LEAPS RTLS Specification

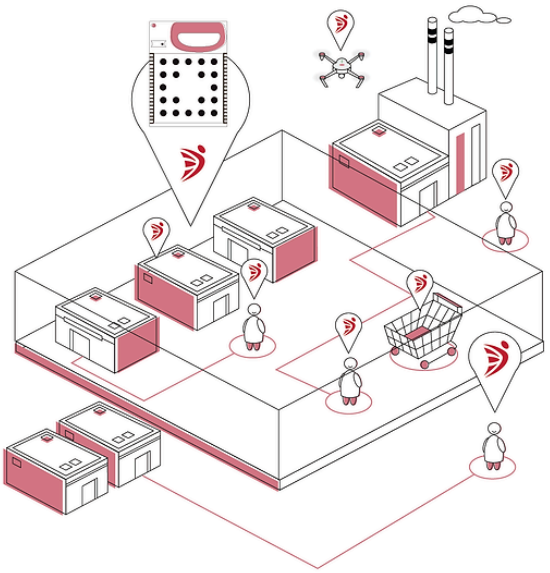
LEAPS RTLS Overview

This section provides an overview of the LEAPS RTLS system from a broader perspective.

Key Features

The LEAPS RTLS system provides an advanced and comprehensive solution for real-time accurate positioning and data telemetry using Ultra-Wideband wireless technology. The core of the solution is the highly sophisticated embedded software stack called LEAPS UWBS (Ultra-Wideband Sub-system) that offers many advanced features, including:

- A great versatility in a small footprint makes LEAPS a unique Swiss Army knife for accurate positioning and data telemetry in real-time. The UWB Sub-system is based on one firmware and is configurable in different modes and networking profiles.
- Highly embedded, effective, optimized stack focusing on versatility, high performance, low memory, and low power consumption.
- Proven system scalability deployed in various large-scale plants and buildings with an operational range of 50,000+ m^2.
- A modular structure facilitates adding new features and support for new hardware, which currently supports over 15 distinct board types and variants.
- Currently, it is available on various hardware platforms, including Murata 2AB, DWM3001C, DWM1001C, ISP3080, Ambiq Micro MCU and Linux Driver.
- An extensive API allows users to easily configure and customize the system according to their specific needs, providing a highly adaptable and versatile solution for real-time location tracking. The application can use binary Type-Length-Value (TLV) frame format via various interfaces like UART, USB, SPI, BLE or human readable shell command line over UART, USB and BLE interfaces.



- The LEAPS RTLS system also provides an extensive range of free software tools that allow easy configuration and management of the system.
- A continuous development of the LEAPS RTLS will provide more features to cover a wider range of applications in the future. This allows the users and product builders to learn one concept and deploy in many applications.

Performance

- The networking stack is designed in the way that it always aims to reuse the air-time using an effective mechanism for both Anchors and Tags. This allows a virtually unlimited amount of nodes to be deployed in a spread area. All of this happens automatically using effective mechanisms of Anchors Auto-Clustering and Tags Roaming.
- Depending on the measurement mode of the Tags, the maximum density can be 320 Hz for the TWR, 600 Hz for the UL-TDoA or an unlimited amount of Tags when DL-TDoA is used. The maximum density is achieved under specific conditions, when all the

Tags are in range with each other, then there can be e.g. 3200 Tags with an update rate 0.1Hz, 320 Tags @ 1Hz or 32 Tags @ 10 Hz. The Tags would function with zero or minimum interference with each other.

- Maximum tag location rate: Depending on network profile and measurement mode. Typically, 10 Hz for TWR, DL-TDoA and UL-TDoA. DL-TDoA can provide up to 50 Hz update rate per Tag.
- X-Y location accuracy: Better than 50 cm, typically 20 cm.
- Point-to-point range: Up to 50 m in Line-of-Sight conditions (CH5/CH9) with LNA, up-to 150 m when PA is used.
- Infrastructure deployment grid size: Typically, 20 x 20m and can work up-to 40 x 40m, with LNA.
- Superior power management provides a long battery lifetime for TWR and TDoA modes.
- Adaptive location rate using motion sensor activity enables a longer battery lifetime and a higher total amount of Tags.

Typical Applications

The Ultra-Wideband technology can enable a wide range of applications, with some typical applications listed below.

SMART CITIES & MOBILITY

- Indoor Navigation
- Driverless Valet Parking and Pick-Up
- Parking Garage Access Control

SMART BUILDING & INDUSTRIAL

- Social Distancing
- Indoor Navigation
- Employee Gathering in Emergencies
- Asset Tracking
- Find Equipment
- Patient Tracking
- Proximity-Based Patient Data Sharing

SMART RETAIL

- Foot Traffic and Shopping Behavior Analytics
- Exhibition Attendee Management

SMART HOME & CONSUMER

- Point and Trigger Controller Application
- Residential Access Control
- Easy (Logical) Access to Personal Devices
- Find Someone/Something Nearby
- Presence-Based Device Activation

About Us

- LEAPS is a company based in Prague (the Czech Republic, EU) that focuses on building and marketing Real-Time Location and Real-Time Telemetry systems based on Ultra-wideband.
- With more than 10 years of experience in system development using Ultra-Wideband, LEAPS has one of the most innovative teams in converting the Ultra-wideband chip into a useful solution.
- LEAPS is the creator of the popular DWM1001C, MDEK1001, DWM3001C and PANS RTLS.
- LEAPS has been focusing on providing RTLS hardware and software, design services, and technology licensing.
- LEAPS RTLS is a collection of advanced software that provides location services for a wide range of use cases. It offers the most advanced fully-embedded UWB Sub-System on the market that covers features ranging from proximity, navigation and tracking to real-time data telemetry and routing backhaul. Imagine a GPS module but using Ultra-wideband and with far more functionality.
- LEAPS provides a new dimension that helps businesses locate new values, improve process efficiency, increase safety, improve reliability, navigate indoors, process automatization ...

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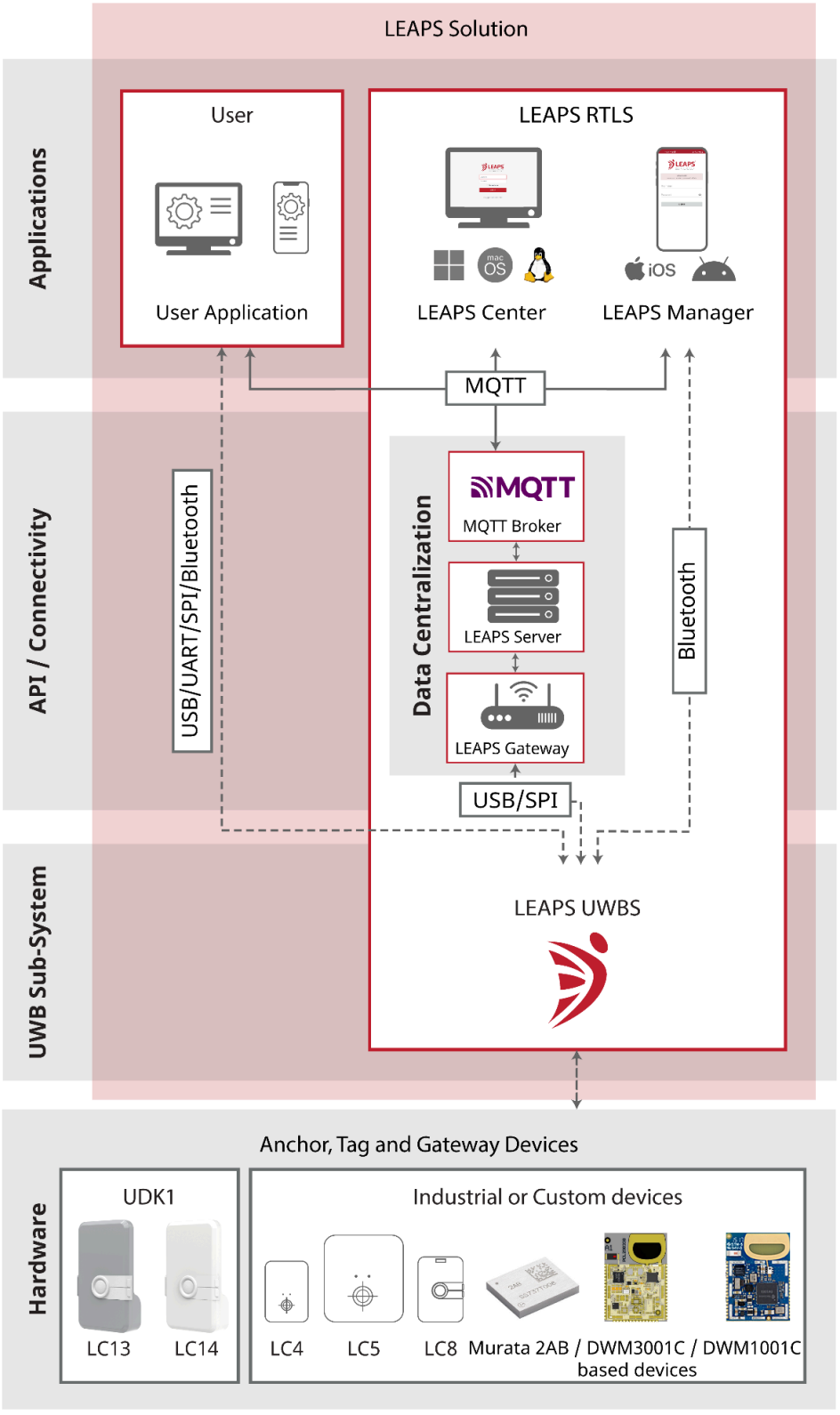
System Architecture Overview

This section provides a more detailed understanding of the LEAPS RTLS and outlines its specific components, which are further elaborated in the following subsections.

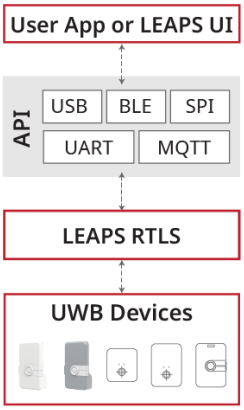


LEAPS UWBS

LEAPS UWBS is a fully-embedded and advanced UWB Sub-System that covers a wide range of use cases. One UWB Sub-System is configurable in different modes and profiles. The UWBS can run as an Anchor, a Tag or a Gateway. The networking profiles are fully scalable with high capacity and low power.

- Versatility makes it easy to balance the system requirements, costs, deployment time and maintenance complexity. Applications range from simple distance proximity, to high speed tracking or navigation of unlimited receivers.
- It integrates a sophisticated UWBMAC that allows adaptive clustering of the infrastructure devices, air-time reuse, slot allocation, etc. A scalable, proven collision detection, collision avoidance, and collision resolution allow the system to function robustly in complex environments.
- Supported measurement techniques include TWR, DL-TDoA and UL-TDoA. Integrated location engines allow the device to operate independently in the navigation mode using DL-TDoA or TWR.
- Superior power management provides a long battery lifetime for TWR and TDoA modes.
- The LEAPS RTLS supports the Ultra-wideband RF compatible with IEEE802.15.4 on UWB Channels 2, 3, 5 and 9 and IEEE802.15.4z on UWB Channels 5 and 9.

LEAPS API



- The LEAPS RTLS software stack provides a range of advanced and open APIs that allow easy configuration of the device to suit custom applications. It provides users with flexibility to tailor the system to their specific needs.
- It utilizes the binary Type-Length-Value (TLV) frame format, making it easier for external devices via UART, USB, SPI and BLE interfaces. When data centralization is used, the communication via MQTT using JSON is available for the high-level applications.
- A command line is supported through the UART, USB and BLE interfaces with more user-friendly and readable text.

LEAPS Manager

LEAPS Manager

LEAPS Manager is a mobile application, available for both iOS and Android, that provides device discovery, device configuration, network configuration, network management and location visualization.

- The Demo Wizard allows an easy and super fast way to configure predefined demo setups of the kit.
- The Grid in 2D and 3D provides real-time position updates and visualization of the devices in the network.
- The communication with the devices is done via the BLE with support for up to 6 concurrent connections to maintain connection reliability.
- When data centralization is used, communication with the LEAPS Server via MQTT is available, allowing remote management and visualization of the devices for the whole network.
- Other useful features include User Management, Firmware Update over BLE, Anchors Auto-Positioning, Position Logging and Debug Console.

LEAPS Gateway

LEAPS Gateway

LEAPS Gateway serves as a bridge between the UWB and the TCP/IP networks.

- The LEAPS Gateway communicates on one side with the LEAPS UWBS via the generic LEAPS API

over SPI or USB, and on the other side with the LEAPS Server via the TCP/IP.
- Depending on the LEAPS UWB networking profile, it provides a medium for transferring uplink and downlink location and telemetry data of the Anchors and Tags to and from the MQTT Broker.
- The interconnection with the UWBS is done via the SPI on a dedicated LEAPS Gateway embedded device. When the interconnection with the LEAPS UWBS is done via the USB, like in the case of the UDK1 devices, LEAPS Gateway runs on a Linux platform as a daemon service.

LEAPS Server

LEAPS Server is a central data hub for the UWB network. It interconnects all the LEAPS Gateway devices with the world via a MQTT Broker.

- It functions as an uplink data concentrator, downlink data router, data processor, location engine, device management, device access control and quality of service.
- It communicates with the world via the connectors. Currently, the supported connector is MQTT, which includes support for AWS.
- The LEAPS Server runs as a daemon service on the Linux platform.

MQTT Broker

An MQTT broker is a server that receives all messages from the clients and then routes the messages to the appropriate destination clients. An MQTT client is any device (from a micro controller up to a fully-fledged server) running an MQTT library and connecting to an MQTT broker over a network.

LEAPS Center

LEAPS Center is a web application that provides device management, network management and visualization of location and telemetry data for the whole network.

- The Grid in 2D and 3D provides real-time position updates and visualization of the devices in the network.
- Other useful features include User Management, Zone Management, Zone History, Floorplan Management, Position History and Position Heatmap.
- The LEAPS Center interconnects with the LEAPS Server via the MQTT Broker. It runs as a service on Linux and Windows platforms.