

UWB technology for location systems

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Agenda

- **Motivation**
 - Limitations and problems of current location technologies
- **UWB technology**
 - Using the UWB technology to positioning a tag
- **Software platform**
 - Creating and visualizing 3D models of the building
- **Using UWB system at MIP**
 - Project work going on with the system

Motivation

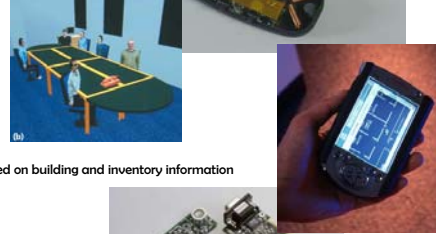
➤ Infrared-based systems

- Examples
 - Active badge systems
 - PARCTab
 - Locust Swarm
- Problems
 - Usually room-level granularity
 - Ease obstruction of signals



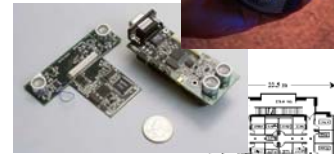
➤ Ultrasound-based systems

- Examples
 - BAT system from AT&T labs in Cambridge (3 cm in 3D)
 - Cricknet
 - Hexamite
- Problems
 - Extensive infrastructure (750 sensors to cover ~1,000 m², BAT system)
 - Easy to JAM (jingling keys)
 - To reach the accuracy extensive calibration and pruning algorithms should be applied based on building and inventory information



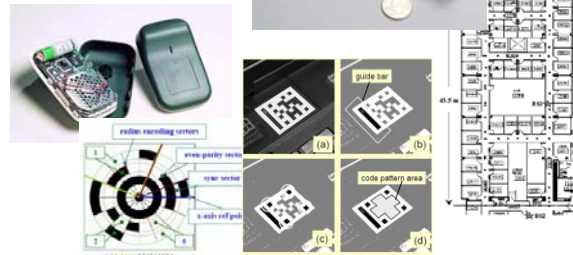
➤ Radio-based systems

- Examples
 - Active RFID tags
 - RADAR, TMI, Nibbles, Horus, and other WLAN-based systems
- Problems
 - Extremely sensitive to reflections of signals, thus must be calibrated to the environments
 - Accuracy for indoor environments typically around 1.5-4 meters



➤ Camera-based systems

- Examples
 - Untagged: Pfinder, EasyLiving
 - Tagged: Cybercode, AR Toolkit, TRIP, BBC free-d
- Problems
 - Domain specific implementations
 - Direct line-of-sight
 - Computational hard



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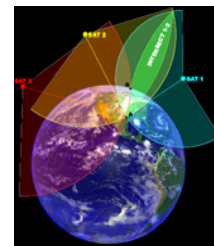
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Motivation – cont'd

➤ Intuitively location is easy for humans

➤ GPS

- technically complex, but relatively accurate system (DGPS)
- ideal infrastructure: globally available, only buy a receiver
- not in indoor environments



➤ General problems for existing location systems

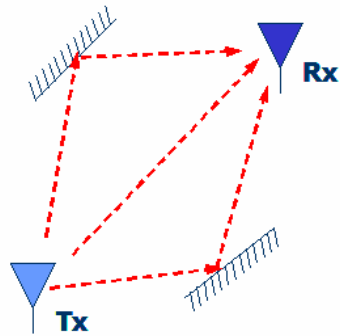
- Easy interference or blocking of signals
- Speed of high-frequency signal makes timing hard
- Signal-strength is extremely error-prone to multi-path and scattering reflections
- For indoor smart environments centimeter-level accuracy is required
- Dense sensor infrastructure

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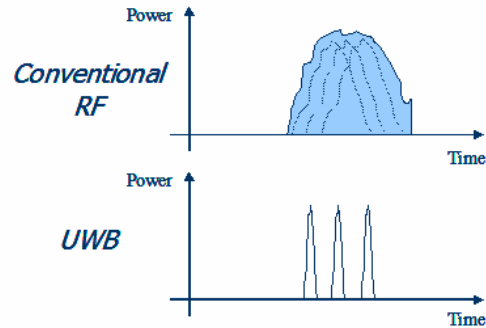
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UWB technology



Multipath is generated by reflections off solid surfaces within an indoor environment.



UWB's short duration pulses are easier to filter in order to determine which signals are correct and which are generated from multipath.

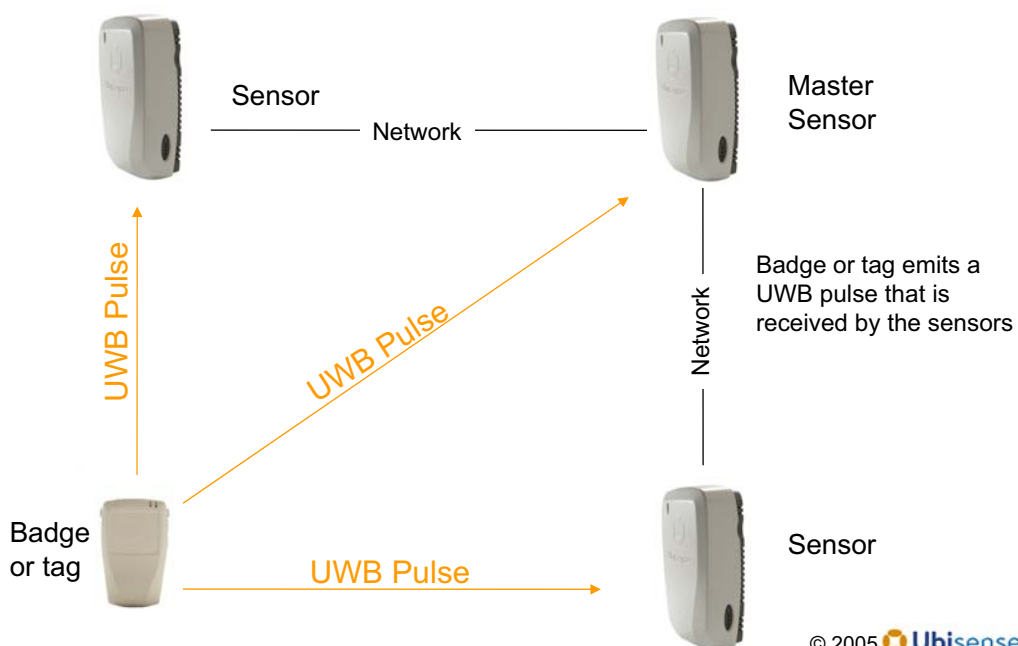
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UWB technology – cont'd



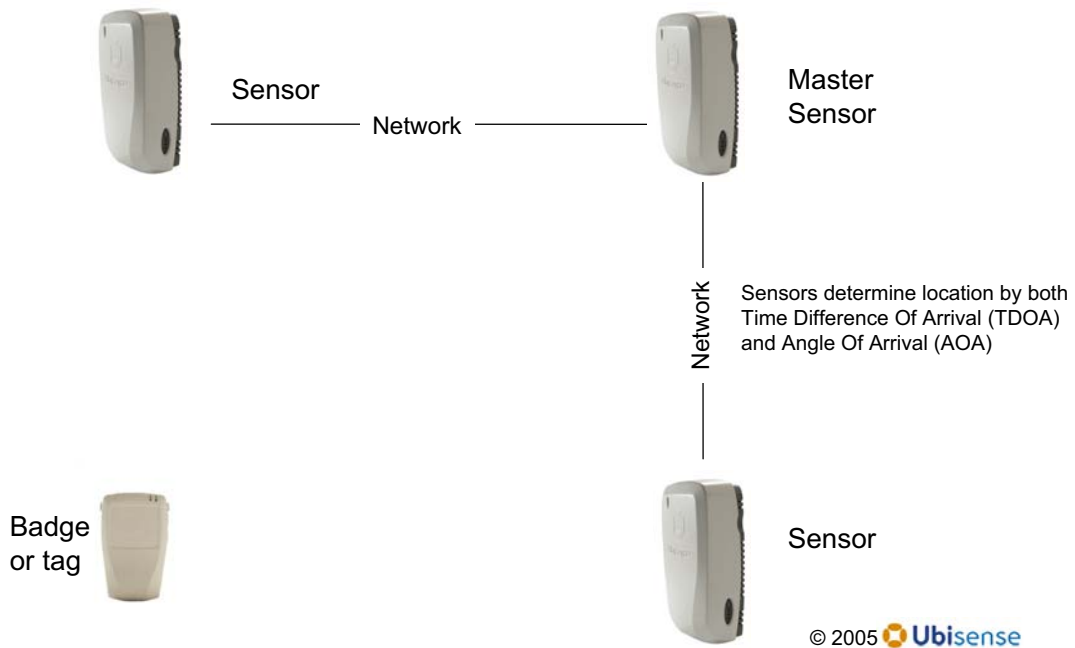
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UWB technology – cont'd

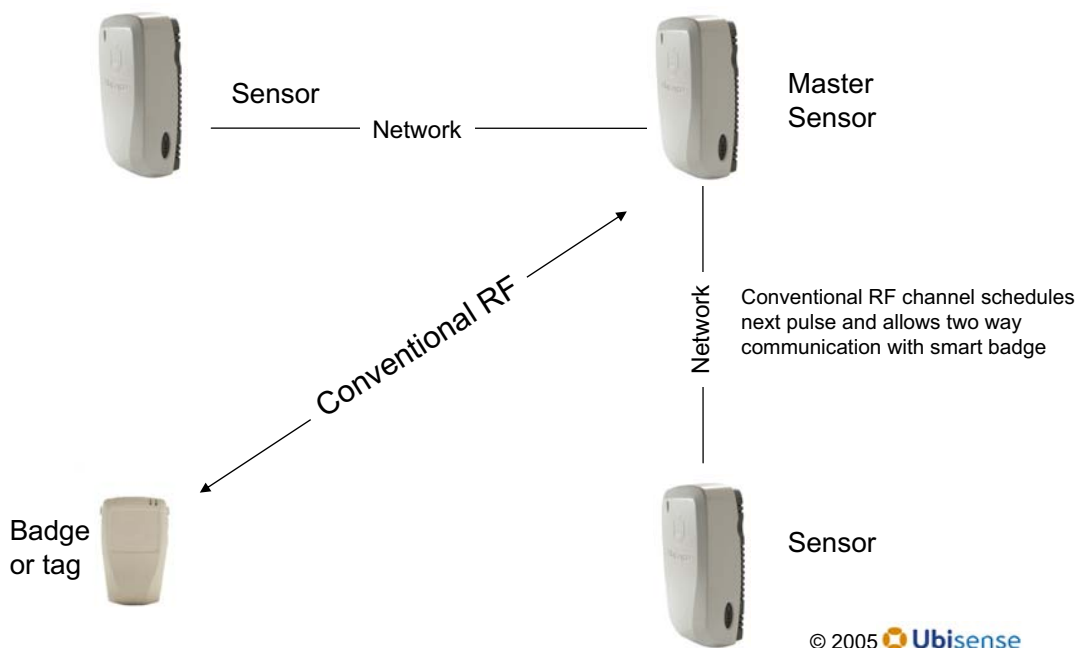


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UWB technology – cont'd



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Key advantages

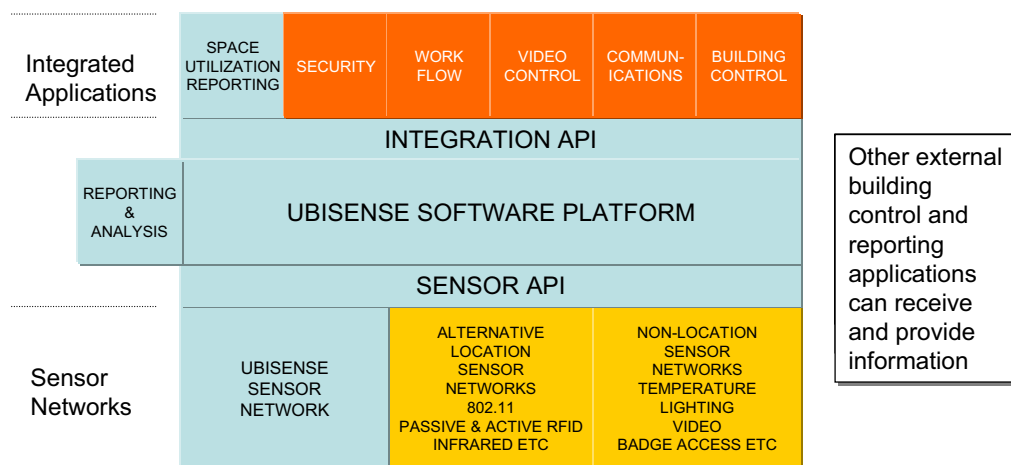
- **High accuracy**
 - 15 cm in 3D
- **High update rate**
 - 39 Hz (max 10 Hz per tag) for each cell
 - Cells could be stacked
- **Low sensor density infrastructure**
 - as location is determined by TDOA and AOA
 - Up to 5,625 ft² (625 m²) using only 4 sensors
- **Dynamic update rate**
 - Increases battery life and tracking accuracy
- **Interactive**
 - Tags have programmable buttons, LEDs and buzzer

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Software architecture



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The software let you

➤ Build & design

- Models of your building and furniture (import from AutoCAD)
- Create route planning for simulation

➤ Administer

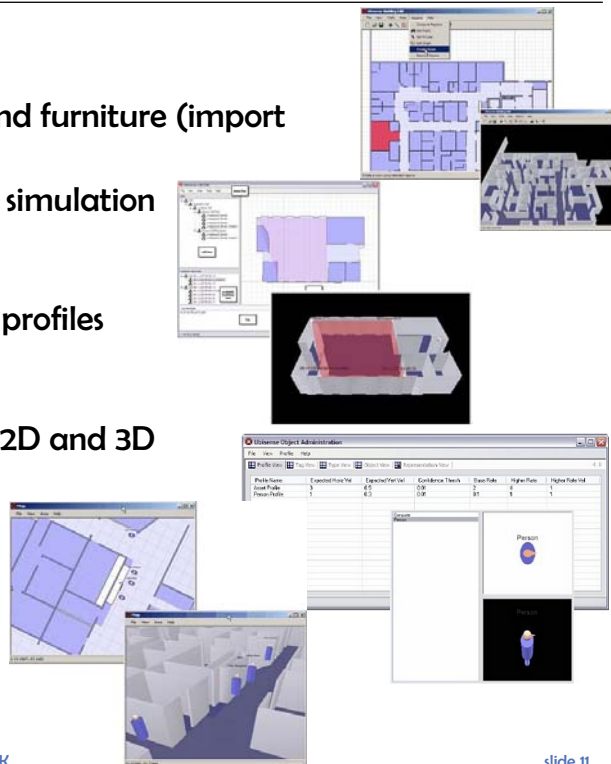
- Battery life and behavior profiles

➤ Visualize

- Pan, zoom, and rotate in 2D and 3D
- Follow objects

➤ Application

- Build event zones
- Relationships to report on



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What are we using it for

➤ Students play along with the technology

➤ Master projects

- 3D measuring of objects or buildings using tags and PDAs
- Guidance systems inside the Maersk building
- Sensor-fusion with outdoor location technologies (GPS)
- Virtual world browsers: Synchronizing the real-world with virtual model in a 3D engine (Quake engine)
- Controlling and keeping track of robots moving around in the building
- Collaborative work environments

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Thanks for your attention

Any questions?