



embracing a better life



SECURE HIGH ACCURACY RANGING ON BLUETOOTH

Imec's secure high accuracy ranging technology provides unprecedented ranging accuracy on standard narrowband radio's like Bluetooth. Whereas today most Bluetooth ranging systems only achieve a 5 meter accuracy in challenging multipath environments, with the new imec super-resolution ranging algorithms an accuracy better than 10cm can be achieved. It provides also a high level of security for smart locks as it is resistant against relay attacks.

Bluetooth ranging technology is already very popular and many localization systems exist based on beacons. Beacon technology generally estimates the distance between devices using the received signal strength (RSSI). Localization of Bluetooth devices is done by combining the distance estimate to several beacons, mounted at fixed and known locations, using triangulation with at least 3 anchors.

Due to many reflections in indoor environments, RSSI-based ranging is inherently inaccurate. Using a combination of a phase-based distance estimation protocol, and advanced signal processing, the imec ranging-technology can accurately separate the Line-of-Sight component from multipath. The result is a robust ranging system with sub-meter accuracy. Unlike Direction Finding (also called AoA, Angle of Arrival), the imec distance measurement works with only a single antenna at either side. With multiple antennas in combination with tracking, the accuracy of the distance measurement can even be much better than 10cm. It can also be combined with AoA technology for which imec's multi-path cancellation techniques also provide superior performance.

This high robustness against multi-path interference enables a range of challenging applications like secure passive keyless entry systems

for cars, smart locks for home or professional use, or secure and easy commissioning by being in the proximity of a device. The unprecedented performance and reliability allow proximity services to move from fairly relaxed use cases like proximity marketing in shopping centers, to more demanding applications like location based secure data access to for instance patient records by authorized personnel in a hospital room. Relay-attack safety, particularly important for passive keyless entry applications in automotive, will be done by including provisions against spoofing of phase based ranging data as well as distance bounding techniques.

The superior performance of imec's Bluetooth High Accuracy Distance Measurement / Channel Sounding (BT HADM / CS)" is demonstrated on commercial chips like NXP's Kinetis® KW35/36 Bluetooth series, as well as with the Atmel (Microchip) AT86RF215 platform for IEEE802.15.4, showing the versatility of the solution to work on standard narrowband radios of various standards and manufacturers. Implementations on other manufacturers devices can be made on request. As associate member of the Bluetooth SIG, imec is a strong supporter of technologies that further enhance Bluetooth localization accuracy like the direction finding feature included in version 5.1 of the Bluetooth Core Specification.

KEY FEATURES

- Accuracy better than 10cm; 10x better than state-of-art today
- Suitable for standard 2.4GHz radios, e.g., Bluetooth Low Energy (BLE) and 802.15.4 / Zigbee
- Secure for spoofing, relay attacks and other attack mechanisms
- Very robust against multipath reflections
- Complementary to Direction Finding / AoA – Enables single anchor localization
- Low processing power requirements, e.g., no overhead at end-point, ARM Cortex™ M4F at gateway side
- Support single or multi-antenna configurations
- Support for multi-device and group ranging

APPLICATION FIELDS

- Passive keyless entry
- Asset localization & tracking
- Indoor navigation
- Proximity services, beacons
- Device commissioning by proximity
- Automotive passive keyless access

KEY BENEFITS

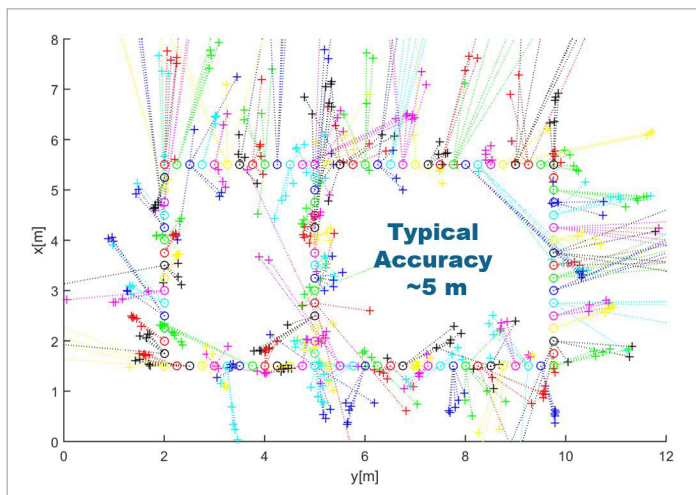
- Very high accuracy compared to RSSI ranging solutions
- Safe against against relay attacks
- Easy to implement on commercial chipsets, without need for radio hardware changes
- Suitable for narrowband, standardized communication platforms (BLE, Zigbee)

Wireless standards	IEEE802.15.4 (available) Bluetooth (available) Approach extendable to WiFi
Frequency band	2.40-2.48GHz (other bands with trade offs)
Line-of-sight accuracy	<2 cm in pure LOS
Accuracy in multipath environment	<50 cm - ranging with 1x1 antenna <30 cm - ranging with multiple antennas <10 cm - localization and tracking
Acquisition time I/Q data	100us-10ms (depends on radio front-end)
Memory footprint	30kB ROM, 50kB RAM
Processing single measurement time	<50ms on ARM Cortex M4F @120MHz & single side, other side no load.
Spoofing resistance	Secure Distance Bounding provides resistance against relay attacks: - Phase based ranging for high accuracy - Protected Time-of-Flight (ToF) - Authentication and key exchange Encryption & TOF
Other	Complements direction finding in Bluetooth 5.1. Compatible with Bluetooth devices supporting I/Q data access

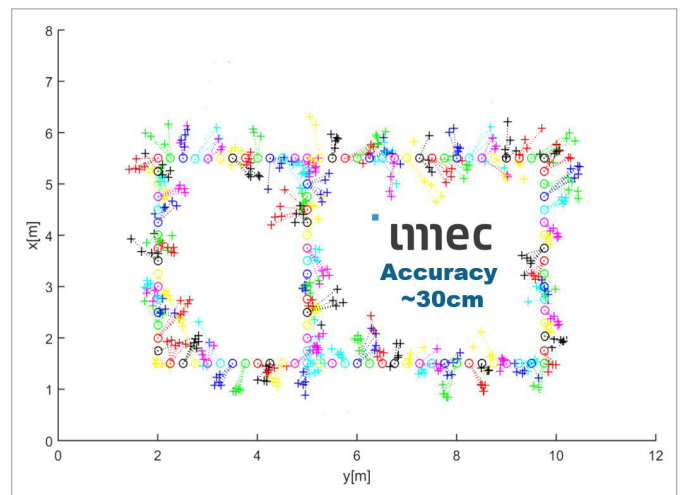
WHITE PAPER

Want to know more about this technology and it's applications? Download our white paper at www.imec-int.com/SDB.

IMEC LOCALIZATION IMPROVEMENT OVER TYPICAL PERFORMANCE



Typical localization performance



Imec localization perform

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