



無線網路效能分析

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- Grade:

- Homework 20%
- Paper Report 25%
- Midterm Test 25%
- Final Test 30 %



Outline

- LAN Introduction
- IEEE 802.3 CSMA/CD Ethernet
- IEEE 802.11 CSMA/CA Wireless LAN
- Bluetooth Low Energy
- Queueing Theory



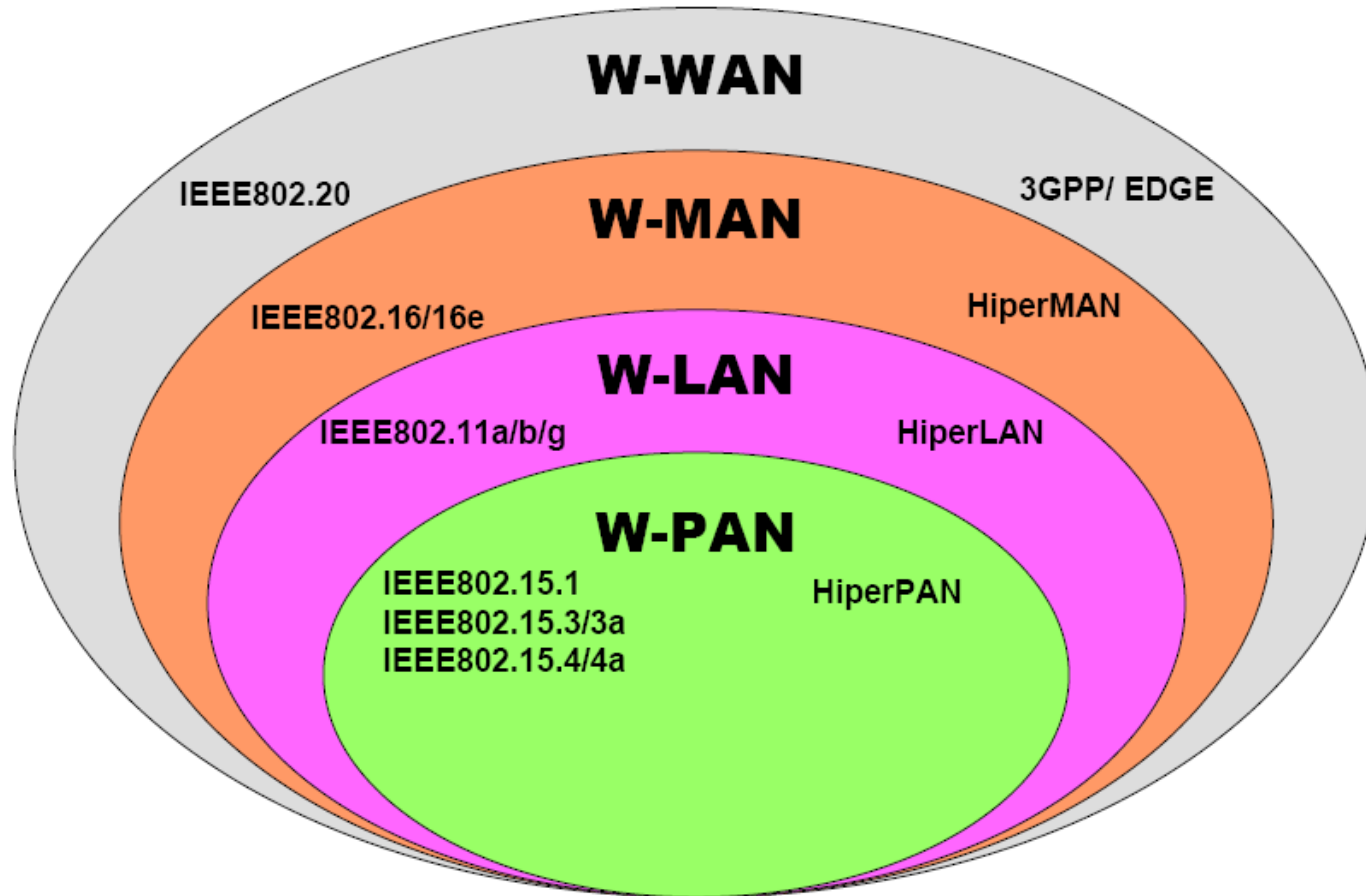
***Introduction to
Local Area Networks (LANs)***



What is a LAN ?

- A LAN is a data communication system allowing a number of **independent devices** to **communicate directly** with each other, within a **moderately sized geographic area** over a physical communications channel of **moderate data rates**.
- PAN ?
- MAN ?
- WAN ?

Global Wireless Standards



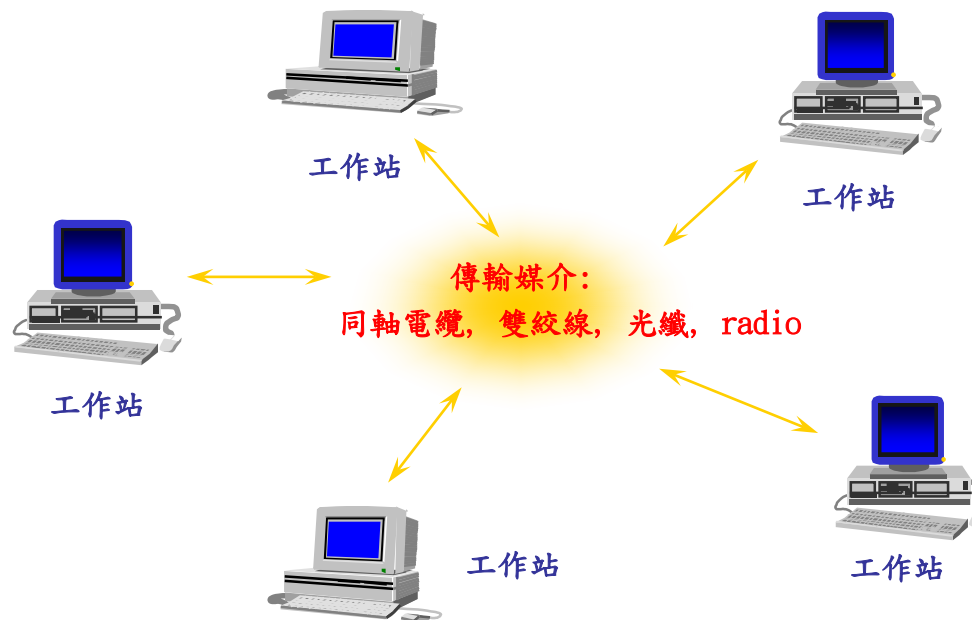


Basic Requirements of a LAN

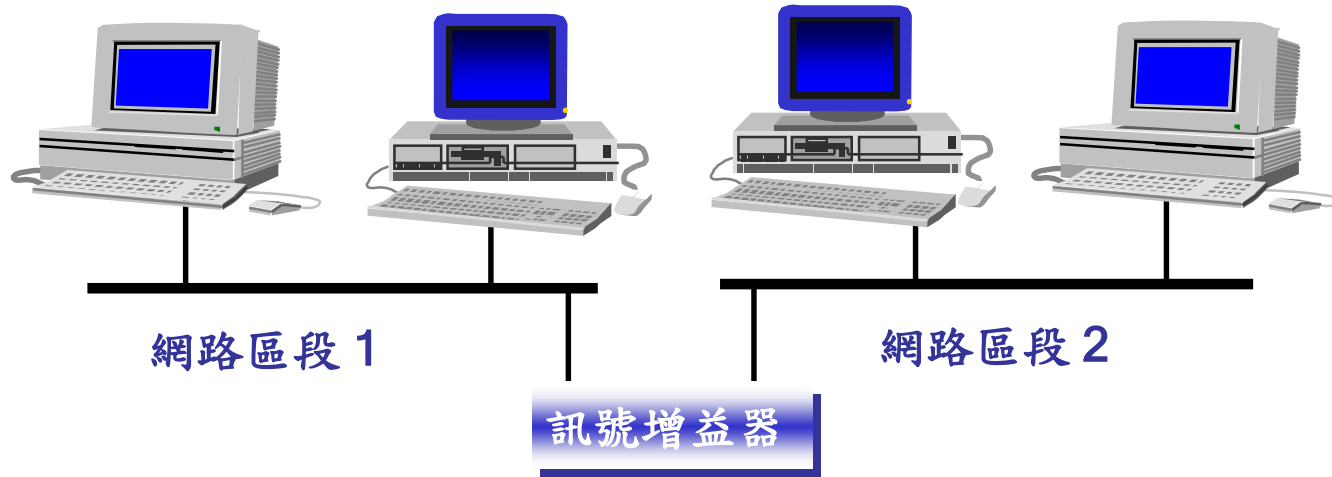
- Data rate of 1 to 1000 Mbps
- Geographic distances spanning at most 1-5 km
- Ability to support **several hundred** independent devices
- **Minimal dependence** on any centralized components or control
- **Efficient** use of shared resources, including the network channel
- **Stability** under high load
- **Fair** access (bandwidth, delay) to the network by all devices
- **Reliability** and good error characteristics
- **Easy** installation, reconfiguration and maintenance
- **Low cost**

LAN Components

- Computers (Networking devices)
- Transmission System (Network Cards, Cabling)



LAN Extension

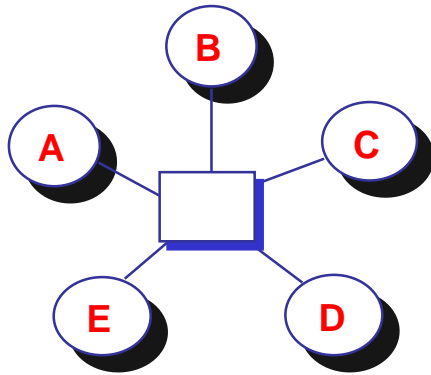




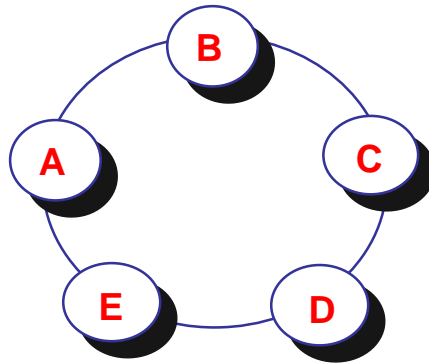
Network Topologies

- Star
 - Single Star (**IEEE 802.12** 100VG-AnyLAN, **ATM**, **IEEE 802.16** WMAN)
 - Multiple Star (Snowflake) (**ATM**, **IEEE 802.15.1** WPAN, **IEEE 802.15.4** LR-WPAN)
- Bus
 - Single Bus (**IEEE 802.3** CSMA/CD, **IEEE 802.4** Token-Bus)
 - Dual Bus (**IEEE 802.6** DQDB)
- Tree
- Ring
 - Single Ring (**IEEE 802.5** Token Ring)
 - Dual Ring (**FDDI**, FDDI-II)
- Mesh (**ATM**, **IEEE 802.15.1** WPAN, **IEEE 802.15.4** LR-WPAN, **IEEE 802.15.6** WBAN...)
- Random (**IEEE 802.11** CSMA/CA)

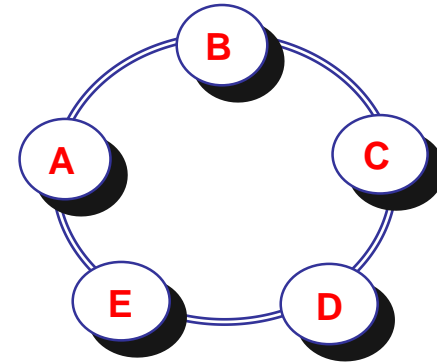
Network Topologies



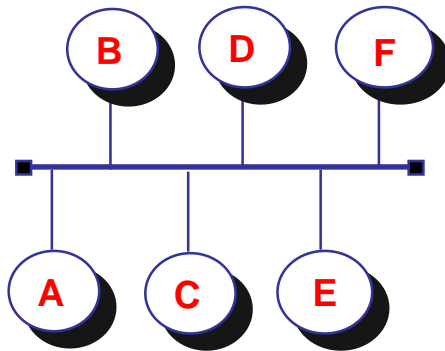
Star



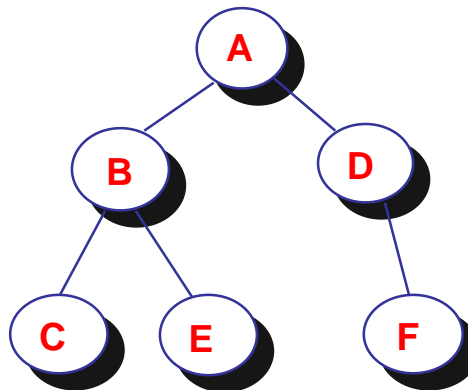
Ring



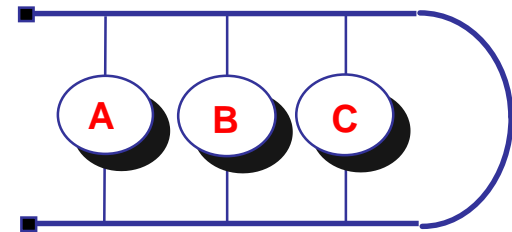
Dual Ring



Bus

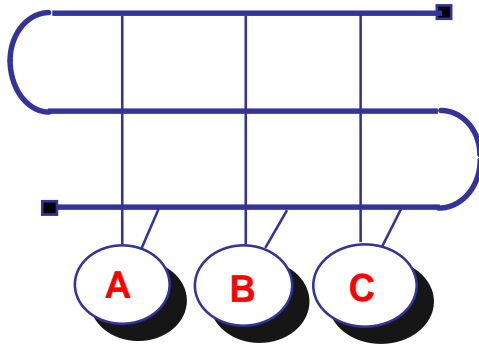


Tree

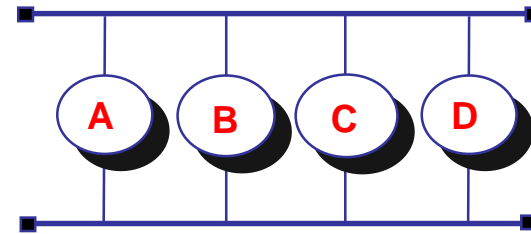


Dual Bus

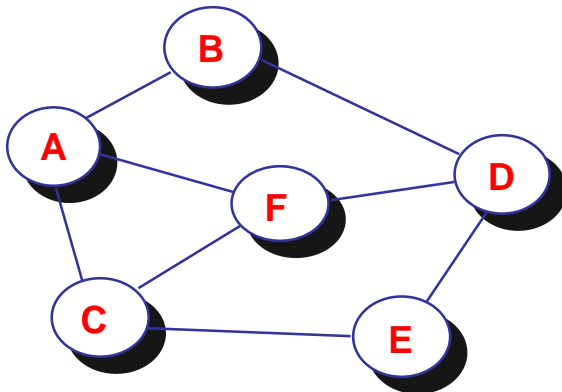
Network Topologies



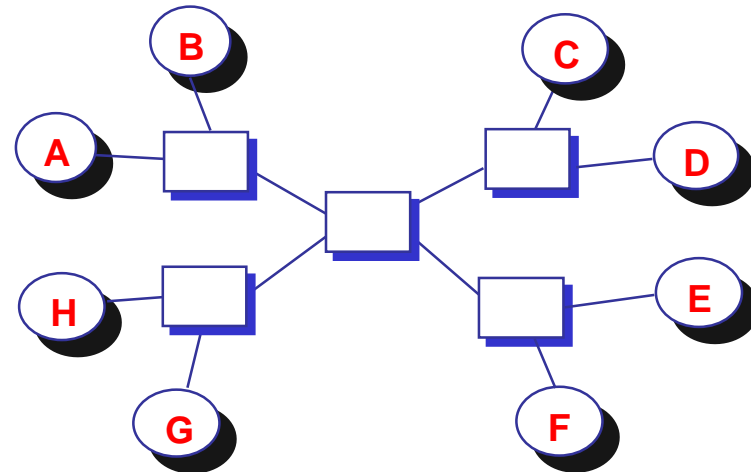
Dual Bus



Dual Bus

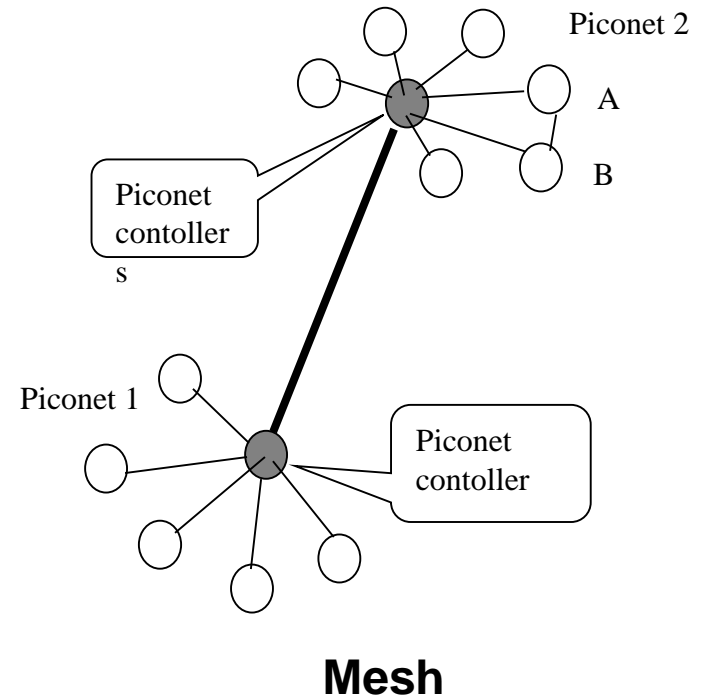
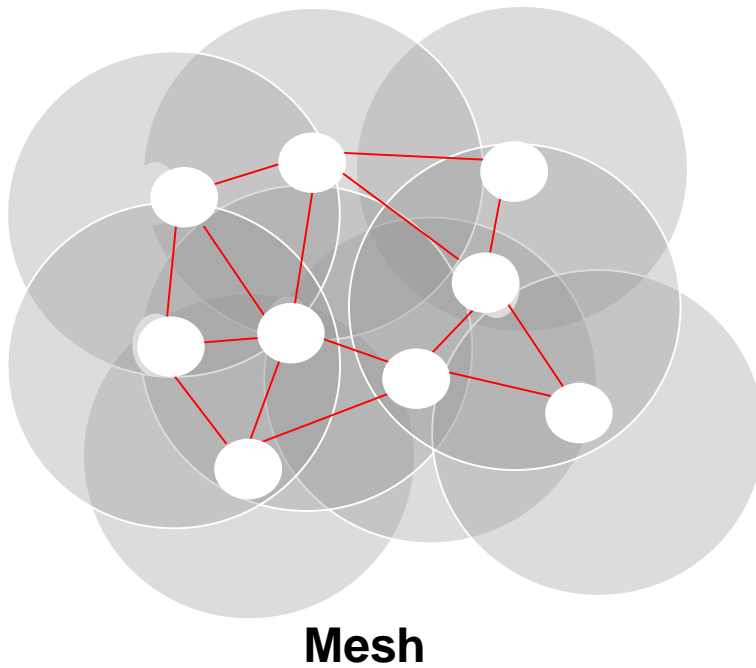


Mesh

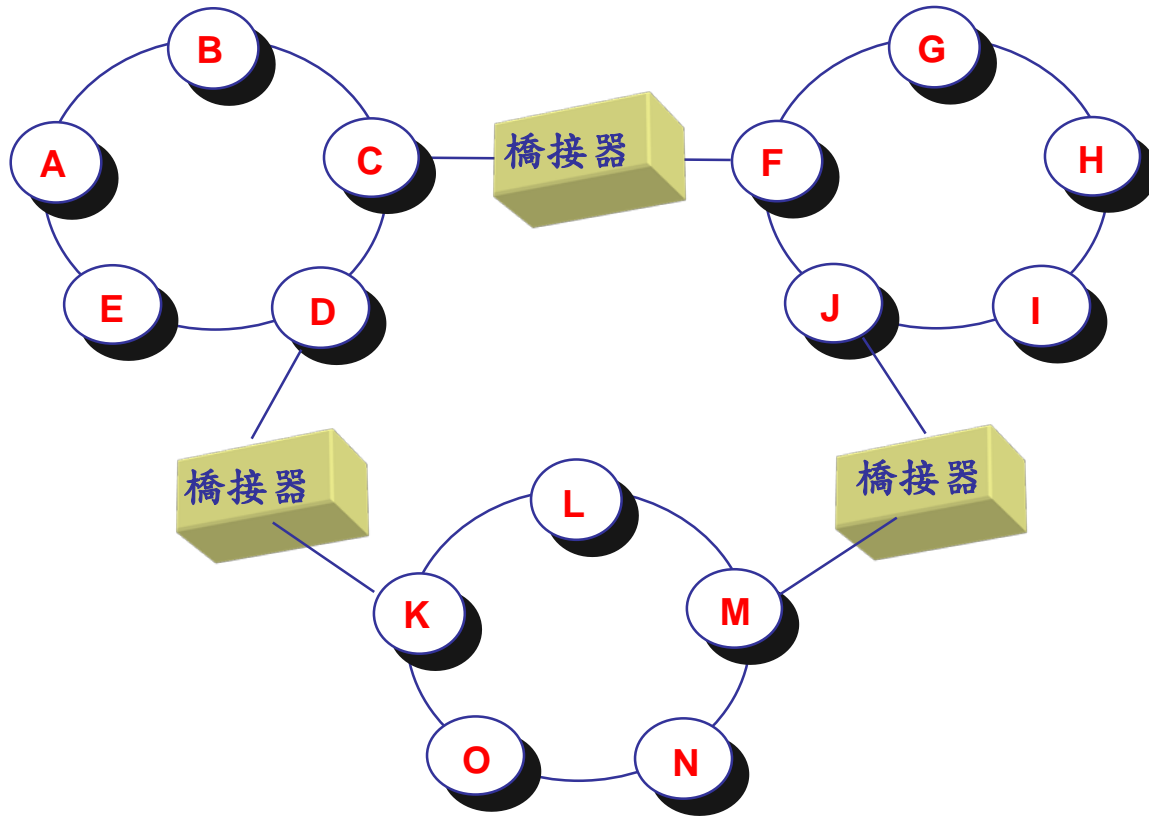


Snowflake

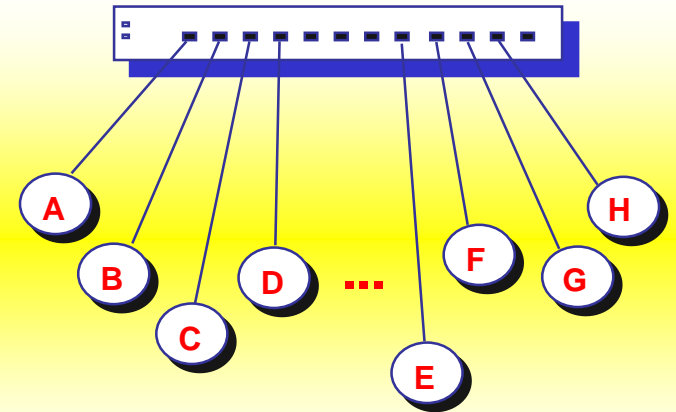
Network Topologies



Network Topologies



Bridged Ring Networks



Hub, Switch or Concentrator

Wireless LAN ?



Open System Interconnection (OSI) Model

- **Physical Layer.** Responsible for transmission of bit streams across a particular physical transmission medium. **Retransmission is not supported.**
 - Encoding/Decoding
 - Scrambling/Descrambling
- **Data Link Layer.** Responsible for providing reliable data transmission from one node to another. Provides **error-free transmission** of frames.
- **Network Layer.** Concerned with routing data from one network node to another. Provides **routing path** selection.
 - Establishing/Maintaining/Terminating network connection
- **Transport Layer.** Responsible for providing data transfer between two end users at an agreed on level of **quality**.
 - Establishing/Maintaining/Terminating transport layer connection

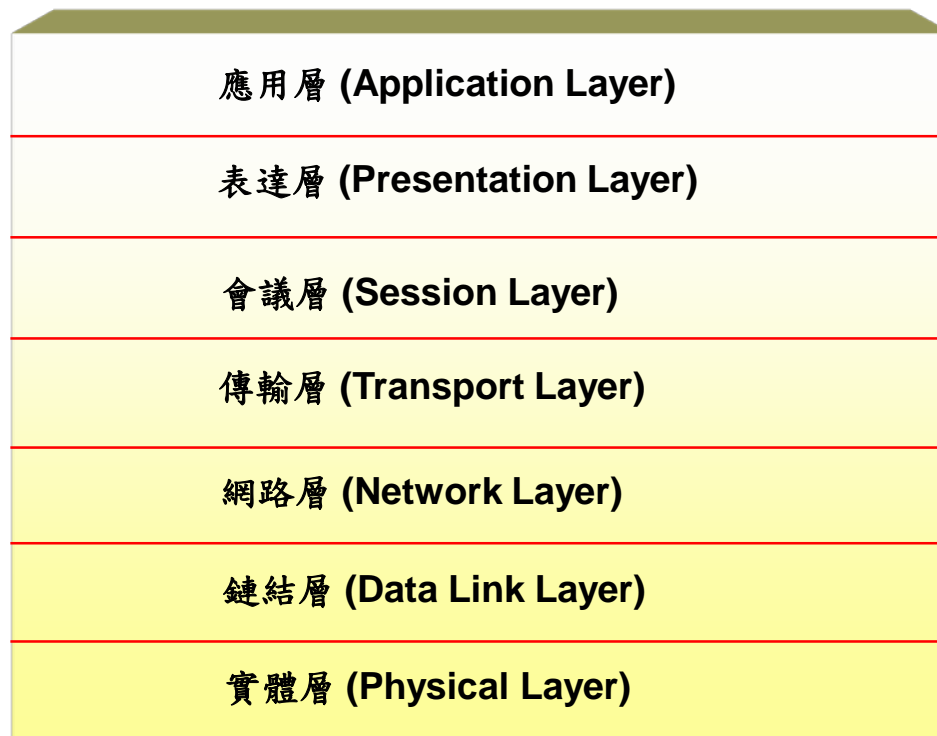


Open System Interconnection (OSI) Model

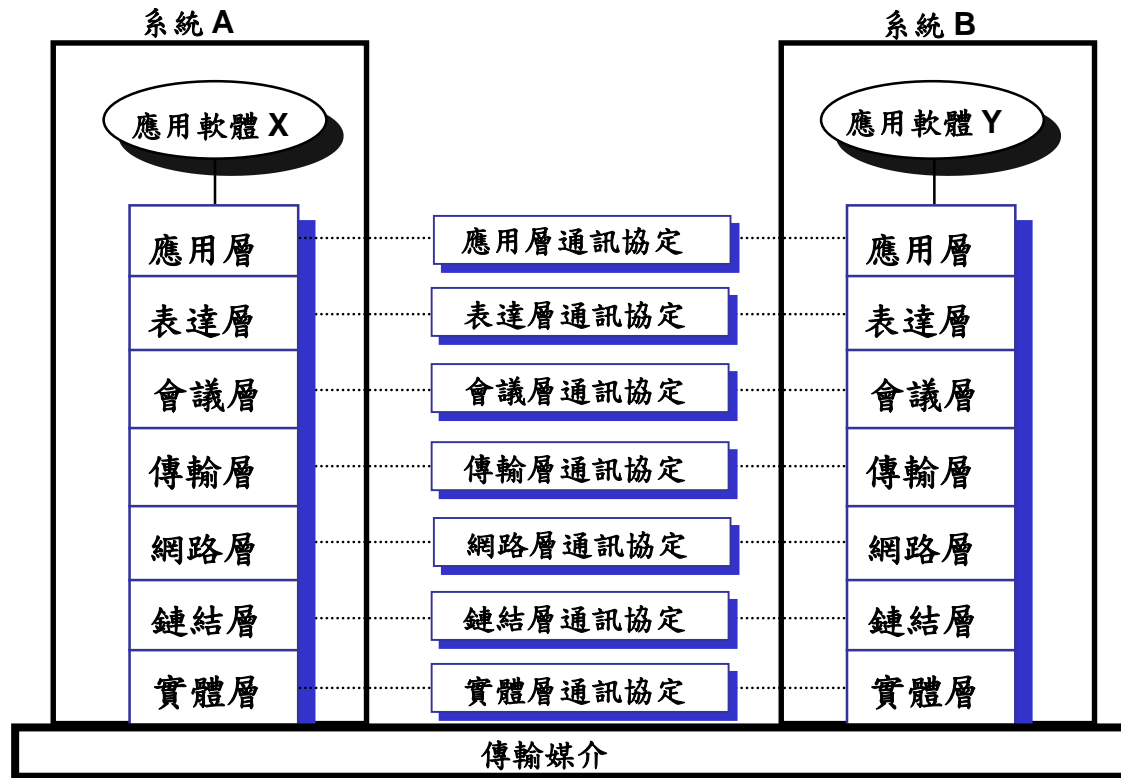
- **Session Layer.** Providing services used to organize and **synchronize** the dialog that takes place between users and to manage the data exchange.
- **Presentation Layer.** Responsible for the presentation of information to the network users.
 - Character code translation/ Data conversion
 - Data compression/expansion
 - Encryption/Decryption
- **Application Layer.** Provides services to application processes or users.
 - File Transfer Protocol (FTP)
 - Remote Login (Telnet)
 - Transaction Server
 - Network Management
 - WWW Server/VoD Server



Open System Interconnection (OSI) Model - Seven Layers



Layering Protocols

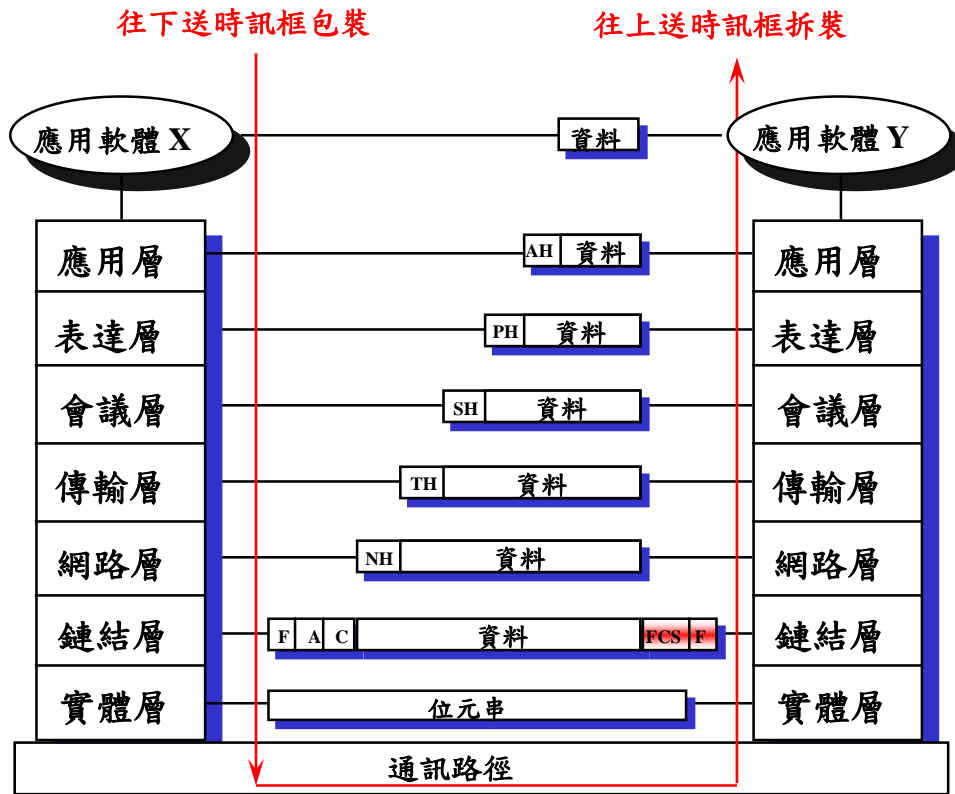




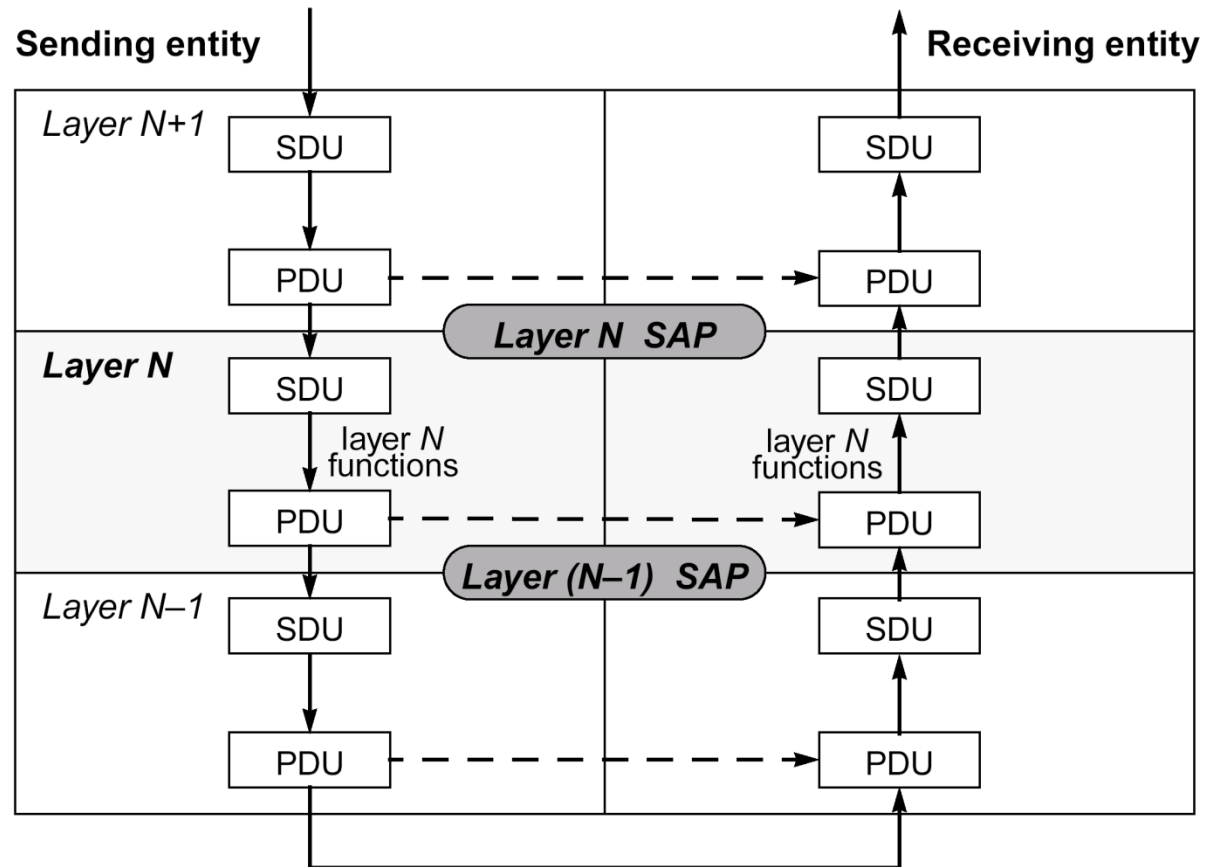
Basic Functions of Protocols

- Encapsulation/Decapsulation
- Segmentation/Reassembly
- Connection Establishing
- Flow Control
- Error Control
- Multiplexing/Demultiplexing

Encapsulation/Decapsulation Mechanisms



SDU and PDU





IEEE Project 802 Standards

- IEEE 802.1 High Level Interface
 - IEEE 802.1D Local Bridge (Spanning Tree Algorithm) } Bridge
 - IEEE 802.1G Remote Bridge } Bridge
 - IEEE 802.1P Traffic Class Expediting and Dynamic Multicast Filtering Priority
 - IEEE 802.1Q Virtual LANs
 - IEEE 802.1X Port Based Network Access Control Authentication
- IEEE 802.2 LLC (Logical Link Control) Reliability → Sequence number and ACK
- **IEEE 802.3 CSMA/CD (Carrier Sense Multiple Access with Collision Detection)**
- IEEE 802.4 Token-Bus
- IEEE 802.5 Token-Ring
- IEEE 802.6 DQDB (Distributed Queue Dual Bus)
- IEEE 802.7 Broadband Technical Advisory Group
- IEEE 802.8 Fiber Optic Technical Advisory Group
- IEEE 802.9 Integrated Voice and Data LAN Working Group
- IEEE 802.10 Interoperable LAN/MAN Security



IEEE Project 802 Standards

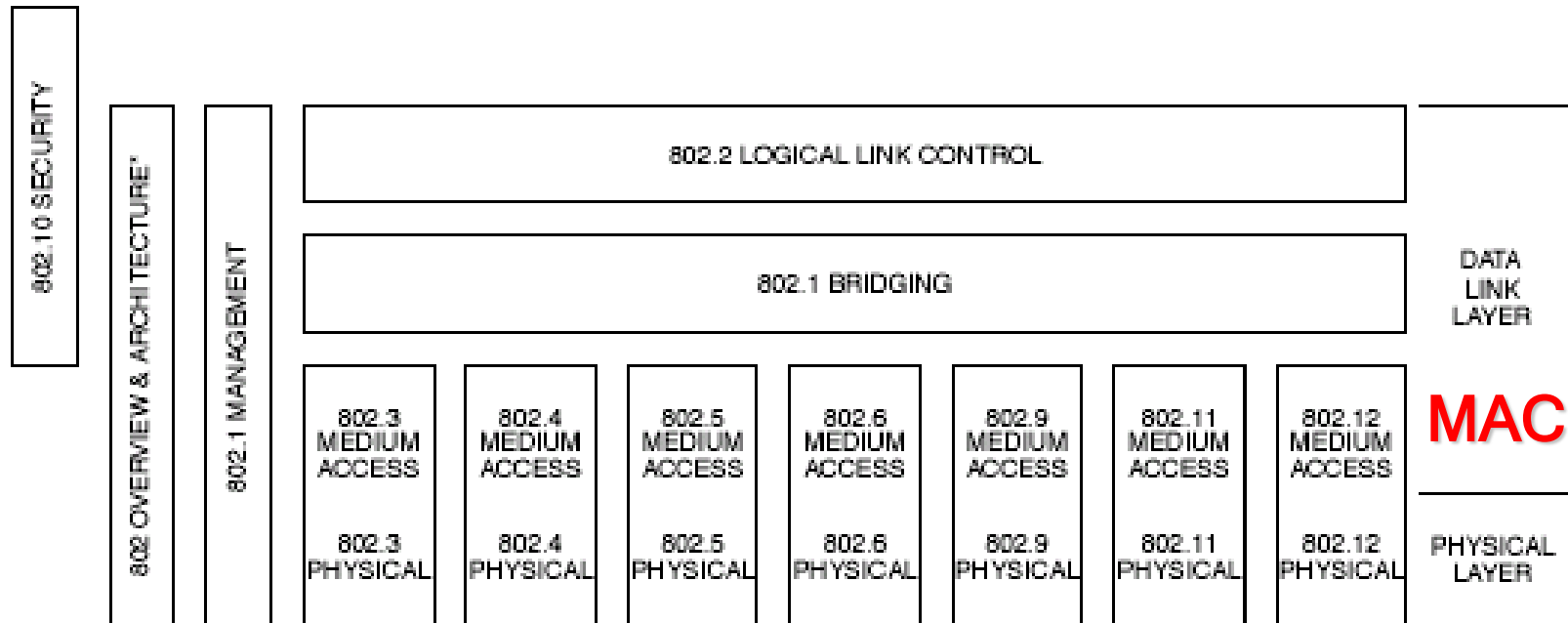
- **IEEE 802.11 CSMA/CA Wireless LAN**
 - IEEE 802.11a High-Speed Physical Layer in the 5GHz Band
 - IEEE 802.11b Higher-Speed Physical Layer Extension in the 2.4 GHz Band
 - IEEE 802.11e Medium Access Control (MAC) Enhancements for Quality of Service (QoS) (**WMM** wireless multimedia / **also named as WME** wireless multimedia extension)
 - IEEE 802.11f Inter-Access Point Protocol (**IAPP**)
 - IEEE 802.11g Further Higher-Speed Physical Layer Extension in the 2.4 GHz Band
 - IEEE 802.11h Spectrum and Transmit Power Management extensions in the 5GHz band in Europe
 - IEEE 802.11i Enhanced Security (**WPA-PSK** preshared key / **WPA2.0**)
 - IEEE 802.11k Radio Resource Management
 - IEEE 802.11n Next Generation WLAN (**WWiSE** world wide spectrum efficiency **vs TGnSync**)
 - **IEEE 802.11p Wireless Access Vehicular Environment**
 - **IEEE 802.11r Fast Roaming**
 - **IEEE 802.11s ESS Mesh Networking**
 - **IEEE 802.11t Wireless Performance Prediction**
 - **IEEE 802.11u InterWorking with External Networks**
 - **IEEE 802.11v Wireless Network Management (Wireless Switch)**
 - **IEEE 802.11w Protected Management Frame**
 - **IEEE 802.11ac High-throughput WLANs on the 5 GHz band**



IEEE Project 802 Standards

- IEEE 802.12 Demand-Priority (100VG-AnyLAN)
- IEEE 802.14 Standard Protocol for Cable-TV Based Broadband Communication Network
- **IEEE 802.15 Wireless Personal Area Networks Access Method and Physical Layer Specifications**
 - **IEEE 802.15.1 Wireless Personal Area Networks (Bluetooth)**
 - IEEE 802.15.2 Coexistence
 - IEEE 802.15.3 WPAN Higher Rate
 - 3a higher speed PHY enhancement amendment for imaging and multimedia (DS-UWB vs MB-OFDM)
 - 3b improve implementation and interoperability of the MAC
 - 3c millimeter-wave-based alternative PHY
 - 57-64 GHz unlicensed band defined by FCC 47 CFR 15.255
 - over 2 Gbps
 - IEEE 802.15.4 WPAN Low Rate (Zigbee) (4a is on going)
 - 4a alternative PHY (high precision ranging / location (<1 meter accuracy), high aggregate throughput, and ultra low power)
 - 4b revisions and Enhancements
 - IEEE 802.15.5 Mesh WPAN
 - **IEEE 802.15.6 Wireless Body Area Networks (WBAN)**
 - SCwng (Wireless Next Generation)
- IEEE 802.16 Broadband Wireless Access Method and Physical Layer Specifications
 - IEEE 802.16-2004 MAC & PHY
 - IEEE 802.16e Mobility
- IEEE 802.17 Resilient Packet Ring Working Group
- **IEEE 802.20 Mobile Broadband Wireless Access (MBWA)**
- IEEE 802.21 Media Independent Handoff Working Group
- **IEEE 802.22 Wireless Regional Area Networks**
- **Wibro (Wireless Internet Broadband Access) - Korea**

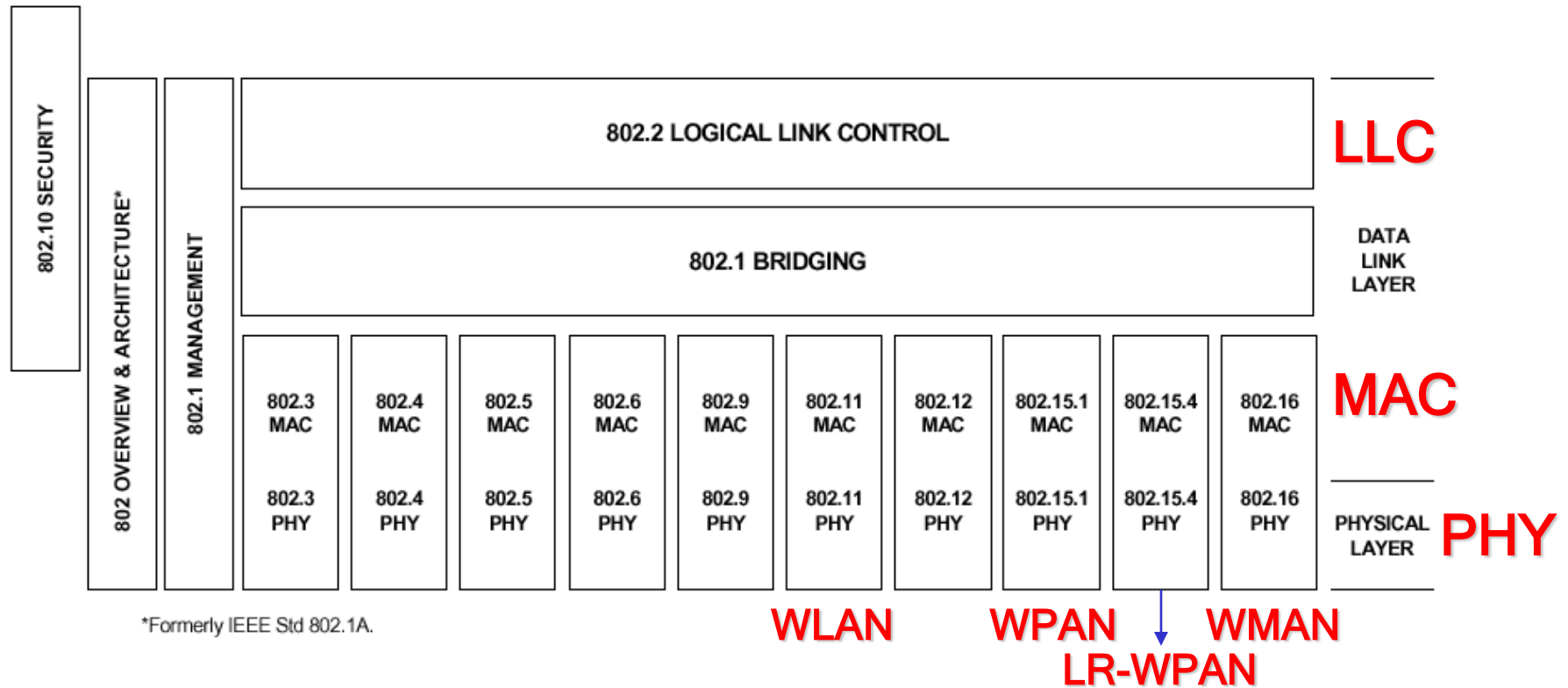
IEEE Project 802 Standards



* Formerly IEEE Std 802.1A.

WLAN

IEEE Project 802 Standards



IEEE 802 Family of standards and OSI reference model



IEEE 802.15 Groups

- IEEE 802.15.1: WPAN / Bluetooth
- IEEE 802.15.2: Coexistence
- IEEE 802.15.3: High Rate WPAN
 - IEEE 802.15.3-2003
 - IEEE P802.15.3a
 - IEEE 802.15.3b-2006
 - IEEE 802.15.3c-2009
- IEEE 802.15.4: Low Rate WPAN
 - WPAN Low Rate Alternative PHY (4a)
 - Revision and Enhancement (4b)
 - PHY Amendment for China (4c)
 - PHY and MAC Amendment for Japan (4d)
 - MAC Amendment for Industrial Applications (4e)
 - PHY and MAC Amendment for Active RFID (4f)
 - PHY Amendment for Smart Utility Network (4g)
- Task Group 5: Mesh Networking
- IEEE 802.15.6: Body Area Networks
- IEEE 802.15.7: Visible Light Communication
- IEEE P802.15.8: Peer Aware Communications
- IEEE P802.15.9: Key Management Protocol
- IEEE P802.15.10: Layer 2 Routing
- Wireless Next Generation Standing Committee