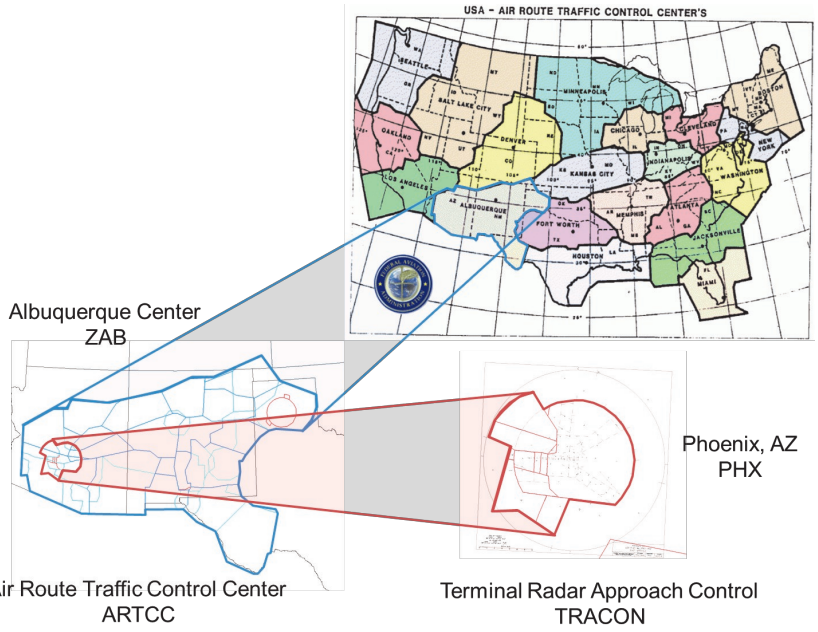
HOW AIR TRAFFIC CONTROL WORKS

How Air Traffic Control Works

At any given moment as many as 5,000 flights navigate the United States' National Airspace System (NAS). These aircraft move safely and expeditiously through the skies, under the direction of air traffic controllers. Each air traffic controller is responsible for issuing instructions to the aircraft that are in a specific part of the airspace. In doing so, the controllers keep the aircraft safely separated from each other, guide the aircraft around weather, and ensure flights move smoothly through the airspace.



The safe operation of a system as complicated as the NAS requires tremendous organization, coordination, and team work. In the NAS are 21 en route air traffic control facilities, called Air Route Traffic Control Center (ARTCC). Also referred to as 'Centers', each ARTCC is further divided into many sectors. High-altitude sectors are typically above 24,000 feet, while low-altitude sectors have a ceiling below that. Each sector has its own radio frequency and is staffed by one, or sometimes two, controllers. Using those frequencies, controllers communicate by voice with flight crews while the aircraft is in their sector. As an aircraft flies from its departure airport to its destination it traverses many different sectors. Each time the aircraft crosses into another sector, a 'hand-off' is made between the controllers of those two sectors. During the handoff the responsibility for separating the aircraft changes from one controller to the next. After the handoff the flight crew is told to switch to the frequency of the new sector. As an example, the flight crew of an aircraft departing from San Francisco may talk to more than twenty different controllers during its flight to Washington D.C.!

Human Systems integration division

NASA

How Air Traffic Control Works

How Air Traffic Control Works

While ARTCCs manage traffic in the en route airspace, Terminal Radar Approach Control (TRACON) facilities manage the airspace surrounding busy airports. Since the airspace around such airports is often congested and complex, air traffic control is transferred to a TRACON facility, specifically to handle the airspace below 20,000 feet and within 30 to 50 miles of the airport. The NAS currently has 27 TRACON facilities. Similar to ARTCCs, a TRACON's airspace is divided into sectors, each staffed by one or two controllers. Also similar to ARTCCs, a TRACON controller typically controls between 5 and 15 aircraft, depicted on the display as a moving 'target symbol' with a 'data block'. Whereas separation requirements in ARTCC facilities specify that aircraft should never come closer than 5 nautical miles laterally and 1000 feet vertically, the typical operations of a TRACON dictate a reduced lateral separation of 3 nautical miles. TRACON controllers today manage aircraft in complex environments, often with many crossing flows of arrival and departure traffic. Keeping aircraft safely separated in these environment can require frequent speed, heading, and altitude instructions.

A typical Flight Data Block, seen above, displays the following information:

Line 1: Call sign (airline and flight number)
Line 2: Altitude (in hundreds of feet) and ground speed (in tens of knots)
Line 3: Runway\runway sequence number
Target Symbol: Aircraft location and indicated airspeed (in knots)

How is NASA involved?

NASA is working on concepts and technologies that will increase the efficiency, safety, and capacity of future air traffic operations. Here at the Airspace Operations Laboratory (AOL), researchers conduct simulations of air traffic operations using the same workstations seen in actual ARTCC and TRACON facilities. However, the AOL has created their own software to drive the workstations. While the displays look and feel like the operational systems, they are in fact research systems that allow us to rapidly prototype and investigate new ideas that would take years to implement into the operational system. This way we can design and test concepts and tools quickly that help controllers do their jobs and the air traffic system run more efficiently. The laboratory arrangement seen in this room was recently used for a project called Air Traffic Management Demonstration 1, or ATD-1, which investigated new types of operations in the TRACON and ARTCC facilities surrounding the Phoenix area. NASA developed ATD-1 technologies are currently transferred to the FAA.

Human Systems integration division

NASA