SICK AG WHITEPAPER

INCREASING EFFICIENCY USING REAL-TIME LOCALIZATION SOLUTIONS

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SUMMARY

Logistic processes in the field of warehousing and production must be efficient. The goal is to lower costs and increase the quality of sequential processes. Entirely in keeping with the Industry 4.0 approach, the data collected in this area form the basis for commercial decisions and indicate possible opportunities for optimization. Being able to localize goods during transport, in particular, constantly poses new challenges for companies. Only if you know where each object is at any given time is it possible to analyze the material flow chains, optimize transport processes, and increase the quality of supply.

This white paper from SICK shows why reliability and transparency in the material flow are a decisive factor in production logistics and intralogistics, and how you can achieve them with the help of localization solutions. It explains the concept of tag-based localization, and describes possible applications of such a real-time locating system as well as the benefits that full object traceability brings to production and logistics companies.

SICK
Sensor Intelligence.

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What are real-time localization solutions?

Real-time localization systems (RTLS) provide information about the exact location at any given time of an object being traced. They therefore offer valuable information about where exactly a certain item currently is. To do so, the item must be equipped with a sender or tag that the appropriate system infrastructure can detect.

Different localization scenarios generally require different localization technologies. In fully automated applications in particular, it is possible for example to perform the object identification and localization using scanning systems. Other technologies that may often also be suitable include RFID (Radio Frequency Identification), GPS (Global Positioning System), LiDAR and Bluetooth Low Energy (BLE).

Ultra-wideband technology

Ultra-wideband (UWB) technology is also used in real-time localization solutions. It offers significant advantages over the other technologies in use.

Secure
Due to physical layer encryption

Reliable
Immune to narrowband fading or jamming

Real time
Refresh rate of 200–1,000 times per second

Accurate
Centimeter resolution in dense multipath environments

Co-existence
Supports bands different from WPAN/Wi-Fi

Low energy
Ultra short air time

Fig. 1: The advantages of ultra-wideband technology at a glance. Source: FIRa Consortium, https://www.firaconsortium.org/.

With a proven and powerful portfolio of code readers, 2D and 3D cameras, 2D and 3D LiDAR sensors, RFID read/write devices, as well as other identification solutions, SICK is an established partner for identification and object tracking in automated applications, e.g. on conveyor systems. Having developed a real-time UWB tag-based localization system and the ability to use the aforementioned technologies in conjunction with the SICK data fusion layer, SICK has now extended this expertise to partially or non-automated applications as well.

Real-time UWB tag-based localization solution for partially or non-automated applications

The real-time UWB tag-based localization solution from SICK comprises UWB tags and receiver antennas. The tags send very brief UWB signals (“blinks”) at regular intervals which are received by the surrounding antennas. The antennas in turn send the time stamp of the received UWB signals to the localization platform via the Ethernet infrastructure. The localization platform then calculates the position of the tags by precisely measuring the difference between the times at which this signal arrived at different antennas. Since only the differences in the arrival times are used to calculate the tag locations, the principle of operation is referred to as time difference of arrival (TDoA).

A real-time UWB tag-based localization solution therefore ensures that the information about which goods are currently located where is also available in partially and non-automated applications. A connected localization software, for example Asset Analytics from SICK, calculates the corresponding location of the tag based on the data obtained. Besides visualization functions, the localization software also offers intelligent standard functions or user-specific services for further utilizing the obtained information.

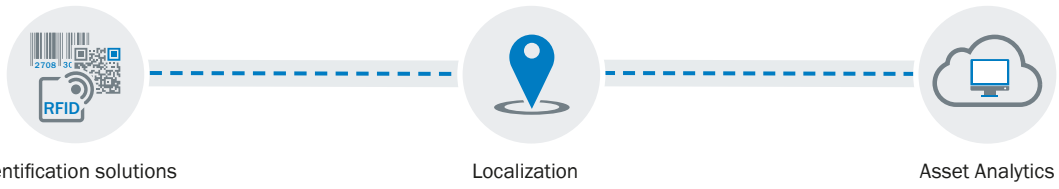

Fig. 2: Complete solution for object tracking from a single source.

Transparency and data acquisition in process chains and value chains

Intelligent networking of machines and processes using various information and communication technologies plays an important role in modern production and logistics companies and serves a key purpose: to collect data along the process and value chain so that the data can then be evaluated and transformed into information. Absolute reliability of the processes and data is essential for this because the knowledge gained is intended to serve as the basis for various kinds of commercial decisions. The objective, therefore, must be to avoid system discontinuities as these can result in delayed and non-congruent information both in the field and in the IT level and thereby have a negative impact on transparency.

In intralogistics, such system discontinuities occur, for example, when objects (assets) or materials at sources leave a rigid production or assembly line or stationary conveying technology in order to be transported to sinks by mobile transport equipment such as forklifts, industrial trucks, tugger trains or by mobile platforms. In contrast to fixed transport systems, no identification or localization of the assets or materials takes places on route through the halls and corridors. This is like a blind spot for the control level. Neither the assets or materials can be traced and, in the worst case scenario, may even be lost without anyone knowing. Process efficiency suffers significantly due to this lack of transparency, which can lead to shrinkage, delays, deliveries to the wrong location, and numerous other errors.

Real-time UWB-based localization solutions can prevent this because they ensure fully transparency throughout the material flow. A system that automatically traces assets with the help of UWB tags and provides insights into the status of the company makes it possible to focus on business decisions and optimization. Companies that spend less time on data collection can devote more time to reducing investment expenses, increasing their revenue, and improving their work processes.

Advantages of a real-time UWB tag-based localization system

Localization data enable production and logistical processes to be planned in an agile manner, thereby ensuring better delivery quality and greater reliability. Knowledge of the precise location of assets or materials in real time brings crucial transparency to the material flow. The real-time UWB tag-based localization system therefore contributes to savings in time and money as it allows asset movements to be analyzed, and workflow bottlenecks to be identified and eliminated. This type of localization system can be used both in indoor areas and also (taking into consideration country-specific regulations) in outdoor areas.

The advantages of a real-time UWB tag-based localization system at a glance:

- Continuous tracking of all physical movements with no “blind spots” improves real-time transparency
- Improved planning and control of material flows and reduced search times lead to a minimization of idle times and a higher capacity utilization
- By monitoring the movement of goods through automated transfers of transported materials and information triggers as they enter or exit certain configurable zones, it is possible to achieve a higher level of process automation
- Transparency and a better overview in large plants or on large premises increases productivity as does the automated management of storage spaces with no manual posting processes
- Minimal downtimes, flexibly prepared or scheduled setup times, and dynamic, optimizable and adjustable routes lead to higher overall equipment effectiveness
- The availability of specific production equipment or goods can be checked in real time
- Allows flexible navigation within logistics and production processes

Implementing a real-time UWB tag-based localization system

The following components play a decisive role when implementing a real-time UWB tag-based localization system:

- Physical devices
  - SICK offers a complete UWB technology-based localization system comprising tags, antennas and the Asset Analytics platform
- Localization area
  - The physical space in which localization services are required. It must be covered by a set of antennas
- Localization cell
  - The localization area is divided into localization cells. Each of these is covered by at least four antennas that are located within line of sight of a master antenna. The localization area is also divided into virtual zones based on the signal quality. The signal strength depends primarily on the distance and any physical obstacles in and around the signal path
- Master antenna
  - Each localization cell must have a master antenna in order to synchronize the antennas within that cell. When using the localization system from SICK, each antenna can be adjusted to the master antenna mode. No radio connection between the master antennas and neighboring cells is required
- Absolute position
  - This is calculated based on the time difference of arrival (TDoA), which is calculated to an accuracy in the submeter range (± 30 cm) using at least 3 antennas
- Presence information
  - The antennas are used to trace the entry and exit of assets in the respective localization cells. Localization is performed based on the nearest antenna

The experts at SICK advise the customer on how best to design the antenna infrastructure in their localization area from an optimization perspective. They ensure that the client's performance requirements on the localization are met using the minimum number of devices, which maximizes the return on investment (ROI).

The prerequisite for successful application of the TDoA principle of operation is that the antennas used to calculate the tag location are very precisely synchronized. Less precise synchronization is required for the tags, on the other hand, which makes it easier to operate them using less power. The antennas are synchronized with a selected master antenna at regular intervals. Since one master antenna generally does not provide sufficient radio coverage to synchronize the entire localization area, the area is divided into localization cells each of which is synchronized by its own master antenna.

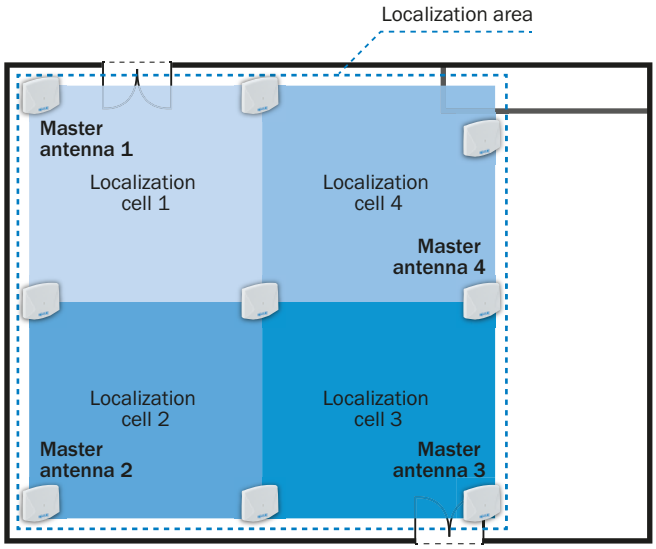

Fig. 3: Division of a localization area into localization cells.

The Asset Analytics visualization and analysis platform from SICK

Asset Analytics is a technology-independent and highly flexible platform for visualizing and evaluating location and sensor data. A large number of modules for extending Asset Analytics are available that make it possible to display, combine, and even merge data from different types of sensors, for example UWB, LiDAR, RFID or bar code sensors. Asset Analytics does not require any installation or special configuration on the end user devices. The data for all objects being traced can be viewed in real time in a web browser running on any computer, tablet or cell phone after logging in with a username and password. A flexible role-based user management feature allows different access rights to be assigned. This enables numerous different users, depending on the type and size of the company, to obtain a transparent view of their own data and minimize the time they spend searching.

Core functions of Asset Analytics

- Data visualization
  - Clear presentation, e.g., of current objection locations, location and status information, as well as additional sensor information in real time

Fig. 4: Asset Analytics provides a clear presentation of localization information.

- Data analysis
  - Processing of the collected data, e.g., to analyze routings, transport times, and downtimes, as well as identify opportunities for optimization

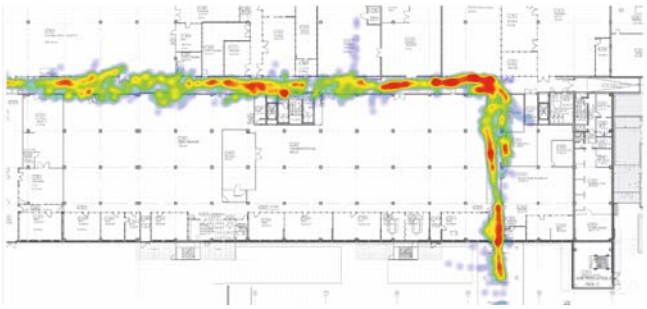

Fig. 5: Asset Analytics simplifies the analysis of routes.

- Event management
  - Automatic triggering of user-defined actions such as SMS or e-mail notifications, e.g., when entering or exiting predefined geozones

Fig. 6: Predefined geozones can, for example, be goods receiving areas or dispatch lanes.

- Integration and API
  - Asset Analytics can be integrated into your application via the API using the REST, WebSocket or MQTT interfaces. SICK can also create custom connectors for the customer's ERP systems, MES, or other systems

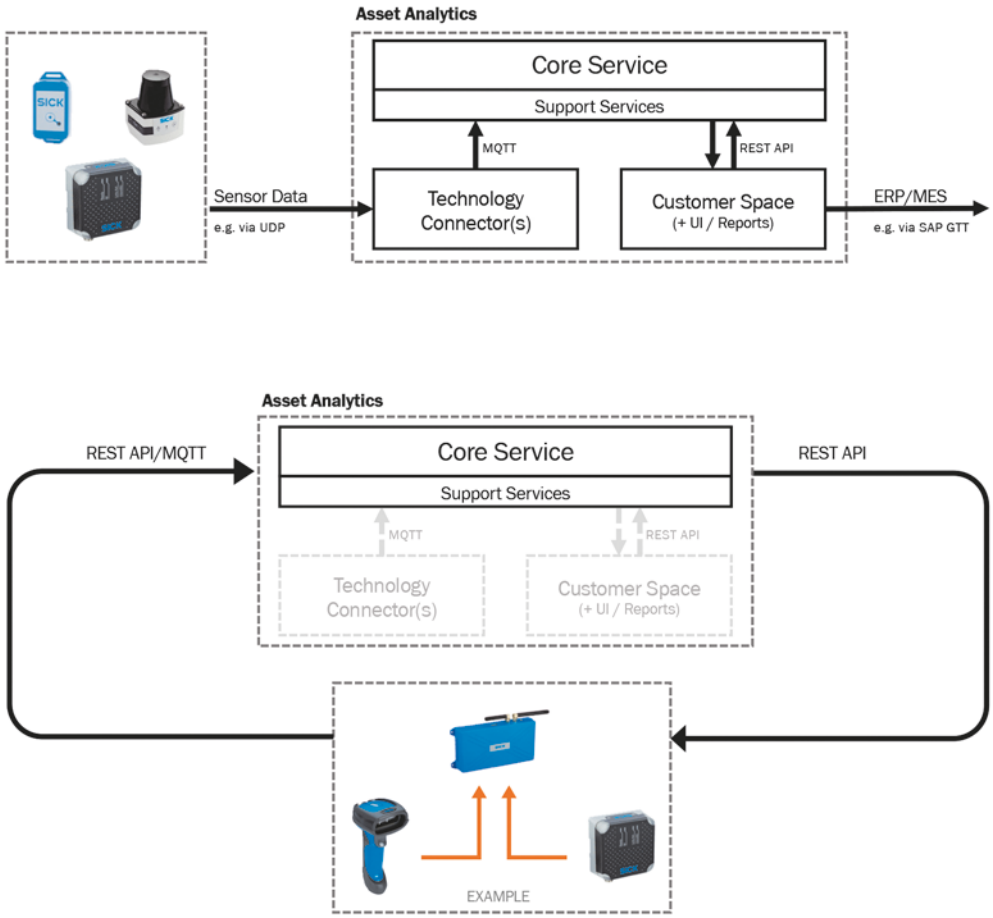

Fig. 7: Integrating Asset Analytics into an application.

- Protection against manipulation
  - All actions in Asset Analytics are logged with time, user-ID, and action details so that unintentional or deliberate manipulation of the system can be recognized and undone

Application examples for tag-based localization solutions

When implementing tag-based localization solutions, it is necessary to first clearly define the application goals. Not only the requirements on the data to be collected, but also the value and characteristics of the assets being tracked, and the application conditions play a decisive role here.

Application example 1: Determining the absolute location of assets
The ability to determine absolute locations is particularly useful for tracing large and high-value assets in open areas, for example production equipment in the form of tools, transport equipment or pallets.

Localization is performed using a UWB tag applied to the asset. The antennas installed on the walls or the ceiling of the localization area and operated using Power over Ethernet (PoE) receive the signals from the tags and transmit the time stamp to a localization platform. This stores the information together with the metadata in a database. All of this data can be accessed via the API of a localization software, for example Asset Analytics from SICK. This can then be used to export raw data or processed data.

Fig. 8: Determining the absolute location of assets using UWB tags and UWB receiver antennas (LOCU1xx and LOCU2xx from SICK). The data collected can subsequently be visualized, analyzed, and further used in the Asset Analytics platform from SICK.

Application example 2: Indirect localization of assets
The principle of indirect localization is particularly useful for tracing low value and high volume assets. These include, for example, consumables such as boxes of screws in the manufacturing industry or toolboxes in the automotive industry.

An indirect tag-based localization solution employs the principles of summarizing assets and linking different technologies. Small objects are identified, for example, based on their bar code and stacked on a pallet that has been equipped with a low cost RFID tag. The identified objects are associated with the pallet details.

The pallets are then transported using manned forklift trucks. The manned forklift trucks are equipped with an RFID read/write device, a UWB tag, and further sensors. When a manned forklift trucks picks up a pallet, the RFID read/write device automatically identifies the pallet. The identification data stored in the RFID tag of the pallet is forwarded to the localization software via TDC-E gateway systems from SICK. The localization software then links this data to the manned forklift truck, and thereby indirectly to its location as this can be determined in real time by means of the UWB tag.

When the sensors detect that the manned forklift truck has put the pallet down again, the current location of the forklift is stored as the last known location of the pallet.

Since indirect localization does not require each of the small objects and assets to be equipped with the higher priced UWB tags, considerable cost savings can be achieved.

Fig. 9: Indirect localization of high volume, small assets involves linking the identification data of those assets with the location data of larger movable objects, for example manned forklift trucks.

Application example 3: Using localization data for completeness checking in posting processes or automated posting
The data from UWB localization systems such as LOCU1xx and LOCU2xx and IIoT gateway systems such as TDC-E from SICK as well as any supporting sensor technologies do not, on their own, create added value. The data can, however, be further processed using software and thereby generate added value. To do so, the localization and time data from all localization systems used must be merged using suitable software algorithms and powerful middleware and interpreted as information.

The localization data thereby obtained can be used, for example, to automate posting processes, i.e., item postings in an ERP system via a middleware, without the need for manual intervention.

Fig. 10: The data collected in various geozones are forwarded by the Asset Analytics localization software to higher-level ERP systems and MES.

It is also possible to perform a completeness check in a picking process using the localization data obtained.

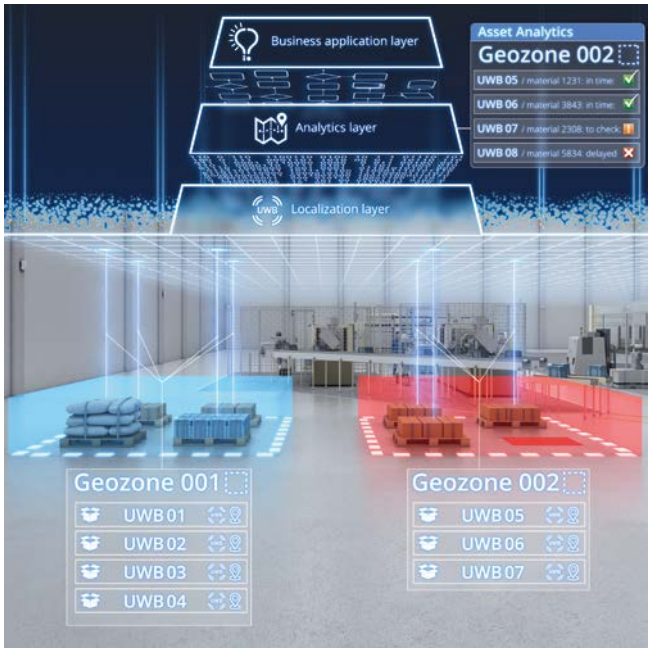

Fig. 11: Asset Analytics can be used to check the completeness of picking operations in defined geozones.

In addition to its own visualization and analysis functions, Asset Analytics also offers open interfaces that enable raw data and pre-processed data to be used in company-wide supply chain and asset management systems as well in as in cloud applications. This connectivity enables the localization data to also be used at the level of the ERP system or MES in order to obtain a better understanding of the material flows. It is thereby possible, for example, to evaluate the running and transport times between sources and sinks and intervene in the supply chain to optimize it.

Savings potential through the use of tag-based localization solutions

The savings achieved through the use of UWB tag-based localization solutions are apparent at several locations in the material flow.

Thanks to the higher data transparency and real-time localization of assets, the time spent each day on searching and the associated legwork are significantly reduced. The number of truck trips between the warehouse and production facilities can also be reduced as a result of the optimized material flow. Furthermore, the automated posting of items based on the localization data obtained (e.g., for goods receipts in production areas) eliminates the need for manual posting processes.

With these savings potentials, the total cost of ownership (TCO) of a real-time UWB tag-based localization is amortized within just a few years. The operating costs are comprised of the following:

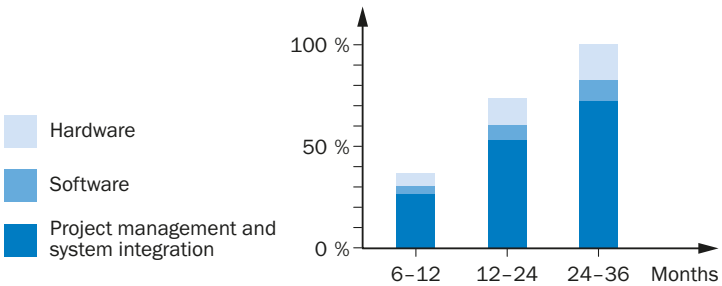

Fig. 12: Based on the total cost of ownership (TCO), the implementation of a localization system is amortized within just a few years.

The SICK localization system: complete solution from a single source

The localization of assets and the transparency in the material flow thereby gained offers clear added value for production and logistics company. The localization data obtained with a real-time localization system enable production and logistical processes to be planned and optimized in an agile manner, thereby ensuring better delivery quality and greater reliability.

SICK offers complete localization solutions that include all the necessary components and which are tailored to the specific requirements of the customer. The solutions include not only high performance hardware and software, but also comprehensive service offerings that are available to customers both online and on-site and provide comprehensive support.

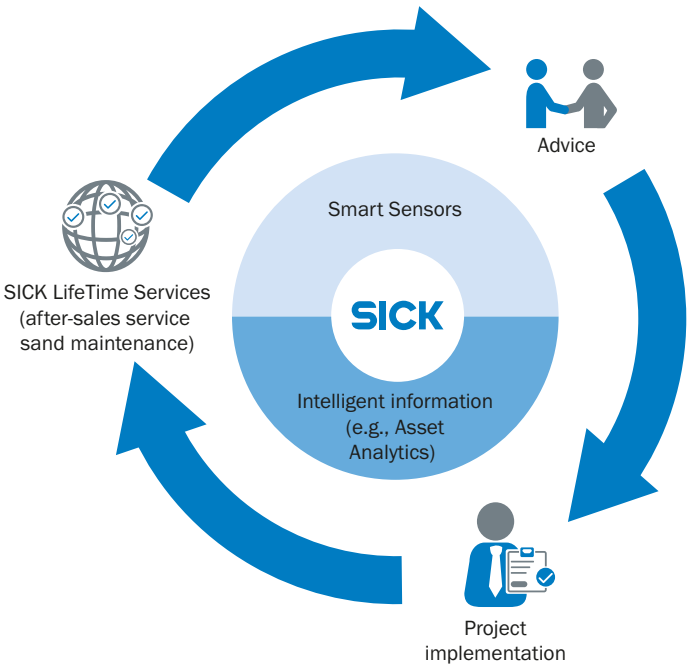

Fig. 13: SICK offers complete solutions for localization tasks that include advice, service, and support.

The complete solutions from SICK ensure that all requirements on reliability and performance for the precise traceability of objects in indoor areas are met when implementing a real-time localization system. Every system meets the highest quality standards and offers industry-specific functionality.

This is possible thanks to SICK's longstanding experience in the area of identification and localization technologies, top down expertise from the network technology right through to the associated protocols and certification, as well as comprehensive experience gained from digitalization projects in real-life companies. Competent advice, best possible support, training offerings, and comprehensive but easy to understand documentation round off these technological solutions. SICK also pays particular attention to the time to value of every digitalization project as well as the acceptance of all involved parties and users because these often neglected but important aspects can frequently make or break a project.

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REFERENCE

FIRa Consortium
https://www.firaconsortium.org/

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