AD-A229 086

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE 1989 Oct

3. REPORT TYPE AND DATES COVERED FINAL

4. TITLE AND SUBTITLE

The Air Traffic Control Environment in 2010

5. FUNDING NUMBERS

6. AUTHOR(S)

John Hopkins, Guy St.Sauveur

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

U.S. Department of Transportation
Transportation Systems Center
Cambridge, MA

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Hq Electronic Systems Division XR
Hanscom AFB, MA 01731-5000

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for Public Release; Distribution Unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

This document has been prepared to assist the Airspace Control Planning Panel by describing the broad outline and general features of the environment for air traffic control functions anticipated in the 2010 timeframe. The description is based on estimates of the volume and nature of air transportation in the early 21st century and the assumption of orderly evolution of technology and concepts now being explored. No specific restrictions were placed on the breadth of the effort, other than the direction to address both military and civil concerns in terms of the respective roles, functions and missions in each sphere of activity. It is hoped that this initial effort at an integrated civil-military overview will be useful in providing part of the foundation for jointly considering future operational concepts, architectures, and initiatives. It is to be seen as an impetus for effective and coordinated planning, rather than as an end in itself.

14. SUBJECT TERMS

ATC, air traffic control, airspace management, communication, navigation, surveillance, decision support, 21st century, 2010, DoD, civil, military

15. NUMBER OF PAGES 12

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	SAR

THE AIR TRAFFIC CONTROL ENVIRONMENT IN 2010

October, 1989

Prepared for the

DOD AIRSPACE CONTROL PLANNING PANEL

Under Sponsorship of

U.S. AIR FORCE
ELECTRONIC SYSTEMS DIVISION
HANSCOM AFB, MA

by

U.S. DEPARTMENT OF TRANSPORTATION
TRANSPORTATION SYSTEMS CENTER
CAMBRIDGE, MA

ABSTRACT

This document has been prepared to assist the Airspace Control Planning Panel by describing the broad outline and general features of the environment for air traffic control functions anticipated in the 2010 timeframe. The description is based on estimates of the volume and nature of air transportation in the early 21st century and the assumption of orderly evolution of technology and concepts now being explored. No specific restrictions were placed on the breadth of the effort, other than the direction to address both military and civil concerns in terms of the respective roles, functions and missions in each sphere of activity. It is hoped that this initial effort at an integrated civil-military overview will be useful in providing part of the foundation for jointly considering future operational concepts, architectures, and initiatives. It is to be seen as an impetus for effective and coordinated planning, rather than as an end in itself.

[illegible]: Airspace; Management planning/control; [illegible]; [illegible] control towers; Air traffic control systems; Civil aviation. (MM)

TABLE OF CONTENTS

THE AIR TRAFFIC CONTROL ENVIRONMENT IN 2010

INTRODUCTION

The facilities, equipment and strategies used to control and manage national and global airspace are in the early stages of dramatic change. The demands arising from rapidly growing civil air traffic can only be met through application of advanced technology matched to new operational concepts. Similarly, military tactical air traffic control (ATC) functions in a wartime environment will be performed using sophisticated new systems which improve command and control functionality and reduce vulnerability. The civil ATC system will encompass a larger but much more structured and tightly controlled airspace, with communication, navigation, surveillance and control functions based largely on advanced and highly automated avionics and satellite technology. By the early years of the 21st century the concepts now being explored and tested will be emerging from the development stage into initial deployment. The new systems will be characterized by a degree of system integration not previously encountered. Because of this, implementation will entail not only the normal lengthy period of research, development and acquisition, but will additionally call for resolving innumerable complex transition, interface, procedural and interoperability issues. Since some of these issues will bear strongly on system and subsystem design and the schedule for phasing in various elements, it is not too early to initiate the process of serious planning for the new ATC environment and its consequences, even though its accomplishment may be 15 to 25 years in the future.

The purpose of this document is to assist the planning process by suggesting the broad outlines of what that future world can be expected to look like insofar as air traffic control functions are concerned. Emphasis is on the overall system and subsystem concepts and their implications for civil and military aviation. The nominal timeframe taken is the year 2010. The degree to which the ATC environment will have reached the stage described here cannot be predicted precisely, but it is reasonable to assume that the major elements of the future system will have been decided and specified (and possibly be under full-scale development and initial implementation) by the end of the first decade of the next century. The basic assumptions on which this discussion is based are that moderate world economic growth will continue without drastic interruption, and that defense forces will exist in a predominantly peacetime environment while maintaining full military capabilities for activities ranging from low-level conflicts and special localized situations to major engagements.

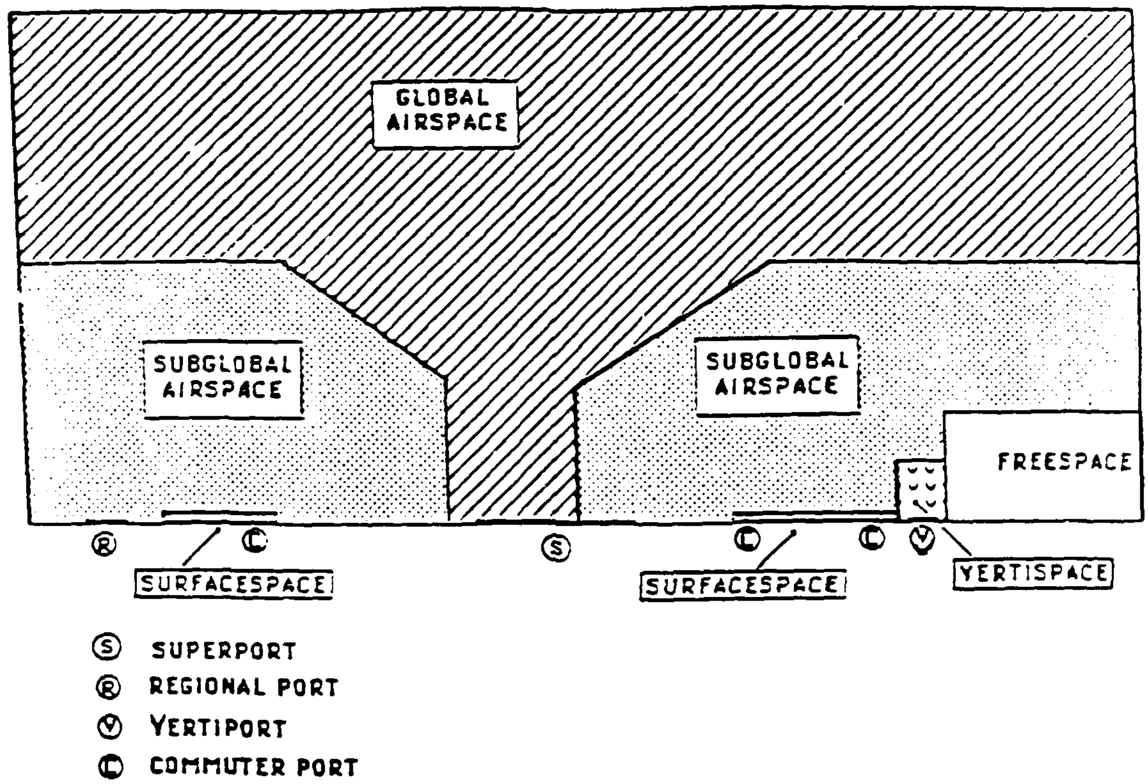
This paper first describes briefly the overall aviation environment anticipated in the first decade of the 21st century, and the "technology environment"--the technologies upon which the future ATC system will be based. Each of the major ATC functions--communications, navigation, surveillance, etc.--is then addressed in terms of how advanced technologies will be used to provide them. Some of the major implications and outcomes expected to result from the expanded capabilities are also noted.

THE AVIATION ENVIRONMENT

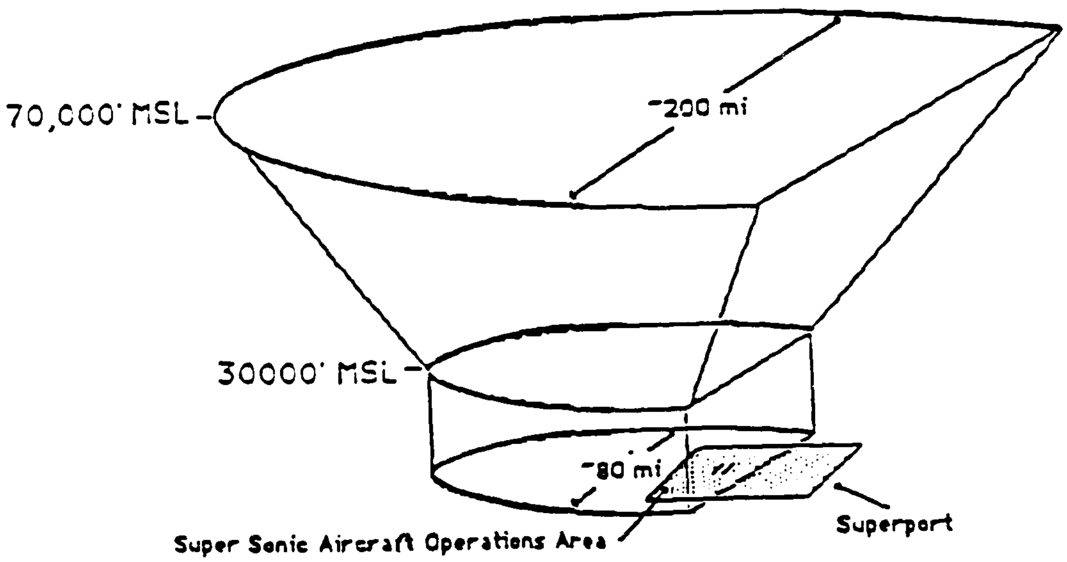
The volume of civil air transportation will have increased dramatically--by perhaps a factor of two to three above current levels--due particularly to a much greater volume of international travel. The spur of vigourous economic competition will be a major force driving aviation toward operational efficiency. The resulting pressures on available airport and airspace capacity will be felt strongly by the ATC system. It will have to accommodate not only more aircraft, but a wider variety of aircraft, likely including tiltrotor or other VTOL/STOL aircraft and a second-generation supersonic transport. Controlled airspace, extending to substantially higher and lower altitudes than at present, will be more tightly regulated. The current specific air route structure will be in the process of being replaced by a controlled but less rigid use of all available airspace to increase efficiency and capacity. Restructuring of the airspace (suggested in Figure 1) will in part occur in response to a greater variety in airports, which may range from "superports" serving very large transports and SST's, to urban vertiports. Highly sophisticated landing systems will be used at the busier airports to facilitate maximum use of parallel and converging runways and efficient sequencing of aircraft for landing and takeoff even in conditions of poor or zero visibility. Tracking of aircraft and management of traffic flows will increasingly be performed on a global rather than national basis, requiring a greatly expanded international organizational infrastructure. The "globalization" of air traffic control will also call for new levels of technical compatibility arising primarily from automation of many flight crew and controller functions. Military aviation activities outside the U.S. will similarly take place in an increasingly structured and controlled environment, whether over land or oceans.

Wartime operations will require extremely flexible and mobile tactical control systems not having the vulnerability of current surveillance radar, beacons, and ground-based landing systems. Given the geographically-constrained nature of many present-day conflicts, these operations may occur in close proximity to on-going civil air traffic operations.

The complexity and magnitude of the vehicle and infrastructure investments which will be required will drive the aviation community toward international collaborative ventures such as consortia for development of an advanced SST or super-transport or regional mega-airports. Inter- and intra-governmental coordination and public-private cooperation on a greatly expanded scale will necessarily become the norm.



Airspace structured in specific segments to accommodate aircraft of like characteristics.



Transition area for supersonic aircraft at superports.

Figure 1. 21st Century Airspace Configurations.

THE TECHNOLOGY ENVIRONMENT

Satellite-based technology will be central to the ATC system being deployed in 2010. Communication satellites in geosynchronous orbits (altitude of approximatly 22,000 miles) will provide nearly instantaneous worldwide communications. Satellites in middle earth orbits--of the order of 10,000 miles--will permit aircraft to determine their location anywhere in the world with an accuracy of tens of meters or better. Active surveillance will also be possible from radar equipment in lower orbits. Typical configurations are illustrated in Figure 2.

Continuing advances in computer technology will result in a high degree of automated monitoring and support for many flight deck functions and for traffic control and management tasks, with manual activities being transferred to computers wherever practicable. Systems based on artificial intelligence concepts will be implemented to assist in diagnosing and resolution of problems.

More generally, advanced digital electronics, incorporating data processing, communications and position-location functions where appropriate, will permeate aircraft and ground facilities alike. Virtually all functions--communications, navigation, surveillance, surface traffic control, etc.--will be critically dependent on specific avionic subsystems or components. Information--in much greater quantities than at present--will be exchanged primarily in the form of data rather than voice transmissions, being presented to controllers and flight crews on multi-function display devices in processed form and only when needed or requested.

Due to the near-total dependence of safety and operations on sophisticated systems, as well as the numerous technical alternatives which will be available, many functions will be provided redundantly: ground and satellite communications; ground-based and satellite position-location; etc. The linked configuration and automated nature of air, ground and space-based systems for provision of basic

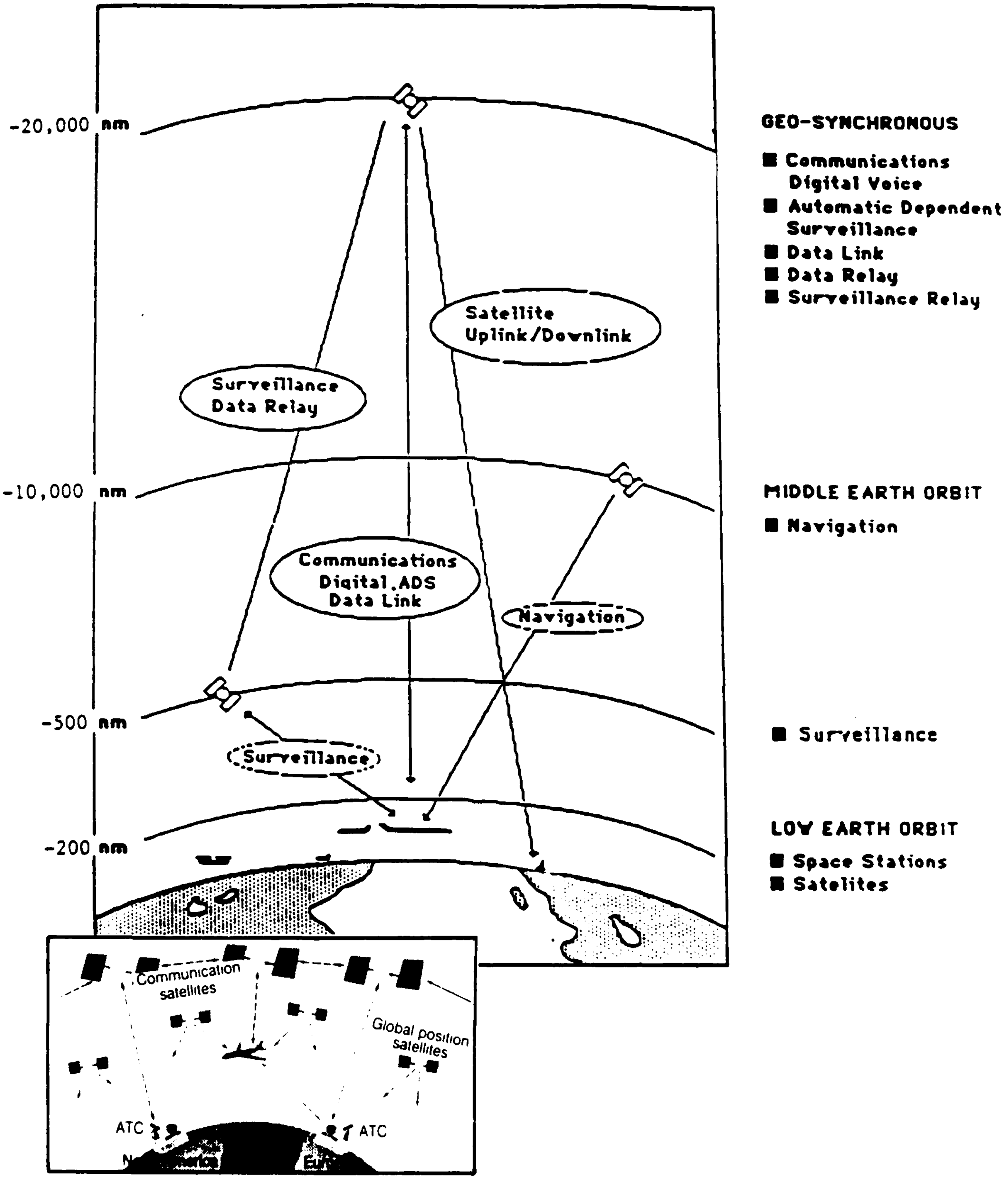


Figure 2. 21st Century Satellite Configuration.

ATC functions will greatly increase the number of critical interconnections and interfaces, as well as the sophistication of the equipment involved. Transition to new systems, and subsequent evolutionary enhancements and changes, will be complex activities requiring extensive detailed system integration, implementation planning and coordination among the various users and participants in operation of the system. Total inherent interoperability between new and old systems, among nations, and between civil and military systems will be a necessity; it will be obtained only through continuous extensive cooperative efforts and comprehensive and detailed system engineering. It is expected that the technical complexity and resulting cost of the various elements will create a true single and common civil/military system, dominated by civil technology which has been developed in the context of interoperability with functionally and conceptually similar tactical military systems.

An important characteristic of the newer technologies will be more rapid technical obsolescence. One major challenge to system designers will be the necessity to create subsystems and equipment which can readily grow to keep pace with needs and engineering advances through software upgrades and replacement of modules, rather than outright replacement of major system elements. This will demand that interface standards and module/subsystem functional specifications be both rigorous and compatible with long-term system growth and evolution.

The pervasive use of automated components and software-based subsystems in the ATC system and in virtually all aircraft will pose a severe challenge: development of testing and certification processes which truly assure safe and efficient functioning and a high level of system integrity. These concerns become particularly critical in considering the effects of modifications, upgrades, complex failure modes, and interactions with other system elements which may not have originally been envisioned. From the conceptual level down to detailed component design, the transition to software-based technology will require a major change of mindset and creation of appropriate changes to the development and acquisition process.

AIR TRAFFIC CONTROL FUNCTIONS IN 2010

During the next 20 years, the civil air traffic control system will undergo steady structural evolution and technical elaboration, leading to an associated sharp increase in the complexity and interdependency of all system elements. Military ATC systems will draw upon the same advancing technologies and will use many of the same concepts. However, they will be driven predominantly by specific challenging mission requirements, particularly the necessity that battle-management systems be flexible, mobile, and not vulnerable to hostile actions. The degree to which the high current level of civil-military ATC interoperability can be maintained for the highly sophisticated systems of the early 21st century is not clear; failure to do so would have significant adverse effects on mission capabilities.

The process of transition to the systems of the early 21st century will be complex, since the next ATC generation--the hardware and software which will ultimately replace everything now in place, on the drawing boards, or in process of development and acquisition--will embody broad conceptual changes which affect all parts of the system and all users, both civil and military. Choices must be made as to the manner in which roles and responsibilities are allocated between people and automated systems, and the degree to which great increases in cockpit information make it appropriate to transfer decision authority from the controller to the pilot.

The implementation of these new approaches and concepts will lead to significant changes in each functional area of the air traffic control system of 2010 and the manner in which functions are implemented. Each major cateagory is discussed below. Although the implications and equipment may differ between civil and military systems, the basic functions and concepts are applicable to both.

For most of the functions a chart is provided to supplement the text by indicating some representative systems or facilities now used, systems or programs now being implemented for full deployment during the next decade, and the technologies, concepts and types of systems which ultimately will replace them. However, in keeping with the overview- and future-oriented nature of this document, these charts are merely for illustrative purposes; they are presented in highly condensed form and are in no way comprehensive.

Communications

There are three primary communications functions, which will become more differentiated in the future. The first is as an integral element in other surveillance and control functions, and comprises essentially automatic communication between avionic subsystems and ground computers and systems. Equipped aircraft now automatically provide information to the ground as part of the radar surveillance process. As described below, air-ground communication is central to the newer concept of dependent surveillance, in which position is determined on the aircraft and communicated to the control facility. This aspect of communications will be subjected to substantial expansion, assuring that the controller and various automated systems on the ground have available all relevant information from the aircraft.

The second type of communications is exchange of information and control messages between people--ground controllers and aircraft flight crews. The information may involve weather, traffic, etc. In the future most of this communication--which is now primarily voice--will occur automatically, with data being directly transferred between ATC computers and aircraft computers, for display to flight crews and controllers when important, or on demand. However, there will continue to be extensive voice communications in terminal areas.

The third type of communications involves exchange of information not directly associated with the air traffic control process, as when flight crews communicate with airline management or passengers make telephone calls. In a military context this would include mission-specific information. The expanding degree to which advanced technology facilitates this type of communication is likely to bring about a dramatic increase in its employment in the civil segment.

Overall, greatly expanded communications capabilities will be at the heart of control and management of air operations in the early 21st century, with dramatic impact on all other functions--navigation, surveillance, weather information, etc. The preponderance of ATC communications will be via digital data links which provide high capacity and efficiency. Voice communications will often be supported by digital communications coupled to voice synthesis systems. Communication will be by means of both direct ground-air links and satellite-based systems, with the choice depending on functionality, capacity and efficiency. Typically en route applications will be via satellite, with ground-based techniques more common in high-density terminal areas which warrant the ground-station investment. Full technical compatibility and interoperability will generally be necessary between the ground and space systems. The communication networks which link all ground facilities to one another--increasingly on a global rather than national or continental scale--will carry enormously greater traffic and will necessarily be extremely reliable and flexible.

Navigation

Satellite-based navigation (GPS and descendants) will dominate due to its near-universal availability and high precision. Three-dimensional position information and a standard time service will be available, providing at least non-precision approach capability virtually everywhere. Existing aviation facilities such as VOR, VORTAC, and TACAN will be phased out; other ground systems such as LORAN-C may continue because of other ground-based users but will play a limited role in aviation. It is expected that inertial

Representative Current Systems or Programs	Representative Planned Systems or Programs	Systems or Concepts Underlying 21st Century Systems
Civil:		
RCAG	NADIN	Primarily satellite
	VSCS	NADIN
	Mode S	
Military:		
AN/ARC-164	JTIDS/MIDS	Milstar
RIVET SWITCH	IVCSS	JTIDS
	HAVE QUICK	
	AWACS	
	Milstar	
	TRV	

Table 1. Representative Current, Planned and 21st Century System Elements for Communication Functions

navigation will be phased out of civil ɼigation applications. Avionic systems will include automatic integrity checking to assure the validity of satellite-based navigational data. "Pseudolites"--ground-based GPS transmitters--may be used for increased precision and reliability in terminal areas.

Representative Current Systems or Programs	Representative Planned Systems or Programs	Systems or Concepts Underlying 21st Century Systems
Civil:		
VOR/DME	VOR/DME	GPS
Inertial	Inertial	
LORAN-C	LORAN-C, GPS	
Military:		
VOR/TACAN	VOR/TACAN	GPS
AN/GRN-20,FRN-43	GPS	VORTEX radar

Table 2. Representative Current, Planned and 21st Century System Elements for Navigation Functions

Landing Systems

Landing systems will be based on extension and application of the current microwave landing system technology, permitting precision approaches (and missed approaches) for straight-in, curved and segmented landings and departures. These will make use of advanced display technology ("synthetic vision") in which a head-up display image of the runway as seen from the instantaneous position of the aircraft will be created in the cockpit.

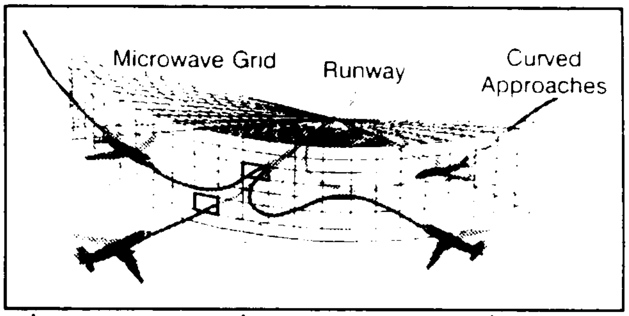


Figure 1. Microwave Landing System.

Where the performance characteristics of the sophisticated microwave systems are not required, improvements in navigation system availability and accuracy (as described above), including GPS applications, will support non-precision operations.

Representative Current Systems or Programs	Representative Planned Systems or Programs	Systems or Concepts Underlying 21st Century Systems
Civil:		
ILS	ILS	MLS
	MLS	GPS
	LORAN-C	
Military:		
ILS (AN/GRN-29)	MLS, MMLS	JTIDS
AN/GPN-22	JTIDS	Milstar
AN/TPN-22	AN/TPN-25	GPS
AN/FPN-62,63	ACLS	PTAG

Table 3. Representative Current, Planned and 21st Century System Elements for Landing System Functions

Surveillance

Improvements in aircraft navigation systems will be such that surveillance functions can be based largely on aircraft-derived position information, transmitted to control centers by either space- or ground-based means. This concept--automatic dependent surveillance (ADS)--will be augmented by cooperative independent surveillance, incorporating ground and space radar and aircraft-derived altitude information. (As shown in Figure 2, radar satellites would be in relatively low orbits--approximately 500 miles above the earth's surface.) Terrestrial surveillance systems will be particularly appropriate in high-density terminal areas; primary radar will transition to predominantly weather-related functions. As noted for communications functions, compatibility, interoperability, and automatic and transparent switchover will be required between space-based and ground surveillance systems.

Representative Current Systems or Programs	Representative Planned Systems or Programs	Systems or Concepts Underlying 21st Century Systems
Civil:		
ARSR	ARSR, ASR, ARTS	ADS
ASR	ADS	Satellite radar
ARTS		
Military:		
ASR (AN/GPN-24)	ASR (AN/GPN-24)	ADS
ATCRBS (beacon)	AWACS	VORTEX (radar)
EARTS	Mark XV (beacon)	
AN/MPN	ATARS	
AN/FPN-47	SRV	
AN/FPS-117	AN/TPS-73	

Table 4. Representative Current, Planned and 21st Century System Elements for ATC Surveillance Functions

Weather Systems

Advanced technologies and functional capabilities--particularly in sensing and communications--will be applied to all aspects of assuring minimum weather impacts on flight operations and safety. Needed observational data of improved precision will be provided in greater quantity through weather satellites, doppler radar, enhanced pilot reports, and other mechanisms. Increasingly elaborate meteorological models running on powerful computers will convert the data into accurate localized forecasts, which can then be communicated automatically to controllers and flyers and displayed in ways that maximize their value. Advanced atmospheric disturbance detection equipment in the vicinity of terminals will virtually eliminate the threat now posed by unexpected windshear and microbursts. As a result, weather-related disruption of flight operations and schedules will be greatly reduced, with parallel improvements in safety.

Representative Current Systems or Programs	Representative Planned Systems or Programs	Systems or Concepts Underlying 21st Century Systems
Civil:		
NWS/FAA systems FSS	AWOS NEXRAD CWSU TDWR LLWAS	Integrated system using Mode S for communications
Military:		
COMEX-CDD 1000	AWDS NEXRAD	Integrated system using JTIDS

Table 5. Representative Current, Planned and 21st Century System Elements for Aviation Weather Functions

Airport Surface Traffic Systems

Sophisticated ground traffic systems, integrated with system-wide flow control, will be deployed at major airports to deal efficiently with ever-increasing levels of traffic and the need for greater capacity. Closely linked to terminal-area airspace control and landing systems, and based in part upon ground surveillance as well as cooperative automated interrogation of aircraft on the airport, Airport Surface Traffic Automation (ASTA) will provide controllers with computer-based support which enables sequencing of aircraft take-offs and landings in a manner which increases capacity and operational efficiency and reduces delays for individual terminals and the overall airspace system.

Airborne Systems

Continuing avionic advances, including greater functionality and much lower cost for relatively sophisticated systems, will lead to virtually universal use of special safety systems to provide an additional layer of protection. These will address detection and resolution of traffic conflicts (TCAS) and sudden weather-related hazards (e.g., windshear). Radar-based detection will be coupled to powerful computer technology using AI approaches for evaluating problems, and for identifying and recommending preferred responses. Sophisticated flat-screen computer displays will present a wide variety of information. Derived from ground sources and sensors on the aircraft, it will be processed to provide flight crews with specific and complete data on any aspect of the flight operation which may be of interest. This will include displays indicating traffic in neighboring airspace and synthetic vision images to support landing under reduced visibility conditions, as described previously.

Air Traffic Control

The air traffic control process of the future will be shaped by the advances in the systems and technologies described above. It will provide controllers with comprehensive and sophisticated automated tools processing and presenting more comprehensive and precise information, and will provide high-capacity digital communications with aircraft and flight crews. Many of the functions now performed by the controller will be substantially automated, with the controller having a more supervisory role than at present, dealing primarily with exceptions and special situations. The availability in the cockpit of detailed traffic information will make it possible for flight crews to take responsibilty for some functions currently handled by controllers, such as assuring aircraft separation and selection of routes.

The complexity of the 21st century system and the dramatic growth anticipated for civil aviation, both domestic and international, suggests that system design will be driven almost entirely by civil needs, and operationally there will be a trend toward increased civil roles and responsibility for shared fixed base ATC facilities currently operated by military services.

Tactical air traffic control systems will be needed to fulfill challenging and diverse military roles throughout the world with a flexible and rapid response. The tactical systems will draw upon the same conceptual approaches, technologies, and engineering advances as used by civil ATC (for example, dependence on satellite communications and automatic dependent surveillance), but will be realized in substantially different ways in order to meet requirements for mobility, adequate invulnerability to hostile action, security, and coordination with battle management systems. At the same time, they will necessarily also be fully interoperable with world-wide civil ATC operations.

Representative Current Systems or Programs	Representative Planned Systems or Programs	Systems or Concepts Underlying 21st Century Systems
Civil:		
ARTCC/TRACON	AAS,AERA TATCA	Extensive automation/integration
Military:		
NAS EARTS	NAS ATALARS ATNAVICS, ATCCS	NAS ATALARS

Table 6. Representative Current, Planned and 21st Century System Elements for Air Traffic Control Functions

Airspace Management

The cumulative result of the advances described above will change the nature of the entire air traffic control process and the role of virtually everyone involved with it. Controllers will be much less involved with routine separation and routing for individual aircraft, and will instead monitor overall system performance and manage traffic flows for maximum capacity. Flow control will become increasing global in nature, rather than national, and the number of control centers will be substantially fewer, since advanced communications systems will eliminate the need for physical proximity to the airspace being controlled and managed. Elaborate automated tools based on artificial intelligence and expert system techniques will support traffic management from gate push-back to arrival at destination gate, based on comprehensive knowledge of near-term traffic schedules, weather predictions, aircraft capabilities, special situations, degradation of any system elements, and optimal use of all airspace, including special-use regions.

Military tactical ATC systems will similarly provide safe, efficient, secure and survivable management, based on automated guidance and control of numerous aircraft from take-off to landing, for missions typically short in time duration, but which negotiate complex air defense corridors--sometimes in proximity to on-going civil operations--and achieving precision landings under zero visibility. They will be required to do this in a highly mobile and flexible way.

Representative Current Systems or Programs	Representative Planned Systems or Programs	Systems or Concepts Underlying 21st Century Systems
Civil:	ATMS	AERA
Military:	ATALARS	ATALARS
	MAMS	MAMS

Table 7. Representative Current, Planned and 21st Century System Elements for Air Traffic Management Functions

CONCLUSIONS AND RECOMMENDATIONS

This document was prepared as a response to the need of the Department of Defense Airspace Control Planning Panel to determine the air traffic control environment of the future. This paper is a first step in that process. Two points in particular should be central to future planning activities. The first is the truly global nature that air traffic control will have. The reality and importance of this trend is gaining wide acceptance in the civil sector both nationally and internationally. International efforts are under way to address the future growth of air traffic and the associated need to achieve a more expeditious system to accomodate global travel. The second area of concern is "interoperability." Past efforts have often appeared to focus on particular major acquisitions to maintain and strengthen the nation's military structure, such as AWACS and Global Positioning Satellite Systems. In the emerging global environment, issues going beyond individual systems become ever-more critical: the need for inter-system compatibility, flexibility and interoperability becomes a major concern. This is especially relevant for DoD, since the design and technology of the air traffic control system will increasingly be determined by civil, rather than military, requirements. Failure of involved parties to work together to address these relevant issues early in the planning stages would exact a high price in the future. A lack of broad designed-in compatibility could ultimately require additional funds for production admendments and adjustments, isolation of individual systems, or even lives lost in battle because of the inability to communicate effectively in real time. It is recommended that a concerted effort now be undertaken by a DoD entity in planning how best to manage military airspace concerns and interfaces. Given a focused DoD position, the ideas and cooperation and support of the civil sector can then be sought. Additionally, an appropriate follow-on activity would be to initiate discussions with any planning groups within our Allied counterparts to establish a joint, cost-effective and "global" position.

GLOSSARY OF ACRONYMS AND SYSTEM ABBREVIATIONS

AAS	Civil	Advanced Automation System
ACLS	Military	Automated Carrier Landing System
ADS	Civil	Automatic Dependent Surveillance
AERA	Civil	Automated En Route ATC
AN/ARC-164	Military	UHF Radio (airborne)
AN/FPN-62,63	Military	Precision Approach Radar
AN/FPS-47,117	Military	Air Surveillance Radar
AN/FRN-43	Military	VORTAC
AN/GPN-22	Military	Radar Data Transfer Subsystem
AN/GPN-24	Military	Airport Surveillance Radar
AN/GRN-20	Military	Tactical Aircraft Control and Navigation
AN/TPN-22,25	Military	Precision Approach Radar
AN/TPS-73	Military	Air Traffic Control Radar
ARSR	Civil	Air Route Surveillance Radar
ARTCC	Civil	Air Route Traffic Control Center
ARTS	Civil	Automated Radar Terminal System
ASR	Civil	Airport Surveillance Radar
ASTA	Civil	Airport Surface Traffic Automation
ATALARS	Military	Automated Tactical Aircraft Launch and Recovery System
ATARS	Military	Advanced Tactical Air Reconnaissance System
ATCCS	Military	Army Tactical Command and Control System
ATCRBS	Civil	Air Traffic Control Radar Beacon System
ATMS	Civil	Advanced Traffic Management System
ATNAVICS	Military	Air Traffic Navigation, Integration, Coordination System
AWACS	Military	Airborne Warning and Control System
AWDS	Military	Automated Weather Distribution System
AWOS	Civil	Automated Weather Observing System
COMEX-CDD	Military	Recorders for Automatic Terminal Information Service (ATIS)
CWSU	Civil	Central Weather Service Unit
EARTS	Military	En Route Automated Tracking System
FSS	Civil	Flight Service Station
GPS	Civil	Global Positioning Satellite
HAVEQUICK	Military	Interim Jam-resistant UHF voice communications
ILS	Civil	Instrument Landing System
IVCSS	Military	Integrated Voice Communications Switching System
JTIDS System	Military	Joint Tactical Information Distribution
LLWAS	Civil	Low-Level Windshear Alert System
LORAN-C	Civil	Long-Range Navigation
MAMS	Military	Military Airspace Mangement System
MIDS	Military	Multifunctional Information Distribution System (British counterpart to JTIDS)
MLS	Civil	Microwave Landing System
NADIN	Civil	Nation Airspace Data Interchange Network
NAS	Civil	National Airspace System

NEXRAD	Civil	Next Generation Weather Radar
PTAG	Military	Portable Tactical Approach Guidance System
RCAG	Civil	Remote Communications Air-Ground
RIVETSWITCH	Military	ATC Communications upgrade program
SRV	Military	Surveillance Restoral Vehicle
TATCA	Civil	Terminal Area Traffic Control Automation
TCAS	Civil	Traffic Alert and Collision Avoidance System
TDWR	Civil	Terminal Doppler Weather Radar
TRACON	Civil	Terminal Radar Approach Control Facility
TRV	Military	Tower Restoral Vehicle
VOR/DME	Civil	VHF Omnidirectional Range/Distance Measuring Equipment
VORTAC	Civil	VOR/Tactical Aircraft Control and Navigation
VORTEX	Military	Satellite-based imaging radar
VSCS	Civil	Voice Switching and Control System