STATEMENT OF NEAL A. BLAKE, DEPUTY ASSOCIATE ADMINISTRATOR FOR ENGINEERING AND DEVELOPMENT, FEDERAL AVIATION ADMINISTRATION, BEFORE THE HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY, SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND COMMUNICATIONS CONCERNING CURRENT R&D TELECOMMUNICATION PROGRAMS. May 21, 1980.

Mr. Chairman and Members of the Subcommittee:

I welcome the opportunity to discuss the FAA's communication development programs, their application to our primary mission, aviation safety, and our plans for the future expansion and upgrading of our communication system. Our communications development activities are vital to providing the highly reliable communications needed to support this mission.

Among the vital services we provide to the flying public are assistance to pilots in flight, pre-flight weather briefings, air traffic control services, dissemination of safety information, and the initiation of search and rescue operations for overdue aircraft. These services would not be possible without communications. Our radars, computers, and skilled personnel would be valueless without the means to communicate with the aircraft in flight and the ability to transmit information using voice and data among our ground based facilities. If we are to continue to provide the highest level of air safety, we must maintain our active and effective communications development program.

The FAA's communication system consists of a large interconnected network of voice and data communications equipment and leased transmission facilities. The present voice communication portion of the National Airspace System is composed of two subsystems; a ground to ground system and an air to ground system. The ground to ground system provides voice communications among all Air Route Traffic Control Centers, terminal control rooms, control towers, and Flight Service Stations and interfaces with military air traffic control and air defense facilities . In addition, the system provides voice communications between Flight Service Station Specialists and users. Moreover, all air traffic control facilities and Flight Service Stations utilize air to ground radio systems for voice communications with aircraft in the airspace under their responsibility.

Our various data communication systems perform a number of functions as shown in Diagram 1. Examples of some of the major functions are: distribution of en route computer programming and maintenance information by the National Airspace System Network (NASNET); distribution of flight plans among our over 290 domestic Flight Service Stations and 20 Air Route Traffic Control Centers by the Automated Service B Distribution Switched Network; the intercenter dissemination of emergency, flow control, and aircraft movement messages by the Center B system; the collection and distribution of weather information from, and to, virtually all of

our facilities and those of some users by the Weather Message Switching Center Network; and the collection of information needed by our Jacksonville flow control computer. Direct connections are used to link the automation computers located in our 20 Air Route Traffic Control Centers in the 48 contiguous states and the three in Alaska, Hawaii and Puerto Rico with each other and with the computers in our 63 major terminals. In addition, 82 smaller automated terminals, which are currently being installed, will be directly linked to our centers. Similarly, aircraft position data reaches our en route centers over dedicated direct data communication lines from our remote radar sites.

To interconnect this array of people, computers, switching centers, and remote facilities, and to facilitate the communications between them, the FAA leases 2 million miles of transmission facilities primarily through the Defense Commercial Communication Office (DECCO). In addition, we own and maintain 16,000 miles of microwave links designed to serve our more remote locations.

The leased facilities represent a significant recurring cost to the FAA. For example, in FY 1979 our cost was over $64 million. Moreover, we have a significant capital investment in communication equipment, plant facilities, and radio transmitters and receivers. This investment now exceeds $400 million.

The present voice communications system was designed initially for manual ATC and flight service operations. These designs date back to 1948 for the radio signaling and control system, and the late 1950's for the more complex 300 and 301 key systems used at our Air Route Traffic Control Centers and terminal control facilities. The latter systems were specifically developed for the FAA ground to ground voice operations of that era. The necessary reliability and availability of voice communication operations in the present environment is obtained by equipment and transmission circuit redundancy, substantial maintenance efforts, and specially equalized radio-ground link transmission facilities.

The cost of leasing our existing Voice Communication System, facilities and equipment, plus the maintenance cost associated with the present radio signaling and control system contribute significantly to the high total recurring cost of voice communications. In 1979, these costs were approximately $126 million, exclusive of radio transmitters and receivers. These operating costs continue to increase due to the expansion of the ATC system and the increasing amount of manpower and materials required to maintain the radio signaling and control system.

The evolution of our voice and data communications systems over the last 4 decades has kept pace with increases in air traffic, the introduction of automation, and some improvements in efficiency. The

capacity and flexibility of these functionally oriented systems, networks and dedicated circuits is adequate for today's manual and semiautomatic ATC environment. However, the technology used in these systems is largely obsolete, materially contributing to our increasing operation and maintenance costs. The potential offered by today's technology in reducing these costs and in improving our efficiency is very attractive. Furthermore, it has become evident to us that continued use of these systems and networks will not be a cost effective solution for the requirements of our more highly automated ATC system in the late 80's and beyond.

We have implemented a program to provide automated flight services at 61 Flight Service Stations and introduce pilot self-service features into the system. The program establishes a data base of weather and flight plan information in a special Flight Service Data Processing System located at each Air Route Traffic Control Center which will provide a quick retrieval capability for the Flight Service Specialists at the new automated facilities. The weather information supplied to these computers will be received from the new weather system data processing computers at Salt Lake City and Atlanta. Our current data communication system will require upgrading to support this capability.

We are planning to significantly upgrade our ATC automation system in the late 1980's. A number of factors make this necessary: continued growth in air traffic, the need to achieve higher levels of

performance and efficiency in the operation of the ATC system, and the increasing age and lack of expansion capability of our current computer complex. As part of this upgrading we will be replacing the current computers in our Air Route Traffic Control Centers. The new computer system will be capable of providing significantly greater automation services, traffic handling capacity and reliability. These computers will require a supporting data communication system which also has the attributes of high capacity and reliability. Our current data communication system will not be adequate to perform this future job, nor was it designed to do this job.

As more advanced automation is introduced into our system it will be necessary to communicate more efficiently with aircraft in order to achieve the full benefits of automation. This will be achieved by connecting our ground data communication system directly to aircraft using the data link capability of our new Discrete Address Beacon System (DABS).

The increased levels of automation will likewise require significant changes to the voice communication system. Loss of a center's communication capabilities or automated radar services may be compensated by adjacent centers assuming control of its airspace. This requires the immediate and automatic switching of up to 270 air to ground radio channels, 12 or more radar data channels, and perhaps a hundred inter-facility communication lines. Our current system is incapable of performing this switching function. In

addition, our operating services have identified new operational requirements which cannot be accommodated practically in the existing system, but which are technically feasible and economically viable with modern state-of-the-art switching technology.

FAA's communications development programs are applied efforts. In our development programs we strive to use up-to-date but proven technology. We closely monitor the research efforts of the Department of Defense and the private sector, and when an improved technology is shown to be reliable, economic and operationally applicable to our needs, we put it through a development, test and evaluation program. We contract with industry for the necessary development, using a functionally oriented specification, and then test the resulting engineering model at our National Aviation Facilities Experimental Center (NAFEC) in Atlantic City, New Jersey (to be renamed the FAA Technical Center) or at an operational site in an off line manner.

Our communications development program is directed at identifying opportunities for the application of new technology, and developing that technology to meet the FAA's unique operational requirements. For example:

- The Voice Switching and Control System (VSCS) Program will apply modern state-of-the-art switching, control and device technology for voice systems in our Air Route Traffic Control Center, terminal and Flight Service Station environments.

- The Small Voice Switching System (SVSS) Program will apply similar technology to our smaller control towers.

- The National Airspace Data Interchange Network (NADIN) is our program to introduce the proven technology of data communication concentrators into our message switching systems and provide a significant expansion capability for the future.

Throughout the design and development of these communications systems, significant attention is being given to the supporting network design. We have been conducting studies stressing network reliability and capacity, such as our computer-based study on NADIN which points out how to organize the network architecture and interconnect the elements to meet our requirements for reliability in a cost-effective manner. System failure modes and the means to detect them are analyzed and backup and recovery procedures are developed. The network design together with the development of the switching systems constitute our "total system design".

Under our new Voice Switching and Control System (VSCS) program we will be developing equipment for each of our operational environments: Air Route Traffic Control Centers, terminals, and Flight Service Stations. The VSCS engineering designs will feature:

- Modern state-of-the-art switching, device, and control technology.

- Modular construction to permit the use of common equipment in each of our facilities and to facilitate expansion as air traffic grows.

- A self-contained capability to provide performance monitoring and more efficient maintenance and certification.

- The capability to rapidly reconfigure the ground and air voice communication circuits at each controller position to meet future automation requirements.

- Automatic circuit failure detection and switching to alternative circuits will permit us to circumvent inoperative circuits between centers, thus improving network reliability in addition to permitting integration with the data network.

- Additional operational features to reduce the communications workload of our controllers and provide a more responsive system.

The Small Voice Switching System is being designed along similar lines for our lower activity ATC towers. This system, which will also utilize modern technology, has the potential for application at approximately 400 facilities throughout the country. We anticipate delivering the engineering model of this system to our NAFEC facility next spring for testing and evaluation.

In the data communications area, we have a program to implement and enhance the National Airspace Data Interchange Network (NADIN), which will initially replace five of our independent low speed networks. NADIN was designed in such a manner as to provide considerable potential for growth through further development.

Key to the initial NADIN configuration, shown in Diagram 2, are intelligent communication concentrators located at each Air Route Traffic Control Center, including those located in Anchorage, Honolulu, and San Juan. The concentrators, which will be upgraded to switches when needed, will connect data communications terminals with remote data bases, and to each other, through two data switches located at Salt Lake City and Atlanta, each capable of managing the entire network under emergency and test conditions. The initial NADIN configuration will also interface with the Canadian aeronautical network, the weather switch at Kansas City, the National Weather Service Computer at Suitland, Maryland and our present en route ATC computers; thus providing an element which may contribute to the extended operational life of our ATC computers.

The initial system is designed and specified to allow for expansion to accommodate additional requirements for data transfer at minimum cost and operational impact to the initial system. The expansion capability includes increases in system capacity and provides for architectural growth and extension. Thus, NADIN, which will initially be a minimally connected store and forward message switching system, can evolve into a highly connected, distributed system with sufficent means to meet our future automation

requirements. A contract award for the initial NADIN configuration is projected for the 4th Quarter of this year.

Current R&D activities include the design and specification of additional data transfer functions for incorporation as NADIN system enhancements. FAA programs and services which we anticipate will utilize this data communications system to meet some or all of their data transfer requirements include:

- The Flight Service Station Automation Program.
- The Air Traffic Control Computer Replacement Program.
- The Flight Data Input/Output Equipment Replacement Program.
- Discrete Address Beacon System/Data Link Program.
- Remote Maintenance Monitoring Program.
- Automated Flow Control
- Aviation Weather System

Our first enhancement to NADIN will include upgrading the system to meet the requirements of the Flight Service Station Automation Program and the Flight Data Input/Output Equipment Replacement Program. In addition, we are investigating the feasibility of using NADIN, with appropriate enhancements, to meet the data transfer requirements of several other agencies within the Department of Transportation.

NADIN and its enhancement program is a significant step in the evolutionary process toward the integrated data system concept shown in Diagram 3. We anticipate that ultimately all FAA facilities will be tied into a nation-wide network using standard interface designs whenever possible. In addition, communications processing computers, which are expansions of the initial NADIN concentrators, will be located at our Air Route Traffic Control Centers to provide each subscriber access to virtually every part of our system.

These processing computers will sense failures within the system and determine the appropriate action which is necessary to maintain communications. The network will use transmission links of several kinds, including microwave and satellite, in addition to appropriate combinations of packet, message and circuit switching to provide the necessary service to all subscribers. These subcribers will include: our en route and terminal ATC computers, our new Flight Services Data Processing System computers, the Automated Flight Service Stations, the new aviation weather processors, the Flow Control Computer, flight data terminals, DABS, and a variety of weather and radar inputs. The two Initial NADIN switches at Salt Lake City and Atlanta will continue to provide message switching and record keeping as part of this network. The DABS data link which will be an extension of the ground system will enable all equipped aircraft within DABS coverage to be conected to the ATC computers and various other computerized data bases throughout the system.

Diagram 4 shows the integrated concept at a typical Air Route Traffic Control Center. Within the center the communications network begins at the communications processor. The network serves the ATC computer, the flight services computer, and the central weather processing complex. External systems which will use the network include DABS, weather radar, and the Flight Service Stations. Other users, either internal or external, may exist depending on the particular Center. These may include the aviation weather processor, the flow control computer or the Initial NADIN message switch.

The network concept reaches down to the major terminal level and consolidates the data communication requirements of those facilities. This may include the ATC computer, flight data input and output terminals, DABS and future terminal weather processing computers. We believe that our integrated data system, of which NADIN and its enhacements is a significant element, will meet our data communication capacity and reliability requirements for the future.

In summary, our integrated communications network will be large and complex. We have a significant requirement to interconnect a wide variety of computers, terminals, and special purpose equipment to effectively perform our mission. Due to the problem of achieving compatability between systems, system interconnection has become a major challenge in our development program. Furthermore, as we enhance our communication systems to match our evolving requirements, we must keep in mind our continuing need to physically upgrade the systems for new subscribers, while maintaining full operation for our existing subscribers.

In addition, we are active in the development of standards on both the national and international level to help us solve these problems. At home, we participate in the Federal Telecommunications Standards Program, along with many other government agencies, working to develop interface standards between data processing and telecommunications functions. Likewise, on the international scene we are active in the International Civil Aviation Organization (ICAO) Automated Data Interchange Systems Panel (ADIS). The end result of the latter activity will be the publishing of Standards and Recommended Practices which the international aviation community will use to technically ensure reliable communications between ground facilities and between airplanes and ground facilities throughout the world. This is an essential activity of our program.

As I previously mentioned, we are currently studying the feasibility of using NADIN, suitably enhanced, to meet some of the data communication requirements of other agencies within the Department of Transportation, including the Federal Highway Administration, the Coast Guard and the National Highway Traffic Safety Administration. Current work involves the identification and quantification of these agencies' requirements for data communication services which can potentially be provided by NADIN. Future work will include performing the necessary engineering and economic analyses to determine the feasibility of this program.

Mr. Chairman, I again thank you for this opportunity to describe our current and future communications programs.