



Smart building access management system

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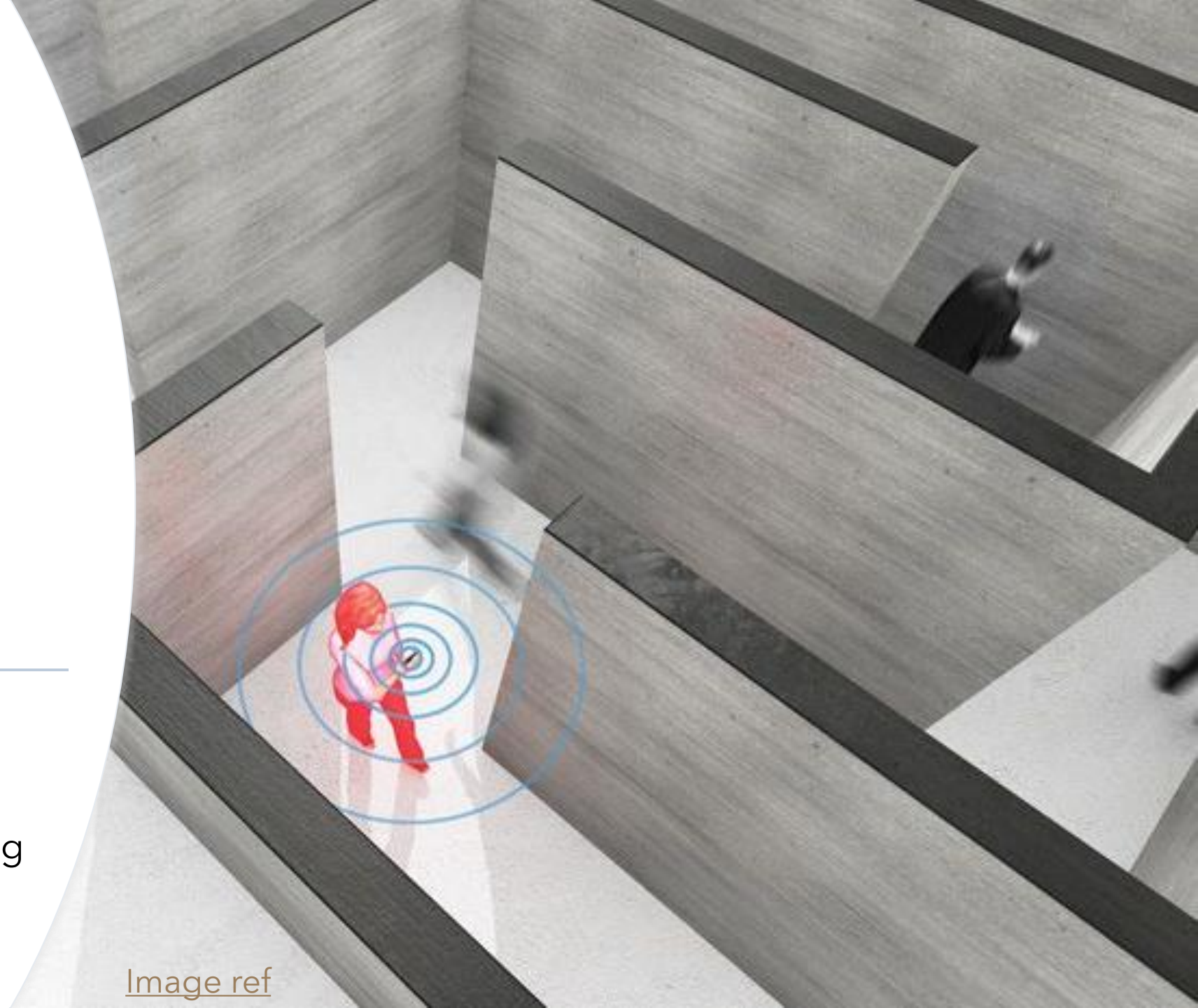
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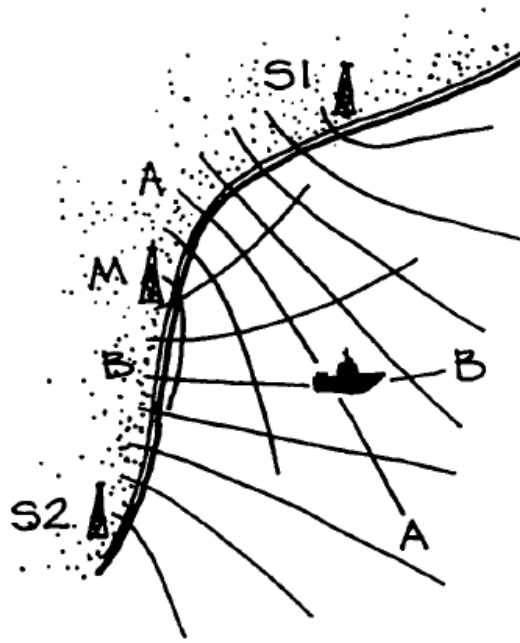
Supervisor: Dr Derek Gilmore

Problem statement

Achieving accurate realtime indoor location tracking to control access within a building

[Image ref](#)





Location Tracking

- [Image Left ref](#) – Star navigation
- [Image Centre ref](#) – LORAN-C
- [Image Right ref](#) – GPS

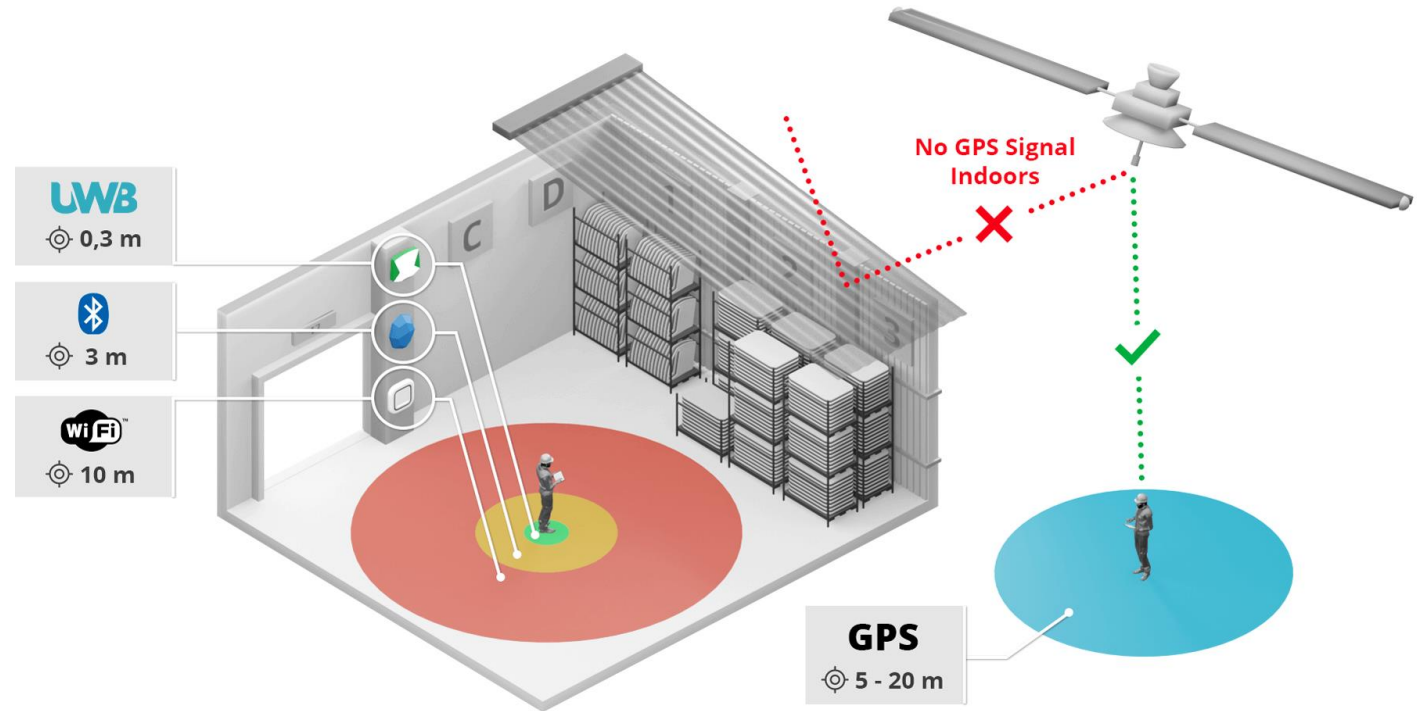


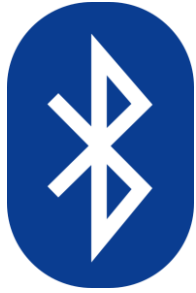
Indoor Location Tracking

- Many use cases
 - Access management
 - Asset tracking
 - Event management
- Previously not viable
 - Outdoor solutions - poor transfer indoor
 - Existing Wireless Protocols - inefficient
 - Wireless Comms Device - large footprint

Wireless Protocol selected

- Bluetooth low energy (BLE)
- Ultra-Wideband (UWB)
- Wi-Fi





- Highly prolific
- IEEE 802.15.1
- 2.4GHz
- 0 – 50m
- Up to 1Mb/s
- BT SIG



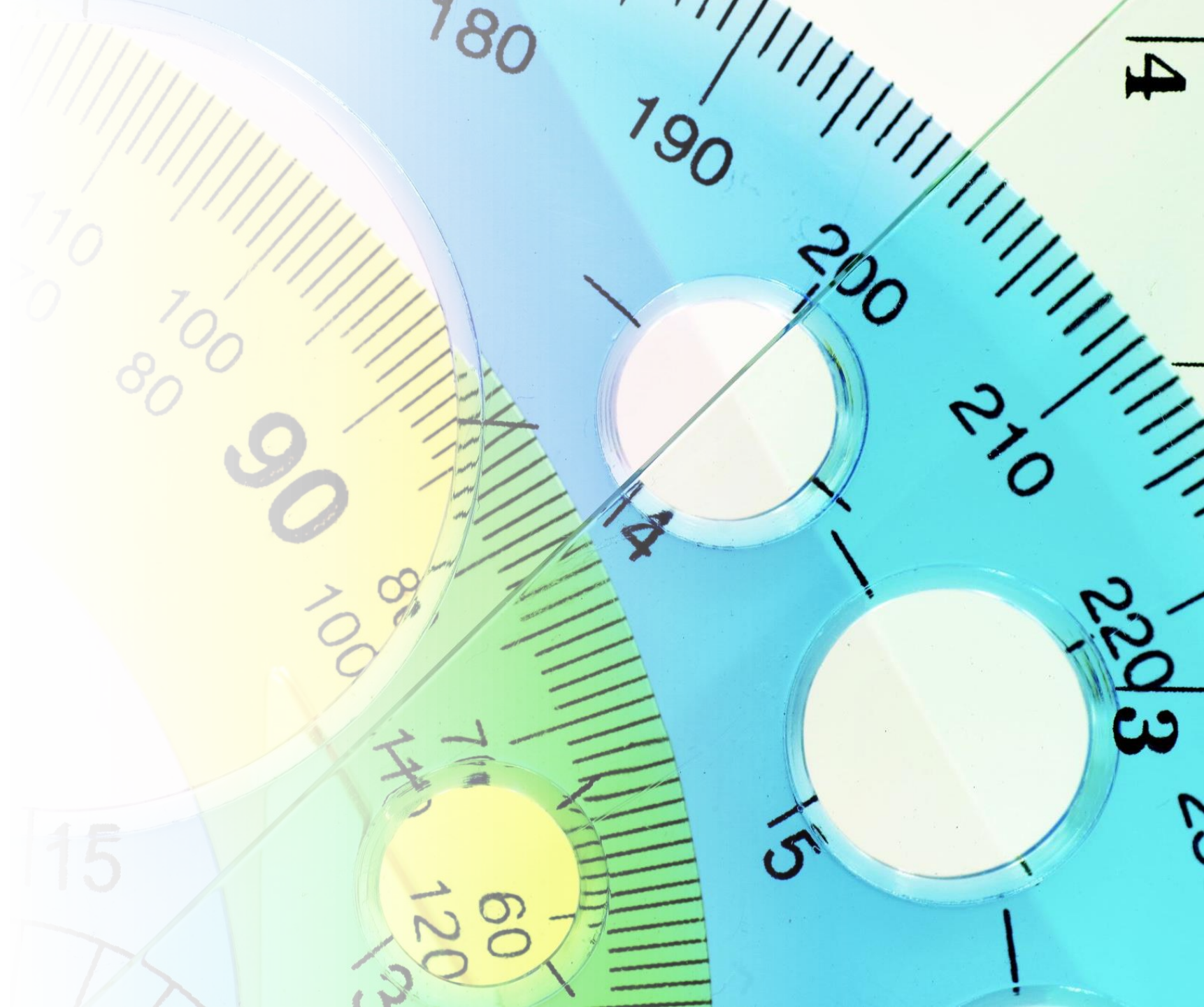
- Relatively new
- IEEE 802.15.4
- 3.1GHz - 10.6GHz*
- 0 – 70m
- Up to 27.24Mb/s
- UWB Alliance

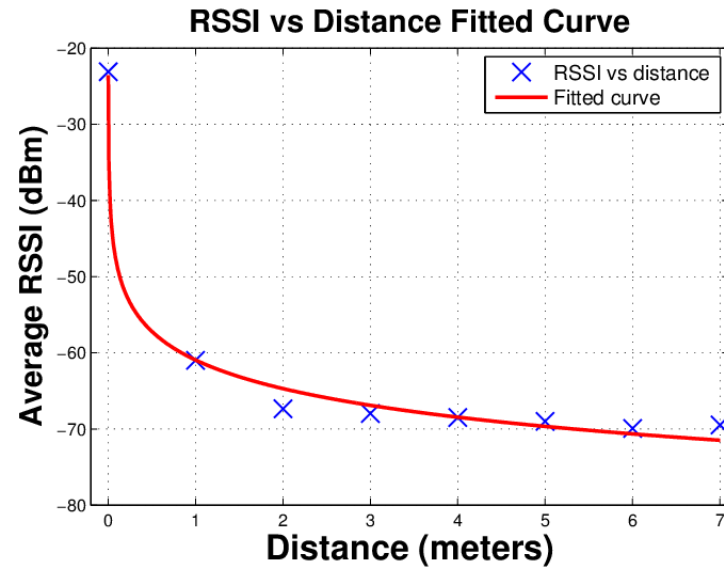


- Most daily used
- IEEE 802.11ax
- 2.4GHz, 5GHz, 60GHz
- 0 – 50m
- Up to 2.4Gb/s
- WiFi Alliance

Measurement Methods

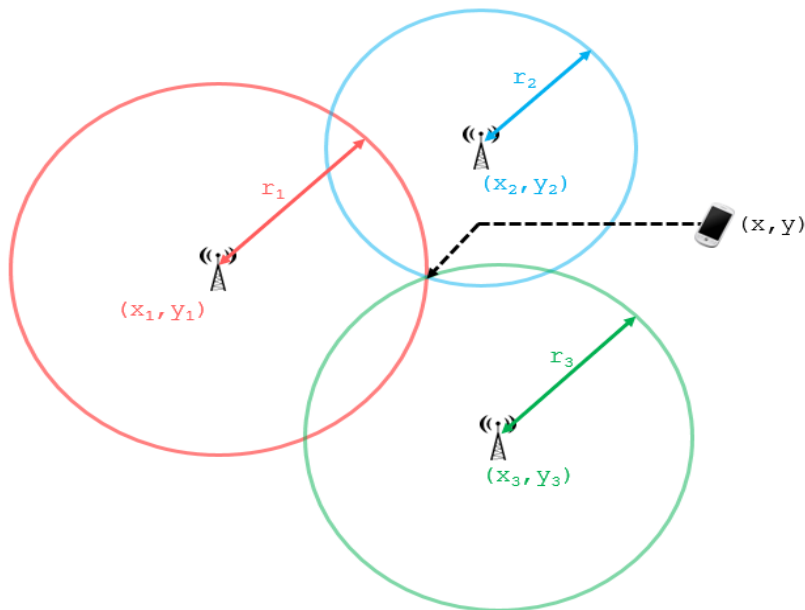
- RSSI and Trilateration
- Time difference of arrival

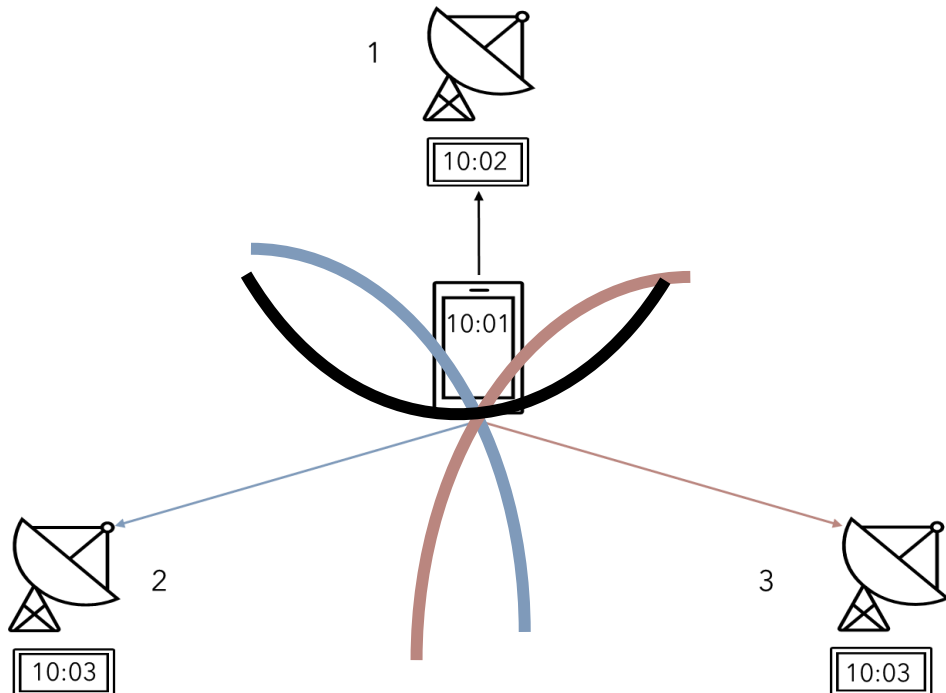




RSSI and Trilateration

- RSSI - [Image ref](#)
 - Relative signal strength index
 - Scalar measurement from Tx - Rx
 - Logarithmic degradation of signal
- Trilateration - [Image ref](#)
 - Establish distance radius
 - Intersecting transmission radii
 - Determine direction from access points





Time Difference of Arrival

- Time of arrival (ToA)
 - Also referred as Time of Flight (ToF)
 - Difference Tx and Rx times
 - Requires synched clocks for all
- Time Difference of Arrival (TDoA)
 - Difference between Rx times
 - Receivers synched only
 - Uses hyperboloids

Comparison Matrix

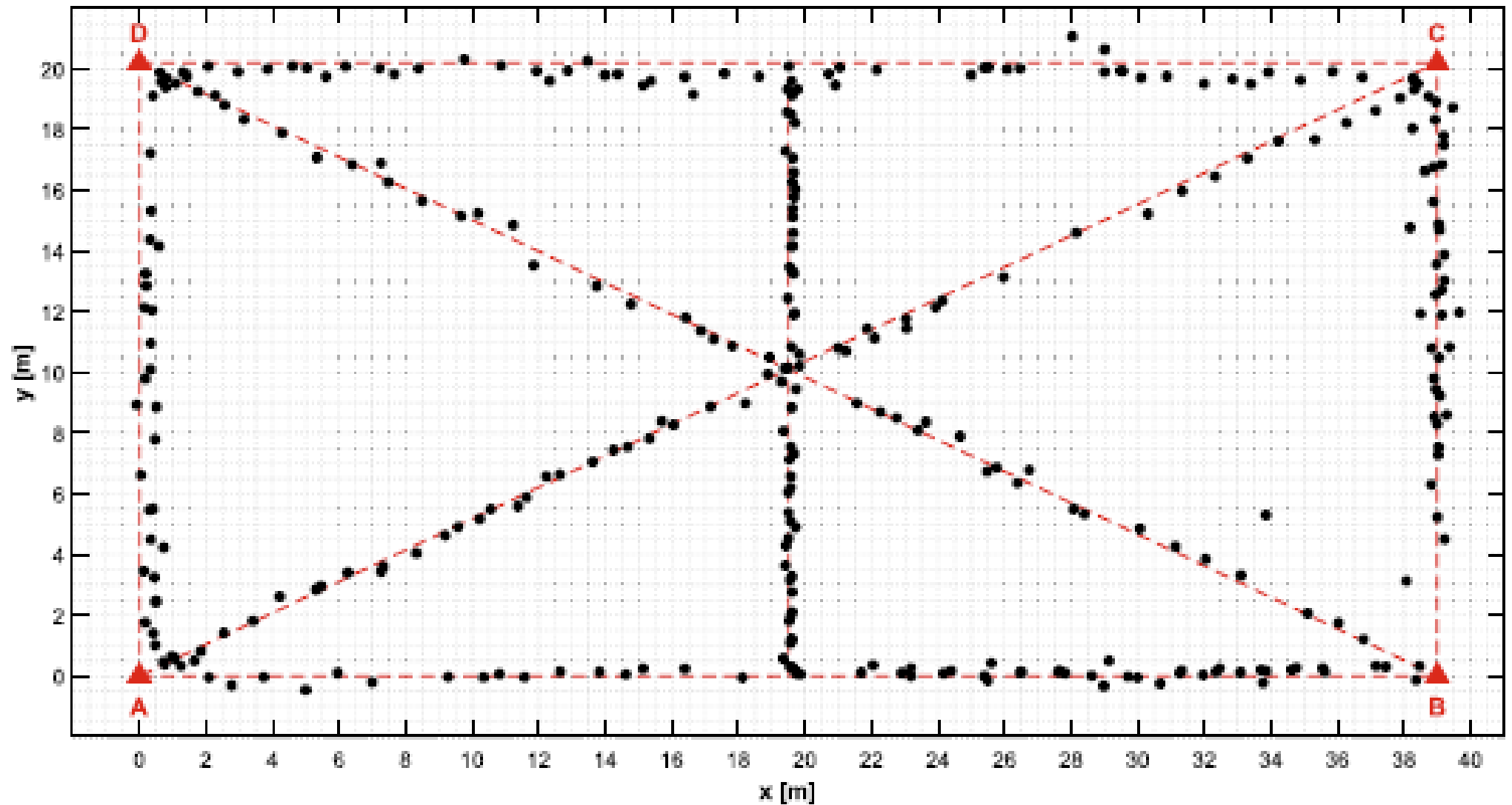
Technology	Accuracy	Tx Power	Scalability	Realtime	Reliability	Measurement Methods
BLE	3m	1mW	Medium	Yes*	Medium	RSSI
UWB	0.3m	0.07mW	High	Yes	High	TDoA
WiFi	10m	1W	Medium	Yes*	Medium	RSSI






Exiting Solutions

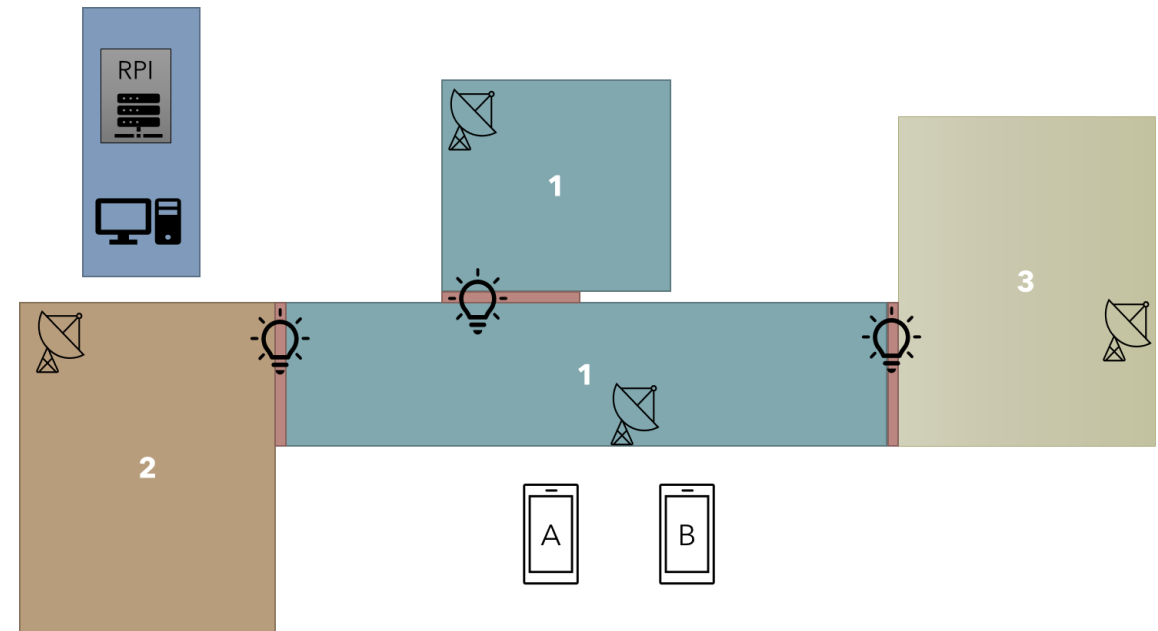


- Path walked
- UWB



Proposed Solution

- UWB modules
 - Decawave DWM1001
 - Opensource APIs for TDoA
 - 4 x Anchors 
 - 2 x Beacons 
- Visually represent actuation 
- Small scale Modular design
 - Facilitate future scalability



Technical Architecture

