IEEE standards for local area networks

Telecommunication Networks Group
firstname.lastname@polito.it
http://www.telematica.polito.it/
Copyright

- Quest’opera è protetta dalla licenza Creative Commons NoDerivs-NonCommercial. Per vedere una copia di questa licenza, consultare http://creativecommons.org/licenses/nd-nc/1.0/
oppure inviare una lettera a: Creative Commons, 559 Nathan Abbott Way, Stanford, California 94305, USA.

- This work is licensed under the Creative Commons NoDerivs-NonCommercial License. To view a copy of this license, visit: http://creativecommons.org/licenses/nd-nc/1.0/ or send a letter to Creative Commons, 559 Nathan Abbott Way, Stanford, California 94305, USA.
LAN standard

- Standard developed in the ‘80s
  - 802.1: LAN internetworking
  - 802.2: LLC sublayer
  - 802.3: CSMA/CD (Ethernet)
  - 802.4: Token Bus
  - 802.5: Token Ring
  - 802.6: DQDB (per reti MAN)
LAN standard

• Other, more recent, committees:
  – 802.7: Broadband Technical Advisory Group
  – 802.8: Fiber-Optic Technical Advisory Group
  – 802.9: Integrated Data and Voice Networks
  – 802.10: Network Security
  – 802.11: Wireless Networks
  – 802.12: 100 base VG
  – 802.13: 100 base X
  – 802.15: Bluetooth
  – 802.17: Resilient Packet Ring
Layer 2 in LANs

- Layer 2 divided in two sub-layers
  - LLC: Logical Link Control
  - MAC: Medium Access Control
LANs layer 2 functions

- Frame delineation
  - MAC (silence among packets and SFD)
- Multiplexing (higher layer protocols)
  - IEEE 802.2 LLC, MAC Ethernet
- Error detection
  - MAC
- Error correction (window protocol)
  - LLC (optionale)
- Addressing
  - MAC used to identify the NIC (Network Interface Card), LLC for higher layer protocol multiplexing
- Flow control over the service interface (toward higher layer)
  - LLC
LLC addresses

- Higher layer protocol multiplexing

MAC + PHY + transmission media
MAC addresses

• Identify the NIC (Network Interface Card)
MAC

• MAC addresses of 6 byte
• Each NIC has a unique MAC address
  – Originally written in ROM
  – Now possible to select the address
• Two parts
  – 3 most significant bytes: Organization Unique ID. assigned to NIC maker
  – 3 less significant bytes: NIC numbering
• Example
  – 02-60-8C-07-9A-4D is a 3com NIC
MAC addresses

• MAC addresses can be
  – single or unicast, if the packet must be received by a specific node
  – Multicast, if the packet can be received by group of nodes
  – broadcast (FF FF FF FF FF FF FF), if the packet must be received by all stations

• Two multicast mode
  – Solicitation: request of service to a multicast group
  – Advertisement: periodic diffusion of info related to a multicast group
NIC address management

• When a (correct) packet is received in a NIC
  – The packet is accepted if the destination MAC address in the packet is
    • Unicast and equal to the NIC MAC address
    • Broadcast
    • Multicast and the multicast group has been enabled (normally via software) on the NIC

• NIC can be configured in promiscuous mode
  – Capture any packet regardless of the MAC destination address
Ethernet and IEEE 802.3

- Ethernet: jointly developed by Digital, Intel and Xerox (DIX) in the ’70s
- Ethernet 2.0 published by DIX in 1982
- In 1985 IEEE defines the standard 802.3 based on Ethernet
- Ethernet and IEEE 802.3 differ only for few characteristics mainly related to the MAC packet format
Ethernet and IEEE 802.3

- CSMA-CD 1-persistent on a bus topology
- Although collision detection is used, collisions may happen due to propagation delays
- Collision is detected during packet transmission
  - When detected, nodes immediately stop packet transmission and send a jamming sequence (to ensure that all nodes sharing the channel detect the collision)
- Nodes involved in the collision wait a random time before attempting to retransmit (statistical contention resolution)
- No ACK is sent to confirm packet reception
Ethernet: packet format

- Preamble = 101010……... 7 bytes
- SFD = 10101011 1 byte
- MAC destination address 6 bytes
- MAC source address 6 bytes
- Higher layer protocol > 1500 2 bytes
- DATA 46 - 1500 bytes
- FCS 4 bytes
- Inter Packet GAP (silence) Equivalent to 12
IEEE 802.3: packet format

- **Preamble**: 7 bytes
- **SFD**: 1 byte
- **MAC destination address**: 6 bytes
- **MAC source address**: 6 bytes
- **Length (<1500)**: 2 bytes
- **DATA**: 0 - 1500 bytes
- **Padding**: 0 - 46 bytes
- **FCS**: 4 bytes
- **Inter Packet GAP (silence)**: Equivalent to 12
Round Trip Delay

- Time needed (in the worst case) to propagate the signal from one node at one end of the bus to the other end of the bus and back
- Round Trip Delay = 2 \( T \)
Ethernet Collision Domain

• Collision domain is the portion of an Ethernet network in which two nodes transmitting at the same time would create a collision
  – Several cables connected by repeaters are in the same collision domain
  – Store and forward devices (bridge, switch or router) separate collision domains

• The collision domain diameter is the maximum distance among any pair of nodes
  – Set to 2800m in 10Mbit/s LANs to keep under control the round trip delay
Ethernet: design parameters

- Minimum packet transmission time must be larger than the network RTD
  - To detect collision while sending the packet
- Minimum packet size depends on network size and transmission speed
- At 10Mbit/s, with 2800m of network size the minimum packet size is 64 byte
- Packet length is also depending on the (Inter-Packet Gap), time needed to detect end of packet transmission
Ethernet: physical layer

- Bit rate: 10 Mb/s
  - bit time = 0.1 µs
- Manchester coding (20Mbit/s clock to make it easier the clock recovery task in an asynchronous environment
  - Preamble to recover the transmitter clock
- Maximum number of station is 1024
- Transmission media
  - 10 BASE 5: thick coaxial cable RG213
  - 10 BASE 2: thin coaxial cable RG58
  - 10 BASE T: 100 Ohm UTP unshielded twisted pair
  - 10 BASE FL, 10 BASE FB, 10 BASE FP: multimode fiber optic (first window)
New generation LANs

Gruppo Reti TLC
nome.cognome@polito.it
http://www.telematica.polito.it/
In the ’90s

• Need to increase bit rate (>10Mbit/s)
• Structured cabling
  – Hierarchical start topology (tree)
• Star center
  – hub (shared bit rate, all ports at the same tx speed)
  – switch (dedicated bit rate, ports can have different tx speed)
• Star center backed up
• Ethernet evolution (also attempts to evolve Token Ring in FDDI, ...)

Copyright TNG group – Politecnico di Torino
Ethernet Switching

- Switches are used to create the topology
- Often one port per node
- Routing options in switches
  - Store-and-forward
  - Cut-through
    - Forward packets as soon as the address is read and processed
    - Reduced latency but FCS not checked
    - Possible only if using the same MAC on all ports, the same bit rate on all ports, the destination port is free, only for unicast packets
  - Fragment free transmission (collided packets are not transmitted)
Ethernet at 100Mb/s

- Since tx bit rate, minimum packet size and RTD must be jointly designed to define a 100Mb/s Ethernet, either
  - Increase the minimum packet size
  - Decrease network size
  - Modify the access protocol

- Two solutions:
  - Fast Ethernet (100Base-T)
    - CSMA/CD with a network size reduced by a factor of 10
  - 100VG (Voice Grade) AnyLAN
    - New polling-based MAC (better for multiple priority traffic)
    - Not compliant with old Ethernet NIC!
1Gbit/s Ethernet

• Gigabit Ethernet packet has the same format of 802.3 packet
• MAC protocol is CSMA-CD
  – Most of the time used in switched configuration as point-to-point tx
• Half duplex and full duplex operation
  – For full duplex tx, maximum distance induced by tx properties and not by the MAC protocol
• Backward compatibility with traditional Ethernet
• Minimum packet size increased by a factor of 10 to keep constant the ratio between packet transmission time and propagation time
• Jumbo frame of large size to increase performance
• 8B10B coding to ease the synchronization task