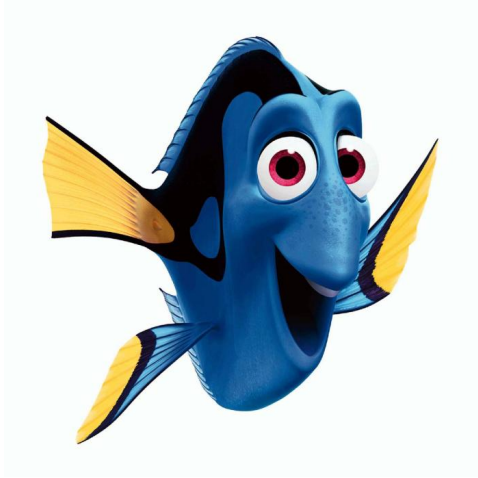# Carnegie Mellon University

Towards More Timely Measurements

Srinivasan Seshan

Wireless Protocol Design

"Those who cannot remember the past are condemned to repeat it"

- George Santayana

- Most wireless protocols react or operate base on recent or immediate observations of RF environment
  - E.g., rate adaptation, handoffs, MAC protocols
- Some systems leverage "hints" from other sources

Wireless Network Management

*"The Only Thing That
Is Constant Is Change"
- Heraclitus*

- Rely on old measurements due to the effort required to perform these surveys
  – Coverage and configuration problems

- Changes at many different time scales:
  – Single day: normal human activity patterns cause changes in user density and network demand.
  – Weeks/months:
    - Changes to construction, building layout or space allocation
   - New RF interference sources

Best of Both Worlds?
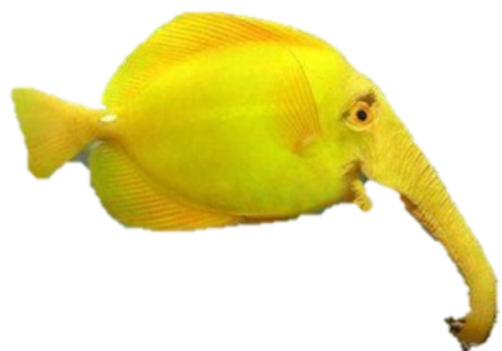
"The most important reason for going from one place to another is to see what's in between"
- Phantom Tollboth

- Current measurements are too stale to make use of in protocols

- In-protocol observations lack sufficient context to make use of by others

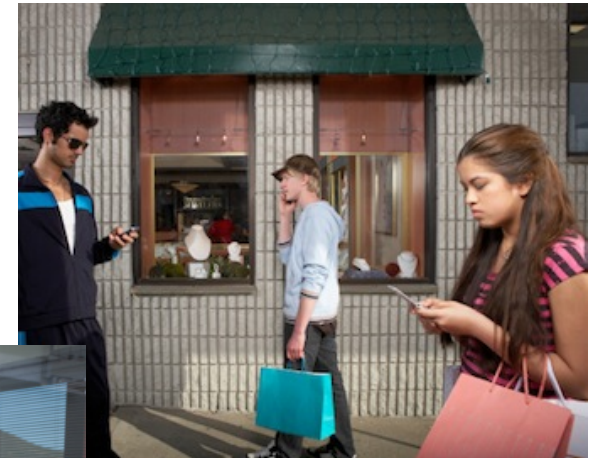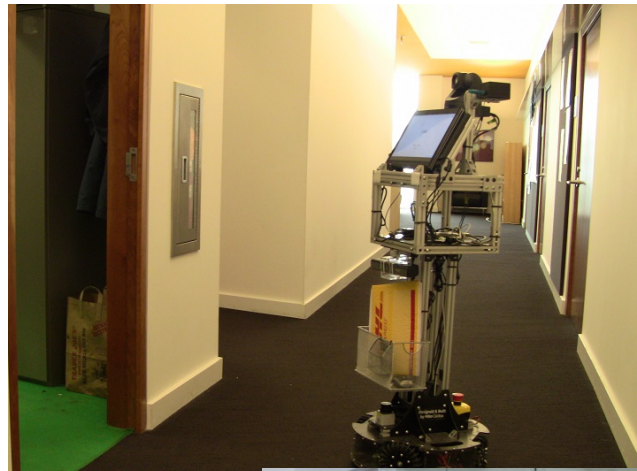- Need more accurate and more continuous measurements

Collecting Wireless Measurements

🔴 Manual WiFi Collection
- Inaccuracies due to human errors

🔵 Dense Sensor Deployments
- Cost and limited physical mounting locations

Timeliness (update frequency) — high / low

Spatial Resolution (# sampled locations) — low / high
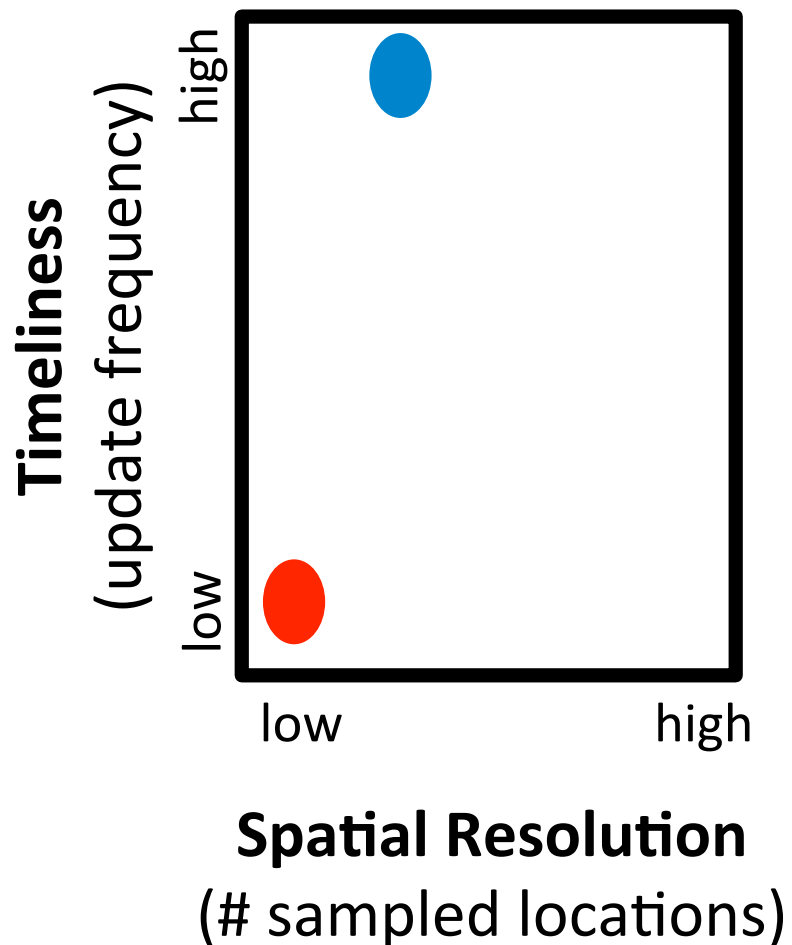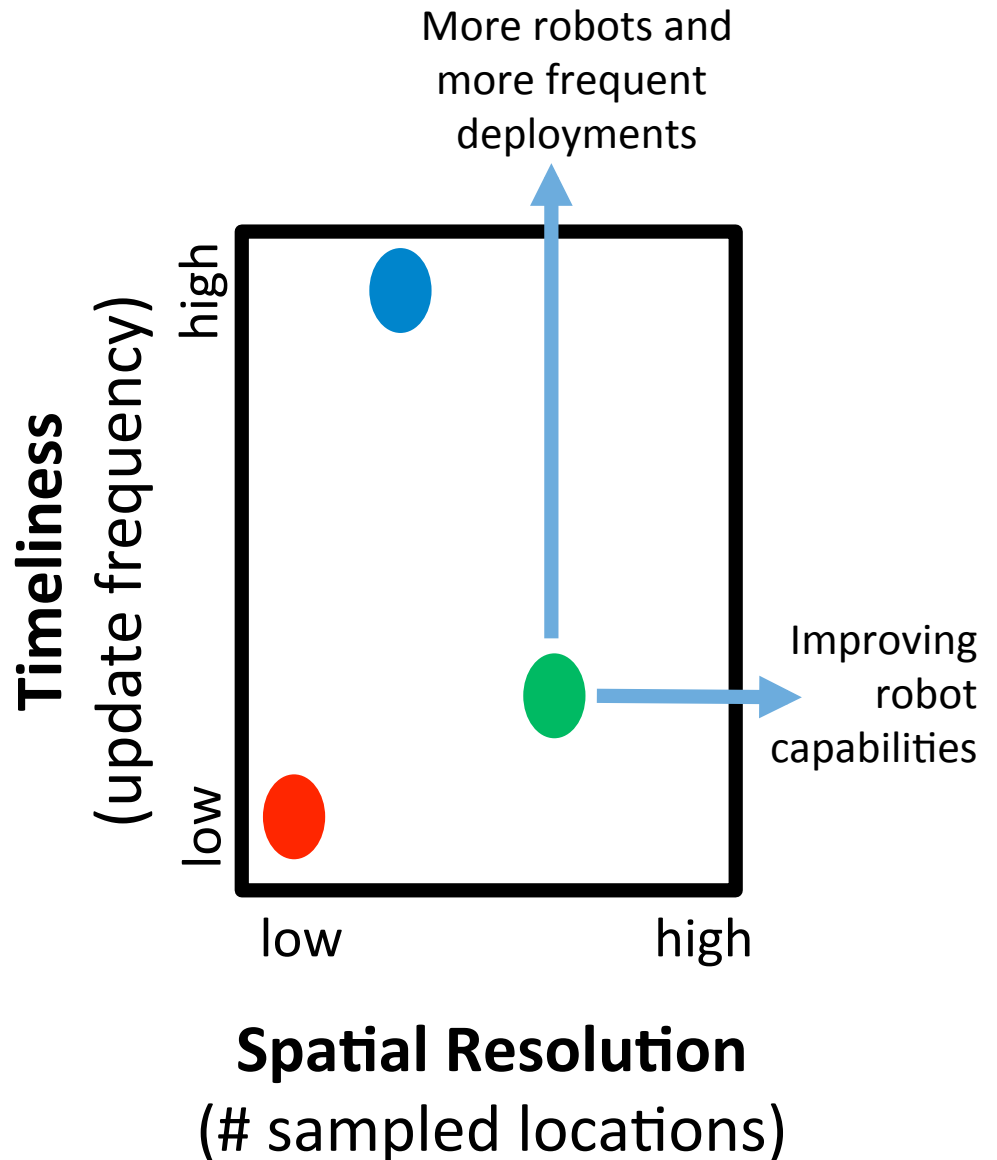
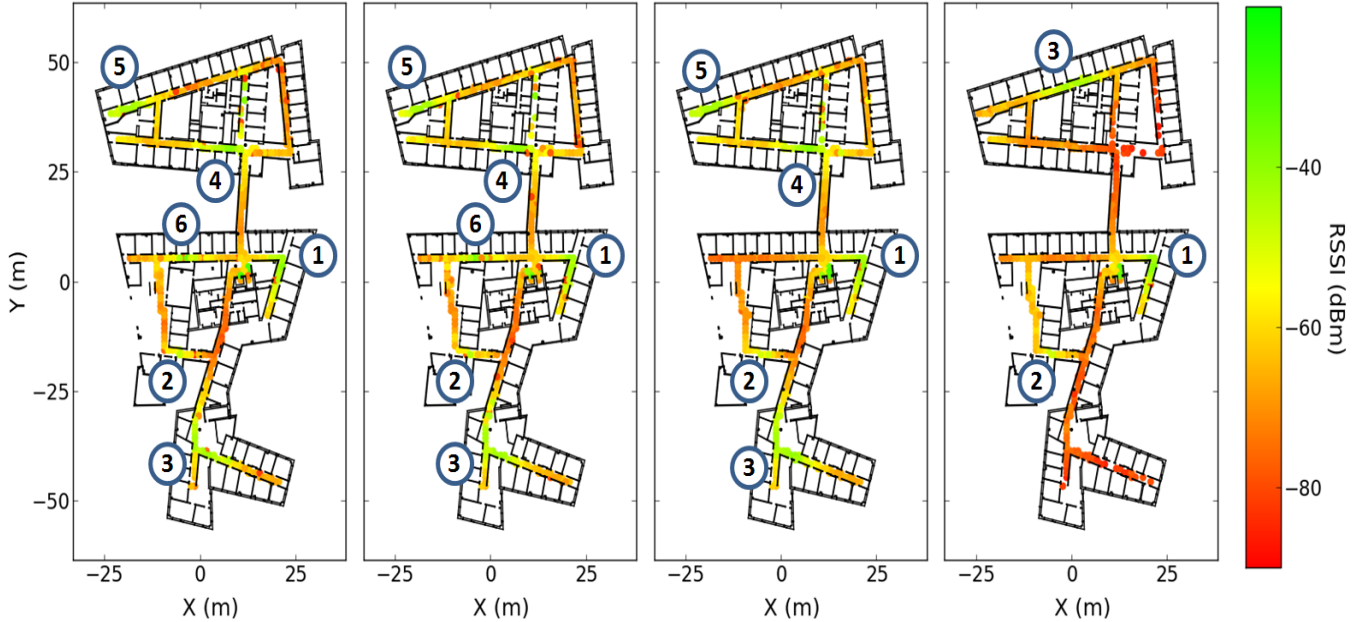# Taking Advantage of Devices that Move

Social
Robots

Mobile
Users

Collecting Wireless Measurements

🔴 Manual WiFi Collection
- Inaccuracies due to human errors

🔵 Dense Sensor Deployments
- Cost and limited physical mounting locations

🟢 Autonomous Robots
- Accurate, non-WiFi localization
- Repeatable/frequent measurements

More robots and more frequent deployments

Timeliness (update frequency)

high

low

Improving robot capabilities

Spatial Resolution (# sampled locations)

low   high

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How Does WiFi Change Over Time?

Daily: Morning, Throughput, and Evening **Throughput**

Weekly: Channel 11 **RSSI** Over Four Weeks

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Crowdsourcing

- **Improving context**
  - E.g., better location
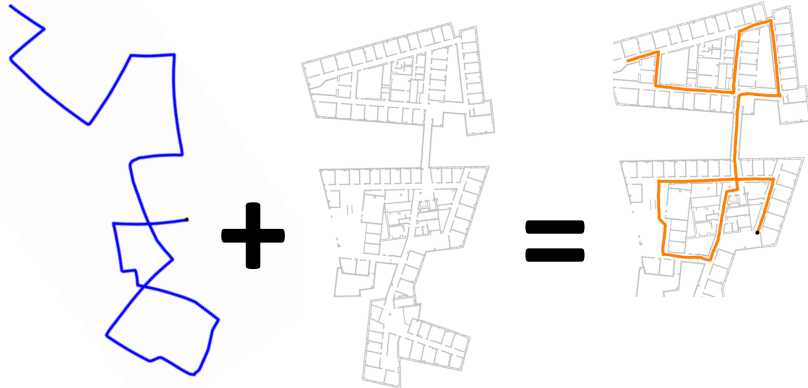
- **Dealing with noise in measurement**
  - Calibration
  - Measurement error
  - Device variation

- **Data collection at scale**
  - BW demands
  - Data coverage challenges
  - Observations on real testbeds

LiveLabs@SMU

- **Looking for post-docs/ research scientists ☺**