FAA Telecommunications Infrastructure Investment Analysis Report

Mission Need Statement # 322

July 13, 1999

[redacted]

for Associate Administrator for Air Traffic System Requirements Services,
ARS-1

Concurrence: ______________________________

Associate Administrator for Airway Facilities Services,
for AAF-1

Fully Releasable

FTI Investment Analysis Team

The FAA Telecommunications Infrastructure (FTI) Investment Analysis Report was prepared by the Investment Analysis Team in June 1999 under the leadership of Stephen Dash (ASD-400), Phone 202-493-4651. To obtain an electronic copy of this report, please contact Dana L. Newcomb, SETA, at 202-651-2423.

Personnel from the following Organizational elements participated on the Investment Analysis Team and in the development of the FTI Investment Analysis Report: ASD-400, ASD-410, ASD-100, ASD-300, AAR-200, ACO-700, AIO-300, AND-300, ANI-70, ANS-400, ANS-700, AOP-100, AOP-400, AOP-500, ARN-200, ARR-100, ARR-200, ATO-420, and SETA. The following individuals were major contributors to this report:

Stephen Dash, ASD-410, IAT Lead

Leon Sayadian, ASD-100

John Rossi, AIO-300

James Glass, ANS-400

Dan Treadwell, ARN-200

Tammye Jenkins, ARR-100

George Beasley, ANI-70

Dave Joyce, AOP-500

Greg Street, ASD-300

Roger Martino, AOP-500

Yanelle Strong-Fischer, ANS-700

Ernie Lucier, ARN-200

Lyle Miller, ATO-420

FTI Investment Analysis Report

EXECUTIVE SUMMARY

The Federal Aviation Administration's (FAA) Associate Administrator for Research and Acquisition (ARA-1), on behalf of the program sponsors, the Associate Administrators for Air Traffic Services (AAT-1) and Airway Facilities Services (AAF-1), directed that an investment analysis for the FAA Telecommunications Infrastructure (FTI) be conducted. The direction was issued upon the formal Joint Resources Council (JRC) approval of Mission Need Statement (MNS)-322 in May 1998.

MNS-322 addresses three principal themes relative to the manner in which the FAA currently provides telecommunications services to users. First, the MNS establishes that the FAA has within its inventory both leased and capitalized assets that are fast approaching the end of their respective contract or life cycles. Although the nature of these life cycle concerns differs among the identified assets, in general, the MNS indicates that most of the assets must be replaced between 2002 and 2006 and, moreover, that no plan is currently in place to support the continuation or the improvement of telecommunications services beyond the end-of-service dates of existing systems. Second, the MNS postulates that the cost of operating and supporting the current telecommunications network assets is expected to grow at least 12.5% per year between 1998 and 2003. According to the MNS, this trend in costs is due to growth in telecommunications requirements and the cost of sustaining inefficient, poorly integrated service solutions. Finally, the MNS recommends that newer technologies and business practices be examined as a means of maximizing resource utilization, providing operational improvements, and reducing costs. Should these issues not be addressed, the MNS concludes, the FAA could suffer reductions in the capacity and efficiency of the National Airspace System (NAS).

Among all of the services or assets discussed in the MNS, the Leased Interfacility NAS Communications System (LINCS) offers the greatest near-term challenge. LINCS is a leased capability whose assets are wholly owned by the supplier. It is the asset upon which virtually all critical telecommunications transport services are provided in the NAS. The contract providing LINCS services will expire in March 2002 and it could take several years to transition to another service provider. Accordingly, the JRC directed that the Investment Analysis address only the LINCS portion of the Mission Need along with any associated capabilities or additional replacements that would logically be related to the replacement of the LINCS contract.

The Investment Analysis and Operations Research Directorate (ASD-400) formed a team to conduct an analysis of the critical issues set forth in the MNS, follow the specific guidance provided at the May 1998 JRC, and develop a methodology suitable to address the key issues postulated in the MNS. The objective of the Investment Analysis Team (IAT) was to recommend a preferred business case solution to support the development of an Acquisition Program Baseline (APB).

Methodology

The IAT first came to agreement on a set of assumptions, constraints, and conditions that would frame the analysis. It then organized four subteams that focused the analysis to develop the following:

- Alternatives which would appropriately address both the range of issues set forth in the MNS and the JRC guidance.
- Network transition model(s).
- Models that would address the costs of the alternatives.
- Assessment of benefits.

A separate cross-functional team was formed to perform a risk assessment of the results of the analysis. Additionally, ARR formed a broad stakeholder team and developed an FTI Requirements Document (RD). Each alternative was assessed against four decision criteria categories: Cost, Risk, Mission Effectiveness, and Strategic Alignment. This process revealed a preferred alternative that was further evaluated by the SEOAT for affordability within the framework of the current and projected Office of Management and Budget (OMB) Facilities & Equipment (F&E) targets and operational budget profiles.

Market Analysis

An Integrated Product Team (IPT) assessment of the telecommunications marketplace was already in progress as the IAT started its work. The IAT built on this initiative and made proactive interaction with industry a key element of its strategy. The strategy had three major elements: 1) assess technological capability, 2) assess marketplace products and services, and 3) gain understanding of contractual trends in the industry and how those trends might influence the IAT analysis. Beyond the more traditional industry interactions during the market analysis process, the IAT formed a relationship with the Government Electronic Industry Association (GEIA) and the Industry Advisory Council (IAC). These activities were helpful in gaining an understanding of marketplace products, capabilities, and contractual trends.

The IAT determined that the principal trend in the set of offered services in the marketplace is that more and more are viewed, marketed, and sold as commodities. The commodities are abundant, generally falling in price, and are packaged for large networks as commodities along with sophisticated value added services. These findings raised two fundamental questions: 1) is the FAA environment one that could leverage these trends, and 2) if the answer to the former question is yes, then how is the IA affected?

Alternative Development and Analysis

The specific JRC direction to focus on the LINCS solution and other related subsystems represented the first challenge to framing the alternatives. The IAT opted to first task the Transition Analysis Subteam to perform an assessment of the time required to transition from the LINCS network to a generic replacement. This was undertaken to determine from the outset whether some kind of "bridge" extension to the current infrastructure would be required regardless of the alternative. The Transition Analysis Subteam determined that it was probable that approximately three years would be required to fully transition from the current LINCS infrastructure to a new contract infrastructure. These findings, along with certain contractual clauses which place limits on when transition can occur, led the IAT to conclude that a continuation of the LINCS infrastructure for up to three years would be a required element of any solution.

Although the JRC had directed that the near-term problem of the LINCS infrastructure take on a special IAT focus, the team learned early on that all the subsystems, to varying degrees, are interrelated and that each of the MNS cited systems would require IAT attention. Accordingly, over and above the LINCS replacement question, each of the MNS-322 identified subsystems was evaluated to assess the following: 1) current service delivery capability; 2) current vulnerabilities across various contractual and supportability criteria, and 3) extent that the subsystem should or could be integrated into that part of the solution focusing on the LINCS replacement issue. This evaluation resulted in the following conclusions: 1) the switching and multiplexing subsystems (i.e., DMN, ADTN, NADIN PSN) should be considered among the alternatives for phased replacement; and 2) the transport subsystems (i.e., RCL, LDRCL, FAATSAT) would continue to provide required connectivity in the short-term and, in the long-term each should be evaluated under separate business case analysis.

The IAT developed three alternatives to assess the MNS issues and JRC guidance. Although each alternative is comprised of a complex set of elements, they can be described generally, as follows:

- *Reference Case Alternative* – Essentially, a "LINCS equivalent" infrastructure model that otherwise continues the FAA practice of managing multiple subnetworks.
- *Interfacility Services Network (ISN)* – A network infrastructure supporting a range of network service offerings and more efficient provisioning of bandwidth. Operational and administrative service offerings remain, as they are today, physically separate. The FAA practice of managing multiple subnetworks continues.
- *Integrated Interfacility Services Network (IISN)* – Procures, as a service, transport, switching, routing, network management and control, and network engineering across operational and administrative domains. After LINCS transition, IISN incrementally eliminates current FAA practice of managing multiple subnetworks.

A Base Case was developed which formed a "current business" profile, projected forward for the ten-year life cycle. The alternatives were assessed against the Base Case life cycle cost projections.

Findings

The IISN Alternative was superior to the other alternatives in three categories. Under *Mission Effectiveness,* IISN scored higher because of the comprehensive integration of its services which yield superior network management and control products, superior overall performance data reporting, and an enhanced capability to provide metric data distribution products to users. The *Strategic Alignment* category was also most favorable to IISN particularly, because of the alternative's capability to more comprehensively integrate security measures, to have clear alignment with NAS Architecture (Version 4.0), and to possess a broader set of integrated services and expected metrics such that performance based contracting structures can utilized. Under the C*ost* category (Figure EX-1), IISN demonstrates that substantial cost avoidance is yielded as a result of two key elements that distinguish IISN from the other alternatives. First, with the gradual and incremental elimination of independent network operations, not only are operations enhanced as a result of having better network management and control, but costs are reduced. Second, the movement toward integrating the transport of administrative and operational domains reduces overall network bandwidth access and costs. The effect of these efficiencies will not occur rapidly. The IAT model projects that the "steady state" period, that is the time at which most of the transition events would be completed, will likely occur in the CY'07 timeframe. However, though it will take some time to transition to greater efficiency, the infrastructure will be in place thereafter for continued efficiency.

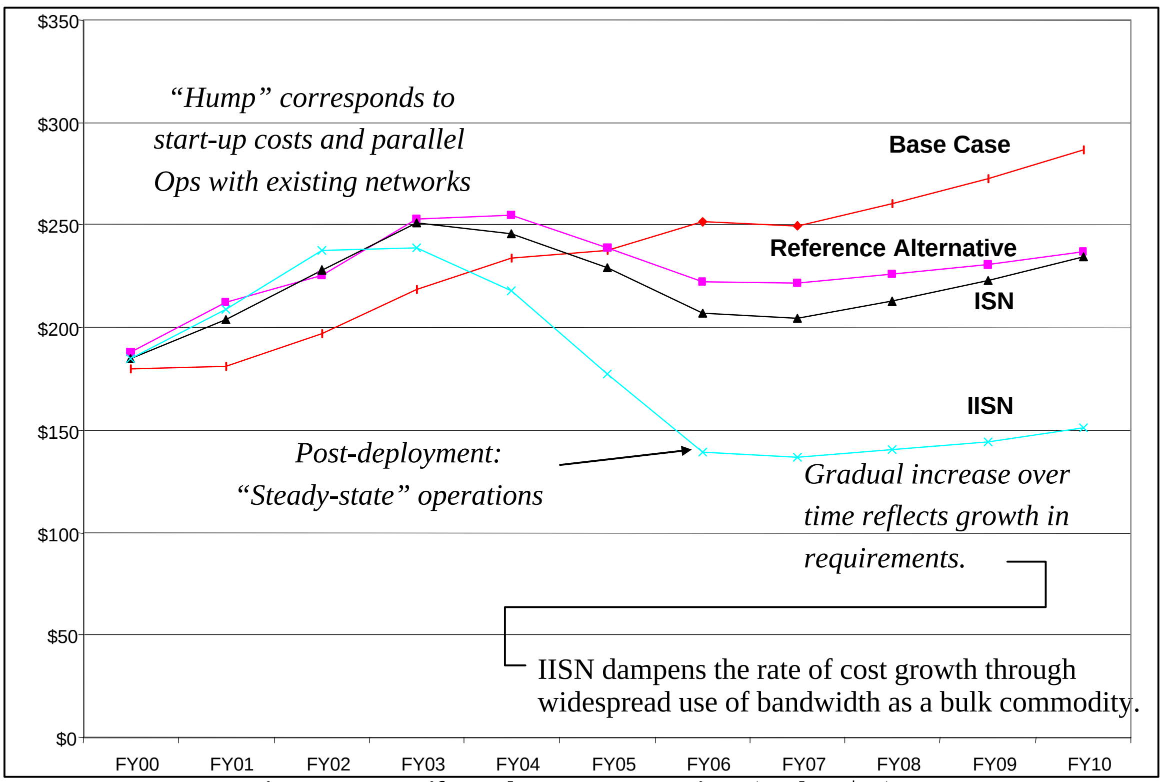

Figure EX-1. Life Cycle Costs Comparison (Budget $M)

Figure EX-1 displays the life cycle costs of each alternative in relation to the Base Case. The total life cycle cost of the Base Case is $2.6B. By comparison, the life cycle cost of the Reference Case Alternative is $2.3B, the ISN Alternative is $2.4B, and the IISN Alternative is $1.9B.

Figure EX-2 depicts the present value cost avoidance of the candidate alternatives in relation to the Base Case. As the figure shows, the net present value of the Reference Case Alternative is $66.1M, of the ISN is $90.4M, and of the IISN is $398.9M.

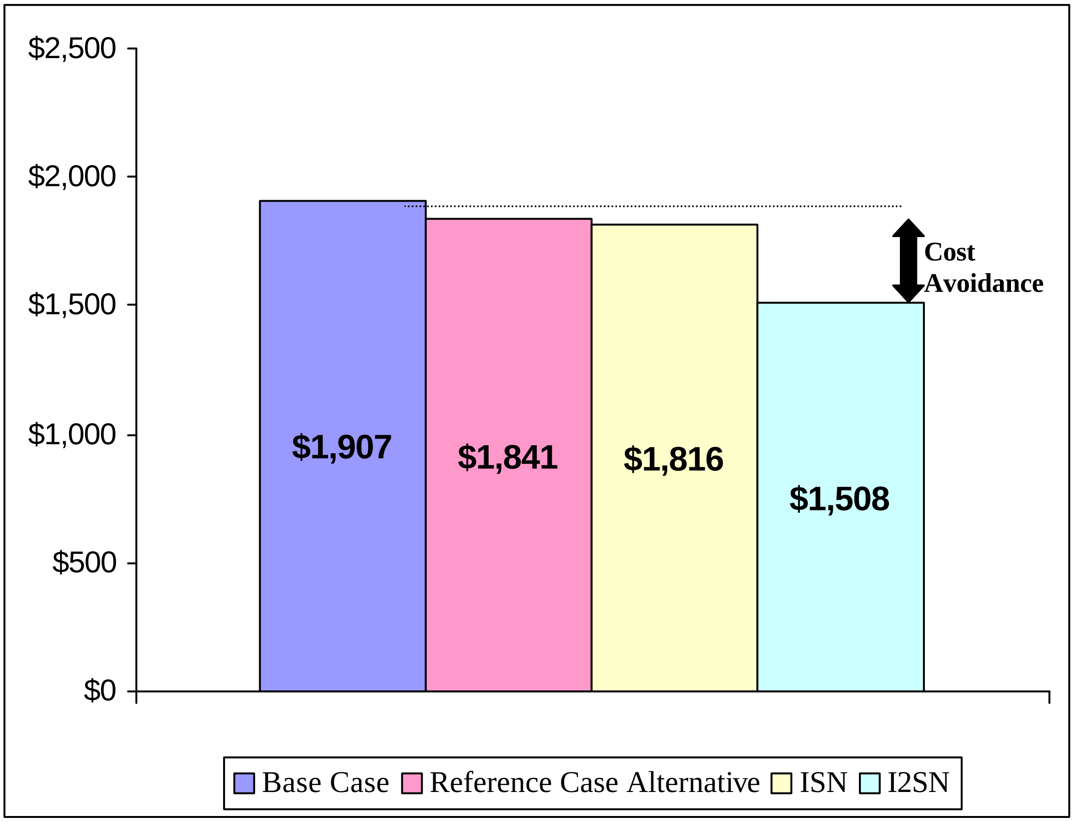

Figure EX-2. Cost Comparison of FTI Alternatives in $M (PV)

As shown in Figures EX-1 and EX-2, the IISN Alternative clearly is the most cost effective solution both in terms of "then-year" life cycle cost as well as Net Present Value.

The IISN was evaluated inferior to the other alternatives only in the *Risk* category. The Reference Case Alternative was evaluated as having the lowest overall risk. This was somewhat predictable insofar as this alternative essentially perpetuates that which is being done today. Both ISN and IISN had relatively equivalent overall risk, the principal concern of LINCS transition risk being relatively equal for the two alternatives. The long-term mission outcomes are riskier for IISN if for no other reason than the alternative reaches farther. The key question, therefore, is how are these risks mitigated. As discussed previously, after the LINCS transition, long-term initiatives are accomplished incrementally. IISN anticipates achievable steps over time. Delays in integrating some of the separately managed services will result in concomitant delays in cost avoidance, but not mission failure.

Summary/Conclusions

The IISN Alternative held clear advantage over the other alternatives and is the preferred alternative. The SEOAT has reviewed the costs associated with the IISN baseline and has determined that the requirements fall within current and projected OMB targets. The cost baseline for the recommended solution, the IISN, is reflected in Table EX-1. However, the IAT recognizes that, particularly as the LINCS infrastructure is concerned, competition in the FTI selection process could very well result in a different funding profile. Accordingly, it would be prudent to reexamine the funding baseline shortly after contract award by holding a formal JRC.

Table EX-1. FTI Integrated Interfacility Services Network (IISN) Life Cycle Costs

	FY 00	FY 01	FY 02	FY 03	FY 04	FY 05	FY 06	FY 07	FY 08	FY 09	FY 10	Total
F&E	$6.1	$29.2	$38.7	$51.5	$52.2	$25.1	$1.1	$.70	$.58	$.20	$.19	**$205.5**
O&M	$176.3	$177.2	$193.4	$183.7	$182.0	$148.3	$134.9	$132.3	$138.5	$140.8	$147.7	**$1,725.7**
Total Program	$181.7	$203.1	$230.7	$233.2	$212.3	$172.5	$136.0	$133.0	$137.1	$141.0	$147.9	**$1,947.6**
Note: Alternative 3, FTI IISN, "High-Confidence" Cost Estimates (Then-Year $M)												

Recommendations

- Reaffirm the need for the FTI program initiative.
- Affirm the recommendation for the IISN Alternative as the Preferred Alternative for FTI.
- Approve the Investment Decision for the IISN Alternative.
- Approve the proposed FTI APB for the IISN Alternative.
- Affirm the concept of "rebaselining" the FTI program after contract award.

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FTI Investment Analysis Report

1.0 INTRODUCTION

This report documents activities conducted by the FAA Telecommunications Infrastructure (FTI) Investment Analysis Team (IAT) that led to the development of the Investment Analysis Report (IAR) and Acquisition Program Baseline (APB). As specified in the Acquisition Management System (AMS) and the Investment Analysis Process Guidelines, the report summarizes the mission need, requirements, assumptions, alternatives, transistion analysis, schedules, costs, benefits, and risks. The report also documents the economic assessment and the results of the affordability assessment conducted by the System Engineering Operational Analysis Team (SEOAT). Finally, it summarizes the IAT's Investment Decision recommendation to the Joint Resources Council (JRC) for providing a telecommunications capability in the National Airspace System (NAS), and it identifies the next steps.

1.1 Background

At JRC1 in May 1998, Mission Need Statement (MNS)-322 was approved and direction to perform an Investment Analysis (IA) was issued. The FTI IAT was formed in July 1998 and set about the task of defining alternatives to satisfy the FTI MNS prior to assessing alternatives and their potential benefits to the FAA. Early discussion within the IAT centered on the question of a "Lease vs. Buy" analysis. Initial market analysis strongly supported the conclusion that the telecommunication marketplace could best meet the FAA needs through a service acquisition model. The IAT adopted an approach, therefore, which assumed a service acquisition model unless evidence surfaced for discrete requirements indicating a "Buy" model. Furthermore, the IAT stepped up its interaction with the information technology industry and two major industry associations, the Government Electronic Industry Association (GEIA) and the Industry Advisory Council (IAC) to develop and assess alternate technical and management approaches to meeting the FTI requirement.

1.2 Scope

The scope of this IAR is driven by the MNS. The approved MNS asserts that most of the FAA's leased and owned telecommunications assets must be replaced between 2002 and 2006 as a result of contract expirations or end-of-service life. MNS-322 further sets forth that no plan currently is in place to support the continuation or improvement of telecommunications services beyond the end-of-service dates of existing systems. It postulates that the cost of operating and supporting the current telecommunications network is expected to grow at least 12.5% per year between 1998 and 2003, which may result in a communications infrastructure that is economically unsupportable. It recommends that newer technologies, such as Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM), and Frame Relay (FR) be investigated as means of maximizing resource utilization and providing operational improvements to the telecommunications infrastructure while reducing costs. Lastly, it asserts that if these issues were not addressed, the FAA could suffer sharp reductions in the capacity and efficiency of the NAS.

The telecommunications systems and services addressed by MNS-322 are:

FAA-leased systems:

- Agency Data Telecommunications Network 2000 (ADTN2000).
- Alaskan National Airspace System (NAS) Interfacility Communications System (ANICS).
- FAA Telecommunications Satellite System (FAATSAT).
- Federal Telecommunications System 2000 & 2001 (FTS 2000/2001).
- Leased Interfacility National Airspace System Communications System (LINCS).

FAA-owned systems:

- Bandwidth Manager (BWM).
- Data Multiplexing Network (DMN).
- Low Density Radio Communications Links (LDRCL).
- National Airspace Data Interchange Network (NADIN I)– Message Switched Network (NADIN MSN).
- National Airspace Data Interchange Network (NADIN II)– Packet Switched Network (NADIN PSN).
- Radio Communications Links (RCL).

1.3 Major Assumptions, Constraints, and Conditions

The Investment Analysis Plan (IAP), found under Attachment 8, identified the following assumptions, constraints and conditions to guide the IA process.

- All systems listed in MNS-322 , including NADIN I&II will be considered.
- Technology is available to support the requirement and some tailored implementation may be required.
- NAS Archtitecture (Version 4.0), the latest version, is accepted as the point of departure in formulating alternatives.
- FTI solution must be operationally suitable.
- The technical solution must interface with existing FAA legacy and user systems.
- The FTI solution must support the transition from legacy interfaces (analog voice interfaces with in-band signaling) to modern digital interfaces.
- The FTI solution must provide for an open system; it must have the capacity to support technological improvements at the interfaces as they emerge.
- The current LINCS contract ends in Jan/Mar 2002; at least three years may be needed to fully implement the LINCS replacement.

- Some type of contractual action will be required to continue LINCS services during a period of transition. These costs are included in the IA process.
- Data resides in the TIPT to determine the current cost of existing systems.
- The accuracy of the Fuschia Book projections (April 1997) of 12.5% growth in telecommunications costs will be determined by sensitivity analysis.
- Transition costs will reflect the cost estimate of site surveys, operational test and evaluation, site preparation, facility modification, infrastructure replacement, and service cutovers.
- The point of departure to identify current and projected connectivity requirements and life cycle cost considerations will be, although not exclusively, the Fuchsia and Currant Books.
- A ten-year life cycle will be assumed for generating the APB.
- The FTI network will incorporate emerging technological advances when it shows clear benefit.

1.4 FTI Analysis Approach

1.4.1 Initial Actions

The IAT began its work several months before the completion of the Initial Requirements Document (IRD). The team took this action for several reasons. First, because of the concerns over the expiration of the LINCS Program contract, the JRC directed that the analysis be accomplished in as short a period as was practicable. Further, the IAT broadly assumed that the general vision for FAA telecommunications had been outlined in the NAS architecture and that there could be no serious challenge to the notion that telecommunications as a service delivered to FAA users was required. In this sense, the IAT had from the outset both a perceived vision and an obvious need for service continuation. This is not to assert that the IAT assumed that the Requirements Document (RD) process would not yield new requirements; rather, the IAT assumed that the formal RD process would not find any major discrepancies.

The IAT next sought to deal with a MNS which had a large number of subsystems needing attention, all of which made up the package of services being provided to NAS users. Although the JRC directed that the near-term problem of the LINCS contract expiration take on a special IAT focus, the team learned early on that all the subsystems, to varying degrees, are interrelated and that each of the MNS cited systems would require IAT attention. Accordingly, over and above the LINCS replacement question, each of the MNS-322 identified subsystems was evaluated to assess the following: 1) current service delivery capability, 2) current vulnerabilities across various contractual and supportability criteria, and 3) extent to which the subsystem should or could be integrated into that part of the solution focusing on the LINCS replacement issue. Sections 2.1 and 4.0 delineate this process in considerable detail.

An IPT assessment of the marketplace already had been initiated when the IAT started its work. The IAT built on this initial work and made a proactive interaction with industry a key element of its strategy. The strategy had three major elements: 1) assess technological capability, 2) assess marketplace products and services, and 3) gain understanding of contractual trends in the industry and how those trends might influence the IAT analysis.

1.4.2 Solution Development

The IAT initially identified a number of technical architectures as potential solutions to the requirement. These architectures were provided to industry for their review, assessment, and comment. The industry review process led to an IAT judgement that no single technology should be viewed as a “silver bullet” solution. The IAT judged, rather, that a number of mature technologies, properly engineered, integrated, and offered as a package of services was the most appropriate approach to ensure current capabilities and future technologies could be applied across the range of current and future FAA requirements. The question for the IAT moved away from technical design and toward a vision of capability and scope.

In assessing the second component of the market assessment (products and services), the IAT determined that the principal trend in the marketplace of telecommunication services is that those things generally regarded as the drivers in the business are more and more viewed, marketed, and sold as commodities. The commodities are abundant, generally falling in price, and are assembled for large networks as commodities riding on the top of value added services. These findings raised two fundamental questions: 1) is the FAA environment one that could leverage these trends, and 2) if the answer to the former question is yes, then how is the IA affected?

The final area of interest under the market analysis was whether there were trends within the industry relating to contracting mechanisms that would be of interest to the IA process. In general, this question was not one so much interested in the particular structure of a contract. Instead of interest were marketplace structures flexible to the extraordinary rate of change in the industry. This general question was important insofar as the IAT would have a sense of how to project future pricing flexibility. The analysis revealed a significant recognition on the part of industry that pricing and service offerings needed to reflect performance based contractual trends or, at a minimum, contracting structures that were flexible to downward market forces in the commodity driven market.

The IAT developed two alternatives, which addressed the requirements of the RD as it emerged from its draft phases, recognized the marketplace findings and trends discussed above, and created a context for dealing appropriately with the multiplicity of sub-networks. A Reference Alternative, which assumed a “LINCS equivalent infrastructure” of dedicated point-to-point circuits while taking advantage of current marketplace pricing for “like” services, also was developed to form the basis for meaningful alternatives comparison. The scope and composition of these three alternatives is addressed in detail in Section 4.0, Alternatives Analysis. Finally, a Base Case was identified which provides a “business as usual” approach using LINCS negotiated prices and which provides a cost baseline against which the alternatives can be compared.

2.0 MISSION NEED, REQUIREMENTS, AND STRATEGIC OPPORTUNITIES

2.1 Mission Need

2.1.1 LINCS Programs of the Mission Need

The JRC directed that the IA address only the LINCS portion of the Mission Need along with any associated capabilities or additional replacements that would logically be related to the replacement of the LINCS contract. In order to ensure a smooth transition from the existing network to the FTI network, it was determined that a bridge contract to maintain LINCS functionality would be required during the 2002-2005 timeframe. The Office of NAS Operations (AOP) has acknowledged the need for the bridge contract and is taking action for its establishment. The bridge contract is essential to mitigating risk by promoting a “soft landing” in the transition from LINCS. The costs associated with this “bridge” are considered a cost to transition and, therefore, are included in the cost analysis.

2.1.2 Remaining Programs of the Mission Need

The IAT next examined each of the remaining systems and services addressed in MNS-322 by first meeting with respective program office representatives and ascertaining each program’s current status, future planning, and associated issues that could impact the IA. This information, in conjunction with each program’s functionality, the results of ARX supportability studies, and contract/service life considerations, led the IAT to conclude that several programs were more appropriate for individual business case analyses and possible integration into FTI at a later date. These programs are:

- **ANICS –** Assumed to continue in its present operational configuration until it is recompeted or extended in the 2003 timeframe. ANICS ground stations (FAA-owned) are sustainable through the 2010 timeframe.
- **FAATSAT –** Assumed to continue in its present configuration until the 2006 timeframe, when it can be recompeted or a new service under FTI acquired that provides the appropriate connectivity such as Low/Medium Earth Orbit satellite service.
- **RCL –** Assumed to continue in its present configuration but not beyond its equipment supportability. Although useage of this asset has not been fully optimized, there has been a modest, yet steady increase in traffic utilization.
- **LDRCL –** Assumed to be sustainable until 2015 and a cost effective solution during the FTI timeframe.
- **Hawaiian LINCS –** Although not identified in MNS-322, a unique telecommunications environment with services that may lend themselves to inclusion under a future FTI contract structure. It was assumed to remain under its current configuration and contract.
- **Critical Telecommunications Services (CTS)** – Funds unplanned Regional requirements. Not included within the scope of FTI because it is envisioned that there will always be a need for the real-time ability to respond to unplanned critical requirements.

2.1.3 Operational and Administrative Traffic

JRC1 discussion also focused on the need for an examination of policy concerning the combining of operations and administrative telecommunications and tasked the IAT to investigate its technical feasibility. A White Paper entitled "An Assessment of the Requirements to 'Merge' Operational and Administrative Traffic" was generated to address these concerns and cited the following findings:

- The FAA presently has both operational and administrative traffic sharing a common physical network. Approximately 1,300 operational circuits are hosted currently on FTS-2000; these include DMN, Automated Weather Observing Systems (AWOS), Direct Access User Terminal Systems (DUATS), and Electronic Tandem Network (ETN).
- Technology permits merging systems with no degradation in service at considerable cost savings.
- Both the FAA Telecommunications Strategic Plan (Version 6.0) and the NAS Architecture (Version 4.0) call for the merger or integration of operational and administrative traffic.

With the application of modern telecommunications technology, such as Virtual Private Networks (VPNs), circuits can share the same physical infrastructure, yet remain logically separated by mechanisms that differentiate among security protection and quality of service (QoS) parameters. This shared physical network approach allows security, performance, and service level requirements to be allocated and met for each connectivity requirement, while employing bandwidth management and other techniques to optimize network performance and reduce transmission costs.

2.2 FTI Requirements

FTI requirements were established based on mission need documented in MNS-322. These included considerations to:

- Accommodate diverse user telecommunications requirements.
- Migrate from dedicated connectivity to bandwidth on demand.
- Integrate voice, data, and video communications within the network.
- Consolidate operational and administrative networks.
- Centralize telecommunications network management.
- Reduce operational and life cycle cost through more efficient system design.

A summary of some of the key, high-level system requirements is provided below. For a detailed requirements description refer to the *Requirements Document for FAA Telecommunications Infrastructure Service*, Coordination Draft, (Attachment 9). The new FTI service shall be classified essential, as defined in NAS SR-1000, *FAA NAS System Requirements Document.*

The new FTI system shall be able to:

- Accommodate today's end user interfaces (i.e., voice switch interfaces, data system interfaces).
- Have the flexibility to transition legacy interfaces (i.e., analog voice interfaces with in-band signaling) to modern digital interfaces.
- Accrue cost benefits from technology refreshment both within FTI, as well as by migrating to more efficient interfaces to FTI.
- Accommodate future program's telecommunications needs (i.e., STARS, NEXCOM, Free Flight, etc.).

2.2.1 Functional Requirements

The top-level functional requirements for the FTI system are listed below:

- **Telecommunications User Services** - FTI shall provide the FAA users with telecommunication services based on industry standards for voice, data, and video. FTI shall provide an integrated voice, data, and video network.
- **Service Delivery Points** - FTI telecommunications services shall be provided between specified service delivery points (SDPs).
- **Transmission Services** - FTI shall provide an integrated voice, data, and video network.
- **Bandwidth Management** - FTI shall provide capabilities that support bandwidth management.
- **Bandwidth Analysis** - FTI shall provide tools to track bandwidth usage of FTI services for analysis of bandwidth requirements.
- **Dynamic Bandwidth Allocation** - FTI shall have capabilities to dynamically allocate bandwidth .
- **Administrative and Operational Shared Network** - FTI shall accommodate consolidation of administrative and operational networks into a shared network, with logical partitioning to preserve the integrity of voice, data, and video information and facilitate service management.
- **Multiplexing** - FTI shall provide a means of consolidating low speed transmission rates into high-speed transmission rates.
- **Asynchronous and Synchronous Interface Port Connections** - FTI shall provide asynchronous and synchronous interface port connections.
- **Legacy Services** - FTI shall conform with existing FAA and non-FAA legacy system protocols, parameters, and services as required for interconnectivity and transport of data.
- **Wide Area Networking (WAN)** - FTI shall provide WAN service for Local Area Networks (LANs), application hosts and servers, Intranet web sites, dial-up users, and dedicated workstations.

- **Teleconferencing** - FTI shall provide teleconferencing services for voice, data, and video including desk top and conference room video systems.
- **Port Redundancy** - FTI shall provide one for 'n' redundancy (the number of user access ports, 'n' is to be determined.)
- **WAN Access** - FTI WAN shall provide access for FAA and non-FAA systems.
- **Aeronautical Telecommunications Network (ATN) Access** - FTI shall be accessible from the ATN network and shall be interoperable with existing services and systems that have implemented ICAO 9705-AN/956, *Manual of Technical Provisions for the Aeronautical Telecommunication Network.*
- **Internet Access** - FTI shall be accessible from the Internet.
- **Multi-cast and Broadcast** - FTI shall provide multi-cast and broadcast functions.
- **Loopback Function** - FTI shall provide local and remote loopback functions for FAA fault isolation and maintenance.
- **Dial-in and Dial-out Services** - FTI shall provide dial-in and dial-out services.
- **Naming and Addressing** - FTI shall accommodate NAS users addressing structures in accordance with FAA-STD-042, NAS Open System Interconnection (OSI) Naming and Addressing (for OSI/ATN) and ENET 1370-002.3 (for IPv4).
- **Exchange of Network Management and Control Information** - FTI shall exchange the following information in with the FAA enterprise management systems.
- **Fault Management Information** - Fault management information shall include trouble tickets, alarms, recovery, and corrective action.
- **Configuration Management Information** - Configuration management information shall include FTI service and asset provisioning, deployment, status, and interface information.
- **Accounting Management Information** - Accounting management information shall include service utilization, status of billing, and ordering data regarding FTI users.
- **Performance Management Information** - Performance management information shall include latency, throughput and Service Level Agreement data for the FTI services and assets.
- **Security Management Information** - Security management information shall include access mode control, intrusion detection, and malicious blockage reports of FTI assets and its services.
- **Telecommunication Service Priority (TSP) Restoration of Services** - Restoration of services shall comply with the mandates associated with the application of the Telecommunication Service Priority (TSP) system. (see Federal Communication Commission's, (FCC) Notice of Proposed Rulemaking dated August 11, 1998, General Document 87-505).

2.2.2 Performance Requirements

FTI shall be consistent with the goals stated in NAS SR 1000 document, for the specified performance requirements reflected in Table 2-1:

Table 2-1. FTI Performance Requirements

PERFORMANCE REQUIREMENTS		
Service	**Minimum Availability**	**Maximum Restoration Times**
Critical	.99999	6 seconds
Essential	.999	10 minutes
Routine	.99	1.68 hours

- **Diversity** - Diversity shall be provided for critical telecommunications service as specified in the NAS SR 1000.
- **Physical Diversity** - FTI transmission paths shall be physically diverse for those telecommunications services specified as critical, having no points in common between specified SDPs.
- **Electrical Diversity** - For those services specified as critical, FTI shall provide electrical separation between transmission paths, such that an electrical component failure on one path does not cause the loss of both paths.
- **Equipment Diversity** - For those services specified as critical, FTI shall have separate equipment components (e.g., cabinets, shelves, and power supplies) at all locations along diverse transmission paths, such that the failure of any single piece of equipment does not cause the loss of both paths.
- **Power Diversity** - For those services specified as critical, FTI equipment shall be connected to two (or more) independent power sources using physically and electrically separated power feeds, such that the failure of one power source, or a physical disruption at any point on one power feed, does not cause the loss of the others.

The FTI shall provide end-to-end service performance as described in Table 2-2:

Table 2-2. End-to-End Service Performance

PARAMETER	SERVICES		
	Voice	**Data**	**Video**
Call setup[1]	150ms – 15 seconds	2 – 30 seconds	2 - 30 seconds
Call tear down[2]	150ms – 15 seconds	2 – 30 seconds	2 - 30 seconds
End-to-end delay[3]	50 – 750 ms	50 – 750 ms	50 - 750 ms

Note: 1) Call setup time is defined as the overall length of time required to establish a switched call between end users.
2) Tear down time is defined as the overall length of time required to tear down or clear a switched call between end users.
3) End-to-end delay is defined as the sum of queuing, servicing, and propagation of the time between source and destination.

- **Legacy Interfaces** - FTI shall interface with existing FAA and non-FAA systems.
- **Quality of Service** - FTI shall accept performance parameters that characterize transmission quality relating to voice, video, and data connections.
- **Toll Quality on Voice Connections** - The FTI shall provide toll quality service on all voice connections.
- **Data Integrity** - FTI shall provide appropriate mechanisms to ensure the integrity of transmitted data.

2.2.3 Security Requirements

Security requirements for the FTI system are listed below.

- **Security Policies** - FTI shall comply with security policies DOT Orders, DOT H 1350.250, *Information Systems Security Guide*, and DOT H 1350.251, *Network Security Guide*; and FAA Orders, FAA Order 1600.54, *FAA Automated Information Systems Security Handbook*, and FAA Order 1600.66, *Telecommunications and Information Systems Security Policy*.
- **Logical Separation of Telecommunications** - FTI shall provide logical separation between administrative and operational telecommunications.
- **Physical Security** - FTI shall comply with FAA Order 1600.6, *Physical Security Management Program*.
- **Physical Access** - Access to FTI equipment shall be controlled, whether located at government or contractor facilities that are either staffed or unstaffed.
- **Monitoring** - FTI management systems shall include security monitoring mechanisms.
- **Information Security** - FTI shall mitigate the information security risk of any compromise, corruption, or interruption of service caused by intentional and unintentional threats.
- **Detection of Unauthorized Access** - FTI shall implement mechanisms to detect and record successful and unsuccessful unauthorized attempts to access the FTI network.
- **Intrusion Protection** - FTI shall implement mechanisms to protect against intrusion to the control systems and operating equipment of the FTI network.
- **Intrusion Reporting** - FTI shall report to system management any unauthorized intrusion or attempted intrusion to the FTI, in compliance with applicable FAA policies.
- **Legacy System Protection** - FTI shall protect legacy systems exposed by interconnection with any new systems.
- **Connection Criteria** - FTI shall employ a set of end-system connection and SDP criteria to maintain minimum standards among all connected systems that help mitigate the risk of compromise to the network to an acceptable level.
- **Intrusion Reporting** - FTI shall report to system management any unauthorized intrusion or attempted intrusion to the FTI, in compliance with applicable FAA policies.

- **Connection Criteria** - FTI shall employ a set of end-system connection and SDP criteria to maintain minimum standards among all connected systems that help mitigate the risk of compromise to the network to an acceptable level.

2.3 FTI Strategic Opportunities and Questions

2.3.1 Introduction

The LINCS contract was established in 1992. Once established, the LINCS contract and the network services it provided marked a significant improvement over what had been procured previously. FAA customers recognized the superior service performance and the reduction in the cost for services delivered. A key element of the LINCS service was a consolidation of transport services under a single provider. FTI offers a similar opportunity to build on that experience and leverage the lessons learned from the LINCS experience. Furthermore, because of the fact that the LINCS infrastructure requires contractual attention, an opportunity exists to evaluate the alignment of the FAA's requirements and business practices with industry offerings.

2.3.2 Lessons Learned

The following items represent a set of lessons learned from previous telecommunications procurement decisions that should be addressed in any telecommunications procurement moving forward:

- Procuring transport service at a circuit level will yield inefficiencies in bandwidth utilization. Seek to provision service as bundled bandwidth.
- The telecommunications marketplace is changing constantly. Ensure that whatever contract vehicle is established remains flexible as to its offerings and conditions.
- A significant cost of any network is the cost to establish the infrastructure. Attention should be paid at contract formation to approaches that will mitigate transition risk both at the front and end of the procurement cycle.

2.3.3 Market Opportunities

The "commodification" of products in the telecommunications industry (as discussed in Section 1) presents three important challenges to the FAA. The first challenge is to ensure that the contract structure established under FTI leverages to the maximum extent the potential downward pressures on commodity pricing over time. Similarly, the contract structure should be sufficiently scoped such that new commodity offerings can be made available under a full service arrangement. Finally, sophisticated value added services are among the commodities likely to be available under FTI. The effective utilization of these services may require significant change in the FAA's current organizational practices of defining telecommunications requirements and solutions.

2.3.4 Key MNS Questions

The MNS postulated two critical points: 1) that the FAA Telecommunications system is inefficient and fails to benefit from modern network capabilities and 2) that the FAA would benefit were the multiple network solutions currently in place integrated to a greater extent than they are today. As to the first point regarding inefficiencies, the key question is whether the NAS operational concept drives a network topology that (as was suggested in Section 1.4.2) does not lend itself to the kind of efficiencies often achieved in the industry. NAS ground infrastructure operations to a great extent revolve around the Air Route Traffic Control Center (ARTCC) facility operations. The required topology is one that is generally “hubbed” to an ARTCC, supports a wide distribution of low data rate site locations and, notwithstanding emerging NAS operational requirements, may not change dramatically over the five to ten years. As an example, it may be quite difficult to yield efficiency when a large number of operational requirements are 9.6K baud radar sites.

An additional question relative to the issue of network efficiency is the possible relationship of administrative telecommunications and the extent that the integration of these telecommunications requirements with the NAS operational traffic would yield efficiency. This question is important because the market analysis showed that the physical separation of telecommunications assets across the two domains was not necessary if the network solution could provide a logical separation. Further, an analysis of recent and projected traffic growth indicates that voice traffic under both administrative and operational domains will likely remain relatively flat. However, data distribution across both domains is projected to rise, particularly the growth of administrative data traffic. This trend can be seen in Figure 2-1.

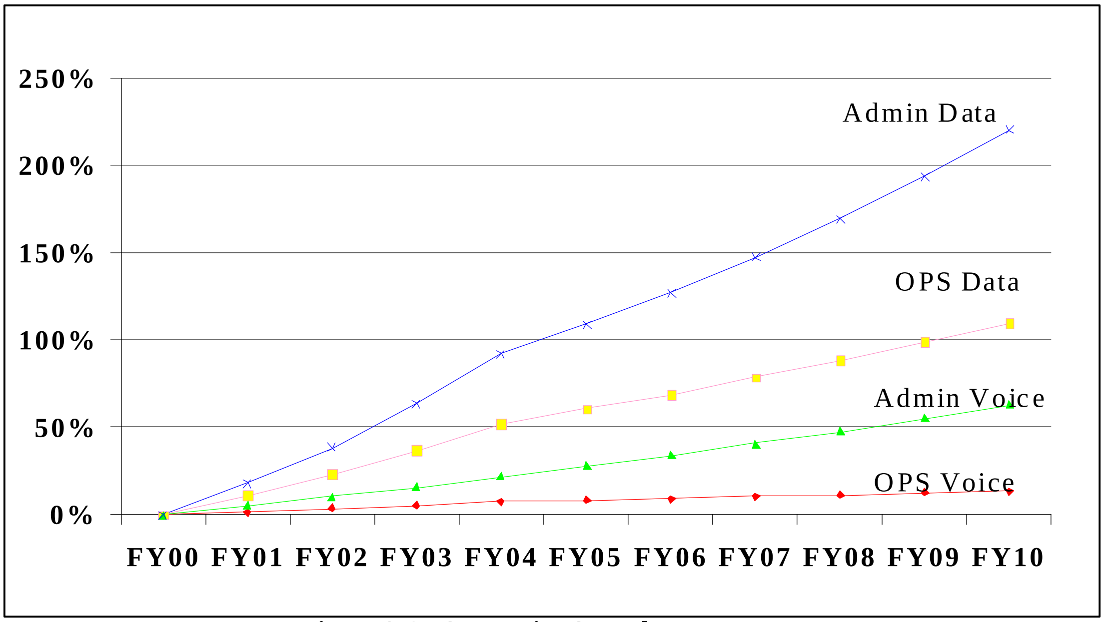

Figure 2-1. Composite Growth Rates

The other central issue raised by the MNS is the inefficiency of maintaining multiple networks. Here, the issue is made even more complex because a number of the network elements are either reaching the end of their service life or the contract vehicle under which the service was acquired is expiring. Beyond those issues, however, is the cost associated with the separate network service and the potential for cost avoidance (among other benefits) were the service more efficiently integrated.

The solution alternatives frame these questions. The analysis shows the costs associated with maintaining separate administrative and operational domains. This analysis addresses the opportunity for efficiency using modern network capabilities, notwithstanding the issues of NAS operational topology discussed earlier. The analysis also addresses the opportunities for efficiency by integrating the requirements of the two domains and by including the integration of a subset of the separately managed network services.

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3.0 BUSINESS MANAGEMENT AND ANALYSIS

3.1 Introduction

The FTI Mission Need established a vision for high-quality, cost effective, secure telecommunications services to support all business activities of the FAA. It emphasized that the strategy used to implement this vision should position the FAA to more cost effectively and efficiently meet its telecommunications requirements. The nature of the changes that FTI can bring to the management, control, and operation of telecommunications services offer potential benefits to the current business practices of the FAA. The following subparagraphs outline current FAA business practices and those related practices readily offered by the telecommunications industry. The developed alternatives in Section 4.0 will address those areas of improvement realized through adoption of current industry offerings.

3.1.1 Current FAA Business Practices

Current FAA telecommunications business practices (planning, engineering, implementation, transition, operation, and management) are driven by the inherent nature of the present telecommunications architecture and resultant FAA internal mode of operation. The current mode of operation is characterized by:

- **(QoS)** - Service levels are fixed and inflexible and characterized by the use of dedicated, point-to-point circuits. A circuit is expensed by the vendor and paid for by the FAA whether it carries traffic or not.
- **Bundled Provisioning** - Provisioning is generally accomplished at the individual circuit level and rarely bundled to satisfy multiple requirements by aggregating bandwidth to achieve cost savings.
- **Usage Measurement** - Essentially no measurement of traffic usage is being accomplished and, therefore, no metrics are available to compare and contrast cost effectiveness with circuit utility.
- **Cost Accounting Systems** - Current accounting practices are geared to recurring costs, paid for through the Defense Information Technology Contracting Office, regardless of usage. Users are not held cost accountable since the Office of NAS Operations pays for all life cycle telecommunications services, two years following a new program's inception.
- **Performance-Based Contracting Models** - A common set of metrics does not exist to compare and contrast the cost effectiveness of current FAA telecommunications systems with future systems. Today's FAA telecommunications systems were separately procured without a common set of technical and management performance metrics. For leased systems, each contract has different terms and conditions. Some contracts provide bandwidth, others provide dedicated circuits, and some provide equipment. Even among contracts that appear to include similar performance metrics, subtle differences in definitions, and computation algorithms frustrate attempts to compare systems using the same metrics.

The resulting support staff requirements, information systems, and processes for accomplishing telecommunications service provisioning are all geared to support an inflexible infrastructure and structured internal processes that can be made more efficient by taking advantage of markeplace value added services.

3.1.2 Industry's Impact on Current FAA Business Practices

An array of industry offerings will provide the FAA with opportunities to change its internal processes and realign its management of telecommunications services to take advantage of the abundance of bandwidth, realize efficiencies and reduce costs. Current FAA business practices will likely be impacted by the following factors.

- **QoS** - Industry offerings now are characterized by an hierarchy of service levels, wherein service is matched to requirement. Activities include on-line service provisioning and real-time adjustments to service levels.
- **Bundled Provisioning** - Provisioning will be characterized from Service Delivery Point (SDP)-to-SDP and controlled by the FAA via Interface Access Devices (IADs), realizing efficiencies from aggregation of bandwidth. New network management tools and services will offer the FAA substantial degrees of flexibility and control in configuring the delivery of services to end users and in managing those services on a real-time basis.
- **Usage Measurement** - Measurement of traffic via network monitoring mechanisms will allow value engineering negotiation and trade-offs with end users. The availability of metrics presents opportunities to revisit how requirements are being satisfied and select more efficient solutions.
- **Cost Accounting Systems (CAS)** - Sophisticated automated administrative and cost accounting systems will complement the FAA CAS and facilitate initiatives toward fee-for-service, where applicable.
- **Performance-Based Contracting Models** - Innovative and creative contract formulation will be possible that benchmarks performance indices with incentives and penalties, providing adjustments appropriately as the marketplace changes, and offering flexibility to introduce new capabilities as they become available in the marketplace.

Once FTI is fully operational, significant changes can be expected in the number and skill mixes of personnel required for management of FAA telecommunications. This is not because the FAA will assign these responsibilities to service providers; rather, it is because the new network inherently will provide real-time information through the use of customized tools. This will allow constant monitoring and performance feedback, ultimately improving and streamlining the process from requirements definition to solution engineering.

4.0 ALTERNATIVES ANALYSIS

4.1 Background

The FAA FTI Alternative Analysis (AA) Subteam was formed to provide detailed alternative FTI architecture analyses to determine how to best satisfy the FAA needs identified in MNS-322. This section includes the results of the subteam's analyses and a discussion of their methodologies and assumptions. Attachment 1, Alternatives Analysis Report, provides the analytical details in support of this section.

4.1.1 Needs Identified by MNS-322

MNS-322 makes the following key points:

- Most of the FAA's leased and owned telecommunications assets must be replaced between 2002 and 2006 as a result of lease expirations or end-of-service life.
- No plan currently is in place to support the continuation or improvement of telecommunications services beyond the end-of-service dates of existing systems.
- The discontinuation of these services without replacement would have a significant adverse impact on NAS critical operations.

The telecommunications systems and services addressed by MNS-322 consisted of the following:

<u>FAA-leased services</u>:

- Agency Data Telecommunications Network 2000 (ADTN2000).
- Alaskan National Airspace System (NAS) Interfacility Communications System (ANICS) satellite only.
- FAA Telecommunications Satellite System (FAATSAT).
- Federal Telecommunications System 2000 & 2001 (FTS 2000/2001).
- Leased Interfacility National Airspace System Communication System (LINCS).

<u>FAA-owned systems</u>:

- Alaskan National Airspace System (NAS) Interfacility Communications System (ANICS) ground stations only.
- Bandwidth Manager (BWM).
- Data Multiplexing Network (DMN).
- Low Density Radio Communications Links (LDRCL).
- National Airspace Data Interchange Network (NADIN I) – Message Switched Network (NADIN MSN).

- National Airspace Data Interchange Network (NADIN II) – Packet Switched Network (NADIN PSN).
- Radio Communications Links (RCL).

Additionally, MNS-322 states, “The cost to operate and support this growing network was $320M in FY97. Based upon projected future requirements identified in the current FAA Telecommunications System and Facility Description Manual, the cost of operating and supporting the system is expected to grow at a rate of at least 12.5% per year between 1998 and 2003. This growth rate may result in a telecommunications infrastructure that is economically unsupportable. It is recommended that a variety of existing or emerging technologies, including Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM), and Frame Relay (FR) be investigated as potential contributors to maximizing resource utilization and reducing system costs. These new technologies also may provide operational improvements to the telecommunications infrastructure.”

At the time of approval of MNS-322, the JRC provided direction that LINCS replacement and the possible replacement of telecommunications systems and services related to LINCS be given priority.

4.1.1.1 Analysis Approach

In order to address and satisfy the concerns raised by MNS-322, the AA Subteam did the following:

- Examined the status and the issues involved with each of the programs listed in MNS-322.
- Developed FAA telecommunications architecture alternatives that dealt with the program issues in a comprehensive way.
- Provided the JRC with a recommended architecture.

4.2 Assumptions and Constraints

The AA Subteam started with a set of assumptions and formulated objectives. Modifications to these assumptions and objectives were made as work progressed.

The assumptions are summarized below:

- Take guidance from MNS-322 and consider each system listed in the MNS.
- Give priority to the replacement of LINCS and to telecommunications systems and services related to LINCS.
- Accept the NAS Architecture as point of departure.
- Assume a ten-year life cycle for generating the APB.

- Develop architectural alternatives consistent with technical performance requirements contained in the FTI Requirements Document.

The Alternative Analysis Subteam set the following objectives for analysis:

- Migrate from point-to-point dedicated connectivity to a digital network that uses bandwidth efficiently.
- Develop architectural alternatives that are suitable operationally.
- Develop a phased approach: in the first phase, LINCS is to be replaced; other phases follow later.
- Provide benefits in each added phase.
- Support transition from legacy interfaces (analog, in-band signaling) to modern digital interfaces (with out-of-band signaling).
- Support operational and administrative voice, data, and video on a common infrastructure, as outlined in the NAS Architecture.
- Provide an open system and architecture; support technological improvements at the interfaces as they emerge.
- Incorporate emerging technological advances into the FTI when they show clear user benefit.
- Prefer leased acquisition; exceptions will be considered when they are clearly cost beneficial.

4.2.1 Telecommunications Traffic Growth Assumptions

The telecommunications growth estimates were formulated by the Cost Subteam, based on current and future traffic projections. These assumptions were used to estimate costs, but did not directly affect the formulation of the alternatives.

4.2.2 Private vs. Non-private Networks

Historically, the FAA has operated ATC voice telecommunications as a private network to limit access, to ensure that calls are not blocked, and to keep call setup times to a minimum. Private networks also afforded a greater degree of management and maintenance control and provided a diverse transmission path. The FAA also has a private network for operational data telecommunications where robust switching and alternate routing provide the necessary speed and diversity. The FAA uses non-private networks for agency voice and data telecommunications. This allows the FAA to communicate with "outside" users and lower costs by sharing telecommunications resources with other government users. The three FTI alternatives require both public and private network components but provide them in fundamentally different ways.

For purposes of this analysis, a private network is defined as a network based on closed user groups in which telecommunications traffic does not contend for network resources with other groups. In an FAA private network, telecommunications traffic may be assigned to dedicated telecommunications resources so that traffic does not contend for resources with other FAA traffic or it can be assigned to on-demand switching and routing resources where it will contend for service with other FAA users. In the latter case, QoS network features can be used to assure that higher priority traffic gets through, even though occasionally, it will do so at expense of delaying or blocking lower priority traffic. Closed user groups are implemented so that only authorized users can communicate among themselves.

Operations traffic mostly will be assigned to private network resources and administrative traffic mostly will be assigned to non-private network resources. Operations and agency traffic that is assigned to non-private network resources will contend for the use of those resources. As in the private network, QoS concepts may be used to assure communications requirements are met. Closed user groups also can be implemented, but typically are not.

Private networks can be implemented in a variety of ways, but only two are of concern here. The first method is used today by the FAA and, typically, consists of FAA managed switches and customer premise equipment (CPE) connected to dedicated transmission circuits. The FAA configures voice switches and CPE (e.g., NADIN) and orders dedicated transmission capacity from vendors sufficient to meet user quality of service requirements. These dedicated transmission paths actually are part of a non-private network infrastructure where FAA traffic is intermingled with non-FAA traffic, but the FAA traffic does not compete for network resources with non-FAA traffic. In other words, FAA traffic is assigned a fixed resource for its exclusive use. The Reference Case Alternative and the Interfacility Services Network (ISN) Alternatives use this method to implement private networks.

Another way to implement private networks, made possible by modern telecommunications systems, is for a vendor to provide end-to-end virtual private network service. The vendor configures his telecommunications resources through software and hardware in such a way that the FAA is provided with closed user groups and its telecommunications traffic does not compete with non-FAA traffic. The Integrated Interfacility Services Network (IISN) Alternative uses this method.

4.3 Architecture Alternative Summaries

Telecommunications Architectural Alternatives were developed to determine if cost savings and operational improvements are attainable through the use of modern technology and business practices and to provide a context for dealing with FAA-owned telecommunications systems and leased services listed in MNS-322, most importantly, LINCS. In keeping with good business practices, the alternatives continued to use elements of the existing MNS-322 telecommunications services and systems until it was cost effective or necessary to replace them. The three architectural alternatives presented below evolved from an initial set of alternatives that were architecture-based “themes” such as hierarchical network, broadcast network, and Intranet. These alternatives then were modified and synthesized into the present alternatives. The original six alternatives are described in Attachment 1.

The telecommunications architectural alternatives are the Reference, the ISN and the IISN. A Base Case also has been identified which provides a “business as usual” approach using LINCS negotiated prices and which provides a cost baseline against which the alternatives can be compared.

The Reference Case Alternative, assumes a “LINCS equivalent infrastructure” of dedicated point-to-point circuits while taking advantage of current marketplace pricing for “like” services.

The ISN Alternative focuses on the JRC mandate to give priority to LINCS replacement. The ISN provides LINCS replacement by a multi-service network having dedicated connectivity, switched connectivity, and IP Routing. It continues FAA ownership of multiplexing and switching networks (DMN, NADIN, BWM) with technical refreshment, as necessary. It also continues the present FAA management of multiple networks and the separation of operations and administrative networks.

The IISN Alternative addresses all of the MNS-322 concerns in the context of the NAS telecommunications architecture. The core of the IISN alternative is a comprehensive leased services contract that provides SDP-to-SDP telecommunications service for voice, data, and video for both operations and administrative traffic. This contract, in addition to providing for LINCS replacement, obviates the need for FAA-owned multiplexing/switching networks and eliminates the FAA practice of managing multiple networks.

4.3.1 Reference Case Alternative

The Reference Case Alternative is a “LINCS equivalent infrastructure” of dedicated point-to-point circuits which takes advantage of current marketplace pricing for “like” services. It is an attempt to capture how the FTI would evolve if the present telecommunications activities and plans were recompeted “as is.” It also provides a technical baseline against which the other alternatives are compared. Figure 4-1 provides a functional block diagram of the Reference Case Alternative architecture.

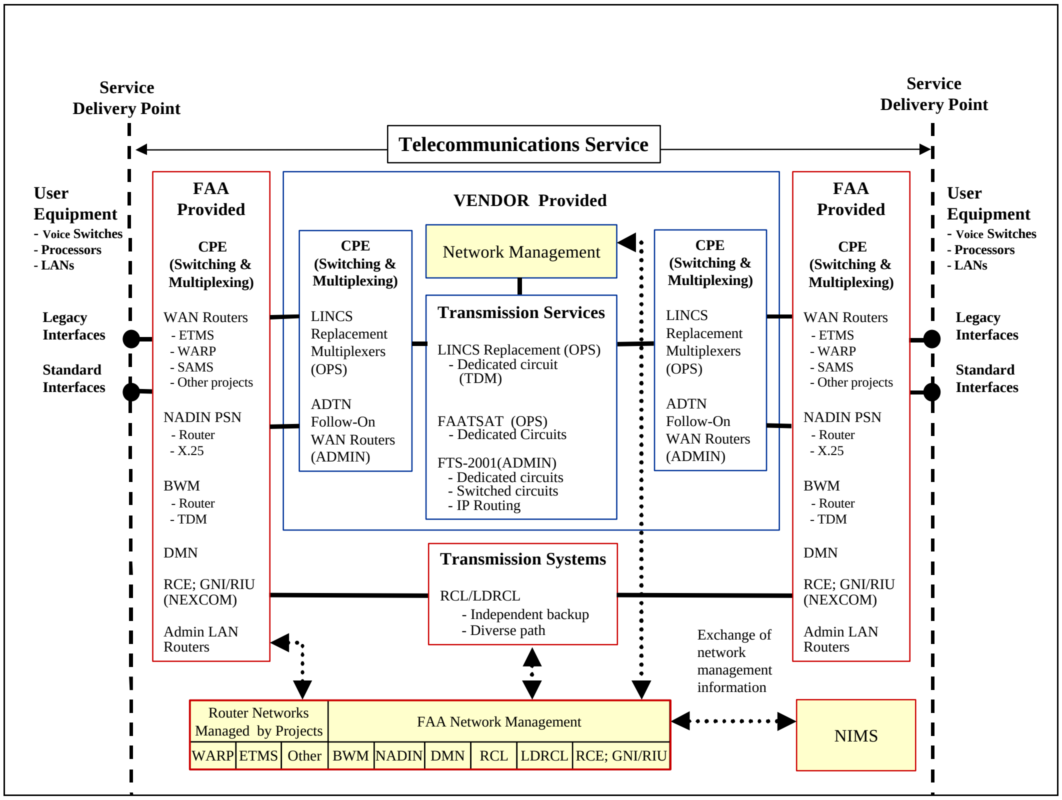

Figure 4-1. Reference Case Alternative Architecture

4.3.1.1 Reference Case Alternative Features

The Reference Case Alternative architecture is characterized by the following:

<u>Interfaces at SDPs</u>

The Reference Case Alternative provides all of the needed legacy interfaces and a limited set of industry standard interfaces at specified SDPs.

<u>CPE (Switching and Multiplexing Equipment)</u>

FAA provided:

- FAA-owned multiplexing and switching systems provide services such as subrate multiplexing, X.25 packet switching, International Civil Aviation Organization (ICAO) compliant message switching, and IP routing.
- DMN will provide subrate multiplexing, modem, and A/B circuit restoral functionality primarily for ARTCC data users who require connections to non-ARTCC locations.
- BWM will multiplex subrate and DS-0 data streams to the DS-1 transmission rate. BWM will provide service primarily on ARTCC-to-ARTCC circuits.

- NADIN PSN will provide both X.25 and IP service for ARTCC-to-ARTCC communications traffic. Additionally, NADIN X.25 service will provide user access to the NADIN MSN service.
- Independent Router networks associated with various projects or services (e.g., STARS, ETMS) will provide IP service to users who have connectivity requirements to non-ARTCC locations.

Vendor provided:

- The vendor provides TDM multiplexers and circuit restoral switches.

Transmission

FAA provided:

- The RCL is used to provide ARTCC-to-ARTCC backup connectivity.
- The RCL and LDRCL provide alternate connectivity to remote sites.

Vendor provided:

- Leased transmission service provides only dedicated circuits for operational traffic.
- FAATSAT satellite service provides secondary connectivity to some remote sites.

Integration of Operations and Administrative Traffic

Operational and administrative networks are kept separate.

ICAO Compliant Message Switching

NADIN MSN will provide ICAO compliant message switching.

Administrative Communications

- Administrative voice telecommunications service is provided by FTS-2001 switched voice service.
- Administrative data telecommunications service is provided by an ADTN IP router network using FTS-2001 transport services.

Network Management

Network management is provided, as follows:

- Network management of leased assets is provided by the vendor of the leased communications service. This vendor will provide a single point of responsibility to the FAA. The vendor will provide NAS Infrastructure Management System (NIMS) and any other FAA designated systems with a read-only terminal that will display management information on the leased system.

- Legacy FAA transmission assets, namely, the RCL and the LDRCL will be managed by the FAA. These assets will be managed the same way they are currently managed. Additional management information on the performance of RCL and LDRCL circuits will be provided by the FAA CPE (e.g., RCE, DMN, NADIN) that uses these circuits.
- Multiplexing and switching systems will be managed by the FAA. All of these systems will be managed separately. Since there will be a proliferation of router networks, there will be a proliferation of router management systems.
- NIMS will be used to integrate the management data from the leased telecommunications systems, legacy transmission systems (to the extent practicable), multiplexing and switching systems, and end user systems to provide end-to-end service management.

Reference Case Alternative Business Practices

The Reference Case Alternative business practices (Figure 4-2) are characterized by:

FAA responsibility for:

- The operations, maintenance, and management of multiple switching and multiplexing systems.
- The operations, maintenance, and management of FAA transmission systems, namely, RCL and LDRCL.
- Overall network management of SDP-to-SDP service.
- Network engineering.
- Multiple organizations will be involved in this effort. TIPT will be responsible for the DMN, NADIN, and BWM systems. Individual program offices will be responsible for engineering their router networks.

Vendor responsibility for:

- The operations, maintenance, and management of the primary transmission service, namely, the LINCS follow-on service.

Service provisioning:

- Service provisioning will be done on a circuit-by-circuit basis.

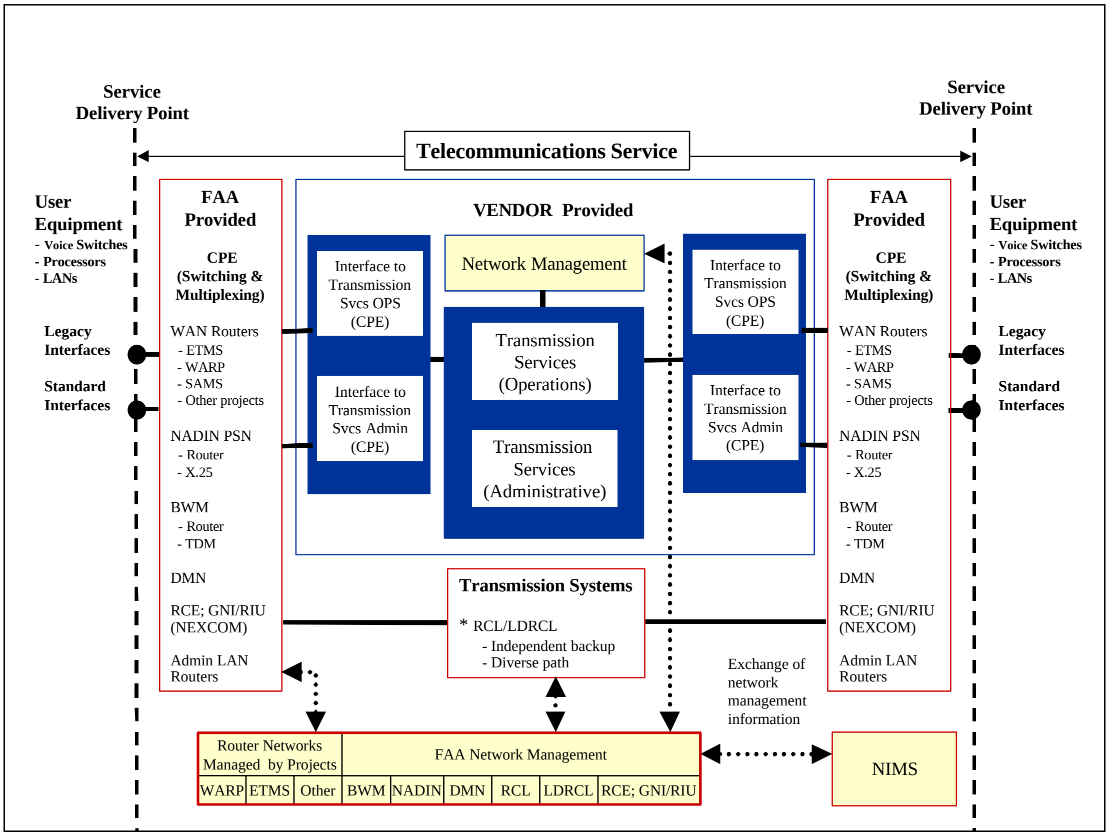

Figure 4-2. Reference Case Alternative Business View

4.3.1.2 Reference Case Alternative Transition Strategy

The major elements of a transition strategy (Figure 4-3) to sustain the Reference Case Alternative architecture are the following:

- Transition from LINCS to a LINCS replacement network (2000-2005).
- Implementation of a bridge contract to provide LINCS functionality (2002-2005). A bridge contract is needed because the LINCS contract expires in March 2002.
- Technological refreshment of the DMN network (2005-2008).
- Technological refreshment of the BWM network (2005-2008).
- Transition from the NADIN X.25 network to the NADIN IP network (2000-2010).
- Technological refreshment of NADIN (2006-2010).

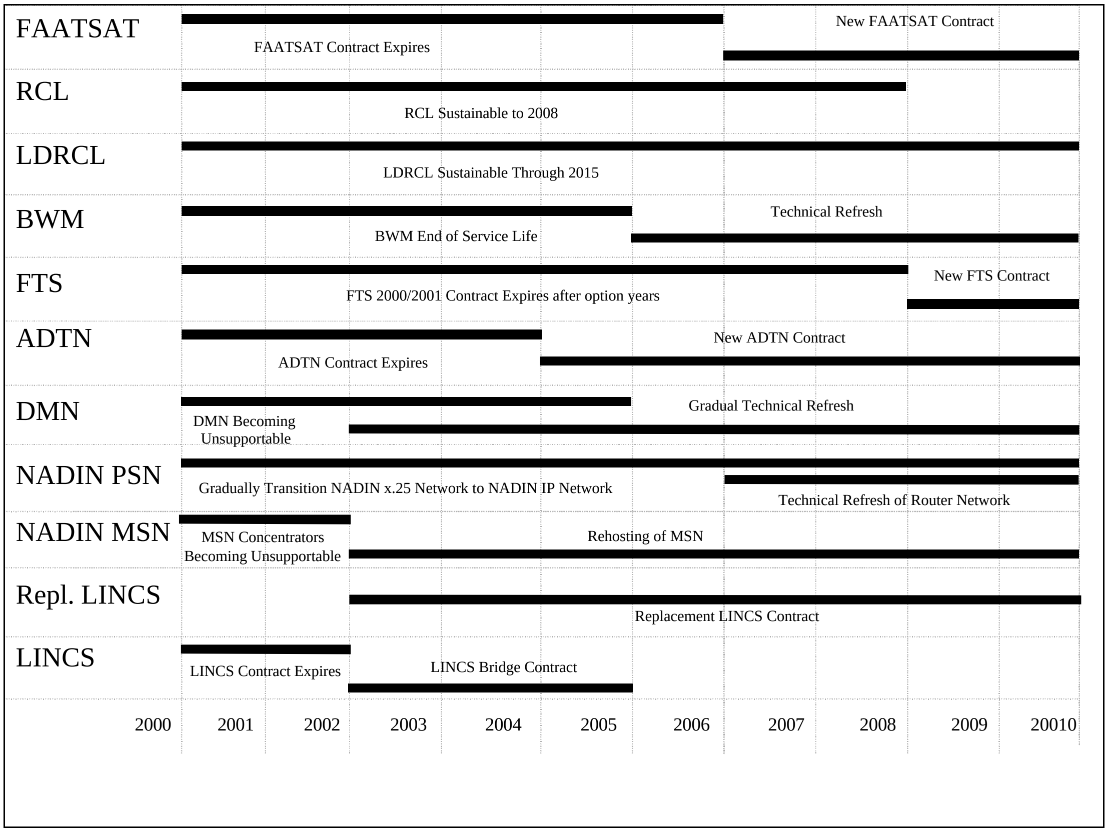

Figure 4-3. Reference Case Alternative Timeline

4.3.2 Interfacility Services Network (ISN) Architecture

This alternative answers the MNS-322 JRC request to look at LINCS replacement and the replacement of systems related to LINCS. The distinguishing feature of the ISN Alternative is the replacement of LINCS by a leased modern multi-service network while retaining and modernizing FAA-owned multiplexing and switching systems. These networks will use the LINCS replacement network for connectivity. The new network that will replace LINCS will be based on modern technologies such as ATM, FR, and IP routing. The AA Subteam, however, did not want to mandate a specific technology because that is best determined through vendor proposals in the context of a competitive procurement. Figure 4-4 provides a functional block diagram of the ISN Alternative.

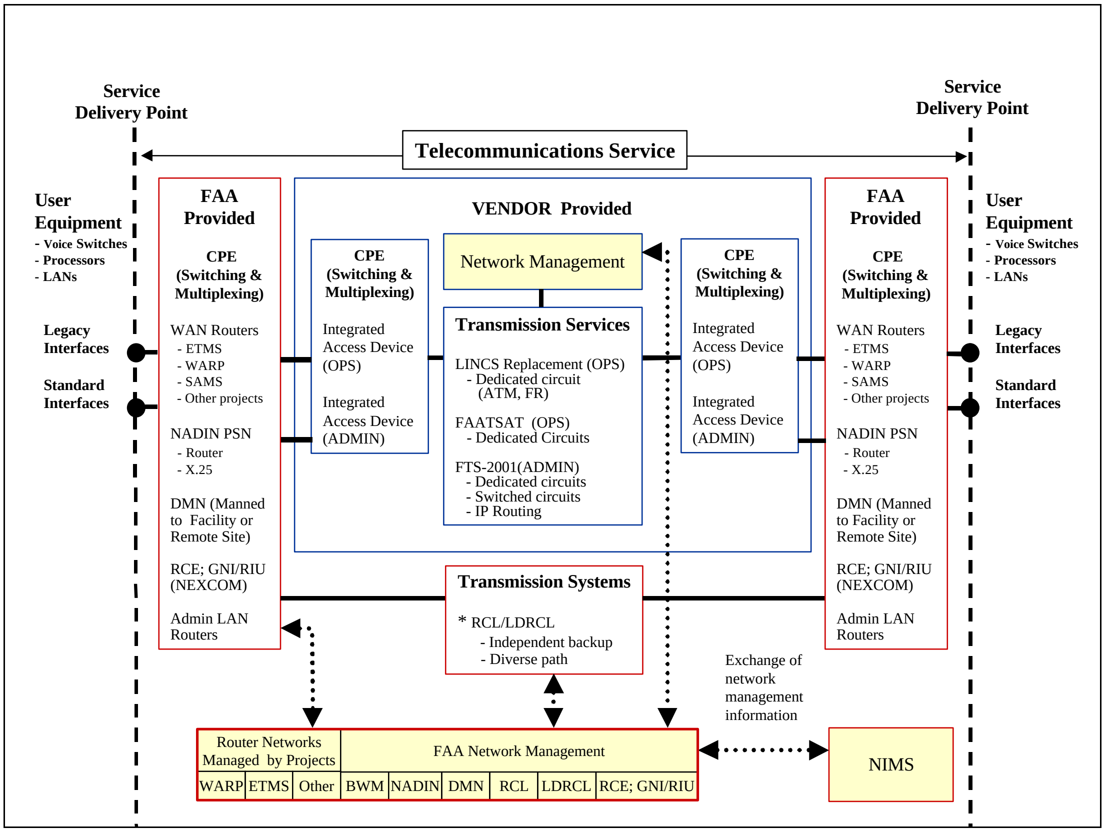

Figure 4-4. Interfacility Services Network Architecture

4.3.2.1 ISN Features

The ISN architecture is characterized by the following:

Interfaces at SDPs

The Reference Case Alternative provides all of the needed legacy interfaces and a limited set of industry standard interfaces.

CPE (Switching and Multiplexing Equipment)

FAA provided:

- The FAA-owned multiplexing and switching systems provide such services as subrate multiplexing, X.25 packet switching, ICAO compliant message switching, and IP routing.
- DMN will provide subrate multiplexing, modem, and A/B circuit restoral functionality primarily for ARTCC data users who require connections to remote sites, i.e., radar and Automated Surface Observing Systems (ASOS) sites.
- BWM will multiplex subrate and DS-0 data streams to the DS-1 transmission rate. BWM will provide service primarily on ARTCC-to-ARTCC circuits until BWM becomes unsupportable (approx. 2005).

- NADIN PSN will provide both X.25 and IP service for ARTCC-to-ARTCC telecommunications traffic. It also will consolidate the management of router networks associated with various operational systems or services (e.g., STARS, ETMS). Additionally, NADIN X.25 service will provide user access to the NADIN MSN service.
- Independent router networks associated with various operational systems or services (e.g., STARS, ETMS) will become NADIN subnetworks. They will provide IP service access to users in non-ARTCC locations.

Vendor provided:

- The vendor provided CPE consists primarily of IADs. These devices convert the communications traffic into the appropriate format for transmission by a FR, ATM, or IP-based transport.

<u>Transmission</u>

FAA provided:

- RCL is used to provide ARTCC-to-ARTCC backup connectivity.
- RCL and LDRCL provide alternate connectivity to remote sites.

Vendor provided:

- A leased transmission service provides a range of services, including dedicated connectivity, switched connectivity, and IP routing. These services will be used to meet user requirements in the most cost-effective way. Users that require (virtual) dedicated connectivity will get it. Over time, these users will be able to migrate to (typically) less expensive bandwidth on demand services if and when their interfaces and operational requirements change.
- FAATSAT service provides secondary connectivity to some remote sites at least until 2006.

<u>Integration of Operations and Administrative Traffic</u>

- Operational and administrative networks are kept separate.

<u>ICAO Compliant Message Switching</u>

- NADIN MSN will continue to provide ICAO compliant message switching.

<u>Administrative Communications</u>

- Administrative voice telecommunications service is provided by FTS-2001 switched voice service.
- Administrative data telecommunications service is provided by ADTN IP router network using FTS-2001 transport.

Network Management

Network management is provided, as follows:

- Network management of leased assets is outsourced to a vendor who will provide a single point of responsibility to the FAA. The vendor will provide NIMS and any other FAA designated systems with standards-based real-time and non-real-time management information on the leased system.
- Legacy FAA transmission assets, namely, the RCL and the LDRCL will be managed by the FAA. These assets will be managed the same way they currently are managed. Additional management information on the performance of RCL and LDRCL circuits will be provided by the FAA CPE (e.g., RCE, GNI, DMN, and NADIN) that uses these circuits.
- Multiplexing and switching systems will be managed by the FAA.
- NIMS is used to integrate the management data from the leased telecommunications systems, legacy transmission systems (to the extent practicable), multiplexing and switching systems, and end user systems to provide end-to-end service management.

ISN Business Practices

The ISN business practices (Figure 4-5) are characterized by:

FAA responsibility for:

- The operations, maintenance, and management of multiple switching and multiplexing systems.
- The operations, maintenance, and management of FAA transmission systems, namely, RCL and LDRCL.
- Overall network management of SDP-to-SDP service.
- TIPT will be responsible for the DMN, NADIN, and BWM systems, as well as engineering the WAN router networks required by various FAA programs, such as Weather Analysis Radar Processor (WARP) and Enhanced Traffic Management System (ETMS).

Vendor responsibility for:

- The operations, maintenance, and management of the primary transmission service, namely, the LINCS follow-on service.

Service provisioning:

- Service provisioning will be done on an aggregated bandwidth basis.

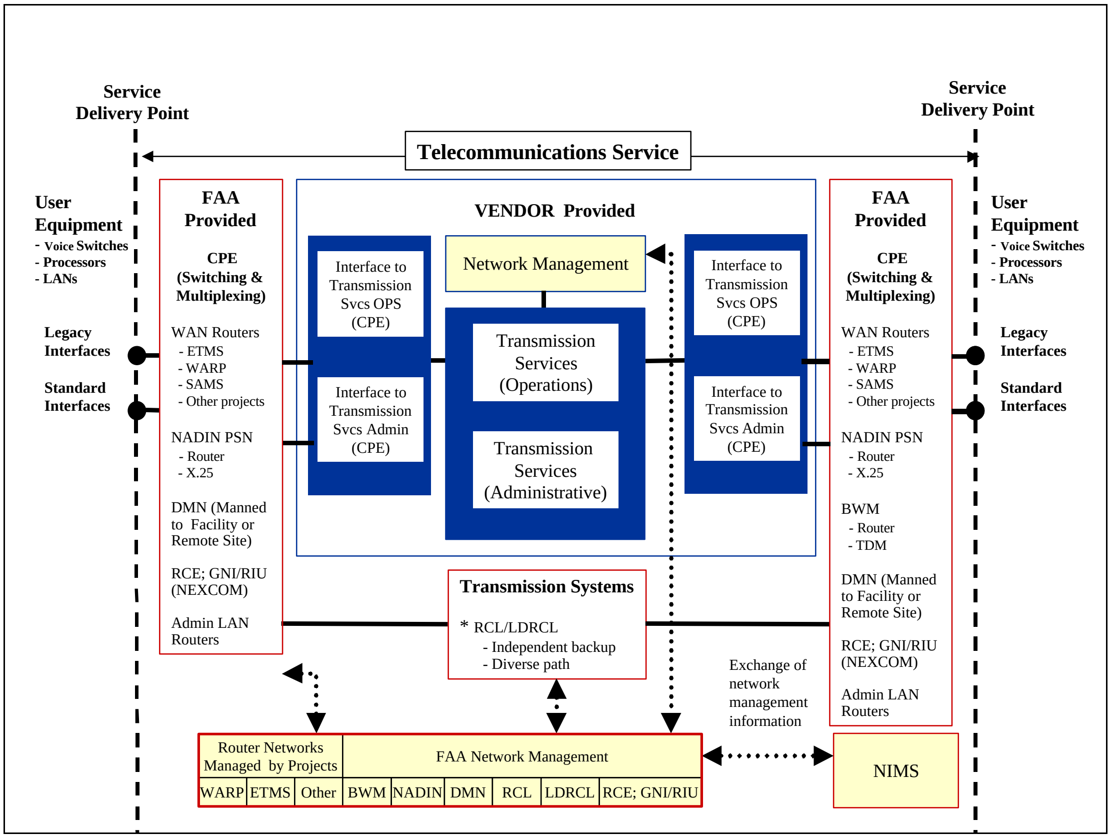

Figure 4-5. Integrated Services Network Business View

4.3.2.2 ISN Transition Strategy

The major elements of the transition strategy (Figure 4-6) to get from the present NAS architecture to the ISN architecture are the following:

- Transition from LINCS to a LINCS replacement network (2000-2005).
- Implementation of a bridge contract to provide LINCS functionality (2002-2005). A bridge contract is needed because the LINCS contract expires in March 2002.
- Transition from BWM provided multiplexing service to FTI service (2002-2005).
- Transition from portions of the DMN network to the LINCS replacement network (2002-2005). Those circuits where both endpoints are located in facilities that will be visited by LINCS transition teams will be cutover to the LINCS replacement network.
- Refreshment of the DMN network (2005-2008). The DMN network that exists in this timeframe will consist almost exclusively of circuits that connect remote sites (e.g., radars and ASOS) to manned ATC facilities. The Codex multiplexer/modems that reach the end of their useful life will be replaced either by a new generation of multiplexer/modems or by multiplexer/modems that were made available as a result of transitioning of some DMN users to the LINCS replacement network.
- Transition from the NADIN X.25 network to the NADIN IP network (2000-2010).

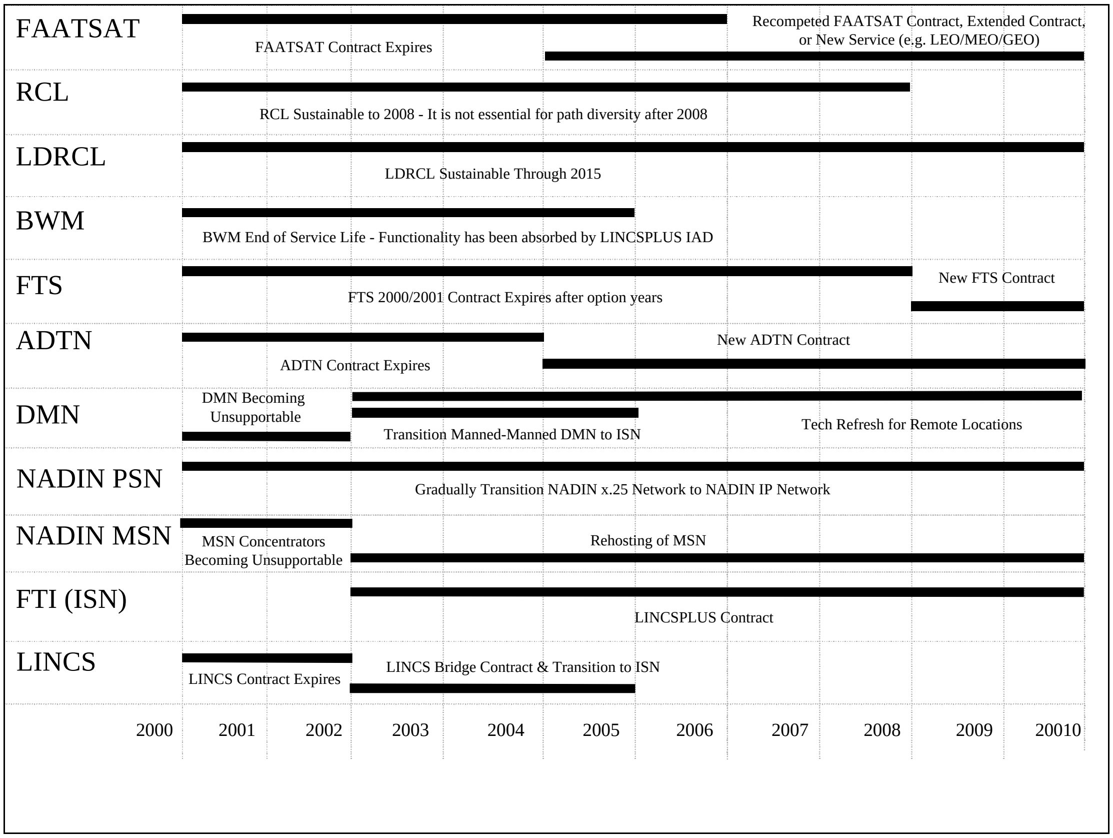

Figure 4-6. Interfacility Services Network Timeline

4.3.3 Integrated Interfacility Services Network (IISN) Architecture

The distinguishing feature of the IISN Alternative is its fidelity to the communications architecture articulated in NAS Architecture (Version 4.0). The IISN Alternative proposes the consolidation of transmission, multiplexing, and switching systems for both operational and administrative telecommunications into one integrated leased network. Figure 4-7 provides a functional block diagram of the IISN Alternative.

4.3.3.1 IISN Features

The IISNAlternative is characterized by the following:

Interfaces at SDPs

This alternative will provide legacy interfaces and a full range of industry standard interfaces.

CPE (Switching and Multiplexing Equipment)

FAA provided:

All of the FAA-owned CPE listed in MNS-322 will be phased out. Present plans are for the FAA to develop CPE related to NEXCOM, namely, the GNI and the RIU.

Vendor provided:

- The vendor is expected to provide a suite of equipment that consists of an IAD, routers, and multiplexers.

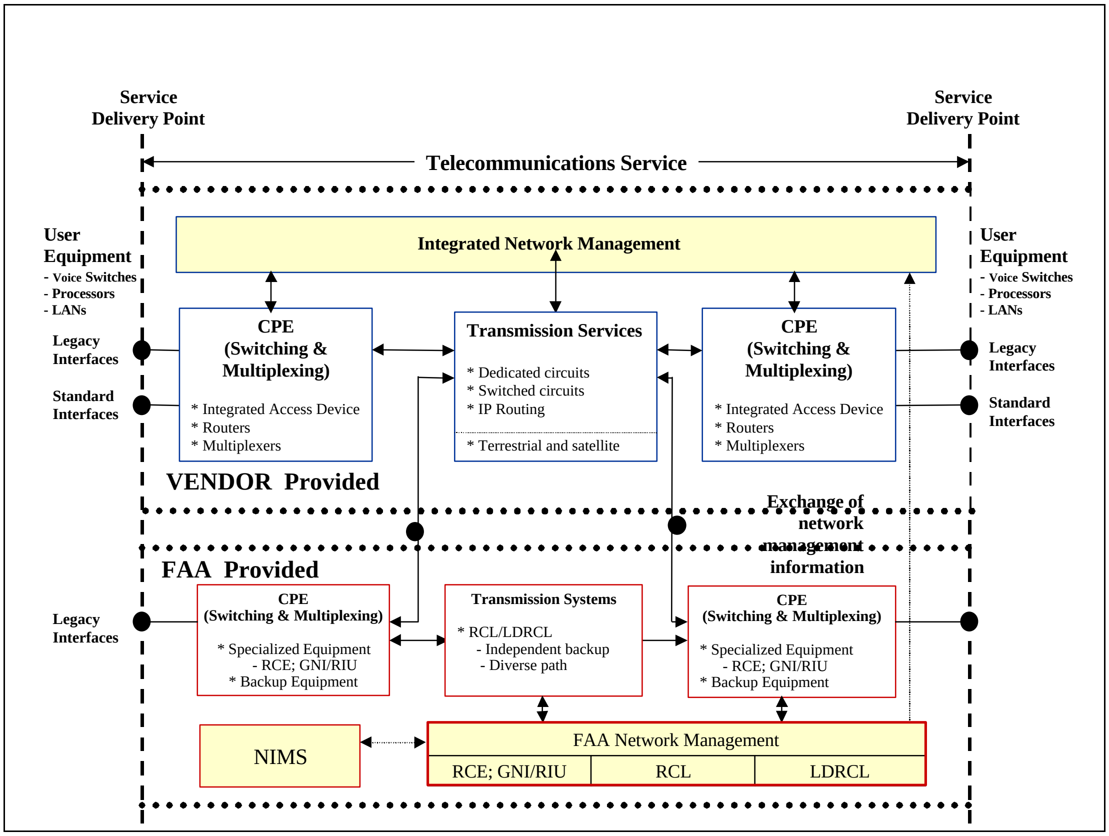

Figure 4-7. Integrated Interfacility Services Network Architecture

<u>Transmission</u>

FAA provided:

- RCL provides ARTCC-to-ARTCC backup connectivity.
- RCL and LDRCL provide either alternate connectivity to remote sites.

Vendor provided:

- A leased service provides both a range of transmission services (e.g., dedicated connectivity, switched connectivity, and IP routing) and a range of multiplexing and switching services (e.g., subrate multiplexing, X.25 packet switching). These services will be used to meet user requirements in the most cost-effective way. Users that require (virtual) dedicated connectivity will get it. Over time, these users will be able to migrate to (typically) less expensive bandwidth on demand services if and when their interfaces and operational requirements change.
- FAATSAT service provides secondary connectivity to some remote sites at least until 2006.

Integration of Operations and Administrative Traffic

Operational and administrative networks are integrated to the extent consistent with security requirements.

ICAO Message Switching

NADIN MSN provides ICAO compliant message switching service and is accessible through the FTI X.25 service.

Network Management

Network management is provided, as follows:

- Network management of leased assets is outsourced to a vendor who will provide a single point of responsibility to the FAA. The vendor will provide NIMS and any other FAA designated systems with standards-based real-time and non-real-time management information on the leased system.
- Legacy FAA transmission assets, namely, the RCL and the LDRCL may be managed by the FAA or by the vendor responsible for managing the leased telecommunications assets. (The decision on how to assign responsibility for the management of FAA transmission assets will be made by the TIPT.) These assets will be managed the same way they are managed currently. Additional management information on the performance of RCL and LDRCL circuits will be provided by the FAA CPE (e.g., RCE, GNI, DMN, and until 2005, NADIN) that uses these circuits.
- NIMS is used to integrate the management data from the leased telecommunications systems, legacy telecommunications systems (to the extent practicable), and end user systems to provide end-to-end service management.

IISN Business Practices

The IISN business practices (Figure 4-8) are characterized by:

FAA responsibility for:

- Oversight of vendor provided SDP-to-SDP service.
- Both real-time and non-real-time oversight will be provided.
- The operations, maintenance, and management of FAA transmission systems, namely, RCL and LDRCL.

Vendor responsibility for:

- The operations, maintenance, and management of SDP-to-SDP service.
- Network engineering

Service provisioning:

- Service provisioning will be done on an aggregated bandwidth basis.

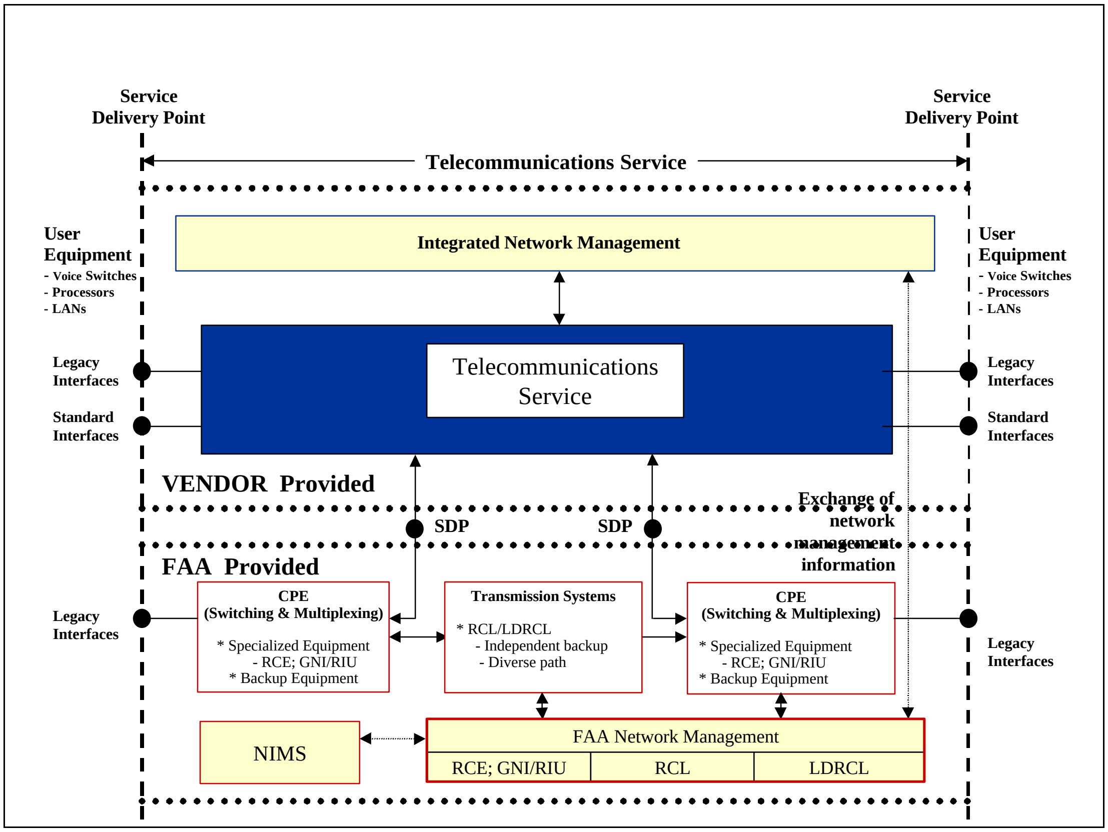

Figure 4-8. Integrated Interfacility Services Network Business View

4.3.3.2 IISN Transition Strategy

The major elements of the transition strategy (Figure 4-9) to get from the present NAS architecture to the IISN are the following:

- Transition from LINCS to a LINCS replacement network (2000-2005).
- Implementation of a bridge contract to provide LINCS functionality (2002-2005). A bridge contract is needed because the LINCS contract expires in March 2002.
- Transition from portions of the DMN network to the LINCS replacement network (2002-2005). Those circuits whose both endpoints are located in facilities that will be visited by LINCS transition teams will be cutover to the LINCS replacement network.
- Transition from BWM provided multiplexing service to FTI service (2002-2005).
- Transition from ADTN service to FTI service (2002-2005).
- Transition of the remaining portion of the DMN network to FTI (2005-2008).
- Transition from the NADIN X.25 network to FTI X.25 service (2005-2008).
- Transition from the NADIN IP network to FTI IP service (2005-2008).

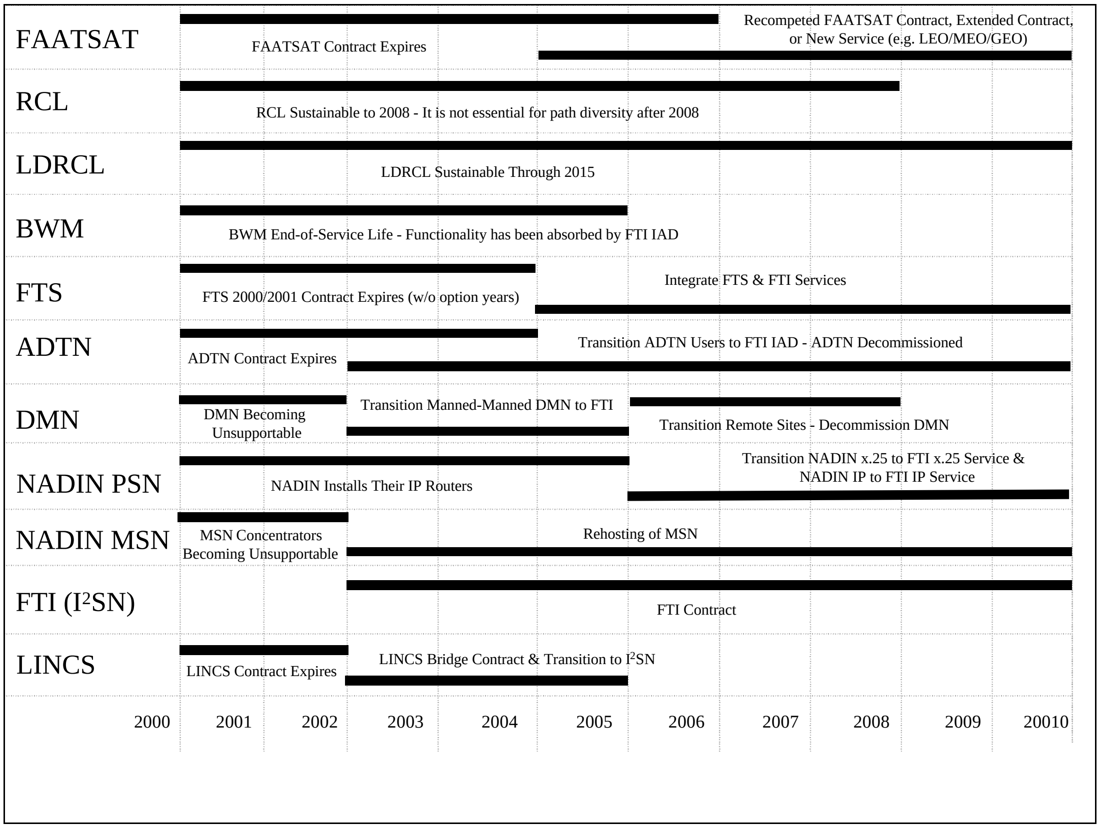

Figure 4-9. Integrated Interfacility Services Network Timeline

4.4 Evaluation

Technical alternatives were evaluated and compared using a set of weighted criteria. The criteria and weights were developed to permit a quantitative assessment of each technical alternative for purposes of evaluation and comparison. The evaluation methodology consisted of the following steps:

- Identify all Mission Effectiveness (technical) requirements in the Requirements Document.
- Organize requirements into independent categories.
- Define the rating system for Mission Effectiveness criteria.
- Develop evaluation criteria for assessing each requirement.
- Assign a relative weight to each criterion.
- Assign a relative weight to each category.
- Rate each alternative using the evaluation criteria.
- Multiply ratings by weights and normalize scores for each Mission Effectiveness category.
- Multiply Mission Effectiveness category scores by weights and compare alternatives.

4.4.1 Evaluation Criteria

Evaluation criteria for all Mission Effectiveness requirements were developed from the FTI Requirements Document. These criteria were selected so that items at the same level of indenture have nearly the same weight and are as independent of one another as much as possible. A quantitative rating system (see Table 4-1) was used to keep scoring uniform across all criteria. The lowest possible rating was arbitrarily given a value of one and the highest (or best) score was a five.

Table 4-1. Rating System for Mission Effectiveness Criteria

Rating	Criteria
5	Requirement can be easily met with off-the-shelf hardware/software or with currently available services; the alternative uses mature technology; with little or no design engineering needed.
3	Requirement can be met by using ancillary hardware/software or new services that are likely to be available; the alternative relies on technology that is still being developed or is evolving rapidly; some design engineering is likely.
1	Requirement must be met by the use of new hardware/software or services that may not be available; the alternative uses technology that is still in conceptual design or experimental stages; significant design engineering is needed.

4.4.1.1 Interface Requirements

- Operational Voice Interfaces
  - Existing: The alternative provides physical and logical voice interfaces equal in performance to those for existing users and systems.
  - Industry Standard: The alternative provides industry standard voice interfaces.
- Operational Data Interfaces
  - Existing: The alternative provides physical and logical data interfaces equal in performance to those for existing users and systems.
  - Industry Standard: The alternative provides industry standard data interfaces.
- Agency Voice Interfaces
  - Existing: The alternative provides physical and logical voice interfaces equal in performance to those for existing users and systems.
  - Industry Standard: The alternative provides industry standard voice interfaces.
- Agency Data Interfaces
  - Existing: The alternative provides physical and logical data interfaces equal in performance to those for existing users and systems.
  - Industry Standard: The alternative provides industry standard data interfaces.

- Video Interfaces
  - Existing: The alternative provides physical and logical video interfaces equal in performance to those for existing users and systems.
  - Industry Standard: The alternative provides industry standard video interfaces.

4.4.1.2 Service Requirements

- The alternative offers voice, data, and video services.
- The alternative provides SDPs.
- The alternative permits dynamic bandwidth allocation.
- The alternative provides multiplexing services.
- The alternative provides WAN services.
- The alternative provides voice, data, and video teleconferencing.
- The alternative provides access to ATN, Internet, and WANs.
- The alternative permits dial-in and dial-out services.
- The alternative provides multicast and broadcast services.

4.4.1.3 Availability Requirements

- The alternative meets the required availability from the users' perspective.
- The alternative provides the required physical, electrical, power, and path diversity.
- The alternative supports the required port redundancy.
- The alternative meets the required restoral times from the users' perspective.

4.4.1.4 Performance Requirements

- The alternative meets call setup time requirements.
- The alternative meets call tear down time requirements.
- The alternative meets latency requirements.
- The alternative supports user QoS requirements.
- The alternative meets data integrity requirements.

4.4.1.5 Integration Requirements

- Traffic Integration
  - The alternative supports integration of operational and agency traffic.
  - The alternative supports integration of voice, data, and video traffic.
- The alternative supports integration of networks (e.g., PSN, DMN).

4.4.1.6 Network Management Requirements

- The alternative provides usage monitoring.
- The alternative provides loopback capability.
- The alternative provides real-time exchange of management and control information.
- The alternative provides exchange of administrative management information.

4.4.1.7 Security Requirements

- The alternative meets network security requirements.
- The alternative meets physical security requirements.
- The alternative meets information security requirements designed to reduce compromise, corruption, or interruption of service caused by intentional and unintentional threats.

4.4.2 Evaluation Matrix

The Alternative Analysis Subteam evaluated each alternative and arrived at scores through discussion and consensus. Traceability to requirements was maintained by listing the specific paragraphs from the Requirements Document with each evaluation criterion in Table 4.2.

Table 4-2. Mission Effectiveness Assesement

MISSION EFFECTIVENESS Technical Requirements	Reference Alternative	ISN	IISN	Weight
1. Interface Requirements	**Reference**	**ISN**	**IISN**	**Weight**
1. FAA Interfaces				
1.1 Operational Voice Interfaces				
Existing (3.1.1.6, 3.5, 5.6.1)	5	3	3	3.00
Industry Standard (3.1.1, 3.1.1.7.8, 5.5.1, 5.5.2)	3	5	5	0.50
1.2 Operational Data Interfaces				
Existing (3.1.1.6, 3.1.1.7.4, 3.1.1.7.9, 3.5, 3.5, 5.6.1)	5	4	3	2.00
Industry Standard (3.1.1, 3.1.1.7.5, 5.5.1, 5.5.2)	3	5	5	0.50
1.3 Agency Voice Interfaces				
Existing (3.1.1.6, 3.5, 5.6.1)	5	5	5	1.00
Industry Standard (3.1.1, 3.1.1.7.8, 5.5.1, 5.5.2)	5	5	5	0.50
1.4 Agency Data Interfaces				
Existing (3.1.1.6, 3.1.1.7.9, 5.6.1)	5	5	5	1.00
Industry Standard (3.1.1, 3.1.1.7, 3.1.1.7.3, 3.1.1.7.5, 3.1.1.7.9, 5.5.1, 5.5.2)	5	5	5	0.50

Table 4-2. Mission Effectiveness Assesement, Cont.

1. Interface Requirements, Cont.	Reference	ISN	IISN	Weight
1.5 Video Interfaces				
Existing (3.1.1.6, 3.5, 5.6.1)	5	5	5	0.50
Industry Standard (3.1.1, 5.5.1, 5.5.2)	5	5	5	0.50
Total Interface Score	**48**	**42**	**40**	**0.100**
Normalized Interface Score	**4.80**	**4.20**	**4.00**	

2. Service Requirements	Reference	ISN	IISN	Weight
2.1 Voice, Data, and Video Services (3.1.1, 3.1.1.1)	5	5	5	1
2.2 SDPs (3.1.1.2, 3.6)	5	5	5	1
2.3 Dynamic Bandwidth Allocation (3.1.1.3.1)	3	4	5	1
2.4 Multiplexing (3.1.1.5)	5	5	5	1
2.5 WAN Services (3.1.1.7, 3.1.1.7.3)	3	4	5	1
2.6 Voice, Data, and Video Teleconferencing (3.1.1.7.1)	4	4	5	1
2.7 WAN, ATN, and Internet Access (3.1.1.7.3, 3.1.1.7.4, 3.1.1.7.5)	5	5	5	1
2.8 Dial-In, Dial-Out (3.1.1.7.8)	4	4	5	1
2.9 Multicast, Broadcast (3.1.1.7.6)	4	5	5	1
Total Service Score	**38**	**41**	**45**	**0.111**
Normalized Service Score	**4.22**	**4.56**	**5.00**	

3. Availability Requirements	Reference	ISN	IISN	Weight
3.1 Availability (3.2)	5	5	5	1
3.2 Diversity (3.1.1.3.1, 3.3.1, 3.3.2, 3.3.3, 3.3.4)	4	4	4	1
3.3 Port Redundancy (3.1.1.7.2)	3	3	3	1
3.4 Restoral (3.1.3, 3.2)	4	5	5	1
Total Availability Score:	**16**	**17**	**17**	**0.25**
Normalized Availability Score	**4.00**	**4.25**	**4.25**	

4. Performance Requirements	Reference	ISN	IISN	Weight
4.1 Call Setup Time (3.4)	5	4	4	1
4.2 Call Tear Down (3.4)	4	4	5	1
4.3 Latency (3.4)	4	4	5	1
4.5 QoS (3.4.1, 3.4.1.1)	3	4	5	1
4.6 Data Integrity (3.4.2)	5	4	4	1
Total Performance Score	**21**	**20**	**23**	**0.20**
Normalized Performance Score	**4.20**	**4.00**	**4.60**	

5. Integration Requirements	Reference	ISN	IISN	Weight
5.1 Traffic Integration				
5.1.1 Voice, Data, Video (3.1.1.1, 3.1.1.3)	2	3	5	0.5
5.1.2 Operations Traffic and Administrative (3.1.1.1, 3.1.1.4, 7.4))	2	3	5	0.5

Table 4-2. Mission Effectiveness Assessment, Cont.

5.2 Network Integration (3.1.1.1, 3.1.1.7.3)	1	3	5	1
Total Integration Score	**3**	**6**	**10**	**0.50**
Normalized Integration Score	**1.50**	**3.00**	**5.00**	

6. Network Management Requirements	Reference	ISN	IISN	Weight
6.1 Usage Monitoring (3.1.2.3, 3.1.2.6)	1	3	5	1
6.2 Loopback Capability (3.1.1.7.7, 5.2)	3	3	3	1
6.3 R/T Exchange of Management and Control Information (3.1.1.4, 3.1.2, 3.1.2.1, 3.1.2.2, 3.1.2.4, 3.1.2.5, 5.1, 5.1.1, 5.2)	2	4	5	1
6.4 Exchange of Administrative Management Information (3.1.2.3)	2	4	5	1
Total Network Management Score	**8**	**14**	**18**	**0.25**
Normalized Network Mgmt. Score	**2.00**	**3.50**	**4.50**	

7. Security Requirements	Reference	ISN	IISN	Weight
7.1 Network Security (3.1.2.5, 7.6.1, 7.6.2, 7.6.3, 7.6.6, 7.6.7, 7.6.9, 7.6.9.1)	3	4	4	1
7.2 Physical Security (3.1.2.5, 7.5, 7.5.1, 7.5.2)	3	3	3	1
7.3 Information Security (7.4, 7.6, 7.6.1, 7.6.2, 7.6.3, 7.6.4)	4	4	4	1
Total Security Score	**10**	**11**	**11**	**0.33**
Normalized Security Score	**3.33**	**3.67**	**3.67**	

The results of the evaluation in Table 4-3 show that the IISN scored the highest, followed by the ISN and the Reference Alternative. The IISN scored best because of the advantages it provides in the areas of Network Management, Network Integration, and in the range of interfaces and services it provides.

The ISN alternative can probably provide adequate technical performance, but the lack of integrated Network Management will negatively impact the quality of delivered services.

The Reference Case Alternative was judged to be the worst alternative because it is very cumbersome to manage and provides a limited range of services.

Table 4-3. Overall Mission Effectiveness Score

Overall Mission Effectiveness Score	Reference	ISN	IISN	Weight
Weighted Interface Score:	4.80	4.20	4.00	1
Weighted Service Score	4.22	4.56	5.00	1
Weighted Availability Score:	4.00	4.25	4.25	2
Weighted Performance Score	4.20	4.00	4.60	2
Weighted Integration Score	1.50	3.00	5.00	2
Weighted Network Mgmt. Score	2.00	3.50	4.50	1
Weighted Security Score	3.33	3.67	3.67	1
Total Weighted Score	**33.75**	**38.43**	**44.87**	

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5.0 TRANSITION AND IMPLEMENTATION

5.1 Introduction

The FAA FTI Transition and Implementation Subteam was formed to provide detailed transition and implementation analyses. Attachment 2, Transition and Implementation Report (TIR), lists the full- and part-time Transition and Implementation Subteam members and selected non-members with their areas of contribution to the subteam's analyses.

5.1.1 Common Work Breakdown Structure (WBS)

The Transition and Implementation Subteam was tasked with developing a transition methodology and a transition cost and schedule. The subteam coordinated with Cost Subteam to ensure that there was a common understanding of the FTI Work Breakdown Structure (WBS). The goal was to ensure that the eventual transition and implementation cost estimates and schedules could be integrated easily into the overall program cost estimates and schedules and could serve as justification for the transition and implementation portions of the FTI Acquisition Program Baseline (APB).

5.1.2 Scope and Focus

Initial analysis of the telecommunications alternatives addressed all of the FAA-leased and FAA-owned telecommunications services and assets identified in MNS-322 as candidates for inclusion in the FTI program. It became clear that an integral and initial part of any alternative and solution had to include the transition away from the LINCS contract that expires in March 2002. Guidance from the JRC requested that the IAT provide clear alternatives to address the termination of the LINCS contract.

As the AA Subteam developed the various alternatives, the Transition and Implementation Subteam made a detailed study of what was involved in transitioning from the LINCS contract to the FTI contract. This section provides a comprehensive analysis of transitioning from the LINCS contract to the FTI contract and services. The transition and associated F&E costs for the Reference Case Alternative were derived from the ISN Alternative.

The subteam made the conservative assumption that the LINCS incumbent contractor would not win the FTI competition. This assumption means that the MCI-owned equipment installed at FAA premises had to be removed or abandoned in place. Section 7.0 assesses the risks associated with the assumption of MCI abandoning in place their monitoring equipment currently installed in sites that are not scheduled to receive a suite of FTI equipment. This assumption does not mean that the transition and implementation cost projections from this analysis are worst case. If it were required to replace monitoring equipment at all sites, additional funds would be required over and above those that are projected in this report.

The following sections describe what is included in these transition and implementation cost estimates for each alternative. These analyses were based on the existing infrastructure and telecommunications services. Adjustments for growth, inflation, or other considerations were made by the Cost Subteam for consistency with the rest of the FTI investment analysis.

5.1.2.1 Transition and Implementation Analysis Scope for FTI ISN

The schedules, risks, assumptions, resource, and cost estimates to transition to and implement FTI ISN include the following:

- Complete transition from LINCS connectivity to FTI telecommunication services (about 4,000 sites with almost 23,000 LINCS circuit terminations).
- Transition from some DMN equipment, where efficiencies can be derived, at the 778 sites projected to receive FTI suites of equipment. DMN modems whose functionality can be integrated into the suite of FTI equipment will be removed. There will still be a significant number of DMN modems that will maintain their current configuration, functionality, and connectivity.
- Reroute the telecommunications path for existing legacy routers at the ARTCCs through the NADIN PSN (CISCO) routers at the ARTCCs and then use the FTI transport.

5.1.2.2 Transition and Implementation Analysis Scope for FTI IISN

The schedules, risks, assumptions, resource, and cost estimates to transition to and implement FTI IISN include the following:

- Complete transition from LINCS connectivity to FTI telecommunication services (about 4,000 sites with almost 23,000 LINCS circuit terminations).
- Transition from some DMN equipment, where efficiencies can be derived, at the 804 sites projected to receive FTI suites of equipment. DMN modems whose functionality can be integrated into the suite of FTI equipment will be removed. There still will be a significant number of DMN modems that will maintain their current configuration, functionality, and connectivity.
- Transition FTS circuit connectivity and transport to the FTI network services.
- Transition ADTN circuit connectivity and transport to FTI network services.
- Reroute the telecommunications path for existing legacy routers at the ARTCCs through the NADIN PSN (CISCO) routers at the ARTCCs and then use the FTI services for transport.

5.1.3 Key Questions

It was deemed that any transition to FTI had to sufficiently address the following fundamental transition and implementation questions for each of the ultimate feasible alternatives:

- What services and systems are the FAA transitioning from during the projected time frame of FTI?

- From what facility locations and from what site-specific equipment will the agency have to transition?
- To what facility locations and to what site-specific equipment or service will the agency transition?
- What is the level-of-effort required to effect transition and implementation at representative facilities?
- What resources will be required to perform the FTI transition and implementation? This includes FAA personnel, FAA contractor support personnel, and assumptions regarding FTI contractor transition and implementation support requirements.
- What are the schedule constraints, if any, for the FTI transition and implementation?
- What is a feasible transition and implementation strategy?
- What are the risks associated with the selected transition and implementation strategy and the resulting costs estimates?
- What are the major assumptions that were used in the subteam's analyses?

5.1.4 Subject Matter Experts

The Transition and Implementation Subteam made extensive use of subject matter experts, both as core subteam members and as ad hoc members to address specific issues. Personnel from ANI, ANS, AOP, and the TIPT with actual telecommunications transition and implementation experience were relied on to identify the real physical issues involved with transition and implementation at various representative facilities and equipment.

5.1.5 Transition and Implementation Cost Model and Tools

The Transition and Implementation Subteam selected the Telecommunications Information Management System (TIMS) as having data of sufficiently high integrity for the purposes of answering some of the key questions mentioned above. The subteam used the following software tools to help in their analyses:

- Microsoft Access software was used to query the TIMS database to identify all the locations and facilities currently using telecommunications services provided by LINCS and the quantity of LINCS circuits at each Location Identifier (LID) and Facility (FAC).
- Microsoft Excel software was used to sort spreadsheets of TIMS data that was used to determine facility size. Then, the data was aggregated according to the selected FTI transition strategy.
- Microsoft Excel software was used to estimate transition and implementation resource requirements. The subteam used the Regional Tracking Program (RTP) format used to plan F&E projects. This is important because the final transition and implementation projections will have to be incorporated into the ANS infrastructure planning and into the ANI-70 Work Plan to ensure that FTI transition and implementation is included in the agency's FY 2000 and subsequent work plans.

- Microsoft Project software was used to develop the schedules for the FTI alternatives and to determine the fiscal year percentage distribution of the cost estimates for the various FTI transition and implementation activities.

A combination of the outputs of the various worksheets were linked into a Microsoft Excel file where the key assumptions were identified and then the costs aggregated in an FTI Transition and Implementation Cost Model. This cost model allows adjustments to various assumptions that then can be reflected in a revised cost estimate. This tool can also be used by ANI, ANS, and the TIPT in the initial FTI implementation planning.

5.2 Key Assumptions

Attachment 2, TIR, Addendum B, Transition and Implementation Assumptions provides the detailed listing of assumptions used during the transition and implementation analyses. Also, there are edit comments on many of the individual cell inputs for most of the spreadsheets used in these analyses.

The subteam used the following key assumptions as fundamental to the transition and implementation analyses.

5.2.1 LINCS Bridge Contract

In accordance with the provisions of the LINCS contract, it was assumed that there would be no transition of NAS operational telecommunications connectivity off the LINCS circuits before four months prior to the expiration of the LINCS contract in March 2002. Continued access to the telecommunications services and connectivity provided by the LINCS contractor is absolutely essential to the transition. The IAT, in consultation with AOP and the TIPT, assumes that AOP will be able to negotiate a follow-on contract to the LINCS contract that allows continued access to the LINCS services and assistance in transitioning to the FTI services. It is assumed that such a bridge contract will provide access to the LINCS services up through September 2005, by which time all transition from LINCS provided services must be completed.

5.2.2 LINCS Focus

Both alternatives include the transition from LINCS to a new NAS telecommunications infrastructure. Accordingly, the initial FTI transition analyses had a distinct focus on the transition from LINCS connectivity. Sections 5.1.2.1 and 5.1.2.2 describe the additional programs addressed in both alternatives.

5.2.3 Disposal Costs in FTI Baseline

Disposal Costs included in the FTI baseline are limited to provide FAA support for the removal of legacy telecommunications assets. The majority of the LINCS disposal costs is addressed in the existing LINCS contract and is not part of the FTI baseline.

5.2.4 Cutover of DMN Operational Circuits Not Included

The cost estimates associated with the DMN efforts were based in part on the results from a site visit to the ZDC ARTCC on April 20, 1999. These cost estimates are limited to the installation of equipment and cable. No operational circuit cutover costs are included.

5.2.5 Schedule Constraints and Assumptions

Refer to TIR, Attachment 2, TIR, Addendum C, Transition and Implementation Schedules.

- No cutovers to FTI telecommunications will commence prior to an FTI In-Service Decision (ISD).
- Commence circuit cutover on June 1, 2002, for FTI Implementation Phase I (ARTCC – ARTCC) connectivity.
- Schedule the cutover for the remaining FTI implementation Phases II-VI with a focus on cutting over all the circuits within the airspaces identified for that phase. No two adjacent airspaces are planned to be implemented in the same phase.
- Order the necessary quantity of FTI equipment required to implement a phase six months prior to the scheduled start of installation for that phase.
- Implementation activity duration, per phase, was based on selected hours from the RTP generic resource worksheets.
- Site surveys should be scheduled for completion two months prior to ordering date for the suite of IAD equipment for that phase.
- Commence FTI Implementation Phase II site preparation activity concurrent with commencing Phase I installation.
- Commence the circuit cutover activity in an implementation phase one week before the scheduled completion of the installation activities for that phase.

5.2.6 Transition Strategy and Implementation Sequence

- Install the ARTCC-ARTCC FTI infrastructure first.
- Cutover the ARTCC-ARTCC telecommunications connectivity (734 LINCS circuit terminations).
- Parallel efforts implementing FTI within an airspace wherever possible.
- For risk reduction:
  - Defer ZOA and ZNY airspace until FTI Implementation Phase III.
  - Avoid adjacent airspaces to mitigate handoff concerns.
  - Implement ZHU and ZMA in separate phases.

FTI Implementation Phase Sequence:

Phase I	ARTCC-ARTCC
Phase II	ZSE, ZLA, ZBW, ZDC, ZMA, ZKC
Phase III	ZOA, ZDV, ZNY, ZID, ZJX, ZFW
Phase IV	ZAB, ZMP, ZTL
Phase V	ZLC, ZOB, ZHU
Phase VI	ZAU, ZME

5.3 Results of Key Questions' Analyses

5.3.1 What and Where to Transition From?

For transitioning from LINCS, the following is the result of the subteam's analysis:

The FAA will transition from 4,000 unique locations and will transition 22,874 LINCS circuit terminations.

The Microsoft Access queries of the TIMS database identified about 5,000 unique locations and about 26,000 LINCS circuit terminations as illustrated in Figure 5-1 below.

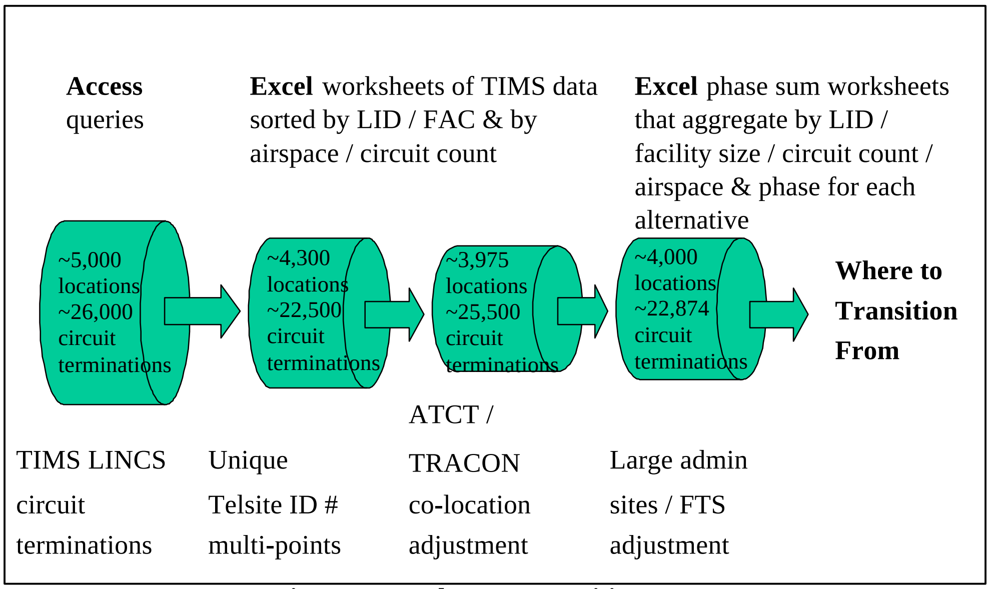


Figure 5-1. Where to Transition From

The database was scrubbed to identify all the unique locations that were actually co-located with another facility. This co-location scrub initially merged those locations with the same Telsite ID # in the TIMS database. A second co-location scrub manually cross-referenced a listing of co-located ATCTs and TRACONs from the terminal program office.

Next, the TIMS database was scrubbed to exclude the 456 multi-point circuits with their 2,000+ tail circuit terminations. Effort to transition the current multi-point circuits was addressed as a circuit cutover factor in the RTP worksheet for the large sites.

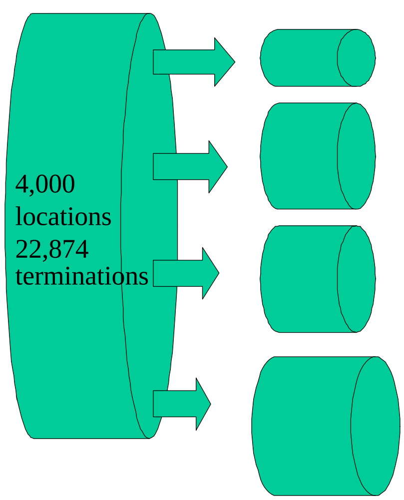
Finally, a few adjustments were made to account for the projected ANI Engineering Center, the projected Atlanta super TRACON, the NOCC, the NADIN switching centers, and inclusion of some of the large administrative facilities like FAA headquarters and the regional offices.

As a result of the analysis, the subteam reduced the number of locations involved in the LINCS to FTI transition from 5,000 to 4,000, and reduced the number of LINCS circuit terminations requiring transition from 26,000 to 22,874.

5.3.2 What and Where To Transition To?

For transitioning from LINCS, the following is the result of the subteam's analysis:

- Under the ISN Alternative, 778 locations would receive suites of FTI IAD equipment. (29 receiving large suites of equipment, 472 receiving medium suites of equipment, 277 receiving small suites of equipment, and 3,222 receiving no suites of FTI equipment).
- Under the IISN Alternative, 804 locations would receive suites of FTI IAD equipment. (39 receiving large suites of equipment, 479 receiving medium suites of equipment, 286 receiving small suites of equipment, and 3,196 receiving no suites of FTI equipment). This is illustrated in detail in Figure 5-2 below.



IAD Suite Size	**ISN**	**IISN**
	(Locations / Circuit Terminations)	
Large	29 / 5,814	39 / 6,018
Medium	472 / 8,670	479 / 8,731
Small	277 / 1,897	286 / 1,934
	778 / 16,381	**804 / 16,683**
No IAD Suite	3,222 / 6,493	3,196 / 6,191
	4,000 / 22,874	**4,000 / 22,874**

Figure 5-2. Where To Transition To

In consultation with the FTI AA Subteam and the Cost Subteam, the required size of FTI IAD suites was determined.

The following criteria were used to select which of the 4,000 sites would receive suites of FTI equipment and what size of suite of FTI equipment. Generally, the top two considerations involved the functionality provided by the facility and the quantity of current LINCS circuit terminations at the location.

- All 20 ARTCCs and six super TRACONs handle a significant volume of traffic and will receive a large suite of FTI IAD equipment under both alternatives.
- Unique facilities such as the FAATC, the Volpe Center, and the NOCC at Herndon (ATCSCC) will receive a large suite of IAD equipment under both alternatives.
- Large Administrative hubs (Regional Offices, ANI Engineering Center, and RWA Headquarters, for example) will receive a large suite of FTI IAD equipment under the IISN, and will receive no suites of FTI equipment under the ISN.
- Large standalone ATCTs will receive a medium suite of FTI IAD equipment under both alternatives.
- All facilities scheduled to receive STARS will receive a medium suite of FTI IAD equipment regardless of the circuit count at the facility.
- The average AFSS handles more than two T-1s worth of Ops traffic. Therefore, all 56 AFSSs will receive a medium suite of FTI IAD equipment for both alternatives.
- ATL and SLC NADIN sites will receive a medium suite of FTI IAD equipment under both alternatives.
- MET SMO has 77 LINCS circuits and will get a medium suite of FTI IAD equipment under both alternatives.
- Remaining SMOs with four or more LINCS circuits will get a small suite of FTI IAD equipment under the ISN Alternative, the ISN Alternative. All remaining SMOs, regardless of circuit count, will get a small suite of FTI IAD equipment under the IISN Alternative.
- All Air Surveillance Radar (ASR) facilities with five or more LINCS circuits will receive a small suite of FTI IAD equipment under both alternatives.
- All Air Route Surveillance Radar (ARSR) facilities will receive a small suite of FTI IAD equipment under both alternatives.
- ATCTs, TRACONs, TRACABs, and ATCT/TRACONs that are not receiving STARS, and have from four-nine LINCS circuits will receive a small suite of FTI IAD equipment.
- Remaining facilities with less than four LINCS circuits will not get a suite of FTI IAD equipment.
- Remaining facilities with four LINCS circuits were evaluated on a case by case basis to determine whether they get a suite of FTI IAD equipment, and if so, which suite size of FTI equipment they would receive.
- It does not address the Alaskan ARTCC and AFSS'/FSS'.

The costs for the equipment were not part of the Transition Subteam analysis, but were provided by the Cost Subteam. When considering the magnitude of the transition and implementation of either FTI alternative, be sure to include the equipment costs described elsewhere in this report.

The scrubbed TIMS data in the Excel spreadsheets for the 4,000 locations and 22,874 LINCS circuit terminations was separated into worksheets according to the size of the facility and the size of the suite of FTI IAD equipment.

These worksheets then were sorted by airspace so their quantities could be aggregated into the corresponding implementation phases.

5.3.3 FTI Transition and Implementation Resource Requirements

The FTI IA Transition Subteam developed transition and implementation cost, schedule, and level-of-effort estimates based on the classification of a facility. For this classification, the subteam selected the quantity of LINCS circuit terminations at a site as the determining factor. Sites with 90 or more LINCS circuit terminations were classified as a large facility. Sites with 10-89 LINCS circuit terminations were classified as a medium facility. Sites with 1-9 LINCS circuit terminations were classified as a small facility.

When the size of the suites of IAD equipment was subsequently determined, it also became necessary to develop a generic work sheet for small size facility that would receive no IAD equipment.

For each size facility, a generic worksheet was developed to estimate the level-of-effort to transition from LINCS provided connectivity to FTI provided connectivity. These worksheets included fixed cost estimates on the labor, travel, per diem, and facility upgrade requirements, as well as variable cost estimates based on the number of LINCS circuit terminations requiring cutover to FTI.

Attachment 2, TIR, Addendum D, provides Generic Regional Tracking Program (RTP) Transition and Implementation Resource Requirement Worksheets for a detailed review of estimates for all the various transition and implementation activities and labor categories. Many of the key assumptions made in the generic RTP worksheets also are discussed in the TIR Transition and Implementation Assumptions.

Figure 5-3 depicts the facility size classification and how the RTP Generic Resource Worksheets were used.

The inputs into the various labor and material categories of the generic RTP resource requirements worksheets were linked to a worksheet and used in developing the FTI transition and implementation cost and schedule estimates. The numbers of facilities and the number of LINCS circuit terminations requiring transition to FTI during a phase were aggregated and then multiplied by the applicable data from the generic RTP resource requirements worksheet.

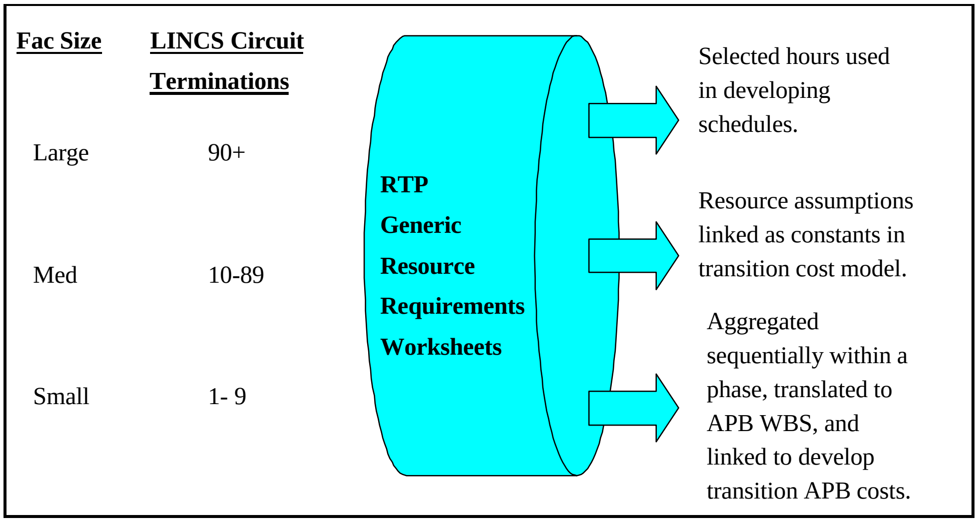


Figure 5-3. Transition Resource Requirements

5.4 FTI Transition and Implementation Schedules

Figure 5-4 and 5-5 show the schedule data that was extracted from the Attachment 2, TIR, Addendum C, Transition and Implementation Schedules.

5.4.1 FTI ISN Alternative Transition and Implementation Schedule

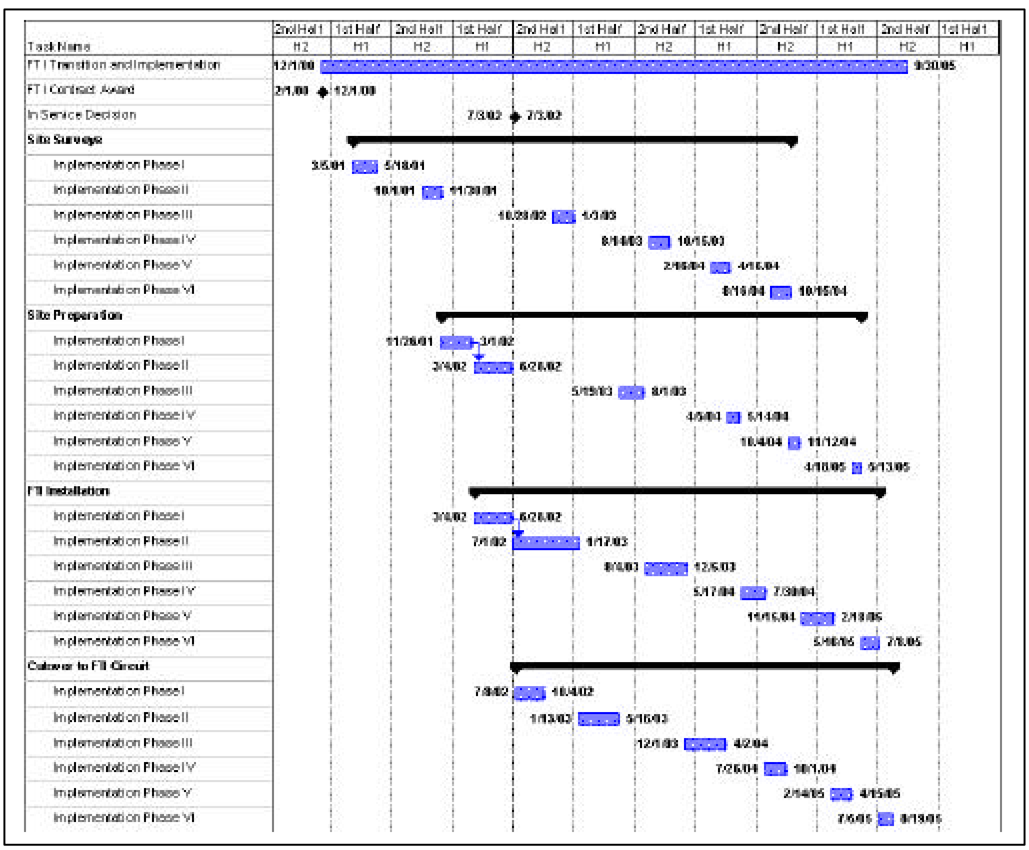


Figure 5-4. FTI ISN Alternative Transition and Implementation Schedule

5.4.2 FTI IISN Alternative Transition and Implementation Schedule

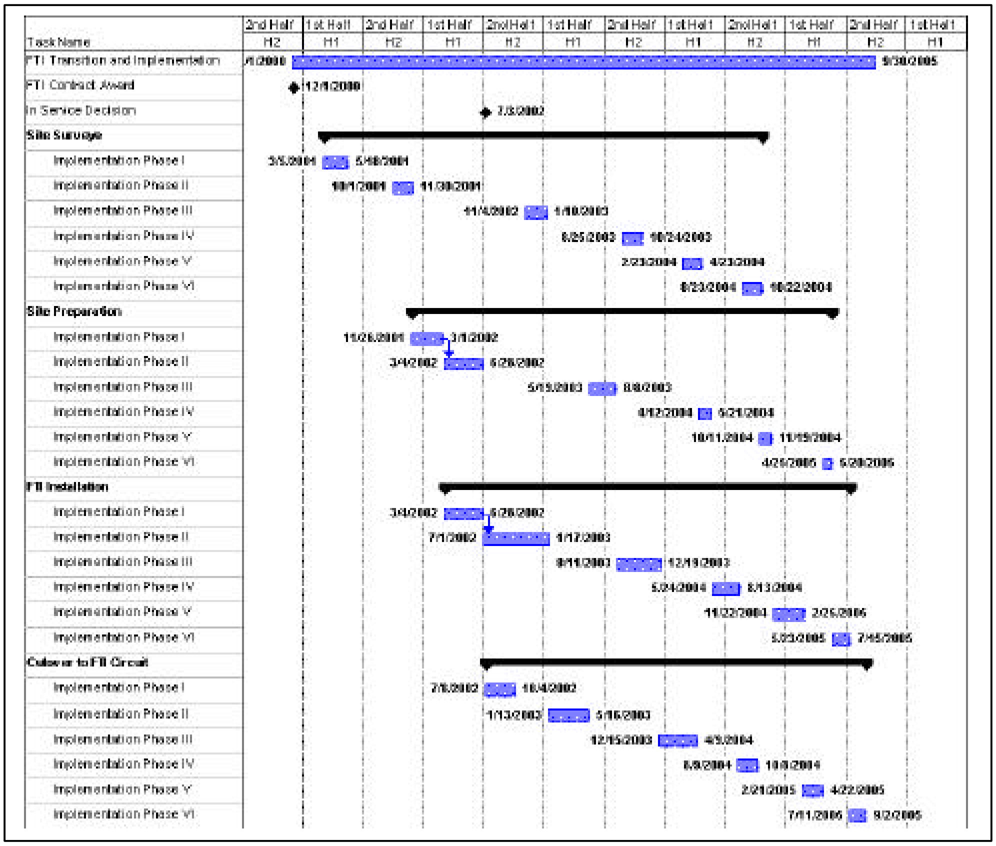


Figure 5-5. FTI IISN Alternative Transition and Implementation Schedule

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6.0 ECONOMIC ANALYSIS

The economic analysis considered the following criteria: FAA life cycle costs, FAA benefits (cost savings to the FAA), net present value (NPV), and benefit-cost (B/C) ratio. The analysis was based on conservative point estimates, or most likely values, provided by the Telecommunications Integrated Product Team (TIPT).

Table 6-1. Summary of the FTI Economic Analysis

OPTIONS	Reference Case		ISN		IISN	
	Range	High-Conf.	Range	High-Conf.	Range	High-Conf.
LCC Costs (Budget $M)	$2,268-$2,414	$2,366	$2,264-$2,495	$2,349	$1,809-$2,023	$1,947
NPV ($M)	$(374)-$293	$(127)	$(66)-$110	$(20)	$349-$504	$391
B/C Ratio	(0.29)-2.69	0.55	0.6-1.7	0.9	2.4-3.4	2.6
		Most Likely		Most Likely		Most Likely
NPV ($M)		$66.1		$90.4		$398.9

The methodology employed in calculating the benefit/cost ratio is described in the following formula using discounted costs:

$$\text{Life Cycle Cost}_{\text{Base Case}} - \text{OPS}_{\text{Alternative}} / \text{F\&E}_{\text{Alternative}}$$

This formula accounted for the fact that F&E investment in the candidate alternative was necessary in order to realize the possible cost efficiencies. The total life cycle cost of the Base Case was used rather than solely OPS dollars because the Base Case required a small amount of F&E investment in the form of tech refresh.

The formula employed to calculate net present value was the following, again using discounted costs:

$$\text{Life Cycle Cost}_{\text{Base Case}} - \text{Life Cycle Cost}_{\text{Alternative}}$$

Crystal Ball, a risk analysis tool, was used to develop high-confidence estimates on cost and benefits using a Monte Carlo simulation. Risk was embedded within the cost estimates through the use of ranges on specific parameters (see Attachment 3, Economic Assessment, for a detailed discussion). Table 6-1 summarizes the ranges on the life cycle cost estimates for all three alternatives. The Reference Case Alternative was determined to have the least amount of risk due to a less technological innovation and less aggressive integration of in-scope programs. The Reference Case Alternative is followed by ISN and finally IISN, depicting the increase in overall risk (Section 7) as multiservices become available and integration becomes more aggressive.

Ranges were placed on variables with the most significant uncertainty. With respect to the Reference Alternative, ISN, and IISN The variable with the most significant effect on the cost estimate at the high-confidence level was Network Transport Charges (APB Section 4.3) (see Attachment 3, Economic Assessment, to view the Crystal Ball Tornado Charts for the Reference

Alternative, ISN, and IISN). Because the recurring charges associated with Network Transport were based on pricing quotes from industry (see Attachment 3, Addendum A, BOE, Sections 4.3.1-4.3.7), there was little uncertainty in this area. Rather, the uncertainty (numerical ranges), was placed on the bandwidth estimates and data rates (see BOE attachment, Section 4.3.2) to encompass the unknown rate of growth in demand for telecommunications throughout the life cycle. A numerical range of –25%/+20% was placed on the initial quantity of administrative and operational data from which the bandwidth growth estimates were derived. A range of -15%/+25% was also placed on the full-period data rates to support data and voice traffic (See BOE, Section 4.3.2).

6.1 Life Cycle Costs

The life cycle cost estimates for the alternatives represent the life cycle costs for the service acquisition, transition, operation and maintenance, and disposition in "then-year" dollars. The cost estimates reflected in Table 6-2 show the cost summary for Facilities & Equipment (F&E) and Operations & Maintenance (O&M). Appendix 3 contains the specific details of the scope of the cost estimate, assumptions, and the basis of these estimates.

Table 6-2: FTI Reference Case Alternative Life Cycle Costs

	FY 00	FY 01	FY 02	FY 03	FY 04	FY 05	FY 06	FY 07	FY 08	FY 09	FY10	Total
F&E	$8.5	$30.8	$36.4	$54.6	$54.9	$35.2	$5.3	$5.2	$4.5	$3.9	$3.6	**$235.5**
O&M	$181.3	$182.9	$190.6	$199.5	$201.2	$205.5	$219.3	$218.3	$223.5	$228.6	$235.4	**$2,134.1**
Total Program	$188.1	$212.3	$225.6	$252.7	$254.7	$239.1	$222.6	$221.4	$225.9	$230.4	$236.8	**$2,366.3**

Note: 1) FTI Reference Alternative, "High-Confidence" Cost Estimates (Then-Year $M)
2) Summation not exact due to statistical variation

Table 6-3. FTI Interfacility Services Network (ISN) Life Cycle Costs

	FY 00	FY 01	FY 02	FY 03	FY 04	FY 05	FY 06	FY 07	FY 08	FY 09	FY10	Total
F&E	$8.5	$27.2	$36.3	$48.2	$45.4	$25.6	$4.2	$3.3	$2.7	$2.8	$2.9	**$203.1**
O&M	$176.2	$177.6	$192.5	$203.4	$201	$204.5	$202.9	$201.6	$209.9	$220.5	$231.9	**$2,211.1**
Total Program	$184.6	$204.2	$228.1	$250.6	$245.5	$229.6	$207	$204.8	$212.6	$223.2	$234.7	**$2,412.0**

Note: 1) Alternative 2, FTI ISN, "High-Confidence" Cost Estimates (Then-Year $M)
2) Summation not exact due to statistical variation

Table 6-4. FTI Integrated Interfacility Services Network (IISN) Life Cycle Costs

	FY 00	FY 01	FY 02	FY 03	FY 04	FY 05	FY 06	FY 07	FY 08	FY 09	FY 10	Total
F&E	$6.1	$29.2	$38.7	$51.5	$52.2	$25.1	$1.1	$.70	$.58	$.20	$.19	**$205.5**
O&M	$176.3	$177.2	$193.4	$183.7	$182.0	$148.3	$134.9	$132.3	$138.5	$140.8	$147.7	**$1,725.7**
Total Program	$181.7	$203.1	$230.7	$233.2	$212.3	$172.5	$136.0	$133.0	$137.1	$141.0	$147.9	**$1,947.6**

Note: 1) Alternative 3, FTI IISN, "High-Confidence" Cost Estimates (Then-Year $M)
2) Summation not exact due to statistical variation

As is shown in the above Tables 6-2 through 6-4, the IISN Alternative is the most cost efficient alternative out of the three. Even at the high-confidence level represented in those tables, IISN is estimated to cost 18% less than ISN, and 19.4% less than the Reference Case. The F&E costs are projected to be slightly higher for IISN than for ISN, primarily because the FTI specific infrastructure would go to mostly administrative locations like the Regional offices, as well as to the mostly operational sites covered by ISN. As the tables show, however, IISN's $2.4 million in added life cycle F&E costs is dwarfed into insignificance by comparing its expected life cycle O&M costs to ISN's, which at $2.2 billion would be $485.4 million or nearly 26% higher than IISN's $1.7 billion.

6.1.1 General Assumptions

- All three alternatives, Reference Alternative, ISN, and IISN are compared against the Base Case.
- The Base Case covers the same timeframe as the proposed alternatives, FY00-FY10, using current telecommunications market pricing.
- The Reference Case Alternative covers the same timeframe as the proposed alternatives, i.e., the beginning of FY2000 through June of FY2010.
- The scope of the Reference Case Alternative matches the scope of the proposed alternatives.
- Based upon the current definition of the proposed alternatives, the Table 6-5 provides a status of the original programs identified in the MNS.

Table 6-5. Telecommunications Programs Within the Scope of FTI

In Scope	Out Of Scope[1]
CONUS LINCS	ANICS
FTS2000 / FTS2001	FAATSAT
DMN	RCL
ADTN2000	LDRCL
Bandwidth Manager	Hawaiian LINCS
NADIN I and II	

- The Reference Case Alternative is a "LINCS equivalent infrastructure" alternative. "LINCS equivalent infrastructure" is defined as "the continued use of predominantly, point-to-point, dedicated services."
- The Reference Case Alternative is developed from currently known costs, i.e., the fiscal year most recently completed: FY98.
- The magnitude of telecommunications costs has been down-scoped to reflect the focus of the IA.
- The Fuchsia Book is used as a key source for projecting cost growth and bandwidth growth.
- The Reference Case Alternative is based upon the cost growth projected by the Fuchsia Book through FY2004. From FY2005 through FY2010, the cost growth will be based upon an extrapolated, "plus or minus "range.

[1] The cost of Headquarters level support and Network Management, Monitoring, and Control for these "out of scope" systems/networks will be included in the Reference Alternative, since it has been suggested that some degree of consolidation will take place with respect to these functions under the NAS Architecture alternative.

- The number and location of sites is based on estimates developed by the Transition and Cost Subteams.
- The amount of equipment to be swapped out and replaced by new equipment is based on estimates developed by the Transition and Cost Subteams.
- The costing of the proposed alternatives will be based upon the projected increases in bandwidth requirements (for which the associated costs will be estimated).

6.1.2 CONUS LINCS Assumptions

- Use continues "as-is" until contract end, March 14, 2002.
- Use phased-out during the three-year extension of LINCS Infrastructure under the assumption that the unit cost of service will increase.
- Transition to another service provider offering a comparable level of service during the 2002-2005 timeframe. LINCS circuits replaced on a one-for-one basis. Newbridge equipment replaced with similar TDMA multiplexing equipment. TDMA equipment will be estimated in suites of TDMA equipment. For example:

  A Sites = Large suites of TDMA equipment suites

  Other A Sites = Medium TDMA equipment suites

  Manned B Sites = Small TDMA equipment suites

- The cost of TDMA multiplexing equipment will be per TDMA mux then multiplied by the number of muxes needed to form the appropriate suite size. The cost per TDMA mux will be an average based on market prices.
- The amount of bandwidth (determined on 1/8), taking growth factors into account, at each site identified by the Transition Subteam will determine the size of the TDMA equipment suite.
- The demarc stays in the same place. All individual circuits will be cut over. Use of the LINCS follow-on service through 2010.

6.1.3 FTS2000/2001 Assumptions

- The FAA will have transitioned all services currently carried on FTS2000 to FTS2001 by the start of the Reference Case Alternative in June 2000.
- The cost of services under FTS2001 will be approximately the same as comparable services under FTS2000. There may be approximately 10% decrease in the cost of FTS 2001 service provided by Sprint.
- The Federal Government will continue to offer "commercial grade" telecommunications services through a vehicle like FTS2001 through 2010.
- DMN assumptions.
- A one-for-one swap-out of existing Codex modems will take place in accordance with the timeline recommended by the Supportability Analysis. All existing DMN modems will be replaced by 2010.

- The Codex 3600 modems will be replaced by Motorola 3460 modems. Additional information regarding this process will be taken from the DMN Supportability Study.
- The replacement cost of the Codex 3600 modems will include a charge factor accounting for installation.
- New requirements will be satisfied by this “next generation” DMN modem/mux starting in June 2000 and continuing through 2010.
- Use of analog lines continues.

6.1.4 ADTN2000 Assumptions

- The network will be sustained through 2010.
- Backbone trunks will be provided by the least cost carrier, i.e., “LINCS follow-on” or FTS2001.
- Nodal equipment will undergo a “Tech Refresh” in FY2000 and FY2005.

6.1.5 NADIN I and II Assumptions

- NADIN I functionality will be subsumed by NADIN II before the start of the Reference Case Alternative in June 2000.
- NADIN II will be sustained through 2010. The upgrade to T1 trunks and the implementation of FR will be completed before the start of the Reference Alternative.
- NADIN II will undergo a “Tech Refresh” in FY2006.

6.1.6 Bandwidth Manager Assumptions

For the Reference Case, it is assumed that the Bandwidth Manager (BWM) network will undergo a one-time technology refreshment in FY04. In contrast, under the ISN and IISN alternatives it is assumed that the services on BWM network will be transitioned to the FTI network and the BWM nodes will be taken out of service.

6.2 Cost Related Benefits

The FTI program is expected to achieve significant cost avoidance over its life cycle. The quantifiable portion of the benefits analysis is derived from the findings of the FTI Cost Subteam. The net cost avoidance projections are calculated by subtracting the ten-year total life cycle cost of a given alternative from that of the Base Case.

Figure 6-1 presents a graphical cost comparison of the three alternatives and the Base Case. The estimated net cost avoidance for each of the alternatives is as follows:

- Reference Case Alternative: $66.1M (PV)
- ISN Alternative: $90.4M (PV)
- IISN Alternative: $398.9M (PV)

All cost avoidance calculations are based on “Most Likely” estimates.

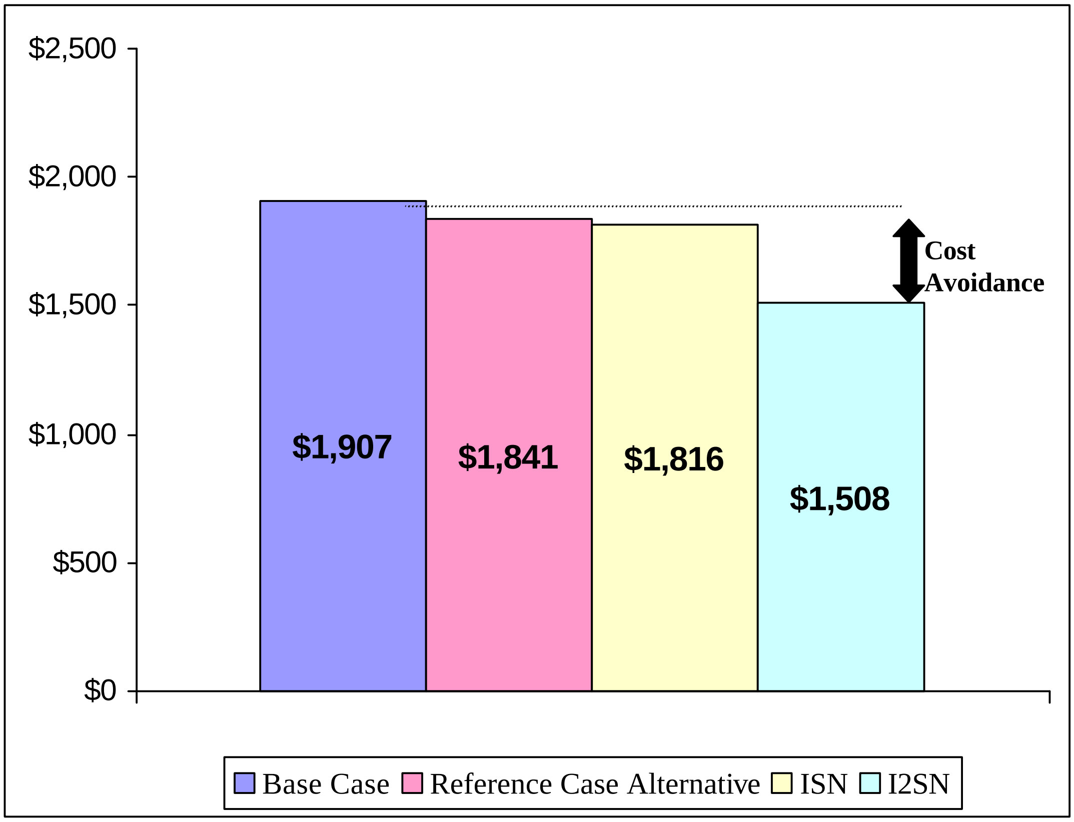

Figure 6-1. Cost Comparison of FTI Alternatives in $M (PV)

Table 6-6 lists the cost differentials between each alternative and the Base Case for each major line item with the APB. The combined totals show that all of the alternatives are projected to have a lower cost than the Base Case over the life cycle.

Table 6-6. Summary of Total Cost Avoidance by APB Line Item

Cost Categories		Reference Case Alternative	ISN	IISN
1.0	Program Management & Engineering	$1.7	($1.9)	($43.4)
2.0	Service Acquisition	$108.2	$66.2	$84.3
3.0	Implementation & Transition	$36.9	$49.6	$50.5
4.0	In-Service Operations & Maintenance	($212.6)	($204.5)	($490.7)
5.0	Asset Disposition	($0.2)	$0.2	$0.4
Combined Totals		**($66.1)**	**($90.4)**	**($398.9)**

Note: () Negative number indicates a cost avoidance subtotal in a given category and combined totals.
(all costs in $ millions PV)

As indicated by the table, there are some APB line items for which the alternatives are actually higher in cost than the Base Case. This reflects the distinction between the Base Case and the alternatives:

Definition of Base Case: The Base Case projects the costs if it were possible to sustain the current contracts, services, and networks indefinitely.
Common Definition of Alternative: The alternatives include the cost to transition from the existing contracts, services, and networks. As a result, there are additional one-time costs, but they are offset by lower recurring costs.

The major sources of cost avoidance associated with the FTI alternatives are achieved in the areas of In-Service Operations & Maintenance and Program Management & Engineering. In fact, the magnitude of the cost avoidance attributable to these areas exceeds the total net cost avoidance because of the additive costs identified above. Attachment 5, Benefits Analysis Report, describes how the alternatives yield the projected cost avoidance in each of these areas.

6.3 Other Benefits

6.3.1 Improved Operations Management

IISN will enhance FAA operations and improve NAS service management through a variety of features and services:

- Positive control and management of SDP-to-SDP telecommunications service,
- Integrated management of switching, multiplexing, routing, and transport services and of operational and administrative networks, and
- Integrated management and delivery of voice, data, and video services.

IISN will provide tools to generate a comprehensive, real-time picture of the overall telecommunications system and service as a natural product of its comprehensive and standards-based network management and control system. The FTI service provider will be required to provide strategic products derived from the above capabilities to FAA organizations that support operations management.

6.3.2 Improved Network Performance

Significant improvements in network performance are likely to be achieved under IISN. The consolidation of operational and administrative networks and the provision of an integrated telecommunications management capability are expected to realize efficiencies through the elimination of “stovepipe” operations and duplicity of effort and resources. Customized network management and monitoring tools will offer substantial degrees of flexibility and control in configuring the delivery of services to end users and managing those services on a real-time basis. Value engineering decisions can be made based on actual performance and usage data. Most user telecommunications service requirements will be met by a hierarchy of service levels and by aggregating bandwidth within the network, rather than provisioning dedicated point-to-point circuits for individual applications. Elimination of full-period dedicated bandwidth and replacement with a bandwidth allocation system for on-demand service will provide major cost savings and match service to requirement. Automated service provisioning, with creation or deletion of services under software control, will speed actual service provisioning and create an opportunity for reduced numbers of service support personnel.

6.3.3 Support NAS Modernization

IISN best supports achievement of fundamental NAS modernization objectives by merging or integrating operational and administrative traffic, consolidating management of current stovepipe transmission systems, and by consolidating multiplexing and data switching functions within an integrated telecommunications infrastructure. This approach is in alignment with the NAS Architecture (Version 4.0) and the FAA Telecommunications Strategic Plan (Version 6.0).

6.3.4 Information Assurance

The great dependence that information technology systems have on operating in an interconnected environment places special emphasis on the security posture of the interconnecting telecommunications infrastructure. FTI is that infrastructure for most NAS and NAS-support systems. As an essential FAA resource, FTI will employ a life cycle approach to assure that this infrastructure is developed and implemented with appropriate protection from internal and external threats. Besides the common security threats that most information technology systems are exposed to, FTI must consider another special category of threat. As the principal interconnection pathway for most NAS systems, FTI can be considered to be a keystone element of the transportation component of the National critical infrastructure. In consideration of Presidential Decision Directive 63 (PDD 63), *The Clinton Administration's Policy on Critical Infrastructure Protection,* FTI also must analyze the threat imposed by possible organized attacks against its role in the National critical infrastructure. Thorough risk analysis and security testing will play important roles in the design, implementation, operations, and maintenance of the system. As part of the security planning and execution for FTI, there are two distinct aspects of information system security that must be addressed. The first aspect is the protection of the resources and operation of the FTI system itself. The second aspect is the protection of the information transported by FTI telecommunications.

With regard to the protection of the FTI system itself, system availability and operational integrity are crucial elements of the system design. Threats and vulnerabilities will be analyzed to select appropriate and cost effective security countermeasures to be implemented within the system. Training, access control, monitoring, audits, and incident response procedures also are considered to be critical elements for the continuous protection of the system. The vulnerability analysis, testing results, as well as security policies and the security plan will be documented to support the Information System Security Certification and Authorization process. As an information system in itself, FTI will be accepted for operation with a known level of residual risk acceptance.

With regard to protection of the information transported by FTI telecommunications, it is an end-to-end, shared effort to provide proper security protection. FTI will provide mechanisms to facilitate the availability, integrity, and confidentiality of transported information; however, it is the responsibility of the FAA systems connected to FTI to consider the threats and vulnerabilities of the telecommunications environment as they make their individual Certification and Authorization decisions. The use of virtual private networks (VPNs) to establish logical separation of the various operational and support systems is a key element of protection while information transits the FTI telecommunications environment. Also, a set of end user connection criteria will be used to maintain standards among all FTI connected systems, and thus help mitigate the risk of a compromise propagating through FTI and other connected systems. As a distinct improvement in security posture above the current state of security, FTI will develop an attack detection and incident response capability that is integrated across the telecommunications infrastructure and integrated with its network management functions. This integrated security management capability is a significant step toward the defense against an organized attack on the air transportation's critical infrastructure as suggested in PDD 63, as well as the increasing sophistication of the network based attacks of experienced hackers.

6.3.5 Improved Customer Service

Based on the IAT market analysis, automated provisioning as a "standard" offering should bring qualitative improvements to ordering, amending, and canceling of services. It is expected that IISN will decrease the average length of time it takes to initiate, process, and implement a telecommunications request. IISN will apply a wider range of standard industry practices and customer service benefits should be manifested as reflected in Attachment 2.

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7.0 RISK ASSESSMENT

This section describes the life cycle risk analysis performed by the FTI Investment Analysis Team (IAT). The analysis employed the "Risk Assessment Guidelines for the Investment Analysis Process" published by ASD-400.

7.1 AMS Guidelines Approach

The Risk Assessment applied five substeps as defined in the guidelines:

7.1.1 Identify Risks

Risks were organized into 11 areas or facets. Although the guidelines suggest only 10 facets, due to the importance of security, the team decided to add it as an eleventh facet. In addition, as explained below, the definitions of several risk facets were slightly modified to reflect FTI's services vs. systems acquisition orientation. Within each facet, applicable goals and plans were identified. Then, risks related to the successful achievement of the plan were identified.

7.1.2 Estimate the Probability of an Adverse Event (Low, Medium, High)

The probability of an adverse event within each facet was estimated. This was accomplished by a series of iterations, leading to a comprehensive review carried out in a meeting of a risk analysis team consisting of the IAT Leader, IAT subteam leads/co-leads, and subject matter experts.

Note: In general, for Steps 2 and 3, where a subteam (e.g., Alternatives), had performed a risk analysis, the results of their analysis was used as a starting point by the Risk Analysis Subteam.

7.1.3 Estimate the Potential Severity of The Impact (Minor, Moderate, Substantial)

Table 4, "Estimating the Probability of an Adverse Impact" in the Risk Assessment Guidelines was applied to estimate the potential severity of impact of each adverse event.

7.1.4 Assign a Risk Facet Rating

Table 7, "Risk Facet Rating Score Assignments" in the Risk Assessment Guidelines was applied to develop an overall Facet Risk Rating Score for each facet. This score reflects the combined effect of the probability of occurrence and impact severity.

7.1.5 Calculate the Overall Alternative Risk Rating

In the final step, a weight was assigned to each facet based on the team's perception of the relevance of the facet in determining each alternative's overall risk. Using these weights, a weighted average of the eleven risk facets was calculated for each alternative. This average served as the basis for comparing the overall risk associated with each alternative.

7.2 Definitions

7.2.1 Risk

For the purpose of the analysis, in general, risk is defined as the probably of an undesirable event occurring combined with the consequences of the occurrence. In the context of the analysis, risk is the probability that an alternative will fail to deliver the benefits projected for that alternative, either in whole or in part, and the consequences of this failure. However, Risk (benefit estimate) and Risk (cost estimate) represent two special cases. They address the accuracy of the benefit and cost estimates, which are influenced by elements such as inadequate methods and/or data to estimate benefits and costs.

7.2.2 Risk Facets

The Risk Assessment Guidelines provide a system acquisition focus. In order to address more accurately FTI risks, several definitions were expanded or modified as shown in Table 7-1.

7.3 FTI Risk Analysis

7.3.1 Step 1 - Identify Risks

As shown in Table 7-2, a Top-Level Risk Matrix covering both alternatives was developed. The matrix identifies the important goals, plans for achieving the goals, and associated risks for each risk facet as defined above.

7.3.2 Step 2 - Estimate the Probability of an Adverse Event

A team consisting of the IA subteam co-leaders and selected subject matter experts was convened to assess the probability of an adverse event for each facet for each alternative. The probability of an adverse event was developed by assessing the consolidated impact of the risks identified within each facet as defined in Table 7-2. To the extent it applied, Table 4 in the Risk Assessment Guidelines, “Estimating the Probability of an Adverse Event,” was used as the basis for assigning probabilities. The results for the Reference Case Alternative and each alternative are shown in Column 2 of Tables 7-5 through 7-7. For scores other than Medium, a brief justification has been included in the table.

7.3.3 Step 3 – Estimate the Severity of Impact of an Adverse Event

After completion of Step 2, the team estimated the severity of impact of an adverse event. A severity assessment of Substantial, Moderate, or Minor was assigned using Table 5 “Estimating the Severity of an Adverse Event” in the guidelines document. The results are shown in Column 3 in Tables 7-5 through 7-7. The rationale for each Substantial rating is provided.

Table 7-1. FTI Risk Facet Definitions

Risk Facet	FTI Specific Definition
Technical	The risk associated with developing a new or extending an existing technology to provide a greater level of capability, performance, or capacity. It includes the risk that the implemented technology will not meet user needs at some point in the future.
Operability	The risk associated with operating within the NAS environment, including compatibility with planned NAS programs, and risk associated with supporting the AF Concept of Operations.
Producibility	The risk associated with the vendor's ability to field COTS equipment and services that meet the FAA's telecommunications needs, when and where they are required to be met. The risk that COTS equipment may not be compatible with the physical elements of FAA facilities.
Supportability	The risks associated with the vendor's ability to field and logistically support the FTI infrastructure. This includes the need for effective interaction with the FAA support organizations.
Benefit Estimate	No change from the guidelines. This risk focuses on the accuracy of the benefit estimate.
Cost Estimate	No change from the guidelines. This risk focuses on the accuracy of the cost estimate.
Schedule	No change from the guidelines.
Management	Management risk consists of three elements: the risk associated with managing the program itself, as it progresses through each of its life cycle phases; the risk associated with having adequate management resources and effective organizational structures in place; and the risk associated with in-service management of the future telecommunications infrastructure.

Table 7-1. FTI Risk Facet Definitions, Cont.

Risk Facet	FTI Specific Definition
Funding	Funding addresses the risk that adequate funding will be available throughout the program life cycle. Both F&E and Ops funding must be addressed. Assessment of this facet requires that affordability during both the implementation phase and in-service management phases be addressed since they employ funding from different appropriations.
Stakeholder	This facet addresses the risk of inadequate support from stakeholders, including Congress, FAA Lines of Business, Regions and Centers, and unions.
Security	Security addresses the risk that information will be compromised or services denied.

Table 7-2. Top-Level Risk Matrix

Goal	Plan	Risk
Risk Facet- Technology		
Avoid unproven technology with high development costs.	Use state-of-the-art hardware and proven concepts that are compatible with evolving communications technologies as the basis of design.	• Design relies on currently unavailable or unproved technology leading to unanticipated implementation or interface problems. • Required capabilities may not be available when and where needed. • COTS equipment and commercial services may need tailoring or modification.
Minimize the effects of unstable and immature requirements on design alternatives; minimize effect of uncertainty in communications technology trends.	Use representative technologies for cost estimating purposes; avoid technology specific solutions; emphasize lease rather than own.	• Selection of a preferred technology at this time may be premature and lead to overly complex design, early obsolescence, and higher costs. • Unidentified internal interfaces may not be easily met.
Support current and future user interfaces and services; support international users.	Use open system interfaces and industry accepted communications standards to the maximum possible extent.	• Complex legacy requirements may be incomplete or incorrectly specified. • New services cannot be easily accommodated.
Meet anticipated NAS capability requirements to support future concepts of operations.	Align communications networks and services to be as efficient, flexible, and cost effective as possible; simplify infrastructure and user access mechanisms; enable incremental expansion and growth.	Unable to support NAS architecture; inflexible design and inefficient use of communications resources limit services and growth.
Achieve a network that effectively integrates services, procedures, and technology.	Insure bidders provide a plan and design that ensures compatibility between network levels, effective cooperation between service supplies including local exchange carriers, Regional Bell Operating Companies, and Interexchange Carriers.	• Technical incompatibilities between equipment and service providers. • Lack of vendor team member cooperation. • Underestimate of complexity of the required network.
Facilitate incremental network element and technology replacement.	Provide an infrastructure that minimizes the complexity of future transition and the insertion of new technologies.	• Replacement of FTI will become increasingly complicated with the addition of services and users. • Migration to improved technologies takes longer, costs more, and has a greater impact on users.

Table 7-2. Top-Level Risk Matrix, Cont.

Risk Facet - Operability		
Meet NAS Architecture requirements and support system dependencies identified in the NAS Architecture.	• Periodically evaluate program plan against the NAS Architecture requirements. • Update/correct program plan and schedule to respond to NAS Architecture changes.	• Operational incompatibility with future NAS and mission support systems. • Inadequate resources necessary to support required changes.
Support the AF Concept of Operations	• Develop the FTI Concept of Operations in close coordination with AF planners. • Ensure that the system specification includes requirements for NIMS/RMMS interfaces and data sharing.	Insufficiently defined concept of operations and related requirements.
Facilitate network management, operation, provisioning, and optimization.	Increase visibility into network utilization; improve monitoring of end-to-end service and network segments; shift management focus from circuits and devices to performance and services.	• Increased time for fault detection, isolation, and overall restoral. • Difficulty matching requirements with billing and difficulty identifying configuration errors. • Inability to continuously assess and re-arrange services as requirements change to avoid paying for what the FAA no longer needs.
• Ensure a smooth introduction of capability, with minimal operational impact. • Minimize impact on operational procedures.	• Ensure the Integrated Program Plan, Acquisition Approach, and specifications are developed by the extended TIPT with inputs from AT and AF. • Identify and minimize areas of potential impact.	Increased more complex FAA user workload.
Risk Facet – Producibility		
Ensure installed equipment is compatible with FAA facilities (floor space, power, etc.).	• Ensure the Integrated Program Plan, Acquisition Approach, and specifications are developed by the extended TIPT with inputs from AT, AF, Regions, and Centers. • Require site surveys and information validation steps in the contractor's planning phase.	• Deficient technical data requirements package, inadequate configuration management. • COTS equipment requires modification to meet FAA facility specifications. • Integrate access and transport. • Vendor/FAA inability to meet and/or coordinate scheduled events in a timely manner.

Table 7-2. Top-Level Risk Matrix, Cont.

Risk Facet - Supportability		
Ensure supportability of all elements of the telecommunications infrastructure.	• Replace systems based on life cycle cost analysis and supportability assessment. • Ensure the FTI contract and networks are sufficiently flexible and expandable to allow replacement of unsupportable systems and services.	• Lack of resources limit the phase out of unsupportable systems. • FTI network limitations preclude absorbing the functions of legacy systems. • FTI O&M concept not fully responsive to FAA supportability needs.
Minimize implementation and support impact on the AF processes.	• Ensure the Integrated Program Plan, Acquisition Approach and specifications are developed by the extended TIPT with inputs from AT, AF, Regions, and Centers. • Ensure effective and complete AF coordination on all documents. • Define approaches, process, and responsibilities, that minimize the use of AF resources.	• Conflicts between FTI O&M plan and AF and regional procedures. • Unclear rules and procedures used as a baseline for defining supportability requirements.
Improve in-service management efficiencies	• SIR will require the use of automated tools for service provisioning, status tracking, and billing. • Tools will provide FAA-wide access. Include metrics and incentives for high quality in-service management in the contract.	• Unidentified or incomplete requirements. • Deficient technical information. • Inability of COTS products and services to meet FAA requirements. • Lack of metrics and low vendor commitment to quality support.
Risk Facet - Benefit Estimate		
Provide the FAA with comprehensive, and accurate benefit estimates.	• Identify and thoroughly assess tangible and intangible benefits. • Quantify future benefits based on accurate projection of utilization, trends, etc. • Include impact of improved business practices in overall estimate.	• Not all benefits are quantifiable. • Difficult to estimate benefits. • Implementation may not provide full benefits.
Risk Facet Cost Estimate		
Provide the FAA with comprehensive, realistic estimates supporting an executable program.	• Project utilization rates and technology trends that will affect costs. • Develop cost models and cost projections based on industry inputs.	• BOE is incomplete or inaccurate. • Inaccurate assumptions. • Inaccurate service pricing projections.

Table 7-2. Top-Level Risk Matrix, Cont.

Risk Facet - Schedule		
Transition to new contract with no disruption in critical services.	Use a sole source "bridge" contract to extend the expiration date of LINCS by three years, complete transition to the new network prior to expiration of the bridge contract.	• Affordable rates cannot be negotiated. • Lack of funds to award the bridge and FTI contracts. • Too many parallel tasks. • Inadequate FAA and contractor resources.
Incrementally replace legacy telecommunications systems with new FTI services.	Implement a phased approach with the first focus on LINCS and ADTN replacement. Replace other services/systems based on business case considerations. Ensure F&E funding is available to support an aggressive transition schedule. Apply a worse case approach to define the transition schedule and associated funding requirements.	• Lack of funds to support initial and incremental system replacements. • Facility limitations related to space, power, etc.
Meet NAS Architecture schedule interdependencies.	Install core capability with sufficient flexibility and scalability to meet future requirements per the NAS Architecture.	• Capabilities are not available when required due to schedule delays. • Adequate funding is not available to provide necessary capabilities, when and where the capabilities are required.
Award an initial contract in FY00.	• Begin acquisition-planning activities in parallel with the IA. • Provide resources within the TIPT required to ensure an aggressive acquisition schedule can be met.	• Schedule slips due to inadequate resources or priorities. • Document development and review process requires excessive time and resources.

Table 7-2. Top-Level Risk Matrix, Cont.

Risk Facet - Management		
Provide the program planning, resources, and controls needed to achieve the requirements of the APB.	• Establish an FTI planning/product team within the TIPT to manage all planning acquisition related activities. • Implement and maintain a program office operating as an integrated element of the TIPT. • Budget for, obtain, and apply the resources necessary to support the program.	• Inadequate program plans. • Deficient risk management plans. • Inadequate management approach. • Unsubstantiated manpower requirements. • Unsubstantiated personnel skills. • Inadequate authority. • Excessive span of control. • Undefined responsibilities. • Undefined integration responsibilities. • Ambiguous organizational interfaces. • Inadequate program office staffing. • Inadequate resource allocation. • Tenuous top management support. • Uncertainties in procurement. • Large number of substantial tasks to manage. • Undefined key metrics. • Uncontrolled requirements change. • Inadequate tracking systems.
Risk Facet – Funding		
Obtain internal and external (vendor financed) funding as required to execute the program. This includes both F&E and Ops funding.	• Work with SEOAT to ensure adequate F&E resources are budgeted. • Fund National program support out of Leased Communications Budget. • Pursue parallel F&E and Ops funding. Evaluate down stream trade-offs between F&E and Ops funding to improve affordability.	• Program affordability. • Unfavorable priorities. • Unrealistic funding profile. • Funds are not available when required to support implementation and transition schedules. • Insufficient operations funding to support operational phase.
Support incremental capability implementation within annual F&E and Ops budget cycle.	• Employ creative financing approach to spread costs over multiple years. • Schedule implementation, transition activities in accordance with available funding.	• Constraints on financing flexibility, length of contract, etc. • LINCS phase out and other schedule drivers limit scheduling flexibility. • Funding is not adequate to support acceptable schedule. • Unfavorable terms of finance. • Unforeseen requirements not accounted for in original funding.

Table 7-2. Top-Level Risk Matrix, Cont.

Risk Facet - Stakeholders		
Establish solid internal and external stakeholder support for required capabilities and resources.	• Initiate early involvement of AT, AF, user, regional stakeholders, industry, and Congress. • Obtain extensive internal FAA and industry feedback as the program evolves. • Develop effective communications paths with all stakeholders.	• Lack of Congressional support. • Conflicting FAA internal priorities for scarce resources. • Diverse user community with conflicting priorities. • Reluctance to introduce new processes and technology which impact the workforce.
Risk Facet - Security		
Ensure the telecommunications network provides required levels of security and security functions in accordance with FAA Order 1600.54, "FAA automated Information Systems Security Handbook."	• Maintain and apply a security risk assessment and security plan. • Complete a sensitivity application certification and certificate of accreditation in accordance with FAA Order 1600.54, "FAA automated Information Systems Security Handbook."	• Security requirements not well understood, and continually evolving as the threat evolves. • Vendors and COTS services security limitations. • Inadequate resources to fund and support a comprehensive security program.

7.3.4 Step 4 - Assign a Risk Facet Rating

A risk facet rating reflecting the combined effect of the probability of an event and the severity of impact was assigned using the Table 7 in the Guidelines, as reproduced below in Table 7-3.

Table 7-3. Risk Facet Rating Score Assignment

	Severity of Impact of an Adverse Event		
Probability of an Adverse Event	**Substantial**	**Moderate**	**Minor**
High	10	8	5
Medium	8	5	2
Low	5	2	0

The risk Facet Rating is shown in Column 4 of Tables 7-5 through 7-7.

7.3.5 Step 5 - Calculate the Overall Alternative Risk Rating

As a final step, the overall risk ranking for each alternative was calculated using a "weighted average" of the facet risk ratings. As shown in Table 7-4, the facets were assigned to one of three major risk areas, Design, Implementation, and Operation. The total risk was apportioned among the three areas as shown on line two of Table 7-4. The weight assigned to each facet was calculated by dividing the risk area weight by the number of facets assigned to that area.

Table 7-4. Weighting Based on Facet Significance

Risk Area	Design Risk	Implementation Risk	Operation Risk
Area Weight	20%	50%	30%
Facets	Technical Producibility Security	Schedule Management Funding Stakeholders	Operability Supportability Benefits Estimate Costs Estimate
Facet Weight	6.67% (20/3)	12.5% (50/4)	7.5% (30/5)

The facet weights are shown in Column 5 of Tables 7-5 through 7-7. The weighted facet score was then calculated by multiplying the Facet Risk Rating by the Facet Weighting. The weighted Facet Scores were then added to produce the Overall Weighted Alternative Risk Score shown for each alternative.

Table 7-5. Reference Case Alternative Overall Weighted Risk Score

Facet	Probability of an Adverse Event	Severity of Impact of an Adverse Event	Facet Risk Rating (0-10)	Facet Weighting Factor (0-1)	Weighted Facet Score
Technical	High Analog-based technology will not be supported by industry, and limit ability to meet new requirements.	Substantial Performance and expandability limited by obsolete technology. Difficult or impossible to meet future NAS program requirements.	10	.067	.67
Operability	High Unintegrated systems can not be effectively managed future interface requirement can not be met.	Moderate	8	.075	.60
Producibility	High Continued availability of analog-based COTS equipment and services is problematic.	Minor	5	.067	.34
Supportability	High Long-term supportability of analog-based systems such as DMN is doubtful.	Moderate	8	.075	.6
Benefit Estimate	Low Benefits were not calculated for the Reference Alternative.	Minor	0	.075	.0
Cost Estimate	Medium	Minor	2	.075	.15
Schedule	Low The alternative is limited in scope, essentially calling for the replacement of LINCS with a similar capability. A conservative schedule has been defined; increasing the probability it will be met.	Moderate	2	.125	.25
Management	Medium	Moderate	5	.125	.63
Funding	High F&E and Ops funding limitations will continue. FAA priorities will severely limit the telecommunications budget. New program driven costs will continue to pressure telecommunications resources. Technology will limit telecommunications unit cost reductions resulting in potential cost growth.	Moderate Potential for substantial impact on the Ops budget due to cost growth in meeting new capability and capacity requirements.	8	.125	1.0

Table 7-5. Reference Case Alternative Overall Weighted Risk Score, Cont.

Stakeholder	Low Essentially a continuation of current capabilities, with little impact on stakeholders.	Minor	0	.125	.0
Security	Medium	Substantial Any security breach can potentially impact air traffic safety.	8	.067	.54
Overall Weighted Alternative Risk Score					**4.77**

Table 7-6. ISN Overall Weighted Risk Score

Facet	Probability of an Adverse Event	Severity of Impact of an Adverse Event	Facet Risk Rating (0-10)	Facet Weighting Factor (0-1)	Weighted Facet Score
Technical	Medium	Substantial Technology may limit ability to replace or upgrade legacy interfaces (e.g., operational voice) and meet new requirements.	8	.067	.54
Operability	High	Moderate	8	.075	.60
Producibility	Medium	Moderate	5	.067	.34
Supportability	High	Moderate	8	.075	.60
Benefit Estimate	Medium	Moderate	5	.075	.38
Cost Estimate	Medium	Moderate	5	.075	.38
Schedule	Medium	Moderate	5	.125	.63
Management	Medium	Moderate	5	.125	.63
Funding	High F&E and Ops funding limitations will continue. FAA priorities will severely limit the telecommunications budget. New program driven costs will continue to pressure telecommunications resources. Technology will limit telecommunications unit cost reductions. Transition uncertainties could drive increased F&E funding requirements.	Substantial Transition related F&E funding hump might not be affordable.	10	.125	1.25
Stakeholder	Medium	Minor	2	.125	.25
Security	Medium	Substantial Any security breach can potentially impact air traffic safety.	8	.067	.54
Overall Weighted Alternative Risk Score					**6.111**

Table 7-7. IISN Overall Weighted Risk Score

Facet	Probability of an Adverse Event	Severity of Impact of an Adverse Event	Facet Risk Rating (0-10) From Table 5-	Facet Weighting Factor (0-1)	Weighted Facet Score
Technical	Medium	Moderate	5	.067	.34
Operability	Medium	Moderate	5	.075	.38
Producibility	Medium	Moderate	5	.067	.34
Supportability	Medium	Moderate	5	.075	.38
Benefit Estimate	Medium	Moderate	8	.075	.60
Cost Estimate	Medium	Moderate	5	.075	.38
Schedule	Medium	Moderate	5	.125	.63
Management	Medium	Moderate	5	.125	.63
Funding	High F&E and Ops funding limitations will continue. FAA priorities will severely limit the telecommunications budget. New program driven costs will continue to pressure telecommunications resources. Technology will limit telecommunications unit cost reductions. Transition uncertainties could drive increased F&E funding requirements.	Substantial Transition related F&E funding hump might not be affordable.	10	.125	1.25
Stakeholder	Medium	Moderate	5	.125	.63
Security	Medium	Substantial Any security breach can potentially impact air traffic safety.	8	.067	.54
Overall Weighted Alternative Risk Score					**6.06**

7.4 Summary

Table 7-9 and Figure 7-1 summarizes the weighted facet scores and the overall risk rating for each alternative. The risk rating was assigned based on the criteria provided in the Risk Assessment Guidelines as reproduced in Table 7-8.

Table 7-8. Overall Alternative Risk Rating Guidance

Numeric Range	Overall Rating
7.0 – 10	High
3.0 – 6.99	Medium
0 – 2.99	Low

As Figure 7-1 shows, the Reference Case Alternative and two alternatives have significant differences at the facet level. However, the overall score for each falls into the medium risk area (3.0 – 6.99). Highlighting the principal areas of risk and respective mitigation approaches, in addition to the numeric scoring, is useful to focus on the actual discriminators among the Reference Case Alternative and the two alternatives.

Table 7-9. Risk Rating of Alternatives

Facet	Reference Alternative Scores	ISN Scores	IISN Scores
Technical	0.67	0.54	0.34
Operability	0.60	0.60	0.38
Producibility	0.34	0.34	0.34
Supportability	0.60	0.60	0.38
Benefit Estimate	0.00	0.38	0.60
Cost Estimate	0.15	0.38	0.38
Schedule	0.25	0.63	0.63
Management	0.63	0.63	0.63
Funding	1.00	1.25	1.25
Stakeholder	0.00	0.25	0.63
Security	0.54	0.54	0.54
Overall Weighted Risk Score	**4.77**	**6.11**	**6.06**
Overall Risk Rating	**Medium**	**Medium**	**Medium**

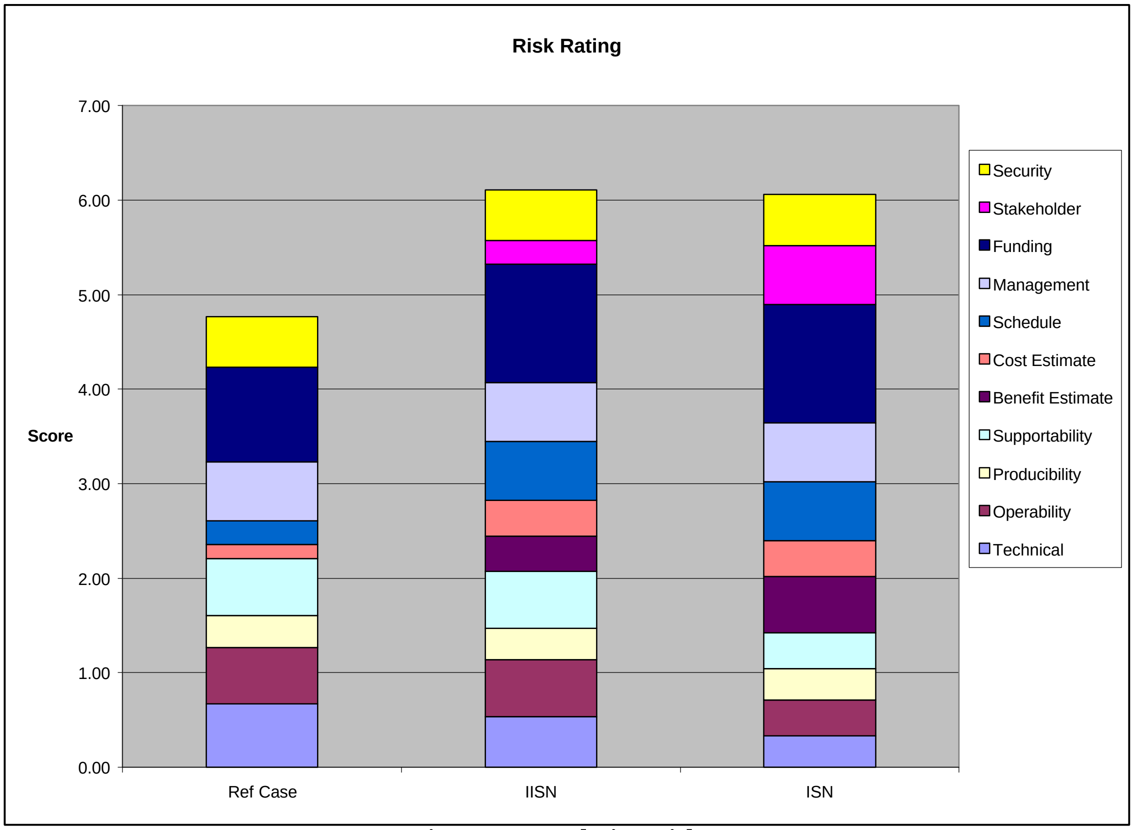

Figure 7-1. Relative Risks

7.4.1 Technical Risks

The basic telecommunications requirements cited in the FTI Requirements Document can be met with technology currently in use in the telecommunications marketplace. Requirements will likely be satisfied with a mixture of TDM, FR, ATM, and IP Routing. This technology is widely deployed and available from multiple carrier providers. There are no requirements that would force technology beyond state-of-the-art solutions. Legacy interfaces will pose an engineering problem but not a technology problem. Availability requirements of .99999 for designated connections or sites require end-to-end, diverse paths; the "last mile" is typically the major problem. These diversity problems exist equally among the alternatives.

- **Reference Case Alternative** - The risk to implement in the near-term is not high insofar as the assumption is that the technology is equivalent to that deployed today. The risk rating found in Table 7-9 reflects the risk that the current inflexible architecture will not offer sufficient flexibility to support future NAS programming requirements.
- **ISN** - Employs service offerings for LINCS replacement only, expanded to a broader number of FAA facilities. The fact that ISN offers only a limited IP service to users is the principal rationale contributing to the rated score.
- **IISN** - Employs service offerings for LINCS, ADTN, BWM, DMN, and NADIN replacement. Additionally, the alternative integrates, where practicable, operational and administrative traffic.

7.4.2 Operability

Many features of modern telecommunications networks will likely require ATC approval for use in an operational environment. The IA assumed toll quality voice compression, but other features such as Voice over IP can provide even more efficiencies. These features provide the flexibility to more cost efficiently meet the diverse requirements and can be introduced over time as their respective capability is validated against existing requirements.

- **Reference Case Alternative** - Inflexible set of service offerings. Requirement can be met utilizing cost inefficient allocation of dedicated circuits.
- **ISN** - Employs bandwidth aggregation for transport, commensurate with LINCS replacement. Negotiation and implementation of service offerings, matched to requirements, is required.
- **IISN** - Employs bandwidth aggregation for transport, commensurate with LINCS replacement, and achieves efficiencies through consolidation of operations and administrative traffic and stovepipe organizations managing CPE programs. Negotiation and implementation of service offerings, matched to requirements, is required.

7.4.3 Schedule

Replacement of the LINCS network is the highest priority since it carries critical circuits in the NAS, while providing transport for other networks. It is a leased capability with assets owned solely by the supplier. Because of the nature of the contract, circuit transition cannot begin until four months prior to the contract end date (March 2002). Detailed analysis indicates three years may be needed to complete the transition.

- **Reference Case Alternative** - Anticipates funded upgrade to existing leased assets at those locations where LINCS backbone assets currently exist. Additionally, requires technical refresh of existing CPE over time.
- **ISN** - Extensive visits to almost 800 sites for IAD installation and certification, requiring three years to implement, for LINCS replacement only
- **IISN** - Extensive visits to almost 800 sites for IAD installation and certification requiring three years to implement, while beginning to integrate other appropriate program functionality requirements.

7.4.4 Supportability

Various networks and systems are reaching the end of their useful service lives, while other networks and systems are sustainable into the 2005-2007 timeframe and more appropriate for further business case analyses and investment decisions at that time.

- **Reference Case Alternative** - Relies on the sustainability of legacy equipment. Presents significant risk for long-term.

- **ISN** - To a lesser extent than the Reference Alternative, relies heavily on the sustainability of legacy equipment
- **IISN** - Phases out FAA CPE by 2006-2007.

7.4.5 Funding

The F&E requirement for network establishment and transition is approximately the same for each of the alternatives under consideration. Accordingly, the risk associated with the accuracy of the estimates was evaluated as roughly equivalent. When the major elements of the funding stream are examined, two categories of risk emerge. The "contract" cost for network establishment and the cost to the FAA to support regional network establishment and transition activities. The contract costs were conservatively derived assuming no creative financing or other financial approaches often found under service contracting vehicles. Accordingly, the baseline fully funds the work.

The required regional activities follow a rigorous model not unlike that used under the LINCS transition. Accordingly, based on the assumptions of the work required, the estimates are tracked to real experience. The slight increase of evaluated risk for ISN and IISN is a reflection of the additional deployment/transition activity under those alternatives as compared to the Reference Alternative. However, the IAT made an assumption that legacy distant-end circuit monitoring equipment would not be replaced, but would remain in place and become part of the FTI network. This assumption eliminates the need to replace (at least during the first phase of transition) equipment at over 3,000 remote facilities. The risk analysis that is documented in Table 7-2 (and subsequent analytical Tables) did not include the risk associated with this assumption. Should this assumption not be valid, a longer period of time would be required to accomplish the transition. The F&E Baseline would also require additional F&E funds in 2004 through 2006.

7.4.6 Cost Estimate

The same offered load and growth assumptions were used to calculate the estimated cost of each of the alternatives under consideration. Accordingly, the alternatives are distinguished by assessments of the degree to which bandwidth can be optimized, the corresponding access costs, and the costs associated with cost avoidance resulting from the elimination of FAA CPE management and operations.

7.4.7 Benefit Estimate

The benefit assessment falls into two general categories: 1) benefits quantified and yielding cost avoidance, and 2) qualitative benefits that could yield efficiencies and lower costs were the potential benefits effectively exploited. The risks associated with quantifiable benefits surface most prominently under IISN. Of these, there are two general categories: 1) benefits associated with purchasing bandwidth at greater bundled levels, and 2) benefits associated with the incremental elimination of FAA managed sub-networks. In each of these general categories, the cost avoidance benefit would be delayed if the modeled activities under IISN do not occur at the rate modeled under the analysis. Delays in IISN execution would cause marginal increases in the projected costs in the direction of the ISN cost projections.

- **Reference Case Alternative** - No quantifiable benefits recorded.
- **ISN** - Quantifiable benefits in bandwidth aggregation within operational domain.
- **IISN** - Quantifiable benefits in bandwidth aggregation across operational and administrative domains. Additional benefits captured as "stovepipe" sub-networks are eliminated.

7.4.8 Producibility

The Reference Case Alternative is at increased risk since it relies on the sustainability of the legacy systems and technology refresh. The continued availability of these analog-based COTS systems cannot be assured as time goes on.

7.4.9 Management

The management of the Reference Case Alternative represents "business as usual" initially, but becomes more difficult with time and the lack of systems integration makes it increasingly difficult to satisfy NAS architecture requirements. The other two alternatives present a management challenge at the outset, but become increasingly more manageable as state-of-the-art tools are put in place.

7.4.10 Stakeholder

Stakeholders may balk at the up-front F&E price tag for the IISN Alternative. However, they need to balance that with the long-term affordability of the other options.

7.4.11 Security

It will be an expensive undertaking to implement security. However, incorporating it into the IISN Alternative will be more straightforward than retrofitting it into the Reference Alternative.

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8.0 AFFORDABILITY ASSESSMENT

The following table shows the F&E funding profiles associated with FTI. Funding was requested in the FY 2000 budget submission to cover activities to initiate the program such as source selection and initial planning, testing, and surveys. Both Senate and House committees approved FY 2000 funding as requested. Therefore, the conference is expected to fully fund this activity. The funding shown for 2001 has been submitted to OST as part of the budget submission.

All figures are millions in then-year dollars.

Table 8-1. Affordability Assessment

	2000	2001	2002	2003	2004	2005	2006+	EAC
IA profile	6.1	29.2	38.7	51.5	52.2	25.1	2.8	205.6

Based on the critical operational need and the priority of the program, the SEOAT has determined this program to be affordable for F&E and has allocated required funding within current OMB targets.

The estimated costs for Operations and Maintenance (O&M) show a marginal increase in costs for FY 01 and 02 during the transition period. Savings are expected to be realized starting in 2003 and OPS funding requirements will decline dramatically thereafter. The small increase in 2001 has been determined to be covered within the current budget request. The increase in 2002 will be submitted as part of the 2002 handoff process. Contract award in anticipated in December of 2000 and F&E and OPS funding requirements will reexamined at that time.

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9.0 DECISION CRITERIA

9.1 Criterion Definition

The IAT utilized standard decision criteria to assess and select among the FTI alternatives. The IAT utilized the criteria established for the subteam analyses feeding each respective category, e.g., Risk Analysis Subteam results are reflected in the Risk Category, as the sub-categories for that category. The weightings for both the sub-categories and the categories were established using a Delphi Technique applied over two sessions, comprised of key members of the IAT. Table 9-1 presents the breakout of the criteria categories and sub-categories, as well as the results of the respective analyses.

9.1.1 Risk

The Risk Category is defined as the risk resulting from uncertainty. The risk rating was assigned based on the criteria provided in the Risk Assessment Guidelines as reproduced in Table 7-5, Section 7. Table 7-9 and Figure 7-1 in Section 7.4 summarizes the weighted facet scores and the overall risk rating for each alternative. As Figure 7-1 shows, the Reference Case Alternative and two alternatives have significant differences at the facet level. However, the overall score for each falls into the medium risk area (3.0 – 6.99). A sensitivity analysis of the weights assigned to the risk areas determined that (1) the relative risk of the Reference Case Alternative with respect to Alternatives 1 and 2 is insensitive to the assigned weightings, whereas (2) the relative risks of Alternatives 1 and 2 with respect to each other are sensitive to the assigned weightings, based upon the proximity of the cross over points and the shallow slopes of the lines and, therefore, the alternatives are indistinguishable with regard to total risk. Risk mitigation approaches for the preferred alternative are discussed in Section 9.4 below.

9.1.2 Return on Investment

The Return on Investment Category is defined as the value of the project in dollarized economic terms.

9.1.3 Mission Effectiveness

The Mission Effectiveness Category is defined as the impact of the project in improving mission performance for internal and external customers. The Mission Effectiveness rating was assigned based upon evaluation criteria developed from the FTI Requirements Document. A quantitative rating system (see Table 4-1, Section 4) was used to keep scoring uniform across all criteria. The Architecture Analysis Subteam evaluated each alternative and arrived at scores presented in Table 4-2 through discussion and consensus. The results of the analysis are summarized in Table 9-1.

Table 9-1. FTI Decision Criteria

Category	Sub-category	Reference Case	ISN	IISN
Risk- The risk resulting from uncertainty. Lower value is better. (25%)	• Design Risk (20%) Technical Risk Producibility Risk Security Risk • Operational Risk (30%) Operability Risk Supportability Risk Benefit Estimate Risk Cost Estimate Risk • Implementation Risk (50%) Schedule Risk Management Risk Funding Risk Stakeholder Risk	4.77	6.11	6.06
Return on Investment – The value of the project in dollarized economic terms. (37.5%)	• LCC (40%) • HC Value • Net Present Value (NPV) • HC Value • Affordability (40%) F&E • Operational Cash Flow • Benefits (20%) • Benefit/Cost Ratio • HC Value ROI Cost Avoidance	$2,268-2,414M $2,366M $(374)-293M $(127)M (0.29)-2.69 0.55	$2,264-2,495M $2,349M $(66)-110M $(20)M 0.6-1.7 0.9	$1,809-2,023M $1947M $349-504M $391M 2.4-3.4 2.6
Mission Effectiveness – The impact of the project in improving mission performance for internal or external customers. Higher value is better. (25%)	• Interface (10%) • Service (10%) • Availability (20%) • Performance (20%) • Integration (10%) • Network Management (10%) • Security (20%)	33.75	38.43	44.87
Strategic Alignment – The extent to which the proposed investment supports strategic organizational objectives. (12.5%)	• NAS Architecture (50%) • Business Processes/ Redesign (50%)	0.44	0.76	0.94

9.1.4 Strategic Alignment

An assessment was made to determine how well each alternative supported strategic goals identified in the *White House Commission on Aviation Safety and Security* report (February 1997), the *National Airspace System Architecture Version 4.0* (January 1999) and the *FAA Telecommunications Strategic Plan* (January 1997). Two additional documents, *A Concept of Operations for the NAS in 2005* (developed by ATS) and *Government/Industry Concept of Operations* (developed jointly by RTCA and the FAA), are incorporated by reference within the *National Airspace System Architecture Version 4.0*. Table 9-2 summarizes telecommunications strategic objectives set forth in these documents.

Table 9-2 Strategic Telecommunications Objectives

Goal	Reference
Provide all NAS users with fully integrated, seamless, high quality telecommunications services.	• *NAS Architecture Version 4.0* • *FAA Telecomm. Strategic Plan*
Provide information sharing among all NAS users for increased situational awareness and enhanced collaborative decision making.	• *NAS Architecture Version 4.0*
Provide a digital telecommunications infra-structure to meet rapidly evolving require-ments and changing technology.	• *NAS Architecture Version 4.0*
Meet unprecedented aviation industry growth projections for the next 10-15 years.	• *NAS Architecture Version 4.0* • *FAA Telecomm. Strategic Plan*
Provide security mechanisms to protect the NAS from information-based and other disruptions, intrusions, and attack.	• *White House Commission Report* • *NAS Architecture Version 4.0* • *FAA Telecomm. Strategic Plan*
Provide cost efficient and timely telecommu-nications services.	• *NAS Architecture Version 4.0* • *FAA Telecomm. Strategic Plan*
Support organizational and business process redesign; develop innovative means to finance rapid modernization.	• *White House Commission Report* • *FAA Telecomm. Strategic Plan*
Provide comprehensive real-time and non-real-time management information for operation, maintenance, configuration management, planning, and accounting.	• *NAS Architecture Version 4.0* • *FAA Telecomm. Strategic Plan*
Accelerate NAS modernization and be fully operational by 2005.	• *White House Commission Report*
Use performance-based contracting practices	• OMB and Congressional guidance • *FAA Cost Accounting System*

Strategic goals were assessed using the quantitative rating system shown in Table 9-3. Ratings were assigned to each alternative for each objective based on the cost or degree of difficulty to achieve the goal. Summary comments explaining the ratings are provided in Table 9-4.

Table 9-3. Rating System for Strategic Alignment Objectives

Rating	Description
1	Does not meet objective; significant cost impact or design changes needed to meet objective.
3	Partially meets objective, moderate cost, or design changes to fully meet objective.
5	Meets objective with negligible cost or design impact.

Table 9-4. Ability of Alternatives to Meet Strategic Objectives

Objective	Reference	ISN	IISN
Provide all NAS users with fully integrated, seamless, high quality telecommunications services.	Little integration of networks and traffic. 2	Integrated but some traffic is kept separate. 4	Full integration of networks and traffic. 5
Provide information sharing among all NAS users for increased situational awareness and enhanced collaborative decision making.	Use of unique protocols and separate networks impedes sharing. 2	Segregation of some operations traffic impedes information sharing. 3	Integration of networks and use of digital standards facilitates sharing. 5
Provide a digital telecommunications infrastructure to meet rapidly evolving requirements and changing technology.	Legacy analog systems are less flexible and constrain growth. 2	Modern technology with digital services is available to most users. 4	Modern technology with digital services and standards is used throughout. 5
Meet unprecedented aviation industry growth projections for the next 10-15 years.	Some networks may reach capacity early and efficiency is low. 3	Network capacity is adequate but efficiency is less than IISN. 4	Network capacity is adequate and efficiency is high. 5
Provide security mechanisms to protect the NAS from information-based and other disruptions, intrusions, and attack.	Requires significant software, router, and switch upgrade. 2	Requires modern equipment with security features. 3	Requires modern equipment with security features. 3
Provide cost efficient and timely telecommunications services.	Does not use the most cost effective technology; new services take 30-60 days. 3	Does not take full advantage of its cost savings capability; service delivery time greatly reduced. 4	Takes advantage of cost saving technology, e.g., bandwidth management and lowest cost routing; service delivery time greatly reduced. 5
Support organizational and business process redesign for rapid modernization and efficient management.	Separate systems not well suited to consolidated management and operation. 3	Greater integration of networks and traffic offer opportunities for streamlining management. 4	Fully integrated network with complete traffic statistics supports business process change. 5

Provide comprehensive real-time and non-real-time management information for operation, maintenance, configuration management, planning, and accounting.	Limited traffic data available; multiplicity of management systems. 2	Greater consolidation of network management function and significant traffic data available. 4	Most network management functions are consolidated and traffic data available on all users. 5
Accelerate NAS modernization and be fully operational by 2005.	Little or no modernization planned by 2005. 1	Major telecom system elements modernized by 2005. 4	Major telecom system elements modernized by 2005. 4
Use performance-based contracting practices.	Continues present design-based contracting practices. 2	A significant part of the system will be procured under a performance- based contract. 4	Telecom services will be procured under a performance-based contract. 5
Total Score	22	38	47
Normalized Score	**0.44**	**0.76**	**0.94**

Table 9-4 shows the IISN supports strategic organizational objectives to a much greater extent than the Reference Case Alternative and is better than the ISN. While IISN and ISN have many components in common, the integration of operations and agency traffic and the integration of operations data networks give IISN a clear advantage over ISN.

9.2 Criteria Evaluation Methodology

To determine the preferred alternative, the decision criteria were scored using an evaluation scale developed by ASD-400 for aggregating the values of unlike criteria. This heuristic scale is laid out, as follows:

- Blue (4): Best Alternative (BA) or virtually equal;
- Green (3): Slightly Worse than BA;
- Yellow (2): Moderately Worse than BA;
- Orange (1): Significantly Worse than BA; and
- Red (0): Unacceptable.

The scale is laid out on a curve relative to the Best Alternative in each criterion. Since the FAA must select from the alternatives presented, scoring on a curve is a better approach than using an absolute scale because it rank orders the alternatives relative to each other.

Any alternative that receives an Unacceptable (Red) score in any criteria should be considered for elimination.

9.3 Criteria Evaluation

As depicted in Table 9-5, the IISN Alternative clearly is preferred over the Reference Case Alternative and the ISN Alternative, ranking as the Best Alternative with three of the four Decision Criteria: Cost, Mission Effectiveness, and Strategic Alignment. The following paragraphs provide the detailed rationale for the value assignments by criterion.

The IISN Alternative is the preferred alternative under the Cost criterion, based upon its dominance of the LCC, NPV, and B/C ratio subcategories. It demonstrated significant cost savings in the areas of Program Management & Engineering and In-Service Operations and Maintenance over the ten year life cycle. The Reference and ISN Alternatives are indistinguishable because of the degree to which their LCC, NPV, and B/C ratio subcategory ranges overlap. The Reference and ISN Alternatives are judged Significantly Worse than the IISN Alternative because of the magnitude of difference between their LCC, NPV, and B/C ratio subcategory High Confidence (HC) values and those of the IISN Alternative.

The Reference Case Alternative clearly had the lowest risk in the Risk Analysis and, therefore, receives a score of 4 in the Risk Category. Since it was determined that the ISN and IISN Alternatives were indistinguishable with regard to risk, they were given the same score. The other alternatives were approximately 25% more risky than the Reference Case Alternative that was considered to be Moderately Worse than the Best Alternative. Therefore, each was given a score of 2 in the Risk Category.

The IISN Alternative demonstrated the greatest Mission Effectiveness and, therefore, receives a score of 4 in the Mission Effectiveness Category. The ISN Alternative and the Reference Case Alternative were determined to be Slightly Worse and Moderately Worse than the Best Alternative, based upon their respective scores and, therefore, were scored 3 and 2, respectively, in the Mission Effectiveness Category.

Table 9-5. Decision Criteria Evaluation

Decision Criteria Categories / Alternatives	Cost (37.5%)	Risk (25%)	Mission Effective (25%)	Strategic Alignment (12.5%)	Score
Reference Case	O 1	B 4	Y 2	O 1	2.0
ISN	O 1	Y 2	G 3	G 3	2.0
IISN	B 4	Y 2	B 4	B 4	3.5

The IISN Alternative best supports Strategic Alignment objectives through its use of fully integrated networks and modern digital technology and standards. While the IISN and ISN Alternatives have many components in common, the integration of operations and agency traffic and the integration of operations data networks give IISN a clear advantage over ISN. The Reference Case Alternative was scored significantly worse than the Best Alternative because of a lack of network integration and the continued reliance on existing systems and technologies.

9.4 Risk Mitigation

The IAT examined mitigation approaches for the primary risks associated with the preferred IISN alternative. Funding represents the most significant risk.

Technical risks will be mitigated in several ways. Initial steps to IISN implementation will address transport and legacy interface domains. New services will be introduced using a phased approach to satisfy requirements. DMN, BWM, and other CPE capabilities will be integrated incrementally. The IA conservatively projects completion of this work by 2007.

Using services that provide the same level of performance as those that are deployed today will mitigate operability risks. New service solutions for meeting requirements will be introduced using a phased approach, wherein, “buy-in” from Air Traffic through the use of “proof of concept” scenarios is achieved as network solutions are evaluated for acceptable operability in an AT environment. The model in the IAT analysis only assumes aggregation of bandwidth. The model makes no assumption relative to the rate migration from current levels of service to more efficient ones. It is assumed that this process will entail a series of negotiations with the ATC user over time.

The transition risk will be mitigated by ensuring that a LINCS bridge contract is in place prior to FTI contract award. This contract will insure that services continue without interruption during the transition process. In addition, the transition approach initially will focus on the critical LINCS transition. The contract selection process will have as a key discriminator the Vendor’s approach to mitigating transition risks. The Regional workforce will likely be impacted during transition. FTI fully funds resources in the F&E baseline to acquire contractor assets to support transition. Further risks associated with transition planning and with the assumptions made in the transition model are addressed under Section 7.4.5.

Supportability mitigation addresses those programs requiring attention in the near-term, while retaining flexibility to take advantage of offeror’s plans to merge other combinations of existing CPE and transmission systems. Under IISN, therefore, supportability of aging capital assets is put at risk only should there be delays in accomplishing the integration function (and therefore the elimination of the equipment) under FTI. This risk is reduced by the fact that the FTI model has conservatively anticipated accomplishment of these activities.

The funding risk will be mitigated through post-contract award “rebaselining.” There are other uncertainties that could effect the F&E funding stream – mostly downward. The obvious advantage of an incumbent network presence, for example, could significantly alter the front-end

F&E requirement. A post-contract award JRC will provide an opportunity to assess the F&E funding requirement that results from the formal contract selection process.

Cost growth estimates are conservative. Analysis indicates that increased traffic estimates would make a stronger case for the IISN Alternative. Should growth increase at a greater rate than that which has been modeled, this would be a demand driven function requiring budget adjustment. The possibility of demand growth projections falling short of downstream actual demand clearly exists. Should this be the case, it would not alter the rank order of the alternative analysis results. Issues relative to affordability of delivering unprojected or new service will present an ongoing management challenge, irrespective of the nature of the network.

Benefits estimates are relationally stable. Should the FAA fail to realize all the projected efficiencies, the cost avoidance curve still would fall between that projected under ISN and IISN. This outcome would still offer a benefit-cost ratio higher than that offered under ISN. Additionally, unlike the limited potential for future efficiency offered by the ISN Alternative, any delay under IISN in capturing the efficiency would not preclude those efficiencies being incrementally achieved moving forward.

10.0 NEXT STEPS

The FTI IAT recommends the following activities be initiated:

- Establish the FTI IPT.
  - Broader stakeholder involvement is essential.
- Submit for approval AMS required documentation:
  - IPT Plan.
  - Acquisition Strategy Paper.
  - Integrated Program Plan.
- JRC approximately 90 days following Contract Award.
  - Use negotiated results of contract:
    - To baseline non-LINCS/ADTN related events, as appropriate.
    - To reassess F&E and OPS requirement.
  - Provide insight on vendor offered transition planning, business practices, and negotiated performance metrics.

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11.0 RECOMMENDATIONS

The FTI IAT recommends the following to the JRC:

- Reaffirm the need for the FTI program initiative.
- Affirm the development approach to the FTI program.
- Affirm the concept of “rebaselining” the FTI program after contract award.
- Affirm the recommendation for the (IISN) Alternative as the Preferred Alternative for FTI.
- Approve the Investment Decision for the (IISN) Alternative.
- Approve the proposed FTI APB for the (IISN) Alternative.

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12.0 GLOSSARY

Term/ Acronym	Definition
A	
AAF	Airway Facilities
A/D	Analog/Digital
ADTN2000	Administrative Data Telecommunications Network 2000
AFSS	Automated Flight Service Station
A/G	Air-to-Ground
AIS	Automated Information System
ANICS	Alaskan National Airspace System Interfacility Communications Systems
AMS	Acquisition Management System
APB	Acquisition Program Baseline
ARINC	Aeronautical Radio Incorporated
ARSR	Air Route Surveillance Radar
ARTCC	Air Route Traffic Control Center
ASOS	Automated Surface Observing Systems
ASR	Airport Surveillance Radar
ATC	Air Traffic Control
ATM	Asynchronous Transfer Mode
ATN	Aeronautical Telecommunications Network
AWOS	Automated Weather Observation System
B	
B/C	Benefit/Cost
BWM	Bandwidth Manager
C	
CAS	Contract Administrative Staff
CBA	Cost Benefit Analysis
CIP	Capital Investment Plan
COTS	Commercial-Off-The-Shelf
CPE	Customer Premise Equipment
D	
DEMARC	Demarcation
DITCO	Defense Information Technology Contracting Office
DMN	Data Multiplexing Network
DoD	Department of Defense
DUATS	Direct User Access Terminal System

E

ETMS	Enhanced Traffic Management System
EUL	End User Location

F

F&E	Facilities & Equipment
FAA	Federal Aviation Administration
FAATSAT	Federal Aviation Administration Telecommunications Satellite System
FAC	Facility
FCC	Federal Communication Commissions
FIS	Flight Information Service
FMS	Flight Management System
FOC	Final Operational Capability
FR	Frame Relay
FRD	Final Requirements Document
FTI	Federal Aviation Administration Telecommunications Infrastructure
FTS 2000/2001	Federal Telecommunications System 2000 & 2001
FY	Fiscal Year

G

G/G	Ground-to-Ground
GEIA	Government Electronic Industry Association
GFE	Government Furnished Equipment
GNI	Ground Network Interface
GSA	General Services Administration

H

HID	Host Interface Display
HCS	Host Computer System

I

IA	Investment Analysis
IAC	Industry Advisory Council
IAD	Interface Access Devices
IAR	Investment Analysis Report
IAT	Investment Analysis Team
ICAO	International Civil Aviation Organization
IISN	Integrated Interfacility Services Network
IP	Internet Protocol
IPT	Integrated Product Team

IRD	Interface Requirements Document
ISD	In-Service Decision
ISDN	Integrated Services Digital Network
ISN	Intelligent Service Network
ISP	Internet Service Provider
IV&V	Independent Verification & Validation

J

JRC	Joint Resources Council

L

LAN	Local Area Network
LCC	Life Cycle Cost
LDRCL	Low Density Radio Communications Links
LID	Location Identifier
LEO	Lower Earth Orbit
LINCS	Leased Interfacility National Airspace System Communications System
LOB	Lines of Business
LTC	Leased Telecommunications Cost

M

MCI	Mode C Intruder
MEO	Medium Earth Orbit
MNS	Mission Need Statement
MSN	Message Switched Network
MTBF	Mean Time Between Failures
MTTR	Mean Time to Repair
MUX/DEMUX	Multiplexer/Demultiplexer

N

NADIN	National Airspace Data Interchange Network
NADIN MSN	NADIN – Message Switched Network
NADIN PSN	NADIN – Packet Switched Network
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NATCA	National Air Traffic Controllers Association
NEXCOM	Next-Generation Air/Ground Communication System
NEXRAD	Next Generation Weather Radar
NIMS	NAS Infrastructure Management System
NPV	Net Present Value

O

O&M	Operations & Maintenance
OPS	Operations
OSI	Open System Interconnection
OT&E	Operational Test and Evaluation
OTS	Off-The-Shelf

P

PASS	Professional Airways Systems Specialists
PBO	Performance Based Organization
PBX	Private Branch Exchange
PSN	Private Switched Network
PSTN	Public Switched Telephone Network
PT	Product Team
PV	Present Value
PVC	Private Virtual Circuit

Q

Q&Q	Quantitative and Qualitative
QoS	Quality of Service

R

RCAG	Remote Communications Air/Ground Facilities
RCE	Radio Control Equipment
RCL	Radio Communications Links
RFI	Request for Information
RIU	Radio Interface Unit
RTP	Regional Tracking Program

S

SAMS	Service Operations Support Automated Management System
SDP	Service Delivery Point
SEOAT	Systems Engineering/Operational Analysis Team
SI	System Integration
SIR	Screening Information Request
SOS	Service Operations Support
STARS	Standard Terminal Automation Replacement System

T

TCP/IP	Transmission Control Protocol / Internet Protocol
TDM	Time Division Multiplexed
TDMA	Time Division Multiplexed Access
TIPT	Telecommunications Integrated Product Team
TIR	Transition and Implementation Report
TRACON	Terminal Radar Approach Control Facility
TSP	Telecommunication Service Priority
TSR	Telecommunications Service Request

V

VHF	Very High Frequency
VPN	Virtual Private Networks

W

WAAS	Wide Area Augmentation System
WAN	Wide Area Networking
WARP	Weather and Radar Processor
WBS	Work Breakdown Structure
Wilco	Will Comply

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13.0 BIBLIOGRAPHY

The following list of documents and reports were reviewed and provided background data in the development of the FTI Investment Analysis Report listed in chronological order (date of publication).

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23. *White House Commission on Aviation Safety and Security* report, February 1997.

List of Attachments

Attachment Number and Title

Attachment 1 – Alternative Analysis Report
Attachment 2 – Transition and Implementation Report
(Addendum A – Subteam Members)
(Addendum B – IA Assumptions)
(Addendum C – Schedules 1 and 2)
(Addendum D –Generic Resource Tracking Program (RTP))
Attachment 3 – Economic Assessment
(Addendum A – Basis-of-Estimate (BOE) - Official Use Only)
(Addendum B – Spreadsheets - Official Use Only)
(Addendum C – Tornado Charts - Official Use Only)
(Addendum D – Crystal Ball Spreadsheets - Official Use Only)
Attachment 4 – Acquisition Program Baseline (APB)
Attachment 5 – Benefits Analysis Report
Attachment 6 – Market Survey Report
Attachment 7 – Mission Need Statement
Attachment 8 – Investment Analysis Plan
Attachment 9 – Final Requirements Document

Note: To obtain an electronic copy of this report, please contact Dana L. Newcomb, SETA, at (202) 651-2423.

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