AN OVERVIEW OF THE FEDERAL GOVERNMENT'S AUTOMATED SURFACE OBSERVING SYSTEM SUSTAINMENT ACTIVITY

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1. INTRODUCTION

Beginning in the early 1990s, the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) deployed the Automated Surface Observing System (ASOS) with the Department of Transportation's Federal Aviation Administration (FAA) and Department of Defense (DOD). ASOS was designed to provide surface observations for aviation operations, weather forecasts and warnings, and climate services.

ASOS is now installed at about 1,000 locations. The ASOS program is in the operations and maintenance phase and it has a product improvement program that focuses on sensor improvements.

A number of factors have changed since ASOS was developed and in order to sustain it into the year 2020, the participating Federal agencies agreed to start planning a technology refresh of the ASOS IT infrastructure.

1.1. Overview of Existing Capability

ASOS is a modular system, designed to automatically collect, process, and transmit surface weather observations. Access to this data is available to a variety of users at local and remote locations on a 24-hour basis. The system includes a Data Collection Package (DCP) to collect and forward the sensor data to an Acquisition Control Unit (ACU). Figure 1 describes the ASOS functional components. The ASOS functions are: direct data ingest, local user input, remote user input, processing and monitoring, data pre-processing, data processing and algorithm, monitoring and diagnostic, observation generation and display, storage, external interfacing, primary communications and distribution, data output, and remote user output. The DCP and ACU have a number of serial interfaces.

The DCP supports the following interfaces:

- Meteorological Sensors. Most sensors (pressure sensors and other ACU-based local sensors are the exceptions) are interfaced directly to the DCP. The DCP processes sensor data and sends the data to the ACU.
- Acquisition Control Unit. The DCP transfers sensor data to the ACU and receives/responds to ACU commands.

The ACU processes the weather data, generates reports, and establishes the communications required to transfer data to external devices. The ACU has interfaces to local sensors, graphical user interfaces, telecommunications, and DCP(s).

- At most ASOS sites the pressure sensors are interfaced directly to the ACU. In the case of a Stand-alone ASOS, all sensors are local sensors. Runway Visual Range (RVR) is considered a local sensor.
- The graphical user interfaces include the operator interface device, video display unit, controller video display, and the FAA ASOS Controller Equipment-Information Display System.
- The telecommunications interfaces include the FAA Automated Weather Observing System (AWOS) Data Acquisition System (ADAS), the NWS Advanced Weather Information Processing System (AWIPS), ASOS voice services (dial-in and very-high frequency radio), Navy air traffic control, and the FAA Weather Systems Processor.
- The DCP interface maintains continuous communication with the DCP, receiving sensor data and issuing commands.

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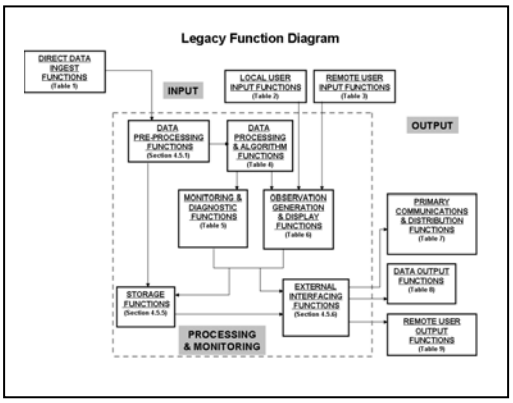

Figure 1. The ASOS functional components.

1.2. Products

The primary function of the ASOS, as documented in joint requirements in the early-1980s, is to provide weather observations in the basic Aviation Routine Weather Report (METAR) and Aviation Selected Special Weather (SPECI) report. ASOS also provides the One Minute Observation (OMO) for use by the FAA.

The basic difference between the OMO and the METAR and SPECI is that the OMO is not transmitted long-line beyond the FAA communications network and FAA systems.

Remote access to ASOS is through dial-in lines used primarily for remote monitoring, maintenance, and data archiving. Existing ASOS configurations do not have the operational capability to distribute data over an Internet Protocol (IP) network.

1.3. ASOS Service Levels

Figure 2 describes the types of meteorological data measured by the ASOS sensors. In addition to automatically measuring and reporting weather conditions the ASOS provides a capability for an observer or other trained person to augment the observation. The policy and procedures for doing this are based on service level standards; i.e., the level of detail in weather observations at sites where there is a commissioned ASOS or AWOS.

- **Service Level D** locations are "stand-alone" sites and have no observer interface. ASOS provides an automated report that includes wind speed and direction, visibility, precipitation and obstructions to vision, cloud height and sky cover, temperature and dewpoint, altimeter. Some sites have freezing rain and lightning sensors. The ASOS Operations and Monitoring Center (AOMC) can access the entire system at all levels for remote maintenance and diagnostics.
- **Service Level C** airports are staffed when the federal government facility is open. During hours that the facility is closed, the airport reverts to stand-alone ASOS or service level D operations. The observer can augment the automated observation with weather phenomena such as thunderstorms, tornadoes, hail, virga, volcanic ash, and tower visibility.
- **Service Level B** airports are staffed with observers or air traffic control specialists who can augment ASOS generated observations. Observations from these airports can include all of the observation elements of service level C and D, plus long-line RVR where appropriate; freezing rain versus freezing drizzle; ice pellets; and remarks for snow depth and snow increasing rapidly; thunderstorm/lightning location and observed significant weather in the vicinity.

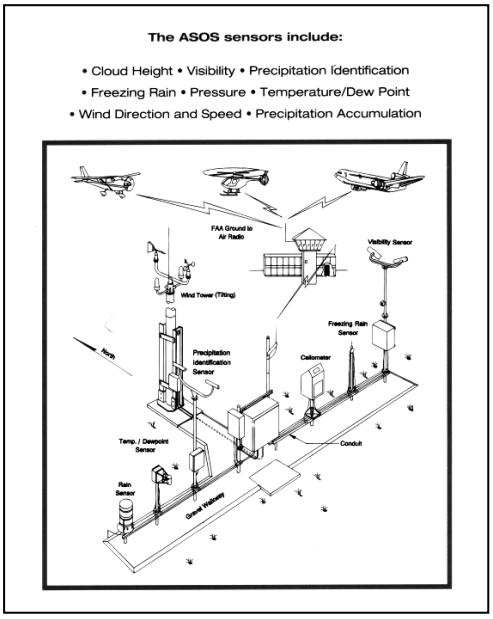

Figure 2. ASOS sensors.

- **Service Level A** airports are staffed with observers or air traffic control specialists who can augment ASOS generated observations. Observations from these airports can include all of the observation elements of service level B, C, and D, plus 10-minute long-line RVR or additional visibility increments; sector visibility; variable sky condition; cloud layers above 12,000 feet and cloud types; volcanic eruptions; and dust, sand, and other obscurations.

2. THE NEED FOR ASOS SUSTAINMENT

The participating Federal agencies recognized that improvements to the ASOS IT infrastructure are required to meet user requirements, comply with federal information technology security policy and procedures, and continue to perform within the ASOS reliability, availability, and maintainability specifications.

2.1. User Requirements

Since ASOS was first deployed, the need for ASOS-generated data has grown significantly and many users have stated a need for the OMO data. Some users would like access to the unprocessed sensor data as well. The 4-D Weather Cube concept will require the OMO data to support the FAA's implementation of NextGen. The ASOS IT infrastructure, NWS and FAA policies and procedures, and NWS and FAA communications and data processing backbones don't support this emerging need.

2.2. Information Technology

ASOS is not capable of IP network connectivity as currently configured. The operating system and the software development tools are obsolete and no longer supported by the developer.

2.3. Obsolete Parts

Several key ASOS components are no longer supported by industry and the ACU processor boards are becoming increasingly difficult to support. Technology refresh will replace the ASOS IT infrastructure, including hardware and software.

In order for OMO data to be made available to NOAA partners, the NWS and FAA must implement the technology refresh, revise its policies and procedures, and implement changes to the communications and data processing backbones.

The ASOS sustainment project provides an opportunity for the participating agencies to meet the NextGen and other emerging requirements, improve IT security, conduct diagnostics and maintenance remotely, and replace obsolete components.

3. OBJECTIVES FOR THE ASOS SUSTAINMENT EFFORT

The immediate focus of the ASOS sustainment project is the implementation and testing of Engineering Development Models (EDM) to demonstrate the performance of the ASOS with modern information technology. The EDMs are production representative systems implemented by the Software and Hardware Teams to demonstrate performance specified in the System Requirements Specification (SyRS) and to finalize the proposed production specifications and drawings. After successful system integration testing, the EDMs will be installed at the NWS, FAA, and DOD in-service engineering sites to measure system performance and for developmental test and evaluation and early system testing in all operational configurations.

3.1. Project Management

Under a project charter approved in 2008, the Project Management Team (PMT) is providing the overall management of this effort and will advise the ASOS Program Management Committee (APMC). This includes providing cost estimates, inputs for business case analysis, the Functional Requirements Document, SyRS, Risk Management Plan, Quality Assurance Plan, and revised Project Development Plan during FY 2009. The NWS Project Manager chairs the PMT and monitors and controls the project costs, schedule, scope, and including quality.

3.2. Software Development

The Software Team will implement the software builds and conduct system integration testing on the EDM. The first software, Build 1, will be based on an ASOS build that is currently being tested and on the FAA's AWOS software that operates with Microsoft Windows and will meet the SyRS developed by the PMT. The FAA will lead the Software Team and the NWS will assist. Software will be developed and tested by build on the EDM. The software builds

will be developed on the EDMs in four increments:

3.2.1. Build 1

Build 1 will support the following configurations:

- ASOS Level D Airports
- ASOS Level C Airports
- Federal AWOS
- ASOS Stand-alone
- New AOMC Software

3.2.2. Build 2

Build 2 will support ASOS Level A, Level B, and airports with multiple DCPs.

3.2.3. Build 3

Build 3 will support hi-res data issued to customers, advanced QC and maintenance monitoring, and automated software downloads.

3.2.4. Build 4

Build 4 will support advanced sensor interfaces and new sensor algorithms.

3.3. Hardware

The Hardware Team will design the hardware component of the EDM. It will work with the other integrated work teams to design the hardware components of the system, including computer processors, power supplies, racks, enclosures, cables, radios, and pressure sensors. The work includes development of the high-level design, detailed design, and communications concept; assembly and unit-level testing of the hardware components at the NWS Sterling Field Support Center; and development of the following documents: high-level design document, Sub-System Design Document (SDD) for hardware configuration items, engineering analysis reports, installation and checkout procedures, and inputs to the Interface Control Documents (ICD). The Telecommunications and Networking Working Group will plan the communications architecture, participate in the EDM design, and conduct a proof of concept demonstration.

3.4. Testing

The Test Team will coordinate and conduct formal testing of the EDMs. A Test Review Board (TRB) chartered by the APMC will evaluate formal test results and report findings and recommendations to the APMC. Based on these TRB recommendations, the APMC will decide whether or not to progress from the EDM to the production system.

3.5. Operations Planning

The Operations, Training, and Deployment Planning Team will provide operations and training inputs during the design and testing of the EDM and will manage the Concept of Operations document and provide inputs to the PMT for the Operational Requirements Document.

3.6. Maintenance, Logistics, and Training Planning

The Maintenance and Logistics Team will develop the maintenance concept and Integrated Logistics Support Plan in accordance with NWS directives and provide inputs to the EDM design process.

3.7. Configuration Management

For purposes of the ASOS sustainment effort the ASOS configuration is defined as the physical suite of hardware which makes up an ASOS. A particular ASOS can have specified capabilities in order to meet site-specific interface requirements.

The EDM will likely retain the current data processing concept in which the ACU performs the central processing, communications, and display functions and the DCP provides an interface between the sensors and the ACU. Initially, three configurations are being considered:

- Stand-alone (where the ACU and DCP functions are combined in a single unit).
- ACU with one remote DCP.
- ACU with multiple remote DCPs.

The standalone configuration has the ACU in a protective enclosure outside with data collected from local sensors connected directly to the ACU. In the ACU with a single DCP configuration, which is by far the most common, the sensors are connected to a DCP at a remote location and sensor data is transmitted from the DCP to the ACU. The two DCP configurations has the capability to collect data from DCP sensor groups at a two separate remote locations, while the three DCP configuration has the capability to collect data from three sensor groups at three separate remote locations.

4. ASSUMPTIONS

The hardware configuration will be standardized across the entire ASOS network in order to maintain a cost-effective and efficient logistics process. The ASOS hardware configuration must remain consistent with the AWOS hardware in a general design and functional sense. The same software application will be running on both the ASOS and AWOS hardware platforms. Unavoidable interface differences between AWOS and ASOS components will need to be managed within the software's configurability features. An analysis of the various ASOS configurations is required.

Remote monitoring and maintenance will reduce the amount of time technicians spend on the road to maintain ASOS. An analysis is required of the more common reasons for maintenance technicians to physically visit an ASOS. These reasons will then be further analyzed to determine if there are system capabilities that might be added to eliminate the need for the visits by handling or diagnosing the issue remotely.

The communications architecture ultimately selected will require changes to the ASOS software, and perhaps also to the ACU hardware. Dial-in connections will not be required when ASOS is connected to an IP network.

ASOS will be able to conduct time checks to synchronize its clock and will store data on its hard drive. The AOMC will no longer have to provide time synchronization and short term data storage. AOMC will backup system files.

A single development team would release one version of software supporting both the AWOS and ASOS systems, versus having development teams for both, thus reducing software support costs. Likewise, combining the full testing resources of the FAA and NWS for the software going into both AWOS and ASOS will bring together a fuller and more diverse set of capabilities, resulting in improved quality of the software releases.

The organization responsible for the facility hosting the ACU will use physical access devices (e.g., keys, locks, combinations, card readers) and/or guards to control entry to facilities containing information systems.

5. CONSTRAINTS

The EDM design will incorporate strategies to deal with parts obsolescence and alternative sources, operating system upgrades and replacement, and sustainability through year 2020.

IT security policies and procedures of DOC NOAA, DOT FAA, and DOD Air Force and Navy are a constraint. ASOS is required to undergo Certification and Accreditation (C&A), Security Content Automation Protocol (SCAP), and Department of Defense Information Technology Security Certification and Accreditation Process (DITSCAP).

The design will modularize the ACU and DCP subsystems so that maintenance staff can replace the lowest repairable units efficiently.

Design considerations include the automatic downloading of software and remote diagnosing of hardware/software problems reducing field visits.

Network connectivity will have to account for agency architectures and system constraints and system boundaries. System configuration checklists will be developed, reviewed, and used to certify all ASOSs before they are connected to the network.

6. SCHEDULE

The tentative plan is for the FAA to lead the software development and to provide software for testing in 2011 on hardware that the NWS will procure. The participating agencies plan to install EDMs at selected facilities for evaluation. The NWS is planning an extensive testing effort to support a milestone in 2012. The NWS will modify and test the AOMC software to account for the improved ASOS capabilities in FY 2012. If the milestone in 2012 results in a deployment decision then the NWS will commence a procurement effort to purchase the technology refresh hardware. The FAA would continue software development with Build 2. After successfully testing Build 2 then the agencies will hold another milestone to decide whether to deploy the build. Figure 3 is the tentative schedule for the project.

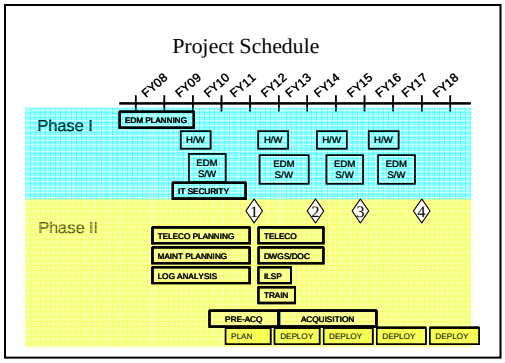

Figure 3. Tentative Schedule for the ASOS Sustainment Project

7. ACKNOWLEDGEMENTS

The NWS, FAA, Navy, and Air Force conducted ASOS sustainment workshops in June and October 2008 to kick-off the planning effort and document design requirements, respectively. The authors acknowledge the contributions of the ASOS workshop participants, specifically their inputs to the functional requirements document (FRD). The authors used text from the draft FRD document to compile this paper. The authors thank Mr. Chet Schmitt and Mr. Bryan Moore for their excellent work on the FRD.

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