

iNET Deployment at Pax River: Identifying and Mitigating the Disruptions

Brian Anderson and Daniel Skelley

Naval Air Systems Command (NAVAIR), Patuxent River, Maryland

Raymond Faulstich

Computer Science Corporation, Lexington Park, Maryland

Recognizing the inability of current telemetry technology to meet emergent needs within the Major Range and Test Facility Base, the Central Test and Evaluation Investment Program launched the integrated Network Enhanced Telemetry (iNET) Project. iNET is taking a systems engineering approach to defining a new architecture for flight test telemetry. The iNET architecture is the first major change to the underlying architecture of flight test telemetry in over 50 years! Changing an architecture that has been in place this long could have unforeseen impacts. Across our ranges, processes, procedures, and systems have characteristics of the traditional telemetry architecture inherent in their design. A careful, defined, and disciplined process is required for assuring the processes, procedures, and systems are ready to accept iNET technology. As one of the initial deployment sites for iNET, NAVAIR Pax River has conducted a continuous process improvement project to study the potential disruptions and mitigations of deploying this revolutionary and potentially disruptive technology. This article describes the study process, the potential disruptions identified, the results of the risk/failure mode effect analysis, and useful end products developed to facilitate the safe deployment of iNET at the Naval Air Warfare Center Aircraft Division at Patuxent River, MD.

Key words: AIRSpeed tool set; continuous process improvement; data flow disruption; flight test; ITD3 process; Lean Six Sigma tool set; network of networks; real-time data telemetry.

Real-time telemetry is an integral component of flight test scenarios executed on Department of Defense (DoD) Major Range and Test Facility Base (MRTFB) ranges. For the last 50 years, virtually all real-time telemetry has been point-to-point one-way transmission of data. Referred to as serial streaming telemetry (SST), data are transmitted one way, from the test article to the remotely located test team. The test team evaluates the data in real-time to ensure safe test execution and to monitor the performance of the test article. Data content and format of the SST data stream are fixed in advance of the test.

As the complexity of weapon systems increased, the amount of data collected onboard test articles began to spiral upwards. However, the rigidity of point-to-point telemetry, coupled with limited spectral resources,

severely limited the amount of data that could be transmitted. Increasingly, most of the data collected onboard a test article were recorded vice being transmitted. In some cases less than three percent of the data being collected are transmitted. Test engineers have to wait until the test article returns to base to retrieve the data recorder so that the majority of the data can be downloaded and analyzed. Limited real-time access to all the data being collected has negatively affected the cost and schedule associated with flight test.

Considering the implications of this trend, it became clear that the traditional SST architecture needed to change. The million dollar question was: “Change to what?” The call for change was led by a rogue group of telemetry engineers who advocated scrapping SST and changing to a technology based on wireless networks. However, wholesale replacement of SST telemetry

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 2009		2. REPORT TYPE		3. DATES COVERED 00-00-2009 to 00-00-2009	
4. TITLE AND SUBTITLE iNET Deployment at Pax River: Identifying and Mitigating the Disruptions				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Air Systems Command (NAVAIR),47123 Buse Rd, B2272 Unit IPT,Patuxent River,MD,20670-1547				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 7	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

with wireless network technology was also problematic. While telemetry networks, via two-way connectivity, could allow near real-time access to all the data recorded onboard the test article, they were ill suited for time critical, no latency variance delivery of critical safety data. Despite its faults, SST excels at the delivery of time critical, no latency variance data. Slowly emerged the realization that telemetry networks and traditional SST were not mutually exclusive. In fact, they complement each other; each doing well, what the other does poorly. The use of wireless network technology to enhance traditional SST is the basis of the iNET architecture.

The iNET architecture describes how a collection of networks works in harmony with SST to meet emergent needs within the MRTFB. This system can be thought of as a “network of networks” consisting of the following:

- a vehicular network (to be developed by iNET) on the test article that handles all onboard data acquisition functions;
- a wireless network (to be developed by iNET) that provides network communications between test articles and between the test articles and the range infrastructure;
- the existing SST links; and
- the existing network infrastructure on DoD Test and Evaluation (T&E) ranges.

The test and telemetry communities realized that the capabilities enabled by this architecture would have far-reaching consequences. Not only would emergent requirements be more easily satisfied, but *T&E would be revolutionized*. However, safely introducing a revolutionary capability into a high-risk environment, like flight test, could prove problematic. A disciplined process was needed to assure that the deployment of iNET did not negatively affect cost, schedule, or the safety of executing flight test.

Independently, during the same time period, the Department of the Navy was developing a disciplined set of tools to improve productivity. In 1999, the Navy Depots adopted the use of AIRSpeed initiatives to increase productivity through process improvement by using a common set of industry-proven tools. The use of AIRSpeed/Lean, Six Sigma (LSS) tool sets has proven to reduce lead times, remove waste (non-value-added cost), and reduce variation.

In 2004, NAVAIR, recognizing the positive impacts that the Depots were experiencing using AIRSpeed, endorsed the utilization of NAVAIR AIRSpeed initiatives across the Naval Air Warfare Centers (NAWC). Recognizing that the AIRSpeed tool set could be used to design (as well as improve) a process, the “iNET Deployment Process” was launched. The

goal of the project was to utilize the AIRSpeed/LSS tool sets to solve the complex problem of deploying iNET technologies without disrupting existing infrastructures, processes, and procedures. This project became a Design for Lean Six Sigma effort, since a process for iNET Deployment did not previously exist.

The iNET AIRSpeed Project: “Chartering the Team”

In the fall of 2007, the iNET Chief Architect developed a charter for the NAVAIR AIRSpeed/Continuous Process Improvement (CPI) Team, with the goal to define a process/concept of operations (CONOPS) for safe deployment of iNET capabilities (*Figure 1*).

In response to the charter, the “iNET Deployment Process” Team was established to design a process for safe deployment of iNET at NAWC Aircraft Division (NAWCAD). The Team consisted of subject-matter experts (SMEs) representing all aspects of flight test and range operations. This talented group of SMEs possesses a breadth of experience including

- flight test,
- airborne instrumentation,
- range communications,
- data processing and display,
- radio-frequency (rf) systems,
- systems safety,
- time space position information, and
- risk management.

The SME knowledge base was used to analyze the planned deployments of iNET capabilities for potential disruptions leading to negative impacts to cost, schedule, and safety of flight testing at Patuxent River, MD.

Project execution

Recognizing the potential of iNET technology to revolutionize flight test at NAWCAD, this team was extremely motivated and dedicated to the task. In addition to meeting weekly for 9 months, they met in several all-day off-site meetings. Using the Lean Six Sigma tool set, the Team methodically progressed through the five design steps for Lean Six Sigma: Define, Measure, Explore, Develop, Implement (DMEDI). While working through the details of the process, the Team never lost its focus—to create a process for the safe deployment of iNET technology at NAWCAD Patuxent River.

Define

In this phase, the goal is to clearly define the problem. The first step was to validate the project charter. Once the charter was validated, the Team used

Project Name: INET Deployment process	Date: 11-14-07
Competency/PEO: 5.2 National Ranges	Deployment Champion: Kathy Seals
Project Sponsor: Dan Skelley 5.2.0	Black/Green Belt: Brian Anderson

Business Impact (\$)
 Telemetry systems have not changed in roughly 50 years. The current systems are very static. Many of the processes that govern flight testing have this static nature embedded. INET deployment offers 2 way dynamic connectivity for interfacing with data on the fly however, it may be a disruptive technology that could have unforeseen safety of flight test impacts, resulting in (x) \$ loss in program operating cost across the NAE.

Opportunity or Problem Statement

When: Current and ongoing for the past 50 years, the basic telemetry structure has not changed.

- iNET may yield disruption in tech demo deployment FY09 timeframe.
- iNET may yield disruption in the FY11/12 Block (1) deployment timeframe.

What: A process for Safe deployment of iNET for flight testing is required.

Where: Initial Operation Capability (IOC) - Patuxent River Md. & Edwards AFB

- Independent substantiations PAX & Edwards

Extent: 100% percent of the time there is not a documented CONOPS process for deployment of potentially disruptive INET technologies.

- A CONOPS for INET utilization could potentially prevent loss of Test Article or loss of Life.

Goal Statement
 Define a Process / CONOPS for Safe Deployment of iNET Capabilities.

Project Scope

In Scope: All Flight Test Processes relevant to Block (1) deployment of iNET.

Out of scope: Non-flight test processes, Block (2) deployment of iNET and beyond.

Project Plan
 Team Launch – October 30, 2007
 Define – November 19, 2007
 Measure – March 4, 2008
 Explore – March 04, 2008
 Develop – May 14, 2008
 Implement – June 25, 2008
 Validate – April 29, 2009

Team Selection

1. **Mark Smedley**– (Airborne Instrumentation) SME / Project Green Belt
2. **Sid Jones** – (iNET / RCC) SME
3. **Ray Faulstich** – (iNET) SME
4. **Jonathon Norton /Dennis Normyle / Bob Myers** - (RTPS Telemetry) SME
5. **Jim Pilkerton / Bob Craft** – (RTPS Test Communications) SME
6. **Patricia Khatiblou /Tom McCaughey** – (RTPS Test Management / Control Room) SME
7. **Robert Jacob / Jason Stewart** – (Range Safety) SME
8. **Paul Conigliaro / Jackie White** – (5.1 Flight Test Engineering) SME
9. **External** – 5.1 & 5.2 West Coast SME's

Figure 1. NAVAIR AIRSpeed Lean Six Sigma Project Charter: iNET Deployment Process.

tools such as swim lane process mapping and voice of the customer/business evaluations to ensure that the problem was understood. Ultimately, the Team thoroughly reviewed the iNET deployment schedule, future iNET capabilities and scenarios, and scenarios relevant to deployments at Patuxent River.

Measure

In the *measure* phase, the Team focused on creating a project schedule, determining the project execution strategy by using a system engineering “V” diagram, and identifying the metrics to decompose. The metrics of choice were 53 preexisting process maps referred to as Operational Sequence Diagrams (OSD). The OSDs were generated by the iNET project during the initial system engineering effort to define the architecture. They are diagrams depicting the flow of events necessary to accomplish each of the 53 use cases the iNET project is chartered to meet.

From these 53, the Team identified the predominant capability to be first used at NAWCAD. The “Fetch Data” scenario describes the details perceived as needed to access previously recorded data from the test article in real-time. The Team then began a 10-week brainstorming session, meeting 3 hours per week, to surface potential disruptions associated with deploying this number-one capability. Using the OSD for “Fetch Data From Aircraft,” the Team walked through the multiple process steps asking questions along the way, such as, “If this step were deployed now, what would be the impacts and or disruptions to existing processes, procedures, and infrastructure?”

From this lengthy brainstorming process, the Team categorized 144 disruptions in a Failure Modes and Effects Analysis (FMEA) spreadsheet.

Explore

While this method for analyzing the impacts of deploying a capability was successful, it was extremely labor intensive. As such, it was unsuitable for use as a standard process in deploying iNET. The Team determined that they needed a standard process, defined by a guidebook, which would steer the range in finding and mitigating the potential disruptions in the deployment of iNET. During this phase, the concept of the Disruption Finder Guidebook was established. However, the process this guidebook would describe was still a mystery.

Develop

In the *develop* phase, the Team looked at many different approaches to identifying the potential disruptions. The lengthy brainstorming session that led to the 144 potential disruptions was simply not efficient enough. A particularly creative member of the

Team suggested that a process used by industry to uncover threats (or disruptions) to the deployment of complex software systems might be of use. After a bit of research, it was determined that a concept used by Microsoft Corporation, called “Threat Modeling,” could be adapted to speed the process of identifying potential disruptions. Central to this concept is the use of data-flow diagrams (similar to the OSDs mentioned above) and an acronym to focus brainstorming disruptions. In the case of Microsoft Corporation, they use the STRIDE acronym which stands for Spoofing, Tampering, Repudiation, Information Disclosure, Denial of Service, and Elevation of Privilege.

The first step is to develop a data flow diagram for the capability being deployed. The Team found that a data-flow diagram could quickly be created using the OSDs as a launching point.

Once a data-flow diagram is documented, the next step is to use the categories identified in the acronym (in the Microsoft case, STRIDE) to guide the Team through a shortened brainstorming exercise to identify the potential disruptions. However, while the STRIDE set of threats might work well for the deployment of a complex software system like Microsoft Vista, it was ill suited for analysis of deploying iNET technology. The Team developed a more appropriate threat description acronym: ITD3. ITD3 stands for Information assurance, Test conduct, Data quality, Data delivery, Displays & human interface. This acronym was derived from the use of affinity analysis to categorize the 144 FMEA disruptions discovered during the 10-week brainstorming session. The Disruption Finder Guidebook outlines the details of each category.

Armed with the ITD3 process, the Team went back to the “Fetch Data From Aircraft” scenario. Using the OSD as a starting point, the data-flow diagram (Figure 2) was created.

The data-flow diagram was analyzed for potential disruptions using the ITD3 acronym. In addition to the previously identified 144 potential disruptions, this process uncovered an additional 61. And, this process only took a few days vice 10 weeks! These additional disruptions were also documented in an FMEA. The Team felt they had a winner. The process was not only much quicker, but also more thorough.

Implement

In the *implement* phase, the Team continued to vet the new process. The iNET Disruption Finder Guidebook was perfected. New threat modeling concepts and lessons learned using the threat models were incorporated. In addition, the process was tested against the next three scenarios. A screen shot of the data-flow diagram for one of these scenarios (“Provide Lossless Telemetry Com-

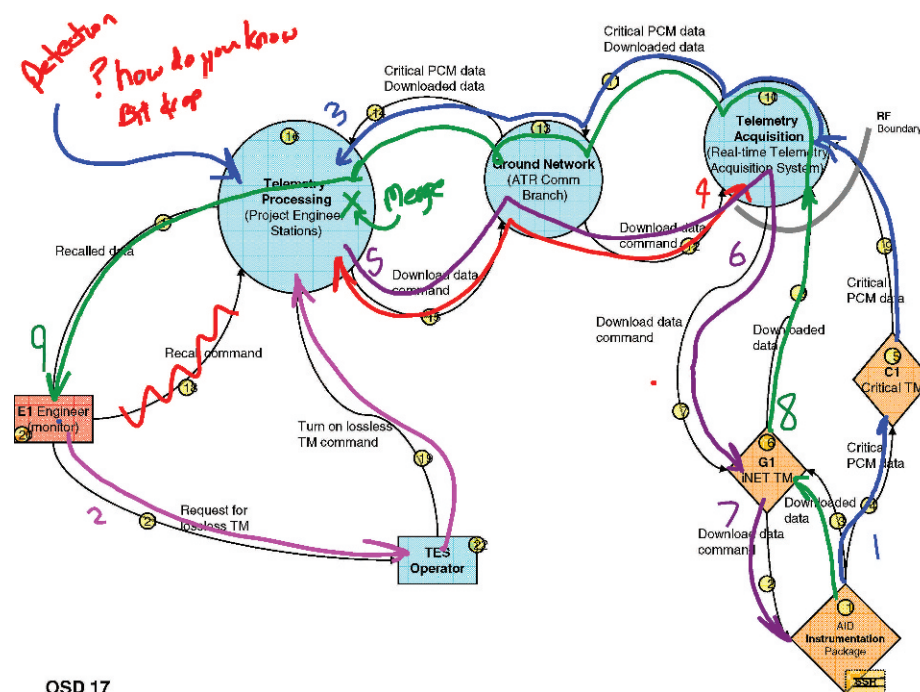


Figure 3. “Provide Lossless Telemetry Communications (aircraft)”/“Detect Telemetry Drop-outs.”

competency SMEs and process owners, yielding potential plans for implementing the top three super-scenarios at NAWCAD.

The Team also designed a process map (*Figure 4*) detailing the new iNET Deployment process for users in the future.

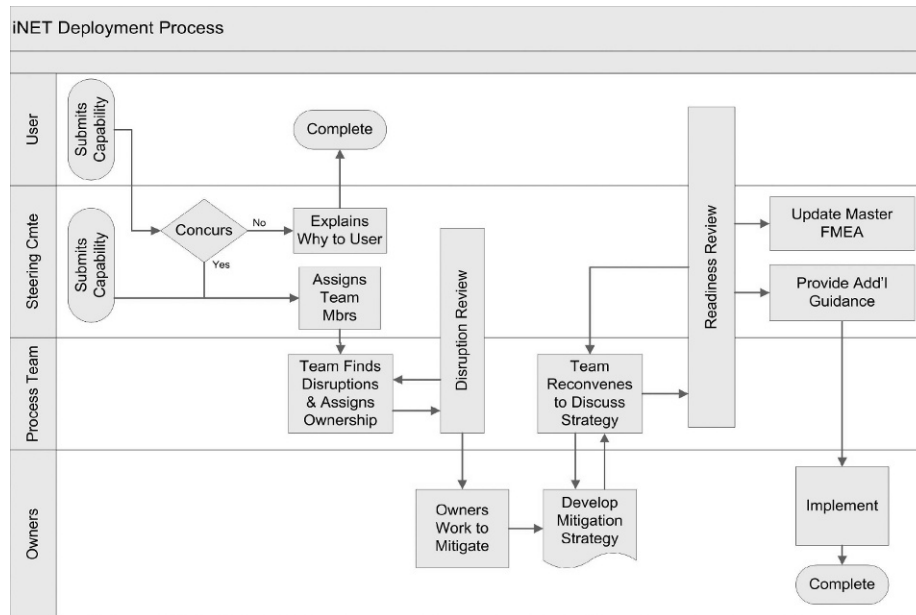


Figure 4. "iNET Deployment Process Map."

Recommendations

Once the AIRSpeed Team had a solid process for deploying iNET at NAWCAD, the question of process administration was addressed. The Team felt that an empowered iNET Steering Committee was required. The iNET Steering Committee would have responsibility for the execution of the process described in the iNET Disruption Finder Guidebook. The Team recommended that the iNET Steering Committee be created and empowered by a Memorandum of Understanding (MOU) signed at the highest levels of the organization (Senior Executive Service (SES) Level leadership of the NAVAIR Ranges, Flight Test, and Laboratories). To aid the functioning of the iNET Steering Committee, the Team created a deployment CONOPS. The iNET Steering Committee is to meet regularly with duties that include the following:

- having overall responsibility to prepare NAWCAD for the deployment of iNET Technology;
- providing guidance to users of the iNET Disruption Finder Guidebook;
- creating ad hoc SME teams to brainstorm disruptions;
- assigning ownership and responsibility for mitigation of disruptions;
- tracking the mitigation status of all potential disruptions to the deployment of iNET.

Technology

At the conclusion of the project, the Team delivered the following solution package to the project sponsor:

1. iNET Disruption Finder Guidebook—(a detailed guide for creating and using threat models);
2. iNET CONOPS document—(how the guidebook and committee work);
3. iNET Master Disruption List (FMEA)—(containing 256 disruptions with failure modes and effects);
4. MOU—(an MOU binding cross-competencies to participate on the iNET AIR 5.0 Steering Committee);
5. iNET AIR 5.0 Steering Committee Charter;
6. recommendation for iNET Steering Committee first agenda & schedule; and
7. recommendation for SMEs by name for Steering Committee participation.

Implementation status

The project sponsor is actively pursuing full implementation of all the recommendations from the iNET AIRSpeed Team. The SES Level leadership of the NAVAIR Ranges, Flight Test, and Laboratories have agreed to the MOU. □

BRIAN ANDERSON is a program analyst for NAVAIR Ranges at Patuxent River, Maryland. He is a former aircrewman with the United States Navy and has logged many hours in rotary wing aircraft as a United States Naval rescue swimmer. Mr. Anderson earned his degree in liberal arts through Navy Campus and is a graduate of the Naval Leadership Development Program. He is also a NAVAIR Certified Lean Six Sigma AIRSPEED Black Belt. His awards include the "Boeing-Vertol Rescue Award," the Patuxent River "Failure Controller Award,"

and the Patuxent River "Citation for Safety." Mr. Anderson has 27.5 years of federal government service, primarily dedicated to designing, developing, and installing airborne instrumentation systems. He is currently working with the NAVAIR Ranges Air Vehicle Modification and Instrumentation Department (AVMI) managing aircraft prototyping programs. E-mail: brian.anderson@navy.mil

DANIEL S. SKELLEY led the iNET Study and is currently the chief architect of the iNET Development Project. He has worked in telemetry for more than 25 years. He has a bachelor of science in engineering degree from the University of Central Florida and a master of science in electrical engineering in communications theory degree from George Washington University. Dan has held positions ranging from instrumentation engineer to the head of Aircraft Instrumentation for the U.S. Navy. He has served as the chairman of the Telemetry Group of the Range Commanders Council and is a NAVAIR associate fellow. In addition, Dan served as the 2000 technical chairman for the International Telemetry Conference. E-mail: daniel.skelley@navy.mil

RAYMOND FAULSTICH is a senior engineer and technical telemetry consultant with the Computer Sciences Corporation, Range and Engineering Services Division in Lexington Park, MD. He augments the integrated Network Enhanced Telemetry project office and execution

team, providing management and technical advice and support. Mr. Faulstich has worked in telemetry for over 35 years. He has held positions ranging from an instrumentation engineer to the director of test article preparation for the U.S. Navy. During this time he has worked on both U.S. Army and Navy test ranges. He has extensive experience with the Range Commanders Council, having served as the chairman of the technical representatives, the Telemetry Group, and the Vehicular Instrumentation Committee. He has a bachelor of electrical engineering degree and a master of science in electrical engineering degree from Georgia Tech and a master of science degree in weapons and vehicle systems from the Royal Military College of Science, Cranfield University in England. E-mail: rfaulstich@csc.com

Acknowledgments

The authors would like to recognize and sincerely thank the members of the AIRSpeed Team. Their enthusiasm, dedication, and insight have led to a truly unique solution that will pave the way for seamless integration of iNET technology at NAWCAD Patuxent River.

Last, the authors want to thank the Director of the Central Test and Evaluation Investment Program. Without his support, the iNET Project would simply not exist.




Mark Your Calendar

T&E in the Acoustical Arena

November 16 – 19, 2010

Kauai, Hawaii



Hosted by the ITEA Mid-Pacific Chapter

Visit www.itea.org for more details

MARK YOUR CALENDAR

9TH ANNUAL DIRECTED ENERGY TEST AND EVALUATION CONFERENCE

PLANNED SPECIAL FEATURES:

- Air Armament Center Perspective
- DE Task Force
- Naval Air Systems Command DE Office
- Air Force Research Lab
- Modeling and Simulation for DE
- S&T/Science & Research/T&E
- T&E Lessons Learned
- Airborne Tactical Laser Panel
- Army Laser Testbed
- Maritime Laser Demonstrator Program
- Data Sharing and Standardization
- Over the Horizon Testing



For More
Information
visit
www.itea.org
or
www.deps.org

AUGUST 3-5, 2010

ALBUQUERQUE, NEW MEXICO