Networking Fundamentals



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Network Connections



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Connection Types



Switched Networks



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Interconnection of Networks (Routers)



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Network Performance



propagation delay = distance / speed of light

transmit time = message size / bandwidth

queue delay = time spent in router queues

latency = propagation + transmit + queue

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Bandwidth vs. Latency

I Byte Object

	Prop delay: 1 ms	Prop delay: 100 ms
Bandwidth: 1 Mbps	1,008 µs	100,008 µs
Bandwidth: 100 Mbps	1,000 µs	100,000 µs

10 MB Object

	Prop delay: 1 ms	Prop delay: 100 ms
Bandwidth: 1 Mbps	80.001 s	80.1 s
Bandwidth: 100 Mbps	.801 s	.9 s

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OSI Model

Function				Example
Ultimate data destination	Application	~ >	Application	Web browser
Format conversion	Presentation	← →	Presentation	ASCII/XDR
Interaction across presentation	Session	← →	Session	Restartable file transfer
Reliable, ordered delivery	Transport	← >	Transport	ТСР
Routing/ Internetworking	Network	← >	Network	IP
Data framing over links	Data link	* >	Data link	Ethernet, WiFi
Bits on the wire	Physical	<→	Physical	SONET, 100BT

IP Hourglass



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Protocol Encapsulation



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Internet Protocol (Network, Layer 3)

Version	HLen	TOS	Length		
Identification		Flags	Offset		
Т	TL	Protocol	Header Checksum		
Source IP Addr					
Destination IP Addr					
Options (variable)				Pad (variable)	
		Data	тс	P HTTP Pay	load

Dynamic Host Configuration Protocol (DHCP)



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Address Resolution Protocol (ARP)



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Domain Name System (DNS)



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Routing



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