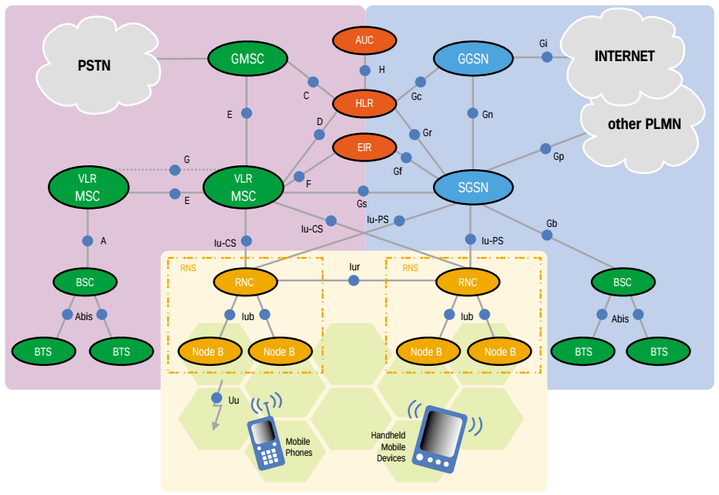
5. Appendix II – Introduction to UMTS

UMTS – Entering the Third Generation of Mobile Networks

The Universal Mobile Telecommunication System (UMTS) is one of the most significant advances in the evolution of telecommunications into the 3rd Generation of Mobile Networks. UMTS allows many more applications to be introduced to a worldwide base of users and provides a vital link between today's multiple GSM systems and the ultimate single worldwide standard for all mobile telecommunications (IMT-2000). The new network also addresses the growing demand of mobile and Internet applications for new capacity in the overcrowded mobile communications sky. UMTS increases transmission speed to 2 Megabits/s per mobile user and establishes a global roaming standard.

Standardization

UMTS is being developed by 3GPP (Third Generation Partnership Project), a joint venture of several Standards Development Organizations - ETSI (Europe), ARIB/TTC (Japan), ANSI T1 (USA), TTA (South Korea) and CWTS (China). To reach global acceptance, 3GPP is introducing UMTS in Phases and Annual Releases. The first release (UMTS Rel. '99), introduced in December of 1999, defines enhancements and transitions for existing GSM networks.



▶ ***Figure 1:*** *Overview of a UMTS network*

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 UTRAN

The GSM Phase 1/2 PLMN consists of 3 subsystems: the Base Station Subsystem (BSS), the Network Switching Subsystem (NSS) and the Operation Subsystem (OSS). The BSS consists of the Base Station Controller (BSC), Base Transceiver Station (BTS) and Transcoding & Rate Adaptation Unit (TRAU). The NSS consists of 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.

UMTS (Rel. '99) incorporates enhanced GSM Phase 2+ Core Networks as a platform, creating an entirely new network and protocol architecture with GPRS (General Packet Radio Services) and CAMEL (Customized Applications for Mobile network Enhanced Logic). The new networks will be installed as islands within the GSM Phase 1/2 landscape, enabling network operators to enjoy the improved cost efficiency of UMTS while protecting their 2G investments and reducing the risks of implementation.

The most significant change in Rel. '99 is the new UMTS Terrestrial Radio Access Network (UTRAN) that includes the UMTS Terrestrial Radio Access (UTRA), a W-CDMA radio interface for land based communications. UTRA supports Time Division Duplex (TDD) and Frequency Division Duplex (FDD).

The TDD mode is optimized for public Micro & Pico cells and unlicensed cordless applications. The FDD mode is optimized for wide area coverage, i.e. public Macro & Micro cells. Both modes offer flexible and dynamic data rates up to 2 Mbit/s.

Another newly defined UTRA mode - Multi Carrier (MC) - is expected to establish compatibility between UMTS and cdma2000.

Implementation - New Network Elements and Interfaces

UMTS standardization and development is moving very quickly, but several steps must be taken before we can enjoy global mobility at the remarkable new speeds. New network elements are being developed and adopted, while existing network nodes are being extensively modified. All of these developments require the creation and integration of new software and hardware modules that will then be manufactured, deployed, commissioned and operated.

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 single 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 requirement, 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 a BTS. GSM and GPRS networks will 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 for the total 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 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. The term Controlling RNC (CRNC) is used to define the RNC that controls Node Bs.

Node B is the physical unit for radio transmission/reception with one or more cells. A single Node B can support both FDD and TDD modes, and it can be co-located with 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. It measures the 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 Combining.The Node B is also responsible for the FDD Softer 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 achieved from the RNC via Outer Loop Power Control.

New Technology - New Testing Challenges

From the technology standpoint, testing UMTS interfaces presents a new set of challenges. UMTS networks are based on the integration of ATM, IP and Mobile Network technologies. ATM brings "unlimited" bandwidth and QoS limits, IP brings "unlimited" coverage, and Mobile Network brings "unlimited" mobility. In addition, UMTS will use CDMA as the air interface technology, introducing different signaling procedures and different control signal levels than those found in GSM and GPRS networks.

Almost every ATM transmission speed from two Megabits/s up to STM4 (622 Megabits/s) is defined for UMTS. Moreover, ATM has been designed to support these speeds at specified quality of service (QoS) levels for traffic with guaranteed delays, losses and error rates. Constant bit rate (CBR) and variable bit rate (VBR) data streams are assigned to VPI/VCI virtual channels to achieve the required bandwidth. It is possible for a single connection to occupy the entire physical bandwidth of a virtual channel, or even require hundreds or thousands of virtual channels with smaller bandwidths.

ATM Adaptive Layers AAL2 and AAL5 protocols are the assembly and reassembly mechanisms used within UMTS networks. AAL5 is primarily used for packet data connections and signaling traffic, while AAL2 with its sub-channels is used for voice and real time applications. Another issue for testing is that AAL2 and AAL5 connections can occur simultaneously in the same physical link.

While ATM provides virtual channels with QoS using either AAL2 or AAL5 protocols; IP distributes almost all applications over the network using hundreds of different application protocols. From the testing point of view, IP (at least IPv4) doesn't care about bandwidth or transmission quality. IP routes the carried information to each destination independently, regardless of where it is in the world. The challenges of testing IP are the large amount of data and the variety of application protocols that it carries.

The UMTS enabled network is being grown from islands within the GSM landscape to full coverage during the next 10 years. Therefore, cross network services must be managed by signaling protocols along with the UMTS specific services. For example, signaling must handle UMTS originated and GSM terminated calls without interrupts. Protocol interactions across the networks and inter-system handover are challenging tasks in the testing of mobility and call control.

During the life cycle of UMTS, one of the most important aspects is quality management. Protocol Testers such as the K1297 help to shorten the development time, increase product quality and maintain the UMTS network. These instruments are essential partners for manufacturers and operators who are phasing into 3G mobile networks.

The K1297 Protocol Tester always refers to standardized UMTS interfaces. It treats the System Under Test (SUT), whether a single network node or a sub-network, as if it were a black box. In both "*Monitoring*" and "*Simulation* & *Emulation*" modes, the tester compares the digital data streams that appear at the interfaces with those defined in the standard.