

Session 139-GNC-49: “Innovations and Support of the National Airspace System at the FAA ”

Paper AIAA-2008-7147: “Future Advanced System Collaborative T&E Requirements, Methods and Practices ”

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Federal Aviation
Administration



Overview

- **The New Verification and Validation (V&V) Methodology**
- **Four Phases of the V&V Methodology Topics**
- **Developing & Defining the Metric-Base Approach**
- **Metric Application Example**
 - Historical Data – Legacy Systems
 - Sample Studies



The New Verification and Validation (V&V) Methodology

- **FAA tasked the William J. Hughes Technical Center to Standardize Agency Testing Procedures**
- **Standardized Methodology ensures that**
 - Quality of V&V product and services
 - Test Plans
 - Test Conduct
 - Test Reports
 - Enabling risk management activities throughout the V&V Process
 - Evaluates how metrics are collected and analysis



The New Verification and Validation (V&V) Methodology - Conti

- **New systems destined for the National Airspace System (NAS) must be autonomous in fulfilling their goal plus contributing to Next Generation Airspace (NextGen)**
- **All systems start at the concept stage, then to development, testing, deploying and maintenance**



Methodology Topics

- *Four Phases of the V&V Methodology*
- **Developing & Defining the Metrics-Base Approach**
- **Sampling of the Metric Methods**



Four Phases of V&V Methodology

- **First Phase – Development Stage**
 - Legacy systems are an intricate part of the planning
 - Use of Historical Data
 - Lessons Learned – lower Risk
 - Legacy Systems
- **Second Phase – V&V Coding**
 - Legacy systems Regression test in Place
 - Development of New Regression Test
 - On site audits begin



Four Phases of V&V Methodology - conti

- **Third Phase – Software development**
 - Metrics collected
 - Define the metrics as the “Standards of Measurement”
 - Gauge Effectiveness and Efficiency of an activity
 - Samples of Measurement Uses
 - Root Cause Analysis
 - Capturing Trends so they can be promptly captured and evaluated



Four Phases of V&V Methodology - conti

- **Fourth Phase – Delivery of the System**
 - Analysis of the new system against Legacy Systems are complete
 - Determine which metrics should be used
 - Gauge Effectiveness and Efficiency and keep what works
- **System is now deployed and the system is in 2nd Level Maintenance Support**



Methodology Topics

- **Interval Based Sampling Technique**
- ***Developing & Defining the Metrics-Base Approach***
- **Sampling of the Metric Methods**



Developing & Defining the Metrics-Base Method

- **Main Task of V&V is to emphasize the modeling task to allow for dynamic testing of systems**
- **New arena in test – Discrete event simulation model on the ATC System**
- **Reviews of the requirements traceability**
 - Gaps in Parent (SSS) and Child (SRS)
 - Cut down the cost on early stage development



Developing & Defining the Metrics-Base Method - Conti

- **Risk deduction in testing**
 - Verification of the critical function implementation and the statistics are analyzed
 - Conduct orthogonal testing which observes the system under atypical conditions
 - Break the system
 - Identification of code that is inefficient or incorrectly implemented i.e., algorithms
 - Tracker accuracy, conflict alert, trajectory modeling, conflict probe and posting

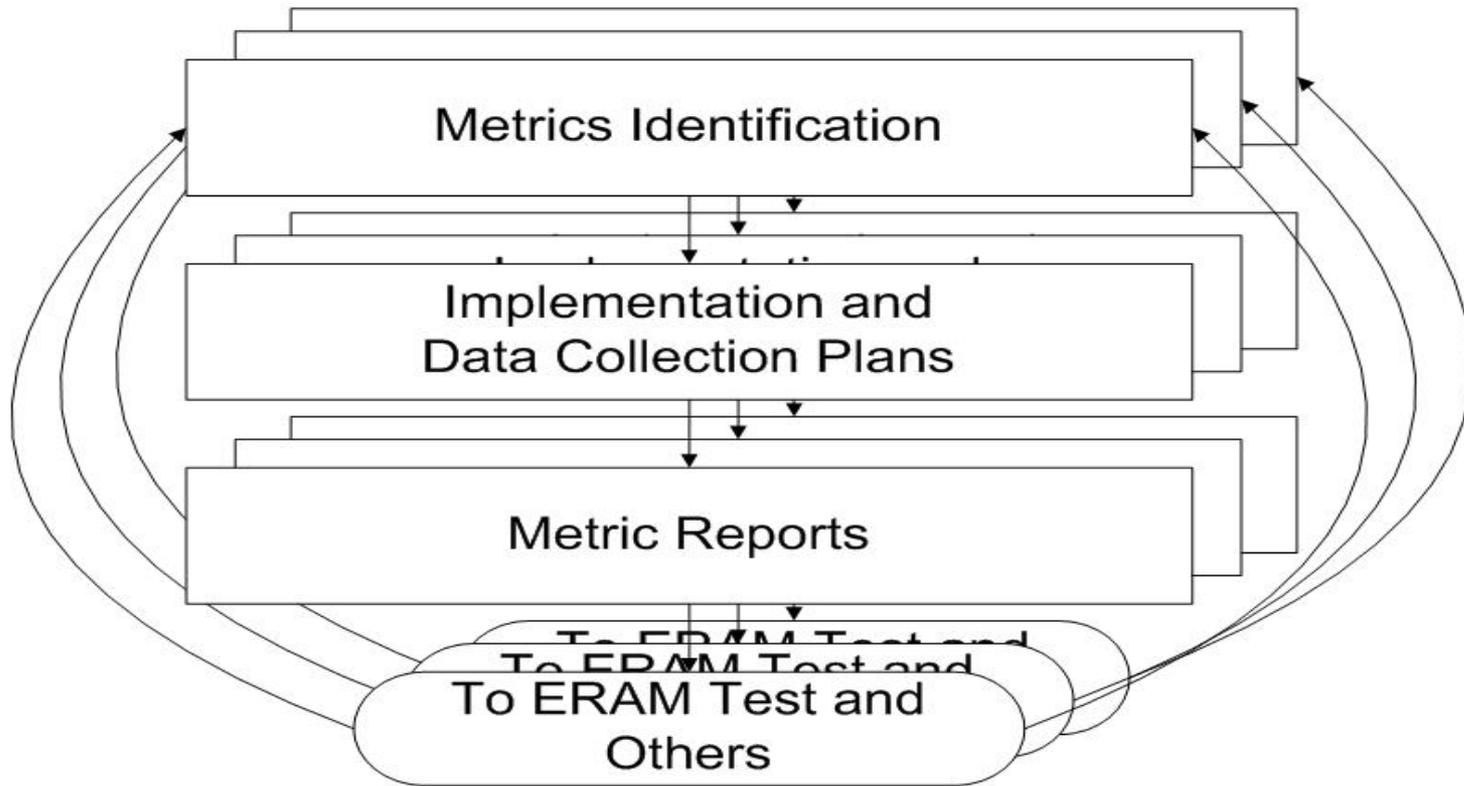


Developing & Defining the Metrics-Base Method - Conti

- **Metrics-Based Approach to Testing**
 - Driven process is partitioned into two-part process
 - Each part independent to add value of its own
- **First part – Key Performance Parameters (KPP) identified using operational use cases**
- **Second part – Actual Studies and reports of the system under development against the defined metrics**



Data Collection/Analysis Phase



Methodology Topics

- *Four Phases of the V&V Methodology*
- **Developing & Defining the Metrics-Base Approach**
- **Sampling of the Metric Methods**



ERAM Surveillance Data Processing

- **First point – Accuracy of radars is an important factor for determining overall performance**

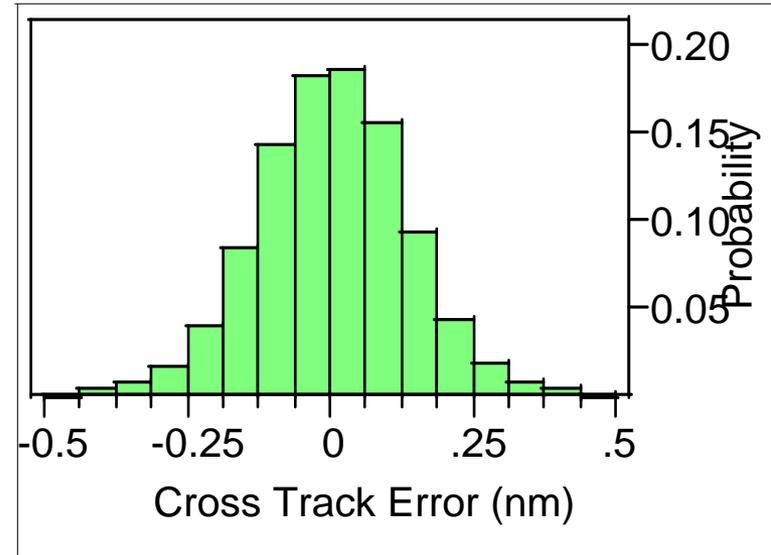
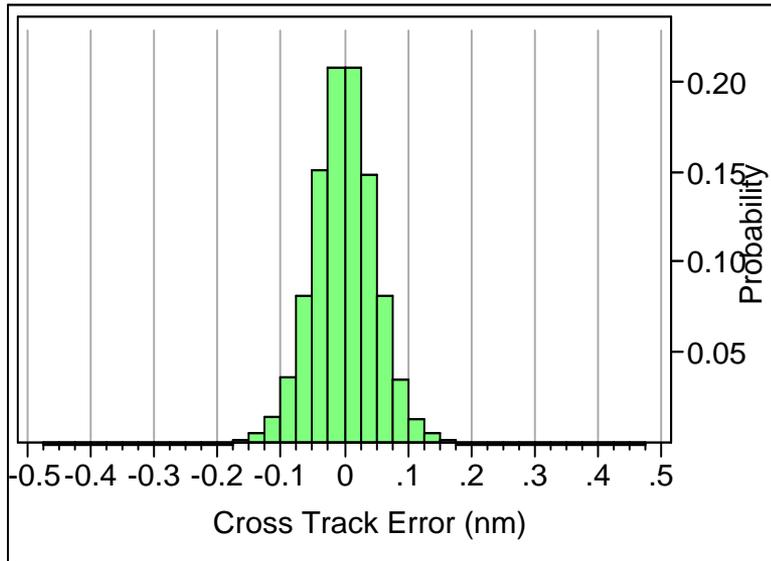


ERAM Surveillance Data Processing

Table 1: HCS Tracker Results from Ref. 2

| | | Horizontal Error | | Cross Track Error | | Along Track Error | |
|----------|-------------|------------------|------|-------------------|------|-------------------|------|
| Type | Sample Size | Mean | RMS | Mean | RMS | Mean | RMS |
| Signed | 54170 | 0.69 | 0.78 | 0.00 | 0.16 | -0.67 | 0.77 |
| Unsigned | | | | 0.12 | | 0.67 | |

ERAM Surveillance Data Processing - conti



Cross Track Error – ERAM (left) and HCS (right)

Sample: ERAM Flight Data Processing – Converted Route Logic

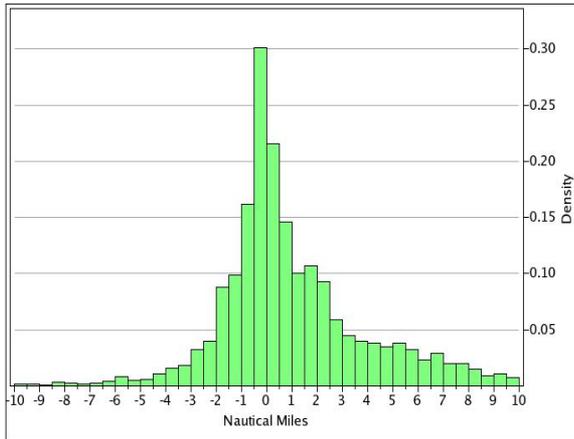


ERAM Flight Data Processing

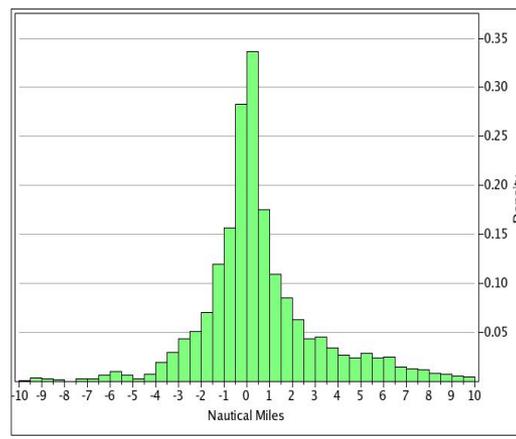


: Lateral Distance

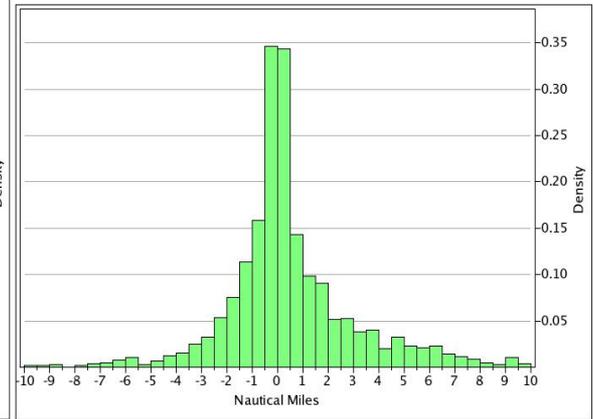
ERAM Flight Data Processing - conti



HCS Lateral Distances



URET Lateral Distances



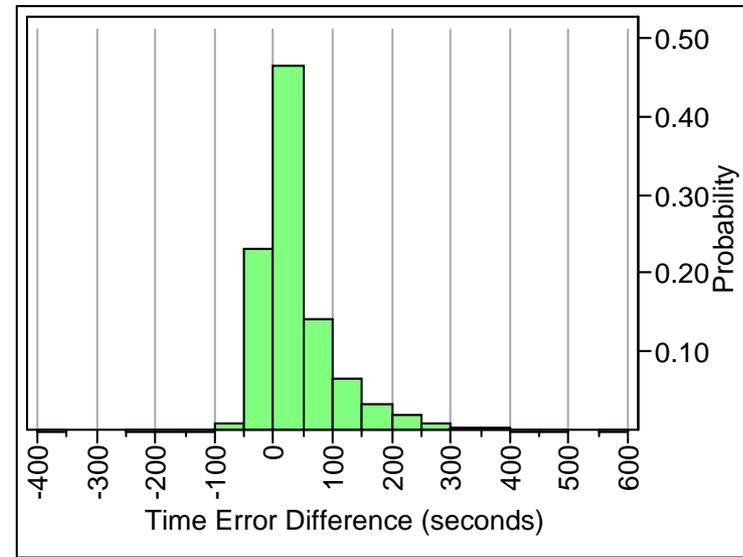
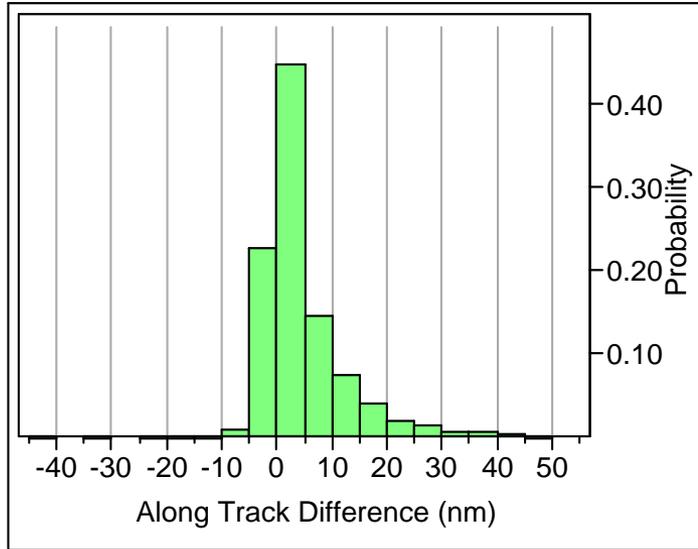
ERAM Lateral Distances

ERAM Flight Data Processing – Automatic Handoff Function

- **Developed Two methods of predicting the handoff**
 - Flight plan converted route – refer to the Flight Plan Trajectory
 - Based on a full 4-D trajectory prediction – refer to the Aircraft Trajectory



ERAM Flight Data Processing – Automatic Handoff Function - conti



HCS-ERAM Along Track Error

HCS-ERAM Time Error

Conclusion

- **Overall objective is to apply the Metrics-Based Approach to future FAA projects.**
 - Through the example implementation on ERAM, the approach has been proven useful in providing measures of the performance on key functions needed at critical decision points.
 - It can buy down FAA risk if integrated into the program's vendor contracts. The use of a cross organizational metrics team with varied skilled sets and expertise had proven to be very constructive as well.
 - It allowed the testing personnel to bring larger sets of FAA resources onto complex problems within their program. With the lessons learned on ERAM, the improved V&V techniques of the Metrics-Based Approach can certainly be applied with even greater success to future FAA programs.

Questions?



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