The Cell Phone and the Future of Mobile Computing

UCLA / CENS

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Talk Overview

- Observations about the mobile market
- Technology trends
- Opportunity for cell phones & mobile computing
- Spectrum of solutions to mobile issue
- Personal Server model
- Issues: ease of use, security, power
- Demonstration of phone-based mobile computing
- Future
Usability Issues for Mobile Devices

NOTEBOOK:
Too large and heavy for anywhere use
BUT DE FACTO MOBILE PLATFORM

Pocket Sized

Attractiveness for mobility

PDA

Cell Phone

Pocket Sized
The mobile phone is the most successful mobile computer there has ever been.

Bluetooth rides the cell phone wave of success.

Cell Phone Shipments Worldwide

Comparison w/ 2005/6

IMS 2004-10

Terminals Shipped (MU)

2002 2003 2004 2005 2006 2007 2008 2009

Bluetooth Terminals Non-Bluetooth Terminals

2005: 545.2 431.2
2006: 460.9 393.7
2007: 329 208.8
2008: 154.4 423.8
2009: 680M

Hands-on estimate: 833M

IDC 2007

2005: 1022M
2006: 82M
2007: 65M

Cell Phones

Notebooks

Cell phone shipments worldwide.
Could cell phones change the mainstream use-model for mobile computing?
Mobile Technology Drivers

1. Computationally Powerful Processors
2. High-Density Storage
3. Wireless Communication (standards)

PLUS

Miniaturization & Low Power
Some Mobile Processor Trends

Intel® XScale™ Family

MAX

- StrongARM ~200MHz
- Cotulla ~400MHz
- Bulverde ~600MHz
- Monahans ~1GHz+

At under 1 Watt

Low-power IA processors coming soon!
Storage Trends

1GB: = 1000 high quality photos, 250 MP3 songs, 1-2 MPEG4 Movies

Significant Storage for Daily Needs in 1 sq. inch
Examples of High-Density Mobile Storage

Toshiba: Tiny Disk Drive
4GB and increasing

USB Flash Disk on a keychain

Nokia high-end N91
complete with a 4GB hard drive which can store up to 3,000 songs

Nokia
Bandwidth & Mobile Computing

'Never underestimate the bandwidth of a station wagon full of tapes hurtling down the highway.'


13Gbps between Palo Alto & Santa Clara

10 x 100GByte Backup Drives

10 miles

60 mph
Store your life experiences

I’m somewhere here

A lifetime of storage 80 years

Storage Required (80 years, 16 hr/day)

Audio 16 kbps 3 TBytes 2014
The size of the display and keyboard are a problem for mobility.

Do you want to do ‘real work’ with the PC display on the left or the cell phone display on the right?
BUT….Electronic Displays are Becoming Ubiquitous

Displays on Airplanes

Work

Home

Internet Access In a Hotel Room

Displays in Public Places
An Opportunity for Mobile Computing

Use the combined resources of cell phone and PC/Display for mutual benefit.
Co-opting a Remote Display/Computer

Approach for interacting with your data:

- Virtual Network Computing (VNC) & Remote Desktop Protocol (RDP)
- Internet Suspend Resume (ISR) – Intel CTG
- SoulPad - IBM [VM boot from flash-disk]
- Personal Server [local wireless server]
- MetaPad – IBM [Dockable compute module]
- Portable PC

- Display Cable
- Network Cable
- Wireless Network
A spectrum of mobile solutions

Less Latency

Carry More

More Latency

Carry Less

Notebook

PC

Meta-pad

Personal Server

Soul-pad

ISR

VNC

Physical Transport

Network Transport
Personal Server Project

Access your data via a web interface

SERVER

BLUETOOTH

My mobile web page

CLIENT
Cell Phone &
Personal Server Demo
Easy Wireless Links

Take a photo of a PC and you are connected!

Camera solution

Camera Captures Optical Tag

Paired

Other solutions NFC mediated connections

Short range physical security ensures that only the camera-phone can capture the information
MAC ADDRESS & PIN (128 bit)
The Problem

If you use a password to access your mobile device using the un-trusted infrastructure, your password will be at risk from key-catchers

Solution

Challenge/Response: Photographic Authentication
**Wireless Personal Media Server**

**Bringing Mobile Content into the Digital Home**

**WIRELESSLY DISPLAY, STREAM, AND DOWNLOAD CONTENT**

- **MOBILE DEVICE**
  - DLNA MEDIA PLAYER
  - WEB SERVER
  - MEDIA SERVER

Applications: Web Pages, Audio & Video

- **Digital Media PC with DVR**
- **SET TOP BOX**
- **Digital TV**

Bluetooth Connections
Remote Frame Buffer (RFB) Protocol

E680 Cell Phone

E680 demonstrates a cell phone providing a full computing experience
Sensor Network Phone Integration

Extending the platform with a sensor bus interface (PSI)

GPRS link

Phone with PSI attachment

Wearable 802.15.4 sensors
Content Creation: Increase resolution of photos

- Cell phone takes several quick-fire low-res photos of a subject
- Images are automatically & wirelessly transferred to a PC
- A super-resolution photo is generated (PC) with image processing
- A copy of the photo can then be sent back to the phone for storage & transport and/or replacing the originals

In collaboration with Nanovision Group
Power Management with Multiple-Radios

Backbone Network

Mobile Device (e.g., cell-phone)

WiFi HOTSPOT

WiFi 80nJ/bit
Bluetooth 120nJ/bit

COOLSPOT
Coolspots Power Management

- Effective power-saving by managing multiple radios
- Coolspot power-saving can double the operational battery lifetime

**Graph:**
- X-axis: Power (mW)
- Y-axis: Wireless Policy
- Data points:
  - Comm Power
  - Syssem Power
  - Battery Lifetime (Hours, 1300 mAH battery)

**Diagram:**
- IP
- Bluetooth
- WiFi
- Switch

- Left:
  - Mobile device
  - Switch
  - Bluetooth
  - WiFi

- Right:
  - Laptop
  - Switch
  - Bluetooth
  - WiFi
Future Drivers for Cell Phone Computing

- Low-Power IA Processors (LPIA)
  - Enabling the cell phone to run x86 binaries

- Tiny High-Density Disk Drives
  - Carry all your applications and data with you

- Ultra Wide Band (UWB) Radio
  - Local radio communication at 100Mbps+
  - Better Transmission Energy per Bit
  - Rapid syncing or movement of data
  - Sharing applications / state
Smart phones with IA processors have the potential to provide mobile professionals with an effective computing capability.

The limitations of a phone’s display and keyboard can be mitigated by wireless access to nearby high-quality displays.

Novel use models, security and power management are key to supporting wireless use.
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Q & A