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# Computer Networks 1

## (Mạng Máy Tính 1)

Lectured by: Dr. Phạm Trần Vũ



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# Lecture 4: Networking Technologies (cont')

***Reference:***

Chapter 4 - "*Computer Networks*",  
Andrew S. Tanenbaum, 4th Edition, Prentice Hall, 2003.



# Content

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- ❑ Broadband wireless
- ❑ Bluetooth
- ❑ Network bridges, hubs, switches, routers
- ❑ Virtual LAN



# Broadband Wireless - WiMAX

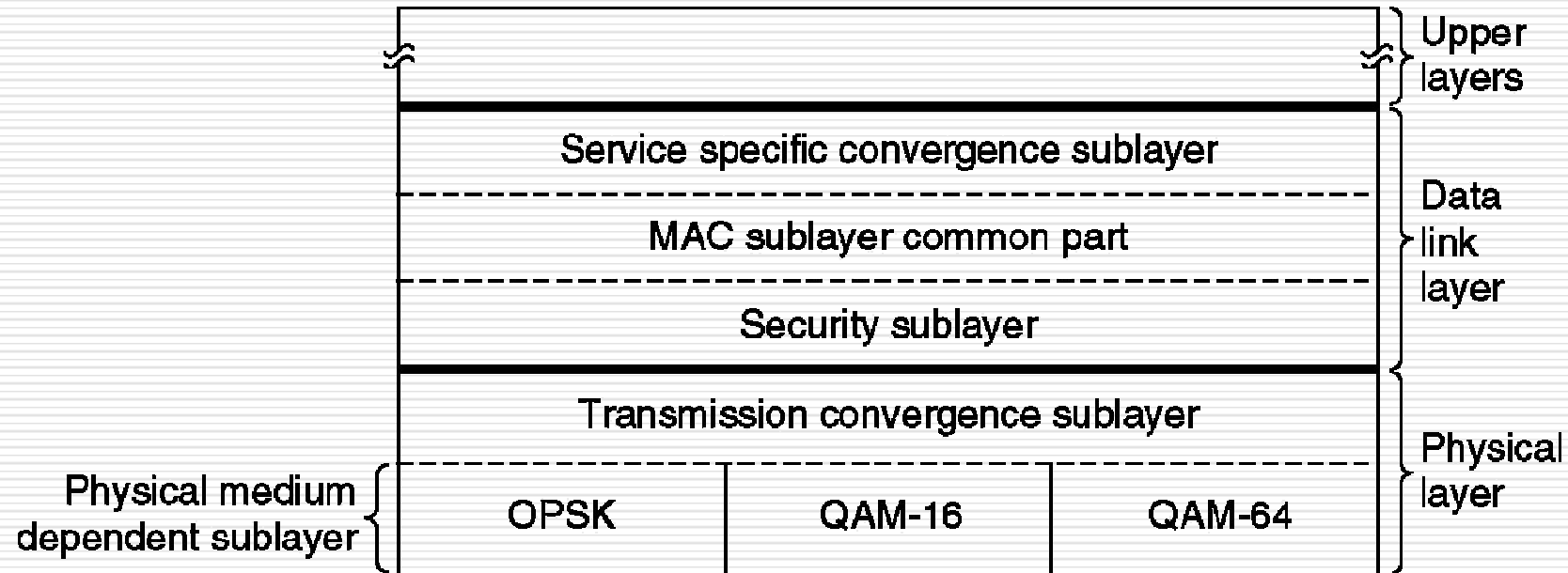
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- Long-range system, up to 50km
- Use licensed spectrum
- Provide internet access to end user from ISP
- Quality of service can be guaranteed



# The 802.16 Protocol Stack

## The 802.16 Protocol Stack.

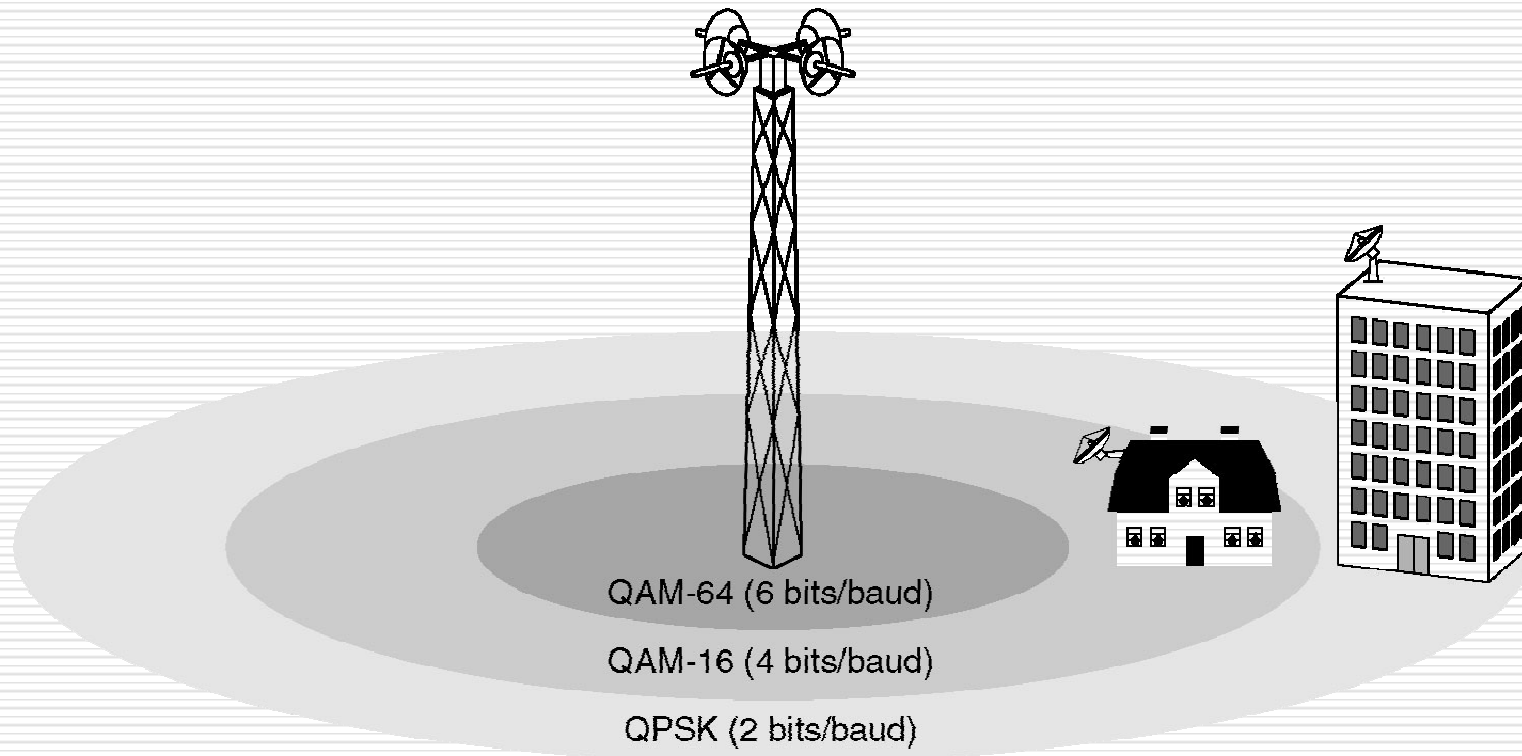




# The 802.16 Physical Layer

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The 802.16 transmission environment.

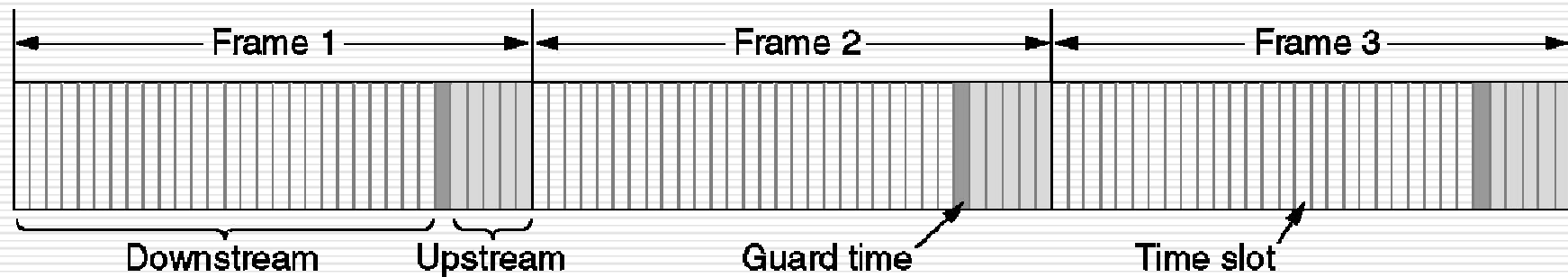




# The 802.16 Physical Layer (2)

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Frames and time slots for time division duplexing.





# The 802.16 MAC Sublayer Protocol

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## Service Classes

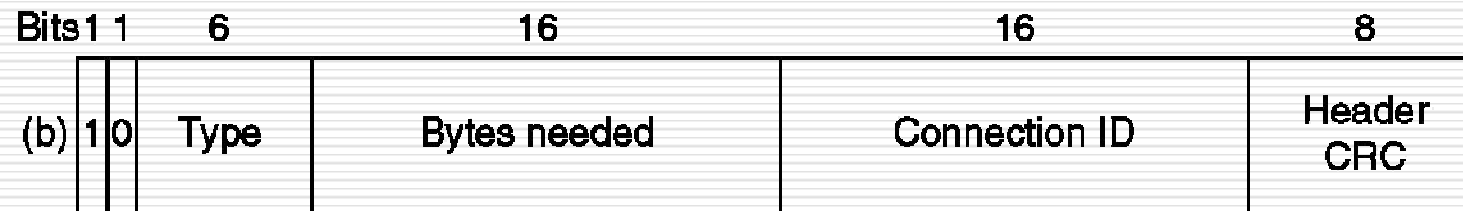
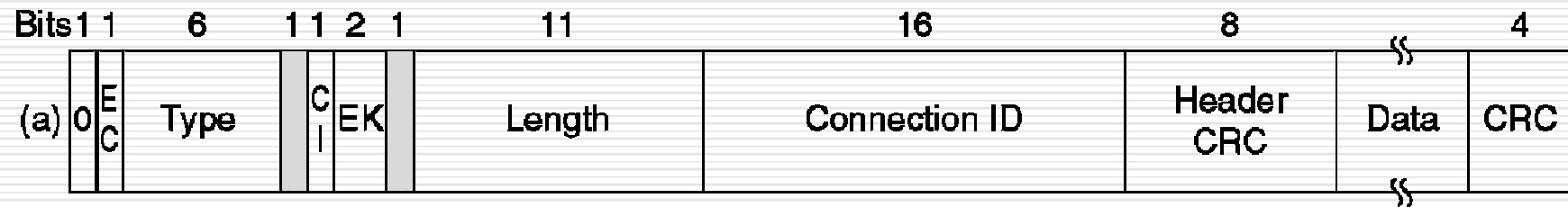
- Constant bit rate service
- Real-time variable bit rate service
- Non-real-time variable bit rate service
- Best efforts service





# The 802.16 Frame Structure

(a) A generic frame. (b) A bandwidth request frame.





# Bluetooth

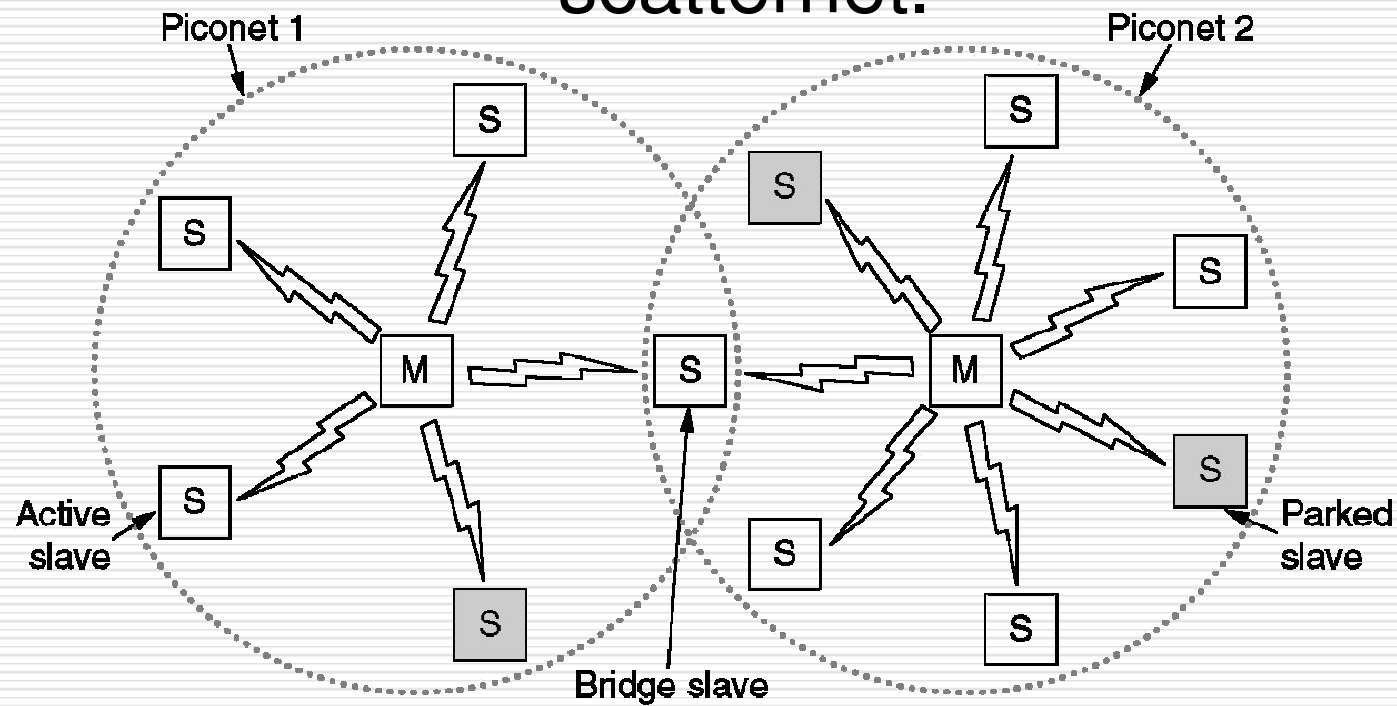
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- Bluetooth Architecture
  - Bluetooth Applications
  - The Bluetooth Protocol Stack
  - The Bluetooth Radio Layer
  - The Bluetooth Baseband Layer
  - The Bluetooth L2CAP Layer
  - The Bluetooth Frame Structure
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# Bluetooth Architecture

Two piconets can be connected to form a scatternet.





# Bluetooth Applications

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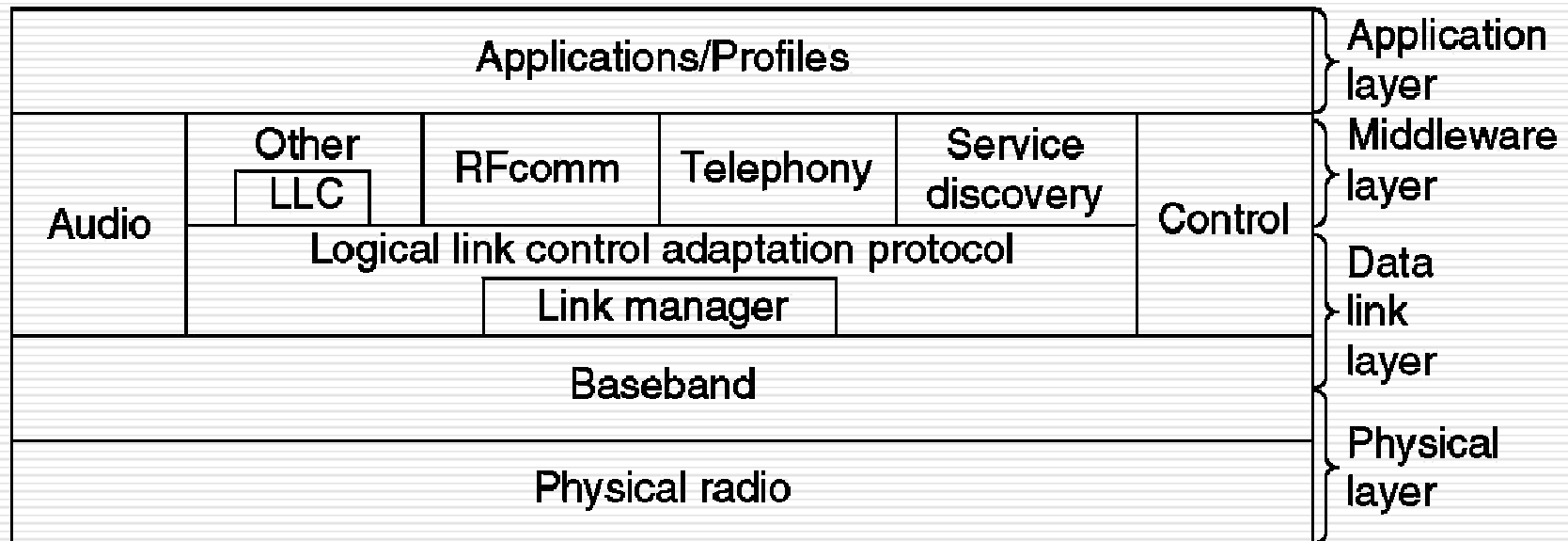
## The Bluetooth profiles.

Name	Description
Generic access	Procedures for link management
Service discovery	Protocol for discovering offered services
Serial port	Replacement for a serial port cable
Generic object exchange	Defines client-server relationship for object movement
LAN access	Protocol between a mobile computer and a fixed LAN
Dial-up networking	Allows a notebook computer to call via a mobile phone
Fax	Allows a mobile fax machine to talk to a mobile phone
Cordless telephony	Connects a handset and its local base station
Intercom	Digital walkie-talkie
Headset	Intended for hands-free voice communication
Object push	Provides a way to exchange simple objects
File transfer	Provides a more general file transfer facility
Synchronization	Permits a PDA to synchronize with another computer



# The Bluetooth Protocol Stack

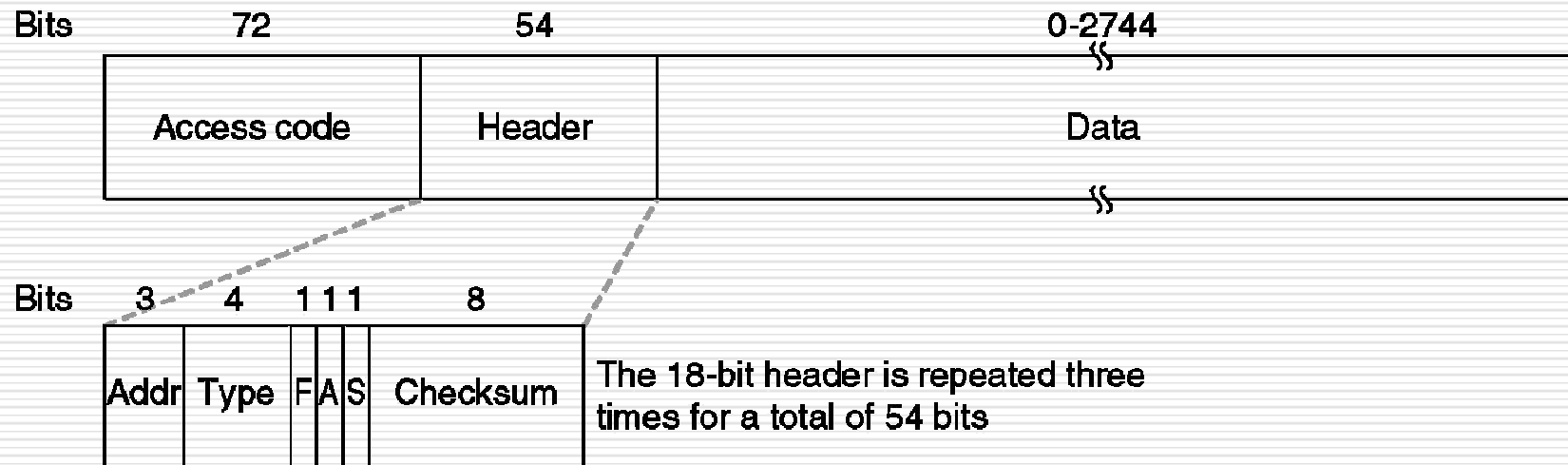
The 802.15 version of the Bluetooth protocol architecture.





# The Bluetooth Frame Structure

A typical Bluetooth data frame.





# Data Link Layer Switching

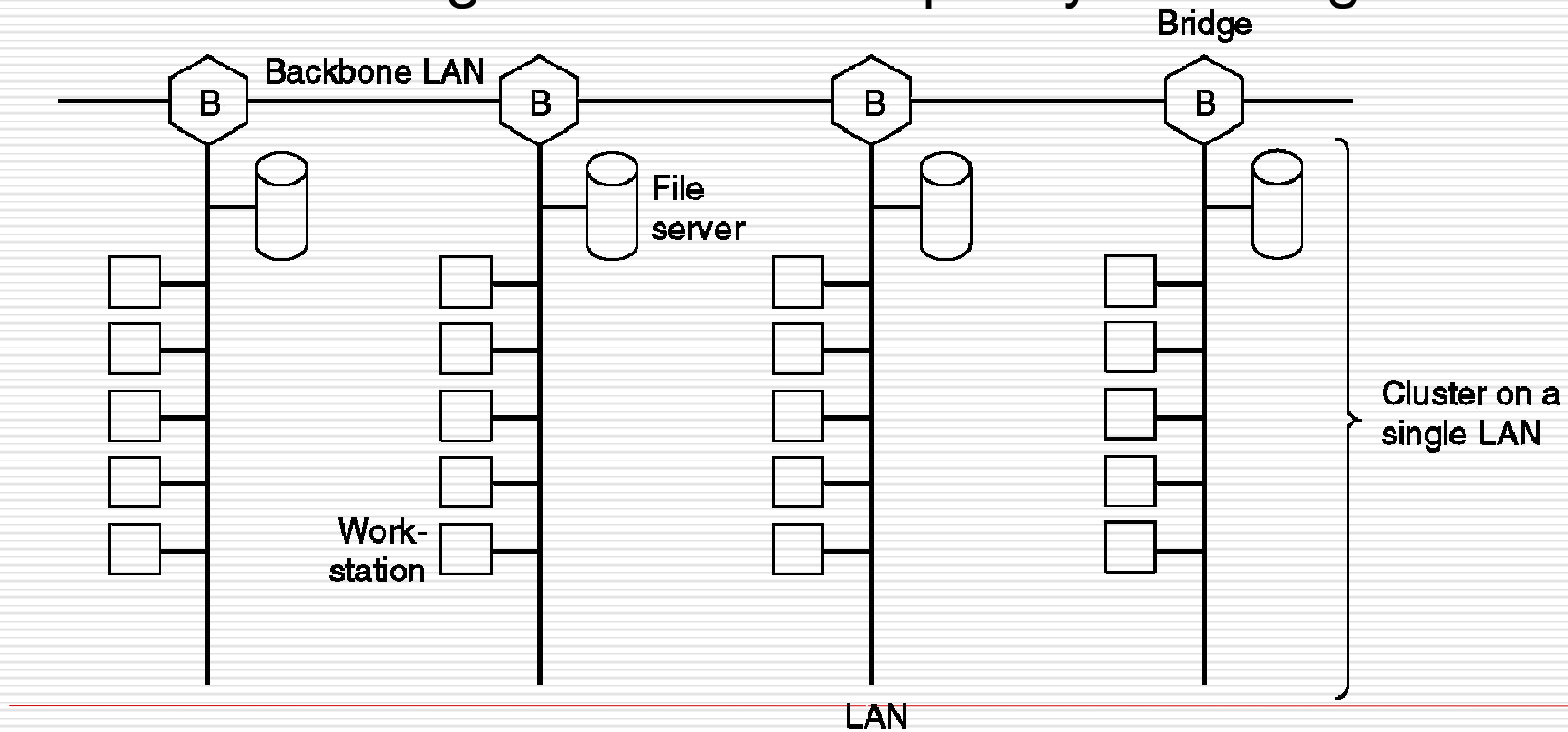
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- Bridges from 802.x to 802.y
- Local Internetworking
- Remote Bridges
- Repeaters, Hubs, Bridges, Switches, Routers, Gateways
- Virtual LANs



# Data Link Layer Switching

Multiple LANs connected by a backbone to handle a total load higher than the capacity of a single LAN.

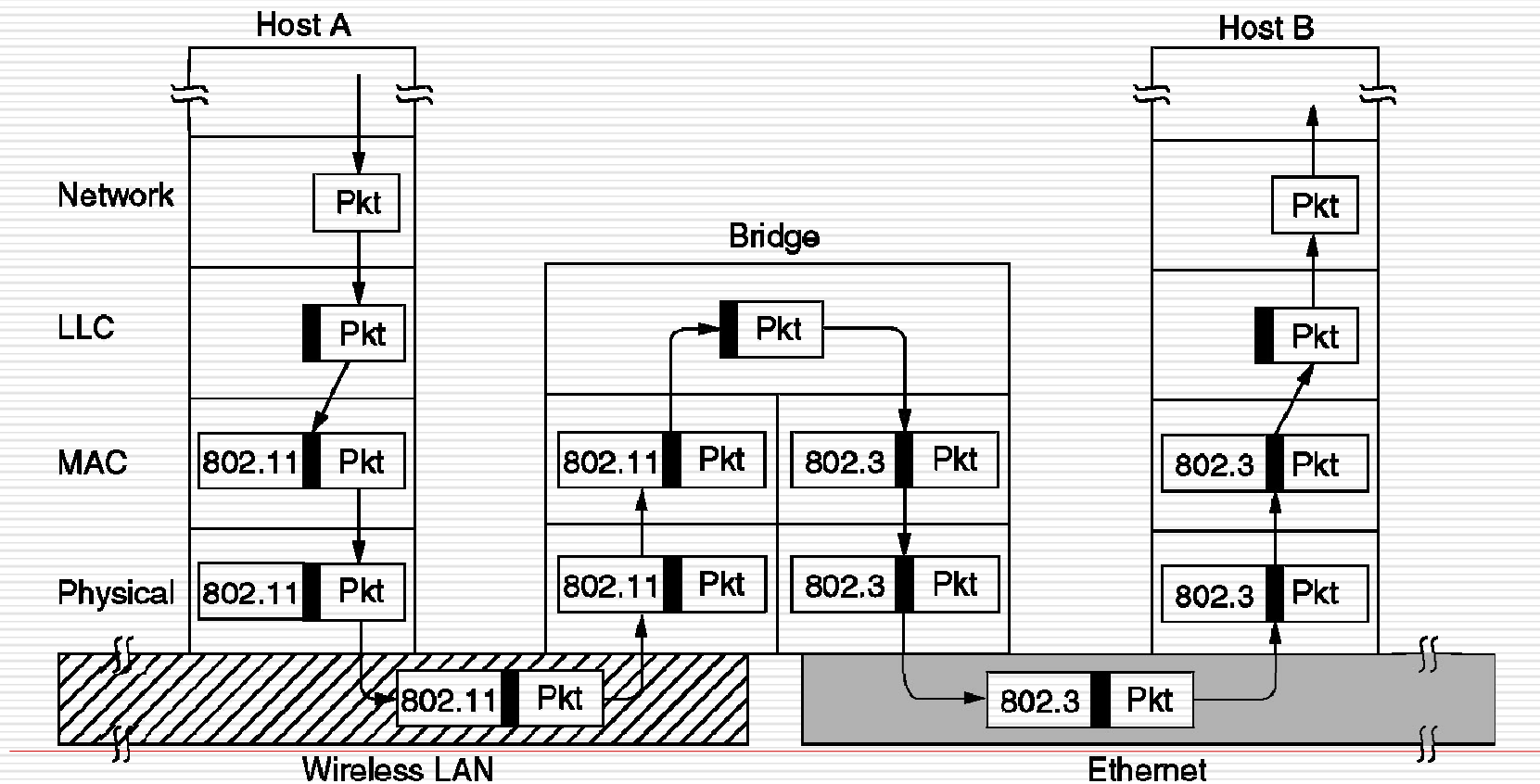






# Bridges from 802.x to 802.y

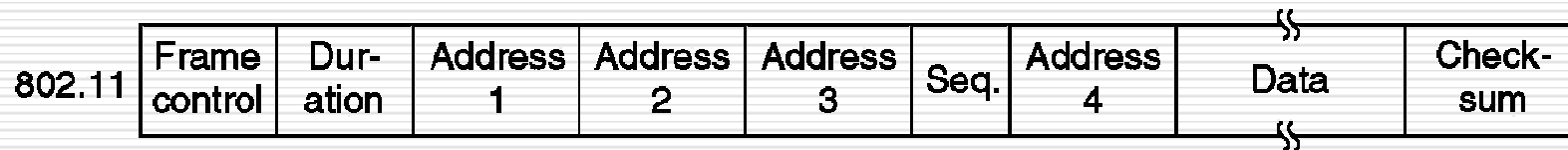
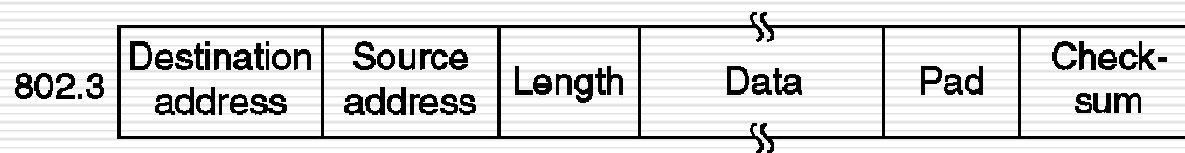
Operation of a LAN bridge from 802.11 to 802.3.





## Bridges from 802.x to 802.y (2)

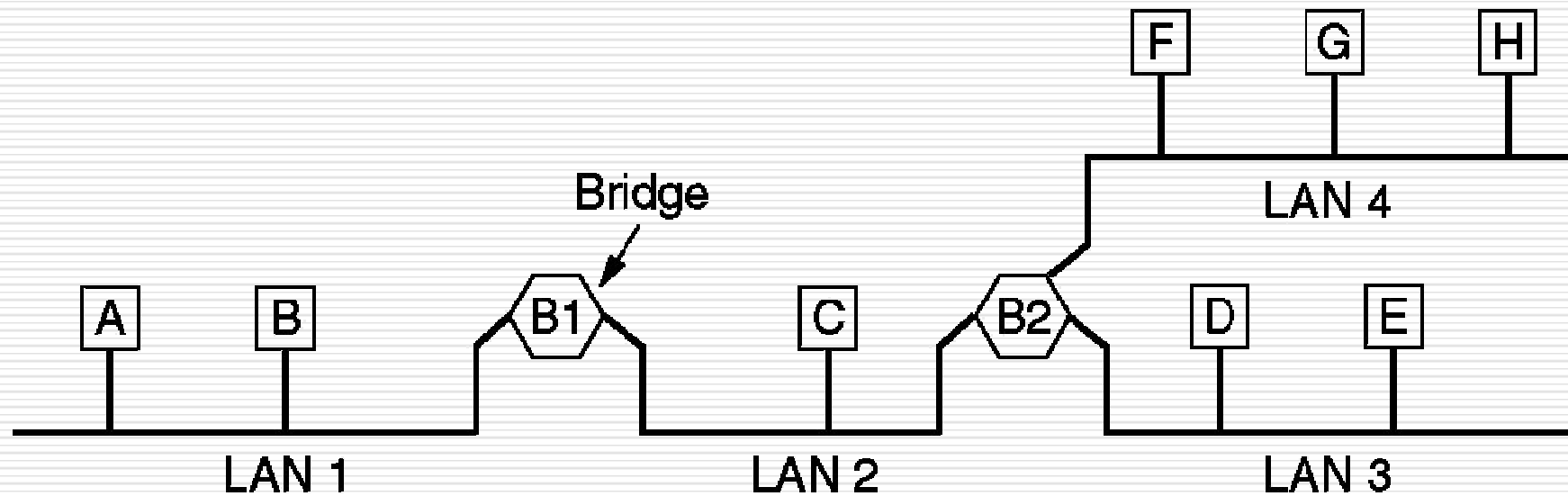
The IEEE 802 frame formats. The drawing is not to scale.





# Local Internetworking

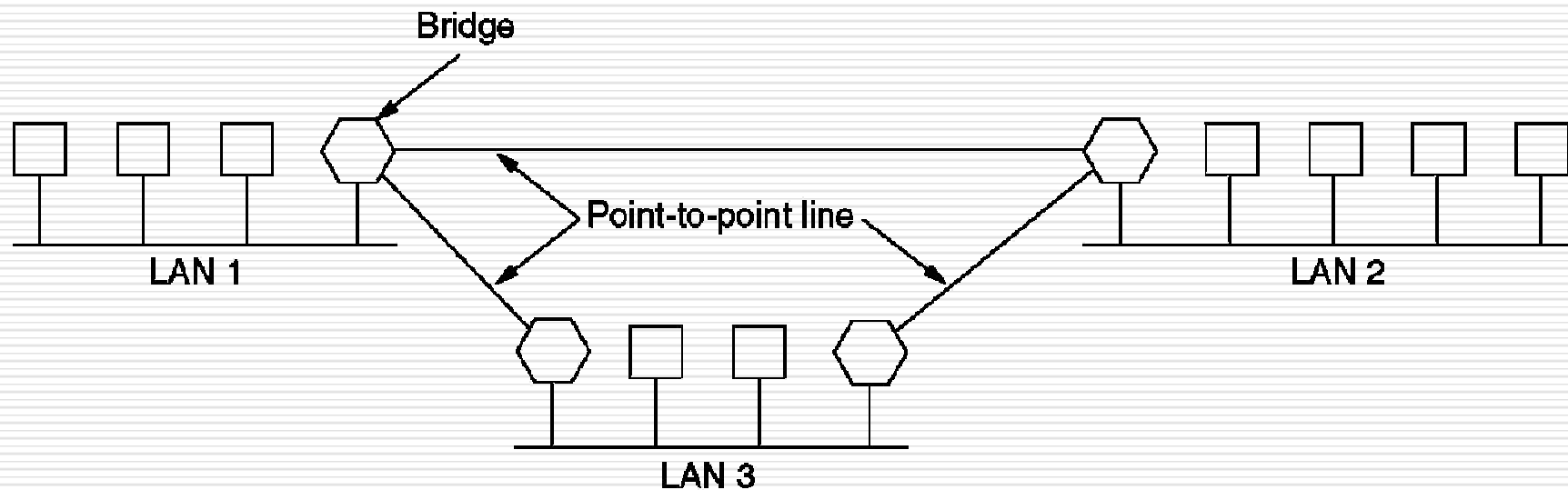
A configuration with four LANs and two bridges.





# Remote Bridges

Remote bridges can be used to interconnect distant LANs.

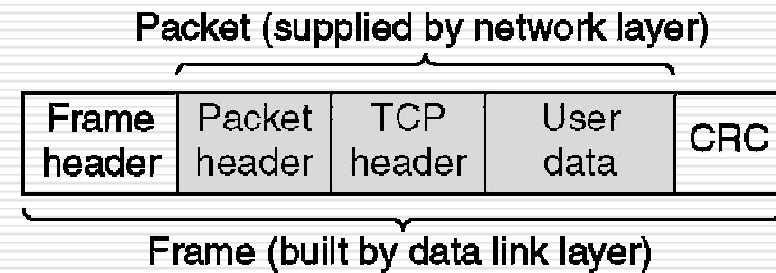




# Repeaters, Hubs, Bridges, Switches, Routers and Gateways

Application layer	Application gateway
Transport layer	Transport gateway
Network layer	Router
Data link layer	Bridge, switch
Physical layer	Repeater, hub

(a)



(b)

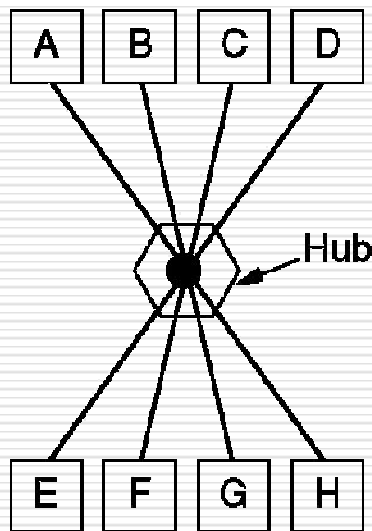
(a) Which device is in which layer.

(b) Frames, packets, and headers.

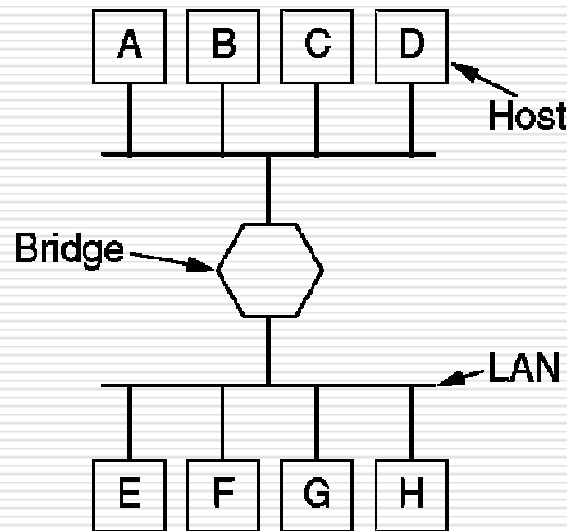


# Repeaters, Hubs, Bridges, Switches, Routers and Gateways (2)

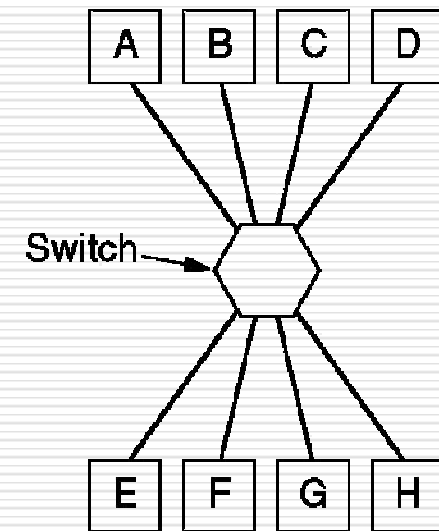
(a) A hub. (b) A bridge. (c) a switch.



(a)



(b)

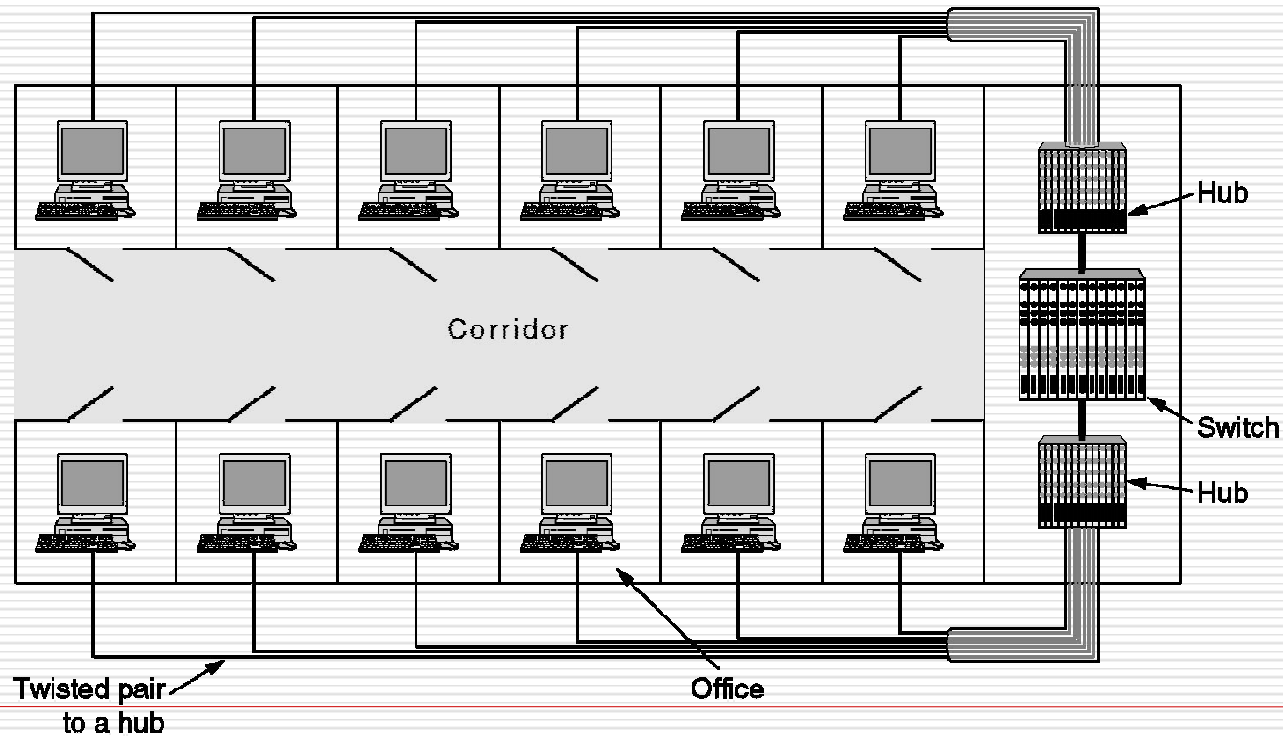


(c)



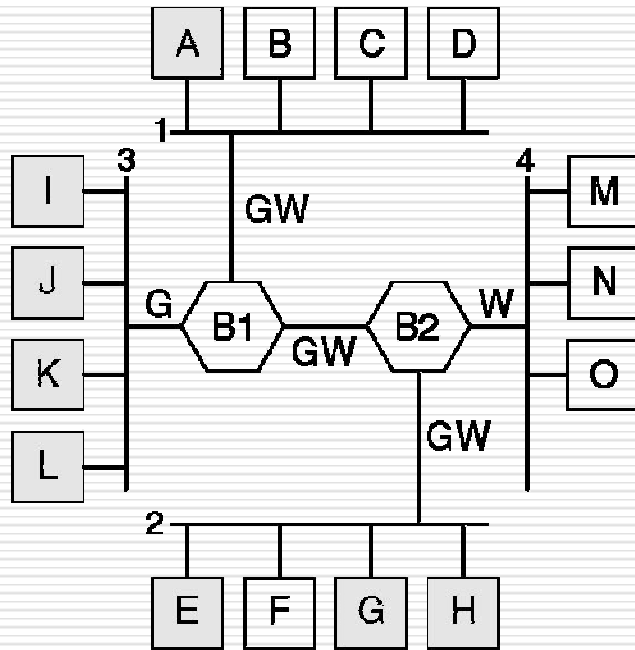
# Virtual LANs

A building with centralized wiring using hubs and a switch.

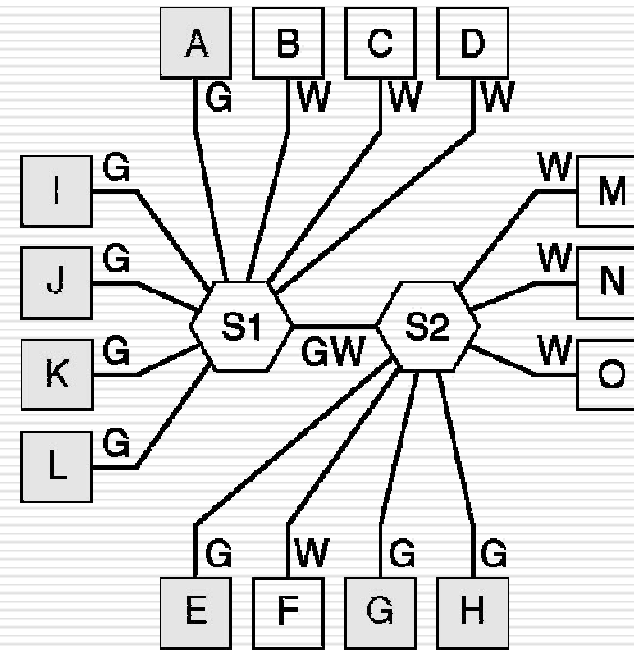




# Virtual LANs (2)



(a)



(b)

(a) Four physical LANs organized into two VLANs, gray and white, by two bridges. (b) The same 15 machines organized into two VLANs by switches.

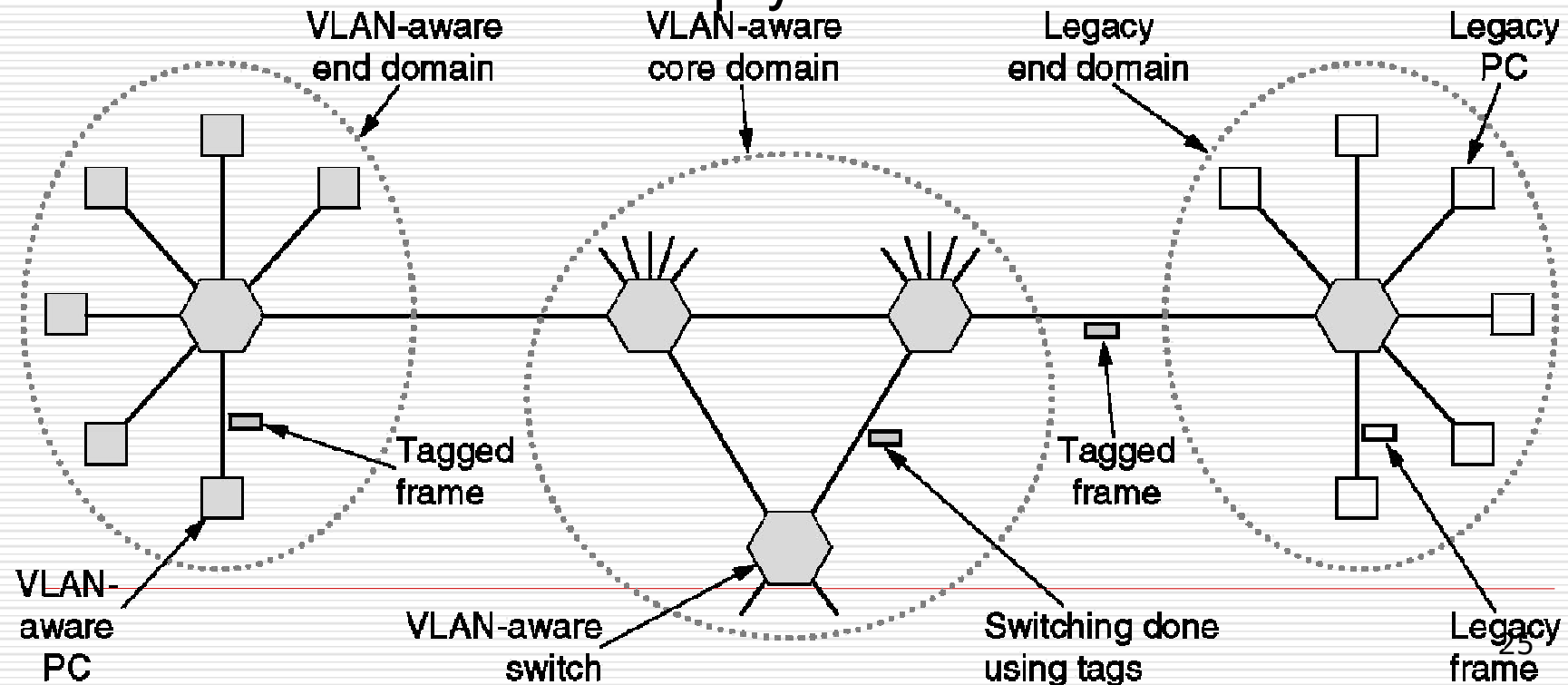




# The IEEE 802.1Q Standard

Transition from legacy Ethernet to VLAN-aware Ethernet. The shaded symbols are VLAN aware.

The empty ones are not.





# The IEEE 802.1Q Standard (2)

The 802.3 (legacy) and 802.1Q Ethernet frame formats.

