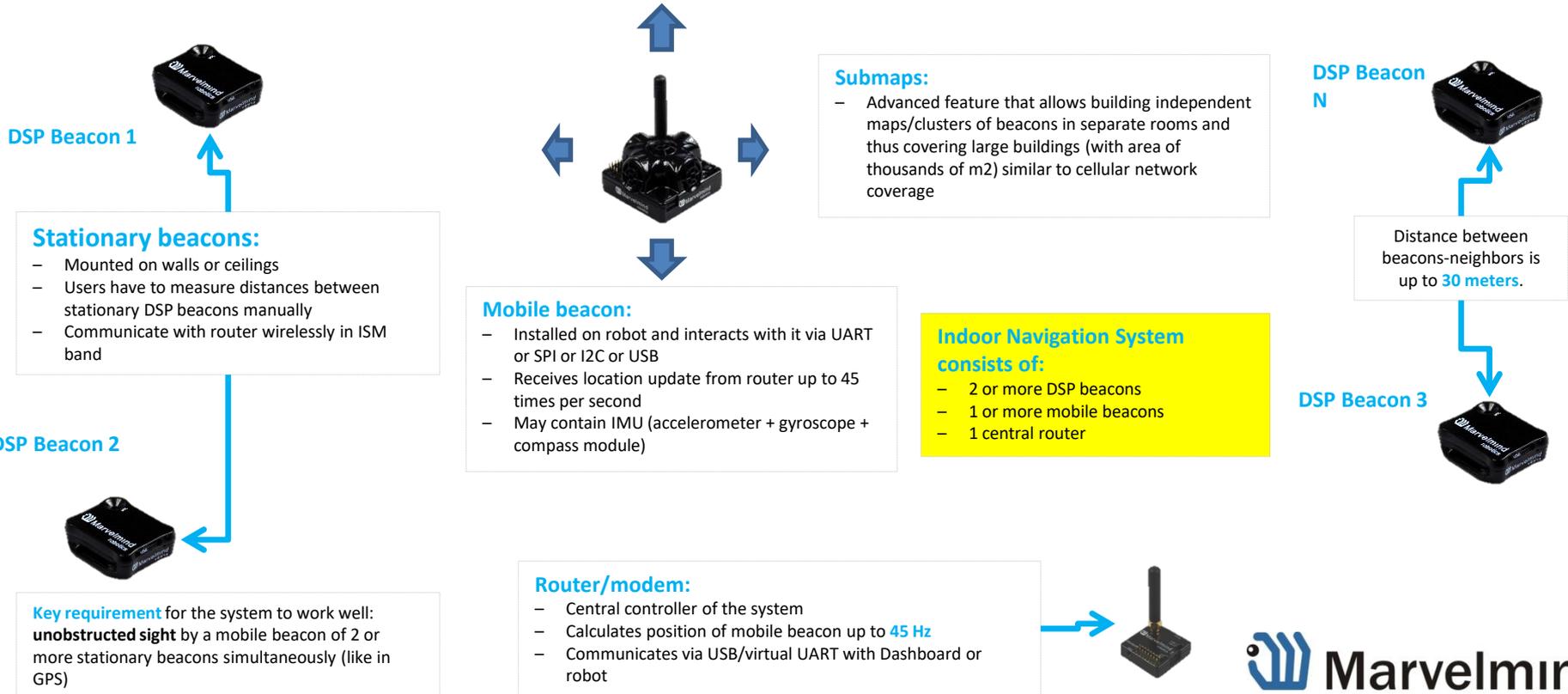


Non-Inverse Architecture (NIA)



Inverse Architecture (IA)



Beacon 1 (19KHz)

Stationary beacons:

- Mounted on walls or ceilings
- In inverse system beacons belonging to the same submap should have different ultrasound frequencies (19 & 25kHz or 25 & 31 kHz, for example)
- Communicate with router wirelessly in ISM band

Beacon 2 (25KHz)



Key requirement for the system to work:
unobstructed line of hearing/sight by a mobile beacon to 2 or more stationary beacons simultaneously (like in GPS)



Mobile DSP beacon(s):

- Installed on robot (human) and interacts with it via virtual UART over USB
- Contains 3D IMU (accelerometer+gyroscope)
- Beacon's update rate doesn't directly depend on the number of mobile beacons unlike in Non-Inverse Architecture
- Calculates its location by itself – not by modem
- Recommended distance from mobile beacon to stationary ones up to 30m

Router/modem:

- Central controller of the system
- Communicates via USB/virtual UART with Dashboard or robot
- Get location data from Mobile DSP beacons
- Supports up to 250 beacons

Submaps:

- Advanced feature that allows building independent maps/clusters of beacons in separate rooms and thus covering large buildings (with area of thousands of m2) similar to cellular network coverage
- In Inverse Architecture every submap must have beacons with non-repeating ultrasound frequency
- Available frequencies: 19, 25, 31, 37, 45, 56 KHz

Indoor Navigation System consists of:

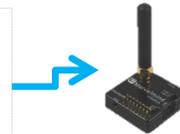
- 2 or more stationary beacons
- 1 or more DSP beacons
- 1 central router

Beacon N (19, 25, 31, 37, 45, 56 KHz)



Distance between beacons-neighbors is up to **30 meters**.

Beacon 3 (31KHz)



Architectures comparison

Version 2018_11_19

	Non-Inverse (NIA)	Inverse (IA)
Typical usage	<ul style="list-style-type: none">- 1-4 autonomous robots/drones - supports up to 250 beacons- When mobile beacon shall be installed on a noisy vehicle, but stationary beacons are in relatively quieter places	<ul style="list-style-type: none">- Many mobile users (people, robots, VR) - supports up to 250 beacons- When mobile beacons are in quieter places
Not recommended	<ul style="list-style-type: none">- In applications, where emitting ultrasound of mobile beacon is undesirable	<ul style="list-style-type: none">- For drones – because mobile beacon is receiving. The range may be limited to just 2-5m. May be improved with future SW releases
Precision	<ul style="list-style-type: none">- ± 2cm or better with more averaging	<ul style="list-style-type: none">- Targeted - ± 2cm- It will be on par with Non-Inverse Architecture, eventually. Currently, Non-Inverse SW is more polished, more stable and shows better precision than the Inverse one
Update rate	<ul style="list-style-type: none">- Depends on the number of mobile beacons (n) as $1/n$ –TDMA is used- Slightly depends on the radio protocol- Depends on the sizes of submaps- IMU fusion is HW and SW supported	<ul style="list-style-type: none">- Does not depend on the number of mobile beacons, because they are receiving- Slightly depends on the radio protocol (the same as NIA)- Depends on the sizes of submaps (the same as NIA)- IMU fusion is HW supported. SW support is coming
Range	<ul style="list-style-type: none">- Can cover as large territory as you wish using submaps- Up to 30m in real life and up to 50m in lab conditions within a submap, i.e. stationary beacons shall be placed every 30m or closer	
Map building	<ul style="list-style-type: none">- Can build a map automatically, if HW v4.9 beacons are used. Mini-beacons cannot build the map, because they are TX-only	<ul style="list-style-type: none">- Manual entry of stationary beacons' location or distances between them is required