IIDRE

White Paper

qorvo all around you

UWB Design Partner since 2017

Decawave

esa business incubation centre Sud France

since 2014

Sources:

DECAWAVE/QORVO WHITE PAPER

https://www.qorvo.com/innovation/ultra-wideband/partners/iidre

https://www.iidre.com/en/home/

Headquarters: France, Bordeaux - Merignac

Region(s) Served: EMEA

IIDRE is a **hardware/software RTLS solution** using the **ultra-wideband (UWB)**. With other technologies, IoT and powerful algorithms, IIDRE provides to his customers high accuracy and real time. IIDRE addressed his solutions for robots, autonomous vehicles, and drones with UWB real time locating solutions. Nowadays, IIDRE offers UWB precise geolocation solutions for indoor fleet management regarding Industry 4.0, smart mobility, etc.

The UWB has the capability to solve indoor location tracking with a clear target: do not waste time to look after items in manufacture processes. IIDRE provides his own GNSS/GPS RTK with ground station to allow a seamless continuity and calculation reference. Nowadays, IIDRE offers 3 types of solutions:

- **Tracking** with a tailored solutions Real Time Locating Solutions for autonomous engine control; Easy deployment, large range, good accuracy, and data rate (TWR).

- **Supervision** for goods or people: up to 1000 indoor assets with a small tag and large autonomy (TDoA).

- **No infrastructure and badges** for distances between persons (physical distancing) or machines (Safety bubble zone): No infrastructure required, good accuracy, large range and data rate (Distance).

UWB General description

The indoor geolocation solution provided by IIDRE uses ultra-wideband (UWB) technology. This solution is based on signals exchanged between mobiles (also called “Tags”) placed on the elements to be tracked (vehicles, goods, persons) and a set of “Anchors” preliminarily georeferenced in the Tags progression area. The UWB signals exchanged (double-sided two-way ranging protocol for time-of-flight measurement - ToF) make possible to determine the distances between the tags and each anchor. This then allows for a multilateration algorithm to compute the tags positions onto a 2D plan from both measured distances and anchors coordinates.
The embedded intelligence in the tags allows for the IIDRE geolocation solution to ensure a good accuracy, even in dense environments, no matter the velocity of each tag.
The geolocation solution provided by IIDRE is easy to deploy. Furthermore, anchors can be added to the infrastructure during runtime, thus giving a great scalability. Wide areas may be covered thanks to transceivers achieving a high range of up to 100 meters, depending on the configuration and the surrounding environment.
A dedicated application allows for the configuration of both UWB parameters and infrastructure. This application also displays tags motions on a map. Therefore, diagnostic information with characteristic features is available to determine the best configuration and troubleshoot the system (histograms of the distances relative to each anchor, number of distances measured, RF quality, ...). Note that another application tailored for asset tracking have also been developed to help the user to process the data monitored thanks to devoted metrics, such as: the covered distance, the average speed, an analysis of the stops (number, duration and location) and a heatmap generation.

UWB Material

The USB dongle is a UWB Tag/Mobile that works with other UWB devices. It connects to an external battery or computer to communicate data. Like all devices, it can act as an Anchor or a Gateway.

The special feature of this device is that it is very simple to connect to a computer via USB to send data. It has a 9-axis inertial unit with an accelerometer, gyroscope, and magnetometer.

- Tag:
  - 50x23x15 mm
  - 15 g
- Anchors:
  - 85x55x20 mm
  - 56 g
  - Built-in nut (1/2")

Technology: UWB IEEE 802.15.4-2011

Operating Frequency: 3.5 to 6.5 GHz

Bandwidth: 500 MHz (4 channels) or 900 MHz (2 channels)

Data rate: 110 kbps, 850 kbps or 6.8 Mbps

Range: wide area coverage, up to 5,000 m²

Refresh rate: in the order of 100 positions per second

Communication: UART or USB

DC characteristics: 5 V -100 mA (typ.)

Easy to use

Easy access to the parameters

Indoor/outdoor deployment

Accurate geolocation

Extendable area thanks to great scalability offered by the adaptative numbers of anchors

Over-the-air-configuration

Tracking of a fast-moving Tag

Embedded 9-axis absolute orientation sensor

Accuracy in the region of 10-30 cm

Transceivers range up to 150 m in Line of Sight (LoS)

Tag positions rate up to 50 Hz

Adaptability to the surrounding environment (tunable UWB parameters)

Adaptability to the host system (data rate, coordinates format, power supply)

Non-Line of Sight (NLoS), Direct Patch, … measures management

UWB Interfaces

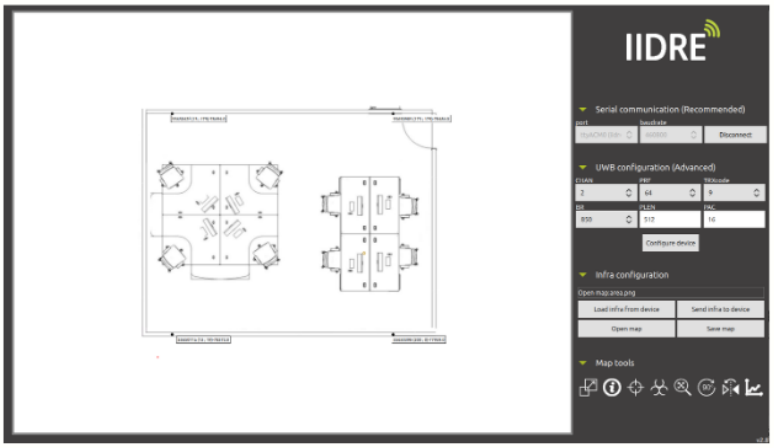
Cloud access or Cross-platform install.

RTLS by IIDRE – companion software for real time data monitoring and infrastructure management.

Traceability by IIDRE – software suite for real time data view and manage with heatmap, zoom, spaghetti trace.

Direct USB interface to parameter, record, or plot (terminal, putty, …).

UART Connectivity.



Cross-platform application for real-time data visualization and data logging which offers unlimited post-processing possibilities. User friendly interface for infrastructure management and for tunable UWB parameters.

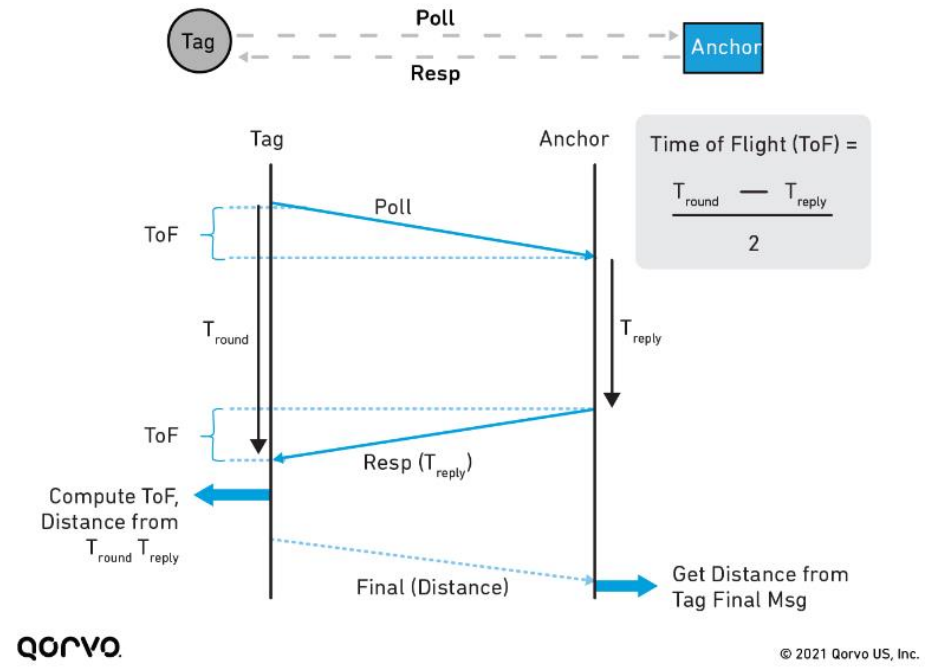
UWB Topologies

UWB technology can be implemented in different ways to address a wide range of different needs. The principal topologies are:

- Two way ranging (TWR)
- Time difference of arrival (TDoA)
- Reverse TDoA
- Phase difference of arrival (PDoA)

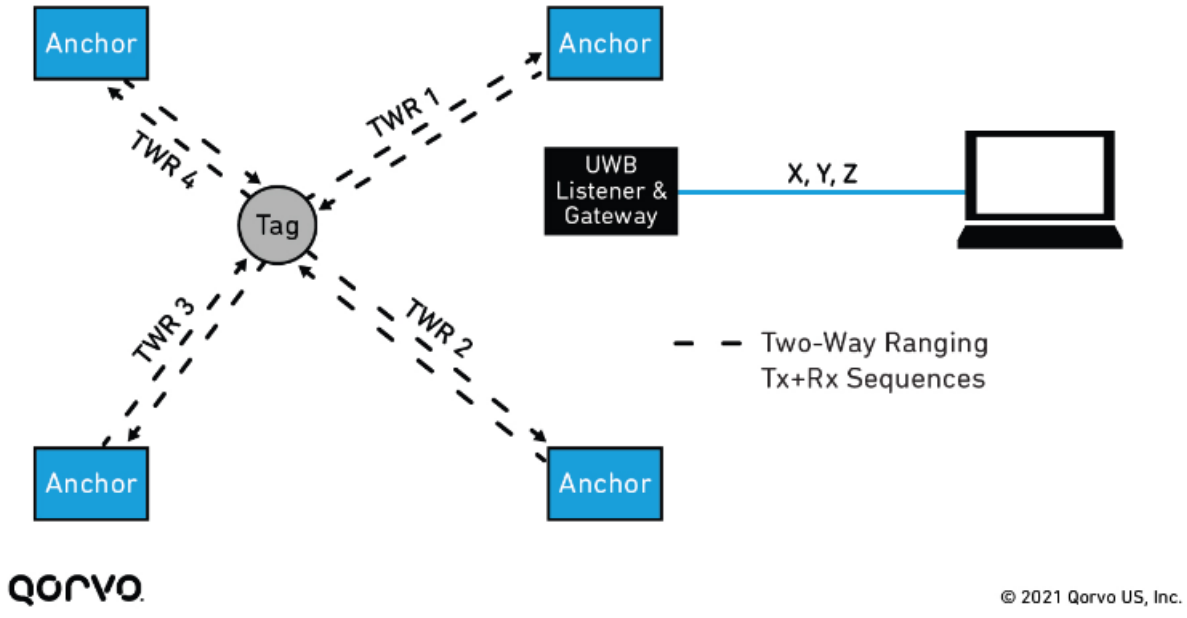
To understand distance and location measurement with UWB, it's important to know the terms "anchor" and "tag." An anchor is generally a fixed UWB device with a known location. A tag generally refers to a mobile UWB device.
An anchor and tag exchange information to establish the distance between them. The exact location of a tag can be determined by communication with multiple anchors.
Some devices can act either as an anchor, as a tag, or both. For example, when two mobile phones use UWB to calculate the distance between them, they may switch roles during the process, alternately acting as tag and anchor.
Two-Way Ranging (TWR). The TWR method calculates the distance between a tag and an anchor by determining the time it takes for UWB RF signals to pass back and forth between them (ToF) and then multiplying that time by the speed of light. A keyless car entry system is an example of an application that uses TWR for secure and accurate distance determination.

Figure 3: Secure two-way ranging between UWB tag and anchor.



As shown in Figure 3, the tag initiates TWR by sending a poll message with the known address of an anchor. The anchor records the time that it receives the poll message and sends a response. When the tag receives the response, it calculates the signal ToF based on the signal round-trip time (T_{round}) and the time it took for the anchor to process and reply to the initial poll message (T_{reply}). The distance is calculated by multiplying the ToF by the speed of light. The tag can then pass the calculated distance to the anchor in a final message if required.
With multiple anchors, each requiring its own antenna, TWR can be used to determine the absolute position of mobile devices or other tags. By determining the distance to three or more anchors in known locations, the device can estimate its location with great accuracy. It can then communicate the distance via UWB or other wireless technologies to location-based applications or gateways, as shown in Figures 4 and 5 below. The disadvantage of using TWR for location measurement in this way is that the tag has to do a lot of communication, which increases its power consumption and limits scalability.

Figure 4: Two-way ranging with 2D/3D assets and listener.



UWB Regulation

UWB operates in regulated unlicensed spectrum, so anyone can implement UWB communications without a telecommunications license as long as their system operates within the regulated frequency and power range.
The Federal Communication Commission (FCC) has defined UWB systems as those operating with an absolute bandwidth (larger than 500 MHz) at a maximum power density at a central frequency (f_c) above 2.5 GHz, or fractional bandwidth greater than 0.2 with f_c lower than 2.5 GHz.
Figure 10 illustrates the calculation of absolute bandwidth (B) and fractional bandwidth. Maximum power density is at the central frequency f_c, and f_H and f_L are the high and low frequencies at which the power spectral density is 10 dB below f_c. B_{frac} is defined as B/f_c. In terms of high and low frequencies, we have

$$f_c = \frac{(f_H + f_L)}{2} \quad \text{so} \quad B_{frac} = 2 \times \frac{(f_H - f_L)}{(f_H + f_L)}$$

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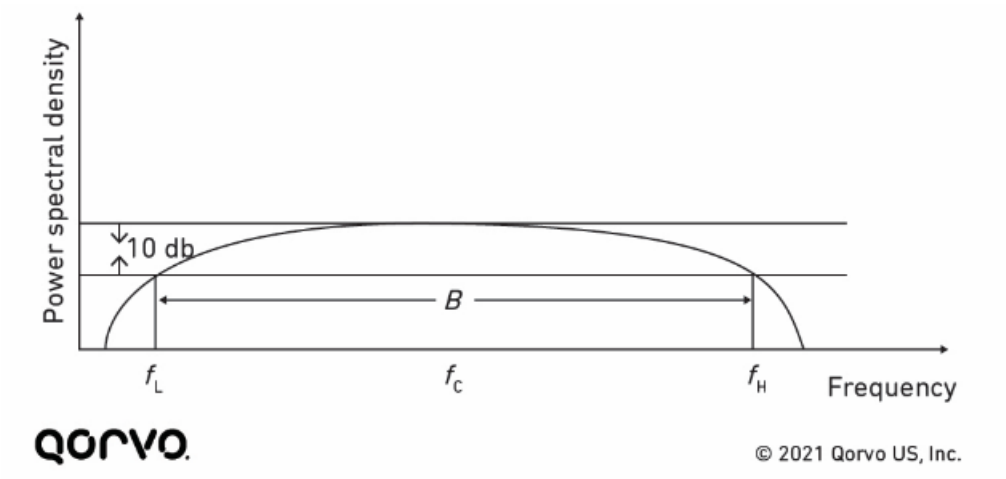
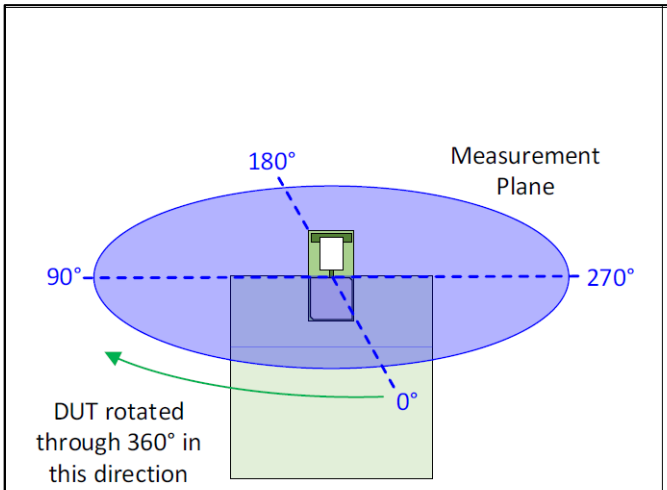
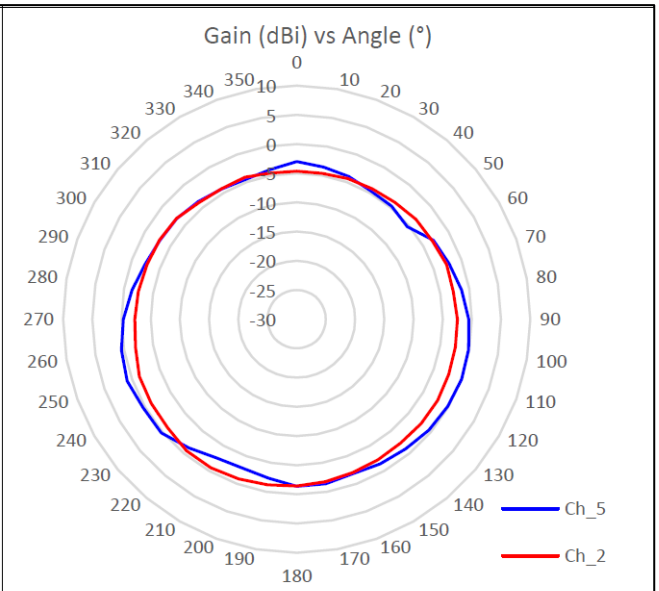
Figure 10: Low, central and high frequencies of a UWB system.



UWB Performance





Azimuth Plane (Theta)