# An Introduction to Airline Communication Types

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WHEN IT MATTERS, IT RUNS ON WIND RIVER

## EXECUTIVE SUMMARY

Today's global airliners use a wide array of communication types to ensure safe and efficient use of controlled airspace for flight operations. These communcations technologies range from human/voice radio transmissions to transponders, GPS, ADS-B, ACARS, SATCOM, and 4G LTE. This white paper briefly describes each of these technologies along with sample use cases in the commercial airline industry.

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When looking from the outside into the workings of modern commercial passenger aircraft it is easy to perceive that the communications strategy to control the flow of aircraft is based upon voice communications over dedicated radio channels. However, the complexity of today's aircraft combined with the density of airspace force requirements to have a far wider mix of digital and analog communications. This white paper briefly describes these technologies and their use in global controlled airspace.

## HUMAN/VOICE RADIO COMMUNICATIONS

Radio communications are the backbone of air traffic control and have served us well over the past century. Most commercial aircraft have multiple radios to enable efficient operations and control through dense air traffic zones.

- **Pilots and ground controllers:** All commercial airliners have pilot-to-ground and pilot-to-pilot radios. These radios are the communications medium for air traffic control, where pilots receive navigation guidance as verbal instructions from aircraft controllers.
- **Flight crews:** Flight crews also have the ability to communicate with their airline through discrete radio channels, separate from pilots. At least one channel and possibly other backup communication systems allow communication between the airline operations and the flight crew.

The VHF civil aircraft radio spectrum, airband, uses the frequencies between 108 and 137 MHz.

## TRANSPONDERS

All commercial aircraft must include a transponder for machine-to-machine communications. The transponder transmits (squawks) identification codes and flight information such as altitude to ground-based radar stations that integrate that data with bearing and range position information. This information is then displayed on air traffic control's radar screen in alpha-numeric form to uniquely track a given aircraft.

A transponder (short for transmitter-responder) is an electronic device that produces a response when it receives a radio-frequency interrogation. All modern transponders in controlled air space use either Mode C or Mode S transponders that report pressure altitude—this removes the human-to-human, pilot-to-controller communication burden to constantly report current altitude to air traffic controllers. Transponders are not always sending; they send (squawk) identification information when interrogated by radars.

Transponders receive on a single frequency, 1030 MHz, and transmit on another, 1090 MHz.

## GPS

The Global Positioning System (GPS) is a U.S.-owned utility that provides users with positioning, navigation, and timing (PNT) services. The GPS consists of three segments: the space segment, the control segment, and the user segment. The U.S. Air Force develops, maintains, and operates the space and control segments. The EU has a similar GPS constellation, Galileo, which is being built by the European Space Agency (ESA). China and Russia also have GPS satellite constellations.

The U.S. GPS space segments consist of a nominal constellation of 24 operating satellites that transmit one-way signals that give the current GPS satellite position and time. The control segment consists of worldwide monitor and control stations that maintain the satellites in their proper orbits through occasional command maneuvers and adjust the satellite clocks. It tracks the GPS satellites, uploads updated navigational data, and maintains the health and status of the satellite constellation. The user segment consists of the GPS receiver equipment, which receives the signals from the GPS satellites and uses the transmitted information to calculate the user's three-dimensional position and time. GPS receivers are now a part of most modern avionics systems, as well as many consumer devices, smartphones, tablets, and automobile navigation systems.

GPS satellites provide service to both civilian and military users. The civilian service is freely available to all users on a continuous, worldwide basis. The military service is available to U.S. and allied armed forces as well as approved government agencies.

A variety of GPS augmentation systems and techniques are available to enhance civilian GPS system performance and improve signal availability and accuracy. The FAA Wide Area Augmentation System (WAAS) is an example of GPS augmentation for avionics systems.

GPS transmissions are modulated to a carrier frequency using two frequencies, one at 1575.42 MHz called L1 and a second at 1227.60 MHz called L2.

## ADS-B

Automatic dependent surveillance-broadcast (ADS-B) is a cooperative surveillance technology for tracking aircraft. The aircraft determines its own position via satellite navigation (GPS) and periodically broadcasts this via a radio frequency. ADS-B is one of the technologies selected as part of the Next Generation Air Transportation System (NextGen) and the Single European Sky ATM Research (SESAR). The U.S. will require the majority of aircraft operating within its airspace to be equipped with some form of ADS-B by January 1, 2020, and in the EU airspace planes with a weight above 5,700 kilograms (12,600 lb.) or a max cruise of over 250 knots will be required to carry ADS-B from 2017 (new planes from 2015).

## ACARS

The Aircraft Communications Addressing and Reporting System (ACARS) is a digital datalink system for transmission of short messages between aircraft and ground stations via airband radio or satellite. ACARS as a term refers to the complete air and ground system, consisting of equipment on board, equipment on the ground, and a service provider.

Generally, ACARS ground units are either government agencies such as the FAA, or an airline operations headquarters, where the government agency is responsible for flight clearances while airline operations communicate gate assignments, ground maintenance requests, and other airline passenger needs.

The primary function of ACARS is to automatically detect and report changes to the major flight phases—out of the gate, off the ground, on the ground, and into the gate (OOOI). These OOOI events are autonomously detected by aircraft sensors such as doors, parking brakes, and strut switch sensors. At the start of each flight phase, an ACARS message is transmitted to the ground describing the flight phase, the time at which it occurred, and other information such as the amount of fuel on board and the flight origin and destination. These messages are used to track the status of aircraft and crews.

ACARS interfaces with flight management systems (FMS), communicating flight plans and weather information from the ground to the FMS. This enables the airline to update the FMS while in flight, and allows the flight crew to evaluate new weather conditions or alternative flight plans.

ACARS sends real-time information from the aircraft to ground stations regarding the conditions of various aircraft systems and sensors. Maintenance faults and abnormal events are also transmitted to ground stations along with detailed messages, which are used by the airline for monitoring equipment health, and to better plan maintenance, repair, and operations (MRO) activities.

Automated ping messages are used to test an aircraft's connection with the communication station. In the event that the aircraft ACARS unit has been silent for longer than a preset time interval, the ground station can ping the aircraft (directly or via satellite). A ping response indicates a healthy ACARS communication.

ACARS interfaces with interactive display units in the cockpit, which flight crews can use to send and receive technical messages and reports to or from ground stations, such as a request for weather information, clearances, or the status of connecting flights. The response from the ground station is received on the aircraft via ACARS as well. Each airline customizes ACARS to this role to suit its needs.

ACARS can send messages over VHF if a VHF ground station network exists in the current area of the aircraft. ACARS messages using VHF data links use the band 117.975–137 MHz. Where VHF is absent, an HF network or satellite communication may be used if available.

## SATCOM

Airborne satellite communications (SATCOM) systems use satellites that are either geostationary or orbiting. With a geostationary system, the satellite remains in a fixed position relative to a given geographical location, and orbits with the Earth to maintain this position. An orbiting communications satellite moves in an orbit that passes above a given geographical location at periodic time intervals.

SATCOM requires a transmitter mounted on an aircraft and uses radio signal to send a message to the satellite-mounted transponder. The message may be stored in the satellite for later forwarding or immediately forwarded to a receiver or transmitter with a receiving capability (transceiver) mounted on another aircraft or ground station (earth station) that can link to a terrestrial telephone system.

For example, Inmarsat is a geostationary system that has four operational satellites. One satellite is deployed over the Pacific Ocean, one over the Indian Ocean, and two provide coverage over the Atlantic Ocean. This system provides almost universal coverage, since the satellites are all close to the equator and have overlapping regions of coverage around the globe, centered along the equator.

Inmarsat offers a number of different types of service formats, including voice, facsimile, and high-speed data, using the same satellites. This service is "end-to-end," or duplex, and therefore can supply a services quality similar to voice-over-IP (VoIP) telephone connections, where the sender and receiver can communicate in near-real-time. All voice services can be used in parallel to the packet data services. Inmarsat connections are secured and compatible with government-grade encryption and secure communications standards, including STU-IIIb, STE, Taclane, KIV-7, and Brent.

Airline passengers see SATCOM connections when Wi-Fi access is provided in-flight. Most avionics and jet engine manufacturers have capabilities to leverage high-bandwidth SATCOM services to send and receive operational data from aircraft systems.

Modern SATCOM systems can support shared-channel IP packet-switched service of up to 492 kbit/s.

## 4G LTE

Bandwidth for airlines continues to increase and many telecom and avionics vendors are teaming to deliver high-speed fourth generation (4G) Long Term Evolution (LTE) Wi-Fi networks for airline passengers globally. China Mobile teamed up with Alcatel Lucent and Air China to deploy a similar system in China.

These 4G LTE Wi-Fi services leverage existing AT&T and China Mobile 4G base stations on the ground for the backhaul connection from the airplane. Regarding the infrastructure costs, AT&T has stated that the "additional costs for building the network will not materially impact the company."

These ground-to-air broadband network wireless services should be capable of providing in-flight broadband, up to an estimated 30 Mbps, with better reliability than SATCOM over terrestrial routes. In addition, a ground-based Wi-Fi network for airlines can also improve communications between airline flight crews and ground staff through the transmission of real-time aircraft data and related analyses.

4G broadband systems use a variety of radio frequencies, depending upon national and individual licensing terms.

## CONCLUSION

Today's complex air traffic control system depends on a wide range of communications technologies to ensure safe, accurate, timely, and efficient operations of our global commercial aerospace systems. These capabilities are constantly augmenting existing systems and technologies with newer communications platforms that improve the operations of global airlines.