Micro-Blog:
Sharing and Querying Content through Mobile Phones and Social Participation

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Context

- Recent years have witnessed the impact of
  - Distributed content sharing (Wikipedia, Blogger)
  - Social networks (Facebook, MySpace)
  - Sensor Networks
  - Wireless connectivity

- Sigificant more impact
  - Latent in their convergence on mobile phone platform

2 Reasons for Convergence
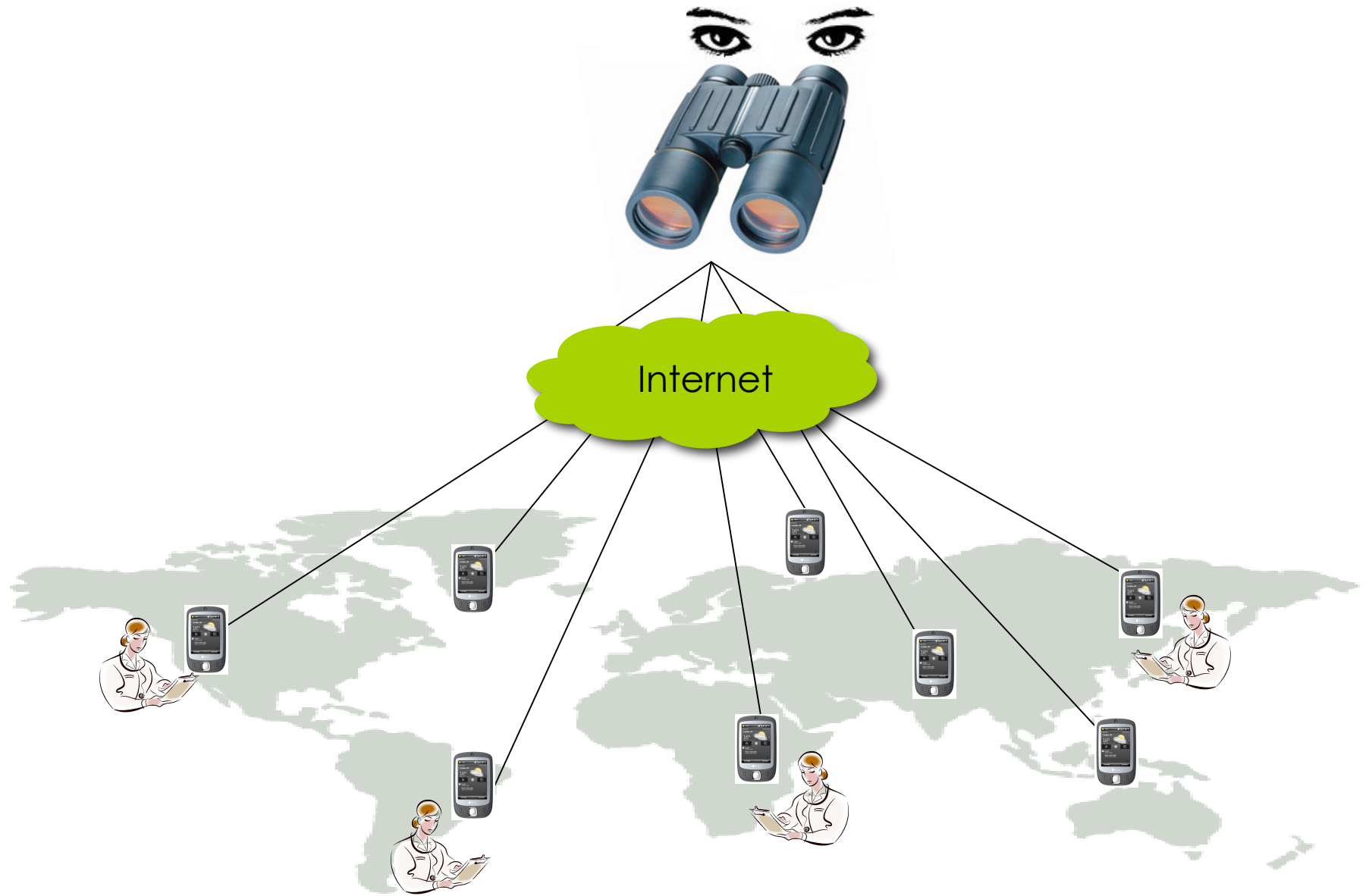
1. Capability
   - Computing and communication
   - Embedded sensing
     - Cameras, microphone, accelerometer, health monitor, compass

2. Density
   - 2.5 billion active phones worldwide
   - Will surpass computer sales
   - Social, cultural acceptance

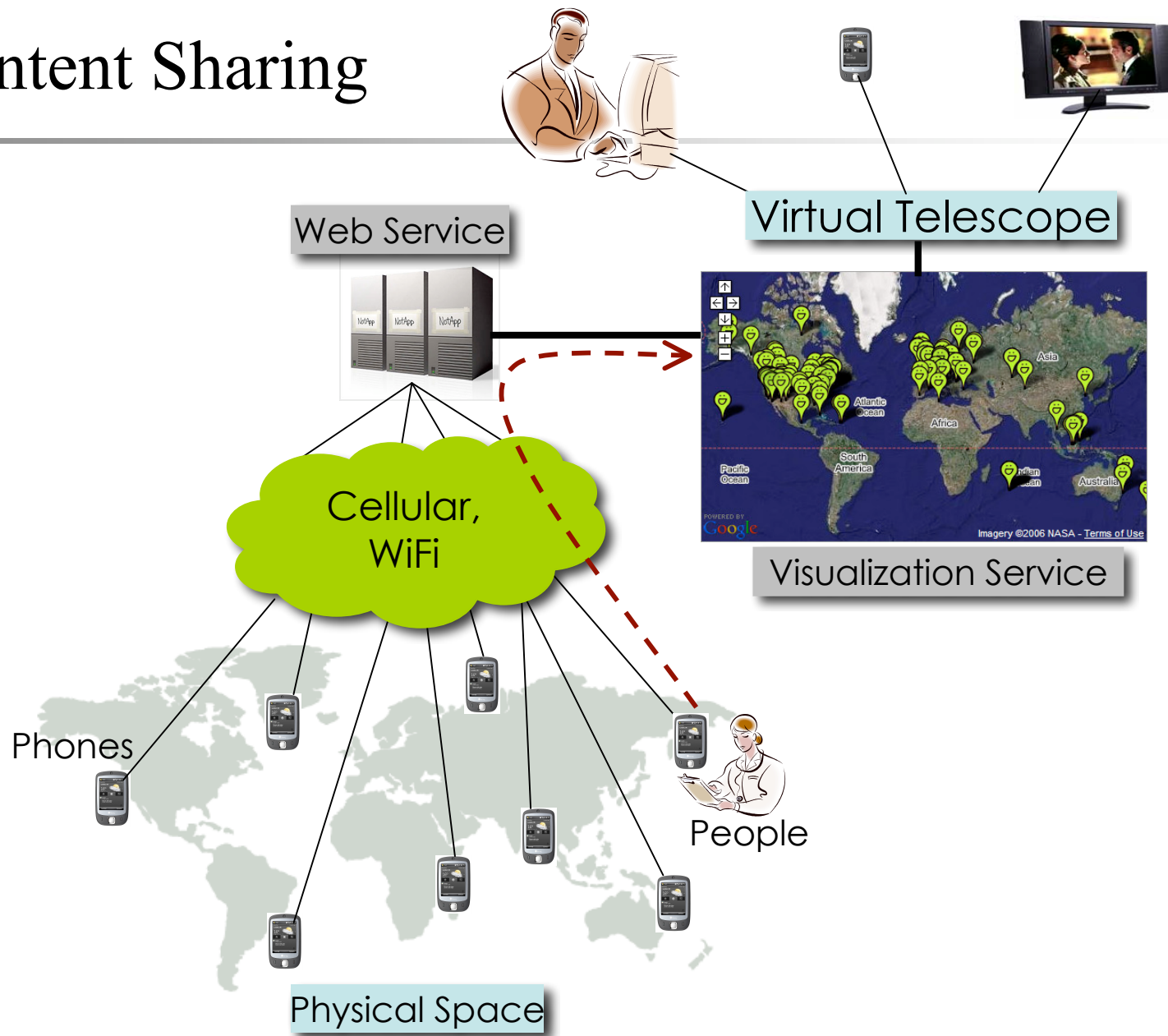# Our Vision

A Virtual Information Telescope

Internet

This Paper

Instantiates this vision through

a system called Micro-Blog

Content Sharing (Step 1 of 3)

- Users encouraged to blog on mobile phones
  - Video, audio, pictures, text, etc.

- Micro-Blog phone client geotags blog
  - Uploads to server over WiFi/GPRS/…

- Micro-Blog server positions blog on Google Maps

- Internet users zoom into maps
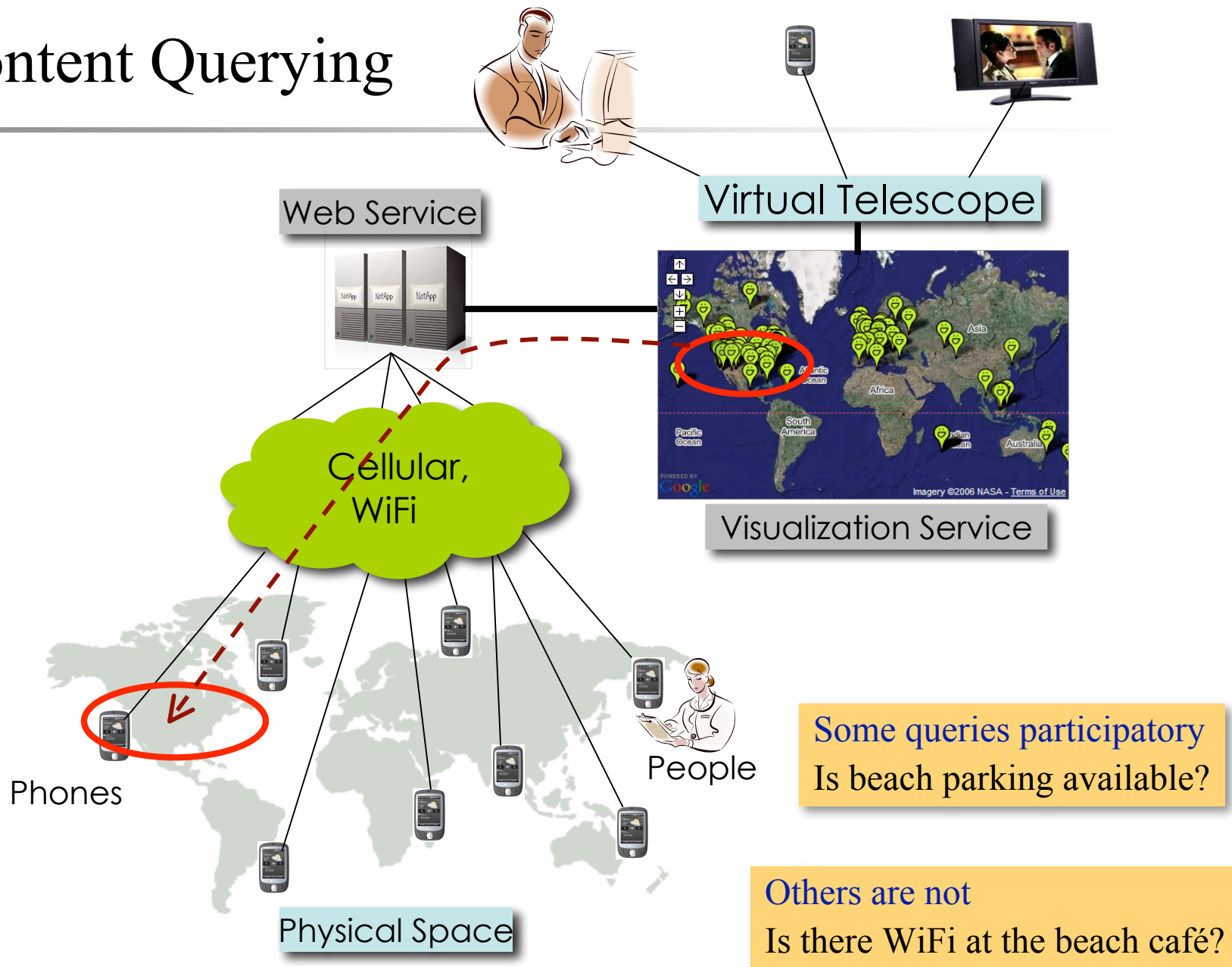 - Witnesses streaming in blogs across the world

Content Sharing

Web Service

Virtual Telescope

Visualization Service

Cellular, WiFi

Phones

People

Physical Space

Content Querying

■ Just browsing content may not be enough

- Querying physical regions can be useful

■ Micro-Blog allows location-specific queries

■ Phones reply to query (incentives necessary)

- Reply posted on Google Map as new microblog

Content Querying

Web Service

Virtual Telescope

Visualization Service

Cellular, WiFi

Phones

People

Physical Space

Some queries participatory
Is beach parking available?

Others are not
Is there WiFi at the beach café?

Content Floating

- Content sharing and querying
  - Is on virtual space (Google Maps)

- Content can be superimposed on physical space too
  - User X creates microblog about restaurant food
  - "Floats" microblog at the restaurant
  - User Y arrives at restaurant
  - X's microblog downloaded onto Y's phone
  - Y can modify content, and "re-float"

- Metaphorically
  - Virtual "sticky notes" floating in air

Floating in Physical Space
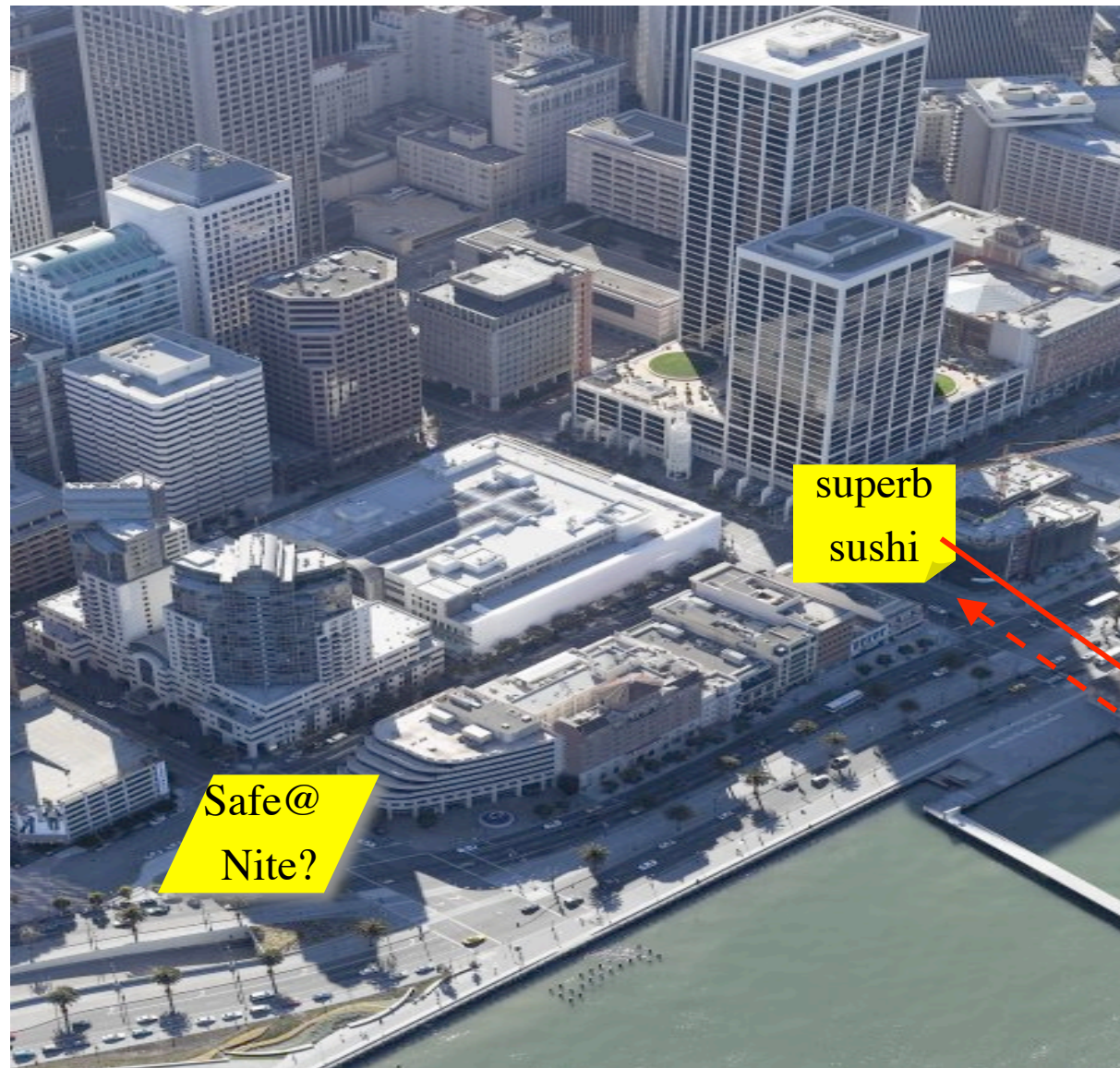
If designed carefully, a variety of
applications may emerge on Micro-Blog

Applications

- **Tourism**
  - View multimedia blogs … query for specifics

- **Micro Reporters**
  - News service with feeds from individuals

- **On-the-fly Ride Sharing**
  - Ride givers advertize intension w/ space-time sticky notes
  - Respond to sticky notes once you arrive there
  - Negotiate deal on third party server

- **Virtual order on physical disorder**
  - Land in a new place, and get step by step information on your mobile
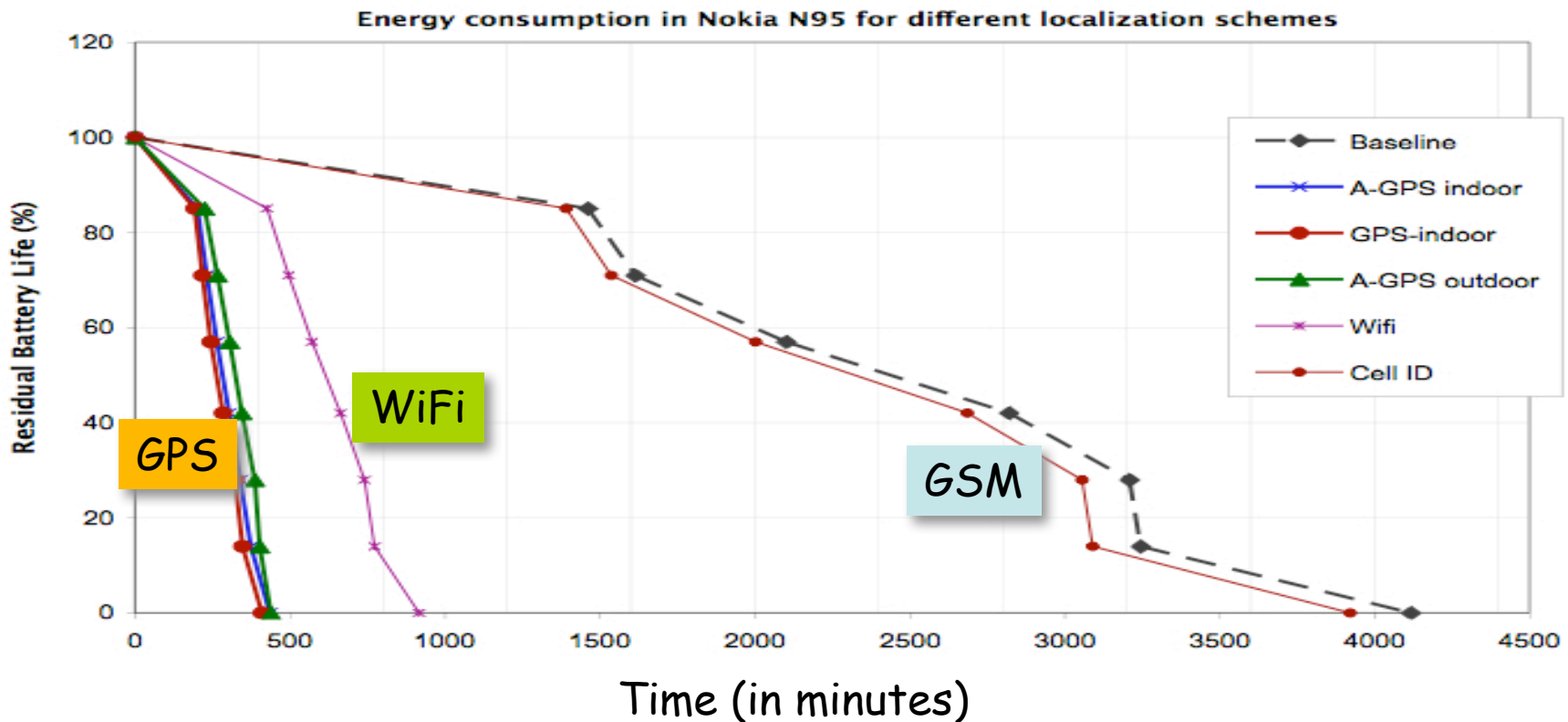
So far, so good.

But where exactly is the research here ???!!**

(1) Energy-Accuracy Tradeoff

- **Continuous GPS major energy sink**   (8 hours batterylife)
  - WiFi, GSM localization improves energy (16, 40 hours)
  - Degrades localization accuracy   (40, 500m)

Energy consumption in Nokia N95 for different localization schemes

Energy-Efficient Localization

- Can we multiplex between localization: GPS/WiFi/GSM
    - To achieve better tradeoff
    - To adapt to application needs

# Multi-Mode Localization

■ Basic Idea

- Perform WiFi sampling by default

- When no macro movement (no WiFi changes)
  - Sample GPS location (say at t_0)

- When movement, trigger infrequent WiFi: $t_i, t_{i+1}, t_{i+2} \ldots$

- Location at t_i is extrapolation from last GPS location at t_0
  - Along the direction of new WiFi location at t_i

$$L_{w+g}(t_i) = L_g(t_0) + i \times v_{est}$$

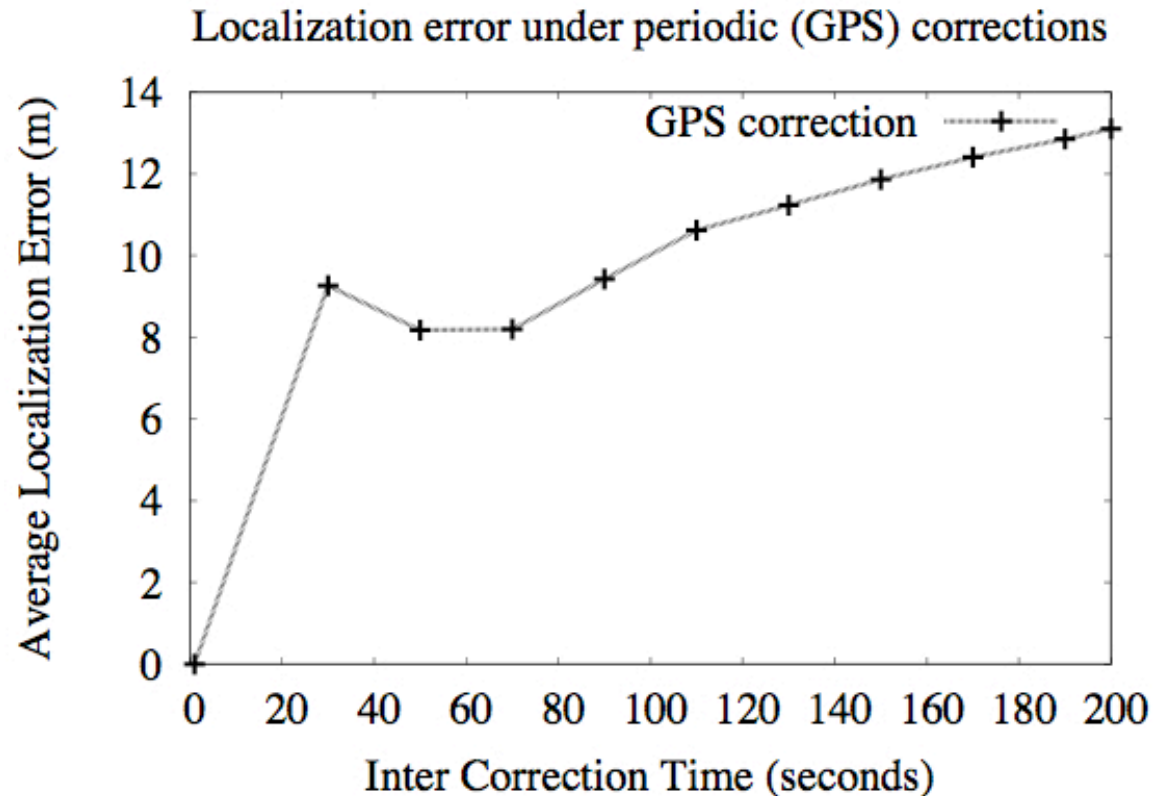 - Once displacement more than threshold, take new GPS reading

Example (w.l.o.g)

- Expected error computed for interpolated path
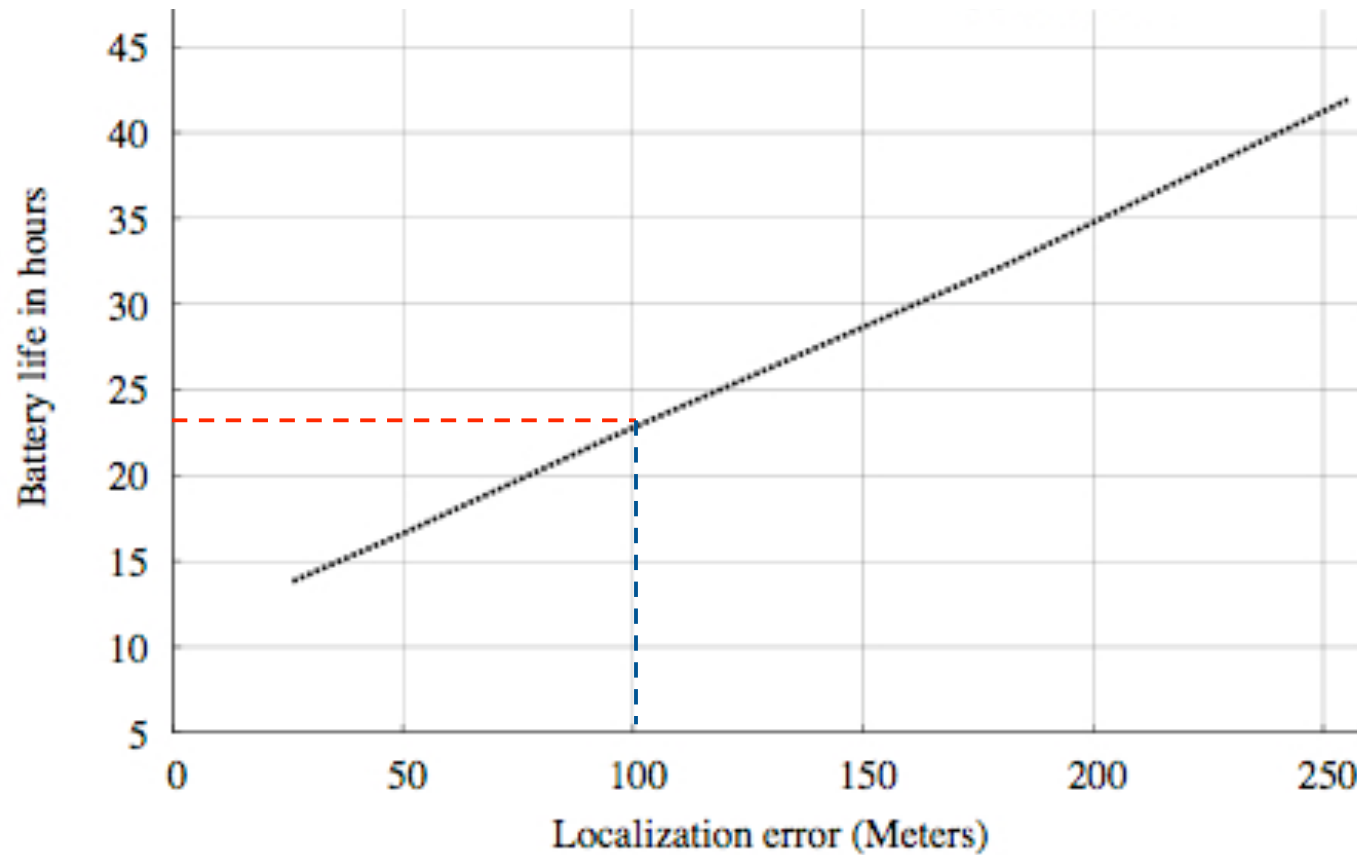 - Simulations based on real mobility traces
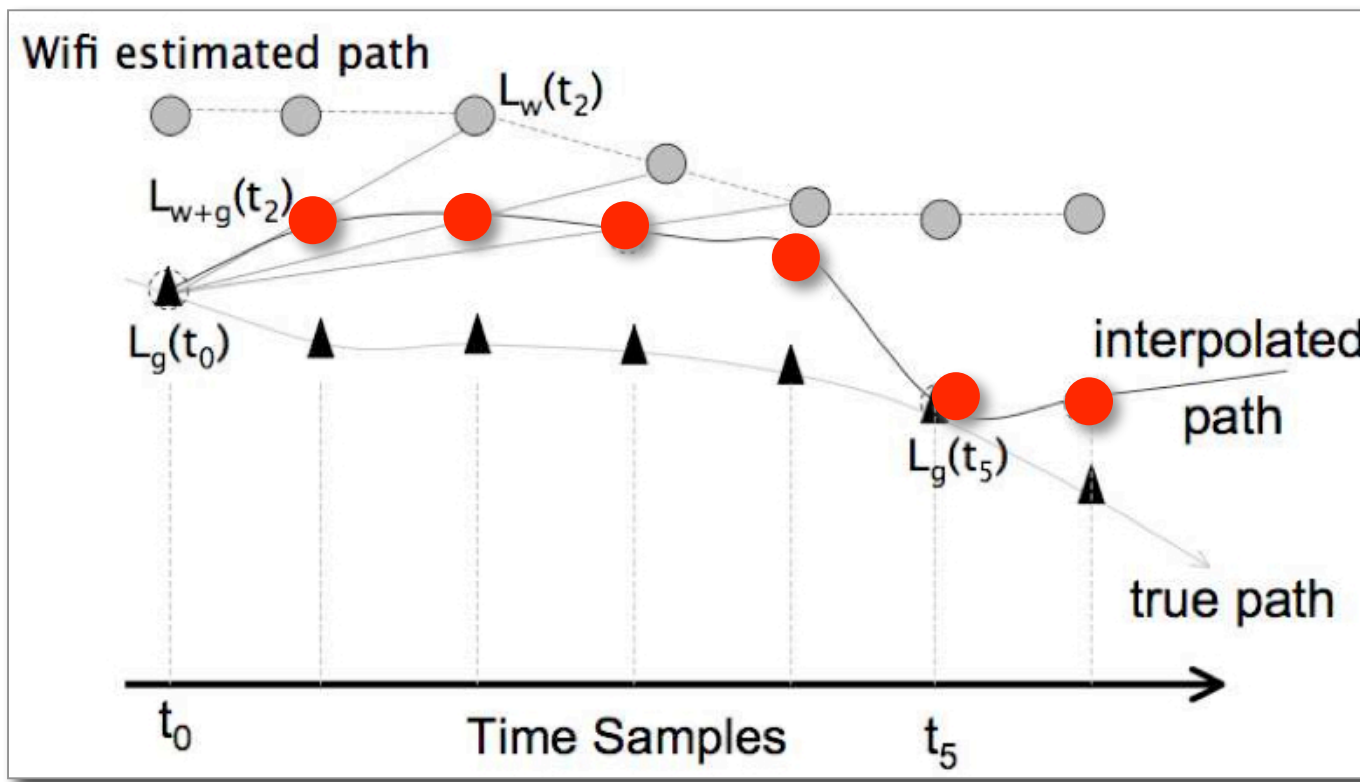
GPS Frequency

■ More GPS samples offer diminishing returns

  ▪ But energy cost increases linearly

  ▪ Opportunity for tradeoff

Localization error under periodic (GPS) corrections

Buy Accuracy with Energy

Better performance, more flexibility

Optimality

- **Multi-mode interpolation a heuristic**
  - Parameters need to be chosen carefully

- **Ongoing work**
  - Optimal localization accuracy for given energy budget
    - Derive bounds

  - Exploit human mobility/activity profiles for prediction
    - Leverage distributions in human pause times
    - Exploit accelerometers to identify activity

Mobisys poster …

(2) Incentives

- No incentives to reply to queries
  - Loss of battery, distraction, spam

- Potential Approaches
  1. Queries restricted to social networks
  2. Queries associated to credit units
     - Every query answered, buys K query credits
     - Value of K can be adapted based on system behavior

     - Hope that users who find Micro-Blog useful will also reply

(3) Location Privacy

- **Phones need to continuously update their location**
  - Poses privacy risks
  - Pseudonymns insufficient

- **We propose 3 blogging modes**
  - Public, Social, Private
  - Users set privacy policy
  - In social mode, only those in social network view blogs

- **For querying**
  - Privacy feasible through K-anonymity based solutions

(4) Content Inaccuracy and Spam

- **"Don't distract me with queries" -- likely reaction**
  - Configuration allows level of tolerated distraction

- **Blog content may be inaccurate - use reputation**
  - Each user's blogs rated over time -- reputation index
  - Penalize upon abuse

  - Alternately, context information can be used to validate
    - Accelerometer, light, sound, neighbors, etc. can be tagged
    - Your picture of African forest is invalid if your phone shows AT&T connections, and sound sensors indicate an A/C nearby
      - Future work

So, where exactly is the research here ???!!**

Several challenges exist … perhaps more to come

Some addressed

Several others merit deeper research

MiroBlog Prototype

- **Nokia N95 phones**
  - Symbian platform
  - Carbide C++ code

Micro-Blog Beta live at

http://synrg.ee.duke.edu/microblog.html

Prototype

Case Studies

■ **Micro-Blog phones distributed to volunteers**

  ■ 12 volunteers
    • 4 phones in 3 rounds
    • 3 weeks

  ■ Not great UI
    • Basic training for users

  ■ Exit interview revealed useful observations
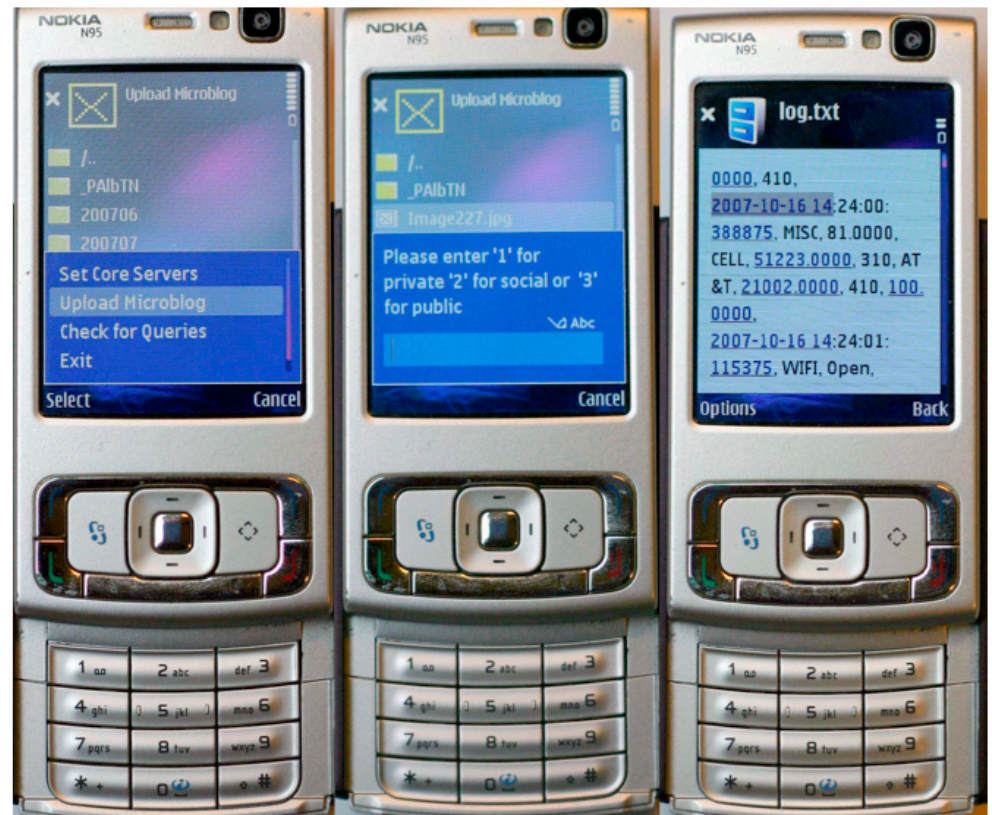
From Exit Interview

1. "Fun activity" for free time
   - Needs much "*cooler GUI*"

2. Privacy control vital, don't care about incentives
   - *"more interesting to reply to questions … interested in knowing who is asking …"*

3. Voice is personal, text is impersonal
   - *"Easier to correct text … audio blogs easier but …"*

4. Logs show most blogs between 5:00 to 9:00pm
   - *Probably better for battery usage as well*

Discussion …

- **Several limitations**
  - Formal characterization of energy vs location accuracy
    - Pareto optimality, achievable bounds necessary

  - Most solutions addressed through configuration restrictions
    - Need to allow locations and yet be anonymized

  - False content cannot be detected
    - Collusion possible, or even operating under the threshold

  - How conclusive is user study?
    - Student volunteers not necessarily best representation
    - Exam period testing may have affected "mood" for microblogging
    - Carrying additional phone + poor UI affect results

Conclusion

- Mobile phones = People centric sensors

- Micro-Blog: attempt towards an information telescope
  - Share, query, and float content on virtual and physical space
  - Some similarity with existing literature & recent start-ups
    - Twitter, Loopt, Socialite, Place-Its, cooltown, MyAura, SenseWeb...

- This paper develops a proof-of-concept
  - Identifies and addresses some challenges
    - Energy-efficient localization, privacy, incentives, spam …
  - Several challenges remain for deeper research

  - Encouraging feedback from "real life" users (read enthusiastic undergrad)
  - However, more work necessary for real "real life" users

Thanks a lot

For your patience

Visit the SyNRG research group @

http://synrg.ee.duke.edu/index.htm