Aerospace Technology Enterprise
Goals & Objectives

Revolutionize Aviation

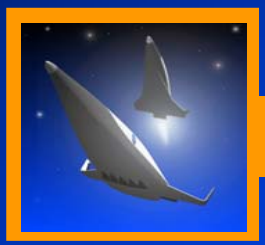
Increase Safety

Reduce Emissions

Reduce Noise

Increase Capacity

Increase Mobility



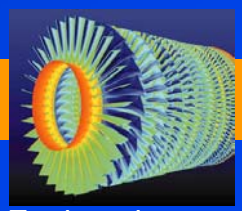
Advance Space Transportation

Mission Safety

Mission Affordability

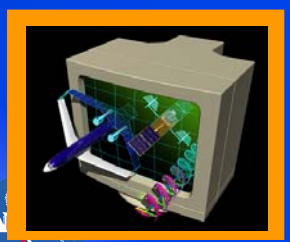
Mission Reach

Pioneer Technology Innovation



Engineering Innovation

Technology Innovation



Commercialize Technology

Goal 1: Revolutionize Aviation

Enable a safe environmentally-friendly expansion of aviation. (Baseline: 1997)

- **Objective 1: Increase Safety "Make a safe air transportation system even safer."**

  Reduce the aviation fatal accident rate by a factor of 5 within 10 years, and by a factor of 10 within 25 years.

- **Objective 2: Reduce Emissions "Protect local air quality and our global climate."**

  Reduce NOX emissions of future aircraft by 70% within 10 years, and by 80% within 25 years (Baseline: 1996 ICAO Standards) and CO2 emissions by 25% and by 50% in the same timeframes (using 1997 subsonic aircraft technology as the baseline).

- **Objective 3: Reduce Noise "Reduce aircraft noise to benefit airport neighbors, the aviation industry, and travelers."**

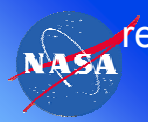
  Reduce the perceived noise levels of future aircraft by a factor of 2 (10 decibels) within 10 years and by a factor of 4 (20 decibels) within 25 years, using 1997 subsonic aircraft technology as the baseline.

- **Objective 4: Increase Capacity "Enable the movement of more air passengers with fewer delays."**

  Double the capacity of the aviation system within 10 years and triple it within 25 years, based on 1997 levels.

- **Objective 5: Increase Mobility "Enable people to travel faster and farther, anywhere, anytime."**

  Reduce inter-city door-to-door transportation time by half in 10 years and by two-thirds in 25 years, and reduce long-haul transcontinental travel time by half within 25 years.



Aviation Systems Capacity Program

Short-Haul Civil Tilt-Rotor (SHCT)

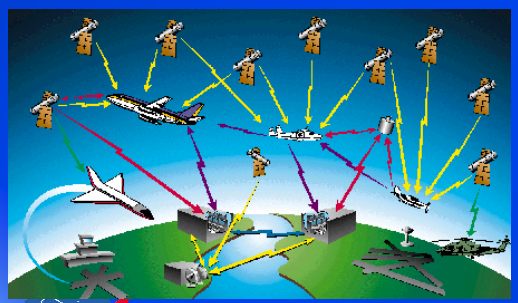
Develop the most critical technologies to enable a civil tilt-rotor:

- reducing perceived noise 12 dB
- enabling safe terminal area operations
- enabling OEI operation

Terminal Area Productivity (TAP)

Safely achieve clear-weather airport capacity in instrument-weather conditions:

- increasing single runway throughput 12 to 15%
- reducing lateral spacing below 3400 feet on parallel runways

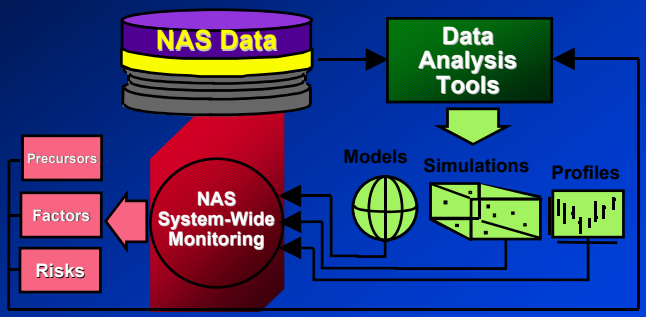


Advanced Air Transportation Technologies (AATT)

In alliance with the FAA, enable next generation of increases in capacity, flexibility and efficiency, while maintaining safety, of aircraft operations within the US and global airspace system:

- increasing terminal throughput 40%
- increasing enroute throughput 20%

Aviation Safety Program



Aviation System Monitoring & Modeling

Monitors and assesses data from every flight for known & unknown issues

Synthetic Vision

Provides commercial & general aviation pilots with clear-day operations all of the time

Weather Accident Prevention

Brings intelligent weather decision-making to every cockpit

System-Wide Accident Prevention

Improves human/machine integration in design, operations, & maintenance

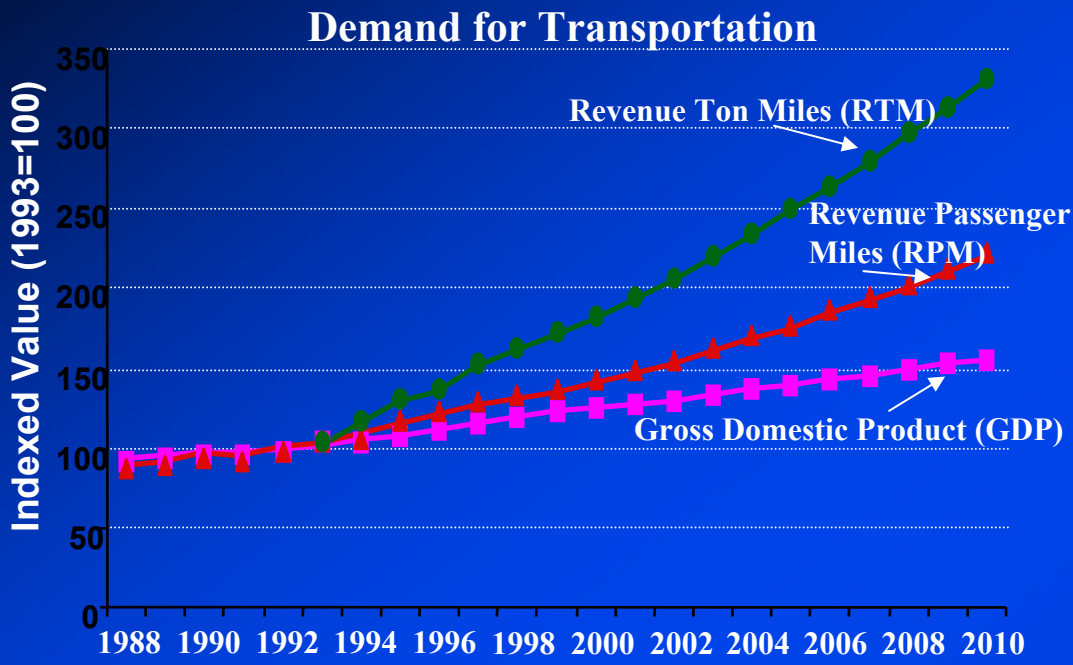
Single Aircraft Accident Prevention

Develops health management & robust control technologies to enable aircraft that are "self healing" & "refuse to crash"

Accident Mitigation

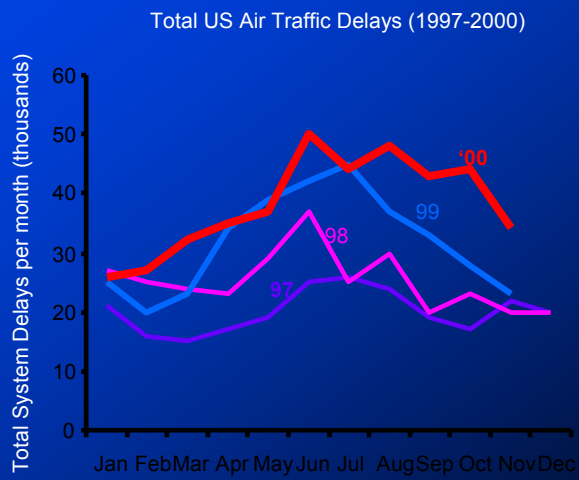
Increases survivability when accidents occur

The Aviation System Problem…



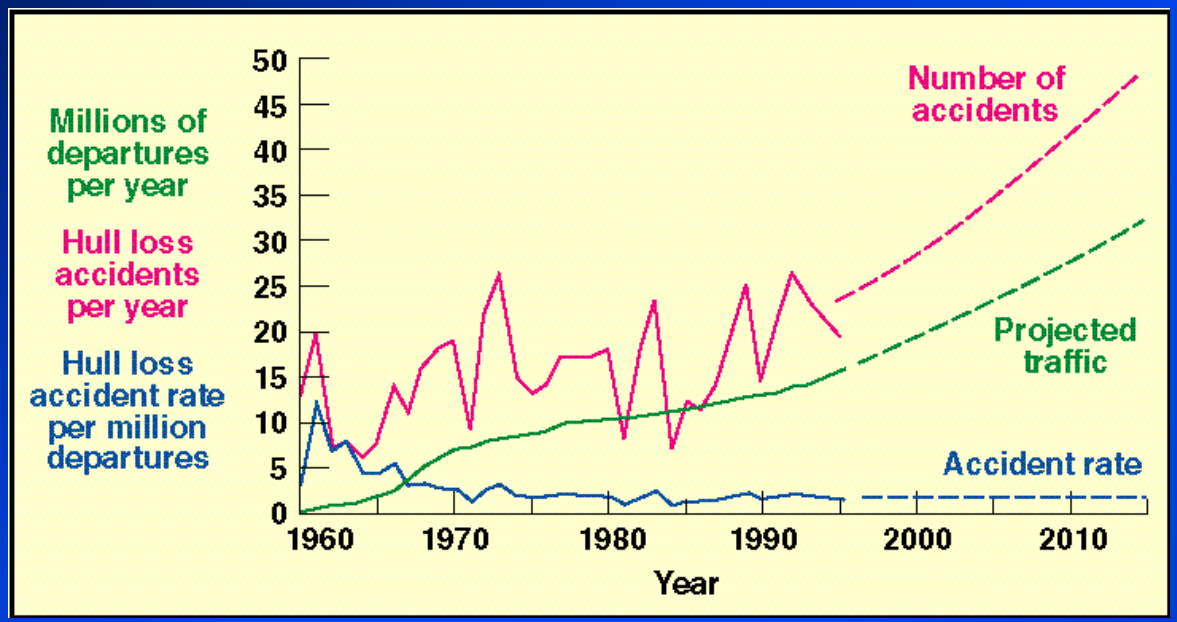
Demand is growing…

Delays are climbing…



The Aviation Capacity and Safety Challenge

Air Traffic to Triple in Next 20 Years



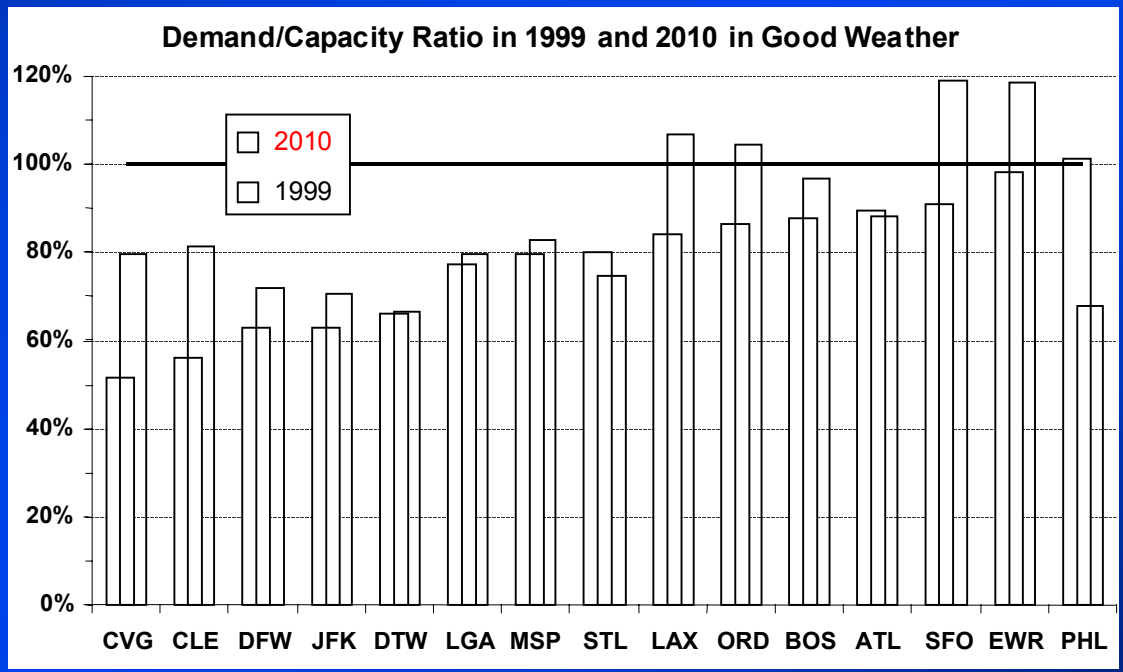
NASA Technology Goals

- While maintaining safety, triple the aviation system throughput, in all weather conditions, within 10 years
- Reduce the aircraft accident rate by a factor of five within 10 years, and by a factor of ten within 25 years

The current air traffic management system is near its capacity limits with extensive system delays and inefficiencies resulting in annual losses to users estimated at over $3.5B.

Major hub airports are running out of capacity

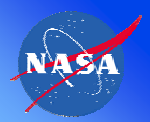
Delays begin to grow when demand / capacity ration exceeds 60%...



Source: MITRE

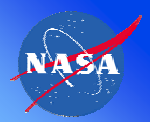
National Airspace System

- **Handles:** **63,000,000 Tower Assisted Operations**
- **Carries:** **544,000,000 Passengers**
- **Over:** **537,000,000,000 Revenue Passenger Miles**
- **Using:**
  - 18,700 Air Carrier A/C
  - 170,000 General Aviation A/C
- **Supported by:**
  - 639,000 Pilots
  - 651,000 Non-pilots
- **Burning:** **18,000,000,000 Gallons of Fuel**
- **Generating:** **$87,000,000,000 Revenues**
- **Producing:** **$5,300,000,000 Profit**
- **In Spite of:** **$3,500,000,000 in Delays**

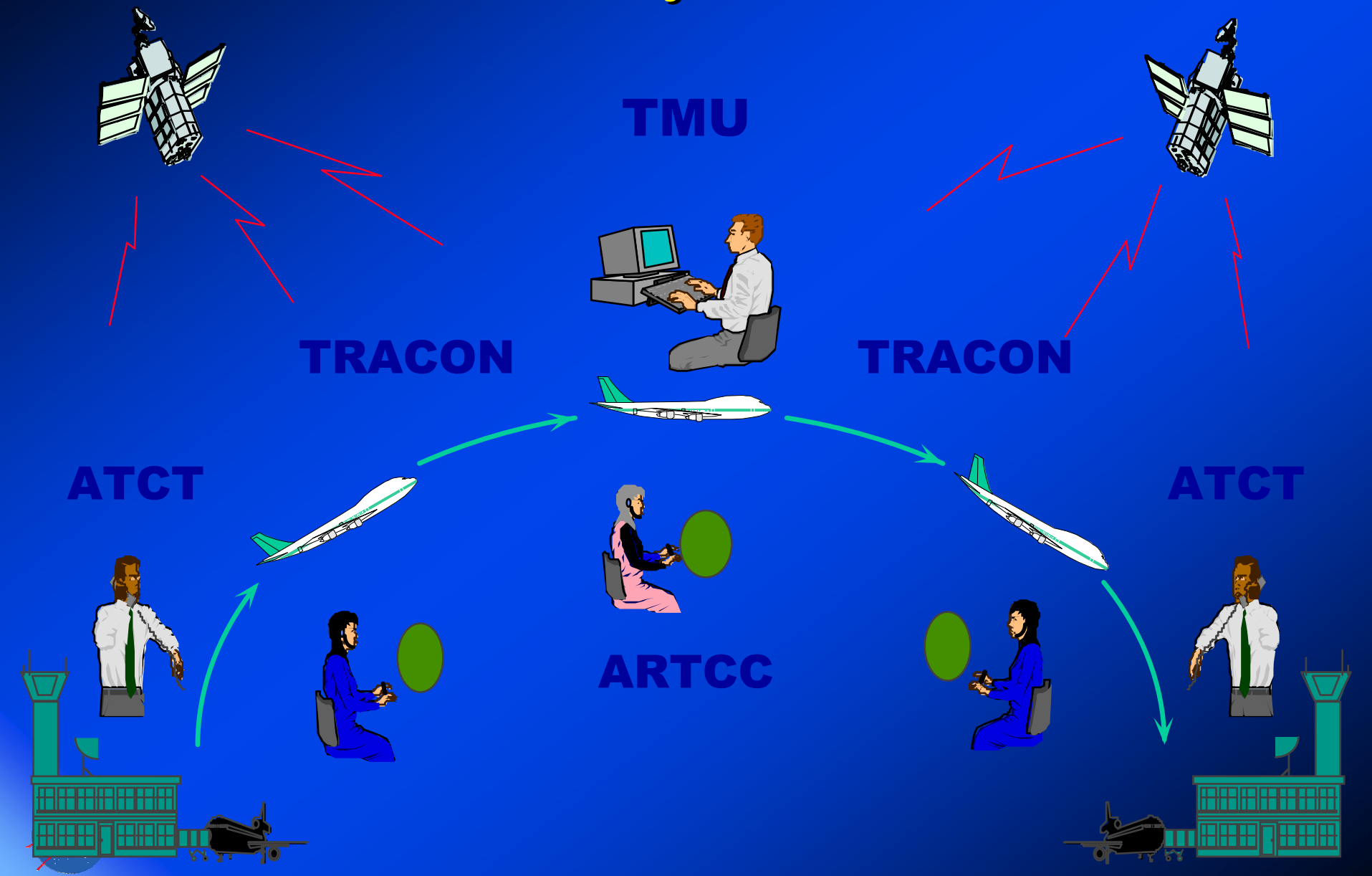


FAA Statistics

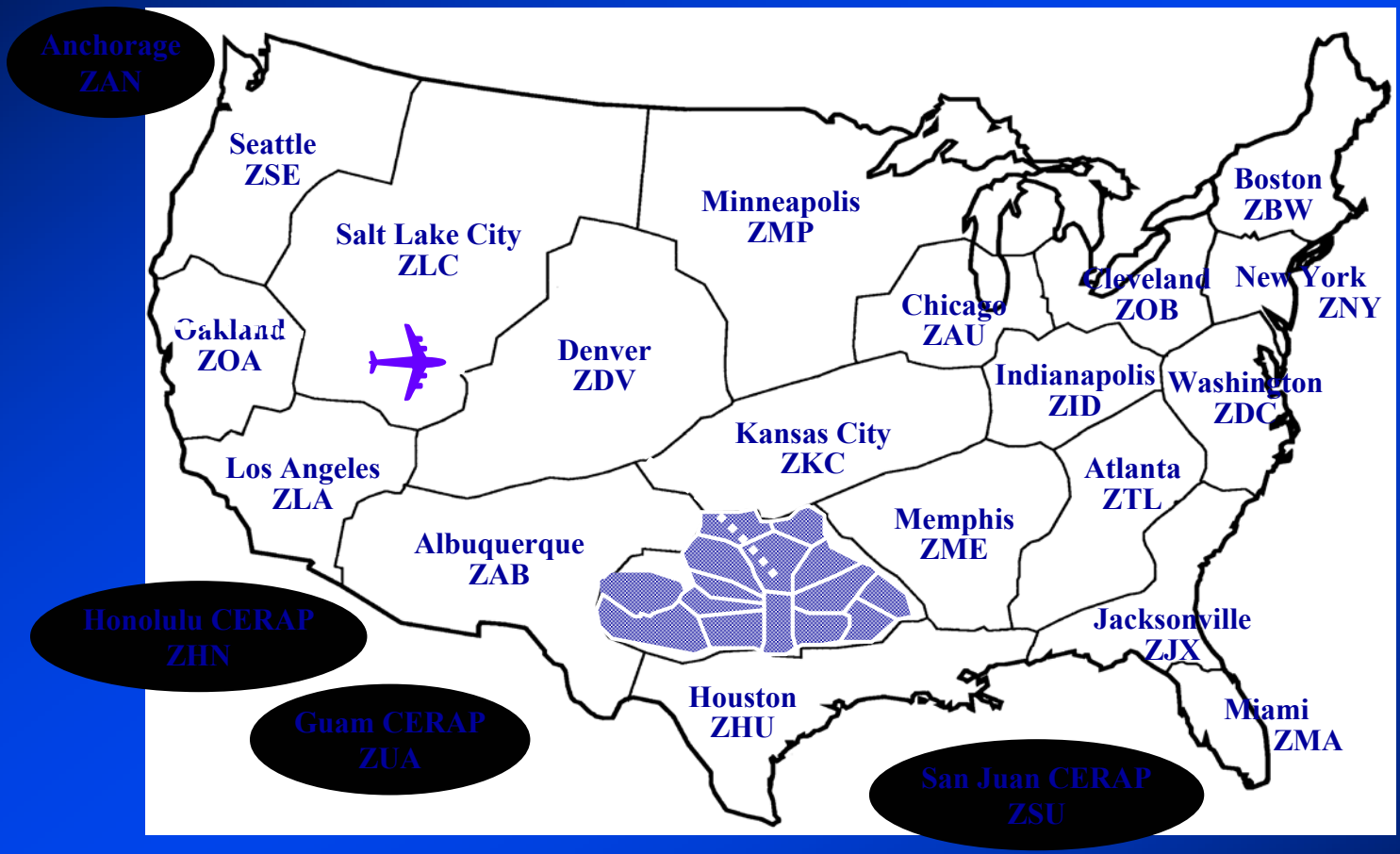
- Employs: 48,000 People
- Including: 17,000 Air Traffic Controllers
- Operating:
  - 21 Centers
  - 194 TRACONs
  - 476 Towers
  - 1 Command Center
- Costing: $9,200,000,000 Annual Outlay



Air Traffic Control System

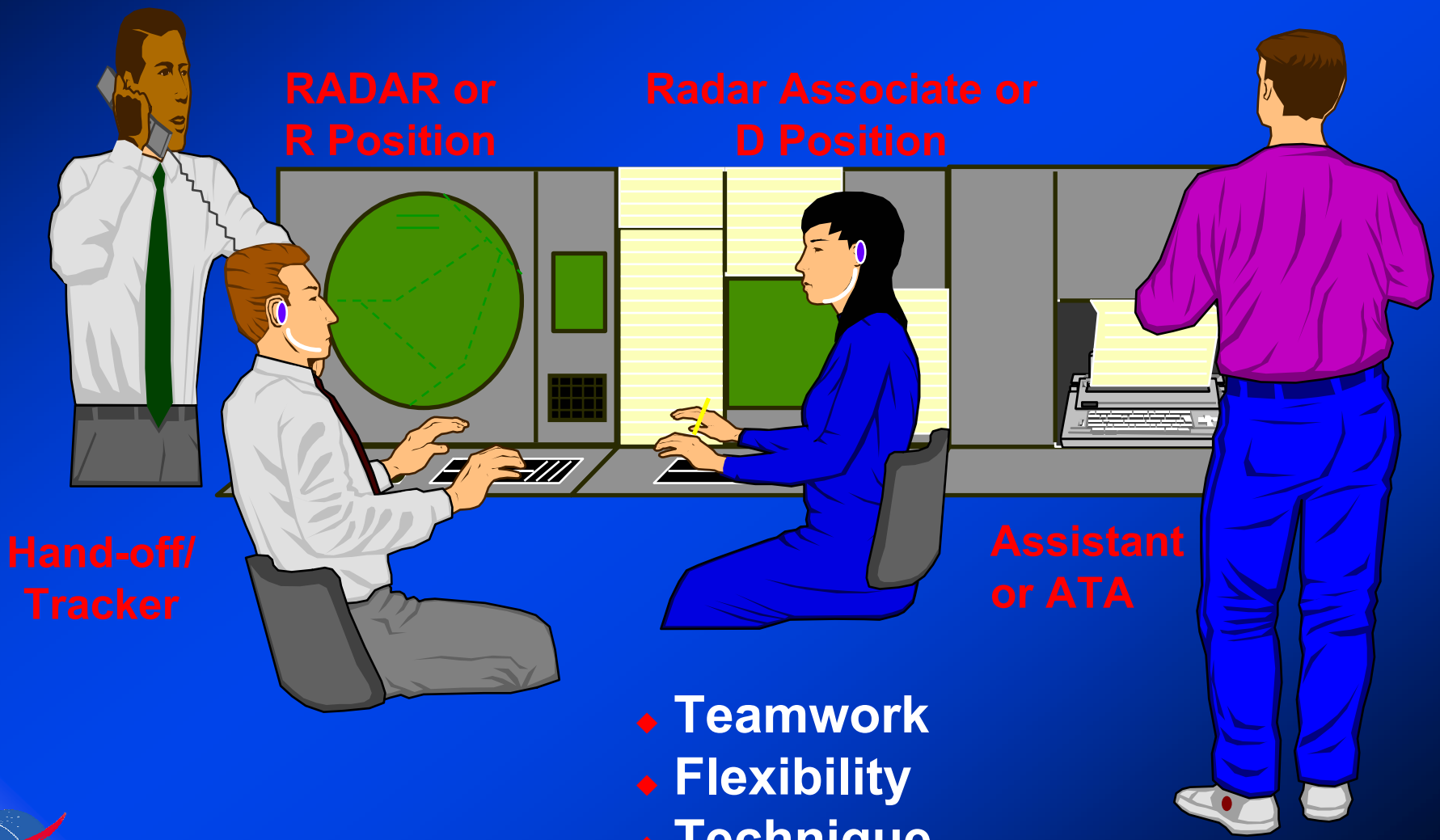


Air Traffic Control Centers

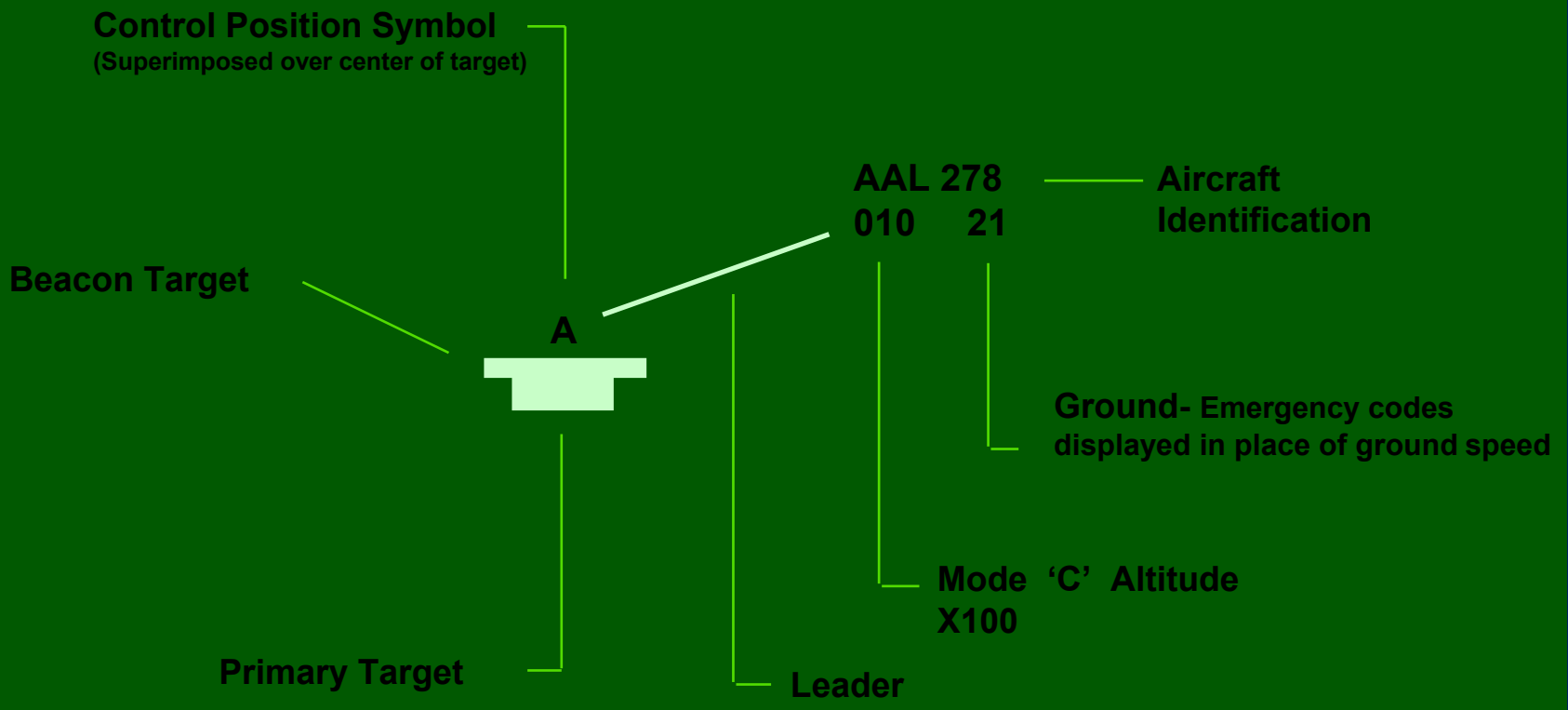


A typical flight across the US crosses 7 ATC Centers and communicates with over 25 air traffic controllers

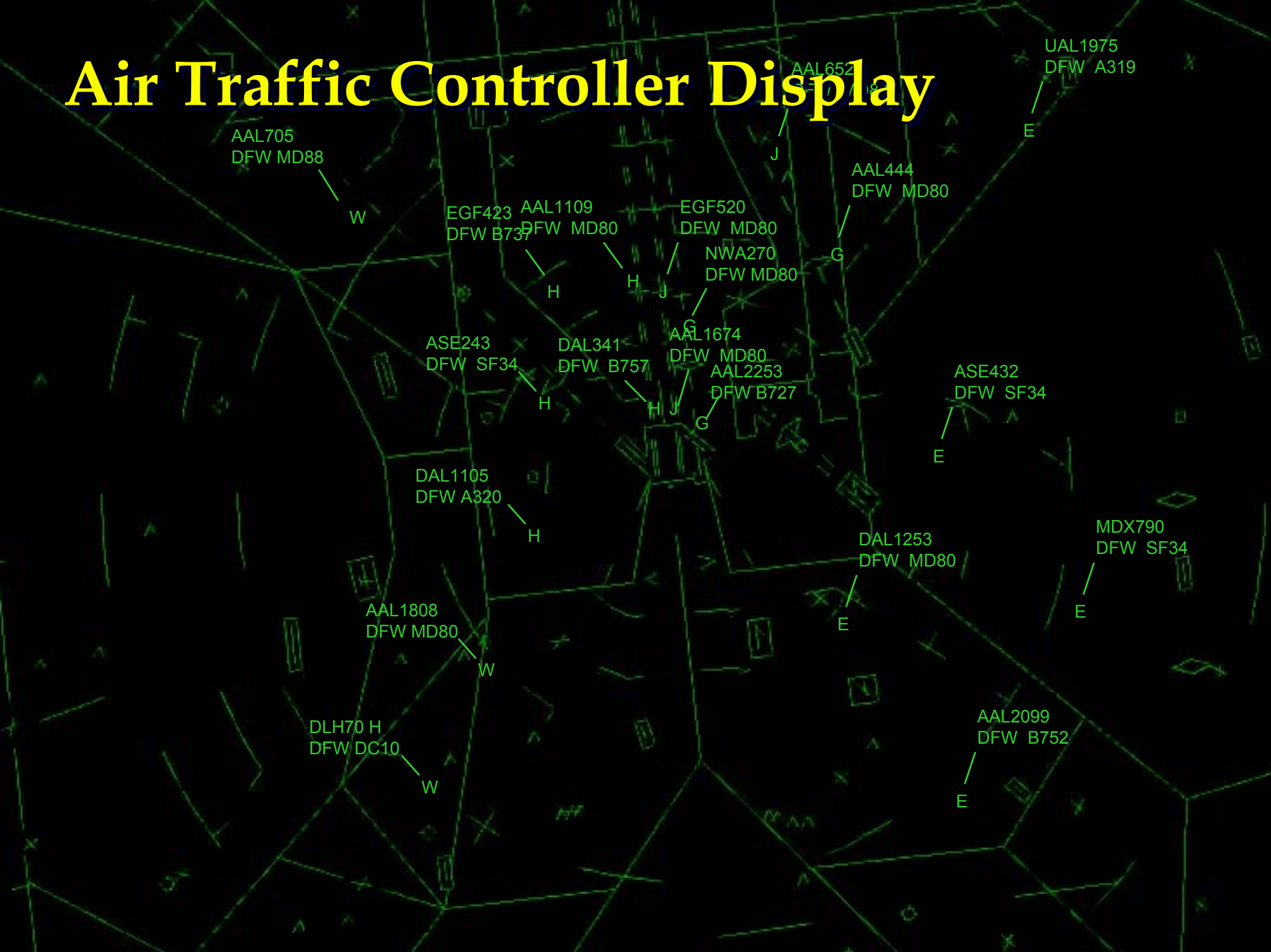
ARTCC ATC Positions



- Teamwork
- Flexibility
- Technique

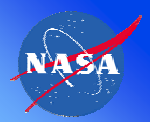


ARTS Full Data Block

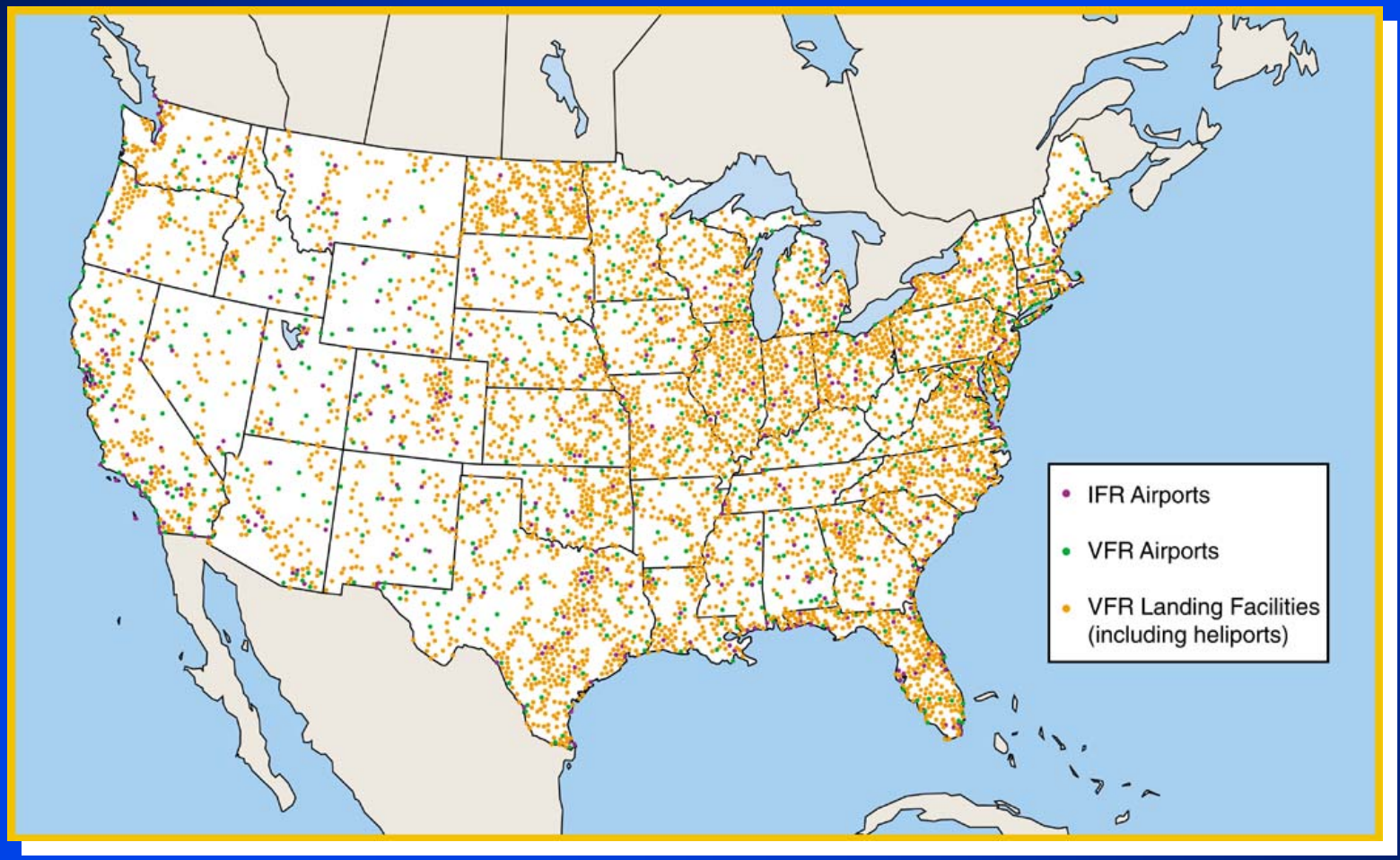

Air Traffic Controller Display
UAL1975
DFW A319
E
AAL652
J
AAL705
DFW MD88
W
AAL444
DFW MD80
G
EGF423
DFW B737
AAL1109
DFW MD80
EGF520
DFW MD80
NWA270
DFW MD80
H
H
J
G
ASE243
DFW SF34
H
DAL341
DFW B757
H
AAL1674
DFW MD80
J
AAL2253
DFW B727
G
ASE432
DFW SF34
E
DAL1105
DFW A320
H
DAL1253
DFW MD80
E
MDX790
DFW SF34
E
AAL1808
DFW MD80
W
DLH70 H
DFW DC10
W
AAL2099
DFW B752
E

Airline operations

- The three rules of airline operations
  - Airlines operate a schedule
  - Air transportation is a commodity
  - Delay is nonlinear
- Hub and spoke business model
- Arrival/departure complexes
- Regional jets' impact on operations



Current System in Limited by Legacy, Ground-Based ATC Infrastructure and Hub & Spoke Architecture



5400 Public Use Airports

715 Airports with Precision Instrument Approaches (ILS)

Top 64 Hub Airports Enplane 80% of all Passengers

The Root Cause of Delays

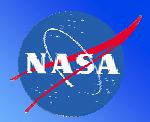
- Airport capacity
  - Runway occupancy time
  - Separation minima (lateral & in-trail)
  - Surface movement capacity: taxiways, ramps
  - Ground processing capacity (gates, e.g.)
- Terminal area airspace capacity
  - Separation minima
  - Route structure (STARS, SIDS)
- En route airspace capacity
  - Separation minima
  - Route structure (Jet & Victor routes)
  - Sector capacity
- System management capacity
  - Workforce availability
  - Computer processing capacity
  - System adaptability

Overscheduling during prime periods
Inadequate surveillance for approach and surface movement
Wake vortex uncertainty
Controller workload
Frequency congestion
Traffic forecasting
Intent and conformance uncertainty

Controller workload
Situation awareness - weather, traffic, etc.
Community noise procedures

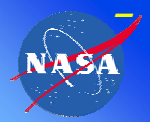
Controller workload
Weather disruptions
Frequency congestion
Information availability
Traffic forecasts
Situation awareness - regional traffic, weather, etc.

Severe weather forecasting
Airline preferences



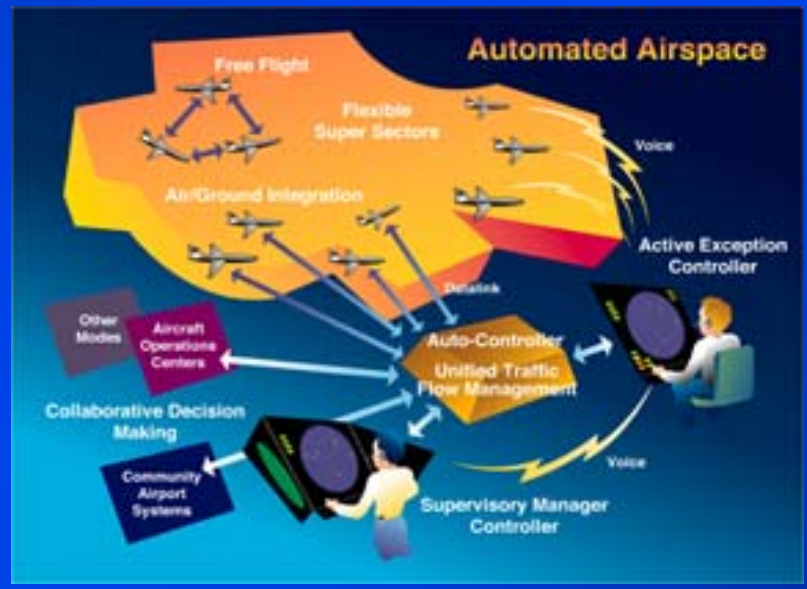
Why This is a Hard Problem to Solve

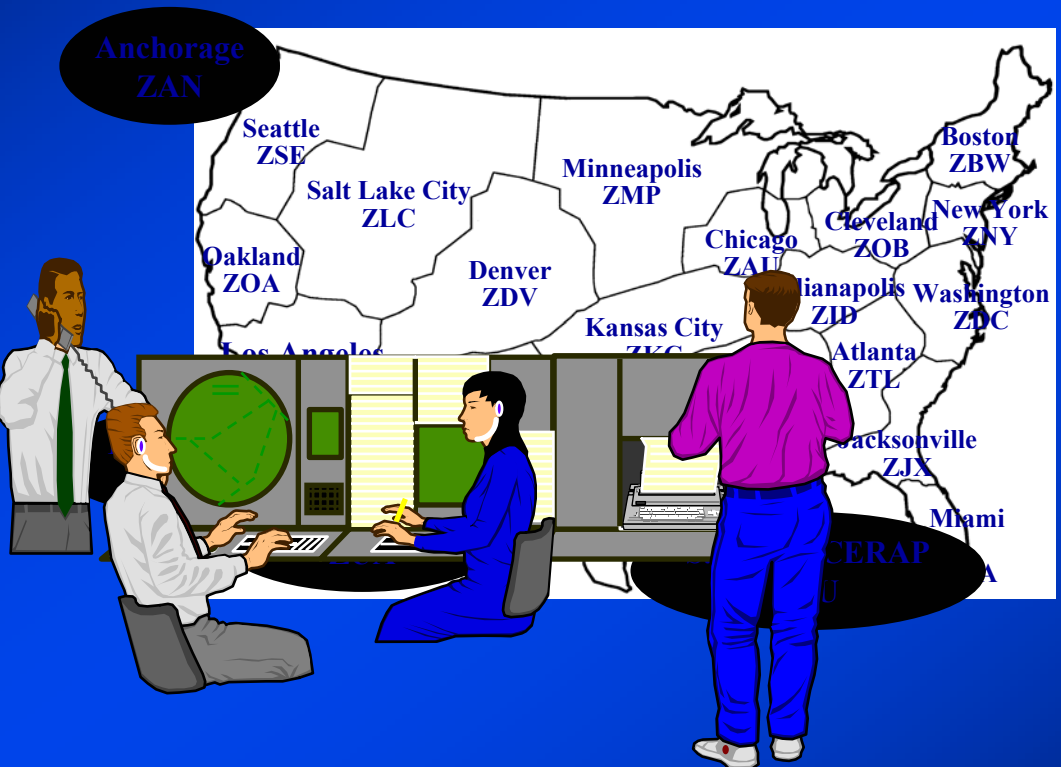
- System integrity is absolutely essential
  - Safety must be maintained
  - Performance must not degrade
  - Risk must reduce
- The system is dynamic and real-time
  - Can't turn it off or take it down for testing, maintenance, upgrades
  - System is highly interconnected - hard to predict all ramifications
- This is one of the largest and most complex systems in the world
  - Limited fidelity of simulation facilities
  - Difficulty in performing field tests
  - Certification standards are stringent
  - Solutions involve not only technology, but also procedural changes, extensive training, and human controller impact
- Non-technical factors come into play
  - Large number of stakeholders
  - Large budget requirements
  - Overcoming poor track record



ATC - Now and in the Future

Tomorrow… strategic management of the airspace with aircraft self-separation and air - ground collaborative decision making - *an integrated, scalable approach*





Today… highly compartmentalized radar surveillance and control of aircraft separation - *a hierarchical, self-limiting approach*

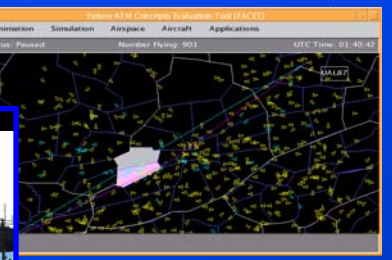
Continuing ATC Modernization

Improved traffic flow management

Remove restrictions across facility/sector boundaries

Reduce separation in the terminal area

Eliminate surface congestion



National Traffic Flow Management Decision Support Tools

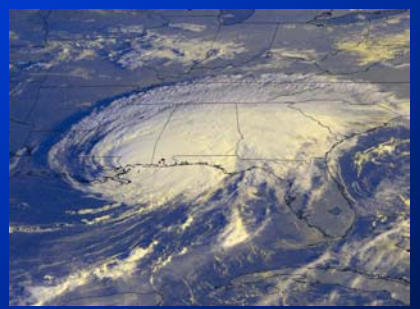
Integrated Airspace Decision Support Tools

Arrival/Departure Decision Support Tools

Runway Productivity Technologies

Surface Congestion Alleviation Decision Support Tools

Aircraft Technology & Operations

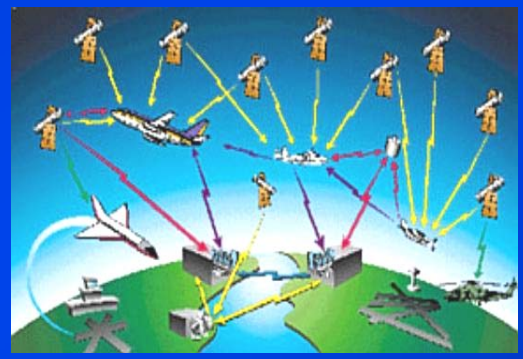


ATM/TFM Weather Integration

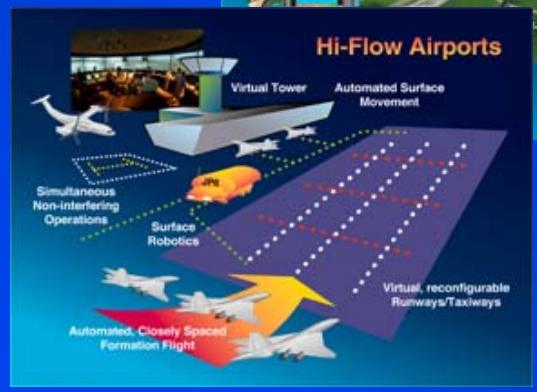
A Revolutionary Approach to Air Traffic Management

Advanced, Global Communication, Navigation & Surveillance

Robust, global systems
Precision approach to every runway in the U.S.
System-wide information sharing

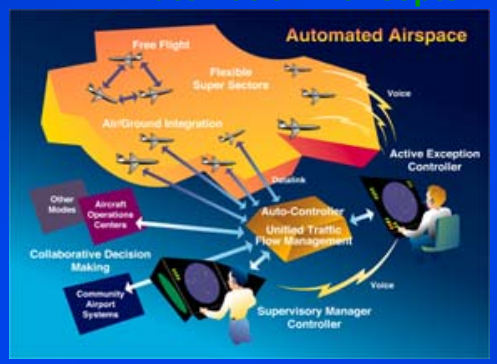


Distributed & High Capacity Infrastructure



Closely spaced aircraft takeoff and landing
Reconfigurable runway/taxiway
Automated zero visibility surface movement
Small airports integrated into the NAS

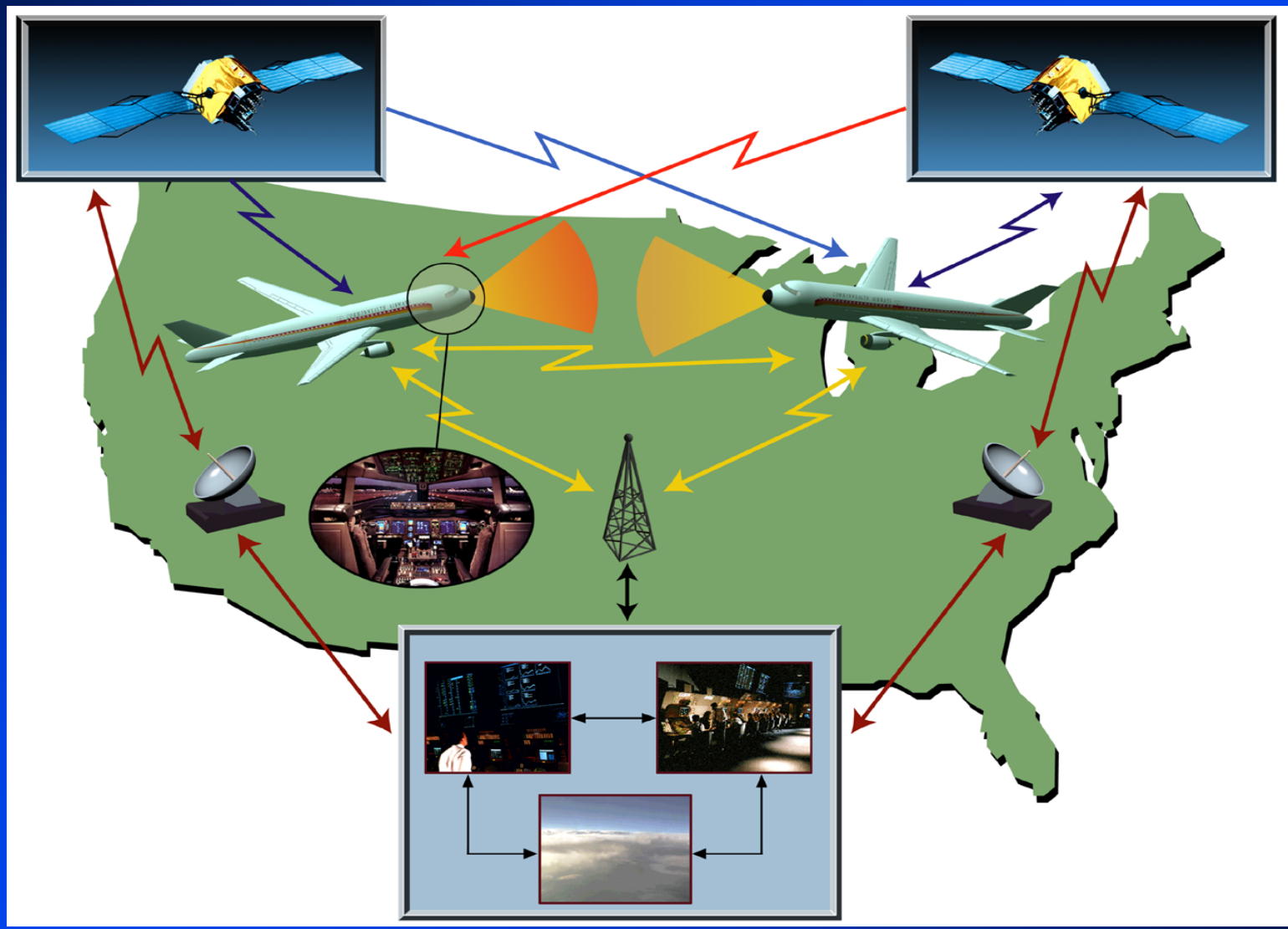
ATM Automation Concepts



Integrated, strategic management of the airspace
Aircraft self-separation
Collaborative decision making

Next-Generation NAS Communications

Weather Information Communication

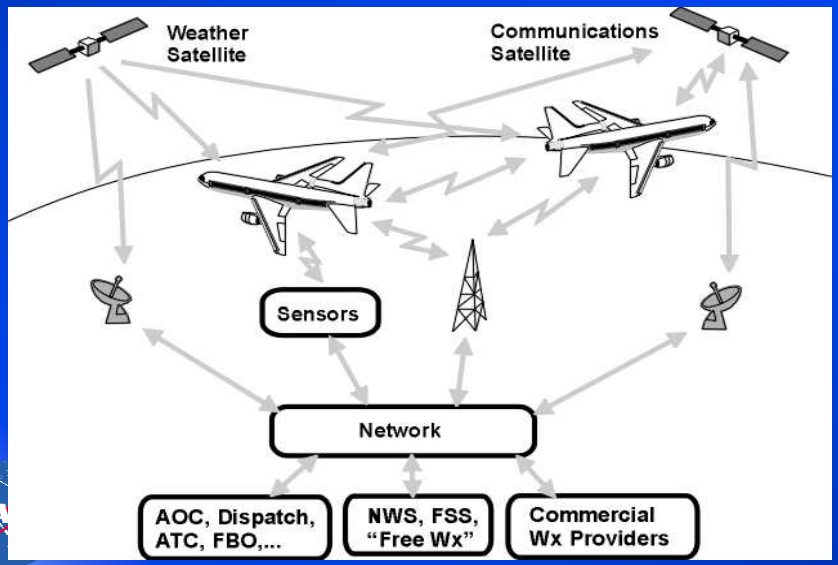


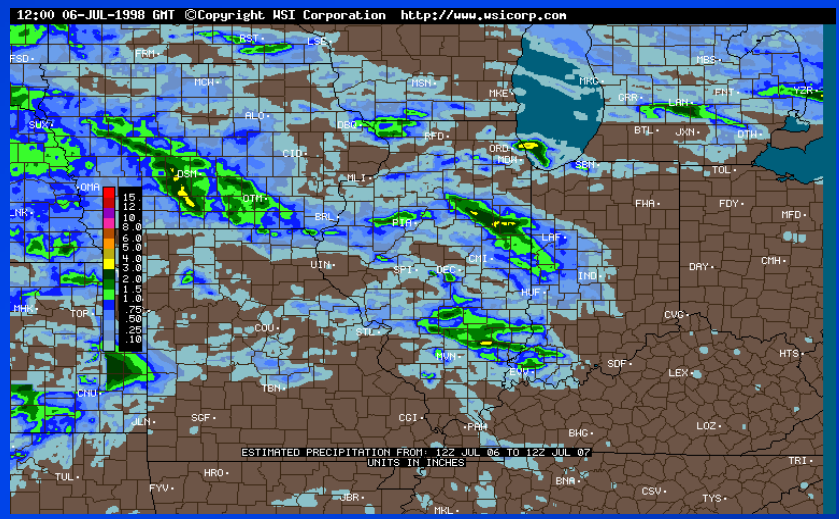
AeroComm Projects

AVIATION SAFETY PROGRAM

WINCOMM - Weather Information Communications

Objective: Develop advanced communications and information technologies to enable high quality, timely dissemination of aviation weather information to all global aviation users.





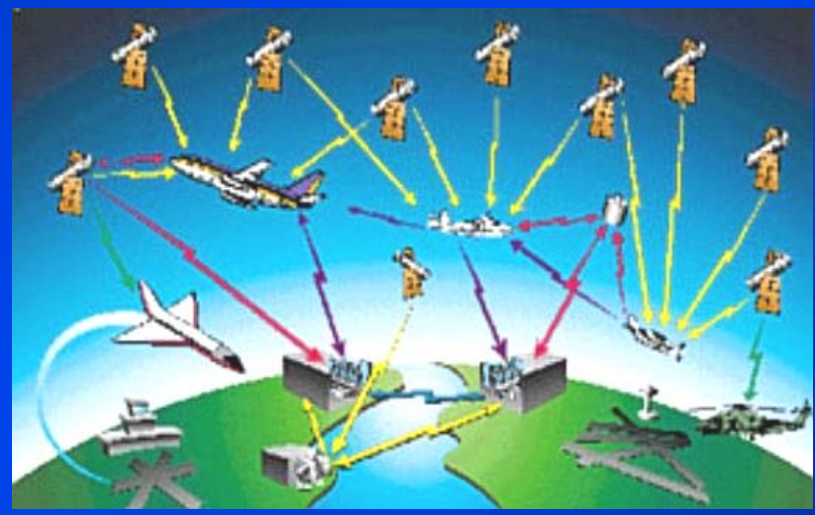
Project Goals:

- **High quality/graphical, timely weather information to all users**
- **Provide greater access/connectivity across all users/platforms on the information network.**
- **Promote an integrated global information network enabling collaborative decision-making further enhancing aviation safety.**

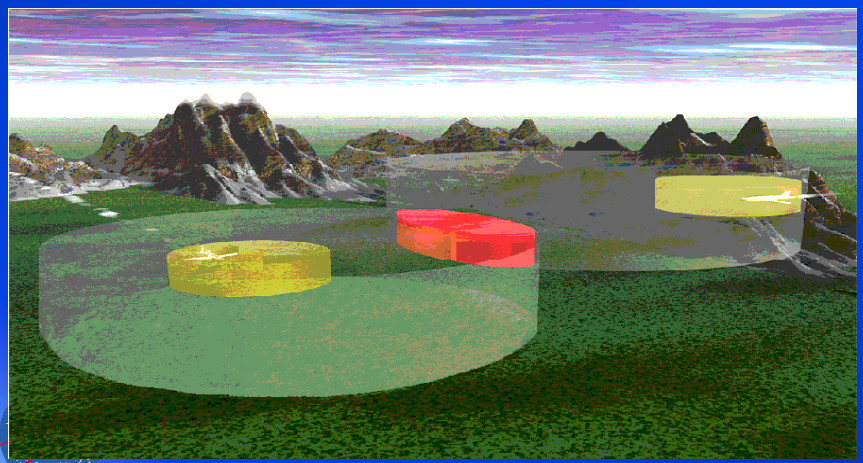
AeroComm Projects

AVIATION CAPACITY PROGRAM

Advanced Communications for Air Traffic Management - AC/ATM



Objective: Develop and adapt advanced communications technologies to enable advanced air traffic management methods and provide global connectivity to all aircraft via satellite communications.



Project Goals:

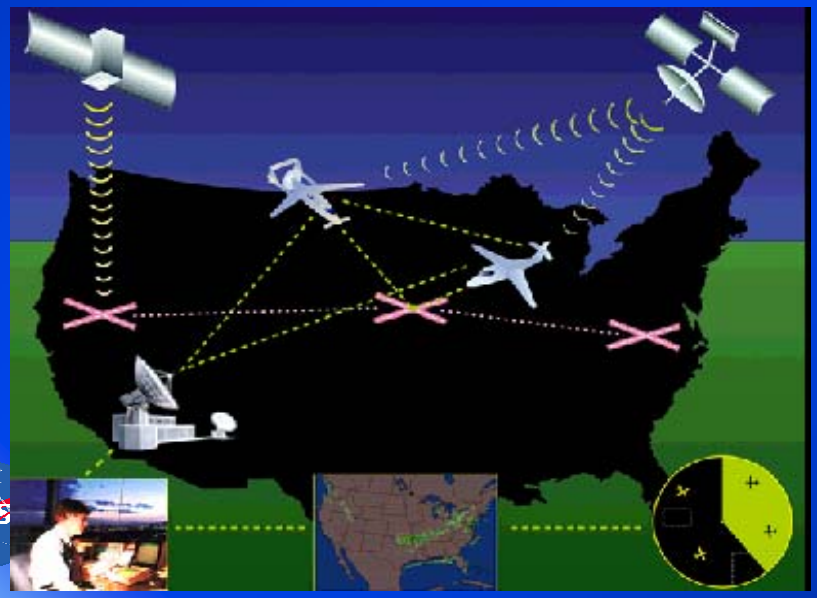
- **Determine communications systems requirements for the emerging AATT ATM concept(s).**
- **Identify communication system and network approaches to meeting future requirements.**
- **Support the demonstration of AATT ATM concepts and hardware.**
- **Develop select high-risk, high payoff advanced communications technologies.**

AeroComm Projects

SMALL AIR TRANSPORTATION SYSTEM (SATS)

Airborne Internet

SATS integrates emerging vehicle and infrastructure technologies to enable access to the vastly under-utilized infrastructure of smaller non-hub airports and airspace to reduce regional transportation time.

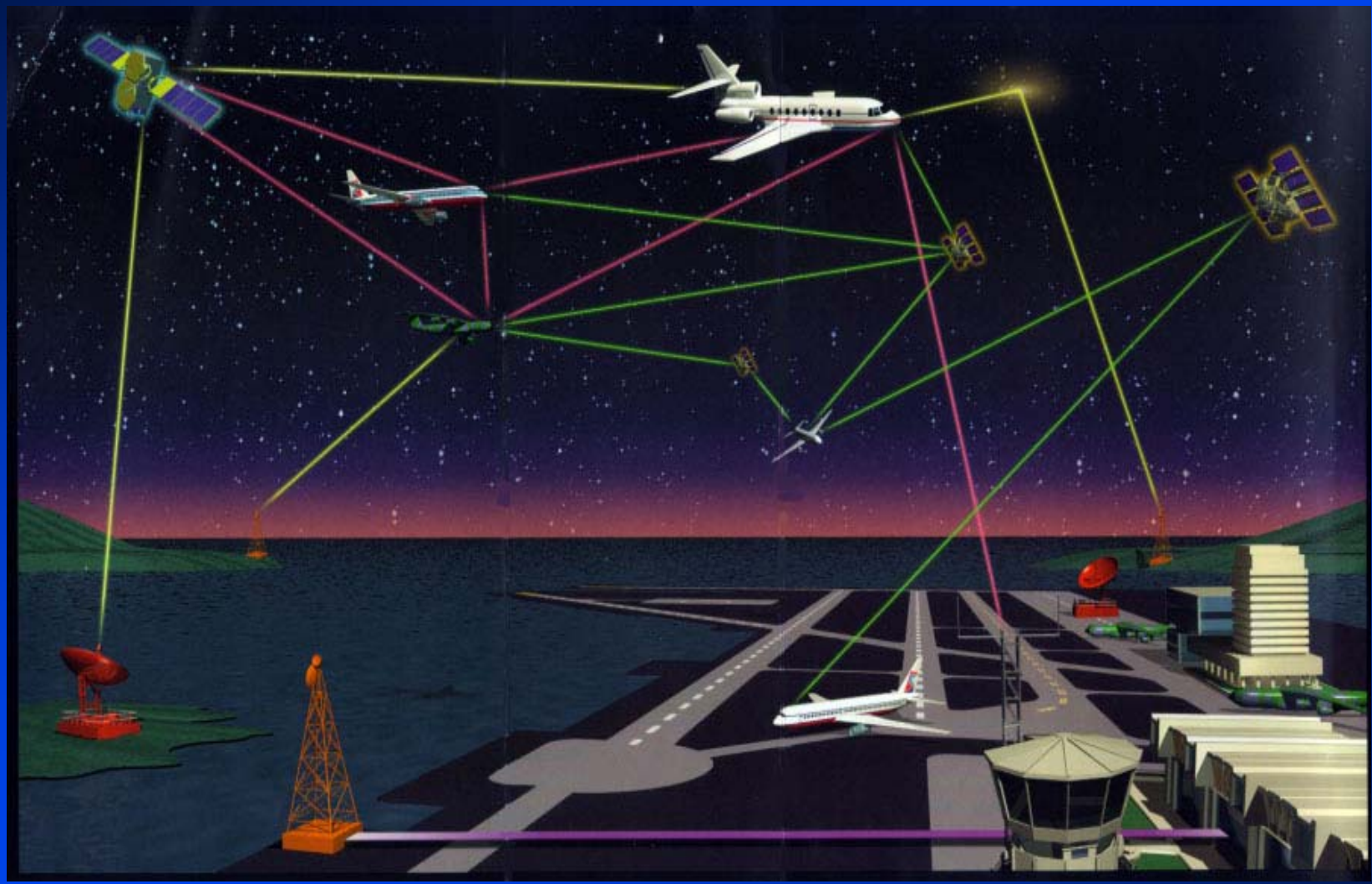


Project Goals:

2022 AI Fundamental Characteristics

- **Client server analogy**
- **Aviation Information System**
- **Integrated CNS**
- **Worldwide compatibility**
- **Seamless connectivity**
- **High user and system capacity**

Support the 2005 SATS Demo



Courtesy of Rockwell Collins