Exp 12: One Hop IoT Network over IEEE 802.15.4 using Netsim software

Aim: To design, simulate, and analyze a one-hop IoT network using the IEEE 802.15.4 protocol in NetSim software**.**

Apparatus: NETSIM V12.2, PC

Procedure :

The following set of procedures were done to generate this sample:

Step 1: Go to New Simulation-→ IoT→Set Grid length to 50m**.**

A network scenario is designed in NetSim GUI comprising of 2 Wireless Sensors, a 6 LOWPAN Gateway, 1 Router, and 1 Wired Node. Connect the above nodes using Adhoc links, wired links.

Step 2: Go to Wireless Sensor1→Properties-→select Interface Zigbee→Go to Data Link Layer → Set Ack Request to Enable and Max Frame Retries to 7. It will be automatically set for Wireless Sensor 2, since the above parameters are Global.

Step 3: Go to LOWPAN Gateway→Properties-→Select Interface Zigbee→Data Link Layer →Set Beacon Mode to Disable by default.

Step 4: The Adhoc link properties are set to NO PATHLOSS for the channel characteristics.

Step 5: Create an Application from Wireless sensor1 to Wired Node 5**.** Right click on the Application Flow, Select Application Type as CUSTOM .

Transport Protocol is set to UDP with Packet Size set to 70 Bytes and Inter Arrival Time set to 4000μs. The Packet Size and Inter Arrival Time parameters are set such that the Generation Rate equals 140 Kbps. Generation Rate can be calculated using the formula:

$$Generation\ Rate\ (Mbps) = Packet\ Size\ (Bytes) * 8/Interarrival\ time\ (\mu s)$$

NOTE: If the size of the packet at the Physical layer is greater than 127 bytes, the packet gets fragmented. Taking into account the various overheads added at different layers (which are mentioned below), the packet size at the application layer should be less than 80 bytes.

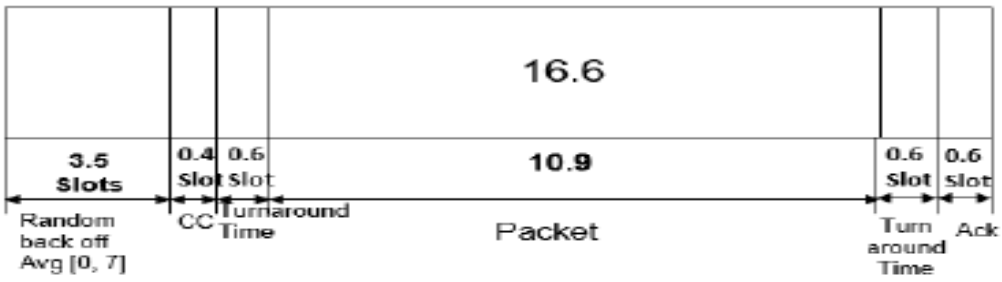
Step 6: Plots are enabled in NetSim GUI. Run simulation for 10 Seconds and note down the throughput.

Similarly, do the other samples by increasing the simulation time to 50, 100, and 200 Seconds respectively and note down the throughputs.

Analysis of Maximum Throughput

We have set the Application layer payload as 70 bytes in the Packet Size and when the packet reaches the Physical Layer, various other headers gets added like:

App layer Payload	70 bytes
Transport Layer Header	8 bytes
Network Layer Header	20 bytes
MAC Header	5 bytes
PHY Header (includes Preamble, and Start Packet Delimiter)	6 bytes
Packet Size	109 bytes



Default, NetSim uses Unslotted CSMA/CA and so, the packet transmission happens after a Random Back Off, CCA, and Turn-Around-Time and is followed by Turn-Around-Time and ACK Packet and each of them occupies specific time set by the IEEE 802.15.4 standard as per the timing diagram shown below:

From IEEE standard, each slot has 20 Symbols in it and each symbol takes 16µs for transmission.

Symbol Time	T_s	16 µs
Slot Time	20 * T_s	**0.32 ms**
Random Backoff Average	3.5 * *Slots*	**1.12 ms**

CCA	0.4 * *Slots*	**0.128 ms**
Turn-around-Time	0.6 * *Slots*	**0.192 ms**
Packet Transmission Time	10.9 * *Slots*	**3.488 ms**
Turn-around-Time	0.6 * *Slots*	**0.192 ms**
ACK Packet Time	0.6 * *Slots*	**0.192 ms**
Total Time	**16.6 * *Slots***	**5.312 ms**

$Analytical\ Application\ Throughput = 70(bytes)\ in\ Applayer * 8/\ 5.312\ ms = 105.42\ kb.$

Output:

Comparison of Simulation and Calculation

Sample	Simulation Time (sec)	Throughput (kbps)
1	10	103.60
2	50	104.62
3	100	104.57
4	200	104.69

Result:

- In this experiment, we verified how to allocate One Hop IoT Network over IEEE 802.15.4. The throughput values stabilize very quickly as simulation time increases, ranging from 103.60 kbps at 10 seconds to 104.69 kbps at 200 seconds.
- This indicates that even with short simulations, the measured throughput accurately represents the system's performance for a one-hop communication scenario.