NAS EA Infrastructure Roadmaps: Supporting Activities

Federal Aviation Administration

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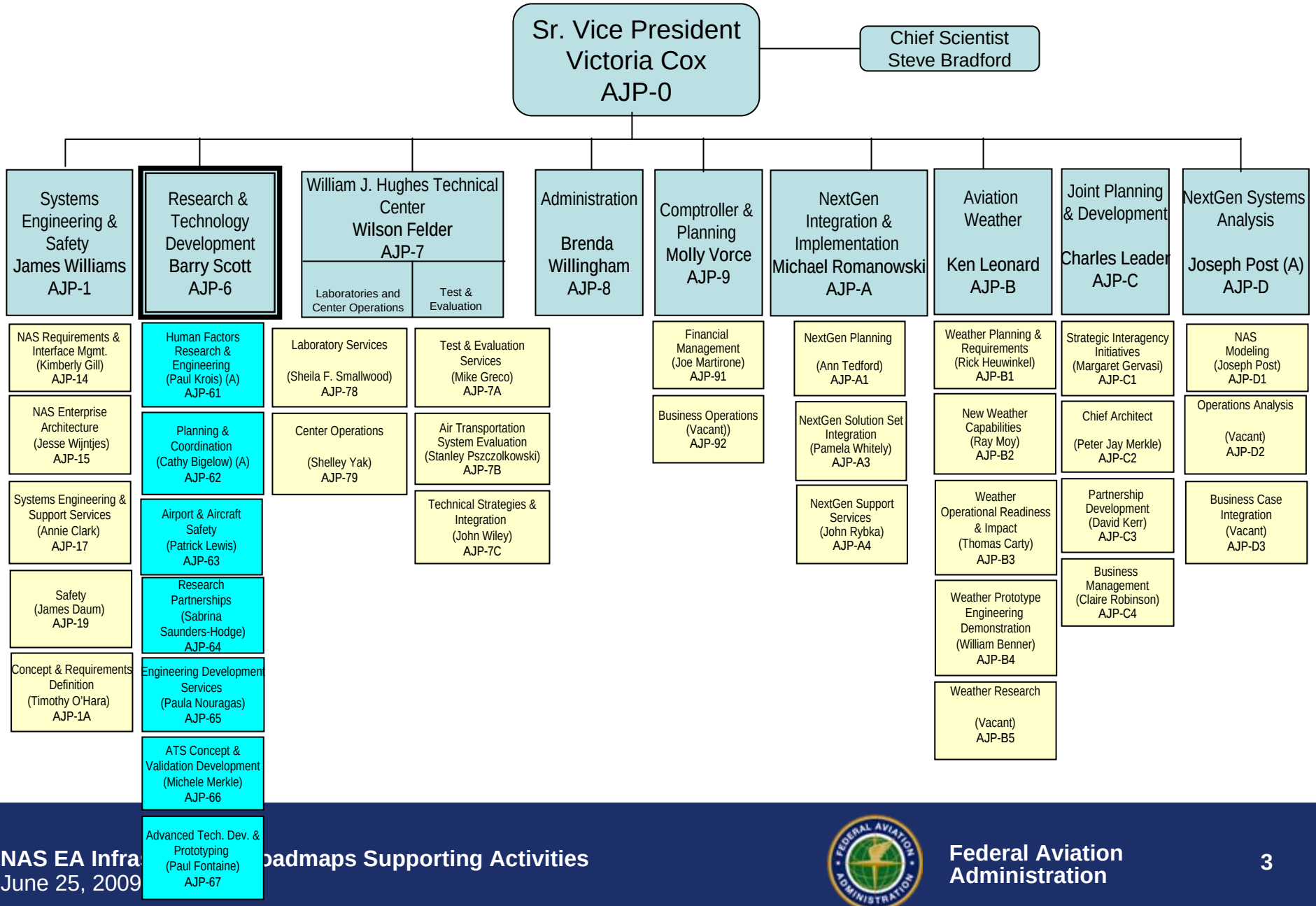
Briefing Outline

- **Role of Research & Technology Development**
- **Objective**
- **Methodology**
- **Human Systems Integration**
- **Concept Development and Demonstration Work**
- **Incorporation of Far-term Research**
- **Next Steps**

NextGen and Operations Planning



Objective

To identify activities internal and external to the FAA that support/impact/influence the decision points on the NAS Enterprise Architecture Infrastructure Roadmaps

Methodology

- **Categorize supporting activities**
  - Standards/Requirements Definition (Global Harmonization)
  - Research (R&TD, FAA/NASA RTT, NASA, MITRE, Academia, etc.)
  - Concept Development/Validation
  - Demonstrations/Simulations (technical, operational, laboratory)
  - Acquisition
- **Review/update all previously listed supporting activities**
- **Identify new near-term, mid-term and far-term supporting activities (internal and external)**
  - Start and end date
  - Decision Points related and Lead Organization responsible
  - Products expected from activity, leading to assignment of Technical Readiness/Maturity Level (TRL)
- **Collaborate with Roadmap Leads, NextGen I&I and Project Managers on mapping to appropriate decision point(s)**
- **Depict supporting activities on NAS EA roadmaps ("Green Swim Lanes")**
  - Research activities will influence multiple roadmaps

Human Systems Integration (HSI) Activities

- HSI impacts will be analyzed in terms of:
  - Specific actors within the domain (e.g., R-Side En-route Controller, Pilot)
  - Convergent or divergent roles (e.g., new actors, obsolete roles)
  - Implied role changes not apparent in the Operational Improvements description
  - Non-Operational Improvements dependent on changes to roles/functions (e.g., changes in and across domains such as Common Automation Platform/Display)
  - Decision Points on HSI roadmap will also be mapped to the infrastructure roadmaps that are influenced by HSI work.

Roadmap	Activity Name	Description	Start Date	End Date	TRL-Start	TRL-End/ Exit Crit	Lead Organization	Decision Point	Category
HumanSystem	Human Factors in Automation of Cross-Domain ATC Decision Support Tools	NextGen operational capabilities require changes in roles, automation, and decision support tools for air traffic controllers. Many of these changes imply the need for human-system integration requirements that cut across the boundardies of current domains. Research in this area addresses the cross-domain guidance, requirements, and standards for new automation, decision support tools, alerts, and conformance monitoring.	10/1/2009	10/1/2012	3	6	AJP-61	Provide HSI requirements and recommendations for cross-domain developments of new automation, decision support tools, alerting, and conformance monitoring.	R

The HSI roadmap is new & still in development. Discussions are underway with other roadmap teams regarding the depiction of HF influences on decision points.

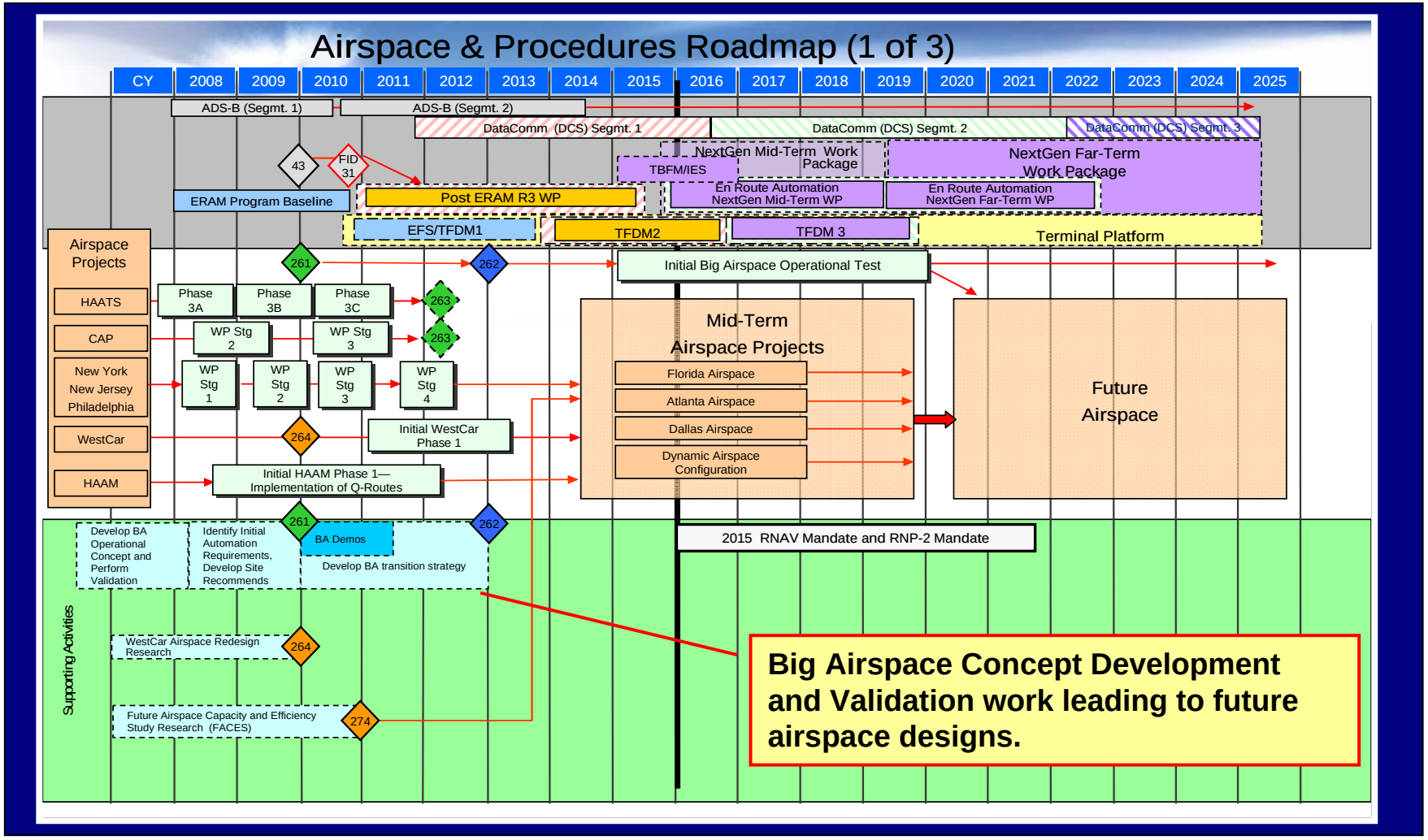
Concept Development Activities

Type of Supporting Activity	Category Code
Research	R
Demonstration/Simulation	D
Acquisition	A
Standards or Requirements Development	S
Concept Development and Validation	C

These activities are all part of the "Big Airspace" initiative, and this list of supporting activities takes the initiative from Concept Development through engineering requirements to testing and the decision to implement.

Roadmap	Activity Name	Description	Start Date	End Date	TRL-Start	TRL-End/ Exit Crit	Lead Organization	Decision Point	Category
Airspace and Procedures - 1 of 3	Develop Initial Big Airspace Operational Concept and Perform Validation	Develop and validate an operational concept for the use of different procedures that will take advantage of cross-domain (enroute and terminal) capabilities that are possible under a NextGen environment.	1/1/2007	3/31/2008	N/A	3	ATO-R	CE-x (generic decision to proceed with concept exploration).	C
Airspace and Procedures - 1 of 3	Identify Initial Automation Requirements and Develop Site Recommendations	*«need task description»*	4/1/2008	12/31/2009	3	5	ATO-R	DP# 261 (Big Airspace candidate sites selected).	R
<>	Big Airspace Procedures Demonstration	*«need task description»*	1/1/2010	6/30/2011	5	6	ATO-R	D-x (generic milestone showing whether demonstration met desired objectives).	D
Airspace and Procedures - 1 of 3	Develop Big Airspace transition strategy	Perform Alternatives Assessment for new hardware/software capability to perform Big Airspace operations. New procurement.	1/1/2010	12/31/2012	6	9	ATO-R	DP# 262 (Decision to implement Big Airspace at candidate areas).	A

Concept Development "Snapshot"



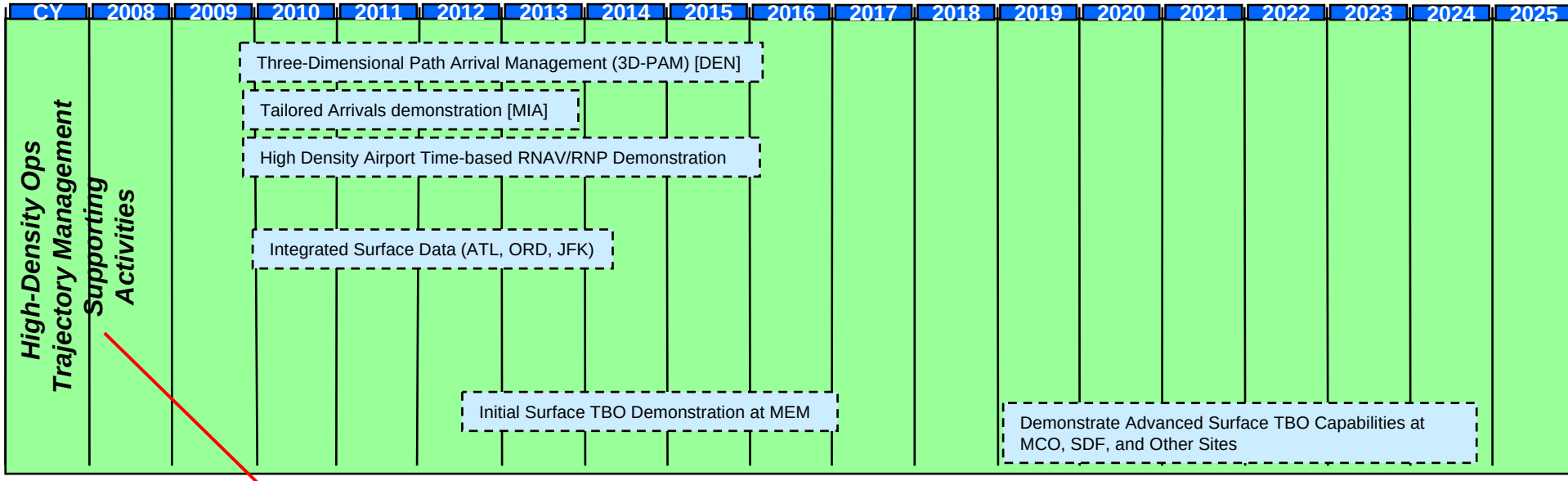
Demonstration Activities

Demo Activities	FY	Short Description	Systems Used	Airspace Adapted	Partnerships
AIRE Surface	**FY08/09/10**	Reduce emissions on the ground via Surface Systems	•ASDE •SDSS	•Memphis •Orlando •JKF	•Sensis •Mosaic ATM
TFDM	**FY10/11**	Terminal Flight Data Manager Phase 1 (TFDM1) integrates Airport Resource Management Tool (ARMT) Tower Data Link Services (TDLS), Surface Movement Advisor (SMA), and Airport System (AMASS) functions.	•ASDE •TFM •SDSS •ERAM •STARTS/ARTS •Wx Cube •Airfield / Ramp Info •TMA	•Orlando	•Adacel •Lincoln Labs
4-D FMS	**FY09/10/11**	Demonstrate operational capabilities and potential benefits of 4D Trajectory Based Operations (TBO)	•TMA / ERAM •ERAM / STARTS •737NG	•Orlando •Miami	•ERAU
Oceanic Trajectory Based Ops	**FY08/09/10**	Increase safety, capacity, productivity and efficiency by improving operational procedures and strategic planning in the oceanic environment	•ATOP •ERAM •Wx Cube	•NY Oceanic •Santa Maria Oceanic	•Boeing •CSSI •MITRE •AA •Foreign carriers •European partners

These are a sample of activities being performed at the Daytona Beach test-bed; other activities and other test-beds show our extensive “network” of demonstration capabilities.

Demonstrations on the Automation Roadmap "Snapshot"

Automation Roadmap: Supporting Activities—High-Density Ops (5 of 7)



In prior years, Demonstrations were not always linked to Decision Points. Collaboration with the roadmap leads and NextGen I&I during the summer integration sessions will result in the linkage of demonstrations to the proper DP(s) they support.

Research Partners Contributing to NextGen
(NASA Examples)

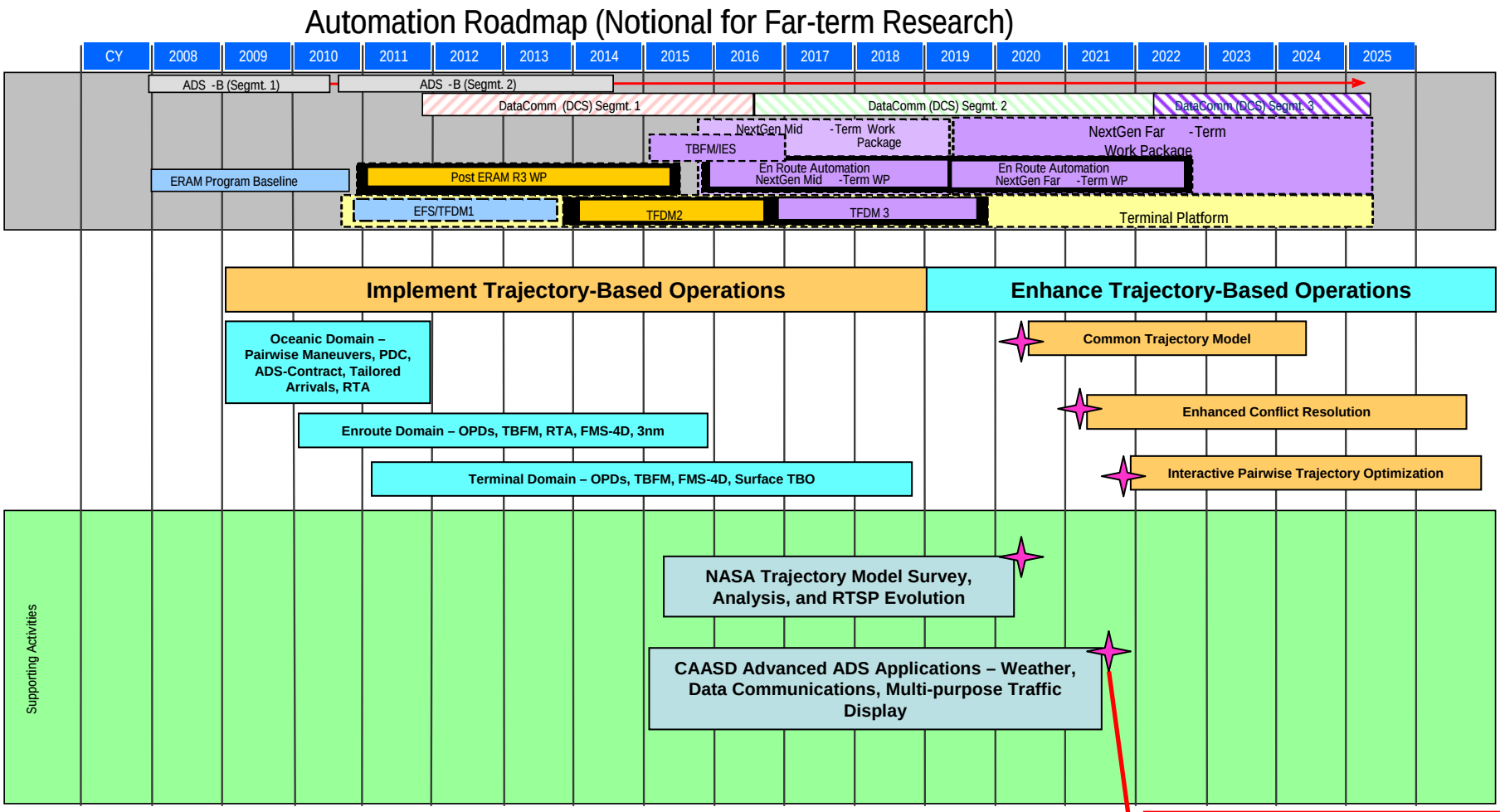
NASA Research and Development to NAS EA Mapping						
Activity Name	**Description**	**Research Roadmap(s)**	**Development/Acquisition Roadmap(s)**	**Start-Date**	**End-Date**	**TRL-End/ Exit Crit.**
Trajectory Modeling Survey	Survey and document the trajectory prediction/modeling algorithms and software capabilities (e.g., EDA, PARR, 4D-FMS) supporting the current state of the art (TMA, URET, FMS), and requirements envisioned for future TP capabilities to support NGATS-relevant trajectory prediction.	Automation	Automation; Aircraft	<>	<>	<>
Measuring Differences Between Trajectory Models	Develop algorithms for measuring the difference between 4D trajectories.	Automation	Automation; Aircraft	<>	<>	<>
Requirements for ATM Trajectory Modeling	Identify and quantify a complete set of constraints and objective functions typically applied to trajectories to support ATM functions.	N/A	Automation; Aircraft	<>	<>	<>
Uncertainty in Trajectory Modeling	Identify and quantify sources of uncertainty for trajectory prediction.	Automation	Automation; Aircraft	<>	<>	<>
Trajectory and Intent Data Matching	Develop data mining techniques for identifying trends in trajectory intent error.	Automation	Automation; Aircraft	<>	<>	<>
Modeling RTSP Performance	Identify suitable techniques for modeling RTSP performance characteristics.	Automation	N/A	<>	<>	<>

"Far-Term" research activities will be depicted, but specific dates and TRL-End criteria will defined in the future .

Research Partners Contributing to NextGen
(CAASD Examples)

CAASD EA Supporting Activities						
Activity Name	**Description**	**Research Roadmap(s)**	**Development/Acquisition Roadmap(s)**	**Start-Date**	**End-Date**	**TRL-End/ Exit Crit.**
Multi-purpose Display of Traffic Information (assume there is a weather component here)	Multi-purpose Display of Traffic Information (assume there is a weather component here)	Weather	Weather	<>	<>	<>
Advanced ADS-B Applications, including weather displays and avoidance	Advanced ADS-B Applications, including weather displays and avoidance	Weather	Weather	<>	<>	<>
Avionics Gap Analysis for Data Communications	Avionics Gap Analysis for Data Communications	Communication	Communication	<>	<>	<>
Availability Analysis of VHF Spectrum required to support A/G digital communications	Availability Analysis of VHF Spectrum required to support A/G digital communications	Communication	Communication	<>	<>	<>
Development of Segment 1 and 2 Data Communications Standards with RTCA 214 and Eurocontrol	Development of Segment 1 and 2 Data Communications Standards with RTCA 214 and Eurocontrol	Communication	Communication	<>	<>	<>
Development of Far-term Data Communications Standards with RTCA and EUROCAE	Development of Far-term Data Communications Standards with RTCA and EUROCAE	Communication	Communication	<>	<>	<>

Partner R&D Activities "Snapshot"



Far-Term research may lead to "influence milestones", rather than Decision Points.

Next Steps

- Participate in roadmap integration and alignment this summer.
  - Seeking to show how supporting activities bridge between programs/systems and sub-capabilities/functions that combine to form Operational Improvements.

- Work with NextGen I&I to place activities on the NAS EA roadmaps

- Continue to commit resources to mature internal & partner supporting activities within the “Green Swim Lanes”.

Backup Slides

Considerations for Next Update Cycle

- Suggestion to make a policy that standards development activities (“S”) may not necessarily require a Decision Point, but instead may be depicted as an “influencing” milestone.

- Identify certain Decision Points and the supporting activities that lead to them as being “critical” to the implementation of a sub-capability / function.
  - Enables executives to set priorities between projects and enforces a rigorous program management approach to these activities.

- Suggestion to follow the “layered model” format as a model for roadmap construction (per Aircraft Roadmap by Van Trees, see back-up slides).

Technology Readiness Levels (1 thru 4), Products, and AMS Phases

TRL	Basic Definition	TRL Products	Typical Research Organization Responsibilities	AMS Phases	AMS Checklists/Milestones	Exit Criteria
1	*Describe Proposed Capability.* Scientific research begins to be translated into applied research and development. Basic principles observed and reported.	Paper studies of a technology's basic properties; Concept Description complete; Initial Concept of Operation.	Clear definition of problem; description of operational need; concept description.	New service needs and Mission/Service Analysis	New or Updated Mission Need Statement; initial requirements document including Concept of Use; initial investment analysis plan.	Concept description; Problem statement; concurrence from Operations.
2	*Define Target Timeframe, Infrastructure, and Operational Environment.* Applications are speculative, and there may be no proof or detailed analysis to support the assumptions. Technology concept and/or application formulated.	Proof of Concept Research Plans complete (includes: Technology Development Research Plan, Research Management Plan, Preliminary Safety Impact Assessment, Initial Single-year Benefits Assessment, Preliminary Human Factors Assessment and Research Plan).	Formulate and prove technology concept; development of product research plans; identify potential alternative approaches.	Mission Analysis/Concept and Requirements Definition	Research Management Plan	Results of analysis and high-level description of alternatives with respect to the problem statement.
3	*Define Concept of Use Within Target Operational Environment.* Analytical and experimental critical function and/or characteristic proof of concept.	Initial Feasibility Assessment (includes: Initial Feasibility Report, technical performance metrics identified, System Functional Requirements).	Simple prototypes for basic algorithms, procedures, human-machine interface (as appropriate).	Mission Analysis/Concept and Requirements Definition	Mission Need Decision (JRC – 1)	Broad functional requirements; proof of concept demonstrated in simulation.
4	*Conduct Functional Demonstrations and Operational Evaluations.* Technology component and/or basic technology subsystem validation in laboratory environment.	Re-assessment of feasibility based on results of lab testing; Updated Feasibility Report; Updated Operational Concept Description; Initial Life-cycle Cost/Benefit Assessment; Updated Safety Impact Assessment; Updated Human Factors Assessment; Initial System/Subsystem Specifications (SSS); Interface Requirements Specifications (IRS); System/Subsystem Design (SSD) Description; Software Users Manual and CHI Description; Human-in-the-Loop (HITL) Test Description and Software Test Description.	Development and demonstration of research prototype for human-in-the-loop testing; initial cost/benefits analysis (ROM); updated concept description including capabilities and limitations; develop technology transfer plan; initial deliveries of research prototype to conduct "pre-development" prototype.	Mission Analysis/Concept and Requirements Definition	Initial Investment Analysis Report; Initial Acquisition Program Baseline; Initial Requirements Document; Action Plan/Exit Criteria	Validated Concept of Operations Functional requirements developed and initial validation complete; components tested in integration lab or system prototype; performance requirements consistent with operational environment; initial business case and cost/benefit analysis.

Technology Readiness Levels (5 thru 9), Products, and AMS Phases

TRL	Basic Definition	TRL Products	Typical Research Organization Responsibilities	AMS Phases	AMS Checklists/Milestones	Exit Criteria
5	*Develop Specific Operational/ Maintenance Plans and Procedures.* Technology component and/or basic technology subsystem validation in relevant environment.	Re-assessment of feasibility based on user testing in a field lab using pre-development prototype (includes: updated SSS and SSD, updated IRS, HITL test results, software test results).	Adapt research prototype to create a pre-development prototype and test in a lab environment; discussions with implementing orgs about capability, limitations, and evolution of system; discussion with operational orgs about use of system in relation to other NAS systems; collaborate on formal cost/benefit analysis.	Initial Investment Analysis	Final Acquisition Program Baseline; Investment Analysis Readiness Decision	Technology transfer plan; test results from limited field environment; performance requirements; identify risks and mitigation strategies; detailed architecture; initial acquisition strategy.
6	*Define Requirements and Transfer Technology.* Technology system/subsystem model or prototype demonstration in a relevant environment.	Feasibility for Customer Acceptance based on user testing in an operational environment using the pre-development prototype (includes: final feasibility report; final Operational Concept Description; Life-cycle Cost/Benefit Assessment; Human Factors Assessment; SSS; IRS; SSD; software users manual and CHI description; software design description).	Test pre-development prototype for functionality, acceptability, and performance in a field environment; demonstrate interactions with other NAS systems discovered during the TRL-5 trials; complete technology transfer.	Initial Investment Analysis	Final Investment Analysis Report; Final Requirements Document; Final Acquisition Strategy paper; Final Integrated Program Plan; re-validated Mission Need Statement; Initial Investment Decision (JRC – 2A)	System-level Specifications and Validation Report based on system testing in the operational environment, prepare for Final Investment Decision.
7	*Develop Implementation Capability.* Technology system prototype demonstration in an operational environment.	Tech transfer to implementing org has been accomplished; no further AJP activity.	Technical expertise in support of implementing organization.	Final Investment Analysis	N/A	System Level Specification inputs.
8	*Qualify Implementation Capability.* Actual technology system completed and qualified through test and demonstration.	N/A	None	Final Investment Analysis	Final Investment Decision (JRC – 2B)	Key site acceptance, test data and verification reports.
9	*Operate Implementation Capability.* Actual technology system proven through successful mission operations.	N/A	None	Acquisition	N/A	In-service decision.

Generally, R&D work ends at TRL-6, but some supporting activities on the NAS EA roadmaps go further.

Layered Model for NAS EA Roadmap Construction

Suggestions to Revise NAS EA Roadmaps

Overview

With thanks to Steve van Trees and his team for re-modeling the Aircraft roadmap along these lines –

Largely a re-engineering of the “linkages” tab on the current NAS EA 6 web site, this model is comprised of 4 “layers”:

1. Mapping between the Operational Improvements and the functions/capabilities associated with them.
2. Mapping between the functions/capabilities and the programs/systems that enable them.
3. Depicting the systems/programs delivering functions/capabilities already present in the NAS.
4. Depicting the supporting activities working to deliver those functions/capabilities the NAS does not currently have.

Preliminary Necessities

Before beginning the roadmap layering, some preliminaries must be made explicit:

An Operational Improvement Concept of Operations must be created that clearly states

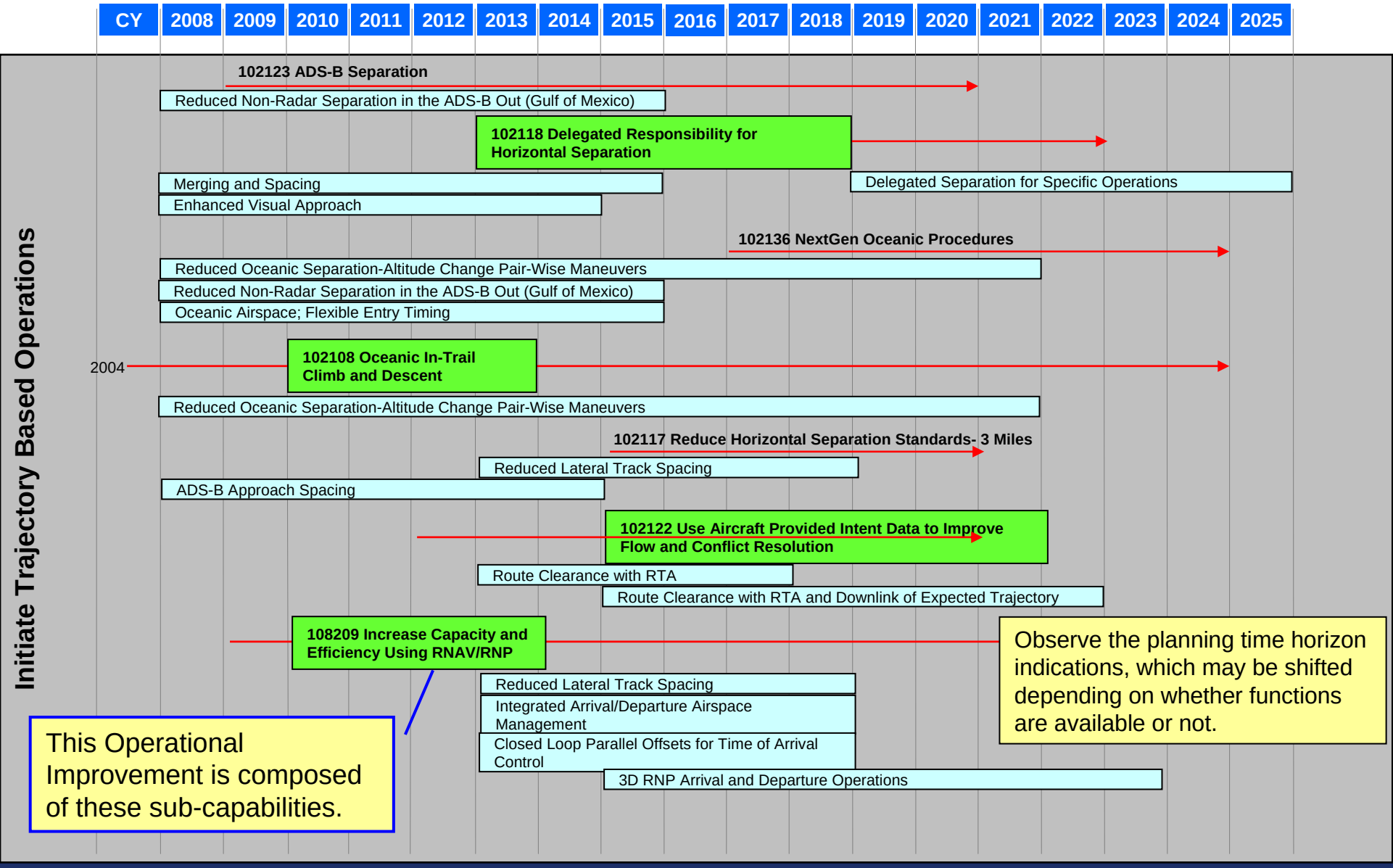
- The desired end to be achieved
- The functions/capabilities that must exist to deliver that end
- A phased implementation approach to getting there

(That is, if you don't have all the functions/capabilities for the end-state, maybe there are functions that can deliver intermediate stages toward the Operational Improvement, and different stages can be implemented as the functions become available.)

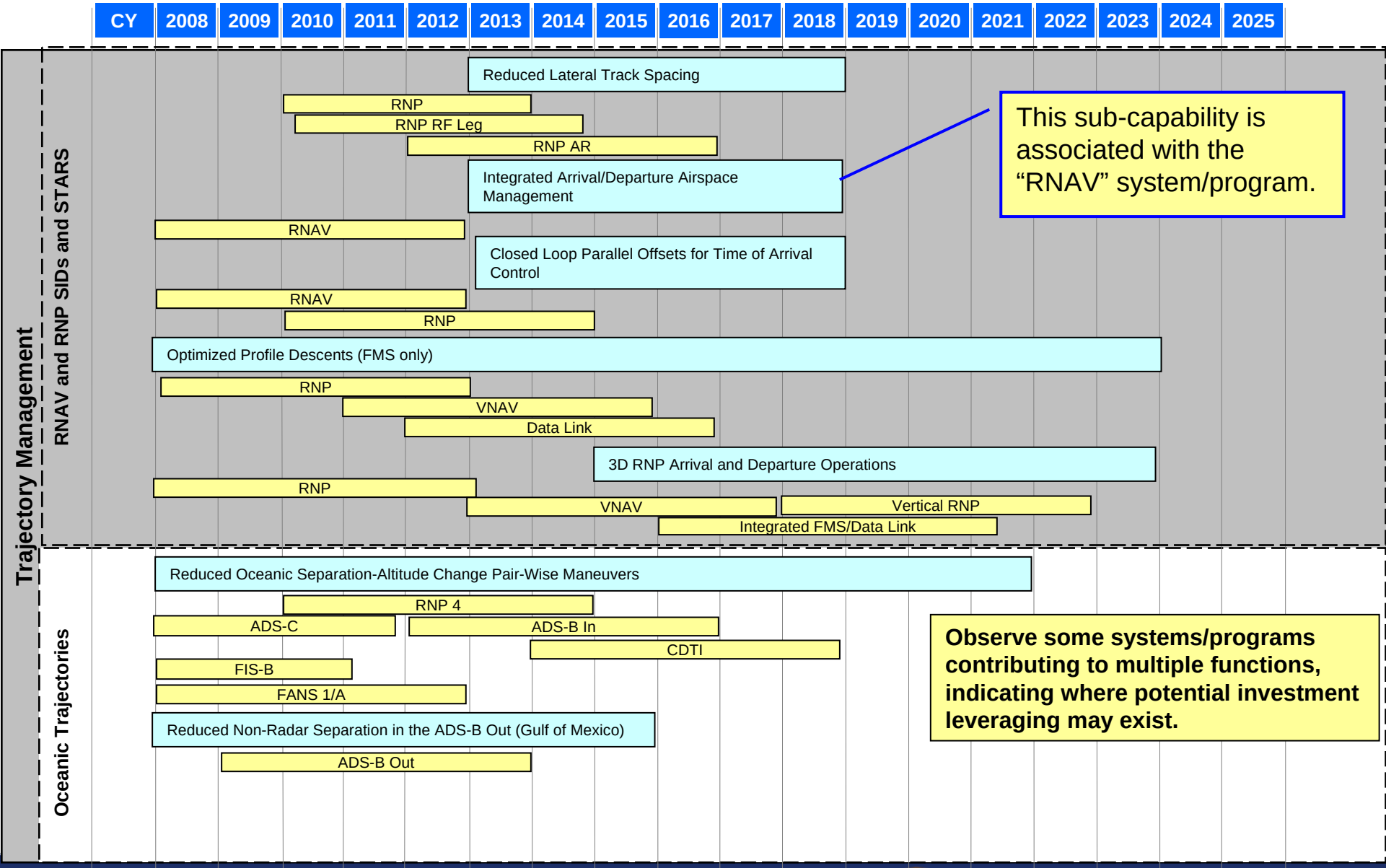
The Set-up

- List Operational Improvements and associated functions/capabilities by Solution Set.
- Categorize functions/capabilities in terms of their general domain; e.g., trajectory management, separation management, capacity management, etc.
- Categorize systems/programs in terms of their contribution to a technical domain; e.g., position and navigation, communications, surveillance, etc.
- Supporting Activities are to be grouped and classified by the same general domains (per #2 above) as the functions/capabilities.

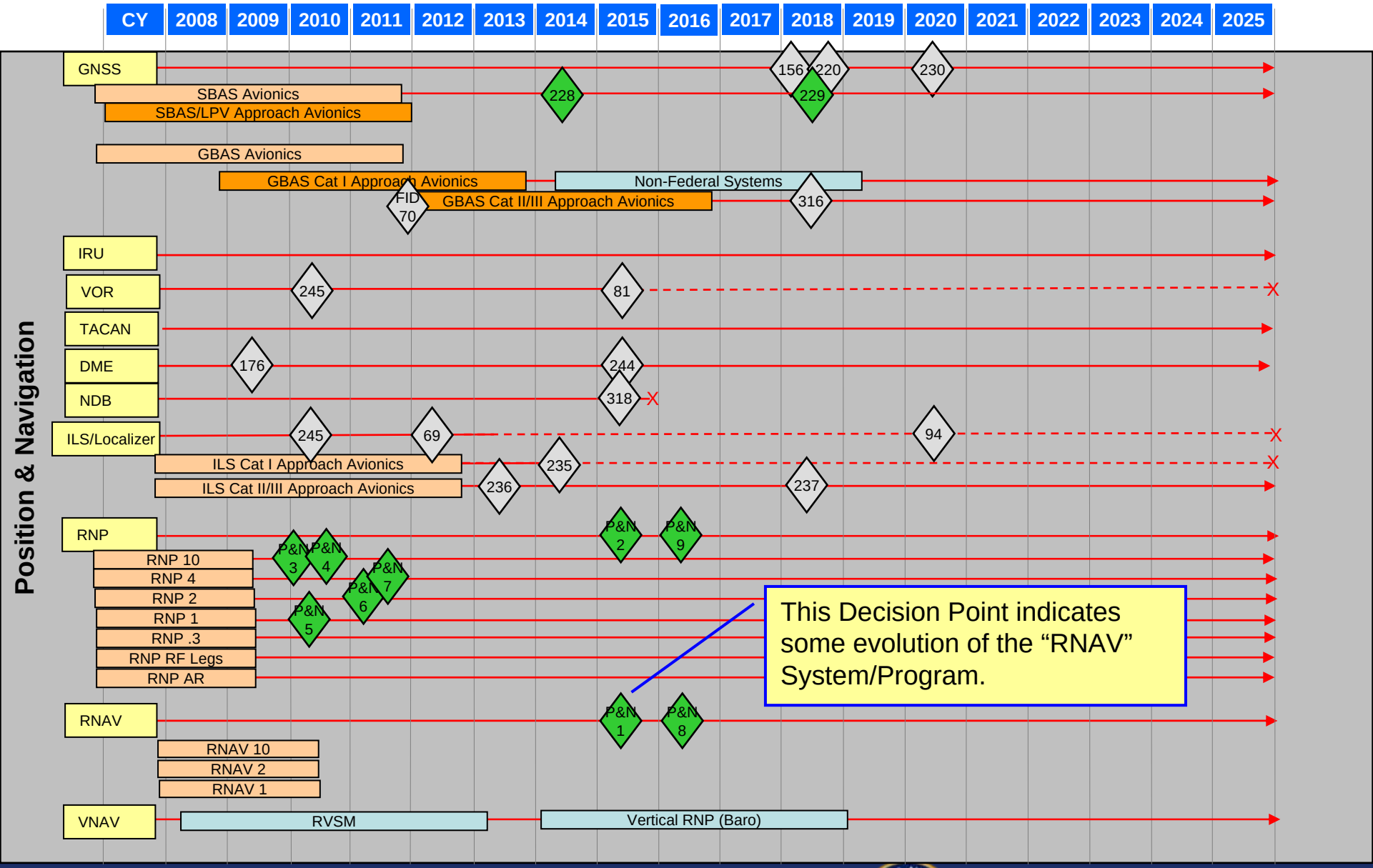
Operational Improvements and Their Associated Functions



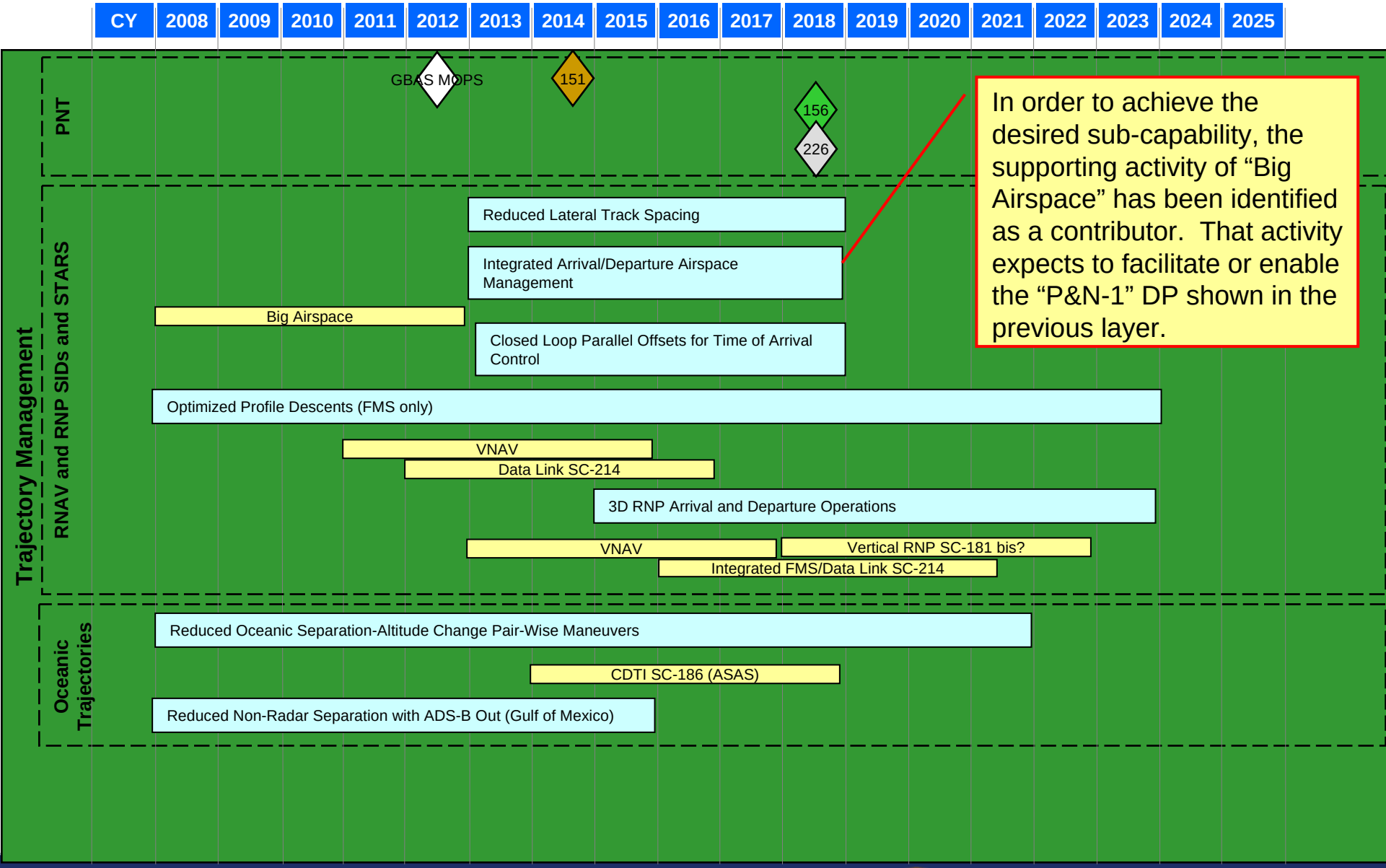
Functions and Their Associated Systems/Programs



Systems/Programs and Current Capabilities



Development of Systems/Programs to Deliver Needed Functions



In order to achieve the desired sub-capability, the supporting activity of "Big Airspace" has been identified as a contributor. That activity expects to facilitate or enable the "P&N-1" DP shown in the previous layer.

Advantages of the Layered Model

- In a web portal, layering permits users to view any dimension of the NAS EA roadmap.
- Users may drill down from the Operational Improvement, or drill up from the system/program, or do cross-cutting at the function layer.
- Executives and Program Management are more easily able to determine “critical path” activities or priorities in investment.
- In a portfolio management approach to programs, it is easier to check status and progress toward implementing an Operational Improvement through greater budgeting transparency.