The NAS Concept & ADS-B Considerations

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Projections for Future

INCREASING DEMANDS

- **FY00 Scheduled US Passenger Traffic (E): 693.7M**
  - Projected FY12: 1,093.9M (57.7% increase)
- **FY00 U.S. Commercial Air Carrier Passenger Jets (E): 4,964**
  - Projected FY12: 8,503 (71.3% increase)
- **FY00 Aircraft Operations: 68.7M**
  - Projected FY12: 91.5M (33.2% increase)

ASSUMPTIONS

- **Rate of aircraft equipage will increase to take advantage of additional capabilities**
- **Number of sectors (currently ~753 en route) will increase until decision support system (DSS) applications become available to offset increasing traffic**
- **Each DSS benefit stream may be preceded by as much as 10+ years of development & deployment**
- **Benefits ramp up slowly after deployment until critical equipage/use thresholds are reached for each application**

Tomorrow's Operational Environment

- **The joint FAA/Industry Concept of Operations envisions, by 2015, a real-time collaborative environment including the following characteristics:**
  - A digital, NAS-wide information system
  - Improved information availability and flow - automatically routed & updated:
    - « Graphical weather
    - « Simultaneous transmission and display of hazardous weather alerts such as wind shear and microbursts based on real-time, automated reports
    - « Traffic density projections
    - « Graphical turbulence "maps", based on en route data exchange, available across the NAS - including the flight deck
    - « Traffic information to the aircraft. Users of Automatic Dependent Surveillance Broadcast (ADS-B) and Cockpit Display of Traffic Information (CDTI) see both ADS-B and non-ADS-B equipped aircraft to support onboard tactical and strategic decisions.
    - « Satellite-based navigation and surveillance data is used by ground-system automation to enhance conflict prediction and alerting capabilities. Separation procedures consistent with technology enhancements are used. These separation procedures supported by the DSSs allow more aircraft to operate according to their preferred profile, even while traffic demand increases.

Tomorrow's Operational Environment (cont')

- **Operational environment, by 2015, exhibits the following characteristics:**
  - Ground/Flight Deck Collaboration:
    - « 4D contracts for point in space routing - electronic transfer of all clearances to support management by trajectory, conformance monitoring
    - « Users make economic decisions based on individual business model within the constraints of the NAS information available
    - « For low visibility and zero visibility operations, participating aircraft are equipped with a VMC-like capability to maneuver on the surface. This capability, coupled with enhanced surveillance of all vehicles in the movement areas, allows the service provider to safely monitor adherence to clearances and the pilot to maintain separation.
    - « Free maneuvering supported by airborne conflict management capabilities is routinely available in low density airspace. In denser environments some flight deck self-separation authority is assigned by ATC when operationally advantageous. Separation assurance responsibility remains with the service provider
    - « Ocean - The pilot's view of nearby traffic supplements the service provider's picture. When operationally advantageous, pilots may obtain approval for special maneuvers with reduced spacing. The pilot's ability to support climbs, descents, and crossing and merging routes is supplemented by the service provider's conflict probe capability.

Tomorrow's Operational Environment (cont')

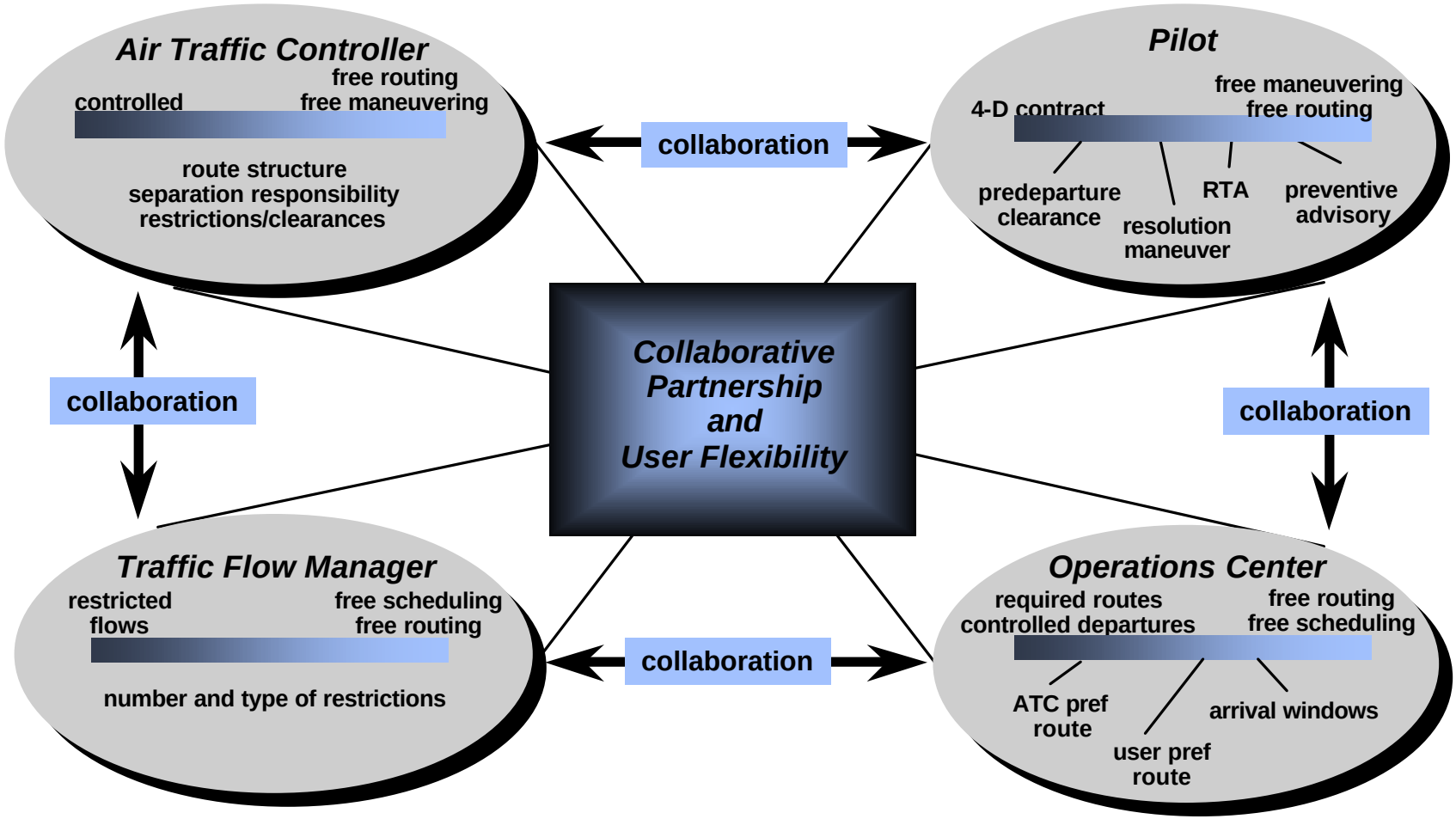
- **Operational environment, by 2015, exhibits the following characteristics:**
  - Ground/Operations Center Collaboration:
    - « NAS-wide, common reference system provides all NAS participants with common situational views
    - « System to system coordination provides the most efficient NAS response to anomalies based on the best business decision provided by each participant
  - System-wide problem prediction and equitable resource allocation
    - « Air-ground negotiation of individual re-routes in collaborative re-routing
  - Efficient aircraft movement thru en route airspace
    - « Transition point and time, delivered and updated - TMA and High Altitude Concept
    - « Situation awareness is enhanced by improved surveillance in all phases of flight. This is especially significant for reducing the need for procedural control in areas lacking current day surveillance
    - « Low altitude airspace structure remains largely unchanged, but widespread RNAV equipage and expanded surveillance coverage with new technology provide increased access to airports and airspace in poor weather conditions

Tomorrow's Operational Environment (cont')

- **Operational environment, by 2015, exhibits the following characteristics:**
  - Efficient departure integration into overflight streams
    - « Aircraft are equipped with satellite based navigation, digital communications, and the capability to automatically transmit position data. Aircraft intent and performance data are provided to DSSs, thus improving the accuracy of trajectory predictions.
    - « DSSs such as the conflict probe, resolution advisor, and automatic trial planning assist the service provider in developing safe and effective traffic solutions.
  - Collaborative Decision Making (CDM), incorporating the flight deck
    - « from strategic preparation during preflight to post-flight analysis
  - As the NAS-wide information pool is broadened by increased equipage, additional applications are identified and developed to take advantage of the data
    - « As the "pipes" for data transfer will have already been developed, the marginal costs for the additional capabilities are minimal
    - « As there are no certification issues, availability to ground based users (AOCs, Base Ops, private vendors, etc) will occur soon after agency deployment

- In summary, the entire NAS will become more strategic in planning, while simultaneously more flexible and responsive to anomalous events, as access to common, real-time information supports a common vision with complimentary decision making system-wide

Perspectives on Collaborative Environment




BACKUP SLIDES

Service Description - Through 2005

- Most communications continue via voice. Limited datalink
  - « Datalink use increases in the Oceanic areas
  - « Domestic datalink message set introduced
- Implementation of CNS/ATM capabilities through the completion of the FAA Free Flight Phase 2 program increases the number of locations with decision support systems (DSSs)
- initial transition to satellite navigation, and the introduction of automatic dependent surveillance
- Increased information sharing and collaboration
- Within terminal areas, use of Area Navigation (RNAV) routes increase across the NAS
- The operation of Unmanned Aerial Vehicles (UAVs) begin.
  - « These are unconventional airborne vehicles that are operated via data link by personnel situated in a ground facility
- The high altitude airspace permits aircraft operations along user preferred profiles from entry into cruise to final exit.
  - « Entry and exit to the airspace is based on preferred profiles for climb and descent. Within that airspace, aircraft operate closer to their optimum altitudes by increasing the available flight levels using 1,000 rather than 2,000-foot separation.

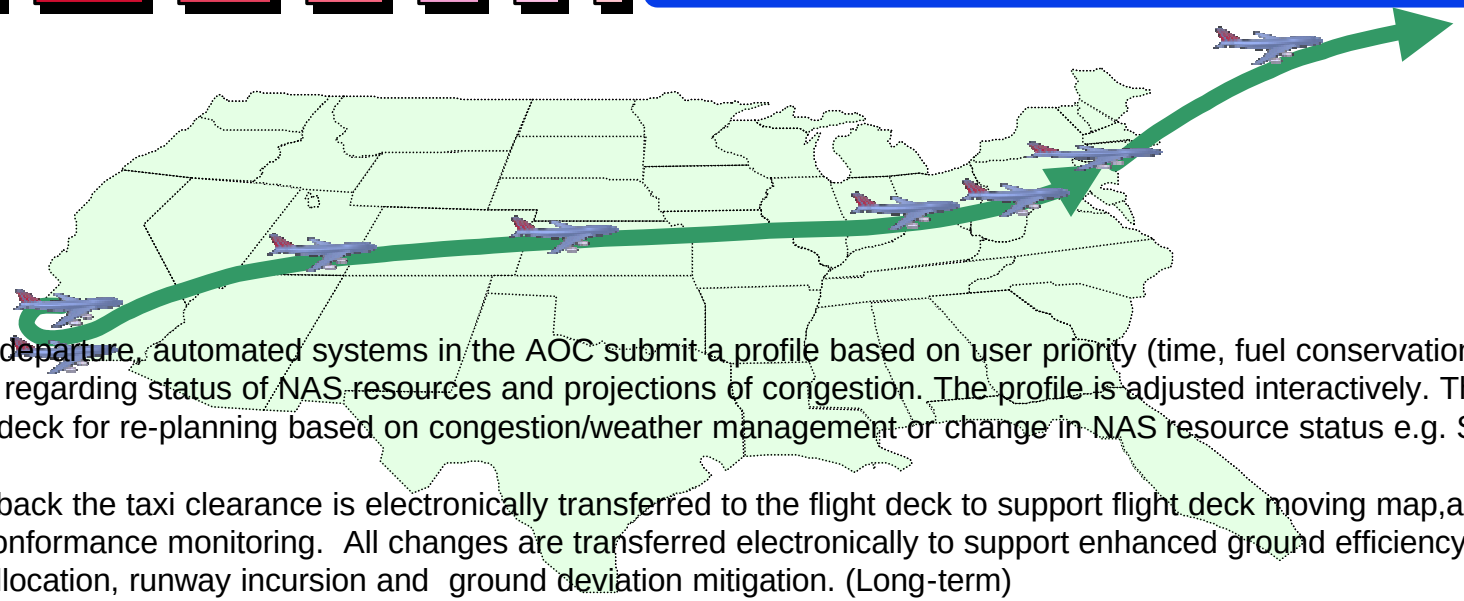
Service Description - 2005 through 2010

- Communications increasingly rely on datalink, however, data makes up an ever increasing proportion of the datalink “pipe”
  - « voice continues to be available throughout the NAS
- NAS-wide information system distributes timely and consistent information across the NAS, for both user and service provider planning, such as;
  - « Dynamic information - current and forecast weather, radar summaries, hazardous condition warnings, information on updated airport and airspace capacity constraints, and SUA schedules
  - « Static data - electronic navigation data, maps, charts, airport facility guides, and published Notices to Airmen (NOTAMs) are also available via the Internet as well as various intranets.
  - « Flight information - on each flight includes the filed flight profile and all amendments, first movement of the aircraft, wheels-up, position data in flight, touchdown time, gate or parking assignment, and engine shutdown.
- Increased efficiency is achieved through widespread implementation of ATM decision support, dynamic alteration of airspace boundaries and separation minima consistent with technology enhancements
- There is increased usage of Decision Support Systems (DSSs) that provide both information and heuristics to support the accomplishment of service provider tasks.
  - « Results in reduction of routine tasks while increasing the service provider’s ability to plan and collaborate appropriate responses to projected situation.
  - « Provides users with greater flexibility in their operations and access to the DSS outputs
- Low altitude airspace structure remains largely unchanged, but widespread RNAV equipage and expanded surveillance coverage with new technology provide increased access to airports and airspace in poor weather conditions.

Service Description - 2010 and Beyond

- Datalink of information, collaboration and auto-negotiation exceeds that of voice
- The oceanic environment closely resembles the en route environment in terms of waypoints, surveillance, airspace structure, and communications.
- Complimentary and collaborative decision making by ground and air system elements based on common information availability
  - « Via the NAS-wide information system, users and service providers collaborate on prioritization and scheduling of NAS infrastructure activities utilizing DSSs that provide information regarding the coverage and status of NAS infrastructure components
- New applications are developed on much shorter product cycles as the “pipelines” for data flow are already established and certified, if necessary
- Enhanced CNS systems and automation in aircraft compliment automation aids on the ground permitting more autonomous operations.
  - « This improved autonomy combined with greater ability to share information permits workload to be distributed between service provider and operator in a balance appropriate for the operations being conducted.
- Continued advancements in the scope and accuracy of the weather information available to the service provider and user, including automatic simultaneous broadcast of hazardous weather alerts for wind shear, microburst, gust fronts; and areas of precipitation, lightning, icing, and low cloud ceilings and visibility.
  - « The NAS-wide information system provides this information to all service providers and, via data link, to participating aircraft. Improved weather information integrated into DSSs and disseminated via data link reduces encounters with hazardous weather.

Data Link/ATM DSS Scenario



• Prior to departure, automated systems in the AOC submit a profile based on user priority (time, fuel conservation, etc) and receive feedback regarding status of NAS resources and projections of congestion. The profile is adjusted interactively. This can occur from the flight deck for re-planning based on congestion/weather management or change in NAS resource status e.g. SUAs. (Mid-term)

• At pushback the taxi clearance is electronically transferred to the flight deck to support flight deck moving map,and onboard and ground conformance monitoring. All changes are transferred electronically to support enhanced ground efficiency, maximized runway allocation, runway incursion and ground deviation mitigation. (Long-term)

• On departure the Enhanced Departure Path EDP DSS uplinks heading, speed and altitude adjustments to support the most efficient climb to the High Altitude Regime based on preferences and requests made by the flight deck or AOC in near-real time. (Long-term)

• In the High Altitude, the mode of operation and sector size has caused a shift from management off the glass to trajectory management - shared 4-D profiles. Upon receipt of arrival transition point and time, the flight deck downlinks its preferred profile as baseline. This preferred profile is based on the availability of NAS information (weather,traffic, outages, etc). All tactical adjustments are made through the electronic exchange of “path objects” - electronic shorthand for offsets, altitude and speed changes, and vectors. (Mid-term)

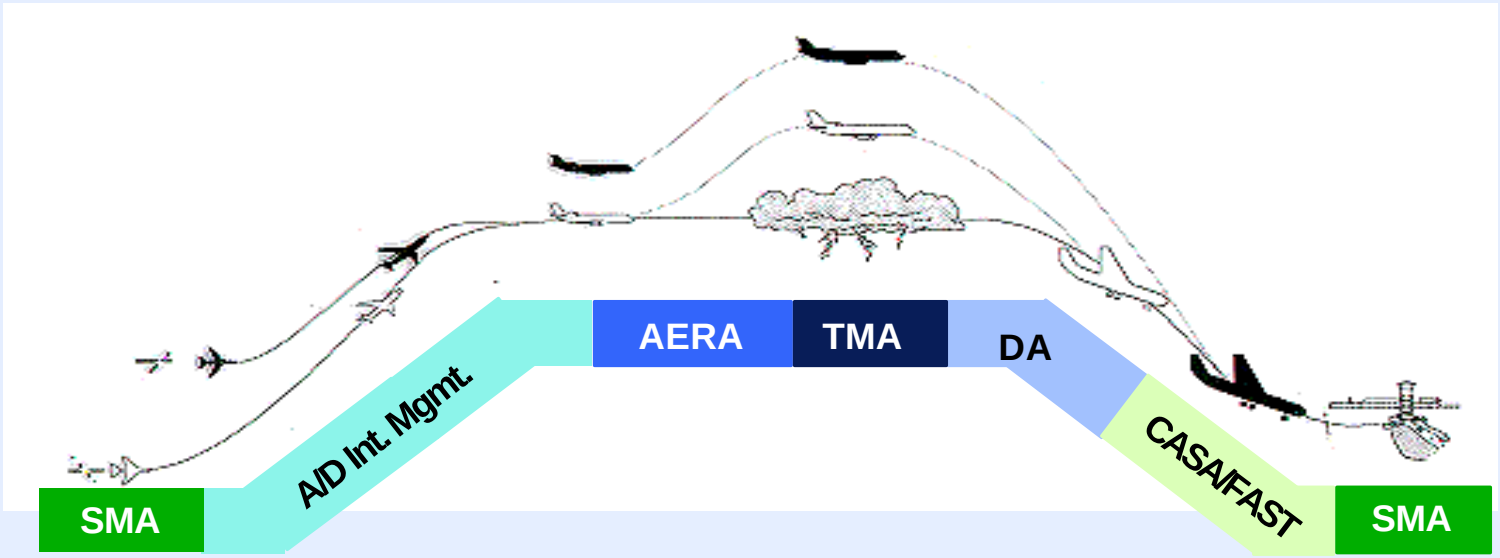
• As the aircraft nears top-of -descent, electronic negotiation provides descent profile and adjusts arrival time to maximize both the flow plan and aircraft operating efficiency based on user preference. (Long-term)

• Descent Advisor, aFAST and other DSSs provide system-to-system trajectory adjustments to ensure maximum flow at the airport. (Long-term)

• At arrive, as on departure, taxi clearances are electronically exchanged and updated to support efficiency and incursion/deviation mitigation. (Mid-term) Electronic course correction during taxi-in. (Long-term)

Integrated Capabilities

Uplink/Downlink capability of intent & NAS information



FOC

ATCSCC

FAA/Industry Data Exchange (GDP, NASSI…)

Decision-Support Tools for NAS Analysis

Collaborative Decision Making

CDM-Ground Delay Program (FSM, Ration-by-Schedule, Schedule Compression...)

TRACON: Terminal Radar Approach Control
ARTCC: Air Route Traffic Control Center
ATCSCC: ATC System Command Center
NASSI: NAS Status Information
NAS: National Airspace System
FAST: Final Approach Spacing Tool
FSM: Flight Schedule Monitor

SMA: Surface Movement Advisor
A/D: Arrival/Departure
AERA: Automated En Route ATC
TMA: Traffic Management Advisor
DA: Descent Advisor
CASA: Controller Automated Spacing Aid
CDM: Collaborative Decision Making