Precise (±2cm) Indoor Positioning System

Placement Manual

v2023_07_07

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Version changes

2023_07_07_v1.2:
- Minor improvements

2023_07_03_v1.1:
- Split-Modem Architecture added
- Multi-Modem Architecture updated
- Minor improvements

2022_04_04_v1:
- Links added to Description
- All links updated to relevant
- Starter-Set photo changed
- All cases updated from Starter Set HW v4.9 to Starter Set Super-MP-3D
- 2D installation for Starter Set-Super-MP-3D added
- Starter Set Super-MP-3D – simple 3D installation added
- Mini-RX Starter Set – simple 3D installation – removed (product is out of production)
- Autonomous inspection drone (IA, 2D, TDMA, Vertical-XZ) slide – temporary removed

2020_07_13_v0.09: Renamed “Room with columns (IA, 2D, TDMA)” -> “Full overlapping submaps (IA, 2D, TDMA)”
2019_08_15_v0.08: Added slides Tunnel 1200x25m, autonomous inspection (NIA, 2D)
2019_07_15_v0.07: Added slides Room with columns (IA, 2D, TDMA), Rooms + corridor (IA, 2D, TDMA), Rooms with columns + corridor (IA, 2D, TDMA), Autonomous inspection drone (IA, 2D, TDMA, Vertical-XZ)
2018_11_07_v0.06: Added slide Real-time tracking: reducing the delay
2018_10_03_v0.05: Added slide Steps beyond default settings
2018_06_25_v0.04: Added slide set Area of 100x100m with tracking using submaps
2018_06_25_v0.04: Added slide set Long distance tracking – 30x30m area
2018_06_19_v0.03: Added case Multi-modem 1.5D – tracking vehicles underground
2018_06_07_v0.02: Added case Business center
2018_05_30_v0.01: Initial release

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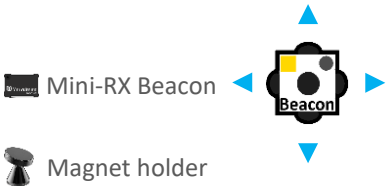
Description

The manual gives practical advices and examples of how to mount the Precise (±2cm) Indoor Positioning System to achieve the best performance in different applications and configurations

Before first start, check: 8 basic steps from unpacking to autonomous drive/flight
To learn more about indoor positioning systems, check: How indoor positioning systems work

Contents

Conventions:



Mini-RX Beacon

Magnet holder

Mobile Beacon

Stationary Beacon

Modem HW5.1

Submap/zone

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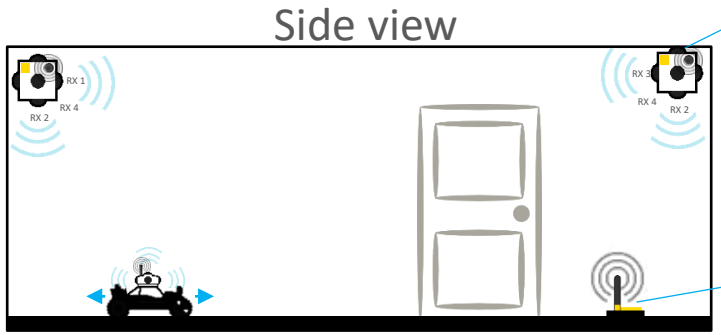
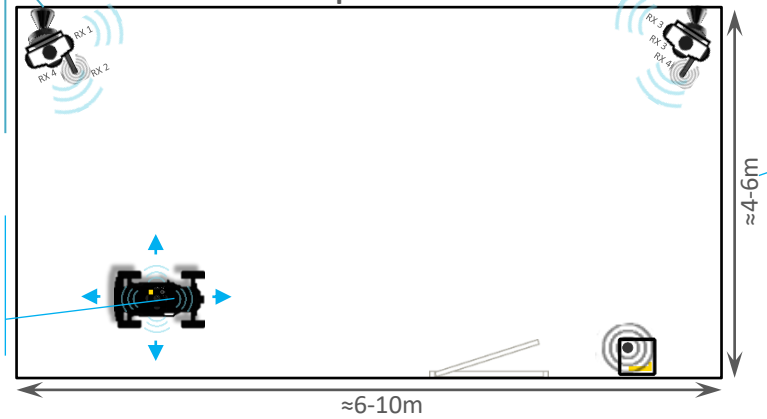
01a: Simple 2D Tracking – for example, RC car indoor



Stationary Super-Beacon
- Shall be placed on a special magnet holder that rotated from the wall by 45 degrees to minimize shadows in ultrasonic coverage.
- Enable only required sensors – to improve sensitivity and external noise immunity. Each sensor has ~90deg beam

Modem HW v5.1
- Must be always powered, when tracking is needed
- May be placed up to tens to hundreds meters away from beacons depending on the resulting RSSI



Magnet holder
Rotated 45 degrees from the wall

Mobile Super-Beacon
- Placed on a forklift/robot, person

Room
- Start with a midsize map of 6x4 to 6-10m or so
- Maximum size of the map for Starter Set is up to 1000m²

Configuration:

- Starter Set Super-MP-3D:
  - 2 x stationary Super-Beacon with different frequencies out of 8 (19kHz, 22kHz, 25kHz, 28kHz, 31kHz, 34kHz, 37kHz, 45kHz)
  - 1 x mobile Super-Beacon
  - 1 x Modem HW v5.1

Notes:

- Designed for 2D tracking (X,Y)
  - One RC car in room
  - One-wheeled robot
  - One person
- Not suitable for drones – 3D (X,Y,Z) tracking is required

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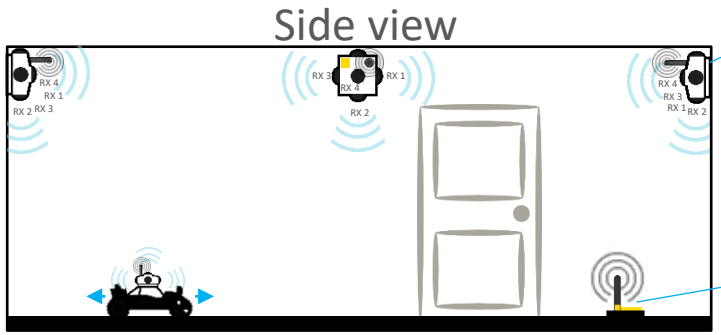
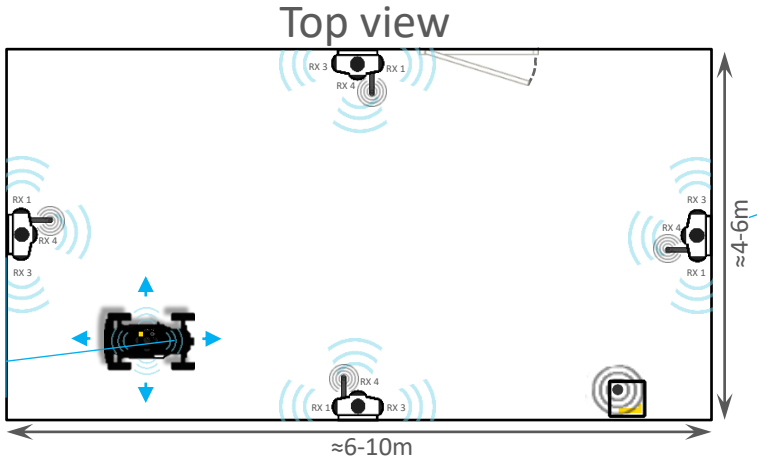
01b: Starter Set Super-MP-3D – simple 3D installation



Stationary Super-Beacon
- Shall be placed on walls or ceiling – to minimize shadows in ultrasonic coverage
- Enable only required sensors – to improve sensitivity and external noise immunity. Each sensor has ~90deg beam

Modem HW v5.1
- Must be always powered, when tracking is needed
- May be placed up to tens to hundreds meters away from beacons depending on the resulting RSSI



Mobile Super-Beacon
- Placed on a forklift/robot, person

Room
- Start with a midsize map of 6x4 to 6-10m or so
- Maximum size of the map for Starter Set is up to 1000m²

Configuration:

- Starter Set Super-MP-3D :
  - 4 x stationary Super-Beacon with different frequencies out of 8 (19kHz, 22kHz, 25kHz, 28kHz, 31kHz, 34kHz, 37kHz, 45kHz)
  - 1 x mobile Super-Beacon
  - 1 x Modem HW v5.1

Notes:

- Supports 3D (X,Y,Z) + 1 redundancy
- Designed for fast evaluation of the Precise (±2cm) Indoor "GPS" with IMU:
  - Drones
  - VR helmets
  - Systems requiring either fast update rate or working challenging environment, when ultrasonic-based navigation must be verified with IMU based navigation
  - IMU+ultrasonic sensor fusion => can support up to 100Hz update rate
  - Useful for additional filtering of location jumps in challenging environment
  - When IMU is needed overall

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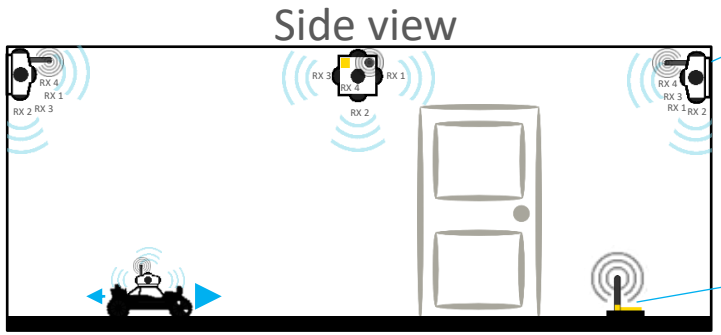
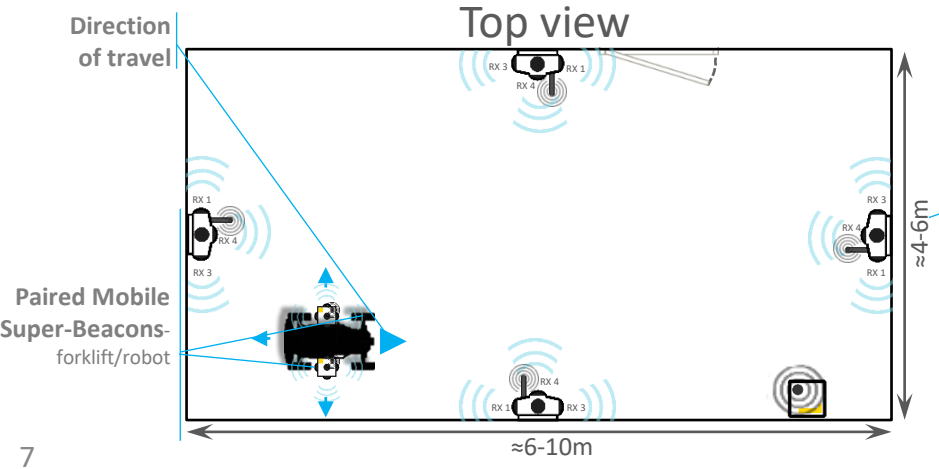
02: Paired beacons – location + direction



Stationary Super-Beacon
- Shall be placed on walls or ceiling – to minimize shadows in ultrasonic coverage
- Enable only required sensors – to improve sensitivity and external noise immunity. Each sensor has ~90deg beam

Modem HW v5.1
- Must be always powered, when tracking is needed
- May be placed up to tens to hundreds meters away from beacons depending on the resulting RSSI



Room
- Start with a midsize map of 6x4 to 6-10m or so
- Maximum size of the map for Starter Set is up to 1000m²

Configuration:

- Starter Set Super-MP-3D + Mobile Super-Beacon:
  - 4 x stationary Super-Beacon with different frequencies out of 8 (19kHz, 22kHz, 25kHz, 28kHz, 31kHz, 34kHz, 37kHz, 45kHz)
  - 2 x mobile Super-Beacon
  - 1 x Modem HW v5.1

Notes:

- Designed for the cases, when not only location, like in a regular GPS, but also a direction is required
- Uses paired mobile beacons install on the robot/drone and doesn't rely on compass that may give indoor with much metal around wrong results
- The larger base between the mobile beacons, the more precise direction can be achieved. Reasonable directional precision with the base >20cm. Strongly recommended – 0.5m or more
- Demo video on setting up the feature
- To learn more about direction/orientation, check: IMU

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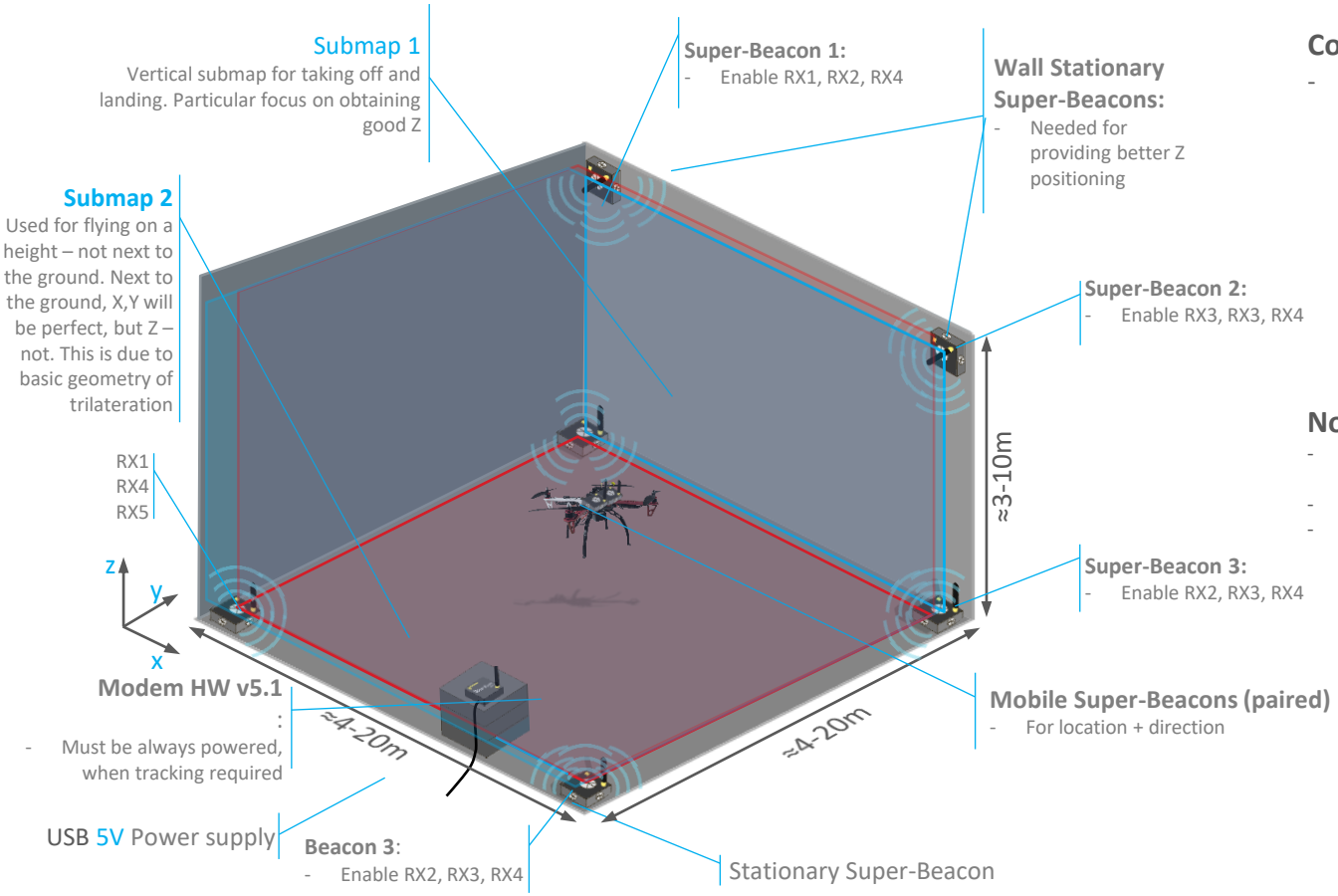
03: Stable “Z” for drone – settings and recommendations



Configuration:

- Starter Set Super-MP-3D + Super-Beacon:
  - 6 x stationary Super-Beacon
  - 1 x mobile Super-Beacon
    (Or 2 mobile Super-Beacons to support Paired Beacon feature – you’ll get location + direction)
  - 1 x Modem HW v5.1

Notes:

- Designed for flying autonomous drones indoor and good Z tracking on all heights
- Supports 3D (X,Y,Z) + N redundancy
- Detailed video help: Help: Z-coordinates for copters

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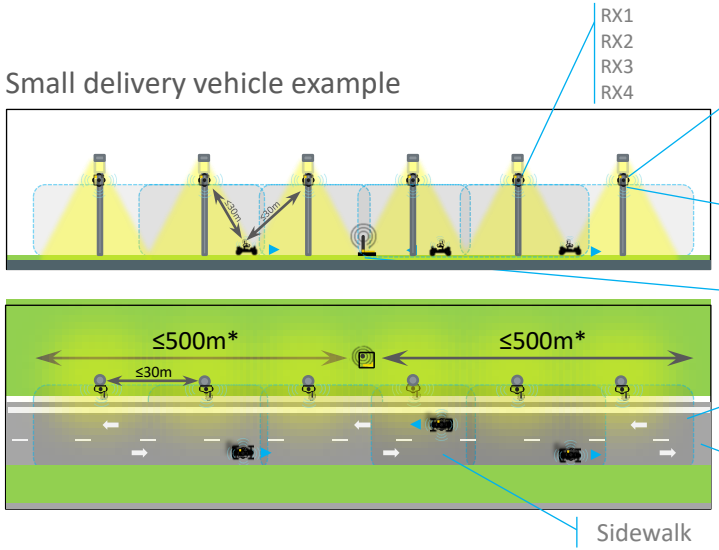
04: Tracking sidewalks, tunnels, metros, mines in 2D

Small delivery vehicle example



Stationary Super-Beacon
- Shall be placed high on lamp poles – to minimize shadows in ultrasonic
- Enable only required sensors – to improve sensitivity and external noise immunity

Light pole

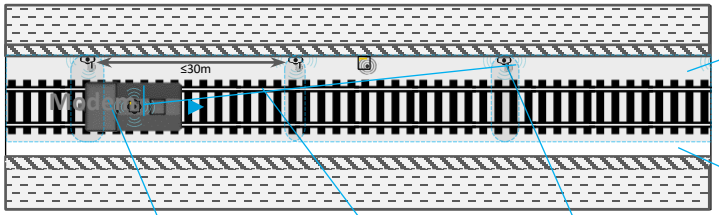
Modem HW v5.1
- Must be always powered, when tracking is needed
- May be placed up to tens to hundreds meters away from beacons

Slightly overlapping submaps

Sidewalk area

Sidewalk

Underground railway transport example



Submap

Tunnel (Underground, mine, etc.)

Train/Trolley

Mobile Super-Beacon

Stationary Super-Beacon

Configuration:

- Starter Set Super-MP-3D + N Super-Beacon:
  - N x stationary Super-Beacon
  - N x mobile Super-Beacon
  - 1 x Modem HW v5.1

Notes:

- Outdoor cases: Park, parking lot, railway
- Indoor cases: Subway, tunnel, long warehouse
- 2D tracking (linear placement)
- Check Help: Microphone diagram video

- Radio limited up to 400m with a full size antenna and up to 1km with special direction antenna in each direction(2km of open space)
- Can be further extended in Multi-modem systems

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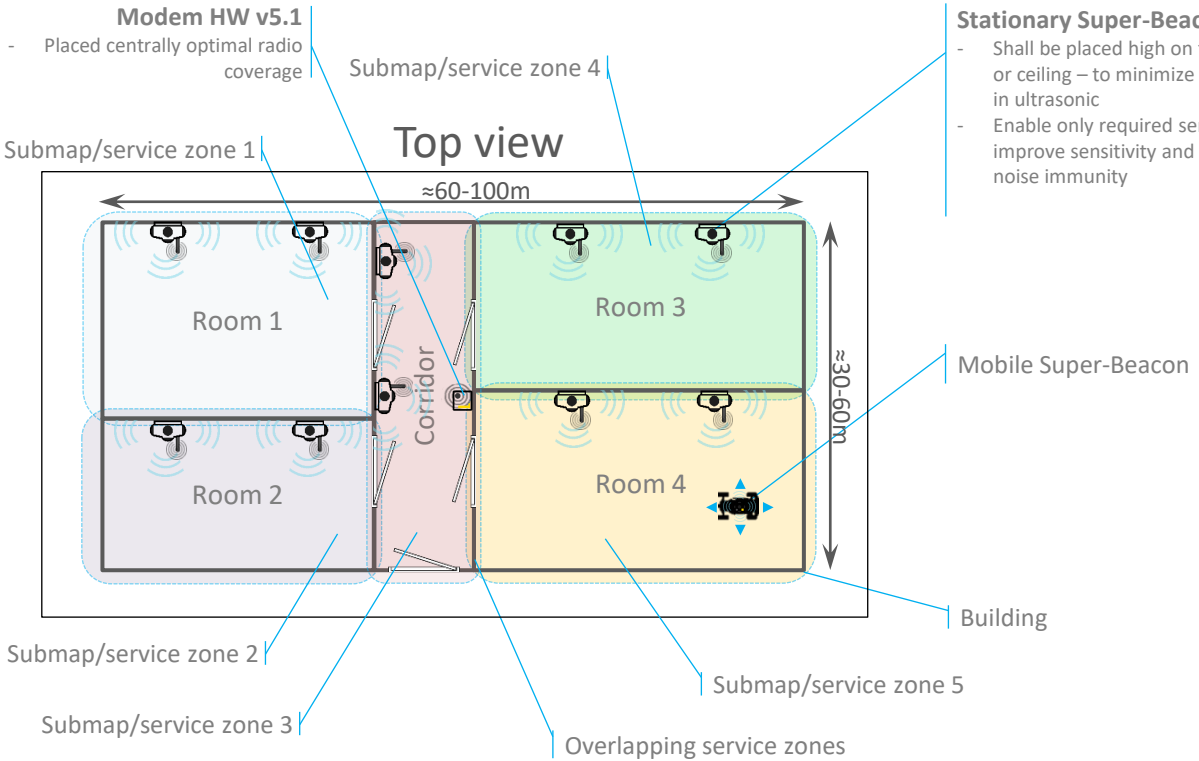
05: Submaps in 2D



Configuration:

- Starter Set Super-MP-3D + Super-Beacon:
  - 10 x stationary Super-Beacon
  - 1 x mobile Super-Beacon
  - 1 x Modem HW v5.1

Notes:

- Designed for multi-room buildings
- This particular configuration supports 2D tracking. Can be made in 3D too, if instead of 2D submaps, 3D submaps are built Check Simple 3D Tracking
- Check Operating Manual
- Check Submaps Help Video
- Check Simple 2D Tracking to build correct 2D maps
- Check in our website https://marvelmind.com/download/ =>
- How to create indoor navigation maps
- How to build large indoor positioning systems
- How to build maps larger then 30x30m?

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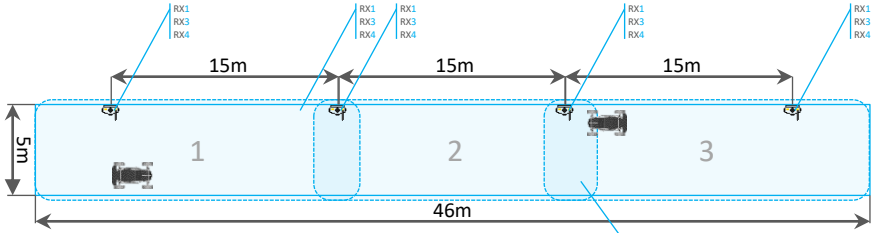
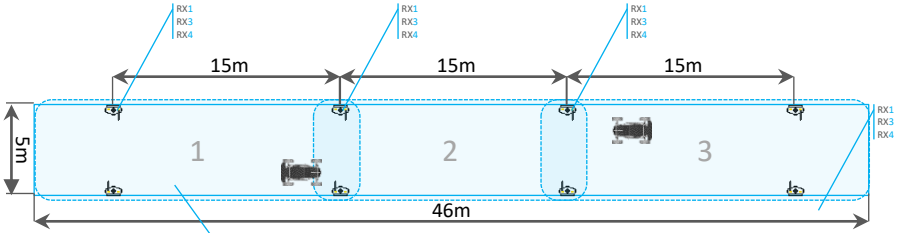
06: Wheeled robot in 46x5m area (2D navigation)

Option 1: Optimal conservative, 2D



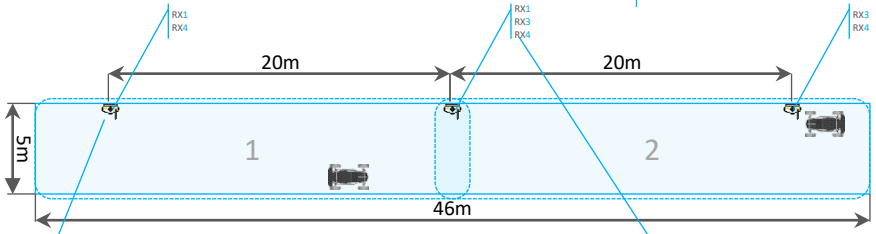
Submap/service zones overlapping for smooth handover between submaps

Option 3: Optimal conservative, 3D



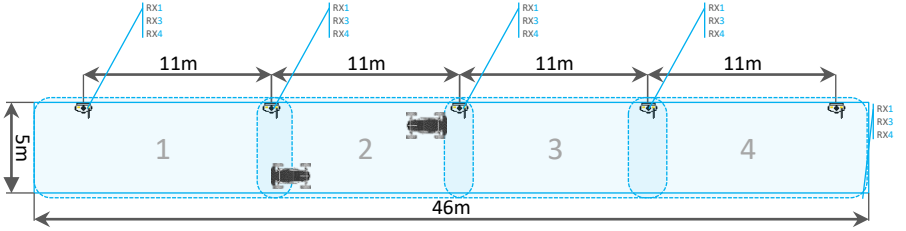
How to build submaps and service zones:
Help video: using submaps to build large maps

Option 2: Stretching, 2D



Enable RX1 (right-facing) and RX4 (front-facing). And disable RX2/RX3/RX5. They are facing down, left, up where the robot cannot be. Disabling of unnecessary sensors increases sensitivity/range and decreases the amount of noise/echo the beacon will pickup

Option 4: Conservative, 2D



Place stationary beacons with USB at the bottom. Enable only required sensors per beacon. Here, for example, enable RX1 (right-facing), RX4 (front-facing), RX3 (left-facing). And disable RX2/RX5. They face up and down where the robot cannot be. Disabling of unnecessary sensors increases sensitivity/range and decreases the amount of noise/echo the beacon will pickup

Note:

- Check Autonomous Delivery Robot – System view

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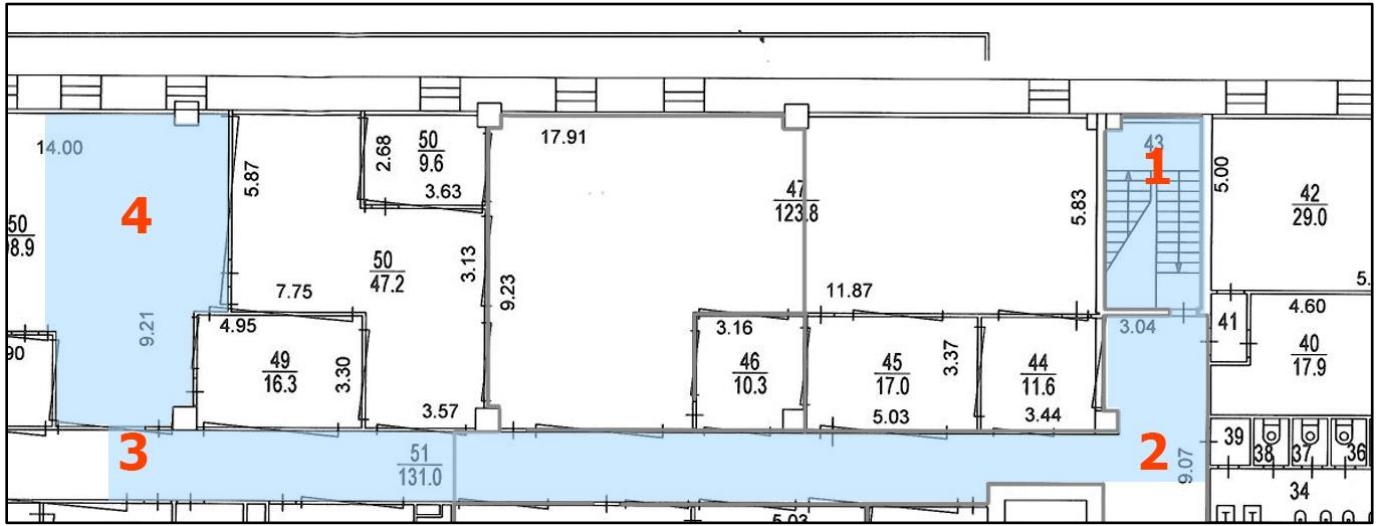
07a: Business center area – Tracking people in 2D



Customer expectations:

- Cover all blue zones with Marvelmind Indoor GPS Tracking System in order to track people
- Show how to place beacons correctly
- Show submaps
- Show sensor settings
- Zones 1 and 4 have to be covered with 3D tracking
- Zones 2 and 3 have to be covered with 2D tracking

Note:

- Check Demo: Precise multi-floor indoor tracking video
- Check Demo: tracking four warehouse workers video

*All the distances are given in meters

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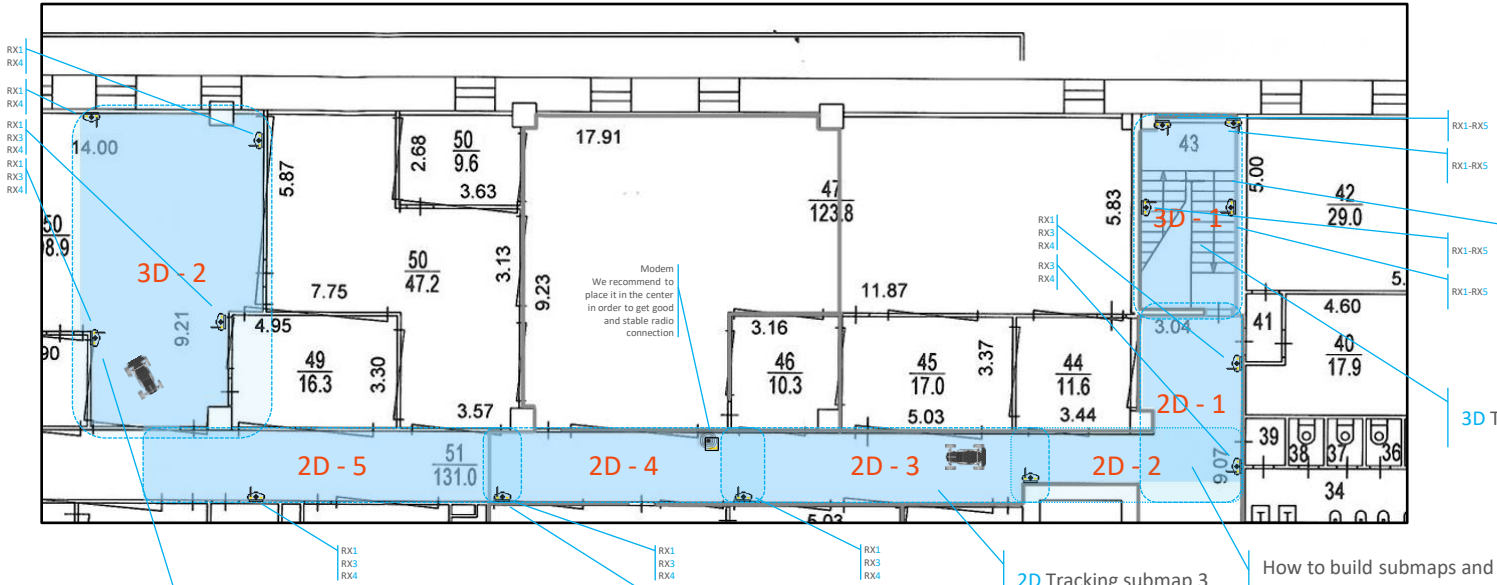
07b: Business center area – Tracking people in 2D



Configuration:

- 14 x Super-Beacon
- 1 x Modem HW v5.1

We recommend to turn on all the sensors in case of different heights and close distances.
3D tracking is required in order to track height changes, while walking through stairs

3D Tracking submap 1

2D Tracking submap 3

How to build submaps and service zones:
Help video: using submaps to build large maps
How to create indoor navigation maps

Enable RX1 (right-facing) and RX4 (front-facing). And disable RX2/RX3/RX5. They are facing down, left, up where the robot cannot be. Disabling of unnecessary sensors increases sensitivity/range and decreases the amount of noise/echo the beacon will pickup

Place stationary beacons with USB at the bottom. Enable only required sensors per beacon. Here, for example, enable RX1 (right-facing), RX4 (front-facing), RX3 (left-facing). And disable RX2/RX5. They face up and down where the robot cannot be. Disabling of unnecessary sensors increases sensitivity/range and decreases the amount of noise/echo the beacon will pickup

*All the distances are given in meters

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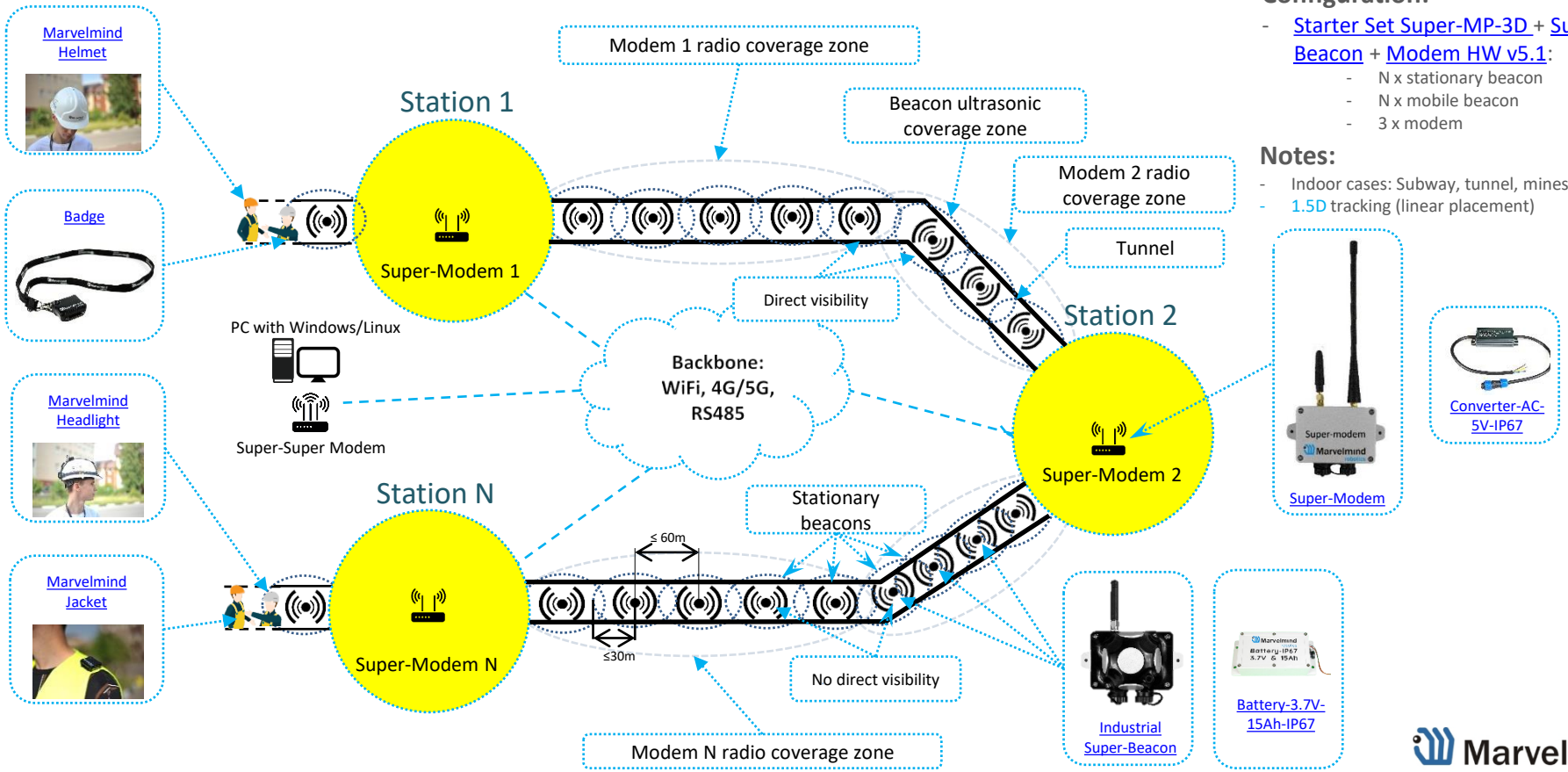
08a: Multi-modem 1.5D – for very large networks



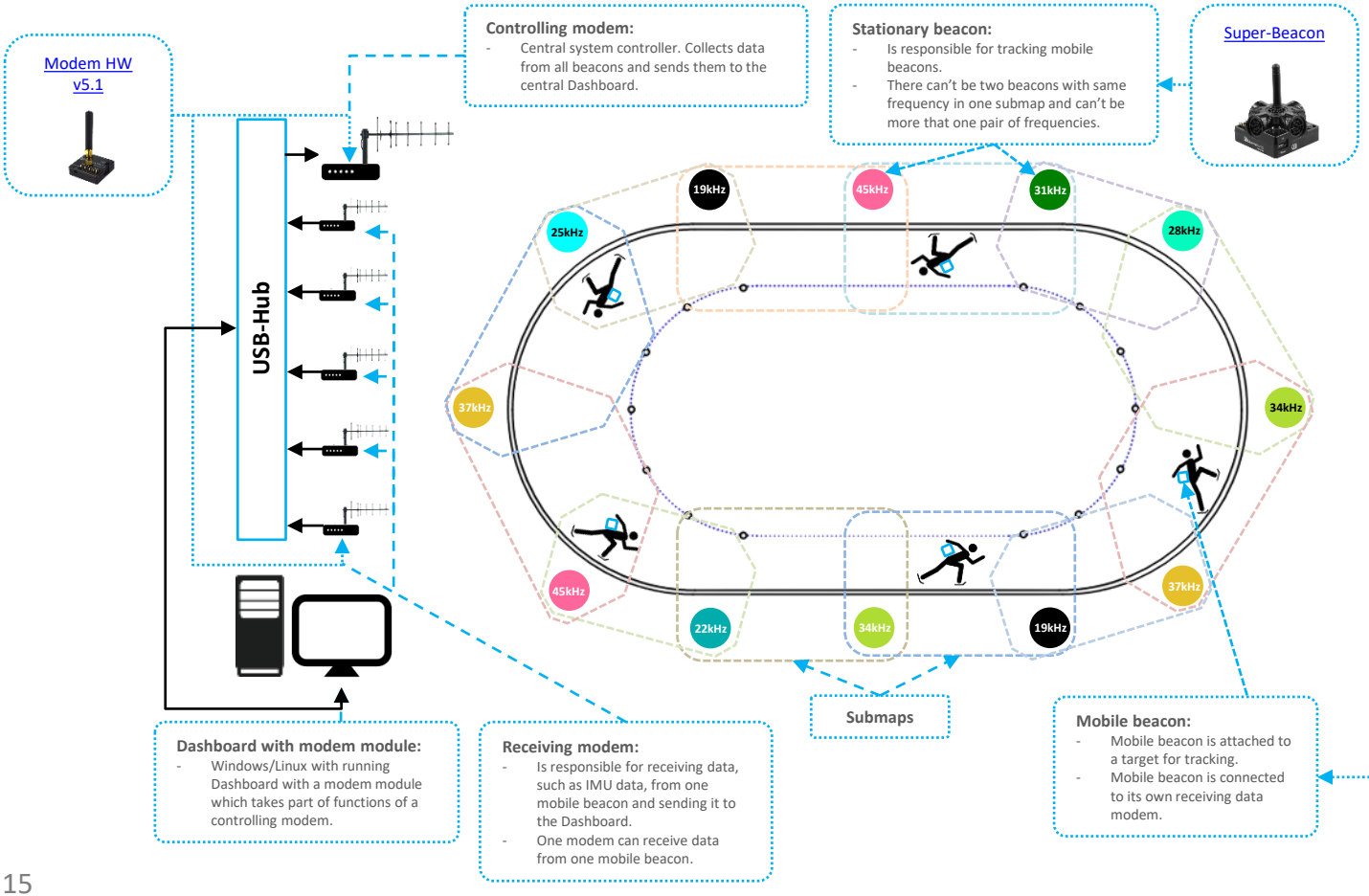
Configuration:

- Starter Set Super-MP-3D + Super-Beacon + Modem HW v5.1:
  - N x stationary beacon
  - N x mobile beacon
  - 3 x modem

Notes:

- Indoor cases: Subway, tunnel, mines
- 1.5D tracking (linear placement)

08b: Split-Modem Architecture – for fast-moving objects



Configuration:

- Starter Set Super-MP-3D + Super-Beacon + Beacon Mini-RX with Omni-Microphone-IP67 + Modem HW v5.1:
  - N x stationary beacon
  - M ≤ 30 x mobile beacon
  - M x receiving modem + 1 x controlling modem

Notes:

- Indoor cases: sports, carting, cycling
- Receiving modem is working in pair with one of the mobile beacons.
- Number of receiving modems corresponds to the number of mobile beacons
- Number of supported mobile beacons at a time is limited to 30 for the 915 MHz band
- Dashboard is working with a special modem module
- Coming soon: option of Super-Modem with support of the Split-Modem Architecture

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9: Area of 100x100m with tracking using submaps

The next slides explain settings for tracking in a large open-spaced warehouses by using Marvelmind indoor “GPS” in NIA with submap feature.

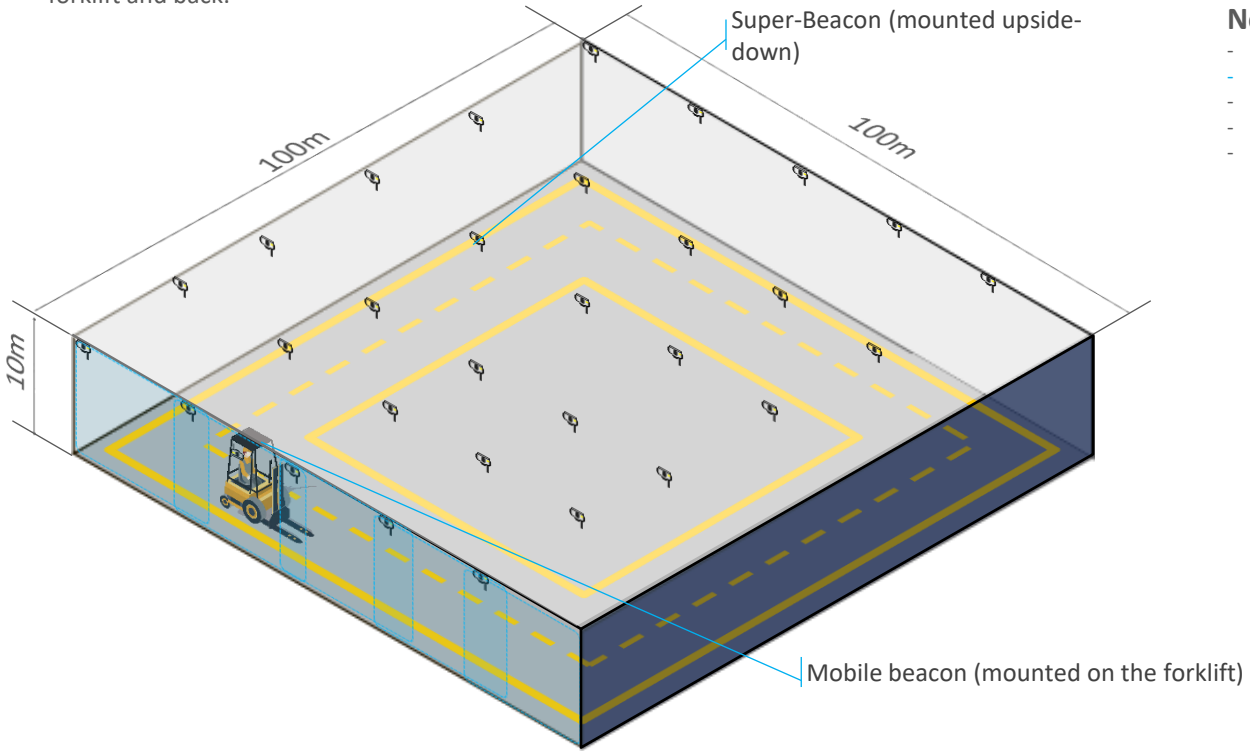
It also contains some mounting hints and setting instructions. We give some examples, and their pros and cons. Since the system is rather flexible, various options are presented.

Learn more in our articles:

- How to build large indoor positioning systems
- How to build maps lager than 30x30m?

9.1: Large 2D (100x100m) tracking – multiple submaps

Here is an example of tracking in open-spaced warehouse with using of NIA. Stationary Super-Beacons mounted on the celling upside down. Mobile beacon is mounted on a forklift facing up. The system provides precise (±2cm) real-time position of the mobile beacon (forklift) in real time (1-6Hz), stores its path and all location in a .CSV for post processing and analyzing. It also allows real-time alarms and two-ways communication (up to 1-2kbps) from the system to forklift and back.



Notes:

- Cases: big open-spaced warehouses
- 2D (x, y) tracking
- Multiple submaps
- There is placing with using of NIA
- Also you can use IA configuration for this map, if you have Super-Beacons with different frequencies (8 frequencies able 19kHz, 22kHz, 25kHz, 31kHz, 34kHz, 37kHz, 45kHz)

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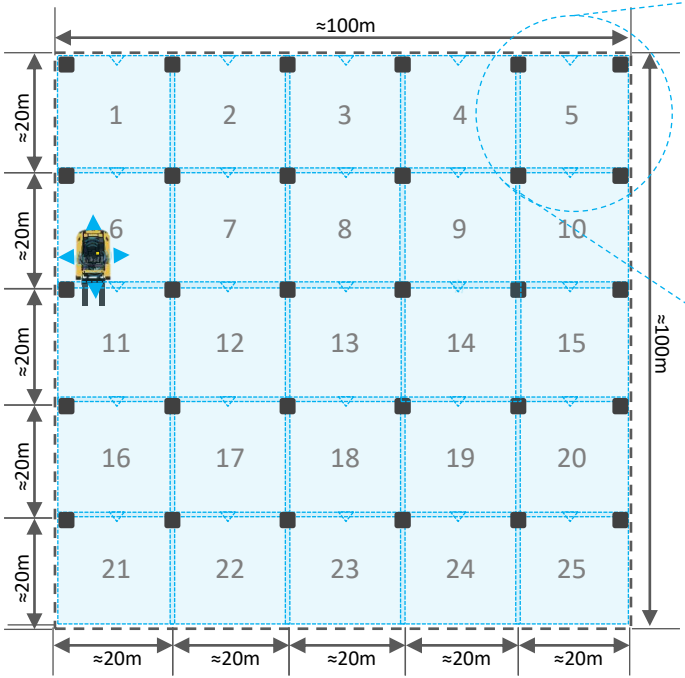
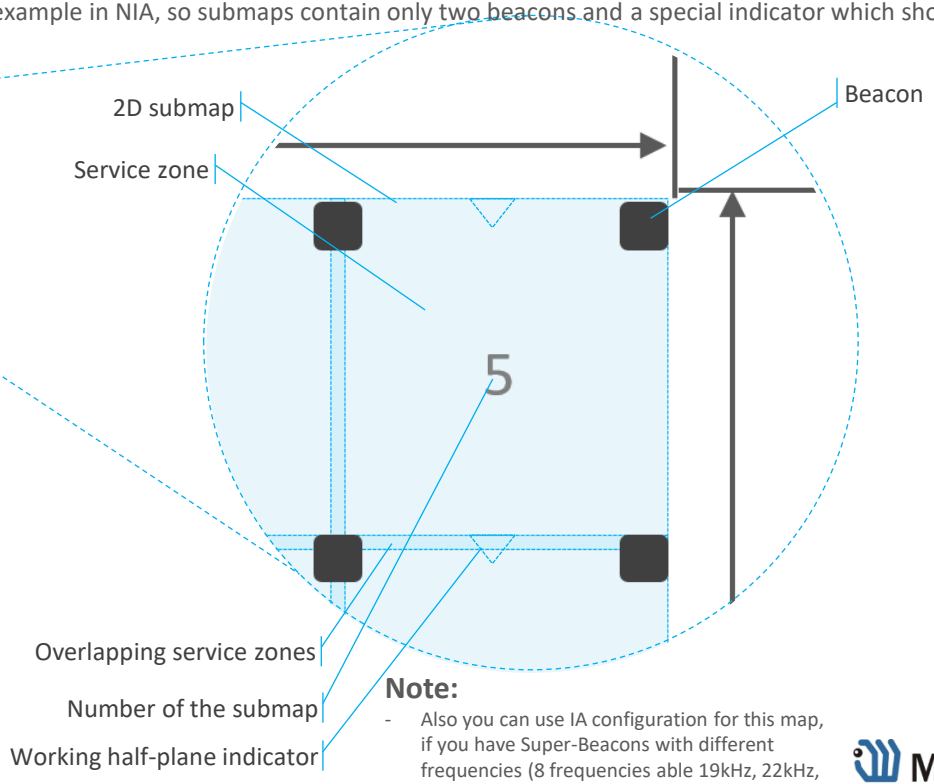
9.2: Detailed system view

All track-needed territory is covered with stationary Super-Beacons. The beacons are placed on the ceiling with a grid that allows the distance of less than 30m from 2 or more stationary Super-Beacons on the ceiling to a mobile Super-Beacon on the forklift at any point, where the tracking is required. Service zones are overlapping for smooth handover. This is 2D map example in NIA, so submaps contain only two beacons and a special indicator which shows the working zone.





Note:

- Also you can use IA configuration for this map, if you have Super-Beacons with different frequencies (8 frequencies able 19kHz, 22kHz, 25kHz, 28kHz, 31kHz, 34kHz, 37kHz, 45kHz)

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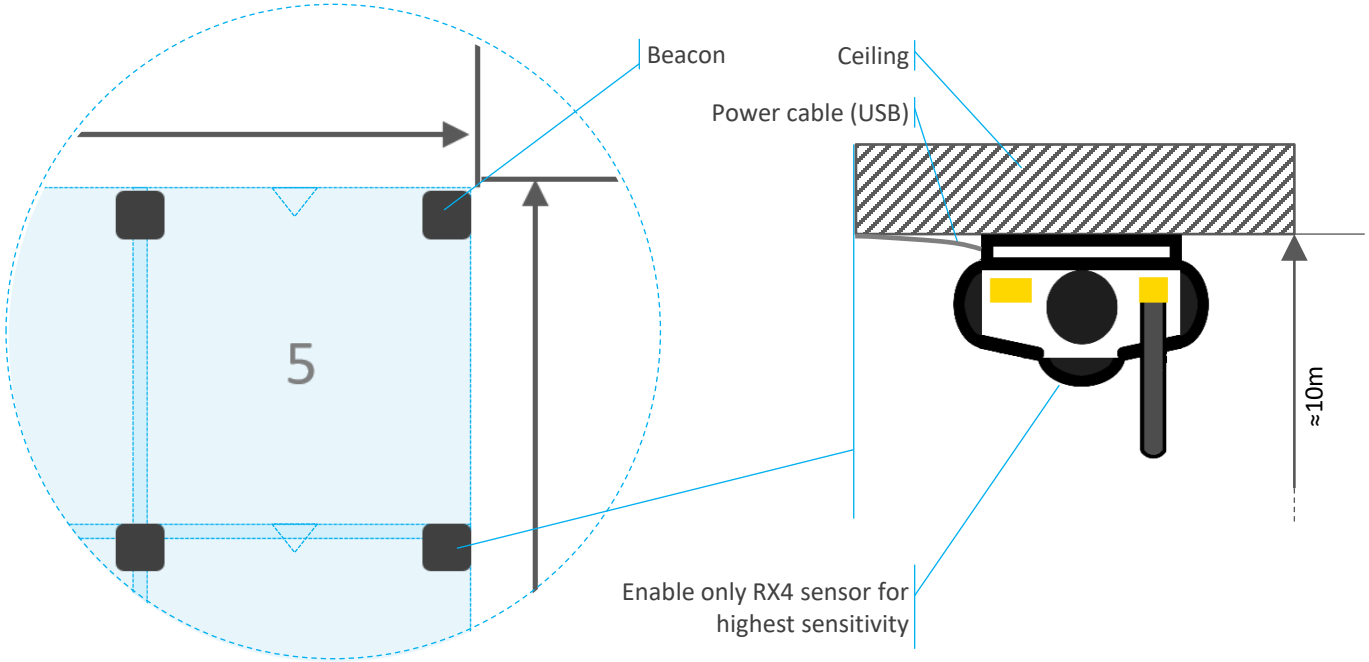
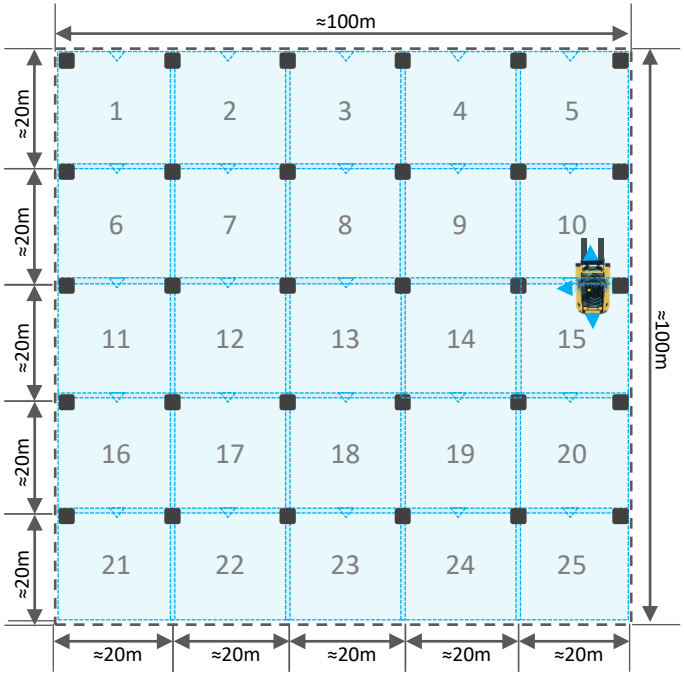
9.3: Detailed beacon mounting view

Beacons are placed on the ceiling upside down. Working sensor is RX4. When other sensors (RX1, RX2, RX3, RX5) are disabled, the beacon has the highest sensitivity in RX4 direction and noise resistance from other directions. The height in the example is 10m.

Beacons can work from the embedded LiPol battery, but it is recommended to provide an external power source (regular USB) or a converter ~110/220=>5V USB



9.4: 2D optimal configuration



Notes:

Since the configuration is for 2D, it gives only X and Y coordinates.
The configuration is designed for tracking, for example, forklifts in open-spaced warehouses without tall shelfs.

Pros:

- Solid tracking
- Very precise (±2cm)
- Designed for forklifts

Cons:

- More beacons (price) than in stretched configurations

Configuration:

100x100m "2D optimal":

- 30 x Stationary Super-Beacon
- 1 x mobile Super-Beacon
- 1 x Modem HW v5.1

Check videos:

- Autonomous Delivery Robot – System view
- Live tracking: precise indoor positioning
- How to precisely (±2cm) track 10 forklifts

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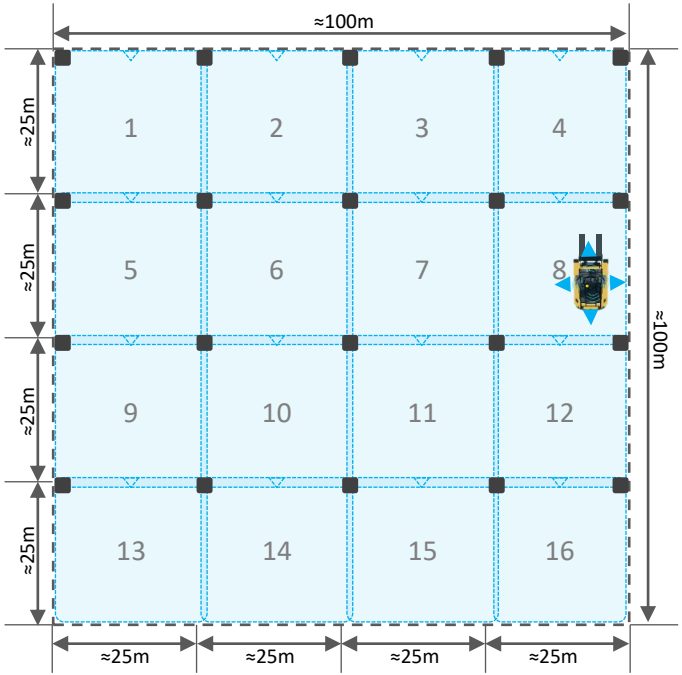
9.5: 2D stretched



Notes:

Configuration “2D stretched” is actually the same as “2D optimal”, but works with a longer distances between beacon. But tracking can be interrupted with external noise or by just too weak ultrasonic signal.
It is also in 2D, so it gives only X and Y coordinates.

Pros:

- Lower total cost than the 2D Optimal configuration

Cons:

- Potentially, less solid tracking than the 2D Optimal configuration

Configuration:

100x100m “2D stretched”:

- 20 x Stationary Super-Beacon
- 1 x mobile Super-Beacon
- 1 x Modem HW v5.1

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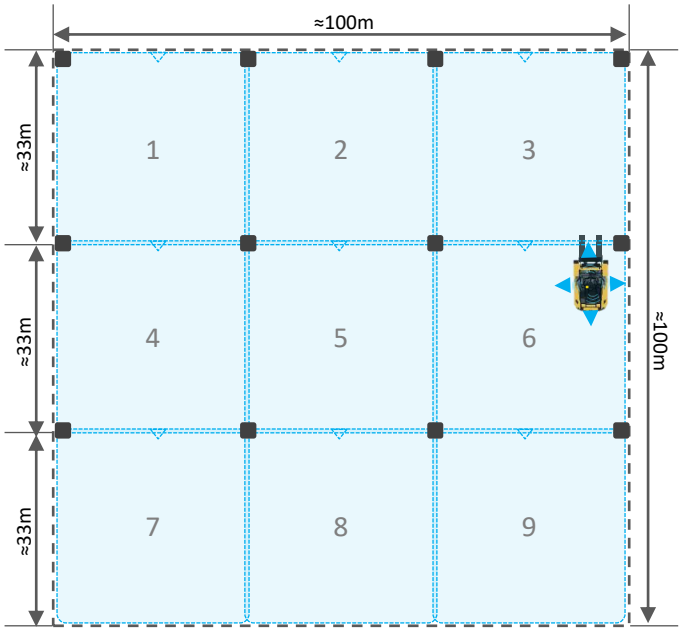
9.6: 2D super-stretched



Notes:

Configuration “2D super-stretched” has the best price as the distances are the largest.

It is 2D, so it gives only X and Y coordinates.

- Pros:
- The lowest total cost among the three configurations
- Cons:
- May require more manual and fine settings than other configurations

Configuration:

100x100m “2D super-stretched”:

- 12 x Stationary Super-Beacon
- 1 x mobile Super-Beacon
- 1 x Modem HW v5.1

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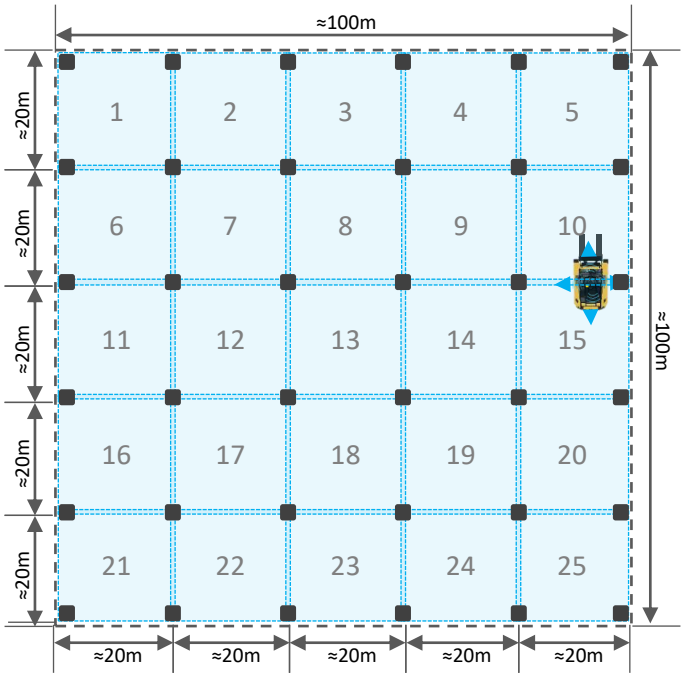
9.7: 3D optimal



Notes:

Configuration “3D optimal” is balanced in price-performance ratio.
The configuration is 3D, so it gives (X,Y,Z) positioning.
It has 3+1 redundancy. That means that, if 1 of 4 beacons in submap is blocked, 3D tracking is still exists.
The configuration is suitable for tracking, for example, not only forklifts, but also drones in open-spaced warehouses without tall shelfs.

Pros:

- Solid tracking
- Suitable for drones – gives 3D (x, y, z)

Cons:

- More beacons than in stretched configurations

Configuration:

100x100m “3D optimal”:

- 36 x Stationary Super-Beacon
- 1 x mobile Super-Beacon
- 1 x Modem HW v5.1

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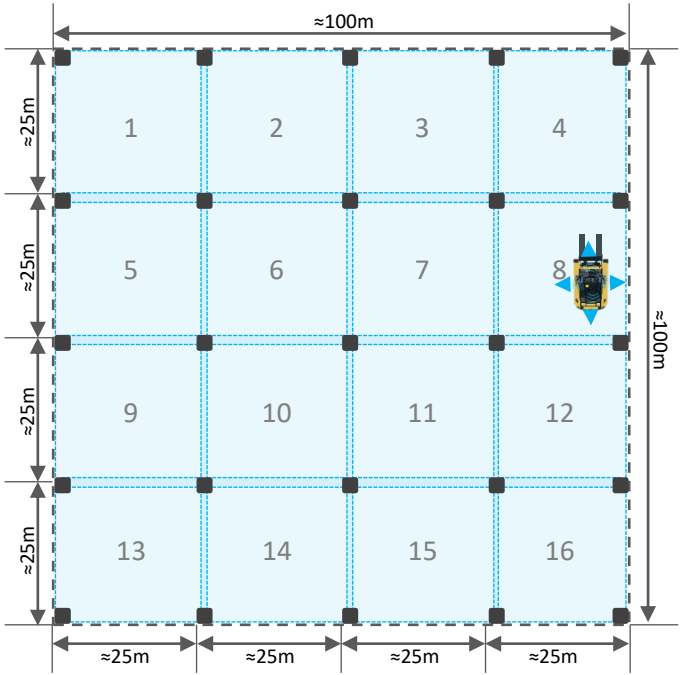
9.8: 3D stretched



Notes:

Configuration “3D stretched” is actually the same as “3D optimal”, but works with a longer distances. That gives an advantage in price, but tracking can be interrupt with noise. The configuration is 3D, so it gives (X,Y,Z) positioning.
It has 3+1 redundancy. That means that, if 1 of 4 beacons in submap is blocked, 3D tracking is still exists.
The configuration is suitable for tracking, for example, not only forklifts, but also drones in open-spaced warehouses without tall shelfs.

Pros:

- Lower costs than in 3D optimal configuration

Cons:

- More complex settings and less solid performance than in the 3D optimal configuration

Configuration:

100x100m “2D stretched”:

- 25 x Stationary Super-Beacon
- 1 x mobile Super-Beacon
- 1 x Modem HW v5.1

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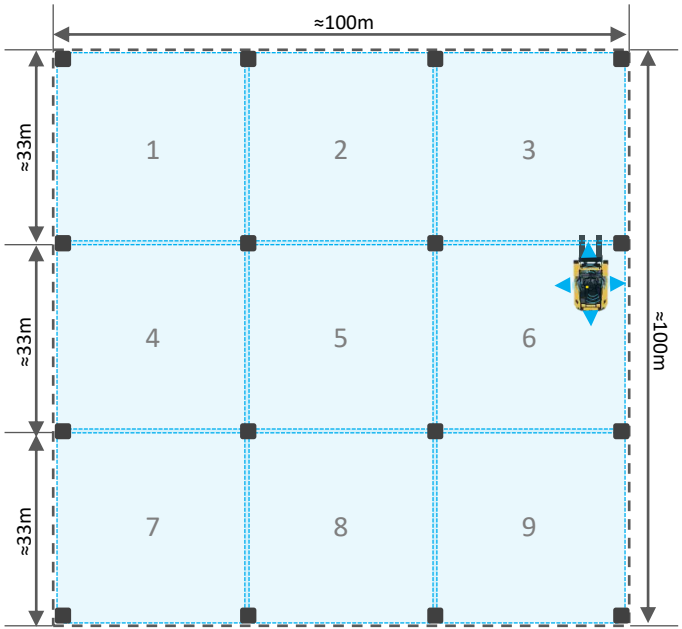
9.9: 3D super-stretched



Notes:

Configuration “3D super-stretched” has the best price as the distances are the largest, but it is mostly designed for future HW/SW version.
It is 3D, so it gives us only X and Y coordinates.
It has 3+1 redundancy. That means that, if 1 of 4 beacons in submap is blocked, tracking is still exists.

Pros:

- The lowest total cost among the three configurations

Cons:

- May require more manual and fine settings than other configurations

Configuration:

100x100m “2D super-stretched”:

- 16 x Stationary Super-Beacon
- 1 x mobile Super-Beacon
- 1 x Modem HW v5.1

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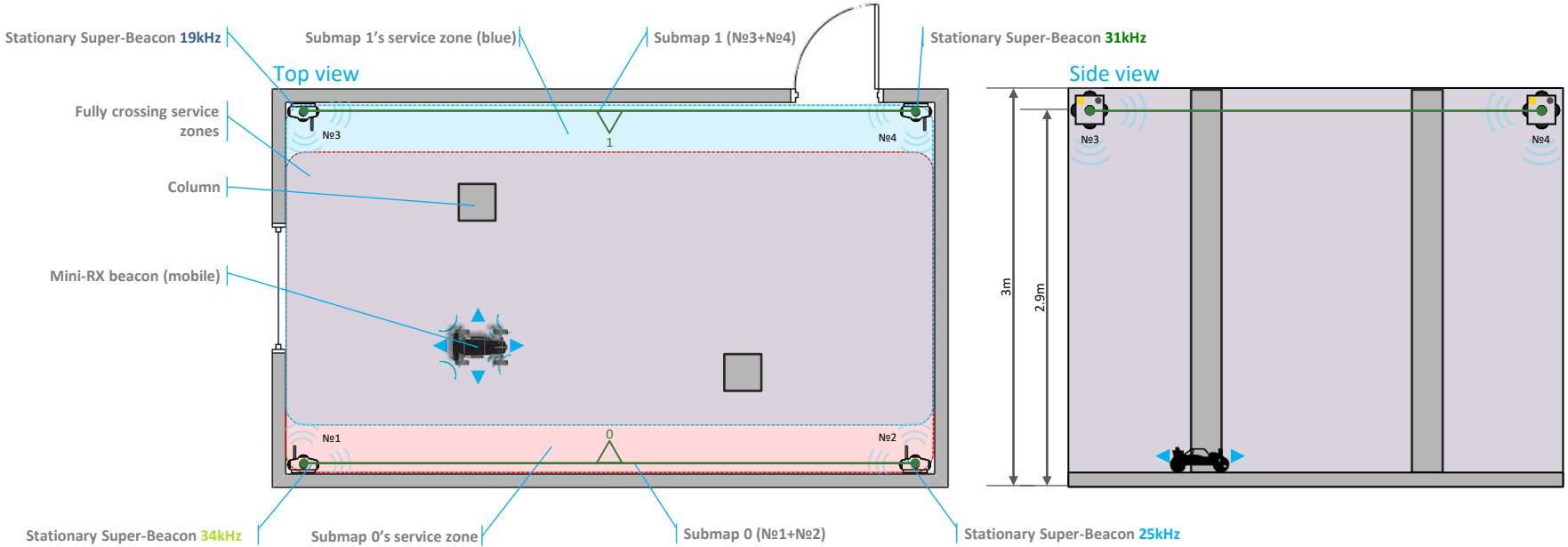
9.10: Summary – 100x100m area

We presented different configurations of tracking mobile assets (vehicles, forklifts, drones) in 100x100m warehouse with ±2cm precision.
We also gave some recommendations of mounting and setting up the system:

- 2D optimal
- 2D stretched
- 2D super-stretched
- 3D optimal
- 3D stretched
- 3D super-stretched

10a: Fully overlapping submaps (IA, 2D)



Configuration:

- Inverse Architecture (IA):
  - 2 x Stationary Super-Beacon 19kHz
  - 2 x Stationary Super-Beacon 25kHz
  - 2 x Stationary Super-Beacon 31kHz
  - 2 x Stationary Super-Beacon 34kHz
  - 1 x Mini-RX as a mobile beacon (or more Mini-RXs for more mobile objects)
  - 1 x Modem HW v5.1

Notes:

- If one submap obstructed, another submap will provide solid tracking
- In one submap frequency of each beacon shouldn't repeat (for example, it can't be two 31kHz, 37kHz, etc. beacons in one submap)
- Check Precise (±2cm) tracking of visitors in Cinema Museum video

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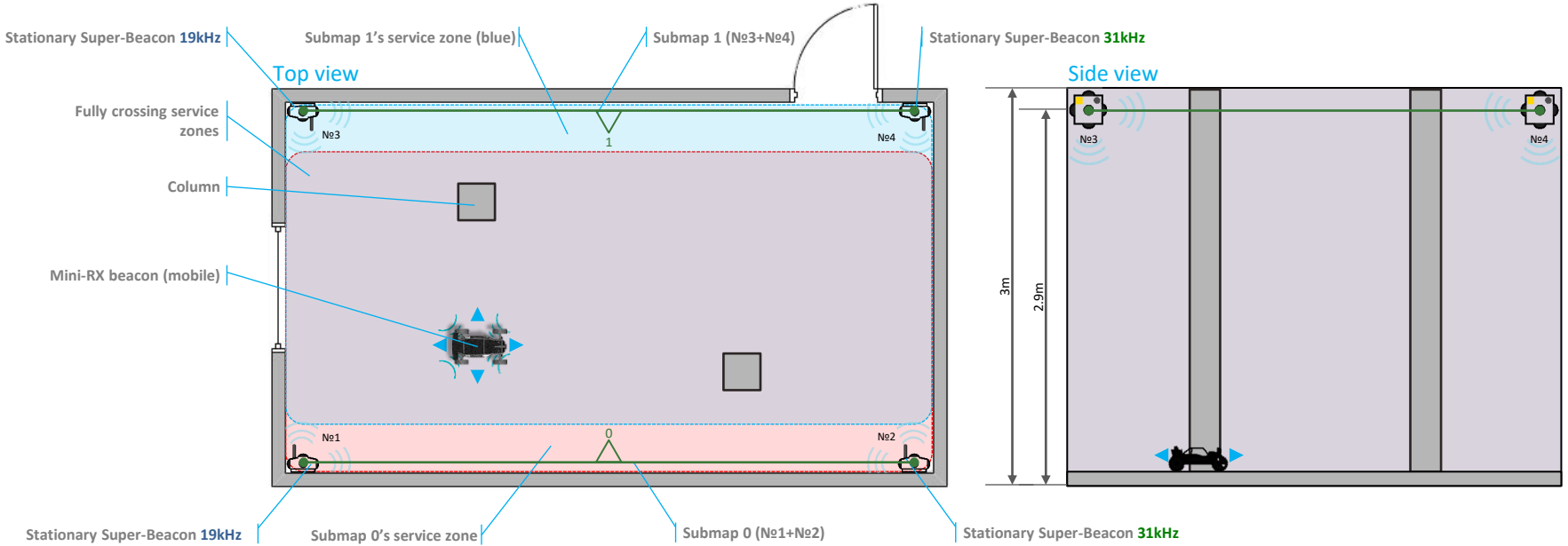
10b: Fully overlapping submaps (IA, 2D, TDMA)



Configuration:

- Inverse Architecture (IA) with TDMA:
  - 2 x Stationary Super-Beacon 19kHz
  - 2 x Stationary Super-Beacon 31kHz
  - 1 x Mini-RX as a mobile beacon (or more Mini-RXs for more mobile objects)
  - 1 x Modem HW v5.1

Notes:

- TDMA feature, which helps to improve the tracking quality in complex situations
- If one submap obstructed, another submap will provide solid tracking
- In one submap frequency of each beacon shouldn't repeat (for example, it can't be two 31kHz, 37kHz, etc. beacons in one submap)
- Check Operating Manual for more details about TDMA (Chapter 6.2)
- Check Track of Marvelmind Jacket indoor video
- Check Tracking of visitors in Cinema Museum indoor video

TDMA settings:

- TDMA sequence length = 2
- TDMA position in sequence:
  - Submap 0 = 0
  - Submap 1 = 1

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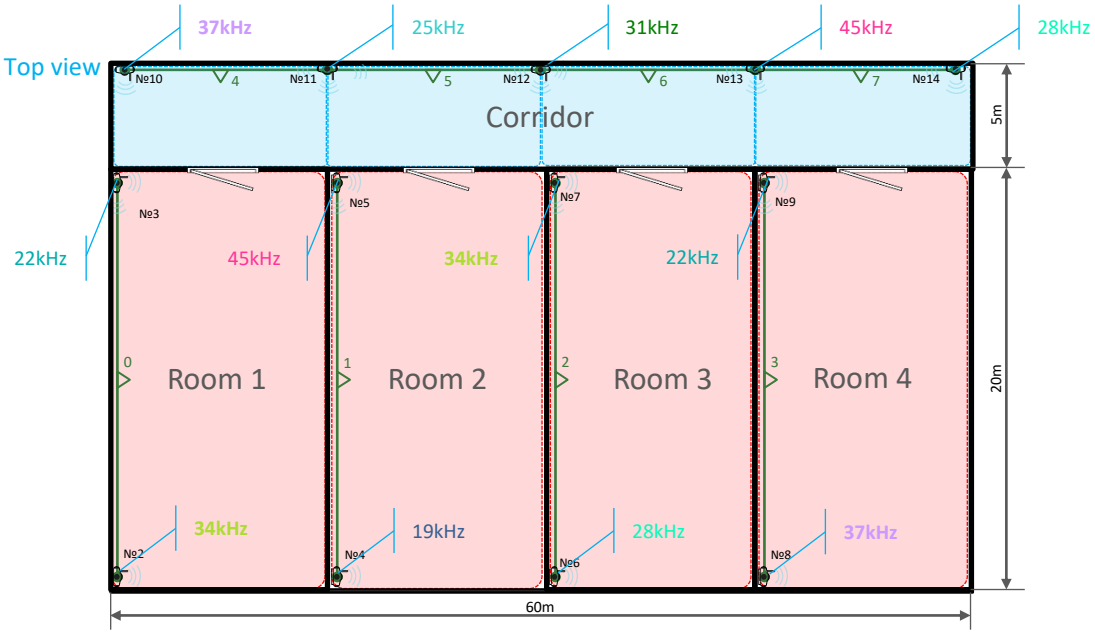
11: Rooms + corridor (IA, 2D)



Configuration:

- Inverse Architecture (IA) with 8 frequencies:
  - 1 x Stationary Super-Beacon 19kHz
  - 2 x Stationary Super-Beacon 22kHz
  - 1 x Stationary Super-Beacon 25kHz
  - 2 x Stationary Super-Beacon 28kHz
  - 1 x Mini-RX as a mobile beacon (or more Mini-RXs for more mobile objects)
  - 1 x Modem HW v5.1
  - 1 x Stationary Super-Beacon 31kHz
  - 2 x Stationary Super-Beacon 34kHz
  - 2 x Stationary Super-Beacon 37kHz
  - 2 x Stationary Super-Beacon 45kHz

Notes:

- Designed for tracking people or robot In the office
- This particular configuration supports 2D
- You can change configurations as you wish.
- In one submap frequency of each beacon shouldn't repeat (for example, it can't be two 31kHz, 37kHz, etc. beacons in one submap)
- Check Operating Manual for more details about TDMA (Chapter 6.2)
- Check Submaps Help Video
- Check Tracking 4 warehouse workers video

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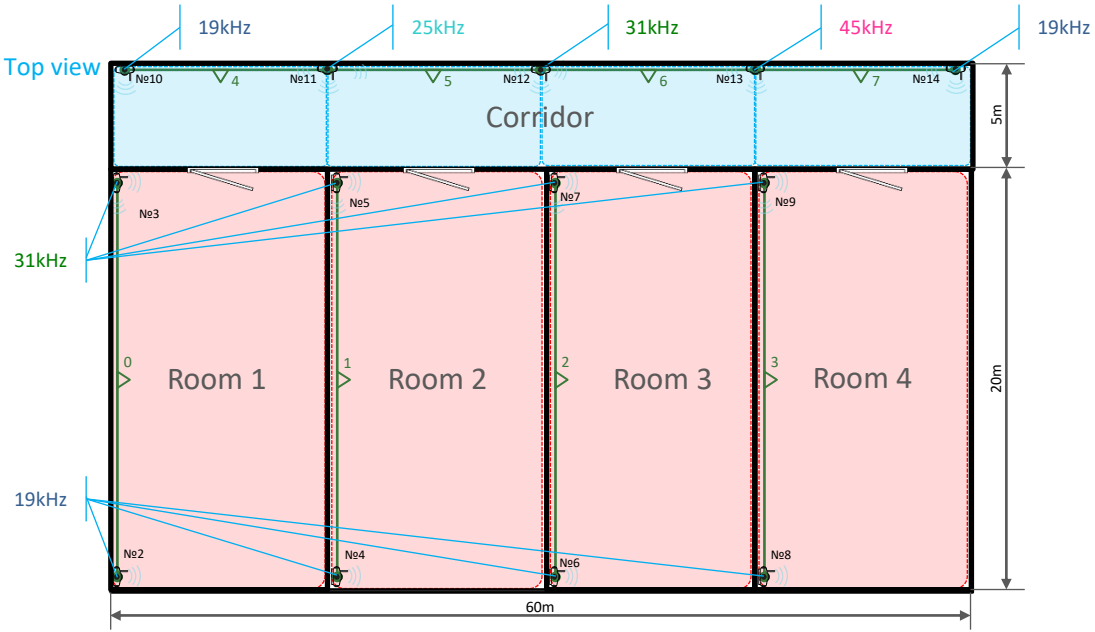
11a: Rooms + corridor (IA, 2D, TDMA)



TDMA case description:

- xxxxxxxxx

Configuration:

- Inverse Architecture (IA) with TDMA:
  - 6 x Stationary Super-Beacon 19kHz
  - 1 x Stationary Super-Beacon 25kHz
  - 5 x Stationary Super-Beacon 31kHz
  - 1 x Stationary Super-Beacon 45kHz
  - 1 x Mini-RX as a mobile beacon (or more Mini-RXs for more mobile objects)
  - 1 x Modem HW v5.1

Notes:

- Designed for tracking people or robot In the office
- This particular configuration supports 2D
- In one submap frequency of each beacon shouldn't repeat (for example, it can't be two 31kHz, 37kHz, etc. beacons in one submap)
- Check Operating Manual for more details about TDMA (Chapter 6.2)
- Check Submaps Help Video
- Check TDMA in Museum demo video
- Check Tracking 4 warehouse workers video

TDMA settings:

- TDMA sequence length = 2
- TDMA position in sequence:
  - Submap 0-3 = 0
  - Submap 4-7 = 1

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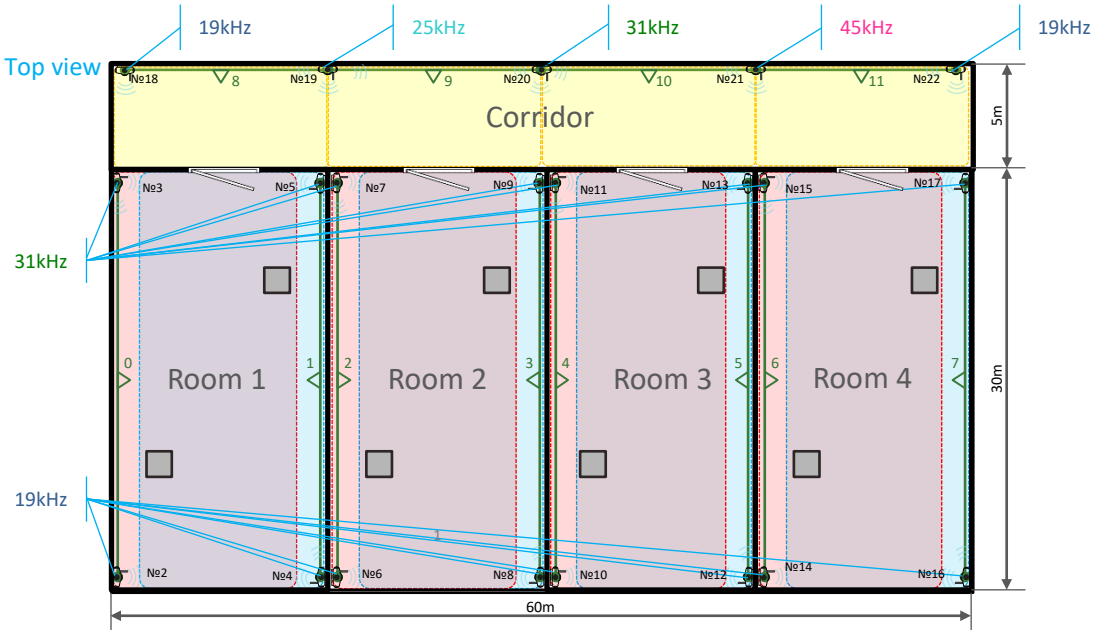
12: Rooms with columns + corridor (IA, 2D, TDMA)



TDMA case description:

- xxxxxxxxx

Configuration:

- Inverse Architecture (IA) with TDMA:
  - 10 x Stationary Super-Beacon 19kHz
  - 1 x Stationary Super-Beacon 25kHz
  - 9 x Stationary Super-Beacon 31kHz
  - 1 x Stationary Super-Beacon 45kHz
  - 1 x Mini-RX as a mobile beacon (or more Mini-RXs for more mobile objects)
  - 1 x Modem HW v5.1

Notes:

- Designed for tracking people or robot In the office
- This particular configuration supports 2D
- In one submap frequency of each beacon shouldn't repeat (for example, it can't be two 31kHz, 37kHz, etc. beacons in one submap)
- Check Operating Manual for more details about TDMA (Chapter 6.2)
- Check Submaps Help Video
- Check TDMA in Museum demo video
- Check Tracking 4 warehouse workers video

TDMA settings:

- TDMA sequence length = 3
- TDMA position in sequence:
  - Submap 0, 2, 4, 6 = 0
  - Submap 1, 3, 5, 7 = 1
  - Submap 8, 9, 10, 11 = 2

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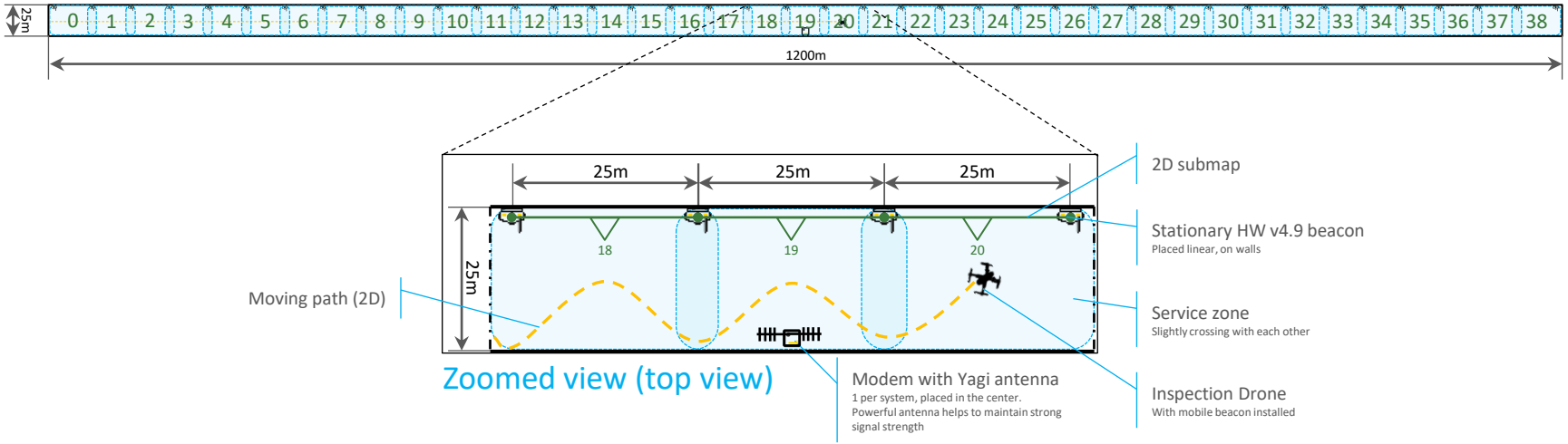
13: Tunnel 1200x25m, autonomous inspection (NIA or IA, 2D)

General view (top view)



Zoomed view (top view)

Configuration:

- Non-Inverse Architecture (NIA) or Inverse Architecture (IA) :
  - 40 x Stationary Super-Beacon (with 8 frequencies for IA)
  - 1 x Modem HW v5.1
  - N x Super-Beacon as a mobile beacon

Notes:

- Designed for autonomous tunnel inspection
- In IA, in one submap frequency of each beacon shouldn't repeat (for example, it can't be two 31kHz, 37kHz, etc. beacons in one submap)
- Check Operating Manual for more details (TDMA chapter)
- Check Submaps Help Video

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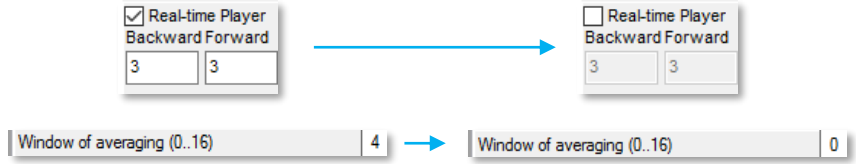
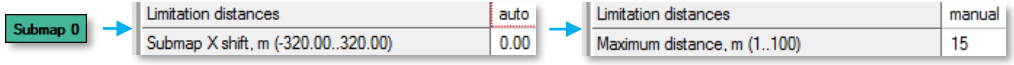
14: Real-time tracking: reducing the delay

Use this instruction if you need the smallest delay possible

1. Turn off the Real-time player
   - Real-time player is a feature, which makes the tracking path smoother. As far as it looks backward and forward, it has some small delay. Turn it off if you need less delay
     Real-time player set to 0/0 or disable
     Real-time Averaging window in Modem settings set to 0 instead of default 4



2. Move radio profile to higher speed => 500kbps instead of default 38kbps
3. Change the limitation of distances
   - Go to submap settings and change it from Auto to Manual and set it to the largest distance between the mobile beacon and stationary beacons in the submap - 10-15m - whatever you have.
     Latency will be 1.2..1.5/Update rate, i.e. for 16Hz ultrasonic update rate, you have ~100ms latency



4. Use IMU + ultrasonic fusion.
   - As soon as you have location update rate 4-8Hz or more, the sensor fusion works well and you will have 100Hz resulting update rate and latency around 12-15ms

Note:

- Check our article:
  https://marvelmind.com/download/ =>
  How to increase location update rate?

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Advanced settings

15a: Tracking in 30x30m area

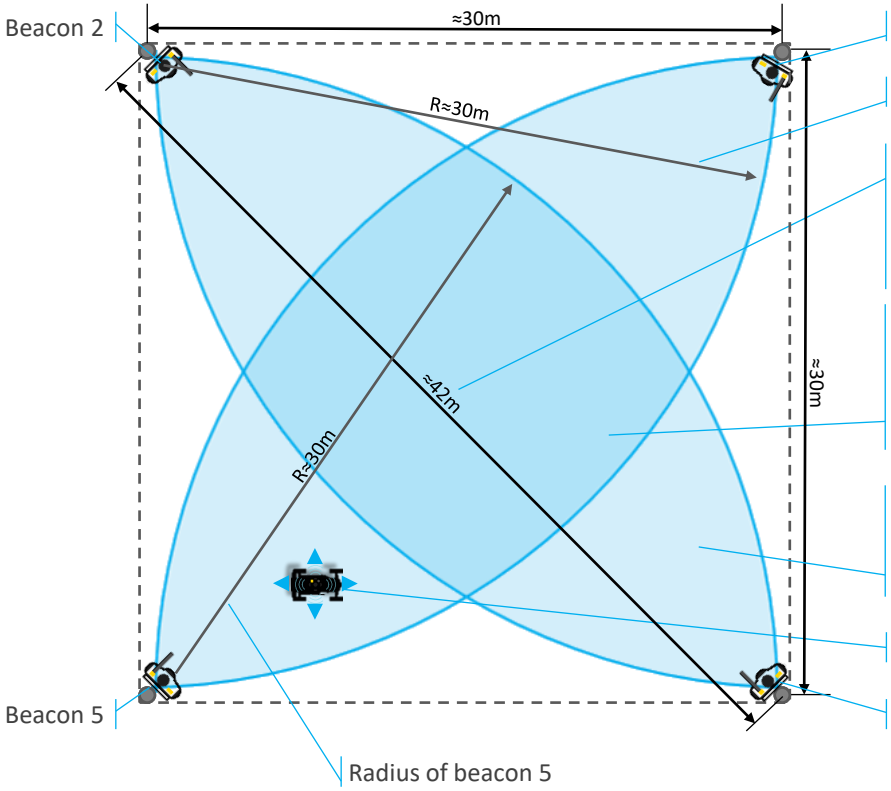
The next several slides give instructions of setting up and mounting the system to cover a 30x30m open space area.

It has different configurations:

1. 2D (x, y)
2. 3D (x, y, z)

Choose one, which suits your requirements.

15b: Tracking in 30x30m area - zones



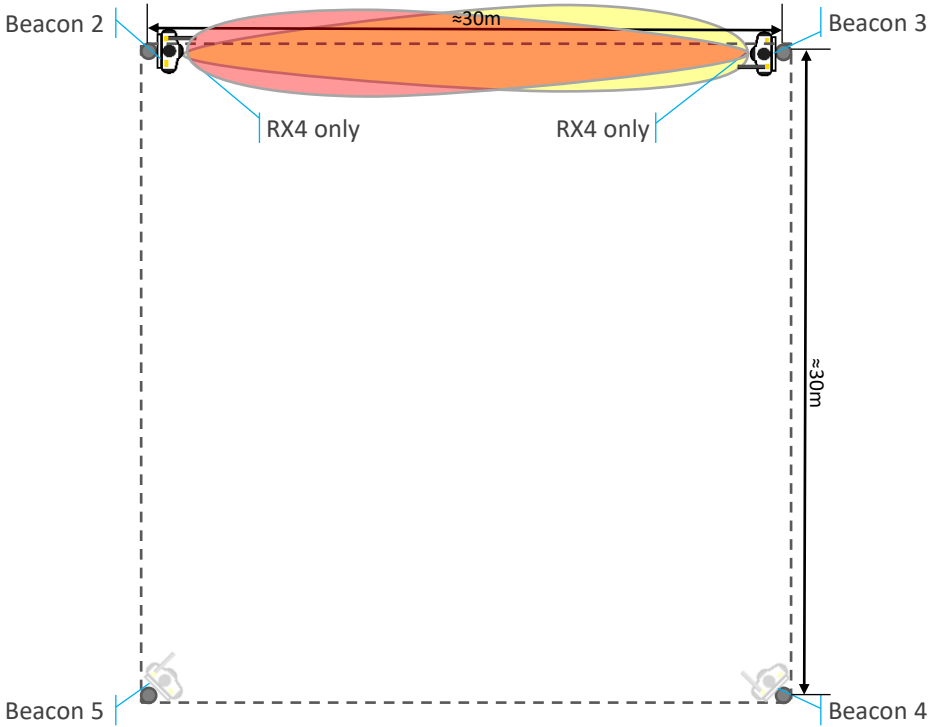
Configuration:

- Starter Set Super-MP-3D :
  - 4 x stationary Super-Beacon with different frequencies out of 8 (19kHz, 22kHz, 25kHz, 31kHz, 34kHz, 37kHz, 45kHz)
  - 1 x mobile Super-Beacon
  - 1 x Modem HW v5.1
- Supports 3D (X,Y,Z) + 1 redundancy
- Supports 2D (X, Y)

See the instructions on the next slides

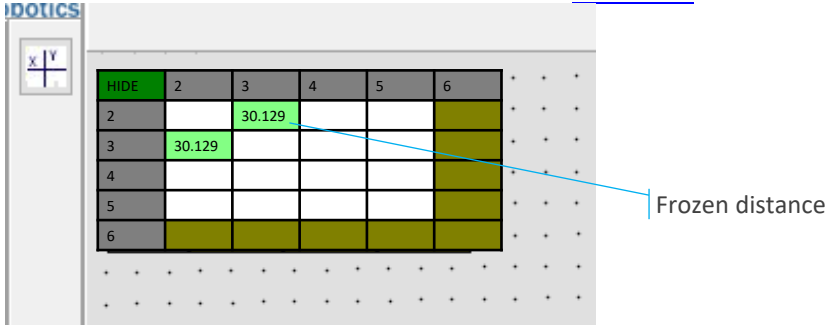
Marvelmind robotics

15.1: Step 1: Building the distances map (2, 3)



Finding distance between beacon 2 and beacon 3

- Face beacons to each other (facing RX4 sensor) (for more information check our Help: Microphone diagram video)
- Turn on RX4 sensor only
- Set the number of periods =100
- Set limitations of distances =45m
- Freeze the distance. How to do it see on the next slide…



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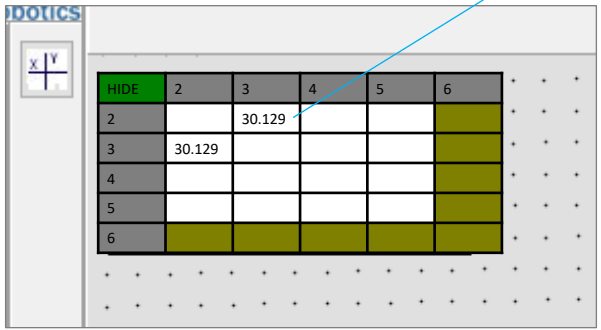
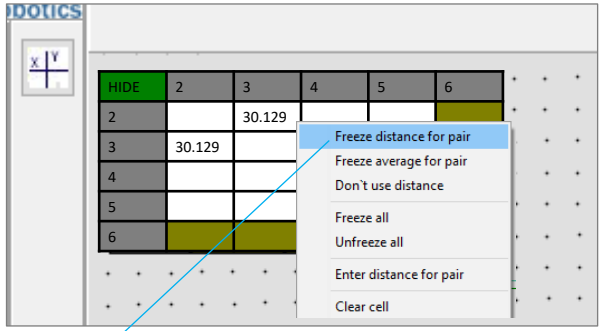
15.1a: How to freeze distance for pair

Wait when the distance tab became white → Right mouse button click on the distance tab



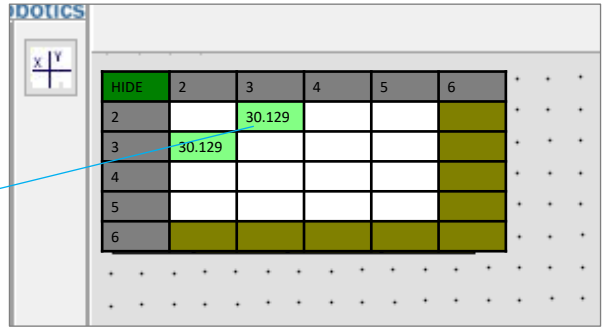
1



2

Click **Freeze distance for pair**

Now it's frozen



3

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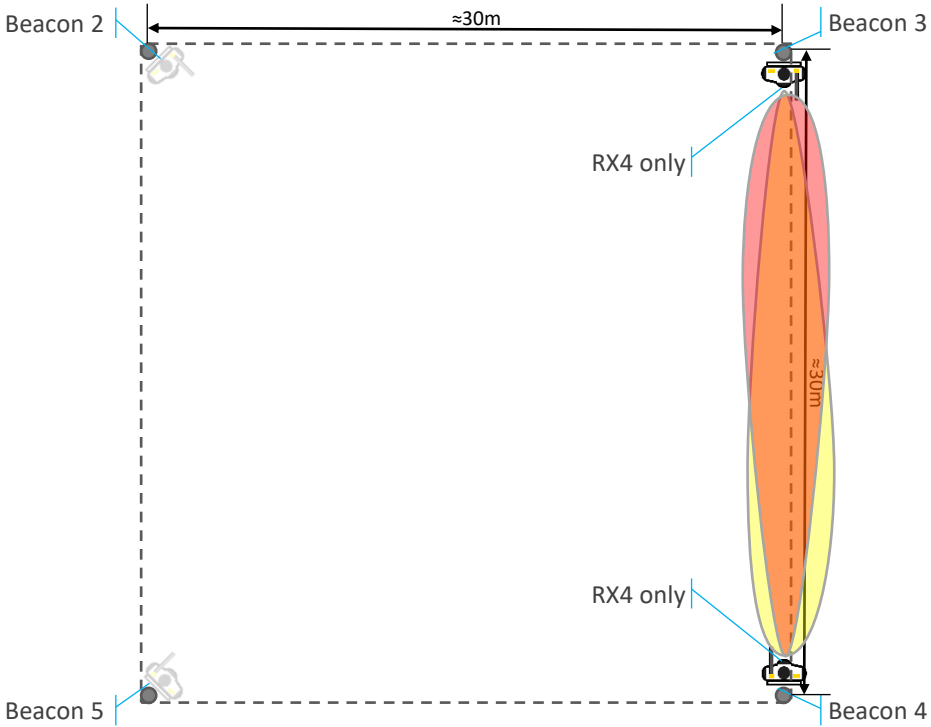
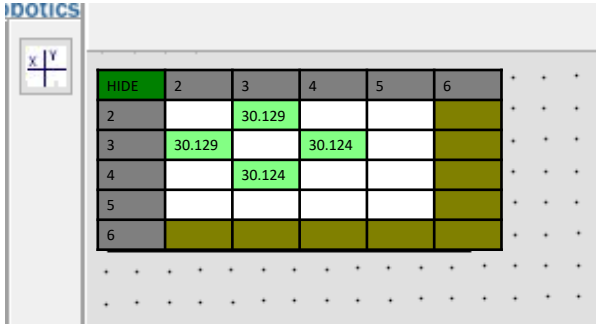
15.2: Step 2: Building the distances map (3, 4)



Finding distance between beacon 3 and beacon 4

- Face beacons to each other (facing RX4 sensor)
- Turn on RX4 sensor only
- Set the number of periods to 100
- Don’t forget to rise up all the limitations of distances (about 45m)
- Freeze the distance. How to do it see on this slide…



HIDE	2	3	4	5	6
2		30.129			
3	30.129		30.124		
4		30.124			
5					
6					

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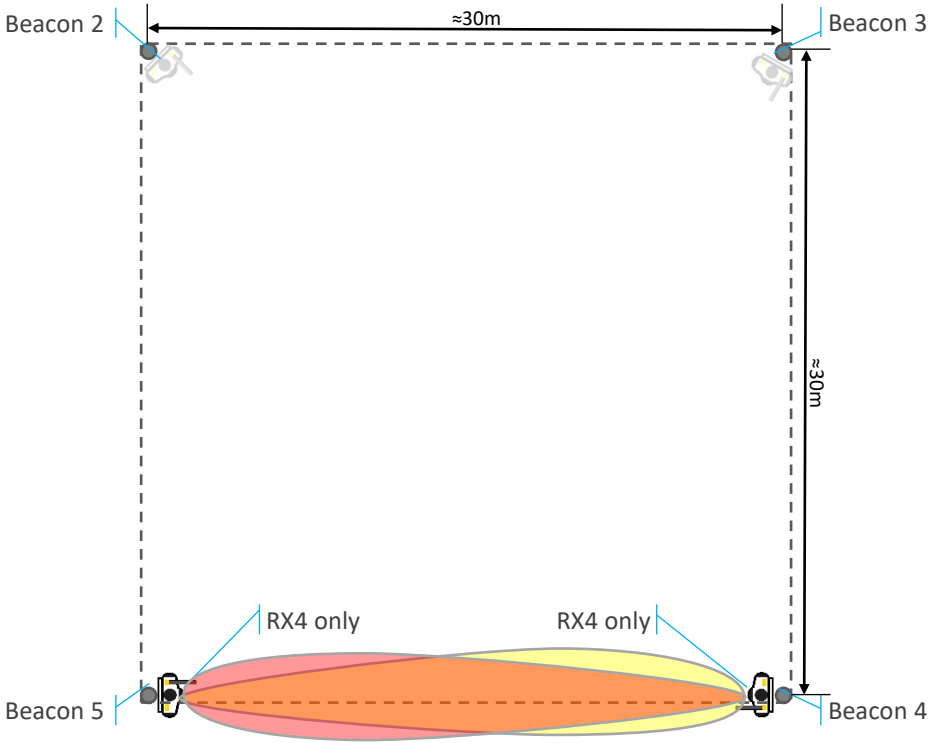
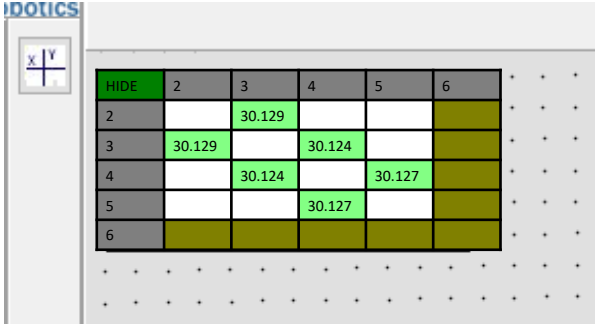
15.3: Step 3: Building the distances map (4, 5)



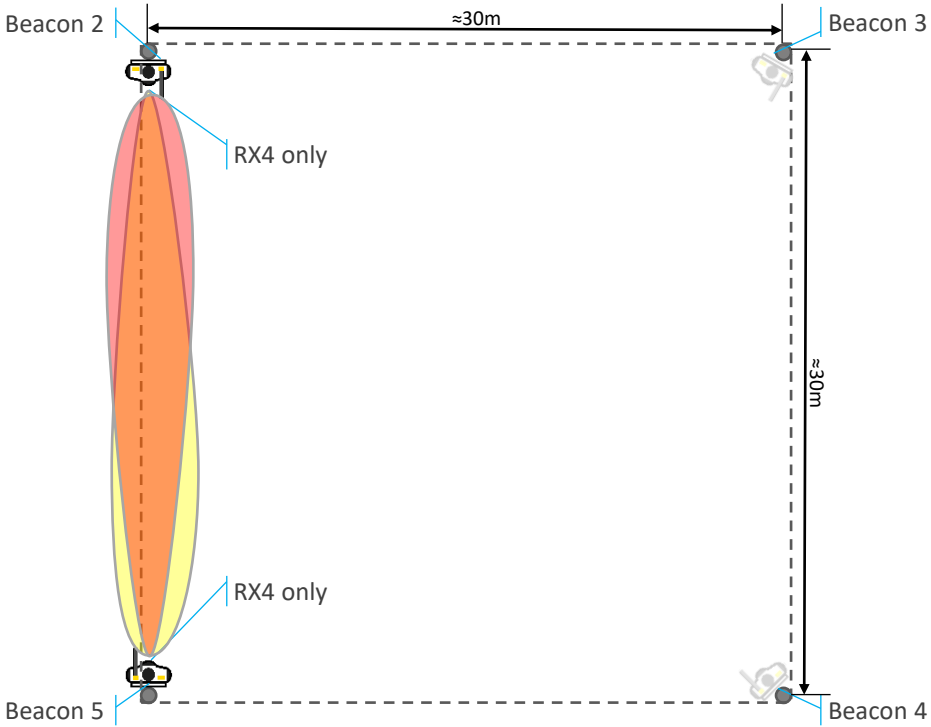
Finding distance between beacon 4 and beacon 5

- Face beacons to each other (facing RX4 sensor)
- Turn on RX4 sensor only
- Set the number of periods to 100
- Don’t forget to rise up all the limitations of distances (about 45m)
- Freeze the distance. How to do it see on [this slide…]



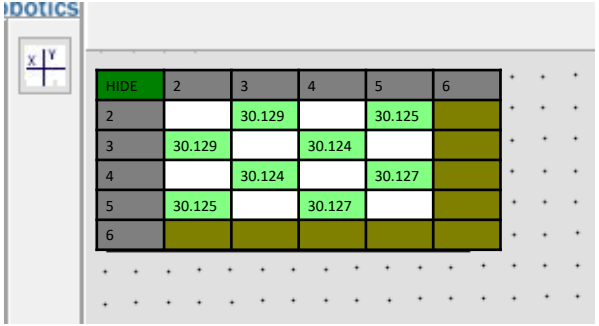
HIDE	2	3	4	5	6
2		30.129			
3	30.129		30.124		
4		30.124		30.127	
5			30.127		
6					

15.4: Step 4: Building the distances map (2, 5)



Finding distance between beacon 2 and beacon 5

- Face beacons to each other (facing RX4 sensor)
- Turn on RX4 sensor only
- Set the number of periods to 100
- Don’t forget to rise up all the limitations of distances (about 45m)
- Freeze the distance. How to do it see on [this slide…]



HIDE	2	3	4	5	6
2		30.129		30.125	
3	30.129		30.124		
4		30.124		30.127	
5	30.125		30.127		
6					

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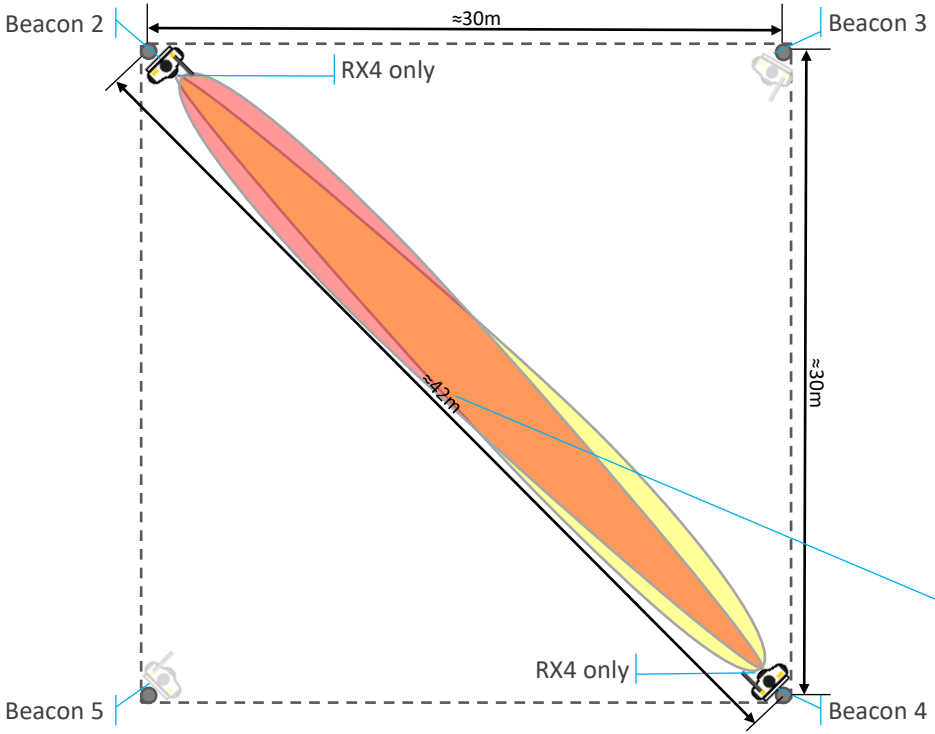
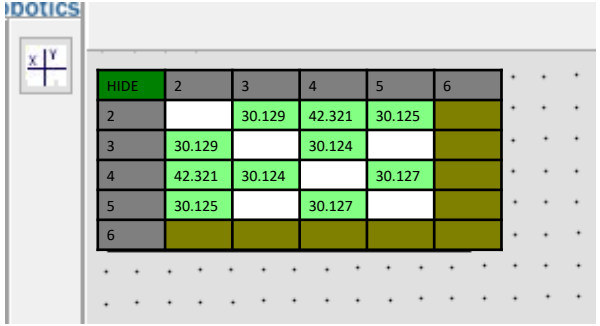
15.5: Step 5: Building the distances map (2, 4)



Finding distance between beacon 2 and beacon 4

- Face beacons to each other (facing RX4 sensor)
- Turn on RX4 sensor only
- Set the number of periods to 100
- Don’t forget to rise up all the limitations of distances (about 45m)
- Freeze the distance. How to do it see on this slide…



HIDE	2	3	4	5	6
2		30.129	42.321	30.125	
3	30.129		30.124		
4	42.321	30.124		30.127	
5	30.125		30.127		
6					

The map is still able to be built automatically, but as the distance is more than 30m, it may be complicated. In this case use some other ways to measure it (laser distance meter, tape, etc.).
Then input it manually

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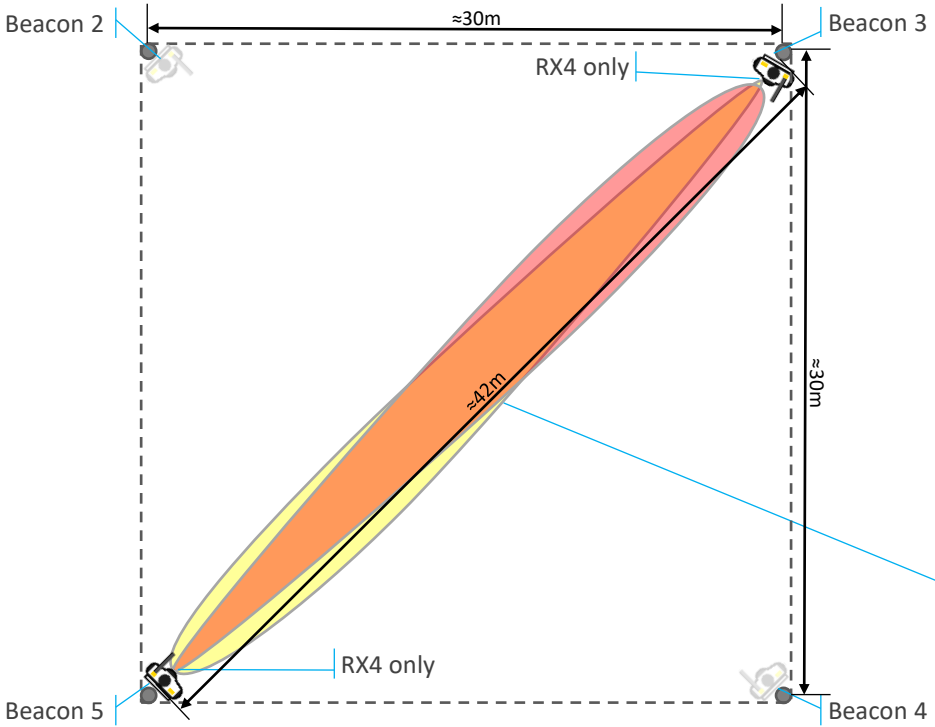
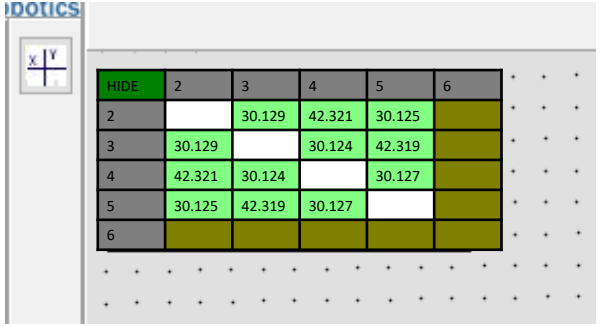
15.6: Step 6: Building the distances map (3, 5)



Finding distance between beacon 3 and beacon 5

- Face beacons to each other (facing RX4 sensor)
- Turn on RX4 sensor only
- Set the number of periods to 100
- Don’t forget to rise up all the limitations of distances (about 45m)
- Freeze the distance. How to do it see on this slide…



HIDE	2	3	4	5	6
2		30.129	42.321	30.125	
3	30.129		30.124	42.319	
4	42.321	30.124		30.127	
5	30.125	42.319	30.127		
6					

The map is still able to be built automatically, but as the distance is more than 30m, it may be complicated. In this case use some other ways to measure it (laser distance meter, tape, etc.).
Then input it manually

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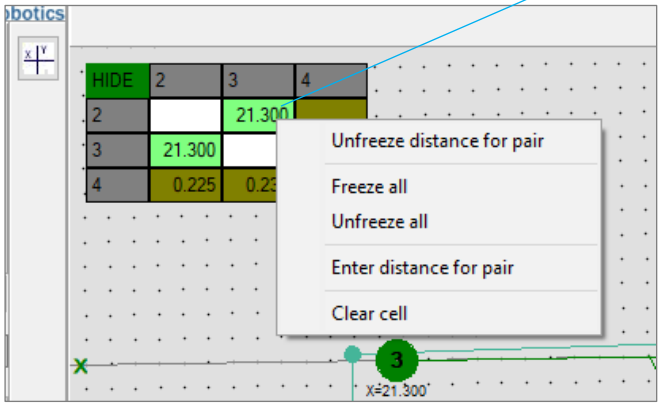
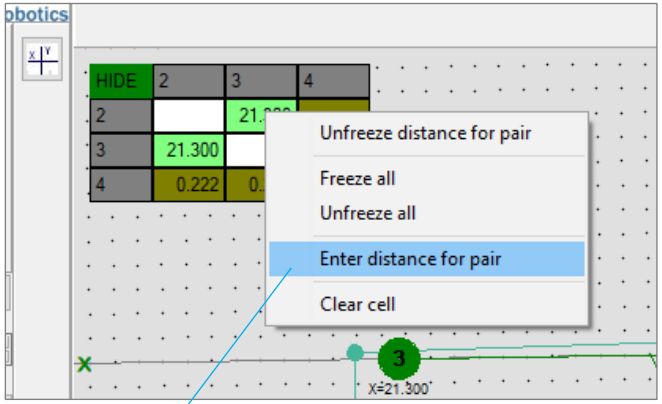
15.6a: Manual distance input

Right mouse button click on the distance tab

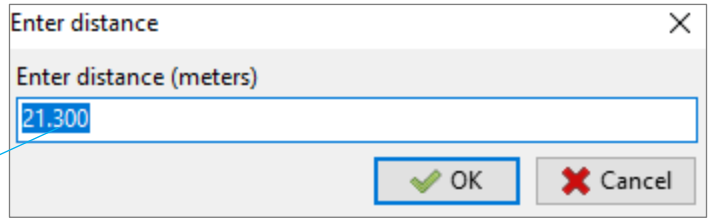


1



2

Click **Enter distance for pair**



Enter the distance

3

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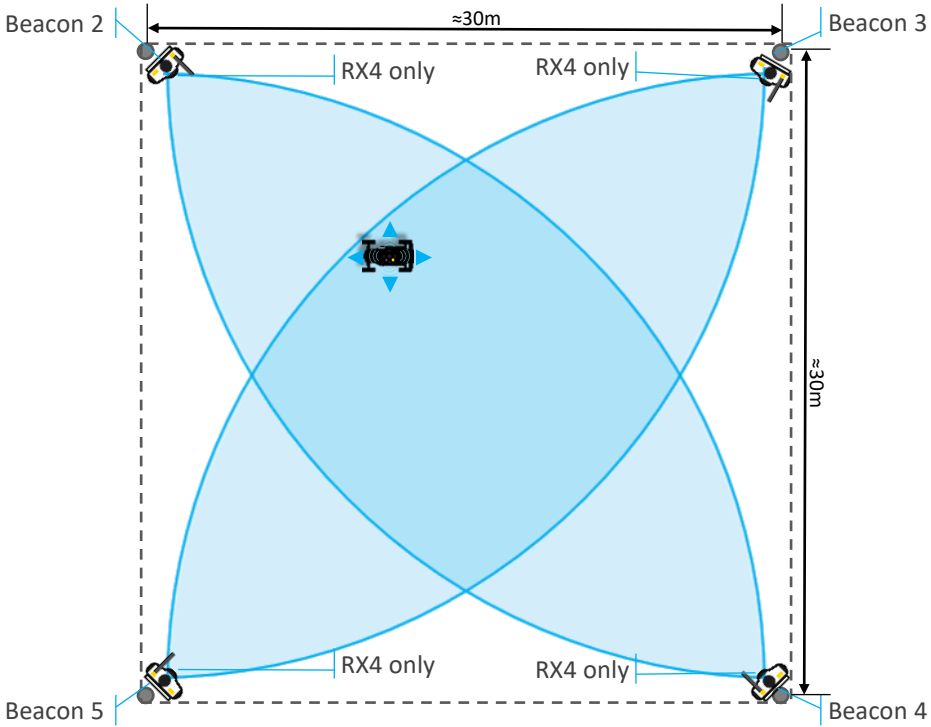
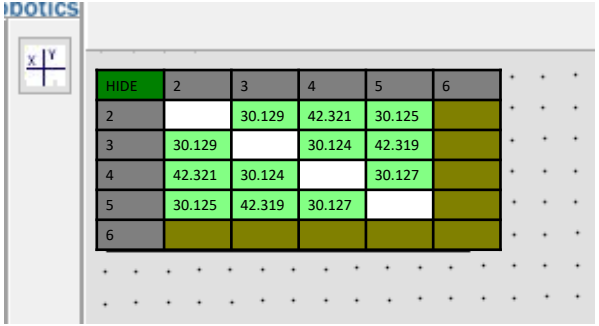
15.7: Step 7(a): The final configuration (3D tracking)



Final configuration for 3D

- Face beacons to the center
- Turn on RX4 sensor only – you will have the highest sensitivity and the highest noise resistance from other directions
- Freeze the map



HIDE	2	3	4	5	6
2		30.129	42.321	30.125	
3	30.129		30.124	42.319	
4	42.321	30.124		30.127	
5	30.125	42.319	30.127		
6					

Now, we finished installation and setting up.

That gave us an opportunity to track in a large area in 3D mode (x, y, z) with 3+1 redundancy in some zone.

Tracking zone is not really limited by 30m, but within 30m it is more confident, stable and reliable.

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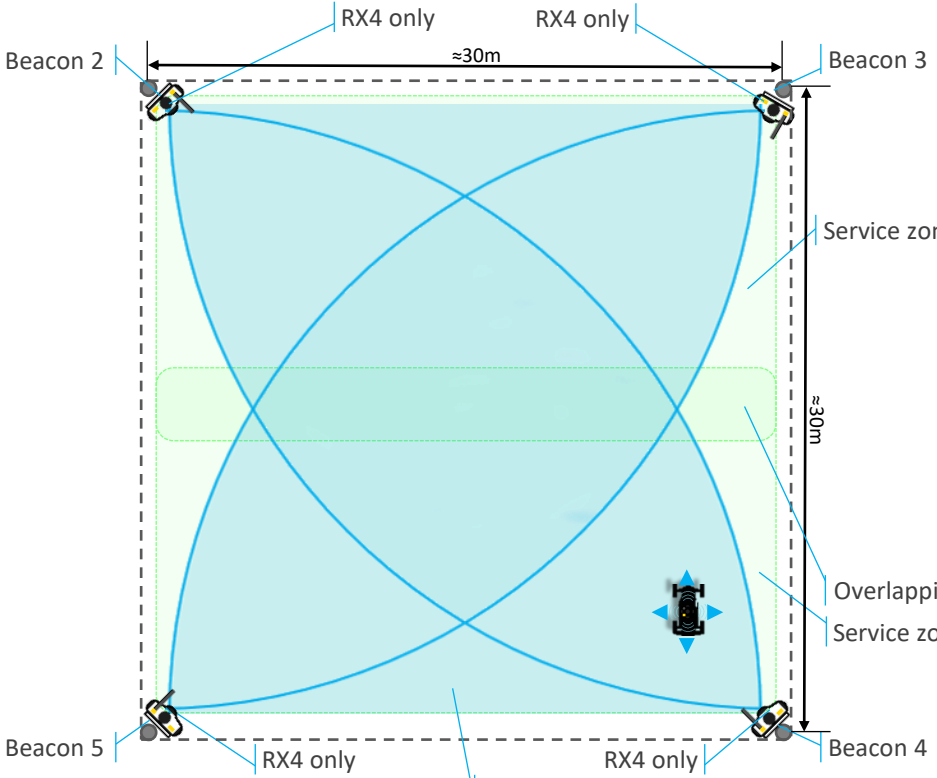
15.8: Step 7(b): The final configuration (2D tracking)



Larger coverage

As we can see, the tracking area of 2D configuration is bigger, but it doesn't provide Z (height) and redundancy. Choose the configuration, which suits your case

Final configuration for 2D

- Face beacons to the center (facing RX4 sensor
- Turn on RX4 sensor only (another option is turn on RX1, RX3, RX4. Depends on the situation)
- Build two submaps. Building submaps video
- Track robot, person, autonomous car and anything else

Now, we finished installation and setting up.

That gave us an opportunity to track in a large area in 2D mode (x, y).

Possible tracking zone in 2D is bigger than 3D – see the blue zones, but it has no Z axis measurement and redundancy.

Tracking zone is not really limited by 30m, but within 30m it is more confident, stable and reliable.

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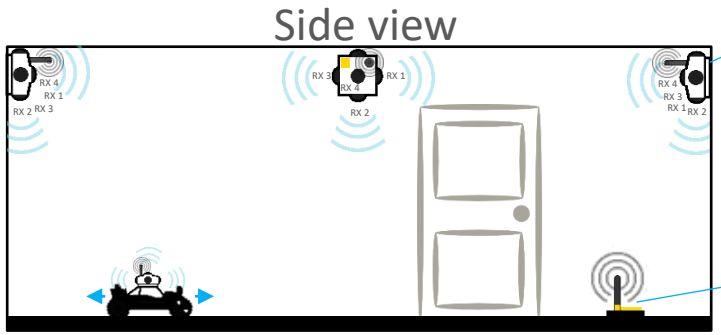
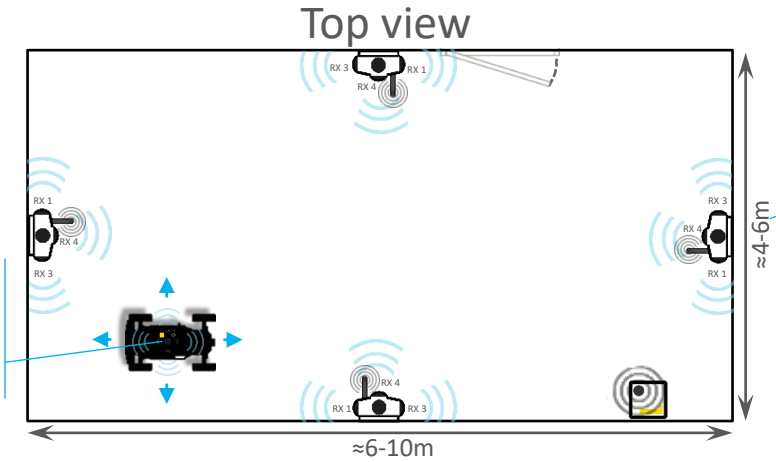
Legacy configurations

16: Starter Set HW v4.9 – simple 3D installation



Stationary Beacon HW v4.9
- Shall be placed on walls or ceiling – to minimize shadows in ultrasonic coverage
- Enable only required sensors – to improve sensitivity and external noise immunity. Each sensor has ~90deg beam

Modem HW v4.9
- Must be always powered, when tracking is needed
- May be placed up to tens to hundreds meters away from beacons depending on the resulting RSSI



Beacon HW v4.9
- Placed on a forklift/robot, person

Room
- Start with a midsize map of 6x4 to 6-10m or so
- Maximum size of the map for Starter Set is up to 1000m²

Configuration:

- Starter Set – HW v4.9:
  - 4 x stationary Beacon HW v4.9
  - 1 x Beacon HW v4.9
  - 1 x Modem HW v4.9

Notes:

- Designed for fast overall evaluation of the Precise (±2cm) Indoor "GPS"
- Supports 3D (X,Y,Z) + 1 redundancy, for example:
  - One forklift and warehouse
  - One-wheeled robot
  - One drone
  - One person
  - Tracking of one VR helmet
- Out of production, but still available for purchase. Get bug-fixing SW updates only.

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17: Contacts

- https://marvelmind.com/help/
- Marvelmind YouTube channel
- FAQ
- For additional support, send your questions to info@marvelmind.com

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