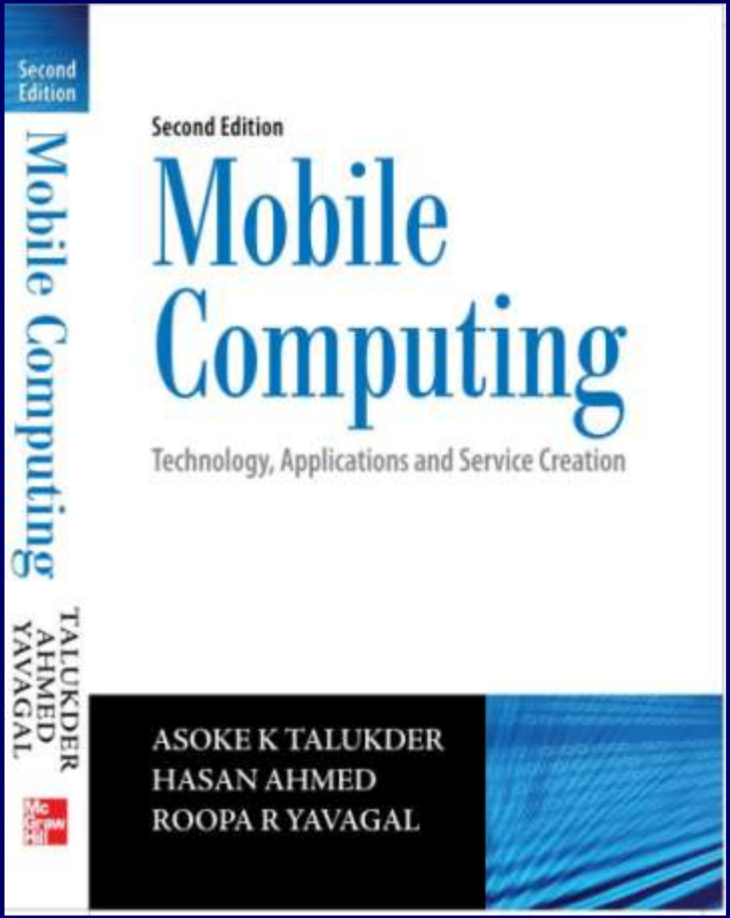


Mobile Computing

Chapter 7

GPRS

Asoke K Talukder

Hasan Ahmed

GPRS

- General Packet Radio Service
- Step to efficiently transport high-speed data over the current GSM and TDMA-based wireless network infrastructures
- Deployment of GPRS networks allows a variety of new applications ranging from mobile e-commerce to mobile corporate VPN access
- GPRS allows for data speeds of 14.4 KBps to 171.2 KBps, which allow for comfortable Internet access
- Allows for short ‘bursty’ traffic, such as e-mail and web browsing, as well as large volumes of data

GPRS

- No dial-up modem connection is necessary
- Offers fast connection set-up mechanism to offer a perception of being ‘always on’ or ‘always connected’
- Immediacy is one of the prime advantages of GPRS

QoS in GPRS

- ❑ Allows definition of QoS profiles using the parameters of service precedence, reliability, delay and throughput
- ❑ Service precedence is the priority of a service in relation to another service which can be either high, normal or low
- ❑ Reliability indicates the transmission characteristics required by an application and guarantees certain maximum values for the probability of loss, duplication, mis-sequencing and corruption of packets
- ❑ Delay parameters define maximum values for the mean delay and the 95-percentile delay
- ❑ Throughput specifies the maximum/peak bit rate and the mean bit rate

GPRS Network Architecture

- GPRS uses the GSM architecture for voice
- To offer packet data services through GPRS, a new class of network nodes called GPRS support nodes (GSN) are introduced
- GSNs are responsible for the delivery and routing of data packets between the mobile stations and the external packet data networks (PDN)
- Two main GSNs are Serving GSN (SGSN) and Gateway GSN (GGSN)

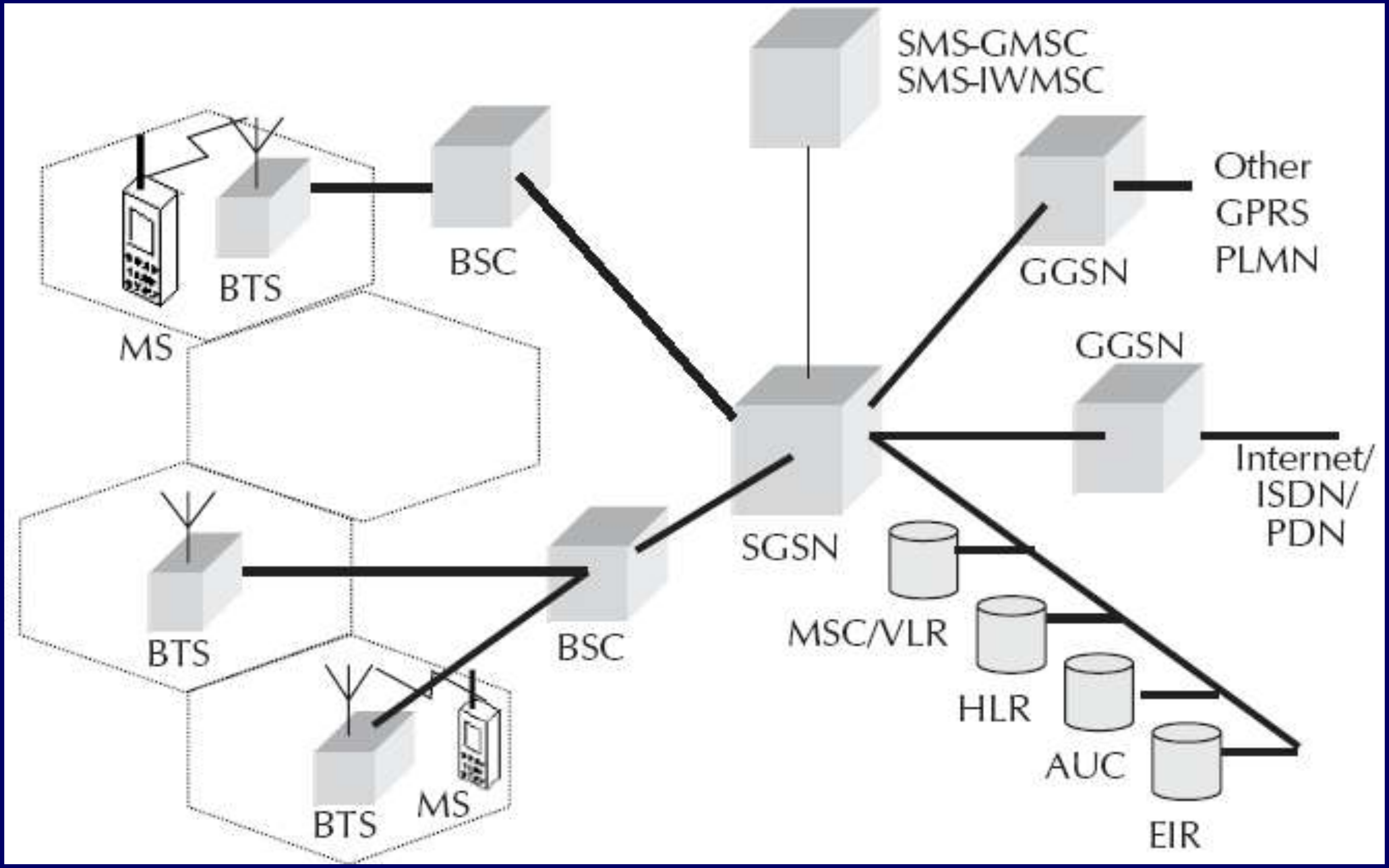
SGSN

- SGSN is at the same hierarchical level as the MSC and so, whatever MSC does for voice, SGSN does for packet data
- SGSN's tasks include packet switching, routing and transfer, mobility management, logical link management, authentication and charging functions
- SGSN processes registration of new mobile subscribers and keeps a record of their location inside a given service area
- Location register of the SGSN stores location information (like current cell, current VLR, etc.) and user profiles of all GPRS users registered with this SGSN
- SGSN sends queries to HLR to obtain profile data of GPRS subscribers

GGSN

- ❑ GGSN acts as an interface between the GPRS backbone network and the external packet data networks and functions like a router in a LAN
- ❑ GGSN maintains routing information that is necessary to tunnel Protocol Data Units (PDUs) to the SGSNs that service particular mobile stations
- ❑ GGSNs convert the GPRS packets coming from the SGSN into the appropriate packet data protocol (PDP) format for the data networks like Internet or X.25
- ❑ GGSN stores the current SGSN address of the user and user’s profile in its location register while performing authentication and charging functions related to data transfer

GPRS System Architecture



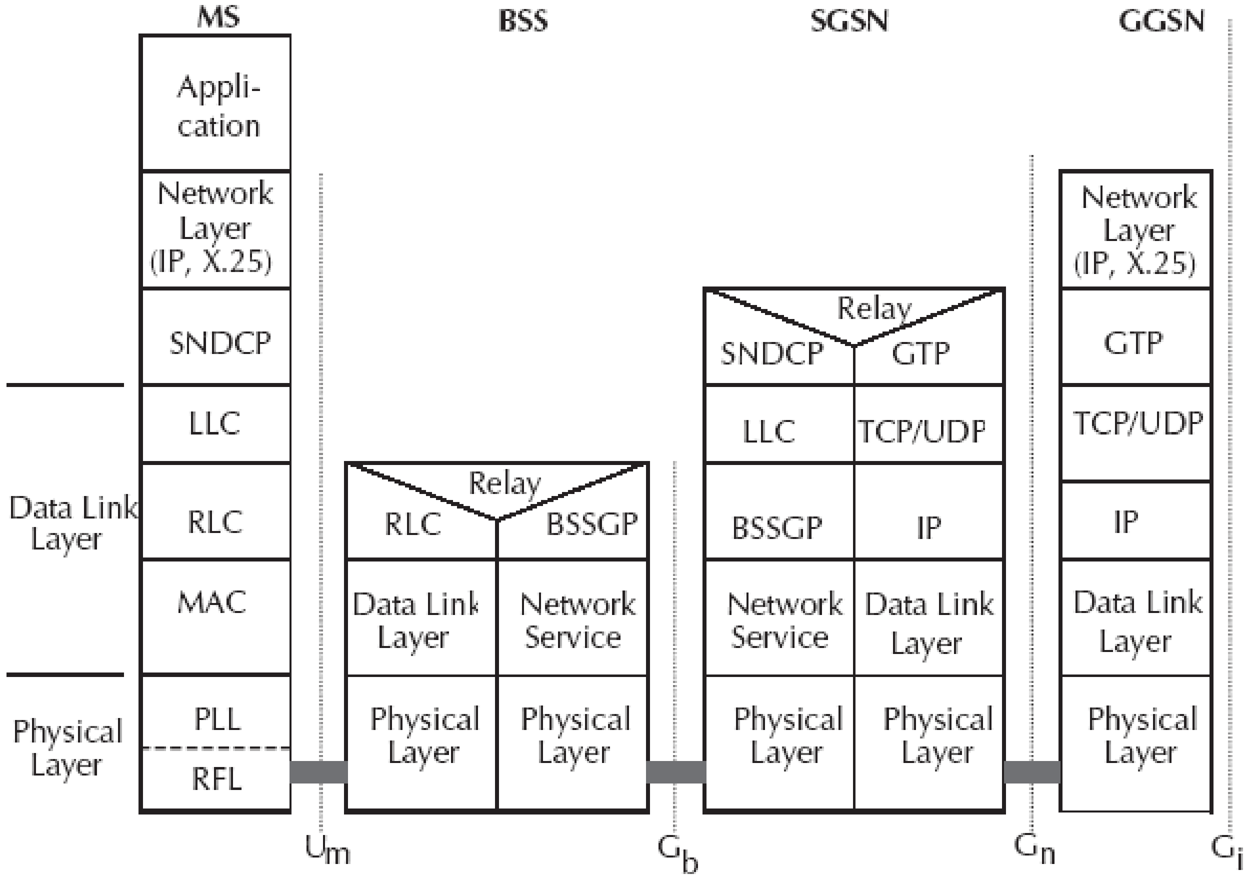
GPRS Network Enhancements

- ❑ Base Station System (BSS) needs enhancement to recognize and send packet data and this includes BTS upgrade to allow transportation of user data to the SGSN. BTS, too, needs to be upgraded to support packet data transportation between BTS and MS (mobile station).
- ❑ HLR needs enhancement to register GPRS user profiles and respond to queries originating from GSNs regarding these profiles.
- ❑ MS (mobile station) for GPRS is different from that of GSM.
- ❑ SMS-GMSCs and SMS-IWMSCs are upgraded to support SMS transmission via the SGSN.

Channel Coding

- Channel coding is used to protect the transmitted data packets against errors
- Channel coding technique in GPRS is quite similar to the one employed in conventional GSM
- Under very bad channel conditions, reliable coding scheme is used where redundant bits are added to recover from burst errors
- Under good channel conditions, no encoding scheme is used resulting in a higher data rate

Transmission Plane Protocol Architecture



SNDCP	Subnetwork Dependent Convergence Protocol	BSSGP	BSS GPRS A Application Protocol
LLC	Logical Link Control		
RLC	Radio Link Control	GTTP	GPRS Tunneling Protocol
MAC	Medium Access Control	TCP	Transmission Control Protocol
PLL	Physical Link Layer	UDP	User Datagram Protocol
RFI	Physical RF Layer	IP	Internet Protocol

Signaling Plane

❑ Protocol architecture of the signaling plane comprises protocols for control and support of the functions of the transmission plane and includes GPRS attach and detach, PDP context activation, control of routing paths and allocation of network resources.

❑ Between SGSN and HLR as well as between SGSN and EIR, an enhanced Mobile Application Part (MAP) is employed which is a mobile network specific extension of the Signaling System SS#7 used in GSM and transports the signaling information related to location updates, routing information, user profiles and handovers.

❑ MAP messages are exchanged over Transaction Capabilities Application Part (TCAP) and Signaling Connection Control Part (SCCP) while BSSGP is an enhancement of GSM's BSSAP.

GPRS Backbone

- ❑ It includes the transmission plane between SGSN and GGSN.
- ❑ User data packets and signaling information within GPRS networks are encapsulated using GPRS Tunneling Protocol (GTP) which is also used in both intra-PLMN (between SGSN and GGSN within one PLMN) and inter-PLMN (between SGSN and GGSN of different PLMNs).
- ❑ GTP protocol tunnels the user data packets through GPRS backbone by adding GPRS specific routing information in the form of GTP packets which can carry data packets from both IP and X.25 data networks.
- ❑ Finally, GPRS backbone has an IP/X.25-over-GTP-over-UDP/TCP-over-IP transport architecture.

BSS-SGSN Interface

The BSS-SGSN interface is divided into four layers:

1. Sub-Network Dependent Convergence Protocol (SNDCP) which transfers data packets between SGSN and MS, multiplexes several connections of the network layer onto one virtual logical connection of the underlying LLC layer and does segmentation, compression-decompression of user data.
2. Logical Link Control (LLC) is data link layer protocol for GPRS which functions similar to Link Access Procedure-D (LAPD) and assures the reliable transfer of user data across a wireless network.

BSS-SGSN Interface

3. Base Station System GPRS Protocol (BSSGP) delivers routing and QoS related information between BSS and SGSN.
4. Network Service layer manages the convergence sub-layer that operates between BSSGP and Frame Relay Q.922 Core by mapping BSSGP's service requests to the appropriate Frame Relay services.

Air Interface

- Air interface of GPRS comprises data link layer and physical layer.
- Data link layer between MS and BSS is divided into three sublayers: the logical link control (LLC) layer, the radio link control (RLC) layer and the medium access control (MAC) layer.
- Physical layer between MS and BSS is divided into two sublayers: the physical link layer (PLL) and the physical RF layer (RFL).

LLC Layer

- ❑ Logical Link Control (LLC) layer provides a reliable logical link between an MS and its assigned SGSN as its functionality is based on HDLC (High Level Data Link Control) protocol and includes sequence control, in-order delivery, flow control, detection of transmission errors and retransmissions.
- ❑ Encryption is used.
- ❑ Variable frame lengths are possible and both acknowledged and unacknowledged data transmission modes are supported.

RLC Layer

- Radio Link Control (RLC) layer establishes a reliable link between MS and BSS.
- It also does segmentation and reassembly of LLC frames into RLC data blocks and ARQ of uncorrectable data.

MAC Layer

- Medium Access Control (MAC) layer controls the access attempts of an MS on the radio channel shared by several MSs by employing algorithms for contention resolution, multi-user multiplexing on a packet data traffic channel (PDTCH) and scheduling and prioritizing based on the negotiated QoS.

PL Layer

- Physical Link Layer (PLL) provides services for information transfer over a physical channel between the MS and the network.
- Its functions include data unit framing, data coding and detection and correction of physical medium transmission errors.
- Physical Link Layer uses the services of the Physical RF Layer.

PRF Layer

- ❑ Physical RF Layer (RFL) performs the modulation of the physical waveforms based on the sequence of bits received from the Physical Link Layer above.
- ❑ It also demodulates received wave forms into a sequence of bits that are transferred to the Physical Link layer for interpretation.

Radio Resource Management

❑ On the radio interface, GPRS uses a combination of FDMA and TDMA.

❑ A series of logical channels are defined to perform functions like signaling, broadcast of general system information, synchronization, channel assignment, paging or payload transport.

❑ Such channels can be divided into two categories: traffic channels and signaling channels.

❑ GPRS traffic channels are allocated when data packets are sent or received and they are released after the transmission of data.

❑ GPRS allows a single mobile station to use multiple time slots of the same TDMA frame for data transmission which is known as multi-slot operation and uses a very flexible channel allocation

Radio Resource Management

❑ Uplink and downlink channels are allocated separately which efficiently supports asymmetric data traffic like Internet.

❑ Physical channels to transport user data packet are called Physical Data Traffic Channel (PDTCH) which are taken from a common pool of all channels available in a cell.

❑ Mapping of physical channels to either packet switched data (in GPRS mode) or circuit switched data (in GSM mode) services are performed dynamically depending on demand.

❑ Demand-wise, the number of channels allocated for GPRS can be changed. For example, physical channels not currently in use by GSM can be allocated as PDTCHs to increase the bandwidth of a GPRS connection.

Security

- ❑ GPRS security is similar to the existing GSM security.
- ❑ SGSN performs authentication and cipher setting procedures based on the same algorithms, keys and other criteria of GSM.
- ❑ GPRS uses a ciphering algorithm optimized for packet data transmission.

Attachment and Detachment in GPRS

- ❑ MS registers itself with SGSN of GPRS network through a GPRS attach which establishes a logical link between the MS and the SGSN.

- ❑ Network checks if MS is authorized to use the services; if so, it copies the user profile from HLR to SGSN and assigns a Packet Temporary Mobile Subscriber Identity (P-TMSI) to the MS.

- ❑ To exchange data packets with external PDNs after a successful GPRS attach, an MS must apply for an address which is called PDP (Packet Data Protocol) address.

- ❑ For each session, a PDP context is created which contains PDP type (e.g. IPv4), PDP address assigned to the mobile station (e.g. 129.187.222.10), requested QoS and address of the GGSN that will function as an access point to the PDN.

Attachment and Detachment in GPRS

- Such a context is stored in MS, SGSN and GGSN while with an active PDP context, the MS is ‘visible’ to the external PDN.

- A user may have several simultaneous PDP contexts active at a given time and user data is transferred transparently between MS and external data networks trough GTP encapsulation and tunneling.

- Allocation of the PDP address can be static or dynamic.

- In case of static address, the network operator permanently assigns a PDP address to the user while in other case, a PDP address is assigned to the user upon the activation of a PDP context.

PDP Context Activation

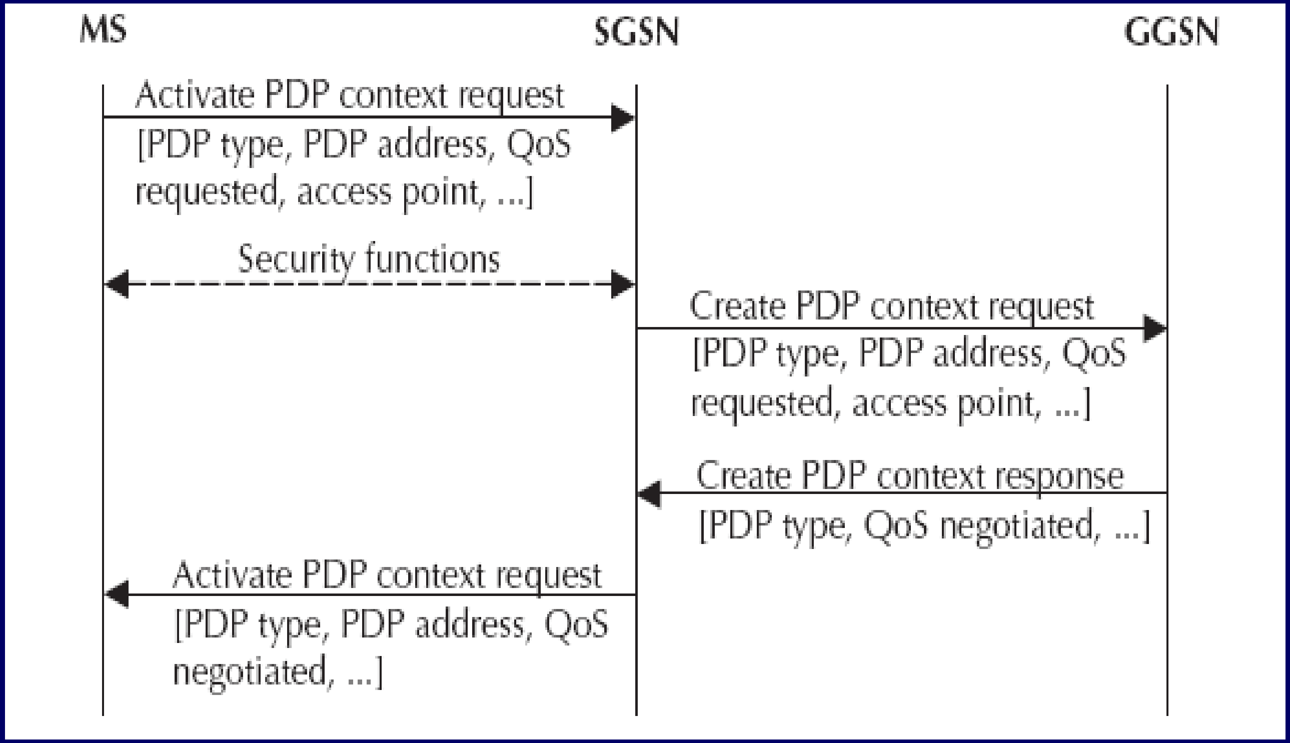
- ❑ Using the message ‘activate PDP context request’, MS informs the SGSN about the requested PDP context and if request is for dynamic PDP address assignment, the parameter PDP address will be left empty.

- ❑ After necessary security steps, if authentication is successful, SGSN will send a ‘create PDP context request’ message to the GGSN, the result of which is a confirmation message ‘create PDP context response’ from the GGSN to the SGSN, which contains the PDP address.

- ❑ SGSN updates its PDP context table and confirms the activation of the new PDP context to the MS.

- ❑ Disconnection from the GPRS network is called GPRS detach in which all the resources are released.

PDP Context Activation



Mobility Management

- Mobility Management functions are used to track its location within each PLMN in which SGSNs communicate with each other to update the MS's location in the relevant registers.

- Profiles of MSs are preserved in VLRs that are accessible to SGSNs via the local MSC.

- A logical link is established and maintained between the MS and the SGSN at each PLMN.

- At the end of transmission or when a mobile station moves out of area of a specific SGSN, the logical link is released and the resources associated with it can be reallocated.

Routing

- Routing is the process of how packets are routed in GPRS.
- Here, the example assumes two intra-PLMN backbone networks of different PLMNs. Intra-PLMN backbone networks connect GSNs of the same PLMN or the same network operator.
- These intra-PLMN networks are connected with an inter-PLMN backbone while an inter-PLMN backbone network connects GSNs of different PLMNs and operators. However, a roaming agreement is necessary between two GPRS network providers.
- Gateways between PLMNs and external inter-PLMN backbone are called border gateways which perform security functions to protect the private intra-PLMN backbones against malicious attacks.

Routing

- Let's say that GPRS MS located in PLMN1 sends IP packets to a host connected to the IP network (e.g. to a Web server connected to the Internet).

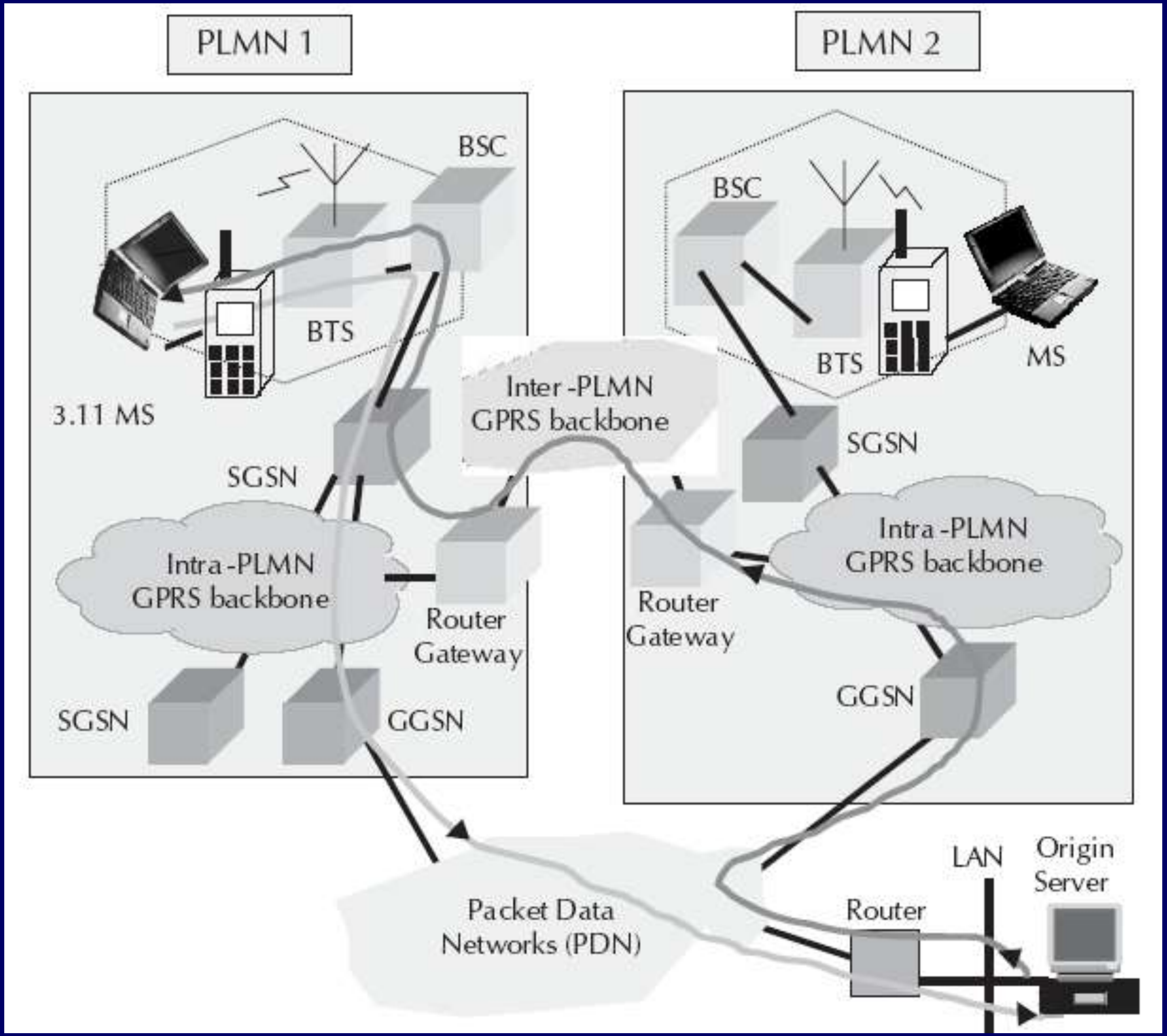
- SGSN that the MS is registered with encapsulates the IP packets coming from the mobile station, examines the PDP context and routes them through the intra-PLMN GPRS backbone to the appropriate GGSN.

- GGSN de-encapsulates the packets and sends them out on the IP network, where IP routing mechanisms are used to transfer the packets to the access router of the destination network and finally, delivers the IP packets to the host.

Routing

- Let us also say that home-PLMN of the mobile station is PLMN2.
- An IP address has been assigned to MS by the GGSN of PLMN2 and so, MS's IP address has the same network prefix as the IP address of the GGSN in PLMN2.
- Correspondent host is now sending IP packets to the MS onto the IP network and are routed to the GGSN of PLMN2 (the home-GGSN of the MS). The latter queries the HLR and obtains the information that the MS is currently located in PLMN1.
- It encapsulates the incoming IP packets and tunnels them through the inter-PLMN GPRS backbone to the appropriate SGSN in PLMN1 while the SGSN de-encapsulates the packets and delivers them to the MS.

Routing


PLMN 1
PLMN 2
BSC
BTS
3.11 MS
SGSN
Intra-PLMN
GPRS backbone
Router
Gateway
SGSN
GGSN
Inter-PLMN
GPRS backbone
BSC
BTS
MS
SGSN
Intra-PLMN
GPRS backbone
Router
Gateway
GGSN
Packet Data
Networks (PDN)
Router
LAN
Origin
Server

Routing

- HLR stores the user profile, the current SGSN address and the PDP addresses for every GPRS user in the PLMN.
- When the MS registers with a new SGSN, HLR will send the user profile to the new SGSN.
- Signaling path between GGSN and HLR may be used by the GGSN to query a user's location and profile in order to update its location register.

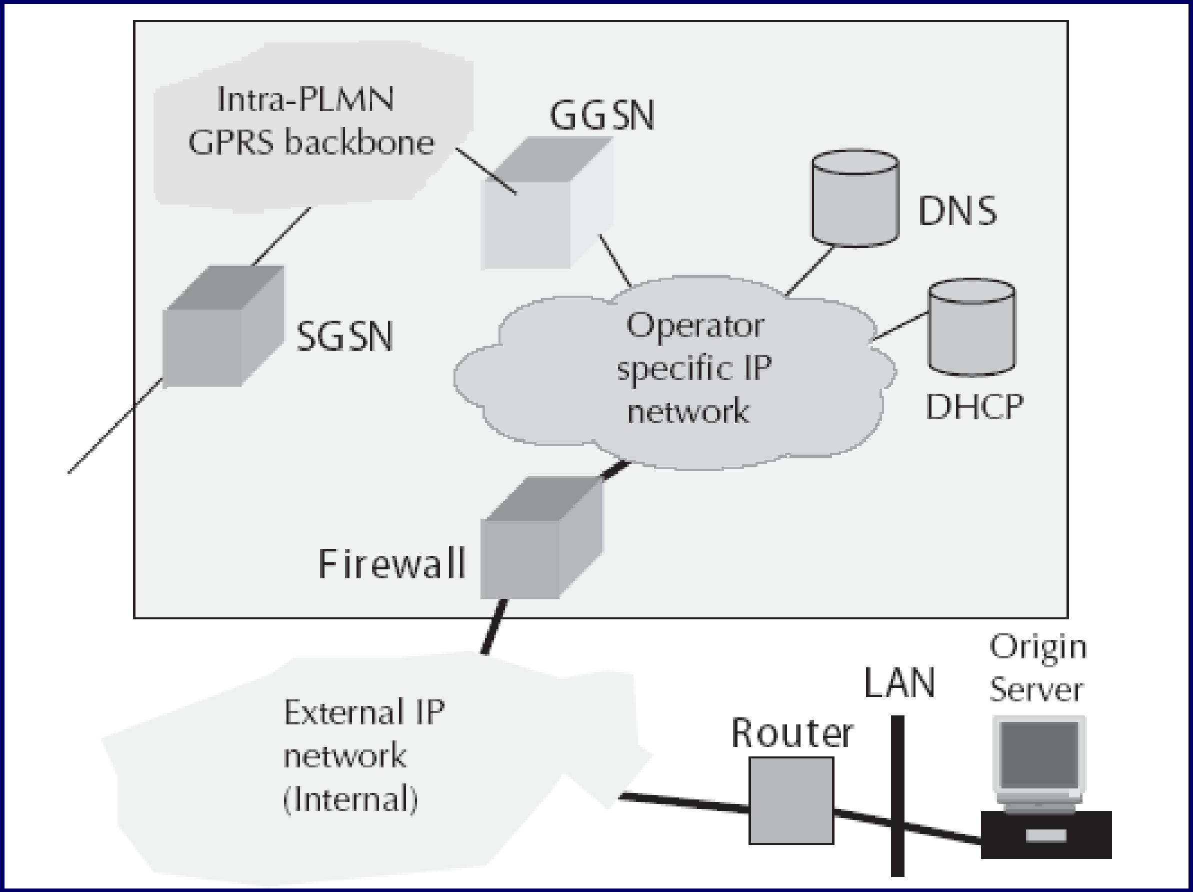
Communicating with IP Networks

- ❑ A GPRS network can be interconnected with Internet or a corporate intranet and supports both IPv4 and IPv6.
- ❑ From an external IP network’s point of view, the GPRS network looks like any other IP sub-network, and the GGSN looks like a usual IP router.
- ❑ Each registered user who wants to exchange data packets with the IP network gets an IP address which is taken from the address space of the GPRS operator maintained by a Dynamic Host Configuration Protocol (DHCP) server.
- ❑ Address resolution between IP address and GSM address is performed by the GGSN using the appropriate PDP context.

Communicating with IP Networks

- Domain Name Server (DNS) managed by the GPRS operator or the external IP network operator is used to resolve host name.
- To protect the PLMN from unauthorized access, a firewall is installed between the private GPRS network and the external IP network.
- Thus, GPRS can be seen as a wireless extension of the Internet all the way to a MS or mobile computer as mobile user has a direct connection to the Internet.

Communicating with IP Networks



Data Services in GPRS

- Any user is likely to use either of the two modes of the GPRS network: application mode or tunneling mode.

- In application mode, user uses the GPRS mobile phone to access the applications running on the phone itself. The phone here acts as the end user device.

- In tunneling mode, user uses GPRS interface as an access to the network as the end user device would be a large footprint device like laptop computer or a small footprint device like PDA. The mobile phone will be connected to the device and used as a modem to access the wireless data network.

GPRS Handsets

- GPRS terminal can be one of the three classes: A, B or C.
- Class A terminal supports GPRS data and other GSM services such as SMS and voice simultaneously. This includes simultaneous attach, activation, monitoring and traffic. As such, a class A terminal can make or receive calls on two services simultaneously while supporting SMS.
- Class B terminal can monitor GSM and GPRS channels simultaneously, but can support only one of these services at any time. Therefore, a Class B terminal can support simultaneous attach, activation, and monitoring but not simultaneous traffic. Users can make or receive calls on either a packet or a switched call type sequentially but not simultaneously. SMS is supported in class B terminals.

GPRS Handsets

- Class C terminal supports only non-simultaneous attach. The user must select which service to connect to. Therefore, a class C terminal can make or receive calls from only the manually selected network service (and so, the service that is not selected is not reachable). The GPRS specifications state that support of SMS is optional for class C terminals.

- Each handset will have a unique form factor. So, terminals will be available in the standard form factor with a numeric keypad and a relatively small display. Other types of phones with different form factors, color displays, cameras are common apart from the latest smart phones.

Bearers in GPRS

- ❑ Bearer services of GPRS offer end-to-end packet switched data transfer.
- ❑ GPRS supports two different kinds of data transport services: point-to-point (PTP) services and point-to-multipoint (PTM) services.
- ❑ GPRS continues to support SMS as a bearer.
- ❑ Wireless Application Protocol is a data bearer service over HTTP protocol, supported by GPRS.
- ❑ Multimedia Messaging Service, too, is supported by GPRS.

Applications of GPRS

- Chat
- Multimedia Services
- Virtual Private Network
- Personal Information Management
- Job Sheet Dispatch
- Unified Messaging
- Vehicle Positioning
- Location based services and Telematics

Limitations of GPRS

- ❑ Limited cell capacity for all users
- ❑ Lower access speed in reality
- ❑ No support of GPRS Mobile Terminate Connection for a mobile server

Billing and Tariffing

Minimum charging information that must be collected are:

❑ Destination and source addresses

❑ Usage of radio interface

❑ Usage of external Packet Data Networks

❑ Usage of the packet data protocol addresses

❑ Usage of general GPRS resources and location of the Mobile Station

Billing and Tariffing

- Various business models exist for charging customers as billing of services can be based on the transmitted data volume, the type of service, the chosen QoS profile, etc.
- GPRS call records are generated in the GPRS Service Nodes.
- Packet counts are passed to a Charging Gateway that generates Call Detail Records that are sent to the billing system.

Next Chapter

Wireless Application Protocol

Thanks

Wireless Application Protocol (WAP)

Definition

Wireless application protocol (WAP) is an application environment and set of communication protocols for wireless devices designed to enable manufacturer-, vendor-, and technology-independent access to the Internet and advanced telephony services.

Overview

Positioned at a high level, this tutorial serves as an introduction to WAP, explaining its basic concept, benefits, architecture, and future.

Topics

1. Introduction

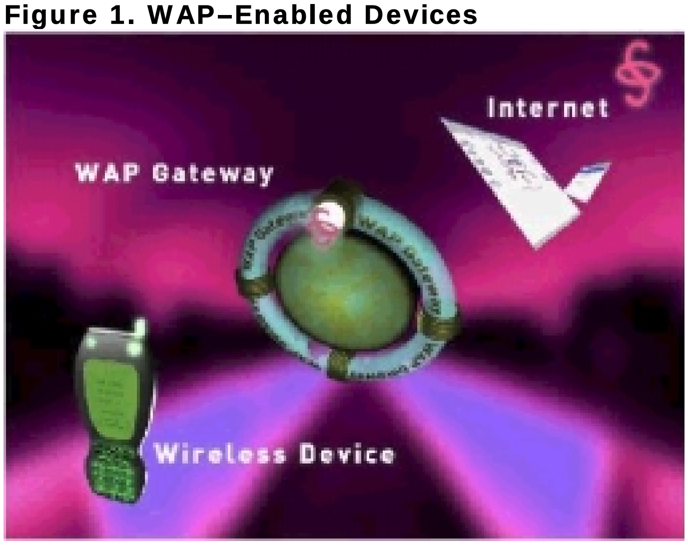
WAP bridges the gap between the mobile world and the Internet as well as corporate intranets and offers the ability to deliver an unlimited range of mobile value-added services to subscribers—independent of their network, bearer, and terminal. Mobile subscribers can access the same wealth of information from a pocket-sized device as they can from the desktop.

WAP is a global standard and is not controlled by any single company. Ericsson, Nokia, Motorola, and Unwired Planet founded the WAP Forum in the summer of 1997 with the initial purpose of defining an industry-wide specification for developing applications over wireless communications networks. The WAP specifications define a set of protocols in application, session, transaction, security, and transport layers, which enable operators, manufacturers, and applications providers to meet the challenges in advanced wireless service differentiation and fast/flexible service creation. There are now over one hundred members representing terminal and infrastructure manufacturers, operators, carriers, service providers, software houses, content providers, and companies developing services and applications for mobile devices.For more information, visit the WAP Forum at http://www.wapforum.org.

WAP also defines an application environment (WAE) aimed at enabling operators, manufacturers, and content developers to develop advanced differentiating services and applications including a microbrowser, scripting facilities, e-mail, World Wide Web (WWW)–to–mobile-handset messaging, and mobile to telefax access.

The WAP specifications continue to be developed by contributing members, who, through interoperability testing, have brought WAP into the limelight of the mobile data marketplace with fully functional WAP–enabled devices (see *Figure 1*).

Figure 1. WAP–Enabled Devices



Based on the Internet model, the wireless device contains a microbrowser, while content and applications are hosted on Web servers.

2. Benefits

Operators

For wireless network operators, WAP promises to decrease churn, cut costs, and increase the subscriber base both by improving existing services, such as interfaces to voice mail and prepaid systems, and facilitating an unlimited range of new value-added services and applications, such as account management and billing inquiries. New applications can be introduced quickly and easily without the need for additional infrastructure or modifications to the phone. This will allow operators to differentiate themselves from their competitors with new, customized information services. WAP is an interoperable framework, enabling the provision of end to end turnkey solutions that will create a lasting competitive advantage, build consumer loyalty, and increase revenues.

Content Providers

Applications will be written in wireless markup language (WML), which is a subset of extensible markup language (XML). Using the same model as the Internet, WAP will enable content and application developers to grasp the tag-based WML that will pave the way for services to be written and deployed within an operator's network quickly and easily. As WAP is a global and interoperable open standard, content providers have immediate access to a wealth of potential customers who will seek such applications to enhance the service offerings given to their own existing and potential subscriber base. Mobile consumers are becoming more hungry to receive increased functionality and value-add from their mobile devices, and WAP opens the door to this untapped market that is expected to reach 100 million WAP–enabled devices by the end of the year 2000. This presents developers with significant revenue opportunities.

End Users

End users of WAP will benefit from easy, secure access to relevant Internet information and services such as unified messaging, banking, and entertainment through their mobile devices. Intranet information such as corporate databases can also be accessed via WAP technology. Because a wide range of handset manufacturers already supports the WAP initiative, users will have significant freedom of choice when selecting mobile terminals and the applications they support. Users will be able to receive and request information in a controlled, fast, and low-cost environment, a fact that renders WAP services more attractive to consumers who demand more value and functionality from their mobile terminals.

As the initial focus of WAP, the Internet will set many of the trends in advance of WAP implementation. It is expected that the ISPs will exploit the true potential of WAP. Web content developers will have great knowledge and direct access to the people they attempt to reach. In addition, these developers will likely acknowledge the huge potential of the operators' customer bases; thus, they will be willing and able to offer competitive prices for their content. WAP's push capability will enable weather and travel information providers to use WAP. This push mechanism affords a distinct advantage over the WWW and represents tremendous potential for both information providers and mobile operators.

3. Why Choose WAP?

In the past, wireless Internet access has been limited by the capabilities of handheld devices and wireless networks.

WAP utilizes Internet standards such as XML, user datagram protocol (UDP), and IP. Many of the protocols are based on Internet standards such as hypertext transfer protocol (HTTP) and TLS but have been optimized for the unique constraints of the wireless environment: low bandwidth, high latency, and less connection stability.

Internet standards such as hypertext markup language (HTML), HTTP, TLS and transmission control protocol (TCP) are inefficient over mobile networks, requiring large amounts of mainly text-based data to be sent. Standard HTML content cannot be effectively displayed on the small-size screens of pocket-sized mobile phones and pagers.

WAP utilizes binary transmission for greater compression of data and is optimized for long latency and low bandwidth. WAP sessions cope with intermittent coverage and can operate over a wide variety of wireless transports.

WML and wireless markup language script (WMLScript) are used to produce WAP content. They make optimum use of small displays, and navigation may be performed with one hand. WAP content is scalable from a two-line text display on a basic device to a full graphic screen on the latest smart phones and communicators.

The lightweight WAP protocol stack is designed to minimize the required bandwidth and maximize the number of wireless network types that can deliver WAP content. Multiple networks will be targeted, with the additional aim of targeting multiple networks. These include global system for mobile communications (GSM) 900, 1,800, and 1,900 MHz; interim standard (IS)–136; digital European cordless communication (DECT); time-division multiple access (TDMA), personal communications service (PCS), FLEX, and code division multiple access (CDMA). All network technologies and bearers will also be supported, including short message service (SMS), USSD, circuit-switched cellular data (CSD), cellular digital packet data (CDPD), and GPRS.

As WAP is based on a scalable layered architecture, each layer can develop independently of the others. This makes it possible to introduce new bearers or to use new transport protocols without major changes in the other layers.

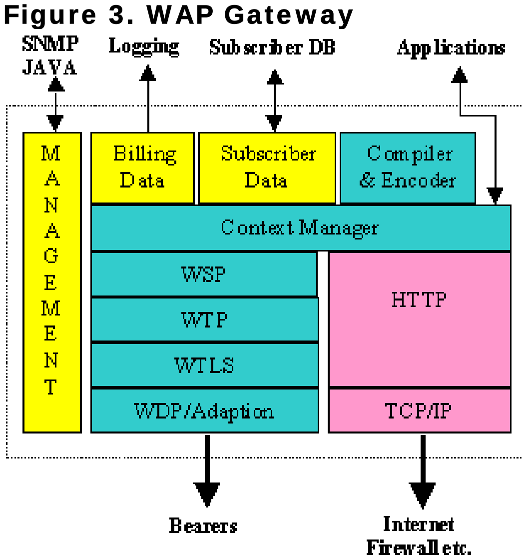
4. Mobile-Originated Example of WAP Architecture

WAP will provide multiple applications, for business and customer markets such as banking, corporate database access, and a messaging interface (see *Figure 2*).

Figure 2. Messaging Interface

The request from the mobile device is sent as a URL through the operator's network to the WAP gateway, which is the interface between the operator's network and the Internet (see *Figure 3*).

Figure 3. WAP Gateway



Architecture of the WAP Gateway

WDP

The WAP datagram protocol (WDP) is the transport layer that sends and receives messages via any available bearer network, including SMS, USSD, CSD, CDPD, IS–136 packet data, and GPRS.

WTLS

Wireless transport layer security (WTLS), an optional security layer, has encryption facilities that provide the secure transport service required by many applications, such as e-commerce.

The WAP transaction protocol (WTP) layer provides transaction support, adding reliability to the datagram service provided by WDP.

WSP

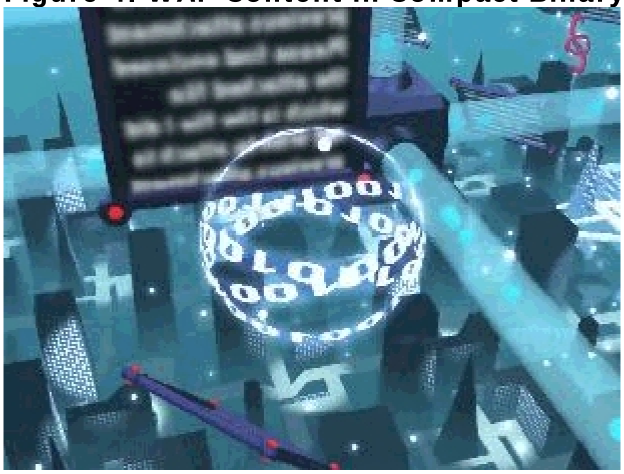
The WAP session protocol (WSP) layer provides a lightweight session layer to allow efficient exchange of data between applications.

HTTP Interface

The HTTP interface serves to retrieve WAP content from the Internet requested by the mobile device.

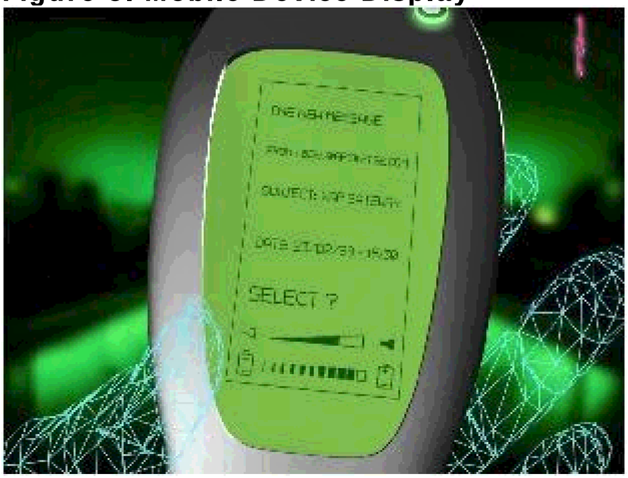
WAP content (WML and WMLScript) is converted into a compact binary form for transmission over the air (see *Figure 4*).

Figure 4. WAP Content in Compact Binary Form



The WAP microbrowser software within the mobile device interprets the byte code and displays the interactive WAP content (see *Figure 5*).

Figure 5. Mobile Device Display



5. The Future of WAP

The tremendous surge of interest and development in the area of wireless data in recent times has caused worldwide operators, infrastructure and terminal manufacturers, and content developers to collaborate on an unprecedented scale, in an area notorious for the diversity of standards and protocols. The collaborative efforts of the WAP Forum have devised and continue to develop a set of protocols that provide a common environment for the development of advanced telephony services and Internet access for the wireless market. If the WAP protocols were to be as successful as transmission control protocol-(TCP)/Internet protocol (IP), the boom in mobile communications would be phenomenal. Indeed, the WAP browser should do for mobile Internet what Netscape did for the Internet.

As mentioned earlier, industry players from content developers to operators can explore the vast opportunity that WAP presents. As a fixed-line technology, the Internet has proved highly successful in reaching the homes of millions worldwide. However, mobile users until now have been forced to accept relatively basic levels of functionality, over and above voice communications and are beginning to demand the industry to move from a fixed to a mobile environment, carrying the functionality of a fixed environment with it.

Initially, services are expected to run over the well-established SMS bearer, which will dictate the nature and speed of early applications. Indeed, GSM currently does not offer the data rates that would allow mobile multimedia and Web browsing. With the advent of general packet radio services (GPRS), which aimed at increasing the data rate to 115 kbps, as well as other emerging high-bandwidth bearers, the reality of access speeds equivalent or higher to that of a fixed-line scenario become evermore believable. GPRS is seen by many as the perfect partner for WAP, with its distinct time slots serving to manage data packets in a way that prevents users from being penalized for holding standard circuit-switched connections.

Handset Manaufacturers and WAP Services

It is expected that mobile terminal manufacturers will experience significant change as a result of WAP technology—a chance that will impact the look and feel of the hardware they produce. The main issues faced by this arm of the industry concern the size of mobile phones, power supplies display size, usability, processing power, and the role of personal digital assistants (PDAs) and other mobile terminals.

With over 75 percent of the world's key handset manaufacturers already involved in the WAP Forum and announcing the impending release of WAP–compatible handsets, the drive toward new and innovative devices is quickly gathering pace. The handsets themselves will contain a microbroswer that will serve to interpret the byte code (generated from the WML/WMLS content) and display interactive content to the user.

The services available to users will be wide-ranging in nature, as a result of the open specifications of WAP, their similarity to the established and accepted Internet model, and the simplicity of the WML/WMLS langauges with which the applications will be written. Information will be available in push and pull functionality, with the ability for users to interact with services via both voice and data interfaces. Web browsing as experienced by the desktop user, however, is not expected to be the main driver behind WAP as a result of time and processing restraints.

Real-time applications and services demand small and key pieces of information that will fuel the success of WAP in the mobile marketplace. Stock prices, news, weather, and travel are only some of the areas in which WAP will provide services for mobile users. Essentially, the WAP application strategy involves taking existing services that are common within a fixed-line environment and tailoring them to be purposeful and user-friendly in a wireless environment.

Empowering the user with the ability to access a wealth of information and services from a mobile device will create a new battleground. Mobile industry players will fight to provide their customers with sophisticated, value-added services. As mobile commerce becomes a more secure and trusted channel by which consumers may conduct their financial affairs, the market for WAP will become even more lucrative.

WAP in the Competitive Environment

Competition for WAP protocols could come from a number of sources:

- **subscriber identity module (SIM) toolkit**—The use of SIMs or smart cards in wireless devices is already widespread and used in some of the service sectors.
- **Windows CE**—This is a multitasking, multithreaded operating system from Microsoft designed for including or embedding mobile and other space-constrained devices.
- **JavaPhone™**—Sun Microsystems is developing PersonalJava™ and a JavaPhone™ API, which is embedded in a Java™ virtual machine on the handset. NEPs will be able to build cellular phones that can download extra features and functions over the Internet; thus, customers will no longer be required to buy a new phone to take advantage of improved features.

The advantages that WAP can offer over these other methods are the following:

- open standard, vendor independent
- network-standard independent
- transport mechanism–optimised for wireless data bearers
- application downloaded from the server, enabling fast service creation and introduction, as opposed to embedded software

6. Summary

WAP provides a markup language and a transport protocol that open the possibilities of the wireless environment and give players from all levels of the industry the opportunity to access an untapped market that is still in its infancy.

The bearer-independent nature of WAP has proved to be a long-awaited breath of fresh air for an industry riddled with multiple proprietary standards that have suffocated the advent of a new wave of mobile-Internet communications. WAP is an enabling technology that, through gateway infrastructure deployed in mobile operator's network, will bridge the gap between the mobile world and the Internet, bringing sophisticated solutions to mobile users, independent of the bearer and network.