

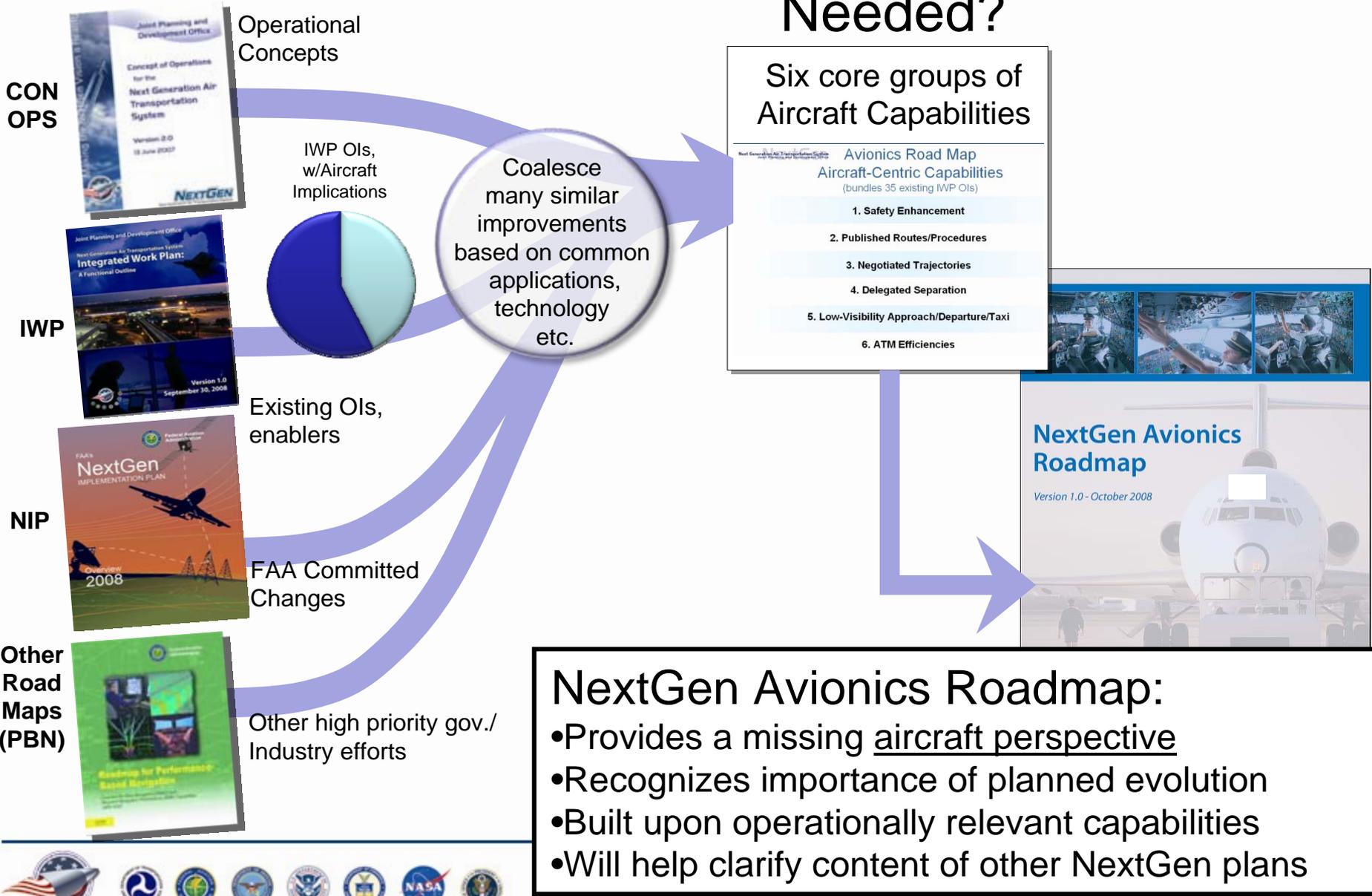
NextGen Avionics Roadmap

JPDO Aircraft Working Group

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Why is a NextGen Avionics Roadmap Needed?



JPDO Aircraft Working Group NextGen Avionics Roadmap

- Translates many proposed NextGen improvements into aircraft-related capabilities and functions.
- Avionics-enabled improvements in the Roadmap are presented in six groups of related operational capabilities

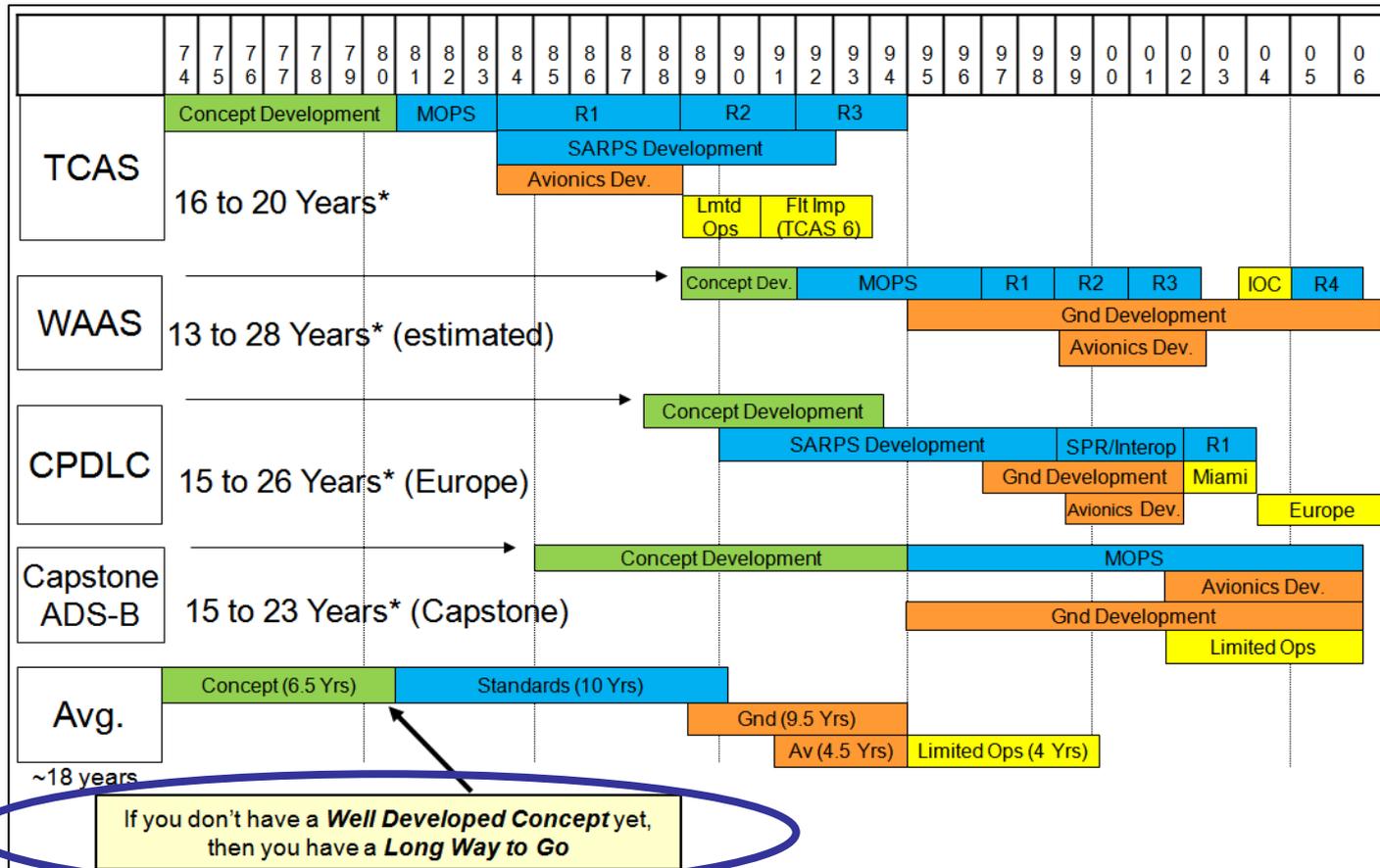


Operational Groupings:

1. Safety Enhancement
2. Published Routes/Procedures
3. Negotiated Trajectories
4. Delegated Separation
5. Low-Visibility Approach/Departure/Taxi
6. ATM Efficiencies

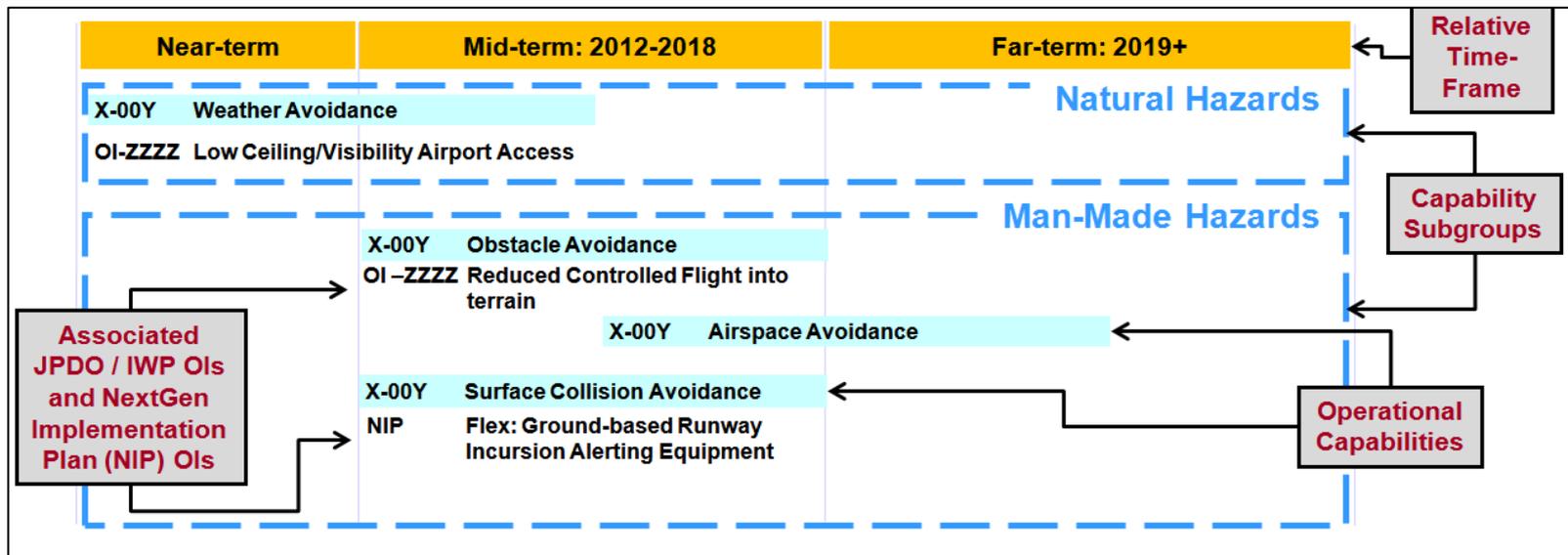
JPDO Aircraft Working Group NextGen Avionics Roadmap

Recognizes the reality and challenge we face in implementing NextGen.
Examples of time spans for changes involving Avionics



JPDO Aircraft Working Group NextGen Avionics Roadmap

Operational capabilities time-ranges are shown and a mapping of the operational improvements (OIs) from the JPDO Integrated Work Plan (IWP), the NextGen Implementation Plan (NIP), and the Performance Based Navigation Roadmap (PBN) that support that capability.



Note: The scope of work in the Roadmap is initially limited to the near- and mid-term implementations up to 2018. Items deferred have been identified.

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Example: Safety Enhancements

Near-term	Mid-term: 2012-2018	Far-term: 2019+
		Natural Hazards
	SAFE-001 Enhanced Low Altitude Operations	
	OI-3010 Reduced Controlled Flight into Terrain – Level 1	
SAFE-002 Weather Avoidance		
NIP FIS-B	NIP On-Demand NAS Information (C-ATM)	
		Man-Made Hazards
	SAFE-003 Obstacle Avoidance	
	OI-3010 Reduced Controlled Flight into Terrain – Level 1	
SAFE-004 Airborne Collision Avoidance		
SAFE-005 Surface Collision Avoidance		
NIP TIS-B	OI-0332 Ground-based and On-board Runway Incursion Alerting	
	NIP Provide Full Surface Situation Information (FT)	
SAFE-006 Airspace Avoidance		
NIP FIS-B (TFRs)	NIP On-Demand NAS Information (C-ATM)	
	NIP Improved Management of Airspace for Special Use	
		SAFE-007 Wake Avoidance & Mitigation: Combination Air and Ground
		SAFE-008 Wake Avoidance & Mitigation: Aircraft Based

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Initially identifying the current key enablers for each operational change. Follow on activity will provide information on equipage evolution and functional changes.

Capability	Key Enablers
SAFE-001: Enhanced Low Altitude Operations – Leverage enhancements to TAWS along with higher integrity and resolution terrain databases to reduce CFIT.	<u>RNP (As required by specific procedure).</u> <i>Improved Terrain Database, TAWS Enhancements</i>
SAFE-002: Weather Avoidance – Reduce impact of hazardous weather through broadcast of text and graphical weather information to aircraft.	FIS-B, Moving Map
Reduce impact of hazardous weather through data link of enhanced weather and turbulence forecasts to aircraft.	FIS-B, Moving Map, and For text only weather information: Initial Data Link (FANS 1/A+, <u>FANS 2/B, ATN Baseline 1 LINK Post Pioneer</u>) For text and graphical weather information: Data Link (Not supported by initial data link enablers)
SAFE-003: Obstacle Avoidance – CFIT is further reduced through availability of higher-frequency updates related to the position of temporary and permanent (fixed) man-made obstacles.	<i>Improved Terrain Database, Improved Obstacle Database, <u>Moving Map</u></i>

Safety Enhancements/Hazard Avoidance & Mitigation Capabilities

Near-term	Mid-term: 2012-2018	Far-term: 2019+
		Natural Hazards
	SAFE-001 Enhanced Low Altitude Operations	
	OI-3010 Reduced Controlled Flight into Terrain – Level 1	
SAFE-002 Weather Avoidance		
NIP FIS-B	NIP	On-Demand NAS Information (C-ATM)
		Man-Made Hazards
	SAFE-003 Obstacle Avoidance	
	OI-3010 Reduced Controlled Flight into Terrain – Level 1	
SAFE-004 Airborne Collision Avoidance		
SAFE-005 Surface Collision Avoidance		
NIP TIS-B	OI-0332 Ground-based and On-board Runway Incursion Alerting	
	NIP	Provide Full Surface Situation Information (FT)
SAFE-006 Airspace Avoidance		
NIP FIS-B (TFRs)	NIP	On-Demand NAS Information (C-ATM)
	NIP	Improved Management of Airspace for Special Use
		SAFE-007 Wake Avoidance & Mitigation: Combination Air and Ground
		SAFE-008 Wake Avoidance & Mitigation: Aircraft Based

Publish Routes and Procedures Capabilities

Near-term	Mid-term: 2012-2018	Far-term: 2019+
		RNAV and RNP SIDs and STARS
	<p>PRP-001 Reduce Lateral Track Spacing Using RNP</p> <p>OI-0348 Reduced Separation – High Density Terminal, Less Than 3 Miles</p> <p>PBN RNP-2 Routes</p> <p>PBN RNP-1 or lower SIDs/STARs where beneficial</p> <p>PRP-002 Integrated Arrival/Departure Airspace Management</p> <p>OI-0311 Enhanced Arrival/Departure Routing and Access</p> <p>NIP Hi Density: Integrated Arrival/Departure Airspace Management</p> <p>PBN Enhanced automation incorporating aircraft navigation capabilities</p> <p>PBN RNAV SIDs/STARs at many of the top 100 airports</p> <p>PRP-003 Closed Loop Lateral Offsets for Time of Arrival Control</p> <p>NIP Hi Density: Time Based Metering with RNAV/RNP</p> <p>NIP 3D PAM Demonstration at DEN</p> <p>PBN Airspace redesign and procedures for RNAV and RNP with 3D, CDA, and time of arrival control</p>	
	<p>PRP-004 Optimized Descent Profiles (FMS Only)</p> <p>OI-0330 Time-Based and Metered Routes with CDA</p> <p>NIP Flex: Use Optimized Descent Profiles</p> <p>PBN Concepts for RNAV and RNP with 3D, constant descent arrivals (CDA), and time of arrival control</p>	<p>OI-0330 Time-Based and Metered Routes with CDA</p> <p>NIP Tailored Arrivals</p> <p>PBN Airspace redesign and procedures for RNAV and RNP with 3D, CDA, and time of arrival control</p>
		PRP-005 3D RNP Arrival and Departure Operations
		PBN Airspace redesign and procedures for RNAV and RNP with 3D, CDA, and time of arrival control
		Reduced Oceanic Separation
	<p>PRP-006 Reduced Oceanic Separation – Altitude Change Pair-wise Maneuvers</p> <p>OI-0353 Reduced Oceanic Separation - Altitude Change Pair-wise Maneuvers</p> <p>NIP Oceanic In-Trail Climb and Descent</p> <p>PBN Limited RNP-4 and 30NM lat in WATRS</p>	
	<p>PRP-007 Reduced Non-Radar Separation with ADS-B out (Gulf of Mexico)</p> <p>OI-0347 Reduced Separation Non-Radar Airspace 5 Miles</p> <p>NIP Commitment to ADS-B in Gulf of Mexico in 2010</p>	

Negotiated Trajectories Capabilities

Near-term	Mid-term: 2012-2018	Far-term: 2019+
Improve Traffic Management with Limited Trajectory		
NT-001 Oceanic Airspace; Flexible Entry Timing	NT-002 Overhead Flow; Flexible Entry Timing	
OI-0304 Improved Collaborative Oceanic Routing	NT-003 Initial Surface Traffic Management	
NIP Flexible Entry Times for Oceanic Tracks	OI-0320 Surface Management – Level 1	
	NIP Provide Full Surface Situation Information	
NT-004 Terminal Airspace; Flexible Entry Timing		
Improve Traffic Management with RTA		
	NT-005 Route Clearance with RTA	
	NIP TBM using RNAV&RNP Route Assignments	
	NT-006 Route Clearance with RTA and Downlink of Expected Trajectory	
	NT-007 Trajectory Clearance with RTA and Downlink of Expected Trajectory	
	OI-0357 Trajectory Based Mgmt – Level 1 Route/Trajectory Digital Exchange	
	OI-0358 Trajectory Based Mgmt – Level 2 Trajectory Based Decision Support	
	OI-0360 Trajectory-Based Mgmt – Level 3 Automation-Assisted Trajectory Negotiation	
	OI-0369 Trajectory Based Mgmt – Level 4 Automated Negotiation/Separation Mgmt	
Improve Traffic Management with Full 4DT		
		NT-008 Airborne Lateral/Vertical/Time Clearance
		NT-009 Taxi Lateral/Time Clearance
	OI-0357 Trajectory Based Mgmt – Level 1 Route/Trajectory Digital Exchange	
	OI-0358 Trajectory Based Mgmt – Level 2 Trajectory Based Decision Support	
	OI-0360 Trajectory-Based Mgmt – Level 3 Automation-Assisted Trajectory Negotiation	
	OI-0369 Trajectory Based Mgmt – Level 4 Automated Negotiation/Separation Mgmt	

Delegated Separation Capabilities

Near-term	Mid-term: 2012-2018	Far-term: 2019+
		Flight-Deck Merging and Spacing
DS-001	Merging and Spacing	
OI-0326	Airborne Merging and Spacing – Single Runway OI-0338, OI-0355, OI-0333	
NIP	Delegated Responsibility for Separation (TBO)	
DS-002	Use Optimized Profile Descents (FMS + FDMS)	
OI-0329	Airborne Merging and Spacing with CDA	
		Delegated Separation Operations
		DS-003 Delegated Separation for Specific Operations
		OI-0356 Delegated Separation – Pair-wise Maneuvers
		OI-0359 Delegated Separation – Oceanic
		DS-004 Delegated Separation for Complex Operations
		OI-0363 Delegated Separation – Complex procedures
		DS-005 Delegated Separation in Flow Corridors
		OI-0337 Flow Corridors – Level 1 Static
		OI-0368 Flow Corridors – Level 2 Dynamic
		CSPA and Converging In Low Visibility
		DS-006 Paired Approach in IMC to Closely Spaced Parallel Runways
		OI-0335 Dependent Multiple Approaches in IMC
DS-008	Enhanced Visual Approach	
OI-0316	Enhanced Visual Separation for Successive Approaches	
NIP	Delegated Responsibility for Separation	
DS-009	ADS-B Approach Spacing	
		DS-007 Independent IMC Approaches to Closely Spaced Parallel Runways
		OI-0334 Independent Parallel or Converging Approaches in IMC
		NIP Improved Operations to Closely-Spaced Parallel Runways

Low-Visibility Approach/Departure/Taxi Capabilities

Near-term	Mid-term: 2012-2018	Far-term: 2019+
Enhanced Approach, Landing, and Takeoff Operations		
LV-001 Low Visibility Approach Operations		
OI-0381 Low Ceiling/Visibility Airport Access		
NIP Ground-Based Augmentation System		
	LV-002 Low Visibility Landing Operations	
	OI-0317 All Weather Airport Access	
	LV-003 Low Visibility Takeoff Operations	
	OI-0381 Low Ceiling/Visibility Airport Access	
Enhanced Surface Operations		
		LV-004 Low Visibility Surface Operations
		OI-0322 Low Visibility Surface Operations

ATM Efficiency Capabilities

Near-term	Mid-term: 2012-2018	Far-term: 2019+
Enhance Aircraft/ATM Information Exchange		
ATM-001 Data Link Pre-departure Clearance Revisions		
OI-0321 Surface Management – Level 2 Data Link/Departures		
NIP Enhanced Surface Traffic Operations		
	ATM-002 Data Link En Route Clearance Delivery and Frequency Changes	
	OI-0352 Automated Clearance Delivery and Frequency Changes	
		ATM-003 Data Link Taxi Instructions
		OI-0327 Surface Management – Level 3 Arrivals/Winter Operations/Runway Configuration
		OI-0321 Surface Management – Level 2 Datalink/Departures
	ATM-004 Data Link NAS Information and Advisories	
	NIP On-demand NAS Information	
Increase Access and Throughput at Non-Towered/Uncontrolled Airports		
		ATM-005 Increase Access and Throughput at Non-Towered/Uncontrolled Airports
		OI-0313 Virtual Towers – Level 1 Sequencing, Separation, and Spacing
		OI-0315 Virtual Towers – Level 2 Sequencing, Separation, Spacing, and Surface Management
Reduce Weather Impacts through Improved Forecasting		
		ATM-006 Reduce Weather Impacts through Improved Forecasting
		OI-2020 Net-Enabled Common Weather Information – Level 1 Initial Capability
		OI-2021 Net-Enabled Common Weather Information – Level 2 Adaptive Control/Enhanced Forecast
		OI-2022 Net-Enabled Common Weather Information – Level 3 Full NextGen

Avionics Roadmap: Appendix 1 -- TBO

- Direct mapping from JPDO Conops and further detailed work
- Subject of the vast majority of Roadmap v.1 comments
- We need to have greater outreach and concurrence on the concepts and detail objectives for TBO
- Current work in AWG-ANS, as well as internal to FAA

TBO Framework

- Mixed-capability TBO forms an inclusionary basis everywhere in the NAS
- All aircraft have an associated 4DT
 - ATM systems are repositories of 4DT
- Transition to 4DT begins with ATM supporting conops, and data communications
- 4DT is negotiated prior to flight, ATM tools set performance, windows, constraints
- Clearances modify trajectories

Avionics Road Map Aircraft-Centric Capabilities

1. Safety Enhancement

2. Published Routes/Procedures

3. Negotiated Trajectories

4. Delegated Separation

5. Low-Visibility Approach/Departure/Taxi

6. ATM Efficiencies

NAV

+COMM

+ADS-B In

Affected by TBO

Spacing and Delegated Separation

- Spacing Applications
 - No change in roles and responsibilities for flight crew or controller
 - Enables precise navigation to be relative to another aircraft
 - Particularly valuable for in-trail and merging – dealing with fourth dimension of time or along-track
- Delegated Separation
 - Ability to delegate separation to flight crew for specific instances
 - Particularly valuable in approach operations, as in visual approaches today

Potential Interaction? Precision on 4D Trajectory Clearance Eliminates Flexibility for Aircraft-Based Spacing/Separation

Unifying TBO and Spacing/Separation

- TBO Concepts must allow aircraft operator some (predetermined) flexibility in the trajectory: a trajectory **window**
 - For flight optimization, when practical (e.g., Continuous Descent Arrival)
 - For maintaining spacing to another aircraft
- Improved efficiency under some conditions will occur with less-specific trajectory clearance
 - Larger window
 - Also enables flight-specific efficiencies where there is excess capacity

Phases of Trajectory Operations

Pre-Negotiation

- ANSP identifies constraints (airspace, airport, weather, minimum acceptable performance)
- Operator identifies objectives and constraints (performance capability, weather)

Negotiation

- Use all available data to define desired trajectory and resolve likely conflicts
- Can occur between ANSP & Flight Crew or ANSP and Flight Ops Center
- Can occur pre-flight or in-flight

Contract

- Trajectory window and performance, request and acceptance
- Window can collapse to single trajectory
- ANSP verifies trajectory is acceptable
- Flight crew verifies trajectory is acceptable

Execution

- Aircraft operator is responsible for compliance to clearance
- ANSP maintains separation except where delegated

**System-Wide
Information
Management**

**Data
Communi-
cation**

**ADS-B,
Data
Comm.**



NextGen Challenges

- End-to-end safety analysis & performance allocation
 - Integrating actions and responsibilities across the agency (AVS, ATO, Airports) to support NAS level changes
- Integration of NextGen into agency wide planning
 - Avionics Roadmap provides a foundation to move forward
 - Roadmap aimed at providing a clear aircraft perspective that must be carried into other permanent NextGen planning work
 - Considerable work still needed to clearly define roles and where work should reside (FAA, JPDO, RTCA, PARC,...) to avoid duplication
- Equipage strategy
 - Complex issues and significant policy considerations involved
- Migration of avionics architecture
 - Air/ground functional allocation – major questions and differing view points

JPDO Aircraft Working Group NextGen Avionics Roadmap

Next Steps

1. Develop mature content for the far term 2019 – 2025
2. Develop specific functional and performance requirements enabling change, design, development and/or implementation
3. Outreach within JPDO and external Stakeholders
4. Expand scope of work to address GA, Military, UAS, etc communities
5. Determine aircraft related operational improvements from the deferred items.
6. Coordinate with JPDO to develop the cost, risk and benefits assessments to support the roadmap and guide future work
7. Find a place for the Avionics Roadmap in JPDO documents.

Questions?