

**Target Generation Facility (TGF)
AJP-7860 Simulation Group**

Project Summary

Fiscal Year 2011

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TGF Project Summary FY 2011

Executive Summary

The Target Generation Facility (TGF) completed another successful simulation year. All simulations were provided on-time and met or exceeded customer expectations. In addition to completing these simulations many enhancements were added to the Target Generation Facility's aircraft dynamics engine, simulation pilot workstation and hardware infrastructure.

En-Route Automations Modernization (ERAM) Test Support

The TGF provided 52 weeks of simulation support for ERAM test. We supported the ERAM Test Design Group (ATO-E/AJE-12A1) in the Operational Evaluations of System Issues Group (SIG) fixes, Problem Reports (PRs), and Automation Issue Management System (AIMS) tickets for ERAM Release 2. We also supported several Demos to ERAM Key site personnel on critical ERAM fixes. We upgraded all scenarios to use IP radars in the TB1/TB2 labs which provide the benefit of all the Air Traffic Control Center radars being available for use (See section 1.1 for details). **TGF tripled our support for ERAM during the last quarter** increasing our laboratory support from 3 or 4 lab simulations per week to 10 to 12 lab simulations per week.

NextGen Integration and Evaluation Capability (NIEC) Laboratory Support

The TGF supported multiple projects in the NIEC Laboratory this fiscal year. We supported the **Staffed NextGen Tower (SNT)** project with multiple simulations. We added significant capabilities to the Virtual Airport Immersion Environment (VAIE) including the simulation of fixed and movable cameras, the simulation of ASDI-X DDU data and integration with the Lincoln Laboratories developed TIDS and FDM technologies.

The TGF in cooperation with the NIEC DESIREE team and MITRE supported the **Advanced Technology Development & Prototyping Group's 4DTBO** simulation integrating four desktop aircraft simulators into a simulation with DESIREE ERAM Simulation and a TMA field replica to support NextGen research. The Simulation of SEA arrivals with RTA interaction with TMA estimates was the research focus.

UAS Project Support

The TGF supported multiple simulations in support of UAS programs. TGF successfully completed the **Multi-UAS Operational Assessment Class D Airspace Simulation** (aka Victorville). In support of this simulation and in cooperation with the AFTIL Laboratory *TGF built a new 360 view tower simulator*. This new simulation capability uses the AFTIL screens / projectors and TGF Simulation Engine, TGF pilot workstations and TGF VAIE software.

In other UAS work, TGF supported the **Network Enabled Operations (NEO) Demo 5 Simulation**. TGF moved resources to the External R&D Enclave and drove a prototype STARS installed in string 7 as well as a prototype ERAM in Rockville.

ERAM Evaluation System (EES)

TGF in support of the Simulation and Analysis Team (AJP-661) and in cooperation with Lockheed Martin (LMCO) integrated TGF with the ERAM evaluation System (aka ERAM in a Box). Two systems were built, installed and demonstrated. Systems were installed in the NIEC and RDHFL Laboratories.

Research Development and Human Factors Laboratory (RDHFL)

TGF provided support to the Human Factors Research and Engineering Group's Separation Management II simulations designed to evaluate the effectiveness of different conflict probe formats, alternative R-side and D-side controller workstations, and alternative tracking devices to the trackball. On-going TGF support included TGF ECO and Simulation Pilot Workstations upgrades and maintenance as well as software enhancements and troubleshooting as required.

Section 1 – Simulation Projects Supported

This section summarizes the simulation efforts supported by the Target Generation Facility during the fiscal year.

1.1 ERAM Operational Testing – Regression Testing – DR Closeout activities

Simulation Dates: October 2010 – September 2011

Program Office: ERAM

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Simulation Summary

In Fiscal year 2011 we continued to support the ERAM Test Design Group (ATO-E/AJE-12A1) in the Operational Evaluations of System Issues Group (SIG) fixes, Problem Reports (PRs), and Automation Issue Management System (AIMS) tickets for ERAM Release 2.

This year we have moved to using the SDRR's in order to expand radar coverage to support the ERAM To Terminal scenarios, involving ZNY and ZDC ARTCC's, PHL

STARS, the N90 and POTOMAC TRACON's, and the ACY ArtsIIe. The SDRR output is being connected through the BYTEX and connecting to the serial ports of the ECG.

We continue to accommodate an intensive ERAM system release schedule and completed over 50 uplevels of the SGET scenario data. In addition our total simulation support time supporting TB1, TB2, I2F has risen to 4566 hours.

1.2 UAS - Victorville

Simulation Dates: January 2010 – September 2011

Program Office: UAS

AFS Unmanned Aircraft Program Office, AFS-407 ???
 ATO Unmanned Aircraft Systems Office, AJR-36 ???

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Simulation Summary

UAS – Victorville is one of several simulations focusing on the logistics of incorporating UAS systems flying in controlled airspace with GA and military air traffic. This simulation involved the Southern California Logistics Airport airspace known as Victorville. The collaborative effort between the TGF and AFTIL facilities provided a realistic real-time visualization of the Victorville air-traffic operations. TGF needed to design and prepare dynamic models of blimps and helicopters. The developers also added functionality supporting escort and touch-and-go flight operations.

1.3 Separation Management II

Simulation Dates: December 2010 – July 2011

Program Office: ATO-E, AJE-15, Separation Management

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Simulation Summary

The Separation Management II simulation is being performed to evaluate the effectiveness of different conflict probe formats and locations, alternative display monitors (30) for R-side and/or D-side controller workstations, and alternative pointing

devices to the trackball. The General En Route airspace was used combining sectors 08 and 22, the airspace included 3 nm and 5nm separation areas.

1.4 Terminal Chicago (C90)

Simulation Dates: February 2011 – simulation not yet completed as of October 2011.

Program Office: AJR-35 Airspace Management Program

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Simulation Summary

The Chicago TRACON (C90) airspace is being redesigned to accommodate changes in current traffic flow associated with the O'Hare Modernization Plan (OMP). The objective is to perform a human in the loop simulation (HITLS) with C90 ATC's to ensure the viability of the proposed redesign of the airspace controlled by and/or affecting Chicago TRACON, Tower, and various airspace (e.g. Rosemont) in the surrounding area. Accordingly, the Chicago TRACON (C90) and O'Hare International Airport were adapted for use in the simulation.

1.5 Staffed NextGen Towers (SNT) 1.5

Simulation Dates: October 25-27 - November 2-4 2010

Program Office: AT System Concept Development

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Simulation Summary

The simulation purpose is to begin evaluating the integration of camera views with the SNT displays and out-the-window displays. Evaluation will include the ability of ATC detection of off-nominal events. We will be eliciting user feedback for the CHI development. This effort will help define requirements for the SNT HITL2 study and DFW-2 demonstration activities. This is a follow-on to the [SNT-DFW](#) project. Airspace to be Simulated. The airspace intended for use in this simulation will leverage The development already completed for the SNT HITL1. DFW center tower, ground, local, and possibly supervisor ATC positions. Off-nominal events may require pilot/researcher directed aircraft deviations.

1.6 Staffed NextGen Towers (SNT) 2.0

Simulation Dates: June 7-9, 14-16, 21-23, 28-30 2010

Program Office: AT System Concept Development

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Simulation Summary

The Staffed NextGen Tower (SNT) concept provides for a paradigm shift from using the out-the-window (OTW) view as the primary means for providing tower control services to using surface surveillance approved for operational use.

The purpose of this simulation/study is to determine if cameras are beneficial for SNT operations in either the Supplemental or Contingency environment. Several camera views were provided for the controller's use, a panoramic view that stitched 4 fixed cameras into a single view, a fixed view display that could be toggled through 4 preselected viewing areas (two for ground and two for local), and a scanning/tracking

camera view that provided auto tracking of arrivals and alerts. User feedback was collected and CHI issues were identified.

1.7 4-Dimensional -Trajectory - Based - Operations (4D-TBO) ZSE

Simulation Date: January 27, March 23-24, May 10-12, 24-26

Program Office: Advanced Technology Development & Prototyping Group,
AJP-67

4D-TBO

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Simulation Summary

This simulation was conducted to investigate pilot and controller issues linked to trajectory-based operations while using the RTA function of aircraft Flight management Systems (FMS). The Seattle ARTCC (ZSE) was adapted for simulation using low to moderate traffic volume. One high sector ZSE46 and one low sector ZSE02 will be the focus of the simulation.

1.8 UAS - Mini-Initial-NAS-Integration (Mini INI)

Simulation Date: December 14 -16,

Program Office: Research and Technology Development
Air Traffic Organization, AJP-65

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Simulation Summary

This study was conducted to determine the impact on UAS navigation when a GE FMS is integrated with the UAS navigation system compared to a previous study conducted without the FMS. Jacksonville (ZJX) sector 29 and 79 were adapted as live controlled sectors.

1.9 UAS – Mini-Initial-NAS-Integration (Mini INI) 2

Simulation Date: April 8

Program Office: Research and Technology Development
Air Traffic Organization, AJP-65

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Simulation Summary

Lost Link Assessment is one of a series of activities that support the integration of UAS into the NAS. This exercise includes a series of simulations using a large class UAS (PredatorB) in normal and contingency flight operations (various lost link events), with

and without an integrated Cockpit Display of Traffic Information (CDTI). The performance data collected will be used to understand UAS operating in the NAS to a greater extent and identify situations which require additional exploration.

1.10 UAS - Mini-Initial-NAS-Integration (Mini INI) Demonstration 4

Simulation Date: April 8

Program Office: Research and Technology Development Air Traffic
Organization

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Simulation Summary

This study was conducted to determine the impact on UAS surveillance using ADS-B integrated with a predator-B Ground Control Station in conjunction w/ lost Link (LL) activity. Miami ARTCC Sectors 02, 20, and 23 were simulated.

1.11 UAS - Mini-Initial-NAS-Integration (Mini INI) Demonstration 5

Simulation Date: September 27 - 29

Program Office: Engineering Development Services, AJP-65

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Simulation Summary

Neo Spiral 2 UAS Demonstration 5 (Demo 5) is one of a series of activities that support the integration of UAS into the NAS. A major objective in understanding UAS operations in the NAS is to capture the performance characteristics of UAS operations within the NAS environment, and to understand specific considerations as the two interact. The experiment is a real-time, human-in-the-loop study whose goal is to explore the NextGen? concept of 4-Dimensional Trajectory Based Operations (4DT TBO) and data sharing, within the scope of specific UAS hazards such as the loss of command and control (“lost-link”). Demo 5 will utilize the FAA’s NextGen? Integration and Evaluation Capability (NIEC) and Standard Terminal Automation Replacement System (STARS) laboratory to conduct simulated flights of a Textron AAI RQ-7B Shadow UAS equipped with a GE Flight Management System (FMS). The simulation will explore how a UAS equipped with FMS will dynamically exchange aircraft intent information with an air traffic control automation system (STARS). The details pertaining to all aspects of Demo 5 are captured in the exercise plan. The performance data collected during Demo 5 will be used to understand UAS operating in the NAS to a greater extent and identify situations which require additional exploration. The ZNY68 and ACY Tracon encompassing R5002 A/B was adapted for use in the simulation.

Section 2 – Technical Summary

This section summarizes the technical achievements and “state of the art” of the TGF during the fiscal year.

2.1 TGF Simulation Engine (ECO)

TGF added the ability to model rotor-craft and airships. TGF added new aircraft models, including models for Unmanned Aircraft Systems. TGF prototyped and implemented complex terminal Air Traffic Control (ATC) procedures to provide realism to UAS simulations. The TGF High Level Architecture (HLA) was upgraded to the IEEE 1516 standard and Flight Management System HLA communications were added; developers worked with aircraft vendors and universities to enhance the IEEE 1516 standard HLA SIMNET interface in order to provide wider access to the Federal Aviation Administration (FAA) for future distributive simulations. TGF greatly expanded NIEC internal simulation network capabilities, including reducing the TGF network communications packet size. The TGF data recordings were enhanced and decoupled from the software architecture; to better meet future requirements of simulation principal investigators i.e. TGF no longer uses serialized java objects to persist simulation state for data reduction.

2.2 Virtual Airport Immersion Environment (VAIE)

TGF completed the development of a new 360 degree nine channel VAIE instance and installed it in the AFTIL laboratory. This system was used for the UAS Victorville simulation.

In FY11 VAIE’s camera simulation capabilities was greatly expanded to support the Staffed NextGen Tower project, supporting multiple scanning, fixed, and panoramic cameras. A capability to provide out-the-window visuals for the Reconfigurable Cockpit System located in the NIEC was also developed, and as part of that capability a whole-earth COTS product, MAK VR-TheWorld, was integrated with DANSIG via the osgEarth library. A in-house implementation of the CIGI protocol, Cigizilla, was developed to replace the aging reference implementation. The existing XML based configuration process for the image generators was replaced with a monolithic database-based configuration GUI to allow more rapid development or modification of simulation configurations for the VAIE. Improvements were made to DANSIG's renderer to allow it to run in a pure OpenGL 3.x mode, enabling access to more advanced features on newer

generation graphics cards. Head tracking support was added to support the use of simulated binoculars in the AFTIL tower cab for the Multiple UAS in Class D Airspace simulation (a.k.a. UAS-VCV), and a proof-of-concept tower placement tool was developed for the AFTIL to explore ideas for future cooperation with TGF.

The VAIE is a highly extensible 3D rendering solution for the Target Generation Facility's high-fidelity air-traffic simulator. The VAIE uses TGF's internally developed DANSIG image generator software which was built from the ground up to be modular and easily customizable. DANSIG uses advanced rendering techniques to efficiently handle many scene lights - often 5 per aircraft - that produce highly realistic lighting effects that interact with the terrain and other aircraft in the scene. OpenSceneGraph based rendering of aircraft and airports. Aircraft and Ground vehicle motion projected to a WGS84 coordinate system using TGF's internal algorithms. Real-time ephemeris calculations for sky color, lighting conditions, star field, etc. are performed using SilverLining. Real-time shadow rendering is based on calculated sun/moon position. Real-time aircraft lights (navigation, taxi, landing, etc.) that follows the light discipline based on aircraft movement and affects the environment. The VAIE renders Real-time weather effects (snow/rain, fog, clouds) and has a Particle-system based special effects for fire, smoke, landing tire smoke etc.

2.3 Sim-Pilot Laboratory Enhancements and Status

TGF Completed the Simulation Pilot laboratory technical refresh installing 26" monitors on the remaining pilot workstations. Each system is a Intel I7 based Linux system running Cent OS 5.4 with a 26" monitor.

2.4 Networking Enhancements and Status

The TGF decommissioned our old cisco 3509 router with a new Cisco 4506-E router/switch. We ceded our firewall and NATing responsibility's to the LABNET group.

The TGF network infrastructure comprises ~30 devices. These devices range from the smallest access layer Cisco 2960G switch to the new core Cisco 4506 installed this fiscal year. The devices provide an infrastructure to transport all TGF simulation network traffic. The type of network traffic ranges from point-to-point to multicast to subnet broadcasts. These different types of traffic may originate and terminate locally with the TGF, or inter-lab, e.g., NIEC displays targets driven by the TGF simulator(s). TGF simulations have increased the network traffic 10 fold with the introduction of VAIE

2.5 Workstation Environment

The workstation environment consists of 64 bit OS (Fedora 13/CentOS 5.4) with SSDs for local storage and are running Intel I7's with 6 gb of RAM. We are using SVN for source code management and GIT for data management. We have an active wiki <http://trac.tgf.tc.faa.gov>.

2.6 TGF Back End Systems Enhancements and Status

TGF transitioned to YP (from NIS+) for local authentication. TGF installed a new backup and restore system to replace the aging server/tape library based Networker backup system. The new system, EMC's Avamar Data Store product, is a fully integrated software/hardware backup and recovery solution that also includes data deduplication, which enables savings in the areas of time, processing, bandwidth and storage requirements. An updated Avamar NDMP compliant NAS storage system to replace the aging SUN NAS storage system is planned for FY12, as well as the addition of an NDMP accelerator node and possibly an additional storage node for the Avamar appliance

2.7 TGF Display Laboratory Enhancements and Status

No significant changes we made to the Display Laboratory this FY. We did host the NEO Demo 5 presentation which utilized our large projection/video wall capabilities.

TGF Acronyms and Abbreviations

ADAR	ARTS Data Acquisition & Router
AGW	ARTS GateWay
ARTS	Automated Radar Terminal System
ATCT	Air Traffic Control Tower
CAS	Controller Awareness Study
CTAS	Center TRACON Automation System
CHI	Computer Human Interface
CPDLS	Controller Pilot Data Link Communications
DFS	Deutsche Flugsicherung (German Simulation)
DIS	Distributed Interactive Simulation
DRVSM	Domestic Reduced Vertical Separation Minimum
DSR	Display System Replacement
EDC	Early Display Configuration
ETVS	Enhanced Terminal Voice Switch
FAST	Final Approach Spacing Tool
FFP	Free Flight Phase
FS1, 2/2+	Full Service 1, 2/2+
GAO	Government Accounting Office
GOERS	GPS Outage En route Simulation
GPS	Global Positioning System
HAD	High Altitude Demonstration
HAT	High Altitude Test
HFL	Human Factors Laboratory
HLA	High Level Architecture
IIF	Integration and Interoperability Facility
LAAEP	LA Arrival Enhancement Project
McTMA	Multi-Center Traffic Management Advisor
NAS	National Airspace System
NATCA	National Air Traffic Controllers Association

PARR	Problem Analysis Resolution and Ranking
PAS	Pseudo Aircraft System
PDU	Protocol Data Units
PTR	Program Trouble Reports
RDHFL	Research Development and Human Factors Laboratory
RNAV	Area Navigation
RVSM	Reduced Vertical Separation Minimum
STARS	Stand Alone Terminal ARTS Replacement System
TATCA	Terminal Air Traffic Control Automation
TFM	Traffic Flow Management
TGF	Target Generation Facility
TMA	Traffic Management Advisor
TRACON	Terminal Radar Approach CONTROL
URET	User Request Evaluation Tool
WJHTC	William J. Hughes Technical Center
XPVD	X-windows Planned View Display

TGF Airports and Centers

ADW	Andrews Air Force Base
DCA	Ronald Reagan International Airport
DFW	Dallas Fort-Worth International Airport
EWR	Newark International Airport
Genera	Generic airspace generated for HFL studies
JFK	John F. Kennedy International Airport
PHL	Philadelphia International Airport
ZDC	Washington Center
ZID	Indianapolis Center
ZJX	Jacksonville Center
ZNY	New York Center
ZOB	Cleveland Center