24th ITEA Test and Training Instrumentation Workshop

Innovating for Tomorrow's Challenges

04/12/21 REV E

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11-May First Day – Tutorials

8:00 a.m. – 12:00 p.m. Morning Tutorials

Basics of Aircraft Instrumentation Systems

Bruce Johnson, NAWCAD

This course will cover a wide variety of topics related to Aircraft Instrumentation. Data, Telemetry, Instrumentation System Block Diagram, Standards, Data Requirements, Transducers / Specifications, Video, 1553 Bus, Using Requirements to Configure an Analog Data Channel, Creating a PCM Map to Obtain a Sample Rate, Telemetry Bandwidth, Record Time, GPS, Audio, Telemetry Attributes Transfer Standard (TMATS), and Measurement Uncertainty - Interpreting the Results. This is great introduction for new hires or a refresher for current employees.

IRIG 106-17 Chapter 7 Packet Telemetry Downlink Basis and Implementation Fundamentals

Johnny Pappas, Safran Data Systems, Inc.

This course will focus on presenting information to establish a basic understanding of the 2017 release of the IRIG 106, Chapter 7, Packet Telemetry Downlink Standard. It will also focus on the implementation of airborne and ground system hardware and methods to handle IRIG 106, Chapter 7, Packet Telemetry data. The presentation will address the implementation of special features necessary to support legacy RF Transmission, data recording, RF Receiving, Ground Reproduction, and Chapter 10 data processing methods.

Predictive Analytics for Performance Assessment

Mark J. Kiemele, Air Academy Associates

Design of Experiments (DOE) is a method that can and should be used not only in the design and development of systems, but also in the modeling and validation of system performance. Building useful prediction models and then validating them can ease the burden of making procurement decisions. This tutorial will examine two prototypes that are built to satisfy a common set of requirements. DOE will be used to model the performance of each prototype. Then validation testing will be used to confirm the models and assess the performance capability of each prototype, i.e., how well the prototypes meet the requirements. This facilitates a comparison of the capabilities of the two systems, thereby enhancing the decision as to which system to pursue. There are no pre-requisites for this tutorial, as the analysis will be demonstrated via computer.

Troubleshooting Ethernet Data with Wireshark

Paul Ferrill, ATAC

The "Troubleshooting Ethernet Data with Wireshark" tutorial will use real-world aircraft data to demonstrate how to use the open source program Wireshark to both view data and troubleshoot problems. The class will include presentation and hands-on usage of Wireshark to look at data as if you were connected to the Ethernet network on an airplane and if you were connected to an IRIG 106 Chapter 10 recorder broadcasting data over UDP. We'll start out with a brief overview of Ethernet fundamentals and then get right on to using Wireshark.

Video and Video Compression

Gary Thom, Delta Information Systems

With the growing complexity of flight test programs and the improved efficiency of compression algorithms, video is an ever increasing component of flight test data collection. This tutorial will provide a basic understanding of video interfaces. This will include a discussion of the signals, formats, resolutions and frame rates. Building on those basics the tutorial will then present a high level description of how video compression works and the trade-offs that can be made when selecting and implementing video compression components. An overview of various video compression algorithms will be provided, highlighting the differences between the algorithms. We will examine the effects of video compression on video quality and investigate some of the causes and resolutions of quality problems. Finally, there will be a brief overview of audio compression.

1:00 p.m. – 5:00 p.m. Afternoon Tutorials

JPEGXS vs H.264/H.265: Why JPEGXS is Better, Faster, and More Reliable

Paul Hightower, Instrumentation Technology Systems (ITS)

There are three ways to see video; uncompressed, lightly compressed and highly compressed. For the small screen highly compressed video is widely used. For the big screen and for content generation lightly compressed video may be used. The best video of course is uncompressed. Uncompressed video delivers to your eyes what the camera sees; all the detail and all the colors with near instantaneous presentation (no latency). Few of us ever experience this level of video because storage and transport bandwidth simply cannot meet the requirements for its use. Very high end equipment is needed which quickly becomes out of economic reach except for the most demanding purposes.

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Enter video compression technologies. Video compression has evolved to address transport and storage issues in general. However, two strategies emerged. The Motion Picture Experts Group (MPEG) focused on transport in narrow band environments and low storage capacity while maintaining good image quality. The Joint Photographic Experts Group (JPEG) remained image quality focused thus requiring more storage capacity and broader bandwidths for transport. MPEG became the most widely used system since endpoint distribution to the masses had to be delivered over narrow band channels (e.g., television, cable, satellite). At the turn of the century, storage costs were still high providing an additional economic pressure to reduce the size of video archived files. Compression ratios of 500:1 or more is needed to meet these challenges. MPEG 4 part 10 (aka H.264) met these challenges and is the most widely used compression system for video. As 4K video emerged, even more compression was needed (up to 2000:1)which was met with the development of H.265 (aka HEVC). H.264 and H.265 (HEVC) and produce relatively good image quality for the small screen in transport bandwidths of less than 10 Mb/s. The image quality is not good enough for the big screen and is not used. The compression tools used in MPEG also introduce significant latency from source to destination. Latency can be as high as 10 seconds! However, for distribution of pre-recorded videos latency is not an issue. It does limit its uses for man-in-the-loop applications such as camera positioning. MPEG enabled widespread distribution but compromises the image quality delivered by the camera. VCR features like fast forward, single step, and backwards play is difficult if not impossible. The high compression also increases the opportunity for corruption and total video stream loss with transport noise and packet loss.

In the year 2000, JPEG changed the underlying method of image compression to one which can provide light compression that is visually lossless when compared to the original image. Other advantages are very low latency (under a millisecond is achievable) more resilience to transport noise, full VCR playback features. Over the past ten years, storage costs have become miniscule and transport bandwidths have grown from a few megabits/second to tens of gigabits/second. These advances now enable a wider use of lightly compressed video using the JPEG standard. The new JPEG XS is a fast, low latency, low complexity, and visually lossless compression system for video streams. Combined, JPEGXS encoding offer the engineering and test community far superior image quality for evaluation and performance studies. Man-in-the-loop applications become practical due to the low latency. Frame-by-frame imagery is identical to that which the camera captured thus delivering all the investment made in the camera and lenses to your eyes. Each frame is individually encoded delivering high image quality at each frame, eliminates Group of Picture (GOP) image loss and enables smooth forward/reverse and frame step playback. Images reconstructed from a JPEGXS encoder exhibit no macroblocking and introduces few if any artifacts of compression. We will explore all these issues in depth and explain why JPEG XS is able to deliver these benefits.

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iNET Telemetry Networks

Thomas Grace, NAVAIR

Chapters 21 through 28 of the Range Commanders' Council (RCC) IRIG-106 standards were developed to support a wide variety of components and system compositions. This tutorial provides a quick overview of these IRIG standards along with providing insight into the new capabilities that systems using these standards can utilize. The presentation includes current performance measured through the developmentally flight-tests. It is intended for anyone who wants an introduction or update on the current status of the TmNS technologies and system capabilities.

Real World Telemetry over IP

Gary Thom, Delta Information Systems

As telemetry ranges are making the move to network centric architectures, it is worth considering the lessons learned over the previous 10 years of designing, installing, troubleshooting and optimizing telemetry data distribution over IP networks. This tutorial will begin with the motivation for moving to Telemetry over IP (TMoIP). It will then provide a basic networking foundation for understanding TMoIP and TMoIP formats. With this basis, we will be able to discuss network design considerations and tradeoffs for a successful TMoIP deployment. Finally, we will present some of the real-world problems and issues that may arise in a TMoIP system and the troubleshooting techniques that can be used to resolve them.

TENA, JMETC, and BDKM for Distributed Testing

Gene Hudgins, JMETC/TENA

The Test and Training Enabling Architecture (TENA) was developed as a DoD Central Test and Evaluation Investment Program (CTEIP) project to enable interoperability among ranges, facilities, and simulations in a timely and cost-efficient manner, as well as to foster reuse of range assets and future software systems. TENA provides for real-time software system interoperability, as well as interfaces to existing range assets, C4ISR systems, and simulations. TENA, selected for use in Joint Mission Environment Test Capability (JMETC) events, is well-designed for its role in prototyping demonstrations and distributed testing.

JMETC is a distributed LVC testing capability developed to support the acquisition community during program development, developmental testing, operational testing, and interoperability certification, and to demonstrate Net-Ready Key Performance Parameters (KPP) requirements in a customer-specific Joint Mission Environment.

JMETC uses a hybrid network architecture. The JMETC Secret Network (JSN), based on the SDREN, is the T&E enterprise network solution for secret testing. The JMETC Multiple Independent Levels of Security (MILS) Network (JMN) is the T&E enterprise network solution for all classifications and cyber testing. JMETC provides readily available connectivity to the Services' distributed test capabilities and simulations, as well as industry test resources. JMETC is also aligned with the Joint National Training Capability (JNTC) integration solutions to foster test, training, and experimental collaboration.

TENA provides the architecture and software implementation and capabilities necessary to quickly and economically enable interoperability among range systems, facilities, and simulations. TENA also fosters range asset reuse for enhanced utilization and provides composability for assembling rapidly, initialize, test, and execute a system from reusable, interoperable elements. Because of its field-proven history and acceptance by the range community, TENA provides a technology already deployed and well tested within the DoD.

Enterprise Big Data Analytics (BDA) and Knowledge Management (BDKM) has the capacity to improve acquisition efficiency, keep up with the rapid pace of acquisition technological advancement, ensure that effective weapon systems are delivered to warfighters at the speed of relevance, and enable T&E analysts across the acquisition lifecycle to make better and faster decisions using data that was previously inaccessible, or unusable. BDA is the application of advanced tools and techniques to help quickly process, visualize, understand, and report on data.

JMETC has demonstrated that applying enterprise distributed BDA tools and techniques to T&E, leads to faster and more informed decision making that reduces overall program cost and risk. This presentation will inform the audience as to the current impact of TENA, JMETC, and BDA on the T&E community; as well as their expected future benefits to the range community and the warfighter.

Test and Evaluation of Laser and Electro-Optical Systems

Douglas Nelson, Teknicare, Inc.

An introduction to the challenges of testing and evaluating laser and electro-optical systems. An overview of the basic physics and terminology of these systems is included. The unique capabilities of laser and electro-optical systems are also discussed to provide a foundation for test objectives. Test and evaluation needs for laser and electro-optical systems including required diagnostic beam propagation and atmospheric measurements are briefly examined.

Please join us in the virtual exhibit hall from 12:00-3:00pm.
Attendees will be able to video chat with exhibitors during this time.

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12-May Second Day - Plenary Sessions, Technical Sessions, & Exhibits

8:00 a.m. Welcome:
Mr. Pete Crump – ITEA President
STAR Spangled Banner
Mr. Michael Elliott, TIW Program Chair

8:15 a.m. Opening Speaker: Brigadier General Matthew Higer, Commander, 412th Test Wing, Edwards AFB – ***"TBD"***

Description coming soon.

9:10 a.m. Keynote Speaker: George Rumford, Director (acting), TRMC– ***"TBD"***

10:00 a.m. 15- minute Break. Please take this time to visit the virtual exhibit hall

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Chair	Time	Title	Presenter(s)
Track 1: Data Analytics			
Larry Freudinger, 412TW, 812 TSS/ENTI	10:15	*Using Docker-Compose to simulate sophisticated infrastructure in development*	Micah Ferrill, ATAC
	10:45	*Genisys: A Team approach to next generation data analytics*	Brandon Burfeind, 412th TW
	11:15	*Building an Agile Knowledge Management Data Center*	Eric Stith, JT4
	11:45	*CHEETAS 3.0: Architecture and Roadmap*	Chris Moyer, TRMC
Track 2: Network Telemetry/Instrumentation Development			
Robert Bieze, JT4	10:15	*Wireless Instrumentation Demonstration & Development At Edwards*	Robert Bieze, JT4
	10:45	*Telemetry Software and System Documentation Made 'Easy'*	Mike Delaney, 812th Aircraft Instrumentation Test Squadron
	11:15	*Wireless Cockpit Interface for F-16 High Speed Camera System*	Benjamin Baird, 896th Test Support Squadron, Eglin Air Force Base
	11:45	*Exploring IRIG 106 TmNS Data Transport Options*	Carl Reinwald, Laulima

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Track 3: Airborne Instrumentation			
James Alich, 412 TW	10:15	*The Future of Flight Test Recorders in a TmNS World*	Mike Delaney, 812th Aircraft Instrumentation Test Squadron
	10:45	*Bomber Modular Data Acquisition System Overview*	Trevor Londergan, Design Engineer, JT4
	11:15	*Digital Model Thermal Engineering Validation*	Joseph Lopez, Design Engineer, JT4
	11:45	*Design for unknown requirements (Instrumentation control)*	Justin Denning, 812th Aircraft Instrumentation Test Squadron
Track 4: Mission Control Systems			
Delane Alan, JT4	10:15	*Next Generation Hardware Decommutation of Real-Time Telemetry Data Using State-of-the-Art Technology*	Cedric Meyers, JT4
	10:45	*HD, 4K and 8K Video Decoding with Inexpensive COTS Products*	Steve Olsen, JT4
	11:15	*TENA on an SoC*	Dr. Scott C. Wolfson, Electronics Engineer, U.S. Army Redstone Test Center
	11:45	*Software-based Video Broadcast for Large Networks*	Sean Hawkes,412th ENRES
Track 5: sUAS			
Edward Trzcienski, BlueHalo	10:15	*sUAS DEW Profiler for DE Mission Planning: Field Test and Operations*	Dr. Steven Fiorino, Air Force Institute of Technology, Center for Directed Energy
	10:45	*sUAS Weather Profiler for DE Mission Planning Fire Control*	Dr. Steven Fiorino, Air Force Institute of Technology, Center for Directed Energy
	11:15	*HPM Sensor on Instrumented sUAS Update*	Mr. W. Mark Henderson, BlueHalo
	11:45	*Development and Testing of Airborne and Ground Based Nodal Atmospheric Characterization Tools*	Alex Clark, BlueHalo, Distributed Operations

12:15 p.m. Lunch Break – Please take this time to visit the virtual exhibit hall

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1:15 p.m. **Digital Revolution and how Data Analytics fits**
This panel will ……. TBD

Panelists:

- Col Randel "Laz" Gordon, Vice Commander, 412 Test Wing *(Invited)*
- Joey, Arora, Program Manager, Platform One
- Major Brandon "Siphon" Burfiend, F-22 Test Pilot, Genisys Director
- Jeffery Corn, Flight Chief, Test Techniques Development Flight Chief, 812 TSS

2:15 p.m. Keynote Speaker: Catherine Bahm, NASA's Deputy Project Manager for the Low Boom Flight Demonstrator (LBFD) X-59 project – ***"TBD"***

1:15 – 5:15 p.m. EXHIBIT HALL FACE-TO-FACE MEETINGS

13-May Third Day - Plenary Session, Technical Sessions, & Exhibits

8:00 a.m. Welcome and overview of the day's events
Mr. Chris Newman – TIW Technical Chair

8:15 a.m. Opening Speaker: Scott Kirsner, Chief Executive Officer, Innovation Leader – ***"TBD"***
Description coming soon.

9:10 a.m. Keynote Speaker: Vandad Espahbodi, Co-Founder and Managing Partner, Starburst Aerospace – ***"TBD"***

10:00 a.m. 15- minute Break. Please take this time to visit the virtual exhibit hall

Chair	**Time**	**Title**	**Presenter(s)**
Track 6: Cellular Technologies			
Thomas O'Brien, TRMC	10:15	*A Vision for Cellular Telemetry*	Thomas O'Brien, TRMC
	10:30	*Cellular 4G LTE Aeronautical Mobile Telemetry Flight Test Results*	Achilles Kogiantis, Perspecta Labs
	11:00	*Flightline Radio Network Project Summary and Next Steps*	Vinayak Hegde, Nokia
	11:30	*Cellular Range Telemetry Project Summary and Next Steps*	Bob Picha, Nokia
	12:00	*Cellular Range Telemetry Evolution to 5G and Future Flight Testing*	Kiran Rege, Perspecta Labs

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Track 7: Program Management & Systems Engineering			
Dr. Paul Waters, 412TW	10:15	*A Conceptual Framework for Flight Test Management Utilizing Agile Development and Project Management Concepts*	Craig Hatcher, 812 TSS/ENTI, 412th TW, Edwards AFB
	10:45	*Digital Engineering and T&E*	Dr. Paul Waters, 412 TW
	11:15	*Strategic Planning*	**TBD**
	11:45	*Utilizing JAMA for requirements Management*	**TBD**
Track 8: Innovation			
Hans Lambrecht, JT4	10:15	*Test Resource Management Center Authorizing Official Overview*	Chip Ferguson, TRMC
	10:45	*The Future of Hybrid Test Environment is Now*	Joseph Stasiowski, FAA
	11:15	*Synthetic Flight Test Data for Big Data Computing*	Bob Baggerman, ATAC
	11:45	*Digital Engineering Innovation Approach for Airborne Instrumentation*	Mike McAlister, 896TSS/RNMEF
Track 9: Cyber T&E and RMF			
Jayson Ek, JT4	10:15	*A Cyber Security Analysis of Development Environments*	Megan Fischer, JT4
	10:45	*Cybersecurity in the Fast Lane: Develop Secure and Compliant Systems the First Time*	Ryan Christiansen, JT4
	11:15	*Information Security*	Robert Hill, 96th RANS
	11:45	*Cybersecurity in the Operational Technology World*	Steve Seiden & Leighton Johnson, Acquired Data Solutions

12:15 p.m. **Lunch Break – Please take this time to visit the virtual exhibit hall**

1:15 p.m. Closing Speaker: Norm Eng, Vice President, Research, Technology, & Engineering, Northrop Grumman – ***"TBD"***

1:15 – 5:15 p.m. **EXHIBIT HALL FACE-TO-FACE MEETINGS**

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Technical Track Session Abstracts

A Conceptual Framework for Flight Test Management Utilizing Agile Development and Project Management Concepts

Craig A. Hatcher, PMP, 412th TW

Tracking schedules for flight test is difficult in a traditional network based scheduling paradigm. Traditional network based scheduling relies on being able to lay out a plan and follow it during project execution without many changes. This paradigm begins to struggle when the plan changes often. Flight test is a very dynamic endeavor. Scope changes frequently based on what is learned in test. Data is also collected at different times than planned due to the realities of test execution. As a result schedules are quickly out of date from both a time and resource usage standpoint. To compensate, network schedules are raised to a very high level to capture blocks of work. Insight into true progress is lost in the process.

The software industry has moved away from network scheduling techniques toward Agile techniques and processes to manage projects. The reason for this paradigm shift is due to the volatile nature of software projects. User needs and scope changes often as users refine what they truly need. Comprehensive network schedules become obsolete quickly. Agile methods have been invented to minimize upfront planning and embrace scope changes as normal and necessary during the project lifecycle.

Flight test and software development projects share similar characteristics. They both are very volatile and require constant management of changes. This presentation will outline a conceptual framework that describes how Agile techniques, concepts, and processes can be used to monitor and execute flight test. In addition, this presentation will show how Agile techniques enable a throughput metric to be constructed that can provide the basis for understanding the capacity of an organization to do work.

A Cyber Security Analysis of Development Environments

Megan Fisher, JT4

Development environments are critical to designing and fielding new technology, but present a particular challenge for the cyber security profession. These environments need to be particularly agile to accomplish their mission, so traditional controls cannot always be applied without sacrificing performance. How do we secure our development environments without limiting their ability to develop? To help answer this question, the 412TENG recently completed a Cyber Table Top (CTT) on a representative development environment. This presentation will take a look at the motivations that drove the 412th to execute a development environment CTT, review the processes applied to this particular table top, discuss the general findings from the exercise and touch briefly on how to display CTT data in a way that will engage leadership.

Bomber Modular Data Acquisition System Overview

Trevor Londergan, JT4

The Bomber Instrumentation Team from the 812th Aircraft Instrumentation Test Squadron (AITS) at Edwards Air Force Base needed a data acquisition system that would serve as the optimal backbone for test B-52H Stratofortress aircraft at Edwards for current and future instrumentation requirements. The modular Ethernet based system would be expandable so that when future programs required additional data parameters to be captured the aircraft would only be grounded for a month or two instead of 6-8 months. The modular tray design allows not only for each subsystem to flow from the laboratory test environment to airborne instrumentation seamlessly but it also successfully has integrated into other programs and aircraft platforms. Due to flexibility of the system, BMDAS is already been established as backbone for the Radar Modernization Program (RMP). The future of BMDAS will be used to collect thousands of analog parameters, including strain, vibration, acoustics, temperature, and flow on the Commercial Engine Replacement Program (CERP) aircraft. The overall success of the system on the B-52H has caused the Bomber Instrumentation Team to investigate the feasibility of incorporating BMDAS on the B-1BLancer test aircraft.

Building an Agile Knowledge Management Data Center Results

Eric Stith, Sebastian Rainer, & Mike Elliott, JT4

Test and Engineering has a large amount of data that's isn't being widely shared and cross-utilized. The CPDC is an attempt to improve collaboration and sharing in T&E, with a focus on building common tools that everyone can use and that work well together. This talk will discuss the reasons for adopting an Agile development process to deliver tools that are useful, and that encourage different test facilities to work together.

Cellular 4G LTE Aeronautical Mobile Telemetry Flight Test Results

Achilles Kogiantis, Perspecta Labs

Flight test results on an Aeronautical Mobile Telemetry (AMT) system employing 4G Long Term Evolution (LTE) Cellular Technology are presented. The AMT system employs a ground network of commercial off the shelf cellular base stations. Very high Doppler shifts due to the high speed of the Test Article (TA) is handled by an appliqué front-end to a COTS mobile transceiver. Doppler compensation allows seamless operation of LTE as the TA traverses the coverage area. The results clearly demonstrate the system can sustain an uninterrupted LTE connection at Doppler shifts, which are much higher than what typical commercial LTE systems can support. High bi-directional data rates up to a maximum range of 60km were achieved, as well as an uninterrupted radio link in both directions. The test confirmed that an appliqué equipped airborne COTS LTE transceiver can successfully operate at high aircraft speeds in a cellular network approach with direct extension to 5G technologies.

Cellular Range Telemetry Evolution to 5G and Future Flight Testing

Kiran Rege, Perspecta Labs

The recently completed Cellular Range Telemetry flight testing with 4G LTE has paved the way for a transition to the next generation 5G system, which will enable testing at higher aircraft speeds over broader areas in the testing range. The current 5G standardization efforts will conclude the NR Release 17 specification by early 2022, offering significantly enhanced capabilities that can be leveraged to design an improved airborne telemetry scheme based on cellular infrastructure. These capabilities include faster and more robust handover mechanisms, integrated access and backhaul, long-range links, along with the already built-in flexibilities provided by the new NR air-interface (e.g. dynamically configurable bandwidth occupancy, and multi-connectivity). We give an overview of how the existing Doppler compensation appliqué designed for 4G is extended for 5G NR, and the challenges of conducting testing at higher speeds in terms of environmental factors, airborne unit SWaP, and network design. The lessons learned during Telemetry testing on the 4G platform will be critical in guiding the work into the 5G era.

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Cellular Range Telemetry Project Summary and Next Steps

Bob Picha, Nokia

The main goal of the Cellular Range Telemetry (CRTM) project, managed by the Test Resource Management Center (TRMC) and funded through Spectrum Access R&D Program, is to evaluate and demonstrate how commercial cellular technology can be used to improve the spectral and operational efficiency of Aeronautical Mobile Telemetry (AMT) systems and determine what enhancements may be required to operate effectively in this environment. Particular areas investigated include the ability to provide RF coverage over a test range using multiple "cells" with fixed-beam antennas at C-band frequencies, the ability to provide seamless handover between cells as the test aircraft executes the airborne segment of a test event, and the ability of a C-band system to operate with Doppler-induced frequency shifts expected for aircraft flying at MACH 2 and beyond. The successful demonstration of the CRTM proof-of-concept occurred at Edwards Air Force Base with the support of the TRMC, EAFB Range Squadron, Flight Test Squadron Holloman AFB, and others.
Airborne RF coverage for the proof-of-concept system was provided by a twelve cell ground station network, with three cells deployed at each of four ground station sites. The radios used were based on a commercial platform and modified to operate at C-band frequencies. Baseband processing at each site was provided by a commercial LTE eNodeB equipment. Backhaul from each site to an LTE core network was provided through 1000baseT and microwave links. The Airborne Terminal proof-of-concept was designed using a commercial LTE SDR implementation with modifications for Doppler compensation. Commercially available RF components were used for the transmit and receive signal paths. This presentation summarizes the lab and flight test results and looks forward at the next steps required to advance the technology.

CHEETAS 3.0 Architecture and Road Map

Christopher Moyer, TRMC

Over the past year, CHEETAS has expanded its user base and efforts to include additional platforms and data types. This growth has resulted in recognition that the CHEETAS architecture needs to evolve into a service-oriented architecture with increased cross platform capabilities and containerization support. This talk will begin introducing the community to the planned design changes, operational differences, and new functionality.

Cybersecurity in the Fast Lane: Develop Secure and Compliant Systems the First Time

Ryan Christiansen, JT4

Cybersecurity can often be confusing, ever changing, and feel like a hindrance to system development. Understanding the roles of cybersecurity personnel in the system development lifecycle can expedite approvals and procurement and provide clear, actionable requirements. This presentation will outline how the Risk Management Framework (RMF) parallels the development lifecycle and effective ways to improve system requirements and compliance. Included will be the inputs needed by the cybersecurity personnel along with the expected outputs from the RMF process. Avoid unforeseen delays and vulnerability potholes by integrating the cybersecurity workforce early and often.

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Cybersecurity in the Operational Technology World
Steve Seiden, Acquired Data Solutions

As Federal requirements for cybersecurity protection increase, so has the importance and need to demonstrate how OT is compliant with these standards. As networks and data become a bigger part of test and measurement systems and instruments, the need for compliance to cybersecurity standards has grown. Test and measurement equipment have become a bigger part of IT, and IT requirements have become a bigger part of test and measurement equipment. Meeting Federal requirements means showing evidence of a secure supply chain, protection of sensitive information, and readiness to mitigate cyber-attacks. Acquired Data Solutions will cover preparing your equipment to comply with today's government standards and the necessary artifacts.

Designing for Unknown Requirements
Justin Denning, 812th Aircraft Instrumentation Test Squadron

Equipment designs for flight test must be functional, rock solid, and flexible to support the inevitable changes in requirements throughout the test program. This presentation will walk through a few of our recent smart designs and we will discuss the mind set we have adopted allowing us to create boxes that not only meet the current requirements, but can easily adapt to changes or even serve a completely different purpose by way of minimal hardware changes, or simply through modifying code.

Development and Testing of Airborne and Ground Based Nodal Atmospheric Characterization Tools
Alex Clark, BlueHalo

With High Energy Laser systems moving from prototype to field testing there has been an increased need for novel Nodal Atmospheric Characterization systems to make measurements of refractive index structure coefficient, Cn2, where integrated path atmospheric characterization systems are not practical. To fill this need Airborne and Ground based Nodal Atmospheric Characterization systems composed of Optical Differential Temperature sensors and miniature sonic anemometers have been developed and tested. The design, testing, and date reduction of airborne and ground based atmospheric characterization systems is the focus of this presentation.

Digital Model Thermal Engineering Validation
Joseph Lopez, Design Engineer, JT4

The purpose of the thermal chamber test is to gather a spectrum of thermal data to increase the fidelity of thermal simulations for future line-replaceable unit (LRU) designs. Data acquisition systems with data recorders are commonly used in airborne instrumentation to capture the various data parameters required, which can generate sufficient heat that exceed the upper thermal limits of electrical components within the LRU. The experimental results from the LRU thermal chamber test is then used in a numerical-thermal simulation to narrow the possible values of the convection and conduction cooling factors to more accurately define expected thermal properties for future thermal tests and LRU designs. The test results obtained from the digital model thermal validation will then help reduce overall Air Force program costs and prevent flight schedule slippage by avoiding possible redesign and rework of LRUs.

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Exploring IRIG 106 TmNS Data Transport Options

Carl Reinwald, Laulima Systems

The IRIG 106 Telemetry Network Standards (TmNS) define a wealth of network-based capabilities for next generation flight test systems. This presentation explores the two distinct data transfer methodologies defined in IRIG 106 Chapter 26: Metadata-Defined and Request-Defined Application Data Transfer. Both methods define the instantiation of TmNS Data Channels, which are used to transfer TmNS Data Messages.The TmNS Data Message structure is briefly examined along with the TmNS Metadata Description Language (MDL), which is used to describe a TmNS Data Message's structure. MDL-described TmNS Data Messages provide great flexibility for managing the data being telemetered from a test article. The network transport characteristics, e.g., UDP and TCP, associated with the two data transfer methodologies are examined. The presentation concludes with an exploration of various data retrieval options available via the Request-Defined Data Transport method.

Flightline Radio Network Project Summary and Next Steps

Vinayak Hegde, Nokia

The main goal of the Flightline Radio Network (FRN) project, managed by the Test Resource Management Center (TRMC) and funded through Spectrum Access R&D Program, is to demonstrate how commercial cellular technology can be used to increase the availability of Aeronautical Mobile Telemetry (AMT) resources for flight testing by off-loading data collection during ground/flight line operations and seamlessly handing over the data flow to existing serial streaming network when ready to fly. Particular aspects evaluated include providing RF coverage for maintenance ramps and taxiways out to "last chance" at C-band frequencies and providing seamless handover between the Flightline Radio Network and existing the existing serial streaming AMT system as the test aircraft moves between ground and airborne test segments. Due to the constraints of the COVID-19 lockdown, the FRN demonstration originally planned for Edwards Air Force Base was modified and run at the Nokia facility in Naperville, Illinois with remote support provided by the TRMC, EAFB Range Squadron, and others.

RF coverage for the proof-of-concept system was provided by a two cell ground station network, deployed at a rooftop location on the campus. The radios used were based on a commercial platform and modified to operate at C-band frequencies. Baseband processing was provided by a commercial LTE eNodeB equipment. The Airborne Terminal proof-of-concept was designed using a commercial LTE SDR implementation with modifications to allow manual and automatic handovers between the flight-line network and a simulated AMT system. Commercially available RF components were used for the transmit and receive signal paths. This presentation summarizes the lab and over-the-air test results and looks forward at the next steps required to advance the technology.

Genisys: A Team Approach to Next Gen Data Analytics

Brandon Burfeind, 412 TW

Know your enemy and know yourself... the old Sun Tzu quote applies just as much today as when it was written. Our ability to understand our capabilities is dependent on our ability to effectively test. The test and evaluation community must face the harsh reality that we collect mountains of data that mostly goes unused; there exists plenty of room for improvement regarding the speed and quantity of decision-impacting knowledge extracted from our analyses. Next Gen Data is a paradigm shift which makes data available for engagement at the engineering, tactical, and operational levels, en masse. It is critical that we build and sustain the proper infrastructure, data platform, and applications to enable this engagement. This data will be used to conduct engineering evaluations, develop tactics, build operational plans, and improve models. The power of data must be harnessed to take test and evaluation into the future.

HD, 4K and 8K Video Decoding with Inexpensive COTS Products

Stephen Olsen, JT4

Video decoding can be accomplished with inexpensive COTS products. High resolution video decoding has been prohibitive in the past with high bitrates and high CPU utilization. In recent years mainstream commercial hardware manufacturers have been integrating dedicated video encoding and decoding modules for use in general computing.

NVidia, Intel, AMD, and Microsoft have developed comprehensive APIs to access dedicated video hardware, as internet video and streaming have increased. These APIs make it relatively easy for developers to access dedicated video hardware such as GPUs or Integrated CPU graphics.

This technical session will discuss:

- Codecs commonly supported by COTS hardware, such as H.264, H.265, MPEG-2, VP8, VP9, which are also used for internet video such as Netflix, YouTube, and Twitch, and T&E instrumentation applications.
- COTS hardware video decoding devices such as nVidia video cards, Radeon video cards, Intel Quick Sync Video.
- APIs and SDKs used to create software to decode video such as NVDEC, Intel Media API, Windows Media Format SDK, AMD Media SDK.

During this session it would also be good to determine, by a rough poll of a group of people, if there is interest for further investigation into a detailed analysis of bitrate, latency, quality, and processing requirement comparison across different codecs, and encoder settings optimization.

Additionally, new codecs just introduced in 2020 may have potential in increasing the video capabilities in Test and Evaluation: H.266 VVC Versatile Video Codec, MPEG-5 EVC Essential Video Coding, MPEG-5 Part 2 LCEVC Low Complexity Enhancement Video Coding.

Next Generation Hardware Decommutation of Real-Time Telemetry Data Using State-of-the-Art Technology

Cedric J. G. Meyers, PhD, JT4

Telemetry decommutation is a critical step in the data flow of real-time flight test data collection. Hardware decommutation continues to be the fastest, most efficient, and most reliable method of decommutating flight-test data. However, the current technology is dated and the hardware is obsolete and unreliable. In addition, recent advances in network telemetry and timekeeping are driving new requirements for telemetry ground stations. These requirements may even change from mission to mission and control room to control room. Therefore, there is a strong need for an updated decommutation system that retains backwards compatibility with existing control room systems.

A new hardware decommutation system is being designed to fill the role of existing, aging systems while leveraging the latest state-of-the-art components and design. The flexible system design supports a wide range of requirements and unique implementations. The system is built on a trusted firmware core with extensive capabilities for future firmware enhancement. State-of-the-art design tools ensure robust hardware and firmware design to reduce failure vectors. Enhanced reliability features ensure uninterrupted and error-free uptime to support critical missions. This presentation will show the design concept of next-generation telemetry decommutation hardware and show how such a system will continue to support the ever-evolving data collection needs of telemetry ground stations and control rooms.

Software-based Video Broadcast for Large Networks

Sean Hawkes, 412th Range Squadron

At the Air Force Flight Test Center, tests are monitored and controlled in a Mission Control Room (MCR). These control rooms contain up to 50 workstations, each with 2 displays. There are also projector displays, server machines and a variety of incoming external video sources.

Our customers require that any display or video source be repeatable to any other display in the room. In each of these rooms, there is a video switch rack mount device that is connected to many other devices throughout the room, each connected to a workstation machine or projector. As a result, there exists an entire network in each room dedicated solely to transporting video.

This solution meets our customer's requirements for complete video distribution. However, the installation, maintenance and replacement costs have necessitated a more modern, lighter-weight solution.

Thanks to the increased processing power of general purpose computers and freely available software, the 412th Range squadron was able to develop a complete, software-based video distribution solution. The software executables are able to run on general purpose computers and video cards. The video signals are broadcast over IP using the standard Ethernet network that is already in place. Our presentation will demonstrate our solution and hopefully convey its light-weight, low-cost nature.

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sUAS DEW Profiler for DE Mission Planning: Field Test and Operations

Dr. Steven Fiorino, Air Force Institute of Technology, Center for Directed Energy

The Air Force Institute of Technology's Center for Directed Energy (CDE), the Army Test Resource Management Center (TRMC), and BlueHalo have developed a sUAS Directed Energy Weapon (DEW) profiler that can provide real-time correlated information on both a DEW's performance as well as on the ambient environment through which the DE beam is propagated. During system capability test and evaluation, the sUAS DEW profiler can provide a Test Director a means to optimize and anticipate courses of action to best employ the available capabilities—systems and personnel—to achieve test objectives. The sUAS DEW profiler is designed to carry a HEL irradiance profiling target board as well as mix of mini-atmospheric sensors which sweep up information on aerosol number concentration, optical turbulence, temperature, winds, and moisture gradients to feed radiative transfer codes such as the Laser Environmental Effects Definition and Reference (LEEDR) and DE beam propagation codes such as the High Energy Laser End to End Operational Simulation (HELEEOS). Using the in-situ micro-meteorological data as well as ingested numerical weather prediction (NWP) data, the latter tools will calculate both real-time and predicted beam broadening, thermal blooming, and transmission, as well as beam intensity profiles at the target. The latter real-time profiles can be compared with beam intensity profiles captured simultaneously by the sUAS HEL irradiance profiling target board, which in combination with the in-situ micro-meteorological measurements, leads to improved post-test

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forensic analysis. The real-time and NWP-predicted turbulence, aerosol, and thermodynamic profiles, in turn, will arm the Test Director with actionable information to facilitate test planning decisions, whether involving schedules, instrumentation mix, and personnel staffing. The sUAS DEW profiler can evaluate all horizontal, slant, and vertical paths of engagement throughout the boundary layer where the large majority of beam effects are known to occur.

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sUAS Weather Profiler for DE Mission Planning: Fire Control

Dr. Steven Fiorino, Air Force Institute of Technology, Center for Directed Energy

The DE-JTO Atmospheric Propagation Technical Area Working Group, Army TRMC, and an industry partner, BlueHalo, have developed a sUAS DEW profiler that is a key potential enabler for the Path Characterization System (PCS) capability central to DE mission planning and fire control. The sUAS DEW profiler has the capability—whether during test and evaluation or effects-centric air/land/littoral operations—to be used as a real-time assessment and forecast tool for HEL and HPM performance based on measured or observed atmospheric conditions. The sUAS profiler carries a mix of mini-atmospheric sensors which sweep up information on aerosol number concentration, temperature, winds, and moisture gradients to feed path-resolved data to LEEDR and HELEEOS. These models assess beam broadening, thermal blooming, and transmission for simulation tools such as the Effectiveness Tool Box (ETB). The sUAS profiler is designed and flown to evaluate all horizontal, slant, and vertical paths of engagement throughout the boundary layer where the large majority of beam effects are observed to occur. In its next increment, the sUAS DEW profiler will simultaneously record DEW irradiance and assess power in the bucket, both of which are fundamental outputs of the PCS for real-time DEW fire control capabilities.

Synthetic Flight Test Data for Big Data Computing

Bob Baggerman, Avionics Test and Analysis Corporation

There is currently quite a bit of development taking place within the DoD test range community in "Big Data" and cloud computing. A problem plaguing development is a lack of suitable flight test data sets for software development and test. Most actual flight test data has restricted distribution and so isn't available for many developers and platforms. Also, it can be difficult to find actual recorded flight test data which have "interesting" properties such as specific flight profiles and events.

Synthetic IRIG 106 Ch 11 format flight test data solves these problems by providing data files that are very similar to what might be expected from an actual flight test. Synthetic data files are data files that contain fake but realistic flight test data as if it had been recorded during an actual flight test. The data in these data files is designed to provide interesting test cases for developers to use.

A synthetic IRIG 106 data file is a complete and properly formed data file in compliance with IRIG 106. Currently these synthetic data files contain a number of different IRIG 106 Ch 11 data types including MIL-STD-1553, PCM, and video. This presentation will discuss the design approach and current status of this effort.

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Telemetry Software and System Documentation Made 'Easy'

Mike Delaney, 812th Aircraft Instrumentation Test Squadron

The documentation for software used in instrumentation and telemetry systems often is out of date or incomplete. Additionally, the pandemic and the influx of new engineers have made it harder to have on-site visits and training. This presentation will provide an overview of how software documentation can be produced easily using free and low-cost streaming tools to produce video tutorials, training, and can be used in software testing.

TENA on an SoC

Dr. Scott C. Wolfson, U.S. Army Redstone Test Center

There is an ever increasing need to miniaturize on-system instrumentation and provide standardized real-time control/status/data links between field instrumentation suites, tactical systems and networked computers during test events. To complicate matters further, these instrumentation suites are typically not collocated and may be exposed to the harsh environments at an open air test range, in a vehicle or on an aircraft. Test & Training Enabling Architecture (TENA) provides this functional capability but limiting factors such as software execution efficiency, command/response time periodicity and computer platform Size/Weight/Power requirements can impose use case constrains in closed-loop situations and other test activities where command/response times are critical. The primary objective of the proposed presentation and subsequent technical paper is to provide design details pertaining to an implementation method that addresses these use case limitations and report on the initial performance improvements achieved.
Modern Field Programmable Gate Array (FPGA) architectures can contain integrated microprocessors and is commonly referred to as a System-on-Chip (SoC). Instantiating TENA on an SoC addresses the identified limitations by utilizing several key characteristics of this architecture. Performance improvements are achieved using the concurrent processing features inherent to the FPGA while the microprocessor enables efficient TENA object model integration and network handling. Additionally, commercial off the shelf FPGA components typically meet or exceed the desired operational temperature range of -40 to 85 degrees C and reduce the overall Size, Weight and Power (SWaP) of instrumentation when compare to the existing PC based systems currently used for TENA implementations. These design aspects also address two primary requirements for Army/DoD on-system instrumentation. Specifically, instrumentation must operate in the same environment as the tactical test articles and must not adversely affect the operator or operation of the test article due to size, weight and power requirements.
Numerous tests are planned for the purpose of documenting and characterizing the achievable performance improvements realized by using this implementation method when compared to current sequential processor / operating system based architectures. The current Technical Readiness Level (TRL) of this design approach is estimated to be in the 4/5 range. Existing efforts will mature this design approach to TRL6 with future plans for deliverable Intellectual Property (IP) cores. When complete, end users will be able to easily instantiate TENA into the design of tactical weapon system and/or instrumentation products.
In summary, any reductions in instrumentation SWaP, improvements to test architectures and expanded use cases are highly desired in the Army/DoD test community. The TENA on an SoC design approach addresses these areas and advances the State of the Art (SoA) in this specific area.

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24th ITEA Test and Training Instrumentation Workshop

Innovating for Tomorrow's Challenges

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Test Resource Management Center Authorizing Official Overview

Bernard (Chip) Ferguson, Test Resource Management Center

TRMC is dedicated to ensuring the DoD (Department of Defense) Components have the right T&E (Test and Evaluation) Infrastructure to accomplish the T&E mission. To provide realistic battlefield environments to test weapon and C4ISR systems, the TRMC facilitates the integration of the National Cyber Range (NCR) Complex, Designated Ranges, and Service-owned ranges with live, virtual, and constructive (LVC) representations of these systems. Interconnected and with the proper instrumentation, these cyber range and LVC capabilities provide the necessary infrastructure to support Service T&E needs.

Mr. Ferguson will brief the processes and procedures of accomplishing the requisite Authority to Operate, to include ATO signature, to integrate the correct test instrumentation necessary for successful test execution. Mr. Ferguson will brief the procedures associated with Network Related, Instrumentation Related and Software Related ATOs. In addition, Mr. Ferguson will discuss the lessons learned from integrating Telemetry Receive and Record System, Optical Thermal Imaging System, High-fidelity Automated Airborne Reconfigurable Tracking System, and Light Detection and Ranging System into the test environment. Finally, Mr. Ferguson will brief how TRMC identifies the associated cybersecurity risks and how TRMC works with the instrumentation developer to find risk mitigation.

The Future of Flight Test Recorders in a TmNS World

Mike Delaney, 812th Aircraft Instrumentation Test Squadron

Flight test instrumentation recorders face a new set of challenges as instrumentation systems migrate to Ethernet based systems, and test articles incorporate network telemetry. There is a need for the recorder to be able to provide past data while recording to support PCM backfill and if test engineers need data that isn't in the PCM stream. This presentation will discuss the limitations of current recorders and aims to start a discussion on what the next-generation of airborne recorders could look like.

The Future of the Hybrid Test Environment is Now

Joseph Stasiowski, FAA

The Covid-19 pandemic of 2020-2021 created unprecedented challenges resulting in innovative solutions for Federal Aviation Administration (FAA) Test and Evaluation (T&E) activities. These challenges presented an opportunity for T&E subject matter experts to quickly adapt, innovate, and create remote and virtual test environments.

With travel and in-person testing paused, the FAA process of conducting in-person T&E needed to change. The William J. Hughes Technical Center's Terminal Automation Branch test team assessed this new reality, creating a virtual test environment that overcame numerous obstacles through innovative solutions. The team conceived and designed a fully integrated remote enterprise test environment at the William J. Hughes Technical Center. This environment has allowed T&E to continue remotely, and has improved and enhanced the overall testing experience, redefining the team's approach to T&E.

The Terminal Automation Branch conducts enterprise integration and testing across multiple National Airspace System (NAS) of systems (SoS). A simulation backbone connects these SoS, which create the enterprise test environment capable of simulating any airspace in the United States. The team was able to replicate this physical testing baseline onto a virtual testing platform with no degradation or loss of

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functionality. The team, with support of engineering and other technical staff, leveraged previously established remote capabilities and expanded those limited capabilities to all of the systems under test, making them more robust in the process.

The team solved extensive logistical and collaboration challenges to accommodate virtual test conduct, such as participant communication, functional chat channels, discrete work areas, as well as assigning and defining objectives and roles for the test runs. These solutions enable the testers to efficiently communicate and move instantly between virtual lab spaces. Lab support is able to remotely monitor and control multiple systems and the end users are able to interact and operate their respective output displays.

The ability to conduct testing remotely has opened up new possibilities and opportunities for increased stakeholder participation. System and software engineers, programmers, and subject matter experts from around the country have been able to participate in testing and provide feedback in real time without incurring travel expenses. The team conducted remote demonstrations of the virtual test environment with more than 80 participants simultaneously viewing individual workstations. Such large numbers of participants viewing displays during an active test event would never have been possible in a typical in-person demonstration. This adaptability has allowed for expedited investigation and resolution of software issues that typically require additional time and travel to solve. Despite significant global challenges, the team continues to meet program goals, testing and evaluating NAS capabilities within this virtual environment.

The Terminal Automation Branch believes this well-established remote testing capability complements in-person testing and represents the test suite of the future. A hybrid environment of in-person and remote testing provides enhanced testing capabilities not possible by in-person testing alone. With test beds spread throughout the United States and the world, connecting systems and personnel together via remote test capabilities improves efficiency and allows for testing to occur in new and innovative ways.

Using Docker-Compose to Simulate Sophisticated Infrastructure in Development

Micah Ferrill, Avionics Test and Analysis Corporation

Virtualization has long proven invaluable for sandboxing and building repeatable environments in development, staging, and production environments. With the increasing popularity of containerization tools and platforms such as docker and Kubernetes that has only increased. Even in cases where bare-metal infrastructure is utilized in production, the ability to easily reproduce complex operating environments has never been easier or more needed in our age of remote work. Docker-compose allows one to combine multiple containers such as a database or object store along with frontend or service containers. All of this is accomplished through a simple text configuration file and many common services are already containerized or even approved for use on DoD networks. In this paper we'll take a look at several examples of using docker compose to combine different services to demonstrate and prototype distributed systems before implementation on bare metal, Kubernetes, etc.

Wireless Cockpit Interface for F-16 High Speed Camera System

Benjamin Baird, 896th Test Support Squadron, Eglin Air Force Base

Airborne high speed camera systems for weapon separation testing are one of the many instrumentation capabilities the 896th Test Support Squadron provides and supports. This presentation addresses the use of a wireless link from the cockpit of the F-16 to the camera system controller for control and status purposes thus eliminating the need for Ethernet and general-purpose input/output (GPIO) wiring. The system integrates

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wireless components to an existing high speed camera system and provides a simple graphical user interface (GUI) for basic command features and selectable camera video preview. The system also simplifies the preflight check and configuration procedure by eliminating the need to open panels for physical access to the system. The presentation will discuss optimal antenna placement, throughput performance, system operation using the GUI, and optional configurations for varying classification of video.

Wireless Instrumentation Demonstration & Development At Edwards

Robert Bieze, JT4

Wireless instrumentation remains a hot topic in the flight test community. It is viewed by leadership as the answer to long, expensive, and complicated aircraft modifications. It is viewed by the CTFs as having potential but risky until proven reliable and useful. It is viewed by cybersecurity groups as extremely risky, but for security reasons. These seemingly competing priorities make the proper development of wireless technology from concept to reliable instrumentation system component extremely important. As developers, it is our job to test, evaluate, and mature potentially beneficial technologies while at the same time determining what types of applications are not beneficial. At Edwards Air Force Base, we are developing modular, non-intrusive instrumentation test systems and using them to test and evaluate these wireless systems. This presentation will cover our plans and progress regarding what technologies we are evaluating and developing. These include 1588 timing over wireless networks, bulk Ethernet transport, PCM streaming over Bluetooth, and more.

Exhibit Hall Hours

Tuesday, May 11th – 12:00pm – 3:00pm

Wednesday, May 12th – 1:00pm – 5:00pm

Thursday, May 13th – 1:00pm – 5:00pm

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