19 NAS INFORMATION ARCHITECTURE AND SERVICES FOR COLLABORATION AND INFORMATION SHARING

The NAS information services offer a new collaborative capability for information sharing between FAA and NAS users and througout the FAA. Information sharing will be improved across all domains and with other organizations that need this information. Generating, processing, and distributing information is an integral part of the NAS. As emphasized in the Air Traffic Services (ATS) concept of operations (CONOPS), information exchange is essential to safe and efficient NAS operations.

The collaboration envisioned for the future is a complex process that is being jointly explored by the FAA and the user community. Collaboration and information-sharing services will evolve as experience is gained. Information exchange begins with data exchange as it now exists and then evolves to the collaborative process, as illustrated in Figure 19-1. The goal of an evolutionary approach is to begin collaboration as early as possible.

In the collaborative decisionmaking process, *users* make decisions associated with their operations (e.g., the priority of a particular flight leaving a location). *Service providers* make decisions associated with NAS resources (e.g., airspace and airport capacity during adverse weather conditions).

The NAS information services are based on consistent information exchange among NAS systems. These services, for the most part, are a result of system interoperability that is transparent to collaboration users and is provided through consistent interfaces developed for each system. To achieve interoperability, coordinated interfaces for data exchange among FAA and NAS user systems must be established during systems development.

Currently, NAS information is managed primarily within individual systems. Overall, this creates many inconsistent and inefficient local information management operations that are based on widely varying standards, definitions, and data structures. The future NAS information systems will make interoperability easier to achieve and more cost-effective. As the NAS grows more complex, system interoperability will become a necessity. Data standardization will support implementation of a common, flexible system with consistent interfaces between systems and which offers more options for the aviation community to share data with and retrieve data from the NAS.

19.1 Information Services Evolution

The NAS information services will be allocated, tailored, and integrated at three levels:

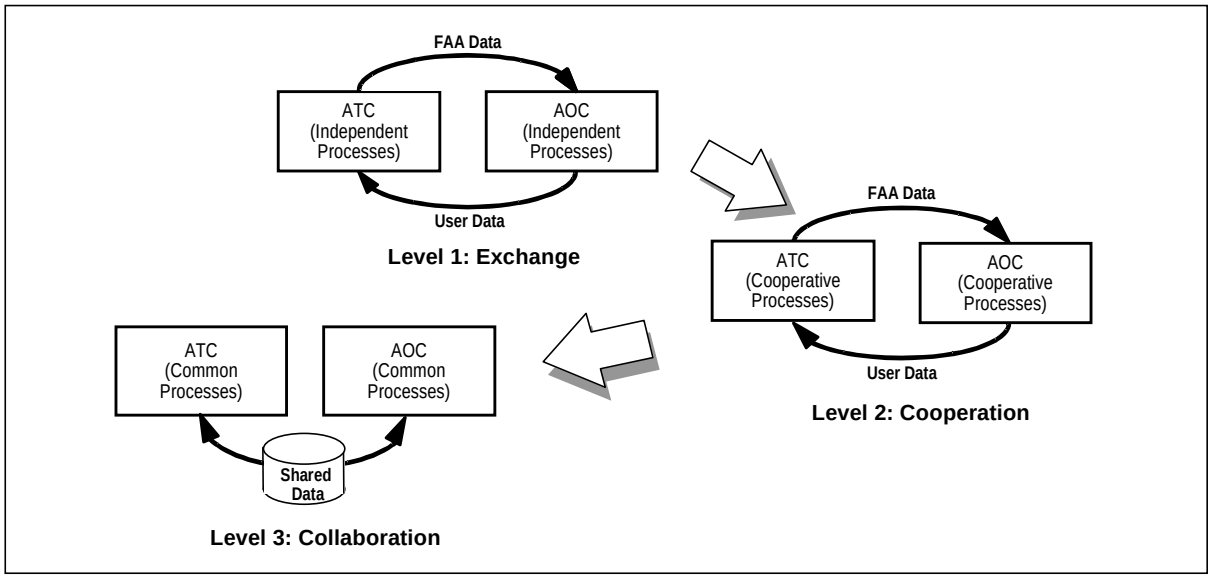

Figure 19-1. Evolution of Collaboration and Information Exchange

- Data standardization and interoperability across applications
- The local or facility levels
- The NAS-wide level.

Each of these will manage and maintain appropriate information for internal use and exchange with other users. Figure 19-2 shows the four major information end-user groups:

- FAA service providers
- Flight planners
- Aircrews
- Aviation auxiliary or indirect users.

A goal of NAS information services (in support of the CONOPS) is to share information seamlessly across these organizational boundaries; this requires data standardization.

Data Standardization and Interoperability

Data standardization will address how data are exchanged between multiple applications. For example, it will ensure compatibility between Center TRACON Automation System/Traffic Management Advisor (CTAS/TMA) applications and conflict probe (CP) applications within an en route center.

Data standards in existing systems are frequently inconsistent—sources for the same data may vary and formats may be incompatible. Interoperability requires translating data whenever information is transferred from one system to another.

Local- or Facility-Level Information Exchange

Local information systems will interoperate through consistently defined information exchange. As local legacy systems are replaced or new systems developed and deployed, commercial data base management systems will be used where applicable, and information models for all systems will be based on managed data standards.

Information exchange at the local or facility level will be the backbone of information exchange at the national level and with NAS users. Specific data categories—such as local weather data, adaptation data, dynamic and static resource data, flight and demand data, performance data and traffic management demand/capacity data—will be stored within the local information systems as required. The data will be updated and made

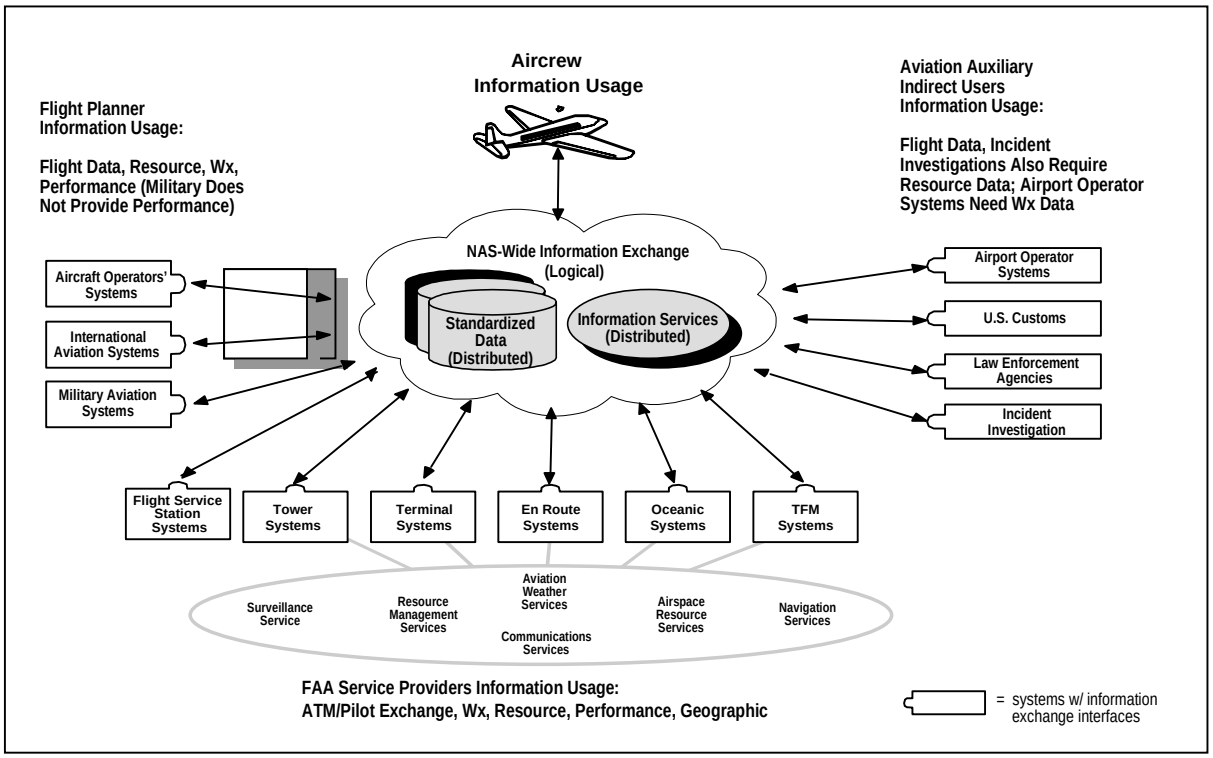

Figure 19-2. Seamless Information Flow in the NAS

available to NAS service providers and users as required.

NAS-Level Common Information Exchange

NAS-level common information systems exchange information across NAS facilities and among NAS service providers and NAS users. These interoperating systems require consistently defined information exchange. As these systems are replaced or new systems are developed, commercial data base management systems will be used where applicable, and information models for all systems will be based on managed data standards.

The standards will involve determining where data come from, who uses the data, how the data are defined, how the data are transformed, and who owns the data. The answers to these questions will help determine the data standards for specific items, such as the flight object (defined as flight plan information and other information, such as preferred runway and taxiway). It will include International Civil Aviation Organization (ICAO) flight-plan-compatible data and will be available to all authorized users, as defined during development of each system.

In some cases, such as for the aggregation and integration of airspace and airway adaptation data, no single authoritative NAS-level information system exists. Systems for such information services will be developed as NAS-wide resources.

The local and NAS-level common information exchange will evolve as depicted in Figure 19-3. These increments comprise a four-step evolution. The first step describes current information services. The second step establishes data standards (including definitions, sources, and formats) for achieving efficient interoperability among legacy systems (near-term view). The structured data can then be stored in external storage media, where the data will be directly accessible by external applications (mid-term view—Step 3). The target view (Step 4) represents the best in system interoperability in which information is easily and unambiguously exchanged as required. As it evolves, it will provide information to both users and service providers, taking into account necessary security precautions.

NAS Information Architecture

The exchange of information across the NAS envisioned by the CONOPS will be based on accepted industrywide information architecture principles.

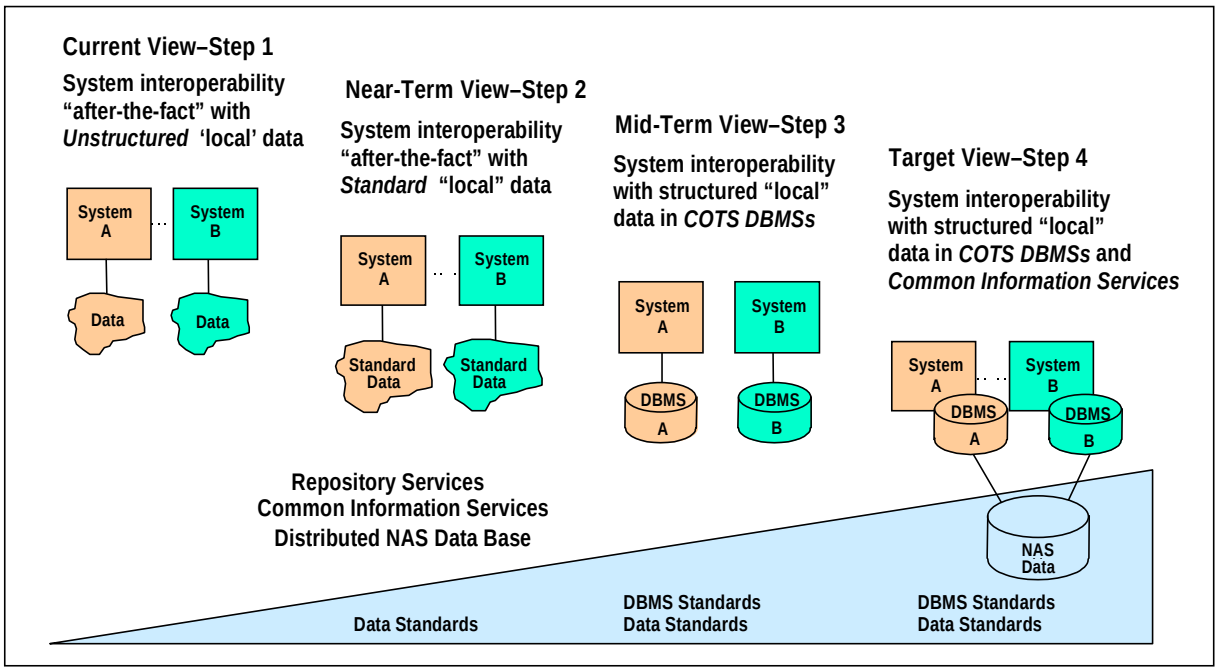

Figure 19-3. Evolution From Existing Information Systems to Future Systems

NAS Information Architecture Goals

The development of the information exchange in the NAS is based on meeting the following four goals:

- *Data Quality and Access:* Supporting the information needs of the many NAS users and service providers with timely, accurate, and complete information via system-to-system, human-to-system, and human-to-human information access
- *Interoperability:* Providing for data exchange, cooperation, and collaboration using data commonly defined by numerous NAS organizations, systems, and users
- *Cost-Effectiveness:* Delivering information in a cost-effective manner and emphasizing information reuse
- *Responsiveness, Flexibility, and Scaleability:* Responding to new functional needs quickly and efficiently.

Local- and NAS-level common information exchange systems will provide information services to foster convenient, widespread, standards-based information exchange supporting both collaborative and better-informed decisionmaking by NAS users and service providers. These systems will manage all types of NAS data, with emphasis on the core types of operational data (i.e., flight, surveillance (positions), NAS resources, and weather data). Both static (i.e., descriptive) and dynamic (i.e., NAS status) data will be managed, and operational data will be used for real-time safety and traffic flow decisionmaking, as well as for pre- and post-event analysis to improve operational performance.

To support data exchange as envisioned, local- and NAS-level information systems will be implemented using a variety of information technologies and tools, including information standards, services, and processes. More importantly, new information management processes will be put in place to achieve coordination across organizations, domains, and systems.

The information exchange will be service-oriented. To be successful, it requires systems that cannot be specified and acquired as a traditional application system. It is a *set of information services* distributed across the NAS and coordinated through a hierarchy of responsibility. This hierarchy of data ownership will enhance operational decisionmaking by providing access to consistent, timely, high-quality NAS information.

How NAS Information Services Are Used

NAS information services will be managed and distributed across the NAS at three levels: NAS-wide, locally, and at the system level. Figure 19-4 distinguishes the basic set of information services by each of the three levels. The issue of data "ownership" is really one of distributed responsibility. The FAA will need to assign new roles (e.g., data administration and data base administration) at the three levels, and NAS users will be responsible for the aspects of information management that naturally fall within their area. For instance, air carriers initiate flight schedules and flight changes; the military manages special use airspace (SUA); and international aviation is active in oceanic airspace.

All three NAS user constituencies will structure their information services consistent with FAA information structures and services and vice versa. They will also have information management responsibilities due to their collaboration on numerous airspace situations, from severe weather (in real time) to ground delays (in near real time) to airspace design (archival/analytic) issues.

For domain-specific implementation information, refer to the domain sections (Section 21, En Route, and Section 23, Terminal). Details of information architecture not described in the domain sections will be developed as part of the information architecture process.

Information services will evolve as software and interfaces for new systems are developed or existing systems are upgraded or replaced. This will require a consistent set of standards and requirements that will apply to new software and operating systems, networks, and interfaces. The evolution is described generically in the following steps.

19.1.1 Information Services Architecture Evolution—Step 1 (Current–2000)

During Step 1, the NAS-level common information exchange implementation is primarily constrained within existing data management ser-

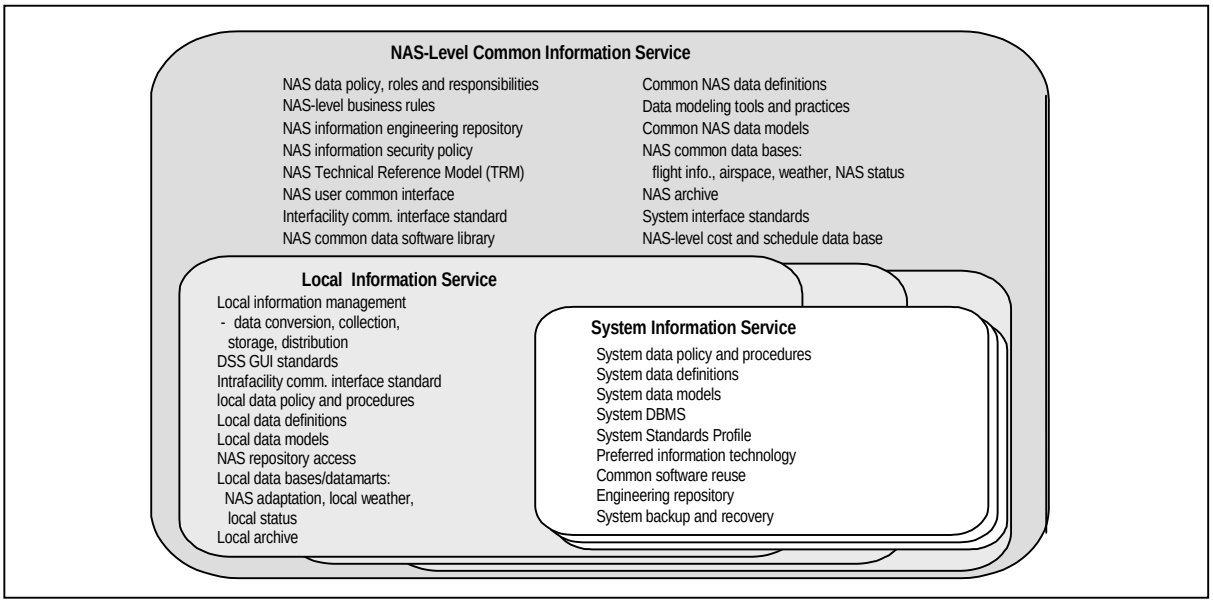

Figure 19-4. Three Levels of NAS Information Services

vices and legacy automation systems. Organizational and technical research groundwork will determine how to move from the way data are currently defined and managed within systems to a way that is compatible with coordinated systems, facilities, and NAS perspective. The initial tasks include:

- Maintaining and augmenting NAS user-to-system and system-to-system exchange of existing data
- Establishing new NAS-wide data management roles and responsibilities
- Baselining existing information definitions and requirements
- Developing data models to help guide the evolution of the information systems.

In transitioning from current information and transmission methods, data will continue to be available in its current form. Some data will remain in its current form in the future (e.g., data available over the Internet). Other data will be added to the current transmission media, particularly the Internet and data link.

19.1.2 Information Services Architecture Evolution—Step 2 (2001–2004)

A set of common, standardized information services supported by the local and NAS-level common information systems will begin to evolve during this step. Determining common data standards and structures will enable establishment of a central data repository for NAS-user access to some local data. Since security systems and procedures will not be fully implemented, external NAS users will access data from data bases established for that purpose, not directly from the applications that generate the data.

The flight object, as described in the CONOPS, significantly changes how flight data will be managed and shared in the future NAS (see Figure 19-5). First, as a replacement for today's flight plan, the flight object is much more comprehensive in scope and encompasses new data such as flight preferences. Second, the responsibility for processing flight object data will be distributed to different systems as a flight moves from preflight planning to in-flight operations to postflight analysis. Third, all data in the flight object associated with a flight will be made available NAS-wide and shared with NAS users as appropriate.

Key activities in the information services evolution during this time frame include:

- Developing requirements and standards for flight object data
- Developing standards for internal interfaces to the local information systems
- Developing standards for interfaces to external NAS users

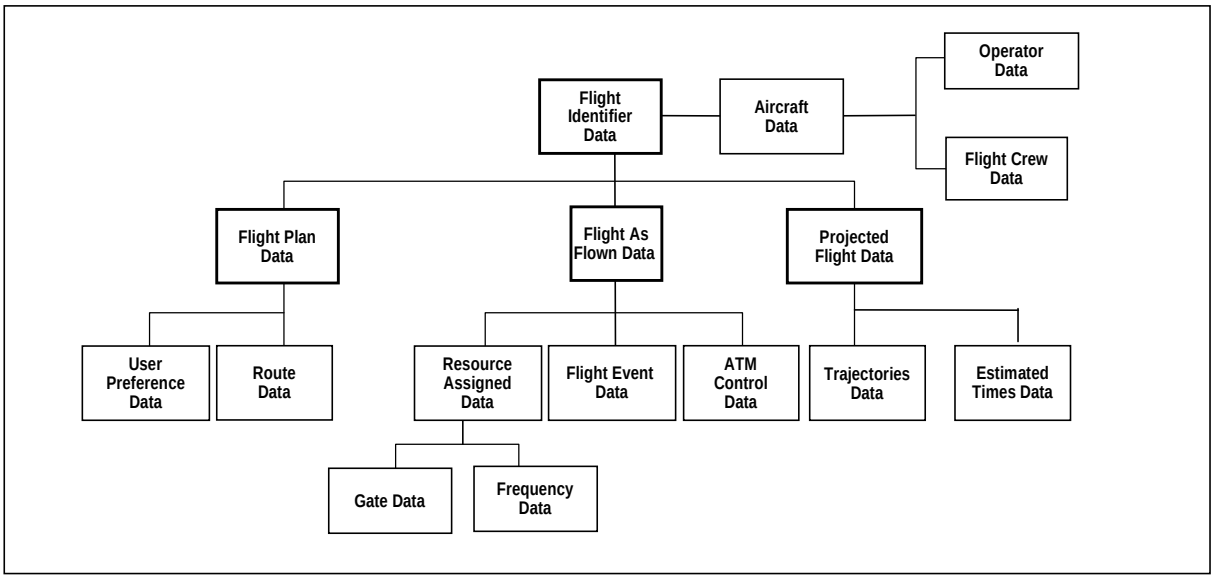

Figure 19-5. High-Level View of the Flight Object

- Implementing data security policies for local and NAS-level common information exchange
- Incorporating local information exchange capabilities into air route traffic control centers (ARTCCs)
- Providing NAS user data, including real-time SUA status and facility status
- Providing security for data access and exchange, as appropriate and available.

19.1.3 Information Services Architecture Evolution—Step 3 (2005–2008)

The set of common, standardized information services supported by the local and NAS-level common information exchange will continue to evolve during Step 3.

Key activities in the information services evolution during this time frame include:

- Developing requirements and standards for NAS resource (facility and airspace) status data
- Beginning deployment of local information system capabilities, tailored to support other facilities
- Providing security for data access and exchange, as appropriate and available.

19.1.4 Information Services Architecture Evolution—Step 4 (2009–2015)

A set of common, standardized information services supported by the local- and national-level information services will continue to evolve. All features—which are currently envisioned for NAS-level common information exchange that supports seamless data exchange within the NAS and with external users—will emerge in this time frame. Additional features will be developed as experience with the evolving NAS-level information services accumulates and as technology and user requirements evolve.

Key activities in the information services evolution during this time frame include:

- Completing and maintaining requirements and standards for all shared NAS data
- Beginning distribution of flight data to NAS users via the NAS-wide information network
- Making flight object data available NAS-wide
- Providing standardized, common data services support for NAS applications
- Providing NAS users access to all authorized NAS data
- Providing security for data access and exchange, as appropriate and available.

19.2 Summary of Capabilities

The modernized information systems will distribute timely, accurate, and consistent information in electronic format across the NAS, resulting in improved services to users, more efficient use of NAS resources, better flight planning, and more cost-effective systems development and acquisition. The information systems will provide users and service providers with a common view of the NAS for collaborative decisionmaking. Common, standards-based data services will provide data collection, validation, processing, storage, and distribution of data to and from data sources that are both internal (e.g., traffic flow management) and external (e.g., the National Weather Service (NWS), airlines, DOD, and international traffic flow managers) to the FAA. Figure 19-6, illustrates collaboration based on the Free Flight concept.

Data will be dynamically updated as situations change. Data types will include:

- *Flight Data:* Such as the filed flight profile and all amendments, first movement of the aircraft, wheels-off time, in-flight position data, touchdown time, gate or parking assignment, and engine shutdown. The current flight plan will be expanded to become the flight object and will include the added information about the flight. The information will be standardized to be consistent with ICAO standards. The user is one of the main sources of this type of data.
- *Resource Data:* Include static resource data, such as NAS boundaries, configurations, runways, and SUAs; and dynamic resource data, such as airport and airspace capacity constraints, current configuration of runways, system infrastructure status, schedule of SUA activity, and schedule of maintenance activity. The FAA is one of the main sources of this type of data.
- *Enhanced Weather Data:* Include current and forecast weather, hazardous weather alerts for windshear events (microbursts and gust fronts) and other hazards such as icing, turbulence, etc.
- *Traffic Management Data:* Include current and anticipated demand/capacity imbalances and planned strategies for managing them.
- *NAS Performance Measurement Data:* Provide information on NAS performance in a meaningful and readily accessible format for better planning.
- *Geographic Data:* Include terrain maps, obstruction locations, airspace boundaries, etc.

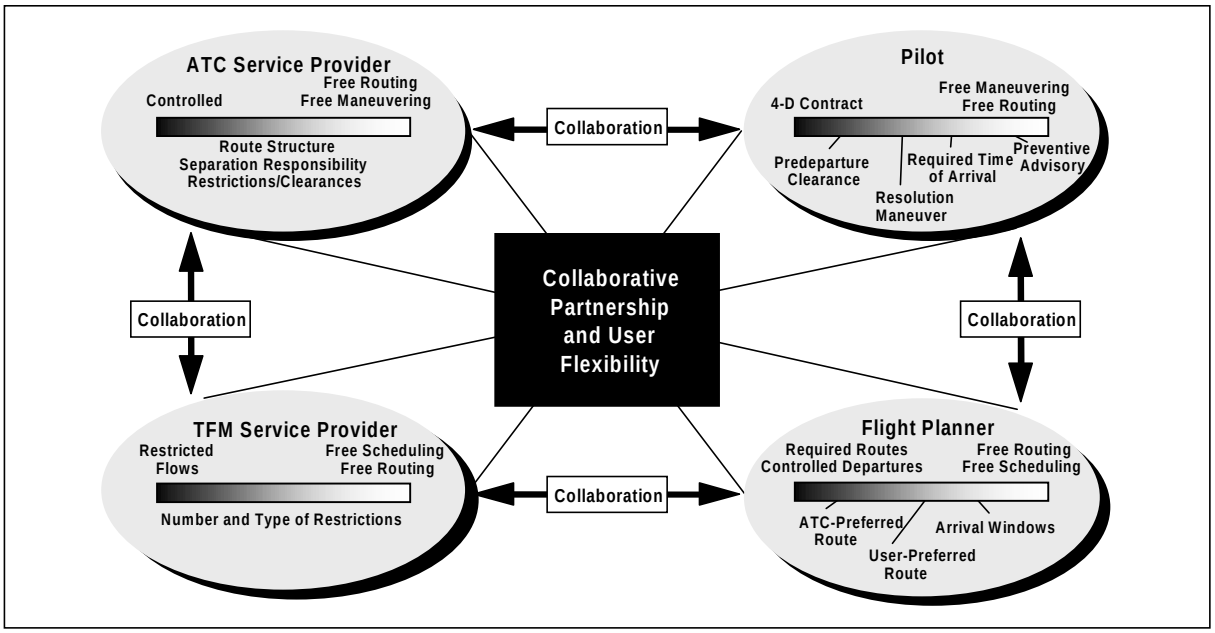

Figure 19-6. Collaborative Decisionmaking in the Future NAS and Electronic Data Exchange for Collaboration

- *Surveillance Data:* Include aircraft-position time and coordinates reports, velocity, and intent information.

The NAS is increasingly dependent on greater information exchange for better and shared planning and decisionmaking. The NAS-wide information network will provide NAS users and service providers with consistent, accurate, timely data to allow for future collaboration.

19.3 Human Factors

The new automation architecture and information-sharing processes will reduce human errors and improve throughput, workload, system confidence, and situational awareness. Human factors goals for this architecture are to:

- Reduce the potential for a human error (e.g., input error, or anomaly in one part of the system to adversely affect the performance of another part or person)
- Base the conceptualization, design, and development of the information interface with the user on the functions people perform and how and when they will be performed
- Define the information architecture in terms that include the user's task-related information requirements and the human component of relevant organizational modeling
- Determine the acceptance criteria for the data structure and standardization using factors that include human performance measures (e.g., for the end-product's utility and usability)
- Devise information architecture suitability and effectiveness measures that relate to operators' and maintainers' time- and event-derived tasks
- Optimize information architecture and implementation to clarify boundaries and procedures for controller and flight crew roles and responsibilities in collaborative operations and interactions
- Develop information architectures that promote the capability for air and ground displays to enhance common situational awareness among various users.

19.4 Information Security

All information service providers are responsible for information exchange security. This includes access privileges, data integrity and availability, and data sensitivity. Security will become a more complicated issue as the local and NAS-level common information systems evolve and as more information is shared among the FAA and NAS users. Protecting the integrity and privacy of FAA and NAS-user provided information will be critical to information exchange effectiveness. For example, users must have confidence in the data they access and confidence that sensitive or proprietary data they provide will be protected. New security systems and procedures will be implemented. See Section 9, Information Security, for a more detailed discussion.

19.5 Transition

The transition timeline for implementation of NAS information services is discussed next. The collaboration and information-sharing transition timeline is shown in Figure 19-7.

Information-sharing capabilities will be implemented during the following time frames:

- Near term: Local information services will include information directory/repository, decision support/data alerts, data management, security, system interface/information sharing, and data archive. Evolutionary steps will be:
  - Provide internal FAA facility information
  - Provide flight data to NAS users (including DOD) external to the FAA facility
  - Provide data access (search and query and publish and subscribe) capability to NAS users (including DOD) external to the FAA facility
  - Develop coordinated interfaces among legacy systems and for new and reengineered systems
  - Develop NAS information services, including data administration, data models, standards, protocols, and common data definitions
- Mid term: Expand information-sharing capability to address other specific information-sharing requirements

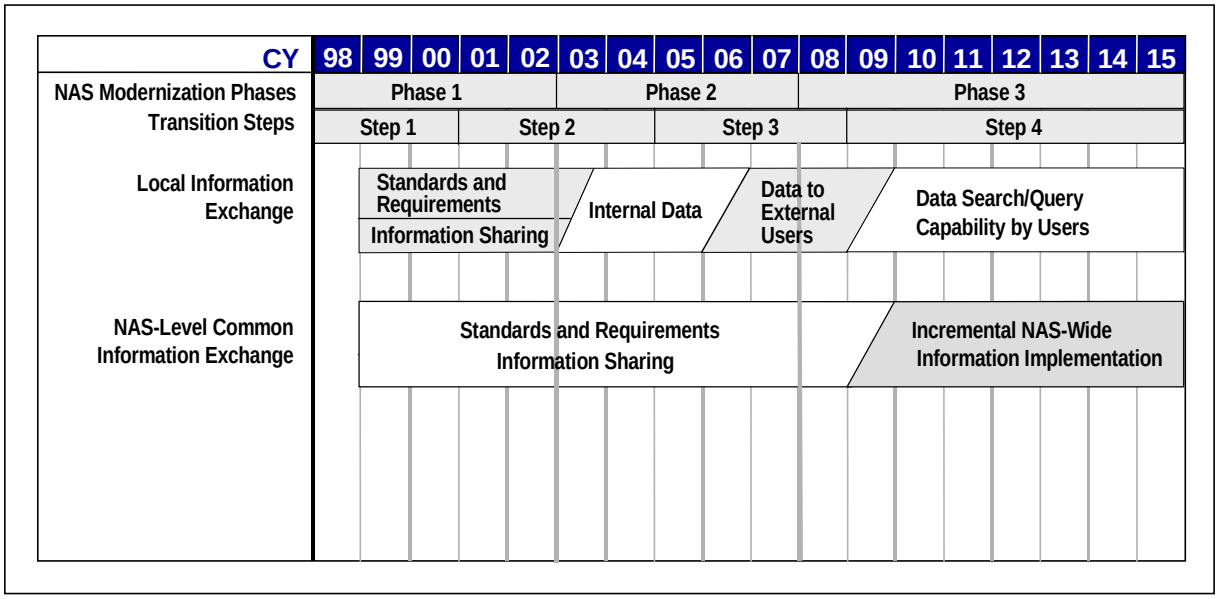

Figure 19-7. Collaboration and Information-Sharing Transition

  - Provide demand data, such as flight information (flight object) and flight schedule information
  - Provide capacity data, such as radar summaries, airport status, and airspace capacity/status
  - Provide notices to airmen (NOTAMs) and weather data, such as hazardous weather warnings
  - Implement NAS information services, which includes standards, protocols, and common data definitions
- Far term: Provide information sharing for the NAS operational concept
  - Manage overall NAS information
  - Plan and coordinate local and NAS-level common system infrastructure, which includes:
    - —NAS data administration services
    - —NAS information technology services
    - —NAS data modeling services
  - Maintain NAS information services, which includes responding to changes in standards, protocols, and common data definitions as requirements evolve.

19.6 Costs

Most of the FAA costs for NAS collaboration and information sharing are covered in the interoperablity costs for each NAS system. Other costs are shown in Figure 19-8. They include:

- Information modeling and standards development
- Standards management, validation, and conformance testing
- NAS-wide engineering knowledge repository development, implementation, and operations and maintenance
- Specific NAS-wide data bases such as a central adaptation data system.

19.7 Watch Items

- Identify priorities for delivery of collaboration information with users
- Establish policies for collaboration and information sharing. These policies are for:
  - Authorizing access to specific classes and types of data for FAA and NAS users
  - Allocating integration and interoperability responsibility among system developers, including clear guidance for commercially available versus developmental tradeoffs
  - Accommodating ad hoc legacy systems for system interoperability and information

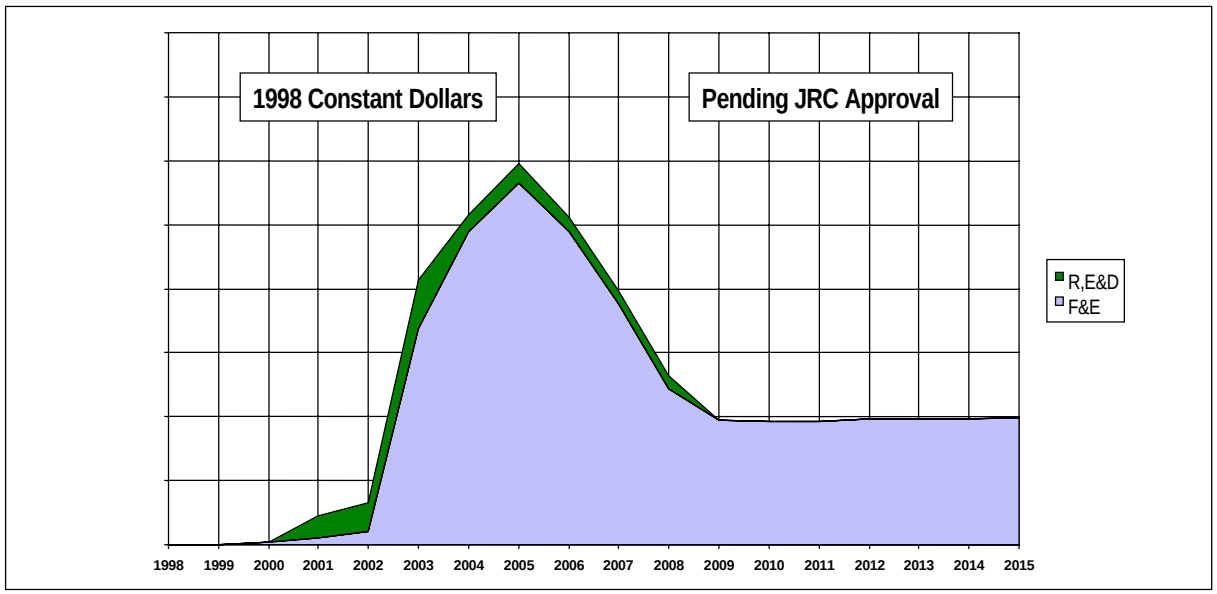

Figure 19-8. Estimated Collaboration and Information-Sharing Costs

exchange (e.g., operational data management system (ODMS), Systems Atlanta Information Display System (SAIDS), special use airspace management system (SAMS), etc.). These systems are currently used within the NAS to meet operational needs, but no requirements exist to access the data, or transition these needed capabilities into developmental systems.