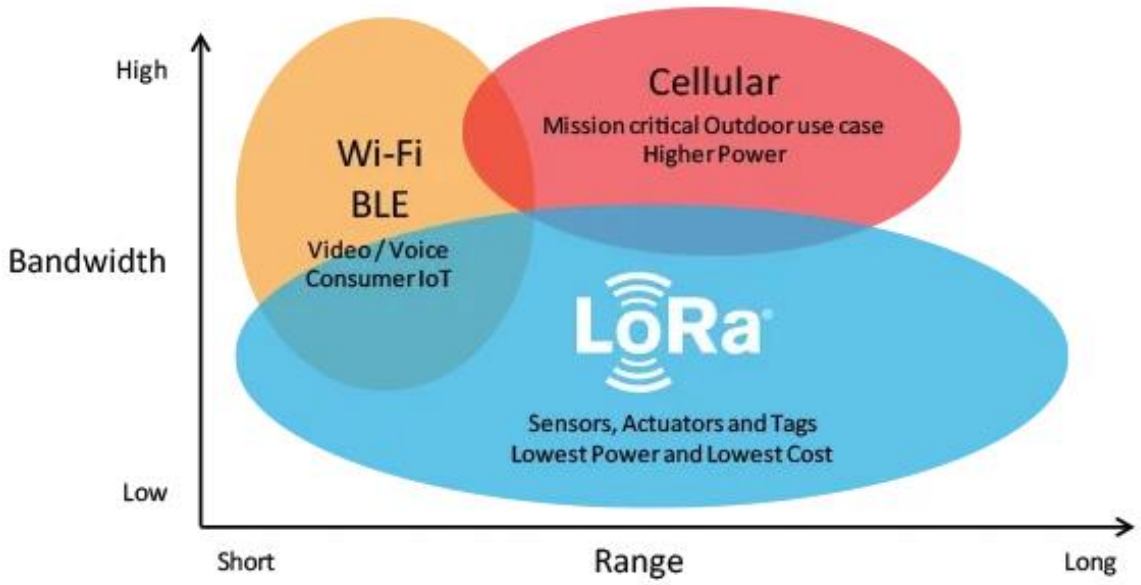
1. Connectivity

First and foremost, we need to finalize a connectivity mechanism for our sensor deployments in the city. I've found a diagram that helps us understanding what type of connectivity exists and is best suited for what use cases.

Few points to consider here are what type of visibility is required in such solutions. Networks can be private (owned by user) or public (owned by enterprise and available to use as a service)

	Network Type	
	Public	**Private**
1.	Zigbee	NB-IoT
2.	Bluetooth	Sigfox
3.	WiFi	LTE-M
4.	LoraWan	

Next chart will show how these network types are compared against bandwidth and range parameters across connectivity possibilities.



And I have gathered few more characteristics to compare our options here and have chosen **LORAWAN** as the preferred technology for such use cases based on latency and availability worldwide. Full reference is available at URL.

On next page, I will compare few more network types against wider parameters.

Network:	Sigfox	LoRa	NB-IoT (Cat NB1)	LTE-M (Cat M1)
Type:	PLWAN	PLWAN	DSSS modulation	LTE (cellular)
Low Power:	+++++	++++	++++	+++
Throughput Kbit/s:	0,1	50	100	375
Bandwidth:	Ultra-narrowband	Narrowband	Narrowband	Low
Latency:	1 – 30s	Based on profile	1.6 – 10s	10 – 15ms
Standard:	Proprietary	Proprietary	3GPP Rel. 13	3GPP Rel. 13
Availability world-wide:	++	+++	++	++
Spectrum:	Unlicensed ISM	Unlicensed ISM	Licensed LTE	Licensed LTE
Complexity:	Very low	Low	Very low	Low / medium
Coverage / range:	Medium / high	Medium / high	High	High
Battery life:	Very high	Very high / high	High	Medium / high
Gateway needed:	Yes	Yes	No, but optional	Optional
Signal penetration:	High	Medium / high	Medium / high	Medium / high
Security:	+++	+++	+++	+++++
Future proof:	+++	+++	+++++	+++++

2. Sensor

As by now we have figured out connectivity options, next stage in solutioning is to identify sensor type, I've short listed following sensors:

	Sensor Type	URL	Network	Comments
1.	Bosch	URL	LoRaWAN	
2.	Nwave	URL		
3.	Libelium	URL		Chosen as **preferred sensor** • IP68 (more dust and water resistant) and IK10 (much more resilient) • Less maintenance headache • Planted in multiple ways under the road, half buried and on the road. • OTA management

3. Data Model

Parking data is maintained inside a NO-SQL database as per the following structure, our solution will transform the data into a structure so it can be retrieved

A. Area

This could be either a street, restaurant parking, building basement or any logical group of location.

https://github.com/qazimobeen/smartparking/blob/master/IoT.Smart.Parking/ParkingArea.json

B. Location

This is a parking spot available at an area defined above, and this structure maintains parking availability of a location within an area.

https://github.com/qazimobeen/smartparking/blob/master/IoT.Smart.Parking/ParkingLocation.json

4. APIs

Swagger files are available at URL

https://github.com/qazimobeen/smartparking/tree/master/IoT.Smart.Parking/IoT.Smart.Parking/bin/Debug/net5.0

5. Security