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On the accuracy of measured proximity of Bluetooth-based contact tracing apps

The paper gives a brief overview of how BLE contact tracing app works, which is similar to how our GAEN based app works:

1. It mentions about how cryptographically derived tokens are used for exchanging between devices on close contact.
2. It describes the centralised architecture, where matchmaking happens on a central server
3. It talks about decentralised architecture, where matchmaking happens on the user's phone and guarantees strong privacy for non-diagnosed individuals.

The paper's main focus is however on how certain factors affect the accuracy of contact tracing methodologies based on RSSI which is proportional to the distance of signal transmission in theory. It mentions about two sections of factors namely:

1. Internal Factors:

    a. One of the main factors that could impact BLE RSSI is the BLE antenna. Depending on the length of the antenna and whether the signal could pass through obstacles, RSSI value would, in turn, be affected as well. Moreover, the maximum TxPower of a BLE device is set by manufacturers and the same RSSI levels on two different devices could be interpreted heavily different.
    b. When it comes to software factors, low power mode on devices could affect the BLE RSSI values as well where it would limit the TxPower of the BLE device.

2. External Factors:

    a. Physical obstacles could impact BLE signals as well. It is claimed that two individuals (one COVID positive and another non-COVID positive) separated by a solid wall could be termed as have been exposed to an infectious case. However, this can only be proved by further testing which we intend to do in our app COVID Guard.

How can BLE Configurations affect RSSI?

1. Level of advertising interval:
    a. LOW_POWER: advertise packets every 1 second
    b. BALANCED: advertise packets every 250 milliseconds
    c. LOW_LATENCY: advertise packets every 100 milliseconds

    On looking into the AltBeacon configurations, it did mention of supporting the above three modes. One of the issues explicitly shows the code on how to scan in the above modes.

2. Level of transmission power (TxPower):
    a. ULTRA_LOW
    b. LOW
    c. MEDIUM
    d. HIGH: Would boost signal strength and improve the transmission of packets.

How is metadata used in packets?

Metadata mainly includes TxPower and RSSI for packets related to contact tracing. Some of the apps integrate it with the packets and some apps keep it separated. Our app integrates the metadata as part of the packets using AltBeacon inbuilt functions like getTxPower() and getRunningAverageRssi().

How is the paper's information used in our project?

Overall, the paper rules out various apps and on what level of configuration they use TxPower and RSSI. However, it is not clear on what factors they are configured at. As such, it is of less use to us.

The authors mention a formula which they have derived for distance calculation of BLE packets. It mentions about three coefficients which correspond to a couple of phone models. This formula calculates fine-tuned RSSI. However, these coefficients are not explained and couldn't be found on the internet as well.

As per my use in the COVID guard, I was able to understand how TxPower, RSSI and advertising intervals play their role in the transmission of packets. From this, the following can be concluded:

1. Greater the TxPower, greater the range of the signal.

2. The more frequent the advertising interval, the more stable the transmission occurs
3. RSSI stands for Received Signal Strength Indicator. It is the strength of the beacon's signal as seen on the receiving device, e.g. a smartphone. The signal strength depends on distance and Broadcasting Power value (TxPower of transmitting device).

REFERENCES

1. Zhao, Q., Wen, H., Lin, Z., Xuan, D. and Shroff, N., 2020. On the accuracy of measured proximity of Bluetooth-based contact tracing apps. In International Conference on Security and Privacy in Communication Networks.