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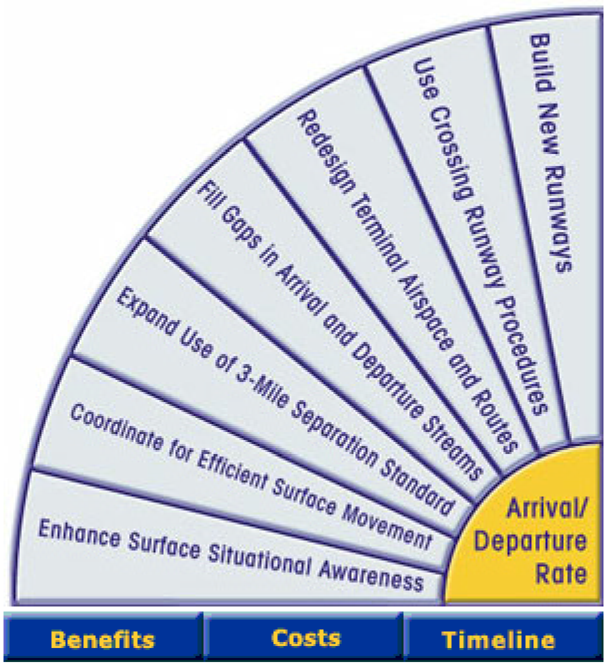
Objective: Increase Terminal Throughput

Related Links

Load Scenario

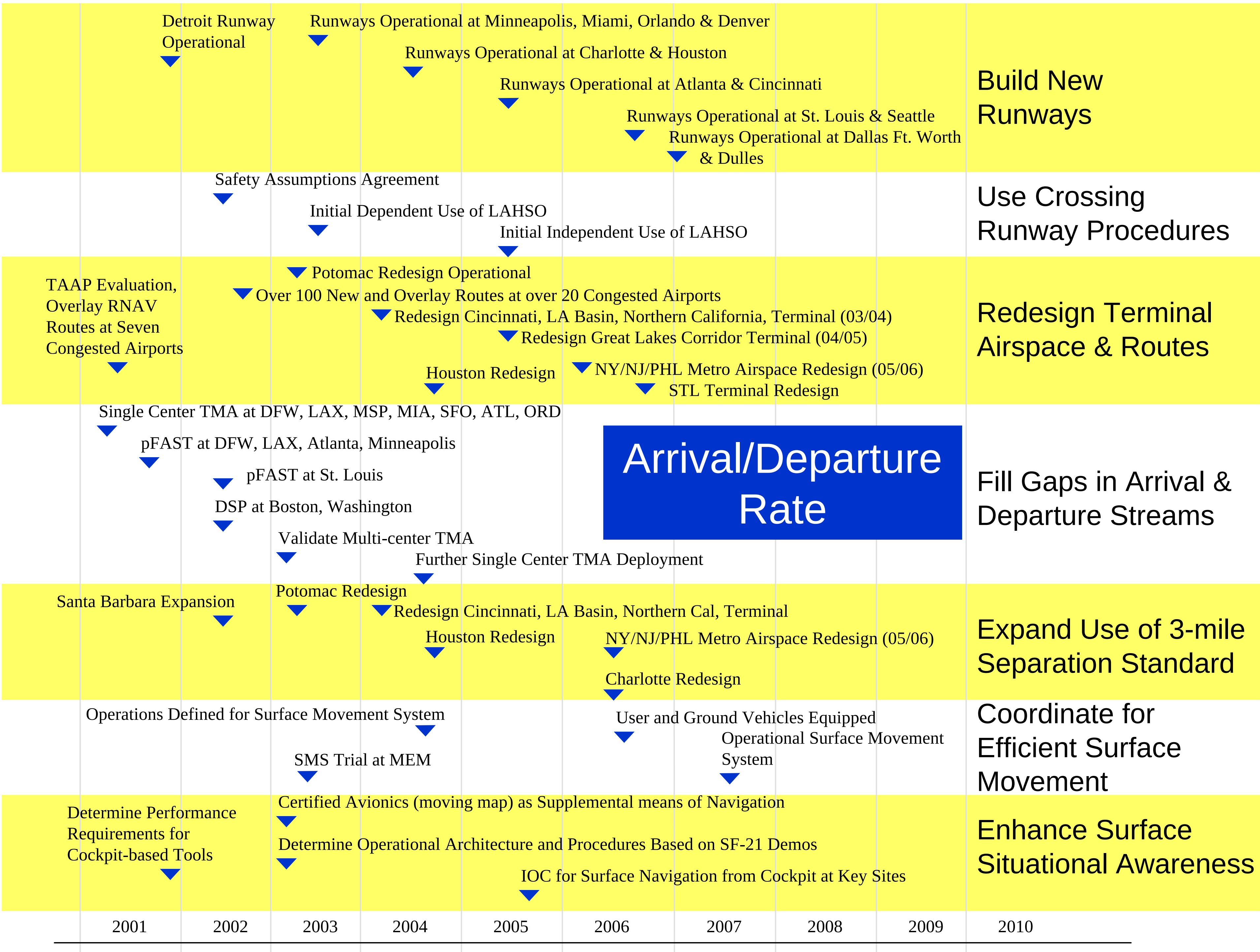
Review Problem



By the FAA's standards, 15 of the top 30 airports suffer from insufficient throughput to meet peak demand.

Given the improvements described in this plan, the arrival and departure rates keep pace with demand at about half of the benchmarked airports. When compared against the demand, the growth in throughput is 13.5 percent, or about 6800 more flights per day arriving or departing from the benchmark airports.

Click on a "Wedge" to access the solution.


Detroit Runway Operational
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Charlotte Redesign
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Operations Defined for Surface Movement System
SMS Trial at MEM
User and Ground Vehicles Equipped
Operational Surface Movement System
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Determine Performance Requirements for Cockpit-based Tools
Certified Avionics (moving map) as Supplemental means of Navigation
Determine Operational Architecture and Procedures Based on SF-21 Demos
IOC for Surface Navigation from Cockpit at Key Sites
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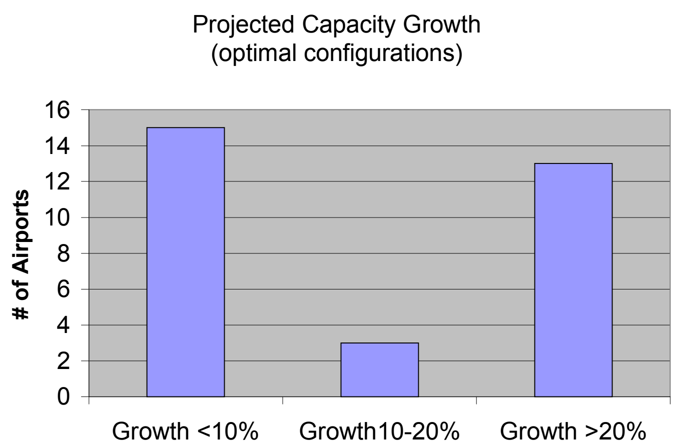
Arrival Departure Rate - Benefits

The performance of the NAS depends upon the balance between capacity and demand and the geographic distribution of any imbalances. Over the next ten years, the forecast demand growth is 11% more flights NAS-wide. There is a concentration of predicted demand growth for the benchmark airports of 11,000 more operations per day (about 24%) by 2010. The current level of demand and forecast growth varies widely across these airports:

					With OEP Enhancements	
Airport	**Annual Operations (000)**	**Demand Growth 2010 (Benchmark)**	**Capacity Benchmark Optimum Hourly Rates**	**Capacity Benchmark Reduced Hourly Rates**	**% Capacity Growth in Optimum Rate (2010)**	**% Capacity Growth in Reduced Rate (2010)**
ATL	913	28%	185 - 200	167 - 174	37%	34%
BOS	508	6%	118 - 126	78 - 88	4%	4%
BWI	315	27%	111 - 120	72 - 75	0%	0%
CLT	460	15%	130 - 140	108 - 116	30%	24%
CVG	478	40%	123 - 125	121 - 125	28%	27%
DCA	343	4%	76 - 80	62 - 66	4%	8%
DEN	529	23%	204 - 218	160 - 196	25%	17%
DFW	866	21%	261 - 270	183 - 185	4%	21%
DTW	555	31%	143 - 146	136 - 138	31%	24%
EWR	457	20%	92 - 108	74 - 78	10%	7%
HNL	345	25%	120 - 126	60 - 60	2%	7%
IAD	480	20%	120 - 121	105 - 117	49%	60%
IAH	491	34%	120 - 123	112 - 113	42%	41%
JFK	359	18%	88 - 98	71 - 71	2%	3%
LAS	521	30%	84 - 85	52 - 57	0%	12%
LAX	784	25%	148 - 150	127 - 128	11%	4%
LGA	392	17%	80 - 81	62 - 64	10%	3%
MCO	366	42%	144 - 145	104 - 112	28%	38%
MEM	386	30%	150 - 152	112 - 120	3%	4%
MIA	517	23%	124 - 134	95 - 108	24%	27%
MSP	522	32%	115 - 120	112 - 112	34%	31%
ORD	909	18%	200 - 202	157 - 160	6%	12%
PHL	484	23%	100 - 110	91 - 96	17%	11%
PHX	639	31%	101 - 110	60 - 65	40%	60%
PIT	448	15%	140 - 160	110 - 131	3%	1%
SAN	208	33%	43 - 57	38 - 49	2%	3%
SEA	446	17%	90 - 91	78 - 81	57%	51%
SFO	431	18%	95 - 99	67 - 72	0%	3%
SLC	367	34%	130 - 132	95 - 105	5%	4%
STL	484	30%	104 - 112	64 - 65	27%	89%
TPA	279	15%	110 - 119	80 - 87	0%	19%

Similar to demand growth projections, predicted capacity growth for the next ten years is also site-specific. To understand the impact the OEP operational changes have, we must examine the balance between capacity and demand by location. At about half of the benchmark airports the growth in capacity is sufficient to meet or exceed the predicted demand, with new runways making the largest difference. Where new runways are not in development, efforts to eliminate inefficiencies in arrival and departure streams with new technologies and improved procedures will help. For these locations the growth in capacity is typically less than 10%.



Matching the site-specific demand forecast against the projected capacity growth, the planned improvements will accommodate (during current hours of operation), about 6800 of the 11000 forecast additional flights in 2010.

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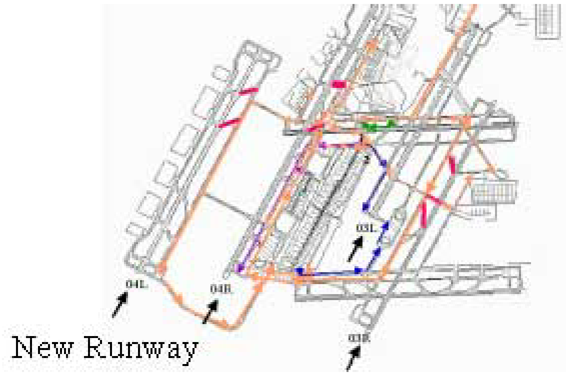
Solution: Build New Runways



Arrival and departure rates at the nation's busiest airports are constrained by the limited number of runways that can be in active use simultaneously. The addition of new runways at 15 airports between now and 2010 will expand airport throughput at the target airport, and possibly for other airports in the same metropolitan area. In most cases the new runways are sufficient to keep pace with forecast demand. But, half of the benchmark airports will not have new runways.

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Runways Operational at Atlanta & Cincinnati	2005
Runways Operational at St. Louis, & Seattle	2006
Runways Operational at Dallas Ft. Worth & Dulles	2007

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Responsible Team: Build New Runways

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Arrival/ Departure Rate

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ARC-1

ASC-1

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ATA-1

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AD-1: Build New Runways

Runway additions allow improved airport configurations.

Background

The FAA has determined the throughput at the country's 31 busiest airports, called the benchmarked airports. Throughput, measured as the arrival and departure rates, depends on the airport runway layout. Increasing the number of runways that can be in use simultaneously is key to expanding an airport's capacity.

Ops Change Description

New runways at 15 benchmarked airports between now and 2010 provide more options for keeping multiple active runways. These additional active runways improve the throughput for the airport, and in some case reduce interaction with other close by airports in the same metropolitan area.

Benefit, Performance and Metrics

Throughput performance is increased by the addition of new runways and supporting taxiways.

Airport/Runway	Date	Capacity Improvement (percent)	Projected Growth to 2010 (percent)	Delays per 1000 Operations (FY 2000)
Atlanta (ATL) 9S/27S	2005	31% in VFR, 50% in IFR	32	30.9
Houston (IAH) 8L/26R	2004	35% in VFR, 37% in IFR	39	28.1
Dallas Ft. Worth (DFW) 18L/36R	2007	11% in VFR, 37% in IFR	22	23.8
Phoenix (PHX) 7/25	Operational	36% in VFR, 60% in IFR	33	22.0
Dulles (IAD) 12R/30L	2007	46% in VFR, 54% in IFR	23	19.5
St. Louis (STL) 12R/30L	2006	14% in VFR, 84% in IFR	35	18.2
Detroit (DTW) 4/22	2001	25% in VFR, 17% in IFR	34	17.6
Cincinnati (CVG) 5L/23R	2005	26% in VFR, 26% in IFR	44	15.4
Minneapolis (MSP) 17/35	2003	40% in VFR, 29% in IFR	11	12.7
Miami (MIA) 8/26	2003	10% in VFR, 20% in IFR	40	11.3
Seattle (SEA) 16W/34W	2006	52% in VFR, 46% in IFR	17	10.4
Orlando (MCO) 17L/35R	2003	23% in VFR, 34% in IFR	14	6.3
Charlotte (CLT) 18W/36W	2004	18% in VFR, 15% in IFR	17	6.0
Denver (DEN) 16R/34L	2003	18% in VFR, 4% in IFR	26	2.2

Note: A new runway is being added to Boston Logan airport (2005) to reduce delay in certain runway configurations. It is not expected to increase the optimum capacity of the airport.

Scope and Applicability

- New runways are planned at 15 of the benchmark airports. Environmental impact studies are underway associated with each airport project.
- In some cases new runways require redesign of routes in the TRACON airspace by removing interference with runways at the same or other nearby airport. Airspace redesign projects are underway in PHL, PHX, DTW, MSP, CLT, MCO, IAD, SEA, and IAH.
- Runway extensions (i.e., lengthening an existing runway) are not explicitly identified here, but will improve capacity by allowing larger aircraft to operate on these runways.

- Taxiways to accompany the new runways are essential to reduce congestion points on runways or at gates.

Key Decisions

- Dallas Ft. Worth (DFW) 18L/36R: supplemental Environmental Impact Statement (EIS) is required due to change in length of proposed runway.
- Atlanta (ATL) 9/27: supplemental EIS required due to change in length of proposed runway.

Key Risks

- Environmental analysis is planed for these new runways. The FAA is currently streamlining the environmental review process.
- If new procedures and airspace changes are required, additional environmental analysis will be required.
- Experience has shown that projected opening dates frequently change due to unforeseen circumstances at the local level. FAA (ARP) will monitor schedules and provide updated information on a quarterly basis.
- Pilots require training/familiarization with new terminal and surface routes and procedures.
- Gates and terminals at some airports may be insufficient to support the additional traffic volume.
- Deployment of Navigation lights, signs, ILS, LAAS, or other precision aids to provide coverage for new runways must be coordinated with runway construction.
- Jepessen and airlines flight planning tools must be updated prior to pilot training to allow airline planning for new runway use.

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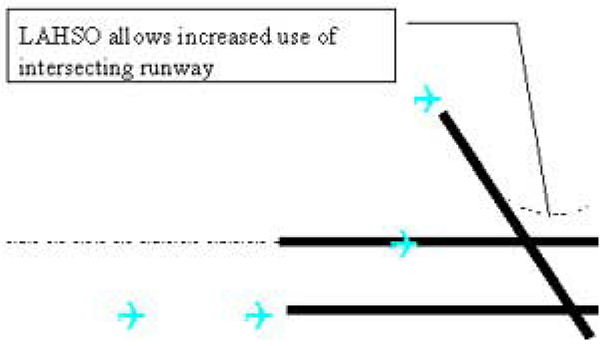
Solution: Use Crossing Runway Procedures



A means for increasing capacity is to make more use of existing runways. Procedures for use of crossing runways under different conditions, Land and Hold Short Operations (LAHSO), are in use at over 200 airports today. These procedures greatly increase the number of arrivals and departures that can be handled without interfering with intersecting traffic.

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Key Dates	
Safety assumptions agreement	2002
Initial dependent use of LAHSO	2003
Initial independent use of LAHSO	2005

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Responsible Team: Use Crossing Runway Procedures

Solutions
Arrival/ Departure Rate

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ATP-1

ATB-1

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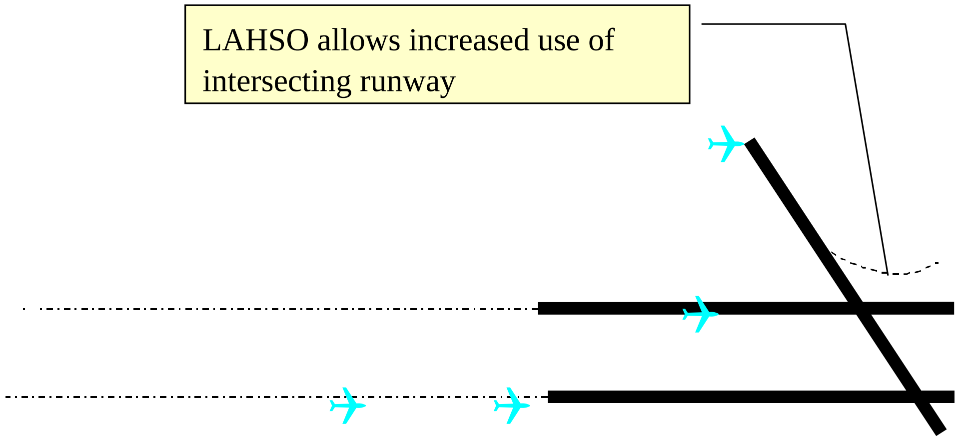
AD-2: Use Crossing Runway Procedures

Land and Hold Short Operations increase use of crossing runways.



Background

Simultaneous Operations on Intersecting Runways (SOIR), either two simultaneous landings or one airplane landing while another was taking off, have been applied under specific waivers to increase airport capacity since 1968. To increase efficiencies for intersecting runway operations, the FAA changed some procedural conditions for conducting SOIR and renamed the program Land and Hold Short Operations (LAHSO). Throughout development of the LAHSO program, users expressed concerns about the safety of conducting LAHSO and associated procedures. In 1997, after the FAA published Order 7110.114, “Land and Hold Short Operations (LAHSO), three major pilot organization, ALPA, APA, and SWAPA launched a vigorous campaign against conducting LAHSO operations as outlined in the order. In April of 1998 the FAA and Industry reached agreement on a number of issues and implemented new procedures for continuance of LAHSO at a number of airports nation wide. The new procedures are based on more critical assumptions and are more restrictive causing significant impact to operations at a number of locations. Pilot organizations were most critical on issues related to safe separation for pilot rejected landings. The FAA, with industry support, attempted to develop and publish “rejected landing procedures” to provide conflict resolution, but test and analysis indicated that the procedures could not guarantee an appropriate level of safety, while conducting independent operations between two intersecting runways. However, data supports a dependent separation procedure that is both safe and offers increased efficiency.

Ops Change Description

LAHSO procedures will improve throughput at airports with intersecting runways. Immediate relief can be provided where dependent operations can be conducted, while analysis of independent procedures continues. LAHSO will be used more widely as more pilots are trained and as compatible procedures are developed for rejected landings and as eligibility criteria are expanded. The expansion will include dependent and independent operations.

Benefits, Performance and Metrics

- LAHSO adds arrival capacity approaching levels for a dependent runway, but will vary with location and airport configuration. It provides up to 10% increase in throughput.

Scope and Applicability

- Changes in LAHSO procedures caused decreased usability, impacting throughput at airports nation wide. Currently, LAHSO is limited to airports where a dependent method of operations exists, or can be identified to support rejected landing procedures.
- Users must collaborate with FAA Air Traffic Procedures to define procedures to make more aircraft types or intersecting runways eligible for LAHSO operations.
- Independent operations using rejected landing procedures are not currently supported based on the safety analysis.
- Extensive analysis is required to prove reasonable assumptions for conducting independent intersecting operations. The study must account for aircraft performance characteristics, wet pavement, general aviation and air carrier mixed operations, and multiple stop locations per runway.

Key Decisions

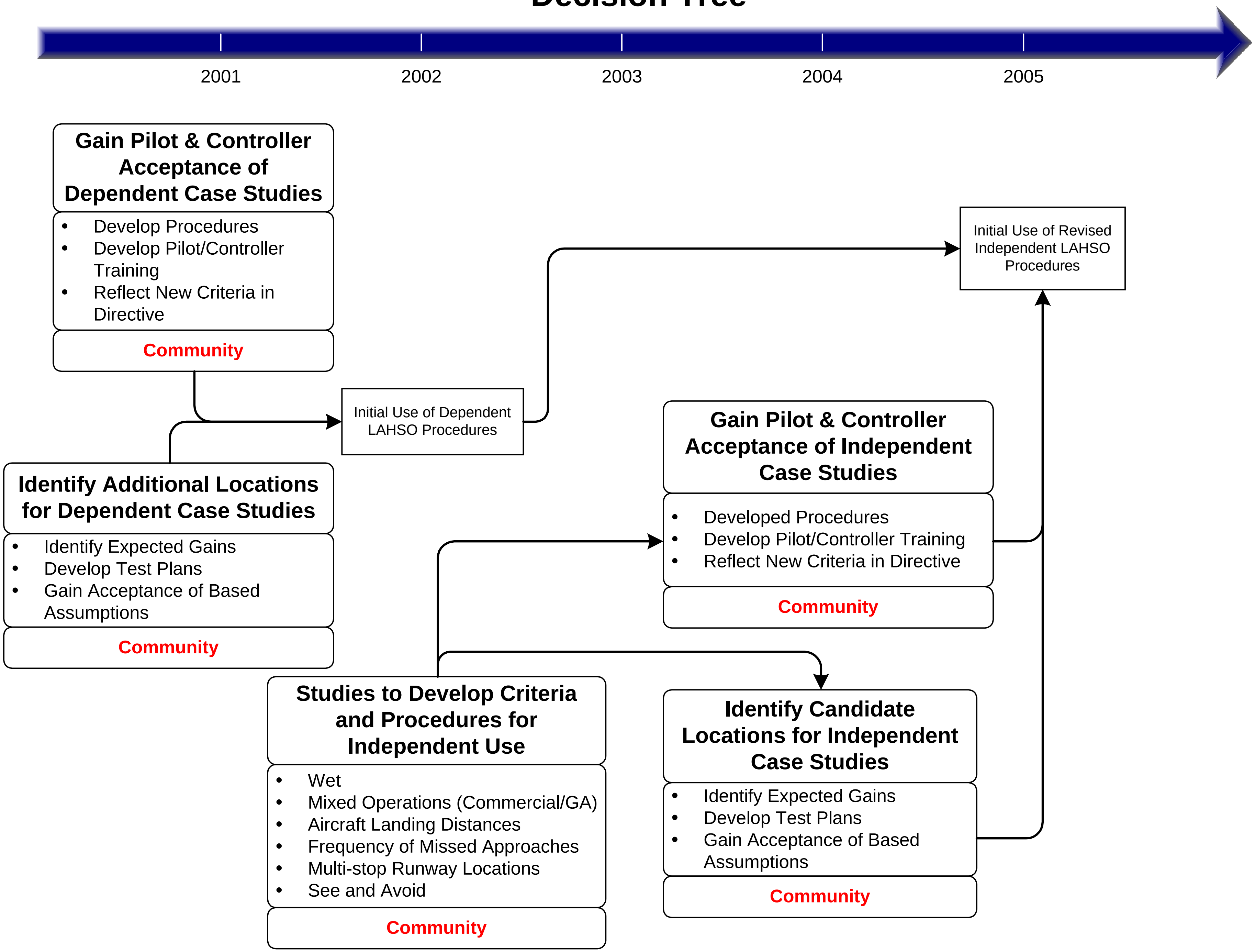
- Concurrence by all stakeholders on safety analysis, approach, and assumptions.
- Established criteria for dependent and independent operations.
- Identification of additional sites for dependent applications and candidates for independent operations.
- Pilot and controller acceptance of roles and responsibilities. The scientific determination of roles and responsibilities through the process of study and analysis needs to involve both pilots and controllers groups. This involvement allows technical input, addressing human factors issues, from both groups to be use in mitigating workload and other safety issues. Participation will demonstrate first hand the significance of how assigning specific responsibilities are based on safety considerations and the ability to identify appropriate tools for pilot or controller to accomplish any task associate with LAHSO.

Key Risks

- Studies do not validate meeting the operational safety requirements.
- Non-acceptance of roles and responsibilities by controllers or pilots.
- Business Case does not support resources based on other program priorities.

V3.0 (30 May 2001)

AD-2: Use Crossing Runway Procedures Decision Tree



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Solution: Redesign Terminal Airspace and Routes

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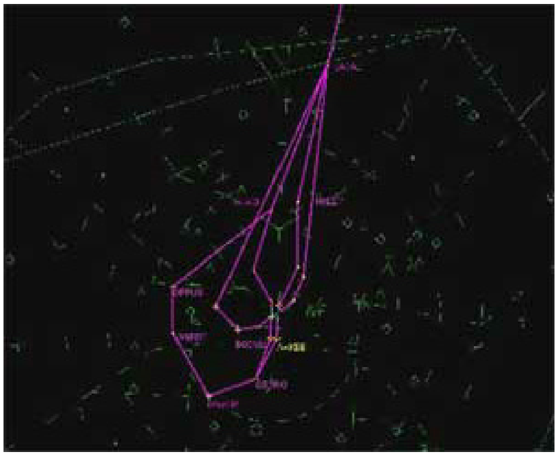

Designing routes and airspace to reduce conflicts between arrival and departure flows can be as simple as adding extra routes or as comprehensive as a full redesign where multiple airports are jointly optimized. New strategies exist for taking advantage of existing structures to depart aircraft through congested transition airspace. In other cases, area navigation (RNAV) procedures are used to develop new routes that reduce flow complexity by permitting aircraft to fly optimum routes with little controller intervention. These new routes spread the flows across the terminal and transition airspace so aircraft can be separated to optimal lateral distances and altitudes in and around the terminal area. In some cases addition of new routes alone will not be sufficient, and redesign of existing routes and flows are required. Benefits are multiplied when airspace surrounding more than one airport (e.g., in a metropolitan area) can be jointly optimized.

Key Dates

► TAAP Evaluation, Overlay RNAV Routes at Seven Congested Airports	2001
► Over 100 New and Overlay Routes at Over 20 Congested Airports	2002
► Potomac Redesign Operational	2003
► Redesign Cincinnati, LA Basin, Northern Cal, Terminal	2004
► Houston Redesign	2004
► Redesign Great Lakes Corridor Terminal	2005
► NY/NJ/PHL Metro Airspace Redesign	2006
► STL Terminal Redesign	2006

Responsible Team: Redesign Terminal Airspace and Routes

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Regional Air Traffic Airspace and Operations Managers

Regional Airspace Focus Leadership Teams

Facility Airspace Design Teams

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ATT-1

AFS-400

AVN-1

AIR-100

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This page was last updated on May 30, 2001

AD-3: Redesign Terminal Airspace and Routes

Terminal airspace and route redesign.

Background

Current congestion in transition and en route airspace often limits the ability to get departing aircraft off the ground. Similarly, airspace congestion can limit arrivals, even if runway capacity is available. In many terminal areas today, arrival and departure procedures overlap either because they were designed for lower volumes and staffing, or because they are based on ground-based navigation. These routes are strongly interdependent. Many airports have common departure fixes or arrival fixes that must service a variety of aircraft types with different performance characteristics. By requiring departures to navigate or funnel through common departure fixes, the throughput rates at the airports involved must be suppressed. Similar problems exist with arrivals.

Terminal airspace optimization and redesign is a foundation component of the National Airspace redesign. Terminal airspace optimization efforts are ongoing initiatives to ensure the airspace design and use is effective for transitioning aircraft to and from the associated airport or airports. Terminal airspace redesign is a major undertaking to develop a structure that takes full advantage of evolving technologies and aircraft capabilities. This redesign will provide flexibility for system users to efficiently transition into and out of terminal airspace while making maximum use of airspace and airport capacity.

Where volume has increased and the current airspace structure is the limiting factor, redesigning these procedures, including the addition of RNAV procedures, will allow for more efficient use of the constrained terminal airspace. Area Navigation, or RNAV, is a method of navigation that permits aircraft operations on any desired course within the coverage of station referenced navigation signals or within the limits of self contained system capability or combination of these. The acronym “RNAV” has been adopted by industry as an umbrella term that encompasses any procedure or operation that utilizes point to point navigation, from ground or air-based/space-based sources. The expectation is that in the future, this will evolve away from dependence on ground-based navigation resources. This is manifested through use of on-board avionics and flight management systems (FMS).

RNAV technologies offer several operational improvements:

- RNAV procedures in terminal airspace can reduce complexity and increase efficiency in the near and mid-term. When designed collaboratively, the procedures require minimal vectoring and/or communications between the flight crews and the ATC controllers. These procedures can be used to reduce voice communications associated with speed and altitude instructions, freeing up more controller time. The procedure, when implemented, describes a flight path that includes position, altitude, and time.
- Reducing spacing on the arrival route structures to the existing separation standards can be accomplished in the long-term through pre-planned navigation routes and speed control techniques (planned for 50 airports). This concept deals with developing

procedures that include the assignment of altitudes and speeds at waypoints located along the FMS/RNAV procedure.

Ops Change Description

The operational change described here includes three concepts to reduce interdependencies between arrival and departure flows:

- AD-3.1: Use existing airspace structures and apply traffic management strategies to depart aircraft through congested transition airspace. Capping and tunneling techniques are included as part of the National Airspace Redesign System Choke Points program.
- AD-3.2: Restructure arrival and departure routes to be independent of navigation aids, using existing RNAV technologies RNAV route development is a primary function of Air Traffic procedural development and a foundation element of the National Airspace Redesign.
- AD-3.3: Optimization and redesign of the terminal area airspace and operations. Terminal optimization and redesign projects are a key component of the National Airspace Redesign.

Benefits, Performance and Metrics

- Increase on-time departures.
- Increase airport capacity utilization effectiveness.
- Reduced excess gate times (duration and/or occurrence).
- Reduction in en route delay.
- Arrival rates percent effectiveness increase for airports where the en route transition sectors suffer high frequency congestion (e.g., ATL northeast arrivals).
- Allows controller to deliver the aircraft with reduced restrictions and vectoring.
- Workload reductions so controllers can reduce restrictions to aircraft and close up spacing to the separation standard.
- Assuming that the use of RNAV is the primary flight practice for arrivals, the percent of control transmissions per aircraft can be reduced per day by the following estimates[1]:

[1] Estimates are generated based on real world experience of actual transmission reductions at several current locations. Estimates are based on current levels of equipage and estimate of current transmission per flight in the terminal area at these locations. Estimates are for airport specific populations.

Airport	Percent	Airport	Percent	Airport	Percent	Airport	Percent	Airport	Percent
BOS	29	ATL	32	DFW	33	LAX	27	MSP	23
EWR	38	MIA	28	STL	17	PHX	33	OAK	19
ORD	42	PHL	37	LAS	37	DEN	37	DTW	20

- The reduction in number of air/ground communications will reduce controller and pilot workload, as well as mitigating the advent of frequency congestion issues in the future. Overall effect is to maintain maximum utilization of available runway capacity.

AD-3.1 Expedited Departure Routes

Scope and Applicability

Two traffic management techniques are being used in the near- and mid-term to expedite departures into congested transition airspace:

- LAADR (Low Altitude Alternate Departure Routes) is a program that allows aircraft to take off, climb to a lower altitude and then achieve their desired/requested altitude later in the flight. Aircraft can proceed to desired altitude as soon as controller clears them. A Letter of Agreement (LOA) is needed between participating facilities along with agreements from participating airlines. This program is facilitated by the ATCSCC. Two LAADR Memoranda of Understanding (MOUs) exist: STL and PHL.
- As part of National Airspace Redesign Choke Points activities, TAAP (Tactical Altitude Assignment Program) is being explored as a viable method to get traffic operating in less congested altitudes, though perhaps these altitudes are less optimal in terms of fuel usage. TAAP is expected to reduce en route congestion and has potential benefits of getting aircraft off the ground sooner, although filing TAAP does not guarantee that the flight will depart sooner. TAAP is voluntary for airline participants (they must file TAAP routes) and involves flying at lower altitudes for shorter length flights. Flights that operate under TAAP are expected to fly at the lower altitudes for the whole length of the flight, and neither the pilot nor controller is supposed to climb the aircraft for efficiency purposes. Routes, between over 100 city pairs, within eight ARTCCs in the Great Lakes corridor, Northeast, and Mid-Atlantic have been identified and agreed upon for TAAP.

Key Decisions

- Determine user participation levels and benefits associated with current and projected usage for both LAADR and TAAP.
- Determine opportunities for benefits and develop additional MOUs with airlines to use LAADR.

- Provide training to controllers, pilots, and dispatch on routes. Develop training materials to outline the differences between these two procedural options, and when they can and should be used.

Key Risks

- Environmental assessment for new routes and adjusted traffic flows may be needed.
- LAADR and TAAP both restrict aircraft to lower altitudes and while potentially providing expedited departure, they may result in increased fuel usage. User participation in TAAP, because it is voluntary, may be limited.

AD-3.2 Routes Independent from Navigation Aids

Scope and Applicability

RNAV allows for the creation of arrival and departure routes (specifically, allowing multiple entry to existing and STAR and multiple exits from Departure Procedures (DPs)) that are independent of present fixes and navigation aids. Airports with complex, multiple runway systems, or with shared or congested departure fixes benefit the most through segregating departures and providing additional routings to reduce in-trail separation increases during climb. Participation and benefits are subject to aircraft equipage levels, pilot/controller education. Radar is required for RNAV operations below FL450 (order 7110.65 5-5-1).

Design, evaluation and implementation of RNAV arrival and departure routes is ongoing across the United States. Current implementation plans include:

- In the near-term, overlay RNAV routes are being developed at EWR, PHL, JFK, CLT, IAH, DTW, and IAD.
- For the mid-term, overlay and non-overlay routes are planned for these and additional sites, including PIT, LAS and PHX (Northwest 2000).
- In the longer-term, RNAV with speed control will be used to support minimal spacing of aircraft on arrival. The controller maintains constant minimum spacing only between back-to-back pairs of RNAV arrivals (both must be equipped to tighten up spacing) through clearances for altitude and speed control procedures. RNAV arrival routes will not change requirements for final approach.
- A national RNAV prioritization plan for arrival/departure procedures is in final review. This will be an addendum to OEP.

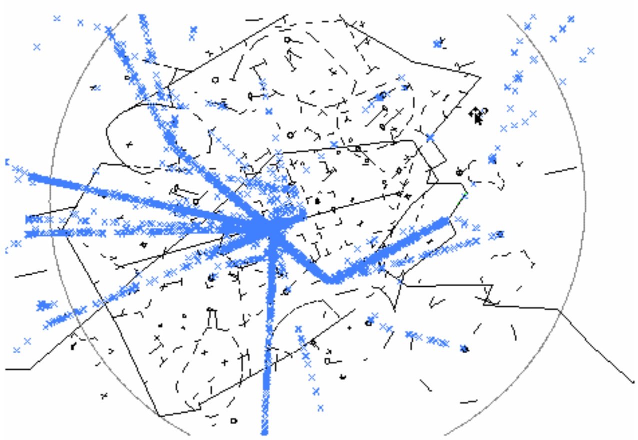
Key Decisions

- Air Traffic and Flight Standards must complete and/or update FAA Orders (STAR/Approach), FAR/CFR's, Advisory Circulars.
- Air Traffic must complete national procedures for RNAV procedure development and implementation.
- Identify and ensure user equipage to deliver desired benefits.
- Manufacturers and users must complete avionics certification for FMC – Required Navigational Performance (RNP), ARINC 424 (for new types).
- Pilot and controller training must be completed. Flight Crew Education includes FMC proficiency, phraseology, and ATC procedures.
- The current RNAV/TARGETS MOU limits use of the TARGETS tool and associated process to 7 sites (EWR, PHL, JFK, CLT, IAH, DTW, and IAD). The MOU will need to be revisited to add additional sites to this process.

Key Risks

- Environmental assessment for new routes and procedures. The implementation timeframe for these projects could increase significantly depending on the level of environmental assessment required by the proposed change.
- Segregated routes based on equipage may penalize non-equipped users. Rulemaking may be required. AOPA has indicated possible acceptance of RNAV equipage being necessary to access major congested airports during specific, limited times of day, but they must maintain access to key GA airports (e.g., Teterboro) located in close proximity to potential RNAV mandated airports.
- Systems that must be in place or may cause risks in delivery include Flight Management Computers (FMC), ATC Host/ARTS automation adaptation and display of RNAV status, and STARS adaptation and display of RNAV status.

AD-3.3 Redesign Terminal Airspace



Improved Terminal Airspace Structure

Scope and Applicability

Terminal airspace optimization (mid-term) and redesign (long-term) projects are ongoing across the United States. Efforts are planned for all major metropolitan areas and congested terminal areas servicing key airports. These include:

- Mid- and long-term, large-scale redesign efforts are being conceptualized in Anchorage, St. Louis, Omaha, New York, Philadelphia, Potomac, Cleveland, Minneapolis, Detroit, Chicago, Bradley, Seattle, Portland, Denver, Cincinnati, Orlando, Charlotte, Houston, Santa Barbara, San Diego, Phoenix, Los Angeles, Las Vegas, Honolulu, and San Francisco. These redesign projects include expansion of terminal airspace (see AD-5), RNAV-base routes (see AD-3.2), arrival and departure corridors, and expanded use of terminal holding. Establishment of arrival reservoirs in the terminal airspace will allow for maximum use of runway capacity.
- Implementation for NY/NJ/PHL Redesign is planned for 2005 and Potomac is planned for 2003. Alternative designs for NY/NJ/PHL and Potomac include optimization using existing infrastructure (tweaking of the current system) and redesign from a "clean-sheet." Redesigned arrival and departure routes will likely be defined as RNAV-based, not dependent on current ground aids. Design concepts include high downwind segments for arrival aircraft, unrestricted departure climbs, fanned departure headings, and VFR flyway corridors.

Key Decisions

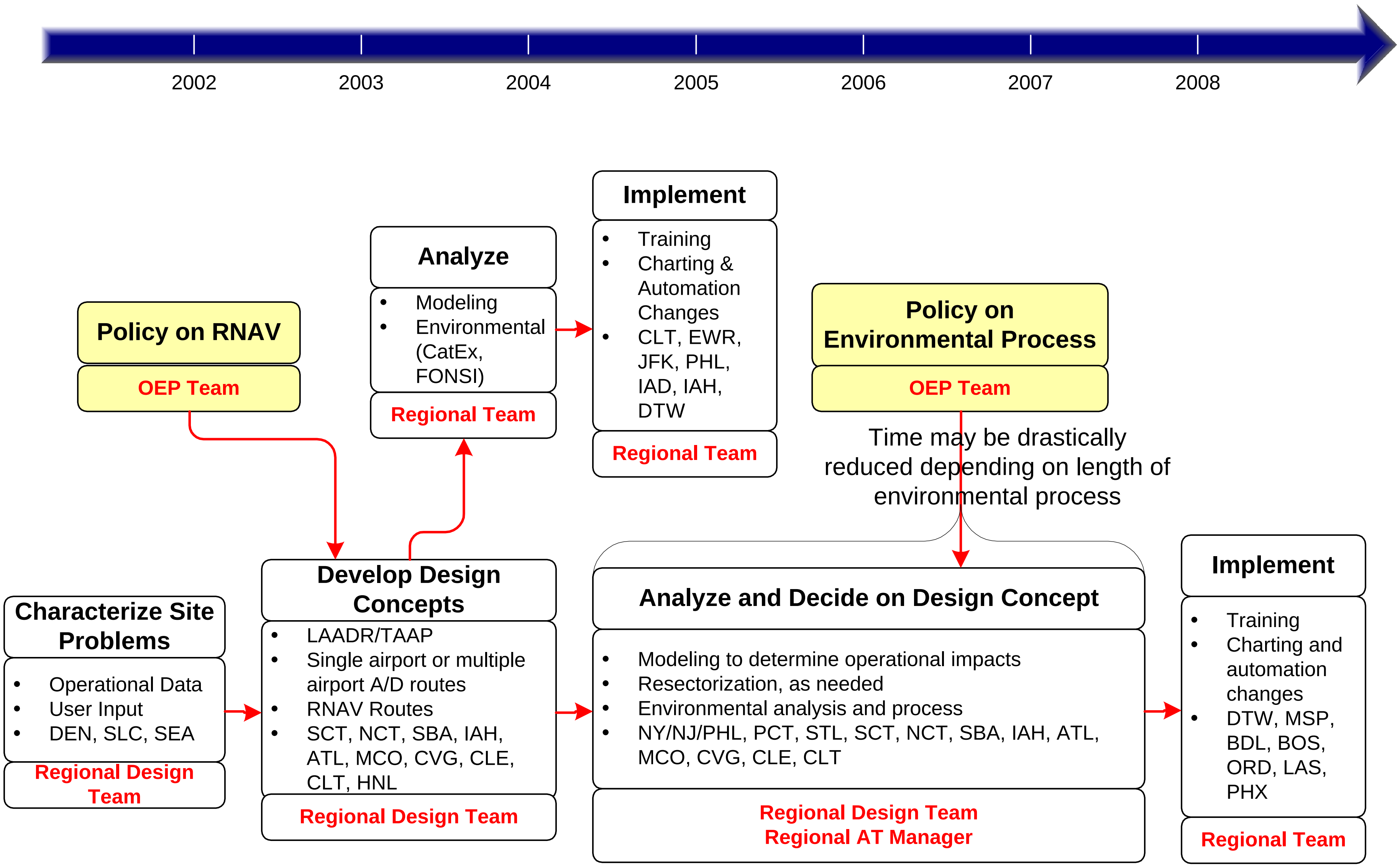
- Prioritization of limited resources to support critical terminal area redesign.
- Develop procedures to support airspace design changes. Provide training to controllers, pilots, and dispatch on routes.

Key Risks

- Systems that must be in place or may cause risks in delivery include ATC Host/ARTS automation, WAAS/LAAS, and frequencies for transitioning and new sectors.
- Environmental assessment for new routes and adjusted traffic flows. The implementation timeframe for these projects could increase significantly depending on the level of environmental assessment required by the proposed change.

V3.0 (30 May 2001)

AD-3: Redesign Terminal Airspace and Routes Decision Tree



Solution: Fill Gaps in Arrival and Departure Streams

Automated decision support tools provide controllers more information on airport arrival demand and available capacity for making decisions on aircraft spacing. Improved sequencing plans and optimal runway balancing increase arrival and departure rates as much as ten percent. Free Flight tools will help air traffic controllers balance runway use and sequence aircraft according to user preferences and airport capacity.

Key Dates

Single Center TMA at DFW, LAX, MSP, MIA, SFO, ATL, ORD	2001
pFAST at DFW, LAX, Atlanta, Minneapolis	2001
pFAST at St. Louis	2002
DSP at Boston, Washington	2002
Validate Multi-center TMA	2003
Further Single Center TMA Deployment	2004

Responsible Team: Fill Gaps in Arrival and Departure Streams

Primary Office of Delivery

Charlie Keegan, AOZ-1

Support Offices

ATP-1

ATB-1

AUA-700

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RTCA

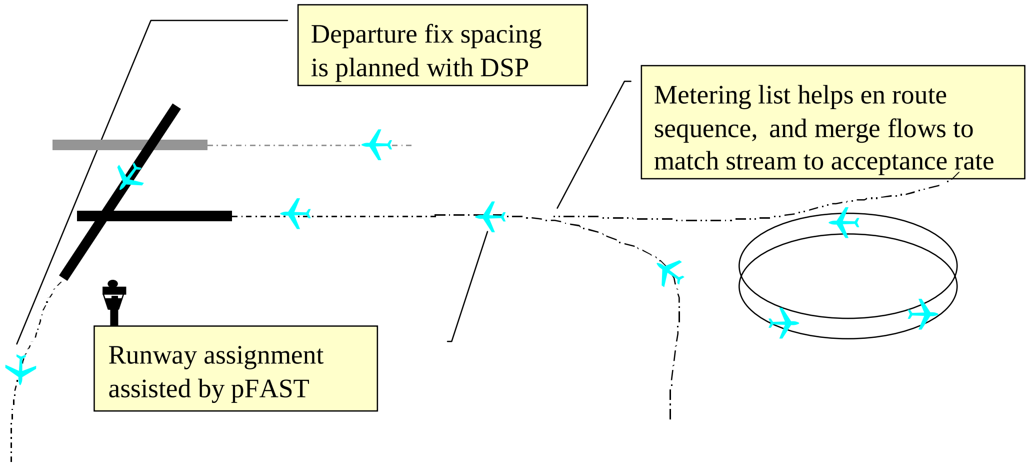
Other Websites

RTCA

Free Flight Program Office:

AD-4: Fill Gaps in Arrival and Departure Streams

Improved planning information through use of decision support tools.



Background

During periods of high traffic demand, realizing the full potential throughput at an airport requires the controller to space aircraft at the minimum required for safety. At most locations, controllers rely on experience and their ability to extrapolate the future position of aircraft to develop spacing plans and to execute these plans. Research on automated decision support tools has shown that controllers can improve their planning, which results in improved throughput.

Ops Change Description

Controllers and TMCs will have improved information on arrival and departure demand and on available capacity. Decision support tools will assist them in developing improved sequencing. These plans will reflect an improved ability to project the future position of the aircraft, to optimize use of runways and fixes, and to account for separation requirements based on aircraft weight classification. The result will be an improved balancing of the airport runway assets and an increase in the airport throughput rate for both arrivals and departures. In addition, the execution of the plan will be improved through the provision of tools that show controllers the delay required for each aircraft. Arrival metering will transition from being mileage based to being time based.

- AD-4.1: *Departure Spacing*—The Departure Spacing Program (DSP) will improve the sequencing of aircraft from multiple airports over common departure fixes and will reduce departure delays. DSP will also provide a means to apportion departure delays among participating facilities and flights, based on determinations made by TMCs of the most advantageous TFM operational scenario for the predicted traffic and weather conditions. Initial DSP capabilities are already available for New York airports.
- AD-4.2: *Metering and Merge Planning*—Traffic Management Advisor – Single Center (TMA-SC) will provide a metering plan to TMCs and provide information to controllers to quantify the differences between assigned meter times and the times that aircraft are

projected to cross a meter fix. A planned enhancement to TMA, Traffic Management Advisor – Multi Center (TMA-MC) will support metering at airports that are near center boundaries or where the arrival flows may interact with the flows to other airports.

- AD-4.3: *Runway Allocation and Spacing*—The passive Final Approach Spacing Tool (pFAST) will provide terminal controllers and TMCs optimal runway assignments for arrivals.

Benefits, Performance and Metrics

- DSP will reduce the coordination time necessary for departures in complex airspace and during severe weather situations, and will result in reduced departure delays.
- Due to improved information from TMA to TMC's and controllers, arrival rates will increase 5-10 percent. Estimated improvements are based on results from implementation at ZFW-DFW.
- Due to runway advisories from pFAST, runways will be better balanced, resulting in an estimated increase in total operations throughput of more than 3 percent.

AD-4.1 Departure Spacing

DSP will provide Tower, TRACON, and Center controllers and TMCs with information on departures. This information will include routes, aircraft status, and departure timeframes.

Scope and Applicability

- DSP will improve the sequencing of aircraft from multiple airports over common departure fixes and will reduce departure delays.
- DSP will initially focus on New York/New Jersey airports (including PHL), then on Boston and Washington area airports in FY 02. DSP will be applicable in the Northeast corridor of the United States, where multiple airports share oversubscribed departure fixes and routes.
- In parallel, the NASA will be developing a controller decision support tool for expedite departure path planning (EDP) to assist the controller in precisely meeting DSP flow rates over departure fixes and, where possible, to merge departures directly into en route streams.

Key Decisions

- None identified.

Key Risks

- None identified.

AD-4.2 Metering and Merge Planning

Decision support tools provide the TMC with a metering plan and the controller with information on the required delays for each aircraft (also see ER-7.2).

Scope and Applicability

- TMA (Traffic Management Advisor) is applicable for airports where arrival demand regularly exceeds capacity.
- TMA-SC (Traffic Management Advisor – Single Center) near-term and mid-term locations include: ZFW-DFW (complete), ZMP-MSP (complete), ZDV-DEN (complete), ZMA-MIA (FY01), ZOA –SFO (FY01), ZLA-LAX (in initial daily-use), ZTL-ATL (FY01), and ZAU-ORD (FY02).
- Additional arrival sites will require site specific adaptation. FFP2 plans to deploy TMA-SC to support arrivals at the following airports: ZME-MEM, ZKC-STL, ZID-CVG, and ZHU-IAH. Deployment order and schedule have not been finalized, but the current plan is to deploy to 1 site in FY 03, 2 sites in FY04, and 1 site in FY 05. Expansion to additional sites may include supporting arrivals to MCO, CLT, SEA, SLC, PHX, and LAS.
- TMA-MC (Traffic Management Advisor –Multi Center) will enhance TMA to work in areas where the airport is close to the center boundaries and where arrival flows interact with flows to other airports. RTCA recommended TMA for several sites that require TMA-MC capability, these include Washington area airports, N90 airports, PHL, DTW, SDF, BOS, and PIT. NASA is developing TMA-MC with emphasis on PHL airspace; this capability should be ready for evaluation in FY 03.
- In parallel, research is also ongoing as part of the Safe Flight 21 program to develop an application that enables more optimal spacing by providing pilots with advisories on airspeeds needed on final approach to maintain spacing objectives and increase efficiency.

Key Decisions

- Priorities for TMA deployments beyond the current recommendations.

Key Risks

- NASA is currently researching TMA-MC. Implementation is dependent on the success of this research and on NASA participation in technology transition.
- New York and Philadelphia redesign activities will result in changes to TMA adaptation and therefore work in these areas needs to be coordinated.

AD-4.3 Runway Allocation and Spacing

pFAST will provide the controller with runway assignments for arrival aircraft.

Scope and Applicability

- pFAST is applicable at airports with multiple arrival runways and that at peak times are at or near capacity. Applicability and benefits depends on airline schedules and airport configuration.
- pFAST near-term and mid-term locations include: DFW (complete), LAX (complete), ATL (FY01), MSP (FY01), STL (FY02). Capability depends on ARTS IIIe or STARS availability for full implementation. Partial benefits may be achieved with current equipment.
- Further implementation of pFAST will be contingent upon infrastructure waterfalls (e.g., STARS). Implementation will be consistent with, and will need to be coordinated with airspace modifications for San Francisco area, Washington area, and New York area airports.
- In parallel, the NASA will be conducting research to add heading and speed advisories to pFAST in order to assist the controller in precisely spacing the aircraft in the arrival stream.

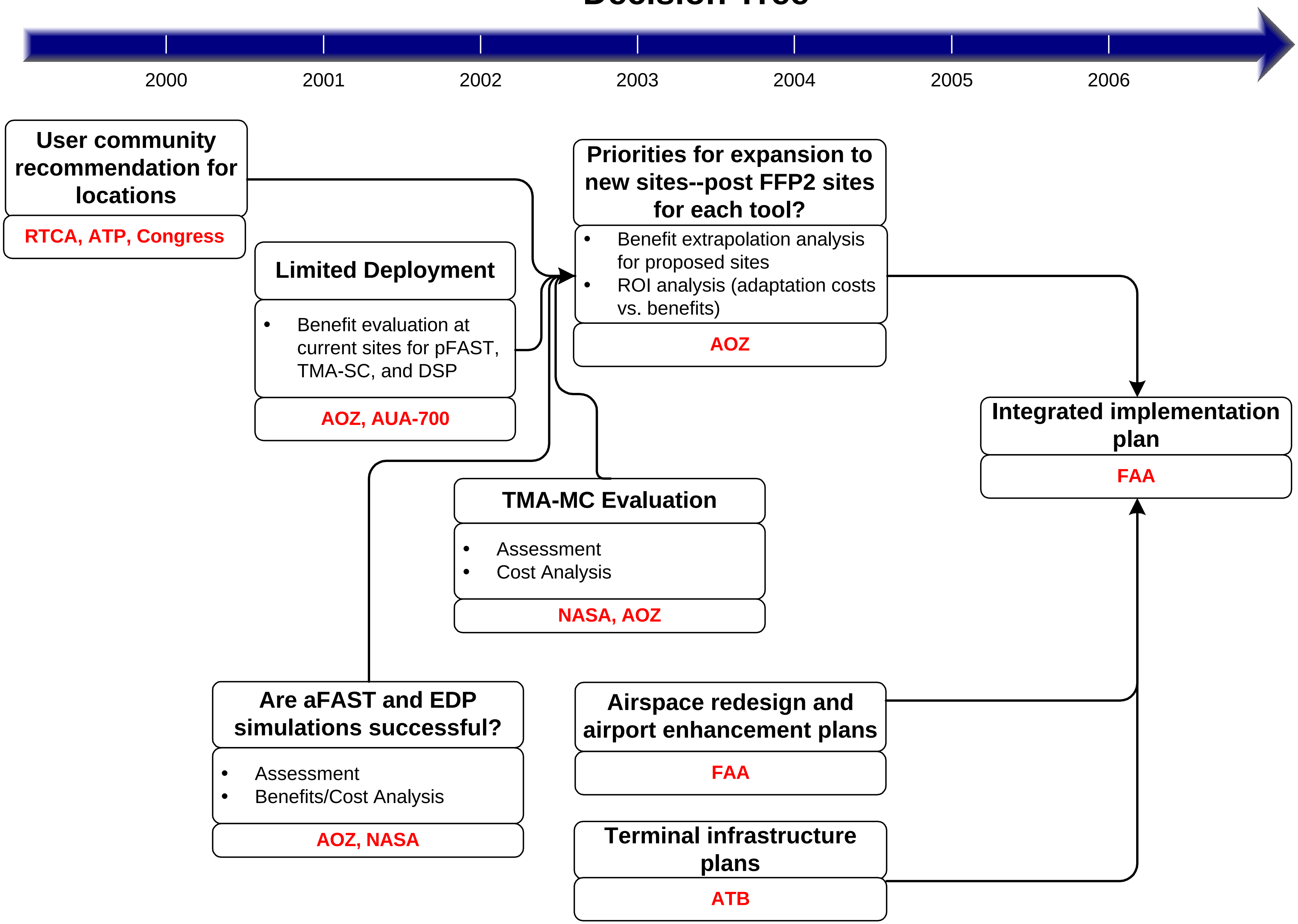
Key Decisions

- Priorities for pFAST deployment beyond the current RTCA recommendations.

Key Risks

- pFAST requires a significant amount of site specific adaptation (pFAST is adapted to reflect how arrivals actually fly in the terminal airspace). Therefore pFAST site specific schedules must be coordinated with other expected changes at the same locations. These changes include modifying airspace, expanding the area in which 3 nmi separation applies, changing arrival routes, and adding new runways.
- To achieve full benefits from pFAST, controllers may need to change their current local operating practices.
- STARS deployment waterfall is uncertain.

AD-4: Fill Gaps in Arrival and Departure Streams Decision Tree



Solution: Expand Use of 3-Mile Separation Standard

Potomac Consolidated TRACON

Current aircraft separation standards allow for 3-mile separation when within 40 miles of a single radar sensor. By identifying opportunities to maximize the use of the 3-mile separation, additional airspace efficiency can be achieved. One effect would be more optimal control of aircraft during transition to and from the airport. Methods to maximize use of the 3-mile separation include: expansion of terminal procedures to surrounding en route airspace at selected single airports, encompassing multiple airports in a single facility with redesigned airspace, and the consolidation of terminal radar approach control facilities (TRACONs). Care must be taken to ensure general aviation access to this airspace is not unduly impaired.

Key Dates

▶ Santa Barbara Expansion	2002
▶ Potomac Redesign	2003
▶ Redesign Cincinnati, LA Basin, Northern California, Terminal	2004
▶ Houston Redesign	2004
▶ NY/NJ/PHL Metro Airspace Redesign	2006
▶ Charlotte Redesign	2006

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Responsible Team: Expand Use of 3-Mile Separation Standard

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Primary Office of Delivery

John Walker, ATA-1

Support Offices

Regional Air Traffic Managers

Regional Air Traffic Airspace and Operations Managers

Regional Airspace Focus Leadership Teams

Facility Airspace Design Teams

ATP-1

AFS-400

Working Forums

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AD-5: Expand Use of 3-Mile Separation Standard

Expand use of 3-mile separation standards and terminal separation procedures.

Background

Current separation standards allow for 3-mile separation when within 40-miles of a single radar sensor. By identifying opportunities to maximize the use of the 3-mile separation standard, additional airspace efficiency may be achieved. This would afford more efficient control of aircraft during transition to and from the airport.

Ops Change Description

Currently, expansion of designated terminal airspace is the only planned opportunity to gain this type of efficiency. Other methods of improving surveillance, such as improved radar update rates or other forms of advanced surveillance, may offer options to expand usage of 3-mile standards or reduce separation standards in transition airspace in the future. In particular, deriving equivalent position accuracy as that within 40 miles of a radar may be achievable through evolving technologies like ADS-B and/or improved surveillance data processing.

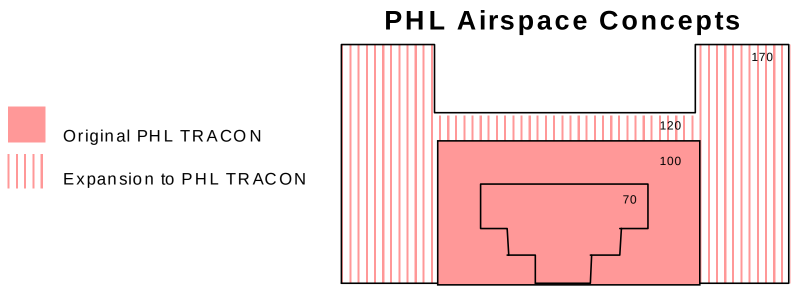
Three methods of expanding designated terminal airspace are described here:

- AD-5.1: Expansion of terminal procedures application by reassigning en route airspace to terminal facilities (does not require consolidation of facilities).
- AD-5.2: "Terminalization of the airspace" through consolidation of terminal and en route operations for airspace servicing the New York metropolitan area.
- AD-5.3: Consolidation of terminal airspace with acquisition of en route airspace.

Benefit, Performance and Metrics

- Percent effectiveness for top airports should increase.
- On time departure rate should increase.
- Excess taxi times should decrease.
- Ground delay programs should decrease.

AD-5.1 Expansion of Terminal Procedure Applications



Scope and Applicability

- Terminal redesign projects in several areas are considering reassigning airspace currently controlled by en route facilities and releasing airspace responsibility to adjoining terminal control facilities to reduce separation, coordination, intermediate level-offs, and other TRACON to center handoff restrictions.
- The applicability of this approach (where en route airspace can be reassigned to terminal control) is dependent on available infrastructure (communications, navigational aids, surveillance coverage, automation upgrades, and facilities) and ability of the workforce to accept additional traffic.
- Current proposed projects include expansion of terminal airspace at Philadelphia, Santa Barbara (Central California), Phoenix, Cincinnati, Seattle, Charlotte, Southern California, Northern California, and Chicago.

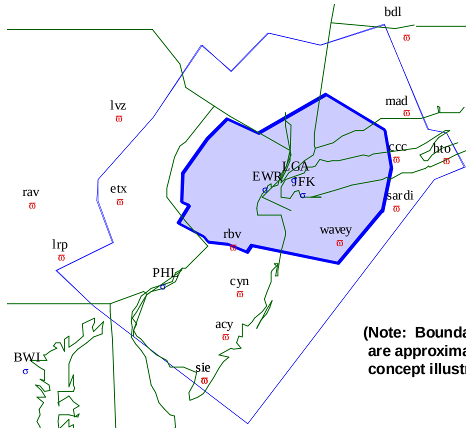
Key Decisions

- Determine other areas of opportunity where it is feasible and applicable to redistribute airspace from en route to terminal facilities.

Key Risks

- Environmental impact assessment may be required. The implementation timeframe for these projects could increase significantly depending on the level of environmental assessment required by the proposed change.

AD-5.2 Single Facility for En Route and Terminal Operations in New York



Scope and Applicability

- The FAA is in the early planning stages of airspace design and control changes surrounding the airspace supporting the New York metropolitan area. This concept involves “terminalization” of the en route airspace controlled by the en route facilities abutting the New York TRACON. “Terminalization” of the airspace will allow for reduced separation and better coordination resulting in greater efficiency in airspace management around New York.
- Effected control facilities include ZNY, ZBW, ZDC in en route airspace; N90, PHL TRACON in terminal airspace.
- Affected major airports: LGA, JFK, EWR, PHL.
- Also affects flows into and out of ZOB and may affect flows to Boston.

Key Decisions

- Determine if a single facility will be pursued.

Key Risks

- Significant environmental analysis will need to be completed. The current NY/NJ/PHL redesign includes environmental analysis to support new airspace and procedures, but does not include environmental analysis for a new building. Environmental impact assessment for a new building will be needed and has not been included in current environmental plans for NY/NJ/PHL Redesign.
- Determine affordability of proposed consolidation of operations. Cost-benefit assessment of the single-facility concept must be completed, and a decision must be made as to how to proceed with the building portion of the concept.
- Several infrastructure changes will be required to implement this concept. Current plans have identified these needed changes and teams are being formed to conduct necessary analysis. Issues being examined by AEA include:

- Rerouting communications and radar data to the consolidated facility or (for high altitude airspace) to the Boston and Washington ARTCCs.
- Providing the kind of radar coverage that would permit use of three-mile separation throughout the airspace in question, including the surveillance data processing that would be required.
- Providing flight data processing for the consolidated facility.
- Creating the necessary infrastructure (e.g., power supply, cooling) associated with the building in which a consolidated facility would reside.

AD-5.3 TRACON Consolidation

Potomac Consolidated TRACON

Scope and Applicability

- TRACON consolidation involves merging separate terminal radar approach controls into a single, consistent operation housed in one building. For example, the Potomac Consolidated TRACON will include the consolidation of Baltimore, Andrews, National, and Dulles TRACONs. TRACON consolidation includes airspace redesign, procedures definition and building a common facility.
- Terminal airspace and facility consolidation projects include: Potomac Consolidated TRACON (2003), Boston Consolidated TRACON (awaiting JRC), Atlanta continued consolidation (2005), Houston (in design), and Central Florida (awaiting JRC).

Key Decisions

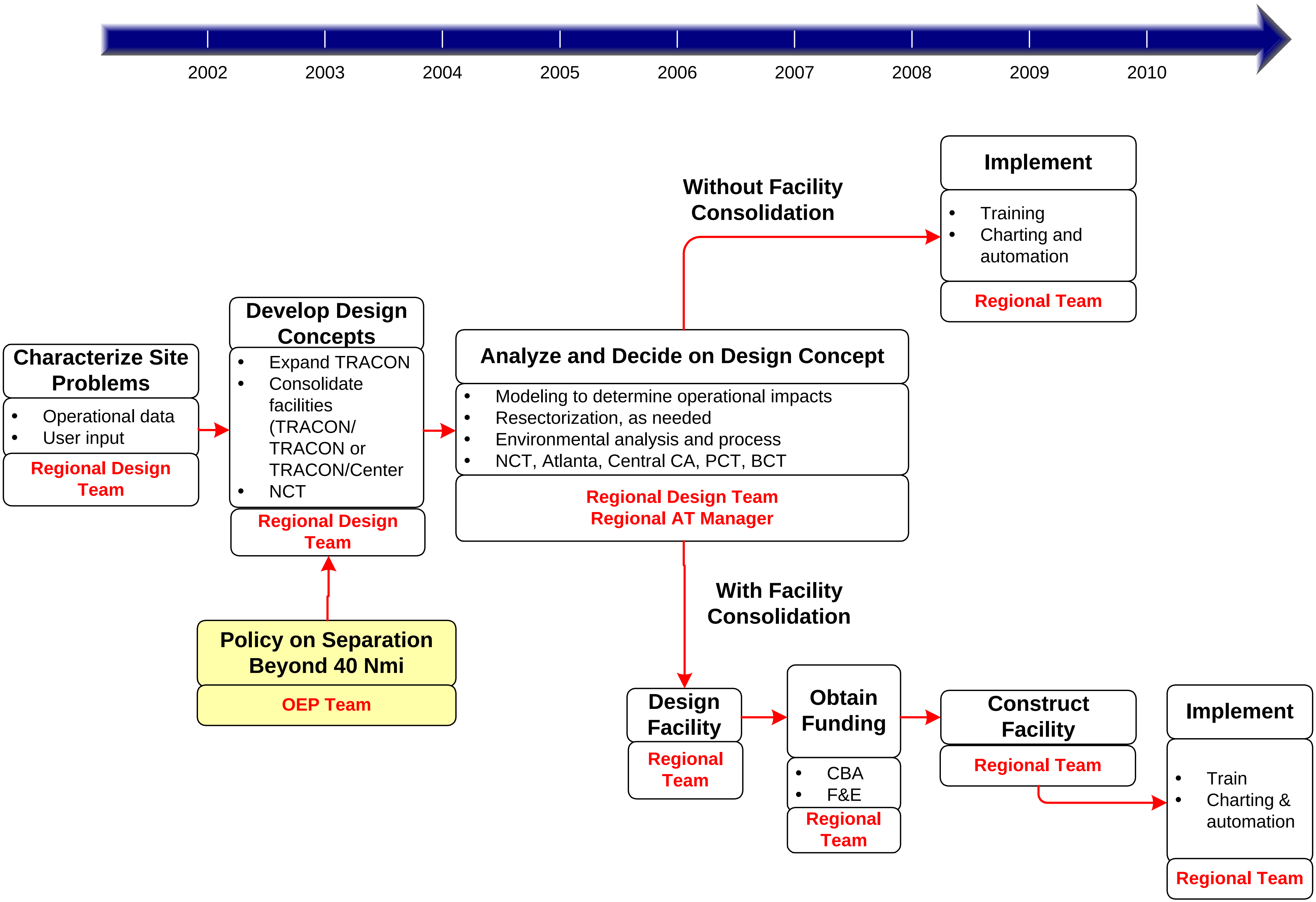
- Determine how and when to consolidate terminal facilities. Current policy is that airspace redesign is assumed to be part of consolidation project: new routes, fixes, arrival/departure areas, new sector and facility boundaries as appropriate. (Note: BCT does not assume redesign of airspace, but other consolidation projects do include redesign.)

Key Risks

- Determine affordability of proposed consolidation of operations.
- Cost-benefit assessment of the proposed consolidations must be completed and evaluated; FAA ATS senior leadership has determined that studies must include operational benefit as well as administrative savings.
- Several infrastructure changes will be required to implement facility consolidation:
  - Rerouting communications and radar data to the consolidated facility.
  - Providing flight data processing for the consolidated facility.
- Creating the necessary infrastructure (e.g., power supply, cooling) associated with the building in which a consolidated facility would reside.
- At one time, NATCA representatives stated that they do not support additional TRACON consolidation. AAT/ATP are discussing the union’s current position on this.
- Staffing for consolidated facilities will need to be negotiated with the union.

V3.0 (30 May 2001)

AD-5: Expand Use of 3-Mile Separation Standard Decision Tree



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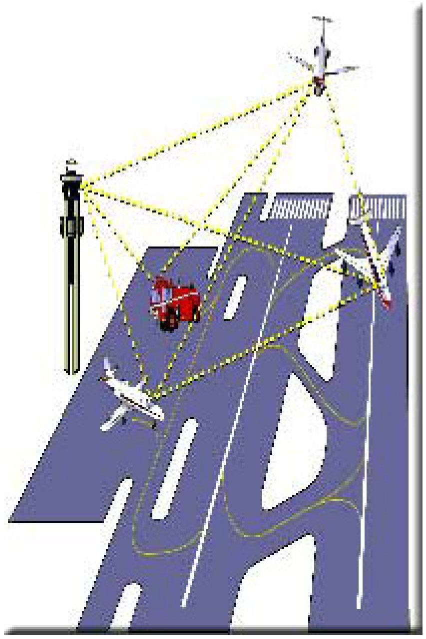


New tools for airport surface traffic management will provide airport personnel the capability to predict, plan, and advise surface aircraft movements. Animated airport surface displays for all vehicles on the ground will display information in real time to all parties of interest, supplementing the available visual information. Additionally, improved decision-making capability for air traffic controllers will help balance runway loads more effectively.

Key Dates

SMS Trial at MEM	2003
Operations Defined for Surface Movement System	2004
User and Ground Vehicles Equipped	2006
Operational Surface Movement System	2007

Responsible Team: Coordinate for Efficient Surface Movement

Primary Office of Delivery

Jeff Griffith, ATP-1

Support Offices

AOZ-1

AND-500

SF-21 SSG

ATB-1

AIR-100

Working Forums

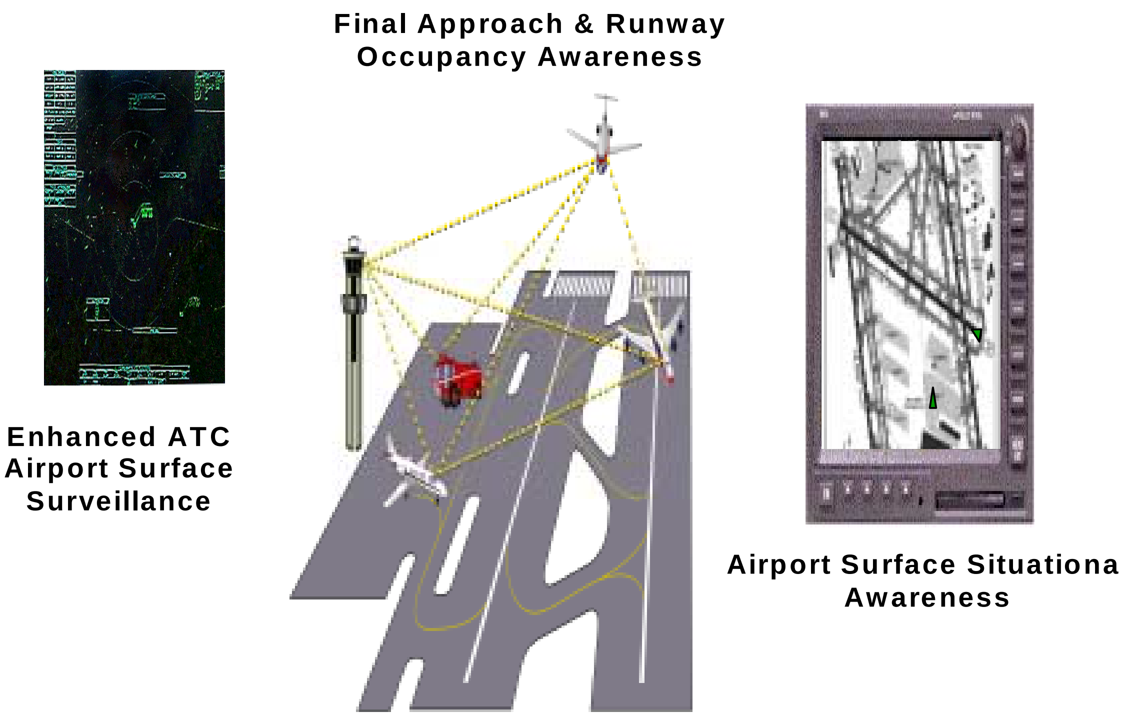
Other Websites

Please send your comments to nas-evol@mitre.org

This page was last updated on May 30, 2001

AD-6: Coordinate for Efficient Surface Movement

Improved planning, movement, and decision-making due to shared situational awareness of surface operations.



Background

Tower controllers have limited information on the position of aircraft on the surface. Pilots have no electronic display of aircraft or ground vehicle position, velocity, or intent information. In addition, the ramp controllers, airport operators, and fixed-base operators have limited information on the location of aircraft on the surface. This lack of shared situational awareness results in inefficiencies in surface movement, gate management, and servicing of aircraft. Uncertainties in surface movement contribute to inefficient use of runways and have safety implications.

Ops Change Description

Distribution of position information on aircraft and selected ground vehicles can improve air traffic control, command and control, and services coordination on the surface.

- Improved traffic flow on the surface will result from improved decision-making supported by new procedures and decision-support tools. The information available includes real-time position data and data link of key events such as push-back and taxi clearance. Aeronautical data link of taxi clearances will reduce required voice communication and provide direct feed of this information into decision-support tools for runway load balancing and departure runway sequencing, better utilizing available runway capacity and reducing taxi times. Data link of taxi clearances will also provide more reliability in execution and agreement of the clearance between pilot and controller. Reduction in voice communication requirements will allow the controller to spend more time working aircraft separation and efficient movement on the surface.

- Shared situational awareness for personnel responsible for flight scheduling, servicing, piloting, ramp and ground control will be achieved through the same set of real-time position information on an airport surface display for all flights and other ground vehicles currently on the airport surface. The shared situational awareness will also benefit air traffic ground control. For example, at airports where a ramp area is not under air traffic control and is not fully visible from the Air Traffic Control Tower (ATCT), the real-time position of all aircraft taxiing to the ramp exit from their gate will be shown to the ground controller (so that the runway sequence of each flight can be considered the flight request for taxi clearance).

Benefits, Performance and Metrics

- Departure throughput rates should increase and average taxi-out times decrease due to better sequencing and load balancing in departure queues.
- Airport surface safety will be improved through increased situational awareness resulting in safer operations on the airport surface.
- Improved communications and coordination will occur between:
  - Gate personnel
  - Ramp personnel
  - Airline Operation Centers (AOC)
  - Fixed-Base Operators
  - Airport Management, Security, Crash-Fire Rescue, and Maintenance personnel
  - Tower and Terminal Radar Approach Control (TRACON) air traffic control and air traffic management personnel

Scope and Applicability

- ADS-B Safety Assessment will be completed September 2001.
- The Surface Management System (SMS) provides tools to manage departure operations, including runway queuing and load balancing.
- The use of SMS in conjunction with other technologies will increase shared situational awareness of airport surface operations between the ATCT, the Ramp Tower, the TRACON facility, the Air Route Traffic Control Center (ARTCC) and the air carriers that operate at an airport, through the use of real-time position data and data link of key events.
- Several technologies will provide information that will improve shared situational awareness, including Automatic Dependent Surveillance - Broadcast (ADS-B) (w/ multi-

lateration), Airport Surface Detection Equipment (ASDE)-3, ASDE-X, Surface Movement Advisor (SMA), and Data Link Delivery of Taxi Clearance (DDTC).

- Interfaces to SMS may include Center TRACON Automation System (CTAS), Enhanced Traffic Management System/ Collaborative Decision Making (ETMS/CDM) and surface sensor systems (e.g., ASDE-X, transponder multi-lateration).
- The availability of a robust surveillance data fusion capability is essential to provide complete and reliable real-time position and Out Off On In (OOOI) information to SMS.
- Fusion of ADS-B and multilateration position reporting with ASDE primary radar in ASDE-X: ADS-B will provide accurate down-link of GPS-based position reports for equipped aircraft and some vehicles. Multilateration will provide position reports for all aircraft and vehicles having tagged beacon transmitters. Traffic Information Service, Broadcast Mode (TIS-B) will provide equipped aircraft and ground vehicles fused position reports of all aircraft and vehicles, whether ADS-B equipped or not.
- The SMS concept is planned research from the National Aeronautics and Space Administration (NASA). We will be testing this capability in Memphis in 2003.
- Free-Flight Phase One (FFP1) SMA provides transitional capabilities that will ultimately be incorporated in SMS. SMA provides estimated landing times for flights currently in the terminal area, based on information from the local Automated Radar Terminal System (ARTS). This provides users (dispatchers, ramp controllers and other airline personnel) improved information on arrival times to improve gate turnaround and avoid conflicts with gate management. FFP1 SMA is located at the following TRACONs and provides data for the associated airports:

TRACON	Airport(s)
Atlanta	ATL
Chicago	ORD, MDW
Dallas/Fort Worth	DFW, DAL
Detroit	DTW
Minneapolis	MSP
New York	EWR, JFK, LGA and TEB
Philadelphia	PHL
St. Louis	STL

- SMS will provide decision-support tools to predict, plan, and advise surface aircraft movements and increase throughput and user flexibility using numerous data sources. SMS can provide controllers with a set of tools for tactical control and strategic planning of aircraft movements (arrivals and departures) on the surface while incorporating airline priorities.
- Aeronautical Data Link will provide digital text communication between equipped aircraft and ground facilities, for the handling of clearances and other standard messages.
- Technologies that will enhance situational awareness in the cockpit, such as Cockpit Display of Traffic Information (CDTI) are discussed in AD-7.

- DDTC is now being evaluated at DTW and IAD, and is a currently available commercial product.
- ASDE-X has planned deployment to 25 sites by 2007, with an additional 34 ADSE-3 sites being upgraded to equivalent functionality by 2009.
- Real-time data feed to AOC's and integration of real-time position information with decision support tools is planned prior to 2010.
- Other necessary surface technologies as referred to in the Surface Evolution Plan (FAA Safe Flight 21 Office/Runway Safety Office):
  - Surveillance Fusion Box
  - Vehicle Tracking
  - Runway Status Lights

Notes:

- Text on ADS-B adapted from *Draft Safe Flight 21 Ops Concept* by the RTCA SF-21 Steering Group Operations/Procedures Working Group, January 12, 2001.
- Information on all surface technologies obtained from *Surface Technology Roadmap, Presentation to Runway Incursion Joint Safety Implementation Team (JSIT)*, presented by David Ford (AND-500), March 7, 2001.

Key Decisions

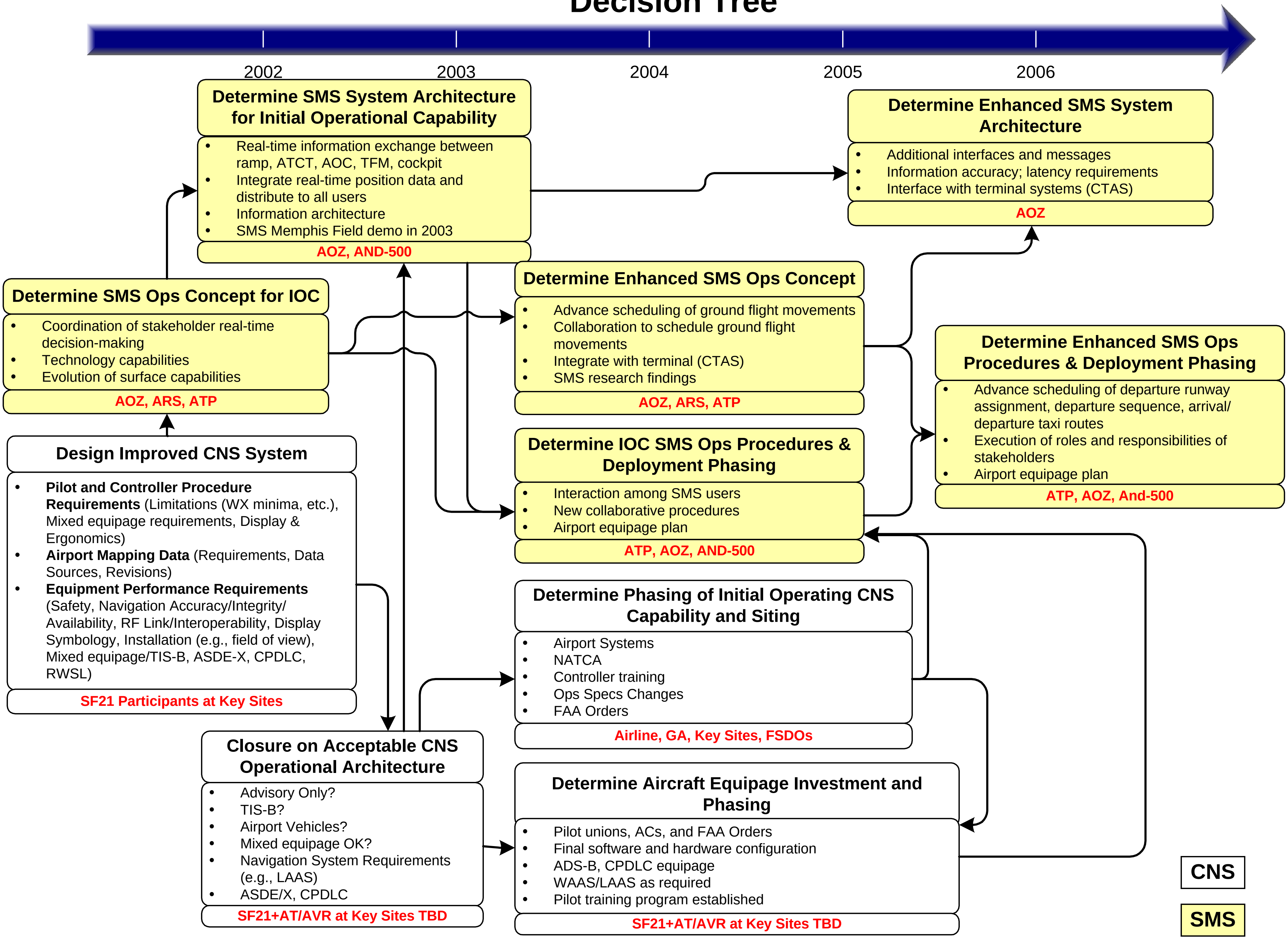
- Mandating ground vehicle equipage to provide or support surveillance.
- Aircraft and key ground vehicle equipage with CDTI is critical to providing full benefit of shared situational awareness to these aircraft and ground vehicles.
- Airport equipage of enabling technologies is critical to achieving the full benefit of SMS.
- ADS-B safety assessments complete in September 2001.
- Vehicle equipage (Part 139): rulemaking necessary to mandate equipage for all surface vehicles.
- Determination after analysis in 2003 Memphis trial on need for Local Area Augmentation System for surface surveillance accuracy requirements.

Key Risks

- Definition of SMS concept and requirements based on ongoing NASA research.
- Completion of NASA demonstration at Memphis in 2003.
- RTCA and international standards for surveillance data and avionics interfaces and protocols are on the critical path for scheduling.
- Deployment schedule for ASDE-X.
- Operational concept validation in Safe Flight 21.
- Development and deployment of cockpit technologies.

V3.0 (30 May 2001)

AD-6: Coordinate for Efficient Surface Movement Decision Tree



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Solution: Enhance Surface Situational Awareness

The Safe Flight 21 program is addressing cockpit-based tools to supplement existing visual navigation aids and controller communications in the pilot's attempts to accurately determine the aircraft's position on the airport surface. The pilot will be able to correlate fixed obstacles and traffic observed on the display with outside visual information, enhancing the pilot's confidence and efficiency in moving about the airport surface. Over time, the availability of reliable and accurate advisory position and intent information will allow pilots to taxi aircraft under reduced visibility conditions with more confidence, shorter taxi times, and reduced potential for runway incursions.

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Key Dates

Determine Performance Requirements for Cockpit-based Tools	2001
Certified Avionics (moving map) as Supplemental means of Navigation	2003
Determine Operational Architecture and Procedures Based on SF-21 Demos	2003
IOC for Surface Navigation from Cockpit at Key Sites	2005

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Primary Office of Delivery

Jeff Griffith, ATP-1

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AD-7: Enhance Surface Situational Awareness

Improve surface navigation and traffic situational awareness with cockpit-based tools.

Final Approach, Runway and Taxiway Occupancy Awareness

Background

The pilot uses visual navigation aids and controller communications to determine aircraft position on the runway surface and uses visual references to maintain separation from aircraft and other vehicles. While the controller is responsible for separation on the runway, the pilot is responsible for separation while taxiing to the runway or gate, regardless of airport visibility. Low visibility and reduced ability to see signage can lead to confusion in navigating the aircraft on the surface. This in turn can result in the reduction of safety and efficiency.

Ops Change Description

Cockpit-based tools provide more robust surface navigation increasing pilot awareness of the aircraft’s position on the airport surface. These tools help the pilot guide aircraft along the surface in accordance with ATC instructions, or in accordance with a self-generated taxi plan in the case of non-towered airports. Initially, these tools will supplement the pilot’s out-the-window visual assessment of the aircraft’s position on the surface, its direction, and speed.

A cockpit moving map of the airport surface could use the same moving map/navigation display used in flight. Additional attributes for effective use on the airport surface would be highly accurate own-ship position information (e.g., from augmented GPS), coupled with a comprehensive, accurate digital map of the airport surface (including runways, taxiways, holding areas, ramps, hangars, and prominent airport structures). With this information, pilots can follow their progress on the airport surface using the cockpit display, and correlate that position by reference to outside visual cues.

Other aircraft and surface vehicle traffic would also be displayed on the cockpit moving map for airports providing this added information via Automatic Dependent Surveillance – Broadcast/Traffic Information Service – Broadcast (ADS-B/TIS-B). These enabling technologies are discussed further in AD-6. In normal operations, the pilot would use both the cockpit display and visual observation to develop the most complete traffic picture. In some cases, the display could be the only source of traffic information for the pilot. This might occur when another aircraft cannot be seen due to blind spots created by airport structures or by one's own wings or tail. Aside from its use for avoiding runway incursions and incidents, the pilot can also correlate traffic observed on the display with outside visual information, thereby easing the process of understanding the intended sequencing when several aircraft are being formed into a queue.

As envisioned in the *Surface Technology Roadmap,*[1] cockpit surface moving map technology will progress through four stages of development, with each stage providing additional information to improve the pilot's situational awareness. For the time frame of the OEP, we are using three of the four stages.[2] Each additional stage will utilize new surveillance and data-link technology, as it becomes available.

1. The initial moving map display does not rely on any communication with FAA ground systems, as it includes only the GPS-based position of the current aircraft on a locally stored airport map.
2. The capability to receive and display target reports for other aircraft and ground vehicles is added for airports with Airport Surface Detection Equipment (ASDE)-X (ADS-B/TIS-B) capability.
3. The capability to receive data link of taxi instructions is added based on the interface with Aeronautical Data Link (ADL).

Future commercially available cockpit surface moving map systems will likely be developed with different capability levels and price points reflecting the additional features available in these three stages of development.

The pilot will also be automatically alerted to the status of the runway by visual cues (lighting system) as the aircraft nears a specific runway. This information will be provided by runway status lights.

Benefits, Performance and Metrics

- Faster taxi times at night and under other reduced visibility conditions.
- Average and excess gate times should decrease.
- Reduction in number of runway incursions.

[1] *Surface Technology Roadmap, Presentation to Runway Incursion Joint Safety Implementation Team (JSIT)*, presented by David Ford (AND-500), March 7, 2001.
[2] Automatic conflict alerts in the cockpit are not included, but the issues (human factors, training, certification) will be addressed as part of ongoing research activities.

Scope and Applicability

- Several successful demonstrations of the cockpit moving map concept have been conducted.
- Moving maps should provide the same capability to receive and display the same surveillance data to tower controllers, pilots, ramp controllers, and others that are involved with surface operations at the proposed 59 ASDE-X sites.
- Operations fall back to the current mode when position sensor (e.g., GPS-based signal) is not providing adequate accuracy or integrity (depending on the complexity of surface application) or if there is a problem with onboard avionics.
- Until very advanced operations are approved, the surface applications should be in support of the visual maneuvering of the aircraft and should only be used in an advisory role.
- If the bottleneck is at the departure end of the runway, increased throughput on the surface will not result in significant capacity benefits.
- Surface movement and guidance control system is required to support low visibility operations on the surface.

Key Decisions

- Mandating cockpit equipage supporting situational awareness due to safety. Decision to be made by FAA with consultation by aviation community.
- Scheduling of cockpit equipage must be coordinated with airport equipage discussed in AD-6.
- Define funding eligibility under the Airport Improvement Program (AIP).
- Determination of which specific types of ground vehicles are required to equip, by airport, and whether rule making is required.

Key Risks

- Specification of RTCA and international standards for cockpit equipage are on critical path for implementing this operational change.
- Specific applications, operational requirements, and certification requirements need to be identified quickly for implementation in before 2010.
- Equipage costs for users and level of user equipage.
- Procedures (cockpit and ATC) need to be developed and tested at ADS-B OpEval 3 at MEM in 2002.
- End to end performance and safety assessment of new surface architecture (including cockpit).
- Database of airport surface features for display must be accurate and affordable.

- Cockpit human factors/workload issues (heads-down time, surface clutter, day/night visibility, and display scale, heads up/down) need to be addressed in the near-term.
- The availability of a robust surveillance data fusion capability is essential to provide complete and reliable real-time position information of all aircraft and ground vehicles to the cockpit moving map, as discussed in AD-6.

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AD-7: Enhance Surface Situational Awareness Decision Tree