PROJECT SUBMISSION DOCUMENT

Course: EEE G627 **Date**: 08th May 2023

Students involved: **Group No. 2**

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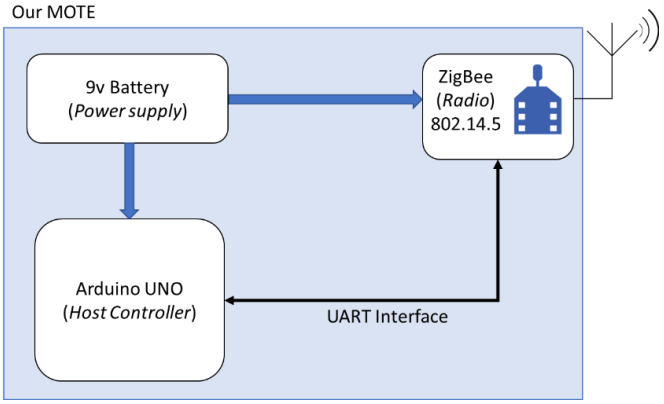
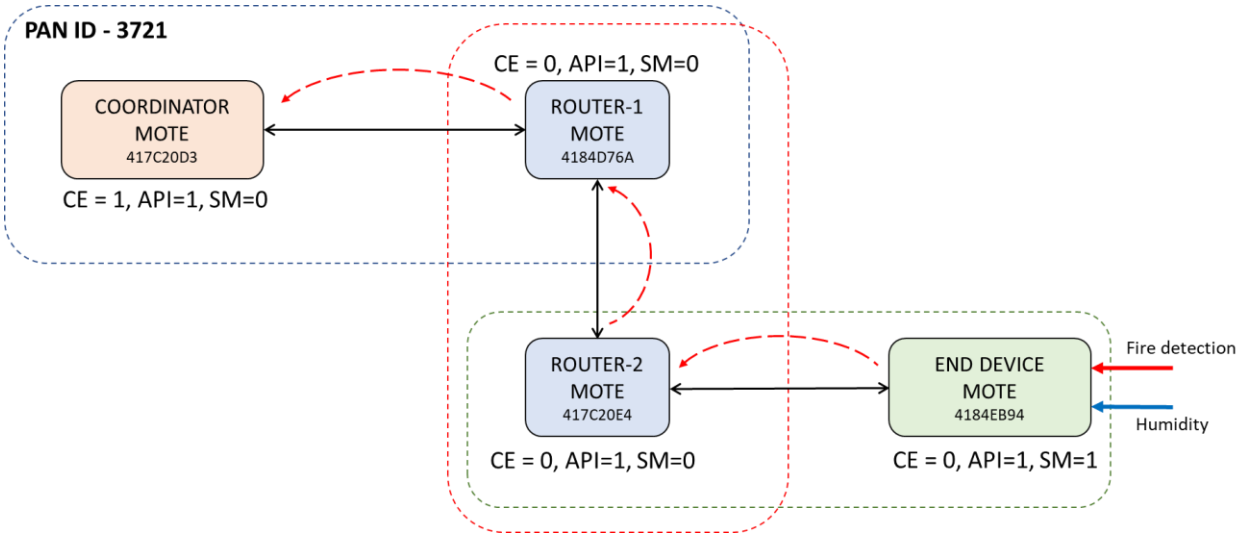
Description of project:

Learn communication scheme of network embedded devices. Specifically, routing strategy and implementation of an actual network of MOTEs to demonstrate same.

MOTE implementation –



Network of MOTEs –



- **COORDINATOR**: To make a ZigBee device a coordinator we set the CE parameter to 1. Also, the coordinator selects the PAN ID to start the network. Also, we enabled the API mode so that the data can be sent as a frame packet.

- **ROUTER:** To configure the ZigBee device as a router we disable the CE parameter. Also, the SM (Sleep Mode) parameter for router must be set to 0 since the router should be powered all the time.
- **END DEVICE:** For end device we set the SM parameter to be a non-zero value.

Controller-Radio communication API frames –

Start delimiter	Length		Frame data								Checksum
			API identifier	Identifier-specific Data							
1	2	3	4	5	6	7	8	9	...	n	n+1
0x7E	MSB	LSB	cmdID	cmdData							Single byte

XBee comes with UART which can be used to send and receive frames/data between a host controller. Between Host and Zigbee the communication happens as API frames. Data received from Zigbee (i.e., Receive type, transmit status type) will be parsed to get the RF Data and print in serial monitor. Data that need to be sent to Zigbee (i.e., Transmit request) frame will be generated and sent. One such frame generation is shown below. Frame for transmitting the sensor reading to Collector.

Frame generation for Transmit request type – Data:" HUMI:35%"

Start	Length	Type	Destination address				RF Data	
0x7E	0x0016	0x10	0x0013A200	0x417C20D3	0xFFFE	0x0000	'HUMI:35%'	Checksum

Checksum = 0xFF – (8-bit sum of each byte in-between Length and CRC)

Destination address = Collector aka Coordinator node

Demonstration –

1. **Broadcast a MAX_PAYLOAD data.**

The maximum payload size in case of unicast message is 255 bytes when the AP parameter is non zero. In case of AP parameter to be zero the maximum payload size is 84 bytes. In case of broadcast message since there is no fragmentation present the maximum payload size is always equal to 84 bytes. This is possible because of NP which reads the maximum number of RF payload bytes that we can send in a transmission.

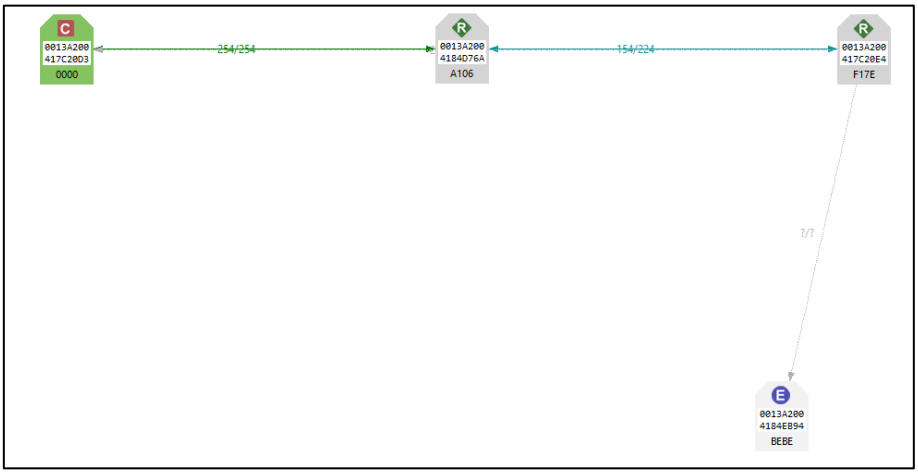
2. **Unicast data to Collector node (COORD) via multihopping.**
    a. A periodic sensor data
    b. A sporadic fire detection alert

At end device we are connecting a dht11 sensor which will periodically send humidity value to the coordinator at an interval of 30 seconds. Also, in case of fire detection we are keeping a push button which when pressed will glow an LED at the coordinator end as an alert. These sensor value reading acts as a periodic event whereas the push button acts as a sporadic event.

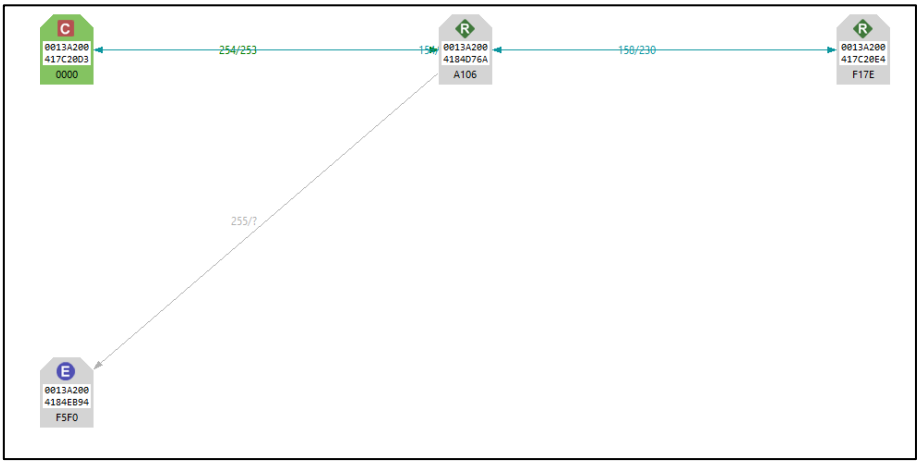
3. Routing and various scenario of network topology.

For ZigBee there are three routing protocols. By default, AODV is enabled. The other two are Source routing and many to one. Since we have less no. of destinations in our network, we chose AODV as it supports up to40 destinations. Beyond that there is more overhead so then Many to one or Source routing is preferred.

1) Ad hoc On demand Distance Vector (AODV) Mesh Routing: Routing paths are created between source and destination, possibly traversing multiple nodes (“hops”). Each device knows where to send data next to eventually reach the destination. AODV should be use in networks that will not scale beyond about 40 destination devices.
2) Many-to-One Routing: A single broadcast transmission configures reverse routes on all devices into the device that sends the broadcast. This Routing should be used when many remote devices must send data to a single gateway or collector device.
3) Source Routing: Data packets include the entire route the packet should traverse to get from source to destination. This Routing should be used when Improves routing efficiency in large networks (over 40 remote devices).

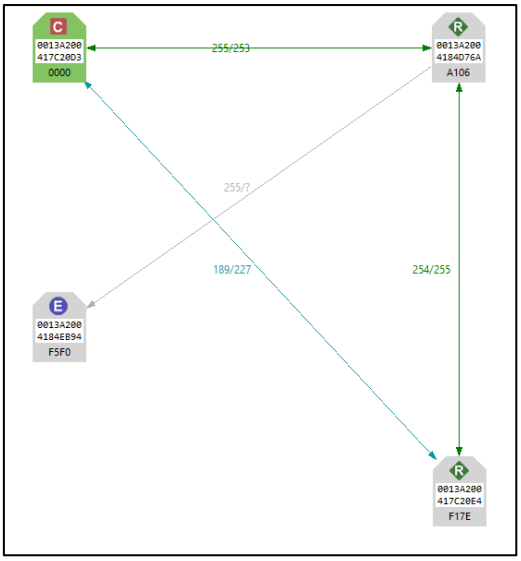


End device data is hopping from ED -> R2 -> R1 -> C (3 hops)



End device location is changed. New updated path way chosen via neighbour discovery.

Data hopping from ED -> R2 -> C (2 hops)



Now both the routers are in vicinity of coordinator. The end device choses the previously held route to pass new messages.

Challenges faced -

We tried to explore the RF routing information (i.e., Routing table, Link quality status) which could be read via a special Zigbee application object – ZDO (Zigbee Device Object). But were unable to get response from Zigbee module.

It is a component of the Zigbee protocol stack that provides a standard set of device discovery, management, and control functions for Zigbee devices. The ZDO layer is responsible for tasks such as network formation, device discovery, binding, and security management. It allows Zigbee devices to communicate with each other by maintaining information about neighboring devices and the network topology. ZDO is a mandatory component of the Zigbee protocol stack, and all Zigbee devices must implement it. By using ZDO, Zigbee devices can interact with each other in a standardized way, regardless of their manufacturer or application

Work division among team members –

1. Saurav Kumar 2022H1400183P

    a. Responsible for Sensor integration and fire detection button, and programming in ArduinoIDE for same.
    b. Support role in Zigbee configuration

2. Sudhanshu 2022H1400186P

    a. Responsible for Zigbee configuration and networking
    b. Host controller programming (ArduinoIDE) for End device
    c. Support in documentation

3. Bharathi Shrinivasan T R 2022H1400182P

    a. Responsible for Zigbee configuration and networking.
    b. Host controller programming (ArduinoIDE) and frame library function development
    c. Support in documentation and project flow

4. Avinash Raina 2022H1400185P

    a. Responsible for Zigbee configuration and networking
    b. Support in network setup and routing verification
    c. Support in documentation and project overall flow

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