Token Ring

Chapter 5

Token Ring

Computer network connecting devices in a closed loop with successive point-to-point links.

- Deterministic, asynchronous, with acknowledgment,
- Speed = 4 / 16 Mbps,
- Technology: developed by IBM,
- normalized by IEEE : 802.5,
- More complex & more expensive than the Ethernet network.

Token Ring

- IEEE 802.5 Standard
- Layers specified by 802.5:
  - Token Ring Physical Layer
  - Token Ring MAC Sublayer

Token Ring *(cont´d)*

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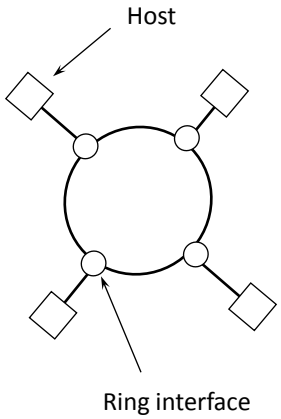
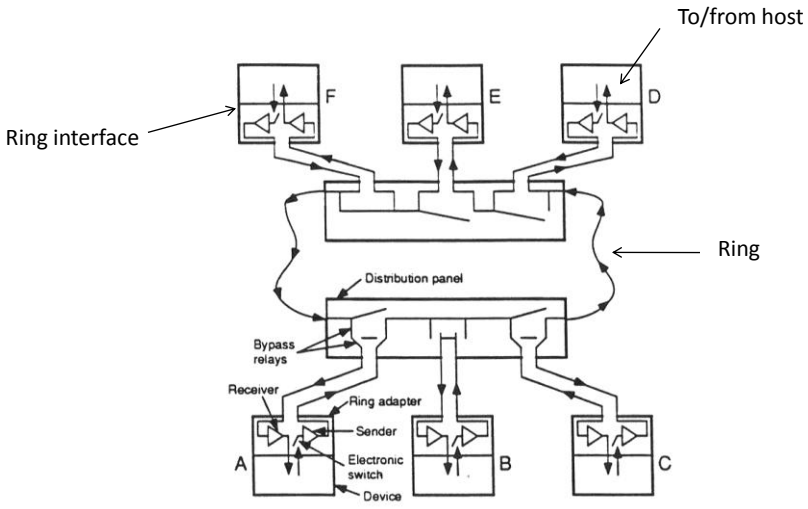


- Token Ring, unlike Ethernet, requires an active interface.

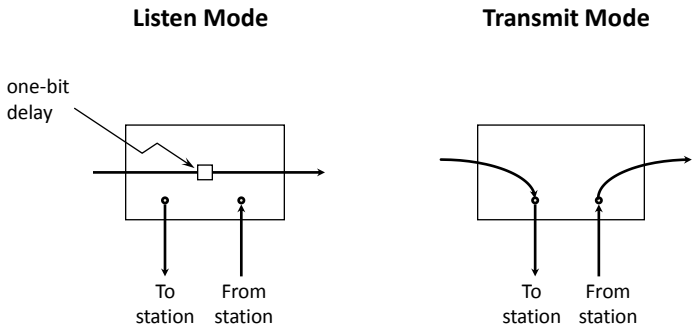
Token Ring Configuration



Token Ring Physical Layer

- Ring Interfaces
  - Listen and Transmit Modes
- Channel Logic
  - Differential Manchester Encoding

Token Ring Interface Modes



Token Ring MAC Sublayer

- Token passing protocol
- Frame format
- Token format

Token Passing Protocol

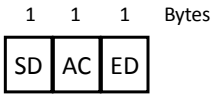
- A token (3 bytes pattern) circulates around the ring
- Token state:
  - Busy: supports a frame,
  - Idle: free (may be captured).

Token Passing Protocol *(cont´d)*

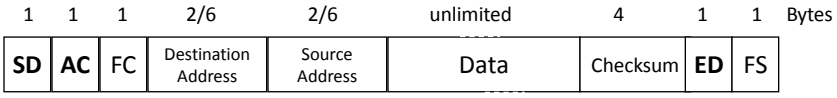
- General Procedure:

1. Sending host waits for and captures an idle token,
2. Sending host changes the token to a frame and circulates it,
3. Receiving host accepts the frame and continues to circulate it,
4. Sending host receives its frame, removes it from the ring, and generates an idle token which it then circulates on the ring.

Token Ring Frame and Token Formats

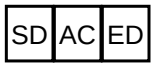


Token Format



Frame Format

Token Ring Delimiters



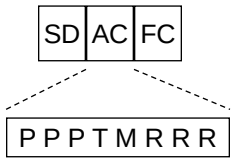
- SD = Starting Delimiter,
- ED = Ending Delimiter,
- They contains invalid differential Manchester codes.

SD

J	K	0	J	K	0	0	0
1 bit	1 bit	1 bit	1 bit	1 bit	1 bit	1 bit	1 bit

J and K are code violations of the Manchester encoding and will be detected by the hardware.

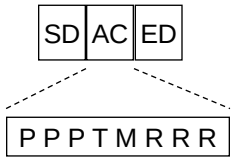
Token Ring Access Control Field



(Note: The AC field is also used in frames)

- **P** = Priority bits (current priority)
  - provides up to 8 levels of priority when accessing the ring
- **T** = Token bit
  - T=0: Token
  - T=1: Frame

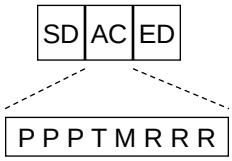
Token Ring Access Control Field *(cont´d)*



M = Monitor Bit

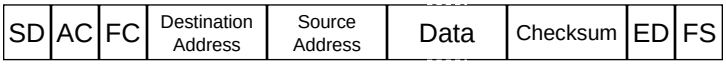
- Prevents tokens and frames from circulating indefinitely,
- All frames and tokens are issued with M=0,
- On passing through the "monitor station" M is set to 1,
- All other stations repeat this bit as set,
- A token or frame that reaches the monitor station with M=1 is considered invalid and is purged.

Token Ring Access Control Fields *(cont'd)*



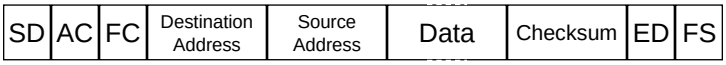
- **R** = Reservation Bits
  - Allows stations with high priority data to request (in frames and tokens as they are repeated) that the next token be issued at the requested priority.

Token Ring Frame Control Field



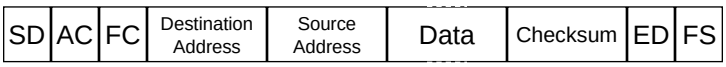
- FC = Frame Control Field
  - Defines the type of frame being sent,
  - Frames may be either data frames or some type of control frame. Example control frames:
    - Beacon: Used to locate breaks in the ring,
    - Duplicate address test: Used to test if two stations have the same address.

Token Ring Address & Data Fields



- Address Fields:
  - Indicate the source and destination hosts
  - Broadcast:
    - Set all destination address bits to 1s.
- Data
  - No fixed limit on length
  - Caveat: Hosts may only hold the token for a limited amount of time (10 msec)

Token Ring Checksum and Frame Status



- Checksum: 32-bit CRC
- FS = Frame Status
  - Contains two bits, A and C
  - When the message arrives at the destination, it sets A=1
  - When the destination copies the data in the message, it sets C=1

A = 1 , Address recognized **C** = 1 , Frame copied

The Token Ring Monitor Station

- One station on the ring is designated as the "monitor station"
- The monitor station:
  - marks the M bit in frames and tokens,
  - removes marked frames and tokens from the ring,
  - watches for missing tokens and generates new ones after a timeout period.

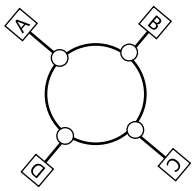
Using Priority in Token Ring

- If a host wants to send data of priority ***n***, it may only grab a token with priority value ***n*** or lower.
- A host may reserve a token of priority ***n*** by marking setting the reservation bits in the AC field of a passing token or frame.
  - Caveat: The host may not make the reservation if the token or frame's AC field already indicates a higher priority reservation.
- The next token generated will have a priority equal to the reserved priority.

Using Priority in Token Ring (cont'd)

- When a new token is generated (i.e., when a sender finishes sending and releases an idle token), or when a sender sends a data frame,
  - R bits are set to the lowest priority,
  - M bit is reset.

Priority Transmission: Example



Host B has 1 frame of priority 3 to send to A

Host C has 1 frame of priority 2 to send to A

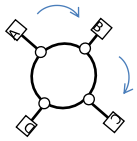
Host D has 1 frame of priority 4 to send to A

Token starts at host A with priority 0 and circulates clockwise

Host C is the monitor station

(priority 0: lowest priority in this example)

Example *(cont ́d)*



Event	Token/Frame AC Field
A generates a token	P=0, M=0, T=0, R=0
B grabs the token and sets the message destination to A	P=3, M=0, T=1, R=0
Frame arrives at C, and C reserves priority level 2. Monitor bit set.	P=3, M=1, T=1, R=2
Frame arrives at D, and D attempts to reserve priority level 4:	P=3, M=1, T=1, R=4
Frame arrives at A, and A copies it	P=3, M=1, T=1, R=4
Frame returns to B, so B removes it, and generates a new token	P=4, M=0, T=0, R=0
Token arrives at C, but its priority is too high. C reserves priority 2. sets M bit.	P=4, M=1, T=0, R=2

Example *(cont ́d)*

Event	Token/Frame AC Field
Token arrives at D, and D grabs it, sending a message to A	P=4, M=0, T=1, R=0
Frame arrives at A, and A copies it	P=4, M=0, T=1, R=0
Frame arrives at B, which does nothing to it	P=4, M=0, T=1, R=0
Frame arrives at C, which sets the monitor bit, C reserves priority 2	P=4, M=1, T=1, R=2
Frame returns to D, so D removes it and generates a new token with P=2	P=2, M=0, T=0, R=0

etc... Attempt to complete this scenario on your own.