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***In our vision, the Internet will go mobile, just as voice communication has done. The key enabler of the Mobile Internet is the Wireless Application Protocol (WAP). WAP enables Internet content to be distributed to and displayed in standard mobile phones and other mobile information devices. The current WAP architecture meets the requirements of current low bandwidth networks and mobile devices with limited capabilities. As more advanced mobile networks are adopted, the existing specifications can continue to be used. In other words, the current WAP standard is mature and successful.***

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## **Introduction**

Providing Internet and WWW services on a wireless data network presents many challenges. Most of the technology developed for the Internet has been designed for desktop and larger computers supporting medium to high bandwidth connectivity over generally reliable data networks. Mass-market, hand-held wireless devices present a more constrained computing environment compared to desktop computers. Because of fundamental limitations of power 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 telephone keypad, voice input, etc.)

## White Paper Overview

### **Abstract**

The Wireless Application Protocol (WAP) is a protocol stack for wireless communication networks. WAP uses WTLS, a wireless variant of the SSL/TLS protocol, to secure the communication between the mobile phone and other parts of the WAP architecture. This white paper describes Wireless Application Protocol (WAP) definition, technology, applications, security architecture of WAP and some important properties of the WTLS protocol. It also talks about some countermeasures and good practices when using WAP.

### **Document Audience**

This document is primarily intended for Marketing, Sales, Product Support, Internet Services Group, Project Engineering and anyone who is interested in WAP Technology.

Similarly, 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 than traditional networks
- ❑ More latency than traditional networks
- ❑ Less connection stability than other network technologies
- ❑ Less predictable availability

Mobile networks are growing in complexity and the cost of providing new value-added services to wireless users is increasing. In order to meet the requirements of mobile network operators, solutions must be:

- ❑ Interoperable – terminals from different manufacturers communicate with services in the mobile network.
- ❑ Scalable – mobile network operators are able to scale services to customer needs.
- ❑ Efficient – provides quality of service suited to the behavior and characteristics of the mobile network; provide for maximum users for a given network configuration
- ❑ Reliable – provides a consistent and predictable platform for deploying services.
- ❑ Secure – enables services to be extended over potentially unprotected mobile networks while still preserving the integrity of user data; protects the devices and services from security problems such as denial of service.

## **WAP- Introduction**

The Wireless Application Protocol (WAP) is an open, global specification that empowers mobile users with wireless devices to Easily access and interact with information and services instantly.

The Wireless Application Protocol (WAP) is a hot topic that has been widely hyped in the mobile industry and outside of it. WAP is simply a protocol- a standardized way that a mobile phone talks to a server installed in the mobile phone network. It provides a standardized way of linking the Internet to mobile phones, thereby linking two of the fastest growing industries anywhere Its founder members include the major wireless vendors of Nokia, Ericsson and Motorola, plus a newcomer Phone.com The WAP Forum has over 120 member companies Mobile information services, a key application for WAP, have not been as successful as many network operators expected. WAP is seen as a way to rectify this situation.

### **Formation**

Motorola, Nokia, Ericsson and the US software company Phone.com (formerly Unwired Planet) were the initial partners that teamed up over two years ago in mid 1997 to develop and deploy the Wireless Application Protocol (WAP). WAP is an attempt to define the standard for how content from the Internet is filtered for mobile communications. Content is now readily available on the Internet and WAP was designed as the (rather than one) way of making it easily available on mobile terminals.

### **Objective**

The goal of WAP is to enable an extremely wide range of wireless terminals, range from mass-market mobile telephones and pagers to more powerful devices, to enjoy the benefits of Web technology and interconnection. Mobile devices have a unique set of features, which must be exposed into the Web, in order to enable the creation of advanced telephony services.



## **Philosophy**

The Wireless Application Protocol takes a client server approach. It incorporates a relatively simple microbrowser into the mobile phone, requiring only limited resources on the mobile phone. This makes WAP suitable for thin clients and early smart phones. WAP puts the intelligence in the WAP Gateways whilst adding just a microbrowser to the mobile phones themselves. Microbrowser-based services and applications reside temporarily on servers, not permanently in phones. The Wireless Application Protocol is aimed at turning a mass-market mobile phone into a "network-based smartphone". As a representative from Phone.com (formerly Unwired Planet) on the board of the WAP Forum commented "The philosophy behind Wireless Application Protocol's approach is to utilize as few resources as possible on the handheld device and compensate for the constraints of the device by enriching the functionality of the network". The Wireless Application Protocol is envisaged as a comprehensive and scaleable protocol designed for use with any mobile phone from those with a one line display to a smart phone, any existing or planned wireless service such as the Short Message Service, Circuit Switched Data, Unstructured Supplementary Services Data (USSD) and General Packet Radio Service (GPRS). Indeed, the importance of WAP can be found in the fact that it provides an evolutionary path for application developers and network operators to offer their services on different network types, bearers and terminal capabilities. The design of the WAP standard separates the application elements from the bearer being used. This helps in the migration of some applications from SMS or Circuit Switched Data to GPRS for example. any mobile network standard such as Code Division Multiple Access (CDMA), Global System for Mobiles (GSM), or Universal Mobile Telephone System (UMTS). WAP has been designed to work with all cellular standards and is supported by major worldwide wireless leaders such as AT&T Wireless and NTT DoCoMo, multiple input terminals such as keypads, keyboards, touch-screens and styluses.

## **Devices which will use WAP**

Handheld digital wireless devices such as mobile phones, pagers, Two-way radios, smartphones and communicators—from Low-end to high-end.

## **Wireless networks on which WAP will work**

WAP is designed to work with most wireless networks such as CDPD, CDMA, GSM, PDC, PHS, TDMA, FLEX, ReFLEX, iDEN, TETRA, DECT, DataTAC, Mobitex.

## **Operating systems compatible with WAP**

WAP is a communications protocol and application environment. It can be built on any operating system including PalmOS, EPOC, Windows CE, FLEXOS, OS/9, JavaOS etc. It provides service interoperability even between different device families.

## **WAP Architecture**

Figure 1 shows the basic WAP architecture. There are three participating entities: the WAP browser, the WAP gateway (also called WAP proxy) and a server on the Internet. When the mobile device wants to connect to the Internet, all the communication passes through the WAP gateway. This WAP gateway translates all the protocols used in WAP to the protocols used on the Internet. For example, the WAP proxy encodes (and decodes) the content to reduce the size of the data that has been sent over the wireless link. Another example is the WTLS protocol. The communication between the mobile device and the WAP gateway is secured with WTLS. WTLS is only used between the mobile device and the WAP gateway, while SSL/TLS can be used between the gateway and the Internet. This means that the WAP gateway first has to decrypt the



encrypted WTLS-traffic and then has to encrypt it again (using SSL/TLS), as shown in Figure 2.

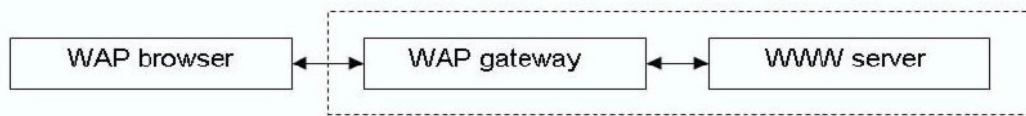


Figure 1: WAP architecture

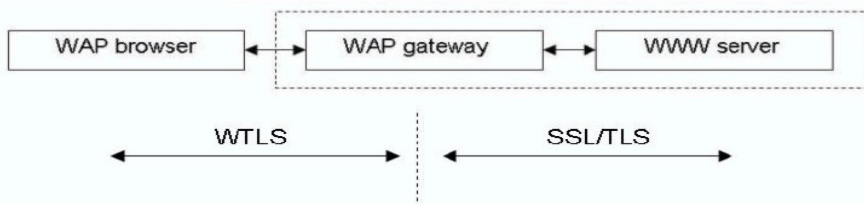


Figure 2: WTLS-traffic gets translated to SSL/TLS-traffic

Many years ago, a theoretical protocol stack was developed by the OSI (Open Systems Initiative). This was done to facilitate a common understanding of the functionality provided by a protocol stack and to facilitate comparisons between different vendor's implementations. The mapping of the WAP protocol stack to the OSI model is shown in Figure 3.

The WAP protocol stack contains the following elements:

- Physical and Data Link Layer: In WAP, Point to Point Protocols (PPP) are used over one or more Over-The-Air (OTA) bearer protocols.
- Network Layer: IP is the network layer of choice. However, not all wireless networks are capable of transmitting IP. That is why SMS or some other non-packet network protocol can be used.
- Transport Layer: The protocol used in the transport layer is UDP. However, this may not be feasible over non-IP networks. That is why (there are also other reasons) that WAP defines an additional transport layer protocol, WDP, which can be used when UDP can not.
- Session Layer: The functionality of the session layer is partially included in WTP. Other aspects of the functionality are implemented in WSP.
- Presentation Layer: The functionality of the presentation layer is included in WSP.
- Application Layer: Some aspects of the functionality of the application layer are included in WSP; the others are implemented in WAE.

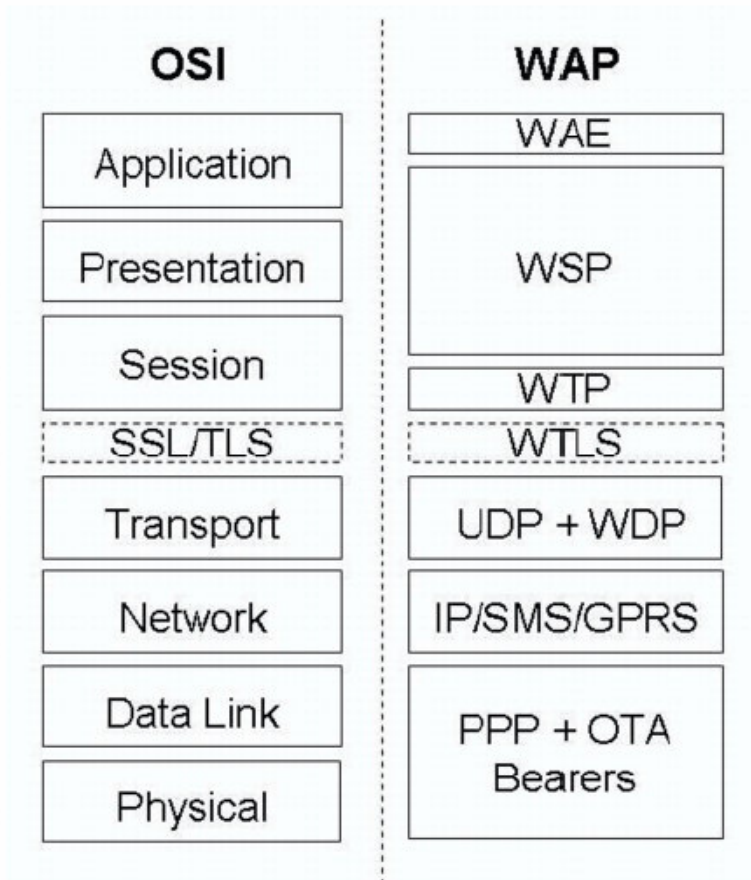


Figure 3: WAP protocol stack

### **Technical Description**

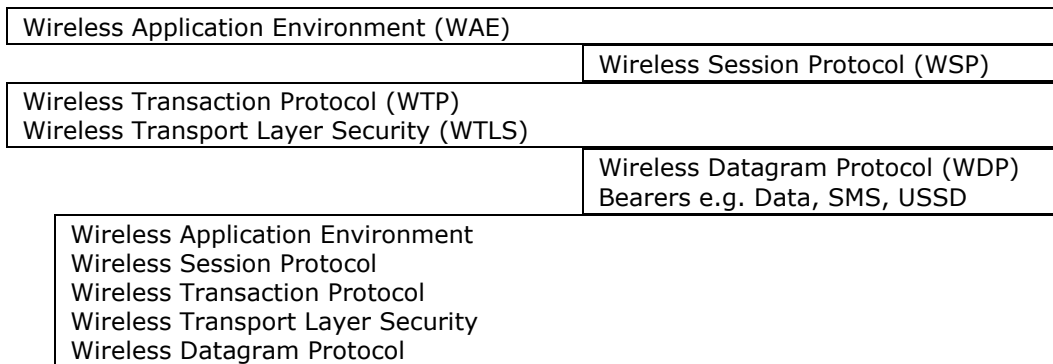
The Wireless Application Protocol embraces and extends the previously conceived and developed wireless data protocols. Phone.com created a version of the standard HTML (HyperText Markup Language) Internet protocols designed specifically for effective and cost-effective information transfer across mobile networks. Wireless terminals incorporated a HDML (Handheld Device Markup Language) microbrowser, and Phone.com's Handheld Device Transport Protocol (HDTP) then linked the terminal to the UP.Link Server Suite which connected to the Internet or intranet where the information being requested resides. The Internet site content was tagged with HDML. This technology was incorporated into WAP - and renamed using some of the many WAP-related acronyms such as WMLS, WTP and WSP. Someone with a WAP-compliant phone uses the in-built microbrowser to:

- ❑ Make a request in WML (Wireless Markup Language), a language derived from HTML especially for wireless network characteristics.
- ❑ This request is passed to a WAP Gateway that then retrieves the information from an Internet server either in standard HTML format or preferably

directly prepared for wireless terminals using WML. If the content being retrieved is in HTML format, a filter in the WAP Gateway may try to translate it into WML. A WML scripting language is available to format data such as calendar entries and electronic business cards for direct incorporation into the client device.

- ❑ The requested information is then sent from the WAP Gateway to the WAP client, using whatever mobile network bearer service is available and most appropriate.

WAP has a layered architecture as shown in the diagram below:



Let us look at each layer in the WAP protocol stack:

### Wireless Application Environment

The WAE defines the user interface on the phone. The application development environment to facilitate the development of services that support multiple bearers. To achieve this, the WAE contains the Wireless Markup Language (WML), WMLScript - a scripting micro-language similar to JavaScript - and the Wireless Telephony Application (WTA). These are the tools that allow WAP-based applications to be developed.

### Wireless Session Protocol

A sandwich layer that links the WAE to two session services - one connection oriented operating above the Wireless Transaction Protocol and a connectionless service operating above the Wireless Datagram Protocol.

### Wireless Transaction Protocol

Runs on top of a datagram service such as User Datagram Protocol (UDP); part of the standard suite of TCP/IP protocols, to provide a simplified protocol suitable for low bandwidth mobile stations. WTP offers three classes of transaction service: unreliable one way request, reliable one way request and reliable two way request respond. Interestingly, WTP supports Protocol Data Unit concatenation and delayed acknowledgement to help reduce the number of messages sent. This protocol therefore tries to optimise the user experience by providing the information that is needed when it is needed - it can be confusing to received confirmation of delivery messages when you are expecting the information itself. By stringing several messages together, the end user may well be able to get a better feel more quickly for what information is being communicated.

### Wireless Transport Layer Security

WTLS incorporates security features that are based upon the established Transport Layer Security (TLS) protocol standard. Includes data integrity checks, privacy on the WAP Gateway to client leg and authentication.



## **Wireless Datagram Protocol**

Allows WAP to be bearer independent by adapting the transport layer of the underlying bearer. WDP presents a consistent data format to the higher layers of the WAP protocol stack thereby conferring the advantage of bearer independence to application developers.

## **Applications**

WAP is being used to develop enhanced forms of existing applications and new versions of today's applications. Existing mobile data software and hardware supplies are adding WAP support to their offering, either by developing their own WAP interface or more usually partnering with one of the WAP Gateway suppliers profiled above. WAP is also given a significant impetus for new players to add mobile as a new distribution channel for their existing products and services - for example, CNN and Nokia teamed up to offer CNN Mobile and Reuters and Ericsson teamed up to provide Reuters Wireless Services. The Wireless Application Protocol will allow customers to easily reply to incoming information on the phone by allowing new menus to access mobile services. This is part of the business case for network operators - by making the value-added services more easily to reply to and request (using menus instead of keywords, for example), WAP can help generate additional traffic on the network and therefore revenue. Previously, application developers wrote proprietary software applications and had to port that application to different network types and bearers within the same platform. By separating the bearer from the application, WAP facilitates easy migration of applications between networks and bearers. As such, WAP is similar to Java in that it simplifies application development. This reduces the cost of wireless application development and therefore encourages entry to the mobile industry by software developers. WAP applications can be broadly divided into two applications:

### **Corporate Applications**

Corporate applications that are being enhanced and enabled with a WAP interface include:

- Job Dispatch
- Remote Point Of Sale
- Customer Service
- Remote Monitoring Such As Meter Reading
- Vehicle Positioning
- Corporate Email
- Remote LAN Access
- File Transfer
- Web Browsing
- Document Sharing/Collaborative Working
- Audio
- Still Images
- Moving Images
- Home Automation

### **Consumer Applications**

Consumer applications that are being enhanced and enabled with a WAP interface include:

- Simple Person to Person Messaging
- Voice and Fax Mail Notifications
- Unified Messaging
- Internet Email
- Prepayment
- Ringtones



- ❑ Mobile Commerce
- ❑ Affinity Programs
- ❑ Mobile Banking
- ❑ Chat
- ❑ Information Services

## **Security Problems with WAP**

There are some security problems with WAP. The most important threat associated with WAP is the use of the WAP gateway. There are however also some security weaknesses in the WTLS protocol and some possible threats by using mobile devices.

### **WAP Gateway**

WAP does not offer end-to-end security. WAP devices communicate with web servers

through an intermediate WAP gateway. WTLS is only used between the device and the gateway, while SSL/TLS can be used between the gateway and the web server on the Internet. This means that the WAP gateway contains, at least for some period of time, unencrypted data (which can be highly confidential). The gateway vendors have to take steps to ensure that the decryption and re-encryption takes place in memory, that keys and unencrypted data are never saved to disk, and that all memory used as part of the encryption and decryption process is cleared before handed back to the operating system.

### **WTLS Allows for Weak Encryption Algorithms**

The encryption protocol used to encrypt data during a WTLS session is negotiated in the handshake phase. There is the possibility to choose the 40-bit DES encryption method. In this method, a 5 byte key is used which contains 5 parity bits. This means that there are only 35 effective key bits in the DES key. It is very easy to find this DES key by a brute force attack.

### **Potential for Viruses**

Mobile phones are getting more and more advanced and have a sophisticated operating system. Furthermore, WAP contains a scripting language (WMLScript). This makes it easier for viruses to affect a mobile phone. What makes it even more dangerous is that it is not possible to run sophisticated anti-virus software on a mobile phone. Viruses for mobile phones have already appeared, but are not yet widespread. But experts agree that it is just a matter of time before they will strike massively. Physical Security The weakest link of the system will be the mobile phone itself. It easily gets lost or stolen and it is likely to be used more and more for the storage of sensitive data. The PIN code offers some

## **WAP Disadvantages**

It is very difficult to configure WAP phones for new WAP services, with 20 or so different parameters needing to be entered to gain access to a WAP service. This is described in details for the Nokia 7110 and Motorola L series in this new edition of "Data on WAP". There are few mobile phones that support WAP and widespread WAP support in handsets is unlikely for a long time. Commercial quantities of WAP phones are not expected until towards the end of Quarter 1 2000.

WAP is a protocol that runs on top of an underlying bearer. None of the existing GSM bearers for WAP- the Short Message Service (SMS), Unstructured Supplementary Services Data (USSD) and Circuit Switched Data (CSD) is optimized for WAP. The WAP standard is incomplete, with key elements such as Push



(proactive sending of information to mobile devices) and wireless telephony (updating address reports and the like) not yet standardized (they will be standardized in WAP 1.2, due for standardization in late 1999 and first implementation in Spring 2000). There are many WAP Gateway vendors out there competing against each other with largely the same standardized product. This has led to consolidation such as the pending acquisition of APiON by Phone.com. Other protocols such as SIM Application Toolkit and Mobile Station Application Execution Environment (MexE) are respectively already widely supported or designed to supersede WAP. WAP services are expected to be expensive to use since the tendency is to be on-line for a long Circuit Switched Data (CSD) call as features such as interactivity and selection of more information are used by the end user. Without specific tariff initiatives, there are likely to be some surprised WAP users when they see their mobile phone bill for the first time after starting using WAP.

### ***Solutions and Good Practices***

Nevertheless the security problems of WAP, there are some easy solutions and good practices to use WAP more securely. The first solution is to switch to a trusted and secure gateway instead of using the default WAP gateway. This is important in sensitive services like electronic banking applications. The problem with this solution is that it is not always very easy for a (non-technical) user to switch to another gateway. Note that if WAP is deployed over GSM, switching from one gateway to another can be done by sending a SMS message. Another possibility would be to change the gateway automatically on request of the target web server.

Another solution is to upgrade all WAP gateways such that they can work in pass through mode. When a WAP gateway works in this mode, it just lets pass all the traffic untouched. In this way, the WTLS encrypted data stream travels from the mobile phone to the server without being decrypted and the gateway would just be a relay for the data stream. A WAP gateway would have two modes. When it is in normal mode, it just works like a WAP gateway works today. When the WAP gateway detects a WTLS stream, it changes to pass through mode and simply lets the data stream pass through to the web server. Upgrading all WAP gateways and WAP servers (they have to "understand WTLS" in this solution) is much easier than upgrading all WAP devices.

There are also some good practices when using WAP. It is a good idea not to use WAP in very sensitive services and to make sure that your system does not support weak encryption algorithms. Also use a secure PIN number (so not 1234) to protect your mobile phone from being misused in case it has got lost.

### ***Conclusion***

WAP as a technology looks very exciting and seems to lead the convergence between Internet and cellular services. In the area of Web technologies, the focus of the WAP Forum and the W3C overlap to a significant degree. WAP will enhance the spread of internet access around the world. India uses GSM technology and WAP can be enabled on this technology. That means that there is a potential for WAP services for 16 Lacs subscribers. Although there will be overlap of Cellphone users and internet users one has to see how much cellular services can penetrate into internet services

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