Air traffic control[1]

Air traffic control (**ATC**) is a service provided by ground based controllers who direct aircraft on the ground and in the air to ensure safe, orderly and efficient traffic flow.

ATC services are provided throughout the majority of airspace, and its services are provided for all users (private pilot, military, and commercial). Such airspace is called "controlled airspace" in contrast to "uncontrolled airspace". By law, pilots must obey the directions of air traffic controllers when they are in controlled airspace.

At major airports, air traffic control begins with the controller in the airport tower, who guides airliners from the loading ramp, along the taxi strips, to the runway threshold. The controller must consider other aircraft as well as the legions of vehicles, such as fuel tankers, luggage and cargo vehicles, and maintenance vehicles, needed for airport operation. The job continues day and night, in all weather, so that at times of reduced visibility large airports rely on special radar to aid the controller.

For take-off, another air traffic controller located in the airport tower may take over, confirming an assigned runway clearance and providing information on wind and weather and other data needed for departure. A departure controller may pass on additional data as the airliner is handed over to the air route traffic control (ARTC), the personnel of which remain in communication with the airliner from one ARTC centre to the next, until the air traffic control tower at the plane's destination takes over.

ARTC radar and computer systems represent a major advance in air traffic control in that controllers are relieved of the accumulation and interpretation of immense amounts of routine material, thereby permitting them more time to assess data relevant to key decisions. In the control room, the controller wears earphones and a microphone for radio communication with aircraft and other controllers. The planes themselves are represented as a data block on a special radar screen in front of the controller.

[1] Texto adaptado de "http://en.wikipedia.org/wiki/Air_traffic_control" [2005 – 07 -31]

The data block includes a symbol for the individual aircraft, along with the plane's identifying call sign, speed, and altitude. Some radar equipment can display additional information pertaining to a particular flight. Flights are kept at separate altitudes and at specific distances from one another. Flight plans are fed into computers and updated as the flight progresses. Air traffic controllers watch these displayed assignments carefully to prevent midair collisions. As aircraft converge on airports and begin the descent for landing, aerial congestion can develop. In this case, new arrivals are directed to a holding area in the sky, about 50 km (30 mi) or so from the airfield. Waiting planes in this area repeatedly circle a beacon, so that they create an aerial “stack”, maintaining a vertical spacing of 305 m (1,000 ft) between planes. Each time a suitable runway becomes available, a plane is taken from the bottom of the stack, permitting the others to spiral down to the next layer.

Navigational Aids


http://www.tti.com.gt/Proyectos/DVOR-DME.jpg

Navigation between airports relies on ground beacons and on electronic and computerized equipment in the plane.

The most widely used ground system is the very-high-frequency omnidirectional range beacon (VOR).

VOR stations, which are not always located at an airport, operate on frequencies that are generally free of atmospheric noise and provide an accuracy lacking in previous equipment. Aboard the plane, a visual display indicates the magnetic course the pilot must fly in order to travel directly to or away from the VOR station.

Most VOR stations also have distance-measuring equipment (DME), which tells the pilot distances to and from VORs. These VOR/DME stations provide excellent service for both private aircraft and scheduled airliners worldwide.

For intercontinental routes, a radio and electronic system called Omega uses a network of eight global transmission sites that emit powerful long-range signals. A computer on board the aircraft receives the signals, analyses their pattern, and calculates the position of the plane anywhere in the world. A different method, the inertial navigation system (INS), requires no ground stations or radio beams, which might be subject to distortion or interruption. The INS uses a gyroscopically stabilized inertial platform, aligned to true north. Accelerometers associated with the system can determine the direction and speed of the aircraft, and a computerized display indicates this information, along with wind speed, drift, and other data. These systems, when combined with an autopilot, enable large jet transports literally to fly themselves on global routes. Many airliners also carry compact weather radar to detect storm conditions en route. Military equipment uses VOR, Omega, and other systems, including more sophisticated radar.

For instrument landings, pilots use an instrument landing system (ILS). Cockpit instruments indicate deviations to either side of the localizer beam leading directly to the runway, and guidance information from the glide-slope beam indicates whether the plane is too high or too low on the approach, which may start some 13 to 16 km (8 to 10 mi) from the airport. Some existing ILS systems can accommodate totally automatic landings, permitting operations in heavy fog. Elsewhere, special radar systems can be used by air traffic controllers to “talk down” aircraft in bad weather.

The ILS system, which is subject to “ground clutter” and occasional distortions, began to be replaced by a microwave landing system (MLS) in the early 1980s. The MLS equipment is more precise, permits curving approaches (unlike the rigidly linear ILS-mediated approach) by multiple aircraft over a broader gateway area, and is cheaper to operate. However, there is now a question as to whether MLS will completely replace ILS or will be superseded by global positioning systems (GPS).

Air traffic control services can be divided into two major subspecialties, **terminal control** and **enroute control**.

Terminal control includes the control of traffic (aircraft and vehicles) on the airport proper and airborne aircraft within the immediate airport environment. Generally, this is approximately a 30 to 50 nautical mile (56 to 93 km) radius of the airport. Terminal controllers work in facilities called control towers and Terminal Radar Approach

Control (TRACON). At some locations, staff is shared between Tower Control and the TRACON, while at others the tower and the TRACON are completely separate entities.

Enroute controllers control the traffic between the terminals. They can also control traffic in and out of airports where the traffic volume does not warrant the establishment of a terminal ATC operation.

Terminal Control

http://images.google.pt/images?q=tbn:SSM8AJOMqWEJ:http://grin.hq.nasa.gov/IMAGES

The primary method of controlling the immediate airport environment is visual observation from the control tower. The tower is a tall, windowed structure located on the airport grounds. Tower controllers are responsible for the separation and efficient movement of aircraft and vehicles operating on the taxiways and runways of the airport itself, and aircraft in the air near the airport, at generally 2 to 5 nautical miles (4 to 9 km) depending on the airport procedures.

Radar displays are also available to controllers at some airports. Controllers may use a radar system called Secondary Surveillance Radar for airborne traffic approaching and departing. These displays include a map of the area, the position of various aircraft, and data tags that include aircraft identification, speed, heading, and other information described in local procedures.

The areas of responsibility for tower controllers fall into three general operational disciplines; **Ground Control**, **Local Control**, and **Clearance Delivery**.

Ground Control

Ground Control is responsible for the airport "movement" areas, or areas not released to the airlines or other users. This generally includes all taxiways, holding areas, and some transition areas where aircraft arrive and departe gates. Exact areas and control responsibilities are clearly defined in local documents and agreements at each airport. Any aircraft, vehicle, or person walking or working in these areas are required to have clearance from the ground controller. This is normally done via VHF radio, but there may be special cases where other processes are used. Most aircraft and vehicles have radios. Aircraft or vehicles without radios will communicate with the tower via aviation light signals or will be led by vehicles with radios. People working on the airport surface normally have a communications link through which they can reach or be reached by ground control, commonly either by handheld radio or even cell phone. Ground control is vital to the smooth operation of the airport because this position will establish the order in which the aircraft will be lined up to depart, which can affect the efficiency of the airport operation.

Some busier airports also have radar designed to display aircraft and vehicles on the ground. This is used by the ground controller as an additional tool to control ground traffic. There are a wide range of capabilities on these systems as they are being modernized. Older systems will display a map of the airport and the target. Newer systems may include the capability to display higher quality mapping, radar target, data blocks, safety alerts, etc. Local and national procedures govern the use of these systems for each tower.

Local Control

Local Control (most often referred to as the generic "Tower" control, although Tower control can also refer to a combination of the local, ground and clearance delivery positions) is responsible for the runway(s) as defined in the local procedures. Local control clears aircraft for take off or landing and ensures the runway is clear for these aircraft. To accomplish this, local control controllers are normally given 2 to 5 nautical miles (4 to 9 km) of airspace around the airport, allowing them to give the clearances necessary for airport safety. If the local controller detects any unsafe condition, a landing aircraft will be told to "go around" and will be sequenced in the pattern by the TRACON controller.

Within the tower, a highly disciplined communications process between local and ground control is an absolute necessity. Ground control must request and gain approval from local control to cross any runway with any aircraft or vehicle. Likewise, local control must ensure ground control is aware of any operations that impact the taxiways and must work with the arrival radar controllers to ensure "holes" in the arrival traffic are created (where necessary) to allow taxiing traffic to cross runways and to allow departures aircraft to take off. Crew resource management procedures are often used to ensure this communication process is efficient and clear.

Clearance Delivery

Clearance delivery is the position that coordinates with the national command center and the enroute center to obtain releases for aircraft. Under normal conditions, this is more or less automatic. When weather or extremely high demand for a certain airport become a factor, there may be ground "stops" (or delays), or re-routes to ensure the system does not get overloaded. The primary responsibility of the clearance delivery position is to ensure that the aircraft have the proper route and release time. This information is also coordinated with the enroute center and the ground controller in order to ensure the aircraft reaches the runway in time to meet the release time provided by the command center.

Enroute Control


http://images.google.pt/images?q=tbn:6vb4C86aK7sJ:http://www.tti.com.gt/Proyectos

ATC provides services to aircraft in flight between airports as well. The level of service is dependant on the type of flight the aircraft falls under (IFR or VFR), the type of airspace the aircraft is in and the services requested by the pilots.

Enroute Air Traffic Controllers issue clearances and instructions for airborne aircraft, and pilots are required to comply with these instructions. Controllers adhere to a set of separation standards that define the minimum distance allowed between aircraft; These distances vary depending on the equipment and procedures used in providing ATC services.

Pilots fly under one of two sets of rules for separation; Visual Flight Rules (VFR) or Instrument Flight Rules (IFR). Air Traffic Controllers have different responsibilites for each of these flight environments.

VFR

Pilots flying VFR aircraft assume responsibility for their separation from all other aircraft (IFR & VFR) and do not have set routes and altitudes. They fly on their own using a "see and be seen" separation criteria. In congested airspace, VFR aircraft are required to have a transponder. This allows the controller to see the aircraft on radar and warn IFR aircraft of any potential conflict. Governing agencies establish strict VFR "weather minima" for visibility, distance from clouds, and altitude to ensure that VFR pilots can see far enough.

VFR pilots can request, and ATC can elect to provide "VFR Advisory Services", if traffic permits. This is also referred to as "Flight Following". Under this environment, the controller will radar identify the VFR aircraft and provide traffic information and weather advisory services for the VFR pilot. Controllers do not provide any instructions concerning direction of flight, altitude, or speed to the VFR pilot receiving advisory services, and they do not provide separation services. This is an optional service and may be discontinued by ATC or the pilot at any time.

IFR

Pilots flying under IFR must file a flight plan with ATC and accept any revisions ATC requests to their route or altitude. In return, controllers will ensure that pilots flying IFR are separated from all other IFR aircraft and terrain by the appropriate minimum separation. The IFR pilot, however, must maintain a close watch for VFR aircraft since ATC has no control over these aircraft. For this reason, VFR aircraft are restricted to altitudes below 18,000 ft. and must have an operating transponder in congested airspace. Once an IFR aircraft is above 18,000 ft (Flight Level 180) the aircraft is considered in "Positive Control Airspace" where only IFR aircraft are allowed.

GENERAL CHARACTERISTICS

Enroute air traffic controllers work in facilities called Area Control Centers (ACCs), commonly referred to as "Center". Each center is responsible for many thousands of square miles of airspace (known as a Flight Information Region) and for the airports within that airspace. Centers control IFR aircraft from the time the aircraft departs an airport or leaves the TRACON's airspace or until the aircraft approaches the airspace controlled by a TRACON or if the airport does not have a TRACON, until the aircraft lands. Centers may also "pick up" aircraft that are airborne and integrate them into the IFR system. These aircraft must, however, remain VFR until the Center provides a clearance.

Center controllers are responsible for climbing the aircraft to their requested altitude while, at the same time, ensuring that the aircraft is properly separated from all other aircraft in the immediate area. Additionally, the aircraft must be placed in a flow consistent with the aircraft's route of flight. This effort is complicated by cross traffic, severe weather, special missions that require large airspace allocations, and traffic density.

As an aircraft reaches the boundary of a Center's control area it is "handed-off" to the next Area Control Center. This "hand-off" process is simply a transfer of identification between controllers so that air traffic control services can be provided in a seamless manner. Once the "hand-off" is complete, the aircraft is given a frequency change and begins talking to the next controller. This process continues until the aircraft is 'handed-off' to a TRACON.

RADAR COVERAGE

Since centers control a large airspace area, they will typically use long range radar that has the capability to see aircraft within 200 nautical miles (370 km) of the radar antenna. They may also use TRACON radar data to control when it provides a better "picture" of the traffic or when it can fill in a portion of the area not covered by the long range radar.

In the U.S. system, over 90% of the U.S. airspace is covered by radar and often by multiple radar systems. A center may require numerous radar systems to cover the airspace assigned to them. This results in a large amount of data being available to the controller. To address this, automation systems have been designed that consolidate the radar data for the controller. This consolidation includes eliminating duplicate radar returns, ensuring the best radar for each geographical area is providing the data, and displaying the data in an effective format.

Centers also exercise control over traffic travelling over the world's ocean areas. These areas are also FIRs. Due to the fact that there are no radar systems available for oceanic control, oceanic controllers provide ATC services using "non-radar" procedures. These procedures use aircraft positon reports, time, alitiude, distance, and speed to ensure separation. Controllers record information on flight progress strips and in specially developed oceanic computer systems as aircraft report positons. This process requires that aircraft be separated by greater distances, which reduces the overall capacity for any given route.

Some ATC service providers (e.g Airservices Australia, Alaska Center, etc.) are implementing Automatic Dependant Surviellance - Broadcast (ADS-B) as part of their surveillance capability. This new technology reverses the radar concept. Instead of radar "finding" a target by interrogating the transponder, ADS transmits the aircraft Latitude/Longitude positon several times a second. ADS also has other modes such as the "Contract" mode where the aircraft reports a position based on a pre-determined time interval. This is significant because it can be used where it is not possible to locate the infrastructure for a radar system (e.g. over water). Computerized radar dispalys are now being designed to accept ADS inputs as part of the dispaly. As this technology develops, oceanic ATC procedures will be modernized to take advantage of the benefits this technology provides.

PROBLEMS

Traffic

The day-to-day problems faced by the air traffic control system are primarily related to the volume of air traffic demand placed on the system, and weather. Several factors dictate the amount of traffic that can land at an airport in a given amount of time. Each landing aircraft must touch down, slow, and exit the runway before the next crosses the end of the runway. This process requires between one and up to four minutes for each aircraft (depending mainly on the number of taxiways and the angle they're making with the runway). Allowing for departures between arrivals, each runway can thus handle about 30 arrivals per hour. A typical large airport with two arrival runways can thus handle about 60 arrivals per hour in good weather. Problems begin when airlines schedule more arrivals into an airport than can be physically handled, or when delays elsewhere cause groups of aircraft that would otherwise be separated in time to arrive simultaneously. Aircraft must then be delayed in the air by holding over specified locations until they may be safely sequenced to the runway. Up until the 1990s, holding was a common occurrence at airports. Advances in computers now allow controllers to predict transit times and sequence planes hours in advance. Thus, planes may be delayed before they even take off, or may reduce power in flight and proceed more slowly in order to fit perfectly into a landing sequence without holding.

Weather

Beyond runway capacity issues, weather is a major factor in traffic capacity. Rain or ice and snow on the runway cause landing aircraft to take longer to slow and exit, thus reducing the safe arrival rate and requiring more space between landing aircraft. This, in turn, increases airborne delay for holding aircraft. If more aircraft are scheduled than can be safely and efficiently held in the air, a ground delay program may be established, delaying aircraft on the ground before departure due to conditions at the arrival airport.

In ACCs, a major weather problem is thunderstorms, which present a variety of hazards to aircraft. Aircraft will deviate around storms, reducing the capacity of the enroute system by requiring more space per aircraft, or causing congestion as many aircraft try to move through a single hole in a line of thunderstorms. Occasionally weather considerations cause delays to aircraft prior to their departure as routes are closed by thunderstorms.

Much money has been spent on creating software to streamline this process. However, at some Area Control Centers, air traffic controllers still record data for each flight on strips of paper and personally coordinate their paths. In newer sites, these flight progress strips have been replaced by electronic data presented on computer screens. As new equipment is brought in, more and more sites are upgrading away from paper flight strips.