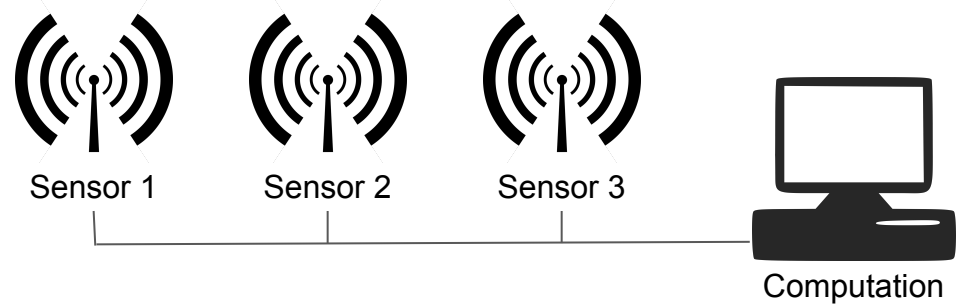


Localisation

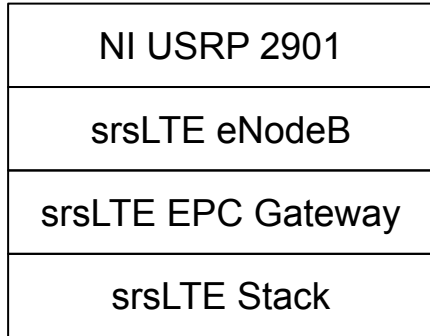
USC ANRG

Setup Diagram

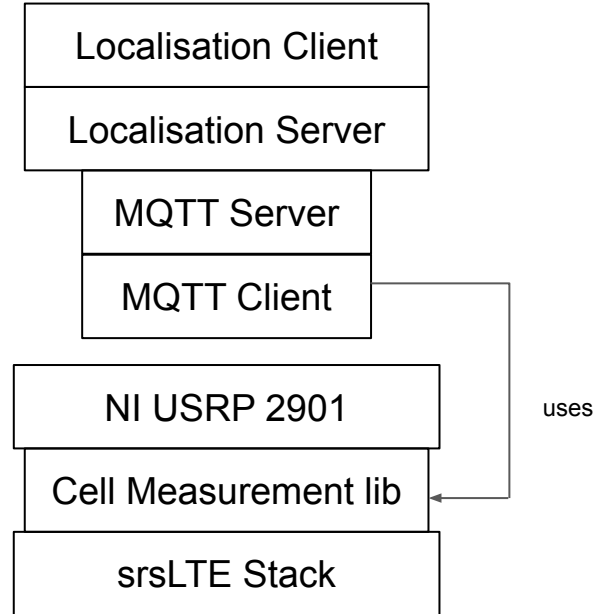


Architecture Diagram

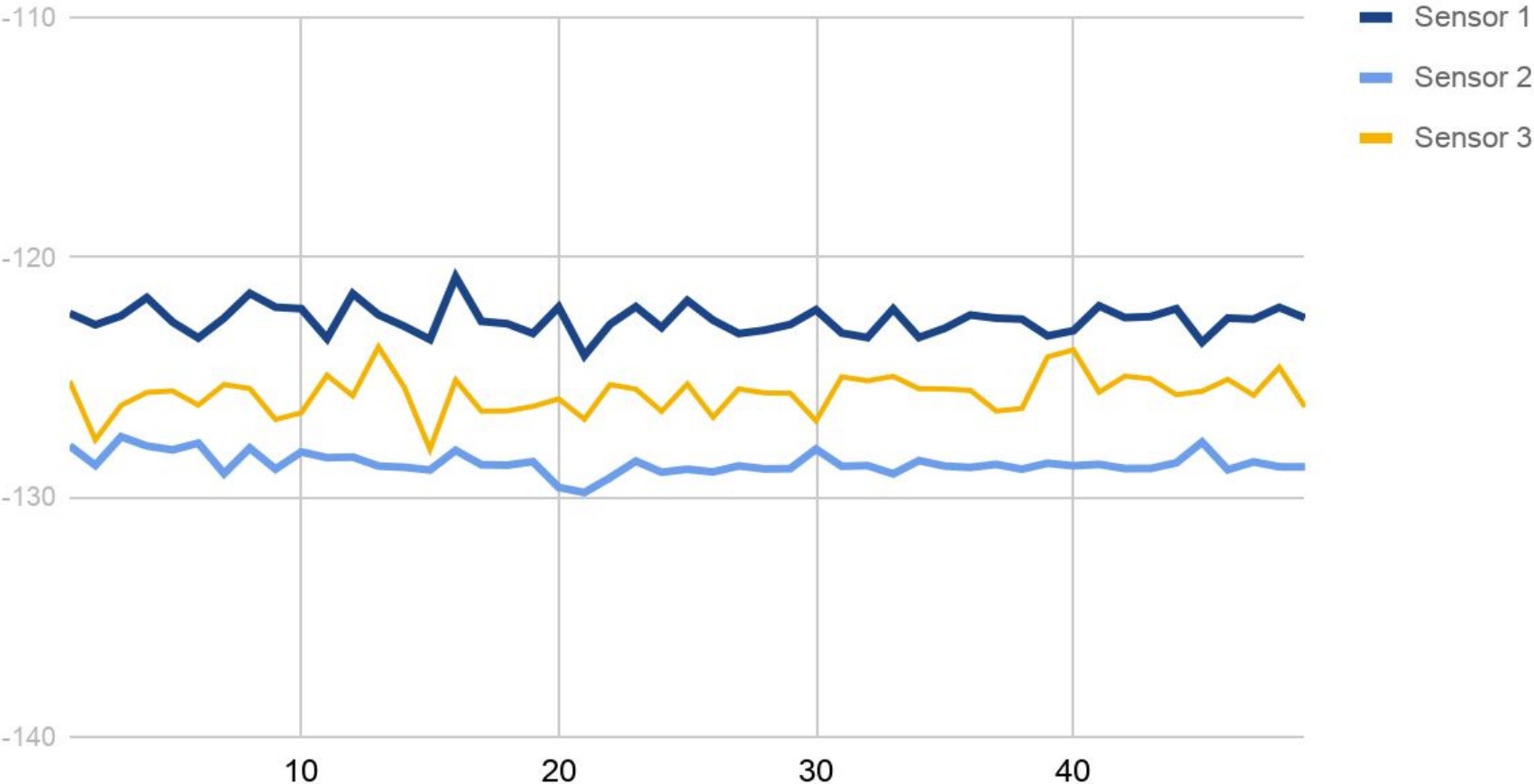
Transmitter



Sensors



RSSI Readings per Radio



srsLTE Configuration

Transmitter:

- EPC and ENB parameters unchanged
- Default LTE downlink frequency 2685MHz (Band 7)

Sensors:

- Specify radio serial to obtain RSSI reading for specific sensor location
- Specify measurement frequency of the transmitter
- Example:
 - `sudo cell_measurement -a serial=3133B4A -f 2685000000`

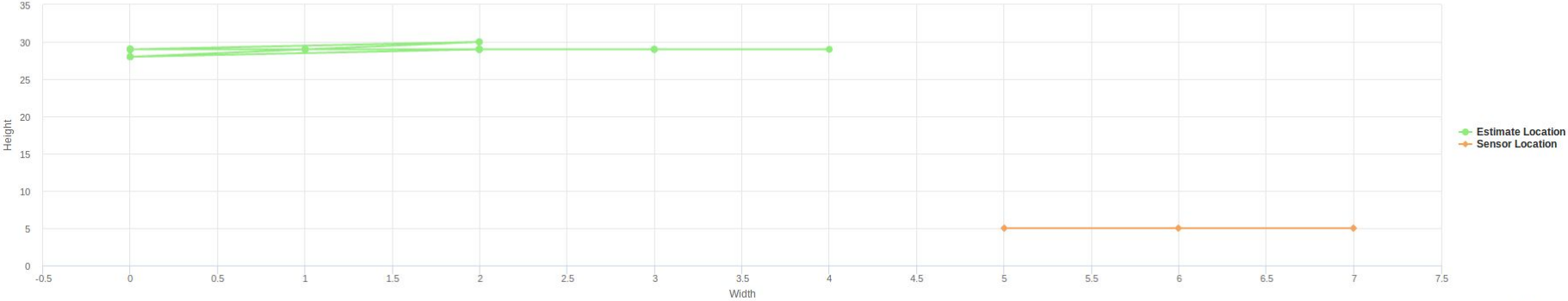
Grid Diagram

Select Channel Name: One

Submit



Real Time Position Tracking



Processing Overhead

Sensor Sensing (iteratively, for 3 sensors): 25-31s

Sensor Sleep Cycle: 45s

Position Estimate (MLE/MMSE/MEDE): 42-59s

MQTT Broker: <1s

Round Trip Time: 42-60s

Framework Accuracy

Localisation is relatively accurate

Average of 100 readings per sensor

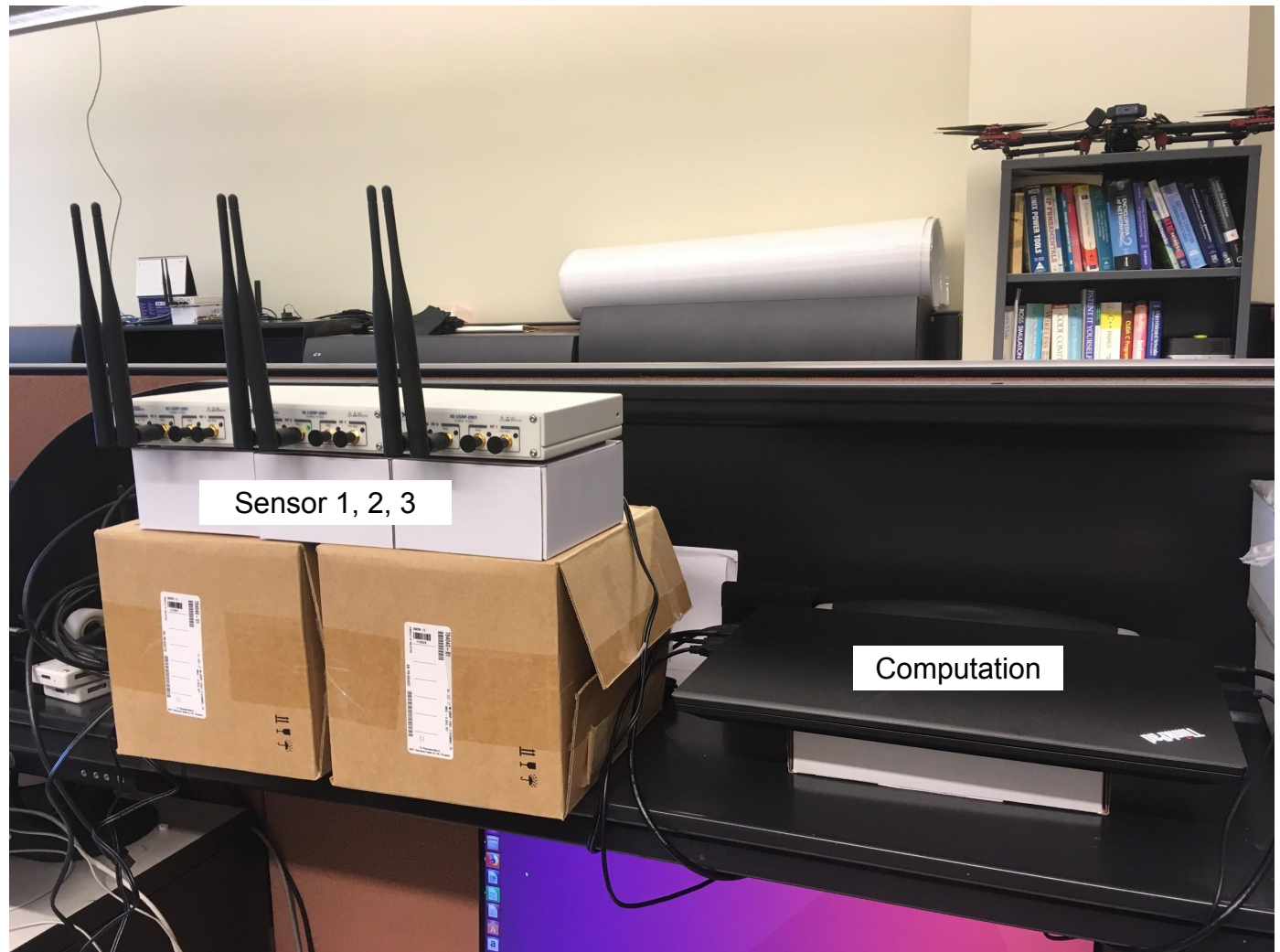
The direction of estimate position is accurate (NSEW)

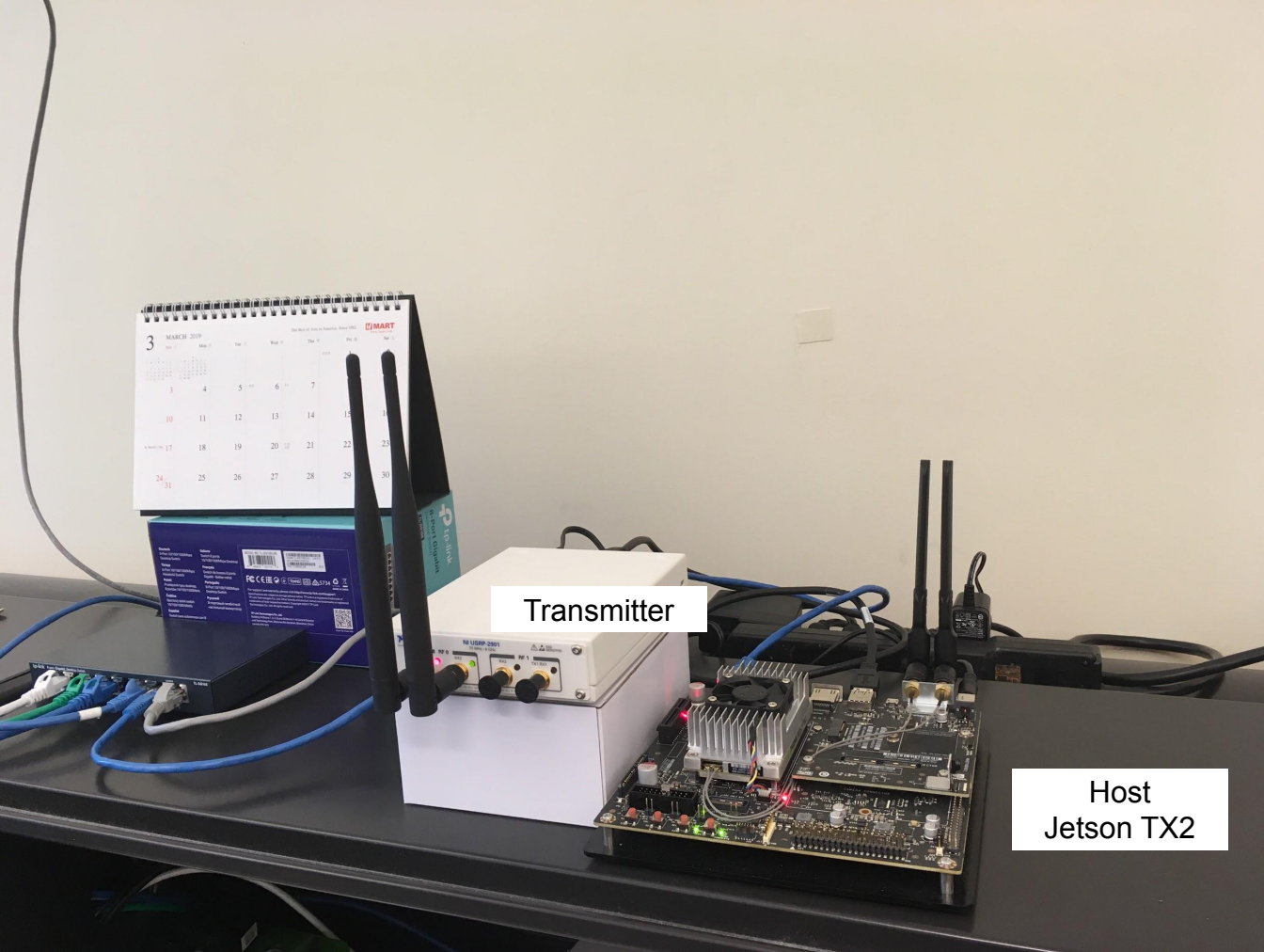
The distance of estimate depends on the position data provided

Currently position data are simulated

Position data can be used if GPS coordinates can be obtained

Pictures





Transmitter

Host
Jetson TX2

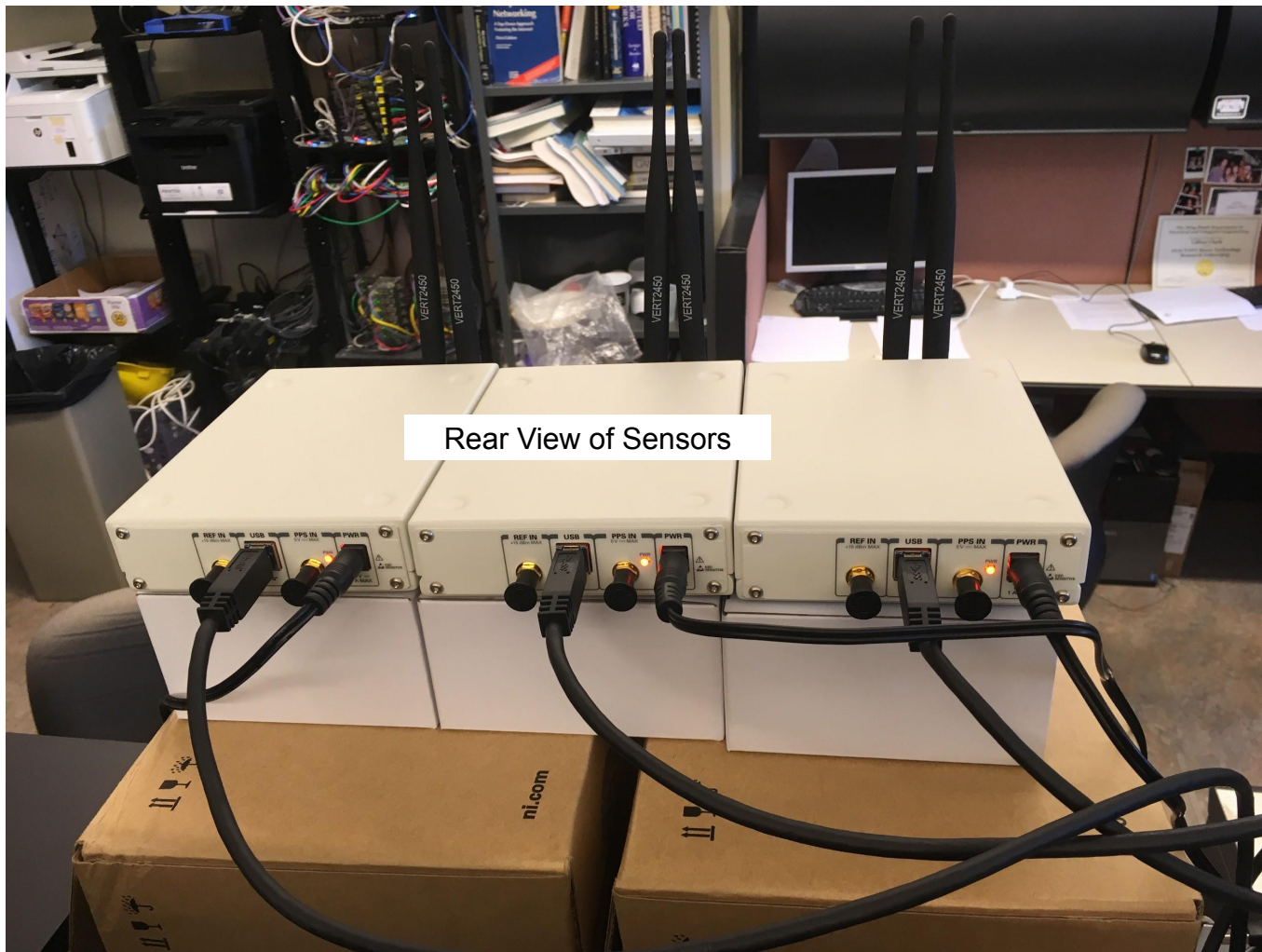


Transmitter

Sensor 1, 2, 3

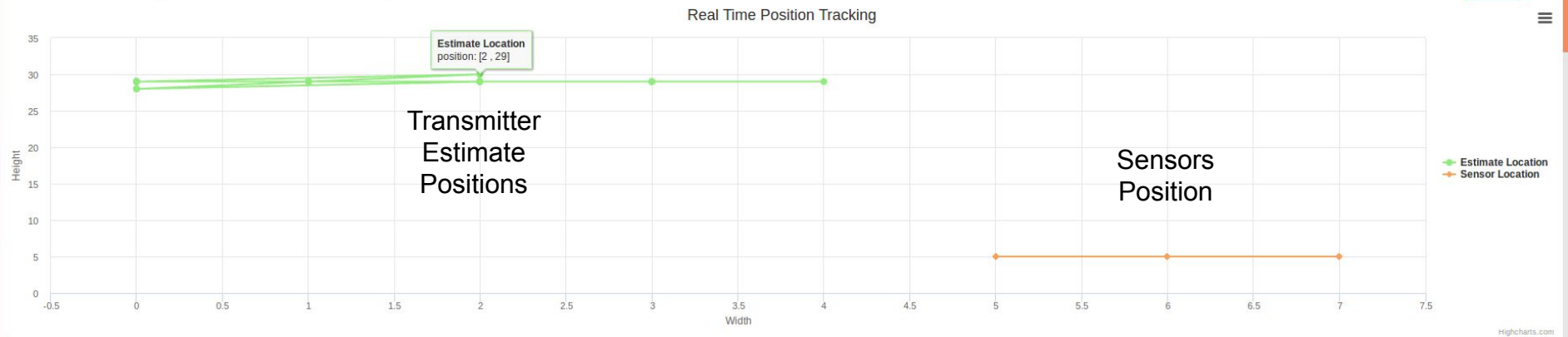
Computation

Rear View of Sensors



Select Channel Name: One

Submit



channel: one
position: 2 29
sensor location: 5 5
estimate time: 44 s
round trip delay: 44.174 s
channel: one
position: 0 29
sensor location: 6 5
estimate time: 42 s
round trip delay: 42.85 s
channel: one
position: 2 29
sensor location: 7 5
estimate time: 42 s
round trip delay: 42.943 s
channel: one
position: 0 28
sensor location: 5 5
estimate time: 43 s
round trip delay: 43.968 s

Sensor Measuring RSSI

```
Please wait.....
{'observation': [-123.4739999999995, -128.74600000000018, -125.83499999999984], 'Tx': [5, 6, 7], 'Ty': [5, 5, 5], 'timestamp': [1556675124.0], 'msg_id': 91, 'real_pos': (5, 5), 'ALG': 'MLE', 'channel': 'one'}
Sending PUBLISH (d0, q0, r0, m91), 'localization/observation', ... (209 bytes)
client publish obs: 91
cell_measurement: /usr/include/boost/thread/pthread/condition_variable.hpp:168: boost::condition_variable_any::~condition_variable_any(): Assertion `!pthread_mutex_destroy(&internal_mutex)' failed.
cell_measurement: /usr/include/boost/thread/pthread/condition_variable.hpp:168: boost::condition_variable_any::~condition_variable_any(): Assertion `!pthread_mutex_destroy(&internal_mutex)' failed.
cell_measurement: /usr/include/boost/thread/pthread/condition_variable.hpp:168: boost::condition_variable_any::~condition_variable_any(): Assertion `!pthread_mutex_destroy(&internal_mutex)' failed.
Please wait.....
{'observation': [-123.05400000000014, -128.73600000000005, -125.40599999999999], 'Tx': [5, 6, 7], 'Ty': [5, 5, 5], 'timestamp': [1556675195.0], 'msg_id': 92, 'real_pos': (6, 5), 'ALG': 'MLE', 'channel': 'one'}
Sending PUBLISH (d0, q0, r0, m92), 'localization/observation', ... (208 bytes)
client publish obs: 92
cell_measurement: /usr/include/boost/thread/pthread/condition_variable.hpp:168: boost::condition_variable_any::~condition_variable_any(): Assertion `!pthread_mutex_destroy(&internal_mutex)' failed.
cell_measurement: /usr/include/boost/thread/pthread/condition_variable.hpp:168: boost::condition_variable_any::~condition_variable_any(): Assertion `!pthread_mutex_destroy(&internal_mutex)' failed.
cell_measurement: /usr/include/boost/thread/pthread/condition_variable.hpp:168: boost::condition_variable_any::~condition_variable_any(): Assertion `!pthread_mutex_destroy(&internal_mutex)' failed.
Please wait.....
{'observation': [-122.86500000000012, -129.448, -125.75999999999988], 'Tx': [5, 6, 7], 'Ty': [5, 5, 5], 'timestamp': [1556675267.0], 'msg_id': 93, 'real_pos': (7, 5), 'ALG': 'MLE', 'channel': 'one'}
Sending PUBLISH (d0, q0, r0, m93), 'localization/observation', ... (198 bytes)
client publish obs: 93
cell_measurement: /usr/include/boost/thread/pthread/condition_variable.hpp:168: boost::condition_variable_any::~condition_variable_any(): Assertion `!pthread_mutex_destroy(&internal_mutex)' failed.
cell_measurement: /usr/include/boost/thread/pthread/condition_variable.hpp:168: boost::condition_variable_any::~condition_variable_any(): Assertion `!pthread_mutex_destroy(&internal_mutex)' failed.
cell_measurement: /usr/include/boost/thread/pthread/condition_variable.hpp:168: boost::condition_variable_any::~condition_variable_any(): Assertion `!pthread_mutex_destroy(&internal_mutex)' failed.
Please wait.....
{'observation': [-122.48800000000001, -129.71400000000008, -124.98999999999997], 'Tx': [5, 6, 7], 'Ty': [5, 5, 5], 'timestamp': [1556675339.0], 'msg_id': 94, 'real_pos': (5, 5), 'ALG': 'MLE', 'channel': 'one'}
Sending PUBLISH (d0, q0, r0, m94), 'localization/observation', ... (209 bytes)
client publish obs: 94
cell_measurement: /usr/include/boost/thread/pthread/condition_variable.hpp:168: boost::condition_variable_any::~condition_variable_any(): Assertion `!pthread_mutex_destroy(&internal_mutex)' failed.
cell_measurement: /usr/include/boost/thread/pthread/condition_variable.hpp:168: boost::condition_variable_any::~condition_variable_any(): Assertion `!pthread_mutex_destroy(&internal_mutex)' failed.
cell_measurement: /usr/include/boost/thread/pthread/condition_variable.hpp:168: boost::condition_variable_any::~condition_variable_any(): Assertion `!pthread_mutex_destroy(&internal_mutex)' failed.
Please wait.....
{'observation': [-122.68300000000005, -128.71699999999998, -124.89899999999983], 'Tx': [5, 6, 7], 'Ty': [5, 5, 5], 'timestamp': [1556675411.0], 'msg_id': 95, 'real_pos': (6, 5), 'ALG': 'MLE', 'channel': 'one'}
Sending PUBLISH (d0, q0, r0, m95), 'localization/observation', ... (209 bytes)
client publish obs: 95
cell_measurement: /usr/include/boost/thread/pthread/condition_variable.hpp:168: boost::condition_variable_any::~condition_variable_any(): Assertion `!pthread_mutex_destroy(&internal_mutex)' failed.
cell_measurement: /usr/include/boost/thread/pthread/condition_variable.hpp:168: boost::condition_variable_any::~condition_variable_any(): Assertion `!pthread_mutex_destroy(&internal_mutex)' failed.
Please wait....cell_measurement: /usr/include/boost/thread/pthread/condition_variable.hpp:168: Boost::condition_variable_any::~condition_variable_any(): Assertion `!pthread_mutex_destroy(&internal_mutex)' failed.
.....
{'observation': [-122.02700000000009, -129.53900000000004, -126.61499999999997], 'Tx': [5, 6, 7], 'Ty': [5, 5, 5], 'timestamp': [1556675483.0], 'msg_id': 96, 'real_pos': (7, 5), 'ALG': 'MLE', 'channel': 'one'}
Sending PUBLISH (d0, q0, r0, m96), 'localization/observation', ... (209 bytes)
client publish obs: 96
cell_measurement: /usr/include/boost/thread/pthread/condition_variable.hpp:168: boost::condition_variable_any::~condition_variable_any(): Assertion `!pthread_mutex_destroy(&internal_mutex)' failed.
cell_measurement: /usr/include/boost/thread/pthread/condition_variable.hpp:168: boost::condition_variable_any::~condition_variable_any(): Assertion `!pthread_mutex_destroy(&internal_mutex)' failed.
cell_measurement: /usr/include/boost/thread/pthread/condition_variable.hpp:168: boost::condition_variable_any::~condition_variable_any(): Assertion `!pthread_mutex_destroy(&internal_mutex)' failed.
Please wait.....
```

Estimate Location Computation

```
estimate start
[0, 29]
time elapsed: 48.7641170025
server publish result: 88
estimate start
[1, 29]
time elapsed: 49.8209650517
server publish result: 89
estimate start
[0, 29]
time elapsed: 51.6832499504
server publish result: 90
estimate start
[0, 29]
time elapsed: 49.6574218273
server publish result: 91
estimate start
[0, 29]
time elapsed: 46.7378940582
server publish result: 92
estimate start
[1, 29]
time elapsed: 49.3101480007
server publish result: 93
estimate start
[0, 29]
time elapsed: 50.4537739754
server publish result: 94
estimate start
[1, 29]
time elapsed: 50.0230529308
server publish result: 95
estimate start
[2, 29]
time elapsed: 49.7115688324
server publish result: 96
estimate start
[0, 29]
time elapsed: 50.1365120411
server publish result: 97
estimate start
[2, 29]
time elapsed: 49.4846029282
server publish result: 98
█
```


How to Run

Transmitter (running in Nvidia)

- `sudo srsepc epc.conf`
- **`sudo srse nb.enb.conf.example`**

Sensor: (in the laptop)

- `python /mqtt-server/mqtt-server.py`
- `lcn-server/ npm start`
- `lcn-client/ npm start`
- `sudo python /mqtt-client/mqtt-client.py (MLE|MMSE|MEDE)`

Update corresponding sensor serial and positions in `sensor.py` if changes made