

# Ultrawideband (UWB) In-building Location Systems

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# Outdoor location applications today

Transportation

Better navigation

Logistics  
Workplace  
Security  
Defence

Better communications

Better record keeping

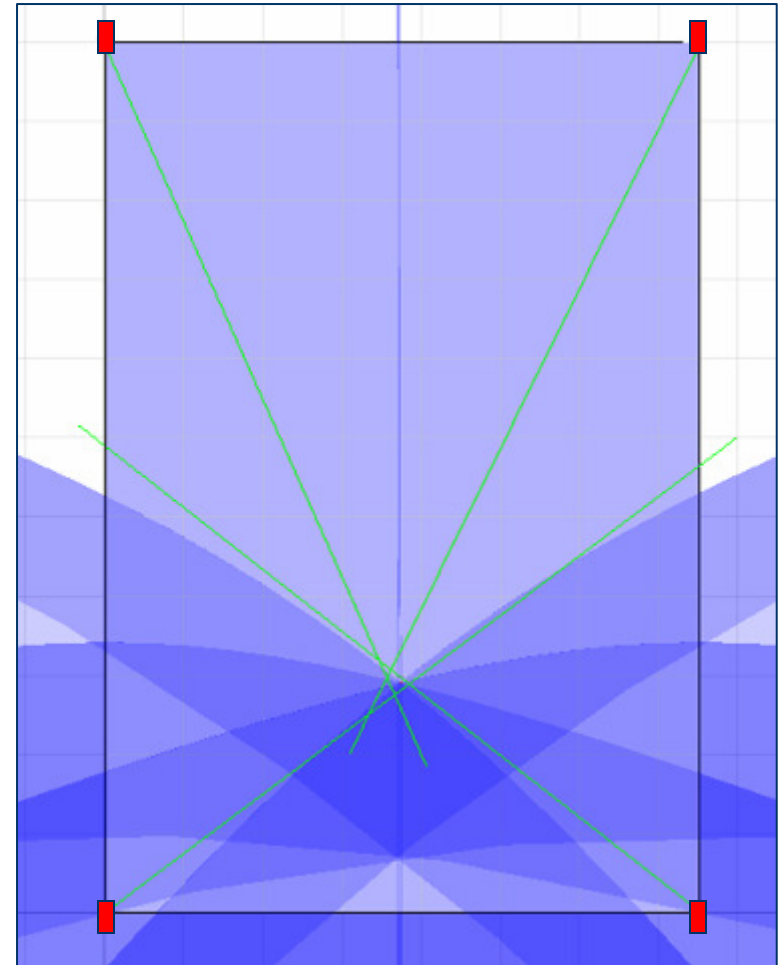
Easier measurement

More effectiveness

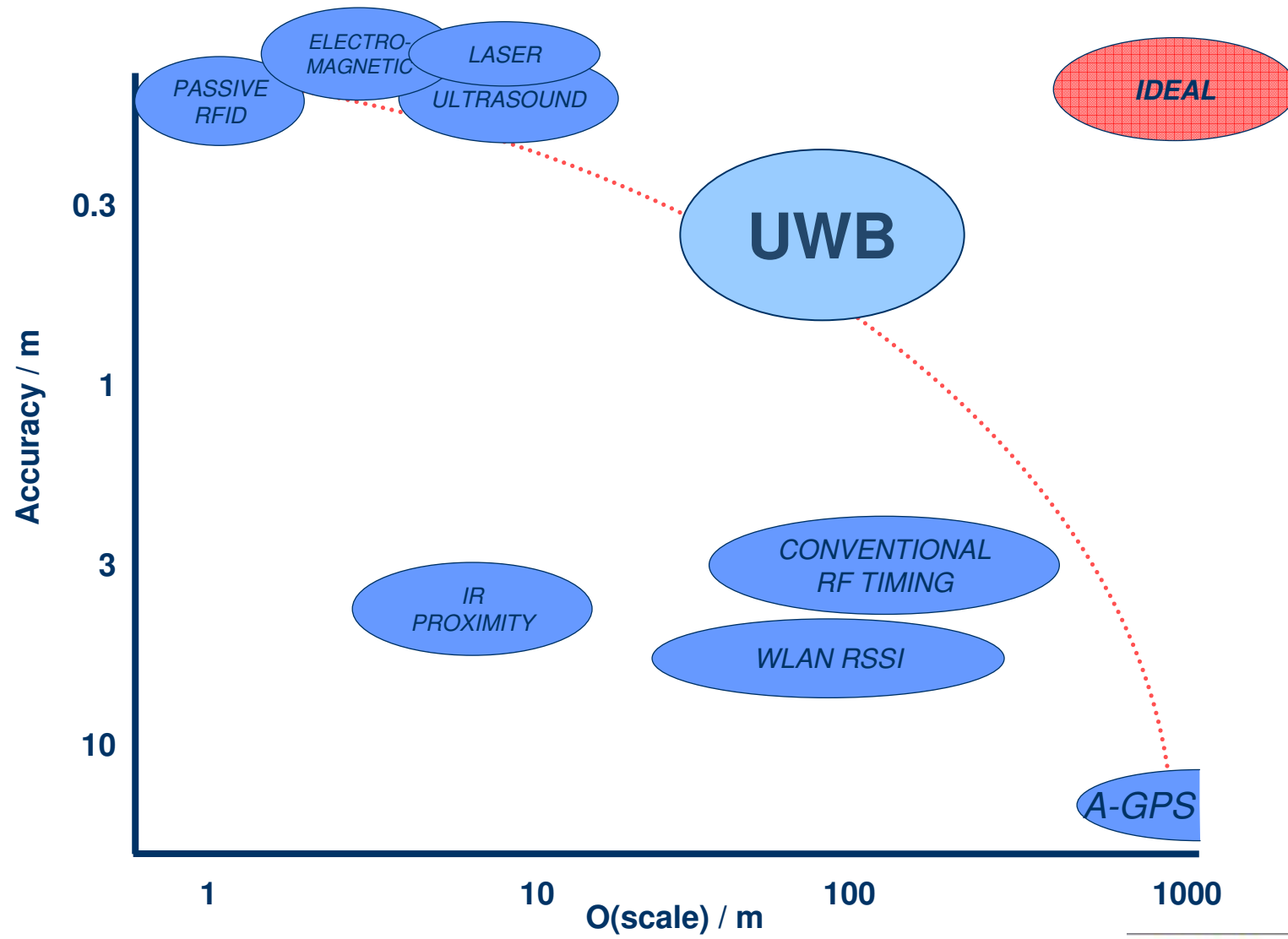
More safety

# RF Location System principles

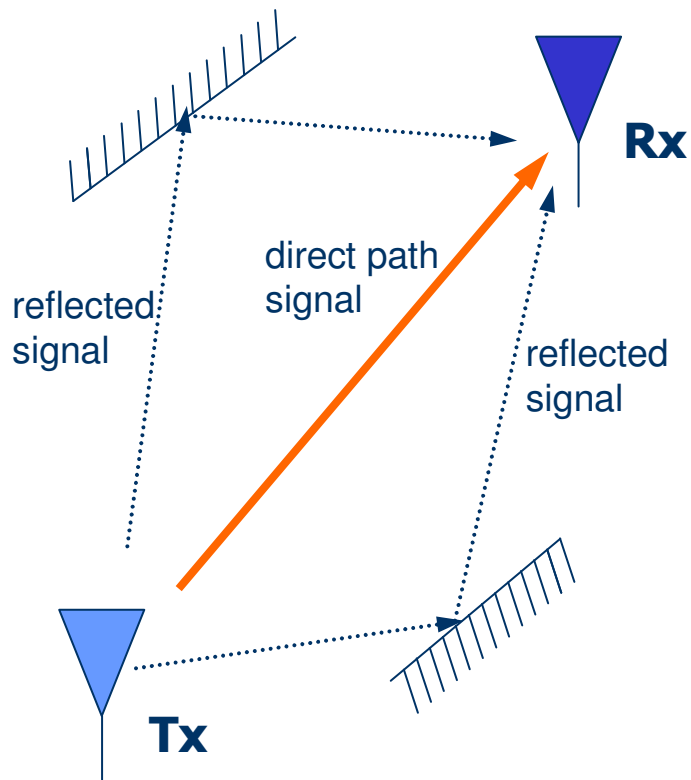
- Measure distances or angles between known points and unknown position
- Several methods:
  - Time-of-arrival of signal (ToA)
  - Time-difference-of-arrival (TDoA)
  - Angle-of-arrival (AoA)
  - Received signal strength (RSSI)
- All suffer from problems indoors
  - Obstructions
  - Reflections



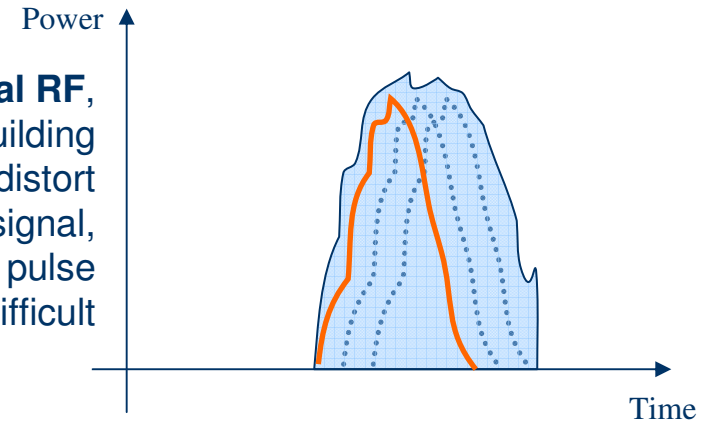
# In-building Location System characteristics



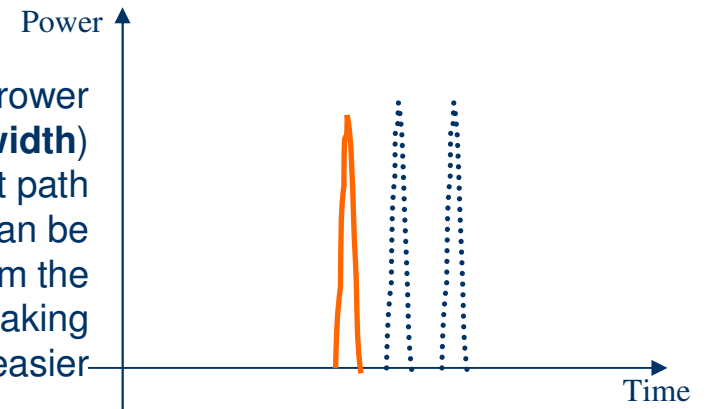
# UWB for In-building Location



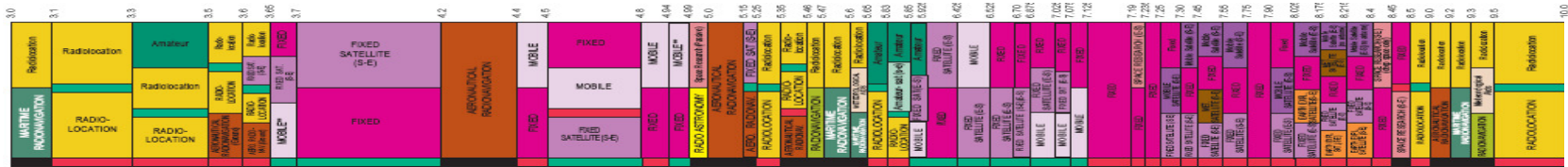
With **conventional RF**, reflections in in-building environments distort the direct path signal, making accurate pulse timing difficult



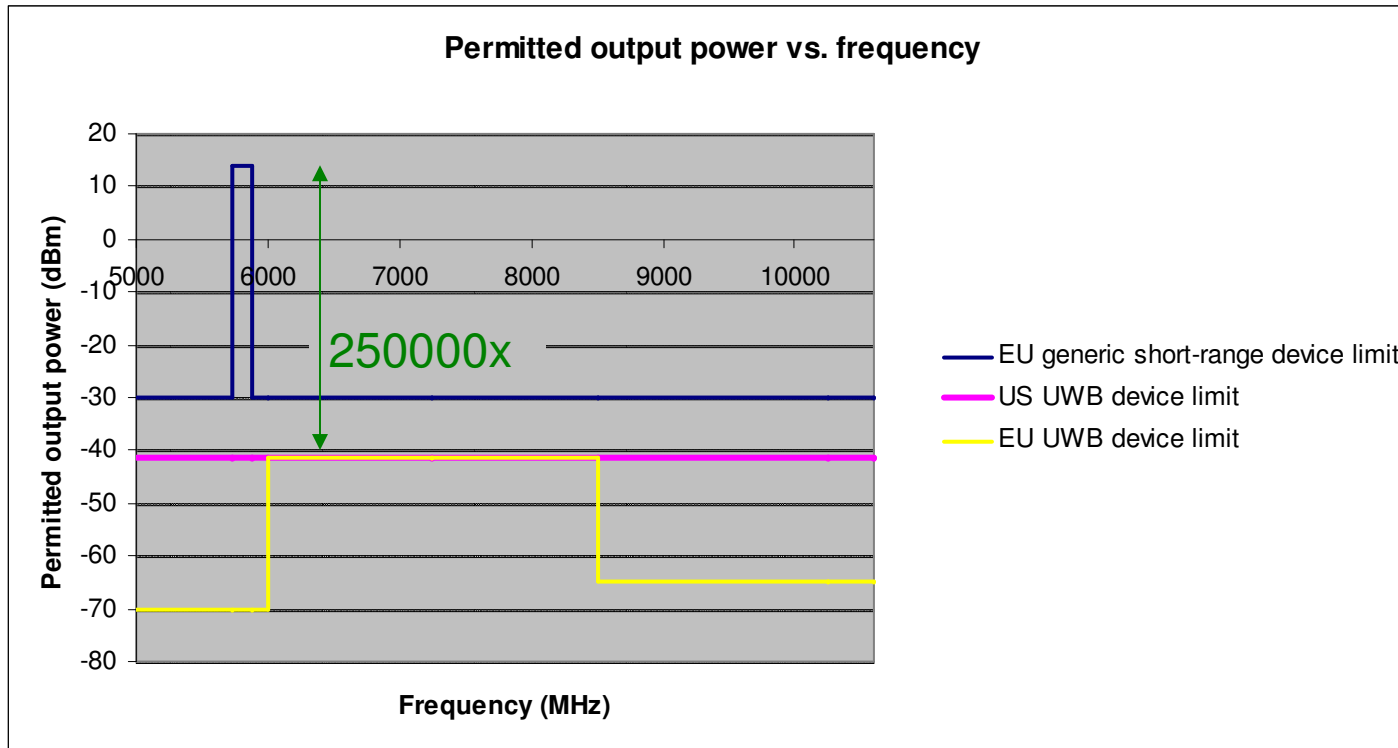
By using narrower (**higher-bandwidth**) pulses the direct path signal can be distinguished from the reflections, making pulse timing easier



# UWB as an underlay service



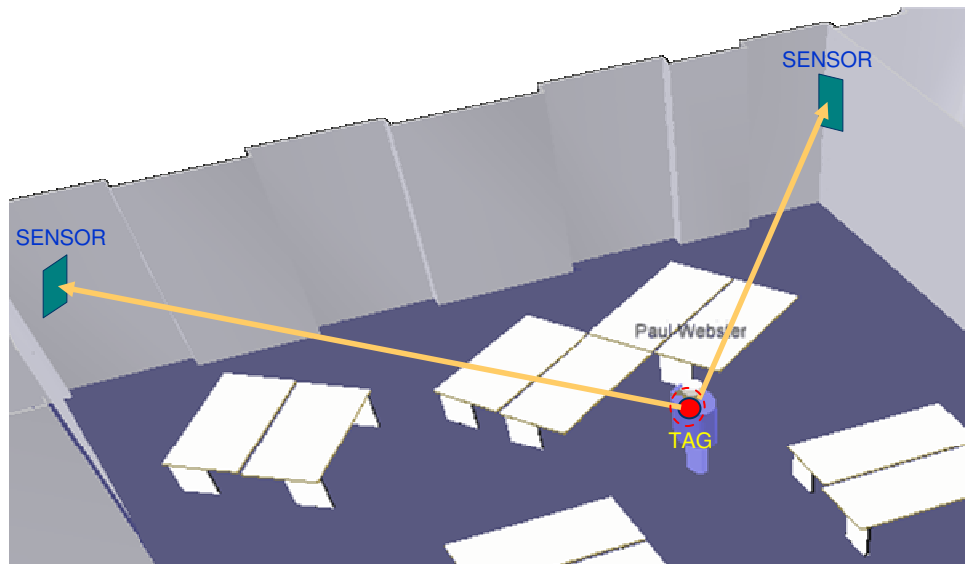
US frequency allocation table – 3 to 10 GHz



# Example UWB location system (Ubisense)



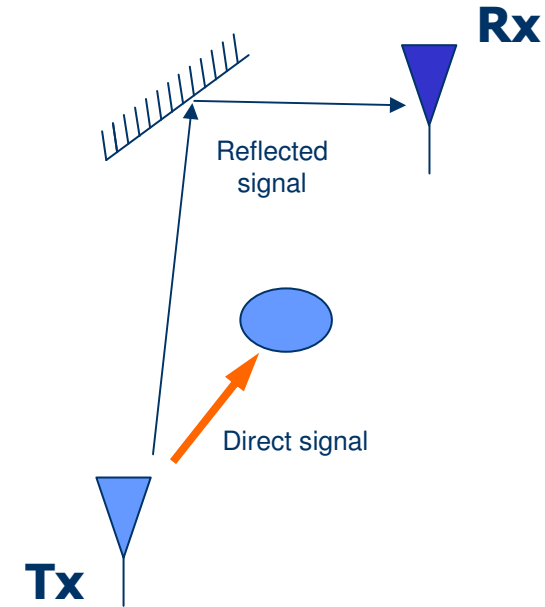
Sensor



Tag

- 3D accuracy: 15cm (95% confidence level)
- Max. tag-sensor range: 160m
- Tag update rate: Variable, 10 updates/sec to 1 update/hour
- Tag battery lifetime: Up to 5 years
- Certifications: US FCC, Industry Canada, EU CE, Singapore iDA

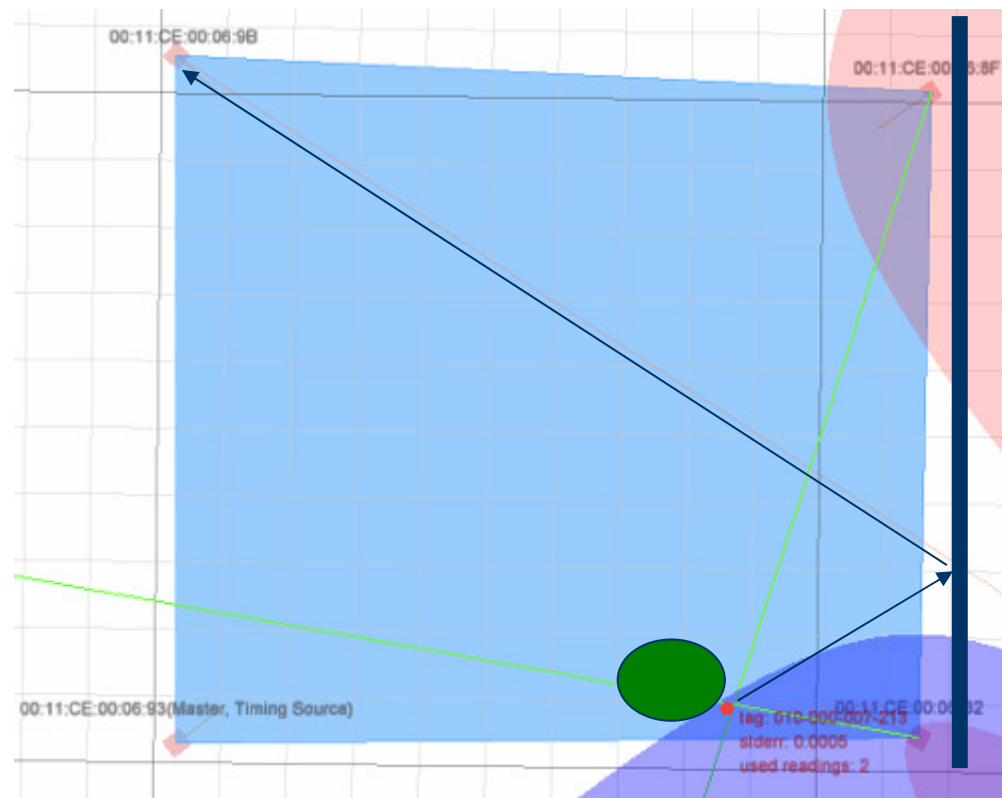
# Dealing with: Obstructions



- Positioning is much more difficult than communications
  - For communications, *any* signal path transfers useful information
  - For positioning, only direct path signal carries any useful information

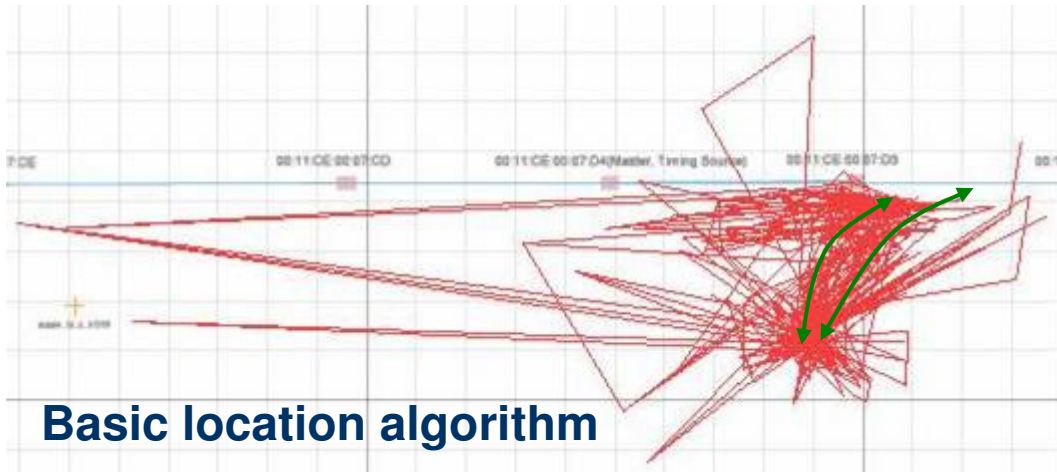
# Dealing with: Reflections (1)

- UWB systems reject all but the first signal to arrive
  - But if the direct path signal is blocked, the first signal **is** a reflection!

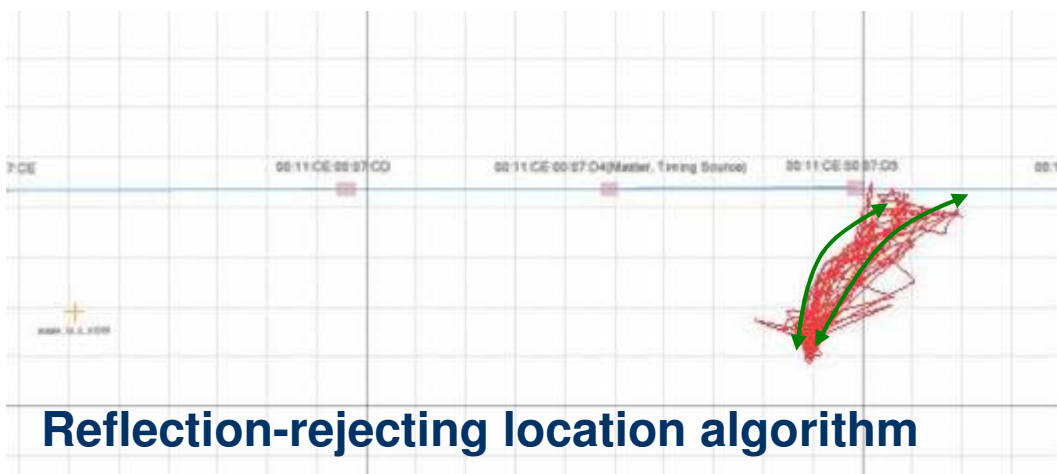


# Dealing with: Reflections (2)

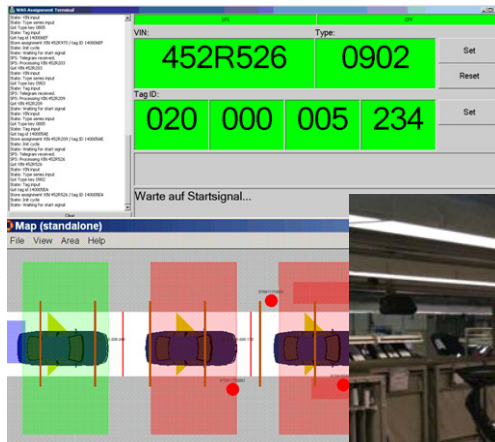
- Need to use surplus measurements to resolve true position



*Actual paths of tool in green*  
*Measured paths of tool in red*

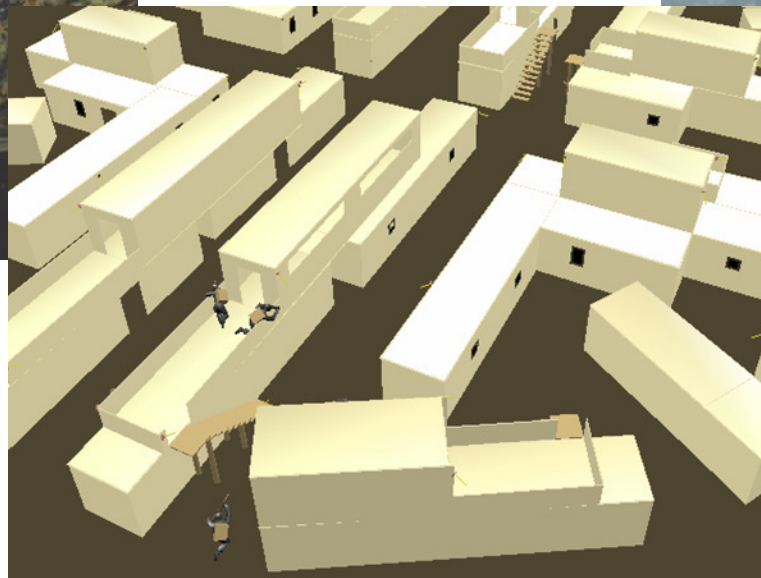


# Applications: Manufacturing



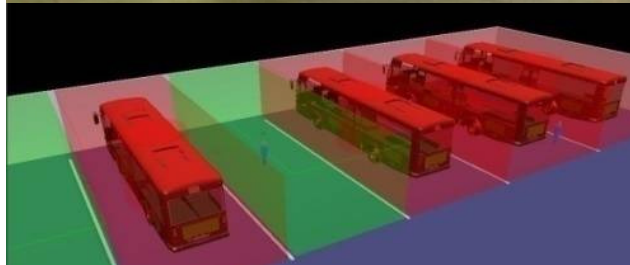
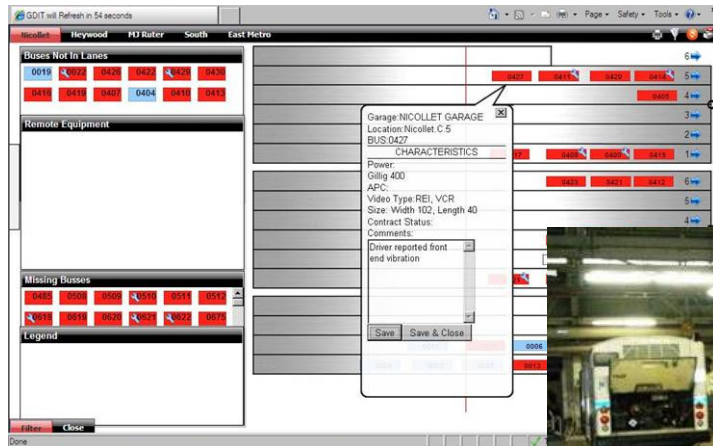
**Automated tool control system, BMW Regensburg:**  
2km production line, 1000 cars, 150 tools, 99.9998% reliability...

# Applications: Military Training



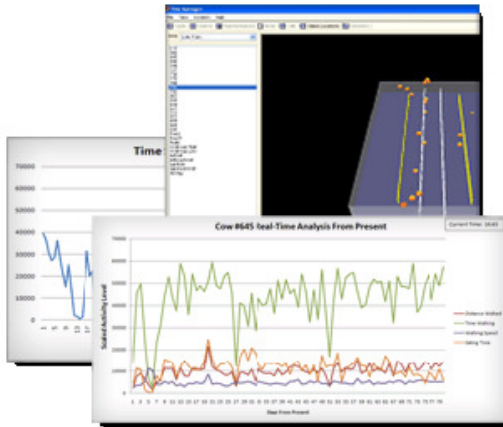
**US National Training Centre, Fort Irwin, CA:**  
20 buildings, 300 sensors, 10000+ soldiers, ...

# Applications: Transit



**Minneapolis Transit bus scheduling system:**  
5 garages, 1000 buses, >99% reliability, ...

# Applications: Agriculture



**Smarter Farming cow health monitoring system:**  
8 sensors / 150 cows (per barn), 30cm accuracy, ...

# Conclusion

- Precise indoor tracking is a very challenging problem
- UWB technology enables accurate indoor positioning
- This technology is being used now in real-world applications