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Interface Control Document

NAS-IC-82422100

En Route Automation Modernization (ERAM)/ North American (NAM) Non U.S. Area Control Center (ACC) System

Version 1.0

May 7, 2019
Final

INTERFACE CONTROL DOCUMENT (ICD)

APPROVAL SIGNATURE PAGE

En Route Automation Modernization (ERAM)/North American (NAM) U.S. Area Control Center (ACC)

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1. SCOPE

This Interface Control Document (ICD) specifies the design characteristics to support Direct TCP/IP interfaces (NAM Direct IP) between the En Route Automation Modernization (ERAM) system and Non-US Area Control Center (ACC) systems via the FAA NAS Enterprise Security Gateway (NESG) and the FAA Telecommunications Infrastructure (FTI).

This ICD supports the exchange of messages defined in the North American (NAM) Common Coordination Interface Control Document (ICD) Area Control Center (ACC) to ACC, Rev E, NAS-IC-21009205 (referred to as the NAM ICD in this document). Section 1 (Historical) of the NAM ICD provides the Air Navigation Service Provider (ANSP) context for this ICD.

This ICD was prepared in accordance with FAA-STD-025f.

1.1 Summary

The Direct TCP/IP interface defined in this document is used for the exchange of Air Traffic Management (ATM) and Class 2 Interface Management messages, defined in the NAM ICD, between ERAM and an adjacent Non-US ACC system. In order to use this interface for ATM messaging, it is necessary that:

1. The Non-US ACC system establish a TCP/IP connection with ERAM via the FAA's FTI network and NESG security gateway, and then
2. Interface Management messages be exchanged between ERAM and the Non-US ACC system to establish a communication Session.

By definition, this means that the minimal interface defined in the NAM ICD, supporting only Class 1 messages, cannot be used with the Direct TCP/IP interface. In addition, support of Class 2 messages is a prerequisite for the use of Class 3 messages via the Direct TCP/IP interface.

The ERAM IRD/ICD document mapping is show in Table 1-I.

Table 1-I. ERAM IRD/ICD Document Mapping

Interface	Interface Requirements Document	Interface Control Document/Web Service Description Document
Surveillance Sources	NAS–IR–34138232 Surveillance Sources/En Route Communications Gateway (ECG)	NAS–IC–34138232–01 Common Digitizer-2 (CD-2) Surveillance Sources/En Route Communications Gateway (ECG)
		NAS–IC–34138232–02 Common Digitizer–Airport Surveillance Radar (CD–ASR) Surveillance Sources/En Route Communications Gateway (ECG)
Surveillance and Broadcast Services (SBS)	NAS–IR–82530001 Surveillance and Broadcast Services (SBS) Service Delivery Point (SDP) to ATC Automation and Service Monitoring User Subsystems	NAS–IC–82530001–01 Surveillance and Broadcast Services (SBS) Service Delivery Point (SDP) to ATC Automation and Service Monitoring User Subsystems
	NAS–IR–82530002 Surveillance and Broadcast Services (SBS) Service Delivery Point (SDP) Common Digitizer–2 (CD–2) to En Route ATC Automation and Service Monitoring User Subsystems	NAS–IC–82530002–01 Surveillance and Broadcast Services (SBS) Service Delivery Point (SDP) Common Digitizer–2 (CD–2) to En Route ATC Automation and Service Monitoring User Subsystems
En Route Communications Gateway (ECG)	NAS–IR–82328217 En Route Communications Gateway (ECG)/National Airspace System (NAS) Host Computer System (HCS) and Future NAS Automation System	NAS–IC–82328217–03 En Route Communications Gateway (ECG)/En Route Automation Modernization (ERAM)
	NAS–IR–82320001 En Route Communications Gateway (ECG)/Internet Protocol Local Area Network (IP LAN) User Systems	NAS–IC–82320001–01 En Route Communications Gateway (ECG)/Internet Protocol (IP) Local Area Network (LAN) User Systems
Serial Devices	NAS–IR–82328234 En Route Communications Gateway (ECG)/Serial Communication Devices	NAS–IC–82328234–01 En Route Communications Gateway (ECG)/Serial Communication Devices

Flight Data Input Output (FDIO)	NAS–MD–581 Flight Data Input/Output (FDIO) Program Software Interface Control Document (SICD)	NAS–IC–82018242–01 En Route Automation Modernization (ERAM)/Flight Data Input/Output (FDIO)
Air Traffic Management (ATM) Intermediate Point of Presence (IPOP)	NAS–IR–82422412 En Route Automation Modernization (ERAM)/User Systems via Air Traffic Management (ATM) Intermediate Point of Presence (IPOP)	NAS–IC–82422412–01 En Route Automation Modernization (ERAM)/User Systems via Air Traffic Management (ATM) Intermediate Point of Presence (IPOP)
Departure Spacing Program (DSP)	NAS–IR–82422409 En Route Automation Modernization (ERAM)/ Departure Spacing Program (DSP)	NAS–IC–82422409–01 En Route Automation Modernization (ERAM)/ Departure Spacing Program (DSP)
National Airspace Data Interchange Network (NADIN) (Service–B Users)	NAS–IR–82424301 En Route Automation Modernization (ERAM)/National Airspace Data Interchange Network (NADIN) (Service–B Users)	NAS–IC–82424301–01 En Route Automation Modernization (ERAM)/ National Airspace Data Interchange Network (NADIN) (Service–B Users)
Weather Message Switching Center Replacement (WMSCR)	NAS–IR–82422507 En Route Automation Modernization (ERAM) with Weather Message Switching Center Replacement (WMSCR)	NAS–IC–82422507–01 En Route Automation Modernization (ERAM) with Weather Message Switching Center Replacement (WMSCR)
	NAS–IR–94022507 Weather Message Switching Center Replacement to National Airspace Data Interchange Network Packet Switched Network Users (WMSCR/NADIN/PSN USERS)	NAS–IC–94022507 Weather Message Switching Center Replacement to National Airspace Data Interchange Network (NADIN) Packet Switched Network User (WMSCR/NADIN/PSN User)
Weather and Radar Processor (WARP)	NAS–IR–25150002 Weather and Radar Processor (WARP) Display Products to ATC User Subsystems	NAS–IC–82422515 En Route Automation Modernization (ERAM)/Weather and Radar Processor (WARP) with Next Generation Radar (NEXRAD) Data

	NAS–IR–25158222 Weather and Radar Processor (WARP) Weather Information Network Server (WINS) to User Request Evaluation Tool (URET) Core Capability Limited Deployment (CCLD)	NAS–IC–82422519 En Route Automation Modernization (ERAM)/Weather and Radar Processor (WARP) Weather Information Network Server (WINS) Component
	NAS–IR–90029414 National Weather Service Telecommunications Gateway (NWSTG) to Federal Aviation Administration Bulk Weather Telecommunications Gateway (FBWTG)	
Standard Terminal Automation Replacement System (STARS)		NAS–IC–21058100 Standard Terminal Automation Replacement System (STARS) to Air Route Traffic Control Center (ARTCC) for Interfacility Data Transfer (IFDT)
North American (NAM)		NAS–IC–21009205 North American (NAM) Common Coordination Interface Control Document (ICD) Area Control Center (ACC) to ACC, Rev E
	NAS-IR-82422100 En Route Automation Modernization (ERAM)/ North American (NAM) Non U.S. Area Control Center (ACC)	NAS-IC-82422100 En Route Automation Modernization (ERAM) / North American (NAM) Non-US Area Control Center (ACC)
System-Wide Information Management (SWIM)	NAS–IR–43070001 System-Wide Information Management (SWIM) Service Registry/User	
	NAS–IR–82420001 En Route Automation Modernization (ERAM)/Web Services	NAS–WSDD–8242–001 En Route Automation Modernization (ERAM)/Flight Information Service (FIS)
ERAM / DCNS	NAS-IR-82424308 En Route Automation Modernization (ERAM) / Data Communications Network Service (DCNS)	NAS-IC-82424308-01 En Route Automation Modernization (ERAM) / Data Communications Network Service (DCNS)

ERAM / TDLS	NAS-IR-22038242 En Route Automation Modernization (ERAM) / Tower Data Link Services (TDLS)	NAS-IC-22038242-01 En Route Automation Modernization (ERAM) / Tower Data Link Services (TDLS)
ERAM / TDLS TIMS	NAS-IR-22038242 En Route Automation Modernization (ERAM) / Tower Data Link Services (TDLS)	NAS-IC-22038242-02 En Route Automation Modernization (ERAM) / Tower Data Link Services (TDLS) Tower Information Management System (TIMS)
ERAM SkyDataSentry / DR&A Subsystems	NAS-IR-82428701 En Route Automation Modernization (ERAM) SkyDataSentry (SDS) to Data Reduction and Analysis (DR&A) Subsystems	NAS-IC-82428701 En Route Automation Modernization (ERAM) SkyDataSentry (SDS) to Data Reduction and Analysis (DR&A) Subsystems

1.2 Subsystem Responsibility List

The interfacing systems, and the common names and the responsible agency for each, are shown in Table 1-II.

Table 1-II. Organization System Responsibility

Subsystem	Common Name	Responsibility	International Civil Aviation Organization (ICAO) North American, Central American and Caribbean (NACC) member state
ERAM	En Route Automation Modernization	Federal Aviation Administration (FAA) AJM-213	United States
NESG	NAS Enterprise Security Gateway	FAA AJW-B4	United States
FTI	FAA Telecommunications Infrastructure	FAA AJM-314	United States
CAATS	Canadian Automated Air Traffic System	NAV Canada	Canada
RADCON-M	RADCON-M	Instituto de Aeronáutica Civil de Cuba (IACC)	Cuba
TopSky-ATC	TopSky-ATC	Instituto Dominicano de Aviacion Civil (IDAC)	Dominican Republic

2. APPLICABLE DOCUMENTS

The following documents form a part of this ICD to the extent specified herein.

In the event of a conflict between the documents referenced herein and the contents of this ICD, the contents of this ICD will supersede these listed documents.

2.1 Government Documents

FAA Specifications:

FAA-ER- 2979 September 25, 2017	ERAM System Specification Document (SSD), Revision H
DTFA01-02-D-03006 Modification P0109	Attachment J.1 FAA Telecommunications Infrastructure (FTI) Services Description
NAS-IC-21009205 15 April 2016	North American (NAM) Common Coordination Interface Control Document (ICD) Area Control Center (ACC) to ACC, Rev E
FAA-STD-042b March 11, 2005	NAS Naming and Addressing Structure for Ground-to-Ground Communication
FAA-G-2100H May 9, 2005	Electronic Equipment, General Requirements

FAA STANDARDS:

FAA-STD-025f November 30, 2007	Preparation of Interface Documentation

OTHER FAA PUBLICATIONS:

FAA Order 6950.22A May 8, 2004	Maintenance of Electrical Power and Control Cables
March 31, 2004	ERAM System Protection Profile, Version 3.0
November 10, 2016	FAA Telecommunications Infrastructure (FTI) NAS Enterprise Security Gateway (NESG) User’s Guide, Volume II – For Non-NAS Users, Revision 5

2.2 Non-Government Documents

Standards:

American National Standards Institute (ANSI) X3.4 December 30, 1986	American National Standard Code for Information Interchange (ASCII)
ANSI X3.41 1974	Code Extension Techniques for Use with the 7-Bit Coded Character Set of ASCII.
ANSI/TIA/EIA-568-B.1 April 1, 2001	American National Standard Institute (ANSI)/Telecommunications Industry Association (TIA)/Electronic Industries Alliance (EIA) Standard, Commercial Building Telecommunications Cabling Standard - Part 1: General Requirements
IEEE STD 802.2 - 1998	Part 2: Local and Metropolitan Area Networks, Logical Link Control
IEEE STD 802.3 - 2002	Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications
Telecommunications Industry Association (TIA)/Electronic Industries Alliance (EIA)-568-C.1 February 2009	Commercial Building Telecommunications Cabling Standard – Part1 : General Requirements
Internet Engineering Task Force (IETF) Request for Comments (RFC) 791 September 1981	Internet Protocol, as updated by RFC 1349
IETF RFC 792 September 1, 1981	Internet Control Message Protocol, updated by RFC 950
IETF RFC 793 September 1981	Transmission Control Protocol, updated by RFC 3168
IETF RFC 826 November 1, 1982	Ethernet Address Resolution Protocol: Or converting network protocol addresses to 48.bit Ethernet address for transmission on Ethernet hardware
IETF RFC 894 April 1984	A Standard for the Transmission of IP Datagrams over Ethernet Networks
IETF RFC 1349 July 1992	Type of Service in the Internet Protocol Suite
IETF RFC 1812 June 1995	Requirements for IP Version 4 Routers

IETF RFC 3168 September 2001	The Addition of Explicit Congestion Notification (ECN) to IP

International Documents:

ICAO Doc. 4444	Procedures for Air Navigation Services-Air Traffic Management, Fifteenth Edition, current version
ICAO Doc 9694-AN/955	Manual of Air Traffic Services Data Link Applications
PAN ICD	Pan Regional Interface Control Document (PAN ICD) for ATS Interfacility Data Communications (AIDC)
ICAO Annex 10, Volume II	Aeronautical Telecommunications
ICAO Doc. 8643	Aircraft Type Designators
ICAO Doc. 7910	Location Indicators
Amendment 1	Amendment 1 to the PANS-ATM (ICAO Doc 4444 15^{th} Edition)

3. Interface Design Characteristics

This section provides the general functions, services and physical design characteristics between an ERAM ARTCC and a Non-US ACC via the FAA FTI and the NESG.

3.1 General Characteristics

This document defines design characteristics for the transfer of ATM messages and Interface Management messages between ERAM and adjacent Non-US ACC systems via the FTI and the NESG.

Figure 3-1 shows the interfaces between ERAM and a Non US ACC system with the physical points of demarcation identified.

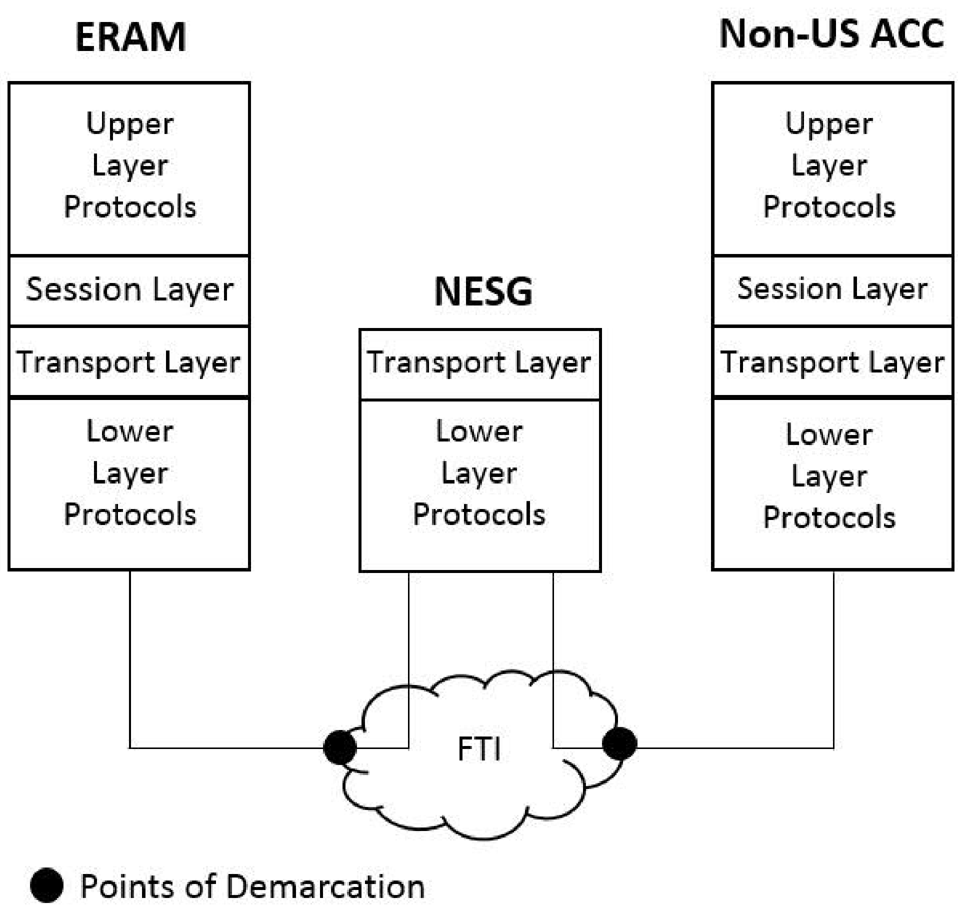

Figure 3-1. ERAM, NESG/FTI, and Non-US ACC System Interfaces with Points of Demarcation

ERAM and a Non-US ACC system exchange Interface Management messages to establish a session used to exchange Air Traffic Management (ATM) messages. To support ERAM-Non-US ACC system messaging, the NESG and FTI provide load balancing, security, routing, and other networking functionality that map to the lower four layers of the seven layer ISO Open Systems Interconnection

(OSI) standard, i.e. up through the Transport Layer. The upper layer ATM messages are documented in the NAM ICD. The Session level Interface Management messages are also addressed by the NAM ICD but are covered in more detail in this ICD.

3.1.1 ERAM, NESG/FTI, Non-US ACC Interface

The ERAM, NESG/FTI, and Non-US ACC system interfaces are as shown in Figure 3-2. The US NESGs are security gateways that provide TCP/IP-based access to NAS systems. Dedicated circuits are provided over FTI infrastructure between the NESGs and Service Delivery Points (SDPs) at Non-US gateways to establish two-way TCP/IP communications between NAS systems and Non-US ACC systems. The circuits provide redundant points of access that Non-US ACCs can use to access each NESG (SLC and ATL) via redundant paths. A Non-US ACC system can use either NESG to access the NAS. If access to a NAS system via one NESG is unavailable, a Non-US ACC system can access the NAS system via the other NESG. Any Non-US ACC system that wants to communicate with a NAS system must first establish a Virtual Private Network (VPN) with an NESG in accordance with the FAA FTI NAS Boundary Protection System (NBPS), User's Guide, Volume II - For Non-NAS Users. The NESG accepts a Virtual Private Network (VPN) from each Non-US ACC via the NAS External FTI Network as specified in this document.

Figure 3-2. ERAM, Non-US ACC System Interface Connections.

Any Non-US ACC system that wants to communicate with ERAM for exchanging ATM messages does so by establishing a TCP/IP connection through the VPN to an ERAM Protocol Gateway Front End Processor (PGW FEP), which resides in the NESG External DMZ. The PGW FEP hosts a NAM Interface

Proxy application (NAM I/F Proxy), which services the TCP/IP connection from the Non-US ACC system and provides application layer proxy services for accessing ERAM. There is a redundant pair of PGW FEPs in the NESG External DMZ for failure recovery and availability purposes.

The PGW FEPs are physically located in the ERAM National ARTCCs (ZLC and ZTL, a.k.a. ERAM National Sites) but connect only to NESG/FTI External DMZ networks available in those facilities. FTI provides connectivity between the ERAM National ARTCCs and their adjacent national Enterprise Maintenance Center (NEMC) facility (SLC for ZLC and ATL for ZTL) where the NESG is located. ERAM switches at each ERAM National Site are provided for connecting the redundant pair of PGW FEPs to FTI. A redundant pair of operational networks and a redundant pair of monitor and control (M&C) networks are provisioned between each PGW FEP and the NESG External DMZ. The redundant PGW FEPs are in an active/standby configuration at each ERAM National Site. Similarly, one ERAM National Site is active while the other is backup.

A Non-US ACC system initiates a TCP/IP socket connection with ERAM through the VPN as a precondition for bringing up the interface between that Non-US ACC system and an adjacent ERAM. The NESG directs the connection request to the NAM I/F Proxy on active PGW FEP at the active ERAM National Site using Load Balancing (see section 3.1.2).

The NAM I/F Proxy performs Non-US ACC system connection validation, application message validation, routing of valid messages received from Non-US ACC systems to ERAM, and forwarding of messages from ERAM to addressed Non-US ACC systems. The NAM I/F Proxy uses a separate, ERAM-internal connection to communicate with each Border ERAM (an ERAM at a US ARTCC that borders a Non-US ACC) on behalf of the Non-US ACC systems.

Once a TCP/IP connection is established between an ERAM and a Non-US ACC system, if either site wants to exchange ATM messages, then their respective system initiates the interface using Interface Management messages. When both sites complete the exchange of Interface Management messages to initialize their interface, ERAM and the Non-US ACC system can exchange ATM messages.

The NESG/FTI provides secure routing of Interface Management and ATM message traffic between the NAM I/F Proxy and ERAM via ERAM's ECG RFW. This is used for ATM and Interface Management messages exchanged between Border ERAMs and Non-US ACC systems.

The NESG/FTI provides secure routing of system management data and message traffic between PGW FEP applications and the ERAM National Sites via ERAM's back-end processors (BEPs) and ERAM National Processing Router Firewalls (ENP RFWs) at these national sites. This is used for ERAM-internal system management functions (e.g., software updates, logging data collection).

Redundant paths through NESG/FTI for a NAM Direct IP connection between ERAM and Non-US ACC systems are established so the overall interface has no single point of failure, i.e., so a lost connection due to a path failure can be re-established on the same or a redundant path. To support the critical ATM services enabled by the interface, the goal is for the end-to-end interface to have an overall availability of at least 0.9999 and to have no interruption of services exceeding 60 seconds during unplanned outages if redundant resources are available.

The US responsibility of the ERAM-Non-US ACC system connectivity is from the SLC and ATL NESGs to demarcation points connecting US and Non-US networks. In addition, the US has responsibility for bandwidth between the NESGs for traffic that needs to be routed from one to the other to reach the active ERAM National Site.

The 95th percentile one-way latency between an ERAM ECG RFW and the NESG via FTI is less than or equal to 225 milliseconds.

The 95th percentile one-way latency between two NESGs is less than or equal to 50 milliseconds.

3.1.2 Load Balancing and Health Monitoring

The NESG uses a Load Balancing function to direct TCP/IP socket connection requests from Non-US ACC systems to an IP address for the active PGW FEP at the active ERAM National Site. There are multiple PGW FEP IP addresses configured for the operational networks to the redundant pairs of PGW FEPs at the ERAM National Site NESGs (SLC for PGW FEPs located at ZLC and ATL for PGW FEPs located at ZTL). The addresses to use to access the active FEP can change as processor failovers and site promotions to the active mode occur.

Load Balancing is a function that allows a Non-US ACC system to address ERAM using a single virtual IP address and avoid having to determine which physical PGW FEP addresses are available for the currently active processor at the currently active ERAM National Site. Load Balancing directs TCP/IP connection requests from the Non-US ACC systems to the active PGW FEP at the currently active National ERAM site, whether ZLC or ZTL. As part of this function, the virtual address used by the Non-US ACC system is changed by Load Balancing to a physical address that Load Balancing knows to be reachable for the active PGW FEP at the active National Site based on health monitoring. Load Balancing also changes the physical address back to the virtual address in packets sent from the PGW FEP back to the Non-US ACC system.

Load Balancing uses TCP Content-Check health monitoring of all PGW FEP IP addresses to maintain up/down status of the IP addresses that can be used to access the PGW FEPs. The health monitoring function is a periodic poll for up/down status. A poll opens a connection to a designated TCP port at each PGW FEP address, sends a text string (Send String) to request status from the NAM I/F Proxy at each of these addresses, receives a text string (Receive String) reply from each address indicating status, and closes the connections. Load Balancing records a “Down” status for an address if there is any response other than that indicating “Up” or if there is a timeout of the request. See Table 3-I for the health monitoring Send String and Request Strings.

Table 3-I. TCP Content-Check Monitor Response Strings

Health Monitoring Strings	Meaning
<site>	Send String to request status, where <site> is a 3 character indicator of the requesting site. Requesting site indicators include: "SLC" for Salt Lake City "ATL" for Atlanta
"U"	Receive String that indicates the connection is up
"D"	Receive String that indicates the connection is down

Normally, two IP addresses are statused as "up," each corresponding to one of two active PGW FEP network connections (a primary and a secondary for redundancy). Load Balancing uses rules to choose which address among the IP addresses statused as "Up" to direct a TCP/IP connection request from a Non-US ACC system. If more than one IP address is statused as "Up" then the rules are to select the PGW FEP's primary address if it is "Up" else its secondary address if it is "Up." As such, all connections are normally to the primary address of the PGW FEP.

ERAM drops any connection it currently has with a Non-US ACC system to accept a new connection from that Non-US ACC system, whether at the primary or secondary address (e.g., in case the original connection is considered down by the Non-US ACC system, which is responsible for requesting TCP/IP connections). If no addresses are "Up" Load Balancing returns a connection denial response to the Non-US ACC system. If a connection request is denied by a PGW FEP, or the PGW FEP drops an existing connection, Load Balancing also returns the denial or dropped connection to the Non-US ACC system. If the Non-US ACC system detects a denial or a dropped active connection, or times out waiting for a connection request while attempting to establish a connection with ERAM, the Non-US ACC system retries the connection request until it either succeeds or gives up attempting to establish the connection. Normally, the TCP/IP connections remain established all the time as ERAM and the Non-US ACC system automatically send Application Status Monitor (ASM) messages to solicit a response when no message is received from the other side within a configurable time period (on the order of seconds). These status messages are the ASM messages defined in the NAM ICD and in section 3.2.2.3, below.

The NESG performs health monitoring of PGW FEP TCP/IP addresses at the designated port at a configurable interval set to 5 seconds.

When Load Balancing a TCP/IP connection request from a Non-US ACC system, the NESG directs a TCP/IP socket connection request to the TCP/IP port identified in the TCP/IP socket connection request. A port is assigned for each adjacent ARTCC-Non-US ACC pair. See Table 3-II for port number assignments.

Table 3-II. Communication Port Number Assignments

ACC Location	ARTCC Port Information
Vancouver (ZVR)	12027: Seattle (ZSE)
Edmonton (ZEG)	12025: Salt Lake (ZLC) 12029: Seattle (ZSE)
Winnipeg (ZWG)	12015: Minneapolis 12023: Salt Lake (ZLC)
Toronto (ZYZ)	12008: Boston (ZBW) 12012: Cleveland (ZOB) 12016: Minneapolis (ZMP)
Montreal (ZUL)	12006: Boston (ZBW) 12010: Cleveland (ZOB)
Moncton (ZQM)	12004: Boston (ZBW)
n/a	12000: Reserved for Load Balancer health monitoring

3.1.3 Security Design Characteristics

Through compliance with "FAA Telecommunications Infrastructure (FTI) NAS Boundary Protection System (NBPS), User's Guide, Volume II – For Non-NAS Users, Revision 5" the NESG ensures the protection of IP communications between ERAM and Non-US ACCs, and between FAA NESG locations. All external communications are isolated from internal communications through use of the application proxies and NESG DMZs as shown in Figure 3-2.

The PWG FEP to NESG connections are local, and the NESG manages interfacility routing. Routing between the PGW FEP and the NESG may be asymmetric, as the connections are redundant and intended to carry the same traffic.

3.2 Functional Design Characteristics

This subsection defines the functional design characteristics of the interface between ERAM and Non-US ACC systems. It discusses the Open Systems Interconnect (OSI) model interface design characteristics (see Figure 3-4), and the Interface Management message design characteristics.

In summary, a Non-US ACC system establishes a TCP/IP connection, via the NESG/FTI, with ERAM when the site wants to coordinate air traffic control operations.

An ERAM and a Non-US ACC system exchange Interface Management messages when activating, deactivating, or testing the interface between them.

An ERAM and a Non-US ACC system exchange ATM messages to coordinate air traffic control operations using the initialized interface.

3.2.1 General Service Functional Characteristics

This section identifies functional design characteristics of the interface between ERAM and a Non-US ACC system Application Processes (AP) via the NESG/FTI. The interface design characteristics consist of the information transferred and protocols used at each layer of the Open Systems Interconnect (OSI) model.

An ERAM and a Non-US ACC system exchange Interface Management messages when activating, deactivating, or testing the interface between them.

An ERAM and a Non-US ACC system exchange ATM messages to coordinate air traffic control operations using the initialized interface.

3.2.2 Application Processes and Message Characteristics

This interface is dependent on the proper functioning of Application Processes (AP) in the end systems (ERAM and Non-US ACC systems) as well as the interconnecting telecommunications (NESG/FTI and Non-US Wide Area Networks (WAN)). An Application Process (AP) is defined as an identifiable set of cooperating capabilities within a system that executes one or more information processing tasks. The following paragraphs describe the application processes that allow ERAM and a Non-US ACC system to exchange ATM messages and Interface Management messages over an established TCP/IP connection.

3.2.2.1 Identification of Each Application Process

Both ERAM and the Non-US ACC system use their Flight Data Processing (FDP) subsystem as their AP.

3.2.2.2 Application Process Capability Characteristics

The interface has no single points of failure outside of periods of planned outages. Re-establishing a lost NAM Direct IP connection within the interface's designed failure recovery time satisfies this intent. The interface is designed to detect and recover from failures within 60 seconds.

3.2.2.3 Message Content Characteristics

ATM messages are documented in the NAM ICD.

Interface Management messages, shown in Table 3-III, are used to manage an interface between ERAM and a Non-US ACC system. These messages are also documented in the NAM ICD.

Table 3-III. ERAM ARTCC/Non-US ACC Interface Management Messages

Session Control Message	Service Status
Initialization Request (IRQ)	Initiates activation of the interface
Initialization Response (IRS)	Response to an IRQ
Termination Request (TRQ)	Initiates termination of the interface
Termination Response (TRS)	Response to a TRQ
Application Status Monitor (ASM)	Message to confirm an adjacent Non-US ACC/ERAM is online and working
Logical Acknowledgement (LAM)	Computer acceptance of a message, including an ASM

3.2.2.3.1 Information Units

The basic units of information exchanged on this interface are ATM messages and Interface Management messages. A particular ERAM at an ARTCC and a particular Non-US ACC system that are exchanging messages are referred to as partners.

The frequency of ATM messages is variable. Interface Management messages are exchanged whenever the interface is to be activated (initialized) or deactivated (terminated) or to confirm that a partner is online.

Before transmission, both communicating partners prepend a four byte ASCII message header, containing the length of the message, excluding the header, in uppercase ASCII hexadecimal characters i.e., characters ‘0’ through ‘9’ and ‘A’ through ‘F’, to every message. The smallest length that can be represented is “0000” and the largest is “FFFF”, which would be 65,535 bytes. Both communicating partners support a minimum valid message size of 17 bytes (the size of an IRQ) and a maximum message size of 1800 bytes, excluding the header.

3.2.2.3.2 Information Code

Both communicating ERAM/Non-US ACC system partners encode all data between them in accordance with American National Standards Institute (ANSI) X3.4, ASCII and ANSI X3.41, Code Extension Techniques for Use with the 7-Bit Coded Character Set of ASCII.

3.2.2.4 Relationship Among Messages

The Interface Management messages ERAM and Non-US ACC systems use to initialize an interface are considered session layer messages. The Interface Management messages are used to start, stop, or monitor a Session between an ERAM and a Non-US ACC system. Interface Management messages include request and response messages. A correlating response message is expected, within a specified timeout period, for each request message.

Once a Non-US ACC system has established a TCP/IP connection then either or both sides of the interface can initiate a Session.

The Session state diagram showing the interrelationship of the Interface Management messages and the impact of transition stimuli on the state of the interface is presented in Figure 3-3.

The interface normally begins in the INACTIVE state. In the INACTIVE state, partners neither use the interface nor want to use the interface, and the interface is considered terminated. In this state, all stimuli are ignored except those to activate the interface.

If a site wants to initiate a session, either a user will enable the interface or the system will automatically enable the interface, which results in an interface activate request. This request causes the system to enter an ACTIVATING state and periodically send an IRQ message to the other partner. Normally, an IRS response is received, the interface state becomes ACTIVE, and is considered initialized. ATM messages are exchanged only in the ACTIVE state.

When a system with an enabled interface receives an IRQ message, the system will respond with an IRS message.

If a site wants to terminate a session, either a user will disable the interface or the system will automatically disable the interface, which results in an interface deactivate request. This request causes the system to send a TRQ message and enter a DEACTIVATING state. Normally, a TRS response is received, and the interface returns to the INACTIVE state. A site can also automatically terminate and re-initialize a session, e.g., to recover from a failure.

After a specified interval of no message reception in the ACTIVE state, the partner that detected the lack of message reception will transmit an ASM to test whether the other partner is still reachable and online for messaging.

In the ACTIVE state, if a system receives an ASM, the system will respond with a LAM.

The complete behavior in each state is covered in the following subsections.

Figure 3-3. ERAM ARTCC/Non-US ACC Session State Diagram with Stimuli and Responses.

3.2.2.4.1 State Transitions

The following four sections consider the impact of Interface Management messages and other stimuli on the four possible Session states, which are INACTIVE, ACTIVE, ACTIVATING, and DEACTIVATING.

ATM messages, which are not shown on this diagram, are only fully exchanged and processed in the ACTIVE state. In the DEACTIVATING state, only computer response messages to ATM messages (e.g. LAM and LRM) are sent or received and processed. Computer response messages will not cause a state transition.

The initial Session state is INACTIVE.

The Activate and Deactivate request stimuli represent either a manual intervention by an operator to enable/disable the interface or an automatically generated event upon detection of specific conditions e.g., if a partner implements automatic interface recovery that entails re-initializing the interface.

3.2.2.4.1.1 INACTIVE State

The only transition from the INACTIVE state is to the ACTIVATING state. The stimulus for this transition is a local ‘Activate Request,’ which is triggered in the system when the site wants to initialize the interface for ATM message exchange and enables the interface.

A local ‘Activate Request’ will cause the system at the local site to transmit an IRQ to the other site and then the Session will transition from the INACTIVE state to the ACTIVATING state.

3.2.2.4.1.2 ACTIVATING State

The only transition from the ACTIVATING state to the ACTIVE state is when the system receives an expected IRS.

As an implementation option, it is possible to transition from the ACTIVATING state to the INACTIVE state if the system encounters a maximum number of consecutive IRQ retries in the ACTIVATING state. If this option is implemented, then the system would send a TRQ and then transition to the INACTIVE state. If this option is not implemented, then the maximum retry attempts in the ACTIVATING state becomes unlimited and there would be not transition from ACTIVATING to INACTIVE based on a maximum number of IRQ retries.

A system will ignore a TRS in this state. Also, since the current state is not ACTIVE, a system will not respond to a received ASM.

The impact of a local Deactivate Request is that the system at the local site will send a TRQ and then transition the state from ACTIVATING to INACTIVE. A Deactivate Request is triggered in the system when the site no longer wants to have an initialized interface for ATM message exchange and disables the interface. Until then (and failure conditions aside), the system at the local site will continue attempting to initialize the interface regardless of the state of the system at the partner site.

If an IRS Timeout occurs, the state will remain ACTIVATING and the system that detected the timeout will send another IRQ.

If a system receives a TRQ, it will remain in ACTIVATING state and send a TRS, allowing the other side to immediately transition to INACTIVE and consider the interface terminated.

If a system receives an IRQ, it will remain in ACTIVATING state and send an IRQ and then an IRS. This additional IRQ is sent because it is possible that the partner site was in the INACTIVE state when the previous IRQ was sent and therefore the IRQ will never be responded to. In that case, just sending an IRS would cause the partner site to transition to ACTIVE allowing it to start sending ATM messages before this site receives an IRS and transitions to ACTIVE where it can process ATM messages. This additional IRQ will prompt the necessary IRS to allow this site to transition to the ACTIVE state.

3.2.2.4.1.3 ACTIVE State

From the ACTIVE state, only a transition to the ACTIVATING or DEACTIVATING state is possible.

While in the ACTIVE state, ATM messages are exchanged and processed.

After a specified interval of no message reception, a system will send an ASM. If a system does not receive a LAM response to the ASM within a specified timeout period, it will send an IRQ to reinitialize the interface and then transition from the ACTIVE state to the ACTIVATING state.

If a system receives a TRQ, it will send a TRS, and then send an IRQ to reinitialize the interface, and then transition from the ACTIVE state to the ACTIVATING state. Receiving an IRS message, TRS message, or LAM message will not cause a transition out of the ACTIVE state.

A system will respond with an IRS to a received IRQ in case this side activated first.

A system will respond with a LAM to a received ASM to confirm this side still wants the interface to remain initialized.

If a local 'Deactivate Request' occurs, the system at the local site will send a TRQ and then transition from the ACTIVE to the DEACTIVATING state.

3.2.2.4.1.4 DEACTIVATING State

The only transition from the DEACTIVATING state is to the INACTIVE state.

From the DEACTIVATING state, a system will transition to the INACTIVE state upon receiving a TRQ, upon receiving a TRS, or upon receiving no TRS after a specified timeout period. If a TRQ is received, the system will also respond with a TRS before transitioning to INACTIVE. A LAM response to an ASM message will be processed, but won't cause a state transition.

ATM messages are not sent or processed except that computer response messages to ATM messages (e.g., LAM, and LRM) are sent or received and processed without causing a state transition.

3.2.2.5 Quality of Service

This ICD contains latency and workload (throughput/frequency) design characteristics not already specified in the ERAM specifications.

This ICD imposes no explicit quality of service design characteristics for Priority, Urgency, Importance, and Expected Bit Error Rate. RMA design characteristics are specified in section 3.2.2.2.

3.2.2.5.1 Latency

Message response times will be as specified in NAS–IC–21009205 North American (NAM) Common Coordination Interface Control Document (ICD) Area Control Center (ACC) to ACC, Rev E.

3.2.2.5.2 Design Workload

Design workload varies with Non-US ACC partner.

This interface supports the ERAM/CAATS interface design workload for the maximum application message rate shown in Table 3-IV.

Table 3-IV. CAATS Design Workload

Message Type	Peak ARTCC Rate /minute	Peak Rate for all of En Route/minute	Average message size (Bytes)

Message Type	Peak ARTCC Rate /minute	Peak Rate for all of En Route/minute	Average message size (Bytes)
CPL	4.88	9.06	383
MOD	3.50	6.50	407
FPL	2.26	4.20	240
CHG	1.13	2.10	210
EST	2.12	3.94	164
CNL	0.07	0.13	155
RTI	7.00	13.00	316
RLA	6.65	12.35	124
RTA	7.00	13.00	277
RTU*	92.40	171.60	309
LAM	19.92	36.99	124
LRM	1.40	2.60	149

* ERAM receives RTUs from CAATS every 10 seconds for 2.2 minutes during handoff. No RTUs are sent from ERAM to CAATS.

3.2.2.6 Error Handling Characteristics

The ERAM/Non-US ACC system processes utilize TCP/IP, Interface Management messaging and appropriate manual intervention, when necessary to address interface error situations.

When operational, the ERAM/Non-US ACC Application Processes report the termination of communication to appropriate monitor and control software. Monitor and control personnel are responsible for determining and correcting the cause of a communications failure.

ERAM failures can cause ERAM to drop the TCP/IP connection with a Non-US ACC system and/or to report “Down” status of TCP/IP address(es) to the NESG Load Balancing function. The Non-US ACC system detects dropped connections or failed connection attempts in this case. ERAM recovery causes the reporting of “Up” status of the potentially new TCP/IP address(es) to which the NESG/FTI directs connection requests from the Non-US ACC system, which must re-connect to ERAM to recover the interface.

Failures affecting the interface without terminating the TCP/IP connection cause the ERAM/Non-US ACC system to detect interface inactivity and timeouts of LAM responses to ASM messages. In this case, ERAM or the Non-US ACC system may terminate the connection as part of recovery.

Upon detection of a fatal interface error with ERAM, a Non-US ACC system will terminate the existing impacted TCP/IP connections and attempt to establish a new connections.

Upon receipt of a connection request from a Non-US ACC system for which ERAM already has a connection, ERAM will drop the already established connection and accept the connection request.

Once a TCP/IP connection is established after recovery from a fatal interface error, the Non-US ACC system will attempt to re-initiate a new communication session with the ERAM system, using Interface Management messages, for any session that was interrupted by the interface failure.

Re-initializing the interfaces is handled as specified in the state diagram on Figure 3-3.

3.2.3 Protocol Implementation

ERAM, Non-US ACC systems, and NESG/FTI communicates using protocols in accordance with Figure 3-4 with respect to the seven-layer OSI reference model.

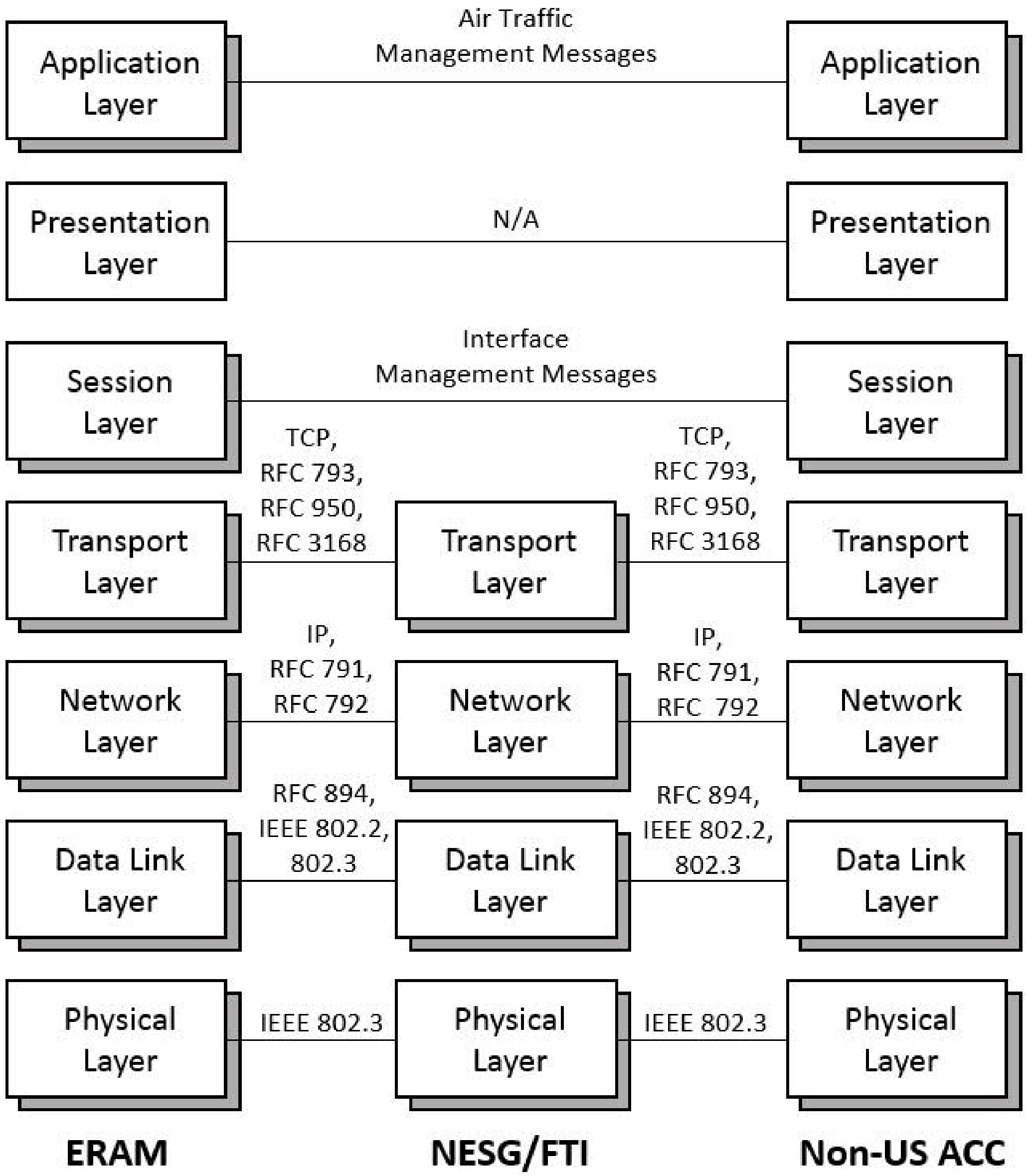

Figure 3-4. OSI Protocol Mapping for ERAM/Non-US ACC Systems

3.2.3.1 OSI Layers

ERAM, Non-US ACC systems, and NESG/FTI routers and switches transmit and receive the protocols specified in this document at the OSI levels those devices handle and use for the NAM Direct IP interface.

3.2.3.1.1 Application Layer Services

ERAM and Non-US ACC systems use their FDP AP to support ATM message transfer at the Application Layer of the OSI model. A communication session (see 3.2.3.1.3) must be established before ATM messages can be exchanged between ERAM and a Non-US ACC system.

3.2.3.1.2 Presentation Layer Services

This ICD imposes no explicit presentation layer services design characteristics.

3.2.3.1.3 Session Layer Services

ERAM and Non-US ACC systems use their FDP AP to support Interface Management message transfer at the Session Layer of the OSI model. See discussion of Session Layer messages in 3.2.2.4.

3.2.3.1.4 Transport Layer Services

ERAM, NESG/FTI, and Non-US ACC systems implement the TCP protocol at the Transport Layer as specified in RFC 793 and as amended in RFC 950 and RFC 3168 over the IP-based interfaces between an ERAM and NESG/FTI, between NESG/FTI and Non-US ACC systems, and between ERAM and Non-US ACC systems.

The NESG/FTI and ERAM implement TCP health monitoring as discussed in section **3.1.2**.

3.2.3.1.5 Network Layer Services

The interfaces between the ERAM, NESG/FTI, and Non-US ACC systems use the Internet Protocol and Internet Control Message Protocol (ICMP) in accordance with IETF RFC 791 and IETF RFC 792.

3.2.3.1.6 Data Link Layer Services

The data link layer between ERAM, NESG/FTI, and Non-US ACC systems are in accordance with RFC 894 or IEEE 802.2, and IEEE 802.3.

3.2.3.1.7 Physical Layer Services

The physical layer between the ERAM, NESG/FTI, and Non-US ACC systems are in conformance with IEEE 802.3.

There are at least two diverse, physical circuits for communicating between ERAM and each NESG/FTI interface point and between Non-US ACC systems and their NESG/FTI interface points. The diverse physical circuits are ordered with avoidance.

3.2.3.2 Naming and Addressing

IP addressing between ERAM, NESG/FTI, and Non-US ACC systems are in accordance with FAA-STD-042B.

3.3 Physical Design Characteristics

The physical design characteristics for the interface between ERAM/Non-US ACC systems and the NESG/FTI are implemented as described in the following subsections.

3.3.1 Electrical Power and Electronic Design Characteristics

Electrical connection design characteristics for the Ethernet interfaces between the ERAM/Non-US ACC systems and the NESG/FTI are specified in IEEE 802.3.

Power for the ERAM interface is in accordance with FAA-G-2100H, section 3.1.1.9.

3.3.1.1 Connectors

For Ethernet connections, ERAM/Non-US ACC systems provide cables with standard RJ-45 connectors for attachment to the NESG/FTI. These connectors are secured by means of a tab on the connector which mates with the jack, thereby preventing improper attachment and preventing detachment during normal movement of the unit. Connector wiring is as specified by EIA/TIA connector wiring specification ANSI/TIA/EIA-568-B.1.

3.3.1.2 Wiring/cabling

Cabling between ERAM/Non-US ACC systems and the NESG/FTI conform to the specifications of the IEEE Ethernet LAN standard 802.3. All cabling is at least Category 5 (commonly referred to as 'Cat 5'), with the connector wiring as specified in ANSI/TIA/EIA-568-B.1. These systems connect by means of metal-conductor cabling. Point-to-point cable length for 10BaseTX/100BaseTX connections is less than or equal to 100 meters. All metal-conductor cabling comply with FAA Order 6950.22, Maintenance of Electrical Power and Control Cables.

3.3.1.3 Grounding

Within the electrical interfaces, grounding complies with FAA-G-2100H, section 3.1.1.9.

3.3.1.4 Fasteners

This IRD imposes no explicit design characteristics for fasteners.

3.3.1.5 Electromagnetic Compatibility

This IRD imposes no explicit design characteristics for Electromagnetic Compatibility.

4. Quality Assurance Provisions

This ICD imposes no explicit Quality Assurance Provisions characteristics.

5. PREPARATION FOR DELIVERY

This ICD imposes no explicit Preparation for Delivery design characteristics.

6. NOTES

6.1 Definitions

N/A

6.2 Abbreviations and Acronyms

ACC	Area Control Center
AMS	Acquisition Management System
A/N	Alphanumeric
ANSI	American National Standards Institute
ANSP	Air Navigation Service Provider
AP	Application Process
ARTCC	Air Route Traffic Control Center
ASCII	American National Standard Code for Information Interchange
ASM	Application Status Monitor
ATL	Atlanta NEMC
ATM	Air Traffic Management
BEP	Back-End Processor
CAATS	Canadian Automated Air Traffic Management System
CCLD	Core Capability Limited Deployment
CD-2	Common Digitizer-2
CD-ASR	Common Digitizer–Airport Surveillance Radar
CHG	Change
CNL	Cancel
CPL	Current Flight Plan
CSMA/CD	Carrier Sense Multiple Access with Collision Detection

DCNS	Data Communications Network Service
DR&A	Data Reduction and Analysis
DSP	Departure Spacing Program
ECG	En Route Communications Gateway
ECN	Explicit Congestion Notification
EIA	Electronic Industries Alliance
ENP	ERAM National Processor
ERAM	En Route Automation Modernization
EST	Estimate
FAA	Federal Aviation Administration
FBWTG	Federal Aviation Administration Bulk Weather Telecommunications Gateway
FDIO	Flight Data Input/Output
FDP	Flight Data Processing (ERAM subsystem)
FEP	Front End Processor
FIS	Flight Information Service
FPL	Filed Flight Plan
FTI	FAA Telecommunications Infrastructure
GFE	Government-Furnished Equipment
HCS	Host Computer System
IACC	Instituto de Aeronáutica Civil de Cuba
IDAC	Instituto Dominicano de Aviacion Civil
ICAO	International Civil Aviation Organization
ICD	Interface Control Document
ICMP	Internet Control Message Protocol
IEEE	Institute of Electrical and Electronic Engineers, Inc.
IETF	Internet Engineering Task Force

IFDT	Interfacility Data Transfer
IP	Internet Protocol
IPOP	Intermediate Point of Presence
IRD	Interface Requirements Document
IRQ	Initiate Request Message
IRS	Initiate Response Message
ISO	International Organization for Standardization
LAM	Logical Acknowledgement Message
LAN	Local Area Network
LRM	Logical Rejection Message
M&C	Monitor and Control
NADIN	National Airspace Data Interchange Network
NACC	North American, Central American and Caribbean
NAM	North American
NAM ICD	North American (NAM) Common Coordination Interface Control Document Area Control Center (ACC) to ACC, Rev E
NAS	National Airspace System
NBPS	NAS Boundary Protection System
NESG	NAS Enterprise Security Gateway
NEMC	National Enterprise Maintenance Center
NEXRAD	Next Generation Radar
NWSTG	National Weather Service Telecommunications Gateway
OSI	Open Systems Interconnection
PGW	Protocol Gateway
PSN	Packet Switched Network
RLA	Radar Logical Acknowledgement

RMA	Reliability/Maintainability/Availability
RFC	Request For Comment
RFW	Router Firewall
RTA	Radar Accept Transfer
RTI	Radar Transfer Initiate
RTU	Radar Track Update
SBS	Surveillance and Broadcast Services
SDP	Service Delivery Point
SDS	SkyDataSentry
SICD	Software Interface Control Document
SLC	Salt Lake City NEMC
SSD	System Specification Document
STARS	Standard Terminal Automation Replacement System
SWIM	System-Wide Information Management
TCP	Transmission Control Protocol
TCP/IP	Transmission Control Protocol/Internet Protocol
TDLS	Tower Data Link Services
TIA	Telecommunications Industry Association
TIMS	Tower Information Management System
TRQ	Terminate Request Message
TRS	Terminate Response Message
URET	User Request Evaluation Tool
VPN	Virtual Private Network
WARP	Weather and Radar Processor
WINS	Weather Information Network Server
WJHTC	William J. Hughes Technical Center

WMSCR	Weather Message Switching Center Replacement
XML	Extensible Markup Language
ZLC	Salt Lake City ARTCC
ZTL	Atlanta ARTCC