



DECUS München e.V.

HP User Society



"Mobile Data Transfer"

-Access Technologies for 3G Services-

Bonn, April 8, 2003

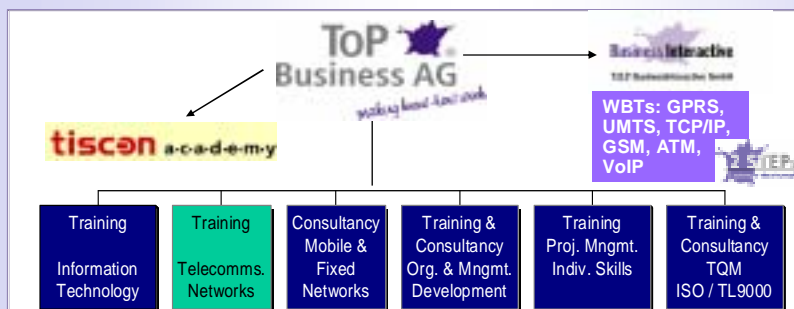
Presented by:

Vice President Training Telecommunication Networks



Klingenhofstrasse 58, 90411 Nuremberg / Germany

About TOP...

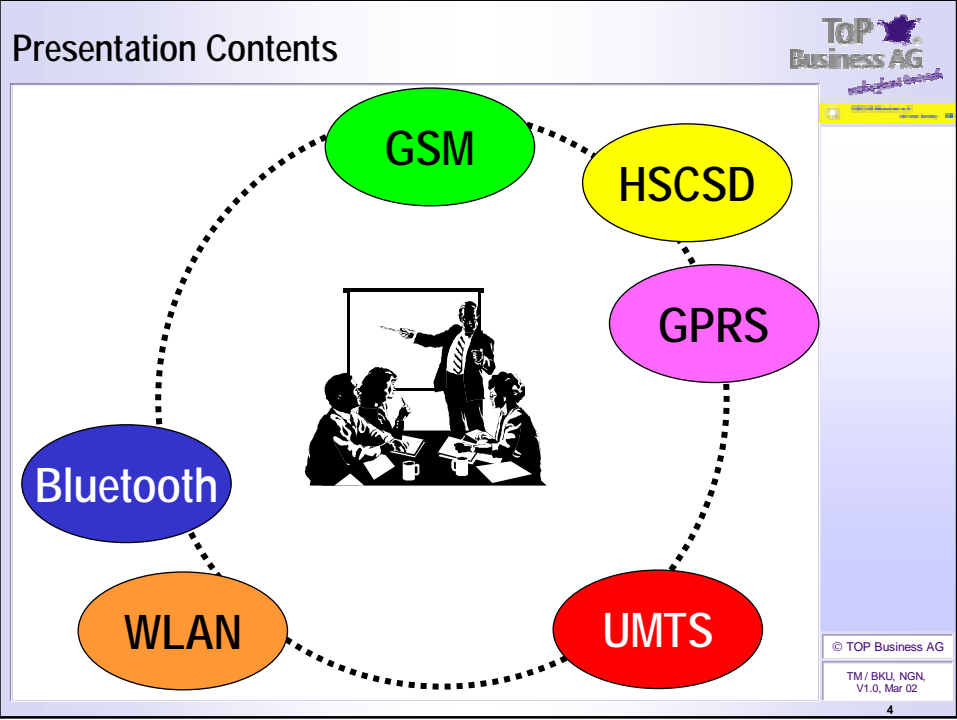
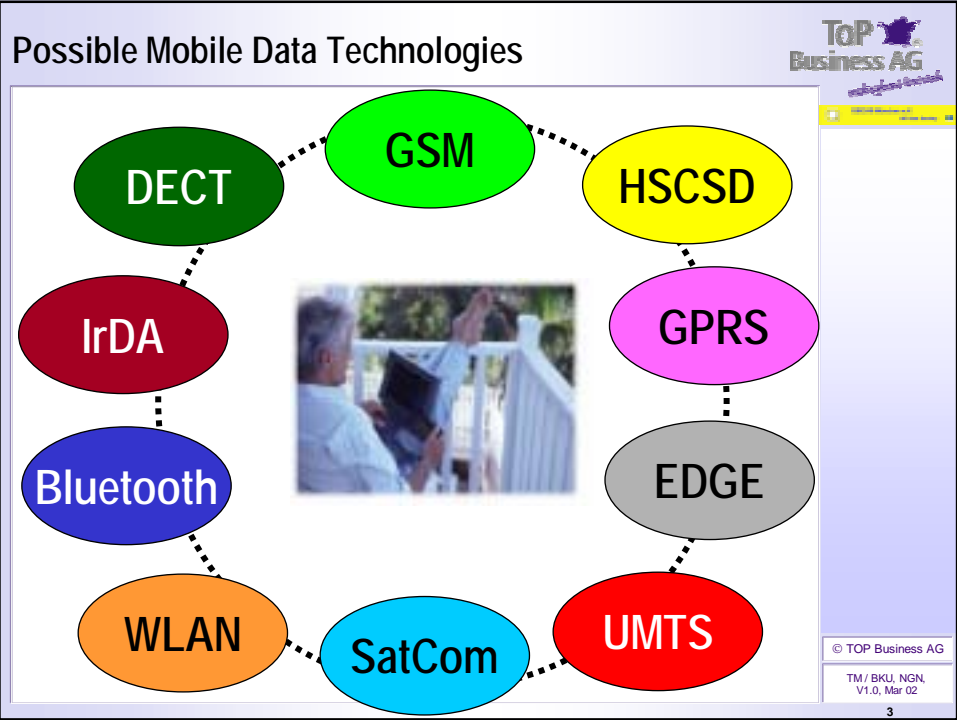


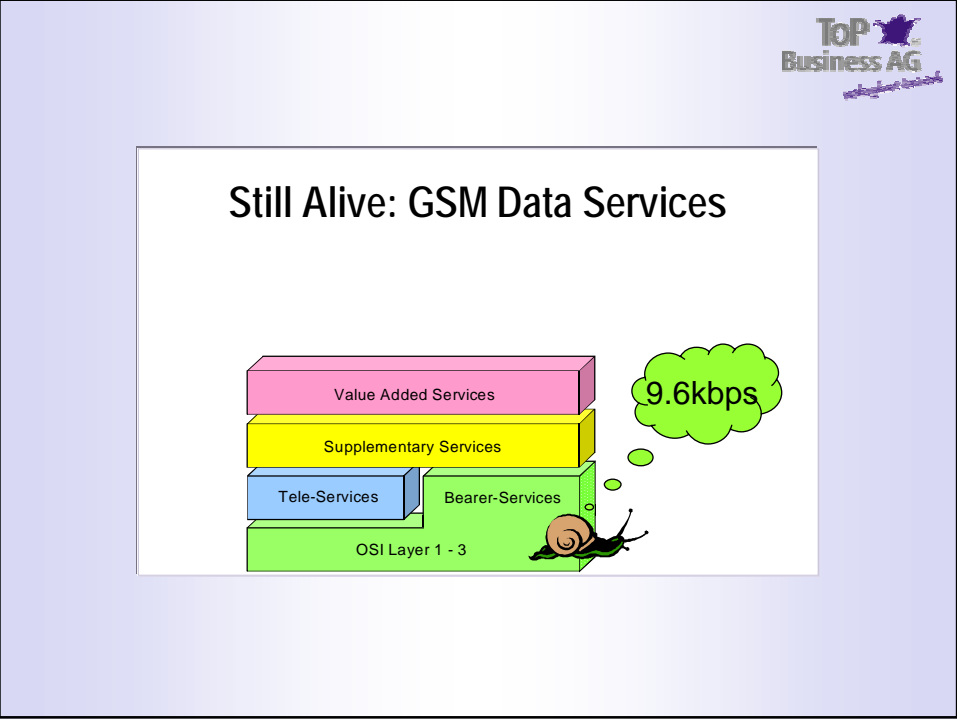
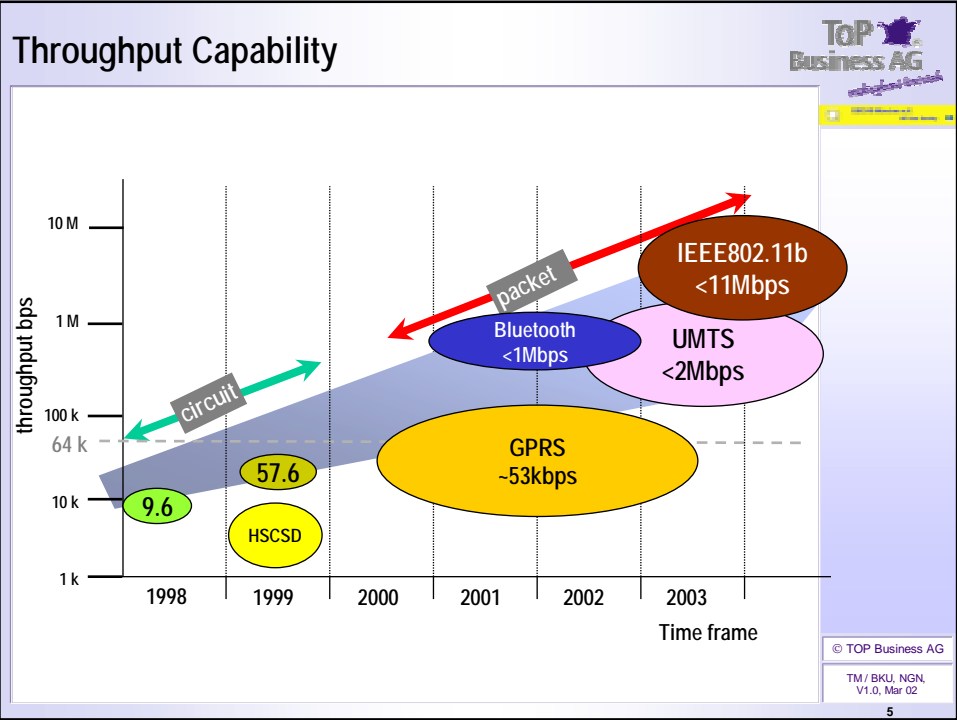
- Since 1994, independent training institute, privately owned
- Training centers: Nuremberg, Hamburg, Neuss, Neu-Ulm
- Total Staff in 2003: 65
- Total Sales in 2002: EUR 7.7m
- DIN EN ISO 9001 certification since 1993
- ETSI, 3GPP, EFQM member




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Transparent / Non-transparent Mode



- ✦ **Transparent Mode**
 - Forward Error Correction by Data Terminal Equipment
 - requires constant data rate
- ✦ **Non-transparent Mode**
 - RLP by MS and IWF
 - Enables flexible bit rates

➔

GSM

HSCSD

GPRS

UMTS

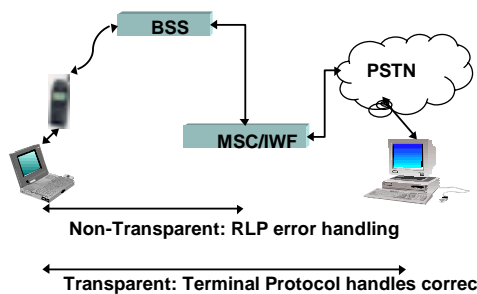
WLAN

Bluetooth


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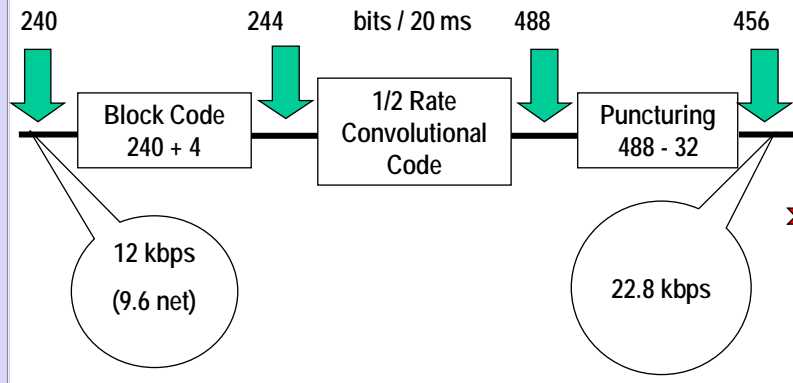
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Standard Channel Coding





➔

GSM

HSCSD

GPRS

UMTS

WLAN

Bluetooth

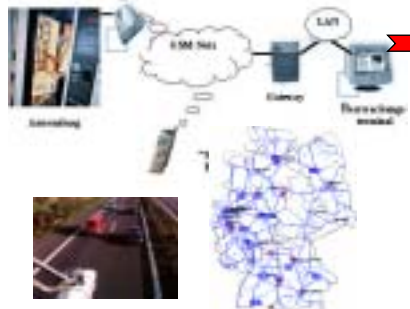
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GSM CS Data Applications

- ✦ 0.3...9.6kbps
- ✦ Circuit-switched
- ✦ Expensive (time-based billing)
- ✦ E-mail browsing (headlines, low content)
- ✦ M2M (Machine-to-Machine communications)
 - Vending machine control



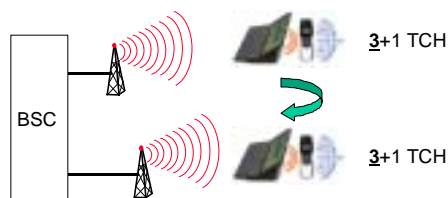
- GSM
- HSCSD
- GPRS
- UMTS
- WLAN
- Bluetooth

- Traffic flow measurements



A First Step Forward:

TS Bundling With High-Speed CS Data



HSCSD Key Features (1)

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- Smooth integration into infrastructure by SW updates
- Net bit rate per TS boost from 9.6 to 14.4 kbps by improved channel coding

290 bits / 20 ms → Block Code 290 + 4 → 294 bits / 20 ms → 1/2 Rate Convolutional Code → 588 bits / 20 ms → Puncturing 588 - 132 → 456 bits / 20 ms

14.5 kbps (14.4 net)

22.8 kbps

GSM
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HSCSD Key Features (2)

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- TCH bundling: 1...4, different for UL and DL
- Higher net bit rate but less resistant against interference
- Handover problems at cell borders
- Adaptive Link Adaptation: Selects either standard or improved channel coding according to transmission quality (BER) for optimized data transmission
- No QoS levels


TCH	9.6 kbps Input	14.4 kbps Input
1	9.6	14.4
2	19.2	28.8
3	28.8	43.2
4	38.4	57.6

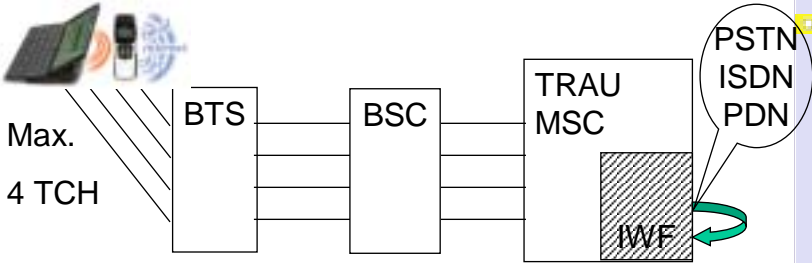
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HSCSD System Architecture





Max.
4 TCH

BTS

BSC

TRAU
MSC

IWF

PSTN
ISDN
PDN

GSM

HSCSD

GPRS

UMTS

WLAN

Bluetooth


- ✦ Split & combine function located in IWF of MSC and MS
- ✦ IWF /MSC: Mapping of 4 TCH at 64kbps each to 1 TCH at 64kbps towards PSTN
- ✦ MS:
 - 3 TS offset between TX and RX
 - TS for adjacent cell monitoring
 - Max. no. of 4 TCH (with 2nd RX)

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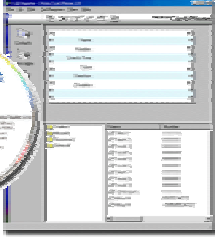
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HSCSD Applications



- ✦ E-Mail retrieval with low volume attachments
- ✦ Data download from host PC
- ✦ Web surfing
- ✦ Still time-based billing
- ✦ Available at:
 - **e-plus**

- ✦ Few roaming possibilities

GSM

HSCSD

GPRS

UMTS

WLAN

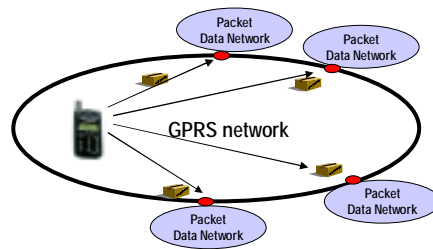
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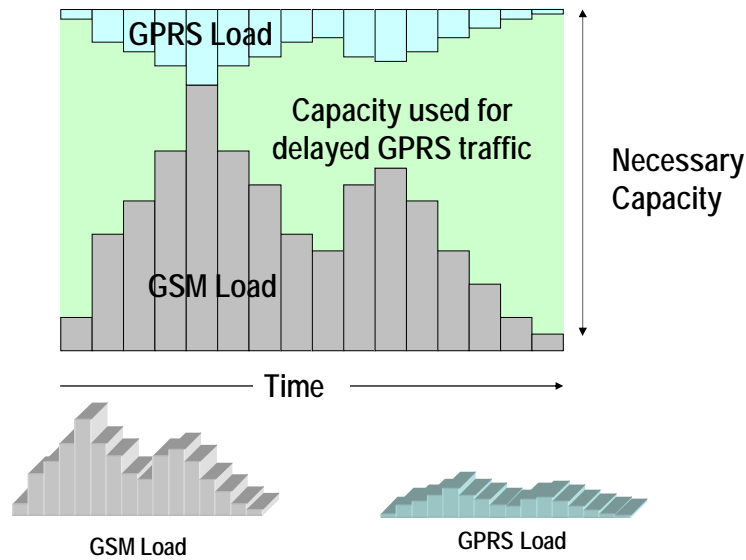
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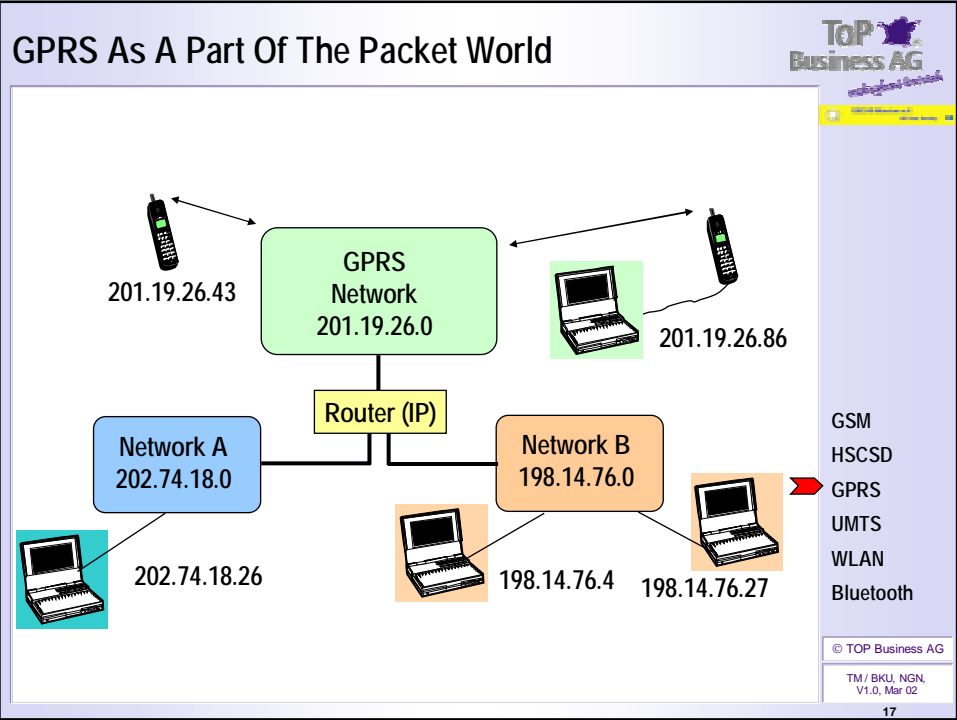
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From CS To PS Data: General Packet Radio Service



The Idea





GPRS Terminals Types

The diagram shows three mobile phone classes: Class B (grey), Class A (yellow), and Class C (brown). Class A is highlighted with a red arrow, indicating it is the focus of the slide.

- ✦ Type A - GSM attached AND GPRS attached
 - simultaneous voice and packet data
 - two radio chains required
- ✦ Type B - GSM attached AND GPRS attached
 - alternate voice and packet data
 - required for mass market applications
 - complex implementation
- ✦ Type C - GSM attached OR GPRS attached
 - manually switched
 - simple to implement


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MS Classes For Multislot Capabilities



Multislot class	max. no. of TS	
class	RX	TX
class1	1	1
class2	2	1
class3	2	2
class4	3	1
.	.	.
class8	4	1
.	.	.
class17	7	7
.	.	.
class29	8	8


Limitation in Phase1

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- HSCSD
- ➔ GPRS
- UMTS
- WLAN
- Bluetooth

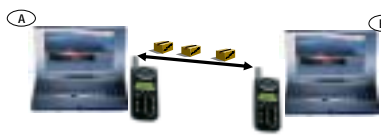
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GPRS Services



- ✦ Point -to-Point Services
 - PTP Connection-Less Network Services (PTP-CLNS) using IP
 - PTP Connection-Oriented Network Services (PTP-CONS) using X.25
- ✦ Point-to-Multipoint Services
 - Transmission of packets between a service requester and a receiver group currently located within a geographical area
 - Both, the receiver group and the geographical area are specified by the service requester
 - PTM-M : PTM Multicast
 - PTM-G : PTM Group Call
 - IP-M : IP Multicast




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- WLAN
- Bluetooth

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QoS Parameter



Quality of Service (QoS) profile defines the quality of service expected in terms the following attributes:


- precedence class
- delay class
- reliability class
- peak throughput class
- mean throughput class

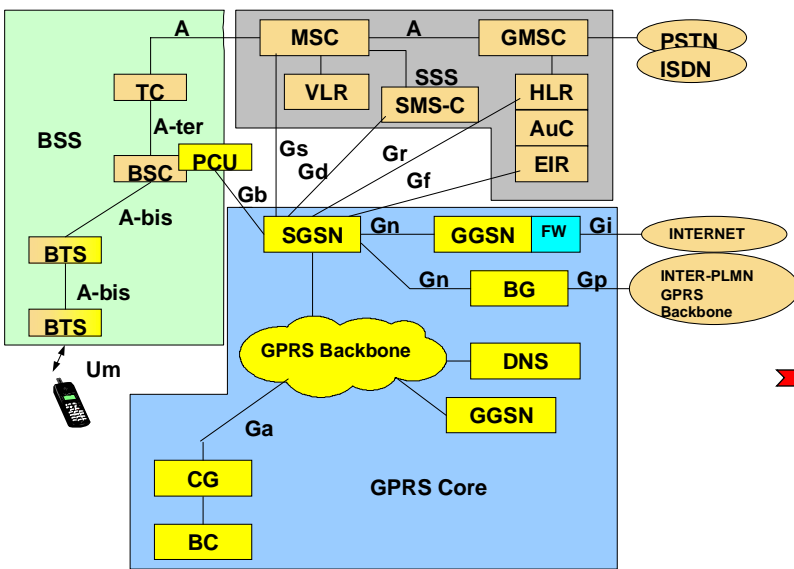
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GPRS Network Architecture





The diagram illustrates the GPRS Network Architecture, showing the following components and interfaces:

- BSS (Base Station Subsystem):** Includes BTS (Base Transceiver Station), BSC (Base Station Controller), and PCU (Packet Control Unit). It connects to the GPRS Core via the A-bis interface.
- MSC (Mobile Switching Center):** Includes VLR (Visitor Location Register), SSS (SMS Service Center), HLR (Home Location Register), AuC (Authentication Center), and EIR (Equipment Identity Register). It connects to the GPRS Core via the Gb interface.
- GPRS Core:** Includes SGSN (Serving GPRS Support Node), GGSN (Gateway GPRS Support Node), BG (Border Gateway), DNS (Domain Name System), and CG (Circuit Gateway). It connects to the BSS via the Gn interface and to the Internet via the Gi interface.
- External Networks:** Includes PSTN/ISDN, Internet, and Inter-PLMN GPRS Backbone.
- Other Components:** Includes TC (Transcoder), A-ter (Termination), A (Access), Gs (GSM System), Gd (GPRS Data), Gr (GPRS Radio), Gf (GPRS Frequency), Gp (GPRS Packet), and BC (Base Controller).

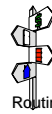
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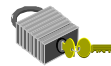
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Serving GPRS Support Node (SGSN) Tasks

- Converts protocols used in the IP backbone to protocols used in the BSS and the MS
- Takes care of authentication and mobility management
- Routes data to the relevant GGSN when connection to an external network is required
- Collects charging data and traffic statistics
- Ciphers the Packet Data Unit (PDU)



Routing Table



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UMTS
WLAN
Bluetooth

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Gateway GPRS Support Node (GGSN) Tasks

- Acts as the interface between the GPF network and external networks
- Collects charging data and traffic statistics
- Allocates IP addresses for users
- Routes packets coming from external networks towards the correct SGSN and vice versa



Address Mapping



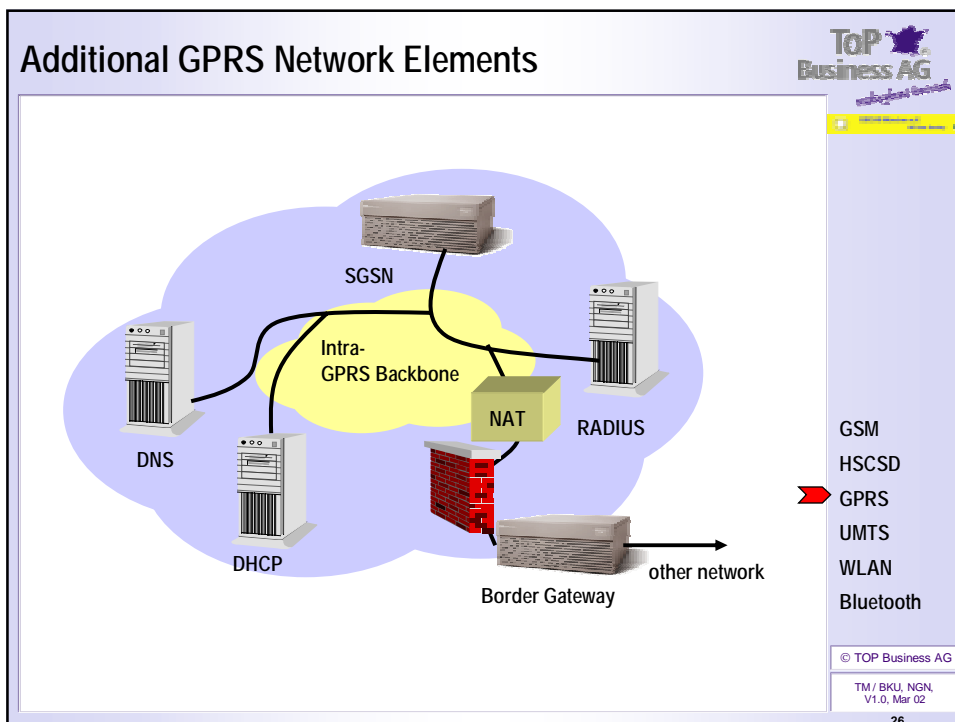
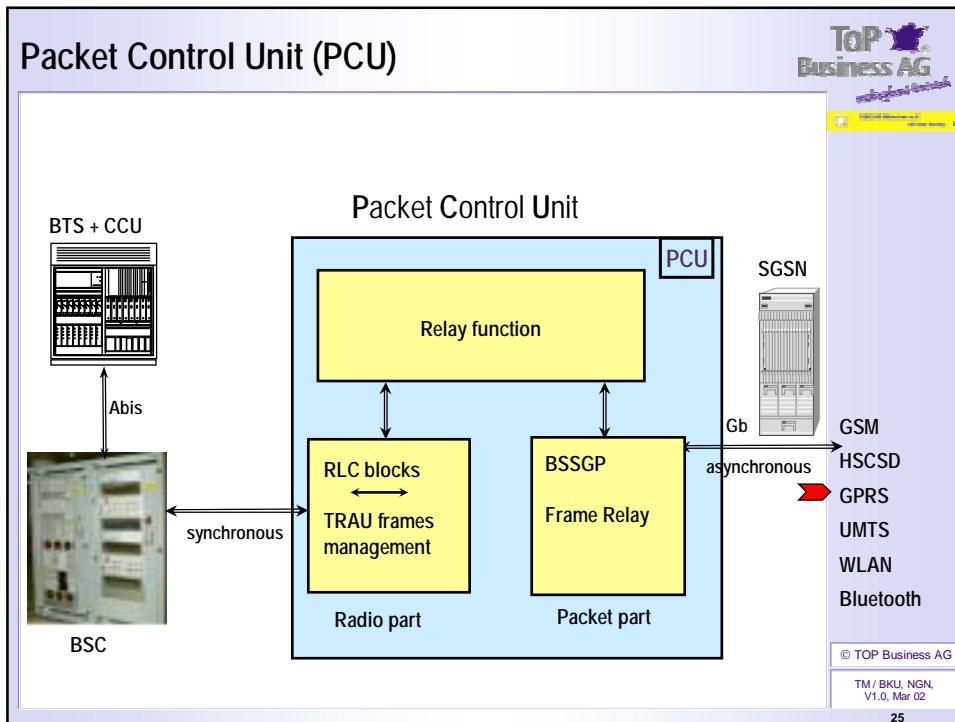
Routing Table

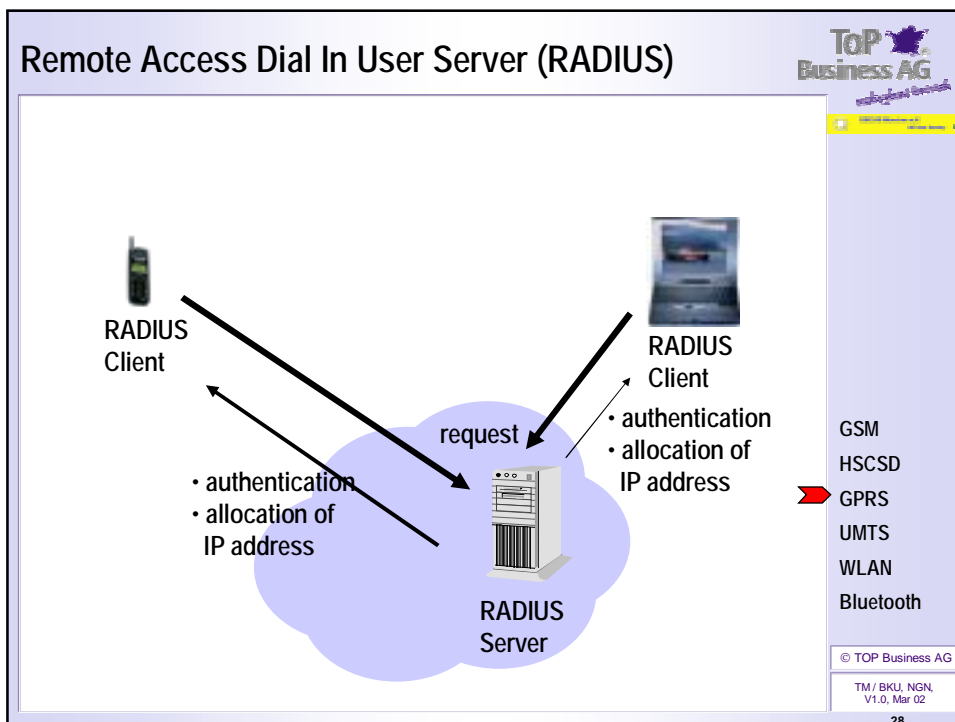
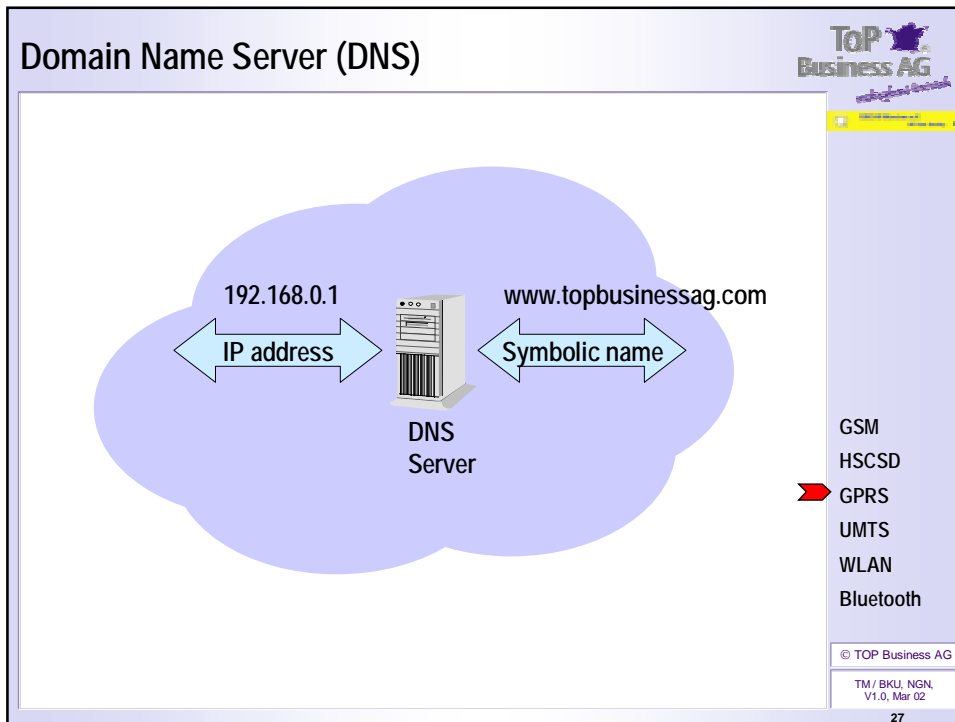
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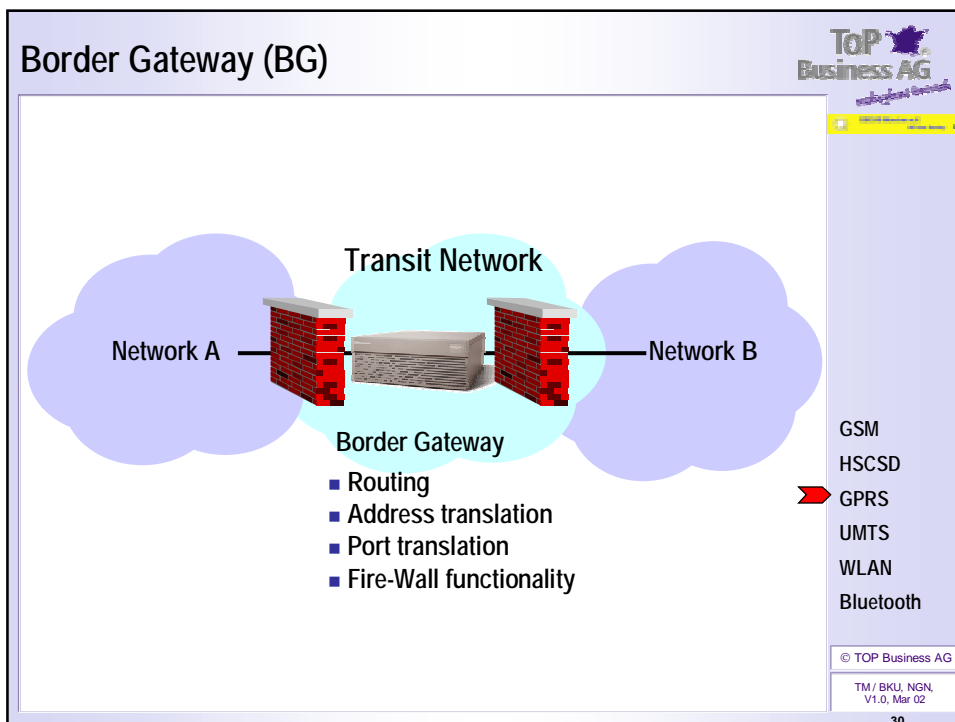
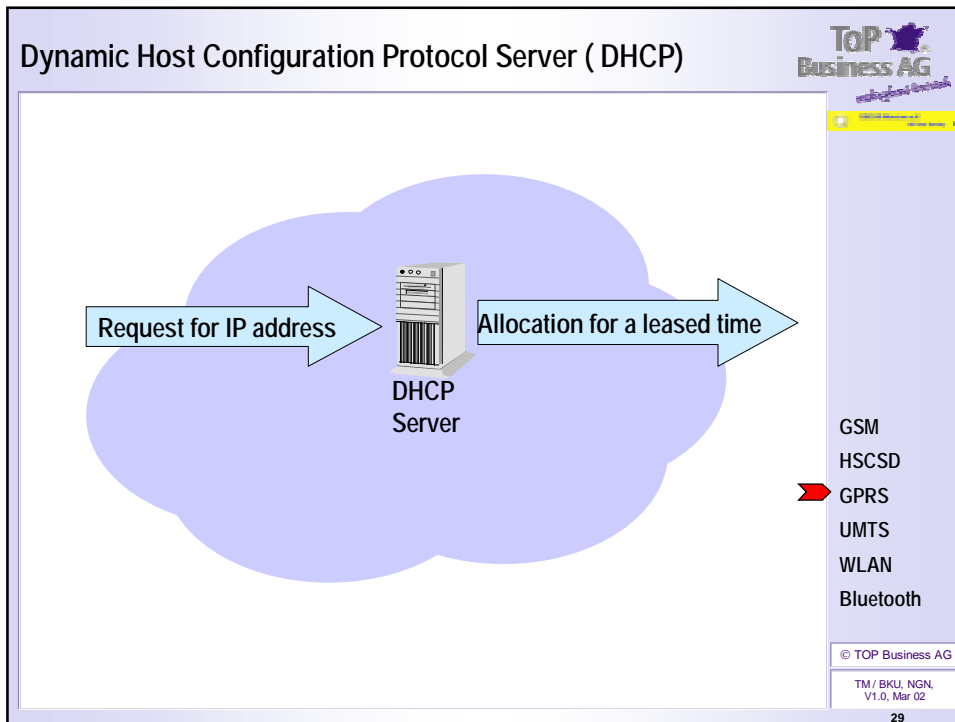
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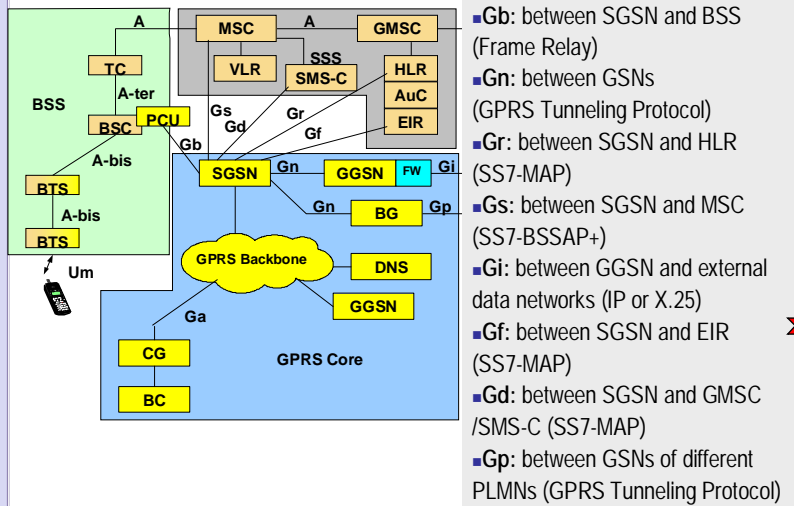
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GPRS Open Network Interfaces

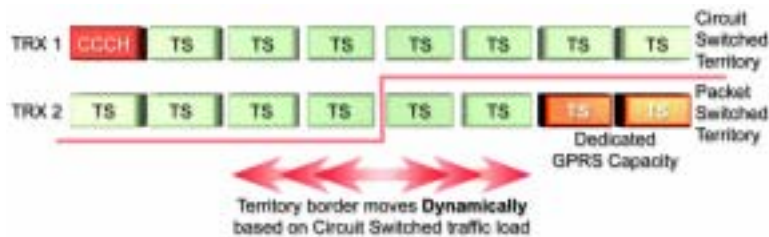


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- UMTS
- WLAN
- Bluetooth

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GPRS Air Interface: Timeslot Allocation




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- HSCSD
- ➔ GPRS
- UMTS
- WLAN
- Bluetooth

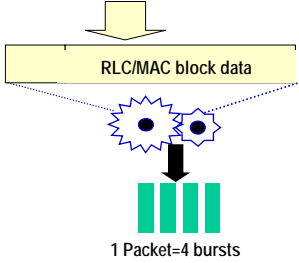
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GPRS Channel Coding



Four different channel coding schemes have been defined for GPRS:



RLC/MAC block data

1 Packet=4 bursts

- Coding Scheme 1 (CS-1)
- Coding Scheme 2 (CS-2)
- Coding Scheme 3 (CS-3)
- Coding Scheme 4 (CS-4)

Channel Coding Scheme	CS1	CS2	CS3	CS4
Single TSL Data Rate	9.05 kbps	13.4 kbps	15.6 kbps	21.4 kbps
3 TSL Data Rate	27.15 kbps	40.2 kbps	46.8 kbps	64.2 kbps
8 TSL Data Rate	72.0 kbps	107.2 kbps	124.8 kbps	171.2kbps

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Coding Scheme Throughputs



Coding Scheme	CS1	CS2	CS3	CS4
Theoretical RLC/MAC User Throughput (kbps)	8	12	14.4	20
User Throughput at Application layer in kbps (without retransmission)	7.0	10.6	12.8	17.9
Effective User Throughput at Application layer in kbps (with retransmissions: BLER = 4%)	6.7	10.2	12.3	17.3
Effective User Throughput at Application layer in kbps (with retransmissions: BLER = 10%)	6.3	9.5	11.5	16.2

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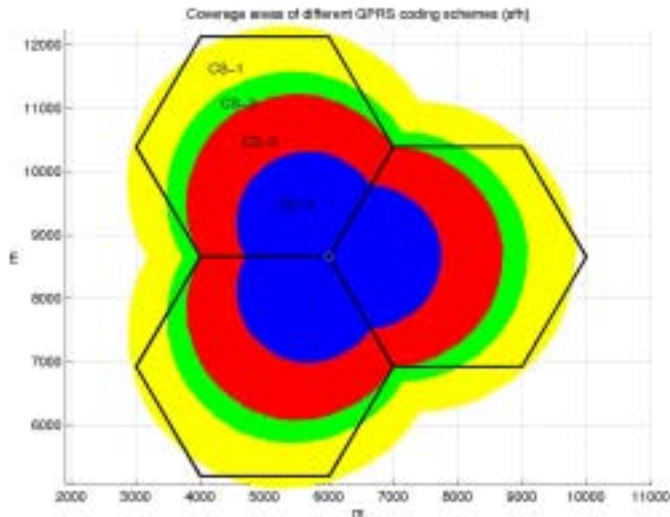
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Coding Scheme Areas



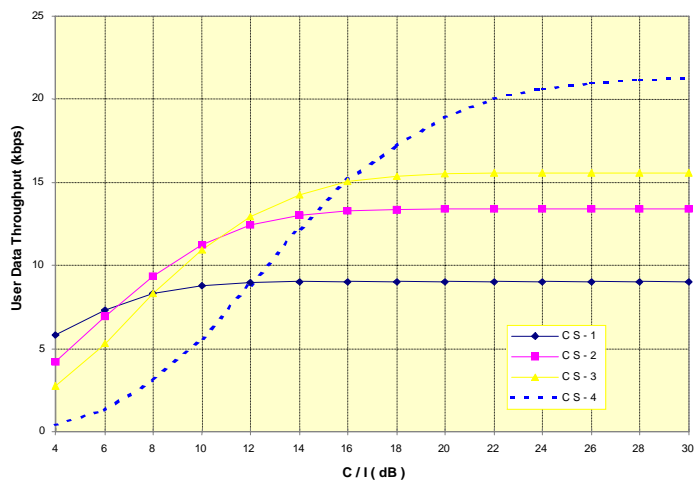
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User Throughput vs. C/I ratio



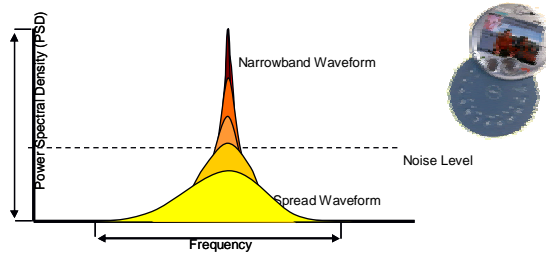
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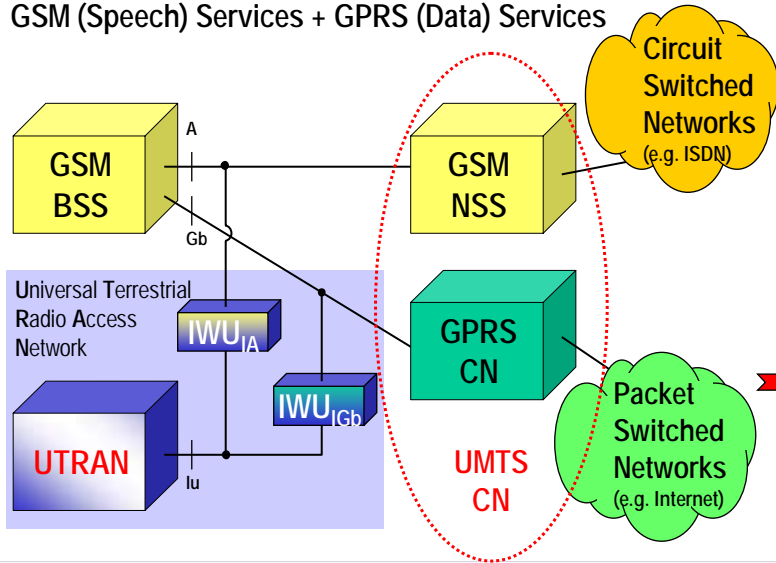
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Global Multimedia Mobility: Universal Mobile Telecommunication System



Evolution from GSM to UMTS

UMTS R99 =
 GSM (Speech) Services + GPRS (Data) Services



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- GPRS
- UMTS
- WLAN
- Bluetooth

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UTRAN Element Tasks

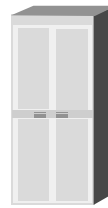
Node B (UMTS Base Station)

- Transmitter (TX) / Receiver (RX) functions
- Spreading and de-spreading
- Softer Handover arrangements
- Power Control
- Micro Diversity
- Encoding and decoding
- Uu interface channelization
- Iub signaling and switching
- ATM termination



Radio Network Controller (RNC)

- Radio Resource Management (RRM)
- Radio Resource Control (RRC)
- Telecommunication Management



RNC

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▶ UMTS
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UMTS Core Network Element Tasks

GSM-NSS / GPRS-CN / Additional Elements

Connection Management (CM)

- Bearer Management (BM)
- Call Control (CC)
- Supplementary Service (SS)
- Short Message Service (SMS)

Session Management (SM)

Mobility Management (MM)

Security issues

Charging

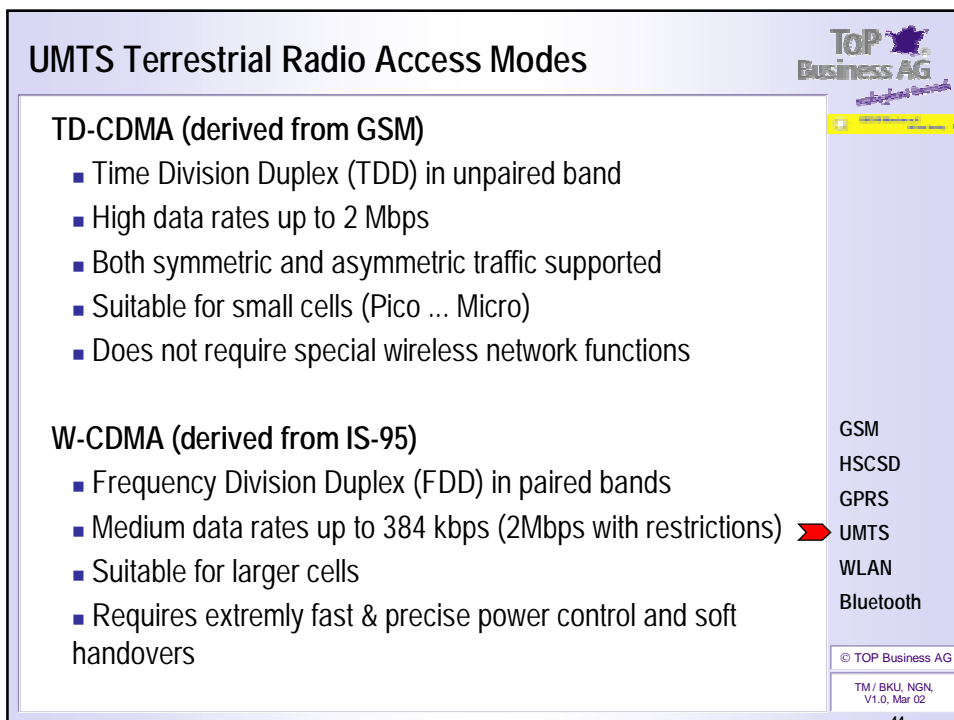
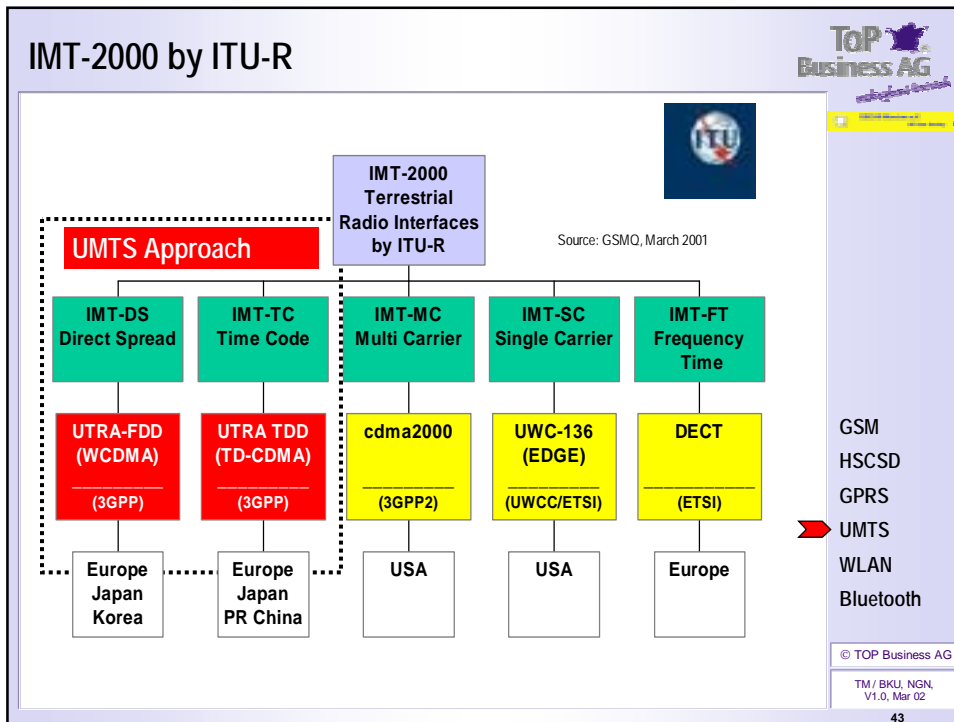


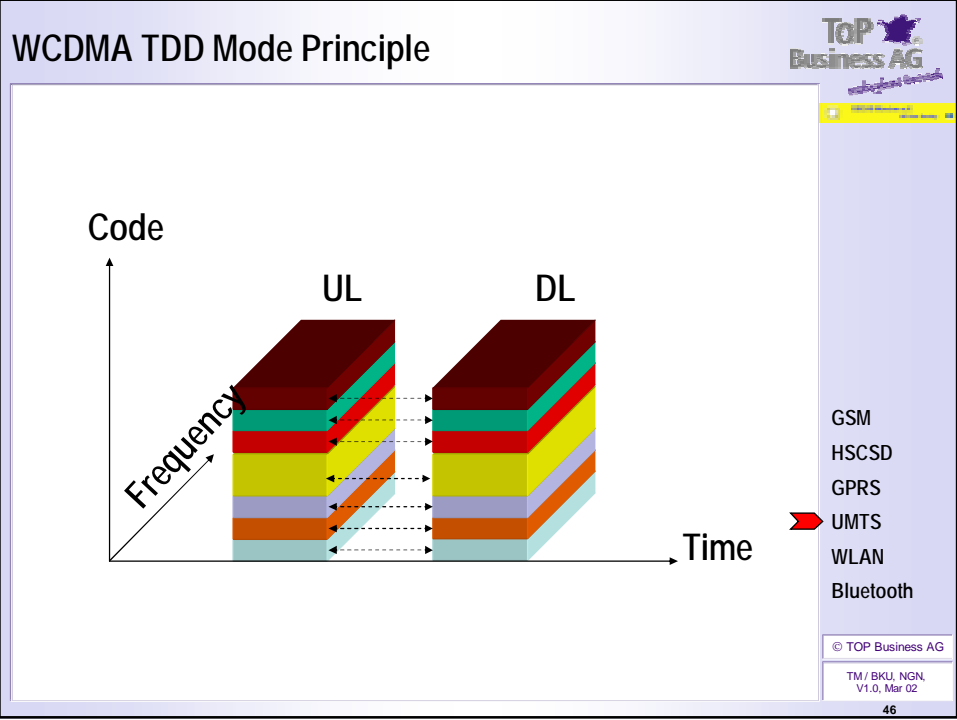
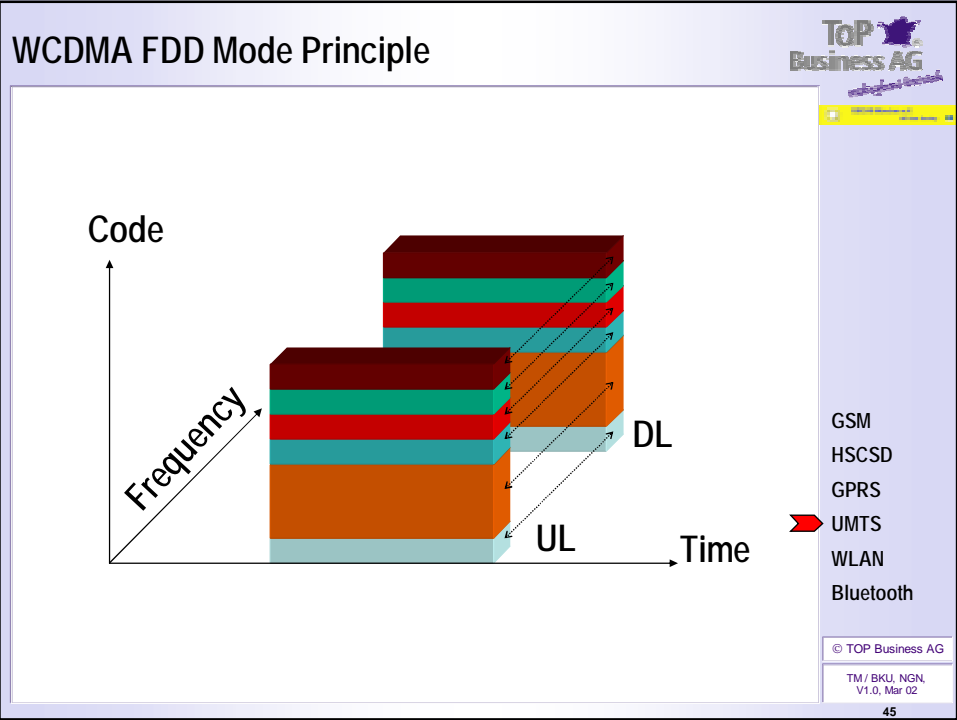
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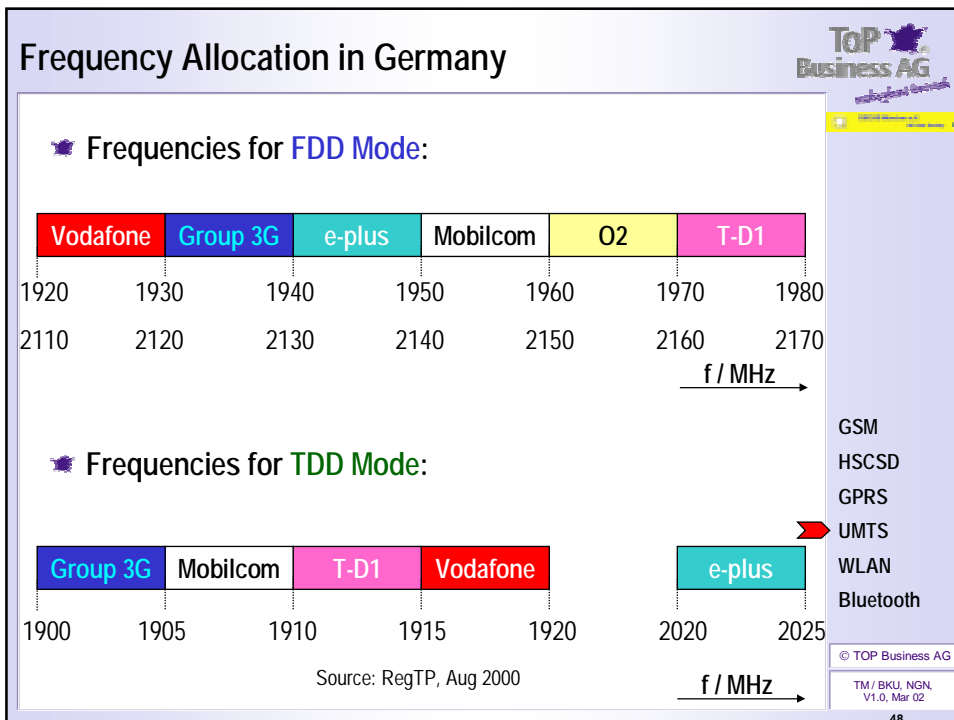
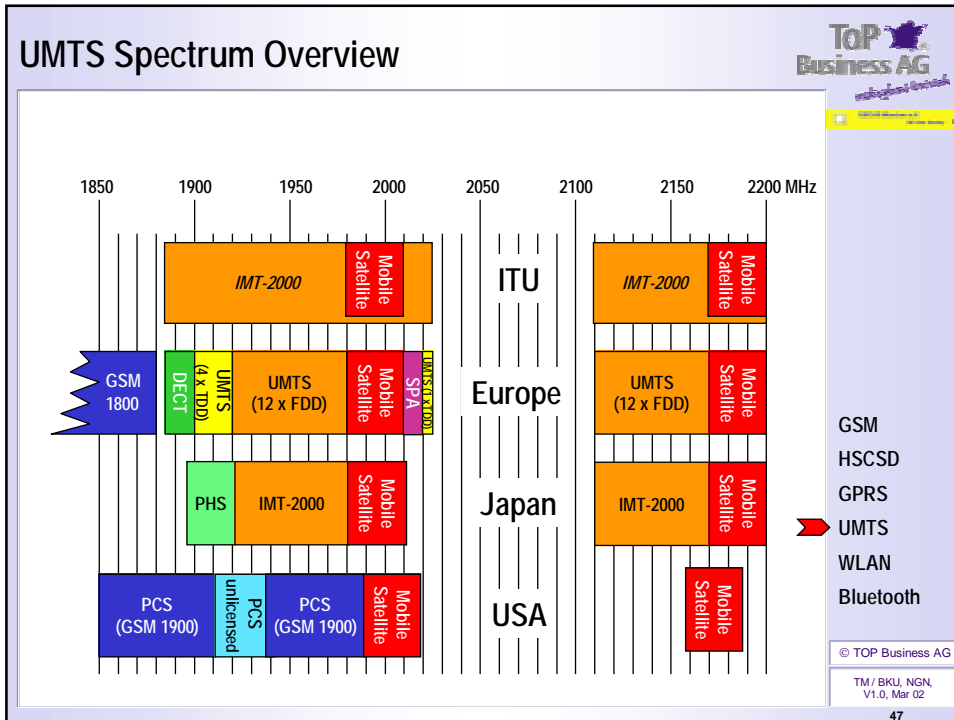
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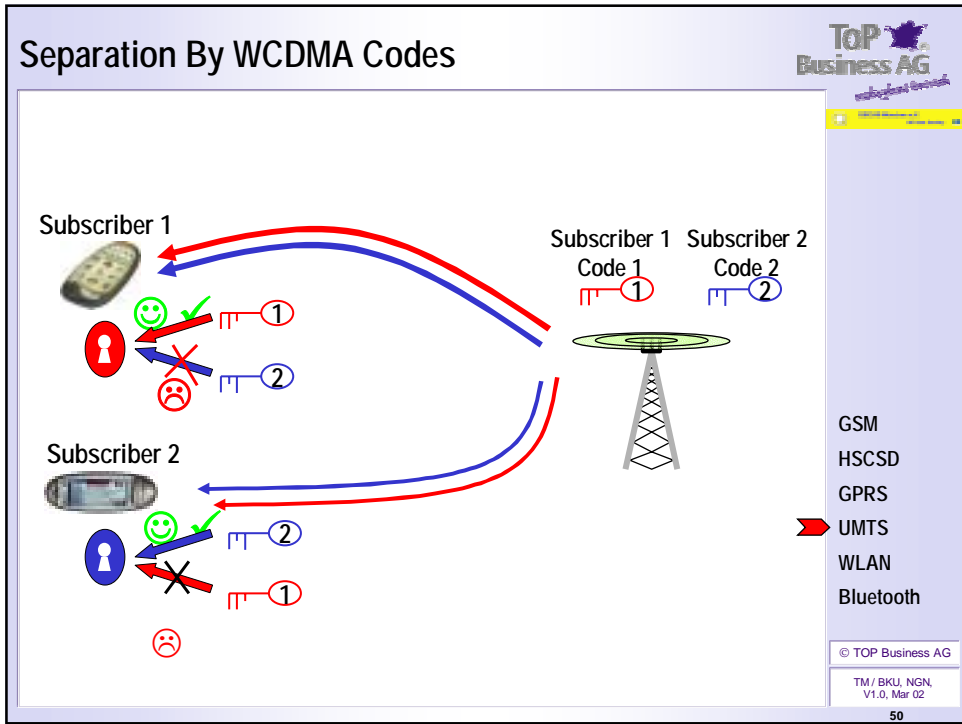
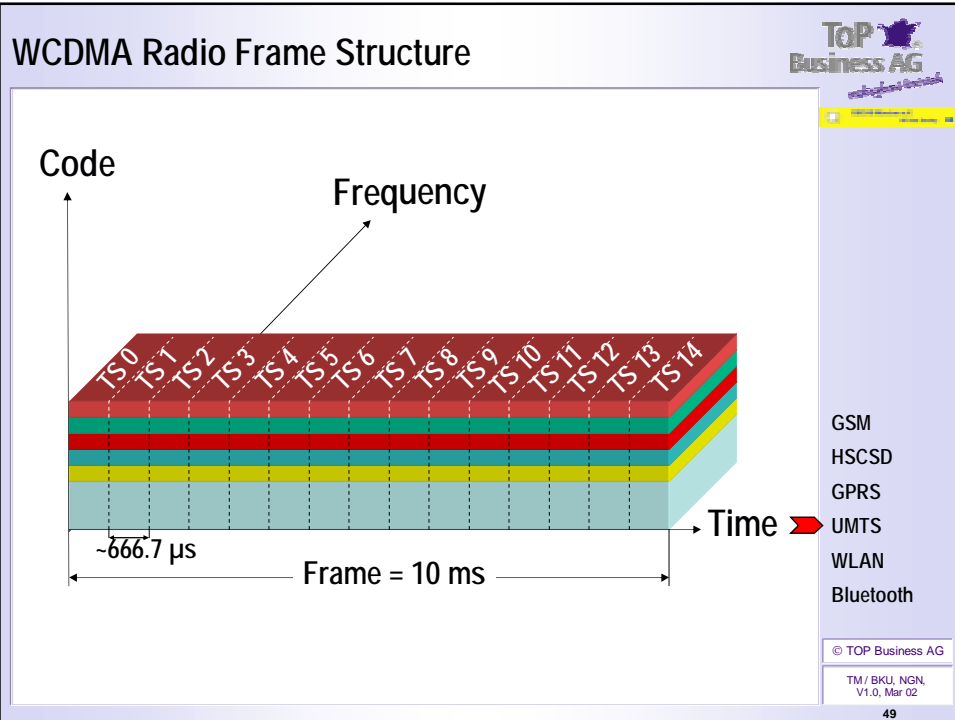
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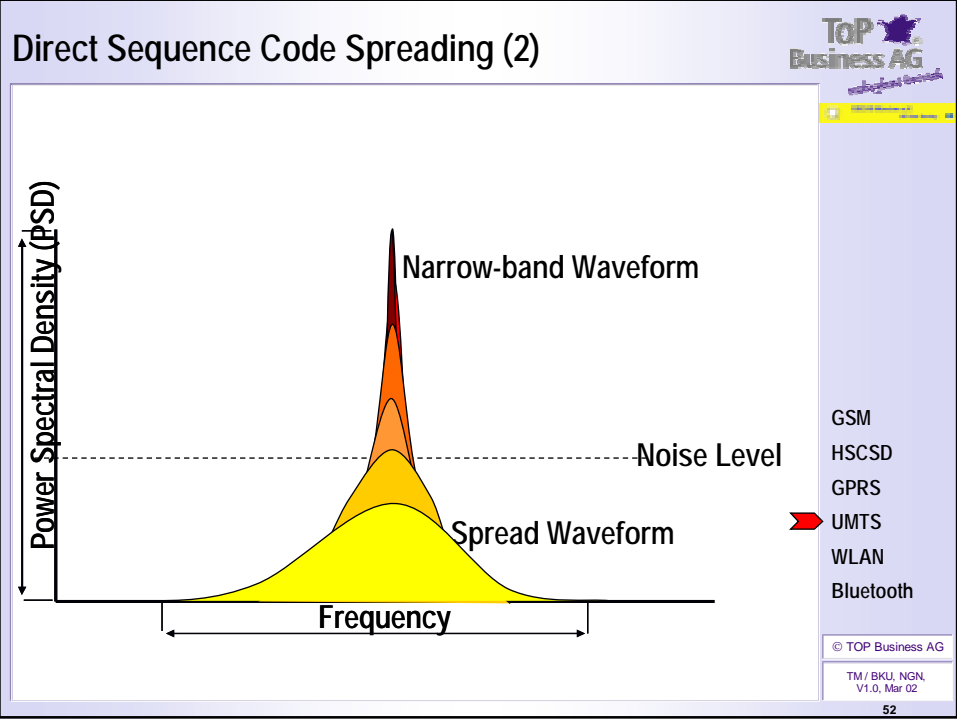
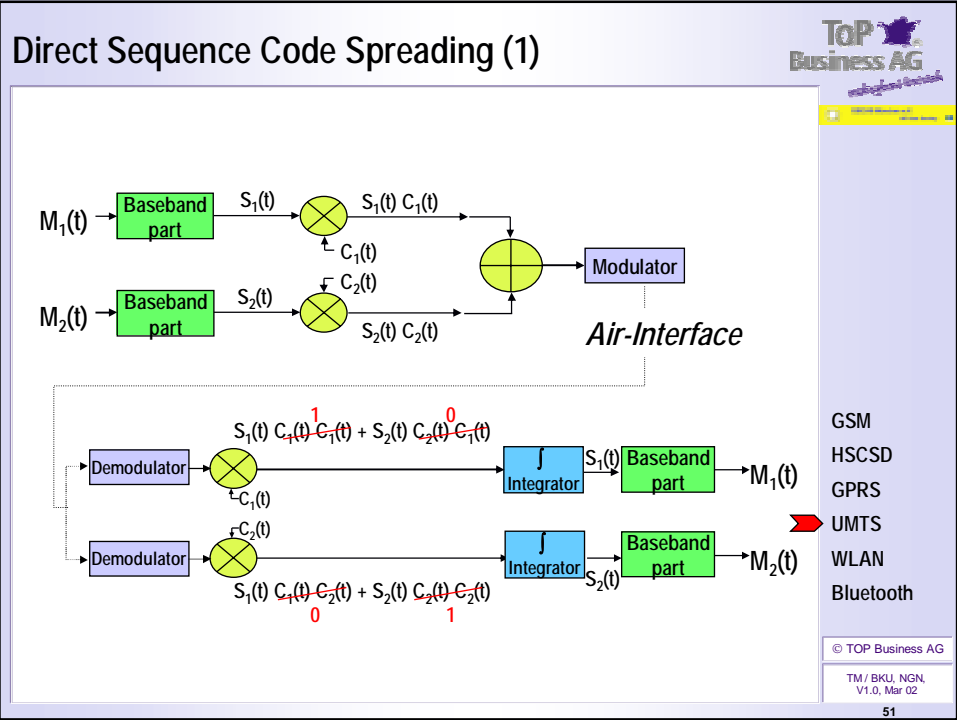
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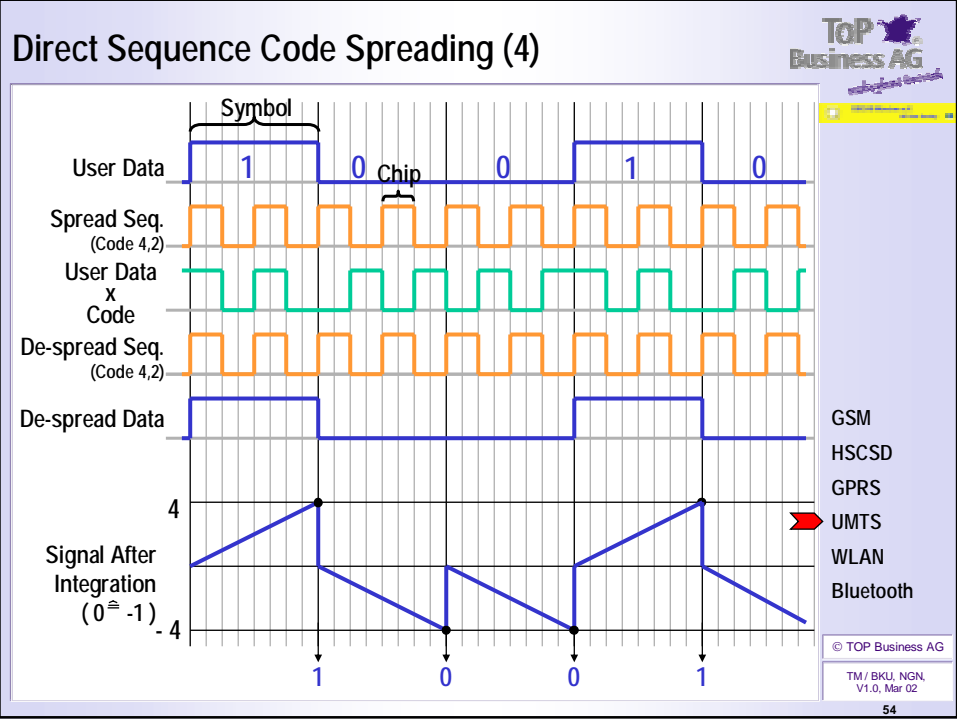
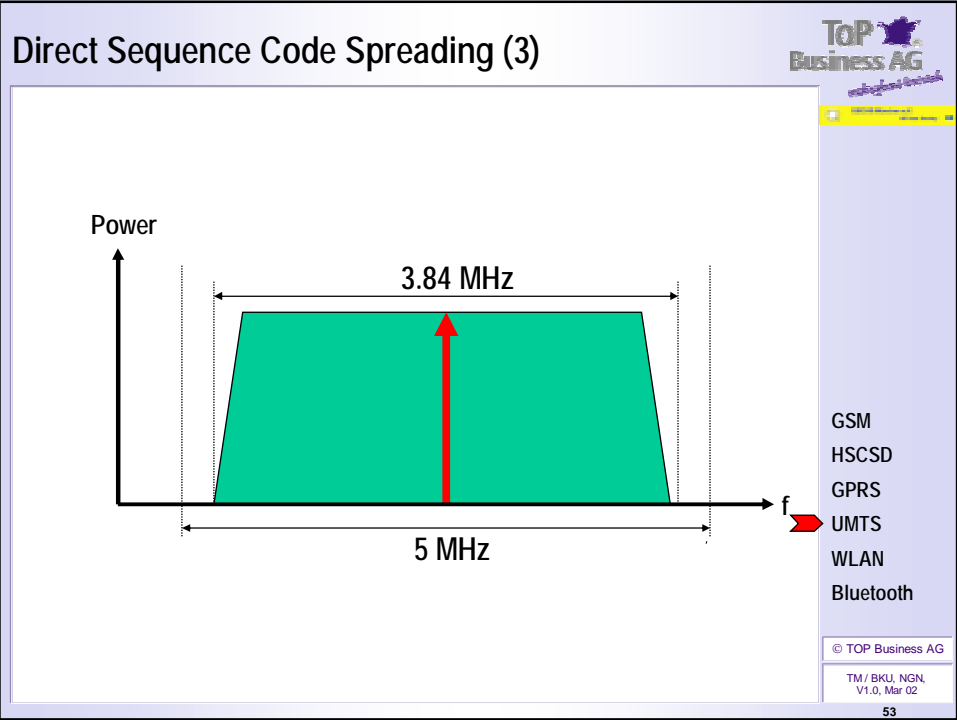


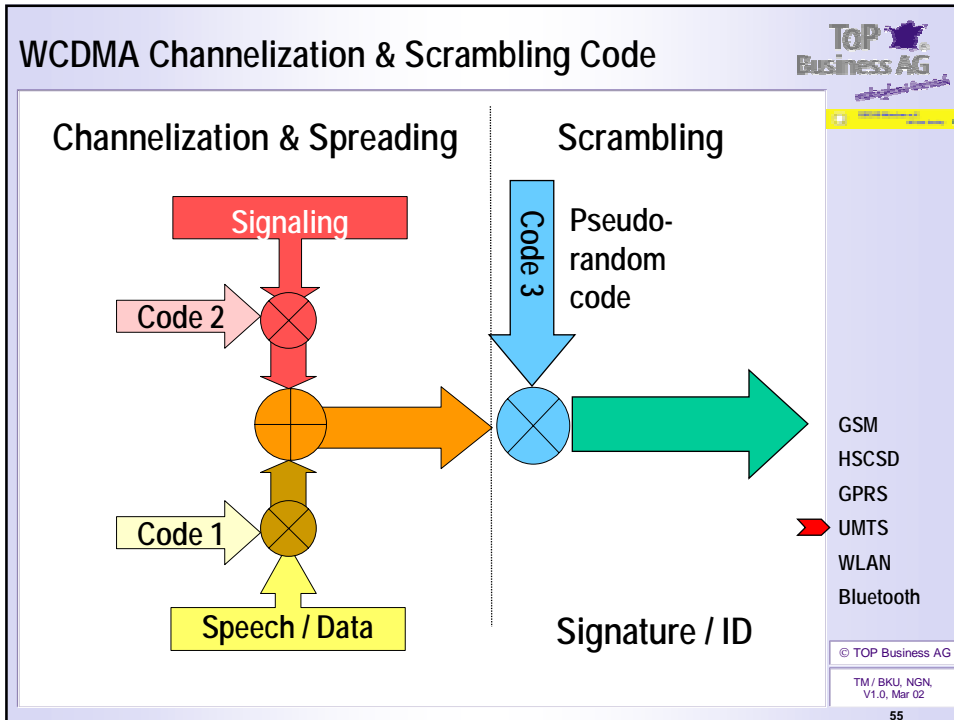












UMTS Service Capabilities

Operating Environment	Real Time / Constant Delay		Non Real Time / Variable Delay	
	Peak Bit Rate	BER / Max. Transfer Delay	Peak Bit Rate	BER / Max. Transfer Delay
Rural Outdoor (Terminal Speed up to 500 km/h)	min. 144 kbps (preferable: 384 kbps)	$10^{-3} - 10^{-7}$ / 20 - 300 ms	min. 144 kbps (preferable: 384 kbps)	$10^{-5} - 10^{-8}$ / 150 ms or more
(Sub-) Urban outdoor (Terminal Speed up to 120 km/h)	min. 384 kbps (preferable: 512 kbps)	$10^{-3} - 10^{-7}$ / 20 - 300 ms	min. 384 kbps (preferable: 512 kbps)	$10^{-5} - 10^{-8}$ / 150 ms or more
Indoor / Low Range Outdoor (Terminal speed up to 10 km/h)	2 Mbps	$10^{-3} - 10^{-7}$ / 20 - 300 ms	2 Mbps	$10^{-5} - 10^{-8}$ / 150 ms or more

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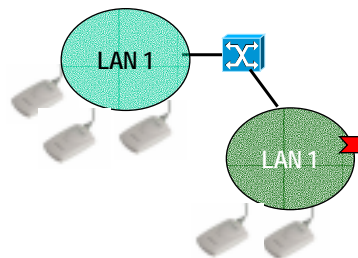
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UMTS Threat? IEEE802.11 WLAN



WLAN - The Ultimate 3G Threat

- ✦ IEEE802.11 standard available since 1997
 - 2.4GHz ISM & 5GHz band
 - Unlicensed!
 - Access points and terminals **now** available at moderate costs
- ✦ In-house coverage for UMTS-like data services
 - <11Mbps
 - <54Mbps
- ✦ Today: isolated networks
- ✦ Tomorrow: interconnected?




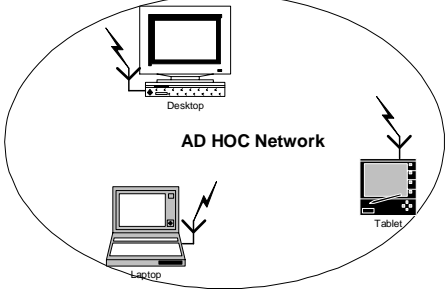
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- UMTS
- WLAN
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Ad-hoc WLAN






- ✦ LAN created solely by wireless devices themselves, with no central controller or access point
- ✦ Each device communicates directly with other devices in the network

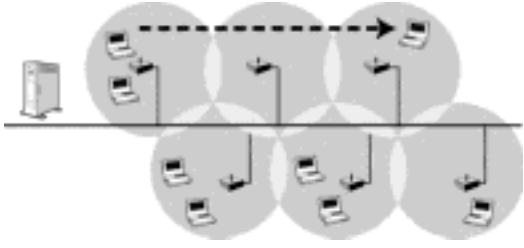
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Infrastructure WLAN





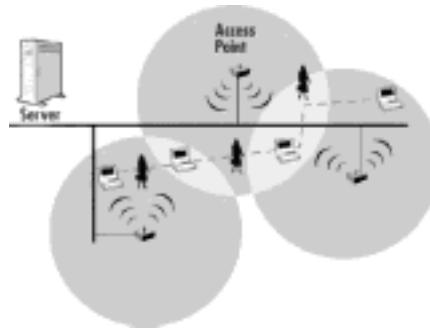
- ✦ Device traffic is managed by access point
- ✦ Carrier-sense collision-avoidance protocol is used

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Roaming WLAN



- ✦ State and location information must be moved along with the station
- ✦ Protocols to transfer this information are not defined in the standard
- ✦ Inter-Access Point Protocol (IAPP) under development for roaming and multi-vendor interoperability

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Current WLAN Implementations

- ✦ First focused on the U.S., now spreading globally
- ✦ PC cards <\$100.-, subscription fee <\$15.-/month

✦ Airwave



– www.airwave.com

✦ Mobilestar



- www.mobilestar.com
- 3000 Starbucks outlets
- Hotels in 27 U.S. states
- 16 airport lounges

✦ Wayport Inc.



– www.wayport.net

✦ Surf And Sip Inc.



– www.surfandsip.com

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WLAN Key Characteristics

	802.11	802.11a	802.11b	802.11g
Standard Approved	July 1997	September 1999	September 1999	Draft Stage Completion expected in 2000
Available Bandwidth	83.5 MHz	300 MHz	83.5 MHz	83.5 MHz
Unlicensed Frequencies of Operation	2.4-2.4835 GHz DSSS, FHSS	5.15-5.35 GHz OFDM 5.725-5.825GHz OFDM	2.4-2.4835GHz DSSS	2.4-2.4835GHz DSSS, OFDM
Number of Non-Overlapping Channels	3 (Indoor/Outdoor)	4 Indoor (UNII) 4 Indoor/Outdoor (UNII) 4 Outdoor (UNII)	3 (Indoor/Outdoor)	3 (Indoor/Outdoor)
Data Rate per Channel	2, 1 Mbps	64, 48, 36, 24, 18, 12, 9, 6 Mbps	11, 5.5, 2, 1 Mbps	64, 36, 33, 24, 22, 12, 11, 9, 6, 5.5, 2, 1 Mbps
Modulation Type	DQPSK (2 Mbps DSSS) DQPSK (1 Mbps DSSS) 4GFSK (2Mbps FHSS) 2GFSK (1Mbps FHSS)	BPSK (6, 9 Mbps) QPSK (12, 18 Mbps) 16-QAM (24, 36 Mbps) 64-QAM (48, 54 Mbps)	DQPSK/QCK (11, 5.5 Mbps) DQPSK (2 Mbps) DBPSK (1 Mbps)	OFDM/QCK (6, 9, 12, 18, 24, 36, 48, 54) OFDM (6, 9, 12, 18, 24, 36, 48, 54) DQPSK/QCK (22, 36, 11, 6.6 Mbps) DQPSK (2 Mbps) DBPSK (1 Mbps)
Compatibility	802.11	Wi-Fi	W-Fi	Wi-Fi at 11Mbps and below



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Security Issues

- ✦ Only low security mechanisms available: optional Service Set Identifier (SSID)
- ✦ Wired Equivalent Privacy (WEP) algorithm with 40-bit / 104-bit secret key for authentication and encryption
- ✦ No management protocol for key distribution defined
- ✦ 802.1x standard was developed specifically to address this issue
- ✦ Access point acts as authenticator using Remote Authentication Dial-In User Service (RADIUS) server

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UMTS - WLAN Co-existence (1)

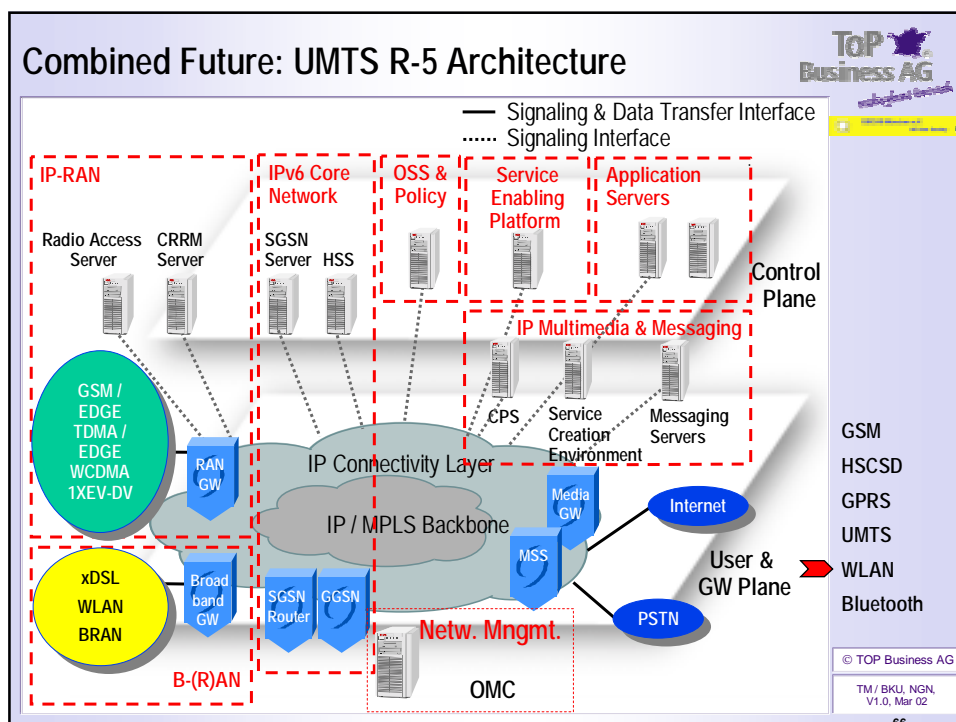
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- Coverage / Availability**
 - UMTS: rural...country-wide...regional...globally ✓
 - WLAN: hot spots
- Data Rate**
 - UMTS: <2Mbps
 - WLAN: <11...54Mbps ✓
- Commercial Availability:**
 - UMTS: year-end 2003 ✓
 - WLAN: year-end 2002 ✓
- Costs**
 - UMTS: high
 - WLAN: low ✓

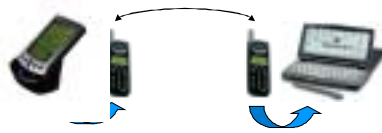
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Short Range Connectivity:



Key Features

- ✦ For voice and data transmission
- ✦ Global usage
- ✦ Low power consumption
- ✦ Based on open standards
- ✦ Very small size
- ✦ Very low cost
- ✦ Line-of-sight not necessary
- ✦ Displacement of IrDA
- ✦ Rival technology to DECT, HomeRF, IEEE 802.11
- ✦ Interference with IEE802.11!

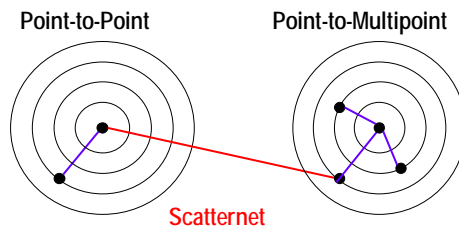
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Bluetooth Topology

- ✦ 2 topology types:
 - Piconet with a max. of 8 devices
 - Scatternet: up to 10 piconets can communicate with each other



- ✦ First device that establishes a communication acts as master and determines physical network parameter (e.g., frequency hopping sequence, synchronization)

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Radio Unit

- ✦ Spectrum: 2,402 - 2,480 MHz
- ✦ No. of used frequencies: 79
- ✦ Multiple Access: CDMA (FHSS)
- ✦ Frequency hopping rate: 1,600 sec⁻¹
- ✦ TX power: 0 dBm
 (optional range: -30 .. +20 dBm)
- ✦ RX sensitivity: -70 dBm
- ✦ Link range: 0.1 .. 10m
 (with increased TX power: up to 100m)
- ✦ Authentication: "SAFER+" Algorithm
 with 128 bit key
- ✦ Ciphering key: 8...128bits

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Connection Types

- ✦ Synchronous Connection-oriented Link (SCO)
 - P-t-P, for speech services
 - 2 sub-sequent TS used in fixed intervals
 - P-t-MP, for symmetric / asymmetric data links
 - 64kbps
- ✦ Asynchronous Connectionless Link (ACL)
 - 2 x 432.6 kbps
 - 721 + 57.6 kbps



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Bluetooth Profiles



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Finally...

More info...

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- www.topbusinessag.com
- www.business-interactive.com

Thanks a lot for Your attention...



...and further enjoy the conference!!

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