

Software Orchestration and Virtualization Reference Architecture for Ground Entry Points

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Ground Architectures Based on Standards

- Standards exists at all levels
- Focus here is for infrastructure and services
 - Services: TT&C, RF Monitoring
 - Infrastructure: RF, Network, Compute
- Strategic need to low level effects enabled by infrastructure
- Modular, Open, Hierarchical



Why?

- Enormous change in space over the last 15 years
 - Exponential increase in satellites
 - ...in bandwidth, ...in beams, ...in orbits
 - ...in performance
 - ...flexibility, resiliency
 - ... contention







- Ground systems MUST take a fundamentally different approach to keep pace
 - Digital architecture
 - Deployed at scale via common NFVi/SDN principals
 - Tight alignment with broadly leveraged communications standards





Crucial Characteristics of the New Ground





Role of Standard Interfaces and Formats

- Incorporate open standards through participation and incorporation into ground architectures:
 - IEEE Digital IF Interoperability (DIFI) Consortium :
 - DIFI IEEE-ISTO Std 4900-2021 Digital RF/IF interoperability standard for VITA-49 (data plane)
 - Object Management Group (OMG) :
 - C2MS Foundational C2 Message ICD for EGS (data plane and control planes) Kratos is co-chair
 - XTCE Common C2 database format (control plane)
 - GEMS Ground Equipment Monitoring protocol (control plane) Kratos is Task Force Chair
 - <u>Metro Ethernet Forum (MEF)</u>:
 - Lifecycle Service Orchestration (LSO) ref. architecture and APIs for ground service automation
 - LSO Presto APIs to orchestrate SDN/NFV services and legacy infrastructure (management plane)
 - <u>ETSI NFV</u>:
 - Open-Source MANO (OSM) ref. architecture, APIs, open source (management plane)
 - Industry/Commercial <u>Kratos leverages these open standards</u>: (control plane and management plane)
 - OpenAPI, REST, RESTCONF, NETCONF, HTML5, HTTPS, CSS3, JavaScript, XML, JSON, YANG
 - Zero Trust Security Standards: TLS/SSL, X509 Certs, LDAP
 - USB, SGLS, DVB-S2, DVB-S2X, CCSDS
 - UCI-OMS
 - Universal Command and Control (C2) Interface (UCI) messaging standard supporting M2M communication for mission-level C2



SDN and NFV



- SDN Software-Defined Networking
 - Concerned with connectivity
- NFV Network Function Virtualization
 - Concerned with deploying software network elements
- Complementary technologies that together lead to Digital Transformation



Digital IF Interoperability (DIFI)

- DIFI is an IP Packet Specification to Transport Spectrum
 - DIFI IEEE-ISTO Std 4900-2021 Digital RF/IF interoperability standard for VITA-49 (data plane)
 - Free spec, straightforward certification, focus on packet layer interoperability
- Consortium for Wide Adoption of an Interoperable
 Digital IF Standard
 - Match the interoperability that is native to analog IFs (e.g., L-band)
 - Create an open, simple, interoperable digital IF standard
 - Encourage adoption of the standard throughout the industry
- Purpose:
 - Define an interoperable standard based on VITA-49
 - Design standard for easy adoption
 - Publish as an open, referenceable standard





The Role of MEF

- When virtualized, satellite ground stations take on properties like IP Networks
 - RF uplinks and downlinks are digitized at the antenna
 - Resulting digital samples are packaged in DIFI packets
 - Further processed by VNFs, deployed as service chains
- Metro Ethernet Forum is a global standards organization that governs the related interface standards



- Ethernet standards
- SDN/Orchestration standards





Lifecycle Service Orchestration

- LSO (Lifecycle Service Orchestration) is the set of MEFdefined specifications enabling standardized service orchestration based on standardized lifecycle services across one or more network service domains
- LSO, in combination with SDN and NFV, allows for providers to leverage NFVI in a standardized manner
- LSO provides a set of standardized APIs for manufacturers & providers a way to normalize integration across the ecosystem





ETSI - European Telecommunications Standards Institute, a Standards Development Organization (SDO)

 MANO - Management and Orchestration Reference Architecture and standardized interfaces

NFV Standards - ETSI MANO





Remote Sensing & TT&C Architecture







Thank You!

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