An overview of the 3G network

UMTS can in many aspects be looked upon as an extension to GSM and GPRS. The greatest changes are related to the access part of the network. The access network, called UMTS Terrestial Radio Network (UTRAN), consists of base stations and base stations controllers.

The base stations are called *Node B*. A Node B can support FDD mode, TDD mode or dual-mode operation. Several base stations are managed by a Radio Network Controller (RNC). The RNC is responsible for the Handover decisions that require signalling to the UE.

A logical view of the network is shown in Figure 1. *Iub* is the interface between an RNC and a Node B. *Iur* is the logical interface between two RNCs. Logically, Iur represents a point-to-point link between RNCs, however the physical realisation may not be a point-to-point link. *Iu* is the interconnection point between an RNC and the 3G Core Network.

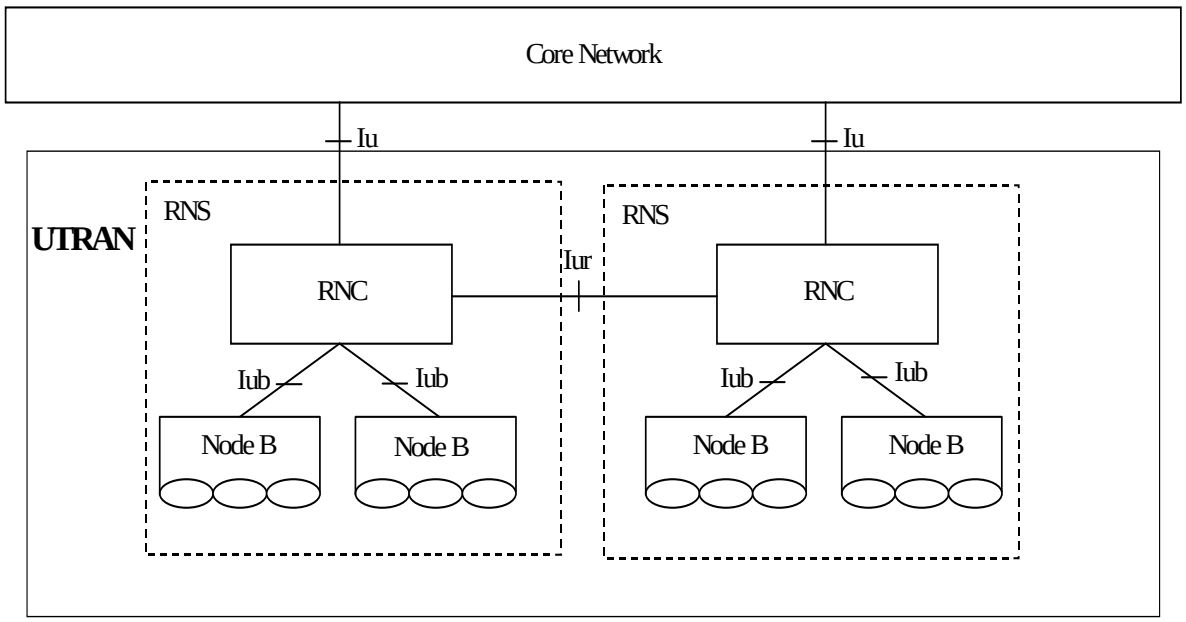

Figure 1: Logical view of UTRAN.

Figure 2 shows the protocol architecture for the lower layers of the mobile station. From the figure we can identify more general parts of a protocol stack, the physical and MAC layers and the link layer, called RLC.

In the link layer, there are several RLC blocks, indicating the multiplicity of actions that can simultaneously take place in a 3G mobile: speech, file-transfer, video etc. each requiring its own protocol. Further a block named RRC is shown in Figure 2. This block has a central role in the system; its general task is to manage a lot of functions for the mobile phone. See a separate paper describing these functions. The functionality contained in RRC belongs to the so-called signalling part of the protocol architecture. This name is to some extent reminiscence from classical telephone systems where signalling meant the procedure that should be done during e.g. communication set-up.

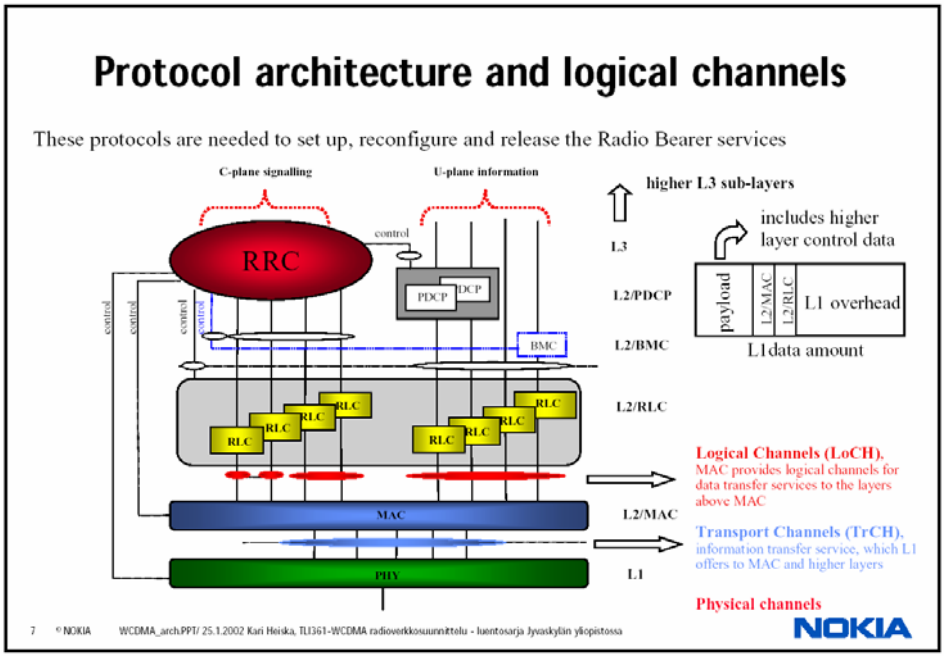

Figure 2. Protocol architecture for the mobile station. RRC – Radio Resource Control; RLC – Radio Link Control; PDCP – Packet Data Convergence Protocol; BMC – Broadcast/ Multicast Control

Besides the control-plane, Figure 2 also contains the User-plane (U-plane), which is where the protocols for the various applications are implemented. This is further illustrated in Figure 3. This figure also shows blocks related to the same sphere of work as RRC, for example MM, taking care of mobility functions. Also, you recognize H.324 belonging to the H.323 series of protocols. In Figure 4, the boxes from "Driver" and above are in the NAS (Non Access Stratum) part of the protocol stack.

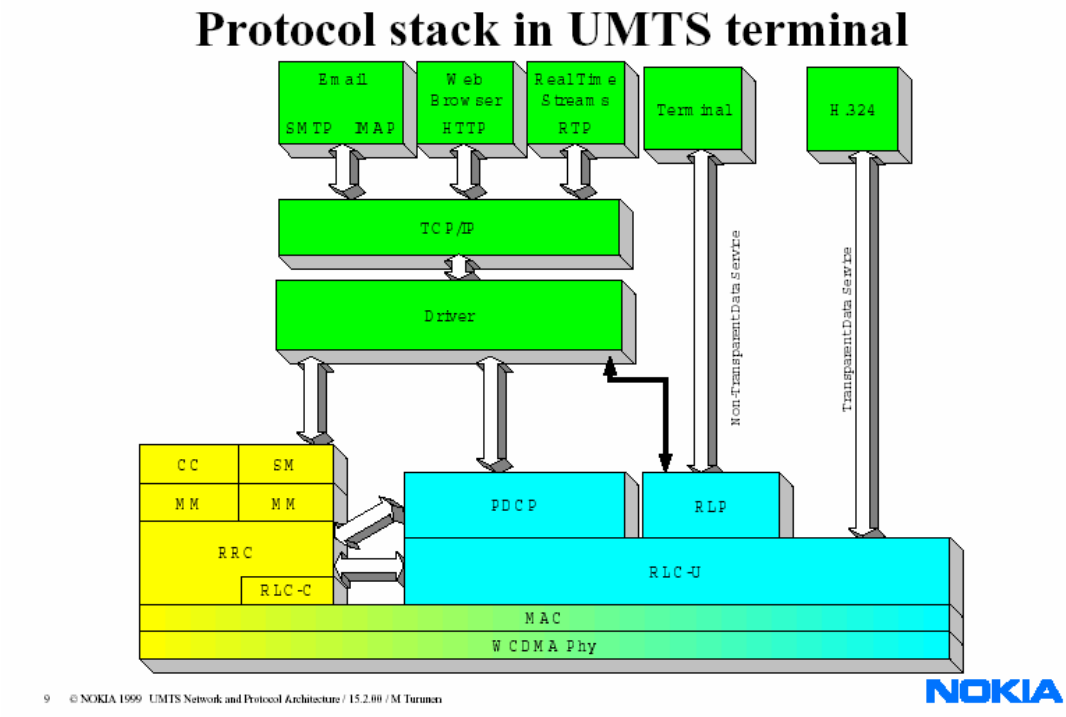

Figure 3: Protocol stack för the user plane.

Description of 3G architecture: User Equipment

The 3G system consists of two main parts: the User Equipment (UE) and the UMTS Terrestrial Radio Access Network (UTRAN). The UE is the mobile phone and the UTRAN is the base station and the network intelligence. Both the UE and the UTRAN are composed of different layers. The four lowest layers are: the physical layer (PHY), the Medium Access Layer (MAC), the Radio Link Layer (RLC) and the Radio Resource Layer (RRC). This text will provide a general description of the UE and the function of the different layers with the focus on the RRC layer since this is the only layer involved in the assignment.

Layers

The RRC layer is the highest layer in the protocol stack and it handles most of the decisions and supervisory functions. Below follows a sample of the functions:

- Broadcast of information.
- Establishment, maintenance and release of an RRC connection between the UE and UTRAN.
- Establishment, reconfiguration and release of Radio Bearers.
- Assignment, reconfiguration and release of radio resources for the RRC connection.
- RRC connection mobility functions.
- Control of requested Quality of Service.
- UE measurement reporting and control of the reporting.
- Outer loop power control.
- Control of ciphering.
- Paging
- Initial cell selection and cell re-selection.
- RRC message integrity protection.

The RRC layer dynamically establishes and releases logical communication channels (Transport Entities), which is used by the various services in the UMTS network. It controls the parameters available, for example: bit rate, level of retransmission and coding scheme. It can give commands to each of the other layer through separate communication channels.

The RLC layer is the layer below the RRC in the protocol stack and it is focused on the actual data transfers. Below follows a sample of the functions:

- Segmentation and reassembly.
- Padding.
- Error correction.
- In-sequence delivery of upper layer Packet Data Units (PDU:s).
- Duplicate detection.
- Flow control.
- Sequence number check.
- Protocol error detection and recovery.
- Ciphering.

The RLC is responsible for retransmission, segmentation and reassembly. This layer contains the transport entities, which are created and deleted dynamically in pairs as services are established or released. One transport entity handles the incoming traffic and the other handles the outgoing traffic.

The MAC layer is responsible for the handling of the logic channels and most of the priority and multiplexing issues. The functions of MAC include:

- Mapping between logical channels and transport channels.
- Selection of appropriate Transport Format for each Transport Channel.
- Priority handling between data flows of one UE.
- Multiplexing/demultiplexing of upper layer PDU:s into/from transport blocks delivered to/from the physical layer on common transport channels.
- Traffic volume measurement.
- Transport Channel type switching.
- Ciphering for transparent mode RLC.

The MAC layer handles the timing of the packet releases and the adding of transport entity addresses on the outgoing traffic. The received traffic is sent to the corresponding transport entity via the MAC layer, which reads the address and removes it.

The physical layer takes care of coding, interleaving and the adding of CRC to the packets. Some of the features of the physical layers are:

- Error detection on transport channels and indication to higher layers.
- Encoding/decoding of transport channels.
- Modulation and spreading/demodulation and despreading of physical channels.
- Frequency and time (chip, bit, slot, frame) synchronisation.
- Radio characteristics measurements and indication to higher layers.
- Inner - loop power control.
- Radio frequency processing.

The Physical layer administrates all radio communication. It handles power control, modulation and measurements.

The UMTS protocol stack is an enormous project with specifications involving thousands of pages. Therefore the stack used in this project is a much smaller version with a limited amount of features. However, even it is reduced with the ambition to be true to the original standard, the system is more likely to give a picture of the principle behind the standard than an accurate description of it.