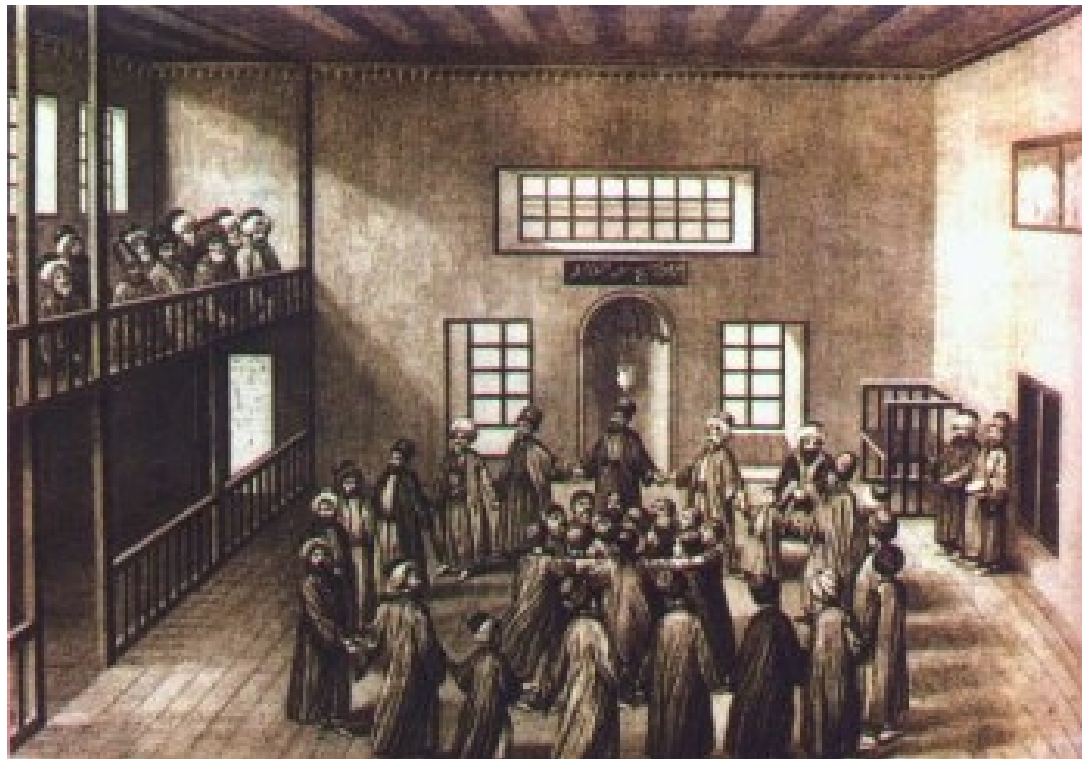


# Wireless Token Ring Protocol (WTRP)

## Performance Comparison with



Mustafa Ergen, Duke Lee, Raja Sengupta, Pravin Variaya

# Automated Vehicle Platoon



- Real-time safety critical control over ad-hoc network
- Vehicles transmit control data in round robin every 20 ms
- Wireless Quality of Service

# Motivations for WTRP



- Quality of service (real time applications)
- Distributed solution (robust against a single node failure)
- Flexible topology (token ring can be created with Pico cells)
- Safety critical applications (need fast recovery from failure)
- No need for clock synchronization (compared to TDMA)
- Partial connectivity (hidden terminal problem)

# Motivations for WTRP



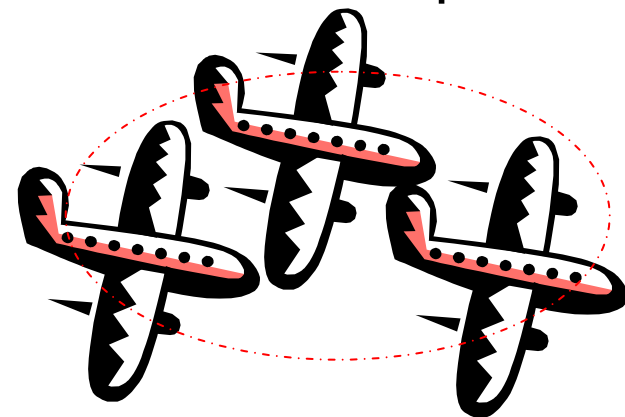
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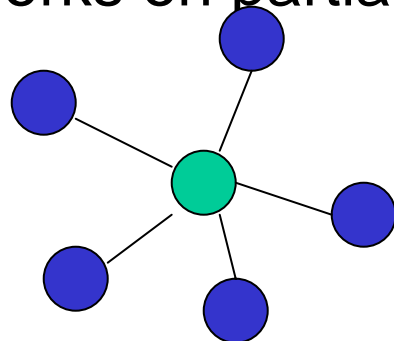
WTRP



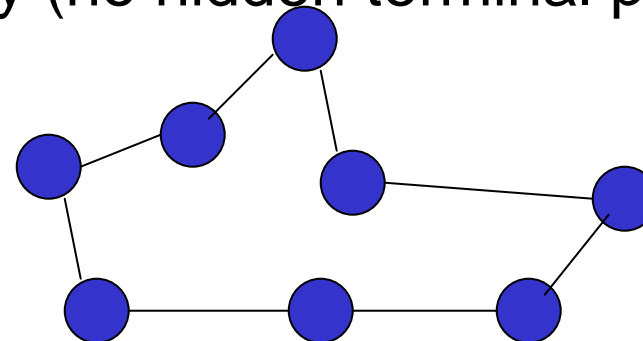


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centralized (802.11 PCF, Bluetooth)

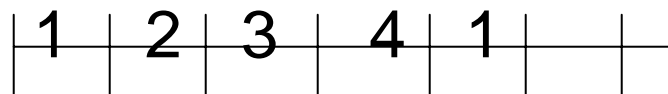


distributed (token ring)



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TDMA



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WTRP

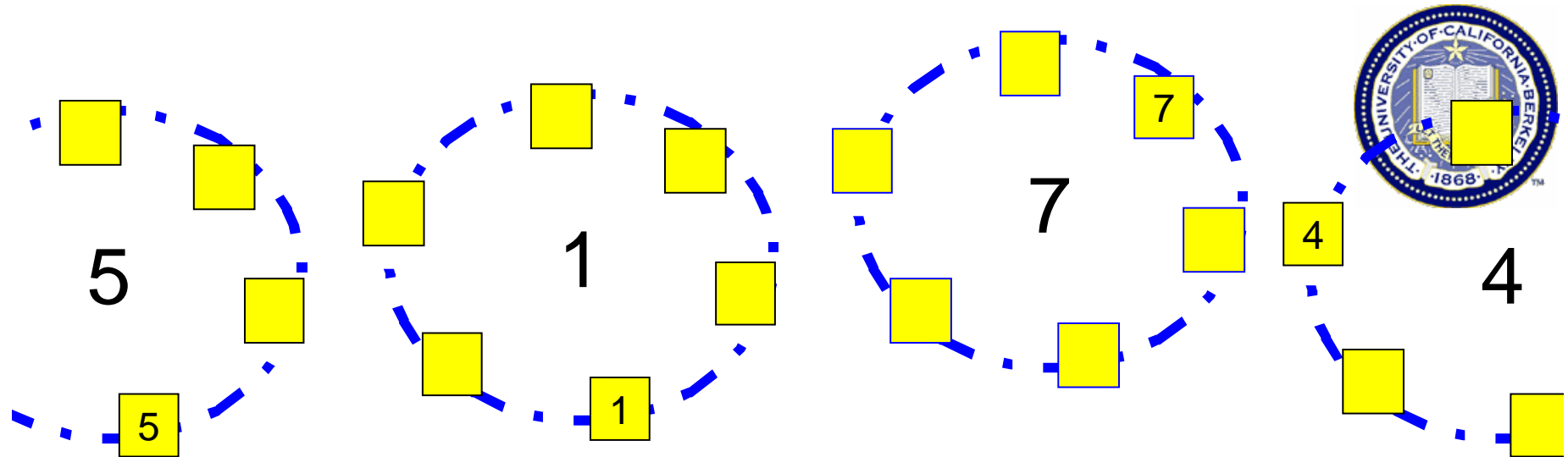


# Additional Challenges From Wireless Medium



- Partial connectivity (unable to hear all nodes in a ring)
- Support for multiple rings
- Self-managed admission control
- Frequent packet loss, corruption





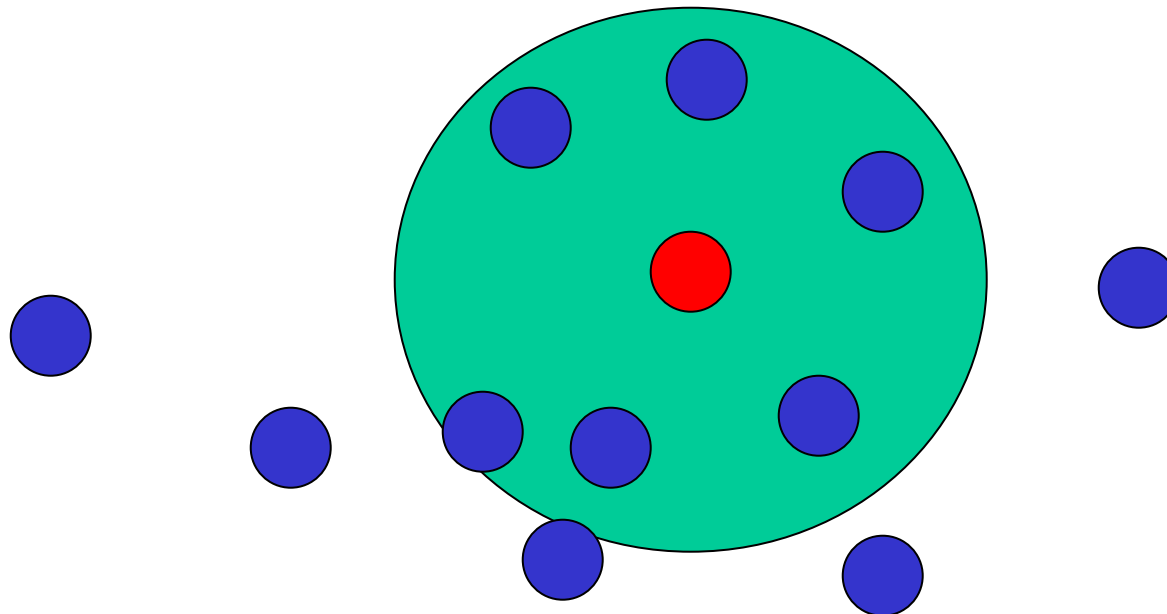
- The Wireless Token Ring Protocol (WTRP) is a medium access control protocol for wireless networks in mission critical systems.
- It supports quality of service in terms of **bounded latency** and **reserved bandwidth**.
- The token passing defines the **transmission order**, and each token is forced to give up the token after a specified amount of time.
- Each ring has **unique ring id** based on unique MAC address of one of the stations of the ring. (The station is called the owner of the ring).
- When owner leaves the ring, another station elects itself to be the **owner of the ring**.



# Connectivity Table



- Each node builds and updates connectivity table that contains information of **all stations in its reception range**, and transmission order of the nodes in its ring





# Unique Priority of Token

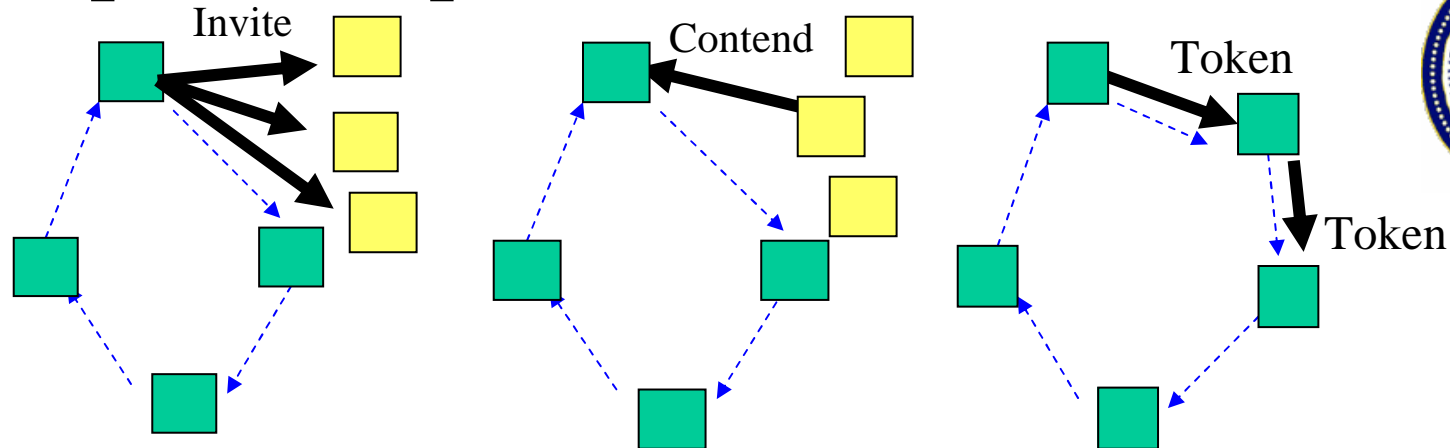
- Based on ring address and generation sequence number pair.
- Station only accept token that has higher priority than the last token that the station has accepted.



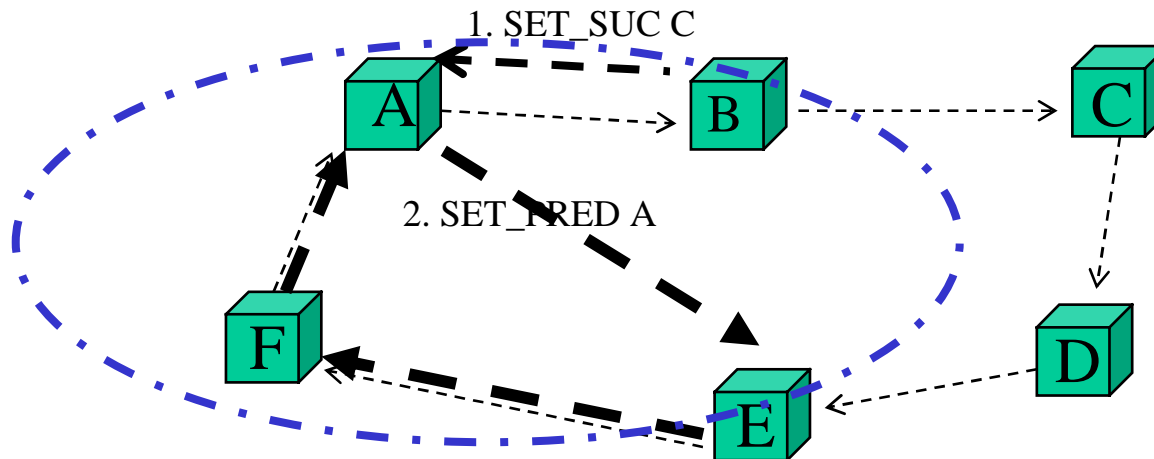
## Implicit ACK

- ACK is thought to be received when the successor initiates a transmission or token.

# Descriptions (Operations)

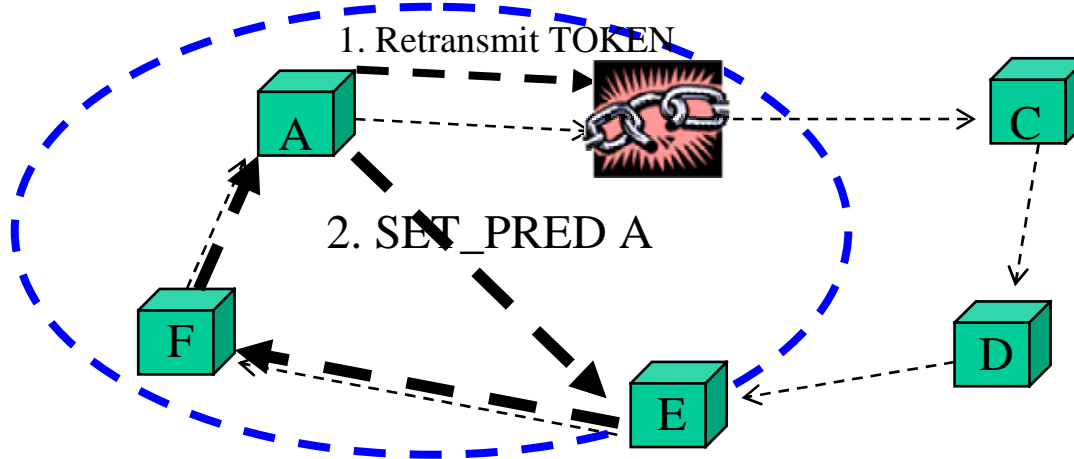


**Joining:** Stations periodically invite other nodes to join the ring by broadcasting the available resources left in the medium

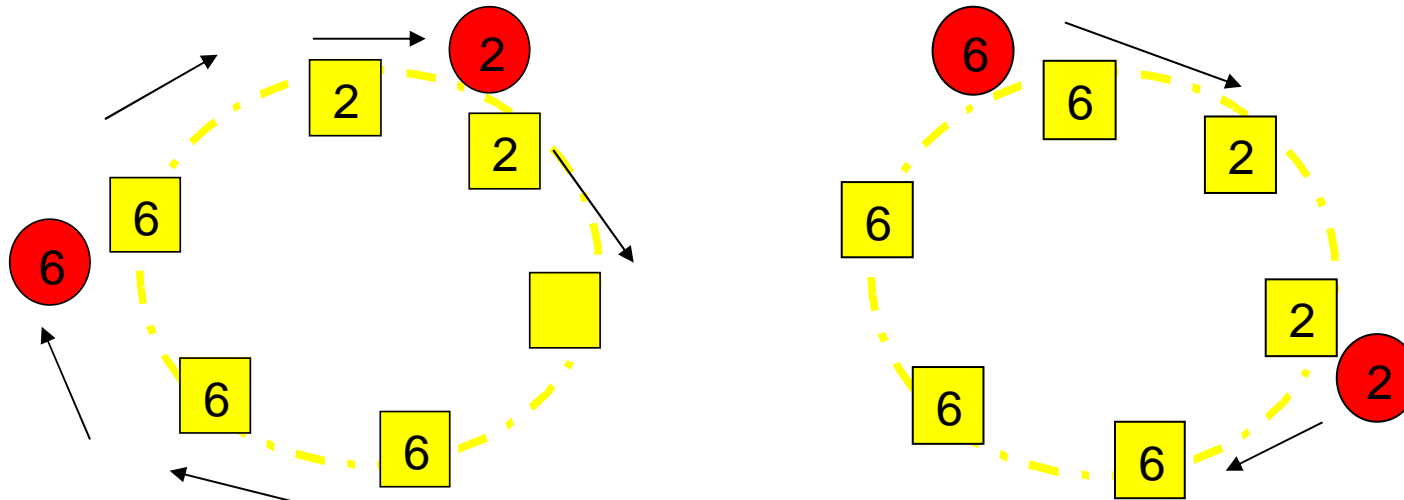


**Leaving:** When B wants to leave, it requests A to connect to its successor, C. If A does not have connection with C, then it connects to the next node in terms of the transmission order of the ring.

# Descriptions (Management)



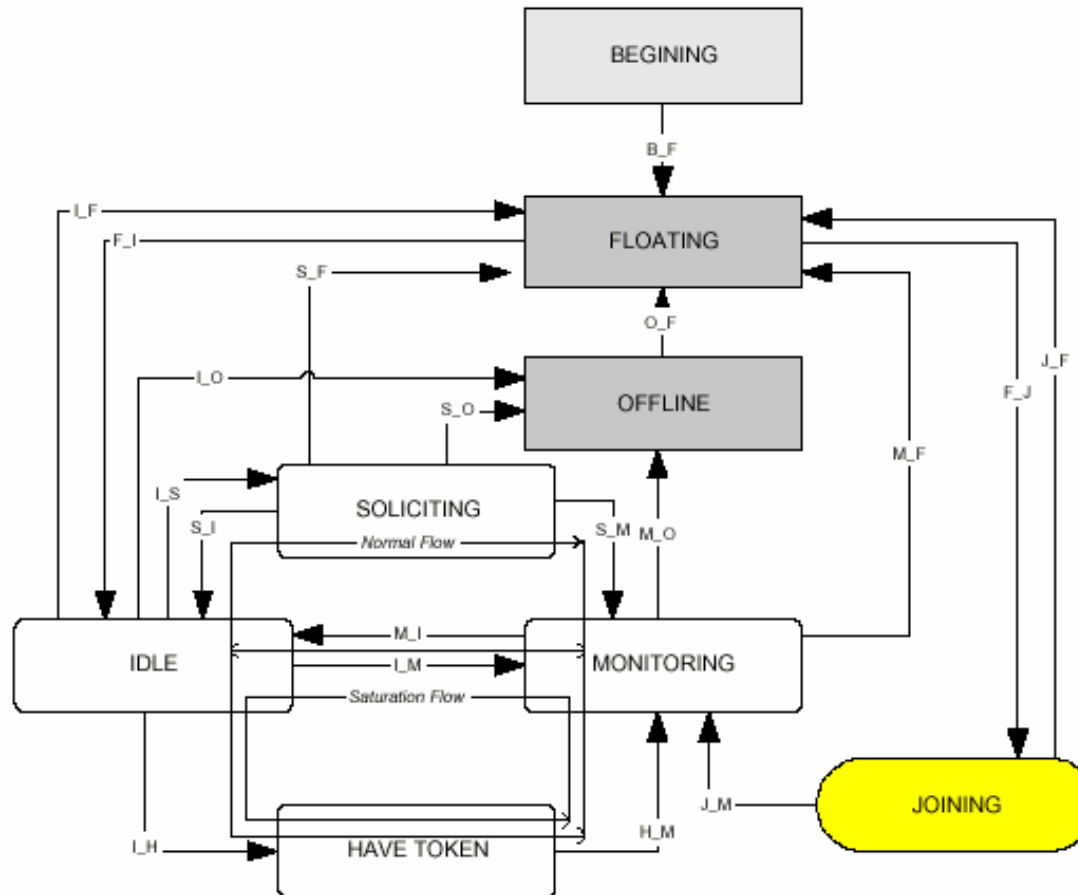
**Ring Recovery** Able to recover quickly by keeping information about topology of the ring, recovers from multiple simultaneous faults by taking increasingly drastic actions



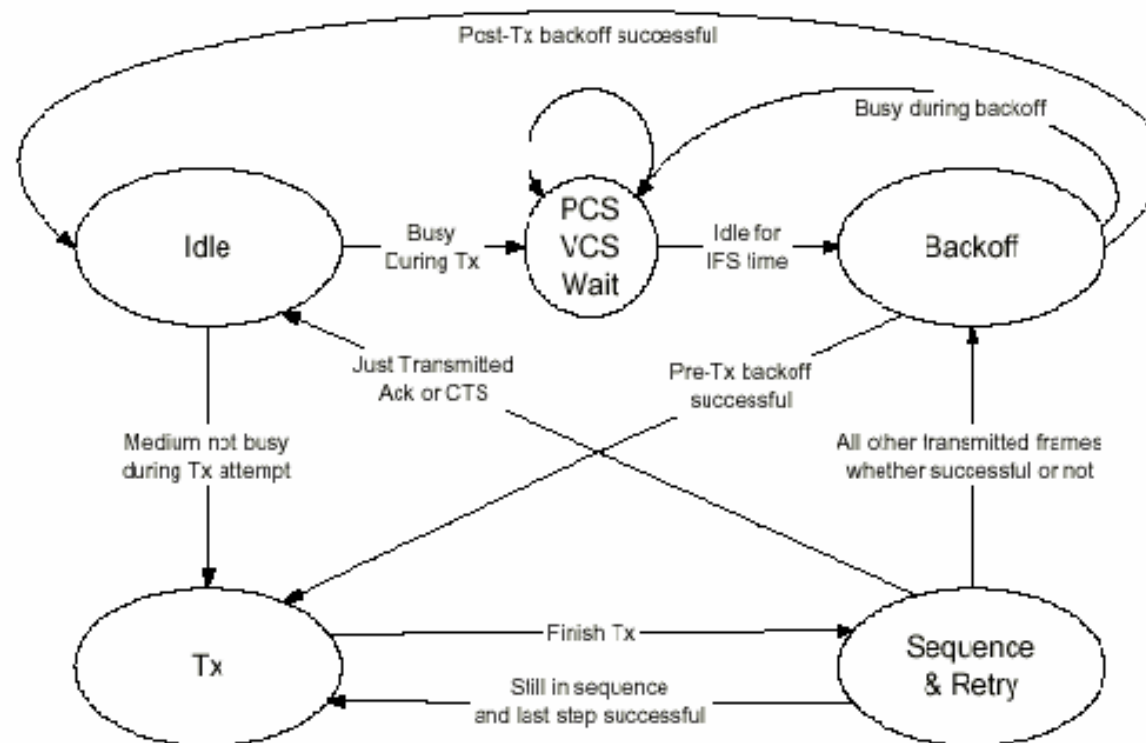
**Token Recovery** Multiple token is deleted using unique priority of token based on generation sequence number and token ring address pair.



# WTRP

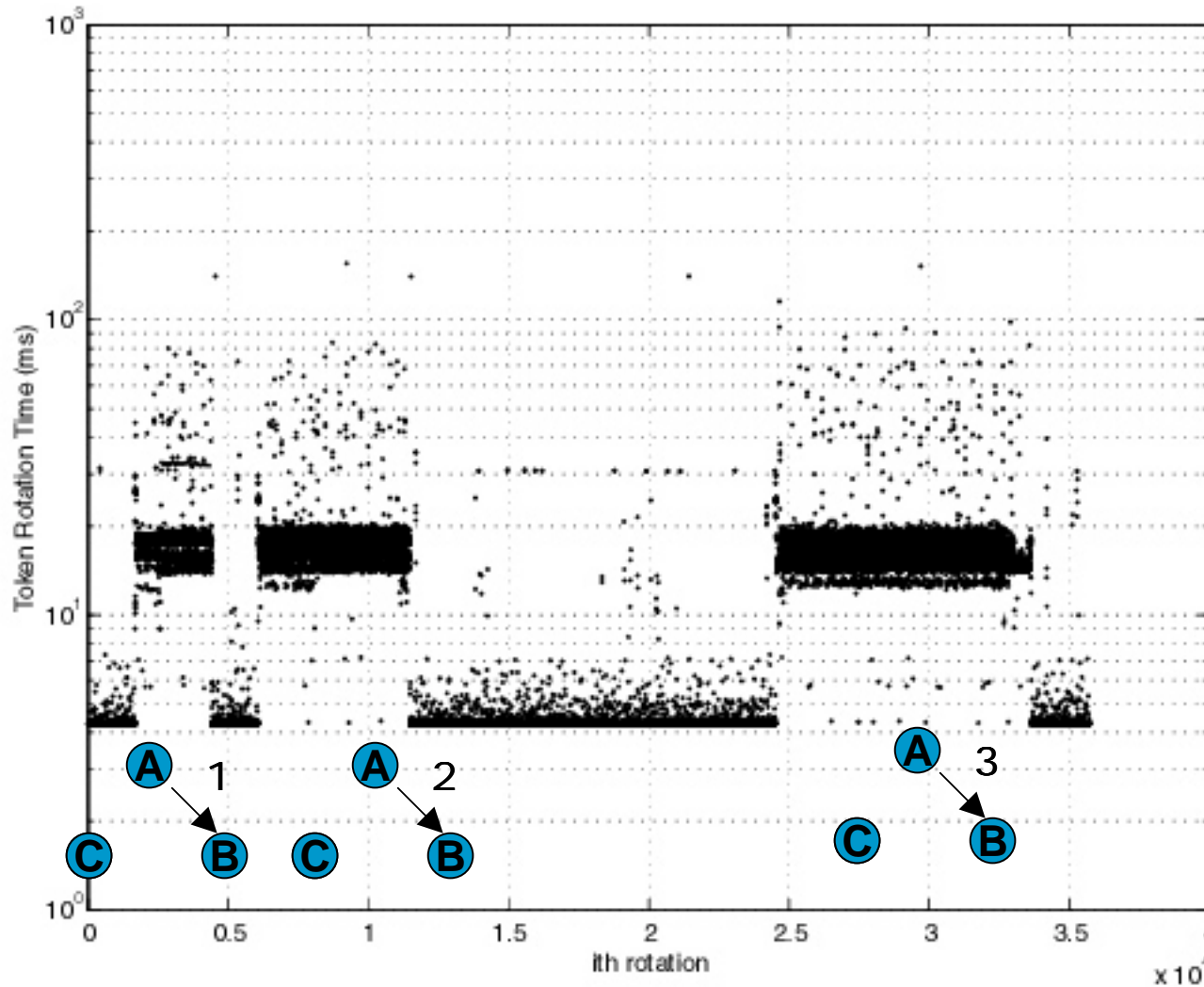


# IEEE 802.11





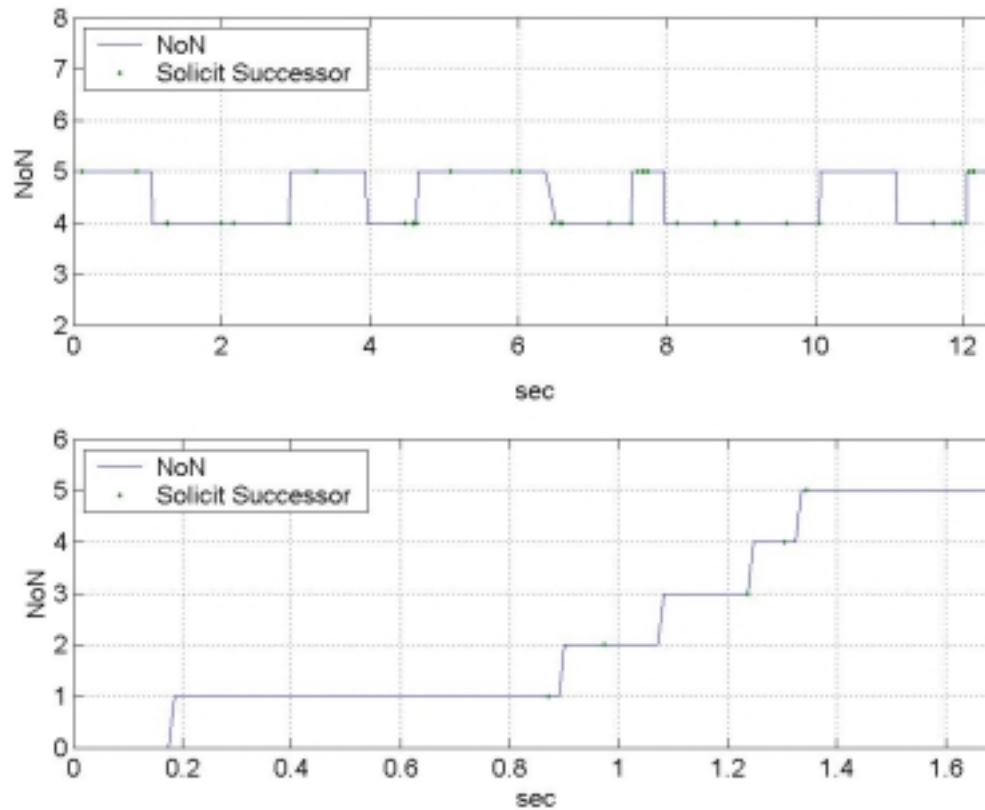
# Token Rotation Time





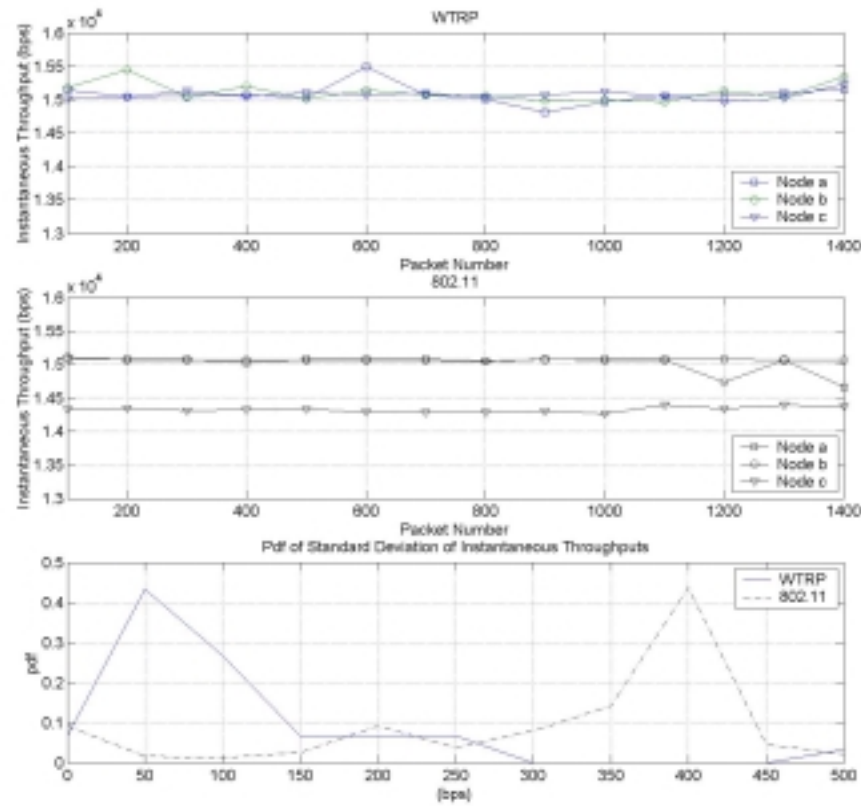


# Robustness

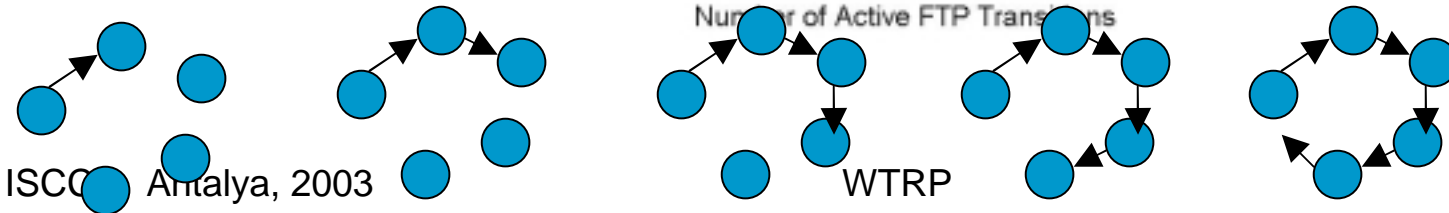
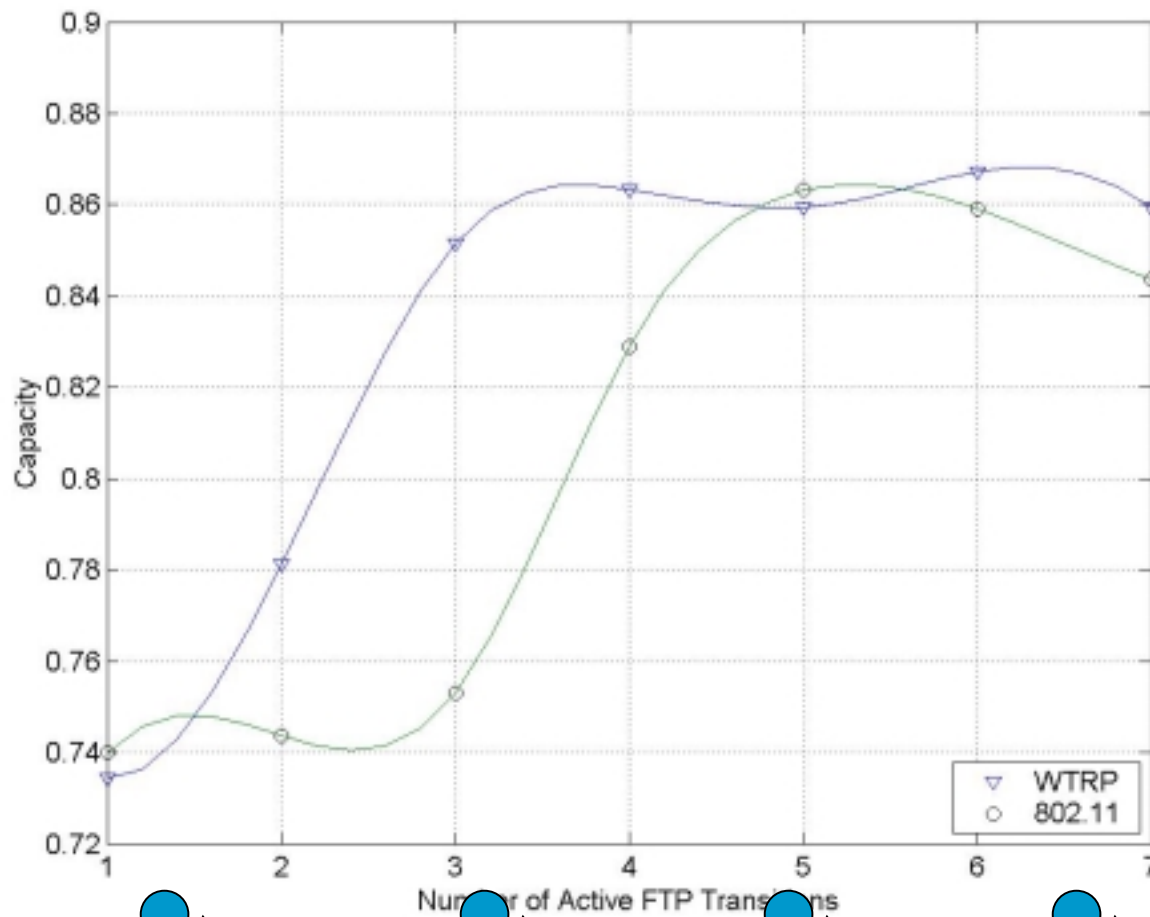




# Fairness



# Throughput



# Conclusions

- The wireless token ring protocol (WTRP) is a medium access control protocol for wireless networks in mission critical systems.
- It supports quality of service in terms of bounded latency and reserved bandwidth.
- WTRP is efficient in the sense that it reduces the number of retransmissions due to collisions.
- It is fair in the sense that each station takes a turn to transmit and is forced to give up the right to transmit after transmitting for a specified amount of time.
- It is a distributed protocol that supports many topologies since not all stations need to be connected to each other or to a central station.
- It can be used with an admission control agent for bandwidth or latency reservations.
- WTRP is robust against single node failure. WTRP is designed to recover gracefully from multiple simultaneous faults.

