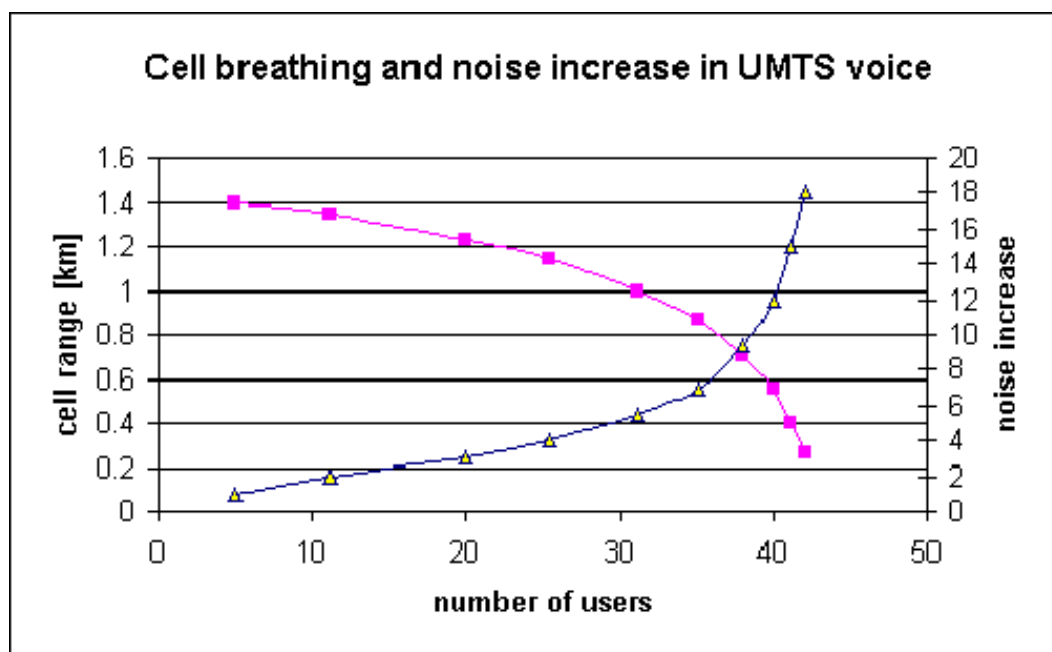
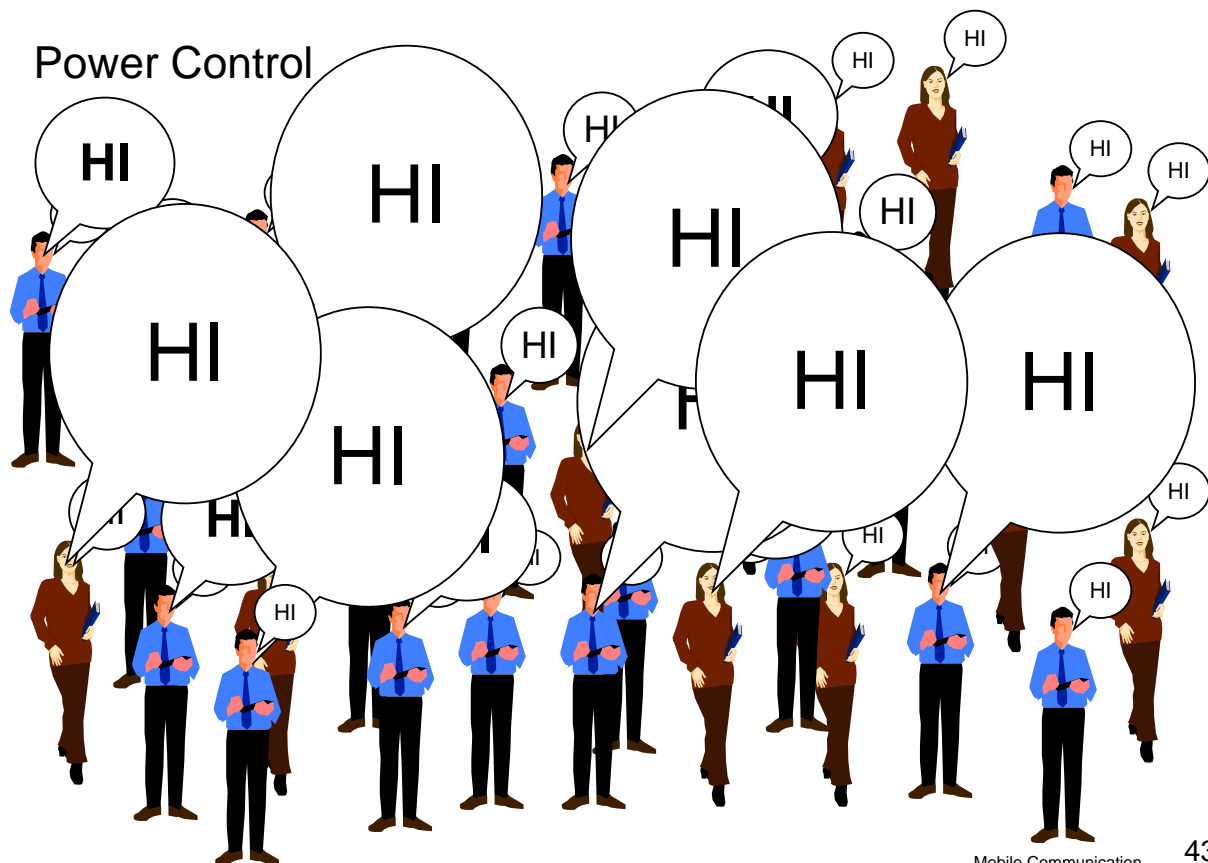


- GSM
  - Mobile device gets exclusive signal from the base station
  - Number of devices in a cell does not influence cell size
- UMTS
  - Cell size is closely correlated to the cell capacity
  - Signal-to-noise ratio determines cell capacity
  - Noise is generated by interference from
    - other cells
    - other users of the same cell
  - Interference increases noise level
  - Devices at the edge of a cell cannot further increase their output power (max. power limit) and thus drop out of the cell
    - ⇒ no more communication possible
  - Limitation of the max. number of users within a cell required
  - Cell breathing complicates network planning

## Breathing Cells: Example



## WCDMA Principle: Power Control



(Slide source: Nokia/NRC guest lectures Mobile Communication 2001-2005)

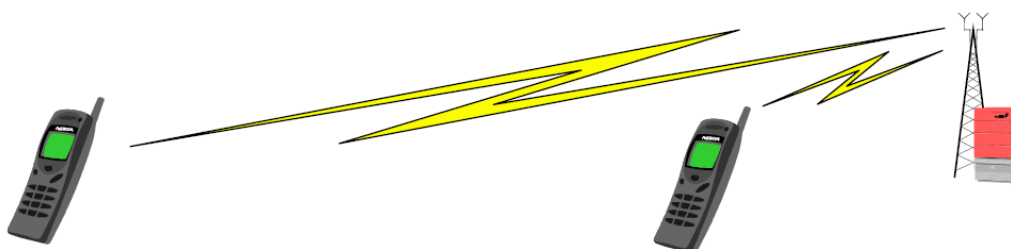
Mobile Communication  
Chapter 7.

43

## Power Control: Motivation

### Power Control

- Target is to equalize received power per bit of all users
- In downlink base station uses same power level for all users
  - "worst" user determines power level of whole cell
- In uplink all users send on the same frequency:  
Base station needs to receive all signals on same level
  - near users can easily overshoot far users (near-far problem)
  - a single over-powered user could block a whole cell



19 © NOKIA UniBonnWCDMA.ppt / 14.07.2003 / Ulrich Müller

**NOKIA**

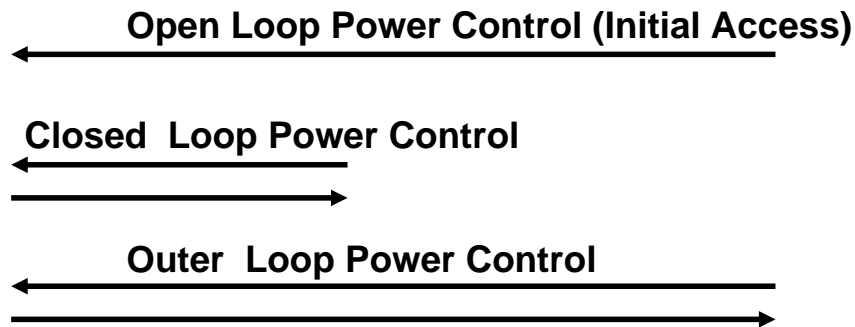
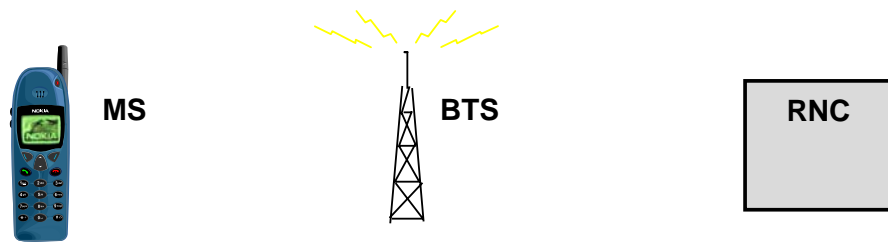
(Slide source: Nokia/NRC guest lectures Mobile Communication 2001-2005)

Mobile Communication  
Chapter 7.

44

# WCDMA Principle: Power Control (2)

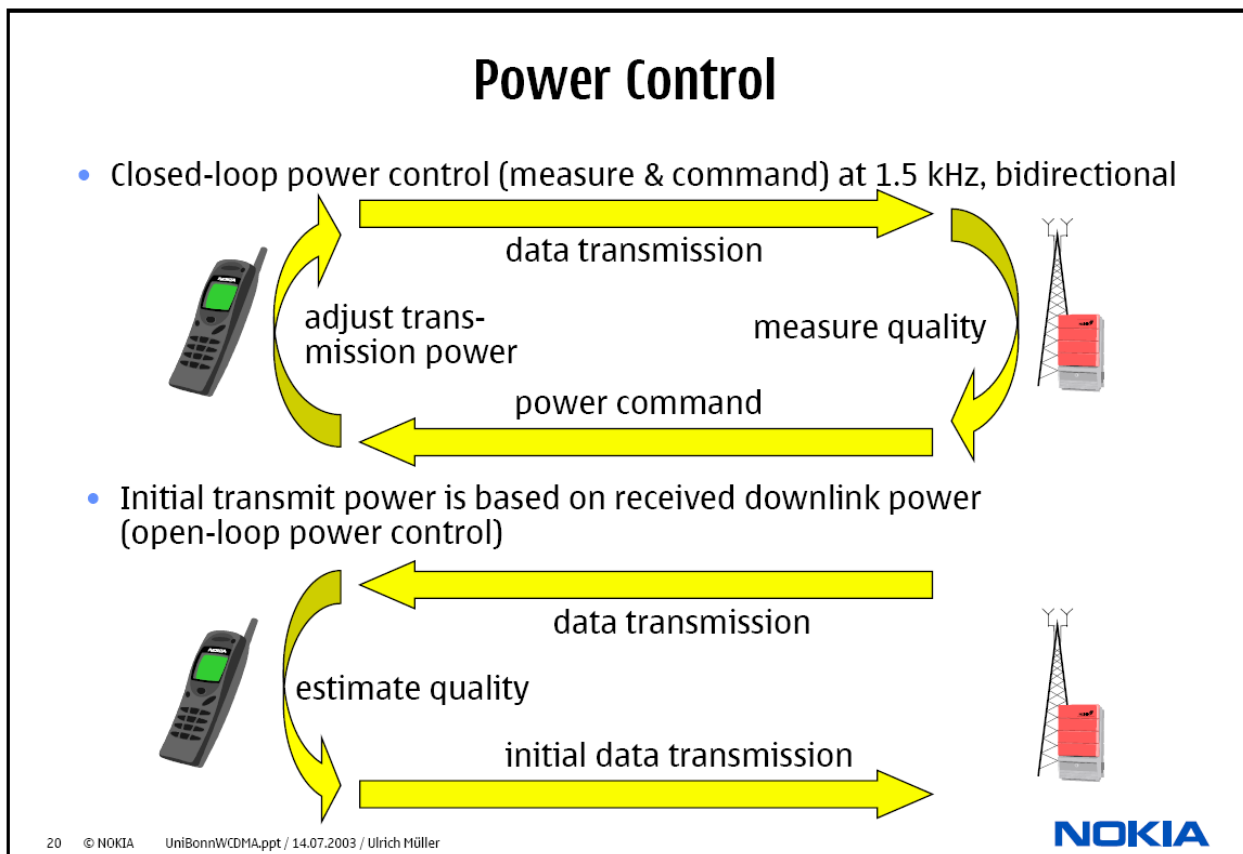
## Power Control (PC) Loops in WCDMA



(Slide source: Nokia/NRC guest lectures Mobile Communication 2001-2005)

Mobile Communication  
Chapter 7.

## Closed-loop vs. open-loop



20 © NOKIA UniBonnWCDMA.ppt / 14.07.2003 / Ulrich Müller

**NOKIA**

(Slide source: Nokia/NRC guest lectures Mobile Communication 2001-2005)

Mobile Communication  
Chapter 7.

- GSM
  - EMS/MMS
    - EMS: 760 characters possible by chaining SMS, animated icons, ring tones, was soon replaced by MMS (or simply skipped)
    - MMS: transmission of images, video clips, audio
  - EDGE (Enhanced Data Rates for Global [was: GSM] Evolution)
    - 8-PSK instead of GMSK, up to 384 kbit/s
    - new modulation and coding schemes for GPRS → EGPRS
      - MCS-1 to MCS-4 uses GMSK at rates 8.8/11.2/14.8/17.6 kbit/s
      - MCS-5 to MCS-9 uses 8-PSK at rates 22.4/29.6/44.8/54.4/59.2 kbit/s
- UMTS
  - HSDPA (High-Speed Downlink Packet Access)
    - initially up to 10 Mbit/s for the downlink, later on 20 Mbit/s using MIMO- (Multiple Input Multiple Output-) antennas
    - uses 16-QAM instead of QPSK

## Example: EDGE coverage for T-Mobile Germany



http://netzvermarktung.k.plenum.de - main - Mozilla Firefox

**Schnell, schneller, T-Mobile**  
Mit T-Mobile automatisch im schnellsten Netz. In der Fläche mit EDGE, an HotSpots mit W-LAN und in den Ballungszentren mit HSDPA.

**web'n'walk Basic Standard**  
Mobil surfen zum günstigen Preis

web'n'walk | EDGE | HotSpot | HSDPA / HSUPA

Quartal IV 2007

**Mobiler Breitbandzugang für alle**  
Auf dem Land shoppen wie in der Großstadt. Malls checken im Grünen oder Spiele und Audio Dateien unterwegs auf das Handy oder den Rechner laden – Dank EDGE stehen Ihnen diese Angebote von nahezu jedem Standort aus zur Verfügung.

Anwendungsbeispiel ansehen >

EDGE ermöglicht Datenübertragungsraten von bis zu 220 Kbit/s im Download. Das entspricht in etwa einer 4fachen ISDN Geschwindigkeit. Im Upload sind bis zu 110 kbit/s möglich.

Weitere Informationen >

Fenster schließen >

Transferring data from netzvermarktung.k.plenum.de...

EDGE is available in the complete GSM network of T-Mobile.

Source: <http://www.t-mobile.de/>

URL [http://www.t-mobile.de/business/netzabdeckung/0,12565,14540-\\_,00.html](http://www.t-mobile.de/business/netzabdeckung/0,12565,14540-_,00.html)  
(used on 18.06.2008)

## High Speed Downlink Packet Access

- High Speed Downlink Packet Access (HSDPA)
  - High Speed Data Packet Access channel introduced as an add on for UMTS services (up to 8-14 Mbit/s downlink shared channel)
  - Transmitted within one cell “eating up” certain amount of codes in SF=16
  - New modulation schemes to achieve more bandwidth
  - Priority classes on HSDPA channels allow prioritising certain users within the shared group
- Added to 3GPP Release 5 specifications
  - Support an evolution towards more sophisticated network and multimedia services
  - The main target of HSDPA is to increase user peak data rates, quality of service
  - Generally improve spectral efficiency for downlink asymmetrical and bursty packet data services.

10 © Nokia Future Mobile / 01.07.04 / Oliver Lüert

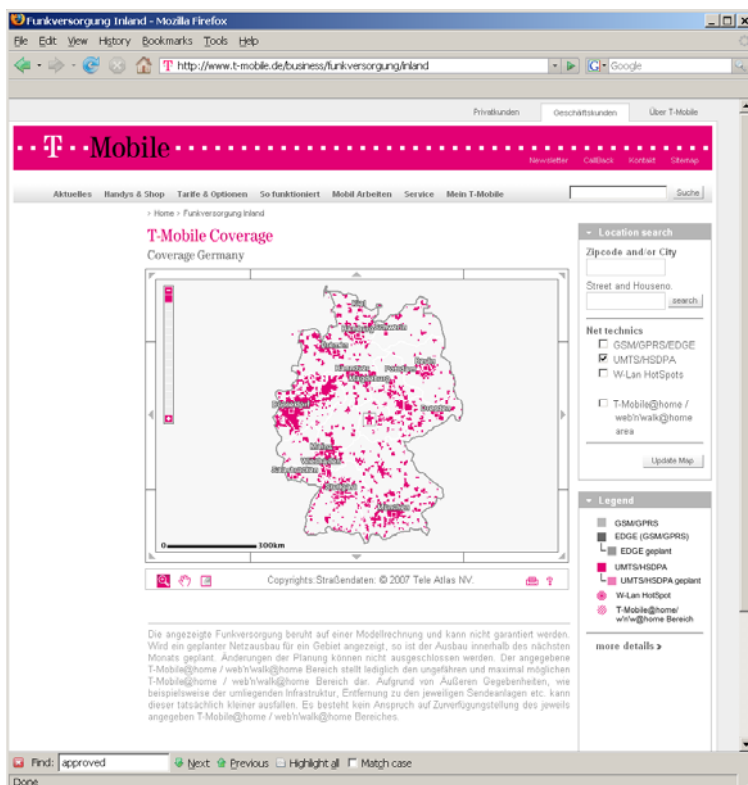
**NOKIA**

49

(Slide source: Nokia/NRC guest lectures Mobile Communication 2001-2005)

Mobile Communication  
Chapter 7.

## Example: HSDPA coverage for T-Mobile Germany



HSDPA is available in the complete UMTS network of T-Mobile.

(UMTS available in main metropolitan areas)

Source: <http://www.t-mobile.de/>

URL <http://www.t-mobile.de/business/funkversorgung/inland>

(used on 18.06.2008)

Copyright © 2008 Prof. Dr. Peter Martini, Dr. Matthias Frank, Institute of CS IV, University of Bonn

Mobile Communication  
Chapter 7.

50

## 7.8. IP Multimedia Subsystem (IMS)

IMS\* represents an overlay network on top of cellular networks and provides an all IP service delivery environment for mobile multimedia service provision.

\* IMS is the “IP Multimedia System”, standardised by the 3rd Generation Partnership Projekt (3GPP), <http://www.3gpp.org>

- SIP, and SDP for Session Control
- DIAMETER for accounting
- RTP, RTCP for multimedia data transport
- COPS for policy provisioning
- plus many others

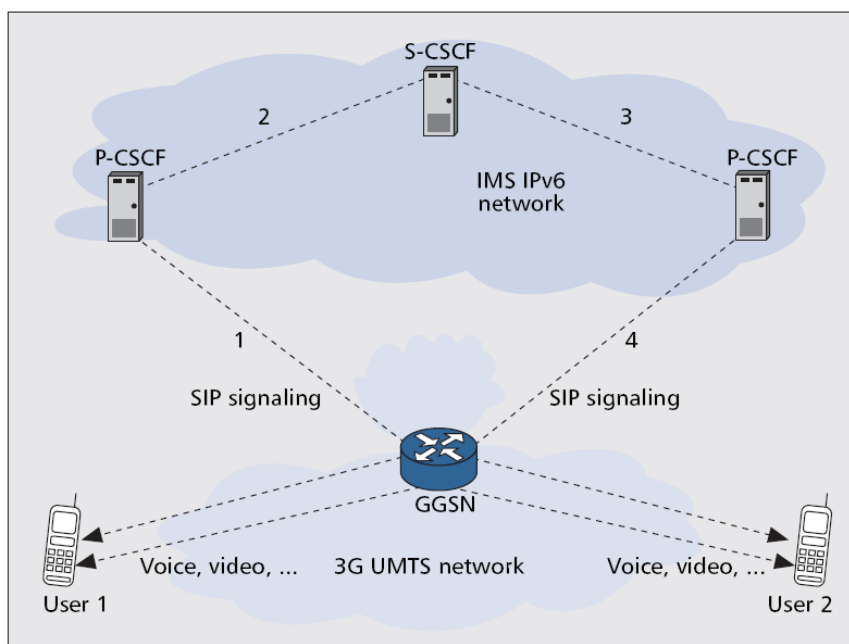
IMS is designed for IPv6, but support for IPv4 has been added in Version 6 of IMS

### Why do we Need an IMS?

- IMS builds on IETF protocols, to create a **robust** and **complete multimedia system**
- IMS defines common interfaces to adopt new and **integrated application services**
- IMS enhancements and operational profiles provide support for operator control, **charging and billing**, and **security**
- IMS provides **QoS**, **single sign-on**, **subscription**, **presence**, and **location**

## IMS – IP Multimedia Subsystem

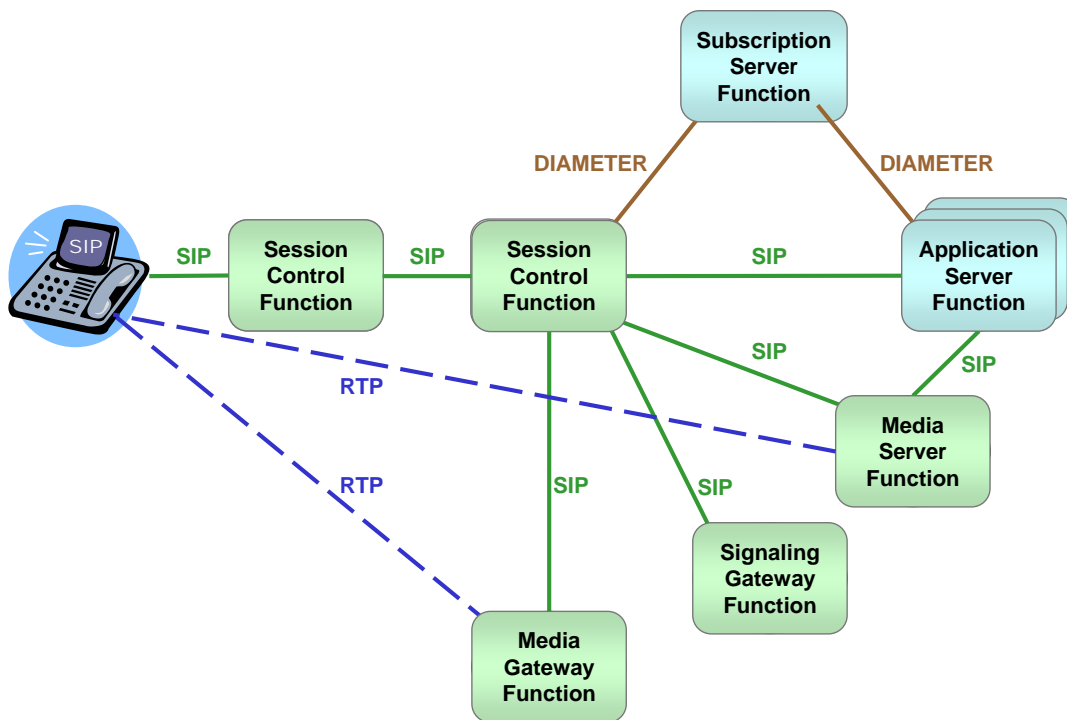
The IMS “service platform” is/was designed by 3GPP (<http://www.3gpp.org>) to assist and control (multimedia) sessions established between peers. The peers willing to involve IMS in their sessions must use some of the IMS nodes as proxies for their session signaling.



CSCF: Call Service Control Function  
P-CSCF: Proxy-CSCF  
S-CSCF: Serving-CSCF  
SIP: Session Initiation Protocol

Source: IEEE Communications Magazine, August 2006, pp. 75-81

# IMS Conceptional Architecture



## 7.9. Mobile Future: 3.5G ... 3.9G ... 4G ...

**3.5 generation** of mobile communication:

- HSDPA/HSUPA (D = downlink, U = uplink) extension to UMTS
- Downlink up to 14.4 Mbit/s, Uplink up to 5.7 Mbit/s

**3.9 generation** of mobile communication:

- UTRAN LTE ("Universal Terrestrial Radio Access Network Long Term Evolution")
- also: "Super 3G"
- Downlink up to 100 Mbit/s, Uplink up to 50 Mbit/s
- 3GPP 3.9G specification approved 2nd half of 2007

**4th generation** of mobile communication:

- All-IP based
- NTT DoCoMO (Japan) testing since 1998
- data transfer rates 100 Mbit/s up to 300 Mbit/s

[http://www.teltarif.de/News\\_10.06.2005](http://www.teltarif.de/News_10.06.2005)

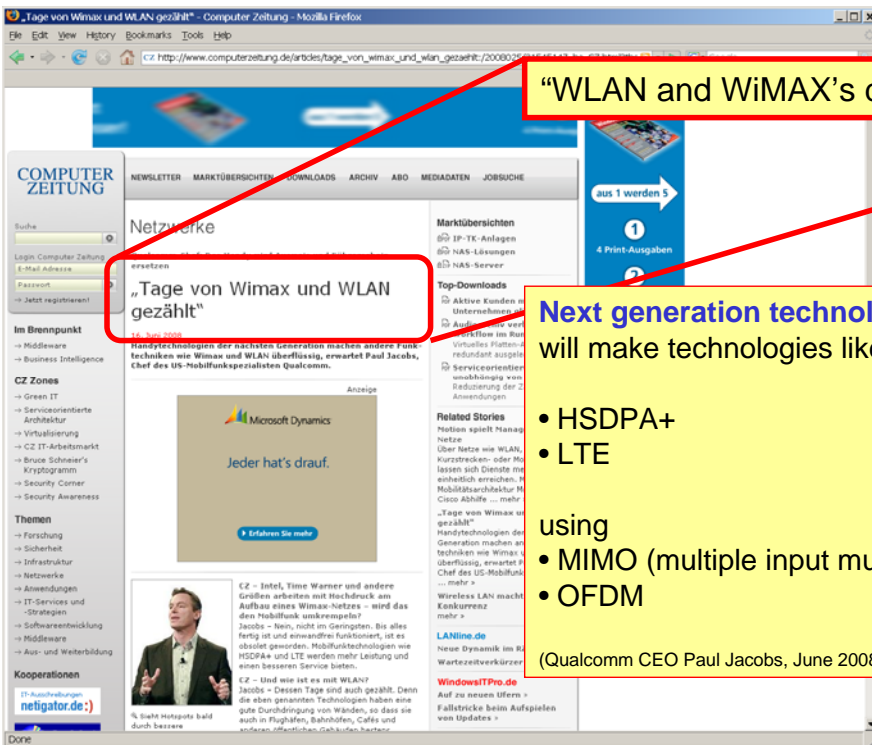
<http://www.teltarif.de/arch/2005/kw23/s17412.html>



# Future statement as of June 2008

More on

[http://www.computerzeitung.de/articles/tag\\_von\\_wimax\\_und\\_wlan\\_gezaehlt/2008025/31545147\\_ha\\_CZ.html?thes=](http://www.computerzeitung.de/articles/tag_von_wimax_und_wlan_gezaehlt/2008025/31545147_ha_CZ.html?thes=)  
 or <http://www.computerzeitung.de/kn31539662>



"WLAN and WiMAX's days are numbered"

Next generation technologies of mobile communication will make technologies like **WLAN, WiMAX, ... obsolete:**

- HSDPA+
- LTE

using

- MIMO (multiple input multiple output) antennas
- OFDM

(Qualcomm CEO Paul Jacobs, June 2008)

# Annex: Ergebnis Frequenzvergabe für UMTS – FDD (1) (in German language)

RUNDENERGEBNIS				
Versteigerung UMTS/IMT-2000-Lizenzen				
Runde:	173			
Lfd. Nr.	Umfang	Höchstbieter	Höchstgebot (TDM)	Höchstgebot* (€ in Tsd)
01	2 x 5 MHz	VIAG Interkom	8.310.400	4.249.040
02	2 x 5 MHz	MobilCom Multimedia	8.170.000	4.177.255
03	2 x 5 MHz	Mannesmann Mobilfunk	8.330.000	4.259.061
04	2 x 5 MHz	Group 3G	8.304.600	4.246.075
05	2 x 5 MHz	MobilCom Multimedia	8.200.000	4.192.593
06	2 x 5 MHz	VIAG Interkom	8.206.600	4.195.968
07	2 x 5 MHz	T-Mobil	8.304.300	4.245.921
08	2 x 5 MHz	E-Plus Hutchison	8.274.300	4.230.582
09	2 x 5 MHz	T-Mobil	8.277.900	4.232.423
10	2 x 5 MHz	E-Plus Hutchison	8.143.900	4.163.910
11	2 x 5 MHz	Mannesmann Mobilfunk	8.143.800	4.163.859
12	2 x 5 MHz	Group 3G	8.141.400	4.162.632
Summe Höchstgebote			98.807.200	50.519.319

\* Eurowerte gerundet

## UMTS-Versteigerung Deutschland

14. Tag = 17.08.2000 (bis Runde 173)

Rundenergebnis des Abschnitts 1 (FDD Frequenzblöcke)



## Ergebnis Frequenzvergabe für UMTS – FDD (2)

STAND DER LIZENZVERGABE					
Versteigerung UMTS/IMT-2000-Lizenzen					
Runde	173	Datum	17.08.00	Uhrzeit	15:51:26
Höchstgebote für Frequenzblöcke [mind. 2 Blöcke erforderlich für Lizenz]					
Bieter	Anzahl der Frequenzblöcke			Lizenzgebot	
	1	2	3	(TDM)	(€ in Tsd)
E-Plus Hutchison	2 × 5 MHz	2 × 5 MHz		16.418.200	8.394.492
Group 3G	2 × 5 MHz	2 × 5 MHz		16.446.000	8.408.706
Mannesmann Mobilfunk	2 × 5 MHz	2 × 5 MHz		16.473.800	8.422.920
MobilCom Multimedia	2 × 5 MHz	2 × 5 MHz		16.370.000	8.369.848
T-Mobil	2 × 5 MHz	2 × 5 MHz		16.582.200	8.478.344
VIAG Interkom	2 × 5 MHz	2 × 5 MHz		16.517.000	8.445.008
debitel Multimedia		ausgeschieden			
Lizenzsumme				98.807.200	50.519.319

### UMTS-Versteigerung Deutschland 14. Tag = 17.08.2000 (bis Runde 173) Stand der Lizenzvergabe (FDD Frequenzblöcke)

- UTRA-FDD:
  - Uplink 1920-1980 MHz
  - Downlink 2110-2170 MHz
  - Duplexabstand 190 MHz
  - 12 Kanäle zu je 5 MHz

Copyright © 2008 Prof. Dr. Peter Martini, Dr. Matthias Frank, Institute of CS IV, University of Bonn

Chapter 7.

## Ergebnis Frequenzvergabe für UMTS – TDD

RUNDENERGEBNIS				
Versteigerung UMTS/IMT-2000-Frequenzen				
Runde:	9			
Lfd. Nr.	Umfang	Höchstbieter	Höchstgebot (TDM)	Höchstgebot* (€ in Tsd)
13	1 × 5 MHz konkret	E-Plus Hutchison	73.600	37.631
14	1 × 5 MHz	MobilCom Multimedia	121.000	61.866
15	1 × 5 MHz	T-Mobil	122.700	62.736
16	1 × 5 MHz	Mannesmann Mobilfunk	121.000	61.866
17	1 × 5 MHz	Group 3G	122.700	62.736
Summe Höchstgebote			561.000	286.835
VIAG Interkom		ausgeschieden		

- UTRA-TDD:
  - 1900-1920 MHz,
  - 2010-2025 MHz;
  - je 5 MHz Kanäle

### UMTS-Versteigerung Deutschland 1. Tag = 18.08.2000 (bis Runde 9) Endergebnis Abschnitt 2 (TDD Frequenzblöcke)

- Ziel gemäß Lizenzierung:**
  - Abdeckung: 25% in der Bevölkerung bis 12/2003, 50% bis 12/2005