Proceedings of the OTA Seminar on the Discrete Address Beacon System (DABS)

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Preface

In response to a request from the House Committee on Appropriations' Subcommittee on Transportation, the Office of Technology Assessment convened a 1-day seminar on January 31, 1980, to examine some of the impacts on the aviation system of the Federal Aviation Administration's (FAA) proposed implementation of the Discrete Address Beacon System (DABS) and the Automatic Traffic Advisory and Resolution Service (ATARS). The objective of the seminar was to provide an information update on the impacts of DABS implementation and to make this information available prior to the appropriation hearings at which Congress considered the FAA request for initial implementation funding, Specifically, the Committee requested that the seminar review the following:

- the impact of DABS/ATARS on the Air Traffic Control Radar Beacon Service;
- the compatibility of DABS/ATARS equipment with upgraded military equipment; and
- the extent to which FAA is and should be coordinating the development of DABS/ATARS with the International Civil Aviation Organization.

This document includes a summary of the seminar findings and a detailed account of the day's proceedings. OTA is undertaking an assessment of air traffic control. The technologies discussed in the workshop are among the many technologies relevant to that assessment. However, OTA does not at this point take a position on any candidate technology.

JOHN H. GIBBONS
Director

Definitions

DABS (Discrete Address Beacon System).—An improved secondary surveillance radar system which can interrogate a specific aircraft within a given airspace. The discrete address function also provides a highly flexible datalink communications capability in support of a wide range of advanced air traffic control services such as weather advisories and the Automatic Traffic Advisory and Resolution Service. The DABS sensor is more accurate than the existing radar beacon system. Increased accuracy may facilitate higher levels of automation in ground systems.

ATARS (Automatic Traffic Advisory and Resolution Service).--A service that would be carried through the DABS datalink and would provide certain air traffic control information automatically, instead of by voice contact with the controller. A pilot in an ATARS-equipped aircraft would receive information on either the identity and relative location, or the identity, location, and altitude, of aircraft in close proximity to his own, depending on the equipment carried in the other aircraft. ATARS receives the surveillance data from DABS sensors and then computes traffic and resolution advisories. In the event of a potential collision, ATARS transmits avoidance instructions. Prerequisites to aircraft use of ATARS area DABS transponder with an altitude encoder and an ATARS display.

NOTE: Appendix A contains a list of the full names of other acronyms used in this Background Paper.

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Summary

Congress is seeking assurance that there exists sufficient technical basis, user community support and user benefits to justify moving ahead with implementation of a major new air traffic control system which will require large funding over time. The following summarizes the statements and discussions during the l-day OTA seminar on the Discrete Address Beacon System:

- The Federal Aviation Administration (FAA) believes that the development work on DABS has been thorough and complete, and that the system is now ready for implementation.

- Some compatibility testing with military systems remains to be done, but neither FAA nor the Department of Defense (DOD) expects any unresolvable problems to arise throughout the remainder of the test program. In addition, there is a need to update some military Identification Friend or Foe (IFF) equipment, a need which exists independently of DABS.

- Debugging and developing confidence in DABS/ATARS requires the procurement and use of hardware in real-world operations in order to validate development and simulation test results. The initial congressional appropriation for implementation would support initial procurement of some of the hardware and allow debugging to begin.

- FAA has designed the DABS signal format to be compatible with existing secondary surveillance radar (SSR). Some questions on international acceptance remain, but are likely to remain unanswerable until the International Civil Aviation Organization (ICAO) can address them—a lengthy process. Rather than delaying the program by waiting for ICAO approval, FAA has gone to considerable lengths to make DABS interoperable and compatible with the present international SSR/ATCRBS (Air Traffic Control Radar Beacon Service) system, and has provided step-by-step information on the DABS program to the international community throughout its development. FAA asserts, without derogating ATCRBS in any way, that DABS will reduce garble (signal confusion due to simultaneous response from more than one aircraft) and enhance the quality of SSR/ATCRBS system response.

- It is impossible to predict with any confidence just what the user acceptance of DABS will be, or at what rate airborne equipment will be installed. No decision has been made on the question of mandatory versus voluntary airborne equippage, nor does there yet exist an approved ground site implementation plan.

- FAA's DABS Implementation Plan is being reviewed within the Agency. It is not likely to receive final approval by the Secretary of Transportation before mid-1980, although he has approved the initial implementation authorization request of $20 million.

- Airline operators and avionics equipment manufacturers foresee fleet operational benefits and marketing opportunities, and therefore are interested in early implementation of DABS. On the other hand, the more diffuse user community of private and business operators is reluctant to commit to a system whose benefits are not yet demonstrated and whose costs are not yet well-defined.

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- User community support would be expected to increase if and when a ground network were to be established, providing demonstrable services which users can evaluate vis-a-vis equipment investment and maintenance costs.
- Implementation plans for DABS should be carefully reviewed and monitored at the level of the FAA Administrator, the Secretary of Transportation, and the congressional committees having jurisdiction to assure that overall system needs are being met.

Opening Remarks

Dr. Gibbons

Dr. John H. Gibbons, Director of the Office of Technology Assessment (OTA), convened the Seminar. Dr. Gibbons briefly described OTA's organization and mission. As one of the several agencies of Congress, OTA addresses complex issues in which substantial components of science and technology are part of the overall calculus of Government policymaking. This is done to clarify for Congress both the range of policy options and the potential impacts of adopting each of these options. Dr. Gibbons noted that because of this very broad charge, and also because of OTA's responsibilities to all the committees of Congress, the organization divides its wide variety of activities into nine program areas, one of which is concerned with transportation issues. Several studies are underway at the present time on different aspects of the impact of advanced air transport technology, undertaken at the request of the House Committee on Science and Technology and the Senate Committee on Commerce, Science, and Transportation. These studies examine issues concerning local air service to small communities, air cargo, and advanced transport aircraft.

The complexities of managing modern air traffic are of great concern to Members of Congress and others, so OTA is considering plans for a study exploring issues and options concerned with potential improvements in safety and efficiency of the U.S. Airport and Air Traffic Control (ATC) System. In advance of a decision to proceed on this proposed effort, the DABS Seminar is being held in response to a special request from Congressman Duncan's House Appropriations Transportation Subcommittee. Noting that this Seminar is an unusually quick response, Dr. Gibbons expressed his expectation that the information to be presented would be of assistance to the Subcommittee in its upcoming hearings on FAA's initial request for DABS implementation funding. Dr. Gibbons noted that the participation of three distinguished Members of Congress (Senator Cannon, Representatives Duncan and Harkin) in the opening of the Seminar underscored the importance of the day's deliberations. He first introduced Senator Howard W. Cannon, Chairman of the Senate Committee on Commerce, Science, and Transportation, and also Chairman of the Subcommittee on Aviation.

Senator Cannon

Senator Cannon's remarks expressed the concern for safety that Members of Congress share with the aviation community. He briefly reflected upon the history of aviation, noting that during the first half century or so of aviation, most safety advances took place in the aircraft themselves, i.e., their design, construction, and performance characteristics. The next major advances resulted from the introduction of the turbine engine, which brought with it such a remarkable increase in powerplant reliability that in-flight power failure has become a rare event, In addition, the jet engine made over-weather flying routine. As the safety, dependability, and comfort of air transportation increased, its acceptance and use increased rapidly, thereby leading to air traffic congestion and the need for new improved methods of control as the next major phase of our quest for aviation safety. Senator Cannon observed that this Seminar constitutes an initial stage in OTA's proposed assessment of technological approaches to the Nation's growing need for an expanded system of ATC and collision avoidance. He recognized DABS as a major advance in technological re*sponse to* these needs. The ability to instantly interrogate and transmit messages to a specific aircraft, free of the garbling often encountered in today's beacons, will provide needed assistance to pilots and controllers and will add significantly to air safety. Senator Cannon observed that this Seminar offers an opportunity for participants to become familiar with the status of development and testing of the system. He suggested that the compatibility of the proposed DABS with other airways modernization systems under development (e.g., microwave landing systems, communications systems, computer advances, and possible civilian use of the Global Positioning Satellite) be kept in mind.

Dr. Gibbons

Dr. Gibbons next introduced Congressman Robert B. Duncan, Chairman of the Subcommittee on Transportation of the House Committee on Appropriations, noting that it was at Congressman Duncan's and Congressman Conte's request that this Seminar was being held.

Rep. Duncan

Congressman Duncan referred to the vast array of complex issues which face Members of Congress and their staff, noting in particular the confusion often generated by the lexicons used to describe the new technologies. Members of Congress must deal rationally with funding decisions that are presented to them. Congressman Duncan endorsed Senator Cannon's emphasis on the need for compatibility between systems, adding that cost-benefit tradeoffs must be accurately presented and that compatibility with the international ATC system must be ensured. He noted the leadership position in aviation that the United States holds—we manufacture more aircraft, carry more passengers more miles, have more privately owned airplanes, and carry more cargo by air than does any other nation—as well as the superiority of equipment and people who operate that equipment. Congressman Duncan spoke of the anticipated growth in U.S. aviation which, while providing increased benefits to the country, will also impose the need for safe and efficient growth in the system that handles the increased traffic. Noting that aviation safety is not a simple matter with simple solutions, he observed that FAA's fiscal year 1981 budget requests for facilities and equipment have increased to about $350 million; over the next 5 fiscal years, these requests are expected to total more than $2 billion. He reminded his audience that urgent fiscal year 1980 supplemental requests totalling $19.2 billion are currently pending before the Committees on Appropriations, and that it is imperative that we know to the best extent possible the expected value of any proposed system.

Congressman Duncan expressed the expectation that in the next decade large funding requests will be submitted to implement a number of new systems for microwave landing, collision avoidance, navigation, communication, and surveillance, as well as the upgrading of computer elements in the ATC system. In anticipation of these substantial investments, the House Committee on Appropriations' Transportation Subcommittee feels strongly that an independent assessment should be made of future air transportation scenarios and the system modifications by which FAA proposes to meet these needs. He emphasized the committee's desire to determine that the most reasonable technological and economic alternatives are being considered. Congressman Duncan explained that the Appropriations Subcommittee, acting through himself and Congressman Conte, the ranking Republican in both the subcommittee and the full committee, had therefore asked OTA to conduct an assessment which addresses two major issues:

Issues

- What are the relative merits of alternative ways of increasing airport and terminal capacity to meet future demand while reducing safety hazards?
- What feasible alternatives to the current air traffic control process would reduce controller workload, increase productivity, reduce delays, and in general increase the safety and productivity of the air transportation system?

Acknowledging that such a study, properly done, will take a considerable amount of time, Congressman Duncan observed that Congress is faced with a fiscal year 1981 budget request of $20 million to begin procurement of DABS/ATARS. The eventual total cost estimate for this procurement is in excess of $250 million for the ground installations alone. Added to this is a significant cost to users of this system for airborne equipment. He acknowledged that FAA clearly believes that DABS/ATARS is an essential element of its effort to enhance the safety and productivity of the air transport system. He added that the DABS datalink service could be the focal point of numerous other possible air traffic control system developments. He noted, however, that other groups contend that there are alternatives to DABS which should also be evaluated. He referred to a recent American Institute of Aeronautics and Astronautics report which argues that long-range plans should aim at minimizing dependence on ground-based radar, adding that systems which help aircraft to navigate precisely without outside human guidance would help greatly to assure efficient separation from other traffic.

Congressman Duncan stated that because of the importance and potential safety impact of the DABS issue, his committee has taken two actions:

- FAA has been directed to contract with the National Aeronautics and Space Administration (NASA) for an evaluation and test of the trimodal beacon collision avoidance systems, and
- OTA has been requested to conduct a review of DABS/ATARS prior to the committee's consideration of the fiscal year 1981 budget.

NASA's Langley Research Center staff is currently proceeding with the technical evaluation of trimodal BCAS, and a report from them is expected in the near future.

Some of the questions the committee would like reviewed in this Seminar are:

Seminar focuses

- What impact will the DABS/ATARS have on the Air Traffic Control Radar Beacon Service (ATCRBS)?
- Will the DABS/ATARS equipment be compatible with upgraded military equipment?
- To what extent is and should FAA be coordinating this development with ICAO?

In addition, Congressman Duncan expressed interest in having the Seminar address the potential for growth that may exist in the present air traffic control system, noting that some knowledgeable people suggest that it could handle growth at least until the end of this century. Problems of international acceptance of a new system and its cost suggest that making full use of the present system's potential for growth might be a wise and prudent course to follow.

Dr. Gibbons

Dr. Gibbons next introduced Congressman Thomas R. Harkin, Chairman of the Subcommittee on Transportation, Aviation, and Communications of the House Committee on Science and Technology, noting that it was under his guidance that OTA's earlier air transportation studies have been undertaken.

Rep. Harkin

Congressman Harkin expressed the longstanding personal interest that he and his staff members have in aviation and its progress. He noted that ever since the Committee on Science and Technology was given jurisdiction over FAA R&l) activities in 1975, its members have followed the progress of DABS and its controversies. When the committee became concerned about possible interference problems both within the system and external to it, they authorized $100,000 for an outside evaluation by the National Telecommunications and Information Administration. Although preliminary information indicates that no unresolvable problems exist, Congressman Harkin feels that the evaluation process is not complete. He felt confident that if the DABS Seminar bears out the preliminary findings, the subcommittee will recommend implementation of DABS.

Project review

Congressman Harkin went on to say that he strongly advocates frequent R&D project scrutiny of the kind provided by the DABS Seminar. With R&D projects or equipment at the most advanced state-of-the-art, new information and data are continuously being developed; new problems arise, too, which may require a shift in emphasis or funding priorities. Thus, when extended periods of procurement and rapidly moving technology are involved, Congressman Harkin feels that Congress should periodically review and reaffirm its decision to proceed with major R&D projects. As an example of this process he referred to the Aerosat program, in which Congress was substantially on its way to making a multimillion dollar commitment when the original justification was materially weakened by changed conditions. By virtue of the annual review process, this situation was detected and Congress was able to defer the project. Based on this experience, Congressman Harkin expressed his belief that, when Congress considers implementing another major system, it is timely to review the benefits and costs and to be certain that all fundamental problems have been resolved. A proposed system should make sense when viewed as an element of the future ATC system. To this end, Congressman Harkin urged the consideration of three factors:

- *Safety:* How does DABS fit in with our overall goal of safer ATC of increased traffic on congested airways?
- *Energy:* How does DABS fit in with the overall energy picture we will be facing in the future? For instance, Congress has authorized NASA to spend $0.5 billion for R&D to make engines more fuel-efficient and to find new materials that will permit airplanes to fly safer and faster as well as more efficiently. But the savings achieved through this expensive R&D can be easily wiped out if the aircraft are unduly delayed by poor air traffic control. Can DABS, therefore, help our air transport system to conserve energy?
- New *Concepts:* How does DABS fit in with other new concepts related to a global system of ATC and with the possibility that Navstar or a global positioning system (GPS) will be the navigational system of the future?

Mr. Maxwell

Chairman Maxwell added his welcome to those of the preceding speakers and expressed appreciation to the three Members of Congress for setting the tone of the Seminar and explaining why OTA is involved in the topic. DABS is a timely subject because the system is approaching the point of transition from design and development to implementation. Congress is preparing for the possible commitment of a very large sum of money; once such commitments are made, major changes will be more difficult to make.

Mr. Maxwell, noting the presence of several who had participated in the activities of the Air Traffic Control Advisory Committee (ATCAC) a decade ago, recalled that the DABS concept was first suggested by ATCAC. He observed that the DABS concept has stood the test of time very well, having matured in its technical details and design during a period of rapidly changing electronic technology. He stressed that the OTA Seminar is not questioning the technical capabilities of the system, but rather is examining both the potential impacts of the implementation of the system and the degree to which it fits into the overall air traffic control picture. Chairman Maxwell described the plan for the remainder of the day's program and urged those present to be forthright in their comments, questions, and observations about the presentations and discussions. He then introduced Mr. Quentin S. Taylor, Deputy Administrator of FAA, as the first speaker on the FAA portion of the program.

Presentations by the Federal Aviation Administration

Mr. Taylor

Mr. Taylor provided an overview of the ATC system of the future. He described DABS as a fully compatible major improvement of the current international SSR, known in the United States as ATCRBS. ATCRBS currently provides the controller with range, azimuth, identity, and altitude information from all altitude-reporting transponder-equipped aircraft. DABS adds improved surveillance quality, discrete aircraft addressing function, and the technical base for a digital communication exchange system. The latter is obviously a very important feature. Mr. Taylor pointed out that FAA has described DABS and the plans and expectations for its implementation many times and in many forums—FAA meetings, meetings with users and industry, international meetings, and meetings and hearings before various bodies of Congress. Partially as a result of this widespread dissemination of information on DABS, FAA feels very confident about the system and the need for it.

Mr. Taylor went on to say that, in FAA's view, the research and development leading to implementation is complete, and that the resulting system is proving to exceed their expectations. FAA perceives broad general support in both industry and the user community for a compatible and evolutionary upgrading of ATCRBS. Mr. Taylor noted that DABS does indeed provide this sought-for compatible evolution from existing internationally standardized SRR, and that DABS was recognized a decade ago as an essential part of an evolving ATC system. To underscore this, Mr. Taylor quoted the 1969 ATCAC report:

> The Committee believes that the air traffic control radar beacon system should be upgraded by (1) providing for the use of phased array and interrogator antennas in the denser hubs to achieve enhanced accuracy and data rate, and (2) by including an additional discrete address mode to increase capacity in the denser regions the addition of this mode would permit the simple addition of two-way air traffic control data link service with ample capacity for the traffic forecast for 1995 . . . upgraded air traffic control radar beacon systems could (thus) provide a common data acquisition data link system which would operate nationally on a single channel.

The committee agreed that the ATCRBS should be upgraded, rather than replaced, it reached a conclusion on the basis of feasibility, cost, and technical risk studies which examined an array of options for a compatible upgrading of ATCRBS.

Mr. Taylor said that DABS implementation will come very close to fulfilling ATCAC's recommendations. He traced the long evolutionary path of research, analysis, design, and testing of DABS, and noted the prototype testing now underway. While all of this has been going on, FAA has been continually studying the needs of the ATC system of the future, and it has become clear, in their view, that DABS lies at the heart of many of the sought-for systems improvement programs. This viewpoint is borne out by various cost-benefit studies and system analyses. He pointed out that further automation of the ATC process will require the surveillance quality that DABS in fact provides. DABS, with its integral datalink, makes possible the realization digital communications for a whole variety of potential applications, among them being the automated traffic advisory and resolution service, connecting ATC automation systems with aircraft automation systems, automatic clearance delivery, rapid transmission of severe weather information, and the potential use of cockpit displays of traffic information.

Mr. Taylor pointed out that FAA has exhaustively studied alternative approaches to achieving these goals and has been convinced by their results that DABS, with its integral datalink, is the most practical and cost-effective way for FAA and the users—especially the general aviation users—to achieve the services and system improvements that ATC requires in order to cope with air traffic demands foreseen in the coming years.

Mr. Taylor noted that the United States is not alone in pursuing evolutionary improvement of the ATCRBS or, as it is known abroad, the ICAO-SSR system. Two other countries, in fact, are presently developing systems which are fully and totally compatible with both DABS and the existing ICAO-SSR system. Thus, there has been an extensive effort, here and abroad, to ensure that compatibility with the ICAO-SSR and with each other is a fundamental part of these system improvements.

Mr. Taylor noted that DABS has been openly discussed with the user community for a number of years, and that last summer FAA surveyed the users again regarding their views of DABS and the various potential impacts of its implementation. The results of that survey have indicated to FAA that there is broader agreement presently than had earlier existed on the importance of DABS and an orderly transition to it. Based on their own studies and their discussions with the user community, FAA believes that DABS is ready for implementation. Mr. Taylor concluded his remarks by welcoming the examination of DABS that the Seminar provides, and expressed his hope that the participants' conclusions regarding the importance and effectiveness of DABS will be similar to FAA's.

Mr. Maxwell

Chairman Maxwell thanked Mr. Taylor for his statement, pointing out that OTA does not reach conclusions in these seminars; rather, they come up with findings which are taken into consideration by the Members of Congress and their staffs in reaching conclusions. He noted again that the purpose of the Seminar was to provide a broader base of information rather than to support one particular conclusion or another. Chairman Maxwell next introduced Mr. Siegbert B. Poritzky, Director of FAA's Office of Systems Engineering Management, who presented an overall status report on DABS.

DABS Status

Mr. Poritzky

Mr. Poritzky noted that Mr. Taylor had laid out the FAA basis for transition to DABS. His presentation added more detail and provided some insight on DABS applications that FAA envisions. While acknowledging that OTA's intention was not to discuss airborne collision avoidance systems in this Seminar, Mr. Poritzky nevertheless pointed out that DABS and ATARS (which will be carried on the DABS datalink) are integral parts of FAA's approach to aircraft separation assurance, and that a brief description of this interaction would be appropriate.

Collision avoidance

Mr. Poritzky referred to the record of extensive and detailed expositions of FAA's aircraft separation assurance program made during the June and July 1979 hearings before the House Science and Technology Subcommittee on Transportation, Aviation, and Communications. Adding to the information recorded in those hearings, Mr. Poritzky stated that FAA's integrated program of aircraft separation assurance, which includes the DABS datalink and ATARS, in addition to active and full beacon collision avoidance systems, conflict alert service, and protected air space, offer the highest practical degree of protection against collisions which can be devised at this time. He pointed out that no single element can do the job, but that an integrated multielement system, each part of which contributes to the aggregate safety of the system, is the best course in FAA's view. He reiterated the point that DABS, its datalink, and ATARS represent the cornerstone of backup protection against collisions in high-density terminal areas.

Mr. Poritzky briefly described the current international standard ATCRBS or SSR as using a ground interrogator which transmits a simple interrogation to all aircraft within its coverage, soliciting either aircraft identity or aircraft altitude in a sequence of interrogations. The aircraft transponder, which is identical for either ATCRBS or ICAO-SSR, replies and provides discrete aircraft identification with one of 4,096 identity codes. This permits the ground system to present aircraft position and range and azimuth and provides aircraft altitude if the aircraft is equipped with an altitude encoder. The system is an evolutionary improvement over the World War II IFF system. Mr. Poritzky went on to point out that DABS is in reality the ATCRBS/SSR to which has been added three features: 1) technical improvements, 2) capability for discrete addressing of aircraft, and 3) a datalink capability.

Garble

Mr. Poritzky next addressed some problems encountered in the present ATCRBS/SSR system. He noted that the number of codes is limited. Since the ground system interrogates all aircraft with the same interrogation code, all aircraft within coverage reply as soon as the interrogations are received. When replies from more than one aircraft are received simultaneously or nearly so, the identity and altitude replies can be garbled, an effect known as "synchronous garble." Since garble diminishes the accuracy and lengthens the acquisition time

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of a target, the control process must take this into account by providing additional safety buffers in aircraft separation, leading in time to delays and less efficient use of the airspace. Another problem arises because a number of interrogations are required of each aircraft in order to positively establish target identity and altitude, and because there may be a number of ground interrogators in each area. Such a situation in a high-density traffic area generates non-synchronous interference, called "fruit." Since many ground stations, both civil and military, may be in a given geographical area, great care must be exercised in order to avoid interference or overloading of transponders. Mr. Poritzky noted that these effects were known long before the ATCAC recommendations of 1969, and that there has been wide agreement as to the necessity of system upgrading in order to overcome these shortcomings.

Fruit

DABS—an evolutionary development

Mr. Poritzky stated that DABS was envisioned as such an evolutionary upgrading. Its great potential is indicated by its capability to accommodate 16 million codes for future automation, instead of ATCRBS' present 4,096. DABS also provides significantly higher accuracy than does the current system. It has no self-limiting interference, and in fact reduces interference to the existing ATCRBS/SSR system when both are used simultaneously in the same geographic area. It also provides an inexpensive way to provide highly reliable automatic datalink communications integrated with the discrete address transponder.

Mr. Poritzky again pointed out that compatibility with, and evolution from, the ATCRBS/SSR has been a basic requirement of the design from the beginning. He noted that the prototype DABS systems now at NAFEC are, in fact, combined ATCRBS/SSR and DABS systems, as indeed they must be throughout a long transition period both in the United States and abroad. Mr. Poritzky said that many of the improvements to the basic beacon systems which are a part of DABS are also applicable to the basic beacon system. As an example, he mentioned that the application of monopulse antenna and receiver techniques improves not only the performance of DABS but that of ATCRBS also. DABS can thus be thought of as a series of evolutionary technical improvements fully compatible with the current international system. The discrete addressing function to be incorporated makes possible a series of new capabilities in the evolving ATC system.

DABS applications

Mr. Poritzky next described a few of the applications of DABS and its datalink. Of great importance, he noted, is the capability, through its discrete address feature, to provide a high-integrity, high-accuracy basic surveillance capability which can be used by today's as well as tommorow's ground computer systems. The garble-free, high-accuracy replies from aircraft will form a far better surveillance data base than the existing system can ever provide.

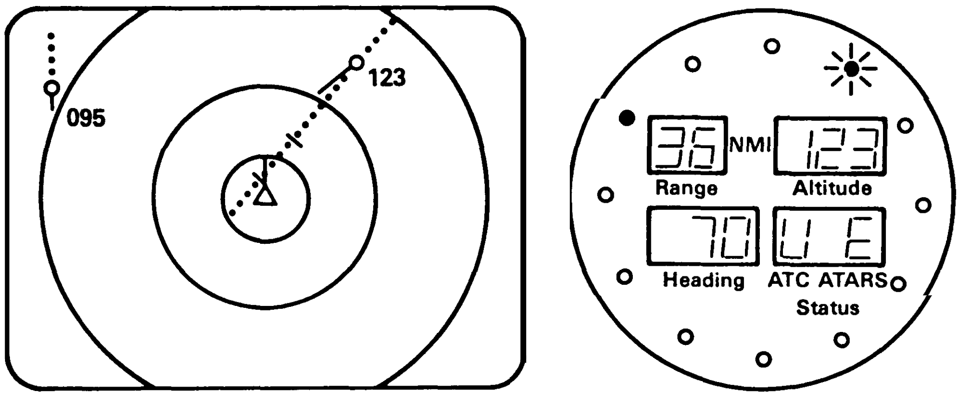
This high-integrity surveillance data is required by high-integrity, improved automated ground ATC data processing systems. DABS provides a mechanism for increasing the data rate of aircraft replies in specific flight regimes, if in fact this capability becomes necessary for the kind of integrated terminal flow management system which is expected in future terminal areas. The Automated En Route Air Traffic Control (AERA) system under development in the advanced concepts operation will require the quality of surveillance capability and datalink capability that ATCRBS/SSR/DABS provides. This reinforces the key role of DABS in future automation.

Mr. Poritzky noted that ATARS uses the surveillance data from the DABS sensors and computes traffic advisory and resolution instructions in a dedicated ground computer system. These messages are delivered to the aircraft via the

DABS datalink. ATARS will provide a long-sought-for traffic advisory service and a resolution service for aircraft operating on instrument flight rules (IFR) and visual flight rules (VFR), respectively. In VFR operations, ATARS is expected to enhance the pilot's see-and-avoid capability by providing the advisories automatically and fully, rather than on request. The resolution service will also provide collision avoidance services not previously supplied to VFR aircraft. For IFR aircraft, the advisory and resolution information will serve primarily as a backup to the ATC system.

ATARS-equipped aircraft may receive traffic advisories regarding both proximate aircraft and those which constitute a potential threat. Mr. Poritzky showed an example (figure 1) of displaying such information and commented that in the

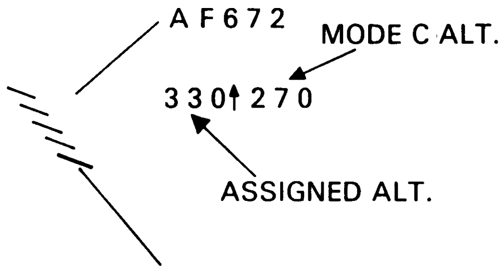
Figure 1.—ATARS Displays



future, DABS and its datalink may be used to provide the cockpit with information on traffic of concern in a more general form. Mr. Poritzky showed an example of a possible cockpit display of traffic information. Another possibility offered by DABS datalink is the prospect of providing automatic clearance confirmation to the pilot, Mr. Poritzky showed a way in which DABS datalink could provide altitude assignment confirmation en route. In the case shown (figure 2) the controller assigns an altitude via voice and at the same time inserts the assigned altitude into the computer. The datalink message is automatically initiated and relayed to the cockpit display. This function would help to prevent misunderstood assigned altitudes or incorrect controller entry of assigned altitudes. Still another way the system can be used is for minimum safe altitude warning (MSAW) (figure 3). The minimum altitude and geography would be stored in the computer on the ground. The MSAW alert is generated by a special "look-ahead" algorithm and the pilot is alerted by a datalink message which he acknowledges. The controller is warned by a flashing "LOW ALT" legend below the affected datablock. This alert would continue until the aircraft is reported above the minimum safe altitude.

Another application described by Mr. Poritzky is that of transmitting severe weather information. Very near real time weather information would thus be available to the flight crew. Mr. Poritzky noted other candidate uses for DABS datalink (figure 4). For instance, DABS datalink can control a beacon collision avoidance system (BCAS) from the ground in areas where BCAS cannot function independently. The DABS datalink format will also be used for air-to-air resolution of collision avoidance maneuvers. Mr. Poritzky pointed out that the wide variety of valuable services that the datalink can potentially offer makes it neces-

Figure 2.—Altitude Assignment Confirmation-En Route

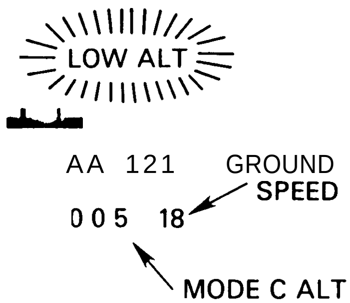


- CONTROLLER ASSIGNS VIA VOICE - PILOT ACKS.
- CONTROLLER INPUTS TO CCC A NEW ASSIGNED ALT.
  - A DL MESSAGE IS AUTOMATICALLY INITIATED TO PILOT
- PILOT SEES AND CONCURS
  - NO FURTHER ACTION
- PILOT SEES AND NON-CONCURS
  - VOICE RESPONSE

THIS FUNCTION CORRECTS:

1. PILOT MISUNDERSTOOD ASSIGNED ALTITUDE.
2. CONTROLLER INCORRECT ENTRY OF ASSIGNED ALTITUDE.

Figure 3.—Minimum Safe Altitude Warning-Terminal



THIS FUNCTION WARNS:
PILOT AND CONTROLLER
WHEN A/C DESCENDS BELOW
MINIMUM SAFE ALTITUDE.

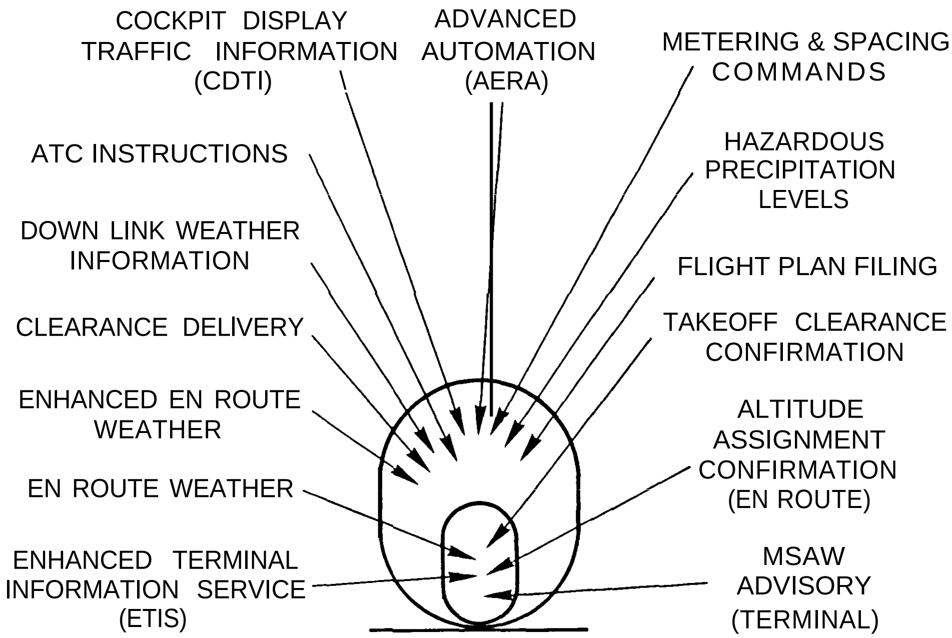
- MINIMUM ALTITUDE & GEOGRAPHY STORED IN COMPUTER
- MSAW ALERT-GENERATED BY MSAW LOOK AHEAD ALGORITHM
- CONTROLLER ALERTED BY: FLASHING "LOW ALT" ABOVE DATA BLOCK
- PILOT ALERTED BY: DATA LINK MESSAGE
- PILOT ACKNOWLEDGES
- ALERTS CONTINUE UNTIL A/C IS REPORTED ABOVE MSAW ALTITUDE LIMITS
- ALL ALERTS ARE REPEATED IF A/C DESCENDS BELOW MSAW ALTITUDE LIMITS.

sary in the near future to establish protocols and priorities for these various services. Again, he pointed out that DABS and its datalink are at the heart of air traffic control improvement.

Alternatives to DABS

Mr. Poritzky then addressed a point referred to by Mr. Taylor, that of whether viable alternatives to DABS are readily available. As an example, he postulated an improved ATCRBS/SSR using a separate datalink on a different frequency for the datalink communications. Over the years, many datalink concepts have been proposed but very few have actually been implemented. Mr. Poritzky again pointed out the dramatic improvement in surveillance data provided by DABS. Its advantage over the postulated example is that it operates on a single frequency; an integral DABS datalink requires no tuning in the aircraft, thus adding an

Figure 4.—Candidate Datalink Services Evolution



important safety dimension, particularly in general aviation. FAA studies have shown clearly that an integrated transponder datalink package is and will continue to be far less expensive than separate packages for surveillance and datalink. These many features and advantages of DABS lead FAA to believe, and their best indications are that the aviation community believes, that users will likely volunteer to implement an integrative transponder datalink in substantial quantities in order to get the benefits from the wide variety of datalink services and the benefits from the improved surveillance information that the integrated system achieves.

Mr. Poritzky noted that FAA studies, strongly supported by the aviation community, show that DABS and its datalink are the right systems for the future. He cited the recent new engineering and development (E&D) initiatives consultative process which has involved many industry experts. The report of that effort shows that there is essential unanimity in the user community on the need for DABS and its datalink. Mr. Poritzky claimed that there is little doubt reflected in that document that the user community broadly shares FAA's view that DABS is an essential element of ATC resolution, Mr. Poritzky described a user community survey conducted last July (figure **5)** to ascertain user views. The results showed very strong support.

ICAO compatibility

He pointed out FAA's policy of ensuring that everything known about DABS during its development is made known to ICAO and the world community, through public meetings, briefings, symposia, and formal briefings to ICAO itself. A fundamental requirement recognized and followed by FAA is that any improvement to ATCRBS/SSR would have to be done compatibly with the ICAO standard SSR in a way which would not make existing air or ground equipment obsolete. FAA has dedicated itself to the premise that transition from SSR to DABS would be slow worldwide and that many ICAO nations would find the basic SSR system satisfactory long after other, such as the United States, have made the transition to the new system. Not only must the systems be compatible, but they must be inter-operable. In addition, FAA is determined that the in-

Figure 5.—Aircraft Separation Assurance Program Formal User Comment Summary-July 1979

	ALPA	AOPA	ATA	EAA	GAmA	NATA	NBAA	NPA
Conflict Alert	PRO	PRO	PRO		PRO	PRO	PRO	PRO
IFR Flight Plans	PRO	CON	PRO		CON[2]	CON	CON	CON[2]
Increased Voluntary Use of Transponders	PRO	PRO	PRO	PRO	PRO	PRO	PRO	PRO
ACAS	CON	CON	CON	PRO	CON[3]	CON	CON	CON[3]
BCAS	Con-Active Pro-Full	Wait & see	pro-Active Wait & See Full		PR0[3]	PRO	PRO	PR0[3]
DABS	PRO	Wait & See	PRO		PRO	PR0[4]	PRO	PRO
ATARS	Wait & See	Wait & See	PRO	CON	PRO	Wait & See	PRO	PRO
PWI	CON	Wait & See	CON				PR0[5]	

[1]If required for increased traffic capacity, not for collision avoidance systems.
[2]Impractical to file for advance clearance at most locations.
[3]This position depends on expeditious BCAS development.
[4]If a reasonable and timely transition plan is developed.
[5]If effective, in VFR uncontrolled airspace.

production of DABS will not detract from the performance of either ground or airborne SSR systems. In fact, Mr. Poritzky stated, it should and will improve it. He noted that in defining its development policy for aircraft separation assurance, FAA recognized that the American problems of high traffic density, broad but not universal use of transponders, and a very high level of general aviation were perhaps unique in the world. It was assumed that other nations might eventually join in these efforts and might also find use for the major improvements to SSR and inclusion of the discrete address and datalink functions. For instance, the United Kingdom has worked on a selective address system improvement called ADSEL; and as a result of very close Anglo-American cooperation the signal formats for DABS and ADSEL are identical. The U.S.S.R. has also worked with FAA in this matter and has expressed a strong interest in DABS, at least until a couple of weeks ago, and interest has been indicated by a number of other countries as well. FAA has discussed the matter with a number of other countries, and European organizations are studying DABS and its capabilities. Eurocontrol has a task force working to examine the capabilities of DABS and to prepare for eventual standardization. An organization called Euro-K, which is an association of European avionics manufacturers, is at work on airborne equipment characteristics.

Transition

The question arises, however, of the impact on foreign air carrier aircraft operating into the United States if a domestic full implementation of the DABS datalink, accompanied by publication of airborne collision avoidance system standards and partial BCAS implementation, is effected prior to an ICAO decision on a worldwide standard. Mr. Poritzky discussed this impact by noting that because DABS and BCAS are both compatible with the existing ICAO-SSR system, any foreign aircraft entering U.S. airspace in a DABS and BCAS environment will continue to receive the same services provided today in accordance with existing ICAO provisions and agreements. It is possible that this may not be a satisfactory answer, especially to international air carriers who may worry that they will receive less protection or less service than U.S. carriers equipped with DABS and its datalink terminal or with BCAS. If and when the United States provides DABS, its datalink service, and ATARS, international carriers with only altitude reporting transponders will still be given full service and full protection to the extent that their SSR system can provide those services. When the datalink is used to provide ATARS or a clearance verification service or digital weather transmissions, only aircraft carrying the necessary airborne hardware can take advantage of those new services. The same applies to BCAS. The full safety services recommended by ICAO will be provided to any foreign carrier. But if the additional services provided by the upgraded system are desired by the foreign carrier, airborne equipment will be needed.

ICAO standardization

Mr. Poritzky stated that FAA has and will continue to make available to all foreign carriers the necessary information to permit them to make their own judgments. At the appropriate time, when and if international interest warrants —and he noted that there is some interest and more interest is developing— international standardization, especially of the DABS format, can be considered. He reported that the ICAO Air Navigation Commission has recently expressed interest in the problem of collision avoidance and inferentially DABS, and the ICAO secretariat has been charged to study the matter and consider possible actions.

Mr. Poritzky noted also that the United States and several other interested states are anxious to continue the flow of information on its developments and to cooperate in any way ICAO wishes in order to pursue DABS and the broader aircraft separation assurance issues. FAA thinks that there will be an eventual need for formal international standardization of the DABS signal format in ICAO. That process can move on a deliberate basis, in FAA's opinion, because DABS is totally compatible with the existing system and will not deter continued use of the existing system by others. Mr. Poritzky expressed the belief that the United States should make no attempt to force DABS on ICAO, noting that there is little immediate need for it outside the United States. When the states of ICAO believe the time is right for initiating the standardization effort, FAA will be ready to participate.

GPS/Navstar

Mr. Poritzky concluded his formal presentation by commenting on the potential interaction of DABS with GPS Navstar. Most people in the field know that FAA has a significant effort underway to examine the capabilities of Navstar as part of the Secretary of Transportation's broad study, in cooperation with the Department of Defense, of the potential utilization of GPS. Mr. Poritzky noted that GPS is a position-determining system which can be used for navigation. That is certainly its primary civil function, and he pointed out that the DABS issues are primarily concerned with improved ATC surveillance and datalink communications. He further noted that a strong feeling has existed within the aviation community over the years that navigation and surveillance should be separate to the extent that it is practical to avoid a single-thread system. To the extent navigation and surveillance are combined in a single system, common mode failures can occur, with dangerous consequences. He favored continued investigation of the use of systems like GPS Navstar and other navigation systems so that position information could be broadcast to the ground when the aircraft was not in the coverage range of the surveillance system. But he pointed" out that there has been a problem confusing the navigation function of GPS Navstar and the surveillance function of DABS and the DABS datalink.

There is another limitation to using the aircraft navigation system to transmit aircraft position to the ground. The feeling has been held very broadly that, since one must depend for surveillance information on the aircraft with the cheapest and least maintained airborne navigation system, such an aircraft now becomes the standard for surveillance information. This further impacts safety unless separation standards are designed to recognize this problem. A clear distinction must be made between a navigation system which has the capability of transmitting its own position to the ground and a surveillance system which is independent from the capability of the navigation system to transmit position information.

Discussion of Mr. Poritzky's remarks

There followed some discussion of Mr. Poritzky's remarks, among which the following significant points were made:

- FAA's present interest in GPS Navstar centers around its navigation function for domestic purposes; however, over ocean areas where dependent surveillance is the only option available, FAA includes that aspect within their interest.
- The ICAO international standard is not likely to cover ATARS. Thus, there is the high probability that some international carriers operating into crowded U.S. international airports will not be equipped with the airborne capability to obtain full advantage from a DABS/ATARS system. This has implications of safety deficiencies, but the situation is true of any dynamic system where non-uniform technical advances produce small discontinuities. In this case, the best overall protection is achieved if everyone is equipped; however, given the anticipated long transition time to an upgraded system, there will also be U.S. operators who are not immediately equipped. In this kind of environment, DABS/ATARS is a backup system to the primary ATC separation system. ATARS is designed to handle both ATCRBS and DABS targets. It provides separation protection against an ATCRBS/mode C-equipped aircraft by providing collision avoidance information to the DABS-equipped aircraft. Thus, as the entire system undergoes the transition, an ATCRBS-equipped aircraft will get as much and possibly more protection than it now gets.
- The ICAO standard will create international agreement on signal format for DABS, the discrete address, and the datalink capability. There maybe subsequent agreements on protocol and priority for use of the datalink capability.
- No decision has yet been made regarding mandatory versus voluntary adoption.
- FAA believes that even on a voluntary adoption basis, the apparent improvements in basic service and the perceived benefits to be obtained ensure that there will be substantial user transition to DABS.

DABS Technical Program

Mr. Solat

Chairman Maxwell next introduced Mr. Norman Solat, Acting Chief of FAA's Communications and Surveillance Division, who described the technical requirements and the three phases of the DABS technical programs. Mr. Solat reiterated some of the background information provided by previous speakers, recalling that the ATCAC report of December 1969 recommended three things in the data acquisition area:

Technical goals

- improve accuracy and reliability of the aircraft position data;
- incorporate in the data acquisition system a digital datalink, which would provide automated ATC information to the cockpit; and
- implement intermittent positive control (IPC), now called ATARS.

ATCAC examined several alternative data acquisition systems, and selected a system that was based upon the need to achieve compatibility with the existing ATCRBS/SSR system, both in operation and in equipment. This requirement makes extensive use of the existing airborne and ground equipment, and thereby lessens the impact on the user by easing the transition phase.

Acceptance of these recommendations necessitated a period of research and development which eventually took the form of a three-phase development program:

- Phase 1.—Concept Validation and System Definition: An effort to design the system and examine its parameters. To choose the operating frequency of the system; to determine the kinds of error protection that would achieve high reliability in the datalink; to determine modulation formats; to examine interrogator or ground sensor design; and to determine means of implementing high-accuracy requirements by reducing garble.
- Phase 11.—System Engineering Development and Evaluation: An effort to develop engineering models for use by the National Aviation Facilities Experimental Center (NAFEC) to demonstrate the surveillance improvements obtainable with DABS, including the ATARS and improvements resulting from the datalink capability.
- Phase 111.—Procurement and Development of DABS: This phase has not yet been initiated.

Mr. Solat remarked that the Phase I methodology was mainly analysis and studies. While there were several industry design and cost studies concerned with minimum-cost transponder design, the major effort was carried out by Lincoln Laboratory in the design and construction of a DABS experimental facility (DABSEF).

Phase I

DABSEF was used to make laboratory measurements, demonstrate system feasibility, and gather new data through actual flight tests with simulated environments. Substantial documentation of Phase I work is available to interested parties. DABSEF demonstrates that a careful choice of modulation technique provides high interference protection within a single frequency DABS/ATCRBS environment. DABSEF experiments also demonstrated that DABS provides many improvements to the ATCRBS system, the most significant of which is monopulse processing, which enhances positional data accuracy and reduces pulse repetition frequency, which in turn reduces overall environmental interference.

Mr. Solat reported that using monopulse processing outputs in degarbling circuits greatly enhances reply processing and significantly reduces garbling in the ATCRBS mode of DABS. He pointed out another feature of DABS that has been demonstrated: the use of the discrete address, which sets up a discrete link between the ground sensor and an individual aircraft, which establishes a datalink with the capability to transmit ATARS information as well as advisories, commands, and other services to that particular aircraft. Error correction codes on the addresses can be used to significantly enhance the datalink's reliability. Through the use of discrete addresses, the number of interrogations can be greatly reduced, and as a result the electromagnetic environment is significantly unburdened. All of these features combine to provide a capacity which enables

DABS to handle many more aircraft than the present ATCRBS can. The product of the Phase I program was an engineering specification for the Phase II development of the system.

Phase 11 activities

Phase 11, as Mr. Solat explained, was a competitive engineering development program, which involved a competition for development of three engineering models. The award went to Texas Instruments, who delivered the three models between June 1978 and April 1979. The second part of Phase 11 is the present test and evaluation period at NAFEC. Crowded traffic models are employed in the ATC simulation to load the DABS sensor as it would be loaded in an actual crowded environment. Live tests are also used to gather data and to assess the accuracy of both the DABS signals and the position data on the controller scope. These tests consisted of performance testing to evaluate the capacity, accuracy, and reliability of the system; ATC testing to evaluate both the controller/DABS interface and the performance of the datalink; and interference testing, which is being conducted in several locations in addition to NAFEC. For example, at NAFEC, the tests are examining the ability of present aircraft to survive in a DABS environment and to make certain that DABS-equipped aircraft are not injecting interference into the present ATCRBS ground systems.

Tests being conducted at the Naval Research Laboratory are demonstrating that the civil systems—ATCRBS and DABS—are indeed compatible on a non-interfering basis with the military systems which operate on the same frequencies. At the Electromagnetic Comparability and Analysis Center in Annapolis, extensive simulations of DABS and ATCRBS interferences have just been completed. Simulations of DABS and military systems are now underway to assess the interference environment between these systems.

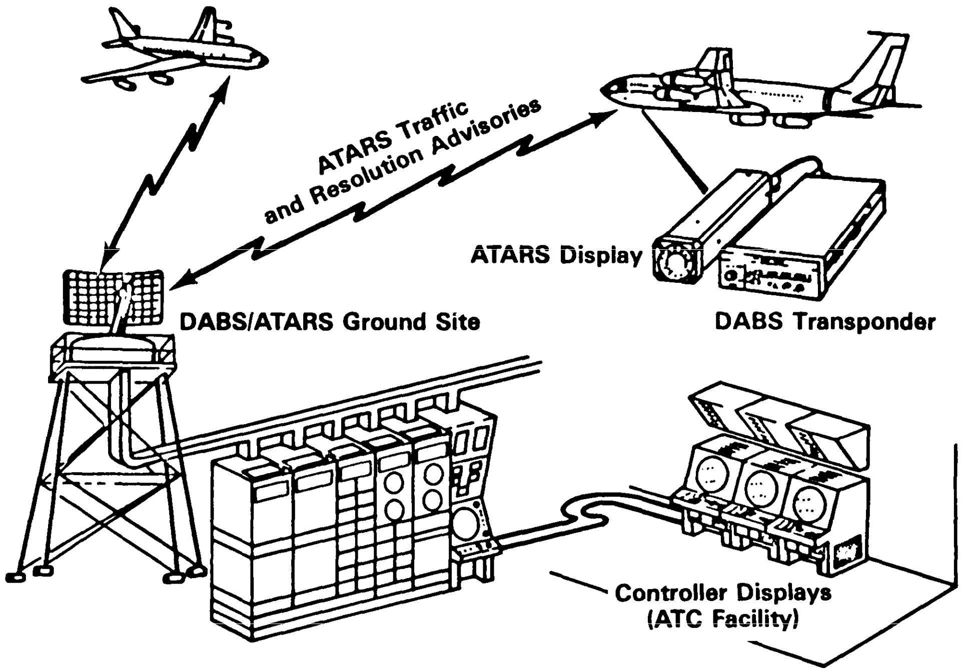
The product of Phase 11 is a transition plan on how FAA will ultimately move ATC from the present into the future. The plan is presently in preparation and is expected to be ready for the Administrator’s signature in February or early March. Mr. Solat reported that the R&D portion of the program is expected to be completed about April of this year when FAA’s operating services will receive a technical data package, consisting of product specifications and supporting data, as well as a DABS national standard.

Phase II results

The results of Phase II to date show that indeed ATCRBS and DABS modes operate compatibly, i.e., on the same frequency without mutual interference. The results also show that when DABS is phased into the existing ATCRBS system, the present interference environment is significantly cleaned up. As an example of demonstrated accuracy improvement, ATCRBS system azimuth accuracies have been improved sixfold through DABS. As a further example of reducing interference environment in the system, DABS requires an average of 1.1 interrogations of an aircraft to obtain an answer. Mr. Solat again stressed that the various expectations for DABS have in fact been demonstrated in Phase 11, and that substantial documentation describes these test results. Mr. Solat showed a picture of the DABS/ATARS concept (figure 6), which portrayed the elements of the system: ground site and a computer, computer connection to the controller, DABS datalink and surveillance link, and the aircraft.

Mr. Solat described the DABS ground network in which DABS sensors in the same area are linked. This permits overlapping coverage in the ATARS mode so that an aircraft is always covered by ATARS as long as it is in an area where there are several DABS sensors. Should one of the DABS ground sensors fail, the other ground sensors will assume the sector coverage through the ground links.

Figure 6.–DABS/ATARS Concept



This provides an automatic track continuity, both at handoffs through fading environments and in case of sensor failure.

Mr. Solat noted also that another major feature of DABS is its complete compatibility with other elements of FAA's separation assurance program, e.g., the ground systems, active BCAS and full BCAS, or an interactive mode.

Mr. Solat discussed ATARS and the two services it provides directly to the pilots of equipped aircraft: traffic advisories and maneuver advisories. If an aircraft is carrying ATARS equipment, it will be protected in the following situations:

- Any aircraft that is equipped with a DABS transponder will be seen by the ground, and the ATARS-equipped aircraft will receive protection against that aircraft.
- An aircraft equipped with today's ICAO ATCRBS/SSR transponder with mode C or altitude encoding will be seen by the ground, and the ATARS-equipped aircraft will receive protection against that traffic.
- An aircraft carrying no equipment at all or carrying an ATCRBS transponder with only mode A or no altitude reporting will be seen by the ground and an ATARS-equipped aircraft will receive limited traffic advisories for protection.

Mr. Solat noted that the cost of admission into ATARS is a DABS transponder with an altitude encoder and an ATARS display. The displays give traffic advisory information, and alerts can be shown on the display as well. In addition to the many air traffic services mentioned before, Mr. Solat described the delivery of frequency assignment messages. As the aircraft moves from sector to sector, the appropriate assigned frequency appears on the display without voice transmission.

In addition to air traffic control services, the datalink could be used for various information services. Examples include terminal information such as RVR, runway-in-use identification, surface winds, altimeter settings, etc. Selected weather information could be supplied on demand: winds aloft, terminal and en route forecasts, surface observation, etc. Mr. Solat reported that in the first implementation of datalink, there will be the capability to provide a very crude radar weather map directly read out of the National Weather Service database.

Mr. Solat reported that at the present time, FAA is almost at completion of the Phase 11 engineering development portion of the DABS program. He showed the key milestones (figure 7): ATCAC requirement in December 1969; program initi-

Figure 7.—Discrete Address Beacon System

Key Milestones
- Through Phase II

- **ATCAC Requirement - December 1969**
- **Program Initiation - January 1972**
- **Concept Validation - February 1976**
- **Development Contract Award - February 1976**
- **First Sensor Delivery - June 1978**
- **Transponder Delivery - January 1980**
- **Technical Data Package - April 1980**
- **National Avionics Std - April 1980**

ation in 1972; concept validation completed in February 1976 and the development contract award to Texas Instruments; delivery of first sensor in June 1978. He added that the first transponders for tests at NAFEC are being delivered now.

Phase III

Mr. Solat said that the key milestones planned for Phase III are:

- July 1980: Delivery of a production RFP
- July 1981: Award of production contract
- October 1983: Start of implementation/operation of DABS
- October 1984: First ATARS implementation

In conclusion, Mr. Solat stressed that DABS is the culmination of more than 10 years of scientific engineering development, using the best talent FAA has available in Government, in industry, and at Lincoln Laboratory and MITRE Corp.

Discussion of Mr. Solat's remarks

There followed some discussion which resulted in clarification of several points as follows:

- The DABS national aviation standard to be published in 1980 is not a manufacturing specification; it is, in essence, a signals-in-space description.
- The Radio Technical Commission for Aeronautics' (RTCA) special committee 142 is meeting at the present time to develop the minimum operational performance avionics standard, to be ready by December 1980.

- The DABS national aviation standard provides the signal format or standards by which industry can begin to build transponders; RTCA's minimum performance standard will eventually become a Minimum Operational Performance Standard (MOPS) or Technical Standard Order (TSO).
- Doubt was expressed that, even though the national aviation standard will be out in 1980, manufacturers will likely await RTCA's issuance of an avionics standard before beginning hard design of equipment.
- The $20 million fiscal year 1981 budget request is the first installment of a multiyear procurement of 120 DABS sensors at a total estimated cost of $250 million. A more exact apportionment of procurements per year will be clarified when the implementation plan is released. A rough estimate was that approximately 40 sensors will be procured in the first 3 years for about **$80** million. **$20** million will be spent in fiscal year 1981, with the balance spent in fiscal years 1982-83. Some nonrecurring costs appear early in the procurement, so the $20 million first installment cannot at this time be accurately correlated with a specific number of DABS sensors.
- The final decision as to ground site requirements for full coverage of the United States has not been made. The first transition plan's 120 sites consist of about 90 terminal area DABS sensors for high density areas where ATARS service is needed, and about 30 en route sensors.
- FAA views ATARS service as the principal backup collision avoidance system for the ATC control process. To receive that service an aircraft must be equipped with the DABS transponder and the associated ATARS display. In areas where there is no DABS coverage there can be no ATARS service. To cover those areas, the FAA separation assurance program includes two beacon systems, one of which is active BCAS, and the other is full BCAS. Active BCAS provides vertical maneuver advisories—up/down commands to avoid an aircraft which is equipped with a DABS transponder or a ATCRBS/mode C transponder. In boundary regions where one aircraft is in ATARS coverage and another is not, but both are DABS-equipped, separation assurance coordination is carried out by using the DABS air-to-air communications format and the conflict information register. All three modes of the trimodal system are incorporated into the 14 modes of full BCAS.
- A solely DABS/ATARS-equipped aircraft cannot air-to-air interrogate a solely ATCRBS/mode C-equipped aircraft if both are out of ground coverage. Air-to-air interrogation can be accomplished only by BCAS-equipped aircraft, but both DABS- and ATCRBS-equipped aircraft can respond. The ability to avoid a collision is best when a DABS-equipped aircraft is interrogated; is somewhat less good when an ATCRBS/mode C-equipped aircraft is interrogated; and is least good when an ATCRBS/mode A-equipped aircraft is interrogated.
- FAA does not believe that datalink capacity will be consumed by Cockpit Display of Traffic Information (CDTI) requirements.
- Datalink has been designed to cover the full 250-nm-radius surveillance area.

Mr. Pozesky

Chairman Maxwell next introduced Mr. Martin Pozesky, Acting Deputy Director of FAA's Systems Research and Development Division. Mr. Pozesky discussed some of the issues of concern to the aviation community and the system designers. Tracing the descriptions of DABS and its benefits described by earlier speakers, Mr. Pozesky referred to the alternative systems which have been examined, noting that DABS has survived the cost-benefit analyses and the test of time. DABS alone has two features important to the aviation community as a whole: with the single implementation of DABS, the user benefits from both improved surveillance and the datalink. He noted that improved surveillance alone does not provide collision avoidance backup; neither does datalink alone provide collision avoidance backup. Nor can automation improvements be built on improved surveillance or datalink alone. Both capabilities are needed, and only DABS provides both.

Future growth

Mr. Pozesky agreed that future growth is a very appropriate issue to consider, noting that the transition to DABS will take 20 years or so. This fact makes it plain that there be no built-in arbitrary limits in the ability of a system to handle future needs. He noted that there are 16 million different addresses available in the DABS system, which means that each airframe in the world could be given a unique address. Each individual DABS sensor has been designed to handle 2,000 aircraft.

Mr. Pozesky noted that while the datalink has the capacity to meet the demands FAA projects for the future, its capacity is not unlimited and not all messages are time-critical. Therefore, a need exists to prioritize the datalink services. FAA believes safety messages must have the highest priority on the datalink. Other services will be provided on a time-available basis.

Mr. Pozesky pointed out that by employing monopulse techniques, the number of interrogation pulses transmitted to an aircraft can be reduced while achieving a better level of surveillance information. The higher quality surveillance information obtained by DABS monopulse is achieved with 25 percent of the amount of interrogation that is necessary in today's system.

Mr. Pozesky said that the first use of the datalink will be in ATARS and its role in separation assurance. He described some of the analyses of datalink's ability to handle a variety of tasks. In one example, a model of 1,700 simultaneously airborne aircraft was used, with additional datalink functions postulated, e.g., ATC messages, CDTI, etc. These studies were done to load the datalink, and results to date show ample capacity for the examples tried.

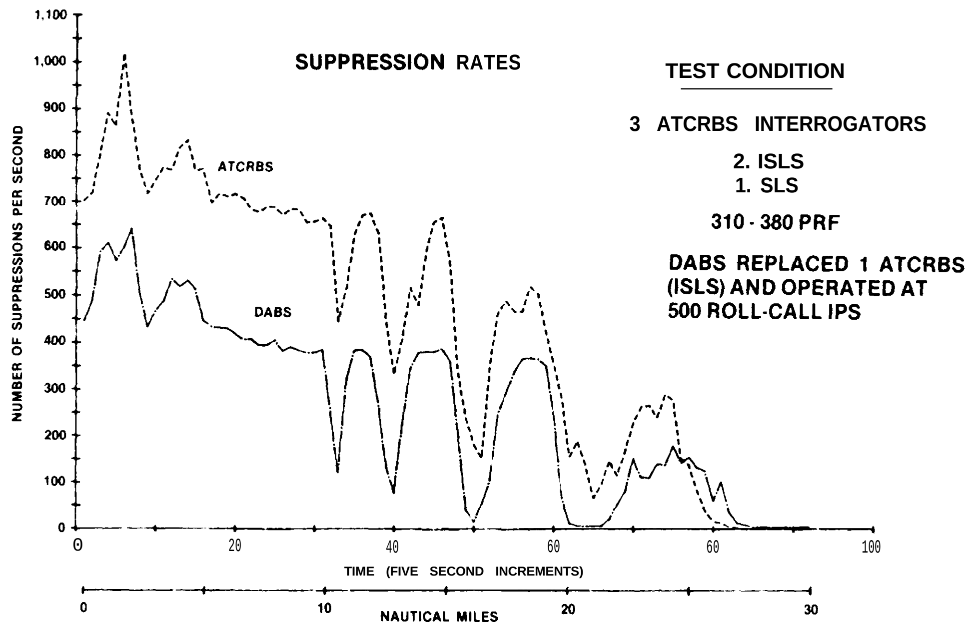
He reemphasized the interoperability of DABS and ATCRBS/SSR, noting that tests showed system reliability to be unaffected by DABS. Through simulation, FAA has tested existing ground equipment with a variety of DABS airborne transponders, and has found no significant impact. While more testing remains to be done, Mr. Pozesky reported that results so far indicate that design expectations will be achieved.

Reduced interference

Interference environment

Mr. Pozesky showed an example (figure 8) of results from a test to determine the effect on the overall interference environment of DABS. A representative measure was made of the amount of interference existing in the test area, caused by a combination of three ATCRBS interrogators, all operating in that area. When one of these ATCRBS interrogators was removed and replaced with a DABS interrogator, the overall interference level (measured in number of sup-

Figure 8.–DABS/ATCRBS EMC



pressions per second) dropped to about 30 percent of the original level. These results form the basis of FAA's belief that one of the first benefits of DABS will be an improvement in the present ATCRBS environment. The new SSR or beacon antenna being procured for terminal areas has been designed to accommodate the DABS and monopulse features, so it will perform today's ATCRBS functions as well as functioning in the transition to DABS.

Mr. Pozesky referred to questions about whether there would be a voluntary or regulated transition to DABS. From an engineering point of view, the DABS design provides for either option, or some mix of both. He concluded his presentation by observing that the majority of the testing is done, and no surprises are expected. DABS was designed to offer optimum compatibility and interoperability for a compatible transition.

DOD Views of DABS

Col. Gilbert

Chairman Maxwell next introduced Colonel Stephen Gilbert, representing the Office of the Secretary of Defense, where he works for the Assistant Secretary for Command Control, Communication, and Intelligence. He reported that DOD has been monitoring the FAA DABS program for several years, but it was only last year that significant compatibility testing of DABS with DOD's Mark 12, Mod 4 IFF equipment occurred. This test program, a cooperative FAA/DOD effort, is underway at the Naval Research Laboratory (NRL), NAFEC, Electromagnetic Compatibility Analysis Center, MIT's Lincoln Laboratory, MITRE, and Bendix Corp. NRL has been assigned the responsibility for testing and evaluating DABS compatibility with two of the five common transponder models in use by DOD. NRL will also monitor the tests done by the Bendix Corp. on the other three types of transponders used by DOD. These tests will include the application of DABS systems and downlink signals to various equipment in use by DOD, and will also include analysis of any problems that arise.

DABS-IFF compatibility

Colonel Gilbert noted that the test plan calls for construction of a DABS signal simulator for both the uplink and downlink signal waveforms. A contract with Bendix will develop the multipurpose, multielement simulator that is capable of simultaneously providing composite signal combinations to simulate the environment in, say, the Los Angeles Basin. To augment that effort, DOD is developing a computer simulation model of the Los Angeles Basin environment. Initial tests are to be made on a one-to-one basis with the DABS signal on a particular piece of equipment. At a later time, the test will use a composite signal with representative signal densities and amplitudes as determined from the computer model. Colonel Gilbert pointed out that DOD's testing is not complete. Some preliminary tests have been done on both the uplink and downlink signals on available transponders and interrogators. As a result of these preliminary tests, some potential problems have appeared with the DABS waveform and the Mark 12 system. Colonel Gilbert noted that the Mark 12 is in use by a majority of the free world's military forces. As such, it represents an investment of $1.5 billion to $2.0 billion on the part of the United States and allied forces.

Colonel Gilbert said that DOD has detected some interference phenomena on the uplink. The phenomena are complex and difficult to analyze because it was found that no two transponder types are alike. Variations are even found between units of a given type of transponder. He pointed out, however, that DOD believes these problems are not insurmountable, and that the National Security Agency, among others, is working to resolve them and to determine what specific fixes could be applied to the equipment.

Similarly, on the downlink waveform, preliminary tests have disclosed some initial problems with the Mark 12 interrogators. Initial testing of a new three-pulse decoder design has produced encouraging results which indicate that the problem can be alleviated.

Colonel Gilbert said that DOD has for some time been looking at a wide range of Mark 12 improvements to meet the electronic threats of the 1980's. This work will be reviewed later this spring in a major review cycle within DOD to determine the best course of action for the future.

In addition, the United States, together with other NATO allies, has begun to design a new IFF question-and-answer system. In all likelihood, if it is developed and deployed, it would operate on a new frequency allocation, although there has been no particular frequency authorized to date. Colonel Gilbert cautioned that this is not a near-term situation, since commitment to full-scale development of such a system, once it is defined, could not be made until 1983. Production of that equipment would not be foreseen before 1985-86. It is thus apparent that DOD will be using its current or upgraded Mark 12 equipment for at least the next 20 years.

As a result of these considerations, DOD has placed a high priority on the completion of the current test program to determine the compatibility with the proposed DABS waveform, and is working closely with FAA to identify and resolve any problems which appear. To this end, DOD plans to continue a few efforts in addition to the DABS uplink simulator and the computer model mentioned previously, Several breadboard models of improved decoders for the IFF interrogators will be fabricated; the best of these will be selected to provide maximum rejection of any DABS replies. The selected encoder design will then be tested with various interrogator systems.

Colonel Gilbert stressed that DOD was only in the preliminary stages of DABS compatibility testing, but that he was confident that the joint FAA/DOD efforts now underway will resolve any problems which may appear between the two systems. DOD recognizes that DABS must be considered in any Mark 12 product improvement and in any development of improved IFF question-and-answer systems. He noted that DOD aimed to consolidate test results by April 1980 and to have completed their review of the Mark 12 improvement program to meet the future ECM threat. By then, a reasonably definitive DOD position regarding DABS impact can be provided. Notwithstanding DOD's confidence that problems can be resolved, Colonel Gilbert said that at the present time DOD does not feel it is in a position to say unequivocally that DABS is completely compatible with DOD requirements. Colonel Gilbert added that, in view of the DOD investment in the Mark 12 system, its compatibility with DABS may be one of the most important issues to be faced. He suggested that the planned OTA Air Traffic Control and Airports project would be aided by a definitive DOD position on two additional issues: DOD plans for implementation and use of DABS within a civil and military context, and DOD plans for implementing the Navstar program and its impact on military and civil ATC.

Discussion of Col. Gilbert's remarks

There followed a general discussion which resulted in clarifying the following points:

- Modifications for compatibility, if required at all, would likely be limited to minor changes to the Mark 12 Mod 4 system alone. It may involve nothing more than a different card or decoder.
- In the unlikely event that a total changeover of equipment is required, DOD would probably not favor a mandatory change until the present equipment has reached the end of its useful life.
- The basic tests of the five types of transponders and interrogators are expected to be completed in April 1980; the computer simulations will continue beyond that time.
- DOD's use of DABS and the rate of adoption depend on several factors, among them being the ultimate decision regarding the new NATO identification system. Should that be approved, the allocation of a new frequency and a changeover of equipment is likely to take at least 15 years. This process would have to await a production decision which can't occur much before 1985.

Remarks From the Floor

DOT View of DABS and Its Implementation

Chairman Maxwell next introduced Mr. George Webber, staff member in the Office of the Secretary of Transportation (OST). Mr. Webber has been involved in recent years with analysis and monitoring of the upgraded third generation ATC system, and offered comments on how DABS is viewed within OST.

M-. Webber

Mr. Webber noted that Department staffs become involved in systems like DABS because of their responsibilities in the major system acquisition process. The Transportation System Acquisition Review Council (TSARC) is analogous to DOD's Defense System Acquisition Review Council (DSARC). He emphasized that his comments were based upon his experience and background and do not reflect an official DOT position.

He expressed general agreement with the points made by FAA speakers. OST agrees that a thorough technical planning and development job has been done by FAA on DABS. He said that FAA has sold DOT on DABS and is now aware of the need to seek continued support for it within DOT and to begin selling DABS to the user community. DABS is one of seven major system acquisitions within FAA. A major system acquisition is a program which involves $25 million or more of R&D, or $100 million or more of implementation cost, irrespective of whether the public or private sector bears the costs of implementation. DABS has been in the systems acquisition management (SAM) process since it was instituted about a year ago. The SAM process is a means of accomplishing the objectives of OMB's circular A-109. Since DABS is monitored by the SAM process, Mr. Webber noted, there appear to be no major concerns in regard to the technical development to date. He stated that the development of DABS has been supported by OST with every intention that once it is successfully completed, it will move ahead into implementation.

He went on to observe that despite some cost overruns on particular tasks, the overall cost estimate was not missed by much—in 1971, DABS development was estimated at $46 million; in 1979, the total cost to completion in 1982 was $57 million. Mr. Webber noted that OST has also been pleased with the technical performance. He reported that TSARC had taken a careful look at DABS alternatives, all ground-based systems such as selective address, ATCRBS with a separate datalink, etc.

Mr. Webber shared his personal view that, while DABS has been seen as a very critical element, or keystone, of the future ATC system, the surveillance improvement is the most important benefit and can be accomplished to a large degree by other means. Nevertheless, Mr. Webber viewed the important and major contribution of DABS as opening the way to the ATC world of tomorrow. He offered his view of applications in the following order:

- Automation: OST has for several years recommended vigorous activity with regard to meaningful, high-productivity levels of automation. FAA's New E&D Initiatives Consultative Conference showed that there is serious interest in high-productivity automation.
- ATARS: The need for collision avoidance has been frequently stated. Mr. Webber suggested that on a benefit basis alone, ATARS might justify DABS, whose datalink permits its operation.
- Cockpit Display of Traffic Information: CDTI has also been mentioned in many forms. Though much work remains to be done and it is too early to define the benefits, the possibility of datalink makes CDT] worth pursuing until it is well understood and its applications can be rationally decided.

Implementation timing

Mr. Webber next raised the question of the pace, or timing, of DABS implementation. Notwithstanding the success of its development and the numerous benefits from its application, is it time to implement DABS? Mr. Webber posed the question of whether DABS, as the keystone of the future ATC system architecture, should be implemented before the future ATC system is designed, or should it await at least the basic outlining of the new system. He pointed out that automation requirements and the approach to automation have not yet been fully defined. While the ATARS concept is attractive, Mr. Webber noted that it has not been fully tested in the ATC environment, though flight tests have been carried out, and CDT1 remains in the early stages of research. He concluded by restating his support of DABS both from the design and development standpoint and from the program management standpoint, but he posed the question: Should we move ahead with implementation at a rapid pace at this time, or should we deliberate while we fill in some of the blanks that exist in the system?

Discussion of Mr. Webber's remarks

There followed some discussion which resulted in clarifying the following points:

- While DOT has approved the initial DABS implementation request of $20 million for fiscal year 1981, TSARC has not yet met to review the manner of implementation. FAA's implementation plan has not yet been submitted to OST or TSARC.
- The budget approval process in DOT and TSARC are separate processes. After a budget is approved, TSARC will, by means of a series of reviews, monitor a major system acquisition as to cost, rate of implementation, etc.
- The House Committee on Science and Technology is the authorizing committee in the House for aviation research and development. However, other committees share responsibilities for implementation decisions, and the Appropriation Committees are always involved with major budget elements.

FAA Concerns About Implementation Delays

Mr. Blake

Chairman Maxwell introduced Neal Blake, FAA's Deputy Associate Administrator for Engineering and Development, who provided the following overview: In 1962, FAA began the design of a National Airspace System (NAS) in three stages. Stage A, which was put in operation in the 1960's and early 1970's provided the controller with the basic capabilities of flight data processing and radar data processing. Stage B was defined in some depth by ATCAC and started to put decisionmaking aids into the system for the controller. The conflict alert function and en route minimum safe altitude function were two of those that went directly into the automation program; others that are recommended and still under development are en route metering and spacing for the terminal area.

While Mr. Webber suggested that FAA should wait until the future automated system is defined, Mr. Blake pointed out that the future system functions are fairly well-known at present. An evolutionary process has been laid out, and the system is about halfway up the automation ladder. FAA has focused first on getting the safety functions into the system. The mid-air and air-to-ground collision statistics point to an uncomfortably high probability of another accident in crowded terminal airspace. Mr. Blake perceives a very pressing need to get something into the system to provide a backup to the controller, particularly in the high-density areas. This factor has come out in congressional hearings, where there has been a lot of pressure on FAA to get on and do something; Mr. Blake said that FAA is trying to respond.

FAA has defined a total approach to aircraft separation assurance, and to put it in context, Mr. Blake noted that the ATC system and the controller constitute the basic separation assurance device. The controller has been provided with aids, e.g., conflict alert in both terminal and en route air space. Conflict resolution assistance will soon be provided to him in the en route airspace. This is the primary system, but is viewed as not good enough. Even though conflict alert is available, there are still many near mid-air collision situations. There are still system errors. FAA is working on all aspects of the problem. The need for a backup system is clear. The highest risk to the commercial passenger is in the high-density terminal airspace. Even around the TCAs and in the TARCs there is a finite risk.

ATARS was designed to meet that risk. As noted earlier, it doesn't cover all the air space, the active BCAS is being developed to do that job outside of radar coverage and in the lower density air space. Regarding the questions asked about implementation and the 120 DABS sites, FAA has looked at both airspace densities and the capabilities of both ATARS and BCAS. BCAS will work in traffic densities up to about 0.02 aircraft per square mile; above that density, something else is needed, and in FAA's view that something else is ATARS.

There is an alternative called full BCAS. It is not as good as ATARS, and it does not work as well with the ground system, but it is an alternative. FAA does not recommend it. The immediate urgency of DABS implementation is to reduce flight risk in major terminal areas with the ATARS system. But there are other things in the near, term which are needed. If one looks at the types of accidents that involve general aviation, it is clear that weather information, particularly for general aviation IFR operations, is a requirement in the fairly near term. One of the very early services that the DABS datalink will provide is weather service, especially severe-weather service in the cockpit.

Thus, the safety functions in the automation system have been conflict alert, conflict resolution, ATARS, BCAS, and weather information. The latter three depend on the DABS datalink for their implementation. FAA proposes to start implementation with the fiscal year 1981 budget, to start bringing these sites up in about 1983, and to put in a total of 120 stations in the first series.

There have been a number of developments in system performance: metering and spacing; national flow control; and ultimately, the integration of these functions into a single system. These capabilities will also utilize the DABS datalink to send clearance changes or vectors to pilots in the terminal area.

The third set of functions are farthest downstream because FAA has given priority to getting the safety aspects into the system. These are performance improvements—reducing delay, giving more fuel-efficient profiles, increasing the productivity of the system, giving the controller more automation aids, etc. This has been referred to earlier in the Seminar as the AERA program. AERA generates clearances that are conflict-free for some 10 to 20 minutes into the future, presents them to the controller, and after his decision sends them by datalink to the pilot.

There is no one thing among all of these components that is "the future automation system. " The future automation system is and will continue to be a series of evolutionary improvements in each of the areas mentioned. And because of the risk of collision, FAA believes that it is urgent to get on with the implementation of the DABS system and to provide ATARS and BCAS equipment at the earliest possible moment.

costs

Regarding FAA's favoring active BCAS over full BCAS, Mr. Blake noted that one of FAA's concerns is cost to the user, and there is quite a cost difference between active BCAS and full BCAS. Many general aviation pilots operating in the terminal area, the high-density area where the risk is highest, will be unable to afford to buy a full BCAS, but they would be able to pay for an ATARS set. FAA's cost targets are on the order of $1,300 to $1,400 with a collision avoidance capability built into it. And that's where the major threat is.

The active BCAS will likely be of primary interest to some of the commuters or air taxi operators that routinely fly out of radar coverage into smaller fields. They are looking for protection against the small general aviation aircraft. And they are the ones that are likely to have transponders on board and little more.

One of the advantages of a full BCAS, if money is no problem, is that one can get many advantages that ATARS provides even before ATARS is part of the ground system—for example, traffic advisories. When ATARS comes into the system, however, one can get the same service for a lot less money. While FAA is not against full BCAS, neither is it likely to become mandatory, precisely because of the cost. Mr. Blake noted that the biggest segment of the flying public is not the airlines, but the general aviator. FAA is very much concerned with keeping the cost to him of all of the services it offers at the absolute minimum.

Implementation timetable

Despite earlier discussion, there persisted some confusion on the part of some attendees about implementation schedules. FAA reiterated that about 5 years will be required to install 120 DABS sensors on site. Airborne equippage will take longer to evolve, and is estimated at about 15 years from the beginning of DABS ground sensor siting, The FAA budget request of $20 million is for fiscal year 1981 implementation. If that request is approved, funding will be made available to FAA in October 1980. Due to the lead times involved, the first contract award is unlikely before July 1981. It will take the contractor an estimated 2 years or so to deliver and install the first set. That means that it will be the summer of 1983 before the first DABS set is in the field. FAA's best estimate at this time is that it will take about 4 years to install the remaining 119 systems— that is, in other words, the summer of 1987. These 120 DABS will not constitute a full implementation. While FAA estimates full implementation to extend over 10 to 15 years, the actual number of DABS sensors eventually placed is not now known. FAA contends that the actual number will depend on what decision is made with regard to the extent of implementation desired. A number of factors will determine this answer, and they are evolutionary, so that decisions will come in sequence. As new systems go, FAA believes that 10 to 15 years is a relatively short time. FAA believes that, given the budget cycle and the program execution schedule, the present request for fiscal year 1981 implementation is not inconsistent with the goal of settling the implementation/compatibility issues by April. The fiscal year 1981 budget had to be formulated last fall, based on FAA's best projection of its situation in October 1980.

Given the assumption of 120 ground stations in place by 1987, there is a question of how long it will take before the user community has installed enough airborne hardware to significantly increase the system safety expected from DABS. The answer depends on whether equippage is voluntary or is mandatory, and since FAA is statutorily prohibited from making unilateral statements about mandatory equippage outside a formal rulemaking process, one can only speculate regarding equippage. In the case of the ground proximity warning system (GPWS), approximately 2 years was required from the time the Federal Government put the air carriers on notice until equipment was available to equip the fleet.

User panel

Chairman Maxwell next introduced Dr. Larry Goldmuntz, President of Economics &Science Planning, who served as moderator of a panel of system users. The panel consisted of Mr. Phil Van Ostrand, representing the Aircraft Owners and Pilots Association (AOPA); Mr. Frank White, representing the Air Transport Association (ATA); Mr. Dave Thomas, representing the General Aviation Manufacturers Association (GAMA); Mr. Bill Home representing the National Business Aircraft Association (NBAA); and Mr. Jack Howell, representing the Air Line Pilots Association (ALPA).

Dr. Goldmuntz

Moderator Goldmuntz began by referring to some of the findings arrived at in the New *E&D Initiatives** effort which bear on the scope of the Seminar. Since the effort was carried out largely by users of FAA E&D, the findings represent a distillation of numerous intensive discussions of issues in several areas relating to future ATC and DABS. The findings areas follows:

> A constant concern of the user community relates to the length of time taken to complete and implement certain vital E&D programs. For example, M&S has been under development for a decade and still has many remaining uncertainties so that an eventual implementation date is simply not in sight. The rate of development of the vortex avoidance system is of equal concern. Meanwhile the airport capacity issue becomes ever more serious.

Dr. Goldmuntz remarked that everybody on all the topic groups felt that the rate of implementation was much too slow, and that 10 to 15 years was probably not acceptable.

> DABS is the desired datalink system. Other datalink systems might be needed for service outside of DABS coverage areas and for exchange of other information.

* * *

> ATARS is a collision prevention backup for aircraft with DABS, and DABS ground station coverage is a requirement for backup for the automation system. An active BCAS capability is a collision prevention backup outside of DABS ground station coverage, or is a requirement in the event of a DABS ground station breakdown.

* * *

> Reducing minimum lateral separation standards for parallel runways that may operate independently under IFR becomes an essential program goal, going from 4,300 to 2,500 feet, for example . . . . As a result of previous studies it can be concluded that with surveillance azimuth accuracy of 1 mini-radian, a data rate of 1 second, and by reducing the time delay in issuing a missed approach command to 3 seconds, the minimum theoretical spacing of parallel runways for independent IFR operations would be 2,500 feet. DABS surveillance and DABS datalink should be developed to achieve these results.

Dr. Goldmuntz observed that DABS has an input to capacity from the point of view of being able to provide parallel runways at distances less than 4,300 feet. That is not all that is required, but it is one of the things that seems to be required, according to the capacity topic group.

The summary recommendations of the Airport Capacity Group were that "The design goals of the FAA DABS surveillance and datalink development program should be surveillance azimuth accuracy of 1 milli-radian''–which has been exceeded—and that "A data rate of 1 second and the capability of reducing

*Economics & Science Planning, Inc., "New Engineering and Development Initiatives–Policy and Technology Choices" (DOT contract No. FA 77 WA-4001), 2 vols., Mar. 1, 1979.

the time delay in issuing a missed approach command to 3 seconds were required to reduce lateral spacing standards for parallel runway s."

The Freedom of Airspace Group considered electronic flight rules, a type of separation or aircraft control procedure that the group felt was applicable for those portions of air space where traffic was not so dense that a complete flight plan would have to be filed, or any flight plan would have to be filed:

> A concept for new flight procedures under IMC conditions, called electronic flight rules, EFR, seems feasible in air space that is under the surveillance of DABS interrogators for those aircraft which become equipped with DABS transponders. This procedure would ultimately, in its simplest avionics implementation, permit a DABS-equipped aircraft to fly under IMC conditions without necessarily filing a complete flight plan, in air space that was under DABS-type surveillance, where the traffic density is sufficiently low so that knowledge of aircraft intent is not essential at all times for separation safety. There would be no limitation on the use of the same air space under IMC conditions by IFR-qualified pilots precisely the way they use the air space today.

The Safety Group conclusions and recommendations relating to DABS or ATARS were that:

> The backup separation assurance system should be based on a DABS/ATARS concept in all the areas within its coverage and on an active BCAS concept for areas outside the coverage. At this point in time FAA E&D should also continue development of a full BCAS capability which will operate effectively in a full range of traffic environments.

Regarding lateral runway separation, from a safety rather than a capacity point of view, the group concluded that:

> The work performed for the FAA by MITRE in 1975 and MIT Lincoln Laboratory in 1972 provides an indication of the tradeoffs between separation distances and parameters such as update rates, surveillance accuracy, communication time. The need to minimize the time delay between detection of a dangerously decreasing traffic separation and action by pilot to correct that situation is clearly critical and indicates a need for improved surveillance and methods of providing improved cockpit and controller information. The DABS surveillance and datalink may be used to provide pertinent information in a cockpit in the most expeditious manner possible.

And regarding ATC system failures and system backup, the group recommended that:

> An ATARS capability will be provided at each DABS site as a collision prevention backup for aircraft equipped with DABS. A BCAS capability will provide a collision prevention backup in the event of a DABS/ATARS outage and in areas not within DABS coverage. Exploration of other complementary backup capability should continue. Examples of such possibilities should be overlays of communications, surveillance, and uses of current precomputed backup clearance for aircraft in the event of failure.

Dr. Goldmuntz pointed out that each one of the initiatives topic groups talked about DABS and ATARS from a different point of view, addressing a different capability either in automation, airport capacity, freedom of air space, or safety. Following this summary of a recent intensive-user exploration of E&D goals for FAA, Dr. Goldmuntz asked Mr. Jack Howell of ALPA to begin the panel discussion,

Mr. Howell, ALPA

Mr. Howell noted that ALPA has followed the DABS development since its beginnings with ATCAC. He spoke of several points that were initially of concern to ALPA, and provided ALPA's views on their current status.

He was pleased with the report given at the Seminar, which indicates that there are no complications with combining DABS and ATCRBS into a usable system. He noted that ALPA argued this issue when DABS/IPC was being worked on at the MITRE Corp. ALPA views the establishment of and compliance with international standards as being of prime importance, since ground-based systems are susceptible to variances not governed by standards. ALPA wants more assurance than has been given on implementation rate, coverage, and schedule of coverage. He implied that ALPA support might be stronger if the pilots had information showing a fast-paced, results-oriented plan for commissioning DABS, BCAS, ATARS, etc., to provide the promised protection. ALPA never was totally satisfied with some of the IPC resolution maneuvers. Mr. Howell wanted to be shown that ATARS has refined these resolution maneuvers in order that he could be more supportive. Noting that he favored the full-capability BCAS, Mr. Howell expressed ALPA's fears that DABS/ATARS research and associated E&D will slow down or de-emphasize work on full BCAS. ALPA is concerned that the lack of mandatory participation in DABS implementation will slow the development of the other capabilities that DABS offers. There followed some discussion, which resulted in the following clarifications:

Discussion

- DABS datalink role in providing a connection between ground automation and aircraft automation functions would be limited to information transfer, rather than a direct ground link to the aircraft's control system.
- [n the event of an integrated-flow system, a part of which is an automated or semiautomated metering and spacing function, it may be sensible to use the datalink to insert a time correction, based on the airport traffic flow dynamics, directly into the area navigation (RNAV).
- Pilots feel generally that information on their airborne weather radar is more detailed and dependable than would be an uplinked picture of the ground-based weather radarscope. This datalink capability would, however, be of value to those aircraft not equipped with airborne weather radar.
- ALPA strongly advocates CDTI, but it doesn't want to have DABS sold on the basis of providing CDTI, only to find out later that the datalink capacity won't support it.
- ALPA strongly supports ensuring compatibility between DABS and the military Mark 12 Mod 4 systems.
- Because DABS appears to be so slow in being implemented, ALPA cannot be as enthusiastic in their support of it as they otherwise might be.

Mr. Home, NBAA

Dr. Goldmuntz asked Mr. Bill Home, Manager for Airspace and Air Traffic Control for NBAA to provide the NBAA views. Mr. Home noted that NBAA has about 2,100 members flying over 4,000 airplanes, of which between 1,500 to 2,000 are jets. Noting the large planned expenditure of about $250 million, Mr. Home expressed concern that several technical questions still need answers before the implementation program goes further. As an example, he felt that "accuracy" had not been adequately defined for different traffic situations. He noted that for years he has been told that ATCRBS will become saturated, but has never been given a traffic saturation limit figure for ATCRBS. NBAA agrees with FAA that the system must eventually be upgraded through a graceful evolution, but there are actions underway or contemplated in other areas, (e.g., part 125, CVR, flight data recorders, etc.) which will bring about operational changes, so that DABS should not be isolated as the sole upgrading action.

Mr. Home also noted his concern about use of the term "increased traffic." He felt that a quarterly monitoring of what is actually happening to air traffic would be useful, noting that deregulation has put more people into airplanes, rather than more airplanes into the system. He questioned whether the actual traffic movements are supporting the forecasts.

Mr. Home noted that reliever airports offer alternatives to continually increased loading of present terminal areas. He noted that there are 4 Special Operations, High Density airports operated under a quota system; and 21 terminal control areas, with a possible additional 38 still negotiable. ATA and other user associations have looked at 30 airports that are considered by ATA to be delay-impacted airports, with a view towards applying the reliever airport concept. Mr. Home expressed concern that the implementation of the system is not clear. This makes decisions very difficult for the user who must determine when he should invest in the airborne equipment, and if he is volume limited, where is it to be put, or what is it to be substituted for?

Mr. Thomas, GAMA

Moderator Goldmuntz next asked Mr. Dave Thomas, consultant to GAMA to comment. Mr. Thomas noted that though GAMA is an association of manufacturers, not users, it is vitally interested in traffic projection and equipment sales. He also noted that by the end of this decade, there will be more turbine jet-hours flown in the U.S. general aviation fleet than there are air carrier hours flown presently.

GAMA has supported the DABS concept from its beginning, and in 1977, an industrywide position was formulated on collision avoidance, of which DABS was a big part. Of interest was whether IPC would be cost-effective. The industry policy is that no general aviation aircraft should be required to carry any unnecessary equipment. This policy recognizes that cooperating equipment, e.g., ATCRBS with altitude reporting and eventually DABS as its replacement, will be required in some airspace. Furthermore, the policy statement said that further development and implementation of DABS should not make ATCRBS or BCAS obsolete. He noted that these ideas were contained in the excerpts from the New E&D Initiatives Study report read by Dr. Goldmuntz.

Mr. Thomas noted that GAMA is concerned with the question of immediate or delayed implementation of DABS depending upon the technical information presently in hand. He spoke of some very preliminary GAMA estimates on user cost and equipment readiness dates, noting that for general aviation, if it is simply an ATCRBS transponder replacement with the simple DABS unit, costs might be about 50 percent more than the present cost of ATCRBS. If a DABS unit with more useful functions is considered, GAMA members want to wait for the RTCA's report SC-142, which will describe the requirements in terms that will allow credible cost estimates to be made.

Following the release of the SC-142 report, Mr. Thomas estimated that about 18 months of engineering would be required, followed by another 18 months for production. This indicates that 1984 is about the earliest date that an early model will reach the general aviation market, and at least 1985 before any significant operation in the fleet will be reached. He expressed his opinion that the FAA schedules are probably optimistic, and that it will be 1985-86 before there is any significant airborne and ground implementation whereby the new system could begin to be debugged on the basis of operating experience. As an indication of post-R&D operating problems with new systems, Mr. Thomas recalled his experience with an airline installing the GPWS. The system was flight-tested in every anticipated mode with good results. During the first 6 months of operation, however, the airline experienced about 2,000 false alarms in the cockpit. He added that there was nothing wrong with the concept with the computer, but that the radio altimeters signalled falsely, corrosion appeared on the antennas, etc.

Mr. Thomas felt very strongly that any further delay in implementing DABS would have a severe impact on ATC upgrading, and that the real risks attendant to the uncertainties identified in discussions today are small. He said that his recommendation to GAMA is to support proceeding with the implementation, noting that it is always possible for DOT to impound the funding in the unlikely event that the DOD reviews, SC-1 42, or other efforts reveal problems that are unresolvable. He concluded by saying that since most of the questions raised should be answered by the end of this year, it makes little sense to abandon the present funding cycle, which would result in an actual delay of about 18 months.

Mr. Van Ostrand, AOPA

Moderator Goldmuntz next called on Mr. Phil Van Ostrand from AOPA for his comments. Mr. Van Ostrand noted that AOPA represents some 240,000 aircraft owners, pilots, and airline passengers. The potential implementation and benefits of DABS are of great concern to AOPA, which recognizes a future need for the improved services in terms of both surveillance and air/ground communication that could be provided by datalink. He said that AOPA shares NBAA's concern over timing of DABS implementation. He noted that while much basic R&D work has been done, there remains much to be done both within FAA and by outside groups to answer lingering questions. One of AOPA'S concerns is that a single-thread ground/air communications system could potentially be threatened by a systems computer failure. Another of AOPA's concerns is the uncertainty about the transition period, especially as regards possible mandatory transition. He said that AOPA does not favor a precipitous implementation schedule that does not allow for an orderly transition. AOPA feels that additional R&D and additional spending to develop the DABS system is merited.

Mr. White, ATA

Moderator Goldmuntz next asked Mr. Frank White of the ATA to offer his comments. Mr. White noted that some comments to Congress and the media in recent months have created the erroneous impression that DABS is either unnecessary or duplicative of other air/ground digital communications systems developed and currently in use by the FAA and the airline industry. Aeronautical Radio, Inc., or ARINC, at the direction of the airline industry, developed the ARINC Communications Addressing Reporting System (ACARS) which operates at a bit rate of 2,400 per second, using VHF air/ground communications channels. It was developed by ARINC for some of the same reasons DABS was developed by FAA—to reduce human intensiveness of air/ground communications. It was found by ARINC that well over half of all the air-ground communications on the ARINC operational control VHF networks was out-off-on-in data—in other words, keeping track of when the aircraft left the gate, took off, landed, and arrived at the gate. Using simple sensors, ACARS senses these four situations and automatically reports via the ACARS datalink to the ARINC data communications ground stations. ARINC data showed that automating this high percentage of its air/ground communications contacts would permit amortizing the total investment in a very few years. Most airline flights which use the ARINC VHF air/ground communications network have decided to invest in ACARS because it is clearly cost/benefit justified. The system concept employed by ACARS is that set forth by RTCA Special Committees SC-110 and 111. RTCA envisioned an air/ground universal datalink, one that might be used on VHF or HF and capable of being a logical extension of the point-to-point ground communications network. ACARS has that capability. Tests will be run on HF using ACARS at a slower bit rate than 2,400 bits per second. It should do the job nicely.

A year after the work of RTCA Special Committees 110 and 111 were completed, in 1968, ATCAC developed the DABS concept. Mr. White noted allegations that DABS will be a third datalink and that it will duplicate both the ACARS datalink and the present ATCRBS reporting and identifying functions. He stated that this is a total misrepresentation of fact. ATCRBS functions will be supported by and will be included in the DABS system and not duplicate them, as was made clear earlier in the Seminar. DABS also adds addressing to the ATCRBS and therefore eliminates synchronous garbling and improves aircraft surveillance.

DABS will also provide a high capacity air/ground and ground/air datalink. All the studies to date show that DABS has sufficient capacity to provide all the necessary data communications for ATC, even including transfer of CDTI. This can be done for all participating aircraft, should it be determined to be an effective addition to the ATC system. This information is contained in the report "Alternative Beacon Based Surveillance and Datalink System, " FAA EM-74-7. These studies show that 12 VHF channels will be required to support the universal datalink in the Los Angeles basin in the year 1995. This assumes a bit rate of 4,800 per second, twice ACARS rate, and an aircraft equipment response time that is about twice the current ARINC spec equipment capability. This is not an inordinate number of channels; however, it would be very difficult to keep track of which aircraft in a terminal area was using which VHF channel and in which operating area. ATA therefore shares the view that ACARS universal datalink, as a method of providing air/ground datalink communications for congested ATC terminal areas, is not the optimum solution. As a result, the airlines, some of which have already implemented the universal datalink in the form of ACARS, share the view of many others that DABS should be implemented to provide air/ground digital communications for ATC purposes.

Airlines advocate DABS with full knowledge that ACARS is still necessary to provide digital communication for the ARINC company operational control channels for the reasons set forth earlier. The airlines have not indicated to FAA that they are interested in having the capability of DABS include the handling of ARINC operational control digital communication. Although the DABS datalink has the capacity to provide such digital communications, as shown by the studies mentioned, the airlines prefer to have the capability of communicating with their aircraft both orally and digitally on channels they control. The use of the DABS datalink as a backup to ACARS, or the converse, remains a possibility in the event of wide-scale failures of either system in unusual circumstances. ATA is investigating this concept.

Mr. White added that the airline industry completed the development of an airborne collision avoidance system over a decade ago and offered it to FAA. Some 3 to 4 years ago it was decided that a good possibility exists that the present ATCRBS might provide the cooperating signals that would permit an airborne collision avoidance system to work. ATCRBS, with its altitude reporting, is a way of finding out where the other aircraft is. It provides the XYZ information, the same as the airborne collision avoidance system developed over a decade ago.

But the fact remains that the system developed a decade ago was designed to do an airborne collision avoidance job. And the signal format and the whole system was tailored to that specific application. ATCRBS was not designed for air-to-air signaling, and it has been difficult trying to make it work. It has only been in the last few months that enough answers are beginning to unfold to permit growing confidence that it is totally practical to interrogate an ATCRBS transponder in an air-to-air link. This means that we have to have the interrogator in another airplane, instead of being on the ground where it was designed to be. That is not DABS; it's more than DABS.

For over 30 years, the ARINC Airline Electronics Engineering Committee (AEEC) has developed characteristics for airborne electronics equipment according to what the airlines desire to have in their aircraft. AEEC has described a DABS transponder, including the active BCAS, for the airline aircraft. The characteristics include wiring procedures and desired functions. The attractiveness of this procedure lies in the fact that it permits an airline that wants particular functions to specify today precisely how the airplane will be wired up, without spending much money. The cost to the 767 and 757, for instance, with or without these wiring provisions and the diversity antenna, is insignificant. The cost of making this provision in those airplanes is never more than what it cost to install an ATCRBS. Thus, it is possible for the airlines to totally accommodate a system that will permit the operator to do the air-to-air interrogation with active BCAS, using the present ATCRBS transponder and then enjoy the benefits of DABS as it is introduced.

So, to answer the questions, "How much protection do I get?" and "When is the first installation made?" Mr. White pointed out that the first airline aircraft that installs the equipment can immediately interrogate the 45,000 general aviation and other aircraft population equipped with an altitude-reporting mode C transponder. Mr. White pointed out, however, that an airline aircraft can avoid a mid-air collision only with another aircraft it can outfly. This means if a system is to approach total effectiveness, there has to exist a cooperative maneuver with the other aircraft. This cannot be done with ATCRBS—there has to be a method of addressing the other aircraft. DABS provides such addressing, and this capability has been recently demonstrated.

Mr. White expressed ATA's confidence that during the coming spring, they will be able to join in saying that DABS is ready to implement. As indication of this confidence, Mr. White said that ATA is telling airline management to budget for DABS. Regarding implementation, Mr. White said that he forsees that, unless something totally unexpected happens to change the situation, the U.S. scheduled airline fleet will be equipped by late 1985 or 1986.

Discussion

There followed a general discussion which resulted in the following clarifications:

- FAA believes that all of the questions raised by Bill Home of NBAA can be answered, and encouraged NBAA to meet with FAA to resolve their questions.
- The introduction of DABS does not require a new computer system, and the existing system will perform better with DABS than without it.
- No further DABS development work is deemed necessary by FAA; however, further work needs to be done in datalink applications.
- FAA does not favor waiting until the future scenario has become better defined before implementing DABS. Scenario development is still an internal activity at FAA, and DABS capability is the cornerstone upon which the future system will be built.
- The user consensus, as expressed in the New E&D Initiatives report, urges prompt action in implementation. FAA's views of collision threats support this consensus.

- The long-range implementation rate depends upon the amount of money available, and the exact number of sites and their location will be decided as the confidence in funding availability develops.
- Many of the problems identified with the military Mark 12, Mod 4 system are not chargeable to DABS; i.e., a strong implication was made that, independent of DABS requirements, the Mark 12 Mod 4 system has internal problems that have to be solved, and as they are solved, the DABS/Mark 12 compatibility issue will subside.
- Of the approximately 40,000 or so sophisticated civil aircraft operating over the United States, the likelihood is that no more than about 200 at the maximum would be dealing with a single DABS ground interrogator at any one time. In this circumstance, assuming CDT] loading on the data link, the DABS capacity will exceed demand by about 50 percent.

General Discussion

Additional discussion centered around the question of user acceptance. Congressional staff members observed a strong endorsement of the technical achievement of the DABS E&D program, but they expressed frustration that the. user groups did not agree on implementation plans or schedules for airborne equipment procurement and installation. While ATA and the airlines are moving ahead vigorously with budgeting plans for DABS, AOPA and NBAA are unwilling to unequivocally support implementation, probably because the FAA implementation plan is not yet available and because, by the very heterogeneous nature of their respective memberships, their aircraft, their system needs, etc., a membership consensus on commitment to equip at this time, or in the future, will be difficult or impossible to obtain. ATA, on the other hand, represents a highly organized industry, whose corporate interests are probably more narrowly channeled toward refining scheduled operations over relatively fixed routes. As such, their situation permits a planning and budgeting process which is unavailable to the more disparate memberships of NBAA and AOPA. GAMA recognized the risk-taking nature of major investments of this sort, and stated their willingness to support moving on with implementation, because they perceived the alternative of waiting another year as less desirable than the, in their opinion, rather low risk of failure of implementing DABS.

Mr. Quinby

Mr. Gil Quinby, a general aviation avionics marketing expert of high reputation, pointed out that the market forces will, in themselves, induce rapid voluntary implementation, once the commitment to implement DABS ground equipment is made. He noted that between 5,000 and 10,000 ATCRBS transponders are sold to general aviation every year for the equipment replacement and new aircraft upgrading markets alone. He predicted that if the DABS program proceeds on schedule, there will be those in the competing general aviation avionics manufacturing community who will anticipate the completion of the detail of MOPS and TSO, and get the jump on their friendly competitors. By about 1983, Mr. Quinby estimated, there will be on the market a DABS-compatible transponder, accompanied by an advertising program which urges the customer to spend a few hundred dollars extra in order to be in a position to take advantage of the new system.

Mr. Thomas

Mr. Thomas of GAMA endorsed Mr. Quinby's argument by noting that, in all national system endeavors, private sector expressions of participation always follow Federal Government program commitment. He reiterated his previous argument that moving ahead now is not a very big gamble, because there is ample opportunity to impound the budget if any unanticipated serious problems show up.

An objection was made to an earlier characterization of the DABS program as "precipitous, " inasmuch as it has slowly and methodically evolved from the days of Project Beacon. There was also support expressed for moving ahead in order to get a production unit fielded as soon as possible so that the inevitable debugging could proceed.

M-. Van Ostrand

Concern was expressed that the implementation would be mandated. Previous bad experience with mandated equipment was cited as a reason for being wary of such a plan. Despite the unwillingness of AOPA to commit itself to an unqualified support of DABS implementation, Mr. Van Ostrand pointed out that, as soon as DABS or other systems become available, and some hard evidence is produced indicating that new capabilities and benefits are available commensurate with cost, the general aviation community will begin to buy and install the equipment to whatever degree of sophistication is suitable to their needs. There was further discussion which expressed a strong preference for marketplace implementation decisions on a system that works properly, rather than a mandated transition.

There followed a discussion concerning DABS impact on airport capacity increases. One approach to increasing airport air traffic capacity is close-spaced parallel runways. To monitor close-spaced parallels, a l-second data rate is needed. En route monitoring does not require this high rate. All en route or terminal DABS sites presently anticipated are being built to a design which will accommodate back-to-back antennas. The terminal data rate is 4 seconds; the en route rate is 10 to 12 seconds. In the back-to-back mode, this gives a 2-second data rate in the terminal, and 6 en route. This does not meet the requirement for close-spaced parallel runways, which would need a higher antenna-rotation rate or a phased-array antenna system,

Regarding the utilization of bandwidth allocated for the present air traffic control, it was pointed out that the spectrum utilization of the DABS signal format, by design, fits into the allocated spectrum, and in fact is a better utilization than ATCRBS.

Dr. Goldmuntz

Mr. Poritzky

M-. Fannon

Moderator Goldmuntz summarized the panelists' remarks and associated discussions as follows: if assurance can be given that the DABS system has enough capacity to provide the services advertised, and that DABS is the best system in terms of increased protection in a given implementation time, ALPA will support its implementation. Dr. Goldmuntz' judgment is that any competitive system would be at least a decade behind DABS at this point. Mr. Poritzky pointed out that FAA is presently examining three methods for feeding CDTI displays. One is full BCAS, the second is ATARS, and the third is by navigation coordinate systems such as inertial systems or broadcasts from a GPS, etc. The aviation community will participate with FAA in making a selection of the best system. Based on present information, he felt that DABS/ATARS is probably the fastest and easiest way to achieve this. Mr. Fannon raised the question of ALPA's concern over entering a foreign country not equipped with DABS ground sites. Dr. Goldmuntz pointed out that a DABS-equipped aircraft in that situation will have the same capability (ATCRBS) that presently exists, along with an airborne system capable of detecting other ATCRBS-equipped aircraft in the vicinity. Even though the ATCRBS-equipped aircraft may be unaware of the DABS-equipped aircraft, the reverse is not true, so that the overall situation is certainly not worse than it is right now. To the extent that at least one of the partners is aware of the other, there should be safety enhancement of collision risk. Furthermore, the full capability of BCAS, as Dr. Koenke pointed out, depends on the DABS air-to-air link or tie breaker. It can utilize DABS sites if they exist, as well as existing ATCRBS sites to get the directional information on the other aircraft. The full-capability BCAS does not require a DABS ground station; it does require DABS in the aircraft for the air-to-air link.

Dr. Koenke

Dr. Goldmuntz

Dr. Goldmuntz noted that the segments of the user community which carry more passengers per aircraft are more interested in moving ahead with the program than are the smaller airplane constituencies. The military problem may appear to be DABS-related, but it is really one which, though solved 12 years or so ago, has moved out of that framework so that updating is required. The updating also needs now to be compatible with DABS. JTIDS, if implemented by the military, offers a possible solution, since it will either incorporate DABS or be compatible.

Mr. Maxwell

Chairman Maxwell thanked Dr. Goldmuntz and the Panel and opened the floor to general discussion. A number of additional points were made.

Some confusion regarding the transition or implementation was cleared up. The FAA implementation plan deals with FAA ground facilities only. It does not address the airborne equipment transition.

Though DABS has the capability to do many things, it was emphasized that the fundamental separation responsibility remains with the controller and the control process; DABS is a tool and backup for the controller. DABS sites, through ground links, will provide redundancy in the event of a system component failure by providing an array of alternative communication paths. For example, in the Los Angeles Basin 1995 model, there are 1,700 aircraft simultaneously airborne. Dr. Koenke stated that currently there are more than 70 ATCRBS sites in the L.A. Basin. Four DABS sites could handle the Basin. As a measure of the redundancy provided, he stated that if one of these four sites went down, the remaining sites, with radar coverage of all the targets, can provide control of all 1,700 aircraft and still provide datalink services.

Dr. Koenke

Mr. Maxwell

Chairman Maxwell pointed out that FAA plans include going to much higher levels of automation in their ground control system. When these higher levels of automation are introduced, they will require a surveillance system that has a higher capacity. Although DABS is viewed presently as a backup system, it becomes a very important integral part of a higher level automated system.

Regarding the appropriations hearings schedule, the OST approval process, TSARC reviews, etc., it was further explained that TSARC is a process that relates to the execution rather than initial approval, of programs. The budget approval process necessarily precedes TSARC, so that programs can be formulated, reviewed for accuracy, and approved. The Secretary has already approved the $20 million budget request. The congressional authorization process follows next, and if the budget is authorized, TSARC will review the FAA plans before FAA issues an acquisition RFP in midsummer. Chairman Maxwell explained that TSARC was set up several years ago to make certain that the various modal administrations having major systems acquisitions prepare their plans early enough for a rational overall Department review before going to Congress. In the present case, when FAA completes their transition plan and procurement plan, it will be reviewed by TSARC and the Secretary. If approval is granted, it sets the stage for budget submittals for fiscal year 1982 and beyond. The fact that OST has approved $20 million in the fiscal year 1981 budget means that the Secretary has approved the program to that extent, and that he has recognized the urgent need to proceed with upgrading the current level of collision avoidance protection.

Mr. Fannon

Mr. Fannon questioned how DABS/ATARS would relate to the effects of the Airline Deregulation Act, e.g., fostering low-density air service, more commuter activity, 3D and 4D RNAV, more off-airways operation, etc. Expenditures for RNAV and DABS should result in operational efficiency improvements. Mr.

Mr. Poritzky

“ Poritzky replied that there is a recognition in the systems planning process of the necessity to improve the total system with these aids. DABS/ATARS, to the extent that it provides coverage, higher accuracy, and more information to the system, will facilitate these other, more flexible route operations.

Further congressional staff concern was expressed about a lack of FAA assurance of user equippage to ensure use of the proposed 120 DABS sites. Several responses made it clear that the bulk of the air carriers will be well-equipped. An estimate of an initial voluntary general aviation DABS equippage was put at around 20 percent, although it was felt that this number would quickly rise, consistent with perceptions of benefits derived, once the ground system is implemented. It was pointed out, also, that historically, new systems were strongly resisted by the user community until the benefits became apparent.

Concluding Remarks

Mr. Maxwell

Chairman Maxwell concluded by noting plans for summarizing the Seminar in a proceedings format. He announced plans for an in-depth OTA assessment of the airport and air traffic control system, with emphasis on terminal area capacity and the appropriateness of FAA plans to meet air transportation growth. Thanking all the speakers, participants, attendees, and staff, Mr. Maxwell adjourned the Seminar at 4:30 p.m.

Appendixes

Appendix A—Acronyms

ACARS —ARINC Communications Addressing Reporting System
AEEC — Airline Electronics Engineering Committee (ARINC)
AERA —Automated En Route Air Traffic Control
ALPA — Air Line Pilots Association
AOPA — Aircraft Owners and Pilots Association
ARINC —Aeronautical Radio, Inc.
ATA — Air Transport Association of America
ATARS —Automatic Traffic Advisory and Resolution Service
ATC — Air Traffic Control
ATCAC — Air Traffic Control Advisory Committee
ATCRBS —Air Traffic Control Radar Beacon Service
BCAS — beacon collision avoidance system
CDT] — Cockpit Display of Traffic Information
CVR — cockpit voice recorder
DABS — Discrete Address Beacon System
DABSEF — Discrete Address Beacon System experimental facility
DOD — Department of Defense
DOT — Department of Transportation
DSARC — Defense System Acquisition Review Council
EAA — Experimental Aircraft Association
ECM — Electronic Countermeasure
E&D — engineering and development
EFR — electronic flight rules
FAA — Federal Aviation Administration
GAMA — General Aviation Manufacturers Association
GPS —global positioning system
GPWS — ground proximity warning system
HF — high frequency
ICAO — International Civil Aviation Organization
IFF — Identification Friend or Foe
IFR — instrument flight rules
IMC — Instrument Meteorological Conditions
INS — Inertial Navigation System
IPC — intermittent positive control
JTIDS —Joint Tactical Information Distribution System
M&S — metering and spacing
MLS — Microwave Landing System
MOPS — Minimum Operational Performance Standard
MSAW — minimum safe altitude warning
NAFEC — National Aviation Facilities Experimental Center
NAS — National Airspace System
NASA — National Aeronautics and Space Administration
NATA — National Air Transportation Association
NATO — North Atlantic Treaty Organization
Navstar —A satellite navigation system now called GPS
NBAA — National Business Aircraft Association
nmi — nautical miles
NPA — National Pilots Association
NRL — Naval Research Laboratory
OMB –Office of Management and Budget
OST –Office of the Secretary of Transportation
OTA —Office of Technology Assessment
PWI — proximity warning indicator
RFP — Request for Proposal
RNAV — area navigation
3D RNAV —three dimensional (space and time) area navigation
4D RNAV –four dimensional (space and time) area navigation
RTCA — Radio Technical Commission for Aeronautics
RVR – Runway Visual Range
SAFI —Semi-Automatic Flight Inspection
SAM —systems acquisition management
SIDS —Standard Instrument Departures
SSR — secondary surveillance radar
STARS —Standard Arrival Routes
TARC –Terminal Area Radar Control
TCA —Terminal Control Areas
TSARC —Transportation System Acquisition Review Council
TSO —Technical Standard Order
UHF — ultrahigh frequency
VFR —visual flight rules
VHF — very high frequency
VMC — Visual Meteorological Conditions

Appendix B—Agenda: OTA Seminar on the Discrete Address Beacon System (DABS)

OTA Conference Center
January 31,1980

9:00 a.m.	REGISTRATION	
9:30 a.m.	WELCOME AND INTRODUCTIONS	DR. JOHN H. GIBBONS, *Director* *Office of Technology Assessment*
	OPENING STATEMENTS	THE HONORABLE HOWARD W. CANNON, Chairman *Subcommittee on Aviation* *Committee on Conmerce, Science and Transportation* *U.S. Senate* THE HONORABLE ROBERT B. DUNCAN, &i_ *Subcommittee on Transportation* *Committee on Appropriations* *U.S. Rouse of Representatives* THE HONORABLE THOMAS R. HARKIN, Chairman *Subcommittee on Transportation, Aviation and Communications* *Committee on Science and Technology* *U.S. House of Representatives*
	SEMINAR PLAN	ROBERT L. MAXWELL, Manager *Transportation program* *Office of Technology Assessment*
10:15 a.m.	INTRODUCTION TO FAA PRESENTATIONS	QUENTIN S. TAYLOR, *Deputy Administrator* *Federal Aviation Administration*
	DABS CONCEPT AND DESCRIPTION What is it? Where is it going? How does it fit in the ATC system? International implications.	SIEGBERT B. PORITZKY, *Director* *Office of Systems Engineering Management* *Federal Aviation Administration*
10:45 a.m.	BREAK	
11: 00 a.m.	DABS AND THE DABS DATA LINK PROGRAM. Testing, compatibility with ATCRBS, schedule for implementation.	MARTIN T. POZESKY, *Acting Technical Advisor* *Systems Research and Development Service* *Federal Aviation Administration*
11:15 a.m.	DABS TECHNICAL ISSUES	NORMAN SOLAT, *Acting Chief* *Communication Surveillance Division* *Federal Aviation Administration*
11: 30 a.m.	MILITARY SYSTEM IMPLICATIONS	COL. STEPHEN GILBERT *U.S. Department of Defense*
11:45 a.m.	GENERAL DISCUSSION	
12:30 p.m.	LUNCH	
1:30 p.m.	USERS PANEL DISCUSSION *Philip Van Ostrand, AOPA* *Frank White, ATA* *David Thomas, CAM* *William Rome, ALMA*	DR. LAWRENCE "A: GOLDMUNTZ, *Moderator* *President, Economics and Science P?.arming, Inc.*
2:00 p.m.	GENERAL DISCUSSION	
3:00 p.m.	SEMINAR SUMMARY	GOLDMUNTZ and MAXWELL
3:30 p.m.	GENERAL DISCUSSION	
4:30 p.m.	ADJOURN TO RECEPTION	

Appendix C—Participants in OTA'S Seminar on the Discrete Address Beacon System

Al Albrecht	Federal Aviation Administration
John Bagnulo	General Accounting Office
Charles M. Barclay	U.S. Senate
James Bispo	Federal Aviation Administration
Neal Blake	Federal Aviation Administration
William Broadwater	Federal Aviation Administration
Malcolm Burgess	Federal Aviation Administration
David Burt	US. House of Representatives
Bruce Butterworth	U.S. House of Representatives
Robert Carpenter	General Accounting Office
George Chatham	Library of Congress
Andy Chinni	U.S. Senate
Anthony Csicseri	General Accounting Office
Scott Crossfield	U.S. House of Representatives
Joseph DaCorte	Bendix Corp.
Ernest Davis	National Transportation Study Board
Emmett DeAvies	U.S. House of Representatives
Marshall Filler	U.S. House of Representatives
Charles Foster	Federal Aviation Administration
James Forsberg	General Accounting Office
Co]. Stephen Gilbert	U.S. Department of Defense
Lee Goolsby	National Aeronautics and Space Administration
Larry Hanes	Texas Instruments
Gabriel Hartl	Air Traffic Control Association, Inc.
David Heymsfeld	US. House of Representatives
P. Douglas Hodgkins	Federal Aviation Administration
William Horn	National Business Aircraft Association
Jack Howell	Air Line Pilots Association
Thomas Imrich	Federal Aviation Administration
Tom Kingsfeld	U.S. House of Representatives
Robert Kleg	Texas Instruments
Edmund Koenke	Federal Aviation Administration
Richard Kowalewski	U.S. House of Representatives
Edward Krupinski	Air Line Pilots Association
Timothy Leeth	U.S. Senate
Jay Lowndes	Aviation Week and Space Technology
John MacKinnon	Department of Transportation
Al McFarland	MITRE Corp.
Charles McGuire	Department of Transportation
Fred McIntosh	National Business Aircraft Association
Richard Mudge	U.S. House of Representatives
John O'Hara	U.S. House of Representatives
Vincent Orlando	Massachusetts Institute of Technology/Lincoln Laboratories
Philip Van Ostrand	Aircraft Owners & Pilots Association
Martina Pearson	U.S. House of Representatives
Pam Peiper	Input Output Computer Services, Inc.
Siegbert Poritzky	Federal Aviation Administration
Craig Potter	U.S. Senate
Martin Pozesky	Federal Aviation Administration
Gilbert Quinby	Narco Avionics Division
Lani Raleigh	Library of Congress
Herman Rediess	National Aeronautics and Space Administration

John Ryan	Federal Aviation Administration
Bill Semos	U.S. Senate
Warren Sharp	Federal Aviation Administration
William Simpson	Operations Research, Inc.
Ed Smick	U.S. Senate
Norman Solat	Department of Transportation
Quentin Taylor	Federal Aviation Administration
David Thomas	General Aviation Manufacturers Association
David Traynham	U.S. House of Representatives
John Vialet	General Accounting Office
George Webber	Department of Transportation
Robert Wedan	Federal Aviation Administration
Jerry Welch	Massachusetts Institute of Technology/Lincoln Laboratories
Frank White	Air Transport Association of America

Contractors/Consultants

Bonnie Back	Systems Design Concepts
Jack Enders	Private consultant
Marcy Fan non	Private consultant
Larry Goldmuntz	Economics & Science Planning
JoAnne Greiser	Systems Design Concepts
Arthur Webster	EXP Associates
Alexander Winick	Private Consultant

OTA

Ernest Baynard	Space, Telecommunication, and Information Systems Program
Yupo Chan	OTA Fellow, Transportation Program
Lee Dickinson	Transportation Program
Steve Doyle	Space, Telecommunication, and Information Systems Program
John Gibbons	Director, Office of Technology Assessment
Samuel Hale	Science, Information, and Transportation Division
Al Landry	Administration Office
Bob Maxwell	Transportation Program
Zal Shaven	Space, Telecommunication, and Information Systems Program
Jerry Ward	Transportation Program

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