Ubiquitous Information Access and M-Links

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Ubiquitous Computing Vision

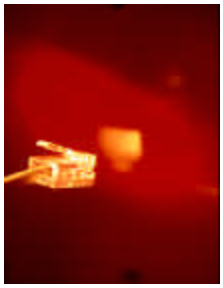
"Each person is continually interacting with hundreds of ... interconnected computers" [1] which ideally "weave themselves into the fabric of everyday life until they are indistinguishable from it" [2].

1."Some computer science issues in ubiquitous computing," *CACM,* 1993
2."The computer of the 21st century," *Scientific American,* 1991

An Elusive Ideal

Ubiquitous computing ⇒
Ubiquitous information access ⇒
Ubiquitous *content*, *devices*, *networks*





Ubiquitous Content

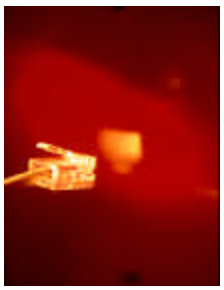
- "Any" electronic content
  - E.g., text, images, audio, video
  - E.g., forms, services, applications, games
- Requires:
  - Powerful CPUs, memories, displays, input devices, software
  - High bandwidth networking
- Best current example:
  - World Wide Web

Ubiquitous Devices

- Devices that are always “at hand”
- Requires:
  - Devices embedded “everywhere” in the environment
  - Highly portable devices carried by “everyone”
- Best current example:
  - Mobile phones
    - +60% Scandinavia
    - +50% Europe/Asia
    - +30% U.S.

Ubiquitous Networks

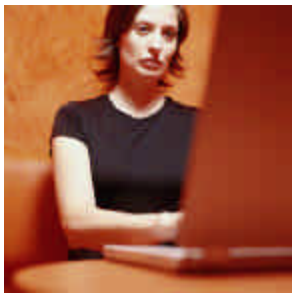
- Networks that don’t “tie us down”
- Requires:
  - “Universal” coverage
  - “Unlimited” bandwidth
- Best current examples:
  - Ethernet
    - High bandwidth *but* local areas
  - CDMA/TDMA
    - Wider areas *but* lower bandwidth



Tensions: Content

- Increasing **content ubiquity** limits device portability, network mobility





Tensions: Devices

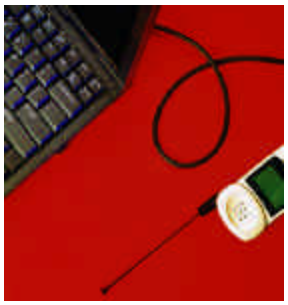
- Increasing **device ubiquity** limits content, network bandwidth




Tensions: Networks

- Increasing **network ubiquity** limits network bandwidth, and thus content capabilities





Pushing on: Content

- Embedded devices
  - Teleporting (Richardson et al.)
  - eClass/Classroom 2000 (Abowd et al.)
  - Smart Media Spaces (Wilcox et al.)
- Wearables
  - Olympus Eye-Trek
  - MicroOptical eyeglass displays
- Transducing/transcoding
  - Digestor (Schilit et al.)
  - Top Gun Wingman (Fox et al.)
  - PowerBrowser (Buyukkokten et al.)

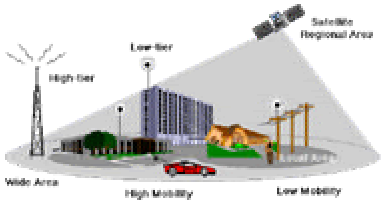


Pushing on: Devices

- Research
  - PARCTAB (Want, Schilit, et al.)
  - CyberGuide (Abowd et al.)
- Commercial
  - Pocket PC, Palm OS devices
  - Web phones
  - Pagers

Pushing on: Networks

- Disconnected use
  - AvantGo
  - TeleWeb (Schilit et al.)
- Multiple networks
  - Daedalus/BARWAN (Brewer, Katz, et al.)



Challenge

- We can't have it all (currently)...
- Hard to change device and network ubiquity
- Start with today's most ubiquitous devices and networks:
  - Mobile phones
  - Mobile phone networks

+

- And try to add content ubiquity
  - World Wide Web

Divergent Trends

- Desktop computers and wired networks continue to **increase** in speed and power

  ⇒ ever richer content will flourish on the Web

- Mobile phones continue to **decrease** in size and weight

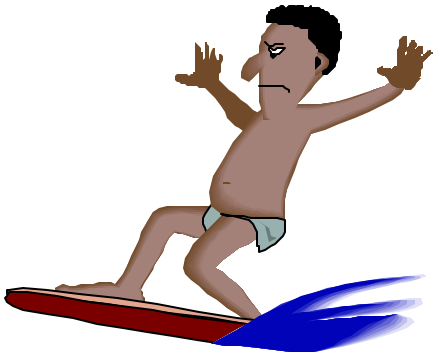
  ⇒ CPUs, memories, networking, and ***tiny displays and input devices*** will be even harder pressed to deal with the content

We want the *whole* Web anytime, anywhere...

...but without the backache!

The M-Links System

...or surfing the Web on a 5” board



video

images

Specially authored content
for mobile Internet devices is a small island

annual reports

white papers

music

train schedule

stock quotes

horoscopes

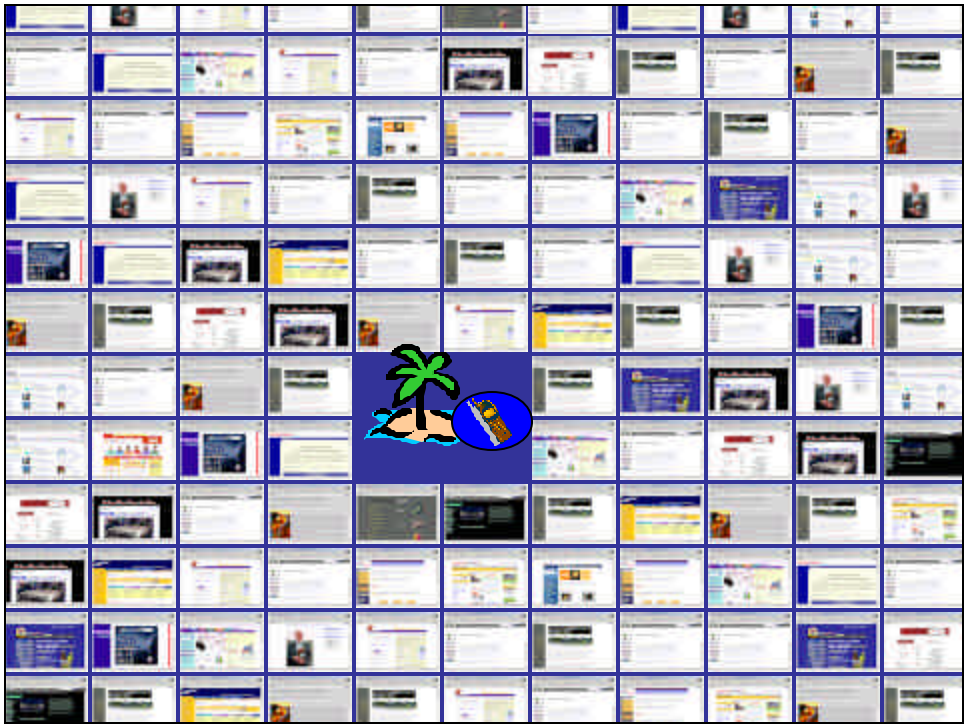
Research papers

weather reports

presentations

product info

in the
World Wide Web Ocean

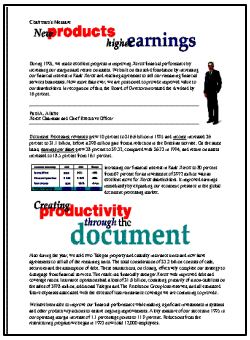


Web Reader's Digestor

Bickmore & Schilit, WWW6, 1997

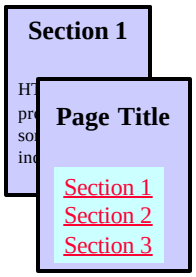
device-independent access to the Web

Digestor converts a big web page into
many small web pages better suited for each device



Transform based on

- Web content
- Device
- User preference



What We Learned

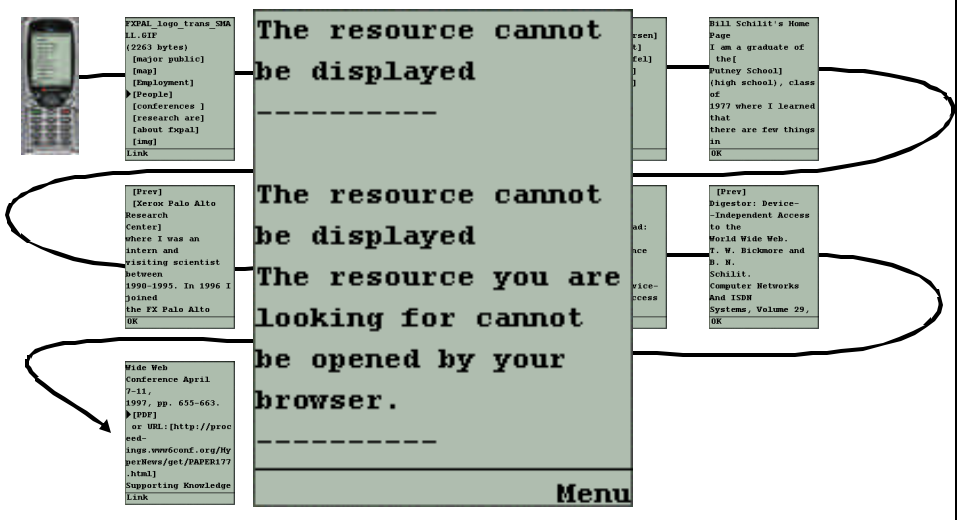
Digestor and other transcoders break down on very small devices

- Painful to use – even a small UI takes up too much space and causes confusion
- Getting at useful bits of information through such a small window is tough
- Users don't think reading is *the* application

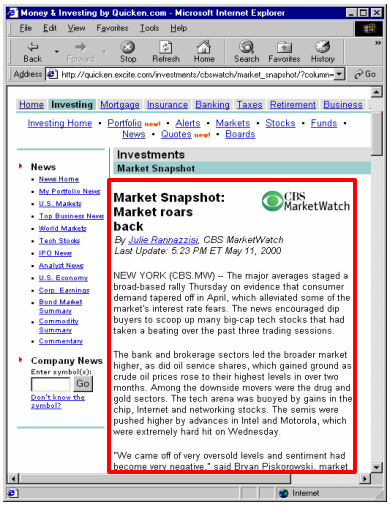
Characteristics of very small devices

Make Model	Network	Markup	Color	Screen Size (WxH)	Dimensions (WxHxD)
Palm Pilot VII		HTML	Gray	160x160 pixels	190g 133x83x19mm
RIM 950	Mobitex	WML	Gray	132x65 pixels	142g 63x89x23mm
NeoPoint NP1000	CDMA PCS	HDML WML	Gray	120x160 pixels 11x24 chars	181g 140x54x25mm
NEC N209i	TDMA	CHTML	Gray	108x82 pixels 9x6 chars	86g 90x46x19mm
Mitsubishi D209i	TDMA	CHTML	Color	96x90 pixels 8x7 chars	63g 125x40x15mm
Sony CMD-Z5	GSM	WML HTML	Gray	96x72 pixels 4x17 chars	82g 88x49x21mm
Samsung SCH-3500	CDMA	HDML WML	Gray	96x32 pixels 4x12 chars	154g 112x52x25mm

An Example



Desktop Browsing moves between Content & Links



Desktop Browsing moves between Content & Links

A new navigation model for small devices

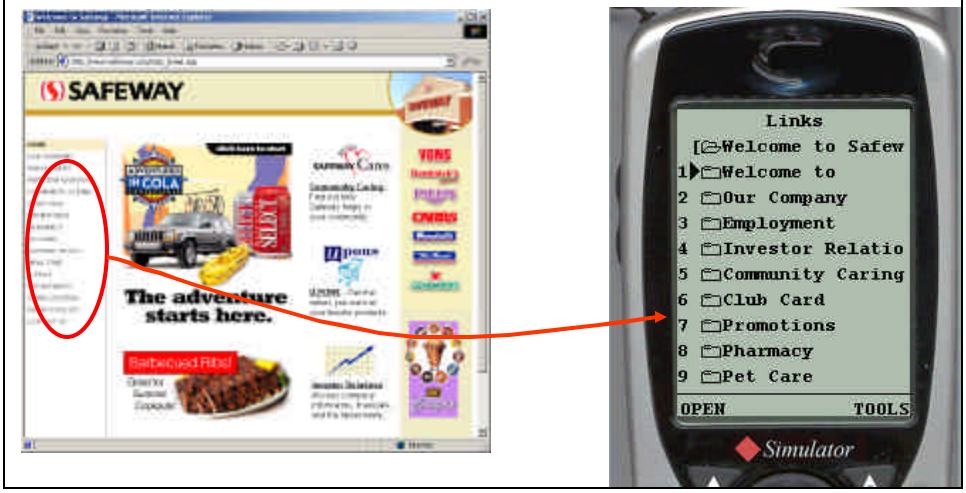
- Very small devices have extremely limited UIs
- Take the integrated "browsing" activity and divide it into separate **modes**:
  - **Navigation** and **Reading**
- Modes often inappropriate on larger devices
  - reduces number of interactors and information a user needs at a given time
  - (seems to be) extremely valuable on such poor devices
- Observations showed reading just one action of many
- M-links generalized the model
  - **Navigation** and **Action**

M-Links Design Objectives

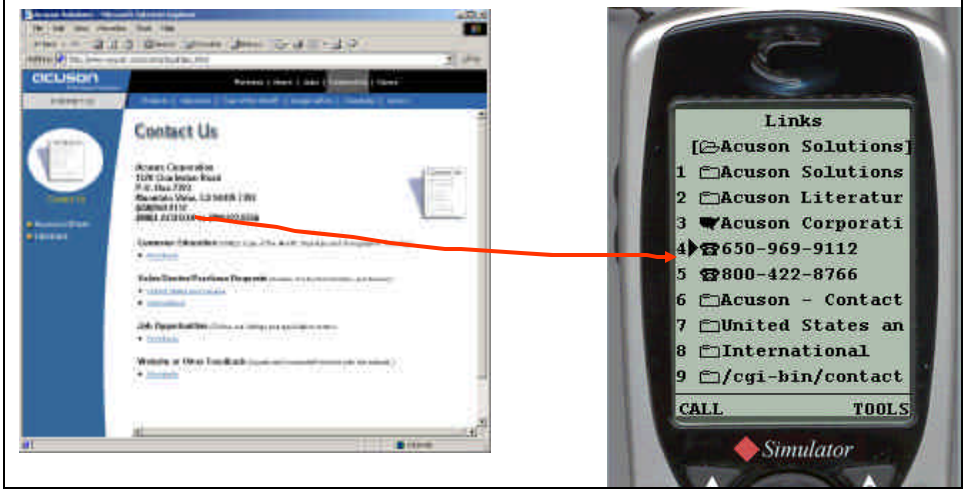
- Make the WWW more navigable
- Get at useful bits of information buried in web pages
- Access more content types and do more than just read
- Enable an open/extensible system

Web Phone Input

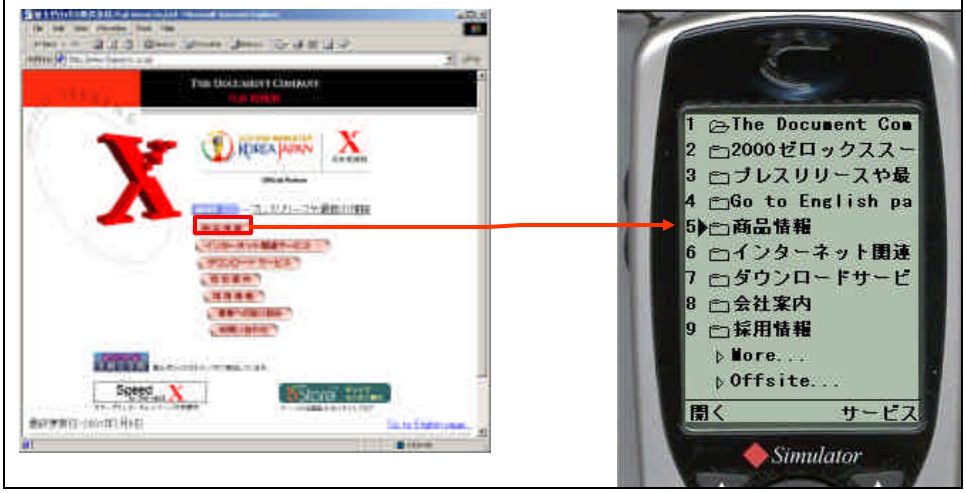
M-Links Transforms HTML
Browsing = Navigation + Action



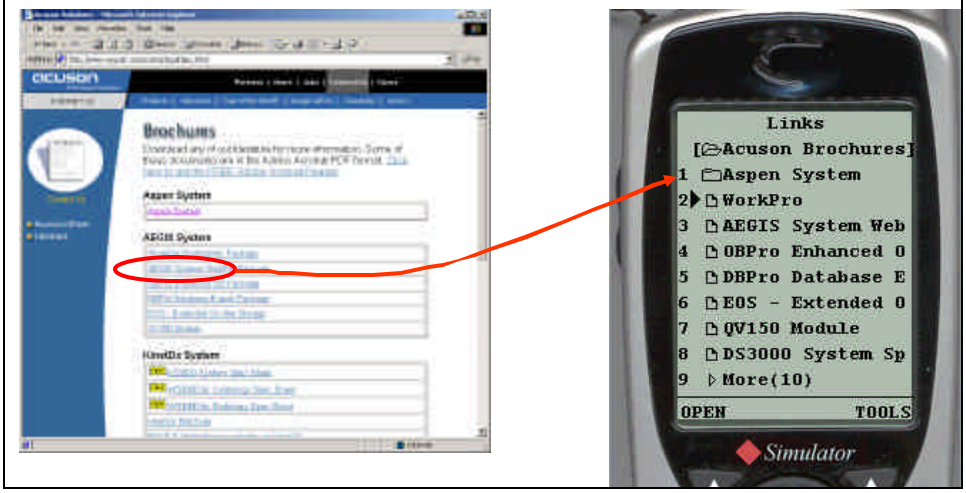
Extracts “Special Links”
Browsing = Navigation + Action



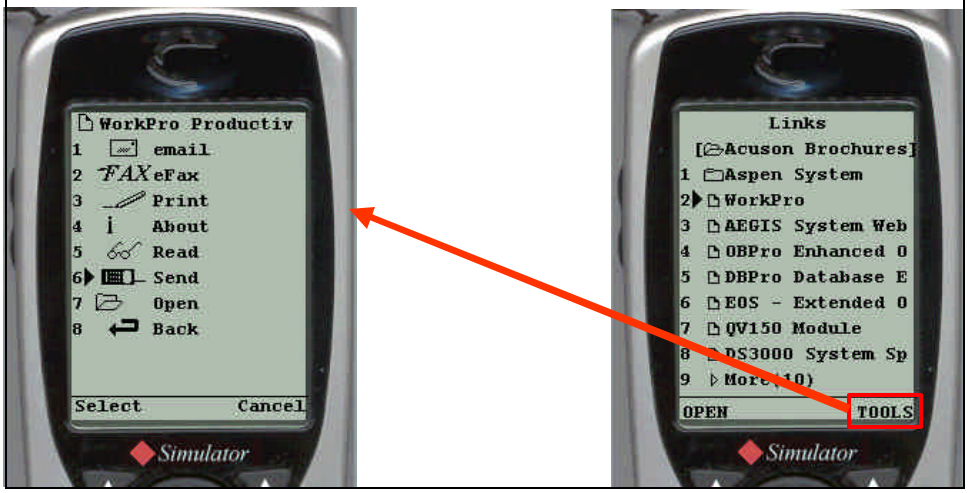
Navigates the World Wide Web
Browsing = Navigation + Action



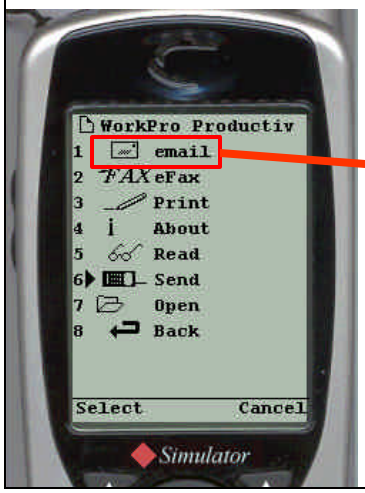
Navigates to Non-HTML
Browsing = Navigation + Action

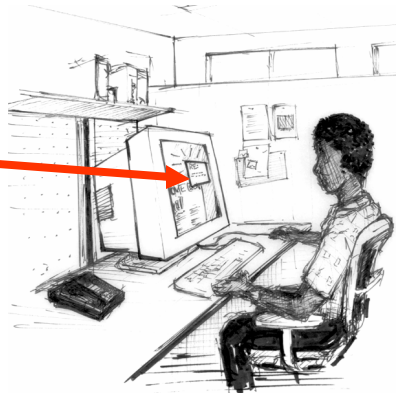


Applies Tools to a Link
Browsing = Navigation + Action

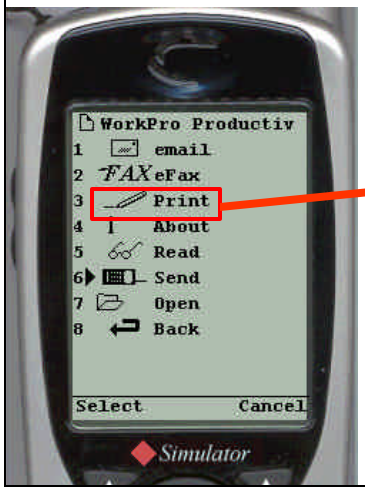


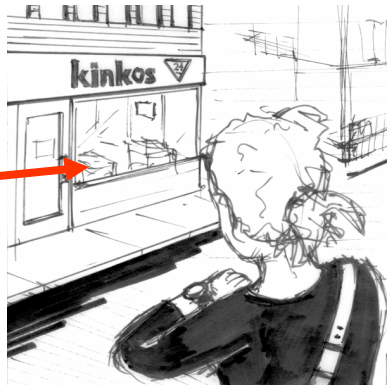
Working with Colleagues
Browsing = Navigation + Action



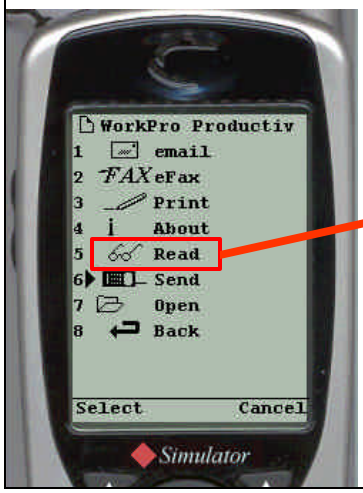


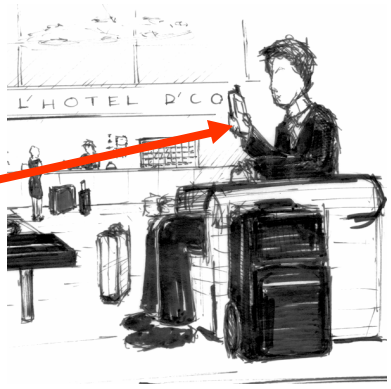
Getting Hard Copy
Browsing = Navigation + Action





Wasting Time (errr... Reading)
Browsing = Navigation + Action





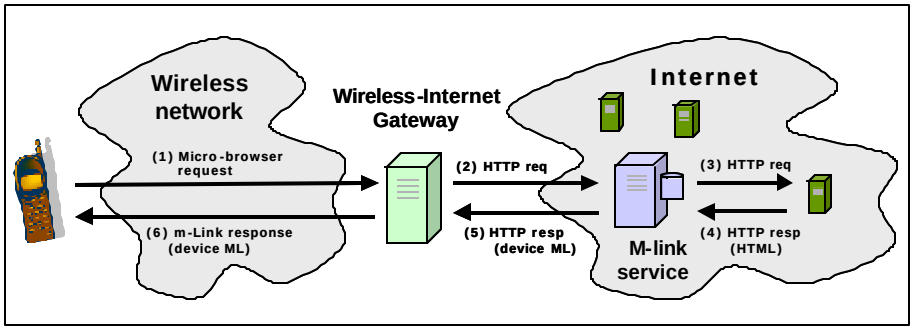
Sending
Browsing = Navigation + Action

- Send a URL directly to another web phone
- Actually sending: **`http://m-links/url`**

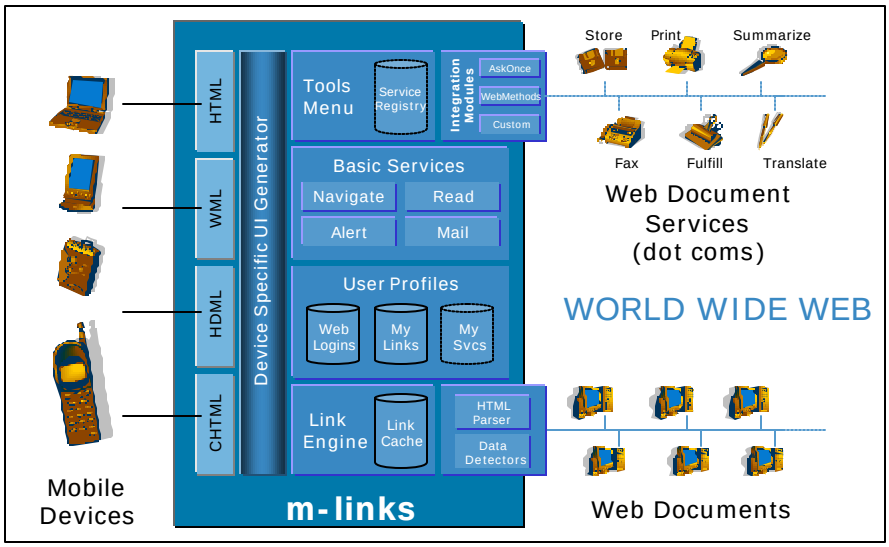
Jonathan gets the "link send"

- Looks like a text page
- Accept takes him to the link's tools page

M-Links System Packet Flow



M-Links Architecture



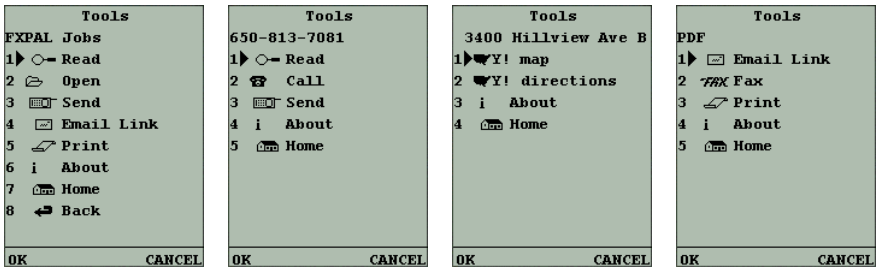
Link Engine

- Like a search engine and caching proxy
- Parses HTML pages to create “Link List”
- Detect phone numbers, addresses, etc
- Produces concise and meaningful names for links
- Caches Link List and names

Producing concise and meaningful names for links

- Tough cases run rampant!
  - **<A HREF="foo">CLICK HERE</A>**
  - **<A HREF="foo?bar=1">CLICK HERE</A>**
- Our approach
  - Insight: HTML destination titles are often reasonable!
  - Quality Metric: URL, ALT text, anchor text, dest-title
  - Merge identical HREFs to get better names
  - Move down Quality Scale to avoid duplicate names
  - "Read Around" is user's escape mechanism

Service Manager drives the Tools menu



TEXT/HTML PHONE # ADDRESS TEXT/PDF

SERVICES.XML
Associates tools with Link Types

```
<service-group ID="email-
   group">
 <service ID="email">
   <rule>
     …
   </rule>
   <execution>
     …
   </execution>
   <presentation>
     …
   </presentation>
  </service>
</service-group>
```

```
<rule>
  <accept match="any">
   <client-accepts>
     .*text/html.*
   </client-accepts>
   <client-accepts>
     .*text/x-hdml.*
  </client-accepts>
  </accept>
  <reject>
    <source-mimetype>
      URL/.*
    </source-mimetype>
  </reject>
</rule>
```

SERVICES.XML
Maps tools to services (URLs)

```
<service-group ID="email-
   group">
 <service ID="email">
   <rule>
     …
   </rule>
   <execution>
     …
   </execution>
   <presentation>
     …
   </presentation>
  </service>
</service-group>
```

```
<execution>
  <execute>
    http://mailit.com/do
  </execute>
</execution>
```

SERVICES.XML
Describes what the user sees

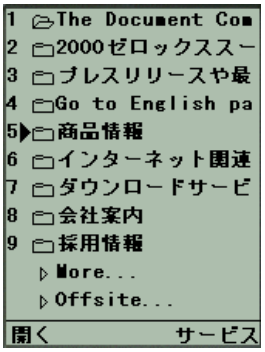
```
<service-group ID="email-
   group">
 <service ID="email">
   <rule>
     …
   </rule>
   <execution>
     …
   </execution>
   <presentation>
     …
   </presentation>
  </service>
</service-group>
```

```
<presentation>
 <language ID="en">
  <service-name>
    email document
  </service-name>
  <short-name>Email Link
  </short-name>
  <description>
    Email a URL …
  </description>
 </language>
 <icon fmt="text/x-hdml">
   envelope1
 </icon>
</presentation>
```

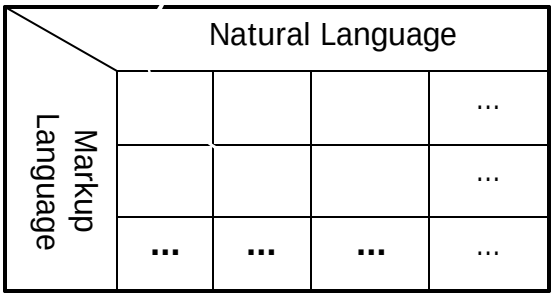
SERVICES.XML
Supports an open-system

- M-Links combines SERVICE info from 3 sources:
  - System list
    - For basic services
  - User list
    - Can add preferences
  - Content (site) provider
    - Can “opt-out” (like with robots.txt)
    - Can add site or content-specific services

Device Specific UI Generator
multi-language^2 template files




```
<HDML VERSION=3.0 MARKABLE=TRUE>
<ENTRY DEFAULT="%(defaulturl)" KEY=u FORMAT=*x>
<ACTION METHOD=GET TYPE=ACCEPT LABEL="GO"
       TASK=GOSUB FRIEND=TRUE DEST="%(next)?u=$u">
<LINE>Enter a web site:<LINE>Ex: cnn or bbc.co.uk
</ENTRY>
</HDML>
```



Some Numbers

- Response time (Sprint menu) 3 sec
- Process web page (cached) 3.5 sec
- Process web page (real time) 5.5 sec

Design Goals

- Make the WWW more navigable on VSDs
  - Redefine browsing = navigation + action
- Get at useful bits of information buried in web pages
  - Data detectors for “special links”
- Access more content types and do more than read
  - Tools (URL-based services) apply to Links
- Enable an open/extensible system
  - Tools combined from 3 sources

Future Work

- Link intensive Portal Sites (yahoo.com)
  - Search, categorization, filtering can help
- Web Pages with Forms & Passwords
  - Moving towards an auto-complete type UI
- Input is still hard (URL, forms)
  - Exploring voice input techniques

Conclusions

- Ubiquitous information access depends on ubiquitous *content*, *devices*, *networks*
  - Tensions exist between these dimensions
  - Trade-offs are inevitable – no perfect solution
  - Awareness of trade-offs helps in design
- M-Links explores a point in this space
  - Platform sacrifices content for ubiquitous devices (nearly) and networks (kind of)
  - Research focuses on increasing content ubiquity

More Info?

- Papers:
  - Schilit, Trevor, Hilbert, and Koh. m-Links: An Infrastructure for Very Small Internet Devices. *MobiCom 2001.*
  - Trevor, Hilbert, Schilit, and Koh. From Desktop To Phonetop: A UI For Web Interaction On Very Small Devices. *UIST 2001.*
- Contact Info:
  - FXPAL Web site http://www.fxpal.com/
  - Jonathan Trevor trevor@pal.xerox.com
  - David Hilbert hilbert@pal.xerox.com
- Summer Internships:
  - Applications due Valentine's Day (Feb. 15th)
  - E-mail us for details!