

*turning knowledge into practice*

# Mobile and Bluetooth Wireless Technologies in Longitudinal Surveys of Human Exposure- Related Behavior

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# Project Background

- EPA STAR Grant
- Investigate technology innovations to collect time, activity, location, dietary and product usage data accurately with low participant burden.
- Have sufficiently low burden that most members of the general household population of the U.S. will be willing to participate in the study for at least 1 week per season for 1 year
- **Pocket PC and Bluetooth based data collection platform**

# Technology Background

- **Bluetooth**

- Short-range communications technology, up to 30 feet, operates in 2.4 GHz spectrum, license free, no line of sight requirement, available worldwide.
- Low power, low cost, low interference, built-in security, ease-of-use, and ad hoc networking abilities
- Supports both data and voice transmissions
- Bluetooth SIG was formed in 1998; first Bluetooth consumer product in 2000

- **Mobile**

- HP Pocket PC hx4700 with Windows CE 4.2, moving to latest Windows Mobile 5.0
- Widcomm Bluetooth stack and Wi-Fi capability
- Windows SQL Server CE, open source OpenNetCF framework

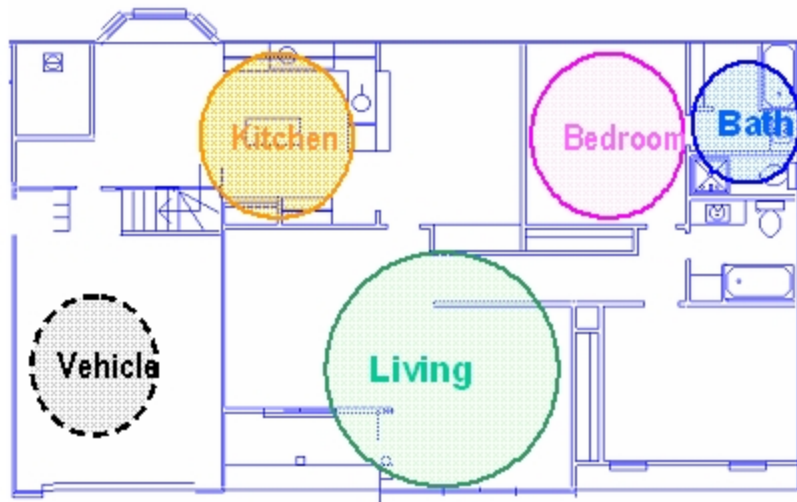


# Automatic Location Collection

- **Outdoor Location Tracking**
  - GPS for outdoor locations; wirelessly transmits to PPC every 5 minutes (configurable).
  
- **Indoor Location Tracking**
  - RF beacons for indoor residential locations; wirelessly transmit to PPC at one minute (configurable) intervals.



# Example Residential Beacon Application



# Beacon Evaluation Results

<b>Sensitivity (of presence in room)</b>	<b>67%</b>
<b>Specificity (of presence in room)</b>	<b>99%</b>

# Automatic Heart Rate, Product Usage Data

- **Real-time Heart Rate Data**

- Polar heart rate chest belt transmits wirelessly to PPC
- Data saved to SQL Server CE and analyzed later

- **Wireless Key fob and Scale**

Fob buttons are used to record on what product was used and when it was used for:

- Personal care products: soaps and shampoos
- Household cleaning products: kitchen and bathroom cleaners and sanitizers
- Pesticide products: Aerosols weighed before and after use; weights sent wirelessly to PPC



# Photo Diary

## Photo Diary

Pictures taken every minute

Pictures are reviewed daily by participants for privacy concern



120° Lens



Pocket PC



Laptop Censor and Analysis



# Development Tools and Technologies

- **.Net Compact Framework**
- **Open source OpenNetCF for Voice Diary**
- **SQL Server CE for Data Storage and Transmission**
- **C# for Bluetooth Communication Protocol Implementation**
- **VB.Net for GUI Implementation**
- **C for Embedded Programming on Body Pack, Beacon and Scale.**
- **Object-oriented, Multi-tier approach**

# Pilot Testing

- **Experimental**
  - **Pre-Pilot Test** – Pre Pilot testing with a total of 12 participants recruited from general population has been completed.
  - **Pilot Test** – 4 different experiment designs to compare different data collection methodologies (Paper, e-form, Voice, Photo). 40 homes (1 week) in Raleigh/Durham.

**Starts in less than 2 weeks ...**



# Lessons Learned

- **Mixed Technologies and Experiment Designs increased Complexity**
- **User Training and Compliance issue**
- **Usability**
  - **Body pack is bulky**
  - **Polar band uncomfortable,**
  - **Wireless headset uncomfortable, heavy, connection breaks up at times, quality of voice sometimes is bad**
- **Power Issues, Hardware issues, Software Stability**
- **Reliability -- noise, interference, wireless doesn't work 100% , Bluetooth is not yet a mature technology**

