Web-Based Nomadic Computing

John J. Barton
Nomadic Computing Department
Hewlett Packard Labs
Palo Alto, CA

"By hyperlinking the physical world and extending web technologies to exploit those links, we support nomadic users of ubiquitous computing devices."
Nomadic Computing

• Ubiquitous Computing (Kindberg & Fox):
  – Spontaneous interaction
  – Physical-virtual connection

• Nomadic Computing is Ubicomp where
  – Mobile, autonomous systems require spontaneity
  – Physical/virtual connections support mobility.

• Beyond Mobile Computing
  – But somewhat short of Star Trek.
Web-Based System for Nomadic Computing

Services

Content & URL Exchange
Context

URLs

Text URLs
URL sensing
WebID
ID sensing

places

http://cooltown.hp.com

beacon

tag
Web-Based System for Nomadic Computing

Services
- Content & URL Exchange
- Context

Places
- URLs
- Text URLs
- URL sensing
- ID resolution
- ID sensing

http://cooltown.hp.com

beacon

- tag
Physical URL Sources

- Infrared Beacon
- URL “Localcast”

Opaque ID
- WebId: ID->URL

Barcodes

Radio freq. tag

(but beacons can give ids and rfid can give full urls)
Web ID, Physical Hyperlinks

- Root Resolver
  - Lookup Bindings for Local Resolvers
    - Bindings to Web Resources
      - Bill Gates's Home
      - Carly Fiorina's Home

- Redirect to Local Resolver
- Local Resolvers

Scan Barcode (or RFID or...)

- Web ID, Physical Hyperlinks
Locations as URL Sources

GPS +

Electro-magnetic Compass

\{ (position, radius) \Rightarrow URL \}
Physical Sinks for URLs
Handheld clipboards for URLs

IDs/URLs

get URL

squirt URL
What Physical URLS Mean: Web Presence

Web

Physical

Jeff

<a:person xlink:href=.../>

<a:place xlink:href=.../>

<a:thing xlink:href=.../>

<a:person xlink:href=.../>

<a:place xlink:href=.../>

<a:thing xlink:href=.../>
Things with Web Presence

ID Tag
Places with Web Presence

![Image of a computer screen showing a web page for the Eureka Conference Room. The page includes details such as location, capacity, and network connection. There are also icons for a beacon and a wireless network.]
Can Users Use This Stuff?

User study at the Exploratorium Science Museum, SF
Physical vs. Virtual navigation

Virtual

Physical

Web pages

Exhibits
Web-Based System for Nomadic Computing

![Diagram showing a web-based system for nomadic computing with sections for "Content & URL Exchange" and "Context".](http://cooltown.hp.com)
Context Dependence With Web Presence Manager

debaty.register(Eureka)

Eureka.URL
<?xml version="1.0" ?>

<person>
  <wpid>debaty</wpid>
  <type>hp employee</type>
  <icon>http://debaty/me.jpg</icon>
  <first-name>Philippe</first-name>
  <email>debaty@hpl.hp.com</email>
  <telnet>236-5010</telnet>
  <last-name>Debaty</last-name>
  <template>jsp/myportal.jsp</template>
  <directory-url>http://debaty2.hpl.hp.com:8080/wpm/debaty.directory</directory-url>
</person>
my personal web presence

Welcome Philippe Debaty.
Again, but now on that tiny screen
Dynamic, Physical hyperlinks + transforming proxies = Context Dependence
Beyond Context-Dependent Information

• Context-Dependent Information
  – Portable Web Browsers
  – Physical Hyperlinks
  – Meta-services for discovery

• Context-Dependent Media Creation
  – Portable Sensors
  – Context aggregation
  – Meta-services for registration
The Basics Of Upload

This API should be about moving this data.

produces

accepts

house.jpg

This API

house.jpg

produces

accepts

house.jpg
Glimmer: Sensor Enhanced Web Clients with Spontaneous Service Discovery
Type-dependent Discovery; Sensor-fill in of Forms

- Sensor Types
- Service Types
- Communications Types as hourglass
- "Glimmer"

Sensor data

"produces" header

G-form URLs

Service Selection

Eureka

Form-Based Interaction

results
Service Selection for Sensors

- PDA
- Camera
- Service List

Accepts

Media

Produces

Service List

Services

Produce/accept

Service List
Form-based Interaction

• Like buying a book from Amazon.com
  – No amazon.exe.
  – But input is sensor data rather than keystrokes.

• “sensor-enhanced” web client.
  – Sensors directly fill appropriate slots in the form

• W3C XForms.
  – Separates form structure from presentation.
  – Provides constructs to describe relationships among different form slots.
Use of XForms Constraints

- “Relevant” constraint enables proper sequencing of events.
- Some form slots can be specified as optional.
- The cardinality of a sensor value can be specified.

```xml
<xforms:bind ref="my:world/my:time"
    relevant="../my:world/my:picture" type="mime/time"
    required="false"/>

<xforms:bind ref="../my:world/my:barcode"
    maxOccurs="10" minOccurs="1" type="mime/id"/>
```
Physical Registration.

Eureka meeting room Web page

Physical registration
Web Forms + Appliances = Web Pages

Device Aggregation

Appliance Data Services

Squirt MLS Form Here

Squirt Business Card

Squirt Photo Here
Web Services for Handheld Digital Sensors
w/ NCD and Stanford groups
Web-based Nomadic Computing

Physical world
Metaservice
service
Interaction model
content structure
encoding
transfer
transport

Physical Hyperlinks Sensorable-Clients
WebID Service-Selectors WebPresence
Services
Browsing Glimmer Forms
XForms (w/input extensions)
XML (Parsing) MIME (packaging, types)
HTTP
TCP/IP…
People

- Web Presence Manager
  - Philippe Debaty, Patrick Goddi, Alex Vorbau, Nic Lyons.
- Exploratorium
  - Mirjana Spasojevic, et al.
- Glimmer & Web Services
  - Tim Kindberg, Andy Fitzhugh, Nissanaka Bodhi Priyantha, Hui Dai, and Fahd Al-bin-ali
- Appliance Data Services
  - Armando Fox, Andy Huang, Ben Ling (Stanford University)
- Wireless Information System Emulator
  - Vikram Vijayaraghavan, Mary Baker (Stanford University)
  - Fredrick Espinoza, Markus Bylund, (Swedish Inst. Comp. Science)
- GLAD
  - Margaret Fleck, Marcos Frid
- Security & Privacy
  - Kan Zhang, Narendar Shankar
- Coolbase
  - Wesley Chan
- www.cooltown.com
  - Megan Taylor
- WebSign
  - Salil Pradhan, et al.
- BadgePad
  - Mark Smith, et al.
http://www.cooltown.com

http://handhelds.org

http://www.exploratorium.edu/guidebook