# Multimodal Localization as the Key for Ambient Intelligent Applications

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# Ambient Intelligence

"Ambient Intelligence (AmI) is a vision of how ICTs will shape our future. It depicts a world of seamless intelligent environments, designed to understand and adapt to the presence of people and free them from manual control of their surroundings"

(Gunnarsdóttir and Arribas-Ayllon, 2011)

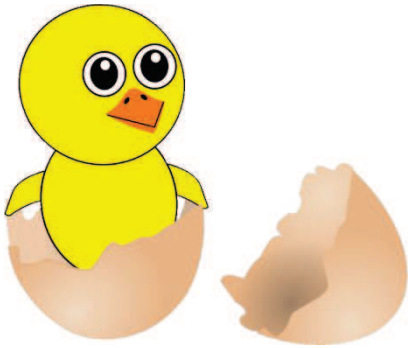
# Ambient Intelligence

1998
From Devices to ‘Ambient Intelligence’:
The Transformation of Consumer Electronics
(Zelkha and Epstein, 1998, Philips).

1999
The AmI vision drove the Europeans view on electronics research, engineering and materials sience.

2003
ISTAG, FP6

# Ambient Intelligence



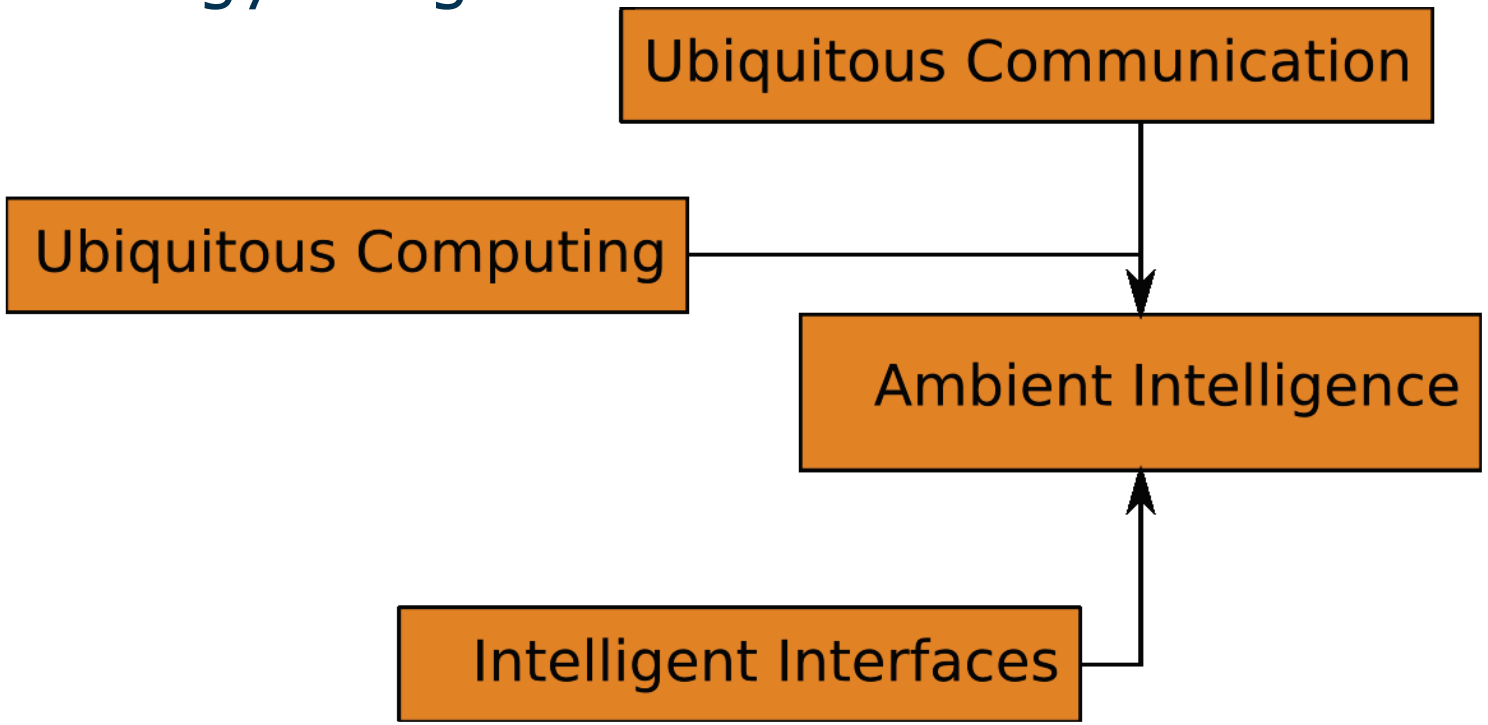
## Now?

"We would expect to be witnessing the emergence of enduring principles and of a growing body of research findings and solved challenges.
Instead, much of the research effort still seems to be devoted to the creation, very often from scratch, of technologies and systems for enabling the scenarios described in the AmI vision"

(José et al, 2010)

# Ambient Intelligence started out as...

A technology integrator



# Ambient Intelligence started out as...

- *"The AmI vision was originally one of maximizing the potential of consumer electronics, telecommunications, materials science and computing, to support 'people and objects to interact with their environment in a seamless, trustworthy, and natural manner"*

  (Aarts and de Ruyter, 2009)

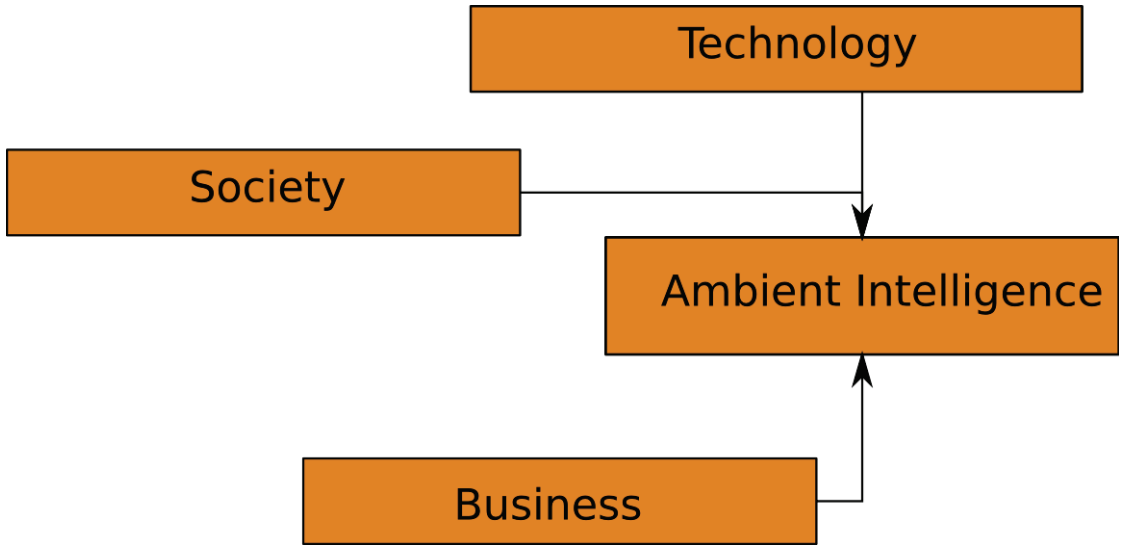
- *Laid-back* rather than *lean-forward* mode

- "Computing should 'move from an *explicit, instructional model* to an *implicit, anticipatory one*' with context aware, personalized, adaptive and anticipatory machine intelligence

  (Gunnarsdóttir and Arribas-Ayllon, 2011)

# Ambient Intelligence is moving towards becoming...

## An innovation framework



# Ambient Intelligence and Responsibility

The Telegraph

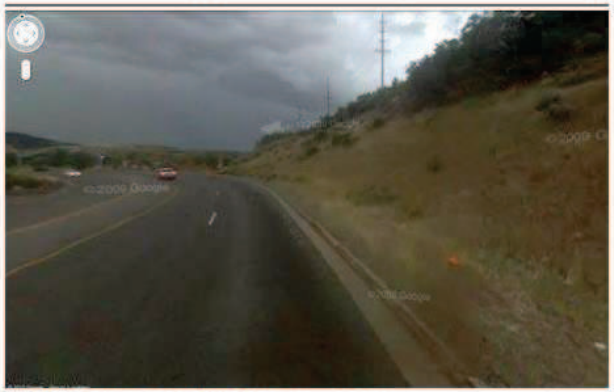
HOME NEWS WORLD SPORT FINANCE COMMENT BLOGS CULTURE TRAVEL LIFE FASHIO

Technology News | Technology Companies | Technology Reviews | Video Games | Technology Video

HOME » TECHNOLOGY » GOOGLE

## Lauren Rosenberg: US woman sues Google 'after Maps directions caused accident'

An American woman, Lauren Rosenberg, is suing Google, the search engine giant, because she was hit by a car after following its "safe" online mapping service.



Deer Valley Drive as seen on Google Maps Photo: GOOGLE

By Andrew Hough
8:15AM BST 02 Jun 2010

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The Los Angeles-based woman, who is in her mid 20s, is claiming damages from the internet giant because she was injured while taking a "safe" route recommended by Google Maps.

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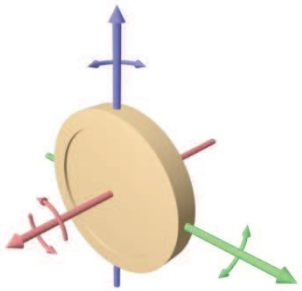
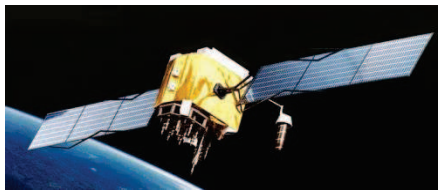
# Localization

**localization** - a determination of the place where something is; "he got a good fix on the target"

- *Princeton University, Farlex Inc*

# Localization Technologies





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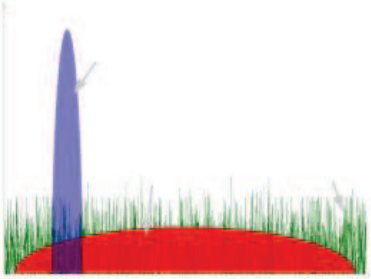
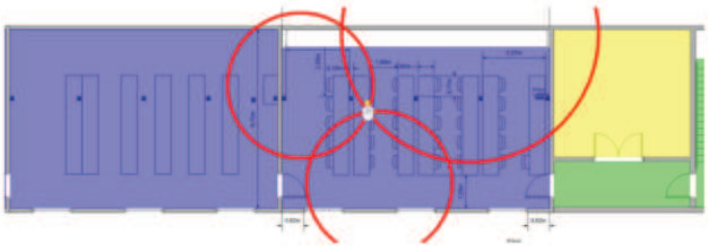
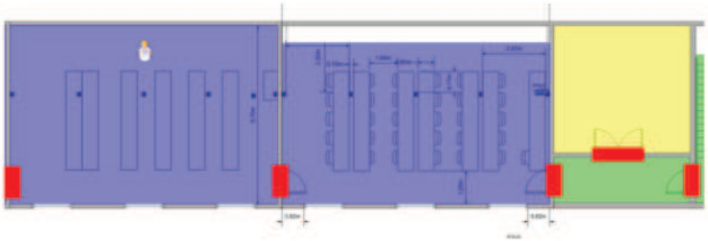


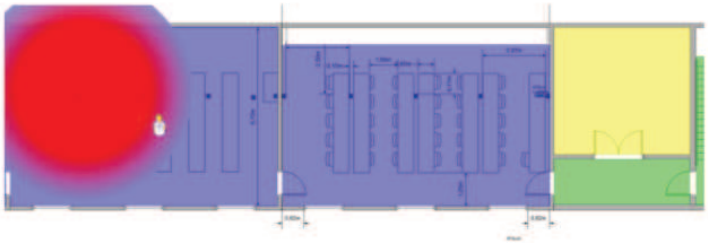
# Localization Techniques



Full Locating (Coordinates)



Chokepoints (Zones)



Presence / Proximity

# Localization Techniques

- Triangulation
  - Multi-lateration
    - Time of Flight (ToF)
    - Time of Arrival (ToA)
    - Time Difference of Arrival (TDoA)
    - Round Trip Time (RTT)
    - Attenuation
  - Angulation
- Proximity
- Scene Analysis
  - Image Analysis
  - RF Pattern Matching

Accurate Clocks
Line of Sight
Synchronization

Path loss
Obstacles

Fingerprinting
Environmental
Changes

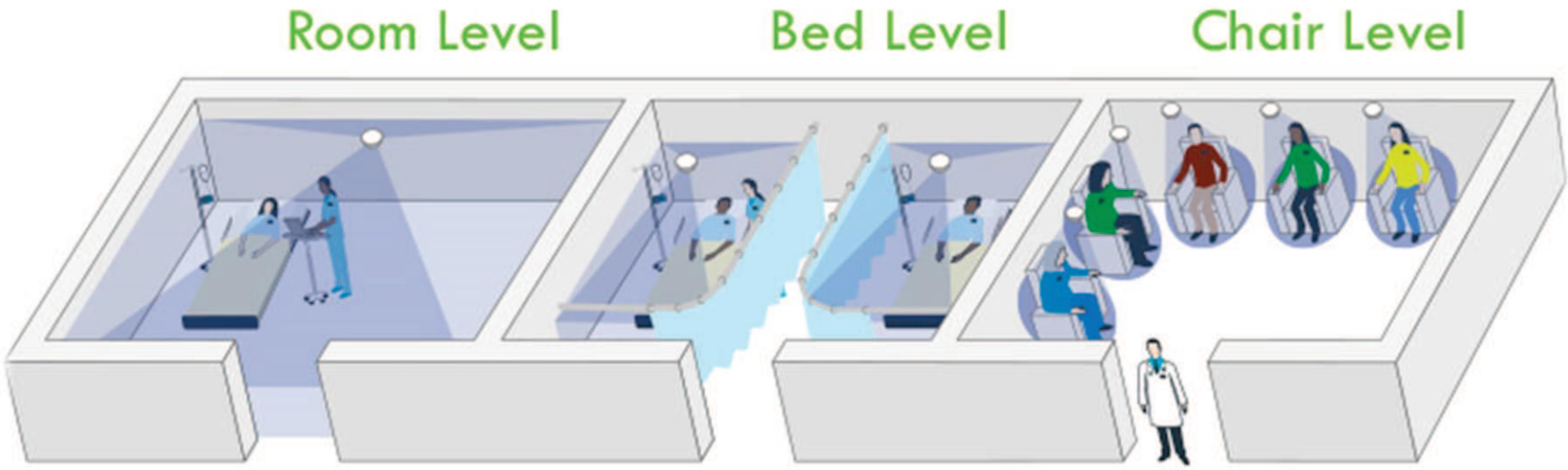
# Scenario

Ellen returns home after a long day's work. At the front door she is recognized by an intelligent surveillance camera, the door alarm is switched off, and the door unlocks and opens. When she enters the hall the house map indicates that her husband Peter is at an art fair in Paris, and that her daughter Charlotte is in the children's playroom, where she is playing with an interactive screen. The remote children surveillance service is notified that she is at home, and subsequently the on-line connection is switched off. When she enters the kitchen the family memo frame lights up to indicate that there are new messages. The shopping list that has been composed needs confirmation before it is sent to the supermarket for delivery. There is also a message notifying that the home information system has found new information on the semantic Web about economic holiday cottages with sea sight in Spain. She briefly connects to the playroom to say hello to Charlotte, and her video picture automatically appears on the flat screen that is currently used by Charlotte. Next, she connects to Peter at the art fair in Paris. He shows her through his contact lens camera some of the sculptures he intends to buy, and she confirms his choice. In the mean time she selects one of the displayed menus that indicate what can be prepared with the food that is currently available from the pantry and the refrigerator. Next, she switches to the video on demand channel to watch the latest news program. Through the 'follow me' she switches over to the flat screen in the bedroom where she is going to have her personalized workout session. Later that evening, after Peter has returned home, they are chatting with a friend in the living room with their personalized ambient lighting switched on. They watch the virtual presenter that informs them about the programs and the information that have been recorded by the home storage server earlier that day.

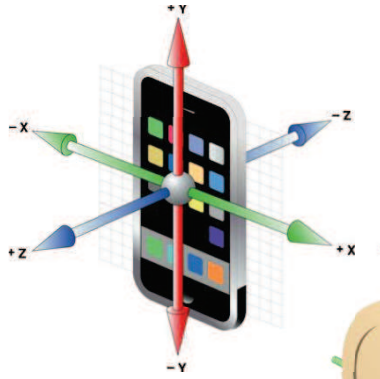
# Scenario

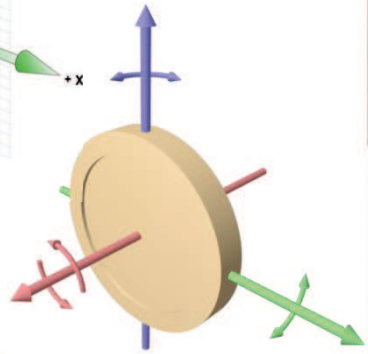
Ellen returns **home** after a long day's work. **At the front door** she is recognized by an intelligent surveillance camera, the door alarm is switched off, and the door unlocks and opens. When she **enters the hall** the house map indicates that her husband Peter is at an art fair in **Paris**, and that her daughter Charlotte is in the **children's playroom**, where she is playing with an interactive screen. The remote children surveillance service is notified that she is **at home**, and subsequently the on-line connection is switched off. When she **enters the kitchen** the family memo frame lights up to indicate that there are new messages. The shopping list that has been composed needs confirmation before it is sent to the supermarket for delivery. There is also a message notifying that the home information system has found new information on the semantic Web about economic holiday cottages with sea sight in Spain. She briefly connects to the playroom to say hello to **Charlotte**, and her video picture automatically appears on the flat screen that is **currently used** by Charlotte. Next, she connects to Peter at the art fair in Paris. He shows her through his contact lens camera some of the sculptures he intends to buy, and she confirms his choice. In the mean time she selects one of the displayed menus that indicate what can be prepared with the food that is currently available from the pantry and the refrigerator. Next, she switches to the video on demand channel to watch the latest news program. Through the 'follow me' she switches over to the flat screen in the bedroom where she is going to have her personalized workout session. Later that evening, after Peter has **returned home**, they are **chatting with a friend in the living room** with their personalized ambient lighting switched on. They watch the virtual presenter that informs them about the programs and the information that have been recorded by the home storage server earlier that day.

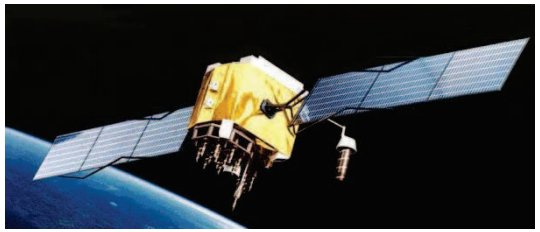
# Accuracy?




Source: Versus Technology, Inc.





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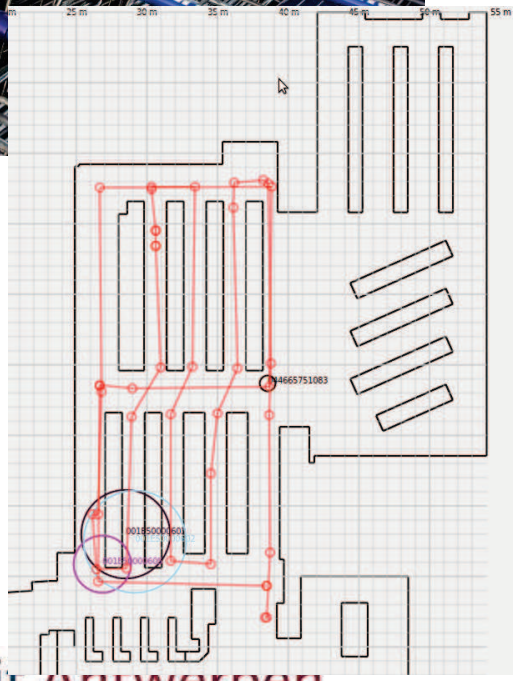
# “Just Enough” Localization



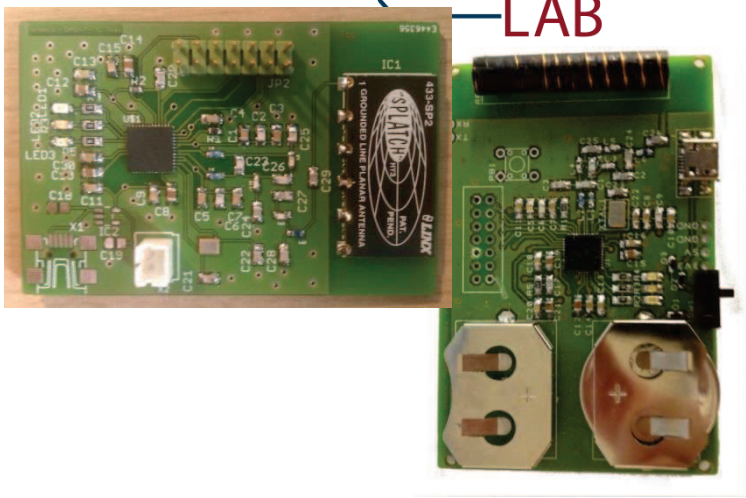
# Market Driven

- One technology to rule them all?
- Multi-modality to rule them all!

DASH7 ALLIANCE

433 Mhz

CoSys LAB



# Market Driven Research

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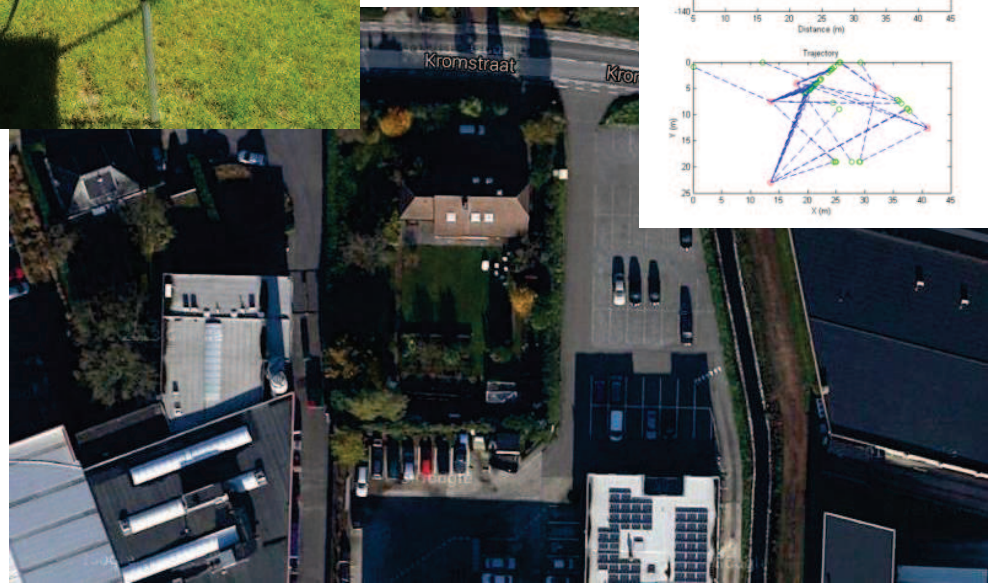
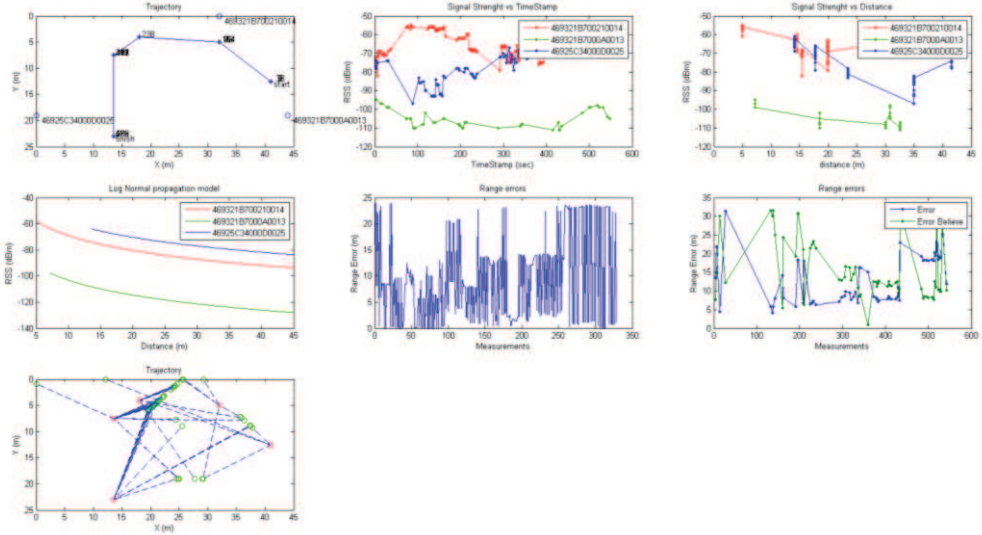
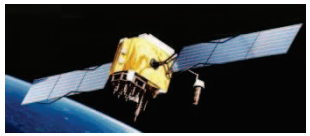


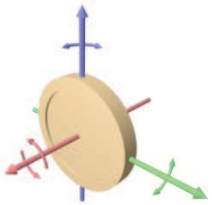



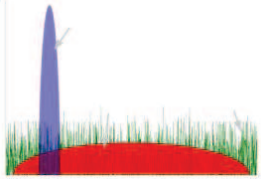
# AmI Student Projects

- https://www.youtube.com/watch?v=oZEcFYYPLkQ
- http://www.youtube.com/watch?v=8Zk499VtEa0
- http://www.youtube.com/watch?v=6GOJ_0Vt2u4&feature=youtube_gdata_player

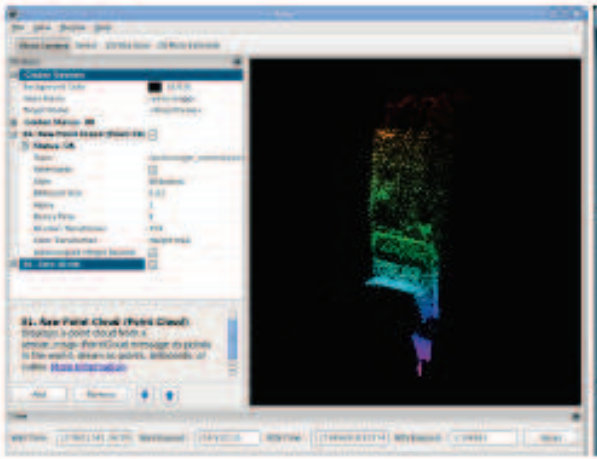
# Localization

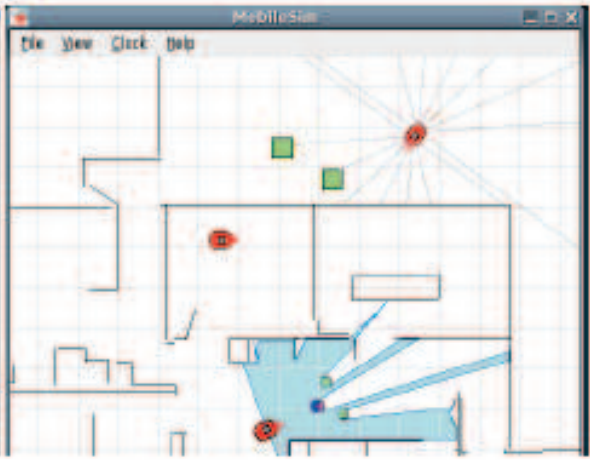




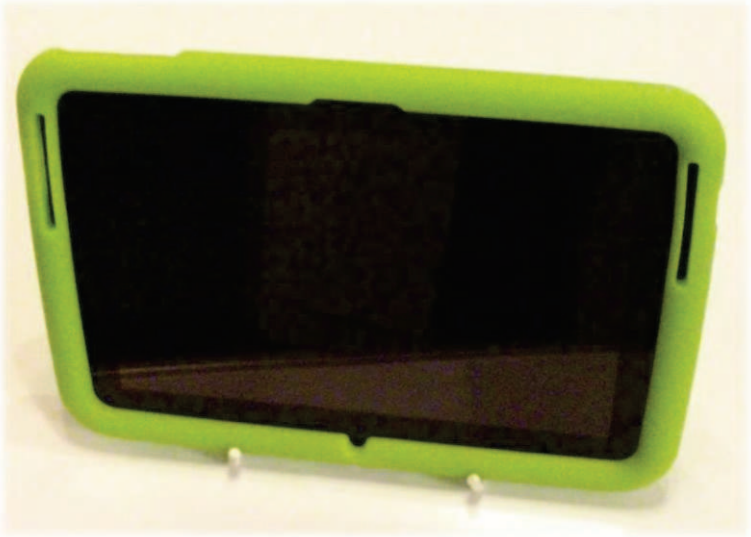


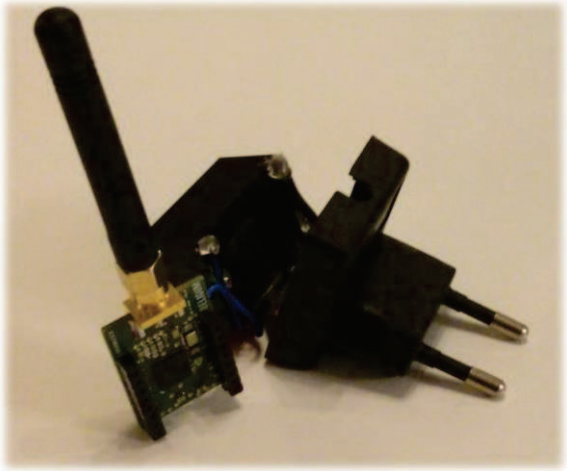
# Realistic Localization Benchmarking



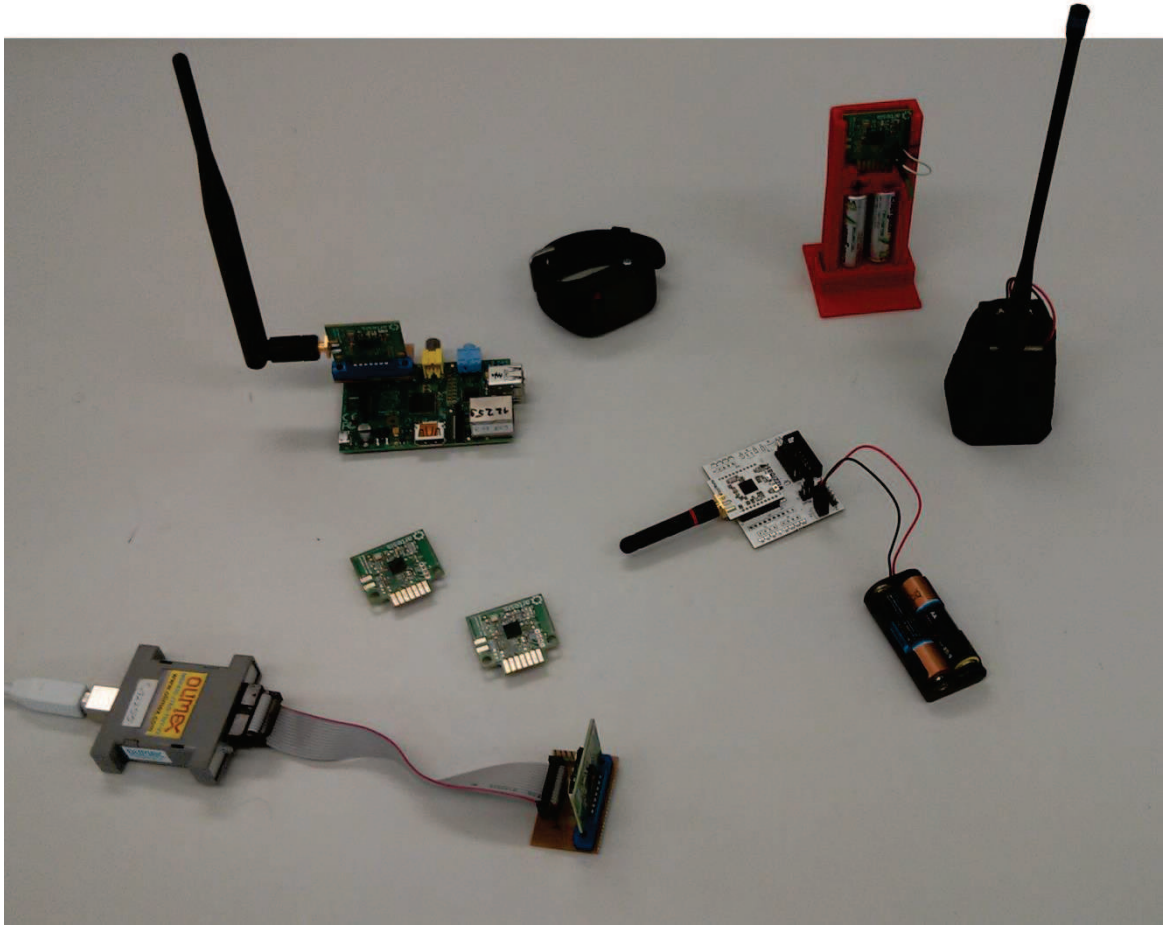


# Guided Tours

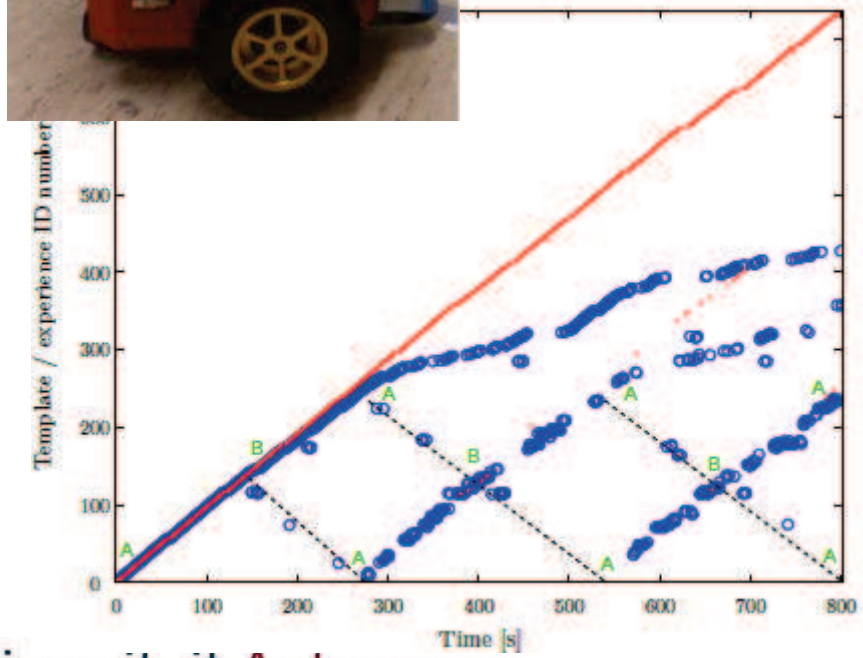




# Dash 7 Localization



# RF Based RatSlam



Multimodal Localization as the Key for Ambient Intelligent Applications

*"Location information will become as indispensable as time information!"*