WHITE PAPER

Ultra-Wideband (UWB) Enables Smart Factory of the Future

Introduction

Micro-location is essential to digitalizing industrial operations through Industry 4.0, smart factory and LEAN initiatives. Process optimization and safety – the two prime considerations to most industries – become more informed through tying who, what, when and where to people, tools, supplies, goods, machinery and events – in real-time.

Current location-based technologies – GPS, Wi-Fi, and **Bluetooth®** Low Energy – cannot achieve micro-location at the precision industry requires. GPSs under ten-meter precision enabled an explosion of retail e-commerce and allowed us to dump those big map books; Wi-Fi helped nail down even finer location precision; and Bluetooth Low Energy locates within a few feet in ideal conditions. But industrial and business applications need finer precision and much higher reliability.

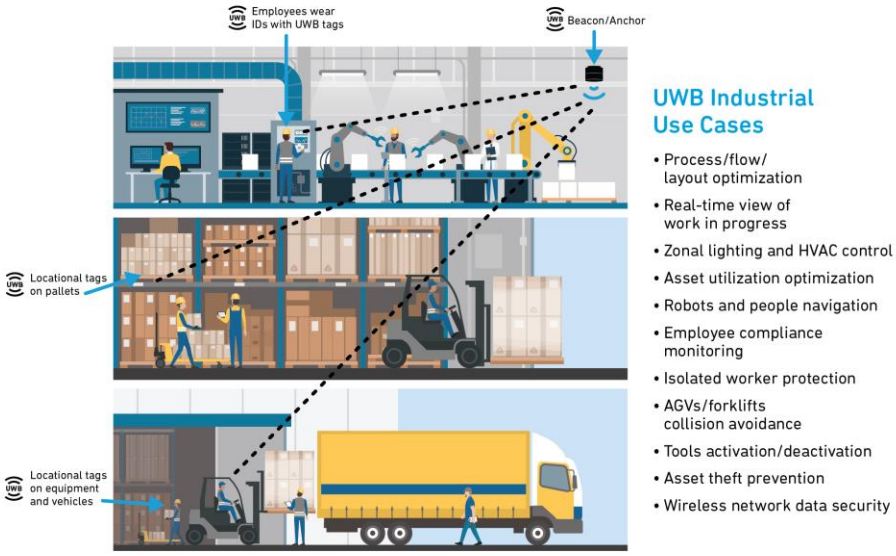
Micro-location in Industrial Settings

UWB technology's centimeter-scale precision has enabled a level of location and communications unmatched by these previous technologies. It is the driving technology behind *micro-location* services, where radio anchors locate tags within as little as a few centimeters. Micro-location delivers information in real-time and allows analytics systems to measure, analyze and alert – instantly. Consider these scenarios with UWB technology in place.

- Process flow – in a production workflow where materials are inches from each other, strategically placed UWB tags and anchors can track material, goods, processes and tasks across the entire production process, while updating production systems that measure and calculate efficiency in real-time and identify – and even predict bottlenecks.
- Asset utilization and retrieval – a tagged tool or other asset in a plant can be quickly located, and workers guided to it through high-precision plant maps on handheld devices.
- Material control – tagged equipment, medical devices and sensitive items, such as controlled substances in hospitals, can be located anywhere in a building and their usage clearly monitored.
- Safety – tags on machinery, such as robotic arms and forklifts, and employee badges, allow automated safety systems to track proximity to sub-meter precision and real-time accuracy to stop machinery and alert personnel when a safety zone violation occurs.
- Emergency events – UWB tags in employee badges identify each worker and location to either be sure they are out of danger or where to direct rescue operations. With location information passed to rescue personnel enroute to the site, they can be more strategic when they arrive onsite, possibly eliminating precious seconds to save a life.

And there are many other potential use cases that enhance efficiency and effectiveness, production, safety and security (Figure 1).

Figure 1. UWB in industrial environments can enhance efficiency and effectiveness, productivity, safety and security.

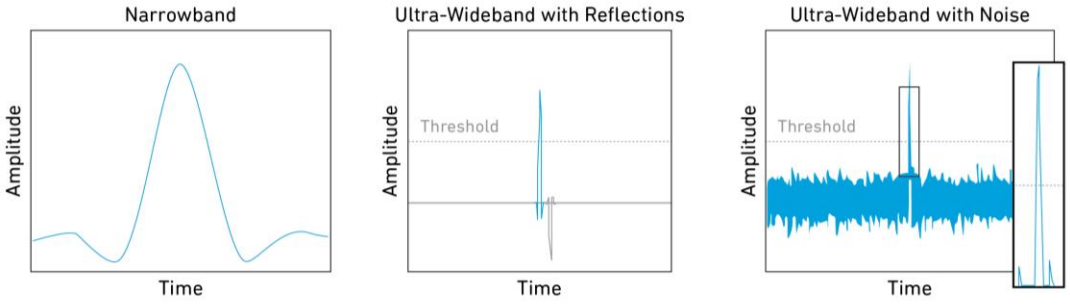


How USB Can Be So Precise

Industrial and commercial sites are full of large objects – often metal and possibly moving – such as walls, vehicles and machinery, and electrical signal noise. GPS signals often cannot effectively penetrate industrial structures. And narrow-band Wi-Fi and Bluetooth Low Energy radio energy is often attenuated, reflected as multi-path signals or lost in such environments as the distance from objects increases.

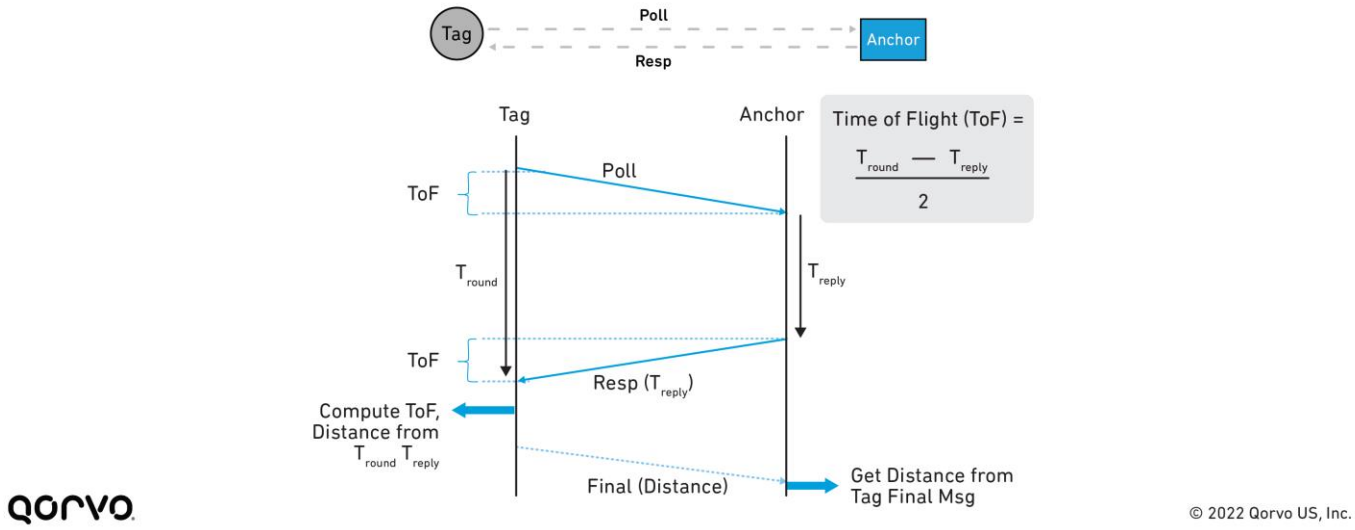
UWB is impervious to the challenges of narrow-band Wi-Fi and Bluetooth Low Energy for ranging and location. In communicating between anchors and tags, UWB radios use very low signaling energy spread out over a greater bandwidth with much faster pulse rise and fall times than narrow-band signals (Figure 2). This approach helps ensure signal integrity, reduces the impact of reflections and noise spikes, and contracts the number of components needed for an infrastructure.

Figure 2. UWB is impervious to noise spikes that can affect narrow-band signals, degrading location capabilities.



UWB uses time of flight (ToF) to measure the distance to a tag (Figure 3). Multiple methods for ToF improve the accuracy of measurement and reduce infrastructure costs. Two-way ranging (TWR) and time difference of arrival (TDoA) ranging methods eliminate the impacts that reflections from walls and machinery (multi-path) have on signal strength. Other ranging methodologies in UWB include phase difference of arrival (PDoA) and reversed TDoA (RTDoA), offering benefits for various types of deployments. These different ranging techniques can be used to identify the distance and direction (vector) to an object.

Figure 3. Calculating distance with ToF.

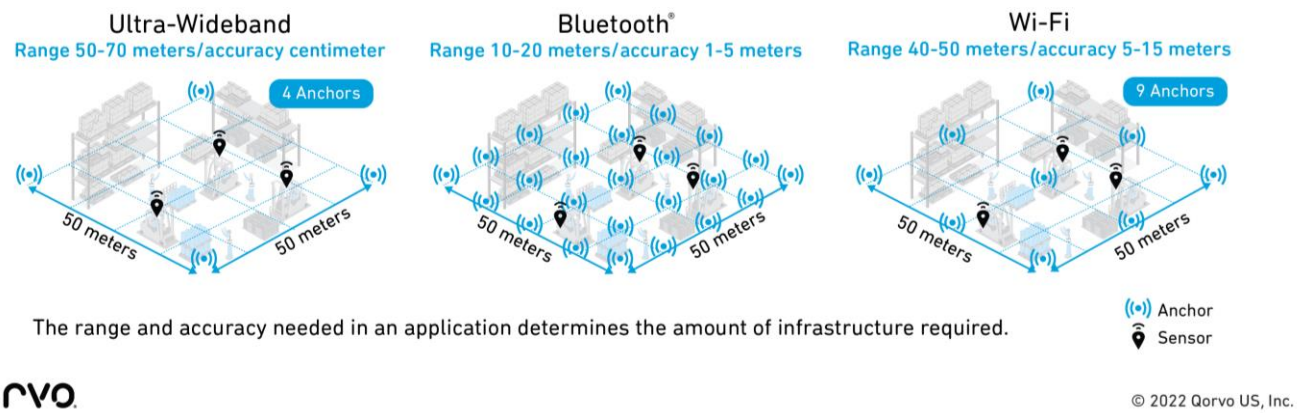


Depending on the need for micro-location services, different infrastructures can be deployed, different ranging techniques implemented and the location can be determined (computed):

- Within the tag itself for navigation purposes, a method called downlink TDoA (DL-TDoA).
- Within the infrastructure when a centralized platform needs to track tags.

With its signal integrity and ranging abilities, UWB can cover greater distances than other location and ranging technologies (Figure 4). Strategically placed anchors can report different ranges and vectors to a tagged object, locating them in two- and three-dimensional space with great accuracy.

Figure 4. UWB's greater range and accuracy enable micro-location with fewer components, reducing infrastructure.



A UWB Ecosystem to Support Industry and Beyond

The FiRa (fine ranging) Consortium (**www.firaconsortium.org**) defines specifications and provides certifications for UWB devices. The consortium supports the enabling of the UWB ecosystem and interoperability between UWB and other technologies to enable micro-location services for industry and consumers.

The upcoming new FiRa standard (FiRa 2.0) opens the door to greater applicability for micro-location using UWB. It includes specific functionalities that target industrial applications. It will help enable greater interoperability between consumer and industrial devices (UWB is already deployed in modern smartphones). And it is seen as the first step toward including UWB in large-scale, real-time location systems (RTLS), enabling indoor and sub-meter accuracy in mapping services, such as Google Maps.

While FiRa 2.0 will help enable new use cases, the ecosystem anticipates a breakthrough of DL-TDoA solutions. These solutions will enable micro-location navigation indoors with privacy as only the mobile device will know its own position. Such services will soon become available to UWB-enabled smartphones. The deployment of relevant UWB DL-TDoA will be up to the OEMs of infrastructure devices, such as access points that combine UWB anchors with Wi-Fi access points. But also, lighting and other fixed power devices that can be installed in public or private facilities could trigger DL-TDoA and activate when a UWB-enabled device is nearby.

You can learn more about UWB in other articles in this document and on the FiRa website. UWB solutions are already being deployed in a variety of use cases. The following describes some of these.

European League of Football

A football (soccer in the U.S.) field is typically 105 by 68 meters (115 by 74.4 yards). That is 7,140 square meters (nearly 8,540 square yards). Sports stadiums often do not have a roof. This makes placement of UWB anchors other than around the field impractical. **Noccela**, a micro-location solution provider, developed a UWB ranging solution using both TWR and TDoA ranging methods. Their solution can cover up to 500 square meters (nearly 600 square yards) per anchor with as fine as two-centimeter (0.8 inch) accuracy of objects moving at up to 60 km/h (over 37 mph). Using UWB, they can cover a soccer field with 16 anchors, strategically placed around the field perimeter while delivering high, 3D positional accuracy.

Used in athletics with sports analytics software, micro-location allows teams to optimize performance. But for the European League of Football (ELF), the solution was instrumental in Europe during the pandemic to keep teams playing. While Covid-19 was raging and before the wide availability of vaccines, players and coaches in the ELF still had work to do. But they needed a way to practice in proximity with other players and team personnel while tracking both social distancing and contact among members. Without the granularity of tracking of individuals, a breakout of Covid-19 could shut down an entire season.

The UWB-based micro-location solution offered point-to-point tracking to upload member tag positions through anchors. The tracking software then recorded where attendees (tags) were at any time. If a case of the disease was reported amongst the team, managers would know immediately all potentially affected members and isolate them without shutting down.

VELUX Modular Skylights

VELUX Modular Skylights are manufactured in Ostbrirk Denmark. When the company wanted to modernize operations and digitalize the manufacturing process across 2,304 square meters (2,756 square yards) in their production sites, they implemented a digital twin of the factory floor utilizing **Sewio's** RTLS solution. The digital twin would monitor, track, trace and analyze their entire manufacturing workflow. A critical input to the data was RTLS tracking of people and machines, which included forklifts and automated worktables (AGVs) that moved the work in process (WIP) through the work site and adjusted to accommodate each worker's height.

The solution incorporated 12 UWB anchors and 59 UWB tags to track objects. For each step in the manufacturing process, the AGV delivers the WIP to a station, where a skilled worker performs the necessary task. The RTLS identifies the nearest worker and adjusts to the appropriate height, creating an ergonomic and safe work environment. If a worker is not present, the system alerts the nearest skilled worker to complete the task. Data from the movement of materials and personnel is processed to provide managers with the real-time information they need to understand the productivity of the plant. The data is also used to manage machine maintenance. With the UWB-based RTLS in place, VELUX Modular Skylights was able to:

- Increase productivity by 10 percent through better shop-floor management.
- Boost performance on maintenance activities by 50 percent.
- Decrease WIP by 10 percent.

SEG Automotive

SEG Automotive manufactures motors and starters for nearly every automotive manufacturer in the world. The company's manufacturing floor and warehouse are in two buildings with a ten-minute truck drive to deliver raw materials from the warehouse to the manufacturing facility. Picking orders were fulfilled manually using a just-in-time process. Manual operations were prone to errors, costly in terms of person-hours, and delayed data entry to the ERP systems, which limited visibility of inventory and handling.

SEG Automotive wanted to replace the manual process with a fully digital, real-time asset booking and tracking system. A key challenge was the closeness of the truck gates. Ensuring materials were delivered to the correct gate required an accuracy of 30 cm.

The deployment of **Sewio's** RTLS took only four months and required 40 anchors across 2,000 square meters (2,392 square feet) and 600 tags to track metal pallets. After integrating the UWB-based RTLS with the existing data tracking and analysis system, SEG automotive achieved the following:

- Eliminated human picking errors.
- Shortened lead times by 50 percent.
- Moved 15 percent of employees to less routine work.
- Continuous track and trace of material as it moved throughout the warehouse.
- Easy scalability to track more objects as needed and expand to the manufacturing site.

Budweiser Budvar Brewery

While shipping its beer to 76 countries around the world, Budweiser Budvar brews its beer in only one city in the world – České Budějovice (Budweis) in the Czech Republic. Producing ten different kinds of beer with dozens of languages on labels created 360 combinations of products to distribute. The warehouse stored over 20,000 pallets of two different sizes of containers, some inside and some in an outdoor facility.

They had managed their inventories using a passive RFID system with RFID anchors on the forklifts and up to 10 tags per tracking position, which were located only inside the warehouse. The legacy solution presented reliability problems, was costly to maintain and scale, caused operational inefficiencies, and did not always provide true location of the goods. Without accurate, real-time tracking, they could not utilize up-to-the-second data for spaghetti diagrams, heat maps and other analytics.

Installing **Sewio's** UWB-based RTLS system took only a month to install, plus another six months to integrate with the rest of their ERP systems. To cover 15,000 square meters (17,940 square yards) for both inside and outside warehouse facilities, they deployed 70 anchors and equipped 15 forklifts with tags that provided 30 cm positional accuracy. The installation and integration resulted in the following:

- 19 percent better uptime compared to the legacy RFID system.
- 19 percent better warehouse utilization.

UWB technology enables delivering the highest accuracy of micro-location services to industry. The technology is already being deployed across multiple industries with significant benefits to business operations. The ecosystem of UWB technology and solution providers, working with FiRa, are paving the way for innovative micro-location services to come.