IEEE 802.5 Token Ring

- Consists of a set of nodes connected in a ring.
- Data flows in a particular direction only.
- Data received from upstream neighbour forwarded to downstream neighbour.
- Token – access to the shared ring
  - a special sequence of bits
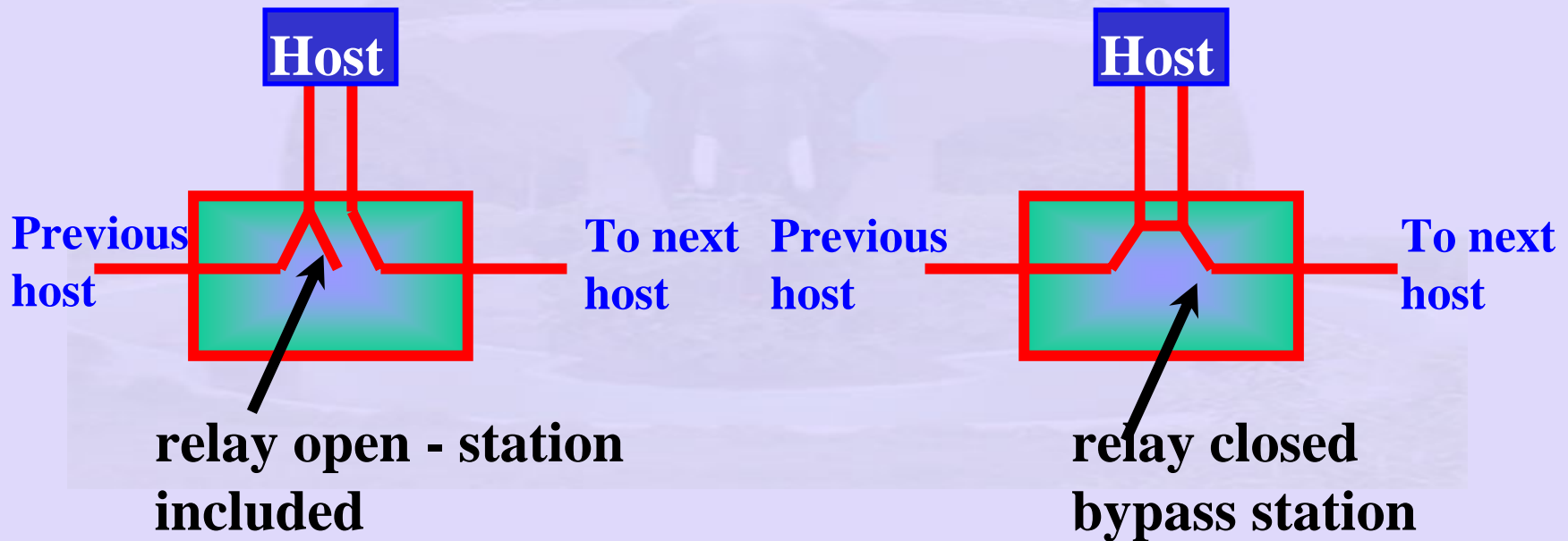 - circulates around the ring.

IEEE 802.5 Token Ring

- Each node receives and forwards token.
- Frame makes its way back to sender
  - frame removed by sender
  - sender reinsert token.
- As token circulates around ring, each station gets a chance to transmit
  - Service round - robin fashion

Token Ring Issues

- Any link or node failure
  - Network rendered useless

- Solution –
  - electromechanical relay
  - Station active relay is open and station included
  - Station is inactive
    - no power
    - relay closed
    - bypass station

Token Ring Issues

Host

Host

Previous host

To next host

Previous host

To next host

relay open - station included

relay closed bypass station

Multistation Access Unit (MSAU)

- Several relays in a box

- Add new station
  – Plug into MSAU

H$_2$

H$_1$

From prev MSAU

H$_3$

H$_4$

To next MSAU
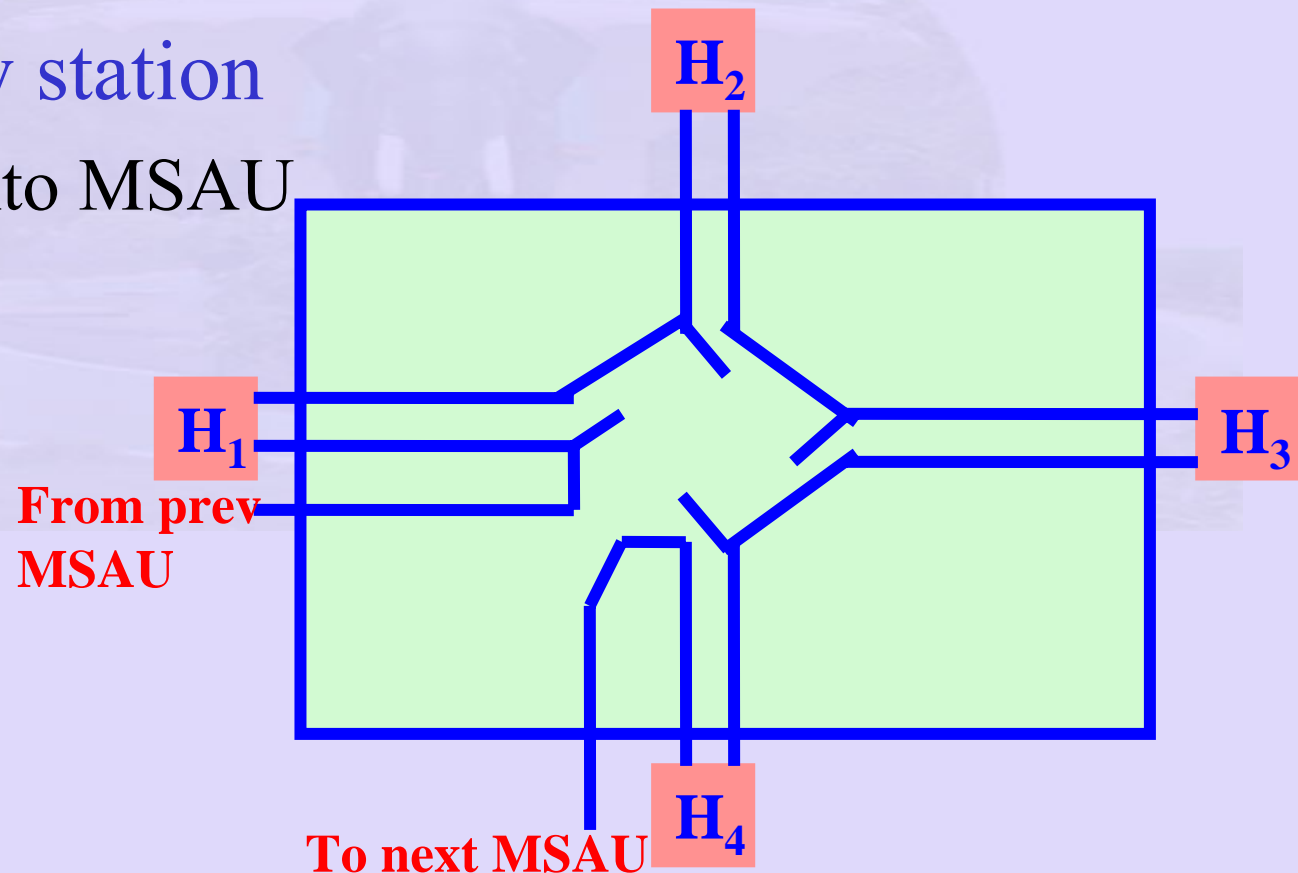
Token Ring (Characteristics)

- **Date rate: 4 Mbps or 16 Mbps**

- **encoding: differential manchester**

- **802.5 upto 250 station**

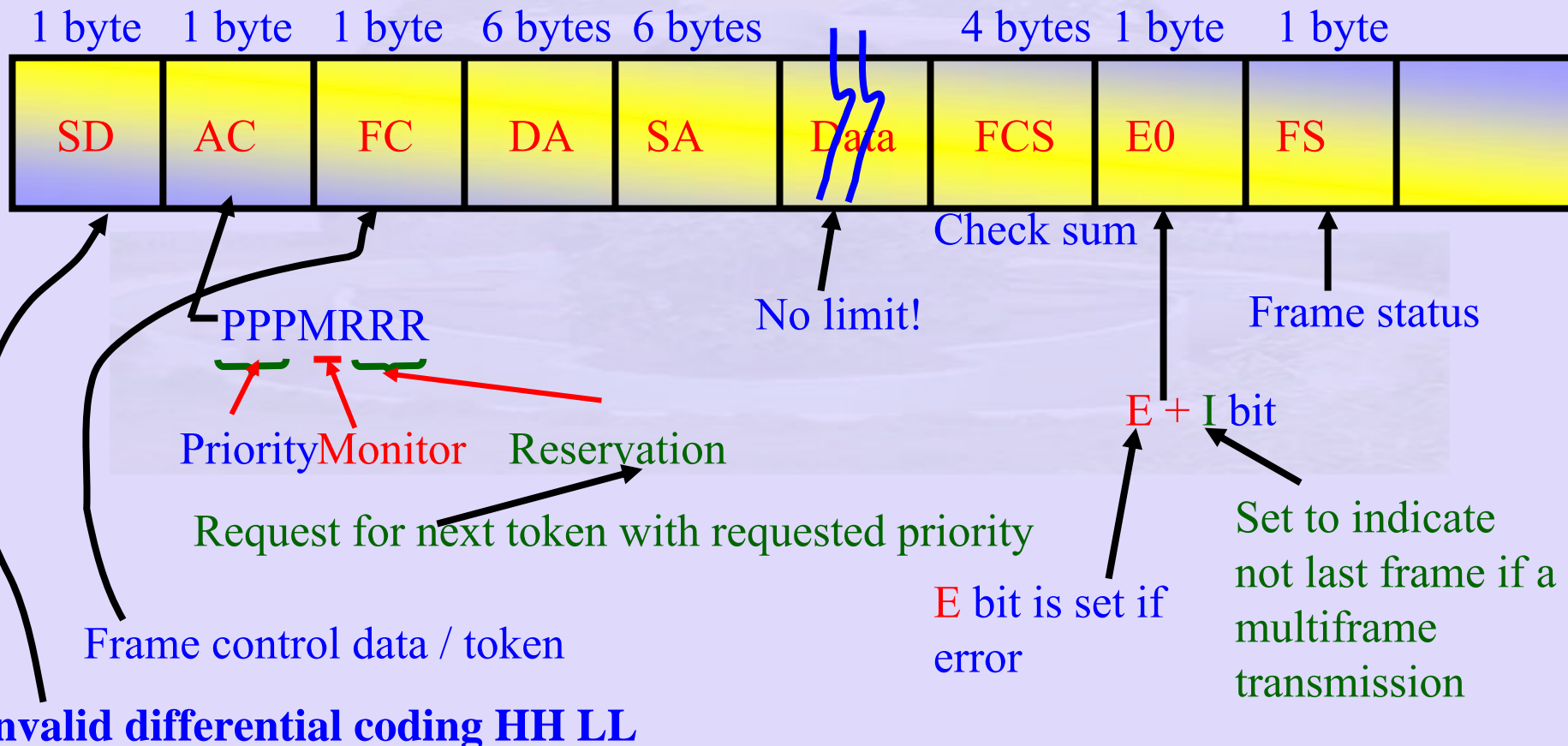- **physical medium is +P for IBM – not specified in 802.5**

Differential Manchester

clock

1   0   0   0   1   0

NRZ

Manchester

Differential Manchester
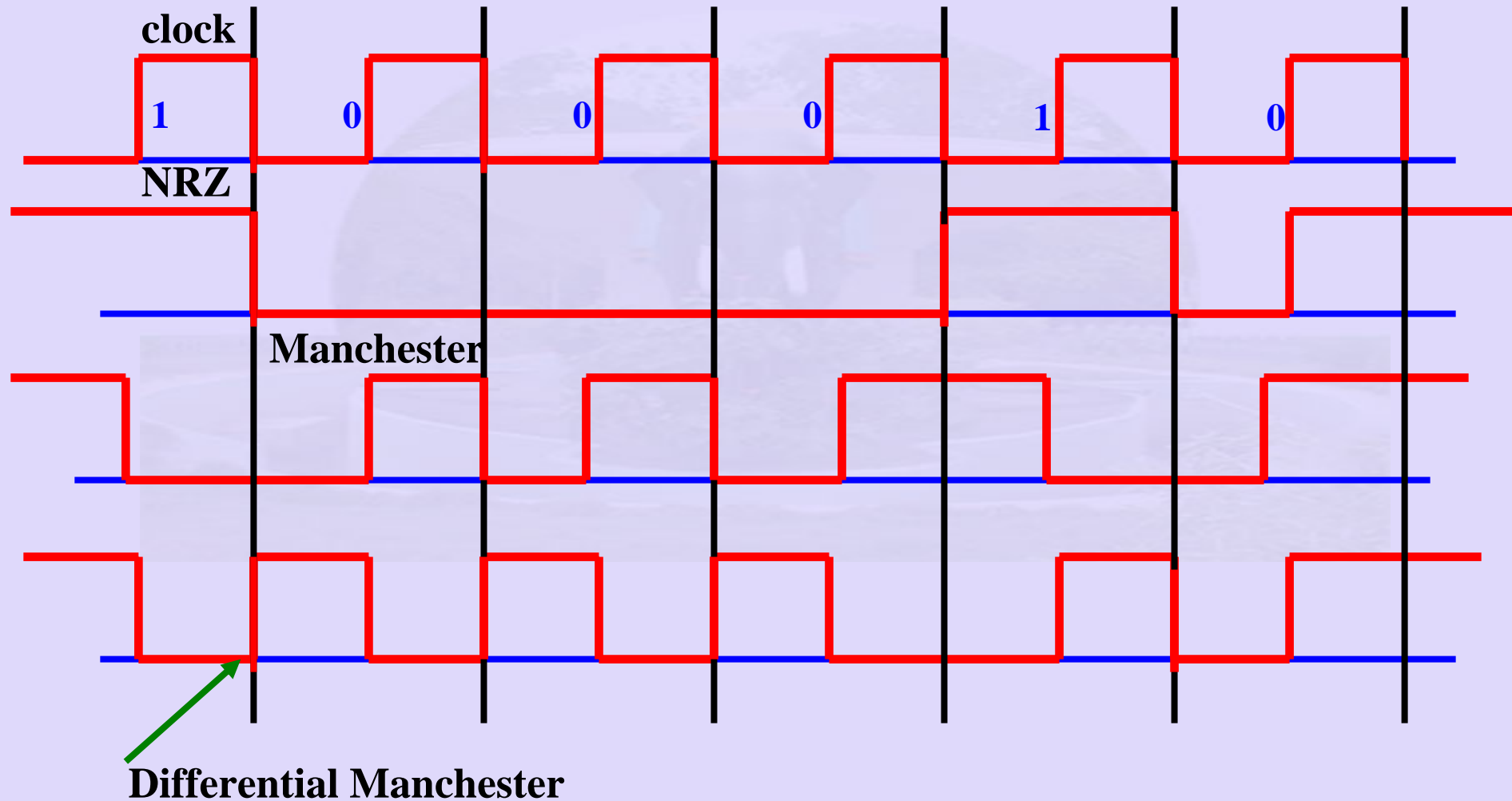
Token Ring Access Control

- Network adapter: receiver, and transmitter, and one or more bits of data storage between them.

- When no stations have anything to transmit token circulates

- Ring has enough storage capacity to hold an entire token.

  – 1 bit / station

Token Ring Frame Format

1 byte	1 byte	1 byte	6 bytes	6 bytes		4 bytes	1 byte	1 byte
SD	AC	FC	DA	SA	Data	FCS	E0	FS

Check sum

No limit!

Frame status

PPPMRRR

Priority Monitor Reservation

Request for next token with requested priority

E + I bit

Frame control data / token

E bit is set if error

Set to indicate not last frame if a multiframe transmission

Invalid differential coding HH LL

IEEE 802.5

- Token Size: 24 bits
  - Minimum number of stations is 24
  - Overcome this by including a monitor which adds the extra bits of delay

- Token operation
  - Token circulates
  - Station seizes a token

IEEE 802.5

- – Modifies a bit in the second byte of token
- – Station that has token transmits data
- – Station drains token out of the ring
- – Station sends data
- – Each packet has destination address
- – All stations downhill check destination address
- – Destination copies packet
- – Packet finds its way back to sending station

IEEE 802.5

- – Sending station removes packet from ring
- – Station reinserts token into the ring
- Size of packet stored in the ring
  - – Larger/smaller than ring
    - • Add/remove bits

IEEE 802.5

- Issues
  - Size of data that given node is allowed to transmit
  - Token holding time (THT) = ∞ ?
    - Utilisation is 100%
    - Unfair to stations to other than the station holding the token
  - THT affects ring performance

Token Holding Time

- Token Rotation Time (TRT):
- TRT $\leq$ Active nodes * THT + Ring Latency
- Ring Latency – token circulation time

Reliable Transmission

- Use A and C bits

- Initially A and C zero.

- Receiver sets A bit after seeing that it is the intended recipient

- Receiver sets C bit after copying frame

- If both A and C are not set – retransmit

Priorities in IEEE 802.5

- Supports different levels of priority
  - 3 bits
  - each station waiting to send, sets priority for packet packet's priority as high current token
  - then token can be seized
  - Intending to send station – sets the priority on currently passing data frame

Priorities in IEEE 802.5

- releasing station sets priority of token to n.
- Lower priority packets circulate for long in ring

- Token Release
  - Early release
    - After transmitting packet
  - Delayed release
    - After removing packet when it returns to the sender

Token Ring Maintenance

- Designated monitor
  - any station can become a monitor
  - defined procedures for becoming a monitor
  - healthy monitor announces that it is a monitor at periodic interval
  - if a station does not see that packet for some time – then it sends a "claim token"
  - if claim token comes back to station then it is monitor
  - if another wants to claim see other stations claim first some arbitration rule.

Token Ring Maintenance

- Role of monitor
  - insert additional delay in ring
  - ensure always that there is a token somewhere in the ring
  - regenerate a vanished token
  - no token seen for TRT => regenerate

Token Ring Maintenance

– orphaned / corrupted packets – drain them if orphaned

- (A and C bits set – parent dies)
- A bit set C bit not set – parent dies

– bit is initially set to 1 by monitor

- monitor notices back when packet passes by monitor a second time

Token Ring Maintenance

- Detection of dead stations
  - some problem un detected
  - suspecting station sends a beacon frame –
  - how far beacon goes decide which stations must be bypassed.