AATT National Airspace System Operational Concept Description (Volume II)

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Preface

This report was developed from the referenced documents in order to conform to the required contents of an Operational Concept Description (OCD) as jointly defined by National Aeronautics and Space Administration (NASA) and the Federal Aviation Administration (FAA) Free Flight Project Office. The majority of the descriptive material has been taken directly from the referenced documents available at the time of publication. Modifications have been made to add sections not in previous concept descriptions, to improve readability, and to reflect the most currently available information.

This approach to the development of this document was taken in order to remain faithful to the efforts that are presently being undertaken by the NASA Advanced Air Transportation Technologies (AATT) Project Office, the Tool Developers and the associated NASA AATT contractors.

This document was prepared by Titan Systems Corporation, 700 Technology Park Drive Billerica, MA under Contract Number NAS2-98005. It represents CDRL #2 of Research Task Order 72 “AATT Operational Concept Description for Air Traffic Management Year 2002 Update”. This document was authored by Paul Abramson and Edmund Koenke. Allan Krueger was the contractor task lead.

Overview

This document is the second volume of a two volume "AATT National Airspace System Operational Concept Description." It provides an operational concept for the future National Airspace System (NAS).

Volume One defines ten Enhancement Areas based on the NAS service model used by the FAA. The enhancement areas are: System Capabilities, Flight Planning, Separation Assurance, Situational Awareness and Advisory, Navigation and Landing, Traffic Management - Strategic Flow, Traffic Management – Synchronization, Airspace Management, Emergency and Alerting, and Infrastructure/Information Management. The operational concept for each of the ten Enhancement Areas is presented and a set of Applications in each Enhancement Area that are planned by the National Aeronautics and Space Administration (NASA) and the FAA are identified.

Volume Two provides a description of the applications contained within each Enhancement Area, with a bibliography for each. Appendix A is a table of acronyms and abbreviations. Appendix B is the complete bibliography. The entries include scholarly papers, conference presentations, and government and private organization publications.

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1. System Capabilities Enhancement Area

The System Capabilities Enhancement Area is composed of three primary components: (1) enhancements to the NAS infrastructure; (2) technological standards by which NAS design shall be guided; and (3) enhancements to the overall system capability that cannot be allocated to another enhancement area, which can include statements of overall economic, performance, or system requirements. It includes infrastructure systems (e.g., Airport Surveillance Radars (ASRs), Air Route Surveillance Radars (ARSRs), Automatic Dependent Surveillance-Broadcast (ADS-B); automation systems themselves; and communications standards including communications interfaces and protocols, information transport, data and communications security.

The System Capabilities Enhancement Area consists of 53 applications, listed below in order of appearance.

1. Radar Augmentation with ADS-B to Support Mixed Equipage in the Terminal Airspace
2. Radar Augmentation with ADS-B to Achieve Existing Separation Standards in Terminal Airspace
3. Radar Augmentation with ADS-B to Support Mixed Equipage in the En-Route Airspace
4. Radar Augmentation with ADS-B to Achieve Existing Separation Standards in En Route Airspace
5. Enhance Existing Surface Surveillance with ADS-B
6. Surveillance Coverage for Airports without Existing Surface Surveillance
7. Air Traffic Management
8. Advanced Technologies & Oceanic Procedures (ATOP)
9. ATC/ATM Decision Support Tools
10. En Route Controller Pilot Data Link Communications (CPDLC)
11. Mode Select (Mode-S)
12. Flight Service Automation System Operational and Supportability Implementation System (OASIS)
13. Precision Runway Monitor (PRM)
14. Standard Terminal Automation Replacement System (STARS)
15. Controller Pilot Data Link Communication (CPDLC)
16. Air/Ground Communications Infrastructure
17. Airport Surface Detection Equipment (ASDE-3)
18. Airport Surface Detection Equipment - Model X (ASDE-X)
19. Weather Systems Processor (WSP)
20. Airport Surveillance Radar (ASR11)
21. Alaskan NAS Interfacility Communications System (ANICS)
22. Automated Surface Observing System(ASOS) Network (ASWON)
23. Automatic Dependent Surveillance Broadcast (ADS-B) - Advanced Technology Development and Prototyping
24. Integrated Terminal Weather System (ITWS)
25. Critical Telecommunications Support (CTS)
26. Gulf of Mexico Offshore Program
27. Local Area Augmentation System (LAAS)
28. Low Level Wind Shear Alert System (LLWAS)
29. NAS Information Security - Information System Security (ISS)
30. Next Generation Air/Ground (A/G) Communications System (NEXCOM)
31. Next Generation Weather Radar (NEXRAD)
32. Runway Visual Range (RVR)
33. Terminal Applied Engineering
34. Tower Data Link Services (TDLS)
35. Weather and Radar Processor (WARP)
36. En Route Automation Program - En Route Automation Modernization (ERAM)
37. Wide Area Augmentation System (WAAS)
38. Airports Technology - Safety (Infrared Deicing)
39. Aviation Safety Risk Analysis

40. System Applications
41. Environmental Research: Environment and Energy
42. Flight Safety/Atmospheric Hazards Research
43. Information Technology Integration
44. Navigation Research (WAAS/LAAS)
45. Operations Concept Validation
46. ADS-B Data Link Evaluation
47. Software Engineering
48. Aviation System Capacity, Planning and Improvements
49. NAS Requirements Development
50. Commercial Space Transportation Safety
51. William J. Hughes Technical Center
52. Advanced Vortex Spacing System (AVOSS)
53. Terminal Weather Doppler Radar (TDWR)

Detailed descriptions of each are provided where available.

1.1 Radar Augmentation with ADS-B to Support Mixed Equipage in the Terminal Airspace

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Safe Flight 21 Master Plan, Version 2.0*; p. 3-10; April 2000

1.1.1 DESCRIPTION

This application integrates ADS-B data with radar data to increase the accuracy and availability of multi-sensor surveillance information in the terminal airspace. Air-to-ground ADS-B messages will contribute to the identification and tracking of ADS-B equipped aircraft when data from multiple sensors is processed for display to the controller. ADS-B will also provide a back up to radar sensors in the event of sensor outage. This application will evaluate the ADS-B accuracy, integrity, and availability for provision of radar-like services as well as the procedures that deal with mixed equipage airspace. No specific mention of mixed equipage applications was found in the current Capital Investment Plan (CIP) (Ref. 5).

1.1.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Master Plan, Version 2.0; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; December 1999
3. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Functional Specification; May 1999
4. Federal Aviation Administration, US Department of Transportation; National Airspace System Capital Investment Plan Fiscal Years 2003-2006; pp. B-29 – B-30; April 2001
5. Federal Aviation Administration, US Department of Transportation; National Airspace System Capital Investment Plan Fiscal Years2003 – 2007, March 2002.
6. Federal Aviation Administration, US Department of Transportation; National Aviation Research Plan, Internet Version; pp. 2-22 – 2-26; April 2001

1.2 Radar Augmentation with ADS-B to Achieve Existing Separation Standards in Terminal Airspace

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft*; p.14; December 1999

1.2.1 DESCRIPTION

The current terminal primary radar and secondary surveillance radar (SSR) systems could benefit from the fusion of ADS-B surveillance information. This augmenting of the current system would provide an independent source for verifying radar surveillance as well as provide more accurate surveillance data, higher update rates, and additional intent information. This better information may improve safety by enabling improved conflict alerting to controllers. Current separation standards would be used with this application. The Safe Flight 21 (SF21) Master Plan (Ref. 1) indicates that this application will not be evaluated in 2002. The current CIP (Ref. 4) indicates that, as part of the SF21 program in 2003, some efforts will be directed at establishing approach/terminal services using ADS-B at Juneau; however, there is no specific mention of an application of achieving existing separation standards with ADS-B in terminal airspace.

1.2.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Master Plan, Version 2.0, p. xiii; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; December 1999
3. Federal Aviation Administration, US Department of Transportation; National Airspace System Capital Investment Plan Fiscal Years 2002-2006; pp. B-29 – B-30; April 2001
4. Federal Aviation Administration, US Department of Transportation; National Airspace System Capital Investment Plan Fiscal Years 2003-2007, Appendix B p. 15, March 2002.
5. Federal Aviation Administration, US Department of Transportation; National Aviation Research Plan, Internet Version; pp. 2-22 – 2-26; April 2001

1.3 Radar Augmentation with ADS-B to Support Mixed Equipage in the En-Route Airspace

Last Revised: December 2002

Description Source: **Federal Aviation Administration**, **US Department of Transportation**; *Safe Flight 21 Master Plan, Version 2.0*; p.3-11; April 2000

1.3.1 DESCRIPTION

As confidence is gained in the fusion of radar and ADS-B data and in the procedures that depend on this fused data, the separation standards might be reduced. The safety of the system would have to be proven not to be adversely impacted by this reduction. The benefit would be an increase in throughput through the en route and terminal areas.

The current en route primary radar and SSR systems could benefit from the fusion of ADS-B surveillance information. This augmenting of the current system would provide an independent source for verifying radar surveillance as well as provide more accurate surveillance data, higher update rates, and additional intent information. This better information may improve safety by enabling improved conflict alerting to controllers. Current separation standards would be used with this application.

Increase the accuracy and availability of multi-sensor (radar) displays by incorporating ADS-B data. Air-to-ground ADS-B messages contribute to the identification and tracking of ADS-B equipped aircraft when data from multiple sensors is processed for display to the controller. ADS-B also provides a back up to radar sensors in the event of sensor outage. ADS-B accuracy, integrity, and availability will be evaluated for provision of radar-like services and towards potential reductions in separation that may be possible from improved surveillance.

No specific mention of this application was found in the current CIP or National Aviation Research Plan (NARP), other than a general reference to expanding development and feasibility exploration of ADS-B in the en route and *oceanic* domains in the 2004-2007 time frame.

1.3.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; December 1999
3. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Functional Specification*; May 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
5. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001

1.4 Radar Augmentation with ADS-B to Achieve Existing Separation Standards in En Route Airspace

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft*; p.14; December 1999

1.4.1 DESCRIPTION

The current en route primary radar and SSR systems could benefit from the fusion of ADS-B surveillance information. This augmenting of the current system would provide an independent source for verifying radar surveillance as well as provide more accurate surveillance data, higher update rates, and additional intent information. This better information may improve safety by enabling improved conflict alerting to controllers. Current separation standards would be used with this application. According to Ref. 1, there are no plans to evaluation this application in the 2002 time frame.

No specific mention of this application was found in the current CIP or NARP, other than a general reference to expanding development and feasibility exploration of ADS-B in the en route and oceanic domains in the 2004-2007 time frame.

1.4.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*, p. xiii; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; December 1999
3. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
4. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001

1.5 Enhance Existing Surface Surveillance with ADS-B

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft*; p.12; December 1999

1.5.1 DESCRIPTION

Ground automation would receive Global Positioning System (GPS) derived positions from equipped aircraft and ground vehicles on the airport movement area. For those locations with Airport Surface Detection Equipment (ASDE) this will provide the position, identification, and speed of all equipped aircraft and fill gaps in ASDE coverage. The local and ground controllers in the tower would then monitor the position and speeds of all the traffic.

It should be noted that improving surface surveillance with ADS-B and multilateration are planned to be part of the ASDE-X program at specified airports (see application 1.18 below).

1.5.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; December 1999
3. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Functional Specification*; May 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
5. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* March 2002
6. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001

1.6 Surveillance Coverage for Airports without Existing Surface Surveillance

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft*; p.12; December 1999

1.6.1 DESCRIPTION

ASDE provides increased safety at airports during low visibility conditions by monitoring aircraft positions and reducing the chance of collisions on the surface. ADS-B and multilateration of other radars could be cost effective means of implementing ASDE-like capabilities at airports without ASDE. This would increase safety monitoring, enhance crash, fire, and rescue capabilities, as well as improve ground ATC.

It should be noted that improving surface surveillance with ADS-B and multilateration are planned to be part of the ASDE-X program at specified airports (see application 1.18 below).

1.6.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; December 1999
3. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Functional Specification*; May 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
5. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001

1.7 Air Traffic Management

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-32 – B-33;

April 2001

1.7.1 DESCRIPTION

This application maintains and upgrades the existing traffic flow management infrastructure to continue mission critical Traffic Flow Management (TFM) operations in 80 ATC facilities.

1.7.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-32 – B-33; April 2001
2. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* March 2002

1.8 Advanced Technologies & Oceanic Procedures (ATOP)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-11; April 2001

1.8.1 DESCRIPTION

This is a new acquisition to address long-term Oceanic automation requirements. This acquisition will provided new hardware and software with related NAS benefits, and provide the best value for the government. Oceanic modernization program will also provide improved controller pilot data link communications (CPDLC), Air Traffic Services Interfacility Communications (AIDC), automatic dependent surveillance addressable (ADS-A) and enhanced controller tools.

1.8.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; National Airspace System Capital Investment Plan Fiscal Years 2003-2007, p. B-54, March 2002
2. Federal Aviation Administration, US Department of Transportation; National Airspace System Capital Investment Plan Fiscal Years 2002-2006; p. B-11; April 2001
3. Federal Aviation Administration, US Department of Transportation; National Airspace System Capital Investment Plan Fiscal Years 2001-2005 Internet Version; p. A-21; 9 August 2000
4. Federal Aviation Administration, US Department of Transportation; Oceanic Procedures Branch; September 2001

1.9 ATC/ATM Decision Support Tools

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007, p. B-41-43,,* March 2002

1.9.1 DESCRIPTION

This application will:

- Integration: support the planned capability available activities for the Free Flight Phase 2 tools/capabilities
- Establish milestones for Traffic Management Advisor – Single Center (TMA)
- Establish milestones for User Request Evaluation Tool (URET)
- Establish milestones for Collaborative Decision Making (CDM)
- Conduct lab and field evaluations of Problem Analysis, Resolution, and Ranking (PARR)

- Conduct lab and field evaluations of Direct-to (D2)
- Conduct lab and field evaluations of Surface Management System (SMS)
- Conduct lab and field evaluations of Traffic Management Advisor – Multi Center (TMA-MC)

1.9.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; National Airspace System Capital Investment Plan Fiscal Years 2003-2007, p. B-41, March 2002
2. Federal Aviation Administration, US Department of Transportation; National Airspace System Capital Investment Plan Fiscal Years 2002-2006; p. B-27; April 2001
3. Titan Systems Corporation, Air Traffic Systems Division; Overview Description, Multi-Center Traffic Management Advisor (McTMA); Prepared Under RTO-62, AATT Operational Concept for ATM – Year 2002 Update, May 2001
4. Titan Systems Corporation, Air Traffic Systems Division; General Description, Multi-Center Traffic Management Advisor (McTMA); Prepared Under RTO-62, AATT Operational Concept for ATM – Year 2002 Update, May 2001
5. National Aeronautics and Space Administration; AATT ATM-SDI CTO-5 Statement of Objectives; p.1; September 2000
6. Federal Aviation Administration, US Department of Transportation; National Airspace System Capital Investment Plan Fiscal Years 2002-2006; pp. 26, B-15 – B-16; April 2001
7. Green, S., Vivona, R.; AATT En route Descent Advisor (EDA) Concept, NASA AATT Milestone 5.10; NASA Ames Research Center; September 1999
8. Titan Systems Corporation, Air Traffic Systems Division; General Description, EDA (En Route Descent Advisor) Prepared Under RTO-62, AATT Operational Concept for ATM – Year 2002 Update, August 2001

1.10 En Route Controller Pilot Data Link Communications (CPDLC)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-13; April 2001

1.10.1 DESCRIPTION

This Application provides a two-way digital exchange of Aeronautical Telecommunication Network compliant air traffic control messages between ground and air. According to Ref. 1, the plan for 2003 is to complete CPDLC Build 1for initial daily use at Miami Air Route Traffic Control Center (ARTCC).

1.10.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-42-43, March 2002
2. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-13; April 2001
3. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2001-2005 Internet Version*; p. A-23; 9 August 2000
4. Federal Aviation Administration, US Department of Transportation; Free Flight Phase 2 WWW Site; http://ffp1.faa.gov/about/about_ffp2.asp
5. Federal Aviation Administration, US Department of Transportation; *FACT SHEET: Controller Pilot Data Link System (CPDLC)*; October 2000
6. Williams, James H.; *En Route Controller Pilot Data Link Communications Status Overview*; January 1999
7. Tron, San; *En Route Controller Pilot Data Link Communications Build 1 Schedule*; January 1999

1.11 Mode Select (Mode-S)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2001-2005 Internet Version*; p. A-31; 9 August 2000

1.11.1 DESCRIPTION

Installation of hardware circuit card assemblies and software to deploy Traffic Information Systems, and Dynamic Reflectors. According to Ref. 1, plans for 2003 involve installation of processor boards and clocks and expansion of TIS coverage.

1.11.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-38, March 2002
2. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2001-2005 Internet Version*; p. A-31; 9 August 2000
3. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-45; April 2001
4. Federal Aviation Administration, US Department of Transportation; William J. Hughes Technical Center; *Mode Select Beacon (Mode S)* (http://www.tc.faa.gov/its/cmd/visitors/data/ACT-300/modes.pdf)

1.12 Flight Service Automation System Operational and Supportability Implementation System

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Aviation System Capital Investment Plan*; pp. Automation-15; January 1999

1.12.1 DESCRIPTION

The Flight Service Automation System (FSAS) provides general aviation pilots with weather briefings and graphics, notices to airmen (NOTAM), and simplified flight plan filing. It cannot be expanded or enhanced to accommodate future functional requirements and has reached the end of its life cycle.

This application replaces the FSAS Model 1 Full Capacity (M1FC) at 61 Automated Flight Service Station (AFSS) facilities with a leased service. The Operational and Supportability Implementation System (OASIS) will consolidate the functionality of the Direct User Access Terminal (DUAT) service with the functionality of M1FC and the interim Graphic Weather Display System (GWDS). OASIS will initially import weather text and graphics products from commercial sources; eventually, it will be modified through pre-planned product improvements to obtain weather graphics from the Weather and Radar Processor. OASIS will be provided as a service from a contractor and includes a reliable, open systems compliant, commercial-off-the-shelf (COTS)/non-developmental item (NDI) hardware and software system configuration. In addition, the OASIS contractor will supply all of the engineering, second- and third-level maintenance, logistics, and training services. Plans for FY 2003 (Ref. 1) call for continuation of OASIS procurement and installation.

1.12.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-69, March 2002
2. Federal Aviation Administration, US Department of Transportation; *Aviation System Capital Investment Plan*; pp. Automation-15; January 1999
3. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2001-2005 Internet Version*; p. A-33; 9 August 2000
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital*

Investment Plan Fiscal Years 2002-2006; p. B-49; April 2001

1.13 Precision Runway Monitor (PRM)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Aviation System Capital Investment Plan*; pp. Surveillance-8 - 9; January 1999

1.13.1 DESCRIPTION

During instrument meteorological conditions (IMC), airports with parallel runways spaced less than 4,300 feet apart cannot conduct independent simultaneous operations due to existing equipment limitations. This results in decreased capacity during inclement weather. Congress mandated that FAA procure and install five precision runway monitor systems (PRM) to address this issue at qualifying airports.

This application resulted in the development of a high-update-rate radar and computer predictive displays that enable controllers to monitor simultaneous independent operations during IFR/IMC to dual and triple parallel runways spaced less than 4,300 feet apart.

The PRM electronically scanned antenna system provides a faster update rate than conventional radars because it uses a computer-controlled electronic scanning sensor beam. The required update rate requirement for parallel runways spaced 3,400 feet apart is 2.4 seconds or less. The five production systems procured under a sole-source contract include a 1.0 second update rate with a capacity of 35 aircraft tracks.

The FAA has awarded a sole-source contract for five limited production electronically scanned units. These systems have a 1.0 second update rate with capacity of 35 aircraft tracks, which will enable airports to maintain capacity, avoid or reduce delays, and save fuel during reduced visibility. The FAA has determined that Minneapolis-St. Paul, St. Louis, JFK, Philadelphia, and Atlanta airports qualify for a PRM system. Installations at Philadelphia and Atlanta airports are contingent on each completing a new runway.

Development and simulation of air traffic control procedures for independent approaches to dual parallel runways spaced 3,000 feet apart have been completed. Results of the real-time simulations showed that PRM will support and benefit these approaches if one of the approaches contains a localizer offset of at least 2.5 degrees.

Future alternatives to the E-Scan PRM system may include automatic dependent surveillance broadcast (ADS-B) or multilateration systems or a combination of both. Analysis and simulations of these alternatives will be performed in their respective projects. No further analysis will be performed under this project. The John F. Kennedy International Airport installation was commissioned in 2002 and the Atlanta construction/installation effort will continue in 2003.

1.13.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-39, March 2002
2. Federal Aviation Administration, US Department of Transportation; *Operational Evolution Plan, Version 4.0,* Master Schedule p. 29, December 2001.
3. Federal Aviation Administration, US Department of Transportation; *Aviation System Capital Investment Plan*; pp. Surveillance-8 - 9; January 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2001-2005 Internet Version*; p. A-7; 9 August 2000
5. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital investment Plan Fiscal Years 2002-2006*; p. B-46; April 2001
6. Federal Aviation Administration, US Department of Transportation, William J. Hughes Technical

Center; *Precision Runway Monitor*; April 1997

1.14 Standard Terminal Automation Replacement System (STARS)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-16; April 2001

1.14.1 DESCRIPTION

This application develops and deploys a new system to replace Automated Radar Tracking System (ARTS). It will provide a digital capable system to meet expanding ATC needs beyond the year 2000. The STARS system will provide new computer workstations with high-resolution color displays and commercially based software to allow the FAA to move toward a uniform configuration at all terminal facilities. FY 2003 plans (Ref. 1) call for continued procurement and deliver of STARS, and development of STARS enhancements.

1.14.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-31, March 2002
2. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-16; April 2001
3. Federal Aviation Administration, US Department of Transportation; *Aviation System Capital Investment Plan*; pp. Automation-8 – 9; January 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2001-2005 Internet Version*; p. A-24; 9 August 2000
5. Federal Aviation Administration, US Department of Transportation; *STARS: Standard Terminal Automation Replacement System*

1.15 Controller Pilot Data Link Communication (CPDLC)

Last Revised: December 2002

Description Source**: Federal Aviation Administration, US Department of Transportation**; *FACT SHEET: Controller Pilot Data Link System (CPDLC)*; October 2000;

1.15.1 DESCRIPTION

CPDLC is a promising technology that could reduce frequency congestion and delays. A joint FAA/Industry Initiative, CPDLC will provide faster, more reliable communication between controller and cockpit. It will enable pilots to choose the most efficient routing while allowing controllers to safely manage the increasing volume.

In July 2000, the FAA elevated the priority of the CPDLC program by including it in the Free Flight Phase 2 program. As an enabling technology, CPDLC is expected to multiply the benefits of the previously implemented free flight tools, resulting in synergistic improvements in the management of congested airspace. Initial Operating Capability is scheduled to begin in Miami in 2002 with expansion to additional en route facilities between 2003 and 2005.

It essentially supplements the party line with a dedicated communications link for routine messages that make up to half of all controller/pilot communications. Multiple data messages can be sent out simultaneously compared to one-at-a-time method with voice-only communications. This not only reduces frequency congestion but will reduce many of the miscommunications between pilots and controllers that are common including:

- Stuck microphones
- Read-back, hear-back mistakes

- Language and dialect differences
- Missed clearances
- Other communications delays and operational errors. Indeed, voice communication errors lead to about 27% of all operational errors.

Tests at FAA's William J. Hughes Technical Center (WJHTC) in 1995 simulating the Atlanta Air Route Traffic Control Center and the Newark area of the New York Terminal Radar Approach Control, using a 90% fleet equipage rate, yielded dramatic decreases in ground and flight delays. In Atlanta, the high altitude en-route departure and arrival sector was a problem. With both voice and data link capability, controllers were able to halve the number of voice messages clogging the frequency. The efficiencies afforded by data link also reduced the time the frequency was used from 55 to 20 minutes out of an hour.

For the departure sector a combination of voice and data link enabled controllers to halve the miles in trail (MIT) separation from 20 miles to minimum in-trail with no loss of safety. Experience with the system ultimately yielded a 10% increase in departures cutting delays from 1,795 minutes to 687 minutes. This test also yielded a reduction of flight time and distance for all aircraft of 20%.

For the arrival sector the combination of voice and data link increased the volume of arrivals between 10% and 40% without having to impose a hold, a safety valve used by controllers when there is too much pressure on the system. FAA estimates a total annual cost savings to airlines of $8.9 million using data link in these two sectors alone.

Background

Studies predicted that early in the this century, increases in flight operations would fuel the demand for air traffic services beyond the capability of the communications systems now in place. Aeronautical Data Link, in general, and Controller-Pilot Data Link Communications in particular, will assist Air Traffic in meeting this increased demand for services.

CPDLC augments voice communications for limited number of air traffic messages and will provide a second communications channel for use by the pilot and controller. It will augment the current voice communications capability, not replace it. While in development, the FAA is studying the impact of CPDLC on both flight and control room procedures as well as human factors issues.

The first two phases of CPDLC implementation, Builds-I and -IA have been approved for implementation. Beginning with Build-I, CPDLC will use the Aeronautical Telecommunication Network (ATN), as defined by the International Civil Aviation Organization. When fully implemented, CPDLC will provide a global, seamless, secure, and error-free communications application for air-ground-based systems.

Benefits

- Shifting routine transmissions from voice to data link would reduce delays
- Reduce the number of miscommunications and operational errors resulting from miscommunications.
- Ease controller workload
- Reduce frequency congestion

Evolution of Data Link

Data link services are in operation at airports across the country and are well accepted by the users. They uplink information to the aircraft using existing communication service providers and require no reply from the flight deck.

Tower Data Link Services (TDLS), such as Digital Automatic Terminal Information System (D-ATIS) and Pre-Departure Clearance (PDC) applications, are implemented at 57 airports where voice frequency congestion is considered a serious problem. These applications uplink information via the Aircraft Communications Addressing and Reporting System (ACARS) and VHF, and have significantly reduced communications traffic on crowded voice frequencies.

Another step in the evolution provides a request-reply functionality initiated by the flight deck. In the case of Flight Information Services (FIS), a ground-based service provider can receive a downlinked request for weather products, compile the requested information, and uplink it to the requesting aircraft for display.

In the mid-1990's, FAA responded to a request by a core group of users and began implementing Oceanic Data Link. These services operate on ACARS using satellites to communicate with aircraft equipped with Future Air Navigation System (FANS)-1 avionics. These avionics include, among other features, a CPDLC message set as well as the Automatic Dependent Surveillance functionality use for flight following beyond radar coverage. FANS-1 CPDLC is now available in both Pacific and Atlantic Oceanic sectors. Considerable data about the operational use of FANS-1 has been collected and studied during the last few years. The lessons learned from the FANS-1 pioneering work are being applied to the implementation of domestic data link services.

Under current plans, national implementation is deferred beyond the Miami Center test site from 2003 to 2005 (Ref. 3).

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1.16 Air/Ground Communications Infrastructure

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2001-2005 Internet Version*; p. A-27; 9 August 2000

1.16.1 DESCRIPTION

Planned improvements to the air/ground communications infrastructure that include replacement of aging and increasingly unreliable equipment, associates site and facility improvements, including the establishment of new facilities intended to broaden communications coverage.

1.16.2 BIBLIOGRAPHY

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1.17 Airport Surface Detection Equipment (ASDE-3)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Aviation System Capital Investment Plan*; p. Surveillance-3; January 1999

1.17.1 DESCRIPTION

This application acquires and installs the ASDE-3 radar system at 34 high-activity airports. ASDE-3 detects and displays aircraft and vehicle movement on the airport surface, allowing controllers to effectively manage airport surface operations during low-visibility conditions, such as rain, fog, and night operations. The ASDE antenna may be located atop the ATCT or remotely on its own tower. Installation on existing Acts may require structural modifications. Current plans include continuation of the ASDE-3 Service Life Extension Program (SLEP) and design of upgraded receiver hardware with an ASDE-X interface (Ref. 1).

1.17.2 BIBLIOGRAPHY

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4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-39; April 2001

1.18 Airport Surface Detection Equipment - Model X (ASDE-X)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2001-2005 Internet Version*; p. A-8; 9 August 2000

1.18.1 DESCRIPTION

Airport Surface Detection Equipment (ASDE-X) provides seamless airport surface surveillance coverage at up to an additional 66 airports not covered by the ASDE-3 and AMASS. ASDE-X installations are planned to continue through 2007 (Ref. 1).

1.18.2 BIBLIOGRAPHY

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1.19 Weather Systems Processor (WSP)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Aviation System Capital Investment Plan*; pp. Weather-10 - 11; January 1999

1.19.1 DESCRIPTION

The Terminal Doppler Weather Radar (TDWR) System or the Integrated Terminal Weather System (ITWS) provides warning of hazardous weather conditions for large airports, but it is not cost-effective to install these systems at low-activity airports. This is a multiyear program to provide warnings of hazardous weather at airports that do not warrant a TDWR. This program was initiated in response to National Transportation Safety Board Recommendation A-90-84. ASR-WSP will be deployed at airports with Airport Surveillance Radars, ASR-9, which do not have a TDWR. The ASR-9 weather channel is modified by adding a modular data processing unit that detects hazardous wind shear and microburst events near airport runways. The unit also detects and predicts the arrival of gust fronts and detects storm cells. The unit and associated algorithms have been implemented on a production radar and demonstrated during tests conducted at Kansas City, Mo.; Orlando, Fla.; and Albuquerque, N. Mex.

Current plans call for deployment and commissioning of all 37 systems in the 2002-2003 time frame. WSP SLEP will be addressed in out years as part of the ASR-9 SLEP.

1.19.2 BIBLIOGRAPHY

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1.20 Airport Surveillance Radar (ASR11)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Aviation System Capital Investment Plan*; pp. Surveillance-5 – 6; January 1999

1.20.1 DESCRIPTION

The FAA plans radar surveillance systems in the terminal area to provide separation services. The older terminal radar systems do not meet air traffic requirements for coverage and capacity. Also, they are logistically unsupportable and are incompatible with the new terminal automation system, which requires digital surveillance inputs.

After completing the ASR-9 project, many terminal areas still have aging analog ASR-7/-8 radars and inadequate weather detection capabilities. The ASR-7/-8 radars also will not provide digitized radar data suitable for use with the standard terminal automated radar system (STARS) equipment.

The ASR-11 Terminal Radar Program will replace ASR-7's and ASR-8's. The ASR-11 is a non developmental digital terminal radar system with an integrated monopulse secondary surveillance radar system. It will be acquired through a joint acquisition with DOD. The system will provide digitized radar data and weather data. The program will also pro-vide, on an as-needed basis, interim digitizers to ASR-8 sites, which will receive STARS in advance of the ASR-11. Current plans call for continuing delivery and commissioning of ASR-11 systems through 2007 (Ref. 1).

1.20.2 BIBLIOGRAPHY

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1.21 Alaskan NAS Interfacility Communications System (ANICS)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Aviation System Capital Investment Plan*; pp. Communications-12 – 13; January 1999

1.21.1 DESCRIPTION

The FAA plans reliable telecommunications circuits for interfacility communications in Alaska. These circuits must support critical air traffic control services as well as remote maintenance monitoring and other routine operational communications. Unlike in the lower 48 states, the commercial telecommunications infrastructure is insufficient to satisfy FAA requirements.

This application supports the FAA strategy for cost-effective interfacility communication transmission and fulfills the requirements of FAA Order 6000.36, Communications Diversity. It provides redundant alternative routes, and avoids single points of failure through circuit diversity to meet NAS service availability and message-quality requirements in the expanding air traffic control environment. The system parallels the radio communications link system and the leased NAS interfacility communications system functions that were not implemented in Alaska due to geographical considerations.

Commercial-off-the-shelf satellite earth stations and associated equipment are being used to establish a voice and data network in Alaska to meet NAS telecommunications requirements. A network monitoring and control system enables rerouting circuits and monitoring circuit quality. The network control center is located in the Anchorage ARTCC.

The Alaskan network will be established in three phases: Phase 1 established satellite earth stations at 51 critical facilities needed to support the instrument flight rules portion of the Alaska air traffic control system. Phase 1 also set up the network control center in the Anchorage center to support NAS facility monitor and control functions. Phase 2 introduces additional earth stations into the network to support essential NAS services, such as weather dissemination, flight planning, etc. Phase 3 implements non-FAA circuit station requirements from other eligible Government agencies (Department of Defense and National Weather Service NAS support requirements). These circuits or facilities will be funded by the requesting agency.

Begun in July 1993, the equipment procurement is for a 10-year period. System maintenance and operations were transferred to the FAA in July 1997. Current plans call for purchase, engineering, and installation of Phase 2-only ANICS sites through 2007.

1.21.2 BIBLIOGRAPHY

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1.22 Automated Surface Observing System (ASOS) Network (ASWON)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-48 – B-49; April 2001

1.22.1 DESCRIPTION

The purpose of ASWON is to support FAA and National Weather Service (NWS) modernization by automating the surface weather observations for pilots, operators, and air traffic personnel. ASWON includes the AWOS, ASOS, Automated Weather Sensors Systems (AWSS), Stand Alone Weather Sensors (SAWS), and ASOS Controller Equipment Information Display System. Current plans call for continuation of the program through 2007 (Ref. 1).

1.22.2 BIBLIOGRAPHY

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1.23 Automatic Dependent Surveillance Broadcast (ADS-B) – Advanced Technology Development and Prototyping

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Aviation System Capital Investment Plan*; pp. Surveillance-11 – 12; January 1999; **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-17, March 2002

1.23.1 DESCRIPTION

ADS-B is a technique for reporting aircraft position information from an onboard global navigation satellite system (GNSS) receiver or other backup source of navigation data. Aircraft identity, altitude, velocity, and position are broadcast directly to ground receivers and to nearby aircraft. Transmitted ADS-B messages received by nearby aircraft are processed, displayed on an airborne cockpit display of traffic information (CDTI), and used for situational awareness, conflict detection, and Free Flight capabilities. Accurate and timely reports from ADS-B minimize runway incursions and improve safety by increasing pilot situational awareness of nearby aircraft and improve efficiency and airspace capacity by potentially reducing current separation standards. ADS-B's modular design and cooperative nature offer a low-cost alternative for surveillance coverage in existing non radar areas and potentially, in the long term, in some areas currently served by radars. ADS-B has been identified by both the FAA and the aviation industry as an enabling technology for Free Flight.

The current advanced technology and prototype development effort for ADS-B is focused on development of domestic (RTCA) and International Civil Aviation Organization (ICAO) ADS-B performance standards. Development of ADS-B Minimum Operational Performance Standards (MOPS) and Minimum Aviation System Performance Standards (MASPS), and revision of baselined standards, will continue through 2007. Development of Standards and Recommended Practices (SARPS), and standards for additional ADS-B applications, will continue in the 2004-2007 time frame.

1.23.2 BIBLIOGRAPHY

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1.24 Integrated Terminal Weather System (ITWS)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Aviation System Capital Investment Plan*; pp. Weather-9 – 10; January 1999; **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. 17, p.B-9-10, March 2002

1.24.1 DESCRIPTION

Weather is responsible for 65 percent of all delays and causes 40 percent of accidents. Air traffic personnel in tower cabs and TRACON facilities rely on several terminal area weather sensors to provide weather data. Data interpretation is performed manually and is labor intensive, and data from the various sensors may be conflicting.

The main shortcoming of the present system is the lack of a weather processor that integrates these data and provides predictions of short-term weather changes, such as wind shear, microbursts, thunderstorms, ceiling, and visibility that affect safety, capacity, and efficiency in the terminal area. Consequently, air traffic management cannot make the most efficient use of terminal airspace resources.

ITWS provides terminal aviation weather data and integrated products from other sensors, including TDWR, NEXRAD, LLWAS, and ASOS. ITWS will cover 47 high-activity airports that have significant convective weather. A new technology to be evaluated in 2002 as part of the ITWS program is the Corridor Integrated Weather System (CIWS), with sustainment of the prototype planned through 2003. CIWS uses short-term weather forecasts, linking together information from ITWS, to form a more regional weather picture of changing weather conditions in the corridor of heaviest traffic between Chicago and the Atlantic coast.

1.24.2 BIBLIOGRAPHY

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1.25 Critical Telecommunications Support (CTS)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Aviation System Capital Investment Plan*; pp. Communications-10 – 11; January 1999

1.25.1 DESCRIPTION

NAS interfacility telecommunications network configurations that connect surveillance, weather, and communication sites installed by F&E programs—such as airport traffic control tower/terminal radar approach control (ATCT/TRACON), airport surveillance radar (ASR), air route surveillance radar (ARSR), and radio communication air/ground (RCAG)—undergo continual change.

Ongoing telecommunication network reconfigurations, capacity upgrades, and enhancements to improve reliability and capability are necessary to accommodate new or modified air traffic interface and location requirements to sustain/improve network performance, and to control operating costs. This creates additional local termination and interfacility connectivity requirements. Examples are: relocating or installing new circuits to establish connectivity to new sites or satisfy new sector boundaries, installing new circuits for connectivity diversity, replacing circuits destroyed by natural disaster, and expanding equipment and circuit capabilities to prevent traffic overloading from service growth.

The FAA plans a flexible method to support these regional operational telecommunication changes within the NAS, as requirements can be unanticipated. The application provides local telecommunication planning, engineering, acquisition, installation, site preparation, testing, and verification for four discrete project activities. Regional offices identify requirements by project type for CTS during annual planning activities to support future installations and other planned events. These requirements are evaluated and prioritized at the national level. Funds to support the highest priority projects are transferred to national contracts or to regions for local procurement of project telecommunication hardware, software, and services.

Today' s leased circuits are carried on extremely high-density trunks, some with a capacity in excess of 20,000 circuits. Documented (through monthly performance reports such as the LINCS CDRL F08) availability for circuits that connect such major facilities as ARTCCs, Level 4 and 5 Acts, and consolidated TRACONs use circuits exceeding 0.99999. These circuits are not the focus of the program. All circuits that do not ride this “backbone” and connect remote communication, navigation, and weather systems to major facilities through a single transmission path are documented to have availability that runs in the 0.997 to 0.988 range. This translates into outages, as there is no alternate path to which to switch services when the circuit fails.

This is the primary focus of the CTS application. Trunk failure can prevent voice and radar data transmission, producing coverage gaps, decreasing safety, and in-creasing delays and maintenance costs. To minimize outages, a second interfacility connection or “diverse path” and A/B switch technology is installed. The CTS program provides leased microwave and terrestrial solutions to add redundancy and increase availability.

This application provides the FAA with the ability to transition telecommunication systems and equipment at existing facilities to support new air traffic sector boundaries, increased bandwidth demands between facilities, facility relocations, and the introduction of new navigation, weather, and communication services/facilities onto existing networks. Activities include circuit consolidations to reduce operating costs and improve performance, relocation of circuits, circuit removal, and expansions.

Current plans call for improvements at over 5,000 facilities in the NAS. Year 2002-2003 plans call for continued installation of new operational circuits for ATS mission support; upgrade of telecommunications interfaces; relocation and addition of operational telecommunications services as required; and emergency activities.

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1.26 Gulf of Mexico Offshore Program

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-55, March 2002

1.26.1 DESCRIPTION

Line-of-sight limitations prevent land-based radios from providing direct air/ground very high frequency (VHF) radio communications coverage in the Gulf of Mexico flight information region (FIR). As a result, separation standards cannot be reduced and increasing traffic demand cannot be met.

To address these limitations, two systems are being deployed in the Gulf of Mexico; the buoy communications system (BCS) and the VHF extended range network (VERN). These systems are directed at expanding direct pilot-controller VHF radio communications. The two systems are planned to provide enhanced communications in the en route portion of the Gulf of Mexico above 18,000 ft, addressing current shortfalls as well as addressing future anticipated traffic growth in the Gulf of Mexico. Current plans call for full operating capability in 2003.

1.26.2 BIBLIOGRAPHY

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1.27 Local Area Augmentation System (LAAS)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Aviation System Capital Investment Plan*; pp. Navigation and Landing-10 – 13; January 1999

1.27.1 DESCRIPTION

The GPS provides a practical starting point for eventual development of a seamless global navigation satellite system. However, GPS, as designed, developed, and deployed by the Department of Defense (DoD), will not satisfy all civil aviation requirements for navigation and landing. For use in civil aviation, augmentations will be required to:

- Improve GPS accuracy for precision approaches
- Provide integrity and continuity for all phases of flight
- Provide the necessary availability to meet radio navigation requirements

The first step in this augmentation is the Wide Area Augmentation System (WAAS), designed to provide a navigation and landing capability down to or near the lowest Category I decision height of 200 feet, depending on obstacle clearance and runway lighting.

The second step is the Local Area Augmentation System (LAAS), being designed to fulfill navigation and landing requirements for Category I at locations where WAAS cannot, and to meet the more stringent Category II/III requirements.

This application is being developed to fulfill navigation and landing requirements (such as availability) at locations where WAAS is unable to provide Category I precision approach, and to provide Category II/III precision approach requirements. LAAS is also expected to enable users to safely taxi aircraft in low-visibility situations. A Government and Industry Partnership (GIP) has been established to develop LAAS for navigation and precision approach of aircraft. This partnership provides in-kind services for developing a certified Category I LAAS. The partnership is a three-stage effort:

- Standards Development

- Full-Scale Development (FSD) for Category I
- FSD for Category III

Program plans call for contract award for CAT 1 LAAS in 2002 and initiation of LAAS procurement in 2003 (Ref. 1). LAAS CAT 1 specifications and MOPS are completed (Ref. 2). LAAS CAT II/III specification and SARPS development will continue in 2003.

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1.28 Low Level Wind Shear Alert System (LLWAS)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Aviation System Capital Investment Plan*; pp. Weather-7 – 8; January 1999

1.28.1 DESCRIPTION

LLWAS provides real-time detection algorithms and notification of hazardous weather events (microbursts and wind shear) in the terminal area at 110 airports. The system's sensors are most effective in open spaces because obstacles like trees and buildings degrade sensor accuracy, which results in false readings. LLWAS sensors at many airports need to be relocated in order to provide accurate wind shear information. Also, the system's hardware and software are obsolete and extremely difficult to support.

This application consists of three distinct efforts:

- Expanding the LLWAS network at nine airports will upgrade systems by improving detection algorithms and modifying microburst and wind shear alert displays.
- Weather information will be presented in a runway-oriented format and the number of weather sensors increased.
- This network expansion also provides interfaces to Terminal Doppler Weather Radar (TDWR) and remote maintenance monitoring equipment.

This application will sustain sensors at 39 sites, replacing aging electronics, reducing support costs, and extending the service life by 15 years. The effort will also incorporate remote maintenance monitoring equipment.

This application will relocate weather sensors at selected airports to restore LLWAS detection effectiveness. The effort provides a national contract to acquire sensor poles and provides funding and technical support for regional implementation.

Year 2003 plans call for delivery of the remaining 25 LLWAS systems (Ref. 1).

1.28.2 BIBLIOGRAPHY

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1.29 NAS Information Security – Information System Security (ISS)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. 17, p. B-9-10, March 2002

1.29.1 DESCRIPTION

The mission of Information System Security (ISS) is to protect the NAS information infrastructure and to help the aviation industry reduce security risks through leadership in innovative information assurance initiatives. The increasing number of network-based attacks, the reliance on the Internet, and the vulnerability of cyber terrorists exploiting information system require substantial investment over several years to certify and authorize the more than 100 systems in the response to Presidential Decision Directive 63 and the more than 600 agency mission support systems. In addition to national security, disruption of the modernized NAS would pose significant threats to safety, and could have considerable impact on the national economy. The FAA must address issues associated with ISS to ensure that its computer and communication systems will continue to support the FAA mission.

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1.30 Next Generation Air/Ground (A/G) Communications System (NEXCOM)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Aviation System Capital Investment Plan*; pp. Communications-18 – 19; January 1999

1.30.1 DESCRIPTION

The FAA requires air/ground radio communications for air traffic control. Very high frequency (VHF) and ultra high frequency (UHF) air/ground radio communication links support all phases of flight.

NOTE: Military aircraft use only UHF frequencies for tactical communications.

The current voice system lacks the channel capacity for near-term air traffic control voice communication demands. Three major problem areas are:

- Accommodating the increasing numbers of channels associated with new sectors and services within the limited radio spectrum bandwidth

- Accommodating the need for integrated data link communications capability to all classes of users (including general aviation)
- Addressing air/ground radio frequency interference and communications security to identify unauthorized users

Domestic passenger enplanements are forecast to grow by about 4 percent per year through 2002 and beyond. Left unchanged, the existing air/ground radio communications system will approach its limits to support this growth in air traffic capacity by 2005; sooner in certain high-traffic density areas like metropolitan Atlanta, New York, Chicago, and Los Angeles.

The air/ground communications system capacity must be expanded to support any additional sectors (channels) and services. Deficiencies in the existing communications system include:

- Lack of available channels for voice services
- Lack of support for data link
- Degraded ability to improve NAS safety and efficiency
- Increasing radio frequency interference
- Outdated equipment and infrastructure
- Maintainability and supportability problems with existing radio equipment
- Security problems with unauthorized (phantom controllers) users

The NEXCOM program will design, implement, and install a new air/ground communications system to address current system deficiencies.

NEXCOM capabilities will:

- Meet future air traffic system requirements
- Be based on ICAO VHF digital link standards
- Be backward compatible with the current analog radio system, both air and ground
- Include capabilities to minimize circuit blockage, increase security, reduce circuit congestion, and provide automatic circuit management
- Permit rapid failure detection and recovery
- Meet air/ground service availability requirements
- Provide compatible interfaces with voice switches and aeronautical telecommunications network elements at control facilities

The application will be completed in three phases or segments. Currently, only the first segment has been approved by the Joint Resources Council (JRC).

Segment 1 will increase voice channel capacity in the VHF spectrum by providing new multimode, analog, and digital voice radio system equipment.

At first, these radios will be operated in the analog mode, as they are today. As user equipage increases, ground equipment will be switched to the digital voice mode. Switching to digital communications allows some frequencies to be recovered and reused in problem terminal areas.

Segment 2 will introduce an integrated data link capability into these same facilities, following deployment of the ground network infrastructure.

Segment 3 (and beyond) will deploy multimode radios in low en route and selected high-density terminal airspace (57 TDLS airports and associated TRACONS) and transition to integrated digital voice and data link in these areas:

- Procure equipment that supports (sustains) the current system and adds the very high frequency digital link-3 (VDL 3) system
- Replace, following completion of the communications facilities expansion (CFE) initial deployment, most of the existing air/ground communications systems, such as radio control equipment (RCE), backup emergency communications (BUEC), and UHF analog radios. NOTE: Communications facility improvements will require a continuing separately funded line item.

The resulting single-digital radio type will be a flexible communications system offering users voice and data capability to match their needs during the transition period and beyond. During the transition, the analog system and the digital system will operate side by side. Spectrum relief will begin with decommissioning of analog channels and their reassignment to the new digital radio system.

Plans for 2002 include completion of analogue voice Initial Operating Capability (IOC); award of system prototype contract; establishment of government/industry partnerships for avionics development; and conduct of IOT&E. Plans for 2003 include mid-service decision and first commissioning of analogue voice.

1.30.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-45-6, March 2002
2. Federal Aviation Administration, US Department of Transportation; *Aviation System Capital Investment Plan*; pp. Communications-18 – 19; January 1999
3. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2001-2005 Internet Version*; p. A-21 - 22; 9 August 2000
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-11; April 2001
5. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; p. 2-206; April 2001

1.31 Next Generation Weather Radar (NEXRAD)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Aviation System Capital Investment Plan*; pp. Weather-4 – 5; January 1999

1.31.1 DESCRIPTION

The Departments of Commerce, Transportation, and Defense provide a national network of next-generation weather radars (NEXRAD) that detect, process, distribute, and display hazardous and routine weather information. The FAA's contributions under this program are the cost share funding of the entire system and acquisition and installation of 12 NEXRAD radars in Alaska, Hawaii, and Puerto Rico. These remote locations required modifications, such as power-conditioning systems, lightning grounding, bonding, shielding, and remote maintenance monitoring modules unique to the FAA.

A triagency operational support facility (OSF) has been established in Norman, Okla., and is responsible for system modifications, enhancements, and product improvements to the network. OSF also provides such services as software maintenance, problem resolution, and configuration management.

OSF has implemented new software algorithms to alleviate anomalous propagation problems. Efforts are also underway to enhance algorithms that will improve the detection capability of aviation weather hazards and will be installed in future NEXRAD Builds. These enhancements will improve the effectiveness of NEXRAD data for aviation users and extend the data's useful life.

Also planned are sequential upgrades to the NEXRAD radar product generator (RPG) processor and the radar data acquisition (RDA) unit. This upgrade will consist of reconfiguring the RPG and RDA to a state-of-the-art, open-system architecture. The upgrade will replace the existing computer system to increase processing capacity and improve logistics supportability.

Current year 2003 plans call for award of production contracts to supply 40 airports with medium intensity airport weather systems (MIAWS) (Ref. 1).

1.31.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-6, March 2002
2. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.1-7-9, February 2002
3. Federal Aviation Administration, US Department of Transportation; *Aviation System Capital Investment Plan*; pp. Weather-4 – 5; January 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2001-2005 Internet Version*; p. A-5; 9 August 2000
5. Federal Aviation Administration, US Department of Transportation; *National Airspace Capital Investment Plan Fiscal Years 2002 - 2006*; p. B-30; April 2001

1.32 Runway Visual Range (RVR)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Aviation System Capital Investment Plan*; pp. Navigation and Landing-8 – 9; January 1999

1.32.1 DESCRIPTION

RVR equipment provides a standardized, accurate means of measuring runway visibility during instrument meteorological conditions. Earlier RVR systems do not support Category IIIb instrument approach procedures, which limits capacity at many airports. Additionally, blowing rain or snow may degrade the performance of earlier systems. This application procures new-generation RVR systems that will support all precision instrument approaches (Category I/II/IIIa/b), are not affected by adverse weather, and incorporate remote maintenance monitoring. The new Rivers are mounted on frangible structures that improve safety by mitigating aircraft damage from accidental impacts. Year 2002 plans call for deployment of 6 RVR systems and year 2003 plans call for procurement and installation of approximately 19 systems (Ref. 1)

1.32.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-6, March 2002
2. Federal Aviation Administration, US Department of Transportation; *Operational Evolution Plan, Version 4.0,* Master Schedule p.13, 25, December 2001.
3. Federal Aviation Administration, US Department of Transportation; *Aviation System Capital Investment Plan*; pp. Navigation and Landing-8 – 9; January 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2001-2005 Internet Version*; p. A-9; 9 August 2000

5. Federal Aviation Administration, US Department of Transportation; *National Airspace Capital Investment Plan Fiscal Years 2002 - 2006*; p. B-53; April 2001

1.33 Terminal Applied Engineering

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace Capital Investment Plan Fiscal Years 2002 - 2006*; p. B-45; April 2001

1.33.1 DESCRIPTION

This application provides up front planning and will determine how best to integrate the modernization of 40 ATC systems at over 400 terminal facilities into the NAS by the year 2007.

1.33.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-38-9, March 2002
2. Federal Aviation Administration, US Department of Transportation; *National Airspace Capital Investment Plan Fiscal Years 2002 - 2006*; p. B-45; April 2001

1.34 Tower Data Link Services (TDLS)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace Capital Investment Plan Fiscal Years 2002 - 2006*; p. B-14; April 2001

1.34.1 DESCRIPTION

Tower Data link Services (TDLS) provides data link capabilities and associated benefits to 58 high density airport traffic control towers (ATCTs).

1.34.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-41, March 2002
2. Federal Aviation Administration, US Department of Transportation; *National Airspace Capital Investment Plan Fiscal Years 2002 - 2006*; p. B-14; April 2001
3. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2001-2005 Internet Version*; p. A-23; 9 August 2000

1.35 Weather and Radar Processor (WARP)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Aviation System Capital Investment Plan*; pp. Weather-6 – 7; January 1999

1.35.1 DESCRIPTION

Air traffic controllers in the en route environment currently obtain weather radar information from the long-range surveillance radars, which are not well suited for this purpose. Next generation weather radars (NEXRAD) will replace long-range surveillance radars as the source of weather data.

Currently, NEXRAD weather data cannot be displayed on existing en route controllers' consoles due to digital-to-analog compatibility problems. Also, Center Weather Service Unit (CWSU) meteorologists do not have an integrated system for collecting and displaying multiple weather inputs. Human interpretation is required, which can be time consuming and inefficient.

WARP is a state-of-the-art automated system that collects, processes, and disseminates NEXRAD data and other weather data to controllers, traffic management specialists, area supervisors, meteorologists, and other users. The system provides mosaics of multiple NEXRAD images to the controller's display system replacement (DSR) workstation for display with aircraft targets. This will enable air traffic controllers to optimize flight routing and reduce en route air traffic delays. WARP will also provide Center Weather Service Unit (CWSU) meteorologists with automated workstations, which will greatly enhance their ability to analyze rapidly changing, potentially hazardous weather conditions.

Development and deployment will occur in three stages. The initial stage, Stage 0, leases commercial hardware/software components to replace the Meteorological Weather Processor. Stage 1/2 will be an FAA-owned system that will be upgraded to receive and process NEXRAD data, and distribute it to controller consoles via DSR. Stage 3 implements upgraded National Weather Service (NWS) gridded model data algorithms, enabling WARP to "ingest" higher resolutions, and develops additional NAS interfaces for cost-effective weather data sharing. This facilitates a common situational awareness within the en route environment. Stage 3 also leverages the FAA's investment in aviation weather research to develop those upgraded algorithms, providing enhanced weather displays to controllers via DSR and to CWSU meteorologists.

Current plans call for continuation of Stage 3 activities (Ref. 1)

1.35.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-46-47, March 2002
2. Federal Aviation Administration, US Department of Transportation; *Aviation System Capital Investment Plan*; pp. Weather-6 – 7; January 1999
3. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2001-2005 Internet Version*; p. A-6; 9 August 2000
4. Federal Aviation Administration, US Department of Transportation; *National Airspace Capital Investment Plan Fiscal Years 2002 - 2006*; p. B-31; April 2001

1.36 En Route Automation Program - En Route Automation Modernization (ERAM)

Last revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* March 2002

1.36.1 DESCRIPTION

This application will improve system efficiency in all ARTCCs through the use of a more modern, open, and supportable en route automation environment that has the capability to readily adapt to evolving requirements and meet the long-term requirements for availability, capacity, and efficiency. The goal for FY 2003 is to award the ERAM solution contract.

1.36.2 BIBLIOGRPAHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* March 2002

1.37 Wide Area Augmentation System (WAAS)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Aviation System Capital Investment Plan*; pp. Navigation and Landing-10 – 13; January 1999

1.37.1 DESCRIPTION

The GPS provides a practical starting point for eventual development of a seamless global navigation satellite system. However, GPS, as designed, developed, and deployed by the DoD, will not satisfy all civil aviation requirements for navigation and landing. For use in civil aviation, augmentations will be required to:

- Improve GPS accuracy for precision approaches
- Provide integrity and continuity for all phases of flight
- Provide the necessary availability to meet radio navigation requirements

The first step in this augmentation is the WAAS, designed to provide a navigation and landing capability down to or near the lowest Category I decision height of 200 feet, depending on obstacle clearance and runway lighting.

The second step is the Local Area Augmentation System (LAAS), being designed to fulfill navigation and landing requirements for Category I at locations where WAAS cannot, and to meet the more stringent Category II/III requirements.

This application will provide the augmentation needed to make GPS fully usable for en route, terminal, nonprecision, and Category I precision approaches. WAAS will provide the required accuracy, availability, continuity, and operational integrity augmentations to GPS.

WAAS consists of a network of precisely located monitors over North America that determines the integrity and accuracy of each visible GPS satellite. Augmentation equipment will generate error correction data and broadcast a signal integrity and position correction message to users via geostationary communications satellites. Broadcasts from the geostationary satellites are on the same frequency as GPS and are suitable for ranging.

The WAAS project also supports development of standards, certification, facilities, and procedures for operational use of WAAS in the NAS. This includes requirements such as GPS procedures for use by air traffic, unique approach procedures for each location, obstacle clearance requirements, aircraft separation standards, airport surveys, support for training programs for civil pilots, and the revision of FAA regulations and documents to reflect satellite navigation use.

To facilitate implementing preplanned product improvements (P^3I) and technology enhancements, a phased approach to system development is being used. Phase 1 will deliver an initial operational capability. Delivery of additional capability is contingent on two factors: (1) results of an independent risk assessment, and (2) results of an ongoing alternatives analysis.

Currently, WAAS IOC for LNAV/VNAV is planned for 2003/2004 (Ref. 1)

1.37.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-48-9, March 2002
2. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.1-17-21, February 2002
3. Federal Aviation Administration, US Department of Transportation; *Operational Evolution Plan, Version 4.0,* Master Schedule p.29, December 2001.
4. Federal Aviation Administration, US Department of Transportation; *Aviation System Capital Investment Plan*; pp. Navigation and Landing-10 – 13; January 1999
5. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2001-2005 Internet Version*; p. A-4; 9 August 2000
6. Federal Aviation Administration, US Department of Transportation; *National Airspace Capital Investment Plan Fiscal Years 2002 - 2006*; p. B-18; April 2001
7. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan*; pp. 2-36 – 2-41; April 2001

1.38 Airports Technology – Safety (Infrared Deicing)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Aviation Research Plan, Internet Version*; pp. 2-73 to 2-77; April 2001

1.38.1 DESCRIPTION

The Airport Technology program began operations of an aircraft deicing facility using infrared energy at a major hub airport. The program will publish specifications for aircraft infrared de-icing system.

1.38.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.1-77-80, February 2002
2. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-73 to 2-77; April 2001
3. Federal Aviation Administration, US Department of Transportation; *FAA R&D Overview: Aircraft Deicing Technology*; September 1999

1.39 Aviation Safety Risk Analysis

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Aviation Research Plan,* p. 2.1-70-76, February 2002

1.39.1 DESCRIPTION

The Aviation Safety Risk Analysis (ASRA) Program focuses primarily on:

- Design/Development and/or enhancement of risk management/decision support tools embedded in FAA analytical systems, e.g., flight standards service Safety Performance Analysis System (SPAS), and the aircraft certification service safety management program products. These tools encompass particulars about air carriers, aircraft design, aircraft maintenance, discrepancy reports, repair stations (both domestic and foreign) aviation training schools, and air personnel.
- Development of advanced risk assessment indicators/safety performance measures and analytical methods. These methods allow the FAA to more effectively and efficiently use information contained in various FAA and industry databases.
- Development of hazard/risk identification and prioritization methodologies.
- Establishment of a forum with industry to exchange aviation risk assessment/risk management and safety performance measures models and methodologies.
- Development of an improved safety analysis methodology that will be used to certify new products by including human factors and operational issues.
- Development of a risk-based process to improve aircraft certification oversight activities and promote synergy with policy development.
- Development and/or enhancement of the Maintenance Malfunction Information Reporting (MMIR) System with capabilities to track critical helicopter parts, to capture part utilization/performance data, and to perform trend analysis on the captured data.
- Development of guidelines for using on-board Built- in Test Equipment (BITE) as approval to return aircraft to service after maintenance.

- Development, with input from the industry, of new procedures, recommendations, tools and techniques to optimize air carrier and general aviation operations at our nation's airports.

Year 2002 activities include the following:

Risk Management Decision Support

- Continued development of systems engineering models of FAA-certificated entities (or FAR parts) within the air transportation system.
- Continued development of risk/hazard/accident models and tools derived from FAA- and industry-accepted FAR system safety oversight models.
- Continued the design of next generation safety critical performance measures and risk indicators based on system engineering and system safety models. These tasks were accomplished in conjunction with industry.
- Began to integrate system models with performance and risk indicators for use by the FAA and industry.
- Continued development of new and enhanced risk analysis models and capabilities.
- Continued the development and incorporation of safety critical performance measures and repair station module into flight standards (SPAS).
- Continued a decision support system requirements study.
- Continued workshops with industry to discuss aviation risk analysis and safety performance measurement methodologies and tools.
- Completed the development of the Aviation Safety Risk Management System.
- Initiated System Approach for Safety Oversight (SASO) information requirements study and analysis.
- Initiated the development of methodological and operations research studies to determine the target level of safety for relevant safety parameters for air carrier operations.

Aircraft Maintenance – Maintainability and Reliability

- Continued the development of a web-based information system prototype that facilitates the collection/ dissemination of aircraft maintenance related data.
- Completed the development of guidance and course material recommendations for one-time or recurrent training on the capability/usage of aircraft on-board BITE and the use/misuse of BITE in aircraft maintenance.
- Continued the development of the Safety Through Accurate Technical Statistics (STATS) software module and integrated it into the web-based Maintenance Malfunction Information Reporting (MMIR) system to track actual flight hours/flight profiles of helicopters.
- Completed a generic model for the continuing analysis and surveillance of the performance and effectiveness of a carrier's inspection program covering the carrier's maintenance, preventive maintenance, and alterations.

Safety Analysis Methodology

- Continued the analysis of airworthiness information to identify unsafe conditions and assess their relative impact on continued airworthiness.
- Continued to establish the standard probability of values of encountering the subject

conditions as ad-dressed in Appendix 4 of Advisory Circular 25.1309-1B.

- Initiated the development of a methodology for evaluating flight crew interface design features relevant to pilot response to failure conditions.
- Completed a review of FAA-maintained certification and continued airworthiness data and began development of methods for the sorting and evaluating of certification and continuous airworthiness data to identify technical problems posing a fleet-wide safety risk.

1.39.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.1-70-76, February 2002
2. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-113 to 2-117; April 2001

1.40 System Applications

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Aviation Research Plan, Internet Version*; pp. 2-203 to 2-206; April 2001

1.40.1 DESCRIPTION

Safety, Separation Standards, and Operational Capability

- Define relationships among safety, separation standards, and operational capability to enhance safety management

ATM and ATC Concepts

- Research new air traffic management and control operating concepts evaluation and/or infrastructure replacements

Free Flight Concepts and Capabilities

- Define and develop requirements for advanced free flight concepts and capabilities that will be needed beyond Free Flight Phase

Enhanced Information Systems

- Continue investigating procedures, user needs, system requirements, and architecture implications for enhanced information systems

1.40.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.4-13, February 2002
2. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-203 to 2-206; April 2001
3. Federal Aviation Administration, US Department of Transportation; *National Airspace Capital Investment Plan Fiscal Years 2002 - 2006*; p. B-11; April 2001

1.41 Environmental Research: Environment and Energy

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Aviation Research Plan,* p. 2.3 –1-7, February 2002

1.41.1 DESCRIPTION

The applications supported by this program, and their activities, are the following:

Aircraft Noise Control

- Harmonized FAA/European Noise Certification Regulations
- Report to Congress on FAA/NASA Subsonic Jet Noise Reduction Research
- Final Assessment of FAA/NASA Light Propeller-Driven Airplane Noise Reduction Technology Research
- Publish Advisory Circular (AC) 36-4d
- New Noise Standard for Large Subsonic Airplanes
- Complete Rulemaking to Amend Helicopter Certification Requirements in 14 CFR Part 36

Engine Exhaust Emissions Control

- Updated the FAA Engine Exhaust Emissions Databank to be Consistent with the ICAO Data Base
- Assessment of ICAO Emission Standards Taking into Account the Required Technological and Scientific Bases
- Develop a Harmonized, Simplified Engine Exhaust Emissions Certification Test Procedure
- Complete Development of Advisory Circular 34-1A, Including Harmonization of Regulatory and Guidance Material Differences with the European Joint Aviation Authorities
- Update Certification Regulation and Guidance Document, AC 34-1, for Consideration of Climb/Cruise Conditions

Aviation Noise Analysis

- Released Integrated Noise Model (INM) Version 6
- Completed the First Phase of the Validation of the Grand Canyon National Park Aircraft Overflight Noise Model
- Validation of the Methodologies Used to Assess Aircraft Noise Exposure and Impact
- Release INM Version 7
- Enhanced Aircraft Noise Modeling for Airspace Management Analysis
- New Helicopter Modeling Methodology and Expanded Helicopter Database

Aviation Emissions Analysis

- Develop Air Quality Assessment Methodologies
    - New Emissions and Dispersion Modeling System
    - Publish Revised Handbook on Procedures for Airport Air Quality Analyses
    - Draft Guidance Document for Reducing Emissions from Ground Support Equipment and Auxiliary Power Units
- Develop Global Emissions Assessment Methodologies
    - Complete Prototype Model System for Assessing Aviation's Global Emissions
    - Forecast of National and Global Emissions Burden

1.41.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,*

p. 2.3 –1-7, February 2002
2. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-178 to 2-182; April 2001

1.42 Flight Safety/Atmospheric Hazards Research

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Aviation Research Plan,* p. 2.1-53-58, February 2002

1.42.1 DESCRIPTION

This program focuses on three areas: aircraft icing, software and digital systems safety, and electromagnetic hazards to aircraft systems.

Aircraft Icing

- 2002: Continued consolidating and assessing atmospheric icing data aloft. Evaluated time effectiveness and aerodynamic performance of environmentally friendly and other modern fluids. Completed study of airfoil sensitivity to location, size, and shape of geometric representations of ice shapes. Published report on recycled glycol technologies/utilization. Recommended practices for icing simulation tools. Published interim report on procedures and methods for laboratory determination of fluid holdover times.
- 2003: Evaluate time effectiveness and aerodynamic performance of environmentally friendly and other modern fluids. Report on global atmospheric icing environment. Report on acquisition of atmospheric icing data from operational aircraft. New initiatives include assessing risk of airplane takeoff operations with inadvertent ice accumulation between deicing/anti-icing and takeoff, and studying icing simulation improvement for SLD conditions.

Software and Digital Systems Safety

- 2002: Completed study and published a report on acceptance criteria/guidelines for verification issues in Object Oriented Technology (OOT). Completed study and published a report on COTS operating systems software and protection schemes. Completed work in the complex electronic hardware case study and published report. Completed study and published report on Advanced Flight Control Systems.
- 2003: Complete investigation of Phase 1 of protection architectures as a protection methodology for safety of COTS software in airborne systems. Complete phase 1 for a study of OOT for issues other than verification. Report on Research of Software Development Tools. New initiatives include researching the partitioning and projection of the Avionics Computer Resource concept; researching software quality metrics and indicators for the safety and integrity factors applicable to software products and services; investigating and defining criteria to be employed in the safe operation of aircraft so as to provide effective protection from abnormal operation of ground-based COTS components; and investigating tool qualification of complex electronic hardware for development and verification purposes.

Electromagnetic Hazards to Aircraft Systems

- 2002: Published interim NASA report on spurious emissions from cell phones and Portable Electronic De-vices and the effects on aircraft navigation equipment. Published final report from lightning strike characterization study for definition of aircraft lightning environment. Revised RTCA DO-160 and prepared advisory circular with updated electromagnetic compatibility test methods and requirements for large systems. Continued “Electro Magnetic Interference/Electro Magnetic Compatibility (EMI/EMC) Continued Protection Integrity

Investigation" for aging aircraft systems and components and recommend methods for detecting EMC performance degradation. Published Protection Integrity Report.

- 2003: Revise AC 20-136 and release AC 20-xx with up-dated lightning environment and test waveform definitions. Release HIRF protection certification test method assessments for Aircraft Certification Office (ACO) engineer training. Provide advisory materials and test methods for HIRF protection certification on complex, highly integrated, and flight-critical electronic and electrical systems. Provide technical data on the effects of portable electronic devices on aircraft radio systems, considering new wireless RF technology being introduced. Continue Electro Magnetic Interference/Electro Magnetic Compatibility (EMI/EMC) continued protection integrity investigation for aging aircraft systems and components. New initiatives include defining the Single Event Effects (SEE) environment as an essential step to ensure safe operation of new-generation electronics in flight-critical systems. The current and future SEE avionics systems risk will help define the appropriate role of future regulations.

1.42.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p.2.1-53-58, February 2002
2. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-99 to 2-102; April 2001
3. Federal Aviation Administration, US Department of Transportation; William J. Hughes Technical Center; *Aircraft Icing*
4. National Aeronautics and Space Administration; Aircraft Icing Research

1.43 Information Technology Integration

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace Capital Investment Plan Fiscal Years 2002 - 2006*; pp. B-63 to B-64; April 2001

1.43.1 DESCRIPTION

This budget line item supports the FAA Chief Information Officer initiatives designed to improve the way the agency manages Information Technology (IT) investment. This effort supports the development and implementation of FAA's IT Strategy to improve processes and optimize IT investments; and to architect, acquire, develop and maintain high quality, mission critical systems within established targets of cost, schedule and risk. It also entails the streamlining of certification processes for airborne and ground systems and continued work toward the implementation of an agency-wide data management program.

1.43.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-80-81, March 2002
2. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-63 to B-64; April 2001

1.44 Navigation Research (WAAS/LAAS)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Aviation Research Plan, Internet Version*; pp. 2-36 to 2-41; April 2001**Federal Aviation Administration, US Department of Transportation**; *National Aviation Research Plan,* p.2.1-13-21, February 2002

1.44.1 DESCRIPTION

WAAS

The FAA uses the National Satellite Test Bed (NSTB) as the foundation for all current research and development activities associated with implementing the WAAS. The NSTB is essential to the development and implementation of GPS and its WAAS augmentations. Findings from the NSTB help the FAA develop required user equipment through avionics manufacturers, continue development of GPS user procedures, and gain international acceptance of a seamless Global Navigation Satellite System (GNSS).

Using the NSTB as a prototype system, the program is developing and implementing the capability to monitor and evaluate system performance of both the basic GPS service and the WAAS during implementation activities. During these evaluations, large quantities of complex technical data will be collected, analyzed, and archived.

The data will be made available to the FAA and other Government Agencies (as well as to industry, academia, and international entities) to facilitate information exchange, foster cooperation around the world, and achieve a seamless global air navigation system.

The results of this "live" data collection and analysis will assist the FAA in: (1) analyzing and defining the satellite-based navigation technology requirements of air traffic and airway facilities; and (2) determining connectivity and interoperability requirements for international augmentation systems being developed by other countries. The information obtained from these performance evaluations will also allow the FAA to monitor the WAAS system contractor performance.

When the Phase I WAAS becomes operational, the FAA plans to approve the use of GPS as a primary means of navigation for en route through non-precision approaches. Initial WAAS capability will provide Lateral Navigation/ Vertical Navigation (LNAV/VNAV) capabilities. Future phases of WAAS are expected to provide precision approach capabilities, which will increase the numbers of airfields with a precision approach capability, and potentially enable the decommissioning of some existing ground-based navigation equipment throughout the U.S.

Key year 2003 milestones for WAAS are expected to be:

- Define optimum SATNAV architecture for Alaska.
- Investigate satellite anomalies.
- Perform time transfer studies for SBAS interoperability.
- Refine WAAS performance monitoring and assessment capabilities.
- Define and test SBAS interoperability scenarios.
- Characterize scintillation effects of ionosphere on WAAS performance for ionospheric algorithm development for future phases of WAAS.
- Develop prototype common reference receiver.
- Develop interference detection and mitigation techniques.
- Analyze impact of additional civil frequencies.
- Begin analysis of use of navigation transponder on Geosynchronous Earth Orbit (GEO) satellite.

LAAS

The LAAS Test Prototype (LTP) system is being used to test and validate the expected performance of LAAS systems. The LAAS is intended to complement the WAAS, and the systems function together to supply users of the NAS with seamless satellite-based navigation for all phases of flight. The LAAS will be used to meet Category I Precision Approach requirements at those locations where WAAS is unable to meet those requirements. LAAS will also be used to meet the more stringent Category II/III requirements at selected locations throughout the U.S. LAAS will yield the extremely high accuracy, availability, and integrity necessary for Category II/III precision approaches. It is fully expected that the end-state configuration will pinpoint an aircraft's position to within one meter or less.

The FAA has developed and provided a functional Category I LAAS specification, architecture, and MOPS to industry for implementing local area systems across the United States. The FAA will validate the capability to perform Category II/III precision approaches through continued research and development efforts associated with the LAAS Program. An LTP has been developed, and is being used to conduct nationwide flight tests in cooperation with several end-state users of LAAS technology including United Parcel Service (UPS) and Federal Express (FedEx).

Key year 2003 milestones for LAAS are expected to be:

- Develop interference detection and mitigation techniques.
- Analyze impact of additional civil frequencies.
- Develop LAAS Category II/III requirements for autoland.
- Further refine the FAA LAAS Category II/III test prototype.
- Develop and validate LAAS Category II/III Specification.
- Validate LAAS Category II/III Integrity Monitoring.
- Develop Improved Signal Quality Monitoring Techniques for CAT II / III LAAS.
- Investigate Ephemeris Monitoring requirements for CAT II / III LAAS.

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1.45 Operations Concept Validation

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Aviation Research Plan,* p. 2.2-19-22, February 2002

The applications supported by this program in 2002, and their activities, are the following:

Operational Concept Development

- Developed detailed concepts for Flight Intent.
- Developed detailed concepts for Information Management of airspace resources to facilitate improved flight planning and impact assessment.
- Developed en route evolution concept including flight data management (FDM) across NAS.

Concept Validation

- Developed test bed for modernization.
- Assessed FAA high altitude concept
- Developed information flow model to translate concepts into interface requirements.

Concept System Design

- Conducted closed-loop modeling of changes in airspace/airports and user demand.

The applications planned for 2003, and their activities, are the following:

Operational Concept Development

- Develop terminal airspace evolution concept
- Develop detailed concepts of operations for the interaction of service providers in en route and terminal airspace to support the validation of the FAA's Air-space Management Concept.
- Develop detailed concept of operations for the evolution of Traffic Flow Management.
- Develop performance framework for concepts including Required ATM System Performance and Real-Time Streaming Protocol (RTSP).

Concept Validation

- Establish the Validation Data Repository to capture all activities and results associated with concept and concept-of-use validation activities in the FAA. Establish metrics to allow comparability of results across program validation efforts in the U.S. and in Europe.
- Validate the information management concept contained in the RTCA concept of operations.
- Validate the flight intent concept of use to assure completeness and harmonization of the definition for integration into ground and airborne decision support systems in the US and Europe.

Concept System Design

- Extend closed-loop system dynamic modeling of decisions and demand dynamics related to scheduling and management of aircraft in congested en route airspace.
- Leverage the work in the human factors research and the human factors and the operational validations experimentation to define the information type, up-date rate, and display requirements needed to support the agreed to operational improvements of the NAS concept of operations through 2010.

1.45.1 BIBLIOGRAPHY

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1.46 ADS-B Data Link Evaluation

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Aviation Research Plan,* p. 2.1-30-33 and p. 2.2-48-52, February 2002

1.46.1 DESCRIPTION

This application involves evaluation of the three ADS-B links (1090MHz, Universal Access Transceiver (UAT), and VHF Datalink (VDL) Mode 4) under the FAA SF21 Alaska Capstone and Ohio River Valley activities. UAT data link evaluation was completed in 2002 under the SF21 Alaska Capstone program. Evaluations for the three data link alternatives were planned for SF21 Ohio River Valley activities in 2002. The FAA announced an ADS-B data link decision in 2002.

1.46.2 BIBLIOGRAPHY

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3. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001

1.47 Software Engineering

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Aviation Research Plan, Internet Version*; pp. 2-31 to 2-34; April 2001

1.47.1 DESCRIPTION

The FAA intends to improve NAS and avionics safety and reduce NAS and avionics acquisition, development, and maintenance costs by developing and implementing improved software processes and procedures. These actions will directly benefit passengers (as well as all elements of air transportation) and greatly contribute to a safe, secure, and efficient NAS.

The FAA Software Engineering Resource Center (SERC), established in June 1998, is a focal point for research on FAA software-intensive systems. The SERC is an FAA-wide resource that addresses strategic software technology problems impacting the mission performance and enhancement of FAA in-house software/systems engineering competencies. The primary SERC facilities are located at the William J. Hughes Technical Center.

The principal products of SERC efforts include a series of standards, guidelines, models, research papers, and “evolvable” prototypes. They demonstrate, validate, and verify the safety properties, performance, and other critical attributes of anticipated new NAS technologies. The SERC also evaluates and validates improved software processes, methods, and engineering tools that enhance architecture and systems, as well as engineering, testing, and certification functions for the life cycle of NAS systems software. The SERC brings together recognized experts and FAA personnel to solve problems related to Commercial Off-The-Shelf/Non developmental Item (COTS/NDI) and the next generation architecture. These activities transfer skills to and increase the technical competency of the FAA workforce.

1.47.2 BIBLIOGRAPHY

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1.48 Aviation System Capacity, Planning and Improvements

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Aviation Research Plan,* p. 2.2-12-18, February 2002

1.48.1 DESCRIPTION

The applications supported by this program, and their activities, include:

- NAS Performance Measurement
- Airport Development
- Capacity Improvement Opportunities
- Architecture Deployment Support
- NAS Plan Handoff

In FY 2003, the program will continue to focus on capacity enhancement at all major airports as well as on terminal and en route airspace. Primary focus areas are: (1) airports where construction of suggested improvements can be completed within two to three years; and (2) air traffic radar facilities, where airspace redesign, reduce controller workload, increase safety, and provide the aviation industry with additional flexibility and predictability during flight. In addition, the program will continue to fine tune air traffic system performance measures. These efforts will concentrate on reducing the cost of service delivery by targeting and coordinating investments across appropriations.

1.48.2 BIBLIOGRAPHY

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1.49 NAS Requirements Development

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Aviation Research Plan, Internet Version*; pp. 2-59 to 2-62; April 2001; **Federal Aviation Administration, US Department of Transportation**; *National Aviation Research*

Plan, p. 2.2-45-47, February 2002

1.49.1 DESCRIPTION

This application will support mission analysis (MA) and NAS requirements development efforts. It will fund studies and other efforts to prepare and validate strategies and proposals designed to increase overall NAS efficiency. Also, it will support the FAA System Efficiency mission goal to *"provide an aerospace transportation system that meets the needs of users and is efficient in the application of FAA and aerospace resource*s."

As part of the Agency's Acquisition Management System (AMS) process, the FAA routinely examines current and projected needs within the NAS, with the goal of defining requirements to meet identified needs. This budget line item provides, on a recurring basis, the means to independently investigate the particulars of selected programs (service or system) or technologies. Such investigations assist in determining and selecting only those programs or technologies best suited to advance overall NAS system efficiency.

Activities of this application include:

- Simulation
- Human factors
- Procedure development
- Performance definition
- Impact analysis
- Workload analysis
- Hazard analysis
- NAS architecture development

1.49.2 BIBLIOGRAPHY

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1.50 Commercial Space Transportation Safety

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Aviation Research Plan, Internet Version*; pp. 2-186 to 2-192; April 2001; **Federal Aviation Administration, US Department of Transportation**; *National Aviation Research Plan,* p. 2.1-88-92, February 2002

1.50.1 DESCRIPTION

The applications supported by this program, and their activities, are the following:

Commercial Space Integration into the NAS

- The FAA intends to investigate and analyze means to integrate commercial space transportation operations seamlessly into the NAS in order to minimize impacts on overall

NAS efficiency. Specifically, the FAA's Space and Air Traffic Management System initiative, as led by the Commercial Space Transportation (CST) line of business, seeks to examine methods to integrate new spaceport and vehicle operations in the NAS in a safe and efficient manner. No activities are planned for this application in 2003.

Reusable Launch Vehicles Operation and Maintenance

- The FAA intends to investigate and analyze standards and processes applicable to commercial Reusable Launch Vehicle (RLV) Operations and Maintenance (O&M) activities to ensure these activities are conducted with adequate protection of public safety. A thorough review of the Space Shuttle operations and maintenance activities will be conducted to determine the "best practices" used by the world's only reusable launch vehicle and their applicability to commercial RLV O&M activities. The FAA will also study the airline industry to determine which "best practices" and "lessons learned" from the aircraft industry could be applicable to commercial RLV activities in terms of their operations and maintenance activities and the effects on safety.

Criteria for Determining "Unproven" vs. "Proven" RLVs

- The FAA intends to improve public safety regarding the operation of unproven and proven commercial RLVs by the development of criteria that formulate a basic methodology to assist in the determination of when an RLV progresses from an "unproven" to "proven" status. The major objectives of this program are to:
  - Continue public safety that is associated with RLV activities by providing additional criteria for the safe operation of RLVs. dwell time over densely populated areas.
  - Ensure that for unproven RLVs:
  - The projected instantaneous impact point (IIP) of the vehicle does not have substantial dwell time over populated areas; or
  - The expected average number of casualties to members of the public does not exceed 30 x 10-6 ($E_c < 30 \times 10^{-6}$) given a probability of vehicle failure equal to 1 ($p_f = 1$) at any time the IIP is over a populated area.
  - Provide criteria that can be used to assist in judging the public safety relevance of methodologies associated with proven RLV.

Reentry Vehicle Maneuverability and its Effect on Public Safety

- The FAA intends to improve public safety regarding reentry of RLVs and reentry vehicles (RV) by understanding the safety issues associated with the level of maneuverability of the vehicle reentering earth. The foremost issue is the differentiation between maneuverable and non-maneuverable reentry vehicles. Although many trajectory analyses should be performed for both maneuverable and non-maneuverable RVs/ RLVs, the results of the analyses and their relative importance toward public safety may differ greatly depending upon the maneuverability capability of the vehicle. The major outcomes from this program include:
- Continue improvement of public safety from RLV activities.
  - Refine the RLV regulations to improve public safety and keeping with development of regulations that are not overly burdensome.
  - Establish guidance and understanding of a vehicle's reentry 3σ left and right, minimum, and maximum IIP trajectories that will indicate where a non-maneuverable vehicle will start its landing cycle (i.e., deploy its parachute) and land.

_ Establish guidance and understanding of a maneuverable vehicle's reentry of limiting trajectories and the "maneuverability landing ellipse" for the vehicle.

_ Develop criteria that address maneuverable vehicles landing ellipse borders defined as a group of termination (impact) points for trajectories from which the vehicle could still maneuver sufficiently to attain a nominal landing location.

_ Determine what trajectory information would be required to evaluate non-maneuverable and maneuverable RLVs/RVs.

1.50.2 BIBLIOGRAPHY

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1.51 William J. Hughes Technical Center

Last Revised: December 2002

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1.51.1 DESCRIPTION

System Support Laboratory

The System Support Laboratory area consists of the En Route System Support, Terminal System Support, Flight Service, and Scan Radars laboratories at the FAA William J. Hughes Technical Center. Overall, this collection of individual laboratories are jointly responsible for activities related to Free Flight Phase 1, NAS operational concept validation, NAS capacity initiatives, and information security. Each component laboratory is described below.

Enroute System Support Laboratory (ESSL)

- The Enroute System Support Laboratory (ESSL) provides a controlled environment for testing NAS En Route systems and subsystems in simulated ATC topographies. The ESSL is capable of replicating each of the FAA's En Route ARTCC environments, (using site specific adaptation) and is used to support extensive field-testing of planned Program Trouble Reports (PTRs), and approved National Change Proposals (NCPs). The ESSL further encompasses several other NAS subsystems, including: the Host Computer System (HCS); the Enhanced Direct Access Radar Channel (EDARC); the Peripheral Adapter Module Replacement Item (PAMRI); the Display System Replacement (DSR); and the Display Channel Complex Rehost (DCCR).

- The systems comprising the ESSL are further capable of interfacing with other systems/subsystems and laboratories, both internal and external to WJHTC, to provide a realistic and platform (using both simulated and live data) upon which extensive NAS system changes can be evaluated. Projects tested within the ESSL will be used to evaluate changes to existing systems, as well as to eventually replace aging ATC equipment. Such evaluations will allow continued system growth, while resulting in a safe, effective, and efficient air traffic control system.

Terminal System Support Laboratory (TSSL)

- The Terminal System Support Laboratory (TSSL) reflects the FAA's commitment to improving automation capabilities in airport terminals. The TSSL projects involve developing and testing hardware and software that will address the current problem of terminal ATC capacity, while also meeting the needs of increased capacity in the future. The centerpiece of the TSSL consists of a series of terminal air traffic control systems, including the Automated Radar Terminal System (ARTSII, III, IIIA, EARTS, and NY TRACON), a mock air traffic control (ATC) tower, and the STARS.

Flight Service Laboratory

- The Automated Flight Service Station (AFSS) Computer Operations Laboratory provides weather information for preflight and in-flight, flight plan processing for coordination between Air Traffic Control Towers and Pilots.
- The AFSS Laboratory, (housed in building 300) consists of six operating systems. There are two developmental systems used for the development of all new software to be released to the field sites, two Flight Service Data Processing (FSDPS) Systems, and two Aviation Weather Processing (AWP) Systems. Each FSDPS and AWP system is used for testing both current software corrections, as well as future NAS NCP enhancements.
- The AFSS Laboratory employs six Computer Operators on two shifts. The operations staff, which consists of both senior and junior operators, has a number of responsibilities, including:
  - National Data Base Tape generation and shipment
  - Yearly, bimonthly and monthly software releases
  - Full system backups
  - Assist with test procedures
  - System preparation and maintenance
  - Software management

Scan Radar Laboratory

- The Scan Radar Laboratory supports the development and testing of state-of-the-art surveillance, radar, and ground-to-air-to-ground equipment. Housed in three locations throughout the WJHTC, the laboratory utilizes radar equipment such as Airport Surveillance Radar (ASR); the Mode Select (Mode S) Beacon System; the Air Traffic Control Beacon Interrogator (ATCBI-5/6); and the Air Route Surveillance Radar (ARSR-2).

Research and Development Laboratory

The Research & Development Laboratory area consists of the Target Generator Facility, Cockpit Simulator, Auto Tracking, and Technical Computer Data Center laboratories at the FAA William J. Hughes Technical Center. Overall, this collection of individual laboratories is jointly responsible for activities related to approach procedures, Free Flight Phase 1, separation standards, operational concept validation, GPS and augmentation, ADS-B, and STARS. Each component laboratory is described below.

Target Generator Facility (NAS Simulation Branch (ACT-510)

- The Target Generation Facility (TGF) generates realistic digital radar messages for targets in a simulated airspace environment that can be adapted to simulate actual NAS En Route and ARTS characteristics by including radar and environmental characteristics of specific FAA ATC facilities. The TGF also has the capability of integrating cockpit simulators from the FAA, NASA, Eurocontrol, and private airlines (i.e., Boeing and TWA) as required within the same simulation airspace, and as simulated aircraft. Therefore, testing within the TGF can use live, simulated, or a combination of both live and simulated data to provide a more realistic environment.
- Scenarios used within the TGF provide ATC systems with realistic radar returns for simulated aircraft following flight plans. Air Traffic Controllers are brought in and sat at Planned View Displays (radar scopes) in one area of the TGF, while Air Traffic Assistants sit at simulator-terminals in another area. In response to "real-time" ATC/pilot commands radar is generated by keystrokes on the Simulation Pilot Workstation and is then transmitted to the controller's PVD. These scenarios and data can be adapted to simulate actual, imaginary or generic facilities as required. The TGF further provides complete data recording and reduction capabilities that support post-simulation analysis.
- Simultaneous simulations in different environments and in different laboratories at the WJHTC can be supported and can run concurrently. For example, a TGF simulation exercise can include both the NAS En Route, and the ARTS systems/laboratories.
- New TGF Inter Facility communication capabilities have been implemented that also allows the TGF to simulate two adjacent ATC facilities. As a result, the TGF is able to respond to requests from both the NAS and ARTS laboratories, while allowing communications with two or more facilities.

Cockpit Simulator

- The current cockpit simulator used by ACT-510 replicates a Cessna 421 and has been used in flying studies within the TGF. The current cockpit simulator can be used in combination with, or independently of the TGF (to perform pilot checkout/familiarization). A second propeller aircraft simulator is under construction, and is planned to be in the same class as a Beechcraft 1900.

Auto Tracking

- Auto Tracking is the capability whereby a given NAS systems (i.e., En Route or Terminal) can correlate the input of radar data received, with a flight plan that has been entered into that same system. As used for testing NAS systems, simulated radar returns are generated/created from simulation input data/tapes containing only flight plan related inputs. When such flight plans are entered into the Simulation program, the program then develops liken RADAR data, to simulate the intended flight path of given aircraft based only on the entered flight plan. When the output from the Simulation program (now containing both the flight plan inputs, and the generated radar data) is read through the TGF, the respective NAS system (En Route or Terminal) correlates the radar data received, with the flight plan data, to provide auto tracking. TGF makes extensive use of the Simulation program to create such flight plan and radar data tapes, to support NAS simulation testing.

Technical Computer Data Center (TCDC)

- The Technical Computer Data Center (TCDC) is a research and development facility that provides software engineering support, systems analysis, computer operations, multiple-platform Automated Data Processing services, and computer mainframe resources for users throughout the FAA. The TCDC houses a large-scale IBM 9672 - G5 mainframe system that runs the OS/390 operating system. Peripheral devices include local communications controllers, 16 dialup lines, a Cisco RSP7000 router, 4245 high-speed printers, HP plotter, an automated tape silo, and a comprehensive network test bed. Database products include DB2 and Oracle. Accessible worldwide 24 hours a day, 5 days a week via the Internet or modem, the Center holds a Department of Defense B2 security rating.

Aviation Support Laboratory

The Aviation Support Laboratory area consists of the Aircraft laboratory at the WJHTC. Overall, this component laboratory is responsible for activities related to the satellite communications and navigation programs, separation standards, Capstone (Safe Flight 21), GPS signal augmentation, terminal area procedures (TERPS), datalink, runway incursion, ADS-B, and aircraft safety.

Aircraft Laboratory

- No description about this specific laboratory is available.

Human Factors Laboratory

The Human Factors Laboratory area consists of the Research Development and Human Factors Laboratory, that engages in human factors research in the context of air traffic control, airway facilities, and operational concept validation. This section describes each of the three research areas.

Air Traffic Control Human Factors

- The ATC concept and acquisition supports the human factors program examines current issues and advanced concepts that relate to human performance in the National Airspace System.
- Research professionals at the WJHTC focus on the development and improvement of person-machine relationships in the NAS. These scientists with the NAS Human Factors Branch and the Research and Development Human Factors Laboratory (RDHFL) work directly with the user community to maximize the potential of new and modified equipment as well as study operational concepts.
- Human Factors specialists and engineers study both future air traffic control concepts and current technology that the FAA is considering. They employ state-of-the-art air traffic control simulation and prototyping capabilities, creating a high fidelity environment that mirrors current and future implementation.
- Controllers visit the laboratory and participate directly in the studies experiencing, in simulation, everything they will see if a concept or new technology is fielded. This provides a reliable and valid test bed for drawing conclusions about how the FAA can employ technology to its maximum potential.

- The laboratory can do approach control and enroute prototyping as well as simulation research. It is highly flexible and can be reconfigured to meet current needs. Researchers can monitor and measure everything that occurs in a simulation. Over the past 40 years, the William J. Hughes Technical Center has been an industry leader in the development of air traffic control performance metrics for use in systems evaluation. The following paragraphs describe some of this work.
- Researchers have designed a new performance rating form for over-the-shoulder observational evaluations. Form designers assessed reliability and validity against objective system measures in real-time simulations. Researchers have also developed multiple measures of controller workload. The Human Factors Branch consolidated ATC measurements tools into a database, which is available to researchers working on any current or future systems issues.
- The Human Factors Laboratory uses state-of-the-art eye-tracking equipment to evaluate scanning behavior. Controller visual scanning is a potential source of human error. Controller scanning patterns change over time, as a function of systems loads and as influenced by overflights that the controller is not actively controlling. Controllers obtain the majority of their visual information only when looking directly at and fixating a specific object or event. Eye-tracking equipment can be used to evaluate the impact of new displays on controller scanning behavior.
- Researchers at the RDHFL have completed several simulation studies to investigate the effects of new operational concepts, such as user preferred routes and shared separation responsibility, on air traffic controller performance, situation awareness, and workload.

Airway Facilities Human Factors

- The Airway Facilities (AF) organization is responsible for maintaining all FAA navigation and surveillance equipment to ensure the efficient and safe operation of the traffic control system.
- The role of the AF Human Factors (AFHF) program is to consider AF human factors in a well-planned, coordinated manner. The objectives are to ensure that equipment, systems procedures, and organizational concepts maximize human productivity; improve training concepts and methods; reduce stressful work environments; and minimize errors. The following are descriptions of some current AF projects.

Human Factors Design Guide

- The AFHF program produced a comprehensive set of human factors guidelines for AF applications. The AF Human Factors Design Guide provides an exhaustive compilation of human factors design practices and principles integral to the procurement, design, development, and testing of FAA systems, facilities, and equipment. The Human Factors Design Guide primarily focuses on FAA ground systems, such as those that are managed by AF, as well as having a general applicability. A compact disk version has just been published and the Design Guide is available on the Internet.

Symbology

- The AFHF program is conducting several studies on symbols and icons representing AF facilities and equipment. The goal is to develop a standard set of visual symbols and color codes that will be used on new AF displays. This is particularly important given the trend to consolidate the monitoring of AF systems into centralized locations where several displays may be combined.

- The AFHF program is also managing an auditory symbology study to review alerting and status sounds now used in AF equipment.
- Human factors recommendations will be developed for the use of sound in new systems. Reducing the risk of operator errors in new AF systems is important. Human factors researchers are trying to anticipate sources of errors in integrated, centralized AF monitoring systems. Recently, an AF Error Mitigation Working Group generated an initial working paper. Further efforts will focus on validating the possible sources of risk in new AF systems through analysis and simulation.

Human Factors in Operational Concept Validation

- The NAS Advanced Concepts Branch conducts applied research to validate new aviation concepts, technologies, and procedures using state-of-the-art modeling, rapid prototyping, and real-time human-in-the-loop simulation techniques. The Branch adheres to a system engineering validation process to assess the operational and technical feasibility of proposed system changes. Products of the research efforts are used to support the investment and implementation decision-making process for NAS modernization.
- Primary sponsors of the work performed include:
  - Air Traffic Service (ATS)
  - Office of System Capacity (ASC-1)
  - Air Traffic Operations Planning Division (ATO-400)
  - Office of Research Acquisition (ARA)
  - Architecture and System Engineering (ASD-100)

Modeling and Simulation Studies

- Operational Concept Development and Validation
- Operational concept validation studies are conducted to provide the necessary data for NAS designers, developers, and operational personnel to make decisions regarding operational procedures, training, and systems required to support improvements in system safety, capacity, and efficiency. Issues associated with pilot and controller workload, roles and responsibilities, equipment usability, and overall system efficiency due to planned changes are evaluated.

Airport and Airspace Capacity

- Airport and airspace capacity studies are conducted to evaluate planned improvements and provide recommendations to enhance existing airport and airspace capacity, accommodate future forecasted traffic demand, decrease delays, and improve overall airport efficiency.

Procedural Development

- Procedural development, human-in-the-loop (HITL) simulation studies are conducted to assist operational personnel in assessing the impact of planned system changes on the human operator. These changes are evaluated in terms of safety, considering the capabilities and limitations of the human operator (pilots, controllers, etc.).

Modeling and Simulation Infrastructure

- The William J. Hughes Technical Center has an array of state-of-the-art “fast time" and "real-time" simulation capabilities to support the studies conducted under the auspices of the NAS Advanced Concepts Branch. To the extent possible and based on the objectives of a particular study, the following fast-time modeling tools are used as a precursor to performing real-time human-in-the-loop simulations:

_ National Airspace System Performance Analysis Capability

_ Airport and Airspace Delay Simulation Model

_ Airport Delay Simulation Model

_ Runway Delay Simulation Model

Runway Capacity Model

- If the study requires a higher level of fidelity, a large-scale distributed network of NAS laboratories and facilities exist to support the real-time HITL simulations. These laboratories and facilities include:

_ Enroute System Support Facility

_ Terminal System Support Facility

_ Integration & Interoperability Facility

_ Simulation Display Laboratory

_ Research Development and Human Factors Laboratory

_ NASA Ames Cockpit Simulators

1.51.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-200 to 2-202; April 2001
2. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.4-7, February 2002
3. Federal Aviation Administration, US Department of Transportation; William J. Hughes Technical Center, Laboratory Management Division Website (http://act400.tc.faa.gov/); (with input by WJHTC personnel); July 2001
4. Federal Aviation Administration, US Department of Transportation; William J. Hughes Technical Center, *Air Traffic Control Human Factors: Research and Development Human Factors Laboratory Fact Sheet* (http://www.tc.faa.gov/its/cmd/visitors/data/ACT-500/atchf.pdf); July 2001
5. Federal Aviation Administration, US Department of Transportation; William J. Hughes Technical Center; *Airway Facilities Human Factors: Research and Development Human Factors Laboratory Fact Sheet* (http://www.tc.faa.gov/its/cmd/visitors/data/ACT-500/airways.pdf); July 2001
6. Federal Aviation Administration, US Department of Transportation; William J. Hughes Technical Center; *NAS Advanced Concepts Branch, ACT540 Fact Sheet* (http://www.tc.faa.gov/its/cmd/visitors/data/ACT-500/advanced.pdf); July 2001

1.52 Advanced Vortex Spacing System (AVOSS)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Aviation Research Plan, Internet Version*; pp. 2-200 to 2-202; April 2001

1.52.1 DESCRIPTION

Advanced Vortex Spacing System is a capability to predict the existence of aircraft wake vortices and to reduce separation requirements. AVOSS is currently listed as a research support effort of Free Flight Phase 2 (Ref. 1).

1.52.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital*

Investment Plan Fiscal Years 2003-2007, p. A-31, March 2002
2. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-200 to 2-202; April 2001
3. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp 26, B-15, B16; April 2001
4. National Aeronautics and Space Administration, Langley Research Center, Hampton, VA; The Aircraft Vortex Spacing System (AVOSS), An element of the NASA Reduced Spacing Operations Research; October 1999
5. Hinton, D. A.; Aircraft Vortex Spacing System (AVOSS) Conceptual Design; NASA TM 110184; August 1995
6. Hinton, D. A.; National Aeronautics and Space Administration, Langley Research Center, Hampton, VA; *An Aircraft Vortex Spacing System (AVOSS) For Dynamical Wake Vortex Spacing Criteria*; May 1996

1.53 Terminal Weather Doppler Radar (TDWR)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; B-38; April 2001

1.53.1 DESCRIPTION

TDWR detects wind shear events such as microbursts, gust fronts, and related hazardous wind shear in the vicinity of airport approach and departure corridors for pilots and controllers.

Current plans call for continuing improvements and SLEP (Ref. 1)

1.53.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-7, March 2002
2. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; B-38; April 2001
3. Raytheon; Air Traffic Control CNS/ATM: Terminal Doppler Weather Radar (TDWR); August 2001

2. Flight Planning Enhancement Area

The Flight Planning enhancement area provides flight plan support for pilots and flight plan data processing. Capabilities include pre-flight and in-flight collaboration, plan filing, processing and usage, and the provision of flight planning information and development support. Collection and processing of proposed and amended flight plans and dissemination of approved IFR and VFR flight plans are also included.

The Flight Planning enhancement area does not contain any explicit enhancements. Applications such as Distributed Air/Ground Traffic Management (DAG TM) Concept Element (CE) 5 and 6 do however provide for on-board flight planning capabilities but are treated explicitly in the Traffic Management Enhancement Areas.

3. Separation Assurance Enhancement Area

The Separation Assurance enhancement area ensures that aircraft maintain a safe distance from other aircraft, terrain, obstacles, weather and selected types of airspace not designated for routine air travel. Capabilities include on-board and ground based separation functions on the airport surface and in the terminal, en route, and oceanic domains. Separation assurance results in a clearance from the controller to the pilot or in a command from an on-board system such as the Traffic Alert and Collision Avoidance System (TCAS) to execute an evasive maneuver.

The Separation Assurance enhancement area consists of 14 applications, listed below in order of appearance.

3.1 Enhanced Visual Acquisition of Other Traffic for See-and-Avoid (Using ADS-B Only)
3.2 Enhanced Visual Acquisition of Other Traffic for See-and-Avoid (Using ADS-B and TIS-B)
3.3 Conflict Detection
3.4 Conflict Resolution
3.5 Delegated Air-to-Air Self-Separation for One-In-One Out Airspace
3.6 Center Situational Awareness with ADS-B
3.7 Radar Like Services with ADS-B
3.8 Reduced Separation Standards with ADS-B
3.9 GPS Based TCAS
3.10 Runway Incursion Reduction

Detailed descriptions of each are provided where available.

3.1 Enhanced Visual Acquisition of Other Traffic for See-and-Avoid (Using ADS-B Only)

Last Revised: December 2002

Description Source: **Federal Aviation Administration**, **US Department of Transportation**; *Safe Flight 21 Master Plan, Version 2.0*; p.3-6; April 2000

3.1.1 DESCRIPTION

This application provides a display of nearby traffic on the CDTI to help the pilot see-and-avoid traffic. If traffic is sighted, the pilot must first assess the threat posed by the nearby aircraft then, if necessary, maneuver to avoid the other aircraft. The effectiveness of see-and-avoid depends on the ability of a pilot to visually acquire the nearby aircraft early enough in the encounter to enable threat assessment and avoidance.

The first phase of this application will be to evaluate see-and-avoid using only ADS-B/CDTI. This will show nearby aircraft that are equipped with ADS-B. The second phase of this application extends the CDTI by displaying non-equipped aircraft, which are detected by ATC radar and transmitted to the CDTI using TIS-B. In areas with significant numbers of aircraft that are not ADS-B equipped, the effectiveness of using CDTI based on ADS-B only for acquisition of traffic would be limited. With TIS-B information, the identity, position and estimated groundspeed of the other traffic that are known to the controller will be supplied to the pilot. This will assist equipped pilots by providing a display of all nearby traffic within the TIS-B supported area. This phase of the application will address the TIS-B function in the ground automation systems and the human-factors issues of presenting TIS-B targets on the CDTI.

In 2001, the SF21 Ohio River Valley project received supplemental-type certificate (STC) approval for installation of ADS-B/CDTI on Boeing 757s and 727s for “Enhanced See and Avoid” applications (working in conjunction with UPS Airlines) (Ref. 4).

3.1.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; p.3-6; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; December 1999
3. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Functional Specification*; May 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-17, March 2002
5. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
6. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.2-48-52, February 2002
7. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001

3.2 Enhanced Visual Acquisition of Other Traffic for See-and-Avoid (Using ADS-B and TIS-B)

Last Revised: December 2002

Description Source: **Federal Aviation Administration**, **US Department of Transportation**; *Safe Flight 21 Master Plan, Version 2.0*; p.3-6; April 2000

3.2.1 DESCRIPTION

This application provides a display of nearby traffic on the CDTI to help the pilot see-and-avoid traffic. If traffic is sighted, the pilot must first assess the threat posed by the nearby aircraft then, if necessary, maneuver to avoid the other aircraft. The effectiveness of see-and-avoid depends on the ability of a pilot to visually acquire the nearby aircraft early enough in the encounter to enable threat assessment and avoidance.

The first phase of this application will be to evaluate see-and-avoid using only ADS-B/CDTI. This will show nearby aircraft that are equipped with ADS-B. The second phase of this application extends the CDTI by displaying non-equipped aircraft, which are detected by ATC radar and transmitted to the CDTI using TIS-B. In areas with significant numbers of aircraft that are not ADS-B equipped, the effectiveness of using CDTI based on ADS-B only for acquisition of traffic would be limited. With TIS-B information, the identity, position and estimated groundspeed of the other traffic that are known to the controller will be supplied to the pilot. This will assist equipped pilots by providing a display of all nearby traffic within the TIS-B supported area. This phase of the application will address the TIS-B function in the ground automation systems and the human-factors issues of presenting TIS-B targets on the CDTI.

3.2.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; p.3-6; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; December 1999
3. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Functional Specification; May 1999
4. Federal Aviation Administration, US Department of Transportation; National Airspace System Capital Investment Plan Fiscal Years 2002-2006; pp. B-29 – B-30; April 2001
5. Federal Aviation Administration, US Department of Transportation; National Aviation Research Plan, p. 2.2-48-52, February 2002

6. Federal Aviation Administration, US Department of Transportation; National Aviation Research Plan, Internet Version; pp. 2-22 – 2-26; April 2001

3.3 Conflict Detection

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft*; p.8; December 1999

3.3.1 DESCRIPTION

This application builds on the safety benefits of using CDTI for traffic situation awareness by alerting pilots to potential conflicts with other aircraft, thereby facilitating timely action (if necessary) to prevent or end the conflict, enabling the pilot to take action to avoid the other aircraft if necessary. This will address human factors and algorithm issues such as false alerts, the relationship to TCAS alerts, and indirect impacts on ATC operations.

3.3.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; p.8; December 1999
3. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Functional Specification*; May 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
5. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.1-26, February 2002
6. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001

3.4 Conflict Resolution

Last Revised: December 2002

Description Source: **Federal Aviation Administration**, **US Department of Transportation**; *Safe Flight 21 Master Plan, Version 2.0*; p.8; April 2000

3.4.1 DESCRIPTION

This application advises the pilot of a maneuver to resolve the previously detected conflict. This application will address human factors and algorithm issues and will address potential interactions with TCAS on one or both aircraft.

No updates to this application were found in the current CIP or NARP.

3.4.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; p.8; December 1999
3. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Functional Specification*; May 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
5. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001

3.5 Delegated Air-to-Air Self-Separation for One-In-One Out Airspace

Last Revised: September 2001
Description Source: None

3.5.1 DESCRIPTION

No description available.

3.5.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; p.xiii; April 2000
2. Lozito, Sandra, Alison McGann, et. al.; *Free Flight and Self-Separation from the Flight Deck Perspective*; Eurocontrol ATM Seminar 1997; 1997

3.6 Center Situational Awareness with ADS-B

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation;** *Safe Flight 21 Master Plan, Version 2.0*; p.3-9; April 2000

3.6.1 DESCRIPTION

This application provides center controllers with enhanced situational awareness of traffic in non-radar airspace by identifying ADS-B equipped aircraft and their trajectories on a controller display. This will aid the controller in providing procedural separation and other non-radar services and in coordinating with the tower controller on airspace changeovers between IFR en route operations and terminal area SVFR operations.

Potential uses of ADS-B to aid search and rescue and for communicating aircraft emergency conditions to the controller are being considered for inclusion in this application.

No mention of this specific Center application for ADS-B was found in the current CIP or NARP.

3.6.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; p.3-9; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; December 1999
3. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Functional Specification*; May 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
5. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001

3.7 Radar Like Services with ADS-B

Last Revised: December 2002

Description Source: **Federal Aviation Administration**, **US Department of Transportation**; *Safe Flight 21 Master Plan, Version 2.0*; p.3-10; April 2000

3.7.1 DESCRIPTION

This application provides terminal area controllers of non-radar airspace with surveillance, conflict alert and Minimum Safe Altitude Warning (MSAW) that are based on ADS-B, to enable provision of radar-like services to VFR and IFR aircraft. This includes emergency services, separation, sequencing, traffic and terrain advisories, navigational assistance, and route optimization. Aircraft not providing ADS-B are handled similarly to aircraft without a transponder in secondary radar airspace.

Initial implementation of this application has been accomplished under the SF21 Alaska Capstone program (Ref. 6). FY 2003 plans call for obtaining approval for "radar-like separation services" using ADS-B on Common ARTS (Ref. 4) as part of the SF21 Ohio Valley program.

3.7.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; p.3-10; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; December 1999
3. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Functional Specification*; May 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-16, March 2002
5. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
6. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.1-30, February 2002
7. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001

3.8 Reduced Separation Standards with ADS-B

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft*; p.14; December 1999

3.8.1 DESCRIPTION

As confidence is gained in the fusion of radar and ADS-B data and in the procedures that depend on this fused data, separation standards might be reduced. The safety of the system would have to be proven to not be adversely impacted by this reduction. The benefit would be an increase in throughput through the en route and terminal areas.

This specific application is not mentioned in the current CIP or NARP.

3.8.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; p.3-10; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; December 1999
3. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Functional Specification*; May 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
5. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001

3.9 GPS Based TCAS

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Aviation Research Plan, Internet Version*; pp. 2-203 to 2-206; April 2001

3.9.1 DESCRIPTION

Incorporate GPS technology into ongoing work in area of low cost avionics to make full use of TCAS.

3.9.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.4-13, February 2002
2. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-203 to 2-206; April 2001
3. Federal Aviation Administration, US Department of Transportation; *GPS Squitter Technology*

3.10 Runway Incursion Reduction

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-19-20, March 2002

3.10.1 DESCRIPTION

With the Runway Incursion Reduction program (RIRP), the FAA intends to reduce the number and rate of runway incursions and improve surface safety at NAS airports through research, development, demonstration, and evaluation of new and emerging methods, procedures, and technologies.

Current plans call for continued research on potential technology solutions for small- to medium-sized airports; completion of the technical and operational evaluation of the RWSL program; and development of performance standards and requirements for selected runway incursion reduction technologies.

3.10.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-19-20, March 2002
2. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.1-10-12, February 2002
3. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-6 to 2-9; April 2001
4. Federal Aviation Administration, US Department of Transportation; *Runway Incursion Reduction Program: About RIRP*; 1999
5. Federal Aviation Administration, US Department of Transportation; *Runway Incursion Reduction Program: What is a Runway Incursion?*; 1999
6. Federal Aviation Administration, US Department of Transportation; RIRP Project: Airport Surface Detection Equipment – Model X (ASDE-X)

4. Situational Awareness and Advisory Enhancement Area

The Situational Awareness and Advisory enhancement area provides advice and information to assist pilots in the safe conduct of flight and aircraft movement. Capabilities include the development and dissemination of weather, traffic and NAS status information and advisories to enhance the situational awareness of pilots and controllers. This area also includes the generation of alerts including conflict alerts, terrain and obstacle alerts, severe weather alerts, wind shear alerts, wake vortex alerts, and microburst alerts. Normal IFR/VFR traffic advisories, automatic terminal information service (ATIS), and weather advisories including icing and clear air turbulence are also included in this area.

The Situational Awareness and Advisory enhancement area consists of 18 applications, listed below in order of appearance.

4.1 Initial FIS
4.2 Additional FIS-B Products
4.3 Low Cost Terrain Situational Awareness
4.4 Increased Access to Terrain Constrained Low Altitude Airspace
4.5 Pilot Situational Awareness Beyond Visual Range
4.6 Runway & Final Approach Occupancy Awareness (using ADS-B only)
4.7 Runway & Final Approach Occupancy Awareness (using ADS-B and TIS-B)
4.8 Airport Surface Situational Awareness
4.9 Center Situational Awareness with ADS-B
4.10 Radar Like Services with ADS-B
4.11 Tower Situational Awareness beyond Visual Range
4.12 Airport Movement Area Safety System (AMASS)
4.13 Flight Informational Services Data Link (FISDL)
4.14 Air Traffic Control/Airway Facilities Human Factors
4.15 Flight Deck/Maintenance/System Integration Human Factors
4.16 Weather Program - Safety
4.17 Weather Program - Efficiency
4.18 Next Generation Weather Radar (NEXRAD)

Detailed descriptions of each are provided where available.

4.1 Initial FIS

Last Revised: December 2002

Description Sources: **Federal Aviation Administration, US Department of Transportation**; *Safe Flight 21 Functional Specification*; p.12; May 1999 & **Federal Aviation Administration**, **US Department of Transportation**; *Safe Flight 21 Master Plan, Version 2.0*; p.3-3; April 2000

4.1.1 DESCRIPTION

Flight Information Services (FIS) is non-control advisory information service needed by pilots to operate more safely and efficiently. FIS includes aeronautical information, current and forecasted weather, weather hazard information and Special User Airspace (SUA) status, necessary for flight planning and for continued safe flight. FIS uses a ground based data server and data links to provide the variety of information. Pilots currently receive weather information or special user airspace information through voice communications with ATC. FIS will provide increased availability of flight services, timeliness and quality of data on weather and system status, access to airspace and a reduction in flight times and flight distances.

This application will enhance pilot awareness of weather and airspace/facility status by incorporating broadcast flight information into cockpit multifunction displays. Initial (text only) products will include NEXRAD graphics, METAR and SPECI surface observations, TAFs and applicable amendments, SIGMETs and convective SIGMETs, AIRMETs, urgent and routine PIREPS, and Severe Weather Forecast Alerts.

4.1.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; p.3-3; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; December 1999
3. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Functional Specification*; p.12; May 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-40-41, March 2002
5. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
6. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001

4.2 Additional FIS-B Products

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Safe Flight 21 Functional Specification*; p.12; May 1999, **Federal Aviation Administration, US Department of Transportation**; *Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft*; p.3; December 1999, & **Federal Aviation Administration, US Department of Transportation**; *Safe Flight 21 Master Plan, Version 2.0*; p.3.3; April 2000

4.2.1 DESCRIPTION

Flight Information Services (FIS) is non-control advisory information service needed by pilots to operate more safely and efficiently. FIS includes aeronautical information, current and forecasted weather, weather hazard information and Special User Airspace (SUA) status, necessary for flight planning and for continued safe flight. FIS uses a ground based data server and data links to provide the variety of information. Pilots currently receive weather information or special user airspace information through voice communications with ATC. FIS will provide increased availability of flight services, timeliness and quality of data on weather and system status, access to airspace and a reduction in flight times and flight distances.

The Initial FIS-B application will enhance pilot enhance pilot awareness of weather and airspace/facility status by incorporating broadcast flight information into cockpit multifunction displays. Initial (text only) products will include NEXRAD graphics, METAR and SPECI surface observations, TAFs and applicable amendments, SIGMETs and convective SIGMETs, AIRMETs, urgent and routine PIREPS, and Severe Weather Forecast Alerts.

This application will add to Initial FIS-B additional exchange of aeronautical data that includes NOTAMS, lightning, icing, turbulence, real-time SUA, and volcanic ash.

4.2.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; p.3.3; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; p.3; December 1999

3. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Functional Specification*; p.12; May 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-40-41, March 2002
5. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
6. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.1-30-33 and p. 2.2-48-52, February 2002
7. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001

4.3 Low Cost Terrain Situational Awareness

Last Revised: December 2002

Description Source: **Federal Aviation Administration**, **US Department of Transportation**; *Safe Flight 21 Master Plan, Version 2.0*; p.3-4; April 2000

4.3.1 DESCRIPTION

This application will enhance pilot awareness of terrain by using on-board databases, GPS navigation, and barometric altitude to generate moving terrain maps on cockpit multifunction displays. The initial capability color-codes vertical clearance to terrain, suitable for VFR operation.. Potential later capabilities include adding obstacle data to the on-board databases and providing alert functions.

No mention of this application was found in the current CIP. The current NARP includes a line item for the SF21 Alaska Capstone program for providing affordable means to reduce Controlled Flight Into Terrain (CFIT).

4.3.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; p.3-4; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; December 1999
3. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Functional Specification*; May 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
5. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.1-33, February 2002
6. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001

4.4 Increased Access to Terrain Constrained Low Altitude Airspace

Last Revised: August 2001

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Safe Flight 21 Functional Specification*; p.29; May 1999

4.4.1 DESCRIPTION

Controlled Flight into Terrain (CFIT) provides a detailed moving map of terrain and obstacles around an aircraft to help pilots maintain proper altitude and terrain clearance. Using the GPS, the aircraft's position is correlated with a database-driven terrain/obstacle map that provides the pilot with real time awareness of the aircraft's position relative to the terrain and obstacles. Loran, VOR and for (Distance Measuring Equipment) DME may be used as a navigation backup to GPS but represent a degraded mode of operation. With this increased situational awareness, the number of CFIT accidents can be reduced. Cost effective CFIT will increase the use of such systems, reduce the CFIT rate and will allow increased low altitude airspace access for CFIT equipped aircraft.

This application is not addressed in the current CIP or NARP.

4.4.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; December 1999
3. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Functional Specification*; p.29; May 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
5. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001

4.5 Pilot Situational Awareness Beyond Visual Range

Last Revised: December 2002

Description Source: **Federal Aviation Administration**, **US Department of Transportation**; *Safe Flight 21 Master Plan, Version 2.0*; p.3-7; April 2000

4.5.1 DESCRIPTION

This application extends pilot situational awareness of traffic that is beyond visual range by including distant traffic and airspace boundaries on the cockpit multi-function display. The application is intended to aid pilot-pilot coordination in VFR, SVFR and night operations by showing the overall multiple-aircraft pattern of operations in the airspace rather than only those aircraft that are closest and within visual range. Air-to-air ADS-B messages will identify and give the trajectory of ADS-B equipped aircraft. Ground-to-air TIS-B messages will identify and give the trajectory of non-equipped aircraft that are in radar surveillance.

Airspace boundaries will be presented from an on-board database.

This application is not specifically addressed in the current CIP or NARP.

4.5.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; p.3-7; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; December 1999
3. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Functional Specification*; May 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
5. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001

4.6 Runway & Final Approach Occupancy Awareness (using ADS-B only)

Last Revised: December 2002

Description Source: **Federal Aviation Administration**, **US Department of Transportation**; *Safe Flight 21 Master Plan, Version 2.0*; p.3-8; April 2000

4.6.1 DESCRIPTION

This application provides pilots on final approach and on the runway with awareness of other aircraft that are on or approaching the runway.

The initial phase of this application provides awareness only of equipped aircraft and/or vehicles, and will be of benefit primarily in situations where all or nearly all aircraft/vehicles are equipped. Evaluation will initially be based on the capabilities of un-augmented GPS and basic CDTI, but augmented GPS or limited CDTI enhancements may be found necessary.

The second phase increases the value of the application by including non-ADS-B-equipped aircraft on the CDTI. The ADS-B data on the CDTI is augmented with TIS-B data from ground-based terminal and surface radar and multilateration techniques. This will provide the pilot of equipped aircraft with information on equipped and non-equipped aircraft, vehicles, and obstructions.

An operational evaluation was conducted under the SF21 program in 2002 to demonstrate applications and gather data on approach spacing, departure spacing, runway and final approach occupancy awareness, and airport surface situational awareness (Ref. 5).

4.6.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; p.3-8; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; December 1999
3. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Functional Specification*; May 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
5. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.2-49, February 2002
6. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001

4.7 Runway & Final Approach Occupancy Awareness (using ADS-B and TIS-B)

Last Revised: December 2002

Description Source: **Federal Aviation Administration**, **US Department of Transportation**; *Safe Flight 21 Master Plan, Version 2.0*; p.3-8; April 2000

4.7.1 DESCRIPTION

This application provides pilots on final approach and on the runway with awareness of other aircraft that are on or approaching the runway.

The initial phase of this application provides awareness only of equipped aircraft and/or vehicles, and will be of benefit primarily in situations where all or nearly all aircraft/vehicles are equipped. Evaluation will initially be based on the capabilities of un-augmented GPS and basic CDTI, but augmented GPS or limited CDTI enhancements may be found necessary.

The second phase increases the value of the application by including non-ADS-B-equipped aircraft on the CDTI. The ADS-B data on the CDTI is augmented with TIS-B data from ground-based terminal and surface radar and multilateration techniques. This will provide the pilot of equipped aircraft with information on equipped and non-equipped aircraft, vehicles, and obstructions.

An operational evaluation was conducted under the SF21 program in 2002 to demonstrate applications and gather data on approach spacing, departure spacing, runway and final approach occupancy awareness, and airport surface situational awareness (Ref. 5).

4.7.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; p.3-8; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; December 1999
3. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Functional Specification*; May 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
5. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.2-49, February 2002
6. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001

4.8 Airport Surface Situational Awareness

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft*; p.10; December 1999

4.8.1 DESCRIPTION

During visual navigating of the airport surface, enhance pilot situational awareness by displaying an airport map with aircraft, vehicle, and obstacle positions based on ADS-B (and possibly TIS-B). GPS augmentation with WAAS is expected to be necessary (and adequate) for this application.

4.8.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; p.10; December 1999
3. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Functional Specification*; May 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-16-17, March 2002
5. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
6. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.2-48-52, February 2002
7. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001
8. Federal Aviation Administration, US Department of Transportation; *Operational Evolution Plan, Version 4.0,* Master Schedule p.8 , December 2001

4.9 Center Situational Awareness with ADS-B

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation;** *Safe Flight 21 Master Plan, Version 2.0*; p.3-9; April 2000

4.9.1 DESCRIPTION

This application provides center controllers with enhanced situational awareness of traffic in non-radar airspace by identifying ADS-B equipped aircraft and their trajectories on a controller display. This will aid the controller in providing procedural separation and other non-radar services and in coordinating with the tower controller on airspace changeovers between IFR en route operations and terminal area SVFR operations.

Potential uses of ADS-B to aid search and rescue and for communicating aircraft emergency conditions to the controller are being considered for inclusion in this application.

No mention of this specific Center application for ADS-B was found in the current CIP or NARP.

4.9.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; p.3-9; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; December 1999
3. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Functional Specification*; May 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
5. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001

4.10 Radar Like Services with ADS-B

Last Revised: December 2002

Description Source: **Federal Aviation Administration**, **US Department of Transportation**; *Safe Flight 21 Master Plan, Version 2.0*; p.3-10; April 2000

4.10.1 DESCRIPTION

This application provides terminal area controllers of non-radar airspace with surveillance, conflict alert and MSAW that are based on ADS-B, to enable provision of radar-like services to VFR and IFR aircraft. This includes emergency services, separation, sequencing, traffic and terrain advisories, navigational assistance, and route optimization. Aircraft not providing ADS-B are handled similarly to aircraft without a transponder in secondary radar airspace.
Initial implementation of this application has been accomplished under the SF21 Alaska Capstone program (Ref. 6). FY 2003 plans call for obtaining approval for “radar-like separation services” using ADS-B on Common ARTS (Ref. 4) as part of the SF21 Ohio Valley program.

4.10.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; p.3-10; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; December 1999
3. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Functional Specification*; May 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-16, March 2002
5. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
6. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.1-30, February 2002
7. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001

4.11 Tower Situational Awareness beyond Visual Range

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft*; p.13; December 1999

4.11.1 DESCRIPTION

Extend tower controller situational awareness of traffic that is beyond visual range, and aid in visual acquisition, by identifying aircraft and their trajectories on a tower display. Intended for VFR, SVFR and night operations, this aids tower-pilot and tower-center coordination by showing the over-all multiple-aircraft pattern of operations in the airspace rather than only those aircraft that are nearest the tower and within visual range. In SVFR operations this also helps the tower controller coordinate with the center controller on airspace changeovers between SVFR and IFR operations. Air-to-ground ADS-B messages will identify and give the trajectory of ADS-B equipped aircraft, and radar data will identify and give the trajectory of non-equipped aircraft that are within radar surveillance.

As part of the SF21 Alaska Capstone program, year 2002 plans call for installing ADS-B in Bethel Tower to increase controller situational awareness (Ref. 4). Research will continue through 2003 on enhanced vision systems, which demonstrated how use of enhanced vision technology supports tower controller information requirements under reduced visibility conditions (Ref. 6).

4.11.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; p.13; December 1999
3. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Functional Specification*; May 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B- 15, March 2002
5. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
6. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.1-101-107, February 2002
7. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001

4.12 Airport Movement Area Safety System (AMASS)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Aviation System Capital Investment Plan*; pp. Surveillance-3; January 1999

4.12.1 DESCRIPTION

This is an ASDE (Airport Surface Detection Equipment Radar) -3 enhancement that provides controllers with visual and aural alerts of potential runway incursions and surface movement conflicts. The system uses the ASDE-3 radar as the display/entry device, requiring no additional displays or entry devices in the tower. Controller entries are required for each change in runway configuration or operating condition. This will require defining the human/machine interfaces and air traffic control procedures.

Current plans call for developing and implementing the ASDE-X interface, and continuing the operational suitability demonstrations at additional sites (Ref. 1).

4.12.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-8, March 2002
2. Federal Aviation Administration, US Department of Transportation; *Aviation System Capital Investment Plan*; pp. Surveillance-3; January 1999
3. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2001-2005 Internet Version*; p. A-7; 9 August 2000
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-39; April 2001

4.13 Flight Informational Services Data Link (FISDL)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-40-41, March 2002

4.13.1 DESCRIPTION

Implementation of Flight Information Service Data Link (FISDL) will provide data link broadcasts of graphic and text FIS/weather products to the cockpit. This timely access to FISDL weather data provides better information to pilots, allowing them to make earlier decisions and reducing the incidence of weather-related GA accidents. Plans for 2002-2203 call for publication of standards for FIS-B data link communications and achievement of operational FISDL service.

4.13.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-40-41, March 2002
2. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-14; April 2001
3. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2001-2005 Internet Version*; p. A-23; 9 August 2000

4.14 Air Traffic Control/Airway Facilities Human Factors

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Aviation Research Plan, Internet Version*; pp. 2-163 to 2-168; April 2001; **Federal Aviation Administration, US Department of Transportation**; *National Aviation Research Plan,* p. 2.1-101-107, February 2002

4.14.1 DESCRIPTION

Human factors problems in today's operations involve human performance constraints and other complications that pose risk to the acquisition of ATC systems. The study of the relationship between shift work schedules and fatigue is identifying techniques for mitigating impacts on controller performance. Taxonomic analysis of operational errors is identifying improvements in how errors are investigated and reported, which in turn is leading to more effective safety interventions. Human factors research provides guidelines and other information for the design and development of ATC systems and product improvements. Tests and criteria for the selection of operational personnel improve applicant screening efficiency and validity.

Human factors research is organized around the following four thrusts:

Information Management and Display

- Determine when and how one might best display what, information through the computer-human interface (CHI); design the system to reduce the frequency of information transfer errors; and minimize the impact when such errors do occur. Display designs are optimized to reduce information overload

Human-Centered Automation

- Keep the operator in-the-loop and situationally aware of automated system performance while balancing operator workload; resolve issues related to the degradation of basic skills should the automation fail.

Human Performance Assessment

- Improve the quality of critical decisions; assess cognitive and con-textual factors leading to human error; develop effective countermeasures to reduce errors and performance inefficiencies; assess the impact of organization culture on performance; and improve and standardize methods for measuring human performance.

Selection and Training

_ Assess the knowledge, skills and abilities needed to excel in highly automated environments; assess retirement and attrition patterns to predict hiring requirements.

Current activities in these four areas are the following:

Information Management and Display

- Human Factors Design Guidance
- Human System Interface Integration
- AF Information Display and Management

Human-centered Automation

- Incremental Decision Support Tool Inter-Operability Assessments
- Tower Controller Flight Data Information Requirements
- Enhanced Vision Systems
- Situational Awareness in Centralized Monitor and Control

Human Performance and Assessment

- Runway Safety Analysis and Guidance/Booklet
- Examination of Causal factors Related to Operational Errors
- Airway Facilities Human Error Reporting Prototype
- Sector Team Communications
- ATC Sector Teamwork and Communications
- Controller Shift Work, Work Schedules, and Fatigue
- POWER Task Load and Performance Assessment of the Display System Replacement
- Team Processes in Centralized Monitor and Control Systems
- Organizational Assessment

Selection and Training

- Prototype Air Traffic Applicant Screening Systems
- Develop and Validate Computerized Application Evaluation Systems
- Prototype Workforce Analysis Tool Development and Analysis

4.14.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.1-101-107, February 2002
2. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-163 to 2-168; April 2001
3. Federal Aviation Administration, US Department of Transportation; William J. Hughes Technical Center; *Airway Facilities Human Factors: Research and Development Human Factors Laboratory Fact Sheet* (http://www.tc.faa.gov/its/cmd/visitors/data/ACT-500/airways.pdf); July 2001

4.15 Flight Deck/Maintenance/System Integration Human Factors

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Aviation Research Plan,* p. 2.1-93-100, February 2002

4.15.1 DESCRIPTION

The FAA is concerned with ensuring the safety and efficiency of operator performance through guidelines, handbooks, advisory circulars, rules, and regulations. It provides industry with human performance information and guidance critical to the design, operation, regulation, and certification of equipment, training, and procedures. The Human Factors Program conducts and manages research that provides the technical information necessary to generate these products and services.

Current activities in this program are the following:

Information Management and Display

- Complete Software Tools for Enhanced Maintenance Documentation
- Complete Human Factors Design and Evaluation for Electronic Flight Bag, Version 2.0/3.0
- Develop/Analyze General Aviation "Head Up" Display Information/Symbology Recommendations
- Address Human Factors issues in Cockpit Head Motion Box in Air Transport "Head Up" Displays
- Complete Computational Model to Assess Information Accessibility
- Determine Operational Criteria/Training Guidance for Night Vision Goggles in Rotorcraft Operations
- Determine Information Requirements for Situational Awareness to Avert CFIT in General Aviation
- Define Display Location Boundaries that Correspond to Eye/Head Position for General Aviation Aircraft

Human-centered Automation

- Provide industry and the FAA expanded guidance addressing training for automated cockpits.

- Complete human factors Certification Job Aid, version 3.0 for FAR Part 25 flight deck displays
- Develop certification guidelines for integrated technology in general aviation cockpits.

Human Performance Assessment

- Provide guidance on the effectiveness of realistic radio communications in line oriented evaluations.
- Provide expanded Aviation Performance Measuring System (APMS) methodologies and analysis capabilities
- Develop improved guidelines for aircraft accident investigation

Selection and Training

- Provide automation reconfigurable events sets
- Provide guidance for simulator motion requirements
- Develop/Distribute advanced analysis methods linking FOQA and simulator data.
- Develop training guidelines for flight deck error management.
- Develop materials to increase general aviation pilot skills to intervene in the accident chain of events
- Develop error avoidance strategies in aviation maintenance and inspection
- Demonstrate and validate the effectiveness of the MRM change program.

4.15.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.1-93-100, February 2002
2. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-156 to 2-162; April 2001

4.16 Weather Program – Safety

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Aviation Research Plan,* p. 2.1-6-9, February 2002

4.16.1 DESCRIPTION

FAA intends to provide weather observations, warnings, and forecasts that are more accurate, accessible, and efficient than existing services. These upgrades will enhance flight safety, reduce air traffic controller and pilot workload, improve flight planning, increase productivity, and enhance situational awareness. These efforts will provide efficiency and capacity benefits as well. The weather program directly supports the FAA Strategic Goal in the performance area of Safety: *"Through research, identify methods that, when implemented, would reduce the fatal accident rate due to weather."*

The applications supported by the weather/safety program, and their activities, are the following:

In-Flight Icing

- Icing Diagnosis Algorithm Approved by FAA for Operational Use
- Deliver probabilistic Integrated Icing Diagnosis Algorithm (IIDA) & Integrated Icing Forecast Algorithm (IIFA) to Users via Aviation Digital Data System (ADDS)

- Implement Extrapolation Features into In-Flight Icing Forecasts
- Test airborne detection systems

NEXRAD Algorithms

- Delivered Storm Tracker Algorithm to ROC for Implementation
- Deliver New Volume Coverage Pattern to ROC for Implementation
- Polarization into all NEXRADs

Aviation Forecast and Quality Assessment

- Implemented ADDS into FAA Operational Facilities, e.g., AFSS
- Implemented at Remote Television (RTV) at the Alaskan Aviation Weather Unit

Model Development and Enhancement

- Implemented 20KM RUC with Cloud Analysis at National Center for Environmental Protection
- Commence Real-Time Testing of Weather Research and Forecasting Model

Winter Weather Research

- Commenced Development of 2-4 Hour Freezing Precipitation Forecast
- Commence Development of Frost Prediction Algorithm

Turbulence

- Commenced Inclusion of In-Situ Turbulence Data Into Models
- Extend Turbulence forecasts to mid-levels (5,000-20,000 feet)

National Ceiling and Visibility

- Completed Development of Detailed Plan for National Ceiling and Visibility Program
- Complete Analysis of Northeast Corridor Data

4.16.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.1-6-9, February 2002
2. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-63 to 2-67; April 2001
3. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-30; April 2001

4.17 Weather Program – Efficiency

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Aviation Research Plan,* p. 2.2-4-7, February 2002

4.17.1 DESCRIPTION

FAA intends to provide weather observations, warnings, forecasts, and wake turbulence standards and procedures that are more accurate, accessible, and efficient than existing services. These upgrades will increase system capacity, improve flight efficiency, reduce air traffic controller and pilot workload, improve flight planning, increase productivity, and enhance situational awareness. These efforts will provide enhanced flight safety as well.

The weather program directly supports FAA Strategic Goal in the performance area of Efficiency by reducing delays.

The applications supported by the weather/efficiency program, and their activities, are the following:

Aviation Weather Analysis and Forecasting

- Convective Weather
  - Commenced Convective Weather Field Experiment in Northeast Corridor
  - Deliver Terminal Convective Weather Forecast Product to ITWS for Implementation
- Terminal Ceiling and Visibility
  - Implemented Consensus Forecast Product of Marine Stratus burn-off at SFO
- Airborne Humidity Sensor
  - Commence Evaluation of Combined Temp/Humidity Sensor
- Oceanic Weather
  - Commence Development of Oceanic Weather Products
  - Complete Oceanic Flight Level Winds Product

Wake Turbulence

- Complete SFO Wake Vortex Analysis to Enable Development of Revised Wake Separation Standards or Alternative Mitigation Procedures
- Complete ASAT Modeling at 2 to 3 Airports for Simultaneous Offset Instrument Approach Application at Closely Spaced Parallel Runways
- Complete Comprehensive Benefit Assessment at 4 to 6 Airports, Based on Results of FY 02 Airport-Specific Data Collection Efforts

4.17.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.1-93-100, February 2002

4.18 Next Generation Weather Radar (NEXRAD)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Aviation System Capital Investment Plan*; pp. Weather-4 – 5; January 1999

4.18.1 DESCRIPTION

The Departments of Commerce, Transportation, and Defense provide a national network of next-generation weather radars (NEXRAD) that detect, process, distribute, and display hazardous and routine weather information. The FAA's contributions under this program are the cost share funding of the entire system and acquisition and installation of 12 NEXRAD radars in Alaska, Hawaii, and Puerto Rico. These remote locations required modifications, such as power-conditioning systems, lightning grounding, bonding, shielding, and remote maintenance monitoring modules unique to the FAA.

A triagency operational support facility (OSF) has been established in Norman, Okla., and is responsible for system modifications, enhancements, and product improvements to the network.

OSF also provides such services as software maintenance, problem resolution, and configuration management.

OSF has implemented new software algorithms to alleviate anomalous propagation problems. Efforts are also underway to enhance algorithms that will improve the detection capability of aviation weather hazards and will be installed in future NEXRAD Builds. These enhancements will improve the effectiveness of NEXRAD data for aviation users and extend the data's useful life.

Also planned are sequential upgrades to the NEXRAD radar product generator (RPG) processor and the radar data acquisition (RDA) unit. This upgrade will consist of reconfiguring the RPG and RDA to a state-of-the-art, open-system architecture. The upgrade will replace the existing computer system to increase processing capacity and improve logistics supportability.

Current year 2003 plans call for award of production contracts to supply 40 airports with medium intensity airport weather systems (MIAWS) (Ref. 1).

4.18.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-6, March 2002
2. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.1-7-9, February 2002
3. Federal Aviation Administration, US Department of Transportation; *Aviation System Capital Investment Plan*; pp. Weather-4 – 5; January 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2001-2005 Internet Version*; p. A-5; 9 August 2000
5. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-30; April 2001

5. Navigation and Landing Enhancement Area

The Navigation and Landing enhancement area provides electronic and visual guidance to pilots/aircraft to enable safe and efficient use of the NAS. Capabilities include airborne, landing, and surface guidance. Information is provided to pilots to determine their location from point-to-point during flight with and without visual reference to the ground. This includes navigation reference definition, on-board navigation, remote determination of aircraft course and position, and approach and landing guidance.

The Navigation and Landing enhancement area consists of 2 applications:

5.1 Alternatives for Using GPS in Free Flight
5.2 Instrument Approach Procedures Automation (IAPA)

Their descriptions are provided below.

5.1 Alternatives for Using GPS in Free Flight

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Aviation Research Plan, Internet Version*; pp. 2-203 to 2-206; April 2001

5.1.1 DESCRIPTION

Determine the future navigation architecture and develop a consensus transition strategy, including the appropriate GPS augmentation capability needed to enable a successful transition to a more effective navigation architecture for the NAS.

The SF21 Capstone program is developing GPS non-precision approaches. The FAA has established a joint airspace technologies and initiatives group to modernize international aviation. The intended outcome is to meet compatibility requirements between the United States and the rest of the aviation world in such areas as Free Flight, GPS, the Flight Management System, the Precision Runway Monitor, and other emerging technologies.

5.1.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.1-30, p. 2.2-13, February 2002
2. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-203 to 2-206; April 2001
3. MITRE, Center for Advanced Aviation System Development; National Airspace System Architecture Alternatives; May 2001

5.2 Instrument Approach Procedures Automation (IAPA)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2002 - 2006*; pp. B-55 to B-56; April 2001

5.2.1 DESCRIPTION

Pilots use instrument approach procedures to land at airfields during IFR conditions. The FAA's National Flight Procedures Office develops and maintains all United States Civil Standard Instrument Approach Procedures (SIAP) as well as those operated by DoD. The FAA's requirement for developing and maintaining new procedures increases as new navigation technologies are implemented in the NAS. This program provides automated tools that allow

FAA specialists to develop more timely and accurate SIAPs and standard instrument departures.

5.2.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-52-53, March 2002
2. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002 - 2006*; pp. B-55 to B-56; April 2001

6. Traffic Management - Strategic Flow Enhancement Area

The Traffic Management - Strategic Flow enhancement area provides for orderly flow of air traffic from a national system perspective in order to maximize overall NAS throughput, flexibility, and predictability. Capabilities include long term planning, flight day traffic flow management, tactical Special Use Airspace (SUA) allocation, and traffic flow data archiving and performance assessment. This service strategically plans the number of aircraft using the national system to ensure safe, orderly, and efficient movement under varying operational conditions.

The Traffic Management – Strategic Flow enhancement area consists of 7 applications, listed below in order of appearance.

6.1 Collaborative Decision Making (CDM) - Enhanced Ground Delay Program (GDP)
6.2 Collaborative Decision Making (CDM) - Initial Collaborative Routing
6.3 Collaborative Routing Coordination Tool
6.4 Traffic Flow Automation System (TFAS)
6.5 Collaborative Decision Making (CDM) Enhancements
6.6 Equitable Allocation of Limited Resources
6.7 System Wide Evaluation and Planning Tool (SWEPT)

Detailed descriptions of each are provided where available.

6.1 Collaborative Decision Making (CDM)-Enhanced Ground Delay Program (GDP)

Last Revised: December 2002

Description Source **Federal Aviation Administration, US Department of Transportation**; *Free Flight Phase One Performance Metrics: An Operational Impact Evaluation Plan*; p.2-2; August 2000

6.1.1 DESCRIPTION

Collaborative Decision Making (CDM) was conceived out of the FAA's Airline Data Exchange experiments that began in 1993. These experiments proved that having airlines send updated schedule information to the FAA could improve air traffic management decision making. CDM has evolved from these same principles in an effort to improve air traffic management through information exchange and data sharing.

The initial focus of CDM, known as Enhanced Ground Delay Program (GDP-E), started prototype operations at San Francisco (SFO) and Newark (EWR) airports in January 1998. Under GDP-E, participating airlines send operational schedules and changes to schedules to the Air Traffic Control Systems Command Center (ATCSCC) on a continuous basis. This schedule information includes, but is not limited to, flight delay information, cancellations, and newly created flights. The ATCSCC uses this information to better implement and manage ground delay programs (GDPs).

GDP-E provides a more accurate view of demand, and it enables airlines to watch over and participate in ATM actions which directly affect their operations. Providing for simplified substitutions, control by arrival times, and daily download of flight schedules improves decision making, thereby reducing delays, unused slots, and needless modifications to schedules.

This application of CDM was part of the FFP1 program, which ended in December 2002. CDM applications will continue in FFP2 (Ref. 9).

6.1.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; Free Flight Phase One Performance Metrics: An Operational Impact Evaluation Plan; August 2000
2. Federal Aviation Administration, US Department of Transportation, Washington DC; National Airspace System Architecture Version 4.0; January 1999
3. Hoffman, R. and M. Ball; Measuring Ground Delay Program Effectiveness Using the Rate Control Index; NEXTOR, University of Maryland; April 2000
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5. Hall, Bill; Moving Toward Arrival-Departure GDP; December 1999
6. A Human Factors Process Survey of the Ground Delay Program – Enhancements Final Results; Crown Consulting, Inc., Washington, DC; August 1999
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8. Shisler, Lara; CDM GDPE Prototype Operations GDPE Overview: The First Year in Review; Metron, Inc. CDM Meeting; February 1999
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12. Federal Aviation Administration, US Department of Transportation; National Aviation Research Plan, Internet Version; pp. 2-203 to 2-206; April 2001

6.2 Collaborative Decision Making (CDM)-Initial Collaborative Routing

Last Revised: December 2002

Description Source **Federal Aviation Administration, US Department of Transportation**; Free Flight; http://ffp1.faa.gov/tools/tools_cdm.asp; July 2001

6.2.1 DESCRIPTION

This application enables traffic management specialists at the ATCSCC and traffic management coordinators at high altitude centers to share real-time traffic flow information among themselves and with the airline operation centers. This capability improves the overall national airspace system operational efficiency through the making of mutually acceptable, more efficient decisions in times of constrained traffic flow. The most common use of Initial Collaborative Routing is to create and assess rerouting strategies around hazardous weather.

This application of CDM was part of the FFP1 program, which ended in December 2002. CDM applications will continue in FFP2 (Ref. 2).

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6.3 Collaborative Routing Coordination Tool

Last Revised: December 2002

Description Source: **Thedford, William, et al., System Resources Corporation**; *En-Route Constrained Airspace Concept Definition*; p.41 – 42; September 1999

6.3.1 DESCRIPTION

Collaborative Routing Coordination Tool (CRCT) is a set of decision support capabilities designed for use by the local traffic manager or the ATCSCC specialist. Using CRCT, the traffic manager can examine congestion and traffic flow problems by identifying a Flow Constrained Area (FCA) as a region of airspace that causes an operationally significant congestion problem. A FCA may be a sector or group of sectors, an SUA, approach control airspace, individual fixes, dynamic events like a weather cell, or a manually identified area. CRCT supports rerouting decision making by a local traffic manager in six steps.

Identifying and Analyzing the Flow Problem Situation

- The Automated Problem Recognition (a CRCT feature) examines the traffic flow to identify congestion and weather problems. Traffic managers are able to monitor predicted sector loading in 30-90 minute time frame; alerts are generated when problems requiring attention are identified. A Flow Constrained Area is defined by the controller/traffic manager when a problem area is defined.

Locating Flights Involved in the Problem

- When an FCA is activated the traffic manager is provided with an automatically generated representation of flights that are predicted to pass through the FCA. The display may be a plan view display showing aircraft locations and routes or a tabular list. The traffic manager can filter the data to include only specific categories of flights (e.g., military flights or flights with a specific destination).

Developing the Reroute Strategy

- The traffic manager may define reroutes for specific flights using a point and click technique.

Evaluation of the Reroute Strategy

- When the reroutes are planned, inter-facility collaboration is initiated. Each facility involved in the collaboration will examine its sector loading and other factors. The traffic managers can modify the reroute strategy to accommodate the joint needs.

Coordinating the Reroute Strategy

- The collaboration produces a collective reroute strategy to include specific flights and reroutes of those flights.

Implementing the Reroute Strategy

- This jointly developed strategy is implemented by directing the controllers to give out the flight plan amendments as per current procedures.

CRCT is expected to be operational in the 5 to 10 year period. MITRE Corporation performed initial work in 1998 and 1999. There are plans to establish stand-alone capabilities at Herndon, VA and at the Kansas City center. These capabilities will function independently and will not be integrated into existing operational systems.

CRCT automatically identifies congestion and flow problems. The congestion measures are based on sector counts. A dynamic density measure has been developed to support the automated problem resolution and is being studied by MITRE. The FCAs are manually identified and activated. Collaboration is defined to be between FAA facility traffic managers and does not include the flight crew, flight deck, or the AOCs. The FCA is the focus for collaborative decision making. It is assumed that suitable communications technology is available.

As such, CRCT represents an excellent technological step that can provide a good foundation for Constrained Airspace Tool (CAT) concept exploration/prototyping to complement functional development. Although both CAT and CRCT activities are attempting to solve common en route "constrained" airspace problems, they complement+ each other in the following way. CRCT activities emphasize near-term implementation solutions (by the shear nature of the FAA/industry emphasis to accelerate early benefits to users by going operational in the '03-'05 timeframe). CAT activities on the other hand, would emphasize more concept exploration (particularly in the area of user collaboration, exploration of using/integrating more TFM control strategies than re-routing, and integration with sector DSTs).

The initial implementation of this tool was established in 2001 under FFP1-CDM. Milestones for CDM will be established for the FFP2 program (2002-2003) (Ref. 8).

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6.4 Traffic Flow Automation System (TFAS)

Last Revised: December 2002

Description Source: **Titan Systems Corporation, Air Traffic Systems Division**; *Overview Description, TFAS (Traffic Flow Automation System);* Prepared Under RTO-62, AATT Operational Concept for ATM – Year 2002 Update, June 2001

6.4.1 DESCRIPTION

The purpose of the Traffic Flow Automation System (TFAS) is to help Traffic Management Coordinators (TMCs) in the ARTCCs, ATCSCC), and TRACONs to manage the flow in domestic U.S. airspace and into 21 major pacing U.S. airports. TFAS will accomplish this by applying Center/TRACON Automation System (CTAS) technology to improve the short-term (up to 45 minutes into the future) reliability of the ATCSCC Enhanced Traffic Management System (ETMS) Monitor-Alert (M/A) tool.

The M/A function is based upon the *traffic demand* at each monitored airport, sector, and fix, and will generate an *alert* whenever traffic demand is projected to exceed a pre-defined *alert threshold*. The ARTCC TMCs, working with the impacted sector controllers, are then responsible for taking any required actions to alleviate the overload and achieve an orderly flow.

TFAS will simultaneously run multiple instances of CTAS (one for each of the 18 CONUS ARTCCs which includes the airspace surrounding the 21 pacing U.S. airports), on networked workstations or on multi-processor application servers, to create a national CTAS functionality. TFAS will function as a trajectory prediction and scheduling 'engine' for ETMS. TFAS will deliver useful information to the SCC and Traffic Management Units (TMUs) by improving the accuracy of the current ETMS. No new GUIs nor procedures will need to be developed nor added to the SCC/TMU toolset.

TFAS will be developed in two phases. Phase I will result in a demonstration system for evaluation by FAA ATCSCC personnel. It will be capable of being used as a daily-use operational test bed. Phase II will result in a robust operational augmentation to ETMS which can be turned over to the FAA for use as an operational system.

The FAA's ATCSCC and ARTCC TMCs use the ETMS to manage national and Center air traffic flows. By reducing ETMS trajectory-modeling errors, the effectiveness of the ETMS Monitor-Alert tool might be improved, thereby reducing delays due to en route congestion.

The TFAS system will be comprised of separate CTAS systems adapted to each of the TFAS Centers and airports, allowing for the most complete system, with minimal changes to the current version of CTAS. During Phase I, simplified adaptations of CTAS will be made. During Phase II, these will be modified to incorporate more advanced scheduling, routing, and procedural information as TFAS matures.

The underlying concept behind TFAS is to use the trajectory prediction capabilities of CTAS with Traffic Management Advisor (TMA) to improve upon the less accurate trajectory prediction capabilities of the current ETMS, which in turn improves the accuracy of the Monitor-Alert (M/A) function within ETMS. The improved accuracy will result in fewer false alerts of upcoming capacity bottlenecks and fewer missed alerts, that is, failure to get an alert when in fact an actual bottleneck occurs in the future. TFAS will only be used to improve sector M/A and will not affect fix or airport M/As.

TFAS will acquire flight plan, aircraft track, weather, and other information from ETMS via the Input Source Manager (ISM). The typical CTAS TMA system acquires aircraft data via an interface to the Center Host computer. This provides CTAS with flight plans and radar track data. The Host radar track data is updated every 12 seconds. The logistics and code modifications necessary for utilizing Host data at each facility preclude TFAS from using this Host data in Phase I. The TFAS Phase I will connect to the ETMS system for track and flight plan data.

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6.5 Collaborative Decision Making (CDM) Enhancements

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-15, B16; April 2001

6.5.1 DESCRIPTION

Flow constrained area information is made available for use on ETMS and a common constrained Situation Display for strategic planning. Sharing of data with industry is improved.

CDM enhancements are planned to be part of FFP2 (Ref. 1).

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6.6 Equitable Allocation of Limited Resources

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp.26, B-15, B16; April 2001

6.6.1 DESCRIPTION

Equitable Allocation of Limited Resources is a procedure to ensure that no single user bears a disproportionate share of delays as a result of CDM. It involves enhancing the ground delay and en route congestion management program to increase focus on ensuring equitable allocation of limited resources to balance demand density across the NAS.

There is no mention of this application area in the current CIP; however, CDM enhancements are planned as part of FFP2 (2003-2005).

6.6.2 BIBLIOGRAPHY

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6.7 System Wide Evaluation and Planning Tool (SWEPT)

Last Revised: January 2003

Description Source**: Titan Systems Corporation, Air Traffic System Division**, *System Wide Evaluation and Planning Tool (SWEPT) Operational Concept Description,* Prepared under RTO 72, AATT Operational Concept Description Update, 2003.

6.7.1 DESCRIPTION

SWEPT represents the next generation of TFM decision support tools (DSTs) that will improve the capabilities of the ATCSCC and TMUs to evaluate traffic flow management problems and initiatives that could be implemented to ameliorate such problems. The exact objectives and scope of SWEPT are not yet established, but they include:

- Support TFM specialists in the identification of effective TFM initiatives to alleviate predicted throughput problems associated with severe weather.
- Monitor current/proposed initiatives to determine effectiveness and identify when modifications may be necessary.
- Support the development of initiative modifications, when required.
- Analyze previously implemented initiatives to determine causes of ineffectiveness.
- Support the development of new approaches to handling severe weather.

SWEPT is in a preliminary definition phase, and as such, a clear statement of its capabilities cannot be put forward. However, a number of capabilities are under discussion and prototype development that will help better define its capabilities by 2004. The description here is a collection of *potential* capabilities that SWEPT might possess.

Regardless of what capabilities are ultimately defined for SWEPT, Future ATM Concept Evaluation Tool (FACET) will provide much of the underlying capabilities so a summary of FACET is provided here.

FACET currently has the following characteristics:

- FACET is a simulation tool for exploring advanced ATM concepts. It:
  - Is a flexible environment for rapid prototyping of new ATM concepts
  - Interfaces with the Host and ETMS data
  - Can be integrated with other tools of varying complexity and fidelity.
- FACET provides a balance between fidelity and flexibility. It:
  - Can be used to model airspace operations at a U.S. National level (up to 5,000 aircraft airborne at any one time)
  - Has a modular architecture for flexibility
  - Is written in “C” and “Java” programming languages that are easily adaptable to different computer platforms such as Sun, Silicon Graphics, PCs, and MACs.

- _ Can be used for both off-line analysis and real-time applications.

FACET provides the following principal functionalities:

- Modeling of en route airspace over the entire continental U.S.
  - _ Center and sector boundaries
  - _ Special Use Airspace boundaries
  - _ Jet Routes and Victor Airways
  - _ Locations of navaids and airports
- 4D trajectory modeling capabilities
  - _ Global Co-ordinate System
  - _ Fly flight-plan routes or direct (great circle) routes over round earth
  - _ Climb/descent performance models for 66 aircraft types, mapped to over 500 aircraft types
  - _ Dynamic models for turns and acceleration/deceleration
  - _ Weather models include winds (Rapid Update Cycle, Convective Cell Forecast Product)
  - _ Ability to add new class of vehicles (e.g., space launch vehicles)

Current analysis capabilities of FACET include:

- Visualization
  - _ Deeper understanding of current-day operations
  - _ New operational concepts
  - _ 2 and 3 D traffic displays
  - _ Display of real-time weather overlay on national traffic flow
  - _ Spatial distribution of congested sectors
  - _ Aircraft Usage of Sectors
- Traffic Flow Management Strategies
  - _ Impacts of airspace restrictions
  - _ Delays associated with miles-in-trail restrictions
  - _ Impacts of alternative restrictions
- Analysis and Benefits Study
  - _ Controller decision support tools
  - _ New vehicles/transportation modes
- Airspace design/utilization policy

SWEPT will have three modes of operation: Real-Time, Off-Line, and Research.

SWEPT Real-Time Mode: In real-time mode, the objective is to support ATCSCC and local TFM specialists in the development and monitoring of TFM initiatives. Some capabilities include:

- Connectivity to ETMS for static (boundaries, waypoints, etc.), dynamic (tracks, flight plans, etc.), weather (CCFP, etc.), and TFM advisory information.
- Monitoring of aircraft conformance with active advisories to identify impediments to initiative effectiveness. This capability will permit the ATCSCC to monitor the conformance of traffic flows to plays that have been initiated from the National Severe Weather Playbook and evaluate the effectiveness of such plays in alleviating traffic flow constraints. The ATCSCC will be able to determine which airline/aircraft are impacted by a play (or multiple initiatives) and how such airlines/aircraft are conforming to the desired actions.
- Planning capabilities (including simulation) to determine effective initiative modifications to alleviate impediments.

SWEPT will have alternative ways of representing congestion data taking into account relevant metrics and measures. It may integrate other TFM tools (e.g., FSM, POET, and DSP).

This mode will also serve as a hardware/software platform for developing additional real-time analysis and monitoring capabilities for the ATCSCC and TMUs.

SWEPT Off-Line Mode: In off-line mode, the objective is to analyze previous day initiatives for quality assurance. Some capabilities include:

- Performing fast-time playback of previous day situations with analysis capabilities to determine causes of initiative ineffectiveness.
- Simulation capability to try determine the effectiveness of alternate initiatives during these situations.
- Statistics generation to support reporting requirements.

SWEPT may have a capability to develop and evaluate new flow management procedures and methods using a flexible simulation environment build upon the FACET capabilities. It will have a number of submodes of operation that are yet to be determined. They may include:

- A training capability
- A real-time database of predicted trajectories to complement ETMS historical databases.

SWEPT Research Mode: It is desirable that researchers at NASA and the FAA have a SWEPT-like capability in order to support research into improve TFM tools. A Research Mode for SWEPT will represent that capability. It will support rapid prototyping and integration of any new tools into the operational SWEPT.

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7. Traffic Management - Synchronization Enhancement Area

The Traffic Management - Synchronization enhancement area supports the merging, sequencing and spacing of aircraft for efficient use of the NAS from the perspective of a local facility or group of facilities. Capabilities include synchronization of both airborne and surface traffic. This service tactically coordinates the number of aircraft using the local system to ensure safe, orderly, and efficient movement under varying operational conditions.

The Traffic Management – Synchronization enhancement area consists of 35 applications, listed below in order of appearance.

7.1 Active Final Approach Spacing Tool (aFAST)
7.2 Collaborative Arrival Planner (CAP)
7.3 Direct-To (D2)
7.4 En Route and Descent Advisor (EDA)
7.5 Expedite Departure Path (EDP)
7.6 Multi-Center Traffic Management Advisor (TMA MC)
7.7 Passive Final Approach Spacing Tool (pFAST)
7.8 Surface Movement Advisor (SMA)
7.9 Surface Management System (SMS)
7.10 Traffic Management Advisor (TMA)
7.11 Regional Metering (RM)
7.12 Autonomous Operations Planner
7.13 DAG CE-5 En Route Free Maneuvering
7.14 DAG CE-6 En Route Trajectory Negotiation
7.15 DAG CE-11 Terminal Arrival: Self Spacing for Merging & In-Trail Separation
7.16 User Request Evaluation Tool (URET)
7.17 Enhanced Visual Approaches (Visual acquisition with existing procedures, ADS-B only)
7.18 Enhanced Visual Approaches (with new procedures using ADS-B only)
7.19 Enhanced Visual Approaches (with new procedures using ADS-B and TIS-B)
7.20 Approach Spacing (for Visual Approaches)
7.21 Approach Spacing (for Instrument Approaches)
7.22 Enhanced Parallel Approaches in VMC/MVMC
7.23 Departure Spacing/Clearance (VMC in Radar)
7.24 Approaches to Closely Space Parallel Runways
7.25 Closer Climb and Descent in Non-Radar Airspace
7.26 In-Trail Spacing in En Route Airspace
7.27 Merging in En Route Airspace
7.28 Passing Maneuvers in En Route Airspace
7.29 Enhanced IMC Airport Surface Operations
7.30 Radar Like Services with ADS-B
7.31 Evaluation of FFPI Tools
7.32 Problem Analysis Resolution and Ranking (PARR)

Detailed descriptions of each are provided where available.

7.1 Active Final Approach Spacing Tool (aFAST)

Last Revised: December 2002

Description Source: **Titan Systems Corporation, Air Traffic Systems Division**; *Overview Description, aFAST (Active Final Approach Spacing Tool),* Prepared Under RTO-62, AATT Operational Concept for ATM – Year 2002 Update, May 2001

7.1.1 DESCRIPTION

Active FAST is designed to deal with the complexities of inter-arrival spacing within the TRACON (particularly on the final approach path). Active FAST generates "control instruction" level advisories whereby controllers issue specific speed and heading instructions based upon the advisories. Advisories will be displayed to controllers via their standard terminal color displays. Dedicated aFAST displays will be provided for TMCs in the ARTCC and TRACON. These displays will be used for strategic planning. Displays will also be available in the Tower. The Tower displays will provide enhanced situational awareness.

As arrivals enter the TRACON, they are assigned a runway and sequence number. Active FAST builds a plan for these arrivals based on aircraft performance characteristics, airspace constraints, and separation requirements. A trajectory for each aircraft is created and adjusted based on real time radar updates. These trajectory calculations include identification of when and where each aircraft should receive speed adjustments or headings. These speeds and headings will eventually be able to be incorporated into future technologies such as Datalink. However, in the near term operational environment, these advisories will be displayed in logical increments (e.g. speeds of 210 knots and 180 knots, headings in 10 degree increments) to the TRACON arrival controller so that they can be issued as control instructions. Active FAST continues to monitor and update the plan based upon radar track updates. The plan is modified when necessary, and ultimately leads to an optimized delivery of aircraft to the runway threshold.

The primary users of the aFAST advisories are the TRACON arrival controllers. However, many other users can benefit from the information. Other controllers within the TRACON can view the aFAST advisories to better understand the arrival controller's plan (e.g. a departure controller may want to know whether or not an arrival may be instructed to slow down or turn). TMCs in the TRACON can use the aFAST information to make dynamic runway changes for aircraft near the TRACON boundary. The information displayed on the Planview Graphical User Interface (PGUI) can also help the TMCs in the TRACON and ARTCC better understand the traffic situation inside the TRACON. Controllers in the ATCT can also benefit from the PGUI by observing where gaps will occur in the arrival stream (for runway crossings or departure slots).

The aFAST system uses aircraft flight plans and position data from FAA computers, inputs from TRACON arrival controllers and traffic managers, and current weather information, to produce advisories to assist controllers in managing and controlling arrival traffic. The weather information is provided either by the Rapid Update Cycle (RUC), or by the Integrated Terminal Weather System (ITWS). RUC provides a weather forecast every 3 hours (80 km grid). ITWS provides a weather forecast every 5 minutes (2 km grid).

TRACON arrival controllers interact with aFAST, both receiving advisories and providing inputs, through standard FAA hardware. The aFAST advisories will be displayed to TRACON controllers on FAA TRACON display systems. Controller inputs will be made through message entry devices. Traffic managers interact with aFAST through dedicated aFAST displays. They provide inputs such as runway spacing requirements, airport configuration, and airport acceptance rates. Traffic managers in both the ARTCC and TRACON may monitor aFAST timelines to gain a more accurate picture of the real-time operation in the TRACON.

aFAST is planned as a follow-on to the previously-implemented pFAST (FFP1).

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7.2 Collaborative Arrival Planner (CAP)

Last Revised: December 2002

Description Source: **National Aeronautics and Space Administration, Ames Research Center**; *Center TRACON Automation System – CAP Fact Sheet*; April 2000

7.2.1 DESCRIPTION

The CAP is an extension of the NASA CTAS, a set of software DSTs that provides computer-generated advisories to assist both Center and TRACON traffic management coordinators and air traffic controllers in the efficient management and control of terminal area air traffic. While

Center TRACON Automation System (CTAS) was designed to assist air traffic service providers (air traffic managers and controllers), CAP assists the users of the NAS (air carriers) by leveraging and expanding the capabilities of CTAS. A specialized CAP Display System was designed and developed in order to facilitate the sharing of CTAS Traffic Management Advisor (TMA) information with air carriers. The CAP Display System provides air carriers with the same CTAS TMA information that is used by air traffic managers and controllers to plan and control the flow of arrival traffic into DFW. In cooperation with the FAA and air carriers, CAP Display Systems were installed at American Airlines and Delta Airlines facilities in DFW in 1998 and 1999, respectively. The CAP Display Systems have assisted air carrier operations in both AOC and Airline Ramp Tower settings by providing accurate time of arrival predictions and situational awareness of Center and TRACON operations.

A major impediment to an airline's ability to accurately predict arrival times for its aircraft is uncertainty in the magnitude of terminal-area ATC delays. At Fort Worth Center, terminal area delays are calculated and assigned to each arrival aircraft by the CTAS TMA. Controllers then issue speed and heading commands to arrival aircraft in order to meet TMA scheduled times of arrival. Because the TMA scheduled times of arrival are actually used to control the flow of arrival traffic, they are more accurate than airline estimates of arrival time. Analysis of airline and CTAS data has shown that for a typical arrival rush period, 66% of the TMA scheduled times of arrival fall within 2.2 minutes of the actual times of arrival, compared to 5.8 minutes for airline predictions.

In addition to improved time of arrival predictions, CAP Display Systems provide airlines with better situational awareness of Center and TRACON operations. The CAP Displays allow airlines to see real-time aircraft position and speed data and assigned landing runway. Airlines also have access to air traffic management information including both current and planned runway configuration and airport arrival rate. This is the first time that real-time air traffic management information used to control arrival traffic has been shared with air carriers.

Based on the success of the CAP Display Systems at American and Delta Airlines, it is expected that CAP will aid all airlines that hub at sites where CTAS operates. To aid in the dissemination of CTAS data, airlines have requested that NASA provide CTAS TMA data in digital format so that it can be integrated into their own decision support systems. In coordination with the FAA, NASA is working with the Volpe Center to develop the capabilities to distribute CTAS TMA information to the airlines via the CDMnet. This should enable greater collaboration between the airlines and air traffic management, further reducing the economic impact of ATM restrictions on the airlines and increasing airline operational efficiency.

No new information was available on CAP for this document update.

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7.3 Direct-To (D2)

Last Revised: December 2002

Description Source: **Titan Systems Corporation, Air Traffic Systems Division**;, *Direct-To (D2)Operational Concept Description;* Prepared Under RTO-72, AATT Operational Concept for ATM – Year 2002 Update, December 30, 2002

7.3.1 DESCRIPTION

D2 is an R-side controller decision support tool that helps controllers work more efficiently and facilitates flying time savings for airspace users. D2 provides advisories for traffic conflicts and time saving direct routing opportunities and includes a rapid feedback trial-planning function that allows the controller to quickly visualize, analyze, and input route and altitude changes. The D2 user interface will be fully integrated with the R-side Traffic Situation Display (TSD). D2 is based on CTAS trajectory analysis methodology and software. All CTAS tools use common software for input data processing and 4D trajectory synthesis. D2 functionality is available by connecting one additional software module to an existing CTAS TMA system.

D2 route advisories and conflict information are displayed in the flight data block and in optional lists on the controller's traffic display. A mouse (or track-ball) click on a conflict advisory, either in the flight data block or the Conflict List, toggles a graphic display of conflict information. A mouse click on the data block activates the trial planning function which shows a graphic display of the trial route, and analyzes the route for traffic conflicts, preferential routing restrictions, and flying time. The trial planner allows the controller to quickly select a different fix and/or add an auxiliary waypoint, by a point and click action. A final mouse click sends the flight plan amendment to the Host computer.

The D2 DST will provide the following functionality to en route controllers:

- A list of potential Direct-To proposed routes, called the Direct-To List, that can be displayed in a window on the DSR radar screen. The proposed direct routes are those that have been calculated to save at least one minute of flying time from the current flight plan-designated route.
- A list of potential aircraft conflicts predicted to occur within the next 20 minutes, called the Conflict List, that can be displayed in a window on the DSR radar screen. This list includes all aircraft under active control in a sector, not only those that are eligible for a Direct-To route.
- A trial planning function that can be activated by mouse clicking on a conflict-pair in the Conflict List or a proposed direct route in the Direct-To List. The trial planner also provides the controller with a flexible interface to select and preview desired flight plan changes directly on the radar screen. Upon acceptance of a trial plan, the trial planner provides automated flight plan amendments to the host computer.

- A fourth line in the Flight Data Block for each flight, highlighting potential conflicts and direct routes. A mouse click on either the conflict field or the direct route advisory field in the data block invokes the trial planning function. Access to the conflict information, direct route information and the trial planner through the data block provides an alternative to the Direct-To and Conflict Lists in windows that could obscure portions of the radar screen.

The conflict graphics that can be displayed through either a mouse click on the conflict field in the Flight Data Block or the associated entry in the Conflict List, show the trajectories of both aircraft including any pertinent top-of-climb or bottom-of-descent points for transitioning aircraft.

D2 is included as a priority research effort under the FFP2 program. Plans for FY 2003 call for lab and field evaluations of D2 (Ref. 17).

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7.4 En Route and Descent Advisor (EDA)

Last Revised: December 2002

Description Source: **Green, S., Vivona, R.**; *AATT En route Descent Advisor (EDA) Concept, NASA AATT Milestone 5.10*; NASA Ames Research Center; September 1999

7.4.1 DESCRIPTION

The En-route Descent Advisor (EDA) is a suite of decision support tool (DST) capabilities designed to assist controllers to enable user-preferred metering and separation in the departure, cruise, and arrival phases of flight. EDA provides fuel-efficient advisories for flow-rate conformance and integrates those advisories with conflict detection and resolution (CD&R) capabilities.

Although adaptable to today's ATC procedures and airspace structure, EDA is designed for the future "Free-Flight-like" environment characterized by dynamic constraints and minimal route structure. EDA lends itself well to such environments where it will facilitate the transition of "random" traffic into an efficient/organized flow at the destination. EDA capability will facilitate the transition of en route procedures from today's "sector" orientation to a "trajectory" orientation. A trajectory orientation is key to enabling Distributed Air-Ground Traffic Management (DAG-TM) concepts in en route airspace.

The EDA concept is based on the development of procedures, DST capabilities, and supporting technologies, to facilitate trajectory-orientated operations resulting in a more efficient and productive en route ATC service. Trajectory-oriented solutions are enabled by providing controllers with active flow-rate-conformance advisories (integrated with CD&R capabilities) and accurate 4D-trajectory predictions. This will reduce the workload and operating costs associated with ATC interruptions/deviations, result in fuel-efficient flow-rate conformance, and form the foundation necessary to support DAG-TM (Free Flight) concepts.

In recent years, EDA capabilities have been de-emphasized in order to emphasize near-term applications including the Conflict Probe and Trial Planner (CPTP) and Direct-To (D2) capabilities. CPTP and D2 are both EDA spin-offs designed to manage traffic that is not subject to flow-rate constraints. Although the benefits of conflict probing and user-preferred trajectories have historically been associated with EDA, these benefits will not be considered here; instead, this report will focus on the unique aspects of EDA over and above these basic capabilities.

FY 2002 work on EDA focused on Build 2 development, which focuses on arrival metering and represents the implementation of Center Automation and Sequencing Tool (CAST) functionality within the CTAS baseline (Ref. 1). The current technical challenge is to advance this multi-build program to successfully develop EDA.

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7.5 Expedite Departure Path (EDP)

Last Revised: December 2002

Description Source: **Titan Systems Corporation, Air Traffic Systems Division**; *Expedite Departure Path (EDP) Operational Concept Description;* Prepared Under RTO-72, AATT Operational Concept for ATM – Year 2002 Update, December 21, 2002

7.5.1 DESCRIPTION

The primary purpose of EDP is to increase the efficiency of departure operations while maintaining or increasing current levels of safety. EDP is also expected to provide a multitude of environmental compatibility enhancements to current departure traffic management practices: reduced fuel burn, reduced noise impact, and reduced terminal area emissions. Lastly, EDP will provide accurate pre-departure time-to-fly estimates to ground-based departure planning tools, significantly enhancing their ability to match airspace throughput to capacity (and reduce taxi delays).

EDP is a decision support tool aimed at providing TRACON TMCs with pertinent departure traffic loading and scheduling information, and radar controllers with advisories for tactical control of TRACON departure traffic. EDP employs the CTAS trajectory synthesis routine to provide conflict-free altitude, speed and heading advisories. These advisories will assist the TRACON departure controller in efficiently sequencing, spacing and merging departure aircraft into the en route traffic flow. The anticipated benefits of EDP include a reduction in airborne delay for departure aircraft, reduced fuel burn and reduced noise impact due to expedited climb trajectories. EDP will eventually share information with both surface and arrival decision support tools to form an integrated decision support system capable of planning, coordinating and executing highly efficient terminal airspace operations

EDP is intended to provide optimized schedules and advisories to departure controllers, while meeting constraints from flow control and ensuring the efficient and safe flow of outbound traffic from airports into en route control sectors. EDP is designed to provide climb profiles as well as lateral path guidance that should allow efficient, uninterrupted climb-out, and safe merge of the flight into en route traffic.

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7.6 Multi-Center Traffic Management Advisor (TMA MC)

Last Revised: December 2002

Description Source: **Titan Systems Corporation, Air Traffic Systems Division**; *Traffic Management Advisor Multi Center (TMA-MC);* Prepared Under RTO-72, AATT Operational Concept for ATM – Year 2002 Update, December 18, 2002

7.6.1 DESCRIPTION

TMA-MC is the extension of TMA-SC to regions where multi-center coordination is required. Ideally, TMA-MC and TMA-SC would be identical, except for the need to coordinate TMA-generated planning information between the facilities. Therefore, TMA-MC will operate in the same way as TMA-SC with minimal restrictions added for acceptable joint facility operation.

One of the ARTCCs involved in the flow management process is assigned the responsibility of entering scheduling parameters into the TMA-MC system. It is expected that the ARTCC TMU whose host computer is associated with the TRACON approach control will make these entries. In general, every TRACON has one and only one controlling ARTCC from a TMA-MC perspective. Any ARTCCs that are computing ETAs for aircraft bound to a TRACON that the ARTCC does not control would send the ETA information to the TMA-MC system in the controlling ARTCC. The planning function in the controlling ARTCC TMA-MC would create the integrated schedule for all flights arriving at the primary airport and send the STAs back to the contributing CTAS systems.

The parameters entered by the controlling ARTCC TMC appear on all TMA displays, including those at the supporting ARTCCs, the TRACON and the ATCSCC. The availability of a TMA display at the ATCSCC would enhance the collaborative planning between ATC facilities. In addition to the scheduling parameters, all TMA displays show the schedule that has been developed by the controlling ARTCC. This schedule assigns airport and arrival fix crossing times to flights to make efficient use of airport arrival capacity and to equitably distribute delay among flights.

After the schedule has been modified by the controlling ARTCC TMC to manage flow and workload, the scheduled arrival fix crossing times are broadcast from the controlling ARTCC TMA to the sector controller displays. The implementation of TBM by the controller in the TMA-MC case follows the same procedures as the TMA-SC case. Controllers give speed and descent clearances and use vectors to control flights to cross the arrival fix at the assigned time. If necessary, controllers can swap the assigned slots for flights that have the same approach speed profiles. The complexity and congestion of the TMA-MC airspace may cause unavoidable delay. This may, in turn, cause some flights to miss their assigned arrival fix crossing time. The frequency of occurrence of this phenomenon and the severity of impact on the overall arrival situation will be the subject of further analysis. As the TBM plan is being implemented, TMCs at the TRACON monitor performance and evaluate the need for re-planning of the arrival schedule.

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7.7 Passive Final Approach Spacing Tool (pFAST)

Last Revised: December 2002

Description Source: **National Aeronautics and Space Administration, Ames Research Center**; *Center TRACON Automation System – FAST Fact Sheet*; April 2000

7.7.1 DESCRIPTION

The Final Approach Spacing Tool (FAST) is a decision support tool for terminal area (TRACON) air traffic controllers. The TRACON typically encompasses the airspace within approximately 40 miles of a major airport. TRACON air traffic controllers manage arrival aircraft, which enter their airspace from adjacent ATC facilities or internal airports. The controllers are responsible for assigning an appropriate runway and landing sequence to each aircraft and maintaining safe separation.

FAST assists air traffic controllers by providing its advisory information on the radar planview displays. Additionally, FAST assists traffic management coordinators by providing schedule information on auxiliary timeline displays.

Early in the development of FAST, its functionality was divided into two parts: Passive and Active. Passive advisories consist of runway assignments and landing sequences to increase the efficiency of runway usage. Active advisories consist of turn and speed commands to increase the precision of final approach spacing.

The strength of an automation system such as FAST is its ability to assign runways based upon accurate estimations of delay savings and workload benefits early in the arrival process. The FAST runway allocation algorithm attempts to meet four primary objectives: making an early and accurate decision, reducing overall system delay, increasing overall system throughput and reducing controller workload.

During each scheduling cycle, FAST builds a trajectory for each aircraft from its current position to the runway threshold. The FAST sequencing algorithm uses these trajectories to systematically order aircraft on common trajectory paths and to merge aircraft on different trajectory paths. Fuzzy reasoning is used to model the controllers' cognitive processes related to determining an efficient landing sequence.

Using the relative sequences of aircraft on each trajectory path, FAST performs conflict prediction and resolution in order to achieve a conflict-free arrival plan. The criteria considered during conflict prediction are wake vortex minimum separation, custom runway specific separation and custom flight-specific separation. When a conflict is predicted, it is resolved by adding delay to the aircraft's trajectories in the form of vectoring and speed control.

PFAST was part of the FAA's FFP1 program, which ended December 2002. PFAST was deployed at Dallas-Fort Worth and southern California TRACON.

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7.8 Surface Movement Advisor (SMA)

Last Revised: December 2002

Description Source: **Lawson, Dennis R. Federal Aviation Administration, US Department of Transportation**, **Office of Air Traffic Systems Development**; *Surface Movement Advisor* http://atm-seminar-97.eurocontrol.fr/lawson.htm; July 2000

7.8.1 DESCRIPTION

SMA is a 100% user-defined system that facilitates an unprecedented sharing of dynamic information among airlines, airport operators, and air traffic controllers. It introduces a decentralized airport "Situational Awareness" tool that presents to the system users the effects that previous, current, and future arriving and departing aircraft had, are having, and will have on parking ramps, gates, taxiways, and runways. For example, SMA provides help to air traffic controllers, supervisors, and coordinators in selecting optimum airport configurations and the specifics on each aircraft before it "pushes back" from the gate for departure. SMA also gives airlines and airport officials touchdown, takeoff, and taxi time predictions for each aircraft as well as access to air traffic control plans for runway utilization, instrument departure routings and airport/runway configurations. This real-time data has potentially huge tactical and strategic monetary value. In addition, several aspects of SMA support the establishment of the "Free Flight" concept as outlined by the RTCA Committee on Free Flight.

SMA's objective, from the outset, focused on reducing only taxi-out times by one minute per operation. Preliminary results from Hartsfield-Atlanta International Airport, where the SMA prototype is undergoing testing, have indicated a reduction in taxi times of over two minutes per operation -- well over 2000 minutes per day.

SMA was part of FFP1 initiatives. Its success has led to development of the Surface Management System, part of FFP2 research.

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7.9 Surface Management System (SMS)

Last Revised: December 2002

Description Source: **Titan Systems Corporation, Air Traffic Systems Division**; *Surface Management System (SMS);* Prepared Under RTO-72, AATT Operational Concept for ATM – Year 2002 Update, November 21, 2002

7.9.1 DESCRIPTION

NASA Ames Research Center, in cooperation with the FAA, is developing the SMS, a decision support tool that helps controllers and air carriers collaboratively manage the movements of aircraft on the surface of busy airports, thereby improving capacity, efficiency, and flexibility.

Detailed information about the future departure demand on airport resources is not currently available in real-time to operational specialists at air traffic control (ATC) facilities and air carriers. SMS provides controllers, traffic managers, and air carrier decision-makers with accurate predictions of the future departure situation (e.g., queuing and delays for individual aircraft, and aggregate demand for each runway or other constrained resources), as well as advisories to help manage surface movements and departure operations.

SMS will predict departure demand over a time horizon similar to that over which the Center-TRACON Automation System (CTAS) Traffic Management Advisor (TMA) supports arrival management using surface surveillance, surface trajectory synthesis algorithms that are functionally equivalent to the CTAS airborne trajectory modeling algorithms, and air carrier predictions of when each flight will want to push back. SMS will provide near-term predictions of departure sequences, times, queues, and delays for runways or other resources to support tactical control of surface operations, and longer time-horizon forecasts of aggregate departure demand (i.e., total demand per intervals of time) to support strategic surface planning. Initially, SMS will display this information in the ATC tower (ATCT) and air carrier ramp towers. In the future, SMS may also display information in the TRACON Traffic Management Unit (TMU), Center TMU, and Airline Operations Centers (AOCs). Displays similar to TMA timelines and load graphs may be used, depending on the recommendations from human factors studies.

SMS will also use its ability to predict the future state of the airport surface to support departure management decisions. For example, SMS will aid the ATCT in constructing departure sequences that efficiently satisfy various departure restrictions (e.g., Miles-in-Trail (MIT) and Expected Departure Clearance Times (EDCTs)). Subsequent development efforts will extend SMS to interoperate with arrival and departure traffic management decision support tools (e.g., the CTAS Final Approach Spacing Tool (FAST), TMA, and Expedite Departure Path (EDP) tool) to provide additional benefits (e.g., coordination of arrival/departure interactions).

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7.10 Traffic Management Advisor (TMA)

Last Revised: December 2002

Description Source: **Titan Systems Corporation, Air Traffic Systems Division;** *Overview Description, Traffic Management Advisor (TMA);* Prepared Under RTO-62, AATT Operational Concept for ATM – Year 2002 Update, April 2001

7.10.1 DESCRIPTION

The TMA portion of CTAS generates schedules for aircraft arriving at a TRACON facility. The Center air traffic controllers and Traffic Management Coordinators (TMCs) manage arriving aircraft that enter the Center from an adjacent Center or depart from feeder airports within the Center. On the basis of the current and future traffic flow, the TMC creates a plan to deliver the aircraft, safely separated, to the TRACON at a rate that fully uses, but does not exceed, the capacity of the TRACON and destination airports. The TMC's plan consists of sequences and scheduled times of arrival (STAs) at meter fixes, published points that lie on the Center-TRACON boundary. The Center air traffic controllers issue clearances to the aircraft in the Center so that they cross the meter fixes at the STAs specified in the TMC's plan. Near the TRACON, the Center controllers handoff the aircraft to the TRACON air traffic controllers.

TMA meters aircraft to "fixes," navigational waypoints used by controllers, pilots, or both, and then to the runway threshold. Build 2 TMA uses "time" as a metering unit rather than "miles-in-trail." The controllers in the TMU observe displays that either show time-lines with aircraft on them or a plan-view of the ARTCC airspace around the adapted airport similar to the plan-view displays controllers currently use to separate and control aircraft. The time-lines show controllers an STA and an ETA for each aircraft. Each time line shows STAs or ETAs to either a meter fix or to the destination runway's threshold. Although only the destination Towers, TRACONs, and ARTCCs see these displays, the flight is monitored by TMA through out its journey.

TMA-SC and TMA-MC will continue to be researched as part of the FFP2 program in 2002 and 2003.

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7.11 Regional Metering (RM)

Last Revised: December 2002

Description Source: **Titan Systems Corporation, Air Traffic Systems Division**; *Regional Metering Operational Concept Description – Draft*, Prepared under NASA AATT RTO-72, October 1, 2002

7.11.1 DESCRIPTION

RM is a novel approach to solving TFM congestion problems at a local and regional level safely, effectively, efficiently, and in collaboration with airspace users. RM fills an operational gap between national (strategic) TFM actions on a 3-6 hour time horizon, and local arrival metering (a la CTAS TMA) on a 20-40 minute time horizon. This gap includes the regional (inter-Center) metering of arrivals upstream of TMA-served airports, local metering of arrivals to airports not supported by TMA/McTMA, and RM of airspace congestion (independent of destination. It further improves CDM and ensures more equitable distribution of delays.

RM operationally replaces the inefficient practice of MIT spacing with a more general, flexible, adaptable, and efficient technique of time based metering. The approach emphasizes control at the local level to enable air traffic service providers with adequate flow controls while maximizing discretion at the local level as to how flow restrictions are conformed to. By orienting TFM restrictions to a time basis, RM enables TMCs to better orchestrate flows from multiple directions and more equitably distribute delays. The time basis also facilitates the CDM concept of Delay Banking. By leveraging CTAS technology to form the building blocks of RM, this capability can be integrated with the other CTAS tools to form a cohesive set of decision support capabilities for en route airspace.

RM capabilities defined herein include algorithms, software functions, processes, and graphical user interfaces (GUI) that can be readily implemented within the FAA's current operational architecture by extension and/or modification to NASA-developed CTAS software and systems, and/or the integrated use of software functions and off-line processes developed upon a SWEPT/FACET platform. RM functions and capabilities include:

- **Perform RM Downstream Planning (Constraint Generation).** This involves the dynamic detection/monitoring of traffic flow/congestion problems (that require RM). This capability is primarily for Downstream Center (DSC) TMCs to help determine when RM restrictions will be needed, but the capability is also available to Upstream Center (USC) TMCs to facilitate a common situational awareness and cooperative USC-DSC planning.
- **Perform RM Upstream Conformance.** This deals with implementation of metering restrictions within the upstream Center/facility.
- RM provides the sector controller with RM data and conformance advisories (e.g., delay feedback) to facilitate efficient path-independent conformance to the target metering times using the process and systems already established to support Free Flight Phase 1 / 2 capabilities (such as TMA arrival metering and trial planning).
- **Coordination/negotiation of metering restrictions between upstream (USC) and downstream (DSC) facilities** (shown as various information flows between facilities and functions). The operational concept is to maximize the DSC's ability to formulate restrictions that will serve its flow needs while maximizing the flexibility of the USC to conform. This requires mutual acceptance of the restriction details. To facilitate collaboration between

TMCs within and between facilities, particularly for inter-Center (USC-DSC) coordination, RM introduces the capability of “Active” and “Provisional” flow-restriction planning.

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7.12 Autonomous Operations Planner

Last Revised: December 2002

Description Source: **Ballin, M.G., Sharma, V., Vivona, R.A., Johnson, E.J., and Ramiscal, E.,** *A Flight Deck Decision Support Tool For Autonomous Airborne Operations*, AIAA-2002-4554, AIAA Guidance, Navigation, and Control Conference, Monterey CA, August 2002.

7.12.1 DESCRIPTION

AOP is a cockpit-based DST that, when integrated with an airborne Flight Management System (FMS), provides the core capability in support of NASA Langley's free flight research. In both en route and terminal areas, AOP enables cockpit crews to select and manage their flight paths, achieving autonomous flight in a distributed control environment. Support capabilities include integrated state-based and intent-based CD&R for separation assurance and integration with airborne navigation and guidance systems for strategic planning.

The main user of AOP is the cockpit's flight crew. Similar to EDA, AOP relies heavily on accurate 4D path predictions for its own aircraft and other traffic in the vicinity to provide CD&R and strategic planning advisories. Because of their critical role to AOP processing and for comparison with EDA examples, illustrations of AOP intent modeling will also focus on the development of aircraft path predictions.

The Autonomous Operations Planner (AOP) will provide flight crews information for en route free maneuvering. AOP functions include:

- Own ship trajectory pre-processing
- Traffic trajectory change point trajectory generation
- Traffic aircraft trajectory estimation
- Traffic trajectory change monitor
- Own ship trajectory change monitor
- Implantation of NLR (Netherlands Research Lab) conflict prevention displays and algorithms into AOP
- Constraint management
- Traffic state flight plan/trajectory generation

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7.13 DAG-TM Concept Element (CE) - 5 En Route Free Maneuvering

Last Revised: December 2002

Description Source: **Titan Systems Corporation, Air Traffic Systems Division**; *DAG-TM CE5 En Route Free Maneuvering Operational Concept Description*, Prepared under NASA AATT RTO-72, September 23, 2002

7.13.1 DESCRIPTION

The purpose of DAG-TM CE 5 is to eliminate excessive and non-preferred trajectory deviations resulting from separation assurance and/or local TFM conformance constraints. Another major purpose is to distribute the separation assurance and tactical traffic management functions to the flight deck, greatly adding to the “scalability” of the system. Finally, CE 5 will allow greater user flexibility and autonomy that is consistent with the goals of the industry efforts towards Free Flight.

Appropriately equipped aircraft accept the responsibility to maintain separation from other aircraft, while exercising the authority to freely maneuver in en route airspace in order to establish a new user-preferred trajectory that conforms to any active local TFM constraints.

In order to implement free maneuvering, several system capabilities are necessary. First, information exchange among all actors must be expanded. CE 5 relies on DAG-TM CE 0, Information Access/Exchange for Enhanced Decision Support, to define the required information. For the autonomous aircraft flight deck situation awareness, this includes:

- State and intent information about other aircraft

- Current and predicted NAS constraint information (delays, flow initiatives, SUA status)
- 4D weather information (winds, temperature, turbulence, storm cells, icing, etc.)
- Real-time pilot reports from aircraft maneuvering near weather-impacted areas

This information comes directly from the ground infrastructure or from other aircraft.

Second, new automation is necessary for both the flight deck and ATC. The flight deck needs automation to process the incoming information for situation awareness, and to assist in the creation of valid, optimized trajectories based on that incoming information. ATC automation also needs to be enhanced for situation awareness, including awareness of free maneuvering aircraft.

Third, the roles and responsibilities of flight crews and the ATSP must be established. Today, trajectory change authority resides only with the ATSP. In the free maneuvering concept, either the flight crew or the ATSP may have authority, depending on the situation. Also, free maneuvering aircraft must be integrated with managed aircraft. The capability for this meshing of ground and airborne traffic management must be achieved for free maneuvering to be successful.

The controller role changes significantly under the CE 5 concept. The controller retains responsibility for all aircraft that are not free maneuvering. The controller uses CD&R decision support tools to assure separation for managed aircraft, and also to monitor the activities of all aircraft. In the case of a potential conflict between a managed and a free maneuvering aircraft, procedures and flight rules are followed by the free maneuvering aircraft and the controller acting on behalf of the managed aircraft. The traffic management coordinator (TMC) continues to set localized TFM constraints as today. Potential changes in the TMC role are a subject for research.

In order to eliminate the “shared” responsibility between air and ground, free maneuvering aircraft will be given priority over managed aircraft, and the resolution of such conflicts will be accomplished by moving the managed aircraft, clearly the responsibility of the ATSP. This priority status for the autonomous aircraft may also provide an incentive for aircraft to equip for free maneuvering capability.

There are a number of assumptions that follow from the distributed responsibility concept. First, controllers’ interaction with free maneuvering aircraft consists of advisories and traffic management directives, such as the need to meet an RTA or to avoid areas of traffic saturation. Second, a free maneuvering aircraft may make trajectory changes without restriction, with the exception that it shall not make a maneuver that creates a new conflict with any aircraft (free maneuvering or managed) within “N” minutes away. Third, free maneuvering aircraft need automatic dependent surveillance broadcasts from other free maneuvering aircraft for adequate situation awareness. These broadcasts should include (at a minimum) state and preferably intent and occur at a frequency of about 1 per second.

Fourth, to complete situation awareness, free maneuvering aircraft need to receive a traffic information broadcast from the ground (unless we assume that all aircraft are equipped for automatic dependent surveillance – broadcast) which includes equivalent data on managed aircraft. These broadcasts may be constrained to every 5 or 12 seconds due to the radar update rate.

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7.14 DAG-TM Concept Element - 6 En Route Trajectory Negotiation

Last Revised: December 2002

Description Source: **Titan Systems Corporation, Air Traffic Systems Division**; *DAG-TM CE5 En Route Free Maneuvering Operational Concept Description*, Prepared under NASA AATT RTO-72, January 8, 2003

7.14.1 DESCRIPTION

The purpose of DAG-TM CE 6 is to integrate flight deck (FD) and air traffic service provider (ATSP) automation to reduce controller workload, reduce flight path deviations, and to enable user preferred trajectories (UPT).

CE 6 will accomplish this purpose through:

- Basic data exchange between ATC and an aircraft/user to support the calibration of air and ground decision support capabilities;
- User and ATSP negotiation for user-preferred trajectory changes:
  - The user formulates UPT (based on constraints) and transmits to the ATSP
  - The ATSP evaluates UPT for approval and amends constraints as needed
- CTAS-FMS integration to facilitate:
  - Reduced datalink/CTAS input workload
  - Trajectory-based clearances and improved flight conformance

DAG-TM CE 6 provides an ATSP focus for implementing en route trajectory negotiation within the framework of distributed decision-making between users and the ATSP. The ATSP retains full responsibility for separation assurance, but users are integrated into the solution processes. Users are able to exercise initiatives and participate in the en route decision-making processes pertaining to the resolution of traffic problems (conflicts and conformance with TFM constraints). CE 6 provides the mechanisms for dynamically incorporating user-determined trajectory data and preferences into the assessment and the resolution or avoidance of potential violations. These mechanisms include processes for exchanging information, identifying and evaluating complex traffic situations, and determining and implementing solutions.

The trajectory negotiation process implemented in CE 6 identifies, reviews and resolves traffic management situations requiring corrective or approval action with respect to potential violations of aircraft separation and local TFM constraints. This process emphasizes the use of continual updates of flight and atmospheric information together with advanced decision support tools to support high-fidelity trajectory prediction and situation assessment and real-time collaboration between users and the ATSP. This approach:

- Enables the ATSP, FD and AOC operations to accurately assess situations and formulate resolution options;
- Affords the ATSP the opportunity to present information to users describing traffic situation and trajectory constraints;
- Affords users the opportunity to present self-optimization preferences for ATSP consideration;
- Promotes the application of resolutions that are sensitive to user preferences; and
- Promotes the use of aircraft and ATSP automation to reduce workload associated with the detection and resolution of traffic problems.

The resulting ATSP flexibility in determining airspace use allows aircraft to fly efficient trajectories based on the changing traffic and atmospheric conditions.

For effective trajectory negotiation, CE 6 requires development of advanced ATSP, FD and AOC automation, and their operational and technical integration based on advanced communications capabilities and human-centered pilot and controller pilot procedures and technologies. These functions must be properly structured and integrated to enable users and the ATSP to evaluate traffic situations accurately and determine and implement optimal courses of action. The operational integration focuses on the establishment of human-centered processes and interfaces for using the computer-derived information cooperatively among the ATSP, FD and AOC to make the best use of trajectory negotiation. The technical integration focuses on derivation, transmission and compilation of valid flight data for use by computerized systems to evaluate and predict actual trajectories, identify and examine constraints and generate trajectory alternatives with high accuracy.

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7.15 DAG-TM Concept Element - 11 Terminal Arrival: Self Spacing for Merging & In-Trail Separation

Last Revised: December 2002

Description Source: **Titan Systems Corporation, Air Traffic Systems Division**; *DAG-TM CE-11*, *Terminal Arrival: Self Spacing for Merging and In-Trail Separation* Prepared under NASA AATT RTO-72, December 12, 2002

7.15.1 DESCRIPTION

CE 11 will bring greater runway throughput and flight efficiency at busy terminal areas and runways by providing the capability for the flight crew to adhere to strategic clearances such as maintaining precise time spacing with other aircraft.

The general idea behind the concept is that implementing a distributed control system, possibly involving integrating the FMS and CDTI avionics with the ATM system, would enable the FC to provide tighter control of the merging and spacing processes. The excess spacing buffers that exist between consecutive aircraft during approach could be reduced. This spacing buffer reduction could increase runway throughput. In addition, voice communications between the FC and the controller should be reduced which may permit additional throughput at busy airports.

This concept is based on the general hypothesis that enabling distributed approach control conducted by the individual participating FCs would provide greater flight efficiency and other benefits and would be more cost effective than providing the air traffic service provider (ATSP) with more automation tools to pursue the same benefits. Future research experiments are to be conducted to prove or disprove this hypothesis.

A basic premise of CE 11 is that a designated "string leader" aircraft follows a desired speed profile from TRACON entry to the Final Approach Fix (FAF) or threshold. The next arriving aircraft is cleared by ATM to merge behind the immediate Lead and then to self-space according to some accepted spacing criterion. This second aircraft then becomes the Lead aircraft for the next (third) arrival aircraft in the string, etc. Various specified spacing gaps are used to account for different wake vortex spacing constraints based upon aircraft type, and allowances for departing aircraft on the runway. Also, natural spacing gaps will occur because of the distribution of arrival aircraft over time. Thus, there will be need to re-start the strings from time to time.

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7.16 User Request Evaluation Tool (URET)

Last Revised: December 2002

Description Source: **The MITRE Corporation, Center for Advanced Aviation System Development**; *User Request Evaluation Tool*; http://www.caasd.org/proj/uret/index.html, July 2000

7.16.1 DESCRIPTION

The User Request Evaluation Tool, or URET, was developed at MITRE’s Center for Advanced Aviation System Development (CAASD) to assist controllers with timely detection and resolution of predicted problems. By helping to manage workload and to allow more strategic planning, URET will help the system support a greater number of user-preferred flight profiles, increased user flexibility, and increased system capacity while maintaining the level of safety. URET processes real-time flight plan and track data with site adaptation, aircraft performance characteristics, and temperature and wind data to build four-dimensional flight profiles, or trajectories, for all flights within a facility or inbound to it. When a conflict (i.e., possible loss of separation) is detected, URET determines which sector to notify and displays an alert to that sector up to 20 minutes prior to the conflict. This longer look-ahead gives controllers more time for strategic planning.

URET combines real-time flight plan and radar track data with site adaptation, aircraft performance characteristics, and winds and temperatures aloft to construct four-dimensional flight profiles, or trajectories, for pre-departure and active flights. For active flights, it also adapts itself to the observed behavior of the aircraft, dynamically adjusting predicted speeds, climb rates, and descent rates based on the performance of each individual flight as it is tracked through en route airspace, all to maintain aircraft trajectories to get the best possible prediction of future aircraft positions.

URET uses its predicted trajectories to continuously detect potential aircraft conflicts up to 20 minutes into the future and to provide strategic notification to the appropriate sector. (A *conflict* is a predicted loss of both horizontal and vertical separation criteria; the ATC system is set up to avoid conflicts.) Trajectories are also the basis for the system's trial planning capability. Trial planning allows the controller to check a desired flight plan amendment that resolves conflicts before a clearance is issued. The controller can then construct the flight plan amendment from that trial plan with the click of a button. The system enables expeditious coordination of these plans and amendments among sectors and facilities with its auto-coordination function.

URET is included in FAA's Free Flight Phase 2 program. URET proved to be beneficial in managing flight diversions on 9/11/01. Current plans call for URET to be deployed at all en route centers by the end of 2005. Seven centers will have URET by the end of FFP1, and the remaining 13 Centers will receive the tool between 2003 and 2005 (Ref. 11).

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7.17 Enhanced Visual Approaches (Visual acquisition with existing procedures, ADS-B only)

Last Revised: December 2002

Description Source: **Federal Aviation Administration**, **US Department of Transportation**; *Safe Flight 21 Master Plan, Version 2.0*; pp.3-4 – 3-5; April 2000

7.17.1 DESCRIPTION

This application helps pilots visually acquire and identify the aircraft called-out by controllers prior to visual approach clearances by showing the identity and trajectory of aircraft on a CDTI. By using the CDTI to aid in the transition to a visual approach, the procedure will be used more often and more efficiently. Visual approaches are the backbone of operations at major airports in the US and provide greater arrival capacity than IFR operations. During visual approaches, traffic advisories are issued to pilots, and once the pilot confirms acquisition of traffic and runway, a visual approach clearance is issued. Most facilities have specific established minima to which visual approaches can be conducted; however, specific environmental conditions such as haze, sunlight, and patchy clouds may result in the suspension of visual approaches at higher ceiling and visibility values. CDTI may help enhance visual approach operations in one of several ways including:

- Improved visual traffic acquisition
- Reduction in pilot and controller workload
- Increased reliability of conducting visual operations to established minima
- Reduction in the minima to which visual approaches are conducted

The first phase of the application avoids significant changes to air traffic management (ATM) communication procedures by not including flight ID in traffic call-outs by controllers. This phase also avoids requiring any additional functionality in the ground automation systems by relying solely on the ADS-B of equipped aircraft for the information displayed on the CDTI.

The second phase of the application extends current pilot/controller procedures for visual approaches to take explicit advantage of the positive identification of traffic that is supported by ADS-B/CDTI. The procedures for traffic call-out by the controller to a CDTI equipped aircraft will be changed to include the flight ID of the traffic. This is expected to further enhance the safety and efficiency of visual approaches.

In the third phase of the application, non-equipped aircraft appear on the CDTI based on a Traffic Information Service Broadcast (TIS-B) of ground radar-based data. This makes the application more broadly usable in situations of mixed equipage. This phase of the application will address the TIS-B function in the ground automation systems and the human factors issues of presenting TIS-B targets on the CDTI.

Enhanced visual approaches are evaluated as part of the SF21 Ohio Valley program.

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7.18 Enhanced Visual Approaches (with new procedures using ADS-B only)

Last Revised: December 2002

Description Source: **Federal Aviation Administration**, **US Department of Transportation**; *Safe Flight 21 Master Plan, Version 2.0*; pp.3-4 – 3-5; April 2000

7.18.1 DESCRIPTION

This application helps pilots visually acquire and identify the aircraft called-out by controllers prior to visual approach clearances by showing the identity and trajectory of aircraft on a CDTI. By using the CDTI to aid in the transition to a visual approach, the procedure will be used more often and more efficiently. Visual approaches are the backbone of operations at major airports in the US and provide greater arrival capacity than IFR operations. During visual approaches, traffic advisories are issued to pilots, and once the pilot confirms acquisition of traffic and runway, a visual approach clearance is issued. Most facilities have specific established minima to which visual approaches can be conducted; however, specific environmental conditions such as haze, sunlight, and patchy clouds may result in the suspension of visual approaches at higher ceiling and visibility values. CDTI may help enhance visual approach operations in one of several ways including:

- Improved visual traffic acquisition
- Reduction in pilot and controller workload
- Increased reliability of conducting visual operations to established minima
- Reduction in the minima to which visual approaches are conducted

The first phase of the application avoids significant changes to ATM communication procedures by not including flight ID in traffic call-outs by controllers. This phase also avoids requiring any additional functionality in the ground automation systems by relying solely on the ADS-B of equipped aircraft for the information displayed on the CDTI.

The second phase of the application extends current pilot/controller procedures for visual approaches to take explicit advantage of the positive identification of traffic that is supported by ADS-B/CDTI. The procedures for traffic call-out by the controller to a CDTI equipped aircraft will be changed to include the flight ID of the traffic. This is expected to further enhance the safety and efficiency of visual approaches.

In the third phase of the application, non-equipped aircraft appear on the CDTI based on a TIS-B broadcast of ground radar-based data. This makes the application more broadly usable in situations of mixed equipage. This phase of the application will address the TIS-B function in the ground automation systems and the human factors issues of presenting TIS-B targets on the CDTI.

Enhanced visual approaches are evaluated as part of the SF21 Ohio Valley program.

7.18.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; pp.3-4 – 3-5; April 2000

2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; December 1999
3. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Functional Specification*; May 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-16, March 2002
5. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
6. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001

7.19 Enhanced Visual Approaches (with new procedures using ADS-B and TIS-B)

Last Revised: December 2002

Description Source: **Federal Aviation Administration**, **US Department of Transportation**; *Safe Flight 21 Master Plan, Version 2.0*; pp.3-4 – 3-5; April 2000

7.19.1 DESCRIPTION

This application helps pilots visually acquire and identify the aircraft called-out by controllers prior to visual approach clearances by showing the identity and trajectory of aircraft on a CDTI. By using the CDTI to aid in the transition to a visual approach, the procedure will be used more often and more efficiently. Visual approaches are the backbone of operations at major airports in the US and provide greater arrival capacity than IFR operations. During visual approaches, traffic advisories are issued to pilots, and once the pilot confirms acquisition of traffic and runway, a visual approach clearance is issued. Most facilities have specific established minima to which visual approaches can be conducted; however, specific environmental conditions such as haze, sunlight, and patchy clouds may result in the suspension of visual approaches at higher ceiling and visibility values. CDTI may help enhance visual approach operations in one of several ways including:

- Improved visual traffic acquisition
- Reduction in pilot and controller workload
- Increased reliability of conducting visual operations to established minima
- Reduction in the minima to which visual approaches are conducted

The first phase of the application avoids significant changes to ATM communication procedures by not including flight ID in traffic call-outs by controllers. This phase also avoids requiring any additional functionality in the ground automation systems by relying solely on the ADS-B of equipped aircraft for the information displayed on the CDTI.

The second phase of the application extends current pilot/controller procedures for visual approaches to take explicit advantage of the positive identification of traffic that is supported by ADS-B/CDTI. The procedures for traffic call-out by the controller to a CDTI equipped aircraft will be changed to include the flight ID of the traffic. This is expected to further enhance the safety and efficiency of visual approaches.

In the third phase of the application, non-equipped aircraft appear on the CDTI based on a Traffic Information Service Broadcast (TIS-B) of ground radar-based data. This makes the application more broadly usable in situations of mixed equipage. This phase of the application will address the TIS-B function in the ground automation systems and the human factors issues of presenting TIS-B targets on the CDTI.

Enhanced visual approaches are evaluated as part of the SF21 Ohio Valley program.

7.19.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; pp.3-4 – 3-5; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; December 1999
3. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Functional Specification*; May 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-16, March 2002
5. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
6. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001

7.20 Approach Spacing (for Visual Approaches)

Last Revised: December 2002

Description Source: **Federal Aviation Administration**, **US Department of Transportation**; *Safe Flight 21 Master Plan, Version 2.0*; p.3-5; April 2000

7.20.1 DESCRIPTION

This application will provide the pilot with additional cues on the CDTI regarding the dynamics of the aircraft that the pilot is following to improve safety and efficiency. The first phase of this application will additional cues on the on visual approach and guidance toward achieving a desired interval. These cues and guidance are expected to allow the pilot to make more consistent and efficient visual approaches.

The second phase of this application will apply these tools (with extension if needed) for instrument approaches. Spacing near minimum radar separation standards will provide more consistent arrival intervals and higher arrival rates. The pilot will receive radar vectors from ATC to intercept the approach course, and at an appropriate time will be given a spacing interval behind the preceding arrival. At a later time, further enhancements to the CDTI may aid in optimizing protection from wake vortex induced by the lead aircraft.

The concept of “approach spacing” is evaluated as part of the SF21 Ohio Valley Program.

7.20.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Master Plan, Version 2.0; p.3-5; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; December 1999
3. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Functional Specification; May 1999
4. Federal Aviation Administration, US Department of Transportation; National Airspace System Capital Investment Plan Fiscal Years 2003-2007, p. B-16, March 2002
5. Federal Aviation Administration, US Department of Transportation; National Airspace System Capital Investment Plan Fiscal Years 2002-2006; pp. B-29 – B-30; April 2001
6. Federal Aviation Administration, US Department of Transportation; National Aviation Research Plan, Internet Version; pp. 2-22 – 2-26; April 2001

7.21 Approach Spacing (for Instrument Approaches)

Last Revised: December 2002

Description Source: **Federal Aviation Administration**, **US Department of Transportation**; *Safe Flight 21 Master Plan, Version 2.0*; p.3-5; April 2000

7.21.1 DESCRIPTION

This application will provide the pilot with additional cues on the CDTI regarding the dynamics of the aircraft that the pilot is following to improve safety and efficiency. The first phase of this application will additional cues on the on visual approach and guidance toward achieving a desired interval. These cues and guidance are expected to allow the pilot to make more consistent and efficient visual approaches.

The second phase of this application will apply these tools (with extension if needed) for instrument approaches. Spacing near minimum radar separation standards will provide more consistent arrival intervals and higher arrival rates. The pilot will receive radar vectors from ATC to intercept the approach course, and at an appropriate time will be given a spacing interval behind the preceding arrival. At a later time, further enhancements to the CDTI may aid in optimizing protection from wake vortex induced by the lead aircraft.

The concept of “approach spacing” is evaluated as part of the SF21 Ohio Valley Program.

7.21.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; p.3-5; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; December 1999
3. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Functional Specification*; May 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-16, March 2002
5. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
6. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001

7.22 Enhanced Parallel Approaches in VMC/MVMC

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft*; p.7; December 1999

7.22.1 DESCRIPTION

During visual approaches to parallel runways the controller will point out traffic to both runways to the pilot. Once the pilot confirms visual acquisition of the preceding traffic to own runway and (if the runways are separated by less than 4300 feet) visual acquisition of the traffic to the parallel runway, a visual approach clearance is issued. If a visual approach cannot be conducted the controller must provide the appropriate radar separations. The use of CDTI based on ADS-B and possibly TIS-B will be used to assist the pilot in acquiring and identifying the other traffic so that visual approaches to parallel runways can be made more often in VMC and MVMC.

No mention of this specific application was found in the current CIP or NARP.

7.22.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; December 1999

3. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Functional Specification*; May 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
5. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001

7.23 Departure Spacing/Clearance (VMC in Radar)

Last Revised: December 2002

Description Source: **Federal Aviation Administration**, **US Department of Transportation**; *Safe Flight 21 Master Plan, Version 2.0*; p.3-6; April 2000

7.23.1 DESCRIPTION

Often minimum spacing is not obtained on departure because of controller workload, pilot response time, and/or limitations of radar surveillance. However, if the CDTI function can aid pilots in departing and maintaining spacing behind a leading aircraft, the controller may be able clear the aircraft for departure based on CDTI spacing and gain additional throughput over the departure routes.

Departure spacing applications are part of the SF21 Ohio Valley program.

7.23.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; December 1999
3. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Functional Specification*; May 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
5. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.2-48-49, February 2002
6. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001

7.24 Approaches to Closely Space Parallel Runways

Last Revised: December 2002

Description Source: None

7.24.1 DESCRIPTION

No description available.

The Precision Runway Monitor program will provide the capability to conduct independent simultaneous IFR approaches on parallel runways spaced less than 4,300 feet apart.

7.24.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; p. xiii; April 2000
2. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-, March 2002
3. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2., February 2002
4. Pritchett, A., B. Carpenter, et. al., Department of Aeronautics and Astronautics, Massachusetts Institute of Technology; *Issues in Airborne Systems for Closely-Spaced Parallel Runway Operations*;

AIAA/IEEE FOURTEENTH DIGITAL AVIONICS SYSTEMS CONFERENCE, CAMBRIDGE, MA, NOVBEMBER, 1995
5. Bone, Randall S., Oscar Olmos, and Anand Mundra, MITRE, Center for Advanced Aviation System Development; *Paired Approach: A Closely Spaced Parallel Runway Approach*

7.25 Closer Climb and Descent in Non-Radar Airspace

Last Revised: July 2001

Description Source: None

7.25.1 DESCRIPTION

No description available.

7.25.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; p. xiii; April 2000

7.26 In-Trail Spacing in En Route Airspace

Last Revised: July 2001

Description Source: None

7.26.1 DESCRIPTION

No description available.

7.26.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; p. xiii; April 2000

7.27 Merging in En Route Airspace

Last Revised: September 2001

Description Source: None

7.27.1 DESCRIPTION

No description available.

7.27.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; p. xiii; April 2000
2. National Aeronautics and Space Administration, Ames Research Center, *Center TRACON Automation System – Expedite Departure Path*; http://ctas.arc.nasa.gov/project_description/edp.html, July 2000

7.28 Passing Maneuvers in En Route Airspace

Last Revised: July 2001

Description Source: None

7.28.1 DESCRIPTION

No description available.

7.28.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; p. xiii; April 2000

7.29 Enhanced IMC Airport Surface Operations

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft*; p.7; December 1999

7.29.1 DESCRIPTION

IMC surface operations with CDTI builds on the surface situational awareness application to allow maneuvering around an airport using a traffic/map display while in IMC down to CAT-3B. Visual acquisition of proximate aircraft, vehicles, and obstacles may be required. However, potentially all navigation may be performed solely with a traffic/map (based on on-board databases, ADS-B and TIS-B).

Under the SF21 Ohio Valley program, applications are being evaluated to enhance surface situational awareness with cockpit-based tools, displays, and maps. The concept of operations for the surface moving map was planned to be completed in 2002. Evaluations of the avionics were planned to take place in the 2002-2005 time frame.

7.29.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; December 1999
3. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Functional Specification*; May 1999
4. Federal Aviation Administration, US Department of Transportation; *Operational Evolution Plan, Version 4.0,*p. 34 and Master Schedule p.8 , December 2001
5. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
6. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001

7.30 Radar Like Services with ADS-B

Last Revised: December 2002

Description Source: **Federal Aviation Administration**, **US Department of Transportation**; *Safe Flight 21 Master Plan, Version 2.0*; p.3-10; April 2000

7.30.1 DESCRIPTION

This application provides terminal area controllers of non-radar airspace with surveillance, conflict alert and MSAW that are based on ADS-B, to enable provision of radar-like services to VFR and IFR aircraft. This includes emergency services, separation, sequencing, traffic and terrain advisories, navigational assistance, and route optimization. Aircraft not providing ADS-B are handled similarly to aircraft without a transponder in secondary radar airspace.

Initial implementation of this application has been accomplished under the SF21 Alaska Capstone program. FY 2003 plans call for obtaining approval for "radar-like separation services" using ADS-B on Common ARTS as part of the SF21 Ohio Valley program.

7.30.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; p.3-10; April 2000

2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; December 1999
3. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Functional Specification*; May 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-16, March 2002
5. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
6. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.1-30, February 2002
7. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001

7.31 Evaluation of FFPI Tools

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Aviation Research Plan,* p. 2.4-11, February 2002

7.31.1 DESCRIPTION

This application conducts evaluations of Free Flight Phase 1 capabilities to gather information on their utilization and on the system benefits derived from their use (FY 2002 activity).

7.31.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.4-11, February 2002
2. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-203 to 2-206; April 2001
3. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-14 – B-15; April 2001

7.32 Problem Analysis Resolution and Ranking (PARR)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. 26, B-15 – B-16; April 2001

7.32.1 DESCRIPTION

Problem Analysis Resolution and Ranking (PARR) is a set of tools that will assist the en route D-position controller in the management of flight data derived URET. It will also assist the controller in the development of strategic resolution for aircraft-to-aircraft and aircraft-to-airspace conflicts, in responding to hazardous weather conditions, and for complying with TFM metering times and flow instructions.

PARR will be evaluated as part of FFP2 priority research support efforts. Current plans call for laboratory and field evaluations in 2002 and 2003.

7.32.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-43, March 2002
2. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. 26, B-15 – B-16; April 2001

8. Airspace Management Enhancement Area

The Airspace Management enhancement area ensures the safe and efficient use of airspace as a national resource through design, allocation, and stewardship of the airspace. Capabilities include airspace design and strategic management of SUA. Classification of airspace to balance the varied needs of user groups and the general public in a safe and efficient manner is accomplished by this service including the development of airspace structures, route structures, and aeronautical charts.

The Airspace Management enhancement area consists of 10 applications, listed below in order of appearance.
8.1 Reduced Separation Standards with ADS-B
8.2 Houston Area Air Traffic System
8.3 Northern California TRACON
8.4 Potomac TRACON
8.5 (DoD)/FAA ATC Facility Transfer
8.6 Airspace Management Laboratory
8.7 Airspace Redesign Enhancements
8.8 General Aviation and Vertical Flight Technology Program
8.9 Separation Standards
8.10 Domestic Reduced Vertical Separation Minima

Detailed descriptions of each are provided where available.

8.1 Reduced Separation Standards with ADS-B

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft*; p.14; December 1999

8.1.1 DESCRIPTION

As confidence is gained in the fusion of radar and ADS-B data and in the procedures that depend on this fused data, the separation standards might be reduced. The safety of the system would have to be proven not to be adversely impacted by this reduction. The benefit would be an increase in throughput through the en route and terminal areas.

This application is not mentioned in the current CIP or NARP.

8.1.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Master Plan, Version 2.0*; April 2000
2. Federal Aviation Administration, US Department of Transportation; Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft; December 1999
3. Federal Aviation Administration, US Department of Transportation; *Safe Flight 21 Functional Specification*; May 1999
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-29 – B-30; April 2001
5. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-22 – 2-26; April 2001

8.2 Houston Area Air Traffic System

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-47; April 2001

8.2.1 DESCRIPTION

This application provides expansion of three city-owned airports to expand capacity. Includes deployment of navaids for new runways, lighting systems, reconstruction at Houston Hobby and a new TRACON servicing the airports. TRACON expansion to support new runway at George Bush Intercontinental Airport, followed by replacement of TRACON with fourth runway construction.

No current information is provided on this in the current CIP.

8.2.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-39, March 2002
2. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-47; April 2001

Northern California TRACON

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Aviation System Capital Investment Plan*; pp. Facilities-4 – 5; January 1999

8.2.3 DESCRIPTION

With the increase of air traffic in major metropolitan areas, the terminal airspace structure has become inefficient, which has resulted in flight delays, circuitous routings, and complex ingress/egress procedures.

This application will consolidate terminal area air traffic control facilities and restructure associated airspace. Consolidation of facilities enables restructuring of the airspace to improve its efficiency. Consolidation provides benefits for the FAA and users. The FAA benefits from reduced operations and maintenance costs; user benefits include reduced delays, more direct routings, fewer altitude changes, and increased system capacity.

This application has been expanded to meet requirements mandated by public law and Executive order for facility accessibility and structural/nonstructural seismic reinforcement of occupied Federal buildings. It consolidates the Oakland, Sacramento, Stockton, and Monterey approach control facilities, along with selected sectors from the Oakland ARTCC. The objectives are increased capacity and greater efficiency and economy of operations. Airspace redesign will precede consolidation, allowing a 6-month transition strategy. Initially, a hybrid ARTSIIIE/EDC STARS automation will be deployed to permit commissioning on schedule. This will ultimately be transitioned to a full STARS final system capability platform when it becomes available.

Plans for 2003 call for completion of decommissioning of the legacy TRACONs.

8.2.4 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-36, March 2002
2. Description Source: Federal Aviation Administration, US Department of Transportation; *Aviation System Capital Investment Plan*; pp. Facilities-4 – 5; January 1999

3. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2001-2005 Internet Version*; p. A-29; 9 August 2000
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-42; April 2001

8.3 Potomac TRACON (PCT)

Last Revised: September 2001

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-41; April 2001

8.3.1 DESCRIPTION

This application addresses the consolidation of the Dulles, Reagan National, Baltimore-Washington and Andrews Air force Base TRACONs into a single control facility to modify the associated airspace. Year 2002 plans call for commissioning of the PCT; year 2003 plans call for PCT airspace redesign.

8.3.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-25, March 2002
2. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-41; April 2001
3. Federal Aviation Administration, US Department of Transportation; *Welcome to the FAA Potomac Consolidated TRACON*; August 2001

8.4 DoD/FAA ATC Facility Transfer

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-44; April 2001

8.4.1 DESCRIPTION

This application designates selected approach controls to be transferred from the DoD to the FAA.

8.4.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-76, March 2002
2. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-44; April 2001

8.5 Airspace Management Laboratory

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Aviation Research Plan, Internet Version*; pp. 2.2-28-31; April 2001

8.5.1 DESCRIPTION

The mission of the Air Traffic Airspace Management Program Office (ATA) is to ensure that the sectorization and routes are designed for the safest and most efficient use by operators, while maintaining diligent consideration for local and national environmental policy, to meet the demand for air transportation.

The ATA Airspace Laboratory serves to support that mission by providing detailed, quality information through the creation of databases, simulation modeling for the analysis and reporting or presentation aids for ATA and Region management and specialists, and development of information systems for, and data requests by, other FAA lines of business as resources permit.

The ATA Laboratory has been identified as the element responsible for supporting airspace design dependencies for FAA Facilities and Equipment (F&E) programs with broad government and industrial involvement, including:

- LAAS – all category approaches.
- Low Altitude Direct Routing using WAAS.
- Runway Incursion Program.
- WAAS Precision Approaches.
- Automatic Dependent Surveillance (ADS) studies.
- Single and Multi-center metering.
- FAST implementation studies.
- New Host Consolidation/Dynamic Resectorization studies.

Current activities focus on continuing collection and management of data from air traffic operations in support of the following:

- Analyze and report Current NAS Traffic Activity.
- Begin Integration of local and regional airspace design concepts into a system-wide national level scope.
- Support environmental studies, especially noise related.
- Support the examination of technologies being acquired or alternative procedures with respect to potential for ATC efficiency and other performance- related improvements.
- Continued development of information systems as demanded by several FAA lines of business.

8.5.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.2-28-31, February 2002
2. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-46 to 2-48; April 2001
3. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-24-25, March 2002
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-26 – B-27; April 2001

8.6 Airspace Redesign Enhancements

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Aviation Research Plan, Internet Version*; pp. 2-203 to 2-206; April 2001

8.6.1 DESCRIPTION

This application conducts evaluations of airspace redesign enhancements in all operational domains to improve system performance and utilization of resources

8.6.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.4-13, February 2002
2. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-203 to 2-206; April 2001
3. Federal Aviation Administration, US Department of Transportation; *National Airspace Redesign Strategic Management Plan Draft Version 5.6*; March 2000

8.7 General Aviation and Vertical Flight Technology Program

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Aviation Research Plan,* p. 2.1-22-25, February 2002

8.7.1 DESCRIPTION

This application supports General Aviation (GA) and Vertical Flight (VF) requirements for Communications, Navigation and Surveillance (CNS) technologies through applied research and development. Resulting technologies support cost-effective air traffic services, improve safety, and expand NAS capacity and efficiency – especially where CNS services are not currently available to GA users. GA & VF program products are integral to NAS modernization.

The GA & VF Technology Program supports research and development across the full spectrum of GA operations. The program's research areas align with the most critical components for GA participation in NAS terminal operations: en route communications and navigation, landing facilities, airmen and controller training, and low-cost avionics. The program also supports the development of procedures and standards to enable Simultaneous Non-Interfering (SNI) operations between fixed-wing and vertical flight aircraft.

Vertical flight Terminal Instrument Procedures (TERPS) efforts support the terminal and en route flight environment. Low-altitude CNS research provides critical data and evaluations for future low-altitude en route infrastructure to support Free Flight. TERPS capabilities facilitate implementation and use of advanced technology in the cockpit and controller workstations for GA needs. These efforts are interrelated and support mutual requirements without duplication or added costs.

The applications supported by this program, and their activities, are the following:

General Aviation

- Enhance standard for application of fixed wing/rotorcraft VFR procedures technology by continuing research supporting use of advanced avionics

Vertical Flight

- Conduct flight tests and data analysis to investigate the potential improvement in efficiency for time-critical vertical flight operations, such as law enforcement and emergency medical service.
- Evaluate helicopter performance through continued flight tests and data analysis to define aircraft and avionics requirements for steep angle approaches (greater than 3 degrees) to a heliport/vertiport.
- Develop procedures and standards to enable simultaneous non-interfering operations between fixed-wing and vertical flight aircraft.
- Continue efforts to use non-radar surveillance in the Gulf of Mexico for FAR 135.79 flight locating requirements.

- Improve and expand the distribution of weather information in the Gulf of Mexico to pilots operating helicopters at low altitudes.
- Continue research to support steep angle IFR approaches and missed approach guidance for helicopters and tiltrotors
- Establish lighting requirements for heliports and vertiports to support ILS and capabilities for vertical flight aircraft
- Initiate research to improve visual guidance to heliports serving hospitals

8.7.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.1-22-25, February 2002
2. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-18 to 2-21; April 2001
3. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002 - 2006*; p. B-28 – B-29; April 2001
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-26, March 2002

8.8 Separation Standards

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Aviation Research Plan,* p. 2.2-32-36, February 2002

8.8.1 DESCRIPTION

This application works to reduce separation standard values within international airspace to make the following benefits available to providers and users of oceanic air traffic control systems: increased system efficiency, increased theoretical system capacity, and increased international standardization of separation criteria and resultant enhanced system safety.

The applications supported by this program, and their activities, are the following:

West Atlantic Route System Reduced Vertical Separation Minima (RVSM)

- Implemented; safety oversight to be conducted

30 nm lateral/30 nm Longitudinal Separation Standard in FAA-Administered Oceanic Airspace

- Developed ICAO Documentation and Specifications
- Develop implementation requirements, operational Concept, and Procedures
- Conduct trials, implement, and conduct safety oversight

Pacific and Western Pacific/South China Sea RVSM

- Conducted Readiness and Safety Assessments
- Implemented; safety oversight to be conducted in the Pacific

Global Standardization of RVSM Safety Oversight Function

- Develop Common Principles and Practices
- Develop Long-term Monitoring Requirements

Reduced Separation Standards in Gulf of Mexico and ICAO Caribbean and South American Region

- Develop Plan, Conduct Data Analysis and Collection, and implement

Investigation of Northern Pacific Airspace Improvement Options Using North Atlantic Cost Effectiveness Methodology

- Formed Government-industry working group
- Formulate possible options; conduct simulation and analysis; identify best options

8.8.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.2-32-36, February 2002
2. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-50 to 2-54; April 2001
3. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-18-19, March 2002
4. Federal Aviation Administration, US Department of Transportation; *RVSM Documentation*; September 2001
5. Federal Aviation Administration, US Department of Transportation; *Oceanic Procedures Branch*; September 2001

8.9 Domestic Reduced Vertical Separation Minima

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Aviation Research Plan,* p. 2.2-37-40, February 2002

8.9.1 DESCRIPTION

The Domestic Reduced Vertical Separation Minima (DRVSM) Program is working to reduce the separation standard within the domestic airspace of the continental United States, in order to achieve the following benefits for providers and users of the domestic air traffic control system:

- Increased system efficiency through reduced fuel-burn and decreased delays.
- Increased theoretical system capacity through increased capability of controllers to support greater numbers of routes and flight levels safely within the same airspace.

Current activities include:

- Rule making
- Safety assessments
- Database development
- Development of monitoring procedures
- Modeling and simulation
- Data analysis
- Procedure development

8.9.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan,* p. 2.2-37-40, February 2002
2. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-55 to 2-58; April 2001

3. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-19; April 2001
4. Federal Aviation Administration, US Department of Transportation; *RVSM Documentation*; September 2001

9. Emergency and Alerting Enhancement Area

The Emergency and Alerting enhancement areas monitors the NAS for distress or urgent situations, evaluates the nature of the distress, and provides an appropriate response to the emergency. Capabilities include emergency assistance and alerting support. This area provides emergency assistance to local, state, federal agencies, foreign agencies and private entities in support of their aviation activities including: airspace and airport planning; procedures development; training; maintenance; flight inspection; charts and forms; and, law enforcement support. This area also includes flight monitoring and following, emergency assistance, and military and government operations assistance. In addition, search and rescue (SAR) alerts are initiated after determining that an aircraft may be overdue, lost, or downed and physical search activities are supported by providing information and direction.

The FAA's immediate response to the September 11, 2001 attacks required unprecedented communications between the FAA's command elements, air traffic controllers, and users. Since 9/11, the FAA had been supporting the North American Air Defense Command (NORAD) activities for homeland defense, and has been improving the communications infrastructure. Priorities were changed and funding in 2003 continues security programs accelerated in FY 2002. Communications upgrades are reflected in the following application for the Emergency and Alerting Enhancement Area:

9.1 National Airspace System Recovery Communications

9.1 National Airspace System Recovery Communications

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. 5-6 and B-72, March 2002

9.1.1 DESCRIPTION

This application ensures that during emergencies, the command and control communications will be able to provide time critical public safety and NAS information between the Administrator, the Administrator's staff, key regional managers, the DOT, and other national level executive personnel. Funding for this area has increased from 2002.

9.1.2 BIBLIOGRPAHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-72, March 2002

10. Infrastructure /Information Management Enhancement Area

The Infrastructure/Information Management enhancement area ensures a safe and efficient NAS through management and operation of the ATC infrastructure, by promoting the optimal use of the aviation radio spectrum, and through the dissemination of aeronautical information. Capabilities include monitoring and maintenance, communications management, and aviation information collection and dissemination. This area provides for the monitoring of all NAS systems. It also includes the management of infrastructure strategic resources, infrastructure systems, logistics, documentation, system status information, and operations and maintenance (O&M) data. It includes planning and managing communication resources including spectrum management. Support for NAS-wide information collection and distribution to all users and service providers including collection and dissemination of aeronautical information (i.e., aeronautical charts, flight information publications, air traffic control, Notice to Airmen (NOTAMs)) and weather information in support of safe and efficient operation of aircraft is also provided.

The Infrastructure/Information Management enhancement area consists of 14 applications, listed below in order of appearance.

10.1 Collaborative Decision Making (CDM)-NAS Status Information
10.2 FAA Telecommunications Infrastructure (FTI)
10.3 Integrated Flight Quality Assurance (IFQA)
10.4 Aviation Safety Analysis System (ASAS)
10.5 Facility Security Risk Management
10.6 Frequency and Spectrum Engineering
10.7 NAS Infrastructure Management System (NIMS)
10.8 National Aviation Safety Data Analysis Center (NASDAC)
10.9 Safety Performance Analysis System (SPAS)
10.10 En Route Data Exchange (EDX)

Detailed descriptions of each are provided where available.

10.1 Collaborative Decision Making (CDM)-NAS Status Information

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation, Washington DC**; *National Airspace System Architecture Version 4.0*; pp.20-5 – 20.6; January 1999

10.1.1 DESCRIPTION

NAS Status Information provides the NAS operational status to AOCs to promote a shared understanding of NAS traffic management decisions.

NAS Status, Increment 1

- Will provide airport-related NAS status information, which is readily available from current systems and sensors, to other FAA facilities and to NAS users. Data for major airports are expected to include current and planned airport configurations, equipment status, arrival and departure rates, and weather data.

NAS Status, Increment 2

- Will provide static and some dynamic information on current and predicted restrictions and constraints, including active SUAs, agreements between facilities about crossing altitudes and speed, miles-in-trail, resource capacities, system outages, preferred routes, and weather conditions that could affect aviation.

This application of CDM was part of the FFP1 program, which ended in December 2002. CDM milestones will be established for FFP2 (2003-2005).

10.1.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation, Washington DC; *National Airspace System Architecture Version 4.0*; pp.20-5 – 20.6; January 1999
2. Collaborative Decision-Making Products for Free Flight Phase 1- PowerPoint Presentation
3. *NAS Status Information*; ATCSCC, Federal Aviation Administration, Washington, DC
4. Charter: NAS Status Information Subgroup, Version 1.1; July 1997
5. Oiessen, Rick; Status of Collaborative Routing and NAS Status Work at Volpe; June 2000
6. Federal Aviation Administration and Subscribers of NAS Data; Memorandum of Agreement: For Industry Access to Aircraft Situation Display (ASDI) and National Airspace System Status Information (NASSI) Data; May 2000
7. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-42-44, March 2002
8. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-15 – B-16; April 2001
9. Federal Aviation Administration, US Department of Transportation; Free Flight Phase 2 WWW Site; http://ffp1.faa.gov/about/about_ffp2.asp
10. Federal Aviation Administration, US Department of Transportation; *National Aviation Research Plan, Internet Version*; pp. 2-203 to 2-206; April 2001

10.2 FAA Telecommunications Infrastructure (FTI)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-34 – B-35; April 2001

10.2.1 DESCRIPTION

This application replaces the existing telecommunications services that support critical air traffic operations.

10.2.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-65-66, March 2002
2. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-34 – B-35; April 2001
3. Federal Aviation Administration, US Department of Transportation; *FTI Program Overview*

10.3 Integrated Flight Quality Assurance (IFQA)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-68; April 2001

10.3.1 DESCRIPTION

This application seeks to develop a capability for collecting and analyzing digital data from flight data recorders.

10.3.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-13-14, March 2002
2. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-68; April 2001

10.4 Aviation Safety Analysis System (ASAS)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-11-13, March 2002

10.4.1 DESCRIPTION

This application will provide information technology infrastructure and develop systems to facilitate partnerships with the aviation community to share data and information supporting safe and secure aviation. The infrastructure and systems provide the tools to enhance the effectiveness of FAA's certification, inspection, and surveillance responsibilities in areas of safety and security in civil aviation.

10.4.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-11-13, March 2002
2. Federal Aviation Administration, US Department of Transportation; *Aviation System Capital Investment Plan*; pp. Automation-21 – 22; January 1999
3. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2001-2005 Internet Version*; p. A-12; 9 August 2000
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-66; April 2001

10.5 Facility Security Risk Management

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-81-82, March 2002

10.5.1 DESCRIPTION

This application will improve and physical security at all FAA-staffed facilities in accordance with FAA Order 1600.69a. This order delineates requirements for physical security protective measures, and establishes standards, objectives, procedures, and techniques for the protection of FAA employees, agency property, facilities, contractors, and the public. This order clarifies and updates facility security procedures for all FAA facilities, and establishes standards for facility security management, control, and safeguarding of assets and facilities.

10.5.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-81-82, March 2002
2. Federal Aviation Administration, US Department of Transportation; *Aviation System Capital Investment Plan*; pp. Facilities-26 – 27; January 1999
3. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2001-2005 Internet Version*; p. A-16; 9 August 2000
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-69; April 2001

10.6 Frequency and Spectrum Engineering

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Aviation System Capital Investment Plan*; pp. Mission Support-18 – 20; January 1999

10.6.1 DESCRIPTION

Radio frequency spectrum is a limited national resource that faces continually increasing congestion and competition among its users. In addition, radio frequency interference (RFI) is a growing problem, particularly near major airports. Careful planning is required to avoid problems with interference, poor propagation, and unavailability of spectrum for particular applications in order to satisfy the strict safety requirements of civil aviation. Frequency interference problems are projected to increase as demands for aviation and non aviation services grow, especially with the increase of GPS use.

Most of the RFI work is completed at the regional level. More complex problems will be jointly addressed by regional offices in coordination with FAA headquarters.

This application will produce frequency engineering models; RFI suppression devices; investigations of modern technology; procedures for RFI elimination; and radio, television, and pager interference evaluation, etc.

Frequencies supporting communication, navigation, and surveillance systems are engineered to ensure interference-free NAS operation. This effort involves electromagnetic compatibility analysis, formal spectrum certification by the National Telecommunications and Information Administration (NTIA), national and international frequency coordination, radio propagation studies, and spectrum capacity analyses. Additionally, the FAA provides both national and international coordination for aeronautical mobile ser-vices, aeronautical fixed services, and aeronautical mobile satellite services in developing ICAO standards and recommended practices.

The application will provide support to obtain and protect necessary frequencies for new, relocated, or replaced NAS facilities through automated computer techniques. RFI problems will be investigated and resolved. It provides spectrum engineering and frequency management support for projects and facilities that are being implemented under the CIP. Furthermore, the project provides the regions with the training, resources, and equipment (spectrum analyzers and hand-held direction finders) required to independently identify the source of interference problems in a timely manner.

10.6.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-73-74, March 2002
2. Federal Aviation Administration, US Department of Transportation; *Aviation System Capital Investment Plan*; pp. Mission Support-18 – 20; January 1999
3. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2001-2005 Internet Version*; p. A-44; 9 August 2000
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-75; April 2001

10.7 NAS Infrastructure Management System (NIMS)

Last Revised: December 2002

Description Source**: Federal Aviation Administration, US Department of Transportation**; *Aviation System Capital Investment Plan*; pp. Mission Support-7 – 8; January 1999; **Federal**

Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-68, March 2002

10.7.1 DESCRIPTION

There is a pressing need to migrate the operation and management of the NAS infrastructure from the current equipment maintenance philosophy to one focused on managing and delivering NAS ATC and advisory services to system users. Currently, Airway Facilities Service (AAF) is operating under a philosophy of equipment maintenance, focusing on the operation and repair of each individual NAS system and subsystem, without regard to the criticality or priority of the individual system to the NAS. This philosophy has worked over the years because thousands of Airway Facilities (AF) field specialists have been available to service the FAA's numerous equipment at the hundreds of facilities across the Nation.

The FAA plans to expand capabilities within the NAS to meet the increasing demands for ATC and advisory services. In addition, maintaining the system with the current number of AF field specialists becomes problematic, as evidenced by the growing mean time to restore (MTTR). Maintaining the system in accordance with the current strategy could result in decreased capacity, reduced levels of service available to ATC services, and increased costs.

The NAS Infrastructure Management System (NIMS) provides the means to migrate the FAA's equipment maintenance philosophy to a service management philosophy. Building on the remote maintenance monitoring system concept—but incorporating modern, commercially available management tools—NIMS will establish a National Operations Control Center (NOCC) and three strategically located Operations Control Centers (OCCs). NIMS will concentrate information and technical expertise to ensure the continued operation of the NAS by directly associating NAS infrastructure components with the delivery of specific NAS services. NIMS will enable the FAA to track and monitor the actual cost of providing NAS services and to assess trends.

The NIMS application will employ a phased implementation approach based on the managed evolutionary systems development concept. The program has three phases.

- NIMS Phase 1 will provide the building blocks for a service-based management system. While providing additional remote monitoring and control to new equipment, Phase 1 will integrate existing element management systems, telecommunications systems, and leased mobile communications for the AF workforce. NIMS will also introduce modern commercial-off-the-shelf (COTS) resource management tools and information security controls.
- NIMS Phase 2 will expand the service management philosophy by providing centralized management of assets that support NAS service delivery, NAS customer and user interaction tools, and technical and cost trend analyses. It will also provide a refinement of Phase 1 capabilities, including a COTS enterprise management tool or legacy system upgrade.
- NIMS Phase 3 will provide intelligent fault correlation, information sharing, and modernization and refinement of prior phase capabilities. Service management will be further enhanced by providing the capabilities to perform predictive maintenance and analysis.

NIMS is currently in Phase 2.

10.7.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-68, March 2002

2. Federal Aviation Administration, US Department of Transportation; *Aviation System Capital Investment Plan*; pp. Mission Support-7 – 8; January 1999
3. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2001-2005 Internet Version*; p. A-30; 9 August 2000
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; pp. B-42 - B-43; April 2001

10.8 National Aviation Safety Data Analysis Center (NASDAC)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Aviation System Capital Investment Plan*; pp. Mission Support-25 – 26; January 1999

10.8.1 DESCRIPTION

The FAA's ability to access and analyze safety data has been limited by lack of standardization, data integrity problems, and dispersed data source systems. These limitations have made analyzing safety data time consuming and labor intensive.

The NASDAC application provides a modern, automated capability for analyzing safety data. The NASDAC imports data from Government and non-Government sources, normalizes and standardizes the data, and provides access and analysis through a set of common safety analysis tools. Growth in demand for safety data has resulted in the NASDAC processing more than 10 times the number of requests for study data originally envisioned.

10.8.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-29-30, March 2002
2. Federal Aviation Administration, US Department of Transportation; *Aviation System Capital Investment Plan*; pp. Mission Support-25 – 26; January 1999
3. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2001-2005 Internet Version*; p. A-12; 9 August 2000
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-69; April 2001

10.9 Safety Performance Analysis System (SPAS)

Last Revised: December 2002

Description Source: **Federal Aviation Administration, US Department of Transportation**; *Aviation System Capital Investment Plan*; pp. Automation-22 – 23; January 1999; **Federal Aviation Administration, US Department of Transportation**; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-14-15, March 2002.

10.9.1 DESCRIPTION

The FAA has the statutory responsibility of conducting surveillance of air operators, air agencies, aircraft, and air personnel to en-sure conformance with FAA aviation regulations.

One of the major functions of safety inspectors is to prevent safety problems. To do that, safety inspectors must have access to synthesized information that reflects potential problem areas in a timely fashion. Existing databases are not integrated, and information cannot be analyzed in an automated fashion. Thus, the FAA does not have the capability to provide safety inspectors with trend analysis information for targeting areas of highest risk or priority or to dynamically adjust work program plans.

SPAS provides an automated capability to analyze safety-critical areas, using performance indicators designed for the needs of safety inspectors. It also provides immediate access to relevant underlying data. Currently, SPAS includes 11 data sources, and 15 other candidate data sources are being evaluated. Current and candidate databases have differing data structures and protocols and contain information on thousands of operators, air agencies, aircraft, and air personnel. SPAS presents a standardized, easy-to-use graphic display with many features to assist inspectors in retrieving critical data from these diverse sources to meet their unique requirements.

With SPAS, safety inspectors can target high-risk certificate holders that pose a greater safety risk and thus dynamically modify the surveillance work program. SPAS also allows the FAA to:

- Monitor the status of aging aircraft
- Track the growing number of aircraft operations
- Increase industry accountability for aviation safety
- Assist the Flight Standards Service in determining resource needs and improving data quality

The application will minimize development costs by using existing databases with commercial-off-the-shelf hardware and software when appropriate. User requirements have been further refined during operational testing. Following successful operational testing, production version, incremental field implementation began, with specially developed training, in September 1997.

The initial production version of SPAS, SPAS II, and its supporting infrastructure will be implemented throughout the safety inspector community. SPAS II will support a large inspector user population through a distributed client/server design and enhanced functionality.

SPAS II was completed in 2001. During 2002, Air Transportation Oversight System (ATOS) data were included in SPAS. Plans for 2003 call for performing enhancements to the system and integration of SPAS into the flight standards business applications. There are no plans for SPAS beyond 2003.

10.9.2 BIBLIOGRAPHY

1. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2003-2007,* p. B-14-15, March 2002
2. Federal Aviation Administration, US Department of Transportation; *Aviation System Capital Investment Plan*; pp. Automation-22 – 23; January 1999
3. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2001-2005 Internet Version*; p. A-12; 9 August 2000
4. Federal Aviation Administration, US Department of Transportation; *National Airspace System Capital Investment Plan Fiscal Years 2002-2006*; p. B-68; April 2001

10.10 En Route Data Exchange (EDX)

Last Revised: December 2002

Description Source: **National Aeronautics and Space Administration**; *Decision Support Tools of the Advanced Air Transportation Technologies Project*; May 2000

10.10.1 DESCRIPTION

Enables real time data exchange between aircraft and ground information systems.

No current information was available on this application.

10.10.2 BIBLIOGRAPHY

5. National Aeronautics and Space Administration; Decision Support Tools of the Advanced Air Transportation Technologies Project; May 2000

6. Coppenbarger, Richard; Trajectory Negotiation and EDX; Free Flight - DAG/TM Workshop, NASA Ames Research Center. Moffett Field, CA; May 22-24, 2000

Appendix A. Acronyms and Abbreviations

4D	Four Dimensional
AAF	FAA Airways Facilities Organization
AAR	Airport Acceptance Rate
AAS	Advanced Automation System
AATT	Advanced Air Transportation Technologies
AC	Aircraft
ACARS	ARINC communications addressing and reporting system
ACO	Airframe Certification Office
ADDS	Aviation Digital Data System
ADL	Aeronautical Data Link
ADS	Automatic Dependent Surveillance
ADS-A	Automatic Dependent Surveillance - Addressed
ADS-B	Automatic Dependent Surveillance – Broadcast
AF	Airway Facilities
aFAST	Active Final Approach Spacing Tool
AFHF	Airway Facilities Human Factors
AFSS	Automated Flight Service Station
A/G	Air/Ground
AIDC	Air Traffic Services Interfacility Communication
AIRMET	Airman's Meteorological Information
AMASS	Airport Movement Area Safety System
AMS	Acquisition Management System
ANICS	Alaska NAS Interfacility Communication System
AOC	Airline Operations Center
AOP	Autonomous Operations Planner
APMS	Aviation Performance Measurement System
ARSR	Air Route Surveillance Radars
ARTCC	Air Route Traffic Control Center
ARTS	Automated Route Terminal System
ASDE	Airport Surface Detection Equipment
ASOS	Automated Surface Observing System
ASR	Airport Surveillance Radars
ASRA	Aviation Safety Risk Analysis
ASWON	ASOS Network
ATA	Air Traffic Airspace Organization
ATC	Air Traffic Control
ATCSCC	Air Traffic Control System Command Center
ATCT	Air Traffic Control Tower
ATIS	Automatic Terminal Information System
ATM	Air Traffic Management
ATN	Aeronautical Telecommunications Network
ATOP	Advanced Technology and Oceanic Processing
ATOS	Air Transportation Oversight System
ATS	Air Traffic Services
ATSP	Air Traffic Service Provider
AVOSS	Aircraft Vortex Spacing System
AWP	Aviation Weather Processor
BCS	Buoy Communication System

BITE	Built In Test Equipment
BUEC	Back Up Emergency Communication
CAA	Civil Aviation Authorities
CAASD	Center for Advanced Aviation System Development
CAP	Collaborative Arrival Planner
CAT	Constrained Airspace Tool
CAT-I	Category One
CAT-II	Category Two
CAT-III	Category Three
CCLD	Core Capability Limited Deployment
CD&R	Conflict Detection and Resolution
CDM	Collaborative Decision Making
CDRL	Contract Data Requirements List
CDTI	Cockpit Display of Traffic Information
CE	Concept Element
CFIT	Controlled Flight into Terrain
CFR	Code of Federal Regulations
CHI	Computer Human Interface
CIP	Capital Investment Plan
CIWS	Corridor Integrated Weather System
CNS	Communication, Navigation, and Surveillance
COTS	Commercial Off the Shelf
CPDLC	Controller Pilot Data Link Communication
CPL	Current Flight Plan
CPTP	Conflict Prediction Trial Planner
CRCT	Collaboration Routing Coordination Tool
CST	Commercial Space Transportation
CTAS	Center TRACON Automation System
CTS	Critical Telecommunications Support
CWSU	Center Weather Service Unit
D2	Direct To
DA	Descent Advisor
DAG	Distributed Air/Ground
DAG-TM	Distributed Air/Ground Traffic Management
D-ATIS	Digital ATIS
DCCR	Display Channel Complex Rehost
DCFM	Dynamic Congestion Flow Management
DFW	Dallas Fort Worth Airport
DME	Distance Measuring Equipment
DoD	Department of Defense
DR	Discrepancy Report
DRVSM	Domestic Reduced Vertical Separation Minima
DSC	Down Stream Center
DSR	Display System Replacement
DSS	Decision Support System
DST	Decision Support Tool
DUAT	Direct User Access Terminal
EAA	Enhanced Airspace Architecture
EDA	En Route and Descent Advisor
EDCT	Expect Departure Clearance Time

EDP	Expedite Departure Path
EDX	En Route Data Exchange
ELT	Emergency Locator Transmitter
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ERAM	En Route Automation Modernization
ESSL	Enroute System Support Laboratory
ETA	Estimated Time of Arrival
ETMS	Enhanced Traffic Management System
EWR	Newark Airport
FAA	Federal Aviation Administration
FACET	Future ATM Concepts Evaluation Tool
FAF	Final Approach Fix
FANS	Future Air Navigation System
FAR	Federal Aviation Regulation
FAS	Flight Advisory Service
FAST	Final Approach Spacing Tool
FCA	Flow Constrained Area
FCFS	First Come-First Served
FD	Flight Deck
FDM	Flight Data Management
F&E	Facilities and Equipment
FEDEX	Federal Express
FFP1	Free Flight Phase One
FFPII	Free Flight Phase Two
FIR	Flight Information Region
FIS	Flight Information Service
FIS-B	Flight Information Service – Broadcast
FISDL	Flight Information Service Data Link
FL	Flight Level
FMS	Flight Management System
FSAS	Flight Service Automation System
FSD	Full Scale Development
FSDPS	Flight Services Data Processing System
FSM	Flight Schedule Monitor
FTI	FAA Telecommunication Infrastructure
GA	General Aviation
GDP	Ground Delay Program
GDP-E	Ground Delay Program Enhanced
GEO	Geosynchronous Earth Orbit
GLS	GPS Landing System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
GWDS	Graphic Weather Display System
HITL	Human in the Loop
HUD	Head-Up Display
IAPA	Instrument Approach Procedure Automation
ICAO	International Civil Aviation Organization
ID	Identification

IF	Instrument Flight
IFQA	Integrated Flight Quality Assurance
IFR	Instrument Flight Rules
IGS	Intelligent Ground System
IIDA	Integrated Icing Diagnosis Algorithm
IIFA	Integrated Icing Forecast Algorithm
IIP	Instantaneous Impact Point
IMC	Instrument Meteorological Conditions
INM	Integrated Noise Model
IOC	Initial Operating Capability
IOT&E	Independent Operational Test and Evaluation
IPT	Integrated Product Team
ISM	Input Source Manager
ISS	Information Security System
IT	Information Technology
ITWS	Integrated Terminal Weather System
JFK	John F. Kennedy International Airport
JRC	Joint Resources Council
Kt	Knot
LAAS	Local Area Augmentation System
LLWAS	Low Level Wind Shear Alerting System
LNAV	Lateral Navigation
LTP	LAAS Test Prototype
M1FC	Model 1 Full Capability
M/A	Monitor Alert
MA	Mission Analysis
MASPS	Minimum Aviation System Performance Standard
MCF	Metroplex Control Facility
McTMA	Multi-Center Traffic Management Advisor
METAR	Meteorological Aviation Report
MIAWS	Medium Intensity Airport Weather System
MIT	Miles in Trail
MMIR	Maintenance Malfunction Information Reporting
MOPS	Minimum Operating Performance Standard
MSAW	Minimum Safe Altitude Warning
MTTR	Mean Time To Repair
MVMC	Marginal Visual Meteorological Conditions
NARP	National Aviation Research Plan
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NASDAC	National Aviation Safety Data Analysis Center
NASSI	NAS Status Information
NAT	North Atlantic Track
NAVAID	Navigational Aid
NDI	Non Developmental Item
NEXCOM	Next Generation A/G Communication System
NEXRAD	Next Generation Weather Radar
NIMS	NAS Infrastructure Management System
NLR	Netherlands Research Laboratory
NOCC	National Operations Control Center

NORAD	North American Air Defense Command
NOTAM	Notice to Airmen
NTIA	National Telecommunications and Information Administration
NTSB	National Transportation Safety Board
NWS	National Weather Service
O&M	Operations and Maintenance
OAK	Oakland Airport
OASIS	Operational and Supportability Implementation System
OCC	Operations Control Center
OCD	Operational Concept Description
OOT	Object Oriented Technology
ONS	Operational Need Statement
OSF	Operational Support Facility
P3I	Pre Planned Product Improvement
PAMRI	Peripheral Adapter Module Radar Interface
PARR	Problem Analysis Ranking and Resolution
PCT	Potomac TRACON
PDC	Pre Departure Clearance
PFAST	Passive Final Approach Spacing Tool
PGUI	Planview Graphical User Interface
PIREP	Pilot Report
PRM	Precision Runway Monitor
PTR	Program Trouble Report
R&D	Research and Development
RAP	Required Aircraft Performance
RCAG	Radio Communication Air Ground
RCE	Radio Control Equipment
RDA	Radar Data Acquisition
RDHFL	Research and Development Human Factors Lab
RFI	Radio Frequency Interference
RIRP	Runway Incursion Reduction Program
RLV	Reusable Launch Vehicle
RM	Regional Metering
RMM	Remote Maintenance Monitoring
RNAV	Area Navigation
RPG	Radar Product Generator
RSP	Required System Performance
RTA	Required Time of Arrival
RTCA	RTCA, Inc.
RTSP	Real Time Streaming Protocol
RTV	Remote Television
RUC	Rapid Update Cycle
RV	Reentry Vehicle
RVR	Runway Visual Range
SAMS	Special Use Airspace Management System
SAR	Search and Rescue
SARP	Standard and Recommended Practice
SASO	System Approach for Safety Oversight
SATNAV	Satellite Navigation
SCC	System Command Center

SEE	Single Event Effects
SERC	Software Engineering Resource Center
SF21	Safe Flight 21
SIAP	Standard Instrument Approach Procedures
SID	Standard Instrument Departure
SIGMET	Significant Meteorological Conditions
SFO	San Francisco Airport
SLEP	Service Life Extension Program
SMA	Surface Movement Advisor
SMS	Surface Management System
SPAS	Safety Performance Analysis System
SPECI	Special Weather Report
SSR	Secondary Surveillance Radar
STA	Scheduled Time of Arrival
STARS	Standard Terminal Automation Replacement System
STAR	Standard Terminal Arrival Route
STATS	Safety Through Accurate Technical Statistics
STC	Supplemental Type Certificate
SUA	Special Use Airspace
SVFR	Special VFR
SWEPT	System Wide Evaluation and Planning Tool
TAF	Terminal Area Forecast
TBD	To Be Determined
TCAS	Traffic Alert and Collision Avoidance System
TCDC	Technical computer Data Center
TDLS	Tower Data Link System
TDWR	Terminal Doppler Weather Radar
TERPS	Terminal Radar Procedures
TFAS	Traffic Flow Automation System
TFM	Traffic Flow Management
TGF	Target Generation Facility
TIS	Traffic Information Service
TIS-B	Traffic Information Service – Broadcast
TMA	Traffic Management Advisor
TMA-MC	Traffic Management Advisor – Multi Center
TMA-SC	Traffic Management Advisor – Single Center
TMC	Traffic Management Coordinator
TMU	Traffic Management Unit
TRACON	Terminal Radar Approach Control
TSSL	Terminal System Support Laboratory
UAT	Universal Access Transponder
UHF	Ultra-High Frequency
UPS	United Parcel Service
UPT	User Preferred Trajectory
URET	User Request Evaluation Tool
USC	Upstream Center
VDL	VHF Datalink
VDL 3	VDL Mode 3
VERN	VHF Extended Range Network
VF	Vertical Flight

VFR	Visual Flight Rules
VHF	Very-High Frequency
VMC	Visual Meteorological Conditions
VNAV	Vertical Navigation
WAAS	Wide Area Augmentation System
WARP	Weather and Radar Processor
WJHTC	William J. Hughes Technical Center
WSP	Weather System Processor
ZID	Indianapolis ARTCC
ZME	Memphis ARTCC
ZFW	Fort Worth ARTCC

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