

A real-time testbed for heterogeneous wireless networks

Miguel López-Benítez, Łukasz Budzisz, Anna Umbert, Nemanja Vučević and Francisco Bernardo

Department of Signal Theory and Communications, Universitat Politècnica de Catalunya (UPC)

Campus Nord, C/Jordi Girona 1-3, 08034 Barcelona, Spain

[miguel.lopez, lukasz, annau, vucevic, fbernardo]@tsc.upc.edu

Abstract— This demonstration presents and describes a powerful real-time testbed emulating an all-IP heterogeneous wireless access network. The demonstration will focus on some conceptual studies related to the radio part. In particular the performance and behaviour of two RAT selection policies will be illustrated under various evaluation scenarios using a reduced testbed version running on a single laptop.

DEMONSTRATION OVERVIEW

Trends in wireless communications are evolving towards the integration of different radio access networks and technologies into heterogeneous infrastructures. This type of communication networks are facing the challenge of providing continuous and ubiquitous connectivity through different technologies while preserving the negotiated end-user Quality of Service (QoS) level during the entire session, regardless of the user mobility. This requirement results in an especially demanding task in the case of vehicular wireless communication scenarios due to the particularities of the vehicular environment. Although the radio part imposes severe difficulties, the fixed infrastructure features need also to be taken into account. In this context, this demonstration is aimed at presenting a sophisticated real-time testbed [1] emulating an all-IP heterogeneous network that includes the UMTS Terrestrial Radio Access Network (UTRAN), GSM/EDGE Radio Access Network (GERAN), and Wireless Local Area Network (WLAN) radio access technologies as well as a DiffServ/MPLS-based common core network in the fixed infrastructure part. The presented tool is a powerful emulation platform that enables advanced Radio Resource Management (RRM/CRRM) strategies and End-to-End Quality of Service (E2E QoS) mechanisms to be accurately evaluated in a realistic environment with various real user applications and mobility patterns, which could not be achieved by means of off-line simulations.

The real-time testbed is implemented with off-the-shell Personal Computers (PCs) running Linux operating system. This approach has been proven to be adequate due to its capacity to assure appropriate levels of real-time management while guaranteeing a high degree of flexibility. The capacities provided by this operating system to interact at low level with the kernel offer the possibility to tune accurately the performance required by the testbed, especially in the issues related with the real-time execution and management.

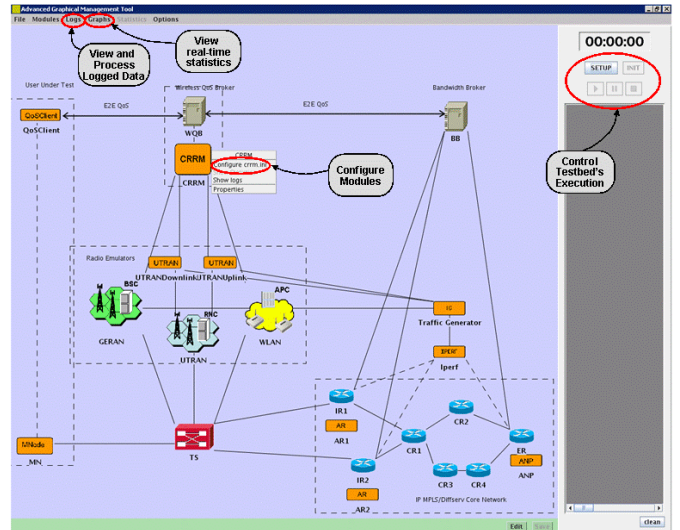


Fig. 1. Advanced Graphical Management Tool (AGMT).

A graphical management and configuration tool called Advanced Graphical Management Tool (AGMT) has been developed to configure the initialization parameters, to control the execution flow, to collect logged data and to obtain statistics during the execution of a demonstration (see Fig. 1).

The real testbed (see Fig. 2) actually consists of three racks including sixteen PCs (together with standard network switches), two stand-alone PCs to run the client and the server applications, and two additional stand-alone PCs to run the user equipment (UE) and the AGMT (see Fig. 3).

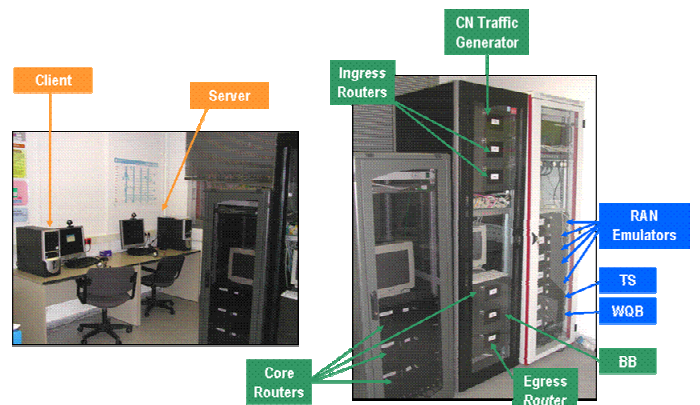


Fig. 2. Testbed photo (except AGMT and UE PCs).

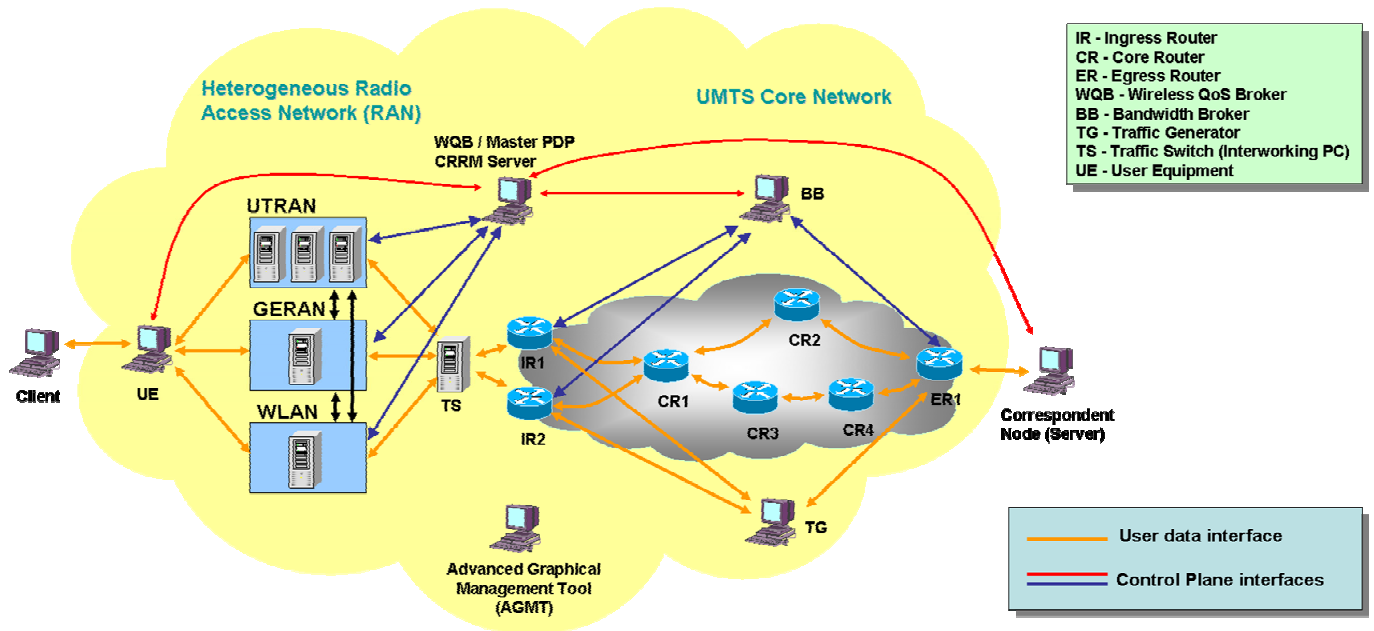


Fig. 3. General Testbed Architecture.

However, the presentation to be performed during the session will demonstrate a reduced testbed version running on a single laptop. Due to the reduced computational capabilities of the presented platform, the demonstration will focus on some conceptual studies related to the radio part. Additionally, all the remaining testbed functionalities related to the fixed infrastructure part and E2E QoS mechanisms will be illustrated in a poster, power point presentation, and/or recorded videos¹.

To illustrate some of testbed's evaluation capabilities, the proposed demonstration will present the implemented algorithms to select the Radio Access Technology (RAT) in the testbed that facilitate the initial admission control, the congestion control and the vertical handover (VHO) functions. In particular, different sophisticated RAT selection algorithms implemented in the testbed will constitute the scope of the performed trials. The performance and behaviour of these RAT selection policies will be illustrated under various evaluation scenarios, where different availability of RATs, mixing of services, and users' mobility patterns will be considered. Some details regarding the presented algorithms are given below:

Network-Controlled Cell-Breathing (NCCB): The main idea of a Network-Controlled Cell-Breathing algorithm, as presented in [2] and [3], is to take the advantage of the coverage overlap that several RATs may provide in a certain service area in order to improve the overall interference pattern and, consequently, to improve the capacity of the

overall heterogeneous scenario. The goal of the demonstrations related to the NCCB algorithm will be to evaluate the initial RAT selection process as well as the RAT selection process during an on-going VHO in a heterogeneous vehicular scenario.

Fittingness factor based algorithm: As mentioned in [4], fittingness factor is a generic CRRM metric that aims at capturing the multidimensional heterogeneity of vehicular scenarios within a single metric. The demonstrations related to the fittingness factor based algorithm will present the RAT selection process during an on-going VHO in a heterogeneous vehicular scenario. The RAT selection process consists of a two-step procedure that incorporates monitoring period (step 1) and the triggering part (step 2). The algorithm is expected to reflect the suitability of allocating a given RAT to a given user of a certain profile, according to the created metrics.

REFERENCES

- [1] F. Bernardo, N. Vucevic, L. Budzisz, A. Umbert, "A Beyond 3G Real-Time Testbed for an all-IP Heterogeneous Network", in Proceedings of the 5th ACM International Workshop on Mobility Management and Wireless Access, Chania, Greece, October 2007
- [2] J. Pérez-Romero, O. Sallent, R. Agustí, L. Wang, H. Aghvami, "A Novel Algorithm for Radio Access Technology Selection in Heterogeneous B3G networks", in Proceedings of IEEE Vehicular Technology Conference 2006-Spring, Melbourne, May, 2006.
- [3] J. Pérez-Romero, O. Sallent, R. Agustí, "Network Controlled Cell Breathing in Multi-service heterogeneous CDMA/TDMA scenarios", in Proceedings of IEEE Vehicular Technology Conference 2006-Fall, Montreal, September, 2006.
- [4] J. Pérez-Romero, O. Sallent, R. Agustí, "A Novel Metric for Context-Aware RAT Selection in Wireless Multiple Access Systems" in Proceedings of the IEEE International Conference on Communications 2007, Glasgow, June, 2007.

¹ Sample videos are available at:

http://www.everest-ist.upc.es/publicdocuments/videos/demonstration1_web_high.wmv
http://www.everest-ist.upc.es/publicdocuments/videos/demonstration2_web_high.wmv