CSE 461 Week 5 Section - Midterm Review

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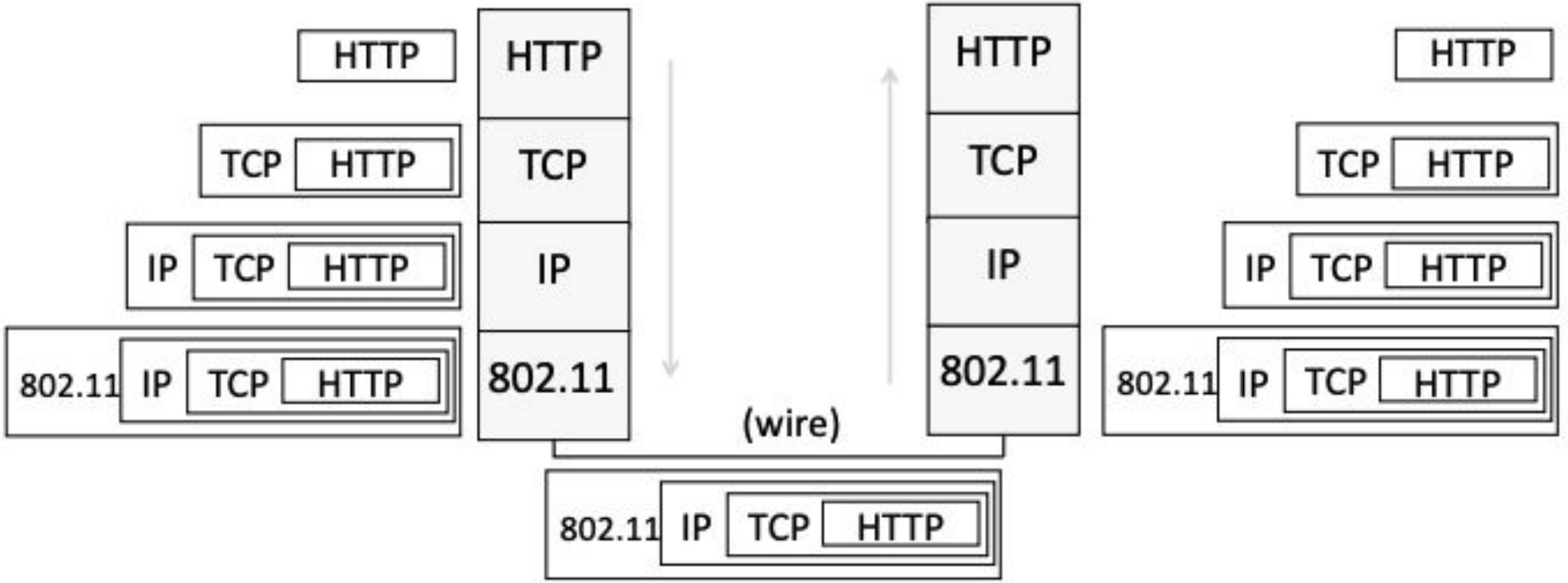
Midterm (5/4) - Logistics

- In class canvas quiz, don’t be late
- the quiz opens at 12:30, closes at 1:20
- don’t cheat

OSI Layers

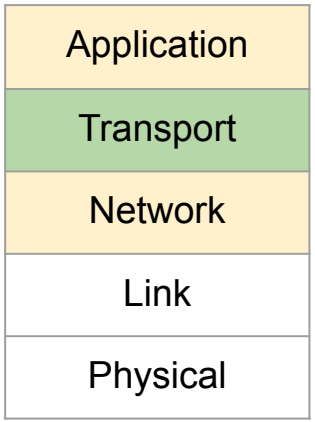
Layer	Function	Example
Application (7)	Services that are used with end user applications	SMTP,
Presentation (6)	Formats the data so that it can be viewed by the user Encrypt and decrypt	JPG, GIF, HTTPS, SSL, TLS
Session (5)	Establishes/ends connections between two hosts	NetBIOS, PPTP
Transport (4)	Responsible for the transport protocol and error handling	TCP, UDP
Network (3)	Reads the IP address form the packet.	Routers, Layer 3 Switches
Data Link (2)	Reads the MAC address from the data packet	Switches
Physical (1)	Send data on to the physical wire.	Hubs, NICS, Cable

Encapsulation (3)



Transport Layer (TCP/UDP)

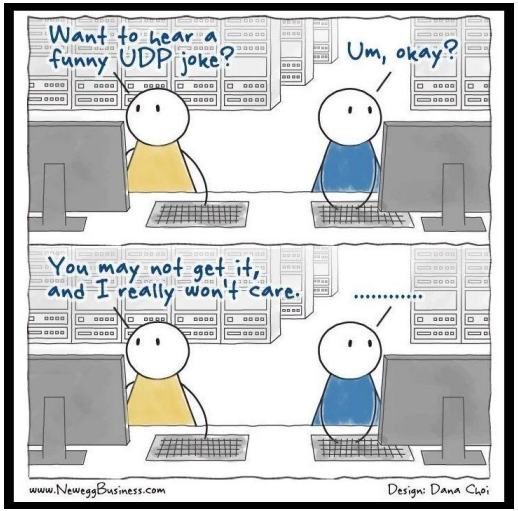
Transport Layer



- Programs that use network service
- Provides end-to-end data delivery
- Send packets over multiple networks

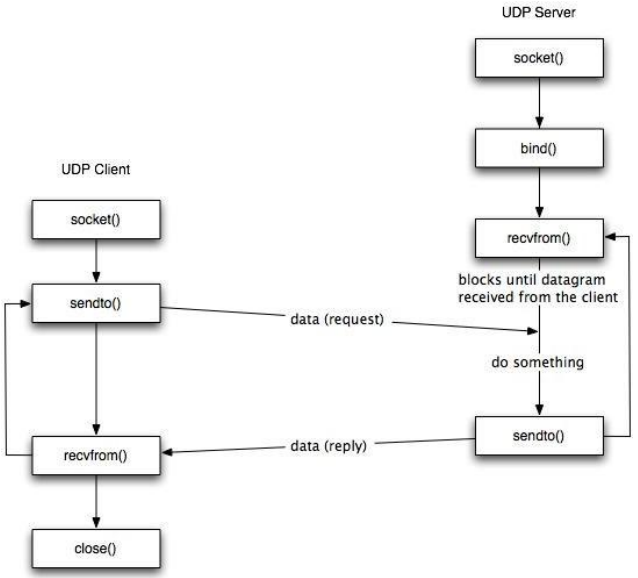
TCP and UDP

"Hi, I'd like to hear a TCP joke."
"Hello, would you like to hear a TCP joke?"
"Yes, I'd like to hear a TCP joke."
"OK, I'll tell you a TCP joke."
"Ok, I will hear a TCP joke."
"Are you ready to hear a TCP joke?"
"Yes, I am ready to hear a TCP joke."
"Ok, I am about to send the TCP joke. It will last 10 seconds, it has two characters, it does not have a setting, it ends with a punchline."
"Ok, I am ready to get your TCP joke that will last 10 seconds, has two characters, does not have an explicit setting, and ends with a punchline."
"I'm sorry, your connection has timed out. ... Hello, would you like to hear a TCP joke?"



UDP

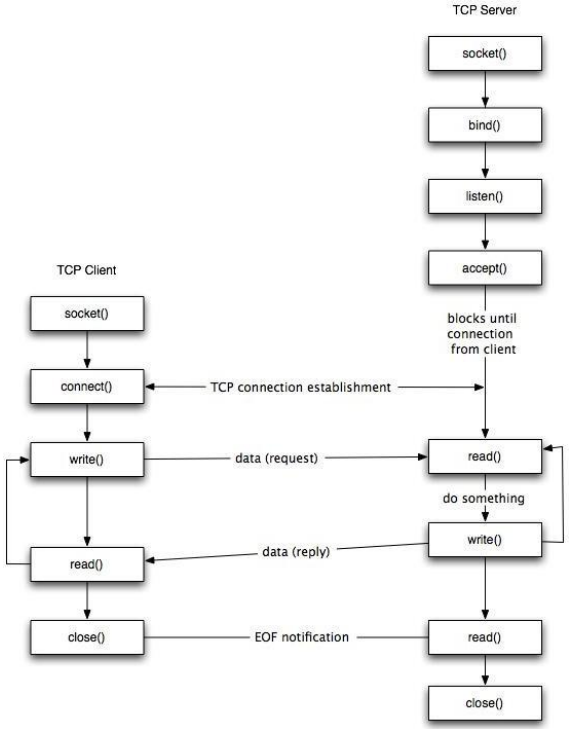
- Information sent as packets, not a stream
- No notion of a connection
- Unreliable, best-effort
- Stateless communication



https://www.cs.dartmouth.edu/~campbell/cs60/UDPsockets.jpg

TCP

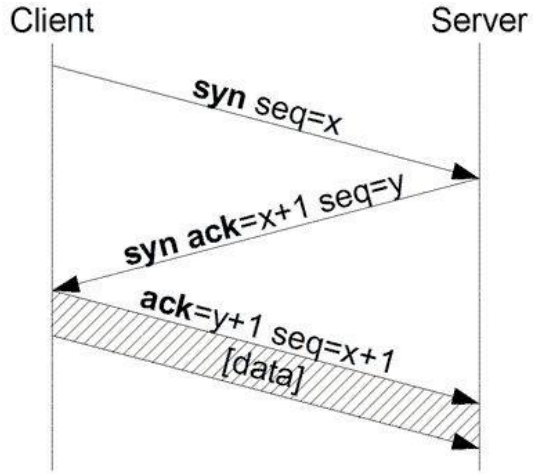
- Information sent as a stream of bytes
- Connection based
- Reliable and ordered



https://www.cs.dartmouth.edu/~campbell/cs60/TCPsockets.jpg

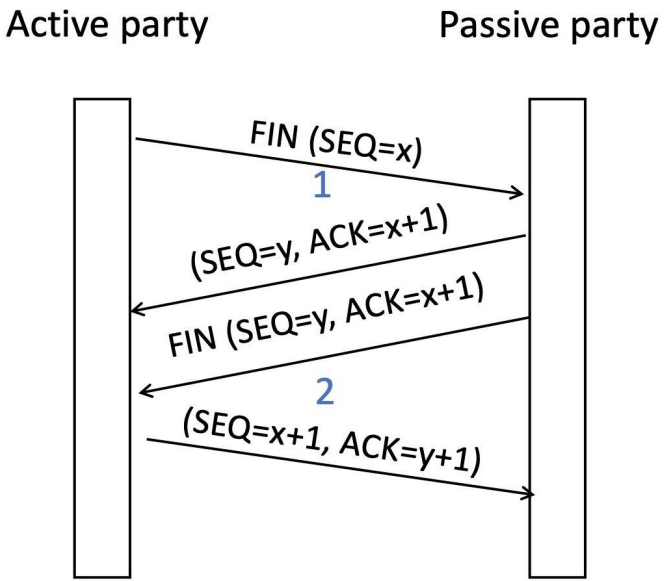
Three-Way Handshake

- Client sends SYN(seq=x)
- Server responds with ACK for previous SYN from client (ACK=x+1), and a SYN with its seq, SYN(seq=y)
- Client responds with ACK=y+1, and seq=x+1
- SYNs are retransmitted if lost



Connection Release

- A party will send FIN(seq=x) when it knows it has nothing more to send.
- FINs can arrive in any order
- When a party receives FIN(seq=x), it responds with ACK=x+1
- Once both parties have sent and received ACKs, wait a while, and close the connection
- https://www.ibm.com/support/knowledgecenter/en/SSLTBW_2.1.0/com.ibm.zos.v2r1._halu101/constatus.htm



Flow Control

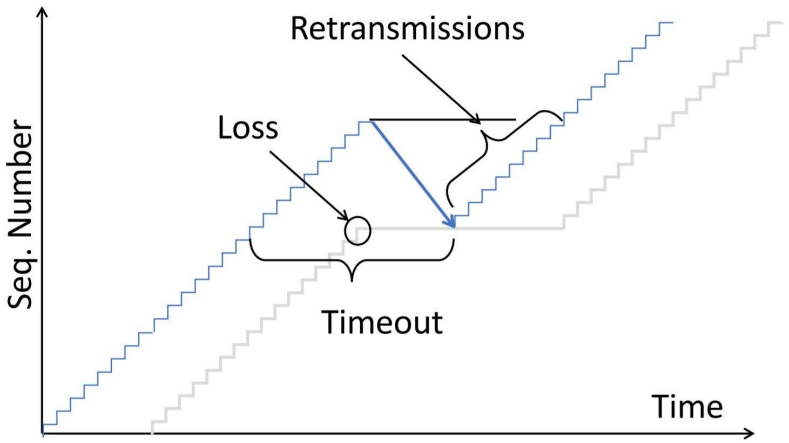
- Stop & Wait
- Sliding Window
  - Go-Back-N
  - Selective Repeat
- Ack Clocking

Sliding Window (Sender)

- LFS = Last Frame Sent
- LAR = Last Ack Received
- Send while LFS - LAR ≤ W (Window size)
- If ACK = LAR + 1, increment LAR

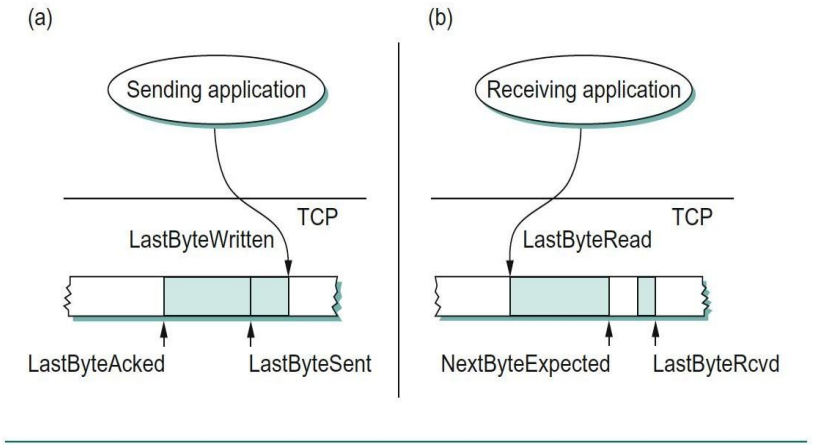
Go Back N (Receiver)

- Receiver maintains Last Ack Sent (LAS)
- Receiver only ACKs if the packet it received has sequence number LAS + 1



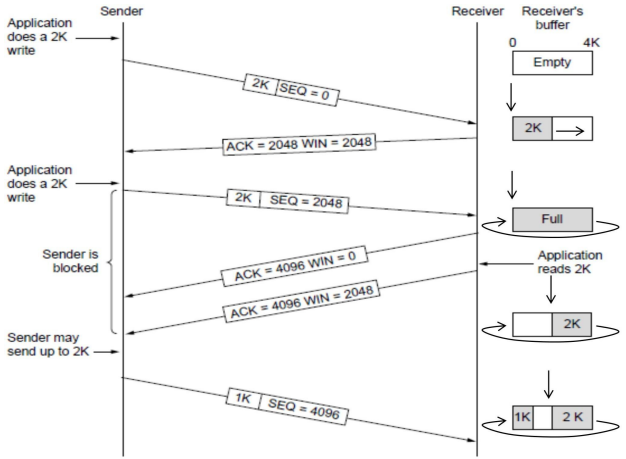
Selective Repeat (Receiver)

- Receiver also maintains a window of W packets [LAS + 1, LAS + W]
- ACKs segments, and contains hints about missing packets



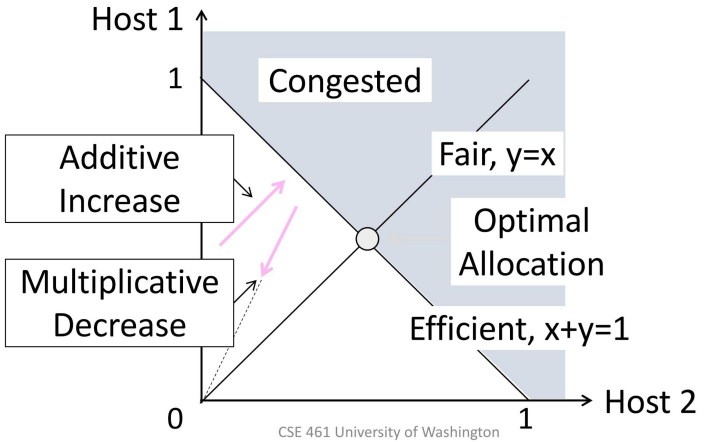
Flow control

- Packets need to be read from the receiver's buffer
- Every ACK also contains the amount of free space in the buffer



AIMD - Congestion Control

- Way to allocate bandwidth
- Hosts additively increase rate while network is not congested
- Hosts multiplicatively decrease rate when congestion occurs



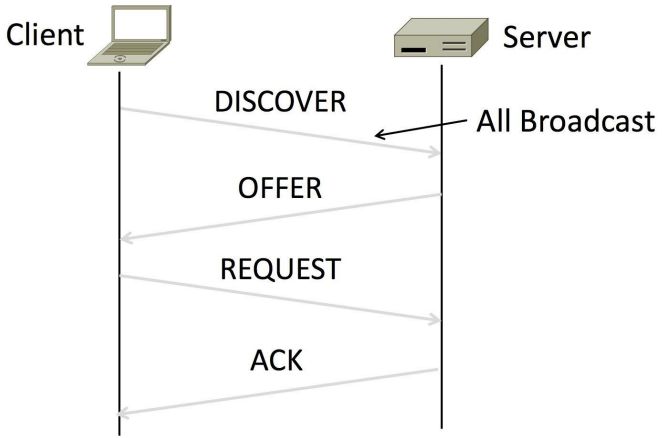
Network Layer

Network Layer

- DHCP, ARP, IPv6, NAT
- Routing

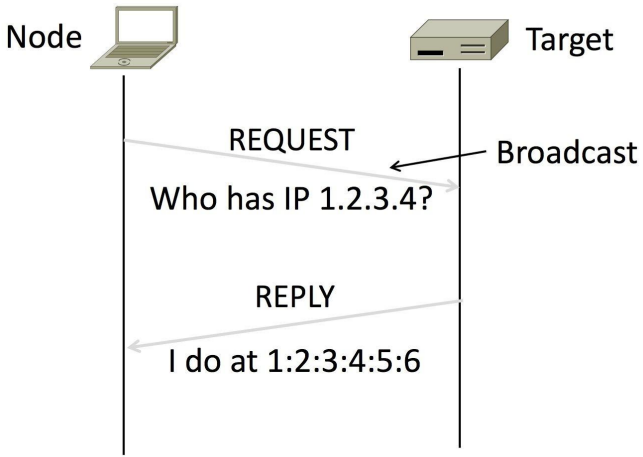
Network - DHCP

- 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

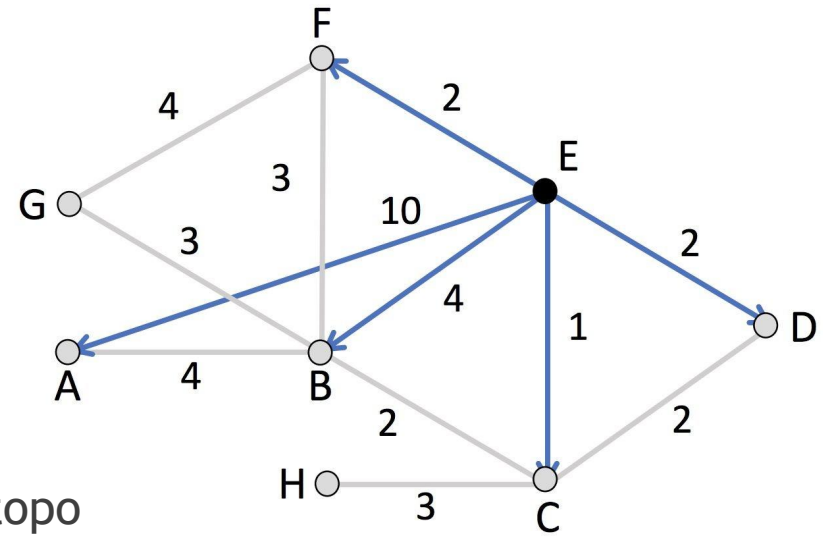
Network – Link-State Routing

- 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

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



- All nodes learn full topo

Network – Link-State Routing #2

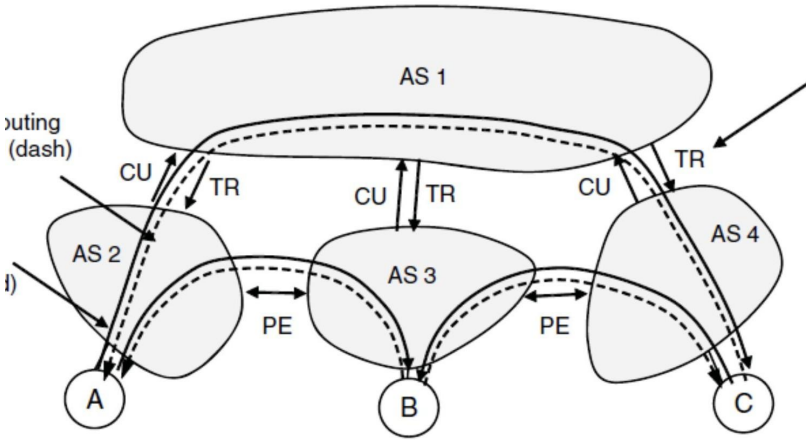
- Run Dijkstra Algorithm to calculate a source-tree
- Lecture Slide example

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



Sample Questions

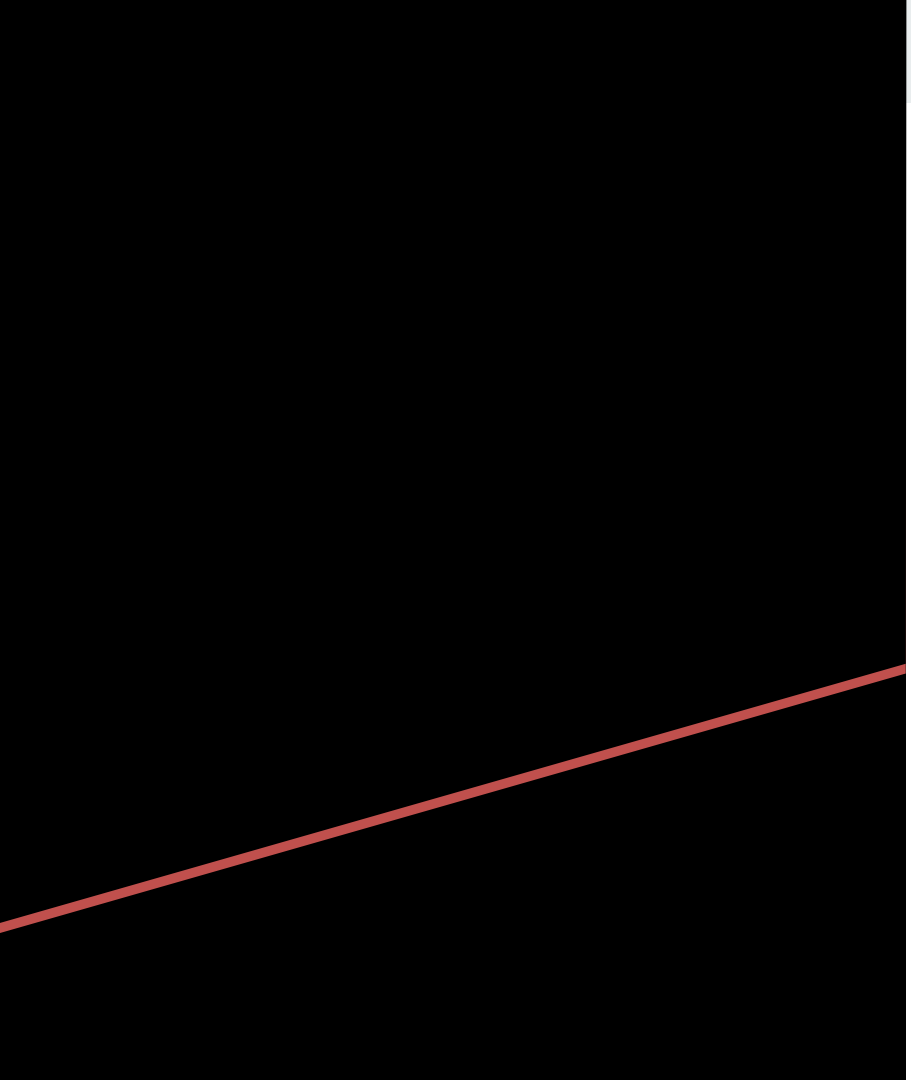
MIDTERM

REVIEW

P1. Imagine a link with the following properties:

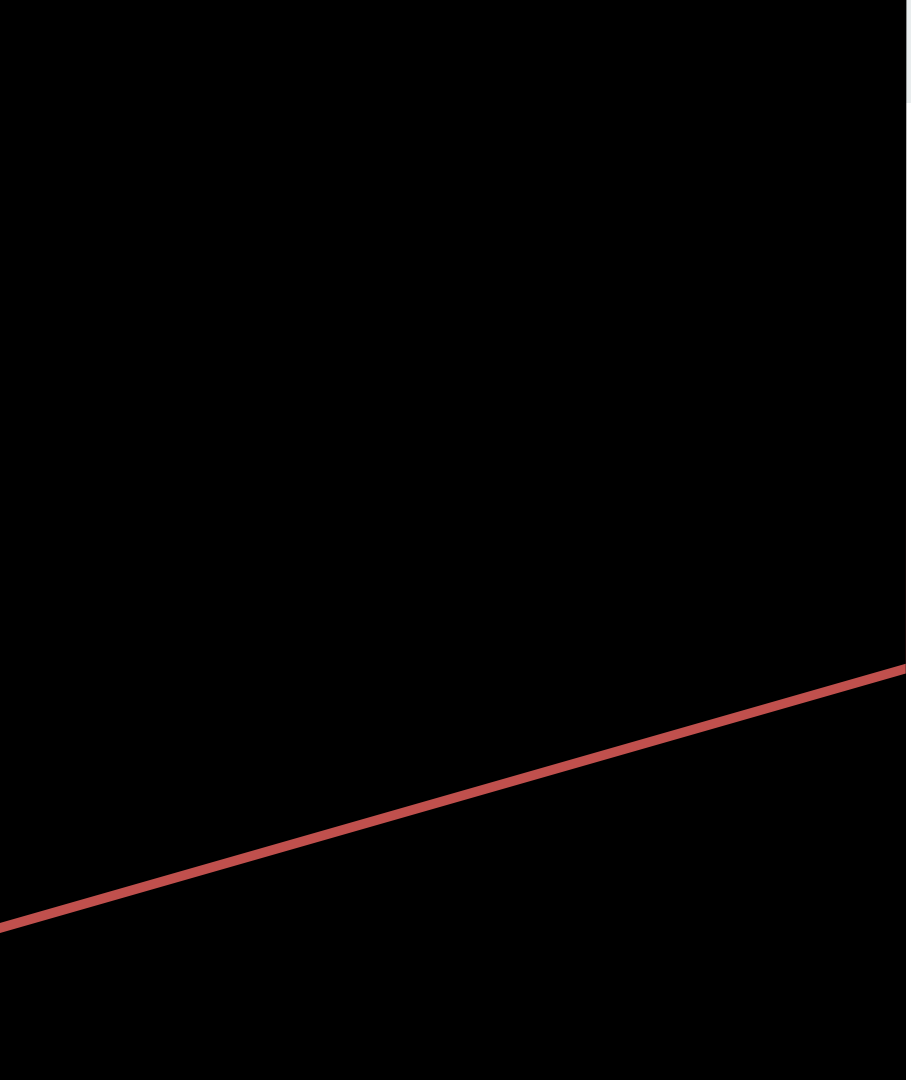
R = 10mbps
D = 25 ms
10 kb packets

a) What is the effect data rate with W = 1



Ans to a)

10 kb / 2 * 25 ms = 200 kbps



b) What is the appropriate window size to fully utilize the link?

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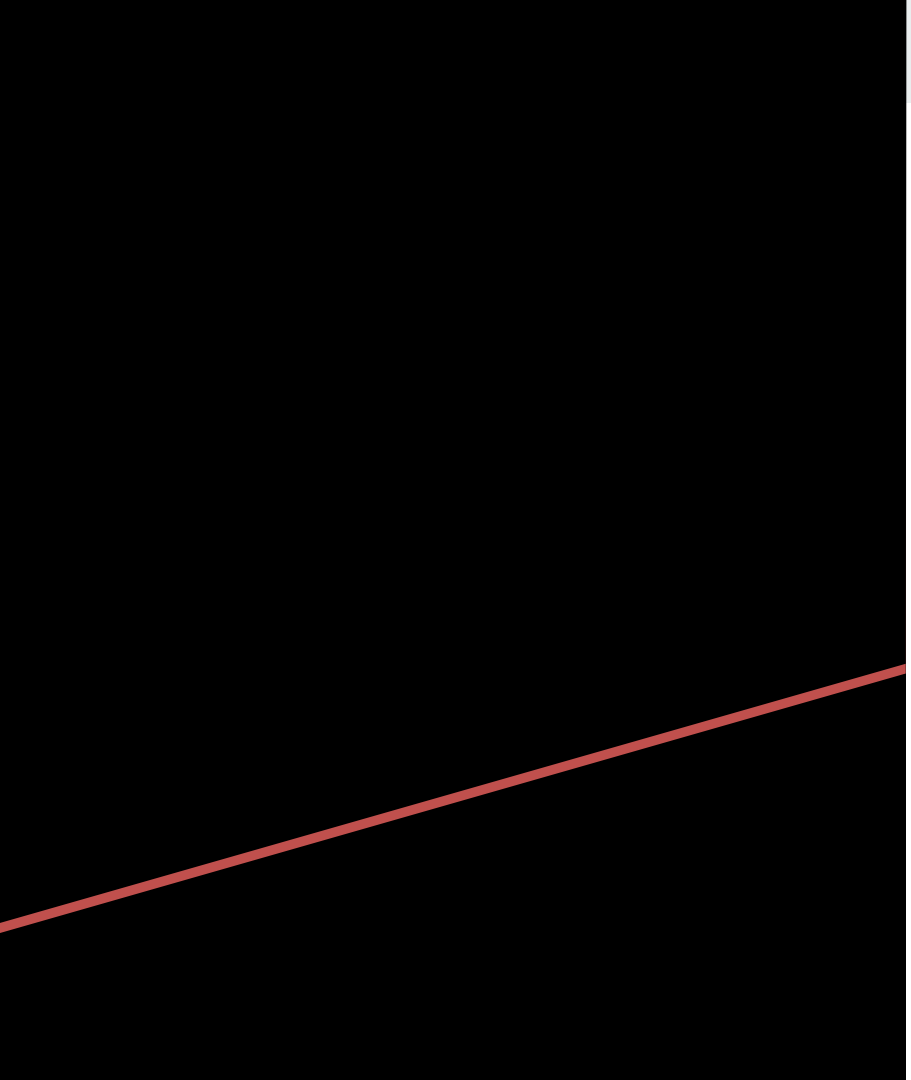
2B * D = 500 kb

W = 500kb / 10kb = 50 packets



c) Assuming TCP slow start with an initial window size of 1, how many ACKs does it take to reach the fully utilized capacity?

c) Assuming TCP slow start with an initial window size of 1, how many packets does it take to reach the fully utilized capacity?

W = 50, we need 49 ACKs

SEE slides 144 at
https://courses.cs.washington.edu/courses/cse461/19au/slides/11-transport.pdf

MORE Practice

Considering the TCP Connection Release phase, as the client(active party) sends out the ACK to the server(passive party), will the client close immediately or it will wait for a certain amount of time? Please also explain why?

Considering the TCP Connection Release phase, as the client(active party) sends out the ACK to the server(passive party), will the client close immediately or it will wait for a certain amount of time? Please also explain why?

ANS: client sides needs to wait for amount of time to ensure its ACK for the FIN from the server side is not lost

BGP routing

What are the relationships that define this protocol?

BGP routing

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Peers and customers

BGP routing

Who would advertise what to whom?

BGP routing

Who would advertise what to whom?

ISP will announce everything it can reach to its customers.

A Customer will announce its customers to the provider.

ISP will announce its customers to its peers.

BGP routing

Would ISP announce its peers to other peers?

BGP routing

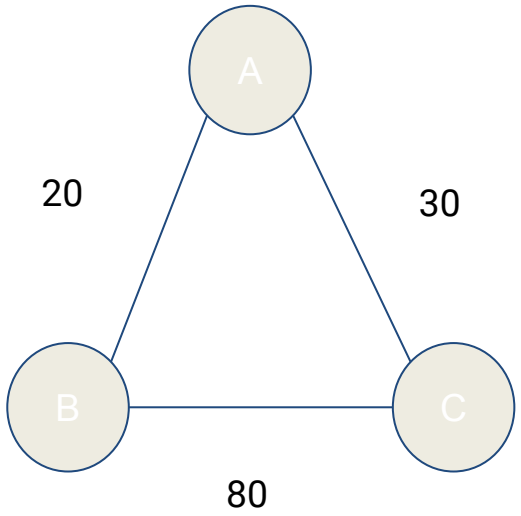
Would ISP announce its peers to other peers?

Routing is not free!

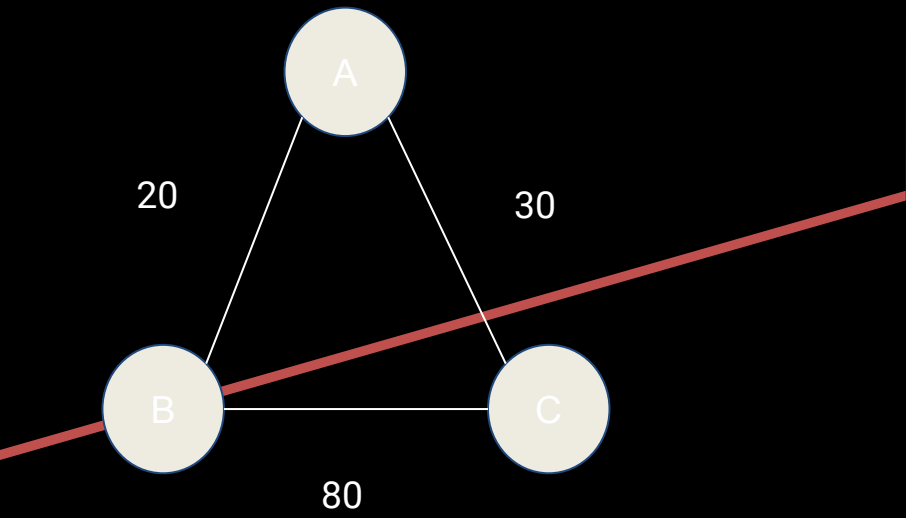
If ISP announce peer A to peer B, when peer B wants to send traffic to peer A, the traffic goes through the ISP, even though the ISP has nothing to do with the traffic!

Distance Vector Routing

Talk to your neighbors about how node A, B, and C establish their routing table using Distance Vector Routing algo? (2 min)

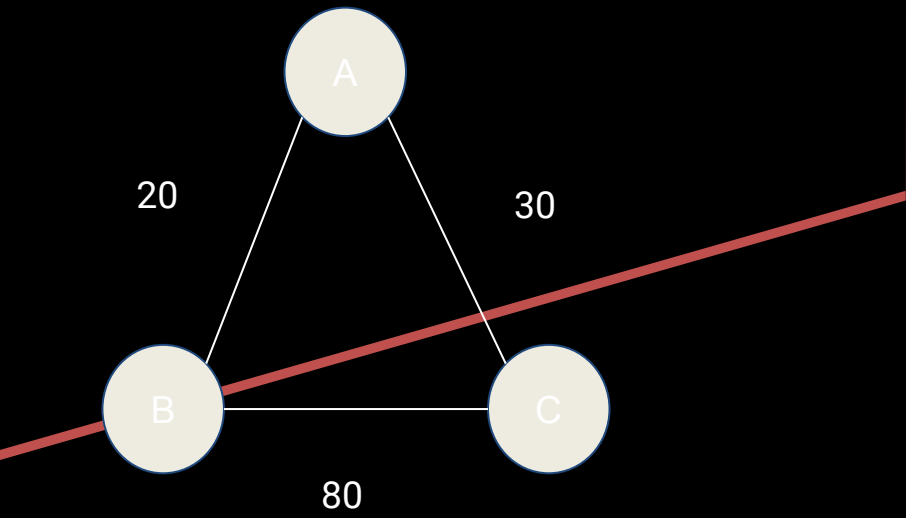


Distance Vector Routing



Talk to your neighbors about how node A, B, and C establish their routing table using Distance Vector Routing algo? (2 min)
#1:
A: (B,20), (C,30); B: (A,20), (C,80); C: (A,30), (B,80);
Each node sends it distances to other nodes to each of its neighbors. Each node updates their distance table.

Distance Vector Routing



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#1:

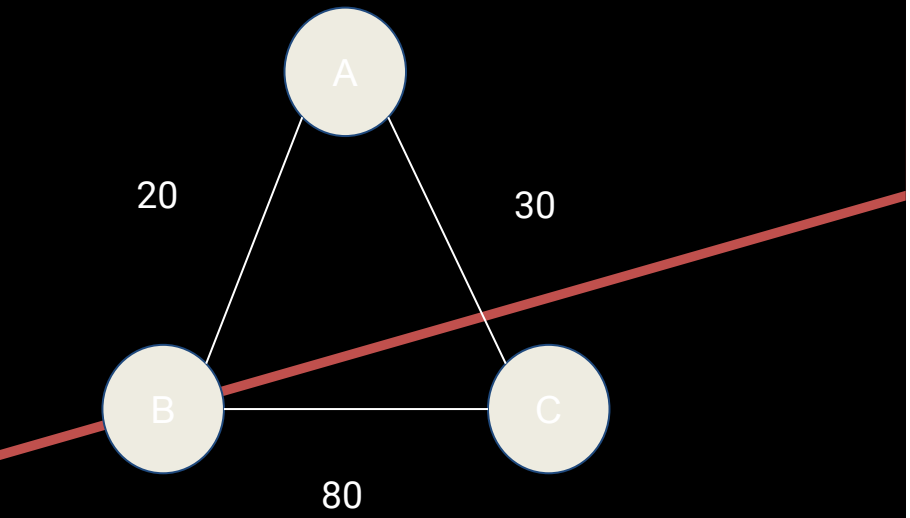
A: (B,20), (C,30); B: (A,20), (C,80); C: (A,30), (B,80);

Each node sends it distances to other nodes to each of its neighbors. Each node updates their distance table.

#2:

A: (B,20), (C,30); B: (A,20), (C,50); C: (A,30), (B,50)

Distance Vector Routing



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#2:

A: (B,20), (C,30); B: (A,20), (C,50); C: (A,30), (B,50)

#3:

Nothing changes. Routing table established.

Distance Vector Routing

What are some advantages of Distance Vector Routing?

Distance Vector Routing

What are some advantages of Distance Vector Routing?

Fewer packets need to be sent. Less bandwidth consumption.

Distance Vector Routing

What is the big problem of Distance Vector Routing?

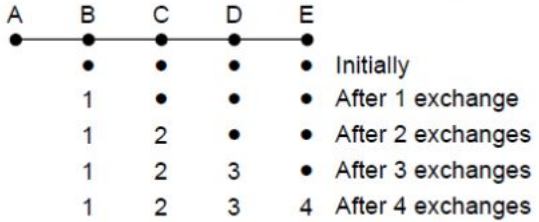
Distance Vector Routing

What is a big problem of Distance Vector Routing?

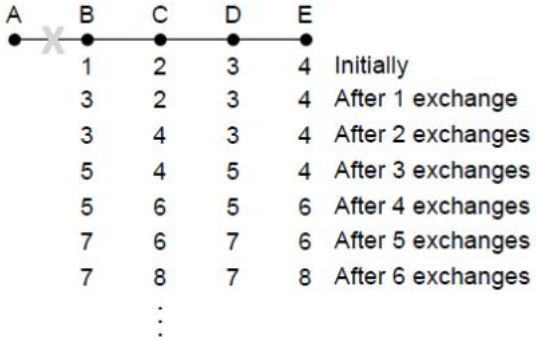
Count-to-infinity problem!

Count to Infinity: Problem

- Good news travels quickly, bad news slowly



Desired convergence

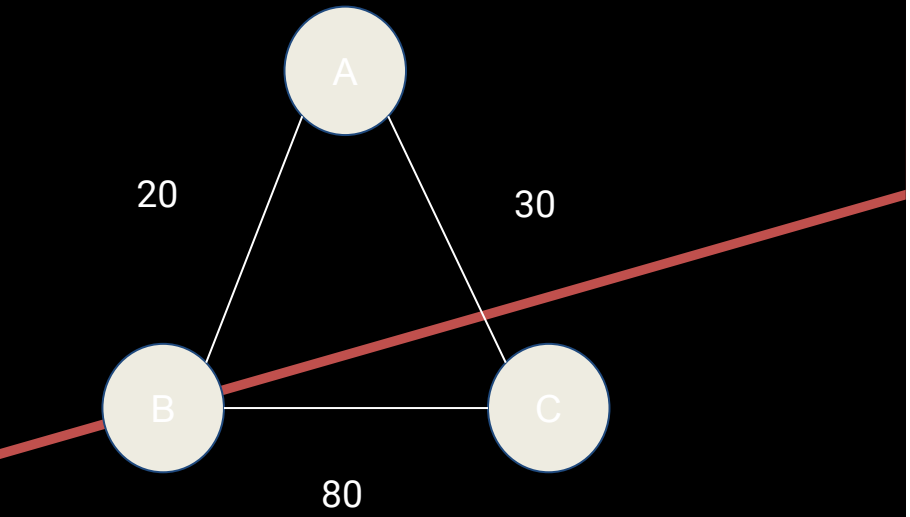


"Count to infinity" scenario

Link State Routing

How does Link State Routing work?

Link State Routing



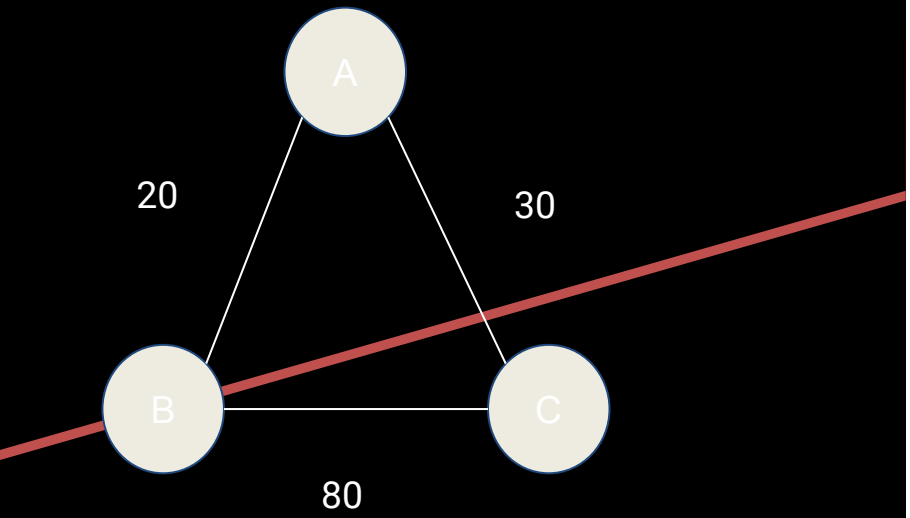
How does Link State Routing work?

Each node send the link to all other nodes.

For example:

node A sends to B and C: (AB,20), (AC,30)

Link State Routing



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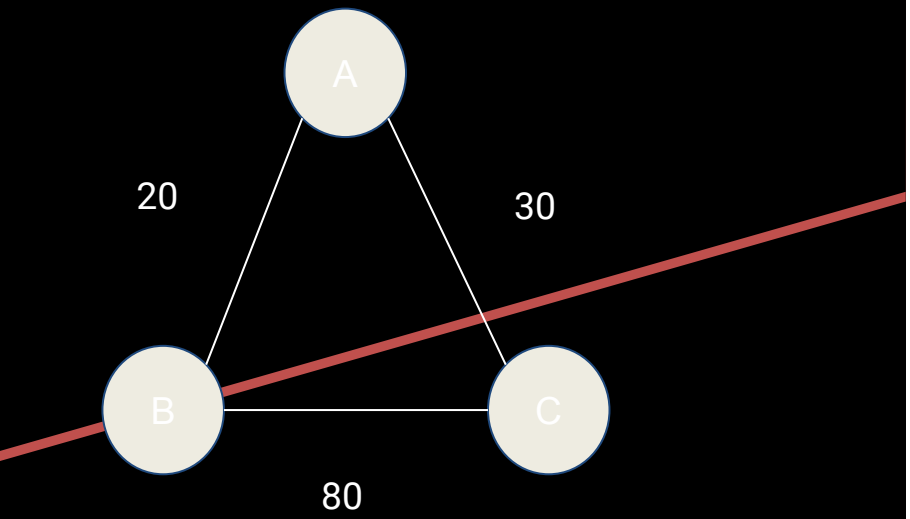
Each node use the packets and Dijkstra’s algorithm to create the full topology of the network.

Link State Routing



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For example:

node A sends to B and C: (AB,20), (AC,30)

Each node use the packets and Dijkstra's algorithm to create the full topology of the network.

Now each node has the shortest path to each other node.

Link State

Routing

What is the advantage of Link State Routing work?

Link State Routing

What is the advantage of Link State Routing work?

Converges fast.

Has a whole understanding of the network.

Link State

Routing

What is the problem of Link State Routing work?

Link State

Routing

What is the problem of Link State Routing work?

Flooding packets. A huge waste of bandwidth.