

MAS-S61 - Emerging Technologies in Location-Aware Computing

J. Paradiso, G. Dublon, B. Mayton

Dynamics

- This is a project class
 - Credit will come mainly from project
 - Class participation as well
- Lectures will center on technologies and applications, then evolve into project sessions
- Once per week, 3 hour block
 - Could evolve into more, shorter blocks?
- Space may be limited
 - We need to produce/distribute hardware & get support...

Tentative Schedule

- Class 1: Introduction to location-aware computing and current research in that area (JoeP)
- Class 2: Radiolocation (UWB and other technologies) (JoeP)
- Class 3: Essential basics of applied CV for location systems and user interfaces (Gershon)
- Classes 4-5: Details of the radiolocation systems we've appropriated and how they're employed (Gershon, Brian, JoeP)
- Classes 5-6: Details of the embedded Intel Atom system used in our basestations and fixed infrastructure (ditto)
- Remaining Lectures - tbd

Potential Guest Speakers...

- JaeWoo Chung
- Qualcomm Peanut team
- Nokia Radio Location team
- Lynx sports tracking team
- Talking Lights folks
- Other industry Reps
- Seth Teller
- Other academics...

Assignment 1

- Do the posted readings, and prepare to discuss them next week
- Submit a 1-page email elucidating why you want to take the class
- Include a sentence or two about your background in programming, math and/or engineering

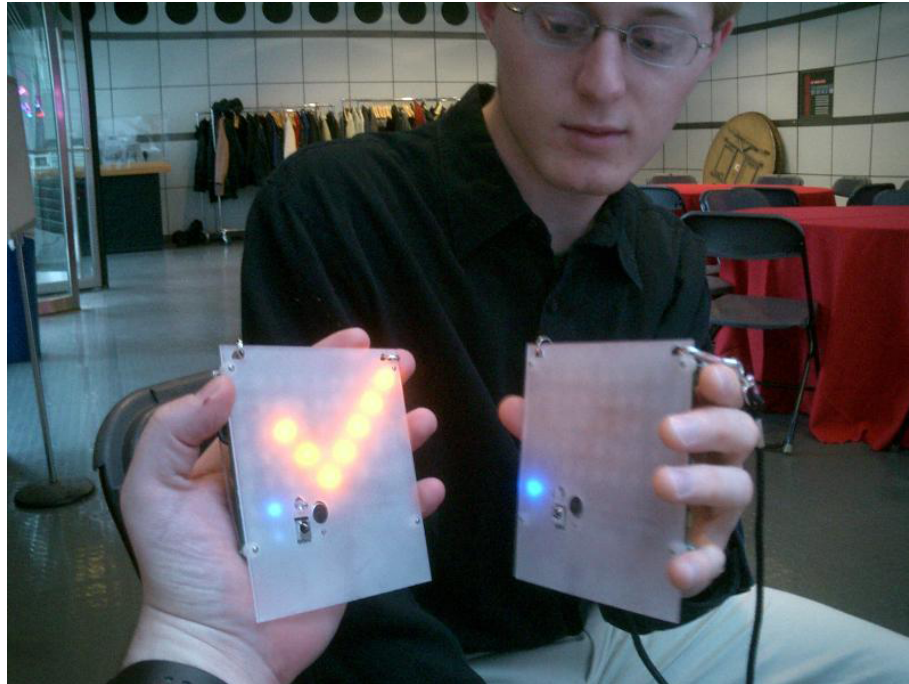
Why is this Interesting?

- Nothing is ever lost...
- Other “Obvious” applications
 - Geofencing
 - Healthcare.... (locating personnel, items)
- Dynamic UI’s
 - Context, proximate interfaces
- Lighting, Utility control
- DoppelLab
- What we can’t guess yet...
- ... And Privacy issues!

Some Prior ResEnv/ML Work...

- IR transponders
 - Locusts (In ceiling with solar cell charger) – Starner 97
 - Squirts (UberBadge 2004)
- Radio
 - Jason LaPenta μ tags 2006
 - Laibowitz Spinner 2009 (also with IR)
- RFID
 - Glass Infrastructure 2010
- Vision/Sensor Hybrid
 - Dublon 2011
- Indoor Ambient Magnetic Positioning
 - Jaewoo Chung

Exchange Business Card, Bookmark Demos



Parasitic Mobility

Responsive Environments Group

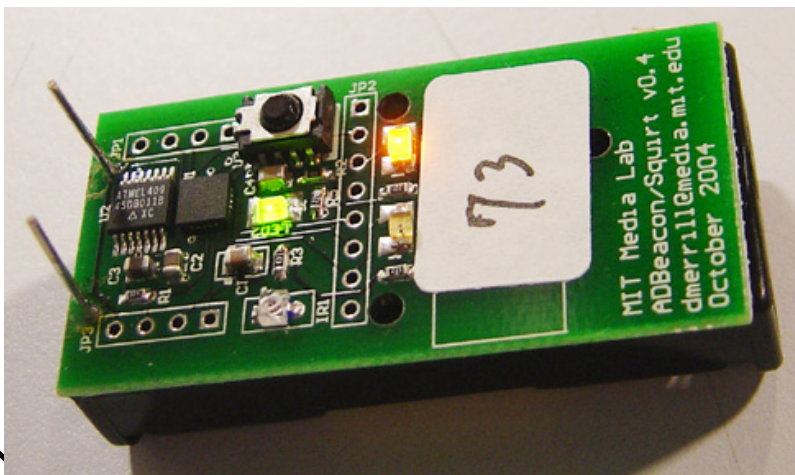
To request more info on this demo:

Aim badge at the hot-spot
Do you see a green Light?

Press either button on the badge.

Orange and Red Light?
The request is noted.

The UbER-Badge Demo Hot-Spot



Device Details – Spinner Social Sensor

**Wearable on collar or as pin/
badge**

Audio system with DSP for
analytics and CD quality
recording

Mini-SD Slot for copious memory

Compass for orientation

**3-axis Accelerometer & 2-Axis
Gyro**

IR communication and line of
sight detection/proximity

802.15.4 Radio with **RF Location
engine**

**Captures social signal and group
dynamics**

New Badge has OLED Display



SPINNER Project - Mat Laibowitz



Camera + Wearable sensor fusion

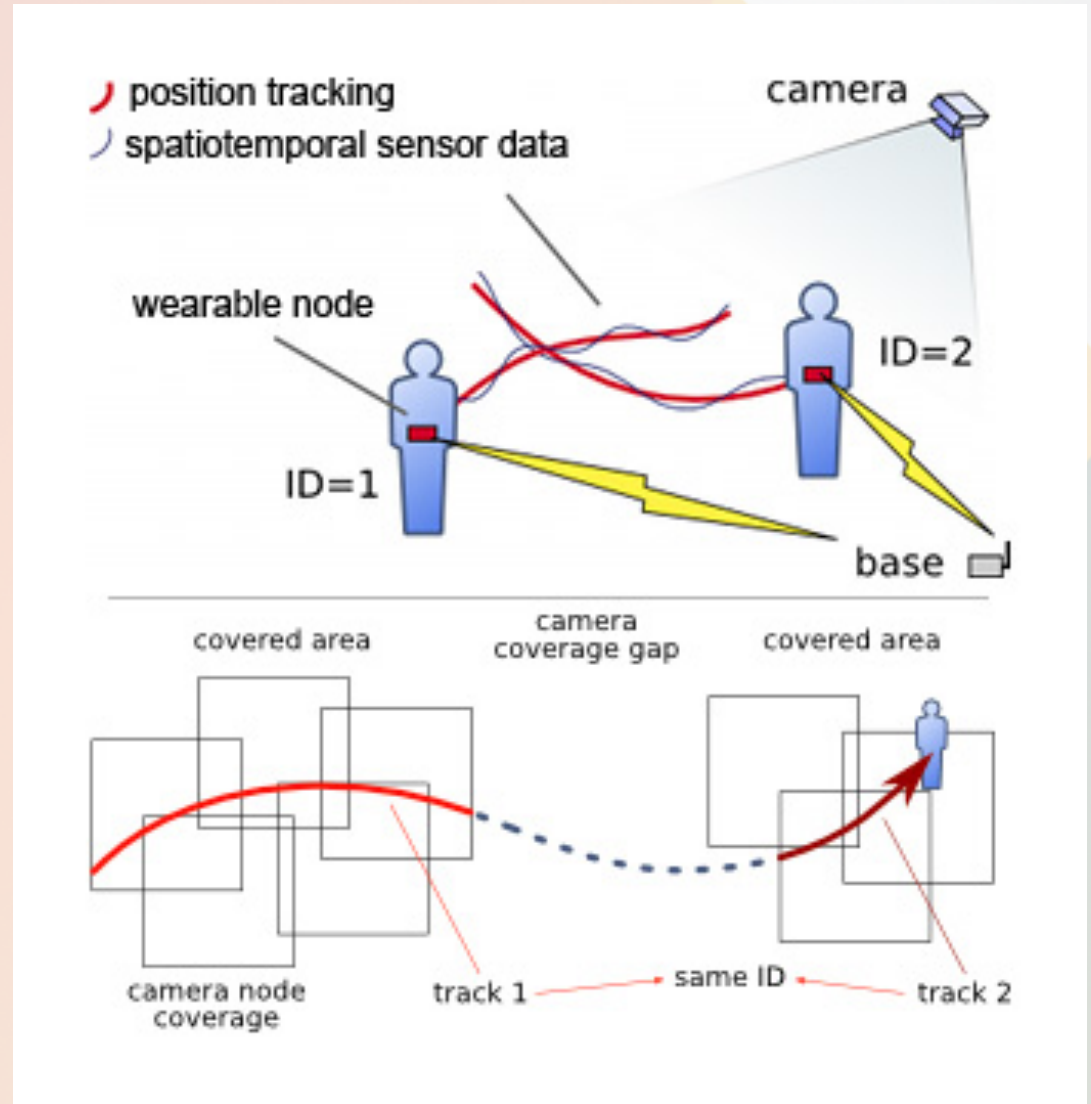


Camera (RF Basestations)

Intel Collaboration



Wearables



New UWB radio will track location at cm-level

Gershon Dublon

hocus pocus

personal video layers for privacy



thanks



gershon dublon and joe paradiso
responsive environments group
mit media lab

Tools:WiFi Location

- This building comes equipped with WiFi Location determination
 - RSSI or BER Based?
 - Several Meter accuracy
- MIT IST doesn't want to give us access...

...Yet

Tools: The WristQue

radio board

CPU/sensor board

250 mWh battery

3D printable enclosure

2cm

4 buttons

1cm

pre-fab silicone bracelet

UWB Radio (?)

- cm-level positioning

Sensors for comfort control

- net activity, T/H

Sensors for lighting control

- synchronous light, color

UI capability

- buttons, capacitive slider, compass, IR

Open doors, inductively recharge

- battery lasts days or weeks...

Brian Mayton

The Qualcomm Peanut

Qualcomm Next Generation Ultra Low Power PAN/BAN

Connecting Sensors, Peripherals, and Gadgets

Low Power Consumption

- Significantly better than Bluetooth
- Scalable transmit power with data rates

Precise Ranging

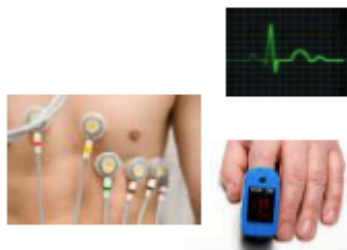
- Sub-foot accuracy
- Benefit to multiple apps (asset tracking, finding nearest device, etc)

Transparent Audio Codec

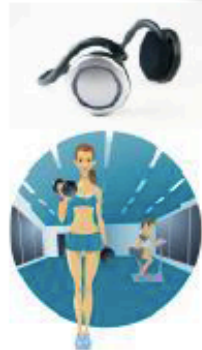
- Excellent for voice AND music
- Stereo channel synchronization ~10us
- Less than 20ms delay

High Security

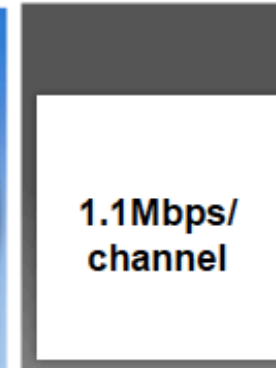
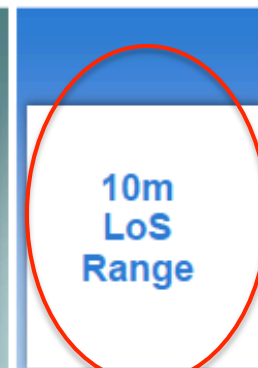
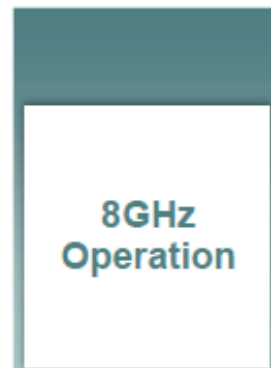
- Inserted at multiple protocol layers
- Range based authentication



Medical



Gaming / Training

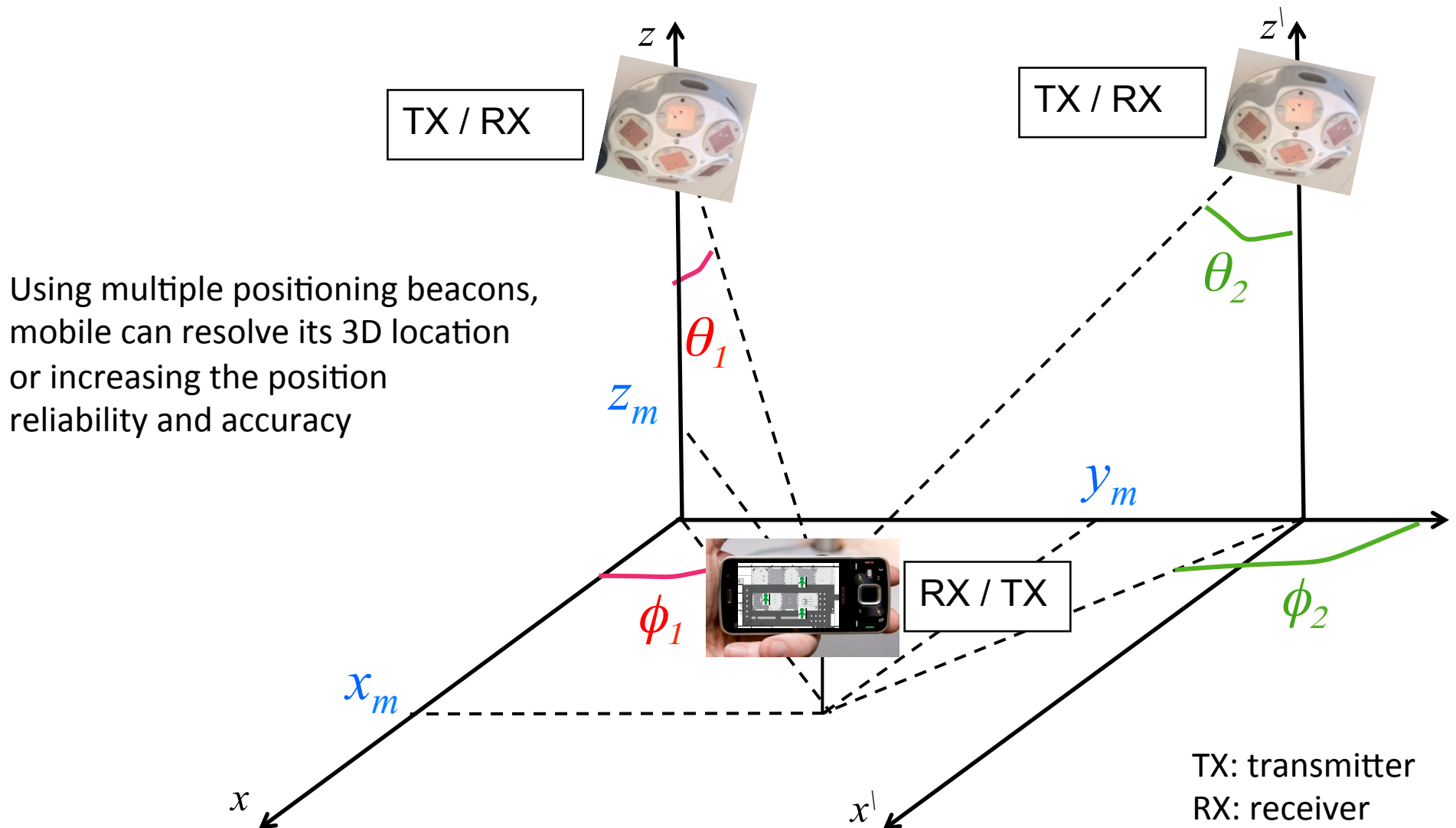


Extendable to 90m

Development chips by Jan, many by spring

Tools – Nokia HAIP

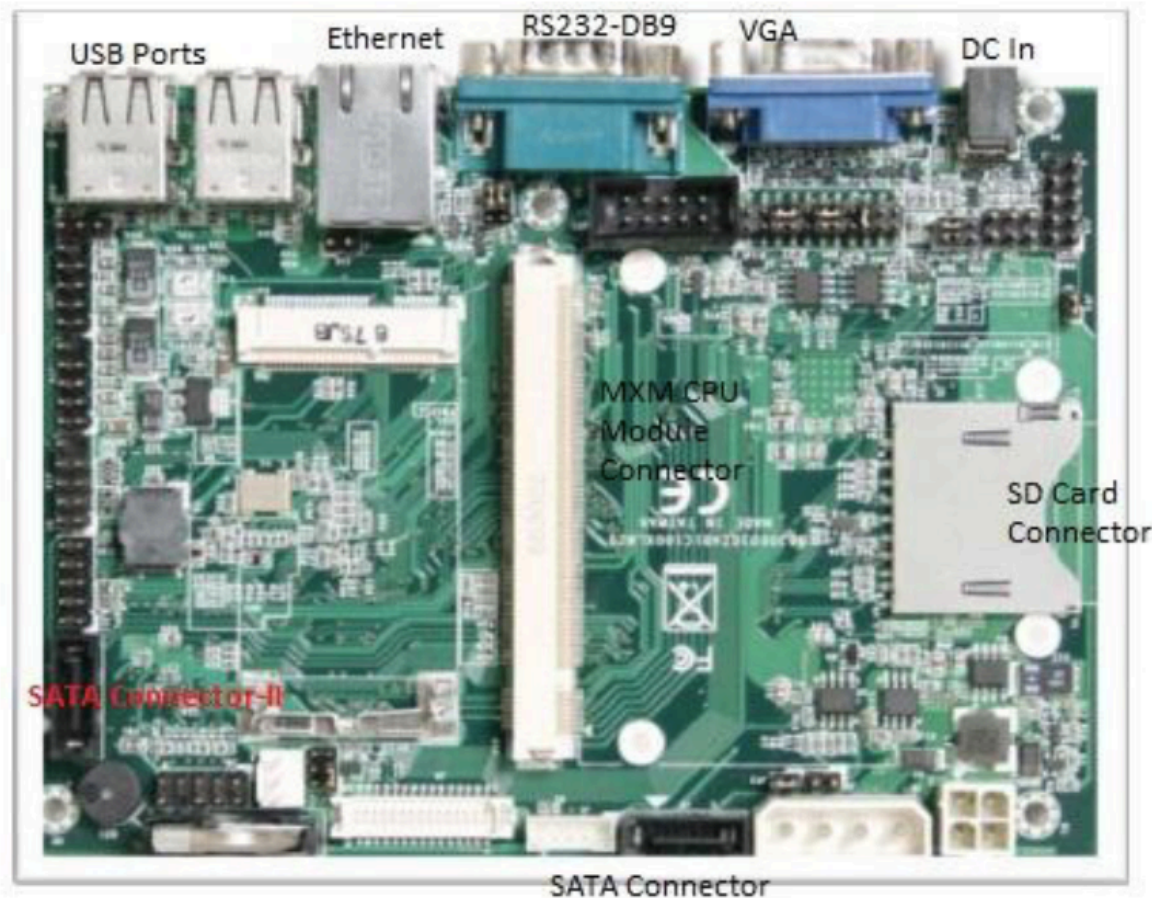
Localization Principle with Multiple Positioning Beacons



- Offers high accuracy; e.g. up to 1m in open indoor areas and 0.3m in office space

Tools – The Intel Atom

- We have many types of Atom board available
 - Standard, dual core, Stellarton (w. embedded FPGA)
 - Great for embedding net-connected processing
 - Above μ C, below Core PC



"Tunnel Creek" Board

Literature... Read for Next Class

- Till Ballendat, Nicolai Marquardt, and Saul Greenberg. 2010. Proxemic interaction: designing for a proximity and orientation-aware environment. In ACM International Conference on Interactive Tabletops and Surfaces (ITS '10). ACM, New York, NY, USA, 121-130.
- Saul Greenberg, Nicolai Marquardt, Till Ballendat, Rob Diaz-Marino, and Miaosen Wang. 2011. Proxemic interactions: the new ubicomp?. *interactions* 18, 1 (January 2011), 42-50.
- Jeffrey Hightower and Gaetano Borriello. 2001. Location Systems for Ubiquitous Computing. *Computer* 34, 8 (August 2001), 57-66.
- Smailagic, A, Kogan, D. (2002) Location sensing and privacy in a context-aware computing environment. *Wireless Communications*
- Hazas et al. (2004) Location-aware computing comes of age. *Computer* Vol. 37
- Schmidt, A, Beigl, M, Gellersen, H W. (1999) There is more to context than location. *Computers & Graphics*
- Cynthia A. Patterson, Richard R. Muntz, Cherri M. Pancake, "Challenges in Location-Aware Computing," *IEEE Pervasive Computing*, vol. 2, no. 2, pp. 80-89, Apr.-June 2003.
- John Krumm, "A survey of computational location privacy," *Springer Personal and Ubiquitous Computing*, Vol. 13, No. 6, August 2009, pp. 391-399.