System Implementation Deliverable Part1: AeroMACS Ground Prototypes Description

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Abstract

This SESAR technical report has been prepared within SESAR Project 15.2.7 “Airport Surface Data Link”. This report is part of WA5 activity aiming to design and implement the AeroMACS Prototypes that will be used in the tests to be performed both in the Manufacturers Laboratory, and in the Airports involved.
This part of the deliverable includes the description of the Ground Prototypes that will be used during P.15.02.07 tests.

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Intellectual Property Rights (foreground)

This deliverable consists of SJU foreground.

The Prototypes described in this deliverable consist respectively of Thales and Selex ES foreground.

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Executive summary

The aim of the overall WA5 activity is to implement the AeroMACS Ground Prototypes that will be used in the tests to be performed both in the Manufacturers Laboratory, and in the Airport involved.
The scope of this document is describing the Ground Prototypes to be used during the P.15.02.07 tests. This description includes both the Functional Scope of AeroMACS prototypes and the installation and setup of the prototypes' devices.
Two AeroMACS Ground Prototypes are considered within P.15.2.7, one of them is provided by SELEX ES and the other one, by THALES. These two prototypes will enable the transition from SESAR simulated datalink and SW based scenarios to HW datalink and real airport environment proofs.
Verification Objectives are described in Part 2 of this deliverable, also as part of the WA5 activity ([2]).

1 Introduction

This deliverable is part of the 15.2.7 WA5 activity, whose goal is the design and implementation of a test bed platform encompassing the functionalities of specified 802.16e/aero profile. This will lead us to move from SESAR simulated datalink and SW based scenarios to HW datalink and real airport environment proofs.

1.1 Purpose of the document

Scope of this document is describing the Prototypes to be used during 15.2.7 tests.

1.2 Intended readership

This document is intended for all the partners involved in SESAR P15.02.7.

1.3 Background

A number of activities have been executed in other 15.2.7 Tasks, leading to results that can be considered as the WA5 baseline.

In particular, Task WA1 produced an AeroMACS System Analysis, developing, among other technical documents, a first draft of AeroMACS System Profile. Subsequently, during Tasks WA3 and WA4 a number of studies and simulations were executed, addressing some items left pending in WA1, leading to the definition of a consolidated version of AeroMACS Mobile Network System Profile. Such a System Profile is under evaluation by Task WA7 (Standardization) at the time of writing this document.

1.4 Acronyms and Terminology

Term	Definition
AAA	Authorisation, Authentication and Accounting
AeroMACS	Aeronautical Mobile Airport Communication System
AMC	Adaptive Modulation and Coding
AMT	Aeronautical Mobile Telemetry
AOC	Airline Operational Communication
ARQ	Automatic Repeat Request
AS	Aeronautical Security
ASN-GW	Access Service Network-Gateway
ATM	Air Traffic Management
BB	Base Band
BE	Best Effort Service
BER	Bit Error Ratio
BS	Base Station

Term	Definition
BW	Bandwidth
COCR	Communications Operational Concept and Requirements
CONOPS	Concept of Operations
COTS	Commercial of the shelf
DCL	Departure Clearance
DDS	Data Distribution Services
DL	Downlink
DoS	Denial of Service
D-TAXI	Departure Taxi
EAP	Extensible Authentication Protocol
E-ATMS	European Air Traffic Management System
EIRP	Effective Isotropic Radiated Power
EUROCAE	European Organisation for Civil Aviation Equipment
FCI	Future Communication Infrastructure
H-ARQ	Hybrid Automatic Repeat Request
HMI	Human Machine Interface
IP	Internet Protocol
IPsec	Internet Protocol security
ITU-R	International Telecommunication Union – Radio Communications
LOS	Line of Sight
MAC	Medium Access Control
MIMO	Multiple Input Multiple Output
MLS	Microwave Landing System
MS	Mobile Station
NET	Network Management Service
NLOS	Non Line of Sight
PENS	Pan European Network Services

Term	Definition
QoS	Quality of Service
RF	Radio Frequency
rtPS	Real Time Polling Service
RX	Receiver
SESAR	Single European Sky ATM Research Programme
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SJU Work Programme	The programme which addresses all activities of the SESAR Joint Undertaking Agency.
SESAR Programme	The programme which defines the Research and Development activities and Projects for the SJU.
SNR	Signal to Noise Ratio
SS	Subscriber Station
SWIM	System Wide Information Management
TMA	Terminal Control Area
TX	Transmit
UGS	Unsolicited Grant Service
UL	Uplink
VALP	Validation Plan
VALR	Validation Report
VALS	Validation Strategy
VLAN	Virtual Local Area Network (IEEE 802.1Q)
VO	Verification Objective
VP	Verification Plan
VR	Verification Report
VS	Verification Strategy
WA	Work Activity

2 Design of a demonstrative IEEE 802.16e/aero prototype

The main goal of this chapter is the design and implementation of a testbed platform encompassing the functionalities of specified 802.16e/aero profile. This will lead us to move from SESAR simulated datalink and SW based scenarios to HW datalink and real airport environment proofs.

2.1 Functional Scope of AeroMACS Prototypes

The Functional Scope of Prototypes used in the various 15.2.7 test campaigns can be described specifying the AeroMACS Prototype System Profile, as done in the following sub-chapters. This will be a subset of the complete AeroMACS Mobile Network System Profile, in order to take into account potential limitations of COTS based prototypes or mockups.

Next tables illustrate to which AeroMACS characteristics the Prototype will provide support. Tables/Items numbers in the tables contained in the following subchapters refer to [3].

Features supported by prototypes are evidenced in green.

2.1.1 PHY profile

Table	Item	Name	WiMAX value	AeroMACS value	Prototype Support	
					BS	Avionic/Vehicular Mock Up MS
4	1	OFDMA	Y	Y	Y	Y
5	5	5 MHz mode	Y	Y	Y	Y
	10	10 MHz mode	Y	N	N	N
	3.5 7 8 8.75	FFT Sizes	Y	N	N	N
6	1	Sampling Factor	Y	Y	Y	Y
7	2	Cyclic Prefix 1/8	Y	Y	Y	Y
	1,3,4	Cyclic Prefix1/4, 1/16, 1/32	N	N	N	N
8	5	Frame Length 5 ms	Y	Y	Y	Y
	1-4, 6-8	Other Frame Length values	N	N	N	N
9	1	TTG	Y	Y	Y	N/A

Table	Item	Name	WiMAX value	AeroMACS value	Prototype Support	
					BS	Avionic/Vehicular Mock Up MS
	2	RTG	Y	Y	Y	N/A
10	1	Number of OFDM symbols in DL/UL for 5 and 10 MHz	Y	Y	Y	Y
	2-4	Number of OFDM symbols in other BW options	N	N	N	N
11	1	PUSC	Y	Y	Y	Y
	2	PUSC w/ all subchannels	Y	Y	Y	Y
	4	FUSC	Y	N	N	N
	6	Optional FUSC	N	N	N	N
	3, 5, 7	Dedicated pilots	IO-BF	N	N	N
	8, 9	AMC	IO-BF	N	N	N
	10	PUSC-ASCA	N	N	N	N
12	1	PUSC	Y	Y	Y	Y
	2, 3, 5	Optional PUSC modes	N	N	N	N
	4	AMC	Y	N	N	N
13	1	Common SYNC symbol	N	N	N	N
14	1-13	UL Sounding 1	IO-BF/N	N	N	N
15	1-2	UL Sounding 2	Y	N	N	N
16	1	Initial Ranging PUSC w/ 2 symbols	Y	Y	Y	Y
	2	Initial Ranging PUSC w/ 4 symbols	N	N	N	N
	3-4	Initial Ranging O-PUSC	N	N	N	N

Table	Item	Name	WiMAX value	AeroMACS value	Prototype Support	
					BS	Avionic/Vehicular Mock Up MS
	5-6	Initial Ranging AMC	N	N	N	N
17	1	HO Ranging PUSC w/ 2 symbols	Y	Y	Y	Y
	2	HO Ranging PUSC w/ 4 symbols	N	N	N	N
	3-4	HO Ranging O-PUSC	N	N	N	N
	5-6	HO Ranging AMC	N	N	N	N
18	1	Periodic Ranging PUSC w/ 1 symbol	Y	Y	Y	Y
	2	Periodic Ranging PUSC w/ 3 symbols	N	N	N	N
	3-4	Periodic Ranging O-PUSC	N	N	N	N
	5-6	Periodic Ranging AMC	N	N	N	N
19	1	BW Request PUSC w/ 1 symbol	Y	Y	Y	Y
	2	BW Request PUSC w/ 3 symbols	N	N	N	N
	3-4	BW Request O-PUSC	N	N	N	N
	5-6	BW Request AMC	N	N	N	N
20	1, 3	Fast Feedback/CQI Channel Encoding 4/3 bits	N	N	N	N
	2	Fast Feedback/CQI Channel Encoding 6 bits	Y	Y	Y	Y
	4	Fast	N	N	N	N

Table	Item	Name	WiMAX value	AeroMACS value	Prototype Support	
					BS	Avionic/Vehicular Mock Up MS
		Feedback/CQI Channel Encoding Primary/Secondary				
21	1	Fast-Feedback Allocation Subheader support	N	N	N	N
	2	Fast-Feedback channel allocation using CQICH Allocation IE	Y	Y	Y	Y
	3	Fast-Feedback channel allocation using CQICH Enhanced Allocation IE	N	N	N	N
22	1	Repetition	Y	Y	Y	Y
23	1	Randomization	Y	Y	Y	Y
24	1	CC Tail Biting	Y	Y	Y	Y
	2	CC Zero Tail	N	N	N	N
25	1	CTC	Y	Y	Y	Y
26	1	BTC	N	N	N	N
27	1	LDPC	N	N	N	N
28	1	Interleaving	Y	Y	Y	Y
	2	Optional Interleaver for CC	N	N	N	N
29	2	Chase Combining HARQ with CTC	Y	Y	N	N
	1, 3	Other Chase combining options	N	N	N	N
30	1-8	HARQ Parameters for Chase with CTC	Y	Y	N	N
31	1-2	Incremental Redundancy HARQ	N	N	N	N

Table	Item	Name	WiMAX value	AeroMACS value	Prototype Support	
					BS	Avionic/Vehicular Mock Up MS
32	1	ACK Channel for HARQ	Y	Y	N	N
33	1-3	BS synchronization in time and frequency	Y	Y	Y	N/A
	4	MS Synchronization	Y	Y	N/A	Y
34	1	CL Power Control	Y	Y	Y	Y
35	1	OL Power Control	Y	Y	N	N
	2	Passive Uplink OL PC	Y	Y	N	N
	3	Active Uplink OL PC	N	N	N	N
	4	UL Power report in BW request and UL Tx report header	Y	Y	N	N
	5-6	Other UL Power report options	N	N	N	N
36	1	MS Power limitation control	Y	Y	N/A	Y
37	1	Physical CINR measurement from preamble for frequency reuse 1	Y	Y	N	N
	2	Physical CINR measurement from preamble for frequency reuse 3	Y	Y	Y	Y
	3	Physical CINR measurement from pilot SC	Y	Y	N	N
	4	Physical CINR measurement from data SC	N	N	N	N
	5-9	Effective CINR measurement	Y	N	N	N

Table	Item	Name	WiMAX value	AeroMACS value	Prototype Support	
					BS	Avionic/Vehicular Mock Up MS
	10	Frequency selectivity characterization report	N	N	N	N
	11	Major group indication	IO-BF	N	N	N
	12	MIMO permutation feedback cycle	IO-MIMO	N	N	N
38	1	RSSI measurement	Y	Y	N/A	Y
39	1	PRBS	Y	Y	Y	Y
40	1-3	Downlink Modulation	Y	Y	Y	Y
41	1-2	Uplink Modulation QPSK 16-QAM	Y	Y	Y	Y
	3	Uplink Modulation 64-QAM	N	IO-64QM	N	N
42	1	Pilot Modulation	Y	Y	Y	Y
43	1	Preamble Modulation	Y	Y	Y	N/A
44	1	Ranging Modulation	Y	Y	N/A	Y
45	1	Normal MAP	Y	Y	Y	Y
46	1	Compressed MAP	Y	IO-Compressed MAP for BS Y for MS	N	N
47	1	Sub-DL-MAP	Y	N	N	N
48	1-2	H ARQ MAP Message	N	N	N	N
49	1	Extended HARQ IE	Y	Y	N	N
50	1	DL Region	N	N	N	N

Table	Item	Name	WiMAX value	AeroMACS value	Prototype Support	
					BS	Avionic/Vehicular Mock Up MS
		Definition Support				
51-60	All	AAS	N	N	N	N
61	1	FHDC	N	N	N	N
	2	2-antenna, matrix A, DL PUSC	IO-MIMO	IO-MIMO	N	N
	3	2-antenna, matrix B, vertical encoding, DL PUSC	IO-MIMO	N	N	N
	6	4-antenna, matrix A, DL PUSC	N	N	N	N
	4-10	Other DL PUSC matrix options	N	N	N	N
62	1-10	DL FUSC matrix options	N	N	N	N
63	1-12	Optional DL FUSC matrix options	N	N	N	N
64	1-12	Optional DL AMC matrix options	N	N	N	N
65	1	DL PUSC-ASCA MIMO	N	N	N	N
66	1	2-antenna, matrix A, UL PUSC	N	N	N	N
	2-3	2-antenna, matrix B, UL PUSC	N	N	N	N
	4	Collaborative SM for MS with single antenna	IO-MIMO	N	N	N
	5	Collaborative SM for MS with two transmit antennas	IO-MIMO	N	N	N
67	1-4	Optional UL PUSC matrix options	N	N	N	N

Table	Item	Name	WiMAX value	AeroMACS value	Prototype Support	
					BS	Avionic/Vehicular Mock Up MS
68	1-4	Optional UL AMC matrix options	N	N	N	N
69	1-9	Closed-loop MIMO	N	N	N	N
70	4	Fast DL measurement	IO-MIMO	IO-MIMO	N	N
	6	Mode Selection Feedback	IO-MIMO	N	N	N
	1-3, 5	Fast MIMO feedback options	N	N	N	N
71	1-3	MIMO midamble	N	N	N	N
72	1-2	MIMO soft-handover Macro-diversity in MDHO	N	N	N	N
73	1	MIMO DL Chase	IO-MIMO	IO-MIMO	N	N
	2-4	Other H-ARQ DL MIMO options	N	N	N	N
74	1	MIMO UL Chase	IO-MIMO	N	N	N
	2-4	Other H-ARQ UL MIMO options	N	N	N	N
75	1	FBSS	N	N	N	N
76	1-6	MIMO soft-handover based macro-diversity transmission	N	N	N	N
77	1-4	UL Macro Diversity	N	N	N	N
78	1	SSTTG	50 usec	50 usec	N/A	Y
	2	SSRTG	50 usec	50 usec	N/A	Y
79	1	Max DL concurrent bursts	10	10	N/A	N
80	1	Max bursts in DL	16	16	N/A	Y

Table	Item	Name	WiMAX value	AeroMACS value	Prototype Support	
					BS	Avionic/Vehicular Mock Up MS
		subframe				
81	1	Max number of UL zones	3	3	N/A	N
	2	Max number of DL zones	5	5	N/A	N
82	1	Max number of CQI channels by MS per frame	2	2	N/A	N
	2	Max number of concurrent CINR measurement processes	2	2	N/A	N
83	All	Max HARQ bursts	Y	Y	N/A	N

Table 1: PHY Profile

2.1.2 Transmit/Receiver/Sync requirements

Table	Item	Name	Values specified	Values required	Prototype support	
					BS	Avionic/Vehicular Mock Up MS
84	1	BS Tx dynamic range		10 dB	Y	N/A
	2	MS Tx dynamic range		45 dB	N/A	N
	3	MS Tx power level min adjustment step	1 dB	1 dB	N/A	N
	4	MS Tx power level min relative step accuracy	+- 0.5 dB +- 1 dB +- 1.5 dB +- 2dB	+- 0.5 dB +- 1 dB +- 1.5 dB +- 2 dB	N/A	N
	5	Spectral flatness	<+-2dB <+2/-4dB	<+-2dB <+2/-4dB	Y	N/A
	6	Power	<0.4dB	<0.4dB	Y	N/A

Table	Item	Name	Values specified	Values required	Prototype support	
					BS	Avionic/Vehicular Mock Up MS
		difference between adjacent SC				
	7	Default BS Tx reference timing accuracy	1pps timing pulse	1 usec	Y	N/A
	8	Network synchronized BS Tx reference timing accuracy	1pps timing pulse from GPS	2.3 usec Tx reference timing shall not change by more than 25nsec Tx carrier freq shall not change by more than 10Hz	Y	N/A
	9	Tx relative constellation error (RMS error)	<-15dB <-18dB <-20.5dB <-24dB <-26dB <-28dB <-30dB	<-15dB <-18dB <-20.5dB <-24dB <-26dB <-28dB <-30dB	N	N
85	1	Min SNR for BER=E-6 with CTC	2.9dB 6.3dB 8.6dB 12.7dB 13.8dB 16.9dB 18dB 19.9dB	2.9dB 6.3dB 8.6dB 12.7dB 13.8dB 16.9dB 18dB 19.9dB	N	N
	2	MS Rx max input level on-channel Rx	-30dBm	-30dBm	N/A	N

Table	Item	Name	Values specified	Values required	Prototype support	
					BS	Avionic/Vehicular Mock Up MS
		tolerance				
	3	BS Rx max input level on-channel Rx tolerance	-45dBm	-45dBm	N	N/A
	4	MS Rx max input level on-channel damage tolerance	0dBm	0dBm	N/A	N
	5	BS Rx max input level on-channel damage tolerance	0dBm	0dBm	N	N/A
	6	Min adjacent channel rejection (BER=E-6, 3dB degradation)	10dB 4dB	10dB 4dB	N	N
	7	Min alternate channel rejection (BER=E-6, 3dB degradation)	29dB 23dB	29dB 23dB	N	N
	8	IL plus NF for MS	5dB 8dB	13dB	N	N
	9	IL plus NF for BS	5dB 8dB	13dB	N	N
86	1	MS UL symbol timing accuracy	+- (Tb/8)/4	+- (Tb/8)/4	N/A	Y
	2	BS reference freq accuracy	+- 2E-6	+- 2E-6	Y	N/A
	3	BS to BS freq synchronization accuracy for HO	1% SC spacing	1% SC spacing	Y	N/A
	4	MS to BS freq synchronization tolerance	2% SC spacing	2% SC spacing	N/A	Y

Table 2: Transmit/Receiver/Sync requirements

2.1.3 MAC profile

Table	Item	Name	WiMAX value	AeroMACS value	Prototype Support	
					BS	Avionic/Vehicular Mock Up MS
87	1	Packet header Suppression	Y	Y	N	N
88	1	Packet IPv4	Y	Y	Y	Y
	2	Packet IPv6	Y	Y	N	N
	4, 7, 8	802.1Q VLAN	N	N	N	N
	3, 5-6	Ethernet CS options	IO-ETH1/IO-ETH-2/IO-ETH3	IO-ETH	N	N
	9	ATM	N	N	N	N
	10,12	Packet IPv4/IPv6 header Compression (ROHC)	IO-ROHC	N	N	N
	11,13	Packet IPv4/IPv6 header Compression (ECRTP)	N	N	N	N
	14-21	Other CS options	N	N	N	N
89	1-2	Fragmentation and Reassembly	Y	Y	Y	Y
	3	Packing of fixed-length SDUs	N	N	N	N
	4	Packing of variable-length	Y	Y	N/A	Y

Table	Item	Name	WiMAX value	AeroMACS value	Prototype Support	
					BS	Avionic/Vehicular Mock Up MS
		SDUs in MS				
	5	Packing ARQ feedback payload	Y	Y	Y	Y
	6	Extended subheader support	Y	Y	N	N
	7	Grant management subheader	Y	Y for BS N/A for MS	N	N
	8	3-bit FSN support	N	N	N	N
90	1	Feedback header	N	N	N	N
	2	Fast feedback subheader	N	N	N	N
	3	MIMO mode feedback extended subheader	N	N	N	N
	4-5	Feedback extended subheader	N	N	N	N
	6	Feedback Polling IE	N	N	N	N
	7-8	PHY report in feedback header	N	N	N	N
91	1	Multicast traffic connection	Y	Y	N	N
92	1	MS management	N	N	N	N
	2	IP management mode	N	N	N	N
93	1	ARQ implementation	Y	Y	Y	Y
	2	ARQ ACK type	N	N	N	N

Table	Item	Name	WiMAX value	AeroMACS value	Prototype Support	
					BS	Avionic/Vehicular Mock Up MS
		0				
	3	ARQ ACK type 1 (Cumulative ACK)	Y	Y	Y	Y
	4	ARQ ACK type 2	Y	Y	N	N
	5	ARQ ACK type 3	Y	N	N	N
94	1-2	MAC support for HARQ	Y	Y	N	N
	3	HARQ channel mapping	Y	N	N	N
	4-7	MAC support for HARQ	Y	Y	N	N
	8	PDU SN extended subheader for HARQ recording	Y	N	N	N
95	1, 3, 5	DSF - BS initiated	Y	Y	Y	Y
	2, 4	DSA, DSC - MS initiated	IO-QOS	N	N	N
	6	DSD -MS initiated	Y	N	N	N
96	1	UGS	Y	Y	N	N
	2-4	RT-VR, NRT-VR, BE	Y	Y	Y	Y
	5	ERT-VR	Y	Y	N	N
97	1	Incremental BWreq header	Y	Y	N	N
	2	Aggregate BWreq header	Y	Y	Y	Y
	3	Grant management	Y	Y	N	N

Table	Item	Name	WiMAX value	AeroMACS value	Prototype Support	
					BS	Avionic/Vehicular Mock Up MS
		subheader				
	4	Multicast polling assignment	N	N	N	N
	5	Request-Grant mechanism combined with CINR report	N	N	N	N
	6	Request-Grant mechanism combined with UL Tx report	Y	Y	N	N
	7	CQICH allocation request	Y	Y[1]	Y	Y
98	1	Neighbour advertisement	Y	Y	Y	Y
	2-3	Support BS index	Y	Y	N	N
99	1	Scanning for cell selection	Y	Y	Y	Y
	2	MS Requests Scanning Interval Allocations from BS	Y	N[2]	N	N
	3	Unsolicited Scanning Interval Allocation by BS	Y	N	N	N
	4	Event Triggered Scanning based on serving BS metrics	Y	Y	Y	Y
	5	MS autonomous neighbour cell	Y	N	N/A	N

[1]This item has been recently been proposed for removal from the final AeroMACS profile
[2]This item has recently been proposed as mandatory in the final AeroMACS Profile

Table	Item	Name	WiMAX value	AeroMACS value	Prototype Support	
					BS	Avionic/Vehicular Mock Up MS
		scanning				
100	1	Periodic Reporting	Y	Y	Y	Y
	2	Event Triggered reporting	Y	Y	Y	Y
101	1-2	Association	N	N	N	N
102	1-4	Association type support	N	N	N	N
103	1-2	Mean BS CINR/RSSI	Y	Y	Y	Y
	3	Relative RX delay	N	N	N	N
	4	BS Round trip delay	Y	N	N	N
104	1	General HO support	Y	Y	Y	Y
	2	HO initiated by MS (MS)	Y	Y	N/A	Y
	3	HO initiated by MS (BS)	Y	Y	Y	N/A
	4	HO initiated by BS (MS)	Y	Y[3]	N/A	Y
	5	HO initiated by BS (BS)	Y	Y[4]	Y	N/A
	6	HO Indication	Y	Y	Y	Y
	7	Cancellation of HO	Y	Y	Y	Y
	8	Metric Triggered HO Requests	Y	Y	Y	Y
	9	Resource Retention Support	Y	Y	N	N

[3] This item has been recently been proposed for removal from the final AeroMACS Profile
[4] This item has been recently been proposed for removal from the final AeroMACS Profile

Table	Item	Name	WiMAX value	AeroMACS value	Prototype Support	
					BS	Avionic/Vehicular Mock Up MS
	10	CDMA HO Ranging	Y	Y	Y	Y
	11	HO_ID support	Y	Y	N/A	Y
	12	Support negotiating of "HO authorization policy" during HO	Y	N	N	N
105	1, 2, 8, 12, 13, 16, 19-20	HO optimization	Y	Y	N	N
	21	Support sending at BS and receiving at MS traffic IP address refresh bit	Y	N	N	N
	9, 10, 11, 14, 15, 17, 18	HO optimization	N	N	N	N
	3-4	Omission of PKM in HO	Y	Y	N	N
	5-7	Omission of secondary management CID procedures	N	N	N	N
106	1,9	Basic CID and SAID update (BS)	Y	Y	Y	N/A
	2,10	Basic CID and SAID update (MS)	Y	Y	N/A	Y
	3-8,11-14	Other CID and SAID update options	Y	N	N	N

Table	Item	Name	WiMAX value	AeroMACS value	Prototype Support	
					BS	Avionic/Vehicular Mock Up MS
107	1-20	FBSS	N	N	N	N
108	1-19	MDHO	N	N	N	N
109	1-8, 11, 14-16, 20-23	Sleep mode	Y	N	N	N
	9, 10, 12, 13	Other power saving options	N	N	N	N
	17-19	HO diversity options in sleep mode	N	N	N	N
110 111	1-6, 9, 13, 15, 17-21 1-4, 8, 10, 12-14, 16-18	Mandatory Idle mode options	Y	N	N	N
	7, 8, 10, 11, 12, 14, 16, 22 5-7, 9, 11, 15	Non mandatory Idle mode options	N	N	N	N
112	1, 5, 7	Basic MBS	IO-MBS	N	N	N
	2-4, 6, 8-11	Other MBS options	IO-MBS/IO-MBS2/IO-MBS3/IO-MBS4	N	N	N

Table	Item	Name	WiMAX value	AeroMACS value	Prototype Support	
					BS	Avionic/Vehicular Mock Up MS
113	1	AAS	N	N	N	N
114	1	MS Network Entry on BS restart	Y	Y	N	N
115	1	NSP Selection	Y	Y	N	N

Table 3: MAC Profile

2.1.4 MAC parameters

The following items concern equipment configuration, so they are neither performance nor functionality items to be tested.

As the indicated default values are taken from the WMF Profile, they are not binding, and could be changed during the field tests.

Table	Item	Name	Min	Def	Max	Prototype support	
						BS	Avionic MS
116	1	Number of concurrent outstanding PKM exchanges	2			N/A	Y
	2	Number of transport SAs simultaneously	2			N/A	Y
	3	PN window size in PNs	128			Y	Y
	4	UCD transition	50ms			Y	N/A
	5	DCD transition	50ms			Y	N/A
	6	Tproc	Tf			Y	N/A
	7	RNG-RSP processing time			2.5ms	N/A	Y
	8	Initial ranging interval			250ms	Y	N/A
	9	Lost DL-MAP interval		30s	600ms 120s	N/A	Y
	10	Lost UL-MAP		30s	600ms	N/A	Y

Table	Item	Name	Min	Def	Max	Prototype support	
						BS	Avionic MS
					120s		
	11	T1			Min(20s, 5xDCD interval)	N/A	Y
	12	T3			60ms 50ms 200ms 200ms	N/A	Y
	13	T4	5s		35s	N/A	Y
	14	T6	10ms		3s	N/A	Y
	15	T7	10ms		1s	Y	Y
	16	T8	10ms		300ms	Y	Y
	17	T10	600ms		3s	Y	Y
	18	T12			Min(20s, 5xUCD interval)	N/A	Y
	19	T14			200ms	N/A	Y
	20	T17	5min	5min		Y	N/A
	21	T18short	50ms		100ms	N/A	Y
	22	T18long	90ms		200ms	N/A	Y
	23	T9	300ms		660ms	Y	N/A
	24	T22			0.5s	Y	Y
	25	Idle mode timer	128s	4096s	65536s	N/A	N
	26	T43			100ms	N/A	Y
	27	T44			100ms	N/A	Y
	28	T46	50ms		100ms	Y	N/A
	29	T47	8f	64f	1024f	Y	N/A
	30	Paging interval length	1f	2f	5f	N	N

Table	Item	Name	Min	Def	Max	Prototype support	
						BS	Avionic MS
	31	Max dir scan time			2s	N/A	Y
	32	Max SDU size	1522B			Y	Y
	33	Number of transport connections in UL	4			N/A	Y
	34	Number of transport connections in DL	4			N/A	Y
	35	Total number of power save class instances	1			N/A	Y
	36	ARQ_RESET MAX_RETRIES		2		Y	Y
	37	Min required CS types per MS		1		N/A	Y
	38	ARQ_RETRY TIMEOUT	20ms		1.3s	Y	Y
	40	ARQ_SYNC LOSS_TIMEOUT	100ms			Y	Y
	41	ARQ RX PURGE_TIME OUT	100ms			Y	Y
	39, 42	Counters on HARQ connections				N	N
	43	ARQ_BLOCK LIFETIME granularity	5ms			Y	Y
	44	AI SN value in HARQ		0		N	N
	45	Power control IE frame relevance			10 MS data Tx	Y	Y
	46	MS max neighbors	32			N/A	Y

Table 4: MAC Parameters

2.1.5 MAC performance

Table	Item	Name	Min	Def	Max	Prototype support	
						BS	Avionic MS
117	1	HO parameters processing time			3f	N/A	Y

2.1.6 Security

Table	Item	Name	WiMAX value	AeroMACS value	Prototype Support	
					BS	Avionic MS
118	1	802.16 Authorization policy support	Y	Y	Y	Y
119	1	PKMv1 Support	N	N	N	N
	2	PKMv2 Support	Y	Y	Y	Y
120 - 121	1	No authorization	Y	Y	Y	Y
	2	EAP-based authorization	Y	Y	Y	Y
	3	EAP-based authorization and Authenticated (EIK) EAP-based authorization	N	N	N	N
	4	RSA based authorization options	N	N	N	N
	5-6	Other RSA options	N	N	N	N
122	1	No data encryption, no	Y	Y	Y	Y

Table	Item	Name	WiMAX value	AeroMACS value	Prototype Support	
					BS	Avionic MS
		data authentication, etc				
	6	CCM-mode with AES key wrap	Y	Y	Y	Y
	2-5, 7-9	Other cryptographic suites	N	N	N	N
123	1	No message authentication	Y	Y	Y	Y
	3	CMAC	Y	Y	Y	Y
	2, 4-6	HMAC based modes	N	N	N	N
124	1, 3	Primary and Static SAs	Y	Y	Y	Y
	2	Dynamic SAs	N	N	N	N
125	1	Unicast SA	Y	Y	Y	Y
	2	Group multicast service SA	N	N	N	N
	3	MBS services SA	N	N	N	N
126	1	EAP authentication methods	-	-	N	N
127	1-3	Certificate profile	N	N	N	N
128	1	MBRA for group multicast service	N	N	N	N
	2	MBRA for MBS service	N	N	N	N

Table 5: Security

2.1.7 Radio profile

Table	Item	Name	WiMAX value	AeroMACS value	Prototype support	
					BS	Avionic MS
129	5	Center Freq Step Fstart Nrange	250 2498.5 {16, ..., 756}	250 5002.5 {0...100, 364...580}	Y	Y
	10	Center Freq Step Fstart Nrange	250 2501 {16, ..., 736}	N	N	N

Table 6: Radio Profile

2.2 SELEX ES Devices installation and setup

2.2.1 Base Station

2.2.1.1 System Overview

The following is the Network Reference Model (NRM) of the AeroMACS Network:

- **Base Station AeroMACS**: fixed wireless communication station that is responsible for receiving, amplifying and retransmitting signals from vehicular or airborne subscriber station. The main task of a Base Station is to provide radio coverage over an area collecting all the traffic from various subscriber stations connected to it.
- **ASN-GW**: implementing mobile wireless broadband connectivity for local areas of service deployment. It comprises a profile C-Access Service Network (ASN) Gateway integrated with an Authentication Authorization Accounting (AAA) server and Home Agent (HA) server at a single node. The ASN-GW communicates directly with Base Stations (BSs) at one end and off loads external IP network data at the other end. The ASN-GW supports the following type of subscribers:
  - **Vehicular or airborne subscriber station AeroMACS**: is responsible for forwarding traffic coming from its terminal equipment to the base station which in turn will send traffic to the final destination.
  - **Vehicular or airborne terminal equipment AeroMACS**: is the terminal apparatus through which the user connects to the network (for example a PC).
- **AOC Controller Working Position (CWP)**: the operator shall manage the communications between the aircraft and its Airlines Operation Centre.
- **ATS Controller Working Position (CWP)**: the operator shall manage the Air Traffic Service between the aircrafts.
- **AOPC Controller Working Position (CWP)**: the operator shall manage the communications between some surface vehicles and the Airport Operations Centre (AOPC) and/or the Air Traffic Control Unit (ATCU).

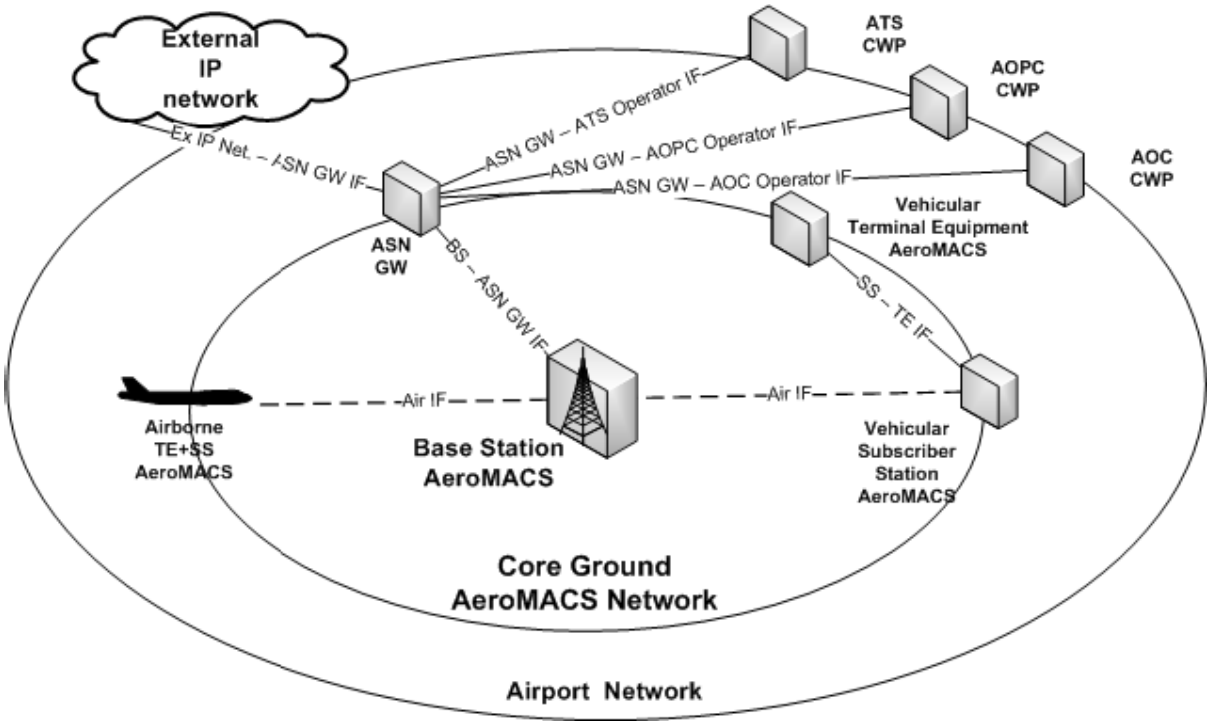

Figure 1: AeroMACS Network Reference Model

2.2.1.2 System Architectural

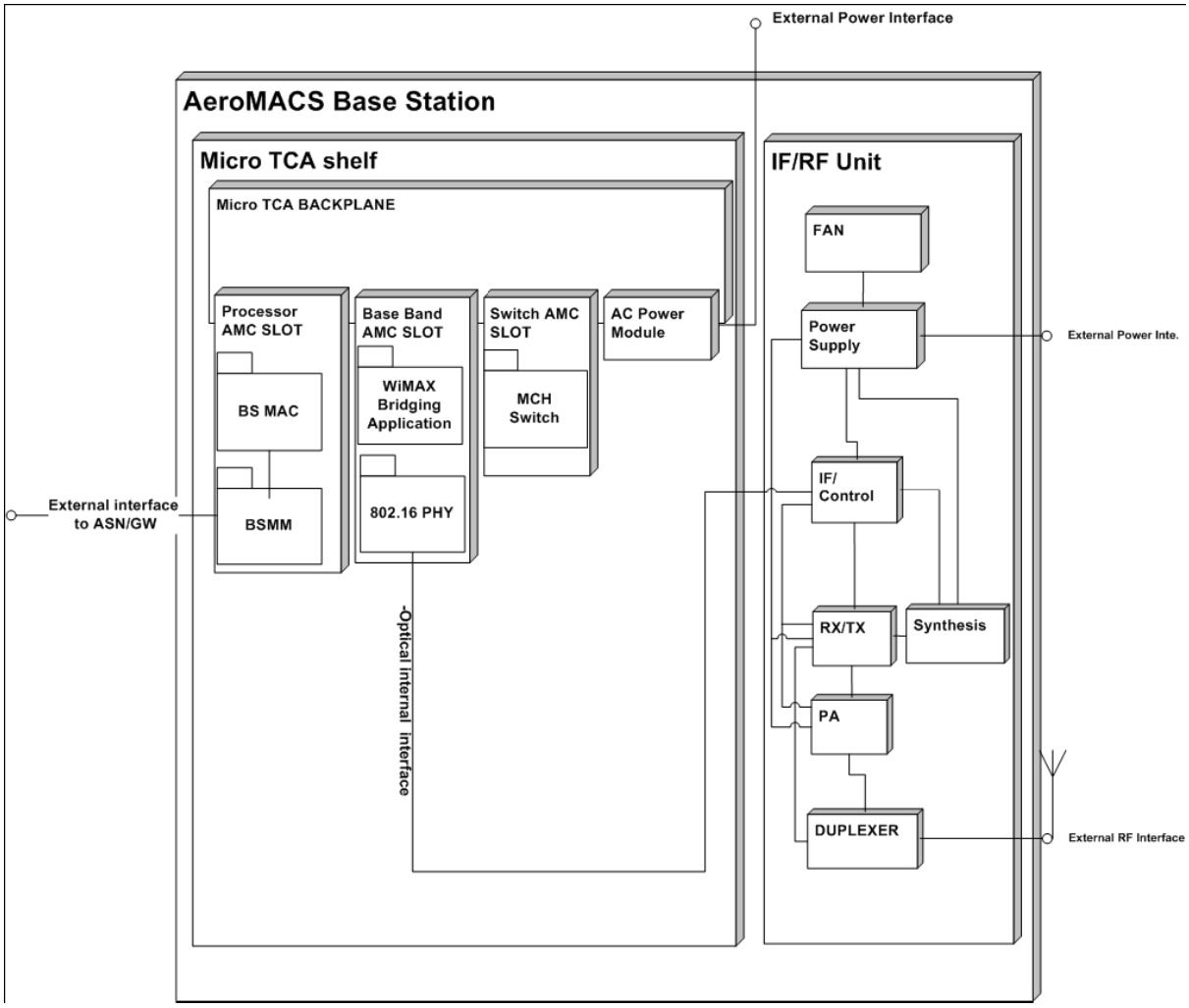

Figure 2: Selex ES BS Architecture

The AeroMACS BS shall be composed of the followings system components:

- Micro TCA shelf unit;
- IF/RF unit**.**

The AeroMACS BS shall have the followings characteristics:

- Power Supply for each unit: 28 VDC;
- Total weight: 8 Kg;
- Total consumption: 160 W;
- Total height: 2 U.

2.2.1.2.1 System Component

2.2.1.2.1.1 Micro TCA shelf unit

The Base Band Micro TCA shelf shall be composed of the following HW items:

- Processor AMC slot;
- Base Band AMC slot;
- Switch AMC slot;
- Micro TCA Enclosure;
- MicroTCA AC Power Module.

The Micro TCA shelf shall have the followings characteristics:

- Power consumption: 80 W;
- Weight: 4 Kg;
- Power Supply: 28 VDC;
- Dimensions:

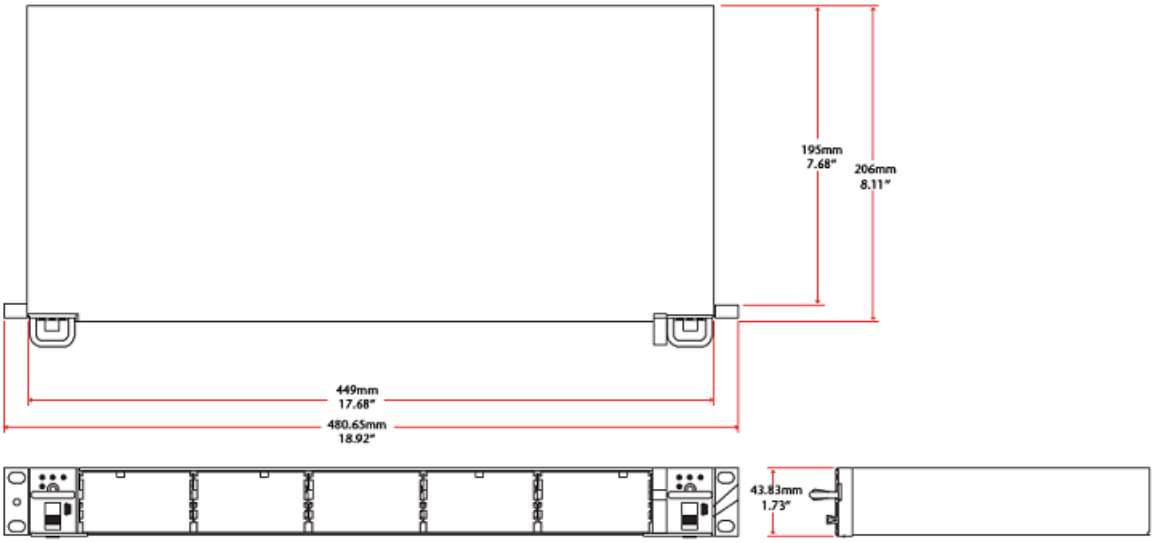

Figure 3: Selex ES BS Micro TCA Shelf Unit

2.2.1.2.1.2 IF/RF unit

The IF/RF unit shall have the followings characteristics:

- Power consumption: 80 W;
- Weight: 4 Kg;
- Power Supply: 28 VDC;
- Dimensions:
    - Height: 1 U;
    - Depth: 226 mm.

Figure 4: Selex ES BS IF/RF Unit

2.2.1.3 Interfaces

This chapter describes the ASN interfaces, classifying them into Internal and External.

Being the Selex ES BS a component of the ASN, some of the Internal ASN Interfaces are actually external to the BS.

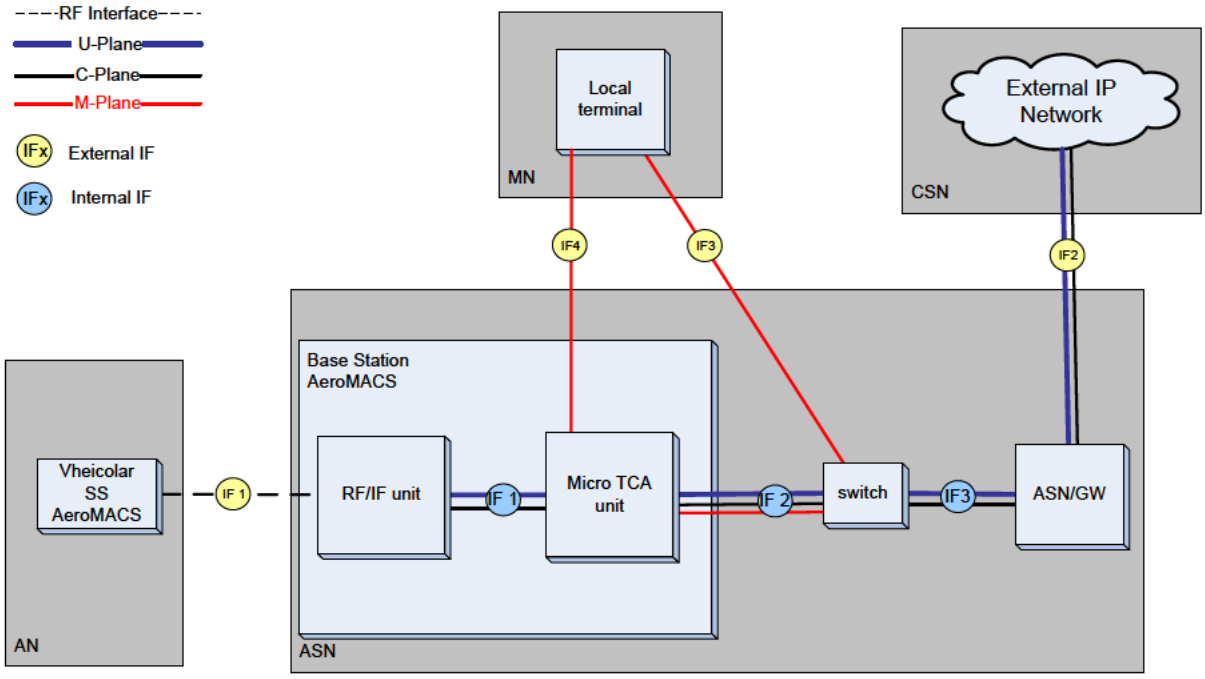

Figure 5: Selex ES ASN Internal and External Interfaces

2.2.1.3.1 External interfaces

2.2.1.3.1.1 IF1 External interface SS <--> RF/IF unit

The IF1 shall be a RF interface defined by IEEE 802.16-2009, as amended by the AeroMACS prototype profile described in 2.1.1.

2.2.1.3.1.2 IF2 External interface ASN/GW <--> External IP Network

The IF2 shall be a standard IP interface.

2.2.1.3.1.3 IF3 External Interface Local Terminal <--> Switch

The IF3 Ethernet/IP external interface shall support the following services:

- Base station operative management: the operator using the Local Terminal with one specific GUI and by a SNMP protocol shall be able to configure the Base Station in operative state.
- Base station alarms management: the operator using the Local Terminal with one specific GUI and by a SNMP protocol shall be able to check the BS status and alarms.

2.2.1.3.1.4 IF4 External Interface Local Terminal <--> BS Micro TCA unit

The IF4 RS-232 external interface by a standard Telnet application, shall support the following services:

- Base station operative management: the operator using the Local Terminal by a Command Line Interface (CLI) shall be able to configure the Base Station in operative state.
- Base station alarms management: the operator using the Local Terminal by a Command Line Interface (CLI) shall be able to check the BS status and alarms.

2.2.1.3.2 Internal interface

2.2.1.3.2.1 IF1 Internal BS interface RF/IF <--> Micro TCA

The IF1 is internal to the BS, and shall be:

- A Common Public Radio Interface (CPRI): is the standard for communication between radio equipment control or base station and one or more radio equipment units in WiMAX/3G/4G cellular networks. In this case shall be the interface to transfer the down link and up link base band (Micro TCA unit) data samples to the IF/RF unit.
- An optical interface.

2.2.1.3.2.2 IF2 Micro TCA <--> switch

This interface is internal to the ASN but external for the BS.

The IF2 shall have the same characteristic of the external IF3 interface and shall support also the following services:

- Base station operative management: the operator using the Local Terminal with one specific GUI and by a SNMP protocol shall be able to configure the Base Station in operative state.
- Base station alarms management: the operator using the Local Terminal with one specific GUI and by a SNMP protocol shall be able to check the BS status and alarms.

2.2.1.3.2.3 IF3 Internal switch <--> ASN GW

This interface is internal to the ASN but external for the BS.

The IF3 shall be:

- A standard Network Working Group of WiMAX Forum (profile A) **R6 interface**: set of control plane and data plane protocols for communication between various functional entities in BS and ASN Gateway.
- A physical IP/Ethernet interface.

R6 interface is being designed as a plug-in to BSMAC. The major functionality of this module is to process R6 control messages, maintain states for R6 transactions, GRE tunneling and forwarding of data between Vehicular or Airborne SS and ASN-GW. R6 module will become part of BSMM module and Layer 3 Application as given below.

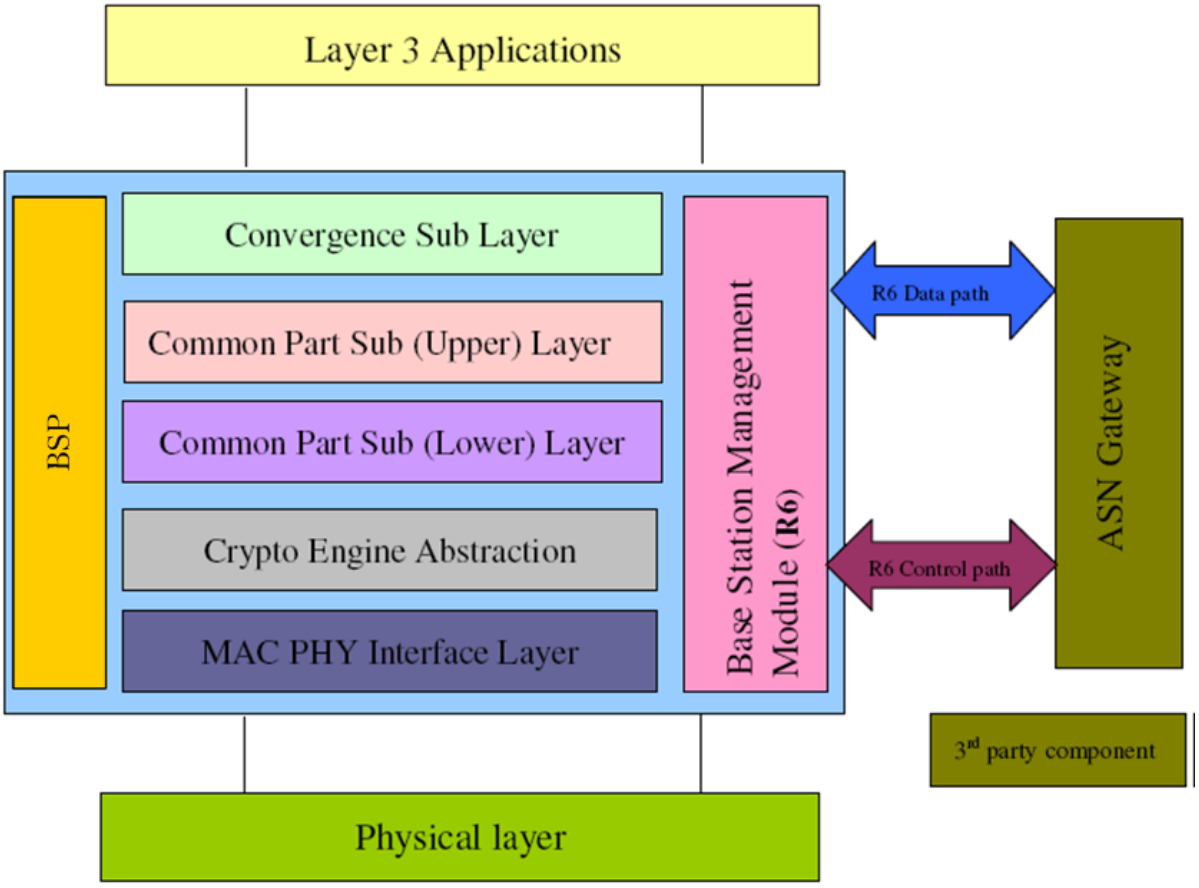

Figure 6: IF3 Internal Switch <--> ASN-GW

The IR6 control path interface shall manage the messages to handle the following services:

- Network discovery and selection of the preferred network service provider;
- Network entry as per IEEE 802.16e-2005;
- IP Connectivity;
- Service flow authorization;
- Admission Control and Policing;
- Quality-of-Service;
- Data forwarding;
- Radio Resource Management;

- Intra-ASN mobility.

2.2.2 Base Station Setup

2.2.2.1 BSMAC configuration

BSMAC configuration parameters are contained in file *config.dat*:

For example the file present in the Path:

/home/Aeromacs/BS/build/posix/wimax_app/bin/configuration/config.dat

Note: If configuration folder is not available in BS/build/posix/wimax_app/bin/ directory , then create a folder by name *"configuration"* and copy the file *config.dat* to it from the following path *:*
BS/root/dat/

Configure the following parameters:

- The below IP address:
  - Base_Station_IP;
  - ASN_GW_IP ;
- The Base_Station_Id: this is unique for a particular BS connected to the ASN.

2.2.3 ASN-GW

The ASN-GW used is an ARICENT WING Release 4.2.0. WING implements mobile wireless broadband connectivity for local areas of service deployment. It comprises a profile C-Access Service Network (ASN) Gateway integrated with an Authentication Authorization Accounting (AAA) server and Home Agent (HA) server at a single node.

2.3 Thales Devices installation and setup

2.3.1 System overview

The whole system overview is given in following picture.

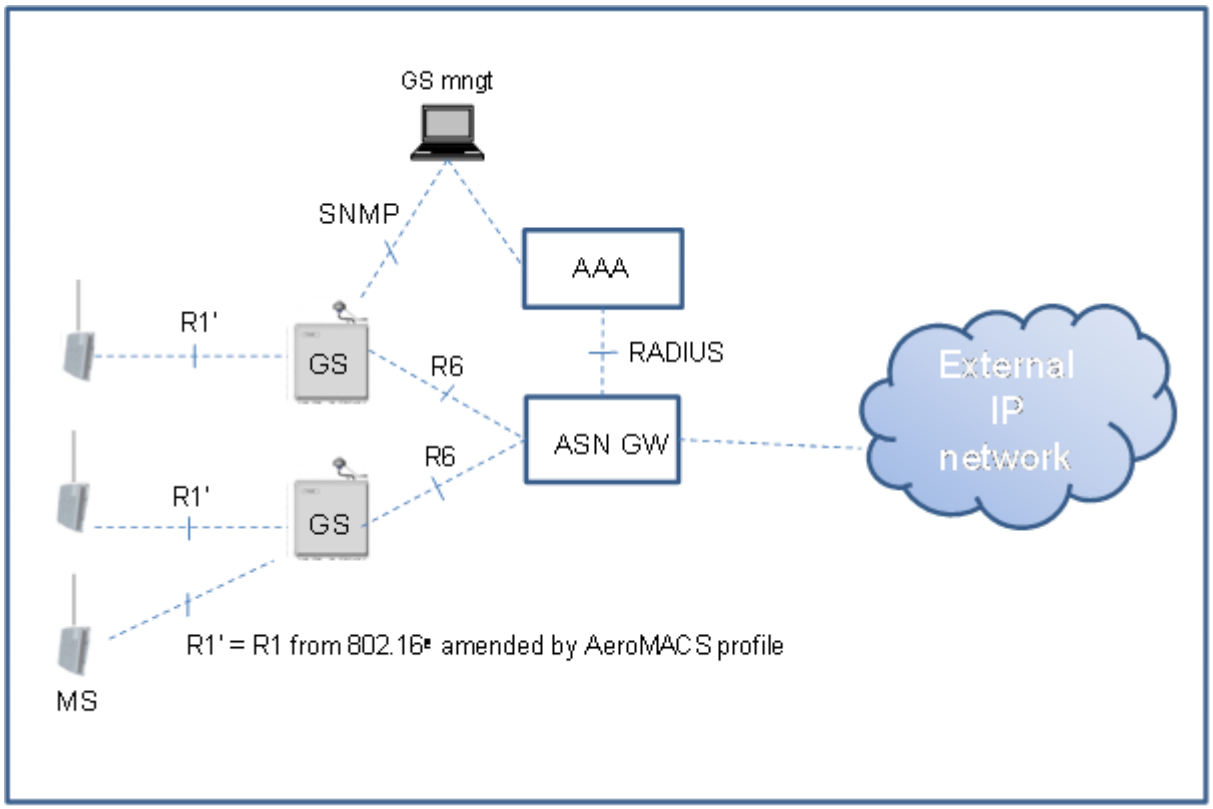

Figure 7: System overview

The architecture is similar to IEEE 802.16e 2009 with adaption according to AeroMACS profile.

The main elements of the architecture are:

- MS: Mobile Station mock-up. It is a rugged WiMAX CPE tailored to match AeroMACS profile.
- GS: Ground Station prototype. It is a full outdoor mobile WiMAX compact base station tailored to match AeroMACS profile.
- GS Mngt: The ground stations are configured and managed through software set up on a personal computer.
- ASN GW: ASN GateWay to external IP network.
- AAA: Authentication, Authorization and Accounting server. It ensures that the network is only accessed by permitted MS.

The main interfaces are:

- R1': air interface between MS and GS. It is alike R1 of IEEE 802.16e with AeroMACS profile adaptation.

- R6: standard IEEE 802.16e interface between GS and ASN GW.
- RADIUS: Radius is the widely used protocol for AAA interactions.
- SNMP: Simple Network Management Protocol, Internet-standard protocol for managing GS devices.

2.3.2 Base Station prototype description

2.3.2.1 Functional Architecture and interfaces

The GS consists in a base station with all-in-one packaging of RF and base-band components as well as GPS function. It is equipped with a dual-slant flat array antenna. It is designed to be installed outdoor on a pole or wall.

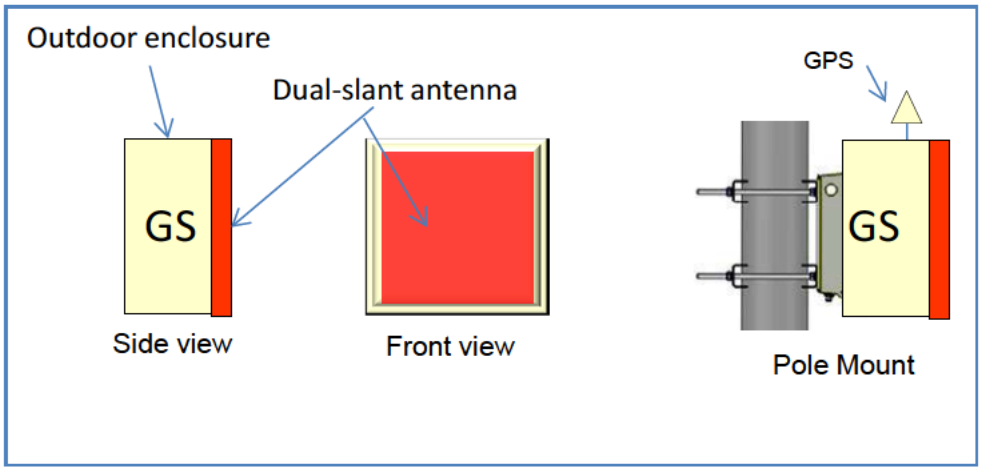

Figure 8: Ground Station physical design

In one enclosure, the GS comprises the following functional elements:

- Dual Receiver / Dual Transmitter, tailored to AeroMACS frequency band.
- Software defined module for WiMAX functions, configured to match AeroMACS profile.
- Ethernet Switch for network interface.
- GPS for synchronization.

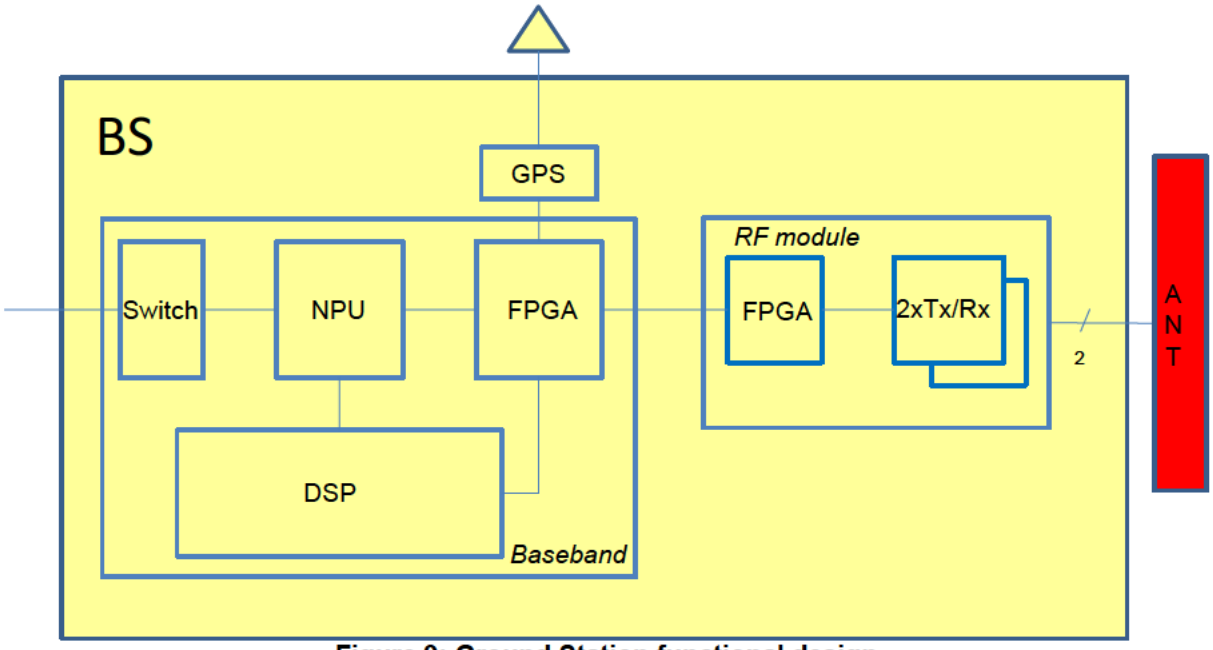

Figure 9: Ground Station functional design

2.3.2.2 Physical characteristics and performances

The GS prototype is a fully integrated outdoor base station, equipped with a dual-slant sectorial antenna and featured with a GPS antenna.

Figure 10: Thales Ground Station

The two physical external interfaces to take care of are:

- The power cable that carries the power from the 220V power source to the GS via a power converter box,

- An Ethernet cable for data exchanges (user and management) between the GS and the system behind.

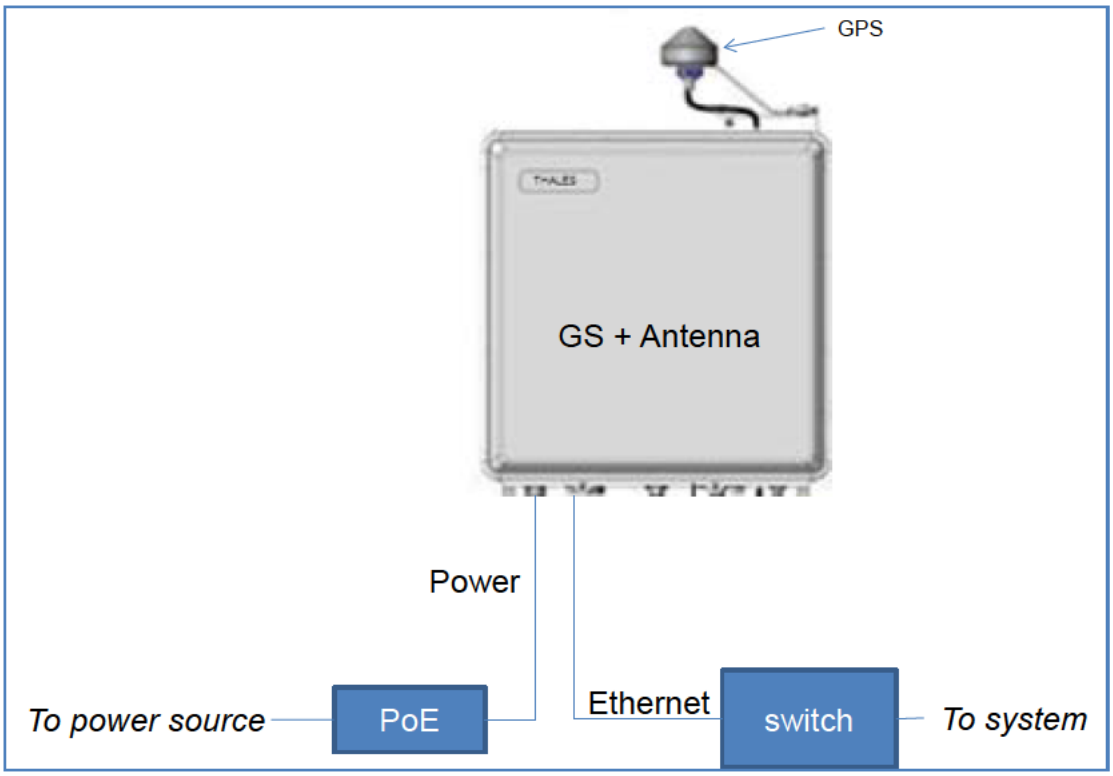

Figure 11: Ground Station physical characteristics

The physical characteristics of the GS prototypes are:

- Dimensions: ~ 400 mm x 372 mm x 130 mm
- Weight : ~ 12 Kg
- Antenna:
    - dual slant (+/- 45°) sector antenna,
    - typical gain: 15dBi,
    - Radiation pattern: Az (90°) /EL (8°)
- Supply voltage: PoE (IN = 220V AC)
- Typical power consumption: 75 W
- Typical operating Temperature Range: -40°C to +55°C
- Operating Humidity: 5-95%, non-condensing
- IP Rating: IP66

The main performances of the GS prototypes are:

- IEEE802.16e 2009 configured according to AeroMACS profile
- Modulation mode : adaptive QPSK, 16QAM, (64QAM)
- Frequency range: 5.091 – 5.150 GHz
- Typical max transmit power: 2 x 23dBm
- Channel BW: 5 MHz (other WiMAX BW not used for AeroMACS)
- Duplex mode: TDD
- Synchronization: GPS
- Operation mode: Stand-alone mode or ASN GW

2.3.3 Mobile Station mock-up

2.3.3.1 Device overview

The MS mock-up is based on a high performance subscriber unit designed for indoor or outdoor use. The MS provides mobile WiMAX wireless access functionality with AeroMACS profile functionality.

Figure 12: Mobile Station equipped with a collinear antenna

Concerning MS interfaces:

- On one side, it comprises two RF ports (2 x N type (female)) for connection to external directional antennas.
- On the other side, the MS has an RJ-45 connector for the Ethernet traffic and power.

For the nomadic applications foreseen during the airport tests, the MS will be equipped with a collinear antenna with an omnidirectional radiating pattern.

The following picture gives an overview of the MS functional architecture:

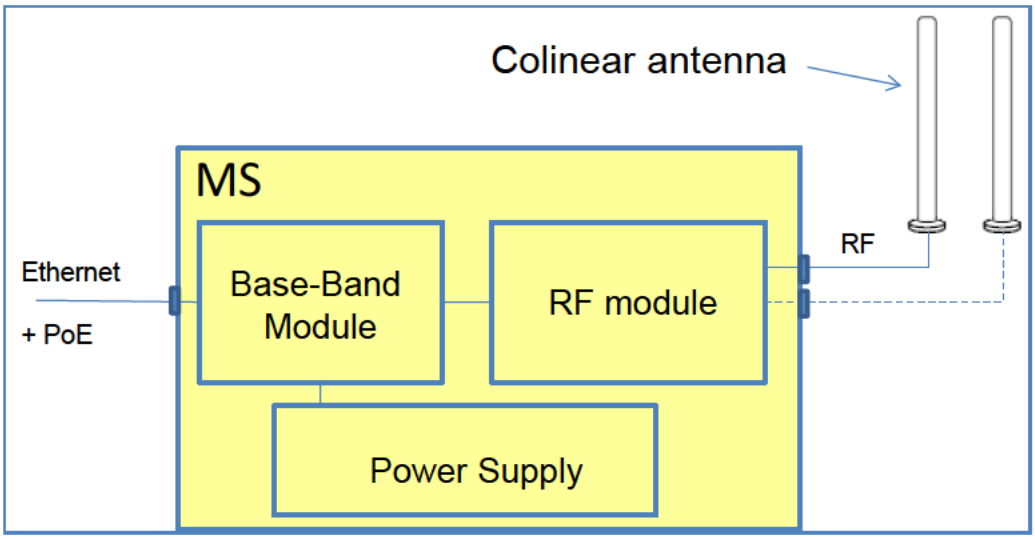

Figure 13: Mobile Station architecture and interfaces

2.3.3.2 Physical characteristics & performances

The main characteristics of MS mock-ups are:

- IEEE802.16e 2009 configured according to AeroMACS profile
- Modulation Modes : Adaptive QPSK, 16QAM, (64QAM)
- Duplex mode: TDD
- Frequency range: 5.091 – 5.150 GHz
- Typical max transmit power: 2 x 23dBm (one port used during the tests)
- Channel BW: 5 MHz (other WiMAX BW not used for AeroMACS)
- Supply voltage: via PoE (IN = 220V AC)
- Power consumption: ~12W
- Dimensions: ~ 300 x 300 x 90 mm
- Weight : < 3 kg
- Typical operating Temperature: -10° to 55°C
- IP rating : IP66

Antenna main characteristics are:

- omnidirectional antenna: collinear
- typical gain: 6 dBi
- Radiated pattern:
  - Azimuth: 360° (ripple +/-1.5 dB),
  - polarization: linear vertical

2.3.4 THALES SETUP

The GS includes a pole mounting kit so that it can easily be installed outdoor on a pole. The antenna consists of a flat array mounted on the GS.

The GS is powered via Ethernet thanks to a PoE injector. Thus it is connected to a 220V AC supply source in the airport premises.

A management PC is connected via a switch to the two GS. It allows controlling the base station parameters and generating and sending the traffic load.

The Mobile Stations are installed either inside a vehicle or in a fix location. They are powered by a PoE injector and connected to an omnidirectional external antenna.

In the case of the vehicle configuration, the antennas are installed on the roof of the vehicle and a GPS is connected to the management laptop of the MS. The laptop embeds a test application that records the MS measurements and the vehicle positions during the airport tests. The PoE injector is connected to a 220V supply source after a DC-AC converter in the case of the vehicle setup.

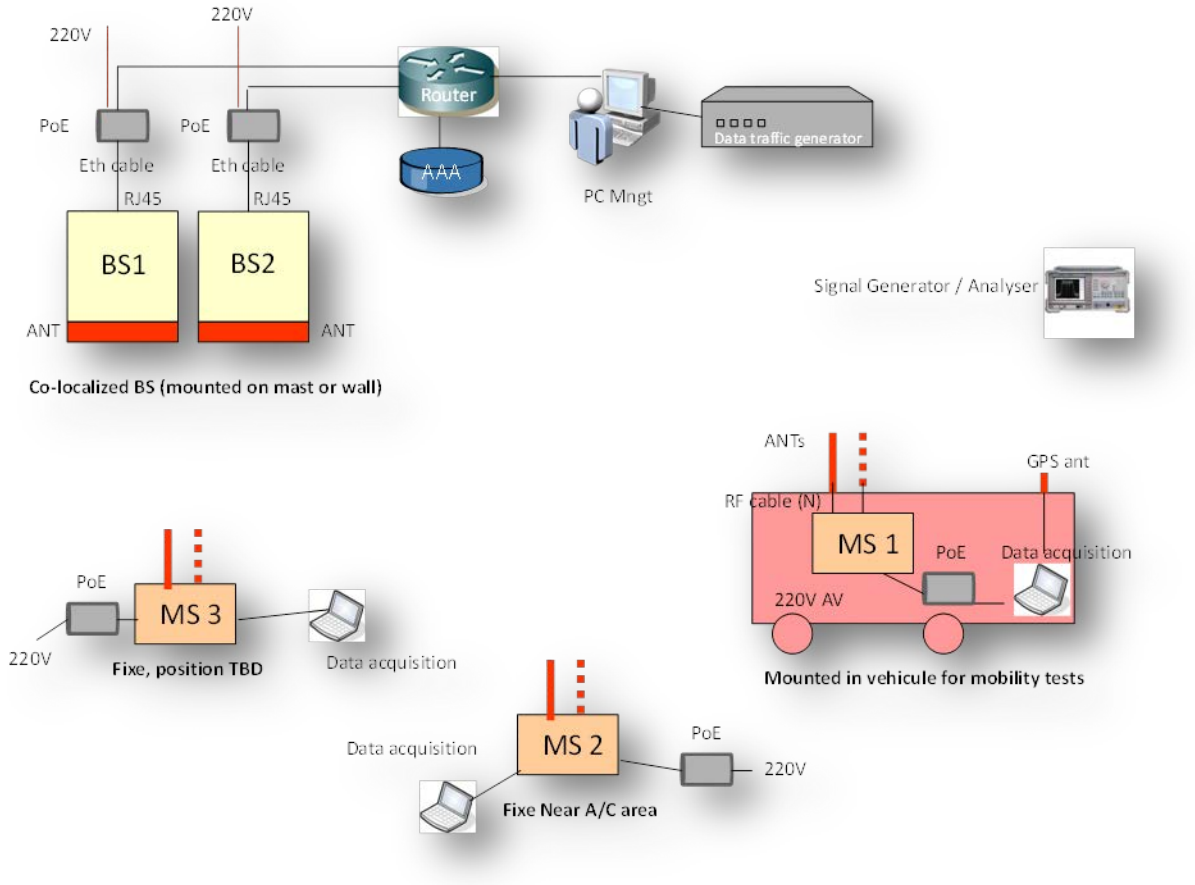

Figure 14: Thales equipment foreseen setup for Airport ground tests

3 References

[1] SESAR/SANDRA AeroMACS Validation Objectives (VVO), “AeroMACS VVO SESAR_SANDRA draft18.xls”, 2-4-2012

[2] SESAR 15.2.7, D05.2 “AeroMACS Verification Strategy”, Edition 00.01.00

[3] Mobile WiMAX Release 1 System Profile WMF-T23-001-R010v09

-END OF DOCUMENT-