Trajectory Negotiation & En Route Data Exchange
DAG CE-6

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Outline

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- Trajectory Negotiation Concept
- Data to be Exchanged
- Required Capabilities
- Initial CE-6 activities - EDX
- Summary

Overview

Problem:

- Limited ability for ATSP to account for user preferences in generating advisories for:
  - Conflict avoidance
  - Conformance to local TFM constraints.
- Limited ability for user (AOC or FD) to formulate intelligent trajectory preferences that take ATSP constraints into consideration
- Inaccuracies/ incompatibilities between ground-based and airborne trajectory predictions impact subsequent ATSP advisories and conformance

Solution:

- Automated exchange/negotiation of trajectory-related data, via two-way datalink

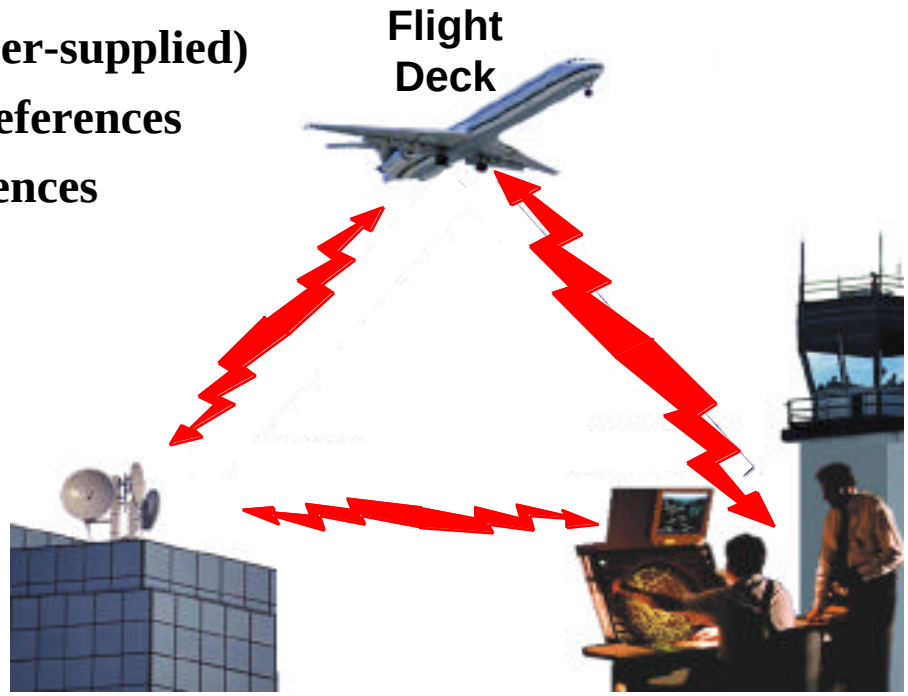
Overview

Assumptions and Considerations:

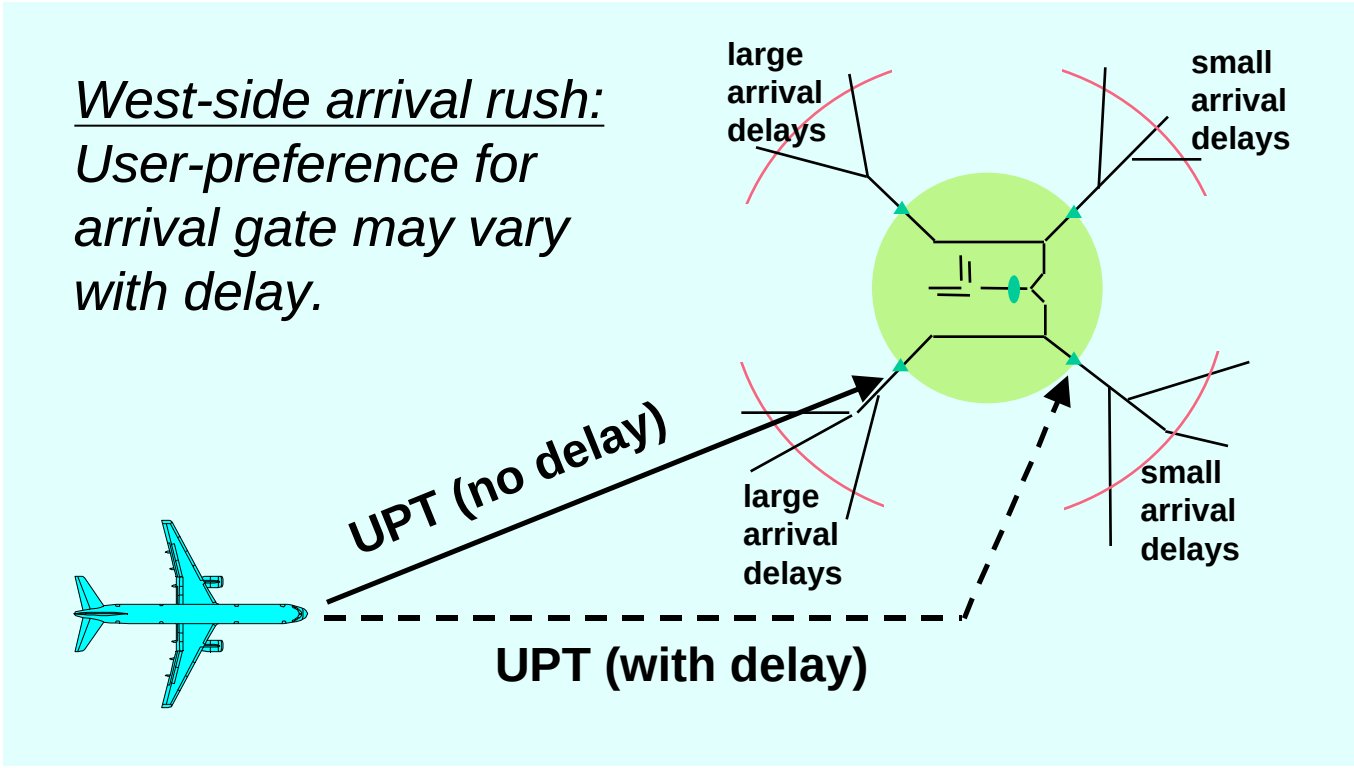
- Develop concepts within ATSP-focussed paradigm (per DAG CE-6)
- Focus on per-flight trajectory preferences as opposed to fleet-wide sequencing preferences
- Minimize workload through automated trajectory planning and data exchange between FD and ATSP DSTs (e.g., between FMS and CTAS)
- Maximize user flexibility
  - User preferences presumed innocent until proven to be in conflict
- Maximize usage of airborne equipage throughout airspace
- Employ concept of “agency”
  - ATSP adapts service to user capability
  - ATSP resolves conflicting preferences through “equitable” arbitration

Trajectory Negotiation Concept
Basic Steps for Enabling User Preferences

1) **User selects preferences**
2) **User communicates preferences**
3) **ATSP predicts trajectories (or user-supplied)**
4) **ATSP analyzes for conflicting preferences**
5) **ATSP resolves conflicting preferences**
6) **ATSP issues clearances**
7) **User executes/tracks clearances**
8) **ATSP monitors conformance**
9) **ATSP updates NAS status**

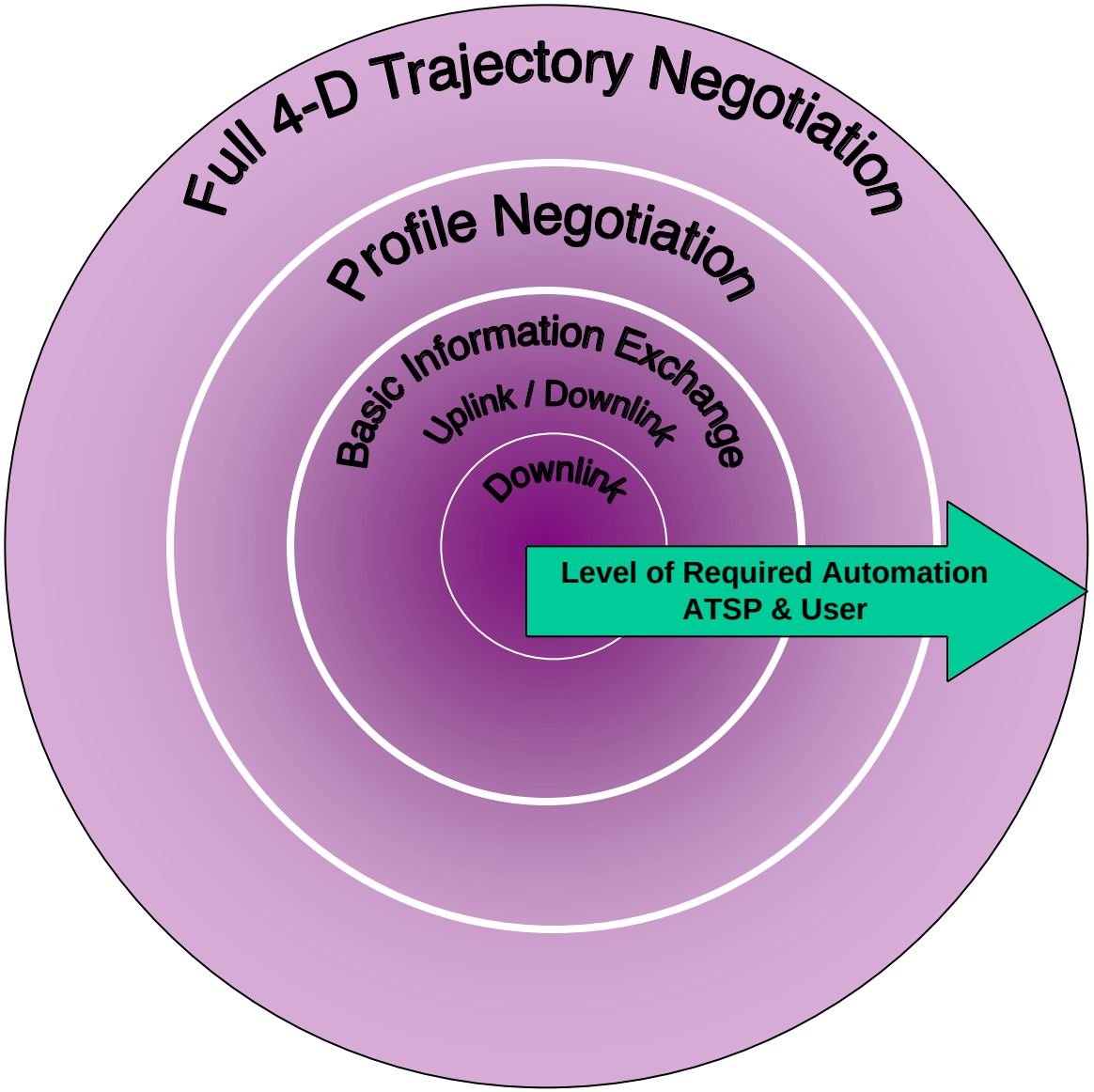


Trajectory Negotiation Concept
Example Problem



Trajectory Negotiation Concept

Evolution of Services



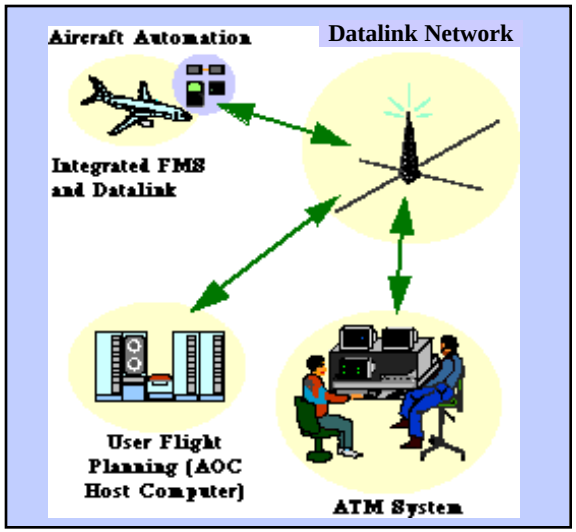
Data To Be Exchanged

	Downlink	Uplink
Basic Information Exchange	• Aircraft state (e.g., airspeed, heading, altitude/position) • Aircraft performance (e.g., weight, thrust/drag factors, cost index) • Atmospheric state (e.g., wind, temperature, pressure) • Flight path intent (e.g., FMS waypoints, speed profile)	• ATSP-computed atmospheric state (e.g., along- path winds, temperature, pressure
Profile Negotiation	• 3-D routing preferences (e.g, FMS waypoints, trajectory change points) • Desired time of arrival (e.g., DTAs at meter fix, approach fix, runway threshold) • Preferred DOFs for conflict resolution	• Crossing restrictions (e.g., required speed/altitude at a fix) • Required time of arrival (e.g., RTA at meter fix, approach fix, runway threshold) • Airspace and ATSP status/constraints (e.g., SUA status, expected delay absorbtion)
4-D Trajectory Negotiation:	• Preferred 4-D trajectory • Finalized/negotiated 4-D trajectory for acknowledgement and conformance • Trajectory deviation weightings	• Finalized/negotiated 4-D trajectory for clearance and tracking

Required Capabilities

Flight-Deck/AOC Automation:

- 4-D flight planning of optimized routes
- Accurate tracking of cleared/negotiated 4-D trajectories
- Integrated FMS/datalink and autoloading of ATSP/AOC data
- Supporting flight-deck CNS for enhanced situational awareness and flight planning (e.g.CDTI)
- AOC tools for generating and communicating fleet-wide operational preferences and constraints to individual flights



ATSP Automation:

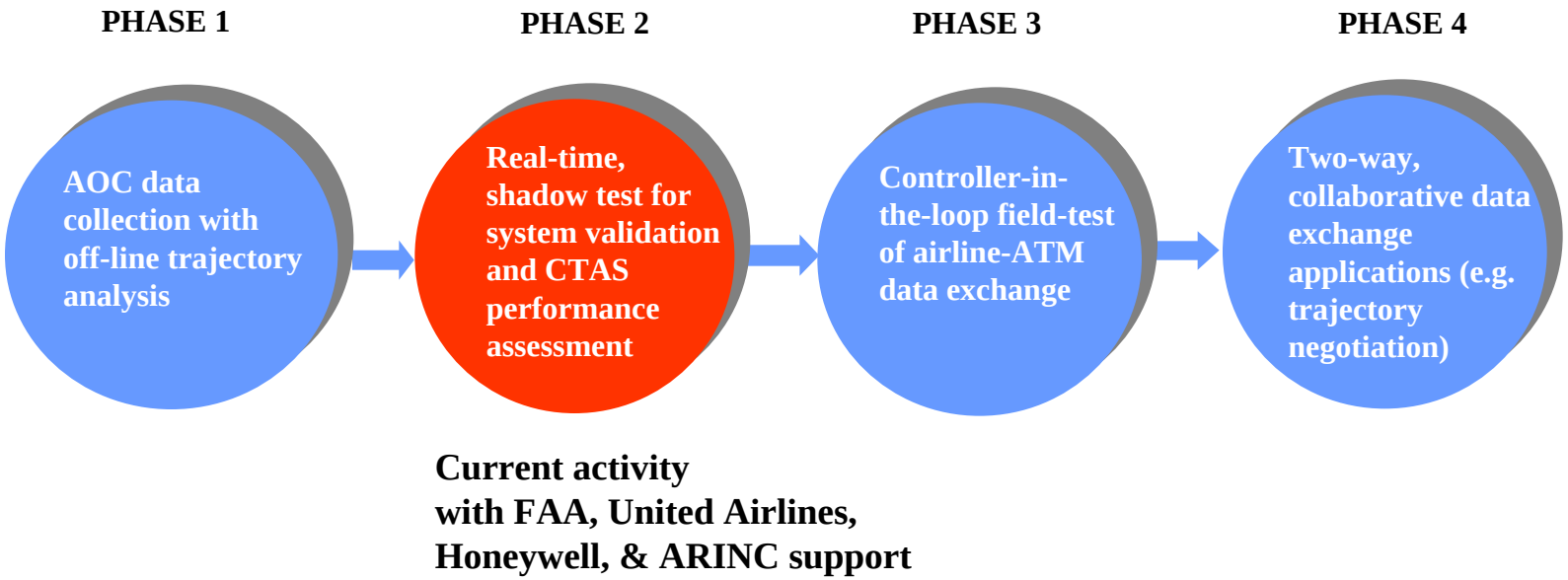
- Integrated TFM scheduling and trajectory planning
- Flexible (RNAV) route planning, adaptable to changing constraints
- Strategic conflict probing and resolution
- FMS-quality trajectory modeling, supported by data exchange
- Conformance monitoring of cleared/negotiated trajectories

Datalink Systems:

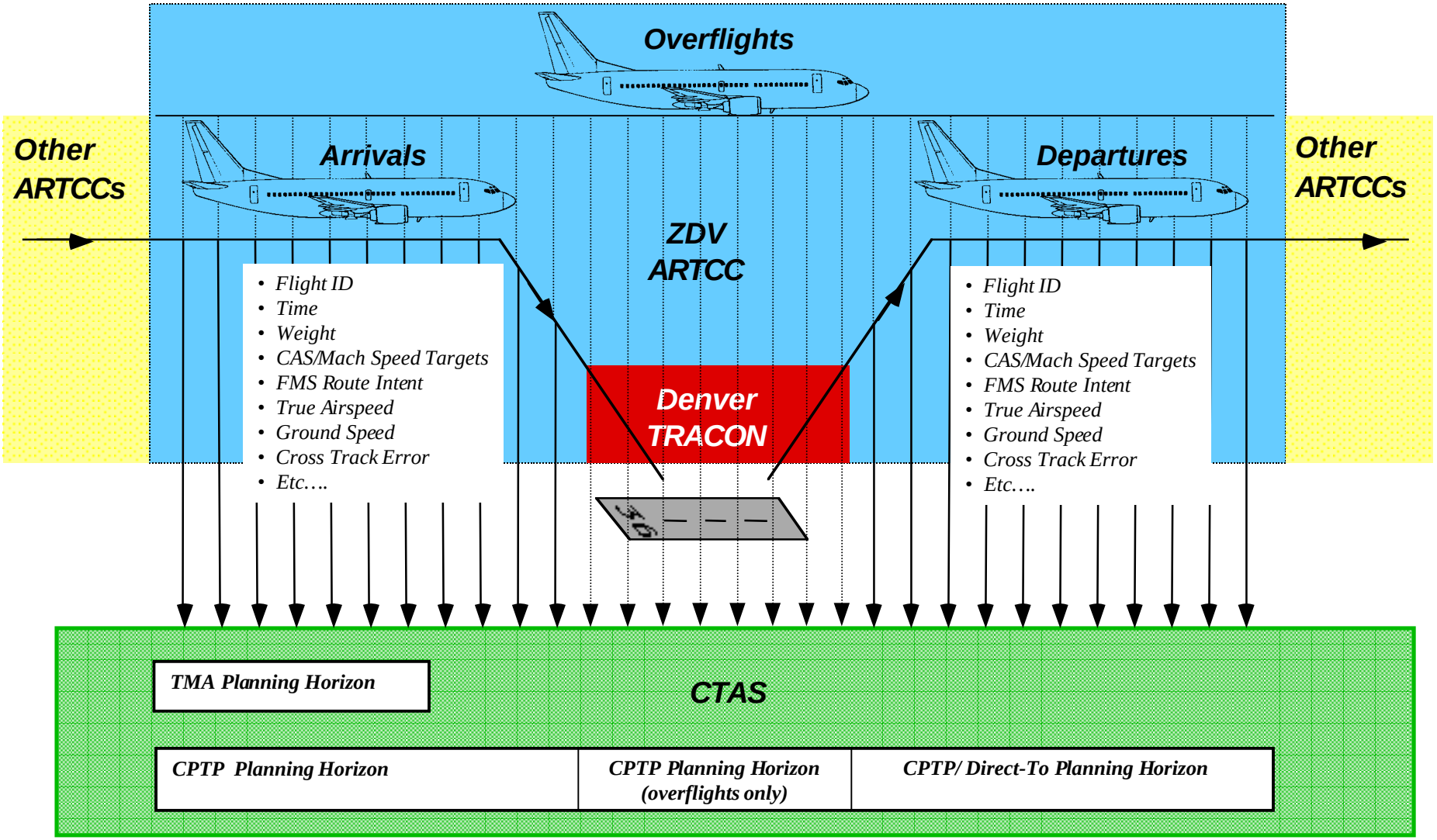
- ATN-compatible datalink services with message sets defined for global interoperability (SARPS Package 1 and beyond)
  - CPDLC (Build 2/2+)
  - ADS

Initial DAG CE-6 Activity:
En Route Data Exchange (EDX)

- **Phase 1-3:** Focus on data exchange as an enabling technology to improve current ATSP (CTAS) enroute tool performance
- **Phase 4:** Develop and validate concepts relating to en route trajectory negotiation between the FMS and CTAS.



Initial DAG CE-6 Activity:
EDX Phase 2 Field Evaluation



Summary

- Trajectory negotiation & data exchange provide a mechanism for:
  - Getting user preferences represented in ATSP advisories
  - Allowing users to generate “intelligent” preferences that are likely to be accepted by ATSP “as is”
  - Improving the accuracy and compatibility of ATSP and FD trajectory predictions
- An operational concept and research plan is needed (under DAG CE-6, working closely with RTCA 194 WG-2) that explores issues relating to:
  - Alternatives for representing trajectory preferences
  - Required automation and evolution of services
  - ATSP/FD roles and responsibilities
- Initial validation activities are being carried out under EDX with FAA support and industry collaboration

Overview

Primary Benefit Mechanisms:

- Improved flight efficiency
- Greater operational flexibility
- Improved airspace and throughput capacity

Trajectory Negotiation Concept
Profile Negotiation Vs. Full 4-D Trajectory Negotiation

Profile Negotiation:

- Decomposes user preference into basic parameters - provides building blocks for ATSP-modified trajectories in response to new/changing NAS constraints
- Supports lesser equipped users
- Less stringent datalink bandwidth requirements
- Less stringent time synchronization requirements

Full 4-D Trajectory Negotiation:

- Leaves no question as to the true intent/preference of user
- Reduces need for complex, data intensive, modeling of trajectory by ATSP
- Provides identical criteria for user trajectory tracking and ATSP conformance monitoring