



## Test Instrumentation Pre-Workshop Tutorials

*Tutorials are a separate fee from the Workshops. The fee to attend a tutorial is \$300 for one 4-hour tutorial, \$500 for two 1/2 days, \$500 for one FULL day or \$700 for 1 full day & 1/2 day.*

**Monday, 22 May**

**1:00 p.m. – 5:00 p.m.**

### **5G NR Specification and System Engineering Aspects**

*Achilles Kogiantis, PhD, and Ankur Sharma, Peraton Labs*

5G wireless cellular networks, based on the 3GPP standard, are being widely deployed in the United States and the rest of the world. 5G is expected to increasingly dominate the worldwide cellular communication market due to its flexibility, wide adoption, and an ever-expanding supplier global ecosystem. The flexible 5G architecture allows multiple networks widely differing in physical, reliability and power characteristics to be supported over a common infrastructure. This flexibility will be particularly useful to Testing Ranges where subnetworks simultaneously supporting high-bandwidth terrestrial communications, low-power sensors and broadband airborne telemetry systems can be flexibly implemented over a common 5G platform. This tutorial is intended to familiarize the Testing Range professionals with a) the key features of the 5G standards specifications – the basic vision, network architecture, the physical and MAC-layer characteristics of the air-interface, and b) the 5G system engineering aspects of deploying a new private network, dimensioning and planning, and its performance assessment. The first half of the tutorial will discuss the 5G standards specifications, while the second half will cover the 5G systems engineering aspects.

### **Electro-Optics/InfraRed Fundamentals**

*Vu Hoang, 775TS/ENV D*

This tutorial is designed to provide an overview of the general concepts and principles of electro-optics and infrared (EO/IR) technology. The tutorial will cover essential topics that are relevant for flight test applications, including electromagnetic waves, optics and optical concepts, resolution, detecting/sampling light, human eye, image processing, pointing, tracking, control and electronics, lasers, and radar vs. EO/IR comparison.

The tutorial will begin with an introduction to EO/IR and its significance in flight test applications before delving into the other topics mentioned above. By the end of the tutorial, the learners will have a broad understanding of EO/IR technology and its relevance in flight test applications. They will also gain insight into the different components and principles that are involved in EO/IR systems, enabling them to make informed decisions when working with such systems.

## **Fundamentals of Aeronautical Telemetry Ground Stations**

*Mark McWhorter, V.P. of Sales & Marketing, Lumistar Inc.*

This short-course is designed to provide a fundamental high-level overview of aeronautical flight telemetry ground stations, followed by a brief presentation of actual ground station hardware. The student will see how ground stations are set up to operate in real time, including the many basic parameters required to successfully receiver telemetry data at the ground station. Ideas related to Mission Planning and techniques for insuring System Maintenance and Readiness will be offered.

## **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.

## **Laser System Test & Evaluation Atmospheric Challenges**

*Douglas H. Nelson, Senior Combat Systems Engineer, Teknikare, Inc. and Mark Stevens, Systems Engineering Department, Naval Postgraduate School*

An introduction to the challenges of testing and evaluating Laser Systems in various atmospheric conditions. An overview of the basic physics and terminology of these systems is included. The unique effects of Laser Systems are also discussed to provide a foundation for test objectives. Test and evaluation needs for Laser Systems including required diagnostic beam propagation and atmospheric measurements are briefly examined.

## **Phased Array Systems for Telemetry Applications**

*Jerrett Eastburg, Raven Defense*

This short course will cover modern phased array design concepts and trades as they relate to telemetry systems and other applications. This course will cover the basics of array design along with the specific performance parameters associated with phased arrays. With a focus on applications and design concepts, the course will

cover analog beamforming, digital beamforming, and true time delay along with the associated pros and cons for each technique. This course will include a design example in which design trades and their implications will be discussed in detail. At the conclusion of the course, the student will be equipped with an understanding of this technology and how it can be applied to meet future communication and telemetry needs. The course is intended to spark excitement and intrigue for entry-level to mid-level engineering students and professionals.

## **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.

**Tuesday, 23 May      Full Day Courses      8:00 a.m. – 5:00 p.m.**

## **Basics of Aircraft Instrumentation Systems**

*Jim Alich, 812 Aircraft Instrumentation Test Squadron (AITS) 412th TW*

This course provides an introduction to the full measurement chain, from sensor to graphic display. It also covers modern airborne data acquisition, recording, RF telemetry, and data reduction/processing systems. This course is intended for scientists, engineers, special instrumentation technicians, and anyone whose work depends on the output from measurement systems to support their mission.

## **Test Foundations for Flight Test**

*Jessica Peterson, Technical Director 412th Operations Group/ Assistant Professor USAF TPS*

The Test Foundations curriculum is designed to equip students with an introduction to the knowledge and skills necessary to be successful flight testers. The curriculum introduces the basic “vocabulary” of the various phases of a flight test program, from program initiation through final reporting. The curriculum begins with a basic Systems Engineering problem decomposition approach applied to various flight test programs. Next the various stages of the lifecycle of a normal test program are decomposed into the subparts of Planning, Execution, Analysis, and Reporting (PEAR). Planning: the basic development strategy for test planning with specific and

achievable objectives and the concepts of hazard and risk identification in safety planning will be introduced. Execution: the fundamentals of flight test control and conduct will be presented with an emphasis on the elements required for safe and efficient test control and conduct. Consideration for test execution will include required personnel, mission preparation, test card generation, communications plans, execution techniques, and post-test debrief. Finally, basic analysis methods and approaches to presenting technical results will be presented. The course will culminate with an in-class exercise to apply the Test Foundations content to test vignettes based on real-world scenarios.

**Tuesday, 23 May**

**8:00 a.m. – 12:00 p.m.**

## **Basic Overview of Telemetry**

*Gary Thom, Delta Information Systems, Inc.*

This course provides a very high level introduction of basic telemetry concepts and components. The course begins with onboard vehicle under test discussing sensors, signal conditioning, commutation, modulation and transmission. It continues on the ground with receivers, data distribution, decommutation, processing and display. The course includes additional concepts like IRIG 106 Chapter 10 and 11 recording and distribution formats as well as IRIG 106 Chapter 7 packet data over PCM.

## **TRMC Solutions for Test and Training**

*Gene Hudgins, TRMC JMETC/TENA*

The Test and Training Enabling Architecture (TENA) was developed as a DoD 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 JMETC events, is well designed for its role in prototyping demonstrations and distributed testing.

Established in 2006 under the TRMC, JMETC provides readily-available connectivity to the Services' distributed test capabilities and simulations. JMETC also provides connectivity for testing resources in the Defense industry and incorporation of distributed testing and leveraging of JMETC-provided capabilities by programs and users has repeatedly proven to reduce risk, cost, and schedule. 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 is the T&E enterprise network solution for secret testing, and uses a hybrid network architecture – the JMETC Secret Network (JSN), based on the SDREN. The JMETC 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 JNTC integration solutions to foster test, training, and experimental collaboration.

TRMC 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.

TRMC has been working with Joint Staff and Air Force JADC2 Cross-Functional Teams (CFTs) regarding JADC2 and Multi-Domain Operations (MDO), to inform them on TENA/JMETC and other TRMC capabilities that could be leveraged to support the emerging Joint Staff Joint Domain Environment (JDE). Additionally, TRMC has been engaged with Army Futures Command (AFC) throughout the year in a number of areas including assessing TENA/JMETC Support coupled with Big Data Analytics (BDA), expanding OSD TRMC collaboration and cooperation to other mission areas including, but not limited to, Cyber, BDA, Knowledge Management (KM), Machine Learning (ML), and Artificial Intelligence (AI).

This tutorial addresses using the well-established TENA and JMETC tools and capabilities combined with BDA tools and techniques to reduce risk in an often-uncertain environment; regularly saving ranges time and money in the process.