Physical Demonstrator Architecture for VIRTUOUS Experiments

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The goal of the VIRTUOUS (Virtual Home Environment on Satellite) project is to show ability to integrate three systems for mobile communication: GPRS, Terrestrial-UMTS and Satellite-UMTS. The integration will be evaluated executing three experiments: QoS guarantee provision, Inter-segment roaming and End-user service experiment, in the integrated system. This paper describes how the demonstrator has been designed and how the experiments will be realised.

I Introduction

The aim of the IST VIRTUOUS project is to study and define a smooth migration path from 2nd to 3rd generation communication systems. In order to do this, the project envisages the integration, in a single system, of a 2nd generation communication system (GPRS) with two other 3rd generation systems, i.e. T-UMTS and S-UMTS. The facilities of an integrated system will be demonstrated by three experiments.

This paper describes the VIRTUOUS demonstrator architecture, paying particular attention to the experiments which are foreseen. For each one of them, a general description of its architecture is discussed, and the structure of the protocol stack is given.

II VIRTUOUS Demonstrator Architecture

The VIRTUOUS demonstrator architecture (fig. 1) is composed by one User Equipment (UE), three access segments, GPRS and S/T-UMTS, and by 2/3G parts of the core network (CN).

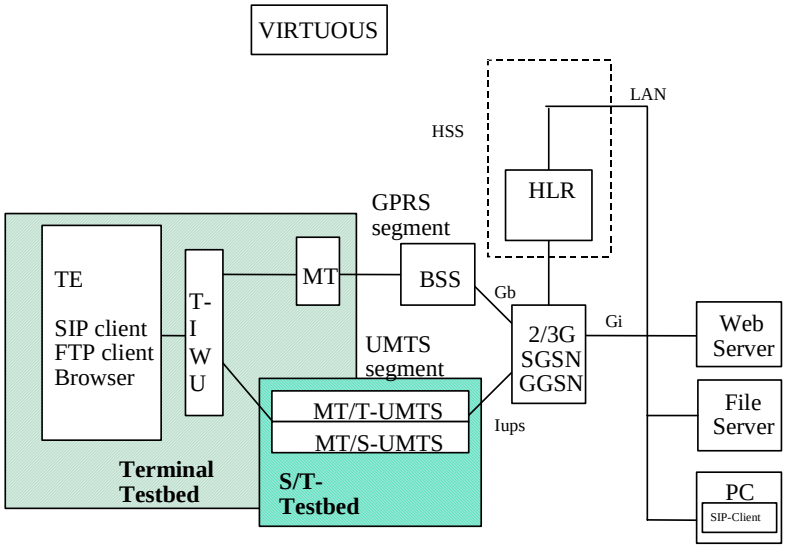

Figure 1 - Demonstrator Architecture

From a hardware point of view the overall demonstrator looks always the same, but the different configurations are established at the beginning of each trial by changing some control parameters of configuration interfaces. The demonstrator consisting parts are described in the following.

II.1 Multi-mode Mobile Station

The multi-mode mobile station is composed of several elements (figure 2):
- Terminal Equipment (TE) supporting the applications,
- three different Mobile Terminals (MTs), corresponding to different radio access technologies
- Terminal Interworking Unit (T-IWU) performing adaptation functions between TE and MTs.

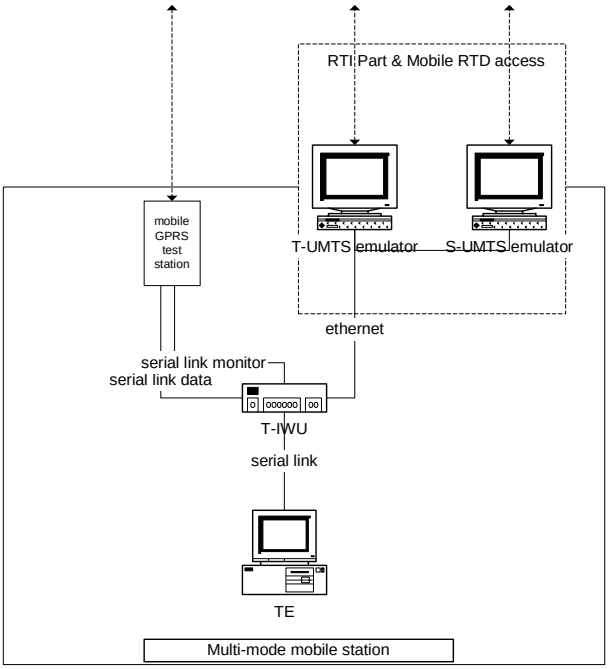

Figure 2 - Physical description of the multi-mode mobile station

It is assumed that the GPRS MT is the Siemens Mobile Test equipment having 2 serials communication ports. One is used for monitoring the GPRS mobile set and network status, and the other one to transfer data between the local TE and a distant TE. Further, the S/T-UMTS emulators are workstations. They can be connected on an Ethernet bus, so that T-IWU needs a single Ethernet port coaxial or RJ45.

II.2 Access Network

The access network of an integrated system will be demonstrated using the constellation presented in figure 3. On PCs with linux operative system, the Access Stratum protocol layers of MTs will be implemented – Mobile Terminal Function Assembly (MTFA) and User Equipment Function Assembly (UEFA). These parts will be connected to the Non-Access Stratum parts via Ethernet, both on satellite and terrestrial sides. On the other side RS232 interfaces connect MTFA and UEFA with physical link emulator, also in both segments, satellite and terrestrial. The same situation is between physical link emulator and Gateway Function Assembly (GWFA) and Base Station Function Assembly (BSFA). Further, these parts are connected with Non-Access Stratum protocols via Ethernet. Non-Access Stratum protocols are in this case RRC and RANAP. They are over Iu IWU connected to the core network, which interfacing part is 2/3G SGSN. The necessary Iu IWU functionality will be provided by protocol tester TK1287.

III VIRTUOUS Experiments Architecture

The following experiments are foreseen:
- *Quality of service experiment*: tests the capabilities of the VIRTUOUS system in providing contracted resources, assuring to each connection a fraction of total resources as defined at the beginning of the connection.

- *Inter-segment roaming experiment*: checks the capability of a MT to perform the choice of the most suitable segment among the three available. The choice is taken according to their status and to a particular selection algorithm.
- *End-user service experiment*: verifies that the system is able to perform connection set-up/release from/to a MT and that the attractive new services can be provided in an integrated system. For this purpose at least one called/calling SIP phone and/or PC is included to perform the information exchange and to set-up the connections.

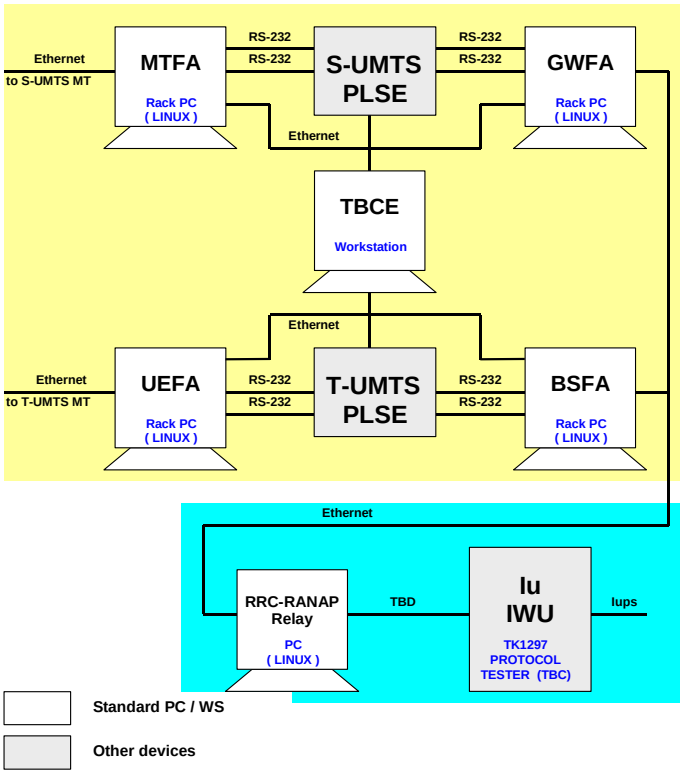

Figure 3 – S/T-URAN Testbed Architecture

III.1 QoS Experiment

Figure 4 depicts the VIRTUOUS demonstrator configuration chosen for the QoS experiment. The attention is limited to the radio access part and is focused on the access stratum part of the UMTS architecture. As a consequence, all CN parts are not foreseen to be included in this experiment.
In the QoS experiment the utilization of different real applications for VoIP, web browsing and file transfer will be investigated. These applications will be running on two PCs, connected to the depicted architecture via two Ethernet links, representative of the terminal equipment from user side and of the called user, interacting with the mobile user of interest, from the network side. The utilized programs for this trial are completely standard applications. This insures the test of the efficiency of the included mechanisms in a real operation. The different machines/PCs are connected via Ethernet links, utilizing sockets to establish a path for data transfer between different parts of the wanted architecture.
The test of the included congestion control and QoS adaptation mechanisms will be executed using more applications running in parallel on the two end-point computers. To distinguish the IP datagrams belonging to different data flows a software module will monitor the TCP port utilized by the socket for the extraction and separation of the flows of different active connections. Based on the sender/receiver addresses the mapping IP datagram-connection is performed ensuring a differentiated treatment to each flow tailored on the specific needs of the active application.

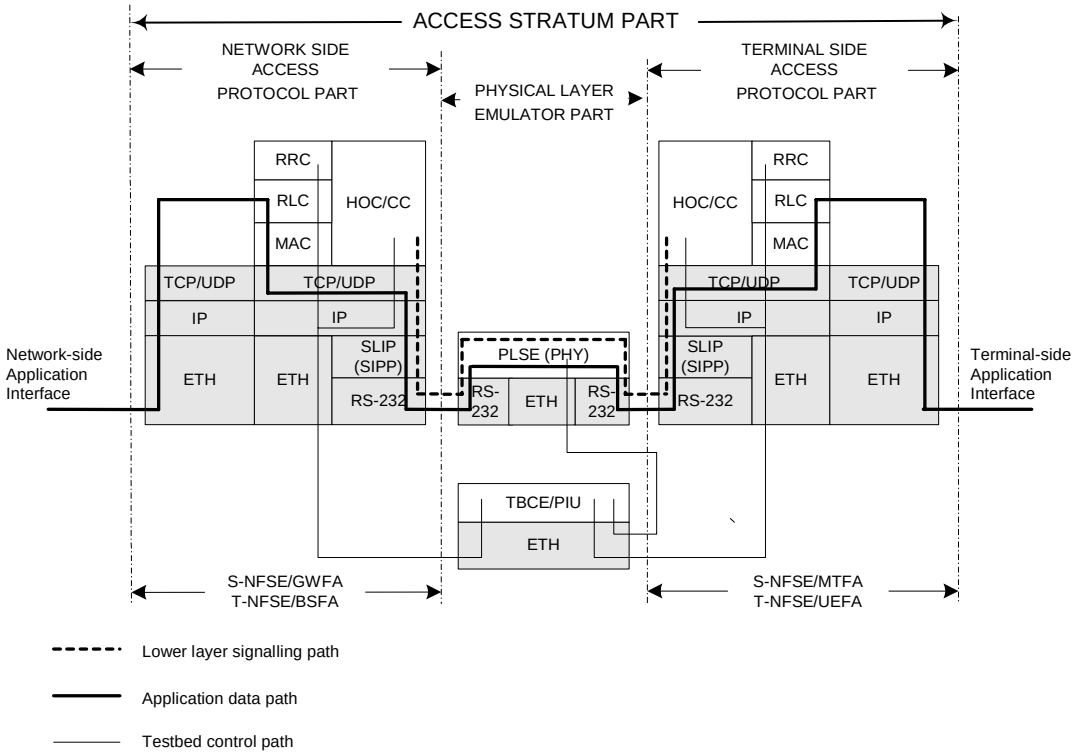

Figure 4 Access stratum protocol architecture for the QoS Experiment

III.2 ISR Experiment

The necessary functions for the performance of the ISR have been investigated and the following functions have been resulted as the minimal required ones:

1. RRC Connection: This is the most easy realizable function for the NAS and RRC signaling between MT and URAN. The ISR messages can be exchanged over this connection.
2. Measurement: Receiving state of the radio segment has to be observed by each MT of the UE.
3. Mapping function: Measured values of MTs have to be mapped into the absolute values that are comparable by the connected T-IWU, where the T-IWU decides the ISR initiation through the mapped values. This function should be different by each MT since each radio segment uses different radio access technology.

The design of the ISR experiment is shown on figure 5. The TCP/IP connections between the test-bed and RRC layers in MTs and RANs will be established during the initial phase, i.e. before the demonstration of the ISR experiment. Through these connections the measurements of the radio signal in each radio segment will be transmitted to the RRC and further to the MM (Mobility Management) layer that is responsible for the mapping of the measured values and interworking with the T-IWU. The MM should collect the coming radio strength values and periodically make the mean values from these. The mean values should be compared with thresholds that has been saved in MMs of each MT according to the characteristic of each radio segment. Only decision for the state of the radio segment is sent to the T-IWU. In the case of ISR signaling, the RRC connection request message is sent to the URAN over the TCP/IP connection established before and let the URAN prepare to receive the NAS signaling. By receiving the confirm message for it, the ISR signaling is to perform over the mentioned TCP/IP connection. Through the usage of the TCP/IP connection as the RRC connection, the procedure for the performance of the frame in the layers below, i.e. encapsulation of the message, is not more necessary and instead of this the message could be directly transmitted.

III.3 End-User Service Experiment

The main focus of the end-user service experiment is to demonstrate typical end-user in an integrated GPRS/S-UMTS/T-UMTS service area. The experiment shows the VIRTUOUS demonstrator as an integrated functional miniature GPRS/S-UMTS/T-UMTS network from an end-user point of view.

The VIRTUOUS end-user services may be regarded as applications on top of a full multi-service IP connectivity system, which comprises 3 segments (GPRS, T-UMTS, S-UMTS). Several end-to-end IP bearers with different QoS have to be used between the Terminal Equipment (TE) of the terminal testbed and hosts and servers in a LAN environment.
The following end user services are considered in the VIRTUOUS project:

- SIP based telephony (conversational class)
- Web browsing (interactive class)
- File transfer (background class)
- Streaming video (streaming class)

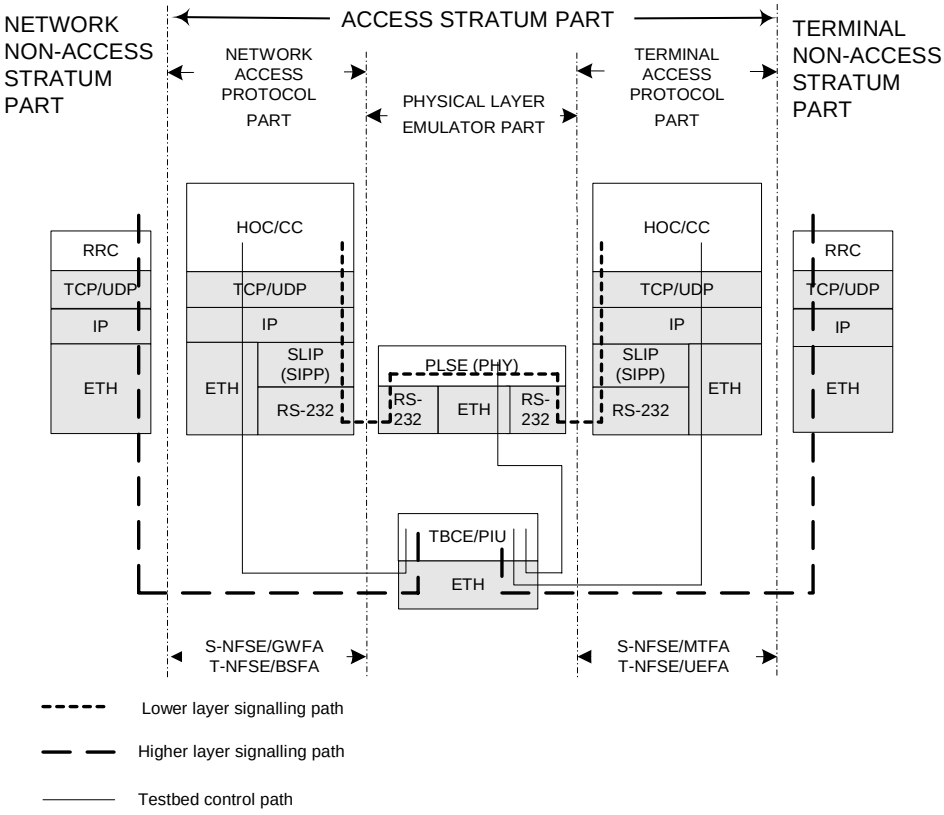

Figure 5 Access stratum protocol architecture for the Inter-segment Roaming Experiment

For the end-user service experiment the NAS signalling connection is required for the transport of messages between the multi-mode mobile and the core network (co-located 2/3G SGSN/GGSN). This NAS signalling connection comprises the RRC connection between the multi-mode mobile and the RNC as well as the RANAP connection between the RNC and the core network. The connection between the multi-mode mobile and the combined 2/3G SGSN/GGSN is established as explained in the ISR experiment. The usage of this connection is essential for the exchange of signaling messages between MS and CN, e.g. to convey the “PDP context activation/deactivation” messages. In addition to this functionality the end-user service experiments require an end-to-end IP connectivity for user data (application data path in Figure 6). This IP connectivity within the three segments (between the multi mode mobile and the GGSN) is achieved by using the PDP context activation procedure. This procedure establishes a packet bearer in the segments.
The messages for the PDP context procedures are triggered by the Session Management (SM). This layer is part in the non access stratum part of the S/T-URAN testbed. The SM functions are necessary for the end-user experiments and have to be implemented on the terminal side. The NAS signalling messages are conveyed through the physical emulator (fig. 6, higher layer signalling path).

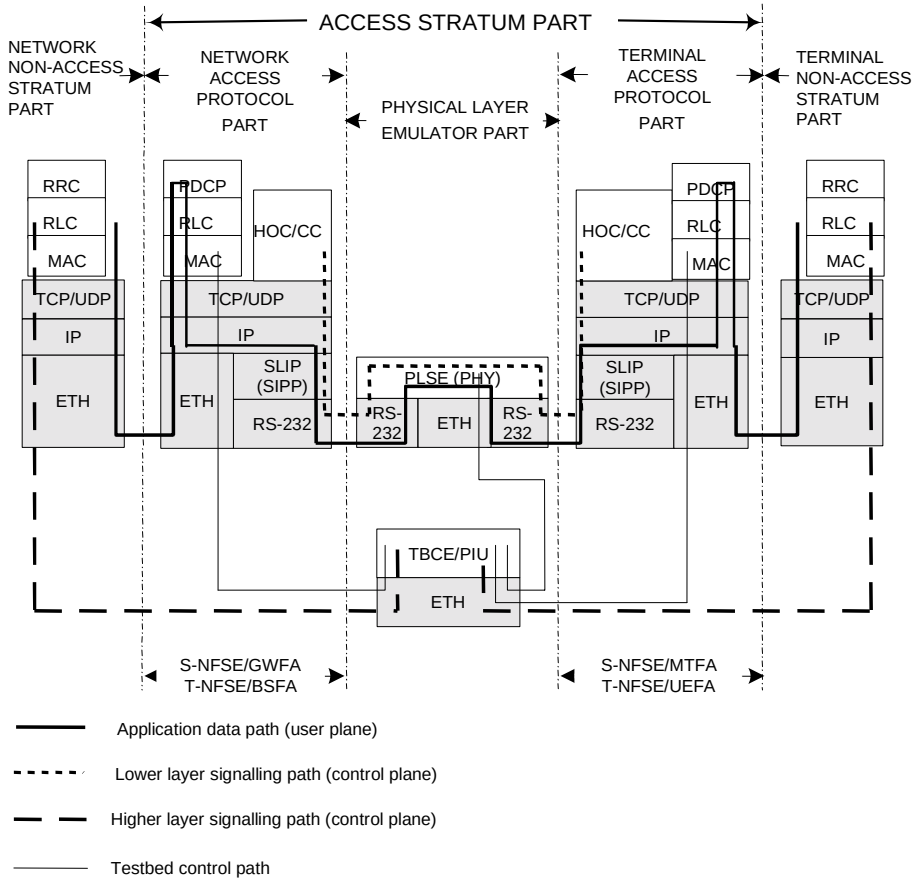

Figure 6 Access stratum protocol architecture for the End-user Service Experiment

The PDP context activation message is sent to the SGSN via the RNC. The PDP context activation request message includes e.g. the PDP type IP, the requested QoS profile, APN. In the PDP context activation procedure the SGSN sends the RAB Assignment request to the RNC (AS functions). This request message contains e.g. - RAB ID, RAB parameters. The RAB parameters indicate the RAB attributes. These attributes are e.g. traffic class (conversational, streaming, interactive, background), RAB asymmetry Indicator, SDU parameters, delivery order, maximum SDU size, transfer delay.
These attributes and the content of the RAB assignment request message enable the establishment of Radio Access Bearers with different characteristics with respect to a desired service (QoS profiles).

IV Conclusion

Three experiments aimed in VIRTUOUS project are to be realized through the investigation of characteristics of each experiment considering the existing 3GPP and other relevant standards. The typical and minimum requirements of each system element have been specified and selected for implementation. The HW devices equipped with these selected functions are to be inter-connected via Ethernet and RS232. This paper presented the physical system architecture build up for realizing an integrated system for mobile communication consisting of GPRS, T-UMTS and S-UMTS segments.

References

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