Airport Surface Surveillance Capability (ASSC) Program

Site Engineering Report For San Francisco International Airport (SFO)

San Francisco, CA

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1.0 INTRODUCTION

The Airport Surface Surveillance Capability (ASSC) system is an automatic detecting, high-resolution ground surveillance system that will track and identify aircraft and surface vehicle movement over all of the airport's taxiways and runways, known collectively as the "Active Movement Area". This multi-sensor system is designed to increase situational awareness and to alert air traffic controllers of impending movement area incursions in time to prevent such occurrences.

1.1 Scope

This document constitutes the ASSC Contract Data Requirements List (CDRL) Item DE02 - Site Engineering Report (SER) describing site preparation requirements to be performed by the FAA in readiness for installation of an Airport Surface Surveillance Capability (ASSC) system at San Francisco International Airport (SFO), in San Francisco, CA. It describes construction site preparation tasks that will facilitate the installation of eighteen Multilateration Remote Units (RU) and two Reference Transmitters (RefTran) positioned strategically around the airport, providing coverage of the movement area. This SER also describes site preparation requirements for installation of a suite of ASSC system equipment cabinets along with interface components and Multilateration Remote Units that will comprise the ASSC system. The ASSC System Interface components for the ASR-9 will be installed at the Northern California Tracon (NCT). The equipment cabinets will be installed within the Airport Traffic Control Tower (ATCT). Tower Display Units (TDU) will be installed in the ATCT Cab.

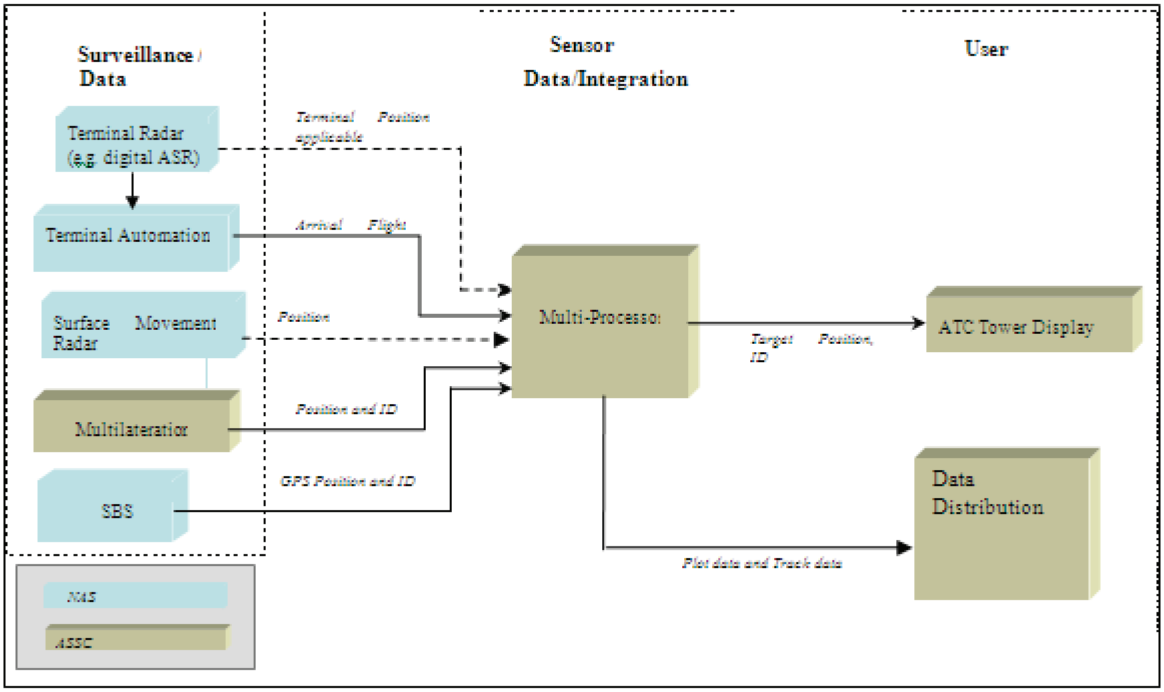
Site preparation by the FAA for ASSC system installation includes modifications to current SFO infrastructure to accommodate the system's spatial requirements as well as system power, grounding, surge protection, communications, HVAC, (heating ventilation and air conditioning) and maintenance accessibility requirements.

The plans/requirements in this document are based on the findings and agreements formed during the Site Engineering Survey (SES), conducted March 6-8, 2012.

1.2 System Description

The core ASSC system consists of a multilateration subsystem, an SBS interface, a data distribution subsystem, a multiprocessor, and multiple displays. The ASSC Multiprocessor subsystem combines independent surveillance data from SBS with data from the multilateration subsystem to provide a single target with Flight ID for display to Air Traffic Control. The Multiprocessor subsystem integrates data from Automated Radar Terminal System (ARTS), MEARTS, and the Standard Terminal Automation Replacement System (STARS) as well as the (optional) terminal secondary surveillance and (optional) surface movement radars. Figure 1 below shows a simplified block diagram of the core ASSC functions. The dashed line between radars and the multiprocessor indicates this connection is optional at sites where the multilateration subsystem is installed.

Figure 1 ASSC Functional Block Diagram



If ASSC is installed at a site, supported by a digital Airport Surveillance Radar and SBS, but the multilateration subsystem is not installed, the Multiprocessor subsystem will use inputs from the ASR and SBS.

The ASSC system can operate in two modes: operational and maintenance. When in operational mode, the system is not accessible for adjustments by personnel other than controllers without control of system being relinquished by those controllers. Operational mode provides those capabilities that allow efficient and safe control of air traffic. Maintenance mode provides tools and information not present in operational mode to allow technicians to diagnose problems and optimize the system.

The definitions and requirements sections below outline the functionality of the ASSC system and the performance necessary to meet the requirements.

1.3 Multilateration Subsystem

The Multilateration subsystem receives, multilaterates, and processes target data on 1090 MHz and 978 (UAT) MHz frequencies. The 1090 MHz processing is done in accordance with DO-181D and DO-260B as a minimum requirement. The 978 UAT processing is done in accordance with DO-282B.

The Multilateration subsystem provides accurate position and identification information on transponder equipped aircraft and surface vehicles by "multilaterating" on signals transmitted by the transponders. Multilateration is the process of determining a transponder's location by solving for the mathematical intersection of multiple hyperbolas (or hyperboloids) based on the time difference between the transponder's signal receipt at multiple sensors. The system will use the altitude provided by the aircraft's avionics.

The Mode S and UAT transponders squit. Older Mode A/C Air Traffic Control Radar Beacon System (ATCRBS) transponders do not squit. The multilateration subsystem interrogates ATCRBS targets so that the system can multilaterate on the reply. Per minimum operating standards DO-185B, the whisper shout technique developed for the Traffic Alert and Collision Avoidance System (TCAS) is used to interrogate these transponders so as to avoid synchronous garble. The subsystem also interrogates Mode S transponders to obtain their Mode A code.

The Multilateration subsystem supports a minimum of 32 Multilateration Subsystem Sensors which are located both on the airport surface and the periphery of the airport to provide surveillance. When Precision Runway Monitoring is provided, Multilateration Subsystem Sensors are located around the approach corridors. Some of the Multilateration Subsystem Sensors have transmit capabilities and are used for whisper shout interrogations and for Mode S interrogations to acquire the Mode A code assigned to aircraft and the Mode C height of the Mode S equipped aircraft.

The Multilateration subsystem consists of the following components:

- Multilateration Subsystem Sensors (MSS)
  The Multilateration subsystem uses two types of sensors – Receiver/Transmitter sensors and Receiver Only sensors. Both types receive, timestamp, and decode both Mode S and ATCRBS transponder reply signals, as well as UAT squits. Reply data is processed by the MSS software and communicated back to the Multilateration Subsystem Processor (MSP) via the communications infrastructure. The MSS transmitter sensors can also request information from transponders using scheduled interrogations commanded by the MSP. Both MSS types feature ruggedized weatherproof enclosures designed for harsh airport environments. The quantity and placement of each type of MSS is determined based on airport configuration, performance requirements, and reliability needs.

- Multilateration Subsystem Processor (MSP)
  The fully redundant, auto-switching MSP is the central computer that collects transponder reply information from all MSSs. The software computes target positions and tracks multilateration targets. The MSP also monitors the status and health of all multilateration components and schedules transponder interrogations as required.

- GPS Independent Time Reference
  Redundant GPS independent time reference units provide high-accuracy system synchronization and stimulation of system-wide built in test (BIT) functionality. Each unit is packaged in a rugged, weatherproof enclosure, and features redundant transmitters to ensure ultra-high reliability for this critical subsystem. The system includes a means for identifying and isolating synchronization problems. The Multilateration Subsystem Sensor clocks drift apart. Using the reference unit

squits, ASSC periodically estimates the difference between the predicted and measured time difference arrivals between Multilateration Subsystem Sensors. If test targets are not included in ASSC and the time reference transmits a UAT squit, Mode S squit, or ATCRBS reply, then the reference units are used as test targets.

- Communications Infrastructure
  The Multilateration system is designed with a non-redundant, but overlapping wireless network communication.

1.4 Surveillance Broadcast Services (SBS) / ADS-B Subsystem

SBS extracts ADS-B data from 1090 MHz Extended Squitter (1090 ES) and the 978 MHz Universal Access Transceiver (978 UAT) transmissions. The 1090 ES link is primarily intended for air transport aircraft and the 978 UAT link is intended for general aviation aircraft and ground vehicles. SBS provides ADS-B reports to ASSC in CAT-033 format via the SBS Service Delivery Point (SDP). ASSC processes CAT33 messages for 1090 ES and UAT targets. ASSC checks SBS provided data against other multilateration and ASR-9 data. ASSC fuses valid SBS inputs with ASSC system tracks.

ASSC accepts ADS-B service status reports in CAT-023 format from the SBS SDP to determine the operational health of the service. Within ASSC, the SBS / ADS-B Subsystem is the subsystem responsible for processing SBS messages.

1.5 Multi-Sensor Data Processor (MSDP) Subsystem

ASSC fuses sensor inputs. Fusion occurs in the Multi-Sensor Data Processor (MSDP) Subsystem. The MSDP subsystem processes all surveillance sources, performs tracking and identification functions, handles surveillance and tracking control, and provides output to the Display subsystem. The MSDP tracks air and surface targets of interest on or approaching the heliports, taxiways, and runways. Multilateration subsystem data in the form of plot and track data is processed by the MSDP subsystem to track and identify targets within the ASSC coverage volume. GPS-based position measurements from ADS-B equipped targets are also provided to the MSDP. This data may be supplemented by plot and/or track data from other radar or beacon sources of the NAS ATC system such as an ASR. The MSDP associates flight plan data, from ARTS IIIA, ARTS IIIE, microEARTS or STARS to targets to enable display of such information. It also supports controller and automated tagging of targets as well as conflict alerting in the form of Safety Logic. The interfaces to the other subsystems are specified in the pertinent NAS ICDs.

The ASSC filters data unsuitable for multisensor fusion based on a data base of sensor coverage and false detection characteristics, and provides filtered, normalized and aligned data for combination. The fusion algorithm is designed to provide "seamless coverage," a single picture combining all source data and maintaining track and ID continuity. Fusion processing provides fused track data that is as good as or better than the best individual sensor track of a vehicle in terms of accuracy and timeliness. It also ensures that a single fusion track is maintained for each vehicle as long as it is detected by any supporting sensor in the coverage volume. The fusion process compensates for intersensor bias errors such as static range/azimuth bias in the ASR and applies an adaptable time adjustment to all reports from each sensor to account for any average communication delays within the system. In addition, the fusion process continuously estimates and corrects for the mean bias between the multilateration and ADS-B measurements for aircraft that are seen by the multilateration subsystem and SBS. The MSDP, in conjunction with sensor subsystems, prevents the display of false tracks to the controller. It provides track history and supporting sensor data to allow user evaluation of fusion decisions.

The MSDP implements the Safety Logic functionality. Safety Logic provides warning to controllers (via the Display subsystem) of potential collision situations. The superior target data quality made possible by the fusion processor provides the best possible information to drive Safety Logic. Safety Logic propagates targets into the future, assigns the targets to surfaces (such as a runway or taxiway), and establishes a movement state and direction state for each target. Predicted runways are calculated for each arriving aircraft. Safety Logic checks the separation between current and future target positions and detects any targets that violate current or projected separation thresholds. Alerts are generated and sent to the Display subsystem for any violations that are detected.

Various alert situations are detected by Safety Logic, based upon what the involved aircraft are doing in the air and/or on the ground (e.g. an aircraft is arriving to a runway occupied by a taxiing aircraft, or an aircraft is departing on a closed runway). An alert causes the Display subsystem to display red octagons around each aircraft or vehicle involved in an alert, and the icons for the involved aircraft or vehicles flash on and off. A text box displays the call sign or Mode S identifiers of the aircraft or vehicles, along with a description of the violation. In addition, a configurable audible message is rendered which can specify important information such as the runway or taxiway, the call signs or Mode S IDs of aircraft or vehicles, a description of the violation, and instructions to the controller. The combination of this audible and visual information provides all of the information necessary for the controller to take immediate action.

The MSDP product, fusion and alerts, are provided to the Display subsystem to assist controllers in avoidance of ground traffic incidents and clarifying relative positions of aircraft and other vehicles under all viewing conditions. The data assists the controller in the safe and efficient routing of ground traffic throughout the airport environment.

The MSDP is the central repository of Maintenance Terminal subsystem status information and is responsible for all data logging for the ASSC system.

1.6 Display Subsystem

The ASSC Display subsystem is the portion of the ASSC system responsible for taking any data from another subsystem and processing that data into a representation of the coverage volume for presentation to an operator (controller or maintenance) on a color display channel. The Display subsystem presents viewable maps, track and data tag information to the controller as well as system status alerts and safety alerts (audible and visual). Additionally, the Display subsystem software is capable of presenting all sensor information (*e.g.*, track position, MLAT plot reports, and SBS reports.), diagnostic information (BIT/FIT), maintenance terminal information, and viewable and nonviewable maps to maintenance personnel. In short, the Display subsystem is the mechanism through which humans interact with the ASSC system.

The Display subsystem consists of up to 15 display processors, each independently displaying surveillance information appropriate for the display channel in question (consistent with both the mode of operation, user permissions, and the user-defined display configuration). The Display subsystem is responsible for managing the information displayed to an operator. For example, if the controller using channel A has data tags turned off in a particular area of the airport and no target trails, but the controller using channel B has all data tags on and target trails set to 3, then the Display subsystem must insure that these user preferences are displayed properly on channels A and B.

1.7 Maintenance Terminal Subsystem

The Maintenance Terminal (MT) subsystem includes the necessary processors and display monitors to perform the Control, Monitoring, Data Recording and Playback capabilities of the ASSC system. A processor/display configuration provides the functional equivalent to presentation in the tower cab. The MT subsystem interfaces to data recording units to provide a redundant recording capability. The MT subsystem also includes a Maintenance Display Terminal (MDT). The MDT provides all of the necessary software tools and programs to allow the user to optimize, control, and monitor the entire ASSC system. The MT subsystem performs the "Operational Data Recording," where all display data such as ASSC system adaptation, tracks, user inputs, Safety Logic data and system status are continuously recorded. The MT subsystem also provides the ability to extract a subset of the recorded system data and adaptation/configuration that spans any user-defined period of time.

The MT subsystem also provides an "Engineering Recording" capability that supports the installation team in evaluating system performance during system setup and optimization. Data can be collected at various stages of processing for use in system optimization. Maintenance personnel can also use these recordings for periodic system evaluation

MT security login features provide controlled access to the system. The system has a login capability that determines the level of access that any user can have. Only one display system can have access to the system control at any one time.

1.8 Other Features

ASSC supports a Precision Runway Monitor (PRM) option that provides surveillance data to the STARS system. ASSC meets STARS requirements while operating as a fully functional ASSC system. Provisions are made to allow the operation of ASSC with PRM functionality disabled. ASSC provides STARS an indication of any system failure that would disrupt PRM operations.

1.9 Data Distribution

The primary function of the Data Distribution Subsystem (DDS) is to acquire fused track data from the ASSC system and distribute this data to various external users. The DDS is able to handle multiple user configurations in order to provide only the desired or allowable track data to a given end user. User control of the DDS is provided via command and control messages from the MDT.

The Data Distribution subsystem consists of fully redundant Data Distribution Processors (DDP) and the appropriate Switches/Routers. The DDP processes all track and plot data received from the ASSC Multi-Processor and MPS. The DDP software filters, formats, and forwards the data based on end user configuration. This processing is performed on an individual basis for up to thirty end users.

1.10 Background

The week of March 5th, 2012, Representatives of the FAA, Saab Sensis, and C&S Companies conducted a site survey of SFO for all areas and surrounding areas of the airport to house ASSC system equipment. The results of this survey are depicted in this SER.

Document titled, *ASSC System Siting Analysis for San Francisco International Airport (SFO), Doc. No.* 840-034107 will be delivered under separate cover to detail Multilateration coverage.

1.11 System Component Location Summary

The proposed installation locations for all the ASSC components are identified in **Table 1: System Component Location Summary**, and shown on the airport layout diagram in **Figure 2 – ASSC Equipment Installation Locations**.

Table 1: System Component Location Summary

Component	Qty	Installation Location	Designation (For Figures)
Equipment in ATCT			
Tower Display Units (includes keyboard, trackball, speakers, PCU, KVM, and speaker control assembly)	2	ATCT Cab	00
Display Processor Cabinet	1	ATCT 7th Floor North Equipment Room	00
Processor Cabinet	1	ATCT 7th Floor North Equipment Room	00
Communications Cabinet	1	ATCT 7th Floor North Equipment Room	00
RMS Cabinet	1	ATCT 7th Floor North Equipment Room	00
Data Distribution Cabinet	1	ATCT 7th Floor North Equipment Room	00
Tower Display Patch Panel	1	ATCT 7th Floor North Equipment Room	00
System Interface Unit (SIU)	1		00
Dual GPS Antenna	2	ATCT 7th Floor Roof above 7th Floor South Equipment Room	00
GPS Surge Protection Box	1	ATCT 7th Floor Roof above 7th Floor South Equipment Room	00
Primary Movement Area Coverage Multilateration System			
RU Receive Only (RO) or Receive/Transmit (RT)	18	ATCT	01
		Boarding Area "G" outside Gate 102	02
		SFO Employee Parking Garage	03
		Singapore Air Hanger/710 McDonnell Road	04
		RTR West	05
		Coast Guard Hanger	06
		United Hanger	07
		Rotating Light Beacon	08
		ASDE-3 Greenfield	09
		MALSR – F Runway 19L	10
		RTR – Main LLWAS #7	11
		Greenfield Runway 28R	12
		LLWAS #4 Showboat Park	13
		Greenfield Runway 28L	14
		PRM Tower	15
		LLWAS #8 Mitten Road	16
		LLWAS #5 Milbrea FD	17
		Boarding Area "A" near Gate 12	18
RU *Reference Transmitters (RefTran)*	2	ATCT	X1
		PRM Tower	X2

Document titled, *System Installation Constraints Document for Airport Surface Surveillance Capability (ASSC) Program, Doc. No.* 830-028938, CDRL: DE01 has been delivered under separate cover to detail system hardware component details.

Figure 2: ASSC Equipment Installation Locations