ENSC 427: Communication Networks
Final Project Presentation
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ZigBee Mesh Network Simulation Using OPNET and Study of Routing Selection

Group 4

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Introduction - Why ZigBee?

Bluetooth

- High power consumption
  - Battery lasts days
- Higher data rate
  - 3.0Mbps (Bluetooth 2.0)
- Short Ranged
  - 10 meters
- Applications
  - Computer connections
  - Mobile phones

ZigBee

- Low power consumption
  - Battery lasts months or years
- Lower data rate
  - 250kbps (operating in 2.4GHz)
- Longer Ranged
  - 100 meters (1500 m in Zigbee Pro)
- Applications
  - Automated HVAC control
  - Agricultural networks

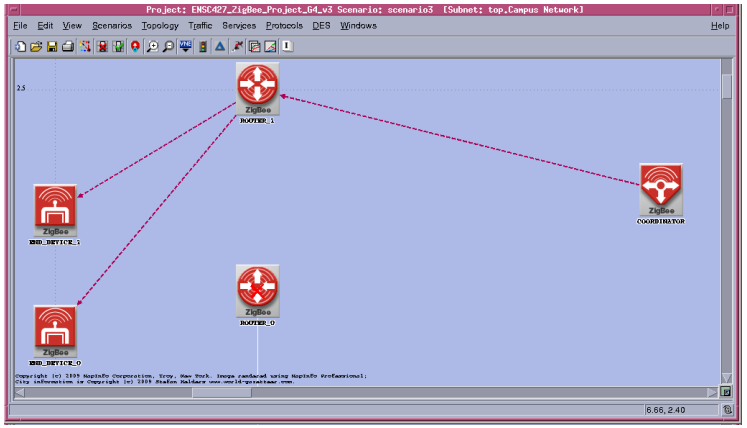
Introduction – ZigBee Qualities

- Dependability
  - Channel selection
  - CSMA-CA
  - Acknowledgements
  - Route Discovery (alternate routes) ← Main focus of project
- Secure Operation
  - Advanced Encryption Standard (AES) based encryption
  - Message timeout
  - Access Control Lists
- Binding Types
  - One-to-one
  - One-to-many
  - Many-to-one
  - Many-to-many

Implementation Details

Overall Design

- We used the Mesh routing topology for Zigbee Networks
- End nodes constantly sent packets to the Coordinator through one of the routers
- The router being used would eventually fail to simulate self healing
- The failure was done by moving the router out of range



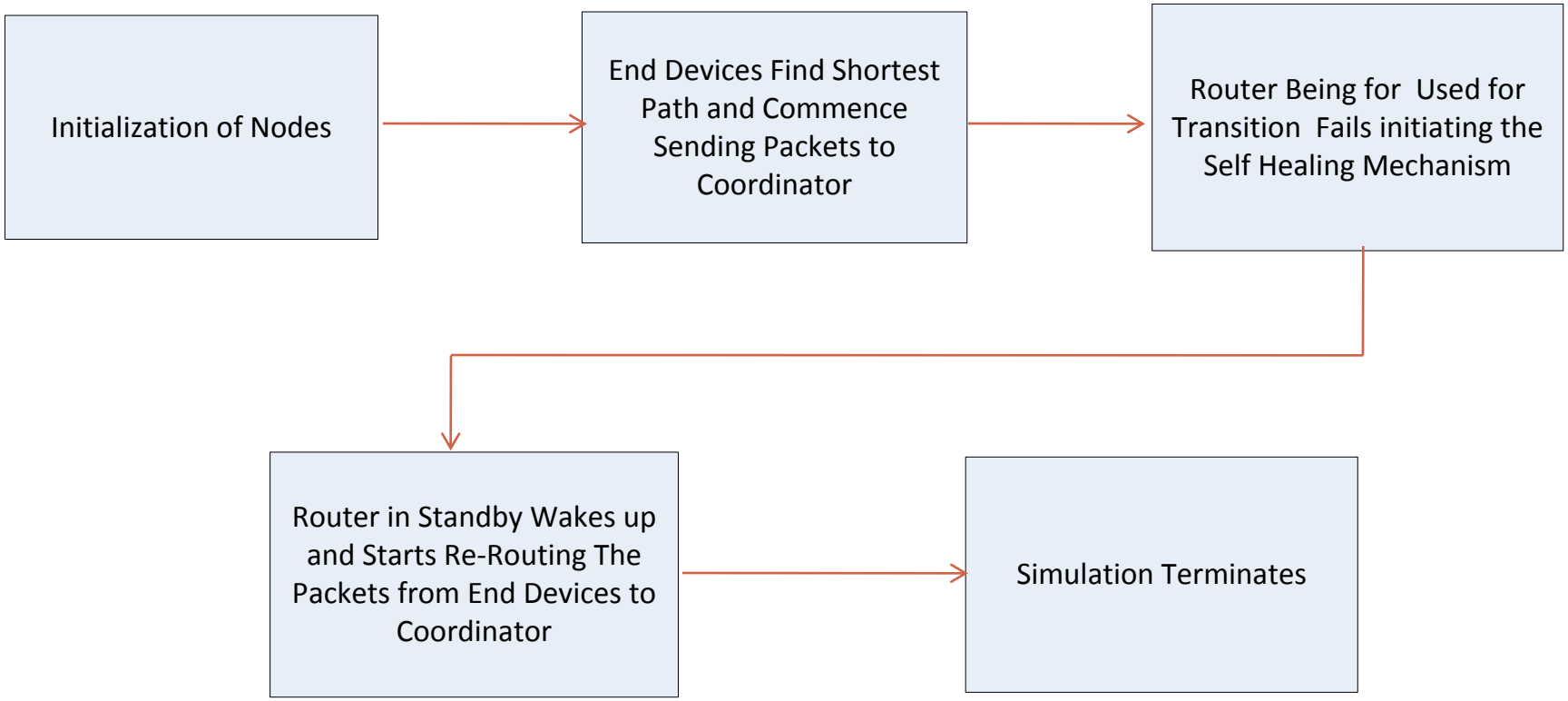
End Device

Router

Coordinator

Implementation Details 2

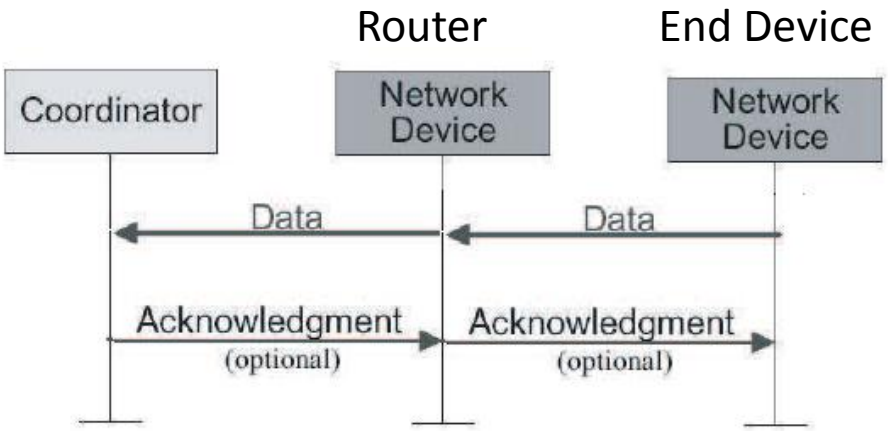
Overview of Simulation



Implementation Details 3

Use for ACK

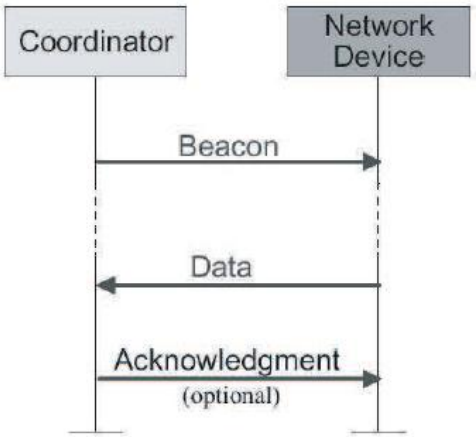
- With out ACK the end nodes would have no way of knowing their packets were not being received by the router and the coordinator
- No re-routing would take place and self healing would fail



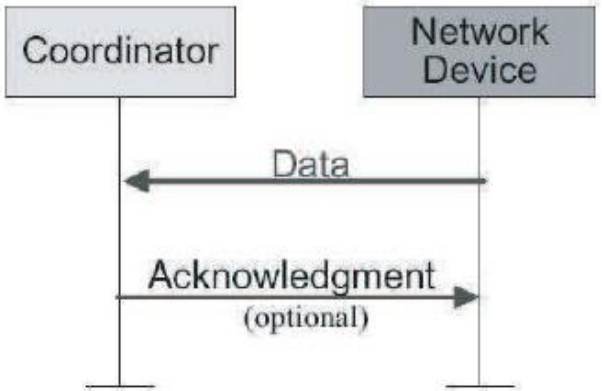
Implementation Details 4

Device to Coordinator Communication: Beacon Vs Non-Beacon Mode

- Device waits for network beacon, When found it synchronizes with Coordinator
- Waits to transmit data using slotted CSMA-CA

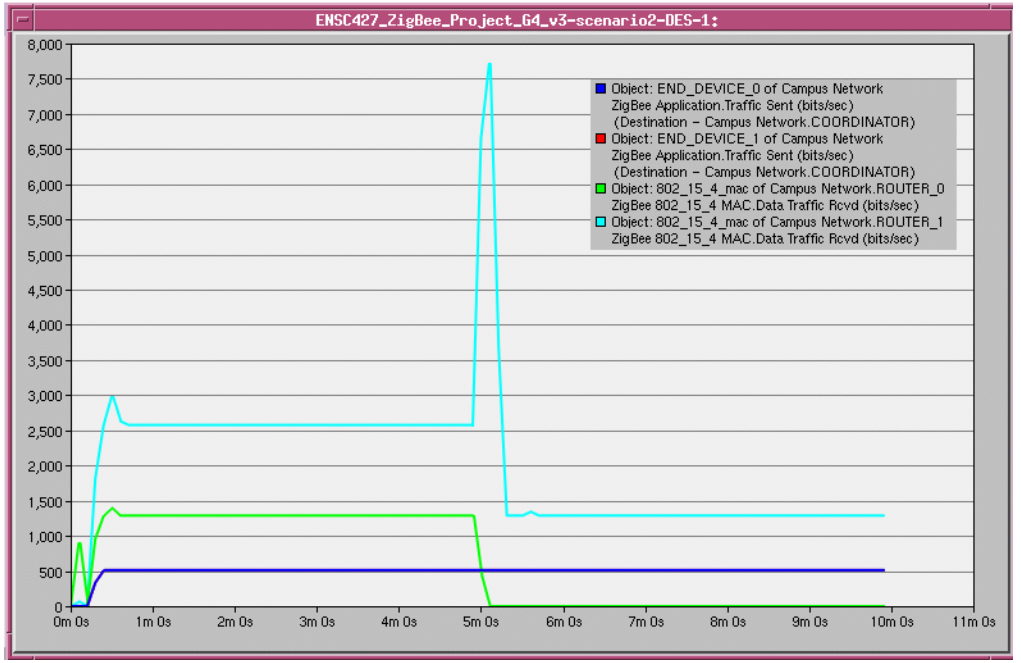


- Transmits Data Frame using unslotted CSMA-CA
- No synchronization required



Implementation Results

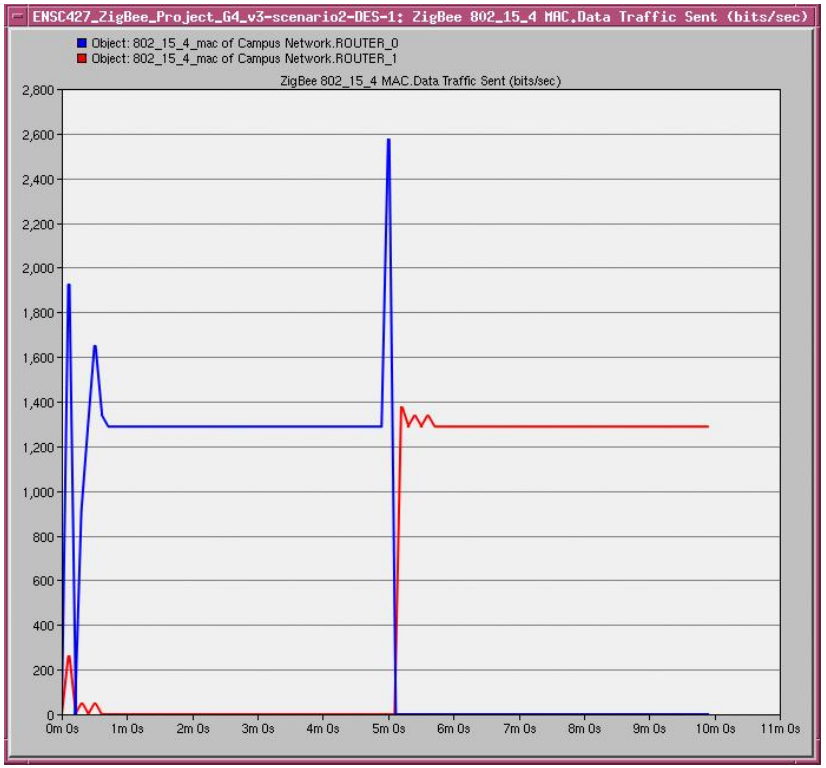
- Traffic Between End Devices and Routers
  - Drop in green line indicates "failure" of router
  - Light blue shows pick up of traffic to resume routing
  - Heavy traffic of light blue is result of Mesh network setting and none-beaconing
  - Receives data from surrounding and keeps track (not to route)

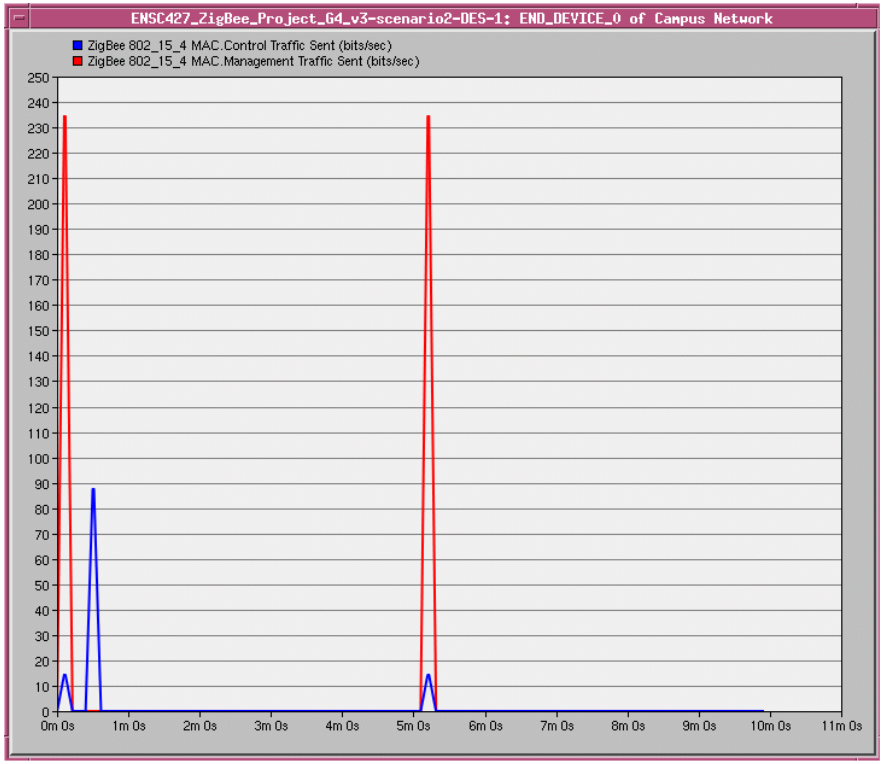


- Green and light blue – traffic received by router
- Blue (red overlap) – traffic sent by end devices

Implementation Results

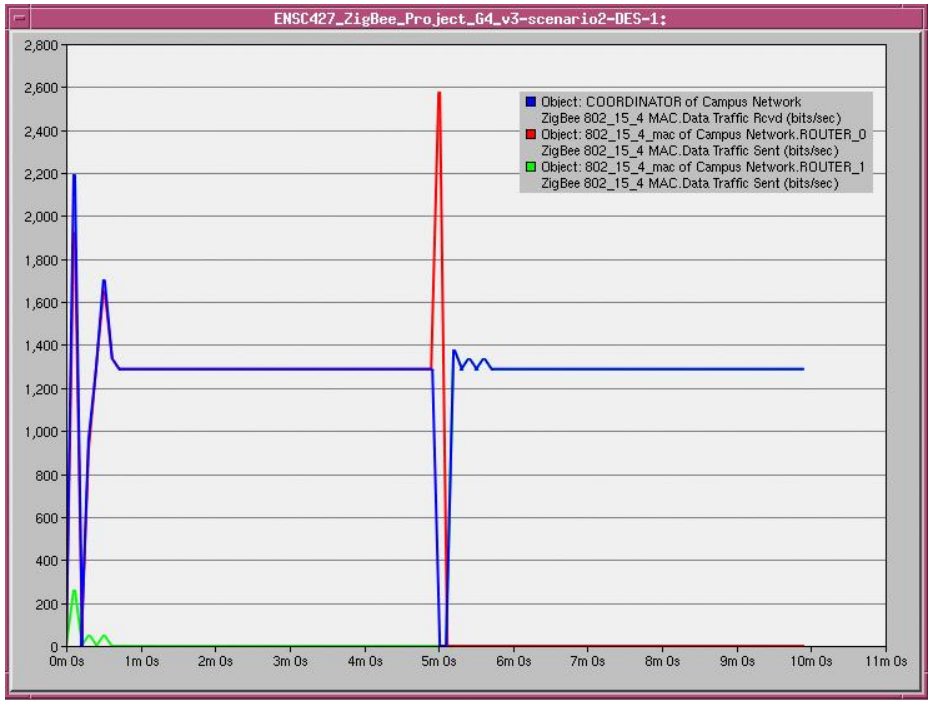
- Traffic Between End Devices and Routers

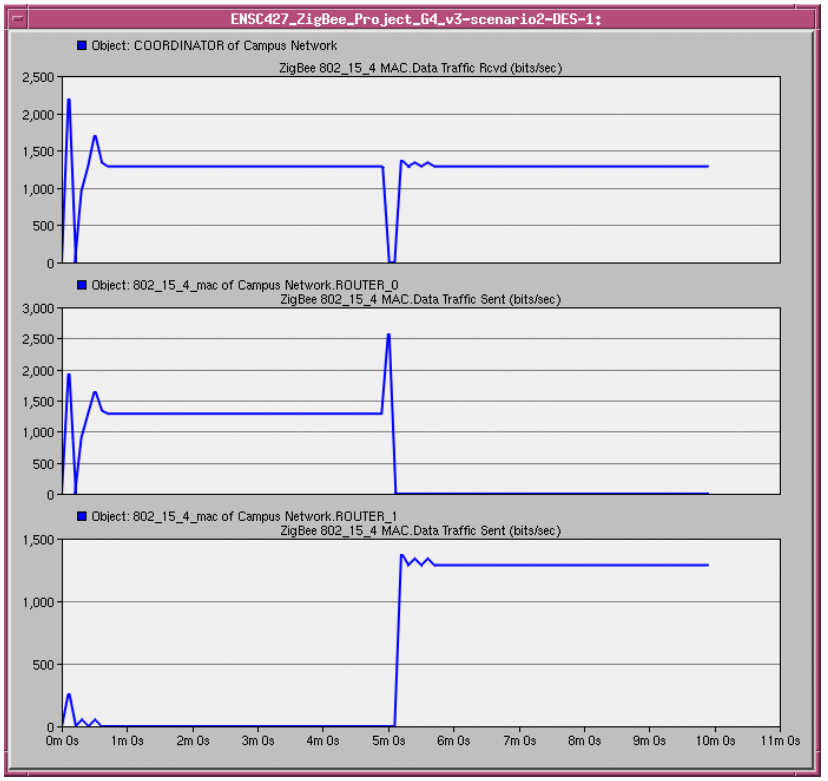




Implementation Results

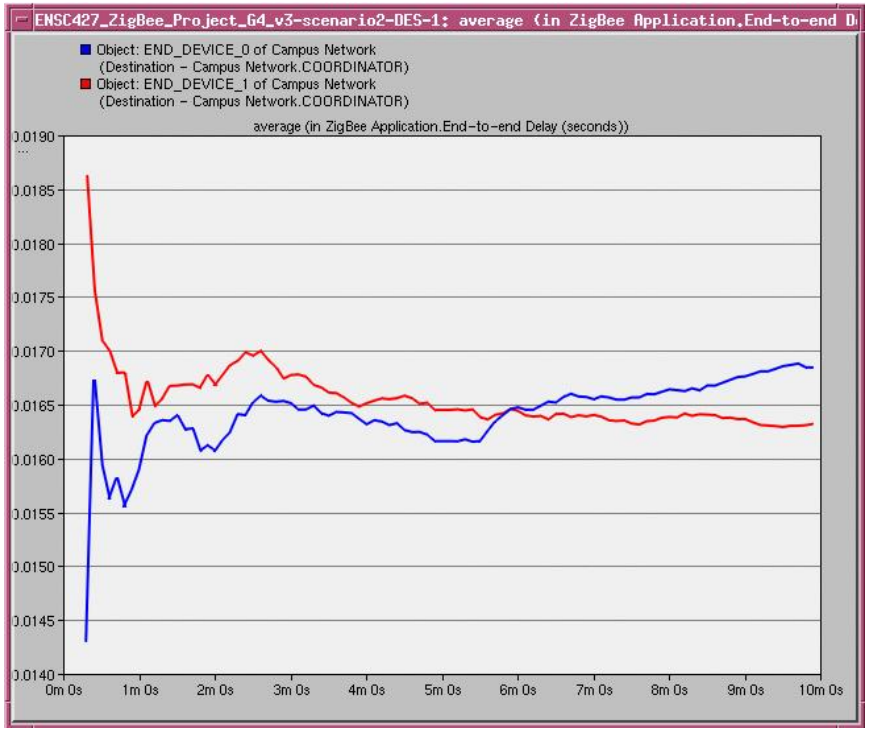
- Traffic Between Routers and Coordinator

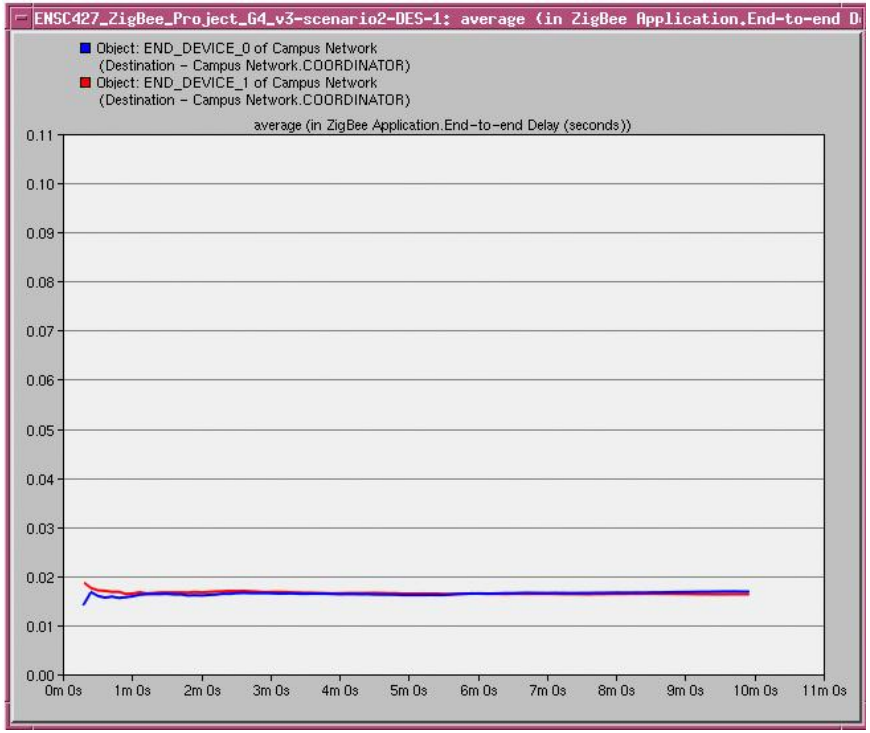




Implementation Results

- End-To-End (ETE) Delay
  - Very minor through rerouting transition
  - Retry occurs at five minute mark





Discussion

- Challenges and Difficulties
- Incomplete ZigBee OPNET Model
  - Multicast Traffic, Indirect Transmission, Security, Slotted Mode, Contention – free operation mode
  - Lack of Implementation Details
    - No specifications on range
  - Slow computer (too many users?)
- Potential Alternative Approaches
  - Programming of more practical router failure

Discussion (continued)

- Improvements and Future Work
  - More realistic application scenarios
    - Including more nodes and variations of topologies

- What We Learned
  - ZigBee
    - Better understanding of the ZigBee protocol
    - Features and potential applications for use in projects
  - OPNET
    - Various functionalities provided by OPNET
    - Limitations – calculating battery life

References

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