



TELEDYNE CONTROLS

A Teledyne Technologies Company

Aviation Safety and Efficiency Solutions Since 1964

Flight Data Monitoring Equipment Overview

Presented by

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Agenda

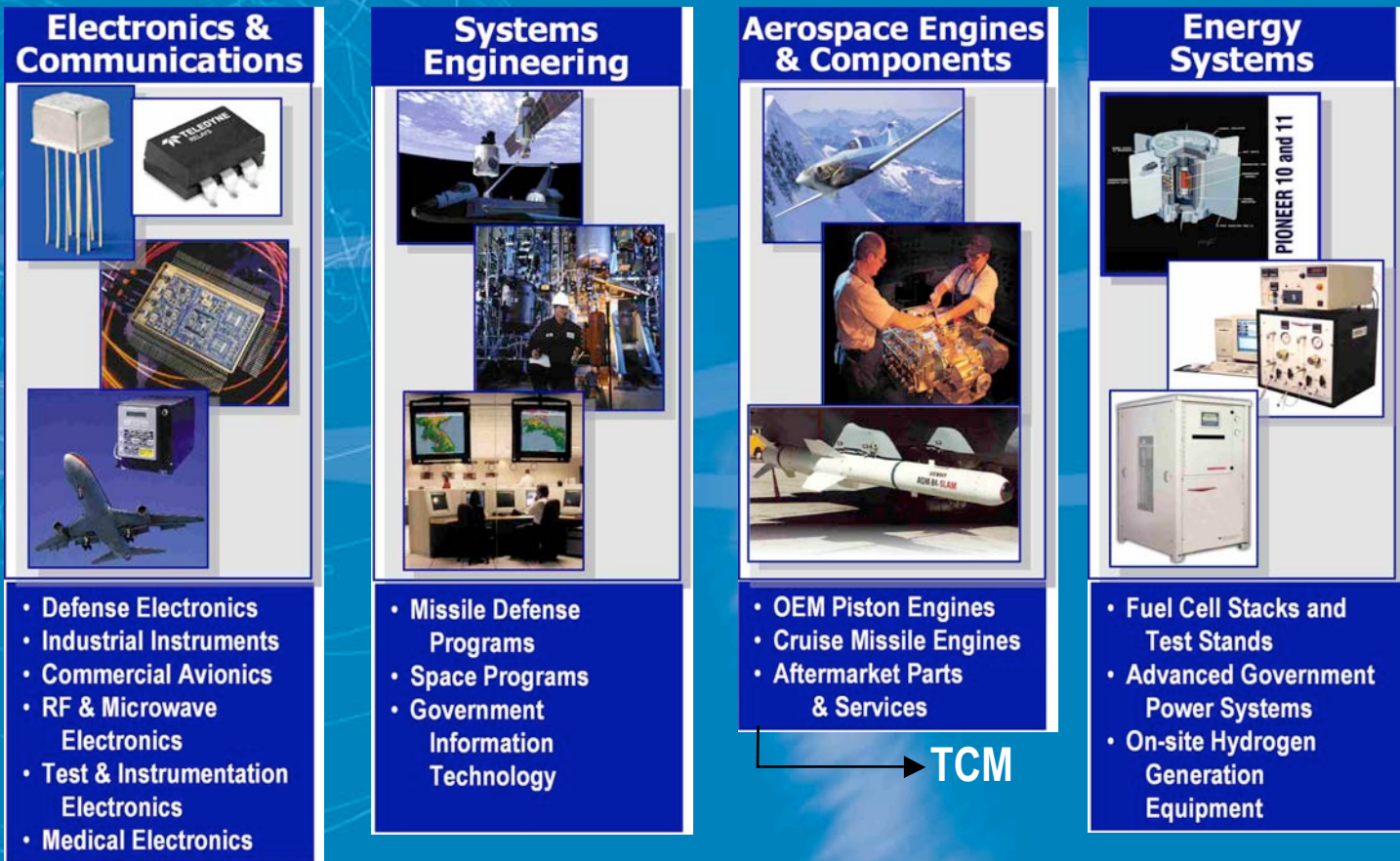
- **Teledyne Controls - Company Overview**
- **On-board Flight Data Products Overview**
- **Off Aircraft Flight Data Products Overview**
- **Turnkey Services**



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Teledyne Technologies - *Four Technology-Based Segments*

➤ Teledyne Technologies – 4 Operating Business Units with over \$1 Billion (USD) in revenues and some 6,600 staff based around the world



Teledyne Controls

TCM

Teledyne Control's Expertise in Aircraft Data Management

- **Since 1964 – Leading provider of avionics and ground-related equipment to Civil and Military operators:**
 - **Flight Data acquisition & data management systems**
 - **Data recording & transfer systems**
 - **Aircraft Information Solutions**
 - **Flight safety and crew training solutions**
 - **Flight data services**
 - **Airborne Communications**
- **Established world leader and authority in the operational processes, technology and interpretation of aircraft flight data replay**



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Teledyne Controls Mission

....right information, in the right place, at the right time....

....make decisions and take action....

....improved safety, efficiency and customer service/mission effectiveness....



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On-board Flight Data Products Overview

Why On-board Flight Data Acquisition?

- **Initially regulated to aid in incident investigation**
 - **Applies mainly to larger aircraft on commercial flights**
 - **Flight Data Acquisition Unit**
 - Acquires and process “Mandatory” flight data
 - **Flight Data Recorder**
 - Crash-survivable “Black Box”
- **Regulations continue to increase the quantity and quality of recorded flight data**
 - **More and better data helps enable meaningful conclusions**
- **Flight & Maintenance Operations, and Management, recognize the benefits of regularly turning flight data into information**
 - **Safety and cost savings benefits**



Flight Data Acquisition & Management Systems

DFDAU / DFDMU



Digital Flight Data Acquisition / Management Unit

- B737
- B767
- MD-80
- MD-90
- F-100
- A310
- Air Force One
- British Nimrod
- B757
- DC-10
- MD-11
- L-1011
- Navy P3
- A300

FDIMU / FDIU



Flight Data Interface Management Unit

- A319
- A320
- A321
- A330
- A340

DMU



Data Management Unit

- B747
- MD-11
- B757
- B767

MFDAU



Mini - Flight Data Acquisition Unit

- Embraer
- Gulfstream
- Bombardier
- CASA
- SAAB
- Cessna
- Dassault
- De Havilland
- Raytheon
- Bell
- Sikorsky



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Teledyne's Flight Data Customers

➤ Flight Data Acquisition

- DFDAU (Boeing) - 172 customers, over 2200 A/C installations
- FDIMU (Airbus) - 85 customers, over 550 A/C installations
- MFDAU (Business/Regional Aircraft) – >30 customers, over 1500 installations

➤ Data Transfer

- Wireless GroundLink® system: 25 customers, installed on over 350 A/C

➤ Data Replay & Analysis

- AirFASE® software: 76 customers
- Vision software: 23 customers

➤ Flight Data Analysis Services

- Currently analyzing data for >220 aircraft
- Large air transport with flight data acquisition and recording



GA Data Acquisition Installations

- Fixed Wing & Helicopter
- Flight Data Recorder
 - Regulatory compliance
 - Maintenance benefits

Aircraft	Flight Data Acquisition Unit P/II
Bell	
212 / 412	22415000-1 w/HUMS
Boeing	
BBJ	2233000-815-1
BV234 / CH-47	2237000-xx (HUMS option) 2241500-3
Bombardier	
Learjet 31,31A,35,36,55,60	2231230-13
Learjet 31A	2231230-3 2231230-7
Learjet 60	2231230-20 2243500-36 (FAA)
Challenger 601/604	2231230-17 2243500-36 (FAA)
Cessna	
Citation 550 Bravo (II)	2231230-5-A
Citation 560 Ultra Encore (V)	
Citation 650 (VII)	
Citation 560 Excel/XLS	
Dassault	
Falcon 50	2244000-211
Falcon 50EX	2244000-11-A (OLD: 2230887)
Falcon 900C/EX	
Falcon 2000/EX	
Embraer	
Legacy (ERJ 135/145)	2243500-16A
Eurocopter	
Super Puma	2237000-xx (HUMS option) 2241500-5 2237000-9/11
Dolphin	
Gulfstream	
GIV	2243500-01 (OLD: 2231230-14)
GV	2243500-01 (OLD: 2231230-14)
Hindustan Aeronautics	
Advanced Light Helicopter	2241500-9
Raytheon	
Super King Air 300	2243500-36 (FAA)
Beechjet 400A	2231230-8
Beechjet 400XP	2231230-19
Hawker 125/800/1000	2231230-5-A (-18 RAF)
Hawker 800XP	2231230-5-B
Sikorsky	
S-61	2237000-2 (HUMS option) 2231230-10-A-1
S-76	2237000-2 (HUMS option) 2241500-4 (HUMS option)

Data Transfer Systems - Data Recording/Transmitting

OQAR/PQAR



Quick Access Recorder

(Optical/PCMCIA)

- B737
- B747
- B757
- B767
- B777
- DC-10
- MD-11
- MD-80
- MD-90
- A300
- A310
- A320/321
- A330
- A330/340
- F28-70
- F28-100
- Air Force C17

WQAR



Wireless GroundLink®

- B737
- B747
- B757
- A320
- A330
- A340
- Navy P3

GateLink / AWLU



802.11 Aircraft Wireless LAN Unit

- A300
- A310
- MD-10
- MD-11
- MD-90

ADL / PDL



ADL pictured

Data Loader (Airborne/Portable)

- B737
- B737NG
- B747
- B757
- B767
- B737BBJ
- MD-11
- MD-90
- C-130



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Teledyne's End-to-End FDM Solutions ...

The Flight Data Monitoring Process

1 Data Acquisition

- Acquire aircraft data parameters



Data Acquisition Unit

2 Data Recording & Storage

- Encrypt & compress data



Quick Access Recorder



Wireless GroundLink



Optical disk or PC card

3 Data Transmission (or Retrieval)

- Frequent, manual retrieval of physical media from QAR
- Automatic, wireless transmission from WQAR via Internet

WIRELESS Internet TRANSMISSION

15 Minutes from Landing to Data Analysis



Groundstation

Decrypt & decompress data

AIR-FASE



4 Data Analysis

- Data processing
- Flight analysis
- Flight visualization & animation



Vision

5 Information Reporting

- Statistical reports
- Trend analysis
- Risk assessment



6 Operator's Flight Safety Program

- Flight safety
- Maintenance
- Engineering
- Flight operations
- ATC/ airports
- Manufacturers
- Flight training



Revision

Feedback & information-based decision making

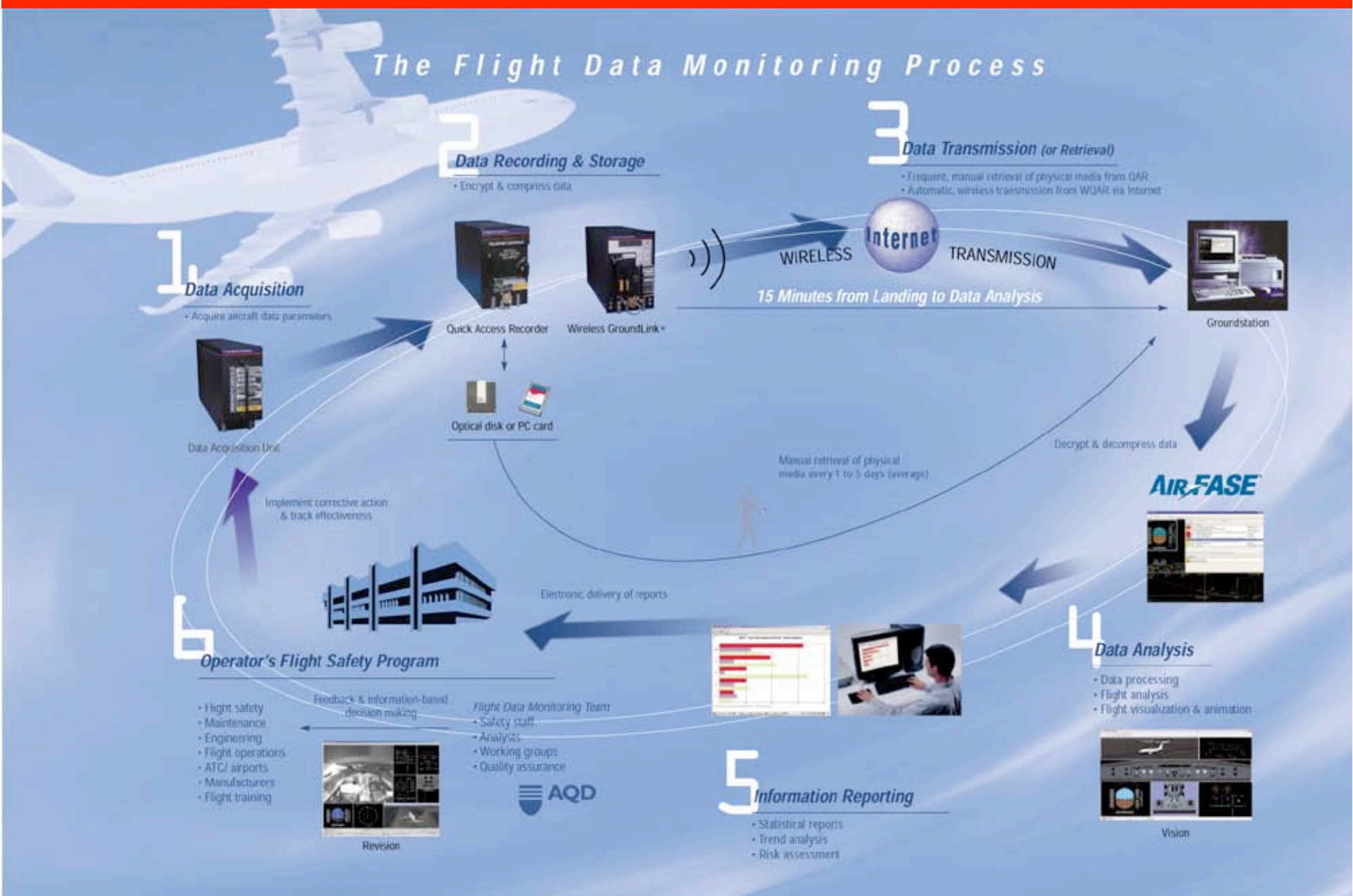
- Flight Data Monitoring Team**
- Safety staff
 - Analysts
 - Working groups
 - Quality assurance



Electronic delivery of reports

Implement corrective action & track effectiveness

Manual retrieval of physical media every 1 to 5 days (average)



Flight Data Evolution in General Aviation

- **Round Dial “Analog/Electrical” Cockpits**
 - Minimal amount of available flight data to acquire & record
 - Minimal mandatory requirements for crash survivable flight data recording
- **Glass “Digital/Electronic” Cockpits**
 - Growing amount of available flight data to acquire & record
 - Digital avionics, buses, engine controls, etc.
 - Relatively low cost avionics are rapidly emerging
- **Interest growing at Operators, OEM’s, FAA and Insurers**



Flight Data Processing Considerations for GA

- Once available flight data is defined
 - How often will it be sampled
 - Amount of on-board processing, if any, before recording
- How will it be recorded?
- How will it be retrieved for analysis?
- How often will it be retrieved for analysis?
- Who will do the analysis?
 - Traditionally, airlines manage their FDM programs
 - GA OEM's are becoming proactive (Embraer, Eclipse, Cirrus)
 - Advantage is more statistical confidence when trending
 - Data can be made accessible to relevant parties
 - Depending on the desired information, operators will need to commit more, or less, resources



Flight Data Retrieval Factors

- **Quantity - More is better**
 - More types of data, more analysis capability
 - Higher sampling rates, better analysis
- **Accuracy - No garbage in, no garbage out**
 - Acquisition, recording, processing, analyzing
- **Data retrieval timeliness - sooner the better**
 - **Manual - human in the loop**
 - Data milking with laptops
 - Pulling & replacing flash cards (EMax)
 - Data gets lost, corrupted, and walks away
 - 60-70% data retrieval efficiency
 - **Automated data retrieval – remove the human**
 - Near 100% data transfer
 - Automated report generation, distribution & access

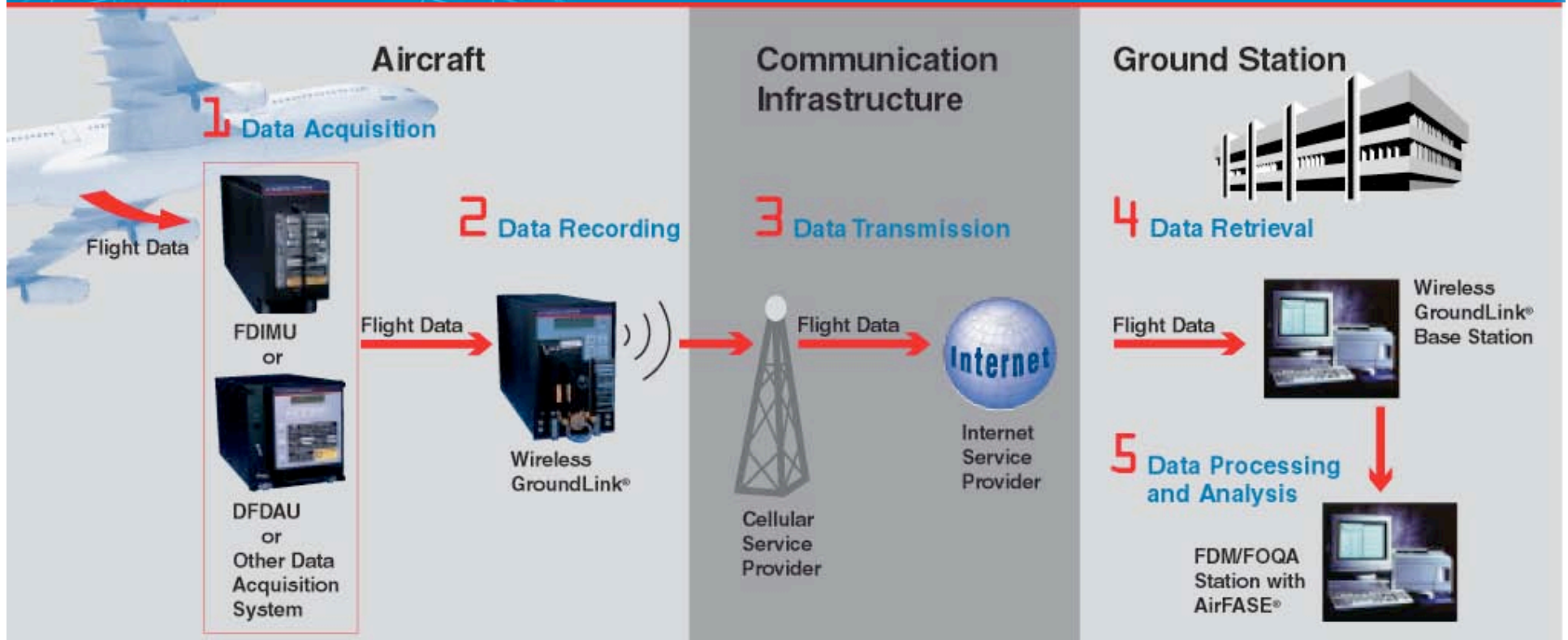


Automate the manual process – focus on improvement

- Cellular Data Acquisition Unit can acquire and record ALL available flight data from defined sources
- Upon aircraft shutdown: ability to encrypt, compress and transmit the data file over cell phone module(s) to a ground station for analysis and archiving
 - Ground station decompresses, decrypts, transcribes and processes the flight data into information – 10-15 minute process
- Routine reports can be automatically sent to appropriate personnel, example
 - Fuel burn reports to management
 - Exceedance events to operations
 - Data sent to aircraft/engine manufacturer
 - No limitation on who gets what information
- Reports/information could also be hosted on a website for accessibility as needed for:
 - Immediate post flight debriefing: flight operation animation, exceedance/incident reviews
 - Viewing performance data for individual/multiple flights
 - Query capability
 - Data “owner” could decide who views what
- Silent Mentor monitors flight activity for operations improvements



Teledyne's Automated Air Transport Solution



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Aircraft Wireless LAN Unit (AWLU – GateLink)

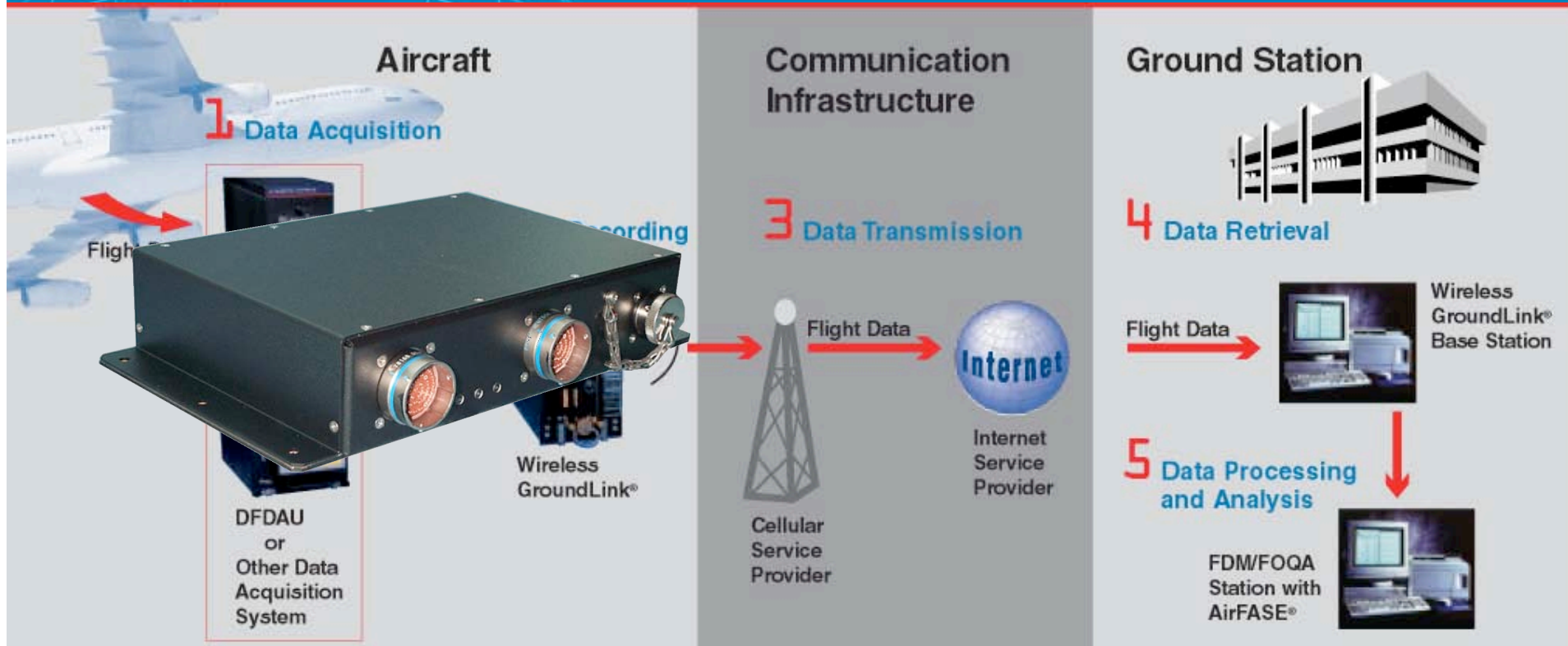
AWLUg4

- Terminal and Cabin Wireless LAN Units (TWLU & CWLU)
- Cellular
- Ethernet
- ARINC 429 receivers and transmitters
- Aircraft Data Recording
- Supports latest IEEE 802.11 standards
- Upgradeable to meet future Cellular and 802.11 standards
- ARINC 429 data available via TCP/IP over Ethernet to wired or wireless devices
- Useful 429 to Ethernet bridge for EFB and other applications
- Teledyne Patent 6181990 covers data acquisition and transmission over “Cellular” communication links



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Teledyne's Patented "Silent Mentor" GA Solution



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Off-Aircraft Flight Data Products Overview

Technology Improves FDM Analysis

- **Flight Tracking – Low Cost for Analog Aircraft**
 - Handheld GPS and Off the Shelf mapping software
 - Appaero type device adds some aircraft movement
- **Digital Avionics - add Engine Condition Monitoring (ECM)**
 - Avidyne EMax – Relatively low data sampling rate
- **Increased data acquisition parameters and sampling rates**
 - Teledyne Continental data acquisition system for Cirrus
 - Alakai Recorder for Cirrus
 - Eclipse and Embraer Phenom integrated data acquisition
- **Additional sensors, switches, digital data**
 - Control Surface Movement (Ailerons, Flaps, Rudders)
 - Control Forces (Yoke, Rudder, Elevator, etc.)
- **Airborne event detection and reporting (ACARS/Datalink)**
- **Manual/Wireless flight data retrieval**



Flight Data Analysis Considerations

➤ Who will manage the data

- Automate as much as possible
- Access related information as needed
 - Pilot - Post Flight Debriefing tools
 - Management - Operational activity
 - Mechanics - Maintenance related events
 - Engine manufacturers – Performance measurements
 - OEM's – Overall trend analysis

➤ Information distribution methods

- Hardcopy – time consuming and expensive
- Emailing – directed and efficient
- Web access – Users get what they need, when they want it
 - Optimally managed by aircraft OEM on all aircraft in-service



Flight Data Replay & Analysis - AirFASE®

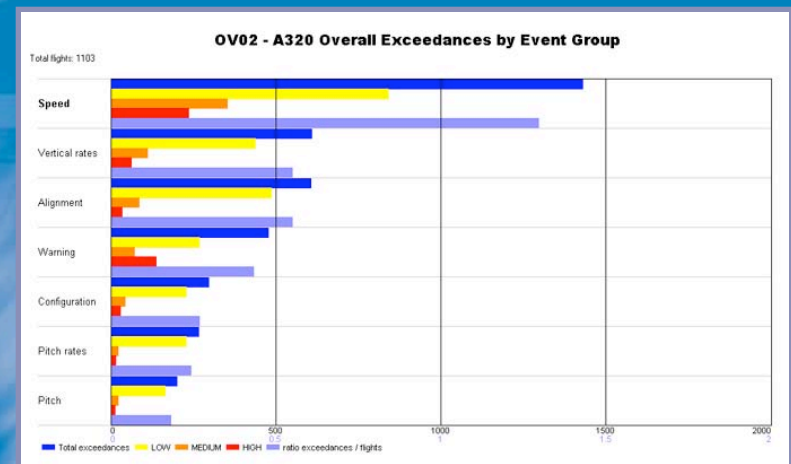
- **AirFASE® (Aircraft Flight Analysis & Safety Explorer)**
- **Combines the best of three analysis tools from Teledyne, Airbus and SPIRENT**
- **Measurement, analysis and reporting software tool for in-flight operational performance of commercial aircraft**
 - **Processes Data**
 - **Archives Data**
 - **Views flight data and events**
 - **Provides graphical views of flight path(s)**
 - **Statistical Analysis (trends, plot & list reporting)**
 - **Animation**



AirFASE® Key Functions...

➤ Data Processing

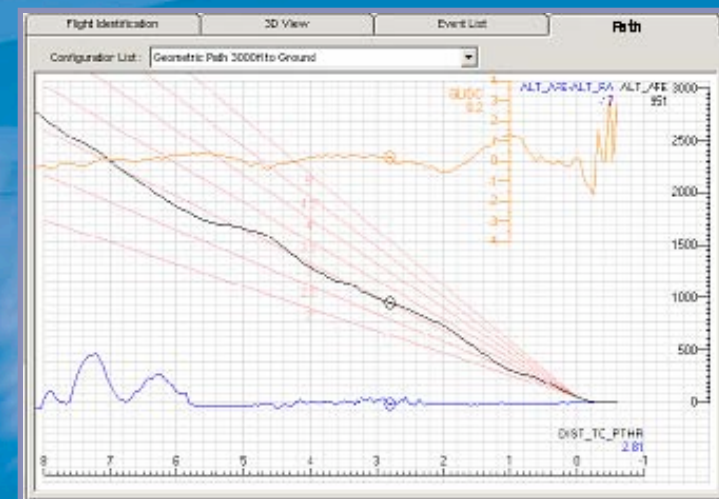
- Transcription of raw flight data into engineering values
- Comparison between recorded flight data and flight profile specifications
- Detection of abnormal events and deviations
- Flight path: geographical flare & geometric path calculation
- Database loading & storage
- Data de-identification
- Long-term trending
- Secure data access & storage



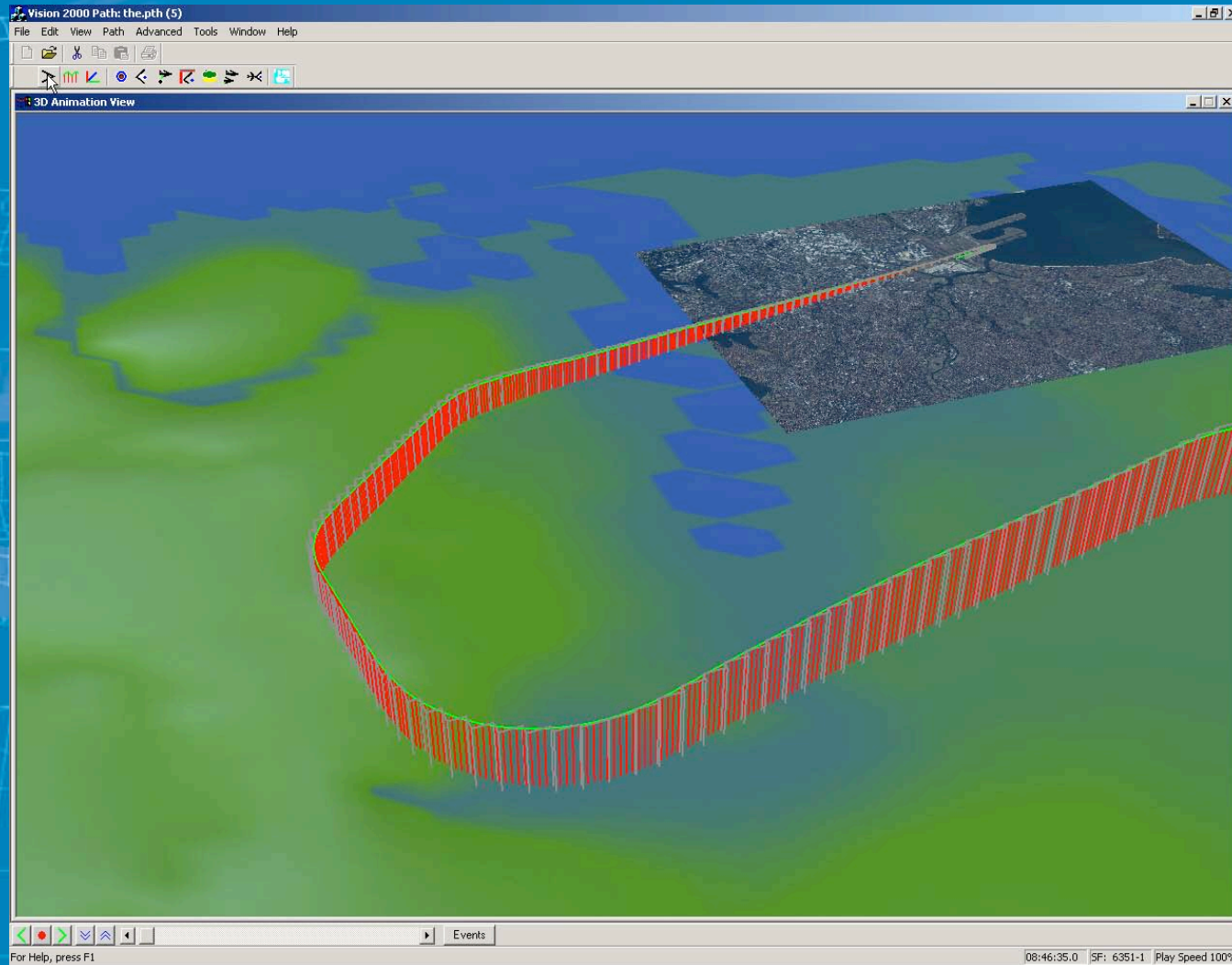
...AirFASE® Key Functions...

➤ Flight Analysis

- Flight data and events views (numerical / graphical format)
- Flight path
- Statistical analysis: events by phase of flights, single deviation events, combined events, risks detection events, etc
- Event categorization based on their level of severity



3-D Flight Path Generation



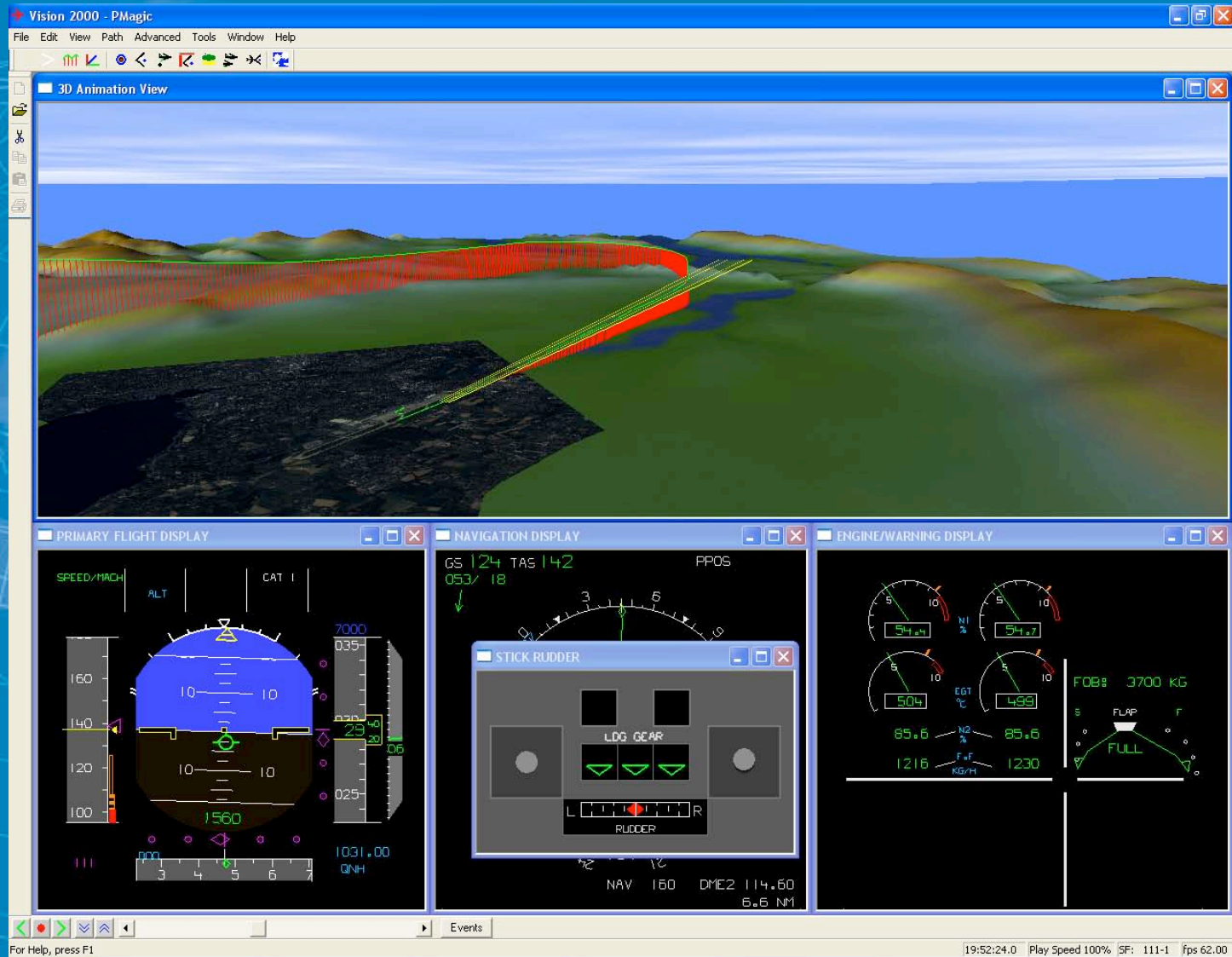
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Space Imaging Satellite Imagery Archive

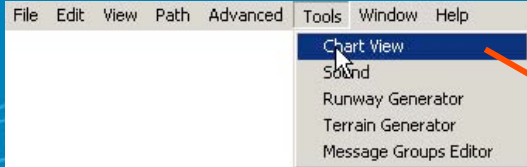


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3-D Glideslope View

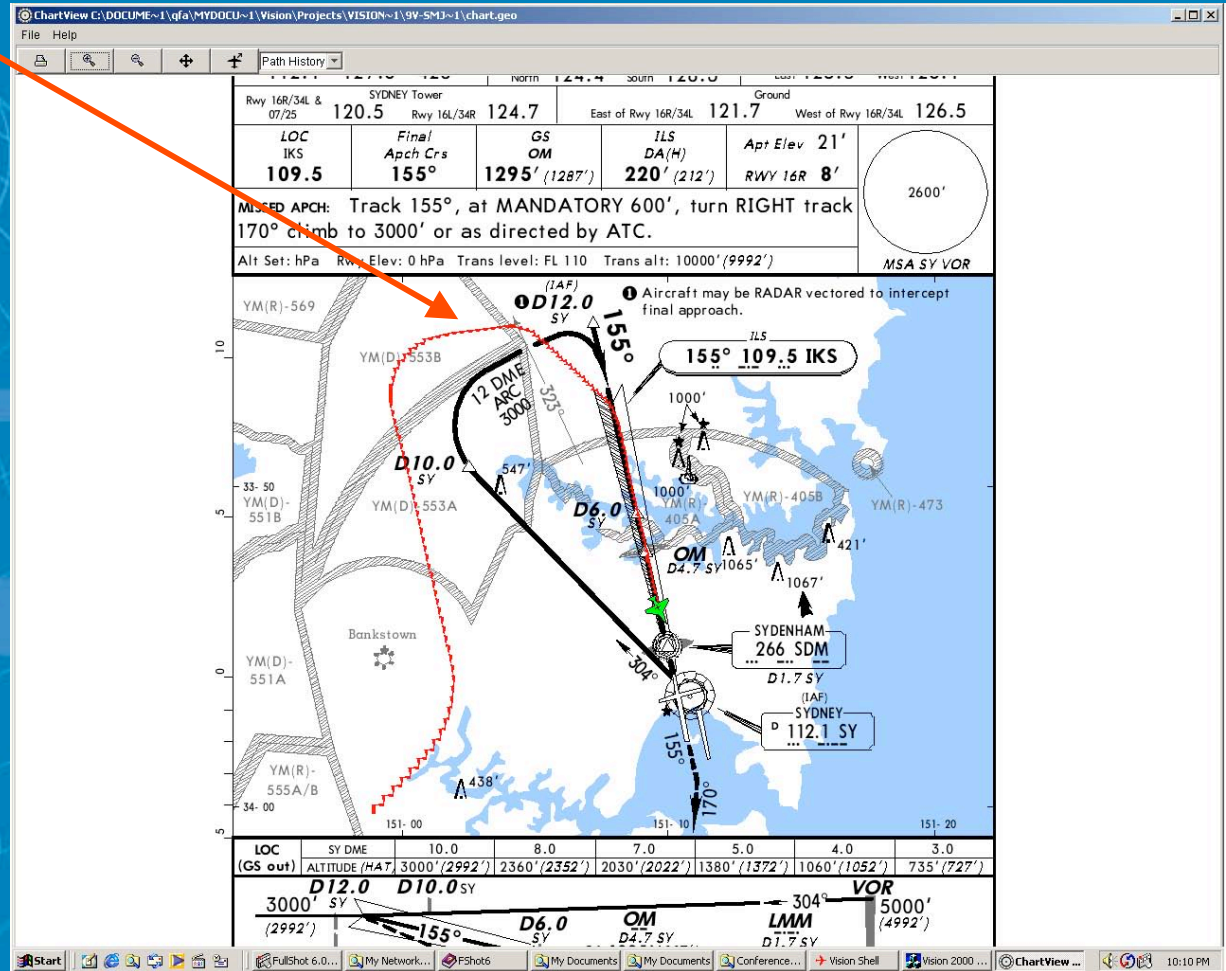


Immediate Post-Flight Debriefing Tool Menu

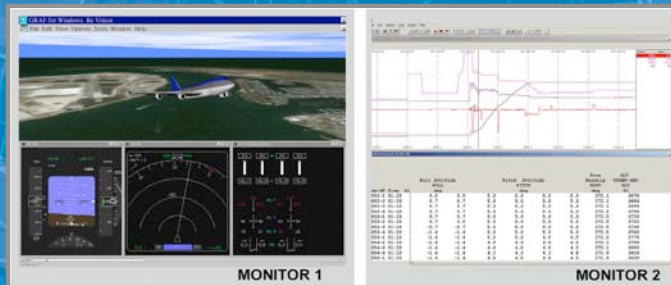


Overlay flight path on an approach plate

Overlay flight path on a Jeppesen chart



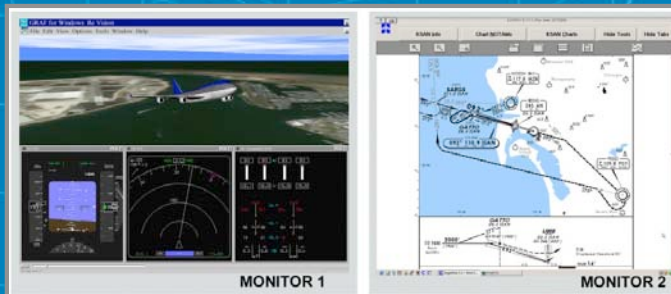
Vision - Enhanced Flight Data Visualization...



MONITOR 1

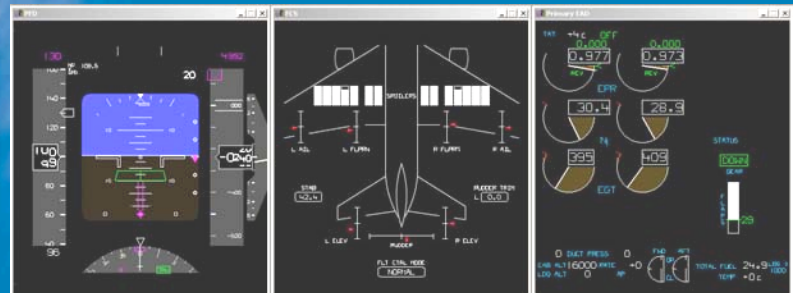
MONITOR 2

AirFASE-Vision in Dual Monitor Modes



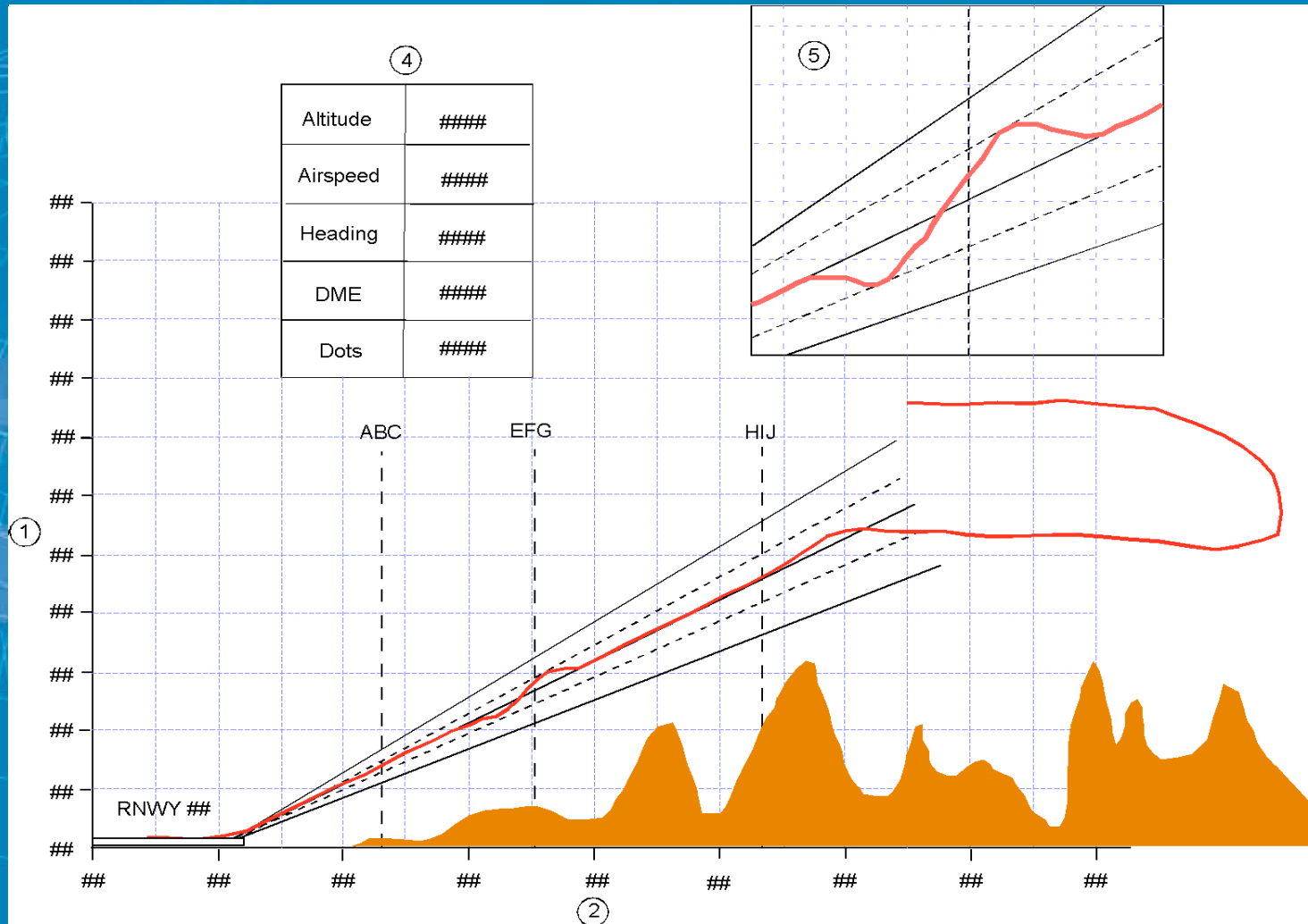
MONITOR 1

MONITOR 2



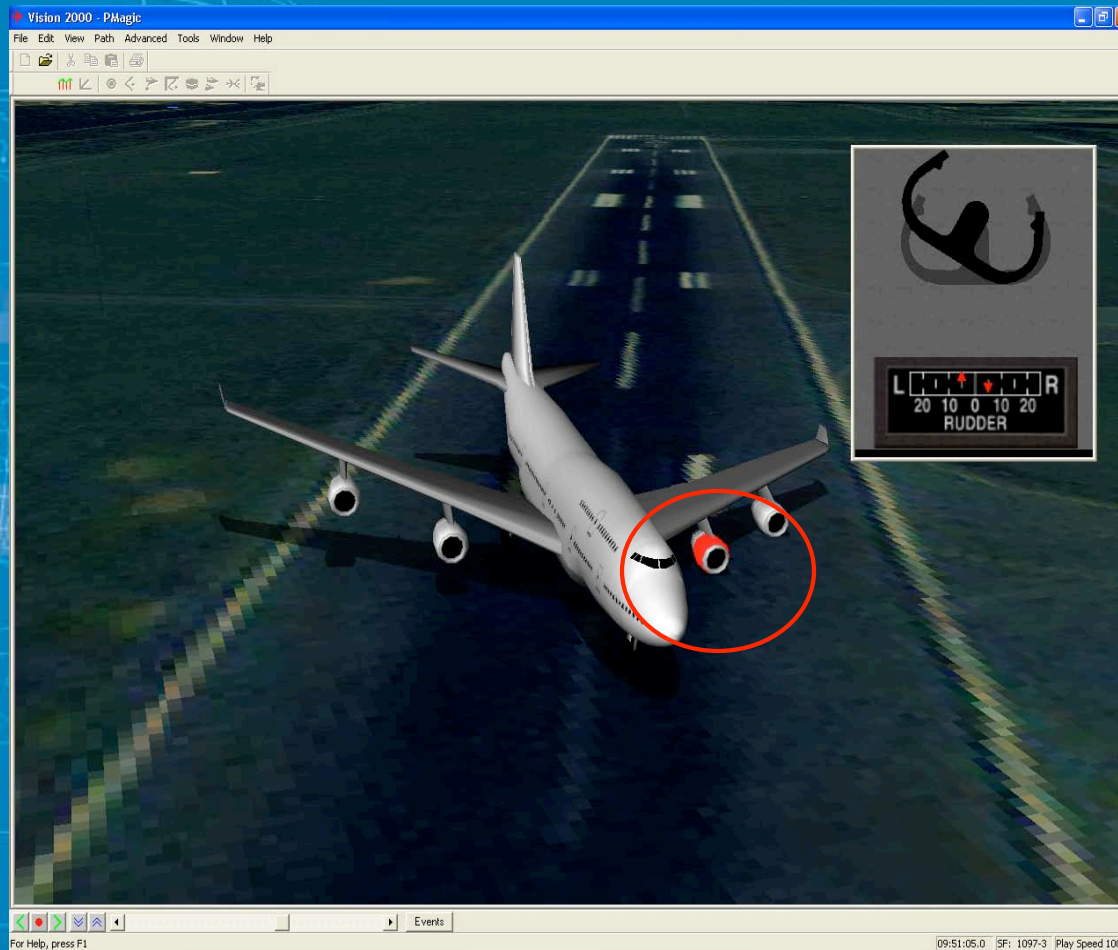
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2-D Correct ILS - VOR-DME in Profile



Aircraft - Ground Simulation Interaction Module

➤ “Intelligent” Surfaces can change color



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Turnkey FDM Services

Teledyne's FDM Service Provides

- Airborne hardware
- Connectivity (air time & Internet connection)
 - Priced per Flight Hour Data processing & reporting
- Report distribution
- Trend Analysis
- Rotables spares & repair
- Update radios, when necessary to maintain connectivity



Air Canada Web-Based FDM Model

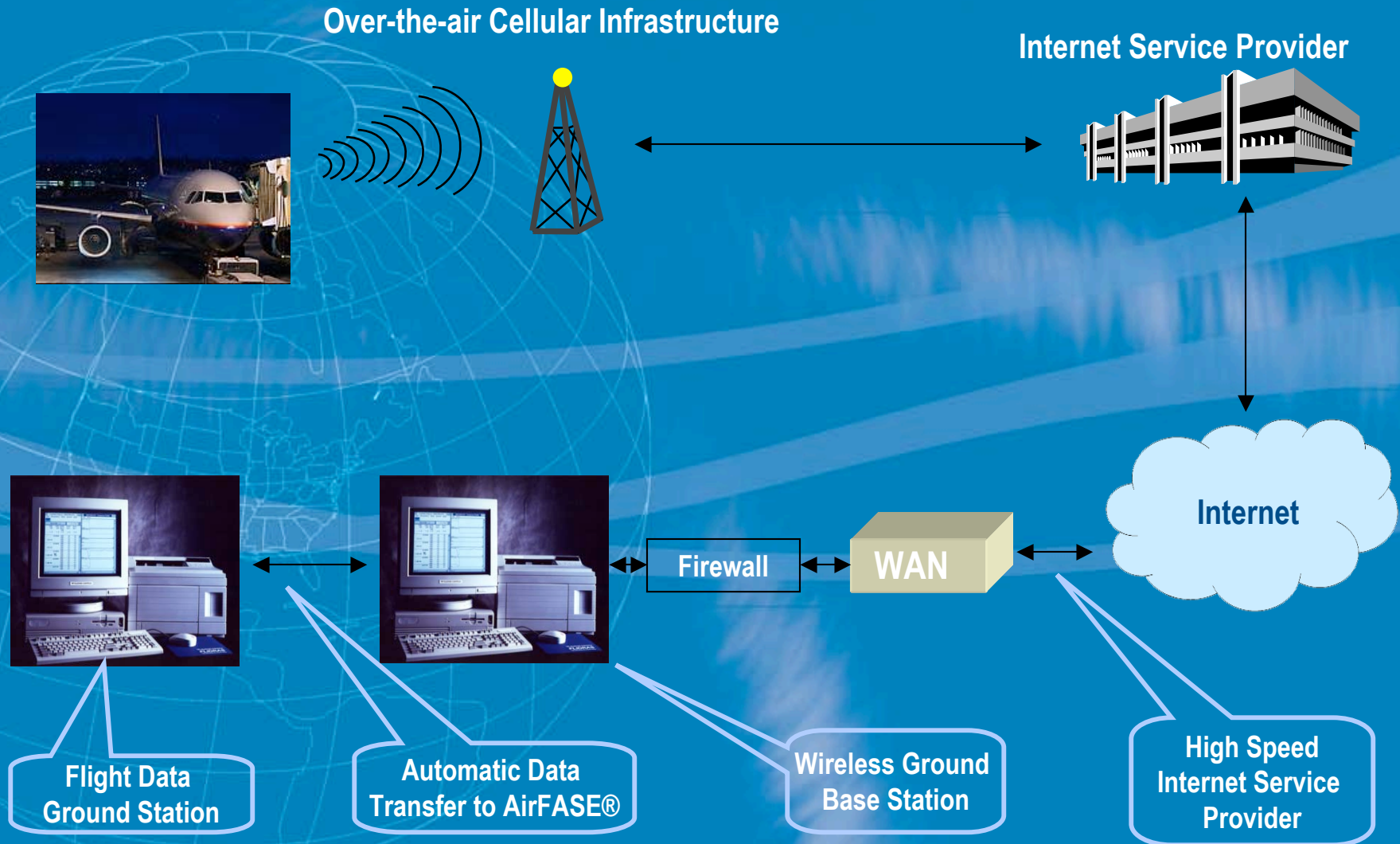
“Air Canada/Teledyne Team effort to provide best in class service to ensure Flight Safety and promote excellence in Aviation.”

- The first time ANY national airline has outsourced its data monitoring function
- Teledyne staffing to support data reading, analysis and daily, weekly, monthly flight operations report output logistics
- Remote data reading and transmission strategies
- Model program for 120 Airbus aircraft
- Ability for users to web-access data
- Advanced and tailored report outputs



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Flight Data Monitoring Efficiency



FDM Tools are Ready for General Aviation

Questions?



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