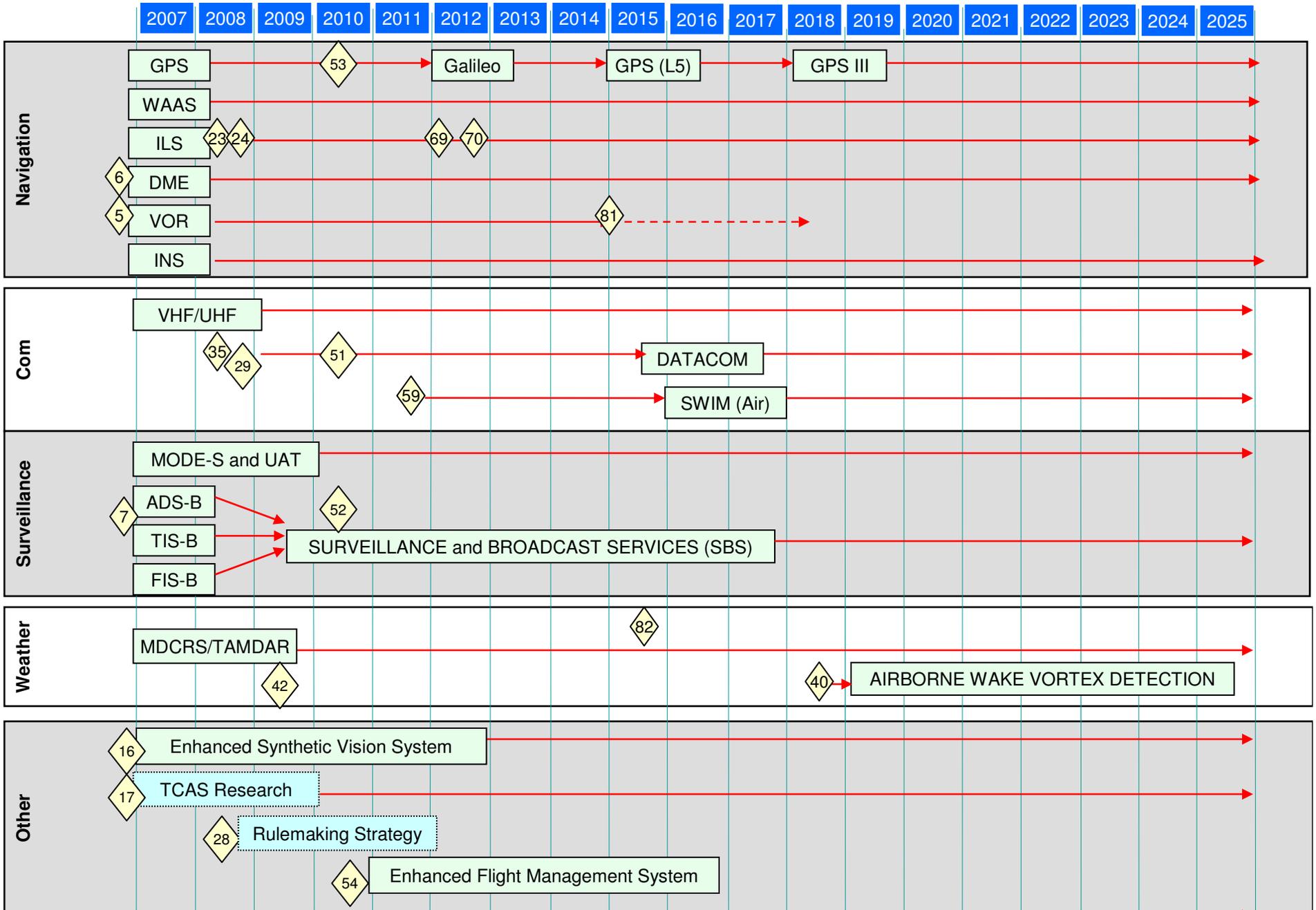


Infrastructure Roadmaps

February 2007

Version 1.0

Avionics Roadmap



Avionics Roadmap Decisions

- ◆ 16 2007 – Decision to develop avionics policy, standards, and equipage strategy for Enhanced/Synthetic Visioning Systems (EVS/SVS) to support low and zero visibility surface operations.
- ◆ 17 2007 – TCAS Research
- ◆ 28 2008 – NextGen Rulemaking Strategy
- ◆ 29 2008 - Submit Airborne data Integrity requirements to Automation Mid-term work package to support exchange of Air-Ground data.
- ◆ 42 2009 - Decision to mandate weather sensor (MDCRS/TAMDAR) equipage on aircraft (Jetliners first, then Taxi/Commuter, and small aircraft later) [NAS EA Roadmap (Wx)]
- ◆ 51 2010 - Final decision published for Rulemaking of new air/ground comm (DATACOM) [NAS EA roadmap (Comm)]
- ◆ 52 2010 – Decision for Avionics Mandate/Rulemaking (ADS-B/MODE-S/UAT) [NAS EA Roadmaps (Avionics)]
- ◆ 53 2010 – Final rule published on Navigation future configuration to be GNSS-based
- ◆ 54 2010 – Decision to develop avionics policy and standards for Enhanced Flight Management System to support 4D super density operations.

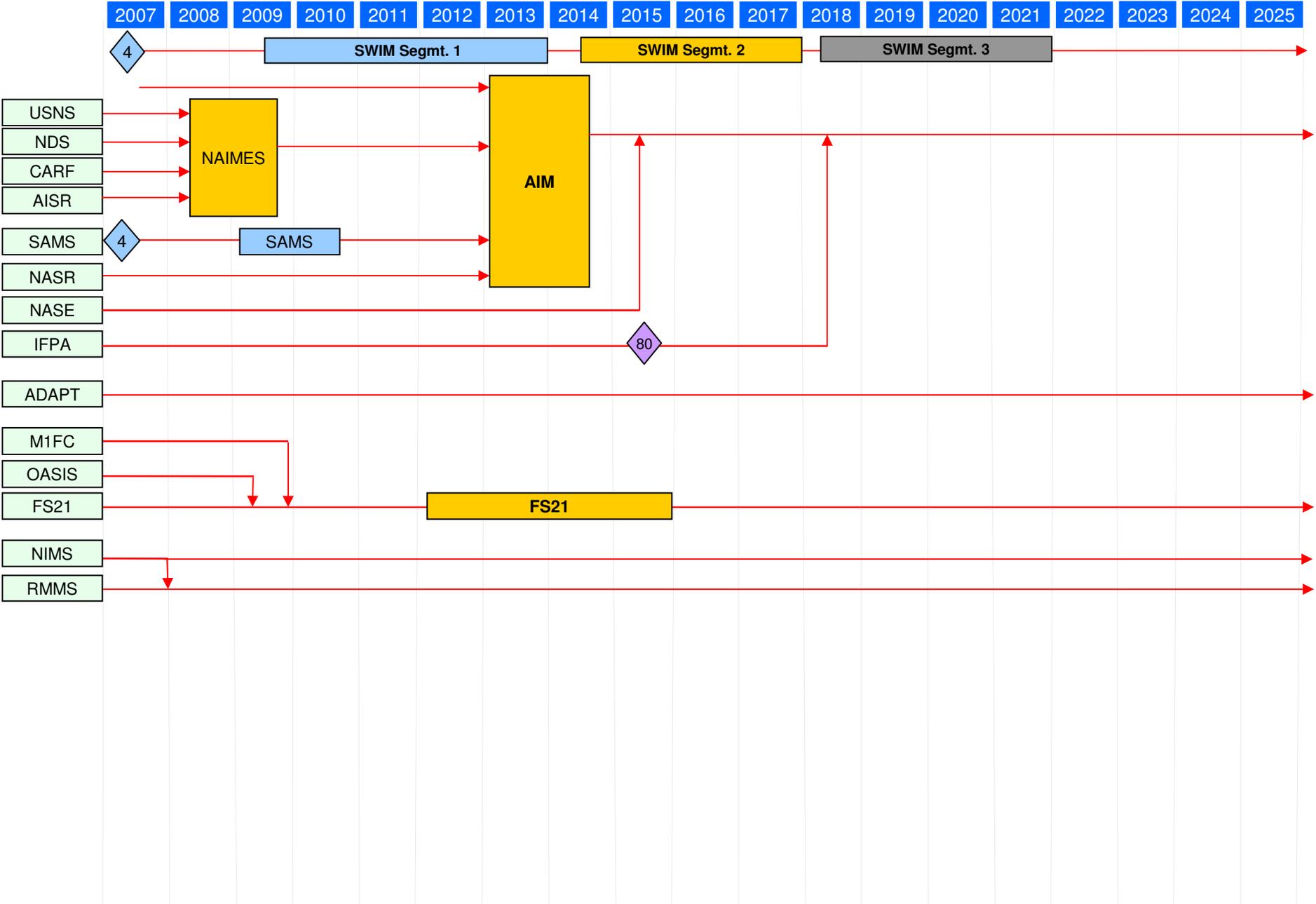
Avionics Roadmap Assumptions (1 of 2)

- This equipage view does not reflect required equipment as defined in the minimum equipment list
- Avionics standards will evolve from a technology-based to an integrated performance-based approach.
- NAS ATS Communication Links
 - VHF, DO-186A (voice domestic via direct controller-pilot communications)
 - HF, DO-163 (voice oceanic through third party provider)
 - UHF, DOD (no civil standard)
 - Satcom, DO-210D and DO-262 (voice oceanic/remote area support through third party provider)
 - VDLM2, DO-281A (limited ATS data communications through third party)
- Broadcast Services will be available over multiple links
- Need to validate that DO-242 (ADS-B) standard were developed under the assumption the radar was the back-up. A different Back-up recommendation will require a re-evaluation of ADS-B standards.
- Current ADS-B standards are being internationally harmonized, however, large implementation differences and equipage are planned.
- Some aircraft are equipped with Mode-S ES Transponders that meet DO-260/TSO-C112. ADS-B “Out” Mode-S ES will require DO-260A/TSO-166A requirements. Current airspace requirements are for Mode-S basic.

Avionics Roadmap Assumptions (2 of 2)

- ADS-B Surveillance backup is off-aircraft (SSR or multilateration).
- Mandate Avionics equipment (GPS/WAAS, Data Comm, ADS-B, Mode-S/UAT, EVS/SVS, eFMS, and TCAS upgrades) must have a viable bundling strategy.
- At publication of final rule/decision expect 7-10 years until full aircraft fleet equipage
- TCAS enhancements need clarified (TCAS and ADS-B/Super-density operations/RA monitoring).
- Different aircraft are expected to equip with different equipment. This roadmap does not currently distinguish between aircraft types.

Automation Roadmap (2 of 2)



2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025

4 SWIM Segmt. 1 SWIM Segmt. 2 SWIM Segmt. 3

USNS
NDS
CARF
AISR

NAIMES

AIM

SAMS
NASR
NASE
IFPA

SAMS

80

ADAPT

M1FC
OASIS
FS21

FS21

NIMS
RMMS

Automation Roadmap Decisions (1 of 3)

- 1 2007 – Approve ERAM Release 2 package contents
- 2 2007 – Final Investment Decision to create an AIM program that assures systems and data harmonization
- 3 2007 – NIMS sustainment or total resumption service by RMMS Decision
- 18 2008 – Approve requirements for ERAM Mid-Term Workpackage initial investment
- 19 2008 – Approve TFMS Work Package 2 package contents
- 20 2008 – Approve consolidation of electronic flight data into Tower Flight Data Manager final investment
- 21 2008 – SAIDS/ACEIDS near-term sustainment final investment
- 22 2008 – SAIDS/ACEIDS near-term sustainment final investment
- 30 2008 - Approve NGATS Staff Virtual Tower Concept
- 31 2008 – Approve migration of ARMT, DFM and TMA Tower displays to TFDM and/or TFMS WP 2
- 32 2009 – Approve requirements for ERAM Mid-Term Workpackage final investment
- 33 2009 – NGATS Staff Virtual Tower initial investment
- 43 2009 – Investment Decision to support ADAPT program depending on determination of mission need
- 44 2010 – Approve ERAM Release 3 package contents
- 2010 – Approve migration of TMA to ERAM and/or TFMS initial investment

Automation Roadmap Decisions (2 of 3)

- ◆ 45 2010 – ARTS 1E/IIIE: upgrade/modernize and hardware consolidation into STARS/ARTS IIIIE configuration final investment
- ◆ 46 2010 – Approve Tower Flight Data Manager 3 final investment
- ◆ 55 2011 – Approve common front end display components: Radar Display Hardware and Flight Data Display Hardware and Software final investment
- ◆ 56 2011 – Approve ERAM Release 4 package contents
- ◆ 57 2011 – Approve migration of TMA to ERAM and/or TFMS WP2 final investment
- ◆ 58 2011 – NGATS Staff Virtual Tower final investment decision
- ◆ 64 2012 – Approve ERAM Release 5 package contents
- ◆ 66 2012 – Assessment of common Information Display (IDS) capability in EnRoute and Terminal
- ◆ 67 2012 – Executive approval to integrate DOTS+ functionality into TFMS WP2
- ◆ 68 2012 – Executive approval to replace CERAP Automation with ERAM or ATOP
- ◆ 73 2012 – Decision to support NASE integration with AIM
- 2013 - Approve ERAM Release 6 package contents

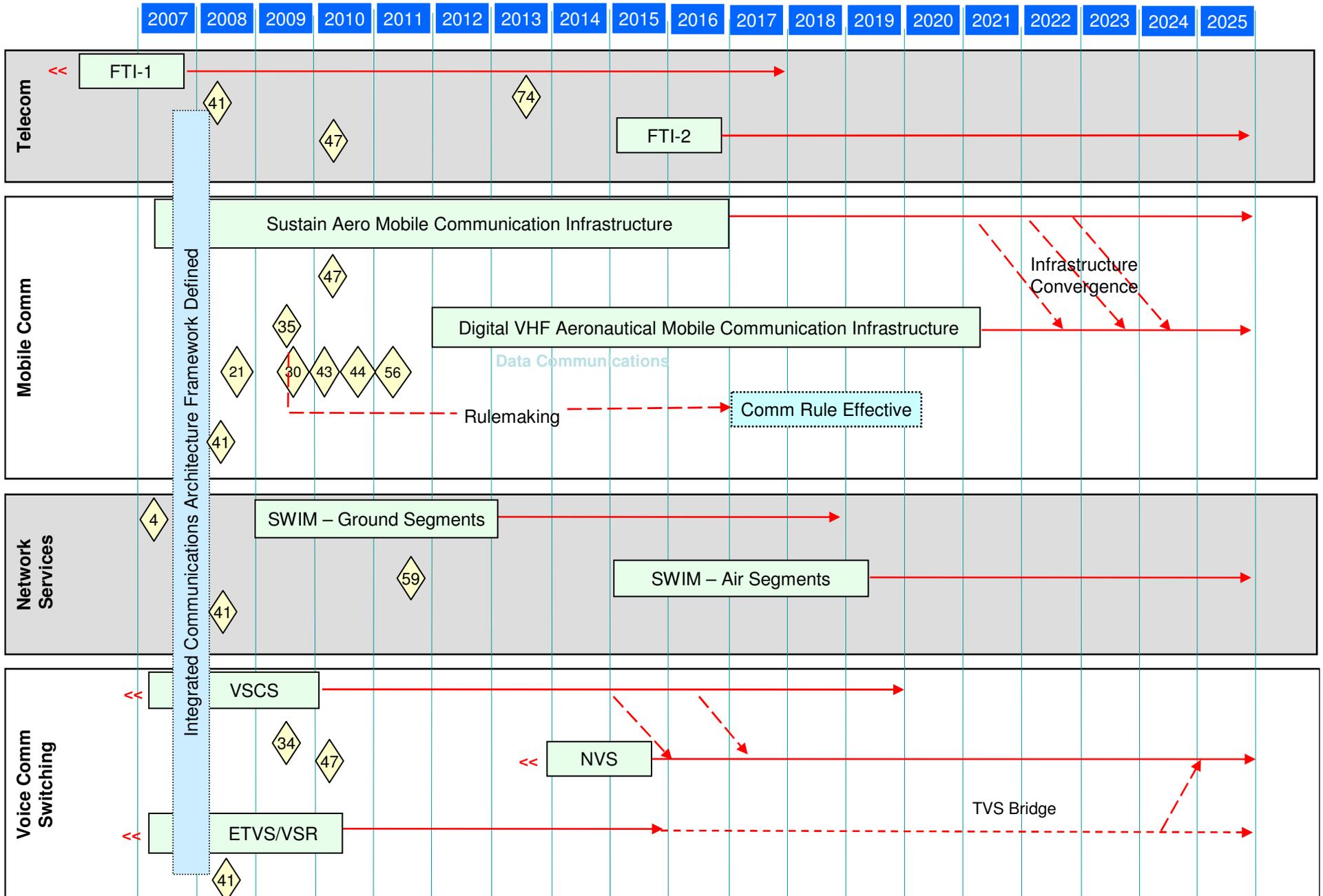
Automation Roadmap Decisions (3 of 3)

- 75 2014 – Approve requirements for ERAM NGATS Work package final investment
- 80 2015 – Decision to support IFPA integration with AIM
- 83 2016 – Approve transition to NGATS automation platforms and display subsystem thought convergence initial investment
- 90 2018 – Approve ARTS IIE system migration to either ARTS IIIE and/or STARS final investment

Automation Roadmap Assumptions

- Overriding goals affecting automation include SWIM, ADS-B, Datacomm, Performance-Based ATM, and Trajectory-based Ops
 - Net-centric operations via SWIM-based architecture link ATM, customers, DHS, and DoD into common information environment
 - Trajectory-Based OPS where flight data are interchanged via data communications
- Consistent security management across datacomm Automation and SWIM supporting facility evolution
- Infrastructure supports airspace design where assets adjust to flow, not flow constrained by infrastructure
- Decision Points are primarily near term, and a potential resource load issue
- Automation systems that provide service on the front-end are depicted
- End state Automation platforms are Tower, TFM, and ATC (EnRoute, TRACON and Oceanic)

Communication Roadmap



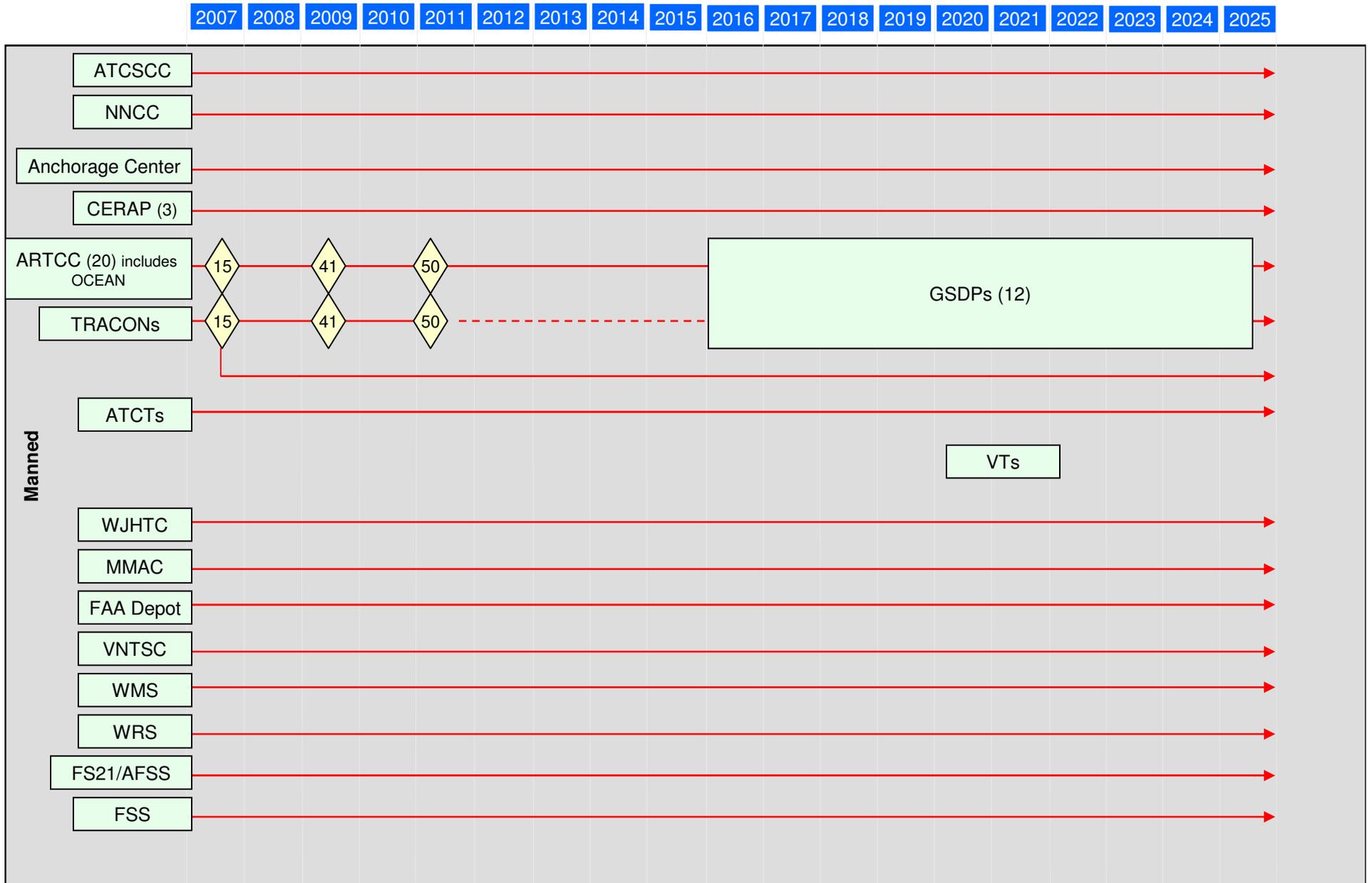
Communication Roadmap Decisions

- 4 2007 - Approve Final Investment Decision for SWIM Ground Segments Implementation
- 34 2009 - Approve Terminal Voice Switch Bridge Contract
- 35 2009 - Approve Final Investment Decision for Data Communications System and initiation of Rule Making
- 47 2010 - Approve Final Investment Decision for NAS Voice Switch
- 59 2011 - Approve SWIM Airborne Segments Implementation
- 74 2013 - Approve FTI Re-Compete Decision

Communications Roadmap Assumptions

- NAS must move from dedicated “nailed up” sector-based and independent facility operations to networked area based operations
- FTI becomes primary Voice/Data transport system
- Next Generation Voice Switch is required to meet consolidation/collocation, Business Continuity Plan, Load balancing/Load Sharing, and 4D Trajectory concepts (resource mapped to flows)
- All flight safety critical A/G communications are over VHF based systems
- Infrastructure evolution is driven by
 - Generally transition strategies start in High migrating to Low altitude
 - Implementation starts in large facilities migrating to small facilities
 - Initially lots of facilities with reduction in number of facilities
 - Infrastructure and people “dedicated to specific airspace” changing to “quickly and easily adapted to airspace as needed”

Facility Roadmap



Facility Roadmap Decisions

15

2007 – TBD

41

2008 – TBD

50

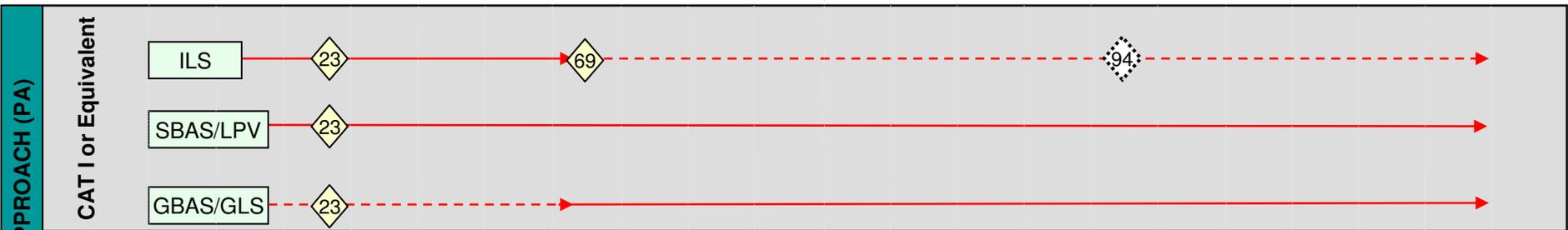
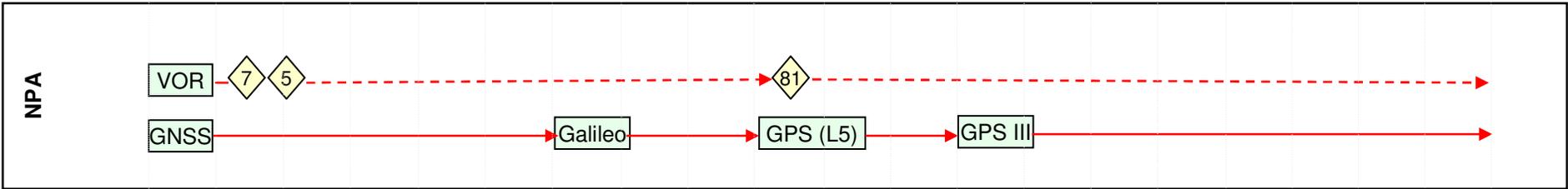
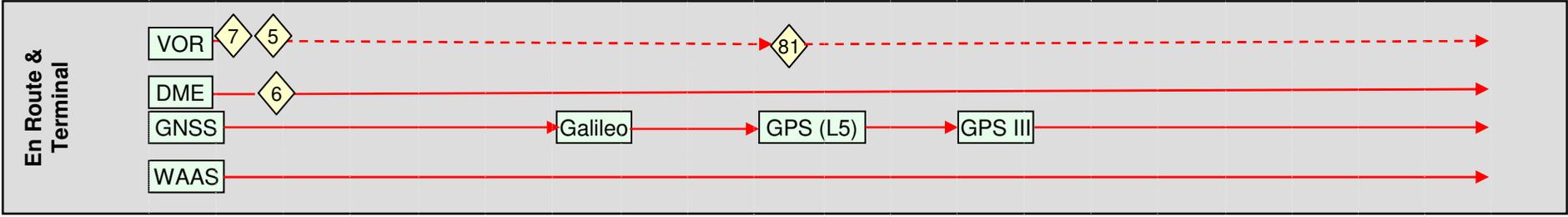
2010 – TBD

Facility Roadmap Assumptions

- Facilities will be built to mandated security and safety guidelines
- The airspace will be restructured to accommodate transitional and NGATS airspace concepts (e.g. Big Airspace, flexible airspace, classic en route airspace, mixed equipage airspace, special use airspace, super-density flexible airspace, etc.)
- GSDPs will use a new geo-independent model, where service delivery is best aligned to manage costs and increase efficiencies
- Up to three (3) times the amount of air traffic will be managed with no resulting increase in the number of controllers
- ATC tasks will evolve consistent with changes in the management of airspace
- BCP will be integrated into the design of the GSDPs
- Available capabilities will include En Route Automation Modernization (ERAM), System Wide Information Management (SWIM), and a network addressable voice system
- Site locations will be determined according to a number of factors that consider safety, security, and human resources

Navigation Roadmap

2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025



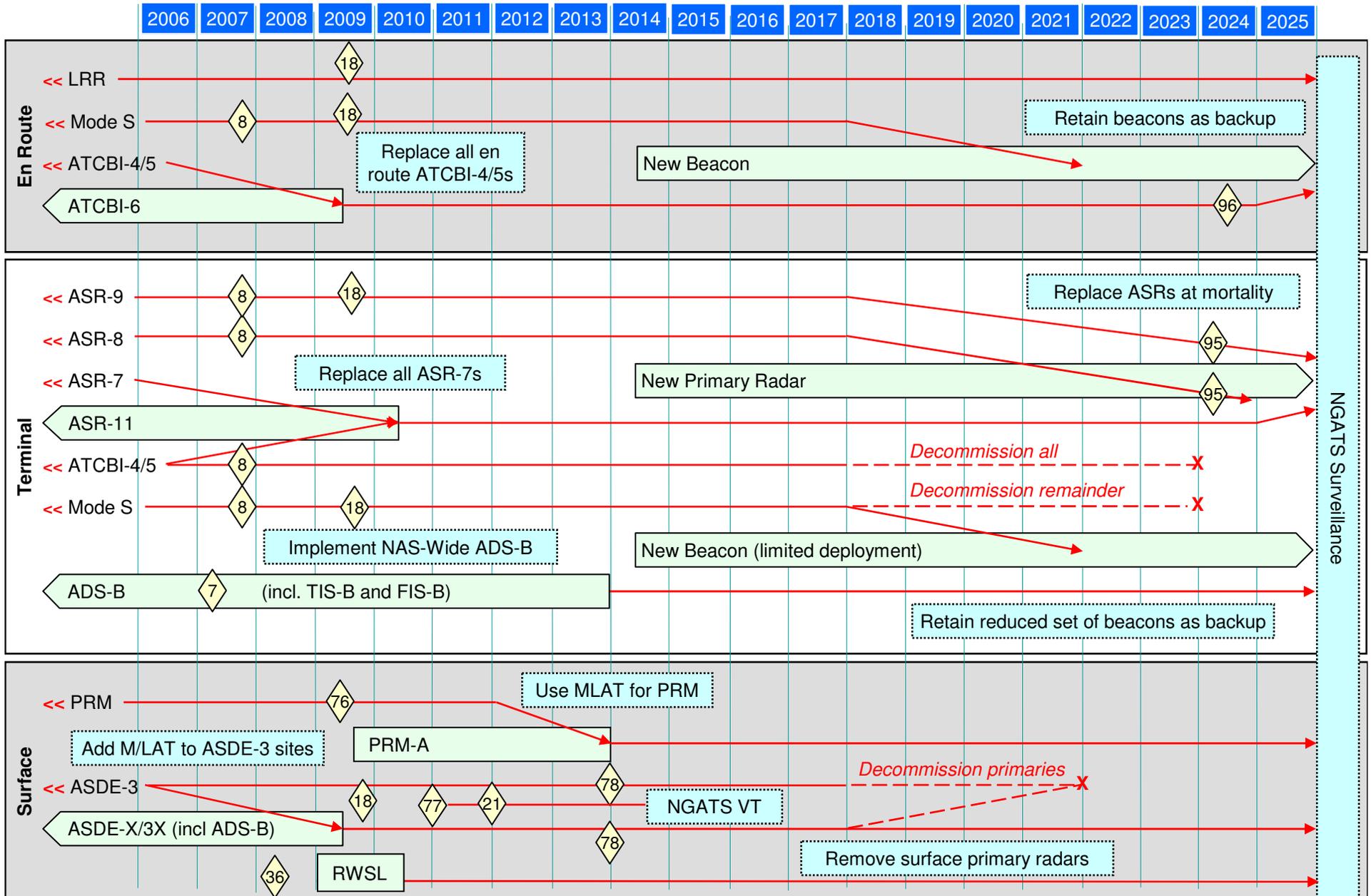
Navigation Roadmap Decisions

- 5 2007 - VOR decision for drawdown based on GNSS
- 6 2007 - Develop rightsizing DME Requirements, e.g., service volume, architecture, pathway
- 23 2008 - Decision on next generation Cat I landing system
- 24 2008 - Decision on next generation CAT II/III service, pending feasibility & schedule of potential ABAS/GBAS solutions and risk mitigation strategies
- 69 2012 - Begin ILS Cat I drawdown - limited backup at OEP airports
- 70 2012 - Determine if CAT II minima is the appropriate requirement at specific airports
- 81 2015 - VOR decision on complete drawdown
- 94 2020 - Decision on complete ILS CAT I drawdown

Navigation Roadmap Assumptions

- The FAA requires an aggressive transition to performance-based service.
 - Decisions needing to be made with the aviation community.
 - define standard services provided by FAA
 - define public use special services
 - define non-public services provide by the airport operator/user
- FAA will provide NAS-wide performance-based service:
 - RNAV/RNP (primarily GNSS)
 - Baseline approach service is Cat I or equivalent
- Policy determination on mitigation strategy for loss of GNSS
 - Determine if the mitigation strategy supports RNAV/RNP
 - FAA will provide Cat I ILS as backup at OEP airports (35 airports)
 - Determination if CAT II minima is the appropriate requirement at required airports
 - CAT III service requirements become responsibility of the airport operator/user
- Fleet Equipage
 - Today = Mixed Fleet – GNSS, D/D and D/D/I
 - Future = Fleet equipped with GNSS
 - Decision/specification of “operational” mitigation
- GPS modernization and sustainment is crucial

Surveillance Roadmap



Surveillance Roadmap Decisions

- 7 2007 - Decision for ADS-B/TIS-B/FIS-B Segment 2 (NAS wide) implementation, including backup strategy (limited secondary radar backup assumed as one of the options)
- 8 2007 - Decision for legacy radar/beacon (ASR-8/ATCBI-4/5, ASR-9/Mode S) low activity refresh through 2020 (limited extension ASR-11 deployment)
- 36 2009 - Decision for migration of PRM to PRM-A, based on multilateration
- 76 2014 - Decision for removal of surface primary radars, based on implementation of ADS-B
- 77 2014 - Decision for replacement of legacy primary radars (ASR-8, ASR-9), based on air traffic safety and weather surveillance requirements
- 78 2014 - Decision for en route and limited terminal replacement of legacy beacons (Mode S), and removal of remaining systems (Mode S, ATCBI-4/5)
- 95 2024 - Decision for replacement of terminal primary radars (ASR-11 PSR) and removal of terminal beacons (ASR-11 MSSR)
- 96 2024 - Decision for replacement of en route beacons (ATCBI-6)

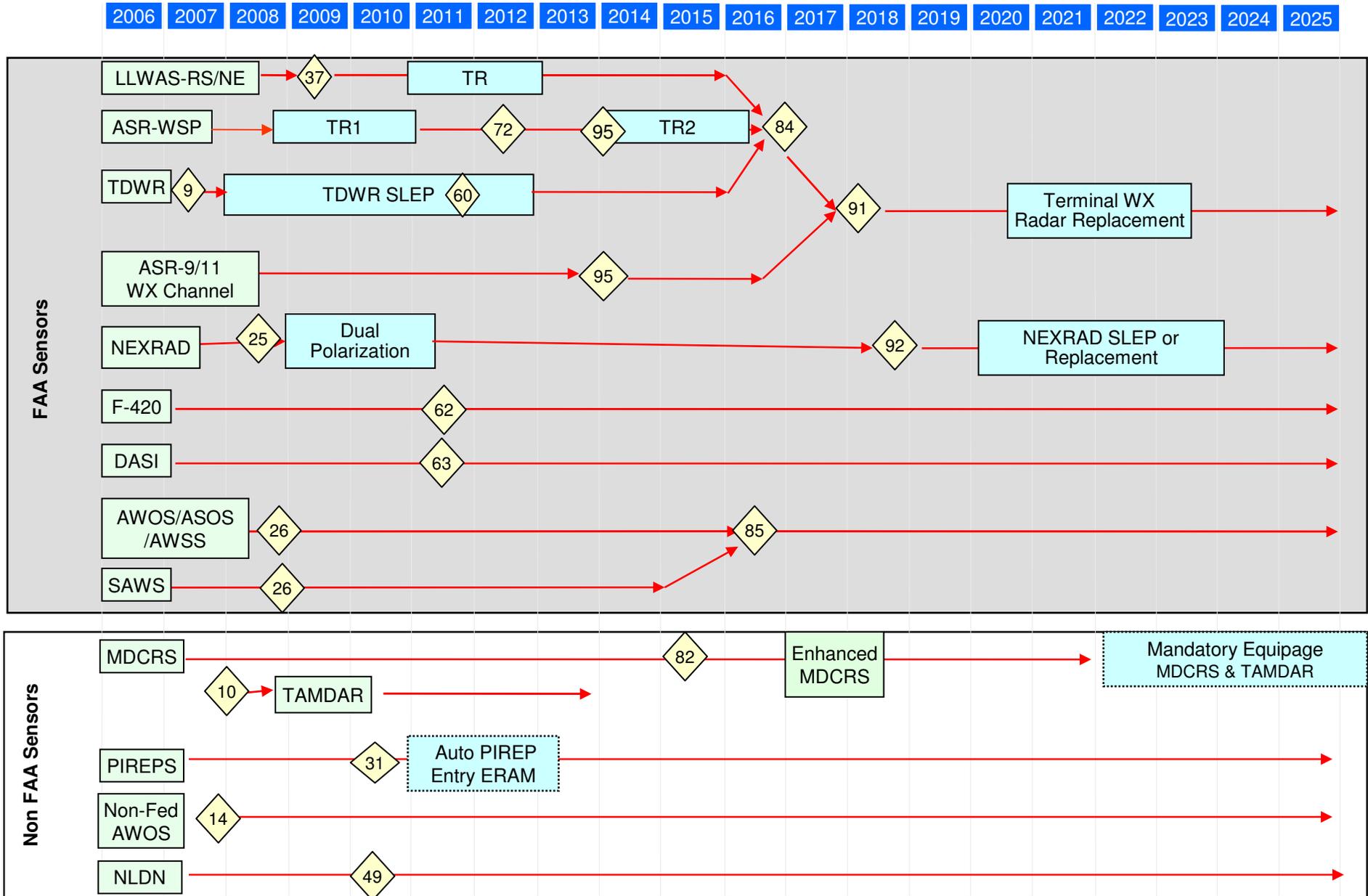
Surveillance Roadmap Assumptions (1 of 2)

- Migration to Automatic Dependent Surveillance - Broadcast (ADS-B) as primary means of surveillance
 - Airspace rule to be in effect and backup to be in place by 2020 (compliance date)
 - Existing surveillance infrastructure will remain in place until then
- Backup to mitigate loss of on-board GPS positioning source required
 - Backup strategy in development, results expected by end of November 2006
 - Roadmap assumes reduced secondary surveillance network as backup (after 2020)
 - Dependent on Backup Strategy
 - Retain all en route beacons (~150 monopulse systems with selective interrogation)
 - Retain limited set of terminal beacons at OEP/High Density Terminals
 - Terminal primary radars are retained
 - Dependent on Backup Strategy
 - Used as safety (ATC) backup in selected terminal areas (High Density terminals ~100 locations)
 - Need for additional systems dependent on current weather surveillance requirements; roadmap assumes all terminal primary radars required

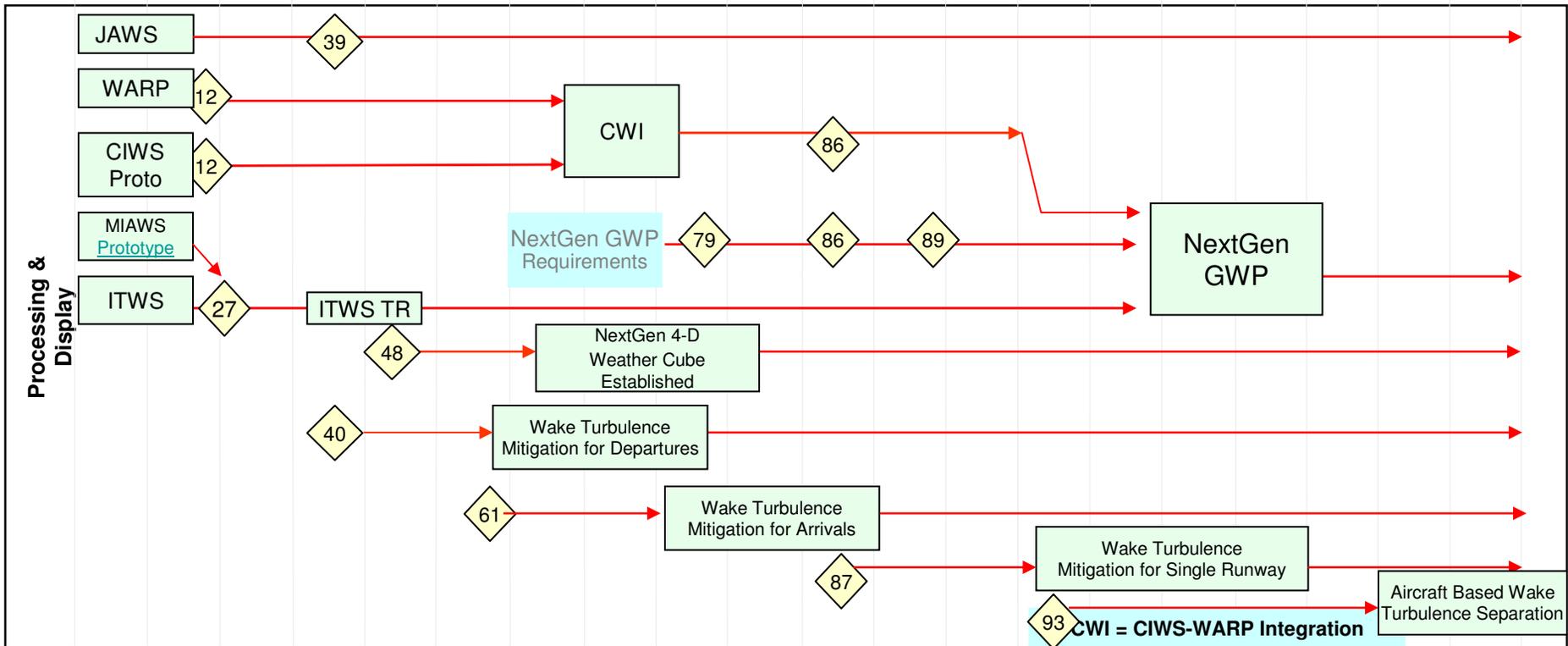
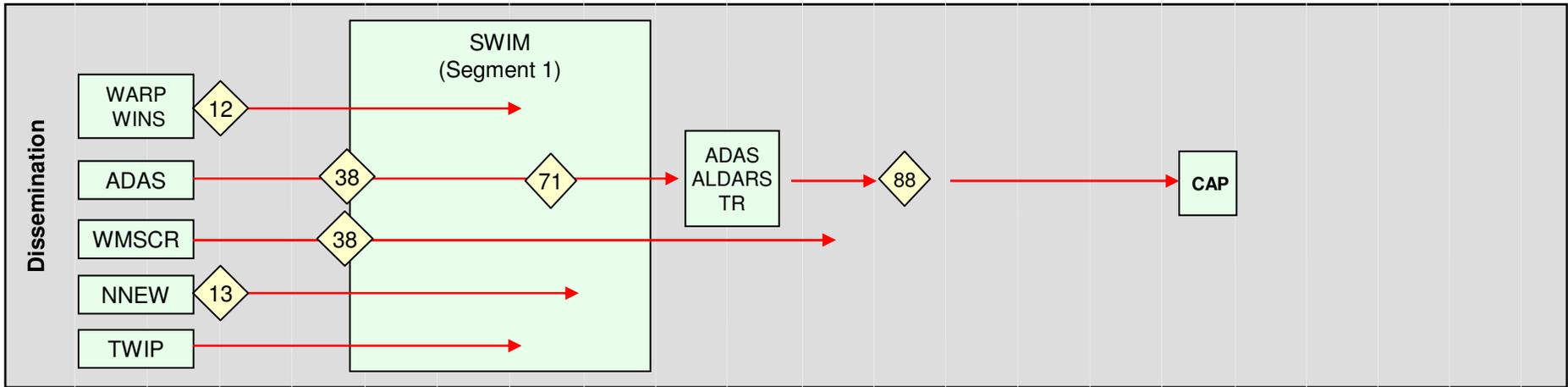
Surveillance Roadmap Assumptions (2 of 2)

- Pending ADS-B Backup Strategy JRC approval, the ASR-11 program may be extended to replace a limited number of ASR-8/ATCBI systems
- If Backup Strategy retains the Primary and Secondary Radars at selected locations past 2020, then additional tech refresh/SLEP work may be required
- Surface primary radars no longer required after ADS-B rule compliance date
 - Requires mandated equipage of all surface vehicles
 - Surface surveillance to be supported by ADS-B
 - Multilateration will be retained as a backup to ADS-B at all ASDE airports
- Multilateration will replace PRM system
 - At non ASDE-X location full Multilateration is required
- Migration of en route Primary Radars to single agency/multi-user (e-Gov concept)
 - En route primary radars not required for normal ATC operations

Weather Roadmap - Sensors



Weather Roadmap – Dissemination, Processing and Display



Weather Roadmap Decisions (1 of 3)

- 9 • 2007 - Investment decision for Terminal Doppler Weather Radar (TDWR) SLEP
- 10 • 2007 - Investment Decision to obtain TAMDAR data
- 11 • 2007 - Investment Decision to subsume Comms functionality of WARP (WINS) into SWIM
- 12 • 2007 - Investment Decisions (2a & 2b) for CIWS-WARP Integration (CWI) as well as the Investment Decision to sustain WARP & CIWS prototype until subsumed into CWI
- 13 • 2007 - Investment Decision re NNEW (NexGen Network Enabled Weather)
- 14 • 2007 - Obtain Surface Obs from non-Fed AWOS systems
- 25 • 2008 - Investment Decision to fund science evolution on NEXRAD
- 26 • 2008 - Investment Decision to 'outsource' automated surface observing systems
- 27 • 2008 - Investment Decision for ITWS
- 37 • 2009 - Investment Decision to Sustain LLWAS-RS wind shear capability with Tech Refresh 2011-2012
- 38 • 2009 - Investment Decision to subsume Comms functionality of ADAS & WMSCR into SWIM
- 39 • 2009 - Investment Decision to Deploy End State JAWS

Weather Roadmap Decisions (2 of 3)

- 40 • 2009 - Begin CRD (Concept & Requirements Development) process to acquire & deploy first Wake Turbulence (WT) capability for mitigating departures (WTMD)
- 48 • 2010 - Investment Decision for NEXGEN 4-D 'Virtual distributed' weather cube (4-D Wx Cube)
- 49 • 2010 - Investment Decision to obtain Total Lightning data
- 60 • 2011- Investment Decision to sustain Terminal Doppler Weather Radar (TDWR)
- 61 • 2011- Investment Decision to add WT for Mitigation for Arrivals (WTMA)
- 62 • 2011 - Investment Decision to replace F-420 wind sensor/display
- 63 • 2011 - Investment Decision to replace DASI
- 71 • 2012 - Investment decision for ADAS Tech Refresh ALDARS
- 72 • 2012 - Investment Decision for WSP Tech Refresh
- 79 • 2014 - NEXGEN GWP decisions
- 82 • 2015 - Investment Decision for CIWS/WARP (CWI) and ITWS to accept Enhanced MDCRS
- 84 • 2016 - Decision to decommission ground-based wind shear capability (TDWR, WSP & LLWAS-RS)

Weather Roadmap Decisions (3 of 3)

- 85 • 2016 - If decision for W6 is to not 'outsource', then an Investment Decision to consolidate automated surface observing systems (and backup)
- 86 • 2016 - Investment Decision 2A for the GWP
- 87 • 2016 - Investment Decision to add WTMSR (WT Mitigation for Single Runway) decision support capability
- 88 • 2017 - Investment Decision to move ADAS/ALDARS functionality to NAP (NextGEN Automation Platform)
- 89 • 2017 - Investment Decision 2B for the GWP
- 91 • 2018 - Decision to replace TDWR, WSP, and LLWAS with less expensive weather radar
- 92 • 2018 - Investment Decision for NEXRAD - SLEP or replacement
- 93 • 2019 - Investment Decision to add ABWTS (Aircraft Based WT Separation) decision support capability to the flight deck

Weather Roadmap Assumptions

- Weather Sensor Sustainment Issues
 - Weather information from ASR-9/11 continues to be required even if surveillance no longer ground based (6-level weather channel)
 - Evaluate need for Wind Shear/Microburst functionality to be ground based (SE study)
 - Rulemaking to support equipage for in situ aircraft observations (MDCRS and TAMDAR-like systems)
- Migrate Weather to common Network Enabled Operations (NEO) communications
- Issues re Convergence of Wx Processing Capability
 - Develop CWI (CIWS-WARP Integration)
 - Weather and Radar Processor (WARP) End of Service
 - Continuation of Corridor Integrated Weather System (CIWS) prototype until CWI “stands up”
 - Develop NextGen General Weather Processor (GWP)
 - Fund NextGen GWP
 - GWP subsumes most of the functionality of CWI and ITWS (may not be FAA ‘box’)
- Fund FAA portion of NextGen 4-D Weather Cube (Wx Fuser)