

**Before the Subcommittee on Aviation,
Committee on Transportation and Infrastructure
U.S. House of Representatives**

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Federal Aviation Administration

Efforts to Develop and Deploy the Standard Terminal Automation Replacement System

**Statement of
The Honorable Kenneth M. Mead
Inspector General
U.S. Department of Transportation**



Mr. Chairman and Members of the Subcommittee:

We appreciate the opportunity to discuss the Federal Aviation Administration's (FAA) efforts to develop and deploy the Standard Terminal Automation Replacement System (STARS). The terminal environment controls aircraft taxiing, departing from, and arriving at airports and consists of both Air Traffic Control Towers and Terminal Radar Approach Control (TRACON) facilities at or near airports. Towers control aircraft on the ground and within 5 miles of an airport. TRACONs control aircraft from the tower's 5-mile radius to about 50 miles out.

STARS will provide air traffic controllers in the terminal environment with color displays, processors, and computer software at over 170 FAA and 100 Department of Defense facilities. STARS is the platform to which a range of capacity-enhancing technologies, such as new automated controller tools and data link communications, will be added.

Today, I would like to discuss four points about the current status of the STARS program. First, significant slippages in the development of STARS have required multiple interim solutions. Second, software development is progressing but challenges remain. Third, FAA has adopted an aggressive deployment schedule that will likely result in further cost and schedule overruns. Finally, we are making several recommendations concerning FAA's deployment strategy that the agency will need to address by this summer.

- ***Schedule slippages have required interim solutions.*** The STARS program, as initially envisioned in 1996, has undergone significant cost increases and schedule delays. Although the STARS acquisition was originally intended to maximize the use of commercially available equipment, significant human factors concerns were identified late in the acquisition that required extensive software development. FAA originally estimated that approximately 120,000 lines of new software code would need to be developed for STARS. The current estimate is over 400,000 lines of development code - a 230 percent increase.

In October 1999, FAA revised its estimated cost of the STARS program to \$1.4 billion – an additional \$462 million over the initial baseline of \$940 million. This increase includes over \$270 million for changes to address the human factors concerns. In our opinion, it is likely that those costs will continue to increase. To give this program perspective, STARS ranks second in projected program costs only to the Wide Area Augmentation System which is estimated to cost about \$2.9 billion. To date, FAA has expended

approximately \$543 million of the \$1.4 billion estimated cost of the STARS program.

FAA now estimates “full service” STARS will not be deployed nationwide until September 2008, 4 years behind the schedule established at contract award in 1996. It is notable that since June 2000, the Department of Defense (DOD) has been managing air traffic at Eglin Air Force Base with the initial version of STARS. The following table compares the initial cost and schedule baseline in 1996 to current estimates.

STARS Cost and Schedule Comparison

	1996 Baseline	Current Baseline
Total Program Cost	\$940 million	\$1.4 billion
Developed Lines of Code	120,000	415,000
Last Operational Site (FAA)	02/2005	09/2008
Last Operational Site (DOD)	07/2007	03/2011

To more effectively manage the program, in 1999, FAA decided to fragment STARS deployment into multiple configurations. One configuration involved an early display configuration (EDC) of STARS. FAA was successful in achieving EDC initial operations at its first site, El Paso, in December 1999 and at Syracuse in January 2000. However, EDC should not be confused with “full service” STARS, which will include new processors, software, and displays. EDC is primarily a display replacement, which heavily relies on existing Automated Radar Terminal System (ARTS) software. In essence, EDC consists of new controller displays and maintenance workstations which use the existing computer processors and software.

FAA also moved forward with an interim measure, known as Common ARTS. Common ARTS provides much of the same functions that STARS will provide when completed. For example, Common ARTS can process 6,000 aircraft tracks from 10 analog or digital radars. STARS will process 6,000 to 7,000 tracks from 16 digital radars. The Common ARTS standard software package can be used at FAA’s highest volume terminal facilities. In 1998 and 1999, FAA installed the Common ARTS upgrade at 5 high traffic sites and 131 low-to-mid-traffic sites. FAA expects to install Common ARTS at 5 more high traffic facilities while STARS is being developed.

- ***Software development is progressing but challenges remain.*** While FAA has made progress developing STARS software, the software necessary for the nationwide deployment of STARS is not scheduled to be complete until December of this year. FAA recently identified other risks to its software development schedule. A preliminary review of existing software at four sites

identified local programmed functions. FAA must evaluate these local programs to determine if they are being used by controllers and if so, whether they are also in the STARS software. FAA does not yet know how much, if any, additional coding will be required at these sites. However, once additional coding is identified and completed, almost 2 years of testing will be needed, which often leads to further rework and retesting. This could have significant implications to the STARS schedule and cost.

- ***Aggressive deployment schedule will likely result in further cost and schedule overruns.*** While FAA has not completed its evaluation of its deployment strategy, late last year the STARS Deployment Action Team put forth two alternatives. One had the deployment extended another 30 years, while the other added \$450 million to the program baseline in order to keep on schedule. Neither alternative was acceptable to the Administrator. FAA has now set out an aggressive schedule to complete deployment by the end of fiscal year (FY) 2008.

To stay within budget and on schedule, FAA developed a process improvement plan that includes new procedures for training, such as using on-site mobile training labs and community colleges instead of sending critical personnel to training at the FAA academy in Oklahoma City, Oklahoma for extended periods. During the 6-year deployment period, STARS will require over 20,000 weeks of training for air traffic controllers and maintenance technicians at facilities nationwide.

While FAA has set out the general schedule for deployment, no specific dates have yet been established for delivery, installation, and site testing. All of this must be accomplished before a site is considered ready for operations. These dates are critical for FAA to determine the timing and extent of training and the number of additional personnel needed to fill behind staff attending training. Also, at the height of deployment, nearly one site per week will be delivered, a true challenge under the best of circumstances. A key concern is whether the Government and its contractor will realistically be able to deploy 239 systems in 6 years within cost and schedule parameters, especially in light of site specific issues such as physical layout or local software changes.

STARS deployment is also dependent on another program working successfully. Because STARS is a fully digital system, FAA must replace over 100 analog ASR-7 and ASR-8 radars with the digital ASR-11 radar currently under development. The ASR-11 program is experiencing program delays that could impact on STARS deployment. For example, during testing at Stockton, California, FAA identified a number of problems that would need to be addressed to satisfy operational use of the ASR-11 such as a gap in the

coverage of weather display, which resulted in erroneous information being displayed.

Recommendations. We are recommending that FAA revise its deployment strategy no later than June of this year. At a minimum, this should include:

- Establishing milestone dates and quantifying all costs associated with delivery, installation, and testing of STARS for the 164 sites outlined in FAA’s deployment schedule;
- Completing a training strategy for over 11,000 air traffic controllers and maintenance technicians that identifies specific dates and personnel requirements necessary to meet FAA’s deployment schedule; and
- Evaluating if additional Common ARTS with displays will be needed to support FAA’s deployment schedule for STARS and, if so, quantifying all associated costs. This should also include a detailed comparison of the capabilities of each system and their ability to be upgraded with future enhancements.

Background

STARS will replace controller workstations with new color displays, processors, and computer software at over 170 FAA and 100 DOD terminal air traffic control facilities. The terminal environment controls aircraft taxiing, departing from, and arriving at airports and consists of both Air Traffic Control Towers and TRACONs at or near airports. Towers control aircraft on the ground and within 5 miles of an airport. TRACONs control aircraft from the tower's 5-mile radius to about 50 miles out.

STARS was designed to provide the software and hardware platform necessary to support future air traffic control tools, such as a data link, and Free Flight. These are important building blocks for future capacity enhancements.

In the mid 1990's, FAA decided to accelerate the acquisition process of STARS by using existing software and hardware or commercial off-the-shelf (COTS) products, rather than developing a new system. STARS requirements were written in general terms to give competitors the latitude to propose various solutions that would meet FAA's needs. In September 1996, FAA awarded a contract to Raytheon Systems Company for the development and implementation of STARS. The original STARS program was estimated to cost approximately \$940 million. The first planned site for full operational capability was September 1998 for DOD

and December 1998 for FAA. The last planned operations site was July 2007 for DOD and February 2005 for FAA.

Schedule Slippages Have Required Interim Solutions

The original STARS development plan was broken down into two phases. The first phase, known as the Initial System Capability, would provide the facilities with new hardware and software capable of providing the same functions as the old automation system being replaced. The second phase, known as Full System Capability, would add additional functions such as the Converging Runway Display Aid.

FAA originally estimated that approximately 120,000 lines of new software code would need to be developed. Although the STARS acquisition was intended to maximize the use of commercially available products, in October 1997, FAA air traffic controllers and maintenance technicians identified numerous unanticipated human factors requirements that would result in extensive software development. As a result of the human factors software development, the program costs and schedule changed.

In October 1999, FAA approved a new development strategy calling for incremental development and deployment. This new strategy required a contract modification, which included:

- Incremental STARS deployment and development at two FAA sites;
- Deployment of the first STARS full service system at Eglin Air Force Base and other DOD sites;
- Procurement of color displays for New York, Dallas-Fort Worth, Ronald Reagan Washington National, Atlanta, Northern California, and Potomac terminal facilities; and
- Procurement of Common ARTS systems for the Denver, Chicago, Southern California, and Dallas-Fort Worth facilities.

As a result of these changes, FAA modified its cost and schedule dates as shown in the following table.

Cost and Schedule Comparison for STARS

	1996 Baseline	Current Baseline
Total Program Cost	\$940 million	\$1.4 billion
Developed Lines of Code	120,000	415,000
Last Operational Site (FAA)	02/2005	09/2008
Last Operational Site (DOD)	07/2007	03/2011

FAA fragmented the STARS development plan into multiple configurations to better manage the software development. FAA’s decision to split the development of STARS using the “*build a little, test a little*” approach resulted in seven configurations, each requiring its own set of milestones for development and testing. Today, the current estimate for developed software is over 400,000 lines of code development with various software configurations. In addition, FAA now

estimates that the last full service STARS will be deployed to FAA facilities by September 2008 – 4 years behind schedule.

Early Display Configuration (EDC) of STARS. One configuration involved the early display configuration of STARS. FAA was successful in achieving EDC initial operations at its first site, El Paso, in December 1999, and at Syracuse in January 2000. However, EDC should not be confused with “full service” STARS, which will include new processors, software, and displays. EDC is primarily a display replacement, which heavily relies on existing ARTS software. In essence, EDC consists of new controller displays and maintenance workstations using the existing computer processors and software.

Common ARTS. FAA also moved forward with an interim measure, known as Common ARTS. Common ARTS provides many of the same functions that STARS will provide when completed. For example, Common Arts can process 6,000 aircraft tracks from 10 analog or digital radars. STARS will process 6,000 to 7,000 tracks from 16 digital radars. The Common ARTS standard software package is being used at FAA’s highest volume terminal facilities. In 1998 and 1999, FAA installed the Common ARTS software upgrade to 5 high traffic sites and 131 low-to-mid-traffic sites. FAA expects to install Common ARTS at 5 more high traffic facilities while STARS is being developed.

Software Development Is Progressing But Challenges Remain.

FAA believes it has turned the corner on software development. We agree that roughly 85 percent of the more than 400,000 lines of code is developed. However, FAA has not started coding the additional 15,000 lines of code necessary to complete the full STARS version that will be deployed nationally starting next year. As described below, challenges exist that place development of that software at risk.

Additional software and testing may impact cost and schedule. A preliminary review of existing software at four sites identified locally programmed functions. FAA must evaluate these local programs to determine if they are being used by controllers and if so, whether they are also in the STARS software. FAA does not yet know how much, if any, additional coding will be required at these sites. However, once additional coding is identified and completed, almost 2 years of testing will be needed which often leads to further rework and retesting. This could have significant implications for the STARS schedule and cost.

Testing developed software. The STARS development plan is like a pyramid. Each configuration is built on top of the previous level. Although the various STARS configurations are designed as separate building blocks, each block is interwoven with the previous level. This means that FAA will test to ensure that configurations are operationally acceptable before testing at the next level. FAA

cannot place the full system in service until it passes a comprehensive test at an actual operational facility. FAA expects these tests may take up to 2 years to complete after development of the software. Due to the interdependent nature of the multiple STARS configurations, any delay in successfully completing the test of one earlier configuration may impact the cost and schedule of the next configuration. FAA is currently scheduled to complete testing in October 2002.

Aggressive Deployment Schedule Will Likely Result in Further Cost and Schedule Overruns

Recognizing that scheduled STARS deployment was less than 1 year away, last summer FAA appointed a STARS Deployment Action Team to identify risks and propose solutions for meeting FAA's aggressive schedule. The Action Team identified several issues that FAA would need to address including:

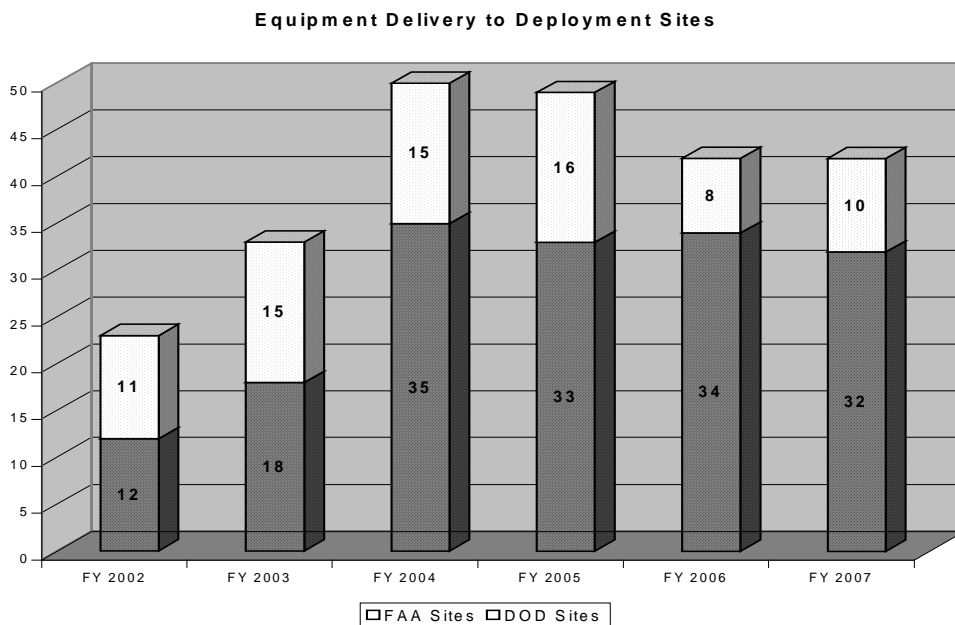
- limited capacity to train maintenance technicians;
- availability of certified maintenance technicians to fill-in behind technicians in training;
- ability to support multiple deployments while continuing to support existing systems; and
- size limitations in small TRACONs that would require workarounds and additional resources.

The Action Team put forth two alternatives. One extended the deployment another 30 years, while the other added \$450 million to the program baseline for

additional resources in order to keep on schedule. Neither alternative was acceptable to the Administrator.

To stay within budget and on schedule, FAA developed a process improvement plan that includes new procedures for training, such as using on-site mobile training labs and community colleges instead of sending critical personnel to training at the FAA academy in Oklahoma City, Oklahoma for extended periods. While FAA has not yet defined the exact parameters of the STARS training effort, STARS deployment will demand extensive time from controllers, technicians, and contractors to transition to this new system. FAA currently estimates a 7-week course for approximately 1,500 technicians and a 1-week course for more than 10,000 air traffic controllers. During the 6-year deployment period, STARS will require over 20,000 weeks of training for air traffic controllers and maintenance technicians at facilities nationwide.

Specific dates for delivery, installation, and site testing have not been established. During the peak activity in 2004, equipment will be delivered to 50 sites per year, or almost 1 new site per week. Once delivered, installing, training, and testing must be done. This is a formidable challenge under the best of circumstances. The following chart shows the FAA and DOD delivery schedule for STARS.



While FAA has set out the general schedule for deployment, no specific dates have yet been established for delivery, installation, and site testing. All of this must be accomplished before a site is considered ready for operations. These dates are critical for FAA to determine the timing and extent of training and additional personnel needs to perform installation and fill in behind staff in training. FAA must also have these delivery dates to address the site-specific needs of the facility, including physical plant (power, space, and environment). It

is important that FAA evaluate each of these issues because many of the deployment and production costs were not updated when FAA modified the contract with Raytheon in 2000. Contract costs for items such as site surveys and STARS training were based on the original deployment dates established back in 1996.

STARS interface risks could cause delays in deployment. STARS deployment is also dependent on another program working successfully. Because STARS is a fully digital system, FAA must replace over 100 analog ASR-7 and ASR-8 radars with the digital ASR-11 radar currently under development. The ASR-11 program is experiencing delays that could impact on STARS deployment. For example, during testing at Stockton, California, FAA identified a number of problems that would need to be addressed to satisfy operational use of the ASR-11 such as a gap in the coverage of weather display, which resulted in erroneous information being displayed.

An additional technical problem has emerged that increases the risk that STARS will suffer cost increases or deployment delays. A radar alignment problem, discovered in testing at Eglin Air Force Base, caused inaccurate radar displays when aircraft moved between areas covered by different radars in use by STARS. Because radars use magnetic north for alignment, and magnetic north drifts, the alignment between the radars varies over time and creates a problem for STARS.

STARS needs to know which radar or combination of radars will accurately depict the most correct position of the aircraft. FAA is working on the problem but does not know its full impact on STARS.

Recommendations

We are recommending that FAA revise its deployment strategy no later than June of this year. At a minimum, FAA should include:

- Establishing milestone dates and quantifying all costs associated with delivery, installation, and testing of STARS for the 164 sites outlined in FAA's deployment schedule;
- Completing a training strategy for over 11,000 air traffic controllers and maintenance technicians that identifies specific dates and personnel requirements necessary to meet FAA's deployment schedule; and
- Evaluating if additional Common ARTS with displays will be needed to support FAA's deployment schedule for STARS and, if so, quantifying all associated costs. This should also include a detailed comparison of the capabilities of each system and their ability to be upgraded with future enhancements.

Mr. Chairman, this concludes my statement. I would be pleased to answer any questions.