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D15

Trials Description

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Abstract:

This deliverable includes the specification and description of the scenarios and procedures that will be used over the AROMA testbed for testing and validating the proposed resource and QoS management algorithms

Keyword list: Trials description, test bed, emulation of the access radio technologies; implementation of the IP-based core network technologies.

DISCLAIMER

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EXECUTIVE SUMMARY

The scope of this document is to provide a description of the selected trials that should be performed in the AROMA testbed for testing and validating the proposed RRM/CRRM/BB algorithms.

The testbed definition and presentation is not the intent of this deliverable. That information is present in “D07 - Testbed Specification”, (30-6-2006) document that should be used as the reference to understand the testbed architecture and available functionalities.

This document describes the trials that are planned be performed in the integrated AROMA testbed. Those trials are focusing in five main areas, going from “Quality measurements with application” to the test of some RRM/CRRM/BB algorithms, E2E QoS strategies and finally with QoS and mobility. Each main area consists of several scenario demonstrations.

At the end of this validation process we can conclude that the proposed RRM/CRRM/BB algorithms are going to be tested in a demonstrator that reproduces the relevant behaviour of the different layers related with the Radio Resource and QoS Management.

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1 INTRODUCTION

This deliverable is devoted to the description of the trials that should be run over the real time AROMA testbed.

The AROMA testbed reproduces in a realistic way a B3G heterogeneous radio access network, that include three RATs (UTRAN, GERAN, WLAN), interfacing a common Core Network. This last one is based on Diffserv/MPLS and policy-enabled networking with improved mobility aspects and a new framework for the E2E QoS Management. In addition to all these elements, the testbed incorporates the capacity to evaluate the QoS experienced by the user when using real applications under controlled conditions of the used RAT and the CN.
Conclusions about the behaviour and utility of the used algorithms and techniques should be extracted after each individual trial. Since the trials are focused in the overall operation of the real time system, the test of each individual module of the testbed is not the objective of these trials. The testbed has been integrated and validated before the test and validation of the algorithms and QoS techniques.

The core part of the network is a set of Linux routers and real traffic is generated and injected in the network, according to the traffic conditions emulated in the radio section. Using real packets in the network give us more granular information about delays, losses and QoS user perception when using the algorithms studied/developed during the project.

The document is organised as follows. Firstly are presented the overall format of the document and a short description of the testbed. The complementary D07, “Testbed Specification”, has a deeper presentation of the testbed architecture.
In section 3, the testbed trials are described. Trials are separated into five groups, each one with several demonstrations. Finally, overall conclusions are presented.

2 CONCEPTS CONCERNING TEST AND VALIDATION PLAN

2.1 A model for the demonstration scenarios

The objective of these scenarios is twofold. On one hand they should refine and adjust the testbed performance, and, on the other hand, they can show the utility of the RRM and CRRM algorithms and QoS techniques developed and implemented in the testbed for mobile operators and technical community. Conclusions about the behaviour and utility of these algorithms should be extracted after each individual trial. Since the test and validation procedures are focused in the overall operation of the real time system, the test of each individual module of the testbed is not the objective of these trials.

The following sections all follow the same structure to describe the algorithms that are going to be tested:

- ***Objective***

  The main purpose of the trial is presented in this part and the effects that the demonstration/s will show should be proposed.

- ***Scenario***

  The main components of the demonstration scenario are described. These components include the application/applications employed by the User Under Test (UUT), the traffic class of the rest of users and the algorithms and techniques enabled for the test.

- ***Input conditions***

  The way the demonstration will be run in the defined scenario is described at this point. Different procedures will be taken for different conditions. For example, the same scenario will be tested with the same conditions except for a different traffic load or for a different enabled algorithm. It is a typical situation to test a scenario with an algorithm enabled and test the same scenario with the same algorithm disabled.

- ***Demonstration/s***

  One or several demonstration procedures will be run under the defined scenario and input conditions. The specific conditions, the concrete objective and the expected results will be specified for each demonstration. The demonstrated effects for every demonstration can be seen in two different ways. These effects can be considered in a qualitative level or in a quantitative level. Qualitative level is referred to a perception of what is the effect of the algorithms and techniques over the defined scenario. Quantitative level is referred to calculated figures during the demonstration; those figures will show the effect of the testbed algorithm and techniques over the global performance of the testbed. In this document only qualitative results are presented. Quantitative results will be given in deliverable D20 -Trials results.

2.2 Short description of the testbed

In order to contribute to the whole understanding of this deliverable we will summarize in this section a short description of the testbed. For more information see deliverable *D07 Testbed Specification* [1].

2.2.1 Radio Access Networks

The AROMA testbed encompasses heterogeneity in the radio access domain. In this sense, three radio access networks are considered:

- UMTS Terrestrial Radio Access Network (UTRAN),
- GSM/EDGE Radio Access Network (GERAN), and
- Wireless Local Area Network (WLAN).

This heterogeneity in the radio part is coordinated by means of a Common Radio Resource Management (CRRM) entity. QoS in the radio part is provided thanks to a Wireless QoS Broker (WQB) that holds QoS management in the radio part as well as CRRM functions. This entity will negotiate the end-to-end QoS with its counterpart in the core network (named the Bandwidth Broker BB).

The progressive introduction of IP technology in the mobile network is stated as a key driver of the AROMA project, so that a progressive transition towards an all-IP radio access network is pursued. In this sense, the AROMA testbed will only consider a scenario which accounts for the introduction of IP transport in the radio access network with the possibility of sharing the IP-based backhaul network for the different radio access technologies. Figure 1 illustrates this architecture.

Finally, it is worth mentioning here that real time emulation is done in the radio part. In addition, there is a UUT whose real traffic (i.e., the generated by the selected applications) is conveyed through the whole testbed, involving the radio and core network parts.

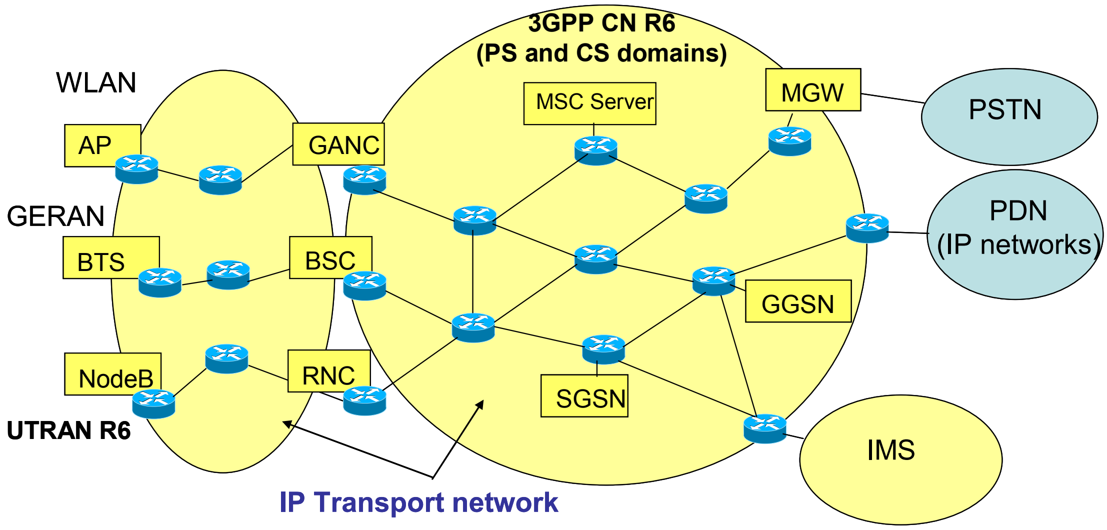

Figure 1 - Architecture for all-IP network considered in AROMA. IP transport is shared among UTRAN, GERAN and WLAN.

2.2.2 Core Network

For the core network part, there is no emulation. The tests are carried out using the communication stack of the Linux operating system, which acts as an IP router with DiffServ and MPLS support.
The CN is based on a DiffServ domain with MPLS forwarding, i.e., inside the CN, packets are forwarded based on their FEC (as reference, see deliverable *D07 Testbed Specification* [1]), that determines and makes the flow to follow a pre-established LSP.

In order to have MPLS and DiffServ at the data-plane, the existing “traffic control” functionalities and the MPLS package for Linux [2] have been used.

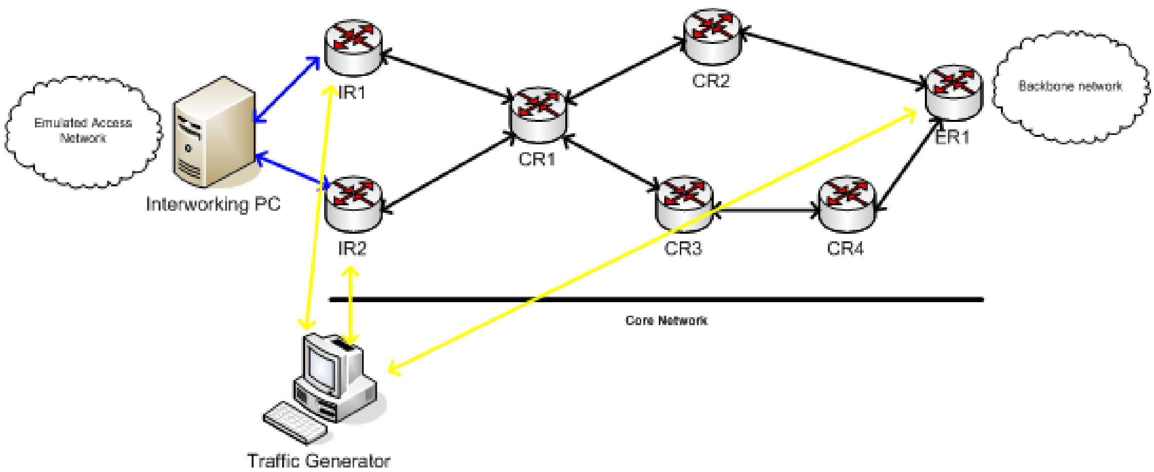

Figure 2 - Core Network Topology

Figure 6 presents the AROMA’s core network topology, composed by seven routers (Linux PCs).
Real traffic, created by a Traffic Generator PC, reproduces all other users’ traffic that are emulated in the AN and which, in a real environment, would cross the CN. Coordination will exist between the traffic generated in this PC and the emulated users considered in the radio part of the network.

The final implementation of WQB, BB, MPDP and QoS Client, was made having in mind the definition of the procedures that are going to be proved with the testbed and which are detailed in the next section.

3 DESCRIPTION OF THE VALIDATION SCENARIOS

3.1 QUALITY MEASUREMENTS WITH APPLICATIONS

The QoS perception has been defined as one of the goals in the AROMA testbed [1]. This task has been defined with aim to evaluate the variation in perceived QoS experienced by a user running multimedia applications when changing QoS management policies or algorithms.

The primary requirement for the applications that should be used in perceptual QoS evaluation is to be widely available. Both commercial and open source applications, that coupe with this, are considered. Depending on the specific behaviour in the network that is tried to be evaluated, some of the applications that may be used are given in Table 1. The rest of this chapter will explain under which circumstances (network conditions) are those applications used to evaluate the perceived QoS.

To evaluate the perceived QoS, the application needs to be captured on the user's side. The modified (degraded) multimedia contents are compared to the reference contents (originals). The applications used should respect the recommendations of QoS metrics [10][11][12]**¡Error! No se encuentra el origen de la referencia.** and be in accordance with the input file types (audio, speech or video).

Table 1: Applications involved in QoS measurements.

End to End Service	End to End Application		Capturing Application
	Server	Client	
Video Streaming	Darwin Streaming Server[3]	QuickTime Pro[8]	Camtasia Studio Recorder[9]
	VLC[4]	VLC	
Audioconference	RAT[5]	RAT	Microsoft Sound Recorder
	NetMeeting[6]	NetMeeting	
Videoconference	VIC[7]	VIC	Camtasia Studio Recorder
	NetMeeting	NetMeeting	

3.1.1 General objective

The general objective is to make the quality measurements with several applications in order to test the QoS perceived by the user under test (UUT) in different network (end-to-end) conditions.

Different actions (like horizontal handover, vertical handover, core network rerouting, etc.) and different CRRM algorithms or QoS policies are meant to be implemented in different scenarios to test the QoS perceived by the UUT in the testbed. At the same time, the user's application may be varied as well.

In particular we will measure the objective QoS when applications like video streaming or videoconference are run with distortion in communication due to handovers, limited bandwidth or congestion, causing packet loss or delay.

3.1.2 Scenario

The UUT has a defined path and speed. Under different RAT preferences and in different network conditions, various applications are to be tested.

The UUT may have handover included or not during session depending on what is supposed to be proven in certain demonstrations.

3.1.3 Input conditions

- Define service to be tested.
- Define applications to be used.
- Define the path and speed of the UUT, having in mind the effect to be tested (handover, bandwidth limitation, congestion level).
- Setup the network to act in a desired manner.

3.1.4 Demonstration 1: Bandwidth assignment

- ***Specific conditions***
  - Requested service: video streaming with specified bandwidth.

- ***Objective***
  With this kind of test, the sensitivity of the applications to bandwidth limitation will be measured. The objective is to compare the behaviour (in terms of QoS perception) of the applications when the bandwidth of the channel is limited as it is common in wireless networks, while having variation in streaming.

  For example, QuickTime applications seem to implement buffers, that will directly influence the resistance of the streaming process to different types of constrains introduced in the intermediate IP models. VLC streaming technology does not implement buffers. This means that VLC is more sensitive to channel bandwidth than QuickTime.

- ***Expected results***
  Different applications should express different behaviour when facing bandwidth limitations.

  Considering the aforementioned example, it is possible that VLC experience degradation while QuickTime not because the accumulated amount of information in the buffer helps QuickTime to overcome bandwidth limitations.

3.1.5 Demonstration 2: Handover impact

- ***Specific conditions***
  - Force the UUT to have the desired HO, by defining the mobile's trajectory and technology preference weights (RAT selection) properly depending on the service under test.
  - Requested service: video streaming or audio/video conference.

- ***Objective***
  Handover impact will be considered in four different ways:

  1. Horizontal HO.
  2. Vertical HO without IR change.
  3. Vertical HO with IR change.
  4. Vertical HO with IR change and IP mobility management handover preparation.

  Those three HO should introduce different levels of loss and delay that will influence the connection. While the HO that does not include IR change introduces the interruption only by the CRRM functionalities, the change of IR will introduce more service distortion. With change of IR, the duration of the HO will be longer as the e2e QoS renegotiation should be done. Also, change in IR changes the point of attachment of the UT and therefore IP mobility management signalling happens. In case 4, an enhancement called the handover preparation stage is introduced to the IP mobility management. In this, a tunnel is established between the IRs just before the actual IP handover happens. This enhances the performance of the network by reducing the packet loss.

- ***Expected results***
  To have different levels of service degradation depending of the HO is expected.
  That is, the higher the distortion introduced by HO is, the lower mean opinion score metric will be obtained. The distortion will depend on HO type, packet loss and delay. The robustness of the application and codecs in use to the aforementioned constraints may also vary the final results.

3.1.6 Demonstration 3: Network Congestion

- ***Specific conditions***
  - Requested service: video streaming or audio/video conference.

- ***Objective***
  Network congestion, caused in radio or core network part, can introduce significant delays and losses in the delivery of IP packets that may affect the performance of real time applications. Moreover, relevant variations of the delay may occur. The influence of the congestion on the quality perception will depend on the application and will be measured.

- ***Expected results***
  The reflection of the congestion to QoS degradation is expected to be obvious. Variations in load level will cause increase in loss and delay, and confirm this. The robustness of the application and codecs in use to the aforementioned constraints may also vary the final results.

3.2 RADIO ACCESS TECHNOLOGY (RAT) SELECTION / COMMON RADIO RESOURCES MANAGEMENT (CRRM) ALGORITHMS

3.2.1 General objective

The objective of these trials is to check the coherence between the results achieved in simulations of Radio Access Technologies (RAT) selection algorithms presented in WP3 conceptual studies [14], and the implementation incorporated in the AROMA real-time testbed. The RAT selection algorithms implemented in the testbed facilitate the initial admission control, the congestion control and the vertical handover. In particular, two following RAT selection algorithms were implemented in the testbed and will constitute the scope of these trials:

- Network-Controlled Cell-Breathing (NCCB)

The main idea of a Network-Controlled Cell-Breathing algorithm, as presented in [15] and [16], 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 generated in the scenario for the CDMA-based systems and, consequently, to improve the capacity of the overall heterogeneous scenario.
The goal of the tests related to the NCCB algorithm is to evaluate the initial RAT selection process as well as the RAT selection process during an on-going Vertical Handover (VHO) in a heterogeneous scenario.

- Fittingness factor based algorithm

As mentioned in [17], fittingness factor is a generic CRRM metric that facilitates the implementation of cell-by-cell RRM strategies by reducing signalling exchanges and aims at capturing the multidimensional heterogeneity of beyond 3G scenarios within a single metric.
The goal of the tests related to the fittingness factor based algorithm is to evaluate the RAT selection process during an on-going Vertical Handover (VHO) in a heterogeneous 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 (UUT) of a certain profile, according to the created metrics.

3.2.2 Scenario

The scenario will include heterogeneous networks that use IP in the Radio Access Network. For each algorithm multiple trials scenarios will be fixed.

In addition to that we also consider different RAT selection scenarios when the VHO mechanism is on course.

3.2.3 Input conditions

The UUT is requesting a service, but connection is not established yet for that UUT.
There are users already connected to the involved RATs, so the corresponding percentages of RAT utilization should be set in the beginning of the test.

3.2.4 Demonstration 1: Initial RAT selection only using NCCB strategy

- ***Specific conditions***
  - Only UTRAN and GERAN RAT are considered.
  - Requested service: Web Browsing and voice

- ***Objective***

  The aim of this demonstration is to analyze the performance of this algorithm at session initiation. The RAT selection decision is taken according to the path loss measurements in the best UTRAN cell, provided by the terminal in the establishment phase.
  The path loss is computed by measuring the received downlink power from a common control channel whose transmitted power is broadcast by the network. Measurements are averaged in periods of T seconds.

- ***Expected results***
  - The RAT assigned to the user is the expected one depending on the path loss measurements.
  - In case that the resulting path loss PL_{UTRAN} is above a given threshold PL_{th}, the selected RAT will be GERAN, while if the path loss is below the threshold the selected RAT will be UTRAN.
  - In case that there is no capacity available for the new session in the selected RAT (i.e. admission control is not passed), the other RAT will be selected instead. Then, if no capacity is neither available in the other RAT, the session will be blocked.

3.2.5 Demonstration 2: RAT selection including VHO using NCCB strategy

- ***Specific conditions***
  - Only UTRAN and GERAN RAT are considered.
  - Requested service: Web Browsing and voice

- ***Objective***

  The aim of this demonstration is to analyze the performance of NCCB algorithm when VHO is considered, according to a procedure presented in the scheme below.

The idea is to keep the high path loss users connected to GERAN and low path users to UTRAN depending on how the propagation conditions change along the session lifetime. VHO is triggered upon the relation of the path loss measurements (PL_{UTRAN}) and the path loss threshold value (PL_{th}) with a certain hysteresis margin (Δ).

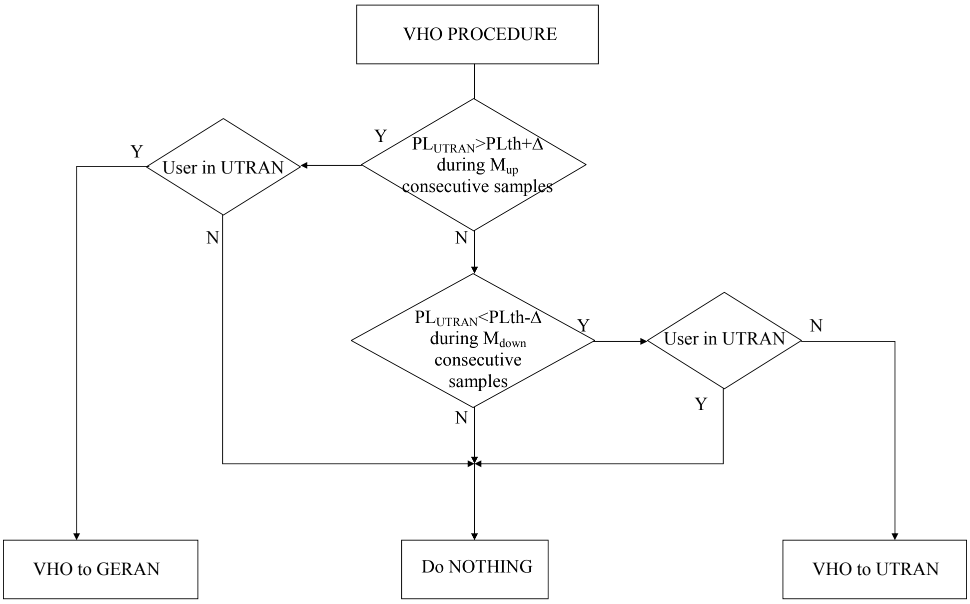

Figure 3. VHO procedure with NCCB algorithm

- ***Expected results***

Analyze the gain produced by the VHO with respect to demonstration 1. These results should be aligned with those obtained in WP3 conceptual studies.

3.2.6 Demonstration 3: RAT selection including VHO using Fittingness factor based strategy

- ***Specific conditions***

    - Only UTRAN and GERAN RAT are considered.
    - Requested service: Web Browsing and voice

- ***Objective***

The aim of this demonstration is to analyze the performance of this algorithm when VHO is considered, following the two-step handover procedure described in [17].

- ***Expected results***

The results should line up with those presented in WP3 conceptual studies [14]. In particular, following a two-step handover procedure, the scope will focus at:

- Monitoring the fittingness factor in the first step of the handover procedure. Expected alignment with evolution of the channel conditions.
- As a second step, if a triggering condition is held during a predetermined period, a VHO should be triggered, if there are available resources in a new RAT and cell.

Optionally, a comparison with the results of demonstration 2 will be made.

3.3 STRATEGIES FOR E2E QoS

3.3.1 General objective

The objective of this set of trials is to demonstrate the performance of some of the strategies that are being proposed within WP3 for providing e2e QoS management over the network, taking into account the new concepts and functionalities introduced in the AROMA project in both the access and core network parts. In that sense we can distinguish two groups of e2e QoS strategies:

1.- QoS negotiation procedures during session establishment

The goal of these procedures is to show that the load status of both the Radio Access Network (RAN) and the Core Network (CN) is taken into account in the session establishment. By testing different load conditions either in the RAN or in the CN it is expected to have different decisions (e.g. the session establishment with QoS requirements can be accepted, accepted with changes or rejected). In addition, the joint admission algorithm that is running in the RAN may impact the final QoS negotiation decision. For these reasons, different joint admission algorithms might be tested within a session establishment with QoS. Examples of these joint admission algorithms are NCCB [14][16] and Fittingness Factor algorithms [18] taken from WP3 activities. For demonstrations, Fittingness Factor algorithm will be used. Also, the specific session admission algorithm of the CN may impact the results.

In the Figure 4 an example of an initialization process is presented. The User is requesting the service from the WQB which will reserve the best RAT and CN path for it. The decision and detailed protocol will depend on the algorithms used in CRRM, CN and WQB.

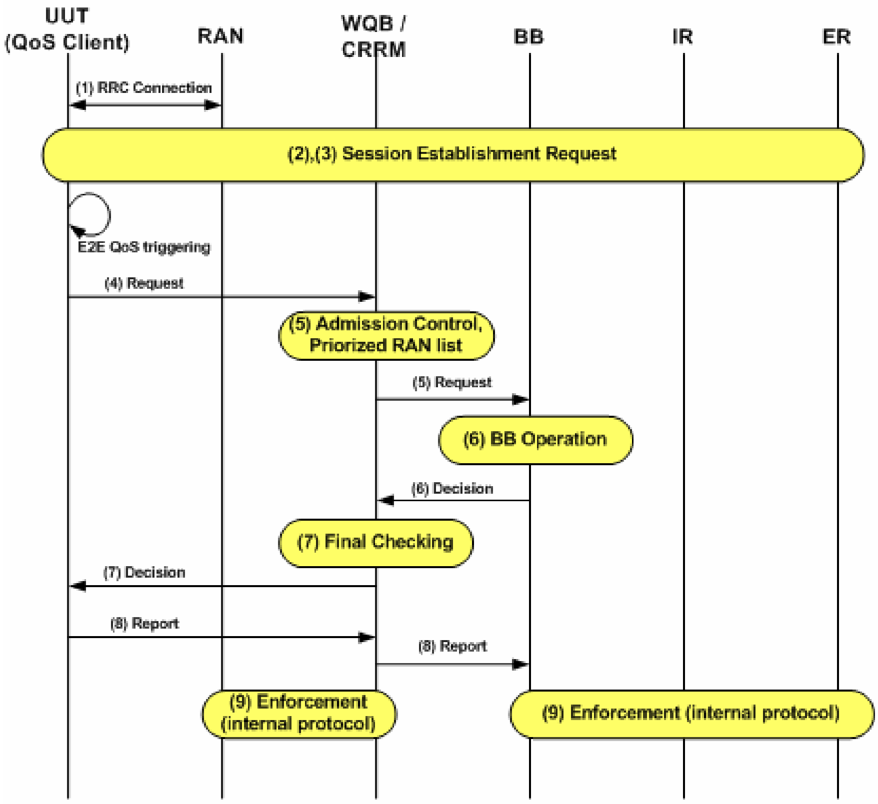

Figure 4: Initialization procedure, a simple overview.

2.- QoS re-negotiation procedures

The aim of this set of procedures is to show how the QoS conditions may adapt themselves along an active session due to load changes in the radio part or in the core network part. These load changes during an active session may trigger a QoS re-negotiation that can be initiated either in the RAN or in the CN. Let us assume that WLAN and GERAN RATs are connected to one of the Ingress Routers (IR) and that UTRAN is connected to the other one (see Figure 6). Then some of the representative examples of situations that might trigger a QoS re-negotiation are:

- RAN triggered re-negotiation: An accepted WLAN connection has to move to UTRAN (Vertical Handover) due to an excessive WLAN occupation that degrades the rest of the services. In this case a QoS re-negotiation between the RAN and the CN is needed due to the change of attachment point (IR)
- CN triggered: In this case an UTRAN connection has to be moved to GERAN due to core network problems, triggering, in consequence, a QoS re-negotiation.

As in the session establishment, the RAN admission and congestion control algorithms (that moves session from one RAT to another depending on load conditions) will impact the final result of the QoS re-negotiation.

Finally, it is important to remark that the UUT may or may not be involved in the QoS re-negotiation, given that only if the QoS profile is downgraded the QoS re-negotiation will need UUT's approval.

In the Figure 5 an example when re-negotiation is triggered from the RAT part is presented. After that the estimation of possible alternatives for RAT are considered and renegotiation in the CN if necessary (if different IR is supposed). The re-negotiation may also be triggered from CN, and the procedure will differ a bit. More details on exact procedures regarding both initialization and re-negotiation will be given in deliverable D16.

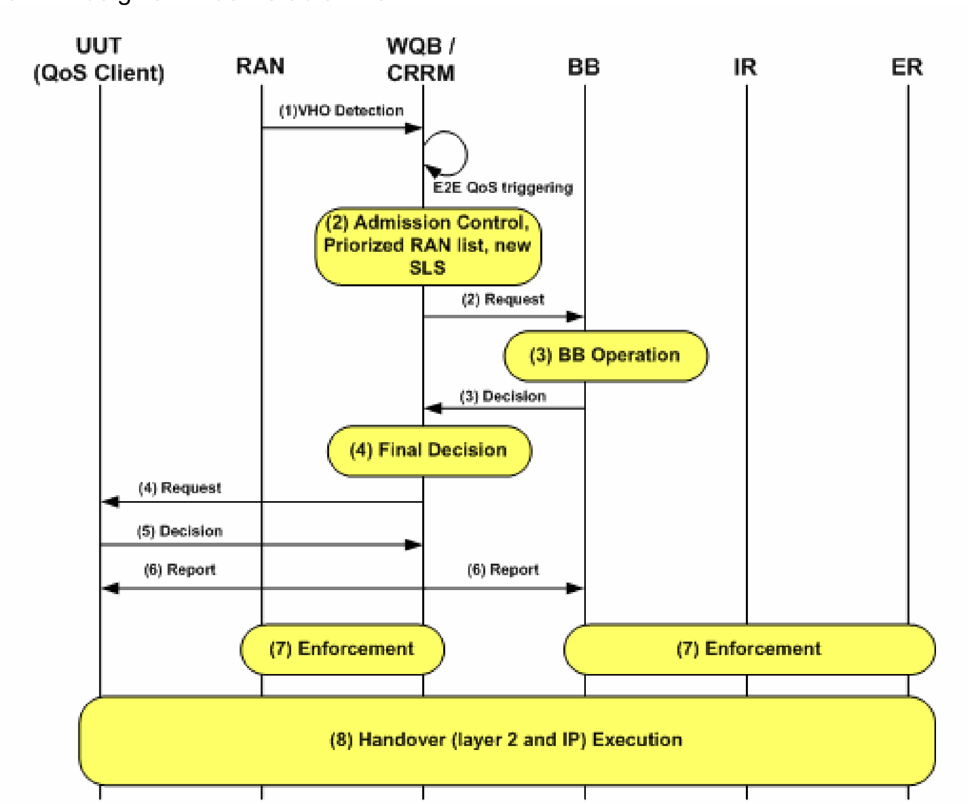

Figure 5: Renegotiation procedure, an example: re-negotiation triggered from RAT.

3.3.2 Scenario

The entities involved in the QoS management are the Wireless QoS Broker (WQB), the Bandwidth Broker (BB) and the Master PDP (MPDP).

As detailed in deliverable D07 [1], the MPDP functions are included in the same module devoted to WQB. Thus, when the UUT is requesting for a new service, the WQB, according to the Common Radio Resource Management (CRRM) algorithm implemented, asks to the BB for one or several Ingress Routers (IR). The BB has information regarding the core network state and can allow or reject the admission of new users in the CN part.

The architecture considered for testing of e2e QoS strategies is shown in Figure 6.

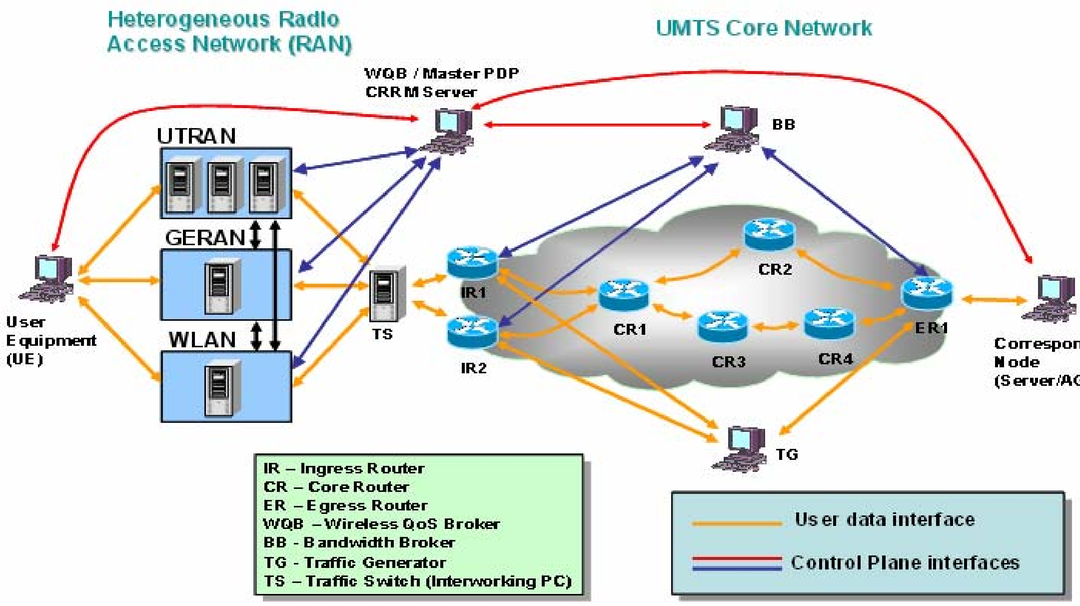

Figure 6. Testbed conceptual architecture for the e2e QoS negotiation (red interfaces)

3.3.3 Input conditions

- The UUT is requesting a service. If the QoS session establishment is going to be demonstrated no connection is supposed to be established before that moment.
- As the RAT selection algorithm the Fittingness Factor must be chosen.
- The percentage of use of different RATs in the beginning of the test is set by means of the users that are already connected to the involved RATs. Moreover corresponding aggregated traffic must be generated in the CN.
- A predefined mapping between the RAT and the IR must be set.

3.3.4 Demonstration 1: QoS negotiation when only the best RAT is considered during session establishment

- ***Specific conditions***
  No specific conditions are needed.

- ***Objective***
  The aim of this demonstration is to analyze the QoS assigned to the UUT during session establishment when the WQB negotiates QoS with BB only for the IR the best RAT is mapped to, according to the fittingness factor based algorithm.

- ***Expected results***
  Variation in successfulness of the session establishment depending on the network load is expected. Comparison with demonstration 2 results will be made.

3.3.5 Demonstration 2: QoS negotiation when all the possible RATs are considered during session establishment

- ***Specific conditions***
  No specific conditions are needed.

- ***Objective***
  The aim of this demonstration is to analyze the QoS assigned to the UUT during session establishment when the WQB request from the BB information on all the IRs possible RATs are mapped to, according a sorted RAT list made by the fittingness factor based algorithm.

- ***Expected results***
  Variation in successfulness of the session establishment depending on the network load is expected. Comparison with demonstration 1 results will be made. Due to consideration of alternative RATs, the results from Demonstration 2 should have more successfully established connections.

3.3.6 Demonstration 3: QoS re-negotiation procedure triggered by a RAT

- ***Specific conditions***
  Increasing the load in the RAT to which the UUT is connected to force the congestion control algorithm to start a re-negotiation procedure.

- ***Objective***
  The aim of this demonstration is to analyze the re-negotiation procedure activated by the RAT due to load conditions.

- ***Expected results***
  Successful re-negotiation between all the involved entity pairs should be demonstrated. For example, the session should go on after the successful re-negotiation process, preserving QoS guarantees.

3.3.7 Demonstration 4: QoS re-negotiation procedure triggered by the network

- ***Specific conditions***
  Increase of the load in the network path (core network part) that the UUT is using, to force the congestion in the network, so the CN will start a re-negotiation procedure.

- ***Objective***
  The aim of this demonstration is to analyze the re-negotiation procedure activated by the core network due to load conditions.

- ***Expected results***
  Successful re-negotiation between all the involved entity pairs should be demonstrated. For example, the session should go on after the successful re-negotiation process, preserving QoS guarantees.

3.4 ADMISSION CONTROL ALGORITHMS IN THE BB

The goal of this demonstration is to evaluate the performance of different CAC algorithms used by the BB during the session setup and handover processes (terminal and network initiated).
For all the tests, in this section, three different types of algorithms will be used:

i) parameter-based – The decision is deterministic, based in mathematical formulae;
ii) measurement-based – network measurements are used as parameters for the algorithm;
iii) adaptative algorithms – The algorithm has the capacity to automatically adapt the parameters based on the information received from the network probes.

3.4.1 Test different CAC algorithm under diverse network conditions

3.4.1.1 General objective

The goal of this demonstration is to evaluate the behavior of the network and the algorithm in terms of:
Time of response of CAC process;
Network throughput achieved for each algorithm;
Path and router occupation inside the network;
Number of accepted/denied flows for each algorithm;
Packet delay and jitter;
Packet losses;

for each type of CAC algorithms (parameter-based, measurement-based and adaptative).
The network status is an important issue that could compromise the achieved results. To get better results, two different network conditions should be addressed: i) heavy load and ii) light load. Two demonstrations are presented next, one for each of the situations.

3.4.1.2 Scenario

When the user requests BW for a new session the BB is interrogated to authorize or deny the session. The BB's decision is performed based in the real status of the network and in the previous requests information (Figure 7).
As the data traffic in the CN and the RAN parts are coupled, when a session is initiated in the radio part, real traffic is injected in the core of the network, what gives BB the possibility to periodically measure the network in order to keep an up to date vision of the network usage – grey messages presented in Figure 7. The measurement periodicity is a BB's configurable parameter that must be correctly chosen because it has great impact in the algorithm performance.
The measurement information is used in the CAC algorithm parameters, or by the adaptative process (depends on the type of algorithm used).

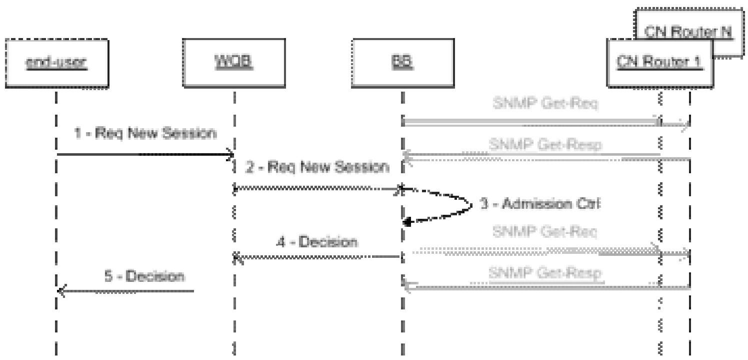

Figure 7. BB receive new session setup

3.4.1.3 Input conditions

As previously referred the network state is an important issue that can change the algorithms behaviour. So, two trials are defined one for each network status. The first one doesn't need any special input conditions; however the second one needs heavy load in the CN. To achieve this, a background traffic generator should be initiated between two end points outside of the CN. This traffic is only perceived by the BB when it measures the network; this action is done with a certain degree of periodicity.

3.4.1.4 Demonstration 1: Test CAC algorithm with light load

- ***Specific conditions***
  No specific conditions are needed.

- ***Objective***
  The goal is to evaluate the performance of the CAC algorithm in a light load scenario.

- ***Expected results***
  Measure the following items:
    - Time of response of CAC process;
    - Network throughput achieved for the algorithm;
    - Path and router occupation inside the network;
    - Number of accepted/denied flows for each algorithm;
    - Packet delay and jitter;
    - Packet losses;

  These values are available from the BB's database and presented in a web application, for easy perception.
  Is expected the authorization of all sessions, and the assurance of QoS SLA for all the active sessions.

3.4.1.5 Demonstration 2: Test CAC algorithm with heavy load

- ***Specific conditions***
  Create and injected background traffic in order to achieve a heavy load CN. The generation should be initiated between two end points outside of the CN.

- ***Objective***
  The goal is to evaluate the performance of the CAC algorithm in a heavy load CN.

- ***Expected results***
  Measure the following items:
    - Time of response of CAC process;
    - Network throughput achieved for the algorithm;
    - Path and router occupation inside the network;
    - Number of accepted/denied flows for each algorithm;
    - Packet delay and jitter;
    - Packet losses;

  These values are available from the BB's database and presented in a web application, for easily perception.
  Is expected the authorization of some sessions (some maybe rejected), and the assurance of QoS SLA for all the active sessions.

3.4.2 CAC's Behavior during a handover process

3.4.2.1 General objective

The goal of this demonstration is to evaluate the impact of the change of IP attachment point on the application used by the UUT. At the moment of IP handover, signaling between mobility management entities and also QoS entities is involved. During that signaling the CAC algorithm for the CN must run; therefore it can create a short period of interruption for the application. With this trial we want to evaluate:

- the CAC performance
- Packet delay and jitter
- Packet losses

3.4.2.2 Scenario

The scenario is the same as previously described.

3.4.2.3 Input conditions

- Define service to be tested.
- Define applications to be used.
- Define the path and speed of the UUT, having in mind the effect to be tested (handover, bandwidth limitation, congestion level).
- Setup the network to act in a desired manner.

3.4.2.4 Demonstration 1: CAC algorithm performance

- ***Specific conditions***
  No specific conditions

- ***Objective***
  The goal is to evaluate the performance of the CAC algorithm.

- ***Expected results***
  Measure the following items:
  - Time of response of CAC process;
  - Network throughput achieved for the algorithm;
  - Path and router occupation inside the network;
  - Number of accepted/denied flows for each algorithm;
  - Packet delay and jitter;
  - Packet losses;

  These values are available from the BB's database and presented in a web application, for easily perception.
  Is expected the handover authorization of all sessions, and the assurance of QoS SLA for all of them.

3.4.3 Pre-emption policy for CAC

3.4.3.1 General objective

The objective is to evaluate the pre-emption policy for the BB CAC proposed in the subsection 4.7.2.2 in D07. This policy allows BE flows to overflow into the region reserved for the EF flows with the risk of being pre-empted by newly arriving EF flows. The resources available in the network, in each link are partitioned between the DiffServ classes: EF, AF and BE. The AF handover flows have a pre-emptive priority over the existing BE flows in the dedicated region. This pre-emption policy dissociates handover flows and new incoming flows. It aims to provide higher session completion probability.

3.4.3.2 Scenario

The scenario is same as described in 3.4.1.2. In addition to that, IP handover is performed by changing the parameters of RAT switching.

3.4.3.3 Input conditions

In addition to the parameters for VHO, background has to be generated in the IP core network in order to create overload situations for either the best-effort or EF services on a given path from an AR to the gateway of the domain. Based on the demonstration to be performed (see below demonstrations), either a BE or EF UUT flow is set up and an IP handover is performed for this flow.

3.4.3.4 Demonstration 1: an EF handover flow pre-empts a lower priority flow

- ***Specific conditions***

  An EF UUT flow is set up and an IP handover is performed for this flow. And, in addition BE background traffic is set up in the IP CN. The path between the gateway and the AR, to which the EF flow handover is performed, is overloaded.

- ***Objective***

  The objective here is to show one aspect of the preemption policy for BB CAC. Here, an EF handover flow has reserved resources at the next target AR. And, in the case those reserved resources are being used by lower priority flows, those flows are preempted by the EF flow.

- ***Expected Results***

  The EF flow should be able to perform an IP handover without almost any degradation in the perceived QoS. On the other side, the lower priority flows, which have been preempted, receive a lower QoS level.

3.4.3.5 Demonstration 2: a BE flow overflows into a higher priority region

- ***Specific conditions***

  A new BE service UUT flow is established. Here, the background traffic is of the EF type. Moreover the EF handover resources are not fully used.

- ***Objective***

  The objective here is to show that the resources reserved for handover flows can also be used momentarily by lower priority flows. Here, it will be shown that a new established BE flow receives a better QoS level if EF handover resources are unused.

- ***Expected Results***

  A newly established BE flow receives a higher QoS level, when EF handover resources are unused.

3.5 QOS AND MOBILITY

3.5.1 General objective

The objective of this set of trials is to use the implementation of QoS-aware mobility management in order to measure the IP handover delay with and without fast handover mechanism. The trials performed can be separated in the following way:

Trials to show the interaction between micromobility protocol and QoS entities

This trial is to show the interactions between the micromobility protocol and QoS entities. In this trial, the UUT is made to change its point of connectivity from one IR to another IR thereby triggering the IP mobility handover procedures. This in turn will trigger the communication between the UUT, QoS and the MPLS entities.

Trials to show the performance

In this trial, performance measurements are to be done. Two sets of measurements can be done. In the first set, traffic generator like iperf is used to measure the throughput and packet loss during the IP mobility handover. In the second set, real application traffic can be used to test the effects of the IP handover.

3.5.2 Scenario

The entities involved in the QoS management are the UUT, WQB and CN routers. The UUT can be forced to do a handover from one IR to another IR.

3.5.3 Input conditions

No additional input parameters to those used for VHO. It can also be noted that no background traffic is used in the CN.

3.5.4 Demonstration 1: IP handover with MPLS

- **Specific Conditions**

  None

- **Objective**

  The objective is to show the interaction between the MPLS mechanism and the IP micromobility management. The IP micromobility signaling is used to trigger the setup of the MPLS LSP tunnels between an AR and the gateway of the domain. In this process, the micromobility management, the BB and the MPLS forwarding plane are involved.

- **Expected results**

  It is expected that the session of the UUT is maintained after a change in the IP point of attachment. Moreover this session maintaining is done through MPLS LSP tunnels.

3.5.5 Demonstration 2: fast IP handover

- **Specific Conditions**

  None

- **Objective**

The objective is to show the fast IP handover considered during a RAT switching. It is shown that during a vertical handover, that thanks to the fast IP handover, there is no packet loss due to delay in the mobility management signaling.

- **Expected results**

When a vertical handover is performed, it is expected that the application connectivity is re-established. In addition to this, if fast handover mechanisms are used, then an IP-in-IP tunnel is also established between the old AR and the new AR. It is expected that there is a performance enhancement with fast handover enabled.

3.5.6 Demonstration 3: evaluation of the IP handover disruption

- **Specific Conditions**

Either audio/video applications are used at the UUT, or TCP/UDP traffic is generated at a correspondent host towards the UUT.

- **Objective**

The objective is to evaluate the IP handover disruption time when IP handover, fast IP handover or MPLS-based handover are used. This evaluation can be done either in a quantitative way by measuring the UDP packet loss or TCP throughput;

- **Expected results**

The expected results are the UDP packet loss or TCP throughput for the traffic generated towards the UUT.

4 CONCLUSIONS

This deliverable provides the description of the test and validation scenarios that have been defined by AROMA consortium partners. These scenarios have been developed in order to show the behaviour of the implemented real time system, where some of the CRRM algorithms and QoS techniques, studied during the project, should be evaluated. Several procedures are going to be tested based on the scenarios described in this Deliverable: RAT Selection, E2E QoS renegotiation, CN Mobility Management and Impact of the Applications, Admission Control Algorithms in BB. The results for these tests will be presented in Deliverable D20.

LIST OF ACRONYMS

3G	3rd Generation
AF	Assured Forwarding
AN	Access Network
AR	Access Router
AGMT	Advanced Graphical Management Tool
BB	Bandwidth Broker
BE	Best Effort
CAC	Call Admission Control
CDMA	Code Division Multiple Access
CN	Core Network
CR	Core Router
CRRM	Common Radio Resource Management
E2E	End-to-End
EDGE	Enhanced Data Rates for GSM Evolution
EF	Expedited Forwarding
ER	Egress Router
GERAN	GSM/EDGE Radio Access Network
GSM	Global System for Mobile Communications
HO	Handover
IR	Ingress Router
IP	Internet Protocol
LAN	Local Area Network
LSP	Label Switch Protocol
MPDP	Master PDP
MPLS	Multiprotocol Label Switching
NCCB	Network-Controlled Cell-Breathing
PC	Personal Computer
PDP	Policy Decision Point
PL	Path Loss
QoS	Quality of Service
RAT	Robust Audio Tool
RAT	Radio Access Technology
SLA	Service Layer Agreement
SLS	Service Level Specification
TCP	Transport Control Protocol
TG	Traffic Generator
TS	Traffic Switch
UE	User Equipment
UDP	User Datagram Protocol
UMTS	Universal Mobile Telecommunications System
UTRAN	UMTS Terrestrial Radio Access Network
UUT	User Under Test
VHO	Vertical Handover
VIC	Video Conference Tool
VLC	Video LAN Client
WLAN	Wireless LAN
WQB	Wireless QoS Broker

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