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LOST® Technology

LOcation System for Sensor Tracking

- LOST is a unique **real time positioning** solution for **indoor and outdoor** applications. It combines **sub-meter accuracy** with **low infrastructure cost.**
- LOST enables **reliable supply chain management** and **efficient asset and goods tracking.**

Overview

LOST is a Real Time Location System. It stands for Location System for Sensor Tracking and is an essential part of a Wireless Sensor Network that determines accurately the position of a sensor, located outdoors or indoors, even in densely packed warehouses or large crowds of people.

The accuracy is better than 1 meter, allowing finding the position of individual crates or pallets. With a minimum configuration of four reference nodes, areas of half km square can be covered. This accuracy is maintained over longer distances by adding more reference nodes to the system.

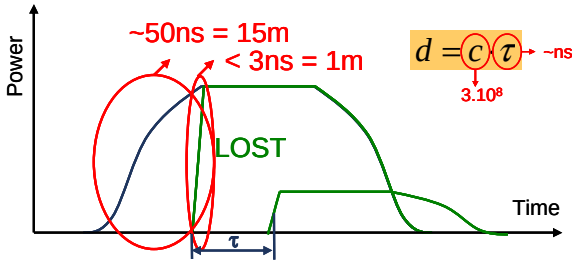
The system relies on the measurements of the distances between a mobile node and a set of fixed reference nodes, obtained from the measurement of the time it takes for a steep RF burst to travel between the mobile node and each of the reference nodes. Due to the steepness of the burst, the attenuation of the signal and the superposition with reflections do not influence the measurement accuracy and therefore the LOST technology is very well suited for indoor applications even in obstructed spaces.

To determine the position of a mobile node, at least 3 independent measurements are needed. In the minimum LOST implementation, 4 independent measurements are combined to correct possible measurement errors or to detect and mitigate non-line-of-sight conditions.

The LOST HW is capable of resolving time differences of 3 ns yielding distance accuracies below 1 meter. This accuracy is further improved by signal processing techniques.
The distances are sent to a tracker server, after pre-filtering in the reference node to minimize data communication and power consumption. In this tracker server, very advanced and proprietary positioning algorithms calculate the position of a mobile node from a set of distance measurements. Redundancy is leveraged to derive the position with high accuracy even under very bad conditions of interferences and obstructions.

Features

- *Sub-meter accuracy.*



Distance d is proportional to travel time τ of RF signal

Accurate travel time measurement.

The steep rising edge of the RF-burst, used to define the time-of-flight, makes it possible to measure exactly the time when the signal arrives at the mobile node or vice-versa. Even when the signal is attenuated due to the large travel distance, or perturbed by reflections, the first edge observed at the receiver will have traveled the shortest distance. In case of the LOST technology, this time of arrival is measured with a 2ns resolution, resulting in a single shot resolution of 0.3m for a round trip. With averaging techniques this resolution is further improved. The final error on the distance measurement depends mainly on the steepness of the edge. Larger distances or heavy obstructions attenuate the peak amplitude of the burst but maintain the edge transition time. Since this edge transition time is max 3ns, the uncertainty on the time-of-flight in Line-of-Sight versus obstructed Line–of-sight is max 3ns, or 1 meter in distance.
With careful configuration of the LOST deployment and thanks to the use of the powerful localization algorithms the position accuracy is typically 50cm or better.

- *Latency lower than 1msec*

One ranging measurement takes 100µs.
The execution of all actions to obtain the position of a mobile node, including the different ranging measurements, the transmission of the data to the tracker server, and the calculations of the positions, takes less than 1ms. So, 1000 mobile nodes can be monitored with a position update every second. When position update rates are relaxed, several thousands of mobile nodes can be monitored.

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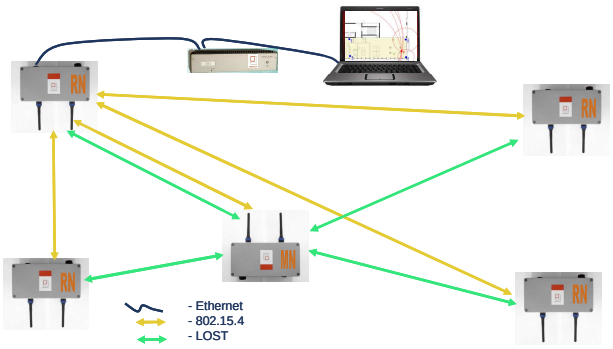
- *Robustness and coexistence.*

The LOST technology operates in the license free 2.4GHz ISM band that is also used for WiFi, Zigbee and Bluetooth. Although LOST is not using any of these communication protocols, it is designed to coexist with them. LOST ranging is performed without notably degrading the throughput of the existing WLAN networks. In addition, LOST has been proven to be very robust against interfering signals. In particular, post-processing is applied with proven success against interferers such as micro-wave ovens or RF noise-filled industrial environments.

- *Calibration Free*



Typical LOST Set-up

Contrary to other RTLS systems based upon Receive Signal Strength Indication (RSSI), there is no need for extensive fingerprinting of the environment. This means that the set-up is straightforward and can be done in a minimum of time. It requires only a survey of the area to be covered to determine the minimum number of reference nodes required and their most suitable positions.
Once the reference nodes are installed and the floor plan with the position of the reference nodes is entered in the server, the LOST system is ready for operation. The system will remain operational even when the characteristics of the environment change. Installing new machinery or adding shelves does not require manual intervention. Even adding Reference Nodes to extend the coverage area does not require a complete new set-up.

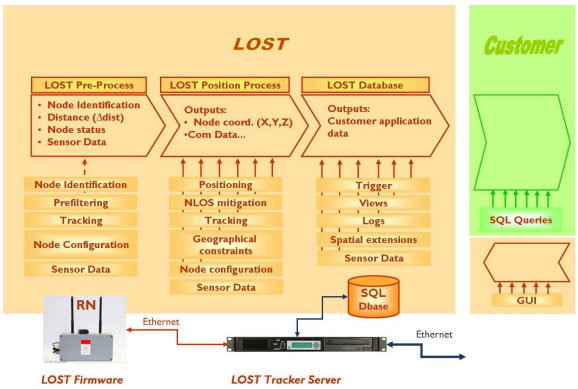
- *Wireless Operation*

Both Reference Nodes and Mobile Nodes have an integrated 802.15.4 based radio to communicate the pre-processed ranging data to the tracker server and to configure and manage the RTLS network. In that way, the behavior of the Reference Nodes can be monitored from the tracker server and whenever needed, settings and firmware can be updated without intervention in situ.

- *Scalability*

The LOST solution is easily scalable in both numbers of Reference Nodes and Mobile Nodes. Only minimum intervention is required in the LOST management system to add extra reference nodes to extend the covered area. Addition of extra Mobile Nodes is "Put and Play" and requires only the acceptance of the unique node identifier code by the system. The number of Mobile Nodes that can be monitored by a LOST system depends on the required position update rate. In applications where real-time tracking is needed, the LOST technology is capable of providing every second the position of up to 1000 Mobile Nodes. Relaxing the position update rate allows more items to be tracked.

- *Powerful location software.*



LOST Software Architecture.

Pre-filtering and Ranging. Each timing sample is evaluated for ranging consistency and discarded if needed. Averaging over a few samples is used to cancel out random errors and to increase the accuracy. Since reflected signals travel over a longer distance, the shortest distances are prioritized, making the LOST technology inherently robust against multipath reflections. Measurements that are disturbed by interferers, reflections or severe Non-Line-of-Sight conditions are detected and automatically ignored or corrected.

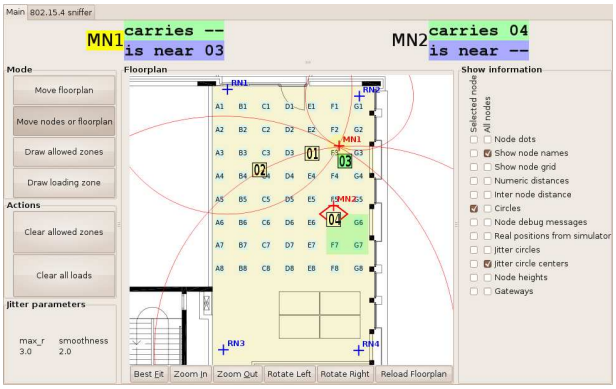
Localization. Out of every set of distances to minimum 3 Reference Nodes, a possible position is calculated. By means of powerful algorithms these positions are evaluated for their likelihood compared to the positions calculated out of the combination of other distance measurements from different Reference Nodes.

NLOS Mitigation. The positioning algorithms are optimized to cope with Non-Line-Of-Sight conditions. Individual obstructions between the Mobile Node and one Reference Node will be detected and corrected. More severe NLOS conditions, obstructing the ranging pulses to more than one reference node, can also be detected. In these circumstances, additional information from previous positions (tracking), geographical information and node activity are used to increase the position accuracy.

Data Base Integration. Location information is stored in a database that is easily accessible via standard PostgreSQL queries. The database uses spatial extensions to make it possible to handle queries that are based on geographical information. Warnings based on geographical constraints can be pushed by the database. The sensor data and their history can be stored and retrieved.

User Friendly Graphical Interface

The GUI provides an interface between the user application and the ranging data base. It is used to enter the floor plan, to position the Reference Nodes and to monitor and manage the Mobile Nodes. It contains a number of set-up wizards that will help the customer go through the set-up of a LOST ranging network.

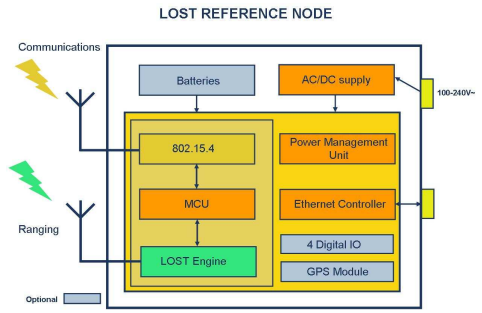


LOST Graphical User Interface

LOST Hardware

- *The Reference Node.*

The Reference Node is the basic element of the LOST system. It is designed to perform several functions: Ranging, Communication, Pre-filtering and Gateway.



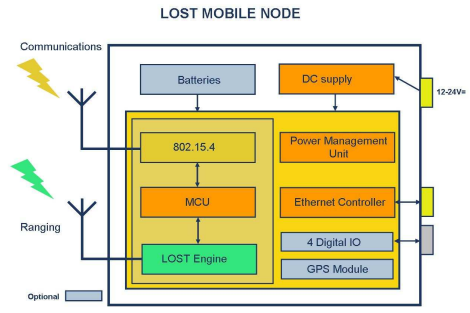
LOST Reference Node

The LOST engine transmits and receives the ranging signals to perform the distance measurements. These ranging edges are decoded and filtered by the MCU. The MCU extracts the timing of the ranging events and controls the communication over the 802.15.4 transceiver. This communication channel is used to transmit the ranging data and node identification to the Gateway Reference and to manage the network .

Reference nodes are usually mains powered. This is not a major inconvenience since the Reference Nodes have a fixed position. Optional battery operation is available. A GPS module can be connected for ease of deployment and maintenance of the LOST RTLS system. The reference node is constructed in a heavy-duty waterproof housing that is suited for outdoor installation and has a size of 20cm by 8cm by 10cm.

- *The Mobile Node*

The Mobile Node is mounted on the vehicle that has to be tracked. It has many functions in common with the Reference Node and therefore is built on the same platform as the RN.



LOST Mobile Node

The LOST Mobile node is normally fed from the battery of the vehicle. It contains a protected DC power supply with a wide operating range. The 802.15.4 communication channel can be used to control the digital IO's on the MN or to transmit data from (the) sensor(s) connected to the MN. It is also used for configuration and status monitoring of the Mobile Node. Sensors or actuators can be connected to the Mobile Node via pins that can be configured as digital GPIO's or ADC inputs.

- *Tracker Server*

The Tracker Server is an appliance based on hardware that is qualified by Essensium.

The main function of the Tracker Server is to gather all the ranging data via the Gateway Reference Nodes and to perform the calculation of the location algorithms. The location data is converted into a database providing the location information of all the LOST nodes.

An SQL database with GIS extension is generated from the location computation. This facilitates the client's data access applications to retrieve information for locating, tracking, tracing, logging, alarming, etc. A client application example is delivered with the Software documentation to ease the integration process.

The Tracker Server is also used for the management and maintenance of the network, for the set-up, the deployment and the configuration during initial installation or any later modification. Finally a demo application is made available to help with the setup of both the hardware and the software.

Technical Specifications

Summary Technical Specifications

- Maximum Distance for Ranging :
  - Mobile Node : 500m
- Maximum Distance for Communication:
  - Mobile Node : 1km
- Positional Accuracy
  - Mobile Node: typically 50cm
- Update Rate: 1ms per node up to 1.000 nodes per area
- Radio Frequency
  - Ranging channel: 2.4GHz ISM band 200MHz bandwidth coexistent with 802.11.xx.
  - Data communication channel: 2.4GHz compliant with 802.15.4. Proprietary software stack
  - Emitted power : 21dBm
- Power
  - Reference Node : 100-240VAC 6.5W
  - Mobile Node : 12-24VDC 6.5W
- Sizes
  - Mobile Node : 19.8x9.8x8cm 1-1.3kg
- Connectivity
  - Reference Node: Ethernet, Power and Status LED.
  - Mobile Node: Ethernet, 4 isolated digital I/O, Power and Status LED
- Certifications EU / CE: CE class A compliance

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