XBee Wireless Mesh Network and Communication-aware Planning in Mobile Robot Exploration

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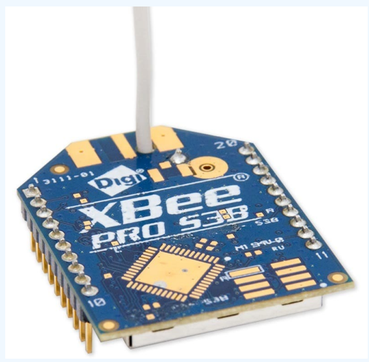
Introduction & Motivation

In DARPA SubT Challenge, the robots are required to navigate through underground environments which are challenging for communication systems. Team NCTU proposed a deployable node – Anchorball as a solution to the communication and localization problem. In Anchorball, xBee RF modules are used as intermediate nodes that forward data packets from the base-station to the robots and vice-versa.
This report focus on the communication survey part of the project.
This is an unfinished project where its remaining parts are still being in constant development.

Hardware



- Xbee-PRO XSC S3B 900Mhz
- Interfaced through USB serial port using Xbee Explorer Dongle

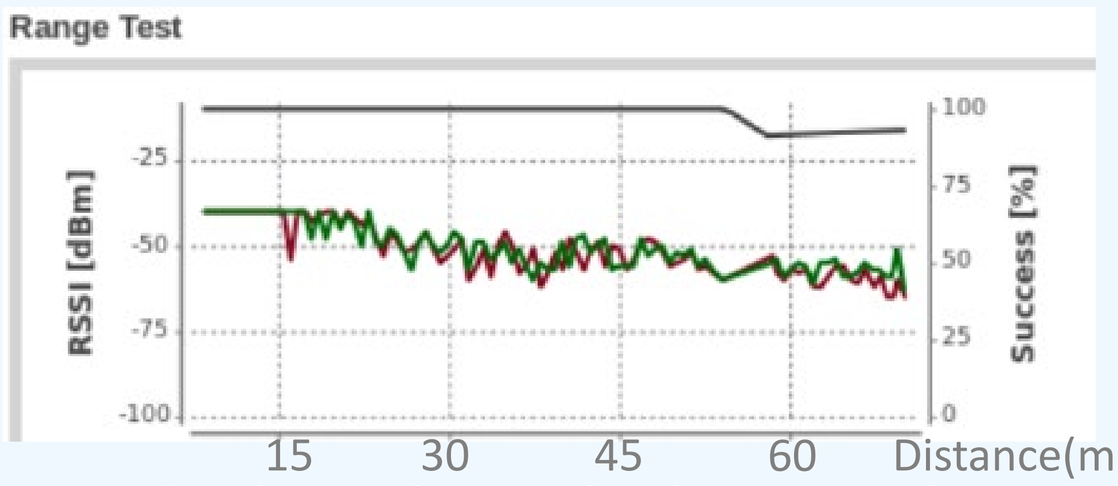
Software

- XCTU – Configuration/Debugging
- XBee Python Library – Integration into our robotic systems using ROS Python.

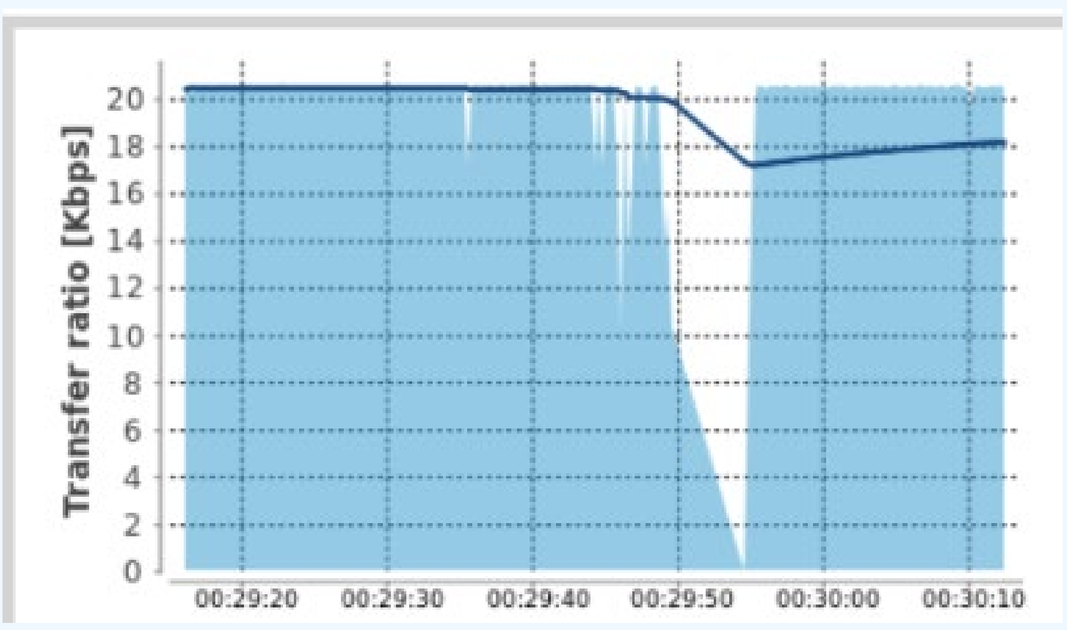
Specifications

- Self-healing Mesh
- Max 256B Payload
- 20kb/s Throughput

Analysis and Benchmark



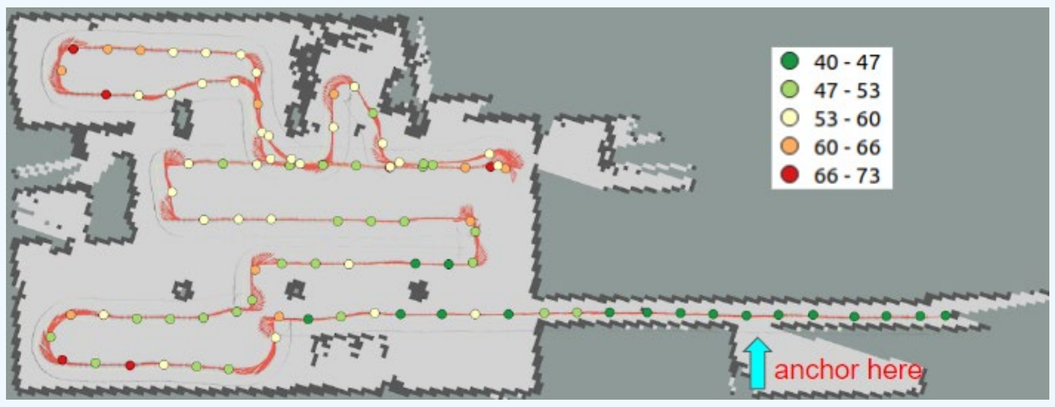
- Results shows that packet loss started at around 50-60m. (Indoor)



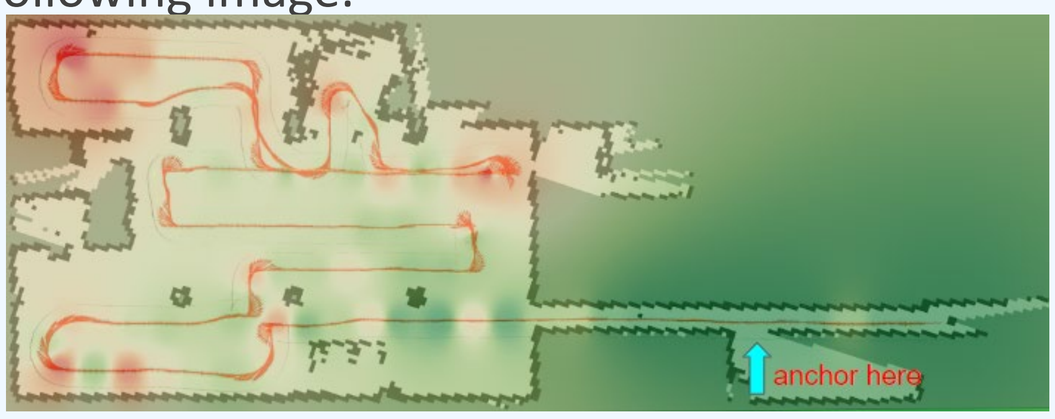
- Self-healing Test – The Mesh network is able to self heal in 6 seconds for a 2-hops connection.
- More results are available at https://hackmd.io/@zlewe/xbee

RSSI Scanner

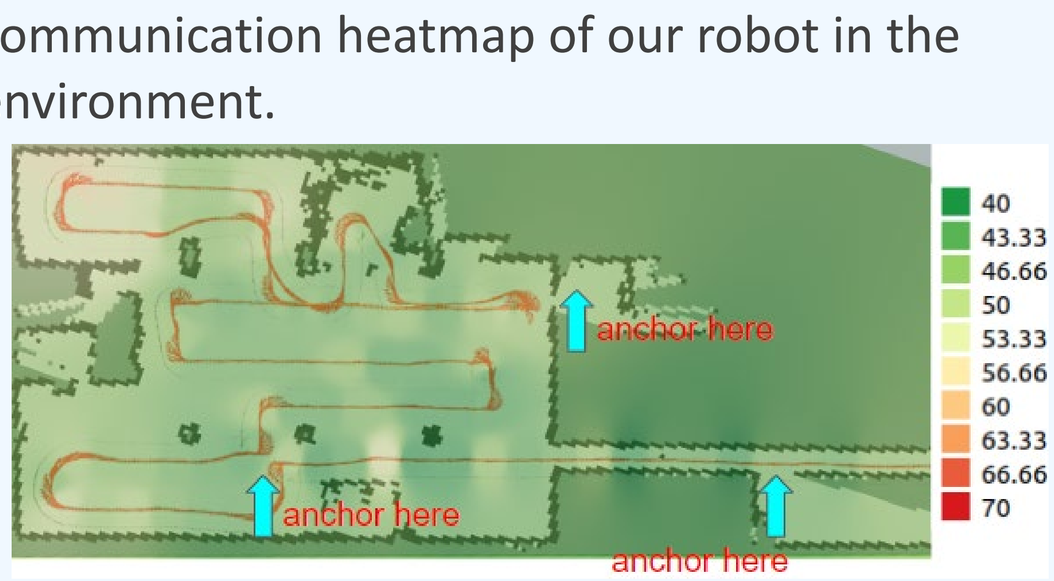
- I've wrote a RSSI Scanner node in ROS that will scan for the RSSIs of all the neighbor nodes (exactly one hop) with a 5 seconds interval.



- For the above image:
  - Red line shows the trajectory of the robot which is obtained by a SLAM algorithm.
  - The datapoints shows the RSSI of a node (blue arrow) at the corresponding coordinate.
- By applying IDW interpolation, we obtained the following image.



- Taking average of the data we collected with all neighboring nodes, we obtained a rough communication heatmap of our robot in the environment.



- In the next part of this project, we wish to utilize this information in the **navigation strategy** of the robot where it would likely **stay in connection**.
- Since this is a mesh network, the robot only needs to be in connection to one of the node at any time period. We also want the robot to **deploy a new node at the 'edge' of the network coverage area**.