RTCA
1828 L Street, NW, Suite 805
Washington, DC 20036

Guidance on Aeronautical Mobile Satellite Service (AMSS) End-to-End System Performance

RTCA DO-215A
February 21, 1995

Prepared by:
SC-165

Copies of this document may be obtained from

RTCA, Incorporated
1828 L Street, NW, Suite 805
Washington, D.C. 20036-5133 U.S.A.

Telephone: 202-833-9339
Facsimile: 202-833-9434

Internet: www.rtca.org

Please contact RTCA for price and ordering information.

FOREWORD

This document was prepared by RTCA Special Committee 165 (SC-165). It was approved by the RTCA Technical Management Committee on February 21, 1995.

RTCA, Incorporated is a not-for-profit corporation formed to advance the art and science of aviation and aviation electronic systems for the benefit of the public. The organization functions as a Federal Advisory Committee and develops consensus based recommendations on contemporary aviation issues. RTCA's objectives include but are not limited to:

- coalescing aviation system user and provider technical requirements in a manner that helps government and industry meet their mutual objectives and responsibilities;

- analyzing and recommending solutions to the system technical issues that aviation faces as it continues to pursue increased safety, system capacity and efficiency;

- developing consensus on the application of pertinent technology to fulfill user and provider requirements, including development of minimum operational performance standards for electronic systems and equipment that support aviation; and

- assisting in developing the appropriate technical material upon which positions for the International Civil Aviation Organization and the International Telecommunication Union and other appropriate international organizations can be based.

The organization's recommendations are often used as the basis for government and private sector decisions as well as the foundation for many Federal Aviation Administration Technical Standard Orders.

Since RTCA is not an official agency of the United States Government, its recommendations may not be regarded as statements of official government policy unless so enunciated by the U. S. government organization or agency having statutory jurisdiction over any matters to which the recommendations relate.

TABLE OF CONTENTS

1.1 Purpose and Scope 1
1.2 Document Organization 1
1.3 AMSS System Overview 2
1.3.1 System Architecture 2
1.3.2 The Aeronautical Telecommunications Network (ATN) 4
1.3.3 Service Providers 5
1.4 Communication Services via AMSS 5
1.4.1 Satellite Coverage 5
1.4.2 AMSS Categories 5
1.4.3 Satellite Subsystem Characteristics 6
1.4.4 Circuit-Mode and Packet-Mode Communications 7
1.4.5 AMS(R)S Operational Service Levels 8
1.4.6 Satellite Subsystem Coordination Centers 9
1.4.7 Aircraft-User, Terrestrial and Ground User Subsystems 9
1.5 Operational Applications 9
1.5.1 Air Traffic Services (ATS) 9
1.5.1.1 Air Traffic Control (ATC) 10
1.5.1.2 Flight Information Services (FIS) 10
1.5.1.3 Alerting Service 11
1.5.1.4 Automatic Dependent Surveillance (ADS) 11
1.5.2 Aeronautical Operational Control (AOC) 12
1.5.2.1 AOC Functions 12
1.5.2.2 Operations Services 12
1.5.3 Non-Safety Services 13
1.5.3.1 Aeronautical Administrative Communications (AAC) 13
1.5.3.2 Aeronautical Passenger Communications (APC) 13
1.6 Operational Goals 13
1.6.1 Global Coverage 14
1.6.2 Compatibility and Interoperability 14
1.6.3 Data vs. Voice Communications 14
1.6.4 Safety 14
1.6.5 Priority, Precedence and Preemption 14

2.0 Performance Criteria for End-to-End Applications 15
2.1 End-to-End Packet-Mode Services Performance 19
2.1.1 Integrity 19
2.1.1.1 Residual Packet Error Rate 19
2.1.1.2 Undetected Packet Error Rate 19
2.1.2 Throughput 19
2.2 End-to-End Circuit-Mode Services Performance 20
2.2.1 Grade of Service (GOS) 22
2.2.2 Probability of Misrouting 22
2.2.3 Circuit-Mode Voice Performance 22
2.2.3.1 Voice Quality 22
2.2.3.1.1 Voice Attenuation Distortion 23
2.2.3.1.2 Voice Group Delay Distortion 23
2.2.3.1.3 Voice Signal-Dependent Noise 23
2.2.3.1.4 Voice Idle Channel Noise 23

2.2.3.2 Voice Transfer Delay 23
2.2.3.3 Voice Call Setup Delay 24
2.2.3.4 New Call Initiation Delay 24
2.2.4 Circuit-Mode Data Performance 24
2.2.4.1 Circuit-Mode Data Bit Error Rate 24
2.2.4.2 Circuit-Mode Data Bit Rate 24
2.2.4.3 Circuit-Mode Data Transfer Delay 24
2.2.4.4 Circuit-Mode Data Call Setup Delay 25
2.3 Priority, Precedence and Preemption 25
2.3.1 Packet-Mode Priorities 25
2.4 Availability 28

3.0 PERFORMANCE OF SUBSYSTEMS 29
3.1 Aircraft-User Subsystem 29
3.1.1 Packet-Mode Performance 29
3.1.1.1 Integrity 29
3.1.1.2 Throughput 29
3.1.1.3 Transfer Delay 29
3.1.2 Circuit-Mode Performance 29
3.1.2.1 Grade of Service (GOS) 29
3.1.2.2 Probability of Misrouting 29
3.1.2.3 Voice Performance 30
3.1.2.3.1 Voice Attenuation Distortion 30
3.1.2.3.2 Voice Group Delay Distortion 30
3.1.2.3.3 Voice Signal-Dependent Noise 30
3.1.2.3.4 Voice Idle Channel Noise 30
3.1.2.3.5 Voice Transfer Delay 30
3.1.2.3.6 Voice Call Setup Delay 30
3.1.2.3.7 New Call Initiation Delay 31
3.1.2.4 Circuit-Mode Data Performance 31
3.1.2.4.1 Circuit-Mode Data Bit Error Rate 31
3.1.2.4.2 Circuit-Mode Data Bit Rate 31
3.1.2.4.3 Circuit-Mode Data Transfer Delay 31
3.1.2.4.4 Circuit-Mode Data Call Setup Time 31
3.1.3 Priority, Precedence and Preemption 31
3.1.4 Availability 31
3.2 Satellite Subsystem 31
3.2.1 Packet-Mode Performance 32
3.2.1.1 Integrity 32
3.2.1.1.1 Residual Packet Error Rate 32
3.2.1.1.2 Undetected Packet Error Rate 32
3.2.1.2 Throughput 32
3.2.1.3 Transfer Delay 32
3.2.2 Circuit-Mode Performance 34
3.2.2.1 Grade of Service (GOS) 34
3.2.2.2 Probability of Misrouting 34
3.2.2.3 Voice Performance 35
3.2.2.3.1 Voice Transfer Delay 35
3.2.2.3.2 Voice Call Setup Delay 35

3.2.2.3.3 New Call Initiation Delay 35
3.2.2.4 Circuit-Mode Data Performance 36
3.2.2.4.1 Circuit-Mode Data Bit Error Rate 36
3.2.2.4.2 Circuit-Mode Data Bit Rate 36
3.2.2.4.3 Circuit-Mode Data Transfer Delay 36
3.2.2.4.4 Circuit-Mode Data Call Setup Time 36
3.2.3 Priority, Precedence and Preemption 36
3.2.4 Availability 36
3.2.5 Satellite Subsystem Segments 36
3.2.5.1 Aircraft Earth Station (AES) Function 36
3.2.5.2 Ground Earth Station (GES) Function 37
3.2.5.3 Space Segment RF Links and Coverage 37
3.2.5.3.1 Transponders 37
3.2.5.3.2 Coverage Area 37
3.2.5.3.3 RF Link Performance 37
3.2.5.3.4 Interference 39
3.2.5.4 Network Control and Coordination 40
3.2.5.4.1 Intrasystem Coordination 41
3.2.5.4.2 Intersystem Coordination 42
3.2.5.4.3 System Coordination Tables 43
3.3 Terrestrial Subsystem 44
3.3.1 Packet-Mode Performance 44
3.3.1.1 Integrity 44
3.3.1.2 Throughput 44
3.3.1.33.3.1.3 Transfer Delay 44
3.3.2 Circuit-Mode Performance 45
3.3.2.1 Grade of Service (GOS) 45
3.3.2.2 Probability of Misrouting 45
3.3.2.3 Voice Performance 45
3.3.2.3.1 Voice Attenuation Distortion 45
3.3.2.3.2 Voice Group Delay Distortion 45
3.3.2.3.3 Voice Signal-Dependent Noise 46
3.3.2.3.4 Voice Idle Channel Noise 46
3.3.2.3.5 Voice Transfer Delay 46
3.3.2.3.6 Voice Call Setup Delay 46
3.3.2.3.7 New Call Initiation Delay 46
3.3.2.4 Circuit-Mode Data Performance 46
3.3.2.4.1 Circuit-Mode Data Bit Error Rate 46
3.3.2.4.2 Circuit-Mode Data Bit Rate 46
3.3.2.4.3 Circuit-Mode Data Transfer Delay 46
3.3.2.4.4 Circuit-Mode Data Call Setup Time 47
3.3.3 Priority, Precedence and Preemption 47
3.3.4 Availability 47
3.4 Ground-User Subsystem 47
3.4.1 Packet-Mode Performance 47
3.4.1.1 Integrity 47
3.4.1.2 Throughput 47
3.4.1.3 Transfer Delay 47
3.4.2 Circuit-Mode Services Performance 47
3.4.2.1 Grade of Service (GOS) 48

3.4.2.2 Probability of Misrouting 48
3.4.2.3 Voice Performance 48
3.4.2.3.1 Voice Attenuation Distortion 48
3.4.2.3.2 Voice Group Delay Distortion 48
3.4.2.3.3 Voice Signal-Dependent Noise 48
3.4.2.3.4 Voice Idle Channel Noise 49
3.4.2.3.5 Voice Transfer Delay 49
3.4.2.3.6 Voice Call Setup Delay 49
3.4.2.3.7 New Call Initiation Delay 49
3.4.2.4 Circuit-Mode Data Performance 49
3.4.2.4.1 Circuit-Mode Data Bit Error Rate 49
3.4.2.4.2 Circuit-Mode Data Bit Rate 49
3.4.2.4.3 Circuit-Mode Data Transfer Delay 49
3.4.2.4.4 Circuit-Mode Data Call Setup Time 49
3.4.3 Priority, Precedence and Preemption 49
3.4.4 Availability 50

4.0 OPERATIONAL PERFORMANCE VERIFICATION GUIDELINES 51
4.1 Performance Verification 51
4.2 Verification of AMSS Service Availability 53
MEMBERSHIP 55

FIGURES

Figure 1-1. Aeronautical Mobile Satellite Service End-to-End System Model 3
Figure 2-1. Packet-Mode Services System Structure 16
Figure 2-2. Circuit-Mode Services System Structure 17
Figure 2-3. Reference Points for Circuit-Mode Service 18

TABLES

Table 2-1. End-to-End Transfer Delay Performance
(with 600 bps Satellite Subsystem Channel rate) 21
Table 2-2. End-to-End Transfer Delay Performance
(with 10,500 bps Satellite Subsystem Channel Rate) 21
Table 2-3. AMSS Satellite Subsystem Packet-mode Priority Structure 26
Table 2-4. AMSS Circuit-Mode Priority Structure 27
Table 3-1. Satellite Subsystem Transfer Delay Performance
(600 bps Satellite Subsystem Channel Rate) 33
Table 3-2. Satellite Subsystem Transfer Delay Performance
(10,500 bps Satellite Subsystem Channel Rate) 33
Table 3-3. Minimum Carrier-to-Noise Density at the Desired BER 38
Table 4-1. Required Link Margins 39
Table 4-1. Verification and Evaluation Method Matrix 52

APPENDIX A KEY TERMS AND GLOSSARY 1

APPENDIX B SHARING SPACE SEGMENT RESOURCES 1

APPENDIX C RF LINK PERFORMANCE 1

APPENDIX D VALIDATION OF AMSS SYSTEM TRANSIT AND CALL SETUP DELAYS 1

1.0 INTRODUCTION

1.1 Purpose and Scope

This document contains guidance for the system and service requirements -- performance, availability and integrity -- for an End-to-End System providing Aeronautical Mobile Satellite Services (AMSS) to end users. The primary elements of the End-to-End System are also considered individually. The material should be useful to users, designers, manufacturers and installers of the AMSS system and its elements.

Compliance with these guidelines is recommended as one means of assuring that the AMSS End-to-End system will perform its intended function(s) satisfactorily under all conditions normally encountered in aeronautical operations. Any regulatory application of this document is the sole responsibility of the appropriate authority.

A near-term perspective is taken in anticipating AMSS service development and thus in defining system and service performance criteria. Development can be foreseen in the evolution toward full utilization of AMS(R)S services, and in implementation of the Aeronautical Telecommunications Network (ATN). Certain performance criteria herein may not be met by one or more of the possible modes of operation of AMS(R)S.

Associated with this document is the companion "AMSS Minimum Operational Performance Standards," (MOPS) RTCA Document No. DO-210. It defines the parameters for the Aeronautical Earth Station (AES), a portion of the Satellite subsystem on-board an aircraft, which provides communications functions necessary for air-ground communications via satellite.

1.2 Document Organization

Section 1.0 of this document contains the Introduction, providing an overview of AMSS systems and the applications being planned by users of AMSS.

Section 2.0 establishes the End-to-End System and service criteria for AMSS communications as developed from the expected needs of users and system characteristics. These criteria are expressed in terms of performance, integrity and availability parameters. Section 2 also defines the four primary elements of the End-to-End System.

Section 3.0 addresses the system and service criteria for each of the four Subsystems comprising the End-to-End System -- the Aircraft, Satellite, Terrestrial Distribution and Ground User Subsystems. As the Satellite Subsystem plays the key role in end-to-end AMSS service, particular attention is devoted to that element.

Section 4.0 provides guidelines for verification of the system elements.

Appendix A provides explanation of key terms and acronyms in a glossary.

© RTCA, Inc. 1995