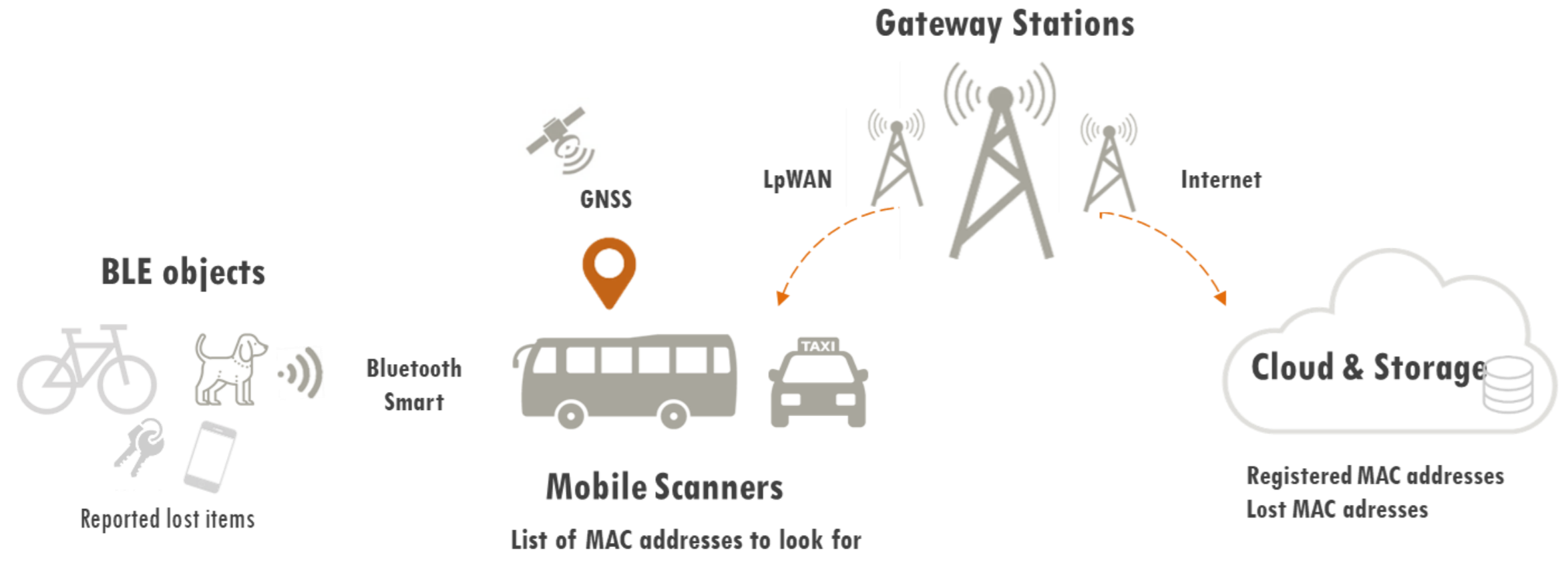


## GOALS

**CityScan** is a cost-efficient multipurpose mobile sensing platform to address the problem of valuable portable items being lost or stolen in the urban environment



## CHALLENGES

### BLE Discovery

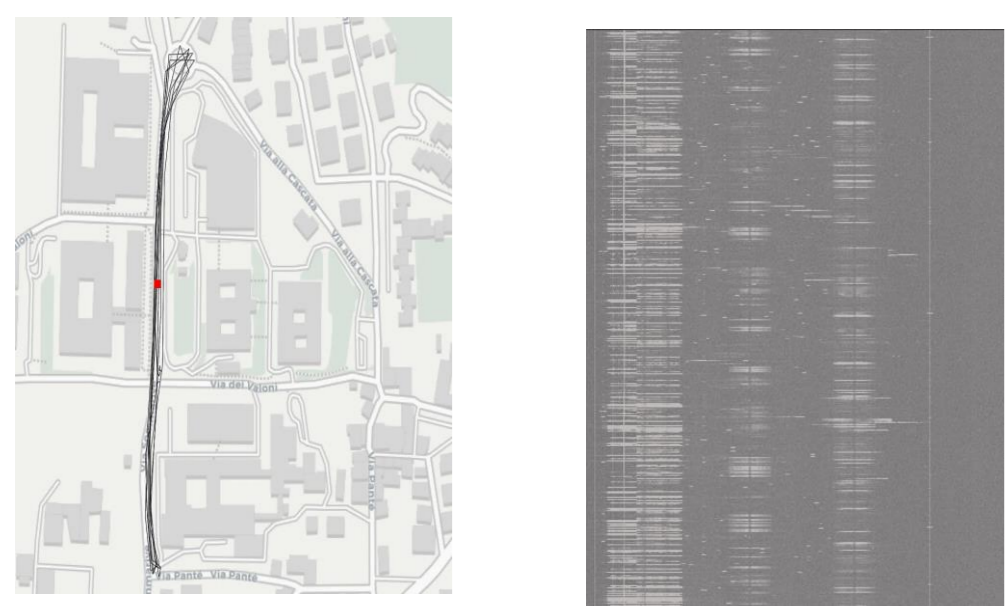
- Enable fast discovery of stolen objects in a crowded city environment
- Select optimal scanning duty cycle parameters

### LpWAN communication

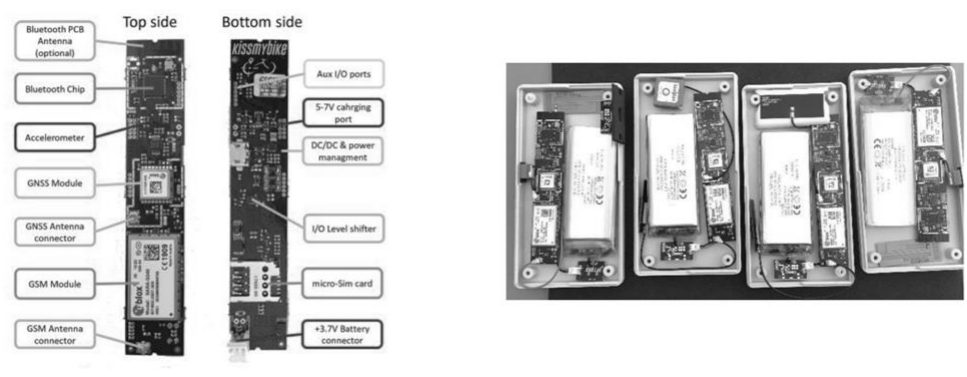
- Select an optimal communication solution that can deliver required data rate in a real-world urban scenario
- Optimize network range and communication reliability

## DEMO SETUP

### BLE Discovery

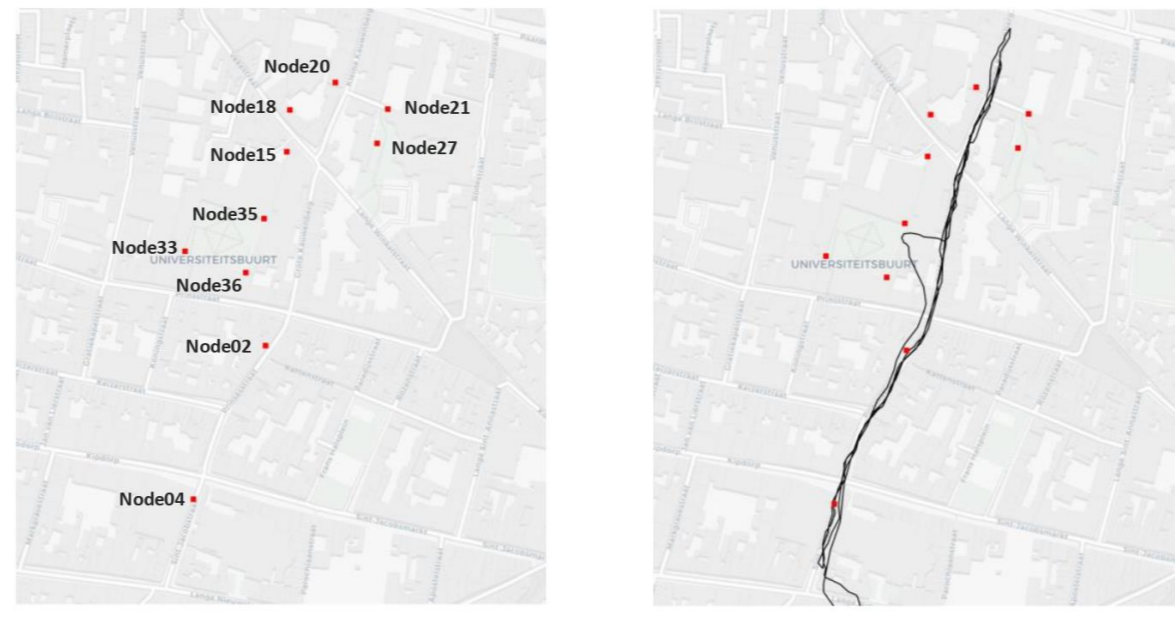


	scanWindow (ms)	scanInterval (ms)
Setting1	16	16
Setting2	48	64
Setting3	80	80
Setting4	160	160
Setting5	240	240
Setting6	320	320

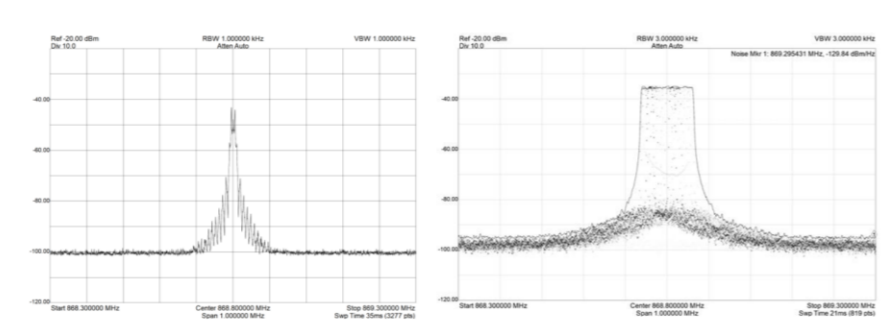


KMB devices Mobile Scanners

### LpWAN



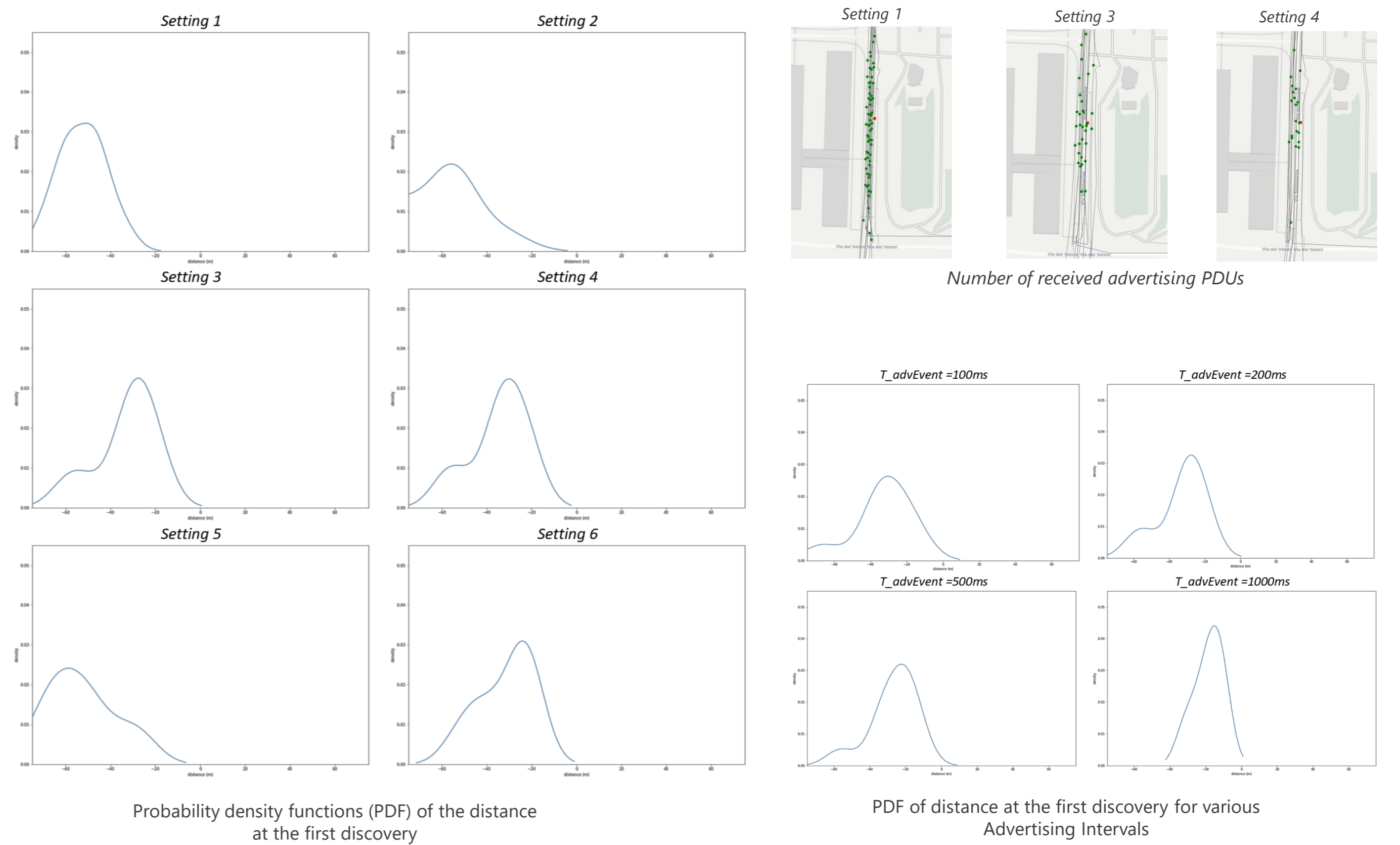
Parameter	Setting 1	Setting 2	Setting 3	Setting 4
Modulation	LoRa, SF12	LoRa, SF9	LoRa, SF7	2-FSK
Bandwidth	125KHz	125KHz	125KHz	200KHz
Output power	14 dBm	14 dBm	14 dBm	14 dBm
Channel	G3 869.5MHz	G3 869.5MHz	G3 869.5MHz	G3 869.5MHz
Preamble	8	8	8	8
Payload	54 Bytes	54 Bytes	54 Bytes	54 Bytes
Code Rate	4/5	4/5	4/5	5
Bit rate	292 bps	1750 bps	5470 bps	9600 bps
Time on air	2438 ms	428 ms	102 ms	56 ms
Symbol time	32 ms	4.6 ms	1.4 ms	0.8 ms
Sensitivity	-137 dBm	-130dBm	-124 dBm	-105 dBm



Narrowband 2-FSK 20KHz and LoRa 125KHz

## RESULTS

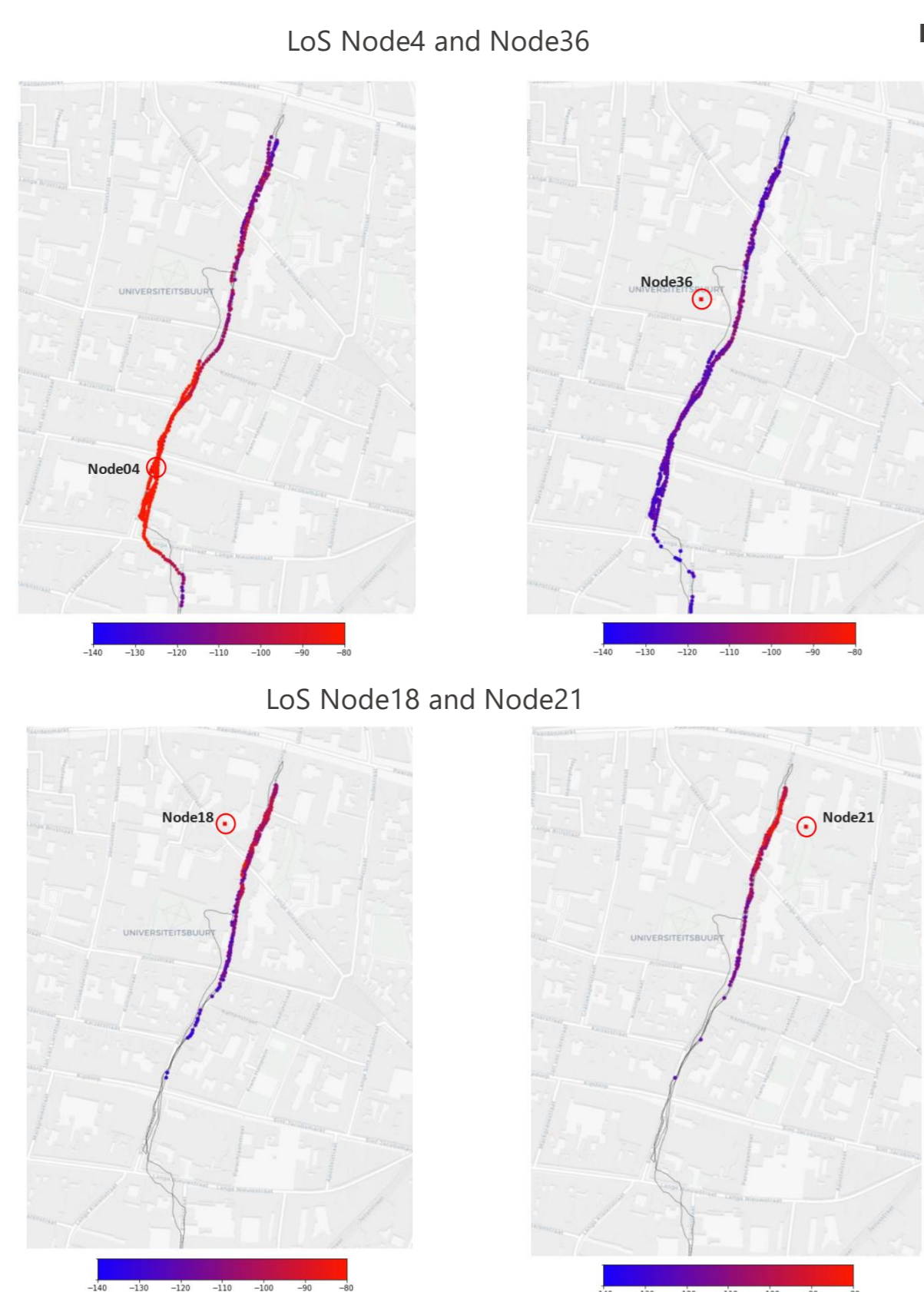
### BLE Discovery



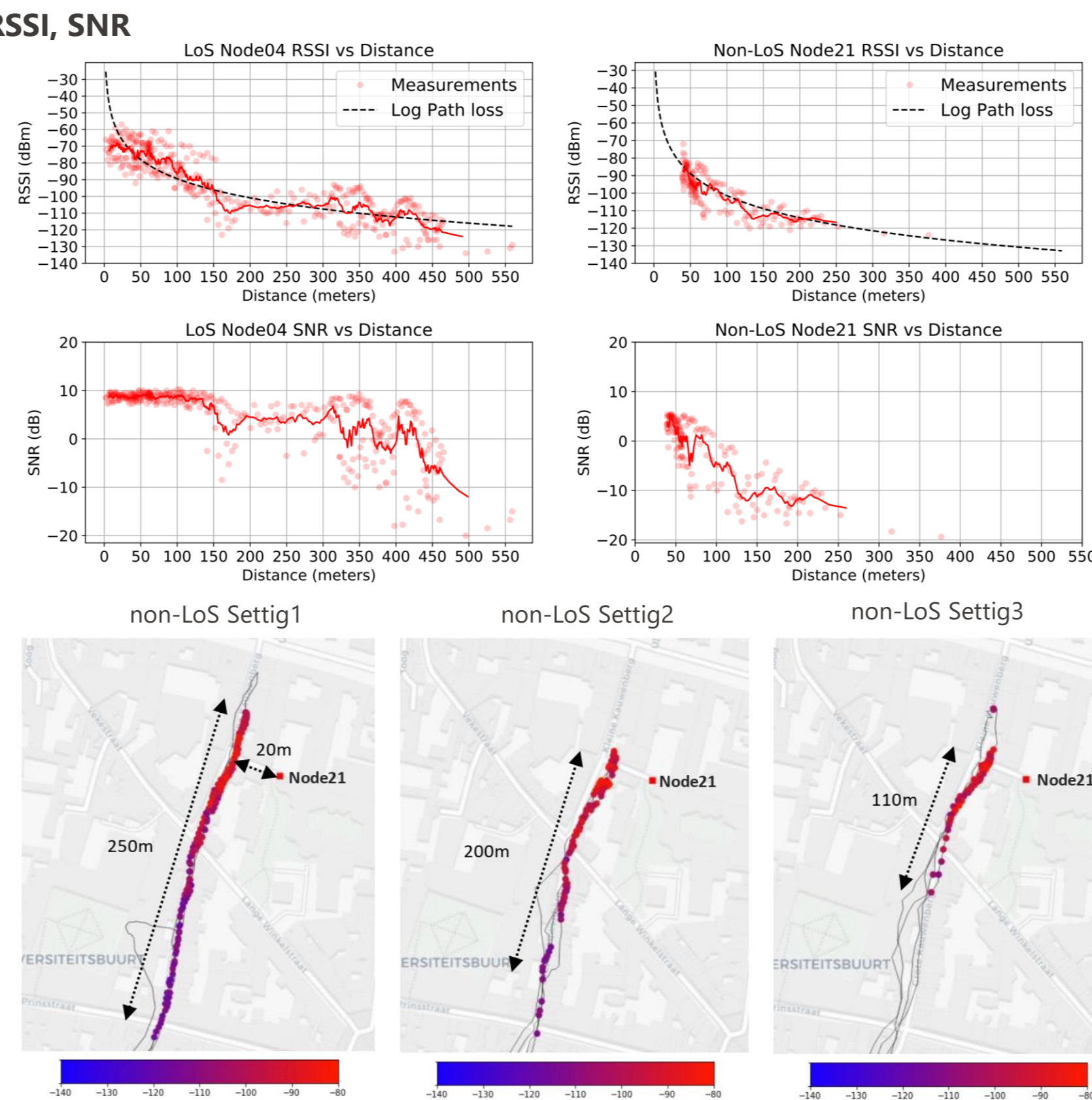
## MORE RESULTS

### Sub-1 GHz

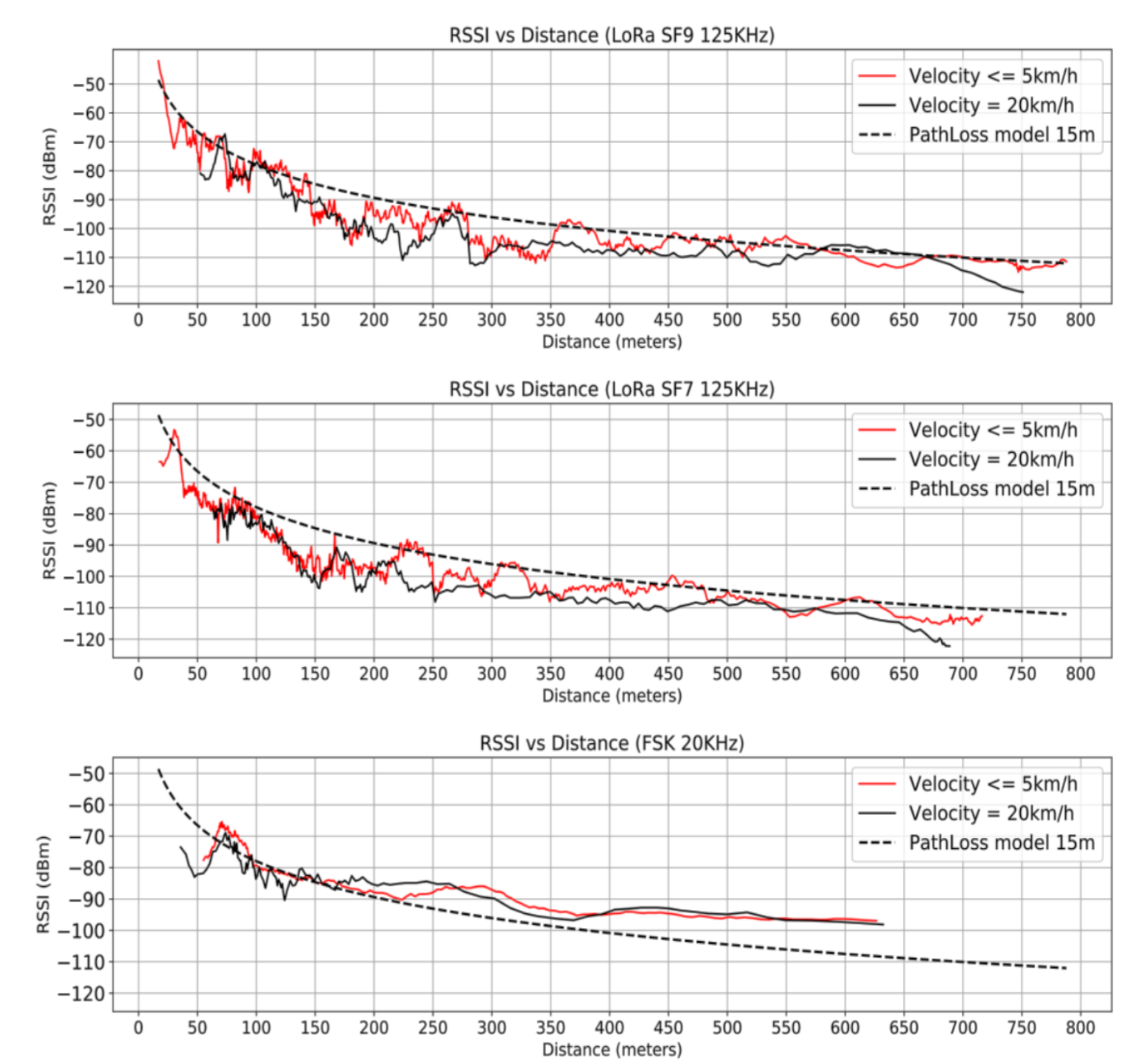
#### LpWAN



#### LoS vs non-LoS nodes: range, pathloss, RSSI, SNR



#### Extended Fresnel zone (15m vs 5m) improved range 30%



## CONCLUSIONS

- None of the Gateways provided 1km range with PDR > 80%
- Difference in LoS and non-LoS cases is up to 60-70%
- Low-rate settings are not suitable due to EU duty cycle limits
- 15- vs 5- m gateway installation provides 30% improvement
- LoS and clear Fresnel zone are essential
- Delivery control to improve PDR and range
- SF7 and FSK are the optimal options to meet EU regulations
- No communication degradation at velocities <= 30km/h

## POST MORTEM

- Scalability testing
- Explore narrowband technologies below 10KHz BW
- Explore LpWAN alternatives e.g. Nb-IoT
- Integrate HW components
- Pilot & Real feedback