WCDMA Radio Access Network

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- What does UMTS mean to us?
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Radio Access Network

• The main purposes of separate RAN
  – Provide a connection between the handset and CN
  – Isolate all radio issues from CN
• The advantage is one CN supporting multiple access technologies
IMT-2000

- RECOMMENDATION ITU-R M.1457-3: Detailed specifications of the radio interfaces of International Mobile Telecommunications-2000 (IMT-2000) specifies following terrestrial radio interfaces for 3G:
  - IMT-2000 CDMA Direct Spread: WCDMA (UTRAN FDD)
  - IMT-2000 CDMA TDD: TD-SCDMA (UTRAN TDD)
  - IMT-2000 TDMA Single Carrier: UWC-136 (EDGE)
  - IMT-2000 FDMA/TDMA: DECT
  - All of these standards are incompatible
- 3GPP term for WCDMA RAN is Universal Terrestrial Radio Access Network (UTRAN)
- UMTS uses WCDMA as its RAN technology. As a result, the terms UMTS and WCDMA are often used interchangeably.

EDGE: Enhanced Data for GSM Evolution
CDMA 2000: Code Division Multiple Access as specified in IS-2000
TD-SCDMA: Time Division Synchronous CDMA
UMTS: Universal Mobile Telecommunications System

WCDMA: Wideband Code Division Multiple Access
FDD: Frequency Division Duplex
TDD: Time Division Duplex
DECT: Digital Enhanced Cordless Telecommunications
WCDMA RAN specifications

http://www.3gpp.org/TB/RAN/RAN.htm
WCDMA RAN nodes

Core Network

GSM BSS

BSC

BTS

BTS

Abis

A

WCDMA RAN

RNC

RBS

RBS

Iur-g

Abis

Iu

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Um

BSS: Base Station Subsystem
BSC: Base Station Controller
BTS: Base Transceiver Station
MS: Mobile Station

RNS: Radio Network Subsystem
RNC: Radio Network Controller
RBS: Radio Base Station (3GPP: Node B)
UE: User Equipment

3GPP TS 25.401 UTRAN overall description (Release 6)

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Radio Network Controller (RNC)

- Controls all WCDMA RAN functions.
- Connects the WCDMA RAN to the core network via the Iu interface.
- Roles of RNC
  - Serving RNC
  - Controlling RNC
  - Drift RNC

3GPP TS 25.401 UTRAN overall description (Release 6)

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Roles of RNC

Serving RNC for UE1, UE3
Controlling RNC for RBS1 cells

Serving RNC for UE2
Controlling RNC for RBS2, RBS3 cells

In UE1=>UE2 call RNC2 becomes drift RNC

3GPP TS 25.401 UTRAN overall description (Release 6)
Radio Base Station (Node B)

- Handles the radio transmission and reception to/from the handset over the radio interface (Uu).
- Controlled from the Radio Network Controller via the Iub interface.
- One Radio Base Station can handle one or more cells.
- Connected to only one RNC

3GPP TS 25.401 UTRAN overall description (Release 6)

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UE1: Soft handover between RBS1 and RBS2

UE2: Softer handover between cells of RBS

UE3: Hard handover between UMTS and GSM (DBSS = Drift BSS, BSC+BTS)
Radio resources

• Power control
  – Cell breathing: traffic load change causes cells to grow and shrink
  – Regulates the transmit power of the terminal and base station
  – Less interference and more users on the same carrier

• Congestion control
  – Reduce the bit rate of non real-time applications
  – Triggers the inter- or intra-frequency handover to move some subscribers to less loaded frequencies.
  – Handover of some subscribers to GSM
  – Discontinue connections and protect the remaining connections

• Admission control
  – Decide if new connections are allowed based on network load

UTRA FDD protocol architecture

MAC: Medium Access Control
RLC: Radio Link Control
RRC: Radio Resource Controller
PDCP: Packet Data Convergence Protocol
BMC: Broadcast/Multicast Control protocol

Control Plane

User Plane

Logical Channels

Transport Channels

Physical Channels

Physical layer

Signaling to control the connection to the handset.
If there is time for it, to retransmit packets which has been received in error.
Transmit and receive data over the radio, including basic protection against bit errors.

3GPP TS 25.301 Radio Interface Protocol Architecture (Release 6)

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Mapping of channels

Uplink
Downlink
Uplink/Downlink

DTCH/DCCH  CTCH  CCCH  BCCH  PCCH

CPCH  DCH  DSCH  FACH  RACH  BCH  PCH

PCPCH  DPCCH  DPDCH  PDSCH  S-CCPCH  PRACH  P-CCPCH

CSICH  CD/CAICH  AICH  SCH  CPICH  PICH

RLC
MAC

3GPP TS 25.301 Radio Interface Protocol Architecture (Release 6)
Time slot configuration example

Frame 1 Frame 2 .... Frame 72

Slot 0 Slot 1 ... Slot 14

Data1 TPC TFCI Data2 Pilot bits

DPDCH DPCCH DPDCH DPCCH

720ms superframe

10ms

Slot 0,667 ms = 2/3 ms

DPDCH DPCCH Uplink

TPC TFCI FBI TPC

DPCH

Pilot Data

DPDCH DPCCH Downlink

3GPP TS 25.211 Physical channels and mapping of transport channels onto physical channels (FDD) (Release 6)

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Who needs UMTS?

• The Harris Interactive survey conducted an online survey on over 10,000 adults in Europe (UK, France, Germany, Spain, Italy and Belgium) regarding 3G in early 2004.

• Some findings from the survey:
  – 49% of the mobile phone users in Europe are not interested in 3G services
  – 44% would not use their phones more than to make regular calls
  – 55% believes 3G will be expensive to use
  – 52% claims not knowing what 3G is and why is it worth having
What does UMTS mean to us?

- You need a UMTS phone
  - GSM phones do not work in UMTS
  - CDMA2000 phones are backward compatible and work in cdmaOne networks.
  - Intelligent terminals
- Efficient power control in UMTS
  - Increased capacity, increased battery lifetime
- High data rate transmission
- WCDMA-GSM handover
  - UMTS/GSM dualband phone for more coverage
- New services
  - Live video conversation, Wireless Internet or VPN, Mobile Media
- New applications
  - Nobody knows what the 3G Killer Application(s) will be
- All basic services like voice and messaging will flow between all systems
## Cellular data rates

<table>
<thead>
<tr>
<th>Cellular Family</th>
<th>Standard</th>
<th>Peak Data Rate (kbits/s)</th>
<th>Typical real life data rate (kbits/s)</th>
<th>Connection type</th>
<th>Modulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSM</td>
<td>GSM-CSD (normal)</td>
<td>9.6 / 14.4</td>
<td>9.6</td>
<td>Circuit</td>
<td>GMSK</td>
</tr>
<tr>
<td></td>
<td>HSCSD</td>
<td>28.8 / 43.2</td>
<td>28.8</td>
<td>Circuit</td>
<td>GMSK</td>
</tr>
<tr>
<td></td>
<td>GPRS</td>
<td>115 / 171</td>
<td>50</td>
<td>Packet</td>
<td>GMSK</td>
</tr>
<tr>
<td></td>
<td>EDGE</td>
<td>384 / 513</td>
<td>115</td>
<td>Packet</td>
<td>8-PSK</td>
</tr>
<tr>
<td>UMTS</td>
<td>FDD</td>
<td>384 / 2000</td>
<td>144</td>
<td>Packet</td>
<td>QPSK</td>
</tr>
<tr>
<td></td>
<td>TDD</td>
<td>384 / 2000</td>
<td>144</td>
<td>Packet</td>
<td>QPSK</td>
</tr>
<tr>
<td>CDMAone</td>
<td>IS-95A</td>
<td>14.4</td>
<td>14.4</td>
<td>Circuit</td>
<td>QPSK</td>
</tr>
<tr>
<td></td>
<td>IS-95B</td>
<td>64 / 115</td>
<td>56</td>
<td>Packet</td>
<td>QPSK</td>
</tr>
<tr>
<td>CDMA 2000</td>
<td>1X</td>
<td>144 / 307</td>
<td>130</td>
<td>Packet</td>
<td>QPSK</td>
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<tr>
<td></td>
<td>1X-EV</td>
<td>2000</td>
<td>tba</td>
<td>Packet</td>
<td>QPSK</td>
</tr>
<tr>
<td></td>
<td>1X-EVDO</td>
<td>2400</td>
<td>tba</td>
<td>Packet</td>
<td>QPSK</td>
</tr>
<tr>
<td>TDMA</td>
<td>CSD</td>
<td>9.6</td>
<td>9.6</td>
<td>Circuit</td>
<td>DQpi/4PSK</td>
</tr>
</tbody>
</table>

GMSK: Gaussian Minimum Shift Keying
8-Phase: Phase Shift Keying modulation scheme
QPSK: Quadratic Phase-Shift Keying
4PSK: Four-Level Phase Shift Keying

http://www.cellular-news.com/
3G Service Examples

Information and Content (Non-Voice) Always-on, IP-based

CONTENT CONNECTIVITY (Internet)

MOBILITY

PERSONAL
Direct Link to a Person

PEOPLE CONNECTIVITY

LOCATION
Knowledge of Location

Voice

Mobile Internet Access
Mobile Intranet/Extranet Access
Customised Infotainment
Multimedia Messaging Service (MMS)
Location-Based Services
Rich Voice and Simple Voice

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The market push

- Application providers and operators are unlikely to implement new features to GSM, money is going to UMTS services.
- Operators must gain revenue from UMTS investments.
- As of January 2005 there were 123 UMTS licenses granted totally in Europe, Middle East, Africa and Asia Pacific and 61 UMTS networks were launched commercially.
- At the same time there were 107 commercially launched CDMA2000 networks.
- The launch of first TD-SCDMA network is planned for mid-2005.
Would you like to know more?

- 3GPP TS 25.xxx series of specifications
  - TS 25.401 UTRAN overall description
  - TS 25.200 series describes the Layer-1 specification
    - TS 25.201: Physical layer – General description
    - TS 25.211: Physical channels and mapping of transport channels onto physical channels (FDD)
    - TS 25.223: Spreading and modulation (TDD)
    - ...
  - Layers 2 and 3 of the radio interface are described in the TS 25.300 series
    - TS 25.301 Radio interface protocol architecture
    - ...
- ITU Activities on IMT-2000
  - http://www.itu.int/home/imt.html
Would you like to know more?

- T-110.498 Special Course in data communications and networks, slides of spring 2003

- Websites
  - Vodafone Live, http://www.vodafone-i.co.uk/live/
  - 3GPP, http://www.3gpp.org/
  - CDMA development group, http://www.cdq.org/

Would you like to know more?

• **WCDMA network vendors**
  – Alcatel
  – Ericsson
  – Lucent
  – Motorola
  – Nokia
  – Nortel
  – Siemens/NEC

• **CDMA2000 network vendors**
  – Ericsson
  – LG Electronics
  – Lucent
  – Motorola
  – Nortel
  – Samsung

Check their websites for 3G information
Thank you!