CS 725/825 & IT 725

Lecture 24

Link Layer

December 3, 2025

Ethernet Frame

802.3 Ethernet frame structure

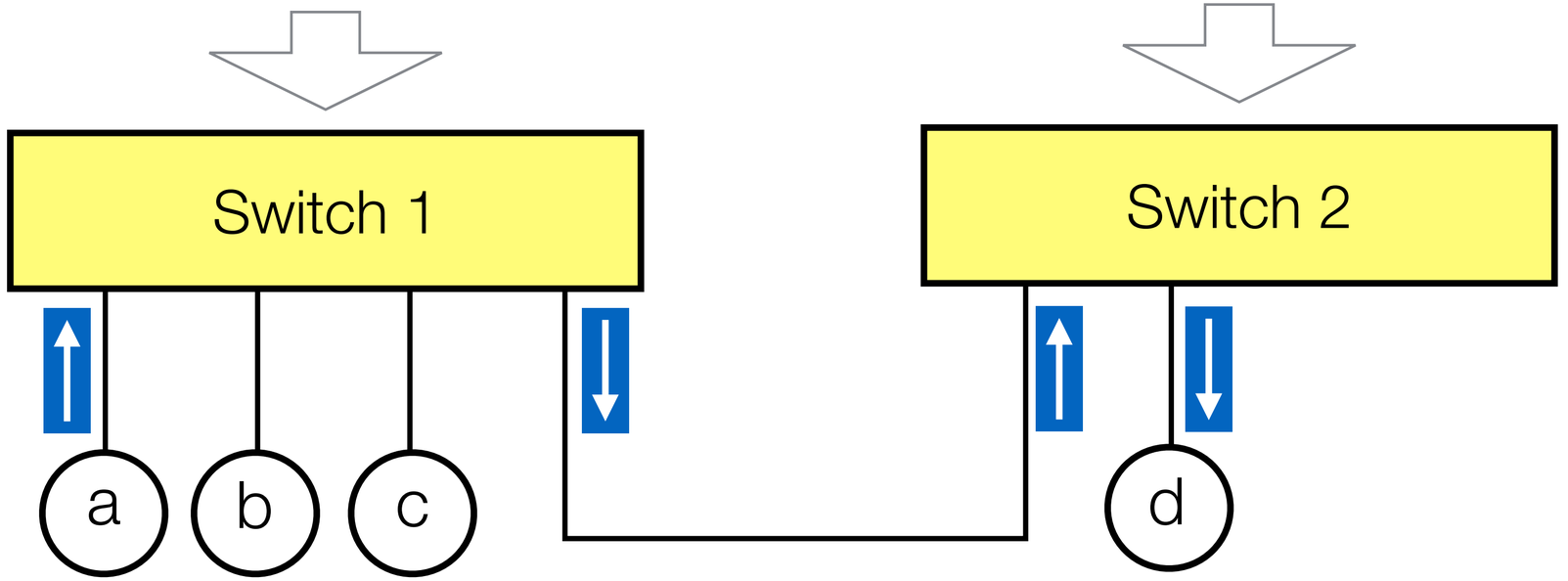
Preamble	Start of frame delimiter	MAC destination	MAC source	802.1Q tag (optional)	Ethertype (Ethernet II) or length (IEEE 802.3)	Payload	Frame check sequence (32-bit CRC)	Interframe gap
7 octets of 10101010	1 octet of 10101011	6 octets	6 octets	(4 octets)	2 octets	42[note 2]–1500 octets	4 octets	12 octets
		64–1522 octets						
72–1530 octets								
84–1542 octets								

Image source: Wikipedia article “Ethernet frame” (https://en.wikipedia.org/wiki/Ethernet_frame)

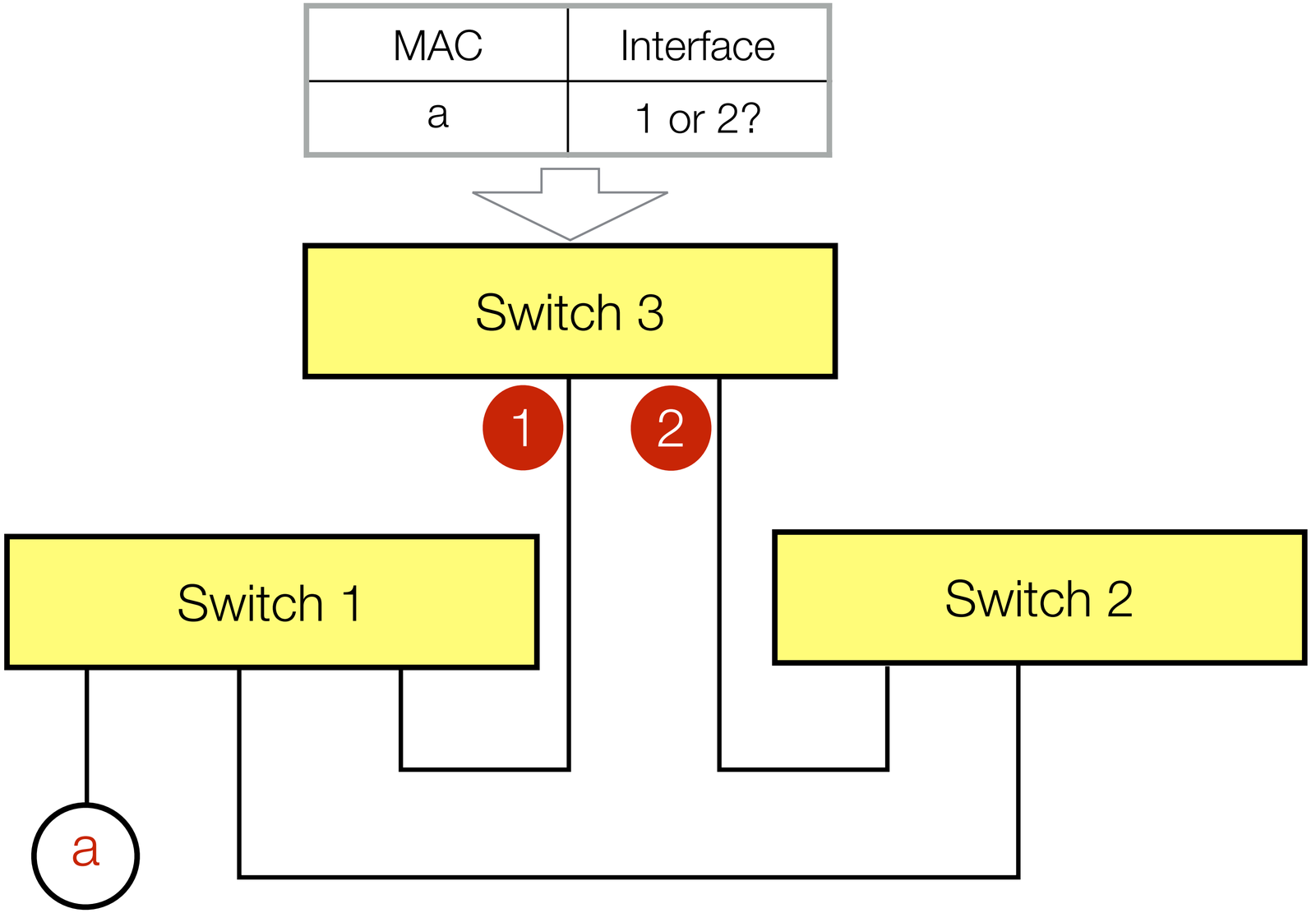
Unicast packet from a to d

MAC	Interface
a	1
b	2
c	3
d	4

MAC	Interface
a	1
b	1
c	1
d	2



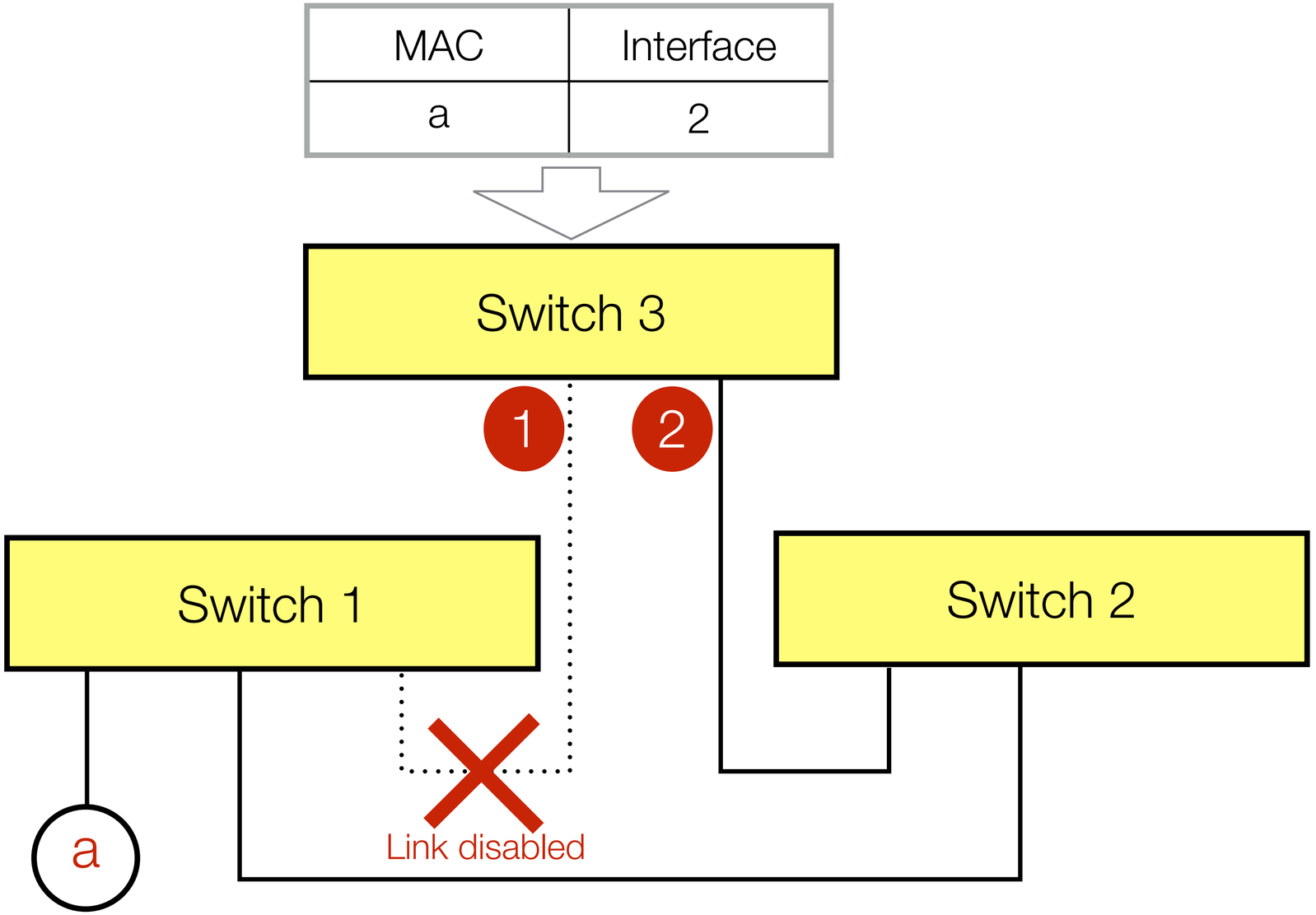
Loops?



Spanning Tree Protocols

- Loops in the network topology help to increase resiliency of the network
  - but introduce problems when populating bridging tables
- Solution: Spanning Tree Protocols (STP)
  - temporarily disable links to break loops
  - monitor health of active links and re-enable links if network partitioning is detected
  - tradeoff: link health monitoring overhead vs repair latency

Spanning Tree Protocols

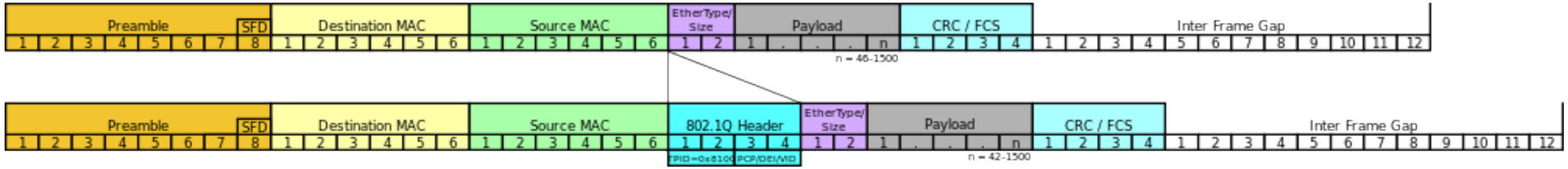


Virtual LANs (VLANs)

- Bridging/switching eliminates delivering unicast traffic that is not destined to the node
- Does not work for L2 broadcast traffic (still has to be delivered to all nodes)
- Solution: Virtual LANs (VLANs)
  - broad approach: decouple logical and physical topology: virtual networks, overlay networks, ...
  - specific approach: break broadcast domains into smaller ones
  - other benefits: QoS, security, control, ...

802.1Q Virtual LANs (VLANs)

- On VLAN capable links adds a 32-bit field to the standard Ethernet frame



802.1Q header:

TPID (16 bits) 0x8100

TCI - Tag Control Information (16 bits)

PCP - priority code point (3 bits)

DEI - drop eligible indication (1 bit)

VID - VLAN Identifier (12 bits)

Wireless Networks

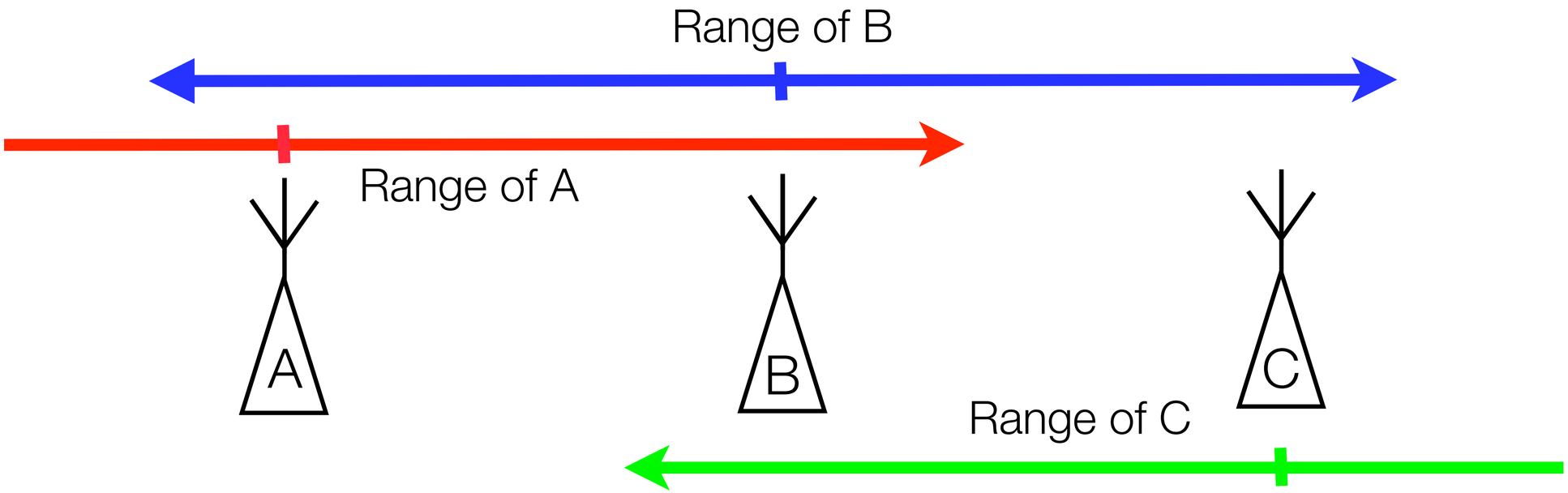
- Radio Frequency (RF) transmission
  - Omnidirectional (broadcast and select)
  - Point to point (directional antennas)
- Organization
  - WLAN
  - Cellular networks (LTE, 5G, 6G …)
  - Personal area networks / home automation / Internet of Things (Thread/ Matter) …
  - Access network

Wireless Networks

- Free Space Optical Networks
  - point to point laser links
  - HPC interconnects
- Acoustic Networks
  - underwater communication

Wireless Link Layer

- Hidden Terminal Problem



Solution: CSMA/CA

- **Collision Avoidance (CA)**
  - make sure that the all nodes in the ranges of both source and destination are allowed to transmit