W4 - the Wireless World Wide Web

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Abstract

In order to separate promises from practice in PDAs and wireless communications, we decided to try to build a wireless PDA-based client to access the World Wide Web. This paper describes our design choices and experience with W4, the Wireless World Wide Web.

1. Introduction

A number of people see personal digital assistants, PDA's, with wireless communication as the "next big thing" in the computer industry. However, the current PDA's obvious limitations in computational power, storage, communication bandwidth, and display size pose the questions: can you build anything, and if so, would anyone want to use it? In order to put these dreams in perspective, we decided to build a wireless interactive application using equipment readily available in the winter of 1994.

The following sections provide a roughly chronological record of this investigation which resulted in W4, a "proof of concept" for the Wireless World Wide Web.

2. Choosing an application

A wireless client for the World Wide Web [1] was chosen as the sample application. A number factors encouraged this choice:

- The client/server interface is well documented and significant amounts of code are publicly available.
- Existing clients like Mosaic have established a de facto user interface.
- A large number of service providers are converging on the Web.
- A significant number of people inside and outside of Digital are interested in the Web.

3. Choosing a PDA

The Apple Newton MessagePad was an easy choice as it had generated a lot of interest and most important, the developers toolkit was available. After some experiments using and programming the Newton, attention turned to wireless communications.

4. Choosing wireless communications

From the beginning, we were not interested in wireless local area communications. We wanted the focus to be on the PDA and not on the installation and management of the network. If we got something built, we wanted to take it on the road. Much of the "look and feel" of mobile computing is lost if you can't bring the demo to the customer.

Press releases from a number of vendors during the summer of 1993 suggested that "real soon" there would be several communications options to choose from. Winter came and visions of a Newton with a PCMCIA card communicator were dashed as such devices were not yet available. However, prototyping using a Motorola InfoTAC radio modem (a box about the size and weight of a Newton) and ARDIS as the wireless data communications carrier seemed to be a good way to go.
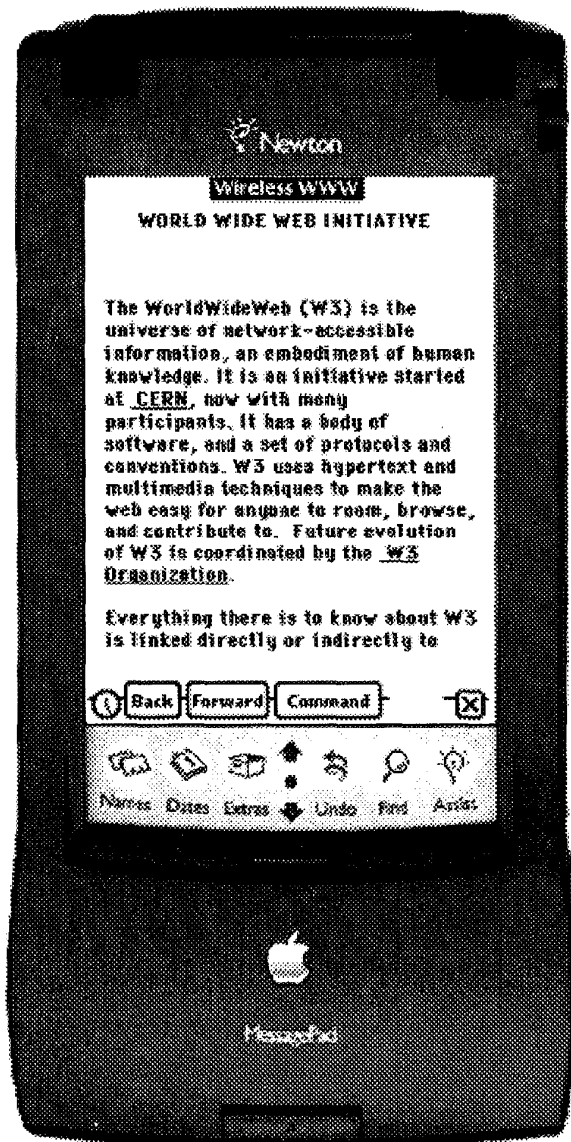
ARDIS was attractive because it had good inbuilding service, was available nationwide, and charged on a per packet basis. Unfortunately, the service available in our area was oriented toward two-way paging and had neither the data rate nor the response time required for an interactive application.

Attention then turned to analog cellular telephones. While little information about data communications was available from the cellular vendors, we constructed a system consisting of three parts: a Newton, a Motorola CELLect modem, and a Motorola MicroTAC phone. With an initial communications choice in hand, focus turned to the application architecture.

5. Application architecture

Early experiments suggested that the PDA should do as little as possible and that wireless bandwidth be conserved. This resulted in the client being split between the PDA and an ULTRIX workstation, with the bulk of the application residing in the workstation.

The PDA acts as a video-text client, displaying screens representing a portion of a hypertext document.

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link is represented by its x,y coordinates, the link width, and the tag. New commands for handling images, line drawings, and forms could be easily added to the protocol.

In order to improve performance and allow operation without communications, a simple cache was added to the PDA-based client. Each time a screen description is received by the PDA, it is added to the cache. Before the PDA makes a request to the workstation for a screen, it checks to see if it is in the cache.

The final performance improvement was to add prefetching to the PDA-based client. After a screen is displayed, the PDA checks to see if the next sequential screen of the document is in the cache. If it isn't, then the screen is requested from the workstation.

6. Experience

Our experience with transmitting data over analog cellular telephones has been generally positive. Depending upon geographic location, we can communicate at 1200-4800 baud using LAPM error control and V.42 bis compression. While in some buildings, calls can only be placed near windows, the only time that we've been completely unable to initiate a connection was when the PDA shared a phone cell with a World Cup soccer game. Data transmissions are minimized by only sending screens to the PDA that have a high probability of being viewed. At 4800 baud, interactive response is satisfactory.

Minimizing the code in the PDA covers for the fact that the PDA is much slower than the workstation. While users familiar with Mosaic on a workstation find W4 a little sluggish, those familiar with PDA's are pleased with its performance. For screens cached in the PDA, it typically takes less than 1 second from the time the user taps a hypertext link until the screen is displayed. A typical round trip time to fetch a screen from the workstation is 2-3 seconds. For multiple screen documents, the prefetch of the next screen usually completes before one has finished reading the current screen.

A pleasant discovery is that most Web documents are quite readable on a 320x240 pixel screen, even though they were designed for a much larger display. The biggest thing Mosaic users notice is not the screen size, but the lack of images and forms.

In many cases though, information providers will gladly accept the smaller display in exchange for Web services away from the desktop. For example, Digital's service organization is looking at the Web as vehicle for delivering service documentation. To investigate this, they produced a hypertext trouble shooting guide for the PATHWORKS PC integration environment. The guide was easily adapted for the PDA's screen size and the entire document can be stored in .3 MB on the PDA. One can easily envision service personnel carrying a device

Each screen is identified with a tag that contains the document URL and an offset within the document. In the simplest PDA-based client, when a hypertext link or scroll arrow is tapped by the user, the tag associated with the interactor is sent in a request to the workstation. The workstation obtains the document from the Web, parses it, formats the desired screen for the PDA, and then replys to the PDA's request.

The reply is a screen description composed of simple screen drawing commands that were designed for efficient decoding in the PDA. Each line of text is specified by its x,y coordinates and a text string. Each hypertext

like W4 with commonly used documents cached in the device and additional documents and updates only a phone call away.

7. Related work

Another design for a wireless Web client was reported in [2]. In this system, the developers choose to move more function into the PDA. As a result, it appears to have lower performance than W4 and it is currently unable to support wireless connections to the Web.

8. Conclusion

Our experience with W4 indicates that it is possible to build useful wireless PDA-based applications today. However, it also indicates that the desired wireless communication options are not yet available. While a separate PDA, modem, and cell phone work for W4, a single package is desired. How this will ultimately be delivered is not clear as PDA's and wireless communication have often been characterized by aggressive product promises followed by tentative product rollouts.

9. References

1. Tim Berners-Lee, Robert Cailliau, Ari Luotonen, Henrik Frystyk Nielsen, Arthur Secret. "The World-Wide Web". *Communications of the ACM 37*, 8 (August 1994), 76-82.

2. Stefan Gessler, Andreas Kotulla. PDAs as mobile WWW browsers. Second World Wide Web Conference '94: Mosaic and the Web, October, 1994. The URL is http://www.ncsa.uiuc.edu/SDG/IT94/Proceedings/DDay/gessler/www_pda.html.