

Research and development opportunities in urban sensing/networking

Lotzi Bölöni

School of Electric Engineering and Computer Science
University of Central Florida- Orlando, FL

March 24, 2010

Research and development opportunities

- Research opportunities
- Business opportunities
- Our greatest wish: a low hanging fruit
 - ▶ John Nash: 20 page paper → Nobel prize
 - ▶ Youtube 21 months after funding → \$1.65 billion
 - ▶ Twitter: wide popularity, very minimal intellectual investment
- High hanging fruit
 - ▶ Millennium prize projects
 - ★ Poincaré conjecture...
 - ★ P versus NP
 - ★ etc...

Urban sensing/networking

- Networking aspect
- Sensing aspect
- Application aspect
- Human/social aspect

What are we interested in

- Are there any open research issues (preferably with low hanging fruit?)
- Is it too crowded?
- Is it an execution-only business?

Networking aspect: Telephony based networking

- Long range, wireless signal (3G tech:)
 - ▶ EDGE (TDMA)
 - ▶ EV-DO, HSPA, LTE (CDMA)
- Base station / Access point based
- No peer to peer connections (exception: Nextel push-to-talk)
- Total bandwidth limited on a cell basis
- Mobility, handoff problems are essentially solved

Research opportunities

- Research mostly driven by (large) companies.
- The need for standards limits implementable innovation.
- No low hanging fruit.

WiFi

- Access point based internet access using the 2.4 and 5GHz ISM bands
- With 802.11n we have an almost complete coverage of the theoretical bandwidth
- Transmission range, and thus mobility are limited by the physics of the frequency band.
 - ▶ The ISM ranges were chosen *because* they have bad propagation properties
- Wide deployment, entrenched standards.

Research opportunities

- Matured field,
- The need for standards limits implementable innovation.
- No low hanging fruit.

WiFi in ad-hoc mode

- Same as WiFi, without infrastructure.
- Computer to computer (or device-to-device communication)
- Brings up the problem of routing
 - ▶ Research topic started in mid 1990s
 - ▶ Popular research topic as people could design a wide range of routing protocols
 - ▶ http://en.wikipedia.org/wiki/List_of_ad-hoc_routing_protocols
- Natively supported by Windows, Linux, ... can be done on Android, Nokia, etc.
 - ▶ Have seen minimal use.
- Problem: lack of convincing use.

Bluetooth

- Short range communication
- Initially had been designed for low bandwidth, but they undershoot the

transfer rate for many obvious applications (eg. stereo music headsets)

- Recent developments (v3.0 and v4.0)
 - ▶ More secure
 - ▶ Higher bandwidth (various tricks)
 - ▶ Low power

Research opportunities

- Matured field
- Highly corporate based...
- No low hanging fruit.

No opportunities for innovative research in networks?

- Here is one.

Vehicle to vehicle technology

- Peer-to-peer, proximity based
- Two vehicles coming from opposite directions
 - ▶ Very short time to connect
 - ▶ Very short timeExchange information
 - ▶ Still: security, authentication, privacy... all apply
- Two vehicles on the same direction
 - ▶ Some type of communication requires low latency
 - ▶ Eg. maintaining convoys, notification of emergency braking, accidents ahead
- Our wireless technologies are inadequate
 - ▶ Is wireless the only possible option? Eg. optical communication...

Research opportunities

- When implemented, will be corporate based but...
- It is in such early stages that you can make a difference.
- Large number of possible applications, some of them might be low hanging fruit.

Vehicle to infrastructure

- DSRC (Dedicated Short Range Communications)
- IEEE 802.11p
- http://en.wikipedia.org/wiki/Vehicular_communication_system
- Applications
 - ▶ Toll-collecting (current used)
 - ▶ Safety
 - ▶ Traffic management (congestion redirection, parking etc)
 - ▶ Surveillance

Research opportunities

- Large number of possible applications, some of them might be low hanging fruit.
- Unclear whether you need *networking* contributions to this.

Urban peer-to-peer

- Proximity based communication.
 - ▶ Let my phone talk to your phone
- The technology is there, but it is blocked
 - ▶ Current recommendation is to put your Bluetooth in invisible mode.
 - ▶ This is what happens when the malware arrives faster than the

legitimate applications.

Networking as landmark

- Use WiFi (and Bluetooth) signatures to identify landmarks
 - ▶ When I have seen this in the Place Lab project several years ago, it seemed to me that it is interesting, but not widely applicable idea
- Guess what, it is used in mainstream application
 - ▶ SkyHook wireless
 - ★ Used by the iPhone
 - ▶ Eye-Fi SD cards for geotagging photos

Sensing aspect

- Sensors

- ▶ increased performance, miniaturization
- ▶ gradually adding them to cell phones
 - ★ chicken / egg problem - you need a push/pull effect from application
- ▶ sensor extensions
 - ★ presumably connected through bluetooth
 - ★ although the Nike+Ipod sports kit (in an athletic shoe) uses a proprietary 2.4 GHz protocol

Challenge

- What can we do interesting with these sensors?
- **Obvious:** store it for local use
- **Not obvious** - but has been done already
 - ▶ Upload to global databases
 - ★ Create a global picture
 - ★ Data mine it.
 - ▶ Local/community based sharing
- There are some opportunities here
 - ▶ How to do data mining without uploading first?
 - ▶ Is the community first? Or the data?
 - ★ How to build a community without sharing the data?
 - ★ Groucho Marx: "I don't care to belong to a club that accepts people like me as members."

Applications

- having an application successful is partly luck / critical mass / being at the right moment in the right place
- YouTube - Google had its own video service!
- Twitter
- Still, there are some rules
 - ▶ Idea has to be good
 - ▶ Execution has to be good
 - ★ You need to be in a very strong position to get away with mediocre execution.

Thoughts about the market: long tail

- YouTube thrives on the **long tail**
 - ▶ Large number of videos, catering to niche audiences
 - ▶ Not everybody believes this is the case
 - ★ <http://denisbhancock.com/2009/02/25/does-the-long-tail-on-youtube-really-matter/>
 - ▶ They conclude that this is the blockbuster model
- I think this is a bit misleading, because people overlap on the blockbuster but diverge on the rest
 - ▶ Everybody must see Ben Hur, Lord of the Rings, Avatar
 - ★ But in the rest you diverge
- Problem with long tail: difficult to control content, you need to crowdsource it, copyright problems
 - ▶ How much does an old video worth? Eg. Toni Basil "Mickey"
 - ★ On TV: nothing
 - ★ On You Tube: an unauthorized video uploaded 9 months ago 600,000 views.

Thoughts about the market: amateur content

- Amateurs moving to professionalism
 - ▶ Blogs have been supposed to be amateurs who are saying their opinions about things
 - ▶ But the most successful ones are professional businesses, with editors, organization...
 - ▶ Example: Engadget
 - ▶ So the net result was a reshake, not a revolution.
 - ★ Existing professional news media who could not adapt was swept away
 - ★ But the professional model remained