Large Area Printed Electronics

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**SWARM LAB COMPONENTS**

- **The “Immersive Electronics Lab”** – exploring a broad range of alternative technologies to the traditional silicon scenario. Mostly orthogonal to the Marvell Lab in Sutradja-Dai Hall, this lab will explore wet-lab based manufacturing technologies for ultra-low power as well as large area electronics.

- **The “nano-mechanical” lab** – exploring the opportunities of NEMS devices including sensing, computing and communication.

- **The “swarm incubation” lab** – providing a playground for Swarm applications and platforms. Would use selected number of targets (e.g. smart grid, BMI and healthcare, immersive User Interfaces.)
ENABLING THE SWARM: 
THE QUALCOMM SWARM LAB AT BERKELEY

“Create an open and universal platform to foster the creation and distribution of a broad range of innovative swarm applications”

An incubator for Swarm applications, building on Berkeley’s combined strengths in technology, circuits, architectures, software and systems

<table>
<thead>
<tr>
<th>Integration</th>
<th>Swarm App Store</th>
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</thead>
<tbody>
<tr>
<td>Middleware and services</td>
<td>Swarm-OS</td>
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<tr>
<td>Distributed Sense-Control-Actuate Platforms</td>
<td>Innovative Devices and Materials</td>
</tr>
</tbody>
</table>

Addressing concerns such as ease-of-use, complexity, responsiveness, reliability, security and efficiency. In close collaboration with Berkeley centers such as BSAC, BWRC, Trust, Chess, MuSyC, ParLab, AMP, BITS.
Novel electronic materials (e.g., III-V on Si and plastics, nanostructures, graphene, organics), and devices for exploring a broad range of alternative technologies to the traditional silicon scenario.

Developing an entirely new processing platform for integrated electronics and sensors, and energy harvesting systems.

Roll-2-Roll Processing

PV rolls
Flexible electronics
Paper-like displays
Food freshness sensors

XoY Electronics: All-on-All
All Additive Printed Arrays

This is a flexible printed backplane integrated with a flexible display media ≠ flexible system

All-printed TFT backplanes suitable for driving reflective displays

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Printed sensors monitor pressure, acceleration, audio, temperature and light continuously.

Sensor signal is sent to the memory through an amplifier.

Memory array is addressed when an event is recognized by a series of sensors.

### Blast Dosimeter Specifications

<table>
<thead>
<tr>
<th>Sensor Type</th>
<th>Specifications</th>
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<tbody>
<tr>
<td>Pressure sensor</td>
<td>0-50 psi</td>
</tr>
<tr>
<td></td>
<td>50-150 psi</td>
</tr>
<tr>
<td>Light sensor</td>
<td>0-400,000 lx</td>
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<tr>
<td>Acoustic sensor</td>
<td>100-185 dB</td>
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<tr>
<td>Accelerometer</td>
<td>0-500</td>
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<td></td>
<td>500-1000</td>
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Electronics need to operate at 200 Hz.
Disappearing Electronics

- Electronics will be embedded into our clothes and bodies

- In order to be seamless to the user, will need to:
  - Be extremely low-power
  - Maintain constant wireless links to the cloud

- Solution: keep the wireless links short & localized…
Leveraging the Environment

• Walls are generally much closer than the nearest base-station…
  • And electrical power already routed to them…

• Vision: eWallpaper

With Elad Alon and John Wawrzynek, from Berkeley Wireless Research Center
Potential Applications

• Providing access to the “cloud”

• Local computation and storage
  • Could actually serve as a “cache” for the cloud…

• Imaging
  • People and the devices on them
  • Gesture recognition

• Wireless powering
**Printed Pulse Oximeters:** Bandage-like, less invasive, more disposable, less sensitive to motion-caused error

- Integrating printing photodetectors with printed light source
- Red photo excitation and light absorption from red emitting polymers.
Integrating capabilities to improve human health, safety, convenience...

Ubiquitous Medical Diagnostics and Therapeutics
nanomaterials for the body monitoring revolution

Roll-to-roll nanoelectronics

Resorbable scaffold electronics

Interactive Bandage
Vital Sign Monitoring

heart rate
pressure
blood glucose
proteins

infection?

wound field
pH, O2, strain

Resorbable Bone Regeneration

Printed nanosensors and actuators
Hardware for Magnetic Resonance Imaging (MRI)

State of the art: One size fits all

Printed Flexible Receiver MRI Coils enable customization, reduce imaging time
Printed MRI Receiver Coils

From one coil to a customized coil array

Cloth-like flexible coils can either be attached to clothing or form a tailored shirt for a tight fit.
What is needed to make flexible electronics happen

- **Flexible systems**
- Development of electronic building blocks
- Development of sensors: sensors add functionality and make a system unique
- Development of simple memory or display
- Power sources: optimized for charge/lifetime of a specific system
- Integration of components
- Demos