4

THE MEDIUM ACCESS CONTROL SUBLAYER

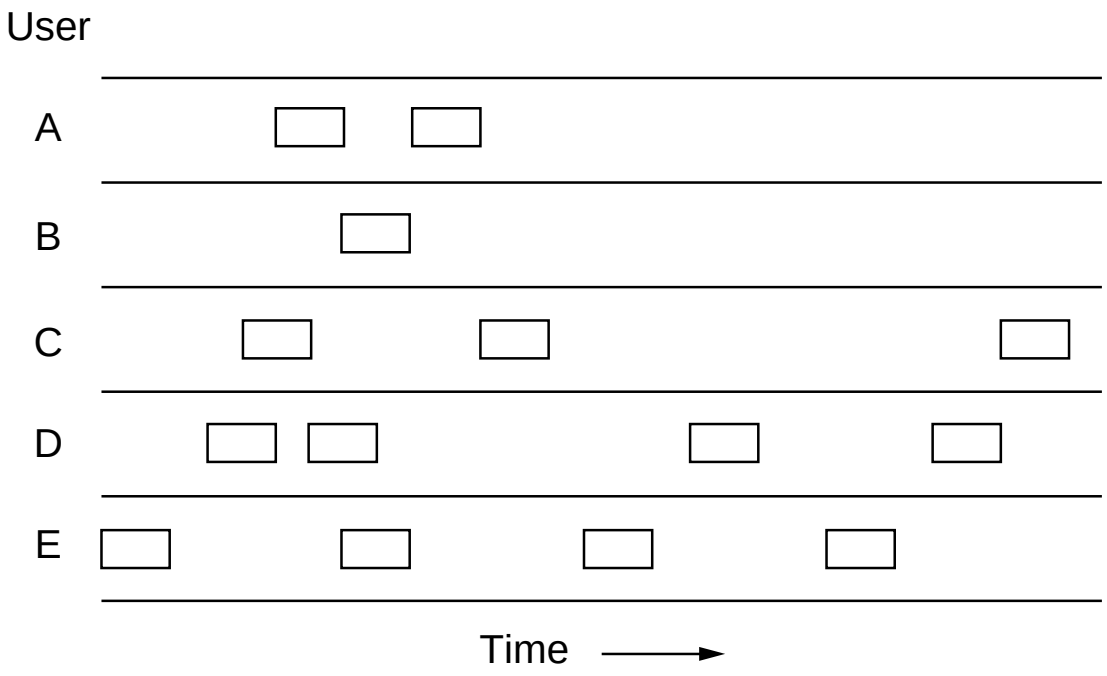

Fig. 4-1. In pure ALOHA, frames are transmitted at completely arbitrary times.

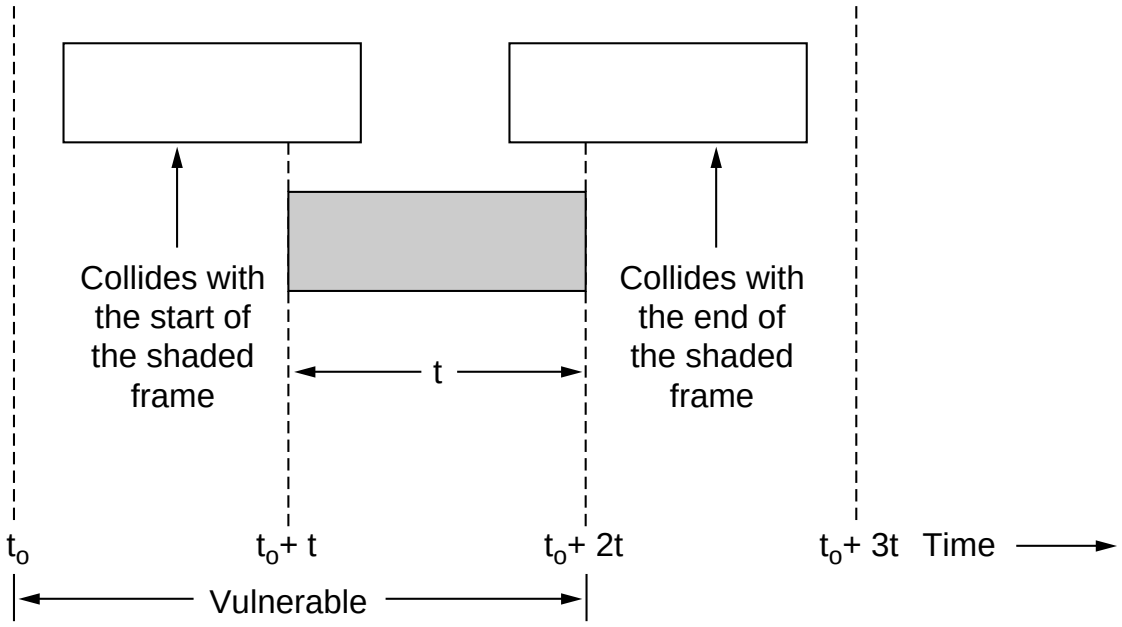

Fig. 4-2. Vulnerable period for the shaded frame.

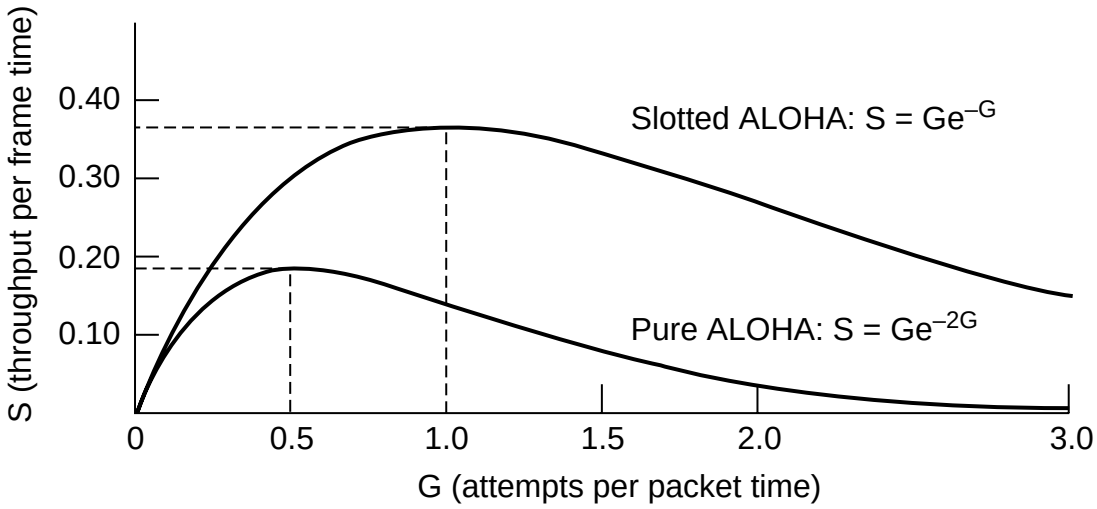

Fig. 4-3. Throughput versus offered traffic for ALOHA systems.

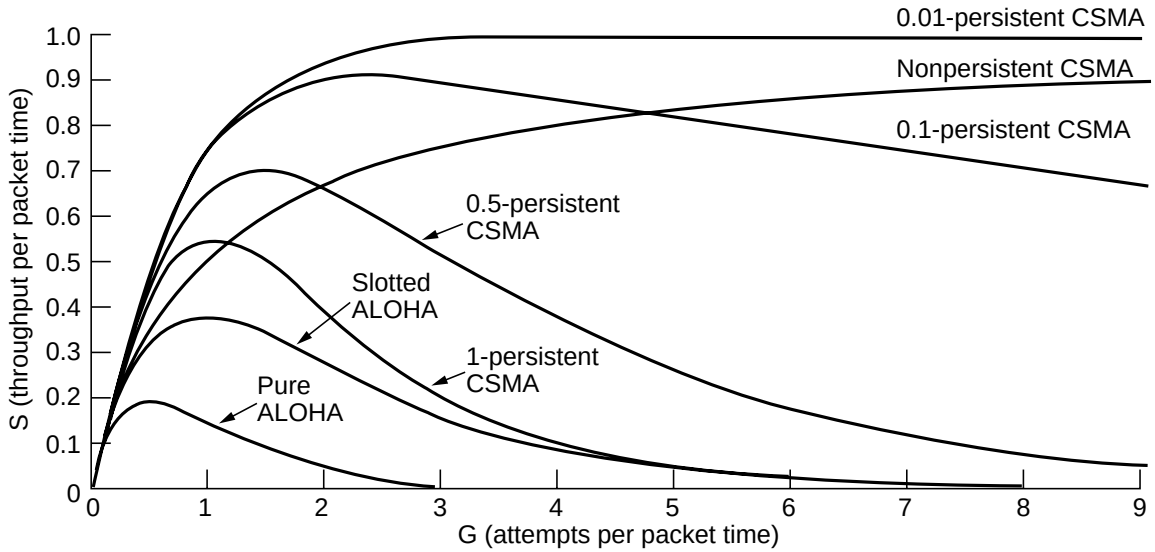

Fig. 4-4. Comparison of the channel utilization versus load for various random access protocols.

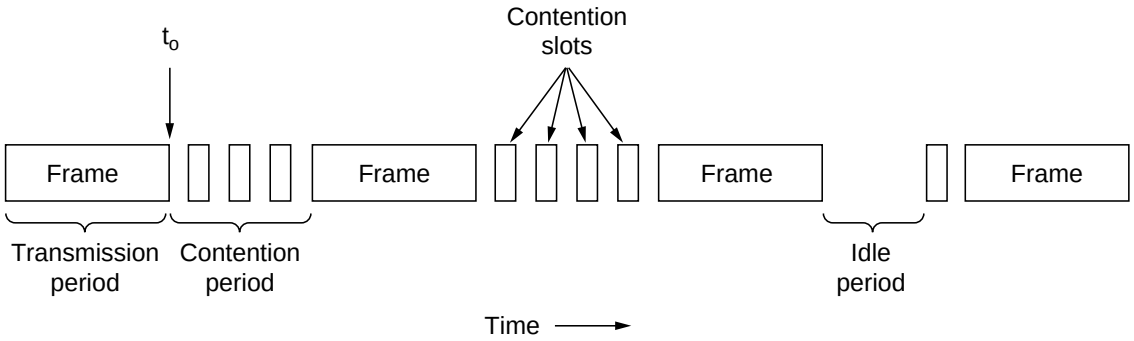

Fig. 4-5. CSMA/CD can be in one of three states: contention, transmission, or idle.

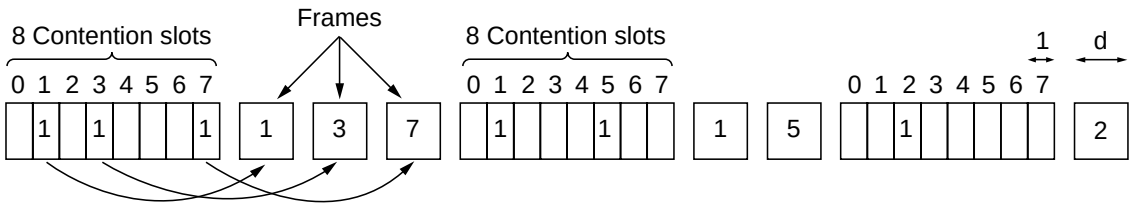

Fig. 4-6. The basic bit-map protocol.

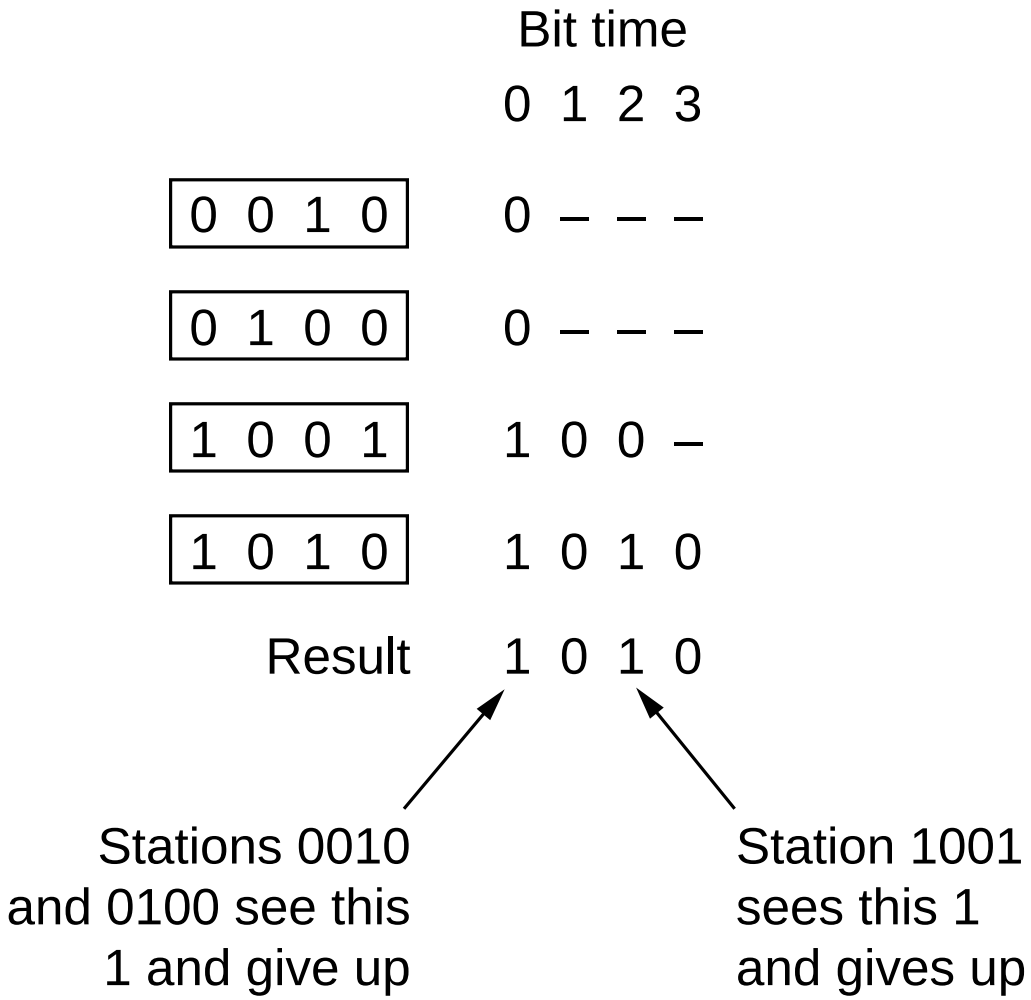

Fig. 4-7. The binary countdown protocol. A dash indicates silence.

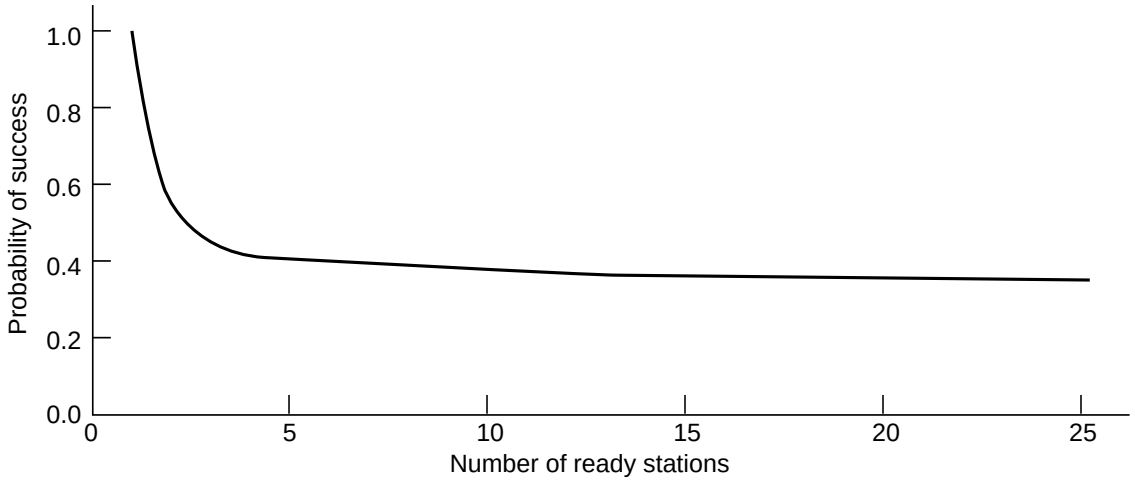

Fig. 4-8. Acquisition probability for a symmetric contention channel.

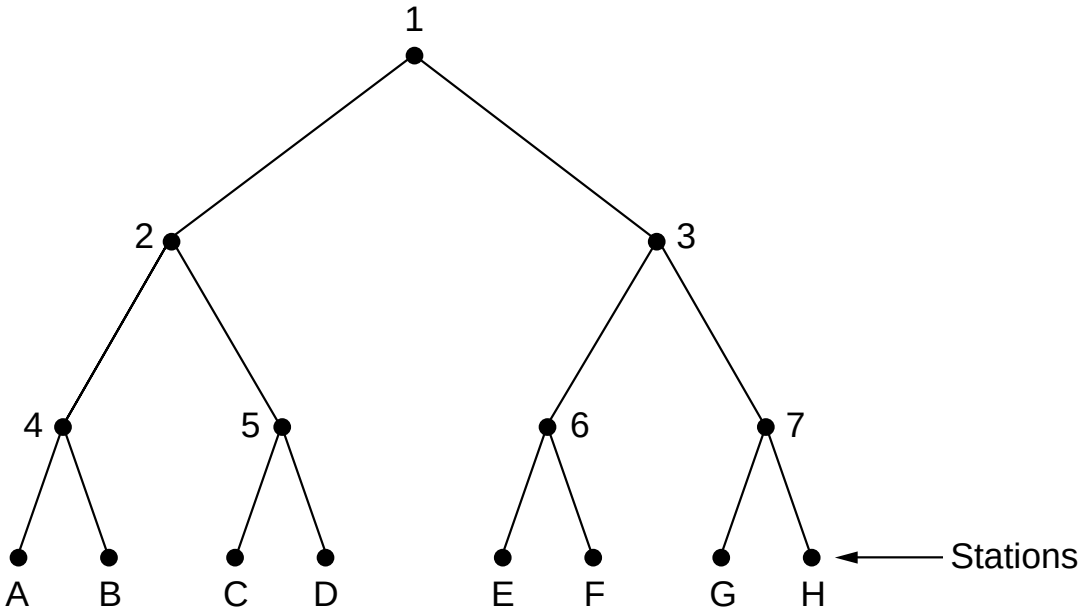

Fig. 4-9. The tree for eight stations.

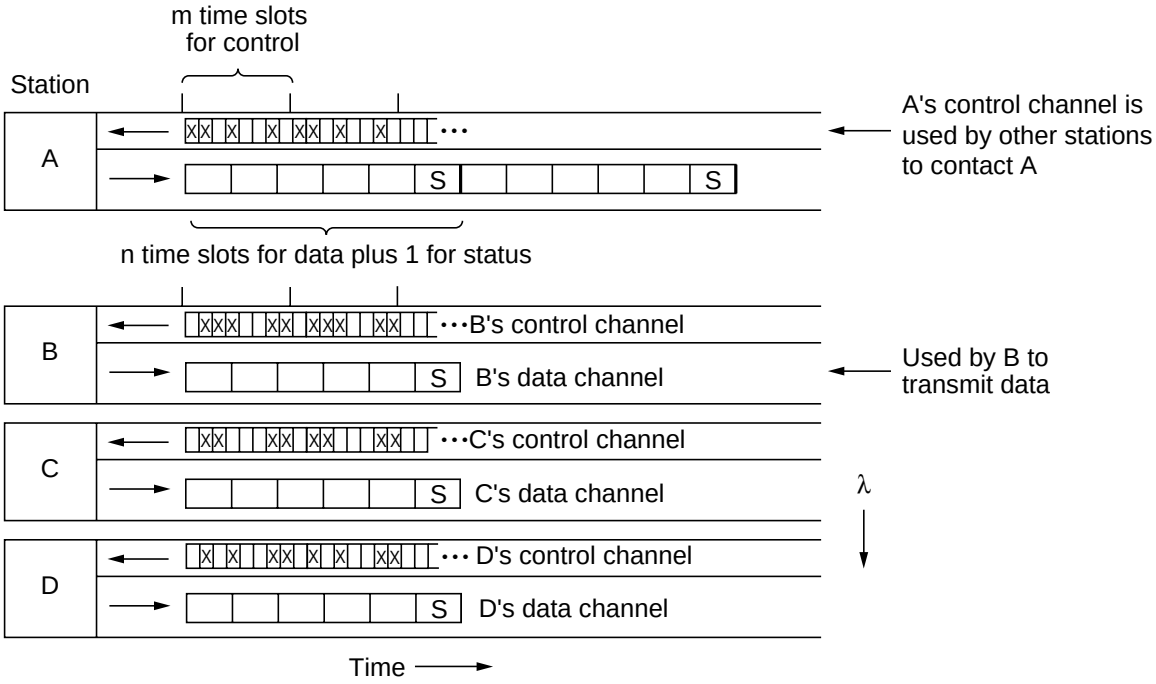

Fig. 4-10. Wavelength division multiple access.

Fig. 4-11. A wireless LAN. (a) *A* transmitting. (b) *B* transmitting.

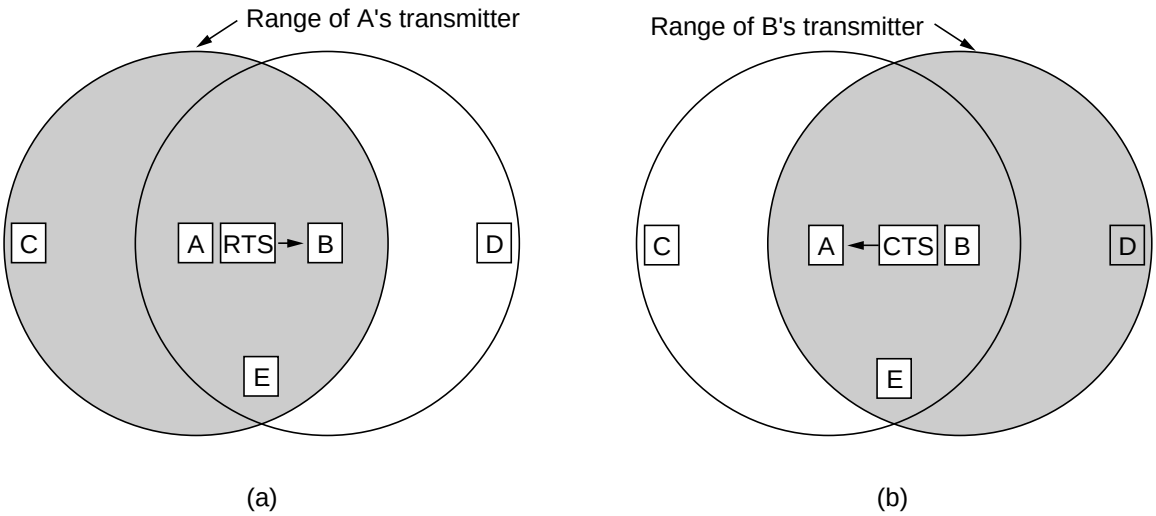

Fig. 4-12. The MACA protocol. (a) *A* sending an RTS to *B*. (b) *B* responding with a CTS to *A*.

Name	Cable	Max. seg.	Nodes/seg.	Advantages
10Base5	Thick coax	500 m	100	Original cable; now obsolete
10Base2	Thin coax	185 m	30	No hub needed
10Base-T	Twisted pair	100 m	1024	Cheapest system
10Base-F	Fiber optics	2000 m	1024	Best between buildings

Fig. 4-13. The most common kinds of Ethernet cabling.

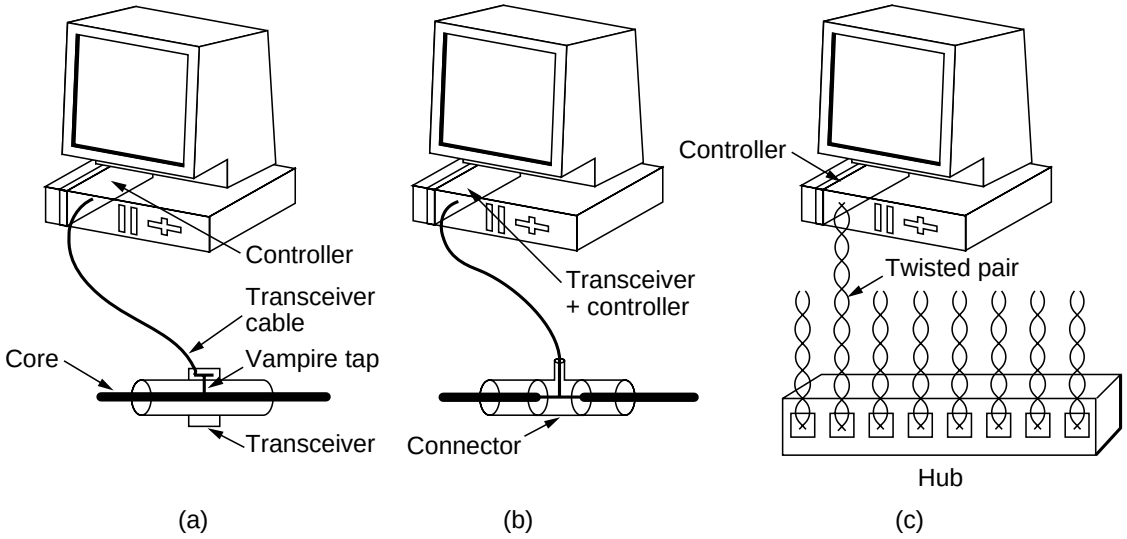

Fig. 4-14. Three kinds of Ethernet cabling. (a) 10Base5. (b) 10Base2. (c) 10Base-T.

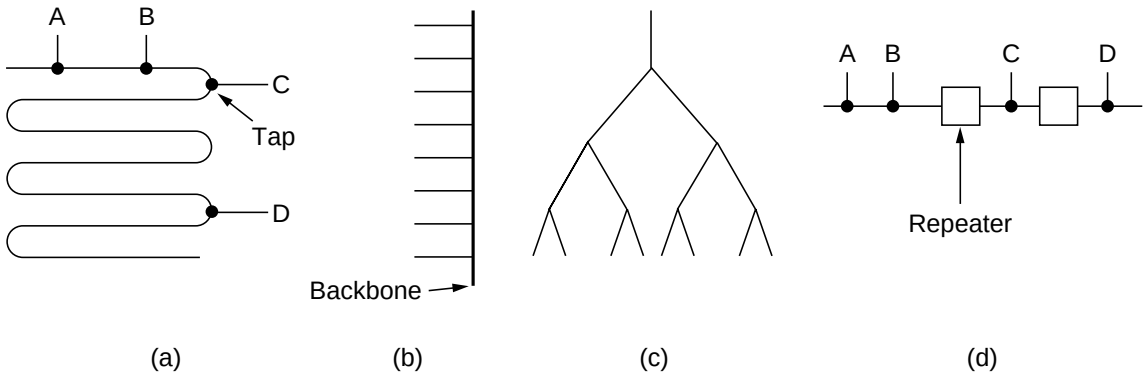

Fig. 4-15. Cable topologies. (a) Linear. (b) Spine. (c) Tree. (d) Segmented.

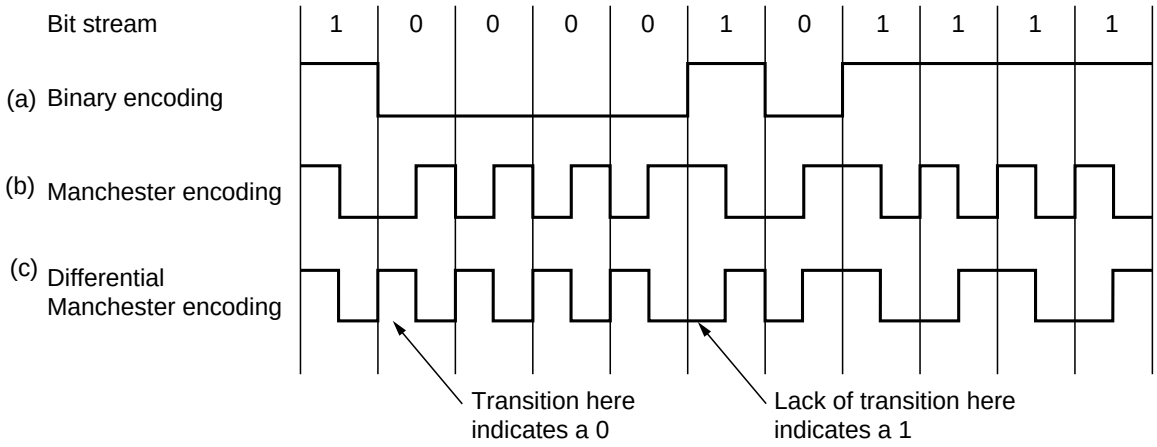

Fig. 4-16. (a) Binary encoding. (b) Manchester encoding. (c) Differential Manchester encoding.

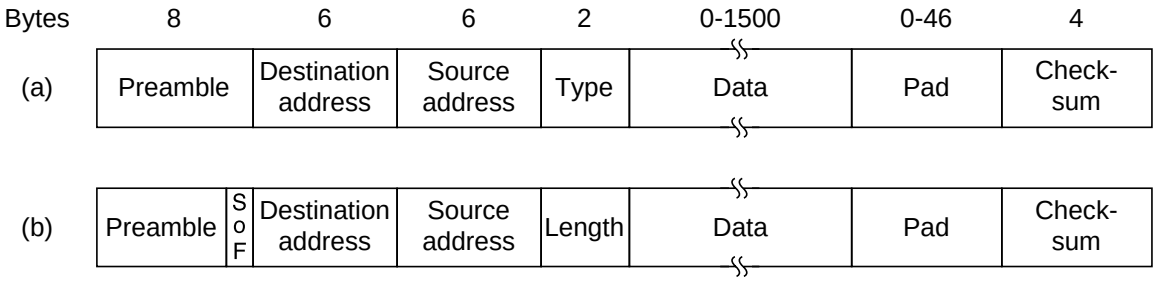

Fig. 4-17. Frame formats. (a) DIX Ethernet. (b) IEEE 802.3.

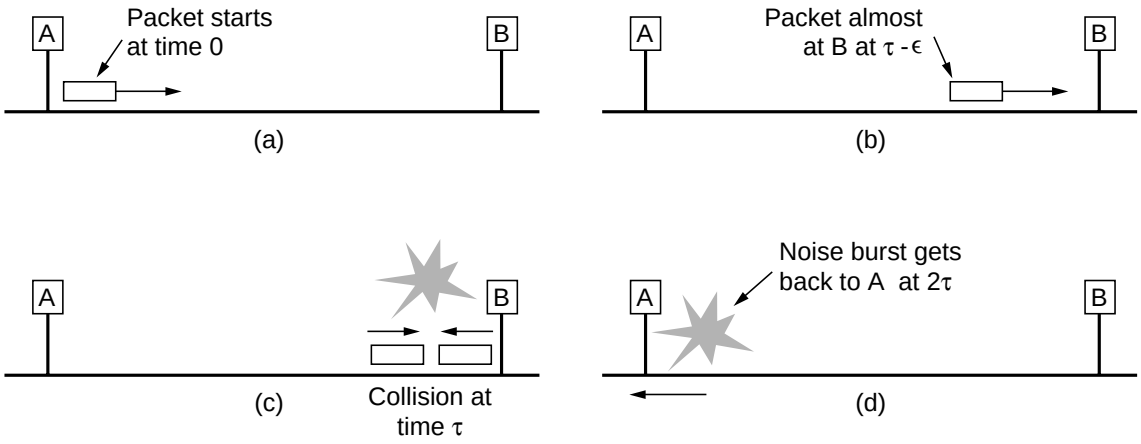

Fig. 4-18. Collision detection can take as long as 2τ.

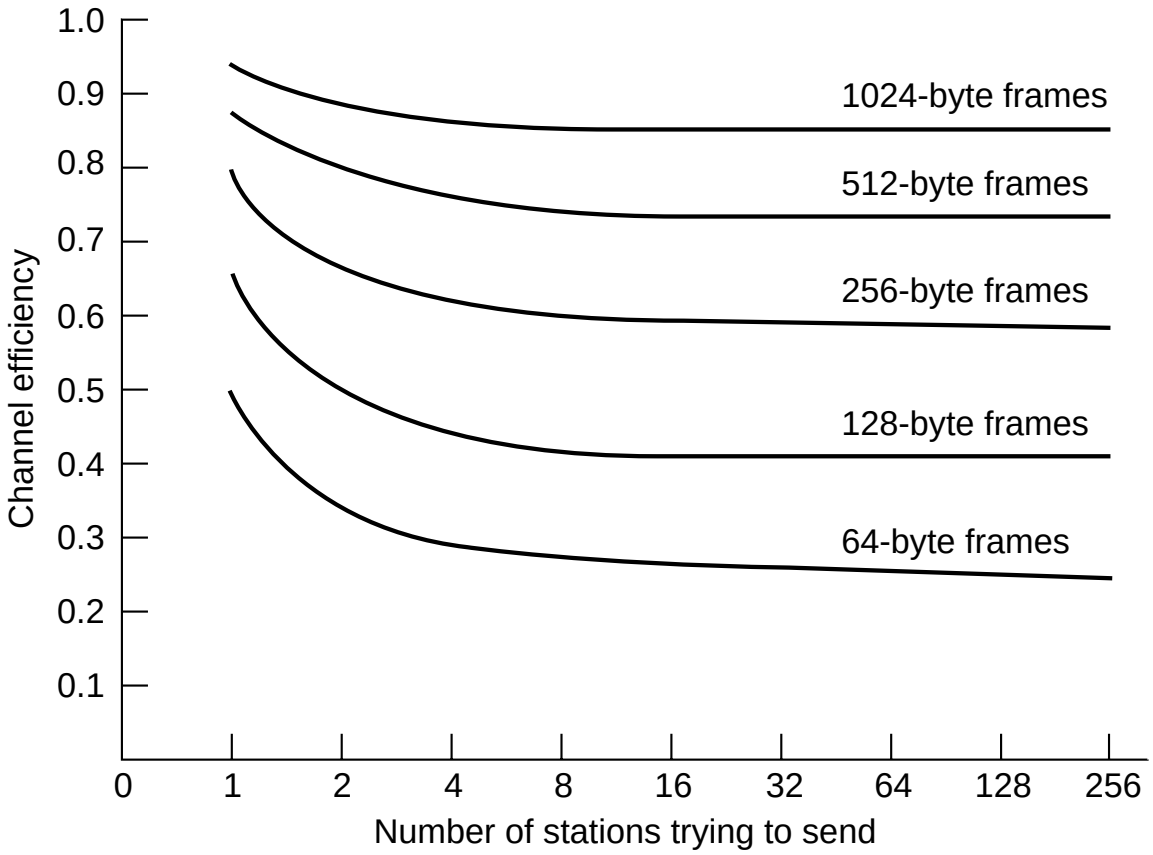

Fig. 4-19. Efficiency of Ethernet at 10 Mbps with 512-bit slot times.

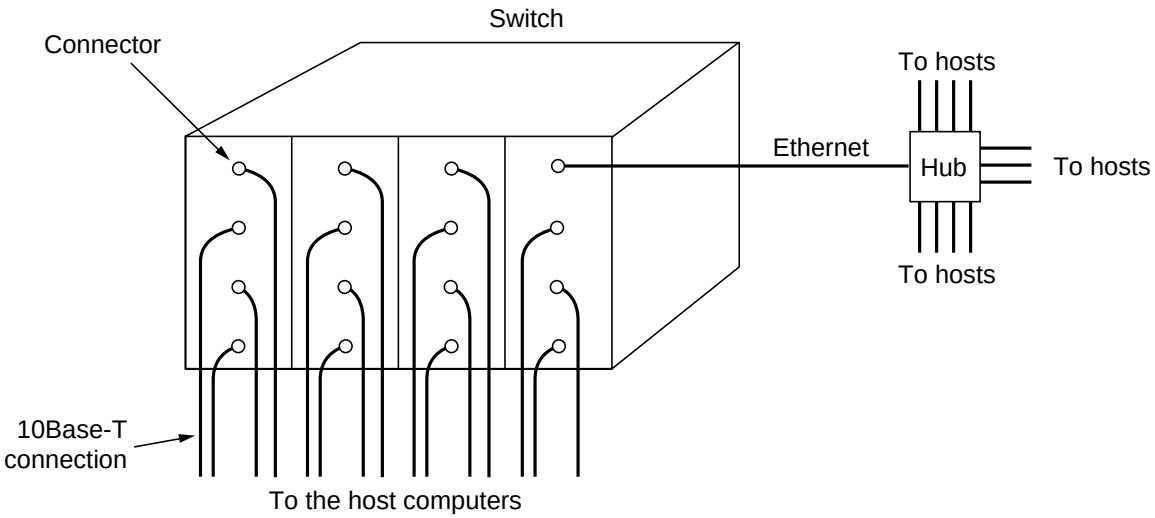

Fig. 4-20. A simple example of switched Ethernet.

Name	Cable	Max. segment	Advantages
100Base-T4	Twisted pair	100 m	Uses category 3 UTP
100Base-TX	Twisted pair	100 m	Full duplex at 100 Mbps (Cat 5 UTP)
100Base-FX	Fiber optics	2000 m	Full duplex at 100 Mbps; long runs

Fig. 4-21. The original fast Ethernet cabling.

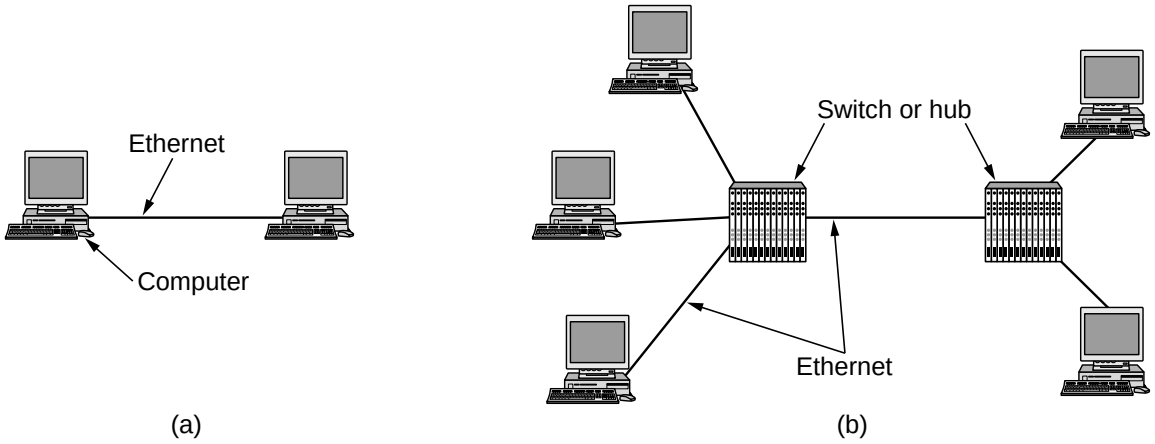

Fig. 4-22. (a) A two-station Ethernet. (b) A multistation Ethernet.

Name	Cable	Max. segment	Advantages
1000Base-SX	Fiber optics	550 m	Multimode fiber (50, 62.5 microns)
1000Base-LX	Fiber optics	5000 m	Single (10 μ) or multimode (50, 62.5 μ)
1000Base-CX	2 Pairs of STP	25 m	Shielded twisted pair
1000Base-T	4 Pairs of UTP	100 m	Standard category 5 UTP

Fig. 4-23. Gigabit Ethernet cabling.

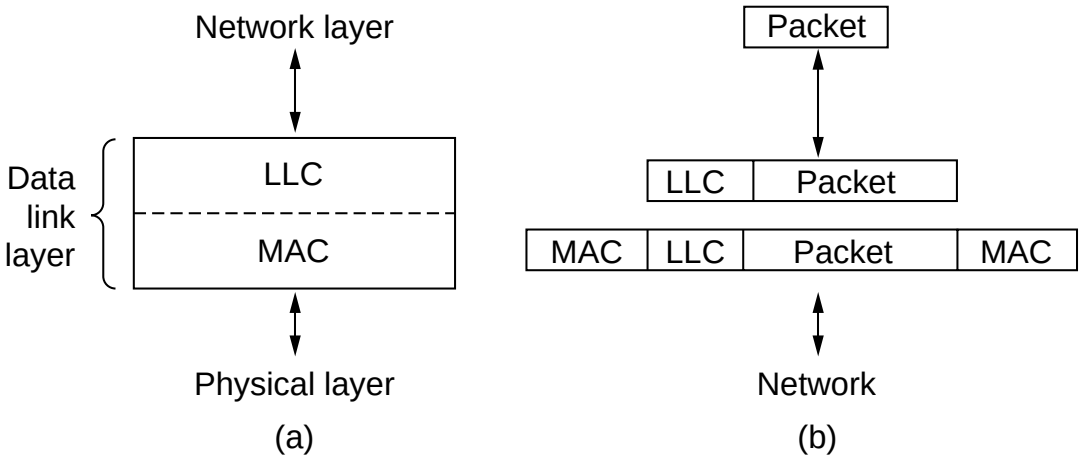

Fig. 4-24. (a) Position of LLC. (b) Protocol formats.

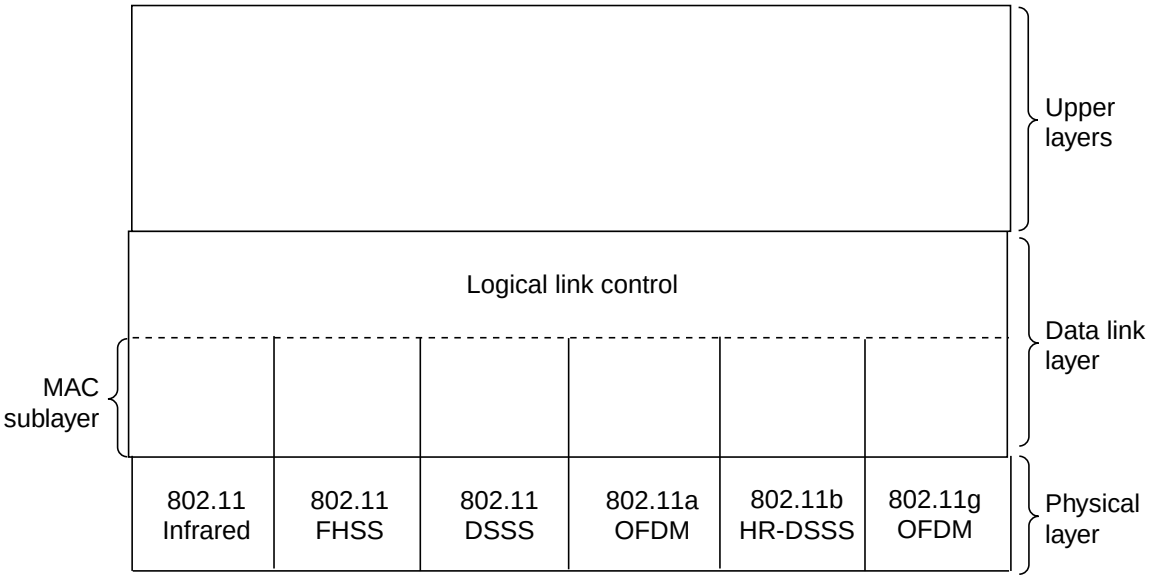

Fig. 4-25. Part of the 802.11 protocol stack.

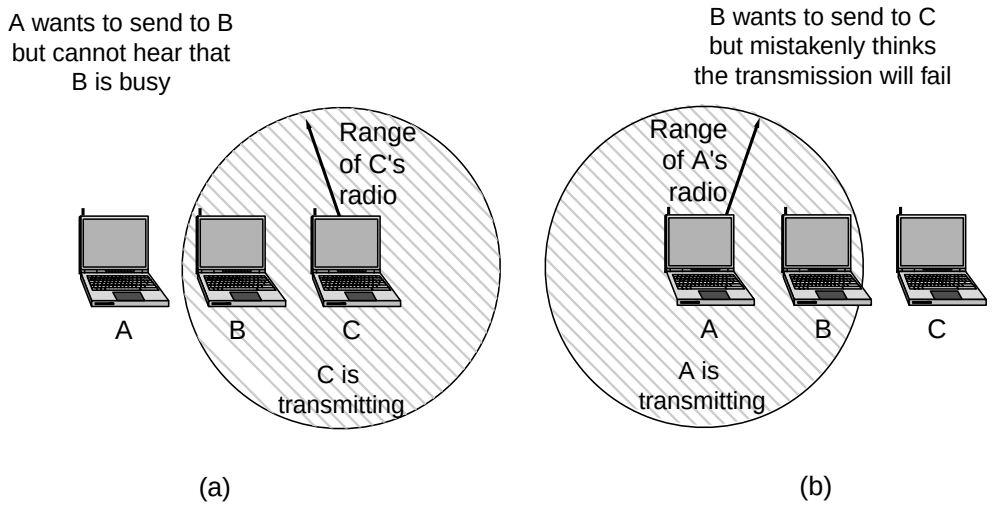

Fig. 4-26. (a) The hidden station problem. (b) The exposed station problem.

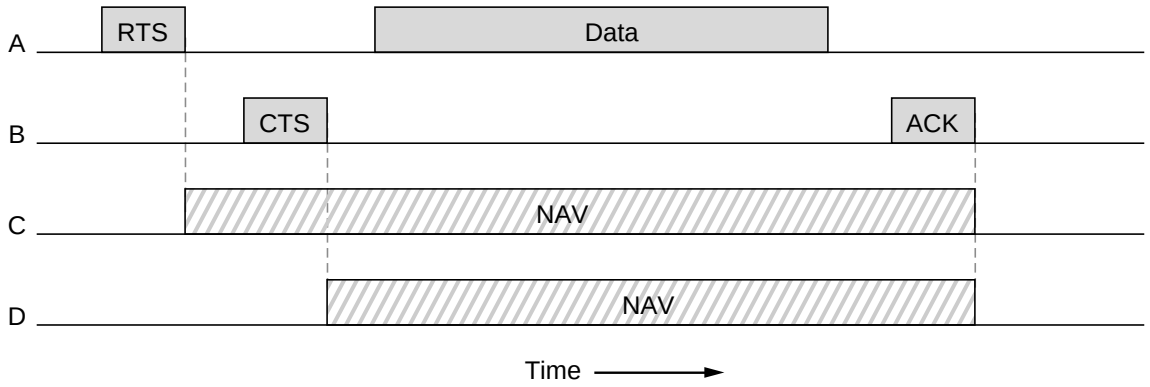

Fig. 4-27. The use of virtual channel sensing using CSMA/CA.

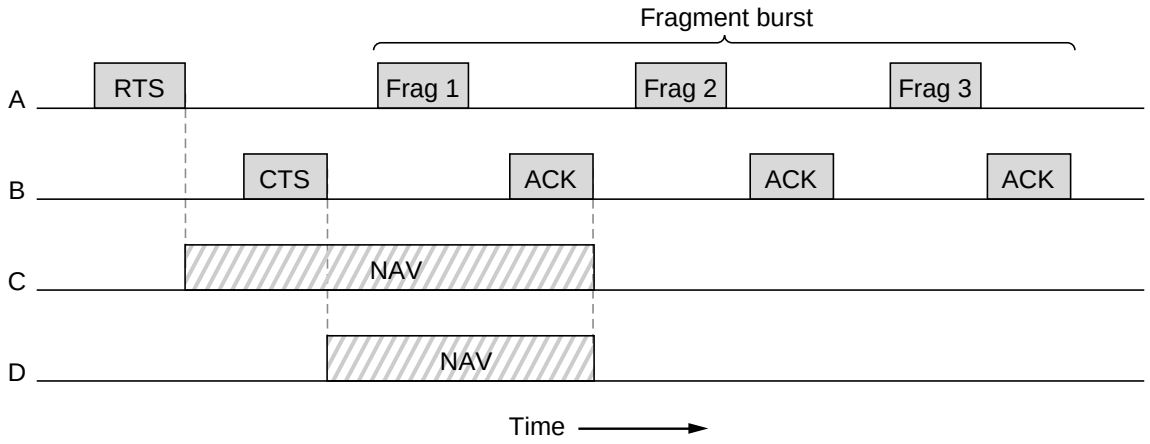

Fig. 4-28. A fragment burst.

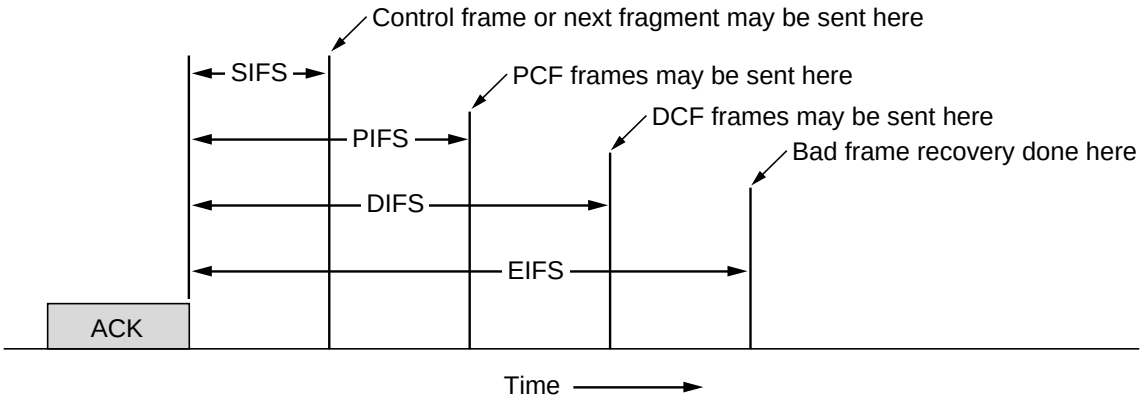

Fig. 4-29. Interframe spacing in 802.11

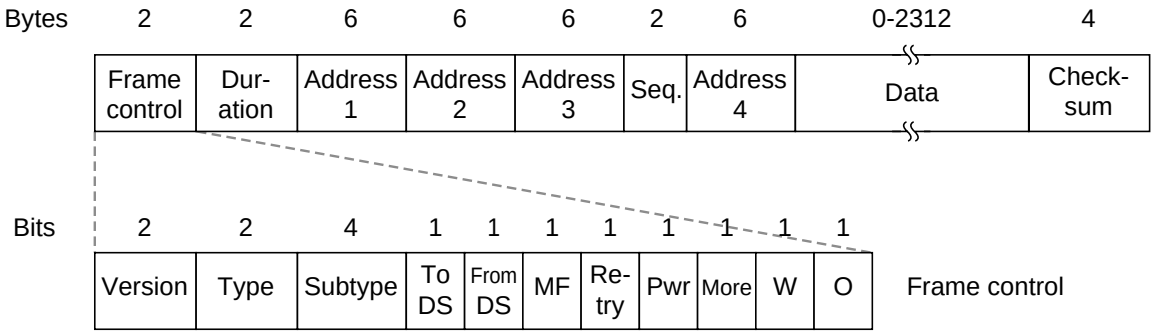

Fig. 4-30. The 802.11 data frame.

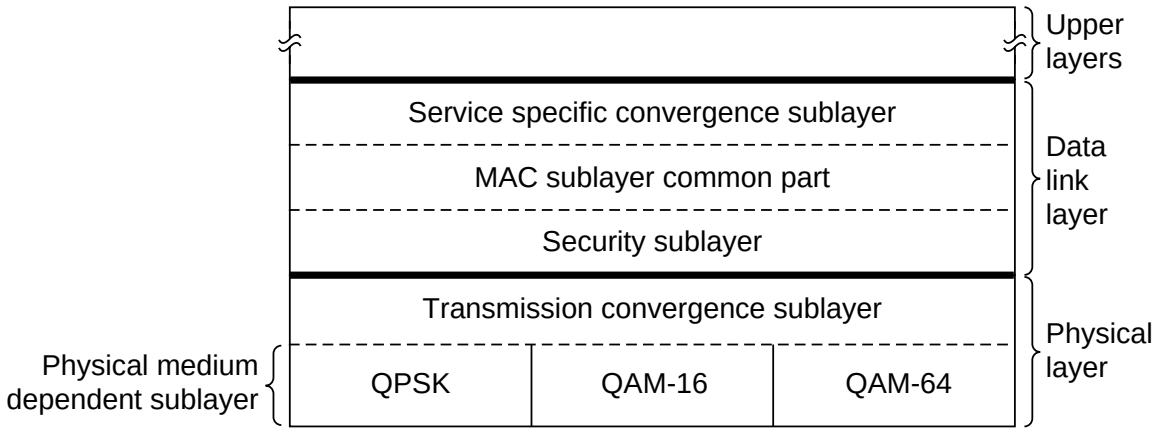

Fig. 4-31. The 802.16 protocol stack.

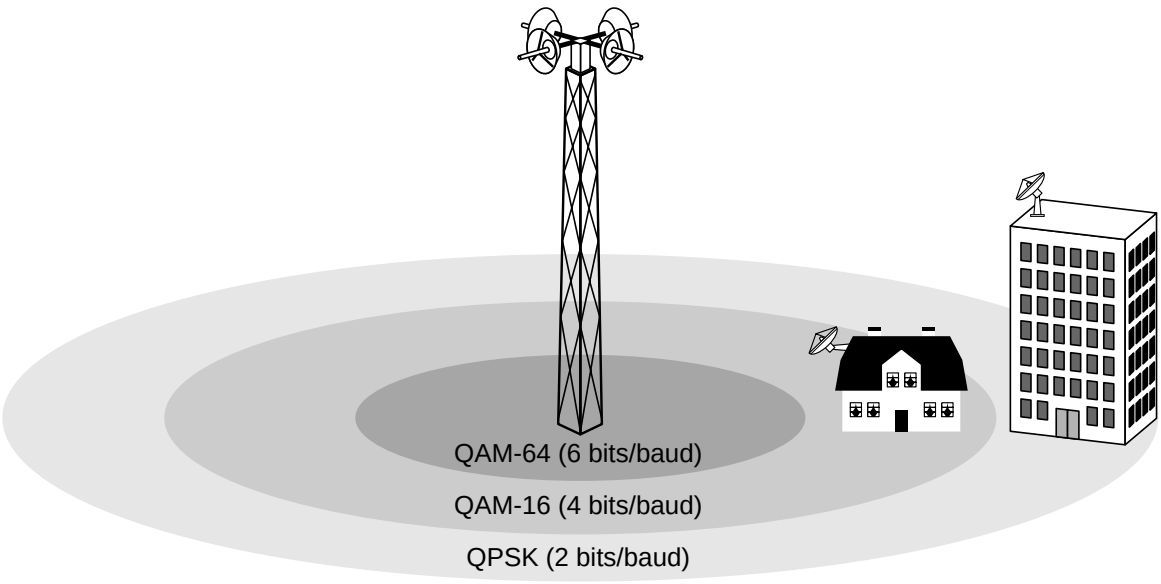

Fig. 4-32. The 802.16 transmission environment.

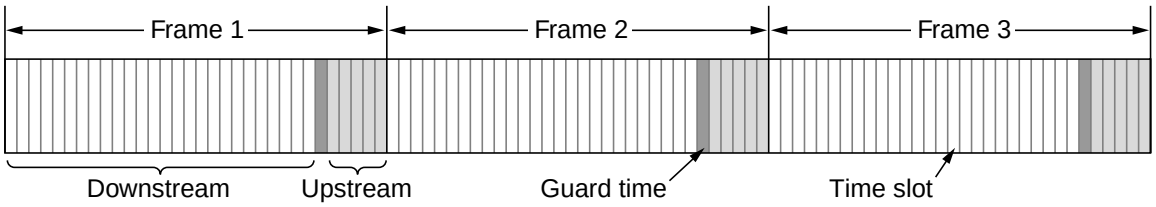

Fig. 4-33. Frames and time slots for time division duplexing.

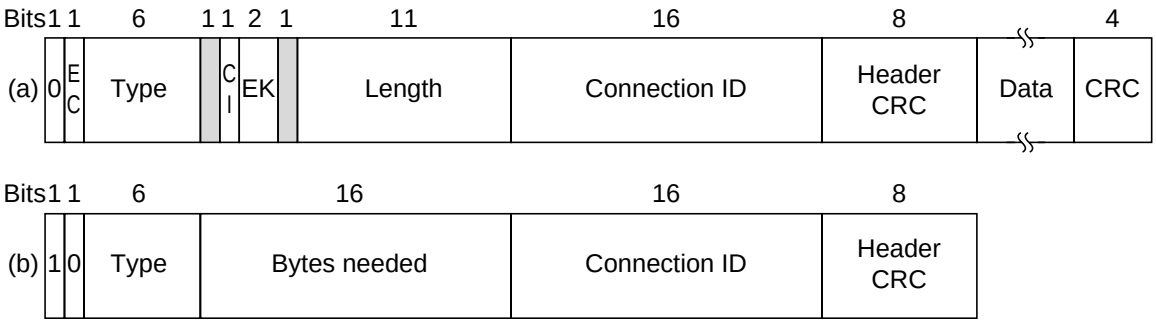

Fig. 4-34. (a) A generic frame. (b) A bandwidth request frame.

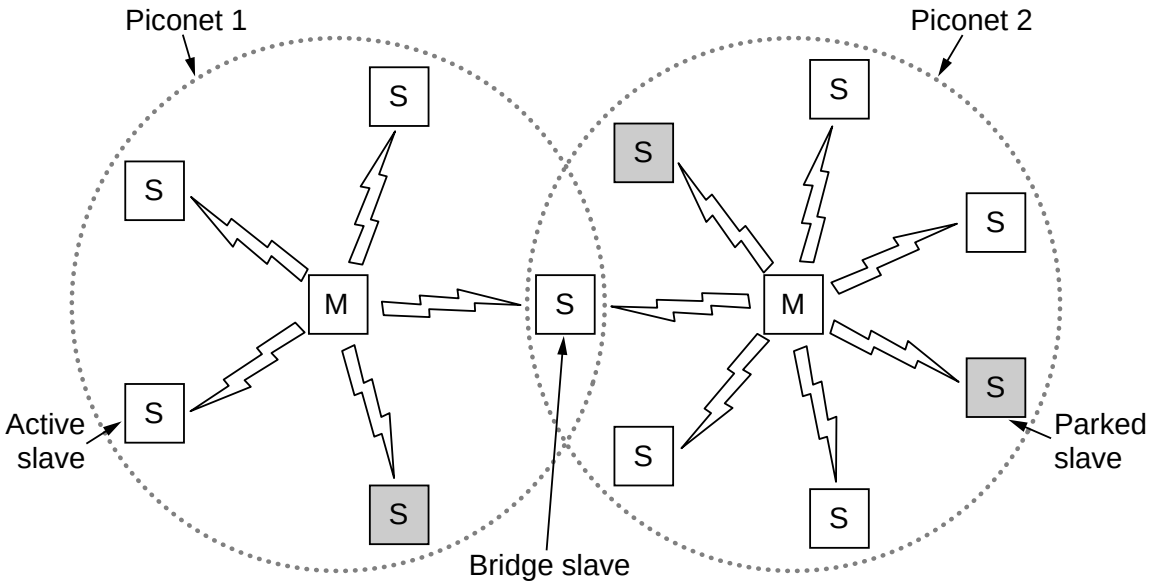

Fig. 4-35. Two piconets can be connected to form a scatternet.

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	Allows 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

Fig. 4-36. The Bluetooth profiles.

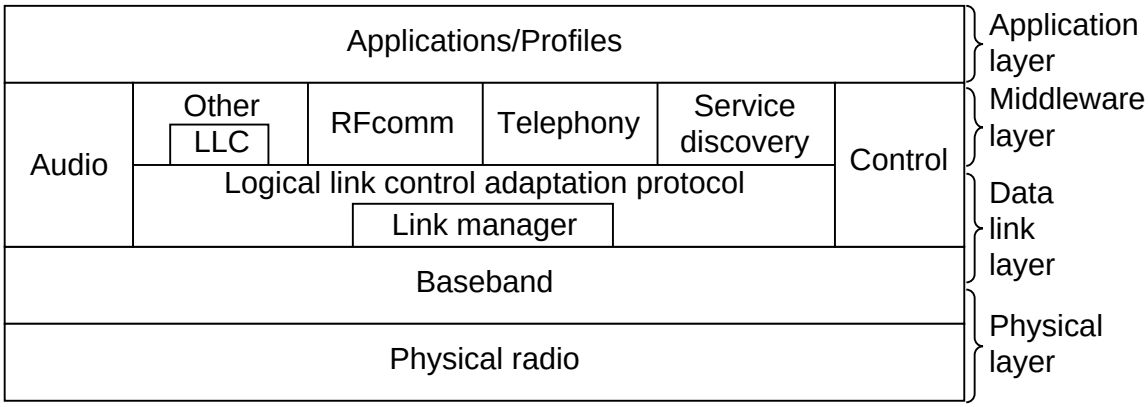

Fig. 4-37. The 802.15 version of the Bluetooth protocol architecture.

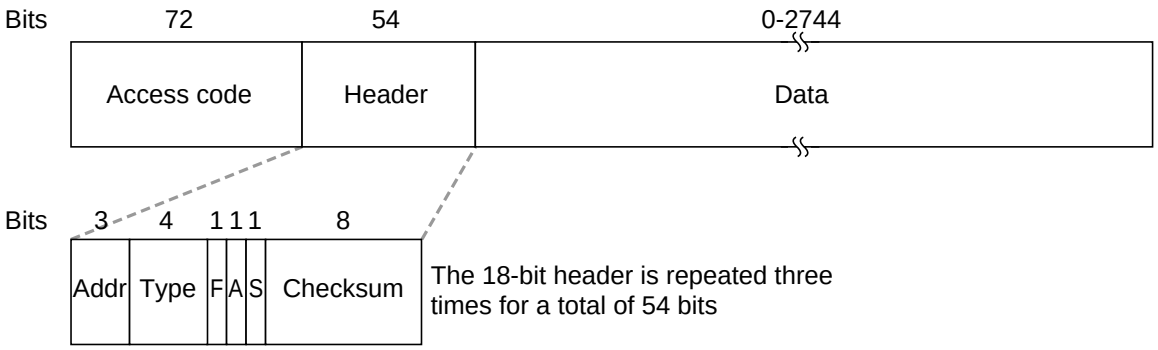

Fig. 4-38. A typical Bluetooth data frame.

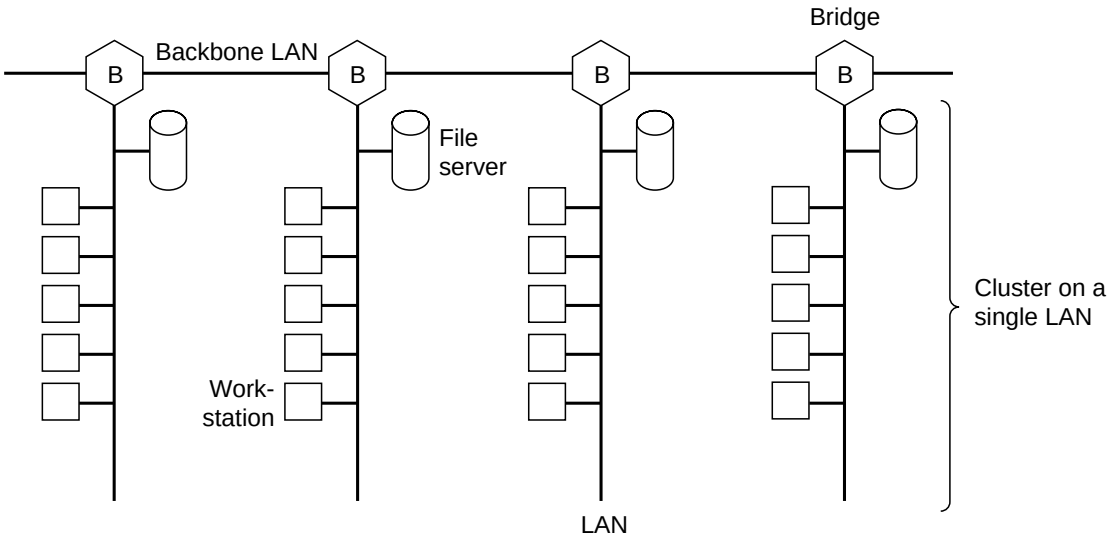

Fig. 4-39. Multiple LANs connected by a backbone to handle a total load higher than the capacity of a single LAN.

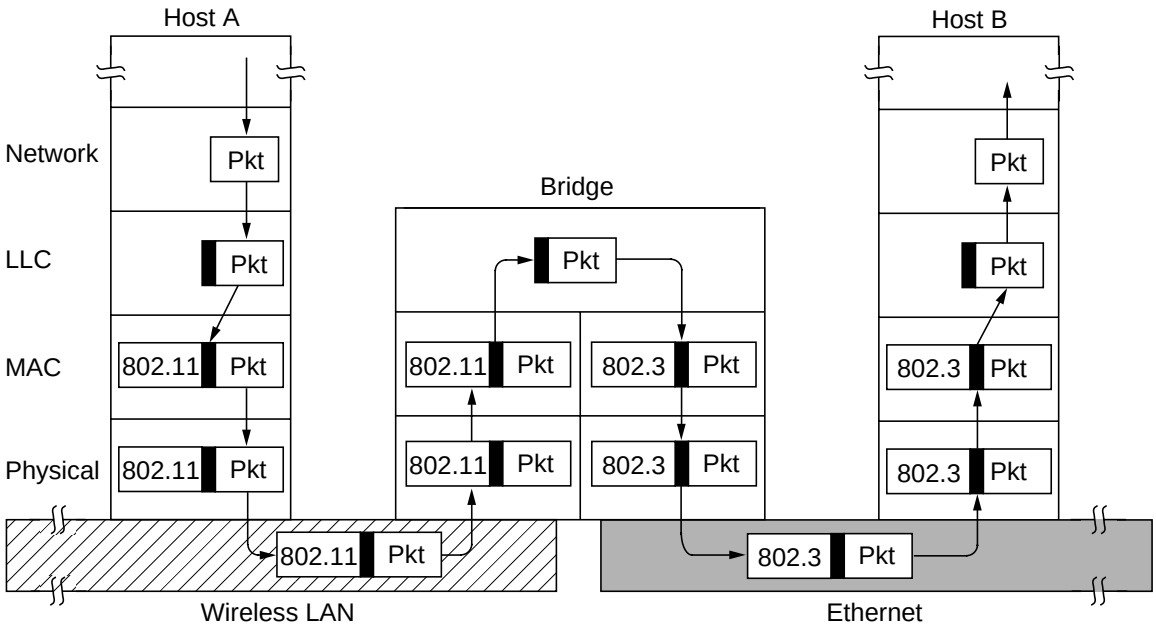

Fig. 4-40. Operation of a LAN bridge from 802.11 to 802.3.

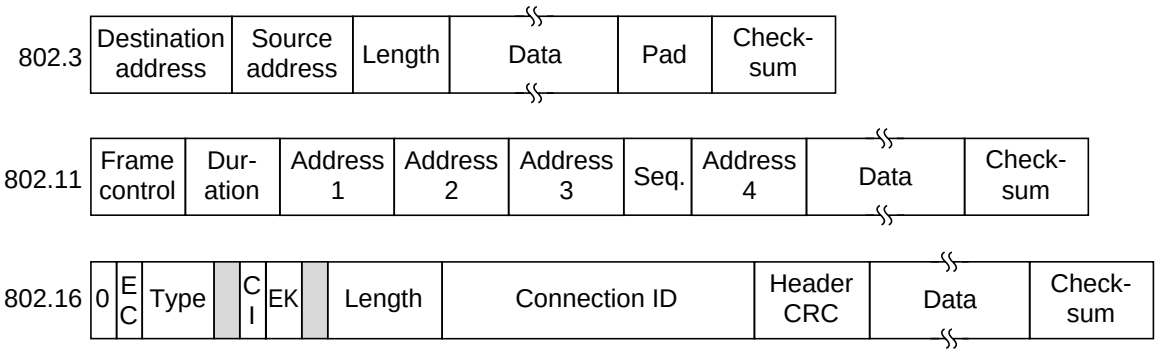

Fig. 4-41. The IEEE 802 frame formats. The drawing is not to scale.

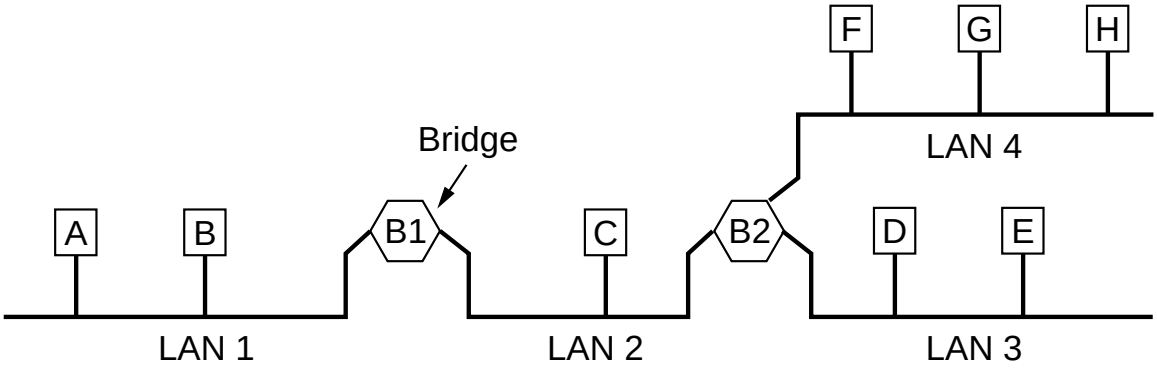

Fig. 4-42. A configuration with four LANs and two bridges.

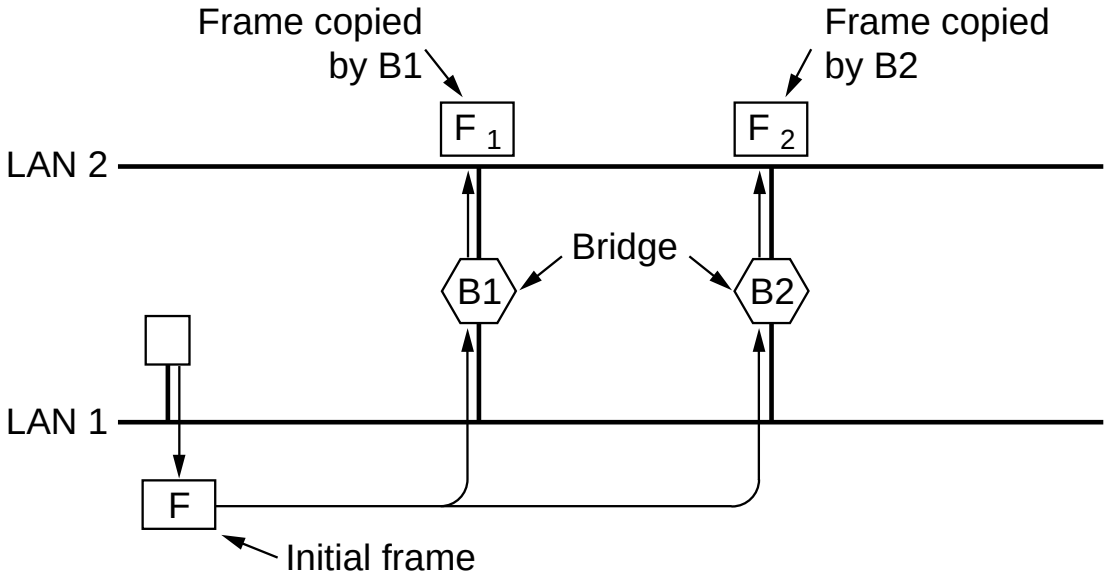

Fig. 4-43. Two parallel transparent bridges.

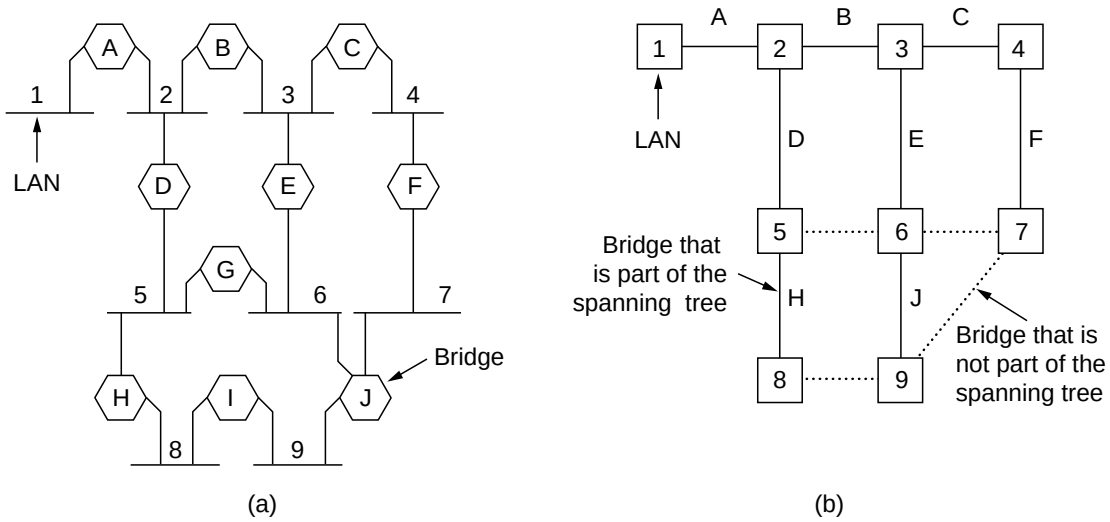

Fig. 4-44. (a) Interconnected LANs. (b) A spanning tree covering the LANs. The dotted lines are not part of the spanning tree.

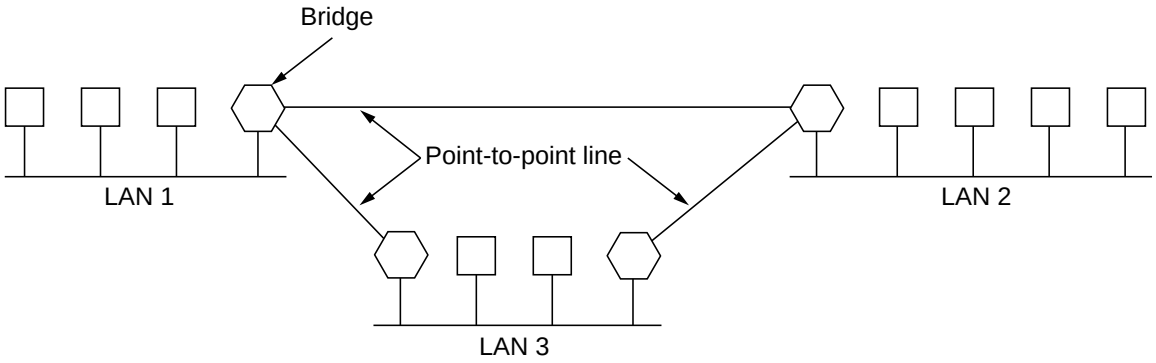

Fig. 4-45. Remote bridges can be used to interconnect distant LANs.

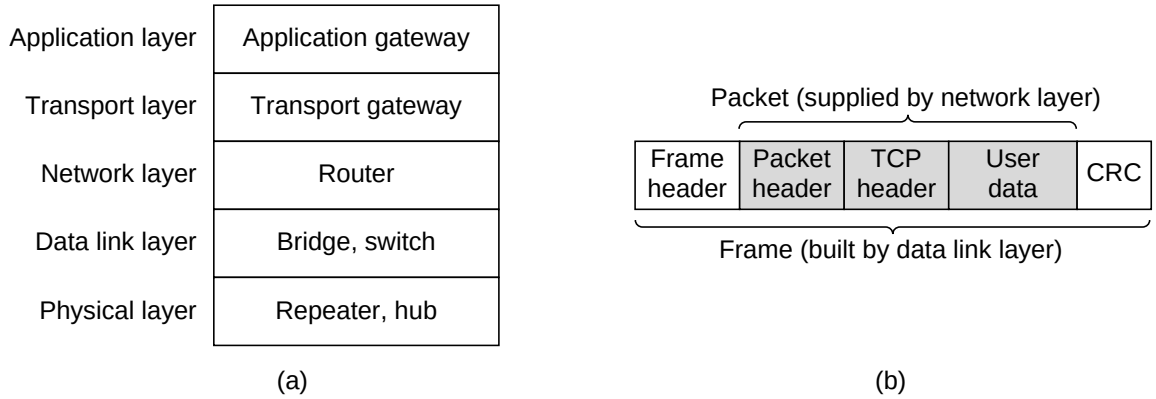

Fig. 4-46. (a) Which device is in which layer. (b) Frames, packets, and headers.

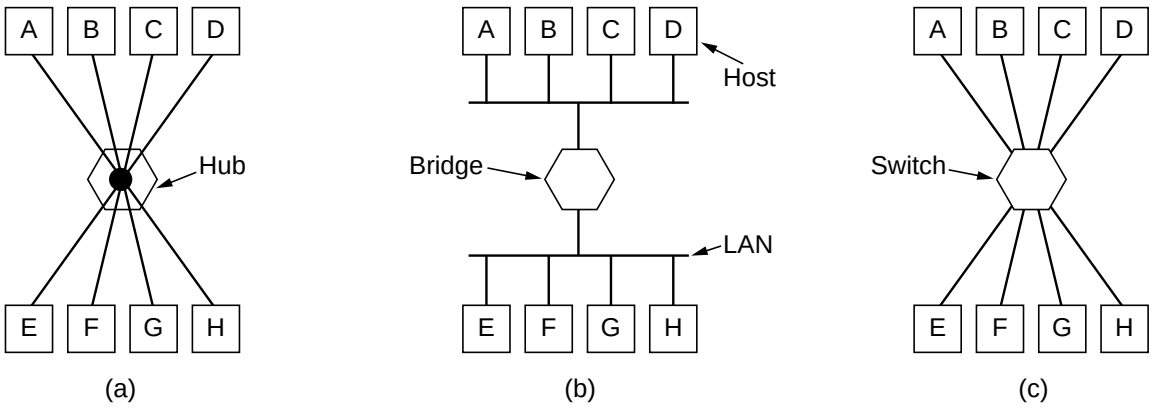

Fig. 4-47. (a) A hub. (b) A bridge. (c) A switch.

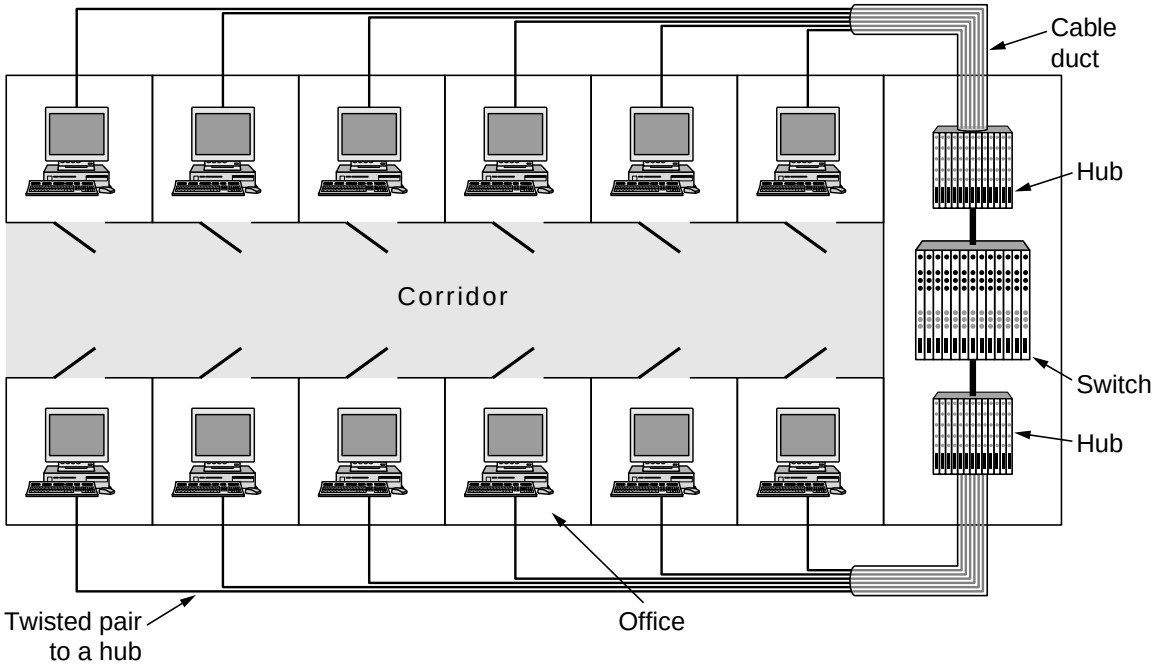

Fig. 4-48. A building with centralized wiring using hubs and a switch.

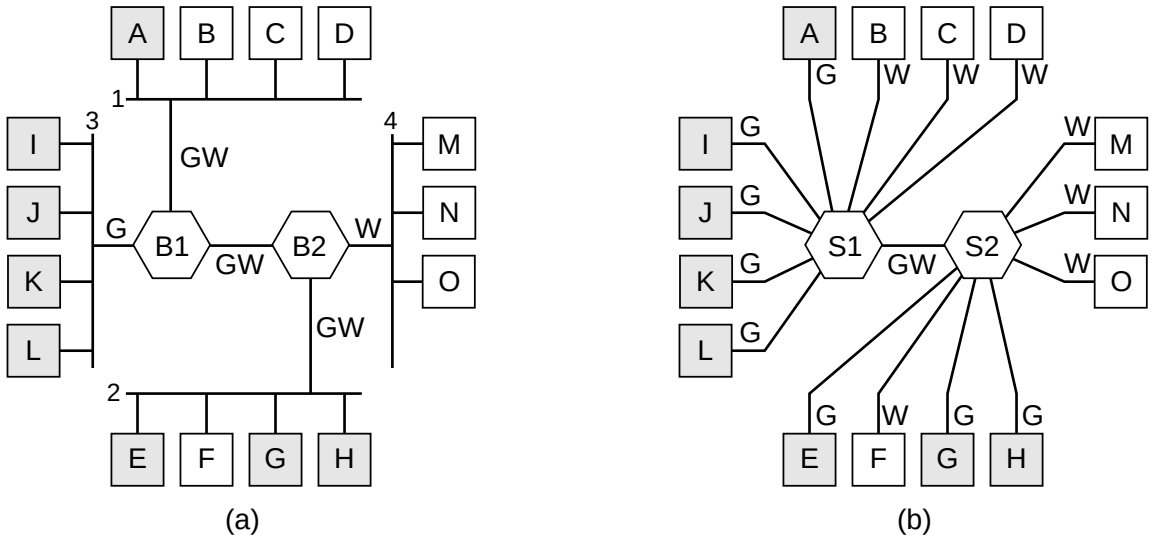

Fig. 4-49. (a) Four physical LANs organized into two VLANs, gray and white, by two bridges. (b) The same 15 machines organized into two VLANs by switches.

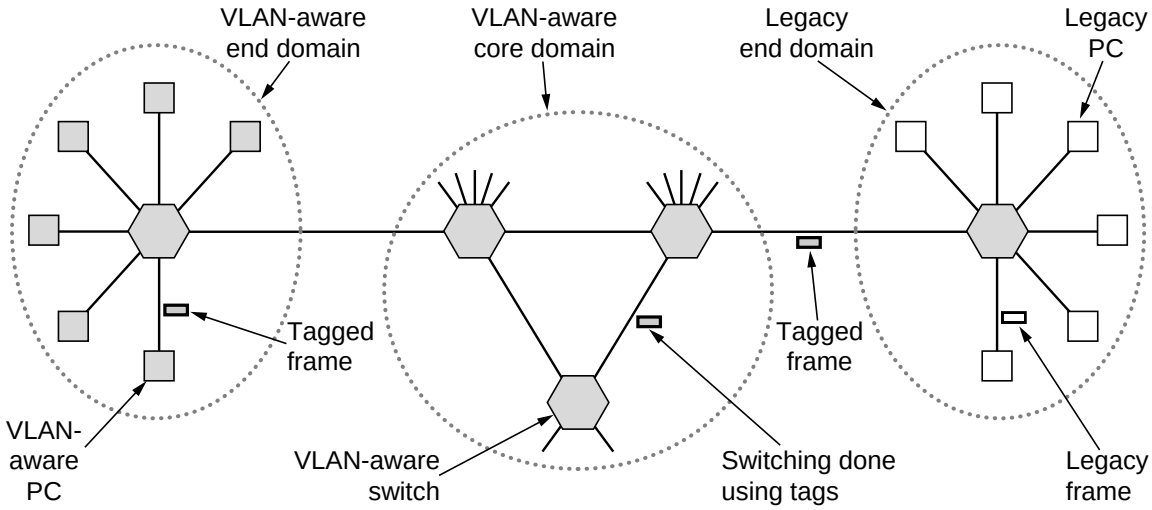

Fig. 4-50. Transition from legacy Ethernet to VLAN-aware Ethernet. The shaded symbols are VLAN aware. The empty ones are not.

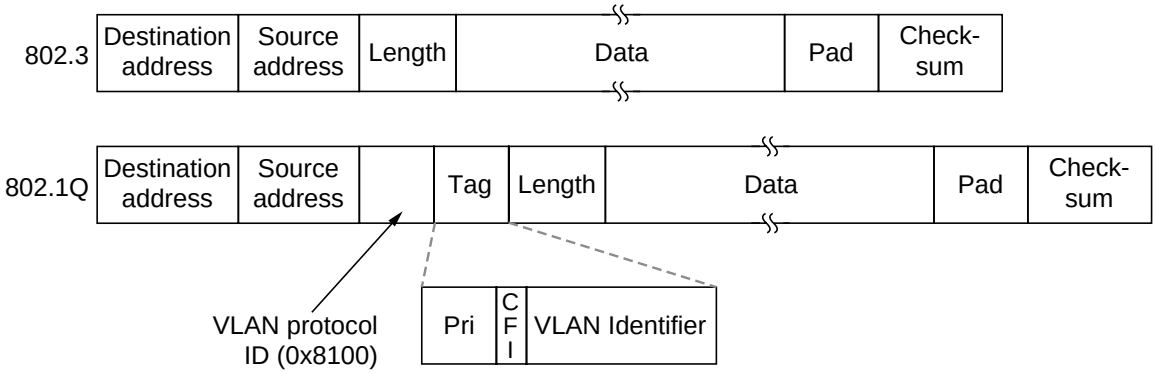

Fig. 4-51. The 802.3 (legacy) and 802.1Q Ethernet frame formats.

Method	Description
FDM	Dedicate a frequency band to each station
WDM	A dynamic FDM scheme for fiber
TDM	Dedicate a time slot to each station
Pure ALOHA	Unsynchronized transmission at any instant
Slotted ALOHA	Random transmission in well-defined time slots
1-persistent CSMA	Standard carrier sense multiple access
Nonpersistent CSMA	Random delay when channel is sensed busy
P-persistent CSMA	CSMA, but with a probability of p of persisting
CSMA/CD	CSMA, but abort on detecting a collision
Bit map	Round-robin scheduling using a bit map
Binary countdown	Highest-numbered ready station goes next
Tree walk	Reduced contention by selective enabling
MACA, MACAW	Wireless LAN protocols
Ethernet	CSMA/CD with binary exponential backoff
FHSS	Frequency hopping spread spectrum
DSSS	Direct sequence spread spectrum
CSMA/CA	Carrier sense multiple access with collision avoidance

Fig. 4-52. Channel allocation methods and systems for a common channel.