Project Timelines

- **Timeline**
  - Submit project ideas and groups by Thursday of Week 2
    - October 1, 2009
    - Rough sketch: goals, work, expected outcome, resources
  - Discuss project ideas in class on October 6, 2009
  - Detailed proposal, timeline by Thursday, October 8, 2009
  - Project mid-course report and presentation by Week 6
    - October 29, 2009
    - Five-minute presentation in class.

- **Final project presentations in the examination week or just preceding it**
  - Wednesday, December 9, 2009
Project Categories

- Core technologies (for the infrastructure: mobile, wireless)
  - Programming support, runtime system
  - Connection to the cloud
  - Time synchronization

- Environmental/Energy Applications
  - Sensor net related, measuring power, energy, water use
  - Actuation and control

- Biomedical/Healthcare Applications
  - Measurements, diagnosis, prognosis.
Example Platforms and Projects

Platforms:
- Android G1
- iPhone OS
- Intel XScale DBPX272
- Microsoft mPlatform
- Cypress PSOC
- Mote (SG imote/gumstix), Sunspot, iPod touch/iPhone, OpenMoko

Projects:
- Challenge projects: e.g., sub-100ns accuracy in time synchronization for sensor networks
- Device interfaces, their modeling, code-generation for embedded sensors
- Architectural modeling of embedded processors in a given language
- DSP library functions for a given Reconfigurable Processor
- OS/RTOS Services for Energy Minimization (eCOS)
- Embedded code library for a platform for baseband / media functions
- 802.11a MAC-layer implementation for Embedded applications
- SDR type projects using reconfigurable or ALU-array resources on chip
Project Ideas

- **iPhone and iPod touch**
  - We have an iphone, can get ipod touch relatively quickly
  - The differences have to do with GPS, Cellular radios

- **Interfacing these machines can require creative solutions**
  - For instance, Bluetooth
    - Iphone does not support serial profile (only HID)
    - One possibility: connect a smart cable from iphone to serial (e.g., [http://pcables.com/](http://pcables.com/))
    - Then use a serial to BT converter

- **Projects that seek to extend platform capabilities**
  - GPS to ipod touch (e.g., Leica gps module)
  - Combinations of GPS and IMU
  - Check [http://sparkfun.com](http://sparkfun.com)
Projects Related to ‘Signatures’

- **Motion signatures:**
  - Detect gait
  - Detect transportation modality, potholes

- **Sound signatures:**
  - Detect sleep cycles (snoring), build adaptive alarm clock
  - Specific events: collision

- **Radio signatures:**
  - Detect spectral signatures, localization

- **Combine with internet access (see next)**
Internet as extension of embedded platform

- Projects related to ultra-lightweight internet access
  - Web services (browser or browserless)
  - Authentication with new ROTs
- Projects that use internet as extension of computation, data
  - Correction on differential GPS
  - Database access (location services)
  - Upload databases (bike paths)
- Google Wave
<table>
<thead>
<tr>
<th>Project</th>
<th>Goal/Success Metrics</th>
<th>Platform</th>
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<tbody>
<tr>
<td>Vehicle Access Community Wireless Network</td>
<td>The demonstration of real system. 2) The network measurement: handover delay, throughput, QoS of virtual AP, comparison with recent work at Mobicom and Mobisys. Mobility prediction models? Geospatial referencing. Look up Thomas Weng regarding instrument geolocation information on IPv6.</td>
<td>Xscale (PXA272)</td>
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<tr>
<td>Ad-hoc time synchronization in wireless networks</td>
<td>Demonstration of a successful ad hoc time synchronization; establish limits on jitter and performance of synchronization protocol.</td>
<td>Lego MindstormsNXT</td>
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<td>Gait detection using accelerometers</td>
<td>Our project goal is to develop a complete and scalable system of accelerometers inter-connected by an I2C bus and interfaced to a data accumulation device. Data could either be processed on a mobile platform in real-time or could be post-processed after the completion of the experiments.</td>
<td>Cypress PSOC</td>
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<td>Enhanced localization via Internet</td>
<td>Demonstrate system on a commodity embedded device -Can mobile platform use enhanced localization to get -&gt; More accurate position data in long test? -&gt; More accurate &amp; faster initial fix? -How much more power is used? -Is tradeoff of power for accuracy reasonable?</td>
<td>PC104</td>
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Examples

- Coordinates data from each Slave through PC communication protocol
  - Buffers data
  - Sends data on to PC

- Translates Serial Data to USB for PC

- Processes incoming data and estimates part type

- Provides analog inputs for each accelerometer
- Converts data to 12-bit digital
- Sends data when requested

Slaves

PC + Power

Master

FTDI

USB

DE-ACCMB3D

CYSC29456-PX1
Example
Augmentation

MCU (ARM, MIPS)

- GPS coordinates
- RS-232
- RTCM data

UART

RF Core

CPU Core (ARM)

DSP Core
Project Ideas

- Duty Cycling for Power Savings
  - Processors can be duty-cycled into sleep states
  - But that takes latency in waking up
  - What takes time in “booting up” machines?
  - Goal: study boot-time performance of selected OS. Add duty cycling capability. Explore features to minimize boot time.
Project Ideas

- Localization and augmentation of localization information

- Problem: GPS localization is accurate to 10 ft. What will it take to make it accurate to less than 1 ft? 10 cm?

- Goal: explore augmentation techniques (infrastructural, ad hoc, global, local) to improve
  - Availability
  - Accuracy
Project Ideas

- Wireless JTAG for Remote Debugging

  - Goal: Ability to remotely debug wireless sensor nodes deployed in the field

  - Approaches:
    - Use additional logic between radios and processor to intercept debugging commands
    - Use p2p among sensor nodes for debugging, testing
Project Ideas

- High accuracy time synchronization of wireless nodes
- Current approach on sensor nodes can get to a few microseconds
- Characterize sources of error and latency
- Implement to reduce synchronization time: beacons, crystals, stack modifications
IEEE 1588 over 6LoWPAN

- IEEE 1588 is a standard for precision clock synchronization protocol for networked measurement and control system
- 6LoWPAN is a standard for IPV6 over low power wireless personal area networks
- Goal: implement 1588 based time sync on top of 6LoWPAN on motes+TinyOS or another platform
Sensor Discovery Service for 6LoWPAN

- Zeroconf is a service discovery protocol
  - Locates devices such as printers, as well as other computers, and the services that those devices offer on a local network using multicast Domain Name System service records (Bonjour by Apple)

- Project Goal: implement a lightweight service discovery protocol for 6LoWPAN that helps locate sensing and actuation services
**iPhone/G1 + 6LoWPAN based for Energy Monitoring**

- WattsUp? Monitors electrical energy at plug outlets
- Normally connected using USB or ethernet
- Project Goal: create a system with an iPhone or Android application to monitor and control energy use from a network of 6LoWPAN based electrical outlet monitors
  - Real-time plots and statistics
Localized Social Networking

- Use G1/iphones to build dynamic graphs of neighbors and overlay with FB friend graphs
- Offline localization
Some Project Submissions
Mobile Interface to Industrial Control

- **Problem:**
  - Plan consoles is attached to equipment, may not be accessible.

- **Mobile Console**
  - Application to communicate with the device controllers using Modbus or OPC
  - Make data available over LAN/WAN on WiFi etc

- Currently one person, another can join and split hardware/software work.
Health/Sensors on mPlatform

- The platform provides some FPGA resources
  - Currently used for communication purposes
- Can these be used to improve efficiency of sensing or sensor data processing?
- Devise an extensible platform for biomedical sensing.
Real-Time Task Scheduler for SHiMMER

- Explore architectural alternatives
  - Event driven versus time-triggered
  - Cost of preemption
  - Composability of task modules