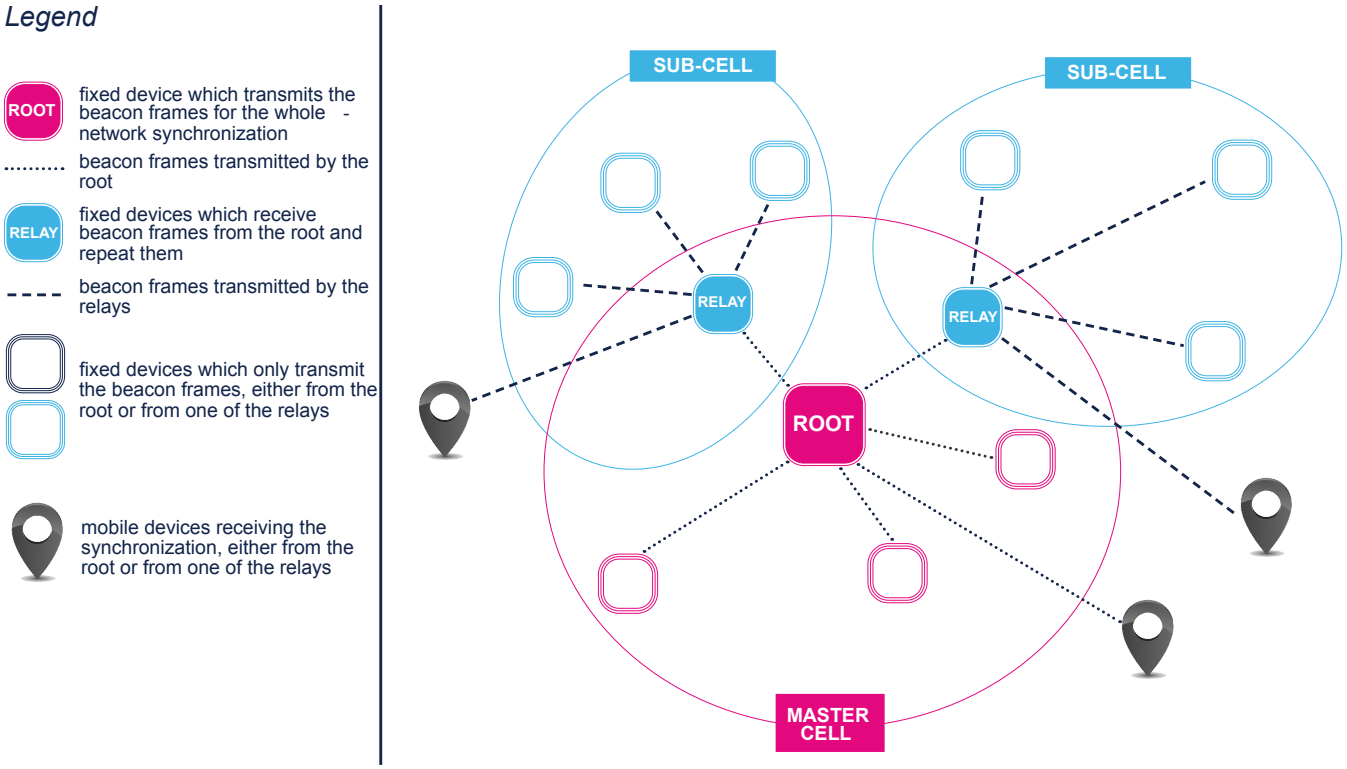
UWB network topology

Introduction

The first step of every deployment is an offline study of the area to cover all predictable environment constraints. An adapted UWB network topology is the key to ensure the best UWB communication between all devices and robust global coverage. This document is a general application note. It is not related to one particular product, like the B-UWB-MEK1 embedding the B-UWB-MOD1, but provides general information as well as a few examples which can be used for all location systems developed by BeSpoon.

Figure 1. Overview on the star network topology



1 General information

B-UWB-MEK1 embeds the B-UWB-MOD1, which features the STM32L476JE 32-bit microcontroller based on the Arm® 32-bit Cortex®-M4 processor.

Note: Arm is a registered trademark of Arm Limited (or its subsidiaries) in the US and/or elsewhere.

Definitions

Table 1 presents the definition of acronyms that are relevant for a better understanding of this document.

Table 1. List of acronyms

Term	Definition
3D_SELF	3D single self-positioning
BLR	Beacon-listening rate
HF	Hyperframe
PHS	Protocol hyperframe size
PSN	Protocol slot number
PSS	Protocol slot size
RTLS	Real-time locating system
RV	Rendez-vous (slot and zone)
SF	Superframe
SFI	Superframe information
TDMA	Time-division multiple access
UWB	Ultra-wideband

References

Refer to the following documents for an introduction to the B-UWB-MEK1 and B-UWB-MOD1 products in indoor location systems:

- Ultra-wideband module for high-precision indoor location (DB4404)
- Evaluation kit for the B-UWB-MOD1 ultra-wideband module (DB4392)
- B-UWB-MEK1 quick start guide (UM2798)
- Modification of the superframe information for UWB products (AN5602)
- SDK advanced documentation

Demonstration software

Contact the local STMicroelectronics sales office or distributor (refer to *www.st.com*) for the latest software and associated documentation.

2 Topology rules

The rules described in this document concern the fixed devices (infrastructure).

The topology starts from a master cell, managed by a root device. Its role is to ensure the time synchronization of the cell of other devices, by sending a beacon frame at a regular time interval.

The master cell can be composed of one root device and up to 63 other devices (current maximum capacity of the system). All the devices must be placed in a way they can receive the beacon frame of the root device. The root device can be placed at any position. Best practices may be to place the root in line of sight (LoS) with other anchors of the cell to give the best UWB synchronization link and so the best localization precision.

In case the beacon frame of the root device is not available for all devices (if the positions hinder LoS, for example), the system administrator must choose one or more devices to relay the beacon frame.

These devices are called relay devices also called secondary beacons, up to 15 devices can be chosen for this role. Then, other devices can be configured to listen to one of the relay devices to compose a sub-cell also called a secondary cell. Some other sub-cells can be created, synchronized on other relay devices for a highly extended setup.

Tracked devices also need to receive a beacon frame to be synchronized. They find by themselves (according to their positions) from which fixed device (root or relay) they may obtain their synchronization.

In Multi-Tag Tracking mode, the use of all relay devices is recommended to optimize the signal quality. In GPS-like positioning mode, the use of all relay devices is mandatory.

The exact amount of relay devices depends on advanced protocol settings called Superframe Information (SFI) and described in the application note *Modification of the superframe information for UWB products* (AN5602)

3 Deployment examples

Single master cell

A UWB network which contains one master cell without sub-cells is the most basic topology. Only one root device and at least 3 other devices are needed for proper 3D positioning.

Figure 2 shows an infrastructure with five devices (in our case: Anchors):

- Device 10 configured as the root device
- All other devices linked to the root:
  - *target Ref anchor = 10*

Be aware that this is the only example on small scale. The coverage capacity of the system is much higher.

Figure 2. Single master cell

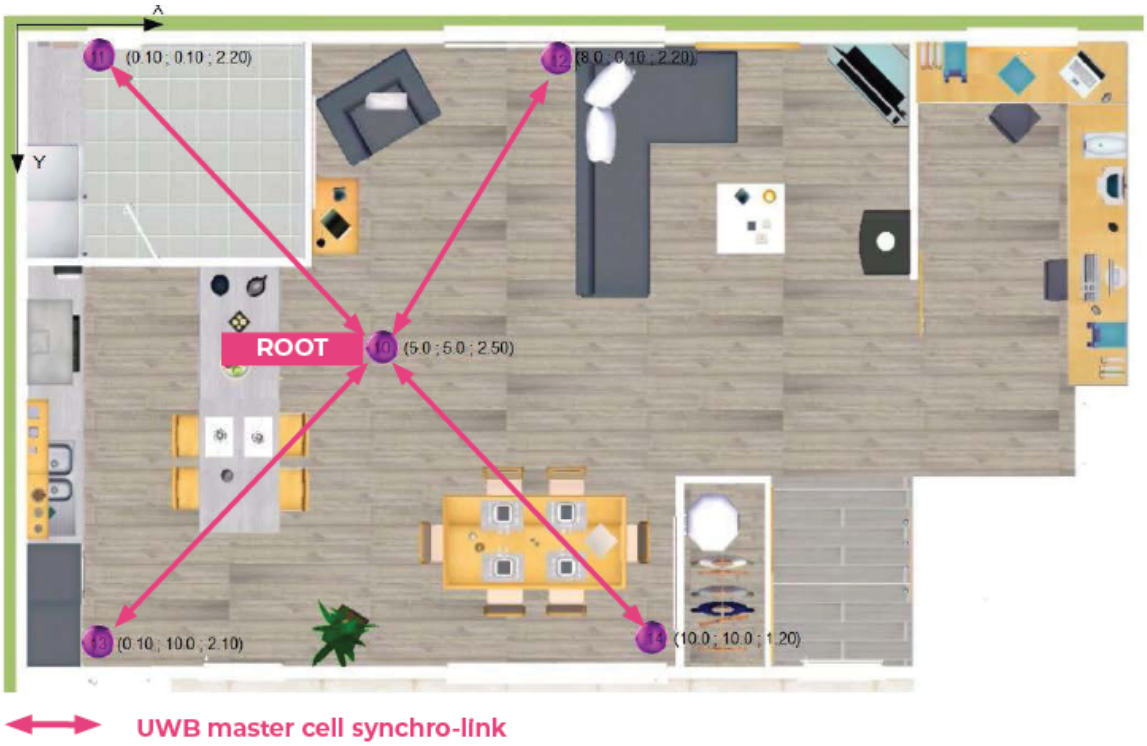


Table 2. One master cell without sub-cells topology

Anchor name	Anchor Mac address	X(m)	Y(m)	Z(m)	UWB Type	Beacon ID	Target Ref anchor
10	[0008:EE08:ACB7:000A]	5.0	5.0	2.50	Root	-	-
11	[0008:EE08:ACB7:000B]	0.10	0.10	2.20	-	-	10
12	[0008:EE08:ACB7:000C]	8.0	0.10	2.20	-	-	10
13	[0008:EE08:ACB7:000D]	0.10	10.0	2.10	-	-	10
14	[0008:EE08:ACB7:000E]	10.0	10.0	1.20	-	-	10

Relay device

Here is an example where the administrator chooses to add a relay device to deal with a localization problem in the room where device 11 (an anchor) is placed.

In this area, the tracked device has trouble getting synchronized with the root device because of a white obstacle, shown by the left side of the black arrow in Figure 3. Adding a relay device role to anchor 11 can solve this issue as the tracked device automatically searches for the best beacon available for synchronization. Device 11 is configured as shown in Figure 3:

- UWB Type: Beacon
- Beacon Id: 1

Figure 3. One master cell with relay device topology

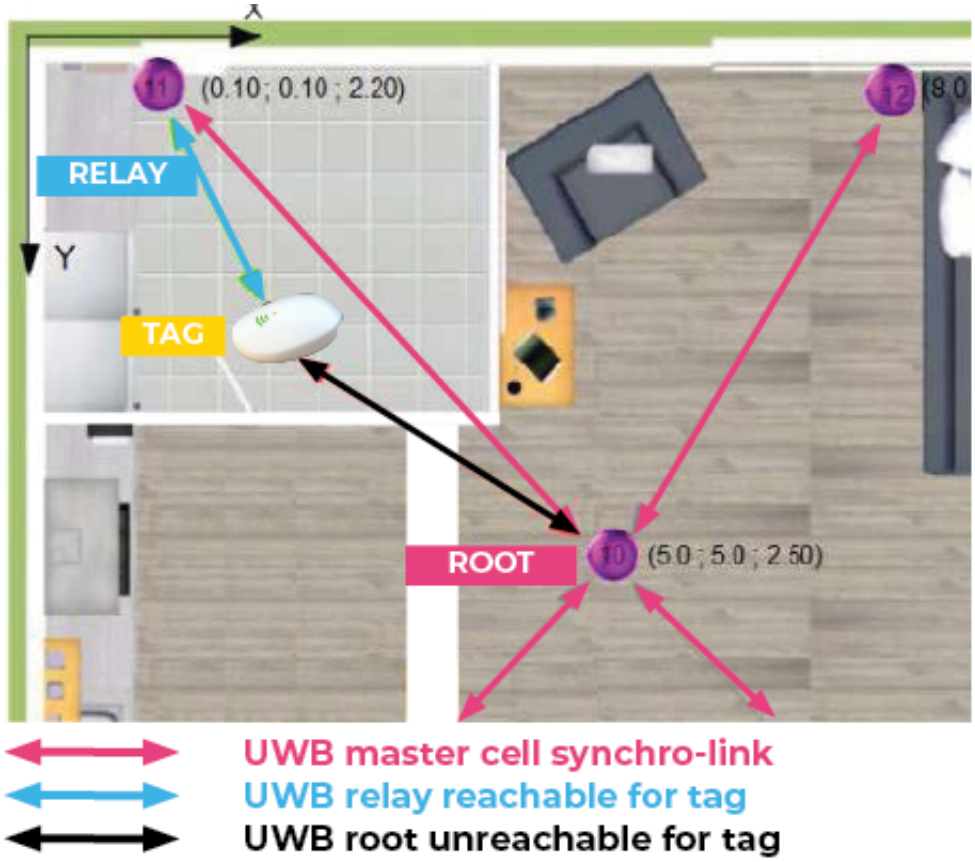


Table 3. One master cell without sub-cells topology

Anchor name	Anchor Mac address	X(m)	Y(m)	Z(m)	UWB Type	Beacon ID	Target Ref anchor
10	[0008:EE08:ACB7:000A]	5.0	5.0	2.50	Root	-	-
11	[0008:EE08:ACB7:000B]	0.10	0.10	2.20	Beacon	1	10
12	[0008:EE08:ACB7:000C]	8.0	0.10	2.20	-	-	10

Sub-cells

In cases where the area to cover is very large and so all the devices cannot get synchronized with the root device, sub-cells can be created to extend the range. Each sub-cell is managed by a relay device and all the devices of the sub-cell are synchronized with it, as shown in Figure 4.

Figure 4. One master cell with sub-cells topology

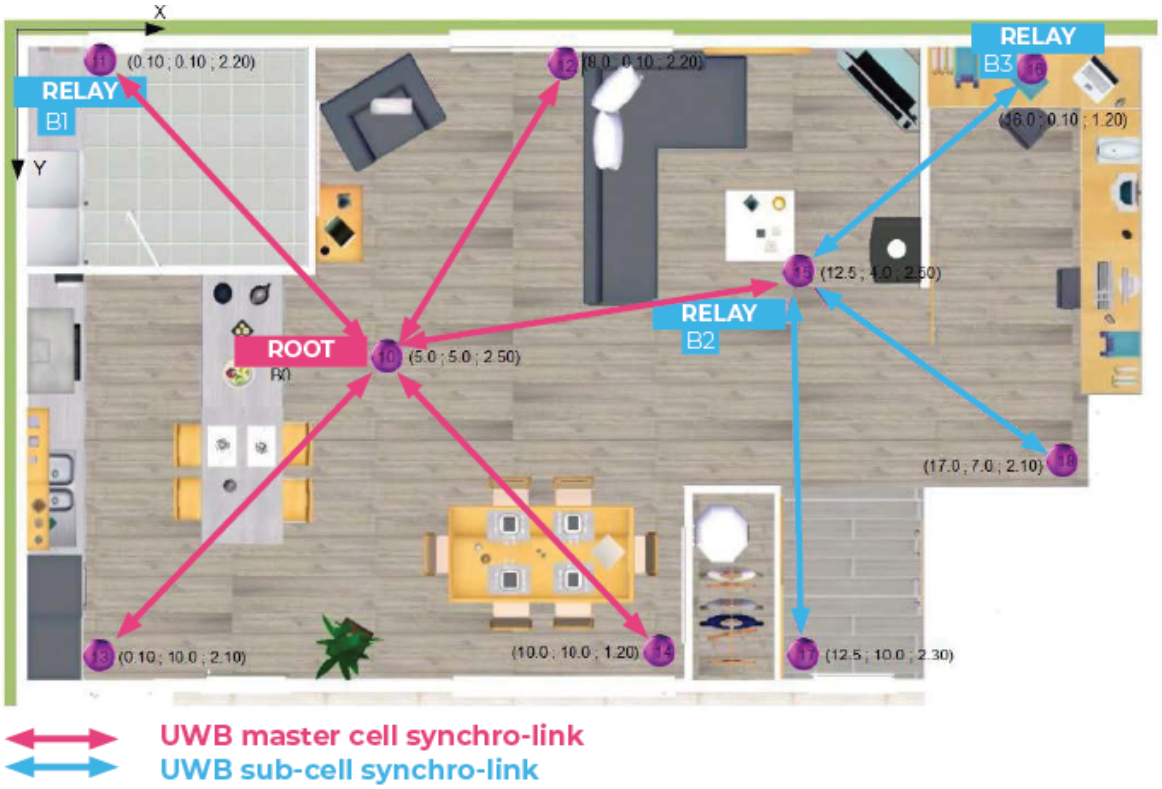


Table 4. One master cell without sub-cells topology

Anchor name	Anchor Mac address	X(m)	Y(m)	Z(m)	UWB Type	Beacon ID	Target Ref anchor
10	[0008:EE08:ACB7:000A]	5.0	5.0	2.50	Root	-	-
11	[0008:EE08:ACB7:000B]	0.10	0.10	2.20	Beacon	**1**	10
12	[0008:EE08:ACB7:000C]	8.0	0.10	2.20	-	-	10
13	[0008:EE08:ACB7:000D]	0.10	10.0	2.10	-	-	10
14	[0008:EE08:ACB7:000E]	10.0	10.0	1.20	-	-	10
15	[0008:EE08:ACB7:000F]	12.5	4.0	2.5	Beacon	**2**	10
16	[0008:EE08:ACB7:0010]	16.0	0.1	1.2	Beacon	**3**	15
17	[0008:EE08:ACB7:0011]	12.5	10.0	2.3	-	-	15
18	[0008:EE08:ACB7:0012]	17.0	7.0	2.1	-	-	15

4 Ask for support

Additional information is available from the documents listed in References. All documents may be updated without notice to individual users beforehand.

For up-to-date support or information about standardized as well as customized solutions, refer to the UWB and product pages on *www.st.com*, or to the nearest STMicroelectronics office.

Revision history

Table 5. **Document revision history**

Date	Revision	Changes
20-Apr-2021	1	Initial release.

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