	Kurose Chapter	Used by Hosts	Used by Routers	Used by Switches	Used by Hubs
Application	Message	The reason for needing a network!	2	Yes	No	No	No
Presentation		Convert/compress/unwrap graphics		Yes	No	No	No
Session		Open & close sessions		Yes	No	No	No
Transport	Segment	Logical Communication Between Processes	3	Yes	No	No	No
Network	Datagram	Logical Communication Between Hosts	4	Yes	Yes	No	No
Link or Datalink	Frame	Communication Between Adapters	5	Yes	Yes	Yes	No
Physical	Frame	The wires or EM signals		Yes	Yes	Yes	Yes

Mnemonic for Kurose's text: *All Turtles Need Less Protection*??
For the full protocol stack: *All People Seem To Need Data Processing.*

HEADERS

As a *message* is passed from the application layer to the transport layer, a TCP or UDP header is added to create a *segment*. Then an IP header is added in the network layer to make a dataframe or *datagram*. In the link layer, an Ethernet or PPP header and trailer are added to make a *frame*. The frame is transmitted on the physical layer according to other protocols not discussed here.

Protocol	Size (B)	Addresses (size in B)	Checksum covers	Length is
UDP	8	Source & destination port numbers (2 B ea.)	Data + header	Segment + headers
TCP	20+	Source & destination port numbers (2 B ea.)	Data + header	Header length
IP v4	20+	Source & destination IP addresses (4 B ea.)	Header only	Header & datagram lengths in separate fields
IP v6	40	Source & destination IP addresses (16 B ea.)	None	Data only
Ethernet	26	Source & destination MAC addresses (6 B ea.)	CRC Data + headers	None
PPP	7-10	None	CRC Data + headers	None

PROTOCOLS!

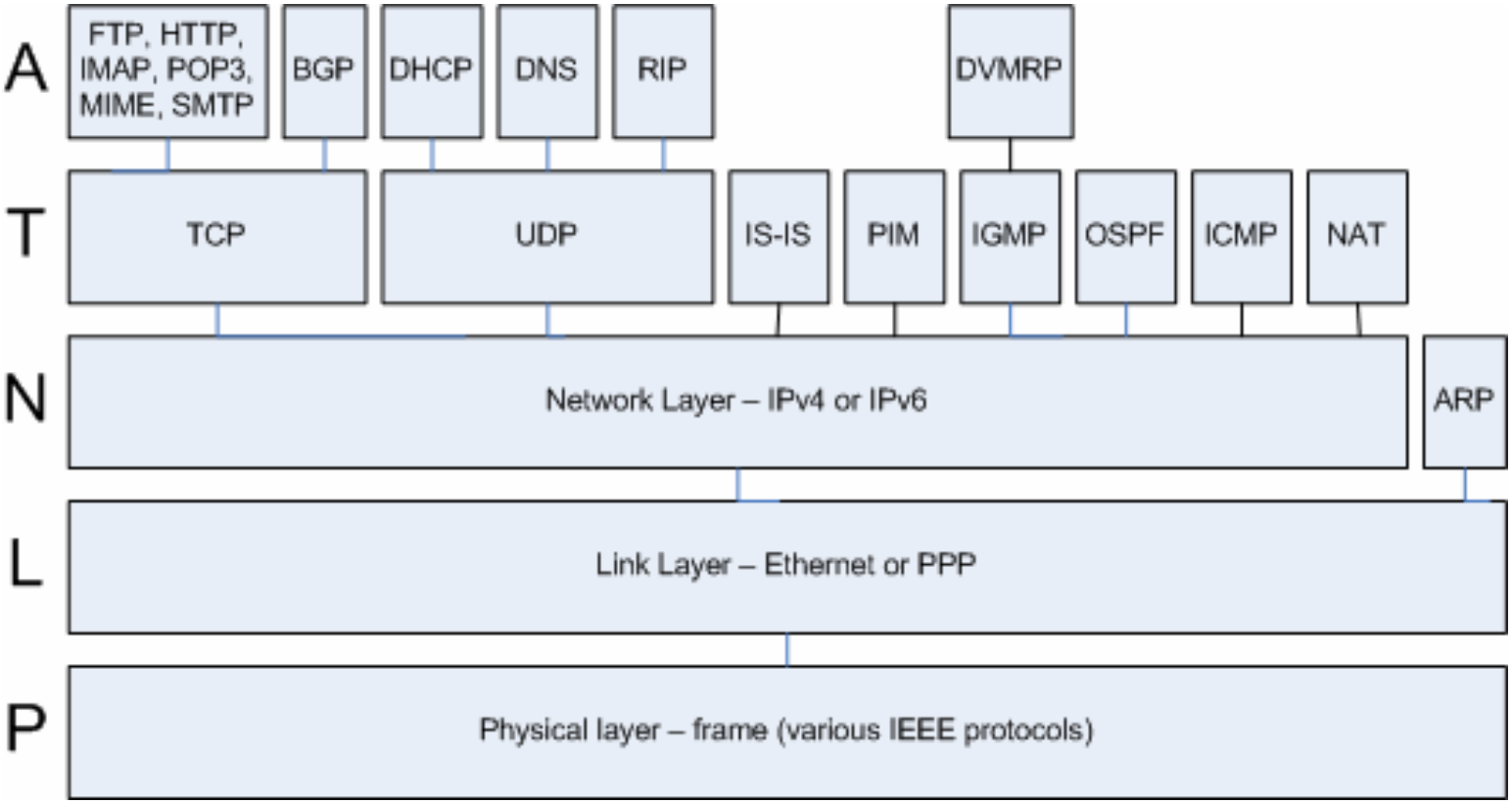
Protocol	Layer*	Purpose	Communicates over	RFC	Port#	Is client/ server?
ARP	L	Translates IP and MAC addresses w/in a subnet	Link layer	826		
BGP4	N	Inter-AS routing protocol	TCP			
DHCP	L, N	Assign IP addresses within a subnet	UDP		67	Yes
DNS	A	Convert hostnames to IP addresses	UDP		53	Yes
DVMRP	N	Multicast routing algorithm and inter-AS routing	IGMP	2715		
Ethernet	L	LAN link protocol	Frames			
FTP	A	Transfer files between hosts	TCP	959	21	Yes
HTTP	A	View web pages	TCP	1945, 2616	80	Yes
ICMP	N	Communicate error messages	IP	792		
IGMP	N	Manage multicast group membership	IP	3376		
IMAP	A	Get email from mail server	TCP	2060		Yes
IP v4	N	Primary network protocol	Link layer			
IP v6	N	New network protocol	Link layer	2460		
IS-IS	N	Intra-AS routing based on LS routing	IP**	1195		
MIME	A	Encode non-ASCII email contents	TCP	2045		No
NAT	N	Hide a subnet behind one public IP address	IP	1631		
OSPF	N	Intra-AS routing based on LS routing	IP	2328		
PIM	N	Multicast routing algorithm	IP			
POP3	A	Get email from mail server	TCP	1939	110	Yes
PPP	L	Point-to-point link protocol	Frames			
RIP	N	Intra-AS routing protocol based on DV routing	UDP	2453	520	
SMTP	A	Exchange email between mail servers	TCP	2821	25	Yes
TCP	T	Reliable transport protocol	IP	793	N/A	Yes
UDP	T	Lightweight transport protocol	IP	768	N/A	No

* A=Application, T=Transport, N=Network, L=Link/datalink

** IS-IS was originally developed to support ISO CLNP networks; was later revamped to work over IP

The previous table focuses on Internet-relevant protocols, and omits virtual circuit protocols (ATM, X.25, etc.) and other networking technologies (AppleTalk, IPX, FDDI, DECnet, SONET, ISDN, Token Ring, etc.). and proprietary protocols (Gnutella, etc.).

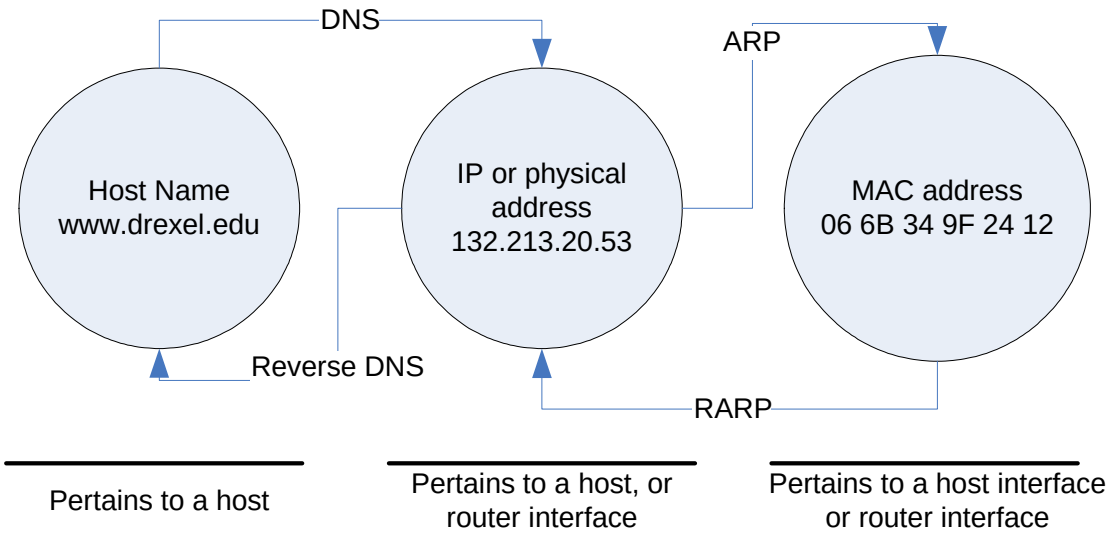
Another way to look at the connections between protocols in the stack is something like this:



This helps highlight the oddball protocols which communicate directly over IP or frames.

ADDRESS TRANSLATION

This summarizes how hostnames, IP addresses, and MAC addresses are translated from one to another. The arrows show the protocols involved in translating that direction.



LAN HARDWARE

This table summarizes key differences among hubs, switches, and routers.

Device	Layer	Address used	Inputs must have same speed?	Require same link protocol?	Isolates collision domains?	Interfaces have MAC addresses?
Hub	Physical	None	Yes	Yes	No	No
Switch	Link	MAC	No	Yes	Yes	No
Router	Network	IP	No	No	Yes	Yes

A bridge is a switch with only two ports. If a bridge does no filtering of traffic between LAN segments, it's just a *repeater* (signal amplifier).

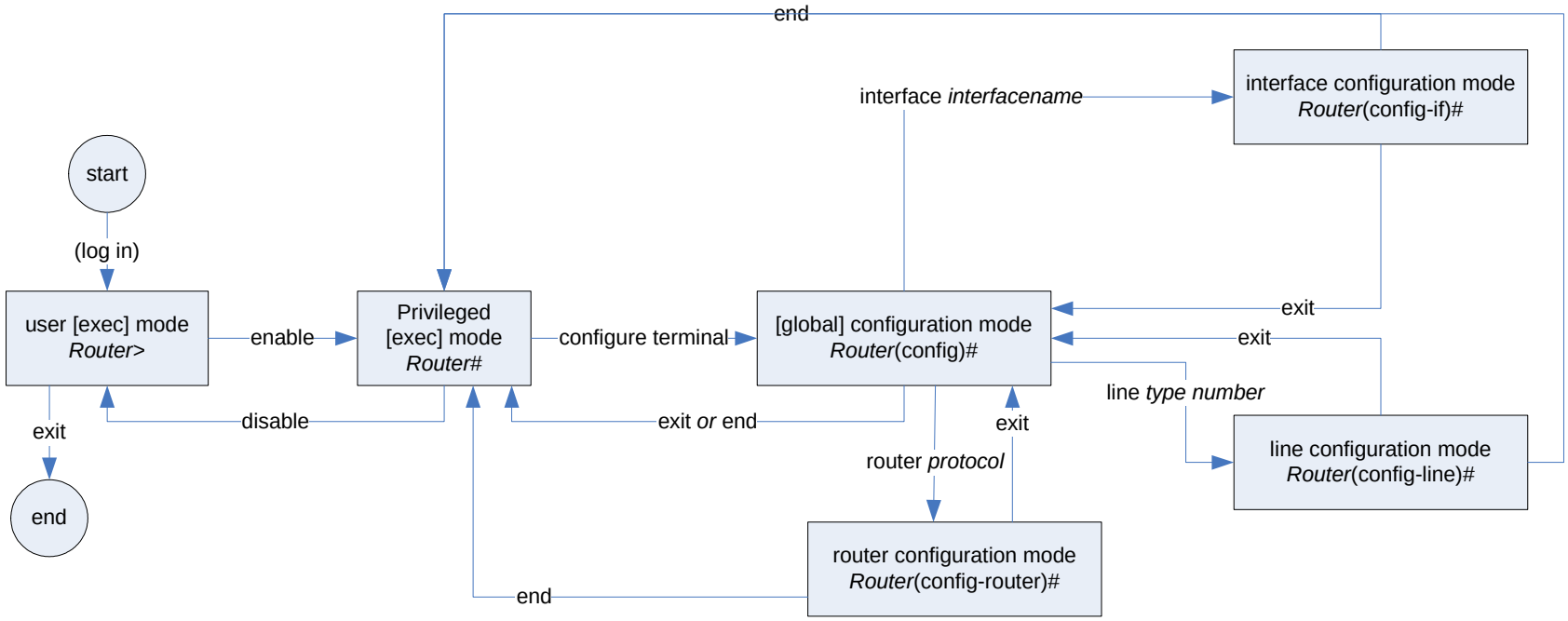
GLOSSARY

802.11 = family of IEEE protocols for wireless networking
802.3 = IEEE protocol for Ethernet
Adapter = the connection between a node and one link of the network
API = Application Programming Interface, connects an application to the network
ARP = Address Resolution Protocol, maps IP addresses to MAC addresses
AS = Autonomous Systems
ASCII = American Standard Code for Information Interchange; plain text format, uses 7 bits per character
ATM = Asynchronous Transfer Mode, a type of VC network
BGP4 = Border Gateway Protocol
BIND = Berkeley Internet Name Domain, the primary DNS software app
Bit = a binary digit, a 0 or 1
Byte = a character or word, eight bits typically
CIDR = Classless Interdomain Routing
Coax = co-axial (sharing one axis)
DHCP = Dynamic Host Configuration Protocol
DNS = Domain Name System
DSL = Digital Subscriber Line
DV = Distance-Vector routing, based on the Bellman-Ford equation
DVMRP = Distance-Vector Multicast Routing Protocol
EM = electromagnetic, e.g. light or radio waves
Ethernet = dominant LAN link protocol
FDDI = Fiber Distributed Data Interface
FTP = File Transfer Protocol
HFC = Hybrid Fiber-Coaxial
Host = a computer on the network
HTML = HyperText Markup Language
HTTP = HyperText Transfer Protocol
IAB = Internet Architecture Board
IANA = Internet Assigned Numbers Authority, works under ICANN
ICANN = Internet Corporation For Assigned Names and Numbers; manages IP addresses and domain names
ICMP = Internet Control Message Protocol
IEEE = Institute of Electrical and Electronics Engineers
IETF = Internet Engineering Task Force
IGMP = Internet Group Management Protocol
IMAP = Internet Mail Access Protocol
IP = Internet Protocol, has versions 4 and 6 (v4 and v6)
ISDN = Integrated Services Digital Network
IS-IS = Intermediate System to Intermediate System
ISOC = The Internet Society
ISP = Internet Service Provider
LAN = Local Area Network
LS = Link-State routing, often based on Dijkstra’s algorithm
MAC = Media Access Control
MIME = Multipurpose Internet Mail Extensions
NAT = Network Address Translation
Node = a host or router on the network
OSI = Open System Interconnection
OSPF = Open Shortest Path First
P2P = peer-to-peer
PIM = Protocol-Independent Multicast
POP = Points Of Presence for an ISP
POP3 = Post Office Protocol
PPP = Point-to-Point Protocol
RFC = Request For Comments
RIP = Routing Information Protocol
SMTP = Simple Mail Transfer Protocol
SNTP = Simple Network Time Protocol
TCP = Transmission Control Protocol
UDP = User Datagram Protocol
VC = Virtual Circuit

Cisco IOS Command Modes

Cisco controls the vast majority of Internet and LAN network equipment sales, so it is helpful to understand some basic navigation and configuration within its router configuration language, IOS (Internetwork Operating System). IOS is a command line-based operating system, with many different operating modes to allow accessing various types of commands and capabilities. The following figure shows common modes within IOS.

A critical aspect of IOS is that the commands which are available, and how those commands are interpreted, varies depending on which mode you're in!



Cisco IOS Command Modes

The name of each mode is given on the first line, followed by the type of prompt you'd expect in that mode. '*Router*' is the hostname of the router, '*interfacename*' is the name of the interface to be edited, such as `ethernet0, serial0, serial1`, etc. The line '*type*' is the line editing terminal type, such as `vty, tty, console`, etc. The '*number*' is the line number to be edited. The '*protocol*' is the routing protocol to be edited, such as `rip, igrp, ospf`, etc. All the other words in the figure are literal commands or command prompt contents.

Figure adapted from Fig 1.1, Boney, James (2005) *IOS in a Nutshell* (2nd Ed). Beijing: O'Reilly.

Cisco IOS Prompts and Commands

The modes, and key commands used within each, are summarized in the following table. All of the modes except User are versions of the privileged mode, which is akin to administrator, superuser, or root access in other operating systems. All privileged modes have a command prompt that ends with the pound sign, #. Commands are all in lower case, though modifiers and parameters may have capital letters. Many other modes exist, such as 'ROM monitor' mode (used when IOS software can't load), dhcp-config, etc.

Mode	Prompt	Scope	Typ. Commands

(all)	(see below)	(see below)	`show`
			`terminal`
			`copy`

User (user exec in Cisco docs)	*`Router`*`>`	View basic config parameters. Edit nothing.	`show users`
			`show version`
			`show line`

Privileged (privileged exec)	*`Router`*`#`	Edit parameters which apply to the whole router.	`clock set` `prompt`

Global configuration	*`Router`*`(config)#`		`hostname`
			`enable`
			`clock timezone`

Line configuration	*`Router`*`(config-line)#`	Edit **physical** line properties	`location`
			`exec-timeout`
			`transport`

Router configuration	*`Router`*`(config-router)#`	Edit routing protocol settings	`ip route` `router`

Interface configuration	*`Router`*`(config-if)#`	Edit interface **protocols**, assign IP addresses	`shutdown`
			`speed`
			`duplex`
			`description`
			`ip address`

Many IOS commands look like Unix or MS-DOS commands. For example, the file system commands include: `cd, dir, delete, erase, format, mkdir, more, pwd, rename`, and `rmdir`.
For more extensive documentation, see http://www.cisco.com/en/US/products/ps6350/prod_command_reference_list.html for Cisco's documentation.