Evolving Role of the Human for Digital Engineering Transformation

National Defense Industrial Association - Systems and Mission Engineering Conference

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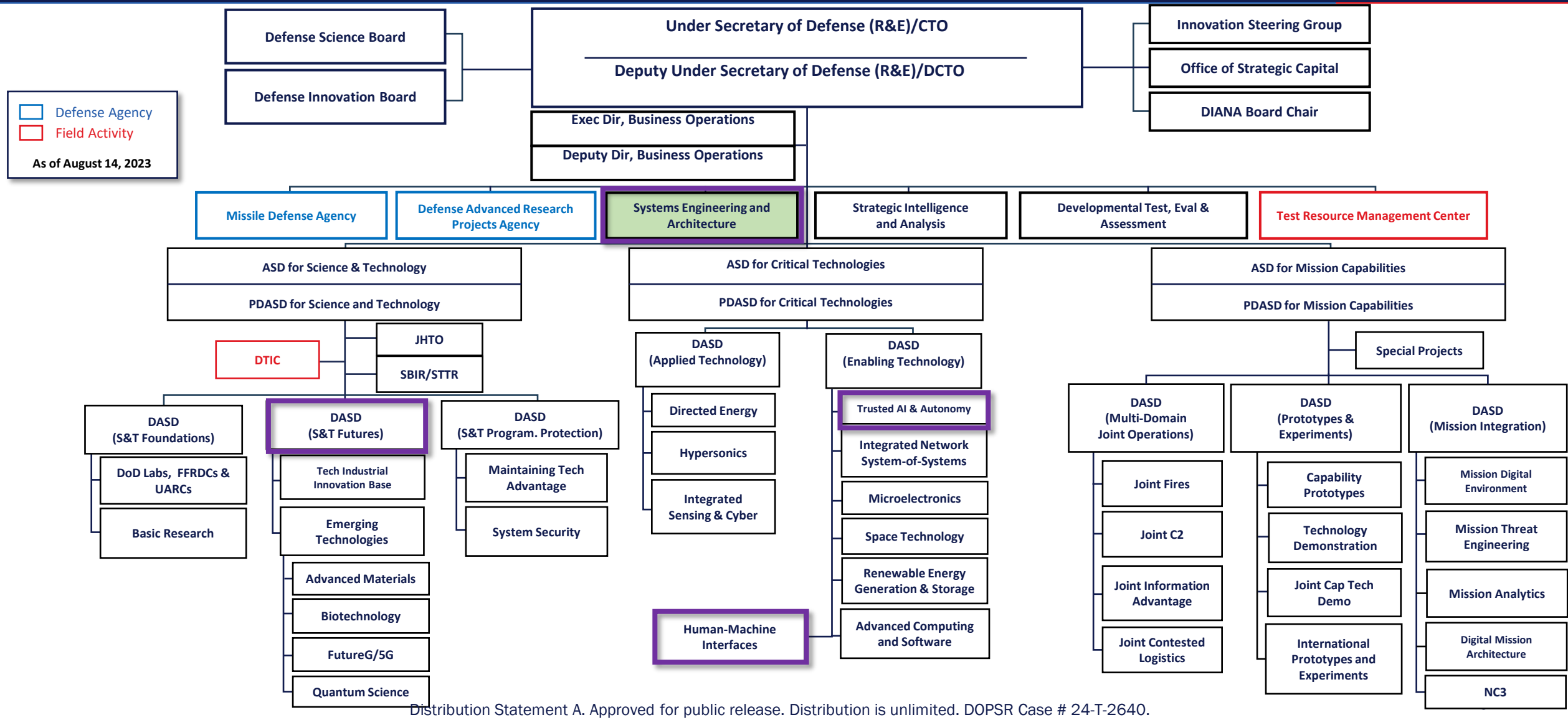
Office of Systems Engineering and Architecture
Office of the Under Secretary of Defense
for Research and Engineering

Norfolk, Virginia
October 2024

Agenda

- Office of the Under Secretary of Defense for Research and Engineering (OUSD(R&E)) and Systems Engineering and Architecture (SE&A) Overview
- Human Systems Integration (HSI) Policy Requirements and Guidance
- HSI in the Digital Thread
- Upcoming HSI Challenges
- Path Ahead

OUSD(R&E) Organizational Structure



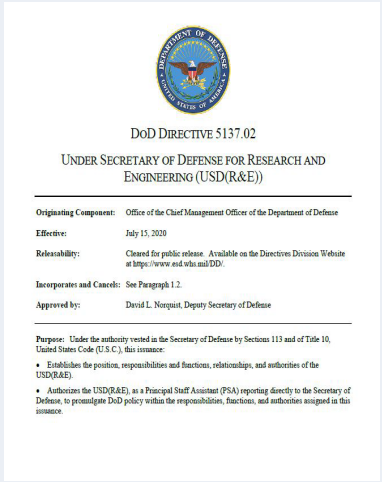
National Security Authorities: Research and Engineering (R&E)

Leaders

HON Ms. Heidi Shyu
Under Secretary of Defense for Research and Engineering

HON Dr. David A. Honey
Deputy Under Secretary of Defense for Research and Engineering

Authority From DODD 5137.02



DoD DIRECTIVE 5137.02

UNDER SECRETARY OF DEFENSE FOR RESEARCH AND ENGINEERING (USD(R&E))

Originating Component:	Office of the Chief Management Officer of the Department of Defense
Effective:	July 15, 2020
Releasability:	Cleared for public release. Available on the Directives Division Website at https://www.esd.whs.mil/DD/.
Incorporates and Cancels:	See Paragraph 1.2.
Approved by:	David L. Norquist, Deputy Secretary of Defense

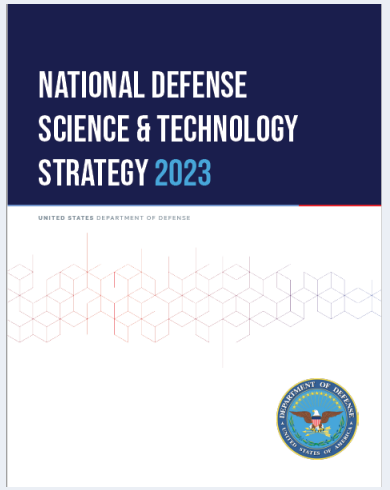
Purpose: Under the authority vested in the Secretary of Defense by Sections 113 and of Title 10, United States Code (U.S.C.), this issuance:

- Establishes the position, responsibilities and functions, relationships, and authorities of the USD(R&E).
- Authorizes the USD(R&E), as a Principal Staff Assistant (PSA) reporting directly to the Secretary of Defense, to promulgate DoD policy within the responsibilities, functions, and authorities assigned in this issuance.

Purpose: Under the authority vested in the Secretary of Defense by Sections 113 and of Title 10, United States Code (U.S.C.), this issuance:
• Establishes the position….of the USD(R&E).
• **Develops** "governing policy and **advances practices** and **workforce competency** for… e**ngineering, …., software development,…. modeling and simulation, ...and digital engineering…."

Priorities

National Defense Science and Technology Strategy 2023

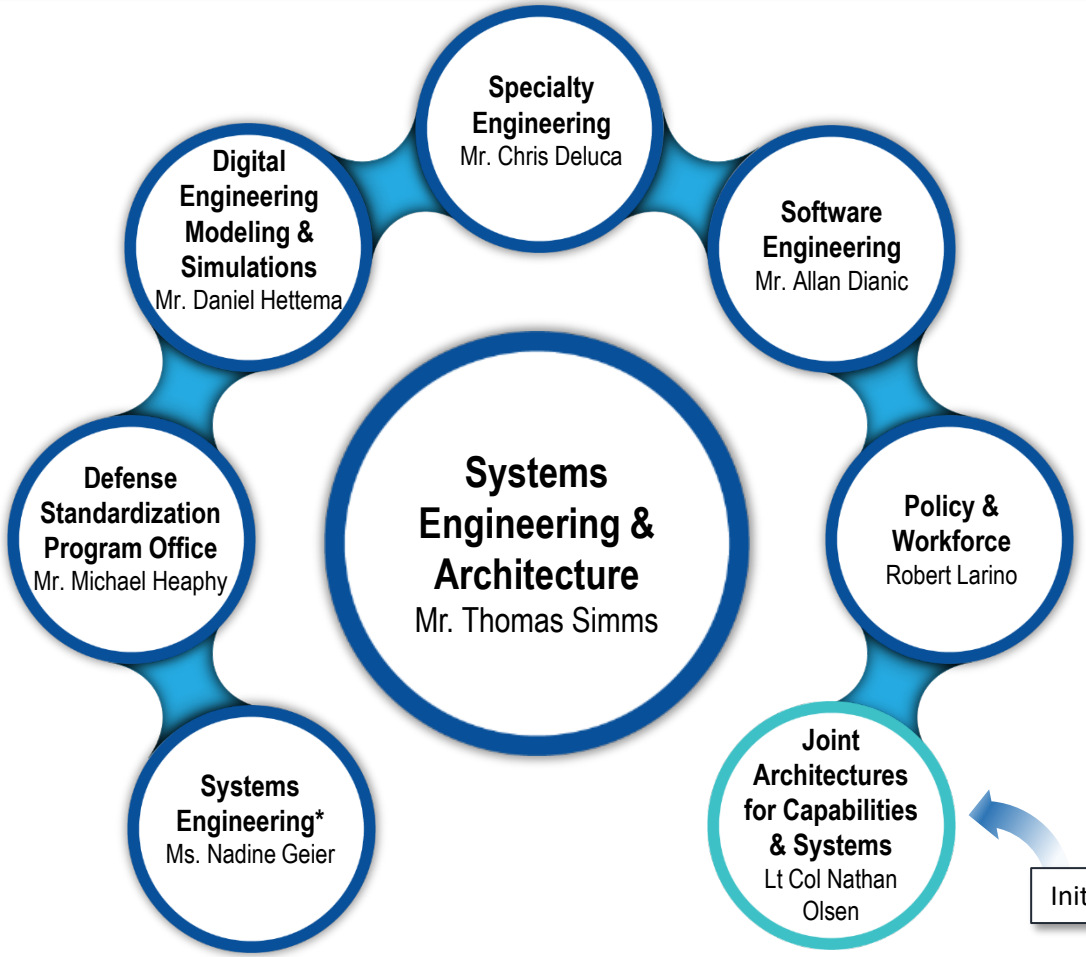


Priorities: to "execute on three strategic lines of effort:

1. Focus on the Joint Mission
2. Create and field capabilities at speed and scale
3. Ensure the foundations for research and development"

SE&A Lines of Effort

SE&A develops and promotes advanced engineering principles, techniques, and practices to improve Joint Warfighting Capabilities.



Lines of Effort

1. Advance the Engineering Practice
2. Connect & Strengthen the Technical Community
3. Develop the Workforce
4. Advance and Manage Standards
5. Provide Technical Expertise for Independent Engineering Assessments
6. Provide System of Systems (SoS) Architectures Guidance

*Includes Modular Open Systems Approach (MOSA)

SE&A Roles and Responsibilities

SE&A: Develops and promotes innovative engineering principles and techniques to advance DoD engineering practice. SE&A develops policy, guidance, standards, and best practice resources; manages DoD Standards; facilitates engineering-related communities of practice; and develops the defense engineering workforce by refining competency models and curricula. SE&A applies engineering and risk management expertise to inform decisions and improve system-of-systems architectures to reduce integration risk in mission-enabling systems.

Policy and Workforce: Leads policy, guidance, and workforce development initiatives for the DoD engineering and technical workforce.

Systems Engineering (SE): Focuses on modernizing SE practice, including using modular open systems approaches to build systems that can be upgraded to incorporate new technology and respond to emerging threats.

Digital Engineering Modeling & Simulations (DEM&S): Focuses on digital engineering transformation and implementation, promoting the use of models and simulations across the DoD life cycle.

Software Engineering (SWE): Promotes Agile/DevSecOps software practices and cross-organizational collaboration to modernize DoD software capability and expertise.

Specialty Engineering (SpE): Focuses on improving delivery of advanced capability to warfighters by modernizing reliability and maintainability, manufacturing and quality, system safety, human systems integration, and value engineering practices.

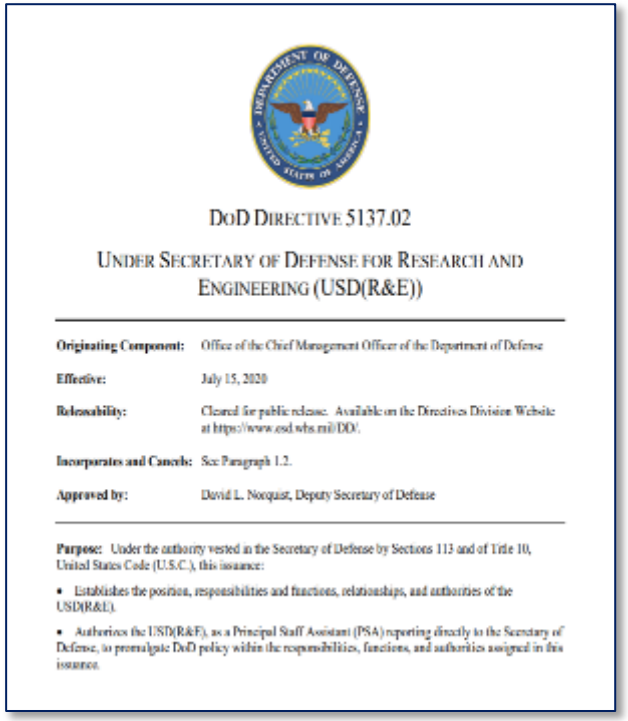
Defense Standardization Program Office (DSPO): Identifies, develops, and provides access to standardization processes and products for the defense community to promote interoperability, reduce cost, and sustain readiness.

Joint Architectures for Capabilities & Systems (JACS): Promotes system of systems fielded with speed, fidelity, and adaptability to enable continual evolution of U.S. warfighting dominance.

Collaborators: OUSD(R&E) offices, the Services, DOT&E, CIO, CDAO, and OUSD(A&S)

DoD Directive 5137.02, USD(R&E) Charter

"2.q. In coordination with key stakeholders, **develops governing policy and advances practices and workforce competency for** the following technical activities: **engineering**, developmental test and evaluation, reliability and maintainability, manufacturability, quality, **system safety, human systems integration**, modular open systems approach, resilient systems, software development, hardware and software assurance, system security engineering, modeling and simulation, and digital engineering."



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Published July 15, 2020

Specialty Engineering at a Glance

POLICY
DoDI 5000.88 ENG
DoDI 5000.95 HSI
DoDI 5000.69 WPNS
DoDI 4245.14 VE

GUIDANCE
BoKs for R&M, M&Q, SS, and HSI
Unmanned System Safety Precepts Guide
Engineering of Defense Systems Guidebook
Systems Engineering Guidebook
Early M&Q Engineering Guide
Defense SOH Strategy

INITIATIVES
DoD-Industry R&M and SS Roundtables
HSI Framework (HSIF) Practitioner Tool
VE Management Advisory Group
Producibility Guide

STANDARDS
IEEE 1413 Reliability Prediction
IEEE 1624 Reliability Organization Assessment
SAE-1025 Failure Modes Effects Analysis
SAE-6500 Manufacturing Management
SAE-6906 Standard Practice for HSI
SD-24 Value Engineering

WORKFORCE DEVELOPMENT
Digital Engineering in R&M Courses
AI R&M and System Safety Courses
HSI Credentialing
M&Q Credentialing

CONGRESSIONAL/GAO TASKING
Head-borne mass research to reduce injury
Protective Equipment modernization
GAO 20-151, Senior Leaders Improve Weapon Systems Reliability

TECHNOLOGY/PROGRAM SUPPORT
RAI Strategy and Implementation Plan
Additive Manufacturing
MBE FMECA

COLLABORATION (LEAD)
Digital Manufacturing Enterprise
DoD-Industry R&M Engineering Roundtable
MIL-STD-882 System Safety / JSSSWG
Joint HSI Steering Committee / WG
R&M, M&Q Service Leads

COLLABORATION (PARTICIPANT)
Focused Sustainment
Defense Safety Oversight Council
Civilian Harm Mitigation and Response
Joint Defense Manufacturing Council
R&M Symposium (RAMS)

HSI Statute and Policy

- **HASC recommendations FY2017 HASC Report (HR) 4909:**
  - ***Continuing top-level HSI leadership*** through existing committees, such as the Joint HSI Steering Committee (JHSISC) and Working Groups
  - ***Provide a DoD HSI Standard practice*** and update existing HSI-related MIL Standards
  - Incorporate additional ***HSI learning content into DAU's systems engineering courseware***
  - Provide support to USD(A&S) to ***strengthen HSI language in the revamped DoDI 5000.02*** *(as a result of the Adaptive Acquisition Framework transformation of DoD policy)*
- **Public Law No: 116-92, SEC. 902, January 3, 2019:**

  "The Secretary of Defense, acting through the Under Secretary of Defense for Acquisition and Sustainment, shall coordinate and **manage human systems integration activities throughout the acquisition programs** of the Department of Defense."
- **DoDD 5000.01, Defense Acquisition System (DAS):**

  "1.2.p. Human systems integration planning will begin in the early stages of the program life cycle. The goal will be to **optimize total system performance and total ownership costs**, while **ensuring that the system is designed**, operated, and maintained **consistent with mission requirements**."

Create an HSI Culture in DoD

Marines prepare to take off in a MV-22B Osprey at Norwegian Air Force Base Bodø during Exercise Cold Response 22, Norway, March 16, 2022. (Lance Cpl. Elias E. Pimentel III/Marine Corps)

Pilot error the cause of Norway Osprey crash that killed 4 Marines (Aug 2022)

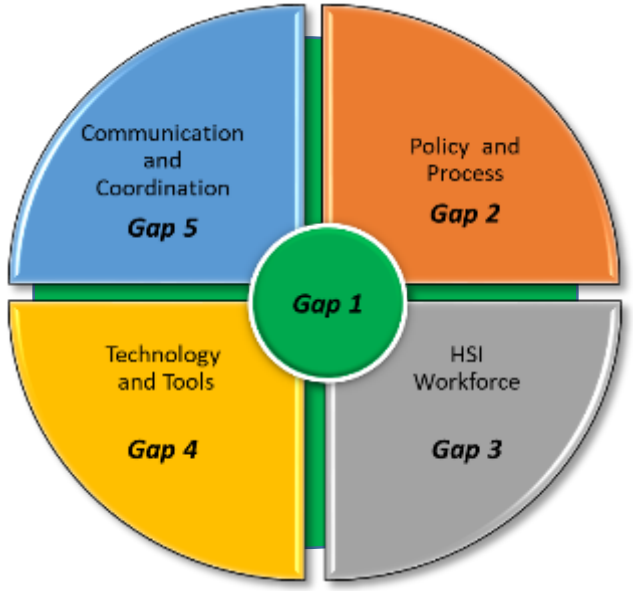
KC-46A's long-troubled vision system cannot reliably show the end of the refueling boom (May 2021)

The Army's futuristic new goggles are a literal pain in the neck (Oct 2022)

***USS Fitzgerald* and container ship *MV ACX Crystal*; *USS John S. McCain* and *Alnic MC* collisions (2017-2018)**
"The ship's user interface was found to have contributed to the sailors' confusion."

Joint HSI Steering Committee

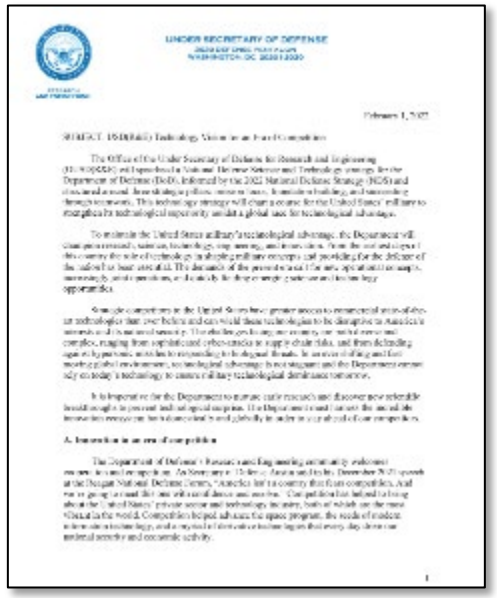
- OSD has **tri-chair** responsibilities in the JHSISC for providing leadership direction for the HSI enterprise across DoD
  - OUSD(R&E) Principal Deputy Executive Director, Systems Engineering and Architecture
  - OUSD(R&E)/DCTO(ST&T), Director, Human Systems Directorate
  - OUSD(P&R)/DASD(SOH) Director, Force Safety and Occupational Health
- The JHSISC guides accelerating the delivery of human systems capabilities, scaling the Department-wide impact of HSI, and synchronizing DoD HSI activities
- The Joint HSI Steering Committee commissioned an HSI Gap Capabilities-Based Assessment (CBA) Report in 2018, which identified five lines of effort to enhance HSI maturity and effectiveness



FY25 Capabilities-Based Assessments

CBA 1	Institutionalize	• HSI Body of Knowledge
CBA 2	Standardize	• DoDI 5000.95 HSI • ANSI/HFES 400 • MIL-STD-882E System Safety • SAE 6906 Standard Practice for HSI • HSI Guidebook
CBA 3	Workforce	• HSI Credential in work • HSI competency assessment • ENG 0620 Introduction to HSI • DoD HSI Course catalog
CBA 4	Tools	• HSI Tools Catalog • HSI Framework Tool • IMPRINT
CBA 5	Collaboration	• Joint HSI Steering Committee • Joint HSI Working Group • DAU and APAN CoPs
CBA	Funding	• Enter POM funding cycle for HSI

DoDI 5000.95 Supported Among Top OUSD(R&E) Enabling Technologies

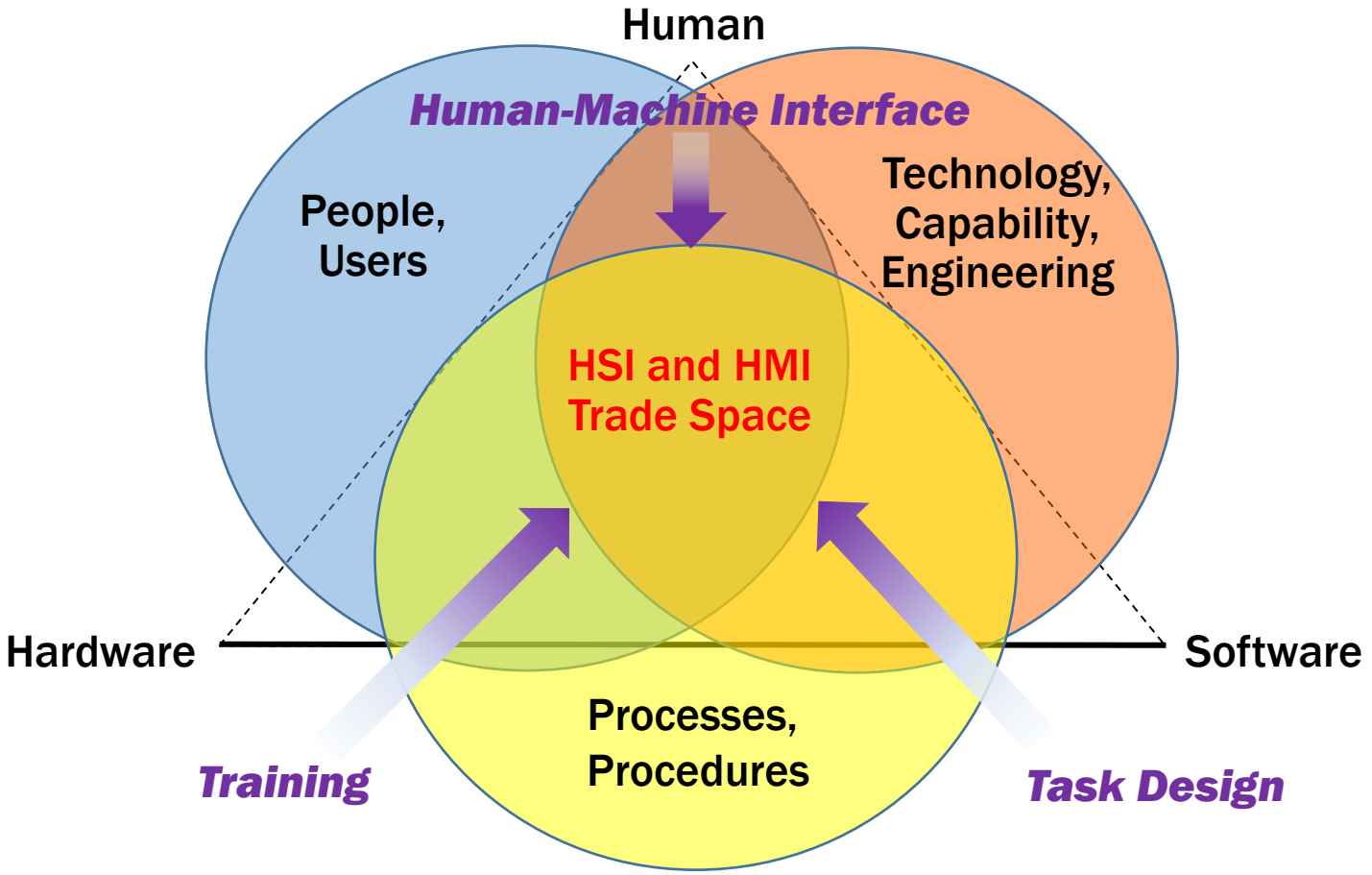


Published 1 Feb 2022

Trusted AI and Autonomy: Autonomy is the engineering discipline that expands robots' **abilities to perform tasks while limiting the need for human interaction**. AI holds tremendous promise to improve the ability and function of nearly all systems and operations. Trusted AI with trusted autonomous systems is imperative to dominate future conflicts. As AI, machine learning, and autonomous operations continue to mature, the DoD will focus on evidence-based AI-assurance and enabling operational effectiveness.

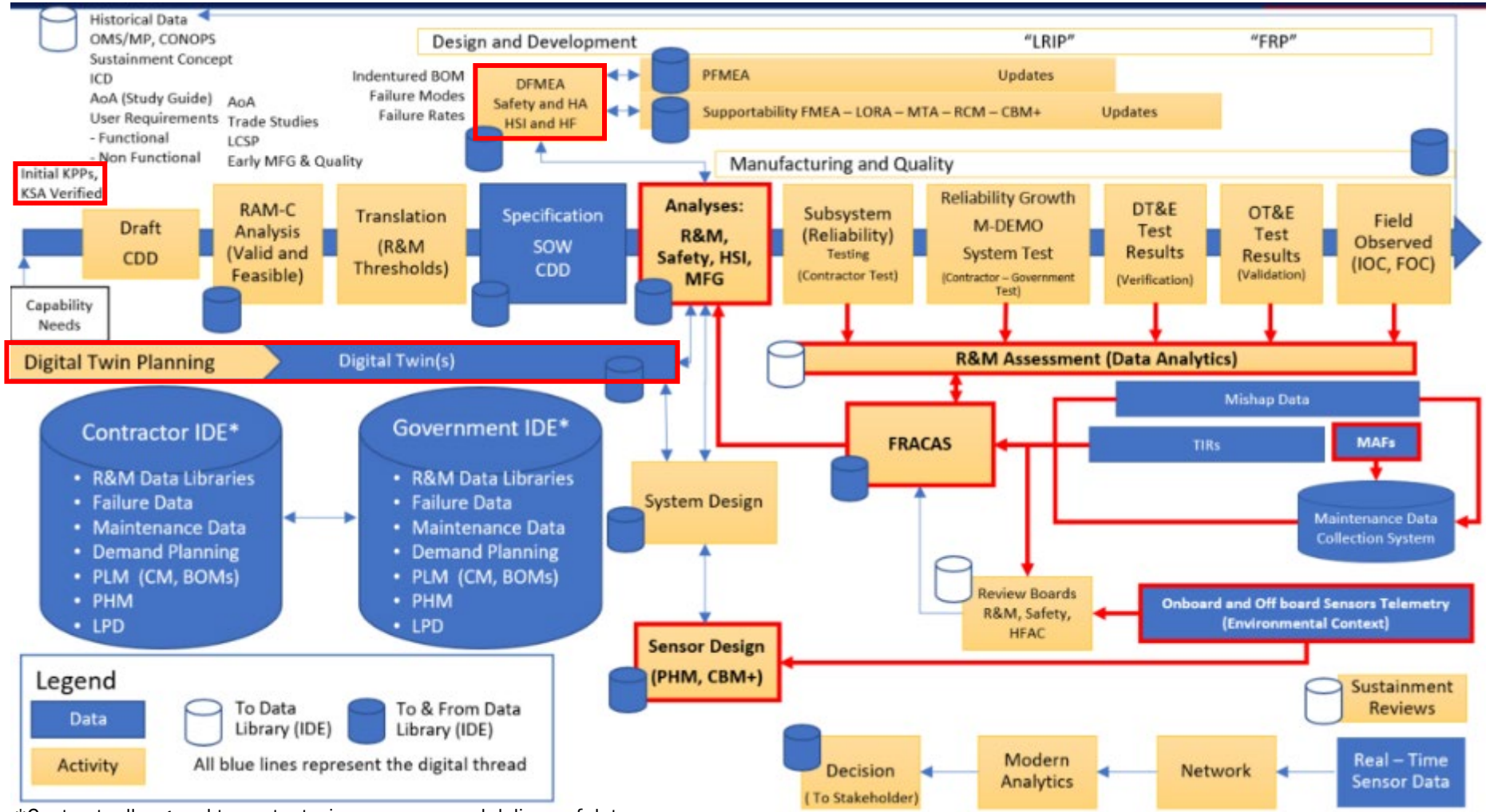
Human-Machine Interfaces: Human-Machine Interface refers to technologies related to human-machine teaming and augmented and virtual reality. Rapid advancements in this technology will have a multitude of benefits for our Service members. **Highly immersive realistic training environments** provide **real-time feedback** to **enhance warfighter performance**. **Intuitive interactive** human-machine interfaces **enable rapid mission planning and mission command** by providing a common operational picture to geographically distributed operations.

The Problem → HSI Is the DoD Solution



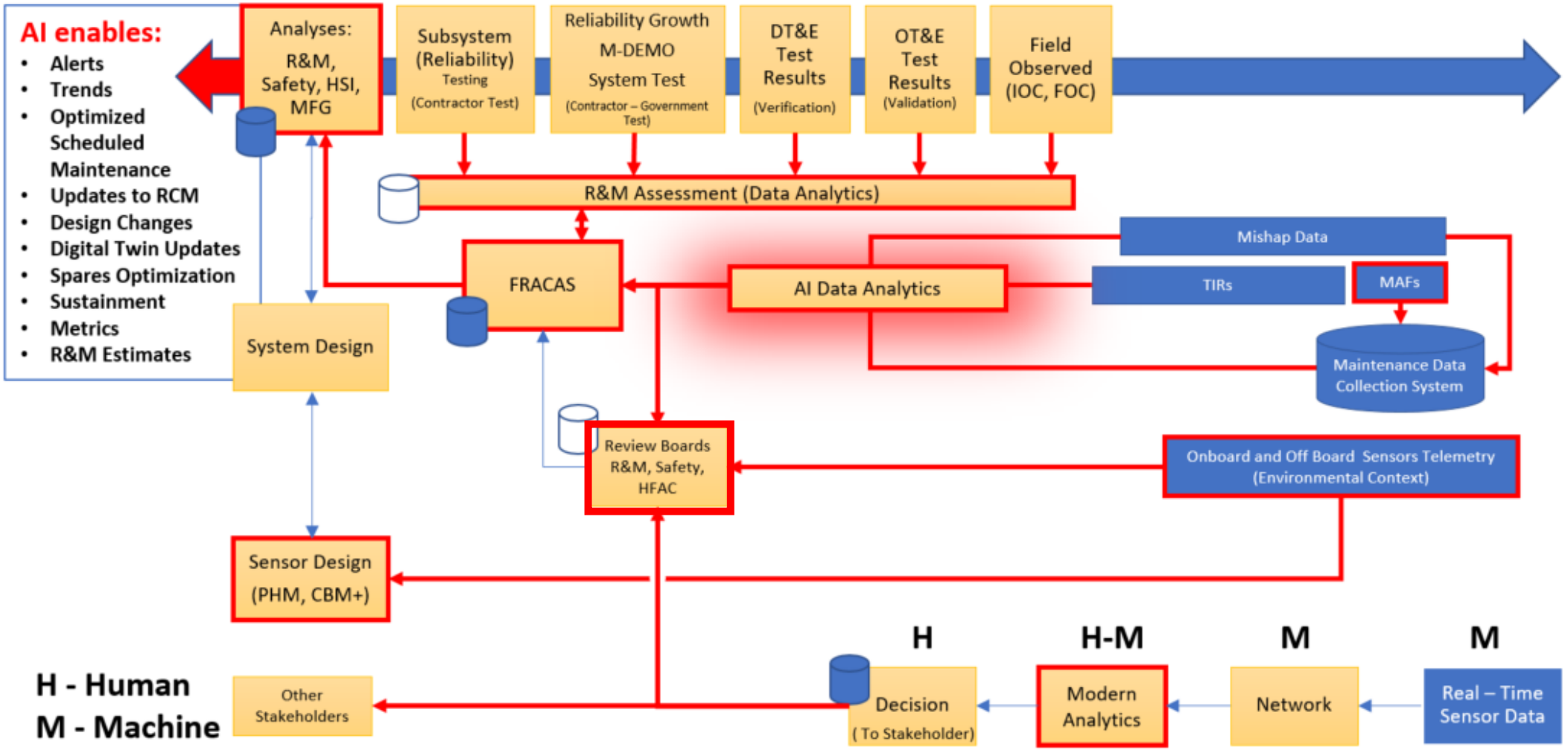
- When Human requirements are not adequately considered ➔ reduced system effectiveness and higher risk for failures.
- Late human requirements integration ➔ increased cost

HSI Data in Failure Reporting Analysis and Corrective Action System (FRACAS) Processes

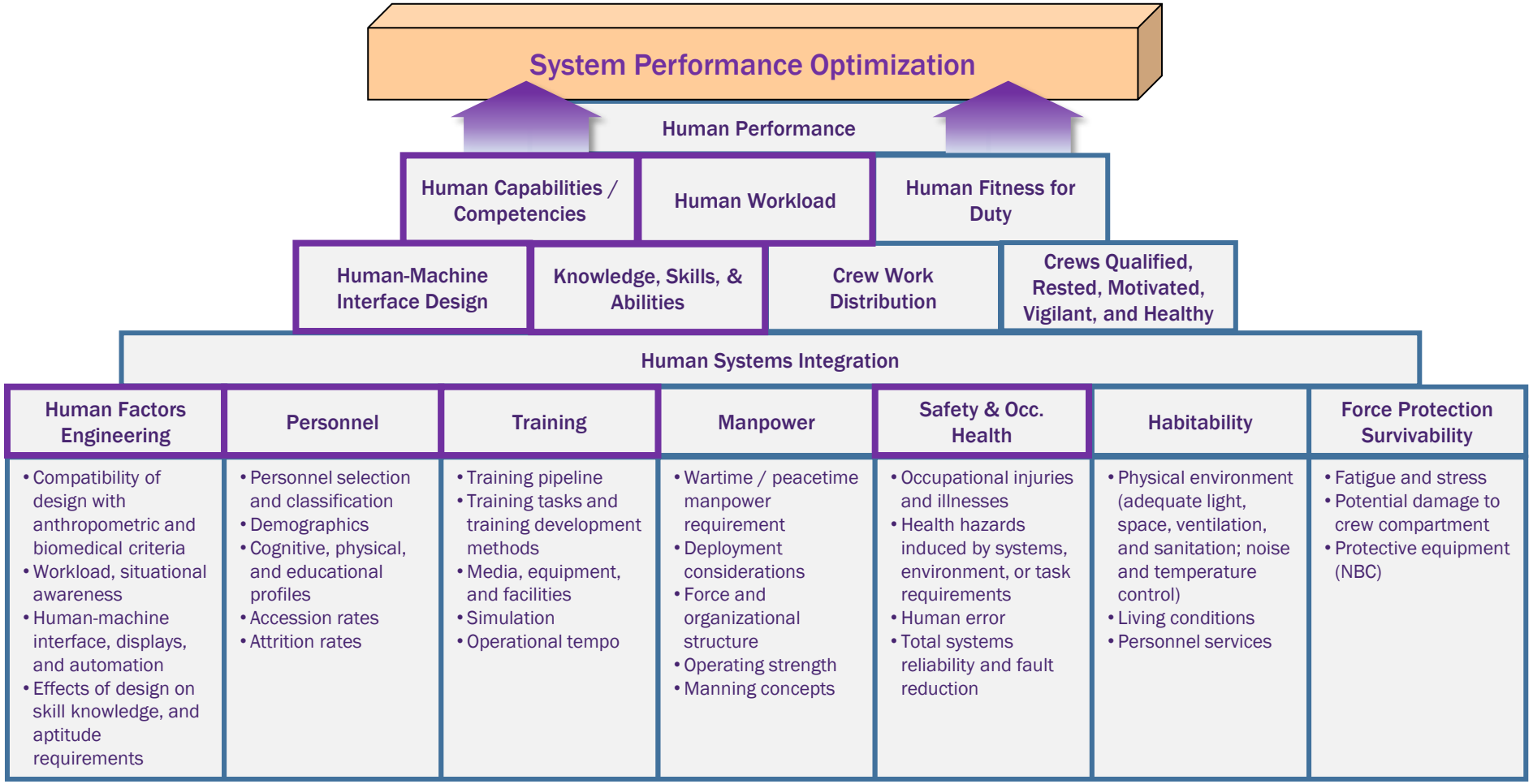


*Contractually agreed to content, views, access, and delivery of data.

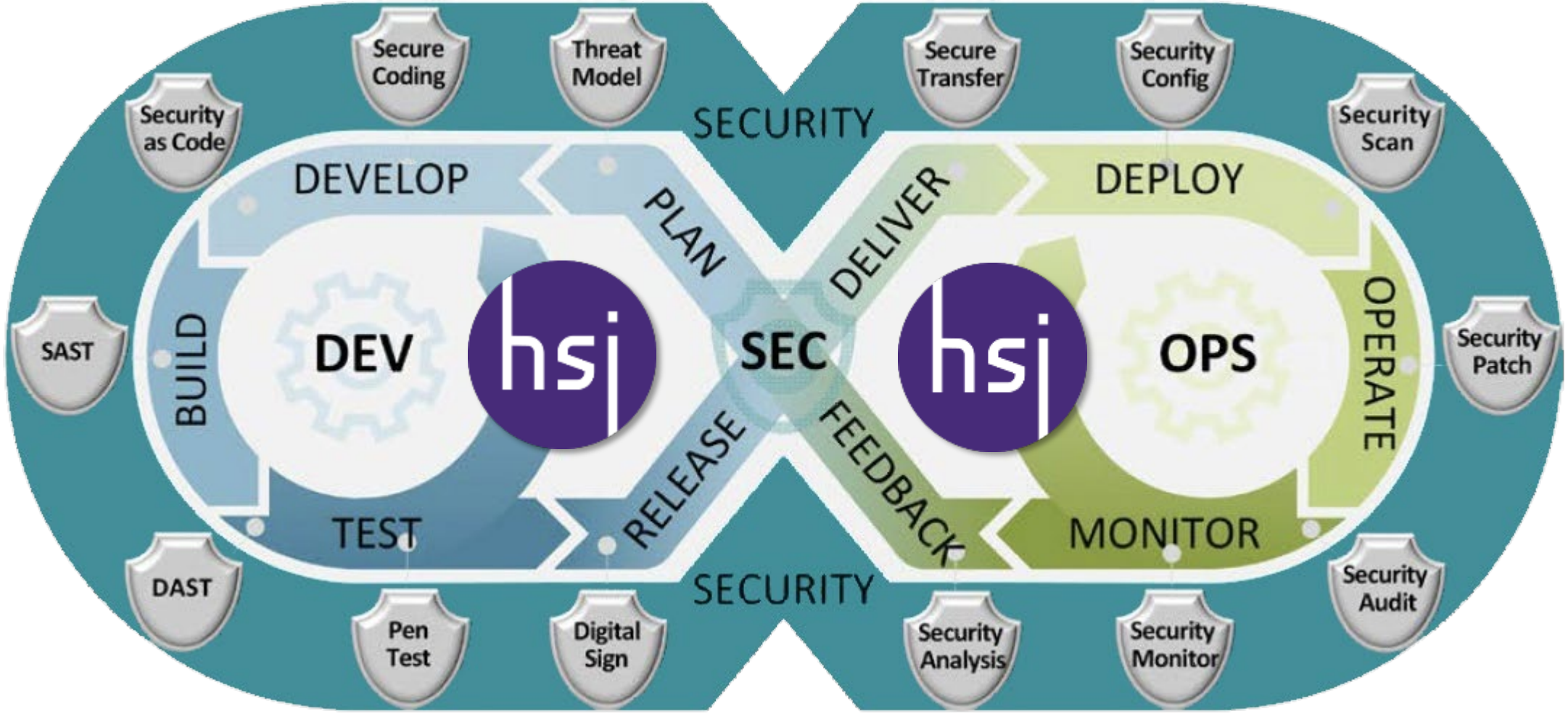
HSI Application in FRACAS Data



Human Performance → HSI Acquisition Translation Model



HSI in the DevSecOps Process



Apply Human Factors Engineering Early in Acquisition

During the design phase, program engineers use computer-aided design (CAD) drawings to investigate form and fit considerations. Engineering design changes may be accomplished early in the design process using modeling to accommodate all users. Users visualize potential solutions in a 3-dimensional (3D), CAD environment to understand human factors design solutions and trade-space opportunities.

Apply Human Factors Engineering (HFE) Early in Acquisition

Proposed solutions based on CAD modeling efforts can be prototyped and tested using “mockups” to inform other HFE design considerations.

Apply Human Factors Engineering Early in Acquisition

Designers compare results of the CAD process (i.e., a prototype “mockup”) and identify meeting requirements to conduct a validation effort through an iterative approach.

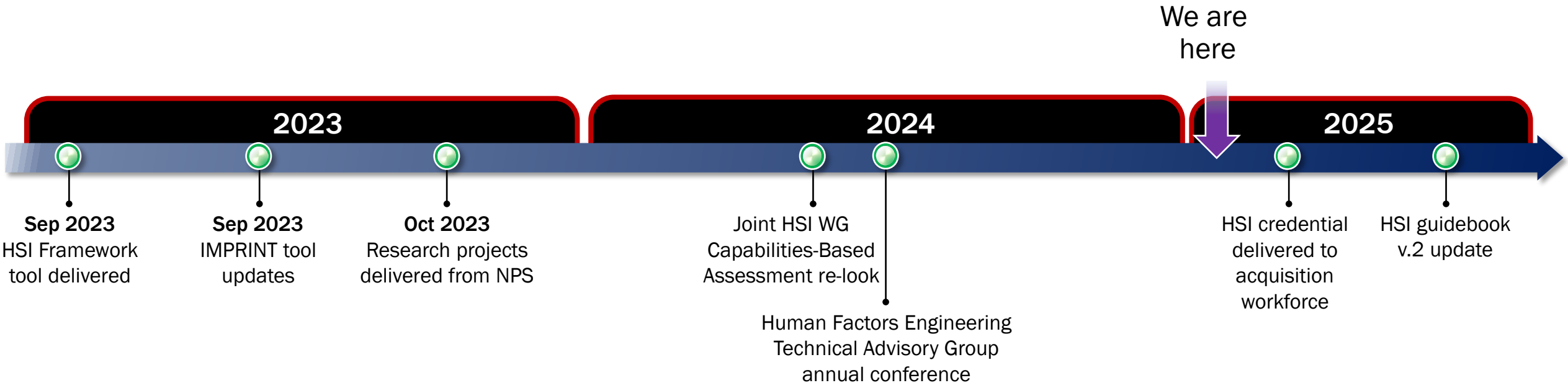
Maintenance considerations can be analyzed before a final design is fielded to ensure maintainers may more easily perform required tasks, which may inform effects on expected operations and sustainment costs.

Future of the HSI CBA in 2025

- **Evolving HSI challenge areas**
  - Lack of decision-maker **awareness and appreciation** of HSI contributions
  - Lack of **metrics** for return of investment (Program and Enterprise-wide)
  - Lack of properly **trained personnel** who claim to be HSI subject matter experts
  - Lack of **digital** data to build human-model behavior into model-based systems engineering
  - Lack of HSI **maturity metrics**
  - Continue to support HSI **workforce development** and understand role in the Engineering and Technical Management competency

Path Ahead

Future Roadmap for Human Systems Integration



Contact

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Questions?

POCs

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BACK-UP

HSI Domain Primer Sheet

Human Factors Engineering domain

The application of knowledge about human capabilities and limitations to system or equipment design and development to achieve efficient, effective, and safe system performance at minimum cost and manpower, skill, and training demands.

Personnel domain

The human aptitudes (i.e., cognitive, physical, and sensory capabilities); knowledge, skills, abilities; and experience levels needed to properly perform job tasks and required to train, operate, maintain, and sustain materiel and information systems.

Manpower domain

Total number of personnel or positions required to perform specific tasks. Indexed by requirements including jobs lists, slots, or billets characterized by descriptions of the people required to fill them and the number of people required to operate, maintain, train, and support a system.

Habitability domain

The consideration of the characteristics of systems focused on satisfying personnel needs that are dependent upon physical environment, such as berthing and hygiene.

Training domain

The policy, processes and techniques, training aids, devices, simulators and simulations, planning, and provisioning for the training, to include equipment used to train personnel to operate, maintain, and support a system.

Safety & Occupational Health domain

The characteristics of system design that can:

- Minimize the risk of acute or chronic illness, disability, injury or death to the operator or maintainers.
- Enhance the human performance and productivity of personnel who operate, maintain, or support the system in the intended operational environment.

Force Protection & Survivability domain

The characteristics of a system that can:

- Reduce fratricide, detectability, and probability of being attacked.
- Minimize system damage and soldier injury.