
decaWave
...thinking outside the band


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ScenSor

Designing the first commercial IEEE 802.15.4a chip

- Luc Darmon, Michael McLaughlin, Dries Neirynck

- IEEE Conference EILAT 2012

Introducing DecaWave

Introducing DecaWave

- DecaWave is a Fabless Semiconductor Company designing and bringing to market a family of IEEE802.15.4a compliant Integrated Wireless Transceivers called ScenSor based on Ultra Wideband Technology

- We make Integrated Wireless Transceivers, A complicated way of saying an integrated radio transmitter and receiver on the same piece of silicon

- **Our Wireless Transceivers can also Locate things.**

We allow Real-Time Location Systems to reach unprecedented performance levels at consumer costs.

Introducing DecaWave: The Vision

“The Internet of Things”

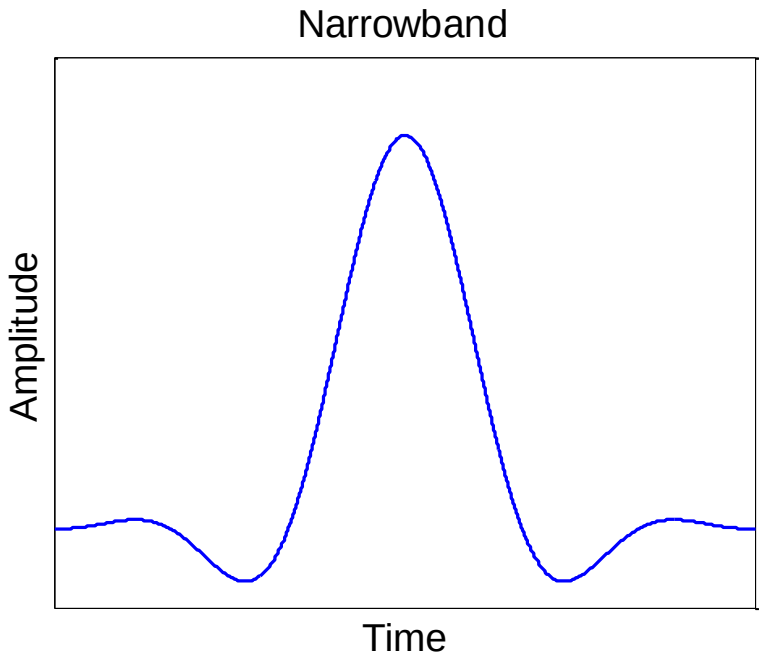
A World where anybody or anything can locate and communicate between any other person or thing, made possible by pervasive, low power, low cost, high data rate wireless transceivers.

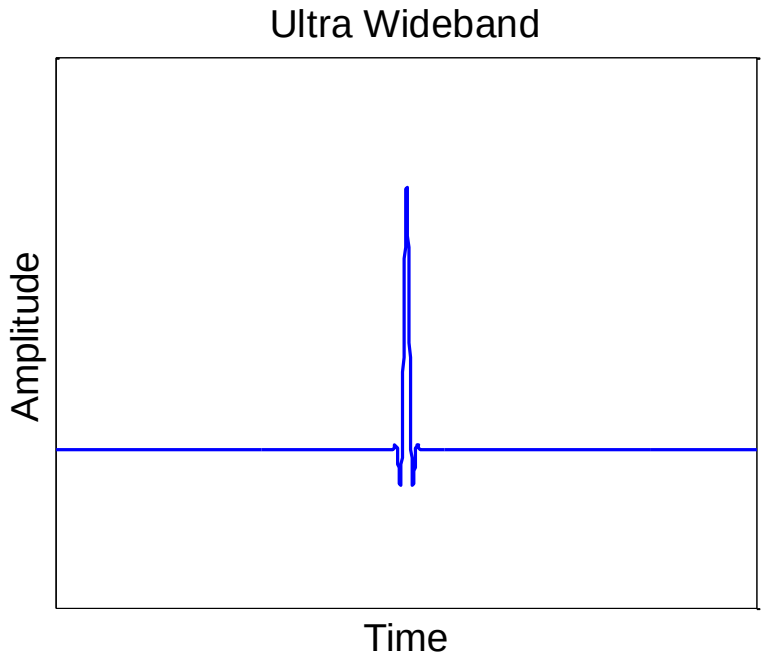
Technology and Technical Solution

COHERENT ULTRA-WIDEBAND

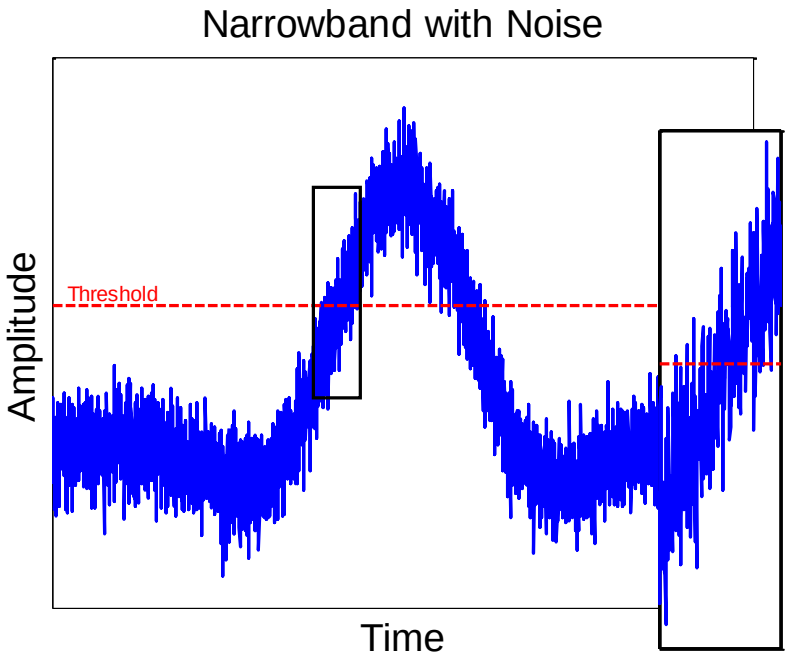
The intuitive explanation

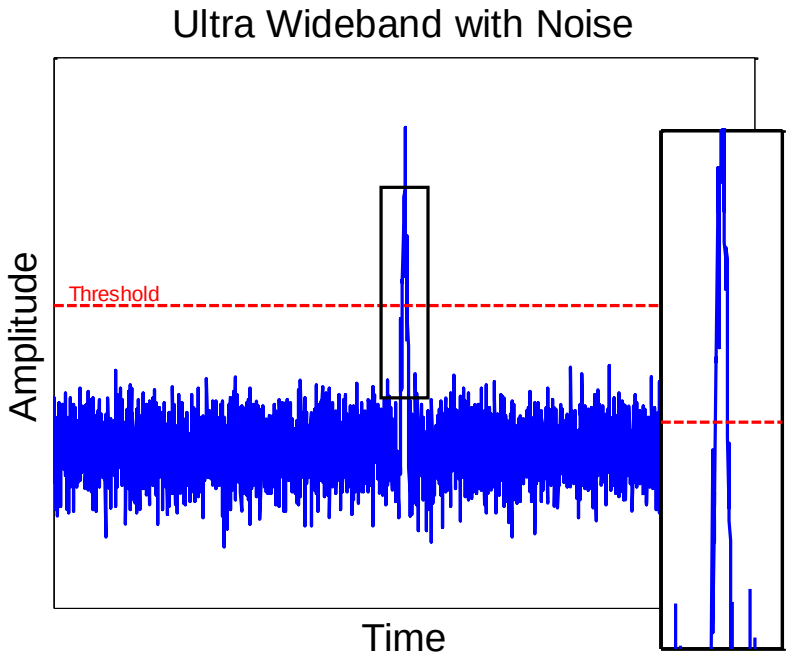
Narrowband versus Ultra-Wideband



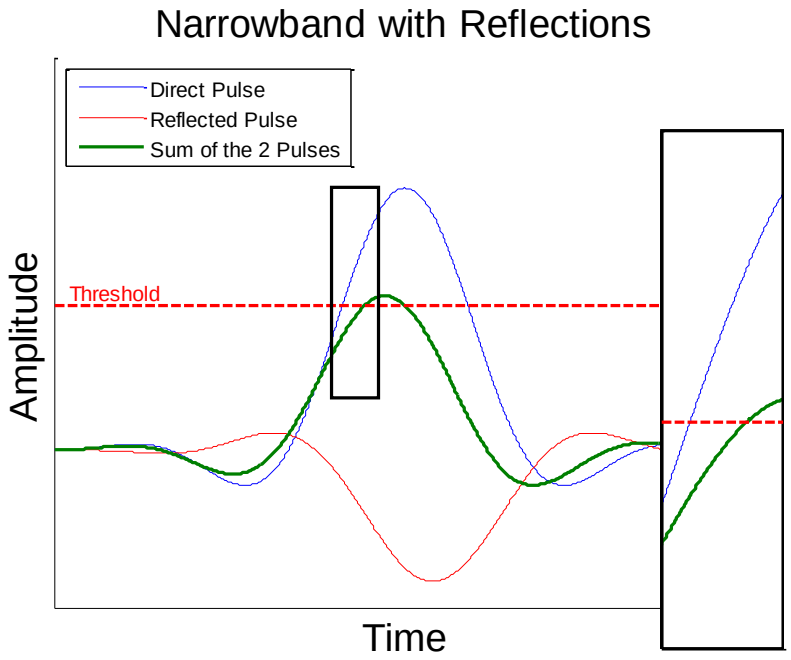


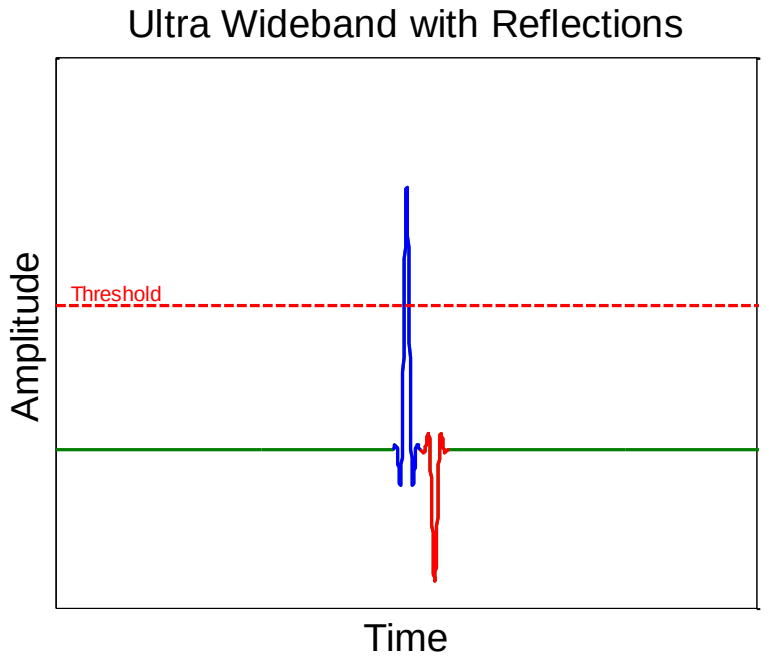
In the presence of noise



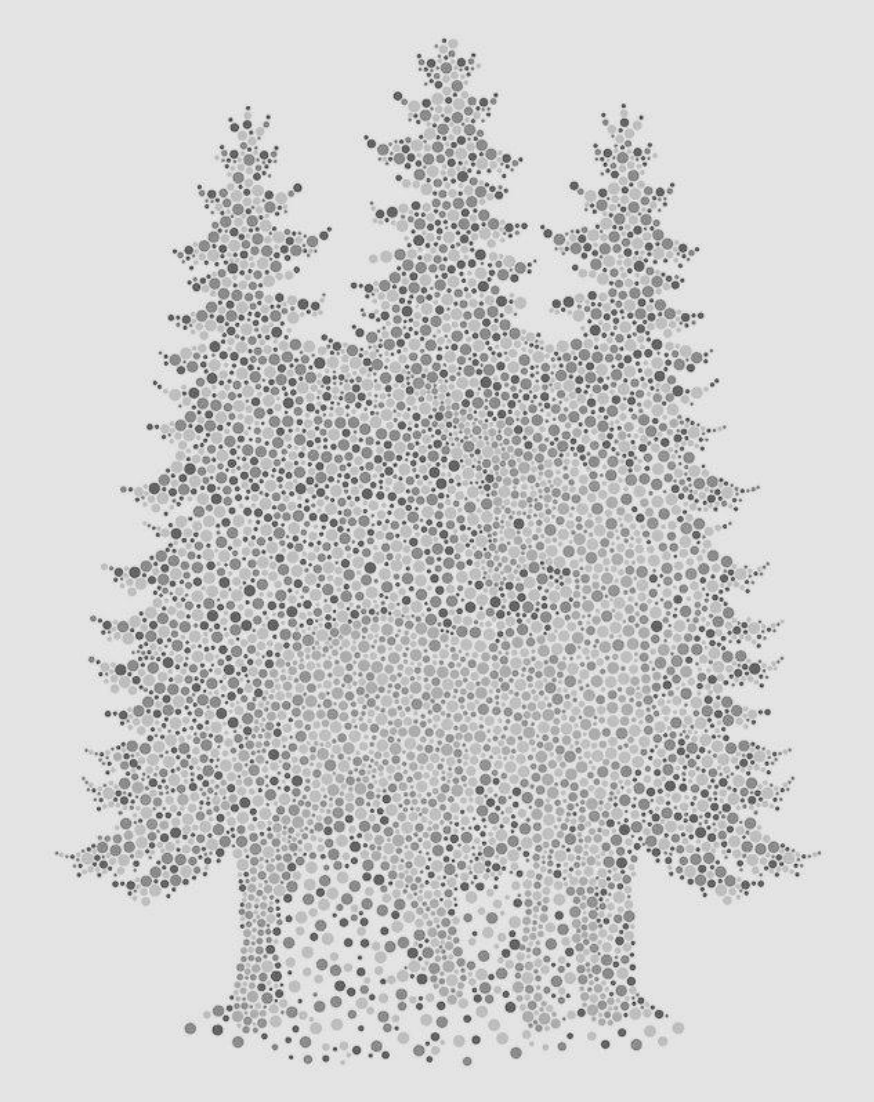


In the presence of multipath

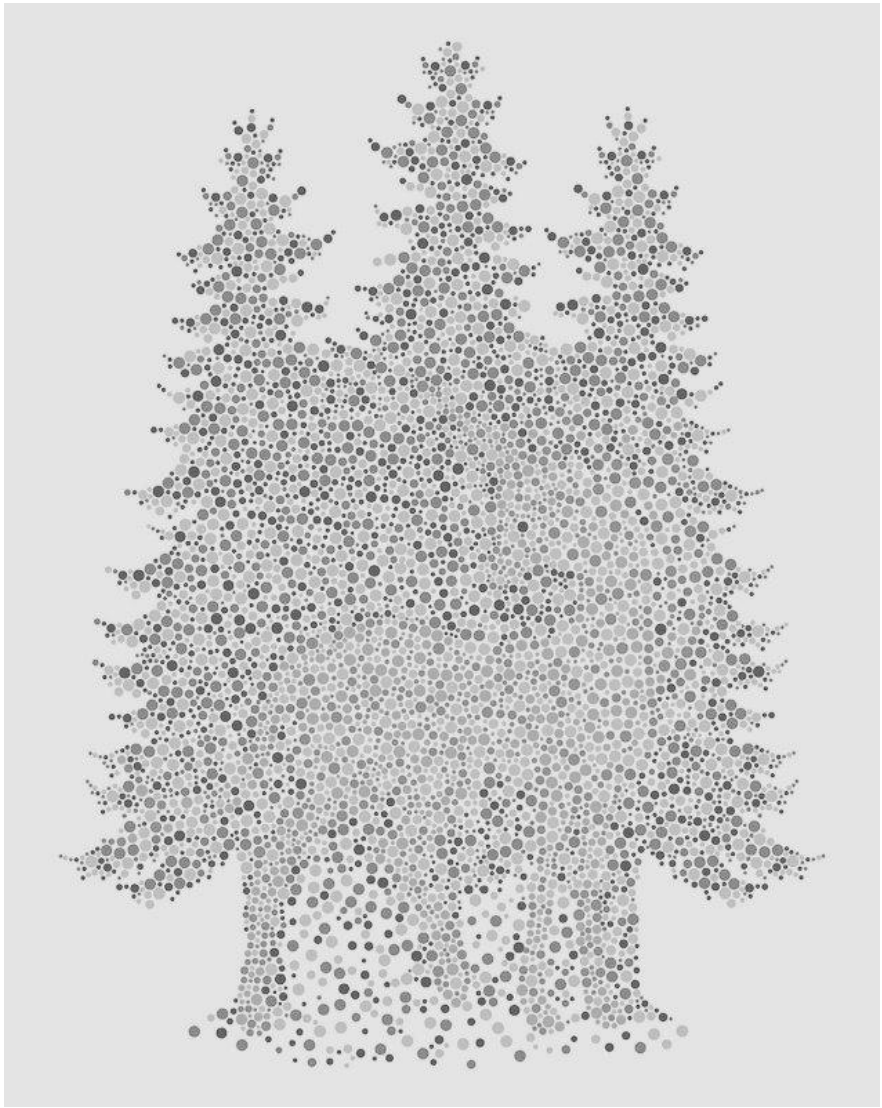




Find the unicorn (non-coherent version)



Find the unicorn (coherent version)



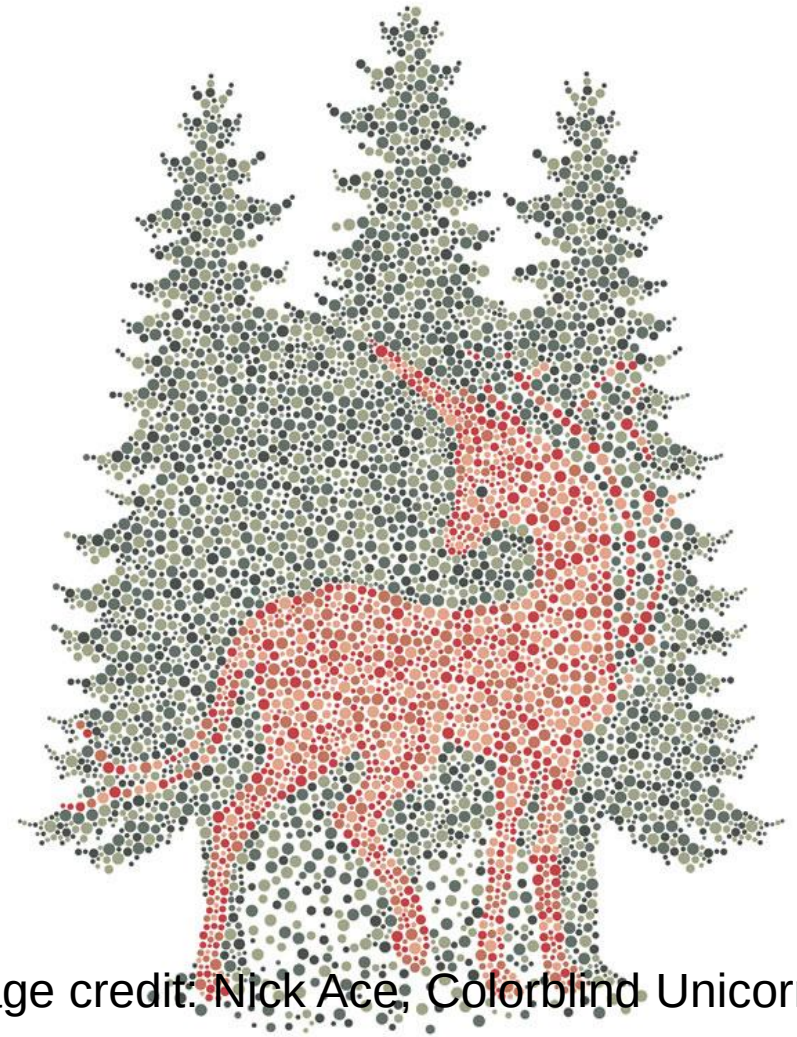
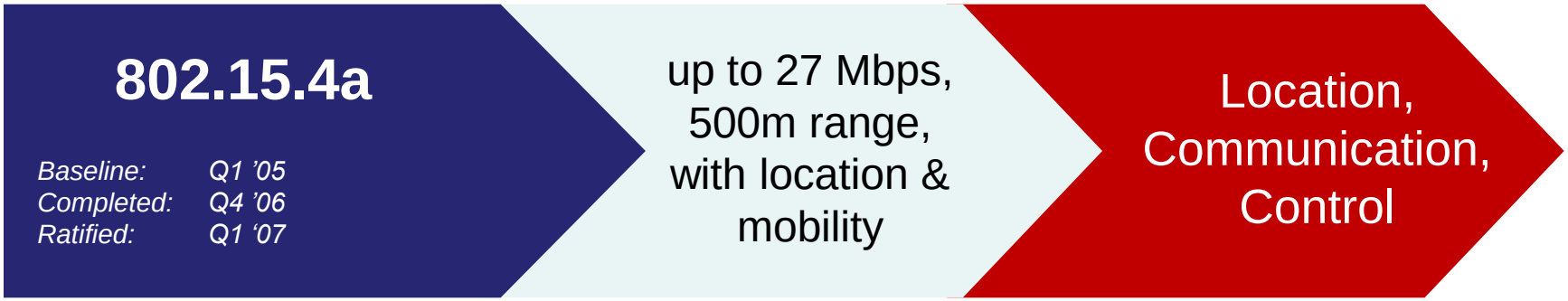


Image credit: Nick Ace, Colorblind Unicorn

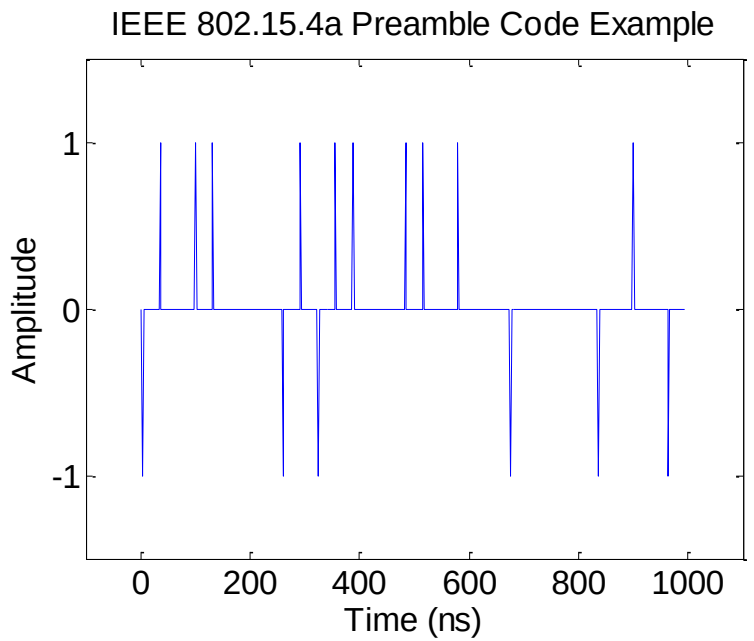
IEEE 802.15.4A

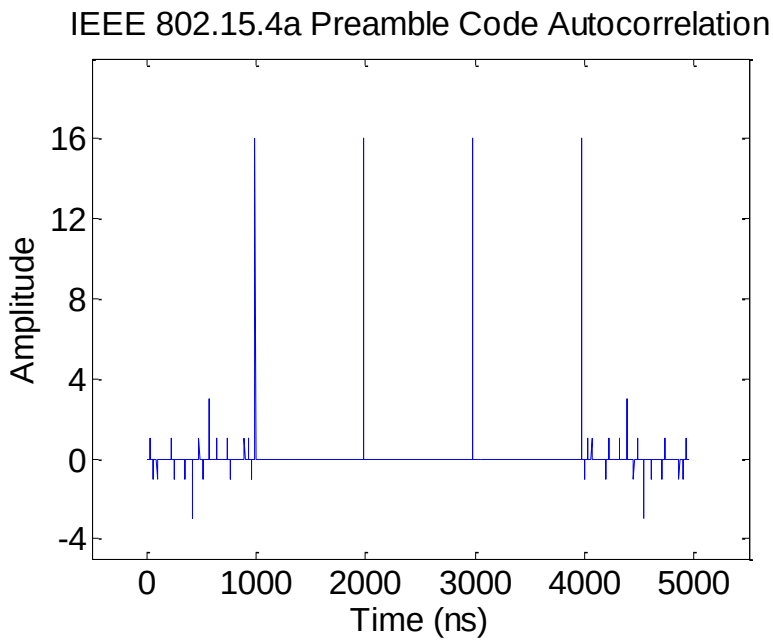
IEEE 802.15.4a



IEEE Standard **Capability** **Utility**

IEEE 802.15.4a preamble





Benefit of ternary codes:

- support both coherent and non-coherent detection
- Perfect autocorrelation allows ranging

IEEE 802.15.4a Payload

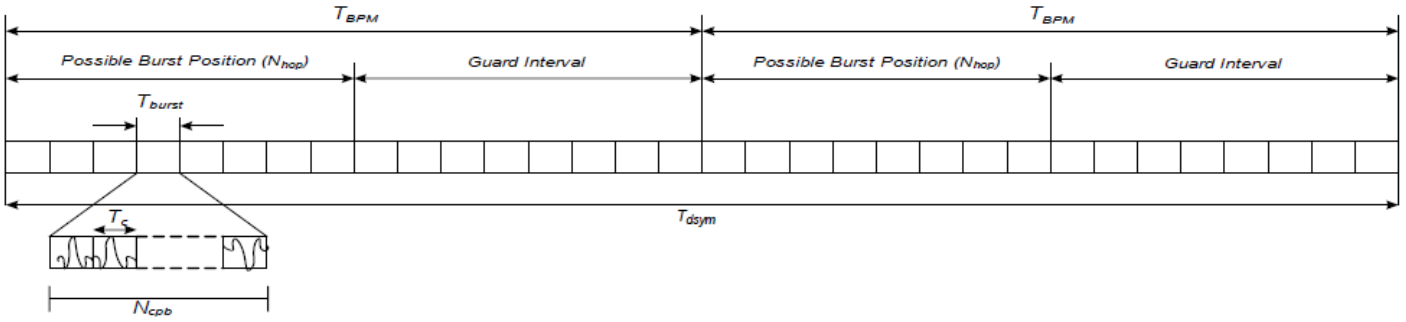
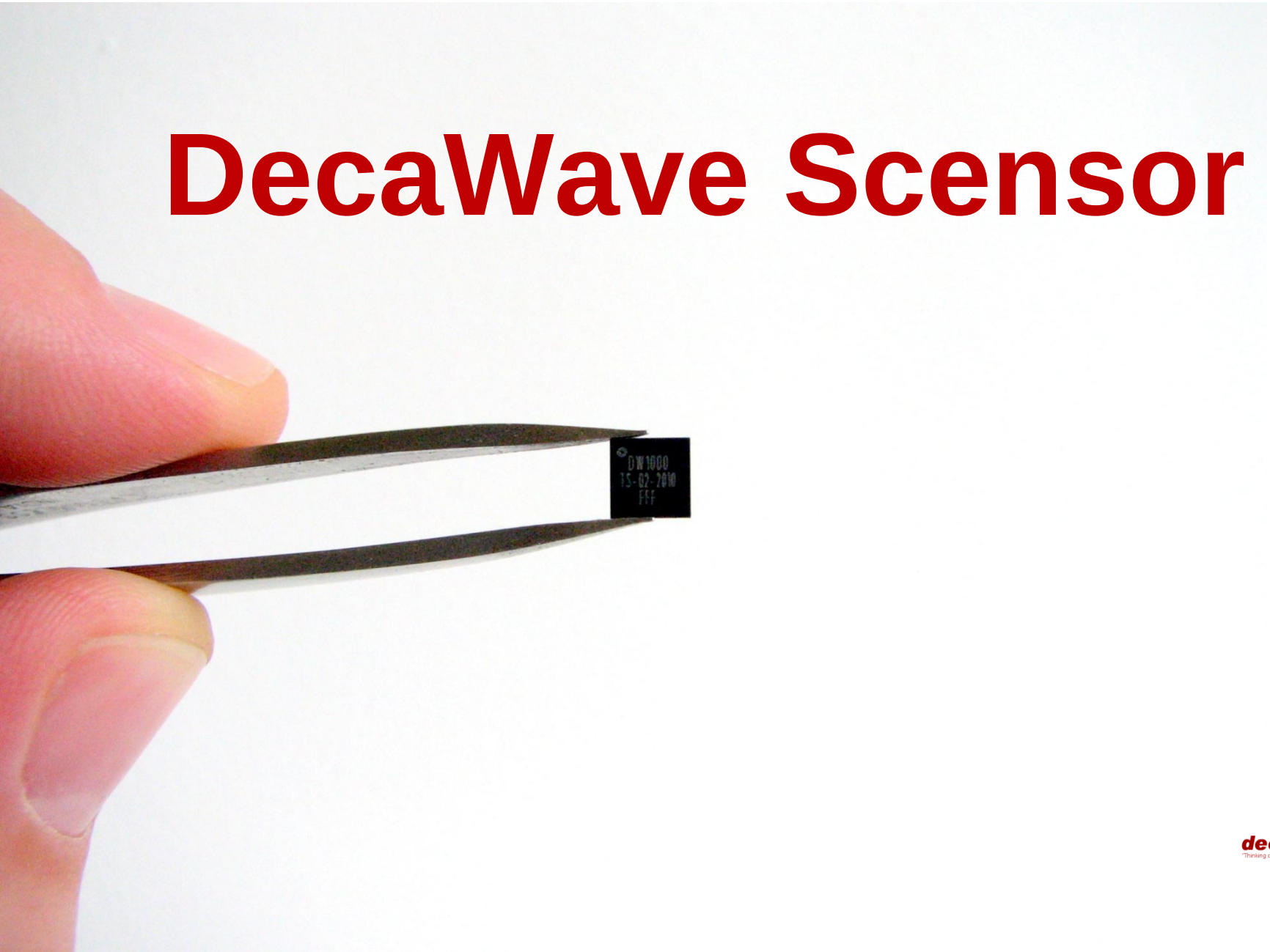


Figure 27c—UWB PHY symbol structure

- Non-coherent RX can only use position information
- Coherent RX benefits
  - Burst phase contains error correction information
  - Burst spreading code allows noise suppression

DecaWave Scensor



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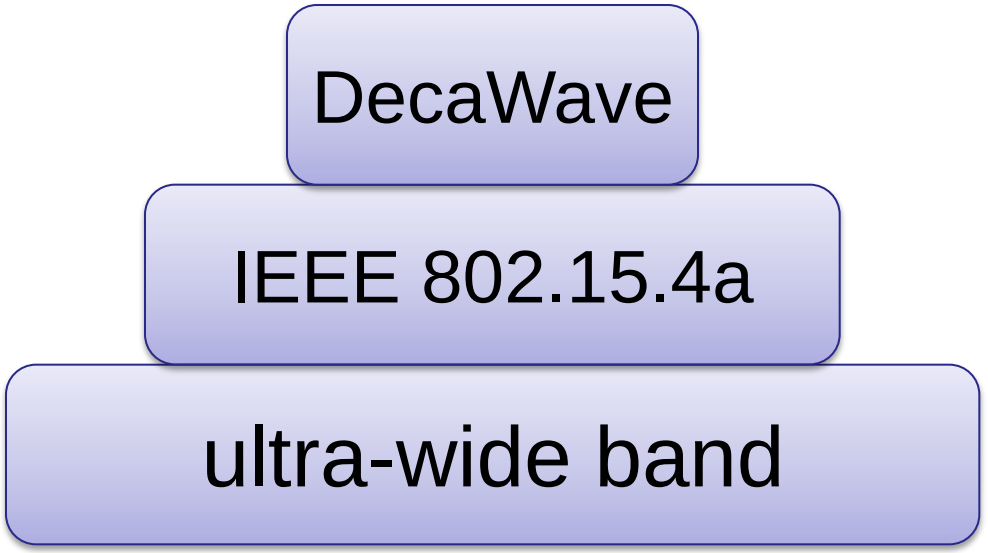
"Thinking outside the band"

Technical Solution

Low power and cost

Superior technical solution

Market Driver of
Precision, Reliability



Enhanced solution built on foundations of UWB

The disruptive value of DecaWave ScenSor IC

Low power and cost

DecaWave

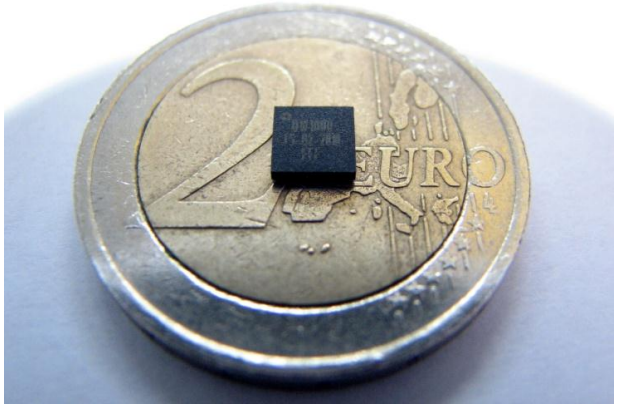
DW delivers a chip that is superior to comparative offerings in numerous ways:

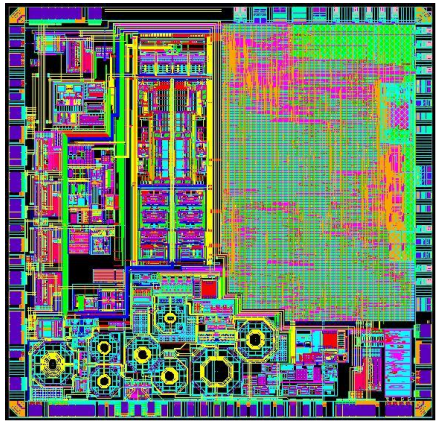
- 5 times smaller, hence cheaper and lower power
- Can locate items within 10 cm of where they are, and highly reliable
- LOS 350m, NLOS 40m, allowing it to be deployed in WLAN APs
- Can identify up to 11,000 items within a 20 meter radius
- Both One way and Two way ranging capability, hence no infrastructure required
- Very high immunity to multi path fading, allowing east installation for end user
- Avoids spectral crowding of the ISM bands, hence dove tailing with WiFi installations

DecaWave solves the problem of location specific identity indoors at ultra low cost & ultra low power

Decawave ScenSor

- Seek, Control, Execute, Network / Sense, Obey, Respond

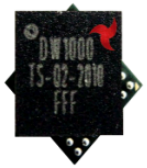




- TSMC CMOS 90 nm
- Output up to -10 dBm
- 6 frequency bands supported from 3.5GHz to 6.5GHz
- 110kbps, 850kbps & 6.8Mbps data rates

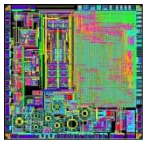
- Decawave's IP (patents and "know-how") allows us to have an ultra-low complexity coherent receiver, thereby giving the benefits of superior range & precision at ultra-low power at a very cost competitive price tag.

Journey to ScenSor Full Production



MPW3 Oct 2012

- **Customer Validation:** 10 Design wins now
- **Technology Benefit:** All bands, all data rates, 450m LOS, 45m NLOS
- **Productisation:** Production ready design



MPW2 July 2011

- **Customer Validation:** 10 customers endorse & request full production, will design with MPW2
- **Technology Benefit:** Proving design robustness and performance.
- **Productisation:** Full featured design with optimised analog front end

MPW1 May 2010

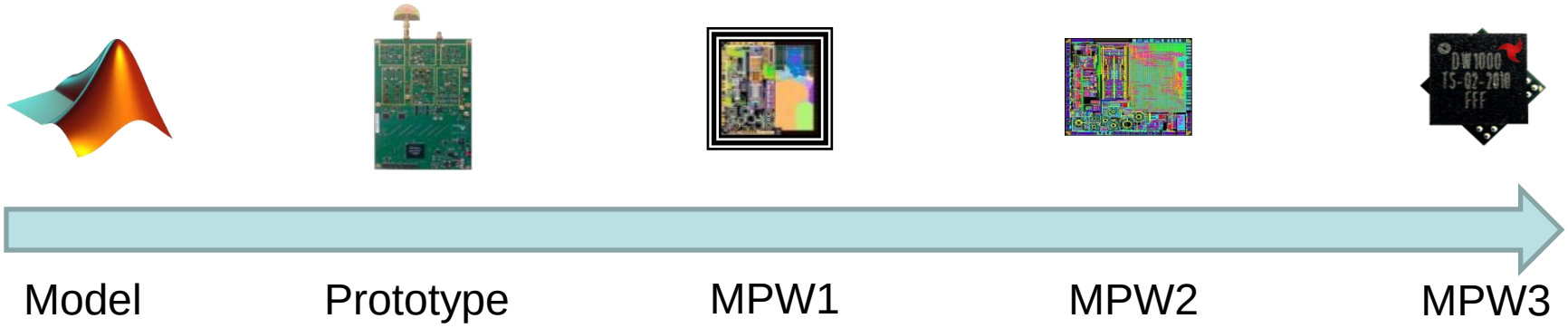
- **Customer Validation:** 2 way ranging & RTLS demo to LG Innotek, Gemalto & Continental
- **Technology Benefit:** full transceiver single chip integration, proving RF architecture
- **Productisation:** Proving cost profile

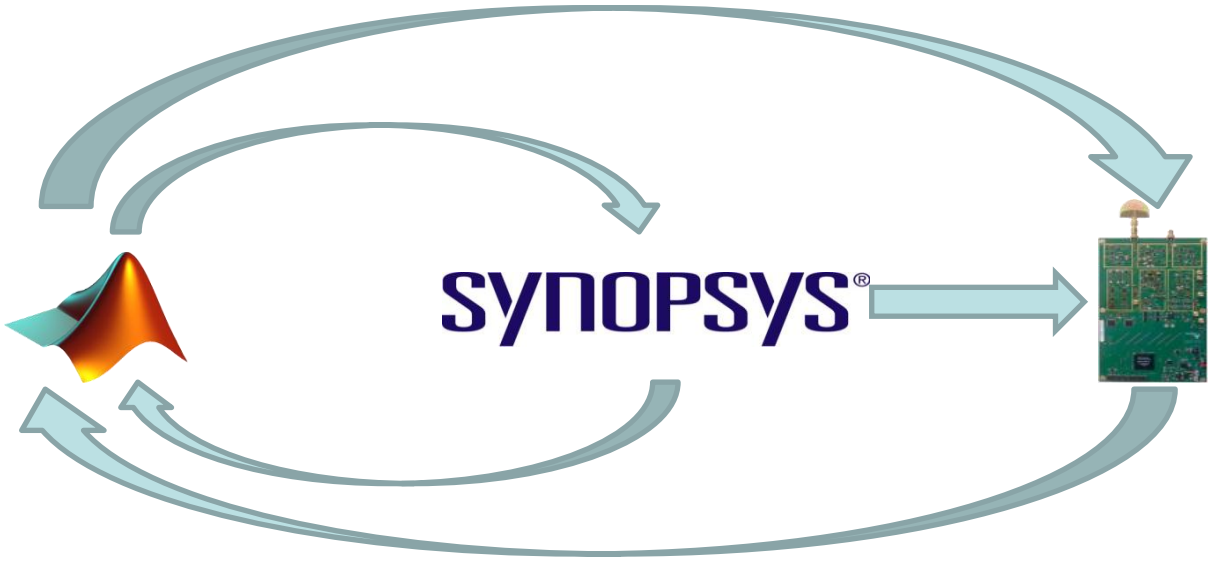
FPGA Prototype March 2009

- **Customer Validation:** Sold 45 kits to 17 customers
- **Technology Benefit:** Communications range and location precision demonstrated
- **Productisation:** Proving algorithms

Slide 21

Design methodology





Typical Use Cases

Two-way ranging: TWR Versus SDS-TWR

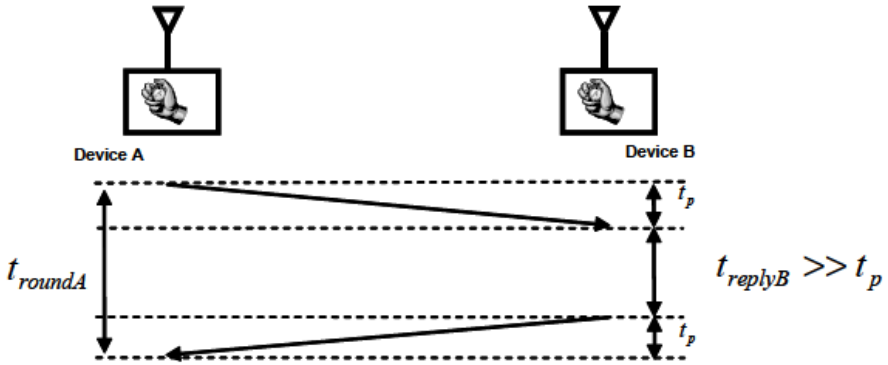


Figure D1.5—Exchange of message in two-way ranging

$$\hat{t}_p - t_p \approx \frac{1}{2} \times t_{replyB} \times (e_A - e_B)$$

Table D1.1—Typical errors in time-of-flight estimation using TWR

$t_{replyB}/(e_A - e_B)$	2 ppm	20 ppm	40 ppm	80 ppm
100 µs	0.1 ns	1 ns	2 ns	4 ns
5 ms	5 ns	50 ns	100 ns	200 ns

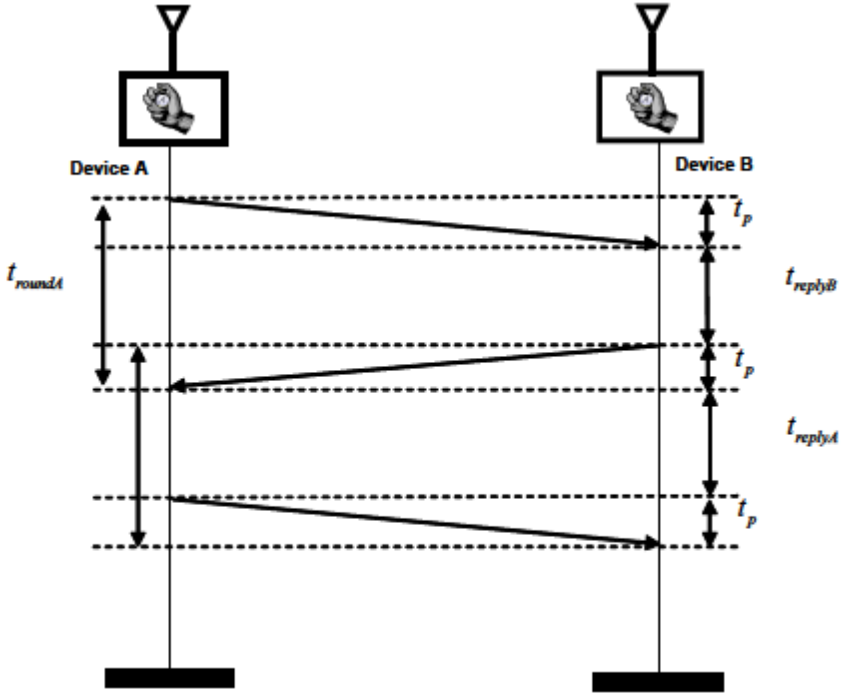
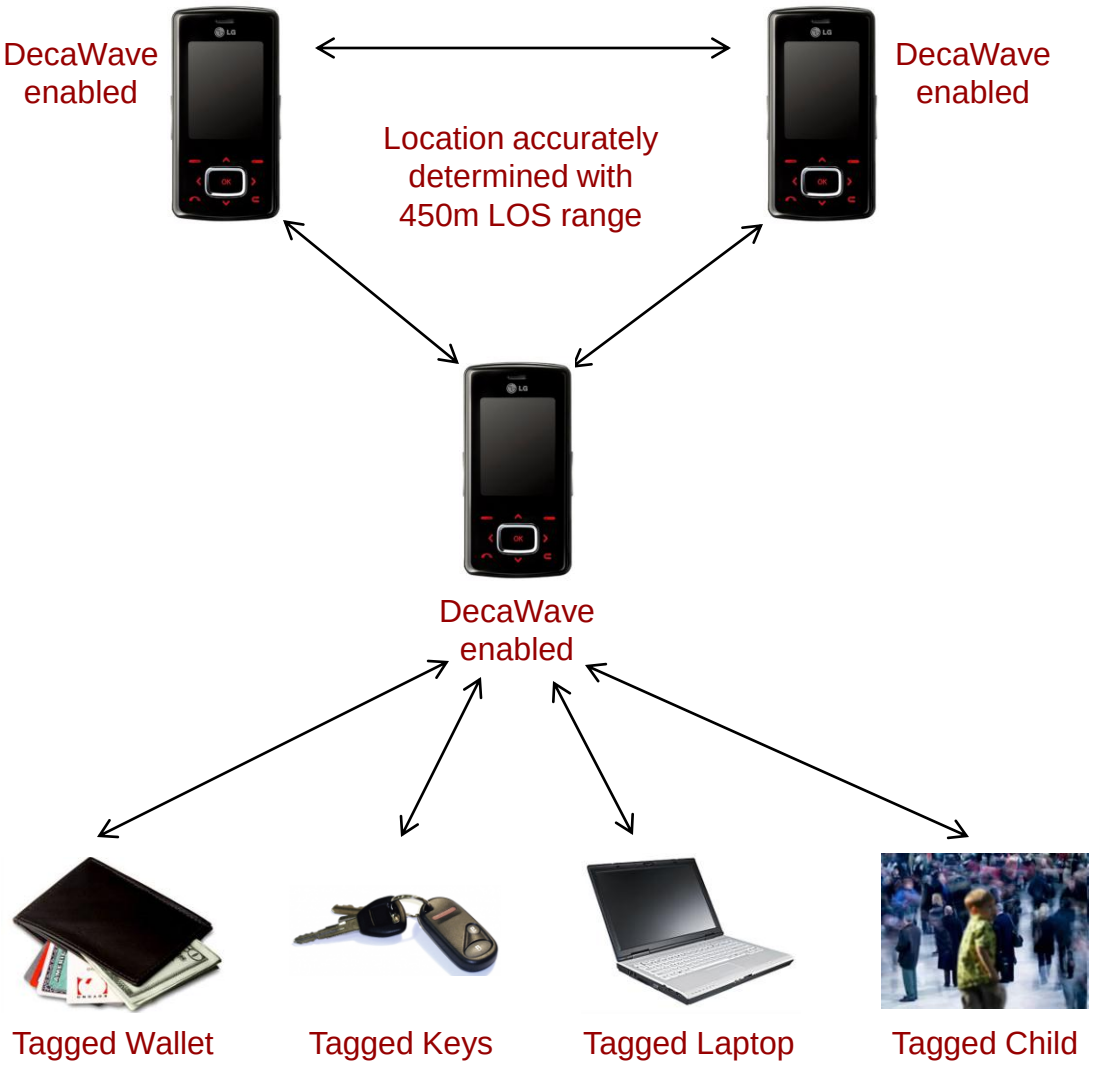


Figure D1.6—Exchange of message in SDS-TWR

Table D1.2—Typical errors in time-of-flight estimation using SDS-TWR

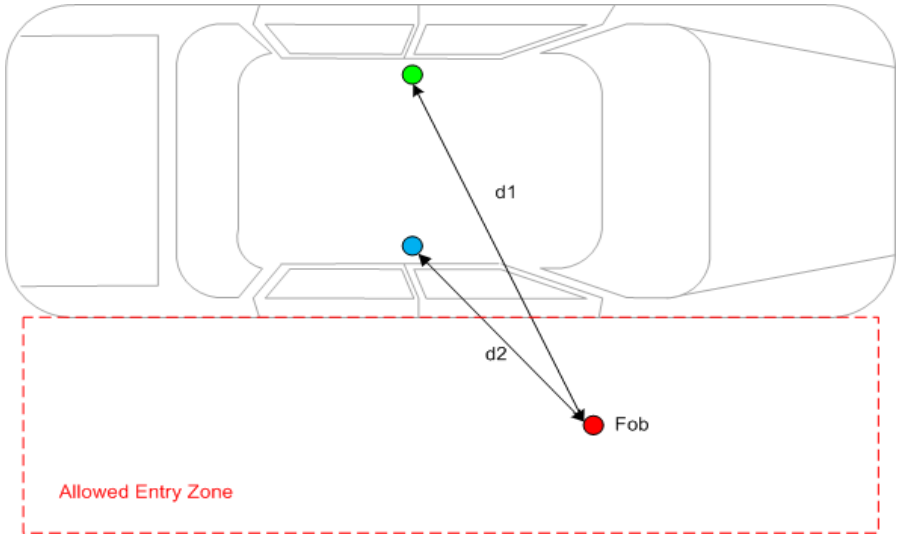
$\Delta_{reply}/(e_A - e_B)$ (µs)	2 ppm (ns)	20 ppm (ns)	40 ppm (ns)	80 ppm (ns)
1	0.0005	0.005	0.01	0.02
10	0.005	0.05	0.1	0.2
100	0.05	0.5	1	2

Mobile Use Case: Proximity Location



- Accurate location relative to other enabled handsets
- Can achieve this without any other 802.15.4a infrastructure
- Location of mislaid personal or secure items and people

Automotive Keyless / Passive Entry



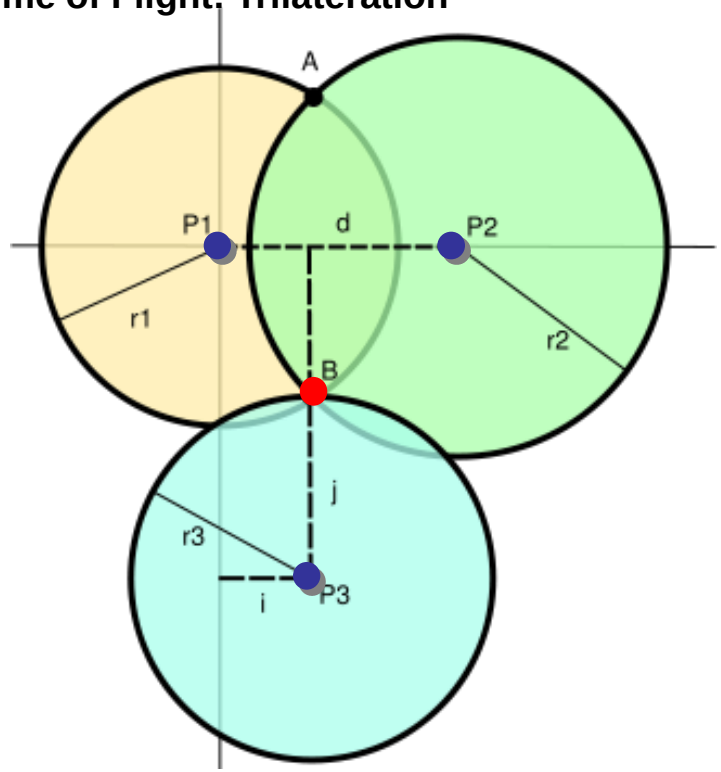
- DecaWave technology can be used to implement secure keyless and passive entry schemes
- Using DecaWave chips in the vehicle and in the key fob the location of the fob relative to the vehicle can be determined

- Based on this information various actions can be taken
  - Relevant doors opened automatically
  - Driver / Passenger welcome messages
- It is very difficult to “hack” this scheme so it is far more resistant to “Relay Attack” than present schemes
- The operating frequencies of existing schemes are suffering more and more interference from new technology such as Smartphones and iPads – DecaWave’s technology resolves those issues

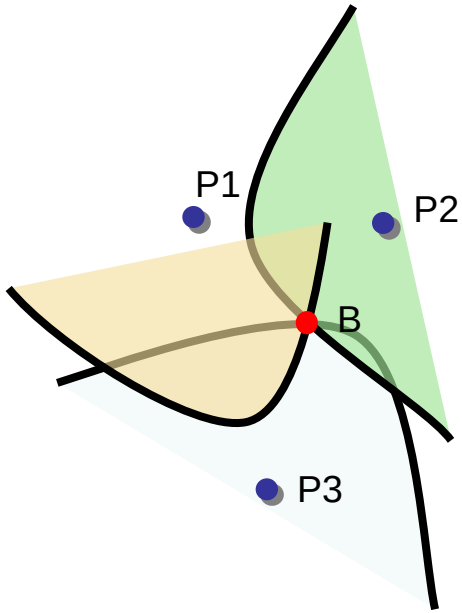
Time of Arrival Based Ranging

$$\hat{d} = (\hat{t}_{RX} - t_{TX})c$$

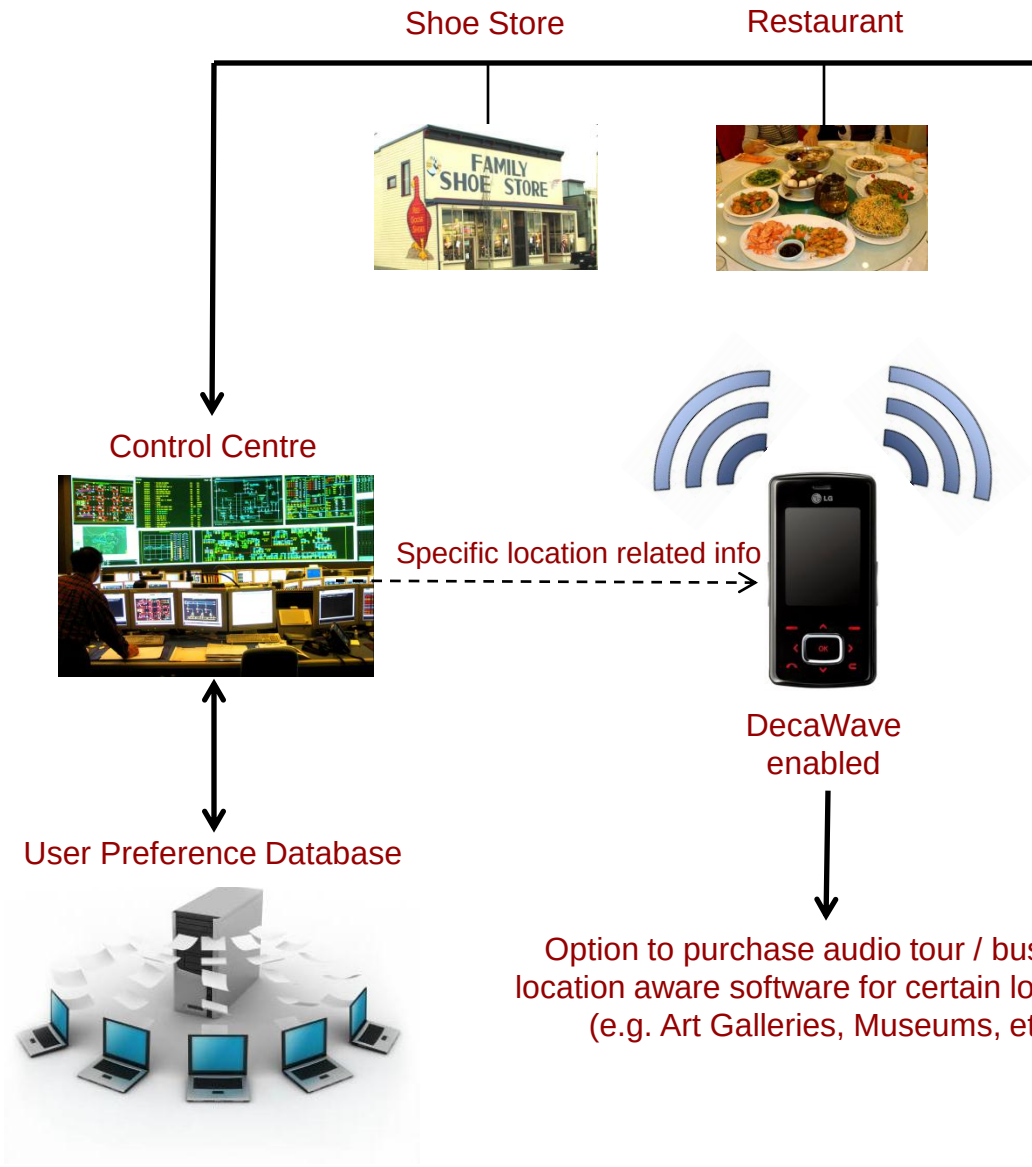
Time of Flight: Trilateration



Time Difference of Arrival: Multilateration



Mobile Use Case: Service and Content



- Determine precise proximity to in-store detector nodes and use the information for location based services
- Requires deployment of 802.15.4a based in-store detectors

Mobile Use Case: Healthcare

Patient with DecaWave enabled wireless bio sensors

Patient's Doctor with DecaWave enabled device

Hospital

Specific location related info

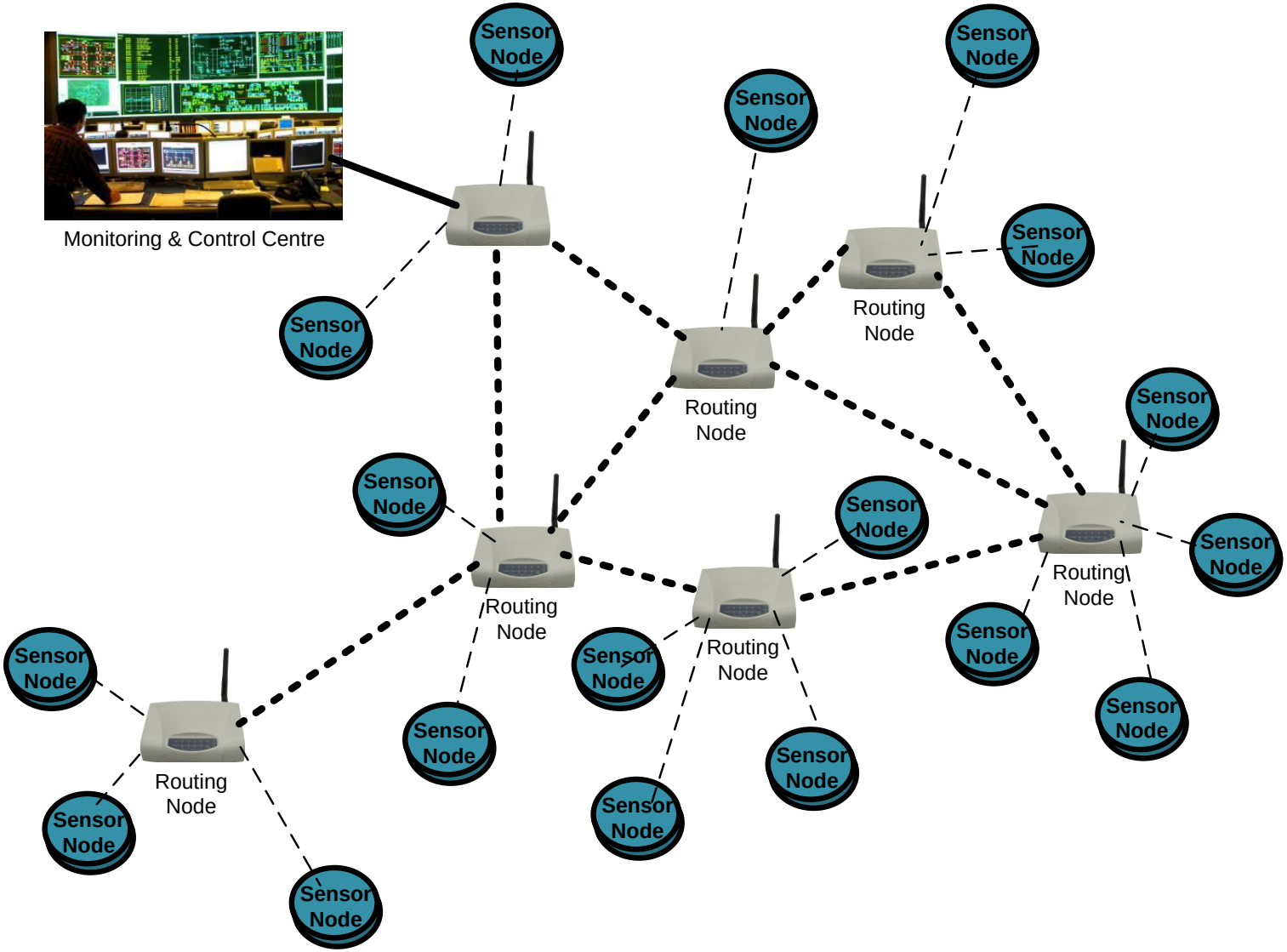
Mobile Network

Medical Equipment Tagged

Patient Details

Patient's Carer with DecaWave enabled device

Wireless Sensor Networks



Decawave's market space

The Market Space

RTLS, WSN

INDUSTRIAL

Factory, Buildings, Enterprise, Agriculture, Healthcare, Warehousing, Safety & Security

AT HOME

Healthcare, Home Automation, Safety & Access,

WiFi, Mobility

Access Points, LBS, Enterprise

Portable Consumer, PC, Tablets

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RETAIL, ePOS

Authentication, Customer Fidelity, Financial Services, LBS

Consumer

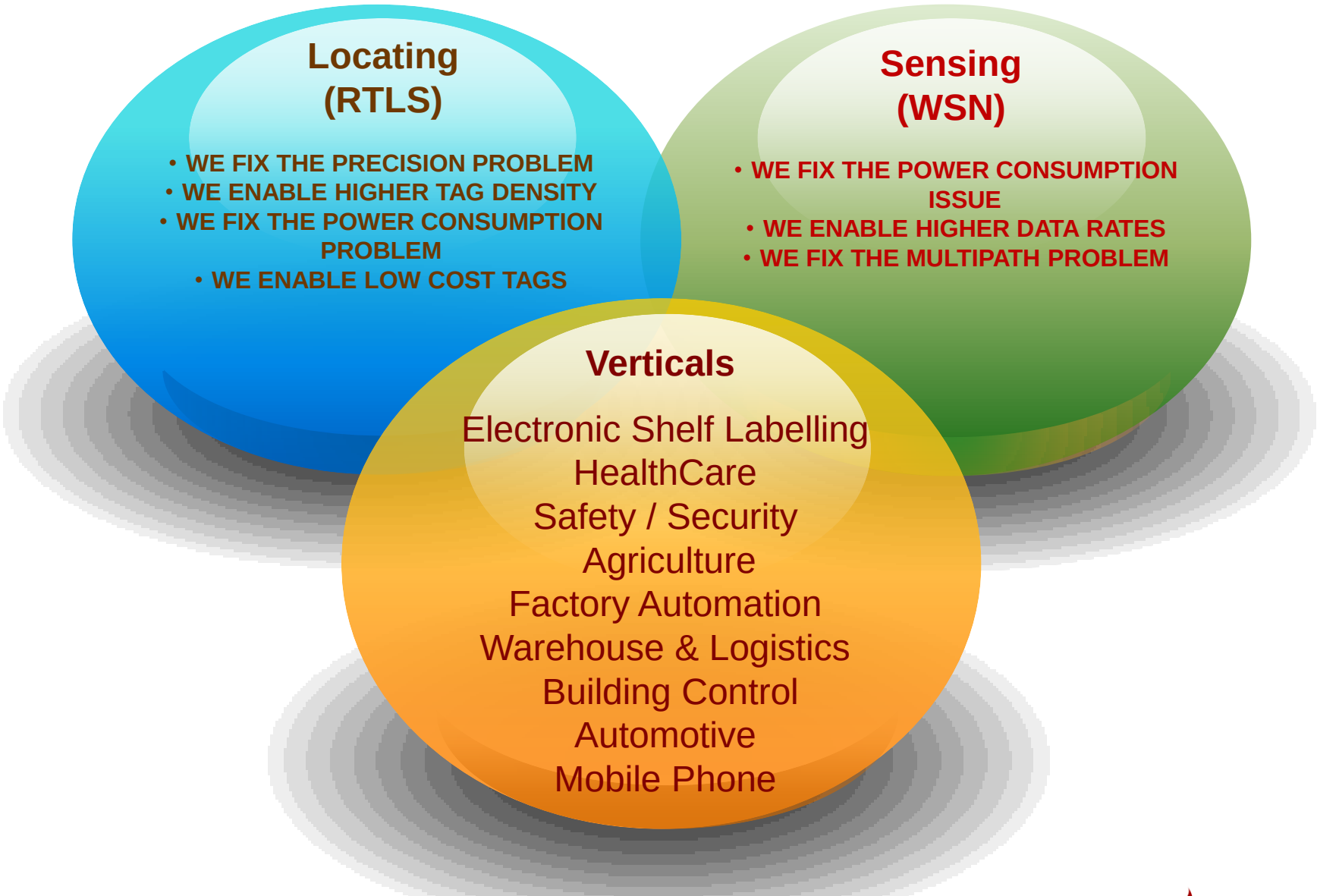
Portable Consumer

At home

Automotive

Secure Access, Communications

The Market: Focus Verticals and Horizontals



Thank you very much!

- Contacts:
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