ITC 2024 Technical Program

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IDs will be verified at the session entrance against the cleared list. If your name is not on the list you will be denied entry. Registrations on BOTH the ITC and TRMC site will be accepted until Friday, October 18th. Click here for more information.

Tuesday, October 22nd, 1:00 – 2:20 p.m. **Aurora A/B**

Session 1 **Special Topics**
Chair **Richard Dean, Morgan State University**

1:00 p.m.
24-01-01

"An Empirical Study on the Deployment and Performance of Citizens Broadband Radio Service in 4G LTE Commercial Networks"
Jose L. Zapata and Harish Ramchandran, The MITRE Corporation

This research explores the deployment of Citizens Broadband Radio Service (CBRS) in 4G LTE commercial networks across multiple locations in Virginia. A commercial off-the-shelf phone, equipped with a commercial cellular measurement application, is utilized to collect measurement data, and analyze key CBRS performance metrics. The findings reveal that CBRS is primarily used as a secondary band, predominantly serving downlink emissions to enhance network throughput. The research also provides an in-depth analysis of the Reference Signal Receiver Power (RSRP) distribution, highlighting the impact of FCC regulations and propagation characteristics within the CBRS band on RSRP measurements. Observations on the usage of Priority Access Licenses (PALs) and Generalized Authorized Access (GAA) within the CBRS band are also presented. These insights contribute to a comprehensive understanding of CBRS's current implementation and its impact on the spectrum sharing ecosystem.

1:20 p.m.
24-01-02

"Impact of Modeling Parameters on Precision of Aggregate Interference Estimates in the CBRS Band"
Cameron Patterson, The MITRE Corporation

The Citizens Broadband Radio Service (CBRS) is a multi-tiered access and authorization framework to accommodate shared federal and non-federal use of the 3.5 GHz frequency band. CBRS is governed by Federal Communications Commission rules. An essential mechanism by which incumbent government users are protected from CBRS interference is understanding aggregate emission levels at locations where incumbents operate, known as "protection points". Due to proprietary concerns, actual CBRS deployment data cannot be shared, and must be approximated. This paper describes a modeling effort to assess the precision of aggregate interference estimates when CBRS device deployment data is approximated. The work examines the extent to which individual modeling parameters affect the variance of aggregate interference estimates at

protection points, and how these results may impact confidence in using modeling to assess the risk of harmful interference.

1:40 p.m.
24-01-03

"Exploring User Interfaces in Interactive Theme Park Attractions"

Alex Drey, Chayse Joseph Inniss,David Sepulveda, Grace Godinez, Isabella de Sousa Proulx, Jordan Christian, Lucas Tuan, Lucia Alday, Makena Dundon, Michaelyn Moses, Olivia Dodge, Tanisha Taariq, Travis Reihner, Zackary Tileston, Patrick Lynch, Karson Knudson, and Dr. Michael Marcellin, University of Arizona

Interactive technologies have risen in popularity in theme park attractions in recent years. This study delves into the usability of the user interfaces commonly found in these attractions. A literature review of prior applications identified key modes of interaction to investigate. The aim is to pinpoint the best combination of technologies and interfaces that offer both enhanced system usability and a consistent user experience across demographic groups.

A test methodology was developed that gave users various input methods to use in an interactive game that involves aiming and targeting. Data was gathered on system usability and cognitive workload via questionnaires, as well as performance metrics such as accuracy, precision, response time, score, and number of user actions. This investigation unveiled critical differences in user interface methodologies, providing insights that can guide the design of future interactive attractions.

2:00 p.m.
24-01-04

"Advantages of a Digital Model for Flight Test Instrumentation"

Troy Troshynski and Cody Raml, Avionics Interface Technologies a Teradyne Company

The DoD's new Digital Transformation initiatives are calling for shortened system development times and lower system life cycle costs. Additionally, the latest 5th and 6th generation avionics systems are employing increasingly complex communications networks. Utilizing digital twins for components of the flight test instrumentation and data acquisition suite can provide many advantages to support the goal of lower system life cycle costs and faster development times. This paper will explore the implementation and advantages offered by digital model for a flight test avionics network data aggregator.

Tuesday, October 22nd, 1:00 – 2:40 p.m. **Aurora C/D**

Session 2 **Time Space Positioning Information (TSPI)**
Chair **Ben Kupferschmidt, Curtiss-Wright**

1:00 p.m.
24-02-01

"Operational Spectrum Comprehension, Analytics, and Response (OSCAR) – Dynamic Spectrum Management Leveraging Range Instrumentation"
Andrew Portune and Ryan Tortorich, Peraton Labs

The increased demand for spectrum resources necessitates capabilities that facilitate spectrum sharing and quick responsiveness in congested electromagnetic environments. Peraton Labs' Operational Spectrum Comprehension, Analytics, and Response (OSCAR) system has been developed to provide efficient spectrum management, real-time situational awareness, and rapid deconfliction. Beyond planning, OSCAR integrates with existing range sensing assets for real-time spectrum monitoring, providing managers and participants with live comprehension of the spectrum environment and improving exercise outcomes. This paper discusses the OSCAR architecture, workflows for improved spectrum management efficiency, and vendor-agnostic control of range sensing assets. Results from use cases are presented and discussed for spectrum usage verification, unauthorized emitter detection, dynamic deconfliction around interferers, and real-time radio reconfiguration upon for dynamic spectrum access.

1:20 p.m.
24-02-02

"Hybrid Tracking System for GPS Denied Environments (HYTS) Overview"
Steven Meyer, NAWCWD; Gary Glazner, USAF; Alvia Sandberg, US Army; Scott Kujiraoka, GBL

Hybrid Tracking System for GPS Denied Environments (HYTS) is a Central Test and Evaluation Investment Program (CTEIP) project to develop a Global Navigation Satellite System (GNSS) based Time-Space-Position-Information (TSPI) capability that could be used in a Global Positioning System (GPS) denied Test and Evaluation (T&E) environment. It is to replace the obsolete Joint Advanced Missile Instrumentation (JAMI) TSPI system and support legacy JAMI sensors during transition. HYTS uses a Multi-Constellation Multi-Frequency (MCMF) GNSS sensor along with Ground Processing software to create and output TSPI messages to Government Test Range displays in real-time. Archived data can be post-mission processed to create accurate TSPI data products. HYTS takes advantage of GPS L1, L2 and L5 as well as Galileo E1, E2 and E5 frequencies. This paper provides a brief overview of the HYTS project and will investigate in more detail the efforts needed to transition from JAMI to HYTS in addition to addressing the solution of the JAMI parts obsolescence issue.

1:40 p.m.
24-02-03

"Deep Learning TSPI from Wave Patterns for Indoor Localization"
Kimberly Tse, Joshua Riojas, Fillip Cannard, Dr. Damiano Torre, Dr. Andres Mauricio Aguirre Mesa, and Dr. Ben Abbott, St. Mary's University

Congested environments resulting in numerous reflections from one or more radio frequency (RF) sources exacerbate the accuracy of Time Space Positioning Information (TSPI). The St. Mary's Unmanned Aerial Systems (UAS) Lab is a highly reflective building (almost entirely metal), so using GPS signals for indoor localization would be

impractical. This brings up the possibility of using RF reflections to determine localization.

This paper presents a new approach for positioning using deep learning algorithms to decipher the interaction of the RF reflections with physical obstacles. We utilized a calibrated infrared camera system with real-time TSPI, validating the synthetic signal strengths (SS) data with the experimental SS data, and implemented a Convolutional Neural Network (CNN)-based TSPI localization capability in an indoor, enclosed environment.

2:00 p.m. AWARD WINNER!
24-02-04 **"Frequency Reuse with Waypoints"**
Phiroz H. Madon, Peraton Labs Inc.

In de-conflicting frequency assignments for test flights at DoD ranges, frequency reuse has great potential for improving spectral efficiency. In effect, it doubles spectrum availability for a given time-frequency window. The Spectrum Access Manager (SAM) implements a feature that determines if, for a conflicting pair of assignments, frequency reuse via spatial separation of flight plans is possible. The feature models a flight plan as an un-sequenced collection of flight areas. The implementation proved to be challenging since, to determine interference between two assignments, an order N x M algorithm for points across the flight areas had to be employed. Better results were achieved by modelling a flight plan as a sequence of elements each of which may be: a Waypoint, a flight area in transit, or a flight area resident. The benefits of this model are: better alignment with range CONOPS, removes the need for an order NxM algorithm, discovers more cases of frequency reuse.

2:20 p.m.
24-02-05 **"A Scalable Framework for Quantitative Risk Assessment in Dynamic Spectrum Sharing"**
Fei Sun, Leidos

Quantitative and actionable risk information is key to spectrum management decisions, improving operations flexibility and efficiency, and assuring overall mission success. In this paper, we present a scalable framework that supports Quantitative Risk Assessment (QRA) for a wide range of distributed, de- centralized, and centralized Spectrum Dependent System (SDS) architectures containing diverse commercial and government participants. The framework assesses and minimizes interference risk without sacrificing SDS network performance. The QRA engine in the framework aggregates individual risk values across all sources and receivers across multiple iterations into a single risk value for each SDS, and aggregates the individual SDS risk values into a cumulative risk score for the entire network.

Tuesday, October 22nd, 1:00 – 3:00 p.m. **Cira B**

Special Session 1 **5G (CUI)**
Chair **Tommy Young, Test Resource Management Center (TRMC)**

1:00 p.m. **"5G Cellular Airborne Transceiver for AMT: Intermediate Results"**
Eric Beck, Kenneth Bocan, Raymond Chadwick, Naveen Danturi, Stephanie Demers, Shobha Erramilli, Anthony Gaeta, Sarry Habiby, Nan Maung, Joseph Landi, Frank Leonardo, Aale Naqvi, Ankur Sharma, Paul Toliver, and Jeff Young, Peraton Labs

A novel 5G airborne transceiver has been designed and developed for 3GPP-based 5G cellular-based aeronautical mobile telemetry (AMT) to support supersonic aircraft speeds via a novel Doppler pre-compensation solution. The initial transceiver design has been completed, developed, and integrated in an airframe. In addition, a private 5G ground network has been installed at customer air base with extensive coverage to support flightline and airborne telemetry testing. The transceiver is undergoing extensive validation of its functionality and performance both in the lab, and in the field under varying network conditions. It is also being put through a series of environmental tests to prove its flight worthiness in preparation for flight tests planned for later in the year. This paper will present updated transceiver characteristics and capabilities, system-level operational view, details of the ground network implementation, and performance testing results and analysis.

1:20 p.m. **"High Efficiency Power Amplification for 5G Signals"**
Achilles Kogiantis and Tony Triolo, Altio Labs

5G systems employ OFDM as the primary modulation scheme due to its benefits in long distance wireless communications. However, these advantages come at a price of a high Peak to Average Power Ratio (PAPR), which significantly affects the efficiency of RF power amplifiers used to achieve long links. Amplifiers are most efficient when operating near their saturation point since this is the point where they deliver the most power. But when pushed into saturation peaks are clipped, causing "spectral regrowth" into adjacent channels. To reduce clipping and meet the spectral mask required for preventing interference, traditional amplifiers are backed-off from the ideal operating point, but this backoff results in standard RF Class-AB amplifier efficiencies that are 10-15%. We will discuss RF power amplifier efficiency enhancement techniques that can be used to bring efficiencies up to 30-50% when amplifying these high PAPR modern communications waveforms.

1:40 p.m. **"Cyber Security Considerations for 5G Telemetry"**
Achilles Kogiantis and Sunil Samtani, Altio Labs

Aeronautical Mobile Telemetry (AMT) refers to a Cyber Physical System (CPS) used to gather sensor data from aircraft during flight testing and transmit in real-time to ground stations for analysis, safety, and performance monitoring. Currently, IRIG-106 is used in AMT with analog uni-directional comms from the air-to-ground. TRMC, through multiple efforts has been transitioning to more modern technologies such as cellular 5G to support AMT that affords many advantages of a modern system such as little to no

coordination and planning, higher throughput, reliable transmission, bi-directional links and a plethora of existing applications on TCP/IP based networking. However, at the same time, it does make the AMT CPS vulnerable to a new attack surface through cellular communications. We discuss various threat vectors and recent cyber and network security developments that can need to be added to commercial 5G to make it adequately protected against these threats for use in AMT.

2:00 p.m. **"Control Room Integration Status"**
Mark Wigent, Laulima Systems

Traditional telemetry systems have been designed around unidirectional communications from air to ground using predefined data formats. Cellular-based telemetry has the potential to transform this paradigm through the introduction of bidirectional communications and IP connectivity between airborne and ground processing systems, creating myriad opportunities to expand test capabilities on the ranges. These benefits include flexible, dynamic access to data access across the DoD test enterprise. In order to leverage the potential benefits of IP-based telemetry created by 5G, traditional control rooms and data processing systems on the ground will need to be enhanced. This session will provide an overview and status of efforts to integrate the traditional control room into 5G-based telemetry systems.

2:20 p.m. **"5G Surrogate Threat Network Status"**
Christopher Harner, NTTR

The Nevada Test and Training Range (NTTR) will be discussing its capital investment to engineer and integrate 5G cellular technologies into range system infrastructure. Presentation will cover several use cases that will encompass, Red, White, and Blue 5G cellular network possibilities and capabilities. Primary focus will be adversary surrogate employment.

2:40 p.m. **"Where Are We Going Next"**
Achilles Kogiantis and Sunil Samtani, Altio Labs

5G NR has rapidly introduced the non-terrestrial capability to enable a mobile to base station radio connection that can be supported by a LEO or even GEO satellites, under the Non-Terrestrial Networks (NTN) specifications. NTN changes radically what was possible up to now in 5G and opens up more use cases for 5G in air-to-air long distance communications and direct to satellite connectivity. Here, we address how an airborne mesh network can be constructed on the basis of 5G NTN to offer an evolution path for communications and surveillance in support of aeronautical mobile telemetry including for hypersonics testing. We discuss the system level aspects and the architectural flexibility a 5G system offers. We then discuss network transport challenges that should be addressed to support modern broadband 5G telemetry. We motivate the consideration of end-to-end handling of transport with adaptive mechanisms tailored to wireless channels and a whole new approach to aircraft instrumentation data based around IP. This will open up a simplified IP-based platform that unifies instrumentation, telemetry and transport that is necessary to support the complex testing needs of AMT.

Tuesday, October 22nd, 3:05 – 4:45 p.m. **Aurora A/B**

Session 3 **Airborne Sensors and Data Acquisition I**
Chair **Bruce Johnson, NAWCAD Pax River**

3:05 p.m.
24-03-01

"Reducing Aircraft Downtime for Airborne Instrumentation: 2024 Update"
Paul A. Cast and Benjamin Baird, 896 Test Support Squadron, USAF

This presentation addresses utilizing technology to significantly reduce the amount of dedicated time required to install airborne instrumentation. The specific use cases addressed are the F-15 and F-16 fighter jets. Technical innovations include the use of wireless instrumentation, batteries, and other technologies. It should be noted that all of these technological innovations are not new to industry; due to cybersecurity, airworthiness, and other concerns, however, Department of Defense aircraft instrumentation organizations have been slow to incorporate these new devices and/or processes into their solutions. In spite of these concerns and challenges, the application of these innovations should greatly reduce aircraft downtime when installing airborne instrumentation on aircraft. This presentation will discuss technology and anticipated time savings of applying the aforementioned innovations towards aircraft instrumentation installations.

3:25 p.m.
24-03-02

"The Development of a Real-Time Integration Processing Technique for PCM Data Between Asynchronous Master and Slave Telemetry"
Dong Geun Yun, Min Jee Park, and Jae Taeg Yu, Agency for Defense Development

In this paper, we describe the development of a real-time integration processing technique for PCM data between asynchronous master and slave Telemetry. In a synchronization parallel processing method of a real-time integration processing technique, the slave encoder receives a DSSP(Dual Sync Start Pulse) as a reference start pulse from master encoder and synchronizes the clock by generating the clock synchronized with master encoder to overcome the limitation of synchronization processing time between asynchronous master and slave Telemetry. The slave encoder transmits processed PCM data according to synchronization clock of slave encoder to master encoder. The master encoder outputs integrated PCM data in real time. After implementing the synchronization parallel processing method, we prove that the designed logic operates normally using Signal Tap. Also, we verify that the data real-time integration processing is possible within one frame cycle through processing time test.

3:45 p.m.
24-03-03

"Quantitative Video Scoring in Flight Test"
Daniel Crump, Brandon Rosso, and Rocco Docimo, Curtiss-Wright

Video capture and encoding has long been a key function of Flight Test Data Acquisition systems. The encoding methods that are used have gradually evolved from H.261 to MPEG-2 and now to H.264 and H.265. With each improvement in video encoding scheme, users of FTI equipment can achieve compression ratios with better quality video. This allows instrumentation engineers to increase the video resolution and frame rate

while making more efficient use of the limited transmission spectrum inherent to FTI operations.

While Curtiss-Wright's design team was weighing options in next generation video encoders, it became clear that quantifiable measurements of video quality we're required to communicate the improvements seen in sample video files to the average Flight test Engineer. In this paper, we will explore industry standard video quality metrics and illustrate a sample data set and results for measuring the quality of FTI video encoding.

4:05 p.m.
24-03-04

"Upgrading Flight Test Data Acquisition Systems with New Capabilities While Maintaining Backwards Compatibility"
Benjamin Kupferschmidt, Curtiss-Wright

Many Flight Test Instrumentation users have a long history of using FTI data acquisition systems and have made major investments in these systems. The large investment in existing systems can sometimes be an impediment to being able to field new technologies. In order to address the need to maintain backwards compatibility while still adding new features, Curtiss-Wright has developed a next generation MnACQ-2700 data acquisition system that includes a new high data rate secondary backplane. This new backplane allows for the addition of a high data rate module while maintaining backwards compatibility with the large, deployed base of modules that use the standard backplane. This paper will explore the design of the high data rate secondary backplane and how it interacts with data that is acquired from the standard backplane.

4:25 p.m.
24-03-05

"Integrating Machine Learning Compute Mechanisms for Unmanned Aerial Vehicle Control"
Ahmad Qureshi, Jimmy Payan, and Dr. Michael Marcellin, University of Arizona

We present a novel integration of Pixhawk autopilot technology with a Jetson Nano for real-time mission control using Computer Vision (CV). The Pixhawk (PX4) autopilot system provides a robust platform for autonomous missions in unmanned aerial vehicles (UAVs), offering precise control and navigation capabilities. The system gains precise and efficient onboard processing capabilities by incorporating the Jetson Nano, a powerful AI computing device, alongside the PX4. Leveraging CV algorithms, the integrated system can autonomously analyze visual data from multiple cameras in real time, allowing for dynamic changes during flight missions. This enables the UAV to respond quickly to obstacles and changing environmental conditions, changing the mission as necessary. We aim to highlight the synergy between the Jetson and the PX4, demonstrating their combined potential to enhance UAV autonomy through intelligent CV-based mechanisms.

Tuesday, October 22nd, 3:05 – 4:25 p.m. **Aurora C/D**

Session 4 **Airborne Sensors and Data Acquisition II**
Chair **Thomas Grace, NAWCAD Pax River**

3:05 p.m.
24-04-01
"Advanced Ring Antenna for Vehicular Communications"
Phil Venezia, Clency Lee-Yow, and Maxim Ignatenko, Vitesse Systems

Reliable communication of telemetry and command data to and from various vehicles, including rockets, missiles, and aircraft, is of critical importance for many systems. This paper presents an antenna system mounted on a cylindrical vehicle that provides a tight control of phase variation in far field within wide field of view. The antenna system overcomes limitations from earlier designs, including need for increasing data demands, spectrum scarcity, and spectrally efficient modulation.

3:25 p.m.
24-04-02
"Using Filters to Help Mitigate Near Term Radio Frequency Interference (RFI)"
Steven Warner, NAWCWD

Radio Frequency Interference (RFI) problem is a significant issue in the airborne telemetry systems, affecting the performance and reliability of signal transmission and auto tracking. This paper explores the application of filters as a viable solution for mitigating RFI problems as a near term solution. The focus is on understanding the sources and characteristics of RFI and effectively selecting and implementing the appropriate filters to combat interference and the challenges associated with filter implementation.

3:45 p.m.
24-04-03
"Power Over Ethernet in FTI, Suitability and Challenges"
Patrick Quinn, Curtiss-Wright Defense Solutions

With the constant drive in Flight Test Instrumentation Installations to reduce weight and wiring simplicity Power over ethernet may be an ideal solution for FTI. This paper discusses why Power Over Ethernet (POE) is ideally suited to Flight Test Instrumentation (FTI) and details some of the challenges of designing in POE into FTI hardware and discusses some of the considerations that must be taken when architecting a Flight Test Instrumentation system with POE components.

4:05 p.m.
24-04-04
"Enhanced Air Delivery Instrumentation"
Jacob J. Lopez and Michael Diehl, U.S. Army Yuma Proving Ground; Alvaro Velador, Tab M. Wilcox, and Adrian Magana, TRAX International

Air Delivery is a challenging test environment. The dynamic conditions of expelling cargo and personnel from a moving aircraft and decelerating them to land safely is not a trivial task. Furthermore, in a developmental test environment there is always a chance for malfunctions. Instrumentation installed on cargo and personnel is used to capture key performance parameters during airdrop test events. The U.S. Army Yuma Proving Ground (YPG) recently began an instrumentation effort to expand its existing capabilities to include onboard Chapter 10 recording and simultaneous Chapter 7 streaming of high definition ethernet video and analog sensor data. This paper will describe the progress towards enhanced air delivery instrumentation.

Tuesday, October 22nd, 3:05 – 4:25 p.m. **Cira B**

Session 5 **Antenna & RF Systems**
Chair **Scott Kujiraoka, GBL Systems Inc.**

3:05 p.m.
24-05-01

"A Study on The Improvement of Prediction Accuracy for Receive Signal Strength in Palau Tracking Station Through Analyzing Dynamic Link of KSLV-II"

Chunwon Kim, Soonho Kwon, Donghyun Kim, Jeongwoo Han, Taejin Lee, Jina Ma, Nagyun Ahn, and Minseok So, Korea Aerospace Research Institute

In this paper, a method for predicting more accurate and precise received signal strength and quality in tracking telemetry station were presented through analyzing Dynamic Link of KSLV-II. According to the recommended link budget method of telemetry standard document IRIG 119-06, 90% coverage antenna gain were applied to predict the receive signal strength. However, in the case of such this method, The level error is high, the fluctuation of the signal level, and the prediction of different polarized signal levels are impossible. The accuracy of receive signal strength was improved through Dynamic Link Analysis using antenna radiation pattern that change according to launch vehicle posture. By doing these, The received signal strength and quality prediction accuracy were improved comparing to the existing link budget, These results minimized prediction errors compared to the link budget method recommended in telemetry standard IRIG 119-06, and made it possible to predict dominant signals for each received polarized signal, and to predict changes in received signal strength for rapid launch vehicle posture.

3:25 p.m.
24-05-02

"Optimizing Telemetry Links in Mil-Aero Environments"

Dan Bromley, Will Higham, and Jason Le Leivre, Pulse Power & Measurement Ltd.

Military and commercial aerospace businesses involved with the testing of multiple, and simultaneously present powered flying objects, such as manned aircraft, drones, or missiles, need to receive and send telemetry data during the entire course of the test flights. By its remote nature, this is accomplished wirelessly using radio communications systems to provide high quality communication links with no signal dropouts or data corruptions. This paper describes the optimization of these wireless links through an RF over fiber backhaul system ensuring high fidelity and wide dynamic range.

3:45 p.m.
24-05-03

"Aeronautical Mobile Telemetry and Radar Transponders - An Interference Study in C-Band-Part 1"

Trung T. Doan and Kip Temple, Edwards AFB

Test missions are gradually migrating telemetry operations to lower and middle C-Band as these bands offer access to 600MHz of available AMT bandwidth. C-Band is also the band of operation for most radar transponders used on the Test Ranges today raising concerns about potential interference between these systems. This study aims to systematically assess and quantify performance degradation in telemetry and transponder systems when co-located on test platforms. Furthermore, it seeks to develop

strategies for mitigating potential interference conditions between telemetry and transponder systems.

4:05 p.m.
24-05-04

"Moving Towards an All-Digital Multi-Channel TM Receivers"
Pierre Marie Bastie, SEMCO

Test ranges support increasingly complex weapon system engagement, some involving more than 10 TM equipped vehicles flying at the same time. While tracking those simultaneous targets is possible duplicating parabolic antennas, a modern approach is to use Digital Beam Forming (DBF) antennas capable of collecting and digitizing TM channels from multiple vehicles at the same time. Today, the digital samples of those TM channels are reconstructed in the analog domain and transported to multiple TM receivers. The innovative concept proposed by SEMCO is to rely on an all-digital multi-channel TM receiver, capable of ingesting those digital samples produced by the DBF antenna and transported via a high-speed IP-based Ethernet link. Either collocated with the DBF antenna for a compact airborne solution or far away when used in a distributed range architecture, such concept will enable the Digital Transformation of the range while re-using range-certified demodulators and TM transport modules.

Tuesday, October 22nd, 3:05 – 5:05 p.m. **Cira C**

Session 6 **Channel Modeling & Equalization**
Chair **Shannon Wigent, Laulima Systems**

3:05 p.m.
24-06-01

"Optimizing Wireless Data Transfer of Railway Traction Systems by Defining Conditions"
Bekir Sami Şahin, ASELSAN INC.

Because of the high availability and reliability requirements of the railway traction systems, online data acquisition and analysis is very crucial. In order to provide uninterrupted passenger operation, data collected from the traction systems should be recorded and transmitted periodically to the maintenance engineer. Data size increases considerably due to the high number of data recorded at high frequency and this leads to a problem of long transmission time and excess uncategorized data.

In this paper, we propose a method for optimizing wireless data transfer of railway traction systems by defining conditions such as warnings, errors and events. Using automated real time data analysis, these predefined conditions are checked and if there is a match, only data packets between pre & post trigger times will be transmitted. Thus, data packet is limited and only categorized data is transferred. Also thanks to the bidirectional data transfer, conditions can be updated at any desired time.

3:25 p.m.
24-06-02

"Telemetry Spectrum Encroachment Update: An Update On Telemetry Spectrum"
Guy Williams, AFTC/EN; Tim Chalfant, GMRE Inc.

A review of spectrum issues that can challenge the future use of radio frequency telemetry. The International Consortium for Telemetry Spectrum (ICTS) will present the status of World Radiocommunications Conference items that address telemetry that were considered at the 2023 World Radiocommunication Conference and maybe planned for future World Radiocommunications Conferences. International telemetry vendors, suppliers, and users need to be aware of, and potentially engage with their national administrations on these items. This paper provides an update to spectrum encroachment challenges per each telemetry band perceived by the ICTS as of interest to the international telemetering community.

3:45 p.m.
24-06-03

AWARD WINNER!

"Assessing Telemetry Receiver Data Quality Metrics Using RCC 118-22 Test Procedures"
Mark Geoghegan, Sean Wilson and James Uetrecht, Quasonix

A Data Quality Encapsulation (DQE) protocol for improving telemetry link quality has been standardized in IRIG 106. A receiver periodically inserts a Data Quality Metric (DQM) in the recovered data so that downstream equipment, such as a Best Source Selector (BSS) or Antenna Control Unit (ACU), can improve overall link quality. A comprehensive set of test procedures have been published in RCC 118-22 V2 R2 to quantify DQM performance over channel conditions typically encountered in aeronautical telemetry environments. This paper examines each test and presents

measured results comparing the block DQM Bit Error Probability (BEP) estimate versus the actual measured Bit Error Rate (BER) from a receiver under test. The objective is to verify that the current test procedures and associated support equipment are sufficient for accurate and efficient receiver DQE testing. This is a crucial step towards realizing the tremendous potential DQM can provide for telemetry systems.

4:05 p.m. **Continuation of above**

4:25 p.m.
24-06-04
AWARD WINNER!

"A Novel Carrier Frequency Offset Estimation Scheme for SOQPSK-TG STC Waveform"

Oussama Ait Sidi Ali, M.A.T.I.S.S.E Doctorale School, Université Bretagne Loire; Alain Thomas, Safran Data Systems; Romain Tajan, IMS-BORDEAUX; Bertrand Le Gal, IRISA

The standardized SOQPSK-TG waveform integrating Space Time Coding offers a solution to the two-antenna problem prevalent in industrial aeronautical telemetry communications. Existing methods suffer from implementation issues due to iterative process delays as well as error propagation due to joint channel parameter estimation. Moreover, their inefficiency at low Signal to Noise Ratio (SNR) does not allow to fully benefit from soft output demodulator extended performance. Indeed, leveraging insights from Rami Othmane's thesis showcasing a decoder functioning 1.5dB below current thresholds, this paper introduces a scheme tailored for the SOQPSK-TG waveform whose novel techniques overcome these challenges. The proposed algorithms not only enhance synchronization accuracy but also facilitate lower SNR operation, enabling higher bit rate transmissions, better range, and more robust receiver chains in aeronautical telemetry scenarios.

4:45 p.m.
24-06-05

"IRIG 106 Chapter 10 Decoder for KSLV-II Telemetry Data Analysis"

Taejin Lee, Chunwon Kim, Jin-A Ma, Soonho Kwon, and Dong-hyun Kim, Korea Aerospace Research Institute

NARO Space Center has established telemetry ground stations comply with the Inter-Range Instrumentation Group (IRIG) 106 standard [1] for the Korea Space Launch Vehicle-II (KSLV-II, Nuri). Among these, the Safran Radio Signal Recorder (RSR) is employed to record the data associated with the launch mission. The RSR is capable of recording and replaying a multitude of input sources, including IF (intermediate frequency), AGC (automatic gain control), PCM, and IRIG-B. All data is recorded in the Chapter 10 (.ch10) format in accordance with the IRIG standard. For subsequent analysis, the recorded files can be playback in the RSR. However, it is also possible to decode the Chapter 10 files for research purposes, such as the analysis of RF channel characteristics and PCM raw data. In this paper, we used IRIG open software and MATLAB to decode the telemetry data in the Chapter 10 file and present the results.

Wednesday, October 23rd, 10:10 – 11:10 a.m. **Aurora A/B**

Session 7 **Communication Systems**
Chair **Doug O'Cull, Systems Engineering & Management Company (SEMCO)**

10:10 a.m.
24-07-01

"A Survey of Software-Defined Radio Technology for Aeronautical Mobile Telemetry"
Joshua Gillis, Travis Berry, and Dr. Michael Rice, Brigham Young University

This paper surveys the capabilities of commercially available software defined radios (SDR) and their suitability for use as receivers and demodulators in aeronautical mobile telemetry (AMT). A case study, defined by 10 Mbit/s SOQPSK-TG operating in any of the IRIG 106 frequency bands, was used to determine SDR suitability for AMT. The survey investigated the frequency range, sample rate, the number of RF input ports, noise figure, automatic gain control (AGC), and cost. Different configurations are examined based on the SDRs capabilities and their use. The results show the costs of the SDRs along with their capabilities. Non-SDR options---digitizing tuners and data acquisition cards---are also briefly surveyed to consider options in which they may be used instead of an SDR.

"Satellite 5G Telemetry and Commercial Ecosystem"
Dr. Achilles Kogiantis, Altio Labs

10:30 a.m.
24-07-02

5G NR has rapidly introduced the non-terrestrial capability to enable a mobile to base station radio connection that can be supported by a LEO or even GEO satellites, under the Non-Terrestrial Networks (NTN) specifications. NTN changes radically what was possible up to now in 5G and opens up more use cases for 5G in broadband Aeronautical Mobile Telemetry. Here, we present the key physical, MAC and higher layer enhancements to the terrestrial 5G needed to enable communication with far and fast moving satellites, along with the limitations and assumptions present in the current NTN definitions, and remaining challenges for introducing 5G NTN to AMT. We discuss the system level aspects and the architectural flexibility of an NTN constellation. Finally, a description of the commercial industry push for Direct-to-Mobile (D2M) service is given and its difference from NTN, the evolution path, and a comparison with the alternative proprietary LEO constellations being currently deployed.

"Embedded Recording in Flight Test Telemetry Receiver"
Florian Sandoz, Gregory Blanc, Maxime Cariou, and Philippe Klaeyle, Safran Data Systems

10:50 a.m.
24-07-03

Any experienced operator of a telemetry range is well aware of the critical importance of recording not only the telemetry bits, but also various types of signals of a ground station. Flight test activities are particularly expensive and time-consuming. In turn, recorded signals are extremely valuable after flight. In recent years, Digital signal processing techniques and FPGAs improved the compactness of Telemetry receivers. Yet

to date, recording is left to separate units, requiring additional space, power supply and cabling.

This paper presents an approach for an all-integrated Telemetry system embedding a Telemetry Receiver and an IRIG-CH10 Recorder. It details the system technical specifications and the architecture that enables to run both the receiver and the recorder tasks on the same signal processing platform. The performance of the system is assessed in terms of degradation of the playback signals. It concludes on the benefits in terms of ground station simplification.

Wednesday, October 23rd, 10:10 – 11:30 a.m. **Aurora C/D**

Session 8 **Modulation & Coding**
Chair **Jim Falasco, AeroGear Telemetry**

10:10 a.m.
24-08-01

"The Art of Encoding a PCM Telemetry Stream: Interweaving Pre-Recorded and Live Analog/Digital Sensor Data in Gun-Launched Instrumentation Systems"
Daniel Salib, Jin Hwan Choi, and Alfred Rotundo, US Army, DEVCOM

Typical Telemetry applications can be easily resolved using Inter-Range Instrumentation Group (IRIG) 106 Chapter 4 (Pulse Code Modulation [PCM] Standards) where live data can be immediately transmitted at a periodic rate for all sensors on board. However, issues arise when multiple high-sampling rate channels are required during a gun-launched in-bore event where transmission is impossible. Further complications are added if using a sensor suite consisting of a mix of digital sensors with fixed Output Data Rates (ODR) and analog sensors allowing control over the sampling period. To overcome these issues, the Telemetry Branch at Picatinny Arsenal has developed custom electronics and firmware to handle the unique projectile instrumentation applications required to gather data from both in-bore gun- launched environments and in-flight dynamics before the telemeter is destroyed upon impact. This paper will dive deep into how the Telemetry Branch has handled the intricacies of telemetry frame building in the application by double buffering mixed signal sensor data in the firmware code.

10:30 a.m.
24-08-02

"Exploring Maximum Bit Rates for Software Defined Radios in Aeronautical Telemetry"
Zachary Hilton, Riley Kirkwood, and Dr. Michael Rice, Brigham Young University

This paper investigates the maximum achievable bit rates for the SMR 7522 and USRP X410 software-defined radios (SDRs) connected to a desktop computer an Intel Core i7 processor pro detecting SOQPSK-TG. We employ a new interface between the host computer and the bit error rate tester: the Lumistar LS68. The new interface converts bit decisions generated by the host computer and exported via Ethernet into clock and data signals. The new interface removes the previous limitations imposed by microcontroller-based interfaces based on a USB link. Our experiments reveal that the USRP can support bit rates up to 8.192 Mbps, while the SMR 7522 is limited to 3.90625 Mbps. We explore the factors influencing these limits, including SDR architectures, host computer processing capabilities, and the impact of custom resampling and automatic gain control (AGC) implementations.

10:50 a.m.
24-08-03

"On the Use of Log A Posteriori Probability Ratios for Diversity Combining"
Dr. Michael Rice, and Willie Harrison, Brigham Young University; Dr. Erik Perrins, University of Kansas

The performance of diversity combining based on the Data Quality Metric (DQM) is limited by the challenges of accurately estimating the received Eb/N0 in the demodulator. This paper develops an alternative method for diversity combining that does not require estimates of the received E_b/N_0. The development of the method starts with the log a posteriori probability ratio for each bit. The log a posteriori probability ratio depends

on E_b/N_0, but a scaled version, called relative reliability, depends on the amplitude of the received signal, not on E_b/N_0. Computer simulations show the BER performance of combining using relative reliability achieves maximum ratio diversity combining. The BER performance of quantized versions of relative reliability is also examined. It is shown that 5-bit quantizers achieve essentially all of the diversity gain; 4-bit quantizers are within 0.1 dB of unquantized performance.

11:10 a.m.
24-08-04

"Spectrally Efficient LDPC Codes for IRIG-106 Waveforms via Random Puncturing"

Andrew D. Cummins and David G. M. Mitchell, New Mexico State University;
Dr. Erik Perrins, University of Kansas

Low-density parity-check (LDPC) codes form part of the IRIG-106 standard and have been successfully deployed for the Telemetry Group version of shaped-offset quadrature phase shift keying (SOQPSK-TG) modulation. Recently, LDPC code solutions have been proposed and optimized for continuous phase modulations (CPMs), including the pulse code modulation/frequency modulation (PCM/FM) and the multi-h CPM developed by the Advanced Range TeleMetry program (ARTM CPM). These codes were shown to perform around one dB from the respective channel capacities of these modulations. In this paper, we consider the effect of random puncturing of these LDPC codes to further improve spectrum efficiency. We present numerical simulation results that affirm the robust decoding performance promised by LDPC codes designed for ARTM CPM.

Wednesday, October 23rd, 10:10 – 11:30 a.m. **Cira B**

Session 9 **Network Telemetry I**
Chair **Viraj Gajjar, Fortemedia**

10:10 a.m.
24-09-01

AWARD WINNER!

"JPEG XS Compression for Video Telemetry"
Stephen Schaphorst and George Nelson, Delta Digital Video

The Joint Photographic Experts Group (JPEG) XS video compression standard provides visually lossless imagery at typical compression ratios of 10:1, allowing transmission of multiple channels of high-definition video over GbE networks. As video bandwidths continue to increase with higher definition and higher frame rate sources, visually lossless encoding with sub-millisecond encode/decode latencies, a networked infrastructure, and a reliably constant bitrate transport stream, becomes a compelling alternative to uncompressed video. An overview of JPEG XS and transport methods is presented along with targeted test platform applications, including AI-enabled object detection-based Region of Interest (ROI) use cases for bandwidth-limited data links. Comparisons and tradeoffs with other light and higher compression technologies are discussed.

10:30 a.m.
24-09-02

"Advancing PortScan Event Detection: Leveraging eXtreme Gradient Boosted Trees with Fast Feature Binning and Unsupervised Learning Features"
Olanrewaju Bucknor, Dr. Arlene Cole-Rhodes, Dr. Richard Dean, and Dr. Farzad Moazzami, Morgan State University

This paper presents a novel approach for enhancing the detection of PortScan events using advanced machine learning techniques leveraging the eXtreme Gradient Boosted Trees (XGBoost) classifier. We introduce a comprehensive framework integrating Fast Feature Binning and Unsupervised Learning Features, supplemented by Early Stopping mechanisms. The utilization of XGBoost facilitates eWicient model training and robust classification, while Fast Feature Binning enhances computational eWiciency by reducing the dimensionality of the feature space without compromising information content. The incorporation of Unsupervised Learning Features empowers the model to discern intricate patterns inherent in PortScan activities, further enhancing its detection capabilities.
Furthermore, Early Stopping mechanisms are employed to prevent overfitting and enhance generalization performance. Through comprehensive experimentation and evaluation, our approach demonstrates superior performance in accurately identifying PortScan events compared to conventional methods. This research contributes to advancing the field of network security by providing a robust and efficient solution for detecting PortScan activities, thereby fortifying defense mechanisms against potential cyber threats.

10:50 a.m.
24-09-03

"Orchestrator and Distributed Integrator (ORDER) – AI/ML Adaptive Orchestration of Range Systems"

Andrew Portune and Bob Creighton, Peraton Labs

The proliferation of range sensing assets and multi-function systems have created a need for advanced orchestration systems capable of rapid integration, easy extensibility, and real-time abstract reasoning over large action spaces. The Orchestrator and Distributed Integrator (ORDER) system is being developed to fulfill this need, leveraging open architectures for portability and AI/ML algorithms for adaptive optimization across single and multi-platform domains. This paper describes ORDER architecture, techniques for integration with range systems, AI/ML approaches for real-time adaptive orchestration in dynamic environments, and exemplar use cases for improving outcomes in spectrum management and test orchestration.

11:10 a.m.
24-09-04

"Reinforcement Learning Assisted Decoding"

Milad Taghipour, Asit Kumar Pradhan, and Bane Vasic, University of Arizona

This paper explores the application of reinforcement learning techniques in the context of the performance improvement of bit-flipping based decoders. We begin with a concise overview of bit-flipping based decoders and reinforcement learning algorithms. We then outline the methodology involved in mapping these iterative decoders into Markov Decision Processes. This enables us to obtain an optimal decision rule and improve the decoding performance through the utilization of reinforcement learning algorithms after bit-flipping decoders. Subsequently, we conduct an analysis of the reinforcement aided bit-flipping based decoder and investigate a number of potential optimal solutions achievable through various reinforcement learning algorithms. We provide a comparative examination of efficiency and complexity trade-offs between data-driven algorithms and traditional methods across the Binary Symmetric Channel and Additive White Gaussian Noise Channel.

Wednesday, October 23rd, 10:10 – 11:30 a.m. **Cira C**

Session 10 **Network Telemetry II**
Chair **Shawn Perry, NAWCAD Pax River**

10:10 a.m.
24-10-01

"Advanced Intrusion Detection In Telemetry Enterprise Networks"
Favour Okonkwo, Dr. Richard Dean, and Dr. Farzad Moazzami, Morgan State University

This paper examines advanced intrusion detection systems (IDS) essential for protecting telemetry enterprise networks against sophisticated cyber threats. It highlights the shift from traditional IDS methods to advanced techniques enhanced by artificial intelligence (AI) and machine learning (ML), focusing on the unique challenges posed by the scale and complexity of telemetry data. We analyze the effectiveness of behavioral analysis, predictive analytics, and threat intelligence integration in telemetry environments alongside a comparative review of current technologies and tools.

The paper illustrates successful implementations and the benefits of advanced IDS through case studies. Our research indicates that despite existing challenges, integrating AI, ML, and analytics into IDS presents promising avenues for improving cybersecurity in telemetry networks. We conclude with actionable recommendations for cybersecurity practitioners and suggest directions for future research.

10:30 a.m.
24-10-02

"Building A Physical 1553 Bus Network"
Otokini George, Perry Jordan, Sterling Holliday, Dr. Richard Dean, and Dr. Farzad Moazzami, Morgan State University

This paper presents the design and implementation of a physical MIL-STD-1553 bus network, utilizing Arduino IoT microcontrollers which will be integrated with sensors to emulate the Bus Controller (BC), Remote Terminals (RTs) and Bus Monitor (BM). Key aspects of the implementation involve ensuring compatibility with the MIL-STD-1553 standard, and addressing signal integrity in the network. The paper will detail the bus architecture, sensor integration and data communication protocols as well as offer insights into limitations of using Arduino-based platforms in complex bus networks.

10:50 a.m.
24-10-03

"Building a Virtual 1553 Bus Network"
Perry Jordan, Dr. Richard Dean, and Dr. Farzad Moazzami, Morgan State University

This paper presents an architecture for building a virtualized MIL-STD-1553 bus network using VMWare products and microcontroller emulation software for a 1553 testbed. Modeling and testing of telemetry networks requires adaptive and rapidly deployable bus and communication network configurations. Virtualized networking and emulated hardware provide the flexibility, speed, and cost savings to effectively model and do robust testing before initial deployments or before committing patches and improvements. This paper will investigate the results of building a virtualized telemetry network as a platform for testing and producing modeling data. This paper will also explore what types of metadata from the virtualized system will be useful for finding cybersecurity exploits and building an intrusion detection system.

11:10 a.m.
24-10-04

“Airbus Helicopter Telemetry Flight Test Range Extended Worldwide by a Mobile Station”

Marc Seznec, Laurent Carton, ARTON, and Christophe Paillet, Airbus Helicopters

Airbus Helicopter France has enhanced the TLM test area using a multi-site TMoIP ground station (3) centrally monitored (paper ITC2023 ID 68). AH also operates a standalone mobile station to be able to carry out TLM tracking regardless the helicopter location. Easily transportable and located at same helicopter area, it is operated by few people and allows parameters monitoring by few displays. Nevertheless, it seems interesting to monitor helicopters in flight within Marignane flight test Telemetry facilities whatever the helicopter's location. This article explains how, through the use of the satellite connection and the ETHERNET architecture, it is possible to integrate the mobile station, as a "fourth" local receiver, allowing flight test reception within available at MARIGNANE even if the helicopter is far from AH premises. PoC results will be delivered, paving the way for future implementation for test worlwide campaign.

Wednesday, October 23rd, 1:05 – 2:25 p.m. **Aurora A/B**

Session 11 **Range Systems I**
Chair **Ernie Broughton, ITC Committee**

1:05 p.m.
24-11-01

"A Subsystems Analysis of Two CubeSat Missions"
Brody Gatza, Aaron Hastings, Orion Roach, Ethan Wegner, Max Georges, and Dr. Erik Perrins, University of Kansas

CubeSats have rapidly become the most cost-effective package for operating a payload in space. With the successful launch of KUbeSat-1, the University of Kansas has shifted its focus to its next space venture. Two design candidates have been proposed for selection as the next KUbeSat mission. The first mission plans to operate a novel CubeSat-scale mass spectrometer for measuring particle density and composition in the upper atmosphere. The second mission would utilize a radar imager for crop or ice sheet measurements. Both missions would allow students to engage in the satellite development process while enabling research into undeveloped areas of the CubeSat market.

1:25 p.m.
24-11-02

"Adopting Radar-Based SLAM in Autonomous Maritime Vehicles for Robust Environmental Exploration"
Baron Young, Maxwell Jung, Cameron Barrett, Wenjin Li, Dhruv Aggarwal, and Dr. Yogananda Isukapalli, University of California, Santa Barbara

The use of unmanned remotely operated drones has become an effective tool for environmental research, military applications, and search and rescue operations. The Unmanned Surface Vessel (USV) looks to extend these capabilities to operate in maritime conditions by providing a modular platform that can navigate autonomously. This allows for data collection in environments that are either too hazardous or impractical for manned vessels. Due to the variability of coastal environments as well as the possibility of intentional jamming, the USV is equipped with a marine radar system that utilizes Simultaneous Localization and Mapping (SLAM) technology. Radar-based SLAM provides an alternative to current mapping technologies like LiDAR and stereo vision, where inclement weather or compromised visibility significantly reduces effectiveness. This system offers a robust solution that can navigate independently with precision in coastal environments.

1:45 p.m.
24-11-03

"A Study on Simulated Launch Flight Test for Telemetry Station Using IRIG 106 Chapter 10 Recorder"
Soonho Kwon, Taejin Lee, Chunwon Kim, Donghyun Kim, and Hanseop Shin, Korea Aerospace Research Institute

For the NURI (KSLV-II) launch mission, the simulated launch flight test method using a light aircraft is described in order to verify the required performance of the 5 ground telemetry station of NARO Space Center. In this paper, using the IRIG 106 Chapter 10 standard recording method, the simulated launch data of the 1/2/3 stages of NURI at different time are encoded into a single file in Chapter 10 format. The performance verification of the 5 stations can be done by playing back the encoded Chapter 10 file at defined lift-off time in a light aircraft during flight and transmitting its RF signal to the

ground stations. Finally, the tracking and receiving performance results of the 5 stations are described.

2:05 p.m. **"AES and SST Together at Last"**

24-11-04 Albert Gabaldon and Jaron Guisa, NAWCWPNS; Jon Morgan, Laulima Systems

Since the last century RDT&E communications have had a, usually hard, requirement to transmit Serial Streaming Telemetry (SST) using a secure means. This security has been accomplished by using a DoD provided and managed encryption algorithm and support system. Today there is a growing trend to provide a secure channel not by using the traditional DoD encryption algorithm but by using commercial and open-source algorithms. This paper will discuss two modes of using the Advanced Encryption Standard (AES) commercial algorithm to support secure SST systems. One mode is popularly used and fielded. The second mode is a novel approach that simplifies the AES implementation.

Wednesday, October 23rd, 1:05 – 2:05 p.m. **Aurora C/D**

Session 12 **Range Systems II**
Chair **Todd Newton, Southwest Research Institute**

1:05 p.m.
24-12-02

"Autonomous Mapping and Navigation For Small-Scale Car Racing"
Kyle Duval, Will Evers, Ryan Li, Cade Matherly, Maxwell Miguelino, Sean Anderson, and Joao Hespanha, University of California, Santa Barbara

We consider an autonomous car racing setting with limited information about the racing environment thus requiring real-time localization, mapping, and control of our car when racing against opponents. We demonstrate the use of efficient navigation algorithms for autonomous car racing and obstacle avoidance when limited to onboard sensing and computation. We build off the open-source F1Tenth platform by heavily modifying a one-tenth scale remote control vehicle, thus allowing our Robot Operating System (ROS) to interact with driving controls and onboard sensors simultaneously. Using LiDAR (Light Detection and Ranging), we use a Simultaneous Localization and Mapping (SLAM) algorithm to generate a map of the surroundings in real-time. The vehicle is able to avoid obstacles autonomously and use the generated map to determine its optimal speed. We validate our algorithms in simulation as well as real-world opponent racing.

1:25 p.m.
24-12-03

"Ground Based Phased Array Telemetry Antenna (gPATMA) System Integration at the Point Mugu Sea Range (PMSR)"
Kevin Bossoletti and Brad Follo, NAWCWD- Pt. Mugu; Scott Kujiraoka, GBL Systems

Efforts have been underway to add phased array telemetry (TM) antenna capability to the Point Mugu Sea Range (PMSR) to support Guided Missile Destroyer testing. This would fill a significant TM data collection capacity gap and increase the ability to receive TM data from a high number of airborne platforms (missiles, targets, and aircraft). This would also augment the existing use of parabolic dish antennas. Past conference presentations have detailed the efforts to establish the infrastructure needed to support these systems at San Nicholas Island (SNI) located in PMSR. This paper will detail the latest effort to integrate the ground-based Phased Array TM Antenna (gPATMA) Systems into PMSR at SNI.

1:45 p.m.
24-12-04

AWARD WINNER!

"Channel Estimation and Equalization of Mixed Signals for a MIMO-OFDM Multiple-Access System"
Funmilola Akeju and Dr. Arlene Cole-Rhodes, Morgan State University

In this work we consider the problem of recovering a set of 16-QAM symbols that have been simultaneously transmitted by multiple users to a base station over a Rayleigh fading AWGN channel, using OFDM modulation. At the base station multiple antennas receive a mixture of the transmitted user symbols. We present a pilot-aided non-orthogonal multiple access (NOMA) OFDM scheme, which provides an estimate of the channel frequency response (CFR) between each user and each receive antenna. Our proposed scheme has been implemented and demonstrated for a MIMO communication system with two to four users, and varying numbers of receive antenna. The SER performance of the MIMO scheme is evaluated based on running Monte Carlo

simulations over varying SNRs, specifically for a two-user system transmitting to five receive-antenna. We outline a method to determine the minimum and the least upper bound on the number of pilot blocks, which is required to effectively estimate the channel frequency response (CFR) with this scheme. We also investigate the performance of the equalization scheme for the MIMO- OFDM system with different numbers of OFDM subcarriers.

Wednesday, October 23rd, 1:05 – 2:25 p.m. **Cira B**

Session 13 **Security and Data Integrity I**
Chair **Charles D. Creusere, New Mexico State University**

1:05 p.m.
24-13-01

"Driver Interface Using CAN-BUS Communication Protocol to Enhance Driver Awareness and Pace"
Thomas R. Schwab and Gabe Vengas, Wildcat Formula Racing; Dr. Michael W. Marcellin, University of Arizona

This project involves the creation of a reprogrammable vehicle driver interface leveraging passive CAN-bus monitoring, designed for the University of Arizona's Formula SAE race car. Built on an ESP32 microcontroller, this interface presents an affordable alternative to standard OEM or aftermarket dashboards, allowing adaptability for different vehicle configurations. Integrating a CAN-bus powered system to interpret and display vehicle data, the interface offers a versatile and user-friendly solution for real-time data visualization. An ESP32 was chosen as the microprocessor unit, as justified by its cost-effectiveness, compact size, ease of use, integrated CAN processing capabilities, alongside its potential for future enhancements utilizing dual-core processing performance. This project takes data collected from the Engine Control Unit (ECU) and sends metrics (such as RPM and battery voltage) to a custom display unit to give previously inaccessible information to the driver.

1:25 p.m.
24-13-02

"Cyber Security Architecture for Networked Telemetry"
Dr. Richard Dean, Wole Akpose, Wondimu Zegeye, and Dr. Farzad Moazzami, Morgan State University

This paper presents a Cyber Security Architecture for Telemetry Enterprise Networks. This work follows from Morgan's development of a Cyber Security Testbed for Telemetry networks. It follows from prior work that shows how Telemetry Networks can be modeled after Supervisory Control and Data Acquisition/Industrial Control Systems (SCADA/ICS) which has received significant treatment in past decades. This work is specifically tailored towards Enterprise telelmetry networks which envision the inclusion of multiple Test Articles spanning multiple Test Ranges over a wide geographic range. The cyber security implications of this structure are significant. The proposed architecture follows the 3 level structure proposed for SCADA/ICS networks. The emphasis here will be in managing the boundaries between each layer and across Test Ranges. The recommendations for SCADA/ICS are adapted to fit the unique applications and security issues for the Telemetry Enterprise.

1:45 p.m.
24-13-03

"Implementing Procedure Tracking Systems with Computer Vision and Sensors"
Frank Yao, Sophie Guan, Spencer Tang, Anoushka Sawant, and Dr. Yogananda Isukapalli, University of California, Santa Barbara

When performing complex step-by-step procedures, users may require assistance and extensive instruction. In this project, we implement a proof-of-concept for an automated procedure tracking system using computer vision and sensors. Our system operates on a single-camera system—an overhead stationary camera on the Jetson Orin Nano single-board computer (SBC)—to ensure good camera coverage as the user completes the

procedure. In addition, the tools the user interacts with in the procedure are augmented with sensors such as accelerometers and gyroscopes. To simulate the expected complexity and use case of a space station maintenance task, we focus on tracking the procedure of installing the bottom bracket of a bike. During the procedure, the program will identify the progress and accuracy of each step and have visual cues to notify users of deviations from pre-defined instructions.

2:05 p.m.
24-13-04

"The Advantages of Using a Data Quality Estimate for Antenna Tracking"
John Carlson, GDP Space Systems

An Antenna Control Unit (ACU) has historically used the AGC signal from receivers to select the best signal to use for antenna tracking. Using the AGC the biggest signal, likely the signal with the best Signal-to-Noise Ratio (SNR), is selected as the tracking reference. But often times, due to signal impairments and interfering signals, the biggest signal is not the best signal. This can cause a breakdown in antenna tracking. A similar problem is solved for a Correlating Best Source Selector (BSS) by using a Data Quality Estimate (DQE) as the metric for best source selection. The DQE not only includes SNR but also includes the effects of signal distortion and interference. A modern ACU uses the DQE to provide superior antenna tracking performance. This paper discusses the improvements in antenna tracking performance using a DQE versus the AGC. Specific conditions include the tracking of the signal with the best DQE, and the avoidance of tracking a reflected or an interfering signal.

Wednesday, October 23rd, 1:05 – 2:25 p.m. **Cira C**

Session 14 **Security and Data Integrity II**
Chair **Malcolm Weir, Ampex Data Systems Corporation**

1:05 p.m.
24-14-01 AWARD WINNER!

"Distributed Network mmWave Radar System"
Ryan Baum, Aditya Ramakrishnan, Nitin Indukuri, Qifei Chen, Tyler Langowski, Jim Buckwalter, Ilan Ben-Yaacov, Dr. Yogananda Isukapalli and Upamanyu Madhow, University of California, Santa Barbara

In today's automotive landscape, vehicles are equipped with more cutting-edge technology than ever before to ensure passenger safety. Millimeter wave (mmWave) radar enables detection through weather conditions like rain, snow, and fog. Although radar is effective in adverse weather conditions, it struggles to distinguish objects when direct line of sight is impaired in dense, cluttered environments. To this end, an individual sensor can be integrated into a distributed network to boost its robustness and versatility. To demonstrate the viability and power of using several multiple-input, multiple-output (MIMO) radar nodes to survey an environment, we propose a distributed network consisting of two MIMO radar nodes communicating with an external server to perform single-object tracking within a confined space. Each radar node collects information about the object and sends data via shared Wi-Fi connection to our server which employs localization algorithms and visualization programs to display the object's position in real-time.

1:25 p.m.
24-14-02

"Quantifiable Measure for Cyber Security Maturity Model"
Dr. Richard Dean, Wole Akpose, Wondimu Zegeye, and Dr. Farzad Moazzami, Morgan State University

This paper presents an Objective Cyber Security Maturity Measure for Enterprise Networks as are envisioned for future networked telemetry applications. Mainstream strategies such as DOE's Cyber Capabilities Maturity Model (C2M2) and NIST's Cyber Security Framework (CSF) are valiant efforts to capture the state of security but fail to deliver measures that are quantitative and objective. This paper is yet another effort to create a useable Maturity Measure that is tied to the design and operation of the enterprise. It provides a measure tied to controls that are fundamental to the security and measure of risk. This effort follows from the NIST 800-53 Controls which are common to both the C2M2 and the CSF approaches. This approach uses Estimation Theory measures which capture the maturity state of the system as designed, with the risk state of the system in operation, to provide an adaptive optimized measure. This is useful both for assessing the security design and for monitoring performance in operation.

1:45 p.m.
24-14-03

"Cybersecurity Considerations When Using Generative AI in Telemetry Post Processing Analysis"
Jeff Kalibjian, Peraton

Recent developments in the maturity of generative Artificial Intelligence (AI) (AI systems that can generate content) over the past few years has been impressive. While, generative AI technologies have their limitations, they will positively impact the data analysis

discipline. However, most generative AI solutions lack basic cybersecurity features that would allow them to be well integrated into an organization's existing cybersecurity framework. After briefly reviewing neural networks, the cybersecurity challenges with generative AI and the possible mitigation strategies for those risks; a deployment scenario will be discussed for leveraging generative AI technologies in telemetry post-processing environments.

2:05 p.m.
24-14-04

"Secrecy Codes for Telemetry Links"

Dallin T. Bowden, Tobias S. Cook, Nathan B. Estoque, and Willie K. Harrison,
Brigham Young University

This paper provides an introduction of finite blocklength secrecy coding over binary erasure wiretap channels (BEWCs) with noisy main channels. We summarize recent results, give examples, and outline their potential use in aeronautical mobile telemetry (AMT). Secrecy (or wiretap) codes are capable of providing reliable communications to intended parties while also keeping data se- cure from illegitimate network users. The dual nature of these codes makes them of interest to AMT, as security is a major concern during the transmission of telemetry data on test ranges.

Wednesday, October 23rd, 3:40 – 5:00 p.m. **Aurora A/B**

Session 15 **Sensors & Data Acquisition I**
Chair **Ryan Chandler, Redstone Test Center**

3:40 p.m.
24-15-01

"Design of a Wearable Device with Integrated Biometric and Environmental Sensors"
Julian Frank, Ben Cruttenden, Brandon Lee, Harshita Gangaswamy, Snehith Nayak, and Dr. Yogananda Isukapalli, University of California, Santa Barbara

This paper details the development of a multifunctional, cost-effective wearable designed to measure critical medical and environmental variables from the user's wrist. The device integrates sensors for directly acquiring heart rate, blood oxygen, body temperature, local weather conditions, and acoustic signals. After collection, the data is wirelessly transmitted via Bluetooth to an Android application, where deep learning and regression analysis techniques further analyze the information to provide insights into the user's well-being, offering predictions and health trends. This device embodies the fusion of environmental and health telemetry in an affordable, accessible format. The report also explores the wearable's potential to enhance group care in settings like nursing homes by facilitating the continuous remote monitoring of residents.

4:00 p.m.
24-15-02

"Physical Data Collection And Transpondence System For Beetleweight Combat Robotics Arena Using Computer Vision"
Wolfgang Roettiger, and Dr. Michael Marcellin, University of Arizona

Beetleweight combat robotics tournaments are spectator events in which two robots, weighing less than three pounds, are remotely controlled to mechanically damage one another. The controlled environment in the arena enables the monitoring of the fight from all angles using cameras. Using an axonometric viewpoint of the arena from above the fight, image detection software can track the position of each robot throughout the match. This means that fundamental physical properties, such as velocity, acceleration, force, and energy in impacts are all approximately measurable. Any metric of a combat robot's performance can be calculated empirically using simple physics, but this rarely holds true in actual combat. This system would enable the rough measurement of several key metrics of a robot in practice. Moreover, this project provides an opportunity for Wildcat Robotics members at the University of Arizona to gain experience working with a tangible application of computer vision.

4:20 p.m.
24-15-03

"Digital Spectroscopy of Ionospheric Plasma with Telemetry-Enabled Waves, Instabilities & Noise Spectrometer (WINS)"
Ahmad Qureshi, Naomi Yescas, Sarina Blanchard, and Mihailo Martinovic, Lunar and Planetary Laboratory, University of Arizona

The Waves, Instabilities & Noise Spectrometer (WINS) instrument, to be deployed on a CubeSat, is designed to delve into the intricacies of the ionosphere by collecting and analyzing electrostatic waves. With a focus on measuring ionospheric plasma, our team is developing a sensor capable of precisely quantifying plasma properties at magnetohydrodynamic scales. The device uses Analog Digital Converters on a custom Printed Circuit Board with a 64 Megasample/second rate to collect samples quick

enough for relevant waves throughout the E and F layers of the ionosphere. The output of this will then pass through a custom Fast Fourier Transform to complete analysis accurately between 32kHz-32MHz in real-time on-board. We anticipate that future observations provided by this instrument will greatly contribute to a deeper understanding of interactions between the magnetosphere, ionosphere, and atmosphere, necessary for accurate characterization and modeling of the near-Earth space environment.

4:40 p.m.
24-15-04

"Enhancing F-18 ECS Reliability Through Telemetry: enDAQ Sensors' Role in Predictive Maintenance and Safety Assurance"

Dylan Pike and Robert Parent, enDAQ

In 2017, the increasing incidence of physiological events (PEs) among F-18 aviators highlighted a critical need for advanced telemetry solutions to proactively address Environmental Control System (ECS) vulnerabilities. This paper explores the deployment of enDAQ sensors, their role in capturing crucial cabin air pressure data during F-18 flights, and the subsequent development of the Hornet Health and Readiness Tool (HhART) to enhance predictive maintenance and safety assurance.

Wednesday, October 23rd, 3:40 – 5:20 p.m. **Aurora C/D**

Session 16 **Sensors & Data Acquisition II**
Chair **Tim Gatton, AeroGear Telemetry**

3:40 p.m.
24-16-01

"Utilizing the Digital Thread to Track Test Points in Test and Evaluation. How Far Can We Take The Digital Thread? What is the Limit?"
Jil Barnum and Pamela Tanck, Northrop Grumman

In Flight Test we are always chasing Test Points closure. What is the NEXT best tool to track test points utilizing the Digital Thread? A big Program is utilizing the digital thread to track test points, create test cards that can be linked to the test points database, create test decks, track test point execution, update test point status and provide mission summary data and metrics. How far can we take the digital thread? What is the limit?

4:00 p.m.
24-16-02

"Enhancing Time Series Analysis in Flight Testing With Real-Time Embedded AI"
Ghislain Guerrero, Rémy Pelluault, Sangaran Sivakumaran, and Fiona Charaix, Safran Data Systems

The field of flight tests has traditionally relied on deterministic data, making the presence of on-board AI uncommon. However, as the number of measurement points in flight tests increases, Safran Data Systems (SDS) recognizes the need to address the growing data flow without scaling the entire acquisition chain. SDS has introduced embedded AI algorithms to reduce the load on the acquisition chain by filtering out nominal data, only keeping outliers. While initially used for monitoring electrical networks, this real-time time series analysis has vast potential. It could revolutionize pre-flight checks by enabling thousands of signals to be checked in real-time, accelerating the go/no-go decision process. SDS envisions using AI to unlock new levels of efficiency and data analysis in flight testing. The future of flight tests could involve intelligent systems that swiftly and accurately assess data, providing invaluable insights and expediting the flight testing process.

4:20 p.m.
24-16-03

AWARD WINNER!

"Hardware-Software Co-Design of Integrative Telemetry System for Off-Road Racing Vehicle"
Alejandro Romero-Lozano, Dylan Correa, Matthew Larsson, Julian Pimienta Rendon, Michael Byerly, Lily Hall, Bea Goco, Jacob Missbrener, Christian White, Owen Ashbeck, Joseph Lee, and Dr. Michael Marcellin, University of Arizona

The University of Arizona Baja Wildcat Racing Team's integrative off-road telemetry system merged modular firmware, custom digitization circuits, and a Python-based GUI with GPU acceleration. The system leveraged I2C, SPI, and UART wired protocols for efficient communications, while also incorporating LoRa for seamless wireless transmission. The system's sensor suite included IMUs, GPS, Hall-Effect sensors, and pressure transducers. It collected comprehensive operational data such as RPMs, positional data, and brake actuation performance. The system improved situational awareness through an alert system designed to notify the driver of potential car tip-over scenarios. This integration of hardware upgrades and software advancements

demonstrated advancements in telemetry technology, drove strategic decision-making, and elevated our team's competitive off-road racing dynamics.

4:40 p.m.
24-16-04

"Improving Rotorcraft Flight Tests Safety and Efficiency With Real-Time Wind Mapping"

Renaud Urli, Sebastian Schmid and Lilian Rocchi, Airbus Helicopters; Gabriel Eket, Airbus Operations

Helicopter testing plays a critical role in ensuring their operational readiness, safety, and performance optimization. At Airbus Helicopters Flight Test Center in Donauwörth, procedures are conducted to validate helicopter performance and systems, involving maneuvers such as power reduction, recovery, and low altitude landing procedures. Traditionally, weather data for these tests was obtained from ground and tower measurements. However, this approach falls short in providing precise wind data within the helicopter's vicinity.

This paper presents efforts aimed at enhancing safety, efficiency, and performance evaluation by providing real time wind data at various altitudes proximate to helicopters during testing operations. To achieve this, the study explores different approaches, with particular focus on a commercially available ground wind LIDAR system.

5:00 p.m.
24-16-05

"Ciphering of Telemetry over IP – Performances on UDP"

Jean Guy Pierozak, Hensoldt Nexeya France; Cedric Tavernier, Hensoldt France

With the evolution of TM data to Packet Streaming and the need the secure its confidentiality, UDP-based ciphering seems to be a good solution. But most of the UDP protocols that cipher packets are not unidirectional and assume that two UDP connections exist to perform a mutual secret sharing or to authenticate each party. We propose a cyphering solution based on a single unidirectional link over UDP, where it is not possible to construct a mutual secret sharing as it is usual for IKEv2 protocol. Similarly to the PGP protocol, the frames contain the necessary material to be authenticated and deciphered. The traffic flow is simply intercepted, ciphered and forwarded toward the desired interface. To obtain an efficient solution, we must consider different modes of operation for symmetric ciphers, and CBC, OFB, GCM are modes often used. Each one has some advantages and disadvantages. We propose to study the performances of these modes in term of speed and resilience in a noisy channel.

Wednesday, October 23rd, 3:40 – 5:00 p.m. **Cira B**

Session 17 **Software Systems and Tools**
Chair **Tab Wilcox, TRAX International**

3:40 p.m.
24-17-01
"Next Generation Data Download"
Malcolm Weir, Ampex Data Systems Corporation

Over 20 years ago, a sea-change in the world of test instrumentation occurred. This was the standardization of recorders under the RCC, and which produced two major benefits: first, the packet formats were standardized across multiple vendors, and second, the mechanism by which data could be extracted from the recorders was standardized so that the custom post-mission infrastructure was eliminated. As time has passed, though, the capabilities of the download mechanisms have been overtaken by requirements and technology. An interface that was once both fast and elegant has become too slow and cumbersome, and functionality has not been added to meet current needs. This paper explores the landscape for download interfaces, with references to technology like STANAG 4575 and RCC IRIG 106 Chapter 10, and considering data-at-rest encryption, cybersecurity and distributed systems.

4:00 p.m.
24-17-02
"Informing the Simulation: Bridging the Gap Between Model and Reality in Extended Range Artillery"
Avi Soffer and Matthew Hawkswell, United States Army Futures Command

For the first time ever the collection of base pressure data, on a projectile with a metal rotating band, has been achieved throughout the interior and intermediate ballistic cycles of a next-generation extended range howitzer. This novel approach utilizes a gyroscopically stabilized Instrumented Ballistic Test Projectile (IBTP) equipped with an On-Board Recorder (OBR). The results offer key insights into the base pressure to breech pressure ratio within next-gen systems. Real-world data is compared to Interior Ballistics of High Velocity Guns (IBHVG2) simulations to identify discrepancies used for improving model accuracy. The collected data, combined with propellant charge dynamics, allows for higher-fidelity structural analyses, conducted with Finite Element Analyses (FEA), and provides a deeper understanding of internal ballistics, paving the way for improved next-generation applications.

4:20 p.m.
24-17-03
"Constraints Based Airplane and Data Acquisition System Configuration"
Gopinath Rajagopal, The Boeing Company

Flight Test and Lab Test Data Systems require unique Measurement and Instrumentation configurations before data acquisition. Configuring each acquisition unit individually demands substantial manual effort. Automating this process through software escalates costs due to extensive support needed for diverse hardware and network architectures.

To enhance this scenario, a framework has been developed. It uses SHACL constraints as input to dynamically generate forms, APIs, and database schemas in real-time. Leveraging RDF/SHACL—a W3C standard renowned for integrating data based on

relationships—the framework dynamically setups for Data Acquisition systems and Aircraft configuration.

RDF/SHACL serves as the backbone, facilitating flexibility in configuring various hardware and network architectures while notably reducing manual intervention. Instead of costly software solutions accommodating every hardware or network structure, this approach offers on-the-fly customization without exhaustive software support.

By harnessing Semantic web (RDF/SHACL's) standardized data integration capabilities, this framework optimizes configuration for Flight Test and Lab Test Data Systems. It streamlines the process, minimizing manual effort and mitigating the need for extensive software development, ensuring agile and cost-effective setup customization for different acquisition units.

4:40 p.m. **"Chapter 7 Packet Telemetry: A Retrospective"**
24-17-04 Katherine Rodittis and Benjamin Kupferschmidt, Curtiss-Wright

The Inter-Range Instrumentation Group's (IRIG) 106 Chapter 7 standard provides a method for embedding variable length, well-defined data formats within a Chapter 4 Pulse Code Modulation (PCM) stream. Chapter 7's approach to embedding data streams within a PCM format offers several strengths and weaknesses. This paper will explore the pluses and minuses of the Chapter 7 standard and propose some alternative approaches that have been used successfully.

Thursday, October 24th, 10:00 – 12:00 p.m. **Cira B**

Special Session 2 **SkyRange and Phased Array Antenna Updates (CUI)**
Chair **Thomas O'Brien, Test Resource Management Center (USDR&E)**

10:00 a.m. **"SkyRange Capability Overview"**
Tyler Neale, TRMC T&E/S&T High Speed Systems Test (HSST)

The SkyRange capability is being developed by the Test Resource Management Center under the High Speed Systems Test Portfolio to address the DoD's hypersonic flight test data collection limitations to enable faster and improved advanced weapon system development. The capability involves the utilization of unmanned aerial systems equipped with novel sensor suites to perform the data collection, allowing for an expansion of flight test opportunities and increased capacity to conduct such testing. Telemetry collection systems serve as one of the primary sensor suites in accomplishing this mission, and these capabilities have been employed with significant success recently, supporting hypersonic efforts within the DoD. This talk will provide an overview of the SkyRange capability by reviewing details of the platforms and sensor suites being utilized and how SkyRange is being and will be employed to meet the DoD's flight test data collection needs.

10:20 a.m. **"Cost Reduction Approaches for High-Performance Digital Beamforming Antennas for SkyRange"**
Anand Kelkar, CDSI

CDSI has been the cutting edge of Digital Beamforming Telemetry antenna development for TRMC. To date, CDSI's focus has been on performance and schedule and has yielded high-performance multi-beam TM antennas. These digital beamforming airborne antennas are currently used to support of several Hypersonic missions around the globe, and surface systems will be delivered soon.
The cost of acquiring this technology has been a hurdle for several potential users who could benefit from the flexibility and features offered by the Digital Beamforming concept. This presentation discusses the approaches and Figures of Merit CDSI has developed and will use, to significantly reduce acquisition cost, while preserving performance to the best extent possible using scenario-level modeling tools.

10:40 a.m. **"Skyrange (RQ-4), Containerized, and Ground Based Arrays "**
Satya Ponnaluri, BlueHalo

In recent years digital phased array antennas have proven their ability to track multiple objects simultaneously across multiple frequency bands without the need for external cuing. This paradigm shift allows for replacement of traditional parabolic dishes with digital phased array antennas. In this talk, we will discuss the different variants of phased array antenna technology developed by BlueHalo and its partners. We will cover the airborne version covering S-band telemetry operations and recent flight test results. We will also discuss ground-based and sea-based phased array antennas covering L, S and C bands.

11:00 a.m. **"Proliferated Phased Arrays for Ground, Maritime, and Airborne Applications"**
Chris Patscheck, Raven Defense

As missile flight testing requirements continue to increase in cadence, range, as well as complexity, advanced phased array antenna systems are becoming more and more relevant as a tool to support data collection requirements to support, augment, and extend current test range capabilities. Legacy missile flight testing applications rarely called for multiple, simultaneous test articles and trajectories beyond the horizon of fixed test range assets. Current and projected future test scenarios require extended ranges well into the broad ocean areas and routinely require tracking of multiple test objects, driving the need for deployable multi-object tracking sensor systems.

Raven Defense has developed the RAPTR phased array antenna system and worked with TRMC, Navy MRTFB, and NSWC Dahlgren to field this capability across multiple programs on a mix of manned and unmanned ground-mobile, maritime and aviation platforms to support flight testing applications. The RAPTR system supports multiple, high-bandwidth target acquisition and tracking across a wide Field of View (FoV) while reducing operator burden across a wide range of environments. This session will provide an overview of RAPTR key system attributes as well as program status updates covering SkyRange, MaNTA/MaNTA+, Ghost Fleet, and the C-37B Phased Array Telemetry System.

11:20 a.m. **Continuation from above**

11:40 a.m. **"Portable Advanced Telemetry Acquisition System"**
Sean B. Berger, Justin Bran, and Kenton "Ken" Meeker, NSWC Corona

The Portable Advanced Telemetry Acquisition System (PATAS) is a US Navy owned portable telemetry data collection capability designed and operated by Naval Surface Warfare Center, Corona. The PATAS is modular, scalable, and can be deployed in various configurations in order to support a wide range of telemetered missile firings. PATAS is not a single arrangement of hardware but a slightly variable number of hardware sets that can be deployed simultaneously to a number of different mission locales worldwide. What distinguishes PATAS from other portable applications is that it's designed to be hand carried and does not require the use of cranes or other heavy equipment. Another distinguishing factor is that PATAS is the only system utilized onboard Navy missile launching ships to capture pre-launch and early phase flight telemetry data. This paper will further explore the unique capabilities of PATAS and the enabling technologies that make PATAS a successful TM data collection capability.