An Overview of the Directed Energy Weapon Systems Modular Open Systems Approach Reference Architecture (DEWS MOSA RA)

Directed Energy Weapons

- Directed Energy Weapons (DEW) utilize beams of energy to destroy, damage, or disrupt a target. Examples include lasers, high power microwaves (HPM), and particle beams. They offer:
  - Potential to "Bend" the Cost Curve
  - Deep Magazines with Rapid Reload and Reduced Logistics
  - Highly reduced collateral damage
  - Precision Effects / Adjustable Effects
  - Engagement at the Speed of Light
  - Air / Land / Sea Platforms

DE-MSHORAD
Army
Laser

SSL-TM
Navy
Laser

THOR
Air Force/Army
HPM

HiJENKS
Air Force/Navy
HPM

AHEL
SOCOM
Laser

DEWs Are Arriving and Being Used

- **ODIN – Optical Dazzling Interdictor, Navy**
  - Low-power laser system for dazzling of Unmanned Aerial System (UAS)-mounted Electro-Optical (EO)/Infrared (IR) sensors
  - First three systems installed on DDG51 Flt IIA ships, five more to be installed through 2023
- **HELIOS, Navy**
  - cUAS, cFIAC, 60 kW, Lockheed
  - To be installed on DDG51 Flt IIA ship in FY22
- **SSL-TM – Solid State Laser- Technology Maturation, Navy**
  - cUAS, cFIAC, 150 kW, Northrup
  - Installed on USS Portland (LPD 27) in 2019, deploys in 2021
- **CLAWS – Compact Laser Weapons System, Marines**
  - cUAS, 5 kW, Boeing, 5 systems, in CENTCOM
  - Integrated with Army C-RAM C2 system and radar
- **HELWS – High Energy Laser Weapons System, Air Force**
  - cUAS, 10 kW, Raytheon
  - 1 unit in CENTCOM
- **THOR – Tactical High Power Microwave Operational Responder, Air Force**
  - cUAS, Raytheon, OCONUS evaluation later this year
- **DE M-SHORAD** – Maneuvering Short Range Air Defense, Army
  - Experimental prototype with combat capability : 50 kW-Class laser for cUAS, cRAM, cRW
  - Prototype demo FY21, 1st Platoon (4 platforms) fielded FY22
- **IFPC-HEL – Fixed/Semi-Fixed Site Protection, Army**
  - Lab demo FY22: 300 kW-Class laser for cUAS, cRAM, cCM will inform prototyping effort
  - Joint range demonstration with Navy HELCAP in FY23, 1st Platoon (4 platforms) fielded FY24

Directed Energy Weapon System (DEWS) MOSA Reference Architecture

- Directed energy systems are becoming technically mature, on the verge of being more widely deployed
- Services and programs all going in their own direction – and there is no OSA for DEWS

Needs

- MOSA-based approach to "guide and constrain" development and procurement
- Well-defined, government "owned" open interfaces between modules
- Developer-independent modules
- Service- and Host Platform-independent OSA

To Enable

- Rapid, cost-effective, and supportable DEWS fielding (reduced time from R&D, to prototyping, to integration, to DT and OT)
- Extend service life of systems through incremental upgrades (including from third-party sources)
- Industrial base expansion and engagement → ecosystem (economies of scale)
- Aligned R&D investment
- Reuse across programs and Services

DEWS MOSA Reference Architecture Stakeholder Organizations

Steering Committee

- OSD R&E and DE JTO
- MDA/DVD
- Navy PEO IWS 2.0
- Air Force AFLCMC/XA
- Army RCCTO

Performing Organization

- The MITRE Corporation

Working Group

Air Force:
- AFLCMC/EBZA
- AFRL RD

Army:
- HQDA RCCTO
- SMDC

Navy
- NAVSEA 05Z/05W
- NSWC DD and NSWC CD
- ONR

DoD:
- MDA/DVD
- OSD Power Beaming

Others:
- IBAS INSITUWARE
- MANTECH/Penn State URC

DEWS RA Vision, Goals, Enablers

Key
Vision
Goals
Enablers

Directed Energy Weapon programs leverage a broadly applicable Reference Architecture, founded on MOSA principles, that accelerates innovation, expedites development, and increases the reuse of standard elements

Broadly Applicable

a) Stakeholder definition of CV-1, QAs, Use Cases, Architecture Principles
b) Agnostic with respect to operating environment
c) Agnostic with respect to host platform

Based on MOSA Principles

a) Leverage open/commercial standards and OSAs
b) Non-proprietary, supplier-agnostic module & interface definitions
c) Protect supplier IP and employs balanced Data Rights within modules
d) Large and small business are full partners in architecture development and governance
e) Create new only when necessary
f) Conformance Certification

Accelerate Delivery of Innovation

a) Follow "gray box" concept (architecture defines what the modules and interfaces do, not how they do it)
b) Provide alternative methods to instantiate near-term and future-focused technologies
c) Ensure small businesses- are fully enfranchised
d) Evolvability is incorporated

Expedite Acquisition

a) Reduce traditional weapon system integration & test time
b) Vendor-agnostic open reference architecture allows government to leverage multiple industry partners
c) Allow faster insertion of new tech from best of breed
d) Enable small businesses-developed enhancements at reduced costs

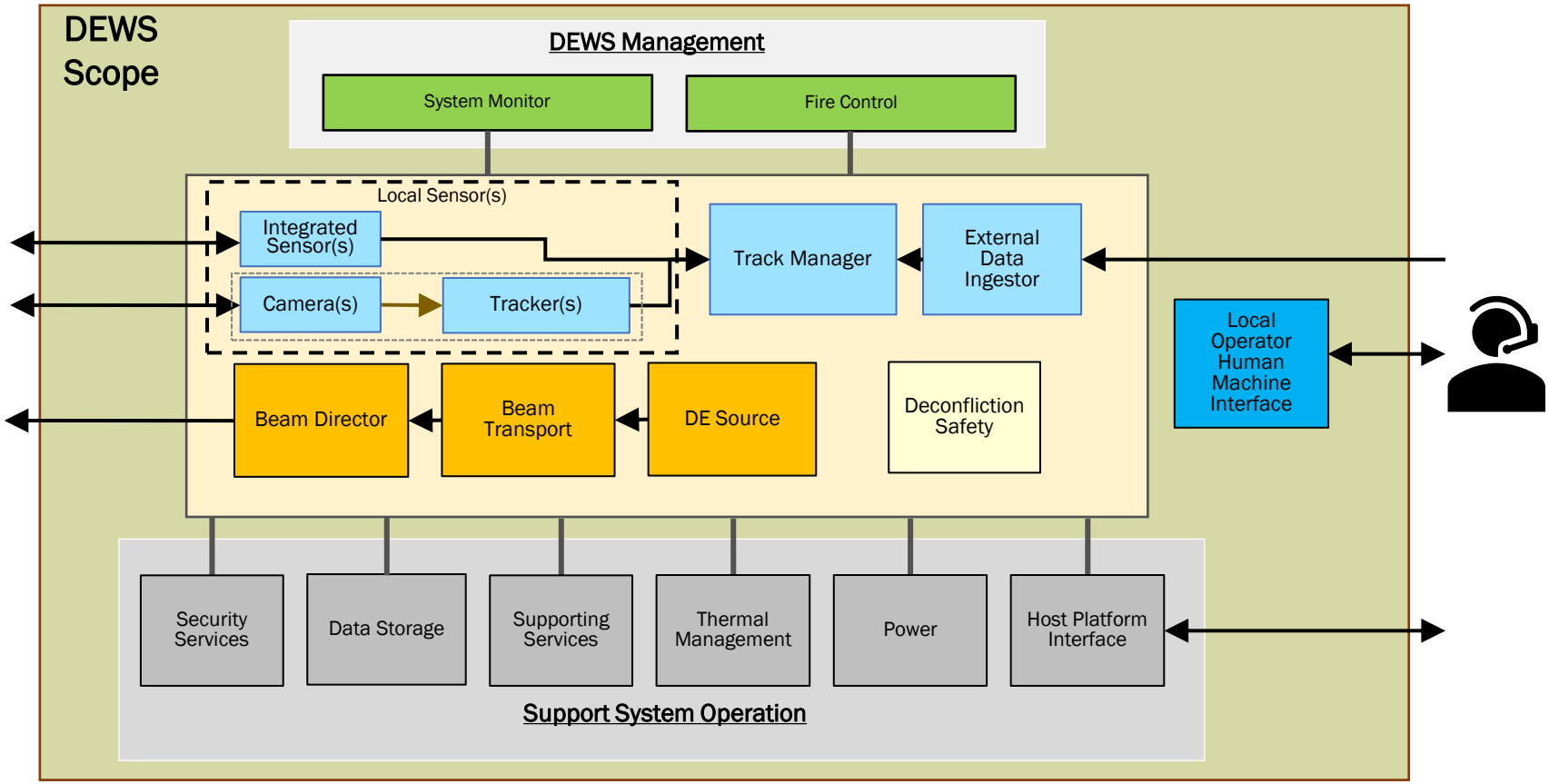
Increase Reuse

a) Facilitate backward compatibility
b) Open business model
c) Portable modules enables cross-weapon portfolio application to reduce design time for new systems

Learn from Systems under Development

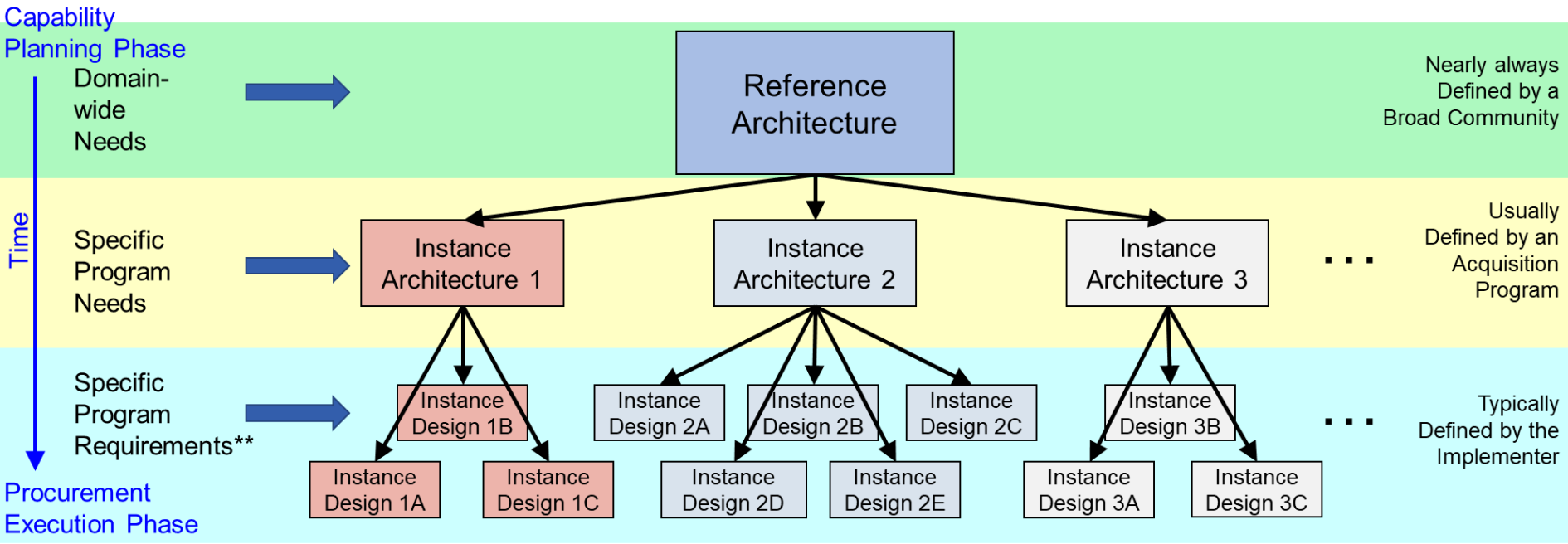
Program Name	Service	Type	Domain	Government Lead	Industry Partners
Bane	Navy	HPM	Land	Dahlgren DEW Office (DEWO)	
Tactical High-Power Microwave Operational Responder (THOR)	USAF	HPM	Land	AFRL	BAE Systems (BAE), Leidos, Verus Research
DE-Maneuver Short Range Air Defense (MSHORAD)	Army	HEL	Land	Army RCCTO	Kord Technologies (Kord)
Indirect Fire Protection High Energy Laser (IFPC-HEL)	Army	HEL	Land	RCCTO, OSD, SMDC	Dynetics (a Leidos Co.), Lockheed Martin Corporation (LMC), MZA Associates Corporation (MZA)
High Power Joint Electromagnetic Non-Kinetic Strike (HiJENKS)	Navy: ONR USAF: AFRL	HPM	Air	Dahlgren /Kirtland	LMC
Self-protect High Energy Laser Demonstrator (SHiELD)	USAF	HEL	Air	AFRL	LMC and Northrop Grumman
Airborne High Energy Laser (AHEL)	USAF	HEL	Air	AF Special Operations Command (AFSOC)	
High Energy Laser with Integrated Optical-dazzler and Surveillance (HELIOS)	Navy	HEL	Sea	PEO IWS 2	LMC
Layered Laser Defense (LLD)	Navy	HEL	Sea	ONR	LMC
Solid State Laser Technology Maturation (SSL-TM)	Navy	HEL	Sea	Dahlgren	NG

DEWS Open Reference Architecture Modules



* Showing only a small subset of interfaces to ensure clarity of the graphic

How a Reference Architecture* fits into the Development Process



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* The Reference Architecture will evolve over time as experience from its use is folded back into it

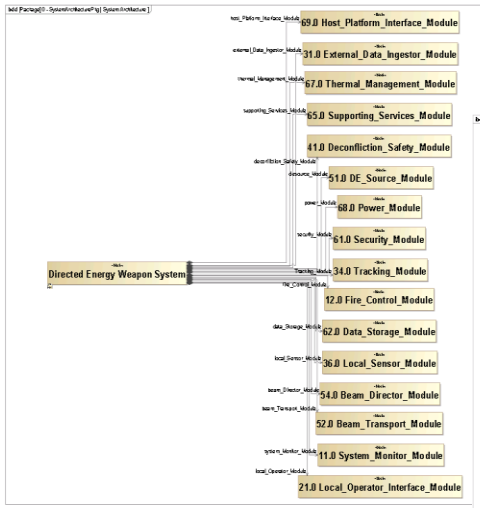
** Selection of the Implemented Design will be based on factors such as price/performance trades, SWaP, etc.

Derived from SOSA 101

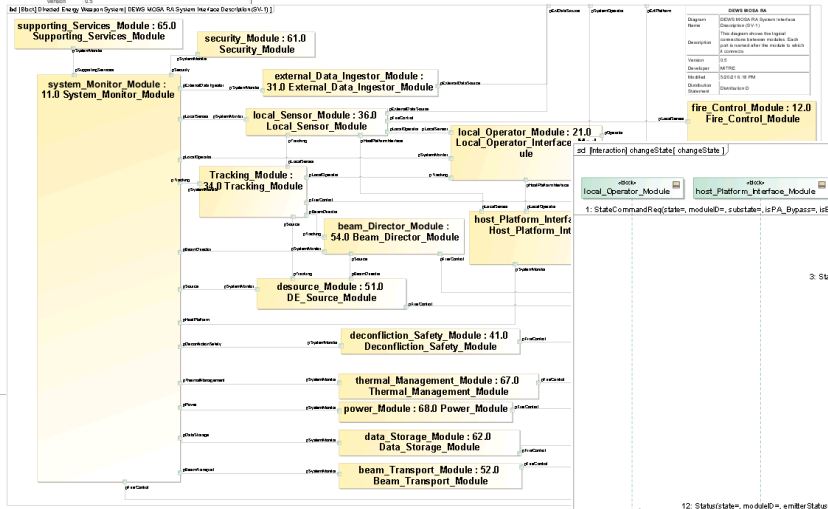
DEWS MOSA Reference Architecture Model

- The DEWS MOSA RA will be provided as a Digital Engineering product, directly usable as a base for implementing programs
- Accompanying documentation will provide guidance on use, including with other standards

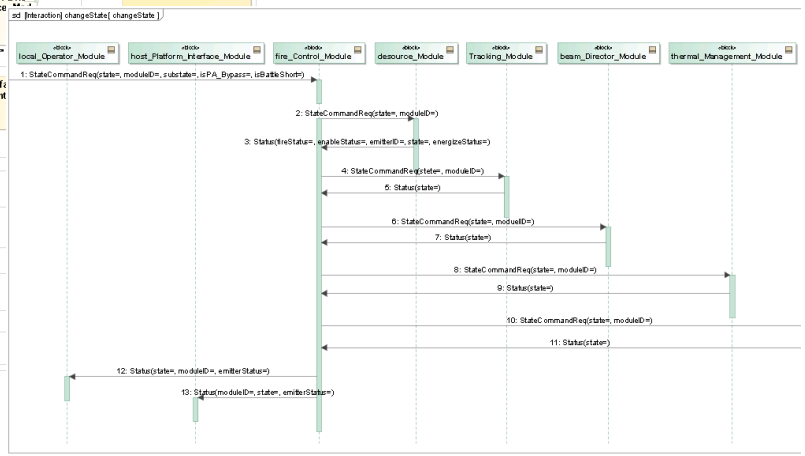
System Architecture



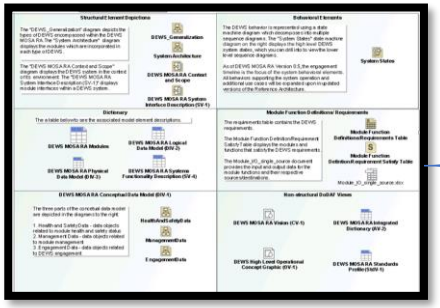
System Interfaces



System Behavior

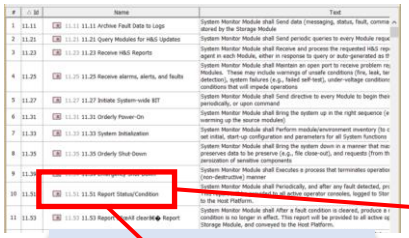


DEWS RA Model Components

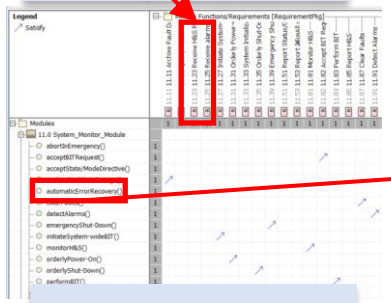


Landing Page to Navigate the Reference Architecture

Requirements

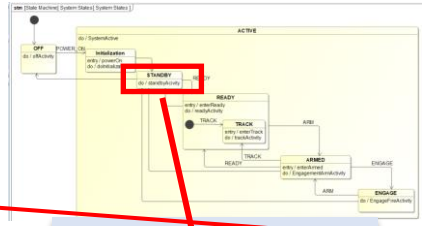


Module Interface Requirements

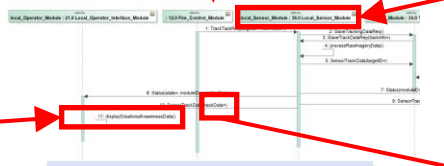


Module Functions

Behavioral



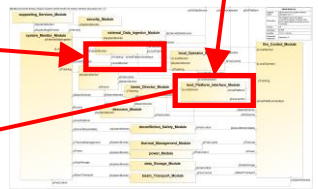
State Machine



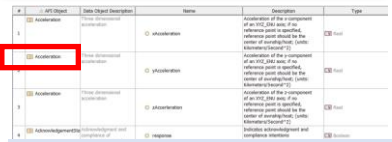
Sequence Diagram

Structural

System Architecture

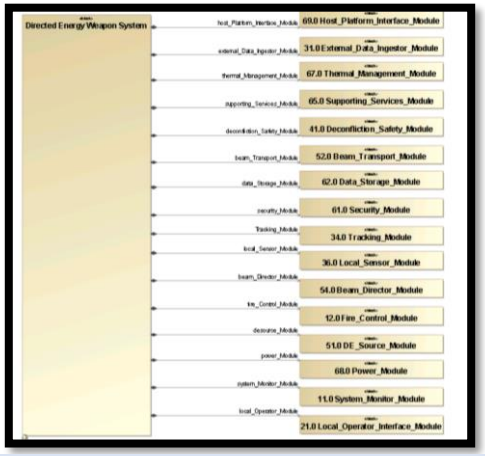


System Interface Description

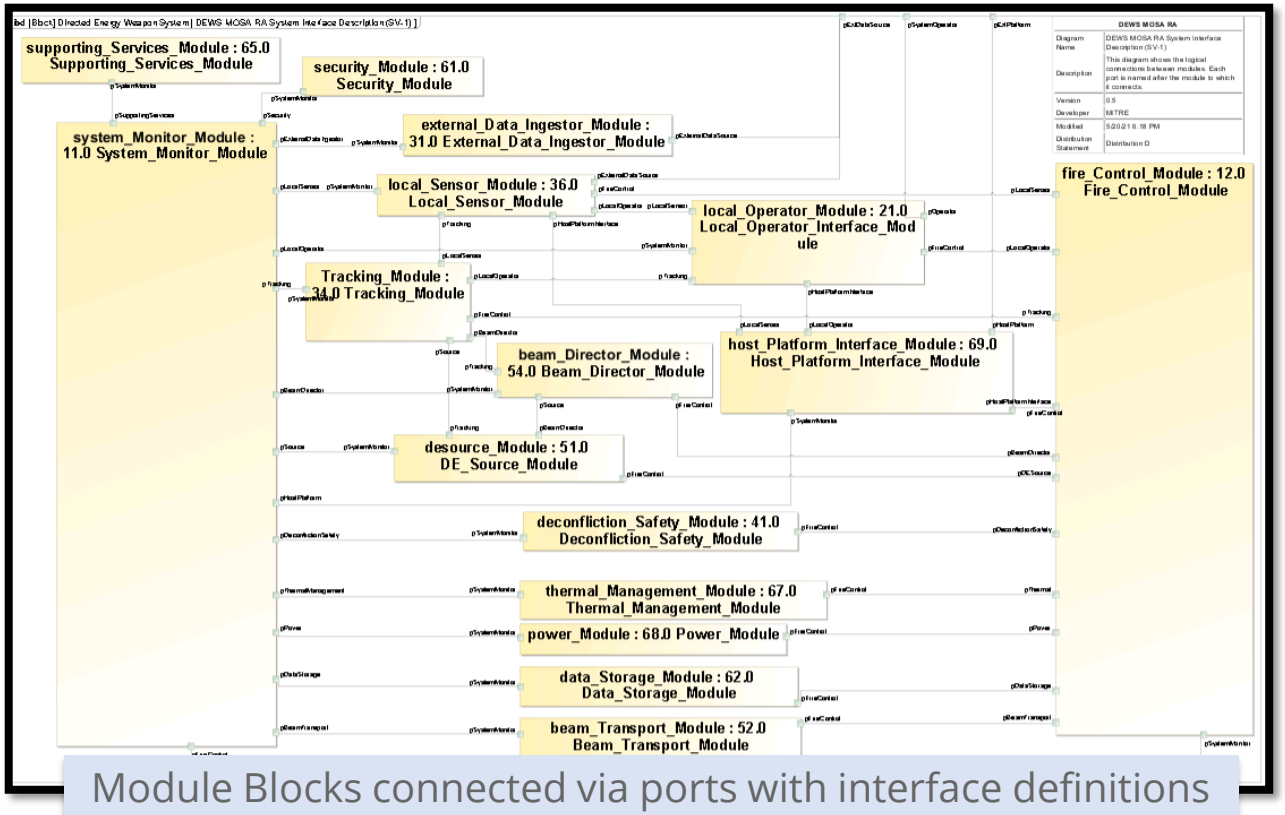


Data Model

DEWS RA Module System Architecture



Module Definitions

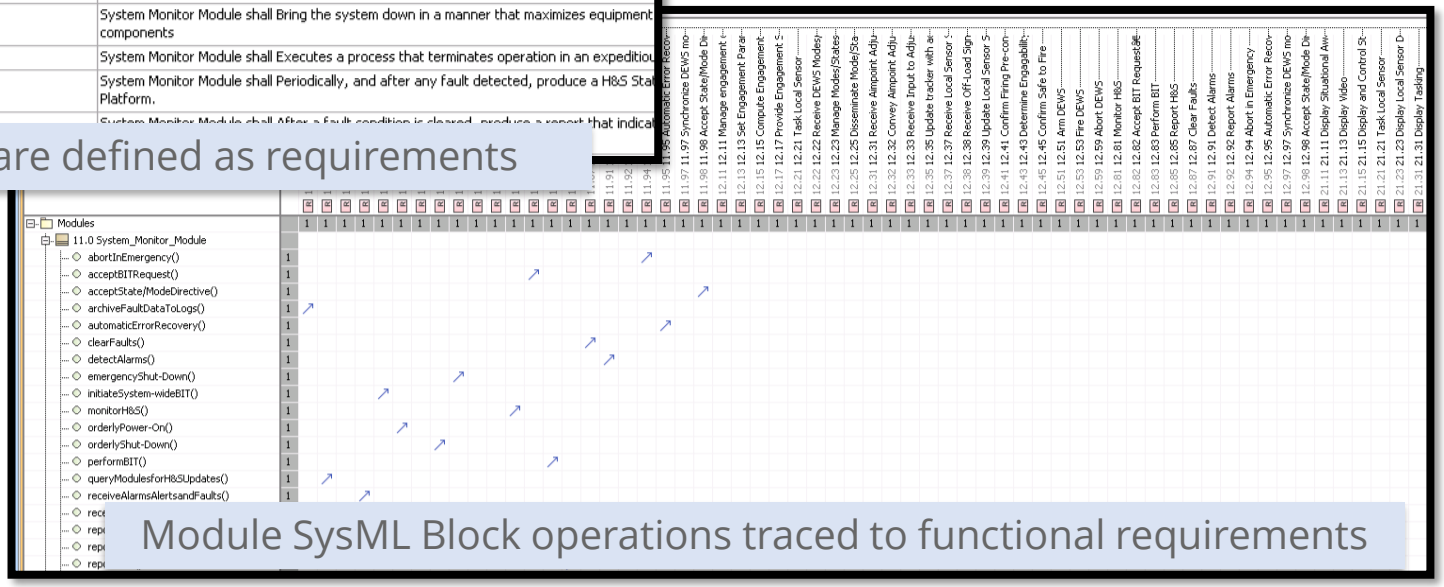


Module Blocks connected via ports with interface definitions

Functional and Interface Requirements

#	Id	Name	
1	11.11	11.11 11.11 Archive Fault Data to Logs	System Monitor Module shall Send data (messaging, status, fault, command, etc.) and vide
2	11.21	11.21 11.21 Query Modules for H&S Updates	System Monitor Module shall Send periodic queries to every Module request routine H&S re
3	11.23	11.23 11.23 Receive H&S Reports	System Monitor Module shall Receive and process the requested H&S reports (that come fr
4	11.25	11.25 11.25 Receive alarms, alerts, and faults	System Monitor Module shall Maintain an open port to receive problem reports from any ar failures (e.g., failed self-test), under-voltage conditions, interlock trips, or other condition
5	11.27	11.27 11.27 Initiate System-wide BIT	System Monitor Module shall Send directive to every Module to begin their BIT process, up
6	11.31	11.31 11.31 Orderly Power-On	System Monitor Module shall Bring the system up in the right sequence (enabling cooling be
7	11.33	11.33 11.33 System Initialization	System Monitor Module shall Perform module/environment inventory (to confirm all are on-
8	11.35	11.35 11.35 Orderly Shut-Down	System Monitor Module shall Bring the system down in a manner that maximizes equipment components
9	11.39	11.39 11.39 Emergency Shut-Down	System Monitor Module shall Executes a process that terminates operation in an expeditiou
10	11.51	11.51 11.51 Report Status/Condition	System Monitor Module shall Periodically, and after any fault detected, produce a H&S Stat Platform.
11			

Module functions are defined as requirements



Module SysML Block operations traced to functional requirements

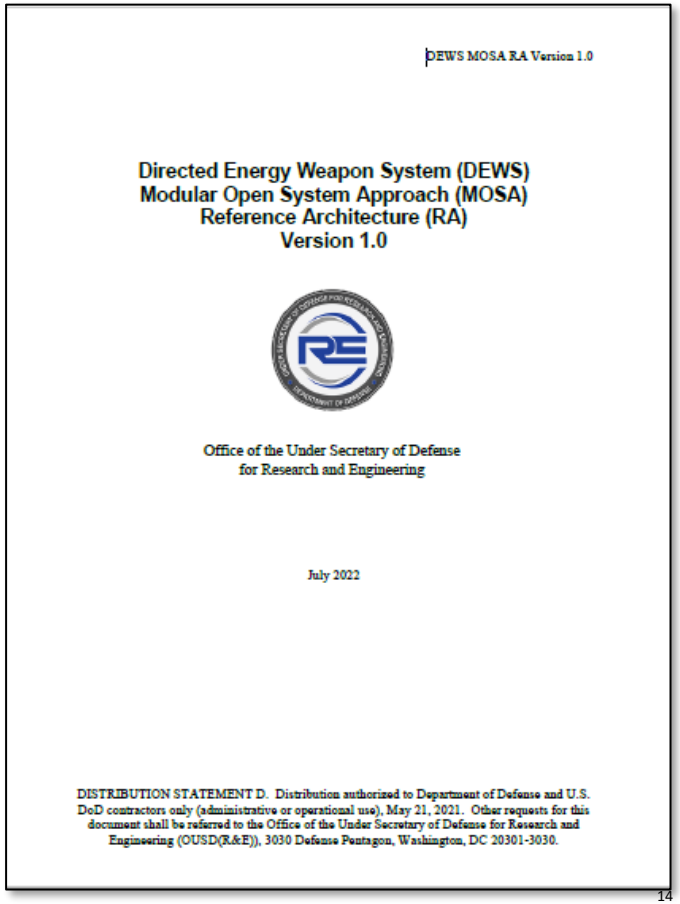
Reference Architecture Released to Government and Industry

Version 1.0 of the Reference Architecture released 22 July 2022

- Reference Architecture Document
- Digital Model and Tools
- Supplemental Material
  - Implementation Guidance
  - Alignment Assessment Guidance
  - Acquisition Guidance

Incorporated feedback from government and industry based on version 0.7 of the Reference Architecture

- Industry review via RFI
- Held an Industry Day on November 4, 2021
- Received hundreds of feedback comments
- Dialog with submitters to address questions



DEWS MOSA RA Version 1.0

Directed Energy Weapon System (DEWS)
Modular Open System Approach (MOSA)
Reference Architecture (RA)
Version 1.0

Office of the Under Secretary of Defense
for Research and Engineering

July 2022

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How to Use the DEWS MOSA RA

- To obtain the DEWS MOSA RA, contact dewsra@mitre.org

- The DEWS RA is complementary to other standards
  - Each platform may have an architecture
  - Integration standards may be used across the wider system
  - DEWS RA v1.0 does not specify hardware-level implementation of interfaces, cabling, and module hosting; look to hardware standardization for these

- The MBSE model provides base objects which can be specialized, extended, and refined to provide instance-specific modeling elements.

DEW Roadmap: Mission Growth From Simple To Complex, & Short Range To Long

Key Aspects

- Achieve military dominance in every mission area where DEW makes technical sense
- Develop operational experience, knowledge, and confidence through operational demonstrations
- Advance and mature the technology to increase lethality, expand the mission set, and counter future adversaries
- Deliver new military capabilities with proven technology