Computer Networks

Final Review

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Final Review

- Before Midterm
  - RTT, Bandwidth-delay product
- Network
  - DHCP, ARP, IPv6, NAT
  - Routing
- Transport
  - TCP, UDP
- Application
  - DNS, HTTP
- Security
  - PKI, Certificate Chain

Before Midterm

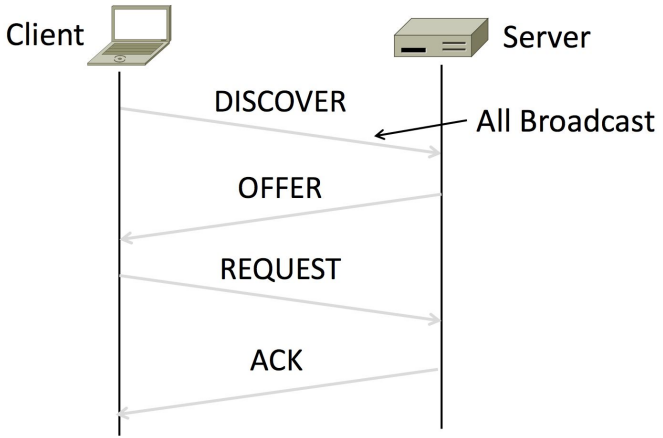
- RTT:
  - Time it takes between sending a request and getting a reply
- Bandwidth (bps):
  - How much data can be sent during a unit time
- Bandwidth-delay Product:
  - Amount of data can be in transit in network

Network

- DHCP, ARP, IPv6, NAT
- Routing

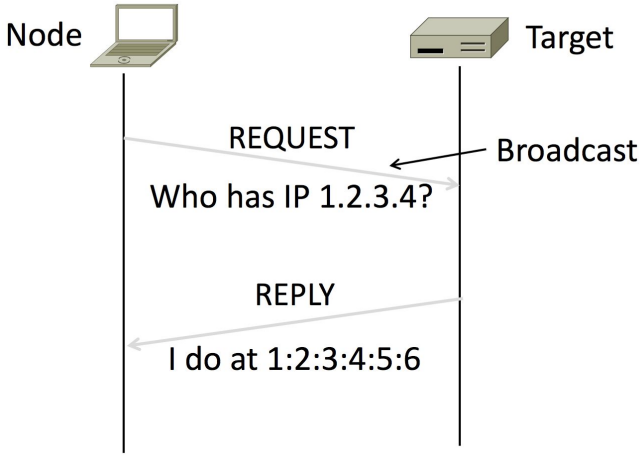
Network - DHCP

- DHCP (Dynamic Host Configuration Protocol)
- Based on UDP
- Bootstrapping
- Leases IP address to computer
- Also setup other parameters:
  - DNS server
  - Gateway IP address
  - Subnet mask



Network - ARP

- ARP (Address Resolution Protocol)
- MAC is needed to send a frame over the local link
- ARP to map the MAC to IP



Network - NAT

- NAT (Network Address Translation)
- Solve IPv4 address pool exhausted
- Many private IP -> One public IP, different port
- Break layering: IP, Transport Layer

Network – IPv6

- IPv4 – 32 bits; IPv6 – **128 bits**
- Only public address, not more NAT

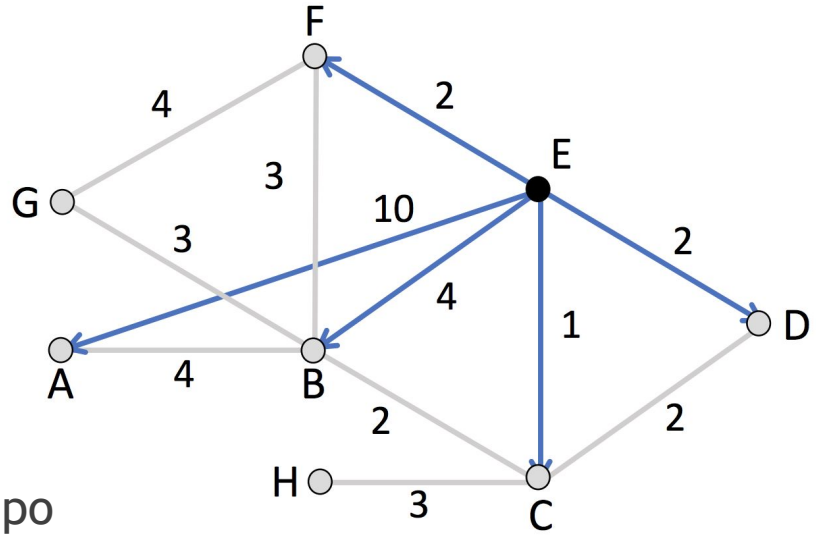
Network – Link-State Routing

- Two Phases:
  - Nodes flood topology (neighbors) with LSP (link state packets)
    - Each node learns full topology by combining LSPs
  - Each node computes its own forwarding table
    - By running Dijkstra (or equivalent)

Network – Link-State Routing #1

- E's LSP:

Seq. #	
A	10
B	4
C	1
D	2
F	2



- All nodes learn full topo

Network – Link-State Routing #2

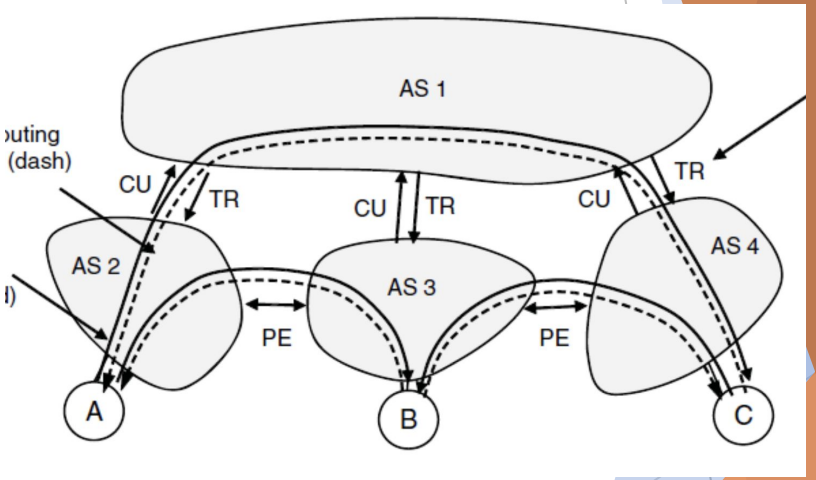
- Run Dijkstra Algorithm to calculate a source-tree
- Lecture Slide example

Network – BGP routing

- ISPs are called AS (Autonomous Systems)
- ASes can be in relationships: Peer and Transit (Customer)
- Border routers of ASes announce BGP routes
  - Announce paths only to other parties who may use those paths

Network – BGP routing – Transit & Peer

- Transit (ISP & Customer)
  - ISP announce every thing it can reach to its customer
  - Customer ISP only announce its customers to ISP
- Peer (ISP 1 & ISP 2)
  - ISP 1 only announces its customer to ISP 2



Transport – TCP/UDP

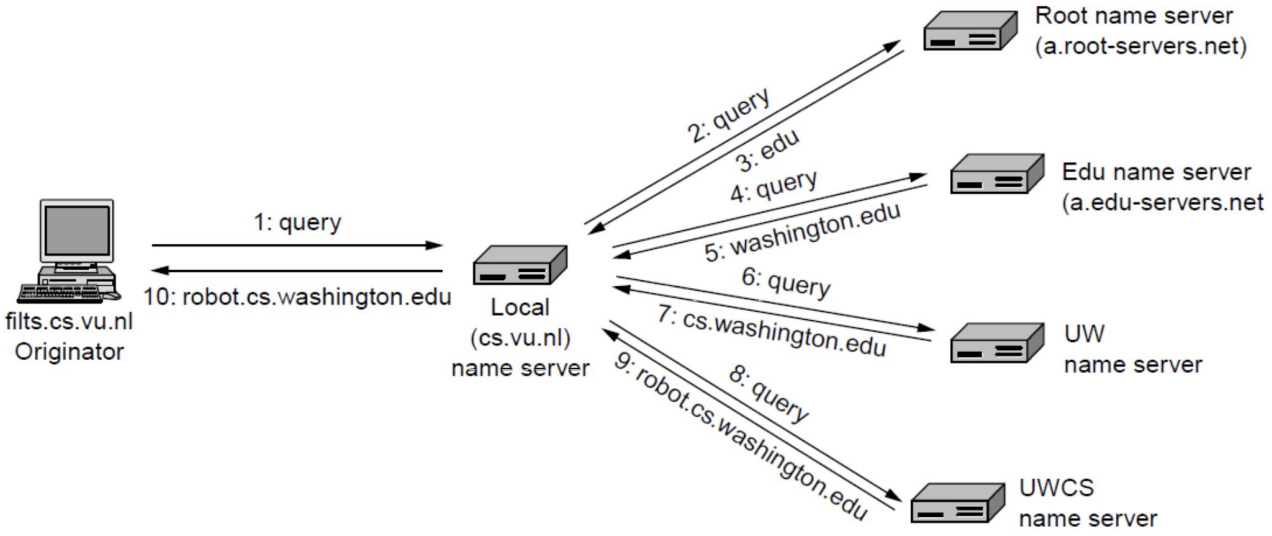
- Comparison of TCP/UDP
  - TCP: full-featured
  - UDP: nothing
- Applications for each
  - VoIP

TCP (Streams)	UDP (Datagrams)
Connections	Datagrams
Bytes are delivered once, reliably, and in order	Messages may be lost, reordered, duplicated
Arbitrary length content	Limited message size
Flow control matches sender to receiver	Can send regardless of receiver state
Congestion control matches sender to network	Can send regardless of network state

Transport – TCP

- Congestion Control (AIMD)
  - Slow-start
    - Double cwnd until packet timeout
    - Restart and double until cwnd/2, then AI
  - Fast-retransmit
    - Three duplicate ACKs = packet loss
  - Fast-recovery (MD)
    - Half cwnd and start AI

Application - DNS

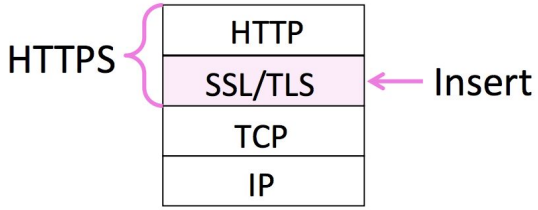


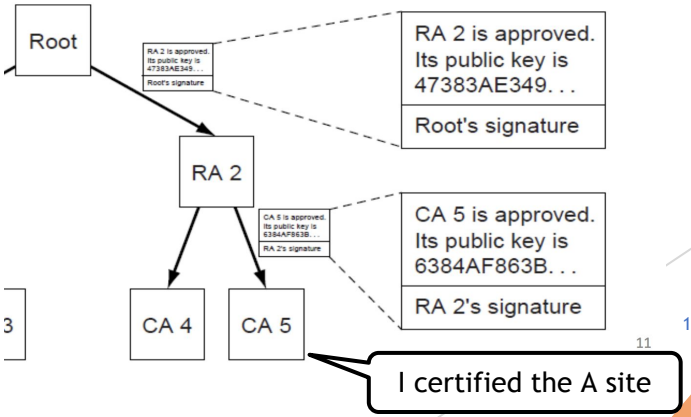
Application – HTTP/HTTPS

- Steps to fetch a web HTTP:
  - Resolve the server IP
  - Setup TCP connection (port 80)
  - Send/Receive HTTP request over TCP
  - Teardown TCP connection
- Steps to fetch a web HTTPS:
  - Resolve the server IP
  - Setup TCP connection (port 443)
  - SSL/TLS negotiation and key exchange
  - Send Encrypted messages
  - Teardown connection

Security – HTTPS (SSL/TLS)

- Additional layer of security
- Authentication & Encryption
  - PKI
    - Root, RA, CA
  - Certificate Chain





Thank you!

Best luck on all your finals!