A Tale of Two OSAs: Integration of the DEWS Reference Architecture into the SOSA™ Technical Standard

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A Tale of Two OSAs

It was the best of times:

Two maturing OSAs, with common roots, agree to harmonize and converge

It was the worst of times

Doing this is a challenge – as you will see (but not impossible)

But it is the right thing to do: The world is a better place with fewer, converged MOSA standards, than with OSAs breeding like rabbits

"The wonderful thing about standards is that there are so many of them to choose from."

– Grace Murray Hopper

- RDML Grace Hopper

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Topics

DEWS and SOSA: Separated at Birth?

Plan for Convergence

Overarching Recommendations

Module Convergence

Interface Convergence

Sensor Open Systems Architecture (SOSA) Technical Standard

Open Systems Architecture (OSA) as a “building block” Reference Architecture

Incorporates functional modules, associated interfaces, and hardware and software infrastructure) for radar, EW, SIGINT, EO/IR, and communications

Vision: Business/acquisition practices and a technical environment for sensors and sensor payloads that foster innovation, industry engagement, competition, and allow for rapid fielding of cost- effective capabilities and platform mission reconfiguration while minimizing logistical requirements

Directed Energy Weapon System (DEWS) MOSA Reference Architecture

Open Systems Architecture (OSA) as a “building block” Reference Architecture

Incorporates functional modules, associated interfaces, and hardware and software infrastructure) for directed energy (HEL and HPM) systems

Vision: Directed Energy Weapon Systems (DEWS) Programs of Record leverage a broadly applicable open Reference Architecture, founded on MOSA principles that accelerates delivery of innovation, expedites acquisition and increases the reuse of standard components

SOSA and DEWS: The Similarities Run Deep

- Both are aligned with MOSA objectives
- Based on similar Quality Attributes and Architecture Principles
- Both emit of energy in the direction of objects of interest – but DEWS “turns it up to eleven*"

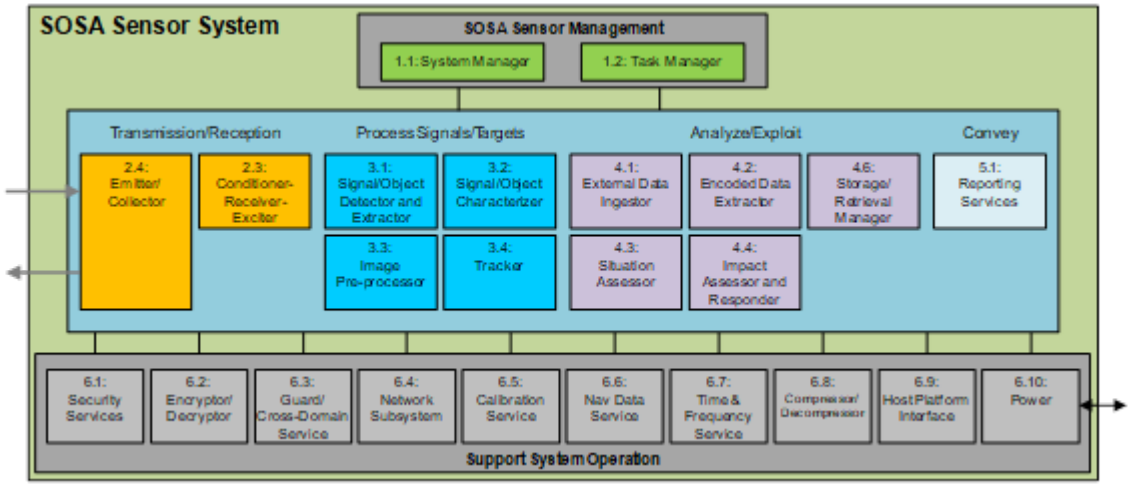


Figure 1. SOSA Modules – Graphical View

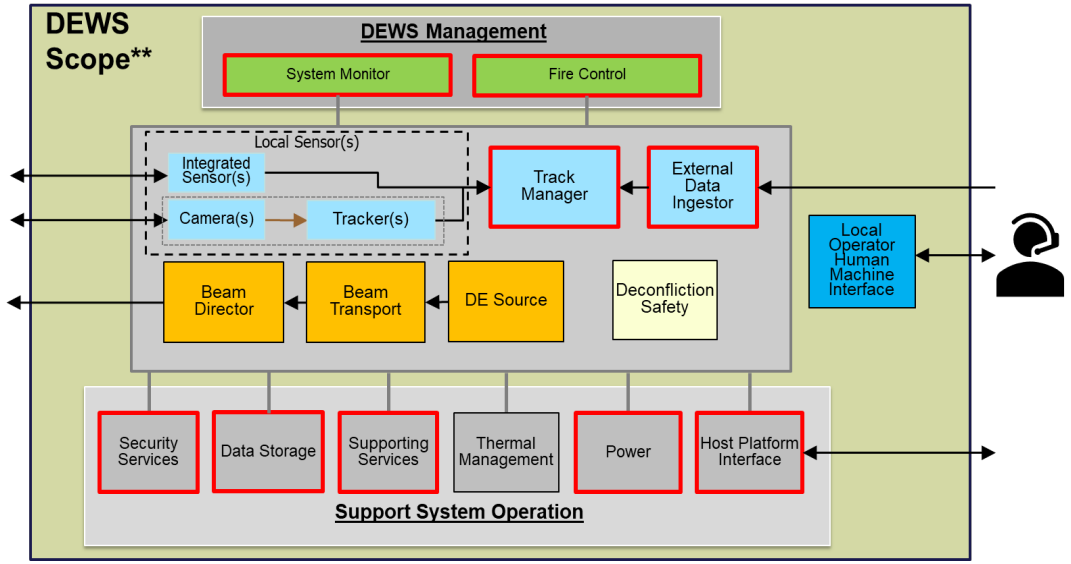
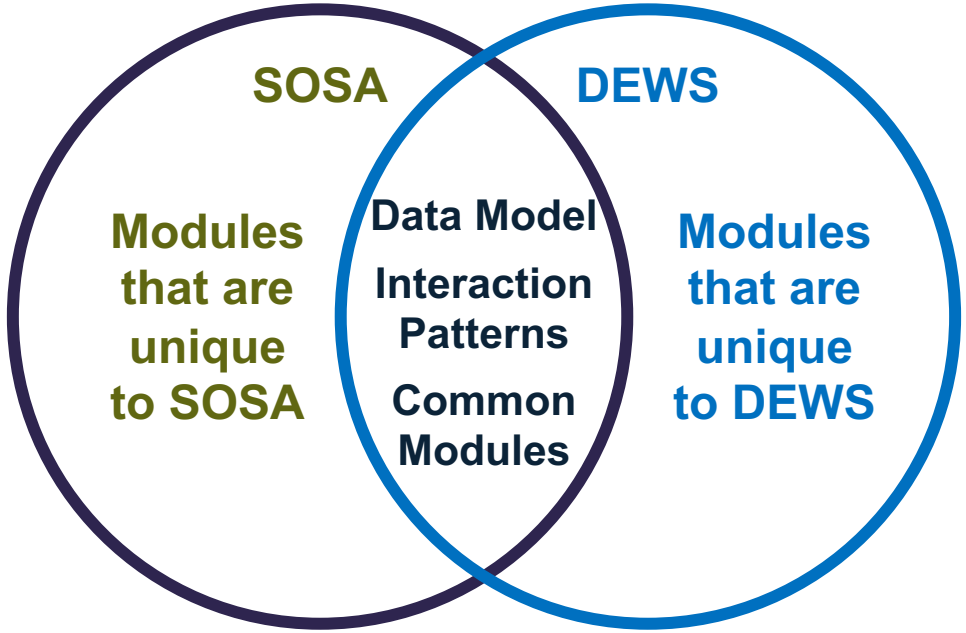


Figure 2. DEWS Modules – Graphical View (red outline = corresponding Modules)

* Reference to “This is Spinal Tap” (1984)

SOSA / DEWS Modular Alignment

Emitter / Collector
Conditioner-Receiver-Exciter
Signal/Object Detector and Extractor
Signal/Object Characterizer
Encoded Data Extractor
Situation Assessor
Impact Assessor and Responder
Reporting Services
Encryptor/ Decryptor*
Guard / Cross-Domain Service
Network Subsystem*
Calibration Service*
Compressor/Decompressor



Local Operator
Local Sensor(s)
Deconfliction Safety*
DE Source
Beam Transport
Beam Director
Thermal Management*

System Manager / System Monitor
Task Manager / Fire Control
External Data Ingestor
Tracker / Track Manager
Security Services
Storage-Retrieval Manager / Data Storage
Nav Data and Time & Frequency Services / Supporting Services
Power
Host Platform Interface

* Potential candidates (later)

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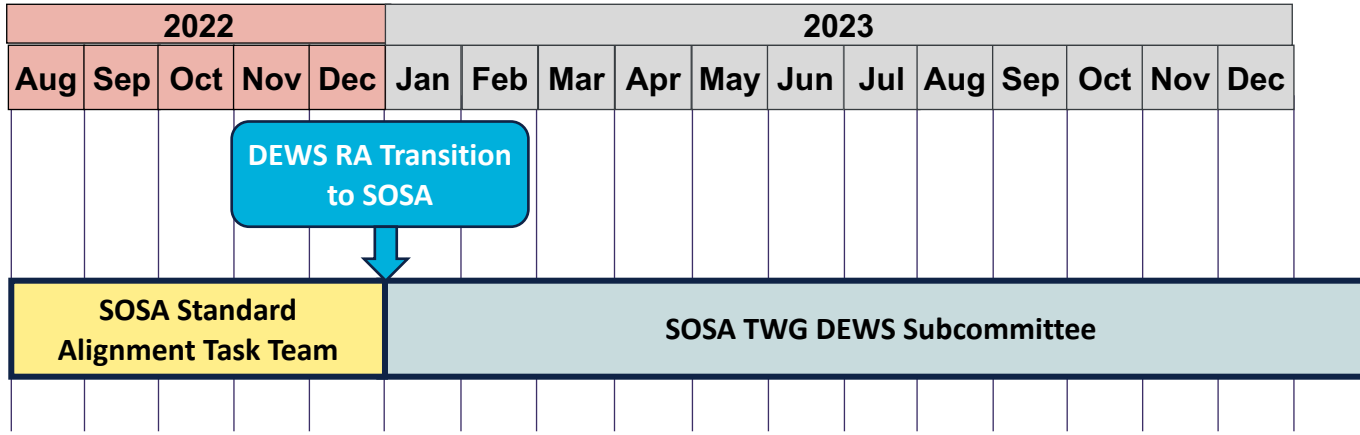
Plan for Convergence

SOSA TS was developed to be multi-INT, incorporating "best of breed" for radar, EW, SIGINT, EO/IR, and comms

DEWS RA was able to leverage a set of prototype exemplar DE systems enabling it to incorporate functional details into DEWS modules

OUSD(R&E), as the DEWS sponsor, determined that the Defense community would benefit from convergence of shared modules and functions between the DEWS RA and the SOSA TS

In August 2022, a joint Convergence process was initiated to integrate the DEWS RA into the SOSA TS



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TOC from "*Recommendations and Roadmap of Actions for DEWS Reference Architecture Integration into the SOSA Technical Standard*"

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Overarching Recommendations from the SATT: Common Functions

Recommendation: SOSA adopt a convention of "common functions" across most modules

DEWS has defined 15 common functions applied to all modules.

Rationale:
SOSA adoption of these or additional/alternate functions as common will ensure uniform and consistent module definition and development

DEWS Common Functions	
xx.81	Monitor H&S
xx.82	Accept BIT Request
xx.83	Perform BIT
xx.84	System Initialization
xx.85	Report H&S
xx.87	Clear Faults
xx.88	Module Shutdown Command
xx.89	Log Activity
xx.91	Detect Faults
xx.92	Report Alarms
xx.94	Abort in Emergency
xx.95	Automatic Error Recovery
xx.96	Request Authentication and Authorization
xx.97	Synchronize DEWS module time
xx.99	Emergency Module Shutdown Command

SOSA Informal Common
Perform Module System Management
Manage Module Health
Manage Module Discovery
Manage Module Configuration
Manage Module Control
Manage Module Security
Manage Module Assignments
Process Module Assignments
Manage Module Resources
Monitor Module Assignments

SOSA Functions Found In:

1. **Signal/Object Detector & Extractor**
2. **Signal/Object Characterizer**
3. **Image Pre-Processor**
4. **Tracker**
5. **Host Platform Interface**

Overarching Recommendations from the SATT: Governance

Recommendations:

1. DEWS should be fully managed by the SOSA Steering Committee (not a separate decision-making structure)
   - DEWS-unique modules would be governed (matured) by a newly formed DEWS Subcommittee under the TWG
2. Common Modules and Interfaces are incorporated into the SOSA Technical Standard
   - DEWS-unique Modules and Interfaces Published as a separate document (or appendix)

Rationale:

There are two aspects to governance:

Decision-making Structure -- which involves the definition of the "interested parties" (per OMB Circular 119 language) that would be involved in determination of direction and content of the Products

Product Development – such as the Technical Standard and other artifacts that result from the work being done

Of the six options reviewed, this was the preferred alternative because it maximized the opportunity to leverage overlap between SOSA and DEWS, but was least constraining to support the higher tempo of updates for the DEWS-unique Modules

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Module Convergence Process

- Compare Module descriptions
  - Identify what is in common → core of harmonized module description
  - Identify what is different → adjudicate if deltas are relevant
- Compare encapsulated Functions
  - Identify Functions in common → keep (tweak if needed)
  - Identify Functions that are different → augment as needed

Module Convergence Example: Power Module (1 of 3)

Common and Different

DEWS Description	SOSA Description
The Power Module either adapts Host Platform power to the power requirements of the DEWS Modules (e.g., converting between AC to DC, making voltage changes, etc.) or generates its own power for the DEWS. The Power Module is also responsible for power conditioning and storage.	The Power module could be responsible for power conversion, conditioning, storage, protection, distribution, and management. It applies to all sensor types. The Power module could receive host platform power (via the Host Platform Interface module) and could convert it to the conditioned power needed by SOSA modules. It could also include the routing and distribution of power to SOSA modules that use it, which can include chassis, switches, relays, transformers, etc. The Power module could provide status such as to indicate whether power is within specification and an alert to impending power loss. It also could provide a management interface that allows configuration, control, and status. Note that some modules could be designed with integrated power supplies. That type of module should have its own power management interface which could be aligned with the power management interface of the Power module.

Adjudication of Yellow:
Generates its own power → will remove
Storage → remain (used for both surge and conditioning)
Via the Host Platform Interface → remain (good for both)

Module Convergence Example: Power Module (2 of 3)

DEWS_ID	DEWS Func	DEWS Description	SOSA Function
68.13	Generate Power	In cases where the DEWS operates independently of Host-provided power, generate its own power internally. This Function is optional	
68.15	Receive Host-Provided Power	In cases where the DEWS doesn't generate its own power, receive input electrical power (e.g., 440VAC, 120 VAC, etc.) from Host Platform Interface Module. This is an optional function.	**Convert between different power characteristics - From Host Platform Interface**
68.16	Power on DEWS	A discrete (an external button or key) to turn on the entire DEWS. After powering up, this function will request power distribution (68.41) to SMM to begin DEWS initialization	
68.21	Power conversion	Transform prime power to match requirements for each DEWS Module (including DC/AC conversion, high voltage, spike protection, etc.)	**Convert between different power characteristics**
68.23	Provide Storage of Electrical Power	Stores energy (for example, in a battery) for use when needed by system modules	**Store power for intermittent input power loss** **Store power to provide long-term power to loads without input power**

Determine voltage limitations for 68.15 – may need separate high/low voltage modes

Power-on process for DEWS is different from that of SOSA

Use of storage is different between DEWS (which is focused on energy surge) and SOSA (which is to coast through intermittent source outages)

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Module Convergence Example: Power Module (3 of 3)

DEWS_ID	DEWS Func	DEWS Description	SOSA Function
68.41	Power Distribution	Discharges energy as needed to support DEWS modules, based on system condition and individual module needs	**Distribute power from power supplies to power loads**
68.55	Power Conditioning	Delivers power at the proper voltage and current characteristics by protecting against high/low voltage or current conditions, filter noise, transient impulse suppression, etc.	**Condition/filter power**
68.61	Accept Remote Control	Provides a digital interface to Local Operator and/or Host Platform to enable remote management and control of all functions	**Provide a digital control interface**
			Protect against voltage and over-current conditions

Consider adding this to Power Conditioning and remove as a separate function. Need clarification if this is internal to SOSA (protecting the sensor) or external (e.g., breaker on host to keep wiring from catching on fire)

Recommendation: The SOSA Power Module is adopted as the DEWS Power Module with some refinements to address missing DEWS functionality

Rationale: Most key power management functionality required by DEWS exists within the SOSA Power Module which requires only modest refinements to address missing DEWS functionality

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Module Convergence Example: Tracker Module (1 of 3)

Common and Different

DEWS Description	SOSA Description
The Track Manager Module maintains an internal store of the mathematical representation of objects of interest (hereafter known as Tracks). It correlates new (or newly provided) detections (either generated locally or from an external source) with existing Tracks, or creates new Tracks if the new detections do not correlate. It can receive Tracks (not just detections) from external track reports. The core functionality of the Tracker is data association, track initiation, track drop, track update, and uncertainty (e.g., covariance) of the Track. Estimation of relative position or location (geolocation) may also be performed. There is only oneTrack Manager in a DEWS.	The Tracker module correlates detections and tracks over time, forming new or updated tracks. It is responsible for all track management functions and producing track reports. The core functionality of the Tracker is data association, track initiation, track drop, track update, state and covariance estimation, and split track handling. Estimation of relative position or location (geolocation), when feasible, is also included in this function.

Adjudication:
Receives Tracks → remain (good for both)
Track reports → remain (good for both)
Split track handling → remain (good for both)
Relative position or location → part of track report

Module Convergence Example: Tracker Module (2 of 3)

DEWS_ID	DEWS Func	DEWS Description	SOSA Function (Edition 1)
34.11	Initiate Track	In the case where new detection(s) is(are) not part of an existing Track, create a new Track	Initiate Tracks
34.12	Receive Engagement Directive	Receives Engagement Directive as distributed by Fire Control Module, including shot duration, # of bursts, time between bursts, # of pulses in burst, pulse repetition rate, focus and aiming offset	
34.13	Associate Detection	For all new detections, makes determination it is part of an existing Track. If a match, mark the detection as new input for existing Track (see Track Update), if not hand over to Initiate Track function	Associate Tracks
34.14	Accept Detection Input	Receives and accept detections from Integrated Sensor, External Data Ingestor or by way of Host Platform Interface	Process Detections
34.15	Update Track	Uses new detection(s) or other track information to update the Track with the newly received data	Track Update
34.16	Accept Track Input	Receives and accept tracks from External Data Ingestor or by way of Host Platform Interface	
34.17	Associate Track	Makes a determination if a newly-received Track is the same as an existing Track, and if it is, merge the Track Parameters to form a fused track (otherwise, store as a new Track)	Associate Tracks
34.19	Delete Track	Removes a Track from the track store, either as a result of a Drop Track indication or because no new detections have been received after a specified time period (or other criteria, such as target killed)	Terminate Track
34.21	Accept Aimpoint Adjustment	Often the desired aimpoint is not the track centroid, and this function accepts that aimpoint adjustment and associates it with the indicated track ID	
34.22	Delete All Tracks	Remove all tracks from the track store (after archiving them to the Data Storage Module)	

Necessary for training and safety

Module Convergence Example: Tracker Module (3 of 3)

DEWS_ID	DEWS Func	DEWS Description	SOSA Function
34.23	Accept Target Designation	Receives and tags the indicated track ID with a designation that identifies it as a target to be irradiated	
34.25	Maintain Track Store	Periodically reviews the existing track store, ensures new detections have been associated and identifies tracks that are stale and delete or clears track data when required. Object characteristics such as orientation, aim point, and any identifying information will be kept fresh. The history of all objects (detections and tracks) are retained.	Maintain Tracks
34.35	Prediction	Upon request extrapolates an existing Track to the specified time to determine current (or future) position, velocity, etc. " all provided with uncertainty values	Track Prediction
34.45	Disseminate Track(s)	Upon request and at pre-determined intervals provide predicted object location to the rest of the DEWS modules, operator, and/or the host platform	

Recommendation: The DEWS Track Manager be adopted for the SOSA Tracker Module

Rationale: Several key track manager functions are provided by the SOSA module, however because SOSA does not (yet) address weapon capabilities as part of the technical architecture, significant functionality would need to be incorporated to address missing DEWS track management functionality

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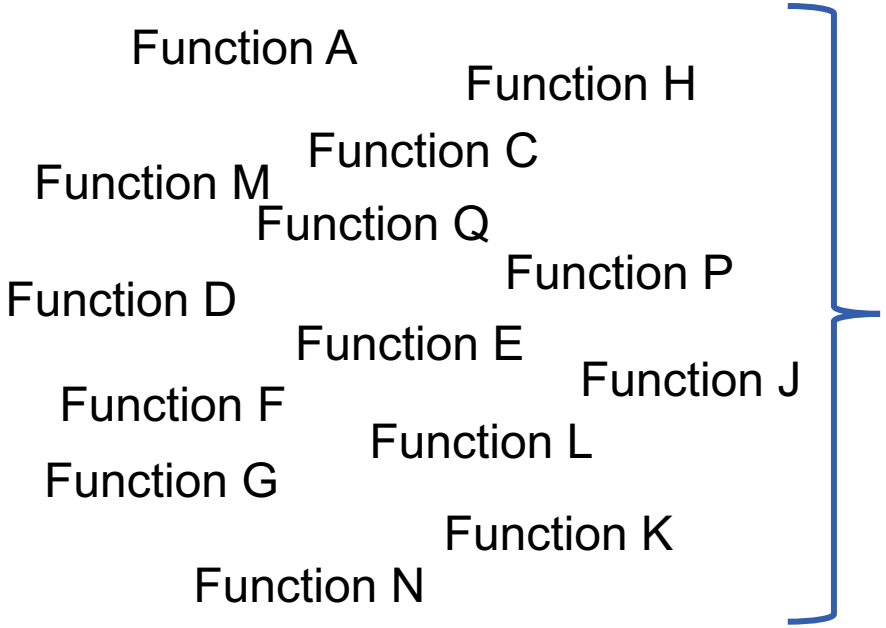
MOSA: Modules Encapsulate Functions

"… functionally is partitioned into discrete, cohesive, and self-contained units with well-defined interfaces that permit substitution of such units with similar components or products from alternate sources with minimum impact on existing units."



Module 1
Function H
Function C
Function A

Module 3
Function F
Function G
Function N

Functions are encapsulated; treat them as an integrated whole – with one set of input/outputs → interfaces

Module 2
Function D Function M
Function Q Function P
Function J Function E

Module 4
Function L
Function K

Modularity is not limited to the physical; software functionality can be modularized too

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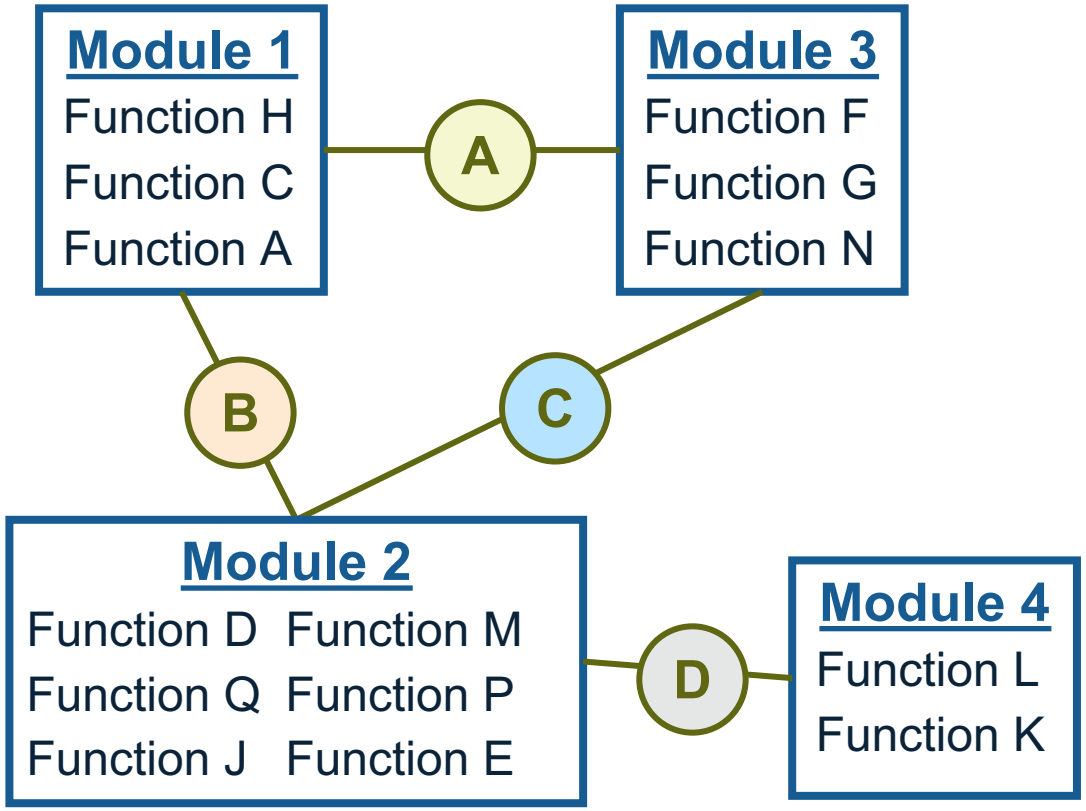
Interfaces are Made of Interactions
Interactions Enable Functions to Exchange Data



Toy Example of Interactions Documented

Interaction on Interface	Producer Function	Consumer Function	Conveyed Signal&Data
A1	C	N	Rx Signal
A2	G	A	Tasking
A3	H	F	Interlock
B2	P	C	Enable
C1	M	G	Tracks
C3	Q	G	Cues
C4	G	E	Signal Quality
C5	J	G	Track Priority
D1	J	L	Write data
D2	K	M	Read data

Interactions between Functions within the same Modules do not appear on Interfaces

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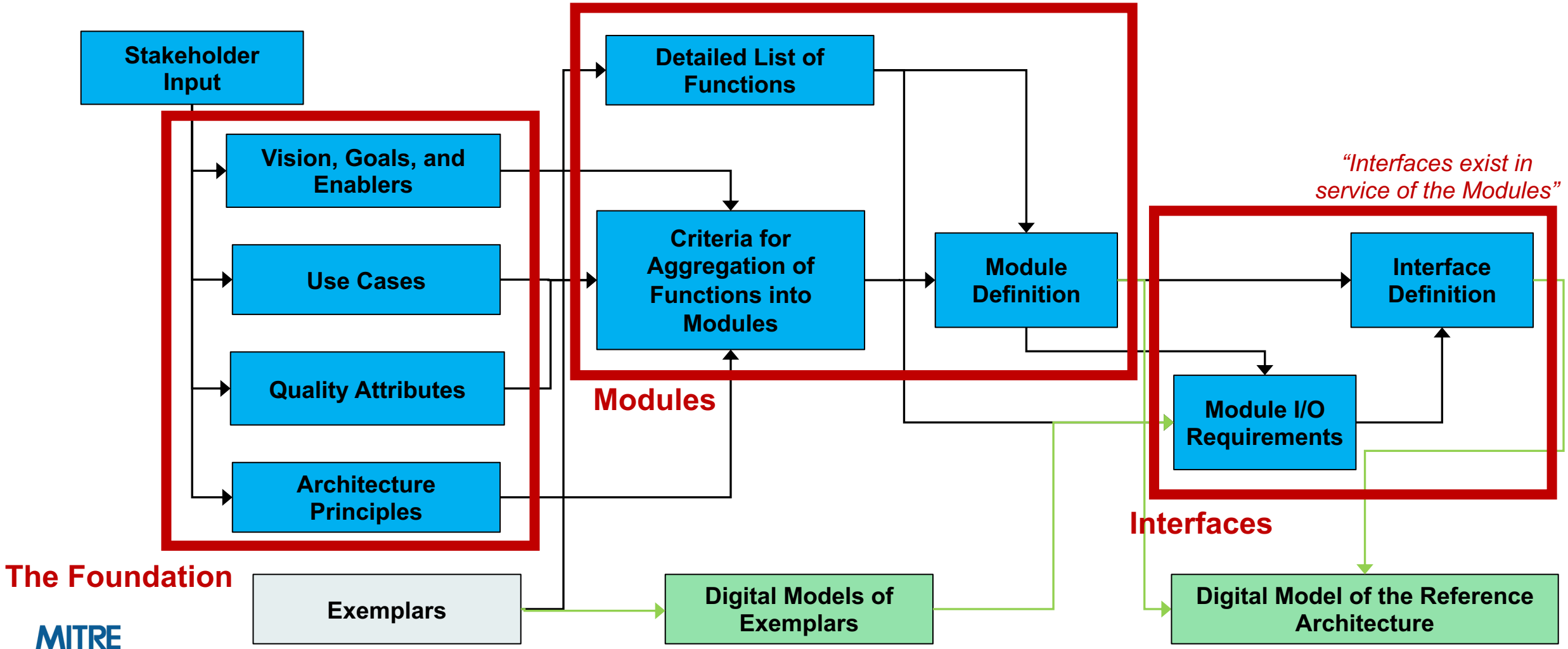
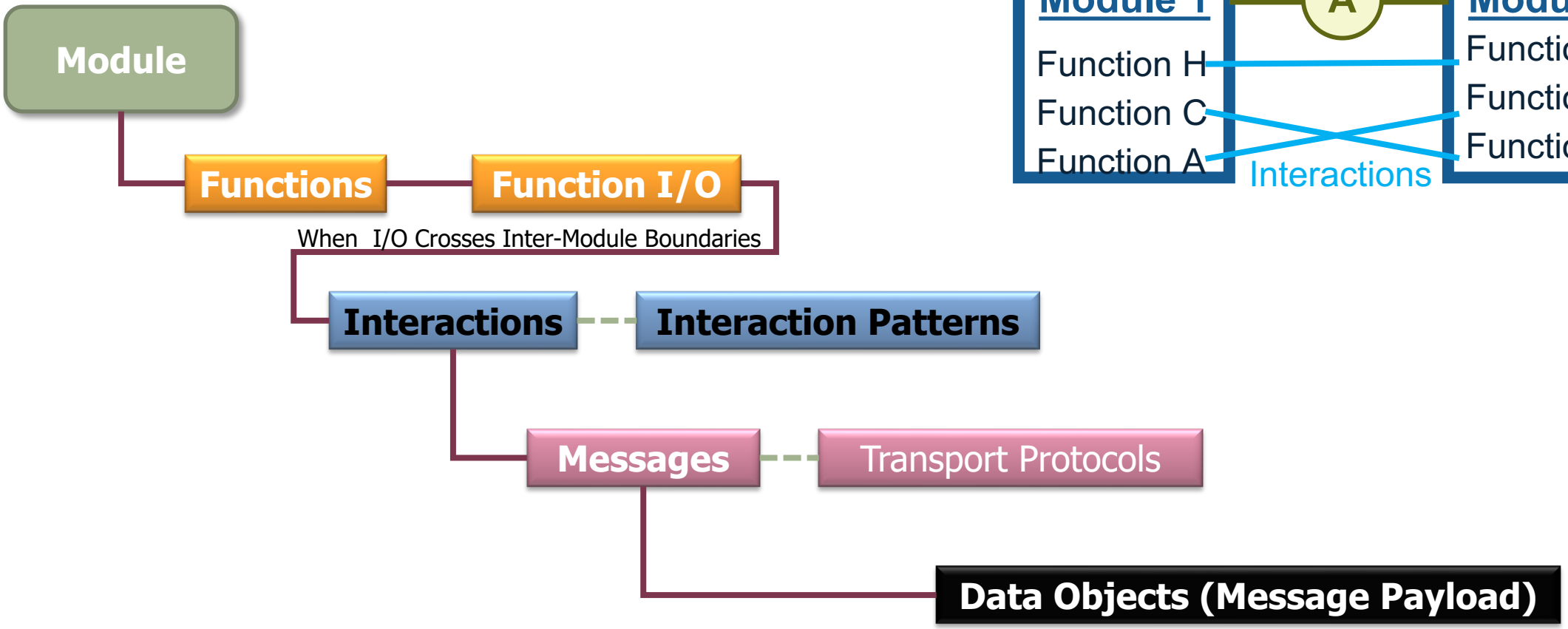
Best Practice for Reference Architecture Development



Relationships/Decomposition



Example (from DEWS) of Functions Encapsulated in a Module

ID	Name	Description
21.11	Display Situational Awareness Data	Display map of system tracks relative to host platform. May include symbology (e.g., MIL-STD-2525), overlays, etc. Display sources include result of the current track store, Local Sensors, primary aperture, or direct feed from External Sensor or Host Platform. This display is also a user interface for functions such as designating tracks. If a track is to be designated for attack, the designated object is tagged as the target
21.13	Display Video	Display Local Sensor video feeds to DEWS operator for use in carrying out engagements. The feeds may be real-time or pre-recorded. The operator display allows the replay, pause, rewind, fast forward, etc. (so-called “TiVo functionality”) permitting reconstruction and analysis.
21.14	H&S Status Update	Request and receive system H&S from the System Monitor
21.15	Display and Control Status	Provide visual display of system status (received from Fire Control), view and control states/modes (conveyed to Fire Control), system power on/off, fault conditions and alarms (including the ability to drill-down to gather more detail, and clearing alarms)
21.16	Initiate BIT	Request that the System Monitor Module that a Built-in Test (BIT) to be performed

Only showing five of the 26 functions for Module 21 (Local Operator HMI)

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DEWS Example: Mapping Functions → I/O Needs → Inter-Module Interactions

ID	Name	Input Needs	Input Source	Product Produced	Product Destination
21.11	Display Situational Awareness Data	Track Data (tracks and kinematic data)	Track Manager Module	Data in display format	Fire Control Module
21.13	Display Video	Video data	Local Sensor Module (real-time) and Data Storage Module (playback)	Video in display format	(local operator display)
21.14	H&S Status Update	H&S status report	System Monitor Module	Status request	System Monitor Module
21.15	Display and Control Status	System status data,	Fire Control Module	Data in display format, Control messages	(local operator display), Fire Control Module
21.16	Initiate BIT	Operator input	(controls internal to this module)	Request to initiate BIT	System Monitor Module

Only showing five of the 26 functions for Module 21 (Local Operator HMI)

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A Tale of Two OSAs Challenge: SOSA Defines Interactions without Reference to Source and Destination Function

SOSA defines each inter-Module Interaction based on either:

- Notional Sensor Thread Logical Flows, or
- Based on a SOA (API-like) approach that makes no assumption about what is at the other end of the connection

SOSA interactions are not associated consumer or producer at the distant end of the connection

DEWS defines each inter-Module Interaction based on consumer / producer (input/output) relationships between the Functions that are involved in the Interaction

DEWS Interactions are tagged with source and destination Function ID numbers

This is a current/active area of convergence that should be fully resolved by the time this presentation is given

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Conclusion

- **It is the best of times – and the worst of times isn't all that bad**
- **Merging two different OSAs is not easy, but it is the right thing to do**
- **This serves as an exemplar for how the community could (should) look at the plethora of existing OSAs and find a way to "trim it back"**
  - Identify commonality and overlap – examine the "touchpoints"
  - Leverage the common
  - Work to find common ground on the deltas
  - Approach it from a win-win perspective
- **Success story: the DEWS RA is being incorporated into the SOSA Technical Standard**
  - Portions of it are already in the SOSA TS revision currently in release review
  - There is work to be done because it is hard (but worth it)

Get Involved – Help Shape the Future

Check to see if your organization a SOSA Consortium member:

https://www.opengroup.org/sosa/members

If not, the process for an organization to join is described here:

https://www.opengroup.org/sosa/join

Once the organization is a member, you can be “onboarded:”

https://www.opengroup.org/sosa/onboarding

The final step is selecting the parts of SOSA Consortium you want to work with. We recommend, at the very least, the DEWS Subcommittee (under the Technical Working Group).

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