GSAW 2024 Tutorial I: Half Day

VITA49 and DIFI Standards in Ground System Architecture

Overview:
Satellite ground system architecture has generally been progressing through evolutionary stages for decades, but the industry is at an inflection point due to recent technological advances. Digital data transport offers exciting new possibilities, including reductions in SWaP, cost, and implementation time. However, it requires standard-driven interoperability frameworks and industry-wide adoption, just as previous generations of technology did.

This tutorial will focus on a new, proven format for signal transport; specifically, digital IF sample transport as described by VITA49 and more thoroughly by the recent the Digital IF Interoperability Standard, DIFI. DIFI is an IEEE-ISTO endorsed standard that addresses several of the interoperability and compatibility concerns that are presented by the VITA49 standard's flexible and varied implementation options. Real-world interoperability use cases will be discussed to include TT&C, Satellite Communications, and RF Monitoring. Implementation recommendations will be shared in the interest of advancing industry knowledge and familiarity with the expected progression towards the ground system architecture of the future.

Outline of Topics

I. Introduction and Welcome
II. Limitations of Legacy, Analog IF Architectures
    a. Physical IF Signal Routing
    b. Overview of Extensive, Proprietary Hardware
    c. Support Requirements: On-Site, Experienced Tech
III. Benefits of a Digital IF Architecture
    a. Signal Distribution Via COTS Networking Equipment
    b. Removal of Analog Cable-Related Signal Degradation
    c. General Flexibility in Architecture and Mission
IV. Overview of Analog to Digital Industry Transition
    a. Technological Breakthroughs Increasing Capabilities and Requirements
    b. Standards Bodies Discussion and Alignment
    c. VITA
    d. IEEE-ISTO DIFI Consortium
V. Overview of VITA49 Standard
VI. Example Use Cases with VITA49
VII. Interoperability and Compatibility Challenges
VIII. Overview of IEEE-ISTO DIFI Standard
IX. Example Use Cases with DIFI
X. Real-World Applications
    a. TT&C
    b. Satellite Communications
    c. RF Monitoring
XI. Conclusion and Wrap-up

Instructors:
Annmarie Stanley, Kratos and Mark Lombardi, Keysight

Biographies:
Annmarie Stanley
Annmarie Stanley is a Software Development Engineer at Kratos with a background spanning over a decade in systems engineering and software development. Annmarie's expertise lies in the development of firmware and its seamless integration with both hardware and software components, resulting in the creation of intricate systems within the satellite communication industry. She has held key leadership roles in numerous Kratos DoD missions, notably spearheading the development of digitizer products that utilize VITA 49, a packet-based protocol that efficiently conveys digitized signal data and essential metadata. Annmarie has been collaborating closely with the Digital Intermediate Frequency Interoperability (DIFI) Consortium. Her role has been to educate and provide vital support to industry in adopting the Digital IF IEEE standard. This standardization has paved the way for interoperable digital IF, revolutionizing the field of satellite communication. Ms. Stanley earned a BS and MS in Computer Engineering from Rose-Hulman Institute of Technology.

Mark Lombardi
Mark Lombardi is a Satellite and Space Workflow Solution Architect at Keysight. He has spent the past decade focused on developing Keysight's Space and Satellite Design, Test and Measurement solutions in support of electronic system design workflow digital transformation. This includes providing software design and verification tools engineers utilize to build digital twins of space systems and the hardware and software that bind the simulated and physical domains through digital threads. Digital twins are applied to the physical test challenges through Hardware-in-the-loop emulations (HiL) of space RF communications and power subsystems. An active member of the DIFI Compliance Working Group, he has prior experience and responsibility supporting satellite and modem developers with realistic hardware-in-the-loop communication system verification using Ansys STK mission modeling connected to RF Satellite Link Emulator hardware.Mr. Lombardi was a Digital Twin panelist at Milcom 2023 and keynote speaker on Space System HiL and Digital Twins at WiSEE 2021 and 2022. Mr. Lombardi was the main author of "Space Communications based on digital twins, built from models, simulations, and kinematics", presented at IAC 2022. Mr. Lombardi co-authored a paper with NASA, "Microhard MHX2420 Orbital Performance Evaluation Using RT Logic T400CS" NASA Technical Reports · Aug 12, 2012.

Description of Intended Audience and Recommended Prerequisites:
Attendees should have a general knowledge of satellite ground operations. This tutorial is designed for system engineers and architects of ground stations.

What can Attendees Expect to Learn:
Attendees can be expected to learn about the Digital IF Interoperability Standard (DIFI), an IEEE-ISTO endorsed standard that addresses concerns regarding interoperability. Satellite ground system architecture has generally remained consistent, or static, for decades. In the current industry progression towards a more dynamic, flexible architecture, new and different methods of command and control, orchestration, and signal transport must be developed and then integrated into existing architectures as part of the transition plan to a next-generation ground station architecture.

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DIFI. DIFI addresses several of the compatibility concerns that are presented by the VITA49 standard's flexible and varied implementation options. Real-world interoperability use cases will be discussed to include TT&C, Satellite Communications, and RF Monitoring. Implementation recommendations will be shared in the interest of advancing industry knowledge and familiarity with the expected progression towards the ground system architecture of the future.