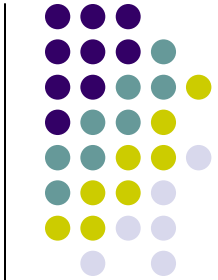
Lecture 6 : MAC2



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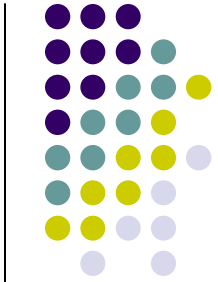
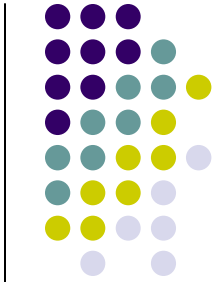
Short Term Course on “Teaching Computer Networks Effectively”. Sponsored by AICTE.

6.1 Collision free protocols



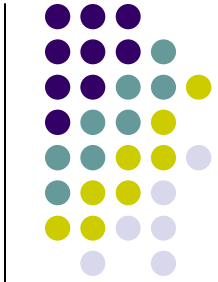
- Reservation Protocols
- Station have a unique address *0 ,…,N-1*
- Bit mapped protocol:
  - Contention period – divide into *N* slots
- station *0* can only send a 1 bit in that slot.

Collision free protocols



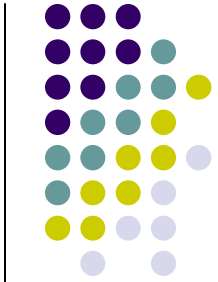
- Station j announces that it has a frame to transmit by inserting a bit in slot j.
- After all N slots have passed by –
  - every station knows numerical order
  - Now transmit in Numerical order
    - no collision at all!

Collision free protocols



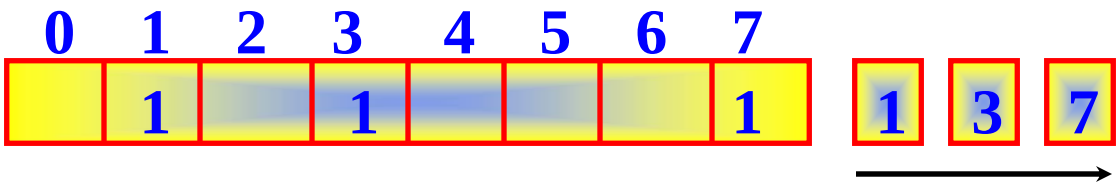
- After last ready frame transmitted –
  - an event generated
- New N bit contention period
- If a station misses
  - wait for next contention period

Collision free protocols



- After all stations have transmitted probability of having a frame to transmit middle of slot
  - wait 1 ½ contention period before transmitting
- Always 1 bit/station/frame transmitted is the overhead

Efficiency



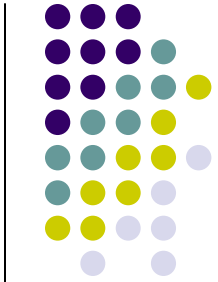
$$High\ load\ U = \frac{d}{Nd + 1}$$

$$Low\ load\ U = \frac{d}{d + 1}$$

$d -$ *frame size*

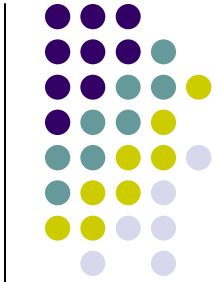
1 - *contention*

Contention Free Protocols



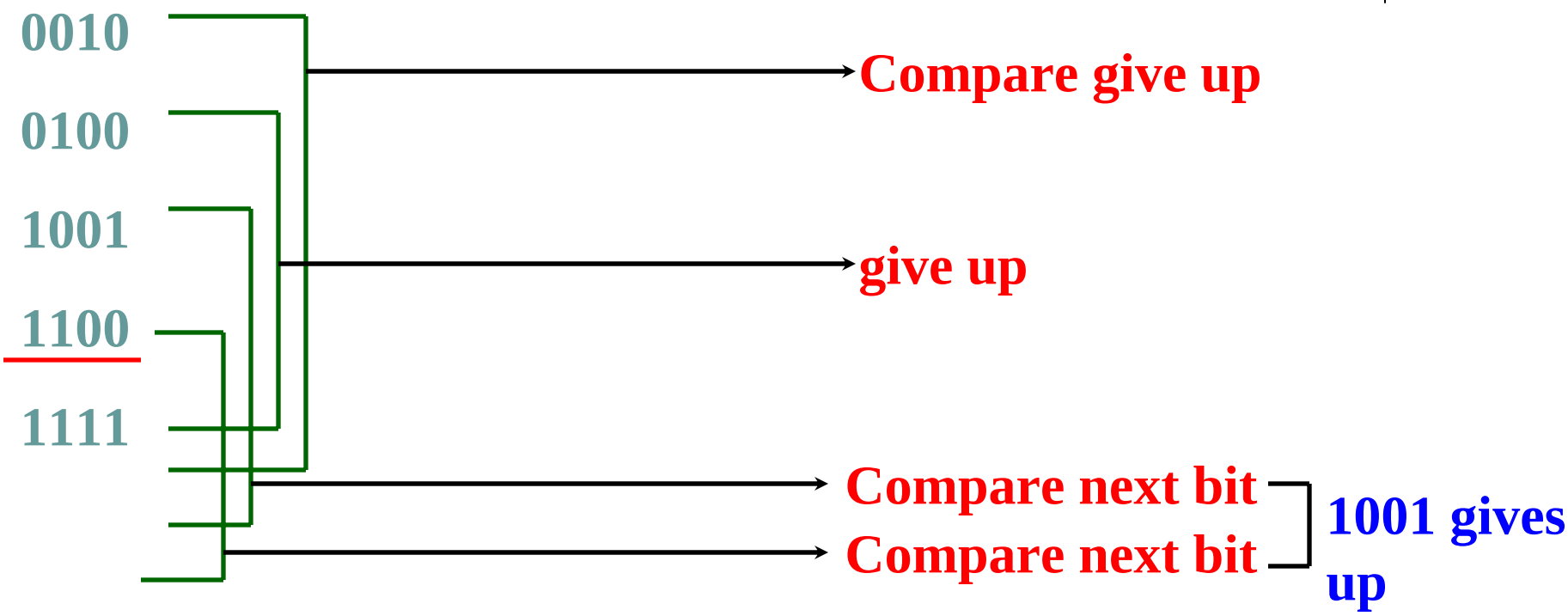
- Binary Countdown:
- Better than bit mapped protocols
- Use binary station addresses
- Each station broadcasts address
  - Example: 0010 0100 1001 1100

Contention Free Protocols



- All addresses same length
- Bits in each position from different stations are ORed
- Collision avoidance
  - arbitration rule
  - if high order bit position of station address overwritten by 1 give up!

Binary CountDown



1100 – gets access!

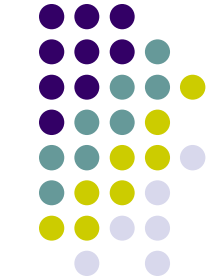
Next new cycle of contention start

Binary CountDown:Analysis

$$U = \frac{d}{d + \ln_2 N}$$

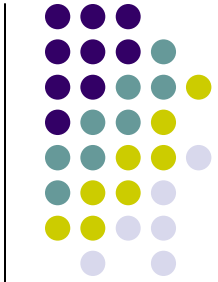
If the higher order bits of a station j address are 1, station j transmits continuously

Limited Contention Protocols



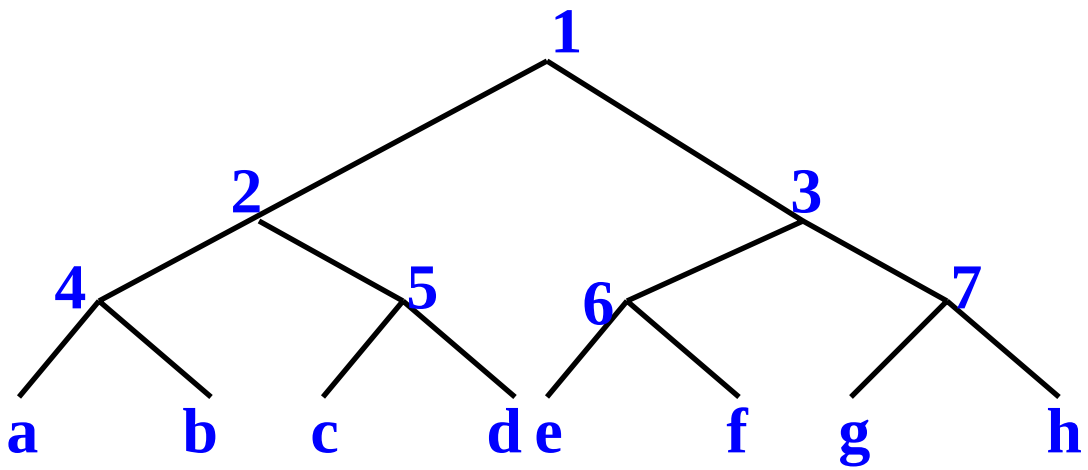
- combine the properties of contention and collision free protocols
- contention at low load to provide low delay
- reservation at high load

Adaptive Tree Walk Protocol



- Adaptive TreeWalk Algorithm
  - low load
    - every body contends
  - collision –
    - reduces number of stations

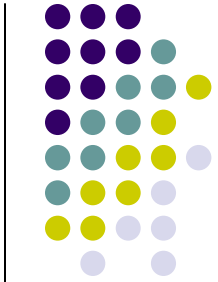
Adaptive Tree Walk Algorithm



First contention all stations permitted to contend

- **if collision then next slot only nodes under 2 can contend**
- **if success next slot – Nodes under 3**
- **if collision then nodes under Node 4**
- **if success next slots Nodes under 5**

Adaptive Tree Walk Algorithm



- Depth first tree walk algorithm
- Heavy load do not start searching at top of tree
  - what level to start the search?
  - depends on number of ready stations

Adaptive Tree Walk Algorithm

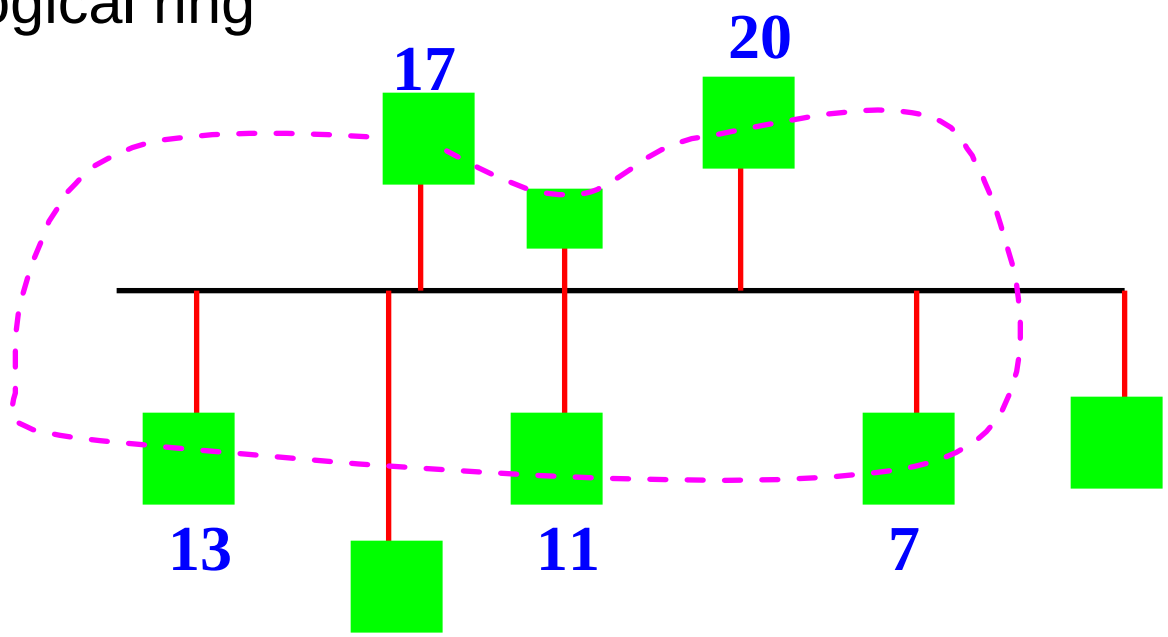
- Each node at level i has N. 2^{-i} station under it.
- q ready stations – uniformly distributed **at level i $2^{-i}q$**
- **level at which search begins**
  - **$2^{-i}q = 1$**
  - **$i = \log_2 q$**

6.2 IEEE 802.4 Token Ring

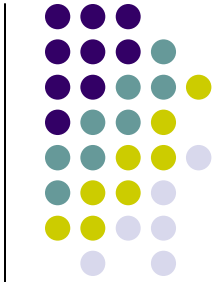
- CSMA/CD – probabilities
  - MAC model – bad link
  - station wait for infinitely a long time!
  - no priorities
    - not useful for real time system.
- Use a ring

IEEE 802.4 Token Ring

- stations take time sending frames.
  - *n* frame , *nT* sec to wait
  - physical ring broken
    - use logical ring



Token Bus Ring Organisation

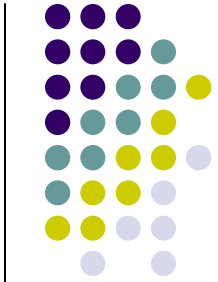


- Linear tree shaped cable on to which stations are attached.
- Each station knows the address of its left and right neighbours.
- Ring is first initialised
  - coordinator to initialise ring.
  - stations inserted in the order of station address

Token Bus Ring Organisation

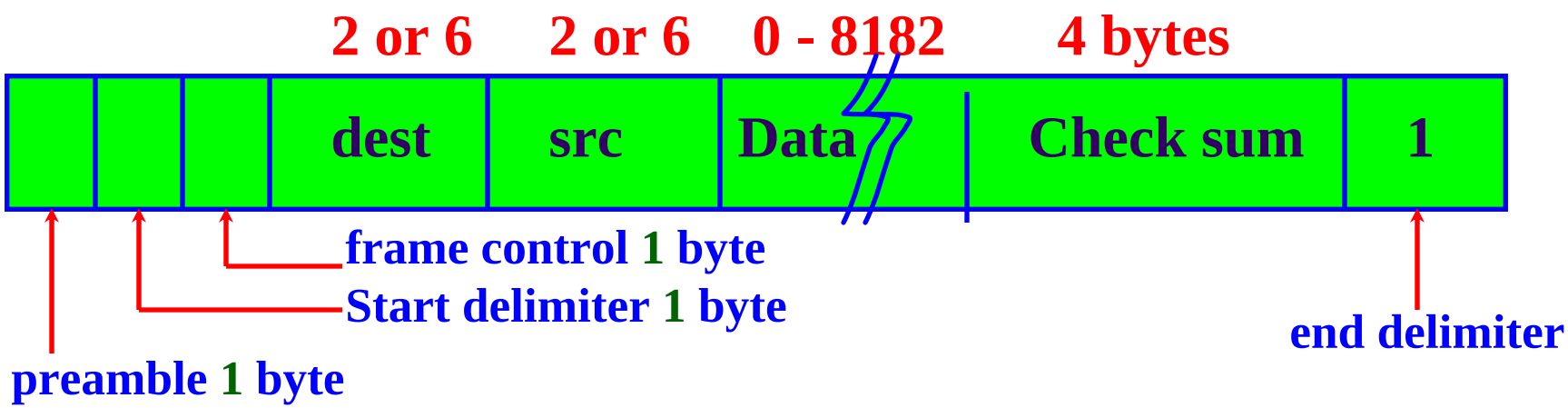
- Token passing from higher to lower order station address
- Token acquired station transmits for certain amount of time
- Hand over token either at end of time or no frame to transmit
- prioritise tokens

Token Bus

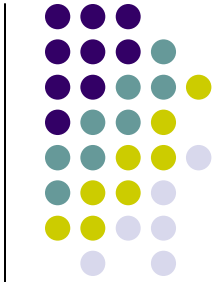


- each maintains a queue of frames
- each one has a timer
- handover token from higher priority to lower priority.
- fraction of token holding time allocated to each priority.
- useful for implementing real – time traffic.

Token Bus Frame Format

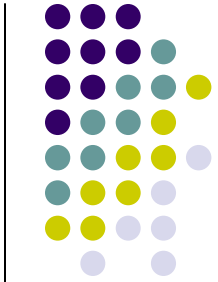


Token Bus Frame Format



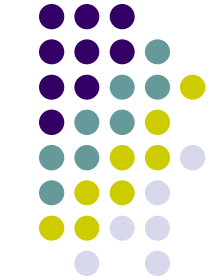
- Preamble – clock synchronisation
- Starting and ending delimiter
- frame boundaries
  - analog encoding symbols (other than 0 or 1)
  - does not occur in analog data
- no need of length field

Token Bus: Issues



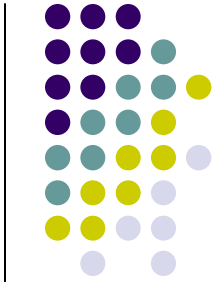
- Frame Control
  - Successors
  - Predecessors
  - Entry of new station
  - Claim token
    - Token lost, station with token dead
  - Protocols to handle all issues
  - Useful for real time traffic

6.3 IEEE 802.5 Token Ring



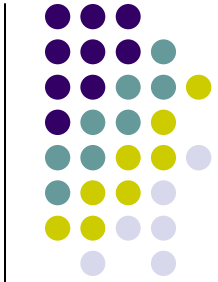
- Consists of a set of nodes connected in a ring.
- Data flows in a particular direction only.
- Data received from upstream neighbour forwarded to downstream neighbour.
- Token – access to the shared ring
  - a special sequence of bits
  - circulates around the ring.

IEEE 802.5 Token Ring



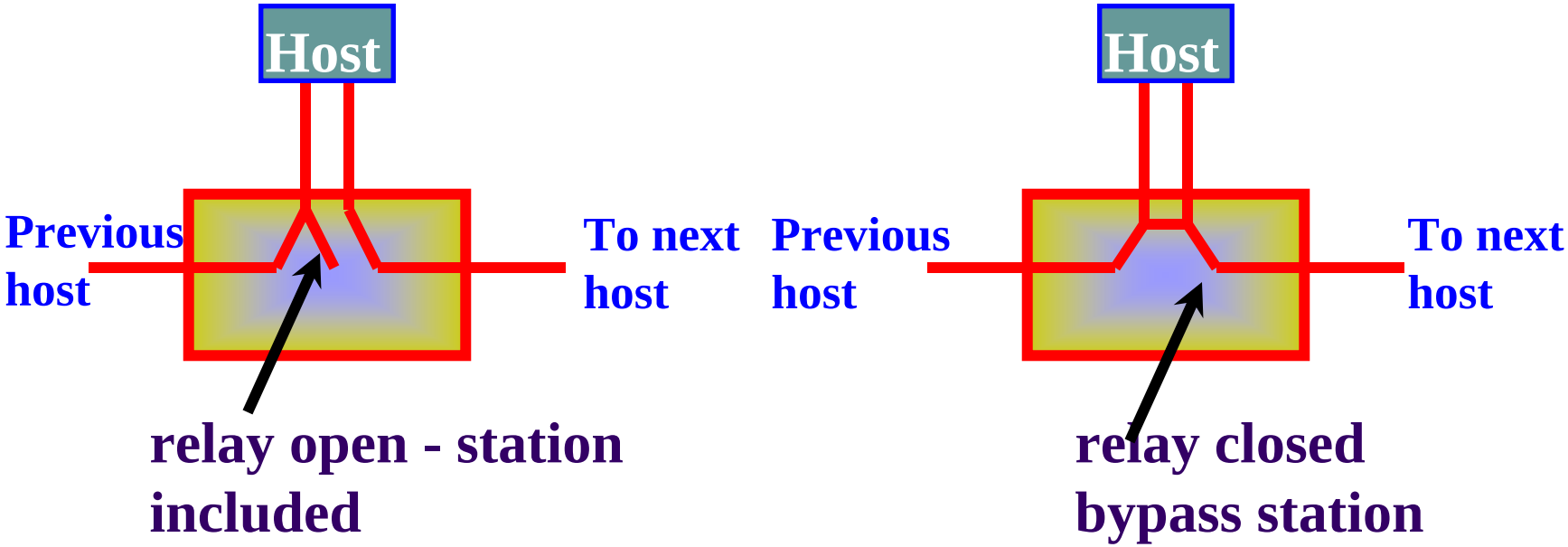
- Each node receives and forwards token.
- Frame makes its way back to sender
  - frame removed by sender
  - sender reinsert token.
- As token circulates around ring, each station gets a chance to transmit
  - Service round - robin fashion

Token Ring Issues



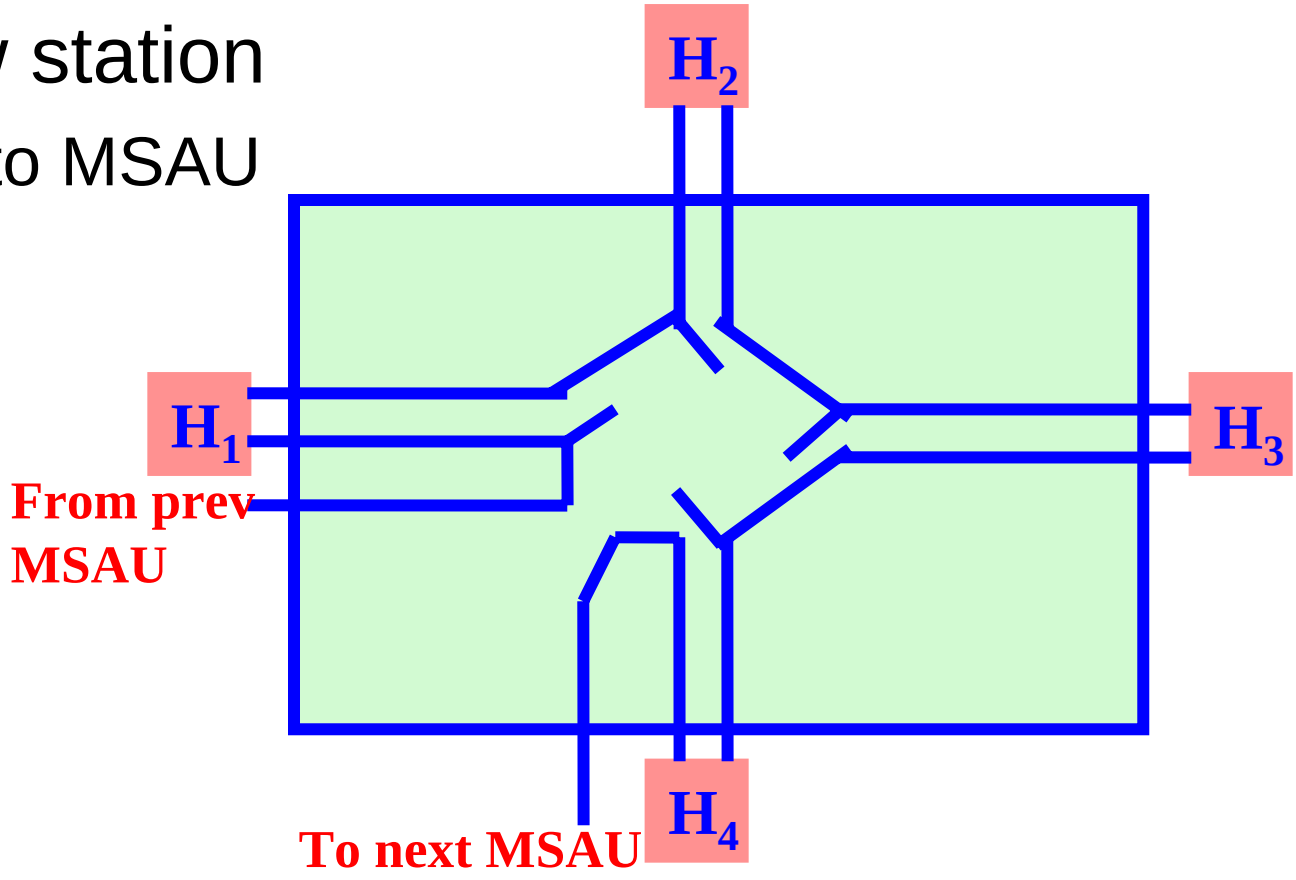
- Any link or node failure
  - Network rendered useless
- Solution –
  - electromechanical relay
  - Station active relay is open and station included
  - Station is inactive
    - no power
    - relay closed
    - bypass station

Token Ring Issues

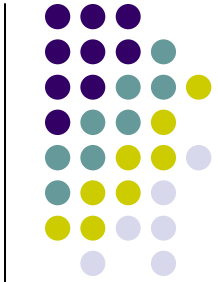


Multistation Access Unit (MSAU)

- Several relays in a box
- Add new station
  - Plug into MSAU

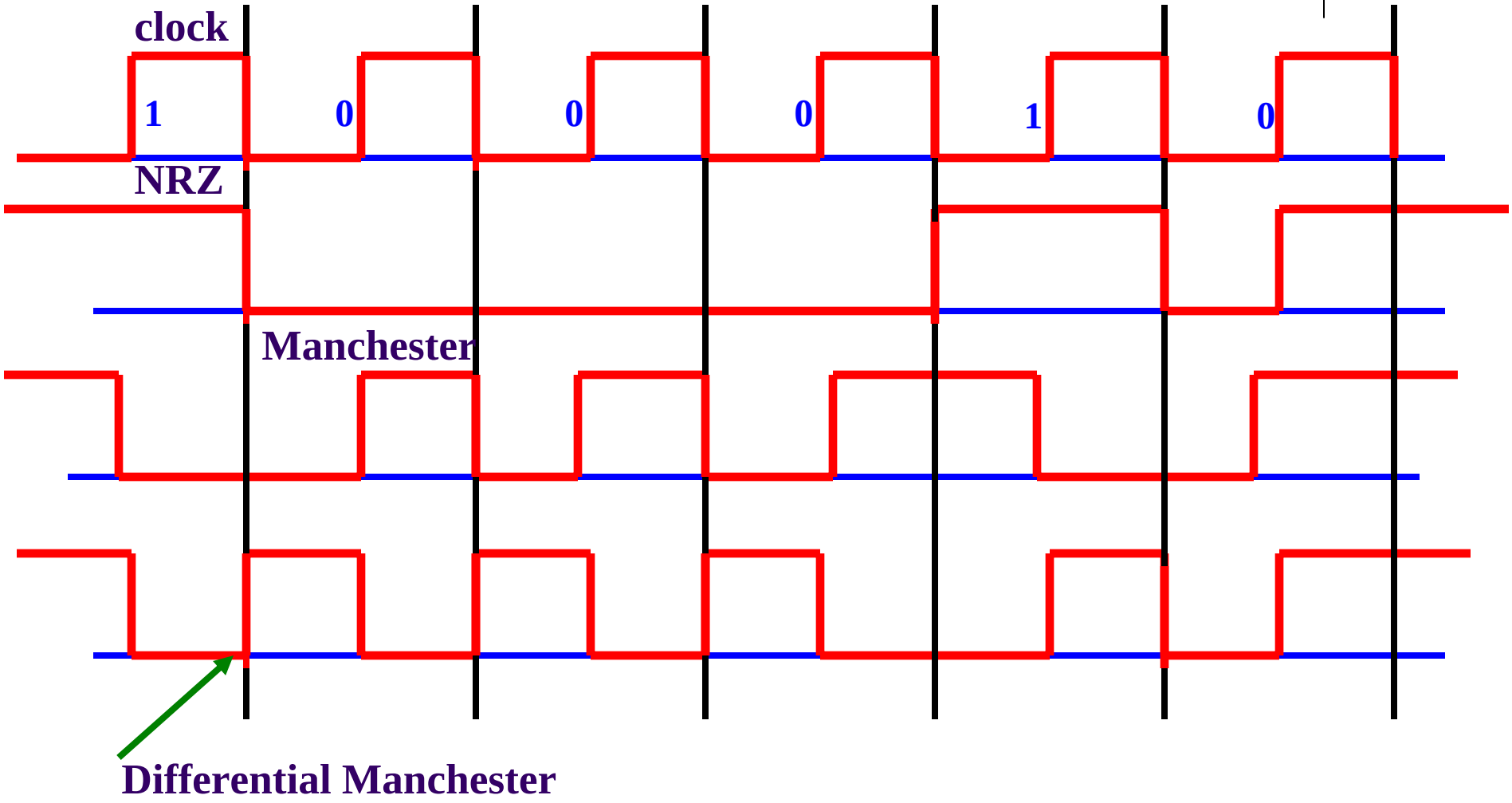


Token Ring (Characteristics)

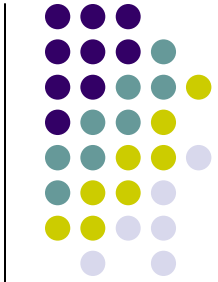


- Date rate: 4 Mbps or 16 Mbps
- encoding: differential manchester
- 802.5 upto 250 station
- physical medium is +P for IBM – not specified in 802.5

Differential Manchester

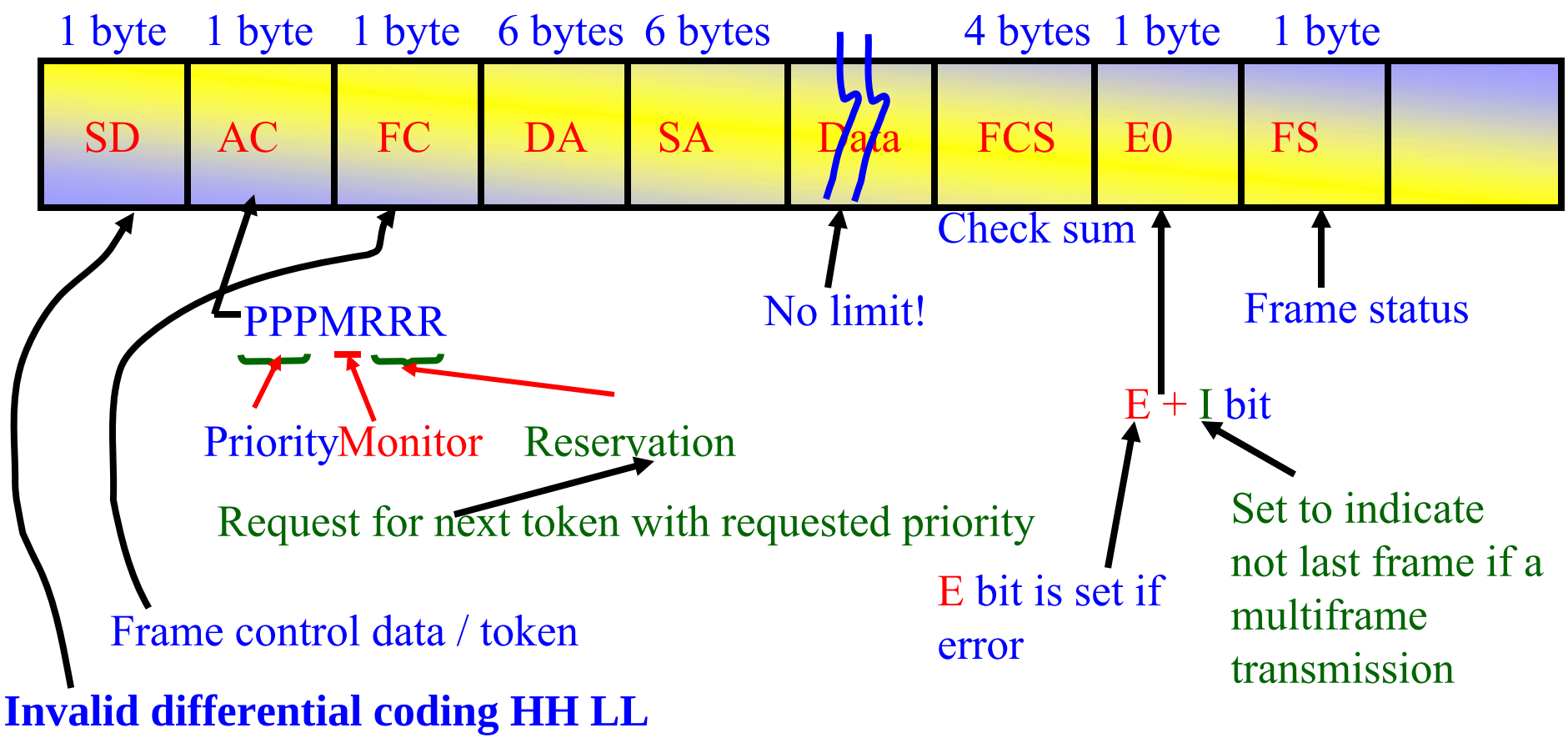


Token Ring Access Control

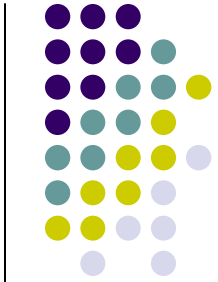


- Network adapter: receiver, and transmitter, and one or more bits of data storage between them.
- When no stations have anything to transmit token circulates
- Ring has enough storage capacity to hold an entire token.
  - 1 bit / station

Token Ring Frame Format

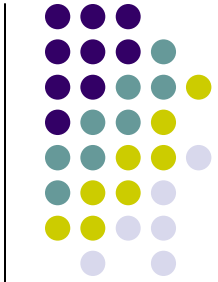


IEEE 802.5



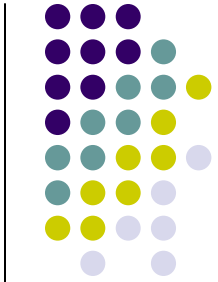
- Token Size: 24 bits
  - Minimum number of stations is 24
  - Overcome this by including a monitor which adds the extra bits of delay
- Token operation
  - Token circulates
  - Station seizes a token

IEEE 802.5



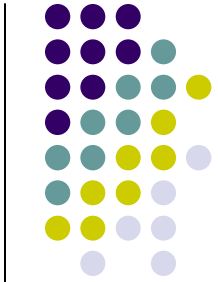
- Modifies a bit in the second byte of token
- Station that has token transmits data
- Station drains token out of the ring
- Station sends data
- Each packet has destination address
- All stations downhill check destination address
- Destination copies packet
- Packet finds its way back to sending station

IEEE 802.5



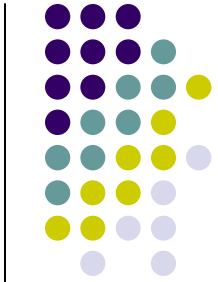
- Sending station removes packet from ring
- Station reinserts token into the ring
- Size of packet stored in the ring
  - Larger/smaller than ring
    - Add/remove bits

IEEE 802.5



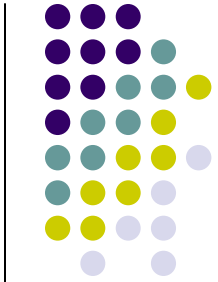
- Issues
  - Size of data that given node is allowed to transmit
  - Token holding time (THT) = ∞ ?
    - Utilisation is 100%
    - Unfair to stations to other than the station holding the token
  - THT affects ring performance

Token Holding Time



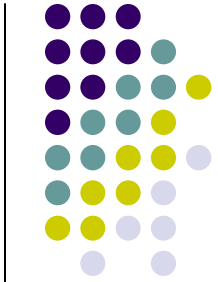
- Token Rotation Time (TRT):
- TRT $\leq$ Active nodes * THT + Ring Latency
- Ring Latency – token circulation time

Reliable Transmission



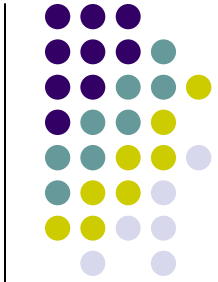
- Use A and C bits
- Initially A and C zero.
- Receiver sets A bit after seeing that it is the intended recipient
- Receiver sets C bit after copying frame
- If both A and C are not set – retransmit

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

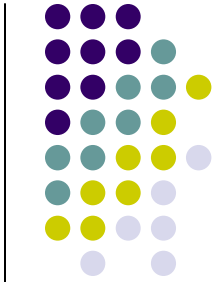
Priorities in IEEE 802.5



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

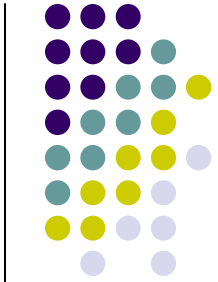
- Token Release
  - Early release
    - After transmitting packet
  - Delayed release
    - After removing packet when it returns to the sender

Token Ring Maintenance



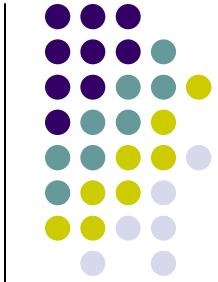
- Designated monitor
  - any station can become a monitor
  - defined procedures for becoming a monitor
  - healthy monitor announces that it is a monitor at periodic interval
  - if a station does not see that packet for some time – then it sends a “claim token”
  - if claim token comes back to station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

Token Ring Maintenance



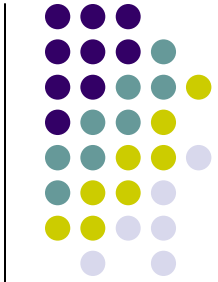
- Role of monitor
  - insert additional delay in ring
  - ensure always that there is a token somewhere in the ring
  - regenerate a vanished token
  - no token seen for TRT => regenerate

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.