



# *Massive Point-to-Point and On-Demand Air Transportation System Investigation*

## **Concept PTP Overview**

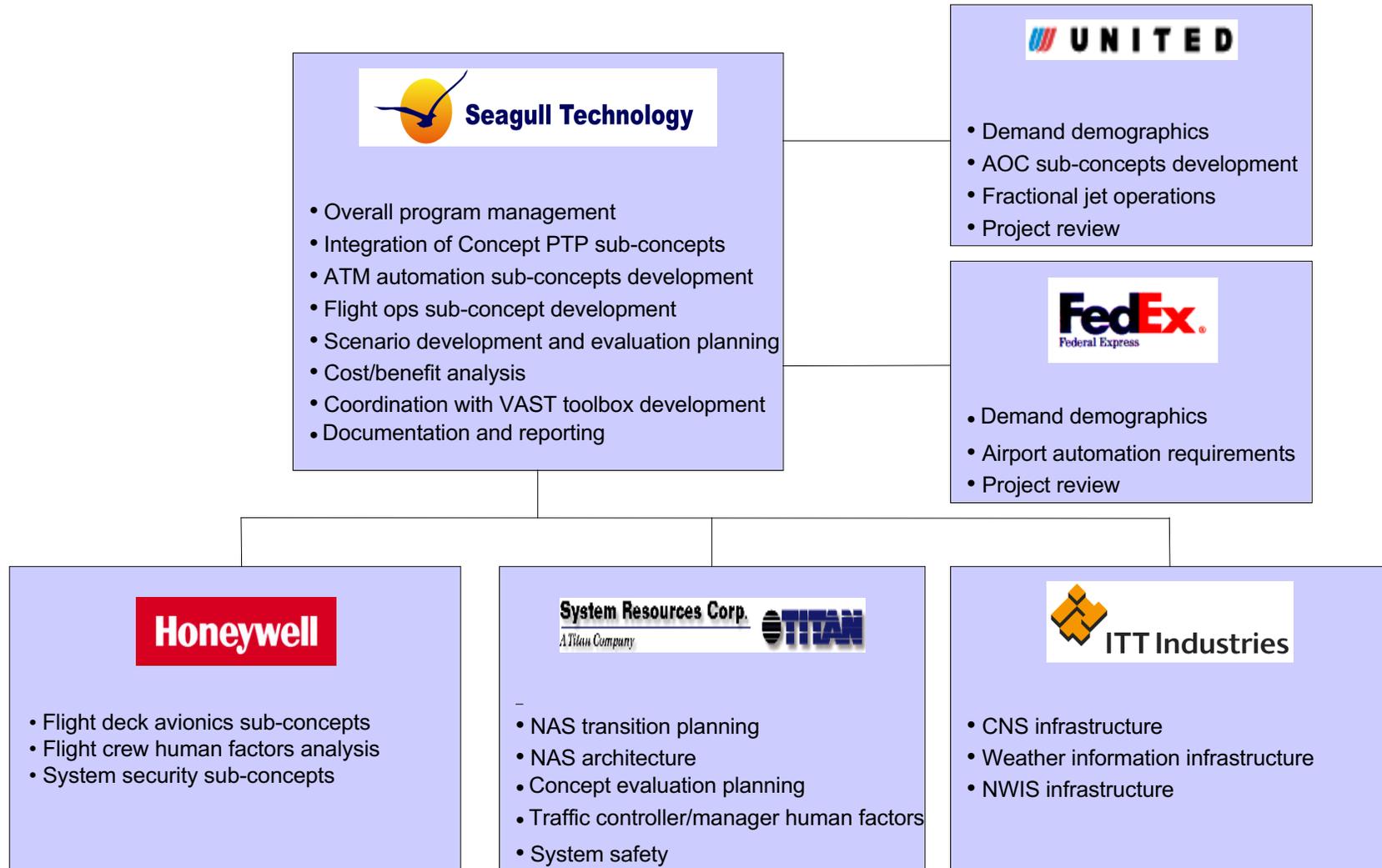
Virtual Airspace Modeling and Simulation (VAMS)  
Project

Technical Interchange Meeting 3  
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# Concept PTP Team





# Outline

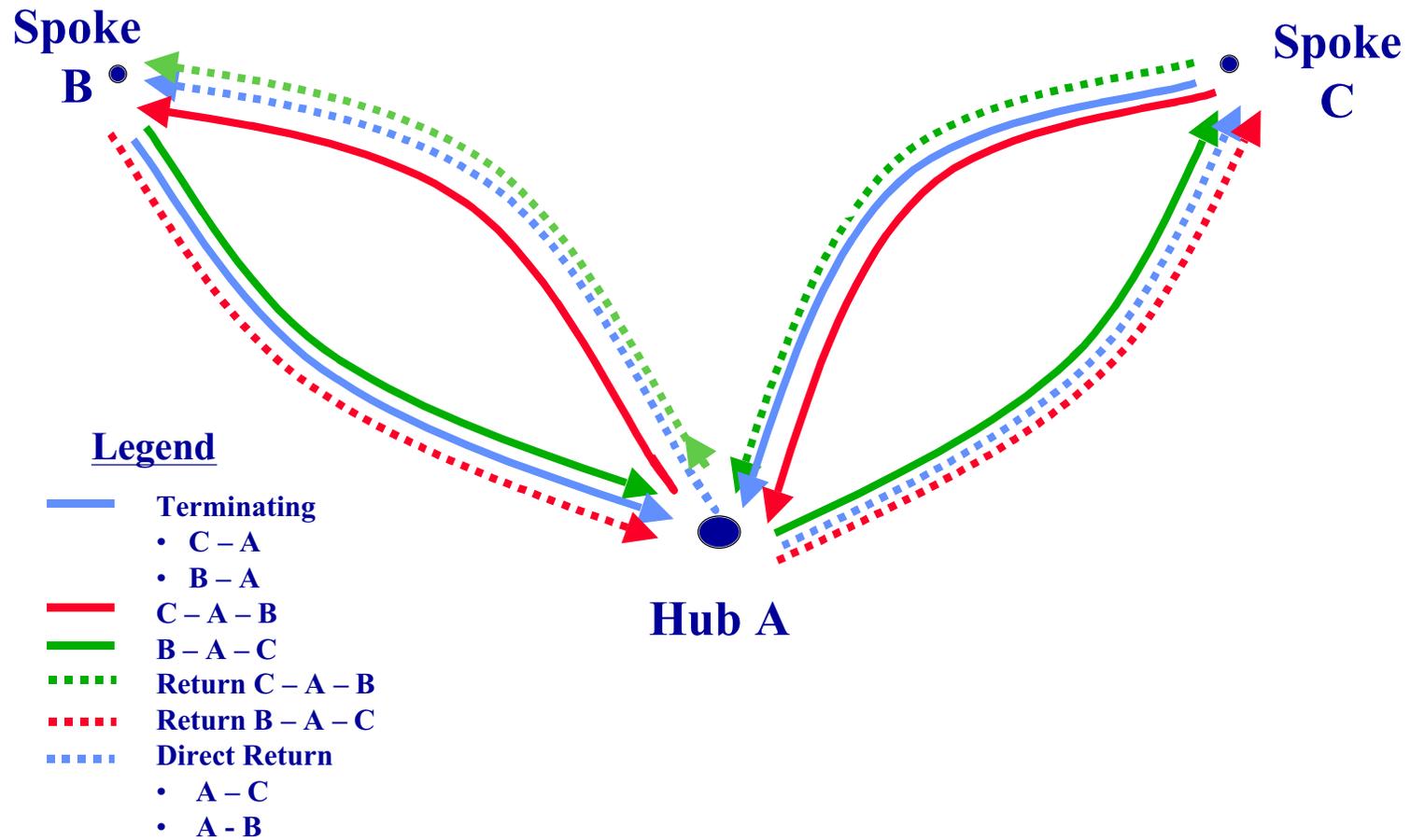
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- **Expected Concept PTP Potential Benefits**
- **Core Ideas**
- **Self Assessment Plans**



# How Concept PTP Will Work

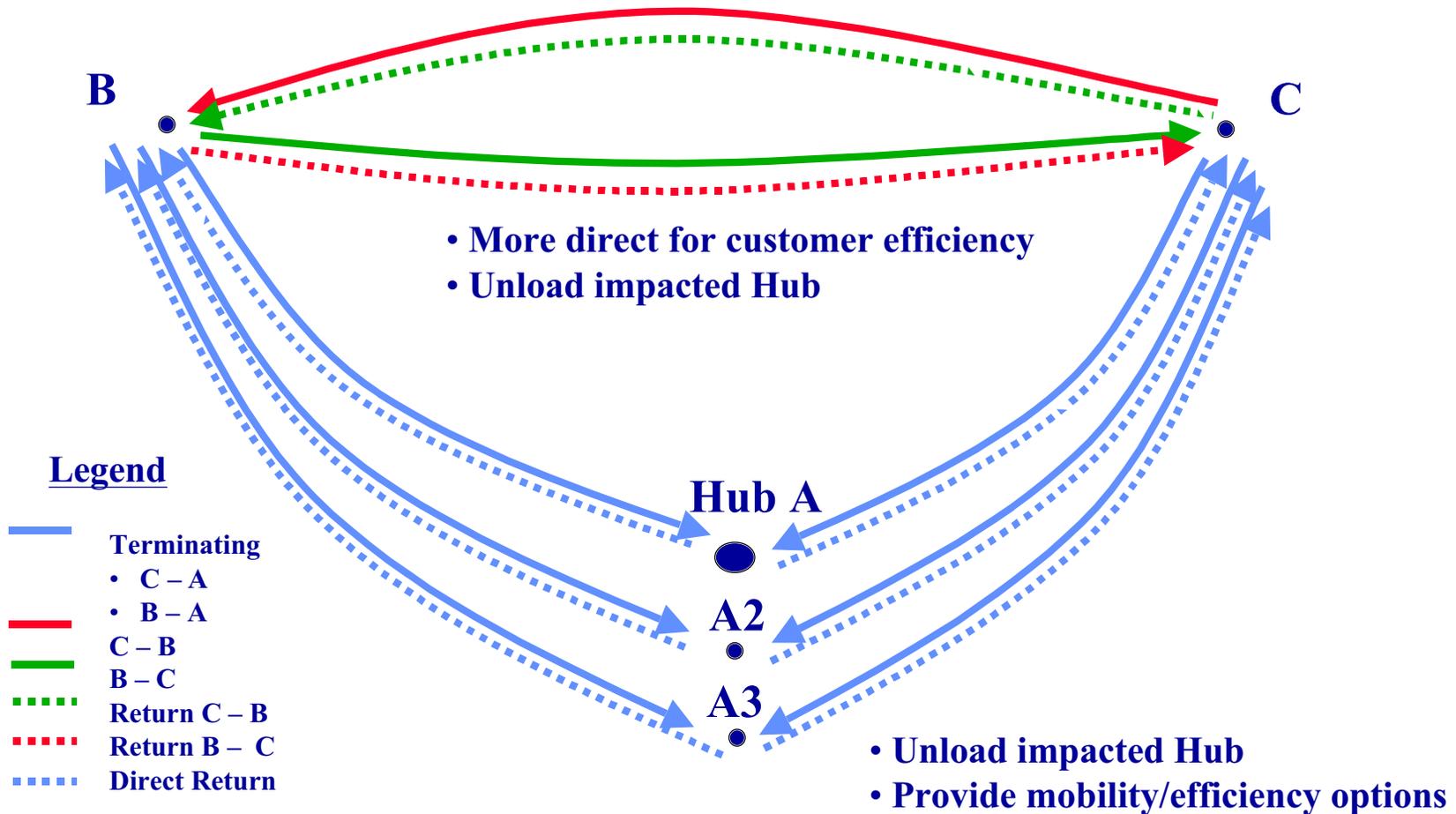
## Current Hub-Spoke Design:





# How Concept PTP Will Work

Point-to-Point Design Has Two Mechanisms to Increase NAS Capacity:





# Concept PTP Premise

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- **Increase National Airspace System (NAS) Capacity by:**
  - **Facilitating and Incorporating Massive Use of Point-to-Point (PTP) and On-Demand Air Transportation between Non-Hub Airports –**
    - › **i.e., Broaden the number of nodes and connectors within the grid**
- **Requires Augmenting NAS Components to Implement the Concept**
  - **Air Traffic Management Systems**
  - **Fleet Operations, CNS, and Weather Information Infrastructure Aircraft Equipage, Fleet Mix and Number**
  - **Commercial Aircraft Operations Management Processes**
    - › **Large scheduled air carriers (travel and shipping)**
    - › **Regional carriers, charter carriers, and air taxi operators**
    - › **Business and fractional jet ownership organizations**
    - › **Other aircraft operators (e.g., UAV, rotorcraft)**



## Key Concept Benefits

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- **Harness underutilized public (and private) airports plus the potential of ATM and AOC automation, advanced avionics, and CNS technologies potential to increase overall NAS CAPACITY**
  - **Benefits analysis will estimate potential overall capacity gain**
  - **Greater number of airports in use can also relieve capacity-limited hub-spoke airports**
- **By-product of concept is an increase in overall transportation system EFFICIENCY**
  - **Benefits analysis will measure a reduction in total travel time**
  - **Facilitates more direct and timely door-to-door service (mobility)**



# Enabling Concept PTP Core Ideas

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**To Mechanize Concept PTP Requires Development of Six Core Ideas:**

## ATM Automation

- **1. Provide Non-Towered Airports with ATM Automation**
- **2. Utilize Expanded Terminal Area Time-Based ATM**
- **3. Mechanize Strategic En Route ATM in New Airspace Structure**
- **4. Expand Traffic Flow Management Capability**

## Airline Operations Automation

- **5. Expand Fleet Operations (Dispatch) for Collaboration and Flight Timing Control**

## Advanced Avionics

- **6. Accommodate Broader Aircraft Spectrum and Exploit Advanced Avionics Equipage**

**Incorporate CNS, NWIS, and Weather Information Infrastructure and Technology Advancements to Enable Core Ideas**



## **Core Idea 1 - Provide Non-Towered Airports with ATM Automation**

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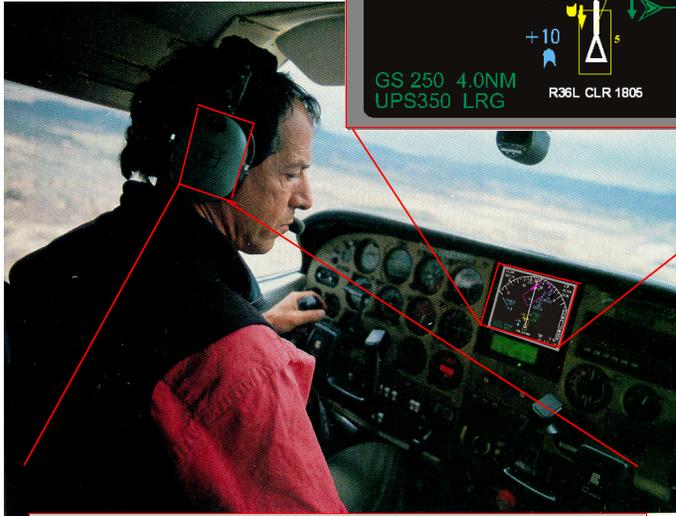
- **Provide same traffic advisory, sequencing, weather and airport information as towered airport**
- **Provide LAAS and smart airport lighting for precision approach/departure**
- **Enable same capacity during IFR as in VFR**
- **Provide mechanism for the Greater NAS to monitor and incorporate small airport operations into emerging ATM decision support tools and automation**
  - **Monitoring small airport operations – additional benefit to provide system security**
- **Increase small airport safety and perceived safety as well as capacity and travel efficiency**



# Core Idea 1 - Non-Towered Airport ATM Automation

## Increase Uncontrolled Airfield Safety, Capacity and Efficiency

Autonomous  
Airfield  
information,  
sequencing and  
traffic advisories

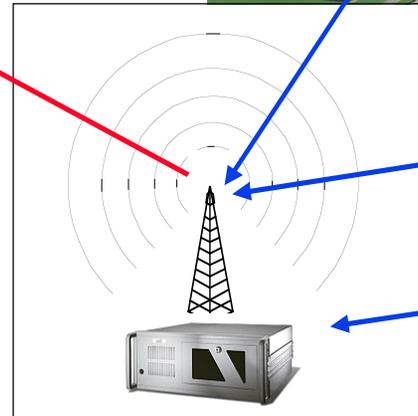


*“Aircraft zero zero four, number two,  
following aircraft on five mile final”*

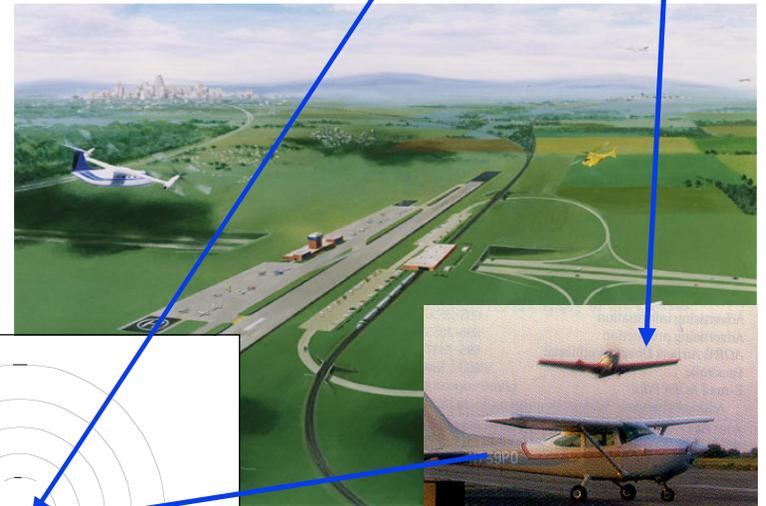


VHF, Datalink

ATM Automation Hub



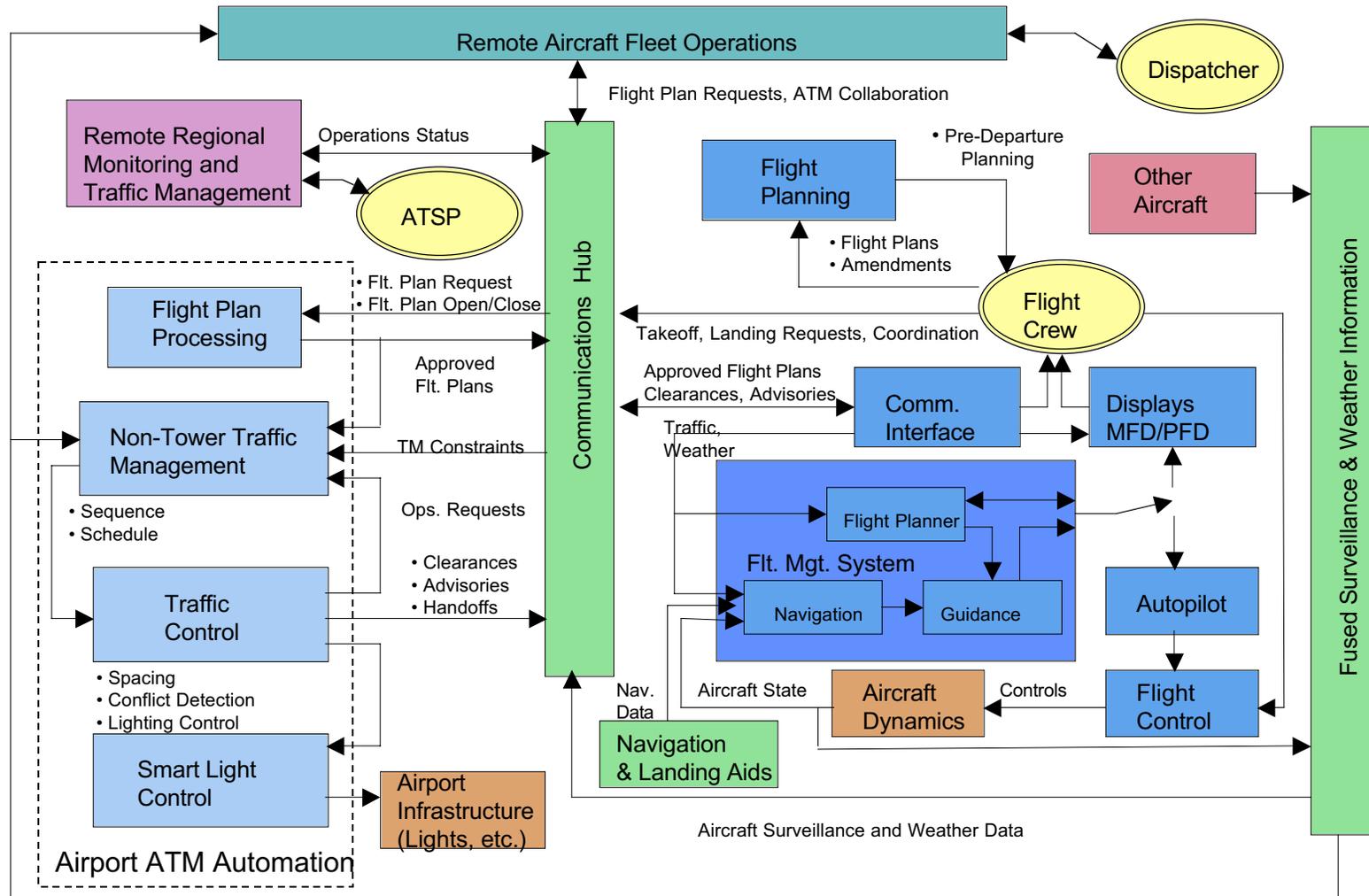
ADS-B



Weather  
Sensors



# Core Idea 1 - Non-Towered Airport ATM Automation



## Integrated Airport ATM Automation – Flight Deck Functional Architecture



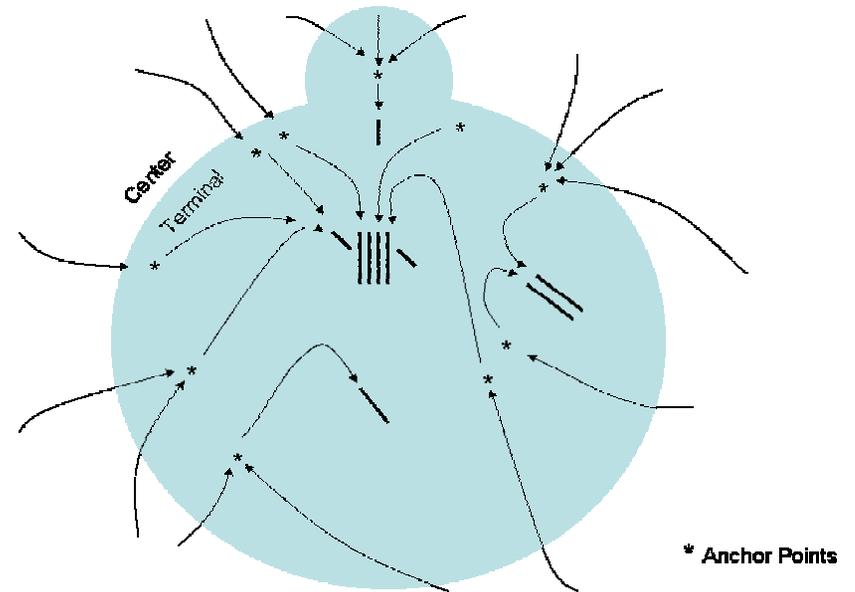
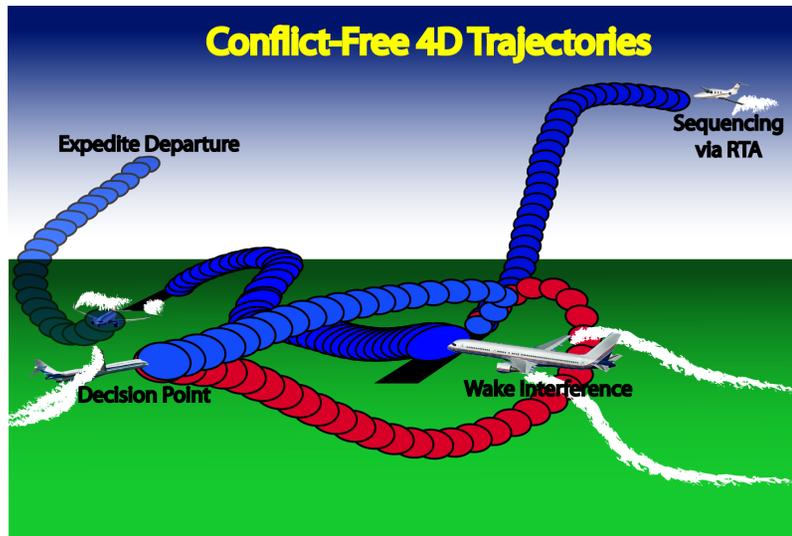
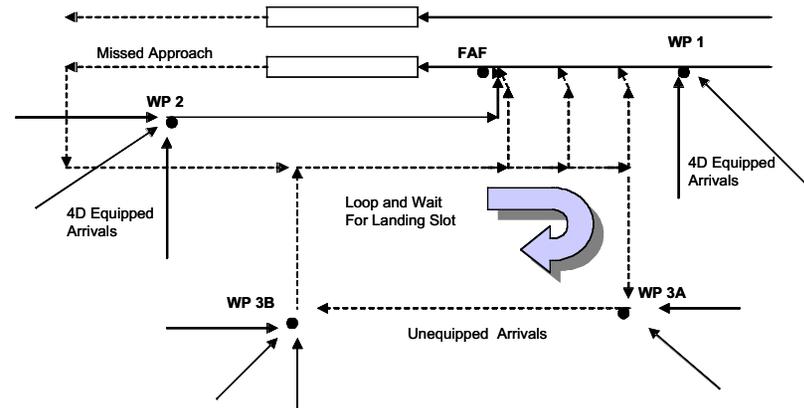
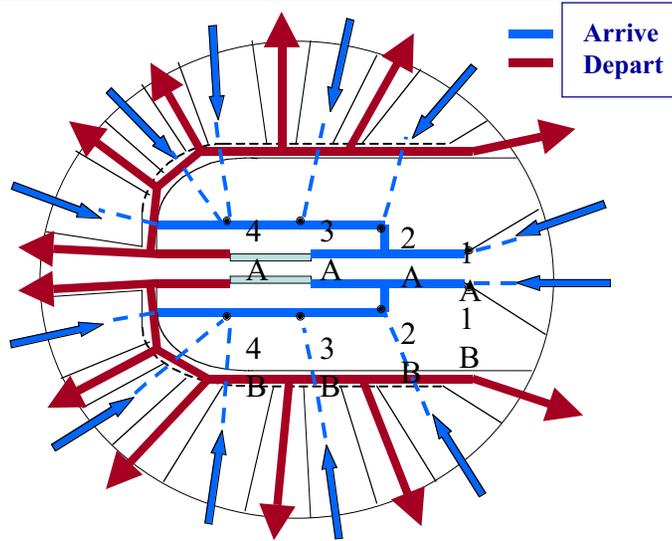
## **Core Idea 2 - Utilize Expanded Terminal Area With Time-Based ATM**

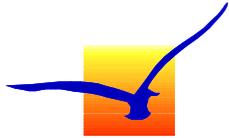
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- **Broaden terminal (TRACON) region to encompass smaller surrounding airports**
- **Redesign terminal airspace and corner-post feeder fixes**
  - **Flexible runway anchor (way) points**
  - **Flexible climb and descent corridors**
  - **Direct paths for 4D equipped aircraft**
- **Expand Traffic Management Advisor (a la Multi-Center TMA) concept to set non-conflicting required time-of-arrival (RTA) at anchor points and intermediate waypoints for transitioning aircraft**
- **Use aircraft 4D FMS and CDTI to follow assigned transition to/from en route, approach/departure paths and RTAs (non-conflicting cells move along precise paths)**
- **Work with Regional TFM to respond quickly to changing runway and airspace conditions**



# Core Idea 2 - Terminal Area Time-Based ATM





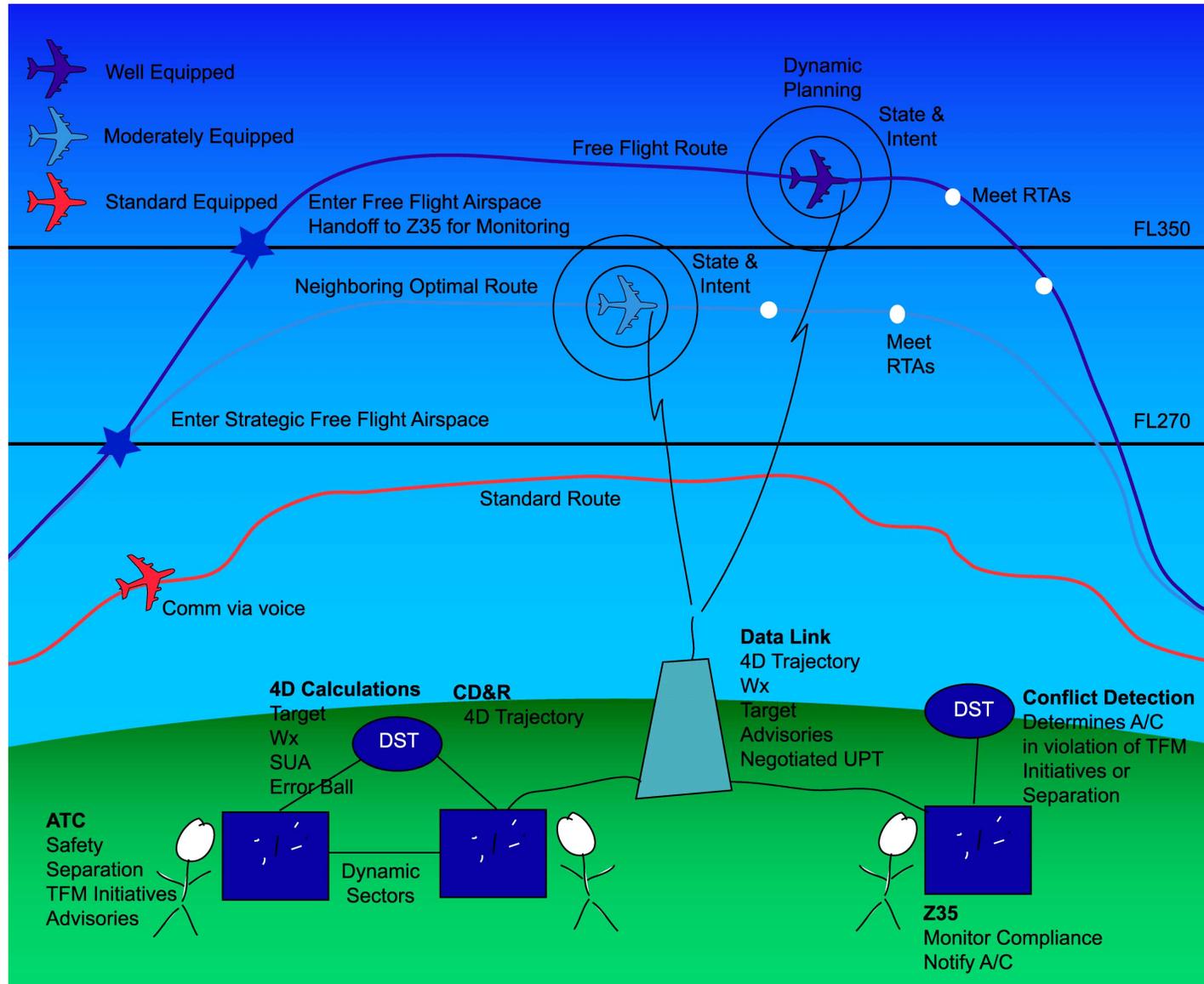
## Core Idea 3 - Mechanize Strategic En Route ATM

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- **Use 4D guidance (either FMS or Operator PCT provided) to meet flight plan destination RTAs**
- **Airspace segregated into three altitude bands to exploit three aircraft equipage levels for separation assurance and increased en route capacity**
  - **Sectorless airspace for FL350 and above – equipped for self separation (“Well equipped,” or Class C aircraft); “Z35”**
  - **Dynamic sectors for FL270 to FL345 – air-ground trajectory negotiation (“Moderately equipped,” or Class B aircraft) and self separation (Class C); sector sizing adjusted to traffic densities and complexities**
  - **Sectored altitude bands below FL270 used by non-equipped managed aircraft (“Standard equipped,” or Class A aircraft) plus climb/descent transition for Classes B and C**
- **Harness aircraft self separation (*a la* DAG TM CE-5 and CE-6) with ADS-B and 4D trajectory intent/guidance – for Class C and Class B aircraft**
- **ATM continues to provide tactical separation assurance backup, for self-separating aircraft**



# Core Idea 3 - Mechanize Strategic En Route ATM





# Core Idea 3 - Mechanize Strategic En Route ATM

		Legend	
Free Flight Airspace	≥FL350	 <p>FC Responsibility: Separation, Adherence to TFM Initiatives, Maintain 4D-UPT</p> <p>Z35 ATC Responsibility: Monitoring Compliance</p>	 ADS-B, TIS-B, FIS-B, ADL, AOP, 4D FMS, RTSP  ADS-B, ADL, 4D FMS, RTSP  No Additional Requirements
	<FL350, ≥FL270	 <p>FC Responsibility: Separation, Adherence to TFM Initiatives, Maintain 4D-UPT</p> <p>ATC Responsibility: Monitoring Compliance</p>	 <p>FC Responsibility: UPT, Maintain 4D-UT Envelop</p> <p>ATC Responsibility: Separation, Neighboring 4D-UT, Adherence to TFM Initiatives</p>
Transitional Airspace	<FL270, ≥FL180	 <p>FC Responsibility: UPT, Maintain 4D-UT Envelop</p>  <p>ATC Responsibility: Separation, Neighboring 4D-UT, Adherence to TFM Initiatives</p>	 <p>FC Responsibility: Route, Maintain 3D-Route Envelop</p> <p>ATC Responsibility: Separation, 4D-Route, Adherence to TFM Initiatives, Advisory Info</p>
	<FL180	 <p>FC Responsibility: UPT, Maintain 4D-UT Envelop</p>  <p>ATC Responsibility: Separation, Neighboring 4D-UT, Adherence to TFM Initiatives</p>	 <p>FC Responsibility: Route, Maintain 3D-Route Envelop</p> <p>ATC Responsibility: Separation, 4D-Route, Adherence to TFM Initiatives, Advisory Info</p>



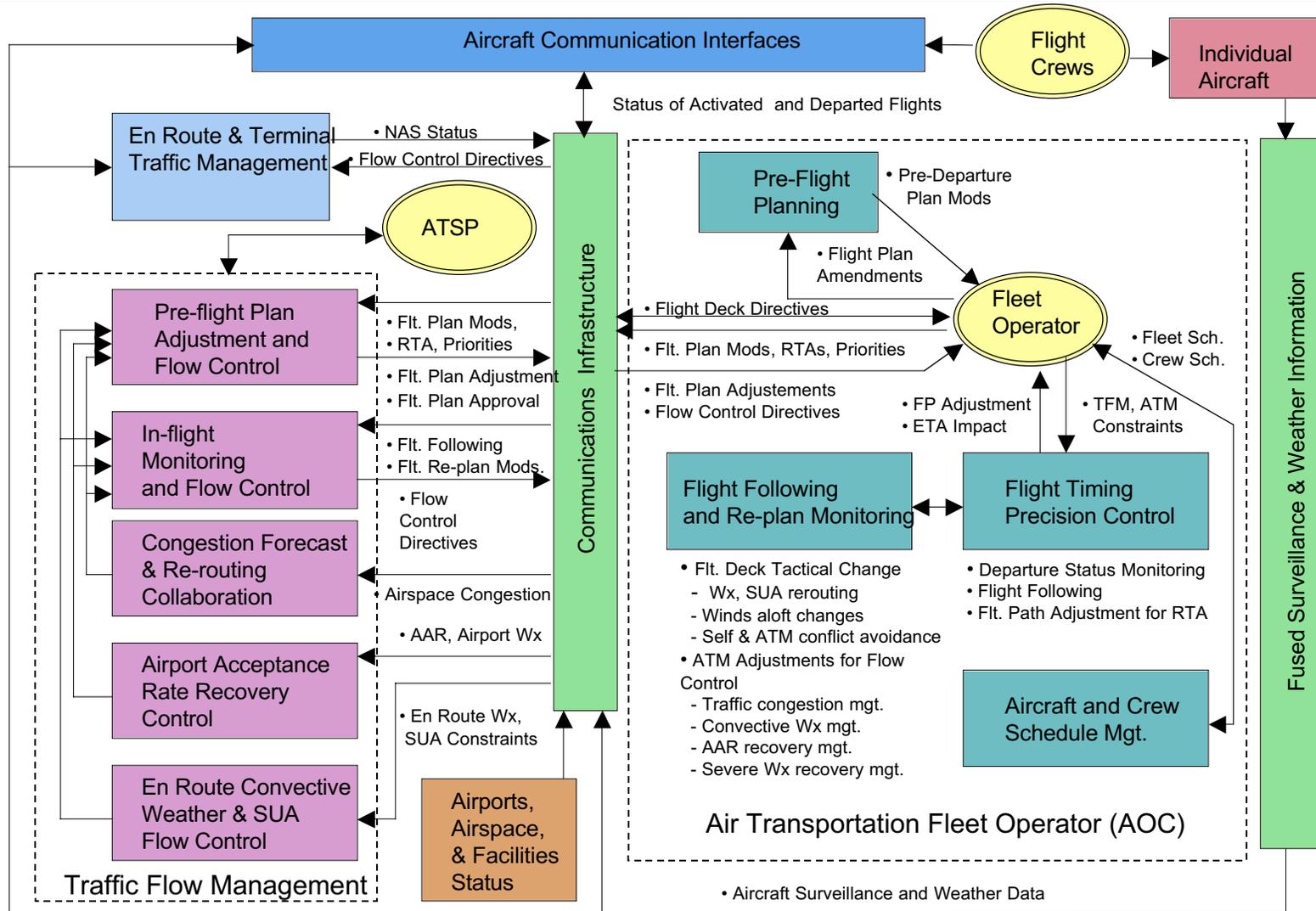
## Core Idea 4 - Expand TFM Processes

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- **National (N-TFM) and Regional Traffic Flow Management (R-TFM) review submitted pre-flight plans and compute suggested path and timing adjustments to lower statistical potential of conflict and to even spatial density**
  - \_ **Fleet Operators submit optimal flight plans with desired time of arrival**
  - \_ **TFM collaborate on plan adjustments with Operators**
  - \_ **Adjustments include flow control measures**
  - \_ **N-TFM focus on international and transcontinental flights**
  - \_ **R-TFM focus on high density shorter flights**
- **During flight:**
  - \_ **Provide flow control input to account for shifting weather, SUA status, traffic congestion and destination runway conditions**
  - \_ **Provide timely assistance to recover flight plans due to AAR and airspace recovery, in accordance with Operator business priorities**



# Core Idea 4 - Expand TFM Processes



## Integrated TFM-Fleet Operator Process Functional Architecture



## **Core Idea 5 - Expand PTP Fleet Operations (Dispatch)**

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- **Fleet Operator/dispatcher optimizes individual aircraft/crew schedules to meet transportation demand and business priorities**
- **Aircraft flight plans optimized but with timing and path constraints or adjustments (from both N-TFM and R-TFM)**
- **Operator uses Precision Control Tool to regulate estimated time of arrival in accordance with submitted flight plan and business priorities**
- **Operator works closely with TFM, en route ATM, and flight crews to keep information on flights current and flight priorities managed**
- **Coordinated flights include both scheduled and on-demand (taxi) cases**



# Core Idea 5 - Expand PTP Fleet Operations (Dispatch)

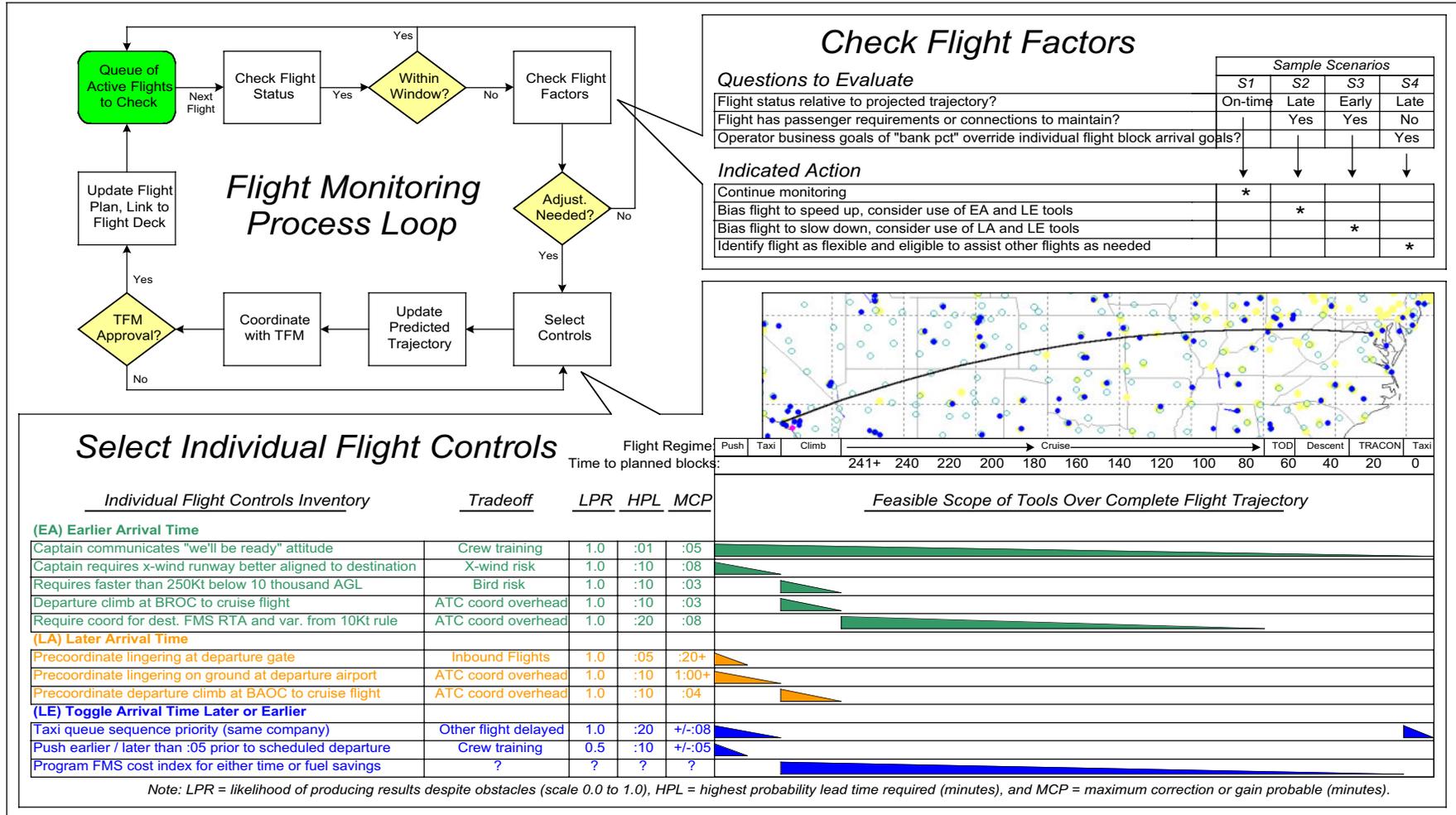


Figure 2-21. Content of the Precision Control Tool (PCT)



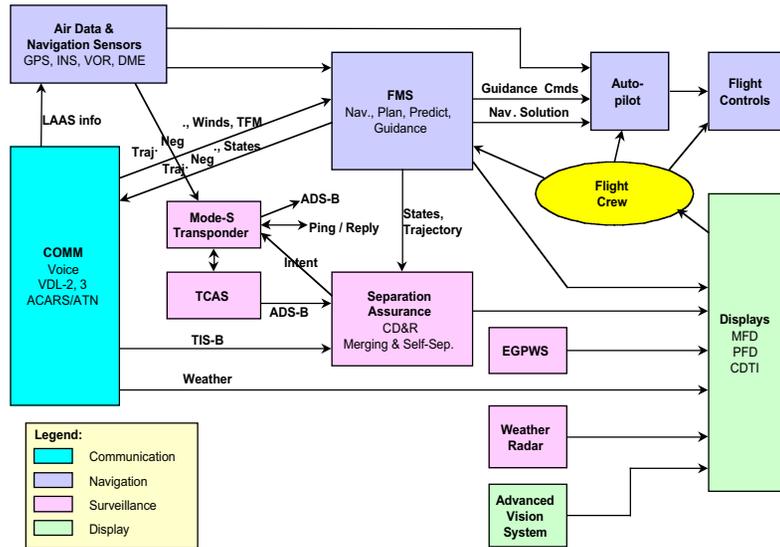
## Core Idea 6 - Exploit Advanced Avionics

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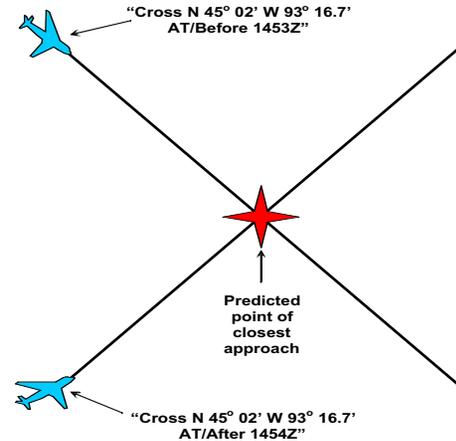
- **Economic benefits promote use of highly equipped aircraft**
  - **Precise 4D (multi-RTA) guidance to follow timed flight plans**
  - **Required total system performance (RTSP) for precise path control and optimal (reduced) spacing for separation assurance**
  - **Strategic conflict detection and collaborative resolution (CD&R)**
    - › **Leverage NASA's Autonomous Operations Planner (AOP)**
  - **Flight re-planning ability to adapt to changing winds/weather, traffic, SUA status, and arrival/departure RTAs**
  - **ADS-B for total airspace surveillance, CD&R, and flight plan monitoring**
  - **Full data link capability**
    - › **ATM/Operator information exchange with aircraft FMS**
    - › **Collaborative flight/traffic management automation**
  - **Wake vortex sensing/mapping/display for separation safety**
- **Fleet size and types optimally fill the O-D demand**



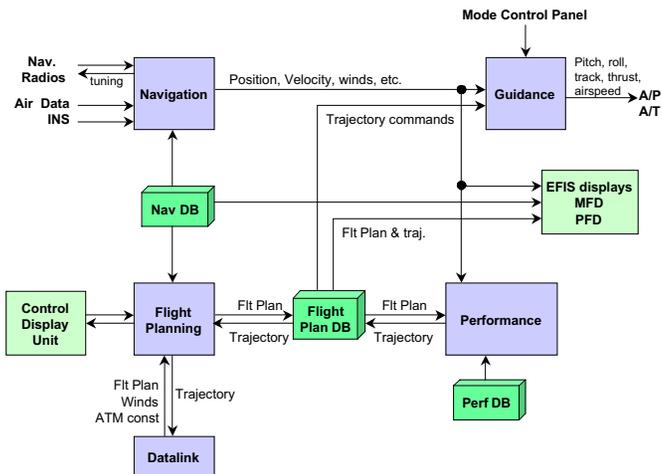
# Core Idea 6 - Exploit and Promote Advanced Avionics Equipage



**Avionics Tightly Integrated With ATM Automation via ADL**



**4D RTA Used For Separation Assurance**



**Advanced FMS Capability Used for Precision Trajectory Control**



## Enable Concept PTP via Integrated CNS and Weather Information Infrastructure

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- **Communications - Data links, wireless, and land lines tie all nodes of system together at all times**
  - **NAS-Wide Information System (NWIS) realized**
  - **All aircraft have continuous communications coverage**
- **Navigation - GNSS enhanced with redundant ground system**
  - **All aircraft guided and monitored to be within flight plan envelopes for increased airspace capacity (plus security benefit)**
- **Surveillance - All aircraft under continuous surveillance**
  - **Either ADS-B or radar transponder equipped**
  - **Linked ground stations provide seamless aircraft state and intent data**
- **Winds/weather/atmosphere - Integrated meteorological sensor system provides common weather data to all nodes**
  - **Collaborative flight planning, re-planning, trajectory timing, weather avoidance based upon common data set**



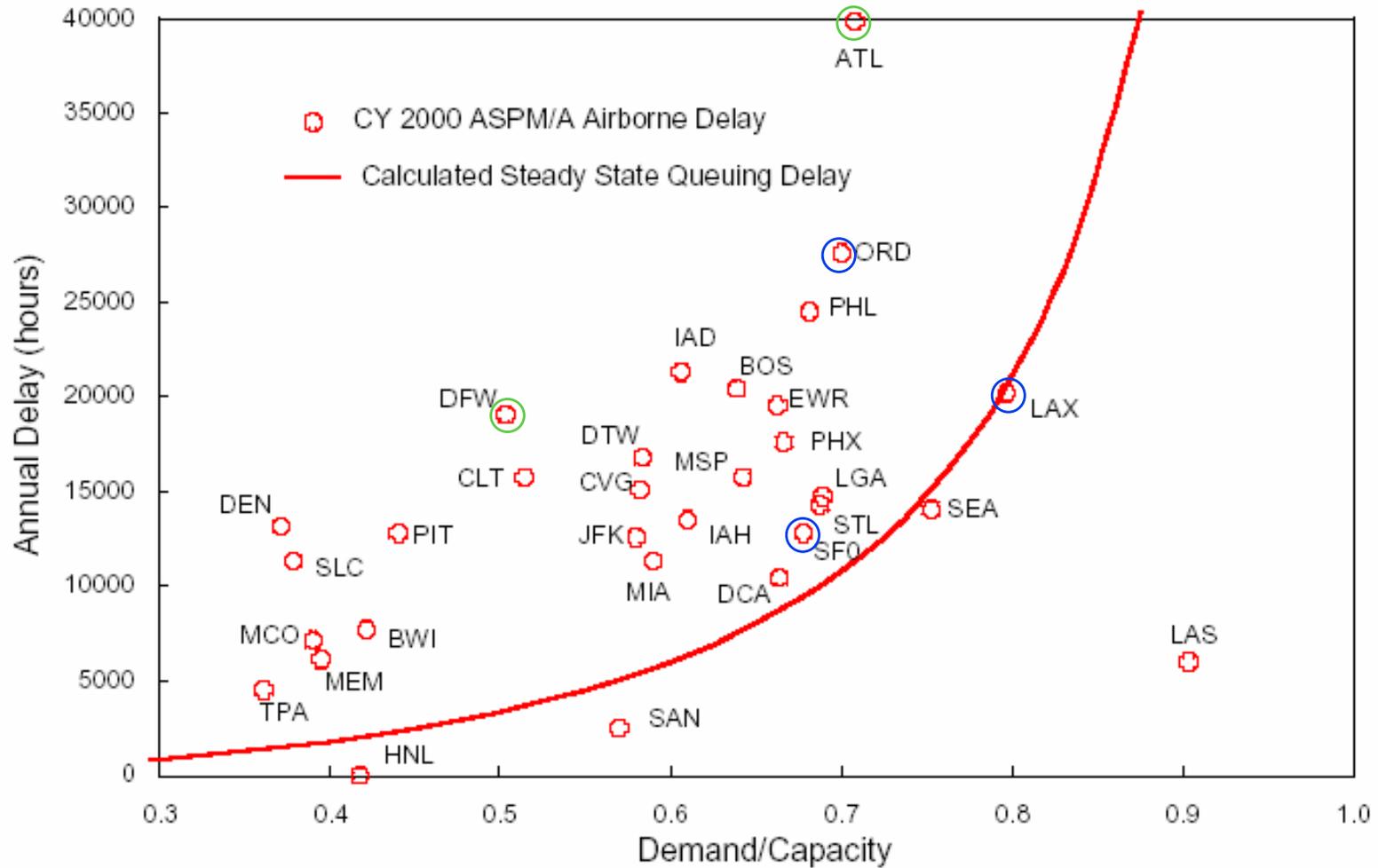
# Concept PTP Evaluation Plans

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- **Determine increase in capacity possible from Concept PTP**
  - **Define capacity as number of passengers and tons of freight hauled**
  - **Examine urban regions that are capacity constrained**
    - › **ORD and ZAU**
    - › **West Coast Corridor (Bay Area and LA Basin)**
  - **Select an array of suitable auxiliary airports to complement Hubs**
  - **Use two mechanisms to provided increased capacity while capping traffic in/out of impacted Hubs**
    - › **Direct PTP flights between Spokes and smaller airports (bypass Hub)**
    - › **Direct flights into auxiliary airports in same urban area as Hub**
  - **Develop city-pair flight plans to and from region**
  - **Estimate types and numbers of aircraft involved**
  - **Compute parametric measure of concept's ability to provide capacity increase**
    - › **Treat percentage of on-demand flights as system parameter**

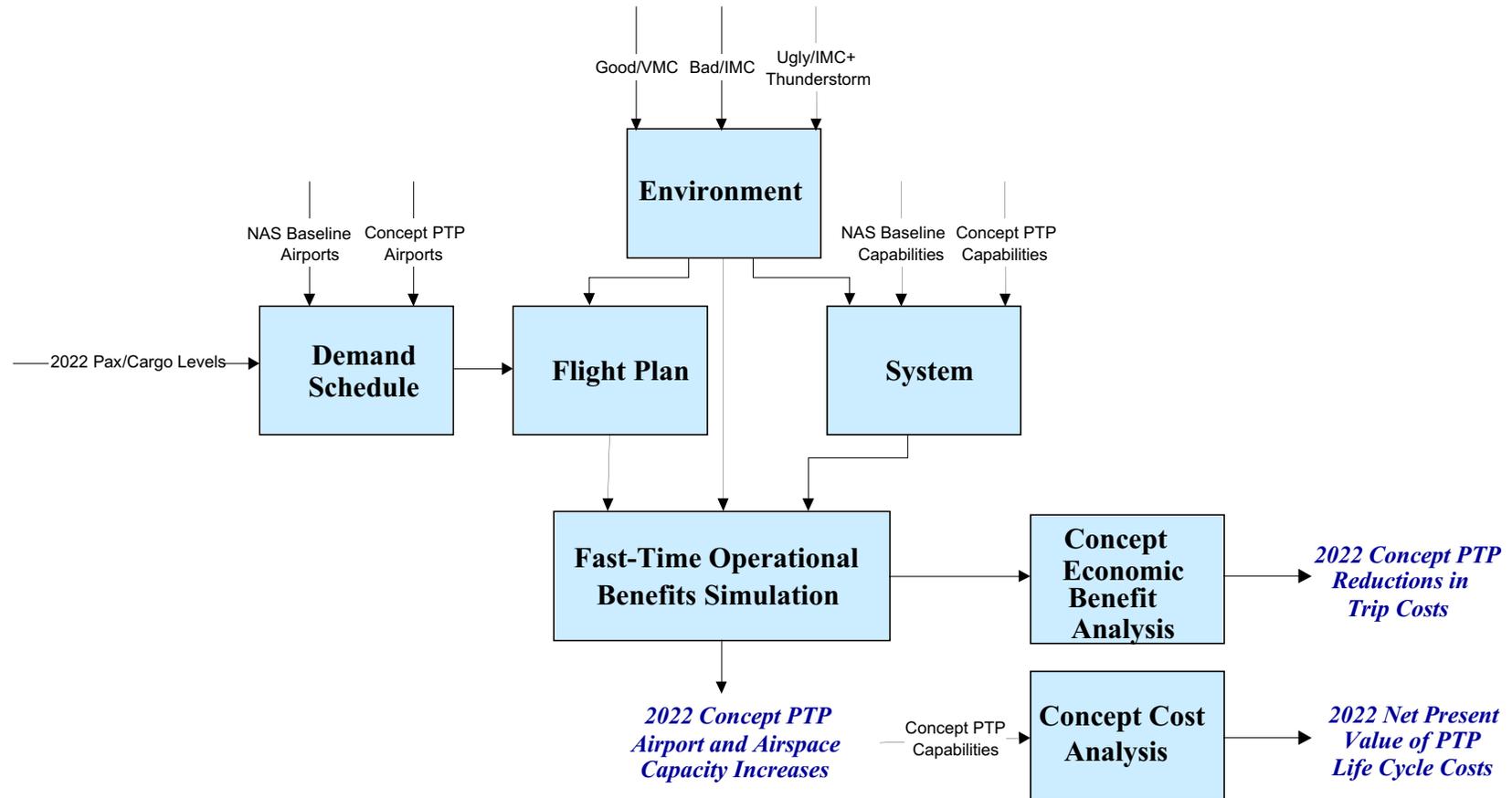


# Concept PTP Evaluation Plans





# Concept PTP Evaluation Plans



## General Self-Evaluation Methodology



# Concept PTP Evaluation Plans

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- **Design high fidelity model of expanded terminal area**
  - **Set up to examine technical feasibility of PTP 2**
    - Use of 4D FMS and ATM automation to interweave complex trajectories
    - Examine effect of parametric separation requirements on capacity
    - Examine effect of good, bad, and ugly weather days
  - **Collaborate with other terminal area concept developers**
  - **Make compatible with ACES design**
  - **Use ORD/ZAU for starting scenario**
- **Attack highest priority safety issues**
  - **For example, reduced separation with ADS-B and measures of Required Total System Performance (RTSP)**
- **Take next step in human performance analysis**