MetroSense Project:

People-Centric Sensing at Scale

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Focus of Sensor Network Research

- Industrial, structural, environmental monitoring systems, military systems, etc.

Characteristics of Existing Systems

- Small-scale, short-lived, mostly-static

- Application-specific

- Wireless multi-hop for data transport

- Very energy-constrained

- Mobility is not a driving factor

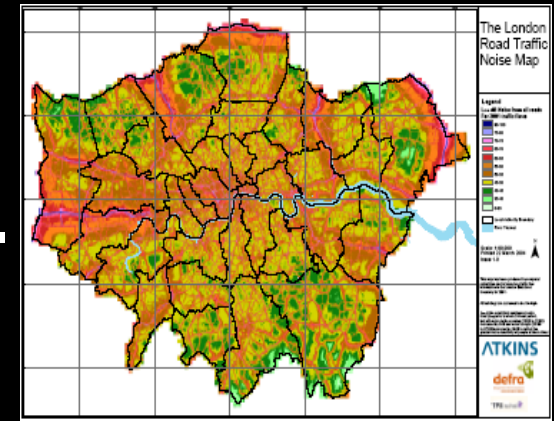- People out of the loop

Sensor networks at a cross roads?

They don't impact our everyday lives, why?

New frontier for sensing.

People-centric, mobility counts, scale matters.

Large Scale Sensing Apps...

- Noise mapping
  - http://www.noisemapping.org/
- Emotion mapping
  - http://biomapping.net
- Congestion charging
  - http://www.cclondon.com/

London Noise Map

Downing Street Noise Map

Emotion Maps of London

Congestion Map London

People-Centric Sensing Apps.

- Heath care applications
  - Emergency care (CodeBlue), assisted living (AlarmNet)

http://www.eecs.harvard.edu/~mdw/proj/codeblue

- Recreational applications
  - Running (Nike+iPod), dancing (interactive dance ensembles)

- Urban gaming
  - http://www.comeoutandplay.org/index.php

What is MetroSense?

Architecture for large-scale sensing focused on mobile sensor platforms.

Captures the interactions between people, and between people and their surroundings.

Based on three design principles that lead to a low cost, scalable solution for people-centric sensing.

- Network symbiosis
- Asymmetric design
- Localized interactions

Mobile people-centric sensor platforms run apps for their own custodians, and in parallel transparently support "symbiotic sensing" for other system users.

Gains scalability and sensing coverage via mobility, and its adaptive "sphere of interaction".

Goal of the Project is to study and evaluate this "opportunistic sensor networking" paradigm
- does it have legs?

Sensing Coverage using MetroSense
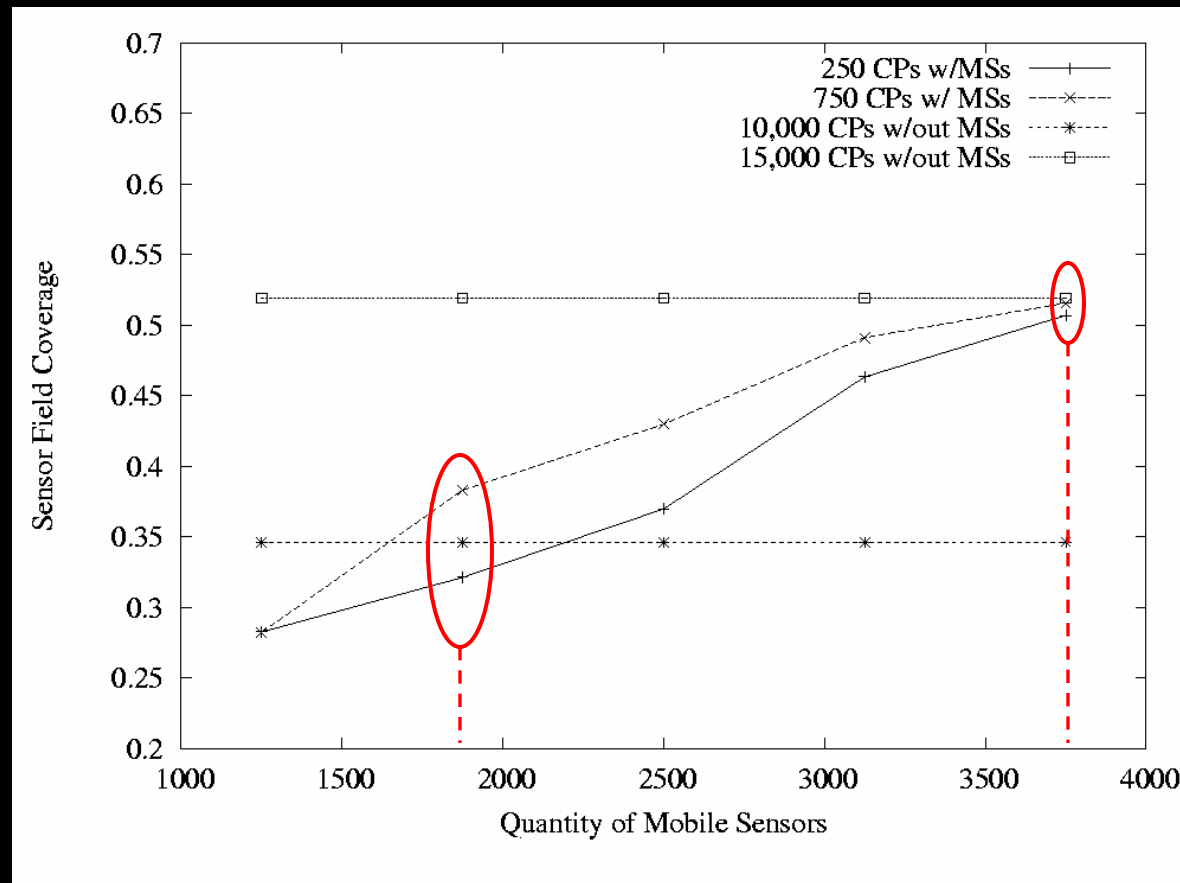
Mobility gives equivalent coverage over time at low cost

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- Security, trust, and privacy important

Large scale sensing perspectives:
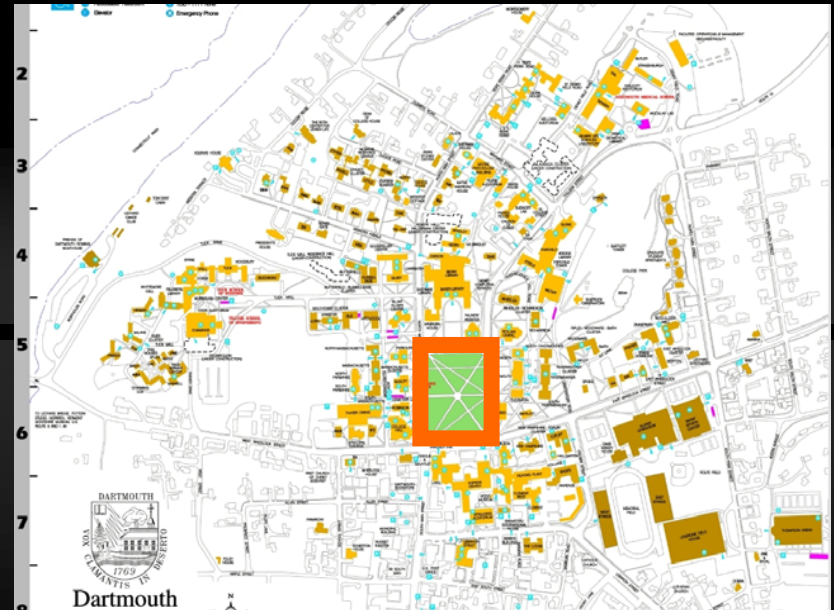
New York City urbanscape (Columbia)

Hanover urbanscape (Dartmouth)

Sensing across a Large Area is Challenging
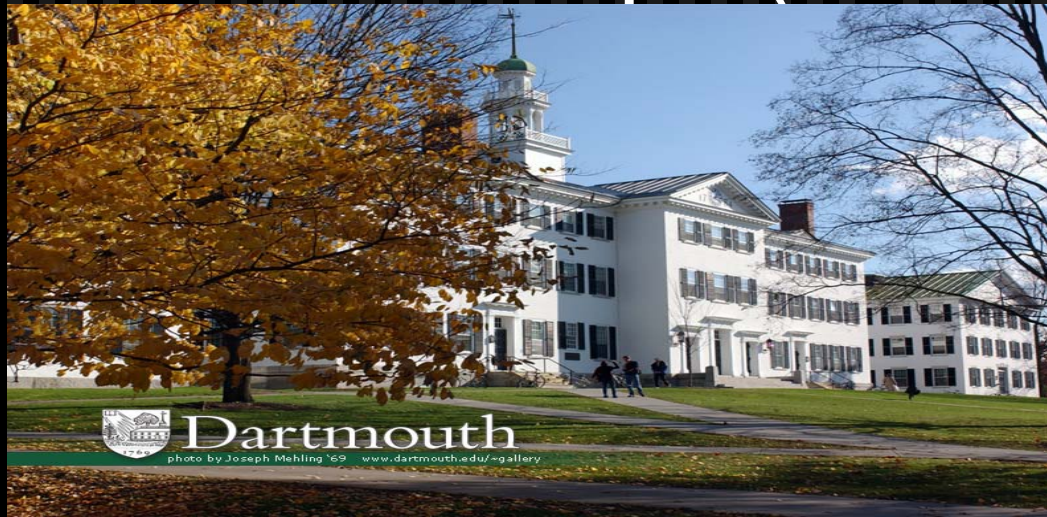
# Sensing across a Large Area is Challenging

- Some simple questions one might ask
  - How many people are sitting, running, walking on the Green?
  - Where is Andrew on the Green?
  - Noise, temperature, allergen distribution across the Green [now, 10AM-10PM, etc.]
  - Others

What is MetroSense? - more details

- ## Physical Infrastructure
  - Sensor Access Points (SAPs) (*symbiosis)
  - Mobile Sensors
  - Static Sensors

- ## Operations
  - Opportunistic Tasking
  - Opportunistic Sensing
  - Opportunistic Collection

- ## Opportunistic Delegation Model

SAP Deployment Map - our target

SAP locations - Aruba APs

WSW'06 at SenSys'06, 10/31/2006
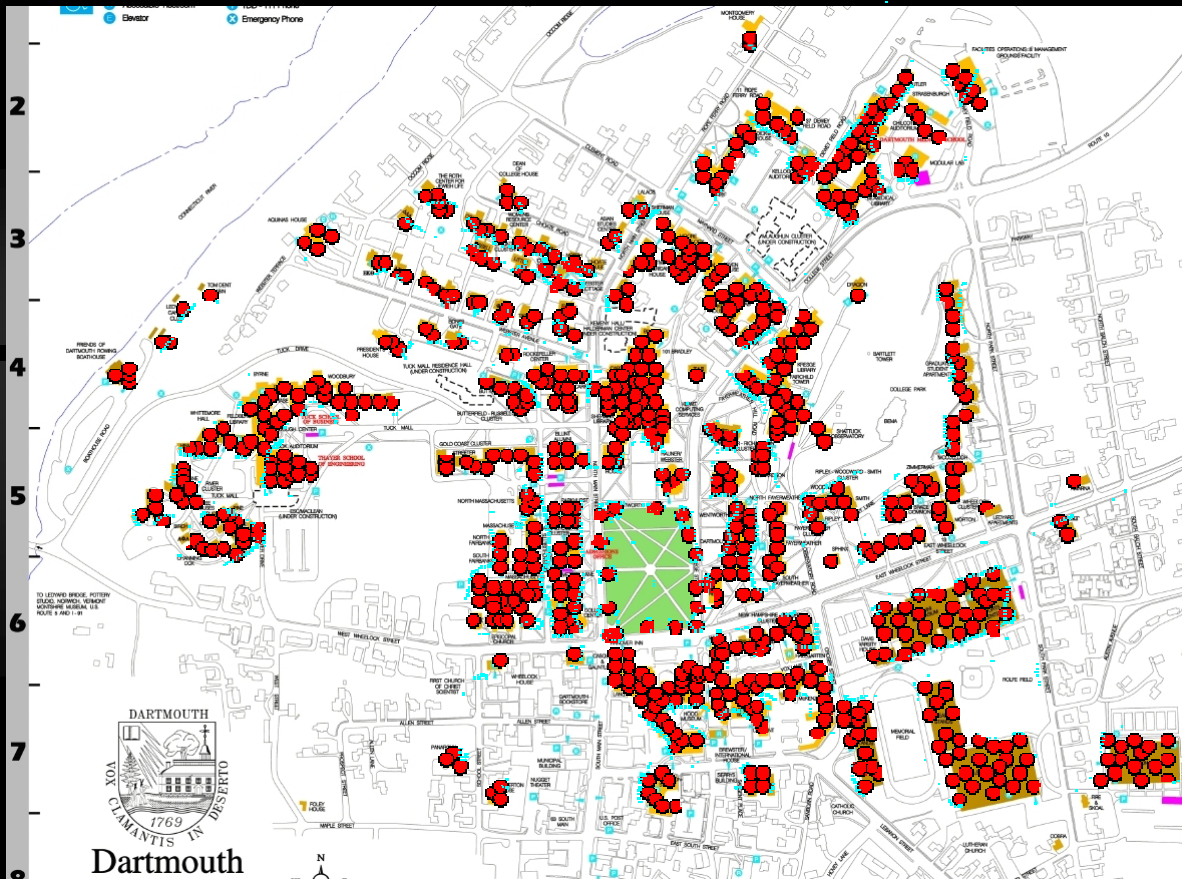
MetroSense Infrastructure

Sensor Access Point (SAP)

People-centric sensing apps

Sensor devices

Dartmouth Pulse

BikeNet
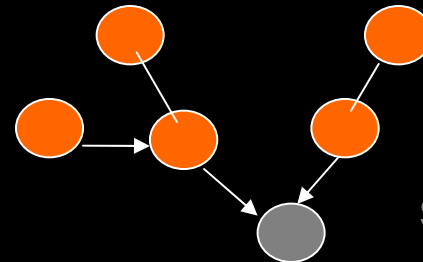
Interacts with static sensor clouds
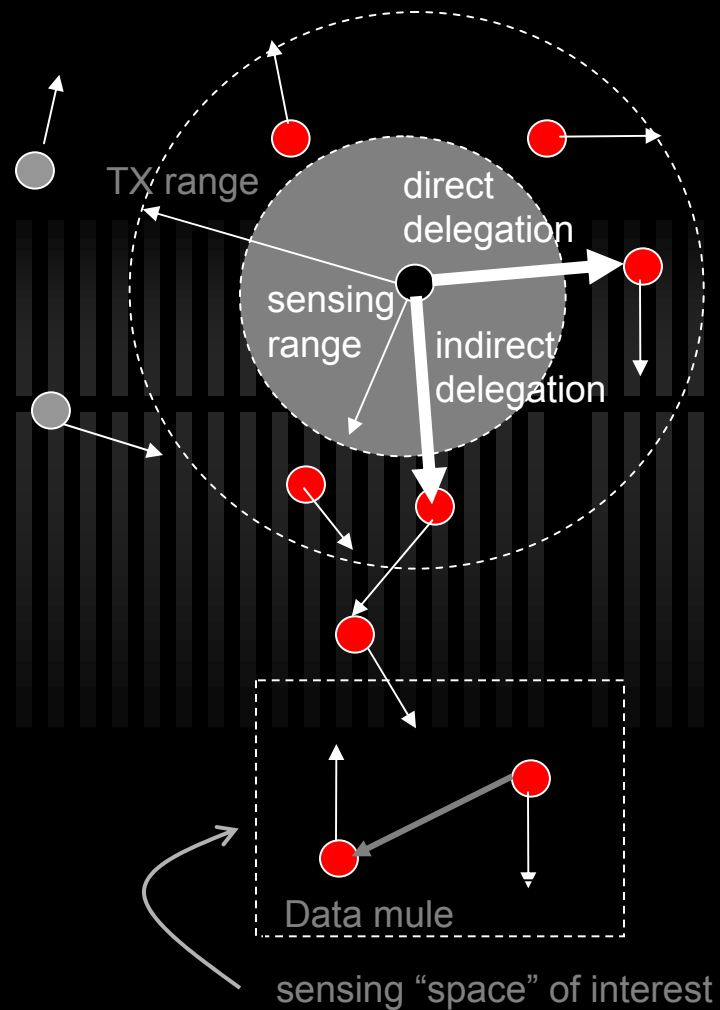
MetroSense Operations

comms & ground-truth sensing

opportunistic tasking

opportunistic sensing

opportunistic collection

limited peering
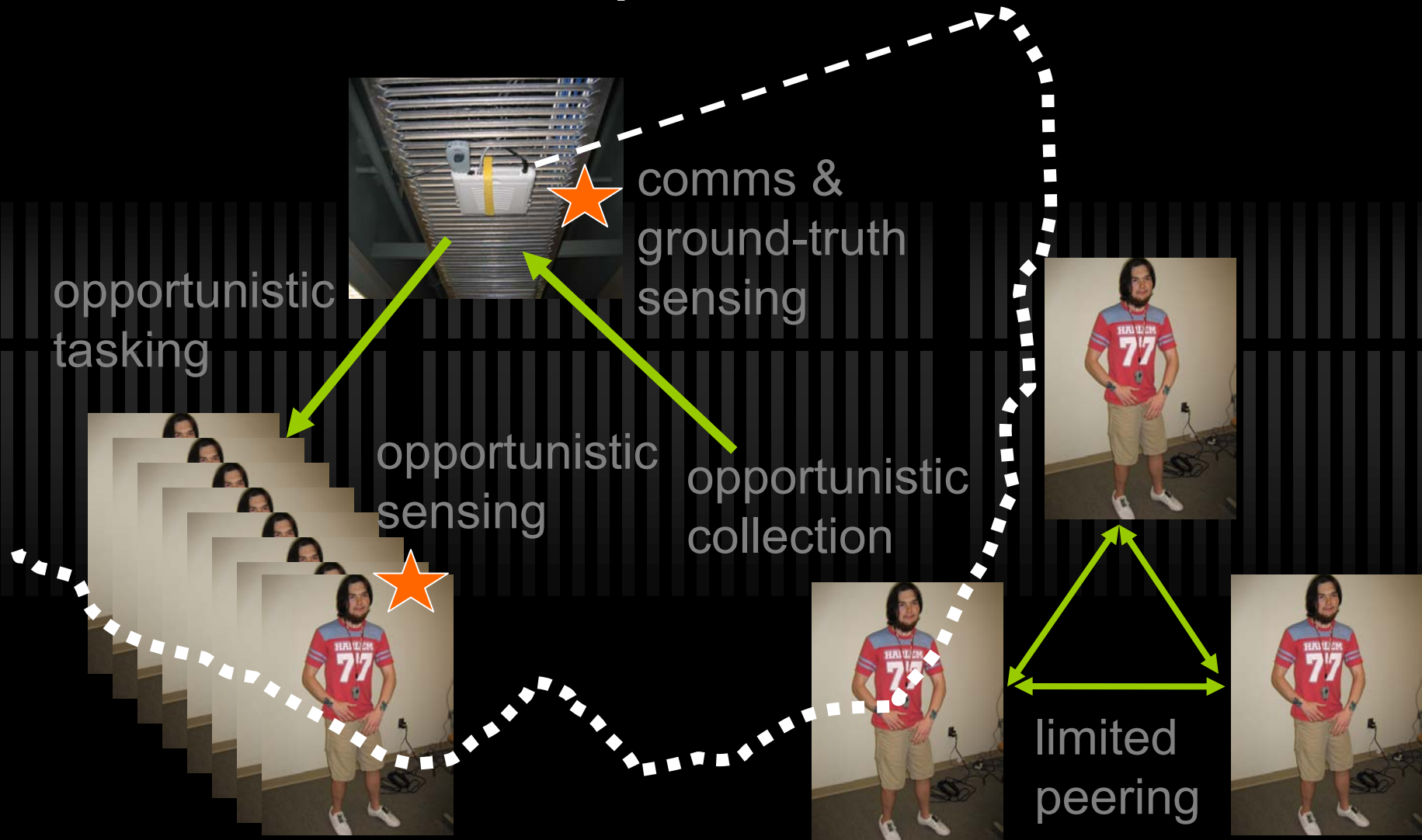
Opportunistic Delegation Model (ODM)

- Goal is to leverage mobility when direct sensing from SAP is not possible
- Application requires sensed modality ß from "space" during [t1, t2]
- SAP delegates "limited" responsibility for "limited" time
- Direct and indirect delegation of roles
  - Sensing, tasking, collection and "data muling"
- Enables new services (ODM Primitives)
  - Virtual sensing range, virtual collection range, virtual static sensor, virtual mobile network
- Design challenges
  - Limited "rendezvous" time
  - Sensor selection challenging

Bikenet Road Warrior
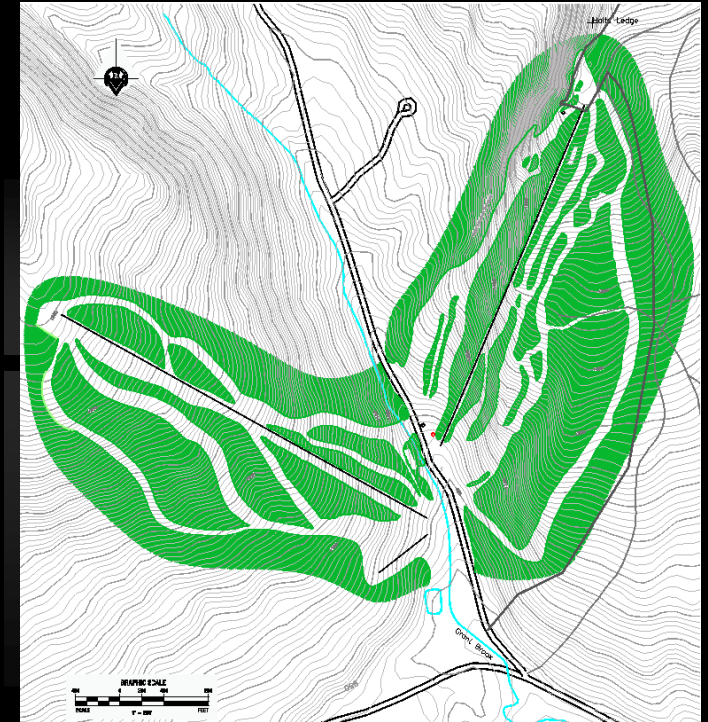

GPS Unit

Measuring terrain slope

Mote broadcasting sync messages from GPS unit

Measuring how fast i kick the ass of inconsiderate motorists

Measuring pedal speed

WSW'06 at SenSys'06, 10/31/2006

Skiscape - @ Dartmouth Skiway

Existing Urban Sensing Initiatives

- Nokia's SensorPlanet
  - http://www.sensorplanet.org/
- CENS Urban Sensing Summit (May 2006)
  - http://bigriver.remap.ucla.edu/remap/index.php/Urban_Sensing_Summit
  - Participatory Urban Sensing
- CitySense (BBN/Harvard)
- MetroSense (Dartmouth/ Columbia)
- Others?

Conclusion

- Next wave in sensor networks is about having "people in the loop"

- Scale and mobility matter and are challenging

- Need a new wireless sensor edge for Internet

- Didn't talk about security, privacy, and trust that are central to this effort

- Early days in this topic

Thanks for listening!

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