ITC will contain some Controlled Unclassified Information (CUI) sessions. Those sessions are marked as such. In order to attend those sessions you must have "registered" on the TRMC Website. This includes anyone who holds an active clearance or have a CAC/PIV card.

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 23rd. Click here for more information.

Tuesday, October 27th, 3:10 – 4:50 p.m. **Aurora A/B**

Session 1 **Communication Systems I**
Chair **Thomas Grace, NAVAIR Patuxent River**

3:10 p.m.
26-01-01

"Information Flow and Workforce Alignment in Large-Scale Telecom Deployment Environments"
Alona Fedorovska, Techcom LLC

Large-scale broadband infrastructure deployment requires simultaneous coordination of field crews, project managers, subcontractors, and client stakeholders across geographically distributed environments. While technical execution in this sector is supported by established engineering standards and quality assurance protocols, the communication infrastructure governing information flow between operational layers remains largely informal, unstandardized, and reactive.
This paper presents the Operational Communication Architecture Framework (OCAF), a structured system for governing information transmission and coordination in multi-team telecom deployment environments. Drawing on direct field observation and systematic organizational analysis conducted within an active multi-state deployment operation, the paper identifies five recurring coordination gap categories and proposes a behavioral-alignment-based framework to address them. The framework is grounded in information architecture and telemetry system design principles and is designed to operate within existing operational tools without adding burden on field personnel. Implications for national broadband deployment programs, including the U.S. Broadband Equity, Access, and Deployment (BEAD) initiative, are addressed.

3:30 p.m.
26-01-02

"Flight Tests of Space-Time Coded ARTM CPM at Edwards AFB"
Michael Rice, PhD, Brigham Young University (retired); Kip Temple, Airforce Test Center, Edwards AFB; Sachin Lal, AV Inc.

Space-time coding with SOQPSK-TG has proved to be a successful technique for eliminating the two-antenna problem. Recently, the space-time coding concept was extended to ARTM CPM. A prototype detector/decoder for space-time coded ARTM CPM was developed for use in flight tests to prove the concept in a real telemetry environment. This article describes flight tests of space-time coded ARTM CPM at Edwards AFB. The test results show that when the two-antenna problem is dominate propagation impairment, space-time coded ARTM CPM solves the two-antenna problem and improves the link availability relative to

uncoded ARTM CPM transmitted from two antennas with a 50/50 power split. When the two antenna problem is not the dominant propagation impairment (e.g., bad propagation off the aircraft) space-time coded ARTM CPM tends to produce more errors than uncoded ARTM CPM. Space-time coded ARTM CPM behaves very similar to space-time coded SOQPSK-TG: error events occur at the same times, but space-time coded ARTM CPM produced more errors than space-time coded SOQPSK-TG.

3:50 p.m.
26-01-03

"Implementation Of A Demodulator And Decoder For Space-Time Coded ARTM CPM Waveform"

Sachin Lal, Huaiyu Zeng, and Arvind Bhat, AV Inc.; Michael Rice, PhD, Brigham Young University (retired)

This paper describes the implementation of a prototype demodulator and decoder for a Space-Time Coded (STC) ARTM CPM waveform to mitigate the "two-antenna problem" in aeronautical telemetry. The demodulator and decoder are realized on an FPGA-based platform built from commercial off-the-shelf components. This prototype was used to characterize and compare the performance of ARTM CPM STC against uncoded ARTM CPM and SOQPSK STC in a real telemetry environment by using it in a series of test flights at Edwards AFB. Laboratory BER performance results of the prototype under controlled telemetry channel conditions are also reported, and these measurements are used to benchmark the STC ARTM CPM implementation against both a baseline uncoded ARTM CPM and a SOQPSK STC receiver. The results show that ARTM CPM STC provides BER improvement over uncoded ARTM CPM but incurs a penalty relative to SOQPSK STC.

4:10 p.m.
26-01-04

"Comparison Analysis and Performance of Packet Transport Methods over Telemetry Links"

Ray O'Connell, RoboCom Technologies

The use of packet based telemetry continues to increase in applications by providing the ease of transporting native packet based data sources with highly reliable streaming RF telemetry link systems. Three transport methods considered in this paper are: packet to synchronized repeating frame, serial line coding, and packet burst. With multiple methods to select from, this paper hopes to provide some guidance with respect to areas of interest for the telemetry engineer when evaluating potential solutions. In chapter 1 a broad overview of the transport methods as related to current standards and commercial hardware is presented. In chapter 2 a more detailed look at the transport methods is presented. In chapter 3 an analysis of the efficiency, complexity and reliability of packet over serial RF transport methods is presented. In chapter 4, lab data of performance and reliability transport method implementations is presented as evaluated over RF channel impairments.

4:30 p.m.

Continuation of above presentation

Tuesday, October 27th, 3:10 – 4:50 p.m. **Aurora C**

Session 2 **Networks, Protocols, and Real-Time Telemetry Links**
Chair **Todd Newton, Southwest Research Institute (SwRI)**

3:10 p.m.
26-02-01

"Protocols and Techniques for Reliable Delivery of TMoIP Streams"
Robert Kovach, Tudas Consulting

The TMoIP protocol, RCC 218-20, has enabled the transport of TM streams over IP infrastructures. TMoIP was initially deployed in range networks, which are designed for plentify capacity and resilient operation. Recently, a use case has emerged to stream TM over networks that are not as reliable as range networks. This provides operational challenges to the reliable delivery of TM streams. The need arises to provide mechanisms to ensure TM stream delivery in lossy networks. This problem has been addressed in the broadcast video industry with the development of protocols to enable reliable transport of video streams over IP networks. It makes sense to explore the utility of these protocols in the TM environment.
This paper will identify protocols applicable to the resilient transport of TM over IP networks, with the focus on standards-based solutions. Addtionally, methods, operation, and tradeoffs will be presented. Finally, real-world implementatons, results and lessons-learned will be presented.

3:30 p.m.
26-02-02

"Evaluating Reliable Mechanisms for TMoIP Transport Over LEO / VLEO Satellite Links"
Jon Spindler, Ethrx LLC.; Matt Molzahn, Parraid LLC.; Shawn Perry, NAWCAD; William Debbaneh, Redstone Test Center (RTC)

IRIG 218 Telemetry over IP (TMoIP) is being evaluated by test ranges for transport across LEO and VLEO satellite links to support mobile telemetry deployments, distributed telemetry collection, remote operation of down range telemetry data collection systems, and telemetry relay use cases in scenarios where fixed terrestrial connectivity is limited or unavailable. During these evaluations, test ranges have observed elevated bit error rates (BER) when transmitting fixed rate TMoIP streams over these links, including cases where the transmitted data rates are relatively low. This paper discusses ongoing efforts focused on evaluating reliable transport mechanisms to improve the integrity of real time TMoIP streams operating over LEO and VLEO satellite links. The work examines the performance of selected transport approaches under representative network conditions and outlines test configurations, and measurement techniques used to assess the impact on telemetry data quality.

3:50 p.m.
26-02-03

"Network Data Analysis of the Ethernet Based UAV System"

Mahmut Kursad Arpacioglu and Muhammet Kursat Serceli, Turkish Aerospace Inc.

Telemetry and Flight Test Management Infrastructure (FTMI) systems, encompassing decommutators, Flight Test Management Centers (FTMCs), network components, and auxiliary test equipment such as meteorology stations and DGPS receivers, play a critical role in applications that require remote measurement and data transmission. In high-reliability domains such as defense systems, aerospace platforms, and space applications, the accurate evaluation of system performance and the sound execution of operational decisions depend directly on the accuracy, integrity, and temporal consistency of the acquired data. Consequently, data acquisition (DAQ) control and verification constitute fundamental components of modern telemetry and FTMI architectures. For UAV programs at Turkish Aerospace (TA), including ANKA, AKSUNGUR, and ANKA-III, the importance of data acquisition monitoring is particularly pronounced in Ethernet based telemetry systems, where high data rates, distributed architectures, and network-induced uncertainties introduce additional complexity. This study investigates the significance of data acquisition control from the perspectives of temporal accuracy, data integrity, system reliability, and operational sustainability. Common anomalies encountered within the data acquisition chain and the monitoring parameters employed for their detection are examined within a systematic framework.

4:10 p.m.
26-02-04

"Ship Telemetry in the Oil and Gas: Architecture, Challenges and Operational Impacts"

Márcio Fernando Calixto, Deise Lima, Marwan dos Santos, and Luiz Fernando Sauerbronn, Petrobras Transporte

Transpetro, the largest integrated hydrocarbon logistics company in Latin America, is implementing a ship telemetry program to increase operational visibility, improve maintenance planning, and support energy-performance management across its fleet. This paper presents the architecture, deployment challenges, and early applications of the program. The solution addresses the collection, standardization, transmission, historization, and use of real-time data from heterogeneous onboard systems. The architecture combines industrial gateways, OPC UA-based interoperability, edge buffering, secure satellite communications, IPsec VPN connectivity, and integration with the corporate Process Information Management System (InfoSCADA). The first implementation was carried out on the Suezmax tanker Henrique Dias and is being scaled to 25 additional vessels with different levels of instrumentation complexity. The resulting data environment supports dashboards for propulsive efficiency, main engine condition monitoring, vessel operational status, energy efficiency, and alarm management. By reducing dependence on manual data collection and improving the frequency, traceability, and quality of operational data, the project establishes a practical foundation for predictive maintenance, condition-based monitoring, and data-driven decision-making. Preliminary business-case estimates indicate relevant potential benefits in fuel efficiency, lubricant management, corrective maintenance reduction, and operational reliability, subject to progressive validation during fleet deployment.

4:30 p.m. **Continuation of above presentation**

Tuesday, October 27th, 3:10 – 4:50 p.m. **Aurora D**

Session 3 **Telemetry for Aeronautical and Automotive Applications**
Chair **Nelson Leite, Brazilian Flight Test and Research Institute**

3:10 p.m.
26-03-01

"Flight Termination Solutions: Current and Future"
Rocco Docimo, Curtiss-Wright; Toby Pike and Harold Rosenthal, Northrup Grumman

The RCC-319 standard is rooted in safety and risk reduction especially around flight termination decisions in a variety of situations, including several different kinds of flight termination system pieces and technologies. Curtiss-Wright is in process of qualifying hardware to these standards, namely the FTR-200-X series to RCC-319 standard for tone based flight termination receivers (FTRs) and the nTTU-2600-X to RCC-324 (Performance and Verification Requirements for Range Tracking Systems including IMU and GPS systems) and an overview of the process and success oriented timeline of those certifications.
We will look at several system architectures utilizing the FTR-200-X and nTTU-2600-X to satisfy requirements in both RCC-319 and RCC-324 and look ahead for future projects including RCC319 Automatic Flight Termination Unit (AFTU) possibilities utilizing the nTTU-2600 after RCC-324 validation.

3:30 p.m.
26-03-02

"Robust Target Tracking via Multiple-Model Filtering"
Rodrigo Negri de Azeredo, Mohamed Hajjem, Safran Data Systems, and Lara Thomas, Safran Data Systems

Modern ground station systems require high pointing accuracy and robust trajectory estimation capabilities in order to maintain reliable communication under uncertain operational conditions. In flight test applications, target trajectories may be affected by measurement noise, propagation disturbances, and abrupt maneuvers, leading to degraded tracking performance and signal loss. This paper investigates the application of Kalman filter-based estimation techniques to improve target trajectory estimation and antenna pointing accuracy in RF tracking systems. First, two single-model Kalman filters are evaluated. Then, an interacting multiple model (IMM) framework that combines multiple motion hypotheses is proposed to improve estimation adaptability under varying target dynamics. The performance of the proposed approaches is analyzed using realistic tracking scenarios including steady-state motion and abrupt target maneuvers. The results demonstrate that the IMM estimator improves trajectory estimation robustness and tracking accuracy compared with conventional Kalman filters, especially during maneuvering phases.

3:50 p.m.
26-03-03

"Iterative Hardware-Software Co-Design of Integrative Telemetry System for Off-Road Racing Vehicle"
Julian Pimienta Rendon, Karsten Yin, Matthew Larson, David Lee, Eric Asato, Adam Esch, Kyle Klekotka, Dylan Correra, and Graham Van Der Beek, University of Arizona Faculty Advisor: Michael Marcellin, PhD, University of Arizona

The University of Arizona Baja Wildcat Racing Team's integrative off-road telemetry system merges custom mixed-signal circuit boards and C++-based domain layer,

alongside a REST API for web-based telemetry access. The system leverages CAN-bus and SPI for efficient wired communications, while also incorporating LoRa for seamless wireless transmission. Data is collected via IMUs, infrared temperature sensing, hall effect based speed sensors, induction tachometer, linear potentiometer and pressure transducers. It monitors RPMs, positional data, displacement, temperature and brake actuation and pressure, bringing real-time data visualization through an improved driver side dashboard interface. Hardware and software advancements significantly refined telemetry accuracy and driving insights, by bringing actionable data allowing the optimization of vehicle performance. This elevation of the telemetry system demonstrates yet another leap forward in the university's off-road racing telemetry.

4:10 p.m.
26-03-04

"Developing and Utilizing Data Acquisition Systems for Race Car Design Optimization"

Aidan Brown, Diana Zarif, Samantha Lane, Logan Bonhorst, Joseph McLaughlin, James St. Leger, Sophia Do, and Jack Fernandez, University of Arizona
Faculty Advisor: Michael Marcellin, PhD, University of Arizona

The University of Arizona's Wildcat Formula Racing team designed and implemented a comprehensive data acquisition and telemetry system to facilitate improvements in race car vehicle dynamics. The system integrates potentiometers, pressure transducers, wheel speed sensors, and accelerometers to capture key vehicle metrics and driver inputs, including brake pressure, steering angle, suspension displacement, and vehicle speed. Data is acquired through a MoTeC M150 electronic control unit (ECU) and transmitted over a Controller Area Network (CAN) bus to an onboard data logger. The collected data enables enhanced driver training, informed vehicle setup tuning, and improvement of the engineering process for future vehicle designs.

4:30 p.m.
26-03-05

"Off-Road Racing Vehicle Automotive Steer by Wire Data Acquisition and Refinement"

Gallia Gountis, University of Arizona; Faculty Advisor: Michael Marcellin, PhD, University of Arizona

The University of Arizona's Engineering 2026 Senior Design team built and integrated a Steer by Wire system into an off-road SAE Baja vehicle, improving capability and driver control. Strain gauge data utilizing remote telemetry collection in partnership with Caterpillar was refined and analyzed over the course of this project. Stress was reduced into force, current and torque values and applied to FEA simulation and part selection. The derived values were used to set requirements for selection of purchased components and applied to system tuning, iteration and failure diagnostics. Further analysis led to greater insight into general performance and steering response, allowing further advancements in design, operation and control of off-roading SAE vehicles.

Tuesday, October 27th, 3:10 – 4:10 p.m. **Cira C**

Session 4 **Telemetry Data (CUI Session)**
Chair **Michael Diehl, U.S. Army Yuma Proving Ground**

3:10 p.m.
26-04-01

"Unsupervised Discovery of Emerging Adversary TTPs from Drone Trajectory Data Using Dynamic Time Warping and K-Means Clustering"
Kirby Hayes and Jeffrey House, Test Resource Management Center (TRMC)

Modern military exercises generate massive volumes of trajectory data from simulated adversary assets. A primary challenge is the post-hoc analysis of these data to objectively identify and quantify emerging tactics, techniques, and procedures (TTPs) without prior knowledge of the adversary's playbook. This research presents an unsupervised machine learning workflow that combines Dynamic Time Warping (DTW) with k-means clustering to automatically discover these TTPs from raw flight path data. By analyzing the resulting cluster characteristics, an analyst can rapidly interpret and label the data-driven behaviors such as "Surveillance" or "Kinetic Attack. This methodology provides a data-driven, objective capability to find "unknown unknowns," quantify adversary behavior, and extract prototypical TTP examples for developing future countermeasures and real-time classification models.

3:30 p.m.
26-04-02

"Telemetry Streams Using Infrared Communication Across Decoupled Interfaces"
Avi Soffer, Jin Hwan Choi, Praveen Sajeev and Vincent Cascella, U.S. Army Futures and Concepts Command

This paper presents a robust infrared (IR) link for transmitting telemetry data across a rotating mechanical interface in precision-guided projectiles. In such systems, where a despun guidance section is coupled to a spinning airframe, wired connections are not viable. To overcome this, an IrDA protocol-based transceiver system was developed and integrated with custom electronics and embedded firmware. The system bridged the rotating interface, delivering a continuous IRIG 106-24, Chapter 4, Class I telemetry stream at 500 kbit/s. Mechanical packaging combining a machined aluminum adapter with 3D-printed optical and structural components eliminated signal reflections and ensured survivability. Six live-fire test flights demonstrated continuous real-time data transmission with no frames dropped, validating this IR-based approach as a practical, cost-effective alternative to slip rings for precision munitions instrumentation.

3:50 p.m.
26-04-03

"Intelligent Data Filtering (IDF)"
Pabel Corral, White Sands Missile Range (WSMR)

Intelligent Data Filtering (IDF) is a proposed AI-edge capability designed to resolve critical data management challenges in Test and Evaluation (T&E) missions. Currently, high-fidelity modern imaging technologies generates massive volumes of irrelevant background data, causing severe network bottlenecks and storage issues. Processing this data requires labor-intensive manual reviews, which delays actionable feedback, inflates costs, and prevents high-tempo testing.

To address this shortfall, IDF deploys directly at the data source to autonomously filter irrelevant imagery, classify key events, drastically reducing data volume and providing limited data analysis. This mitigation of data overload and data analysis provides test officers with rapid, actionable intelligence for dynamic, on-the-fly adjustments. Ultimately, IDF is an operational necessity for the timely and cost-effective validation of advanced systems. This solution can apply to modern telemetry data collection assets.

Wednesday, October 28th, 10:15 a.m. – 11:35 a.m. **Aurora A/B**

Session 5 **Cybersecurity for Telemetry Systems**
Chair **Richard Dean, Morgan State University**

10:15 a.m.
26-05-01

"EISSAF Framework for Telemetry Systems: A Systematic Approach to Threat Coverage and Zero-Trust Integration"

Wole Akpose, 6igma Group; Richard Dean and Farzad Moazzami, Morgan State University

Enterprise telemetry systems face escalating cyber threats across aeronautical, space, marine, and automotive domains, yet traditional frameworks insufficiently address their multi-layered complexity. This paper introduces the Enterprise Information Systems Security Architectural Framework (EISSAF) for telemetry security assessment. EISSAF organizes security across four layers, three perspectives (People, Policies, Technology), and four attributes (Confidentiality, Integrity, Availability, Privacy), examined through three lenses (Threat, Defense, Impact), yielding 48 cells. We apply EISSAF to a domain-correct case study pairing three public resources: the SPARTA v3.2 space-cyber threat catalogue (Threat), the OPSSAT-AD satellite-telemetry benchmark (Impact), and NIST SP 800-207 Zero Trust (Defense). Mapping 67 SPARTA techniques covers 15 of 48 cells (31.2%) versus 3 (6.2%) for an operational-only baseline: a 25.0 pp, 5× improvement. OPSSAT-AD lights 5 cells, all coinciding with SPARTA-flagged cells (100%), validating the threat map against real on-orbit anomalies. The Defense lens lights 13 cells (27.1%) and fully mitigates 9 of 15 SPARTA-lit cells, partially mitigates 5, and leaves 1 residual (kinetic physical). A telemetry-specific adaptation table reconciles the seven tenets with microsecond-latency and on-orbit compute constraints, and a DevSecOps pipeline covers 22 of 48 cells through 15 automated gates.

10:35 a.m.
26-05-02

"AI-Driven Cyber Defense: Automating Threat Intelligence for Telemetry Environments"

Dakhari Shorter and Nishan Kafle, Morgan State University
Faculty Advisor: Farzad Moazzami, Morgan State University

Unmanned Aerial Vehicles (UAVs) and networked OT/ICS systems increasingly rely on high frequency telemetry to support real-time operation, yet that same telemetry is a primary attack surface for threats such as GPS spoofing, sensor data injection, and signal hijacking. This paper presents a single, staged research pipeline that carries raw aerial telemetry from capture through to an explained, classified security incident, entirely offline. The pipeline begins with data acquisition from a simulated UAV flight, proceeds through a modular processing stage that translates raw binary MAVLink packets into clean, structured text, and concludes with an AI-driven reasoning stage, Tau, that classifies anomalies using a local large language model and produces operator-facing explanations mapped to MITRE ATT&CK for ICS techniques. Framing the work as sequential stages of one system, rather than two separate efforts, reflects the actual data flow validated in this paper: acquisition feeds processing, processing feeds Tau, and Tau produces the final output.

10:55 a.m.
26-05-03

"Implementing and Evaluating Post-Quantum Key Establishment in Telemetry Systems"

Yuxing Yang, University of Illinois Urbana-Champaign; Faculty Advisor: Dominic Saebeler, University of Illinois Urbana-Champaign

Telemetry systems require secure key establishment to protect transmitted data. The development of quantum computers creates a need for post-quantum cryptography (PQC) to replace current asymmetric algorithms. This paper presents the implementation and evaluation of post-quantum key establishment in a telemetry communication setting. A software-based test bed is developed to simulate communication between a Test Article (TA) and a Ground Station (GS). The system uses both classical Elliptic Curve Diffie-Hellman (ECDH) and post-quantum ML-KEM. The test bed enables repeated experiments and measures system-level performance, including latency, CPU time, memory usage, and communication overhead. The proposed system provides a platform for analyzing the impact of post-quantum cryptography on telemetry systems.

11:15 a.m.
26-05-04

"Mitigating Cybersecurity Challenges of Agentic AI Use in Telemetry Post-Processing"

Jeff Kalibjian, Peraton, Inc.

Use of generative AI based applications and tools has become pervasive throughout many industries, including aerospace. However, using generative AI to control and coordinate a series of processes and procedures (i.e., Agentic AI) is not as ubiquitously found due to governance and compliance challenges related to the use of such technologies. Despite these obstacles, use of Agentic AI is still growing rapidly. Agentic AI holds great potential for transforming telemetry post-processing which typically involves a series of actions or activities related to analyzing data sets associated with sub-system functionality. After reviewing basic Agentic AI technologies and cybersecurity issues around its use, an agentic based telemetry post processing system is proposed and discussed.

Wednesday, October 28th, 10:15 a.m. – 12:15 p.m. **Aurora C**

Session 6 **Ground Systems Architectures and Range Automation**
Chair **Tim Chalfant, Int'l Consortium for Telemetry Spectrum**

10:15 a.m.
26-06-01

"Autonomous Polarization Switching in S-Band Monopulse Tracking Antenna Systems for Rocket Telemetry Campaigns"
Mustafa Çelik, PROFEN Communication and Koç University; Ahmet Kayıkçı, Bartu Ilgaz, Kadir Koca, and İsmail Şişman, PROFEN Technology Inc; İsmail Lazoğlu, Koc University

Ionized rocket plumes cause severe S-band signal attenuation and polarization transitions during launch. In single tracking chain monopulse systems, switching between RHCP and LHCP introduces a systematic 180° phase shift that leads to immediate loss of tracking lock. This article presents an autonomous polarization switching method in which an SDR based power analyzer continuously monitors RHCP and LHCP signal levels, and the ACU triggers polarization transitions within a 100 ms decision window upon threshold crossing. The system maintains tracking continuity by automatically reloading pre-calibrated phase values into the tracking receiver unit, compensating for the switching-induced phase shift without operator intervention. The system was validated on fixed and transportable 6.3 meter parabolic antenna platforms through UAV testbeds and a live rocket flight campaign. Continuous monopulse tracking lock was achieved throughout high-dynamic flight phases on both antenna platforms.

10:35 a.m.
26-06-02

"Lightweight Composite Sub-Reflector Support Structure for 6.3m Transportable S-Band Telemetry Tracking Antenna"
Mustafa Çelik, PROFEN Communication and Koç University; Yakup Esmer, Kadir Koca, and İsmail Lazoğlu, Koc University

This paper presents the structural redesign of the sub-reflector support assembly for a trailer-mounted 6.3 meter S-band Cassegrain telemetry tracking antenna. The conventional metal structure was replaced with composite tubular struts of optimized geometry and additively manufactured polymer junction connectors, achieving a 60 percent weight reduction. The new assembly can be installed by two operators in under 30 seconds, removing the injury risk associated with lifting the original heavy structure during field setup. The composite struts were selected for their environmental durability and dimensional stability. Structural integrity under operational loads was verified through finite element analysis (FEA), and the redesigned assembly was validated in the field, including live flight test campaigns. RF performance and monopulse tracking accuracy showed no degradation compared to the original system.

10:55 a.m.
26-06-03

"Propagation And Visibility Aware Xl-MIMO Dimensioning For 6G Uplink Systems"
Nubantood Khalil, Morgan State University
Faculty Advisors: Dr. Arlene Cole-Rhodes, and Dr. Peter Taiwo, Morgan State University

Extremely large multiple-input multiple-output (XL-MIMO) systems are expected to enable 6G through ultra-high spatial resolution and near-field communication. This paper proposes a novel propagation- and visibility-aware XL-MIMO dimensioning framework for uplink deployment. Departing from conventional beamforming-centric design with fixed array geometry, we treat physical array dimensions as propagation-driven system parameters.. We derive a scaling law linking carrier frequency, wavelength, array aperture, antenna count, visibility conditions, and a target near-field radius, based on Rayleigh-distance. Practical uplink constraints, including pilot overhead, coherence time, mutual coupling, and receiver complexity, are incorporated through an uplink-feasibility analysis. Results show that higher carrier frequency reduces aperture requirements but increases antenna-count and tightens feasibility constraints, laying the foundation for practical XL-MIMO array dimensioning and operating-band selection in 6G uplink systems.

11:15 a.m. **"High Efficiency Bi-Directional Amplifier for High PAPR 5G Waveforms"**
26-06-04 Tony Triolo, Achilles Kogiantis, and William Johnson, Altio Labs

5G networks utilize OFDM as the primary modulation method due to its advantages in long-range wireless communication, while using high-order modulation and multi-carrier waveforms to achieve very high data rates. As a result, these waveforms have very high peak-to-average power ratios (PAPR) that make amplification difficult and inefficient. This high PAPR greatly impacts the efficiency of RF power amplifiers as they are operated near their saturation point resulting in peak signal clipping and out of band interference. In this talk we discuss our approach to linearizing the amplifier by a combination of crest factor reduction and digital pre-distortion (DPD) techniques. We demonstrate the substantial improvements we can achieve with CFR/DPD in terms of adjacent channel leakage ratio (ACLR), Error Vector Magnitude (EVM), and protection of IRIG-106 receivers for Aeronautical Mobile Telemetry applications.

11:35 a.m. **"RCC 118 Standardization of Best Source Selector Test Methods and Procedures"**
26-06-05 Mark Geoghegan and Sean Wilson, Quasonix, Inc.

A Best Source Selector (BSS) is a critical component in modern telemetry architectures as it seamlessly combines the outputs of multiple receive data sources into a higher quality single output stream. If source quality information is also available, even higher levels of BSS performance can be achieved using advanced data fusion algorithms such as Maximum-Likelihood-Bit-Detection (MLBD). A Data Quality Encapsulation (DQE) protocol suitable for this purpose has been standardized in IRIG 106. It periodically embeds a Data Quality Metric (DQM) directly along with the telemetry payload. Recently, RCC 118 test methods and procedures were published and used to verify DQE/DQM compliance for telemetry receivers. This paper investigates how to test and characterize BSS performance with the goal of supporting the development and publication of RCC test methods and procedures for BSS equipment.

11:55 a.m. **Continuation of above presentation**

Wednesday, October 28th, 10:15 a.m. – 12:15 p.m. **Aurora D**

Session 7 **Data Acquisition I**
Chair **Jim Falasco, Aerogear Telemetry**

10:15 a.m.
26-07-01

"Deterministic Real-Time Data Monitoring over Avionics Full-Duplex Switched Ethernet (AFDX) Networks in Flight Test Instrumentation Systems"
Osman Birkan Ozseven, Fatih Erden, Mehmet Fudayl Uncuoglu, Muhammed Peker, Ahmet Ata, Berkcan Kucukkasap, Mertcan Aksoy, and Celal Yalcin, Turkish Aerospace

Flight Test Instrumentation (FTI) systems require deterministic timing when acquiring avionics data during certification campaigns. AFDX (ARINC 664 Part 7) provides bounded bandwidth through Virtual Links governed by Bandwidth Allocation Gaps, but adding real-time monitoring raises latency and jitter concerns. This paper presents a non-intrusive passive monitoring framework that reads multi-criticality AFDX traffic at the switch without degrading safety-critical frames. Worst-case latency and backlog bounds are derived using min-plus Network Calculus and evaluated through discrete-event simulation of a multi-node gigabit AFDX network. Results confirm bounded delivery under 100% peak load with zero frame loss, provided Virtual Link allocation accounts for non-preemptive monitoring overheads. The approach removes dependency on legacy instrumentation buses while preserving isolation of safety-critical functions, offering a scalable, vendor-independent method for flight-test campaigns.

10:35 a.m.
26-07-02

"A Solution to Reduce Data Transfer Duration for Onboard Recorded Raw Data"
Doğukan Çevik, Mahmut Kürşad Arpacıoğlu, Cenk Özdemir, Tayfun Şahin, Aysu Kırdar, Eyüp Yaka, and Yaren Cemal, Turkish Aerospace

During flight test activities, Flight Test Instrumentation (FTI) data are recorded onboard aircraft using dedicated recorders. Following flight completion, these data sets must be transferred to ground systems for analysis. When performed through physical means, the data transfer requires multiple manual steps such as removing the onboard storage media, copying the data to intermediary computers, and transferring it to internal storage systems. This process is time-consuming and results in and operational delays, particularly as data sizes continue to increase. This study proposes a wireless data transfer solution that enables the transfer of recorded data from the onboard recorder to a data transfer computer which is connected to Turkish Aerospace internal network on ground immediately after the moment the aircraft wheels touch down on the runway. To support this process, dedicated software applications have been developed for both the onboard FTI system and for the data transfer computer. The objective of this approach is to significantly reduce turnaround time between flight completion and data availability, while minimizing human intervention and operational effort. The developed software components play a critical role in ensuring synchronization, transfer reliability, and operational robustness throughout the process.

10:55 a.m.
26-07-03

"IP Camera Integration to a Legacy FTI System"

Doğukan Çevik, Mahmut Kürşad Arpacıoğlu, Cenk Özdemir, Tayfun Şahin, Aysu Kırdar, Eyüp Yaka, and Yaren Cemal, Turkish Aerospace

In Turkish Aerospace (TA), video data during flight tests are acquired through an analog camera integrated with the KAM500 data acquisition system. However, low image quality and insufficient image clarity are well-known limitations of analog video acquisition systems. In addition, the exact acquisition time of the video data cannot be determined, making it impossible to calculate transmission delays. To overcome these limitations, it is proposed to acquire video data using an IP camera capable of providing high-definition images and to combine the video stream with IRIG time data in order to eliminate uncertainties in latency measurements. This study explains the integration of an IP camera into an existing KAM500 DAQ system, which includes the EBM/102 module to receive IP camera stream packets, while maintaining a telemetry bandwidth usage comparable to that of an analog camera video stream. To address the associated challenges, specialized software tools have been developed to operate independently on both the aircraft and the ground station.

11:15 a.m.
26-07-04

"The Evolution of Smart Mobile Devices in Flight Tests Instrumentation Systems"

Dr. Nelson Leite, Wagner Lima, and Lucas Sousa, IPEV

In flight testing (FT), measurement quality is crucial, but the pilot capability in executing test points as planned, become a key factor to assure program effectiveness. In ETTC 2013, both IPEV and CW proposed the use of Smart Mobile Devices (SMD) to assist FT. So, the introduction of SMD in cockpit operation to assist test point execution and validation becomes essential and mainly in small aircrafts, where space and crew ejection constrains restricts the possible solutions. Later in ETTC 2018, IPEV introduced its real-time data validation system for android (iSAD). iSAD evolved and its spinoffs were used in several fight test campaigns. This paper presents iSAD development, evolution and its next steps. The main technical challenges include: limited processing capability; harsh environment; and WIFI security. Actually, the Ultra-Small Form Factors computers, opens new horizons for the integration of advanced tools based on smart devices by using distributed processing architectures.

11:35 a.m.
26-07-05

"An Advanced Approach to Flight Test Instrumentation Command and Control"

Melissa Beldon, Bill Domitrovich, and Russ Heinbockel, Northrop Grumman Corporation

Legacy Flight Test Instrumentation (FTI) systems rely on physical pilot interfaces for command and control (C2). The advancements of the industry are driving toward smaller, faster, more independent methods of flight testing including unmanned applications. How can FTI systems adapt to meet the needs of the customer? This paper looks at the most common elements of an FTI system and evaluates how the reduction in legacy C2 approaches and the implementation of next generation

technologies can advance FTI systems and shift flight testing into the future. The solutions from the laboratory integration of several FTI system components will be available this year as part of an ongoing effort of technical advances of FTI systems by Northrop Grumman.

11:55 a.m.
26-07-06

"Multitask Graph Convolutional Network With Feature-Space Graph Induction & PPCA Denoising For CubeSat Telemetry Anomaly Detection"

Pruthviraj Sadhankar, Rishabh Anand, Vivek Marujolla, Hyeseong Song, Xheon Arnado, and Nischay Rawal, KUbeSat at University of Kansas; Faculty Advisor: Erik Perrins, University of Kansas

The reliance on commercial off-the-shelf (COTS) components in 3U CubeSat missions introduces significant reliability gaps, primarily due to sensor "infant mortality" and radiation-induced signal noise. This investigates a robust health monitoring framework that combines Probabilistic Principal Component Analysis (PPCA) with Graph Convolutional Networks (GCN) to detect anomalies in "dirty" telemetry environments. Following the logic that "failed sensors = noise," we implement PPCA as a machine learning-based filtering stage to eliminate signal artifacts and reconstruct missing data points from sparse 3U downlinks. The cleaned features are then processed by a GCN to model the topological dependencies across power rails. We utilize historical telemetry from the BIRDS and SatNOGS datasets for training. Validation is performed via a high-fidelity Digital Twin in MATLAB/Simulink, where we will inject sensor-level faults to benchmark the framework's accuracy against raw, un-filtered data. This study seeks to provide a mission-ready pipeline for flight computers that maintains high detection precision despite component degradation.

Wednesday, October 28th, 10:15 a.m. – 11:55 a.m. **Cira C**

Session 8 **Receivers, Antennas, Modulation, and Coding Techniques I**
Chair **David Mitchell, New Mexico State University (NMSU)**

10:15 a.m.
26-08-01

"Radio Implementation and Interception of a McEliece Based Cryptosystem"
Tyler Randall and Jared Wilcken, Brigham Young University; Yuxing Yang, University of Illinois Urbana-Champaign; Faculty Advisors: David Mitchell, New Mexico State University and Willie Harrison, Brigham Young University

Telemetry systems require encryption schemes to securely transmit data. The recent development of quantum computers has excited the need for post quantum cryptography (PQC) to protect this data. This paper is a report on the hardware implementation of a McEliece based cryptosystem that utilizes low-density parity-check (LDPC) codes. Software Defined Radios (SDRs) are used to encode, transmit, and intercept a message over a wireless communication channel. Using a combination of the dual code attack (DCA) and the attack on the sum of two codewords (ASTC), it is shown that the original message can be recovered by an eavesdropper with a sufficiently strong receiver signal-to-noise ratio.

10:35 a.m.
26-08-02

"Performance Comparison of Best Source Selector (BSS) Algorithms"
Mark Geoghegan, Quasonix, Inc.

A Best Source Selector (BSS) is used to process telemetry data from multiple receive sources. The goal is to produce a single data stream that is better than any of its individual inputs. Algorithms fall into two general categories: weighted and unweighted. Weighted schemes use side information from each source to improve the reliability of the output decisions. This paper compares the theoretical performance of BSS algorithms using weighting schemes commonly available in aeronautical telemetry systems. Two IRIG 106 standardized approaches, Data Quality Metrics and Encapsulation (chapter 2) and Pulse Code Modulation (chapter 4), are featured. They provide embedded side information in the forms of probability of bit error (DQM) and a known periodic frame sync pattern (FS) respectively. These schemes are transport efficient and work with encrypted data and non-collocated receivers. The BSS performance of various algorithms will be analyzed with and without FEC.

10:55 a.m. **Continuation of above presentation**

11:15 a.m.
26-08-03

"Time Domain Equalization for OTFS"
Richard Simeon, University of Kansas; Faculty Advisor: Dr. Erik Perrins, University of Kansas

Orthogonal Time Frequency Space (OTFS) is a new modulation suitable for high-mobility communications in multipath channels with different Doppler shifts. While it is superior to OFDM in terms of Doppler resiliency, efficient decoding of OTFS is generally dependent on the sparsity of the channel. When Doppler shifts are not integer multiples of the OTFS Doppler resolution (` ` fractional Doppler"), channel sparsity is destroyed and contributes to suboptimal decoding

performance in the delay-Doppler domain due to signal energy leakage across Doppler bins. Time domain channel equalization is immune to fractional Doppler, and we show that time domain decoding outperforms delay-Doppler domain decoding when paths exhibit fractional Doppler. We also apply machine learning (ML) to time domain channel estimation that improves on existing time domain estimation methods.

11:35 a.m.
26-08-04

"Reliable Low-Latency Telemetry over LEO Satellite Links via Network-Layer Fountain Coding"

Michael Luby, Adrian Chadd, and Scott Brown, BitRipple

Real-time telemetry over LEO satellite links such as Starlink and Starshield is challenged by packet loss that grows with rate and varying conditions, while retransmission adds latency real-time streams cannot absorb. This work presents a transparent network-layer transport based on LT3 fountain coding that replaces retransmission with proactive, loss-tolerant encoding and requires no changes to avionics or telemetry applications. Native UDP over a Starlink Mini uplink has no loss-free operating point and degrades sharply beyond 20 Mbps. From 5 to 20 Mbps the tunnel holds residual loss at or below native UDP and, more importantly, changes the character of the loss: where native UDP loses packets continually, the tunnel keeps the stream clean for long stretches and confines loss to brief, infrequent episodes, at about 10% overhead and a millisecond of added jitter.

Wednesday, October 28th, 3:30 – 5:30 p.m. **Aurora A/B**

Session 9 **Machine Learning for Telemetry Data**
Chair **Hovannes Kulhandjian, California State University, Fresno**

3:30 p.m.
26-09-01

"An Unsupervised Anomaly Detection Audit Across Heterogeneous Spacecraft Missions"

Wole Akpose, 6igma Group; Richard Dean, Farzad Moazzami, and Wondimu Zegeye, Morgan State University

Real-time spacecraft telemetry monitoring needs anomaly detectors that operate without labelled examples, generalize across mission regimes, and meet strict latency budgets. We audit four unsupervised detectors (PCA subspace reconstruction, a dense auto-encoder, Isolation Forest, and a windowed auto-encoder) and five score-fusion strategies across all three missions of the ESA OPSSAT Anomaly Detection Benchmark (44.7 million samples, 48 to 100 channels). Training, score orientation, and the operating point are label-free. Detection is feasible but strongly mission-dependent: Isolation Forest reaches AUC 0.94 and 0.84 on Missions 3 and 2, while no detector exceeds 0.61 on Mission 1, and the best detector differs by mission. Score fusion does not help: no fusion strategy beats the best single detector on any mission. We further show that label-free score orientation has a structural blind spot for low-reconstruction-error anomalies. Per-mission detector selection runs in 0.006 to 0.50 ms per sample, two orders of magnitude below the slowest fusion and far inside the 150 ms budget.

3:50 p.m.
26-09-02

"QuantumSense: An Adaptive ML-KEM Scheme Selection Framework for Latency-Constrained Satellite Telemetry Pipelines"

Yuxing Yang, University of Illinois Urbana-Champaign; Shuhe Cui, National University of Singapore; Kevin Wei, University of Washington

Post-quantum migration in satellite telemetry introduces a core tension: post-quantum and hybrid handshakes can increase connection-setup cost, while bandwidth-constrained telemetry links impose strict latency budgets. Fixed-scheme deployments are simple to audit, but they cannot react when round-trip time, available bandwidth, or concurrent handshake load changes during operation. We propose QuantumSense, a lightweight adaptive framework that evaluates seven key-exchange configurations: elliptic-curve Diffie–Hellman (ECDH), the Module-Lattice-Based Key-Encapsulation Mechanism (ML-KEM) at three security categories, and three corresponding ECDH–ML-KEM hybrid configurations. During online replay, QuantumSense selects only from an operator-approved action set containing an ML-KEM component. The framework uses a contextual bandit policy based on round-trip time (RTT), available bandwidth, and concurrent hand-shake load. Using Ground Station–Test Article (GS–TA) testbed measurements, QuantumSense first selects Hybrid-768 within 15 handshakes after a simulated regime change. When measurements from the evaluated high-concurrency settings are pooled, QuantumSense reduces mean latency by 27.3% and 99th-percentile (P99) latency by 17.3% relative to static Hybrid-512, while classical-only ECDH remains outside the online action set.

4:10 p.m.
26-09-03

"Optimizing Sequential LDPC Decoders via Reinforcement Learning for Next-Generation Telemetry Systems"

Yair Barraza and Matthew Ochoa, New Mexico State University; Faculty Advisor: David Mitchell, New Mexico State University

To meet the demands of next-generation deep-space telemetry, low-density parity-check (LDPC) decoders must overcome significant latency and power consumption barriers. This research addresses these barriers by replacing standard simultaneous "flooding" decoders with a sequential processing architecture. We show that the decoder schedule can be optimized via reinforcement learning (RL), in which an agent chooses the node update sequence that maximizes the reward.

To validate our approach, we test the decoder using the industry standard NASA CCSDS (128, 64) LDPC code. In this work, we introduce two trained RL-driven schedules: a low-level and a high-level scheduler. Under identical channel noise conditions, our proposed RL trained decoders are shown to obtain an error-rate reduction of an order of magnitude over the random sequential and flooding baselines at high signal-to-noise ratios. Furthermore, we demonstrate that the high-level scheduler achieves comparable convergence speeds to the low-level scheduler while bypassing inner-loop memory bottlenecks, offering a pathway to efficient hardware implementation.

4:30 p.m.
26-09-04

"Adaptive ReID-Based Single-Person Tracking with QR-Guided Enrollment and Lightweight Identity Verification"

Derrick Cook II, Opeyemi Adeniran, Morgan State University; Facutly Advisors: Dr. Peter Taiwo and Dr. Kofi Nyarko, Morgan State University

This paper presents an adaptive person re-identification (ReID) framework for single-target tracking in crowded environments, optimized for CPU-only edge deployment (7.5 FPS). The pipeline integrates YOLO26 detection, OSNet extraction, QR-guided enrollment, and a neural classifier. Identity is verified using a combined score of OSNet cosine similarity against an exponentially updated gallery and classifier output. To reduce computational load, ByteTrack IoU handles inter-frame continuity, activating OSNet only every N=2 frames. The system mitigates identity swaps via a distractor embedding bank and handles appearance drift through adaptive gallery updates. Evaluation across six verification intervals (N=1, N=2, N=5, N=10, N=20, N=30) highlights the trade-off between inference frequency and tracking continuity, validated by precision, recall, accuracy, and F1 metrics against annotated ground truth.

4:50 p.m.
26-09-05

"Solar-Powered Telemetry System for Water Level Monitoring and Consumption Estimation in Agricultural Irrigation"

Hovannes Kulhandjian, Martin Garcia, and Julian Gutierrez, California State University, Fresno

This paper presents the design, hardware implementation, and field deployment of a solar-powered telemetry system for monitoring water level and supporting water-consumption estimation in agricultural irrigation infrastructure. The system was motivated by irrigation turnouts in which water delivery is mechanically controlled

and the delivered volume is not continuously measured. A non-contact MaxBotix MB7380 ultrasonic sensor is mounted above the water surface and interfaced with a Raspberry Pi 4B for measurement acquisition, timestamping, local storage, and wireless communication. A Bluetooth link, built on the IEEE 802.15 Serial Port Profile and Object Push Profile, provides short-range transfer of measurement records to an Android device. A separate environmental-control subsystem monitors enclosure temperature, humidity, voltage, and current, and switches cooling fans through a relay when thermal limits are exceeded.

The field enclosure is powered by a 10-W photovoltaic panel and a rechargeable Ni-MH battery bank, enabling operation at remote irrigation locations without utility power. The complete node was assembled for approximately $466 in commercial off-the-shelf hardware and was installed above operating canal turnouts on the Fresno Irrigation District network, demonstrating non-intrusive integration with existing infrastructure. Water-level measurements can be combined with a calibrated basin geometry or hydraulic relationship to estimate stored volume or delivered water. Beyond the original Raspberry Pi implementation, a lower-power ESP32-based alternative with a real-time clock was also prototyped to reduce idle power draw for long-term unattended operation. The resulting platform, along with its bill of materials, project timeline, and documented implementation lessons, provides a practical and reproducible foundation for low-cost irrigation telemetry, remote record keeping, and future distributed water-management systems.

5:10 p.m.
26-09-06

"TA FTMC Activity Report"

Volkan Tutay, Samed Durmus, Hatice Celik, Muhammet Kursat Serceli,Yakup Soysal, Furkan Kamil Tut, Burak Iplikci, Ipek Cersil Polat, Mustafa Melik Gecgel, Onur Yoruk, and Mahmut Kursad Arpacioglu, Turkish Aerospace

Flight test campaigns at Turkish Aerospace (TA) must be managed cost-effectively and on tight schedules. Telemetry-based monitoring reduces cost, improves safety, and accelerates these campaigns, so the integrity and accuracy of test data are paramount. This study introduces the Flight Test Management Center (FTMC) Activity Report Software, an end-to-end tool for post-flight telemetry and flight test management infrastructure (FTMI) systems analysis, encompassing decommutators, Flight Test Management Centers (FTMCs), network components, and auxiliary test equipment such as meteorology stations and DGPS receivers. After each test it generates a comprehensive report that quantifies data losses across all test points and activities, visualizes key aircraft and ground parameters, and—by processing every subsystem's status in parallel—attributes each loss to a specific link in the air-to-ground chain. The approach reduces manual effort, accelerates anomaly detection and resolution, and supports the continuous improvement of the telemetry and FTMI systems.

Wednesday, October 28th, 3:30 – 5:30 p.m. **Aurora C**

Session 10 **Data Acquisition II**
Chair **David Hodack, NAWCAD**

3:30 p.m.
26-10-01

"Real-Time Telemetry Data Transfer Platform"
Mustafa Ufelek, Mahmut Kursad Arpacioglu, Onur Yoruk, Huseyin Oguzhan Eryigit, and Akin Sarper, Turkish Aerospace, Inc.

Turkish Aerospace Flight Test Technic department provides flight test infrastructures such as Telemetry Systems, Flight Test Management Centers and Flight Test Data Systems for a wide range of indigenous platforms across fixed-wing(HURKUS, HURJET, KAAN), rotary-wing (T-625 GOKBEY,T-129 ATAK), and unmanned aerial vehicle (ANKA,AKSUNGUR) categories. The speed of operations during test and data analysis activities of indigenously developed aircraft constitutes a critical factor in overall program success. System-level and software-based enhancements that shorten the time span between the conceptual design phase and entry into service make substantial benefit to the efficiency and effectiveness of the product development lifecycle.

During the flight test phase of aircrafts, data packets which are transmitted from the aircraft to Flight Test Management Centers via Telemetry Systems are visualized and analyzed in real-time by using Real-Time Data Monitoring software. In the post-test data analysis phase, processed data sets are shared by telemetry responsible engineers with the relevant design teams to support detailed data analysis activities.

Through the implementation of a Real-Time Telemetry Data Transfer Platform, the data delivering process—previously conducted using legacy methods and requiring 2 hours—has been reduced to a matter of minutes. The core architectural principle of the software is based on extracting data packets not after the completion of flight activities, but from the onset of operations which are categorized according to specific test points and data set groups. Following engine shutdown, the relevant data sets are delivered to the responsible design teams within five minutes for analysis.

3:50 p.m.
26-10-02

"Design and Comparative Performance Analysis of V and W-Shaped Time-of-Flight Mass Analyzers for CubeSat Applications"
Anjali Patel, Anchal Patel, Amir Unz, Aziz Alani, Manuel Peña and Varun Kore, University of Kansas; Faculty Advisors: Dr. Erik Perrins and Dr. Adam Gorrell, University of Kansas

As part of the primary payload of the KUbeSat-2 mission, this study investigates the design, modeling, and comparative performance of V and W-shaped Time-of-Flight (TOF) mass analyzers for a compact mass spectrometer. Initially, the V-shaped analyzer was designed for 1U CubeSat volume to achieve a maximum mass resolution of 1776.91 for 14 amu ions but it showed lower mass resolution for heavier ions. To address this limitation, a W-shaped design was developed, which provides more uniform mass resolution across a wider mass range with an average resolution of 235.66. A W-shaped design also offers operational flexibility by

enabling both V and W-shaped modes within the same instrument architecture. Overall, the results highlight that the W-shaped analyzer enhances performance while remaining compatible with CubeSat constraints, making it suitable for future small-satellite mass spectrometry missions.

4:10 p.m.
26-10-03

"An Analysis for Regional Data Availability and Out of LOS Conditions"

Mahmut Kürsad Arpacioglu, Mustafa Melik Gecgel, Ipek Cersil Polat, Yakup Soysal, and Irem Ulusoy Kandemir, Turkish Aerospace

Continuous telemetry data reception is critical for safety and performance evaluation during flight tests at Turkish Aerospace Inc. To identify and predict signal loss, a real-time analysis framework was developed. This paper presents two custom real-time modules—Out of Line of Sight (LoS) Conditions and Regional Data Availability—integrated into the IADS (Interactive Analysis and Display System) environment using external C++ software libraries.

The framework splits the airspace into two parts based on altitude. For high-altitude flights (above 3,000 ft), the Out of LoS module checks the aircraft's position against geometric LoS limits. Using current speed and heading, it calculates exactly when and where the aircraft will leave the coverage area, sending real-time alerts to test conductors. For low-altitude and runway operations (below 3,000 ft), the Regional Data Availability module analyzes telemetry coverage quality across specific runway sectors to help improve ground RF infrastructure.

Post-flight, this system helps engineers determine if data dropouts happened due to physical obstacles or equipment faults. Ultimately, this approach improves situational awareness and optimizes telemetry coverage.

4:30 p.m.
26-10-04

"Closing The Configuration Consistency Gap in A COTS IRIG-106 PCM Telemetry System"

Chiekeziem Udenta, Rochester Institute of Technology; Mason Joyner, Dominique Stewart, and Dr, Oluwatobi Busari, Morgan State University

This paper describes the design, configuration, and staged verification of an IRIG-106 Chapter 4 PCM telemetry system for a student-built liquid-propellant rocket, integrating a twelve-sensor suite through a Curtiss-Wright KAM-500 chassis, an S-band PCM/FM downlink, and a Lumistar LS28 ground segment. We argue that in modern COTS telemetry the dominant integration risk has migrated from hardware to configuration consistency between the transmit-side frame definition and the ground-side parameter database, and we demonstrate this failure mode and its mitigation experimentally. Verification results include over-the-air link characterization to 120.6 dB equivalent path loss with zero bit errors, temperature channels verified at the ice point to better than 0.6 ◦C, and a uniform pressure noise floor of 0.008% of full scale through the complete acquisition–transmission–decommutation chain. An airborne reconfiguration transmitted against a stale ground file pair — invisible to receiver lock and frame synchronization — was flagged by a frame-embedded counter check on the first frame, with zero false passes thereafter, while the onboard recorder supplied every frame lost during a 13.4 s transmitter outage, sample-exact against the downlink. Configuration

consistency, we conclude, is a property to be verified in the bitstream, not assumed from the toolchain.

4:50 p.m. **Continuation of above presentation**

Wednesday, October 28th, 3:30 – 5:30 p.m. **Aurora D**

Session 11 **AI-Driven Sensor Fusion, Compression, and Processing I**
Chair **Yogananda Isukapalli, University of California, Santa Barbara**

3:30 p.m.
26-11-01

"ML-Aided UAV Swarm Autonomy Framework"
Noor Ahmed and Charles Milligan, Research Institute for Tactical Autonomy (RITA); Jorge Power and Andrew Oldenburg, Reliable Systems Services Corp.

Unmanned Aerial Vehicles (UAVs) are increasingly gaining attention in both commercial and military applications for executing specific tasks with unprecedented accuracy, however, enabling a group/swarm of UAVs to operate in autonomous fashion remains a significant challenge. While recent advances in Machine Learning (ML) have addressed some of these challenges such as collusion-free routing, obstacle avoidance, and inflight object/image identification, porting these algorithms for swarms lies a critical gap between the real-time interplay of ML inferences and the swarm's networking, communication protocols, and its cyber-physical data (speed, velocity, trajectory, etc.) fusion requirements. This paper proposes a design, implementation, and experimental evaluation methodologies for adaptable ML-Aided autonomous UAV swarm framework.

We discuss the building blocks of the framework components including the application networking, Software Defined Radio (SDR) communication links, messaging protocols, and application-aware signal processing for light-weight ML models for FPGA-based small UAVs platforms using GNU Radio IDE to illustrate the efficacy of the proposed framework.

3:50 p.m.
26-11-02

"Autonomous Control and Real-Time Sensor Feedback Integration in 30 lb Combat Robotics"
Jack Tanner and Daniel Hoffmeister, University of Arizona; Faculty Advisor: Dr. Michael Marcellin, University of Arizona

Featherweight combat robotics involves two opposing thirty-pound robots competing in an enclosed arena, typically operated by a human pilot. This work represents a transition toward data-driven combat robotics by establishing a foundation for comprehensive onboard telemetry, increased visibility into subsystem behavior, and future autonomous decision-making capabilities. A combination of sensors, including speed control, weapon speed measurement, and thermal monitoring, provides continuous insight into both system state and environmental interactions. These inputs feed a closed-loop control system that identifies opponents, estimates system dynamics, and issues real-time corrections for drive and weapon actuation. By removing human reaction delays and increasing control update rates, autonomous operation enhances precision and consistency, while the structured combat environment serves as a reliable testbed for evaluating performance under rapidly changing conditions.

4:10 p.m.
26-11-03

"Prompt Engineering for Improved AI-driven Risk Management in Cybersecurity"
Oyewande Oluwatoyosi and Hannah Abedoh, Morgan State University; Faculty Advisor: Dr. Farzad Moazzami, Morgan State University

Prompt engineering has emerged as a key aspect of ensuring the effectiveness, transparency, and reliability of large language models (LLMs) in cybersecurity. But its research remains disjointed and with limited or no synthesis on the role and challenges of prompt engineering in cybersecurity practices. This study is a systematic literature review (SLR) of 32 peer-reviewed papers obtained from Scopus, IEEE Xplore, and ACM Digital Library following the PRISMA guidelines. Evidence shows the use of prompt engineering in threat detection, vulnerability assessment, incident response, compliance validation, phishing detection, and cyber defense automation. This study reveals the benefits of using the model for contextual reasoning, explanations, adaptive decision-making, and knowledge-driven threat analysis, but also outlines some potential drawbacks, including adversarial manipulation, the absence of standard frameworks for prompt engineering, privacy leakage, and prompt injection. Synthesized insights are grouped in three areas: improve AI performance; AI governance and decision support; and prompt security and risk management. To conclude, prompt engineering has evolved from being simply a way to optimize inputs to a governance and intelligence-control mechanism that allows the responsible use of AI in cybersecurity risk management, as well as continued research and safe application.

4:30 p.m.
26-11-04

"Telemetry Driven Ergonomic Energy Systems for Real Time Monitoring and Optimization"

Nathaniel Bidwell, Joseph Hill, Makenna Dundon, Gwendolyn Alviar, Bobby Limperis, Icarus Newton, Lucia Alday, Aidan Monroe, and Elizabeth Springer, University of Arizona; Faculty Advisor: Dr. Michael Marcellin, University of Arizona

Amusement parks rely heavily on energy to power attractions, shows, and guest experiences. This project presents a telemetry-driven interactive system that captures mechanical energy from human activity and converts it into stored electrical power for user-triggered outputs. Generators integrated with sensors collect data on rotational speed, voltage, and current to estimate power generation and system efficiency. An embedded microcontroller processes this sensor data, enabling real-time monitoring and responsiveness. The data is displayed through an interactive interface that provides real-time feedback on user energy contribution. Designed as a scalable proof of concept, this system demonstrates how telemetry and sensor-based data can enhance human-powered energy collection and support energy optimization strategies.

4:50 p.m.
26-11-05

"Ember Watch: A Model Driven Approach to Real-Time Wildfire Detection"

Jake Gilbert, Frank Xiao, Manny Lemus, Aliston Ma, and Kevin Yu, UC Santa Barbara; Faculty Advisor: Dr. Yogananda Isukapalli, UC Santa Barbara

Wildfires pose a significant threat to ecosystems, communities, and infrastructure. In 2025 alone, more than 5 million acres across the United States were burned by forest fires. This work presents the Ember Watch System, a distributed environmental sensing network designed to detect early signs of wildfires. Each low-power remote node measures temperature, humidity, carbon monoxide (CO), carbon dioxide (CO2), and atmospheric pressure, transmitting data via LoRa radio up to 10 kilometers to a central monitoring station. A trained model with a

classification RMSE of .1214 evaluates each payload for fire risk, generating alerts when ignition conditions emerge. By combining distributed sensor collection, energy-efficient nodes, and long-range communication, EmberWatch enables faster wildfire detection.

5:10 p.m.
26-11-06

"Intelligent Data Middleware As Mission-Enabling Telemetry Infrastructure: An Ai/Ml-Ready Framework For Real-Time Defense And Commercial Data Serialization, Orchestration, And Adaptive Optimization"

Donald Layden, Big Duck Applied Sciences

Modern defense telemetry systems generate high-velocity data streams from autonomous platforms and sensor networks — each in proprietary schemas incompatible with the AI/ML systems that need them most. The bottleneck is not data volume — it is the absence of intelligent middleware capable of serializing heterogeneous telemetry at mission speed. This paper presents IDDMF and ICDMF — AI/ML-ready middleware frameworks by Big Duck Applied Sciences (BDAS) that serve as the intelligent operating layer between raw telemetry and downstream AI/ML consumers. The architecture delivers configurable ingress and egress pipeline microservices, a vendor-agnostic AI/ML API layer, no-code operator orchestration, and an adaptive closed-loop optimization engine — transforming passive telemetry collection into active, mission-enabling intelligence across defense test ranges, sensor fusion environments, and autonomous platform networks.

Wednesday, October 28th, 3:30 – 5:10 p.m. **Cira C**

Session 12 **Telemetry Systems (CUI Session)**
Chair **Jacob Lopez, U.S. Army Yuma Proving Ground**

3:30 p.m.
26-12-01

"Bridging Quantum Sensing and Classical Communications: An Investigation using Rydberg Receivers with Aeronautical Mobile Telemetry Waveforms"
Frank Cruz, Air Force Test Center, Edwards AFB

In today's environment of modern communication systems, multiple constraints and impairments affect wireless link quality. It is reasonable to say that modern communication systems have reached a technological limit due to thermal noise inherent in communication system hardware. While techniques can be employed to limit noise impairment and improve on hardware, these improvements do not provide a significant advantage in efficiency or performance. To improve on the impacts of these limitations, a new technique utilizing quantum sensors commonly known as Rydberg sensors, are currently being researched and developed by several stakeholders. This paper will address the potential of atomic-based sensors having a positive impact on aeronautical mobile telemetry (AMT) receivers. Furthermore, a functional demonstration is briefly discussed integrating a Rydberg sensor with a "classical" AMT receiver conducted in collaboration with the National Institute of Standards and Technology (NIST).

3:50 p.m.
26-12-02

"Enhancement of White Sands Missile Range (WSMR) Telemetry through Quick Reaction Test Capability"
Joshua Dannhaus and Joseph Ruiloba, TEWS-TTD, WSMR

To address critical shortfalls in Test and Evaluation (T&E) capabilities, the Test Resource Management Center (TRMC) has recently funded two Quick Reaction Test Capability (QRTC) projects to enhance the telemetry capability at White Sands Missile Range (WSMR). These projects will directly support emerging requirements for multi-domain operations (MDO), simultaneous test engagements, hypersonic weapon systems, and assist in making challenging Time, Space, Position Information (TSPI) flight termination decisions. This paper provides a technical overview and status update on the Coupled Sensor Array (CSA) and GeoTrack Technology QRTC projects. It analyzes the initial test results against legacy Range telemetry systems and outlines the proposed integration roadmap for these two capabilities.

4:10 p.m.
26-12-03

"ATARI - Enabling AI in Aircraft"
James Charleston, 812th AITS/ENIE

There is a need to accelerate Flight Test and Evaluation, compressing the time from test point complete to useful information. To meet this need in a spectrum efficient manner, flight test instrumentation systems need to incorporate High-Performance Computing (HPC) with Artificial Intelligence and Machine Learning (AI/ML) capabilities. The AI Test Aircraft Research and Integration (ATARI) program is developing a software framework and edge computing hardware that will be incorporated in flight test instrumentation systems at Edwards AFB. This presentation will describe the ATARI software architecture, including scalability

and modularity, and the implementation details including the Apache Kafka data backbone, containerization, and cybersecurity.

4:30 p.m.
26-12-04

"The Savanna Testbed – Facilitating Modernized Analytics for the Test & Evaluation Community"
David Jungreis, KBR, Inc

The Savanna Testbed is a component of the Test Resource Management Center's efforts to modernize evaluation infrastructure for agile decision-making on behalf of the Office of the Under Secretary of War for Research & Engineering. It provides a virtual analytic environment consisting of compute and data resources to enable operations research, data science, and analytics practitioners to collaboratively perform analysis using streamlined workflows in a secure, controlled environment with established governance and a responsive user feedback processe. This presentation will discuss how the Savanna Testbed is useful to the Department of War, how to get an account to access the testbed, and how to perform analysis on the testbed using R or Python.

4:50 p.m.
26-12-05

"Novel Approach for Remote Classified Operations at White Sands Missile Range (WSMR)"
Joshua Dannhaus, TEWS-TTD, WSMR; Brian Simonin, Southwest Range Services, Mission Support Contractor for WSMR; Pedro Hernandez, TEWS-ROD

This presentation addresses the persistent challenge of conducting remote classified operations at White Sands Missile Range (WSMR) without deploying personnel to the field. A variety of methods have been explored over the last decade, including SecureSwitch, fuzzy math cross-domain solutions, and Commercial Solutions for Classified (CSfC), but none have successfully met all security, technical, or logistical requirements. This briefing proposes a new methodology that isolates and removes classified (Red) data from the Precision Acquisition System (PAS) slave data stream. The remaining unclassified pointing data is then encrypted and transmitted over the existing black network via secure IPSec tunnels.

Thursday, October 29th, 9:00 – 10:20 a.m. **Aurora A/B**

Session 13 **Software Systems and Tools I**
Chair **Laura Boucheron, New Mexico State University (NMSU)**

9:00 a.m.
26-13-01

"Experimental Transmitter Characterization Of The ADALM-Pluto Software-Defined Radio for Short-Duration Cubesat Missions"
Thomas Francois, Missouri University of Science and Technology; Faculty Advisors: Jonathan Kimball, Kurt Kosbar, and Ronald Stanley, Missouri University of Science and Technology

Software-defined radios (SDRs) for spaceflight often rely on uprated components that are correspondingly expensive, placing them beyond the reach of many university and low-cost satellite programs. Development SDR platforms incorporate RF transceivers related to devices used in some space-qualified systems, raising the question whether such hardware could support short-duration CubeSat missions. This work presents an independent characterization of the ADALM-Pluto by Analog Devices Inc., including output power linearity across frequency and gain, reference oscillator frequency stability versus temperature, and thermal operating limits. Published manufacturer measurements characterize the PlutoSDR under ambient laboratory conditions; agreement with measurements obtained using a low-cost RF test framework supports the credibility of the extended characterization presented. These results provide practical data for satellite development programs to evaluate the PlutoSDR for short-duration space missions.

9:20 a.m.
26-13-02

"Flight Test Engineering Infrastructures Management Software"
Yeter Sahin, Mahmut Kürşad Arpacıoğlu, Onur Yörük, İpek Çerşil Polat, Onur Yeşil, Hüseyin Oğuzhan Eryiğit, and Yunus Öcel, Turkish Aerospace, Inc.

In flight test activities, the efficient, traceable, and sustainable management of all operations, encompassing engineering infrastructures such as telemetry systems, flight test management centers, and flight test data systems, is of critical importance. As the scale and complexity of flight test programs increase, managing critical operational processes and technical infrastructure requirements through traditional or fragmented methods leads to coordination deficiencies and inefficiencies.

The "Flight Test Engineering Infrastructure Management Software" is an integrated, web-based software platform developed to enable the end-to-end digitalization, automation, and centralized monitoring of the relevant processes. The designed system consolidates administrative and technical operational workflows into a single hub, thereby strengthening coordination among flight test teams. This solution enhances asset visibility, operational traceability, and process control by establishing a unified digital environment for infrastructure and activity management. By integrating telemetry infrastructure management with operational tracking processes, the platform supports digital transformation within flight test organizations and provides a scalable foundation for future capabilities.

9:40 a.m.
26-13-03

"Flight Test Management Centers, Receiving Systems and Frequency Allocation / Management System"

Ayse Bilsel, Busra Dogan, Aslı Tekin, Cemile Timurkaan, Onur Yesil, Yunus Ocel, Efe Erkan, Onur Yoruk, Ipek Cersil Polat, Mustafa Melik Gecgel, Mahmut Kursad Arpacioglu, Turkish Aerospace, Inc.

High-density flight test operations are complex processes that require the coordinated operation of Flight Test Management Centers (FTMC), ground receiving systems, and operational personnel. To overcome these operational challenges, an integrated decision support platform is designed to optimize telemetry resource allocation through a centralized constraint-based algorithm. In this paper, spectrum analysis encompasses not only aircraft data acquisition requirements but also telemetry frequencies associated with satellite passes and ammunition firing tests. Within narrow telemetry bands, critical frequency interference can occur not exclusively aircraft-to-aircraft, but also among aircraft-satellite, aircraft-ammunition, ammunition-ammunition, ammunition-satellite and satellite-satellite systems. The developed architecture proactively detects and mitigates this dimensional spectrum contention during the planning phase, based on mission profiles and hardware configurations. The system provides deterministic resource management drives through link-margin evaluations and prioritization algorithms. Ultimately, this approach minimizes configuration errors inherent in manual process and maximizes spectrum and infrastructure efficiency, thereby ensuring the safe execution of concurrent multi-platform test campaigns.

10:00 a.m.
26-13-04

"Telemetry Analysis and Visualization: A History of Transforming Data into Understanding"

Nate Roehrig and Robert Poland, Sandia National Laboratories

Join Sandia National Laboratories in celebrating the twenty-year anniversary of the first release of the Telemetry Analysis and Visualization Suite (TAVS). TAVS is a software-based telemetry data solution, capable of transforming data into understanding - enabling engineers to gain insights into flight tests and flight test data. Through its long history, TAVS has evolved from a post-flight analysis tool for fixed frame telemetry into a suite capable of visualizing live data during flight. Sandia National Laboratories continues to develop TAVS to support additional standards, most recently: RCC 218-20 TMoIP and IRIG 106 Chapter 7. Let's celebrate as we walk through TAVS' history, its current core capabilities, and where TAVS is heading.

Thursday, October 29th, 9:00 – 10:20 a.m. **Aurora C**

Session 14 **Communication Systems II**
Chair **Oluwatobi Busari, Morgan State University**

9:00 a.m.
26-14-01

"Electric Boat Monitor and Control Panel Design Using Control Area Network (CAN) Bus Telemetry"
Alyson Jones, Derrick Cook, and Marcus Bazemore, Morgan State University;
Faculty Advisors: Dr. Richard Dean and Brian Palmer, Morgan State University

This paper presents the design and preliminary validation of a Controller Area Network (CAN) Bus telemetry system for monitoring and controlling Morgan State University's electric boat conversion. An ESP32-S3 telemetry controller is integrated with a CAN Bus / National Marine Electronics Association (NMEA) 2000 network to acquire, process, and distribute real-time vessel data across battery management, motor control, navigation, and range prediction subsystems. Operator-facing outputs are delivered through an onboard GPS/Chartplotter display, implemented in the current prototype with a SIMRAD chartplotter, and a companion mobile application. A dynamic range prediction engine is designed to directly address range anxiety, a primary barrier to electric marine adoption by continuously estimating remaining range, safe return distance, and destination feasibility based on live telemetry. Bench validation has confirmed reliable 250 kbps CAN bus communication, establishing the foundation for full-system integration and upcoming sea trials on the Chesapeake Bay.

9:20 a.m.
26-14-02

"Implementation of CAN Bus Telemetry for Battery Management in Electric Boat Conversions"
Alyson Jones, Derrick Cook, and Marcus Bazemore, Morgan State University;
Faculty Advisors: Dr. Richard Dean and Brian Palmer, Morgan State University

This paper details the design and implementation of a Controller Area Network (CAN) telemetry system for "Morgan's Electric Boat Project," a proof-of-concept initiative focused on converting Internal Combustion Engine (ICE) maritime vessels to all-electric drivetrains. The integration of a 120 kWh Lithium Nickel Manganese Cobalt (NMC) battery—comprising 6,720 individual cells—necessitates a robust Battery Management System (BMS) capable of high-fidelity monitoring. We propose a telemetry architecture that utilizes CAN bus and NMEA 2000 standards to interface the BMS, Master Control Unit (MCU), and user interface. This system enables real-time monitoring of voltage, current, and thermal data, ensuring safe operation and optimized charging cycles. Preliminary results demonstrate the feasibility of using standardized CAN protocols to bridge the gap between automotive EV components and maritime navigation systems.

9:40 a.m.
26-14-03

"Turning Existing Telemetry Infrastructure into a Geolocation System: An Interactive Demonstrator for Flight Tests"
Sebastien Bonnart, Florian Sandoz, Laurent Blaise, Lara Thomas, Damien Devlies, and Oussama AIT SIDI ALI, Safran Data Systems

Reliable, continuous knowledge of the Device Under Test (DUT) position is a critical requirement for flight test telemetry. Emerging hypersonic and long-range test

scenarios are stretching existing range infrastructures, creating new needs for geolocation solutions that work both within and across multiple ranges.
This paper presents an interactive real-time demonstration of DUT geolocation based on data provided by COTS telemetry equipment. The paper details the architecture and implementation of the demonstrator and the geolocation performance achieved for several test geometries. It also discusses data fusion concepts and other ways to further improve performance.

10:00 a.m.
26-14-04

"Planning Flight-Test Telemetry Campaigns Through Terrain-Aware Link Budget Estimation and Spectrum Analysis"

Tafnes Barbos and Lucas Sousa, Flight Tests and Research Institute, Instituto de Pesquisas e Ensaios em Voo - IPEV

This paper discusses the development of a novel software tool to support telemetry test flight setup, with respect to the geographic analysis of the telemetry-ground antenna position relative to the test bed, as well as the selection of the most suitable communication telemetry link channel. To accomplish that, the theory for both functionalities is presented: (1) the received power estimation considering a complete communication link, including path and terrain-induced diffraction losses; and (2) the use of power spectrum analysis with statistical techniques to select the best carrier frequency for air-to-ground communication. In addition, real flight data are presented and compared with the received power estimates. Lessons learned demonstrate how the proposed software can effectively assist in the setup of future flight-test campaigns.

Thursday, October 29th, 9:00 – 10:20 a.m. **Aurora D**

Session 15 **Receivers, Antennas, Modulation, and Coding Techniques II**
Chair **Erik Perrins, University of Kansas**

9:00 a.m.
26-15-01

"Decoder Performance of AMT LDPC Codes"
Trevor Wai and William Harbor, Brigham Young University;
Faculty Advisors: David Mitchell, New Mexico State Univeristy and Willie Harrison, Brigham Young University

Low-density parity-check (LDPC) codes are a commonly used class of forward-error correction (FEC) codes that provide methods of detecting and correcting errors of received messages passed along noisy channels. IRIG106, a comprehensive standard for telemetry developed by the Range Commanders Council, provides a standard for LDPC codes to provide a reliable method of communication in aeronautical mobile telemetry (AMT). However, IRIG106 does not provide a standard of decoding methods for LDPC codes. We aim to explore the space of decoders that exist for LDPC codes and examine the error rates as a function of signal-to-noise ratio (SNR) to evaluate performance.

9:20 a.m.
26-15-02

"Subsystems Design Analysis For Kubesat-2"
Aaron Hastings, Amir Unz, Kenisyn Mellema, and Nicholas Yeary, University of Kansas; Faculty Advisors: Dr. Adam Gorrell and Dr. Erik Perrins, University of Kansas

The KUbeSat Organization at the University of Kansas seeks to develop their second 3U cube satellite, KUbeSat-2. The primary objective of this mission is to determine the molecular consistency of low earth orbit using an in-house designed mass spectrometer. A secondary objective includes the utilization of an internally developed image compression algorithm to reduce data downlink sizes using proposed S-band communication systems. This document provides an overview of the systems-level design approach to KUbeSat-2, including current design options for the spacecraft's structure, mass spectrometer payload, power systems, software, and communication systems. In addition to on-board subsystem considerations, other aspects such as the organizational structure and proposed ground station will be discussed.

9:40 a.m.
26-15-03

"An Empirical Assessment of Multiple G/T Measurement Methods"
Terry Hill, Quasonix, Inc.; Kip Temple, Air Force Test Center, Edwards AFB; Ron Taylor, NASA Wallops Flight Facility

G/T is a widely accepted figure of merit for a receiving system and a critical parameter in any link budget. The solar test remains the most widely used field technique because the sun provides a strong, repeatable source that can be observed without specialized transmit equipment. This paper presents a side-by-side evaluation of the linear-receiver and attenuator methods described in IRIG 118-25, Volume 2, Chapter 1, variations on those methods that have been implemented on some ranges, and a calibrated-receiver method that is already used within the telemetry community but is not presently standardized. The methods are compared in terms of required equipment, usable dynamic range,

calibration burden, susceptibility to compression and noise-floor effects, test efficiency, and suitability for absolute versus trending measurements. Bench characterization and field measurements are used to determine when each technique yields accurate and operationally relevant results.

10:00 a.m. **Continuation of above presentation**

Thursday, October 29th, 9:00 – 10:00 a.m. **Cira C**

Session 16 **Range Systems**
Chair **Mark McWhorter, Lumistar**

9:00 a.m.
26-16-01

"Beyond the Red Button: Leveraging Real-Time Telemetry for Operational Awareness of Flight Termination Capability"
Jean-Guy Pierozak, Hensoldt Nexeya France

Flight termination decisions are among the most critical and time-constrained tasks in launch operations, requiring Range Safety Officers to rapidly assess both vehicle behavior and the operational readiness of the flight termination chain. While modern telemetry continuously provides Flight Termination Receiver (FTR) status, vehicle navigation, and communication information, these data are typically presented independently, requiring operators to correlate multiple sources under significant time pressure. This paper proposes a telemetry-enabled operational framework that integrates FTR health, GPS navigation, and ground station coverage into a unified view of the flight termination capability throughout the mission. Through representative operational scenarios, the paper illustrates how this integrated awareness supports earlier anomaly identification, anticipates degradation of the termination capability, and enables more informed and timely flight safety decision-making. The framework introduces a real-time correlation engine that weighs telemetry parameters based on mission phase and safety boundaries, enabling proactive degradation detection.

9:20 a.m.
26-16-02

"Plume Attenuation Concerns When Receiving Airborne Tracking Signals"
Scott Kujiraoka, GBL Systems; Russell Fielder, SA-Tech/NAWCWD; An Le and Geoffrey Constable, NAWCWD

In order to conduct operations on a Government Test Range, methods of tracking have to be established for Range Safety and Communication purposes. This function of tracking airborne test platforms can be accomplished via a Flight Termination System (FTS), Telemetry (TM), and/or Beacon Tracking System. In order to verify that these systems operate correctly, a Link Analysis needs to be performed to confirm the communication link between the Airborne Platform and the Ground Receiving Station. There are many variables which are involved in this Link Analysis, but one of the most misunderstood variables is Plume Attenuation. This is the attenuation of the signal as it travels through the exhaust plume of a missile or plane. This paper will investigate how this parameter can be determined. The results of this study could greatly support future FTS and TM Systems development.

9:40 a.m.
26-16-03

"AI-Enabled Autonomous Drone Detection and Tracking Turret Using Embedded Vision and Real-Time Control"
Hovannes Kulhandjian, John Garcia, Fernando Solorzano, and Jose Elias Bravo, California State University, Fresno

This paper presents the design, implementation, and experimental evaluation of an embedded artificial intelligence system for real-time drone detection and closed-loop pan–tilt tracking. A custom YOLOv8 detector is trained using 1,043 labeled

drone images and deployed on a Raspberry Pi 5 equipped with a Hailo-8 AI accelerator. The perception output is coupled to independent proportional–integral–derivative (PID) controllers that command two stepper-motor axes, while a graphical interface supports live adjustment of controller gains and detection thresholds. Experimental results compare YOLOv8n, YOLOv8s, and YOLOv8m under consistent indoor test conditions at 3-ft and 6-ft target ranges. At 3 ft, YOLOv8m achieved a mean confidence of 0.75, with 98.8% of detections above 0.50 and 85.2% above 0.70, while operating at an effective 28.9 frames/s; YOLOv8m retained the highest confidence at 6 ft as well. In dynamic tracking tests, the system maintained target lock through repeated horizontal and vertical motion, and stationary targets settled within the 30-pixel deadzone in approximately 1.5–2.0 s. A separate background-only characterization found that confidence thresholding alone does not eliminate false detections, motivating additional target-validation logic for deployment. A 30-min continuous test further demonstrated stable embedded operation. The results demonstrate the feasibility of integrating edge AI, real-time vision, and closed-loop electromechanical control on a compact, low-cost platform for autonomous tracking research and engineering education.

Thursday, October 29th, 11:00 – 12:00 p.m. **Aurora A/B**

Session 17 **Software Systems and Tools II**
Chair **Doug O'Cull, Quasonix, Inc.**

11:00 a.m.
26-17-01

"The Subject-Matter Expert As Developer: AI-Assisted Tooling For High-Volume Telemetry Data"
Andrew Correnti, Radeus Labs

Small engineering teams rarely have a dedicated software developer, so they default to spreadsheets or expensive commercial software for jobs those tools were never built for. This paper traces how a Radeus Labs engineer, with no formal software background, used an AI coding assistant to retire a Tableau license and replace it with a purpose-built browser tool for analyzing antenna control unit telemetry: logs recording roughly 60 parameters once per second, tens of thousands of rows a day. Built and validated against field data over a single weekend, not months of formal development, the tool needs no installation, is shared as a single link, and has since been joined by several related tools covering other recurring engineering calculations. We describe this evolution from manual analysis through commercial software to custom application, the AI-assisted process itself, and lessons that generalize to any telemetry engineer facing similar data-volume and tooling constraints.

11:20 a.m.
26-17-02

"FTI as a Function - Flight Test Instrumentation in Integrated Modular Avionics"
Moises Gonzalez-Martin, Joel Izquierdo Pérez, Diego Sánchez de Rivera Córdoba, Airbus Defence & Space

The paradigm governing Flight Test Instrumentation (FTI) is undergoing a deep transformation. Traditional architectures, historically built dedicated physical hardware, complex wiring, and severe space limitations, are progressively yielding to a next-generation framework: FTI as a Function. This modern approach embeds data acquisition and telemetry functionalities directly into Integrated Modular Avionics (IMA) via software. By establishing a reusable, platform-agnostic logical module (virtual tapping), the instrumentation capabilities remain integrated within the final production aircraft rather than being stripped out post-test.

11:40 a.m.
26-17-03

"Operationalizing Spectrum Awareness: Integrating Planning, Measurement, and Analytics into a Unified Test Range Platform"
Tony Triolo, Kyriakos Manousakis, Josh Morman, Nicholas Chang, Sunil Samtani, Altio Labs; Shrirang Gadgil and Rob Ziegler, Peraton Labs

Modern test and evaluation environments rely heavily on RF spectrum, yet the tools used to plan, monitor, and analyze its use remain fragmented. This presentation describes the Consolidated Spectrum Tools (CST), a unified platform that integrates spectrum planning, scheduling, and real-time measurement into a single web-based environment. By combining mission data, live sensor inputs, and historical usage metrics, CST provides a dynamic, continuously updated view of

spectrum activity. Its modular, plugin-based architecture supports advanced analytics, interference detection, and flexible integration with range-specific instrumentation. This approach enables a shift from static coordination to data-driven spectrum management, improving operational awareness and decision-making across test ranges.

Thursday, October 29th, 11:00 – 12:00 p.m. **Aurora C**

Session 18 **AI-Driven Sensor Fusion, Compression, and Processing II**
Chair **Michael Marcellin, University of Arizona**

11:00 a.m.
26-18-01

"A Real-Time Geological Classification and Speech Recognition System for Planetary Extravehicular Activities"

Chloe Andersen, Lily Chen, Bruce Huang, Ilai Tamari, and Shruthi Unnithan, UC Santa Barbara; Faculty Advisor: Yogananda Isukapalli, UC Santa Barbara

Planetary extravehicular activities (EVAs) present a fundamental telemetry challenge: astronauts must make rapid decisions under stringent time, power, and communication constraints. We present the Surface Assistant for Geological Evaluation (SAGE), a handheld edge-telemetry and decision support system for planetary field geology. Operating fully offline on an NVIDIA Jetson Orin NX, SAGE concurrently runs four pipelines: a rock classification ConvNeXt-Tiny model that classifies rock samples with 91% accuracy and extracts family-specific geological features with 86% balanced accuracy, a volume and mass estimator combining AprilTag scaling with Segment Anything Model (SAM) segmentation, a live speech-to-text (STT) system based on a fine-tuned NeMo FastConformer model with multimodal geological context, and an integrated UI with manual navigation through a joystick and a mission summary generator. All results are structured into a local mission log during the EVA and integrated into a static web-based Ground UI for post-mission review by Earth-based geologists. By consolidating rock identification, volumetric estimation, and audio annotation into a single autonomous handheld device, SAGE maximizes the scientific return of every EVA.

11:20 a.m.
26-18-02

"Integrated Raspberry Pi Companion Computer System for Drone Flight Control"

Loren Ashfield, David Chang, Zachary Duckering, Vishal Seenivasan, and Adit Suman, UC Santa Barbara; Industry Advisor: Phillip Tokumaru, AeroVironment, Inc.; Faculty Advisor: Yogananda Isukapalli, UC Santa Barbara

The paper presents the design and evaluation of an embedded companion computer system using a Raspberry Pi Compute Module 5 (CM5). This computer handles complex computation tasks for a proprietary flight controller named the Varmint, developed by AeroVironment (AV). The CM5-based design fulfills the purposes of a companion computer at a roughly 5-10x lower cost than AV's previous solution. A compact, four-layer carrier printed circuit board (PCB) is developed to interface the CM5 with the Varmint, as well as fit AV's size constraints. This carrier PCB houses the CM5 and attaches to the Varmint via a SODIMM slot. The complete system is implemented on a physical drone to showcase proper signal integrity and transmission. The drone control is configured using the ROSflight firmware. The system is successfully integrated and bench-validated, demonstrating potential for flight.

11:40 a.m.
26-18-03

"Distributed mmWave MIMO Radar Sensing Via Network-Based Synchronization and Auto-Calibration"

Vihan Jayaraman, William Ni, Andrey Otvagin, Oviya Seeniraj, Jason Wang, and Anirban Banik, UC Santa Barbara; Faculty Advisors: Upamanyu Madhow and Yogananda Isukapalli, UC Santa Barbara

Individual commercial mmWave MIMO radar nodes can track objects within their limited field of view (FOV), but their sensing capability is confined to a small area. When multiple radar nodes are organized into a distributed network, they can collaborate to jointly track targets across a broader region. This work presents a networked radar sensing framework, Chirp, that synchronizes node clocks through a local network connection. Once synchronized, nodes coordinate with a central server to simultaneously capture radar frames, detect shared targets within overlapping FOVs, then perform a spatial calibration to calculate the relative pose of each node with respect to a designated reference node. The results of our framework demonstrate the feasibility of such a setup in an outdoor space with three nodes for calculating relative distances between distributed radars.

Thursday, October 29th, 11:00 – 12:00 p.m. **Aurora D**

Session 19 **Simulation, Virtual Test Environments, and Digital Twin Integration**
Chair **Shawn Perry, NAWCAD**

11:00 a.m.
26-19-01

"System Level Testing Using Real World Data In Avionics"
Cody Raml, Avionics Interface Technologies

Avionics systems are becoming increasingly more complex and can be accurately described as 'flying data centers'. Vast systems of integrated sensors must all work in harmony to provide information superiority. With increased complexity, it is no longer sufficient to focus on component level testing in the lab. System level testing on real equipment is necessary to ensure on-aircraft success. Modern test methods paired with real data must be leveraged to rapidly find issues and bottlenecks. Digital models and AI can be used to learn turn past mistakes into future test coverage. This paper will explore the benefits of utilizing modern test methods and real data to meet modern testing needs.

11:20 a.m.
26-19-02

"Disaster-Aware UAV Path Planning with Vision-Integrated Proximal Policy Optimization"
Clinton Imaro, Morgan State University; Faculty Advisor: Dr. Peter Taiwo, Morgan State University

Autonomous UAV navigation in disaster response requires fast route planning while avoiding hazards such as fire and flooding. We present a disaster-aware path-planning framework that combines a CNN-based vision classifier with a Proximal Policy Optimization (PPO) navigation agent. The classifier converts aerial imagery into hazard-risk cues, and the PPO agent uses these cues to select movement actions in a simulated grid environment. This study evaluates the proposed approach in controlled 50 × 50 fire-density simulation maps, providing an initial proof-of-concept for vision-informed PPO navigation under different hazard conditions. In the final 100 episodes, PPO reached 99% and 100% strict exact-goal success on the light/sparse and moderate maps. The dense/heavy case shows that PPO alone may struggle when hazard layouts become highly restrictive, even when partial progress toward the goal is achieved.

11:40 a.m.
26-19-03

"Performance Evaluation of Risk-Map PPO with Safety Shield for Monocular and Stereo UAV Collision Avoidance"
Clinton Imaro, Morgan State University; Faculty Advisor: Dr. Peter Taiwo, Morgan State University

Autonomous UAVs in disaster response face dual threats from environmental hazards and physical obstacles. This paper evaluates a risk-map PPO navigation controller with an evaluation-time safety shield for monocular and stereo UAV collision avoidance. A frozen PPO policy trained with CNN-based hazard awareness is reused with depth-derived obstacle-risk maps, while the shield performs local lookahead before navigation actions are executed. Stereo depth is

estimated with OpenCV StereoSGBM, while monocular depth is generated from the left image using MiDaS Small. Both perception modes are converted to a common perceived risk-map interface and evaluated in controlled UAVStereo-derived scenarios using success rate, collision rate, path efficiency, hazard exposure, intervention count, and latency. Ground-truth or unperturbed obstacle information is used for collision checking and evaluation, not as additional controller input. Raw PPO transfer is treated as an ablation baseline and is unsafe, producing 0.000 success and 0.600 collision rate in unperturbed evaluation. With the safety shield, collision rate falls to 0.000 for both sensing modes. Under the shared risk-map interface and controlled UAVStereo-derived benchmark, monocular PPO + shield reaches 0.956 unperturbed success at 40.84 ms total latency, while stereo PPO + shield reaches 0.808 success at 12.26 ms and remains substantially faster.

Thursday, October 29th, 11:00 – 11:40 a.m. **Cira C**

Session 20 **Special Topics in Telemetry**
Chair **Richard Simeon, University of Kansas**

11:00 a.m. **"a Virtualized Flight-Test Range: Scalable Today, Waveform-Agile Tomorrow"**
26-20-02 Oussama AIT SIDI ALI, Safran Data Systems

Flight-test ranges must support increasing telemetry throughput, more simultaneous channels, and an uncertain evolution of the air-to-ground link. Conventional architectures, where receiver processing remains tied to dedicated hardware at each ground station, limit scalability and waveform agility.

This paper presents a virtualized telemetry range architecture based on a stable digital acquisition layer and shared software processing. Ground stations perform RF acquisition, digitization, timestamping, metadata association, and transport, while waveform-specific receivers run as software instances in a shared processing pool. The approach is demonstrated with a virtualized PCM/FM receiver on general-purpose computing platforms, illustrating both horizontal and vertical scaling. The same architecture enables range-wide spectrum awareness, preflight channel assessment, and, with antenna pointing metadata, emitter localization and tracking.

11:20 a.m. **Continuation of above presentation**