w@p™ **Forum**

Wireless Application Protocol

White Paper

Wireless Internet Today • June 2000

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Executive Summary

According to The Strategis Group, there will be more than 530 million wireless subscribers by the year 2001. New estimates report that the number of wireless subscribers will break the one billion mark by 2004, and a "substantial portion of the phones sold that year will have multimedia capabilities." These multimedia capabilities include the ability to retrieve Email, and push and pull information from the Internet. In order to guide the development of these exciting new applications, the leaders of the wireless telecommunications industry formed the Wireless Application Protocol Forum (www.wapforum.org).

The Wireless Application Protocol (WAP) is the de-facto world standard for the presentation and delivery of wireless information and telephony services on mobile phones and other wireless terminals. Handset manufacturers representing 90 percent of the world market across all technologies have committed to shipping WAP-enabled devices. Carriers representing more than 100 million

subscribers worldwide have joined **WAP Forum**™. This commitment will provide 10's of millions of WAP browser-enabled products to consumers by the end of 2000. WAP allows carriers to strengthen their service offerings by providing subscribers with the information they want and need while on the move. Infrastructure vendors will deliver the supporting network equipment. Application developers and content providers delivering the value-added services are contributing to the WAP specification.

Enabling information access from handheld devices requires a deep understanding of both technical and market issues that are unique to the wireless environment. The WAP specification was developed by the industry's best minds to address these issues. Wireless devices represent the ultimate constrained computing device with limited CPU, memory, and battery life, and a simple user interface. Wireless networks are constrained by low bandwidth, high latency, and unpredictable availability and stability. However, most important of all, wireless subscribers have a different set of essential desires and needs than desktop or even laptop Internet users.

WAP-enabled devices are companion products that will deliver timely

information and accept transactions and inquiries when the user is moving around. WAP services provide pinpoint information access and delivery when the full screen environment is either not available or not necessary.

The WAP specification addresses these issues by using the best of existing standards, and developing new extensions where needed. It enables industry participants to develop solutions that are air interface independent, device independent and fully interoperable.

The WAP solution leverages the tremendous investment in Web servers, Web development tools, Web programmers and Web applications while solving the unique problems associated with the wireless domain. The specification further ensures that this solution is fast, reliable and secure. It enables developers to use existing tools to produce sophisticated applications that have an intuitive user interface. Ultimately, wireless subscribers benefit by gaining the power of information access in the palm of their hand.

The **WAP Forum** has published a global wireless protocol specification, based on existing Internet standards such as XMLand IP, for all wireless

networks. The WAPspecification is developed and supported by the wireless telecommunication community so that the entire industry and most importantly, its subscribers, can benefit from a single, open specification.

Wireless service providers are able to offer a new dimension of service that complements the existing features of their networks, while extending subscriber access to the unbounded creativity of the Web. Handset manufacturers can integrate microbrowser functionality at minimal cost, because the WAP specification is open and public. Application developers gain access to a whole new market of information hungry users, while protecting and leveraging their current investments in Web technology. Subscribers gain real, anytime, anywhere information access with a simple and effective user interface, available on a variety of networks and devices.

While the WAP specification solves the transport and content problems of the constrained wireless environment today, the **WAP Forum** is constantly working to improve the state of wireless access to information. By working to build liaisons with ARIB, CDG, ECMA, ETSI, TIAand W3C, the **WAP Forum** will continue to ensure that a single,

open standard will be available to meet the wireless information needs of subscribers and industry participants worldwide. The **WAP Forum** is working with these standards bodies towards a goal of convergence with the XHTMLand HTTPstandards, in order to optimize them for the wireless environment.

The WAP Forum

The Wireless Application Protocol Forum is an industry group dedicated to the goal of enabling sophisticated telephony and information services on handheld wireless devices. These devices include mobile telephones, pagers, personal digital assistants (PDAs) and other wireless terminals. Recognizing the value and utility of the World Wide Web architecture, the **WAP Forum** has chosen to align its technology closely with the Internet and the Web. The WAP specification extends and leverages existing technologies, such as digital data networking standards, and Internet technologies, such as IP, HTTP, XML, SSL, URLs, scripting and other content formats.

Ericsson, Motorola, Nokia and Phone.com (formerly Unwired Planet) founded the **WAP Forum** in June 1997.

Since then, it has experienced impressive membership growth with members joining from the ranks of the world's premiere wireless service providers, handset manufacturers, infrastructure providers and software developers. As of mid-2000, the **WAP Forum** has more than 400 members.

The **WAP Forum** has drafted a global wireless protocol specification for all wireless networks and is contributing it to various industry groups and standards bodies. This WAP specification enables manufacturers, network operators, content providers and application developers to offer compatible products and secure services on all devices and networks, resulting in greater economies of scale and universal access to information. **WAP Forum** membership is open to all industry participants.

The Goals of WAP Forum

The **WAP Forum** has the following goals:

■ To bring Internet content and advanced data services to wireless phones and other wireless terminals.

■ To create a global wireless protocol specification that works across all wireless network technologies.

- To enable the creation of content and applications that scale across a wide range of wireless bearer networks and device types.

- To embrace and extend existing standards and technology wherever possible and appropriate.

The **WAP Forum** does not develop products, but instead creates license-free standards for the entire industry to use to develop products. Each company's product line can then offer its own unique features, while still conforming to the WAP specification. Since the **WAP Forum** is not a handset manufacturer, voicemail vendor, or infrastructure provider, all companies in the telecommunications industry are assured that they are not competing with WAP, because WAP does not promote any particular product or product line. Instead, the **WAP Forum** promotes and supports all companies that are developing products based on the WAP specification.

In order to accomplish these goals, the **WAP Forum** has developed the WAP specification according to design principles as outlined below.

Build on Existing Standards

As much as possible, the **WAP Forum** seeks to use existing industry standards as the basis for its own architecture and design. For example, a WAP Gateway is required to communicate with other Internet nodes using the standard HTTP 1.1 protocol. Furthermore, the specification calls for wireless handsets to use the standard URL addressing scheme to request services.

It is also very important for the **WAP Forum**'s standards to be developed in such a way that they complement existing standards. For example, the WAP specification does not specify how data should be transmitted over the air interface. Instead, the WAP specification is intended to sit on top of existing bearer channel standards so that any bearer standard can be used with the WAP protocols to implement complete product solutions.

When the **WAP Forum** identifies a new area of technology where a standard does not exist, or exists but needs modification for wireless, it works to submit its specifications to other industry standards groups. The **WAP Forum** currently has several different relationships with other standards bodies:

- The **WAP Forum** is submitting its specifications to the European Telecommunications Standards Institute (ETSI). In addition to having a formal liaison between the two groups, the MExE (Mobile Execution Environment) subgroup within ETSI's Special Mobile Group 4 is cross-referencing the WAP specification to define a compliance profile for GSM and UMTS.

- The Cellular Telecommunications Industry Association (CTIA) has an official Liaison Officer to the **WAP Forum**.

- The **WAP Forum** has established a formal liaison relationship with the World Wide Web Consortium (W3C) and the Telecommunications Industry Association (TIA). The **WAP Forum** is collaborating with these organizations in the area of WWW technologies in the wireless sector. The W3C, TIA and the **WAP Forum** intend to continue to work together in selected technical areas to jointly create and promote technical specifications of interest to all three organizations.

- The **WAP Forum** is in the process of forming a liaison relationship with the Internet Engineering Task Force (IETF).

As new standards emerge, the **WAP Forum** will continue its active role in ensuring that these new standards remain compatible with the work of the **WAP Forum**. For example, the **WAP Forum** will be working with the W3C and IETF to ensure future convergence with HTML-NG (Next Generation) and HTTP-NG specifications, and to provide input to these groups regarding the requirements of future wireless network technologies. In addition, the **WAP Forum** is carefully watching the development of the International Mobile Telecommunications 2000 (IMT-2000, or often 3G) family of standards by the International Telecommunication Union (ITU).

Invite Full Industry Participation

The **WAP Forum** strongly believes that the best technology standards can only come about with full industry participation. With this principle in mind, the **WAP Forum** has been established as a forum open to any industry participant. By encouraging participation across the entire telecommunications industry, the **WAP Forum** is able to:

■ Produce open standards that result from many industry experts working together.

■ Develop consensus in the industry for how all the components of a solution will interoperate.

■ Produce standards through an open and collaborative process—no one vendor receives favorable treatment, and the entire industry benefits from the results.

■ Benefit from the innovations of dozens of contributing companies rather than the efforts of only one or two vendors.

To date, the **WAP Forum** has grown to a membership of more than 100 companies that all believe that an open standards process is the best way to develop solutions for wireless Internet access.

Maintain Bearer Independence

To best address the needs of the widest possible population of end users, the Wireless Application Protocol is designed to work optimally with all air interfaces.

This principle allows the largest number of service providers, software developers and handset manufacturers to benefit from one unified specification. Service providers can implement a common solution across

their own disparate networks so that every subscriber has the best possible user experience on each network. Applications can be developed using one standard that will work across a variety of networks. Handset manufacturers can use the same software in all of their product lines, reducing development time and simplifying support issues.

By making minimal demands on the air interface itself, the WAPspecification can operate on the widest number of air interfaces. It defines a protocol stack that can operate on high latency, low bandwidth networks such as Short Message Service (SMS), or GSM Unstructured Supplementary Service Data (USSD) channel.

Being air interface independent also makes the specification easy to extend to new networks and transports as they develop. As air interfaces become more sophisticated, the services they provide can be designed to comply with the WAPspecification, further encouraging the use of one standard across all networks.

Maintain Device Independence

In addition to being air interface independent, the WAPspecification is also independent of any particular

device. Instead, it specifies the bare minimum functionality a device must have, and has been designed to accommodate any functionality above that minimum.

Device independence offers similar benefits to bearer independence: applications developed for one standard can operate on a wide variety of devices that implement the specification; network operators gain a consistent user interface for their services across multiple vendors' handsets; application developers do not have to write separate versions of their code for different devices; and service providers can choose any standard compliant device that meets their own unique market requirements. Device manufacturers are assured that they will have many applications written for their device by implementing the specification, yet are able to add their own brand features above and beyond the minimum standards to make their device unique in the marketplace.

Why WAP Is Necessary

Ensure Interoperability

Service providers must feel secure that their investments will yield benefits in the future. They will not be able to do so until equipment and software offered by different suppliers can be made to work together. The WAPspecification has been designed to encourage easy, open interoperability between its key components. Any solution component built to be compliant with the WAP specification can interoperate with any other WAP-compliant component. Service providers can choose equipment and software from multiple WAP-compliant vendors, selecting each piece of the solution that is appropriate for the service provider's particular needs.

Bearer and device independence both help foster interoperability. But interoperability goes beyond these two principles to require that each WAP-compatible component will communicate with all other components in the solution network by using the standard methods and protocols defined in the specification.

Interoperability provides clear benefits for handset manufacturers and infrastructure providers. Handset manufacturers are assured that if their device complies with the WAP specification it will be able to interface with any WAP-compliant server, regardless of the manufacturer. Likewise, the makers of a WAP-compliant server are assured that any WAP-compliant handset will interface correctly with their servers.

Encourage and Foster Market Development

The WAP specification is designed to bring Internet access to the wireless mass market. By building open specifications, and encouraging communication and technical exchanges among the industry players, the **WAP Forum** has already begun to open the wireless data market in new ways. Just over a year ago, the idea of a single wireless data standard was unheard of, yet today the WAPspecification is available to the public, and dozens of companies are promoting this vision of the future. The revolution is under way to bring information access to any handset, at a reasonable price and in an easy to use form factor.
Providing Internet and Web-based services on a wireless data network presents many challenges to wireless service providers, application developers and handset manufacturers.

While the obvious limitations are rooted in the nature of wireless devices and data networks, there are also more fundamental differences that are important to understand. The next few sections outline the challenges that must be overcome to make wireless Internet access appealing to the average wireless subscriber.

The Market Is Different

Bringing computing power to a wireless handset opens an extensive new market for information access. This market is very different from the traditional desktop or even the laptop market because the subscriber has a different set of needs and expectations. Some of these differences include:

- Ease of use: Despite the fact that using a desktop computer has become progressively easier over the last five years, a wireless computing device must be dramatically easier to use than even the simplest desktop computer. These devices will be used by people who potentially have no desktop computing experience. Furthermore, they will often be used in a dynamic environment where the user is engaged in multiple activities. Subscribers won't be focused on their handset the way they are when they are sitting in front of a desktop computer. Therefore, the devices must be extremely simple and easy to use. Applications built for these devices must therefore present the best possible user interface for quick and simple usage. There can be no installation scripts, complicated menu structure, application errors, general protection faults or complicated key sequences such as ctrl-alt-del, or alt-shift-F5.

- Market size: The growth and size of the wireless subscriber market has been phenomenal. According to Global Mobile magazine, there are more than 200 million wireless subscribers in the world today. According to Nokia, there will be more than one billion wireless subscribers by the year 2005. The wireless market is enormous: it can afford and will demand optimized solutions.

- Price sensitivity: Even with today's sub-$1000 computers, a price difference of $50 between two models is not considered significant. However, a difference of $50 between two handsets is very significant, especially after years of subsidized handset pricing by the service provider. Market studies have shown that a mass-market handset must be priced under $149 to be competitive. Asolution must add significant value at a low cost to be effective in this market.

- Usage patterns: Subscribers expect wireless data access to perform like the rest of their handset: The service should be instantly available, easy to use and designed to be used for a few minutes at a time. Hourglass icons telling subscribers to wait will not be acceptable.

- Essential tasks: As soon as professionals step out of the office, information needs and desires change. Wireless Internet subscribers will not want to use their handset to "surf the Internet." They will have small, specific tasks that need to be accomplished quickly. Subscribers will want to scan Email rather than read it all, or see just the top stock quotes of interest. Receiving timely traffic alerts on the handset will be essential, whereas the same information may not be as valuable at the desktop. The best applications will give the user a comprehensive, personalized summary of important information and will allow them to easily drill down for more detailed information.

The Network Is Different

Wireless data networks present a more constrained communication environment compared to wired networks. Because of fundamental limitations of power, available spectrum

and mobility, wireless data networks tend to have:

- Less bandwidth
- More latency
- Less connection stability
- Less predictable availability

Furthermore, as bandwidth increases, the handset's power consumption also increases which further taxes the already limited battery life of a mobile device. Therefore, even as wireless networks capitalize on higher bandwidth, the power of a handset will always be limited by battery capacity and size, thus challenging the amount of data throughput. Deployment of the WAP standard will accommodate more users per MHz since it uses the available bandwidth at an extremely efficient level. The result of placing more users on a given amount of spectrum can yield lower costs for both the network provider and the customer. A wireless data solution must be able to overcome these network limitations and still deliver a satisfactory user experience.

The Device Is Different

Similarly, mass-market, handheld wireless devices present a more constrained computing environment compared to desktop computers. Because of fundamental limitations of battery life and form factor, mass-market handheld devices tend to have:

- Less powerful CPUs
- Less memory (ROM and RAM)
- Restricted power consumption
- Smaller displays
- Different input devices (e.g., a phone keypad, voice input, etc.)

Because of these limitations, the user interface of a wireless handset is fundamentally different than that of a desktop computer. The limited screen size and lack of a mouse requires a different user interface metaphor than the traditional desktop GUI.

These conditions are not likely to change dramatically in the near future. The most popular wireless handsets have been designed to be lightweight and fit comfortably in the palm of a hand. Furthermore, consumers desire handsets with longer battery life, which will always limit available bandwidth, and the power consumption of the CPU, memory and display.

Because there will always be a performance gap between the very best desktop computers and the very best handheld devices, the method used to deliver wireless data to these devices will have to effectively address this gap. As this gap changes over time, standards will have to continually evolve to keep pace with available functionality and market needs.

WAP Specification

The WAP specification is a major achievement because it defines for the first time an open, standard architecture and set of protocols intended to implement wireless Internet access. It also provides solutions for problems not solved by other standardization bodies (e.g. W3C, ETSI, TIA, IETF, etc.) and is a catalyst for wireless development and standardization.

The key elements of the WAP specification include:

- definition of the WAP Programming Model as seen in Figure 1 (shown on followoing page), which is based heavily on the existing WWW Programming Model. This provides several benefits to the application developer community, including a familiar programming model, a
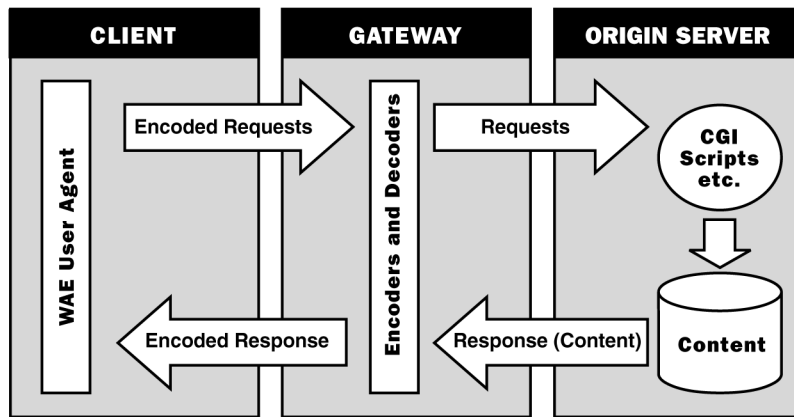
Figure 1: The WAP Programming Model

proven architecture and the ability to leverage existing tools (e.g., Web servers, XML tools, etc.). Optimizations and extensions have been made in order to match the characteristics of the wireless environment. Wherever possible, existing standards have been adopted or have been used as the starting point for WAP technology.

■ A markup language adhering to XML standards that is designed to enable powerful applications within the constraints of handheld devices. The Wireless Markup Language (WML) and WMLScript do not assume that a QWERTY keyboard or a mouse are available for user input, and are designed for small screen displays. Unlike the flat structure of HTML documents, WML documents are divided into a set of well-defined units of user interactions. One unit of interaction is called a card, and

services are created by letting the user navigate back and forth between cards from one or several WML documents. WML provides a smaller, telephony aware, set of markup tags that makes it more appropriate than HTML to implement within handheld devices. From the WAP Gateway, all WML content is accessed over the Internet using standard HTTP 1.1 requests, so traditional Web servers, tools and techniques are used to server this new market.

■ A specification for a microbrowser in the wireless terminal that controls the user interface and is analogous to a standard Web browser. This specification defines how WML and WMLScript should be interpreted in the handset and presented to the user. The microbrowser specification has been designed for wireless handsets so that the resulting code will be compact and efficient, yet provide a flexible and powerful user interface.

■ A lightweight protocol stack to minimize bandwidth requirements, guaranteeing that a variety of wireless networks can run WAP applications. The protocol stack is shown in Figure 2.

■ A framework for Wireless Telephony Applications (WTA) allows access to telephony functionality such as call control, phone book access and
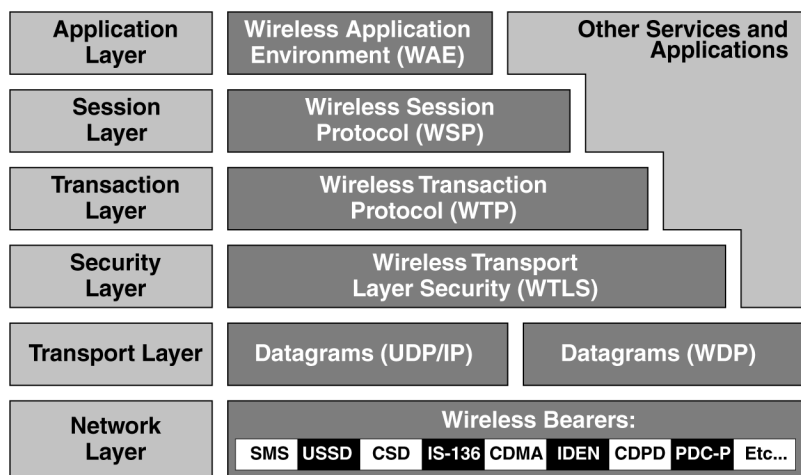

Figure 2: The WAP Protocol Stack

messaging from within WMLScript applets. This allows operators to develop secure telephony applications integrated into WML/WMLScript services. For example, services such as Call Forwarding may provide a user interface that prompts the user to make a choice between accepting a call, forwarding it to another person or forwarding it to voicemail.

WAP Solution Benefits

The WAP specification was written to address the challenges of traditional wireless data access within the context of the design objectives of the **WAP Forum**. This section outlines how the WAP specification meets these goals.

Delivers an Appropriate User Experience Model

The WAP specification defines a powerful and functional user interface model that is appropriate for handheld devices. Users navigate through cards with up and down scroll keys instead of a mouse. Soft keys allow the user to perform specific operations appropriate to the application context, or select menu options. A traditional 12-key phone keypad is used to enter alphanumeric characters, including a

full set of standard symbols. Navigation functions such as Back, Home, and Bookmark are also provided, in keeping with the standard browser model.

By using the existing Internet model as a starting point, this user interface provides familiar functionality for those accustomed with the Web. It also provides a user interface that is easy to learn and highly discoverable for the first time user.

The microbrowser allows devices with larger screens and more features to automatically display more content, just as a traditional browser does on a PC when the browser window is expanded on screen.

Leverages Proxy Technology

The WAP specification uses standard Web proxy technology to connect the wireless domain with the Web. By using the computing resources in the WAP Gateway, the WAP architecture permits the handset to be simple and inexpensive. For example, a WAP Gateway will typically take over all DNS services to resolve domain names used in URLs, thus offloading this computing task from the handset. The WAP Gateway can also be used to

provision services to subscribers and provide the network operator with a control point to manage fraud and service utilization.

A WAP Gateway typically includes the following functionality:

- Protocol Gateway – the protocol gateway translates requests from the WAP protocol stack to the WWW protocol stack (HTTP and TCP/IP).

- Content Encoders and Decoders – the content encoders translate Web content into compact encoded formats to reduce the size and number of packets traveling over the wireless data network.

This infrastructure ensures that mobile terminal users can browse a variety of WAP content and applications regardless of the wireless network they use. Application authors are able to build content services and applications that are network and terminal independent, allowing their applications to reach the largest possible audience. Because of the WAP proxy design, content and applications are hosted on standard WWW servers and can be developed using proven Web technologies such as CGI scripting.

The WAP Gateway decreases the response time to the handheld device by aggregating data from different servers on the Web, and caching frequently used information. The WAP Gateway can also interface with subscriber databases and use information from the wireless network, such as location information, to dynamically customize WML pages for a certain group of users.

Addresses the Constraints of a Wireless Network

The protocol stack defined in WAP optimizes standard Web protocols, such as HTTP, for use under the low bandwidth, high latency conditions often found in wireless networks. A number of enhancements to the session, transaction, security and transport layers provide HTTP functionality better suited to the wireless network environment. Here are just a few examples of these improvements:

■ The plain text headers of HTTPare translated into binary code that significantly reduces the amount of data that must be transmitted over the air interface.

■ A lightweight session re-establishment protocol has been defined that allows sessions to be suspended and resumed without the overhead of initial establishment. This allows a session to be suspended while idle to free up network resources or save battery power.

■ WAP provides a Wireless Transaction Protocol (WTP) that provides reliable transport for the WAP datagram service. WTP provides similar reliability as traditional TCPdoes, but without behaviors that make TCP unsuitable in a wireless network. For example, TCPtransmits a large amount of information for each request-response transaction, including information needed to handle out-of-order packet delivery. Since there is only one possible route between the WAP proxy and the handset, there is no need to handle this situation. WTPeliminates this unnecessary information and reduces the amount of information needed for each request-response transaction. This is just one example of the optimizations WTP provides.

■ WAP's WTPsolution also means that a TCP stack is not required in the phone, which allows for significant savings in processing and memory cost in the handset.

■ The improvements made in the WAP protocol stack lead to significant savings in wireless bandwidth. Figure 3 compares the number of packets needed to process a stock quote query from a desktop browser using HTTP1.0 with the same query from a WAP browser. The WAP protocol uses less than half the number of packets that the standard HTTP/TCP/IPstack uses to deliver the same content. This improvement
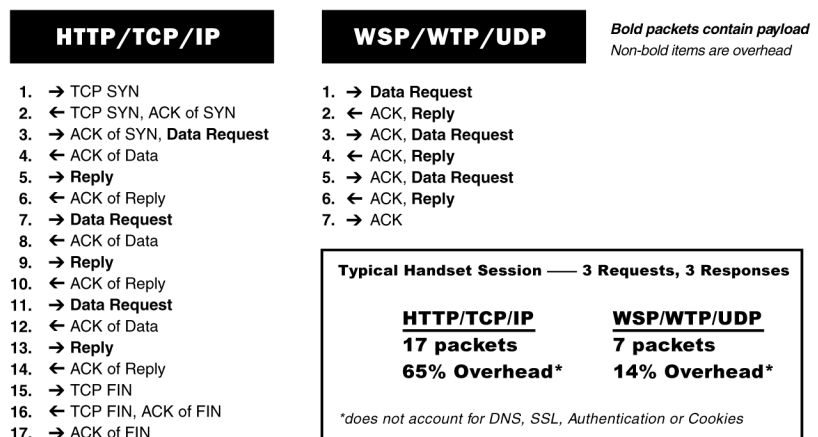
HTTP/TCP/IP

1. → TCP SYN
2. ← TCP SYN, ACK of SYN
3. → ACK of SYN, **Data Request**
4. ← ACK of Data
5. → **Reply**
6. ← ACK of Reply
7. → **Data Request**
8. ← ACK of Data
9. → **Reply**
10. ← ACK of Reply
11. → **Data Request**
12. ← ACK of Data
13. → **Reply**
14. ← ACK of Reply
15. → TCP FIN
16. ← TCP FIN, ACK of FIN
17. → ACK of FIN

WSP/WTP/UDP

1. → **Data Request**
2. ← ACK, **Reply**
3. → ACK, **Data Request**
4. ← ACK, **Reply**
5. → ACK, **Data Request**
6. ← ACK, **Reply**
7. → ACK

Bold packets contain payload
Non-bold items are overhead

Typical Handset Session —— 3 Requests, 3 Responses

HTTP/TCP/IP	WSP/WTP/UDP
17 packets	**7 packets**
65% Overhead*	**14% Overhead***

does not account for DNS, SSL, Authentication or Cookies

Figure 3: WAPProtocols Conserve Wireless Bandwidth

is essential to best utilize the limited wireless bandwidth available.

Provides a Secure Wireless Connection

Many applications on the Web today require a secure connection between the client and the application server. The WAP specification ensures that a secure protocol is available for these transactions on a wireless handset. The Wireless Transport Layer Security (WTLS) protocol is based upon the industry-standard Transport Layer Security (TLS) protocol, formerly known as Secure Sockets Layer (SSL). WTLS is intended for use with the WAP transport protocols and has been optimized for use over narrow-band communication channels. WTLS ensures data integrity, privacy, authentication and denial-of-service protection. For Web applications that employ standard Internet security techniques with TLS, the WAP Gateway automatically and transparently manages wireless security with minimal overhead.

Optimized For Handheld Wireless Devices

The WAP specification defines a microbrowser that is the ultimate thin client, able to fit in a limited amount of memory in the handheld device. The

use of proxy technology and compression in the network interface reduces the processing load at the handheld device so that an inexpensive CPU can be used in the handset. This further helps reduce power consumption and extends battery life, meeting the needs of both handset manufacturers and wireless subscribers.

Implements New Wireless Functionality

The WAPspecification also defines new functionality that has not been defined by any other standard, such as a voice/data integration API and the groundwork for wireless push functionality.

The Wireless Telephony Application (WTA) allows application developers to initiate phone calls from the browser and respond to network events as they occur. The WTA API accomplishes this by providing an interface to the local and network telephony infrastructure. The local interface allows WML and WMLScript to access a specific set of telephony functions, such as a function call to dial a phone number from the mobile handset. The network interface allows an application to monitor and initiate mobile network events, so that the application can take action or update information based on these events. This

functionality can be used to keep an updated list of the phone numbers dialed into an active conference call. These network and local APIs are powerful features that no other standard provides.

Standard HTTPhas no support for "push" functionality. The WAP specification defines a push mechanism that will allow any Web server to send information to the client. This is an extremely important feature because it allows applications to alert the subscriber when time-sensitive information changes. There are a number of applications that make use of this functionality, such as traffic alerts and stock quote triggers, or Email and pager notifications.

Enables Application Development Using Existing Tools

Web developers will find it easy to develop WAP applications since the WAPProgramming model closely follows the existing WWW development model. WMLis a tag-based document language specified as an XMLdocument type. As such, existing XMLauthoring tools, as well as many HTMLdevelopment environments, can be used to develop WMLapplications.

Since the WAP specification uses standard HTTP 1.1 protocol to communicate between the WAP Gateway and Web servers, Web developers can deploy their applications on any off-the-shelf Web server. WML developers can use standard Web tools and mechanisms such as Cold Fusion, CGI, Perl, ASP and others to generate dynamic WML applications. Developers can either use separate URLs for their HTML and WML entry points, or use a single URL to dynamically serve either HTML or WML content according to the requestor's browser type.

Although it is possible to translate HTML into WML using an automated system, in practice the best applications use WML to tailor the interface to the specific needs of the wireless user. This allows for the best possible use of the handset features, such as soft keys, and provides the best user experience. The most valuable parts of any Web application are typically the unique content it provides and the back-end database interaction, not the particular HTML that was written to interact with the user. Therefore developing a corresponding WML front-end leverages previous engineering effort, while providing significant user interface benefits.

Adapts New Standards for the Industry

Wherever possible, the WAP specification optimizes and extends existing Internet standards. The **WAP Forum** has taken technology elements from TCP/IP, HTTP and XML, optimized them for the wireless environment, and is now submitting these optimizations to the W3C standards process as input for the next generations of (XHTML) and HTTP (HTTP-NG).

The **WAP Forum** will continue to evolve the WAP specification to keep pace with new technologies. In the best tradition of Internet protocol standards, the WAP specification divides network functionality into several layers, so that each layer can develop independently of the others. Low level layers can be replaced to support new bearers without requiring changes to the high level APIs or the intervening stack layers. This protects the initial investment in the protocol stack, and makes the standard flexible as new and faster wireless data protocols become available.

How Service Providers Benefit From Using WAP-Based Solutions

Service providers can add significant value to their existing voice offerings by adding a WAP-based solution to their wireless networks. Enabling access to Web-based content is only the beginning. As service providers discover how they can use a visual interface to increase feature usage and decrease operation costs, they will find that providing a WAP microbrowser-enabled handset to every subscriber will yield significant benefits.

By choosing a WAP-based solution to deploy wireless data, network operators will gain:

- A whole new dimension of relationship and communication with their subscribers. Network operators can now use a visual interface to stay in touch with their subscribers, and market new services to them. This creates new opportunities for improved customer service and increased usage of network services.

- Control of the data connection to their subscribers. By using a WAP-based solution, network operators can ensure that they are part of the

value proposition to their subscribers. Service providers can use the WAP Gateway to track and bill for the service, and provision general feature control, just as they do now for their voice services.

- An easy method to deploy TeleServices applications, such as Call Feature Control, prepaid wireless recharge and automated Customer Service. Since the applications are stored on a standard Web server inside the service provider's infrastructure, when new services are added, or features are changed, these changes are instantly available to every subscriber in the network.

- Immediate access to all WAP-enabled wireless content. Since WAP is a specification that many developers are using, service providers will benefit from an abundance of available content. This parallels the situation on the Web today, where any public Web page is available to anyone on the Internet with a Web browser.

- Choice among open standards vendors. Service providers can purchase their WAP Gateway from one provider, and use WAP-enabled handsets from several other vendors.

Having the option to choose from several vendors helps keep pricing competitive for the service provider, and ensures that competition will stimulate feature development.

- Freedom to use and integrate new air interface technologies. Since WAP is an open specification, service providers do not have to fear losing their wireless data solution if they change or add a new air interface.

How Handset Manufacturers Benefit From Using WAP-Based Solutions

Integrating a microbrowser into its product line allows a handset manufacturer to meet the demands of today's advanced service providers. By offering a WAP-based solution, handset manufacturers can:

- Integrate a microbrowser into the handset at low cost, since the WAP specification calls for a low-profile browser that will not demand large memory or expensive CPU requirements.

- Offer one microbrowser that works on all WAPservers and therefore on all the networks that offer WAP-based services.

- Increase the perceived value of their handsets to subscribers.

How Developers Benefit From Using WAP-Based Solutions

Application developers can reach the largest possible audience when they write their applications in WML because they are writing to an industry standard. Additional benefits for developers include:

- Access to an entirely new, immense market of information-hungry wireless subscribers, while complementing their existing Internet services.

- Because WML is an XML-based language, it is an easy markup language for existing Web developers to learn.

- WML's basis in XMLalso positions it well as a future target markup language for automatic content transformation. The W3C is currently defining the eXstensible Style Language (XSL), which provides a powerful mechanism for the dynamic transformation of well-formed XML. Using an XSLstyle sheet, content written in XML-defined markup languages can be
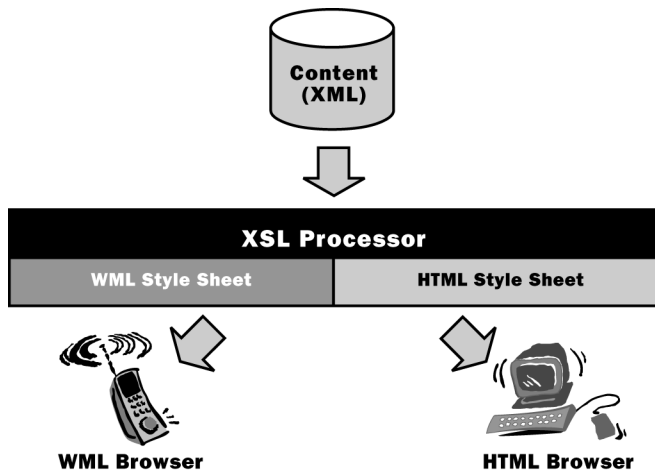
Figure 4: The Future Of Content Development

automatically translated into content suitable for either HTML or WML, as shown in Figure 4. Likewise, content written in well-formed XML can also be translated to other XML-based markup languages, using a different XSL style sheet.

■ While the technology for universal content is still being developed, WML has been designed to be an integral part of this technology. Application developers can feel secure using WML today, knowing that there will be a migration path to the future.

■ Since WMLis part of an open standard, and was developed by an independent organization, all developers can be assured that they are on equal footing with other developers. No single developer has unique access to APIs or special functionality.

■ By writing in WML, a developer's work becomes available to any network and device that is WAP-compliant. WMLand the WAP specification truly deliver on the "write once, use anywhere" promise.

■ WML provides the application developer with the power to take full advantage of the user interface. Applications can map soft keys for easy user input and use special features to maximize the effect of displaying text on a limited screen.

■ WML allows application developers to integrate their applications with device and network telephony functions. Applications that use these features can truly leverage the advantages of operating in an integrated voice and data device.

■ WML allows the use of icons and bitmapped graphics, for devices that support them. One application will work equally well on a phone with or without graphics by offering alternate text to the phone that is not capable of displaying images.

■ An application written in WMLwill look good on any device that is WAP-compliant. If one device is able to display more lines of text than another, the microbrowser will do so automatically, making the best use of the device's and application's capabilities.

■ An application can be customized to take advantage of a particular device's capabilities, by using standard HTTPheader mechanisms to learn about the device's capabilities.

How Subscribers Benefit From Using WAP-Based Solutions

Ultimately, subscribers are the most important beneficiaries of the work of the **WAP Forum**. The WAP specification was developed and written by experienced telecommunications experts who not only understand the technologies involved, but also the real

needs of the subscriber. Consequently, the WAP specification delivers significant value to the subscriber.

The WAP specification pulls together existing technologies and defines new standards to provide subscribers with:

■ Fast, efficient access to essential information from a wireless handset.

■ Peace of mind that all transactions are completely secure.

■ An easy to use interface metaphor that meets the needs of the user within the restrictions of a constrained network and device.

The widespread adoption of the WAP specification is yielding these benefits:

A common user interface metaphor that is being used by all industry participants. Just as the desktop metaphor is the de-facto standard for applications on PCs, the WAP card metaphor provides a common interface to which all applications can conform.

Ubiquity of service. Wherever subscribers go, they will have access to their own personal content using a WAP-enabled browser.

Wide selection of devices. In addition to handsets with different features and form factors, subscribers will be able to use PDAs and pagers that are also WAP-enabled.

A large selection of applications. Over the last few years, the Internet model has proven to be the least expensive and most effective way to deliver new applications and services to computing users. Now that this model has been extended to wireless devices, subscribers will gain access to a wealth of applications.

The WAP Forum Vision for the Future of Wireless Internet

Although the Wireless Application Protocol specification has already been published, the work of the **WAP Forum** has just begun. As new handset technologies, network protocols and Internet standards develop, the **WAP Forum** will take an active role in helping shape these new technologies and standards, making them relevant to the wireless data market.

The **WAP Forum** is continually gaining membership and devoting resources to educate its membership on the best ways to make open, interoperable

solutions that the entire industry can benefit from. The **WAP Forum** meets periodically to continue the evolution of its own standards and develop new standards to drive innovation in the industry in new and exciting directions. Recent submissions to the **WAP Forum** have covered topics such as:

■ Over-The-Air-Provisioning (OTAP)
■ Persistent Storage
■ SIM Tool Kit
■ Location Services
■ Network Management
■ Broadcast Services
■ IMT-2000 (3G) Multimedia
  Capabilities
■ Corporate Data Access

Conclusion

The WAP specification is a truly open standard that enables public content, corporate intranet and operator-specific solutions to reach wireless subscribers today. The WAP specification leverages and extends existing Internet standards, enabling application developers to tailor their content to the special needs of wireless users. Handset manufacturers can enhance their product lines at minimal cost with new usability benefits. Wireless service providers can establish a new and powerful way to interact with their subscribers through a vital point of control in their own network. The ultimate beneficiaries are wireless subscribers who can be more productive than ever before.

WAP Forum membership is open to all industry participants. Visit the **WAP Forum** Web site at (www.wapforum.org) to download the current version of the Wireless Application Protocol specification. Further details and the **WAP Forum** membership application form are also available on the **WAP Forum** Web site. W@P

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