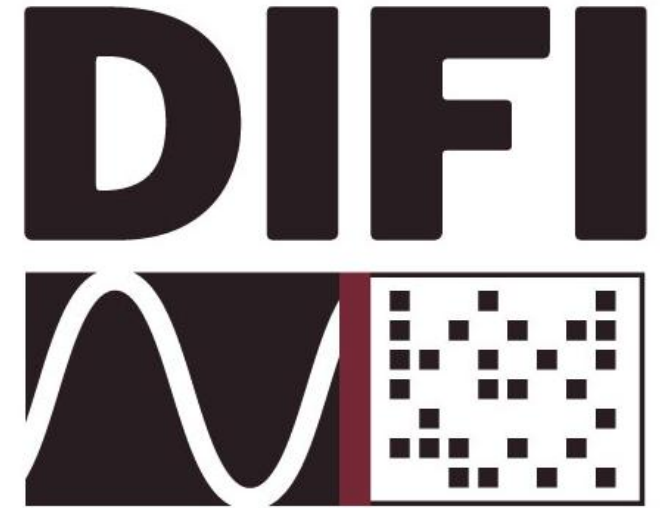


DIFI Consortium
ESA Specifications Working Group
Status Update

Jeremy Turpin, Chair
Chief Scientist & Co-Founder, ALL.SPACE

October 12, 2026



ESA WG - Executive Summary

Chair: Jeremy Turpin, ALL.SPACE

Assistant Chair: Ryan Stevenson, Kymeta

Cadence: First Wednesday monthly · 11:00 AM Eastern

Origin: Launched at the DIFI Board's instigation in early 2024 as a shared ESA / DIFI forum

Working Group Participants (24 organizations)

- | | | |
|------------------------------|-----------------------|--------------------------|
| • ALL.SPACE | • Groundspace | • SES |
| • Apothym Technology Group | • Keysight | • St Engineering iDirect |
| • Bascom Hunter Technologies | • Kratos | • Systems Technologies |
| • Blue Halo | • Kymeta | • TEMIX Communications |
| • Cobham SATCOM | • Quintech | • ThinKom |
| • ETL Systems | • Rohde & Schwarz | • Viasat |
| • Geon Technologies | • Safran Data Systems | • Wavestream |
| • Global Invacom | • SatixFy | • WORK Microwave |

Differences for DIFI?



Electronically Steered Antennas (ESA)



Gimbaled / Parabolic Antennas



VS

Management and control
(not waveform data!)
differentiates electrically-
from mechanically- steered
antennas from a DIFI
perspective!

*Thinkom VICTS is intentionally classed as an ESA for our purposes, since in an RF sense it is a phased array, even though it is mechanically actuated!

ESA vs. Gimbale Differences

ESA

- Widely different technology and implementation
- Varying performance across field of view
- Limited field of view
- Dynamic and frequently changing performance capabilities during operation
- Often distributed amplification / receivers / frequency conversion (multiple LNA/LNB/HPA/BUC)
 - DIFI reference plane not necessarily well-defined
- Potential for multiple and even dynamic number of beams / links per antenna
- Potential for multiple points of digitization
- **Very fast beam changes lead to need for high-speed synchronization of tracking / pointing commands and waveform traffic**

Gimbale

- Same performance throughout field of view (other than asymmetric antennas and spectral masks...)
- Single set of performance capabilities
- Single LNB / BUC
 - DIFI reference plane well-defined
- Single beam / link per antenna
- Single point of digitization
- Slow Beam changes (repointing)

Commonalities



- Waveform data from modem to antenna
- Need for communication of performance between terminal and modem

ESA Physical Use Cases for DIFI



ENDPOINT TOPOLOGIES

1

One Modem Endpoint, One Antenna Endpoint

2

Multiple Modem Endpoints, One Antenna Endpoint

3

Multiple (dynamic) modem endpoints, multiple (dynamic) antenna endpoints

DEPLOYMENT SCENARIOS

4

Land, Maritime Mobility operation on small platforms

5

Aero ARINC 793-compliant installations

6

Gateway many (static) modem endpoint to many (static) antenna endpoint ESA

ESA WG Objectives



Objectives: (approved by the Board (1-3) in Summer 2024, and extended (4-6) in Spring 2026)

1. *(complete) Identify the set of DIFI-supported use cases for ESA*
2. *(complete) Identify the M&C features, capabilities, and data required to meet the use cases*
3. *(complete) Propose the mechanism for implementing the ESA-specific M&C features*
 - *Many-to-Many relationship between modems, beams / streams, panels, and satellites*
 - *Rapid, synchronized beam / link control and IF data streams*
 - *Dynamic / configuration-dependent beam performance and behavior*
 - *Implemented through some combination of:*
 - *Existing OpenAMIP functionality*
 - *New Extensions to OpenAMIP (i.e., timing sync, stream ID)*
 - *Existing DIFI functionality*
 - *DIFI extension (i.e., OpenAMIP over DIFI, or equivalent DIFI command packets)*
4. *(complete) Evaluate and select additional topics of interest to the working group members*
 - *Driving industry engagement and adoption of new recommendations*
 - *Determining the right way for Inclusion of antennas (and modems) in plugfests*
 - *Tying in validation and certification of OpenAMIP extensions to DIFI validation and certification*
5. *(complete) Create & Issue specific recommendations for changes / extensions to OpenAMIP*
6. Create specific recommendations for changes / extensions to DIFI
 - *(complete) OpenAMIP over DIFI (existing white paper)*
 - *Security implications*
 - *(complete) Power control*
7. Create specific recommendations for top-level “System Controller” function to fill M&C needs that do not fit logically within either DIFI or OpenAMIP.
8. Work to encourage and drive adoption of the recommendations.

Ensure that ESAs work in DIFI and the greater ecosystem without simplifying assumptions that turn ESAs in practice into...poorly performing parabolic antennas.

4 of 8 complete



Key Outputs from the ESA WG



DELIVERABLES

- 1** **ESA WG M&C Requirements Document**
Requirements for monitor & control of electronically steered antennas in DIFI systems (Rev 3).
- 2** **ESA WG M&C List**
Consolidated catalog of ESA monitor & control parameters and data points.
- 3** **OpenAMIP over DIFI White Paper**
Trade study recommending encapsulation of M&C streams within DIFI.
- 4** **OpenAMIP Extension Recommendation**
“difi:” extensions to OpenAMIP for ESA beam control, timing & metadata.
- 5** **ACC Specification Proposal**
Draft DIFI Associated Control Channel packet class submitted to the Spec WG.

ACTIVITIES & OUTREACH

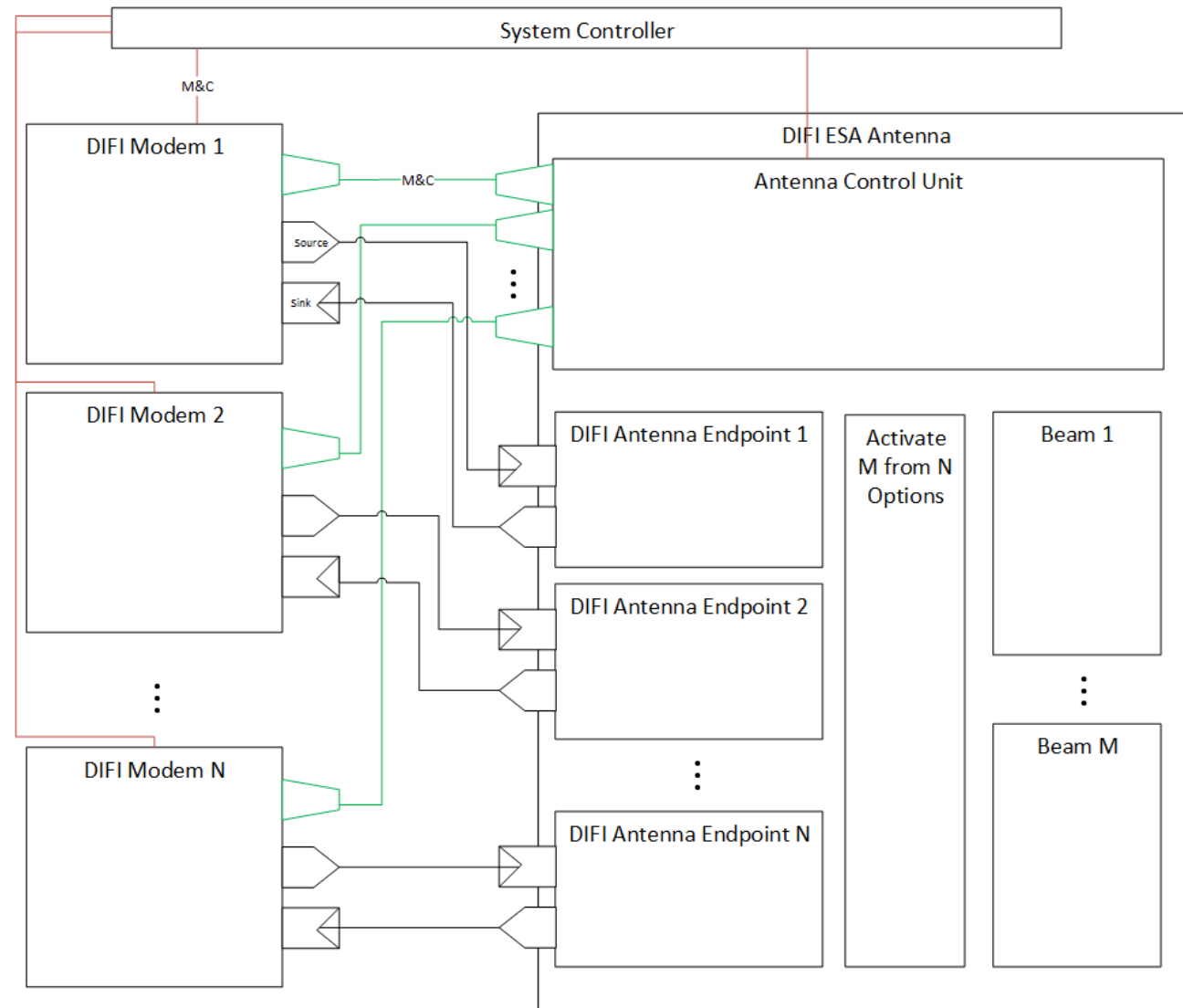
- **MILCOM 2024 Workshop**
ESA Working Group summary presentation & panel.
- **MILCOM 2025 Workshop**
ESA Working Group summary presentation.
- **DIFI Webinar — May 2025**
ESA WG progress with community target questions.
- **Monthly WG Calls & Board Updates**
Ongoing cadence since April 2024.

System Diagram for General ESA



HOW IT WORKS

- Multiple modems connected to “one” multibeam antenna
- Dedicated DIFI endpoint (software / networking) in the antenna for each modem
- ACU selects which antenna endpoints are active and connected to hardware beams at each moment in time
- System controller (as human-in-the-loop or machine-machine interface) is added due to multi-modem multi-antenna-endpoint



DIFI Standard Recommendations



ESA WG proposals to the DIFI Specification Working Group

Associated Control Channel (ACC)

New optional DIFI packet class that encapsulates opaque M&C streams (e.g., OpenAMIP), bound to a DIFI Stream ID, with a lightweight Reliable Mode supporting TCP-like delivery over UDP DIFI datagrams.

Reference Plane & Power Reporting

Add an “Air Interface” reference plane and express Boresight EIRP in dBm; report available EIRP in real time via a new short-form query message.

Fault & Event Handling

Add fault codes such as “Computational Capacity Exceeded” and support event-driven reporting of exceptional events for dynamic beamforming.

Security, Authorization & Validation

Standardize authorization and validation of M&C traffic across shared, multi-beam infrastructure — confidentiality, integrity, and availability.

M&C feature, capability, and data Req'ts



To support the identified use cases, we need new M&C capability (over and above current DIFI & OpenAMIP or other protocols).

Key Areas:

- ESA reference Plane
- Dynamic Antenna Performance & Available RF Power
- Additional Fault Codes
- Security, Authorization, and Validation
- Pointing and Tracking
- System Controller to Antenna
- Modem to Antenna (timing and synchronization)
- Antenna Capability & Status Reporting

OpenAMIP extensions for DIFI



Recommended “difi:” extensions to OpenAMIP for ESA operation

Transport

Tunnel OpenAMIP (TCP) over the DIFI UDP M&C path using a TCP-over-UDP proxy.

Timing & PNT

Add sub-second time precision, a PNT source field, and position, orientation, and time uncertainty parameters for fast repointing.

Beam Control

Sample-index execution timing plus an opaque configuration_id echoed in the DIFI context packet to confirm which samples map to which antenna configuration; enable scheduled handovers.

Beam Metadata & Blockage

Report tracking mode / status, real-time beamwidth, expected PSD and maximum compliant EIRP, and predicted blockage.

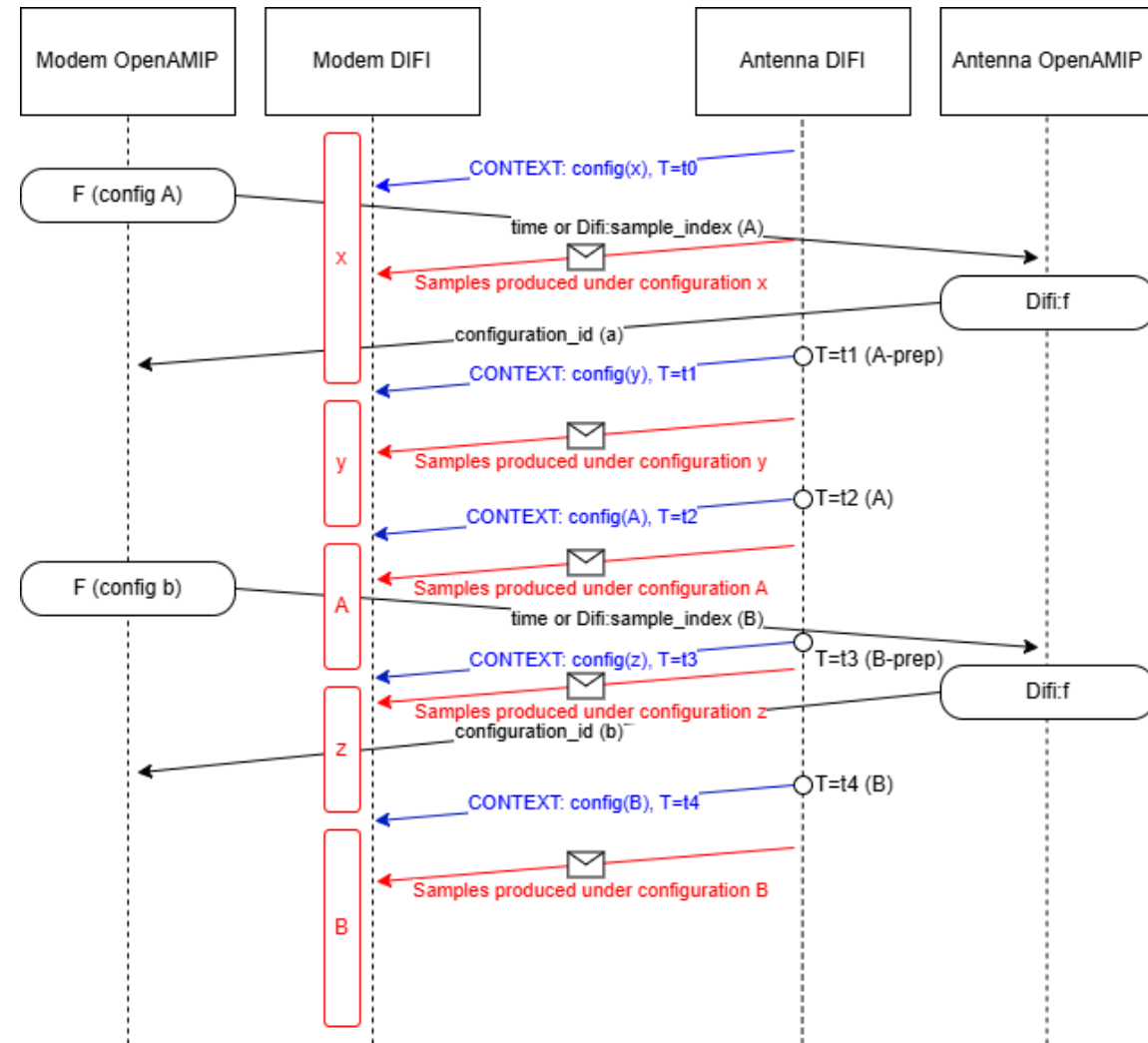
Deduplication & Signaling

Set frequency, power, and gain via DIFI only (ignored in OpenAMIP); advertise a DIFI-compatibility flag in identification messages.

OpenAMIP <> DIFI Sample-level Sync



- Key recommendation for the OpenAMIP extensions: Allow beam update commands to use sample-level timestamps in the update requests
- DIFI and OpenAMIP then share configuration identifiers (x, y, A, z, B in the chart at right) so the antenna can explicitly associate samples from BEFORE the change (frequency update, beam pointing direction, tracked satellite) and AFTER the change in configuration.
- The objective is to allow modems to drive antennas to re-point as fast as the antenna allows, and know exactly how long the old configuration remains valid and exactly when the new configuration is live at sample-level time granularity.



Conclusions

- The ESA WG has made proposals for enhancements of both the DIFI standard and OpenAMIP.
- Next steps include refining these recommendations with feedback from the working group and the greater industry.
- Enhancing the recommendations with concrete examples of the use cases behind the solution is key obtain widespread industry support and backing for the recommended changes and features.
- More participants in the WG are very welcome! Please join on the portal and join in the monthly calls.
- Questions?