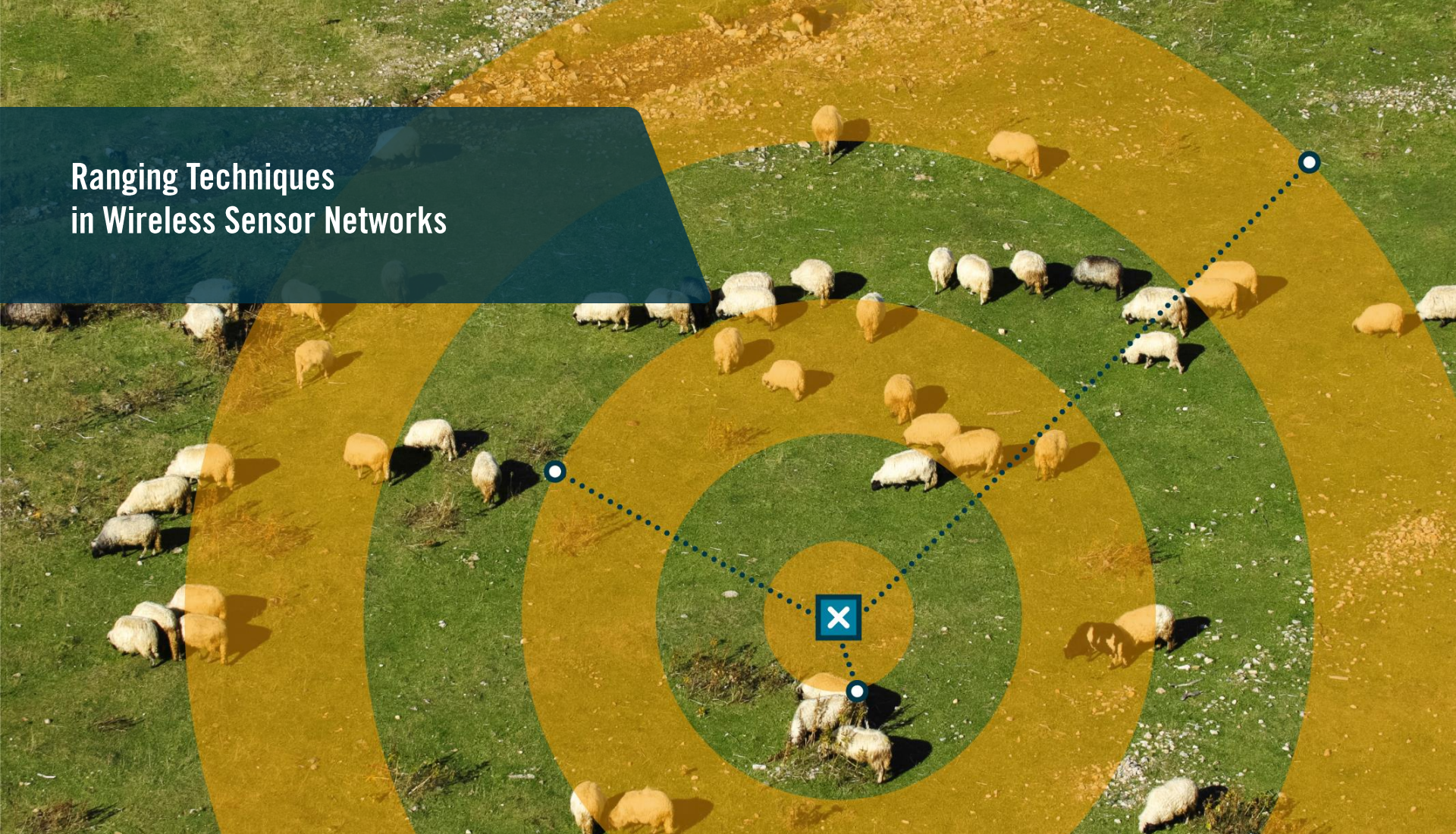


Ranging Techniques in Wireless Sensor Networks



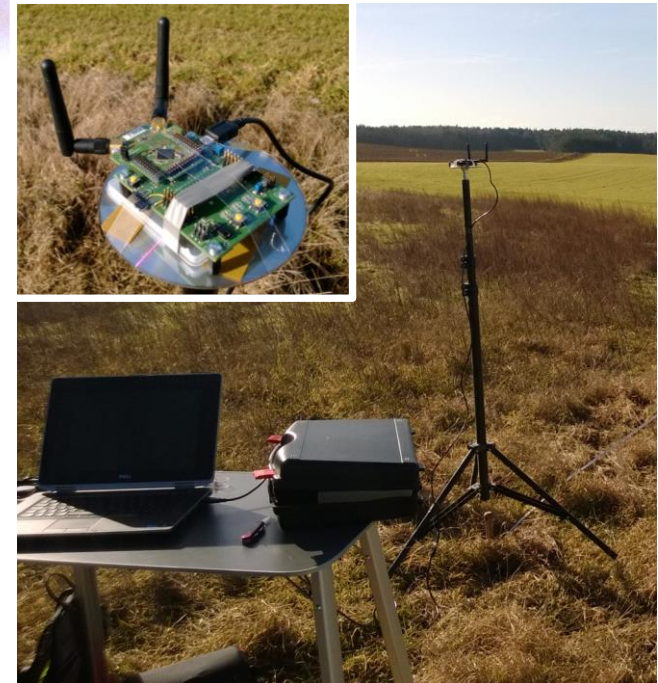
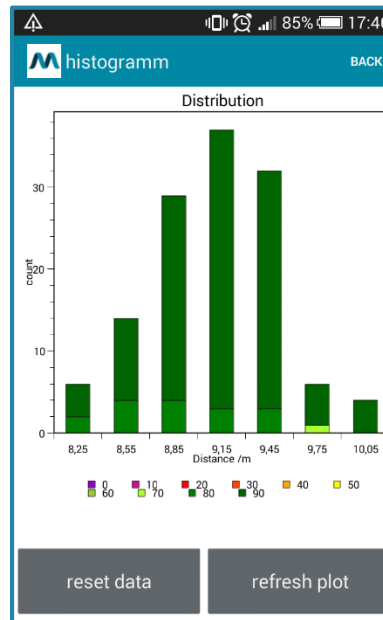
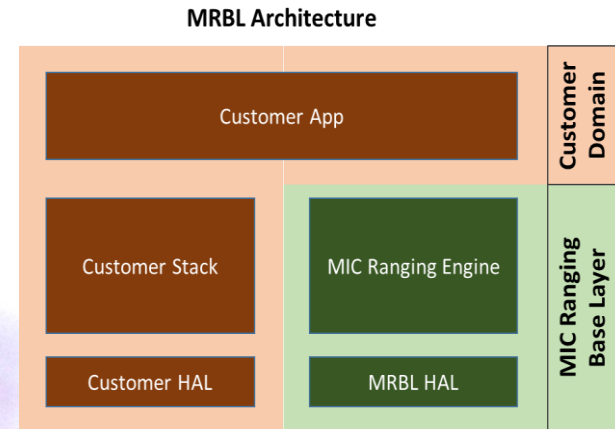
WIRELESS DISTANCE MEASUREMENT

WE KNOW THE DISTANCE !


metirionic

Metirionic GmbH

- **IP provider** for ranging solutions in wireless sensor networks
 - Ranging SW-IP
 - Tailored HW solutions
- **Engineering Services**
 - System development
 - SW development
 - Application development
 - HW development
- **Customers**
 - System developer
 - System integrators



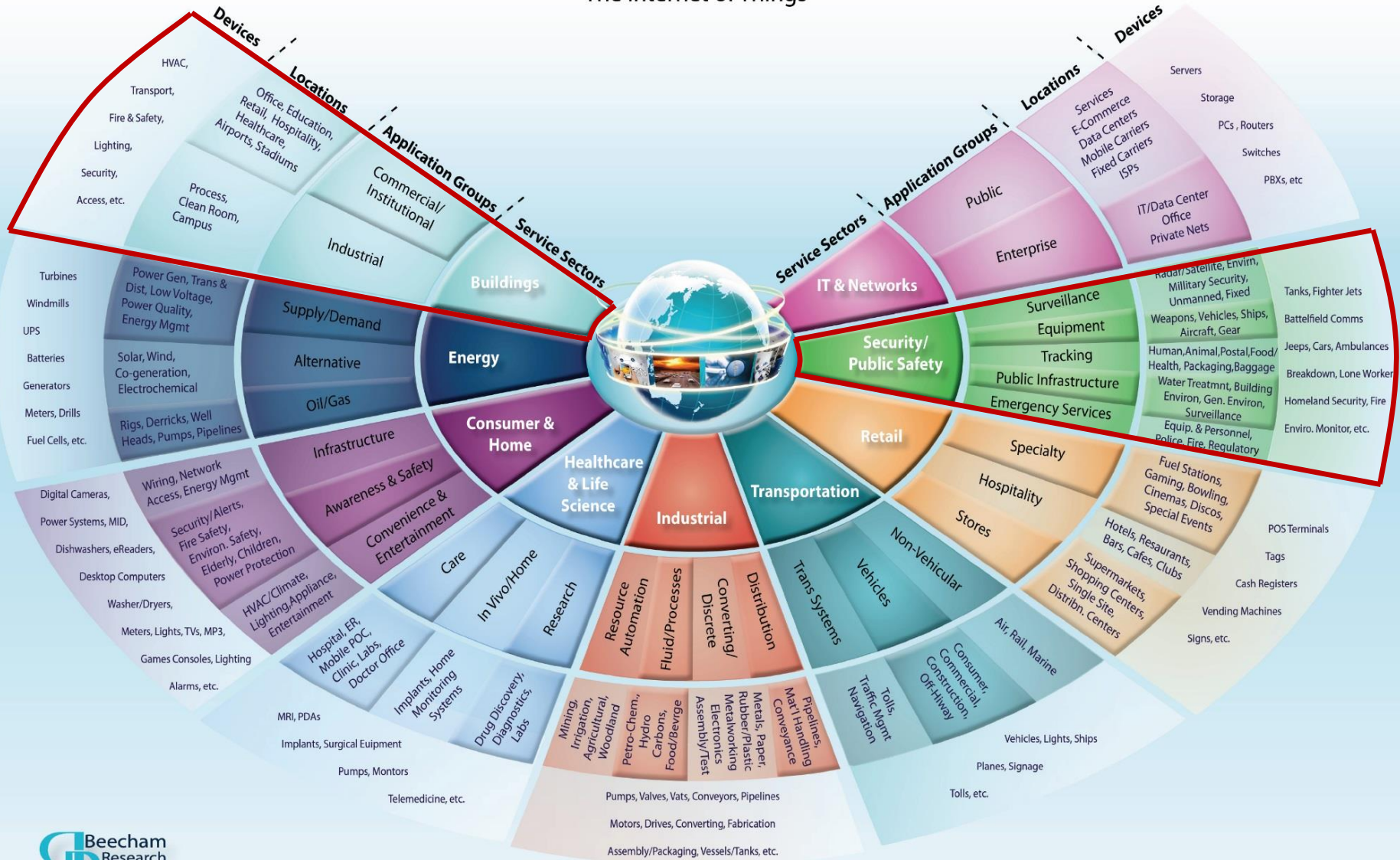
M2M World of Connected Services

The Internet of Things



M2M World of Connected Services

The Internet of Things



Vertical-Markets: LED-Lighting

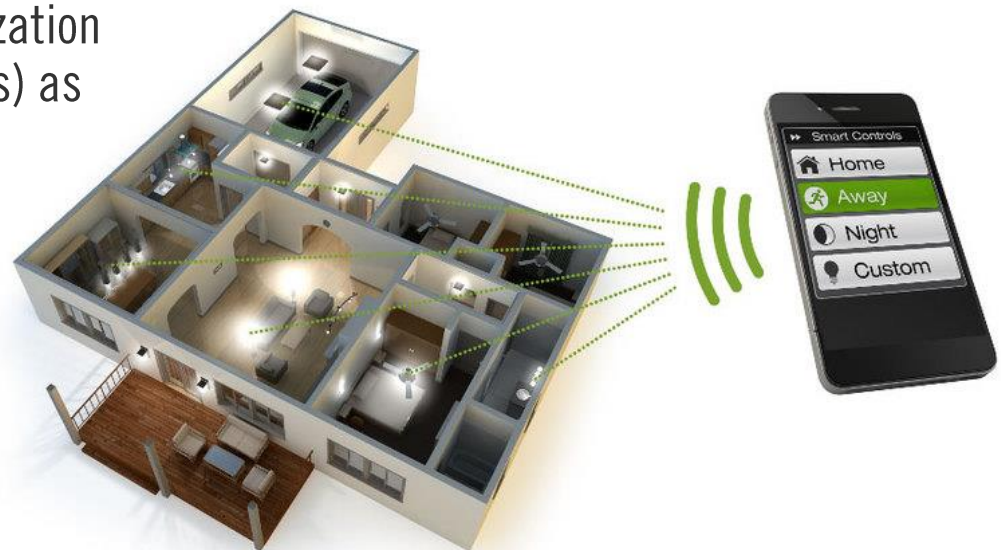
- LED Technology changed the Lighting Market dramatically
- New Functionality: dimming, colors, setting the right scenes and connectivity.
- Microcontroller as major component of LED lights

Industrial:

- LED lamp enabled ranging and localization network (mains powered anchor nodes) as base for value-added services
- Intelligent emergency lighting

Consumer:

- Simplified commissioning procedure (proximity detection)



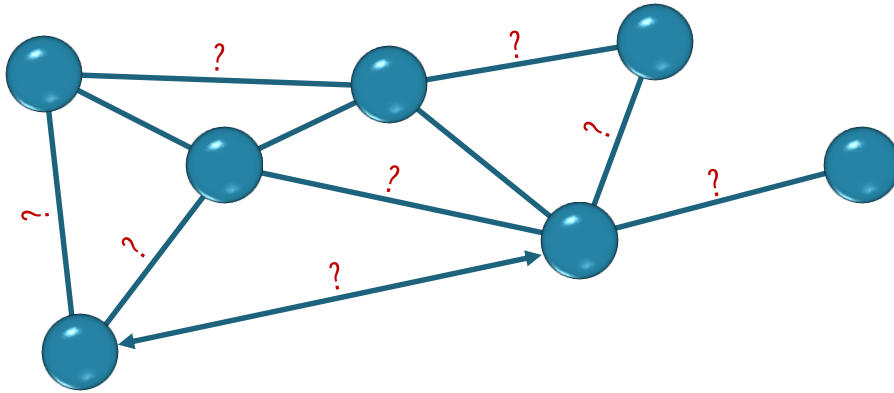
Vertical-Markets: Dairy Farm

Sensor networks required for:

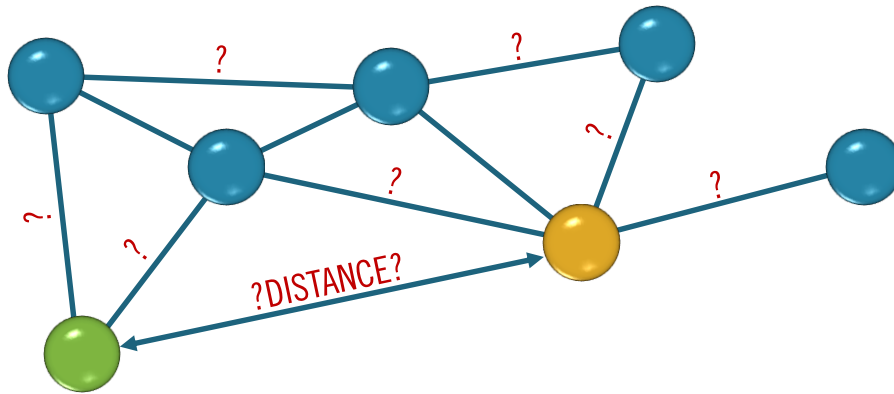
- Automation of farming processes (robotic farm)
 - Feeding
 - Milking
 - Cleaning
- Health monitoring of individual cows
 - Activity monitoring
 - Rumination
 - Heat detection



Distance Measurement in Sensor Networks



Distance Measurement in Sensor Networks



Objective:

Distance measurement between two addressable nodes in a meshed network.

- RSSI** ⇒ Received Signal Strength Indicator
- Phase Difference Measurement** ⇒ Phase measurement of incoming radio signal
- Ultra Wideband (UWB)** ⇒ Time-of-flight measurement

Ranging with: Received Signal Strength Indication

Technology:

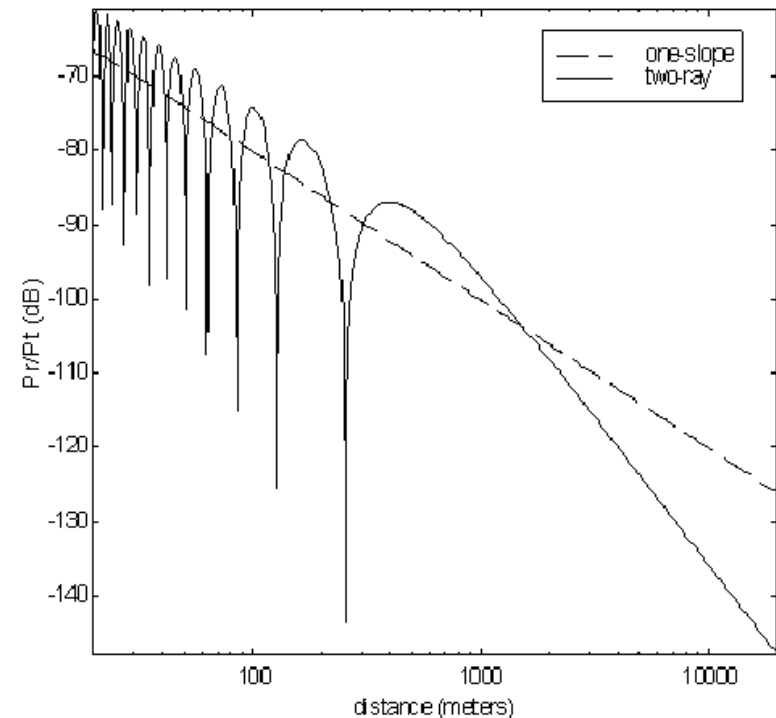
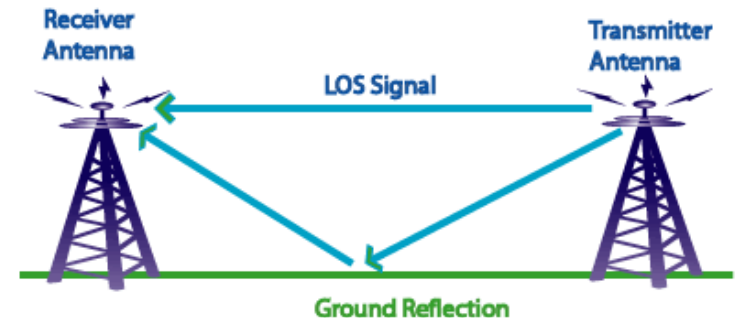
- Measurement of the signal strength of the incoming radio signal

Pros:

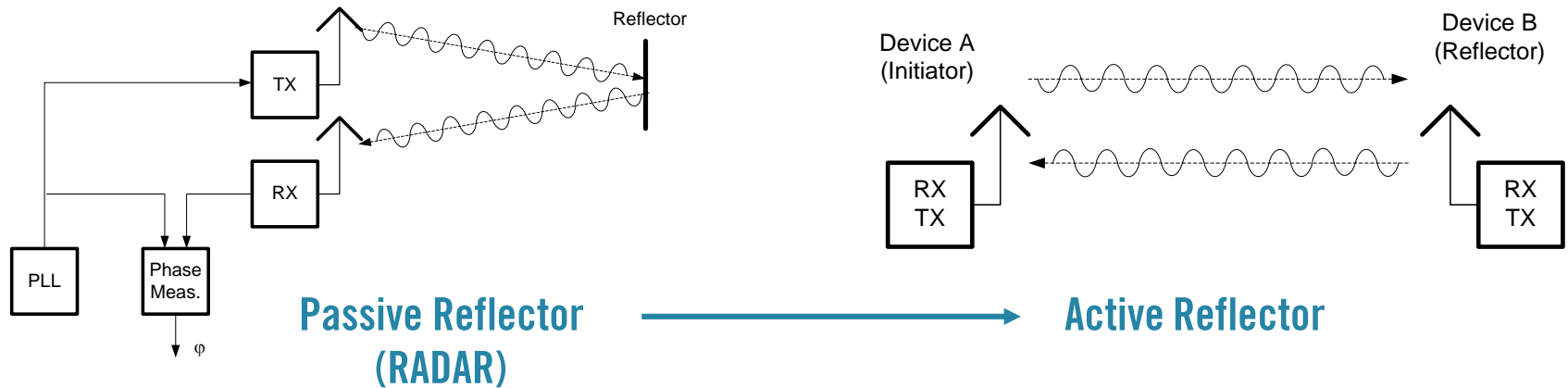
- + Inherent to each state-of-the-art receiver
- + Fast Measurement

Cons:

- Location depended deep fades of RSSI
- High inaccuracy in indoor environment



Ranging with: Phase Difference Measurement



Technology:

- Initiator sweeps through a set of frequencies
- The active reflector measures the phase of the incoming frequencies
- Reflector will retransmit and the initiator will measure the phase of the incoming frequencies
- All measurement data concentrated in the initiator to calculate the distance

Pros:

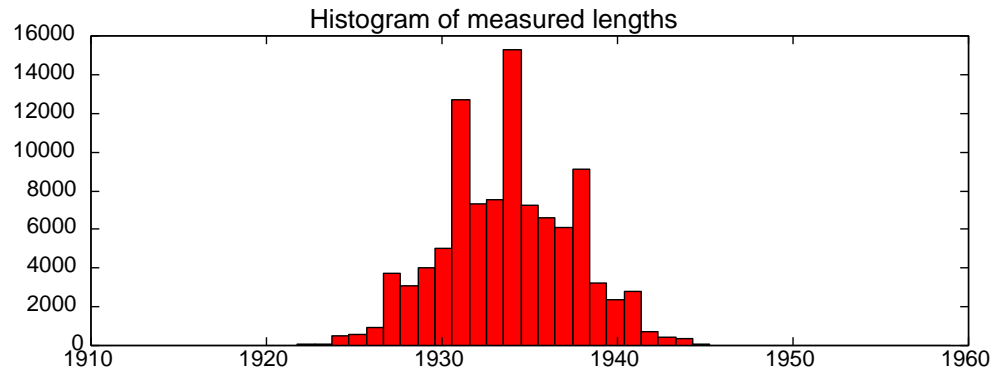
- + Good accuracy
- + Low system complexity
- + Integration capability to WSN

Cons:

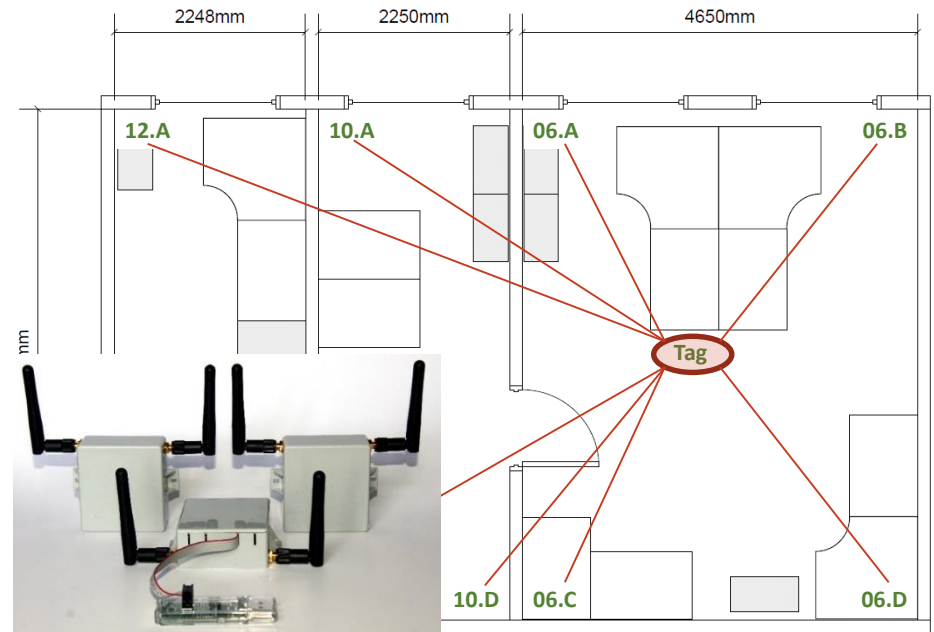
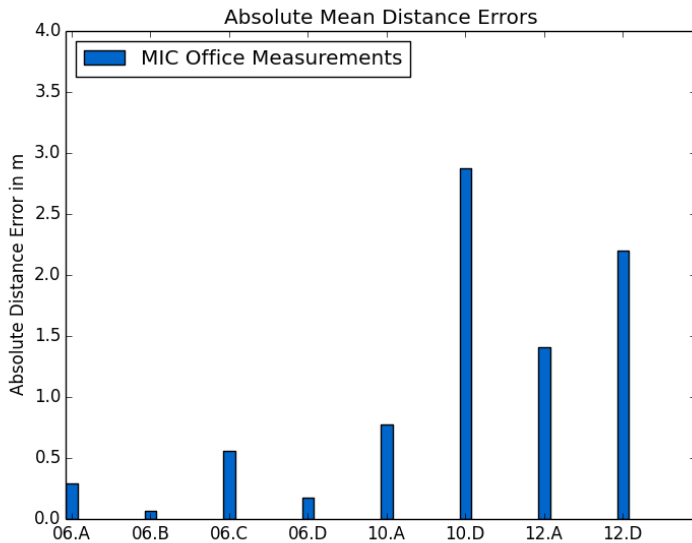
- Phase Measurement Unit as additional radio hardware building block

Ranging with: Phase Difference Measurement - Results

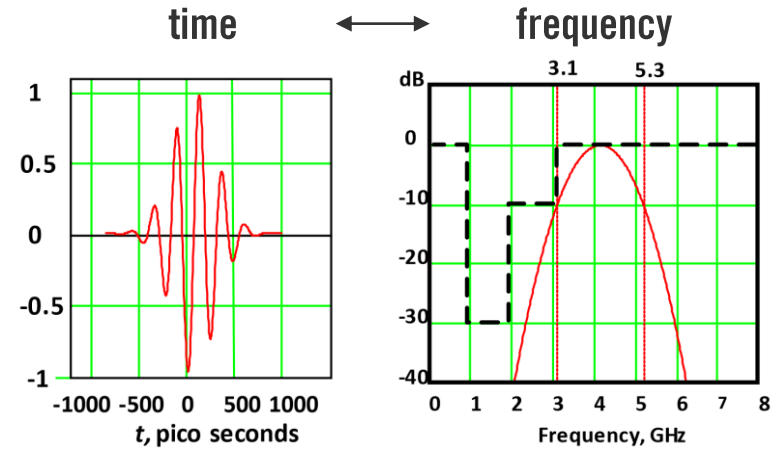
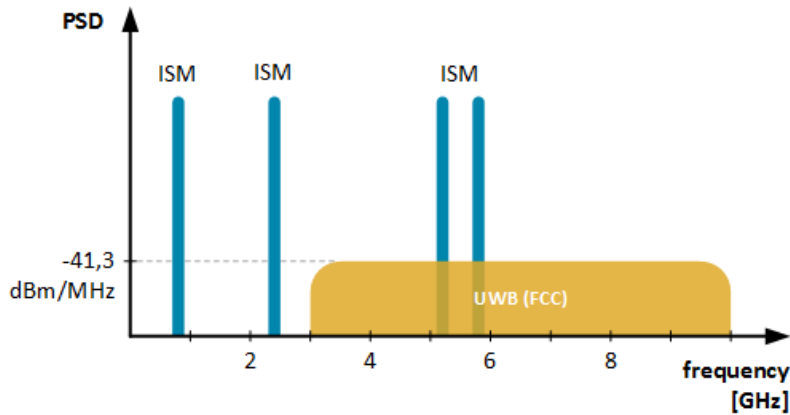
Ideal cable based
reference measurement:



Real Life Indoor scenario:



Ranging with: Ultra Wide Band Solutions



Technology:

- Transmission of short radio pulses with a large bandwidth ($BW > 500$ MHz)
- Signal time-of-flight measurement

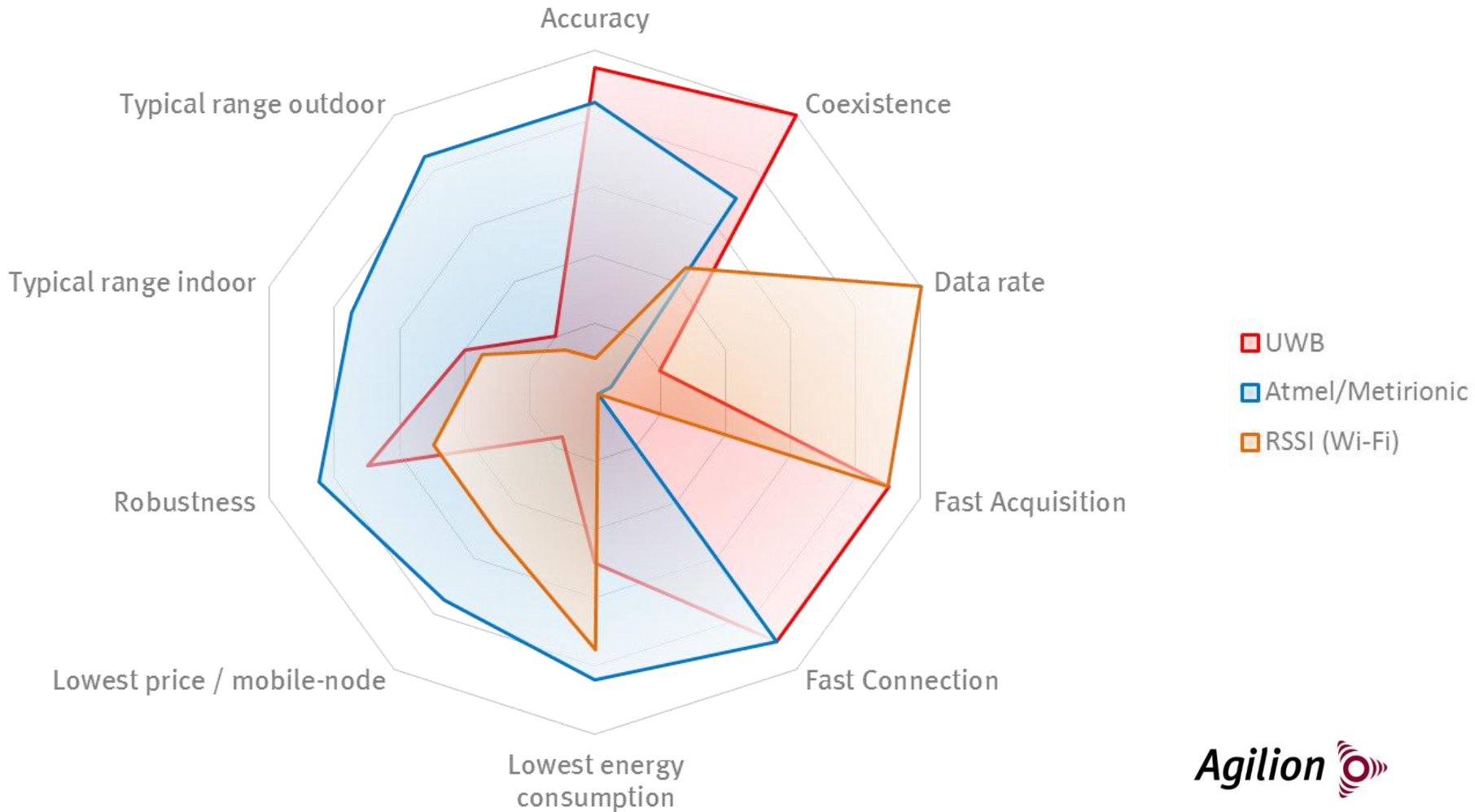
Pros:

- + High accuracy
- + High acquisition speed

Cons:

- High system complexity
- Energy consumption

System Performance Comparison



WE KNOW THE DISTANCE !

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