

Ubiquitous Computing using Wireless Broadcast

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Ubiquitous Computing Applications

- Adapt their behaviors based on the user's current situation
 - e.g., current location, nearby devices
- Source of the situation information
 - Sensors
 - Services in the environment or the Internet

Building Applications – Infrastructure-based Approach

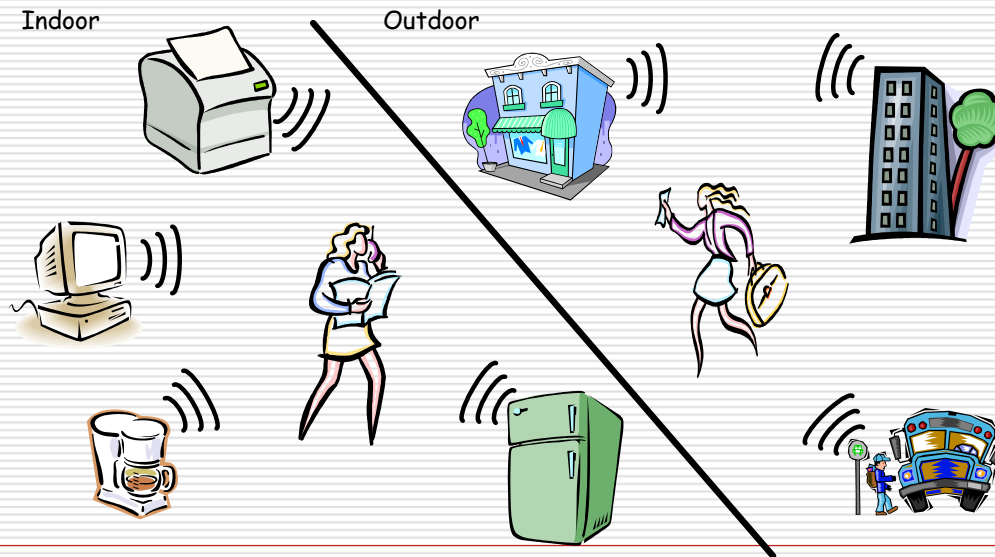
- Basic idea
 - Applications and data sources live in the infrastructure
- Advantages
 - Users carry minimal devices
 - A variety of data sources are readily available
 - Works well for applications in engineered spaces
- Problems
 - Privacy
 - Complexity/scalability
 - Re-authentication required when crossing domains

Building Applications – Wearable Approach

- Basic idea
 - Applications and data sources (sensors) are all carried by the user
- Advantages
 - Privacy
 - No infrastructure cost
- Problems
 - Size and form factor
 - Battery life
 - Access to connectivity

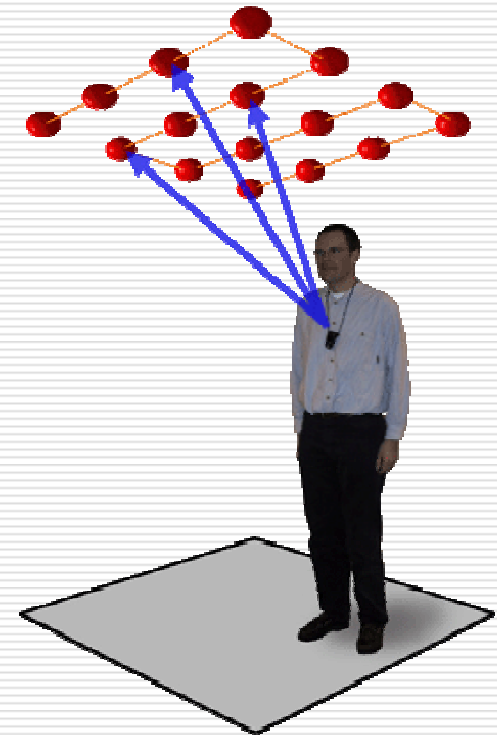
Our Approach – Ubiquitous Broadcast Computing

- Combining the best of both approaches
 - Applications on the client device for privacy
 - Data sources in the infrastructure
 - Use of wireless broadcast for the communication between applications and data sources



Example Application – Location System

- ☐ Infrastructure-based approach
 - Bat ultrasonic location system
 - ☐ Users carry ultrasound transmitter
 - ☐ Networked sensors in the infrastructure



Example Application – Location System

- ☐ Wearable approach
 - Scene analysis
 - ☐ Camera worn by users

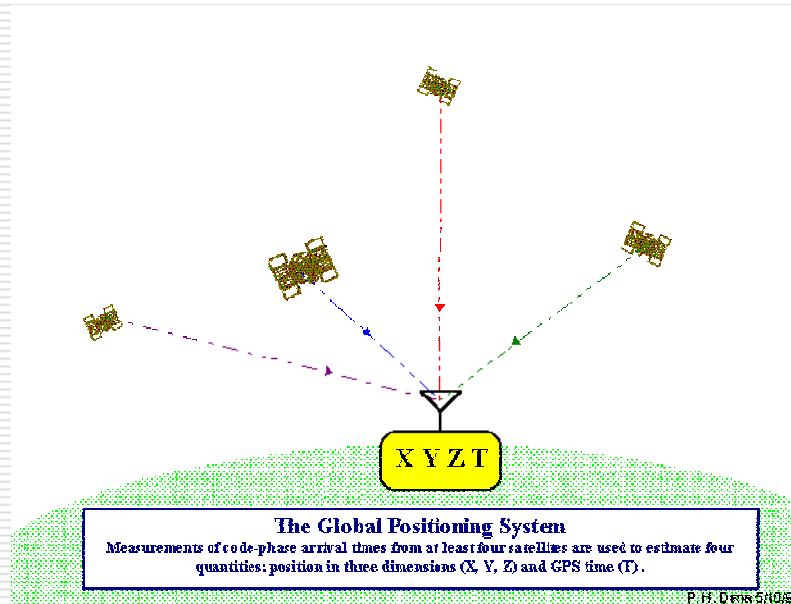


Example Application – Location System

☐ UBC approach

☒ GPS

- ☐ Signal transmitted from satellites (infrastructure)
- ☐ Receiver carried by the user



Ubiquitous Broadcast Computing

☐ Characteristics

- Privacy
- Scalability
- Universality
- Incremental deployment
- Upgradeability
- Comprehensibility

Ubiquitous Broadcast Computing

□ Characteristics

- Privacy
- Scalability
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Clients receive broadcast information silently without revealing anything about the user

Ubiquitous Broadcast Computing

□ Characteristics

- Privacy
- **Scalability**
- Universality
- Incremental deployment
- Upgradeability
- Comprehensibility

Broadcast can support many users simultaneously without requiring more bandwidth

Ubiquitous Broadcast Computing

□ Characteristics

- Privacy
- Scalability
- **Universality**
- Incremental deployment
- Upgradeability
- Comprehensibility

Clients do not need authentication, thus can work seamlessly across administrative domains

Infrastructure providers do not have to worry about compromising their network

Ubiquitous Broadcast Computing

□ Characteristics

- Privacy
- Scalability
- Universality
- **Incremental deployment**
- Upgradeability
- Comprehensibility

Infrastructure cost can be minimal (e.g., simple wireless sensors can be deployed in any environment without requiring connectivity)

Ubiquitous Broadcast Computing

□ Characteristics

- Privacy
- Scalability
- Universality
- Incremental deployment
- Upgradeability —
- Comprehensibility

Broadcast data is self-describing and clients can easily find the appropriate parsers and applications for the data

Ubiquitous Broadcast Computing

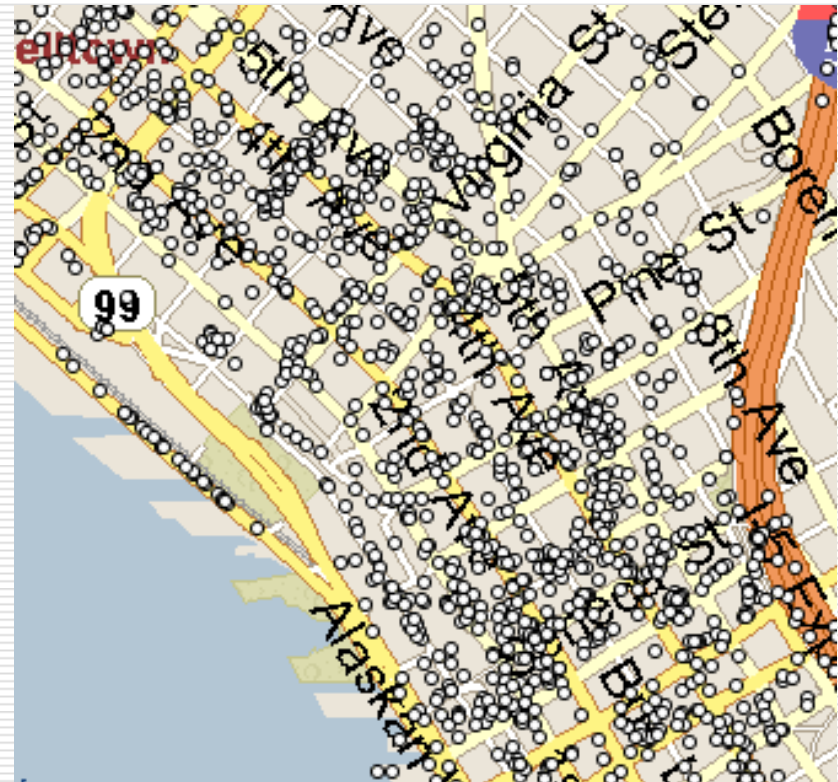
□ Characteristics

- Privacy
- Scalability
- Universality
- Incremental deployment
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- **Comprehensibility**

Broadcast communication provides easy-to-understand mental model

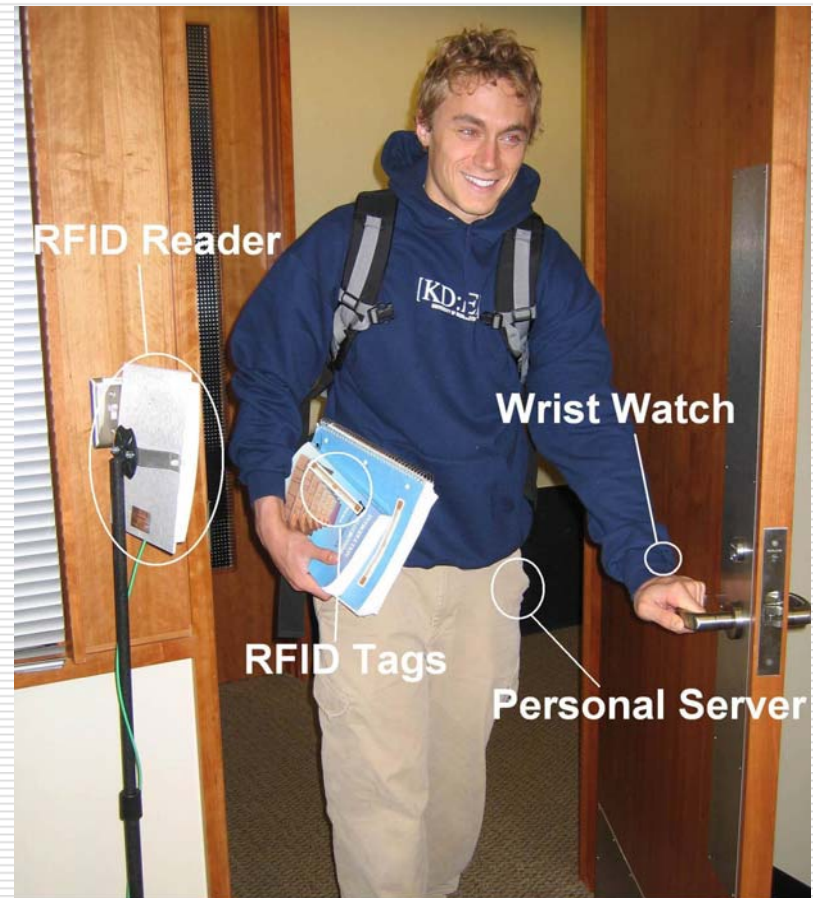
Application 1 – Place Lab

- ❑ Computes users' current position
- ❑ Data source: WiFi APs periodically broadcast their unique SSIDs
- ❑ Client device: computes its current position by looking up APs' SSID in client-cached database



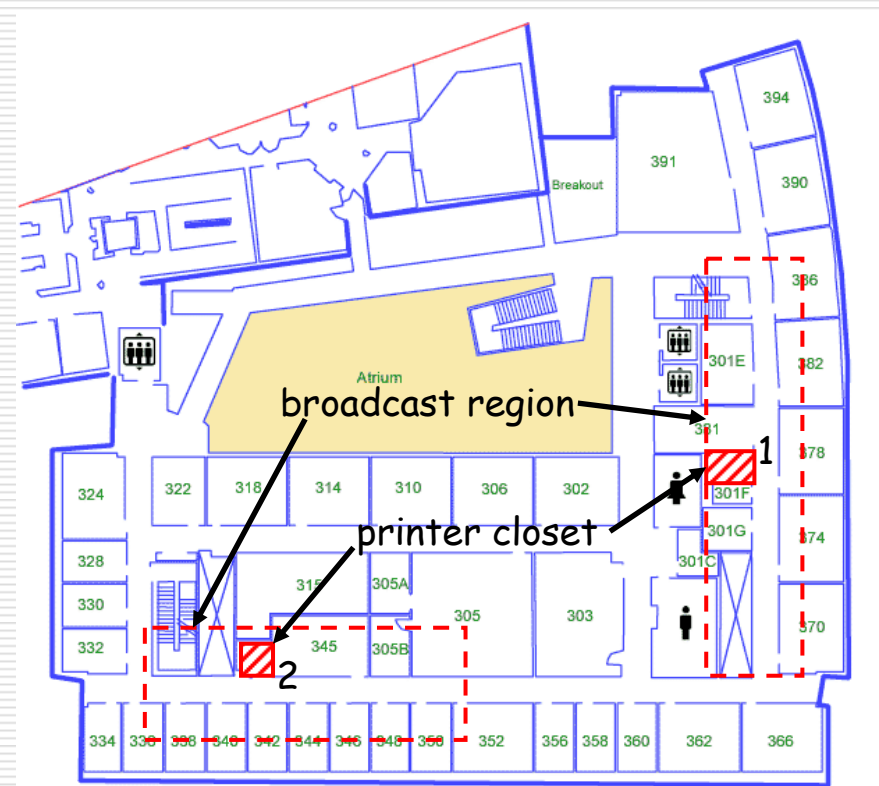
Application 2 – RFID-based Reminder

- ❑ Alerts users when something is left behind
- ❑ Data source: long-range passive RFID readers in the environment read tags and broadcast the list of tags IDs
- ❑ Client application: checks if all the user's items that should be present are all there



Application 3 – Printer Queue Reminder

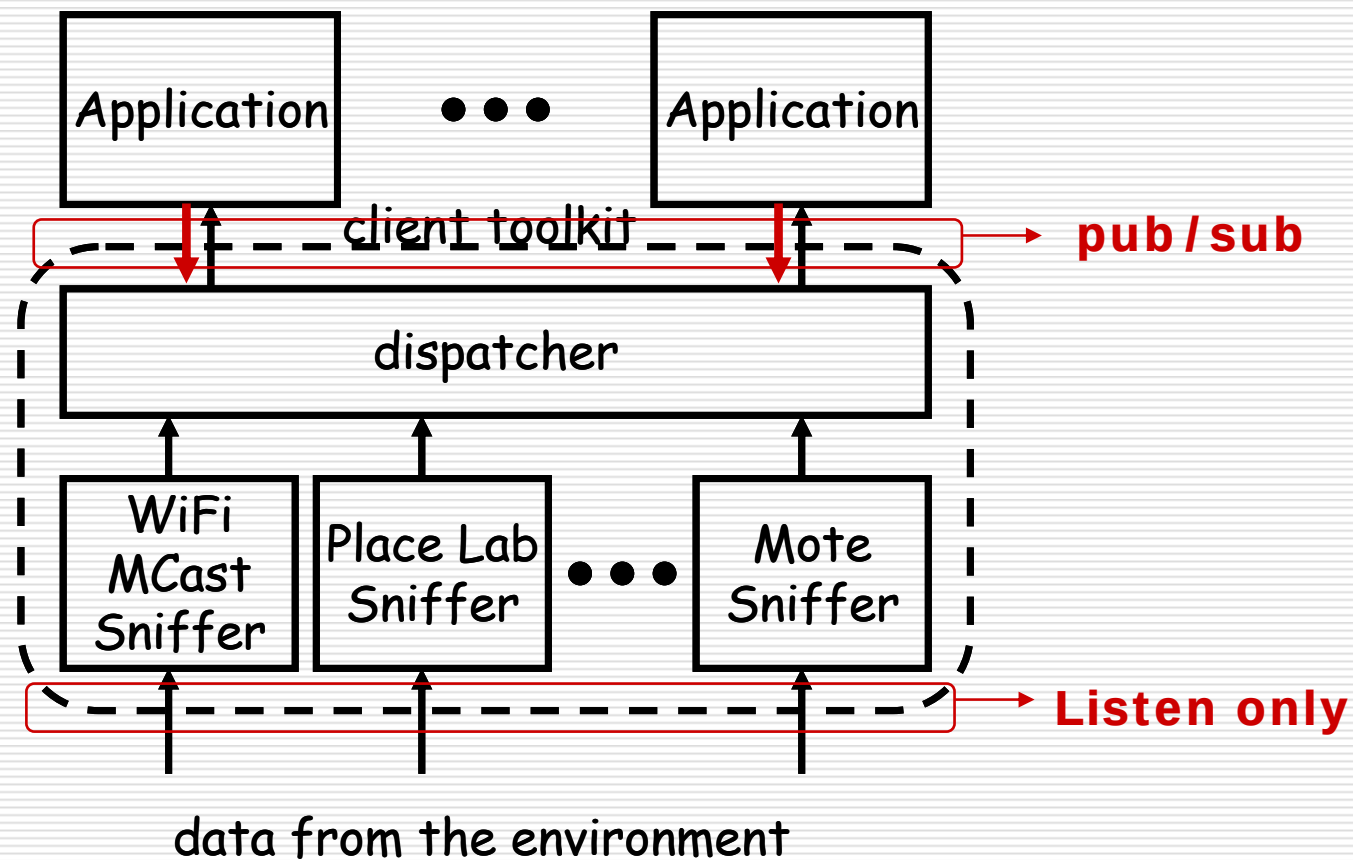
- ❑ Reminds users to pick up printed documents when they pass by a printer closet
- ❑ Broadcast data
 - Printer queues
 - RFID tags read in printer room
- ❑ Client app alerts the user if the list contains the user's documents



Broadcasting Infrastructure

- Broadcast data
 - Sensor data
 - Information from non-sensor sources
 - Capability tokens
 - Broadcast channel guide information
- Broadcast medium
 - Short-range wireless technologies
 - WiFi, RF, ZigBee, UWB, ...

Client Toolkit



Related Work

- ❑ TV, radio
- ❑ Microsoft SPOT: broadcasting digital data over sidebands of FM radio frequency
- ❑ Broadcast file systems
- ❑ HP Cooltown: URLs received over local IR channel and use to access object's web page over WiFi
- ❑ Location systems: passive listening
 - RightSPOT: FM radio version of Place Lab approach
 - RADAR: Place Lab approach with signal strength
 - MIT cricket: RF + ultrasound time of flight

Conclusion and Future Work

- ❑ Ubiquitous Broadcast Computing
 - Wireless broadcast of locally-relevant data
 - Privacy-friendly, scalable
- ❑ Future work
 - Building more applications
 - Scalability: coordinated use of bandwidth
 - Privacy for two-way communication



Question?