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Note from the Authors: This article is an excerpt from Chapter 10, Section 10.6 of *Wireless Internet & Mobile Business How to Program*. This article provides an overview of the Binary Runtime Environment for Wireless (BREW) and the EPOC wireless platforms. The article also introduces Handheld Devices Markup Language (HDML), Wireless Markup Language (WML), compact HyperText Markup Language (cHTML), Java 2 Micro Edition (J2ME), eXtensible Markup Language (XML) and eXtensible HyperText Markup Language (XHTML). We also discuss the Wireless Application Protocol (WAP), which is designed to standardize development across different wireless technologies worldwide.

10.6 Wireless Platforms and Programming Languages

The following article introduces a few of the many programming languages used for wireless communications development including the Wireless Markup Language (WML), Java, Handheld Devices Markup Language (HDML) and compact Hypertext Markup Language (cHTML). We also discuss the specific platforms (e.g., Java 2 Micro Edition and the Wireless Application Protocol) associated with them. Programming languages and mark-up languages form the foundation for the platforms. Platforms help manufacturers and developers incorporate specific technologies and capabilities into larger devices (e.g., cell phones, PDAs, etc.). These platforms and languages are discussed in detail in later chapters of this book.

10.6.1 Handheld Devices Markup Languages (HDML)

The *Handheld Devices Markup Language (HDML)* was one of the first programming languages to target small, handheld devices. HDML was originally developed by Unwired Planet in 1996, which became **`Phone.com`** and is now known as Openwave (**`www.openwave.com`**).[46] HDML is similar to *Hypertext Markup Language (HTML)*, which is used to design and format Web pages. However, HTML is not effective for devices with limited screen sizes and viewing capabilities. HDML has evolved into the *Wireless Markup Language (WML)* used in the *Wireless Application Protocol (WAP)*. WAP and WML are discussed later in this article.

Even though HDML is no longer supported in many newer mobile devices, it is still present in the majority of older wireless devices used worldwide. Europe, Japan and many other countries are using WAP devices that no longer support HDML. However, some CDMA-based phones in the United States and Canada support both WML and HDML.[47] The conversion of HDML to WML code is not difficult, and Openwave (HDML's founder) has been working with the development of WML to replace HDML. Other programming languages such as *Extensible Markup Language* (*XML*) and *Extensible Hypertext Markup Language (XHTML)* are also replacing HDML. XHTML, which is based on XML, is described briefly later in this article.

10.6.2 WAP and WML

In 1997, the Wireless Application Protocol (WAP) was developed by Nokia, Ericsson, Motorola and others to foster the emergence of the wireless Internet.[48] WAP is intended primarily for Internet-enabled digital phones, pagers and other handheld devices. WAP is a set of communication protocols designed to enable communication between different kinds of wireless devices and to allow users access to the Internet via mobile devices. It is designed to standardize development across different wireless technologies worldwide. WAP applications can be used on Palm OS, Windows CE, Mac OS and J2ME.[49]

The *Wireless Markup Language (WML)* is a scripting language based on the *Extensible Markup Language (XML)*. *WML tags* (e.g., tags in the programming language that describe what is being developed) are used to "mark up" Web pages to specify how those pages should be formatted on a wireless device. *Microbrowsers*, designed with limited bandwidth and memory requirements, can access the Web via the wireless Internet. Without graphics and animations, the transmission consumes less bandwidth and memory, and it becomes easier to view on the small screens of wireless devices. WML content is delivered by WAP. and is similar to HTML with a few formatting differences.

A WML document is called a *deck* and contains one or more blocks called *cards*. Each card consists of text content and/or navigational controls for user interaction. Only one card can be viewed at a time, but navigation between cards is rapid because the entire deck is stored by the microbrowser.[50]

Those who favor WAP technology see it as a short-term solution for introducing users to the wireless Internet. WAP has had major financial investments by carriers and device manufacturers, and developers worldwide have created thousands of content pages that can be used on WAP-enabled devices. However, WAP 1.1 has been criticized for security breaches, limited bandwidth and unreliablity.

The limited bandwidth capabilities of WAP-enabled devices causes additional problems. WAP-enabled devices can handle the transmission of multimedia, but they are overloaded during peak hours.[51] Due to this limitation, producers of business-to-business (B2B) and business-to-consumer (B2C) applications are anticipating the release of 3G.

The communications process between a mobile device and the Internet is important to understand when learning wireless communications. Each system (i.e., WAP/WML, i-mode and Java/J2ME) has its own process for sending and receiving information to and from the Internet. WAP communications involve many components, but we focus on three—a *WAP-enabled mobile device*, a *WAP gateway* and a *Web server*. When a user requests information from the Internet, the device sends the request through a WAP gateway. A WAP gateway serves as the link between the mobile device and the Internet, similar to a *proxy server* in wireline Web communications. WAP gateways are designed to convert WAP to *Hypertext Transfer Protocol (HTTP)*. HTTP is the common protocol used in the transfer and viewing of information in Web transactions. The WAP gateway communicates with the Web server, which is connected to the Internet. The Web server processes the mobile-device request by searching through existing databases and stores of information, such as Web pages. The Web server then sends the requested information back to the WAP gateway using HTTP. The gateway translates the information back into WAP and sends it to the mobile device.[52]

The documents that mobile devices request off the Internet from the Web server are in the form of WML documents. WML is present over the entire communications chain from the request by the mobile device to the Web server and the documents are returned from the Web server to the mobile device. When a user completes this same type of request from a desktop computer, the computer sends a request over the Internet using HTTP to the Web server. The Web server processes the request and sends the information back to the machine in the form of an HTML or XHTML document. Desktop computers cannot process WML documents and most mobile devices cannot process HTML documents which facilitates the need for WAP, the WAP gateway and WML. However, *WAP 2.0* (the specifications were released in 2001 for public review) supports XHTML Basic documents. XHTML Basic will support WML tags for documents but will change the types of information and documents which can be requested and rendered on a mobile device in the future.

10.6.3 Compact HTML (cHTML) and i-mode

NTT DoCoMo is one of the leaders in developing wireless technologies and 3G networks. Its *i-mode* service has become the most popular wireless service in Japan, offering voice service combined with text-messaging, animated graphics and Web browsing. The number

of subscribers continues to grow, with over 28 million people using the service as of July, 2002.[53]

The markup language used in i-mode is *compact HTML (cHTML)*. cHTML, a subset of HTML, is designed for mobile devices and has its own unique tags and attributes. cHTML is not widely used except in i-mode phones and devices. In the future, cHTML could merge with a form of WAP or XHTML, both of which are described in this section.

The i-mode service is similar to WAP with a few notable differences. When a user makes a request to the mobile Internet from an i-mode phone, the information request is translated to cHTML and transmitted over the network. The request is sent directly to Web servers at NTT DoCoMo, which process the information and send it back to the user. NTT DoCoMo has over 40,000 pages of content designed in cHTML specifically for the i-mode service and stores all the information on its own servers. This eliminates the need to translate from one language to another to communicate over the network because NTT stores both the content and runs the i-mode service.

10.6.4 Java and the Java 2 Micro Edition (J2ME)

Java is one of the most widely used programming languages in the world. It is particularly appropriate for computers implementing Internet-based and intranet-based applications and any other software for devices that communicate over networks, including cell phones, pagers and PDAs. Java is a powerful computer programming language appropriate for experienced programmers building substantial systems.

Java has different application development platforms available for software engineers to use, depending on their intended target devices or systems. To accommodate the constraints of programming wireless devices, Sun Microsystems and other developers (including the iDEn Subscriber Group at Motorola Corporation) developed *Java 2 Micro Edition (J2ME)*.

J2ME is used primarily to develop applications for wireless devices such as cell phones and PDAs. WAP cannot manipulate data or perform complex applications and must always be connected to a server, whereas J2ME does not.[54] J2ME, on the other hand, uses the strengths of Java (e.g., portability and security) to produce mobile applications. These applications can monitor and alert consumers when stock prices change or when a checking account is overdrawn. J2ME also allows for game-playing over wireless devices. J2ME can run on multiple platforms and across different devices.

10.6.5 XML and XHTML

Extensible Markup Language (XML) was developed in 1996 by the *World Wide Web Consortium's (W3C's) XML Working Group* and is related to *Standard Generalized Markup Language (SGML)*. XML is a widely supported *open technology* (i.e., non-proprietary technology) for data exchange. XML documents contain only data, and applications display that data in various ways. For example, a PDA may render data differently than a cell phone or a desktop computer would.

XML permits document authors to create their own markup for virtually any type of information. This extensibility enables document authors to create entirely new markup languages to describe specific types of data. Some of the markup languages created with XML include XHTML, VoiceXML™ (for speech) and WBXML (WAP-Binary XML used for SyncML).

XML tags describe the data in a document, therefore, it is possible to search, sort, manipulate and render an XML document by using related technologies, such as the *Extensible Stylesheet Language (XSL).* XML documents are highly portable, which is useful for mobile devices and application designs. Special software is not required to open an XML document—any text editor that supports *ASCII/Unicode*® characters can be used. Unicode is an encoding standard that facilitates the production and distribution of software. Most operating systems, programming languages, databases and Web browsers currently support, or are planning to support, Unicode.

Some standards and technologies are converging together to form a combined, single standard. For example, WAP and i-mode are converging to XHTML. XHTML is not a procedural programming language like *C*, *Fortran*, *Cobol* or *Pascal*. Rather, it is a markup language for identifying the elements of a page so that a *browser*, such as Microsoft's *Pocket Internet Explorer*, can render that Web page on a mobile device.

XHTML is a markup language created from XML. XHTML takes advantage of the XML's strict syntax to ensure well-formed code. This makes XHTML better equipped than HTML to represent complex data for business-critical and mission-critical applications on the Internet. For browsers to determine whether an XHTML document contains the expected markup (e.g., the proper set of elements in the proper order etc.), the XHTML document is compared against another document called a *document type definition (DTD)* that describes every XHTML element and attribute name and combination.

With the emergence of the wireless Web and Web-enabled appliances, incorrect markup (e.g., coding errors) poses a portability problem. Small devices such as PDAs and wireless phones have limited amounts of memory and cannot provide the extra resources required to process incorrectly written HTML. Documents intended for these devices must be well formed to guarantee uniform processing.

10.6.6 EPOC

EPOC is an operating system platform designed for next-generation wireless devices. It is a product of Symbian, Nokia, Motorola, Psion, Ericsson and Matsushita. EPOC provides computing and communication power for wireless devices comparable to that of today's desktop computers.[55]

EPOC supports both mobile-phone and PDA platforms. EPOC technology allows users to send and receive mail, fax messages and to connect to the wireless Internet at 2.5G speeds; it may support 3G speeds.[56] EPOC allows developers to use such programming languages as C++ to develop for platforms like WAP and the Internet. In addition, EPOC will support *TCP/IP protocols* (which are commonly used for the wired Internet), GSM, Bluetooth wireless technology and infrared standards. EPOC also provides support for data synchronization with PCs and other devices. It supports Unicode characters (Unicode is discussed in Appendix C, Unicode) and is one of the first platforms to integrate Unicode into its working environment. A few EPOC devices are already available on the market. For more technical information about EPOC, please visit **`www.symbian.com`** or **`www.ericsson.com`**.

One of the most notable EPOC products is the *Ericsson R380 World™ smart phone,* which incorporates GSM cell-phone technology with Symbian PDA capabilities (Fig. 10.7).[57] The R380 is one of the few phones that can operate in both the U.S. and Europe. This device supports SMS (popular in Europe) WAP browsing and e-mail.[58] The R380 currently is available only directly through Ericsson.

Fig. 10.7 Ericsson R380 phone, which uses the EPOC operating system. (Courtesy of Ericsson.)

10.6.7 Binary Runtime Environment for Wireless (BREW)

Binary Runtime Environment for Wireless (BREW) is a software applications platform developed by Qualcomm and introduced in May, 2001.The platform enables software developers to create applications that can be accessible through a variety of wireless devices.[59] BREW is a layer of code that allows development of handset-independent applications (i.e., the applications will run regardless of who manufactures the device or what type of handset it is) running on Qualcomm chipsets.

There are many areas in which BREW could have an impact on the wireless market. BREW's ease of use and development allows manufacturers to reduce costs and shorten time-to-market for products. BREW's possible applications include navigation assistance, instant messaging, e-mail, e-wallets, games, Internet radio, music players, music videos and personal information management.[60] Developers who wish to make their applications available to BREW-based users can undergo an application certification program offered by Qualcomm for a fee.[61] This program certifies that an application will work on the BREW platform and be made accessible to users.

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The notation **<www.domain-name.com>** indicates that the citation is for information found at that Web site.

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