CS4222/5422

Solutions for Tutorial 9

Answer 1:

(a) We are using LoRa standard. LoRa uses the Sub-GHz frequency band for communication. The specific frequency would be either 865-868 MHz band, or 900-920 MHz, depending on which part of the world that you are currently located.

(b) We are given channel bandwidth of 125 KHz

Assuming the nodes are concurrently transmitting and there is no option of performing time division multiplexing.

Number of transmitters: 20 MHz/ 125 kHz = 160 concurrently transmitting devices

When employing LoRa, we can support much larger number. This is because CSS enables orthogonal (CSS spreading) transmitters to communicate at the same time on the same frequency channel.

(c) There are several; a) Higher sensitivity and range, b) a greater number of concurrent transmissions, c) better reliability owing to spreading and error correction mechanism

(d) We could implement a simple MAC protocol that requires little synchronization among devices owing to the large-scale nature of the sensor node deployment. We would be using ALOHA styled protocol, i.e., the node transmits when they want!

(e)

Gt, Gr =. 2 dBi
Distance (meters) = 4000
Frequency: 900 MHz
Receiver sensitivity: -146 dBm

We can use Friis propagation equation to estimate minimum transmitter strength to achieve sensitivity of -146 dBm at the receiver.

Around -46 dBm should be the transmitter signal strength

You can try out these values using the following calculator:
https://www.pasternack.com/t-calculator-friis.aspx

Answer 2:

(a) Several benefits over IPv4

(i) Very large address space. IPv4 supports 2^32 addresses, while IPv6 supports 2^128 addresses. The large address space can ensure every IoT device can be uniquely addressed. It makes lot of sense when we talk about trillion deployed IoT device.
(ii) Various compression mechanisms are part of the specification that makes it more applicable to constrained IoT devices

(b) Header and address compression mechanisms in IPv6:

Header compression: Streamlined header compared to IPv4. Ipv6 header is 40 bytes, and many of fields can be compressed.

Address compression: IPv6 address can be compressed. Consecutive groups of zeros can be replaced with double colon (::), it helps to reduce size of address when transmitted.

(c) The IPv6 address provided is aecb:222::10. To expand it into its full form, we need to replace the double colon with the appropriate number of zeros to complete the 128-bit address. The expanded address is: aecb:0222:0000:0000:0000:0000:0000:0010

Answer 3:

(a) Important difference between two standards is that Bluetooth 5.2 supports much higher bitrate at the PHY layer. It means that advertisements could be transmitted faster.

If we ignore presence of extended advertising. One advertisement packet is 47 bytes or 376 bits long. The time it would take to transmit this packet over two standard is as follows:

BLE (4.2) = 376 / 1,000,000 = 0.376 milliseconds
BLE(5.2) = 376/ 2,000,000 = 0.188 milliseconds

(b) Transmit power: 10 milliwatts

In a single advertising cycle, the same packet would be sent over **three** advertising channel.

Power consumed would be: 10 milliwatt * 0.376 milliseconds * 3 = 11.28 micro joules

(c) For audio streaming; Connection oriented because we want to transmit large amounts of data and ensure there are no lags in audio.

For sending beacons: Advertising mode is more suitable as they are suitable for sending small amounts of information and allow efficient transmission to number of devices without overhead of establishing connection.

d) Extended advertisements in Bluetooth 5.x use three primary advertisement channels (37, 38, and 39) for broadcasting the advertisement packet header and a portion of the payload. The remaining payload is transmitted on one or more of the secondary/data channels (0-36) in a process known as channel hopping. This approach helps to minimize interference and optimize the use of available radio spectrum.