



Federal Aviation Administration
Alaskan Region

Capstone Program Management Office
801 B Street, Suite 500
Anchorage Alaska 99501

Capstone Program Plan

Version 1.0

10 March 1999



March 10, 1999

Preamble

This document is designed for use as a high level program plan during the Capstone project. The term high level as it is used here, means the contents are intended to create an umbrella of objectives under which detailed work plans are developed and accomplished. Each organization tasked with a particular objective or element takes on the responsibility for developing their own work plan, procedures for participants to use the element, and record and report the progress made toward validation. Due to the complex nature of this project and the large number of organizations involved, modifications of portion of the plan are inevitable. To accommodate future developments facilitated by the validation efforts within the Capstone area, a version number, beginning with one, and the date of each successive version are printed on the cover.

Table of Contents

EXECUTIVE SUMMARY.....III

1.0 INTRODUCTION 1

1.1 IMPROVING AVIATION SAFETY, CAPACITY, AND EFFICIENCY IN ALASKA 1

1.2 PROVIDING ANSWERS TO TECHNICAL AND COST/BENEFIT QUESTIONS OF DECISION MAKERS 1

1.3 BACKGROUND 2

1.4 PURPOSE..... 3

1.5 OBJECTIVE..... 4

 1.5.1 Safety..... 4

 1.5.2 Capacity and Efficiency..... 4

 1.5.3 Information for Decision Makers 4

1.6 BENEFITS..... 4

 1.6.1 Capstone long term benefits: 5

2.0 ARCHITECTURE 5

3.0 CONCEPT OF OPERATIONS..... 7

3.1 AIR TRAFFIC MANAGEMENT 7

3.2 STREAMLINED AVIONICS CERTIFICATION 7

3.3 EXPANDED GPS CAPABILITIES..... 7

3.4 MULTIPLE FUNCTION DISPLAY UNIT (MFD) 8

3.5 AUTOMATIC DEPENDENT SURVEILLANCE-BROADCAST (ADS-B) SYSTEM 8

3.6 FIS WEATHER, SPECIAL USE AIRSPACE, NOTAMS, AND PIREPS..... 9

3.7 CONTROLLED FLIGHT INTO TERRAIN (CFIT) AVOIDANCE USING A TERRAIN DATA BASE..... 9

3.8 AUTOMATED WEATHER REPORTING SYSTEMS 9

4.0 IMPLEMENTATION 1

4.1 CAPSTONE PROGRAM ORGANIZATION..... 10

 4.1.1 Capstone Management Review Board..... 10

 4.1.2 Capstone Program Office (CPO) 11

 4.1.3 Capstone Program Office staffing 12

 4.1.4 Alaska Region Lines of Business..... 13

4.2 ACQUISITION PLAN 14

 4.2.1 Procurement of Individual Components..... 14

4.3 SAFETY STUDY AND MEASUREMENT..... 17

 4.3.1 Data Collection..... 17

 4.3.2 Reporting..... 17

 4.3.3 Analysis and Simulation 17

 4.3.4 Human Factors..... 18

4.4 TEST PLAN..... 18

 4.4.1 Testing 18

4.5 PUBLIC RELATIONS AND COMMUNICATIONS 18

 4.5.1 The Alaska Department of Transportation and Public Facilities (DOTPF)..... 19

 4.5.2 National Weather Service..... 20

 4.5.3 Department of Defense and Coast Guard 20

 4.5.4 University of Alaska 20

 4.5.5 Industry Council 20

 4.5.6 Aviation Organizations 20

 4.5.7 NISC..... 21

5.0 COST BENEFITS 21

6.0 THE DEMONSTRATION AREA 21

6.1 REMOTE TRANSCEIVER SITES. 22

6.2 NEW NON-PRECISION GPS INSTRUMENT APPROACHES 22

6.3 COVERAGE AREA EXPANSION..... 23

7.0 SCHEDULE AND TIMELINES..... 23

8.0 OTHER RELATED CAPSTONE PROGRAM DOCUMENTATION 23

Executive Summary

The “Capstone Program” accelerates nationwide efforts to improve aviation safety and efficiency through a multi-year introduction of current and emerging concepts and technologies. Initial validation plans include the installation of government-furnished Global Positioning System (GPS) driven avionics suites in up to 200 commercial aircraft serving the Yukon-Kuskokwim delta area. For the first year and beyond, compatible data link transceivers installed at strategically located ground stations are designed to facilitate traffic and flight information services.

The name “Capstone” is derived from the program’s effect of drawing and holding together concepts and recommendations contained in reports from the Radio Telecommunications Conference of America (RTCA), the National Transportation Safety Board (NTSB) and the Alaskan aviation community. Each of these groups work in partnership with the FAA as we identify and mitigate risks associated with a transition toward modernization of the National Airspace System. The plan incorporates guidance from both, internal and external, national and local organizations as we draw together safety improvements and validation work under an single program.

Elevated accidents rates and the absence of airspace services such as RADAR make Alaska the ideal location to begin the national free flight enhancement program. Increased pilot situational awareness top the list of safety improvements possible through introduction of modern avionics suites and ground stations and correlate well with Alaska’s needs. Aircraft chosen to participate in the avionics validation are equipped with:

- An IFR-certified GPS receiver for enhanced “spaced based” navigation capabilities,
- Automatic Dependent Surveillance-Broadcast (ADS-B) and Traffic Information Services for traffic advisory and collision avoidance,
- A terrain advisory data base to help avoid collisions with terrain,
- Flight Information Services including on screen graphical weather maps, special use airspace status, wind shear alerts, NOTAMs, and PIREPs to provide the pilot with current decision making material and,
- A panel mounted multiple function color display unit to present the information from each component to the pilot.

The initial ground station network unites new data link technologies with existing communications facilities at up to twelve (12) locations in the test area. As technologies are validated, more sites are planned in future years to allow for coverage area growth. The sites create a data link connection between FAA air traffic control facilities, participating aircraft and airline operations centers. To facilitate collection of data, the primary ground base data link site in Bethel shares common roots with the equipment employed by the Cargo Airline Association (CAA) ADS-B demonstration in the Ohio Valley. Other ground site transceivers share at least

one common frequency with the primary ground based server to enable a low cost solution for general aviation aircraft. The components of the ground system are:

- A router computer processor(at a field site), to direct data flow through the ANICS satellite to a gateway computer which feeds information into the Micro-EARTS in the Anchorage center,
- Remote displays installed at any location, for example, at the Bethel Airport Traffic Control Tower, and
- Displays in the aircraft operator's dispatch office for flight following.

Other major parts of the Capstone plan include:

- Traffic Information Service-Broadcast (TIS-B) will be implemented to enable the pilot of a Capstone-equipped aircraft to see both ADS-B and radar targets on the multiple function display.
- GPS non-precision instrument approach procedures are developed for runways at remote village airports within the Capstone test area.
- Where possible an FAA-certified basic automated weather observation system with radio broadcast capability is installed to enable air carrier use of the new non-precision GPS instrument approach procedures.
- Delivery of improved weather products via the Flight Information Service to the pilot

The University of Alaska's Aviation Technology Department will be used to:

- Develop and deliver training, and
- Perform an independent evaluation of system safety improvements.

The Capstone Program Office reports to the Alaskan Regional Administrator, and serves to plan and coordinate implementation. The office is staffed by individuals detailed from various "straight lined" divisions within the Region. Oversight of the program is provided by a Management Review Board, made up of Senior Executive and FAA managers from participating organizations, providing periodic review of and advice to the Capstone initiatives.

1.0 Introduction

The first priority of Capstone is to improve aviation system safety, capacity, and efficiency in Alaska through the introduction of new communications, navigation, and surveillance (CNS) technologies that enable pilots to cope with weather and terrain hazards and potential traffic conflicts.

Secondly, to provide answers to technical and cost/benefit questions that are needed to enable decision makers in the FAA and industry to make key new CNS technology choices. These questions have been raised by the RTCAs Free Flight Operational Enhancement documents, and answers provided by Capstone on the elements it is addressing will supplement answers generated elsewhere in the Safe Flight 21 Program.

Both purposes and subsequent evaluation work provide an improved aviation system in the areas where it is implemented, and an infrastructure from which to gather data necessary to make the best possible decisions on implementing the future National Airspace System (NAS) Architecture 4.0.

1.1 Improving Aviation Safety, Capacity, and Efficiency in Alaska.

1.1.1 Safety: The NTSB identified a number of improvements in Alaska's aviation system that would reduce fatal accidents in the various sectors of Alaska aviation. Capstone provides an improved ground and air infrastructure that furnishes pilots with better information on the location and severity of hazardous weather; improved instrument approaches to small airports; and traffic avoidance information to reduce the incidence of mid-air collisions.

1.1.2 Capacity and efficiency: Capstone will provide modern infrastructure to increase the availability of smaller airports, through weather observations and non-precision approaches. Capstone has been designed over the past 4 years through a collaboration of Alaska operators and the Alaska FAA, for the benefit of the Alaska public.

1.2 Providing Answers to Technical and Cost/Benefit Questions of Decision Makers

Decision makers in the FAA and industry must make technology choices between alternatives in areas where new systems will be fielded under NAS 4.0, and Capstone is designed to provide information to support these decisions.

In the FAA, decision makers will allocate resources toward the implementation of systems, such as ADS-B. Other decision makers will set regulatory policies on the certification of CNS equipment. Others will determine what changes in air traffic procedures are appropriate given the actual, operational characteristics of alternative surveillance systems.

In the private sector, decision makers in avionics companies must determine whether to allocate resources for the development of a specified type of avionics at a specific point in time based on expected demand for them. Decision makers in airlines and general aviation aircraft owners must

determine whether to allocate resources to purchase new CNS equipment based on expected costs and operational benefits.

Capstone will provide answers to some of the key questions these decision makers now have which must be resolved to make their determinations correctly in a timely fashion. This will be accomplished through a real-world operational evaluation of the Capstone infrastructure. Information will be produced on what air traffic procedures work best with the new equipment based on real operations with pilots and controllers. Information will be produced for operators on the real costs of acquiring, installing, maintaining and operating the equipment, and on the safety, capacity, and efficiency benefits of the equipment.

Capstone is not a technology demonstration, it is an operational evaluation for the purpose of providing sound, impartial, data-based answers to technical, operational, and economic questions that have as yet been unanswered.

1.3 Background

Alaska suffers an average loss of 45 lives each year from aircraft accidents. These numbers are five times greater than any other area of the country. A study prepared by ASD-SETA for ASD-430, concluded approximately 38 percent of these fatal accidents could be avoided by providing the pilot with an improved situational awareness of terrain, weather, and other aircraft. The area around Bethel, Alaska represents an ideal location to start the Capstone validation. With a high percentage of Alaskan accidents occurring in the area; an aircraft fleet geographically contained by mountains limiting service to communities inside the area; lower terrain in the immediate proximity reducing safety risks associated with the validation of Capstone components; and, many communities in the area without weather reporting capabilities, NAS instrument routes or approach structures.

	Operational Enhancement	FY 99	FY 00	FY 01
1	FIS for SUA Status, Weather, Wind Shear, NOTAMS, PIREPS	X		
2	Cost Effective CFIT Avoidance through Graphical Position Display	X		
3	Improved Terminal Operations in Low Visibility Conditions		X	
4	Enhanced See and Avoid	X		
5	Enhanced Operations for En Route Air-to-Air		X	
6	Improved Surface Navigation			X
7	Enhanced Airport Surface surveillance for the Controller		X	
8	ADS-B for Surveillance in Non-Radar Airspace		X	
9	ADS-B to Enhance Radar and Automation Performance		X	

Table 1-1. RTCA Operational Enhancements

The Capstone Program incorporates several initiatives to improve flight safety and efficiency. It also serves to validate the deployment and operation of GPS-driven technologies in Alaska.

Under the umbrella of the national Safe Flight 21 Program, Capstone will initially demonstrate three of the operational enhancements recommended by RTCA and depicted in Table 1-1. As the program progresses and money becomes available, Capstone offers a natural next step environment to validate many of the other enhancements over the next 3 to 5 years.

Table 1-2 identifies four components from a 1995 NTSB safety study of Alaska that are supported by deployment of avionics and ground evaluations/demonstrations from FY 1999 through 2001.

Elements	Airborne Systems; Evaluation	Ground Systems; Evaluation
A. Navigation Equipment		
· Equipment functional validation	Mixed aircraft types: single piston, multi-piston, turbo-prop. Installation procedures development and documentation.	Selected airports in and around the Bethel hub.
· GPS en route navigation.	Operational baseline database.	Airspace action to reduce floor of controlled airspace.
· GPS terminal arrival and departure.	Human factors baseline database.	Controller procedure baseline database.
B. Weather Sensing		
· Equipment installation, automated weather observation systems.	None.	Begin acquisition of 38 airports with GPS N/P approaches

Table 1-2. NTSB Report Response

1.4 Purpose

Capstone provides the avionics and ground system infrastructure that will lead to improved aviation safety in Alaska. It also provides the launching platform for validation of many essential elements needed to move toward a “proof of concept” demonstration of the Free Flight concept. Introduction of the future communication, navigation and surveillance components of the NAS 4.0 Architecture allows an assessment of operational capabilities and mitigation of monetary and safety risk exposure. The technology fielded under Capstone may be modified during national implementation.

Capstone provides for field evaluation of alternative ADS-B technologies. The technology fielded under Capstone may be modified during national implementation and need to be replaced.

1.5 Objective

The major Capstone objective is to quantify flight safety improvements in Alaska. Equipage of aircraft in the Yukon-Kuskokwim delta area provides an excellent opportunity to work with the Safe Flight 21 office to evaluate data link technology and the 9 operational enhancements that are envisioned by RTCA. Specific objectives of Capstone are:

1.5.1 Safety.

1.5.1.1 Reduce the fatal accident rate (on a per-flight-hour basis) due to en route and approach navigational errors in reduced visibility by 25 percent in the equipped aircraft within one year after installation of equipment and new low altitude airspace design and procedures are in place.

1.5.1.2 Reduce the fatal accident rate from mid-air collisions en route between the airports involved in Capstone and in the vicinity of Bethel by 25%.

1.5.1.3 Reduce the fatality rate due to search and rescue failures for equipped aircraft in the Bethel area.

1.5.2 Capacity and Efficiency.

1.5.2.1 Reduce the number of flights canceled due to inadequate destination weather reporting at airports equipped with new automated weather sources by 10% within one year.

1.5.2.2 Reduce flight delays due to weather by 5% within one year for flights into Capstone airports.

1.5.2.3 Reduce operators costs for fuel wasted due to adverse weather situations on equipped aircraft in the Bethel area within one year.

1.5.3 Information for Decision Makers

1.5.3.1 Together with the Safe Flight 21 office, provide a report to the Associate Administrator for Regulations and Certification containing the relevant technical data on ADS-B system performance of all three candidate ADS-B systems (Mode S, VDL4, UAT) in mountainous terrain including at lower altitudes, in extremely low temperature operations, and on a variety of small airframes.

1.5.3.2 Provide data on fuel savings achieved due to better in-flight information on the location and severity of icing conditions, winds aloft, and below minimums landing conditions.

1.6 Benefits

Under Capstone, the Alaskan Region will serve as a real-world test bed for tools, procedures and certification techniques. During the project selected commercially operated aircraft are equipped to interface with ground sites installed within Alaska.

Immediate impact items include:

- Improved situational awareness for pilots,
- More weather reporting sites,
- Improved area navigation and instrument approach capabilities,
- Stimulation of the avionics manufacturing industry,
- Improved capability for dispatchers and controllers to flight follow aircraft,
- Improved search and rescue,
- Adapted M-EARTS to receive data link information,
- Fuel savings for equipped carriers,
- Immediate potential for reducing near mid air collisions,
- RADAR like coverage at altitudes below 10,000 feet.

1.6.1 Capstone long term benefits:

- Procurement of avionics to attract manufacturers who can, individually or jointly, deliver avionics and ground equipment which meet performance specifications in a timely manner.
- Provides answers to questions regarding GPS performance during periods of natural interference.
- Launches efforts to accommodate 180,000 small aircraft nation wide with affordable avionics.
- Facilitates search and rescue missions by recorded aircraft flight tracks.

2.0 Architecture

The three segmented architecture is depicted in Figure 2-1.

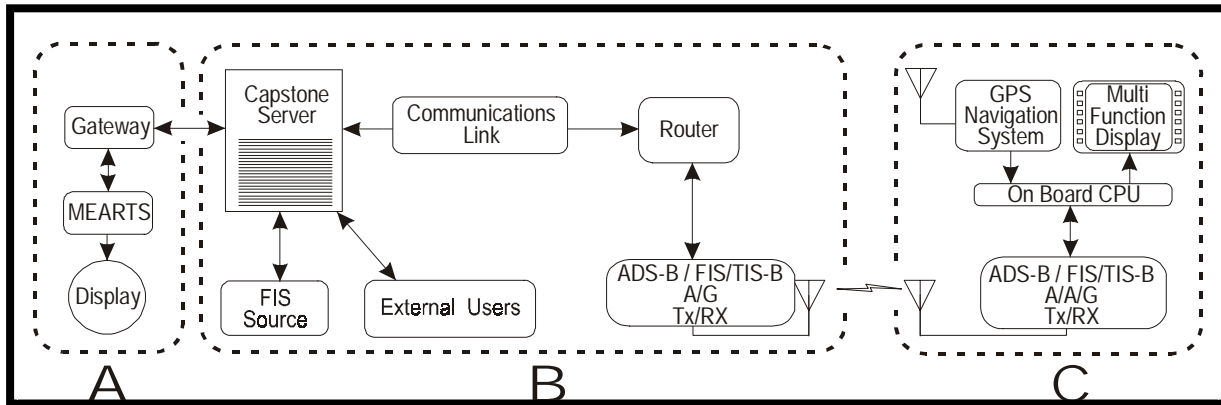


Figure 2-1. Capstone Architecture

Segment A: Segment A is comprised of a Gateway, Micro En Route Automated Radar Tracking System (Micro EARTS), and a display screen. The Gateway provides the physical interface for data transfer between Micro-EARTS and the Capstone server. Micro-EARTS will process Automatic Dependent Surveillance – Broadcast (ADS-B) target information obtained from appropriately equipped aircraft, and collected via the Capstone network. Among the planned features for Micro-EARTS is the ability to fuse the ADS-B target data with existing radar data and return the combined Traffic Information Service (TIS) data to the Capstone network for transfer to appropriately equipped aircraft. A display screen will depict the target data at ZAN for future use in conflict alerting, safe altitude warnings and other purposes.

Segment B: Includes the Capstone Server, Flight Information Services (FIS) data and user accesses, the telecommunications link, router, and the transmitter/receiver (TX/RX) radios. The Capstone Server is a series of logical or physical drives that will collect, process and transmit data between all sources and destinations. The FIS data will come from existing sources and be injected directly into the data flow. The Capstone Server will be able to prioritize and geographically filter the combined data for efficient transmission as well as provide access to selected data for external users. The telecommunications links will be provided by the Alaska NAS Interfacility Communications System (ANICS), or leased, long-haul commercial service. The router will interface the transmitter/receiver radios to the network. The radios will capture the ADS-B data from appropriately equipped aircraft, and broadcast FIS/TIS data from the Capstone Server to the airborne segment.

Segment C: This is the airborne segment. The airborne transmitters broadcast the ADS-B data to the ground segment and other airborne segments. The receivers collect ADS-B data from the other airborne segments, and FIS/TIS information from the ground segments for processing by the On-Board CPU. The CPU makes the collected data available for the pilot to select to the multi-function display. The Global Positioning System (GPS) provides location, speed and heading data to the CPU for the aircraft’s use and inclusion in the ADS-Broadcast.

3.0 Concept Of Operations

Government and Industry are actively working together to ensure these technologies are introduced safely and efficiently. Safety is paramount, along with satisfactory risk mitigation demonstration for the systems deployed. Deployment of avionics and ground systems creates an infrastructure to permit initial procedures development, procedures revisions, familiarization of ground personnel and flight crews, controllers, and avionics installers with modern equipment and concepts.

3.1 Air Traffic Management

New air traffic management procedures to be introduced under the Capstone Program are included in an Operational Requirements Document (ORD). After development of the ORD, the Air Traffic Control (ATC) organization will continue in an active role as a supporting resource for the development team. Information is gathered on system performance and products that will be useful in constructing procedural applications within the ATC environment. When system development and deployment are able to support real-world testing, testing includes verification/validation of these procedural applications. Additional testing ensures that the current equipment-based procedures are compatible and can be maintained throughout the transition to GPS-based and data link technologies with no derogation of safety or efficiency.

3.2 Streamlined Avionics Certification

Certification of equipment installed in aircraft under Capstone is closely coordinated between AIR-100, the residing directorate in Kansas City, the Aircraft Certification Office in Anchorage and the corresponding Flight Standards offices in all three locations. The combined installation of TSO 129 GPS receivers intended for IFR use while limiting the remaining components to “VFR enhancements” allows for a streamlined approach in this first step toward future certification of new technologies.

3.3 Expanded GPS Capabilities

Capstone demonstrates the operational capabilities of the GPS driven technologies which improve pilot situation awareness through visual flight enhancements and improved instrument flight capabilities. Initially, the GPS navigation system is incorporated to improve flight safety and reliability. GPS is used during VFR operations to build pilot confidence and system skill, for example:

- During preflight checks, the pilot verifies that the GPS receiver is operating properly by comparing its position readout with the surveyed location of the departure runway’s threshold.
- Upon departure, the pilot selects a GPS-direct flight course for point-to-point VFR operations between airports or intermediate fixes.

- The pilot also uses the GPS navigation system to verify the location of landmarks visually sighted along the route of flight and to make position reports to his dispatcher and air traffic controllers.
- The pilot uses the GPS navigation system to establish flight tracks passing in close proximity to Special Use Airspace or noise sensitive areas.
- The pilot uses GPS coordinates to establish way points at remote hunter and fisher drop off points.
- The GPS signal supplies data for the ADS-B, TIS-B and terrain data technologies.

Commercial operators who elect to self equip with a second TSO 129 GPS receiver qualifies for Part 135/121 IFR flights using GPS as the primary navigation system. New GPS non-precision instrument approach procedures are developed for airports within Alaska. The pilot of a dual TSO'd GPS equipped aircraft can fly under instrument flight rules on existing routes and transition to conduct the new stand alone GPS instrument approach procedures.

3.4 Multiple Function Display Unit (MFD)

Participating aircraft are equipped with a cockpit mounted multi-function color display screen. The different functions offered are accessed by selector knobs, buttons, or touch screen features depending on the manufacturer. One function uses GPS information to allow the user's aircraft position to be displayed on the screen. Pilots can view:

- A map display of their selected route information,
- Flight Information Services(FIS) such as weather, special use airspace, NOTAMS and PIREPS
- ADS-B and TIS-B target symbols to avoid mid air collisions
- terrain in close proximity of their aircraft is presented behind other on screen symbols in a wall papering manner.

The MFD and associated computer driven functions are certified for in flight advisory information only. Use of these capabilities is limited to Visual Meteorological Conditions(VMC).

3.5 Automatic Dependent Surveillance-Broadcast (ADS-B) System

ADS-B receives information transmitted from GPS satellites. This GPS information is routed into an aircraft's ADS-B system through a computer processor to generate flight path data such as location, altitude, speed and trajectory. This aircraft specific data is displayed on the pilot's MFD and rebroadcast to other ground and airborne receivers for use in collision avoidance, flight following and air traffic management. The transmitted ADS-B information can be received on any of the following:

- Air traffic control displays at the Anchorage ARTCC through a ground router computer (at a field site), which directs the data to flow through the ANICS satellite and back to a gateway computer in the center.
- The multi-function display screen in participating aircraft,
- A remote display installed at any location, for example at the Bethel Airport Traffic Control Tower, and
- A display in the aircraft operator's dispatch office for flight following.

The Capstone project employs one ADS-B ground station using Mode S (1090 MHz), VDL-4 (VHF Data link-4), and the Universal Access Transceiver (UAT) at Bethel and possibly other locations in follow-on years. The remaining ground stations and Capstone aircraft equipped for the initial start up, will receive a single frequency ADS-B transceiver.

The Traffic Information System-Broadcast fuses ADS-B and RADAR targets for use in air traffic management and is rebroadcast to participating aircraft using the data link.

3.6 FIS Weather, Special Use Airspace, NOTAMs, and PIREPs

Capstone will work in conjunction with AND-700 effort to field FIS. Government or commercial FIS products are transmitted to aircraft via a data link communications system. This joint effort allows Capstone to provide FIS text messages and graphical information concerning special use airspace, weather, NOTAM's, and PIREP's. Each component can be selected and viewed by the pilot on the MFD.

3.7 Controlled Flight into Terrain (CFIT) Avoidance using a Terrain Data Base

This capability is enabled by installing a terrain data base into a computer processor carried on the aircraft. The data base contains information for the entire state of Alaska. A graphical presentation of the terrain is presented to the pilot on the multi-function display unit. Terrain is generally presented using a "wall paper" effect behind the moving map display. As terrain appears along a route of flight, the pilot is alerted and is able to avoid potential conflicts.

- Prior to departure, the MFD allows the pilot to see a plan view of terrain which will be encountered along the path used for initial climb out.
- After departure and during approach, terrain projecting into the aircraft's flight path appears on screen, and the pilot uses this information to avoid terrain.

3.8 Automated Weather Reporting Systems

Automated weather observation equipment with the necessary functionality required to support instrument approaches for commercial operators is installed at airports not currently equipped. These weather sensors provide the following information to pilots in the area:

- Wind speed, direction, and gusts,
- Altimeter setting,
- Temperature and dew-point,
- Cloud height and sky cover, and
- Visibility.

The equipment will provide an automatic radio broadcast of observations and have the capability to provide remote weather observations via a non-dedicated “dial-up line” to access the broadcast over plain old telephone service (POTS)

4.0 Implementation

The implementation of the Capstone Program includes the following:

- Capstone Program Organization.
- Acquisition Plan
- Test Plan
- Safety Study and Measurement
- Involvement of the Alaskan Aviation Industry and Public Relations and Communications

4.1 Capstone Program Organization

The following describes the Capstone management process. The management structure and resulting program office are initiated to ensure responsible implementation results in accomplishment of the established elements of this plan.

4.1.1 Capstone Management Review Board

The Capstone Management Review Board is established to provide broad policy guidance, advice, and counsel to the Capstone Program Office. In an effort to provide connectivity between primary lines of business impacted by the Capstone validation, the following FAA executives or their designees make up this board:

- Associate Administrator for Research and Acquisitions, ARA-1
- Assistant Administrator for Region and Center Operations, ARC-1
- FAA Director for Communications, Navigation, and Surveillance
- Safe Flight 21 Program Manager

- Administrator, Alaskan Region, AAL-1 (Chair)
- Manager, Flight Standards Division, AAL-200
- Manager, Airway Facilities Division, AAL-400
- Manager, Air Traffic Division, AAL-500
- Manager, Airports Division, AAL-600
- Manager, NAS Implementation Center, ANI-700
- Manager, Aircraft Certification Office, ACE-115

The Management Review Board convenes approximately once per quarter, or as requested by any executive member, to review the Capstone Program progress.

4.1.2 Capstone Program Office (CPO)

The CPO operates under the direct authority of the Alaskan Regional Administrator, AAL-1 for all coordination efforts during the project. The CPO is led by the Capstone Program Manager and staffed on a full-time basis by a small cadre of FAA and contract support personnel. One AND-400 contract employee works in Washington DC and is designated by the Safe Flight 21 Program Office to serve as the principal liaison for the Capstone Program Office. Capstone OPI's work within their straight-line division or office, as program requirements dictate, to support and assist the CPO as described below. Division representatives attend scheduled meetings and perform services as the need arises. Two individuals will be assigned to the Capstone Program Office under the NAS Implementation Support Contract (NISC) to support the program on a full-time basis.

4.1.2.1 The CPO representatives assist the Capstone Program Manager with planning, scheduling, budgeting, implementing, and evaluating the Capstone Program. Each representative ensures appropriate program coordination is effected within their own straight line organization at the regional and national levels. CPO representatives and contacts provide technical expertise to support program planning and decision making.

4.1.2.2 The Capstone Program Office is responsible for the following:

- Developing the Capstone Program architecture and defining system interfaces.
- Advocating and supporting technology demonstrations under the Safe Flight 21 "Free Flight Operational Enhancements" program umbrella.
- Maintaining a Capstone procurement process featuring the selection and assignment of a responsible lead office for each major acquisition and a method for documenting agency consensus for procurement decisions.
- Promoting, on a regional and national basis and with industry, participation in Capstone Program planning and activities.

- Developing program plans, specifications, cost estimates, selection criteria, and other procurement documentation for acquisition of Capstone systems and equipment.
- Establishing an integrated Capstone program schedule. The schedule will include program goals, acquisition schedules, equipment delivery and site implementation milestones, and will illustrate program dependencies.
- Implementing a progress reporting system to facilitate the flow of information and assist with communication and coordination mechanisms.
- Coordinating all programs and activities directly contributing to the accomplishment of the Capstone Program.
- Preparing future budget requirements for equipment, services, personnel, and other resources with the Safe Flight 21 office.
- Coordinating the development of test and evaluation plans including schedules, responsibilities, and field support requirements for operational capabilities demonstrations, contractor acceptance testing, certification and flight check.
- Developing and maintaining database tools to support the various aspects of the Capstone Program implementation. Where applicable, these database tools will be linked to the master program schedules.
- Preparing “after action” reports detailing program accomplishments, lessons learned, and recommendations to achieve future Free Flight Operational Enhancements on a national basis.
- Supports Safe Flight 21 activities: to develop and implement plans and schedules for Capstone activities in the Alaskan Region which support evaluation of Free Flight Operational Enhancements (FFOE) and ADS-B data link.

4.1.3 Capstone Program Office staffing

The Capstone Program office is staffed and supported through temporary assignments by the Alaskan Region straight line organizations and the Regional Administrators staff. Each straight line organizational representative is responsible to develop individual detailed work plans for each aspect of the program to which they are the lead. Staffing for the office consists of:

- Office Manager
- Business Manager
- Administrative Officer
- Two Flight Standards Representatives
- One Air Traffic Control contact

- One Airways Facilities contact
- One National Airspace System Implementation contact
- One Aircraft Certification Office contact
- One Logistics contact
- One Legal counsel Office contact
- Two NISC contract employees
- One Safe Flight 21 coordinator (Office in Washington DC)
- One AVN procedures contact
- Other participants

4.1.4 Alaska Region Lines of Business

A major requirement of the Capstone Program is to develop, test, and certify aircraft, air traffic control, and flight standards procedures. While new procedures and certifications are being evaluated, existing procedures and certifications will be followed in parallel to support operations by aircraft unequipped and not participating in the Capstone Program.

The assigned representatives from the organizations listed in Table 4-1 below are responsible for completion of the related tasks. Each line of the business develops: detailed work plans to ensure project timelines are maintained; procedures to use each assigned element; as well as records and reports progress to the Capstone management review board through the CPO manager.

Capstone Elements	OPI
Ground station w/connectivity	AF
• (GBS)3 link	AF
• 1 link	AF
• Server	AF
AT LAN network (tower, FSS)	AF/AT
Automated weather systems	ANI
Software updates	AF/AT
Automation, Software, Gateway for radar processor	AF/AT
SATCOM	AF
LAAS	AF
FIS	AT
FTE	AT
M-EARTS adaptation	AF/AT

Avionics	
An IFR-certified GPS navigation receiver	ACO/FS
Automatic Dependent Surveillance-Broadcast (ADS-B)Transmitter/Receiver	
A moving map display with TIS-B traffic and terrain advisory services	
A multi-function color display	
Onboard computer processor	
Certification activity	
Procedures, Operations	
GPS non-precision procedures	AVN
Flight check	FS/AVN
Training program	FS/AF/AT/ANI
Contract oversight at UAA	FS

Table 4-1 Capstone Elements and OPIs

4.2 Acquisition Plan

The Capstone budget provides for procurement of avionics, ground system components, installation of equipment, training of personnel, maintenance of equipment, software upgrades, and technical and program management support. Technical and program management support services are procured by tasking FAA’s existing NISC contracts and by establishing contracts for services with the University of Alaska. The University of Alaska is contracted to develop and deliver training for pilots, dispatchers, air traffic controllers, and flight service specialists. The University also provides an evaluation of operational and safety benefit improvements provided through the Capstone Program. Appendix A provides information on the funding for Capstone. An acquisition work plan detailing the requirements for individual OPIs will be prepared.

4.2.1 Procurement of Individual Components

The Alaskan Region’s Logistics Division published a “Request for Information (RFI)” that announced to interested avionics vendors the FAA’s proposed Capstone Program and requested submission of information on their products, services, and capabilities to meet the needs for Capstone. Information provided by the vendors who responded will be considered as the FAA prepares performance specifications for Capstone Program avionics and ground transceiver equipment.

4.2.1.1 Avionics are purchased through a contracting process. The successful vendor provides the avionics suites meeting the requirements for Capstone. Under terms of the Aircraft Owner Agreement, the aircraft owner who voluntarily decides who installs the avionics suite in his aircraft is provided with a fixed amount of funding for each aircraft to accomplish the installation. Owner may install the avionics by one of the following three methods:

- Use the manufacturer's instructions, the owner's facilities, and the services of the owner's own authorized and licensed technicians,
- Procure the services and facilities of a licensed avionics installation contractor, or
- Procure the facilities and services from the avionics equipment manufacturer using either the services of his own technician, a contractor, or the avionics equipment manufacturer.

The contract with the manufacturer provides for a standard maintenance warranty for all parts and labor.

The Capstone avionics equipment performance specifications requires the successful bidder to provide a full Operational Capabilities Demonstration in advance of contract award. The vendor is responsible for demonstrating the full capabilities of its equipment suite and proving that it has overcome any developmental problems associated with either equipment or software. Any integration problems resulting from joint venture contract arrangements, the use of sub-assemblies manufactured by others, or similar problems are solved.

The Capstone project requires an ADS-B system formatted in Mode S, VDL-4, or UAT. This system must be able to interface with all GPS Navigation Systems certified to TSO C129a Class A1 or have an internal GPS sensor certified to TSO C129a Class B1 for reporting of aircraft position. The enhanced see and avoid information will be a pictorial presentation of ADS-B data from participating aircraft.

4.2.1.2 The program plan includes procurement of at least one transmitter/receiver set designed the same or similar type as those used in the Safe Flight 21 Cargo Airline Association's Ohio Valley ADS-B demonstration. Other ground based transceivers may employ one of the three data link candidates. ADS-B ground stations must be fully compatible with existing ground-based telecommunications systems, i.e., telephone or Alaska NAS Inter facility Communications System (ANICS) and transmit aircraft position reports between the aircraft and various connected ground facilities. Installations are accomplished by FAA technicians and/or contractor personnel, in existing FAA facilities and joint-use FAA/military facilities, in accordance with the manufacturer's instructions. A standard maintenance warranty for all parts and labor will be specified in the contract.

4.2.1.3 Micro-EARTS at the Anchorage ARTCC is being adapted to receive and process the ADS-B position reports transmitted via the three different data link spectrum in this plan. The program modification purchased through this contract is expandable to nationwide facilities using Micro EARTS. Traffic Information Service-Broadcast (TIS-B) will be implemented so that the pilots of Capstone-equipped aircraft can see both ADS-B aircraft position reports and radar targets for all nearby traffic on their multiple function display (MFD). A communications gateway processor will be installed at the ARTCC to interface between the Micro-EARTS and the remote transmitters/receivers. The gateway processor will accept data for Mode S, UAT or VDL Mode 4 aircraft data links and route surveillance-related data (i.e., position, velocity, turn rates) to the Micro-EARTS for surveillance and display processing. ADS-B and radar track

position information will be forwarded from Micro-EARTS to flight data processing for correlation, conformance monitoring, etc.

4.2.1.4 Flight information services are provided by either the FAA or a commercial vendor contracted to offer weather products, SUA notifications, NOTAMs, and PIREPs. This information is provided as selected by the pilot and presented on the MFD.

4.2.1.5 Up to 10 automated weather reporting systems, which meet current FAA approval, will be procured and installed. The weather observation equipment will meet at least the minimum functionality required by the Federal Aviation Regulations to support an instrument approach procedure for commercial operators. Weather sensors will provide the following observations: (a) wind speed, direction, and gusts; (b) altimeter setting; (c) temperature and dew-point; (d) cloud height and sky cover; and (e) visibility. The equipment will provide an automatic radio broadcast of observations and have the capability to provide remote weather observations via a telephone line or connection to Service A. The equipment will be capable of remote status and maintenance monitoring. Equipment specifications will incorporate Airway Facilities Division's requirements for standardization, maintenance training, and supply support. The weather observation equipment is installed at airports by FAA technicians and/or contractors in accordance with the manufacturer's instructions. A standard maintenance warranty for all parts and labor will be specified in the contract.

4.2.1.6 The Program Office has technical and specialized program management support services for specific tasks. NISC personnel are used to assist in preparation of technical equipment specifications, equipment selection criteria, site plans, test requirements, procedures, installation designs, program schedules, and the program's work breakdown structure for cost control. TSSC personnel may be tasked to perform specific other technical tasks as required.

4.2.1.7 Capstone contracts with the University of Alaska (UAA) to provide initial training elements for pilots, FAA personnel, technicians, and others in the use of Capstone equipment. The training will cover operational features, and implementation of new procedures developed. Training will be made available at the UAA's Aviation Complex at Merrill Field in Anchorage and Bethel.

Initial ground training by instructors working inside a university style curriculum provides students a classroom, laboratory and simulator environment. Simulations include hands on use of ground and airborne equipment. As the program matures, and field validation information becomes available, modifications to the training process are needed to ensure the best possible procedures evolve for nationwide implementation. All initial and recurrent ground or flight training are conducted within the FAA approved training programs of the specific carrier involved.

As the aviation companies, flight standards field offices, and avionics manufacturers work together to validate a variety of avionics ship sets, add airports to their operations specification, modify manuals and develop training programs encompassing Capstone procedures, continuous updating of training programs will be required.

4.2.1.8 Software changes during the period of testing (estimated as through 2001) are provided by the FAA. These include software upgrades for both avionics and ground systems.

4.3 Safety Study and Measurement

One full time Capstone office representative is assigned the task analyzing safety risk factors and monitoring safety during Capstone. Specific objectives are as follows:

- Identify and define safety risks associated with Capstone throughout the Capstone program time frame and the means to mitigate the risk along with potential measurable metrics.
- Analyze data collected during Capstone and provide analysis results for further use during Capstone.

A safety baseline is established to determine the Bethel area accident baseline. This baseline enables the UAA to gauge the safety impact of technologies introduced during Capstone over the next three to five year period.

4.3.1 Data Collection

Both human and electronic means are incorporated to make up the data collection process. Data routed through the ADS-B ground station is loaded into the Anchorage ARTCC data base and uploaded to headquarters daily. Pilots reporting forms capture navigation, terrain, and mid-air collision avoidance and flight information service reliability for the process. UAA's use of historic NTSB aircraft accident records establishes a safety baseline on which future accident rate improvements are gauged.

All airports currently served by the initially equipped aircraft are slated, as money comes available, to receive a accurate GPS runway survey. These "known points" are key elements to collecting test information from pilots using GPS driven avionics.

4.3.2 Reporting

The UAA is the focal point for gathering and compiling data. As data is compiled, reports generated by UAA are forwarded to the Capstone field office who coordinates them with the Alaska Region matrixed staff, and forwarded to the Safe Flight 21 office for final publication and distribution as part of the Safe Flight 21 Test results.

4.3.3 Analysis and Simulation

The UAA will develop metrics; make observations; interview personnel (pilots, operators, equipment manufacturers, FAA personnel, and others); and analyze all relevant safety and operational data. UAA will report its findings and recommendations to the Capstone Program Office for changes in equipment specifications, operational procedures, flight regulations, training, or other matters.

4.3.4 Human Factors

The human factors representative identifies and mitigates human factors issues associated with realization of the operational enhancements outlined in section 3.2. Specific responsibilities include the following:

- Ensure that planning and implementation activities of the avionics and ground systems incorporate the human factors activities that will be necessary to conduct operational testing;
- Establish human performance metrics that objectively measure the effectiveness in meeting the human factors goals;
- Ensure coordination between equipment programs and with Safe Flight 21 so that all human factors interdependencies and issues are addressed and resolved in a timely manner;
- Ensure adequate information on human factors components of the demonstration become available in time to allow for tailoring of systems based on lessons learned during the implementation of the various ground and airborne systems.

4.4 Test Plan

The Safe Flight 21 Program Office leads the effort to develop a test plan for the CAA activity. Alaska participates in developing test plans. The Capstone Program office, Capstone-participating pilots, UAA, FAA Tech Center, and others report, collect and analyze data to be used in the testing. The testing in Alaska is used to measure the operational and safety effectiveness of the installed Capstone equipment.

4.4.1 Testing

The Test and Evaluation Management Plan developed by the Safe Flight 21 office lays out test methods, requirements, criteria, and measurements. Measurements are through verbal and written inputs, analysis from the FAA Capstone office and matrixed representatives from the region and headquarters, and analysis and simulation by UAA.

4.5 Public Relations and Communications

The Capstone Program Office (CPO) Manager will act as principal spokesman for the program. With support from CPO personnel, the manager will coordinate, brief, and conduct seminar and liaison activities for interested internal and external individuals and organizations to ensure program success. Communications will be maintained with these and other organizations:

- Alaskan Regional Management Team and field facilities and offices,

- Labor/management organizations including the National Air Traffic Controllers Association (NATCA), the National Association of Air Traffic Specialists (NAATS), and the Professional Airways System Specialists (PASS),
- Anchorage ARTCC, Bethel ATCT, and Kenai AFSS,
- FAA Industry Council,
- State of Alaska Department of Transportation and Public Facilities,
- Rescue Coordination Center,
- U.S. Military,
- University of Alaska,
- Scheduled and unscheduled airlines; air taxi and charter operators; business and general aviation groups,
- Affected communities including Alaskan Native associations, and
- FAA contractors such as NISC and TSSC.

The following matrix represents the main body of the Capstone industry council. A brief synopsis of the role each group fulfills is provided:

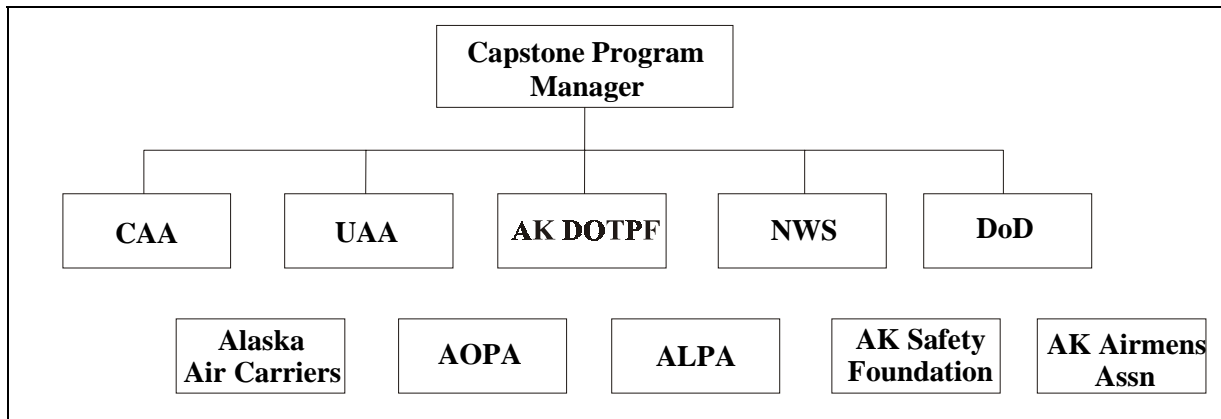


Figure 4-1

4.5.1 The Alaska Department of Transportation and Public Facilities (DOTPF)

The Alaska Department of Transportation and Public Facilities (DOTPF) owns and is the sponsor for the 10 village airports planned to receive weather observation equipment and stand alone non-precision GPS instrument approach procedures under the Capstone Program. The DOTPF sponsor reviewed Capstone’s proposed development for each of the initial airport locations planned to receive the GPS non-precision instrument approach procedures and

concluded no noise sensitive areas are affected and no extraordinary circumstances exist. Alaska DOTPF requested that FAA exclude the Capstone Program from further environmental processing. The CPO coordinates Capstone activities with the DOTPF throughout the life of the program. DOTPF's cooperation will be a key to successful installation of Capstone infrastructure on airport property.

4.5.2 National Weather Service

The National Weather Service (NWS) is the provider of a myriad of weather products throughout Alaska. They use a variety of sensors to obtain weather conditions to provide users and the FAA. They also provide area forecasts and specific forecasts for the larger cities. The NWS and FAA work hand in hand to gather and distribute weather related information and products.

4.5.3 Department of Defense and Coast Guard

The DOD and Coast Guard have representatives on the Alaskan Region Industry Council.

4.5.4 University of Alaska

The University of Alaska, Anchorage (UAA) has an Aviation Technology Division that is actively participating in the Capstone Program. The university sends a delegate to the Industry Council and participates in most aviation organizations. The UAA responsibilities include the following:

- Train pilots, FAA personnel, technicians, and others in the use of Capstone equipment, operational features, and new procedures developed and implemented during the program.
- Use historic NTSB aircraft accident records to establish a safety baseline on which future accident rate improvements are gauged.
- Gather and compile safety information during testing of operational enhancements.

4.5.5 Industry Council

The Alaskan Region Industry Council actively works on Free Flight operational enhancements subjects. The group helped define the Capstone architecture for Alaska and is considered a major player in the development, implementation, and evaluation of the Capstone Program in Alaska. The Industry Council will provide direct input to the Capstone Program Manager and represent the interests of the various segments of Alaskan aviation.

4.5.6 Aviation Organizations

Most aviation organizations have chapters in Alaska. They represent the varied interests of aviators in the state. These organizations bring users' concerns and issues to the table and help insure a continued dialogue with aviators. Organizations actively involved with the Capstone Program include the Aircraft Owners and Pilots Association (AOPA), Alaska Airmen's

Association (AAA), Alaskan Aviation Safety Foundation (AASF), Alaska Air Carriers Association (AACA), Cargo Airline Association (CAA) and Northern Alaska Aviation Users Group (NAAUG).

4.5.7 NISC

Two NISC representatives will provide program management, planning, and technical support for the Capstone Program Office. They will support all elements of the Capstone demonstration as specified in the NISC task order.

5.0 Cost Benefits

A cost benefit analysis is conducted by the Safe Flight 21 office and described in the Safe Flight 21 Cost Benefit Analysis Plan. This is used to justify budget requests for implementation of systems that follow the year 2001.

6.0 The Demonstration Area

The demonstration area for the initial Capstone validation is loosely bordered on the west by the Bering Sea and on the east by the Kuskokwim Mountains. The northern and southern borders generally parallel the Norton Sound and Kuskokwim Bay, respectively. The area is dotted with small villages that depend heavily on aviation as the only reliable source of year-round transportation. Access to these numerous bush communities is primarily by air but water and snow mobile service is possible for some on a seasonable basis.

The Yukon-Kuskokwim delta region of western Alaska was selected by the FAA's Industry Council as the most logical location for initiating the "first year" Capstone Program. Their reasoning is based on several considerations:

- The area is serviced by a relatively fixed and limited number (up to 200) of commercially operated aircraft.
- The accident rate is about 5 times greater than the national average for similar air transportation service.
- There is virtually no radar coverage at altitudes below 10,000 feet where the small aircraft are operated.
- Operators have a need for enhanced flight following capability.
- With relatively few flights to/from airports outside the test area, almost 100 percent avionics coverage can be achieved.
- There are a large number of special VFR operations at Bethel so pilots will be able to use the enhanced see and avoid capabilities on a frequent basis.
- For the initial installment, up to twelve remote transmitter/receiver systems will be installed to provide the required geographic coverage.

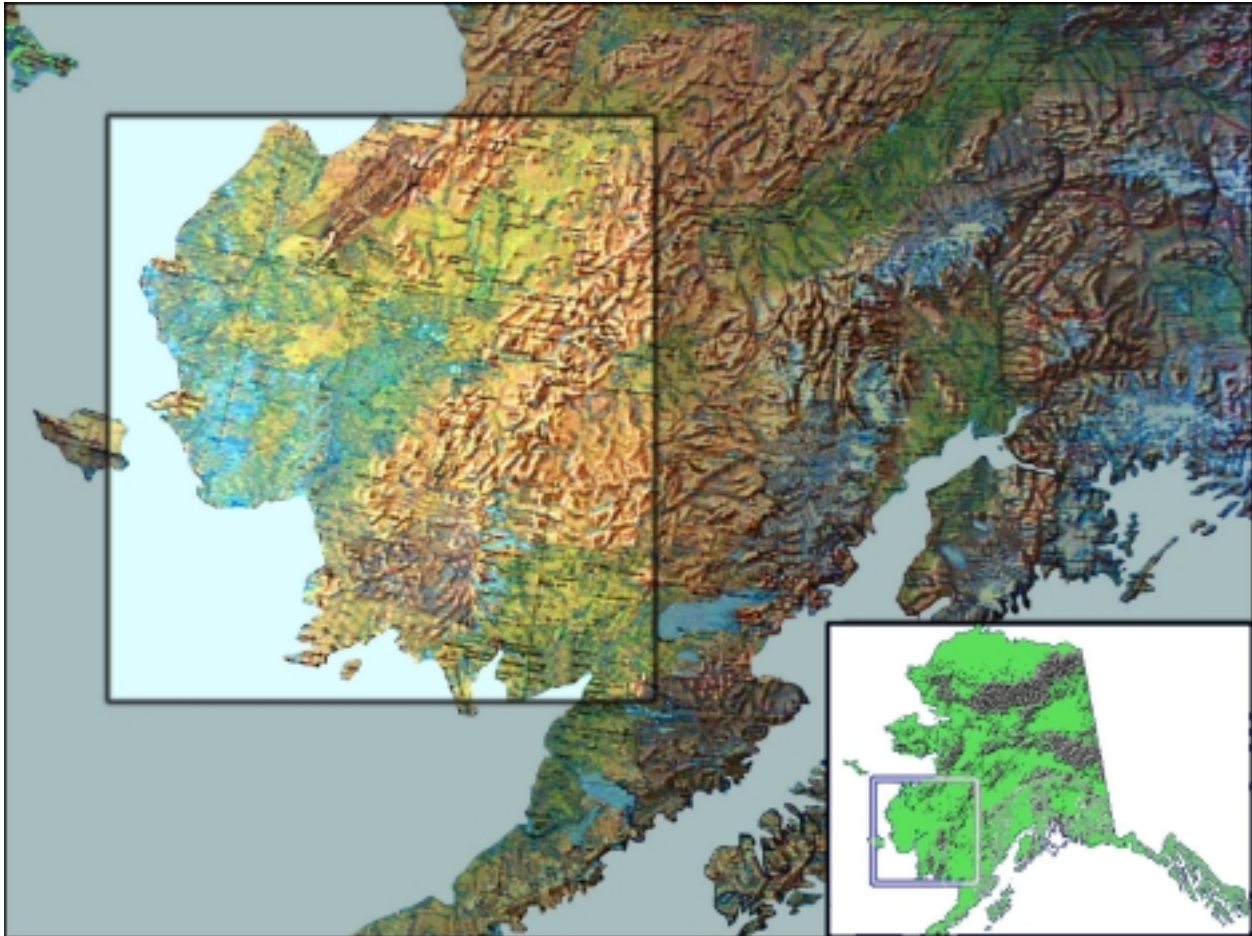


Figure 6-1 Capstone Demonstration Area

6.1 Remote Transceiver Sites.

Sites to be selected will, as much as practical, produce service coverage down to 1,000 feet above ground level (AGL), or better. Remote equipment will be installed in incremental phases beginning with the area immediately around Bethel and expanding from there. Preference for locations will be given to FAA-owned and joint-use facility locations for economic availability of shelter, power, and communications.

6.2 New Non-precision GPS Instrument Approaches

Under the Capstone Program, the Alaskan Region's Flight Procedure's Office will request development of a first-time GPS-based non-precision instrument approach to one or more runways at each of the following ten remote village airports. These airports were jointly recommended by the Alaska Department of Transportation and Public Facilities and the Alaska Air Carriers Association as the highest priority locations within the Capstone demonstration area for an instrument approach procedure. They are:

- Kipnuk

- Platinum
- Scammon Bay
- Holy Cross
- Kwigillingok
- Kalskag
- Mt. Village
- Russian Mission
- St Michael
- Koliganek

In anticipation of Capstone, these airports have been GPS-surveyed for preparation of the non-precision GPS instrument approach procedures. To conduct instrument approaches under FAR Part 121 or 135, weather reporting is essential. These same airports are slated to receive automated weather reporting equipment during the Capstone program.

6.3 Coverage Area Expansion

The initial Capstone area will expand in FY2000-2001 toward Cold Bay and Anchorage. As money is appropriated, areas containing the original 49 airports will be phased into later versions of this plan.

7.0 Schedule and Timelines

Project Capstone is accomplished in four phases to assure successful development, planning, production, installation of the project. Airborne equipment is ordered in groups of fifty each to allow also for scheduling and installation in respective aircraft at Bethel. Ground stations are ordered and installed as the preceding installations mature, are successfully networked, and the follow-on locations are revalidated. The 1999 timeline is Appendix C of this document. Out year timelines are under development for inclusion in future versions of this program plan.

8.0 Other Related Capstone Program Documentation

Related components include an Internet Home page at www.alaska.faa.gov/capstone, Capstone Newsletter, and a Management Review Board Quarterly briefing document.

Appendix A Capstone Requirements and Costs

Requirement	FY 99		FY 00		FY 01	
	Qty	Cost (K)	Qty	Cost (K)	Qty	Cost (K)
Ground Systems						
Ground station w/connectivity		1200				
· 3 link	1		2	800		
· 1 link	11		4	1200	6	2000
· Server			1	250		0
AT LAN network for FSS				0	1	250
AT LAN network for tower				0	1	130
ADS-B equipped vehicles at ANC				0	200	200
Anchorage International surface survey						150
Additional airport instrument runway surveys				150		
AWOS	3	1000		0		0
· Additional coverage near BET			7	2000		0
· coverage extensions				0	8	2500
Software updates				0		1000
Automation, Software, Gateway for radar processor		2800				
SATCOM						800
LAAS						1000
FIS		250		100		100
FTE				600	6	600
Washington DC tech support		400				
Alaskan Tech support, Misc		850		250		500
Airports	10		10			
Avionics						

1. An IFR-certified GPS navigation receiver	Up to 200 a/c	4000	10 a/c	1500		
2. Automatic Dependent Surveillance-Broadcast (ADS-B) Transmitter/Receiver			2 / 737 3 / 727			
3. A moving map display with TIS-B traffic and terrain advisory services			3 / DC-6 1 / C-130 1 / 188			
4. FIS providing weather maps, special use airspace status, wind shear alerts, NOTAMs, and PIREPs						
5. A multi-function color display						
Procedures, Operations						
GPS non-precision procedures			15	100		X
Flight check			15	50		
Training program/Safety Study		500				X
Total		11000		7000		9230

APPENDIX B

ACRONYMS

AAL	FAA Alaskan Region
ACC	Area Control Facilities
ADS	Automatic Dependent Surveillance
ADS-A	Automatic Dependent Surveillance-Addressed
ADS-B	Automatic Dependent Surveillance-Broadcast
AFSS	Automated Flight Service Station
ANI	FAA Engineering Center
ANICS	Alaskan NAS Interfacility Communications System
AOPA	Aircraft Owners and Pilots Association
ARTCC	Air Route Traffic Control Center
ASOS	Automated Surface Observing System
ATIS	Automated Terminal Information System
ATS	Air Traffic System
AWOS	Automated Weather Observing System
AWP	FAA Western Pacific Region
CDTI	Cockpit Display of Traffic Information
CERAP	Center/Radar approach Control
CFIT	Controlled Flight into Terrain
CFO	Capstone Field Office
CNS	Communications, Navigation and Surveillance
CPDLC	Controller-Pilot Data Link Communications
DGPS	Differential GPS
DOT	Department of Transportation

DSS	Decision Support Systems
F&E	Facilities and Equipment
FIS	Flight Information Services
FSDO	Flight Standards District Office
FSS	Flight Service Station
FY	Fiscal Year
GNSS	Global Navigation satellite System
GPS	Global Positioning System
HAZMAT	Hazardous Material
HVAC	Heat, Ventilation, Air Conditioning
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
LAAS	Local Area Augmentation System
Mode S	1090 megahertz data link
Micro EARTS	Enroute Air Route Traffic System
NAS	National Airspace System
NISC	NAS Implementation Support Contract
NOTAM	Notice to Airmen
NWS	National weather Service
O&M	Operations and Maintenance
OT&E	Operational Test and Evaluation
R&D	Research and Development
SUA	Special Use Airspace
TACAS	Traffic Alert and Collision Avoidance System
TIS	Traffic Information Service

TIS-B	Traffic Information Services-Broadcast
TRACON	Terminal Radar Approach Control
TSSC	Technical Support Services Contract
UAA	University of Alaska, Anchorage
UAT	Universal Access Transceiver
VDL	VHF Data Link
VFR	Visual Flight Rules
WAAS	Wide Area Augmentation System
WARP	Weather and Radar Processor

Appendix C Capstone 1999 Timeline

