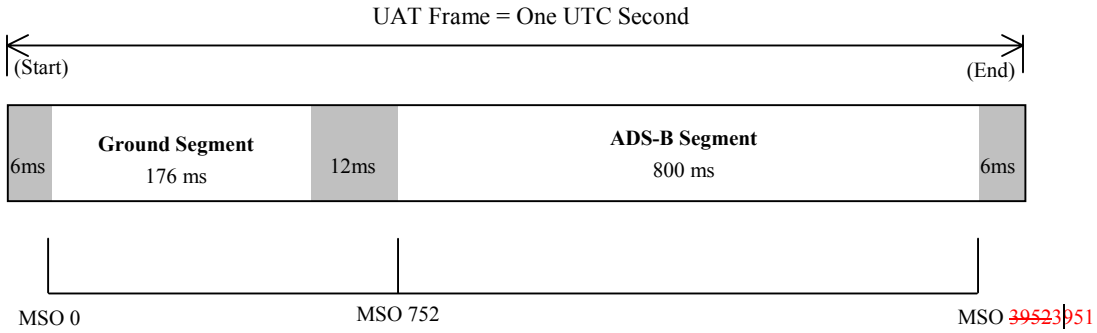
other UAT transmissions on the UAT medium, presuming appropriate ground system design), and an ADS-B Segment in which ADS-B Messages are broadcast by aircraft and, in the preferred UAT implementation of TIS-B, TIS-B ground stations. Guard times are incorporated between the segments to allow for signal propagation and timing drift. The UAT frame is further divided into Message Start Opportunities (MSOs) that are spaced at 250µs intervals. This spacing represents the smallest time increment used by UAT for scheduling message transmissions, and all such transmissions must start only at a valid MSO.



Message Start Opportunities (MSOs)

Note: Shaded segments represent guard times for signal propagation and timing drift (not to scale).

Figure 1-1: UAT Frame

As shown in Figure 1-1, 176 milliseconds in each 1-second UAT frame are devoted to Ground Uplink Message transmissions (providing an uplink payload capacity of over 100 kbps), and 800ms are devoted to ADS-B Message transmissions. MSOs start at the end of the initial 6ms guard time, are spaced at 250µs intervals, and are numbered sequentially from 0 through ~~3952~~3951.

1.3.2 Ground Uplink Message Transmissions

As mentioned above, Ground Uplink Messages are used to provide flight information such as text and graphical weather data, airspace advisories, and other aeronautical information to the flight deck. Ground Uplink Messages may also be used to provide TIS-B uplink information should high-volume TIS-B requirements during airspace transition to ADS-B exceed levels which are best broadcast in the ADS-B segment of UAT frames. Each Ground Uplink Message provides 432 bytes of payload data. Airborne UAT equipment receives and decodes these broadcast uplink messages, and then makes them available to other airborne applications such as cockpit displays or an on-board database that the pilot can later access to retrieve desired information.

In actual implementation, UAT-equipped aircraft will likely be in receiving range of more than one (and possibly several) ground uplink stations at any given time. To ensure that these multiple uplink broadcasts can be received by the airborne UAT equipment without significant interference from one another, a time-slotted scheduling discipline is applied to the uplinks. The Ground Uplink segment is therefore divided into 32 ground broadcast slots, and each ground station is assigned one or more of the slots to broadcast uplink message(s) into its coverage volume. Assignment of the ground broadcast slots to the ground stations is made on an a priori basis and allows for re-use of the slots by more distant stations similar to traditional radio frequency allocation techniques.

Each of the 32 Ground Uplink slots is 5.5 milliseconds in length, yielding a total of 176 milliseconds for the Ground Segment depicted in Figure 1-1. Section 2.2.3.2 describes the Ground Uplink Message format in more detail, but it should be noted that each Ground Uplink Message takes slightly over 4 milliseconds of the 5.5 milliseconds reserved for the uplink slot. The unused gaps provide propagation guard time for 200 nautical miles of protection for Ground Uplink Messages on adjacent time slots.

Adherence to the slot-based message-starting discipline for Ground Uplink Messages allows for efficient use of the Ground Uplink segment of each UAT frame, as well as enabling the airborne UAT equipment to determine range to each ground uplink station that is supplying messages to it. For this reason, Ground Uplink Messages are allowed to start only at pre-determined, fixed MSOs within each UAT frame, beginning with MSO 0. Because the Ground Uplink slot is 5.5 milliseconds long, each slot spans the equivalent of 22 MSOs (5.5 milliseconds divided by 250μs/MSO). Therefore, valid MSOs for the start of Ground Uplink Messages are 0, 22, 44, 66, and so on, up to MSO 682. With this MSO-based scheduling scheme, the airborne UAT equipment is able to determine the propagation delay for a Ground Uplink Message, and consequently the range to that ground station. When coupled with information on the position of multiple ground stations supplying Ground Uplink Messages (as provided in the uplink messages themselves), a back-up positioning/navigation capability may be made available.

Detailed description of payloads of specific Ground Uplink Messages is beyond the scope of this document. UAT enveloping of those payloads, however, is fully defined. RTCA/DO-267 provides further information on potential FIS-B payloads.

1.3.3 ADS-B Message Transmissions

As shown in Figure 1-1, the ADS-B Segment of each UAT frame is 800 milliseconds long, and spans 3200 MSOs (i.e., from MSO 752 to MSO ~~3952~~3951). All aircraft-transmitted ADS-B Messages (as well as ground-transmitted TIS-B messages) are transmitted in this segment of the frame. Each UAT-equipped aircraft makes exactly one ADS-B Message transmission per frame, and makes a pseudo-random selection from among any of the 3200 MSOs in the segment to start transmission of the message. Approximately 6 milliseconds of guard time are appended after the ADS-B Segment to fill out the UAT frame to the end of the UTC second. This guard time serves two purposes: (1) it accommodates some clock drift in airborne equipment to reduce the risk of ADS-B transmission overlap with Ground Uplink Messages, and (2) it provides room for completion of ADS-B Message transmissions that are initiated on the last few valid MSOs in the ADS-B Segment.

The pseudo-random selection of an MSO within each UAT frame for the start of an aircraft's ADS-B Message is intended to prevent two aircraft from systematically interfering with each other's ADS-B Message transmissions. Adherence to the MSO-based timing scheme enables the receiving UAT equipment to determine range to the UAT equipment that transmitted the message. This information could be used in validity checks of the position data conveyed in the ADS-B Message itself. Appendix I provides more detail on UAT timing discipline, and how this aspect of UAT system design can be exploited for such range measurements.

1.3.4 Traffic Information Service - Broadcast (TIS-B) Transmission

Traffic Information Service - Broadcast (TIS-B) is a ground-based service to ADS-B-equipped aircraft to provide SV and other data on non-ADS-B-equipped aircraft. TIS-B