



Precise indoor location within a chip
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BeSpoon et l'homme Connecté

URSI 25 Mars

GPS: 24 cells around the world



picoGPS: 7 billions picocells
focused on individuals



Now, IR-UWB fits on a chip.

We partnered with  **Leti** started this activity in 2000



We are a French Fabless startup
Started in 2009 by GSM veterans

Our patented chips measure distances across walls, with 10cm accuracy

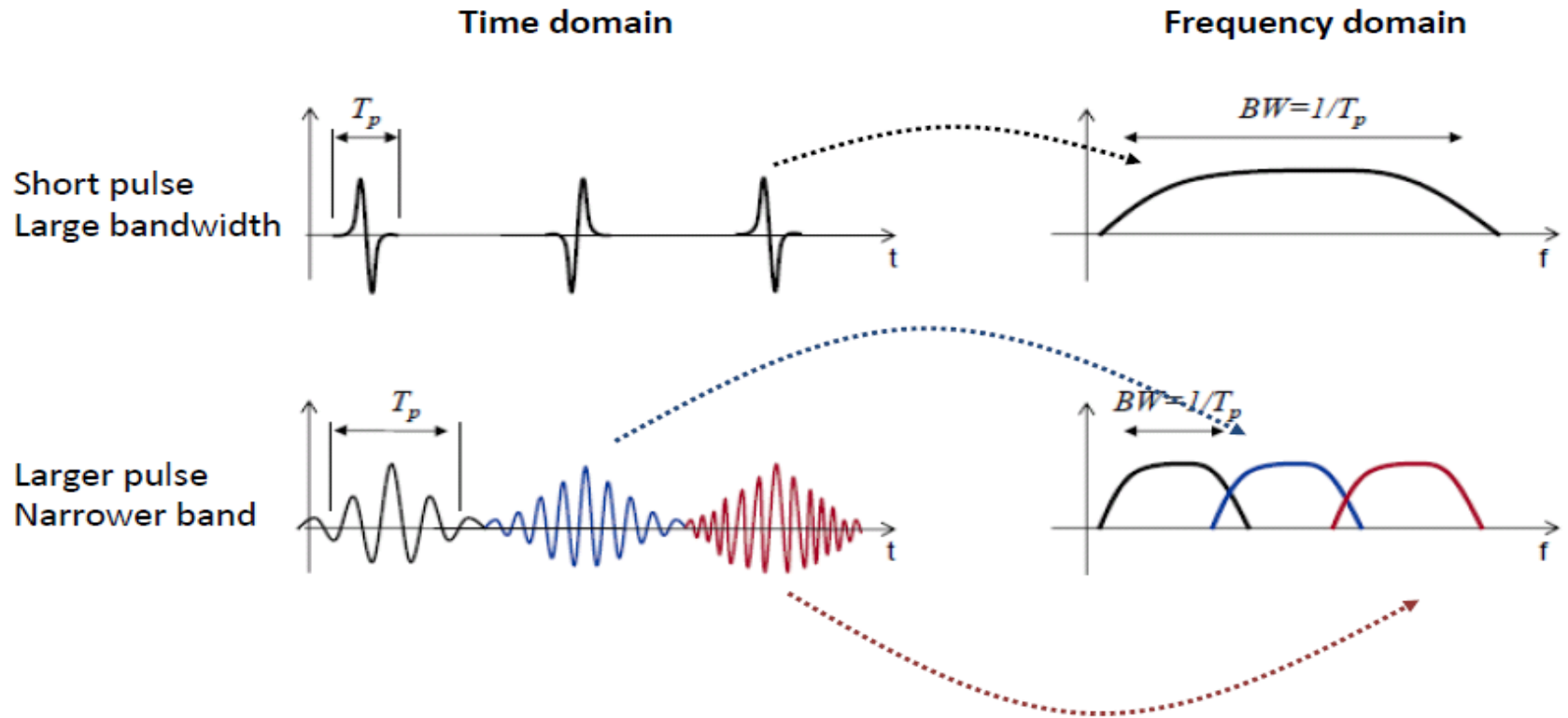


They are not affected by obstacles

What radio system?

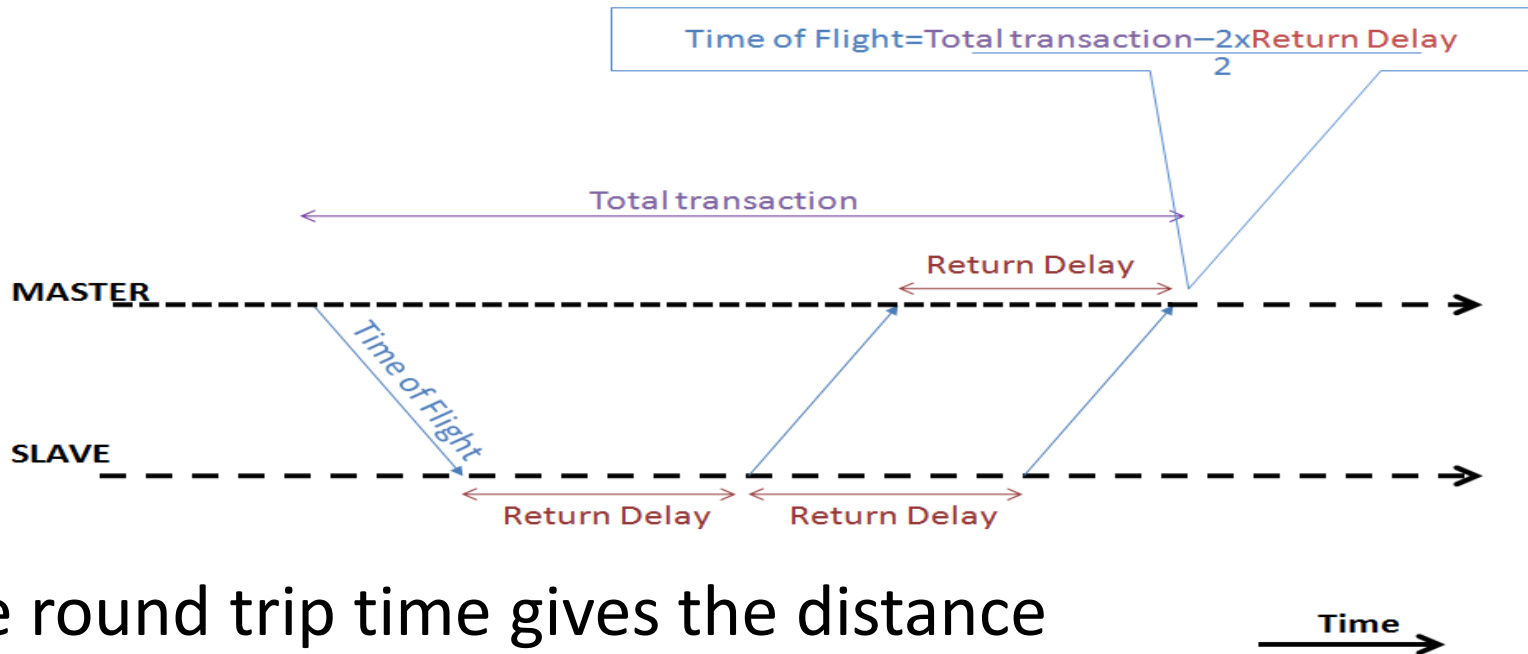
- Impulse Radio – Ultra Wide Band
- Large Band = Narrow Pulse = Time precision
- FCC-ETSI standards: Very low output power

IR-UWB: A Pulse radio

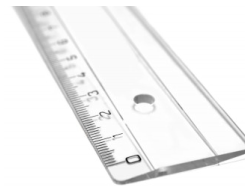


**BeSpoon: Bandwidth support 1GHz & 500MHz @ 10dBc
(T_p from 0.7ns to 3ns)**

How does it work?



- The round trip time gives the distance
- Is it rocket science?
 - A few cm accuracy = sub nanoseconds chronometer
 - And highly synchronised clocks



3 cm

=

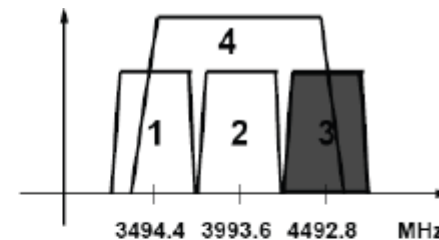
0,000000001 second



What frequency?

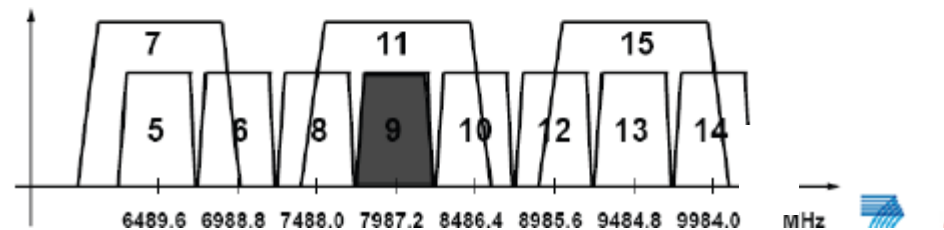
- Between 3.1 and 10.6 GHz
- Channels of 500MHz or 1GHz bandwidth

(LFB): 3244 - 4742 MHz



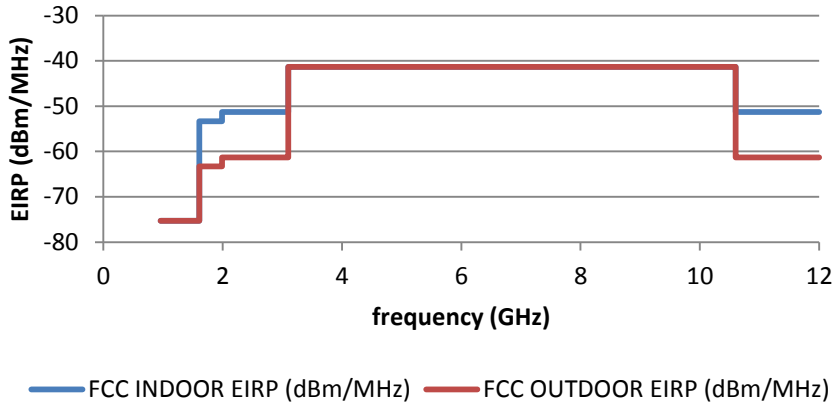
(HFB): 5944 - 10234 MHz

■ : Mandatory channel

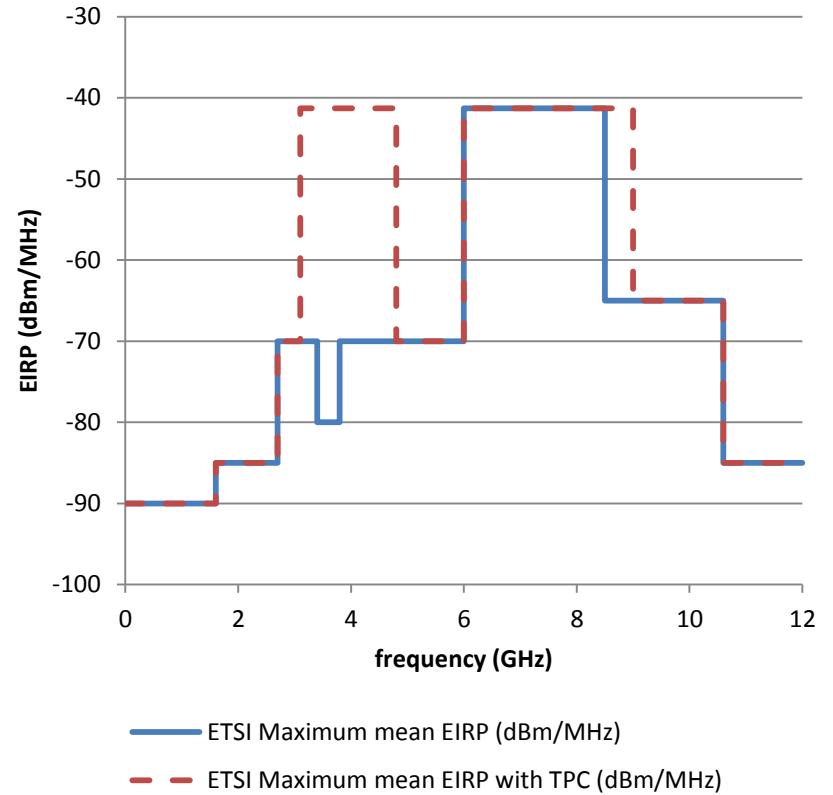


Regulation

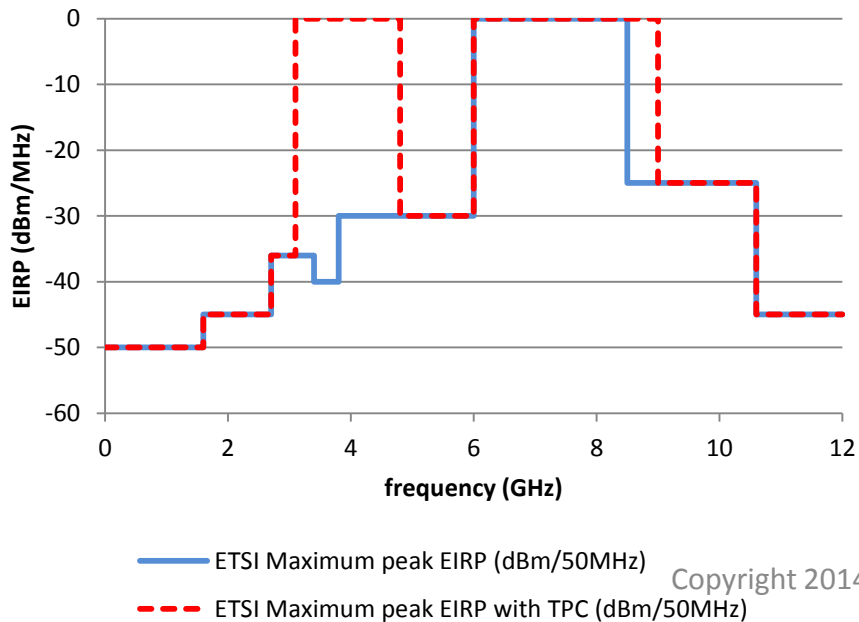
FCC Mask - Maximum Mean EIRP



ETSI Mask - Maximum Mean EIRP

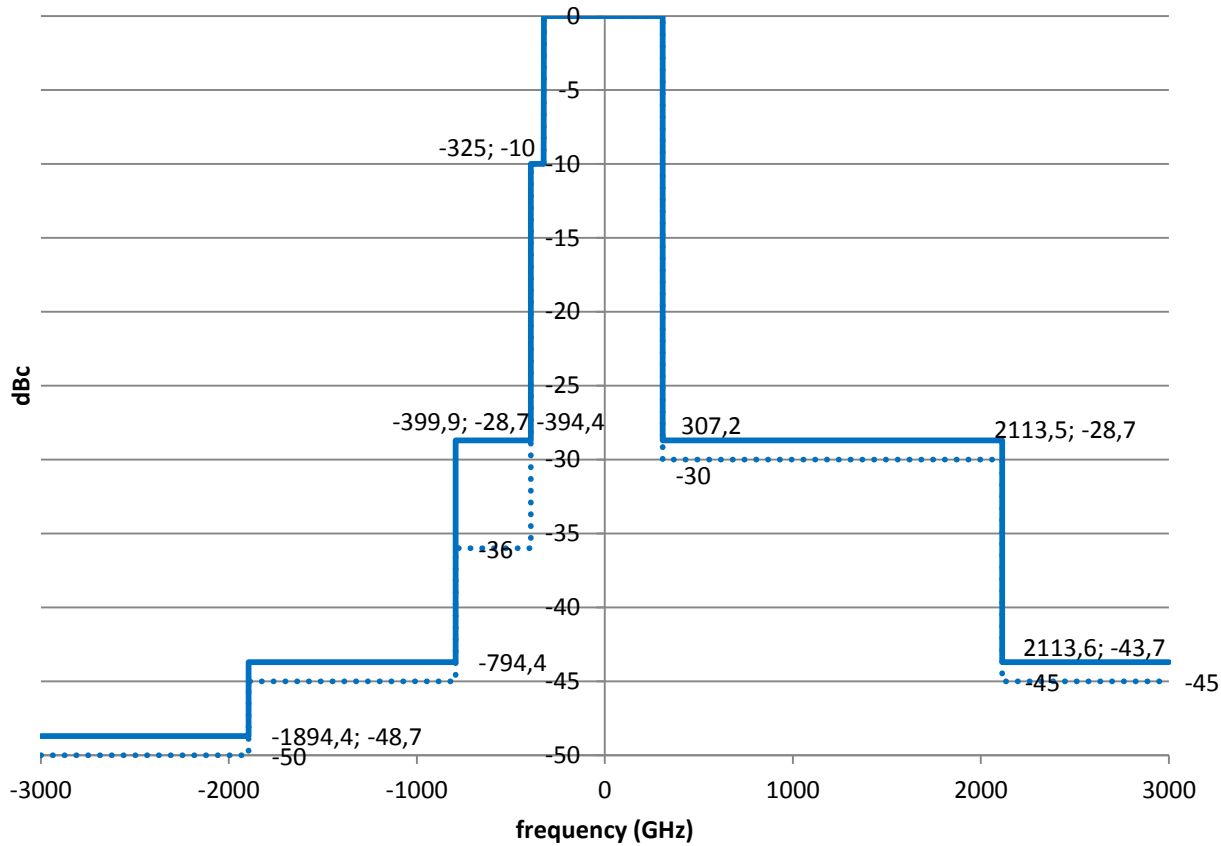


ETSI Mask - Maximum Peak EIRP



Modulation Spectrum

FCC / ETSI Masks dBc



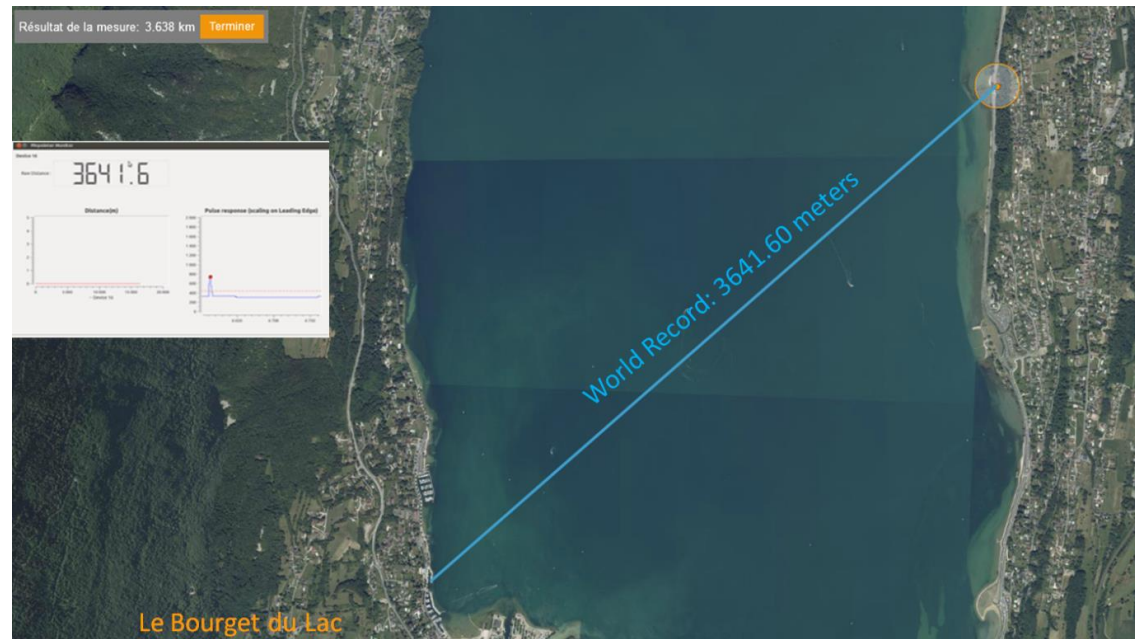
— spectrum (mean) spectrum (max)

What operation range?

- World record in Line of Sight ($-41,3\text{dBm/MHz}$) = 880 m
- Emergency mode LAES ($-21,3\text{dBm/MHz}$) = 3.6 km
LAES (Location Tracking Application for Emergency Services)
- Similar to WiFi indoor

⇒ Sensi $< -110\text{dBm}$

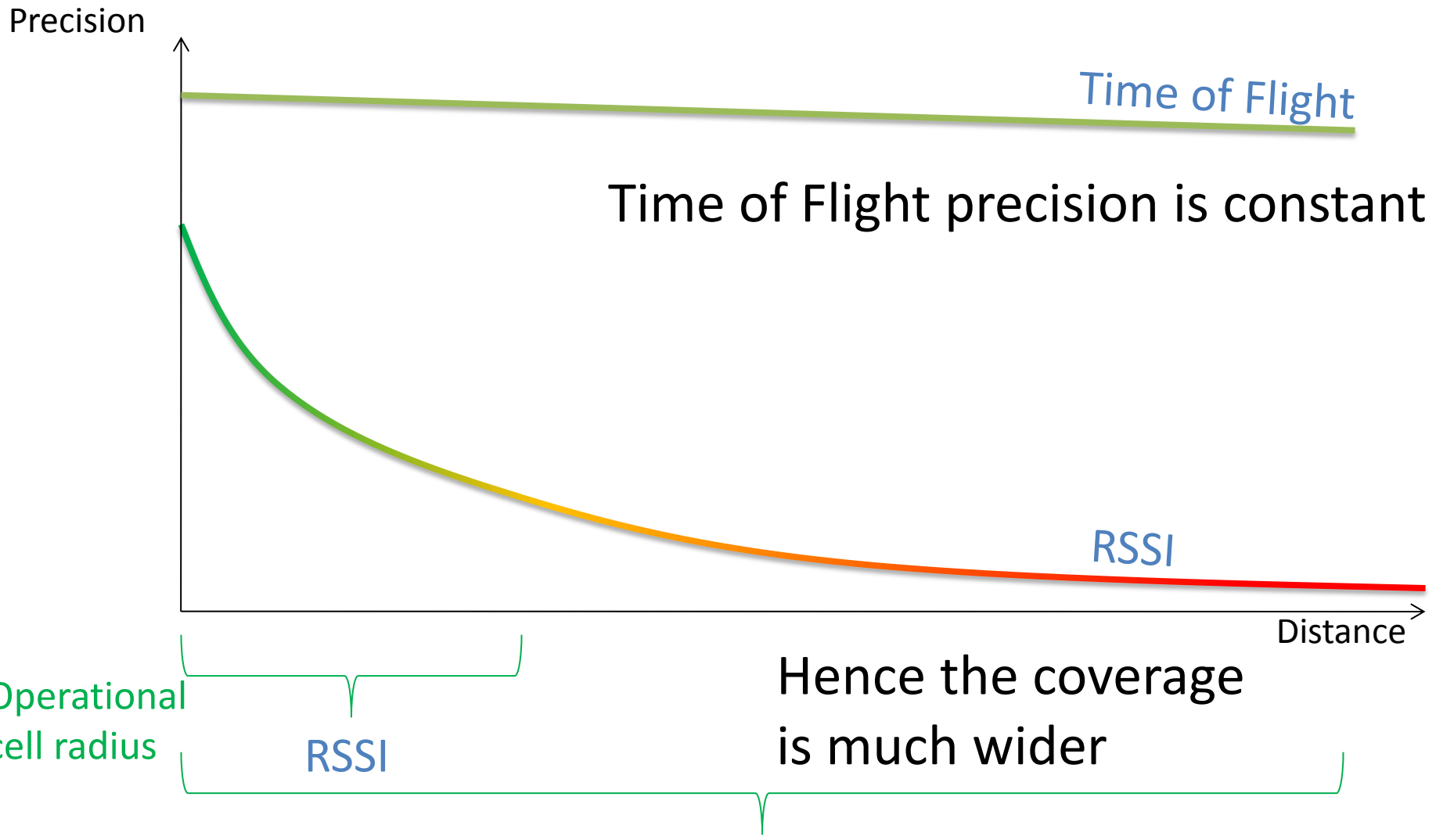
⇒ Coherent integration



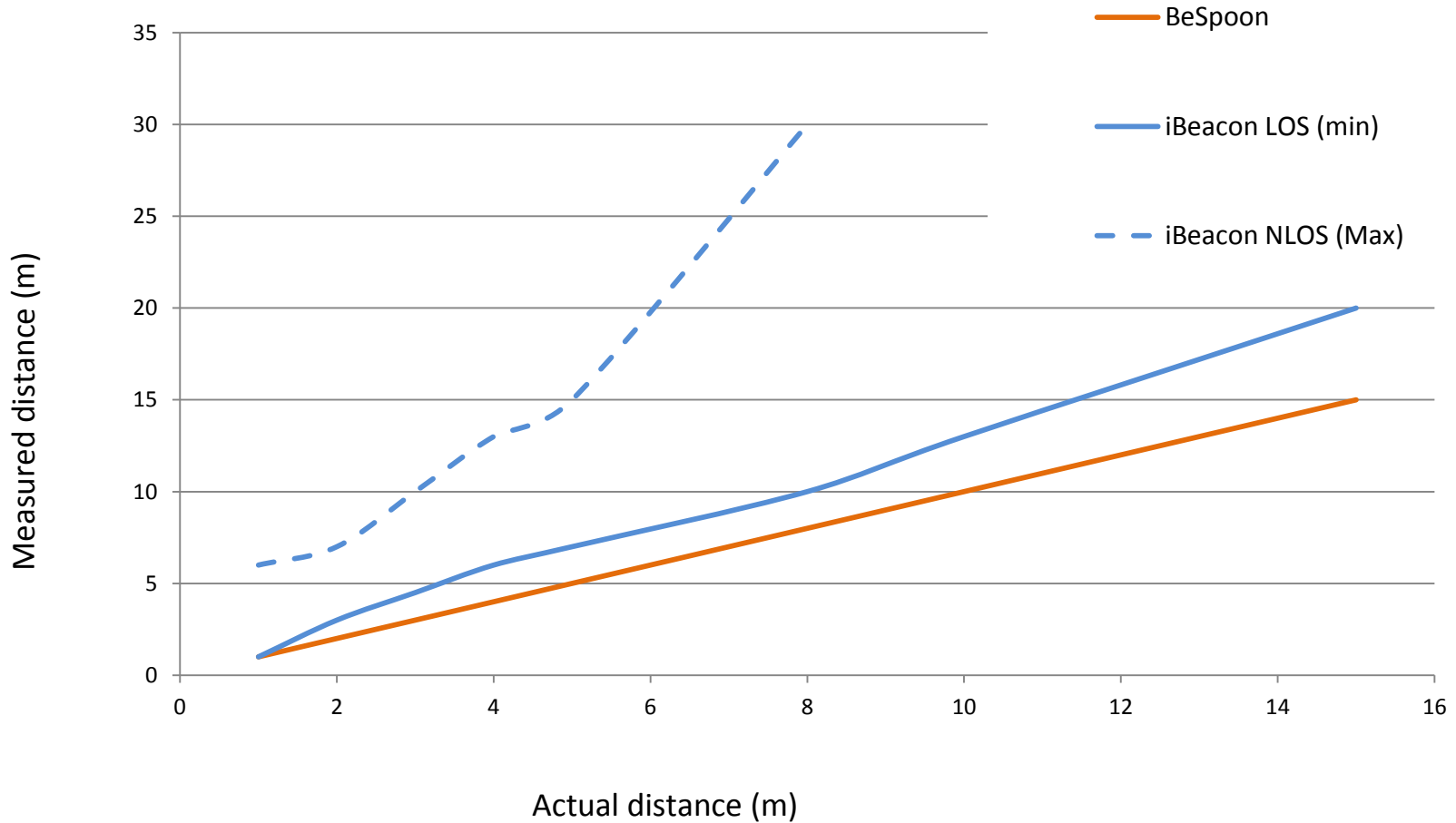
ETSI Low Duty Cycle

- $T_{on} \leq 5\text{ms}$ in 3,1 à 4,8GHz band
 - Our PRP (Pulse Repetition Period) = 15,6MHz
- ⇒ Max integration 78000 Pulses
- ⇒ Need Efficient protocol

Time of Flight vs Signal Strength



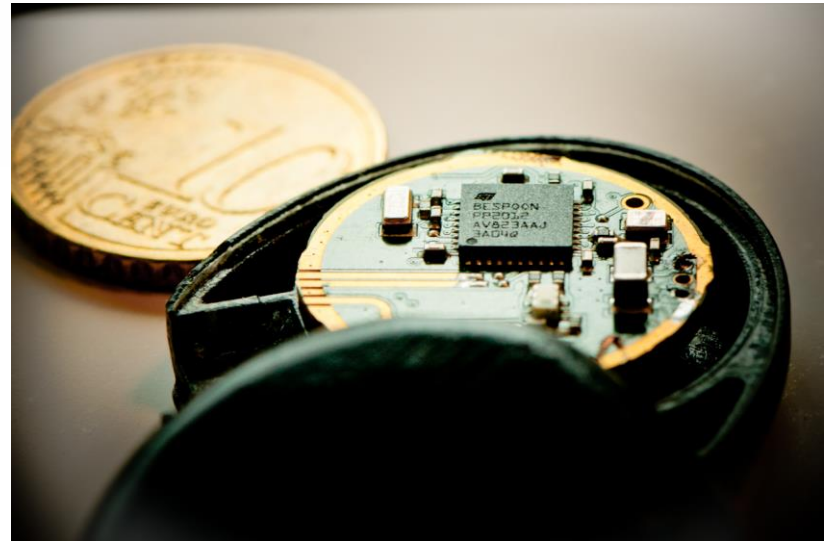
UWB vs Bluetooth



SpoonPhone set up

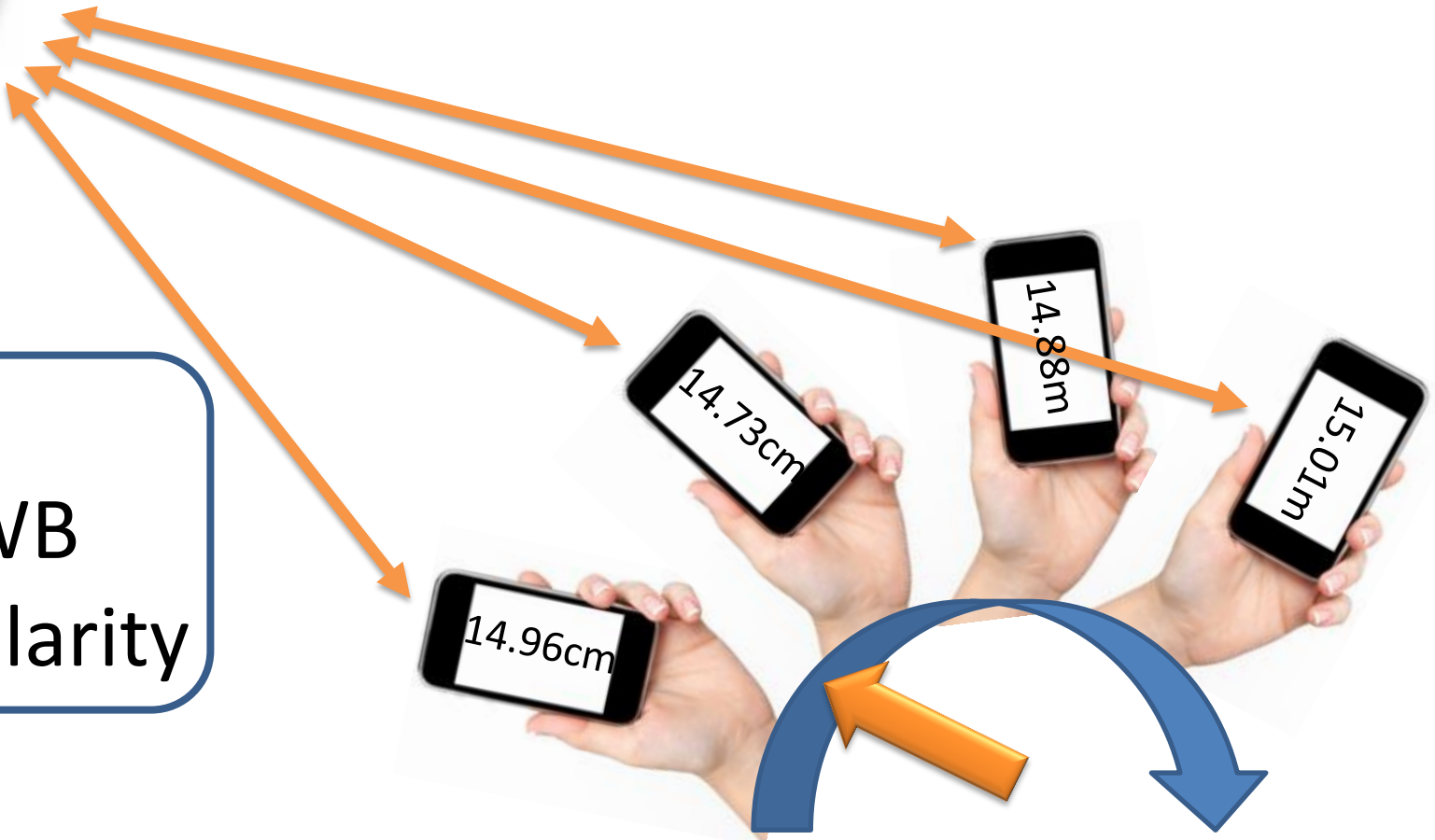


Ultra Low power 8051 MCU @ 20MHz



Non Real time OS

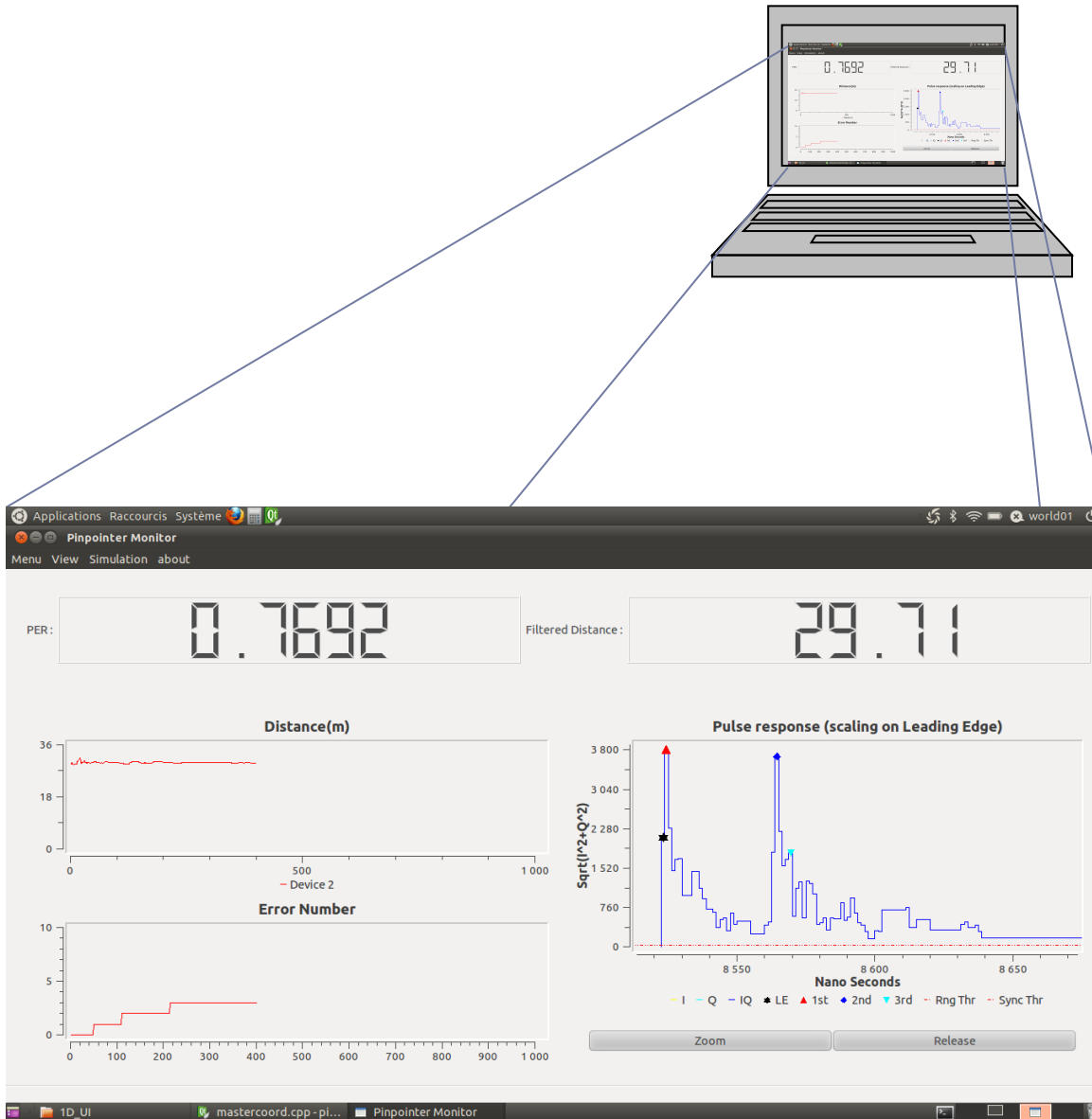
Precision bring new usages



IR-UWB
granularity

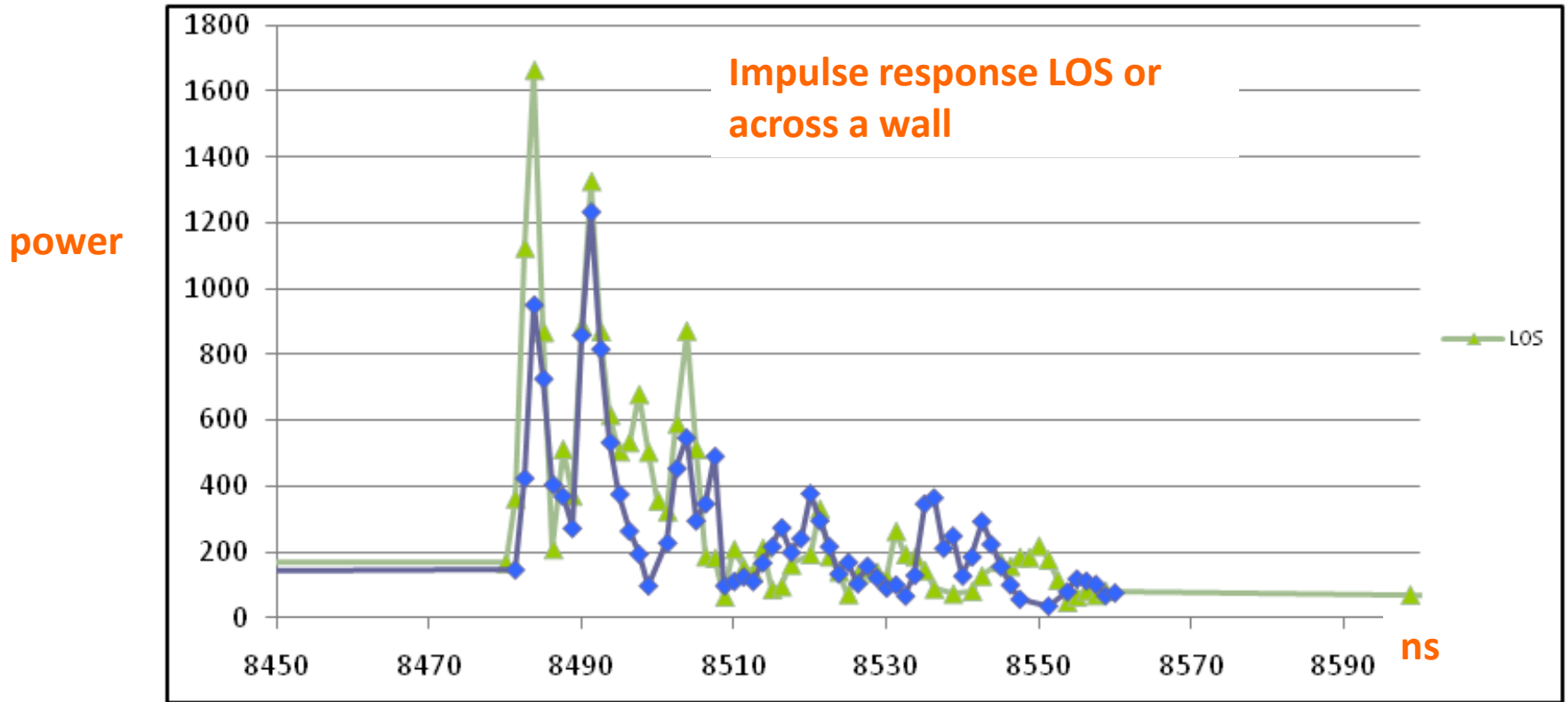
1D Precise Distance + Magneto + Gyro = 2D

Academic Dev Kit



- Leading edge TOA
- Max peak TOA
- 2nd Peak (below max.) TOA
- 3rd Peak (below max.) TOA
- Impulse response: 64 max. power values of 1ns steps (possible not contiguous)

Channel studies



$$PL_{dB}(d) = PL_0 \text{ dB} + 10n \log_{10}(d) + \chi_{\sigma}(\text{dB})$$

Be
Spoon
we position

Our chips unlock Mobile Geofencing