Development of a Complex Geospatial/RF Design Model in Support of Service Volume Engineering Design

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ABSTRACT

Today’s National Airspace System (NAS) is managed using an aging surveillance radar system. The radar technology is not adequate to sustain the support of aviation growth and cannot be adapted to use 21st century technologies Therefore, FAA has begun to implement the Next Generation Air Transportation System (NextGen) that would transform today’s aviation and ensure increased safety and capacity. The first building block of the NextGen system is the implementation of the Automatic Dependent Surveillance-Broadcast (ADS-B) system. One of the most important design aspects of the ADS-B program is the design of the terrestrial radio station infrastructure. This design determines the layout of the terrestrial radio stations throughout the United States and is optimized to meet system performance, safety and security. Designing this infrastructure to meet system requirements is at the core of Service Volume (SV) Engineering. In this paper, the authors present a complex Geospatial/RF design ER Development model-based ADS-B SV Engineering design that captures radio sites layout and configuration parameters. CORE software is selected to implement the model-based SV Engineering environment.

Keywords: Automatic Dependent Surveillance-Broadcast (ADS-B) System, CORE Software, Geospatial, NextGen, RF Design, Service Volume

INTRODUCTION

Today’s National Airspace System (NAS) is managed using an aging surveillance radar system. The radar technology is not adequate to sustain the support of the aviation growth and cannot be adapted to use the 21st century technologies Therefore, FAA has undertaken the implementation effort of the Next Generation Air Transportation System (NextGen) that would transform today’s aviation and ensure increased safety and capacity in our NAS.

The first building block of the NextGen system is the implementation of the Automatic
Dependent Surveillance-Broadcast (ADS-B) system. One of the most important design aspects of the ADS-B program is the design of the terrestrial radio station infrastructure. This design must determine the layout of the terrestrial radio stations throughout the US optimized to meet system performance, safety and security. Enabled by the Global Positioning System (GPS) satellite system and a nationwide radio stations terrestrial infrastructure, ADS-B will enhance surveillance capabilities and improve aviation safety and capacity in US (FAA, 2008, 2009, 2010). ADS-B services in the United States are based upon two non-interoperable data link technologies (Bruno & Dyer, 2008):

- 1090 MHz Extended Squitter (1090ES) this data link is applicable primarily to commercial aviation aircraft.
- 978 MHz Universal Access Transceiver (UAT): this data link operates at 978 MHz and is applicable primarily to general aviation aircraft.

These two data link technologies will enable the following four ADS-B services that are required within NAS.

- ADS-B - Surveillance of 1090ES and UAT aircraft to FAA Air Traffic Control is a service that receives position broadcasts from ADS-B equipped aircraft and distributes this information to ATC automation systems for providing separation assurance and traffic flow management.
- ADS-R - ADS-B Rebroadcast is a service that receives ADS-B position broadcasts, and rebroadcasts the same information to near-by aircraft that are equipped with a different ADS-B data link.
- TIS-B - Traffic Information Services Broadcast is a surveillance service that derives traffic information from radar/sensor sources and uplinks this traffic information to ADS-B equipped aircraft.
- FIS-B - Flight Information Service Broadcast is an uplink service that provides aeronautical and flight information such as textual and graphical weather reports and Notice to Airmen (NOTAM) (Gilbert & Bruno, 2009).

The SV Engineering RF design includes the layout of the terrestrial radio stations throughout the US. This layout is optimized to meet system performance, safety, and security at a minimum cost. The ADS-B RF design and optimization approach is given in (Boci, Sarkani, & Mazzuchi, 2009). The SV Engineering design effort culminates with the generation of the final SV design data package that is used for implementation and configuration of the SV based on the final radio station layout and configuration to include but not limited to radio station location, radio station’s antenna system and radio channel assignments to name a few.

**A MODEL-CENTRIC APPROACH TO SV DESIGN**

One of the SV design team objectives was the acquisition of a software environment that would be used to capture the SV design data. There are several factors that influence the decision process for selection of such an environment. Consistent with ISO 42010 (Emery & Hilliard, 2009), the most important factors in this determination are the concerns of stakeholders. In addition, several engineering teams within the ADS-B project have a need for SV Engineering data. The potential users of the data captured from the SV Engineering design are illustrated in Figure 1.

It must be noted that the SV Engineering design team has to maintain several design data packages to accommodate the needs of different design teams. A model-centric approach (Bayer et al., 2010) was adopted to capture and maintain SV design and configuration data.

The model-centric approach aligns with INCOSE “System Engineering Vision 2020” (INCOSE, 2007). The goal is to develop a model-centric tool that would enable SV Engineering to capture, manage and distribute its
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