**RESEARCH PLAN**

**Motivation and Background:**

WiMax is currently one of the most promising networking technologies considered for 4G wireless communication. In this proposal, we would like to explore the wide-area capabilities of WiMax, together with vast number of mobile phones, to create a **WiMax phone-based sensor network platform** that can scale up to millions of mobile phones and their users and cover a very large geographical area. Simply put, this project is about building a large-scale sensor network on top of mobile phones communicating over a 4G WiMax network. This sensor network platform will consisted of (1) a variety of built-in sensors (e.g., accelerometers, microphones, cameras, GPS, etc.) or application-dependent sensors (e.g., air quality sensors, etc.) on mobile phones, (2) WiMax as the data network for collecting and aggregating data sensed from mobile phones over large geographic area, and (3) a distributed, overlay networking platform for analyzing and processing sensor data over a large number of mobile phones.

![Fig. 1. Phone-based sensor network platform](image)

To demonstrate the feasibility and practicability of this phone-based sensor network platform, **green and health mobile applications** will be developed on this platform. These green and health applications will leverage the phone’s continuous presence with a person (“lifestyle companion” as called by Apple Inc.) and use it to motivate **green and health lifestyle routine change**. These applications will be described in more details later.

While the WiMax network is currently being planned and deployed in Taiwan, the WiMax service is yet available and accessible to us. In the meantime, we would consider other less-advanced, but currently available networks such as WiFi or cellular networks in our health and green applications. Moving from the less-advanced network to WiMax would be both easy and desirable for improving the quality of the applications to users.

**Green and Health Mobile Applications**

We will describe some examples of green and health mobile applications.

**Mug-Forest (Health):** This is the phone-extension of the Mug-tree project whose goal is to motivate office workers to drink water regularly and to develop a good water-drinking habit. Our extension comes in two parts. The first part is the phone extension, in which a person’s cell phone can be attached (detached) to his/her everyday drinking mug for enabling this service. By using available sensors on a smart phone, the phone can detect who/when/where/what is in a drinking action. For examples, a phone’s accelerometer can be used to detect a drinking action; a phone’s camera can be used to recognize what was the type of drink (i.e., water, soda, etc.); etc. The second part is the collaboration extension, in which many people’s drinking behaviors are virtually linked together to form a “forest”. That is, each user
participates by registering his/her phone to our system, and then he/she is designated a “tree” in a forest. His/her drinking habit would affect not only his/her tree but the overall wellness of the forest. We hope to use social collaboration for an effective habit development and behavior persuasion. This collaboration requires WiMax data communications about sharing each other’s drinking actions, as well as reminders and encouragements, over the phones.

**Garbage-Reduce (Green):** Everyday, we throw away trash without thinking about its effect on the environment and whether nature can keep up the speed of breaking down our waste than the speed of our waste generation. This project proposes a phone application that brings awareness on the amount of waste we generate. This is done by attaching simple sensors (such as weight or infrared sensors) to recycle or non-recycle trash bins. When a piece of trash is thrown into a trash bin, the bin will try to identify the person by searching for a nearby mobile phone. A game would then be played on a mobile phone to reflect his/her waste generation behavior, as well as to motivate waste reduction/recycle behaviors.

**Zero Carbon City Guide (Green):** This is a location-based capture and retrieval service that tracks a person’s impact on the environment in terms of the amount of greenhouse gasses that he/she produces. The service will provide location-aware wireless access via WiMax-ready mobile devices to useful recommendations on transportation, food, activities, and products that help reduce a person’s carbon footprint. The recommendations are contributed and maintained by the community in a Web 2.0 fashion. The service will identify sources of high energy consumption and issue timely alerts.

**Elders-Monitor (Health):** This is a location and vital-sign tracking application running on mobile phones for mobile elders with chronic disease or dementia. The tracking data is communicated through a wide-area wireless access such as WiMax. A mobile phone, carried by an elder, is equipped with a wearable GPS module that transmits his/her location information and vital sign sensors such as wearable heart-rate sensing module.

**Love-me, Care-me (Health):** This is about a care mediation tool for mediating care-giving and care-receiving between a depressor and his/her caregiver. This care mediation tool runs on a mobile phone. The goal is to reduce so-called “perceived burden” when giving, receiving, and requesting care. For example, a caregiver may have a day-time job, and may not always be available to provide care to a depressor. When a depressor requests care from a caregiver at an inconvenient times (i.e., during a meeting), the perceived burden on the caregiver increases - as the caregiver has to decide whether to stop his/her current activity to pay care to the depressor, or to continue his/her current activity by rejecting the request of the depressor. At the same time, the perceived burden on the depressor also increases. Since the depressor does not know the availability of the caregiver, the depressor must cope with the unpredictability of rejection from the caregiver. This mobile care mediation tool will use experience sampling method to enable the depressor and caregiver to both share and learn each other’s mood (care urgency), activities, and availability status. This tool will also explore the creative use of “dignity” and “empathy” design for care mediation.

**Significance**

This proposal fits well with Intel’s goal and investment to support Taiwan’s deployment of a nationwide WiMax network (a part of Taiwan’s M-Taiwan mobile program). New “data-oriented” application/services for consumers and application platform for mobile developers are needed to drive the growth for this advanced WiMax nation-wide network in Taiwan and demand for Intel WiMax technologies.

**Deliverables**

The project deliverables are described as follows:
Some of the project results will be published in academic publications. Our academic publications will acknowledge the general grants from Intel.

We will submit quarterly reports to Intel disclosing our progress in this project. In addition, we will also submit a final year report summarizing final results.

We will prepare and be ready for demonstration and showcase of our technologies for Intel visitors or other industry events.

**A project timeline and measurement plan (1 page)**

The project is planned with quarterly milestones. We anticipate the prototype implementation to be completed by the 1st quarter and begin the initial integration between the closely-related components during the 2nd quarter. The 3rd quarter is dedicated to the preparation of the demonstrator to be showcased in IDF. With the feedback, we plan to refine the system using the remaining time in the last quarter.

<table>
<thead>
<tr>
<th>I. Phone-based sensor network platform</th>
<th>1st Quarter (2008.8.01-2008.10.31)</th>
<th>2nd Quarter (2008.11.01-2009.1.31)</th>
<th>3rd Quarter (2009.2.01-2009.4.30)</th>
<th>4th Quarter (2009.5.01-2009.7.31)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design &amp; Implementation</td>
<td>Testing</td>
<td>Optimization</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Design and Implementation</td>
<td>User Studies</td>
<td>Optimization &amp; Redesign</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Delivering Items</th>
<th>Quarterly Summary</th>
<th>Quarterly Summary</th>
<th>Demo &amp; Quarterly Summary</th>
<th>Final Report</th>
</tr>
</thead>
</table>

**BUDGET**

- Personnel Expense
- Equipment Purchase
- Travel Expense
- University/Department Administration Overheads

**Total:** US$ 60,000