A History of Engineering and Science in the Bell System

National Service in War and Peace (1925-1975)

Prepared by Members of the Technical Staff,
Bell Telephone Laboratories.
M. D. Fagen, Editor.

Bell Telephone Laboratories, Incorporated

Credits for figures taken from
other than Bell System sources
appear on page 721.

First Printing, 1978

International Standard Book Number: 0-932764-00-2

Library of Congress Catalog Card Number: 75-31499

Printed in the United States of America

2.3 FAA Air-Route Traffic Control System

2.3.1 No. 300 Switching System

The 1950s saw a tremendous increase in air traffic, resulting mainly from the introduction of the faster and larger jet aircraft. This aircraft placed greater demands on the communications services used to control commercial and private aircraft that operated daily over thousands of miles of United States airways. In 1956, the Civil Aeronautics Administration, which later became the Federal Aviation Agency (FAA), requested help from AT&T and Bell Laboratories in formulating requirements for a new communications system dedicated specifically for the FAA in their air-route traffic control centers (ARTCC). This system became known as the No. 300 switching system.

The No. 300 system was only one of a number of communications projects undertaken by Bell Laboratories to fulfill the growing needs of the FAA at various aviation-related locations. These projects covered all phases of aircraft control and ranged from the development of specific equipment, such as lightweight headsets, to complete, dedicated switching systems and from dedicated, nationwide voice networks to broadband radar remoting systems. Not to be overlooked were the communications services required for airport control towers and for the more than 300 flight service stations scattered across the country.

The No. 300 system was designed to be extremely flexible and to handle large volumes of calls with no restrictions imposed on the number of calls that could be in progress at the same time. It was a nonblocking system with 100-percent access. Calls through the system were switched on a four-wire basis with all the signaling, switching, and voice-communications facilities required for handling thousands of calls per day. For the most part, the No. 300 system consisted of racks of wire-spring relays and step-by-step and crossbar switches in a separate equipment room. In the operating portion of an ARTCC, there could be as many as 300 attendant positions, each having access through special keys, lamps, loudspeakers, and telephone sets to up to 200 lines of varying types.

Speed was the essential built-in system characteristic so vitally needed for the successful control of aircraft. A single push on a single button by a controller established an immediate connection to the local control tower, a remote Air Force base, another ARTCC, or simply a nearby controller position (see Fig. 12-17). Similarly, connections could be established to customer-owned radio links for contact with the aircraft as it followed its assigned track in the sky. This *direct-access* capability was perhaps the most important feature available to the controller. Of course, it was impractical to have direct access to all lines. Therefore a method was provided that permitted the attendant *indirect access* by seizing a line and dialing a code number to connect to any other desired location.

Associated with the access arrangements was a feature known as "override." This feature was provided due to the urgency of much of the communications in an ARTC. It enabled any controller to reach any line or other position regardless of the amount of traffic in the system or whether the line or trunk was busy. No action was required on the part of the called party to complete the overriding call.

Many other unique features were created, especially for use in the No. 300 system. Because of the semidark lighting in an ARTCC, back lighting of the key control panel was provided and was controlled by the attendant at the position. A position-blanking feature, also controlled by the attendant, was provided at each position. This feature automatically extinguished all other lamp displays at a position upon receipt of an incoming call for which the position had primary answering responsibility. A syllabic lamp was also provided to give a visual indication of speech received on radio channels. The light intensity of the lamp varied with the volume amplitude of the incoming speech. Also, there was an electronic chime that provided for the selection of one-out-of-five fundamental tone frequencies so that adjacent positions receiving incoming calls did not have the same incoming call-signal tone.

To train a controller to operate the No. 300 system, Bell Laboratories was asked to design a training simulator. Such a unit was designed, built, and tested in 40 days. The simulator provided all the basic operating features

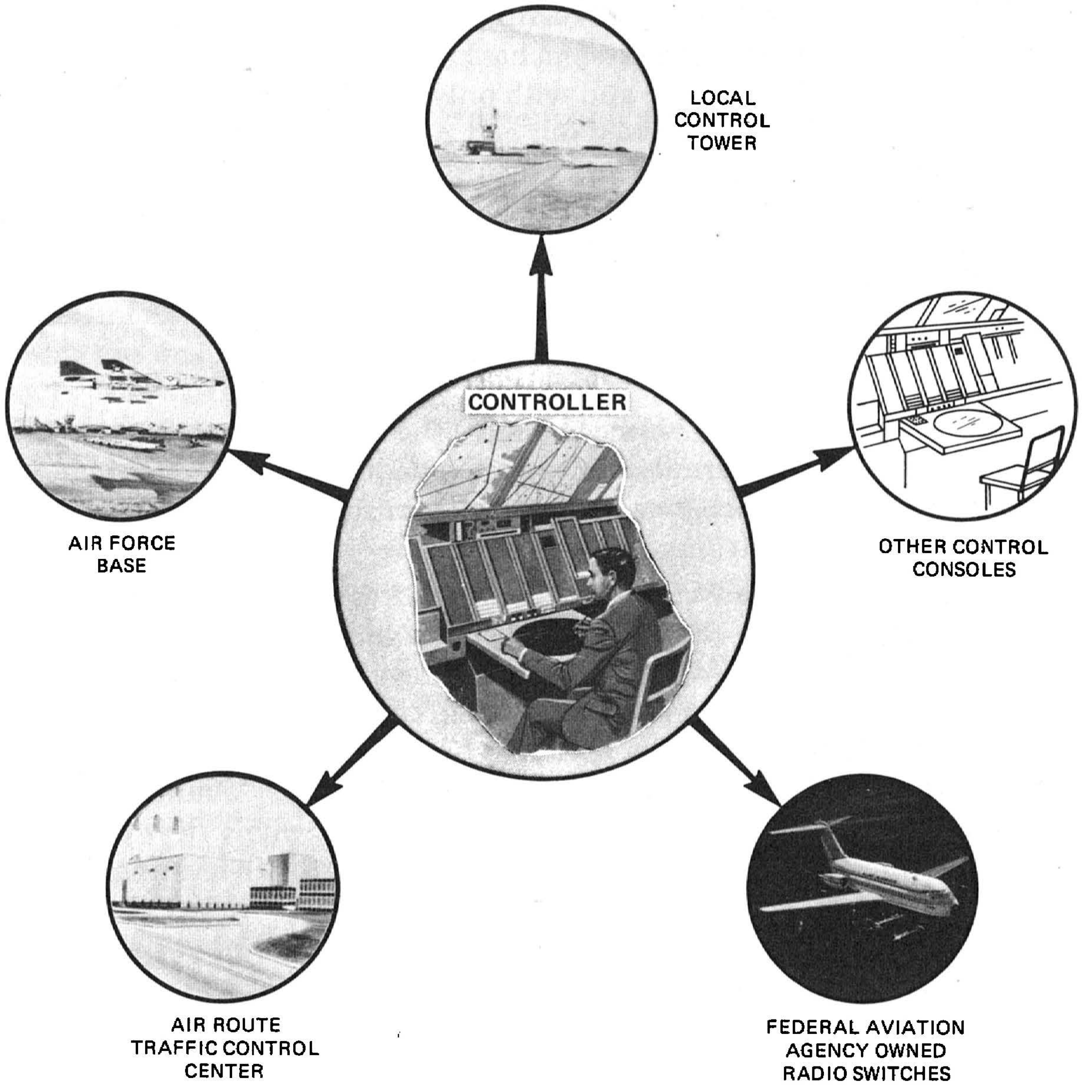

Fig. 12-17. Air route traffic control voice-communications system.

available to an attendent controller in the ARTCC and served as a model for subsequent training facilities used by the FAA.

In the early 1970s, Bell Laboratories, at the request of the FAA, designed a system maintenance monitor console to provide a central monitoring location and continuous status display of all communications equipment used by the FAA in an ARTCC. From this console an FAA engineer and an assistant had access to any position or line serving the No. 300 system, to conference bridging, and to the local PBX.

In 1976 there were 20 ARTCCs being served by the No. 300 switching system and the Bell System within the continental United States. These ARTCCs had been served by this system since 1961. There is also a No. 300 system in Alaska. Several design changes in the system have made it usable in other locations to serve different purposes. It is important to note that the reliability of the system has been outstanding with no system downtime at any installation and with only minor parts replacement. In time, the system will be phased out and replaced by one with more sophisticated facilities and switching techniques controlled by computers. In view of the record of the present system, this will result in space savings only, a factor which may become significant if any expansion of today's facilities should be required.

2.3.2 No. 301 and No. 301A Switching System for FAA Airport Towers

Closely tied to the No. 300 system were the No. 301 and No. 301A systems. These systems were also designed by Bell Laboratories for the FAA to meet the communications needs of airport towers and other related locations.

The No. 301 system was developed in 1961 to replace existing equipment, mainly the key-telephone equipment installed in airport towers that was rapidly becoming outmoded. Its development was undertaken to provide the FAA with a reasonably small communications system that permitted speedier operation, occupied less space, and suited the layout of airport tower facilities. The No. 301 system retained a number of the features of the old arrangements, but incorporated many new concepts of operation, which stemmed from experiences with air-terminal traffic congestion.

One important innovation incorporated in the No. 301 system was a single-lamp-per-key status display—previous displays had two lamps. Another new feature was a multiple-access attendants' telephone circuit that allowed an attendant simultaneously to talk on radio and to override other lines. The override arrangement was a carry-over from the No. 300 system. Because of extreme low-light conditions in a tower, a dark-environment, lamp-control circuit was also made available. Nonlocking pushbutton operation had already become a standard feature.

The No. 301 system was used initially in the control towers as well as in nearby instrument flight control rooms. These were commonly referred to as instrument flight rule (IFR) rooms since they controlled the operation of aircraft flying under instrument-flight, rather than visual, conditions.

A greater emphasis by the FAA on the control of aircraft in the immediate vicinity of an airport and the desire to consolidate IFR activities brought about the need to expand the basic No. 301 system. An enlarged, more flexible adaption of the No. 301 system was created. This No. 301A system provided all the features available in the No. 301 with some improvements and, it allowed for a growth factor that was previously lacking.