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ADS-B UAT MOPS

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Standard Interference Environment

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SUMMARY

This paper represents a draft for the Standard Interference Environment assumptions for UAT. This definition will serve as a basis for incorporating an Appendix to the MOPS to define the interference environment under which UAT receivers will be required to operate. The definition is required to validate the criteria to assess UAT performance.

The UAT is designed to operate in the lower portion of the 960-1215 MHz aeronautical radionavigation service (ARNS) band. This portion of the band is highly utilized throughout the world for International Civil Aviation Organization (ICAO) standard systems such as distance measuring equipment (DME), and military systems such as Tactical Air Navigation (TACAN), and in some States Joint Tactical Information Distribution System/Multifunctional Information Distribution Systems (JTIDS/MIDS). Each of these systems share a common characteristic in that they utilize pulses that are short in relation to UAT pulses. As a result, the UAT waveform and receiver front-end has been specifically tailored to tolerate a high-density pulsed environment. In addition, the random-start nature of the UAT ADS-B access protocol results in self-interference. The extent of this interference is dependent on the number of aircraft visible to the "victim" UAT.

Due to the complexity of the potential interference environment, UAT performance in an operational environment was determined through the use of high-fidelity computer simulations. Those simulations were based on two specific inputs: 1. the performance of the UAT receiver in the presence of interference as a function of signal-to-interference and desired-to-undesired signal overlap; and 2. the time/amplitude distribution of interfering signals. This appendix will address the assumptions driving the latter input, while the UAT test specifications (Section 2.4) will ensure that UAT equipment meeting this MOPS can match the assumed UAT performance.

Operational Environments

The UAT 978 MHz operating frequency was selected to minimize the impact to existing DME/TACAN use. That channel is reserved worldwide for "emergency use", so as a result there are very few operational 978 MHz DME/TACAN systems. In the United States for example, both 978 MHz and 979 MHz are reserved for DME "ramp tester" equipment. Such an application is very low power, offering no interference to UAT use. Europe however does use both 978 MHz and 979 MHz.

As a result of the diverse environments in which UAT would have to operate, a number of different interference scenarios were postulated and simulated. The goal was to insure that the UAT design would provide the necessary performance as air traffic increases in the future and to insure that UAT receivers are measured against the most challenging interference environment from JTIDS/MIDS and DME sources. UAT receiver locations in these scenarios were chosen to represent the most challenging geographic areas. The analysis of DME interference both co-channel and adjacent channel in Core Europe was done by examining the existing assignments of DME/TACAN in Europe. The underlying assumption for DME/TACAN co-channel interference in Europe is that those assignments on 978 MHz would eventually be moved. The interference environment resulting from this assumption has been utilized to insure that UAT operation in those geographic areas can provide an adequate level of performance as locations are reassigned over time. Also, since current assignments allow latitude for regulators to expand usage of 979 MHz, some reasonable assumptions were

made to predict future DME interference. *ADD TEXT HERE FROM AL'S DME WRITEUP*

The aircraft distributions were based on scenarios developed by the Technical Link Assessment Team (TLAT) to assess the three candidate ADS-B links against common scenarios. The future scenarios selected were Los Angeles Basin 2020 and Core Europe 2015. These scenarios provided two diverse environments for ADS-B systems to operate. These scenarios provide a basis for UAT performance assessment for all interference sources. This Appendix catalogs the characteristics of the primary scenarios.

Cosite Environment: In addition to all the scenarios for the external interference environment, effects were included to account for on-board sources of interference from co-located L-Band systems. The components of this cosite environment were estimated during the joint Eurocontrol/FAA Technical Link Assessment Team (TLAT) deliberations and have been further refined for the expected UAT aircraft installations.

External Environment: Several external environments were defined. Each was composed of UAT self-interference, off-board DME/TACAN, and JTIDS/MIDS signals.

The scenarios utilized for UAT interference are summarized as follows:

a. Current Europe –

UAT	1200 aircraft in 300 nmi radius circle
DME/TACAN	3, 978 MHz TACAN; 1, 979 MHz TACAN
JTIDS/MIDS	Baseline Scenario B (Note 1)

b. Core Europe 2015

UAT	2091 aircraft in 300 nmi radius circle
DME/TACAN	2- 979 MHz TACAN, 1 – 979 MHz DME
JTIDS/MIDS	Baseline Scenario B (Note 1)

c. Los Angeles 2020

UAT	2694 aircraft in 400 nmi radius circle
DME/TACAN	None
JTIDS/MIDS	Baseline Scenario B (Note 1)

d. Low Density Environment

UAT	360 aircraft in 400 nmi radius circle
DME/TACAN	2- 979 MHz TACAN, 1 – 979 MHz DME
JTIDS/MIDS	Heavy Scenario A (Note 1)

Note 1: JTIDS/MIDS scenarios are defined in terms of source time slot duty factor (a measure of number of pulses per second), and source received power level. For the MOPS effort a number of operational JTIDS/MIDS scenarios were provided by the US

Department of Defense as representing postulated training needs. The scenarios are summarized in Table 1.

Baseline Scenario B	50% TSDF	-39 dBm
	50% TSDF	-60 dBm
	300% TSDF	-84.5 dBm
Heavy Scenario A	50% TSDF	-39 dBm
	50% TSDF	-60 dBm
	300% TSDF	-78 dBm

Table 1

The UAT interference environment is summarized in Table 2, taking into consideration the effects from the sources of external interference resulting from airborne and ground UAT transmitters, DME/TACAN and JTIDS/MIDS. Also, to fully assess the resulting performance of a victim UAT receiver, practical implementation limitations of the UAT receiver that impact receiver availability, are also included. The effects of co-site are further defined in Table 3, depicting the assumptions of transmission rates of onboard L-Band transmitters, including signals from onboard DME equipment, TCAS and transponders.

UAT Interference Effects

		Scenarios		
		Core Europe 2015	**LA 2020**	**Low Density**
Standard Interference Environment	UAT Self Interference	Per TLAT Core Europe (2091 a/c in 300 nmi radius) + 100 Surface vehicles per major airport @ 28-32 dBm and 1 Basic msg/sec	Per TLAT LA 2020 (2694 a/c in 400 nmi radius) + 100 Surface vehicles per major airport @ 28-32 dBm and 1 Basic msg/sec	Per TLAT Low Density (360 a/c in 400 nmi radius) + 100 Surface vehicles per major airport @ 28-32 dBm and 1 Basic msg/sec
	DME	All currently planned 979 assignments (Al M to translate into the signal conditions present for each victim situation)	None	A single 10 KW beacon @ 3600 pps at scenario center
	JTIDS (levels at UAT rxr)	TSDF 50% @ -39 dBm + TSDF 50% @ -60 dBm + TSDF 300% @ -84.5 dBm	TSDF 50% @ -39 dBm + TSDF 50% @ -60 dBm + TSDF 300% @ -84.5 dBm	TSDF 50% @ -39 dBm + TSDF 50% @ -60 dBm + TSDF 150% @ -78 dBm + TSDF 150% @ -82 dBm
Installation/Implementation	Cosite	See "Cosite Events" table (Class dependent and scenario independent)		
	UAT Implementation Effects (Applies to all classes)	Retrigger capable		
		T/R switching results in 2 millisecond receiver blanking immediately before and after ownship transmissions		
		-20 dBc pedestal for 4 usec duration immediately before and after ownship transmission		
		"Pulse stretching": add 15 usec extra receiver blanking when SIR < -50 dB, 0 usec otherwise		

Table 2

Cosite Events

Event	Event Blanking Interval (usec)		Events per Second			
	Event Duration	Additional Blanking due to Rx Recovery	**A0**	**A1**	**A2**	**A3**
DME Interrogations	12	15	70	70	70	70
ATCRBS Replies	21	15	100	100	200	200
Mode S Replies	64	15	0	0	4.5	4.5
Mode S Interrogations	20	15	0	0	5	5
Whisper Shout Interrogations	25	15	0	0	80	80

Table 3