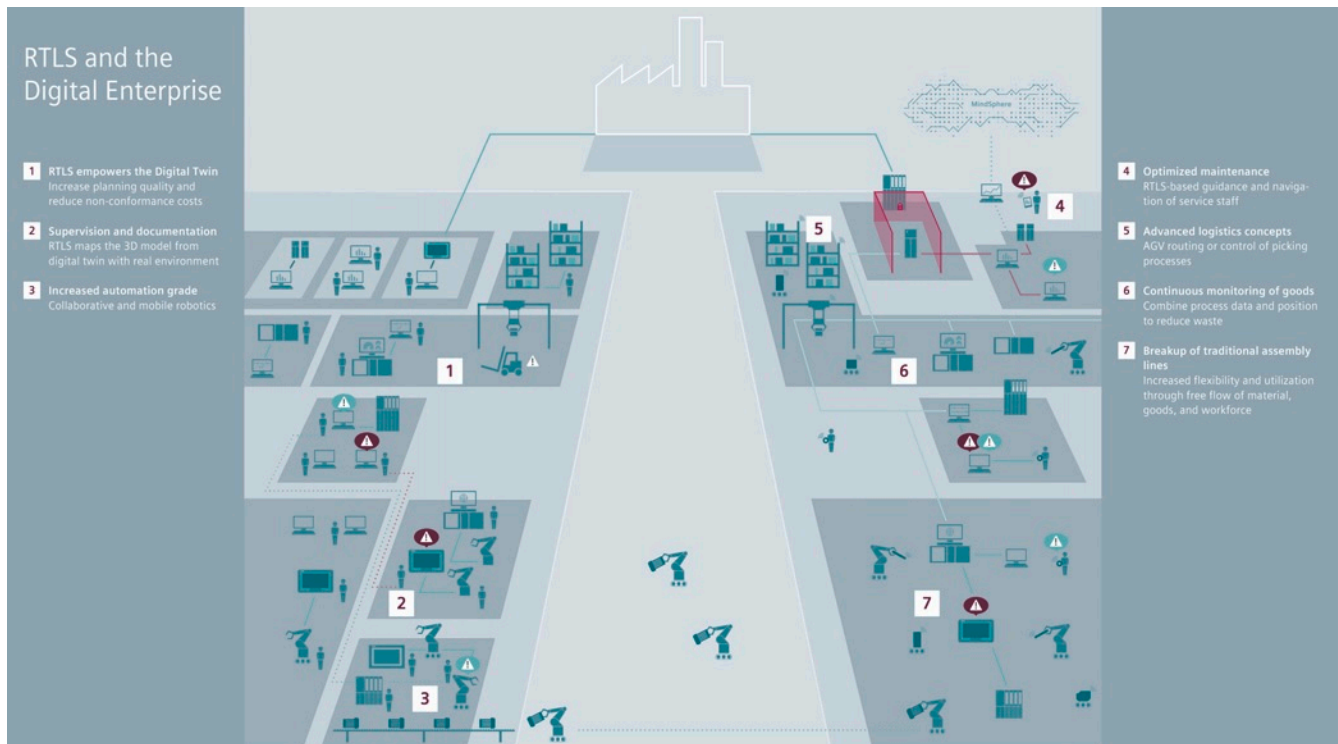**SIEMENS**

White Paper

Real-Time Locating Systems (RTLS) in Production

For a digital enterprise in motion

Customer requirements and increasingly dynamic markets demand that companies act with greater flexibility – in product development as well as in manufacturing and logistics. The automatic synchronization of real processes with the digital image in the systems (digital twin) is essential here in order to avoid mistakes, reduce costs and deliver ordered products to customers on a just-in-time basis. Real-Time Locating Systems (RTLS) represent key technology in this area.

Faced by continuously growing competitive pressure, industrial enterprises are being forced to respond by driving down their costs still further while at the same time developing an ever more distinctive product offering to address specific customer needs. These pressures are posing new demands on tomorrow's production. To keep abreast of this rapid pace of development, it is no longer enough simply to incrementally improve quality and productivity. What are called for in many cases are concepts which will totally revolutionize work processes as we know them.

Traditional continuous-flow production, for instance, is set to be replaced by a dynamic self-organizing manufacturing concept which enables improved utilization of machine fleet capacity while at the same time increasing flexibilization of the production range. Greater automation in the assembly of large-scale products (such as vehicles, aircraft, machines and plant equipment) using collaborative mobile robots is a key driver helping manufacturers to expand their competitive lead. Ultimately, innovative logistics and material flow concepts are called for which will eliminate costly search and assignment processes.

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RTLS and the Digital Enterprise

1 RTLS empowers the Digital Twin
Increase planning quality and reduce non-conformance costs

2 Supervision and documentation
RTLS maps the 3D model from digital twin with real environment

3 Increased automation grade
Collaborative and mobile robotics

4 Optimized maintenance
RTLS-based guidance and navigation of service staff

5 Advanced logistics concepts
AGV routing or control of picking processes

6 Continuous monitoring of goods
Combine process data and position to reduce waste

7 Breakup of traditional assembly lines
Increased flexibility and utilization through free flow of material, goods, and workforce

RTLS enable a large number of applications in a digital enterprise that would otherwise be difficult or costly

These concepts call for a complete "digital twin" of all assets of relevance for production such as tools, materials and products – which is able to provide an answer to the question "what's where and when." This information is supplied by Real-Time Locating Systems (RTLS).

For a mobile robot to be directed over the optimum route, for instance, it needs to be provided continuously with data relating both to its own position and that of the product being processed. The same applies to Automatic Guided Vehicles (AGVs) which no longer follow fixed tracks but are able to navigate freely within a dynamically changing production environment.

Monitoring and documenting individual production steps also calls for a continuous comparison between the position of a tool (such as a screwdriver) and the digital 3D model of the product in order to correctly specify, monitor and document parameters such as the torque for a specific screw. Ultimately, an RTLS delivers the required information about "what's where and when" as it occurs in real time for every asset of relevance across applications in production and logistics.

At the same time, RTLS can help make user support processes leaner and more efficient. In the maintenance sector, locating assets for servicing can be simplified by automatically comparing the position of service personnel with the digital model of the plant.

Areas of application include the chemical and pharmaceutical industry, where it can be used to simplify the maintenance of mobile assets, or equipment (such as containers, mobile units or vehicles) in airports or the depots of public transport networks. Here, RTLS can reduce the need for time-consuming searching and consequently minimize costs.

Locating systems consist of different transponders (front left: with e-paper display for dynamic display of information, front right: for production resources) as well as a network of gateways (back) that then provide information to the locating server.

RTLS: one of the technological foundations for a digital infrastructure

Real-Time Locating Systems (RTLS) consist of active transponders attached to toolholders, tools, AGVs, robots or also products. Over the locating infrastructure, made up of what are known as anchors and a locating server, the transponders can be automatically located within fractions of a second, and their position transmitted to the control systems.

Ultra Wide Band (UWB) technology has a decisive role to play here. It uses comparatively weak radio signals whose low transmission level prevents them interfering with other systems, but which have a comparatively large frequency spectrum (3-7 GHz). This allows extraordinarily high locating precision and also makes for particularly simple installation.

The active transponders emit a radio signal at defined intervals which is received by at least three gateways, each synchronized with the other. The gateways transmit the collected data together with the transponder ID number and the receiving time, measured with ultra-high accuracy, via a gateway to the locating server. This software calculates the position of each transponder by a method called Time Difference of Arrival (TdoA). Accuracy is increased still further using flanking measures such as automatic correlation of RTLS position data with the 3D model of the product and production environment stored in the digital twin.

The data is then transmitted on the basis of defined rules by the server to different target systems ranging from Programmable Logic Controllers (PLCs), Manufacturing Execution Systems (MES) and other IT systems through to cloud-based applications based for instance on MindSphere.

The use of UWB and TDoA allows the accuracy of RTLS systems to be increased to within just a few centimeters in production environments. At the same time, it allows the costs for the required components as well as for commissioning and operation to be reduced to a level which makes the technology affordable across a broad-based range of applications.

Using TDoA also helps significantly extend the life of transponder batteries, providing the assurance of reliable function over several years. Using UWB, transponders can also be equipped with a data interface and combined for instance with the robot controller, making the location information available not only over the higher-level system, but also directly to the robot itself with only a negligible delay.
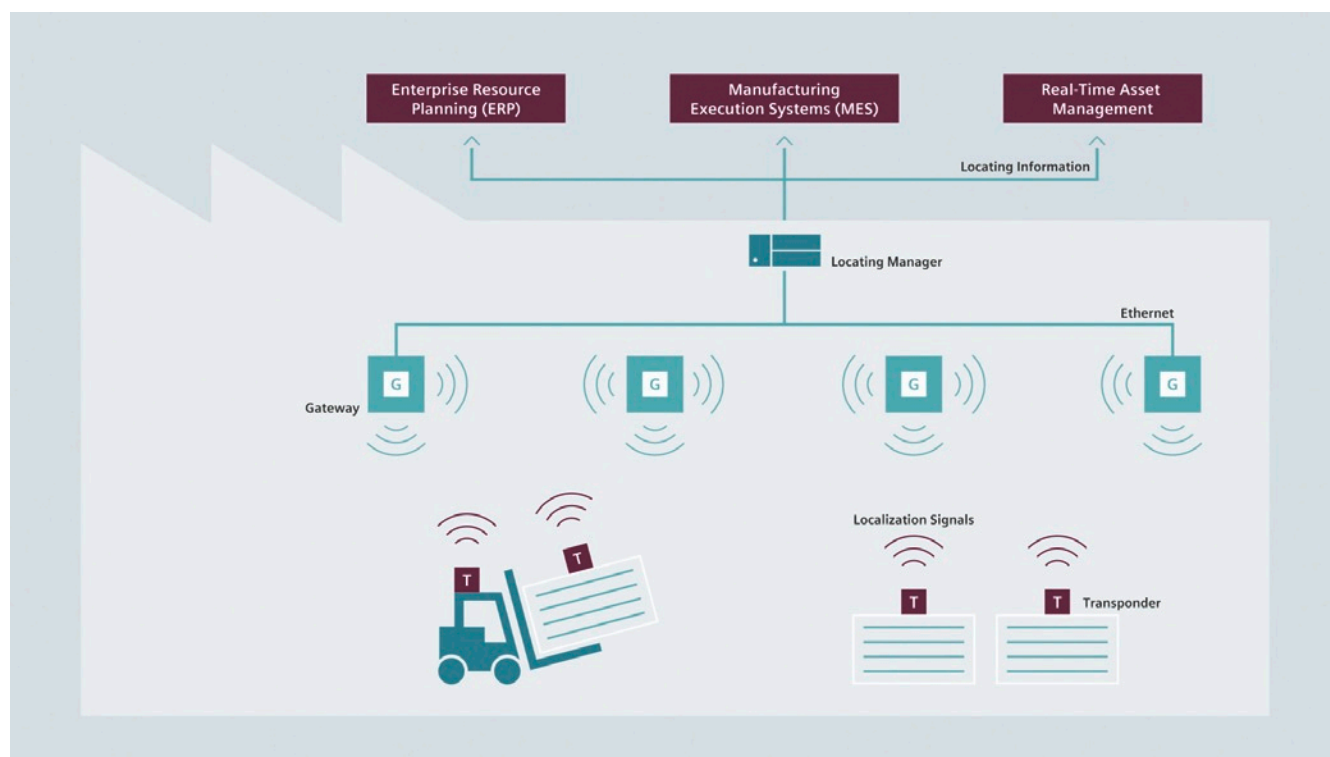
Seamless locating with accuracy measured in centimeters of all relevant objects anywhere on the company premises

The SIMATIC RTLS solution is the basis for innovative paperless manufacturing concepts. It helps to avoid time-consuming material searches in a highly dynamic and flexible production environment.

Application in the Smart Factory

In the "Smart Factory" of the future, RTLS systems will supply the essential foundation for the use of intelligent production units, involving the cooperation of different production facilities such as transport vehicles and mobile robots with machines and plants. At the same time, the actual location of a machine or robot will become a variable factor, meaning that an autonomously controlled, highly efficient work flow can only be organized with knowledge of the current spatial configuration of the factory.

Specifically, this means that:

- Tool use can be documented through identification of the tightened screw by means of the xyz position and comparison with the 3D model and can be saved in a product database together with the relevant tool data (e.g. torque)

- Removal of materials from storage systems can be monitored in order to ensure correct use of parts

- It is possible to control the assembly of large products (e.g. aggregates, power drives, special machines, airplane parts) in which the use of other identification technologies is technically or economically problematic due to the product structure

- Automatic inventory monitoring and thus optimization for aids such as containers, mesh pallets and tools can be performed

- Position monitoring for finished products can be realized in order to minimize search processes when products are stored temporarily due to disruptions in the production sequence, missing parts, failures etc.

- Dynamic self-organization of production processes takes place whereby the products are automatically transported to the next available processing station by automated guided vehicles (AGVs)

- and much more.

Unlike RTLS solutions in use today, in the future wireless location will become an infrastructure available to wide-ranging different applications and scenarios.

UWB-based RTLS solutions permit a complete production hall and countless thousands of assets to be equipped, taking RTLS technology out of the niche role it currently occupies and making it available to serve as an infrastructure for multiple applications.