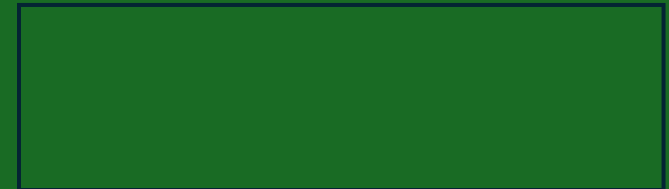




Indoor location- Wi-Fi, BLE and UWB



From Novelty to Operational Necessity

The shift from 'Nice-to-Have' to 'Critical Requirement'

Wait... We **CARE** about
INDOOR LOCATION?!



NOVELTY

Nice-to-Have



OPERATIONAL NECESSITY

Critical Requirement

Back in the Early 2000s, When I Was Young and Naive...

I Started a Wireless Company **Airepapce**

Indoor GPS for Indoor Location?

APs are just like satellites!
this could work!



Treat the APs like Satellites!



Overlay Network Needed...

~~No Coverage~~



WiFi Fixes This!



Manual Fingerprinting...



Machine Learning
to the Rescue!

Apps Not Popular...



Mobile Apps
Everywhere!

It Seemed So Simple!

Industries Adopting Indoor Location Technology



The Quest for Precision

Indoor Location Evolution (2000-2025) & The Path Forward

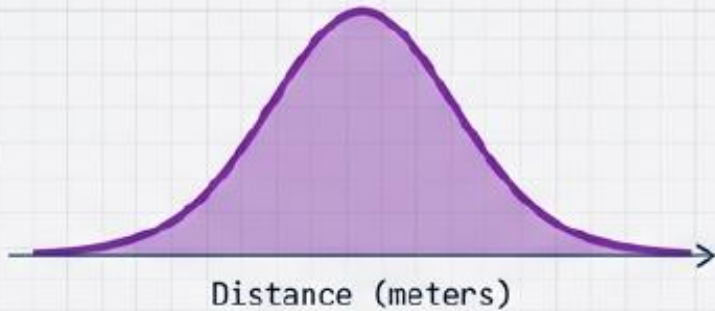


Wireless Conference Presentation | State of the Industry

The Accuracy Spectrum

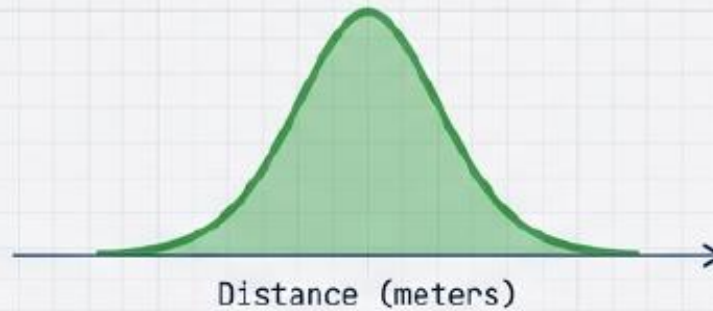
Why Bandwidth Matters: Comparing the Physics of Location

Wi-Fi



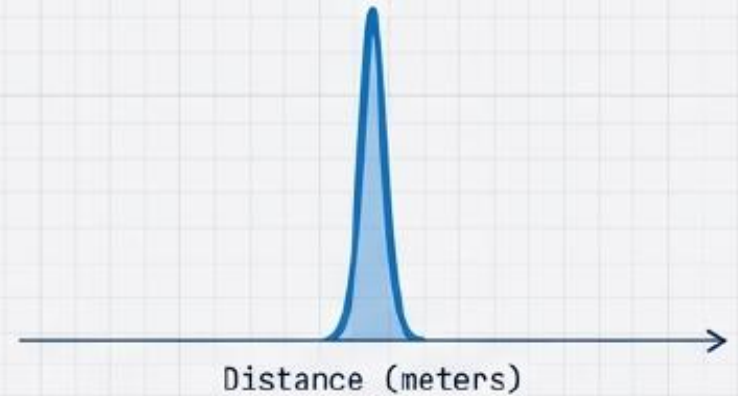
Accuracy: ~5-15 meters
Use Case: Presence Detection

BLE



Accuracy: ~2-5 meters
Use Case: Proximity / Zone

UWB

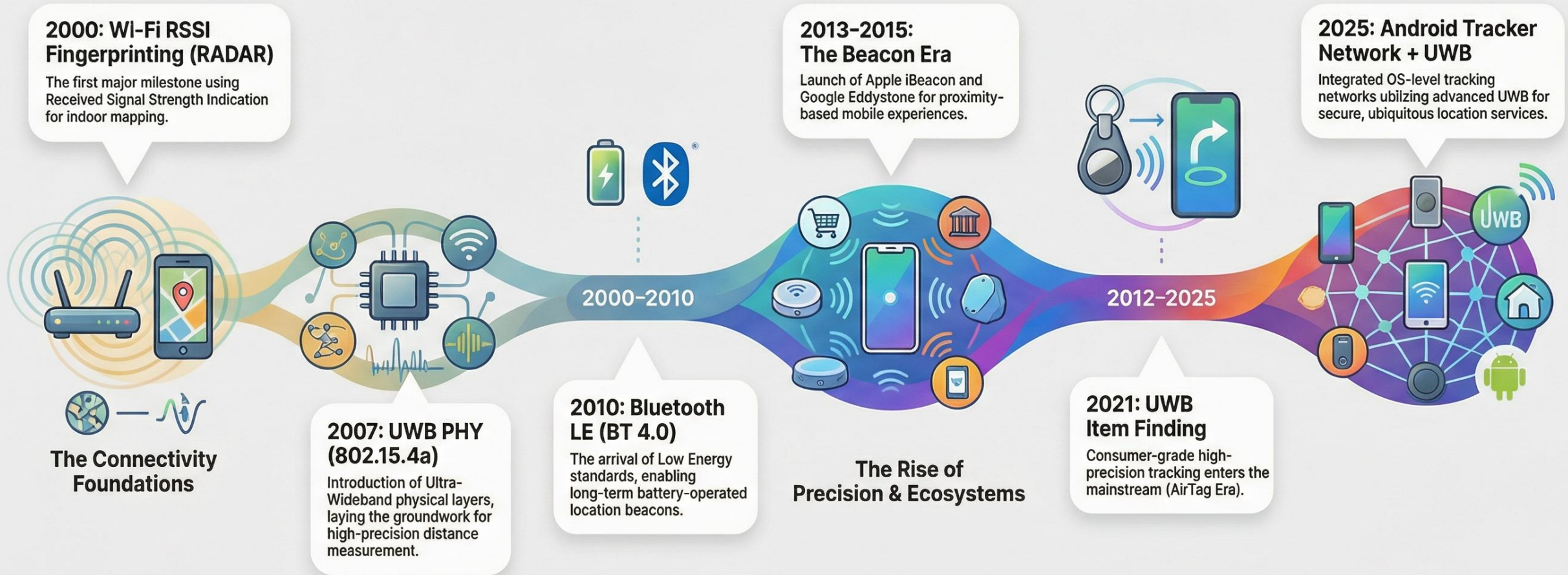


Accuracy: 10-30 centimeters
Use Case: Pinpoint Precision

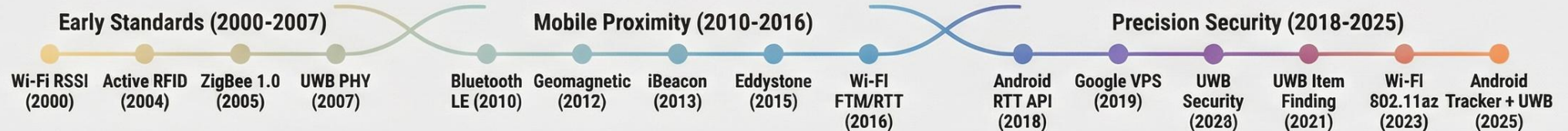
LOWER ACCURACY

HIGHER ACCURACY

25 Years of Indoor Location: From Connectivity to Precision (2000–2025)



A Comprehensive Technology & Milestone Timeline




What happened to Wi-Fi location?

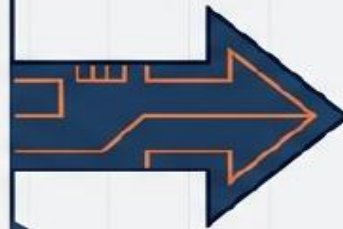
The Ecosystem Barrier: The “Apple Opportunity”

Why Wi-Fi Location missed the consumer revolution.

802.11mc (Wi-Fi
RTT) Standard.



Sub-meter accuracy
Standardized since 2016
Supported by Android 



No iOS
Support for
Developer
RTT

**Result: Impossible to build universal consumer apps
(Venue Maps, Wayfinding) using Wi-Fi RTT.**

Auto-placement with Wi-Fi 7 access points

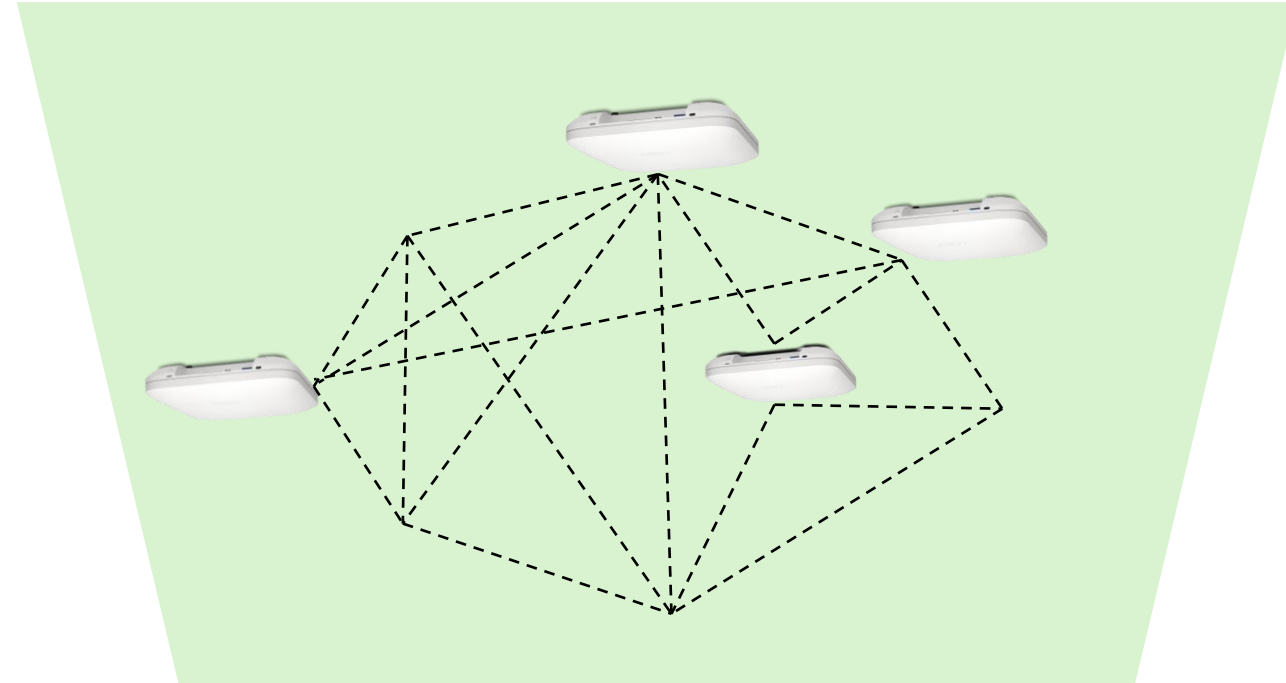
AP47 Wi-Fi 7 supports Wi-Fi, Dual BLE and UWB (Ultra-Wideband)

Auto-placement now uses UWB for positioning

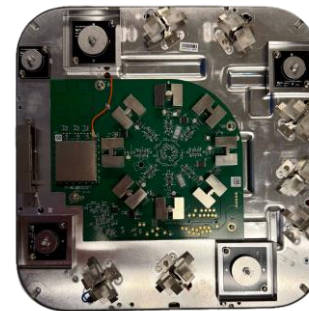
- vBLE for comm and orientation
- UWB for positioning
- GPS enabled for anchor locations

Non-disruptive to Wi-Fi

- No longer requires use of Wi-Fi for location and comm
- No Wi-Fi downtime for placement



Inter-AP communication over BLE and UWB



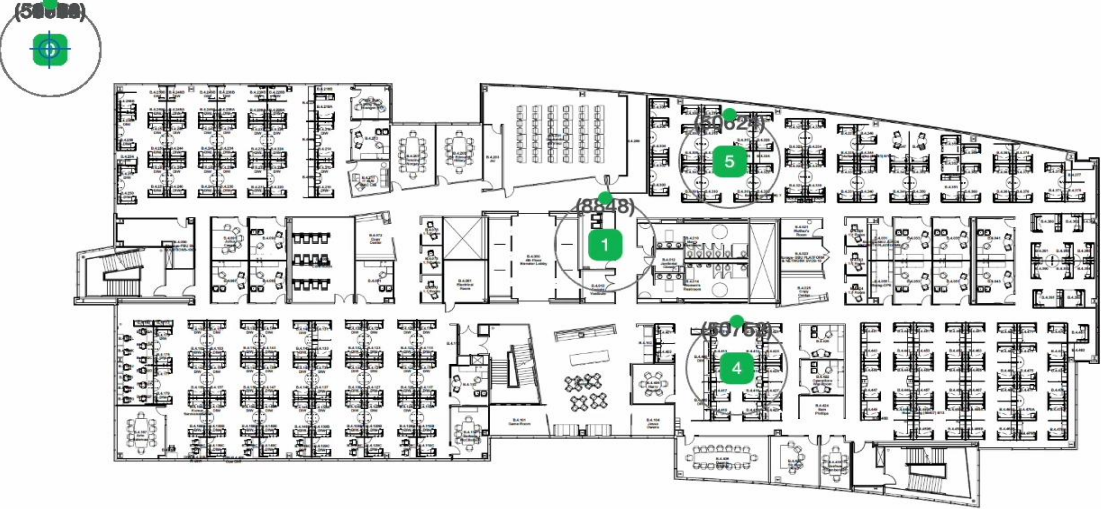
Patented 16-element BLE Antenna Array

Seamless UWB auto-placement AIOps

Set Scale Set Origin

Undo Redo Map Contrast: 100

Auto Placement
The placement of APs on this floorplan have been automatically set.
[View Changes](#)



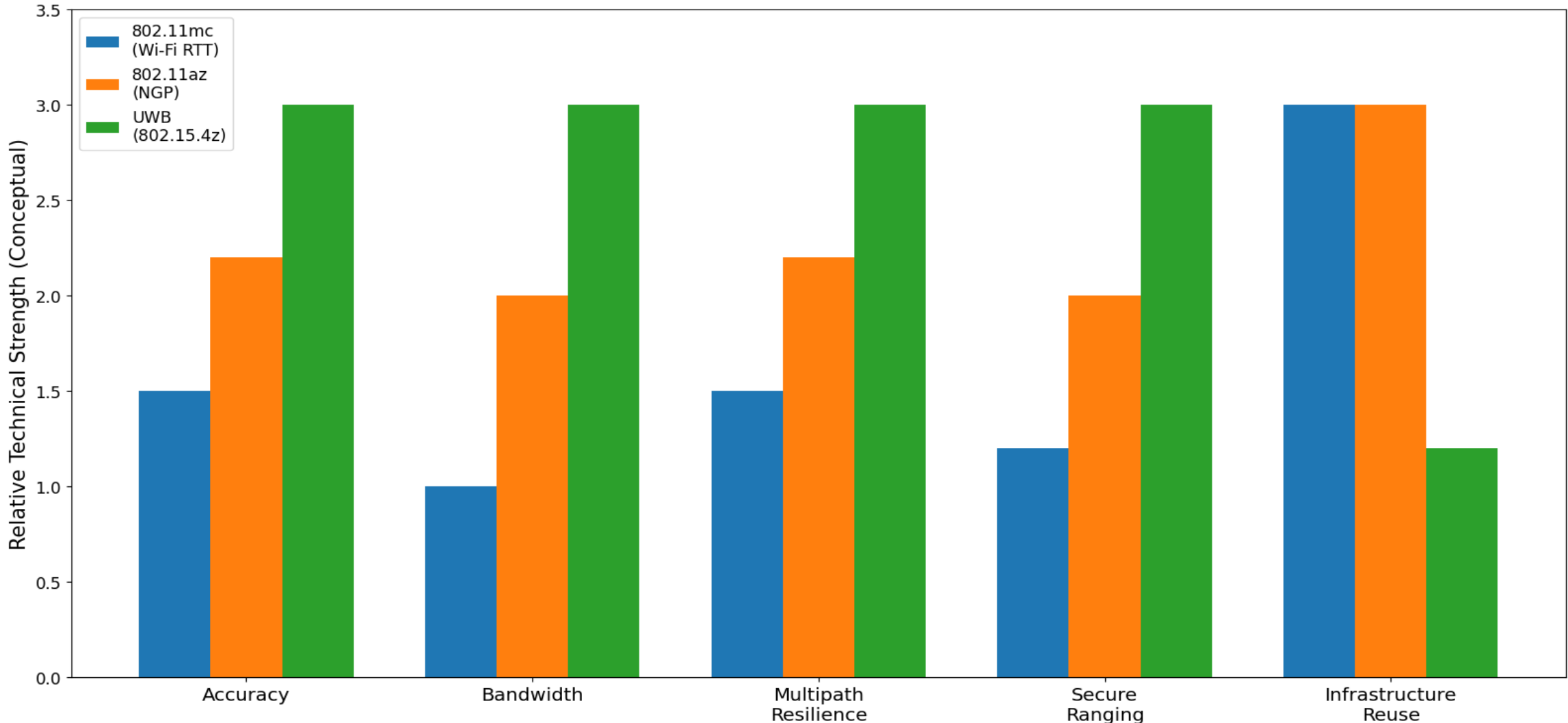
The floorplan shows a complex layout of rooms and corridors. Five green circular icons, representing APs, are placed at strategic locations: 1 in a central hallway, 2 in a large open area, 3 in a smaller room, 4 in another large open area, and 5 in a room at the top right. A magnifying glass icon is in the top right corner of the floorplan area. On the left side of the floorplan, there is a circular icon with a green plus sign and a minus sign, and a label '(500m)' above it. At the bottom left of the interface, there are three icons: a printer, a plus sign, and a vertical line.

- Simplifying deployment
- Converging AIOps
- Standards based



802.11az to the rescue of Wi-Fi location?

Indoor Location Technical Comparison:
802.11mc vs 802.11az vs UWB



People Often Tell Me I'm Like a Dog with a Bone...

So in **2014...** Ten Years Later...

I Started Another Wireless Company



Now we've got BLE
in all the mobile devices!
I'll give this another shot!

Let's Solve Indoor Location with **BLE!**

10
YEARS
LATER

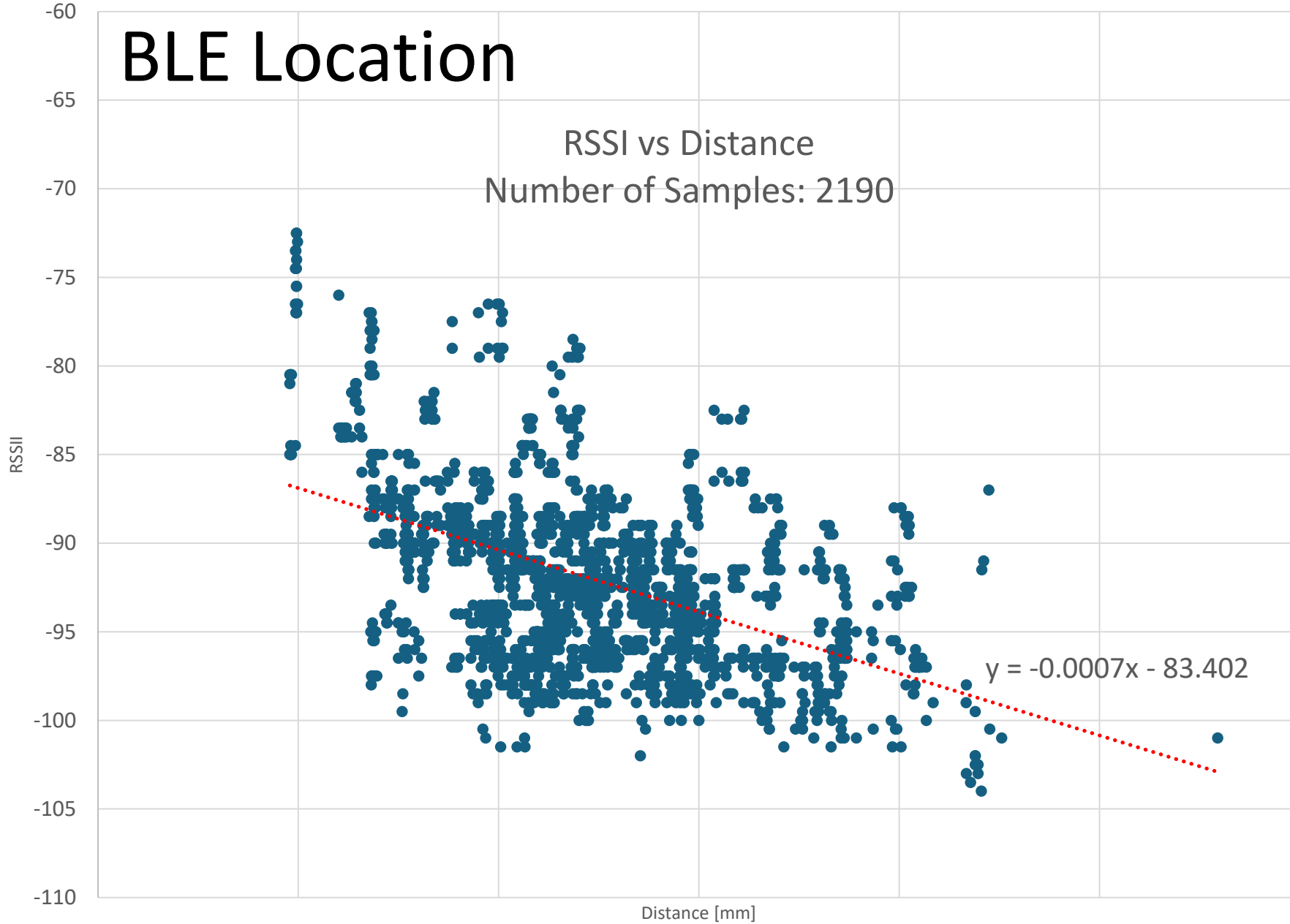


Now we've got BLE
in all the mobile devices!
I'll give this another shot!

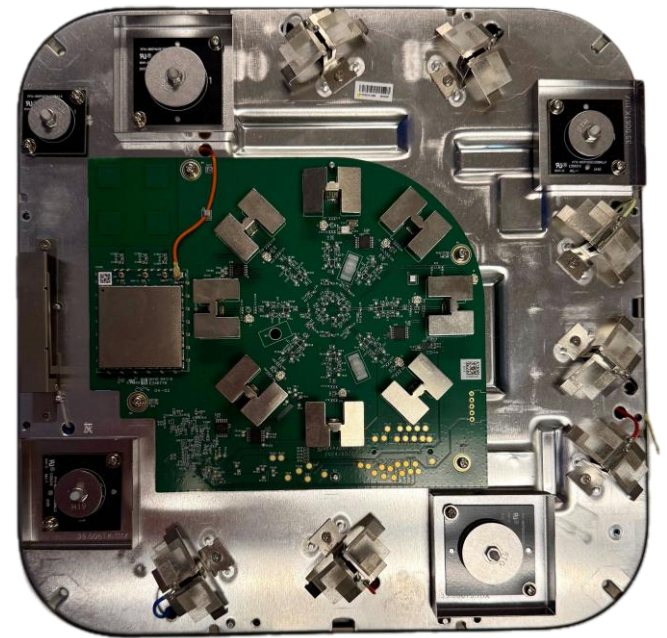


Let's Solve Indoor Location with **BLE!**

BLE Location



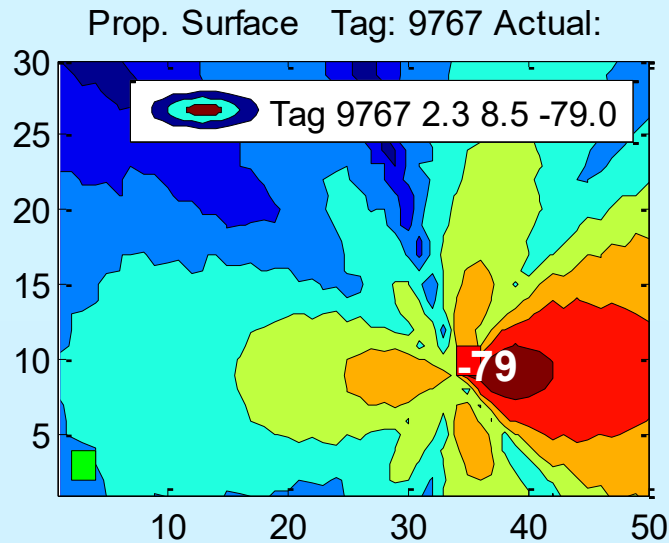
Best results distance between AP
up to 25 Meters



VBLE technology

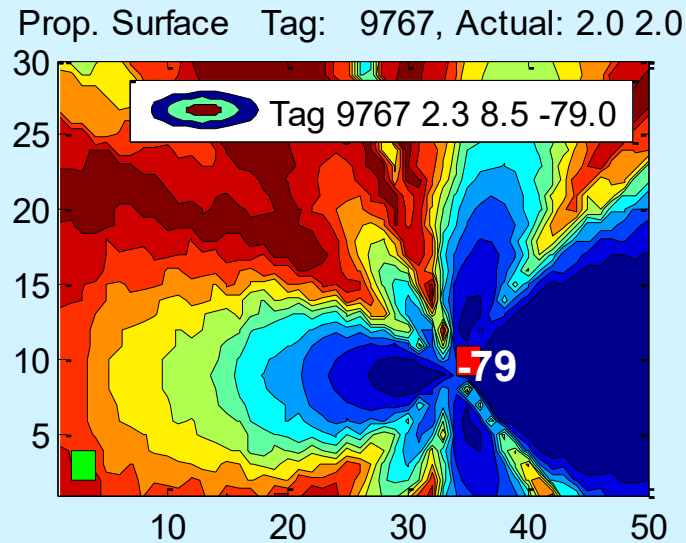
Create RSSI Surface from machined learned RF Model

$$\text{RSSI} = \text{PLE} * \text{Log}(D) + \text{INT}$$



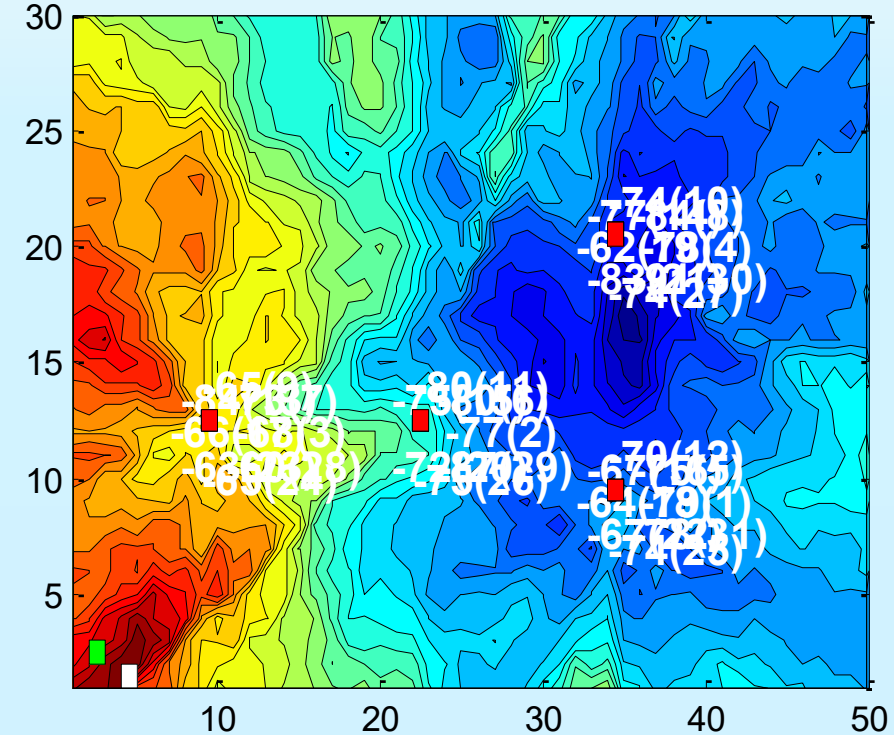
Create Probability Surface for each beam

$$y = f(x | \mu, \sigma) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$



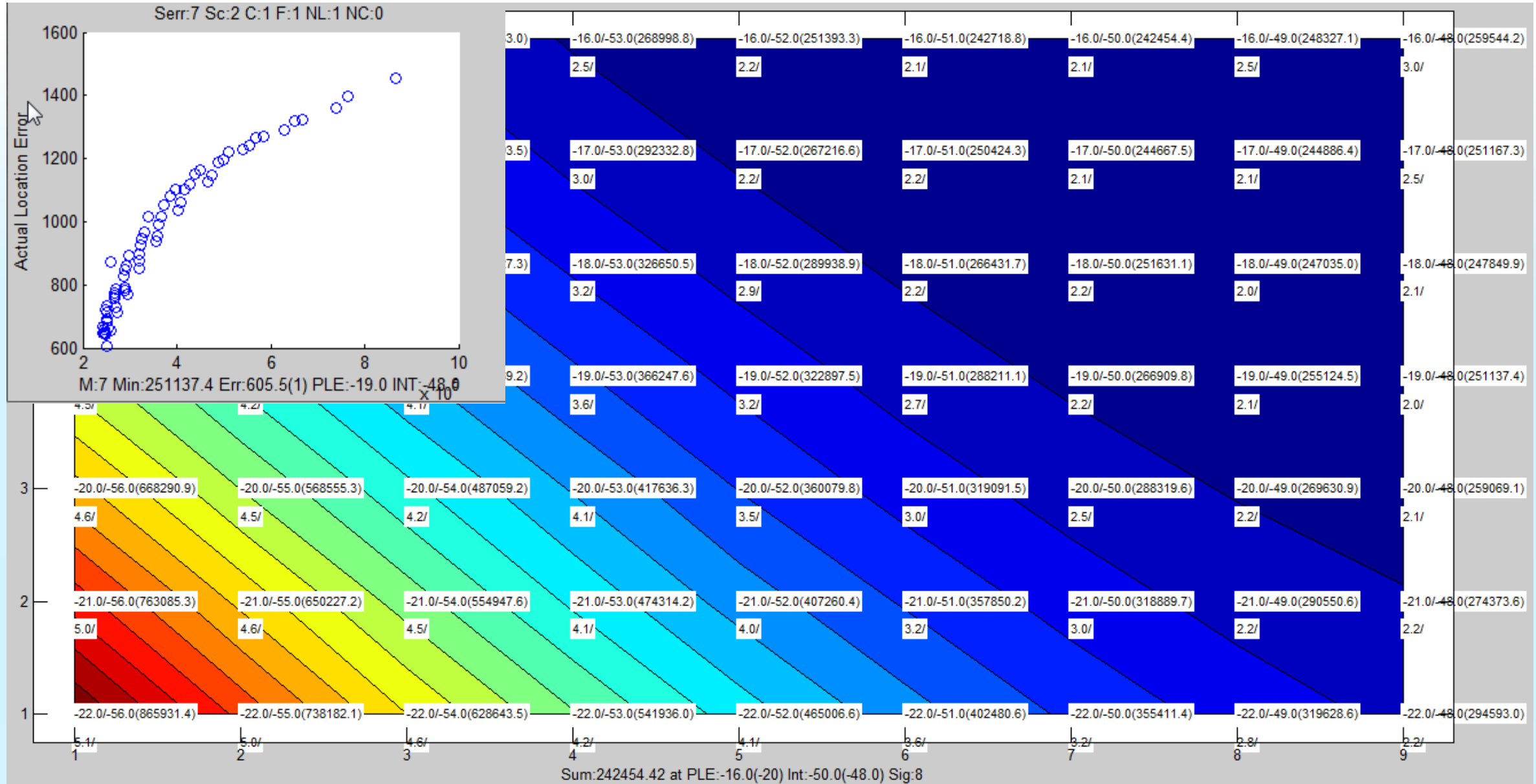
Combine Probability Surfaces

Actual: 2.2 Est: 1.0 4.0 Error 1.1 Tags: 31



Use Statistical Filtering to Track Moving Objects

Unsupervised Machine Learning Location



ADVANCEMENTS IN BLE LOCATION ACCURACY

BLE 6.0

HIGH-PRECISION RANGING



- Phase-Based Ranging (PBR)
- Round-Trip Time (RTT)

Centimeter-Level Accuracy

UNIFIED RANGING PROTOCOL



- Cross-Vendor Interoperability

ENHANCED FRAME SPACING



- Improved Reliability

BLE 6.2

FASTER UPDATES



- Ultra-Short Connection Intervals

SECURE RANGING



- Anti-Spoofing Protections

BETTER TESTING SUPPORT



- Enhanced LE Test Modes



IMPROVING INDOOR LOCATION ACCURACY & RELIABILITY

BLE location accuracy is better than WiFi, BUT...

We want to know what aisle the shopper is in and what product they're standing in front of.



And we want to make sure users have privacy.

OK, I hear you, Let's try this location stuff one more time...

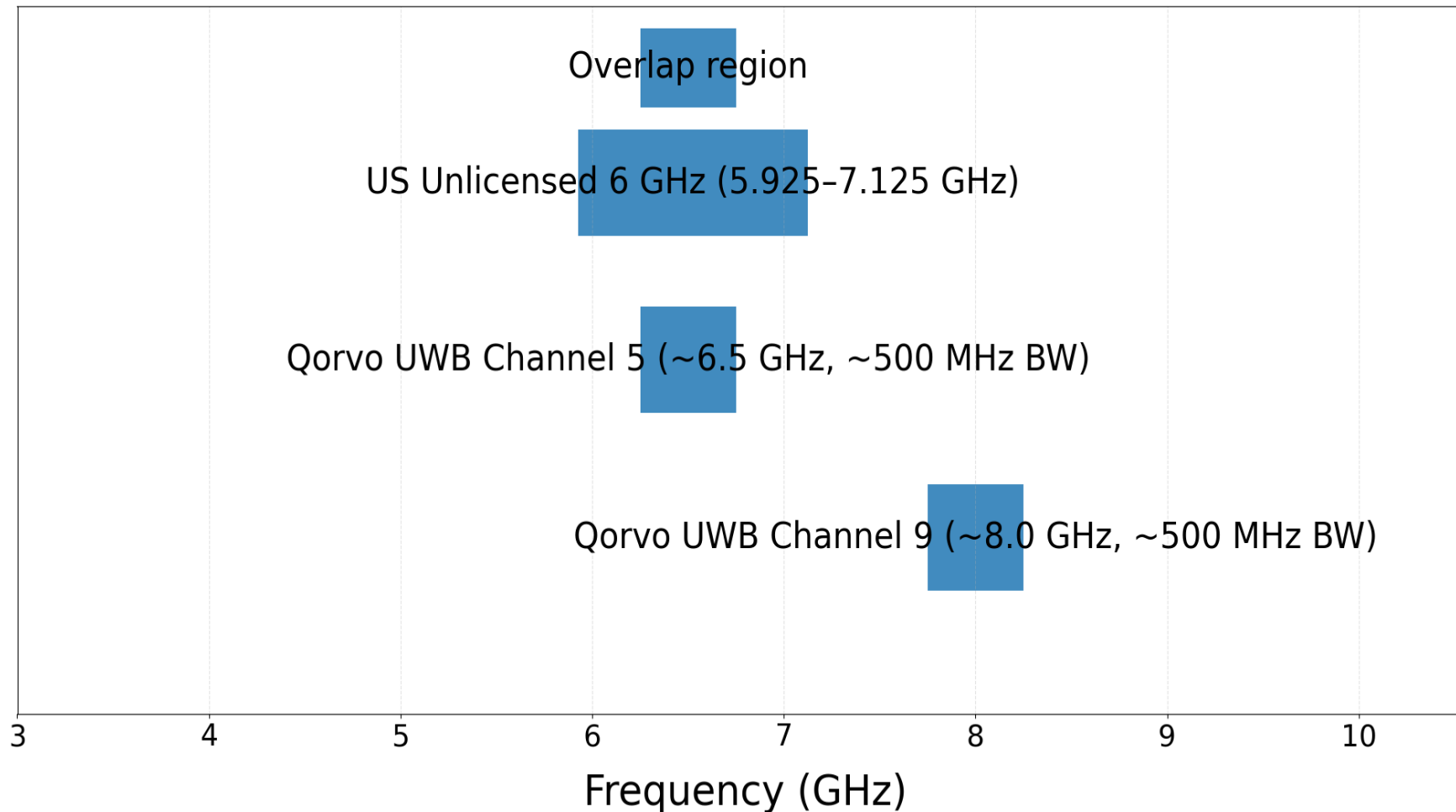
UWB



UWB for **Precise Indoor** Positioning!

UWB

Spectrum Comparison: Qorvo UWB vs US Unlicensed 6 GHz V

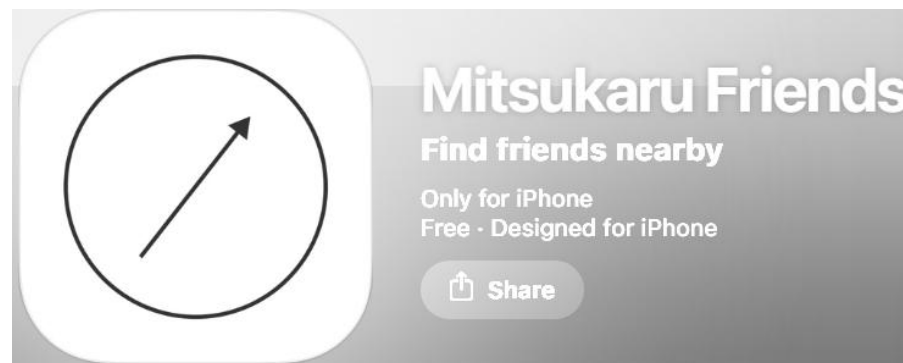


UWB Supported Smartphone Models

Samsung Galaxy (UWB Supported)	Apple iPhone (UWB Supported)
Galaxy Note 20 Ultra	iPhone 11
Galaxy S21+	iPhone 11 Pro
Galaxy S21 Ultra	iPhone 11 Pro Max
Galaxy S22+	iPhone 12 (all models)
Galaxy S22 Ultra	iPhone 13 (all models)
Galaxy S23+	iPhone 14 (all models)
Galaxy S23 Ultra	iPhone 15 (all models – U2 chip)
Galaxy S24+	iPhone 16 (except 16e)
Galaxy S24 Ultra	iPhone 17 (all models)
Galaxy Z Fold2	
Galaxy Z Fold3	
Galaxy Z Fold4	
Galaxy Z Fold5	

Developer Access to UWB on Apple iPhone

- Apple provides access to UWB via the Nearby Interaction framework (iOS 14+).
 - Developers can access distance and direction between supported devices or accessories.
 - Works with other UWB iPhones and certified third-party UWB accessories.
 - Requires user permission and active session (typically foreground app use).
 - Raw low-level UWB radio data is NOT accessible to developers.
 - Designed with strong privacy and system-level control.



Developer Access to UWB on Android

- Android provides UWB access via the Jetpack UWB API (Android 12+).
 - Apps can access distance and (if supported) angle measurements.
 - Requires UWB-enabled device hardware.
 - Requires UWB_RANGING permission and user consent.
 - Access is session-based and privacy controlled.
 - Raw UWB radio waveform data is NOT exposed.



Works with Android
Find Hub



vs.



FiRa Consortium

omlox

Focus & Use Cases



Consumer Devices

- Smartphones & Access Control
- Indoor Navigation
- Peer-to-Peer Ranging



Industrial RTLS

- Asset Tracking
- Warehouses & Logistics
- Worker Safety

Technical Approach



Peer-to-Peer Protocols

- Device Interoperability



UWB Infrastructure

- Core Zone & omlox Hub

Technology Mix



- Ultra-Wideband (UWB)



- UWB + BLE, RFID, GPS

Interop & Collaboration

Consumer UWB Devices



Industrial UWB Systems





SKULL AND CROSSBONES

RIP
BOB



Thank you

And if you want to discuss location
feel free to reach out