National Aeronautics and Space Administration

Airspace Operations and Safety Program (AOSP)
Airspace Technology Demonstrations (ATD) Project

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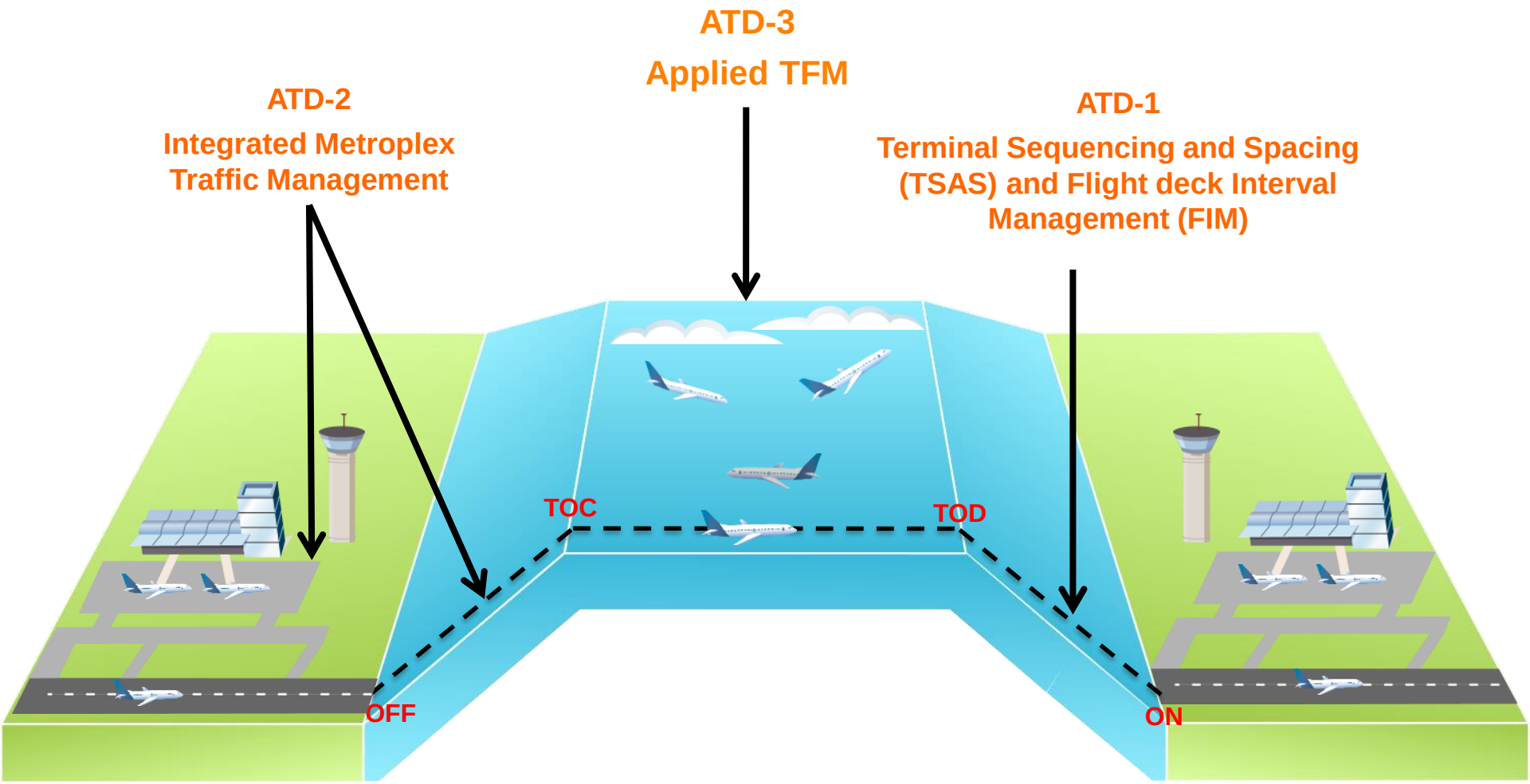
Airspace Technology Demonstrations (ATD) Project

ATD Domains


ATD-3
Applied TFM
ATD-2
Integrated Metroplex Traffic Management
ATD-1
Terminal Sequencing and Spacing (TSAS) and Flight deck Interval Management (FIM)
TOC
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Airspace Technology Demonstration 1

Terminal Sequencing And Spacing (TSAS)
with
Flight deck Interval Management (FIM)

ATD-1 Technologies

FIM Flight Deck Interval Management for Arrival Operations

CMS Controller-Managed Spacing in Terminal Airspace

TMA-TM Traffic Management Advisor (TMA) with Terminal Metering

Operational Scenario

Time-based scheduling provides runway arrival times and fix crossing times for arriving aircraft.

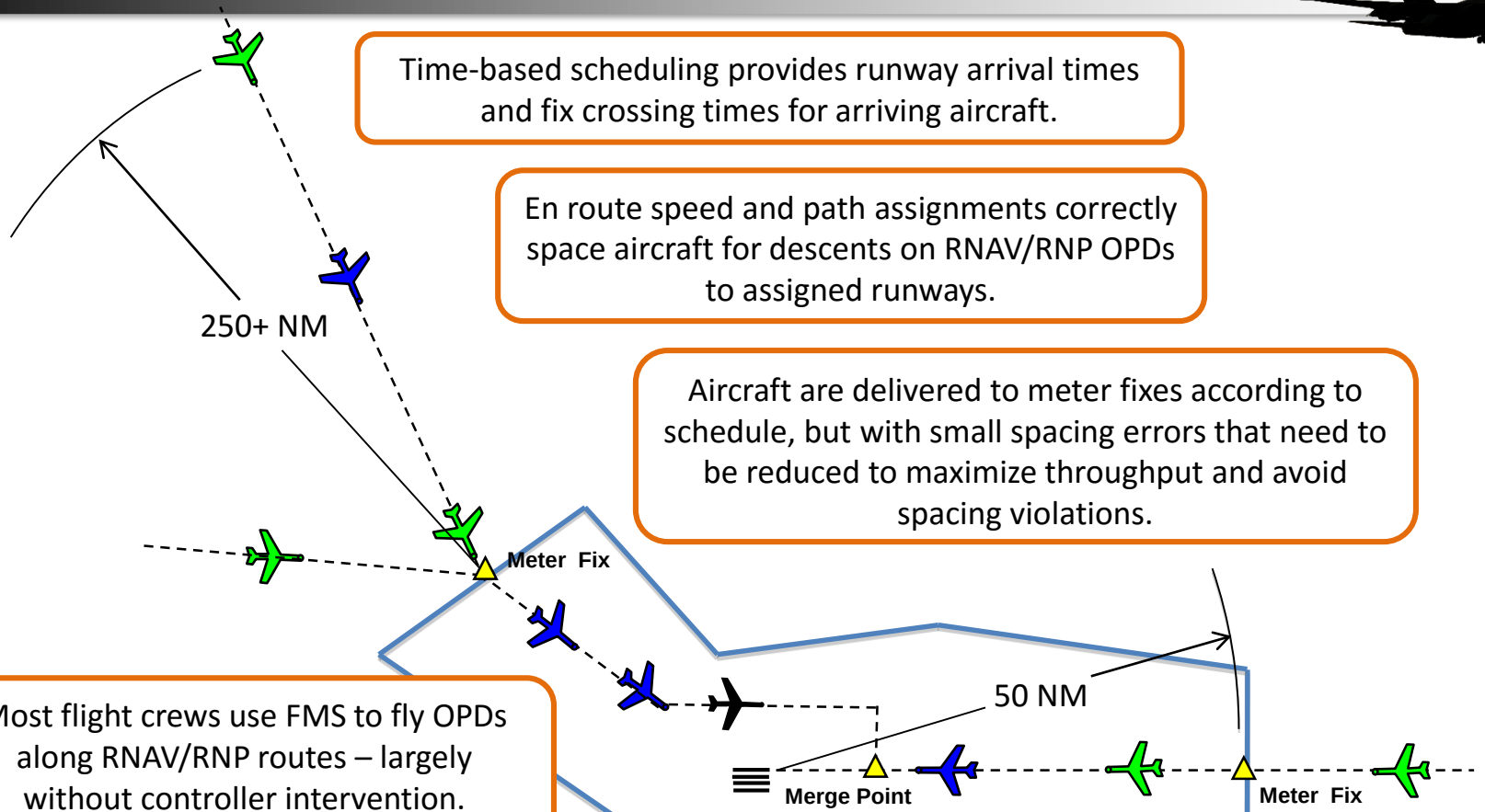
En route speed and path assignments correctly space aircraft for descents on RNAV/RNP OPDs to assigned runways.

Aircraft are delivered to meter fixes according to schedule, but with small spacing errors that need to be reduced to maximize throughput and avoid spacing violations.

Most flight crews use FMS to fly OPDs along RNAV/RNP routes – largely without controller intervention.

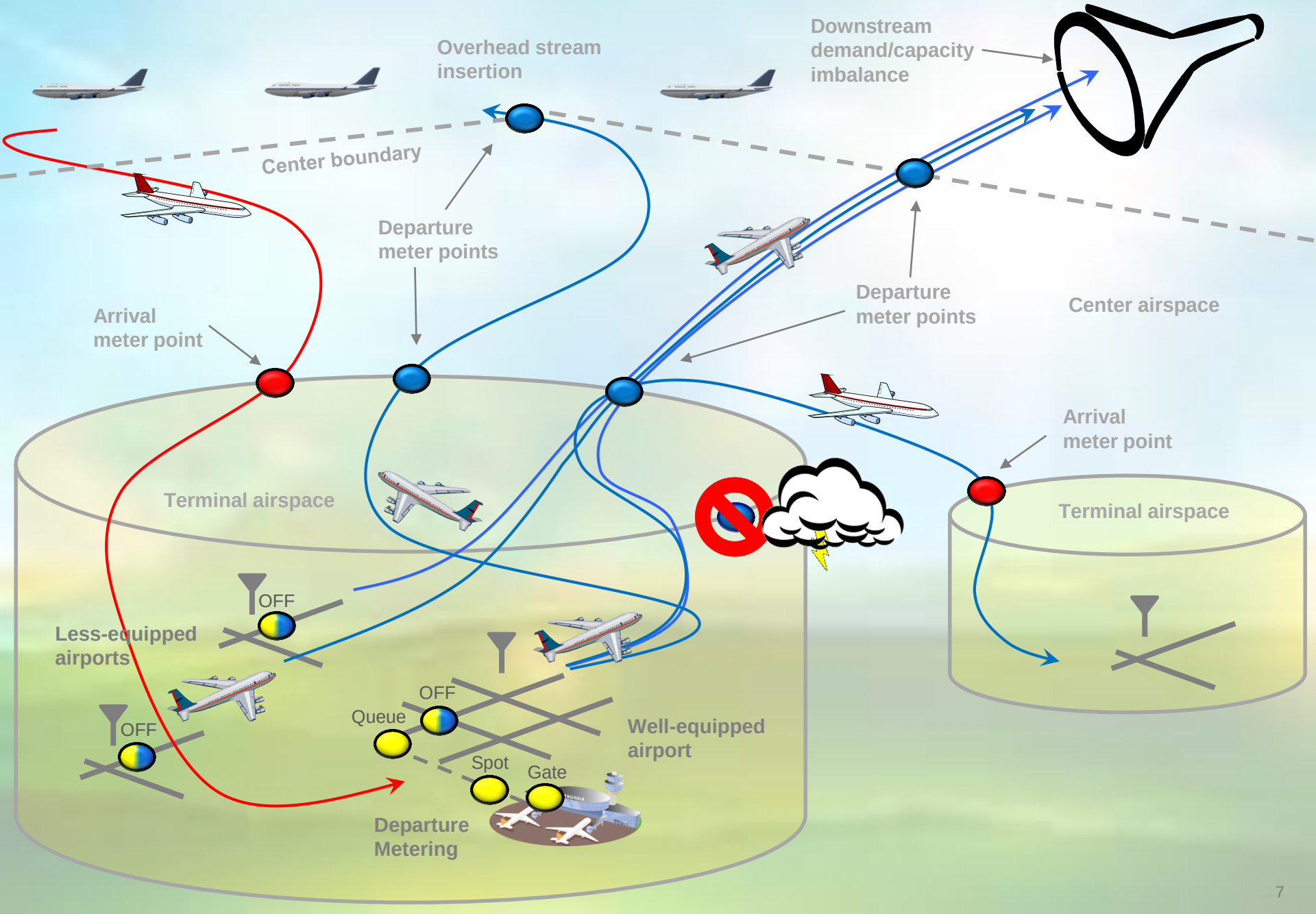
Some flight crews use onboard speed guidance to achieve and maintain precise traffic spacing.

Terminal controllers correct residual spacing errors and cope with disturbances and off-nominal events using tools and display enhancements based on 4-D trajectories.



Integrated Arrvial/Departure/Surface Metroplex Management

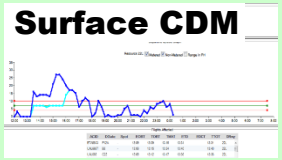
Operational Environment for the ATD-2 Concept



Operational Concept Graphic (OV-1)

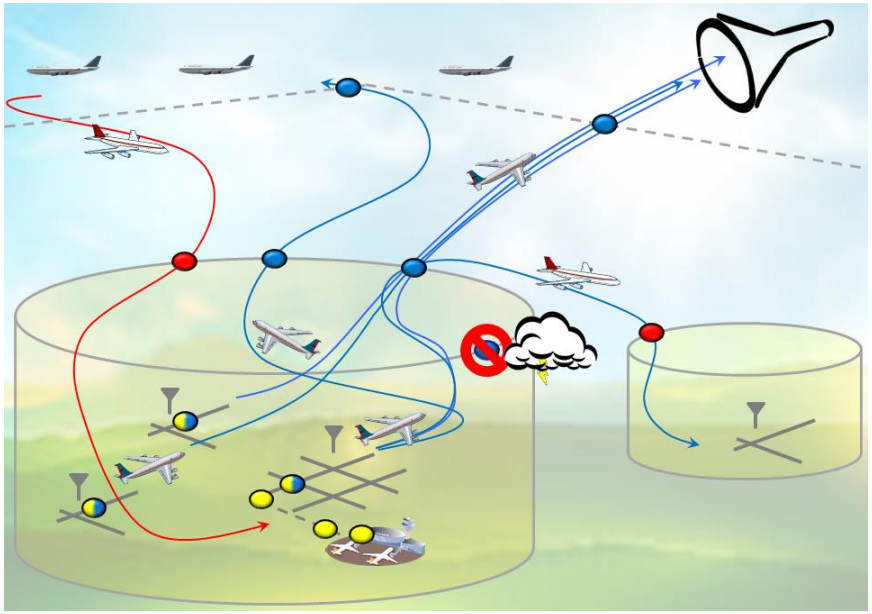
- TFDM EFD is controller interface to ATD-2 scheduling and metering
- Better predictability improves TMI compliance

- Tactical pushback advisories build on SARDA research
- Manage ramp traffic and meet strategic TMATs
- Ramp and gate status and intent information



- Builds on Surface CDM concept engineering effort
- Identify need to meter and compute ration-by-schedule strategic TMATs
- Accommodate airline priorities

Surface Components



- Earliest off block times
- Airline priorities via CDM
- Flight data

- Strategic TMIs
- Surface delays
- Multi-center coordination

- Airport conditions
- Additional flight operators

- Information exchange with commercial applications

External interfaces via SWIM and SWIM extensions

- Tactical departure scheduling builds on IDAC and PDRC
- Manage traffic to satisfy TMIs and departure metering

- Integrate TBFM/IDAC with ATD-2 surface system
- Improve TBFM departure trajectory predictions
- Departures into overhead and metered arrival streams

- Local TMIs and demand predictions for all airports
- Metroplex coordination and planning functions
- Explore departure controller advisory requirements

Airspace Components

Airspace Technology Demonstration 3

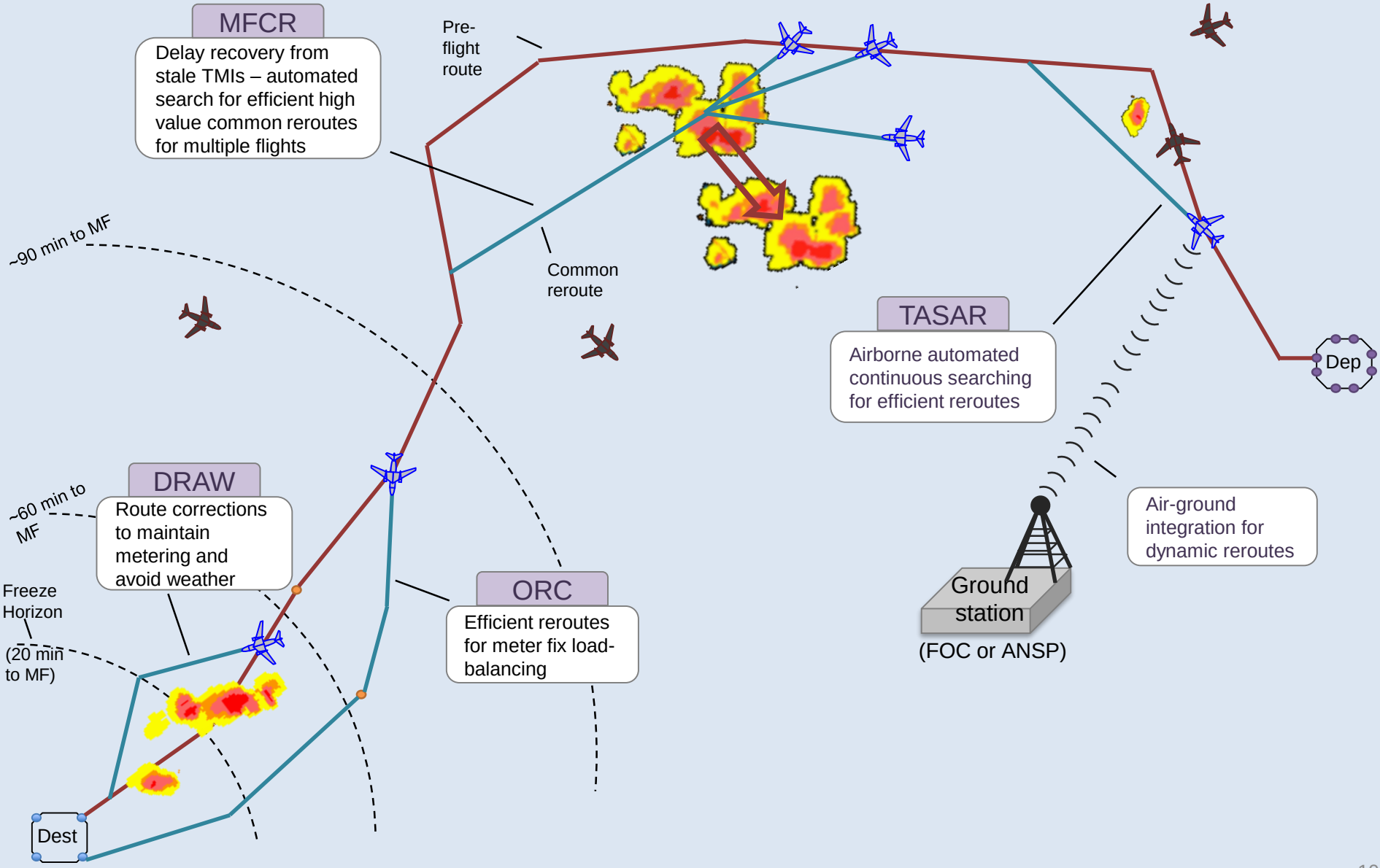
Applied

Traffic

Flow

Management

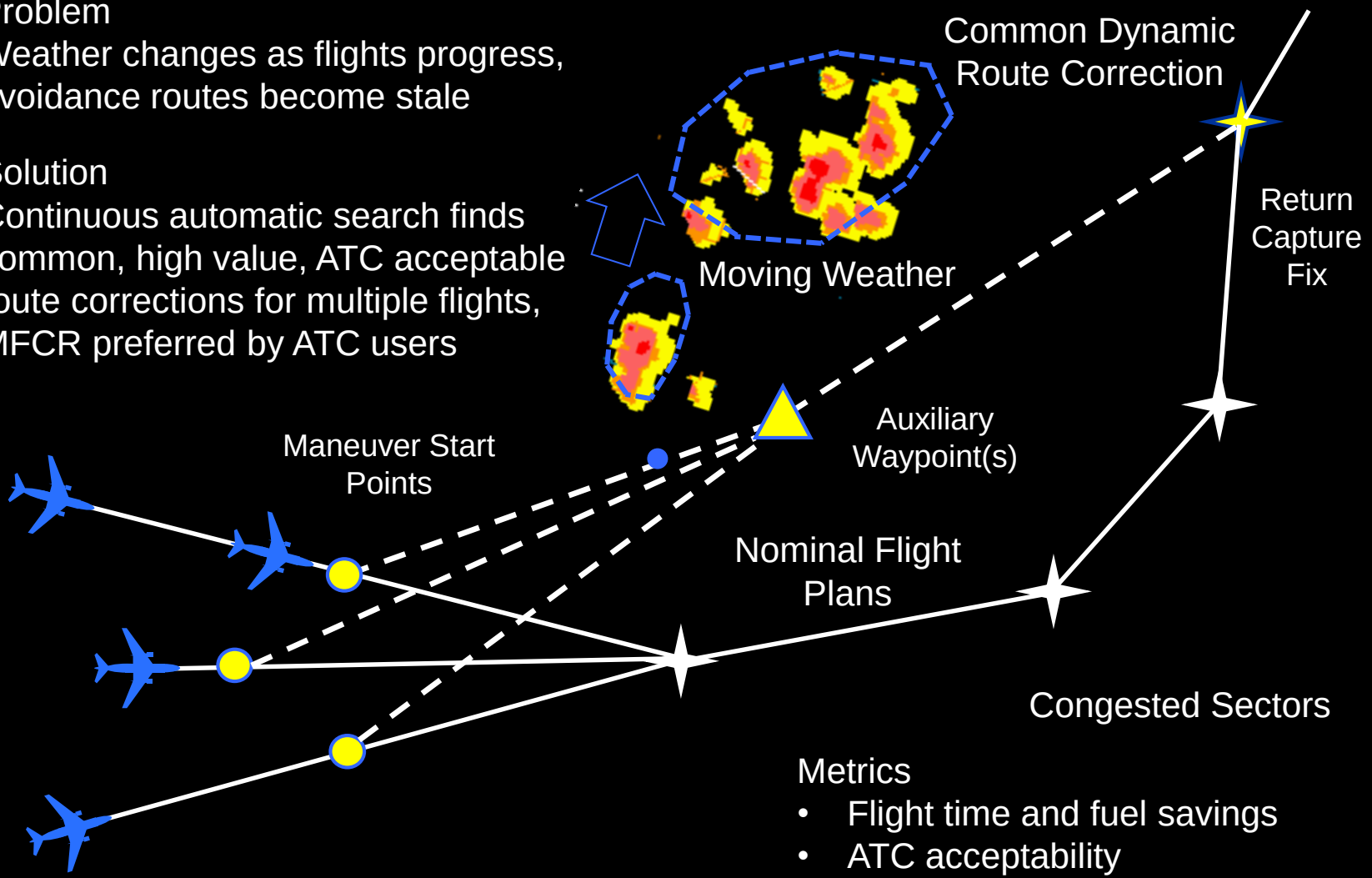
ATD-3 Integrated Concept



Multi-Flight Common Route (MFCR)

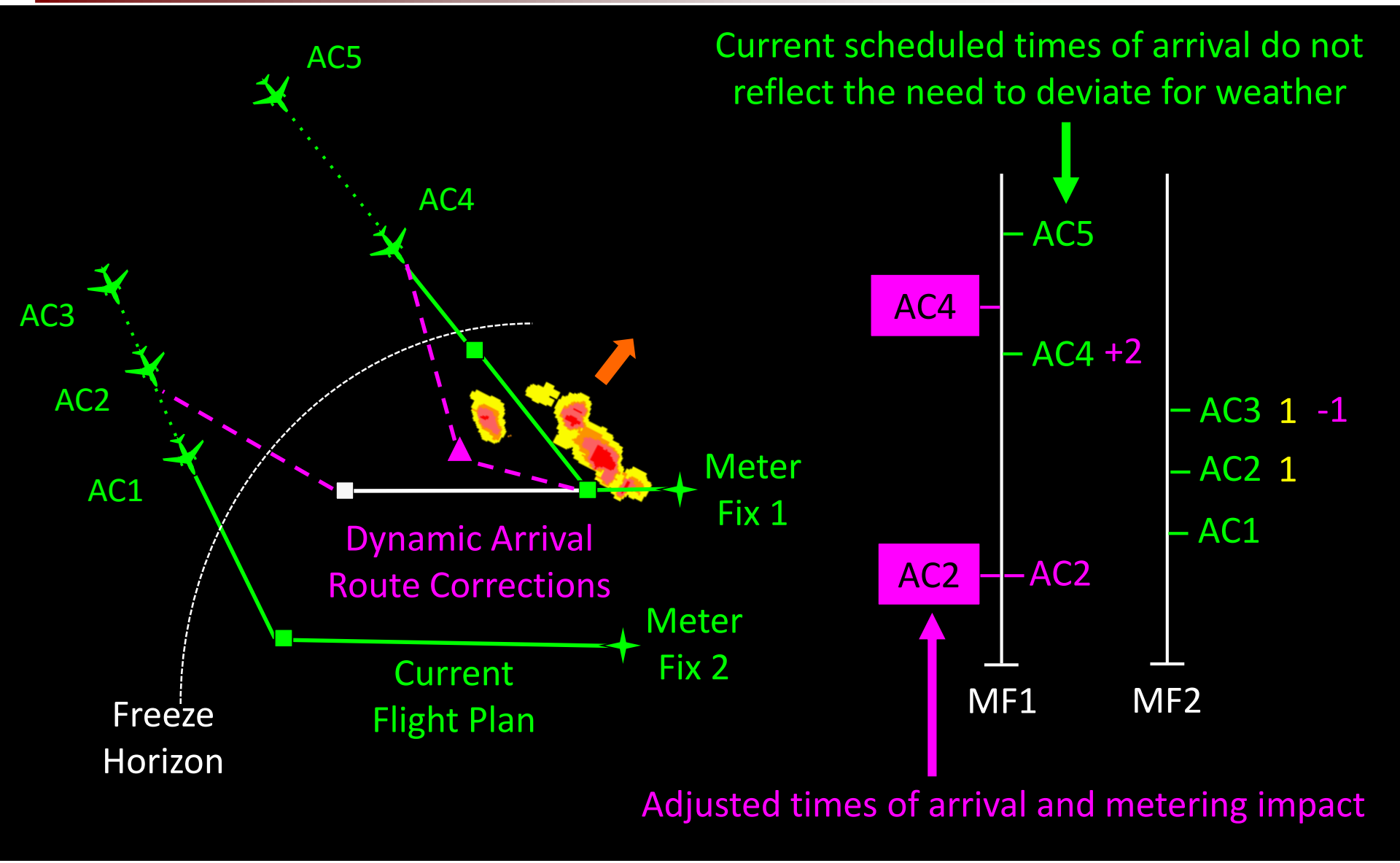
Problem
Weather changes as flights progress, avoidance routes become stale

Solution
Continuous automatic search finds common, high value, ATC acceptable route corrections for multiple flights, MFCR preferred by ATC users



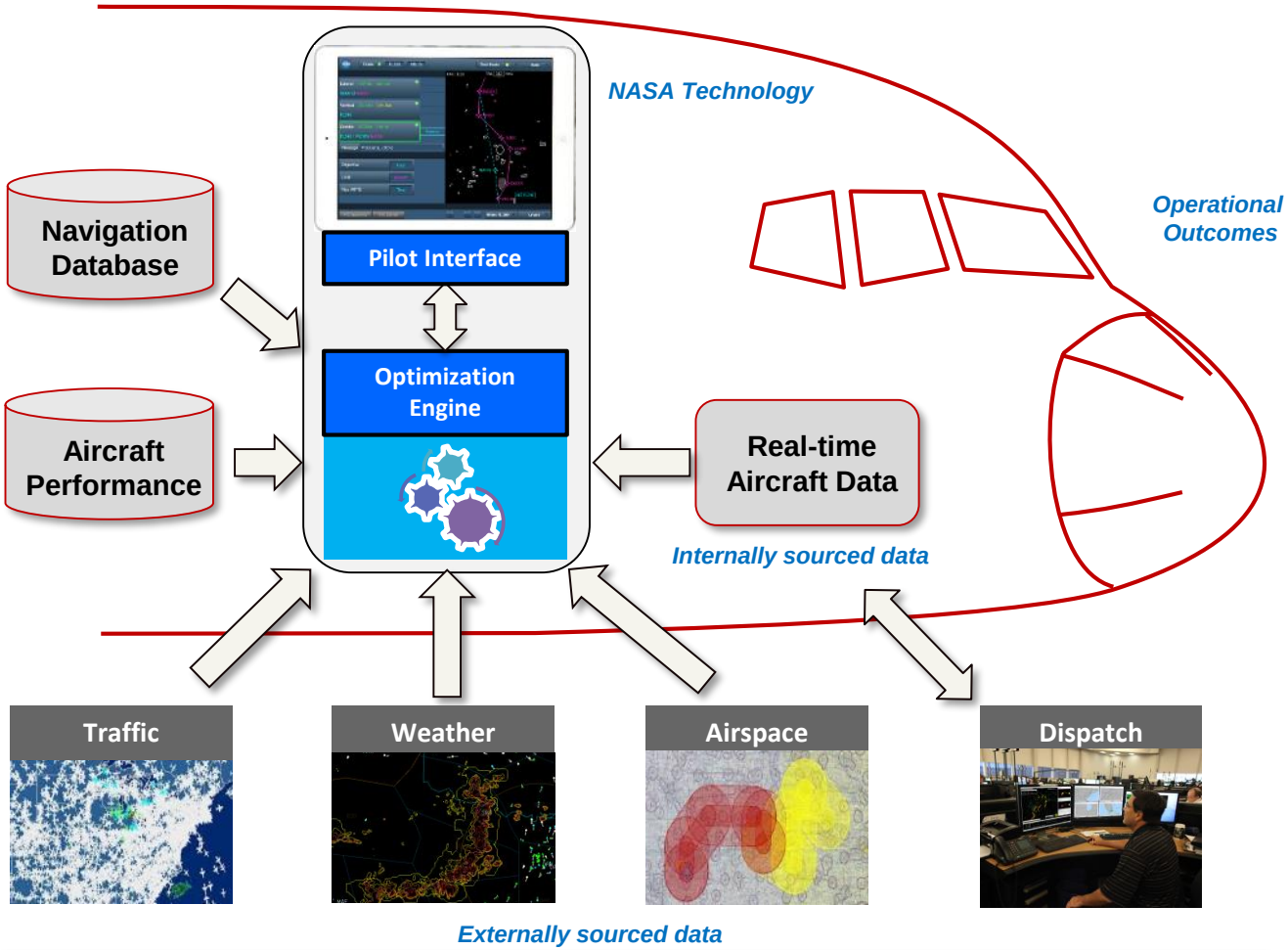
Metrics
- Flight time and fuel savings
- ATC acceptability
- Reduced operator workload

Dynamic Re-routes for Arrivals in Weather (DRAW)



Traffic Aware Strategic Aircrew Request (TASAR)

Pilot uses onboard automation tool to optimize an aircraft's trajectory



Tool leverages networked connectivity to real-time operational data

Greater flight efficiency en route

Crew Request ⇕ ATC Response

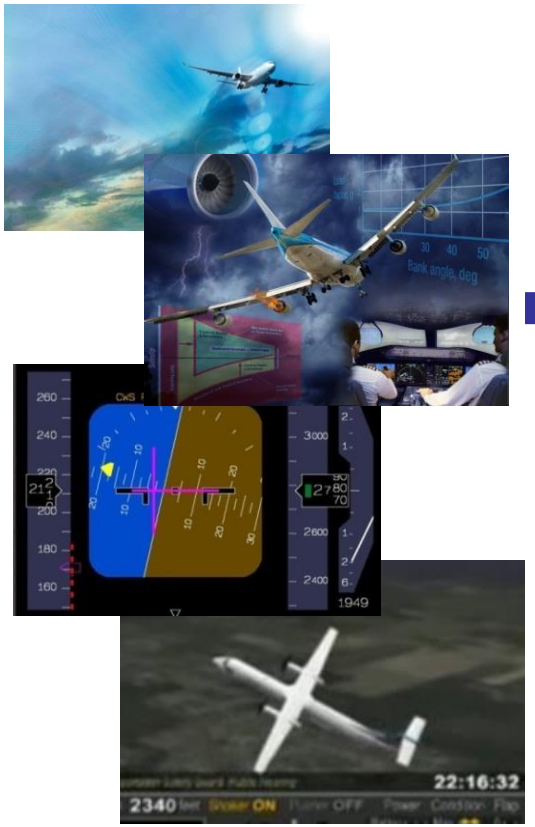
Increased ATC approval of requests

Technologies for Airplane State Awareness

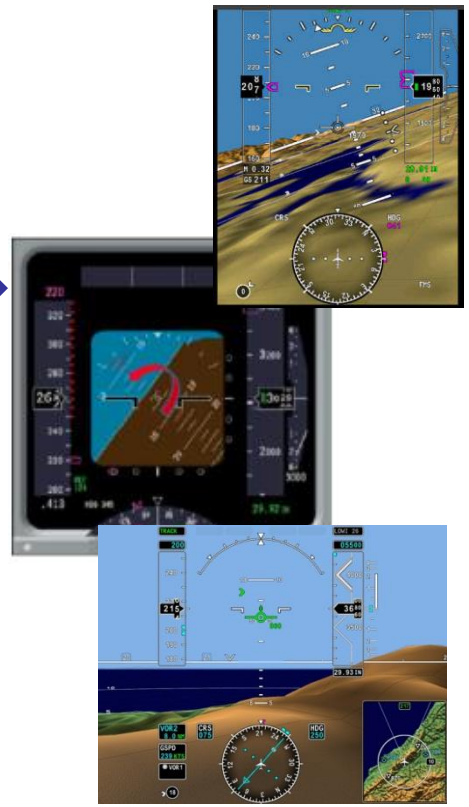
Technologies for Airplane State Awareness (TASA)

- CAST's Airplane State Awareness Joint Safety Implementation Team (ASA JSIT) Recommended Research Safety Enhancements (SEs)
- NASA's precursor safety focus to *Increase Pilots' Ability To Avoid, Detect, And Recover From Adverse Events That Could Otherwise Result In Accidents/Incidents*

Cause and Effect



Safety Enhancements



TASA: Safety Enhancements (SE)

Summary of Significant Themes Across All Events

	Lack of External Visual References	Flight Crew Impairment	Training	Airplane Maintenance	Safety Culture	Invalid Source Data	Distraction	Systems Knowledge	Crew Resource Management	Automation Confusion / Awareness	Ineffective Alerting	Inappropriate Control Actions	Total
Formosa Airlines Saab 340	x	x			x		x	x	x		x		7
Korean Air 747-200F	x			x		x	x		x		x		6
Flash Airlines 737-300	x		x		x		x		x	x	x	x	8
Adam Air 737-400	x		x	x			x	x	x	x	x	x	9
Kenya Airways 737-800	x		x				x		x	x	x	x	7
Aeroflot-Nord 737-500	x	x	x	x	x		x	x	x	x	x	x	11
Gulf Air A320	x		x				x		x		x	x	6
Icelandair 757-200 (Oslo)	x						x		x	x	x	x	6
Armavia A320	x	x			x		x		x	x	x	x	8
Icelandair 757-200 (Baltimore)	x				x	x	x	x	x	x	x	x	9
Midwest Express 717	x				x	x	x		x		x	x	7
Colgan Air DHC-8-Q400	x	x	x		x		x	x	x	x	x	x	10
Provincial Airlines DHC-8	x		x				x			x	x	x	6
Thomsonfly 737-300	x		x	x	x		x			x	x		7
West Caribbean MD-82	x	x			x		x	x	x	x	x	x	9
XL Airways A320		x	x	x	x	x	x	x	x	x	x		10
Turkish Airlines 737-800	x			x	x	x	x		x	x	x		8
Empire Air ATR-42	x	x					x		x	x	x		7
Overall	17	7	9	6	12	5	18	7	16	14	18	12	

Flight Deck Tools

- 200 Design Virtual-Day VMC Displays
- 207 Attitude and Energy State Awareness
- 208 Airplane Systems Awareness

Training Models, Data and Tools

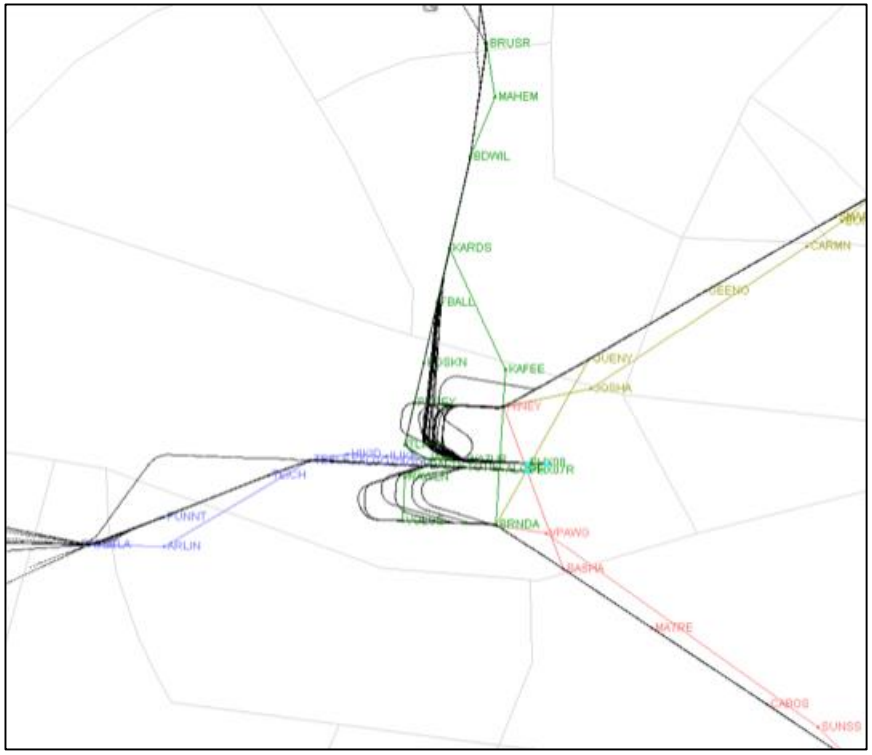
- 209 Research Simulator Fidelity
- 210 Flight Crew Performance Data
- 211 Training for Attention Management

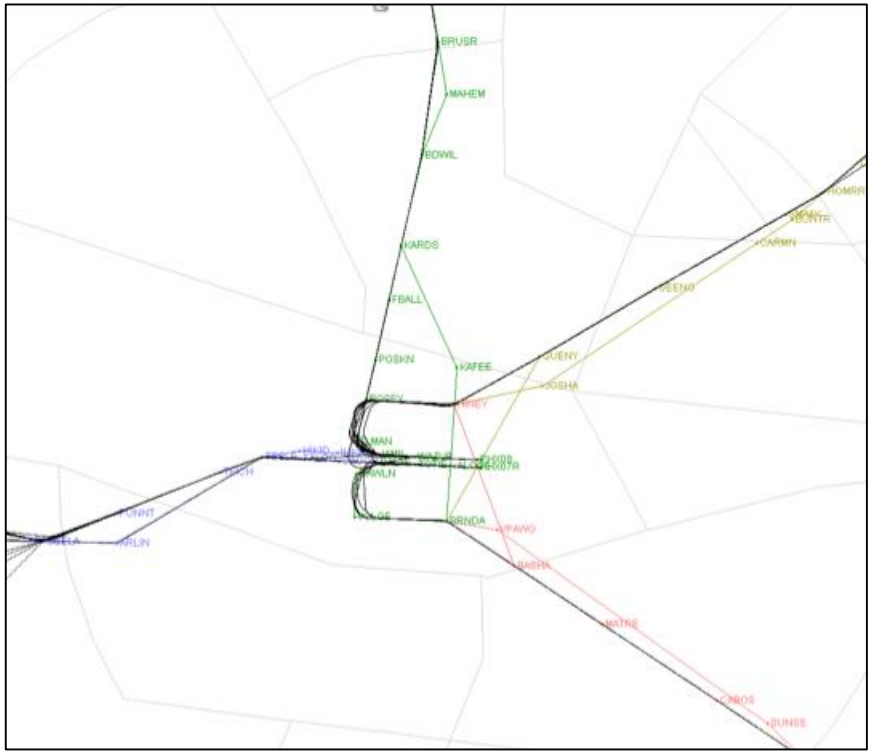
Concluding Remarks

- NASA has developed several foundational technologies in preparation for demonstrations
- These tools leverage the FAA and Industry investments in NextGen infrastructure: ADS-B, RNAV/RNP routes, OPD procedures, Surface Collaborative Decision Making (S-CDM), and Electronic Flight Data
- These technologies demonstrate the benefits of a critical set of NextGen capabilities for future trajectory based operations

Thank you

Operational Improvement



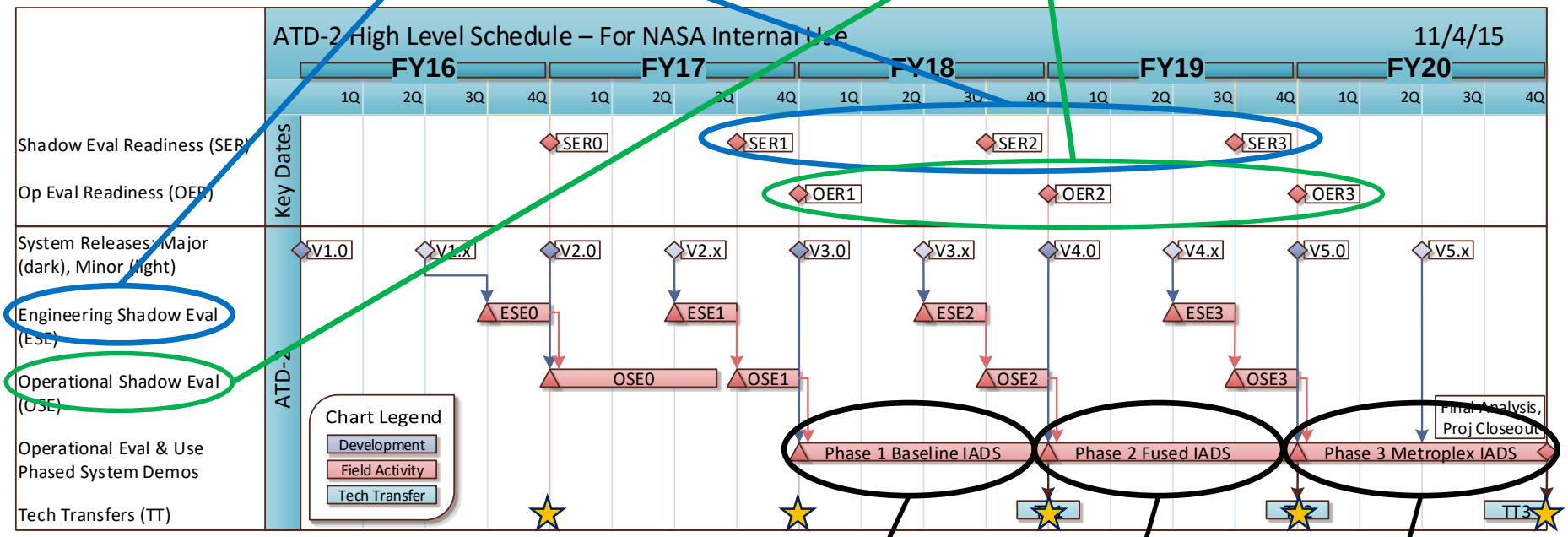


During high-fidelity human-in-the-loop simulations, terminal controllers have been able to maintain consistent use of PBN procedures during busy traffic periods without increased workload by using TSS.

Field Demonstration Strategy

Engineers assess readiness for shadow evaluation by operators

Operators assess readiness for operational evaluation & use



	Commitments to FAA
Sep 2016	ATD-2 system installation at CLT
Sep 2017	ATD-2 demonstration commences
Sep 2018	interim technology transfer
Sep 2019	interim technology transfer
Sep 2020	final technology transfer

Phase 1: Baseline IADS

Phase 2: Fused IADS

Phase 3: Metroplex IADS

Optimized Route Capability (ORC)

- **Capability**
  - Intelligent off-loading of over-loaded meter fixes
  - Data-driven processes to predict when capacity limits will be exceeded
  - Ability to identify optimal path routing options to balance capacity
- **Benefits**
  - Improving overall system efficiency by utilizing data-driven traffic flow management decisions to optimize route configurations
  - Reducing delay and fuel consumption by minimizing the need for holding and tactical maneuvering (i.e., vectoring)
  - Enhanced utilization of Performance-Based Navigation (PBN) routing and other NextGen capabilities
  - Augments today's metering capabilities

Without intervention, demand exceeds capacity at NW arrival gate and results in holding

1. ORC identifies excess demand
2. ORC alerts TMC/STMC
3. ORC identifies candidate reroute
4. TMC/STMC accepts solution