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Air Traffic Control from Anywhere to Anywhere: The Case for ATC Facility Consolidation

By Michael Harrison, Ira Gershkoff and Gary Church
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Executive Summary

Air traffic control—in the United States, Europe and other advanced countries—is on the verge of a paradigm shift that promises to at least double the capacity of the skies without expanding the workforce, i.e. doubling productivity. The NextGen program in the United States is implementing key technology and procedural building blocks for this transition, but the program is at risk of becoming merely an upgrade of hardware and software, rather than redesigning the airspace and consolidating its far-flung, labor-intensive facilities. Without these additional changes, the end result will be a far more costly, albeit higher-tech, system.

Three key enablers of the paradigm shift are performance-based navigation, far more precise surveillance of aircraft positions, and digital communications instead of voice. Together, these will make it possible to manage air traffic *from anywhere to anywhere*. A controller located in Miami will be able to manage traffic in Seattle, for example. Thanks to these changes, the entire airspace can be reconfigured, expanding its capacity to handle two or three times as many aircraft safely.

This reconfigured airspace, in turn, should drive the reconfiguration of staffed facilities. ATC facilities will no longer need to be located directly beneath the airspace they manage. And that means most of the 187 Centers and TRACONs, many of which are aging and in need of major refurbishment if kept in service, can and should be shut down. They can be replaced by a much smaller number of facilities, many of which can be designed from the outset to function in the from-anywhere-to-anywhere paradigm.

This study presents an original plan for consolidation of airspace and ATC facilities in the continental United States. Under this plan, the current 20 en-route Centers and 167 TRACONs would be consolidated into five high-altitude Centers, eight Integrated Control Facilities, and 38 consolidated TRACONs.

ATC facilities, such as Centers and TRACONS, have significant economies of scale, as demonstrated by the much higher productivity of the larger existing facilities. Current productivity data are used in this study to estimate the operating cost savings that would be obtained via the proposed consolidation. In the U.S., annual savings simply from economies of scale would be $314 million. Combined with further productivity gains from NextGen technology and procedure changes, total operating cost savings from the reconfigured system range from $540 million to $680 million per year. There would also be annual savings in equipment and facility maintenance estimated at $109 million per year. Total operating cost savings will thus be in the vicinity of a billion dollars a year.

While it was beyond the scope of this study to estimate the cost of the consolidated facilities, the study did estimate the savings from closing and disposing of obsolete Centers and TRACONs. This one-time saving, at $1.7 billion, should be applied toward the cost of developing the new, consolidated facilities (which would require a legislative change). At this point, the FAA has not developed cost estimates for an integrated plan for consolidation. Any new facility costs are speculative without a detailed, time-sequenced consolidation plan.

To summarize, the overall saving from consolidating facilities (as well as ATC ground equipment that is no longer needed as NextGen is implemented) is estimated in this study to be the following:

One-Time Consolidation Savings	
Centers and TRACONs closed	$689 million
ATC equipment and structures retired	654 million
Salvaged equipment value	294 million
Avoided facility refurbishment costs	98 million
Total one-time savings:	$1,735 million

Annual Consolidation Savings	
Productivity gains from economies of scale	$314 million
Next-Gen productivity increases	540–680 million
Facility and equipment maintenance savings	109 million
Total annual savings:	$963–1,103 million

The FAA’s current approach to facility consolidation is problematic. Its original 2010 concept, the Future Facilities Program, called for large-scale consolidation including the creation of Integrated Control Facilities. However, since then the agency has failed to produce a detailed plan outlining a schedule for closing obsolete facilities and opening new ones, despite being called upon by Congress to do so. Instead, it is focusing all its attention on developing an initial ICF in the most technically and politically difficult portion of the airspace: the New York/New Jersey area. And like several previous proposals for large-scale facility consolidation, the proposed Liberty ICF has already encountered significant congressional intervention.

This study calls for rethinking the current approach to NextGen and the consolidation of airspace and facilities. The FAA's Air Traffic Organization should develop a nationwide airspace reconfiguration plan and develop a facility consolidation plan consistent with that. The latter would identify the facilities to be closed, the new and consolidated facilities to replace them, and an overall schedule for what happens when. Labor agreements must be worked out in advance of consolidation, to ensure that the productivity gains inherent in consolidation will actually be realized.

Congress should develop a process to permit large-scale consolidation to proceed without micro-management, as it has done for needed but difficult military base closing and consolidation. It needs to allow the Air Traffic Organization to make use of new funding options, such as issuing revenue bonds, to finance the facility consolidation program. And it needs to permit the ATO to retain the proceeds from selling the land and buildings associated with facilities that will be closed, to help fund the development of the new facilities.

If Congress cannot accomplish those admittedly difficult tasks in the near future, the alternative is to delegate these responsibilities to a revamped ATO that would be insulated from both congressional micro-management and federal budget constraints. This would involve separating the ATO from the FAA, enabling it to charge aircraft operators for its services (like airports and other utilities) and use the revenue stream to back ATO revenue bonds. The FAA would regulate the reformed ATO for safety, at arm's length. This model has been used successfully overseas, including in Australia, Canada, Germany and the U.K., each of whose self-supporting air navigation service providers has successfully consolidated its equivalent of Centers and TRACONs along the lines proposed in this study.

Without consolidating airspace and ATC facilities, NextGen is at risk of becoming merely a very costly upgrade of hardware and software, without the large productivity gains that should constitute a major portion of the business case for this transition. And without a timely commitment to large-scale facility consolidation, the Air Traffic Organization will be forced to spend billions in coming decades refurbishing and rehabilitating aging and unneeded facilities. Consequently, the time for action on these issues is now.

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Figures and Tables

Glossary

ADS-B: Automatic Dependent Surveillance-Broadcast—a new form of surveillance with much greater precision than radar.

ATO: Air Traffic Organization—the branch of the FAA responsible for developing and operating the air traffic control (ATC) system.

BRAC: Base Realignment & Closure—a process developed to overcome political opposition to military base closing, by requiring a yes or no vote, without amendments, on a detailed plan developed by subject-matter experts.

Center: abbreviated version of Air Route Traffic Control Center, the kind of ATC facility responsible for en-route (high-altitude) flights.

FIR: Flight Information Region—international term for a large block of airspace under the control of a Center.

FLXXX: Flight Level XXX—ATC term for higher altitudes, using first three digits (e.g., FL 290 means 29,000 feet).

FSEP: Facility, Services and Equipment Profile—an FAA database on maintenance of equipment.

GPS: Global Positioning System—global satellite constellation that provides information for positioning, navigation and timing; a key enabler for the NextGen ATC concept.

ICF: Integrated Control Facility—proposed new facility dealing with a blend of en-route and terminal airspace, encompassing functions of both Centers and TRACONs.

NAS: National Airspace System—the airspace, both domestic and oceanic, for which the FAA has air traffic control responsibility.

OMB: Office of Management & Budget, the White House budget office.

OPSNET: Operations Network—FAA database on flight operations and ATC activities.

PBN: Performance-Based Navigation—emerging concept in which the paths aircraft may travel are based more explicitly on their performance capabilities. RNAV and RNP are two forms of PBN.

REMS: Real Estate Management System—an FAA database on its real estate and facilities.

RNAV: Area Navigation—flight paths that go directly from a point A to a point B, defined by an onboard computer, rather than having to overfly individual ground navigation signals such as VORs.

RNP: Required Navigation Performance—a more advanced form of PBN defined by how precisely an aircraft can fly a given path (e.g., RNP 0.3 means it can reliably stay within 0.3 nautical miles of a defined path).

TCU: Terminal Control Unit—international term for an ATC facility responsible for the departure and arrival airspace near airports; analogous to TRACON in the United States.

TRACON: Terminal Radar Approach Control—FAA ATC facility responsible for departure and arrival airspace near airports.

USATS: U.S. Air Traffic Services Corporation—Clinton Administration DOT proposal for an air traffic control corporation in 1994.

VOR: VHF Omnidirectional Radio—a ground-based navigation aid identifying a specific geographical location on aeronautical charts.

Part 1

Introduction

In developing the Next Generation Air Transportation System (NextGen), the most important element is transforming how the airspace is used. As a step in this direction, the FAA's Air Traffic Organization (ATO) has begun deploying performance-based navigation (PBN), which allows planes to fly shorter, more-direct routes, saving fuel and time. By transforming navigation, the ATO is beginning to move away from the "highways in the sky" that have characterized the National Airspace System (NAS) for over 75 years. PBN has been widely accepted by the user community, and airlines and business jets are equipping for it now.

But the legacy airways built on signals from ground-based navigational aids still define the *structure* of the airspace, provide the aircraft routing to manage controller workload, and describe the sectors of airspace managed by controllers to sequence and separate aircraft. PBN can significantly enable increased safety, capacity and efficiency by using the airspace differently to accommodate growth and improve operations. Satellite navigation can deliver uniform navigation performance anywhere in the NAS, breaking the limitations on traffic volumes now defined by ground-based navigational aids. There is broad consensus that basic PBN (in the form of area navigation—RNAV) should become standard everywhere and more-advanced PBN (in the form of Required Navigation Performance—RNP) should be used wherever beneficial. .

In addition to moving forward with PBN, the ATO has been deploying automated dependent surveillance–broadcast (ADS-B), the second element of satellite operations, allowing the Global Positioning System (GPS) and its augmentations to provide far more precise knowledge (than provided by radar) of where planes are in real time. After 2020, the date by which all aircraft in the system must be equipped with ADS-B, surveillance will no longer depend on radar and its limited coverage of the airspace (called service volume). ADS-B represents a significant game changer, eliminating the geographical limitations of radar that currently define facility airspace. With ADS-B, aircraft position is precisely reported, whether on the surface or at any altitude. This change shatters current limitations in airspace design. The distinction between terminal and en-route airspace—built on airways in the sky based on ground-based navigation aids and ATC sector boundaries governed by radar coverage—becomes obsolete.

The third key building block is the use of modern digital communications instead of traditional voice radio. Communications is the last barrier tying air traffic control facilities geographically to specific airspace. Thanks to networked digital communications, that last barrier can be removed, leading to control of air traffic *from anywhere to anywhere*. Voice switching has advanced to where a controller could physically be located in Miami and control Seattle airspace and talk to aircraft in Seattle airspace, receive surveillance through digital networks from Seattle, and support the full range of services provided today by the ATO.

In 2004, Aviation Management Associates (AMA) began examining how the physical infrastructure of some 20 air traffic control centers (Centers), 167 terminal radar control facilities (TRACONs), and over 124 stand-alone air traffic control towers could be consolidated to gain airspace operational improvements and reduce the future cost of manned facilities.[1] By 2005, AMA identified critical technology enablers that would make it possible to consolidate facilities:

- A surveillance data network to move surveillance information from its source to everywhere in the NAS;
- Fusion tracking to combine existing radar information with ADS-B data;
- Voice switching to allow controllers to reach any ground radio station to send and receive voice messages to and from the aircraft;
- Adaptation tools to reconfigure the airspace so that boundaries (workload) could be managed dynamically;
- Conformance monitoring tools to reduce workload and detect performance issues before they become errors; and
- Transitional information integration: creating a means to provide the controller with information about the airspace and its underlying network of airports, replacing the need for substantial local knowledge.[2]

Each of these technology enablers is either well underway or planned by the ATO. It is now time to aggressively pursue consolidation of airspace and subsequent reduction in air traffic control facilities. For the first time, airspace can be designed around how it is used by the aircraft, rather than by the limits of radar and communications coverage.

The ATO has recognized the need to consolidate air traffic control facilities, many of which are outdated and deteriorating. The average age of the Centers is 49 years. They were originally built at a time when automation meant mainframe computers and required considerable space. All Centers need infrastructure upgrades, but not all Centers are needed. Likewise, attempts to consolidate smaller TRACONs have met with mixed results. In some cases, only minor airspace changes have been made. In other cases, the redesign of airspace has driven how the larger TRACONs operate.

NextGen has created a new opportunity to consider consolidation, breaking away from the geographically bound ATC facility to a new airspace structure that is tailored to aircraft performance, gaining capacity and efficiency. New, consolidated facilities can be designed to support how the airspace will be used under NextGen with performance-based navigation and satellite-based surveillance operations. The facility's form can fit its function. Under NextGen, the artificial boundaries of today's airspace can be transformed to recognize the benefits of PBN, and many of the current operational restrictions can be eliminated. The distinction between en-route and terminal airspace can be challenged, creating a hybrid facility to serve major metropolitan airspace volumes.

The FAA and its ATO have begun to move in this direction. The ATO's Future Facilities Program received approval from the FAA's Joint Resource Committee to move to initial investment analysis for Segment 1 on September 15, 2010. The Initial Investment Decision for Segment 1 was made on November 16, 2011.[3] The program is currently developing a business case for its first project, the Liberty Integrated Control Facility (ICF), and Final Investment Decision is expected early in FY 2013. Liberty ICF covers the greater New York/New Jersey and Philadelphia airspace and would lead to the consolidation of nine existing TRACONs. Liberty ICF is justified based on savings to users through improved efficiency in use of the airspace. The ATO is promoting delay reductions in congested metropolitan airspace while also enabling reduced fuel consumption and noise. ATO employees working in this facility will benefit from an improved work environment and likely higher compensation.

While there appears to be energy around the New York/New Jersey airspace, little action is taking place to consider a national consolidation strategy to match the number and purpose of ATC facilities to the airspace under NextGen.

The concept of ICFs is to combine large and small TRACONs and pull airspace away from selected Centers near major airports, so as to redefine that airspace and how it is used. For the Northeast alone, this would involve combining 45 TRACONs and altering airspace controlled by four Centers. The agency has estimated the cost of just the initial Liberty ICF at $2.3 billion.[4] The overall Northeast plan spans the airspace from New York to Chicago and is estimated to cost over $5 billion. The expected completion date for this first round of changes is 2023. Between now and 2023, opportunities for other consolidations will be lost if the ATO proceeds with its current focus solely on the Northeast and especially on Liberty ICF.

The FAA has been down this path before, taking on large consolidations only to have the project die due to citizen objections over airspace redesign, objections from the workforce on relocation, local opposition to job losses with the transfer of personnel to a consolidated facility, and resistance from Congress tied to job losses from proposed facilities closures. The FAA's history on changing the airspace is also mixed. The East Coast Plan and the Expanded East Coast Plan went on for years with considerable local community opposition to flight tracks the FAA wanted to use.[5]

In February 2012, the president signed the "FAA Modernization and Reform Act of 2012" (P.L. 112-95), whose Section 804 requires the FAA to produce a plan recommending future realignments and consolidations of services and facilities. In the legislation, the FAA is to propose an overall national plan for realignment and consolidations accompanied by justification for each action, projected costs and savings, and the timing of the consolidation. The FAA is to seek input from labor organizations and industry stakeholders, and provide an opportunity for Congress to review. If Congress does not object within 30 days of receiving the plan, the FAA can implement the plan. Because the Act requires specifics on consolidation, the FAA must now look at a strategy that not only deals with ICFs and metroplex airspace, but the balance of the facilities as well.

The legislation had the effect of halting smaller TRACON consolidations while the ATO figures out a strategy for realignment of airspace and facility consolidation beyond the initial planning for the New York area ICF.

The rest of this report proceeds as follows. In Part 2 we explore the wide variation in controller workload across the numerous Centers and TRACONs nationwide, ranking their productivity to identify low-productivity candidates for consolidation. Part 3 discusses the problem of aging and obsolete facilities, and the prospect of the ATO investing large sums for refurbishing facilities that should instead be shut down, unless a serious consolidation program—which is not what FAA is proceeding with—can be implemented in the near future. (Our research was limited to publicly available documents. Having access to actual Air Route Traffic Control Center and Tower/Terminal sector-by-sector staffing and current unit costs for terminal and Center operation and maintenance costs with individual condition reports would have permitted a more detailed consolidation scheme.) In Part 4, we outline what such a large-scale consolidation plan could consist of, illustrated by a number of examples. Next, in Part 5 we estimate the savings in annual operating costs that this plan would bring about thanks to economies of scale, and also the capital cost savings that should be realizable by selling off the real estate and buildings that house facilities to be closed down. Part 6 discusses the political obstacles to this kind of consolidation effort, and suggests alternatives for Congress in addressing them. Finally, Part 7 concludes with specific recommendations.

Part 2

Workload Considerations

The ICF model fits well for metroplex areas, breaking down the barriers of existing airspace constraints, physically combining TRACONs, and releasing selected airspace from the Centers for use by the ICF in managing arrivals and departures. Doing so would mean direct performance benefits for the users. However, there are other models to consider that may produce equal or better airspace redesign and use of PBN at lower overall cost. In examining the options and different migration strategies, the vision of ATC *from anywhere to anywhere* supports the technical and operational transformation needed, but the people and jobs issues remain dominant obstacles to successful transition.

The ATO's approach to consolidation represents a geographic path of largess, where there are six geographical areas nationwide targeted for consolidation. Just the single ICF for New York is estimated at $2.3 billion. For all of the ICFs planned in the Northeast alone, the cost is expected to be over $5 billion. FAA's track record has been to underestimate cost by 40 to 50% on new facilities. For this amount of funding, the remaining five areas besides the Northeast could cost an additional $25 billion or more. At these costs, the consolidation would need to be spread over 20 to 30 years unless there was a dramatic increase in FAA funding (which seems highly unlikely). The net present value of changes in how airspace would be used becomes severely diluted while waiting decades for the facilities. The full benefits of PBN and other NextGen improvements cannot be realized without fully changing how the airspace is controlled and used.

Recently, Southwest Airlines, which has been a strong advocate of using RNP, made the following statement in a 2012 filing of its annual report with the Security and Exchange Commission:

> *In addition, the Company has taken significant steps towards Required Navigation Performance ("RNP") operations. RNP is one of the cornerstones of the FAA's strategy to modernize the U.S. Air Traffic Control System by addressing limitations on air transportation capacity and making more efficient use of airspace. RNP combines the capabilities of advanced aircraft avionics, GPS (Global Positioning System) satellite navigation (instead of less-precise ground-based navigation), and new flight procedures to (i) enable aircraft to carry navigation capabilities rather than relying on airports; (ii) improve operational capabilities by opening up many new and more-direct approach paths to produce more efficient flight patterns; and (iii) conserve fuel, improve safety, and reduce carbon emissions. Southwest began developing GPS approach procedures during the first quarter of 2010, completed RNP training of nearly 6,000 pilots in November 2010, and commenced RNP procedures in revenue service in January 2011. In the first twenty*

> *days of RNP activation, Southwest performed 1,400 RNP approaches, and, by the end of 2011, Southwest had conducted 6,790 RNP approaches; however, for reasons out of its control, Southwest's total number of RNP approaches has slowed to fewer than 400 per month. Southwest must rely on RNP approaches published by the FAA, and the rate of introduction of RNP approaches has been slower than expected, with RNP approaches currently available at only 17 airports. In addition, even at airports with approved RNP approaches, the clearance required from air traffic controllers to perform RNP approaches is often not granted. As a result, in the second half of 2011, the Company decided not to equip its Classic (737-300/500) aircraft with RNP capabilities."*[6]

Unless the airspace is changed in sync with implementing new facilities, users will not receive the benefits promised by NextGen. The New York ICF (and all the others) must open with the airspace changes in place and with the realignment of roles and responsibilities within the airspace pre-defined and understood by the users. The function of the ICF should follow the airspace changes.

A policy change relating to "best equipped/best served" is also needed, to incentivize users to equip their aircraft. This change can be as simple as changing priorities within the *Air Traffic Control Handbook* (FAA Order JO 7110.65U), which in Chapter 2 states under Operational Priority "Provide air traffic control service to aircraft on a 'first come, first served' basis," followed by a list of special exceptions ranging from movement of the president to military operations. The FAA has previous history of failing to deliver the full benefits promised due to the lack of training and implementation of ATC procedures that integrate the aircraft in the operations. To spend money on ICFs only to deliver ATC services to the lowest common denominator in the airspace is counterproductive and will not achieve the goals of NextGen.

The planning and program funding must assure that the technology, procedures and airspace changes all come together as part of the timeline for each new facility. The aviation community must be assured that the merger-of-facility investment will be accompanied by airspace and procedural changes that benefit the users. This broader approach to consolidation should include the following key objectives:

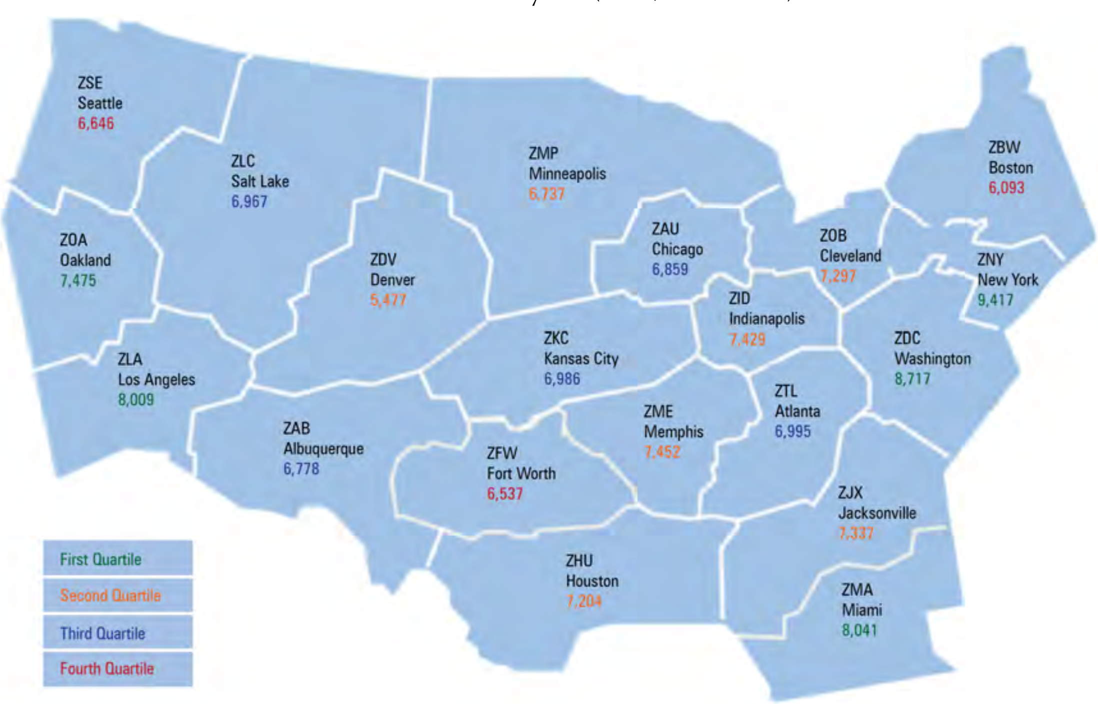
- Align the workload to the new airspace design;
- Rationalize staffing levels for controllers;
- Create opportunities to improve services through airspace and procedural changes, embracing RNAV everywhere and RNP where beneficial;
- Eliminate distinctions between en-route and terminal airspace domains and procedures;
- Provide a facility that itself is flexible and can change with future changes in airspace configuration;
- Reduce management, support and administrative staffing;
- Closely manage the workforce plan to reduce the number of needed controllers consistent with airspace and procedural changes, and finally;
- Reduce the number of physical assets.

Management of controller workload is an important element of consolidation. In the Centers, the lowest unit of airspace volume is the sector. Over time, sectors have been divided and made smaller so as to handle increases in traffic. As sectors shrink in volume, staffing must go up and coordination requirements increase. The process of handing off responsibility from one sector to another and then calling the pilot to change radio frequencies at the point of transfer of control increases the workload, as well as the possibilities for miscommunication. More time is spent in receiving and handing off traffic than actually separating it. This is the tipping point where broad airspace and procedural changes are needed to rebalance the workload.

Currently, workload is not balanced across the Centers and TRACONs. Some are much more productive than others, as measured by the number of operations handled per controller in the facility. Lower-workload facilities can be combined to reach a higher balance of workload. A good productivity metric is the number of operations per year divided by the number of controllers, as well as the facility size in terms of operations per year. To assess current productivity, we used traffic-handled data from the FAA's OPSNET database for FY 2005. This time period was selected because it is pre-recession and during a period when the airlines had their first profitable year since September 11, 2001. Since controllers are also paid by the complexity of traffic (the more traffic the higher the pay) this simple measure of productivity gives insight into the differences among Centers and among TRACONs.

Figure 1: Operations per Controller at Centers

Current Center Layout (OPS/Controller)

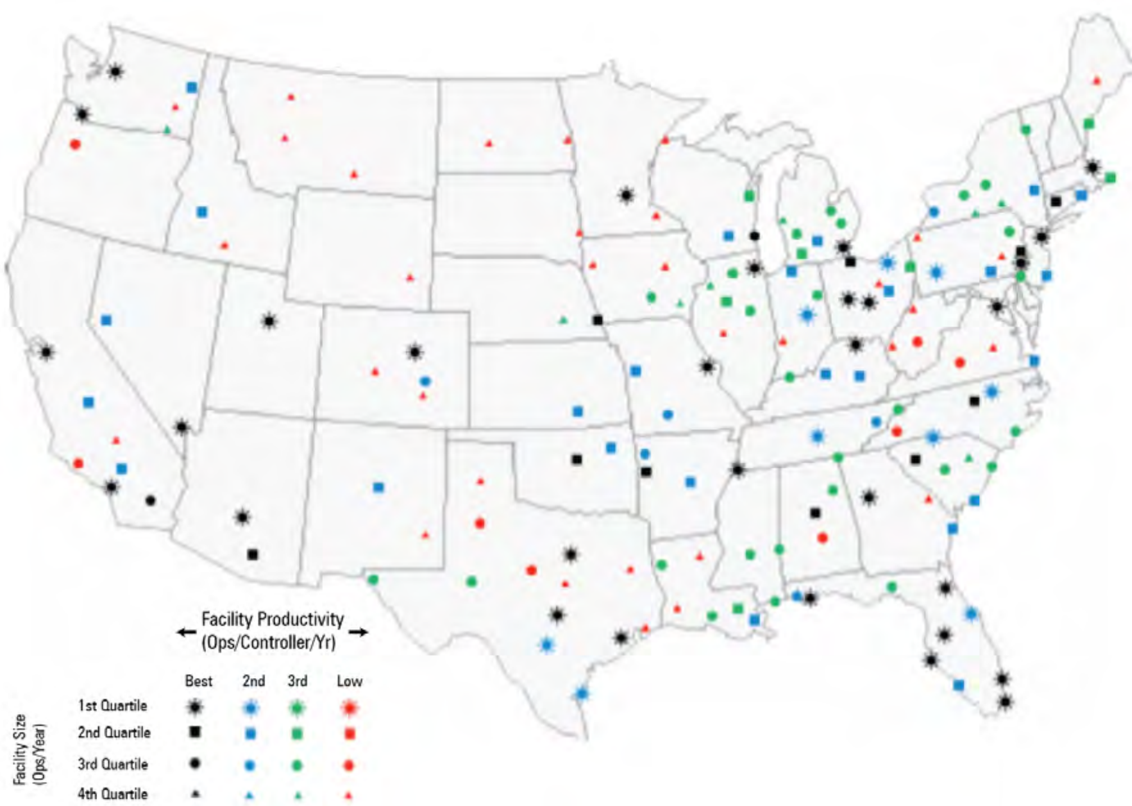


Source: FAA OPSNET FY2005

Figure 1 provides an overview of productivity in terms of operations handled and the staffing levels for Centers. (An operation is the measure of traffic counts recorded in the FAA's OPSNET database.) The number of annual operations is divided by the staffing for each facility to achieve operations per controller for the year. Each quartile of productivity is colored differently. What this information shows is that New York is the most productive Center and Denver is the least. Those Centers in the third and fourth quartile represent large sectors with significant over-flight activities, fewer handoffs, and lower operations counts.

Figure 2: TRACON Productivity

Productivity of TRACON/Tower Facilities in CONUS



TRACONs handle approaches and departures, and their productivity is based on the arrival and departure operations at the airport or airports in a TRACON's geographic area of responsibility. For TRACONs, Figure 2 presents productivity information, again in quartiles, the best being the upper left of the legend and the worst being the lower right of the legend.

As is the case with Centers, there are also significant differences in productivity across the various TRACONs. Figure 2 not only shows the differences among TRACONs, but also shows areas where operations may not warrant continued physical presence in the community served.

The first principle for consolidation is to recognize that not all facilities are needed, and that many handle less traffic than would warrant a full facility collocated with the airspace controlled. If the concept of air traffic control *from anywhere to anywhere* is taken seriously, many of the smaller facilities should be brought together to reduce cost, now that the communications and surveillance can be routed anywhere.

Center staffing is split between high- and low-altitude sectors with approximately one-third of the staffing assigned to high altitudes and two-thirds to low altitudes. Figure 3 provides the staffing levels by Center. Anchorage (ZAN) is the lowest-staffed facility and is not considered in this consolidation discussion. Note that Atlanta (ZTL), Cleveland (ZOB), Chicago (ZAU) and Indianapolis (ZID) have the highest staffing, in the 400-460 range, primarily because of low-altitude sectors. On the lower end of staffing, Seattle (ZSE), Oakland (ZOA), Albuquerque (ZAB), and Salt Lake (ZLC) are at 200 to 260 controllers.

Figure 3: Controller Staffing, by Center

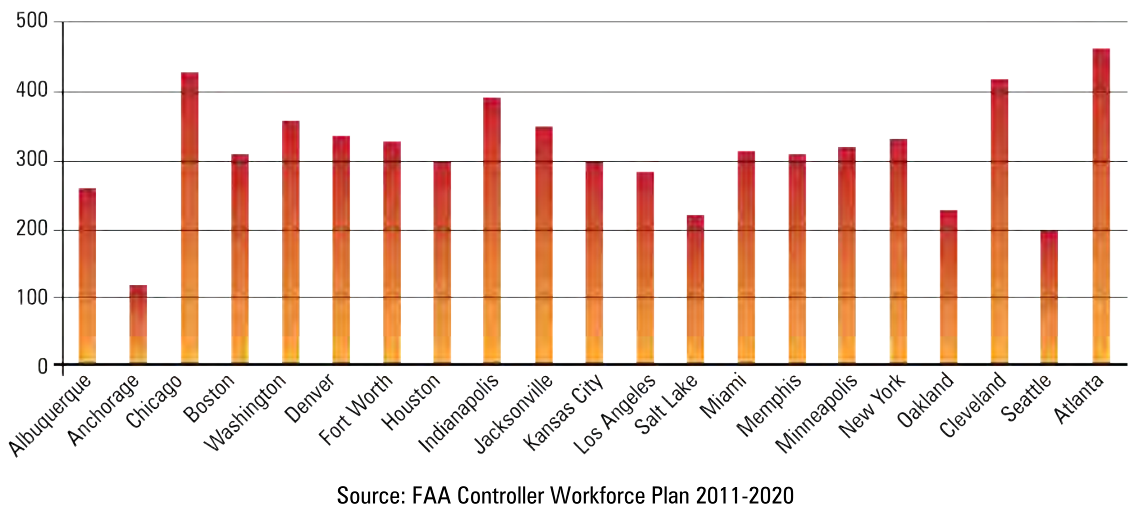
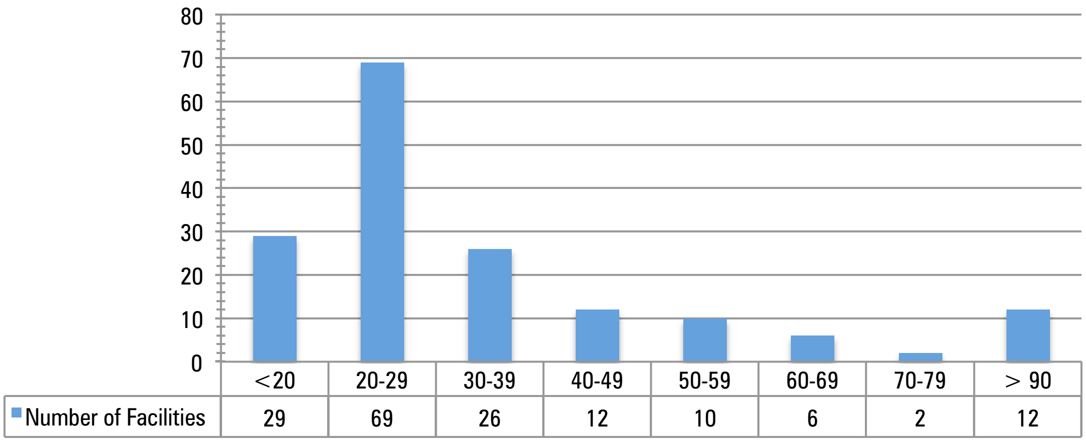


Figure 4 shows the number of TRACON facilities grouped into eight size categories ranging from fewer than 20 controllers to more than 80 controllers. These groupings indicate that the majority of the TRACON facilities are staffed at levels between 20 and 29 controllers. The smallest facility is Palm Springs with only 11 controllers; the largest is Southern California TRACON with 266 personnel.

Figure 4: TRACON Facilities Grouped by Controller Staffing



Source: FAA Controller Workforce Plan 2011-2020

Table 1 identifies the individual TRACONs within groups ordered by staffing levels. In consolidation, an existing facility would need to absorb between 11 and 30 additional controllers to reduce the number of smaller, less-productive TRACONs. Targeting the left two groups of Figure 4 would allow the ATO to increase productivity and reduce facility costs. This represents 98 facilities that could be geographically combined.

Table 1: TRACON Controller Staffing

Staffing	Facilities in Grouping
Fewer than 20 Controllers (29 locations)	PSP, TWF, HLN, ELM, BGM, CPR, BPT, SUX, BIS, LNK, MLI, ROW, MLU, RST, GTF, ASE, MFD, PIA, FSD, CKB, RDG, PUB, NMM, SPI, FLO, CID, PSC, ALO, MWH
20 to 29 Controllers (69 locations)	PWM, GPT, MKG, ERI, HTS, ACT, LCH, RIC, YNG, BTW, ILM, MBS, TRI, BIL, GGG, AMA, AGS, FAR, DLH, GSP, BTR, AZO, JAN, CMI, AVL, HUF, R90, FNT, HSV, CHA, MGM, U90, TOL, RNO K90, GRB, ELP, TLH, EVV, GGR, SBN, LAN, MSN, E10, FWA, SHV, SAV, BOI, LEX, AVP, LFT, ABI, CRW, LBB, BFL, MDT, CHS, GRR, RFD, SYR, MYR, ABE, CAK, MOB, DSM, EUG, FAY, CAE, ROC
30 to 39 Controllers (26 locations)	MCO, Y90, ACY, MAF, ROA, BHM, FSM, SBA, P80, OKC, RSW, GEG, ALB, SGF, TYS, COS, FAT, GSO, LIT, BUF, MEM, P31, PVD, A11, DAY, MSY
40 to 49 Controllers (12 locations)	PBI, ICT, TUL, SDF, AUS, MCI, ABQ, ORF, T75, JAX, S56, CMH
50 to 59 Controllers (10 locations)	BNA, CRP, L30, RDU, PIT, SAT, IND, MKE, D21, CLE
60 to 69 Controllers (6 locations)	S46, M98, DAB, P50, A90, D01
70 to 79 Controllers (2 locations)	TPA, CVG
90 or More Controllers (12 locations)	PHL, CLT, D10, I90, HCF, C90, MIA, A80, PCT, NCT, N90, SCT

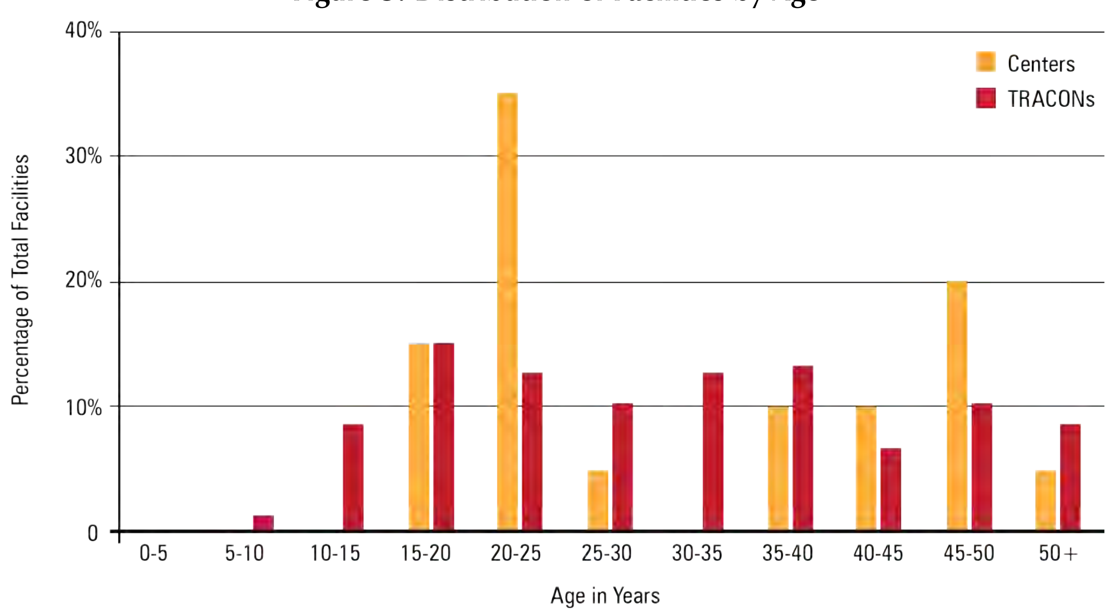
Part 3

Facility Age and Funding

Based on the commissioning dates from the FAA Facility File, Centers, towers and TRACONs are showing their age. Note that for the Centers, major rehabilitation within the facility occurred with its transition in automation in the late ‘80s and ‘90s. But the physical building itself is too old to accommodate modern automation (e.g., no ability to support raised floors for cabling, security setbacks from roads, backup power, etc.).

Figure 5 provides an overview on facility age distribution. Note that 45% of Centers and 39% of TRACONs are over 35 years old. In selecting TRACONs that can accept additional locations during consolidation, we take account of the fact that older facilities are more difficult to modernize.

Figure 5: Distribution of Facilities by Age



Source: FAA Facilities Files

Not only are the facilities old and expensive to modernize, but also any significant facility overhaul must be accomplished while the facility remains operational. This increases the cost of facility modernization. Due to their age, these facilities do not lend themselves to many of the common "green" building designs used today for highly automated workplaces. In addition, physical security requirements (access controls, road setbacks, perimeter security, etc.) have had to be adapted for the specific sites.

FAA's FY 2012 budget added a new line of funding called Future Facilities Investment Planning under the capital investment portion. The congressional conference mark-up was for a funding level of $15 million. The OMB-approved level for FY 2013 is for $95 million, reflecting a decision by the FAA to proceed with the development of Integrated Control Facilities, as discussed in Part 1.

The FAA's Capital Investment Plan for FY 2013-2017 identifies funding lines for various categories of facility spending, as shown in Table 2. Power systems have been included here because the majority of the funding is to support power and backup power for the manned facilities to sustain operations.

Table 2: FAA ATC Facility Capital Investment Budget ($millions)

Facilities Functional Area	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
NextGen Future Facilities	$95.0	$92.5	$95.7	$157.9	$172.3
Center Building/Plant Improvements	$46.0	$52.4	$52.4	$62.4	$62.4
Terminal ATC Facilities – Replace	$64.9	$108.0	$109.0	$110.0	$110.0
Tower/TRACON – Improve	$25.2	$52.7	$52.7	$52.7	$52.7
Electrical Power Systems – Sustain/Support	$85.0	$100.0	$100.0	$100.0	$100.0
Total	$316.1	$405.6	$409.8	$483.0	$497.4

Source: FAA Capital Investment Plan 2012

New York Center was commissioned in 1963 and is one of the oldest Centers. It is facing upgrade costs to the facility of over $45 million and another $21 million in power systems. With the current funding profile for sustainment, at $50-60 million per year for improvements for all of the 20 Centers, FAA will only make a dent in their needs. Nine Centers are older than 37 years. If New York were representative, there would be approximately $594 million in improvements for the older facilities, taking over 11 years (2023) at the proposed funding in the FAA Capital Investment Plan. The sooner the older facilities can be closed, the more funding will be available for ICFs and other new facilities.

The ATO needs to lay out a funding strategy that looks at consolidation over the long haul. Such a strategy should:

- Address affordability;
- Consider other methods of funding the improvements, such as using ATO revenue bonds, loans from an infrastructure bank, or leasing new facilities where communities are interested in jobs;
- Seek additional legislation to allow the FAA to retain sales proceeds and other savings from closures to support construction of modifications and new facilities;
- Seek land that is already federally owned to reduce land costs; and
- Identify opportunities for cost recovery.

While the ICF approach is being promoted as a NextGen benefit to users, the ATO must also put strong emphasis on reducing operating costs and increasing productivity.

Without a defined consolidation plan and process that names facilities for closing on a specific schedule, the ATO is in a quandary of having to continue sustaining and improving outdated facilities while seeking resources to build new ones. Annual facility capital costs are rising to nearly $500 million a year. Without engaging in planning for closing facilities, the upgrade will never progress and the facility maintenance backlog will continue to grow.

One of the key goals of the NextGen program is to redesign the air traffic control system to be flexible and scalable. This requires eliminating the traditional boundaries between en-route and terminal airspace. The ATO's infrastructure, automation, equipage, procedures and regulations must change from a geographical focus to a more strategic air traffic management focus, where the facility form follows the new airspace function, and this facility form is itself physically flexible and scalable.

The ATO Future Facilities Special Program Management Office (SPMO) was created to plan, design and develop ATC facilities of the future. Given the importance of this effort, and its involving a number of the ATO's lines of business, the SPMO reported directly to the ATO's Chief Operating Officer and the FAA Deputy Administrator. Following its launch in September 2010, the SPMO defined a long-term strategy and approach to facilities transformation. The concept was that future facilities would deploy and deliver services based on NextGen technologies that provide benefits through new operational concepts. By combining terminal and en-route operations in the same facilities, the aim would be to integrate user-beneficial procedures and blend the workforce to accommodate greater capacity and efficiency. Since facilities no longer require proximity to the air traffic and can carry out air traffic control *from anywhere to anywhere,* they no longer need to be located beneath specific portions of the airspace. The new facilities would be sited and staffed to balance employee, fiscal, operational, safety and security requirements. The plan divided the country into six segments of airspace, with new, integrated facilities planned within each segment. By approaching the transformation in segments, the ATO hoped to mitigate operational, budgetary, technical, political and economic risks, as lessons learned from implementation of earlier segments would be applied to later segments.

But in 2011 the Future Facilities SPMO was dismantled, and the Future Facilities program was put under the control of the ATO's Technical Operations office, several levels lower in the organization.[7] Its focus changed from an overall long-term restructuring effort to developing the first Integrated Control Facility. The highest need for ICFs was determined to be New York and Chicago and the airspace in between.

Taking on the New York airspace first will certainly result in lessons learned, but will be difficult and not necessarily the most cost-effective approach. New York has a track record of resisting airspace changes (East Coast Plan, Expanded East Coast Plan), well-organized employees who will resist relocation, a congressional delegation that resists facility closures, and high-cost real estate (whether it be commercial space or workforce housing). The workforce, local communities or Congress blocked previous attempts at consolidation in this region.

The Future Facilities program intends to use a site-by-site investment analysis process on ICFs to make decisions. The multi-year transformation of ATO air traffic control facilities will run until at least 2034, with ICFs taking on greater airspace responsibility in metropolitan areas and redefining Center airspace to focus more on high altitude airspace. The Liberty ICF and a similar ICF facility for Chicago would take airspace from the associated Centers, but not all airspace, requiring continued sustainment of the Centers. An alternative approach would be to transfer airspace to adjoining Centers and close the Centers losing airspace.

The ATO's planned approach does not consider leveraging savings from closed facilities to fund new facilities. If the ATO is truly going to use investment analysis on a location-by-location basis, it will need to justify each move as beneficial. The ATO would do better to reach agreement on a multi-tiered consolidation with ICFs in the mix, rather than focusing on the ICF for New York, New Jersey and Philadelphia and then going on to the next location. The ATO should prepare a total consolidation plan, with locations and dates for consolidation, that aggregates cost and benefits for a total plan and a timeline for the transition, for both facility changes and the implementation of NextGen policies and procedures.

Part 4

An Integrated Approach to Consolidation

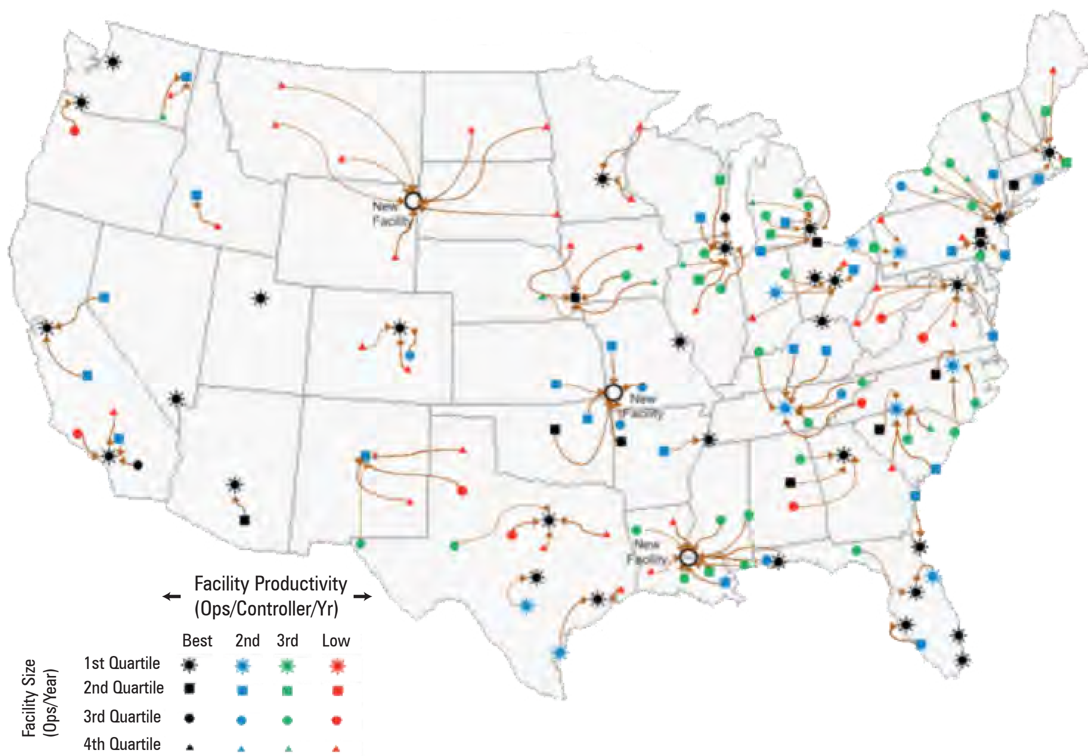
Geographical consolidations by moving smaller TRACONs into larger TRACONs or even Centers need not wait for creation of ICFs. Rather, the ATO should carry out a multi-tiered consolidation comprising: 1) a mix of traditional relocations, 2) the creation of interim ICFs, and 3) the redistribution of airspace among the Centers to attain the objective of making the airspace flexible and scalable. By laying out a larger, national plan, a single investment analysis can be produced that includes a combination of relocation to existing or expanded facilities, closing old facilities, building new facilities to bring smaller facilities together, and making significant upgrades to others. During the consolidation, some moves and shifts of airspace control will be interim measures to capture the benefit of airspace changes early in the transition and the closing of smaller facilities (those fewer than 30 controller positions).

With the congressional language and requirements in the FAA Modernization and Reform Act of 2012, the ATO has an opportunity to develop a consolidation "waterfall" that addresses more than just the idea of ICFs. The aggressive approach proposed below would close major facilities and combine minor facilities into consolidated locations to increase productivity. It consists of three major elements.

Geographic TRACON Consolidation

In this element, smaller, lower-activity TRACONs are relocated into existing TRACONs, either to fit within existing space in the receiving TRACON or expanding that TRACON to accommodate more positions. This consolidation would be driven from older facilities into newer existing facilities and in some cases the construction of a new facility to house multiple TRACONs as one. Figure 6 is a re-depiction of the productivity summary in Figure 2. The arrows show the consolidation. The objective is to take lower-productivity and lower-staffed TRACONs and move them to higher-productivity TRACONs. This yields a reduction in supervisory and support personnel as well as increasing the productivity of individual controllers. It leads to closing 125 TRACON facilities.

Figure 6: Proposed TRACON Consolidation

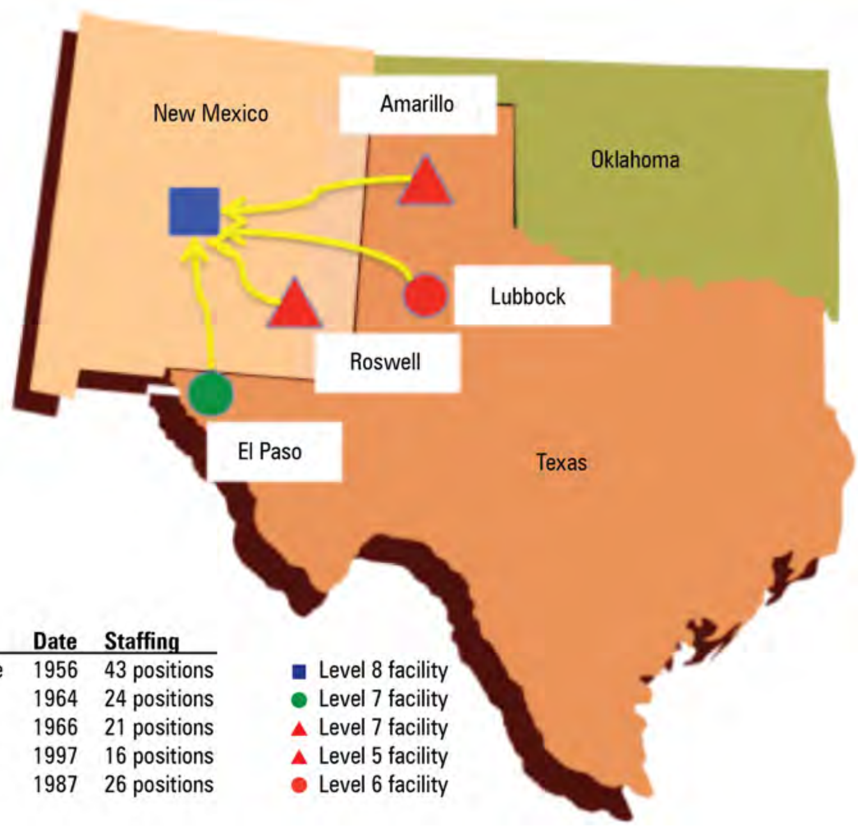


To explain the approach, some examples are offered. The geographical consolidation builds on the concept that TRACONs within close proximity of each other can be drawn together into a single facility. The key here is to identify the gaining facility first and evaluate its potential for expansion. In this first example, Albuquerque is selected because of the area's quality of life and ability to attract controllers willing to relocate. The Albuquerque TRACON is pictured in Figure 7; it has a new addition that replaced an original tower that dated back to 1956. Albuquerque would need expansion to accommodate additions to the current staffing of 43 positions. Albuquerque has land to handle an expansion, by using some of the land adjacent to the base building that is now devoted to parking. Since the facility is located on government land, there is adequate space for a replacement parking lot.

Figure 7: Existing Albuquerque Tower and TRACON

Source: Bing Maps

Figure 8: Consolidation of Four Facilities into Albuquerque



Facility	Date	Staffing	
Albuquerque	1956	43 positions	Level 8 facility
El Paso	1964	24 positions	Level 7 facility
Amarillo	1966	21 positions	Level 7 facility
Roswell	1997	16 positions	Level 5 facility
Lubbock	1987	26 positions	Level 6 facility

Targeted for consolidation into Albuquerque would be El Paso (24 positions), Amarillo (21 positions), Roswell (16 positions) and Lubbock (26 positions). Note that the number of staffing positions is greater than the number of physical control positions needed for the airspace since staffing reflects 24/7 coverage and development of new controllers. In addition, each of those four is a tower/TRACON configuration, and the tower portion of air traffic control would remain at its current airport. On average, tower controllers make less annual income than radar controllers, so at a combined facility controllers are trained on both positions. It is expected that the tower controllers would retain their pay at the airports. Relocating terminal controllers to Albuquerque, which is also a combined tower and TRACON, would lead to a terminal-only staff and a combined tower and TRACON staff. Figure 8 shows the consolidation.

Controllers are compensated in pay bands based on the level of a facility (currently from Level 4 to Level 12) and their development within the facility (from developmental to fully certified controllers). In addition to the facility level, there is a local differential pay that is added as a percentage of base pay. This locality pay differential compensates for area living costs.

At Albuquerque, the combined terminal control activities are classified as a Level 8 facility and would likely grow to a Level 9, with associated pay implications under the current ATO approach to compensation. All of these facilities have the same locality pay differential of 14.16%. Roswell is a fairly new facility commissioned in 1997 and is a combined tower/TRACON. The building would continue to be amortized as a tower structure following consolidation.

Albuquerque is not planned to be a metroplex area or an ICF, so investment in major expansion of the facility would make sense, and a space exists for a larger base building associated with the tower.

Labor constitutes a significant cost. As currently characterized, there is a single pay structure for a facility, based on its level. All employees under the same roof have the pay scale based on the facility level and then receive the locality pay in addition. A significant labor negotiation point will be this philosophy of one pay structure for the facility. As facilities combine, the future configuration may house multiple units that have significantly different flight activities. If Roswell were to be relocated to Albuquerque, those individuals would initially be controlling only Roswell traffic. Controllers could be fully qualified for Roswell but may be developmental controllers for Albuquerque's terminal airspace. If different levels are contained within the same physical facility, higher-level facilities could use lower-level facilities as sources for experienced controllers. Likewise, new trainees could enter a consolidated facility, start at the lowest facility level and work their way up.

Another example is in Washington State. In Eastern Washington there are three tower/TRACON combinations: Spokane, Grant County at Moses Lake and Pasco/Tri-Cities. Spokane is a Level 7 facility for pay, with the others being Level 6. Spokane is like Albuquerque with 32 controller positions, while Grant County has 19, half of which are developmental controllers. Pasco/Tri-Cities has 19 controllers. Each location splits between tower and TRACON. Tower personnel would remain; TRACON personnel would move. There is an advantage here when consolidating a tower/TRACON combination. Those employees who refuse to move for reasons of family or strong ties to the community can opt to stay and remain tower controllers.

The third example is more complex, featuring combining facilities under one roof but operating them as separate entities. A significant portion of the United States has low flight activity, mainly the states of Montana, Wyoming, North Dakota and South Dakota. The area is also targeted for increases in military unmanned aerial systems operations at existing military bases where terminal services are handled by the military. Table 3 summarizes the TRACONs in these states. The proposal is a full consolidation of all TRACON services into a new location.

Table 3: Example of Small TRACON Consolidation

Facility Location	State	Staffing	Level
Billings	Montana	21	6
Great Falls	Montana	16	5
Casper	Wyoming	13	5
Bismarck	North Dakota	15	5
Fargo	North Dakota	21	6
Sioux Falls	South Dakota	17	6

Source: FAA Controller Workforce Plan 2011-2020

Because these facilities are tower/TRACON combination facilities, the number of terminal controllers and remaining tower controllers would need to be determined. Combining these six locations into a new facility would allow the ATO to identify a location that has the best quality of life for controllers where they would choose to move. Those that want to remain behind would be tower controllers only. Once the tower/TRACON-combined facility is separated, some of the towers may be candidates for contract towers.

Nationwide, three new combined TRACON facilities of this type would be needed. The first of these is as described for Montana, Wyoming, North Dakota and South Dakota. The second is in the four states of Kansas, Missouri, Oklahoma and Arkansas. This new facility would integrate surrounding TRACONs. The third one would serve Louisiana and Mississippi and should be constructed away from the coastal hurricane region of the two states. New Orleans Louis Armstrong International Airport's TRACON is on the eastern fringe of the Houston Metroplex and is currently a Level 9 facility. New Orleans could either become an ICF, or be cut out and added to the Houston ICF, while at the same time consolidating a significant number of smaller facilities.

These three cases of combining into an existing, neighboring facility to cover a larger geographical area would operate as separate entities housed in the same physical plant. This is because the physical distance separating the locations precludes merging of airspace. The Louisiana/Mississippi location may be an exception. Here airspace could be combined, taking the low-altitude sectors from Houston and Jacksonville, forming an ICF.

Interim ICFs

In this second component of our plan, one physical and one virtual move would be made. The physical move involves geographical consolidation as above. The virtual move integrates multiple newly constituted larger TRACONs into an ICF with multiple physical locations. An example is in the state of Florida. Orlando would gain Daytona Beach and Tallahassee. Jacksonville would gain Savannah, Georgia. Miami would absorb West Palm Beach. At this point there would be Tampa, Orlando, Jacksonville, and Miami, the low sector airspace of Miami Center and a portion of Jacksonville Center. Rather than combine these facilities physically into a new ICF, they operate with a new airspace structure as a virtual ICF. This is possible because each of the major airports has a high origin/destination passenger loading and the airspace can be segregated for arrivals and departures.

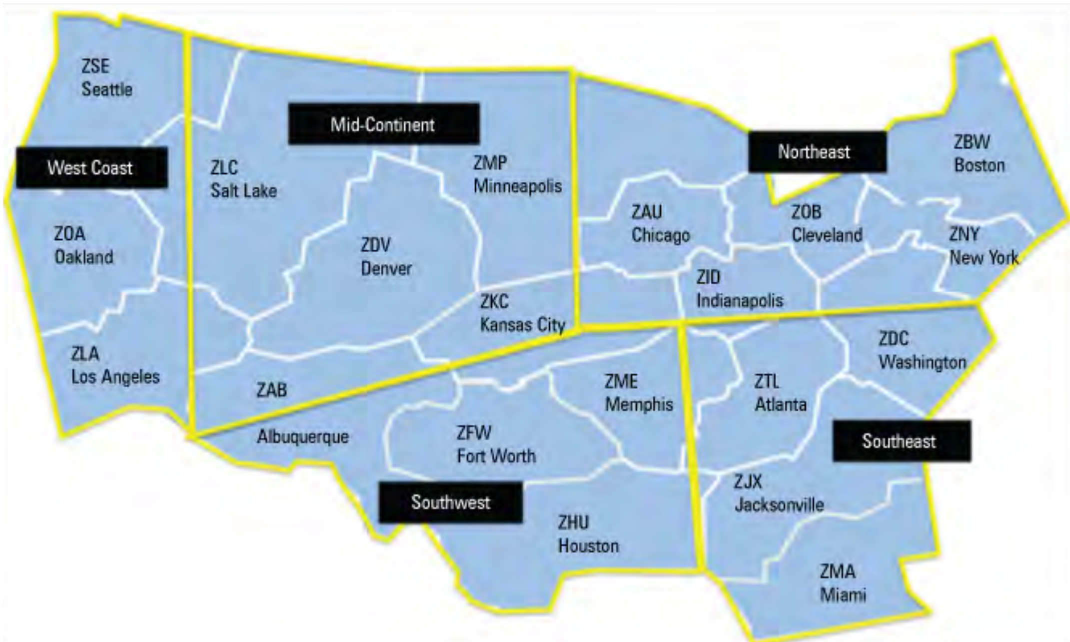
This same approach can be accomplished on the west coast, where the Southern California TRACON absorbs remaining outlying TRACONs (Palm Springs, Santa Barbara and Bakersfield), Northern California TRACON gains Fresno and Reno, and there is a realignment of low sectors from Oakland and Los Angeles Centers. The newness of the Southern California TRACON and Northern California TRACON make them prime candidates for expansion to become ICFs. If the virtual ICF concept works out well in Florida, then the virtual ICF would include Las Vegas and Southern California.

Center Airspace Redistribution

In this third component, the objective is to first change the airspace and then reduce the number of Centers. A series of high and low airspace swaps would occur between Centers and ICFs, between Centers and larger metroplex TRACONs leading to metroplex ICFs, and between Centers themselves to balance the workload and increase productivity. The one-third/two-thirds split between high- and low-sector staffing is used here to illustrate the process. This means that if any Center gives up its low airspace, it would need to gain the high airspace sectors from two adjoining Centers to remain labor-neutral. Likewise, a Center that gives up its high airspace to another would need to gain sufficient low airspace sectors from another Center. In the end, there would be five high Centers as illustrated in Figure 9.

Following completion of the airspace swaps (high and low), Los Angeles, Minneapolis, Kansas City, Memphis, Washington, Boston and New York close. With a shift of oceanic to Seattle, Oakland could close as well. This would require a new Center function that would shift Seattle and Portland to an ICF. Atlanta becomes an ICF. With Cleveland handling the low sectors for the Northeast (except that given up to the ICFs) and either Chicago or Indianapolis as the high, one of the two can close. Miami low is retained and deals with island and Caribbean traffic. The number of low Centers could collapse further with airspace going to the ICFs.

Figure 9: High Altitude Center Consolidation End State



Note that Centers in large metropolitan areas are selected to close because these areas will have ICFs that can absorb low altitude sectors and the job impact is lower. Each candidate is also a higher cost area. New York is a Level 12 facility with a 28.72% locality pay differential. Boston is a Level 11 facility with a 24.8% differential. Washington is also a Level 12 facility with a 24.22% differential. However, each of the Centers that would close has an ICF or large TRACON in their future that would absorb some of these positions.

Appendix A provides more details on the swaps of airspace between Centers that leads to five high-altitude Centers and nine low-altitude ones (29,000 ft. and below) that could further be reduced as the ICFs in major metropolitan areas are formed and take control of the airspace. This approach targets Centers where an ICF would be expected and in high-cost areas. The airspace redistribution and end state were then used to assess savings and productivity improvements.

Part 5

Savings and Productivity Potential

Operating Cost Savings

Consolidation of Centers and TRACONs into smaller numbers of high Centers, ICFs and consolidated TRACONs would yield significant and quantifiable operational benefits, even with no change in the way traffic is managed. If we then add in the productivity gain from NextGen (which requires infrastructure of fewer, more modern facilities to be effective), the gains are greater still. Facility consolidation therefore not only improves productivity in and of itself, but also is an enabler of additional benefits from NextGen.

We quantified the potential savings by first performing a regression analysis of the controller staffing levels at each facility as a function of various measures of workload. We obtained data on controller staffing from the 2010 document *Controller Workforce Plan, 2011-2020.*[8] Data on operations handled by each facility came from FAA OpsNet for FY2005. The key workload regression equations were as follows:

Center Controllers Needed = 84.6 + 0.0000713 × Air Carrier Ops
+ 0.0001193 × Air Taxi Ops
+ 0.000213 × General Aviation Ops
+ 0.0000171 × Military Ops

The correlation coefficient (R^2) for this equation is 0.817, indicating a high degree of explanatory power.

TRACON Controllers Needed = 8.56
+ 0.0000791 × IFR Itinerant Ops
+ 0.000157 × IFR Overfly Ops
+ 0.000162 × VFR Overfly Ops
+ 0.000179 × VFR Itinerant Ops

The R^2 for this equation is an even stronger 0.926.

Both equations show strong statistics, with good fits to the data and all but one of the independent variables being statistically significant. (The one exception was the military operations in the Center equation, however, this is not a problem because military operations impose very little workload on the Center controllers. The military typically uses altitudes and airspace away from private sector air traffic and performs most of the standard ATC functions through its own resources.)

The key parameter in both equations is the constant term, i.e., the number appearing directly after the equals (=) sign, which is 84.6 for Centers and 8.56 for TRACONs. Both equations can be interpreted as saying that the workload is proportional to the traffic being handled; as operations increase, workload and therefore controller requirements increase in proportion. However, the constant terms represent a fixed cost; if there were no traffic at all, each Center would still need about 85 controllers and each TRACON about eight or nine. When two facilities are consolidated into one, the workloads represented by the operations counts add together but only one fixed cost is needed. This represents a real saving in controllers from consolidation of facilities. This is why consolidation of facilities will save money in the operations budget, even with no changes in controller workload or procedures (of the kind to be brought about by NextGen).

Moreover, the controllers retained are those necessary to provide a critical mass of experiences at the facility, including supervisory skills needed at every facility. Thus, the controllers retained are likely to have above average experience and pay scales, and any estimate calculated at the average controller pay and benefits rate is probably conservative. Controllers retained are experienced, and that means fewer new controllers would need to be hired. Most of the changes can be handled by attrition and selected reassignments. Balancing retirements, new hires and developmental controllers is an essential element of consolidation.

To get at the average cost per controller, we used the classification level for each ATO facility, which is a level between 4 and 12. A higher-level facility will have more complexity in its air traffic, will require more experience of its controller workforce, and will generate higher rates of pay for the controllers working that facility. Developmental and trainee controllers, who are not yet certified in all the functions of the facility, receive a lower rate of pay until they become fully qualified.

Two additional factors were added to the pay rates. As noted previously, each facility has a cost of living adjustment known as a "Locality Pay Differential Percentage." The highest factor is for New York, which adds 28.72% to the base pay. The minimum locality percentage is 14.16%, which applies to most of the facilities outside major urban centers. In addition, we added 25% across the board to all the pay rates to represent the cost of benefits (e.g., health care and retirement contributions by the ATO).

The consolidation plan outlined in Part 4 was used as the basis for this analysis. It assumed that 20 domestic Centers would be reduced to five high-altitude Centers and the initial nine low-altitude Centers would then be reduced by using ICFs. In addition, 163 TRACONs would be reduced to 38

TRACONs. The annual cost of a controller for each facility was taken to be a weighted average of the loaded pay rates of certified and developmental controllers assigned to that facility. The estimated number of controller positions "saved" for each closed facility is the number in the constant terms of the above regression equations (84.6 for Centers and 8.56 for TRACONs). The savings was then calculated for the average pay rate at that facility.

Table 4 shows the effect of consolidation on controller costs. Total operating cost savings from consolidation alone is more than $300 million per year. While the Center consolidation saved 18% more controllers than that of the TRACONs, the dollar value of the consolidation savings was just about exactly double; this reflects the fact that all Centers are level 10 or higher, while the TRACONs span the entire spectrum of facility levels.

When the productivity benefits of NextGen are added, total savings could be as high as $680 million per year. The high level of recurring annual savings is important for justifying what will be a major capital investment in new facilities for the ATO.

Table 4: Annual Operating Cost Savings from Facility Consolidation

	Centers			TRACON			Total Savings
	#	Diff.	Annual Value	#	Diff	Annual Value	
Baseline Controllers	6448	--	--	6109	--	--	
With Facility Consolidation	5178	1270	$209 million	5031	1078	$105 million	$314 million
With NextGen Productivity (Low Assumption)	4386	2062	$339 million	4055	2054	$201 million	$540 million
With NextGen Productivity (High Assumption)	3820	2628	$432 million	3567	2542	$248 million	$680 million
Total Best-Case Annual Value		**$680 million**					

Facility Cost Savings

Assuming that geographical, ICF and airspace distributions are accomplished and the airspace is changed to match the NextGen concepts with air traffic control *from anywhere to anywhere*, capital cost savings would be realized by closing and selling off unneeded facilities and land. To get a value for the savings, the FAA's Real Estate Management System (REMS) database was used. This database carries an FAA valuation of the assets for both land and buildings. The following assumptions were made:

- The value of each facility was taken at 100% of the value listed in the FAA REMS database. REMS does not discount for age or current condition of the building. In Appendix B, we discount the buildings at 20% of cost to identify an estimated market value that a sale of a facility would obtain and in terms of the annual cost of maintaining that facility;
- The land and building values were only counted for those facilities that were assumed to close;

- If the facility was on airport property, no value for land was assumed. This is why the land valuations are much lower than that of the buildings, and also why the TRACON land valuations are near zero, because most are on airport property. Most of the TRACONs not on airport property are already consolidated facilities, which are assumed to continue to be used as today;
- For Centers, the savings would be the value of all buildings and all land. There were 33 land records and 224 building records associated with the Centers, reflecting some outbuildings;
- The savings in buildings for TRACONs was done for each location using the following guidance:
    - All building records at the facility were sorted from highest to lowest square footage and the value of the building with the highest square footage at the airport was taken as being the TRACON;
    - If the record showed a tower and did not differentiate a TRACON, the value of the base building was used for that location;
    - The administrative offices (e.g., Flight Standards District Offices) were not included;
    - Where the valuation on a square footage basis was low, we took the next building associated with the record as well. Some of the buildings are leased and the REMS valuation appears to be the annual lease payment. This may understate the value, but no correction was made to the value. In other cases, the REMS database appears to have two different valuations with two different records that were actually part of the same building with valuation allocated. In these cases both records were counted;
    - If the designated REMS category was just "office" and over 1,000 square feet, but not designated for a particular administrative use (e.g., Flight Standards or Airport District Offices), the building value was included.

The REMS database has grown over time without much attention to accurate descriptions of the building, its location, function and value. While the approach used may overstate or understate value, at least it provides a rough order of magnitude of potential savings. The individual site location data is contained in Appendix A.

Table 5: Direct Facility Cost Savings from Center and TRACON Consolidations (Land and Buildings)

	Land Value	Building Value
Centers	$19,289,639	$363,616,267
TRACONs	$410,711	$305,281,761
Total	$19,700,350	$668,898,028

We used REMS and an FAA database on equipment maintenance to analyze consolidation of ATC equipment located on numerous structures throughout the country. We estimated that by carefully managing the overlap of radio coverage footprints, the number of radio communications towers could be reduced by 20%. Likewise, en-route radars can be reduced by 20% if coverage overlap is managed more tightly. (Primary radars will need to be kept in service to meet national security requirements, while secondary radars will be used to back-up ADS-B.) Under NextGen, with GPS as the primary navigation tool, VOR(VHF Omnidirectional Radio) navigation is needed only as back up, enabling a reduction in VORs of about 60% (from 1,200 to 500). The total estimated savings to be realized from land, buildings and structures for this additional set of redundant assets is $653.6 million. There is another $98 million in planned refurbishment expense for facilities in REMS that we are designating for closure. Adding these additional amounts to the total from Table 5 (Centers and TRACONs) yields a grand total of $1.44 billion in one-time proceeds.

REMS includes data on maintenance of all the facilities included. For those REMS buildings and structures shut down and disposed of, we were able to tabulate the maintenance costs saved. That total is $98.65 million per year.

The FAA's FSEP database documents maintenance visits each year to all the sites where ATC equipment is located, including both travel time and on-site time. These equipment maintenance expenses are separate from the facility maintenance expenses included in REMS. Details of that analysis (along with more details on the REMS analysis) are provided in Appendix B. The salvaged equipment due to equipment consolidation has an estimated value of $294 million. The annual maintenance cost savings was estimated at $10 million.

Combining both one-time proceeds from redundant assets and annual maintenance cost savings gives us the totals shown in Table 6. The consolidation of staffed facilities and ground-based navigation aids should yield $1.7 billion in one-time savings and ongoing savings of $109 million per year. These savings should be dedicated to helping pay for the new facilities needed for NextGen, as outlined in this report.

Table 6: Overall Cost Savings from Consolidation

Type of Saving	REMS totals ($M)	FSEP totals ($M)	Grand Totals ($M)
Asset sales (one-time)	$1,440	$294	$1,734
Maintenance savings (annual)	$99	$10	$109

Part 6

Political Considerations

Obstacles to Consolidation

Any consolidation brings objections because local jobs are lost, families are displaced, and communities are disrupted. With geographical consolidations, most are tower/TRACON combinations where some controllers will remain as tower controllers and others will move. While this softens the blow for some who remain, normally their pay would be affected downward, since being qualified in both tower and TRACON carries a premium. Pay levels and locality compensation become a significant issue in any consolidation.

The ATO's typical approach of addressing consolidation one at a time does not provide an integrated picture of the benefits of a consolidation transition and creates uncertainty as to the ATO's motives. Moreover, local and congressional opposition can reverse an isolated relocation decision. Without the big picture for transition as a package, the pieces will not be integrated in terms of airspace use and overall cost-effectiveness from fully realized NextGen benefits.

Under the consolidation provision in the 2012 FAA reauthorization bill mentioned in Part 1, the ATO is required to submit an overall consolidation plan to Congress that has had input from the workforce and the aviation stakeholders. Congress has 30 days to object or the plan will go into effect. If and when such a plan is submitted, at least one of the 535 members would certainly object. In this approach, there is no provision for a fallback process, which makes gaining congressional approval very difficult.

With a truly comprehensive nationwide plan for consolidation, the pain would be spread across a large segment of the nation, and Congress would have to focus on the magnitude of the problem. The magnitude of this problem is comparable to the challenges faced by the Department of Defense with regard to military base closings. One possible approach would be to combine the DOD and FAA realignments and consolidation with the objective of re-purposing Department of Defense land for new FAA facilities. An alternative would be to enact air traffic control consolidation modeled directly after the Base Closing and Realignment (BRAC) process that has been used several times for large-scale military base closings.

Lessons from Overseas

Large-scale consolidation of ATC facilities has been a strong trend in other advanced countries over the past two decades. We first present a brief description of consolidation efforts in typical countries and then discuss factors that appear to have made this process easier in countries other than the United States.

Australia. During the 1990s, a reorganized Airservices Australia carried out both airspace restructuring and consolidation of facilities consistent with the revamped airspace. Prior to the reform, Australia had six flight information regions (FIRs) defined by the boundaries of its states. By the end of that decade, the airspace was consolidated into two: Brisbane for the northern part of the country and Melbourne for the southern part. Two new, identical, state-of-the-art centers, one in each of the two FIRs, replaced the six previous air control centers. Each has the capacity to back up the other.[9] Airservices also plans to shift the functions of the terminal control units (TCUs) for Adelaide, Perth and Sydney into the Melbourne center.

Canada. In Canada, most terminal control units were integrated into en-route centers prior to the creation of Nav Canada in 1996. But Nav Canada completed this consolidation by merging the TCU of Calgary into the Edmonton Area Control Center and the TCU of Ottawa into the Montreal ACC. The company studied reducing the number of ACCs below the current seven, but found that these consolidations did not pass its business-case test. It did consolidate flight service stations and flight information services, and eliminated its regional administrative offices.[10]

Germany. The German air navigation service provider, Deutsche Flugsicherung (DFS) has pursued a systematic program to separate the tower function from the approach function, integrate approach with en-route, and consolidate the en-route centers, consolidating airspace at the same time. Between 2003 and 2006 Germany's lower airspace was consolidated from five FIRs to three and the upper airspace, between 2003 and 2008, from three FIRs to one.[11] As of 2011, en-route facilities had been consolidated into two centers—Düsseldorf and Frankfurt, both housed in the same facility but operated as separate entities.

United Kingdom. During the 1990s, the U.K.'s ANSP, National Air Traffic Services (NATS), made the decision to consolidate its airspace and facilities. En-route operations would be consolidated from four centers to two, both brand new: Swanwick, near London, and Prestwick, in Scotland. Swanwick was opened in 2002 and Prestwick in 2010.[12] Both consolidations involved the relocation of hundreds of controllers from two of the previous centers at Manchester and West Drayton. London Area Terminal Control was also relocated from West Drayton to Swanwick, and Manchester Area Control, Scottish Area Control and Oceanic were relocated to Prestwick.

Other Countries. France is in the process of consolidating approach control in the Paris area into the en-route center at Athis-Mons, creating a French equivalent of an ICF called OPERA (Organisme Parisien d'En Route et d'Approche). Norway's AVINOR consolidated all ATC for southern Norway into a center outside Sola, near Stavanger. South Africa's ATNS consolidated its airspace from five FIRs to two, with centers only in Cape Town and Johannesburg. Taiwan's ANWS consolidated its airspace into north and south FIRs served by two consolidated centers and 11 remote towers.

How Overseas ATC Differs from Ours. Every country has similar underlying problems when facing consolidation of ATC facilities. Controllers generally don't want to move, and elected officials object to losing the jobs and related economic activity in their portion of the country. What is different in all the above countries is both the governance structure of the air navigation service providers and their source of funding. In each of those countries (and many others), the ANSP is a self-funded entity, regulated for air safety by the national aviation safety agency. Because the ANSP's funding comes directly from its customers (and not from appropriations by elected officials), the ANSP's decisions about consolidating facilities in order to increase productivity are made by the ANSP as business decisions. Obviously, each ANSP must consult and negotiate with its workforce on consolidation, and several of those discussed above have had to endure strikes before reaching an acceptable plan for employee transitions. The ANSP in each case also consults with its customers, since increasing the productivity of ATC is in the customers' interest.

Controllers and others sometimes raise questions about the safety implications of facility consolidation. Such questions are legitimate, since job number one in air traffic management is safety. In the governance structure prevailing in countries with self-funded ANSPs, an independent third-party government safety regulator decides those safety questions. By contrast, when such questions are raised about U.S. facility consolidation, the safety regulator is the FAA—the same organization that has proposed the consolidation. That fact seems to invite political intervention in consolidation decisions.

In short, consolidations are more likely to succeed overseas because they are business decisions, vetted for safety by an independent safety regulator. By contrast, such decisions in the United States are inherently political, for two reasons. First, Congress must approve the agency's budget each year, giving members of Congress a direct role to play in decisions about programs and facilities. Second, because the safety regulator is part of the same organization as the ANSP, the lack of a neutral safety arbiter also invites Congress to intervene.

Facility consolidation in this country would be more likely to take place if the key decisions about which facilities to close, and when, could be de-politicized. Based on the overseas experience, that would require (1) separating the ATO from the FAA, so that the FAA could serve as a neutral arbiter of consolidation's safety implications, and (2) making the ATO self-funding, to enable it to make business decisions in consultation with its customers and its workforce.

Part 7

Recommendations

ATO Consolidation Plan to Congress

Congress has directed the FAA to produce an overall ATC facility consolidation plan, and the ATO should not limit this plan to just the Northeast. The plan should:

- Develop the objectives and strategies for overall consolidation;
- Include the concept of airspace swaps between Centers, creating high-altitude Centers and leading to closure of other Centers;
- Identify Centers and TRACONS targeted to be closed;
- Identify facilities that would gain functions and staff from facilities to be closed;
- Define criteria for conversion of towers that lose the TRACON from FAA to contract towers;
- Define the number of ICFs and the areas to be served;
- Identify the staffing strategy for Tower/TRACON consolidation that defines how tower controllers would be retained and paid;
- Define the pay strategy for combined facilities that are operating different airspace and workloads, ending the current practice that all controllers within a facility are paid based on the same scale.

Liberty ICF

As noted in Part 3, beginning the facility consolidation process with the New York area ICF is clearly a high-risk proposition. Between resistance to airspace change, difficulties with site selection, and labor-management issues, Liberty ICF could well be the most difficult of all the needed consolidations. A much lower-risk approach would be to start with an ICF like Houston, where labor-management relations are better, land is readily available, the cost of living is lower, and opposition to airspace changes would likely be far less than in New York. Implementing the first-ever ICF on time and on budget would be more likely in that kind of setting. A successful initial ICF would give airspace users the benefit of the changes to the airspace and procedures and would build support for doing likewise in the rest of the NAS.

To be sure, if a Liberty ICF could be implemented successfully in the near term, the benefits would be much larger. A significant portion of all ATC delays and loss of efficiency today can be traced to inefficiencies in the New York/New Jersey airspace. If Liberty ICF actually opened with new airspace structure and procedures in place, then significant benefits would be realized. Working through difficult airspace and labor-management issues there would hold the ATO's feet to the fire in a high-visibility, need-to-perform setting.

But if Congress and the ATO are determined to take on the difficult case of Liberty ICF first, *all* of the following commitments should be obtained beforehand:

- The ATO must provide a funding strategy for consolidation over the long haul that addresses affordability and considers other methods of funding the improvements (such as revenue bonds);
- Labor agreements need to be negotiated in advance of site selection, dealing with facility level, pay differentials within the facility itself (not all controllers need the same pay brackets), and incentives for relocation;
- Arrivals, departures, overflights and low-altitude routes through the airspace need to be defined, built on PBN (performance-based navigation), and specifically targeted for segregation of traffic. They need to be properly modeled, simulated and tested before construction of the ICF, right-sizing the facility to the airspace;
- Liberty ICF should open based on an aircraft package of PBN and ADS-B capabilities;
- Liberty airspace should change to priority services based on “best equipped/ best served” as opposed to “first come/ first served” except as dictated by international agreements;
- Removal of the airspace from New York Center should lead to New York Center closing, with airspace responsibility transferred to others. This move alone could eliminate the need for $60 million in backlogged facility improvements at the Center, making those funds available for use elsewhere;
- The re-designed airspace for the ICF needs to have an airspace class definition, merging current Class B airspace. This redesign and designation is contingent on the PBN-based procedures and will require PBN T Routes for direct-as-possible flights through the airspace for general aviation.

These requirements should be applied to all ICFs, not merely to whichever one is developed first.

Technology Changes

PBN provides the opportunity to very precisely guide aircraft on a defined track. Demonstrations have shown that using RNAV can reduce workload for both the pilot and the controller during the approach. In designing the airspace, intermediate level-offs should be eliminated. Many of these level-offs are for the purpose of transfer of control (TOC) between controllers. This handoff requires time, voice communications between controllers, and then a call to the aircraft to change frequency, acknowledgment by the pilot and then a call in and acknowledgment by the controller. All of these transactions represent workload. The controller automation needs a tool to electronically handle the TOC to reduce coordination tasks. Ultimately, data link will provide the TOC radio frequency change to the aircraft, but terminal data link is planned for much later deployment; its deployment schedule should be accelerated.

The airspace design should rely on RNAV, RNP and radius-to-fix turns for both arrivals and departures. There is a strong likelihood that an RNP value of between 0.5 and 0.3 will be needed in the lower-altitude phases of arrivals. The FAA's current plans only call for RNP 1.0 until on final approach. This consumes too much airspace.

If the en-route automation (ERAM) software is the cornerstone for NextGen, what is the automation requirement for an ICF? Functional requirements for ICF automation are needed early so that ERAM and terminal automation can be examined to determine how much change would be needed for each platform to deliver performance-based operations in the airspace.

Consolidation of TRACONs and low-altitude Centers provides an opportunity to extend services to non-towered airports, especially in bad weather. The controller can provide separation services to the airport surface without a tower for lower-activity airports. This is possible because of ADS-B and voice communications that can be added at the airport.

Congressional Actions

While the FAA Modernization and Reform Act of 2012 (P.L. 112-95) creates the opportunity for the FAA to submit a consolidation plan coordinated with the workforce and the users, it does not go far enough to enable large-scale consolidation. In order to bring about consolidation most effectively, Congress needs to develop:

- A Base Closing and Realignment approach like that used by the Department of Defense that supported communities that lose jobs and facilities;
- A possible combination of Department of Defense and ATO consolidation efforts;
- New investment options for funding, including ATO revenue bonds, long-term leasing, lease to own, and public-private partnerships for both facilities and services;
- The ability to retain savings and sale proceeds from each closing of a facility that can be dedicated toward the capital cost of new facilities in the consolidation plan; and
- A national strategy to enable airspace and route changes that is both efficient and environmentally sound.

If the above set of measures cannot be achieved, an alternative would be for Congress to reform the ATO's governance and funding along the lines adopted in other countries that have successfully implemented facility consolidation. This type of reform would need to include:

- Separating the ATO organizationally from the FAA, to enable the FAA to regulate the ATO for safety at arm's length. The new ATO could be a separate modal administration within the U.S. DOT (as recommended by the Mineta Commission) or a government corporation as proposed by U.S. DOT in its 1994 USATS legislation;
- Enabling the new ATO to be self-funding, based on charging users for its services (in accordance with ICAO recommendation), with such revenues being available to support the issuance of NextGen revenue bonds by the ATO;
- Creating a governing board for the new ATO, representing all aviation stakeholders including ATO employees, along the lines of the stakeholder board of Nav Canada.

By taking this one-time action, Congress would be delegating potentially hundreds of decisions about facility consolidation to the new ATO, as it has done several times for military base closings via the BRAC process. This action would also address the currently unresolved NextGen funding problem, and ensure an independent safety assessment of all decisions made in connection with implementing NextGen, including facility consolidation.

Part 8

Conclusions

This report's purpose is to broaden the thought processes on consolidation—it is not just the creation of a NextGen ICF. Nor can the focus on NextGen dilute the need to reduce the number of other ATO facilities. Air traffic control *from anywhere to anywhere* is the basic premise—and promise—of NextGen. By any measure, it is a game changer in how airspace is defined and used, where facilities are as scalable and flexible as the airspace itself. The dynamic, ever-changing airline industry means that airspace and ATC facilities must become scalable and flexible.

This study provides an integrated approach involving geographical consolidation, Center consolidation and ICFs to serve as examples of what is possible. Shifting the ATO's focus from individual NextGen components to an overall plan for flexible airspace and a much smaller number of next-generation facilities is required now.

The potential for major gains in controller efficiency and productivity is considerable. Closing some facilities and shifting their workload to larger, modern facilities produces efficiencies by itself. In addition, the gains from better processes coming out of NextGen will further improve the system's productivity. The total potential is a gain of up to 40% overall, a level that should improve the business case for both facilities consolidation and NextGen overall.

The business case for large-scale facility consolidation is strengthened by our finding that the disposal of obsolete facilities, structures and equipment could yield $1.7 billion in proceeds that could and should be used to help pay for the new ICFs and other facilities. In addition, we estimate annual maintenance cost savings in excess of $100 million per year. Those annual savings are in addition to the large productivity gains brought about by consolidations, which we estimate as saving between $314 million and $680 million in annual operating costs. After adding in savings on facility and equipment maintenance, total savings in ATO operating costs would be in the vicinity of $1 billion per year.

Congress needs to address facility consolidation, first by requiring the ATO to produce a complete long-range plan. Then it must define and develop a way in which the plan can be implemented. This could be done via a variant of the Base Closing and Realignment process used for military base closings. Or it could be through reforming the governance and funding of the ATO to enable it to carry out facility consolidation as a series of business decisions, vetted by arm's length safety regulation by the FAA. But the time for action is now. With a large and growing backlog of aging Centers and TRACONs, *not* enacting an overall facility consolidation plan will lead, de facto, to wasting billions of dollars refurbishing and modernizing Centers and TRACONs that ought to be shut down.

About the Authors

Michael J. Harrison is a former Director of Architectural and Systems Engineering for the Federal Aviation Administration. In that role, he was responsible for the development of the FAA's $10 billion to $18 billion capital investment plans to execute strategies for aviation transportation investments. In addition, he provided leadership and long-term business planning for the FAA in various management capacities, with emphasis on planning, research, systems engineering and engineering development. With an extensive background in aviation, from flight operations to air traffic management and airport operations, much of his experience has been in systems engineering for development of requirements, transition strategies, program planning and execution and defining new operational concepts in aviation. This includes experience in technology assessment, feasibility, safety risk assessments, measures of performance, architectures, systems integration and consensus standards development.

Ira Gershkoff has over 25 years experience in airline operations and IT, in positions ranging from analyst to vice president. He is a recognized leader in streamlining processes to improve performance, with a smooth transition from the old to the new. Recent work has resulted in patent-pending technology to vary airline schedules in response to fluctuations in demand. Benchmark tests show profitability improvement of tens to hundreds of millions of dollars for major carriers. He was winner of a Small Business Innovation Research grant from the National Science Foundation and has applied the technology to additional applications for air taxi and air charter services. Previously he provided strategic IT consulting services examining the costs, benefits and risks of transitioning from a point-of-sale system to a centralized application model, which resulted in long-term savings of $2 million per year in network maintenance costs. He has also evaluated crew scheduling procedures for four airlines, with recommended process changes expected to result in savings of up to $2.5 million annually.

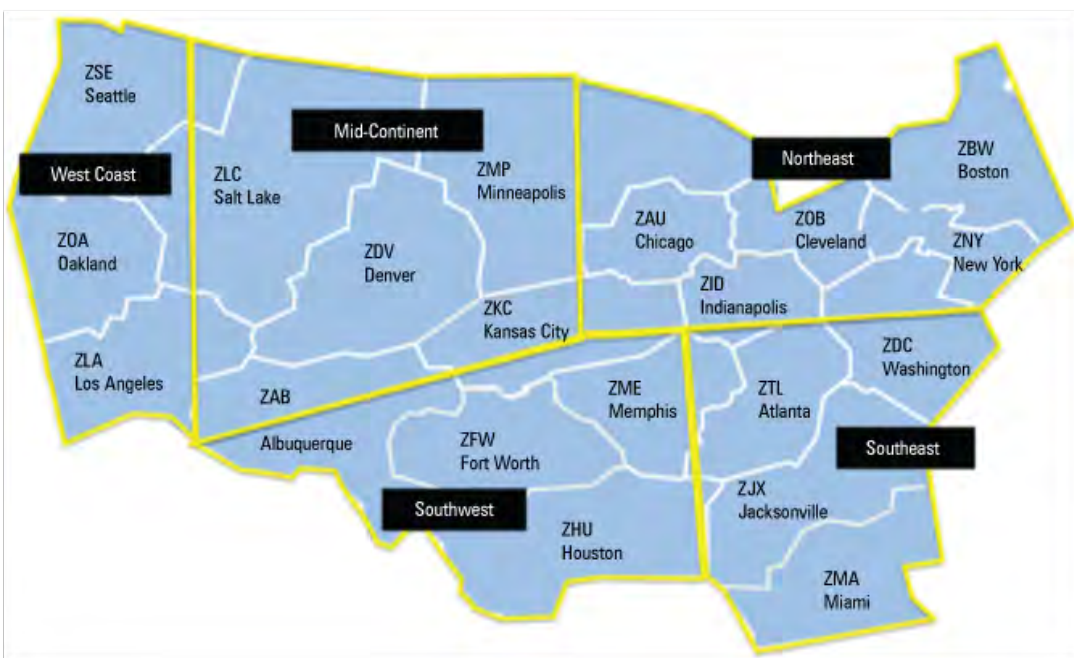
Gary Church is principal of Aviation Management Associates, Inc., which he established in 1984. He has extensive experience and current involvement in all facets of air traffic control operations, airspace management and security, communication, navigation and surveillance aviation related activities. He has worked with federal agencies including the Federal Aviation Administration, National Aeronautics and Space Administration, Transportation Security Administration and Research and Special Projects Administration. He previously worked as an air traffic controller with the Federal Aviation Administration, and as manager of air traffic control for the Air Transport Association. He is a licensed instrument rated pilot.

Appendix A

Appendix A: Center Airspace Redistribution and Facility Closings

In this appendix the approach is to first change the airspace and then reduce the number of Centers. A series of high and low airspace swaps occurs between Centers and ICFs, between Centers and larger metroplex TRACONs leading to metroplex ICFs, and between Centers themselves to balance the workload, reduce the need for relocating personnel, and increase productivity. The one-third/two-thirds staffing split between high- and low-sector staffing is used here to illustrate the process. This means that if any Center gives up its low airspace, it would need to gain the high airspace sectors from two adjoining Centers to remain labor-neutral. Likewise, a Center that gives up its high airspace to another would need to gain sufficient low airspace sectors from another Center. In the end, there would be five high-altitude Centers as illustrated in Figure A-1.

Figure A-1: Five Segment High Altitude Center Airspace



Starting on the West Coast, Oakland becomes the high-altitude Center. It gains all of Seattle's and Los Angeles's high airspace, except the eastern portion that goes to Salt Lake Center. It also continues to support oceanic air traffic control operations. Initially Oakland gives up a portion of its low airspace (FL 290 and below) to Northern California TRACON that will ultimately become an ICF. The remaining low airspace not needed for San Francisco, Oakland and San José arrivals and departures is split between Seattle Center and Los Angeles Center. Salt Lake loses a segment of high airspace to Oakland.

Since Los Angeles Center will be giving up a significant quantity of low airspace to the Southern California ICF, it would close with the opening of the ICF and some of the controllers would move from the Palmdale location to San Diego.

Whether Oakland is the high or Seattle is the high makes no functional difference, except that the oceanic functions would need to move from Oakland to Seattle. The issue will be handling the high-altitude traffic to and from Alaska. If the move is made to Seattle, two Centers could be closed completely as personnel are moved to the ICFs for San Francisco and Los Angeles. Seattle retains its low sectors unless a decision is made to make Seattle the high Center.

In the Mid-Continent airspace segment, Salt Lake becomes the high Center, releasing part of its low sectors to West Coast and to Denver. A portion of the high sectors from Minneapolis Center goes to Salt Lake and its low sectors are divided between Denver and Chicago. Minneapolis closes.

Kansas City would close, giving up its high airspace to Salt Lake and Indianapolis. The low sectors go to Denver, Fort Worth and Chicago. Denver ends up with the Salt Lake lows, a portion of Kansas City lows, a portion of Minneapolis's lows and its own lows, However, Denver is a metroplex and will end up with an ICF so it will release a significant segment of airspace around the metroplex area (FL 290 and below for approximately 80 to 130 miles from the Denver International Airport). This ICF is a replacement for the Denver TRACON that has previously absorbed Aspen, Colorado Springs and Pueblo.

Because Dallas, Houston and Memphis will have ICF facilities, a considerable portion of low-altitude sectors from the Centers will go to the new ICFs. Albuquerque gains the high sectors from Fort Worth, Houston and Memphis, along with a slice of the current southern edge of Kansas City. Fort Worth and Houston retain their lows and Fort Worth gains the western portions of the Memphis lows less the airspace needed to support both the Memphis and Nashville airspace that would go to an ICF. Memphis closes and its personnel staff the ICF that may be a conversion of Memphis Center's physical plant. This location accommodates the physical consolidation of six TRACONs.

In the Southeast, the high Center is based at the current Jacksonville Center, gaining highs from Miami, Washington and Atlanta. Jacksonville lows are split between Miami and Atlanta. Washington loses most of its low to Potomac TRACON that also absorbs TRACONs in Virginia and West Virginia, as well as the airspace above Washington and Baltimore to FL 290. Potomac becomes an ICF. Washington gives up a portion of its high sectors to Indianapolis and closes. Atlanta handles the airspace below FL 290 and gains all the TRACONs in Alabama. It subsequently gives up its lows to a new ICF or becomes the ICF itself.

In the Northeast, there are ICFs for Boston, the New York area and Chicago, taking substantial airspace from their current Centers. Indianapolis and Chicago combine into one to become the Northeast High Center. Whether it is Chicago or Indianapolis does not matter, one of them closes, but remember, Chicago has gained some of the low airspace from Minneapolis. This new Northeast High Center gains high-altitude sectors from New York, Cleveland, Boston and parts of Washington Center. The oceanic function in New York moves to the Northeast High Center as well. Major portions of Boston low sectors are consolidated with the Boston ICF. Cleveland is retained to cover the low sectors of Indianapolis (or Chicago), New York (outside of the ICF), portions of Washington Center lows. Boston, Washington, New York and either Chicago Center or Indianapolis will close.

The objective is to form five high-altitude Centers. Flights from the east coast to the west coast would go through only two Centers, Northeast and Mid-Continent or Southeast and Southwest. Airspace is redesigned around RNAV Q Routes and can be dynamically adjusted. Airspace below the high sectors is either retained by a reduced number of Centers or given to the ICFs. Flights oriented north-south will either fly through Northeast to Southeast Centers or Northwest through Southwest Centers, and West Coast traffic stays within the same Center. This maps well to existing and future traffic patterns at high altitude.

In the end, Los Angeles, Minneapolis, Kansas City, Memphis, Washington, Boston and New York close. With a shift of oceanic to Seattle, Oakland could close as well. This would require a new Center function that would shift Seattle and Portland to an ICF. Atlanta becomes an ICF. With Cleveland handling the low sectors for the Northeast (except that given up to the ICFs) and either Chicago or Indianapolis as the high, one of the two can close. Miami low is retained and deals with island and Caribbean traffic.

Note that Centers in large metropolitan areas are selected to close because these areas will have ICFs that can absorb low-altitude sectors, and the job impact is lower. Each candidate is also a higher-cost area. New York is a Level 12 facility with a 28.72% locality pay differential. Boston is a Level 11 facility with a 24.8% differential. Washington is also a Level 12 facility with a 24.22% differential. However, each of the Centers that would close has an ICF or large TRACON in its future that would absorb some of these positions. Table A-1 summarizes the moves for airspace and subsequent status of the facility.

Table A-1: Airspace Gains and Losses by Center

Current Facility	Airspace Gain	Airspace Loss	End State Status
Oakland	Seattle and Los Angeles High Sectors	Segment of High to Salt Lake; low airspace to Northern California TRACON that will become an ICF; Low airspace not needed by ICF goes to Seattle and Los Angeles	West Coast High
Los Angeles	Interim low from Oakland	Low airspace to new ICF anchored by Southern California TRACON. High sectors to Oakland.	Closes
Seattle	Low sectors from Salt Lake (portion) and interim low from Oakland	High sectors to Oakland and Salt Lake	Remains West Coast Low Center covering airspace not delegated to the ICFs
Salt Lake	Portion of high from Seattle and Oakland; retains current highs; portion of Minneapolis highs; portion of Kansas City Highs, Denver Highs	Low to Seattle and Denver	Mid-Continent High
Denver	Portion of low sectors from Salt Lake; a portion of Albuquerque lows; western low sectors from Minneapolis; portion of Kansas City Lows	Highs to Salt Lake; Denver lows around Denver to Denver ICF	Mid-Continent Low
Kansas City		Lows to Denver, Chicago and Fort Worth; High sectors portions to Salt Lake and Indianapolis	Closes
New York		Low airspace to ICF, High sectors to Indianapolis/Chicago	Closes
Boston		High sectors to Indianapolis/Chicago; low to Boston ICF and Cleveland	Closes
Chicago	Low sectors from Cleveland	High sectors to Indianapolis or retain	Becomes Northeast High or closes if Indianapolis becomes the Northeast High
Minneapolis		High portions to Salt Lake and Indianapolis; western lows to Denver and eastern lows to Chicago	Closes
Albuquerque	High sectors from Fort Worth, Houston and Memphis	Lows to Denver and Fort Worth	Southwest High
Fort Worth	Retains Lows; gains Albuquerque lows and western portion of Memphis lows	Low airspace needed for Dallas, Memphis and Nashville ICFs high sectors to Albuquerque	Southwest Low
Houston	Retains lows	Highs to Albuquerque	Southwest Low along Gulf Coast
Memphis		Highs to Albuquerque; western lows to Fort Worth, eastern lows to Atlanta for use by Atlanta ICFICF	Closes
Jacksonville	Highs from Miami, Washington and Atlanta	Lows to Miami and Atlanta	Southeast High
Washington		Highs to Jacksonville and Indianapolis; lows to Atlanta and Cleveland	Closes
Atlanta	Lows from Jacksonville and Washington and western portion of Memphis	High to Jacksonville Portion of Lows to ICF	Southeast Low or closes depending on ICF structure and relationship with Miami
Miami	Lows from Jacksonville	Highs to Jacksonville	Handles lows and Caribbean traffic
Indianapolis/ Chicago Combination	High sectors from New York, Cleveland, Boston and a portion of Washington	Low sectors to Cleveland	Either Chicago or Indianapolis closes; the remaining unit become the Northeast High
Cleveland	Low sectors from Chicago, Indianapolis, New York (west of ICF) and a portion of Washington	Highs to Indianapolis/Chicago; gives up ICF airspace	Northeast Low

Appendix B: Estimated Savings from Consolidation

This appendix presents a detailed estimate of the dollar value that is obtainable from consolidating FAA facilities according to the criteria discussed earlier in this report. The starting point is an inventory of all of the FAA's owned or leased land, buildings, structures and equipment. Based on assumptions of which facilities can be consolidated, we derive the total value of those facilities that can be captured, both in terms of estimated market value that a sale of a facility would obtain and in terms of the annual cost of maintaining that facility.

The analysis was based on two key databases of FAA properties:

1. The **REMS** (Real Estate Management System) database contains 63,841 records of FAA facilities in the U.S. and its territories. All of the records are categorized as land, buildings or structures. For each record, it includes the use of the facility, the estimated cost of building it, and the annual maintenance cost of the real estate components. (Maintenance cost of the equipment itself is covered elsewhere.)

2. The **FSEP** (Facility, Service and Equipment Profile) database contains 75,239 records of FAA facilities, services and equipment. Each record was categorized as one of over 400 different types of facilities/equipment/services. A key feature of the database is a specification of maintenance requirements in terms of number of visits per year and travel time to the facility.

Key Assumptions

For each record in each of the databases, an assessment was made of whether that asset could be liquidated in a consolidation scenario. If the operation could be run without it, its capital value and annual maintenance cost were assumed to be saved. The details of making that assessment involved a number of assumptions about how the records were to be analyzed. The most important of these were as follows:

Airport Land – If the FAA has a building on airport property, the land cannot be liquidated and has no value that can be captured. If the FAA were to close a facility on airport property, the land would simply revert to the control of the airport authority, with no compensation to the FAA. Buildings and structures can have realizable value, but the land itself does not.

Surplus or Closed Facilities – If a facility of any type is designated as surplus or closed, then it is assumed that it can be liquidated immediately, with no adverse consequences.

Consolidation Scenarios – For Centers and TRACONs, the analysis was based on the scenario presented in Parts 5 and 6 of this report. This assessment also considered consolidation of ATC equipment, involving numerous non-staffed facilities. By carefully managing overlap of radio coverage footprints, the number of radio communications towers may be reduced 20%. En-route radars can be reduced by 20% if coverage overlap is managed more tightly. Primary radars will need to be retained, as these provide the primary surveillance capability for the Department of Defense. Secondary radars represent the back up system for ADS-B. Thus, the benefits from radar consolidation are limited by the coverage overlap that can be eliminated. With GPS, VOR navigation is needed only as a back up, which enables a reduction of VORs from roughly 1200 to 500, or about 60%.

Resale value – Some facilities cannot be sold or have no value if they were sold. For example, the FAA has invested in roads, bridges and parking lots, none of which have any portability. If a parking lot adds value to a surplus building, then the value of that lot is assumed to be captured in the value of the building; the lot has no value by itself.

Land is assumed to be salable at 100% of its market value. Buildings are assumed salable at a 20% discount to their original cost. Structures (i.e., physical housing for equipment such as a radar unit or large antenna) tend to have limited use outside of the purpose for which they were designed, and therefore are assessed to be salable at an 80% discount to their original cost.

Equipment resale value depends on the demand for that equipment, both from the FAA and from private sector users. If the FAA is still using that type of equipment around the system, then we assume that it will be refurbished (at a cost of 25% of its new value), put in storage, and used for future installations of that equipment. If the equipment cannot be refurbished for a reasonable cost or is no longer in general use, then it is assumed to be scrapped at a salvage value of 5% of its original cost.

Expense from Redistribution – If assets are consolidated, the savings are often not proportional to the reduction in units, because not all of the components of the service being consolidated scale up the same way. Where used, this parameter reduces the potential savings. For the equipment consolidations, we generally assessed the extra expense to be 5% for savings of 20%-25%, and 10% for savings of 50% or more. However, there were several case-by-case exceptions.

Recoverability of Maintenance Costs – For the REMS database, if the asset is salable, then the maintenance costs are always assumed to be recoverable, i.e., if the asset is sold or closed, the maintenance costs stop immediately and therefore represent tangible savings. If the asset is not salable, then the maintenance costs might or might not be recoverable, on a case-by-case basis. If the asset is judged to be "not affected by consolidation," then no credit is taken for any recovered savings (because the asset will continue to be needed).

Estimation of Equipment Maintenance Costs – The FSEP database documents the number of maintenance visits per year required for each piece of equipment. For remote sites, it also shows the one-way travel time. Furthermore, if a site visit entails inspection of a number of pieces of equipment, only the primary piece of equipment shows the visits and travel time. Estimating the maintenance costs therefore required the following assumptions:

- Each piece of equipment requires an average of 20 minutes per visit.
- If travel time to the site is specified, it is doubled (to produce a round-trip time) and added to the minutes required for maintenance.
- When travel time and annual visits are not specified, the maintenance visit is grouped with the maintenance of several other assets collocated with the asset being analyzed. In these cases (which represent the majority of the records), we used the average visits per year multiplied by 20 minutes per visit to obtain the annual maintenance minutes for that equipment record. The travel time is picked up only for the asset designated as the primary reason for the visit.
- A mid-level maintenance technician was assumed to earn a fully burdened salary of $130,000 per year; at 1920 hours per year, this amounts to $67.71 per hour.

Results from REMS Analysis

Table A-2 is a spreadsheet containing the results of the analysis of the REMS data. The total of 63,841 records divides into 28 combinations of "Type of Facility" (2nd column) and "Use Code" (3rd column). The airport land and redundant (to be closed) facilities are shown in the first two rows and are 0% and 100% recoverable respectively. In the remaining 26 categories, 14 have no recoverable value, and the others are partially recoverable, depending on whether the item represents a consolidation of Centers, TRACONs, or radar or radio sites. The column labeled "% Extra Expense from Redist [ribution]" shows the loss of benefits resulting from imperfect scaling, e.g., if two facilities are consolidated into one, the maintenance cost may be slightly more than half of the total for the two original facilities. For real estate assets, this same column can also signify the discount level from market value. The exceptions from these general rules are explained in the last column, marked "Justification/Comments."

Net recoverable value shown from the REMS database is $1.34 billion out of a base of $9.1 billion, or about 15%. There is an additional $98 million in facility refurbishment cost that would be avoided if these facilities were liquidated; this brings the total recoverable value up to $1.44 billion. More than half of this asset value ($689 million) comes from the liquidation of surplus and closed facilities, with about half the remainder coming from land and structures for navigation and traffic aids. Warehouses account for the third-highest category. These documented recoverable savings represent a significant resource that could be used to cover part of the cost of new, consolidated facilities. For the asset maintenance costs, the assessed recoverable savings is $99 million annually out of a base of $471 million, or 21%.

Table A-2: Types of Facilities and Their Liquidity in a Consolidated Scenario

# Records	Type of Facility	Use Code	Use	Recoverable Facility Value						Recoverable Maintenance					Justification/Comments
				Is Facility Salable?	Total Value	% Recoverable	% Extra Expense from Redist	Recoverable Value	Refurbishment Capital Required	Can Maint be Offloaded?	Total Annual Cost	% Recover-able	% Extra Expense from Redist	Recoverable Value	
1686	Airport Land		Various	No	97,654,809	0	0	0	0	Yes	10,403,008	0		0	Airport land cannot be sold
1247	Redundant		Various	Yes	745,572,532	100	0	745,572,532	34,387,454	Yes	13,972,287	100	0	13,972,287	Facilities that are closed or surplus
520	Building	10	Office	Yes	677,065,314	12	10	73,123,054	4,363,421	Yes	66,648,328	12	10	7,198,019	70% of 80 ARTCC buildings, 25% of all TRACON buildings, 0 for admin buildings; net 14%
49	Structure	12	Airfields Pavements	No	21,420,997	0	0	0	0	Yes	481,140	0	0	0	No resale value; part of the land
31	Structure	15	Power Development and Distribution	No	17,446,631	0	0	0	0	Yes	341,825	30	0	102,547	Houses power equipment; mission critical; but Airport can assume maintenance
39	Building	23	School	No	224,074,392	0	0	0	0	No	3,580,699	0	0	0	Mostly Oklahoma City buildings; note affected by consolidation
95	Building	30	Family Housing	Yes	34,254,486	25	40	5,138,173	476,829	No	562,799	25	0	140,700	25% recoverable, with 40% discount on homes
23	Land	30	Family Housing	Yes	24,408,337	25	0	6,102,084		Yes	129,891	25	0	32,473	Not affected by consolidation
33	Land	40	Storage	Yes	1,809,519	0	0	0	0	Yes	57,282	0	0	0	Salable if # storage facilities can be reduced
809	Structure	40	Storage (Other than Buildings)	Yes	59,009,307	0	0	0		Yes	1,256,434		0	0	Principally fuel or oil tanks, 2-3 per airport; salable if # storage facilities can be reduced
829	Building	41	Warehouses	Yes	441,491,307	25	5	104,854,185	4,958,906	Yes	3,122,795	25	5	741.664	70% of 40 (est.) ARTCC, 25% of 170 TRACONS, otherwise 0; minimal add inventory
73	Building	60	Service	No	257,067,885	0	0	0	0	No	2,869,006	0	0	0	Used for maintenance and non-operating svcs; not affected by consolidation
43	Structure	60	Service (Other than Buildings)	No	8,252,469	0	0	0		No	150,836	0	0	0	Used for maintenance and non-operating svcs; not affected by consolidation
3402	Structure	66	Parking Structures	Yes	103,027,869	5	0	5,151,393	297,099	Yes	589,998	5	0	29,500	Can be re-leased
60	Structure	70	Research and Dev (exc. Labs)	No	3,670,356	0	0	0	0	No	90,092	25	0	0	Tech Center + Misc other facilities
891	Structure	71	Utility Systems	No	125,630,670	25	0	31,407,667	2,454,037	Yes	2,606,739	20	5	651,685	Lighting, power, sewer, water; recoverable if facility to be closed
1454	Building	72	Communications Systems	Yes	246,171,958	20	20	39,387,513	4,556,665	Yes	13,463,505	20	5	2,558,066	Buildings salable at 20% discount
636	Land	72	Communications Systems	Yes	138,160,998	20	0	27,632,200		Yes	3,041,794	20	5	608,359	20% of radio comm sites can be recovered
2946	Structure	72	Communications Systems	Yes	166,789,133	20	80	6,671,565		Yes	3,499,115	20	5	664,832	Structures resalable at 80% discount
4446	Land	73	Navigation and Traffic Aids	Yes	653,496,701	25	0	163,374,175	32,068,374	Yes	25,275,839	25	5	6,003,012	Core savings from program
6946	Building	73	Navigation and Traffic Aids	Yes	2,584,909,700	25	0	129,245,485		Yes	252,291,452	25	5	59,919,220	Core savings from program
18991	Structure	73	Nav and Traffic Aids (Exc. Buildings)	Yes	1,229,639,876	25	80	61,481,994	14,310,454	Yes	25,368,789	25	5	6,025,087	Core savings from program
48	Building	74	Laboratories	No	339,171,956	0	0	0	0	No	6,054,693	0	0	0	Not affected by consolidation
6559	Structure	76	Roads and Bridges	No	200,863,918	0	0	0	0	Yes	4,213,505	0	0	0	Not affected by consolidation
881	Building	80	All Other	No	377,238,581	0	0	0	0	No	9,113,163	0	0	0	Not affected by consolidation
480	Land	80	All Other	No	28,812,526	0	0	0		No	2,409,709	0	0	0	Not affected by consolidation
10561	Structure	80	All Other	No	290,672,926	0	0	0		No	5,155,128	0	0	0	Not affected by consolidation
63	All		Misc Mixed Codes	No	34,992,258	0	0	0	0	No	13,907,075	0	0	0	Small numbers of records; minor value
63841	Total Facility Records				9,132,777,410	0	0	1,399,142,022	97,873,240		470,656,925	0	0	98,647,450	Total Value and Recoverable Value

Source: FAA REMS database

Results from FSEP Analysis

An approach similar to that used for REMS was done for FSEP's 75,239 records. The first reduction was to remove all records for which FAA was not the owner or lessor of the asset. If the FAA was maintaining an asset on behalf of some other government or private institution, then the FAA should be reimbursed for that service. Such facilities are not affected by consolidation. This reduced the record pool to only those records with responsibility code "A" (FAA owned), "I" (FAA owned, DOD maintenance), "J" (Federal facility managed by FAA), or "S" (FAA leased). This reduced the record pool to 70,978 records.

Two other records types could also be eliminated. A system code of "3" represents runway aids such as VASI systems or localizers. These cannot be consolidated and are therefore removed from consideration, reducing the pool by 8,894 records to 62,084. System code "0" represents National Defense facilities, which also cannot be consolidated. This further reduced the record pool by 383 records, to 61,702.

The remaining records consisted of about 300 unique facility/equipment codes categorized according to whether they were used for En Route, Terminal, both, or some other FAA service. The total number of combinations to be analyzed was an unmanageable 546. To get the list down, we rank-ordered the list from highest to lowest number of records, and deleted all the low-count categories that collectively added up to 20% of the total records, but more than 80% of the categories. The idea here was to take a sample, make the calculations on the sample, and then factor up the total based on the records that had been deleted, while assuming that the deleted records had similar characteristics to those that were kept. This brought the total of categories down to 82.

As we analyzed the 82 categories, we realized that some of them represented data services, which would still need to exist after consolidation. About 75% of the remaining categories were found to be unaffected by consolidation and therefore represented no recoverable value. We were left with 20 categories that would be recoverable from consolidation, representing 12,714 records. Then, based on whether the equipment type in the category represented a terminal, en-route or radio/navigation facility, we applied the appropriate recovery percentage to the maintenance costs to calculate the potential savings. Similarly, we evaluated salvage value for the decommissioned units.

Results are shown in the spreadsheet of Table A-3. The bulk of the maintenance cost savings is in remote units: VORs and radio communications equipment that is installed in the field, often in relatively remote areas. When the recoverable percentages were applied, the net annual benefit in saved maintenance costs was just over $10 million per year.

The salvaged equipment had a value of $294 million. This represents a one-time cash infusion because it is generated by liquidation of surplus units. One-third of this figure comes from one type of equipment (standby generators) and another quarter from VORs. Both are expensive units that will be needed as replacements in the future, which makes it worthwhile to refurbish the decommissioned units and hold them in inventory for future replacement needs.

Table A-3: Equipment Costs and Values

Equipment Type					Environmental / Technical Maintenance				Recoverable Maintenance Costs				Salvage Value of Decomm Units		
# Records		Facility Code	Facility Type	Savings Group	Annual Env Mins (incl Trav)	Annual Cost (@ $67.71/hr)	Annual Tech Mins (incl trvl)	Annual Cost (@ $67.71/hr)	Total Annl. Cost All Maint.	% Recov-erable	% Expense from Redistribution	Annl Recov. Value	New Equip Costs	% Value of Decom. Units	$ Value of Decom. Units
255	256	DCBUS	Direct Current Backup System	ENR	71,400	80,575	76,500	86,330	166,905	70%	0%	116,834	40,000	5%	357,000
284	540	DCBUS	Direct Current Backup System	TRM	79,520	89,738	85,200	96,148	185,887	25%	5%	44,148	40,000	5%	134,900
407	947	DMUX	DeMultiplexer	ENR	113,960	128,604	122,100	137,790	266,394	70%	0%	186,476	25,000	5%	356,125
718	1665	DMUX	DeMultiplexer	TRM	201,040	226,874	215,400	243,079	469,953	25%	5%	111,614	25,000	5%	213,156
322	1987	ELD	Electrical Distribution System	ENR	374,032	422,095	96,600	109,013	531,108	70%	0%	371,776	10,000	5%	112,700
284	2271	ERMS	Environmental Remote Monitoring Subsystem	ENR	79,520	89,738	85,200	96,148	185,887	70%	0%	130,121	40,000	5%	397,600
910	3181	FCPU	Facility Central Processor Unit	ENR	254,800	287,542	273,000	308,081	595,622	70%	10%	375,242	10,000	5%	286,650
499	3680	FDIOR	Flight Data Input / Output Remote	TRM	139,720	157,674	149,700	168,936	326,610	25%	5%	77,570	50,000	20%	1,185,125
342	4022	FOTS	Fiber Optics Transmission System	TRM	99,930	112,771	124,420	140,408	253,179	25%	5%	60,130	100,000	50%	4,061,250
302	4324	LAN	Local Area Network	All	84,560	95,426	90,600	102,242	197,668	42%	5%	78,494	4,000	5%	29,981
427	4751	PCS	Power Conditioning System	ENR	119,560	134,923	128,100	144,561	279,484	70%	10%	176,075	30,000	5%	403,515
738	5489	RCAG	Remote Center Air / Ground Comm Facility	Radio	500,272	564,557	1587,176	1,791,128	2,355,685	20%	0%	471,137	60,000	75%	6,642,000
611	6100	RCE	Radio Control Equipment	Radio	184,280	207,950	232,820	262,737	470,697	20%	0%	94,139	100,000	75%	9,165,000
753	6853	RCLR	Radio Communications Link Repeater	Radio	1,688,808	19,05,820	1,303,570	1,471,079	3,376,899	20%	0%	675,380	100,000	75%	11,295,000
240	7093	RCLT	Radio Communications Link Terminal	Radio	67,200	75,834	78,000	88,023	163,858	20%	0%	32,772	100,000	75%	3,600,000
1710	8803	RCO	Remote Communications Outlet	Radio	645,380	728,311	1,781,244	2,010,134	2,738,445	20%	0%	547,689	60,000	75%	15,390,000
1322	10125	SX	Standby Generator	ENR	374,480	422,601	396,600	447,563	870,164	70%	10%	548,203	150,000	75%	93,696,750
945	11070	TDS	Telecommunications Demarcation System	ENR	264,600	298,601	283,500	319,930	618,531	70%	10%	389,674	100,000	5%	2,976,750
708	11070	TDS	Telecommunications Demarcation System	TRM	198,240	223,714	212,400	239,693	463,407	25%	5%	110,059	50,000	5%	420,375
937	12715	VOR	VHF Omnidirectional Range	VOR	2,267,272	2,558,616	2,970,012	3,351,659	5,910,275	60%	0%	3,546,156	200,000	75%	84,330,000
12714			Totals			8,811,976		11,614,682	20,426,658			8,143,697			235,053,877
			+25% for removed sample									$10,179,621 per year			$293,817,347 one time

Source: FAA FSEP database

Results – Combined

The sum of results from the two databases shows a net recoverable value of $1.734 billion in one-time asset liquidation, plus $109 million in annual avoided maintenance costs.

Depending on the discount rate selected and the length of time that these maintenance costs would be sustained, the total value is on the order of $2.5 billion to $3 billion. Provided that these savings are recognized as real and that appropriate incentives are put in place for FAA management, these documented recoverable savings can have a significant impact on the funding of NextGen.

Endnotes

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