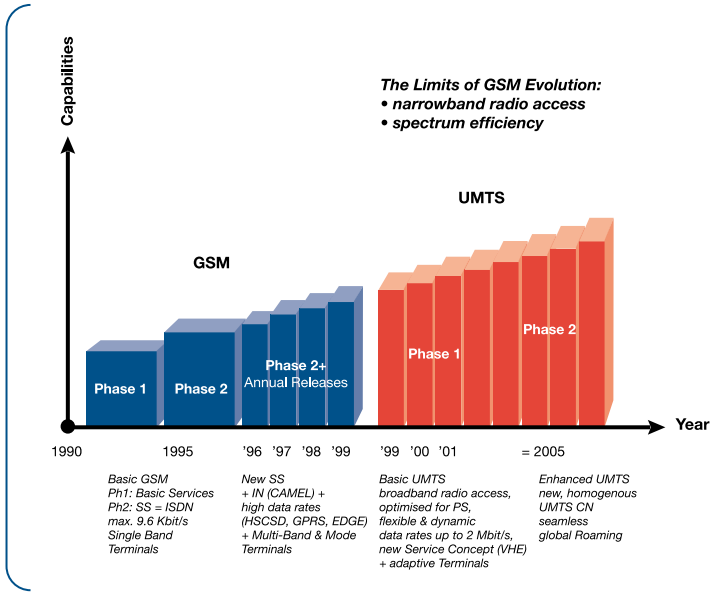


▶ ***Figure 2.*** *Evolutionary Concept*

2 UMTS network architecture

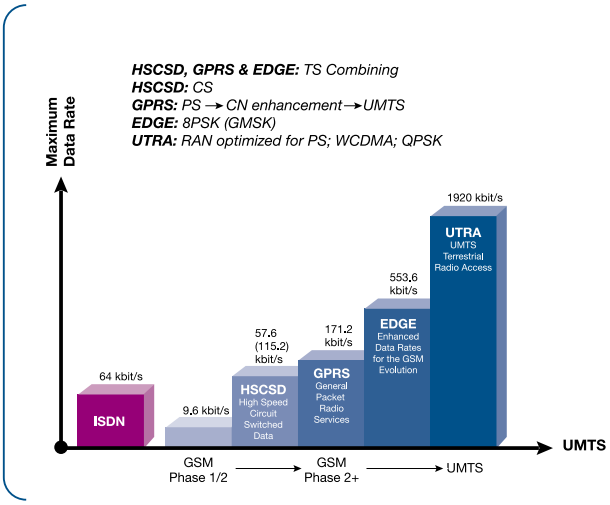
2.1 Principles

UMTS (Rel. '99) incorporates enhanced GSM Phase 2+ Core Networks with GPRS (General Packet Radio Services) and CAMEL (Customized Applications for Mobile network Enhanced Logic). This enables network operators to enjoy the improved cost efficiency of UMTS while protecting their 2G investments and reducing the risks of implementation.

In UMTS release 1 (Rel. '99), a new radio access network UTRAN (UMTS Terrestrial Radio Access Network) is introduced. UTRAN, the UMTS RAN, is connected via the Iu-Interface (Iu-PS for PS data / Iu-CS for CS data) to the GSM Phase 2+ CN.

"GSM-only" Mobile Stations (MS) will be connected to the network via the Um GSM radio interface. UMTS/GSM Dual-Mode User Equipment (UE) will be connected to the network via UMTS radio interface Uu at very high data rates (up to almost 2 Mbit/s). Outside the UMTS service area, UMTS/GSM UE will be connected to the network at reduced data rates via the Um GSM air interface.

Maximum data rates are 115 kbit/s for CS data by HSCSD (High Speed Circuit Switched Data), 171 kbit/s for PS data by GPRS and 553 kbit/s by EDGE (Enhanced Data Rates for the GSM Evolution). Handover between UMTS and GSM is supported, and handover between UMTS and other 3G systems (e.g. MC-CDMA) will be supported in order to achieve true worldwide access.



▶ ***Figure 3.*** *Transmission Rates*

2.2 The UMTS Network Architecture

The Public Land Mobile Network (PLMN) described in UMTS Rel. ´99 incorporates three major categories of network elements:

- GSM Phase 1/2 core network elements: MSC,VLR, HLR, AC and EIR
- GSM Phase 2+ enhancements: GPRS (SGSN and GGSN) and CAMEL (CSE)
- UMTS specific modifications and enhancements, particularly the UMTS Terrestial Radio Access Network (UTRAN)

2.2.1 Network Elements from GSM Phase 1/2

The GSM Phase 1/2 PLMN consists of three subsystems: the Base Station Subsystem (BSS), the Network Switching Subsystem (NSS) and the Operation Subsystem (OSS). The BSS consists of the functional units: Base Station Controller (BSC), Base Transceiver Station (BTS) and Transcoding & Rate

Adaptation Unit (TRAU). The NSS consists of the functional units: Mobile Services switching Center (MSC), Visitor Location Register (VLR), Home Location Register (HLR), Equipment Identity Register (EIR) and the Authentication Center (AC). The MSC provides functions such as switching, signaling, Paging, and Inter-MSC Handover. The OSS consists of Operation & Maintenance Centers (OMC), which are used for remote and centralized Operation, Administration and Maintenance tasks.

2.2.2 Network Elements from GSM Phase 2+

GPRS (General Packet Radio Services)

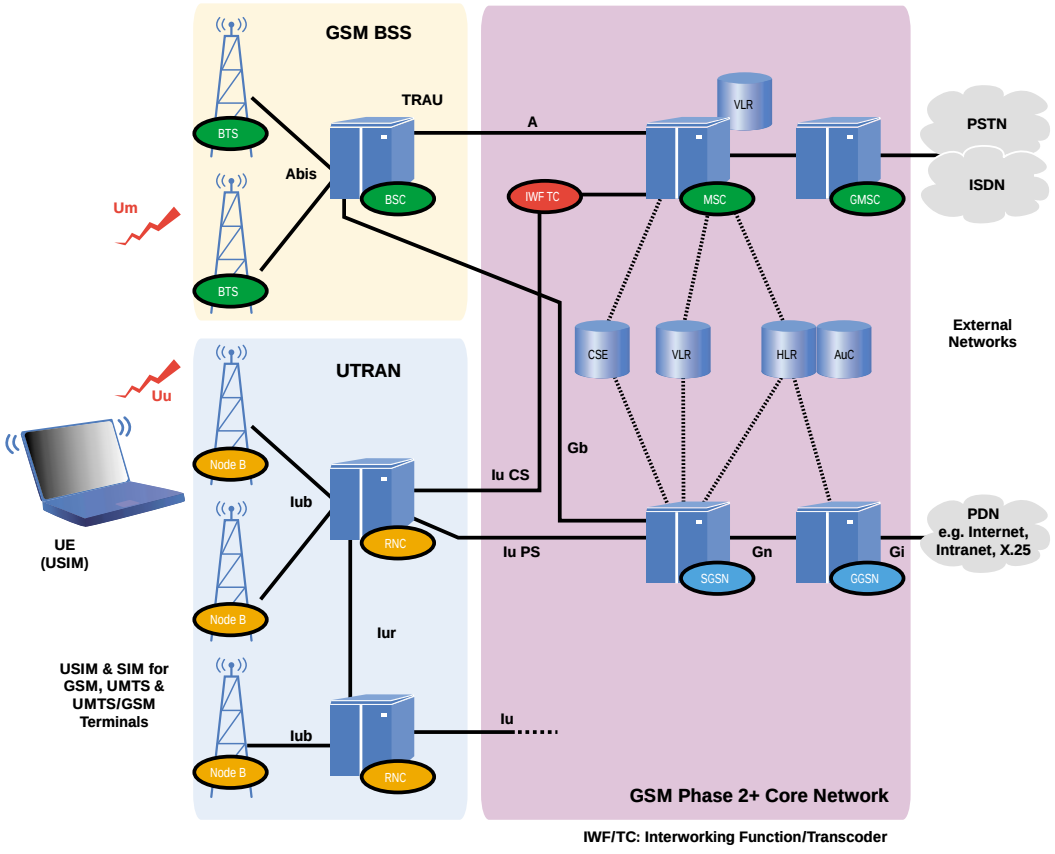
The most important evolutionary step of GSM towards UMTS is GPRS. GPRS introduces Packet Switching (PS) into the GSM Core Network and allows direct access to Packet Data Networks (PDN). This enables high data rate PS transmission well beyond the 64 kbit/s limit of ISDN through the GSM CN, a necessity for UMTS data transmission rates of up to 2 Mbit/s. GPRS prepares and optimizes the CN for high data rate PS transmission, as does UMTS with UTRAN over the RAN. Thus, GPRS is a prerequisite for the UMTS introduction.

Two functional units extend the GSM NSS architecture for GPRS PS services: the Gateway GPRS Support Node (GGSN) and the Serving GPRS Support Node (SGSN).

The GGSN has functions comparable to a GMSC. The SGSN resides at the same hierarchical level as a VMSC/VLR and therefore performs comparable functions such as routing and mobility management.

CAMEL (Customized Applications for Mobile network Enhanced Logic)

CAMEL enables worldwide access to operator specific



▶ ***Figure 4.*** *UMTS Phase 1 Network*

Intelligent Network (IN) applications such as Prepaid, Call Screening, and Supervision. CAMEL is the primary GSM Phase 2+ enhancement for the introduction of the UMTS Virtual Home Environment (VHE) concept. VHE is a platform for flexible service definition (collection of Service Creation Tools) that enables the operator to modify or enhance existing services and/or to define new services. Furthermore, VHE enables worldwide access to these operator-specific services in every GSM and UMTS PLMN and introduces Location Based Services (by interaction with GSM/UMTS Mobility Management).

A CAMEL Service Environment (CSE) and a new CCS7 protocol, the CAMEL Application Part (CAP) are required on the CN to introduce CAMEL.

2.2.3 Network Elements from UMTS Phase 1

As mentioned above, UMTS differs from GSM Phase 2+ mostly in the new principles for air interface transmission (W-CDMA instead of TDMA/FDMA). Therefore, a new radio access network called UTRAN must be introduced with UMTS. Only minor modifications, such as allocation of the transcoding function (TC) for speech compression to the CN, are needed in the Core Network to accommodate the change. The TC function is used together with an Interworking Function (IWF) for protocol conversion between the A and the Iu-CS interfaces.

UTRAN (UMTS Terrestrial Radio Access Network)

The UMTS standard can be seen as an extension of existing networks. Two new network elements are introduced in UTRAN, Radio Network Controller (RNC) and Node B. UTRAN is subdivided into individual Radio Network Systems (RNS), where each RNS is controlled by a Radio Network Controller (RNC). The RNC is connected to a set of Node B elements, each of which can serve one or several cells.

Existing network elements, such as MSC, SGSN and HLR, can be extended to adopt the UMTS requirements, but RNC, Node B and the handsets must be completely new designs. RNC will become the replacement for BSC, and Node B fulfills nearly the same functionality as BTS. GSM and GPRS networks will

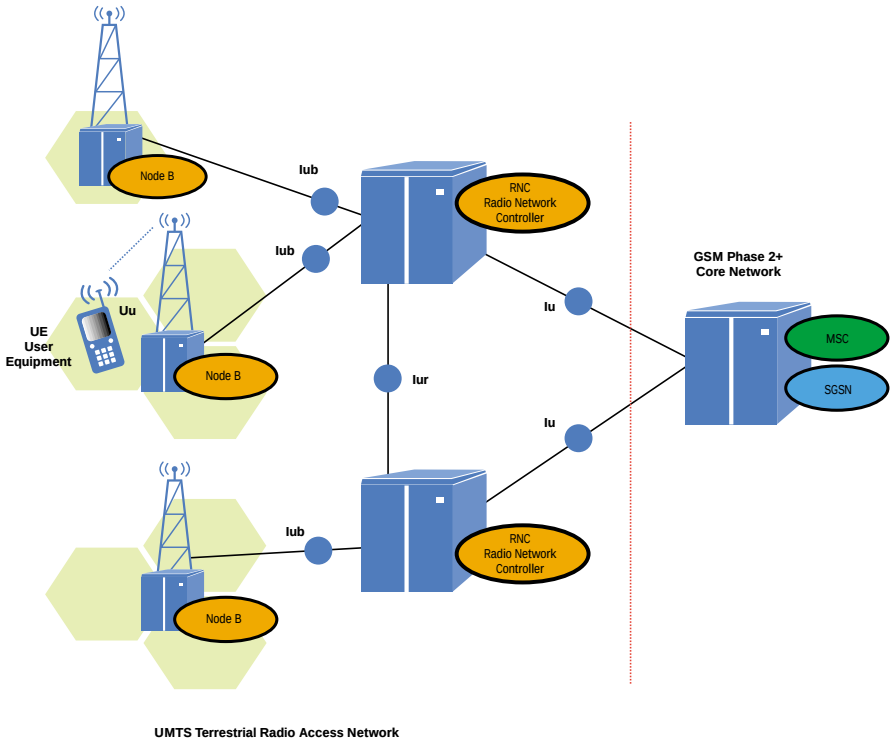


Figure 5. *UTRAN Architecture*

be extended and new services will be integrated into an overall network that contains both existing interfaces such as A, Gb, Abis and new interfaces that include Iu, Iub and Iur.

UMTS defines four new open interfaces:

- Uu: User Equipment (UE) to Node B (UTRA, the UMTS W-CDMA air interface)
- Iu: RNC to GSM Phase 2+ Core Network interface (MSC/VLR or SGSN)

  Iu-CS for circuit switched data

  Iu-PS for packet switched data.
- Iub: RNC to Node B interface
- Iur: RNC to RNC interface; not comparable to any interface in GSM

The Iu, Iub and Iur interfaces are based on ATM transmission principles.

The Radio Network Controller (RNC) enables autonomous Radio Resource Management by UTRAN. It performs the same functions as the GSM Base Station Controller (BSC), providing central control for the Radio Network System (RNS) elements (RNC and Node Bs).

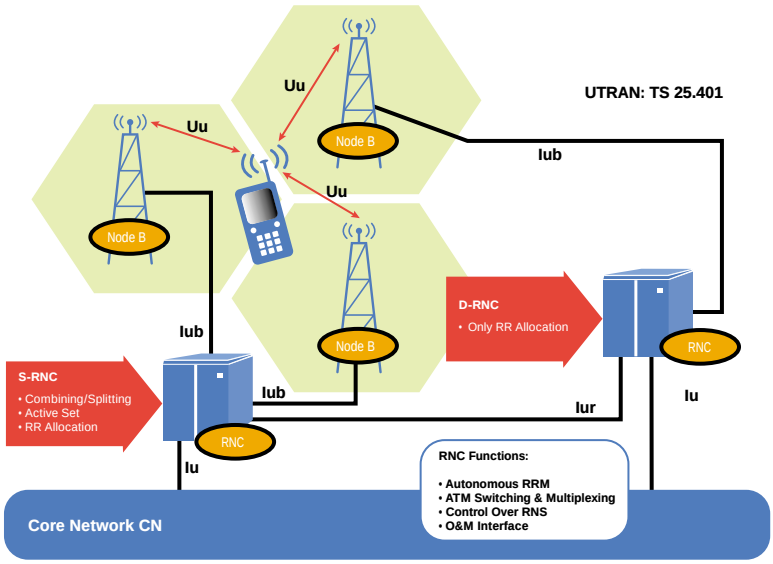
The RNC handles protocol exchanges between Iu, Iur, and Iub interfaces and is responsible for centralized Operation & Maintenance of the entire RNS with access to the Operation SubSystem (OSS). Because the interfaces are ATM-based, the RNC switches ATM cells between them. The user's circuit-switched and packet switched data coming from Iu-CS and Iu-PS interfaces are multiplexed together for multimedia transmission via Iur, Iub, and Uu interfaces to and from the User Equipment (UE).

The RNC uses the Iur interface, which has no equivalent in GSM BSS, to autonomously handle 100% of the Radio Resource Management (RRM), eliminating that burden from the Core Network. Serving control functions such as Admission, RRC connection to the UE, Congestion and Handover/Macro Diversity are managed entirely by a single Serving RNC (SRNC).

If another RNC is involved in the active connection through an Inter-RNC Soft Handover, it is declared a Drift RNC (DRNC). The DRNC is only responsible for the allocation of Code resources. A reallocation of the SRNC functionality to the former DRNC is possible (SRNS Relocation). The term Controlling RNC (CRNC) is used to define the RNC that controls the logical resources of its UTRAN access points.

Node B is the physical unit for radio transmission/reception with cells. Depending on sectoring (Omni-/Sector Cells) one or more cells may be served by a Node B. A single Node B can support both FDD and TDD modes, and it can be co-located with a GSM BTS to reduce implementation costs. Node B connects with the UE via the W-CDMA Uu radio interface and with the RNC via the Iub ATM-based interface. Node B is the ATM termination point.

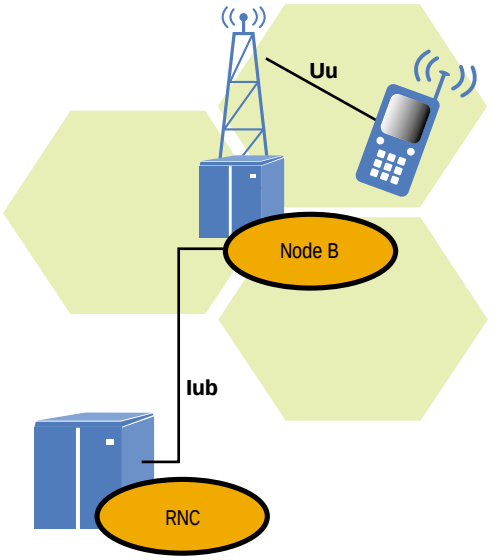
The main task of Node B is the conversion of data to/from the Uu radio interface, including Forward Error Correction FEC, Rate Adaptation, W-CDMA Spreading/De-Spreading, and QPSK Modulation on the air interface. It measures quality and strength of the connection and determines the Frame Error Rate (FER), transmitting these data to the RNC as a Measurement Report for Handover and Macro Diversity



▶ ***Figure 6.*** *RNC Functions*

Combining. The Node B is also responsible for the FDD Soft Handover. This Micro Diversity combining is carried out independently, eliminating the need for additional transmission capacity in the Iub.

The Node B also participates in Power Control, as it enables the UE to adjust its power using DL TPC commands via the Inner Loop Power Control on the basis of UL Transmit Power Control TPC information. The predefined values for Inner Loop Power Control are derived from the RNC via Outer Loop Power Control.



Physical Node
- Connected via Uu/Iub
- Support of 1/several cells
- FDD and/or TDD Mode operation

- ATM Termination (Iub)
- **Data conversion for Uu transmission**

- Inner Loop PC
- Measurement reports
- FDD: Micro-Diversity (Softer HoV)

Figure 7. *Node B Functions*

The UMTS UE is based on the same principles as the GSM MS – the separation between ME and the UMTS SIM card (USIM). The following figure shows the user equipment functions.

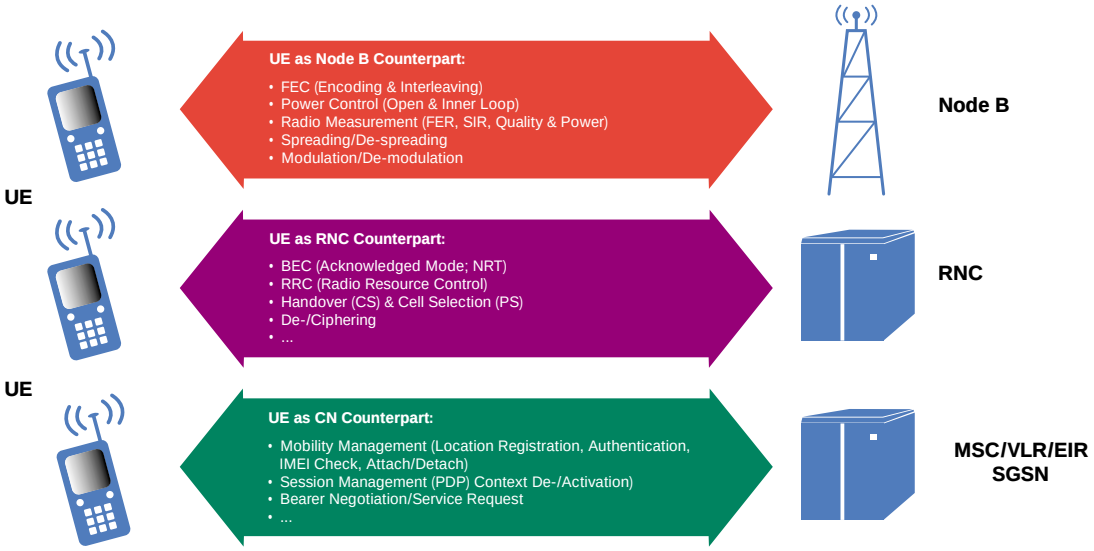


Figure 8. *UE Functions*

The UE is the counterpart to the various network elements in many functions and procedures.