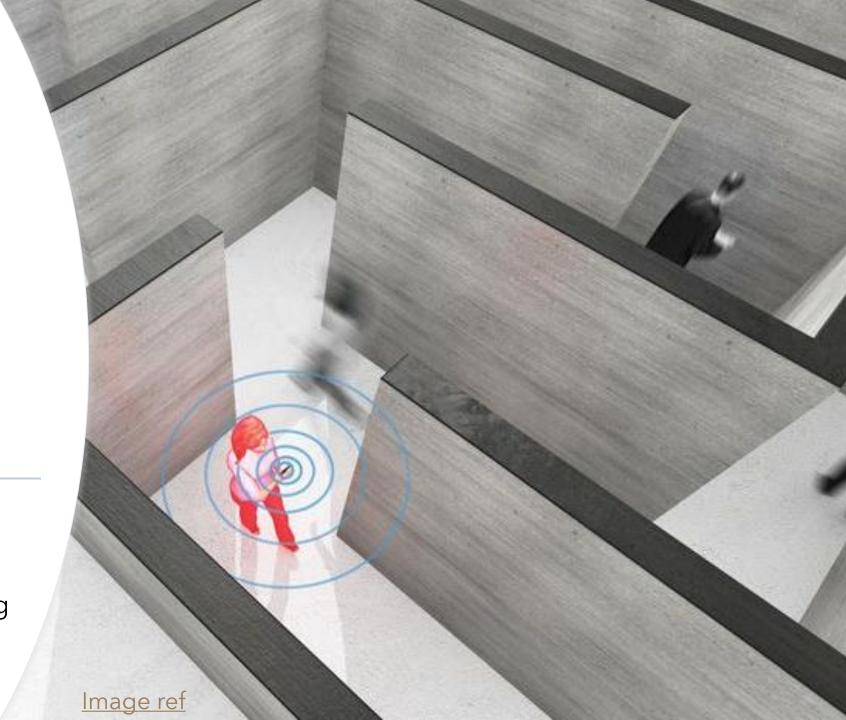
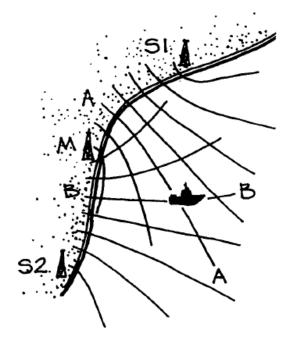


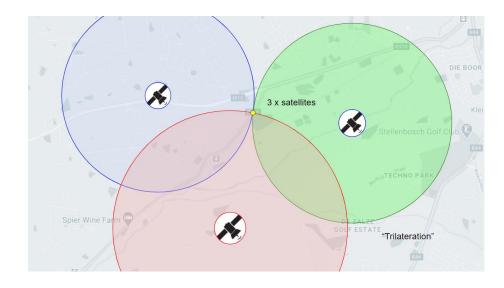
Problem statement

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









Location Tracking

- <u>Image Left ref</u> Star navigation
- <u>Image Centre ref</u> LORAN-C
- <u>Image Right ref</u> GPS

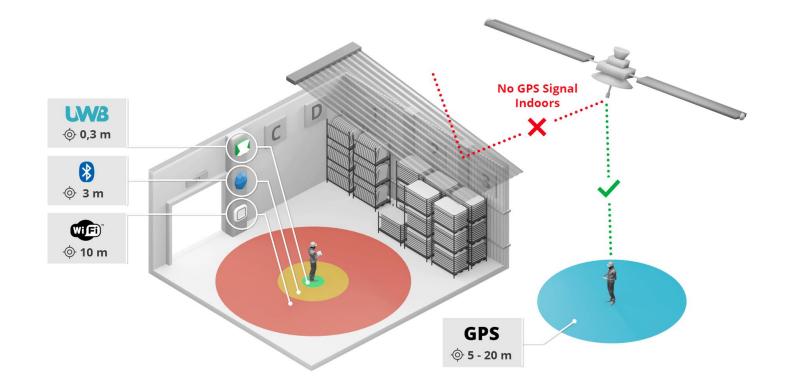


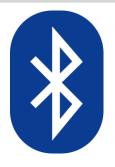
Indoor Location Tracking

- 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

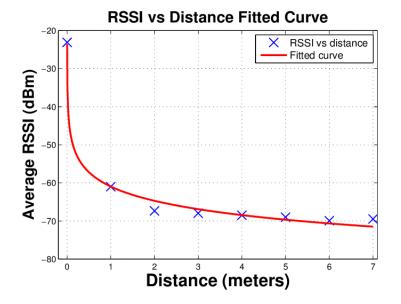


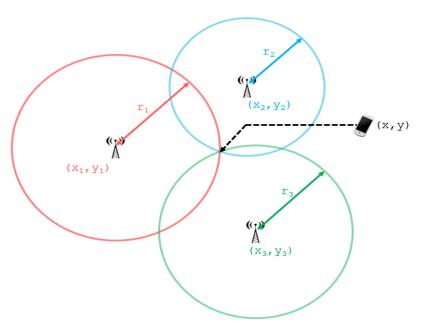
- Most daily used
- IEEE 802.11ax
- 2.4GHz, 5GHz, 60GHz
- 0 50m
- Up to 2.4Gb/s
- WiFi Alliance

Measurement Methods

- RSSI and Trilateration
- Time difference of arrival

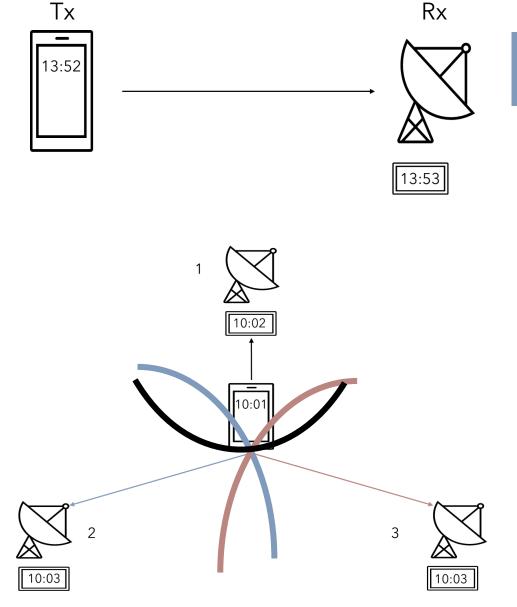






RSSI and Trilateration

- RSSI <u>Image ref</u>
 - Relative signal strength index
 - Scalar measurement from Tx Rx
 - Logarithmic degradation of signal
- Trilateration <u>Image ref</u>
 - 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		



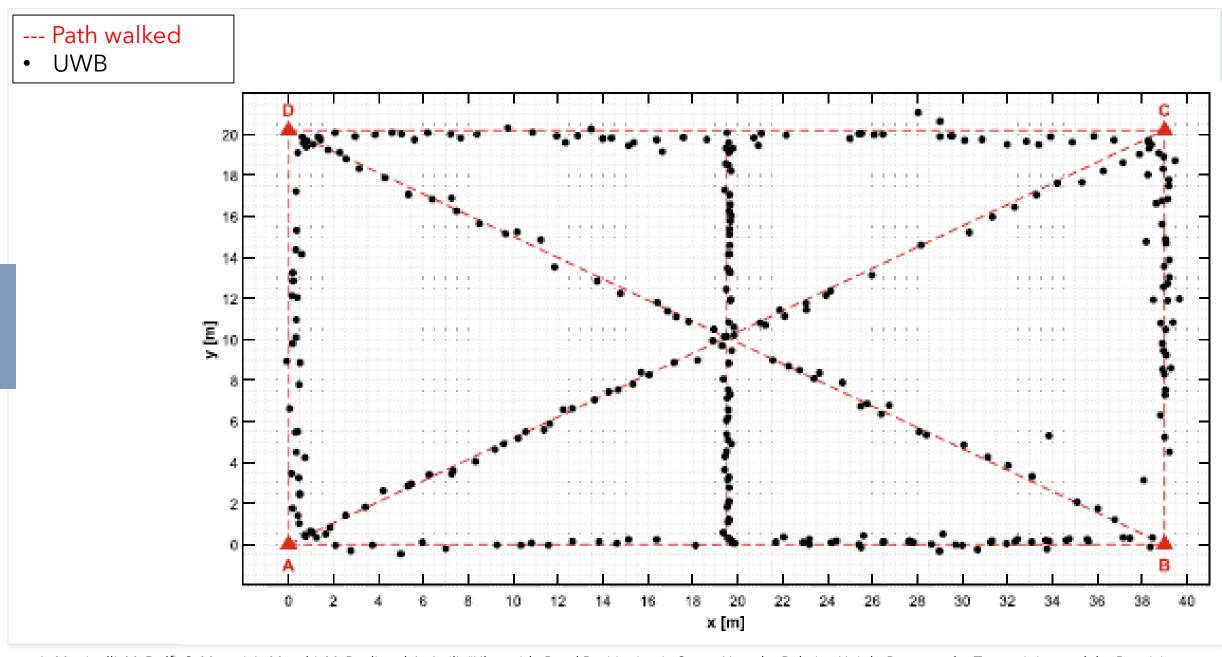




Exiting Solutions



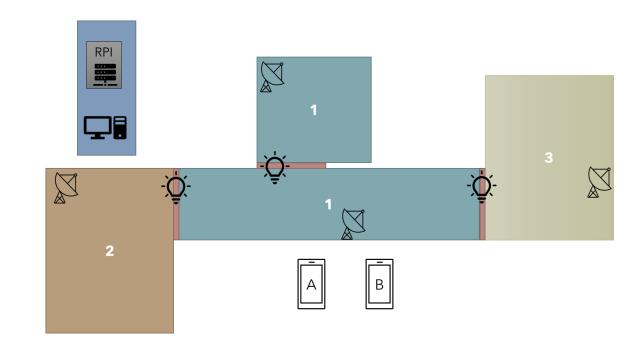
X. Zhao, Z. Xiao, A. Markham, N. Trigoni and Y. Ren, "Does BTLE measure up against WiFi? A comparison of indoor location performance," European Wireless 2014, 2014.



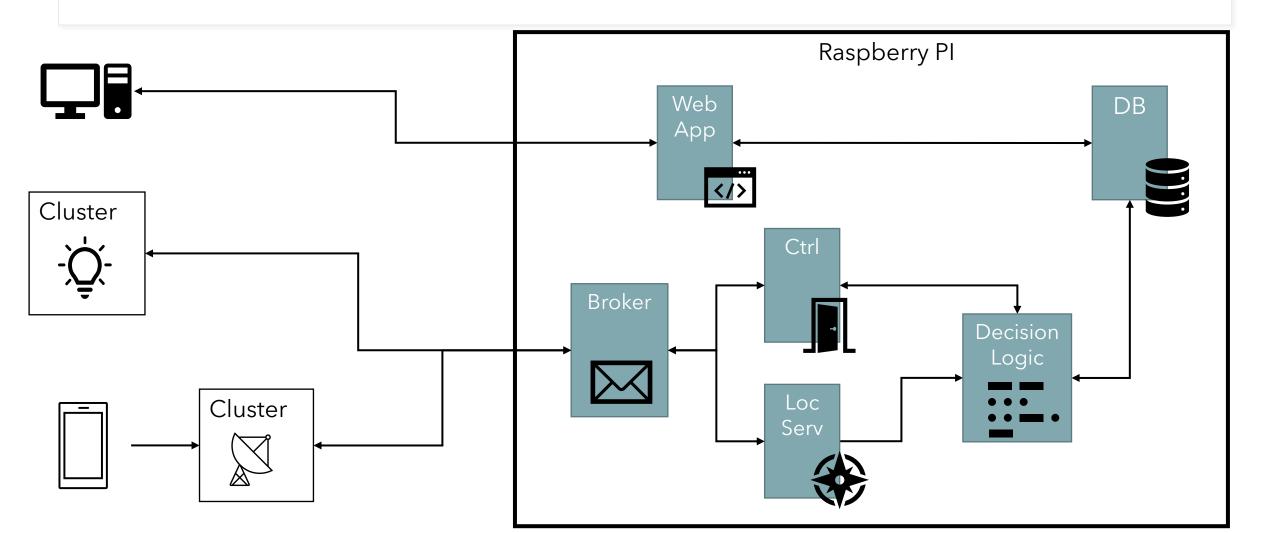
A. Martinelli, M. Dolfi, S. Morosi, L. Mucchi, M. Paoli and A. Agili, "Ultra wide Band Positioning in Sport: How the Relative Height Between the Transmitting and the Receiving Antenna Affects the System Performance," International Journal of Wireless Information Networks (2020) 27:18-29, 2019

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



Project Plan

Delivery Tasks		Time	March			April			June			July				August						
		W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	
Cont Research Log																						
Phase 1	Set up & install	hardware																				
	Establish single	device tracking																				
	Test Single Devi	ce Tracking																				
	Establish multi	device tracking																				
	Test Multi devic	e tracking																				
	Indoor location	detection												*								
Phase 2	Develop Access	program																				
	Test Access Prog	gram																				
	Integrate Locati	on and Access																				
	Test Integration																					
	Location based	access																\Rightarrow				
Phase 3	Develop RT Data	a visualisation																				
	Integrate Locati	on and Access																				
	Technical Test s	oloution																				
	Analyse & Colla	te results																				
	Present Results																					*