ACATS FORUM

Wireless Roadmap

NGN Concentration Meeting

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A Thematic Network Project supported by the European Commission
Part 1: Existing Wireless Technologies & Evolution
   Path Towards 3G

Part 2: Future & Emerging Technologies

Part 3: Market Analysis & Prospects

Part 4: Open Issues
Existing Wireless Technologies & Evolution Path Towards 3G
1G – Analog

2G – Digital
- TDMA
- PDC
- GSM
- CDMA

2.5G – Packet Digital
- GPRS
- EDGE
- CDMA2000

3G – High-Speed Digital
- W-CDMA
Evolution of Wireless Standards

- **2G**
  - PDC
  - TDMA
  - CDMA
  - Japan
  - Europe, China
  - US, Japan
  - China

- **2.5G**
  - GSM
  - HSCSD
  - EDGE

- **2.75G**
  - GPRS
  - CDMA2000 1xRTT

- **3G**
  - Unified 3G
  - Separation of Up and Down Links
  - EDGE Uplink + OFDM Downlink
  - GPRS/UMTS Uplink + WLAN Downlink
  - Convergence: WLAN, WCDMA, OFDM
  - Seamless IP Connectivity

- **4G**
  - TD-WCDMA
  - CDMA2000 3xRTT
  - SD-WCDMA
UMTS compared with the existing and future fixed/mobile technologies

Data Rate per User (bits/second)

**Mobility**
- Fixed Wireless
- Indoor-Cordless
- Pedestrian
- Vehicular + Suburban
- Rural Areas

**2G**
- GSM
- CDMAOne
- PDC
- DAMPS
- ISDN
- 9.6 kbps

**2.5G**
- GSM II+ (GPRS)
  - IS-95 B
- EDGE
  - [2001-2]
- B-ISDN
- 144 k

**3G**
- UMTS (W-CDMA)
  - [2002-5]
- CDMA 2000
  - IS-136 HS
- Wireless LAN
- 384 k
- 2 Mbps

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# UMTS Applications

<table>
<thead>
<tr>
<th>Services Categories</th>
<th>Speed (Kbit / Sec)</th>
<th>Switching</th>
<th>Bit Flow</th>
<th>Examples of Applications</th>
</tr>
</thead>
</table>
| Voice               | 16                 |           | Symmetric | - Voice calls  
|                     |                    |           |           | - Audio on Demand                                             |
| Simple Messaging    | 14.4               | Packet    | Symmetric | - Low speed alarm / telemetry  
|                     |                    |           |           | - Virtual Banking  
|                     |                    |           |           | - SMS                                                        |
| Switched Low Speed  | 64                 | Circuit / Packet | Symmetric | - Interpersonal messaging  
| Data                |                    |           |           | - Traffic telematics                                          |
| Medium Speed        | 384                | Packet    | Asymmetric| - Remote surveillance / diagnostic  
| Multimedia          |                    |           |           | - Web browsing  
|                     |                    |           |           | - On-line newspapers                                          |
|                     |                    |           |           | - Games on demand                                             |
|                     |                    |           |           | - File transfer (DB access)                                   |
| High Speed          | 2.000              | Packet    | Asymmetric| - Remote surveillance / diagnostic  
| Multimedia          |                    |           |           | - On-line shopping                                            |
|                     |                    |           |           | - Photo journalism                                            |
|                     |                    |           |           | - Games on demand                                             |
|                     |                    |           |           | - Narrow cast TV                                              |
| High Interactive    | 144                | Circuit   | Symmetric | - Video conferencing                                          |
| Multimedia          |                    |           |           | - Collaborative working                                       |

**Increasing Customer Sophistication**
Future & Emerging Technologies
Terminal diversity between: PC, mobile phone, PDA, pager, ...
Future Requirements (2)

Higher data rates are needed!

<table>
<thead>
<tr>
<th>Transmission Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>10 sec</td>
</tr>
<tr>
<td>1 min</td>
</tr>
<tr>
<td>10 min</td>
</tr>
<tr>
<td>1 hour</td>
</tr>
</tbody>
</table>

- **UMTS**
  - photo
  - report
  - video clip

- **GSM 2+**
  - web
  - photo
  - report
  - video clip

- **ISDN**
  - e-mail
  - web
  - photo
  - report
  - video clip

- **PSTN**
  - e-mail
  - web
  - photo
  - report
  - video clip

- **GSM Ph1**
  - e-mail
  - web
  - photo
  - report
  - video clip
Future Requirements (3)

Impacts of mobility on applications

- Adjust applications to available capacity
  - E.g., change video coding
- Activate/deactivate applications according to available capacity
  - E.g., download emails when enough capacity
- Take into consideration also the cost of transmission
  - E.g., wait for low cost service or change the place to get cheap access

Applications/services shall cope with

- Variable
  - bandwidth, transfer delay, processing capacity, terminal capabilities, transfer cost, temporary coverage loss, …
- Different
  - terminal types, operating systems, manufacturers, radio protocols, …

Applications/services must be

- configurable, self-learning, adaptable, scaleable

IP based, not telecom based!!!
- Faster service deployment
- Reduced Costs
- Higher availability
Why IP Architecture?

- Future high bandwidth services will be data services
- IP protocols optimised for data
- IP used widely throughout corporate and public networks
- IP telephony technology and standards evolving
- IP will be convergence layer for voice, data and multimedia services for fixed and mobile applications
- Single System for Residential, Office, Cellular, Satellite Environments
1994 – Ericsson

New device communications capabilities
- Personal, home, car, office, etc.
- Hands-free headset.
- Cordless telephone.
- Synchronization of PDA, cell phone, computer.
- Serial port emulation.
- Wearable computing.
- Wireless LAN access.
- Ad-hoc network.
- Peripherals: Printer, scanner, fax machine.

Open Issues
- Testing
- Compatibility
- Operability
Emerging Technologies: PAN

- **PAN**
  - Personal Area Networking

- **2.4 GHz**

- **10 m radius**
  - No line-of-sight requirement, as with IR

- Eight pico nets, each with up to 10 devices

- 128 bit security encryption

- Variable speeds, based on slots used in each dir.
  - Approx. 57 Kb/sec. To 723 Kb/sec.

Source: 3Com
Emerging Technologies: Fixed Wireless

- **MMDS - Multipoint Multichannel Distribution System**
  - Also known as WDSL (Wideband DSL)
  - Spectrum in 2.1, 2.3 and 2.5 GHz bands

- **Line of sight connection from tower to dish receiver**
  - Up to 65 km apart
  - Sprint Broadband: 14+ cities
  - Worldcom: 5+ cities

- **5 Mb/sec max download (1.5 Mb/sec typical)**

- **256 Kb/sec upload**

- **Oct, 01 FCC decision allows companies to reallocate spectrum for new broadband technologies**
  - Non-line of sight
  - Up to 6 Mb/sec shared download
  - IPWireless.com
Emerging Technologies: Satellite Broadband

- Fixed Internet
  - Similar to fiber without cables

- 288+ satellites in LEO
  - 2 Mb/sec uplink at 28.6-29.1 GHz band
  - 64 Mb/sec downlink at 18.8-19.3 GHz band

- Scheduled launch 2005

- Sponsors
  - Craig McCaw
  - Bill Gates
  - Saudis
  - Motorola
  - Boeing
Other Emerging Technologies

- Multi-Radio Systems
- Broadband Radio Access Networks (BRAN)
- IP Quality of Services
- WAP
- Intelligent Networks (IN)
- Integration of Broadcasting and Mobile
- Networked Audio Visual systems
Market Analysis & Prospects
Wireless telephony is a fast growing market, but the industry is changing.

Wireless markets have rapidly developed by focusing on voice services:
- Started as a premium service for business customers
- Now a mass market product, mainly thanks to pricing structure innovation (pre-paid) and handset cost reduction

Soon “net customer additions” will not be sufficient to maintain operators’ growth of revenues and profitability:
- New customers have higher acquisition costs but lower ARPU
- Growing competition for market share generally implies price erosion

Innovation focus is shifting to data in order to ensure the industry growth.
Source: Durlacher Research Ltd, Eqvitec Partners Oy
Total number of users by 2005: 350 M
Penetration 87% at 2005!
But… how about data?

![Data Users Chart](chart_data.png)
How data users are divided into different categories?

![Graph showing the growth of data users in Europe from 1999 to 2005.
- UMTS-data
- Edge-data
- GPRS-data
- GSM-data
- SMS-data

Million data users

Data users have increased significantly from 1999 to 2005, with UMTS-data and Edge-data receiving the highest share.

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By year 2005, out of 350 M mobile users, only 32 M needs UMTS (rest of the mobile users are happy with existing networks, GSM, GPRS, EDGE)

Recent Market Analysis (8/2/2002) shows that 3G new entrants will face massive difficulty in gaining new mobile subscribers, even in markets that are currently evolving
Open Issues
Communication with devices becomes

- Personal, home, office, car, mall, stores, gas stations

We need pre-defined rules for communicating

- Download
  - Information
  - Authorization
- Upload
  - Identity
  - Financial data
Research Issues

- The security of the personal info-sphere
- The security of the virtual community
- The security of the infrastructure
Heterogeneous Networks

Capacity ~10 kbps - 1 Gbps

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Interworking with Wireless IP Networks

- Home agent
- Mobile IP
- GPRS
- GPRS MM
- WLAN
- Internet
- Fixed network
- Host in Internet
The Need for Interoperability

Different functionalities

Emergence of novel network architectures (VoIP, IN, GPRS, UMTS, etc.)

Advancement of telecommunication technology

Need to merge different existing network systems in interworking schemes and solve interoperability problems between state of the art equipment and older, legacy systems

There is a need to design and develop novel, low cost, flexible, highly efficient and scaleable systems able to operate as a high performance protocol gateways, which will bridge the “compatibility” gap between different telecommunication networks, such as ISDN, SS7, IN, ATM, GSM, GPRS/UMTS and also provide interfaces to IP based networks.
Interworking nodes that bridge the “compatibility” gap between different telecommunication technologies

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Interoperability emphasises the need for validation/conformance testing

More than 35% of the product development cycle and costs is devoted to testing phases

Testing standards and specifications are currently under development from standardisation bodies and various organisations like ETSI, ITU, ANSI etc

Notations under development include TTCN-v2, TTCN-v3,...

Test specifications often contain ambiguities/errors, therefore testing procedures are essential!

However, there is a long procedure involved from Abstract Test Suites to “executable” test suites against specific equipment