Delay Management Using Packet Fragmentation in Wireless Industrial Automation Systems

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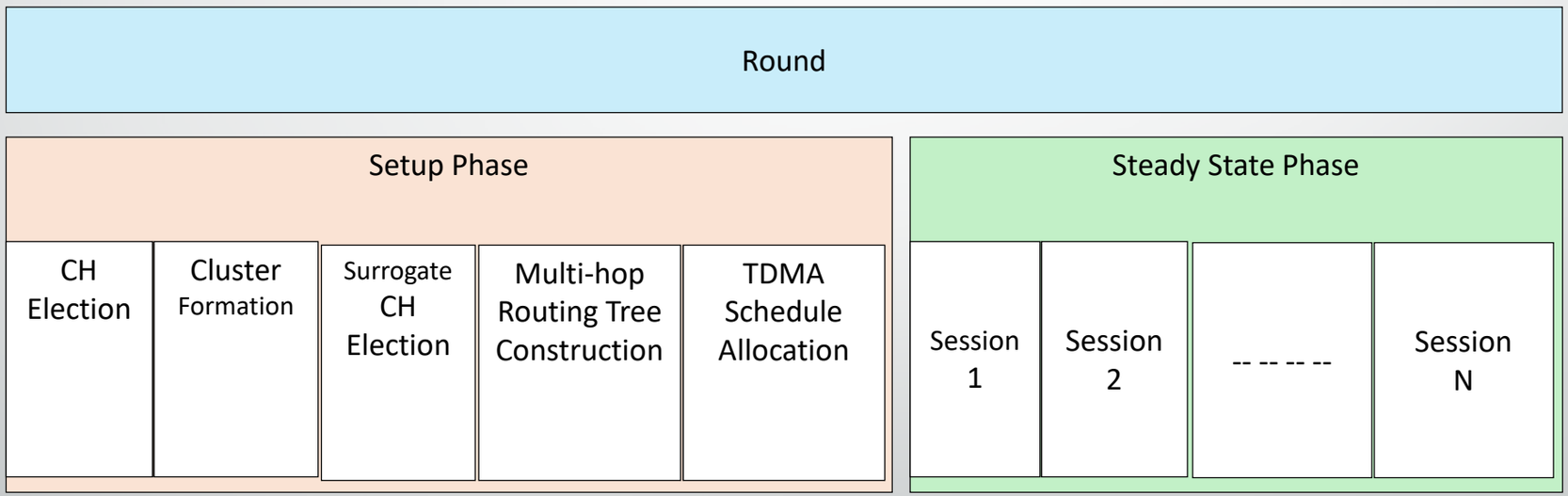
Introduction

- Delay management is crucial for industrial automation systems.
- Most industrial applications have heterogenous traffic, could be used for regular updates or critical alerts.
- Prioritized MAC schemes are essential.
- This work compares a packet fragmentation-based scheme FROG-MAC with Fuzzy Priority Scheduling-MAC (FPS-MAC).

Research Gap

- No previous MAC protocol offers an opportunity to interrupt ongoing transmission on the channel.
- FPS-MAC has been designed to steal the data slots from periodic traffic in order to transmit the higher priority data first
- FPS-MAC operates in two phases of set-up and steady state phase.
- For the event situation, the Emergency Indication Slot (EIS slot) is used, where the nodes having some urgent data indicate the channel requirement.
  - Two types of nodes: node which detected the event recently and the one who has buffered emergency traffic.
- Fuzzy based scheduling
  - Priority level of each node is computed using information about “intra-cluster distance (distance between member node and Cluster Head (CH)),” “residual energy,” “slots required,” and “emergency bit”.

Relevant Work: FPS-MAC Operation



Relevant Work: FPS-MAC Operation

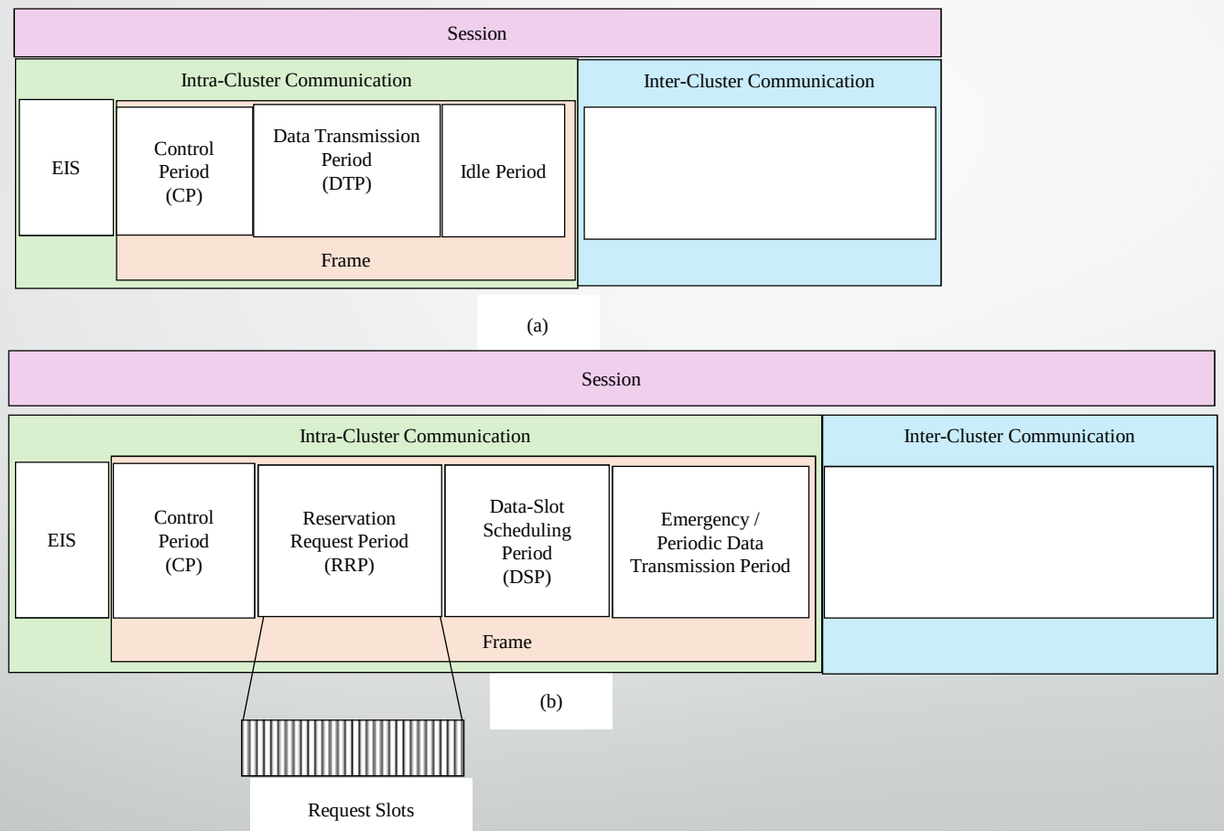


Figure 2: TDMA Frame Format for FPS-MAC- (A) Periodic Transmission, (B) Event Situation

Relevant Work: FROG-MAC Operation

- Asynchronous MAC protocol
- Introduced a novel technique: the ability to interrupt ongoing transmissions on the channel
- Low priority data is transmitted in fragments, and high priority as a single unit
- The pauses between fragment transmissions allow the data of emergency nature to request and obtain channel access quicker

Relevant Work: FROG-MAC Operation

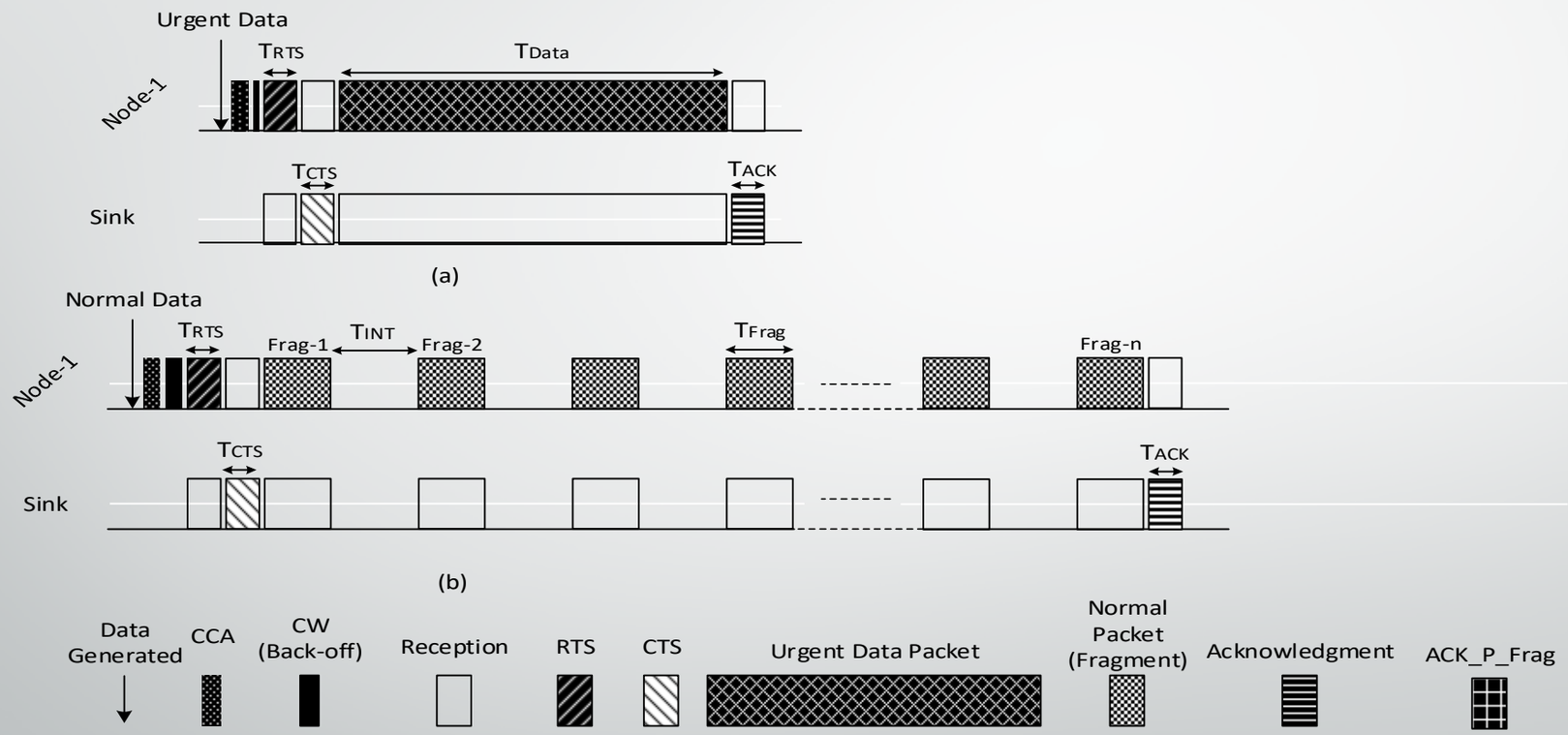
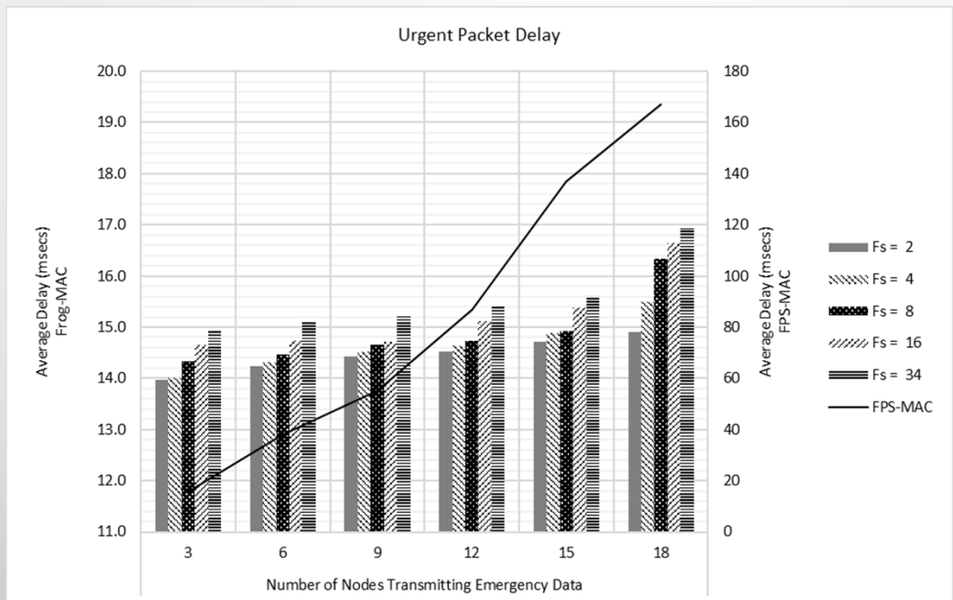


Figure 3: Basic Operation of FROG-MAC [13]

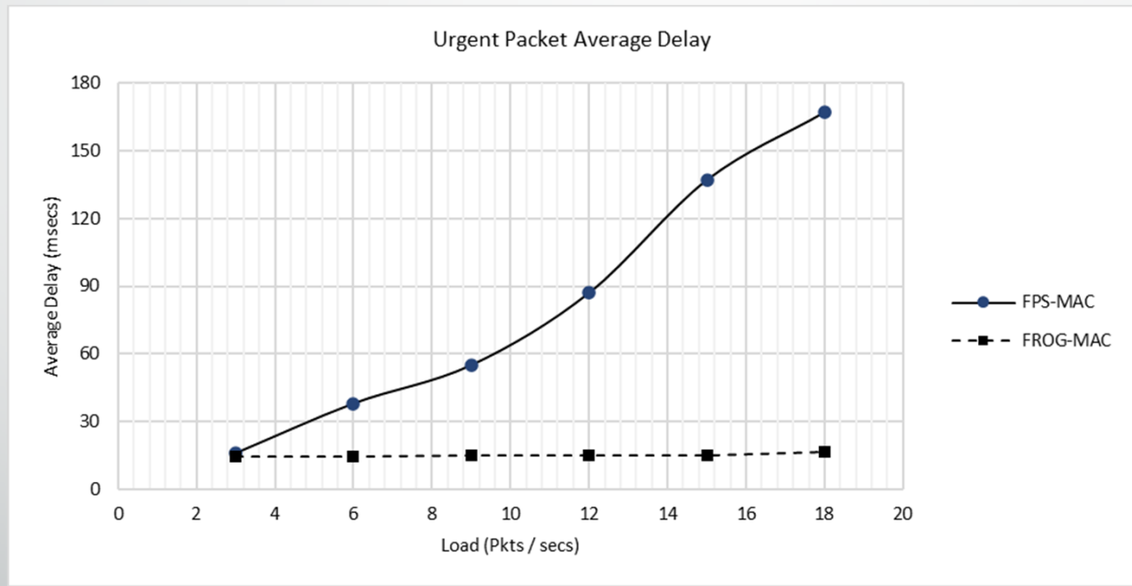
Simulation Settings

Simulation Parameter	Simulation Settings
Simulation Area	50 X 50 m
Simulation Duration	5000 Sec
Total Number of Nodes	21
Number of Transmitting nodes	Variable
Message Generation Interval of Urgent/Emergency/Event-detection Traffic	2 min
Message Generation Interval of Normal/Periodic Traffic	10 sec
Data Packet Length	34 Bytes
Fragment Size for FROG-MAC	Varying (2 to 32)

Performance Evaluation: Average Delay



Performance Evaluation: Average Delay



Conclusion and Future Work

- Performance comparison of FROG-MAC and FPS-MAC is presented.
- Delay has been shown to improve if FROG-MAC is used.
- In future, ML algorithms can be integrated with FROG-MAC for achieving a dynamic fragmentation scheme.
- FROG-MAC will be compared with standard protocols for various applications, such as with IEEE 802.11-p for vehicular networks.

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