CSE 461 Midterm Review

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Slides borrowed from last year

Physical layer

Latency

Transmission delay: time to put message on the wire.

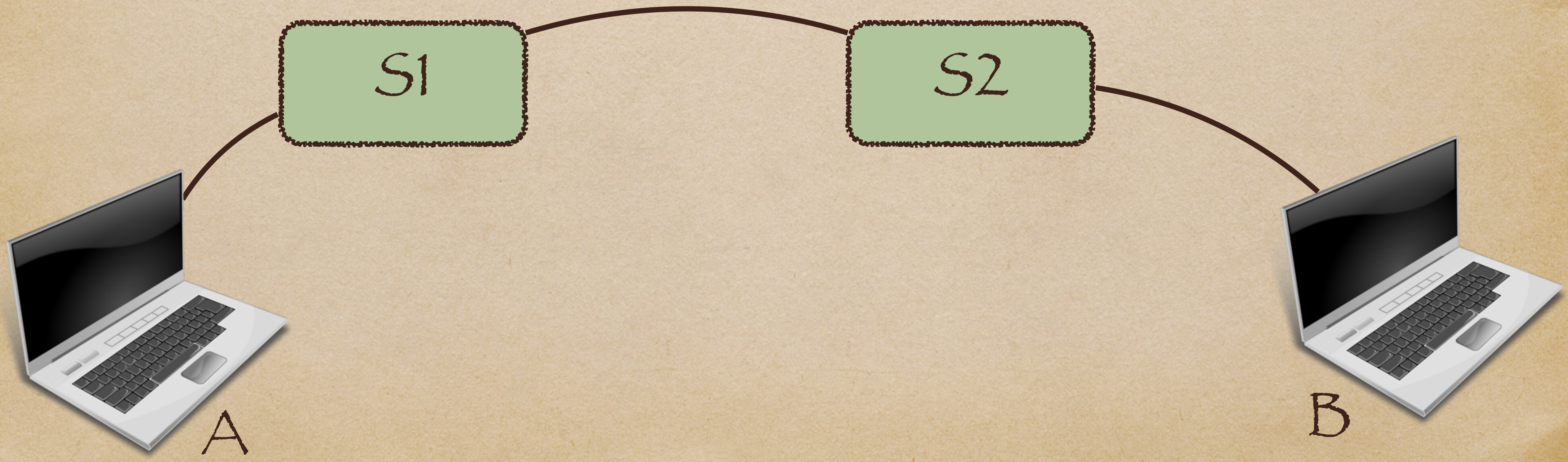
T_delay = Message(bits) / Rate(bits/sec)

Propagation delay: time for bits to propagate across wire.

P_delay = Length(m) / Speed of signal(m/sec)

Latency

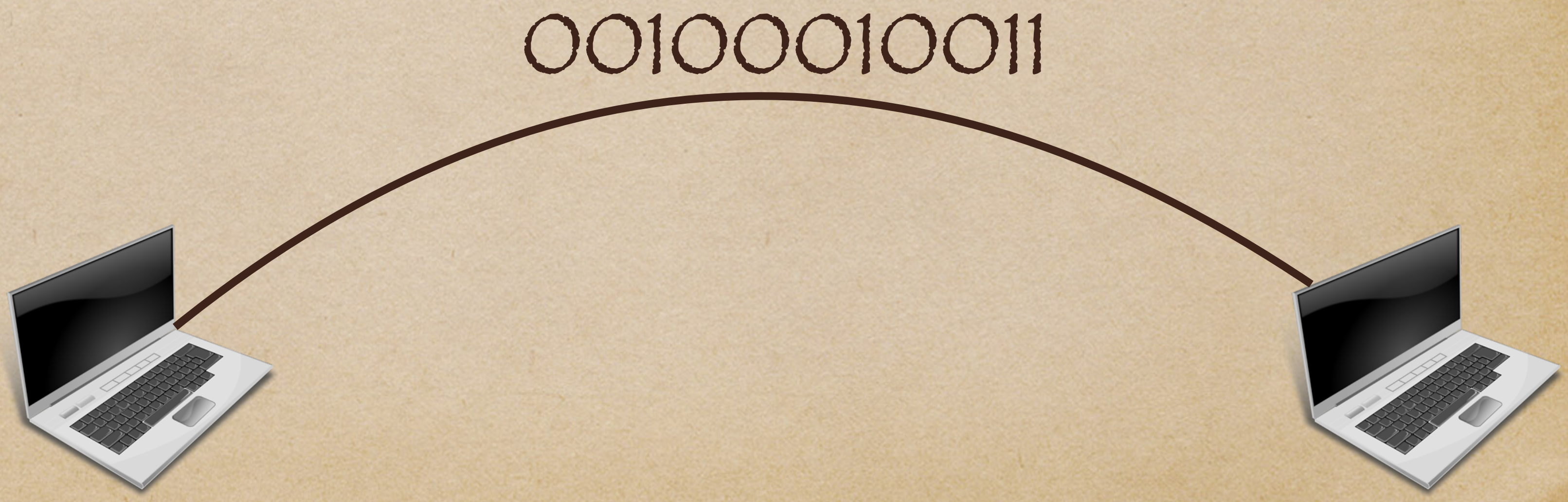
Assume 100-Mbps bandwidth, two store-and-forward switch, packet size of 100000 bits, each link introduce a propagation delay of 5ms, calculate latency.



BD product

A measurement of the amount of data in flight.

BD = Rate * Delay



Shannon Capacity

Maximum rate information can be transmitted over a channel of a specified bandwidth in the presence of noise.

$C = B \log(2, 1 + S/(BN))$ bits/sec

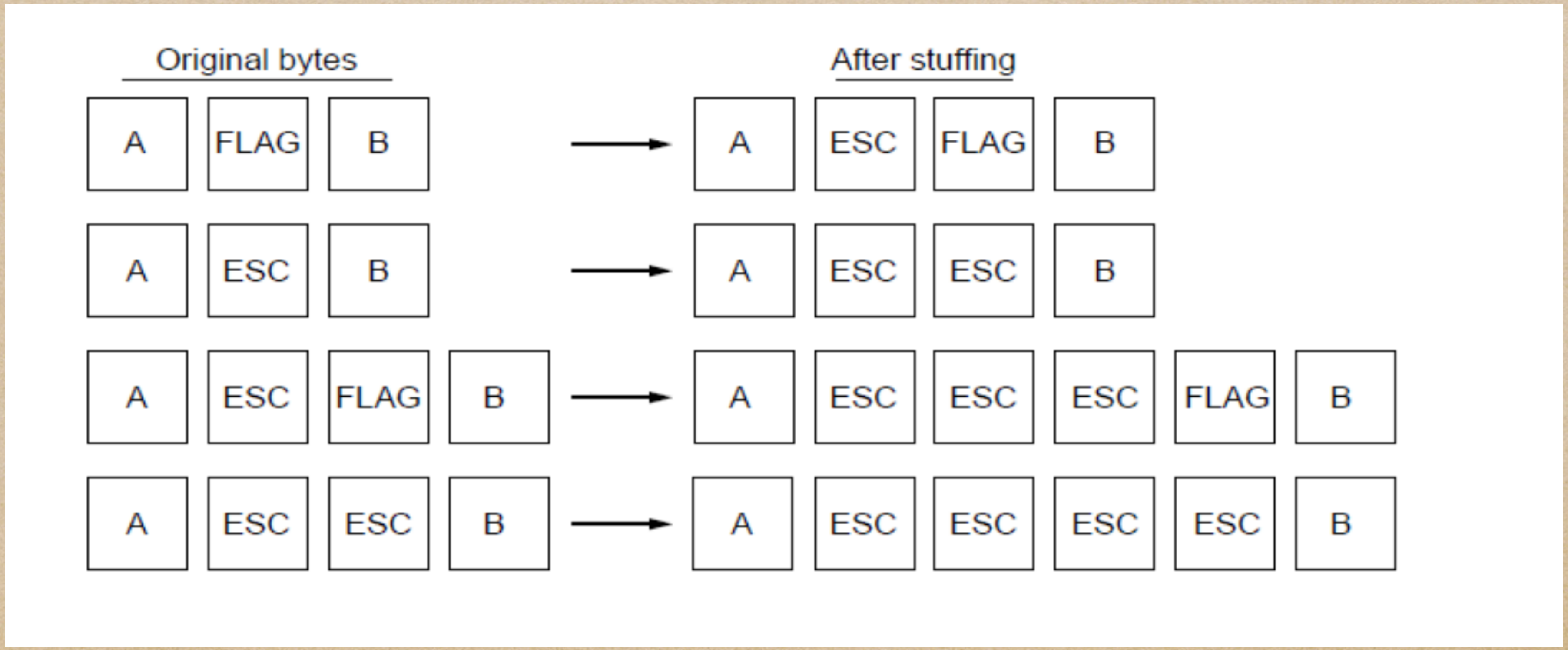
Link layer

Framing methods

- Byte count
- Byte stuffing
- Bit stuffing

Byte stuffing

- Have a special flat byte value
- Replace the flag inside the frame with an escape code
- Need to escape the escape code too



Hamming distance

- Hamming distance of a code is the minimum distance between any pair of valid codewords.

Hamming distance

Error detection:
For a code of distance $d+1$, up to d errors will always be detected.

Error correction:
For a code of distance $2d+1$, up to d errors will always be corrected by mapping to the closest codeword.

Hamming distance

Assume a code has hamming distance 5

How many errors it can detect?

How many errors it can correct?

2D parity

0	1	1	0	
1	0	0	1	
1	1	0	0	
1	1	0	1	

Internet checksum - sender

Add using one's complement	0010
	1101
	1110
	0011
	————
	0010
Negate to get sum	1101

Internet checksum - receiver

Add using one's complement

0010

1101

1110

0011

1101

————

1111

Negate and check it is 0 0000

Internet checksum

Assume 4-bit works, is the following frame received correct ?

0010, 1101, 0111, 0010, 0110

Cyclic Redundancy Check

Sender:

1. Extend n data bits with k zeros
2. Divide by generator value C
3. Keep remainder, ignore quotient
4. Adjust k check bits by remainder

Receiver:

Divide and check for zero reminder

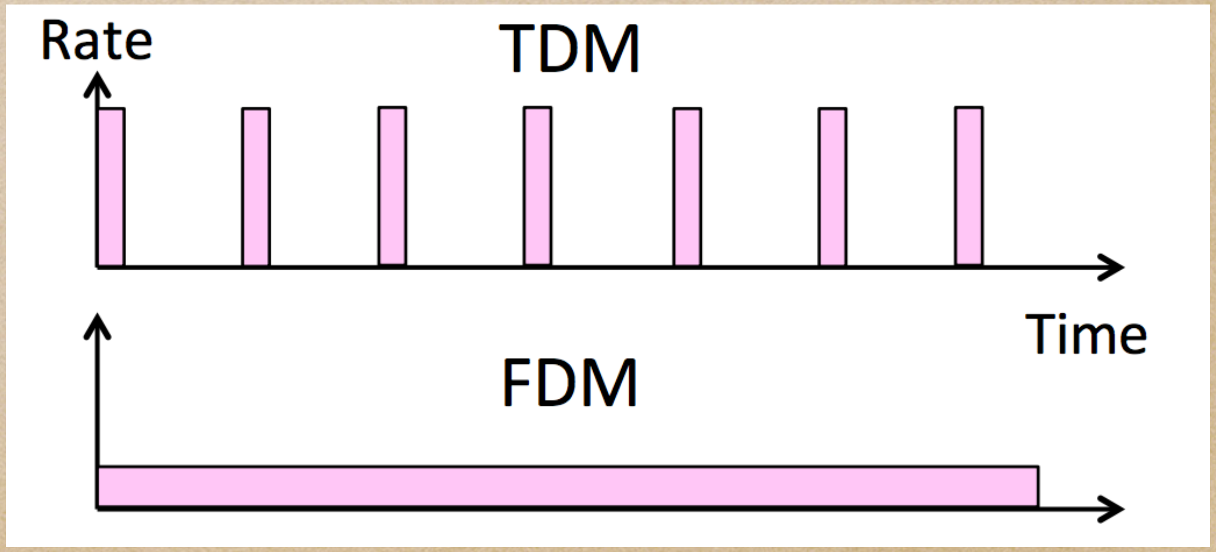
Multiplexing

Time Division Multplexing (TDM)

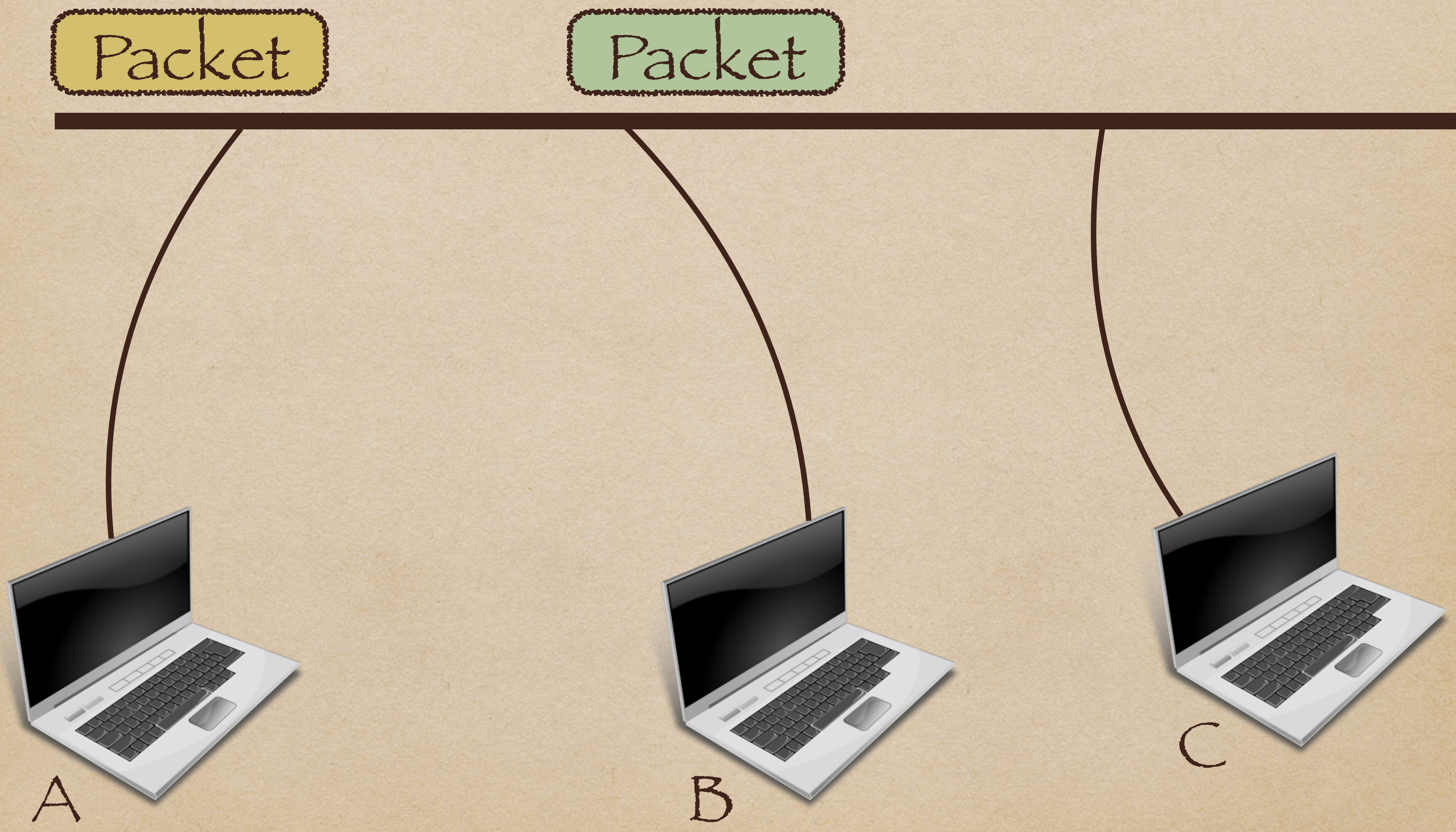
User take turns on a fixed schedule

Frequency Division Multplexing (FDM)

Put different users on different bands



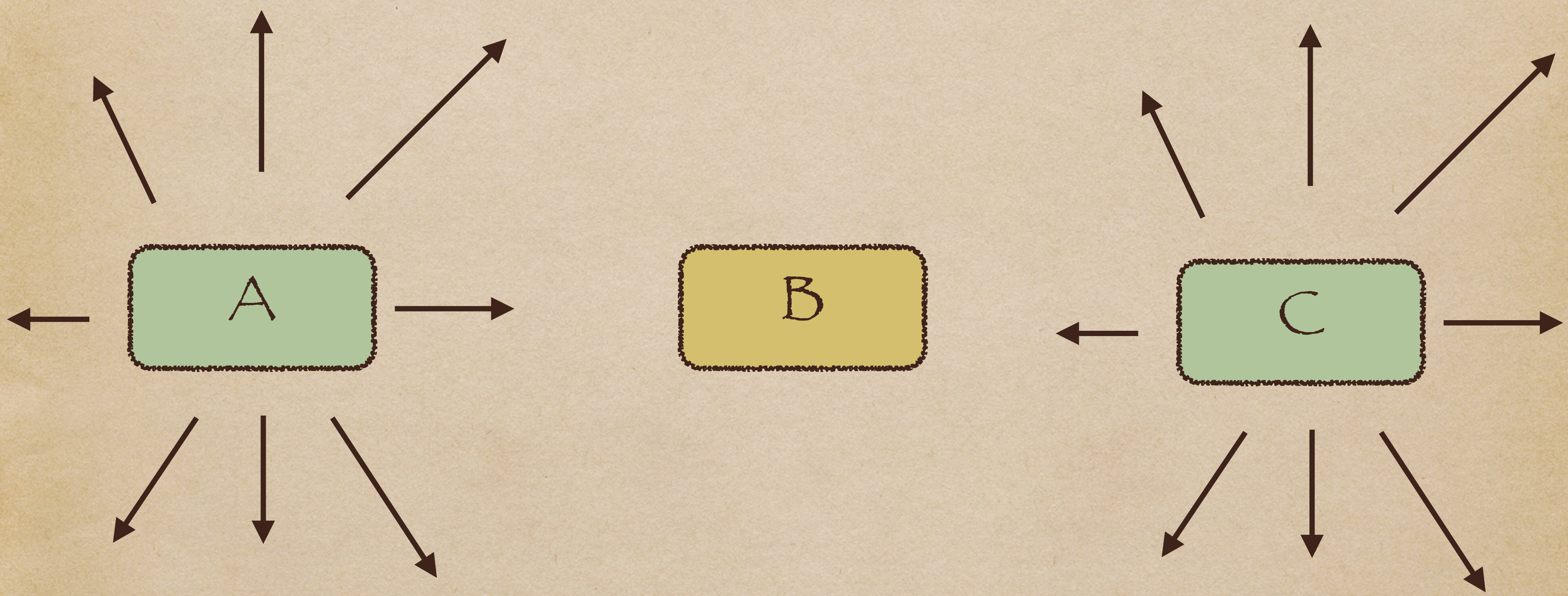
CSMA/CD in classic Ethernet



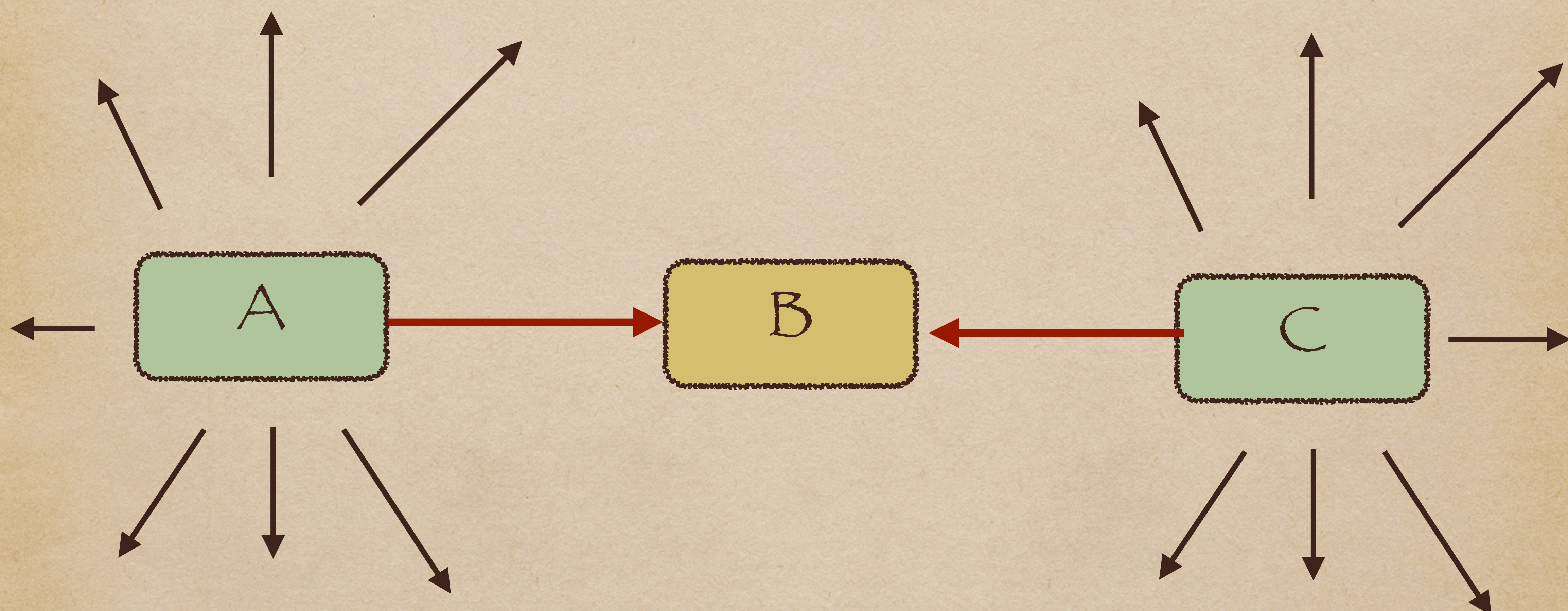
Exponential back-off

- Whenever a collision is detected, wait a random number between 0 and 2^n - 1 inclusive before sending again.
- n is usually 10 at max

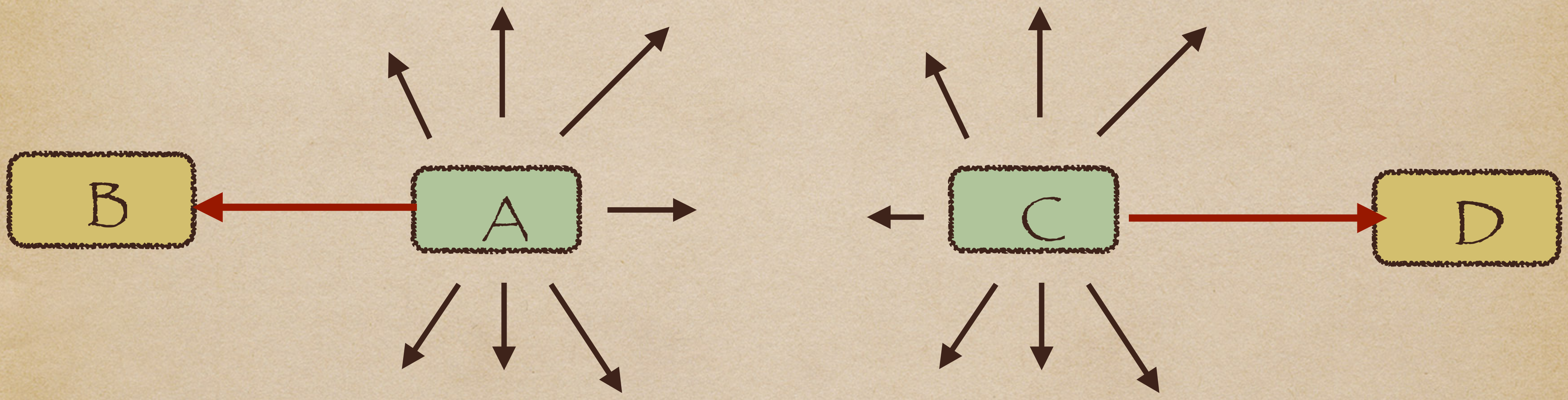
Wireless



Hidden terminals



Exposed terminals

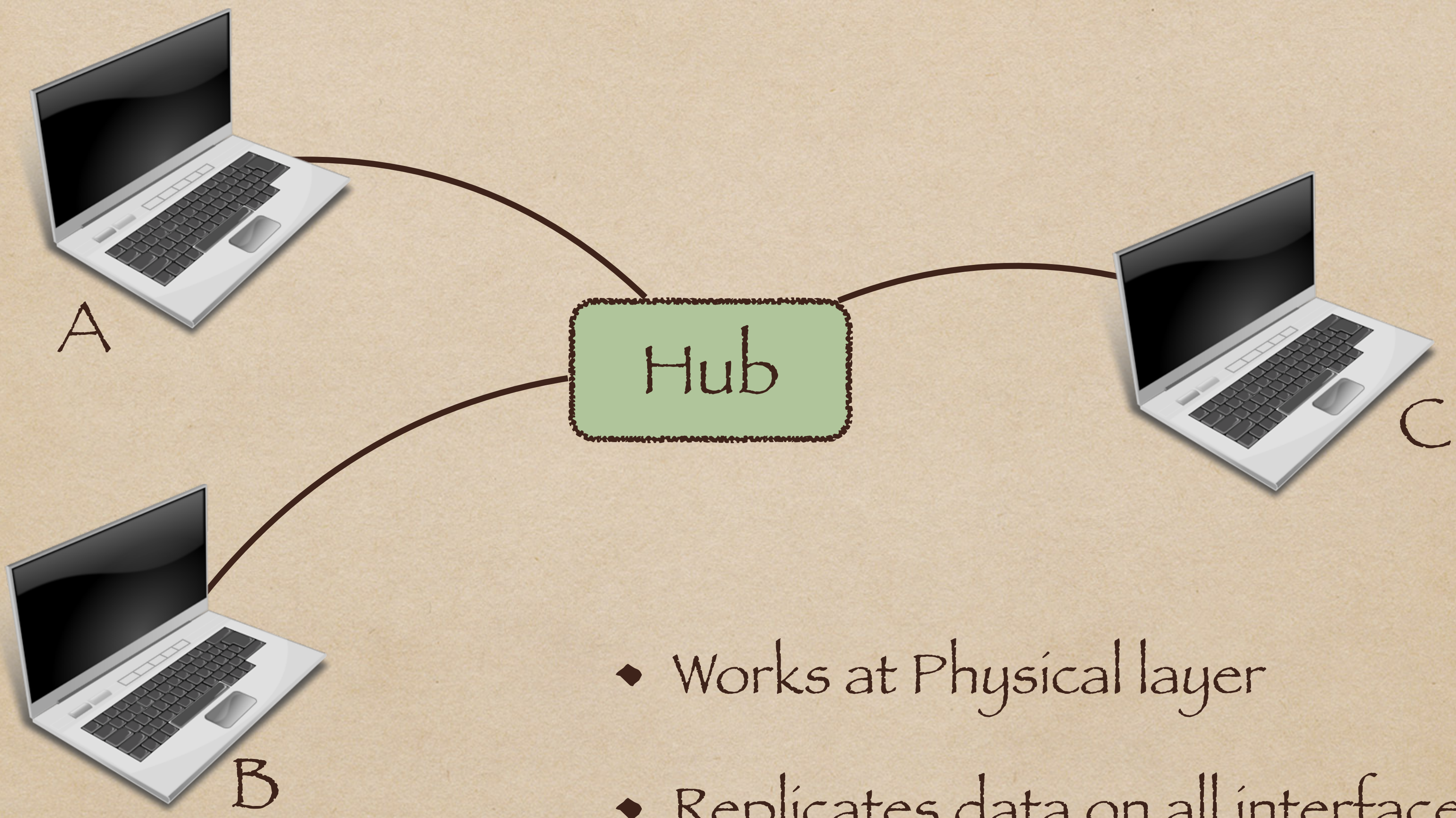


MACA

Protocol:

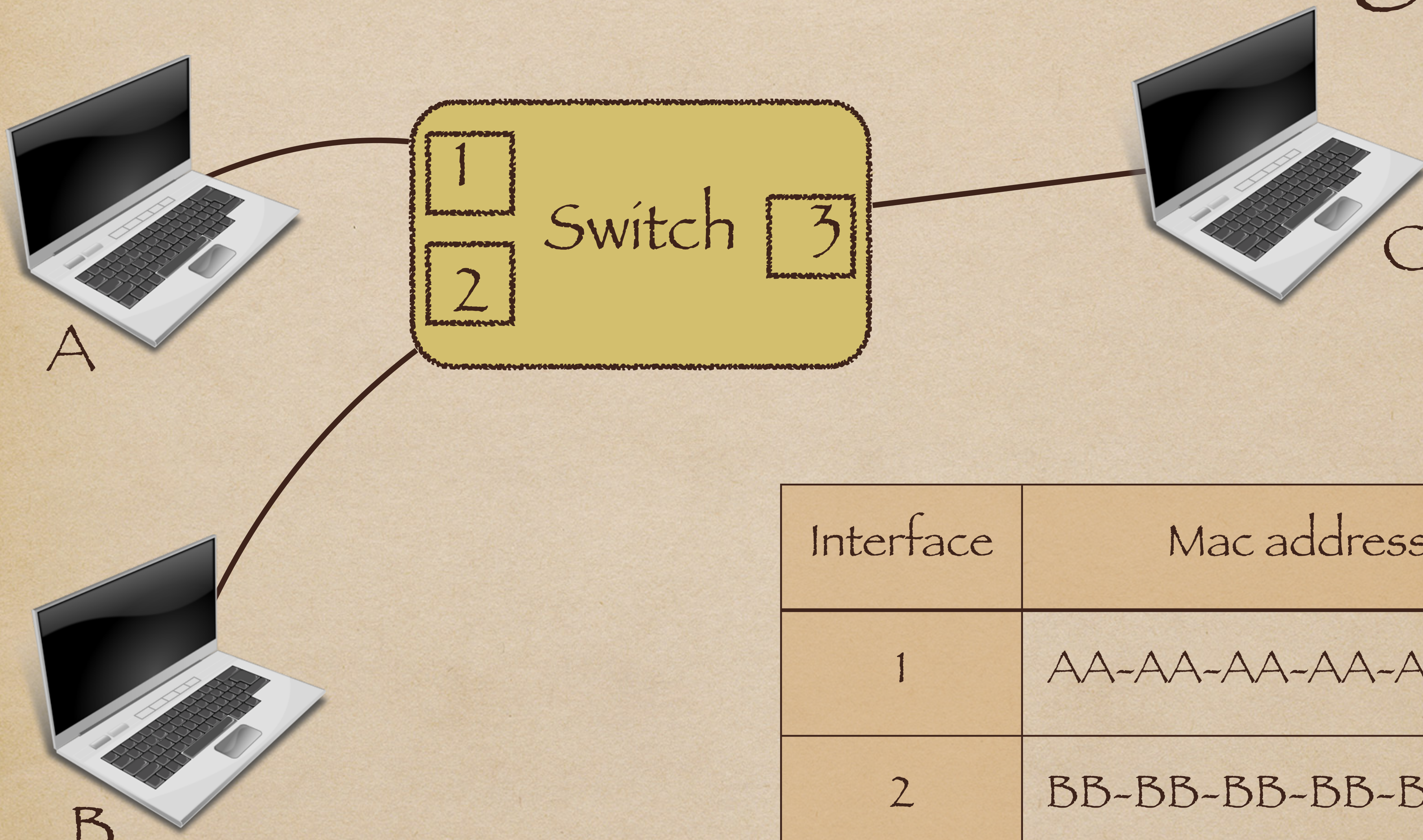
1. Sender transmits RTS (Ready to send)
2. Receiver replies with CTS (Clear to send)
3. Send transmits frame while nodes hearing CTS stays silent

What is network Hub?



- Works at Physical layer
- Replicates data on all interface
- Cheap and simple, waste bandwidth

What is network Switch/Bridge?

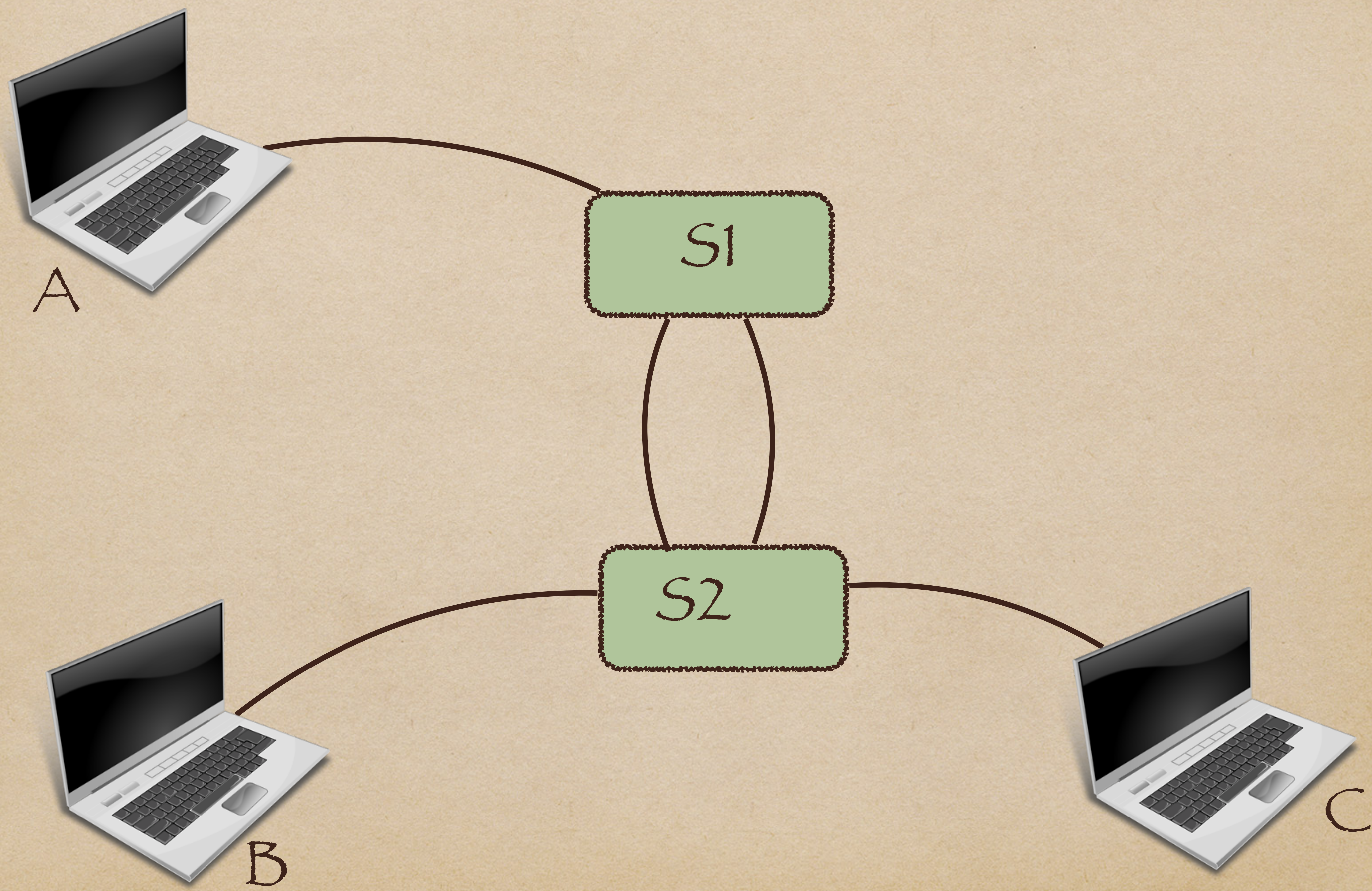


Interface	Mac address
1	AA-AA-AA-AA-AA-AA
2	BB-BB-BB-BB-BB-BB
3	CC-CC-CC-CC-CC-CC

What is network Switch/Bridge?

- Works at Link layer
- Learns Mac address
- Forwards packet using switch table
- Connects devices together

Forwarding loops

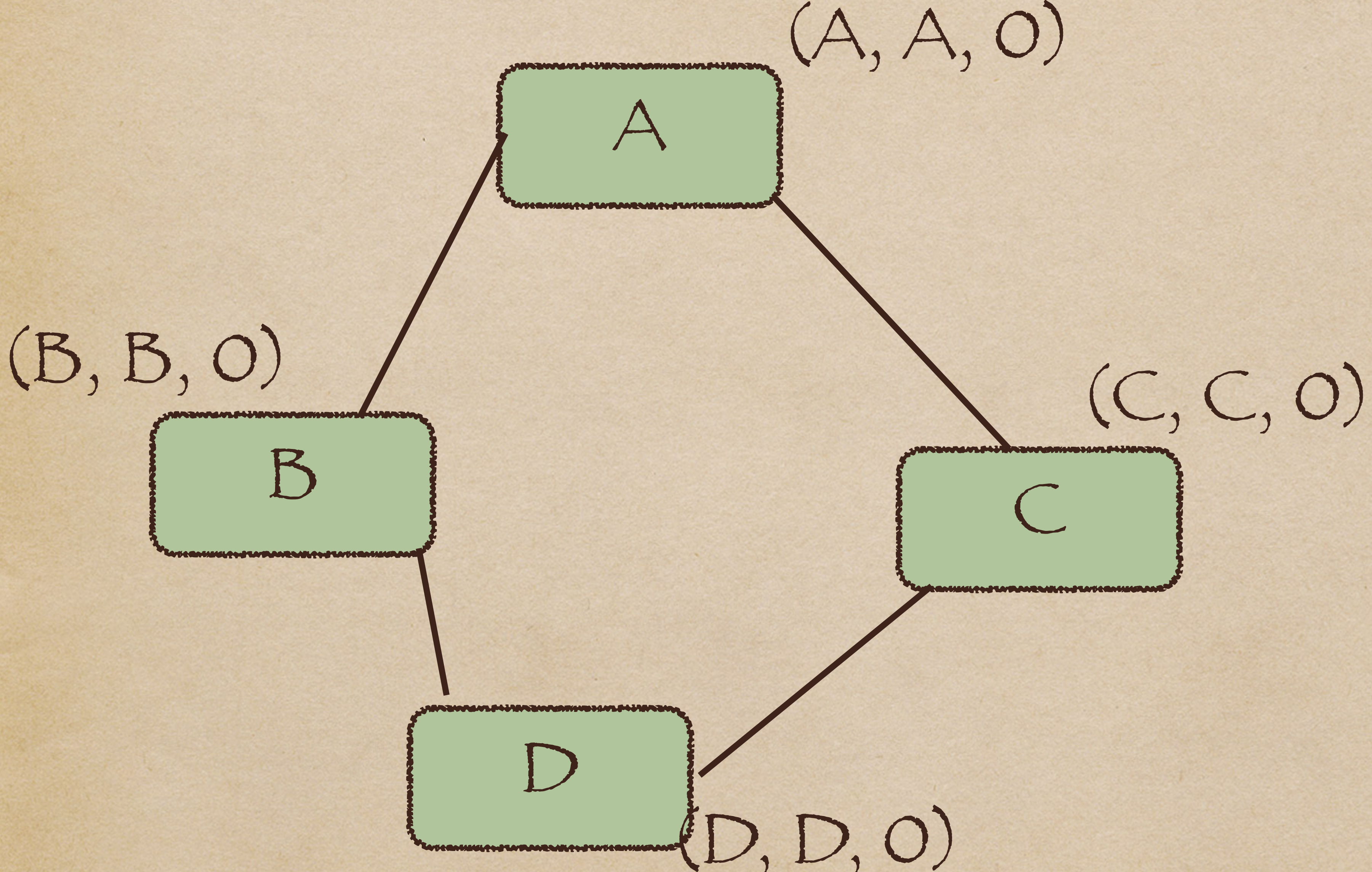


Spanning tree Algorithm

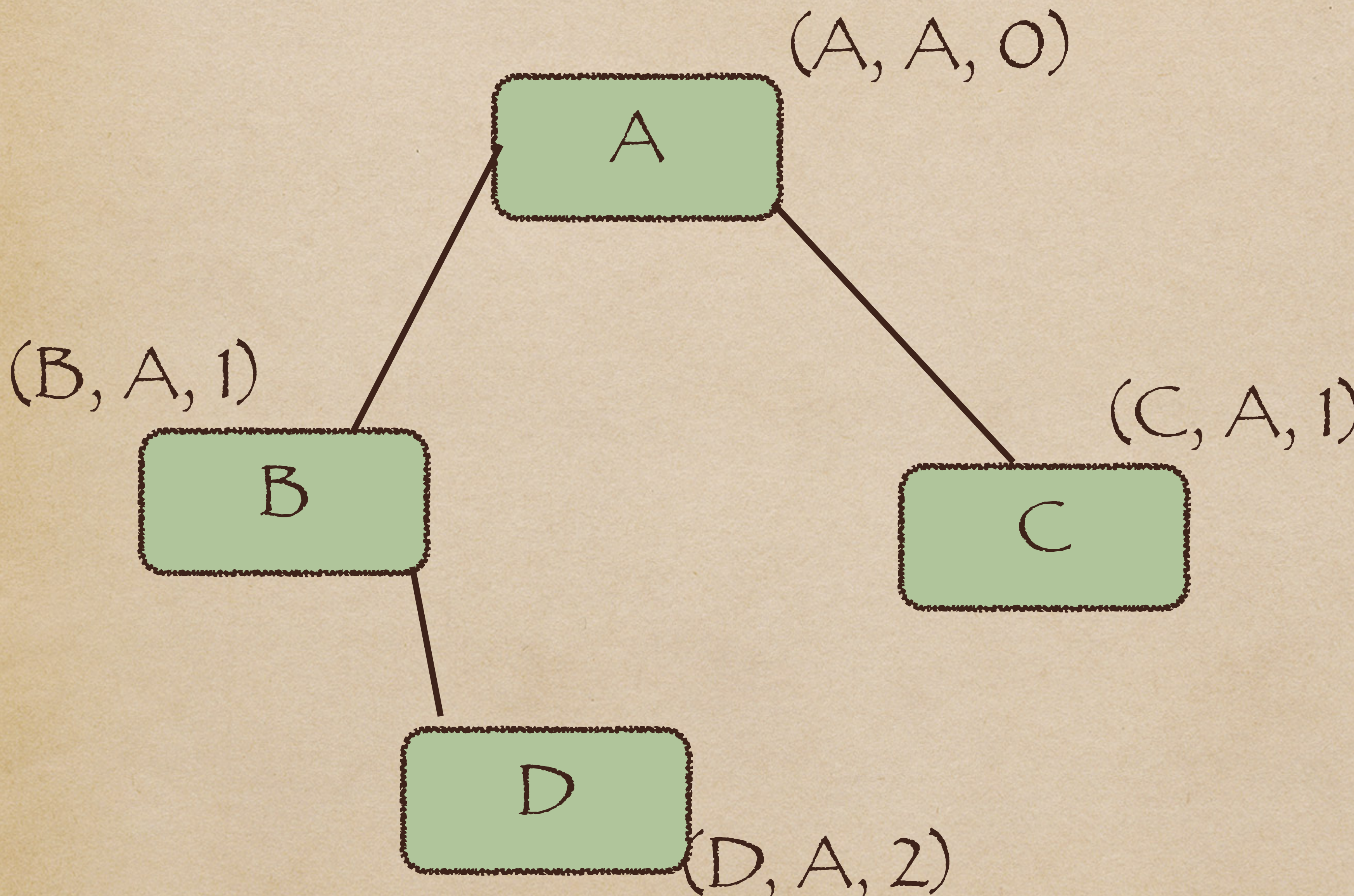
Outline:

1. Elect a root node of the tree. (Switch with lowest address)
2. Grow tree as shortest distances from root
3. Turn off port for forwarding if they aren't on the spanning tree

Spanning tree Algorithm

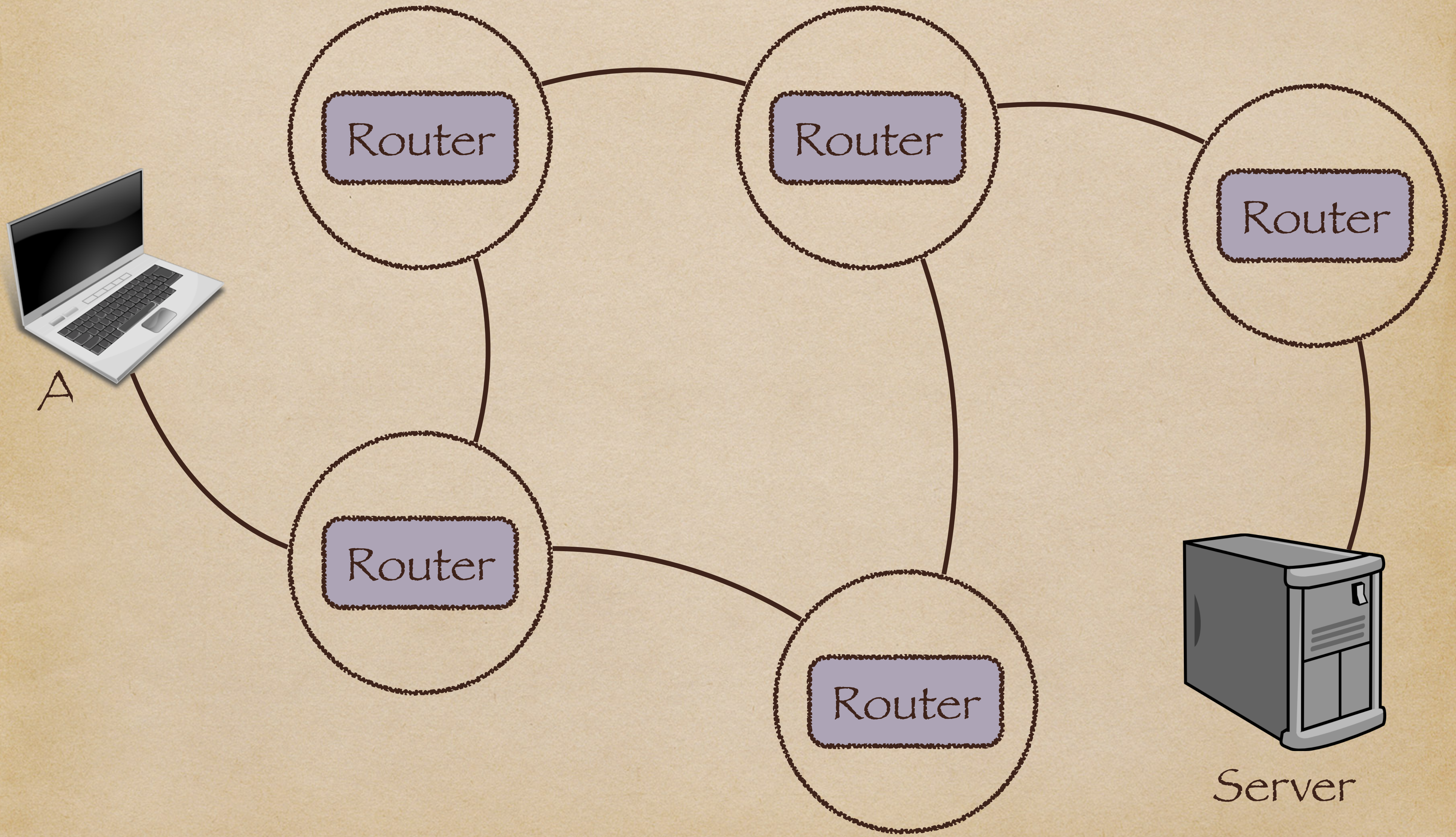


Spanning tree Algorithm



Network layer

What is network Router?

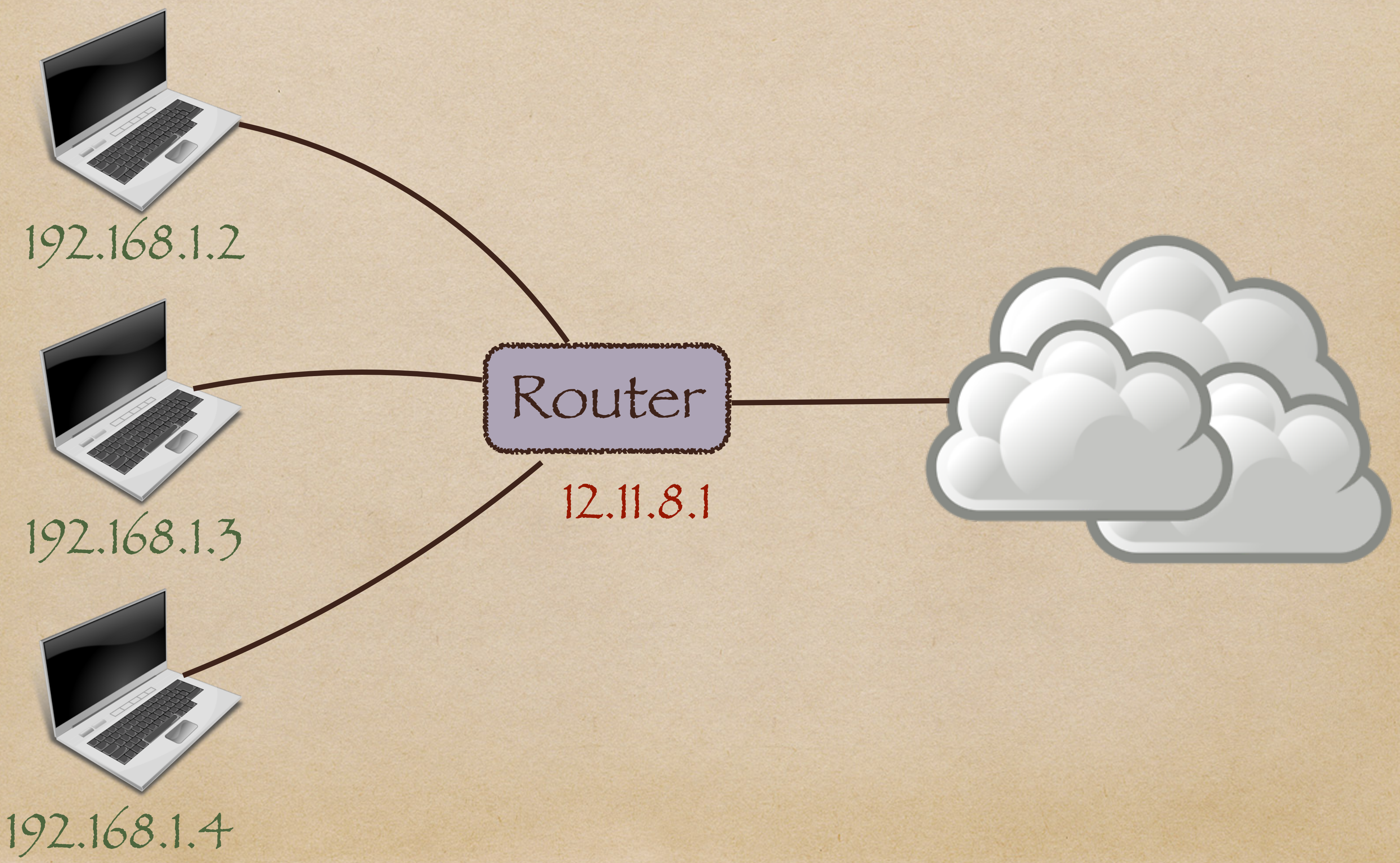


What is network Router?

- Works at Network layer
- Gateway between local network/private network to Internet
- Carries functions like wifi transmission, NAT, DHCP and routing

Let's talk about DHCP

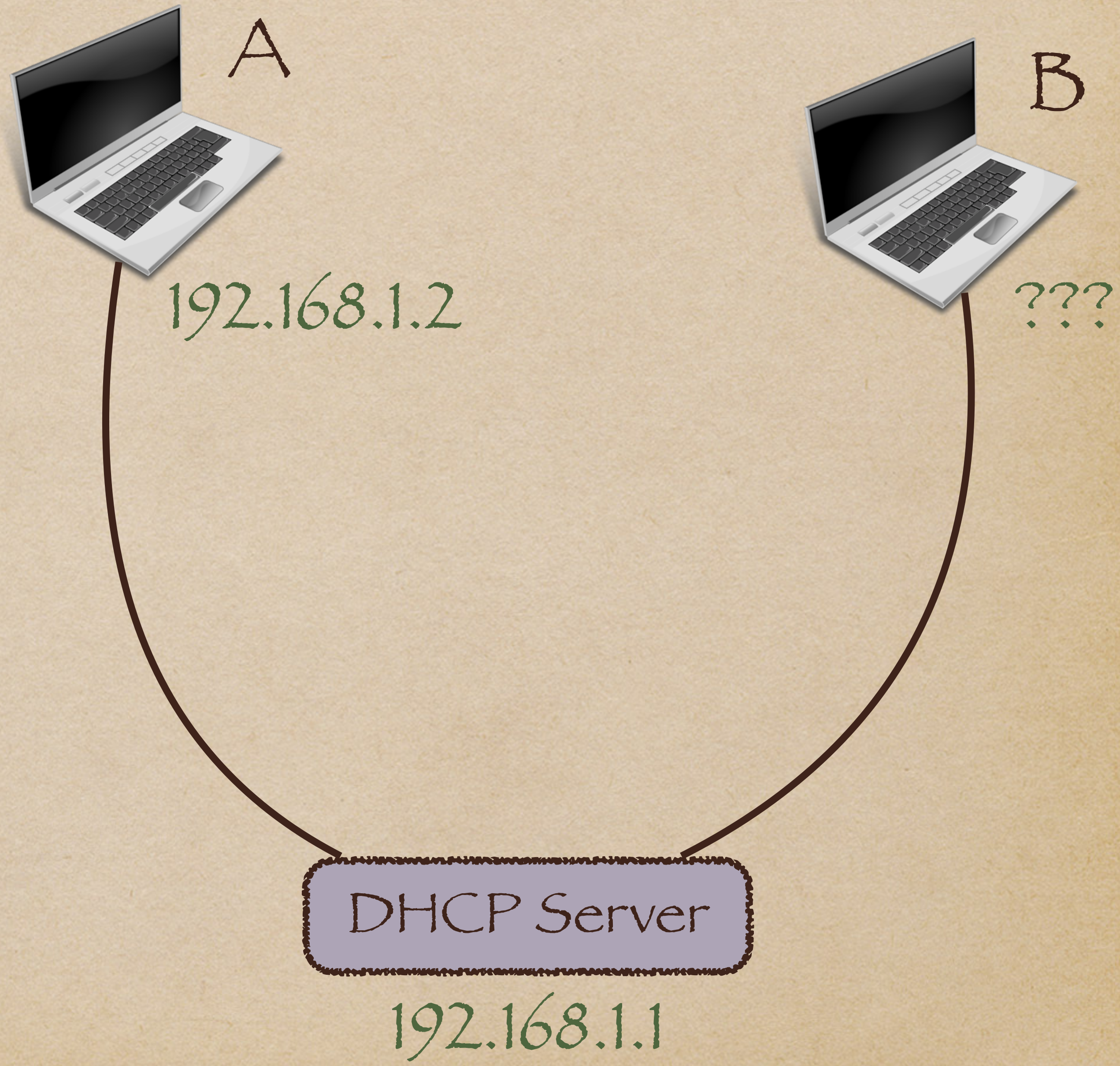
Private address public address



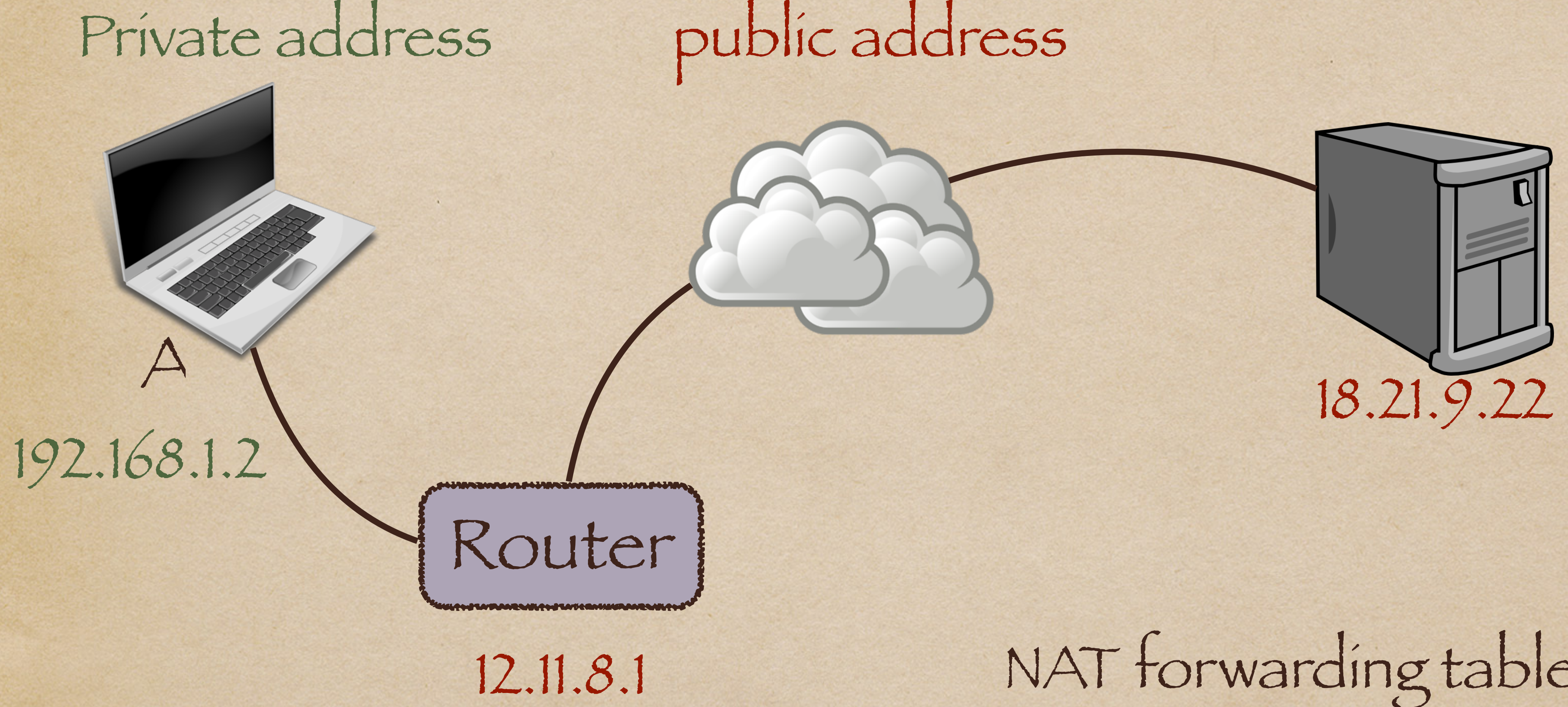
Let's talk about DHCP

Protocol:

1. DHCP Discover
2. DHCP offer
3. DHCP request
4. DHCP ACK



NAT



NAT forwarding table

Private address	Public address
192.168.1.2:12345	12.11.8.1:22222

Forwarding methods

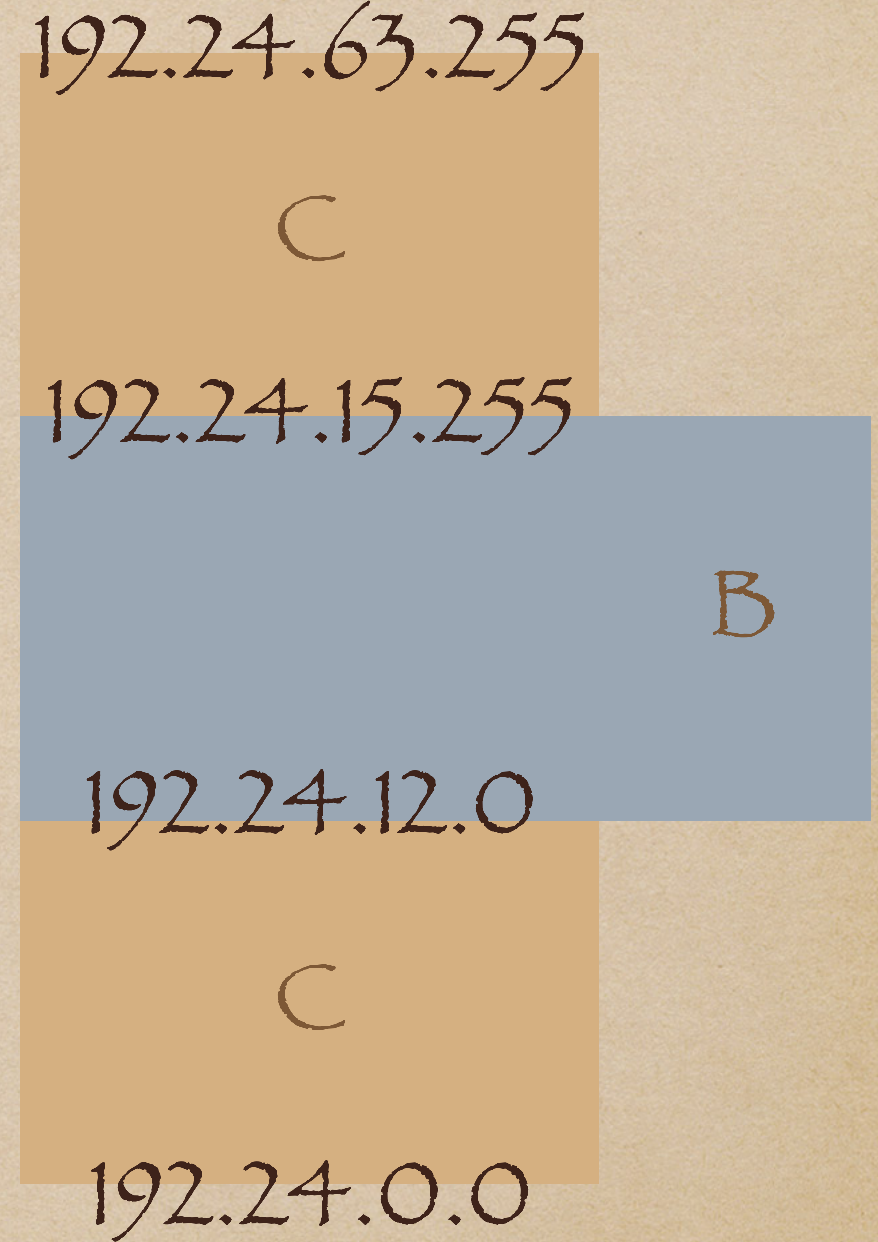
- Datagram model
- Virtual circuit model

Routing methods

- Dijkstra's Algorithm
- Distance vector (Distributed version of Bellman Ford)
- Link-State Algorithm

Longest prefix matching

Prefix	Next hop
192.24.0.0/18	C
192.24.12.0/22	B



Good luck!