Global Information Assurance Certification Paper

Wireless Application Protocol 2.0 Security

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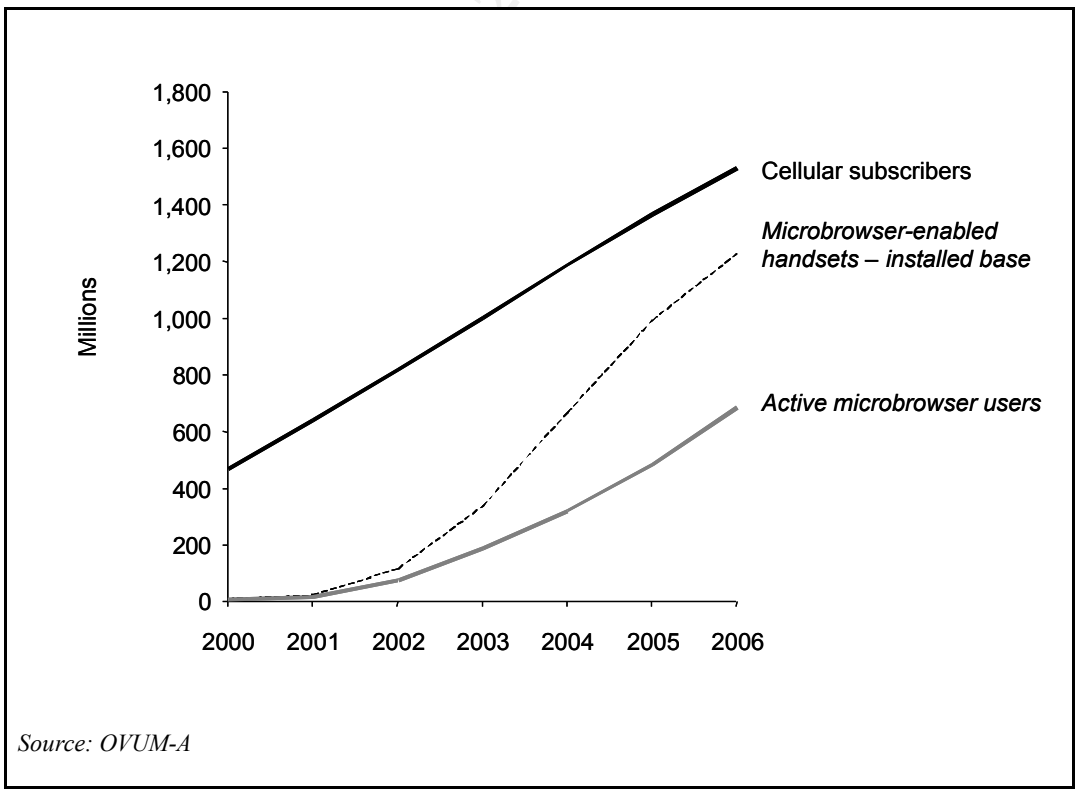
Introduction

During recent years the Internet and wireless voice communications have undergone wide and rapid acceptance. The Internet has proved to be an easy and efficient way of delivering services to millions of wired users. Mobile phones are equally efficient at providing remote services. It was then only a question of time before these two technologies would begin to converge, to bring the convenience of the Internet to the wireless community.

The mobile phone market has grown ten-fold from 1994 to 1999, from 26 million units to 278 million units. Personal computers doubled in the same period. There are now more mobile phones sold annually than PCs and TVs combined [GOLD-A]. The communications industry is fast recognising that the future of e-commerce lies in networked computing from the mobile phone.

Current projections indicate that there will be 1.5 billion mobile subscribers by 2006, 684 million of which will use microbrowser[1]-enabled services. This compares with 500 million desktop or laptop Internet users. By 2006, 82% of the installed base will be microbrowser-enabled, but not all will be used [OVUM-A]. See the figure below for the forecasted trends from now to 2006.

Figure Forecast for cellular subscribers, microbrowser-enabled handsets and active microbrowser users (2000 to 2006)



Source: OVUM-A

[1] Software that allows the user to access the Internet from a mobile device.

The major problem with converging these technologies is the difference in device structure and network properties. Internet access is generally obtained via a desktop or laptop and this will be replaced by a smaller wireless device. This has limited display capabilities, limited input facilities, limited memory and CPU, plus limited battery power. In addition the wireless network, compared to the wired network, has lower bandwidth that can cause poor performance, high latency and less connection stability.

In order to address these issues, the WAP Forum[2] has introduced a standardised way to provide communication between the wired and wireless worlds. The phenomenal growth in wireless web phones, personal digital assistants and other handheld devices, together with strong demand for mobile Internet services, have provided the momentum behind Wireless Application Protocol ('WAP').

WAP is optimised for small devices and is based on the Internet client/server architecture. Essentially, it is the mobile equivalent of traditional Internet protocols, but with adaptations to the bounds of the wireless network and the wireless device. It is bearer-independent and supports the major operating systems used in handheld devices (including Epoc, JavaOS, PalmOS and Windows CE).

The WAP Forum released WAP 1.1 in June 1999 and WAP 1.2 was ratified in December 1999. The next generation WAP, WAP 2.0 (also known as WAP-NG), was released for public review on 1 August 2001. WAP 2.0 continues the standard's convergence with Internet technology and is based on the Internet Engineering Task Force ('IETF') standard of TCP/IP and the World Wide Web Consortium's ('W3C') recommendation of XHTML[3]. It also improves the user experience through additional features, such as Data Synchronization (Sync ML), Multimedia Messaging Service, Persistent Storage Interface, Provisioning, Pictograms and an evolved version of WAP Push [WAPF-A].

This paper will focus on WAP 2.0, how it differs from previous versions of WAP and how these differences impact on security. It will assume the reader has previous knowledge of WAP 1.x, which has already been detailed in earlier SANS documents (for example, [SANS-A], [SANS-B], [SANS-C] and [SANS-D]), and will begin by summarising current WAP 1.x security mechanisms.

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2 The WAP Forum is an industry association of wireless device manufacturers, service providers and software companies. It was founded in 1997 by three mobile phone manufacturers (Ericsson, Motorola and Nokia), together with the US software company Phone.com (formerly Unwired Planet).

3 eXtensible HyperText Markup Language ('XHTML').

WAP 1.1 security

The main security initiative in WAP 1.1 is the Wireless Transport Layer Security protocol ('WTLS'). WTLS provides similar functionality to that of the Internet's transport layer security v1.0 protocol ('TLS'), the IETF's standard for securing Internet browsing, and this, in turn, is based on Secure Sockets Layer ('SSL') v3.0 Internet protocol.

However, compared to traditional TLS/SSL, WTLS provides faster algorithm processing (by minimising protocol overheads), enables more data compression and provides the added functionality of datagram support[4], optimised handshake[5] and dynamic key refreshing.

WTLS provides a robust, efficient basis for secure transactions and supports data integrity, authentication and privacy services between communicating applications [WAPF-D]. A summary of each security service and the corresponding WTLS security mechanism is outlined in the table below.

Security requirement	**Security mechanism**
Confidentiality/privacy	■ Secret key cryptography using bulk ciphers, such as RC5_CBC, DES_CBC, 3DES_CBC, IDEA
Authentication/authorisation and non-repudiation	■ Public key cryptography using key exchange suites, such as RSA, Diffie-Hellman, Elliptic Curve Diffie-Hellman
Integrity	■ MACs - HMAC based (for example SHA-1, MD5) or XOR based (for example SHA-1)

[4] TLS/SSL cannot operate over UDP, whereas WTLS can.

[5] For optimised handshakes, in contrast to the full handshake, the server obtains the client certificate from a certificate distribution service or from its own source, without requesting it over the air from the client.

WAP 1.2 security

To address the lack of both non-repudiation services and real end-user authentication in WAP 1.1, the WAP Forum introduced two new initiatives in WAP 1.2:

- the WMLScript Crypto Library – provides application layer security by the use of WMLScript applets to enable cryptographic signing of WML content. These applets run on the client and are stored within a WMLScript Crypto library; and

- the WAP Identity Module ('WIM') - 'a tamper-resistant[6] device which is used in performing WTLS and application level security functions, and especially, to store and process information needed for user identification and authentication' [WAPF-B].

These two initiatives are supported by a wireless Public Key Infrastructure ('PKI'), which provides the functions that store and process information needed for user identification and authentication [WAPF-B].

WAP 2.0 security

A much publicised criticism of WAP 1.x, and a primary cause of reluctance to adopt the protocol, is the lack of end-to-end security or end-to-end authentication. This is due to the presence of a WAP gateway, which effectively acts as a bridge between the mobile and IP networks. The gateway is the single point of translation between the WAP and standard Internet protocols (WTLS and TLS/SSL) and markup languages (WML[7]/WMLScript[8] and HTML[9]/JavaScript). As part of the translation process, data is momentarily present in plaintext and it is this 'gap' in security that can, potentially, pose a serious security risk.

In an attempt to reduce this risk, gateway operators claim to take precautions to ensure plaintext is never written to disk, decryption and re-encryption takes place in the volatile, internal memory and is erased as quickly as possible, the gateway is physically secured and administrative access to the gateway is limited. However, the residual risk may still be too unacceptable for services that require secure transactions, such as banking and brokerage.

Alternatively, vendors with strenuous security requirements could host their own

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6 Tamper-resistant means that certain physical hardware protection is used, which makes it unfeasible to extract or modify information in the module (volatile, non-volatile memory and other parts) [WAPF-B]

7 Wireless Markup Language ('WML').

8 Wireless Markup Language Script ('WMLScript').

9 Hyper Text Markup Language ('HTML').

gateway. This would be within the vendor's own network environment and would be under their control and security measures. Data, encrypted by WTLS, would pass directly between the client and the vendor's gateway and would then pass through the vendor's network to their web server. This would, effectively, provide a form of end-to-end security. However, in practice this is a very large overhead for vendors. Also, the majority of WAP phones are sold with the mobile operator's gateway setting pre-loaded. It can be complicated and frustrating exercise to change that setting and some operators prevent users from accessing any gateway other than their own.

WAP 2.0 addresses the lack of end-to-end security by introducing support and services for Internet protocols (including TCP/IP[10], TLS and HTTP[11]) into the WAP environment. Internet protocols can, therefore, be used directly between the client and wireless network and this eliminates the need for protocol translation at the WAP gateway. In doing so, this effectively provides transport level end-to-end security.

WAP 2.0 architecture

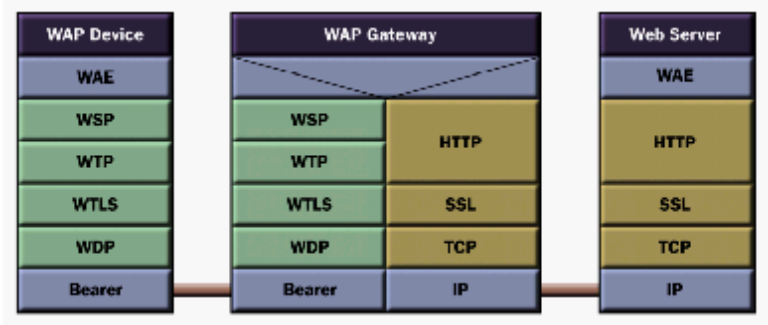
In the previous versions of the WAP specification, a new set of protocols, collectively known as WAP 1.x stack, were created to facilitate the transfer of data along low-bandwidth mobile networks to constrained devices. With the emergence of high-speed wireless networks (for example, 2.5G and 3G) and improvements in device technology, appropriate IP connectivity can now be achieved between the device and wireless network. WAP 2.0 takes advantage of this by introducing Internet protocols directly into the WAP environment.

The previous WAP 1.x stack and proposed WAP 2.0 stacks are detailed in figure 2 overleaf.

Note the use of a WAP 'proxy', to replace the gateway in WAP 2.0. This is not used for translation, merely as a conduit to optimise the communications process and perhaps offer mobile service enhancements, such as location-based services. A proxy is also required to enable 'push' capabilities.

[10] Transmission Control Protocol/Internet Protocol ('TCP/IP').
[11] HyperText Transfer Protocol ('HTTP').

WAP 1.x Gateway



P 2.0 Security

WAP 2.0 Proxy with profiled HTTP, TLS and TCP

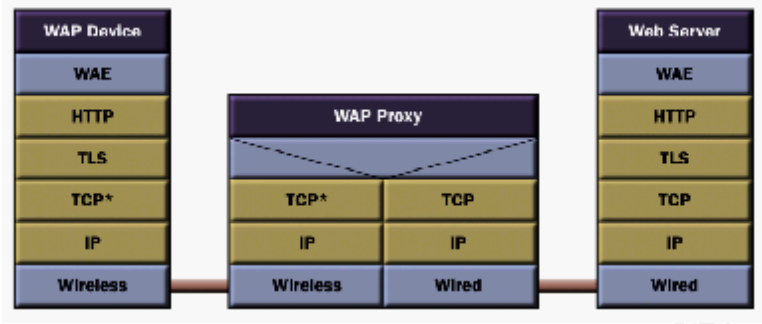


Figure WAP 1.x stack versus WAP 2.0 stack

Source: WAP Forum [WAPF-A]

The WAP 2.0 stack essentially replaces the four layers beneath the Wireless Application Environment ('WAE') of the WAP 1.x stack as follows (see figure 3 overleaf):

HTTP

- replaces the wireless session protocol ('WSP') and wireless transaction protocol ('WTP'); and
- supports HTTP request/response transactions, response message body compression and the establishment of secure tunnels.

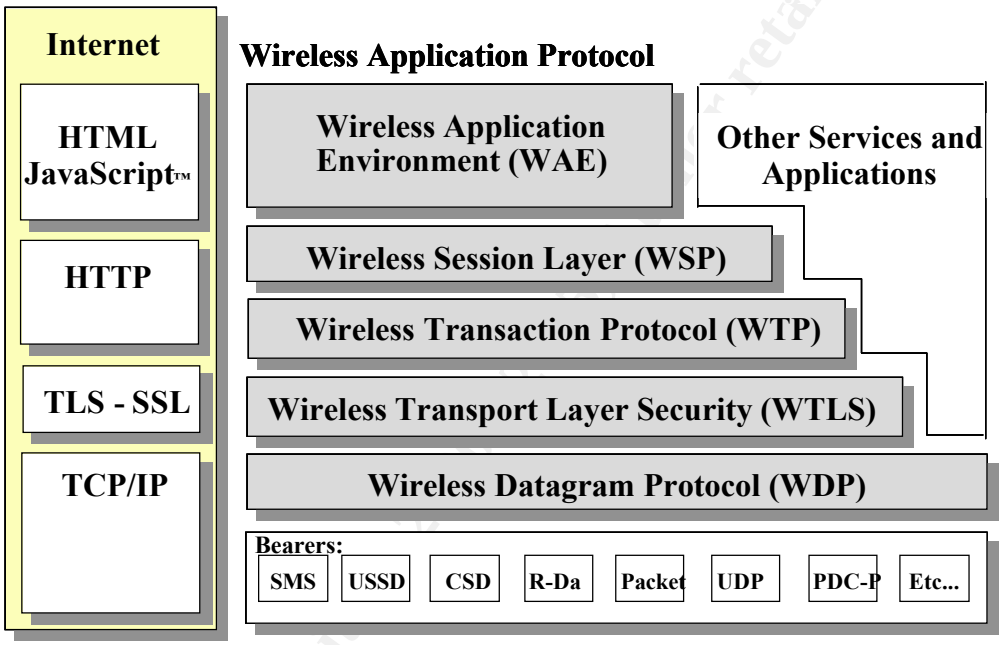
TLS/SSL

- replaces wireless transport layer security ('WTLS'); and
- supports secure transactions with cipher suites, certificate formats, signing algorithms and the use of session resume.

TCP

- replaces wireless datagram protocol ('WDP'); and
- provides connection-oriented services.

Figure Internet and WAP protocol stacks



Source: WAP Forum

It is important to note that HTTP, TLS and TCP protocols are not identical to the Internet versions as they are 'wireless profiled'. This means they have been optimised for wireless environments and can interoperate with the standard implementations in the Internet [WAPF-C].

The 'profiled' TLS specification use similar security mechanisms/algorithms to those listed previously for WTLS:

- MACs to carry out message integrity checks (supports the common MAC algorithms SHA-1 and MD5)
- public key cryptographic authentication of the client and server (be it origin or proxy), either through the use of certificates or anonymously (supports the use of RSA, Diffie-Hellman and Elliptic Curve Cryptography algorithms); and
- message confidentiality is protected by secret key cryptography (using DES, triple DES, RC5 and IDEA algorithms).

The WAE, nominally viewed as the 'WAP browser', has evolved in WAP 2.0 to embrace developing standards for Internet browser markup language [WAPF-A]. WAP 1.x uses the lightweight markup language WML (which is a subset of XML[12] and is similar to the Internet's HTML, but optimised for use in handheld mobile devices). WAP 2.0 introduces WML2, which is based on the basic profile of XHTML, developed by the W3C to replace and enhance the HTML language commonly used today. This will eventually enable developers to write applications for both PC and WAP clients using a common subset of language elements and development tools.

Conclusion

WAP 2.0 continues to support the original WAP 1.x stack and, by encompassing both stacks, provides backwards compatibility. Although this has the advantage of enabling connectivity over a broader range of networks and wireless bearers, the wireless environment is now exposed to security issues related to the Internet protocols as well as those related to WAP 1.x and the WAP 1.x architecture.

Some of the weaknesses in WTLS are also present in the current TLS/SSL used over the Internet, and will therefore also apply to the 'profiled' TLS used by WAP 2.0. These include: no obligation to exchange certificates; no obligation to verify certificates and authenticate owners; and the permitting of anonymous Diffie-Hellman mode (where exchanges are not supported by public key certificates) and may allow man-in-the-middle attacks (where an attacker is able to substitute his own public key for the requested public key).

Therefore, some of the old security issues will still remain in WAP 2.0. However, WAP 2.0 does address arguably the largest barrier to WAP's use and acceptance, the 'gap' in security caused by protocol translation at the gateway. There will, no doubt, also be the introduction of new security threats and issues to the wireless

[12] Extensible Markup Language ('XML').

environment as it continues its convergence with the Internet.

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