

The key objectives of the SMA program are:



SURFACE MOVEMENT ADVISOR (SMA)

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I. Introduction

The National Airspace System (NAS) experiences deficiencies that are evident to users and air traffic management alike. While today's air traffic control system provides a very high level of safety, it cannot handle the current volume of traffic without delays. Therefore, it will certainly not be able to handle the 10 percent traffic increase projected for large U.S. hub airports by the year 2000. Furthermore, the existing system was not designed to accommodate upcoming improvements in efficiency created by the development of inertial and satellite navigation systems or the free flight concept. Consequently, there have been and will continue to be major delays, particularly on the ground, during periods of high volume traffic.

The major surface management goals shared by airport users are to get arrivals promptly off the runway and to their gates, and get departures airborne with minimum or no delay. Congested taxiways create havoc on the ground and cause problems for landing aircraft trying to turn off the runway. This, in turn, can result in go-arounds and subsequent delays for other "inbounds." Even when off the runway and on the way to parking, arrivals often find that access to their gates is blocked by other taxiing aircraft. Departures also get caught up in "grid lock" and consume valuable time waiting to taxi or in lengthy take-off queues.

The Federal Aviation Administration (FAA), in collaboration with National Aeronautics and Space Administration (NASA) and Mitre Corporation's Center for Advanced Aviation System Development (CAASD), is researching and developing new Air Traffic Management (ATM) functionalities that build the foundation of collaborative decision making and decision support tools. These will allow air traffic controllers to work cooperatively with airlines and airport managers to reduce ground delays caused by airfield congestion. The goal of the FAA's Office of Air Traffic Systems Development ATM Integrated Product Team (IPT) is to develop automation systems and automated air traffic management functions that improve system capacity, safety and performance, reduce aircraft delays, and maximize the flexibility and efficiency of gate-to-gate operations. The Surface Movement Advisor (SMA) tool, a product of the ATM IPT's Surface Automation Research & Development (R&D) Product Team, is an essential part of that effort.

SMA is a 100% user-defined system that facilitates an unprecedented sharing of dynamic information among airlines, airport operators, and air traffic controllers. It introduces a decentralized airport "Situational

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Awareness" tool that presents to the system users the effects that previous, current, and future arriving and departing aircraft had, are having, and will have on parking ramps, gates, taxiways, and runways. For example, SMA provides help to air traffic controllers, supervisors, and coordinators in selecting optimum airport configurations and the specifics on each aircraft before it "pushes back" from the gate for departure. SMA also gives airlines and airport officials touchdown, takeoff, and taxi time predictions for each aircraft as well as access to air traffic control plans for runway utilization, instrument departure routings and airport/runway configurations. This real-time data has potentially huge tactical and strategic monetary value. In addition, several aspects of SMA support the establishment of the "Free Flight" concept as outlined by the Radio Technical Commission for Aeronautics (RTCA) Committee on Free Flight.

SMA's objective, from the outset, focused on reducing only taxi-out times by one minute per operation. Preliminary results from Hartsfield-Atlanta International Airport, where the SMA prototype is undergoing testing, have indicated a reduction in taxi times of over two minutes per operation — well over 2000 minutes per day.

II. SMA Prototype Development

The design and development of an SMA prototype that could assist in the reduction of taxi times posed numerous risks. The unprecedented sharing of the same information in the same format, and in real time by all airport users, had never been tried .

Risk mitigation started in the concept exploration phase. In order to minimize the impact of evolving requirements and their containment, the SMA program determined that users would dictate the functional performance of the SMA system and participate as members of the program management team. To that effect, the System Design Team (SDT) process was established.

Four separate SDTs, representing SMA's target users, were established. Air traffic controllers (National Air Traffic Controllers Association (NATCA)), air traffic supervisors (Supervisor's Committee (SUPCOM)), airlines (Air Transport Association (ATA)), and the airport operators/managers were all represented by their own team. These SDTs defined their problems and worked potential solutions with program developers, software engineers, physical scientists, and experts in the field of human factors. Each SDT had a specific charter to define, baseline, finalize, and freeze their operational requirements for the SMA prototype. To that effect, each SDT met separately and agreed on its own particular set of requirements and priorities.

The SDTs contributed to the development and evolution of the SMA Operational Concept, Operational Requirements Document (ORD) and Mission Need Statement (MNS). SDTs also participated in both the Preliminary Design and Final Design Reviews, and in the acceptance, testing, and field demonstration/validation activities.

The risk associated with implementation of large numbers of complex functional requirements was mitigated by implementing sets of requirements that were more manageable, but still satisfied users' needs. A "Super" SDT (select representatives from the four separate user teams) was convened to resolve differences that had arisen from the separate SDTs, and to "freeze" the functional requirements, after reaching agreement, for the first version of SMA.

The Hartsfield Atlanta International Airport was chosen as an ideal site for implementation of the SMA prototype. Hartsfield hosts a large number of operations (domestic and international), significant taxi delays, and a physical configuration that supports the thorough testing and evaluation of the SMA tool.

The SMA proof-of-concept effort began in late 1994 (see attached schedule) with surveys that provided valuable insight on the availability of NAS resources. This data collection also revealed that various

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fragmented databases are currently used by the airline, airport, and air traffic control communities to manage day-to-day airfield operations. The functional inventory information provided an accounting of all airfield and air traffic resources, including data availability.

Development of the SMA software and architecture is the result of collaboration between the FAA and NASA. The system consists of an integrated set of newly developed software (75K lines of code (loc)) and commercially available software (CAS) packages (more than 300K loc) residing in commercial off the shelf (COTS) hardware (Silicon Graphic computers, CISCO routers, etc.) that interfaces to NAS data (Radar tracks, flight information), airline data (Flight Information Display System (FIDS), electronic Official Airlines Guide (OAG)), and airport/ramp tower "pushed-back" and/or "blocked-in" data.

The SMA functionalities at Hartsfield are distributed to the air traffic tower cab via a local area network (LAN) and to the airlines, ramp towers, airport management areas, Air Route Traffic Control Center (ARTCC), Terminal Radar Approach Control (TRACON), and Delta Air Lines' strategic Operational Control Center (OCC) via the existing airport LAN and modems. At present there are 19 active SMA displays throughout facilities on the airfield and immediate adjacent areas. The impact of SMA on each segment of the airport's operation is currently being evaluated.

SMA functionalities are presented to the system users through a set of Graphical User Interfaces (GUIs) designed in accordance with user requirements, then validated by the users themselves. All users see the same information at the same time in the same place on very similar screens — they are all literally "playing from the same sheet of music." The use of a touch-screen provides the best option for a tower air traffic controller since it allows maximum freedom of movement within the cab and reduces human/machine-dependent interactions. All other system users interface the SMA through a traditional PC keyboard and mouse/trackball arrangement. GUI features are presented in an X-Windows environment where icon functions are toggled to activate, deactivate, or "quick-look" a particular function.

SMA functionalities and the GUIs are divided into three major groupings:

- 1) ATC tower cab screens,
- 2) airport/ramp management screens and
- 3) airline screens.

The screen formats and the types of information displayed meet the users' requirements as defined by the SDTs.

ATC tower screens include, but are not limited to:

- Average "push-to-off" times
- Departure queue information
- Aircraft currently pushing back from gates
- TRACON arrival lists
- "Quick look" for the "recommended" departure "splits" (runway balancing)

Ramp tower and airline screens include, but are not limited to:

- Arrival lists
- Current airport configuration (active runways, departure splits)
- Total number aircraft scheduled to depart (within 15 minute increments, up to 1 hour in the future)
- Departure rates for various runways
- Statistical information (airfield activity, predicted load, etc.)

III. Atlanta's SMA Operational

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Assessment

The 90 day operational evaluation of the prototype SMA began on February 19, 1997 and ended May 19, 1997. The full-time (24 hours a day, seven days a week) assessment was conducted to determine the validity of the system and its functionalities, to assess the quantity and value of benefits obtained from the system, and to begin determining the feasibility of national deployment.

The assessment evaluated several major aspects of the SMA system's design. These included accuracy of spatial information on arriving and departing aircraft, and the validity of algorithms and accuracy of the data used to recommend "optimal" airport configurations to air traffic control.

Participants in the assessment included the airline and airport operator communities (including the City of Atlanta Department of Aviation and Delta Air Lines' newly commissioned OCC) and all local FAA facilities (the Atlanta tower cab, TRACON, and ARTCC).

The original "aim high" goal for SMA was to reduce taxi-out delays by an average of 1 minute per operation. Preliminary, empirical data indicates that more than twice that is attributable to the presence of SMA in Atlanta. It is interesting to note that some of the benefits being realized from SMA were never anticipated. However, those unexpected "bonus values" illustrate the significance of sharing data among airport users. For example, when SMA was turned off (for "baselining" purposes) during its operational assessment, U.S. Customs and U.S. Immigration operations were disrupted. Prior to SMA, Customs and Immigration officials had to wait for information about an airplane until it had actually arrived at the gate. With SMA, local and federal agencies may plan their activities based on direct access to real-time, dynamic airfield information and on SMA's time-of-arrival and time-at-the-gate predictions.

IV. National Implementation

Two processes will have to take place simultaneously: 1) costing of the installation and 2) development of the required documentation. Both of these processes will be dependent upon results from the operational assessment of the prototype. The assessment will provide the overall impact SMA had on Atlanta airport operations and will provide SMA functional demonstration and validation. This information may then be used to measure the advantages of installing SMA at other major U. S. airports.

The costing will be a multifaceted process and will require several steps. First, the SMA functionalities will be apportioned among three user-specific parcels: air traffic controllers/ supervisors, airlines, and ramp/airport managers. Each of the parcels will contain functions the associated users deemed necessary for their specific areas of responsibility. The users will then prioritize the functions, within their parcels.

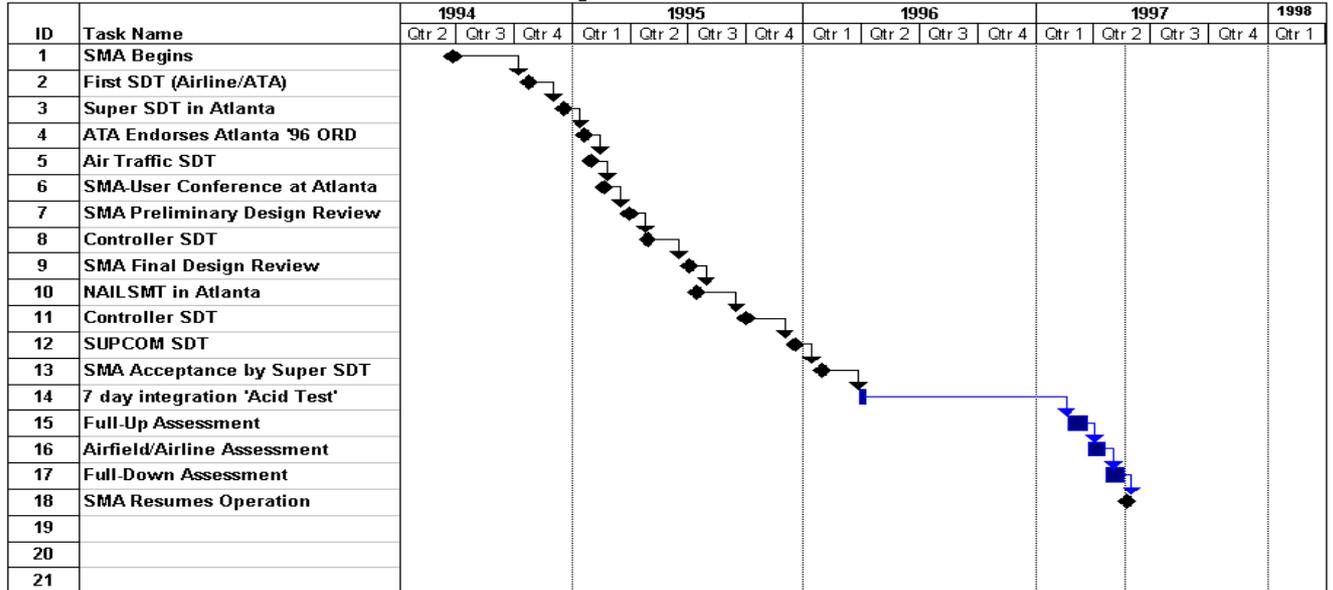
Each of the 29 different SMA functions have one or more dependencies on airport or airline equipment or data (Automated Radar Terminal System (ARTS), FIDS, etc.), or on human input (air traffic controllers designating the airport configuration or ramp managers providing "push-back" data). Therefore each function can be mapped to a specific set of dependencies. From site surveys to be completed by the SMA team, a list of user-desired functionalities and enabling data at the thirteen SMA candidate sites will be developed. From the field site surveys and the operational assessment in Atlanta, a cost and direct monetary benefit will be determined for each airport, which will in turn provide the basis for an accurate cost benefit analysis. This will enable FAA senior management to determine the most effective SMA acquisition and implementation strategy.

Function/dependency mapping, system costing, and development of system acquisition documentation must all take place simultaneously to efficiently implement SMA. Once the operational assessment is completed and SMA functionalities have been parceled and validated, a formal, "generic" SMA functional requirement

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can be established. From this functional requirement, the System Level Specification (SLS) can be developed. Using prototype documentation, generic functional requirements, and the SLS, a template defining the elements for the Statement of Work (SOW) and Interface Requirements Documents (IRDs) can be developed. The SOW/IRD templates may in turn then be tailored for each of the candidate SMA sites.

SMA Major Milestones Chart



Legend ◆ Milestone ■ Task

Acronyms			
SDT	System Design Team	ATC	Air Traffic Control
ATA	Air Transport Association	SUPCOM	Supervisor Committee
ORD	Operation Requirements Document		
NAILSMT	NAS Integrated Logistics Support Management Team		

Note: Years are calendar.