KUNGL TEKNISKA HÖGSKOLAN
Institutionen för mikroelektronik och informationsteknik

2G1330 Mobile and Wireless Network Architectures

WAP, Heterogeneous PCS, 3G

Lecture notes of G. Q. Maguire Jr.

For use in conjunction with *Wireless and Mobile Network Architectures*, by Yi-Bing Lin and Imrich Chlamtac, John Wiley & Sons, 2001, ISBN 0-471-39492-0

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Lecture 5

- WAP (Ch. 19), Heterogeneous PCS (Ch. 20), 3G (Ch. 21)

Wireless Application Protocol(WAP)

Goal: a set of communication protocol standards to make accessing online services from a mobile phone simple

> “The motivation for developing WAP was to extend Internet technologies to wireless networks, bearers and devices.”[1], page 4.

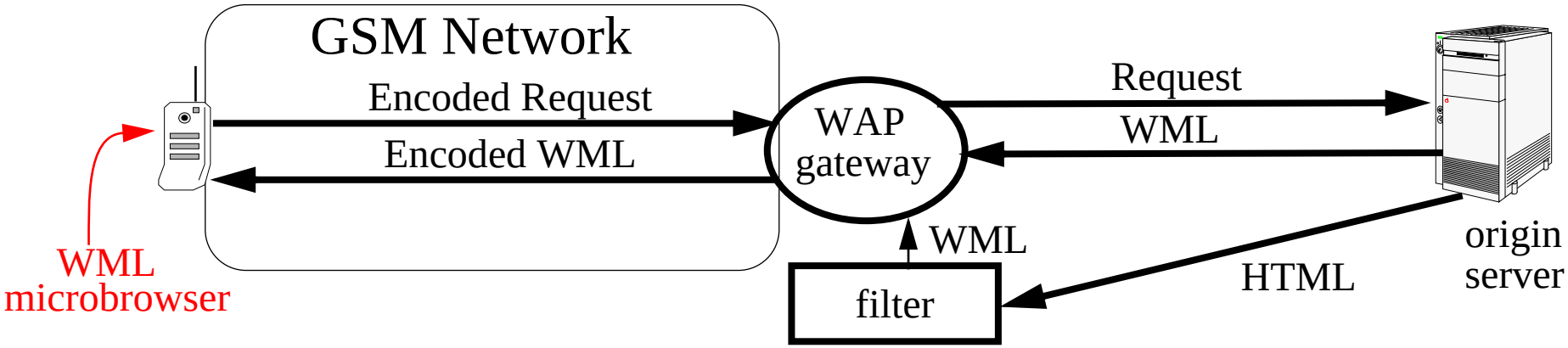
Initially conceived by four companies: Ericsson, Motorola, Nokia, and Unwired Planet (today called Phone.com)

WAP Forum is an industry association to promote WAP:

http://www.wapforum.org

WAP Model

Now called the WAP “Proxy Model” - since WAP gateway acts as a proxy:



The basic (erroneous) thoughts behind WAP were:

- that terminals were “limited” in processing/memory/display,
- that the communication channel was expensive,
- that the operator was “the” natural intermediary in every mobile user’s interaction with any services, and
- that a special protocol stack was necessary to “optimize” for the above.

Push services

In push services **content** is sent to the user without the user requesting it.

WAP (first round) Summary

Massive failure, because:

- tried to introduce a WAP protocol stack
- did not really provide an **end-to-end service** {because they wanted to keep the operator in the middle of all transactions} - the result is that content was in clear text in the WAP gateway
  - the result was significant security problems - especially because the changes that were introduced into the “WAPified” SSL introduced problems
- most operators used SMS to carry the WAP traffic and this was too expensive and had very significant delay problems
- many terminals had problems with their software and each type had its own resolution, size, … - so content had to be prepared for a specific terminal {which increased content development costs - since automatic conversion was not really successful}

Today WAP 2.0 moves toward being an IP based stack (with HTTP, TLS, and TCP) - although of course they still support their earlier “optimized/wapified” stack. The new model is a direct connection between mobile and HTTP server.

WAP 2.0

Wireless Profiled HTTP (WP-HTTP)a profile of HTTP for the wireless environment and is fully interoperable with HTTP/1.1. Built on HTTP request/response transaction. Supports message body compression of responses and the establishment of secure tunnels.

Transport Layer Security (TLS)a wireless profile of the TLS protocol, includes cipher suites, certificate formats, signing algorithms and the use of session resume. Support end-to-end security at the transport level.

Wireless Profiled TCP (WP-TCP)provides connection-oriented services, optimized for wireless environments and fully interoperable with standard TCP implementations. Builds upon IETF Performance Implications of Link Characteristics (PILC) working group recommendations

Wireless Session Protocol (WSP), Wireless Transaction Protocol (WTP), Wireless Transport Layer Security (WTLS), Wireless Datagram Protocol (WDP) - as now “Legacy Protocol Layers”[1]

WAP 2.0 new & enhanced services

WAP Push	allows content to be sent or "pushed" to devices by server-based applications via a Push Proxy. Enhanced for the WAP 2.0 release improve real-time applications; provides control over the lifetime of pushed messages, store & forward capabilities at the Push Proxy, and control over bearer choice for delivery.
User Agent Profile (UAProf)	provides a mechanism for describing the capabilities of clients and the preferences of users to an application server, based on the Composite Capabilities / Preference Profiles (CC/PP) work of the W3C Wireless Telephony Application (WTA)
External Functionality Interface (EFI)	specifies the interface between WAE and components or entities with embedded applications that execute outside of the defined WAE capabilities (i.e., basically allowing plug-in modules) - thus allowing access to external devices (e.g. smart cards, GPS, digital cameras, sensors, …)
Persistent Storage Interface	a standard set of storage services and interface for organizing, accessing, storing and retrieving data on the wireless device or other connected memory device.
Data Synchronization	adopts SyncML language for the data synchronization (see www.syncml.org)
Multimedia Messaging Service (MMS)	permits delivery of varied types of content
Provisioning	provides clients with information needed to operate on wireless networks; permits network operator to manage the devices on its network using a common set of tools
Pictogram	tiny images, that can be used to quickly convey concepts in a small amount of space

Heterogeneous PCS

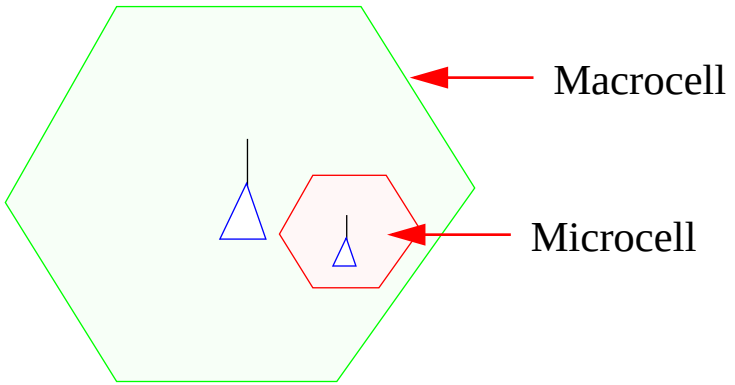
Utilize multiple types of radios to get the advantages of each to:

- increase capacity and/or
- increase coverage area and/or
- decrease power consumption and/or
- increase bandwidth and/or
- decrease delay, …

Similar Radio technologies + Same Network technology (SRSN)

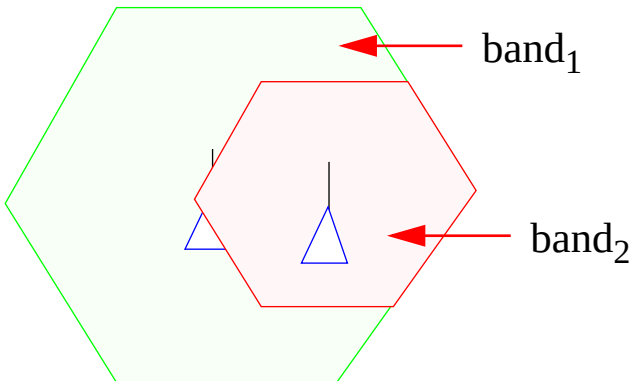
with different power levels

different size cells; for example macrocells with microcells for hotspot coverage; microcells “borrow” radio channels from the macrocellular system - so that they use a different channel than the overlapping macrocell



with different frequency bands

multiband system such as: GSM900+GSM1800macrocell since the cells can overlaps arbitrarily they can of course be of different sizes



Different Radio technologies + Same Network technology

Both using IS-41 as network protocol:

- IS-136 + AMPS
- IS-95 +AMPS

Different Radio technologies + Different Network technology

Generally high-tier PCS with low-tier PCS

Examples:

- AMPS +PACS or GSM +PACS
- GSM + DECT

Tier Handoff

Tier Handoff performs handoffs from one system to another.

For the case of SRSN - different power levels, the macro and microcells use the same air interface and the handoffs is as usual.

For the case of SRSN - different bands, just a little harder than usual (because the handset might not be able to listen to more than one frequency at a time).

For the case of DRSN it is harder yet generally requires modification in the handoff of each system, in some cases the handoff might only work in one direction

For the case of DRDN the easiest is to simply set up a new call (perhaps via automatic redial) in the new network.

Registration for SRSN & DRSN

Fairly straight forward since the systems use the same network technology.

Key problem is: Who does the tier selection?

Registration for DRDN

Since the different systems use different registration & authentication and different data may be store in their different HLRs (and VLRs) ⇒ define a new **multitier HLR** to integrate the two.

Implemented via **tier manager**

Single (SR) vs. Multiple registrations (MR) - the former is simpler, the later reduces the registration traffic and decreases the time required for tier handoffs.

Call delivery

SR case	simply query the MHLR to find where to deliver the call
MR case	either select the tier to try based on some heuristic (for example, always try low-tier first or try the system where the MS register most recently) or page first, then try the one where you get a response

User identity(identities) and MSs

Their can be

- a single identity or several identities
  - user can be associated with a single logical “number” or multiple
  - identities can have a primary association with a MS or no
- single or multiple MSs
  - user can use one (multimode MS) or several MSs
  - D>oes the user choose which device to use or does the multitier manager?

A hard problem is what to do when the service (for example, streaming video) only makes sense on a subset of the MSs or PCS systems.

Major forces driving heterogeneous PCS

consolidation/mergers&acquisitions/bankrupcy/… ⇒ new owner may end up ownin several different types of systems, examples:

- AT&T acquisition of McCaw's cellular system
- Bell Atlantic merger with NYNEX
- Merger of Vodaphone with AirTouch
- DeutscheTelekom's (T-Mobile) Voicestream Wireless Corp. acquistion of WLAN operations of MobileStar

Third Generation Mobile (3G)

Offering data rates greater than ISDN (144kbps), typically thought to be 384kbps and perhaps upto 2 Mbps when stationary near a base station.

Six types of services:

- Interactive multimedia (video conferencing)
- High speed multimedia (“broadcast” TV)
- Medium speed multimedia (web browsing)
- Circuit switched data (FAX)
- Speech (telephony)
- Messaging (e-mail, SMS, …)

All based on CDMA; Europe’s Universal Mobile Telecommunications System (UMTS) will be Wideband CDMA (W-CDMA, 25 MHz channel bandwidth):

- ETSI agreed to use a combination of wideband code division multiple access (W-CDMA) and time division multiple access (TD/CDMA) on the air interface
- W-CDMA will be used to cover larger areas
- TD/CDMA for local (indoor) applications

Paradigm shifts

- voice-centric ⇒ data centric
  - shift to packet switching
  - problems: QoS, streaming media
- continually evolving terminals and data applications - end users **expect** the same services (and more) from wireless systems as they expect from wireline systems

3rd Generation Partnership Project (3GPP)

Original scope was to produce **globally applicable** Technical Specifications and Technical Reports for a **3rd Generation Mobile System** based on evolved GSM core networks and the radio access technologies that they support ⇒ Universal Terrestrial Radio Access (UTRA)[1], W-CDMA, UMTS (in Europe) and FOMA (in Japan)

Amended to include the maintenance and development of the Global System for Mobile communication (GSM) Technical Specifications and Technical Reports **including** evolved radio access technologies (e.g. General Packet Radio Service (**GPRS**) and Enhanced Data rates for GSM Evolution (**EDGE**)).

See: *http://www.3gpp.org/*

ETSI is the 3GPP Secretariat

1. Both Frequency Division Duplex (FDD) and Time Division Duplex (TDD) modes.

Third Generation Partnership Project 2 (3GPP2)

A collaborative third generation (3G) telecommunications standards-setting project comprising **North American** and **Asian** interests developing global specifications for **ANSI/TIA/EIA-41** “Cellular Radiotelecommunication Intersystem Operations network evolution to 3G”, and global specifications for the radio transmission technologies (RTTs) supported by ANSI/TIA/EIA-41.

Focus is cdma2000

See: *http://www.3gpp2.org/*

TIA is the 3GPP2 Secretariat

Mobile Station Application Execution Environment (MExE)

Building on ideas from WAP, UMTS introduces a Mobile Station Application Execution Environment (MExE) to provide a standard environment for the MS to access the internet and intranet services.

MExE Classmark

classifies the MS based on its capabilities (processing, memory, display, …)

MExE classmark 1	based on WAP
MExE classmark 2	based on PersonalJava (supports JavaPhone Power Monitor package)
MExE classmark 3	based on Java 2ME Connected Limited Device Configuration(CLDC) and Mobile Information Device Profile (MIDP) environment - supports Java applications running on resource constrained devices.
MExE classmark 4	based on ECMA's Common Language Infrastructure Compact Profile - supports CLI based applications running on resource constrained devices (CLI designed to be programming language and OS neutral)

for further information see: *http://www.mexeforum.org/*

Common Language Infrastructure for MExE devices: Classmark 4

Service discovery and management

Browser installed on a MExE device should support MIME type text/vnd.sun.j2me.app-descriptor. Allows user to browse and discover a Java application which can then be downloaded. Capability negotiation information in the request header can determine which application to present.

MID applications (MIDlets) and MIDlet suites are indicated to the user, if the terminal has a display, may be presented as an icon and a tag or as a textual tag

Java Application Descripto (JAD) file can be downloaded and to determine if the MIDlet is suitable for download and installation

- If it is, then JAR file can be downloaded and installed
- If not, the MExE UE should be able to prompt the user so that the user (they can delete some existing applications if there is not enough space to install the new application)
- If the application chosen already exists on the device, the user should be notified so they can choose to either to download the chosen version or to retain the existing one
- user should be able either to launch the MIDlet immediately or later

CLI MExE Devices

SMExE Classmark 4 devices shall be based CLI Compact Profile specifications, these define the runtime environment and APIs available to a CLI based MExE device such that services (specified in the form of language independent classes and interfaces) can control such a device in a standardised way.

CLI Compact Profile Namespaces

- System
- System.Collections
- System.Globalization
- System.IO
- System.Text
- System.Threading
- System.Runtime.CompilerServices
- System.Reflection
- System.Net
- System.Xml

Application management features for a Classmark 4 application

- Discovery
- Download
- Verification
- Installation
- Execution Start
- Execution Pause
- Execution Resume
- Execution Stop
- Execution Terminate
- Uninstall

Support for network protocols

Protocol	Optionality
HTTP/1.1	Mandatory
HTTPS	Mandatory
SOAP	Mandatory
Gopher	Optional
ftp	Optional
mailto	Optional
File	Optional

3G Physical Layer

There has been great fighting over what is the “best” physical and link layer for 3G, due to political, economic, … reasons.

Indications are that there will be several 3G CDMA modes (at least 5 different choices), but there might be some hope for harminization at the network level (with at least 3 choices: ANSI-41, GSM MAP, and IP)!

Gateway Location Register (GLR)

3GPP introduces a Gateway Location Register (GLR) to reduce traffic between VLR and HLR {especially for the case of international roaming}. The GLR is located in the visited network.

While it can clearly reduce signaling costs when the user is not in their home country - the book does not address the question of “Does this really matter?” Since there is an enormous amount of bandwidth available via fibers - does the signaling traffic really matter? Does the GLR reduce the delays for providing service to the user?

3G QoS

Four QoS classes:

conversational	for delay sensitive traffic, with limited transfer delay
streaming	for one-way real-time traffic
interactive	for delay-insensitive traffic such as e-mail, telnet, …
background	for delay-insensitive traffic such as FTP, background bulk transfer of e-mail, …

7 QoS parameters: max/min/guaranteed bit rates, max. packet size, reliability, …

Major problems with how to **map** between the QoS of different systems.

Wireless Operating System for Handsets

There has been a battle brewing for who will define and dominate the OS market for 3G handsets - which given the expected handset volume could be a very large market.

Candidates:

- Microsoft - WinCE (and its successors)
- Symbian's EPOC OS - built upon Psion's OS - Symbian formed by Nokia, Ericsson, Motorola)
- 3Com's PalmOS
- ???

Mobile Virtual Network Operator (MVNO)

A virtual operator who uses the physical infrastructure of other operators.

Pyramid Research projects a greater than 3x ROI for MVNOs vs. facilities-based UMTS network operator[1].

See: *http://www.pyramidresearch.com/info/rpts/mvno.asp*

Richard Branson's Virgin Mobile signed up 700,000 customers in the first year alone![2]

"Freed from a large subscriber base that is necessary to cover network deployment costs, an MVNO can target a more finely segmented market."[3]

Mobile Virtual Network Operators: Oftel inquiry into what MVNOs could offer consumers - *http://www.oftel.gov.uk/publications/1999/competition/mvno0699.htm*

1. *http://www.pyramidresearch.com/static_content/feature_articles/010402_feature.asp*
2. *http://www.adventis.com/mvno/main.htm*
3. *http://www.gii.co.jp/english/pr8818_mvno.html*

πG

See: Theo Kanter, “Adaptive Personal Mobile Communication -- Service Architecture and Protocols”, Tekn. Dr. Dissertation, KTH, December 14, 2001
http://ps.verkstad.net/Thesis/Final/theoDissertation.pdf

4th generation?

Matthias Unbehaun, “Self-deployed Wireless Access Networks”, a coming doctoral dissertation in Radio Communication at KTH later in 2002. Proposal presentation: March 22nd at 10:00

Place: KTH Stockholm, S3/Radio Seminar room

proposal: *http://www.s3.kth.se/~matthias/Public/dissertation/Proposal.pdf*

Further reading

WAP

[1] WAP Forum, “Wireless Application Protocol (WAP) 2.0 Technical White Paper”, www.wapforum.org " January 2002.
http://www.wapforum.com/what/WAPWhite_Paper1.pdf

Heterogeneous PCS

[2] Ian F. Akyildiz and Wenye Wang, “A Dynamic Location Management Scheme for Next-Generation Multitier PCS Systems”,IEEE Transactions on Wireless Communications, V. 1, No. 1, January 2002, pp. 178-189.

3G

[3] Janos A. Csirik, “A guide to 3GPP security documents”, AT&T Research, http://www.research.att.com/~janos/3gpp.html

[4] Gavin Stone, MExE: Mobile Execution Environment White Paper, Ronin Wireless, MExE Forum, Dec. 2000
http://www.mexeforum.org/MExEWhitePaperLrg.pdf

[5] 3rd Generation Partnership Project (3GPP) - *www.3GPP.org*

[6] *www.3GPP2.org*

[7] 3GPP TS 23.057 V4.4.0 (2001-12) 3rd Generation Partnership Project Technical Specification Group Terminals Mobile Station Application Execution Environment (MExE), Functional description, Stage 2 (Release 4)
http://www.3gpp.org/ftp/Specs/2001-12/Rel-4/23_series/23057-440.zip

[8] PersonalJava™ Application Environment
http://java.sun.com/products/personaljava

[9] JavaPhone™ API
http://java.sun.com/products/javaphone

[10] Java 2 Micro Edition
http://java.sun.com/j2me

[11] Connected Limited Device Profile (CLDC)
http://java.sun.com/products/cldc/

[12] Mobile Information Device Profile (MIDP)
http://java.sun.com/products/midp/

[13] ECMA's Common Language Infrastructure (ECMA-335)
http://cedar.intel.com/media/zip/ECMA-335.zip

[14] ECMA's Common Language Infrastructure Technical Report (ECMA-TR-084)
http://cedar.intel.com/media/zip/ECMA-TR-084.zip

[15] Erik Meijer and John Gough, "Technical Overview of the Common Language Runtime", *http://research.microsoft.com/~emeijer/Papers/CLR.pdf*