

Flight Test of Weather Data Exchange Using the UAT ADS-B Data Link

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OVERVIEW

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BACKGROUND

- A large percentage of aircraft delays, accidents, and fatalities are related to weather.
- Weather information enhances safety of flights and improves air traffic services.
- Weather Accident Prevention Program (WxAP) goal of developing technology to reduce:
 - Weather-related accident causal factors by 80% by 2007,
 - Turbulence-related injuries by 50% by year 2007.



WINCOMM

- Goal is to develop advanced communications and information technologies enabling high quality and timely dissemination of strategic weather information.
- NASA GRC working on demonstrating the feasibility of disseminating effective safety related data.
- Air traffic is expected to increase by at least 40% by 2012.
- Preparing for flight tests to transmit and receive weather data on GA aircraft.



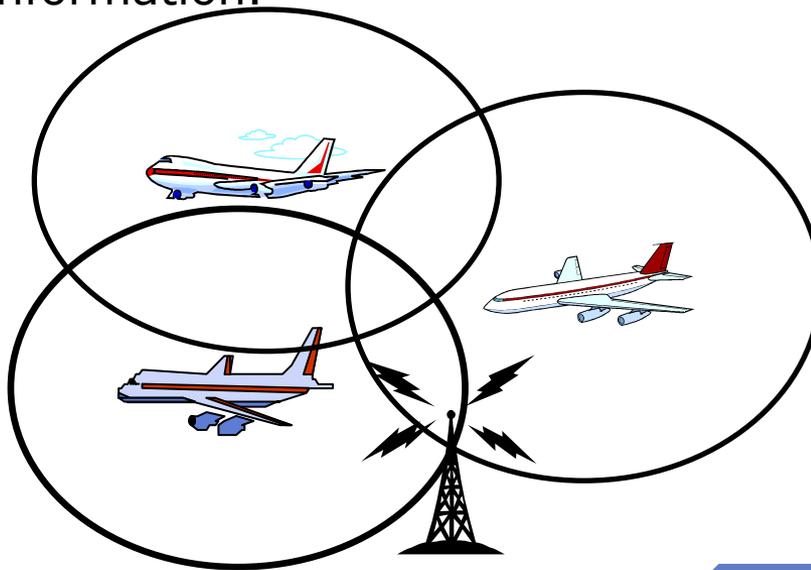
UNIVERSAL ACCESS TRANSCEIVER (UAT)

- FAA Link Decision specifies UAT for General Aviation (GA) aircraft
- Multi-purpose aeronautical data link intended to support:
 - Automatic Dependent Surveillance-Broadcast (ADS-B),
 - Flight Information Service-Broadcast (FIS-B),
 - Traffic Information Service-Broadcast (TIS-B).
- Transmits and receives in the aeronautical radio navigation frequency band (978 MHz).
- “Clean sheet” design optimized toward the support of broadcast applications to support surveillance and situational awareness.
- Air-Ground, Air-Air & Ground-Air Capability.



AUTOMATIC DEPENDENT SURVEILLANCE-BROADCAST (ADS-B)

- Potentially more accurate than current secondary surveillance radar system.
- Broadcasts latitude, longitude, altitude, velocity with high degree of accuracy (GPS).
- Transmits long ranges (~100 miles in all directions).
- Equipped aircraft receives air and ground broadcasts and displays weather and traffic information.





CURRENT SYSTEM

- Current meteorological observations made primarily by weather balloons and large commercial aircraft (low resolution).
 - Gaps in data.
 - Lacking data below 25,000 ft.
 - Data is scarce at off-peak times.
- Currently air-traffic control uses secondary radar.
 - Rotating radar antenna sends interrogations to aircraft and receives reply .
 - Measures the bearing and range of an aircraft.
 - Less accurate as aircraft gets further away.
- New System (ADS-B)
 - Based on potentially more accurate navigation systems (e.g. GPS).
 - Position reports broadcast by the aircraft.



CAPSTONE PROGRAM

- Approved for use in Alaska in January, 2001.
- First operational use of ADS-B to support Air Traffic Control (ATC) “radar-like services”.
- Allows ATC to support Instrument Flight Rules (IFR) separation of 5 NM based only on ADS-B surveillance.
- Updates available to nearly 200 equipped aircraft operating in the vicinity of Bethel, Alaska.
- Program has entered its second phase, which involves increasing the coverage, equipage, and services.



SAFE FLIGHT 21 EAST COAST IMPLEMENTATION

- Focused on providing broadcast services in the near-term along the east coast of the United States.
- Ground stations will uplink traffic and weather data over UAT.
- Provide coverage from Atlantic City, NJ to Miami, FL.
 - Coverage extends from the coast inland about 150 miles.
- Provide service to small aircraft that may be flying at low altitudes (e.g., 2,000 to 3,000 feet).
- Initial broadcast weather products that will be provided:
 - Graphical Weather (NEXRAD),
 - Meteorological Aviation Reports (METARs),
 - Terminal Aerodrome Forecasts (TAFs).

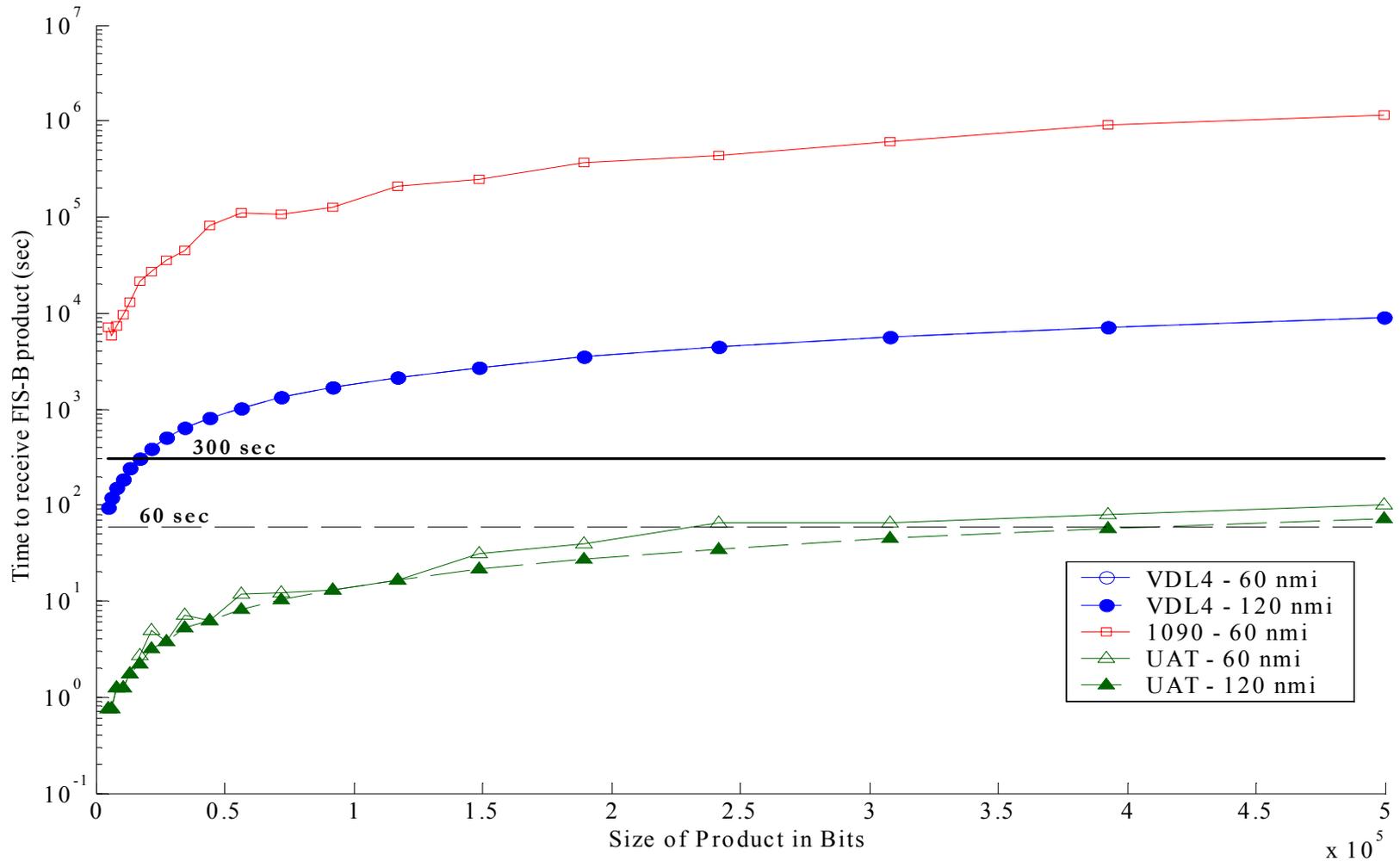


RESULTS OF UAT PERFORMANCE ANALYSIS

- The Multi-Aircraft UAT Simulation (MAUS) examined both the uplink of FIS-B information from the ground to aircraft and the air-to-ground transfer of TAMDAR data.
- Study showed:
 - UAT provided adequate capacity in the ground uplink segment for broadcasting the weather products examined,
 - ADS-B message structure is capable of accommodating the TAMDAR data for GA aircraft.
- In both cases, the UAT data link provided a probability of message delivery that was more than adequate to ensure reception.

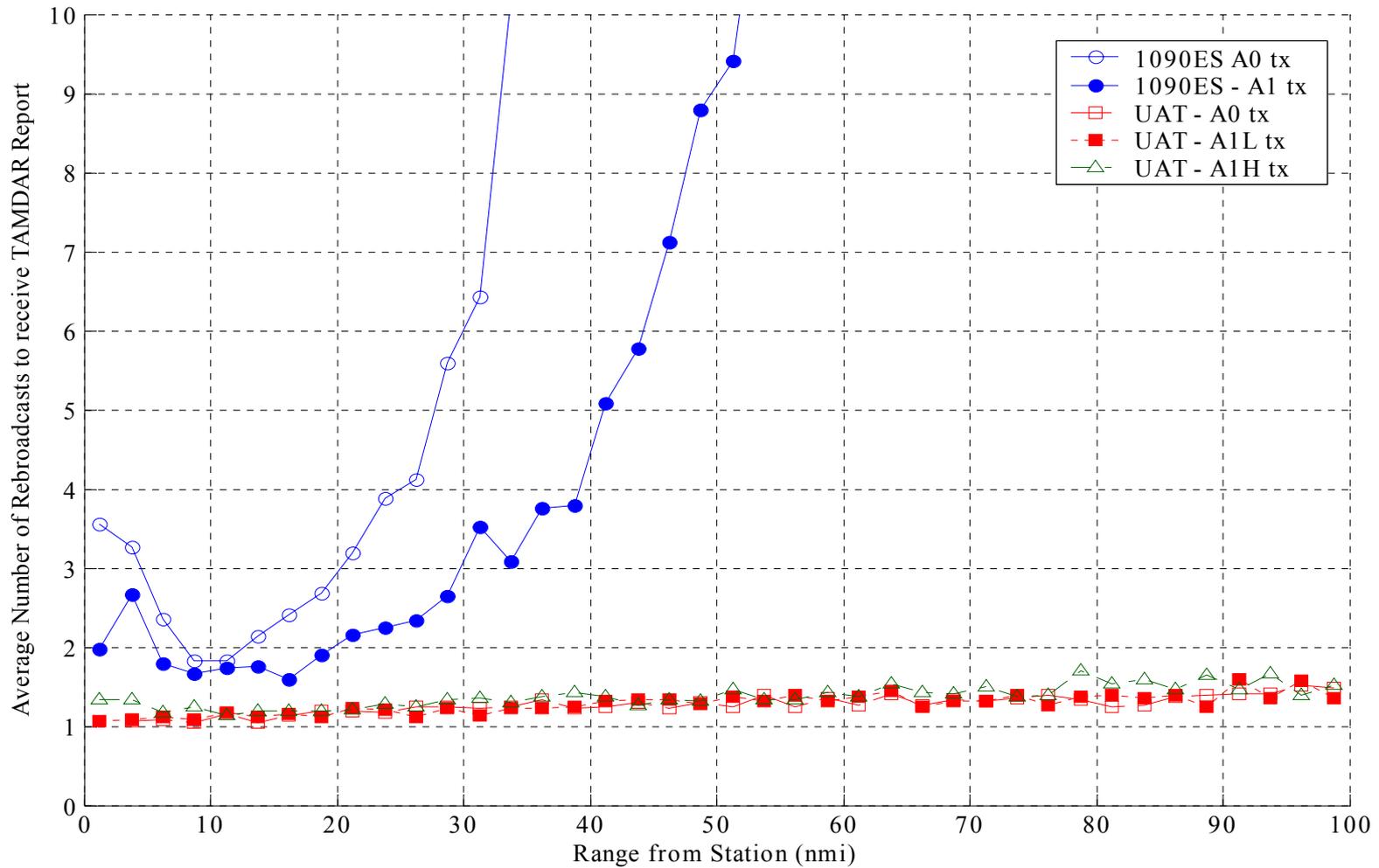


AVERAGE TIME FOR A0 AT 5Kft TO RECEIVE DATA AT MAX. RANGE





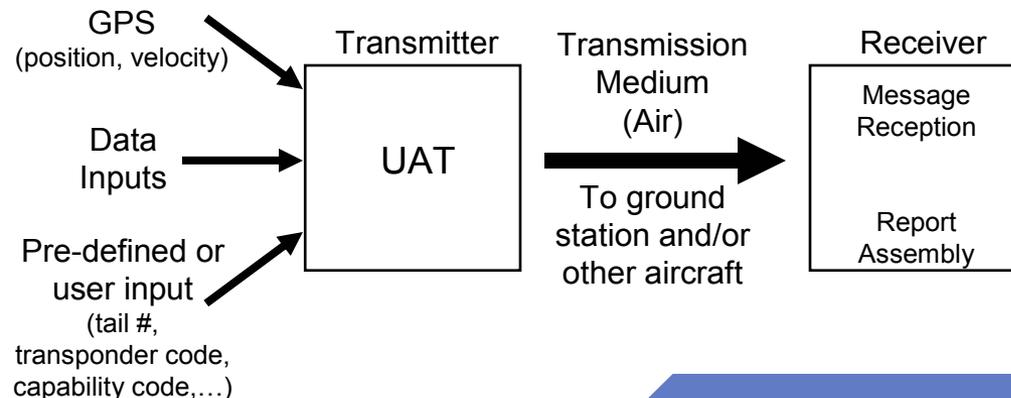
REBROADCASTS FOR GROUND RECEPTION IN LA 2007





CURRENT UAT ADS-B SYSTEM

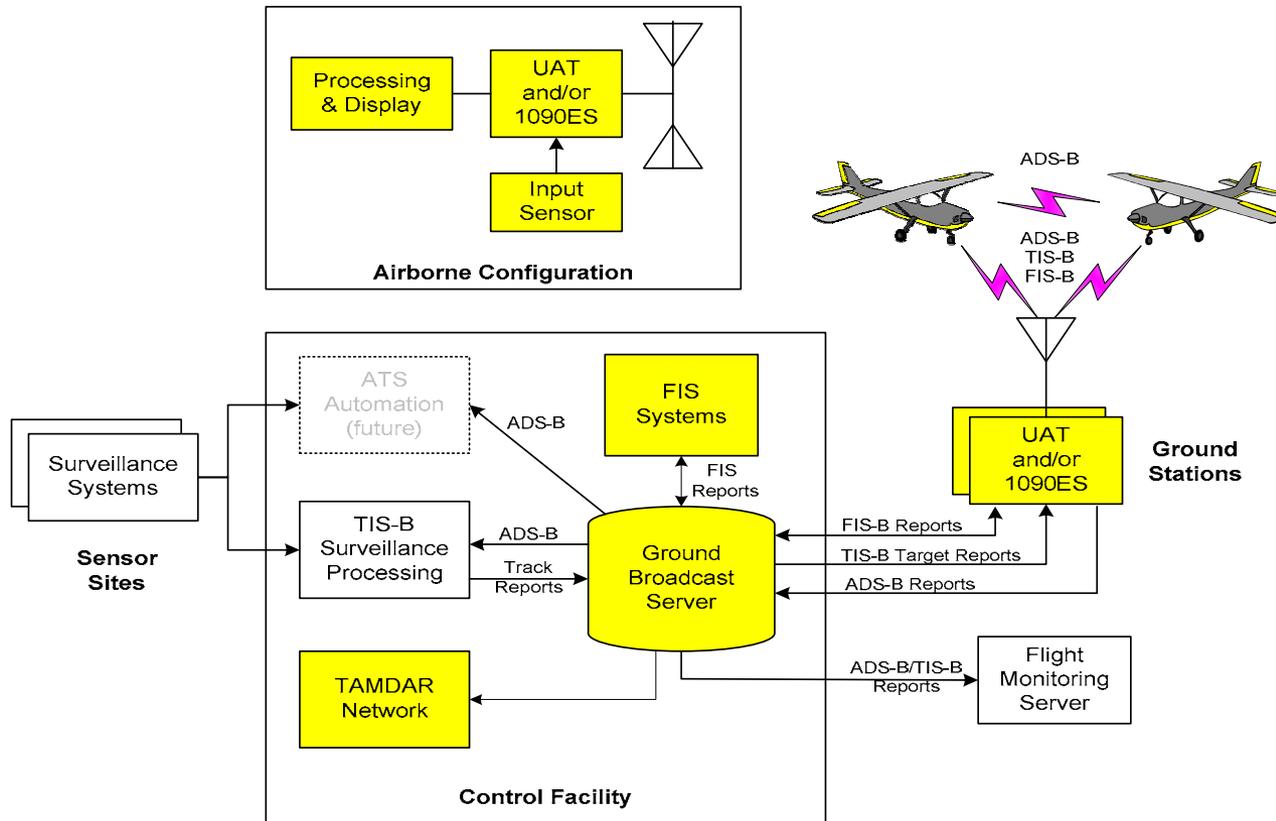
- Figure below is block diagram of the functional flow of information in the current UAT ADS-B system.
- Information (including TAMDAR data) and crew inputs on the transmitting aircraft, enter from the left side of the diagram.
- Data is arranged into various types of ADS-B messages according to MOPS specified formats.
- Data is broadcast to receiver subsystems located on other aircraft or on the ground.
- Receiver processes the received message and passes it to the appropriate application.





MODIFICATIONS REQUIRED FOR IMPLEMENTATION

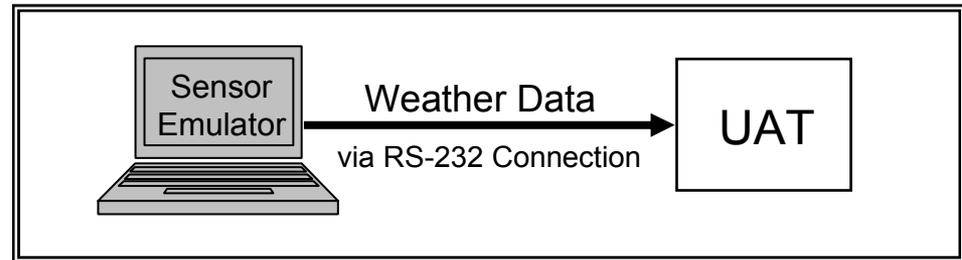
- High-level architecture of the infrastructure currently being implemented on the East Coast of the United States.
- Flight tests will necessitate modifications to shaded boxes.





GENERATION AND TRANSFER OF TAMDAR DATA

- TAMDAR data
 - Temperature
 - Wind Direction
 - Turbulence
 - Wind Speed
 - Humidity
 - Airspeed
 - Icing



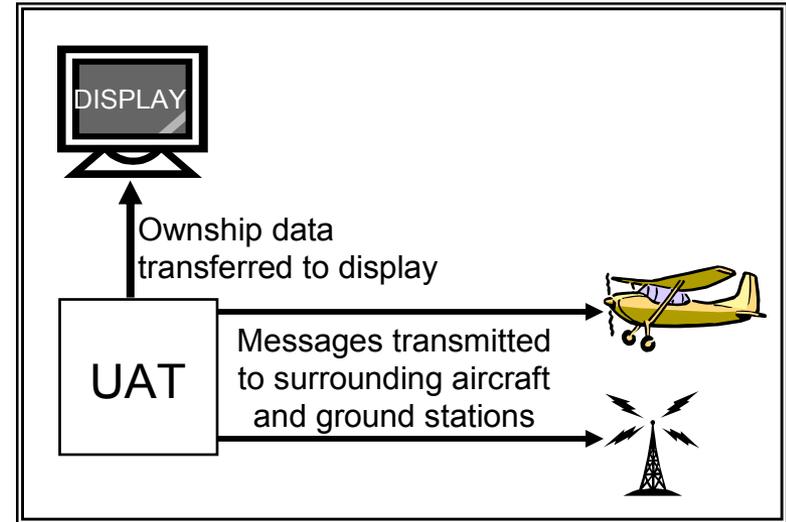
Phase of Flight	Period (sec)
Ascent	6
En route	180
Decent	60

- Data also includes one extra parameter: Transmit Bit
 - Decides when to broadcast TAMDAR data
 - Based on transmission periods suggested by RTCA DO-252.



TRANSMISSION OF DATA BY UAT RADIO

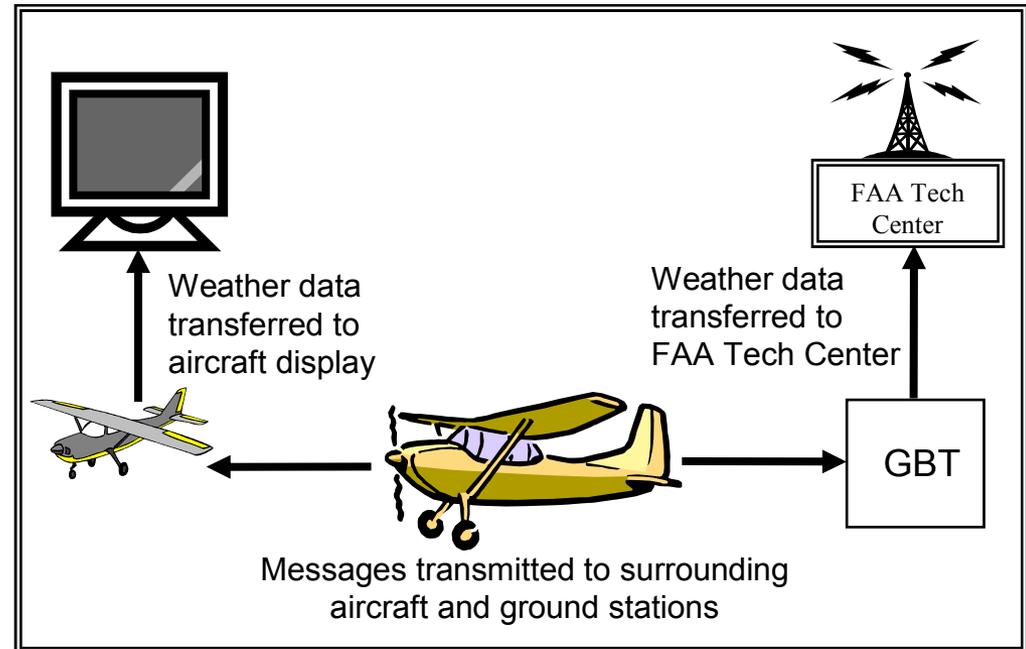
- Ownship data transferred to the display on the flight deck of the aircraft every 3 secs.
- If the Transmit Bit in the TAMDAR message is set, the data will be included in the unreserved bits of the UAT ADS-B messages that are broadcast by GA aircraft.
- The ADS-B equipages for GA aircraft are A0, A1L and A1H.
 - A0 and A1L equipages transmit a message type with 96 unreserved bits,
 - A1H equipage transmits a message type with 64 unreserved bits.
- Messages containing TAMDAR information broadcast to surrounding aircraft and ground stations.





RECEIPT OF DATA BY OTHER AIRCRAFT AND GROUND STATIONS

- UAT radio will receive and decode message.
- If message type code indicates message contains TAMDAR data, UAT radio will extract weather data from the message payload.
- On receiving aircraft, weather data is transferred to the aircraft's TAMDAR processor.
- At receiving ground station, data is transferred to the FAA Tech Center for forwarding to a TAMDAR network, which will transport the data to the appropriate agency.



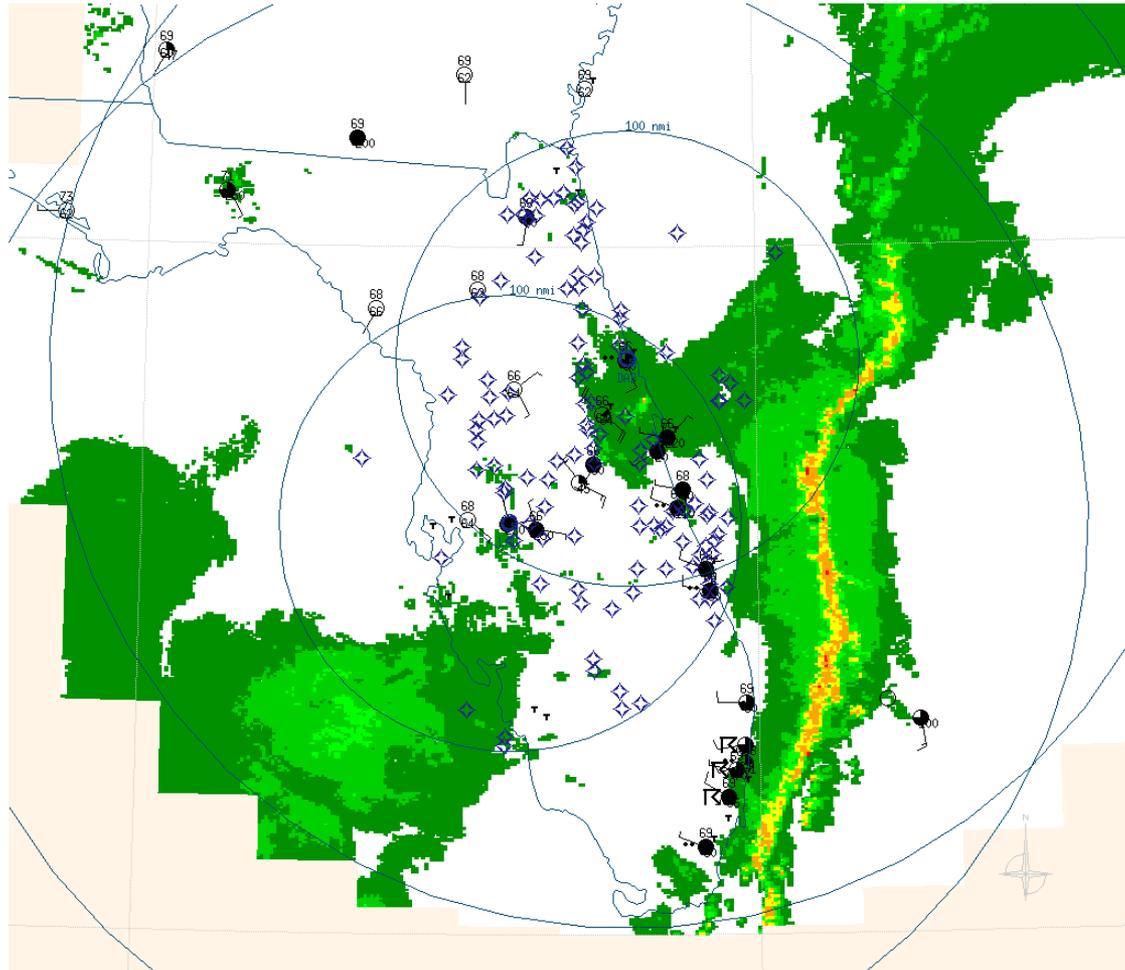


GROUND UPLINK CONSIDERATIONS

- Formats and procedures specified for encoding FIS-B information for uplink over UAT in the Capstone and East Coast implementations.
- Additional products included in the uplink messages will require a number of modifications to the ground-based information flow.
- Access to products will be arranged with the provider(s).
- Minor modifications may be necessary to the GBT.



Sample Display of Weather and Traffic



Recorded and
displayed 4/04