1. Wired LAN

Rekayasa Internet

Teknik Komputer

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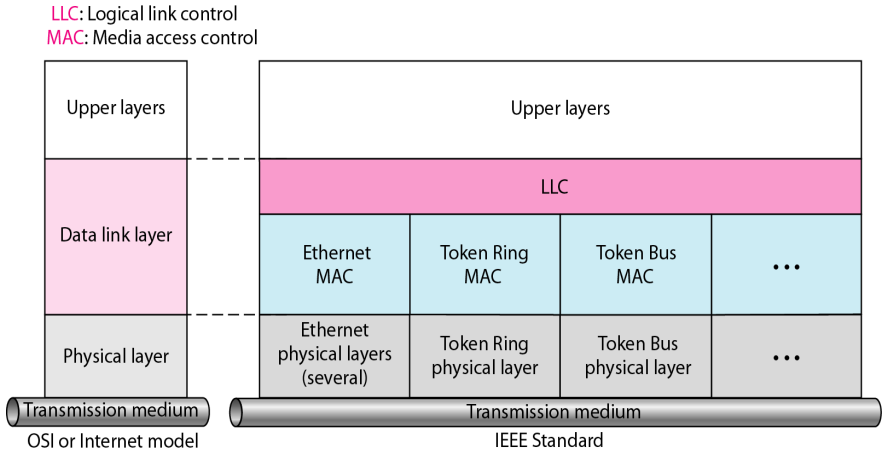
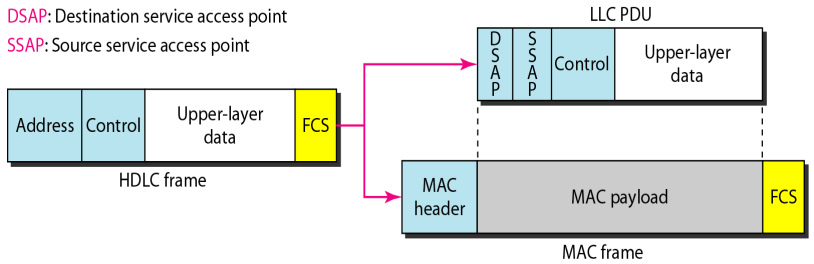
IEEE Standards

- In 1985, the Computer Society of the IEEE started a project, called Project 802, to set standards to enable intercommunication among equipment from a variety of manufacturers. Project 802 is a way of specifying functions of the physical layer and the data link layer of major LAN protocols.

IEEE Standard for LAN



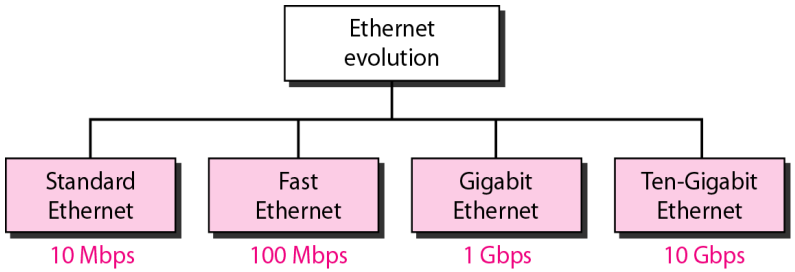
HDLC frame compared with LLC and MAC frames



Standard Ethernet

- The original Ethernet was created in 1976 at Xerox's Palo Alto Research Center (PARC). Since then, it has gone through four generations. We briefly discuss the Standard (or traditional) Ethernet in this section.

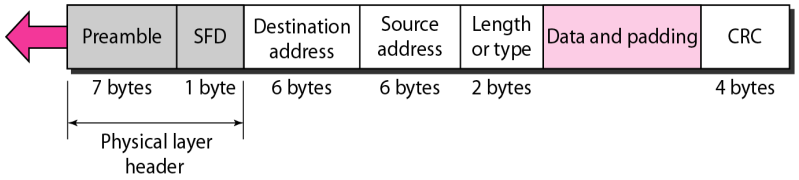
Ethernet evolution through four generations



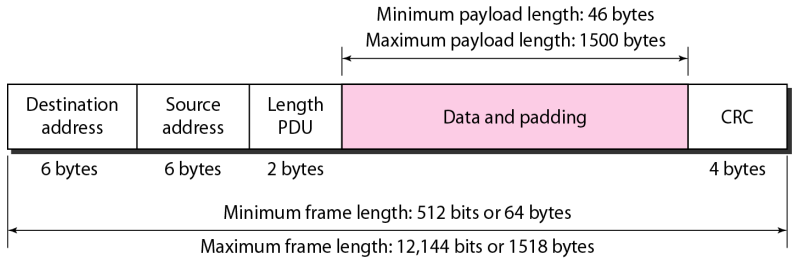
802.3 MAC Frame

Preamble: 56 bits of alternating 1s and 0s.

SFD: Start frame delimiter, flag (10101011)



Maximum and Minimum Lengths



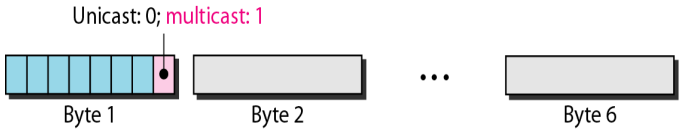
Frame length:

Minimum: 64 bytes (512 bits)

Maximum: 1518 bytes (12,144 bits)

Example of an Ethernet address in hexadecimal notation

Unicast and Multicast Address



Example

Define the type of the following destination addresses:

a. 4A:30:10:21:10:1A b. 47:20:1B:2E:08:EE

c. FF:FF:FF:FF:FF:FF

Solution

To find the type of the address, we need to look at the second hexadecimal digit from the left. If it is even, the address is unicast. If it is odd, the address is multicast. If all digits are F's, the address is broadcast. Therefore, we have the following:

a. This is a unicast address because A in binary is 1010.

b. This is a multicast address because 7 in binary is 0111.

c. This is a broadcast address because all digits are F's.

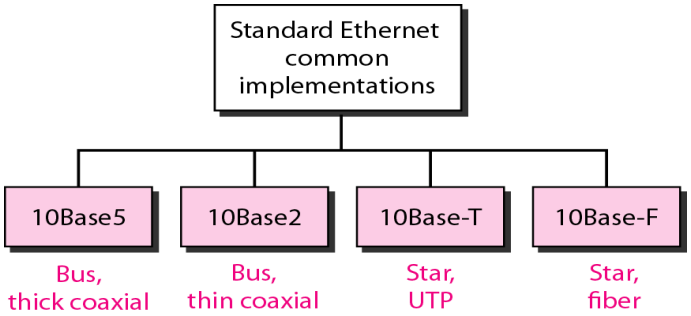
Example

Show how the address 47:20:1B:2E:08:EE is sent out on line.

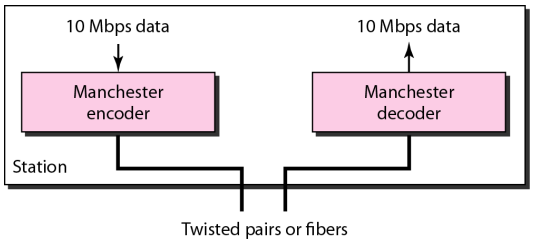
Solution

The address is sent left-to-right, byte by byte; for each byte, it is sent right-to-left, bit by bit, as shown below:

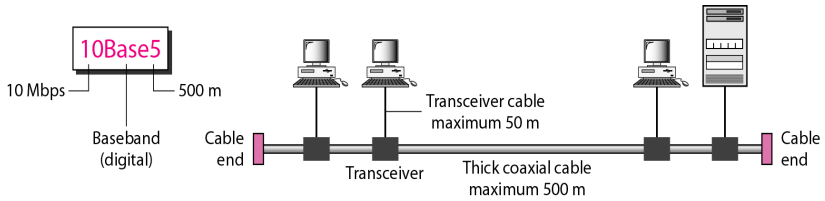
Categories of Standard Ethernet



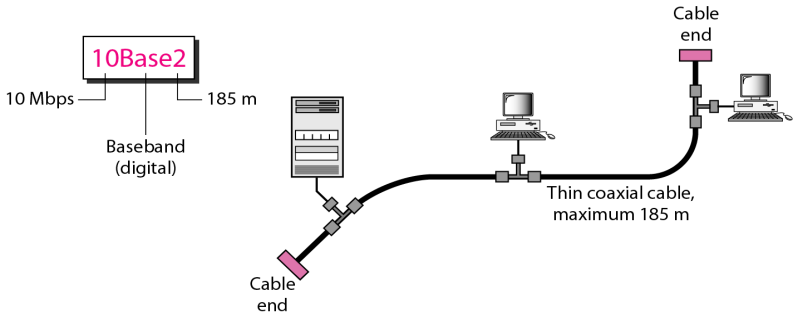
Encoding in a Standard Ethernet implementation



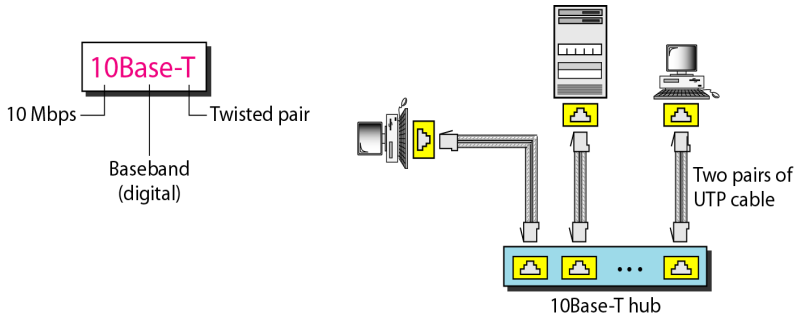
10Base5 implementation



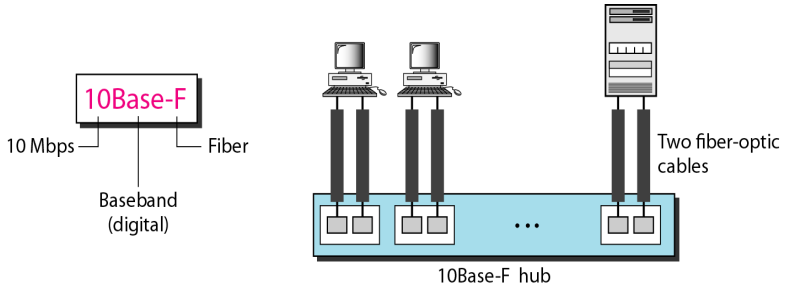
10Base2 implementation



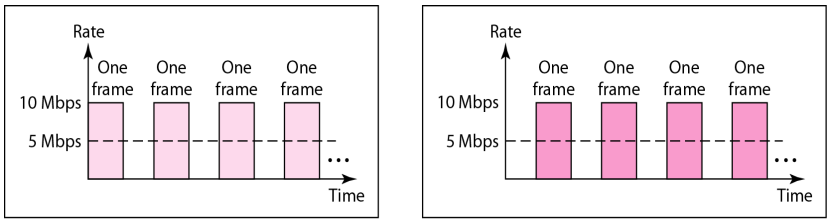
10Base-T implementation



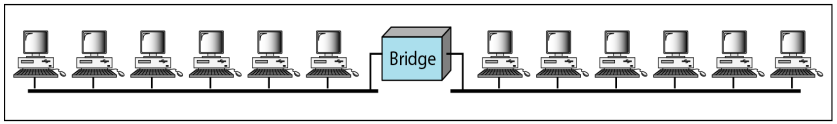
10Base-F implementation



- The 10-Mbps Standard Ethernet has gone through several changes before moving to the higher data rates. These changes actually opened the road to the evolution of the Ethernet to become compatible with other high-data-rate LANs.

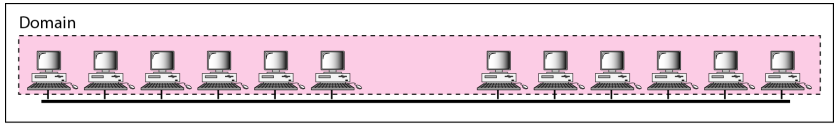


a. Without bridging

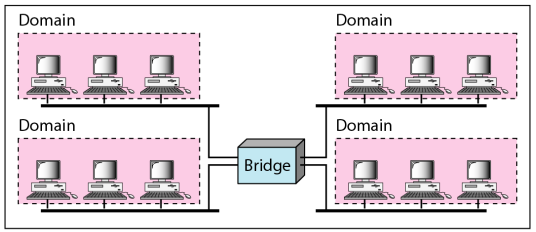


b. With bridging

Collision domains in an unbridged network and a bridged network

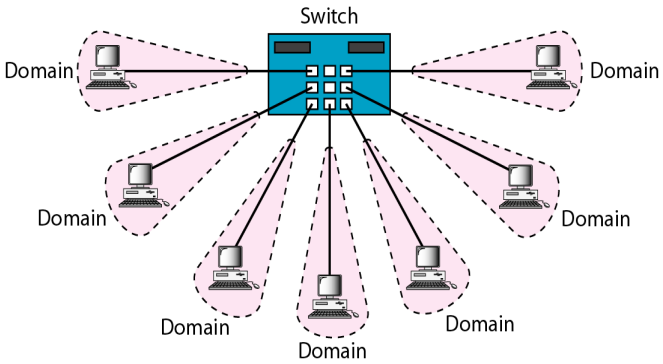


a. Without bridging

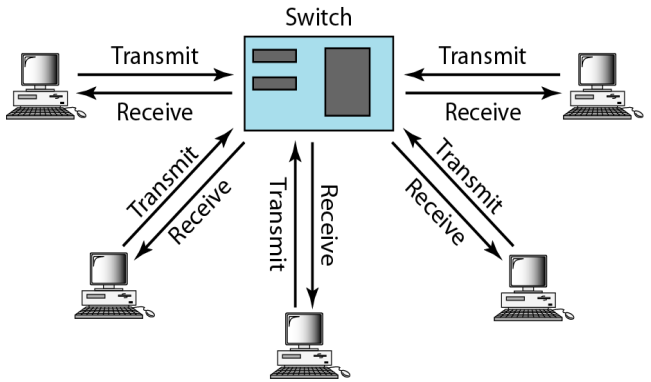


b. With bridging

Switched Ethernet



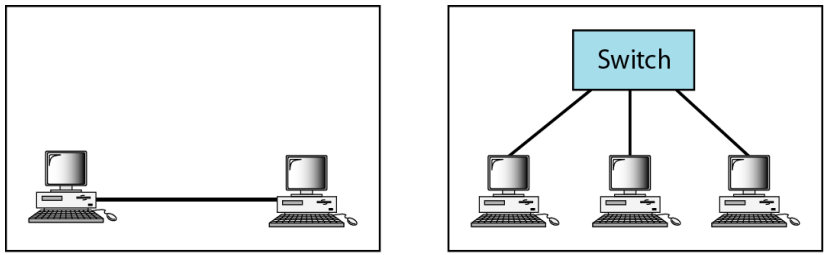
Full-duplex switched Ethernet



Fast Ethernet

- Fast Ethernet was designed to compete with LAN protocols such as FDDI or Fiber Channel. IEEE created Fast Ethernet under the name 802.3u. Fast Ethernet is backward-compatible with Standard Ethernet, but it can transmit data 10 times faster at a rate of 100 Mbps.

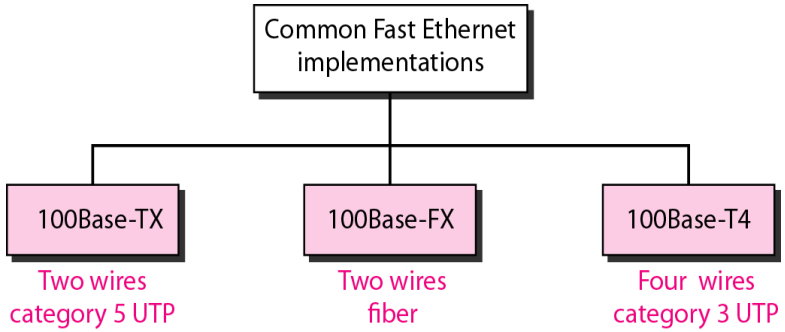
Fast Ethernet topology



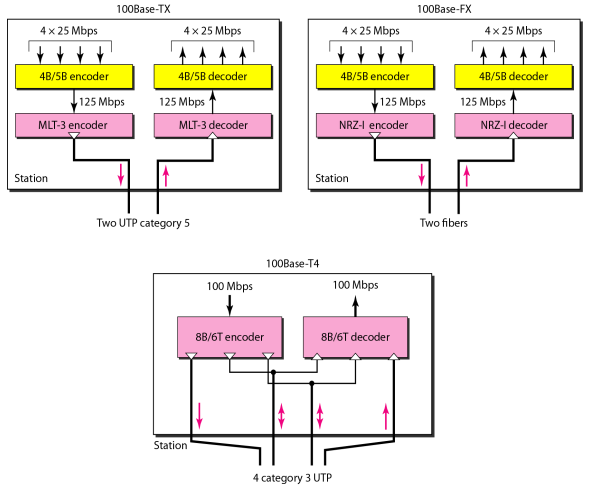
a. Point-to-point

b. Star

Fast Ethernet implementations



Encoding for Fast Ethernet implementation



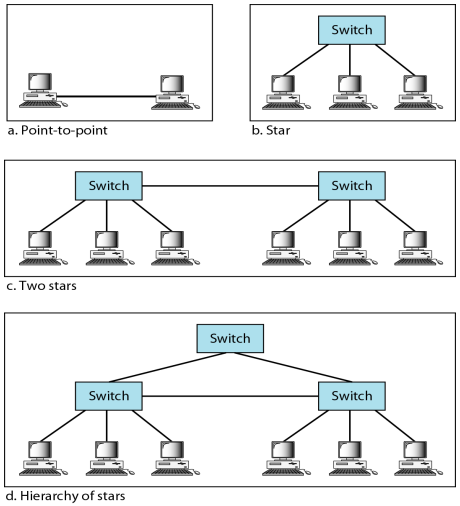
Summary of Fast Ethernet implementations

Characteristics	*100Base-TX*	*100Base-FX*	*100Base-T4*
Media	Cat 5 UTP or STP	Fiber	Cat 4 UTP
Number of wires	2	2	4
Maximum length	100 m	100 m	100 m
Block encoding	4B/5B	4B/5B	
Line encoding	MLT-3	NRZ-I	8B/6T

Gigabit Ethernet

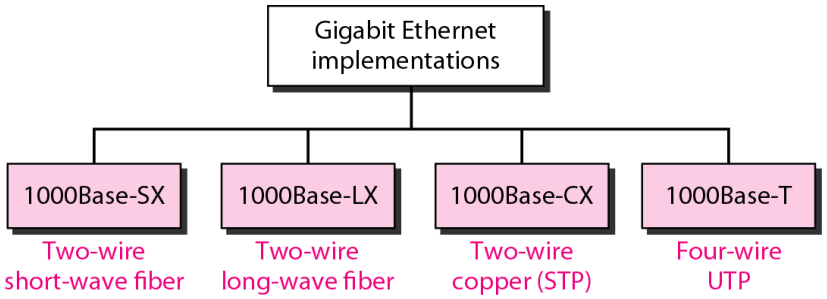
- The need for an even higher data rate resulted in the design of the Gigabit Ethernet protocol (1000 Mbps). The IEEE committee calls the standard 802.3z.

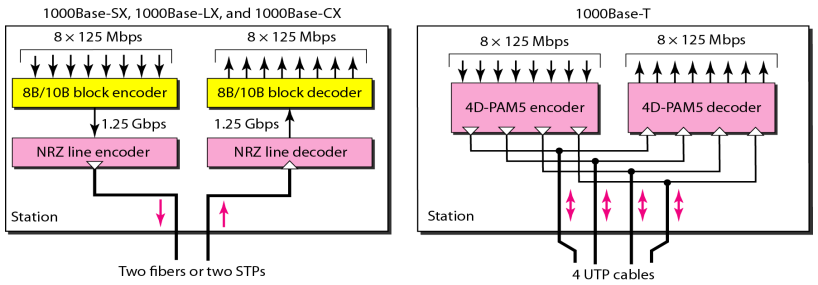
- In the full-duplex mode of Gigabit Ethernet, there is no collision;
- the maximum length of the cable is determined by the signal attenuation in the cable.



a. Point-to-point
b. Star
c. Two stars
d. Hierarchy of stars

Gigabit Ethernet implementations





Summary of Gigabit Ethernet implementations

Characteristics	*1000Base-SX*	*1000Base-LX*	*1000Base-CX*	*1000Base-T*
Media	Fiber short-wave	Fiber long-wave	STP	Cat 5 UTP
Number of wires	2	2	2	4
Maximum length	550 m	5000 m	25 m	100 m
Block encoding	8B/10B	8B/10B	8B/10B	
Line encoding	NRZ	NRZ	NRZ	4D-PAM5

Summary of Ten-Gigabit Ethernet implementations

Characteristics	*10GBase-S*	*10GBase-L*	*10GBase-E*
Media	Short-wave 850-nm multimode	Long-wave 1310-nm single mode	Extended 1550-mm single mode
Maximum length	300 m	10 km	40 km

Wireless LAN

Rekayasa Internet

Teknik Komputer

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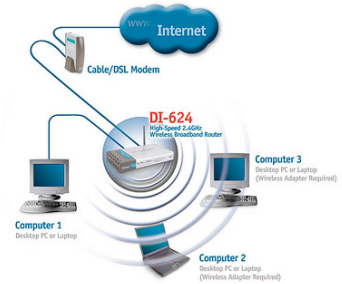
Wireless LAN (WLAN)

- A WLAN is a type of Local Area Network (LAN) that uses high frequency radio waves rather than wires to communicate and transmit data. It is a flexible data communication system implemented as an extension to or as an alternative for, a wired LAN.



The benefits of using a WLAN instead of a wired network connection

- Increased Productivity - WLAN provides "untethered" network and Internet access.
- Fast and Simple Network Set-up - There are no cables to install at a users desk or work area.
- Installation Flexibility - WLANs can be installed in places where wires can't, and they facilitate temporary set-up and relocation.
- Reduced Cost-of-Ownership - Wireless LANS reduce installation costs because there is no cabling; as a result, savings are greatest in frequently changing environments.
- Scalability - Network expansion and reconfiguration may be less complicated than expanding a wired network,

IEEE 802 Standards

IEEE 802 Standards	
802.1	Bridging & Management
802.2	Logical Link Control
802.3	Ethernet - CSMA/CD Access Method
802.4	Token Passing Bus Access Method
802.5	Token Ring Access Method
802.6	Distributed Queue Dual Bus Access Method
802.7	Broadband LAN
802.8	Fiber Optic
802.9	Integrated Services LAN
802.10	Security
802.11	Wireless LAN
802.12	Demand Priority Access
802.14	Medium Access Control
802.15	Wireless Personal Area Networks
802.16	Broadband Wireless Metro Area Networks
802.17	Resilient Packet Ring

IEEE 802.11

- IEEE has defined the specifications for a wireless LAN, called IEEE 802.11, which covers the physical and data link layers.

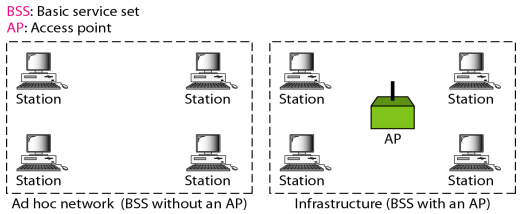
Arsitektur IEEE 802.11

Standard 802.11 mendefinisikan 2 layanan:

1. Basic Service Set (BSS)
2. Extended Service Set (ESS)

Basic Service Set

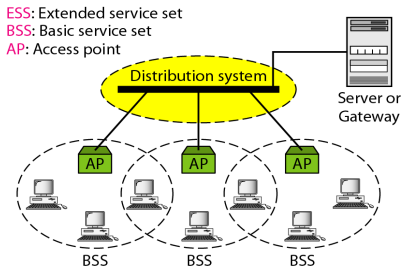
- IEEE 802.11 mendefinisikan BSS sebagai sebuah blok dari wireless LAN
- Sebuah BSS terdiri dari perangkat tetap/ stasioner atau wireless mobile dan sebuah access point (AP)
- Sebuah BSS tanpa AP adalah jaringan stand alone dan tidak dapat mengirim data ke BSS lain --> arsitektur ad-hoc



A BSS without an AP is called an ad hoc network; a BSS with an AP is called an infrastructure network.

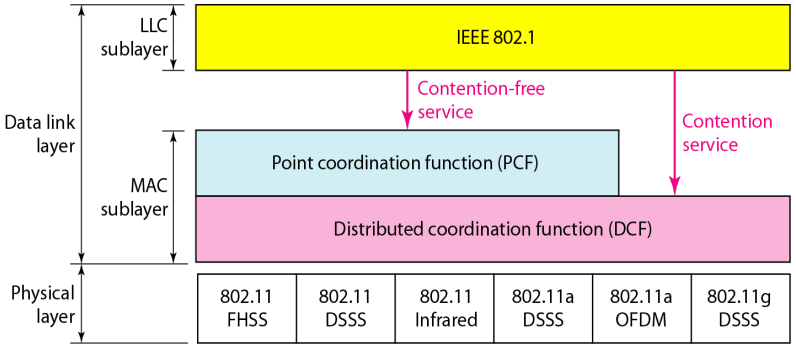
Extended Service Set

- ESS terdiri dari dua atau lebih BSS dengan Access Point. Dalam hal ini, BSS akan dihubungkan melalui sistem distribusi, yang terhubung langsung dengan wired LAN.



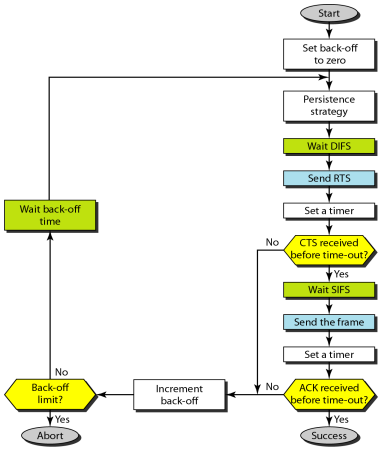
- IEEE 802.11 tidak membatasi yang digunakan pada sistem distibusi, bisa saja teknologi LAN seperti Ethernet.

MAC layers in IEEE 802.11 standard



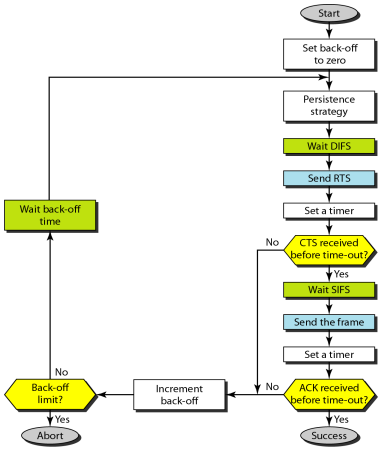
Carrier Sense Multiple Access/ Collision Avoidance

- CSMA/CA (Carrier Sense Multiple Access/Collision Avoidance) is a protocol for carrier transmission in 802.11 networks.
- Unlike CSMA/CD (Carrier Sense Multiple Access/Collision Detect) which deals with transmissions after a collision has occurred, CSMA/CA acts to prevent collisions before they happen.



Carrier Sense Multiple Access/ Collision Avoidance

- In CSMA/CA, as soon as a node receives a packet that is to be sent, it checks to be sure the channel is clear (no other node is transmitting at the time). If the channel is clear, then the packet is sent. If the channel is not clear, the node waits for a randomly chosen period of time, and then checks again to see if the channel is clear. This period of time is called the backoff factor, and is counted down by a backoff counter. If the channel is clear when the backoff counter reaches zero, the node transmits the packet. If the channel is not clear when the backoff counter reaches zero, the backoff factor is set again, and the process is repeated.



IEEE 802.11 Standards

Table 1: IEEE 802.11 Standards

Standard	Frequency band	Bandwidth	Modulation	Maximum data rate
802.11	2.4 GHz	20 MHz	DSSS, FHSS	2 Mb/s
802.11b	2.4 GHz	20 MHz	DSSS	11 Mb/s
802.11a	5 GHz	20 MHz	OFDM	54 Mb/s
802.11g	2.4 GHz	20 MHz	DSSS, OFDM	54 Mb/s
802.11n	2.4 GHz, 5 GHz	20 MHz, 40 MHz	OFDM	600 Mb/s
802.11ac	5 GHz	20, 40, 80, 80 + 80, 160 MHz	OFDM	6.93 Gb/s
802.11ad	60 GHz	2.16 GHz	SC, OFDM	6.76 Gb/s

FAQs

- **Why do 802.11b and 802.11g WLAN products operate in the 2.4 GHz frequency range?**

  A: This frequency range is called the ISM (Industrial, Scientific and Medical) band. The ISM band has been set aside by regulatory agencies for unlicensed use by a variety of products including wireless networks, cordless phones, microwave ovens and some low power scientific and medical equipment. The fact that a license is not required for a product to operate in this frequency range has greatly accelerated the development of wireless networking products.

FAQs

- **Why do 802.11a WLANS operate in the 5 GHz frequency range?**
- A: This frequency is called the UNII (Unlicensed National Information Infrastructure) band. Like the 2.4 GHz ISM band used by 802.11b and 802.11g products, this range has been set aside by regulatory agencies for unlicensed use by a variety of products. A major difference between the 2.4 GHz and 5 GHz bands is that fewer consumer products operate in the 5 GHz band. This reduces the chances of problems due to RF interference.

- **What is the transmission range of WLAN products?**

  A: Radio Frequency (RF) range, especially in indoor environments, is a function of transmitted power, antenna design, receiver design, and interference. Interactions with typical building objects, including walls, metal objects, windows, and even people, can affect how signals propagate, and thus what range and coverage a particular system achieves. The range of coverage for typical WLAN systems varies depending on the number and types of obstacles encountered. Coverage can be provided for a greater area through the use of multiple access points, wireless repeaters or wireless bridges.

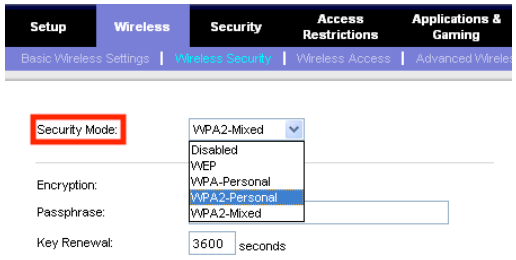
- **What is a Wireless Gateway?**
- A: A wireless gateway is a special type of access point which allows wireless network clients to share an Internet connection (DSL or cable modem). Wireless gateways typically include features such as NAT and VPN support which may not be found in simple access points.

- **What is the wireless SSID?**
- A: The wireless SSID, also known as the ‘Network Name’, is the Service Set Identification for your radio network (this item is case sensitive: use capital and lower case letters as shown in the SSID) The Service Set Identifier (SSID) controls access to a given wireless network. This value MUST match the SSID of any and all access points and clients that you want to communicate with. If the value does not match, access to the system is not granted. The SSID can be up to 32 case sensitive characters.

- **What can be done to secure a WLAN?**
- A: Using a WEP key is the basic security mechanism which is available with all 802.11a, 802.11b and 802.11g devices. Newer security mechanisms such as Wi-Fi Protected Access (WPA) and 802.1x are also available with some products

- **What is WEP?**
- A: WEP (Wired Equivalent Privacy) is an optional IEEE 802.11 feature used to provide data security that is equivalent to that of a typical wired LAN. WEP uses data encryption to provide a basic level of security for WLAN users. WEP allows the administrator to define an "encryption key" which is used to encrypt data before it is transmitted through the airwaves. When WEP is enabled, all stations (clients and Access Points) are required to have the same WEP key. Network access is denied to anyone who does not have the correct key.

- **What is WPA?**
- A: WPA stands for Wi-Fi Protected Access. It is a recent specification which provides stronger security than WEP via enhanced encryption and user authentication.



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