

D06.2: AeroMACS Verification Report

Document information		
Project Title	Airport Surface Datalink	
Project Number	15.02.07	
Project Manager	Indra	
Deliverable Name	AeroMACS Verification Report	
Deliverable ID	D06.2	
Edition	00.01.00	
Template Version	03.00.00	
Task contributors		
THALES; SELEX; INDRA; AIRBUS; EUROCONTROL; DSNA		

Abstract

The general purpose of the 15.2.7 project is to verify the AeroMACS Data Link. This document describes the Verification report within the 15.2.7 Project regarding phase 1 testing.

Authoring – D06-Part 2

Prepared By - Authors of the document.		
Name & Company	Position & Title	Date
THALES		30/07/2013
SELEX ES		15/11/2013

Document History

Edition	Date	Status	Author	Justification
00.00.01	05/06/2013	Draft	THALES	New Document
00.00.02	25/06/2013	Draft	SELEX ES	New document reviewed
00.00.03	08/07/2013	Draft	THALES	Thales Test results added
00.00.04	15/11/2013	Draft	SELEX ES	Selex ES Test results added
00.00.05	26/11/2013	Draft	SELEX ES	Fixes and editorial changes and after Thales comments
00.00.06	06/12/2013	Draft	THALES	Reviewer comments taken into account.
00.01.00	06/12/2013	Final	INDRA	Final version for handover to SJU

Intellectual Property Rights (foreground)

This deliverable consists of SJU foreground.

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

2 of 100

EXECUTIVE SUMMARY	6
1 INTRODUCTION	7
 1.1 PURPOSE OF THE DOCUMENT 1.2 INTENDED READERSHIP	7 7 8
2 CONTEXT OF THE VERIFICATION	10
 2.1 SYSTEM OVERVIEW	12 <i>12</i>
3 CONDUCT OF VERIFICATION EXERCISES	14
 3.1 VERIFICATION EXERCISES PREPARATION	
4 VERIFICATION EXERCISES RESULTS	16
 4.1 SUMMARY OF VERIFICATION EXERCISES RESULTS	
5 CONCLUSIONS AND RECOMMENDATIONS	
6 REFERENCES	19
6.1 REFERENCE DOCUMENTS	19
APPENDIX A DETAILED VERIFICATION EXERCISES REPORT	20
 A.1 VERIFICATION EXERCISE # TLAB_010 REPORT	20 20 24 32 33 33 33 33 33 33 43 43
A.3.1 Verification Exercise Scope A.3.2 Conduct of Verification Exercise A.3.3 Verification exercise Results A.3.4 Conclusions and recommendations A.4 VERIFICATION EXERCISE # TLAB_040 REPORT	44 45 46

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

3 of 100

A.4.1	Verification Exercise Scope	47
A.4.2	Conduct of Verification Exercise	
A.4.3	Verification exercise Results	
A.4.4	Conclusions and recommendations	56
A.5 V	'ERIFICATION EXERCISE # TLAB_050 REPORT	57
A.5.1	Verification Exercise Scope	57
A.5.2	Conduct of Verification Exercise	57
A.5.3	Verification exercise Results	
A.5.4	Conclusions and recommendations	
A.6 V	'ERIFICATION EXERCISE # LAB1_1 CONNECTION ESTABLISHMENT REPORT	64
A.6.1	Verification Exercise Scope	
A.6.2	Conduct of Verification Exercise	
A.6.3	Verification exercise Results	
A.6.4	Conclusions and recommendations	
A.7 ∖	'ERIFICATION EXERCISE # LAB1_2 POWER CONTROL REPORT	
A.7.1		
A.7.2	Conduct of Verification Exercise	
A.7.3	Verification exercise Results	
A.7.4	Conclusions and recommendations	80
	'ERIFICATION EXERCISE # LAB1_3 QUALITY OF SERVICE REPORT	
A.8.1	Verification Exercise Scope	
A.8.2	Conduct of Verification Exercise	
A.8.3	Verification exercise Results	
A.8.4	Conclusions and recommendations	
	PRIFICATION EXERCISE # LAB1_4 SECURITY REPORT	
A.9.1	Verification Exercise Scope	
A.9.2	Conduct of Verification Exercise	
A.9.3	Verification exercise Results	
A.9.4	Conclusions and recommendations	
	'ERIFICATION EXERCISE # LAB1_5 RADIO CHARACTERISTICS REQUIREMENTS REPORT	
A.10.1		
A.10.2		
A.10.3		
A.10.4		
	'ERIFICATION EXERCISE # LAB1_6 TRANSMIT POWER REPORT	
A.11.1		
A.11.2		
A.11.3		
A.11.4	Conclusions and recommendations	

founding members



List of tables

Table 1: Testing organization	.10
Table 2: Covered verification Objectives in Phase 1	.13
Table 3: Phase 1 Thales lab. Tests	
Table 4: Phase 1 Selex lab. tests	.13
Table 5: Summary of Thales lab. tests results for phase 1	. 16
Table 6: Summary of Selex Lab. tests results for phase 1	. 16

List of figures

Figure 1: Lab_test_bed_01 (Thales)	.14
Figure 2: Lab_test_bed_02 (Selex)	. 15
Figure 3: Picture of test bed in Thales Lab	. 22
Figure 4: AeroMACS Setup on Agilent Spectrum Analyzer	.64
Figure 5: Picture of test bed in Selex ES Lab	.65
Figure 6: Spectrum Analyzer connected to AeroMACS BS	.70
Figure 7: Preamble Detection by MS	
Figure 8: DCD Decoding by MS	
Figure 9: Initial Ranging - the MS receives a RNG_RSP with Status Success	.71
Figure 10: SS Basic Capabilities Exchange between MS and BS	.72
Figure 11: Registration procedure and Service Flow Creation	
Figure 12: Initial Network Entry Time	.75
Figure 13: Open Loop passive Power Control Protocol	.79
Figure 14: Closed Loop Power Control adjustment at the MS	. 80
Figure 15: QoS - Test bed	. 80
Figure 16: Wireshark Log on ASN-GW ports: no transmission for IP flow not compatible with the SF	
Classification for DL	.84
Figure 17: Successful IP Flow in UL	. 85
Figure 18: IPERF Log at the ASN-GW: 2 Mbps requested to be sent in DL	.86
Figure 19: IPERF Log at the MS: 1Mbps Max Baud Rate respected	.86
Figure 20: SF1 loaded with 2 Mbps	
Figure 21: SF2 loaded with 3 Mbps	
Figure 22: Baud rate on SF1	.88
Figure 23: Baud rate on SF2	. 88
Figure 24: Net Entry without authentication - WS Log	.91
Figure 25: EAP-based Authentication Procedure	
Figure 26: AeroMACS BS measured Spectral Mask	. 95
Figure 27: Selex AeroMACS BS prototype target spectrum mask	
Figure 28: BS Output Band Power	

founding members



Executive summary

The goal of project 15.2.7, in strong collaboration with Project 9.16, is to define, validate and demonstrate the technical standard based upon existing IEEE 802.16e of the future airport surface data link as foreseen by the aviation community and ICAO. Therefore, it includes the modification of the IEEE 802.16e standard and the developing of a new AeroMACS profile dedicated for airport surface datalink for ATC / AOC services, in order to be compliant with SESAR / ICAO FCI recommendations.

The mentioned evaluation will assess the performance and capacity of the technology by means of analytical work and simulations in order to develop design specifications. Moreover, prototypes were defined and developed to demonstrate results through measurements and trials, in strong coordination with the appropriate standardization bodies.

Therefore, 9.16 and 15.2.7 projects are contributing to the development of an aviation technical standard to be recognized by ICAO in direct and strong cooperation with Eurocae WG82 and RTCA SC 223.

The purpose of the present document is to report tests results corresponding to the verifications performed in project 15.2.7 phase 1 as described in the dedicated 15.2.7. Verification plan [3].

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

6 of 100

1 Introduction

1.1 Purpose of the document

The overall 15.2.7 verification activity has been divided in two separate working activities phases as described in the verification strategy (see D05.2 document [1]):

- Phase 1 is related to Laboratory Tests only. This Task verifies the main part of the MS/BS Interoperability and RF performances objectives.
- Phase 2 is related both to additional Laboratory Tests and Toulouse Airport Tests (task T10).

Within the 15.2.7 project, verification tests consist in:

- Laboratory tests, held in SELEX and THALES premises, with both partners pieces of equipment,
- Field tests, held in Toulouse Airport, by THALES & DSNA, with THALES pieces of equipment.

The overall verification tests will cover the following aspects:

- MS/BS Interoperability, including AeroMACS Profile,
- RF specification and performances,
- RF performances in real environment (Airport).

This document provides the Verification report for the phase 1 testing activities of the AeroMACS Data Link performed within the 15.2.7 project. It describes the results of the verification exercises defined in the "AeroMACS - verification plan [3]" and how they have been conducted.

1.2 Intended readership

This document is a deliverable for the task "WA6: Integration & testing". It is intended to be used primarily by the partners of the 15.2.7 Project. However, for coordination reasons, also Projects SESAR 9.16, SANDRA SP6 and SANDRA SP7 should take this deliverable into account.

Other operational/system projects, like WP3, could make use of the deliverables of 15.2.7/9.16 projects.

1.3 Structure of the document

The structure of the document is based on 7 chapters:

- Chapter 1 is an introduction describing the purpose of the document and the intended readership.
- Chapter 2 describes the context of the Verification.
- Chapter 3 gives a brief description of the conduct of the verification exercises.
- Chapter 4 summarizes verification exercises results
- Chapter 5 gives conclusion and recommendations
- Chapter 6 reports in details the results for each test case
- Chapter 7 lists the reference documents

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

7 of 100

1.4 Glossary of terms

For terminology clarification, the following terms are defined below:

- "Mock-up" : Part of MS test equipment
- "Prototype" : Base/Mobile station prototype equipment
- "System (test) platform": Bring together several prototypes, mock-up and tools

1.5 Acronyms and Terminology

Term	Definition		
ADD	rchitecture Definition Document		
АТМ	Air Traffic Management		
CLI	Command Line Interface		
DOD	Detailed Operational Description		
E-ATMS	European Air Traffic Management System		
E-OCVM	European Operational Concept Validation Methodology		
GS	Ground Station (Base Station in WiMAX terminology)		
IRS	Interface Requirements Specification		
INTEROP	Interoperability Requirements		
MS	Mobile Station (Subscriber Station or CPE in WiMAX terminology)		
OFA	Operational Focus Areas		
OSED	Operational Service and Environment Definition		
SESAR	Single European Sky ATM Research Programme		
SESAR Programme	The programme which defines the Research and Development activities and Projects for the SJU.		
SJU	SESAR Joint Undertaking (Agency of the European Commission)		
SJU Work Programme	The programme which addresses all activities of the SESAR Joint		

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

8 of 100

Term	Definition	
	Undertaking Agency.	
SPR	Safety and Performance Requirements	
SUT	System Under Test	
TAD	Technical Architecture Description	
тѕ	Technical Specification	
VALP	Validation Plan	
VALR	Validation Report	
VALS	Validation Strategy	
VP	Verification Plan	
VR	Verification Report	
VS	Verification Strategy	

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

9 of 100

2 Context of the Verification

Project 15.2.7 is a technological project dealing with the adaptation of the WiMAX 802.16-2009 standard (in the aeronautical C band) and with the definition of a profile suited to airport surface communications supporting both ATS and AOC data exchanges.

In this context, the verification approach consists in assessing and collecting evidences on the suitability and performances of the proposed technology (AeroMACS) against the on-going standardization of the new generation of airport data link system, performed in close conjunction with RTCA SC223 and Eurocae WG82.

The objective of the verification phase is thus to perform operational evaluation using lab testing and field trials together with analysis and modeling to deliver the appropriate material for decision making and for preparation of pre-operational and implementation decisions.

2.1 System Overview

As already stated, AeroMACS Data Link global overall verification is addressed by Project 15.2.7, but also by Projects 9.16, SANDRA SP6 and SANDRA SP7.

This section provides the general verification background.

Identify the scope of the intended verification: It could be mainly IBP/V&V Platform Verification for WP03 or System / Sub-system / Function Verification for Sys L3 X.Y.Z.

Describe who the stakeholders are and how they are concerned by the scope of verification.

In any case, tell which systems will be verified. If relevant, tell which Operational Package/Sub-Package/Operational Focus Areas are concerned by the verification scope.

Prerequisites to the scoped verification as integration activities or preliminary verification activities are stated at §**¡Error! No se encuentra el origen de la referencia.**

This document focusses on the Verification test cases achieved within the 15.2.7 Project, namely:

- Lab tests: performances measurement related to the new AeroMACS profile and interoperability between different vendors pieces of equipment,
- Field tests: tests in real airport environment focused on the ground segment datalink.

The table below gives an overview of main partners involved in lab and field tests within project 15.2.7 and close contributing project 9.16:

	P 15.2.7	P 9.16
Lab. test	THALES, THALES Lab.	SELEX ES Selex Lab.
Lap. lest	SELEX ES, Selex Lab.	
	THALES + DSNA	SELEX ES + Airbus
Field test	Toulouse airport	Toulouse airport
	Focus on ground component of AeroMACS	Focus on airborne component of AeroMACS

Table 1: Testing organization

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

11 of 100

2.2 Summary of Verification Exercise/s

2.2.1 Summary of Verification Objectives and Success Criteria

The verification objectives addressed by the phase 1 can be found in the D05.2 document [1]. They are listed in table below.

General VO Id	Title	VO description
AeroMACS_VO_Interop_01	Profile compliance	Verify that the AeroMACS profile parameters selected in the AeroMACS BS and MS are interoperable, and that they are suited to the SESAR usage.
AeroMACS_VO_Interop_02	Link adaptation	Assessment of the different modulation schemes and the throughput hence supported. Verify proper DCD reception and decoding.
AeroMACS_VO_Interop_03	Network Entry	Verify that AeroMACS MS and BS perform all relevant actions at Network Entry that affects the air interface.
AeroMACS_VO_Interop_04	Quality of Service	Verify that the MS-BS interface supports nrtPS, rtPS and BE QoS classes and the corresponding fields: delay, jitter, packet loss, and throughput.
AeroMACS_VO_Interop_05	SF establishment, change and deletion	Verify the completion of the control messages transmission to successfully complete the creation, change and deletion of a service flow to the MS.
AeroMACS_VO_Interop_07	Dynamic BW allocation	Verification of correct allocation of MAC resources.
AeroMACS_VO_Interop_09	ARQ testing	Verify the correct frame retransmission after packet losses.
AeroMACS_VO_Interop_10	Uplink Power Control	Check that a data transfer continues properly when there is a fading in the UL channel. Verify that MS- BS interface supports the closed loop power control.
AeroMACS_VO_Interop_11	Security functions	Verify that the security functions on the air interface are interoperable between AeroMACS MS and BS. Verify the fragmentation and correct reassembling of the packets and the data integrity (FCS).
AeroMACS_VO_RF_01	Cell Coverage	Verify the cell coverage.
AeroMACS_VO_RF_02	Interferences	Verify the out of band interference level generated.
AeroMACS_VO_RF_03	Spurious emissions	Verify the spurious emissions transmitted by AeroMACS.
AeroMACS_VO_RF_06	Transmission grid	Verify that AeroMACS MS transceiver can be tuned by 250 kHz steps with respect to the 5145 MHz reference frequency.
AeroMACS_VO_RF_07	Power classes	Verify the compliance of AeroMACS BS/MS to one of the defined power classes
AeroMACS_VO_RF_08	Transmit power requirements	Verify AeroMACS Transmit power requirements

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

12 of 100

Table 2: Covered verification Objectives in Phase 1

2.2.2 Verification Exercises List and Dependencies

In the first verification phase, SELEX and THALES performed the test cases reported in following tables. The corresponding detailed tests cases as well as their success criteria are to be found in the verification plan for phase 1 (see [3]).

Test Case	Test Case	Lab.	VO's addressed
nr.	Name	Environment	
TLAB_010	Profile	Lab_test_bed_01	AeroMACS_VO_Interop_01_A/B/C/D/E
	compliance		
TLAB_020	Quality of	Lab_test_bed_01	AeroMACS_VO_Interop_04_A/E
	Service		AeroMACS_VO_Interop_07_A
			AeroMACS_VO_Interop_09_A/B/C
TLAB_030	Security	Lab_test_bed_01	AeroMACS_VO_Interop_11_E
TLAB_040	Power &	Lab_test_bed_01	AeroMACS_VO_RF_01_B/C
	sensitivity		AeroMACS_VO_Interop_02_A/B
			AeroMACS_VO_RF_07_B/C/D/E
TLAB_050	Radio	Lab_test_bed_01	AeroMACS_VO_RF_06_B/C
	Performances		AeroMACS_VO_RF_02_A
	and		AeroMACS_VO_RF_03_A/B
	interferences		AeroMACS_VO_RF_08_F
			AeroMACS_VO_RF_08_G

Table 3: Phase 1 Thales lab. Tests

Test Case nr.	Test Case Name	Lab. Environment	VO's addressed
LAB1_1	Connection Establishment	LAB1	Interop_01_A/B/C/D/E Interop_03_A/C/D/E/F RFReal_01_A
LAB1_2	Power Control	LAB1	Interop_10_A/B
LAB1_3	Quality of Service	LAB1	Interop_04_ B/C/D Interop_05_A Interop_07_A /D
LAB1_4	Security	LAB1	Interop_11_A/B
LAB1_5	Radio Performance	LAB1	RF_06_A/B
LAB1_6	Transmit Power	LAB1	RF_07_A RF_08_A/C/D

Table 4: Phase 1 Selex lab. tests

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

3 Conduct of Verification Exercises

3.1 Verification Exercises Preparation

Prior to lab testing, the test beds described in the verification plan ([3]) identified Lab_test_bed_0x (x=1,2) were configured in order to be able to perform the tests in THALES and SELEX labs.

In the verification plan, the Thales test bed was described as follows.

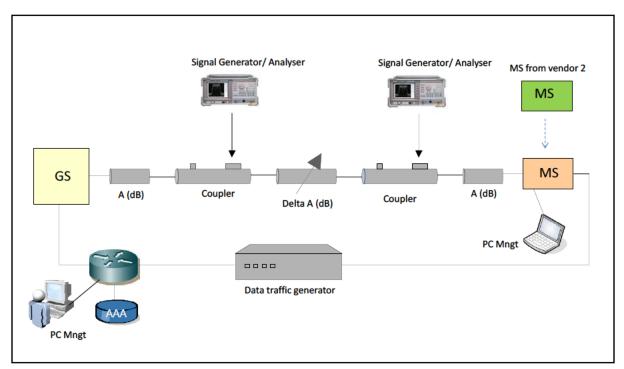


Figure 1: Lab_test_bed_01 (Thales)

Same preparation was performed with Selex test bed as described below.

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

14 of 100

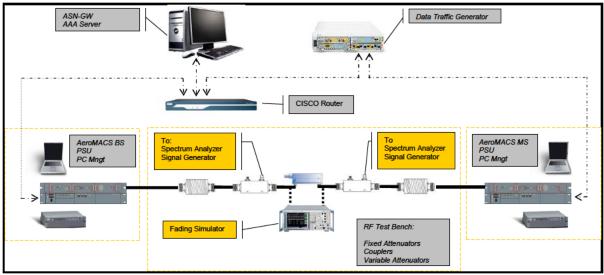


Figure 2: Lab_test_bed_02 (Selex)

3.2 Verification Exercises Execution

Verification Exercises execution took place in the planned time frame for phase 1.

3.3 Deviations from the Planned Activities

Most aspects related to the verification activities were described in the Verification Plan. However, even if it was provided in the Verification Plan this may have changed from the planning to the conduction of the verification exercise e.g. modification of a verification objective, requirements not addressed by unexpected constraints during prototype development phase, etc... The purpose of this chapter is to highlight the changes in respect to the content within the Verification Plan.

3.3.1 Deviations with Respect to the Verification Strategy

The verification strategy described in the verification plan is applied.

3.3.2 Deviations with Respect to the Verification Plan

If any, deviations with respect to the verification plan are highlighted in each verification exercise report in § Appendix A. Slights deviations were noted concerning TLAB_020, LAB1_1 and LAB1_5 Verification Exercises without changing verification strategy (see § A.2.2.3, § A.6.2.3, § A.10.2.3 for detailed description).

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

15 of 100

4 Verification exercises Results

4.1 Summary of Verification Exercises Results

The results of the different Verification test cases are summarized in following tables:

- OK: Verification objective achieves the expectations
- NOK: Verification objective does not achieve the expectations

Test Case	Test Case	Lab. Environment	VO's addressed	Result
nr.	Name			
TLAB_010	Profile compliance	Lab_test_bed_01	AeroMACS_VO_Interop_01_A/B/C/D/E	ОК
TLAB_020	Quality of Service	Lab_test_bed_01	AeroMACS_VO_Interop_04_A/E AeroMACS_VO_Interop_07_A AeroMACS_VO_Interop_09_A/B/C	OK
TLAB_030	Security	Lab_test_bed_01	AeroMACS_VO_Interop_11_E	OK
TLAB_040	Power & sensitivity	Lab_test_bed_01	AeroMACS_VO_RF_01_B/C AeroMACS_VO_Interop_02_A/B AeroMACS_VO_RF_07_B/C/D/E	ОК
TLAB_050	Radio Performances and interferences	Lab_test_bed_01	AeroMACS_VO_RF_06_B/C AeroMACS_VO_RF_02_A AeroMACS_VO_RF_03_A/B AeroMACS_VO_RF_08_F AeroMACS_VO_RF_08_G	ОК

Table 5: Summary of Thales lab. tests results for phase 1

Lab Test Case nr.	Test Case Name	Lab. Environment	VO's addressed	Result
LAB1_1	Connection Establishment	LAB1	Interop_01_A/B/C/D/E Interop_03_A/C/D/E/F RFReal_01_A	ОК
LAB1_2	Power Control	LAB1	Interop_10_A/B	OK
LAB1_3	Quality of Service	LAB1	Interop_04_ B/C/D Interop_05_A Interop_07_A/D	ОК
LAB1 4	Security	LAB1	Interop 11 A/B	OK
LAB1_5	Radio Performance	LAB1	RF_06_A/B	ОК
LAB1_6	Transmit Power	LAB1	RF_07_A RF_08_A/C/D	OK

Table 6: Summary of Selex Lab. tests results for phase 1

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

4.2 Analysis of Verification Exercises Results

The detailed analysis of the verification Exercises can be found in each verification exercise report in §Appendix A.

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

17 of 100

5 Conclusions and recommendations

The main objective of the verification phase is to assess the performances of AeroMACS prototypes.

By analyzing the phase 1 verification results reported in this report, the verification objectives were successfully tested in labs: among others, profile compliance verification, quality of service assessment, sensitivity and radio performances measurement allowed collecting positive evidences on the suitability of the prototypes to assess the AeroMACS technology regarding the on-going standardization.

In conclusion, these phase 1 lab measurements gave a good characterization of the prototypes with positive test results. This gives a good confidence before the field testing to be conducted in Toulouse Airport (phase 2).

This phase 2 testing will gather additional measurements in real environment of Airport surface datalink and thus complement significantly the assessment of the AeroMACS technology in ground segment context with some important information as cell coverage, LOS / nLOS propagation behavior, mobility effect...

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

18 of 100

6 References

6.1 Reference Documents

The following documents were used to provide input:

- [1] P 15.02.07 D05.2 AeroMACS Verification Strategy
- [2] P 15.02.07 D05.1 AeroMACS Prototypes Description
- [3] P 15.02.07 D06.1 AeroMACS Verification Plan

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

19 of 100

Appendix A Detailed Verification Exercises report

This appendix includes the detailed the verification exercise reports.

A.1 Verification Exercise # TLAB_010 Report

A.1.1 Verification Exercise Scope

Verify that the AeroMACS profile parameters (OFDMA, Channel bandwidth, frame length, TDD, channel frequency) selected in the AeroMACS GS and MS are interoperable.

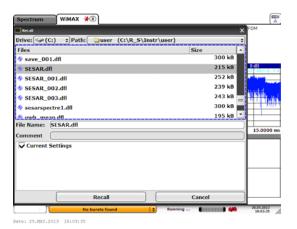
A.1.2 Conduct of Verification Exercise

A.1.2.1 Verification Exercise Preparation

Lab_test_bed_01

Spectrum Analyzer: Rohde & Schwarz FSV-7 with WiMAX option R&S FSV-K93

The configuration defined for Sesar is loaded before the measurement.



Data Traffic generator/analyzer: IXIA

IXIA is configured with prepared configuration file that generate one traffic stream in each direction (UL and DL).

Save	Recent Configuration Files	Test SESAR	
🚽 Save As	Test SESAR 2CPE sources 24/05/2013 17:00:39 C\Documents and Settings\TRC000_2\Local Settings\Application Data\Lsia\Lsia\Lsia\Lsia\Lsia\Lsia\Lsia\Lsi		
lecent Work	Test SESAR 19/04/2013 11:27:24 C\Documents and Settings\TRC000_2\Local Settings\Application Data\tixa\tixa\tixa\tixa\tixa\tixa\tixa\t		Open configuration file Pick this option to open the full configuration file
			Pick this option to open the full configuration in

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

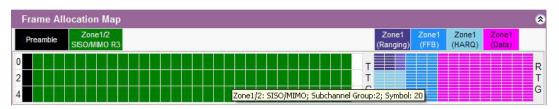
20 of 100

Equipment:

MS/GS are configured according to AeroMACS profile. Namely, prepared configuration files are loaded in the equipment:

RF Profile	SESAR_RF_conf2
MCS Profile	SESAR_MCS_conf2
PHY Profile	SESAR_PHY_conf2
MAC Profile	SESAR_MAC_conf2

As an example, main selected physical parameters are: bandwidth 5 MHz, frame length 5 ms, TDD split 32:15, (UL 15 symbols : including 12 symbols for data -pink, 3 reserved for FFB -blue).



Concerning modulation and coding scheme, the whole set of possibilities for DL and for the UL the optional 64 QAM is selected when needed for the test:

1					
4	0	QPSK (CTC) 1/2	1	1	QPSK (CTC) 1/2
1	1	QPSK (CTC) 3/4	\checkmark	2	QPSK (CTC) 3/4
V.	2	16-QAM (CTC) 1/2	$\overline{\varphi}^{i}$	3	16-QAM (CTC) 1/2
	3	16-QAM (CTC) 3/4	\bigtriangledown	4	16-QAM (CTC) 3/4
\checkmark	4	64-QAM (CTC) 1/2		5	64-QAM (CTC) 1/2
4	5	64-QAM (CTC) 2/3		6	64-QAM (CTC) 2/3
1	6	64-QAM (CTC) 3/4	V	7	64-QAM (CTC) 3/4
¥	7	64-QAM (CTC) 5/6		8	64-QAM (CTC) 5/6

MS & GS are linked together according to test bed configuration with proper attenuation and switched on.

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

21 of 100



Figure 3: Picture of test bed in Thales Lab

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

22 of 100

A.1.2.2 Verification Exercise execution

Step	action	Action result	PCO	Result
1	Set frequency on the GS : - 5120,5 MHz Provision new RF parameter on the GS	New frequency provisioned on GS	GS control MMI Spectrum analyzer	ОК
2	Set frequency scan of MS : - 5093,5 – 5147,5 MHz, step 250 kHz (5002,5 + n*0.25 for n = {364580} in MHz.)	MS connects eventually to the GS	GS control MMI	ОК
3	Initiate traffic in the UL or DL thanks to the traffic generator (either Ixia or Iperf)	Communication established in both directions (UL and DL)	Ixia	OK (Ixia)
4	Confirm the GS OFDMA mode (Spectrum analyzer on GS side)	GS Preamble demodulated	Spectrum Analyzer	OK
5	Measure the GS bandwidth (Spectrum analyzer on GS side) Note: Focus on main channel + adjacent + alternate	Most of Energy included in main central channel 5 MHz	Spectrum Analyzer	ОК
6	Measure the GS Frame Length (Spectrum analyzer on GS side)	Frame of 5 ms	Spectrum Analyzer	OK
7	Check that MS and GS operate in TDD mode (Spectrum analyzer on GS side)	MS et BS alternately emits with ratio as defined on the GS (Note: activity seen only on DL as UL is attenuated by directional coupler to spectrum analyzer)	Spectrum Analyzer	ОК
8	Set frequency on the GS : - 5093,5 MHz	MS connect to new GS frequency	GS control MMI	OK
9	Set frequency on the GS : - 5147,5 MHz	MS connect to new GS frequency	GS control MMI	OK
10	Set frequency on the GS : - 5098.5	MS connect to new GS frequency	GS control MMI	OK
11	Set frequency on the GS : - 5103.5	MS connect to new GS frequency	GS control MMI	OK

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

12	2	Measure the MS bandwidth	Bandwidth 5 MHz	Spectrum	OK
		(Spectrum analyzer on MS side)		Analyzer	

A.1.2.3 Deviation from the planned activities

None.

A.1.3 Verification exercise Results

A.1.3.1 Summary of Verification exercise Results

- Step 4: OFDMA mode verified
- Step 5/12: GS/MS 5MHz bandwidth confirmed
- Step 6: Frame Length measured and OK
- Step 7: TDD Mode verified
- Step 8/9: Edge frequencies reached
- Step 10/11: Complementary measurement at future airport frequencies OK.

A.1.3.2 Analysis of Verification Exercise Results

The testing of these core AeroMACS functionalities (OFDMA, TDD, Frame length, frequency) are done through a configured spectrum analyzer with WiMAX measurement functions.

DL synchronization and frame structure verification done at 5120,5 MHz and also at 5093,5 and 5098,5 MHz, 5147,5 MHz is shown below (Spectrum analyzer was wired on BS side so that UL bursts are sufficiently attenuated to focus on DL activity). One can see that the DL OFDM burst is properly synchronized and demodulated.

founding members

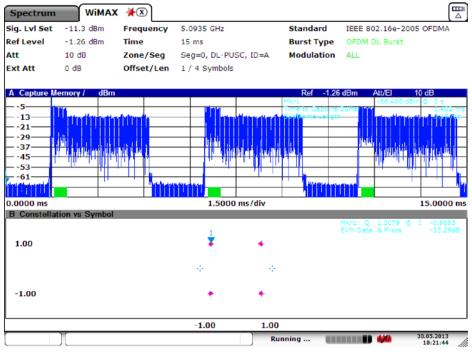


Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

24 of 100



Date: 29.MAY.2013 17:00:06



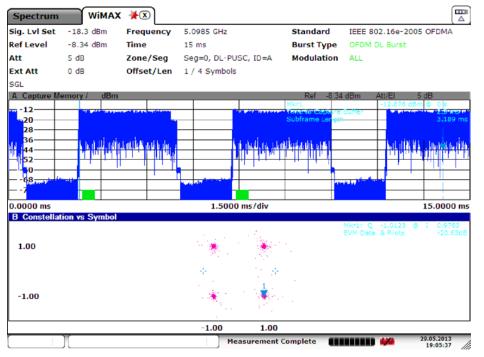
Date: 30.MAY.2013 18:21:44

founding members

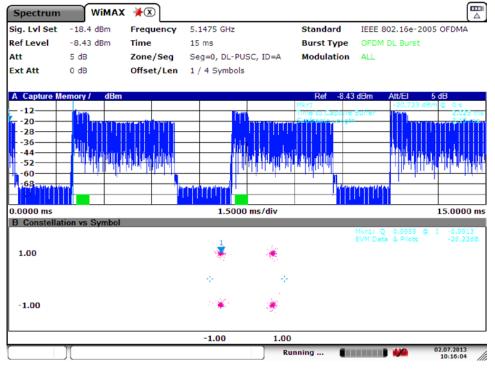


Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

25 of 100



Date: 29.MAY.2013 19:05:37



Date: 2.JUL.2013 10:16:03

founding members



26 of 100

Below is given an example of DL demodulation with 64QAM traffic and 16QAM traffic.



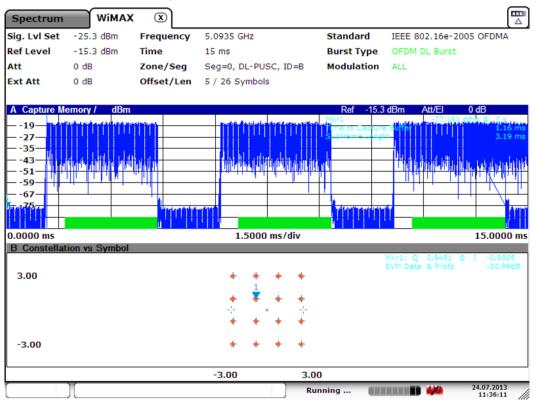
Date: 12.JUL.2013 13:54:12

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

27 of 100



Date: 24.JUL.2013 11:36:12

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

28 of 100

Same positive result for the UL OFDM burst (example below at 5103,5 MHz for QPSK, 16QAM, 64QAM) (spectrum analyzer was wired on MS side so that DL bursts are sufficiently attenuated to focus on UL activity).



Spectrum	WiMA	x 🗴						
ig. Lvl Set	-26.8 dBm	Frequency	5.1035 GH	iz		Standard	IEEE 802.16e-2	005 OFDMA
tef Level	-16.8 dBm	Time	15 ms			Burst Type	OFDM UL Burst	
tt	0 dB	Zone/Seg	Seg=0, UL	-PUSC,	ID=A	Modulation	ALL	
xt Att	0 dB	Offset/Len	0 / 9 Sym	bols				
A Capture Me	emory / dBm	1				Ref -16.8	dBm Att/El	0 dB
-19				-		Mkr1 Time to Capture	Boffer -62.009	dBm @ 0 s 27092 m
27								
43			_	Hilm				
51	11111			111				
-59		alles to all a surfler of	ter the second s		Marke	and courseling	and the second second	To a leasure to a
L a uh	i.c.	at in a state of	ali da		h h.	d de la la la compressione de la compression de la compression de la compression de la compression de la compre	1.4	kill house to a
0.0000 ms			1.5	5000 ms	/div			15.0000
B Constellat	ion vs Symbol						Mkr1: 0 0.0687	© I -3.0782
3.00			14	2	21		Mkr1: Q 0.0687 EVM Data & Pilots	-27.02d
3.00			1 A 1	* *	2			
				* *	٠.			
				a	- 24			
-3.00			۰	* *	*			
			-3.00		3.00			
			-3.00		3.00			

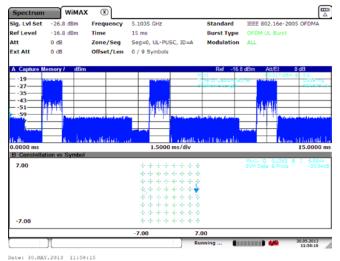
Date: 30.MAY.2013 11:57:12

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

29 of 100



On the pictures above, measured frame duration is 5 ms (3 repetitions can be observed as the analysis time duration of spectrum analyzer is tuned to 15 ms). Detailed time measurements reveals an active DL Burst of 3,2 ms long and an UL burst of 1,5 ms long, consistent with ratio 32:15. The TDD nature of the frame is also clearly shown.

About the 5 MHz bandwidth, it was confirmed through spectrum measurement as shown below, where energy is concentrated on the centered 5 MHz channel for the edges of the band and the center.

Spect	rum		WiM	AX 🦂	×						
Ref Le	vel -:				_		100 kHz		25 MH	z	
Att			5 dB (SWT	10 s 🗎	VBW	30 kHz	Mode	e Sweep		
●1Rm C	Irw		_								
-20 dBm					Adj			011		Adj	-44.70 dE
20 000			_								6.2500 MH
-40 dBm								M1	M1[1]		-41.09 dBn
-40 080							1	~			5.1205000 GH
-60 dBm							}		1		
-60 GBU									Dia.		
			_						Amm	N D2	
				~	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~					D3 D4	
CF 5.1	205 G	Hz					691	L pts			Span 25.0 MHz
Channe											
Ch	anne			Bandwi	dth		Offset	1	Po	wer	
TX1 (Re	ef)			5.0	00 MHz					-24.08 dBm	
Tx Tota	al									-24.08 dBm	
Ch	annel		E	Bandwi	dth		Offset		Lo	wer	Upper
Adj				5.0	00 MHz		5.000	MHz		-63.73 dB	-63.14 dB
Alt1				5.0	00 MHz		10.000	MHz		-75.79 dB	-76.15 dB
Alt2*				5.0	00 MHz		15.000	MHz		-200.00 dB*	0.00 dB*
Marker											
Type	Ref	Trc		Stimu	lus	1	Response		Function	Fu	nction Result
M1		1		5.	1205 GH		-41.09 d				
D1	M1	1			2.5 MH	z	-31.37	dB			
D2	M1	1			2.68 MH	z	-34.19	dB			
D3	M1	1			5.0 MHz	z	-42.03	dB			
D4	M1	1			6.25 MHz	z	-44.70	dB			
	_			_		_					29.05.2013
		1							Measuring)	18:01:19

Date: 29.MAY.2013 18:01:19

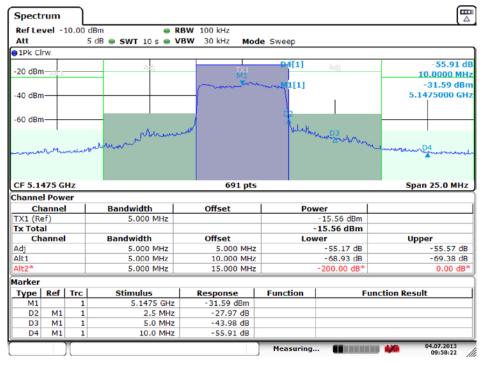
founding members



30 of 100

Ref L	evel	-10.00) dBm	RBW 100 kH;	z			
Att			5 dB 👄 SWT 10 s	s 👄 VBW 30 kH	Z Mode Sv	weep		
1Pk (Clrw							
-20 dB	mater		Adj	M1	D 1[1]	Adj	-28.19 dB 2.5000 MHz	
-40 dB	m—				~~~d[1[1]	I	-30.75 dBm 5.0935000 GHz	
-60 dB	m-		_	A	Ch. Twice			
	m	فستنقد	an and the way			Zarade	Varon Mar Baran Mar	
	0935	GHz			691 pts			an 25.0 MH
Chann	0935	GHz wer	Bandwidth					an 25.0 MH
Chann Ch	0935 Iel Po Ianne	GHz wer			591 pts			an 25.0 MH
Chann Ch TX1 (f	0935 iel Po ianne Ref)	GHz wer	Bandwidth		591 pts	wer		an 25.0 MH
Chann Ch TX1 (F Tx Tot	0935 iel Po ianne Ref)	GHz wer	Bandwidth		591 pts	ver 15.12 dBm 5.12 dBm		an 25.0 MH
Chann Ch TX1 (F Tx Tot Ch	0935 Iel Po Ianne Ref) tal	GHz wer	Bandwidth 5.000 MHz	Offset	591 pts Pov -1 Low	ver 15.12 dBm 5.12 dBm	Sp	an 25.0 MH
Chann Ch TX1 (F Tx Tot Ch Adj	0935 Iel Po Ianne Ref) tal	GHz wer	Bandwidth 5.000 MHz Bandwidth	Offset	591 pts Pov -1 Low	ver 15.12 dBm 5.12 dBm ver	Sp Upper	an 25.0 MH
TX1 (F Tx Tot	0935 Iel Po Ianne Ref) tal	GHz wer	Bandwidth 5.000 MHz Bandwidth 5.000 MHz	Offset Offset 5.000 MHz	591 pts	ver 15.12 dBm 5.12 dBm ver - 54.93 dB	Sp Upper -55.41 dB	an 25.0 MH
Chann Ch TX1 (F Tx Tot Ch Adj Alt1	0935 iel Po ianne Ref) tal ianne	GHz wer	Bandwidth 5.000 MHz Bandwidth 5.000 MHz 5.000 MHz	Offset 5.000 MHz 10.000 MHz	591 pts	ver 15.12 dBm 5.12 dBm ver - 54.93 dB - 68.51 dB	Upper -55.41 dB -69.22 dB	an 25.0 MH
Chann TX1 (F Tx Tot Ch Adj Alt1 Alt2*	0935 el Po anne Ref) tal anne	GHz wer	Bandwidth 5.000 MHz Bandwidth 5.000 MHz 5.000 MHz	Offset 5.000 MHz 10.000 MHz	591 pts	ver 15.12 dBm 5.12 dBm ver -54.93 dB -68.51 dB 200.00 dB*	Upper -55.41 dB -69.22 dB	an 25.0 MH
Chann Ch TX1 (f Tx Tol Ch Adj Alt1 Alt2* Marke	0935 el Po anne Ref) tal anne	GHz wer	Bandwidth 5.000 MHz Bandwidth 5.000 MHz 5.000 MHz 5.000 MHz 5.000 MHz	Offset Offset 5.000 MHz 10.000 MHz	591 pts 	ver 15.12 dBm 5.12 dBm ver -54.93 dB -68.51 dB 200.00 dB*	Upper -55.41 dB -69.22 dB 0.00 dB*	an 25.0 MH
Chann Ch TX1 (F Tx Tol Ch Adj Alt1 Alt2* Marke Type	0935 el Po anne Ref) tal anne	GHz wer	Bandwidth 5.000 MHz Bandwidth 5.000 MHz 5.000 MHz 5.000 MHz Stimulus	Offset 5.000 MHz 10.000 MHz 15.000 MHz (Response)	591 pts 	ver 15.12 dBm 5.12 dBm ver -54.93 dB -68.51 dB 200.00 dB*	Upper -55.41 dB -69.22 dB 0.00 dB*	an 25.0 MH
Chann Ch TX1 (f Tx Tol Ch Adj Alt1 Alt2* Marke Type M1	0935 iel Po ianne Ref) tal ianne r Ref	GHz wer	Bandwidth 5.000 MHz Bandwidth 5.000 MHz 5.000 MHz	Offset 5.000 MHz 10.000 MHz 15.000 MHz Response - 30.75 dBm	591 pts 	ver 15.12 dBm 5.12 dBm ver -54.93 dB -68.51 dB 200.00 dB*	Upper -55.41 dB -69.22 dB 0.00 dB*	an 25.0 MH

Date: 4.JUL.2013 10:05:46



Date: 4.JUL.2013 09:58:22

founding members



31 of 100

A.1.3.3 Unexpected Behaviors/Results

None.

A.1.4 Conclusions and recommendations

The testing allowed checking the core AeroMACS functionalities (OFDMA, TDD, Frame length, frequency). No recommendations for next phase (Airport tests) as all verification objectives are addressed satisfactory.

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

32 of 100

A.2 Verification Exercise # TLAB_020 Report

A.2.1 Verification Exercise Scope

Test QOS: verify the traffic priority functionality, verify SF BE rules, verify of correct allocation of MAC resources and verify the correct frame retransmission after packet losses in case of ARQ or not.

A.2.2 Conduct of Verification Exercise

A.2.2.1 Verification Exercise Preparation

Same as for TLAB_010 see § A.1.2.1. Additionally, QOS service flows are configured as defined in verification exercise execution.

A.2.2.2 Verification Exercise execution

Step	action	Action result	PCO	Result
P1: Te	est QOS priority			
1	Set frequency on the GS : - 5120,5 MHz Switch on the GS	GS on	GS control MMI	OK
2	Configure on the GS two SF, each with a different classifier based on @IP source from each source. The SFs have the same characteristics except the priority: in one case 0 and in the other case 7.		GS control MMI	ок
3	Set frequency scan of MS : - 5093,5 – 5147,5 MHz, step 250 kHz (5002,5 + n*0.25 for n = {364580} in MHz) Switch on the MS	MS connects eventually to the GS	GS control MMI	ОК
4	Tune the variable attenuator so to obtain the max available modulation.	64QAM	GS control of MMI	ОК
5	Simulate two UP streams on the IXIA generator with two different @IP sources. The sum of data rate is more than can be achieved with QPSK and less that can be achieved with 64QAM		IXIA MMI GS control MMI	ок
6	Increase the attenuation so to obtain a QPSK modulation. Data rate decreases.	QPSK	GS control of MMI	OK

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

D00.4	2 - AeroMACS Verification Report			
7	Check that the stream with less priority is affected first by data rate downgrade.	Packet loss on the stream with less priority	IXIA	OK
P2: te	est BE			
1	Configure on the GS one DL SF of BE type with a maximum data rate of 300 kbps and a classifier based on any stream. Check that for BE type only the max data rate can be set.		GS control MMI	OK
2	Simulate one DL stream on the IXIA generator with a data rate of 1 Mbps.	One stream generated.	IXIA GS control MMI	OK
3	Check that the DL stream data rate is limited corresponding to the max data rate of SF.	Data rate limited to 300 kbps	IXIA GS control MMI	OK
P3: A	RQ testing			
1	ARQ is activated on the BS. Simulate a data stream through IXIA and generate some impairments: attenuation at the sensitivity limit of a modulation (modulation is fixed, ACM disabled).		IXIA	OK
	Check the packet losses after a long time			
2	ARQ is deactivated on the BS, modulation is fix, ACM disabled. Simulate a data stream through IXIA and same attenuation as above.		IXIA	ОК
	Check the packet losses after a long time			
3	Compare the packet losses and latencies	Packet losses in greater when no ARQ	IXIA	OK
P4: B	W allocation			
1	Configure on the GS one UL SF of BE type.	SF parameters set	GS control MMI	OK
2	First generate a stream corresponding to BE service flow and almost max data rate.		IXIA	OK
3	Configure on the GS with one UL SF of UGS type a fixe bandwidth can be allocated.		GS control MMI IXIA	OK

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

34 of 100

A.2.2.3 Deviation from the planned activities

In P4.3 steps on the test, the test is adapted as follows to be executed based on the guaranteed rate of the flows. BE and UGS streams are generated simultaneously, and one shall observe that, in case of bandwidth shortage, the stream related to UGS is prioritized compared to the BE one and that the UGS stream is maintained in a regular way (for UGS scheduling the BS provides the MS with fixed size grants in a periodic manner) whereas in the BE case the allocated bandwidth to the stream varies (for BE scheduling the BS does not provide dedicated polling opportunities to the MS).

A.2.3 Verification exercise Results

A.2.3.1 Summary of Verification exercise Results

- Phase 1: QOS priority is working as expected. The stream classified in a SF with the higher priority is privileged.
- Phase 2: It was verified that the Best Effort type QOS essentially offers to set a max data rate limit and the test shows that it is correctly enforced by the equipment.
- Phase 3: ARQ testing performed better than Non ARQ in terms of packet loss.
- Phase 4: It was correctly observed that the UGS service flow takes over the BE service flow and that the MS, in case of UGS, is provided with fixed size grants regarding bandwidth allocation.

founding members



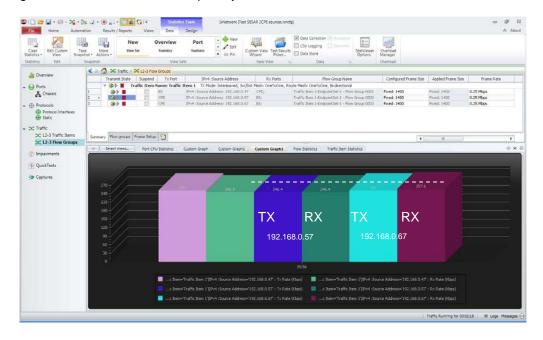
Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

35 of 100

A.2.3.2 Analysis of Verification Exercise Results

- Phase 1: QOS priority

Two UL SF of BE type are defined. One with the lowest priority for the data coming from IP address 192.168.0.67 and one with the highest priority for the data coming from IP address 192.168.0.57. A data rate shortage is created by increasing the attenuation on the link (downgrading of modulation), and the resulting aggregate data rate is lower than the required data rate for data transmission. The observation is that the data flow with a SF of higher priority is privileged over the one with a lower priority in terms of bandwidth allocation.

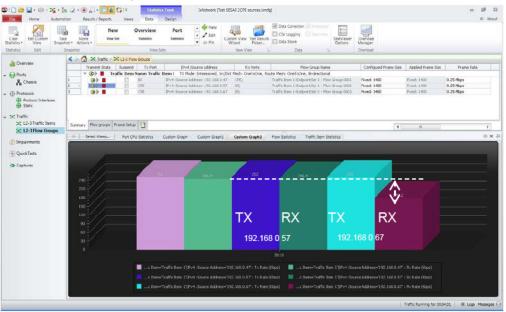


founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

36 of 100



- Phase 2: Best Effort

The QoS parameters associated with BE service are maximum sustained traffic rate and traffic priority. It was observed that a data flow with more than the maximum allowed data rate is limited to max. This is showed on following picture. One UL and one DL BE SF with 300 kbps max are defined. When transmitted more than 300 kbps, the received data rate is limited to 300 kbps.

founding members

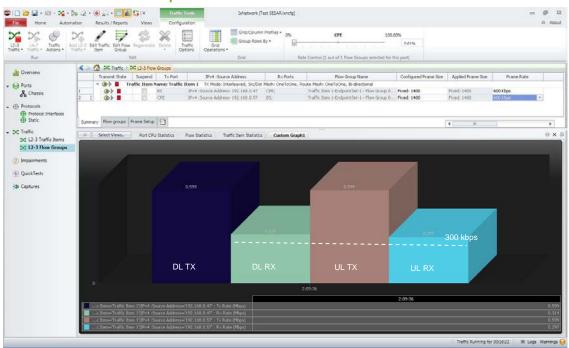


Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

37 of 100

Edition 00.01.00

Project Number 15.02.07 D06.2 - AeroMACS Verification Report



- Phase 3: ARQ testing

The test consists in verifying that an ARQ connection compared to a non ARQ connection in the same radio conditions, has less packet losses and higher latency, due to the fact that packet are retransmitted.

This is shown in the two pictures below where the attenuator is tuned to be at the sensitivity limit: same signal conditions but in the first case ARQ is activated and in the second case it is deactivated. In first case, we are able to observe that the packet losses are maintained low whereas latency increases due to packet retransmission and in the second case, as no packet retransmission occurs, packet losses increase regularly.

founding members

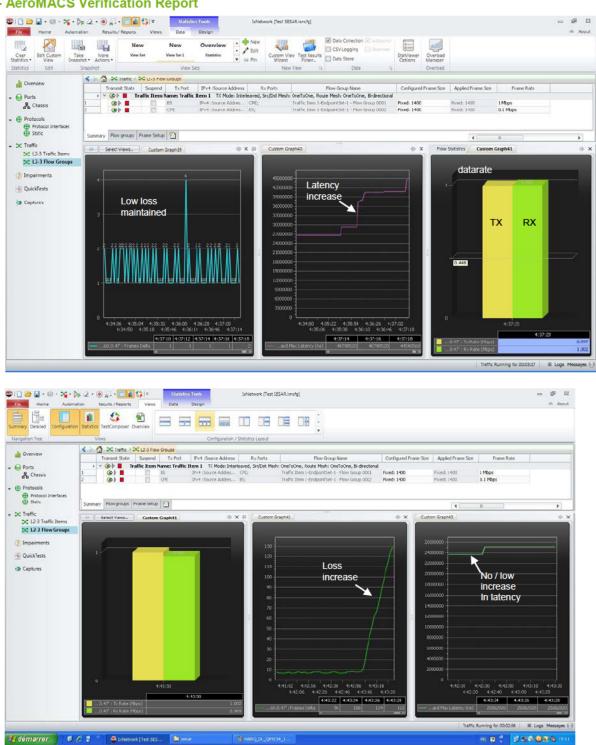


Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

38 of 100

Edition 00.01.00

Project Number 15.02.07 D06.2 - AeroMACS Verification Report

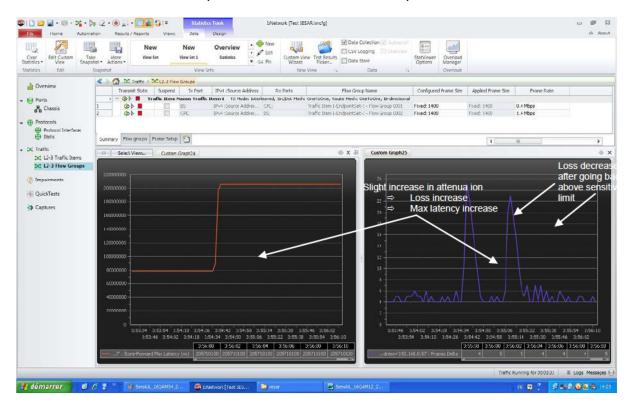


founding members

Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

39 of 100

Additional tests are presented below with ARQ enabled. The variable attenuator is tuned one dB below sensitivity threshold (so that packet losses begin) and back above sensitivity threshold. One can see the effect of packet retransmissions to reduce packet losses.



founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

40 of 100

- Phase 4: Bandwidth allocation

Two UL service flows were defined with same priority and same max sustained rate. One is BE and associated with IP SRC 192.168.0.57 and the other is UGS with IP SRC 192.168.0.67. A data rate shortage is then created by increasing the attenuation on the link (downgrading of modulation), and the resulting aggregate data rate is lower than the required data rate regarding the data traffic to transmit. One can see that UGS is privileged over BE.

		ews Configuration							& Acout
L2-3 L4-7 Traffic Traffic - Actions	Add L2-3 Edit Traffic Edit Flow Teger	erate Delete Traffic Options	Grid Colum Grid Operations •		CPE	58.99%	1.01%		
fun	Edit		Grid	Rate	Cartral (1 out of 2 Sow Groups s	selected for this p	art)		
Dveniew	Transmit State Susp		IPv1 :Source Address	Ry Ports	Flew Group Nam		Configured Frame Sze	Applied Frame Sze	Frame Rate
Ports Declassis Protocols Photocol Interfaces Static		em Name Traffic Rem 85 IPv CPL IPv		t Mesh: OneToOne, Rout CPE; BS;	e Meshi OreiToOrei, Bi-directiona Traffic Item I-EndpointSet-1 - Pio Traffic Item I-EndpointSet-1 - Fio Traffic Item I-EndpointSet-1 - Fio	al ow Group 1001 ow Group 1002	Pixed: 1400 Pixed: 1400 Pixed: 1400	Piced: 1400 Piced: 1400 Piced: 1400	0.25 Mbps 1 Mbps 1 Mbps
DC Traffic DC L2-3 Traffic Items DC L2-3 How Groups	Summary Plaw groups Frame	Concertainty and	om Graph Custom Graph1	Custom Graph2	Now Statistics Traffic Item St	tandics	1		• • • •
Impairments QuickTests									
	11								
3 Captures	1000 -			1002.4	96	100.1			
	1005 - 1005 - 405 - 405 -		267	TX 192.1	RX	TX 192.16	8.0.67 RX		
	800		2467	ΤХ	RX	TX 192.16	RX		

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

41 of 100

Edition 00.01.00

Project Number 15.02.07 D06.2 - AeroMACS Verification Report

< >< @	eton Results / Reports	Views Configurat		Grid/Column Profiles - C Group Rows By -	×	CPE	58.99%	1,01%			A About
tun		dit		Grid	Rate Control (1	out of 2 flow Groups	selected for this p	ort)			
Oveniew	Transmit State	CL2-3 Flow Groups Suspend Tx Port	IPvi :Source Add	tress Ry P	ets	Flow Group Nat	ne	Configured Frame Sze	Applied Frame Sze	France Rate	
Ports Dechasois Protocols Protocol Interfaces Dechasois		affic Item Name Traffic Ite B5 1 CPL 1		wed, Src,Det Mesh; Orie1e 2.168.0.47 CPE; 2.160.0.57 BS;	One, Route Meshi O Traffic Ite Traffic Ite		iał low Group 1001 low Group 1002	Fixed: 1400 Fixed: 1400 Fixed: 1400	Piced: 1400 Ficed: 1400 Ficed: 1400	0.25 Mbps 1 Mbps 1 Mbps	R
C Traffis C Traffis C 12-3 Traffic Items DC 12-3 Flow Groups	Summary Plow groups I	Frame Setup						1	н		•
) Impairments	Select Views.	Port CPU Statistics Cu	ustom Graph Custom	Graph1 Custom Gra	ph2 Flow State	stics Traffic Item 3	statistics				• X
	1	After BW sl		-	ph2 Flow Stat:		100.				• ×
Impairments QuickTests	1000- 800-		hortage			RX	тх	RX 168.0.67			⇔ ×

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

42 of 100

In following pictures, one can see that bandwidth allocation granted to MS in case of UGS is fix and stable while the allocation for BE is erratic in time.



A.2.3.3 Unexpected behaviors/Results

None.

A.2.4 Conclusions and recommendations

The testing allowed checking QOS functionalities.

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

43 of 100

A.3 Verification Exercise # TLAB_030 Report

A.3.1 Verification Exercise Scope

Security: verify that BS and MS are able to use encryption.

A.3.2 Conduct of Verification Exercise

A.3.2.1 Verification Exercise Preparation

Same as for TLAB_010 see § A.1.2.1. Additionally, a AAA server was used (Freeradius.Net 1.1.7-r0.0.2).

A.3.2.2 Verification Exercise execution

Step	action	Action result	PCO	Result
1	Set frequency on the GS : - 5120,25 MHz Switch on the GS AAA server is on	GS on	GS control MMI	ОК
2	Set frequency scan of MS : - 5093,5 – 5147,5 MHz, step 250 kHz (5002,5 + n*0.25 for n = {364580} in MHz.) Switch on the MS	MS connects eventually to the GS		ОК
3	Ping the MS from the PC of the GS	Ping OK	PC MMI	OK (PC of MS)
4	Sent file via FTP from the PC of the GS to the PC of the MS	File transfer done	PC MMI	ОК
5	Deregister MS Remove secret information on MS	MS tries to connect without success to the GS	GS control MMI	ОК
6	Deactivate authentication on the GS.	MS connects eventually to the GS		OK
7	Sent file via FTP from the PC of the GS to the PC of the MS	File transferred (cyphering not used)	PC MMI	ОК

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

44 of 100

A.3.2.3 Deviation from the planned activities

None

A.3.3 Verification exercise Results

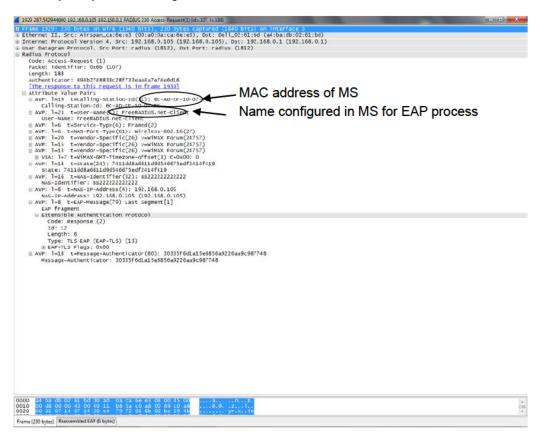
A.3.3.1 Summary of Verification exercise Results

The test showed that the Authentication, Authorization, and Accounting (AAA) process performed as expected.

A.3.3.2 Analysis of Verification Exercise Results

We observed that when the MS was well configured with the certificates and other secret information (password...), it was correctly authenticated and authorized to communicate. Without this mandatory information, the MS was not authorized to register.

To illustrate this, below we can see two captures by Wireshark of the Radius exchanges with the AAA server: one shows the Access-Request message from MS relayed to the AAA server and the other shows the Access-Accept response message from the AAA server.



founding members



45 of 100

1930 287.554206000 192.168.0.1 192.168.0.105 RADIUS 225 Access-Accept(2) (d=107, 1=183)	0 X
Frame 1930: 225 bytes on wire (1800 bits), 225 bytes captured (1800 bits) on interface 0	
B Ethernet II, Src: Dell_02:61:bd (a4:ba:db:02:61:bd), Dst: Airspan_ca:6e:e3 (00:a0:0a:ca:6e:e3)	
a Internet Protocol Version 4, src: 192.168.0.1 (192.168.0.1), bst: 192.168.0.105 (192.168.0.105) a User Datagram Protocol, Src Port: radius (1812), bst Port: radius (1812)	
© User Datagram Protocol, Src Port: radius (1812), Dst Port: radius (1812) Radius Protocol	
Code: Access-Accept (2)	
Packet identifier: 0x6b (107)	
Length: 183	
Authenticator: 08456e080ab30f1a0f4f128c89e5ebfe	
IThis is a response to a request in frame 19291	
[Time from request: 0.011265000 seconds] = Astribute value Pairs	
B AVP: 1-58 t=Vendor-Specific(26) v=Microsoft(211)	
B AVP: 1-58 t-vendor-specific(26) v-Microsoft(311)	
AVP: 1=6 t=EAP-Message(79) Last Segment[1]	
EAP fragment	
Extensible Authentication Protocol code: Success (3)	
Id: 12	
Length: 4	
■ AVP: 1=18 t=Message-Authenticator(80): 7b3e0f74f4fbffc624e1fbe838c1f81f	
B AVP: 1=23 t=User-Name(1): FreeRADIUS.net-Client	
0000 😰 0c 00 04 📲	
Frame (225 bytes) Reassembled EAP (4 bytes)	

A.3.3.3 Unexpected behaviors/Results

None.

A.3.4 Conclusions and recommendations

It was verified that the equipment properly implement authentication via the AAA server to handle an encrypted communication.

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

46 of 100

A.4 Verification Exercise # TLAB_040 Report

A.4.1 Verification Exercise Scope

Verify the modulation and coding schemes supported by MS and BS, measure the modulation sensitivity assess the dynamic modulation change and check the MS/BS maximum tolerable input.

A.4.2 Conduct of Verification Exercise

A.4.2.1 Verification Exercise Preparation

Same as for TLAB_010 see § A.1.2.1. Verification Exercise execution

Step	action	Action result	PCO	Result
Phase	1 : measure performances of the uplink			
1	On the GS control MMI: - Set frequency : 5093,5 MHz - UL sub channelization is set to fix - Fix the UL modulation to 64QAM 5/6 Provision the GS	provisioned	GS control MMI	ок
2	Set frequency scan of MS : - 5093,5 – 5147,5 MHz, step 250 kHz (5002,5 + n*0.25 for n = {364580} in MHz.)	MS connects eventually to the GS	GS control MMI	OK
3	Initiate a communication between MS and GS.	Communication established in UL direction	IXIA	OK
4	Tune the variable attenuator so to obtain the Max Power on the MS and to be at the limit of sensitivity. Then, write down the RSSI level of the GS and the max attenuation of the link.	Attenuation, GS RSSI, MS emitting power, UL data rate	GS MMI, MS MMI	ОК
5	Do step 1 to 4 with each available UL modulation: 64 QAM ³ / ₄ , 16QAM ³ / ₄ , 16QAM ¹ / ₂ , QPSK ³ / ₄ , QPSK ¹ / ₂			ОК
Phase	2 : measured performances of the downlin	k		
1	On the GS control MMI:	GS on	GS control MMI	OK

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

500.2	- AeroMACS Verification Report			
	- Set frequency : 5103,5 MHz			
	 Fix the DL modulation to 64QAM 5/6 			
	- GS power fixed to max			
	Switch on the GS			
2	Set frequency scan of MS :	MS connects eventually to	GS control MMI	OK
	 5093,5 – 5147,5 MHz, step 250 kHz (5002,5 + n*0.25 for n = {364580} in MHz.) 	the GS		
	Switch on the MS			
3	Initiate a communication between the GS and the MS.	Communication established in DL direction	Ixia	ОК
4	Tune the variable attenuator so to be at the limit of sensitivity.	Obtained values: Attenuation, MS RSSI, GS emitting power, DL data rate	GS MMI, MS MMI	OK
	Then, write down the RSSI level of the GS and the max attenuation of the link.	Deduce the sensitivity of the MS		
5	Do step 1 to 4 with each available UL modulation: 64 QAM ¾, 16QAM ¾, 16QAM ½, QPSK ¾, QPSK ½			ок
Phase	3 : threshold between automatic modulatio	n / coding changes		
1	On the GS control MMI:		GS control MMI	ОК
	- Set frequency : 5098,5 MHz	eventually to the GS		
	- Automatic Modulation			
	- GS power fixed to max			
	Switch GS on and MS on			
2	Initiate a communication in both direction.	Communication established in UL and DL direction	Ixia	OK
3	Tune the variable attenuator from less attenuation to more attenuation so to obtain modulation change in the UL and the DL.	Attenuation versus	GS control MMI	ОК
	Write down the attenuation corresponding to each modulation change.			
Phase	4: Max tolerable input signal at MS			
1	On the GS control MMI:	GS on. MS connects	GS control MMI	OK

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

	 Set frequency : 5093,5 MHz DL sub channelization is set to fix Fix the DL modulation to QPSK 	eventually to the GS		
	³ ∕₄ Switch on the GS			
2	Initiate a communication between the GS and the MS: DL.	Communication established in DL direction	IXIA	OK
3	Tune the variable attenuator to increase receive level at MS. Write down the attenuation when error occurs.	Receive power threshold of degradation	IXIA	ОК

A.4.2.2 Deviation from the planned activities

None.

A.4.3 Verification exercise Results

A.4.3.1 Summary of Verification exercise Results

The results are summarized below:

- Phase 1: measure performances of the uplink
 - UL measured sensitivity and max data rate are summarized in table below. Measurements are made with BS1 @ 5093,5 MHz.

UL Mod	UL	UL Max
	Sensitivity	datarate
64 qam 2/3	-71 dBm	1,91 MBps
64 qam 1/2	-82 dBm	1,42 MBps
16 qam 3/4	-82 dBm	1,42 MBps
16 qam 1/2	-84 dBm	0,94 MBps
qpsk 3/4	-86 dBm	0,69 MBps
qpsk 1/2	-94 dBm	0,45 MBps

Note: 64QAM is optional in AeroMACS for the uplink.

Note: With sub-channelization (down to 2 sub-channels used out of the 17 subchannels) a gain of more than 6 dB is observed (of course the effect is reduced data rate).

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

- Phase 2: measured performances of the downlink is summarized in following tables
 - o Measured sensitivity @ 5103,5 MHz with BS2 is summarized in table below

Modulation scheme	DL Sensitivity	
64 qam 5/6	-73 dBm	
64 qam 3/4	-77 dBm	
64 qam 2/3	-79 dBm	
64 qam 1/2	-82 dBm	
16 qam 3/4	-83 dBm	
16 qam 1/2	-87 dBm	
qpsk 3/4	-91 dBm	
qpsk 1/2	-93 dBm	

o DL Measured data rate is summarized in table below

Mod & coding rate	DL Measured Data rate [Mb/s]
64QAM 5/6	9.2
64QAM 3/4	8,3
64QAM 2/3	7,4
64QAM 1/2	5,5
16QAM 3/4	5,5
16QAM 1/2	3,7
QPSK 3/4	2,7
QPSK 1/2	1,8

- Phase 3 : threshold between automatic modulation / coding changes
 - o In the Downlink:

Auto DL Mod	Received level	
64 qam 5/6 ->	64 qam 3/4	-74 dBm
64 qam 3/4 ->	64 qam 2/3	-77 dBm
64 qam 2/3->	64QAM 1/2	-79 dBm
64QAM 1/2->	16 qam 3/4	-83 dBm
16 qam 3/4->	16 qam 1/2	-84 dBm
16 qam 1/2->	qpsk 3/4	-86 dBm
qpsk 3/4->	qpsk 1/2	-90 dBm

o In the Uplink:

Auto UL Modula	Received level		
16 qam 3/4->	16 qam 3/4-> 16 qam 1/2		
16 qam 1/2->	qpsk 3/4	-83 dBm	
qpsk 3/4->	qpsk 1/2	-85 dBm	

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

50 of 100

- Phase 4: a -30 dBm input signal is OK at MS receiver.

A.4.3.2 Analysis of Verification Exercise Results

The results are analyzed below:

- DL & UL Data rates are consistent with what was calculated in theory.
- DL & UL Sensitivity is examined relatively to the theoretical table of SRD. The measured sensitivity is between 1 to 2 dB better than theoretical value. Transition margin for automatic modulation / coding changes is found to be consistent with sensitivity measurements.
- In UL, sub-channelization allows greater attenuation hence greater distance (at the prize of a reduced data rate).

Some IXIA Screenshots to illustrate the results the data rates achieved with 64QAM ³/₄, 16 QAM ³/₄, QPSK ³/₄ in the downlink.

🕸 🗋 😂 🛃 • 🗐 - 😂 • 🕽 		in Tools DeNetwork [Test SESARJance]g] guration	යා මේ වයි About
	d L2-3 Edit Traffic Edit Flow Regenerate Delete	Cold Cold	
Run	Edit	Grid Rate Control	
Overview	STRaffic -> CC L2-3 Flow Groups		
	Transmit State Suspend Tx Port		rfigured Frame Size Applied Frame Size Frame Rate
- 😡 Ports		ic Item 1 TX Mode: Interleaved, Src/Dst Mesh: OneToOne, Route Mesh: OneToOne, Bi-directional IPv4 :Source Address- 192.168.0.47 CPE; Traffic Item 1-EndpointSet-1 - Flow Group 0 Flow	1: 1400 Proed: 1400 8.3 Mbps
a Chassis	2 0 CPL	IPv4 (Source Address-192.160.0.57 BS; Traffic Item 1-EndpointSet-1 - Flow Group 0 Free	
Protocoli Protocoli Interfaces Statc Col Traffic Ci 22-3 Traffic Items Ci 22-3 Traffic Items Ci 22-3 How Groups Dispairments QuickTests Captures	Summary Row groups Prame Setup		4
	Select Views	Flow Statistics Custom Graph	6 X 0
	Tx Port Rx Port	Traffic Item IPvil :Source Address Tx Frames Rx Frames Prames Delta Loss %	
	> 1 B5 CPE	Traffic Item 1 192.168.0.47 96,323 96,323 0 0 0.000	
	2 CPE 85	Traffic Rem 1 192.168.0.57 11,606 11,606 0 0.000	
	14 4 1/1 (botal rows: 2)	All Loss Throughput Latency	
	1		≡ Logs Messages 🖂

founding members



Edition 00.01.00

Home Automat	p 📿 • 🖲 💭 • 🕅 🚺 🛟 tion Results / Reports	l ∓ Traffic To Views Configura		xNetwork [Test SESAR.ixnc	fg]				-	Abo
1 1 1 Mar 1 1	L2-3 Edit Traffic Edit Flow Reg	generate Delete Tra	effic Grid		Absolute Value Relative Increase	Multiple Ports Selected	n 10%			
Run	Edit			irid.		Rate Control				
Overview	K > 🙆 DC Traffic + DC L	2-3 Flow Groups								
Overview	Transmit State Si		IPv4 :Source Add			Flow Group Name	Configured Frame Size	Applied Frame Size	Frame Rate	
Ports			tem 1 TX Mode: Interlea							
A Chassis			IPv4 :Source Address- 192 IPv4 :Source Address- 192			1-EndpointSet-1 - Flow Group 0. 1-EndpointSet-1 - Flow Group 0.		Fixed: 1400 Fixed: 1400	0.1 Mbps	
Protocols	- WF II	L OF	ar 11 1200 00 M001035- 176	10010101 003	Traine atem	a componitation a componitation of		10,00, 1100	on maps	
Traffic DC 12-3 Traffic Items DC 12-3 Flow Groups										
QuickTests	Guerrano Flow means From	no Colum (S)								
QuickTests	Summary Flow groups Fram	. –						4		•
QuickTests	Select Views	Traffic Item Statistics		om Graph3		1.1 1.1 1.1 1.1 1.1 1.1 1.1 1.1 1.1 1.1		4		
QuickTests	II Select Views	Traffic Item Statistics	Traffic Item IPv4 :Sou	rce Address Tx Frames		ames Delta Loss %		4		
QuickTests	Select Views	Traffic Item Statistics		rce Address Tx Frames 192.168.0.47 246,4		ames Della Loss % 0 0.000 0 0.000		4		
 Impairments QuickTests Captures 	III Select Views Tx Port 1 BS 1	Traffic Item Statistics / Rx Port CPE	Traffic Item IPv4 :Sou Traffic Item I	rce Address Tx Frames 192.168.0.47 246,4	663 246,663	0.000		4 [• • ×
QuickTests	III Select Views Tx Port 1 BS 1	Traffic Item Statistics // R.R.Port CPE 05	Traffic Item IPv4 :Sou Traffic Item I	rce Address Tx Frames 192.168.0.47 246,6 192.168.0.57 4,4	663 246,663	0.000		4 (

List Traffic Applied Frame School Roods By* Antalia Protein Pr	1 🗋 😂 🔒 - 🗐 - Þ¢ - (ation Results / Reports	Views Config		ork [Test SESAR.ixncfg]					-	a ∰ 83 About
Overview Potic Configured Frame: Society Society Media: Society Media: Society Media: Configured Frame: Society Media: Society Media: Society Media: Society Media: Configured Frame: Society Media: Society Media: Configured Frame: Society Media: Society M	L2-3 L4-7 Traffic Ar Traffic - Traffic - Actions - T	dd L2-3 Edit Traffic Edit Flow Iraffic Item Group	Regenerate Delete	Fraffic Grid Grid Operations •	Rows Pu -			0.03%			
Control control in the second address in the control of the second address in the	Run			Grid			Rate Control				
Porte Constant Porte P	overview	and the second se		1							
Image: Section 1 Image: Section 2000 Product 0.000 Product 0.0000 Product 0.000 Product 0.000 Product 0.000 Pr								Configured Frame Size	Applied Frame Size	Frame Rate	
Order in the reader is a reader in the reader is a reader reader is a reader is a reader is a reader is a reader is r		1 📀 🖬	85	IPv4 :Source Address- 192.168.0	.47 CPE;	Traffic Item 1-En	dpointSet-1 - Flow Group 0.				_
Serect Verse Traffic Item Statistics Custom Graph 6 1 EV Traffic Item 1 Tra	Protocol Interfaces Static Static Color Traffic Color 12-3 Traffic Items Color 12-3 Flow Groups Impairments Color 12-3 Flow Groups Color	Summery Row groups	Frame Setup 🕆 1								~
To Port Rx Port Traffic Item IPvi / Scurce Address To Promes Promes Loss % 3 IDS CPE Traffic Item 1 192:100.0.47 60,746 00 0.000 2 CPE BS Traffic Item 1 192:108.0.57 503 500 0 0.000			and the second			2000					
b 1 ES CPE Traffic Item 1 192.108.0.47 66,746 0 0.000 2 CPE BS Traffic Item 1 192.108.0.57 503 503 0 0.000 1 192.108.0.57 503 503 0 0.000 1 192.108.0.57 503 503 0 0.000				and the second se	And a state of the	Du France France	Delta Lass M				
2 CPE B5 Traffic Rem 1 192.168.0.57 500 D 0.000		10000000				CONTRACTOR OF THE OWNER					
						100 X 200 X	70				
To be been		wor lates) 1/1 PPI II	n: 2)	All Loss Throughpu	t Latency 🧿		14				- E
										₩ Loo	Massacer 6

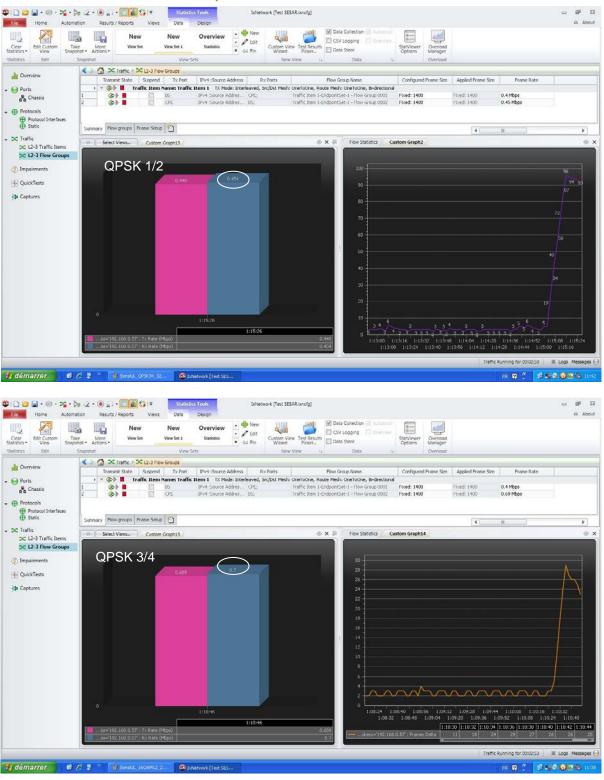
Some screenshots for max data rates in the UL are shown below (the data rate is shown at sensitivity limit).

founding members

Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

52 of 100

Edition 00.01.00

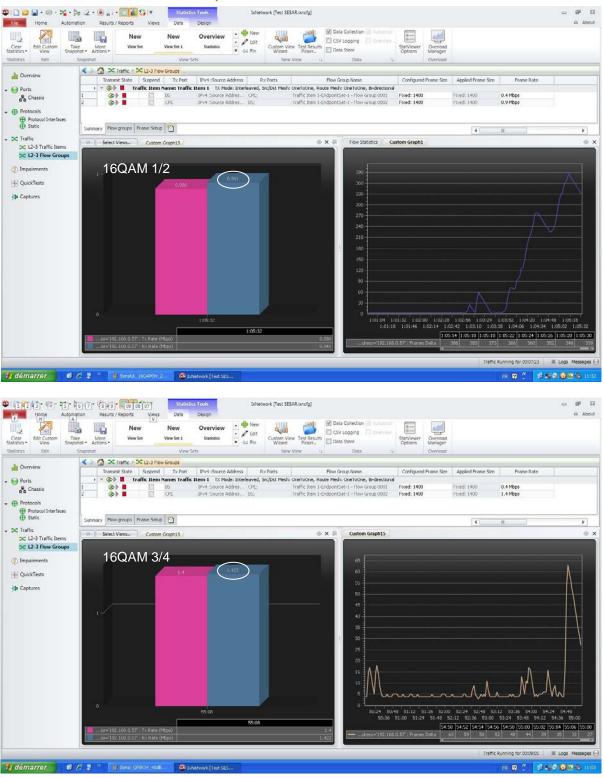


founding members

Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

53 of 100

Edition 00.01.00

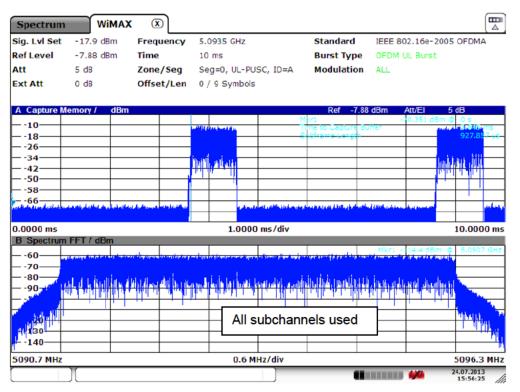


founding members

Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

54 of 100

Below the effect of sub channelization in the UL is depicted:



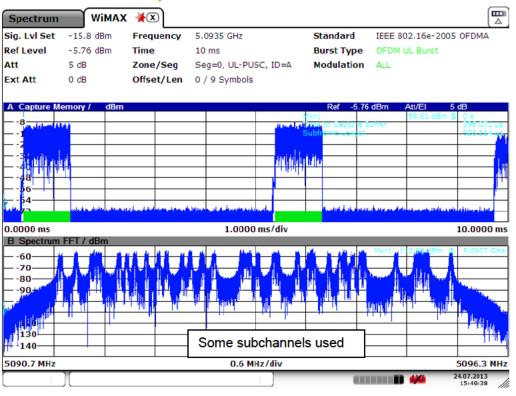
Date: 24.JUL.2013 15:56:25

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

55 of 100



Date: 24.JUL.2013 15:49:38

A.4.3.3 Unexpected behaviors/Results

None.

A.4.4 Conclusions and recommendations

Measurements performed well. With sub channelization, we can expect to see an increase in cell coverage but with less data rate.

For next phase, one recommendation could be (if possible regarding installation of two antennas in the vehicle) to complement the test in Toulouse Airport with MIMO A for the mobile stations (context of ground segment) in order to assess any improvement in reception performances.

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

56 of 100

A.5 Verification Exercise # TLAB_050 Report

A.5.1 Verification Exercise Scope

The test purpose is to measure radio performances (power spectral flatness, interferences, unwanted emissions).

A.5.2 Conduct of Verification Exercise

A.5.2.1 Verification Exercise Preparation

Same as for TLAB_010 see § A.1.2.1.

A.5.2.2 Verification Exercise execution

Step	action	Action result	PCO	Result
1	Set frequency on the GS : - 5120,5 MHz Switch on the GS	GS on	GS control MMI	ОК
2	Set frequency scan of MS : - 5093,5 – 5147,5 MHz, step 250 kHz (5002,5 + n*0.25 for n = {364580} in MHz.) Switch on the MS	MS connects eventually to the GS	GS control MMI	ОК
3	Initiate a communication in both directions.	Communication established in both directions (UL and DL)	IXIA	ОК
Phase	e 1: Spectrum mask measurement			
1	Measure spectrum Mask and check flatness of the 5 MHz BW of GS	Spectrum measurement of the 5MHz channelization. Measurement of the flatness.		ОК
2	Measure spectrum Mask and check flatness of the 5 MHz BW of MS	Spectrum measurement of the 5MHz channelization. Measurement of the flatness.		ОК
3	Tune BS to other frequencies and go to 1 5093,5 MHz – 5098,5 MHz – 5103,5 MHz – 5147,5 MHz	MS connects eventually to the GS		ОК

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

Phase 2: Test the unwanted emission level outside the band								
1	Set frequency on the GS : 5093,5 MHz	Frequency tuned	GS control MMI	OK				
2	Measure the spurious emission out of band (particular focus on f= 5126 MHz (AMT) & on f=5038,8 MHz (MLS))			ОК				
3	Tune BS to 5103,5 MHz and go to 2	Frequency tuned	GS control MMI	OK				

A.5.2.3 Deviation from the planned activities

None

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

58 of 100

A.5.3 Verification exercise Results

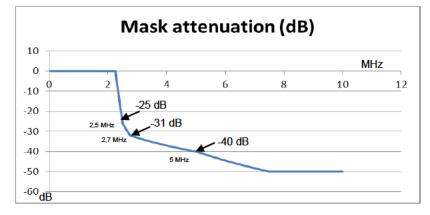
A.5.3.1 Summary of Verification exercise Results

- Phase 1: The 5 MHz spectrum was measured through the spectrum analyzer at the different frequency including the adjacent and alternate channels. It complies with specified mask.
- Phase 2: An analysis is made over the frequencies to detect the unwanted emissions. They are below the specified maximum level.

A.5.3.2 Analysis of Verification Exercise Results

- Phase 1:

The specified spectrum mask is as follows:



As an example reported for analysis, one can find below the measurement results for the 5093,5 and 5103,5 MHz frequency which are planned to be used at the Toulouse Airport.

5103,5 MHz DL spectrum is represented below. It fits the mask.

founding members



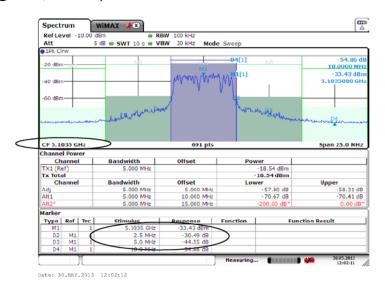
Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

59 of 100

Sig. Lvl Set	-17.7 dBm	Frequency	5.1035 GHz	Standard	IEEE 802.16e	- 2005 OFDMA
RefLevel	-18.2 dBm	Time	15 ms	Burst Type	OFDM DL Bur	st
Att	5 dB	Zone/Seq	Seg=0, DL-PUSC, ID=A	Modulation	ALL	
			•	Hodulution		
Ext Att	0 dB	Offset/Len	1 / 4 Symbols			
SGL		05 00 dt	The Deve duridate			
-	Tx Power	-35.29 di				
- 12,500 MHz	-7.375 MH		Freq. at ∆ to Limit 5.095710145 GHz	-88.98 dBm	-53.69 dB	- 3.69 dB
-12.500 MHz	-7.375 MH -4.875 MH		5.095710145 GHz	-88.53 dBm		-3.39 dB
-4.875 MHz	-4.075 MH		5.099333333 GHz	-75.91 dBm	-53.25 dB -40.63 dB	-10.27 dB
-9.875 MHz	-2.725 MH -2.375 MH		5.100782609 GHz	- 75.91 dBm	-40.63 dB -36.70 dB	- 10.27 dB
2.375 MHz	2.725 MH		5.106217391 GHz	- 71.98 dBm	-36.70 dB	- 10.28 dB
2.375 MHz	4.875 MH		5.107847826 GHz	- 80.34 dBm	-45.05 dB	-14.28 dB
		2 100 KHZ	5.107647620 GHZ			-14.28 UB
Screen A: Spe				PR	Clrw	
CHECK RESU 	sk dBr				Mkr1 -36.81 0	dBm @ 5.1035 GH
48				N I		
			2,5 MHz	N I		
			30 dB	L		
-68		\	<u> </u>			
Spect Masl	k dBr	~~~		me		
		5 MI		+		
-98		~ -41		+		
5091.00 MHz			2.50 MHz/div			5116.00 MH
2021.00 1112			2.50 PHT27 UIV			24.06.2013

Date: 24.JUN.2013 17:35:41

UL spectrum @ 5103,5 MHz represented below fits also the mask.



As a confirmation of the analysis, another spectrum measurement is presented for the DL & UL 5093.5 MHz frequency: it is also in conformance with mask.

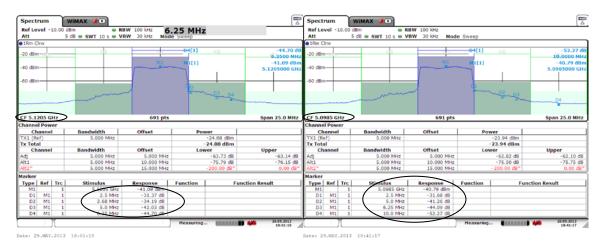
founding members

Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

60 of 100



Two additional tested frequencies UL 5120,5 MHz and UL 5098,5 MHz are given below.



Besides, below a measurement about flatness is highlighted, showing flatness is also OK.

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

61 of 100

Spectrum	WiMAX	¥x					
Sig. Lvl Set	-22.7 dBm	Frequency	5.0935 GHz		Standard	IEEE 802.16e	-2005 OFDMA
Ref Level	-12.7 dBm	Time	15 ms		Burst Type	OFDM DL Bur	st
Att	0 dB	Zone/Seg	Seg=0, DL-PUS	SC, ID=A	Modulation	ALL	
Ext Att	0 dB	Offset/Len	1 / 30 Symbols	5			
A Capture Me	emory / dBm				Ref -12.7	dBm Att/El	0 dB
-15 							
0.0000 ms			1.5000	ms/div			15.0000 ms
B Spectrum Diff Upper Diff Lower - 0.3-Diff Upp	Pass Pass per	dB				Mkr1	MI AV PK : 0.000 @ Carr 1
-0.1 0.1 0.3 _{Diff Lov}	ver	ar an include a standard and a standard a st The standard a standard	Approximity Marking a	lingation and the	MAND SAME	NH WAR	<u>prazerov pokietk</u>
0.5 -210 Carrier			42 Car	rier/div			210 Carrier
)[Run	ning 🔳	····) 🚧	12.07.2013 13:19:40

Date: 12.JUL.2013 13:19:41

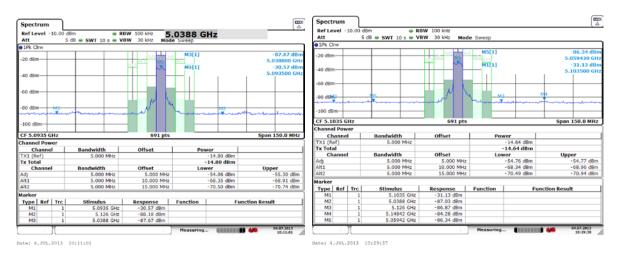
founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

62 of 100

- Phase 2: Unwanted emissions measurement at output of MS and BS equipment are analyzed below with respect of the frequencies that will be used at the Toulouse airport (5093,5 MHz and 5103,5 MHz). A particular focus is done on the MLS frequency (5038,8 MHz) and the AMT frequency (5126 MHz).



The maximum spurious level is at least 53 dB below the max. If we consider the BS emitting at 23 dBm over 5 MHz, this gives a level of 7 dBm in the RBW100 kHz corresponding to a level of spurious below -46 dBm in RBW 100 kHz.

A.5.3.3 Unexpected behaviors/Results

None.

A.5.4 Conclusions and recommendations

The stations perform well regarding spectrum mask and spurious. No particular recommendation for next phase testing.

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

63 of 100

A.6 Verification Exercise # LAB1_1 Connection Establishment Report

A.6.1 Verification Exercise Scope

The purpose of this Verification Exercise is checking that the MS properly connects with the BS, and that both the devices under test (MS and BS) are compliant with the specific AeroMACS RF requirements detailed in the Verification Exercise execution Section.

A.6.2 Conduct of Verification Exercise

A.6.2.1 Verification Exercise Preparation

The test bed described in Figure 2 was arranged. The following main components were used: <u>Spectrum Analyzer</u>: Agilent E4445A PSA Series, 3Hz-13.2GHz; 89600 VSA SW (Build 15.01.356.0).

The specific AeroMACS setup is loaded before test execution.

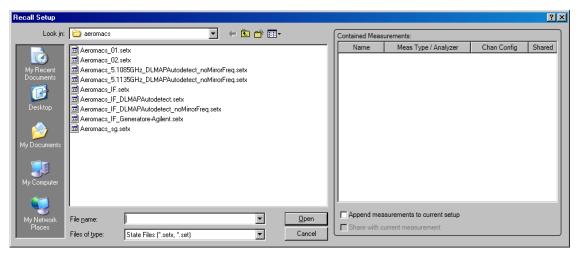


Figure 4: AeroMACS Setup on Agilent Spectrum Analyzer

Equipment:

MS/BS are configured according to AeroMACS profile (BW 5MHz, frame length 5 ms, TDD Mode, DL/UL split (e.g. 32:15), etc.). In particular, prepared configuration files are pre-loaded in the equipment. For instance, in the BS it is possible to set the BS IP address, the IP address of used ASN GW, Base Station ID, and some other internal parameters.

ASN-GW is an Aricent Wing ASN-GW.

MS, BS and ASN-GW were linked together according to test bed configuration with proper attenuation and switched on.

founding members



64 of 100



Figure 5: Picture of test bed in Selex ES Lab

Fading Simulator and Data Traffic Generator shown in Figure 2 were not used in this test.

Step nr.	Action	Action description	PCO (Point of Control and Observation)	Comment
1.	Switch on MS	Set the center frequency modifying the MS config file and reboot	MS CLI	ОК
2.	Verify that MS begins scanning for BS	Check MS status	MS CLI, MS indicator LEDs	OK.
3.	Switch on BS			ОК
4.	Configure BS to first channel (5093.5 MHz)	Set the center frequency using CLI BS Reboot BS	BS CLI	ОК
5	Reboot BS			ОК

A.6.2.2 Verification Exercise execution

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

6.	Verify that MS connects successfully	MS CLI, MS indicator LEDs	OK
7.	Verify that both BS and MS use orthogonal frequency-division multiple access	WiMAX Vector Spectrum Analyzer	ОК
8.	Verify that both BS and MS use 5 MHz Channel Bandwidth	WiMAX Vector Spectrum Analyzer	ОК
9.	Verify that both BS and MS use 5 ms frame length	WiMAX Vector Spectrum Analyzer	ОК
10.	Verify that both BS and MS are able to operate in TDD mode	WiMAX Vector Spectrum Analyzer	ОК
11.	Configure BS to next channel	BS CLI	ОК
12.	Reboot BS		ОК
13.	Verify that MS loses connection	MS CLI and for signal WiMAX Vector Spectrum Analyzer	ОК
14.	Verify that MS begins scanning	MS CLI	ОК
Repeat	t steps 613. for channels 5113.5 and 5	147.5 MHz	

A.6.2.3 Deviation from the planned activities

A different set of frequencies has been used, with respect to what previously hypothesized in [3]. This modification has allowed testing the lowest and highest AeroMACS frequencies in the 5091-5150 MHz band.

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

66 of 100

A.6.3 Verification exercise Results

A.6.3.1 Summary of Verification exercise Results

ID	Result	Description	When observed	Expected result	Obtained result	vo	Comment
1	ODFMA	Verify that both BS and MS use orthogonal frequency-division multiple access	Step 7	OFMA structure	OFMA structure verified	AeroMACS_V O_Interop_01_ A	OK- by means of Spectrum Analyzer
2	Size	Verify that both BS and MS use 5 MHz Channel Bandwidth.	Step 8	5 MHz	5 MHz bandwidth confirmed	AeroMACS_V O_Interop_01_ B	OK- by means of Spectrum Analyzer
3	Frame	Verify that both BS and MS use 5 ms Frame Length	Step 9	5 ms	5 ms Frame Length verified	AeroMACS_V O_Interop_01_ C	OK- by means of Spectrum Analyzer
4	Duplex	Verify that both BS and MS are able to operate in TDD mode	Step 10	TDD	TDD Mode verified	AeroMACS_V O_Interop_01_ D	OK- by means of Spectrum Analyzer
5	Freqs	Verify that the Channel Frequencies usable in the AeroMACS are in 5091- 5150 MHz range	Step 4 Step 11	Expected channel frequency	Verified use of channels 5093.5, 5113.5 and 5147.5 MHz	AeroMACS_V O_Interop_01_ E	OK- by means of Spectrum Analyzer
6	Scannin g	MS starts with the scanning of the spectrum. It should be checked the correct decoding of the preamble by the MS in order to get synchronized with the BS (no step	Step 2 Step 6 Step 14	Scanning procedure	Checked correct preamble decoding and correct UCD/DC D decoding by MS	AeroMACS_V O_Interop_03_ A	OK – by MS CLI

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

	.2 - Acion	IACS Verification R	epon				
		2). In addition, it should be verified the correct decoding of DCD message for getting all the DL parameters (no step 2).					
7	Initial Rangin g	Verify that, after successful DL Synchronization, MS send a CDMA code at a power level below PTX_IR_MAX, measured at the antenna connector. Verify that, in case of no RNG- RSP is received at MS side, MS try to send a new CDMA code at the next appropriate initial ranging transmission opportunity (applying the correct MS power increase) until the BS doesn't send RNG-RSP message or until MS doesn't receive a proper RNG-RSP. Verify the correct reception of Basic CID and Primary CID.	Step 6	IR procedure	Initial ranging procedure verified	AeroMACS_V O_Interop_03_ C	OK – by MS CLI
8	Basic	Verify the correct exchange of Service Basic Capability information	Step 6	Basic Negotiatio n Capabiliti es	Correct SBC- REQ/SBC -RSP exchange verified	AeroMACS_V O_Interop_03_ D	OK – by MS CLI

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

9	Admissi on	Verify the Admission Control Procedure	Step6	Admissio n control procedure	Correct Authentic ation procedure verified	AeroMACS_V O_Interop_03_ E	OK – by MS CLI
10	Registr ation	Verify that BS and MS successfully conclude the registration procedure	Step6	Complete d registratio n procedure	Correct Registrati on procedure verified	AeroMACS_V O_Interop_03_ F	OK – by MS CLI
11	Availabl e Channe Is	Verify that MS connects successfully to BS for each configured channel	Step 6			AeroMACS_V O_RFReal_01 _A	OK – by MS CLI

A.6.3.2 Analysis of Verification Exercise Results

Many Objectives (Result IDs from 1 to 5 in previous Chapter) were verified by visual inspection of the Spectrum Analyzer wired to the BS. In Figure 6 it is possible to appreciate how OFDMA Mode, TDD Mode, Frame Length, Channel Bandwidth and Channel Frequency are evidenced (together with other information out of scope for this test, like EVM and Modulation).

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

69 of 100



Figure 6: Spectrum Analyzer connected to AeroMACS BS

During the test the various phases of Initial Network Entry were executed by BS and MS (Results ID from 6 to 10). In particular, looking at the MS CLI, it was possible to follow the preamble detection and the DCD decoding by the MS side during scanning, the various steps of Initial Ranging, the exchange of Service Basic Capabilities Information, the Authentication/Registration procedure, and the final allocation of Service Flows. Some examples are evidenced in the next images.

Test_01.txt - WordPad	
Elle Edit View Insert Format Help	
11:10:27:974 RT : LMAC : STATE : SYNCHRONIZING	<u>^</u>
11:10:27:974 RT : MPI: Scan Start Request : Frequency:460	
11:10:27:974 RT : MAC->PHY: PHY SCAN START REQ Frequency:460 initial-tx-pwr:144	
11:10:28:199 RT : PHY->MAC: PHY SCAN_END_RESULT no_of preambles = 1 PreambleID:99 RSSI:-50 BS-Freq:460	
11:10:28:199 RT : PHY scan sent - 10 & no: of bs -10 & mTotCellCnt =9	
11:10:28:199 RT : Start-Freq: 5113500.000000 BS Freq: 462 ChannelNumber:462 PrevChnlNum: 462	
11:10:28:199 RT : SRC: Initialization : CLPC: TX PWR Max:218 Min:144 Inital:144	
11:10:28:199 RT : LMAC : STATE : SYNCHRONIZING	
11:10:28:199 RT : MPI: Scan Start Request : Frequency:462	
11:10:28:199 RT : MAC->PHY: PHY SCAN START REQ Frequency:462 initial-tx-pwr:144	
11:10:28:424 RT : PHY->MAC: PHY SCAN END RESULT no of preambles = 1 PreambleID:99 RSSI:-50 BS-Freq:462	
11:10:28:424 RT : SYNC List - BS-No:1 Freq:448 RSSI:-50	
11:10:28:424 RT : SYNC List - BS-No:3 Freq:446 RSSI:-51	
11:10:28:424 RT : SYNC List - BS-No:5 Freq:452 RSSI:-50	
11:10:28:424 RT : SYNC List - BS-No:7 Freq:456 RSSI:-50	
11:10:28:424 RT : SYNC List - BS-No:9 Freq:460 RSSI:-50	
11:10:28:424 RT : Cell Sync Attempt Req preamble =99 centre freq = 448	
For Help, press F1	NUM

Figure 7: Preamble Detection by MS

founding members



70 of 100

Test_01.txt - WordPad	_ 🗆 🗵
<u>File Edit View Insert Format Help</u>	
11:10:30:159 RT : MAC -> PHY : PHY PARAM CHNG REQ	
11:10:30:162 RT : MPI COMP-DLMAP RSSI:-87 CINR:14 FN:656000	
11:10:30:162 RT : UMAC:SRC->LMAC: DCD: Coding Scheme:O MOD:1 CodeRate:O	
11:10:30:162 RT : UMAC:SRC->LMAC: DCD: Coding Scheme:O MOD:1 CodeRate:2	
11:10:30:162 RT : UMAC:SRC->LMAC: DCD: Coding Scheme:O MOD:2 CodeRate:O	
11:10:30:162 RT : UMAC:SRC->LMAC: DCD: Coding Scheme:O MOD:2 CodeRate:2	
11:10:30:162 RT : UMAC:SRC->LMAC: DCD: Coding Scheme:O MOD:3 CodeRate:O	
11:10:30:162 RT : UMAC:SRC->LMAC: DCD: Coding Scheme:O MOD:3 CodeRate:1	
11:10:30:163 RT : UMAC:SRC->LMAC: DCD: Coding Scheme:O MOD:3 CodeRate:2	
11:10:30:163 RT : MAC->PHY: Sending DCD Config	
11:10:30:163 RT : Initail Tx Power :20 Eirxp:-45 BSEirp:40 DLRssi:-87	
11:10:30:163 RT : Recvd MPI_PHY_DCD_CFG_CFM indication = 0	
11:10:30:167 RT : FN:656002 CDMA Code:3 Sub-chnlOff:0 SynbolOff:0 RNG-Typ	e:0
11:10:30:167 RT : LMAC-SRC : IR - CDMA index : 3 SubChnl Off : 0 Sym off	: 0
<pre>frameNum:0 powerLv1:0 repCode:0 ranging_slot:0 rang_type:0</pre>	
11:10:30:366 RT : RNG: T3 RNG-RSP T3 timer expired FN:656041 RetryCnt:25	Max- 🚽
L DetriegeD	
For Help, press F1	NUM //

Figure 8: DCD Decoding by MS

Test_01.txt - WordPad	- D ×
File Edit View Insert Format Help	
Retries:3	
11:10:30:966 RT : LMAC SRC : T2 Tmr For BroadCast Rng Oppur Is Activate	d 🛛
11:10:30:966 RT : OLPC MAC->PHY :PRAM CHNG Time-Off:0 Power-Off:35 Freq	-Off:0
11:10:30:966 RT : MAC -> PHY : PHY PARAM CHNG REQ	
11:10:30:966 RT : FN:656162 CDMA Code:0 Sub-chnlOff:0 SynbolOff:0 RNG-T	ype:0 🔜
11:10:30:967 RT : LMAC-SRC : IR - CDMA index : O SubChnl Off : O Sym of	f:0
frameNum:0 powerLvl:0 repCode:0 ranging_slot:0 rang_type:0	
11:10:30:987 RT : LMAC: RNG RSP Received FN:656166	
11:10:30:987 RT : Code:0 Symbl:0 Chnl:0 FrmNo:35 AttrPres:1 Basic-CID:0	
PrimCID:0	
11:10:30:987 RT : CLPC : LMAC-SRC : PRAM CHNG Time-off:38 Power-Off:35	
11:10:30:987 RT : MAC -> PHY : PHY PARAM CHNG REQ	
11:10:30:987 RT : RNG RSP : Rng status : 3 (1 = Cont; 2 = Abort ; 3 =	
Success)	
11:10:30:987 RT : UMAC SRC : STATE : IR_CONTENTION : Waiting For CDMA	Alloc
IE	-
11.10.20.001 DT . III WAD . Descived TE . CDWA Allow	<u>`</u>
For Help, press F1	NUM //

Figure 9: Initial Ranging - the MS receives a RNG_RSP with Status Success

founding members



71 of 100

🗉 Test_01.txt - WordPad	
Eile Edit View Insert Format Help	
11:10:31:467 RT : Deleting Initial-Ranging connection-CQID: 16 CID:0	
11:10:31:467 RT : UMAC SRC : The Basic and Primary CID's Are Updated	
11:10:31:467 RT : LMAC: Deleting UL CID: 0 CQID:16	
11:10:31:467 RT : DLQConfigReq Cid :12 :: CQID :3	
11:10:31:467 RT - MSC : Preparing SBC REQ	
11:10:31:467 RT : UL-Flow Config REQ: CID:12 CQID:17	
11:10:31:468 RT : DLQConfigReq Cid :1011 :: CQID :4	
11:10:31:468 RT : UL-Flow Config REQ: CID:1011 CQID:18	
11:10:31:468 RT : Resource Clearance - SF State:0 mDelSf:1 AckCnt:254	
11:10:31:468 ERROR : Invalid MSC State:3	
11:10:31:516 RT : UL FEC Code Changed from 2 to 0	
11:10:31:536 RT : MSC : SBC-REO sent to BS - T18 SBC RSP Timer is Activated FN:65627	76
11:10:31:601 RT SBC-RSP is received from BS	
11:10:31:602 RT : SBC RSP : ATH policy From BS:0 MS:0	1000
11.10.21.602 DT . CWAC Volidation flag - Folge WS AuthCode.0 DS Authcode - 0	-
For Help, press F1	NUM //

Figure 10: SS Basic Capabilities Exchange between MS and BS

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

72 of 100

_ 🗆 ×

📕 Test_01.txt - WordPad

File	Edit	View	Insert	Format	Help	

11:10:31:602 RT : MSC : STATE : INITIAL N/W ENTRY REC	ISTRATION
11:10:31:602 TI: MSC : Preparing REG REQ FN:656289	>
11:10:31:636 RT : MSC: REG-REQ sent to BS. T6 REG RSF	
11:10:31:661 RT : MPI COMP-DLMAP RSSI:-86 CINR:15 FN:	656300
11:10:31:666 RT : MSC : T6 REG RSP Timer is Stopped	
11:10:31:666 RT CREG-RSP is received from BS	
11:10:31:667 RT : REG RSP:SKIP ADDR AQUISITION Not Pr	ocessing Currently
11:10:31:667 RT : REG RSP: REG HO CONN PROCESSING TIM	E:Not Processing Currently
11:10:31:667 RT : REG RSP: REG HO TEK PROCESSING TIME	Not Processing Currently
11:10:31:667 RT : REG RSP: REG SN REPORT BASE Not Pro	cessing Currently
11:10:31:667 RT : MS : STATE : OPERATIONAL MODE	
11:10:31:671 RT : CLPC : LMAC-SRC : PRAM CHNG Time-of	f:O Power-Off:29
11:10:31:671 RT : MAC -> PHY : PHY PARAM CHNG REQ	
11:10:31:671 RT : CLPC : Recvd Power adj:8	
11:10:31:671 RT : CLPC : LMAC-SRC : PRAM CHNG Time-of	f:O Power-Off:25
11:10:31:671 RT : MAC -> PHY : PHY PARAM CHNG REQ	
11:10:31:671 RT : CLPC : Recvd Power adj:8	
11:10:31:708 RT : DHCP DISCOVER - Len:576	
11:10:31:916 RT : CLPC : LMAC-SRC : PRAM CHNG Time-of	f:0 Power-Off:21
11:10:31:916 RT : MAC -> PHY : PHY PARAM CHNG REQ	
11:10:31:916 RT : CLPC : Recvd Power adj:8	
11:10:32:161 RT : MPI COMP-DLMAP RSSI:-86 CINR:14 FN:	656400
11:10:32:166 RT : CLPC : LMAC-SRC : PRAM CHNG Time-of	f:0 Power-Off:17
11:10:32:166 RT : MAC -> PHY : PHY PARAM CHNG REQ	
11:10:32:166 RT : CLPC <u>: Recvd Power adj:8</u>	
11:10:32:401 RT CSF : DSA Request Received	
11:10:32:401 RT :	
11:10:32:401 RT : DSA/DSC REQ/RSP : Direction	: DL Direction
11:10:32:401 RT : DSA/DSC REQ/RSP : Service Flow ID	: 4
11:10:32:401 RT : DSA/DSC REQ/RSP : CID	: 2021
or Help, press F1	NUM

Figure 11: Registration procedure and Service Flow Creation

A.6.3.3 Considerations on Initial Network Entry Time

EUROCAE WG82 is currently discussing about the need to specify, in the MASPS, a maximum allowed Net Entry Time for AeroMACS MSs. Currently the maximum value required in the draft MASPS is 90 seconds.

Measurements done in this Verification Exercise can be used as input for this topic.

Net Entry Time has of course to be minimized, in order to make the AeroMACS MS ready for operations as soon as possible, after landing or switch on.

There are more ways to reach this goal. One possibility is pre-configuring MSs with the list of frequencies operated at destination airports. This solution would surely minimize the Net Entry Time, but would imply the need to use and maintain databases indicating the frequencies in use for any Airport,

Another solution is having the MSs to scan the whole band (5000-5150 MHz) at switch-on (auto-learning). This of course lengthen the Net Entry Time, also considering that various phases of Net Entry involve devices potentially located throughout the world (e.g. in most cases AAA/DHCP Servers will not be

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

73 of 100

located in the visited Airport). Figure 12 describes a possible initial Network Entry procedure comprising MS-to-Network EAP authentication process and multiple Domain authentications.

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

74 of 100

Edition 00.01.00

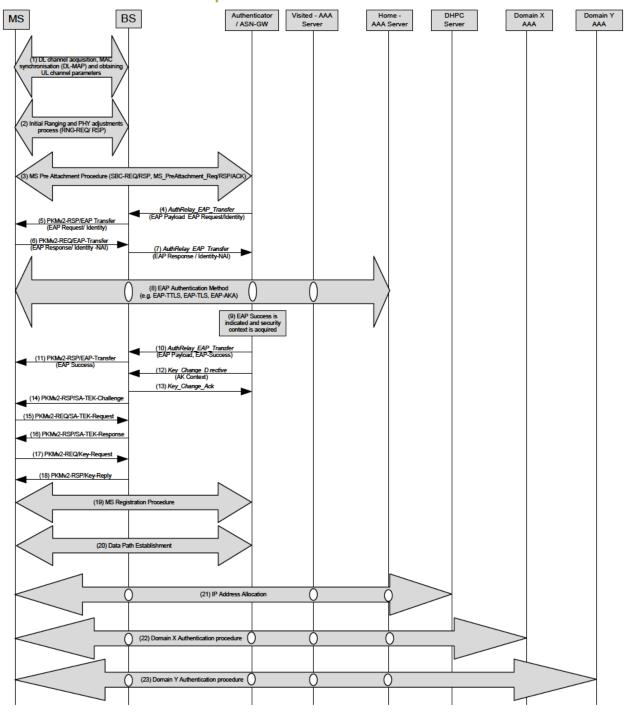


Figure 12: Initial Network Entry Time

founding members

Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

75 of 100

In this Verification Exercise the Network Entry Time (consisting in Physical/MAC Synchronization, Authentication/Registration and Service Flows Creation) was measured being about 9.330 seconds. This time does NOT include time for self-test and other power up functions. Furthermore, all of the devices involved in the process were located in the same room.

It is worth observing that in this exercise the MS had been previously configured to scan a limited list of frequencies. If instead the MS had to scan the whole frequency band 5000-5150 MHz, an extra time should be considered for physical layer scanning. It is estimated that the order of magnitude of the time needed to span the whole band looking for a valid preamble could be tens of milliseconds per channel. Therefore, assuming for instance this time being 30 ms, the extra-time needed to span the whole band would be 30ms * 580 = 17.4 seconds. This would lead to a total Net Entry Time of 9.33 + 17.4 = 26.73 seconds.

It is also worth underlining that this result has been obtained in a controlled environment (the Lab). Real environments (Airports) can introduce huge degradation factors (attenuation, multipath fading, shadowing, Doppler effects, etc.) that may increase the packet error rate and the number of retransmissions, with subsequent increase in the Net Entry Time. For this reason, the 90 seconds currently hypothesized in the draft EUROCAE MASPS as maximum net entry time are considered appropriate.

A.6.3.4 Unexpected behaviors/Results

None.

A.6.4 Conclusions and recommendations

The Verification Exercise allowed checking the basic AeroMACS functions and Initial Network Entry message exchanges. All the related verification Objectives were checked successfully.

A.7 Verification Exercise # LAB1_2 Power Control Report

A.7.1 Verification Exercise Scope

The purpose of this Verification Exercise is checking that the MS properly applies an Open/Closed Loop Power Control procedure and that the physical measurements which drive them are correct within specified tolerances.

A.7.2 Conduct of Verification Exercise

A.7.2.1 Verification Exercise Preparation

The same test bed described in A.6.2.1 was used.

A.7.2.2 Verification Exercise execution

founding members



76 of 100

Step nr.	Action	Action description	PCO (Point of Control and Observation)	Comment
1.	Switch on MS			ОК
2.	Switch on BS			ОК
3.	Enable OL (passive) PC and disable CL PC		Mngt PC connected to MS	ОК
4.	Verify that MS connects successfully and properly estimates RSSIs		Mngt PC connected to MS	ОК
5.	Verify that MS properly operates in open loop PC		Mngt PC connected to MS	ОК
6.	Disable OL PC and enable CL PC		Mngt PC connected to MS	ОК
7.	Verify that MS properly applies CL PC		Mngt PC connected to MS	ОК

A.7.2.3 Deviation from the planned activities

None

A.7.3 Verification exercise Results

A.7.3.1 Summary of Verification exercise Results

ID	Resu It	Description	When observed	Expected result	Obtained result	VO	Comment
1.	Open Loop	Verify that the MS	Step 5	Power Control	OL passive	AeroMACS_VO _Interop_10_A	OK – by MS CLI

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

77 of 100

	PC	properly applies a (passive) open loop power control technique		Steps	PC steps correctly verified		
2.	Clos ed Loop PC	Verify that the MS properly applies a closed loop power control technique	Step 7	Power Control Steps	CL PC steps correctly verified	AeroMACS_VO _Interop_10_B	OK – by MS CLI

A.7.3.2 Analysis of Verification Exercise Results

The Open Loop passive Power Control has been tested first, during the Initial Ranging phase: from the MS CLI it was possible to observe that the MS starts transmitting a CDMA code at the lowest power level in the transmission opportunity allocated by the BS with the previous UL-MAP message (or the optional Compressed DLMAP-ULMAP). Then the MS starts increasing the transmitting power at 1dB steps, until it does not receive a RNG-RSP from the BS.

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

78 of 100

Test_01.txt - WordPad	
e Edit View Insert Format Help	
repCode:O ranging slot:O rang type:O	
11:10:30:366 RT : RNG: T3 RNG-RSP T3 timer expired FN:656041 RetryCnt:	25 Max-Retries:0
11:10:30:366 RT : LMAC_SEC + T2 Thr For BroadCast Rng Oppur Is Activat	ed
11:10:30:366 RT : OLPC MAC->PHY :PRAM CHNG Time-Off:0 Power-Off:38>Fre	q-Off:0
11:10:30:367 RT : MAC -> PHY : PHY PARAM CHING REQ	
11:10:30:367 RT : FN:656042 CDMA Code:2 Sub-chnlOff:0 SynbolOff:0 RNG-	Type:0
11:10:30:367 RT : LMAC-SRC : IR - CDMA index : 2 SubChnl Off : 0 Sym	
repCode:O ranging slot:O rang type:O	Land a second
11:10:30:566 RT : RNG: T3 RNG-RSP T3 timer expired FN:656081 RetryCnt:	25 Max-Retries:1
11:10:30:566 RT : LMAC_SEC : T2 Tmr For BroadCast Rng Oppur Is Activat	ed
11:10:30:566 RT : OLPC MAC->PHY :PRAM CHNG Time-Off:0 Power-Off:32 Fre	q-Off:0
11:10:30:566 RT : MAC -> PHY : PHY FARAM CHNG REQ	. \
11:10:30:567 RT : FN:656082 CDMA Code:0 Sub-chnlOff:0 SynbolOff:0 RNG-	Type:0
11:10:30:567 RT : LMAC-SRC : IR - CDMA index : O SubChnl Off : O Sym c	off . 0 frameNum:0 powerLv1:0
repCode:0 ranging slot:0 rang type:0	
11:10:30:661 RT : MPI COMP-DLMAP RSSI:-86 CINR:17 FN:656100	
11:10:30:766 RT : RNG: T3 RNG-RSP T3 timer expired FN:656121 RetryCnt:	25 Max-Retr
11:10:30:766 RT : LMAC_SEC : T2 Tmr For BroadCast Rng Oppur Is Activat	
11:10:30:766 RT : COLPC MAC->PHY :PRAM CHNG Time-Off:0 Power-Off:36>Fre	g-Off;0
11:10:30:766 RT : MAC -> PHY : PHY PARAM CHNG REQ	. /
11:10:30:767 RT : FN:656122 CDMA Code:1 Sub-chnlOff:0 SynbolOff:0 RNG-	Tvpe:0
11:10:30:767 RT : LMAC-SRC : IR - CDMA index : 1 SubChnl Off : 0 Sym c	ff : O frameNum:O powerLvl:O
repCode:O ranging slot:O rang type:O	•
11:10:30:966 RT : RNG: T3 RNG-RSP T3 timer expired FN:656161 RetryCnt:	25 Max-Retries:3
11:10:30:966 RT : LMAC_SRC : T2 Tmr For BroadCast Rng Oppur Is Activat	
11:10:30:966 RT : OLPC MAC->PHY :PRAM CHNG Time-Off:0 Power-Off:35 Fre	
11:10:30:966 RT : MAC -> PHY : PHY PARAM CHNG REQ	112-73978-1800-18777-18
11:10:30:966 RT : FN:656162 CDMA Code:0 Sub-chnlOff:0 SymbolOff:0 RNG-	Type:0
11:10:30:967 RT : LMAC-SRC : IR - CDMA index : O SubChnl Off : O Sym o	
repCode:0 ranging slot: <u>0 rang type:0</u>	
11:10:30:987 RT (LMAC: RNG RSP Received FN:656166)	stop
11:10:30:987 RT : Code:0 Symbl:0 Chnl:0 FrmNo:35 AttrPres:1 Basic-CID:	0 PrimCID:0
11.10.20.007 DT . CIDC . IMAC SDC . DDAM CUNC Time off.20 Downer Off.20	
Help, press F1	N

Figure 13: Open Loop passive Power Control Protocol

The Closed Loop Power Control algorithm is activated after the BS and the MS have exchanged the reciprocal Capabilities, after Ranging.

During the test, the Variable attenuator has been gradually increased by a specified amount of dBs, and it has been verified that the MS has subsequently received commands from the BS (PMC-REQ messages) to gradually increase its Transmitted Power by the same amount of dBs.

🗉 Test_01.txt - WordPad	- D ×
<u>File E</u> dit <u>V</u> iew Insert Format <u>H</u> elp	
11:12:31:671 RT : MAC -> PHY : PHY PARAM CHNG REQ	_
11:12:31:671 RT : CLPC : Recvd Power adj:8	
11:12:31:671 RT : CLPC : LMAC-SRC : PRAM CHNG Time-off:0 Power-Off:25	
11:12:31:671 RT : MAC -> PHY : PHY PARAM CHNG REQ	
11:12:31:671 RT : CLPC : Recvd Power adj:8	
11:12:31:916 RT : CLPC : LMAC-SRC : PRAM CHNG Time-off:0 Power-Off:21	
11:12:31:916 RT : MAC -> PHY : PHY PARAM CHNG REQ	-
For Help, press F1	NUM //

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

79 of 100

Figure 14: Closed Loop Power Control adjustment at the MS

A.7.3.3 Unexpected behaviors/Results

None.

A.7.4 Conclusions and recommendations

It was verified that the equipment properly implements OLPC and CLPC protocols.

A.8 Verification Exercise # LAB1_3 Quality of Service Report

A.8.1 Verification Exercise Scope

The purpose of this Test Case is to verify that all QoS related requirements are satisfied (SF creation and deletion, traffic parameters, bandwidth management) for all the QoS scheduling Types defined.

A.8.2 Conduct of Verification Exercise

A.8.2.1 Verification Exercise Preparation

The test bed described in 15 was used (no need for Spectrum Analyzers in this case).

IP Addressing Plan

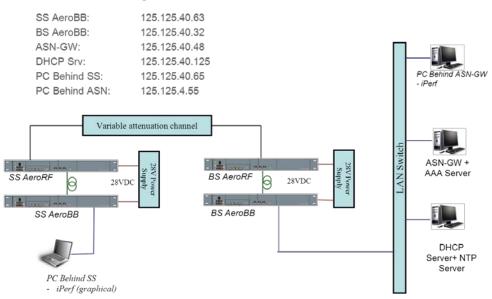


Figure 15: QoS - Test bed

founding members



80 of 100

A.8.2.2 Verification Exercise execution

Please note that in this Test Case, 1 Service Flow (SF) means 1 SF DL and 1 SF UL.

Step nr.	Action	Action description	PCO (Point of Control and Observation)	Comment
1.	Switch on BS			ОК
2.	Set 1 SF (SF1) with the scheduling type (QoS class) to be used as 1 among nrtPS/rtPS		Mngt PC connected to ASN-GW/AAA	ОК
3.	Switch on MS			ОК
4.	Start an IP Flow not compatible with the SF Classification for DL (then for UL) traffic	Using IPERF	IPERF @ PC connected to ASN-GW x DL (MS x UL)	ОК
5.	Verify that the IP packets are not transferred on the air interface	Using IPERF	IPERF @ PC connected to MS x DL (ASN- GW x UL)	ОК
6.	Change the IP Flow with a configuration compatible with the SF Classification for DL (then for UL) traffic	Using IPERF	IPERF @ PC connected to ASN-GW x DL (MS x UL)	ОК
7.	Verify that the IP packets are transferred on the air interface	Using IPERF	IPERF @ PC connected to MS x DL (ASN- GW x UL)	ОК
8.	Verify that data exceeding the MSTR is dropped or delayed	Using IPERF	IPERF @ PC connected to MS x DL (ASN- GW x UL)	ОК
9.	Verify that all traffic parameters related to the QoS class respect requirements		Mngt PCs connected to MS and BS	ОК

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

10.	Set 1 additional SF (SF2) with the same configuration of the SF of step 2		Mngt PC connected to ASN-GW/AAA	ОК
11.	Restart MS			ОК
12.	Start two IP Flow one compatible with SF1 configuration and the other with SF2. SF1 throughput > SF2 throughput SF1 throughput + SF2 throughput > Channel capacity	Using IPERF	IPERF @ PC connected to ASN-GW x DL (MS x UL)	ОК
13.	Check fairness between flows (SF1 throughput = SF2 throughput)	Using IPERF	IPERF @ PC connected to MS x DL (ASN- GW x UL)	ОК
14.	Switch off MS			ОК
15.	Pass to another scheduling type (QoS class) and repeat steps from 2 to 14 until all types have been tested			ОК

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

82 of 100

A.8.2.3 Deviation from the planned activities

None.

A.8.3 Verification exercise Results

A.8.3.1 Summary of Verification exercise Results

ID	Result	Description	When observed	Expected result	Obtained result	VO	Comment
1	MSTR	Verify that the Maximum Sustained Traffic Rate value for a SF is respected	Step 8			AeroMACS_ VO_Interop_ 04_B	ОК
2	QoS	Verify that the data traffic for a SF is managed following the QoS configuration	Step 9			AeroMACS_ VO_Interop_ 04_C AeroMACS_ VO_Interop_ 04_D	ОК
3	DSA	Verify that the correct DSA procedure is implemented	Step 5 Step 7 Step 9			AeroMACS_ VO_Interop_ 05_A	ОК
4	Dynam ic BW allocati on	Verification of correct allocation of the MAC resources	Step 5 Step 7 Step 8 Step 9 Step 13			AeroMACS_ VO_Interop_ 07_A AeroMACS_ VO_Interop_ 07_D	ОК

A.8.3.2 Analysis of Verification Exercise Results

Both the nrtPS and rtPS Classes of Services were tested, as requested in Step #2. Initially, the SF1 was set with nrtPS Class of Service with the following characteristics:

- Priority= 1 (default)
- Max Baud Rate: 1 Mbps (both for UL and DL)

founding members

Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

83 of 100

- Classification Rules (both in UL and DL):

- DHCP messages exchange enabled (on ports #67 and #68 in this example)
- ICMP messages exchange enabled (e.g. ping messages)
- NTP messages exchanges (enabled on port #123 in this example)
- UDP messages exchanges enabled (on ports #2222 and #2223 in this example)

An IP flow was then started in DL (using IPERF application running on the PC behind the ASN-GW), and sent to a not allowed destination port (#2220), and it was verified that no UDP messages were sent in any GRE tunnel towards the MS (see Figure 16).

A similar operation was then done in the inverse direction (UL), and it was again verified that no message was transmitted by the MS on the air interface.

7 6.8 .	2.2_4_5.pcap			
Eile	<u>E</u> dit ⊻iew <u>G</u> o) <u>C</u> apture <u>A</u> nalyze	Statistics Telephony Tools Hel	p
	¥ ¥ ¥	🕷 🖻 🛃 🗙	22 占 🔍 🔶 🔿	77 👱 🗐 📑 €, ♀, @, 🖻 🛎 🖄 % 🕱
Filter:				▼ Expression Clear Apply
	Time	Source	Destination Protoco	
	0.000000	125.125.40.48	125.125.40.48 TCP	x11 > 51919 [PSH, ACK] Seq=1 Ack=1 win=16 Len=3 -
	0.000023	125.125.40.48	125.125.40.48 TCP	51919 > x11 [PSH, ACK] Seq=1 Ack=4 Win=31 Len=9
-	0.000035	125.125.40.48	125.125.40.48 TCP	х11 > 51919 [АСК] Seq=4 Ack=10 win=16 Len=0 TSV=
	1.790201	125.125.4.55	125.125.40.63 UDP	Source port: 35589 Destination port: netiq
	1.790207	125.125.4.55	125.125.40.63 UDP	Source port: 35589 Destination port: netiq
	1.790213	125.125.4.55	125.125.40.63 UDP	Source port: 35589 Destination port: netiq
	1.790225	125.125.40.48	125.125.4.50 ICMP	Destination unreachable (Port unreachable)
	1.872363	125.125.4.55	125.125.40.63 UDP	Source port: 35589 Destination port: netiq
	1.872367	125.125.4.55	125.125.40.63 UDP	Source port: 35589 Destination port: netiq
	1.872369	125.125.4.55	125.125.40.63 UDP	Source port: 35589 Destination port: netiq
	1.872376	125.125.40.48	125.125.4.50 ICMP	Destination unreachable (Port unreachable)
	1.954113	125.125.4.55	125.125.40.63 UDP 125.125.40.63 UDP	Source port: 35589 Destination port: netiq Source port: 35589 Destination port: netiq
	1.954119	125.125.4.55	125.125.40.63 UDP	
	1.954123	125.125.40.48	125.125.40.63 UDP 125.125.4.50 ICMP	Source port: 35589 Destination port: netiq Destination unreachable (Port unreachable)
	2.036085	125.125.40.48	125.125.40.63 UDP	Source port: 35589 Destination port: netig
	2.036090	125.125.4.55	125.125.40.63 UDP	Source port: 35589 Destination port: netig
	2.036090	125.125.4.55	125.125.40.63 UDP	Source port: 35589 Destination port: netig
	2.036103	125.125.40.48	125.125.4.50 ICMP	Destination unreachable (Port unreachable)
	2.118006	125.125.4.55	125.125.40.63 UDP	Source port: 35589 Destination port: netig
	2.118010	125.125.4.55	125.125.40.63 UDP	Source port: 35589 Destination port: netig
	2.118012	125.125.4.55	125.125.40.63 UDP	Source port: 35589 Destination port: netiq
1	2.110012	125.125.4.55	125.125.40.05 00.	
			(8544 bits), 1068 byt	es captured (8544 bits)
	nux cooked		125 4 55 (125 125 4 5	5)
				5), Dst: 125.125.40.63 (125.125.40.63)
	er Datagran ta (1024 b		Port: 35589 (35589),	Dst Port: netiq (2220)
H Dat	ta (1024 b)	ytesj		
<u> </u>				
0020	7d 7d 28		04 08 04 50 00 00 00	
0030	52 66 99	f7 00 01 fd fa ac 00 00 04 00	00 00 00 00 00 00 00 00 00 01 86 a0 ff ff fc	
0040		39 30 31 32 33	34 35 36 37 38 39 30	
0060	32 33 34	35 36 37 38 39	30 31 32 33 34 35 36	37 23456789 01234567
0070		21 22 22 24 25		
Use	-	ocol (udp), 8 bytes	Packets: 668 Displayed: 668	Marked: 0 Load time: 0:00.281 Profile: Default

Figure 16: Wireshark Log on ASN-GW ports: no transmission for IP flow not compatible with the SF Classification for DL

founding members

Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

84 of 100

Then, an IP Flow was started in UL, with a configuration compatible with the SF Classification for UL (in this example the correct destination port), and it was verified that the UDP messages sent by the MS were correctly received by the ASN-GW (see Figure 17).

1 🗆	6.8.2.2_6_7.pcap	<u>- Wireshark</u> io <u>C</u> apture <u>A</u> nalyze	Statistics Telephony	<u>T</u> ools <u>H</u> elp				
		🕷 🖻 🛃 🗙	2244	د 😂 🐌		Q Q 🗹 🖉 🛙	2 畅 🐝 🖼	
	Filter:				 Expression Clear Apply 	,		
A	No. Time	Source	Destination	Protocol	Info			1
2	1 0.000000	125.125.40.32	125.125.40.48	IP	Fragmented IP proto	col (proto=GRE 0:	x2f, off=0, ID=f0	F7) [Rea
Z	2 0.000006	125.125.40.63	125.125.4.55	ENIP	Source port: 50457		t: EtherNet/IP-1	
	3 0.000026	125.125.40.63	125.125.4.55	ENIP	Source port: 50457	Destination por	t: EtherNet/IP-1	
	4 0.000026	125.125.40.63	125.125.4.55	ENIP	Source port: 50457	Destination por	t: EtherNet/IP-1	
<u>- </u>	5 0.000036	€25.125.40.63	€25.125.4.55	ENIP	Source port: 50457	Destination por	t: EtherNet/IP-1	
	6 0.000042		125.125.4.55	ENIP	Source port: 50457		t: EtherNet/IP-1	
- -	7 0.150041	125.125.40.32	125.125.40.48	IP	Fragmented IP proto			F8) [Rea
<u> </u>	8 0.150 MS	125.125.40.63	125.125.4.55	behind A	Source port: 50457	Destination por	t: EtherNet/IP-1	
	9 0.150094	125.125.40.63	125.125.4.55 125.125.4.59 C	petitid 1	Source port: 50457		t: EtherNet/IP-1	
	10 0.150094	125.125.40.63	125.125.4.55	ENIP	Source port: 50457		t: EtherNet/IP-1	
	11 0.150102	125.125.40.63	125.125.4.55	ENIP	Source port: 50457		t: EtherNet/IP-1	
	12 0.150103	125.125.40.63	125.125.4.55	ENIP	Source port: 50457		t: EtherNet/IP-1	
	13 0.249934	125.125.40.32	125.125.40.48	IP	Fragmented IP proto			F9) [Rea
	14 0.249938	125.125.40.63	125.125.4.55	ENIP	Source port: 50457		t: EtherNet/IP-1	roy Errer
	15 0.249980		125.125.4.55	ENIP	Source port: 50457			
	16 0.249980		125.125.4.55	ENIP	Source port: 50457	421 421 4	t: EtherNet/IP-1	
	17 0.249987	125.125.40.63	125.125.4.55	ENIP	Source port: 50457		t: EtherNet/IP-1	
	18 0.249988	125.125.40.63	125.125.4.55	ENIP	Source port: 50457		t: EtherNet/IP-1	
	19 0.400024	125.125.40.32	125.125.40.48	IP	Fragmented IP proto			fa) [no:
	20 0.400028	125.125.40.63	125.125.4.55	ENIP	Source port: 50457		t: EtherNet/IP-1	ia) [kea
	21 0.400028		125.125.4.55	ENIP	Source port: 50457		t: EtherNet/IP-1	
	22 0.400067	125.125.40.63	125.125.4.55	ENIP	0.00000000			
		123.123.40.05	123.123.4.33	ENIP	Source port: 50457	Descination por	t: EtherNet/IP-1	
	<u> </u>							•
	🕀 Frame 5: 151	L4 bytes on wire	(12112 bits), 1	.514 byte	es captured (12112 bi	ts)		
	⊞ Linux cooked	d capture						
	🗄 Internet Pro	otocol, Src: 125	.125.40.63 (125.	125.40.6	3), Dst: 125.125.4.5	5 (125.125.4.55)		
	😐 User Datagra	am Protocol, Src	Port: 50457 (50)457), Ds	t Port: EtherNet/IP-	1 (2222)		
	EtherNet/IP	(Industrial Pro	tocol)	2010				
		145						
	0020 7d 7d 04	37 c5 19 08 ae	05 c6 4d b6 00	00 00 0	0 }}.7 <mark>M.</mark>			
		ce 00 Of 08 bd	00 00 00 00 00			•		
	0040 00 00 08	ae 00 00 00 00	00 01 86 a0 ff					
		39 30 31 32 33	34 35 36 37 38					
	0060 32 33 34	35 36 37 38 39	30 31 32 33 34	35 36 3	7 23456789 0123456 2 20012245 6720012			
	User Datagram Pro				Marked: 0 Load time: 0:00.203		rofile: Default	
	4				- 10110-10-2000 emor 01001200			

Figure 17: Successful IP Flow in UL

Similarly, a DL IP Flow was created with a configuration compatible with the SF Classification for DL (in this case the correct destination port), and it was verified that the UDP messages sent by the PC behind ASN-GW were correctly received by the MS.

Subsequently, it has been verified that data exceeding the MSTR were dropped (step #8). In fact, using IPERF on the PC behind ASN-GW, an IP flow with 2 Mbps Baud Rate was sent to the ASN-GW to be transmitted to the MS (see Figure 18) without changing the previously configured 1 Mbps Max Baud Rate allowed to SF1. The result was that the data flow bit rate effectively registered at the MS was about 1 Mbps, coherently with the configured MSTR.

The same kind of test was repeated in the opposite direction (UL), and the same correct behavior was observed. It was observed that all traffic parameters related to the QoS class were compliant with the requirements.

founding members

Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

85 of 100

🗄 6.8.2.2_8 iperf pc GW.txt - WordPad
Eile Edit View Insert Format Help
[root@localhost ~]# iperf -c 125.125.40.63 -u -i 1 -l 1024 -t 10 -b 2000k -p 2222
Client connecting to 125.125.40.63, UDP port 2222
Sending 1024 byte datagrams
UDP buffer size: 108 KByte (default)
[3] local 125.125.4.55 port 43105 connected with 125.125.40.63 port 2222
[JD] Interval Transfer Bandwidth
[3] 0.0-1.0 sec 245 KBytes 2.01 Mbits/sec
[ID] Interval Transfer Bandwidth
[3] 1.0- 2.0 sec 244 KBytes 2.00 Mbits/sec
[ID] Interval Transfer Bandwidth
[3] 2.0- 3.0 sec 244 KBytes 2.00 Mbits/sec
[ID] Interval Transfer Bandwidth
[3] 3.0- 4.0 sec 244 KBytes 2.00 Mbits/sec
[ID] Interval Transfer Bandwidth
[3] 4.0- 5.0 sec 244 KBytes 2.00 Mbits/sec
[ID] Interval Transfer Bandwidth
[3] 5.0- 6.0 sec 244 KBytes 2.00 Mbits/sec
[ID] Interval Transfer Bandwidth
[3] 6.0-7.0 sec 244 KBytes 2.00 Mbits/sec [ID] Interval Transfer Bandwidth
[3] 7.0-8.0 sec 245 KBytes 2.01 Mbits/sec
[JD] Interval Transfer Bandwidth
[3] 8.0-9.0 sec 244 KBytes 2.00 Mbits/sec
[ID] Interval Transfer Bandwidth
[3] 9.0-10.0 sec 244 KBytes 2.00 Mbits/sec
[ID] Interval Transfer Bandwidth
[3] 0.0-10.0 sec 2.39 MBytes 2.00 Mbits/sec
[3] Sent 2443 datagrams
For Help, press F1 NUM

Figure 18: IPERF Log at the ASN-GW: 2 Mbps requested to be sent in DL

📕 6.8.2.2_8 iperf pc MS.txt - WordPad _ 🗆 🗵 <u>File Edit View Insert Format Help</u> **B** D 🛩 🖬 🎒 🖎 🛤 👗 🖻 🛍 ٠ _____ _____ Server listening on UDP port 2222 Receiving 1470 byte datagrams UDP buffer size: 208 KByte (default) [3] local 125.125.40.63 port 2222 connected with 125.125.4.55 port 43105 [ID] IntervalTransferBandwidthJitterLost/Total Datagram[3] 0.0-10.0 sec1.18 MBytes990 Kbits/sec1.461 ms1234/2443 (51%) Jitter Lost/Total Datagrams ^Croot@aeromacs-HP-Compaq-8200-Elite-SFF-PC:/home/aeromacs# iperf -c 125.125.4.55 -u -i 1 -b 2000k -t 10 -p 2222 _____ For Help, press F1 NUM

Figure 19: IPERF Log at the MS: 1Mbps Max Baud Rate respected

founding members Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

86 of 100

Then, a second Service Flow (SF2) was set with the same characteristics of SF1. However, SF1 was loaded with an IP Flow with Baud Rate= 2Mbps, while SF2 was loaded with an IP Flow with Baud Rate= 3 Mbps (see Figure 20 and Figure 21).

📋 6.8.2.2_12_13 iperf pc GW on SF1.txt - WordPad	- D X
<u>File Edit View Insert Format H</u> elp	
[root@localhost ~]# iperf -c 125.125.40.63 -u -i 1 -l 1024 -t 60 -b 2000k -p 2	222 🔺
Client connecting to 125.125.40.63, UDP port 2222	
Sending 1024 byte datagrams	
UDP buffer size: 108 KByte (default)	
[3] local 125.125.4.55 port 44685 connected with 125.125.40.63 port 2222	
[ID] Interval Transfer Bandwidth	
[3] 0.0- 1.0 sec 243 KBytes 1.99 Mbits/sec	
[ID] Interval Transfer Bandwidth	
[3] 1.0- 2.0 sec 244 KBytes 2.00 Mbits/sec	
[ID] Interval Transfer Bandwidth	
[3] 2.0- 3.0 sec 244 KBytes 2.00 Mbits/sec	
[ID] Interval Transfer Bandwidth	
[3] 3.0- 4.0 sec 244 KBytes 2.00 Mbits/sec	
[ID] Interval Transfer Bandwidth	
_ 5 31 4 0- 5 0 000 244 VButes 2 00 Woite/000	_ _
For Help, press F1	NUM //

Figure 20: SF1 loaded with 2 Mbps

📱 6.8.2.2_12_13 iperf pc GW on SF2.txt - WordPad	
<u>File Edit View Insert Format H</u> elp	
[root@localhost ~]# iperf -c 125.125.40.63 -u -i 1 -l 1024 -t 60 -b 3000k -p 22	24
Client connecting to 125.125.40.63, UDP port 2224 Sending 1024 byte datagrams UDP buffer size: 108 KByte (default)	
<pre>[3] local 125.125.4.55 port 57558 connected with 125.125.40.63 port 2224 [ID] Interval Transfer Bandwidth [3] 0.0- 1.0 sec 367 KBytes 3.01 Mbits/sec [ID] Interval Transfer Bandwidth [3] 1.0- 2.0 sec 366 KBytes 3.00 Mbits/sec [ID] Interval Transfer Bandwidth [3] 2.0- 3.0 sec 366 KBytes 3.00 Mbits/sec [ID] Interval Transfer Bandwidth</pre> [3] 2.0- 3.0 sec 366 KBytes 3.00 Mbits/sec[ID] Interval Transfer Bandwidth	T
For Help, press F1	UM //

Figure 21: SF2 loaded with 3 Mbps

The channel attenuation had been set in order to cause a QPSK ³/₄ Modulation/Coding, with a consequential Channel Capacity equal to 2,81 Mbps, hence much lower than the total bandwidth needed to support the traffic requested by the 2 IPERF applications (3+2=5Mbps), coherently with the condition requested by step #12.

It was observed that the two IP flows were divided fairly between SF1 and SF2 (see Figure 22 and Figure 23). The little difference evidenced is exclusively due to the different observation periods

founding members

Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

87 of 100

between the 2 Service Flows: in fact the 2 IPERF transmissions were started manually, so the 2 observation periods are different.

6.8.2.2_12_13 iperf pc MS on SF1.txt - WordPad	
<u>File E</u> dit <u>V</u> iew Insert F <u>o</u> rmat <u>H</u> elp	
root@aeromacs-HP-Compaq-8200-Elite-SFF-PC:/home/aeromacs# iperf -s -u -p 22	222
Server listening on UDP port 2222 Receiving 1470 byte datagrams UDP buffer size: 208 KByte (default)	
[3] local 125.125.40.63 port 2222 connected with 125.125.4.55 port 44685 [3] 0.0-61.7 sec 9.61 MBytes 1.38 Mbits/sec 16.932 ms 4804/14648 (33% ^Croot@aeromacs-HP-Compaq-8200-Elite-SFF-PC:/home/aeromacs#	*)
For Help, press F1	JUM //

Figure 22: Baud rate on SF1

6.8.2.2_12_13 iperf pc MS on SF2.txt - WordPad	
<u>File E</u> dit <u>V</u> iew Insert F <u>o</u> rmat <u>H</u> elp	
aeromacs@aeromacs-HP-Compaq-8200-Elite-SFF-PC:~\$ iperf -s -u -p 2224	
Server listening on UDP port 2224 Receiving 1470 byte datagrams UDP buffer size: 208 KByte (default)	
[3] local 125.125.40.63 port 2224 connected with 125.125.4.55 port 575 [3] 0.0-60.8 sec 10.9 MBytes 1.43 Mbits/sec 29.265 ms 10853/21979 ^Caeromacs@aeromacs-HP-Compaq-8200-Elite-SFF-PC:~\$	
For Help, press F1	NUM //



A.8.3.3 Unexpected behaviors/Results

None

founding members

Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

88 of 100

A.8.4 Conclusions and recommendations

It was verified that all QoS requirements are satisfied for the QoS scheduling Types defined.

A.9 Verification Exercise # LAB1_4 Security Report

A.9.1 Verification Exercise Scope

The purpose of this Test Case is to verify proper working of Security features.

A.9.2 Conduct of Verification Exercise

A.9.2.1 Verification Exercise Preparation

The test bed described in 15 was used, except for one difference: in fact, the ASN-GW and AAA Server were located in different devices.

A.9.2.2 Verification Exercise execution

Step nr.	Action	Action description	PCO (Point of Control and Observation)	Comment
1.	Switch on MS			
2.	Switch on BS and ASN- GW/AAA			
3.	Establish a communication and verify that the chosen authentication method is supported: No authentication or EAP based authentication		R6 i/f with Wireshark	With Authentication enabled, insert valid credentials

A.9.2.3 Deviation from the planned activities

None.

A.9.3 Verification exercise Results

A.9.3.1 Summary of Verification exercise Results

ID	Result	Description	When	Expected	Obtained	VVO	Comment

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

			observed	result	result		
1.	No Authenticatio n	Verify that authenticati on and key exchange steps are skipped	Step 3	Network entry without authentic ation		AeroMACS _VO_Intero p_11_A	ASN- GW/AAA shall be configured with no Authenticati on
2.	Authenticatio n	Verify that authenticati on and key exchange steps are present	Step 3	Network entry with authentic ation		AeroMACS _VO_Intero p_11_B	

A.9.3.2 Analysis of Verification Exercise Results

The ASN-GW was initially configured in order not to require Authentication to the MS entering the Network; BS and MS were switched on, and the MS started the Net Entry procedure, that was completed successfully. The related messages exchange in the ground network between BS, ASN-GW and DHCP Server is evidenced in the Wireshark log shown in Figure 24.

founding members



7 6.9	0.3.1Test_1.pca	ap - Wireshark			
Eile	<u>E</u> dit <u>V</u> iew <u>G</u>	o <u>C</u> apture <u>A</u> nalyze	Statistics Telephony I	ools <u>H</u> elp	
		🕷 🖻 🛃 🗙	2 占 🔍 🔶	🔿 💫 🏹	: 👱 🚍 🗨 Q, Q, 🖭 🖋 🖄 🥵 🎉 🔀
Filter:				•	Expression Clear Apply
No.	Time	Source	Destination	Protocol	Info 🔺
	. 0.000000	125.125.40.32		WIMAX	MS_PreAttachment_Req - MSID:00:00:77:b6:90:ac, TID:0x0001
	0.000735	125.125.40.48		WIMAX	MS_PreAttachment_Rsp - MSID:00:00:77:b6:90:ac, TID:0x0001
	0.002398	125.125.40.32		WIMAX	MS_PreAttachment_Ack - MSID:00:00:77:b6:90:ac, TID:0x0001
	0.047872	125.125.40.32		WIMAX	MS_Attachment_Req - MSID:00:00:77:b6:90:ac, TID:0x0002
	0.048230	125.125.40.48		WiMAX	MS_Attachment_Rsp - MSID:00:00:77:b6:90:ac, TID:0x0002
		125.125.40.32		WIMAX WIMAX	MS_Attachment_Ack - MSID:00:00:77:b6:90:ac, TID:0x0002 Path_Reg_Reg - MSID:00:00:77:b6:90:ac, TID:0x0001
	0.052357 30.551634	125.125.40.48 125.125.40.48		WIMAX WIMAX	Path_Reg_Reg = MSID:00:00:77:b6:90:ac, TID:0x0001 Path_Reg_Reg = MSID:00:00:77:b6:90:ac, TID:0x0001
	0.768373	125.125.40.32		WIMAX WIMAX	Path_Reg_Red = MSID:00:00:77:b6:90:ac, TID:0X0001 Path_Reg_Rsp = MSID:00:00:77:b6:90:ac, TID:0X0001
		125.125.40.32		WIMAX	Path_Reg_Ack = MSID:00:00:77:b6:90:ac, TID:0x0001
	. 6.162729		255.255.255.255	DHCP	DHCP Discover - Transaction ID 0x96976e
		125.125.40.48		DHCP	DHCP Discover - Transaction ID 0x96976e
	6.166467	125.125.40.125		DHCP	DHCP Offer - Transaction ID 0x96976e
	6.166666	125.125.40.48		DHCP	DHCP Offer - Transaction ID 0x96976e
	6.262676	0.0.0.0	255.255.255.255	DHCP	DHCP Request - Transaction ID 0x96976e
		125.125.40.48		DHCP	DHCP Request - Transaction ID 0x96976e
		125.125.40.125		DHCP	DHCP ACK - Transaction ID 0x96976e
		125.125.40.48		DHCP	DHCP ACK - Transaction ID 0x96976e
	6.761514	125.125.40.63		NTP	NTP client
	6.761552	125.125.40.63		NTP	NTP client
		125.125.40.63		NTP	NTP client
		125.125.40.63		NTP	NTP client
		125.125.40.63		NTP	NTP client
	6.763114	125.125.4.55	125.125.40.63	NTP	NTP server
	6.763125	125.125.4.55	125.125.40.63	NTP	NTP server
E Er	ame 18: 35	0 bytes on wire	(2800 bits), 350) bytes c	aptured (2800 bits)
	inux cooked		(1100 0.00), 00.	,	aptured (2800 bits)
			.125.40.48 (125.1	125.40.48), Dst: 125.125.40.32 (125.125.40.32)
		ing Encapsulati			,,,
				L25.40.48), Dst: 125.125.40.63 (125.125.40.63)
,	00.04.00	01 00 06 68 05	ca Oc 68 00 00	00 08 00	
0010		4e d4 31 00 00			hh EN.1/}{0
0020	7d 7d 28	20 20 00 08 00	00 00 00 01 45	00 01 32	}}(É2
0030		00 ff 11 9b 1f	7d 7d 28 30 7d		.1
0040	00 43 00	44 01 1e T9 ac	02 01 06 01 00 74 74 28 25 00	96 97 68 00 00 00	.C.Dn
			e\ Packets: 61 Display		
91.4		C !	me O.A. Nat En		

Figure 24: Net Entry without authentication - WS Log

Subsequently, the test was repeated after having properly reconfigured ASN-GW/AAA Server in order to require an EAP-based Authentication. The complete procedure was verified.

Figure 25 shows the related Log file, registered at the ASN-GW. In particular, it is possible to appreciate the following steps:

- In step #7 in Figure 25 the ASN-GW sends the ID request to the BS (that has opened a GRE tunnel towards the MS), receiving the BS response (in step #8) containing the MS MAC address and realm.
- The ASN-GW sends an Access-Request to the AAA Server, starting the Authentication Process, and the AAA Server replies with an Access-challenge, after having verified the presence of the MS in its MSs list. This message contains the EAP Message type and the keys to be exchanged in the next transactions.
- The ASN-GW encapsulates the received message in an EAP-REQ to the MS, to which the MS answers with a EAP RSP (Client Hello). The ASN-GW forwards the Client-Hello to the AA Server (step #15 in Figure 25).
- The AAA Server replies the ASN-GW with an Access-challenge (Server-hello) containing also the Server Certificate, and the Request of the Client Certificate. The ASN-GW encapsulates this information in the subsequent EAP-Request to the MS

founding members

Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

91 of 100

- The MS answers to the ASN-GW with its Client Certificate, and other information (Client Key Exchange, Certif. Verify, Change Cypher Spec, etc). The ANS-GW encapsulates this information for the AAA Server in step #19
- After a series of acknowledges among the three involved parties, the AAA Server accepts the whole procedure with the Access-accept message in step #24, including the Home Agent Address with which the ASN-GW will create the tunnel for data exchange (PC behind ASN-GW)
- After having successfully created a tunnel with the HA, the ASN-GW sends an EAP_Transfer (Success) to the MS, and subsequently the Key_Change_Directive, containing the keys for Air ciphering (step #35)
- The MS sends beck a Key_Change_Ack and then the first ciphered message (MS_Attachment_Req in step #37)
- After a brief exchange of acknowledges, the ASN-GW sends a Path_Reg_Req to the MS, meaning that the Authentication Phase has successfully concluded and the final Registration/SF Creation may be started.

📶 Wing_ASN_With_Security_Success@relaymode.pcap - Wireshark	×
Elle Edit Yew Go Capture Analyze Statistics Telephony Iools Help	
≝ ≝ ≝ ≝ ⊨ ⊡ % ≈ 2 ⊨ °. ⇔ ⇒ ⇒ 7 ⊻ ⊨ ≡ ⊙ Q Q ⊡ ⊯ ⊠ % % 13	
Filter: Expression Clear Apply	
No. Time Source Destination Protocol Info	
6 73.569995 125.125.40.39 125.125.40.48 wiMAX MS_PreAttachment_Ack - MSID:18:03:73:c6:79:97, TID:0x0001	
7 73.574233 125.125.40.48 125.125.40.39 wiMAX AR_EAP_Transfer [Request, Identity [RFC3748]] - MSID:18:03:73:c6:79:97, TID:0x(0
8 73.666392 125.125.40.39 125.125.40.48 wiMAX AR_EAP_Transfer [Response, Identity [RFC3748]] - MSID:18:03:73:c6:79:97, TID:0	×
9 73.669788 DellPcba_53:25:Broadcast ARP Who has 125.125.40.47 Tell 125.125.40.48	
10 73.670031 Dell_c0:b5:49 DellPcba_53:25:9¢ARP 125.125.40.4 is at 00:11:43:c0:b5:49	
11 73.670044 125.125.40.48 125.125.40.4 RADIUS Access-Request(1) (id=26, l=229) 12 73.671416 125.125.40.4 125.125.40.48 RADIUS Access-challenge(11) (id=26, l=91)	
12 73.671416 125.125.40.4 125.125.40.48 RADIUS Access-challenge(11) (id=26,]=91) 13 73.691573 125.125.40.48 125.125.40.39 wiMAX AR_EAP_Transfer [Request, EAP-TLS [RFC5216] [Aboba]] - MSID:18:03:73:c6:79:97,	
14 73.767285 125.125.40.49 125.125.40.49 WinAx AR_EAP_Transfer [Response, EAP-TLS [Ref5210] [Abd043]] - MSID:18:03:75.03767997,	
1573.770611 125.125.40.48 125.125.40.4 RADUS Access-Request(1) (16427, 1-286)	·
16 73.793105 125.125.40.4 125.125.40.48 RADIUS Access-challenge(1) (1d=27, 1=117)	
17 73.799871 125.125.40.48 125.125.40.39 wiMAX AR_EAP_Transfer [Request, EAP-TLS [RFC5216] [Aboba]] - MSID:18:03:73:c6:79:97,	
18 73.867997 125.125.40.39 125.125.40.48 wiMAX AR_EAP_Transfer [Response, EAP-TLS [RFC5216] [Aboba]] - MSID:18:03:73:c6:79:97,	,
19 73.874840 125.125.40.48 125.125.40.4 RADIUS Access-Request(1) (id=28, 1=230)	
20 73.876513 125.125.40.4 125.125.40.48 RADIUS Access-challenge(11) (id=28, l=1117)	
21 73.879144 125.125.40.48 125.125.40.39 wiMAX AR_EAP_Transfer [Request, EAP-TLS [RFC5216] [Aboba]] - MSID:18:03:73:c6:79:97,	
22 73.968865 125.125.40.39 125.125.40.48 wiMAX AR_EAP_Transfer [Response, EAP-TLS [RFC5216] [Aboba]] - MSID:18:03:73:c6:79:97,	,
23 73.971476 125.125.40.48 125.125.40.4 RADIUS Access-Request(1) (id=29, l=230)	
24 73.972431 125.125.40.4 125.125.40.48 RADIUS Access-challenge(11) (id=29, l=296)	
25 73.973906 125.125.40.48 125.125.40.39 wiMAX AR_EAP_Transfer [Request, EAP-TLS [RFC5216] [Aboba]] - MSID:18:03:73:c6:79:97,	
26 74.526544 125.125.40.39 125.125.40.48 wiMAX AR_EAP_Transfer [Response, EAP-TLS [RFC5216] [Aboba]] - MSID:18:03:73:66:79:97,	,
27 74.530067 125.125.40.48 125.125.40.4 IP Fragmented IP protocol (proto=UDP 0x11, off=0, ID=2fe7) [Reassembled in #28]	
28 74.530102 125.125.40.48 125.125.40.4 RADIUS Access-Request(1) (id=30, l=1506) 29 74.664121 125.125.40.4 125.125.40.48 RADIUS Access-challenge(11) (id=30, l=154)	
29 74.664121 125.125.40.4 125.125.40.48 RADIUS Access-challenge(11) (id=30, l=154) 30 74.665702 125.125.40.48 125.125.40.39 wiMAX AR EAP_Transfer [Request. EAP-TLS [RFC5216] [Aboba]] - MSID:18:03:73:c6:79:97.	
31 74.707466 125.125.40.39 125.125.40.48 wimax Ar EAP_Transfer [Response, EAP-TLS [RFC520] [Abbda]] - MSD101805.757(3):75(6):79.97	
32 74.709664 125.125.40.4 RADUS ACCESS-Request(1) (1d=31, 1=230)	·
33 74.816721 125.125.40.4 125.125.40.48 RADIUS Access-Accept(2) (id=31, 1=554)	_
34 74.822267 125.125.40.48 125.125.40.39 wiMAX AR_EAP_Transfer [Success] - MSID:18:03:73:c6:79:97. TID:0x0006	
35 74.822482 125.125.40.48 125.125.40.39 wiMAX Key_Change_Directive - MSID:18:03:73:c6:79:97, TID:0x0001	
36 74.822762 125.125.40.39 125.125.40.48 wiMAX key_change_Ack - MSID:18:03:73:c6:79:97, TID:0x0001	
37 74.949540 125.125.40.39 125.125.40.48 wiMAX MS_Attachment_Req - MSID:18:03:73:c6:79:97, TID:0x0002	
38 74.951125 125.125.40.48 125.125.40.39 wiMAX MS_Attachment_Rsp - MSID:18:03:73:c6:79:97, TID:0x0002	
39 74.951577 125.125.40.39 125.125.40.48 wiMAX MS_Attachment_Ack - MSID:18:03:73:c6:79:97, TID:0x0002	
40 74.995773 125.125.40.48 125.125.40.39 wiMAX Path_Reg_Req - MSID:18:03:73:c6:79:97, TID:0x0001	
41 75.737069 125.125.40.39 125.125.40.48 wiMAX Path Reg Rsn - MSTD:18:03:73:c6:79:97. TTD:0x0001	r.
⊕ Frame 7: 85 bytes on wire (680 bits), 85 bytes captured (680 bits)	
B Ethernet II, Src: DellPcba_53:25:9e (00:0d:56:53:25:9e), Dst: d4:be:d9:b9:ce:cb (d4:be:d9:b9:ce:cb)	_
⊞ Internet Protocol, Src: 125.125.40.48 (125.125.40.48), Dst: 125.125.40.39 (125.125.40.39) ⊞ User Datagram Protocol. Src Port: wimaxasnon (2231). Dst Port: wimaxasnon (2231)	•
	-
0000 d4 be d9 b9 ce cb 00 0d 56 53 25 9e 08 00 45 00	-
0020 28 27 08 b7 08 b7 00 33 4b 96 01 01 08 82 00 2b ('3 K+	
0030 18 03 73 c6 79 97 00 00 00 00 00 01 00 00 00 3e	_
0040 00 05 01 01 00 05 01 00 1a 00 0a 00 19 00 06 0a	-
Frame (frame), 85 bytes Packets: 51 Displayed: 51 Marked: 0 Load time: 0:00.218 Profile: Default	



founding members

Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

92 of 100

A.9.3.3 Unexpected behaviors/Results

None.

A.9.4 Conclusions and recommendations

The proper Authentication features were verified in all of the impacted devices (MS, BS, ASN-GW, AAA Server).

A.10 Verification Exercise # LAB1_5 Radio Characteristics Requirements Report

A.10.1 Verification Exercise Scope

The purpose of this Verification Exercise is to verify that the BS Radio characteristics requirements are satisfied.

A.10.2 Conduct of Verification Exercise

A.10.2.1 Verification Exercise Preparation

The same test bed described in A.6.2.1 was used, except for the fact that a MS was not needed in this case.

A.10.2.2 Verification Exercise execution

Step nr.	Action	Action description	PCO (Point of Control and Observation)	Comment
1.	Switch on MS			Not executed as not needed
2.	Switch on BS			ОК
3.	Verify that MS connects successfully		Mngt PCs connected to MS and BS	Not executed as not needed
4.	Send payload to be transmitted by BS		Mngt PCs connected to BS	Not executed as not needed. The BS starts transmitting autonomously at the start-up.
5.	Verify the tune of center frequencies by the BS		WiMAX Spectrum	ОК

founding members



93 of 100

		Analyzer	
6.	Verify the supported 5MHz channelization	WiMAX Spectrum Analyzer	OK

A.10.2.3 Deviation from the planned activities

Steps 1, 3, 4 were not executed as not needed (the BS starts transmitting autonomously at the start-up).

A.10.3 Verification exercise Results

A.10.3.1 Summary of Verification exercise Results

ID	Result	Description	When observed	Expected result	Obtained result	VO	Comment
1.	BS TX Spectru m Mask	Verify the tune of center frequencies by the BS	Step 5	BS Centre Frequenc y tolerance better than \pm 2x10 ⁻⁶	BS Centre Frequency tolerance better than ± 2x10 ⁻⁸	AeroMAC S_VO_RF _06_A	OK- by means of Spectrum Analyzer
2.	BS TX Spectru m Mask	Verify the supported 5Mhz channelizatio n	Step 6	5 MHz Channeliz ation	5 MHz Channelization verified	AeroMAC S_VO_RF _06_B	OK- by means of Spectrum Analyzer

A.10.3.2 Analysis of Verification Exercise Results

The AeroMACS BS prototype spectrum mask was measured. It is represented in Figure 27.



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

94 of 100

🔆 Agi	ilent 21:59:46	Mar 17, 19	170		Marker
Ref0 o #EmiPk⊺	1Bm	Atten 10 d	IB	▲ Mkr3 7.50 M -50.900	
Log 10 dB/			3R		Marker Trace Auto 1 2 3
	Marker △ 7.500000 -50.900			1 Maryly 2 Min Maryly 2	Readout, Frequency
LgAv	Aller Carlow and a construction of the constru			un haite and haite	Marker Table
	5.113 50 GHz W (-6 dB) 3 k er Trace		VBW 30 kHz X Axis	Span 20 M #Sweep 7.5 s (601 pt Amplitude	
1R	(1)	Freq	5.113 57 GHz	-26.41 dBm	
16	(1)	Freq	3.20 MHz	-27.74 dB	
2R 20	(1) (1)	Freq	5.113 57 GHz 5.00 MHz	-26.49 dBm -33.54 dB	
20 3R	(1)	Freq Freq	5.113 57 GHz	-26.49 dBm	
36		Freq	7.50 MHz	-50.90 dB	More 2 of 2
File Op	eration Stat	us, A:\SCF	EN044.GIF file	saved	
-	Figure	e 26: Aei	oMACS BS n	neasured Spectral	Mask

The BS center frequency error measured was about ±100 Hz at 5.091 MHz, i.e. less than 2x10⁻⁸.

Note: The BS prototype spectrum mask was implemented making reference to the target mask reported in Figure 27. At the moment of the prototype specification no MOPS were available, and hence no target masks, neither in draft form.

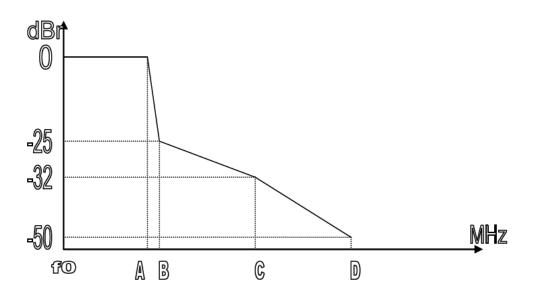


Figure 27: Selex AeroMACS BS prototype target spectrum mask

The target Spectrum Mask adopted has the following attenuations:



95 of 100

param	att.	Freq.
А	0 dBr	2.5 MHz
В	-25 dBr	3.2 MHz
С	-32 dBr	5.0 MHz
D	-50 dBr	7.5 MHz

A.10.3.3 Unexpected behaviors/Results

None.

A.10.4 Conclusions and recommendations

The AeroMACS BS prototype spectrum mask was measured.

A.11 Verification Exercise # LAB1_6 Transmit Power Report

A.11.1 Verification Exercise Scope

The purpose of this Verification Exercise is to verify that the Transmit Power requirements listed in the Verification Exercise execution Section are satisfied.

A.11.2 Conduct of Verification Exercise

A.11.2.1 Verification Exercise Preparation

The exercise was executed with the test bed described in Figure 2.

A.11.2.2 Verification Exercise execution

Step nr.	Action	Action description	PCO (Point of Control and Observation)	Comment
1.	Switch on MS			ОК
2.	Switch on BS			ОК
3.	Send payload to be transmitted by BS		Mngt PCs connected to BS	ОК
4.	Verify the BS output power range		Mngt PC connected to BS and for signal WiMAX	ОК

founding members



			Spectrum	
			Analyzer	
5.	Verify that if the BS belongs to Class 1, then its transmitted power keeps in the range of 20 <ptx,max<23 dbm<br="">for QPSK modulation</ptx,max<23>		Mngt PC connected to BS and for signal WiMAX Spectrum Analyzer	ОК
6.	Lower and raise the Variable attenuator Level at steps of 1 dB		Variable Attenuator	ОК
7.	Verify that the MS output power is increased or decreased in order to compensate the power fluctuations	Check the MS TX power with the Spectrum Analyzer, check the UL MAP IE on the RF Link	Mngt PCs connected to MS and BS, and for signal WiMAX Spectrum Analyzer	ОК

A.11.2.3 Deviation from the planned activities

None.

A.11.3 Verification exercise Results

A.11.3.1 Summary of Verification exercise Results

ID	Result	Description	When observed	Expected result	Obtained result	VO	Comment
1.	Verify the BS output power range		Step 4			AeroMACS_ VO_RF_08_ D	OK- by means of Spectrum Analyzer
2.	Verify that if the BS belongs to Class 1, then its transmitted power		Step 5			AeroMACS_ VO_RF_07_ A	OK- by means of Spectrum Analyzer

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

	keeps in the range of 20 <ptx,m ax<23 dBm for QPSK modulation</ptx,m 					
3.	Transmit Power Control and Relative Step accuracy	Verify power control procedure during initial ranging phase, Closed Loop and Open Loop Power Control mode	Step 7	Verify that the MS output power is increased or decrease d in order to compens ate the power fluctuation s	AeroMACS_ VO_RF_08_ A/C	OK- by means of Spectrum Analyzer

A.11.3.2 Analysis of Verification Exercise Results

The exercise was executed with the test bed described in Figure 2.

In order to verify the BS TX Output power, the total attenuation introduced by the attenuator and cables between the BS under test and the Spectrum Analyzer was measured. It resulted being 16 dB.

Then the Spectrum Analyzer measured the BS "Band Power", that is the BS TX power actually contained in the 5 MHz band, evidenced by markers in Figure 28.

The resulting BS TX Output Power was calculated as (16 + 6.87) = 22.87 dBm (Class 1).



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

98 of 100

₩ Agilent 20:29:03 Mar 14,	1970		Trace
Ref 10 dBm Atten 20 Avg	0 dB	▲ Mkr1 5.00 MHz Band Pwr 6.87 dBm	Trace <u>1</u> 2 3
Log 10 dB/	Manual Manual Contraction of Contrac		Clear Write
Delta Marker Fr			Max Hold
5.111000000 G PAvg Band Pwr 6.8	iHz	and the second s	Min Hold
V1 S2 S3 FC AA			View
£(f): FTun Swp			Blank
Center 5.108 50 GHz Res BW 180 kHz	VBW 180 kHz	Span 20 MHz [°] #Sweep 1.5 s (601 pts)	More 1 of 2
File Operation Status, A:\S	CREN041.GIF file s	aved	

Figure 28: BS Output Band Power

The OL passive Power Control and CL Power Control procedures have been verified. Analysis is shown in A.7.3.2.

A.11.3.3 Unexpected behaviors/Results

None.

A.11.4 Conclusions and recommendations

The BS TX Output Power has been measured. The OL passive Power Control and CL Power Control procedures have been successfully verified.



Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

99 of 100

-END OF DOCUMENT-

founding members

Avenue de Cortenbergh 100 | B -1000 Bruxelles www.sesarju.eu

100 of 100