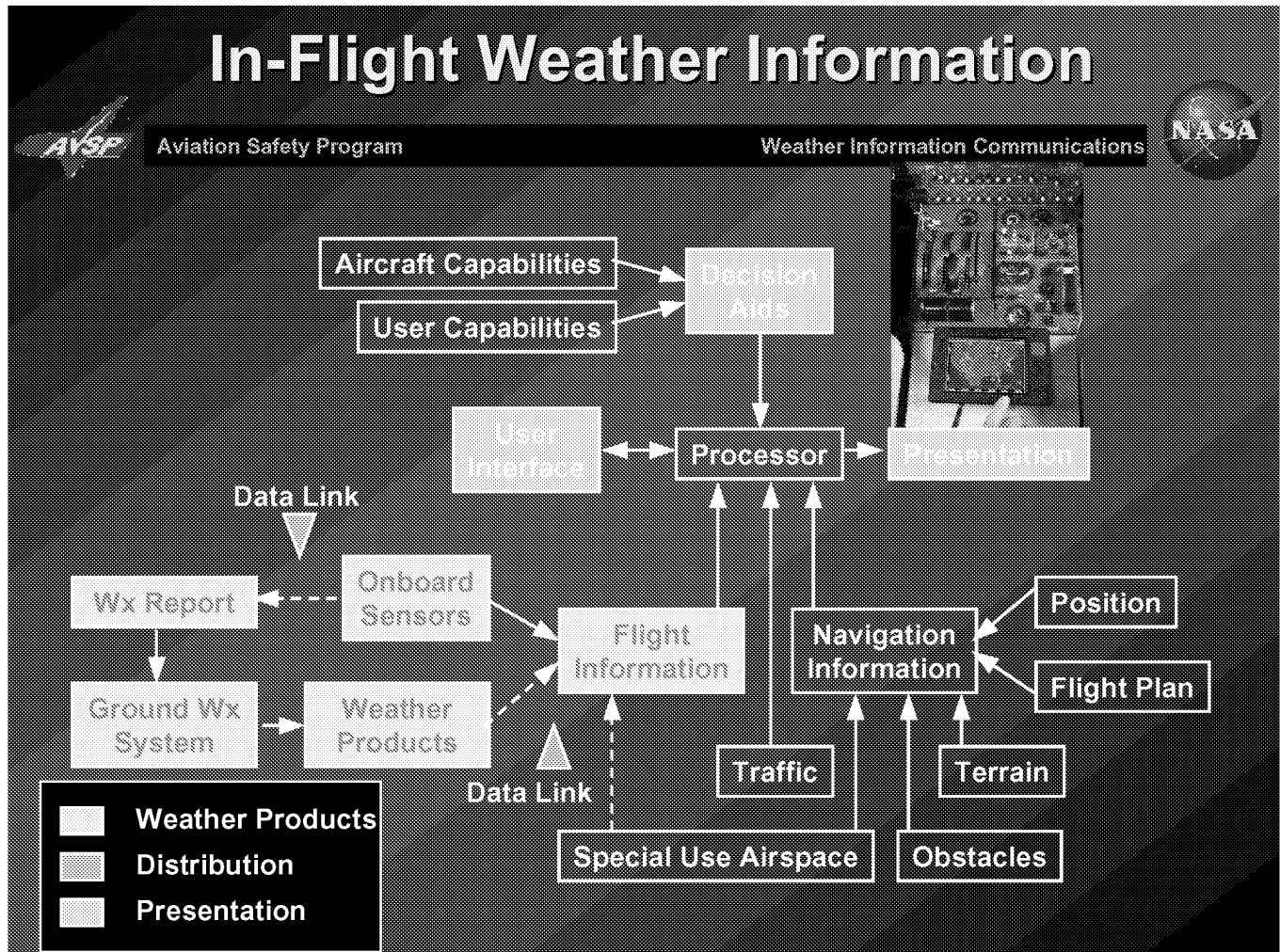


Weather Information Communications (WINCOMM) Overview and Status

*Weather Accident Prevention
2nd Annual Project Review
June 5-7, 2001
Cleveland, OH*

**K. (Gus) Martzaklis
NASA Glenn Research Center
Cleveland, OH 44135
(216) 433-8966
k.martzaklis@grc.nasa.gov**



System Elements

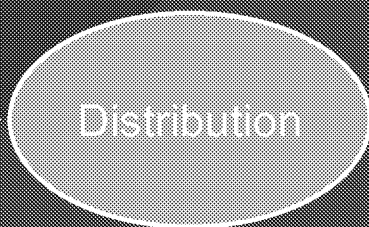


Aviation Safety Program

Weather Information Communications



Weather
Products



Presentation

Enhanced
Weather
Products
(**AWIN**)

Communications
Networks and
Data Links
(**WINCOMM**)

Operator
Support
(**AWIN**)

Technology Investment Areas



Aviation Safety Program

Weather Information Communications



- Datalink Requirements & Architecture Analyses:
 - Mid-Term (2010)
 - Far-Term (>2020)
- Air/Ground Datalinks
 - Ground-based (terrestrial)
 - Satellite-based
 - Airborne-based
- Network Technologies
 - Aeronautical Telecommunications Network (ATN)
 - Internet Protocol (IP)

(Focus: Commercial Air Transport and General Aviation)

NAS Information Exchange



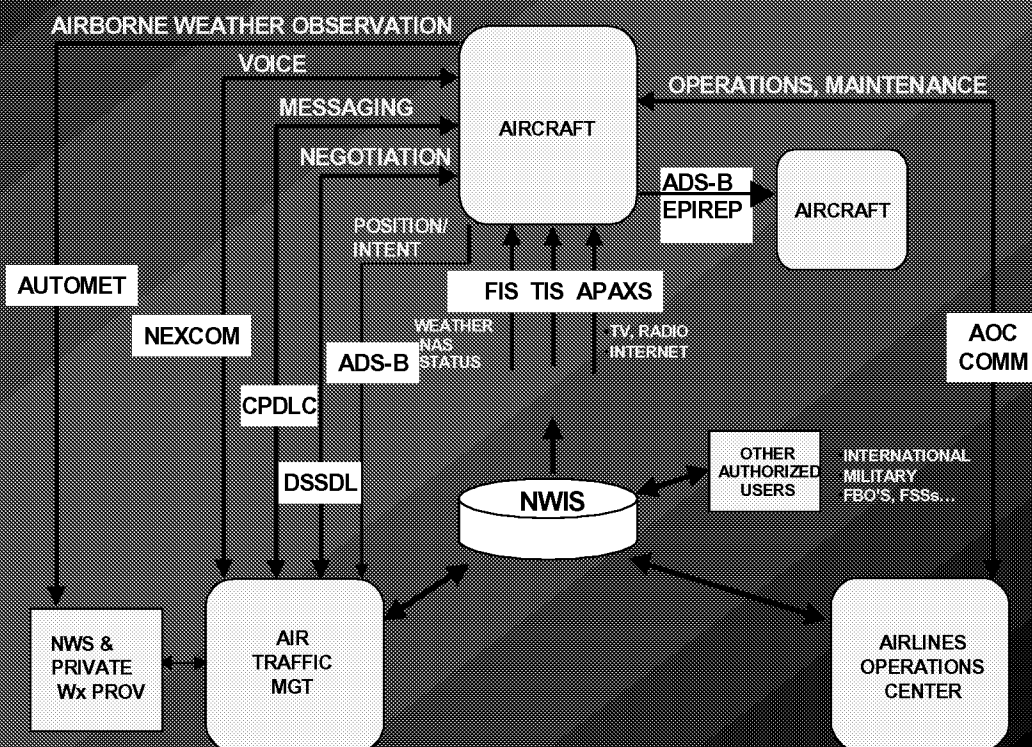
Aviation Safety Program

Weather Information Communications



Options:

- Analog Voice
- ACARS
- VDL Modes 2-4
- Mode S
- UAT
- SATCOM
- HFDL
- Commercial
- Proprietary Links



FIS Datalink Architecture Analyses*



Aviation Safety Program

Weather Information Communications



Key results to date:

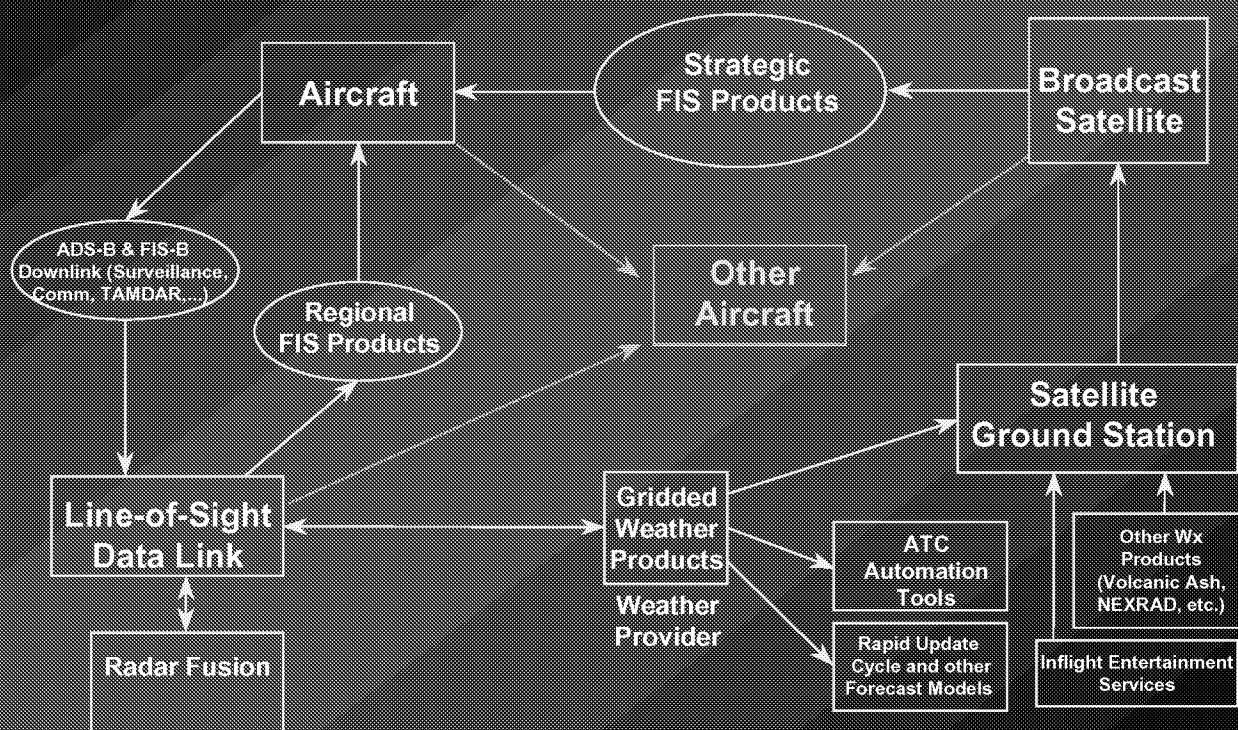
- SAIC, ARINC, TRW, Crown Communications Weather Datalink Architecture Study (May, 2000) and in-house analyses:
 - Broadcast is preferable to addressed 2-way for FIS (Weather)
 - VHF-Broadcast can support regional FIS data, however challenge to meet national implementation goals (coverage/interference)
 - Need broadband solution which could support regional/national goals (SATCOM and/or line-of-sight)
 - Hybrid broadcast solution, optimal:
 - Ground-based narrowband for local/regional FIS
 - SATCOM for national/strategic

Hybrid FIS Datalink Architecture



Aviation Safety Program

Weather Information Communications



FIS Datalink Architecture Analyses*



Aviation Safety Program

Weather Information Communications



On-going tasks:

- Comprehensive AutoMET/TAMDAR datalink architecture options
- JH/APL tasks:
 - Independent investigation of ground, satellite and hybrid datalink architectures for FIS
 - 2007-2015 implementation timeframe
 - Investigation of 'ADS-B' datalinks for FIS/Wx and low-altitude AutoMET (TAMDAR) dissemination
 - Mode S (1090), UAT, VDLM4
 - Supported by high fidelity modeling and simulation

Air Transport: Ground-based Datalinks*



Aviation Safety Program

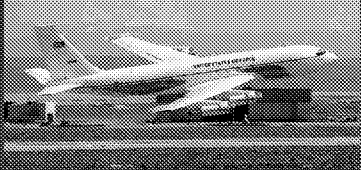
Weather Information Communications

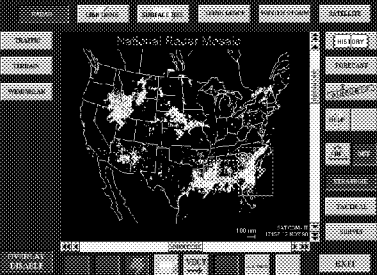


FedEx MD-11

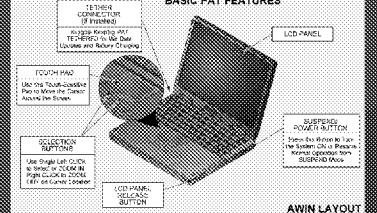


USAF C-135C





BASIC PAT FEATURES



AWIN LAYOUT



Boeing Transport Cooperative Agreement

Honeywell Transport Cooperative Agreement

- Phase I (FY98-00) efforts (Boeing & Honeywell) utilized off-the-shelf comm for rapid implementation (air phone, VHF/ACARS, ...)
- Optimal long-term operational end-solution may differ (VDL Mode 2, SATCOM)
- Recent In-Service-Eval's (ISE) of HI system by UAL (Electronic Flight Bag concept)

Air Transport: Ground-based Datalinks*



Aviation Safety Program

Weather Information Communications



Results to date:

- Grants with Ohio University to assess addressed VDL-Mode 2 datalink for weather dissemination.
- Laboratory bench testing completed
- Initial flight experiments completed (Ohio U King Air)

Future activity:

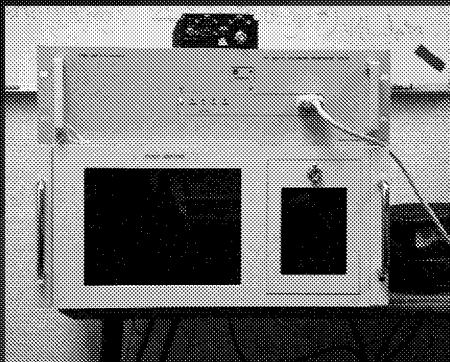
- Partnering with ARINC to jointly evaluate VDL-2 datalink performance for FIS (Weather) applications. (VDL-2 is future upgrade to ACARS)
- Experiments will include both signals-in-space as well as network characterization (ATN).
- Hardware will be integrated on NASA B-757 research aircraft for upcoming flight experiments with ARINC ground-system.

Air Transport: Ground-based Datalinks*



Aviation Safety Program

Weather Information Communications



Equipment



Ohio University King Air



Transmitter Location



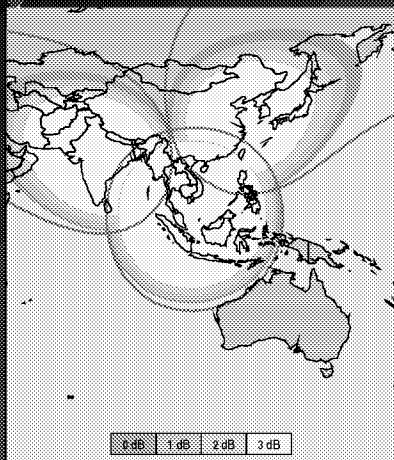
NASA Langley B757 Aircraft

Air Transport: Satellite-based Datalinks*



Aviation Safety Program

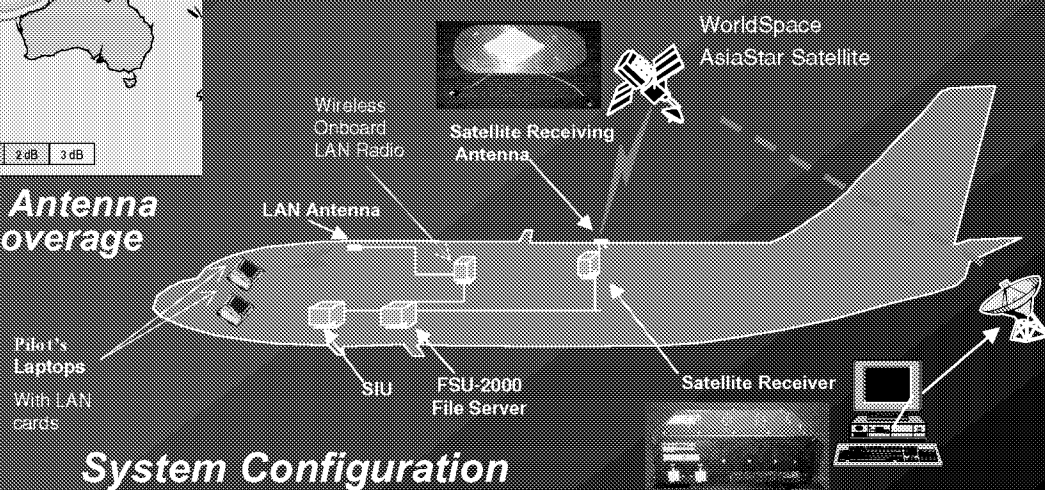
Weather Information Communications



AsiaStar Antenna Beam Coverage

Worldwide Transport

Technology development and operational evaluation of graphical weather to the cockpit via broadcast SATCOM for commercial transport oceanic operations



System Configuration

Air Transport: Satellite-based Datalinks*



Aviation Safety Program

Weather Information Communications



Worldwide SATCOM Transport Datalink:

- NASA / Rockwell Collins / Jeppesen / American Airlines / Worldspace team
- Government/industry cost-sharing
- In-Service Evaluation via two American Airlines B-777s flying trans-pacific routes
- 1st 777 install completed, including all certs
- 2nd 777 install completion May, 2001
- Trial 'runs' completed to Japan
- First 'official' flight May 21, 2001; commence data collection thereafter

Air Transport: Satellite-based Datalinks

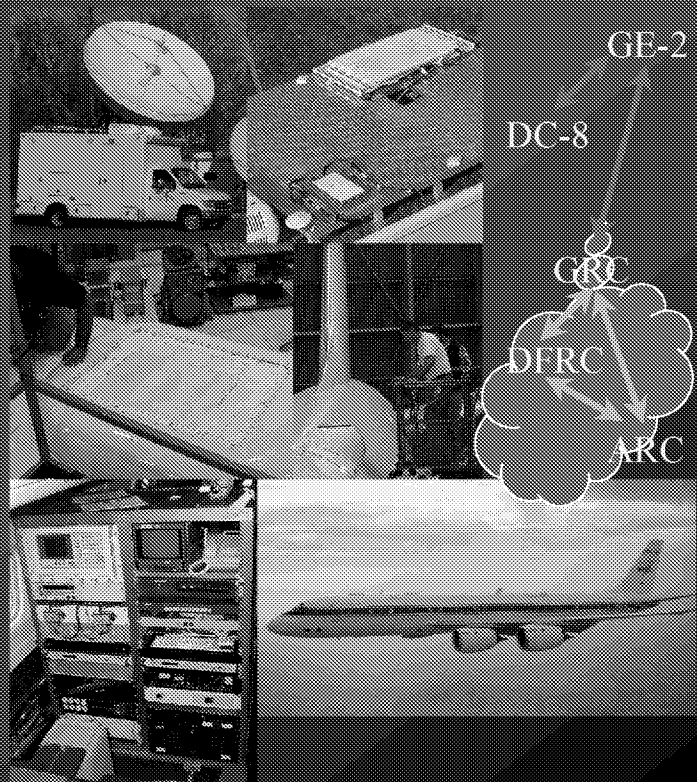


Aviation Safety Program

Weather Information Communications



- Enabling technologies:
 - Phased array antennas
 - Broadband mobile terminal
- Joint NASA/Boeing development
- Up to 1000x capacity increase
 - 256 Kbps off aircraft
 - 2.18 Mbps to aircraft
- Ground-mobile experiments
- Proof flight test Dec, 2000 (DC-8)
- Upcoming B-757 experiments
- Enabling to *Connexion by Boeing*



General Aviation: Ground-based Datalinks*



Aviation Safety Program

Weather Information Communications



- Cooperative NASA research with ARNAV and Honeywell (NavRadio)
- VHF-based broadcast & 2-way datalinks
 - VDL-Mode 2
 - GMSK
- Addresses near-term need for broadcast of graphical weather to the G/A cockpit
- Resulting FAA/industry implementation:
 - G/A focused service volume
 - Dual vendors (ARNAV & Honeywell)
 - 5 year FAA contract (FY00-04)
 - 2 national frequencies per vendor
 - Free text weather products
 - Fee-based value/graphical products



General Aviation: Satellite-based Datalinks



Aviation Safety Program

Weather Information Communications

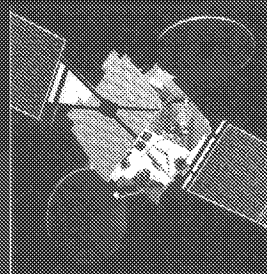


Flight test and evaluation of worldwide weather datalink capability using broadcast Satellite Digital Audio Radio Services (S-DARS).

Johannesburg, South Africa
September, 1999



Internal Equipment (GPS, Laptop Computer, etc.)



AfriStar Satellite



Patch Antenna Mounted to Cessna 172



Satellite
Receiver

General Aviation: Satellite-based Datalinks*



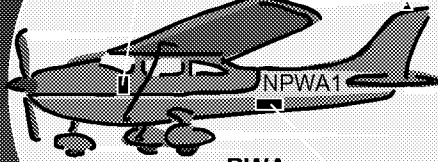
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Weather Information Communications



PWA™ airborne weather display

PWA™ antenna



PWA receiver

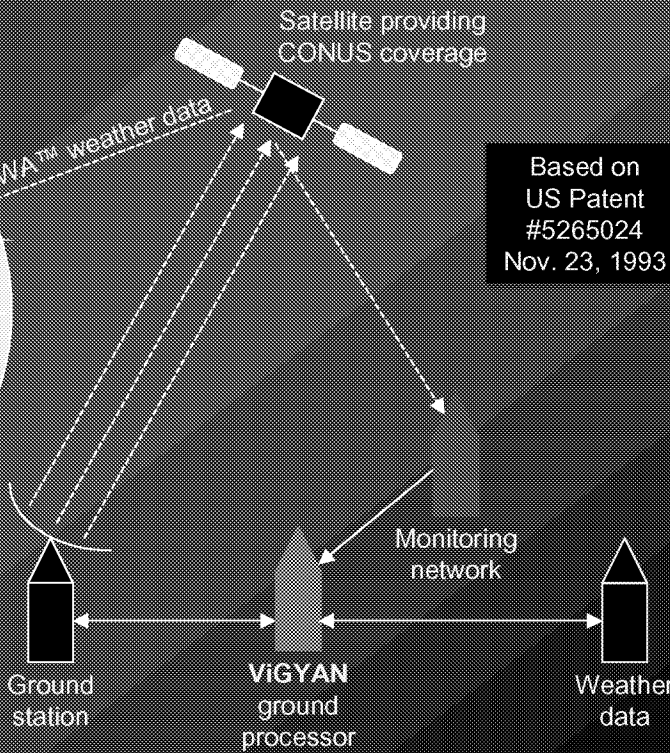
Satellite providing CONUS coverage

PWA™ weather data

Based on
US Patent
#5265024
Nov. 23, 1993

SBIR Phase III with ViGYAN

- Enable Pilot Weather Advisor™
- Low-cost SATCOM broadcast datalink
- Initial flight evals Fall, 2001



Low-Altitude AutoMET Reporting



Aviation Safety Program

Weather Information Communications



- Use aircraft operating below 20,000 ft altitude to sense and report

- Moisture
- Temperature
- Winds

- To be used by:

- Forecast models
- Weather briefers
- Controllers
- Other aircraft

- Investigating numerous airborne-based datalinks and architectures for technical feasibility

**MDCRS &
AMDAR Coverage
from Transports**

20,000 ft. MSL



**AutoMET
Coverage**

Ground Level

AutoMET: Airborne-based Datalinks*



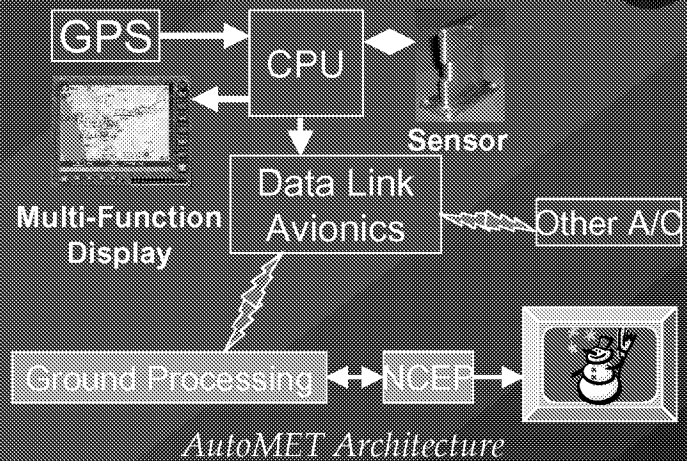
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Weather Information Communications



Airborne-based Datalinks:

- Extension of MDCRS service (ACARS/ARINC)
- VHF/GMSK (ARNAV Systems)
- VDL-Mode 2 (ARINC & HI)
- UAT (FAA Capstone & UPSAT)
- Satellite (OrbComm, others)
- ADS-B Datalinks (JH/APL)



AutoMET Architecture



NASA
Cessna
206

Network Protocols Development



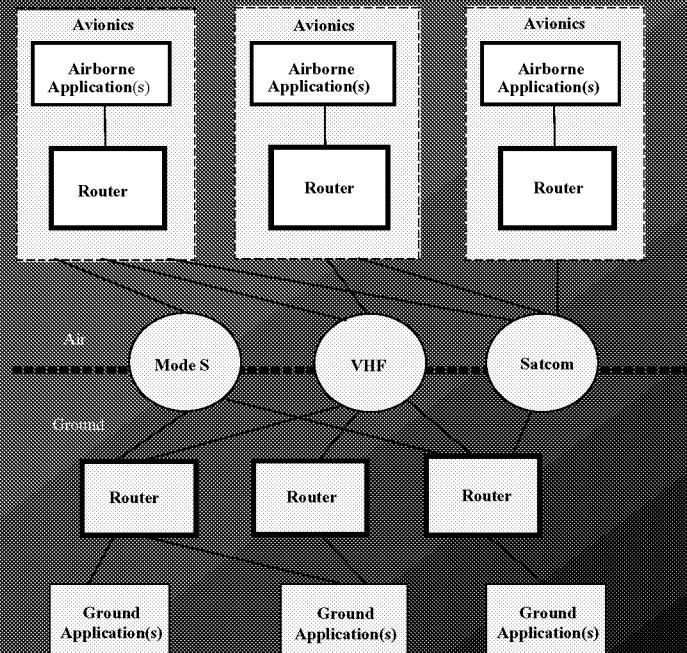
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Weather Information Communications



•Past tasks with MIT/LL for FIS:

- ATN and Internet Protocol (Mobile IP) network feasibility
- IP-over-VDL Mode 2 datalink interface definition
- Joint NASA/ARINC research:
 - FIS over IP/VDL-Mode 2
 - FIS over ATN/VDL Mode 2
- ATN over broadband SATCOM feasibility
- Next-generation Mobile IP research for aeronautical app's



Network Routing Connectivity

FAA/NASA Collaboration



Aviation Safety Program

Weather Information Communications



- FIS Datalink & Weather Requirements Offices (AUA & ARW)
 - Co-funded tasks under NASA/FAA Memo of Agreement:
 - Low-altitude AutoMET datalink technical architecture alternatives
 - FIS/Weather datalink technical architecture analyses:
 - Mid-Term (2004-2007)
 - Far-Term (2010 and beyond)
 - Terminal area weather datalink communications alternatives
- Office of Architecture and System Engineering (ASD)
 - Joint Research Project Definitions (JRPDs):
 - FIS datalink architecture analyses & NAS Architecture integration
 - Terminal area broadband communications
- CAPSTONE Program (Alaska)
 - UAT datalink investigation for AutoMET; SATCOM augmentation

Summary



Aviation Safety Program

Weather Information Communications



- NASA datalink technology investments in
 - FIS datalink architecture development guidelines
 - Ground, satellite and airborne weather datalink systems and supporting network standards
- Strong partnerships with industry, FAA and academia evidenced by
 - Cost-shared NASA/industry technology development
 - Jointly co-funded NASA/FAA tasks
- As a result, beginning to see introduction of 1st generation systems into the marketplace
- Continued future NASA research and technology development into breakthrough, next-generation systems and component technologies.