Swarm Visions Symposium
December 6, 2011

THE UNPAD

JOHN WAWRZYNEK
HUMAN CENTRIC DEVICES

Desктops ➔ Laptops ➔ Handhelds ➔ ???

Smartphone > PC Shipments Within 2 Years – Implies Very Rapid / Land Grab Evolution of Internet Access

Global Unit Shipments of Desktop PCs + Notebook PCs vs. Smartphones, 2005 – 2013E

2012E: Inflection Point
Smartphones > Total PCs

Morgan Stanley

Note: Notebook PCs Include Netbooks. Source: Katy Huberty, Ehud Gelblum, Morgan Stanley Research. Data and Estimates as of 11/10
HANDHELD

- Problems:
  - limited interactivity, weak interfaces,
  - content largely lives on device*, so must carry it with you,
  - large form-factor.

* iCloud, google-docs, help. Oceanstore is a better idea!

OceanStore: An Architecture for Global-Scale Persistent Storage

John Kubiatowicz, David Bindel, Yan Chen, Steven Czerwinski,
Patrick Eaton, Dennis Geels, Ramakrishna Gummadi, Sean Rhea,
Hakim Weatherspoon, Westley Weimer, Chris Wells, and Ben Zhao
University of California, Berkeley
http://oceanstore.cs.berkeley.edu

6/9/2011
Desksops ➔ Laptops ➔ Handhelds ➔ unPad

*Long Range Vision of the BWRC*

- The “pad” goes away, but its functionality (plus more) stays: unpackaged communication, computation, storage.
- **People seamlessly interact with content, the environment and one another through of collection of interconnected sensors and actuators.**
  - Sensors and actuators cluster as needed for a particular functionality.


* E. Alon, B. Broderson, G. Kelson, K. Lutz, A. Niknejad, G. Nikolic, J. Rabaey, P. Wright, A. Wolisz

**Will suitable sensors and actuators exist to make it feasible?**

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AUDIO AND VIDEO
An Ultra-Wearable, Wireless, Low Power ECG Monitoring System

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Fig. 3. (a) QUASAR ECG Sensors, (b) Sensors attached on a T-shirts and worn on a human body

For long-term use, such devices could be implanted.
Skinput: Appropriating the Body as an Input Surface

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Figure 11: Our sensing armband augmented with a pico-projector; this allows interactive elements to be rendered on the skin.

A wristband that uses sonar on the skin to detect where someone taps their finger along their arm -- in this way it puts virtual buttons on your arm you can press.
Pinstripe: Eyes-free Continuous Input on Interactive Clothing

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Figure 1. To use Pinstripe, you pinch and roll a fold of your garment between your fingers. This easy gesture allows you to control a linear value on a mobile device.

Figure 8. Typical Pinstripe gesture. Most users associate moving the thumb in the ‘out’ direction with an increase in value.

Smart clothing -- a T-shirt whose fabric you can pinch in different places, the T-shirt knows where you pinched and sends body-centric messages out.

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**EWallpaper**

E. Alon, A. Arias, J. Wawrzynek

2D mesh connected nodes:
- CPU, memory, RF transceiver,
- antenna, other sensors
  (acoustic, IR)

PWR / Enet
**eWallpaper Applications**

Computing/storage/communication/sensing

- RF imaging
  - Full awareness of room occupants
- Narrow-beam communications
  - Simultaneous device to device and device to WAN and wired networks
- Power delivery
  - Beamed power to lightweight sensors/actuators, possibly body embedded
- Computation/storage
  - Data trans-coding, routing, personal profile caching, “OS” functions (resource allocation, security, ...)

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[Image of eWallpaper technology]
Watching video/TV is the most common pre-sleep activity.

Video delivery will be (is) a major consumer of internet energy.

Adam Wolisz - similar application using attention detection
LIMITLESS AND UNPREDICTABLE POSSIBILITIES OF THE UNPAD

- **Health care**: potential for continuous monitoring, prediction, recommendation
- **Family & Social Life**: remote interaction, scheduling, etc.
- **Education**: remote teaching
- **Entertainment**: interactive games, movies, ...
- **Commerce**: shopping
- **Business**: remote presence, collaboration
- **Public Safety**: first responders, public broadcast
- **Military**: networked troops

Absent a grand-plan, danger of “stove-piping”. Ad hoc solutions specific to particular domains (teleconference, sensor-nets, police/firefighters).

Economies of Scale: Once sensors and actuators are everywhere, developers rely on them (Jan).
BIG SYSTEM-LEVEL CHALLENGES FOR UNPAD

1. How to optimally control allocation of resources? spectrum, space, energy, computation, storage, sensors/actuators

2. How do we permit the necessary economies of scale (portability of applications, sharing of functionality, etc.)?

3. How are applications developed and deployed?

Answering these questions will require a holistic (systems level) approach, and must borrow ideas from many areas of EE and CS.

A few simple abstractions are key (e.g., Unix file device abstraction, BSD sockets)
Hierarchical “Service” Model

- Sensors/actuators (with associated computing/storage) advertise availability of service (ex: temperature at some location)

- Other computing agents wrap-up sub-services and advertise enhanced service (ex: current weather)

- Ex: Personal agent then uses service to recommend. “Should I run in Tilden Park today or go to the gym?”

A similar service model could work for abstracting the underlying mechanisms of commissioning spectrum, computation, storage, routing, ...
THANKS!