Location Context and Its Applications

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❖ Location Based Service (LBS)

❖ Positioning

- GPS

- Cellular Networks

- WLANs

❖ Other location context

❖ Recent trends

❖ Potential applications

❖ Conclusion

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❖ Location-based services (LBSs) and advertising allow consumers to receive services and advertising based on their geographic location. For example, businesses can provide information about traffic, restaurants, retail stores, travel arrangements, or automatic teller machines based on the consumer's location at a particular moment in time. Such services can be provided in response to a consumer's manual input of his or her location information into the handset or by using so-called "auto-location" technology to track the location of the consumer automatically

FTC Workshop Report (2002)

❖ LBSs allow that a mobile user use services based on his/her position and identity

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" The Internet will not be successfully translated to the mobile world without location awareness which is a significant enabler in order to translate the Internet into a viable mobile economy"…

*Bob Egan, Vice President*
Mobile & Wireless, Gartner Group

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Monthly income per user in Euro, Nokia Forecast
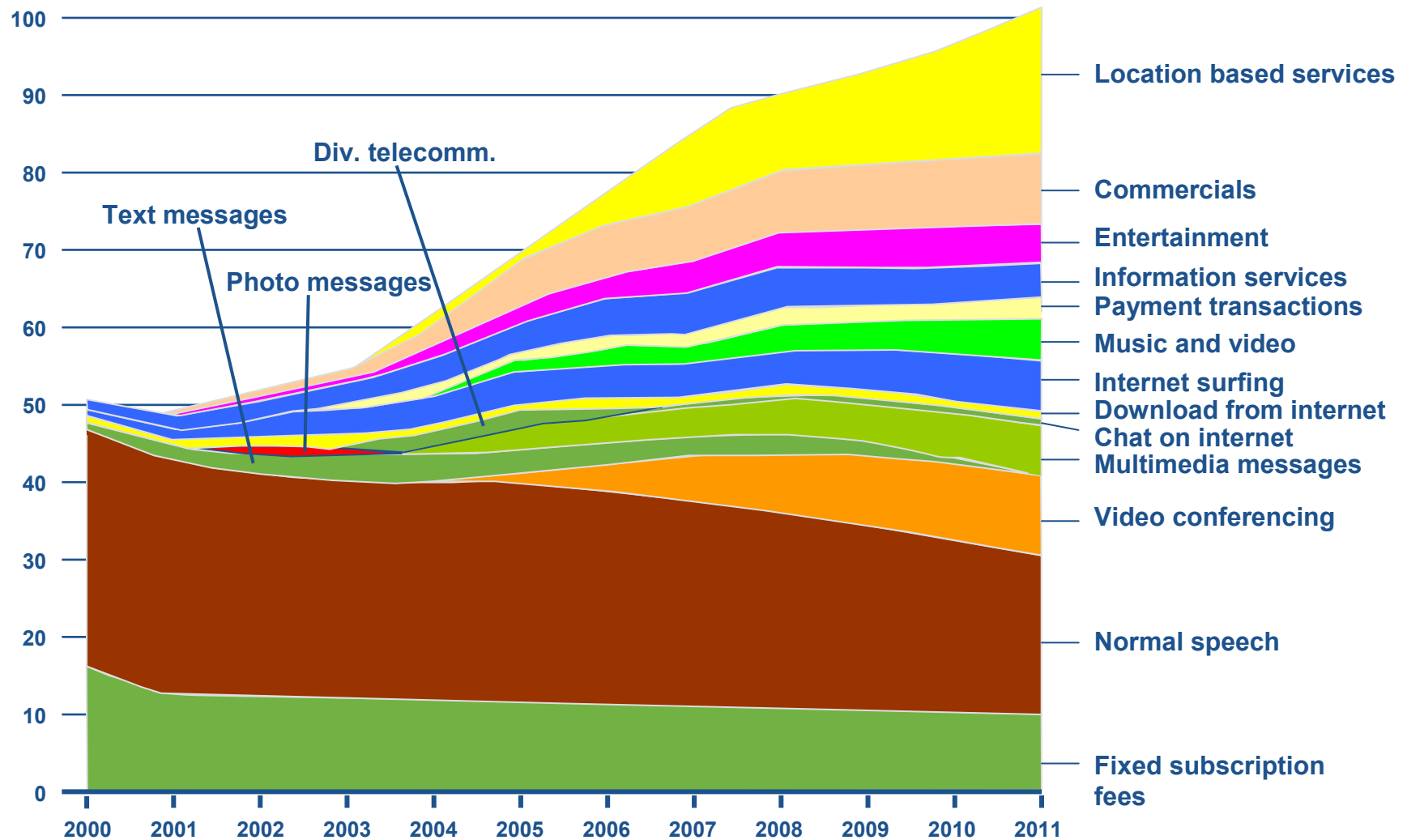
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❖ Triangulation from four or more satellites

❖ GPS is the norm outdoors

❖ Problems

  ▪ Indoor

  ▪ GPS-equipped

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Positioning in cellular networks
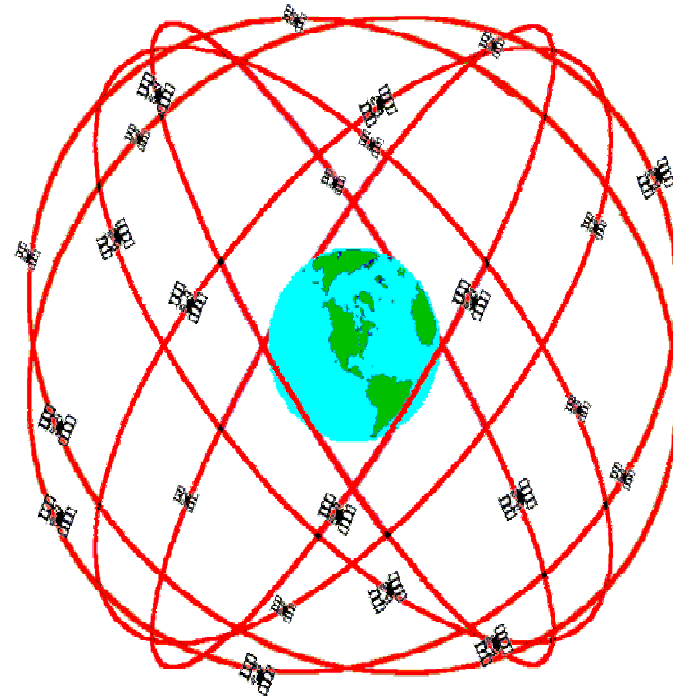
❖ **A-GPS**

- Cellular network gives hint for available GPS satellites
- Same problem as GPS

❖ **Cell-ID**

- The position of a mobile station (MS) is approximated by that of a base station (BS)
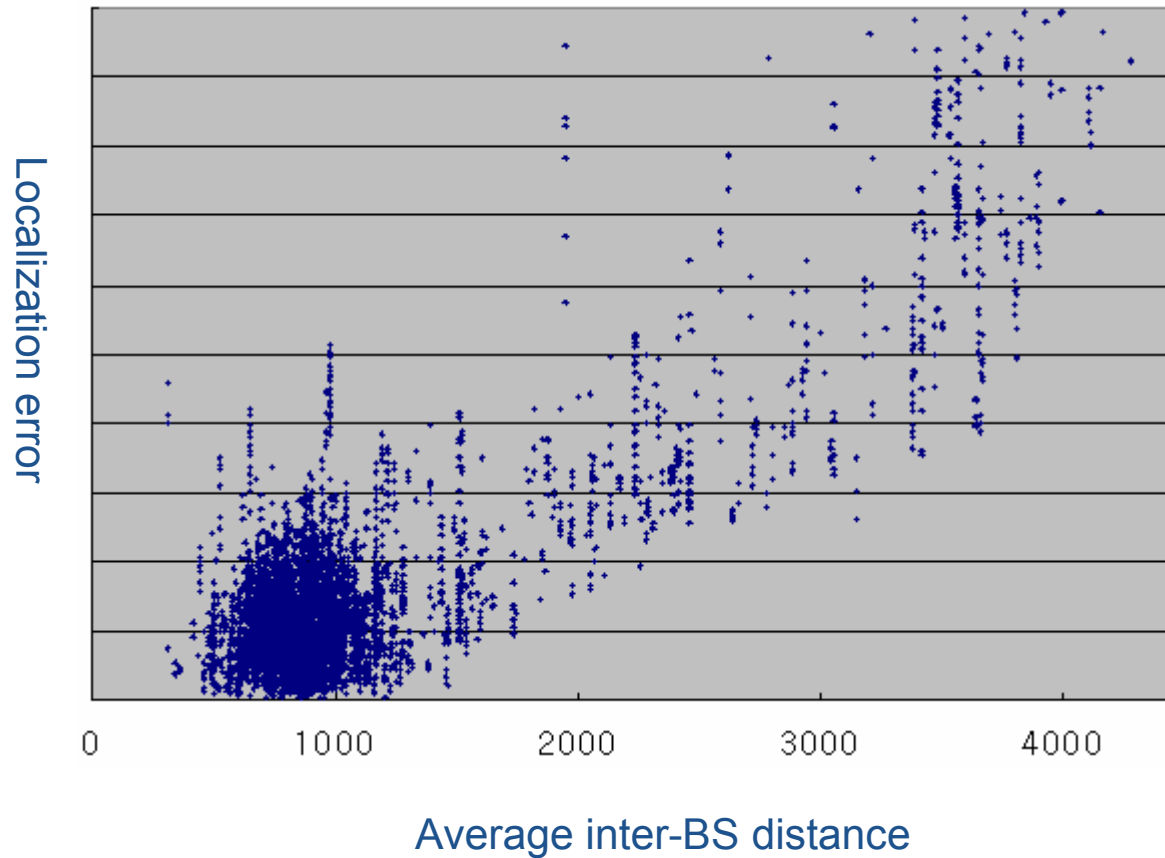
❖ **Weighted centroid (WC)**

- The weighted average of positions of BSs around

❖ **Pattern matching (PM)**

- For each given unit area, received signal strength (RSS) is recorded a priori and then compared
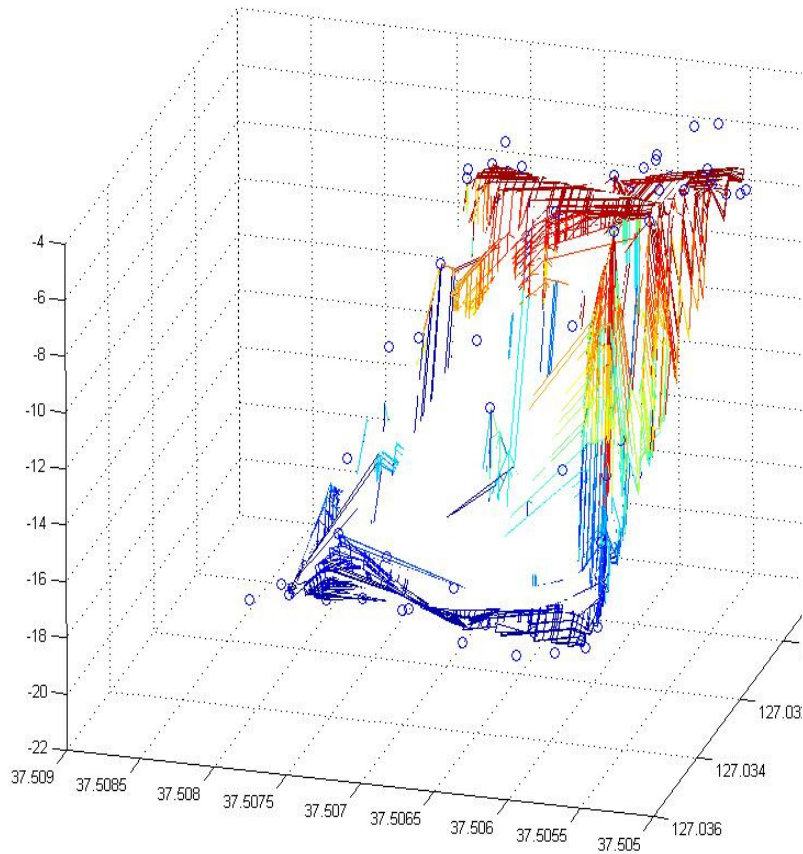
❖ Highly dependent on the average distance between BSs

Localization error

Average inter-BS distance

Pattern matching

❖ First, we store the fingerprints of RSSs from BSs in a DB

❖ Granularity of RSS record matters

Localization error vs Grid Size (m)
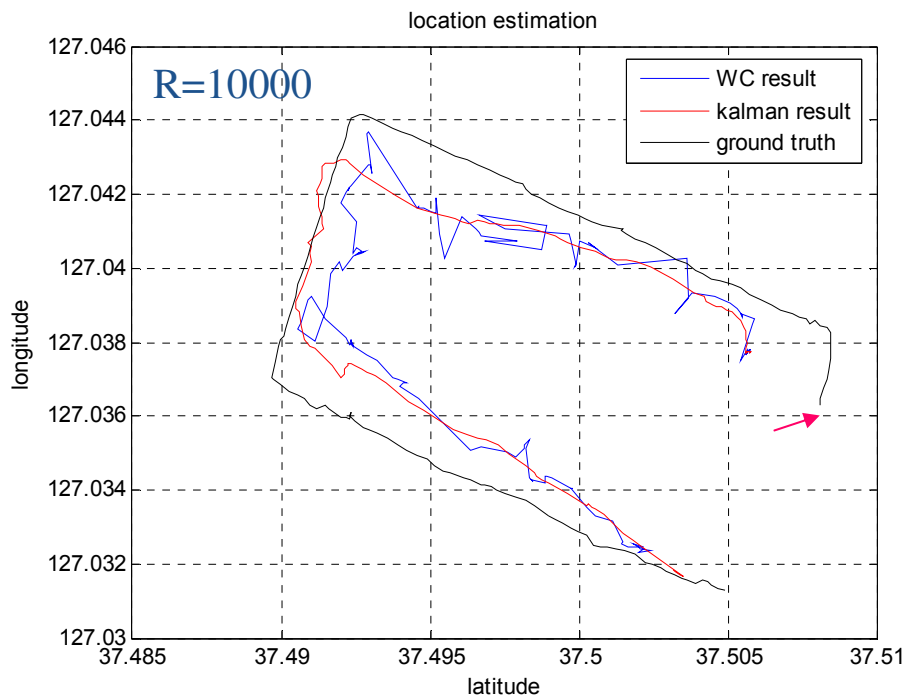
— Pattern matching (PM)

▬ Weighted centroid (WC)
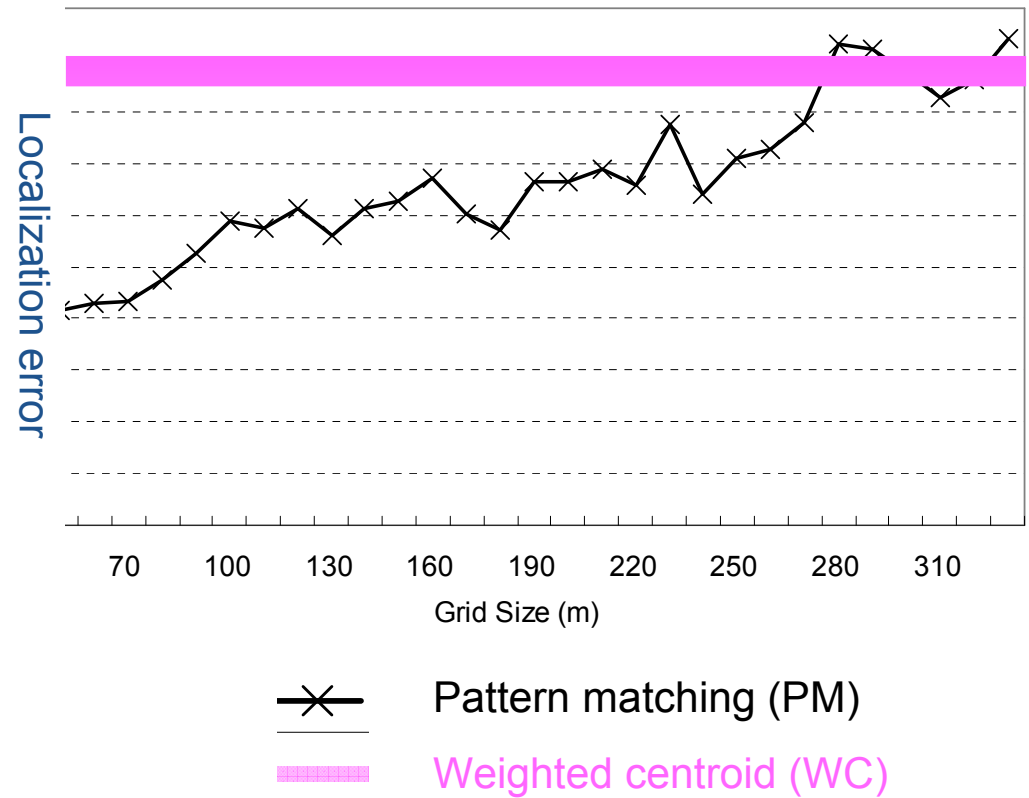
Pattern matching vs. Weighted centroid

❖ If RSS records (seeds) are stored densely enough, PM is better

❖ AGPS phones will help fill the DB

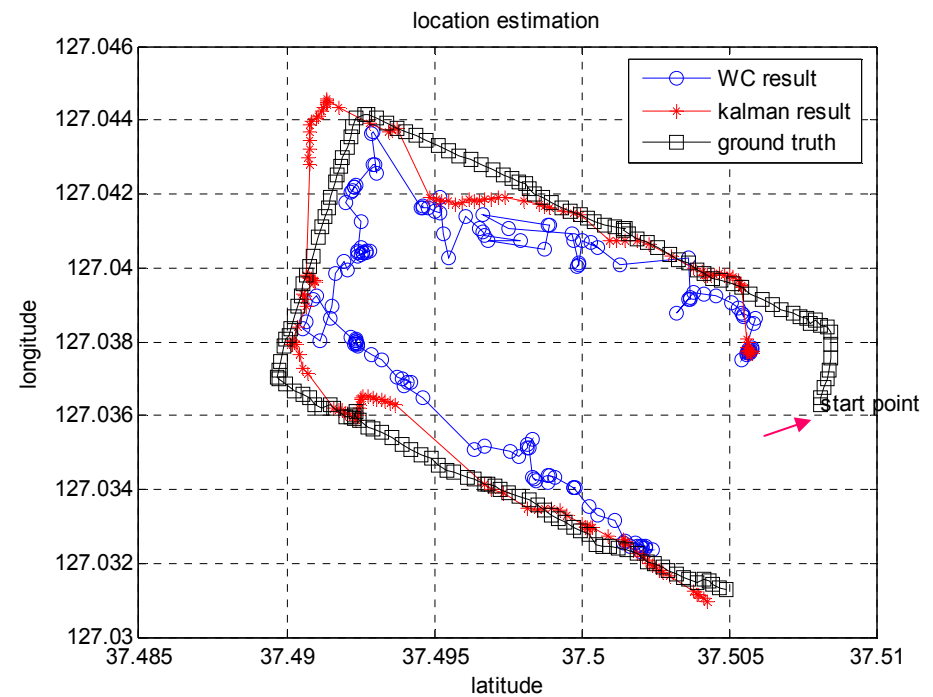Legend:
- PM seeds (green)
- PM is better (red)
- WC is better (yellow)
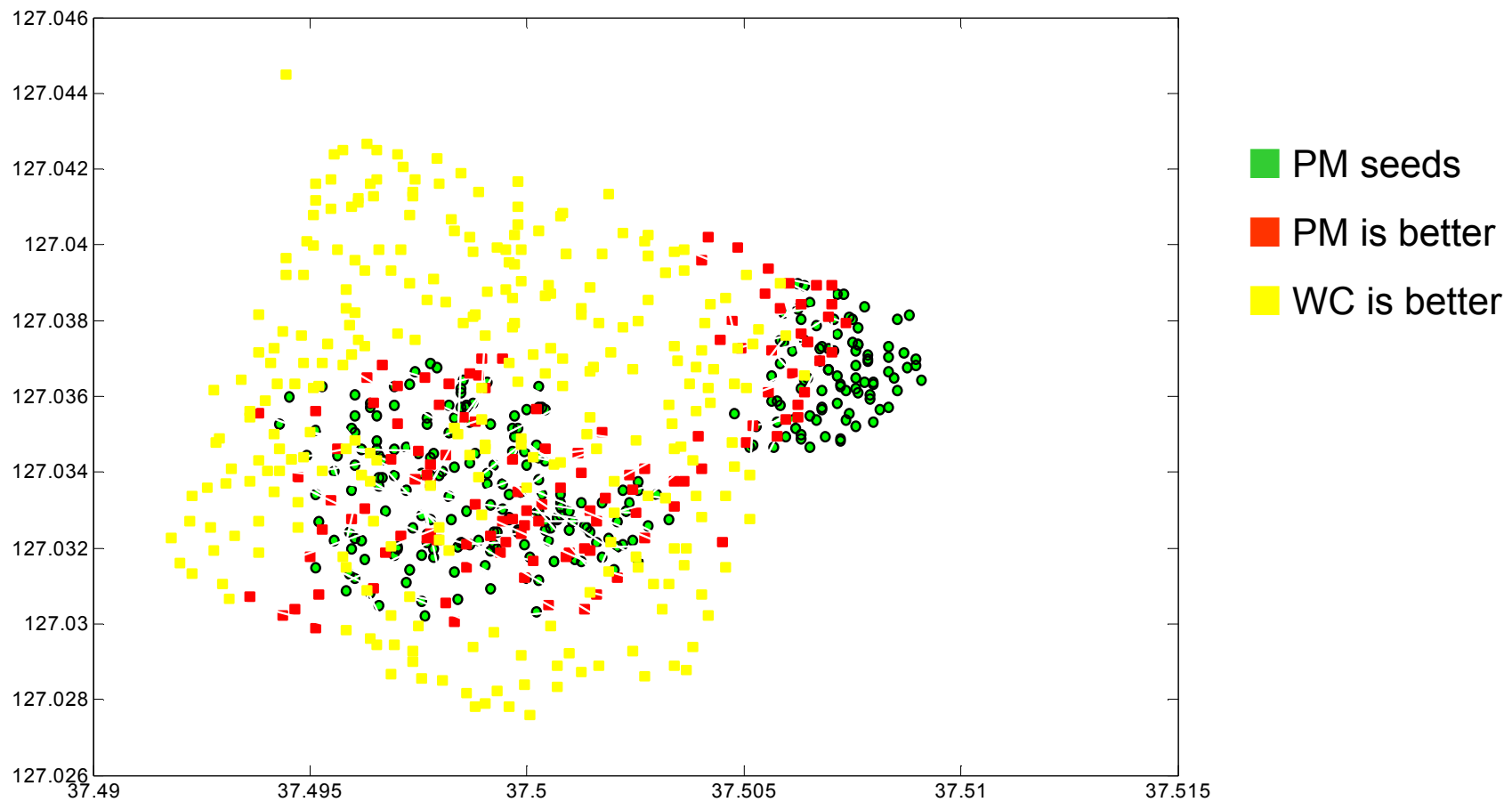
❖ We want to locate a moving MS over time

- The previous positions matters
- Also intermittent GPS availability is vital

Without GPS

With occasional GPS

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❖ **Pattern matching or fingerprinting**

❖ **Number of APs whose positions are known is critical**

❖ **AP location DB is not so accurate**

- One more error source

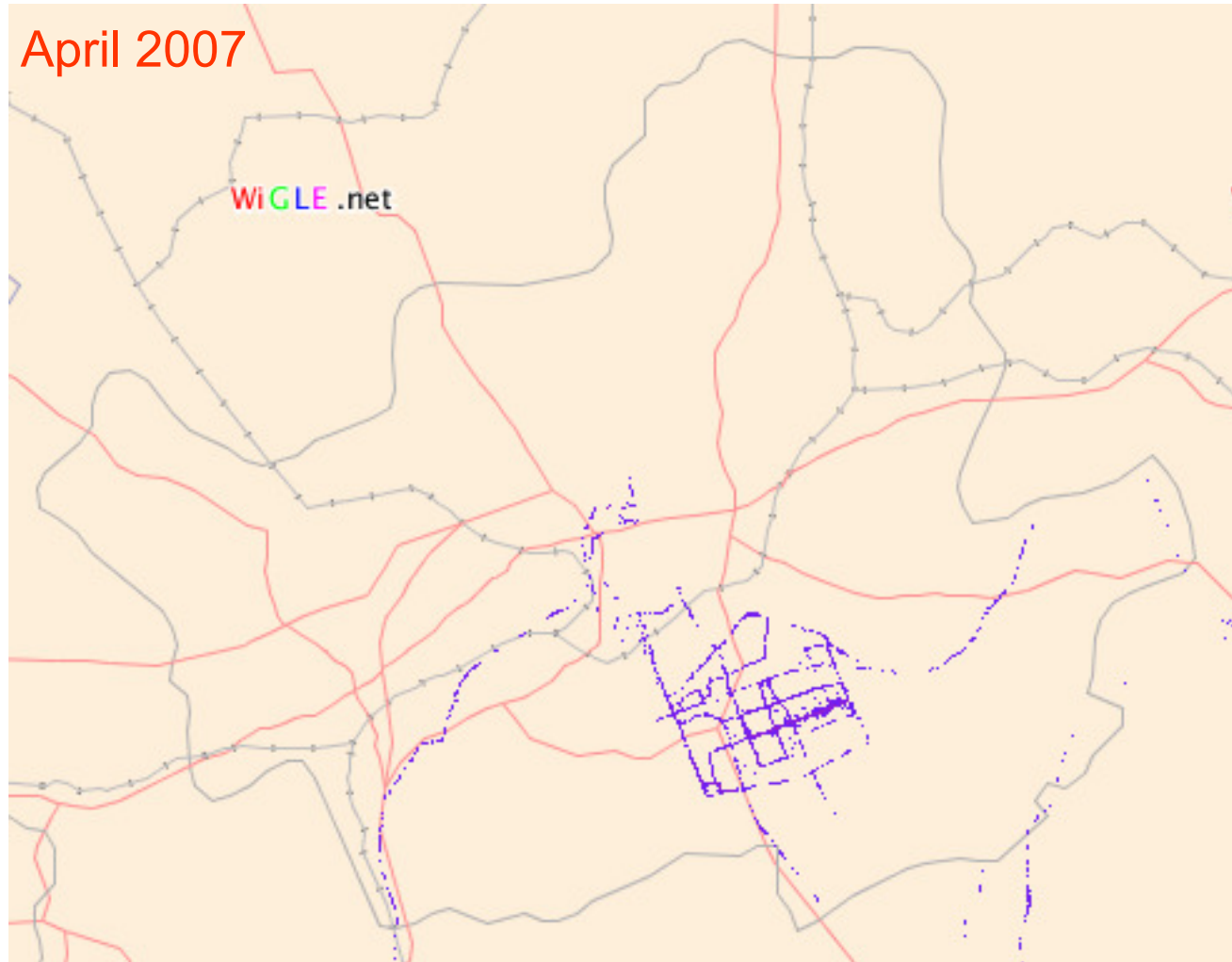❖ **WLAN can have synergy with Cellular**

	802.11		GSM		802.11 + GSM	
	accuracy	coverage	accuracy	coverage	accuracy	coverage
Downtown Seattle (Urban)	20.5 m	100.0%	107.2 m	100.0%	21.8 m	100.0%
Ravenna (Residential)	13.5 m	90.6%	161.4 m	100.0%	13.4 m	100.0%
Kirkland (Suburban)	22.6 m	42.0%	216.2 m	99.7%	31.3 m	100.0%

Source: www.placelab.org

❖ Location DB of APs can be built by Web 2.0
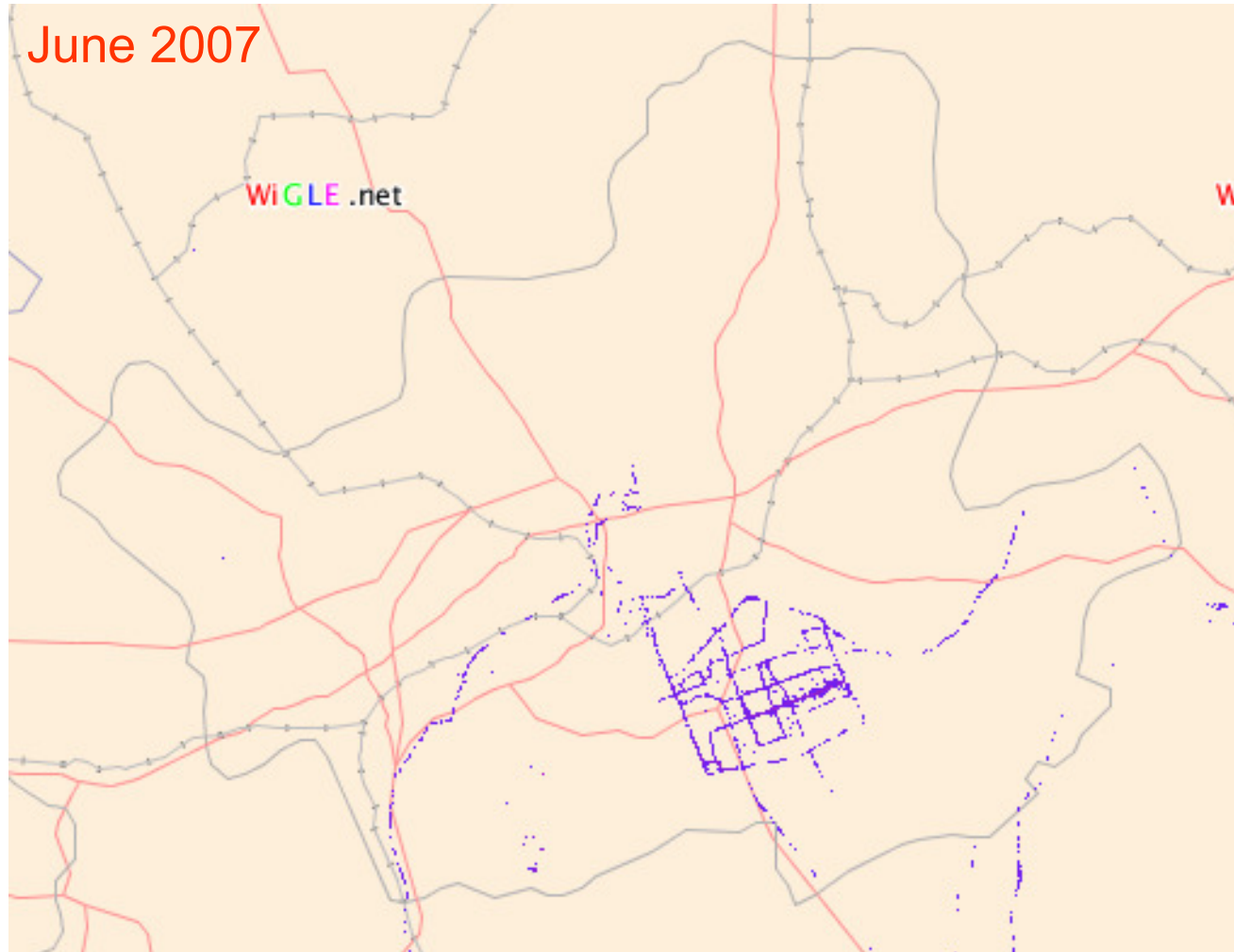
April 2007

WiGLE.net

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❖ **What is the difference?**

June 2007

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- ❖ Positioning
  - GPS
  - Cellular Networks
  - WLANs
- ❖ Other location context
- ❖ Recent trends
- ❖ Potential applications
- ❖ Conclusion

❖ The MS keeps monitoring the BSs around, and old BSs tend to be retained longer than necessary

❖ If we consider this phenomenon, we may be able to figure out the direction of the MS

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❖ Depending on the RSS history, we can guess whether the MS is moving or now

- Red square is the point at which the MS is guessed to be static
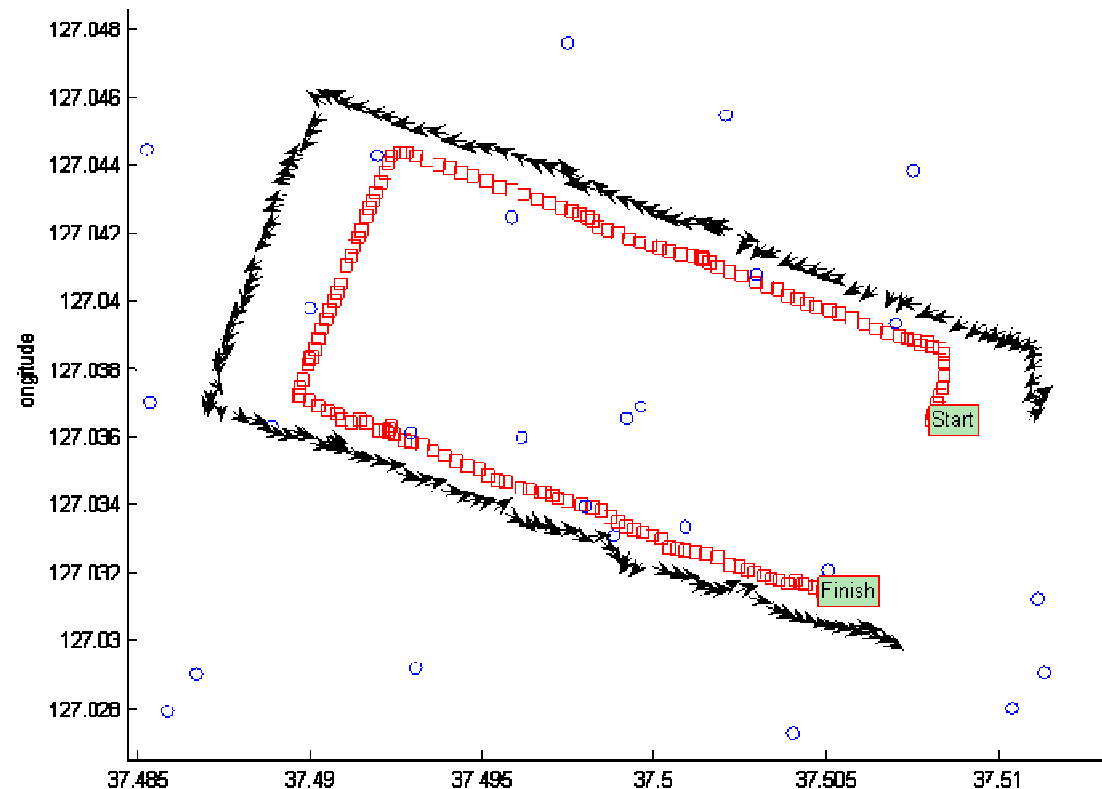

speed & anchor

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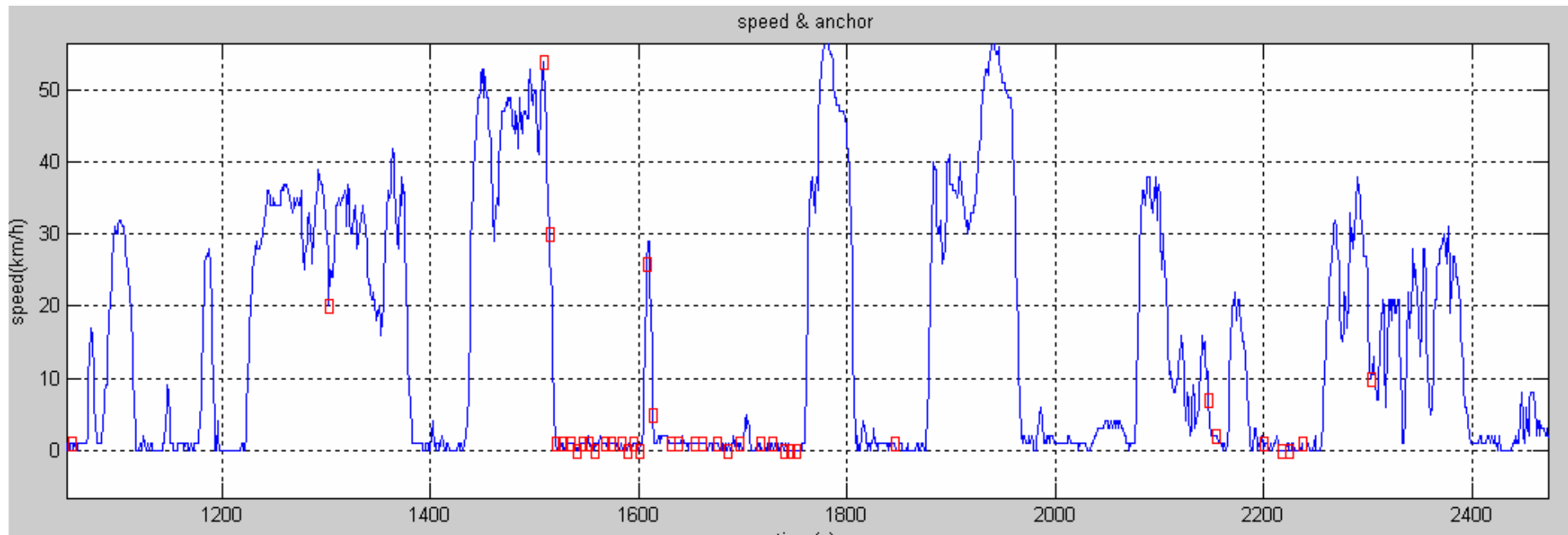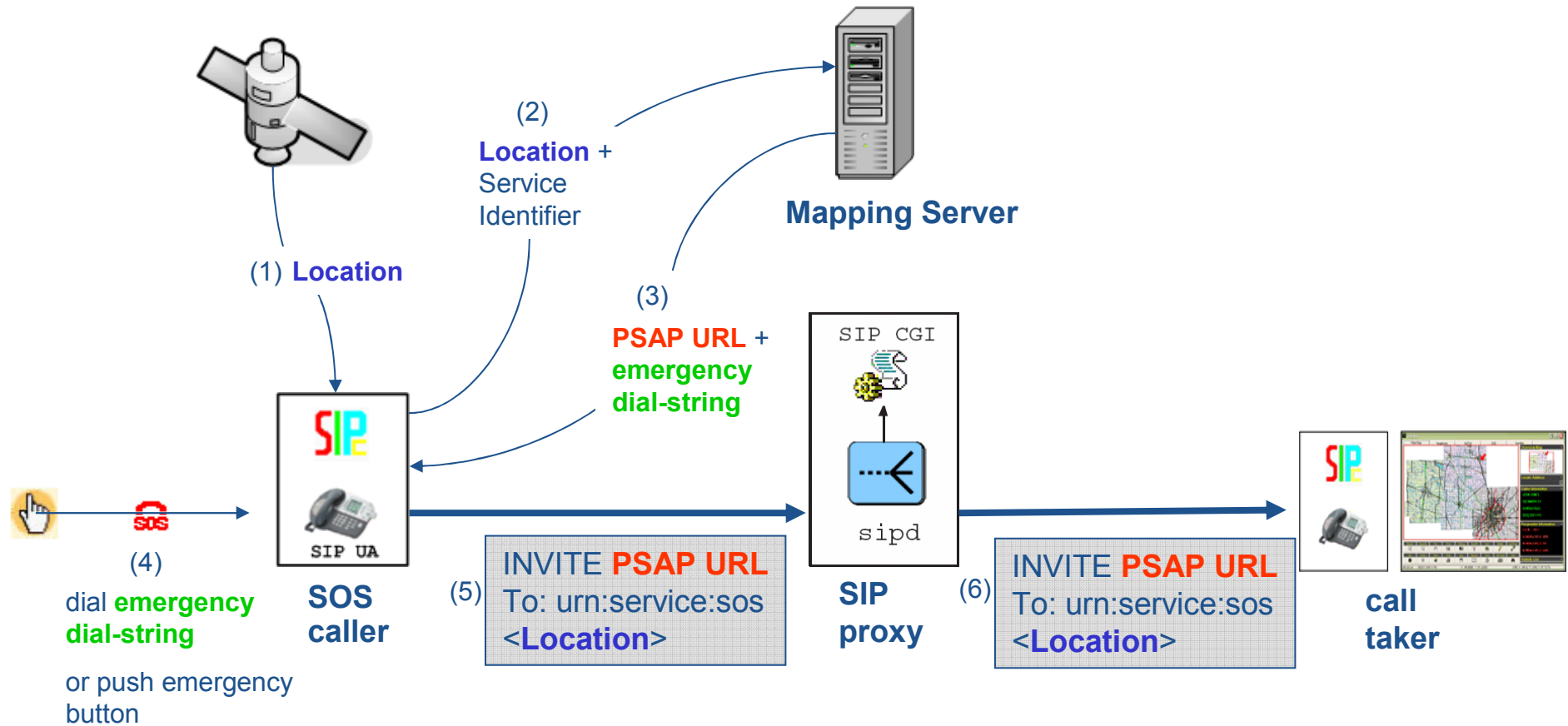- ❖ Potential applications
- ❖ Conclusion

❖ Emergency Context Resolution with Internet Technologies

(2) **Location** + Service Identifier

Mapping Server

(1) **Location**

(3) **PSAP URL** + **emergency dial-string**

SIP CGI

sipd

(4) dial **emergency dial-string**

or push emergency button

SOS caller

(5) INVITE **PSAP URL** To: urn:service:sos **<Location>**

SIP proxy

(6) INVITE **PSAP URL** To: urn:service:sos **<Location>**
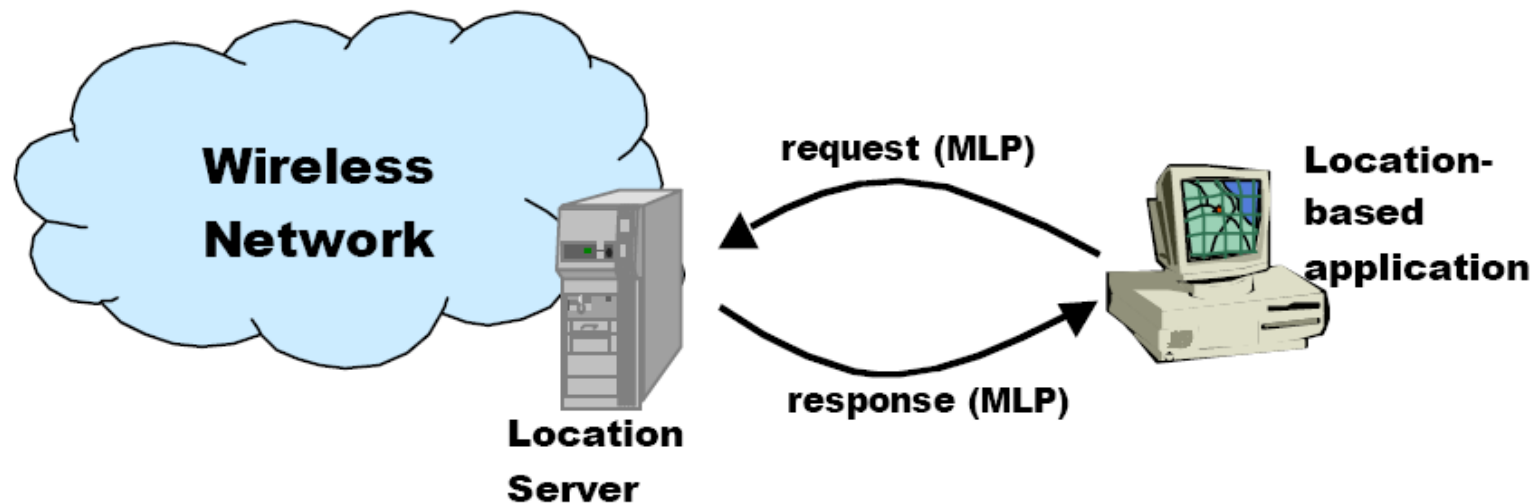
call taker

Source: Henning Schulzrinne at Columbia University

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❖ **Mobile location protocol (MLP)**

- Is an application-level protocol for getting the position of mobile stations independent of underlying network technology.

- Serves as the interface between a Location Server and a Location Services Client

- ❖ IEEE 802.11u, 802.11v, 802.11k want to augment functions for location service
- ❖ E.g. in 802.11v, each AP can have its geographic or civic location

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❖ **Finding services based on location**
- physical services (stores, restaurants, ATMs, …)
- electronic services (media I/O, printer, display, …)

❖ **Using location to improve services**
- communication
  - incoming communications changes based on where I am
- configuration
  - devices in room adapt to their current users
- awareness
  - others are (selectively) made aware of my location
- security
  - proximity grants temporary access to local resources

Source: Henning Schulzrinne at Columbia University

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A focus on networking

❖ **Geographic routing**

- (x, y) is the locator of a node
- Assumes location-independent identifier can be mapped to the current locator

❖ **Cognitive radio**

- The location and area of primary network may be helpful
  - Power control, directional antenna and so on

❖ **Opportunistic networks**

- Just like FriendFinder, NeighborFinder service may emerge (say, dead reckoning)

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❖ Location-based service will be proliferated

❖ Positioning technologies are getting mature

❖ Some lessons

- Accurate positions play vital roles
- No single winner

❖ After all, convergence of various (especially wireless) communication technologies will help to enhance the precision of positioning technologies

❖ Eventually, wired world as well as wireless world will benefit from location context

- Infrastructure nodes as well as end-user devices

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