Wireless Access Protocol(WAP) architecture

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Abstract

While the evolution of cellular networks has resulted in many mobile services, such services are primarily for voice. Mobile phone users do have the desire to access the Internet. However, Internet protocols are not designed to operate efficiently over mobile networks. WAP, the standard developed by the WAP forum, addresses these issues nicely by adapting to the restrictions of the wireless network – low bandwidth, small display, limited input facilities, limited memory and CPU, and less connection stability. WAP interfaces with different entities through the use of a gateway/proxy and a set of lightweight data presentation/formatting scripts. Such scripts allow information to be formatted in such a manner that is suitable for transmission over wireless and for presentation on a small wireless device with limited display capability. In this paper, I will deal with the overall WAP model and architecture.

Introduction

While the evolution of cellular networks has resulted in many mobile services, such services are primarily for voice. Mobile phone users do have the desire to access the Internet. Hence, efforts were made to enhance the capability of mobile phones and devices. WAP is an open protocol for wireless multimedia messaging. WAP(Wireless Application Protocol) allows the design of advanced, interactive, and real-time mobile services, such as mobile banking or Internet-based news and travel services.

Internet protocols are not designed to operate efficiently over mobile networks. Standard HTML web content cannot be displayed fully on the small-size screens of wireless devices, pagers, and mobile phones. WAP addresses these issues nicely. WAP is a license-free wireless protocol standard that can bring data information and telephony services to wireless devices.

In the mid 1990s, Ericsson made advances in value-added services on the mobile networks through the creation of the Intelligent Terminal Transfer Protocol(ITTP). Nokia and others, however, made advances in device user interfaces, such as Handheld Device Markup Language(HDML) and HDTP(Handheld Device Transport Protocol). HDTP can be viewed as a new, lightweight protocol optimized for client/server transactions over wireless links. Further, Nokia again made another advancement through the introduction of the smart short message services(SMS) concept, which allows GSM users to access services present in the Internet. With such fragmentation of effort by different companies, a joint effort for a widely acceptable standard became a necessity. Hence, WAP was born.

The WAP Forum

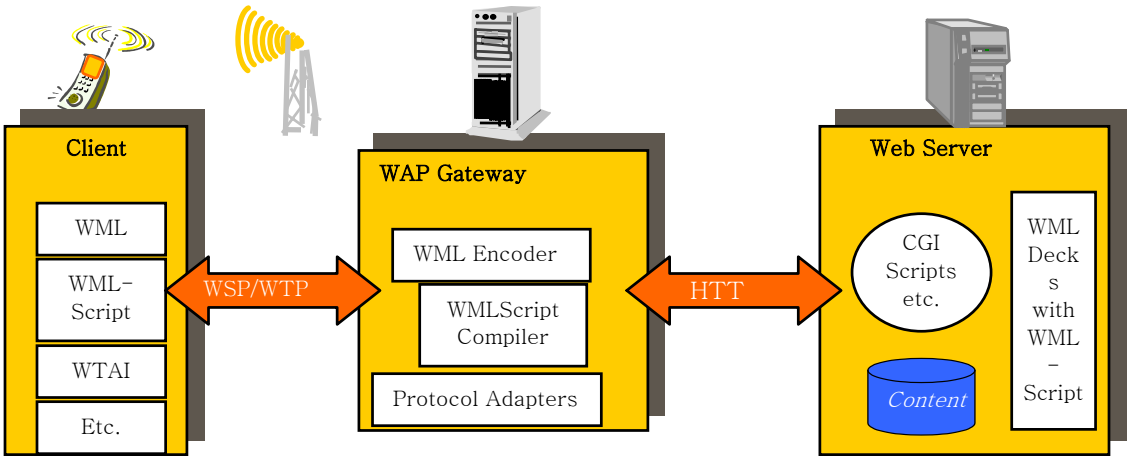
In 1997, Ericsson, Motorola, Nokia, and Unwired Planet formed the WAP Forum(www.wapforum.org). More than 90 companies in the wireless telecommunications business are members of the WAP Forum. WAP is the standard developed by the WAP Forum, a consortium formed by device manufacturers, service providers, content providers, and application providers. WAP specifies an application framework and protocols for wireless devices. WAP is a kind of fusion of mobile networking technologies and Internet technologies.

The WAP Forum's objectives include :

- To bring Internet content and advanced data services to digital cellular phones and other wireless terminals.
- To create an interoperable wireless protocol specification that will work across differing wireless network technologies.
- To enable the creation of content and applications that could scale across a wide range of wireless bearer networks and device types.
- To embrace and extend existing standards and technologies

The key features provided by WAP include :

- A programming model similar to the Internet
- Wireless Markup Language(WML)
- WMLScript
- Wireless Telephony Application(WTA)
- Optimized protocol stack



<WAP architecture >

The WAP Service Model

In the current Internet model, the client runs a copy of the Web browser, which uses the underlying Internet protocols to access useful content residing in a server in the network. Such interactions occur through using HTTP request and reply messages. WAP is based on an Internet technology that has been optimized to address the constraints of wireless links and wireless devices. Services created by HTML do not usually fit well on small handheld wireless devices due to their display limitations. In addition, such devices do have limited storage and computing capability, and this implies that excessive or redundant information is not welcome. Hence, WML is used instead HTML. WML pages can be also be encoded in binary format to reduce the amount of data to be transmitted over the wireless interface.

The WAP service model reveals the presence of a WAP proxy, which is responsible for protocol conversion and data formatting. It acts as the interface between the wired and wireless worlds. These two environments have extreme differences, such as available bandwidth, bit error rates, and storage and processing capabilities. When a mobile device requests information via the WAP, it is intercepted and interpreted by the WAP proxy, which then forwards the request via HTTP on behalf of the mobile device to the appropriate HTTP server in the network. When the proxy receives the information in response to its earliest request, the information is stored and converted (formatting) to a suitable form for processing and display on the mobile device using the WAP protocol.

1. The user selects an option on their mobile device that has a URL with WML content assigned to it.
2. The phone sends the URL request via the phone network to a WAP gateway, using the

binary encoded WAP protocol.

3. The gateway translates this WAP request into a conventional HTTP request for the specified URL, and sends it on to the Internet.
4. The appropriate Web server picks up the HTTP request.
5. The server processes the request, just as it would be any other request. If the URL refers to a static WML file, the server delivers it. If a CGI script is requested, it is processed and the content returned as usual.
6. The Web server adds the HTTP header to the WML content and returns it to the gateway.
7. The WAP gateway compiles the WML into binary form.
8. The gateway then sends the WML response back to the phone.
9. The phone receives the WML via the WAP protocol.
10. The micro-browser processes the WML and displays the content on the screen.

Adapting to the Restrictions of the Wireless Network

Low Bandwidth

The size of an average HTML page these days, including graphics, is around 20KB. With a 56 Kbps modem, the download time for this page would be in the region of 4 seconds. As the bandwidth of a wireless network is around 9.6Kbps, however, the download time for the data equivalent of just that one page would be around 17 seconds. That is not making any allowances for the network itself being slow due to congestion, or for latency. The majority of mobile users are not aware of access speeds, and they should have to care about the differences in access methods to get the same perception of performance. WAP addresses this bandwidth issue by minimizing the traffic over the wireless interface. WML and WMLScript are binary encoded into a compact form before they are transmitted, in order to minimize the bandwidth restriction.

Less Connection Stability and Unpredictable Bearer Availability

Wired network access provides a more or less reliable connection to the network. That is not the case in wireless networks, where the bearers might be inaccessible for shorter or longer periods of time due to fading, lost radio coverage, or deficient capacity. If you have ever lost a connection when you were driving in your car, you will know just how frustrating this can be. The architects of the WAP protocol infrastructure, when putting together the specifications for WAP, have taken the problem of connection stability into account and have designed into the layers.

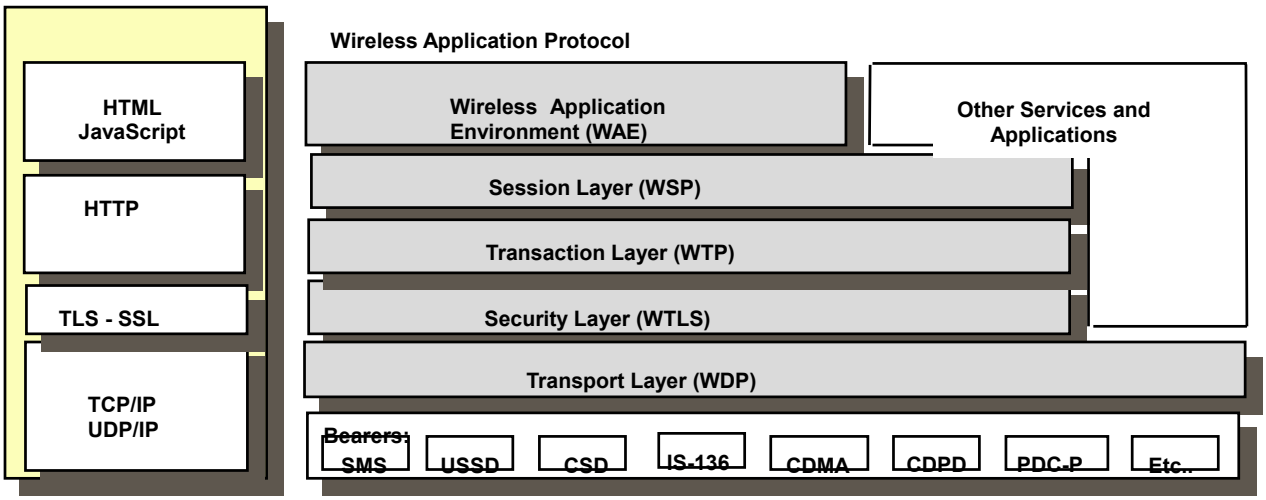
Small Display

Instead of using the flat document structure that HTML provides, WML structures its document in *decks* and *cards*. A *card* is a single unit of interaction with the end-user, such as a text screen, a selection list, an input field, or a combination of those. A card is typically small enough to be displayed even on a small screen. When an application is executed, the user navigates through a series of cards-the series of cards used for making an application is collected in a deck.

Limited Memory and CPU

Wireless devices are usually not equipped with large amounts of memory or computational power in comparison to desktop computers. The memory restriction applies to RAM as well as ROM. Even though it is likely that more memory and more powerful CPUs will be available in the near future, the relative difference will most probably remain. WAP handles these restrictions by defining a lightweight protocol stack. The limited set of functionalities provided by WML and WMLScript makes it possible to implement browsers that make small claims on computational power and ROM resources. When it comes to RAM, the binary encoding of WML and WMLScript helps to keep the amount of RAM used as small as possible.

The WAP Protocol Architecture



<Comparison between Internet and WAP protocol architecture >

The WAP architecture provides a scalable and extensible environment for application

development on mobile communication devices. It achieves this through a layered protocol design, covering protocols at Layer 4 and above. The WAP protocol stack is independent of the underlying network, which could take the form of GSM, CDMA, CDPD, iDEN, etc. Hence, WAP is essentially an application stack specification; it is not network-centric.

Wireless Application Environment(WAE)

Generally, WAE enables a spectrum of applications to be supported over WAP. WAE has two main elements, namely: (a) user agents, and (b) services and formats. The former includes the WML and WTA(Wireless Telephone Application) user agents. The latter consists of WML scripts, image formats, etc. A user agent can take the form of a Web browser. The WML user agent is responsible for the interpretation of WML and WMLScript. WAP employs the same addressing model as in the Internet, that is, it use Uniformed Resource Locators(URLs). A URL uniquely identifies an available resource. WAP also uses Uniform Resource Identifiers (URIs) to address resources that are not accessed via well-known protocols.

Wireless Session Protocol(WSP)

The WSP provides both connection-oriented and connectionless services. It is optimized for low-bandwidth networks with relatively long latency. WSP is a binary version of HTTP version 1.1, but with the additions of : (a) session migrations, (b) header caching, etc. WAP connection mode allows the establishment of sessions between a client and the WAP gateway or proxy. It can handle session interruptions as a result of mobility and reestablish session states at a later point in time. Header caching allows better bearer utilization since in HTTP, most of the requests contain static headers that need to be re-sent again.

Wireless Transaction Protocol(WTP)

WTP is designed for transaction-style communications on wireless devices. In a transaction, users express their intentions and financial commitments to service providers for processing. Very often, such transactions demand reliable, fast, and secure communications. WTP is a lightweight protocol suitable for implementation in thin clients. WTP implements selective retransmission of lost segments.

Wireless Transport Layer Security(WTLS)

WTLS is needed for WAP to ensure data integrity, privacy, authentication, and protection from denial-of-service. It is based on Transport Layer Security(TLS) 1.0, but optimized for

wireless channels. It provides transport layer security between a WAP client and the WAP gateway/proxy. Digital certificates are used for authentication and nonrepudiation of server and client. Encryption is also used to enhance the degree of confidentiality.

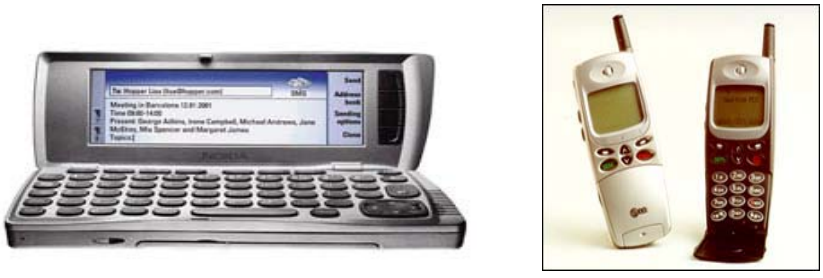
Wireless Datagram Protocol(WDP)

WDP is the transport layer protocol in WAP. It has the same functionality provided by the Internet User Datagram Protocol(UDP). Whether WAP uses UDP or WDP, datagram delivery services are provided by port number functionality and the characteristics of different bearer services are hidden from the upper layers. WDP can be extended to provide segmentation and reassembly functions.

The WAP Programming Model

As shown earlier, the WAP programming model is similar to the WWW programming model. WAP uses proxy-based technologies to connect between the wireless domain and the WWW. The WAP proxy acts as a protocol gateway, which is responsible for translating requests from the WAP protocol stack(WSP, WTP, WTLS and WDP) to the WWW protocols(HTTP and TCP/IP) It also performs encoding and decoding, which make Web access over the wireless interface efficient and compact.

WAP devices use a micro-browser that is more compact and lightweight, but is analogous to the WWW browser. The micro-browser can be viewed as a reduced version of JavaScript called WMLScript. WAP also supports a standard naming model, such as the WWW-standard URLs. WAP supports content typing and includes display markup, images, and s scripting language. WAP use the underlying network protocols to enable communication of browser requests from wireless terminals to network Web servers. For examples, the Nokia 9290 communicator, which is a fully integrated mobile terminal combining phone, fax, e-mail, calendar, and imaging. It also offers Internet access via WAP and HTML-based WWW browser.



< A Commercial WAP-enabled phone, Nokia 9290(left), LG SP110(right)>

Markup Language

Pages or services created using HTML do not work very well on small handheld devices, since they were specifically developed for use on desktop computers with larger color screens. Also, low bandwidth wireless bearers wouldn't be suitable for delivering the large files that HTML pages often consist of. Therefore, a markup language specifically adapted to these restrictions has been developed-WML. WML provides a navigation model for devices with small display screens and limited input facilities (no mouse and a limited keyboard). In order to save valuable bandwidth in the wireless network, WML can be encoded into a compact binary format for transmission between the phone and the network, and vice-versa. Encoding WML is one of tasks performed by the WAP gateway, which is the entity that connects the wireless domain with the Internet.

WAP also provides a means for supporting more advanced tasks, comparable to those solved by using JavaScript in HTML. The solution in WAP is called WMLScript. WML is very similar to the HTML used to write current Web sites. It is simple enough that any developer currently used to HTML can cross-train in a matter of hours. Naturally, there are some differences between HTML and WML, as WML has to be very simple. There are no nested tables, only very basic font control, and the pages(or decks as they are called) have to be quite small, so that they do not take ages to download at the current wireless date transfer speed of 9,600 bps.

- WML is the worldwide industry standard. WML is not yet mainstream in North America but is catching on fast.
- HandHeld Device Markup Language(HDML) is used mostly in North America but is quickly being superseded by WML

```
<wml>
<card id = "Welcome" title="Welcome">
<p>Welcome to the Wireless Internet</p>
<do type="accept" label="OK">
 <go id="accept" href="/cgi-shl/Next.pl"></go>
</do>
</card>
</wml>
```

<WML example>

The future of WAP

The future of WAP depends largely on whether consumers decide to use WAP devices to access the Web, and also on whether a new technology comes along that would require a different infrastructure than WAP. On the consumer side, the factors largely involve the limitations of WAP and of handheld devices: the lower bandwidth, the limited input ability, and the small screens all require user to adapt from their regular Web-browsing expectations. The bottom line is that WAP is not and can never be the Web on your mobile phone. On the technological side, it is true that mobile phone data speeds will get faster, and this may require a different infrastructure, which will require different handsets to carry the technology. The new challenger is GPRS(General Packet Radio Service) and Mobile IP. Also, Web browser for the PC will also soon come with the ability to view WAP pages. What this means to the average user is that the instant information access available to mobile users can be combined with the rich content of the Internet. You will simply have two windows open on the PC-one for the traditional content and the other for the WAP content-thereby having the best of both worlds.

Conclusions

In this paper, we examined WAP, a protocol that has been standardized and deployed. WAP allows the introduction of mobile Internet services into mobile wireless devices via mobile cellular networks. WAP interfaces with different entities through the use of a gateway/proxy and a set of lightweight data presentation/formatting scripts. Such scripts allow information to be formatted in such a manner that is suitable for transmission over wireless and for presentation on a small wireless device with limited display capability. News, stock rates, shopping, and advanced calling services can all be done via WAP-enabled mobile devices.

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