National Aeronautics and
Space Administration

John F. Kennedy Space Center

Kennedy Space Center / Advanced Systems

Development of U.S .Government General Technical Requirements for UAS Flight Safety Systems utilizing the Iridium Satellite Constellation

Kennedy Space Center / Advanced Systems

KSC is the National Center for Next-Generation Range Technology Development and Demonstration

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Unmanned Aircraft Systems (UAS)

Summary

- **FAA need for over-the-horizon communication standard – Range Safety Standard**
- **Development of government standard for over-the-horizon communication system - Flight Safety Communication System**
- **Current Standards group work – RTCA SC-203**
- **Current DoD Iridium -** Joint BFT Mission Management Office (JMMO) – *Iridium-Based BFT*
- **NASA work on Iridium development and demonstration**
- **NASA Flight Safety Communication System -** NASA's Tracking and Data Relay Satellite System (TDRSS)

FAA UAS

Before the FAA permits widespread UAS flights in the National Air Space (NAS), a back-up communications system for reliable control of UASs during loss-link and over-the-horizon scenarios needs to be standardized.

Flight Safety System

- Technical development initiative will develop the U.S. Government Flight Safety System technical requirements for Unmanned Aircraft Systems (UAS) utilizing the Iridium Satellite constellation

- The core requirement was to utilize a satellite system to send GPS tracking data and other telemetry from a flight vehicle down to the ground.

SC-203 products will help assure the safe, efficient and compatible operation of UAS with other vehicles operating within the NAS.

Benefits

- **Technical benefits:**
  - (1) A reliable set of standards that conform to government Range Safety requirements for flight safety systems
  - (2) a uniform set of standards to be implemented by all government agencies that provide measurable performance
  - (3) an immediate solution to simplifying the safe integration of UAS into the NAS by providing reliable, continuous UAS control during loss-link and over-the-horizon scenarios.

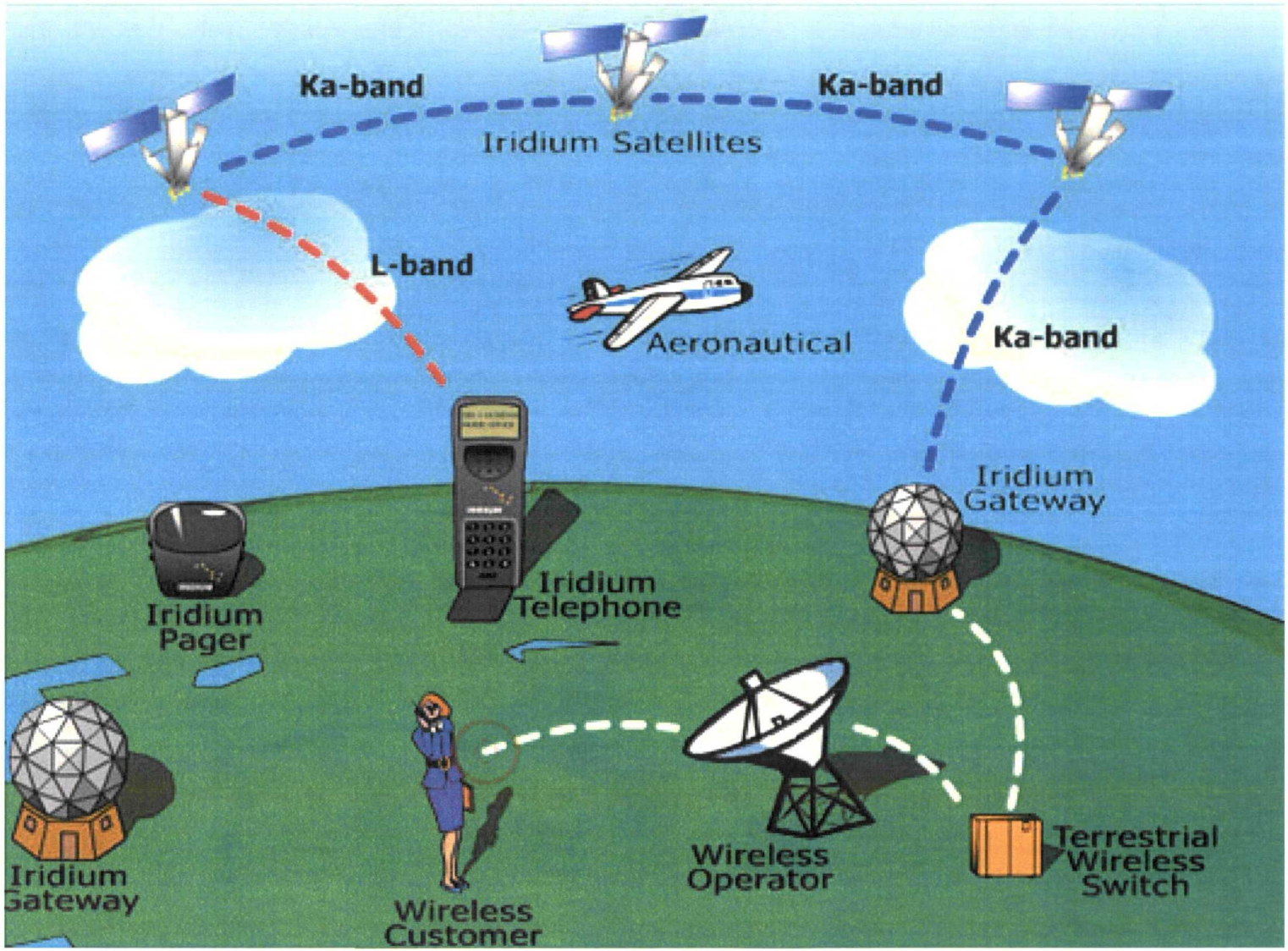
- **Economic benefits:**
  - (1) Lower government investment for flight safety systems because of a uniform standardization
  - (2) lower cost to independent agencies because manufacturers products will not have to be individually tested for performance reliability by the FAA
  - (3) increase in commercial development of flight safety systems due to the availability of a nonproprietary set of standards
  - (4) lower UAS costs due to limited destruction of the aircraft and property

NASA Iridium Development and Demonstration

- *Iridium is one of the few satellite communication systems that would meet the requirements for UAS flight safety systems because it is one of the only true satellite systems that has world-wide coverage.*
- *Iridium Short Burst messaging (SBM) service is highly reliable with a Link Margin of 15 dB.*

- This technology was demonstrated experimentally by NASA on two Piper Cubs flights, two P3 Orion flights, two sounding rocket flights, two balloon flights and a F104.

Iridium


Ka-band
Ka-band
Iridium Satellites
L-band
Aeronautical
Ka-band
Iridium
Gateway
Iridium
Pager
Iridium
Telephone
Iridium
Gateway
Wireless
Customer
Wireless
Operator
Terrestrial
Wireless
Switch

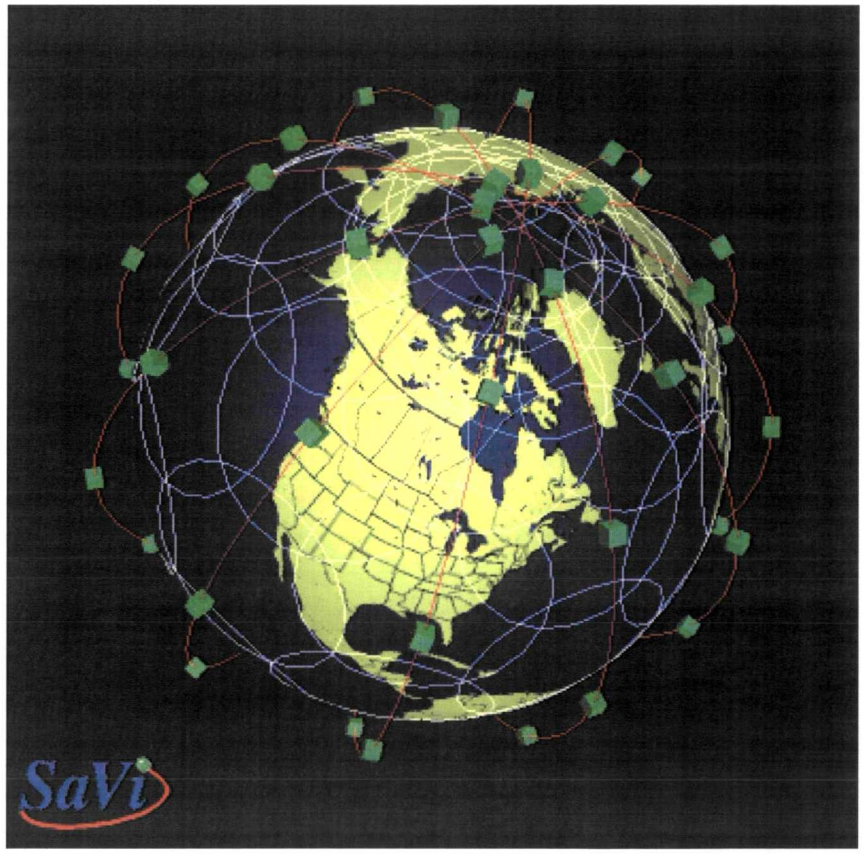
Iridium

- The Iridium constellation has more satellites than any other commercial constellation. The 66 Iridium satellites are in a near-polar orbit at an altitude of 485 miles (780 km). They fly in formation in six orbital planes, each comprising 11 satellites, evenly spaced around the planet. Each Iridium satellite completely circles the Earth once every 100 minutes, traveling at 16,832 miles per hour, and traveling from horizon to horizon across the sky in about ten minutes.

- Services for Range Safety:
  - Iridium 9601 Short Burst Data (SBD) Transceiver
    - 15 dB Link Margin low data rate
  - Iridium OpenPort delivers up to 128 kbps — on an all-IP backbone.

- Normal Service
  - Digital Voice and Data 2.4 Kilobits per second

Iridium Aircraft Antenna Pattern



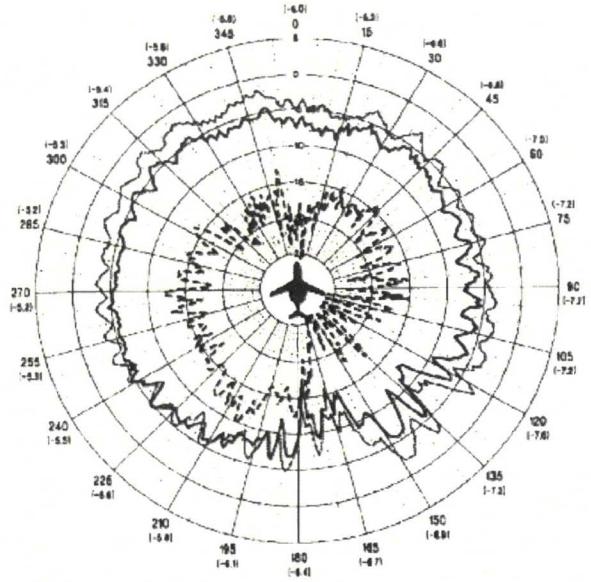


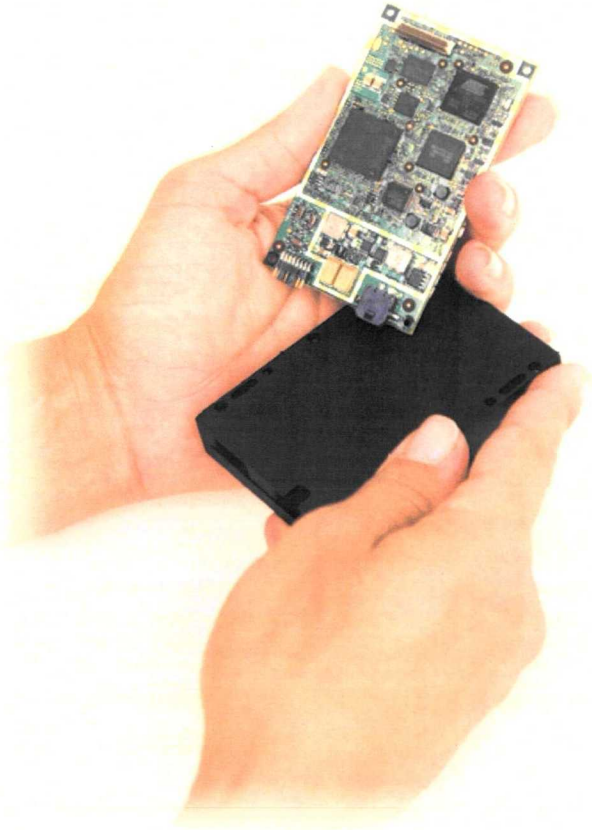
Figure 4. TCA Antenna Pattern - Flat Turn

Data was sent via Short Burst Messaging

- 1960 bytes maximum length
- Latency 5 seconds to 20 seconds maximum global network
- 875 bytes per 2 seconds average
- Reliability 96.61 %
- Availability 99.2%

Iridium Modems for Flight

Antenna: Single, GPS/Iridium antennasatellite **(U.FL interface)**
Size: 50.0mm x 85.0mm x 11.6mm
(2.0" x 3.3" x 0.5")
Power: Input voltage: 3.3 - 6.2 VDC
Average consumption at 4.2 VDC
Two-way < 100 mA
Transmitting < 350 mA
Interfaces: UART type interface



Two-way Short Burst Data (SBD) messaging

- Integrated GPS, allowing for a single antenna to handle all radio frequency communications
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F104 Flight Test Using Iridium Short Burst Messaging

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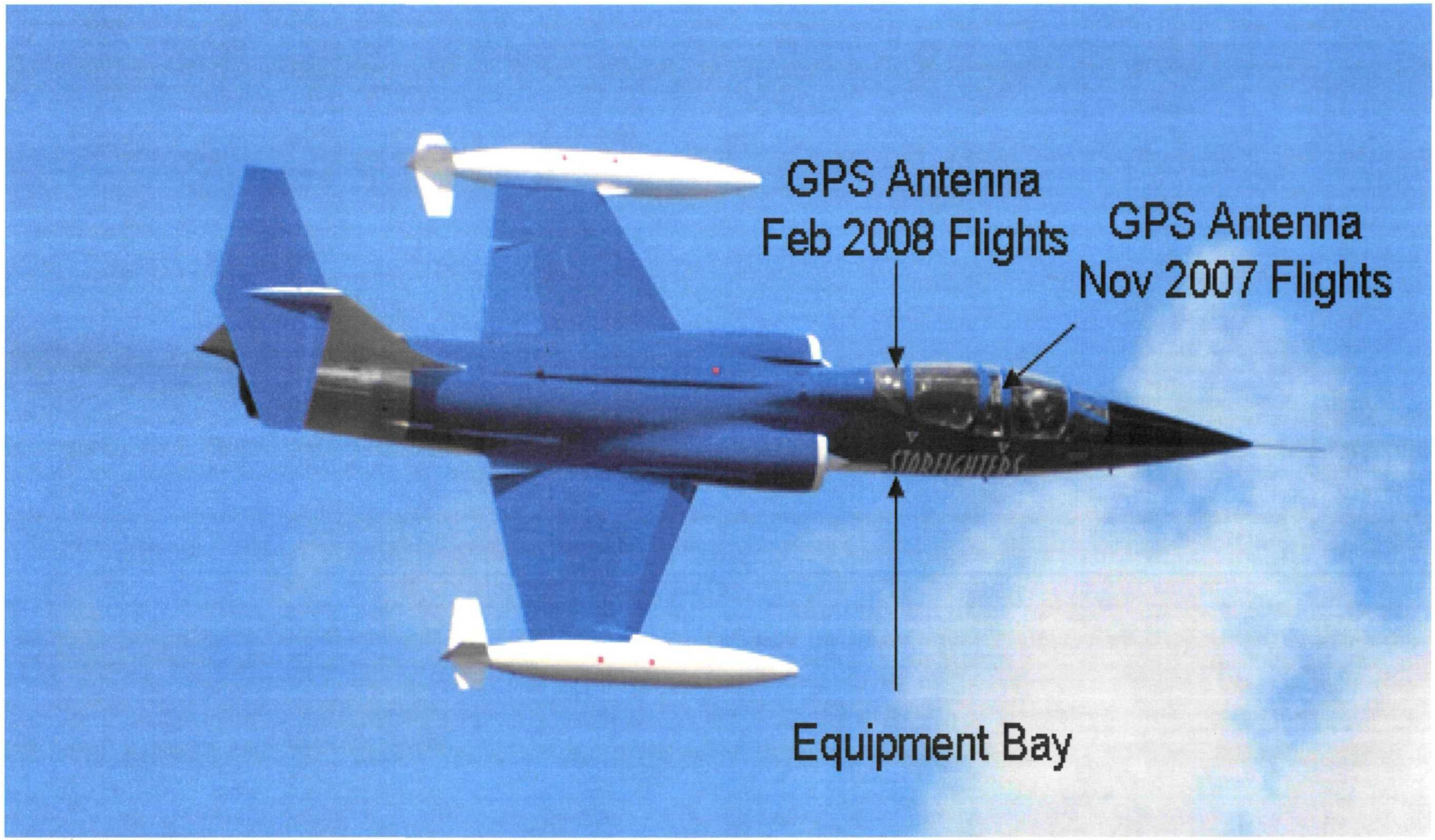

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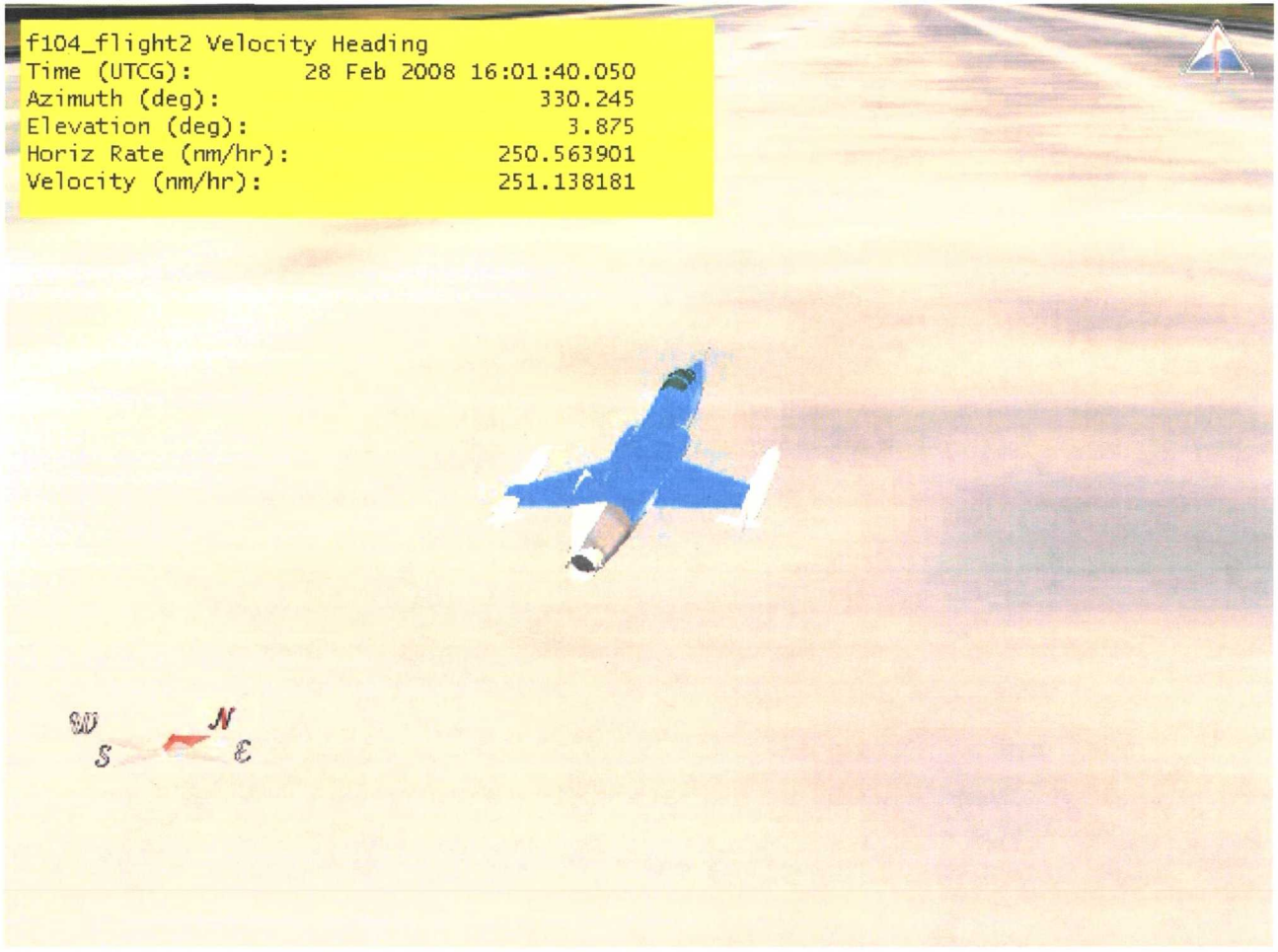
F104 Flight Test Using Iridium Short Burst

F104.wmv

Test Flight

Flight Data


f104_flight2 Velocity Heading
Time (UTCG): 28 Feb 2008 16:01:40.050
Azimuth (deg): 330.245
Elevation (deg): 3.875
Horiz Rate (nm/hr): 250.563901
Velocity (nm/hr): 251.138181
W
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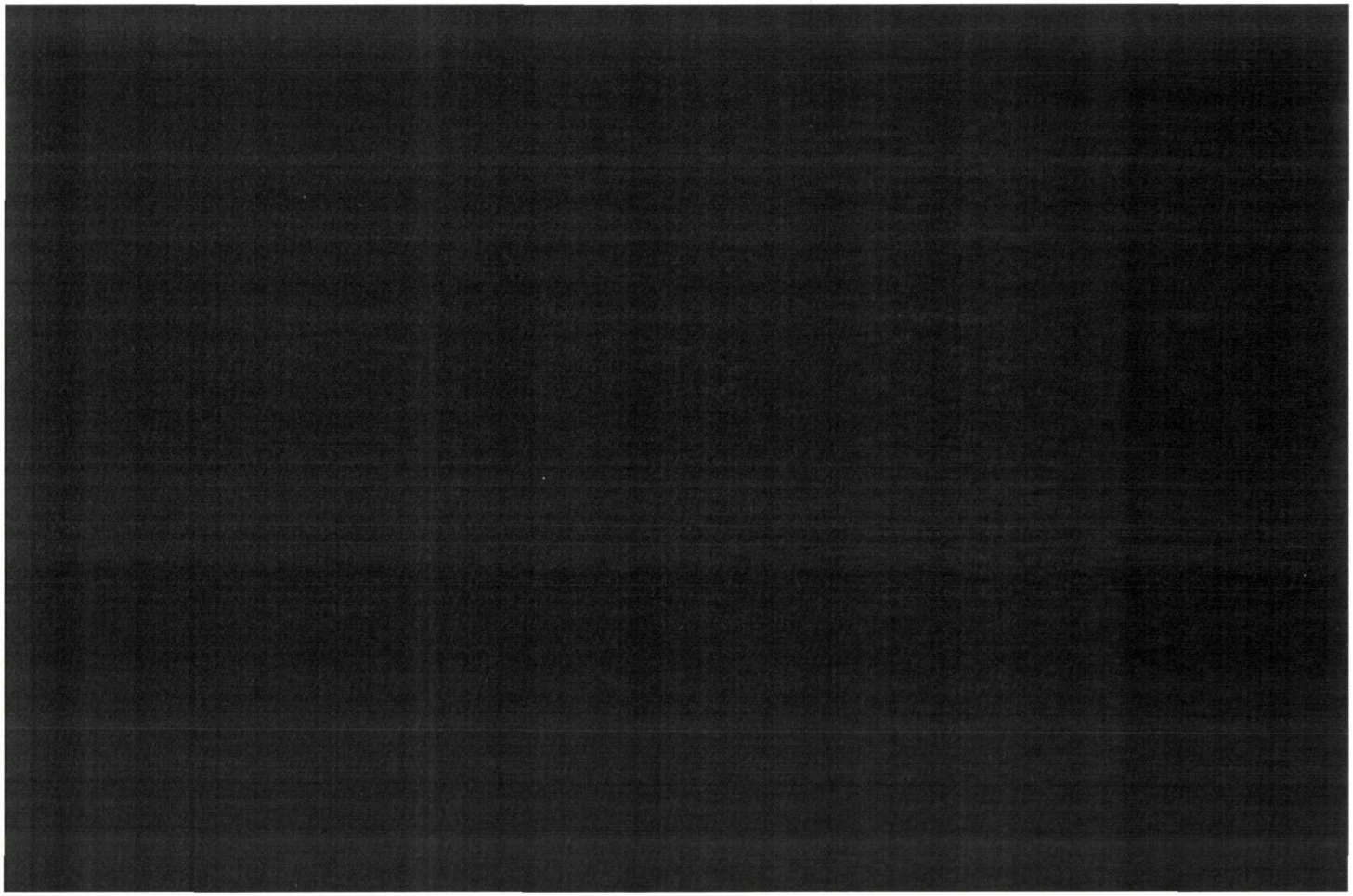
STARS TEST FLIGHT



Iridium-Based BFT (IB-BFT)

Technology – Short Burst Messaging

Architecture -

Hardware –

•Current Standards group work – RTCA SC-203