



Defense Acquisition University

DAU Lunch and Learn

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Types of Testing

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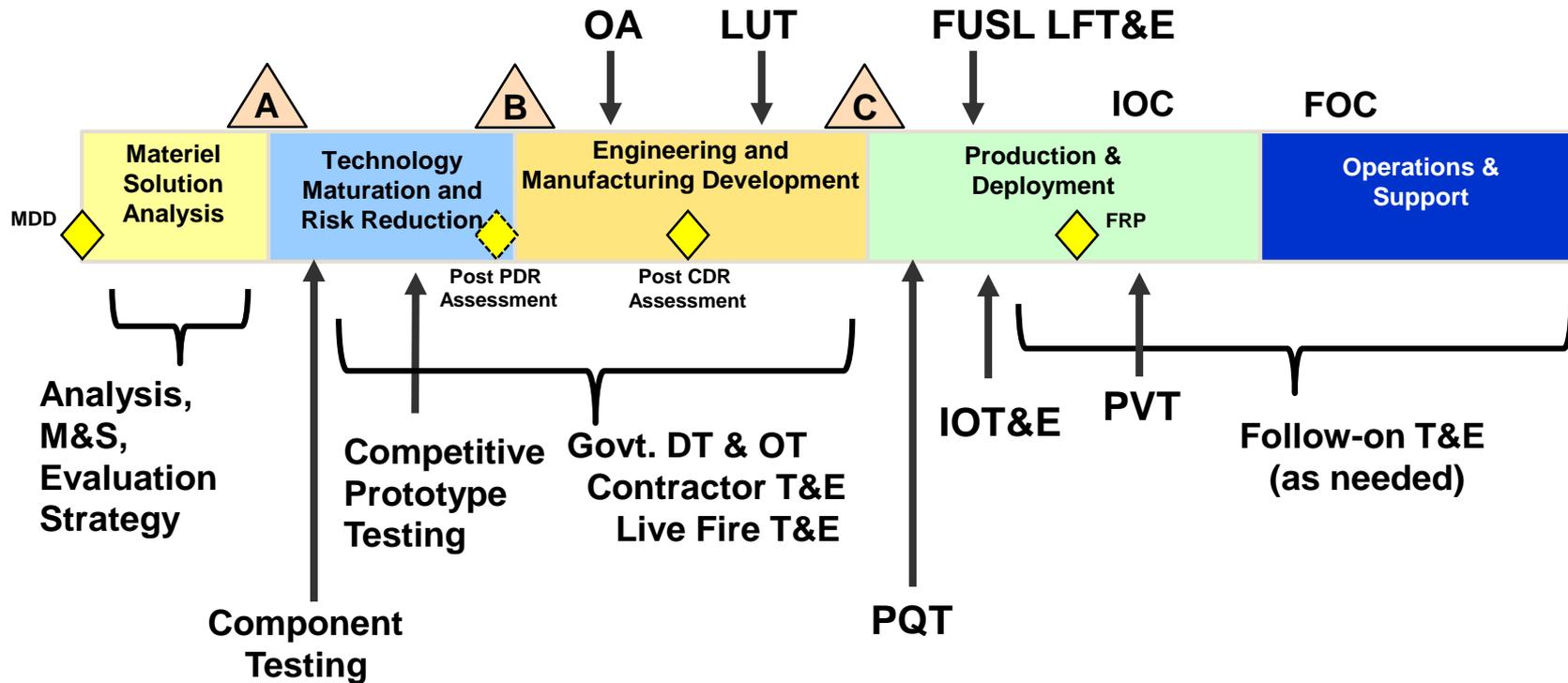
Purpose of Testing

- “Program managers use DT&E activities to manage and mitigate risks during development, to verify that products are compliant with contractual and operational requirements, and to inform decision makers throughout the program life cycle.” *
- “T&E provides engineers and decision-makers with knowledge to assist in managing risks, to measure technical progress, and to characterize operational effectiveness, suitability, and survivability.” **

* DoDI 5000.02, January 7, 2015 Encl 4 Para 2.a.

** DoDI 5000.02, January 7, 2015 Encl 5 Para 1.a.

T&E in the Acquisition Lifecycle



OA = Operational Assessment
LUT = Limited User Test
PQT = Production Qualification Test
PVT = Production Verification Test
IOT&E = Initial Operational Test and Evaluation
OER = Op. Test. Activity Evaluation Report
FUSL LFT&E = Full up System Level Live Fire T&E

Types of Testing

- **Developmental Testing**
 - **Government DT**
 - **Contractor DT**
 - **Inspection**
 - **Analysis (includes modeling and simulation)**
 - **Demonstration**
 - **Test**
- **Operational Testing**
- **Live Fire Testing**
- **Combined/Integrated DT/OT**
- **Others**
 - **Experiments**
 - **Demonstrations**
 - **Modeling and Simulation**

Before we begin testing...

- **Developmental Evaluation Framework**
 - New in the DoDI 5000.02 as of January 2015
 - Identify key data assessing progress toward achieving: key performance parameters, critical technical parameters, key system attributes, interoperability requirements, cybersecurity requirements, reliability growth, maintainability attributes, developmental test objectives, and others as needed.
 - Show the correlation and mapping between test events, key resources, and the decision supported.



DoDI 5000.02 DEF Direction



Department of Defense INSTRUCTION

NUMBER 5000.02
January 7, 2015

USD(AT&L)

SUBJECT: Operation of the Defense Acquisition System

References: See References

1. PURPOSE This instruction:

a. In accordance with the authority in DoD interim DoD Instruction 5000.02 (Reference (b)), management of all acquisition programs in accordance with Office of Management and Budget Circular A-11 (Reference (c)).

b. Authorizes Milestone Decision Authorities (MDAs) to use and acquisition procedures in this instruction to more efficiently, consistent with statutory requirements and Reference (a).

2. APPLICABILITY This instruction applies to OSD, the Military and Security Service Component, the Chairman of the Joint Chiefs of Staff and the Joint Staff, the Office of the Inspector General of the Department of Defense, the Field Activities, and all other organizational entities within the DoD this instruction as the "DoD Components").

3. POLICY The overarching management principles and mandates of the Defense Acquisition System are described in Reference (a). This instruction contains detailed procedures that guide the operation of the system.

4. RESPONSIBILITIES

a. Defense Acquisition Executive (DAE). The DAE is the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)). The DAE will act as the MDA for Major Defense Acquisition Programs (MDAPs) and Major Automated Information System (MAIS) programs. In accordance with Table 1 in Enclosure 1 of this instruction, the DAE may

Describe a *developmental evaluation methodology* in the *TEMP starting at Milestone A* that will provide essential information on programmatic and technical risks as well as *information for major programmatic decisions*. Starting at Milestone B, the developmental evaluation methodology will *include a developmental evaluation framework to identify key data that will contribute to assessing* progress toward achieving: KPP, CTP, KSA, interoperability requirements, cybersecurity requirements, reliability growth, maintainability attributes, developmental test objectives... the developmental evaluation framework will show the *correlation and mapping between test events, key resources, and the decision supported*.

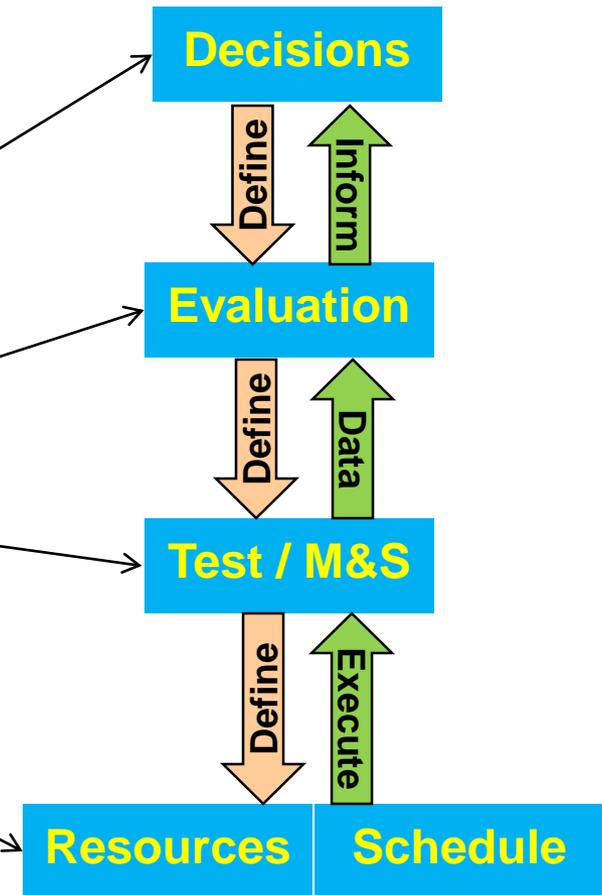


DT&E Strategy Overview



Articulate a logical *evaluation* strategy that informs decisions

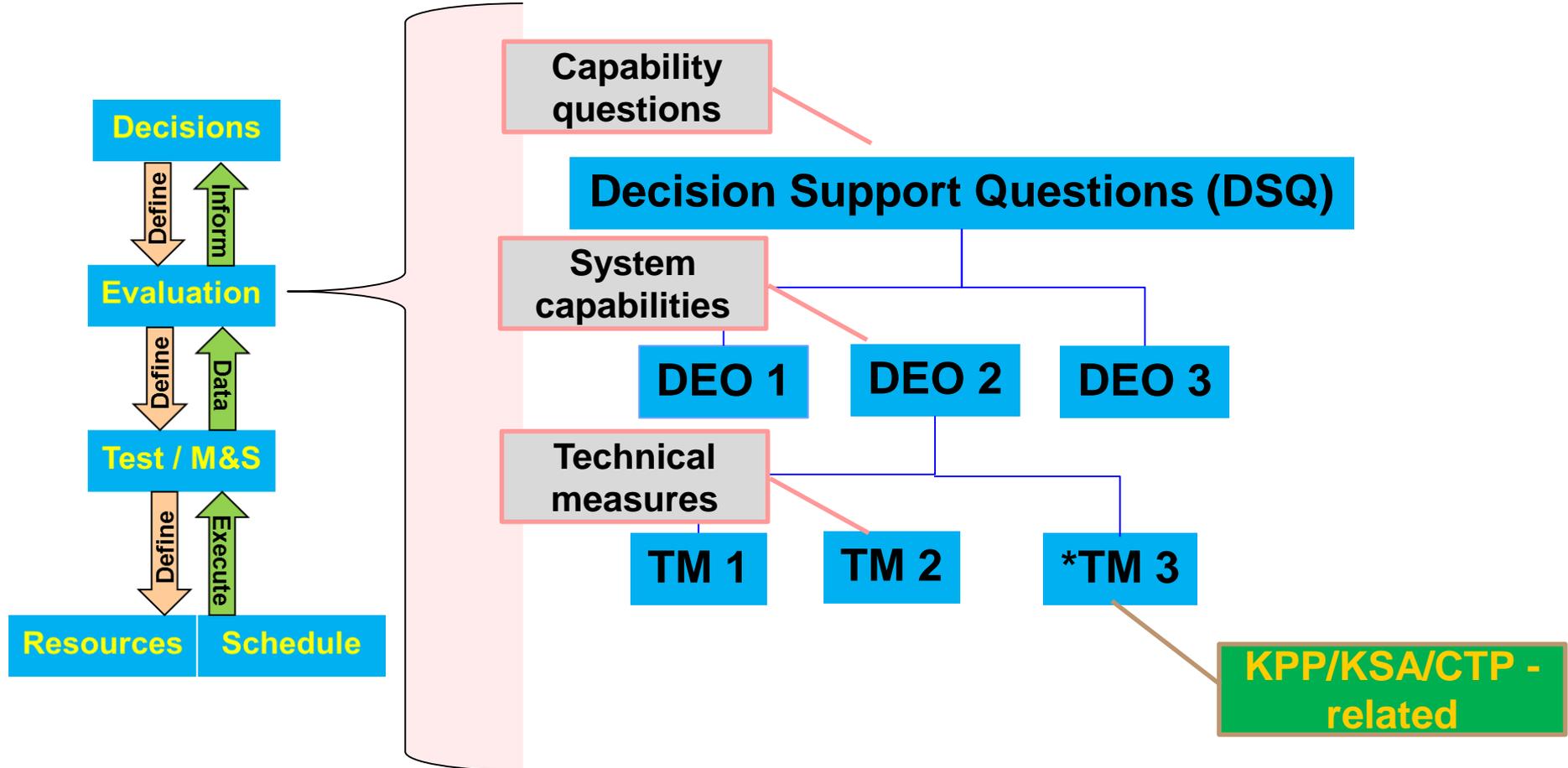
- How acquisition, programmatic, technical and operational decisions will be *informed* by evaluation
- How system will be *evaluated*
- How test and M&S events will provide *data* for evaluation
- What *resources* are required to execute test, conduct evaluation, and inform decisions



DT&E story thread: decision – evaluation– test & resources



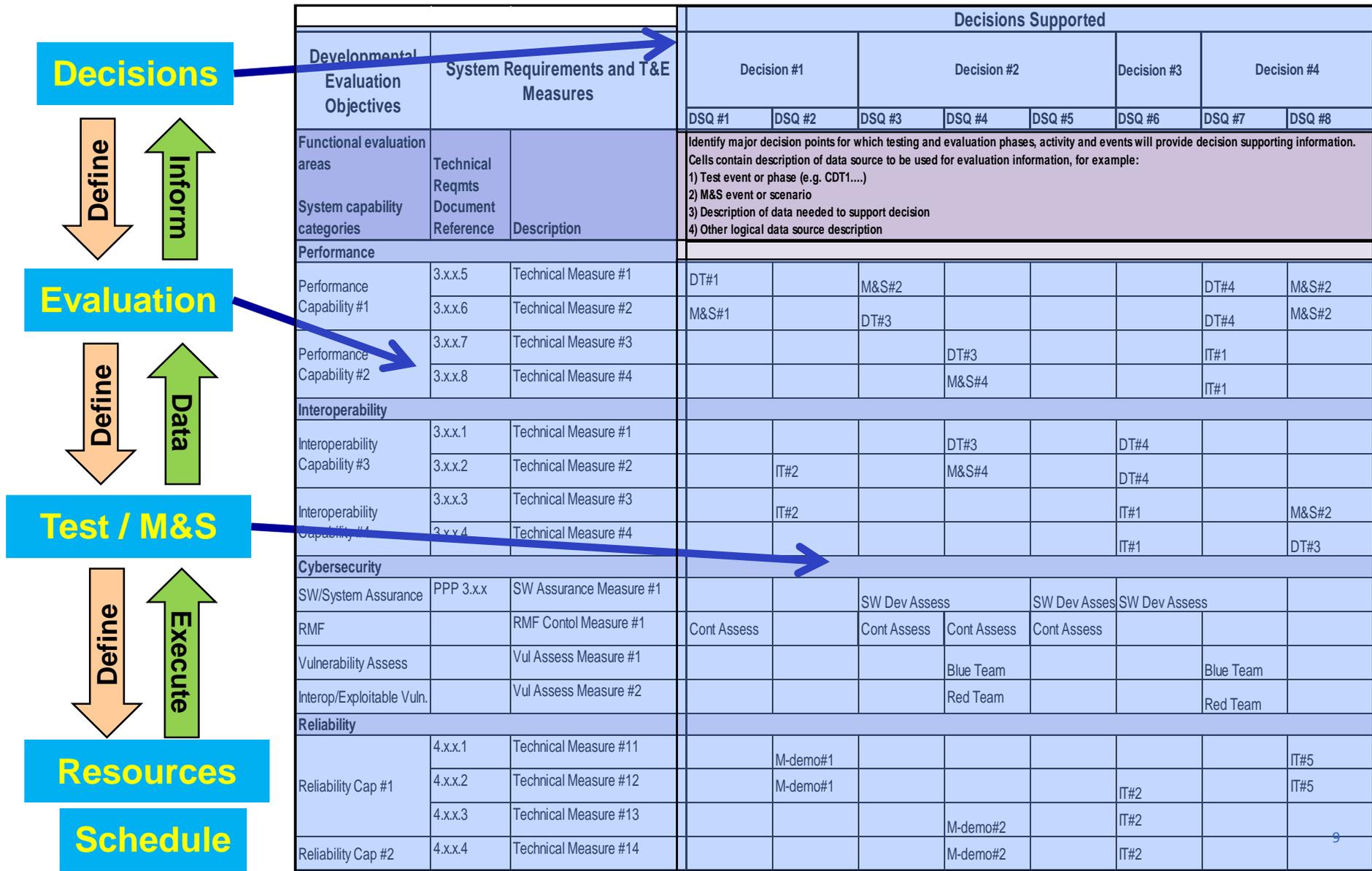
Developmental Evaluation Framework (DEF)



**System Engineering decomposition:
Evaluate system capability - Inform decisions**



Developmental Evaluation Framework





Core Team Overview: Assist Chief Developmental Tester in Applying DEF to Programs



- DASD(DT&E)-facilitated DEF Core Team
 - Small, focused group of SE, T&E and program acquisition SMEs
 - Program Manager, Chief Engineer, Chief Developmental Tester, Lead Developmental Test & Evaluation Organization lead,
 - Provide acquisition strategy and capability/requirements SME
 - DASD(DT&E) deploys to program office location, at no cost to program, to build DEF
 - Develop DT&E strategy by facilitated discussion
 - Decisions Supported – Key program decisions needing T&E generated knowledge to inform them
 - Decision Support Questions (DSQ) - Questions related to performance, reliability, cybersecurity or interoperability that when answered provide T&E information to decision-makers
 - Developmental Evaluation Objectives (DEO) – system capability categories
 - Technical Measures (TM) – “inch deep-mile wide” quantification of capabilities
 - T&E and M&S events – data generators for system evaluation



Questions & Additional Information



Please contact DASD(DT&E) DEF Technical Lead:

**Dr. Suzanne Beers
sbeers@mitre.org**

Before we begin testing...

- **Operational Evaluation Framework**
 - Describe the overall evaluation approach focusing on key decisions in the system lifecycle and addressing key system risks, program unique Critical Operational Issues (COIs) or Critical Operational Issue Criteria (COIC), and Critical Technical Parameters (CTPs)
 - Development of the system and processes (include maturation of system design)
 - *System performance in the mission context*
 - Operational Test Agency (OTA) independent assessments and evaluations
 - Survivability and/or lethality
 - Comparison with existing capabilities, and Maturation of highest risk technologies
 - Reliability Growth
 - Design of Experiments

Integrated Evaluation Framework

Figure 3.1, Top-Level Evaluation Framework Matrix

Key Requirements and T&E Measures				Test Methodologies/Key Resources (M&S, SIL, MF, ISTF, HITL, OAR)	Decision Supported
Key Reqs	COIs	Key MOEs/ MOSs	CTPs & Threshold		
KPP#1:	COI #1. Is the XXX effective for...	MOE 1.1.	Engine thrust	Chamber measurement Observation of performance profiles OAR	PDR CDR
	COI #2. Is the XXX suitable for...		Data upload time	Component level replication Stress and Spike testing in SIL	PDR CDR
	COI #3. Can the XXX be...	MOS 2.1.			
		MOE 1.3.			
		MOE 1.4.	Reliability based on growth curve	Component level stress testing Sample performance on growth curve Sample performance with M&S augmentation	PDR CDR MS-C
KPP #2		MOS 2.4.	Data link		MS-C SRR
KPP #3	COI #4. Is training....	MOE 1.2.		Observation and Survey	MS-C FRP
KSA #3.a	COI #5. Documentation	MOS 2.5.			MS-C FRP

Reliability Growth
[General Guidance](#)
[Ship-Specific Guidance](#)
[Example for Figure 3.1](#)

Differences in Test Conduct

DT&E

- Technical in nature
- Controlled environment
- Specification achieved?
- Technical personnel
- “Tweaked System”

OT&E

- Performance oriented
- Realistic, operational environment
- Operationally effective & suitable? (IOTE specific)
- Typical users & maintainers
- Configuration fixed

Differences in Scope of Tests

DT&E

- **Single system**
- **Component through system level testing**
- **May include operators and/or user**

OT&E

- **Production representative system (IOTE), including operators (users) & logistics support**

Differences in Measurements & Frequency

DT&E

- **Technical in nature**
- **Controlled environment**
- **Specification achieved?**
- **Technical personnel**
- **“Tweaked System”**

OT&E

- **Performance oriented**
- **Realistic, operational environment**
- **Operationally effective & suitable? (IOTE specific)**
- **Typical users & maintainers**
- **Configuration fixed**

Developmental Testing



- **Developmental Test and Evaluation activities verify conformance of tested items against their technical requirements. They include the following:**
 - **Part and component qualification testing**
 - **Environmental testing**
 - **Integration testing**
 - **Subsystem testing**
 - **Interoperability testing**
 - **Supportability Testing**
 - **Full scale system test**
 - **Live Fire testing (Lethality, Vulnerability, Survivability)**
 - **Production Verification Test**
 - **First Article Test**
 - **Acceptance tests**
 - **Follow-on DT&E**

Characteristics of Developmental Test

- **Conducted under exacting constraints to diminish the effects of external conditions**
- **Provides answers to specific technical questions**
- **Driven by the specification**
- **Conducted on ranges or in labs by experts**

- **Build the RFP**
 - **Spec (Verification)**
 - **SOW**
 - **Data**

T&E Support to RFP

- **All important T&E management processes & tasks should be included in the RFP, such as:**
 - Decision analysis, T&E planning, assessment, test plans & reports, data requirements, risk & configuration mgmt.
 - A checklist (all T&E tasks, products, etc.) is useful during SOW evaluation to ensure completeness
- **The primary theme to remember:**
 - If a T&E item or requirement is not in the SOW, it probably won't be in the RFP
 - If it isn't in the RFP, it probably won't be in the contract
 - If it isn't in the contract, *don't expect to get it!*

RFP T&E Content

The RFP should describe the following (as applicable):

- **Overall T&E management structure, responsibilities, experience of T&E staff, and application of T&E best practices.**
- **The contractor's approach to technical data, including management, control, access, and delivery of T&E data.**
- **M&S responsibilities, expectations, and M&S tools.**
- **The approach and procedures to perform RAM.**
- **The contractor's IA/CyberSecurity responsibilities.**
- **T&E planning and resources, including the change management process for updates to test plans and test assets; and required Government and contractor test resources.**
- **Software T&E, including contractor & Govt. responsibilities during test execution; and the process for contractor (Deficiency Report) DR and resolution.**

SE Activities: Develop System Spec

- **Content:**

- Administrative information
- Six sections
 - Scope
 - Applicable documents
 - Requirements
 - **Verification**
 - Packaging
 - Notes
- Concluding material
- **PRODUCT oriented!**

- **Use and Preparation:**

- MIL-STD-961E: Specifications
- MIL-STD-962D: Standards



The spec is **PRODUCT**
Oriented



The system shall attain
a top speed of 190 miles
per hour

<https://assist.dla.mil/online/start/>

<http://quicksearch.dla.mil/>

http://www.assistdocs.com/search/search_basic.cfm ***

Verification

- **Verification Methods (MIL-STD-961E)**
 - **Analysis** - uses established technical or mathematical models or simulations, algorithms, charts, graphs, circuit diagrams, or other scientific principles and procedures to provide evidence that stated requirements were met.
 - **Demonstration** - actual operation of an item to provide evidence that the required functions were accomplished under specific scenarios.
 - **Inspection** – the examination of supplies and services to determine whether they conform to specified requirements.
 - **Testing** – scientific principles and procedures are applied to determine the properties or functional capabilities of items.
- **Refer to 3.13.1 of Incorporating T&E into DOD Acquisition Contracts for guidance** – “The offeror must supply more than a simple table indicating the method of verification (analysis, inspection, simulation, test, or demonstration).”

Statement of Work

- Reference MIL-HDBK-245D 3 APRIL 1996
- Specifies in clear, understandable terms the **work to be done** in developing or producing the goods to be delivered or services to be performed by a contractor.



The SOW is PROCESS Oriented

The CDRL

- **Exhibit A (CDRL)**
 - **Ensure content covers everything you want the contractor to deliver, because if you don't get this right, nothing else matters!**
 - **Identify whether each CDRL item requires delivery of technical data, computer software, both, or neither (e.g., IMS, CPR)**



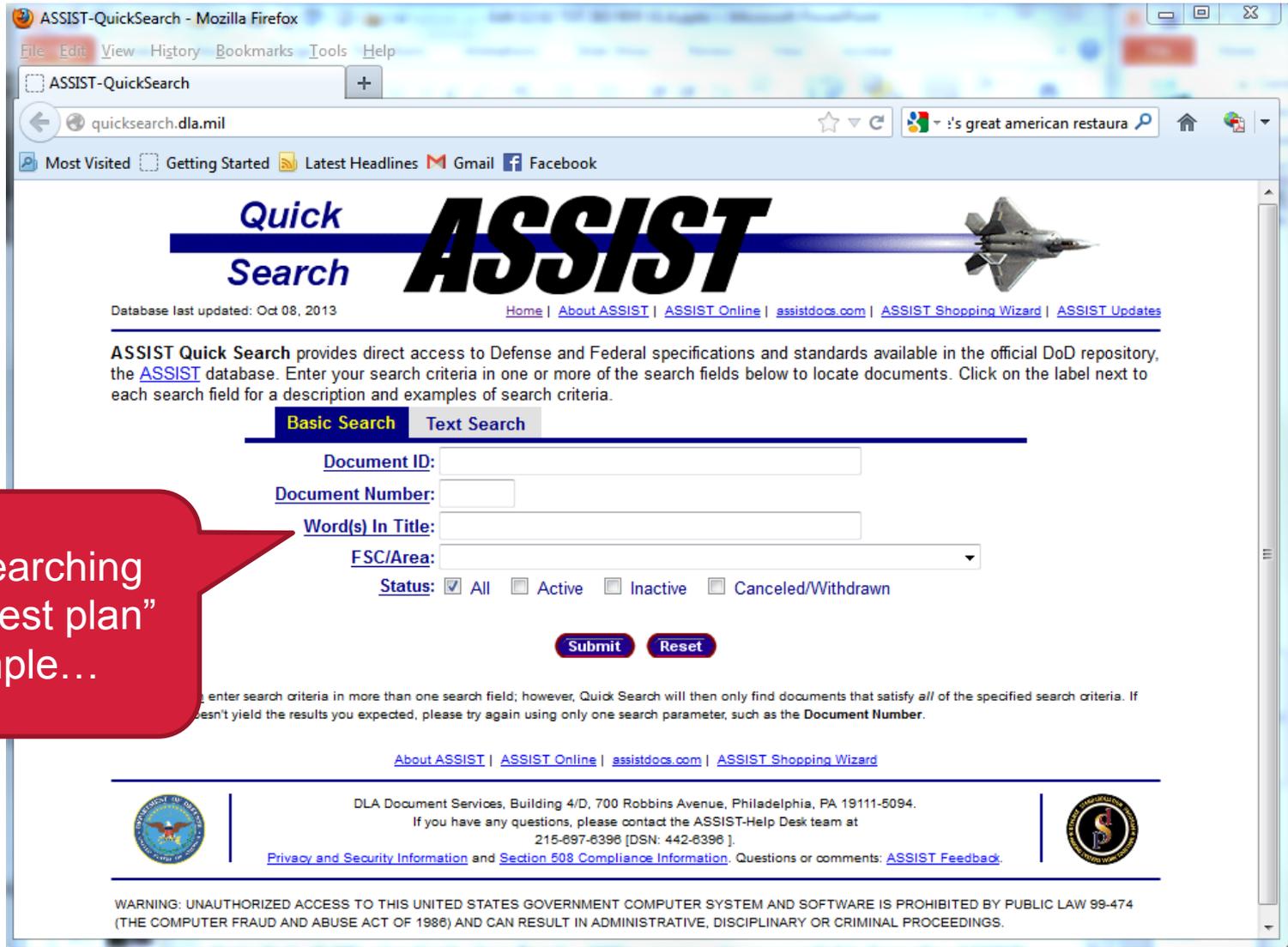


Data Item Descriptions (DIDs)

- **DIDs describe data to be acquired from contractors**
 - description and purpose for the data
 - Application
 - The office of primary responsibility
 - Preparation instructions that can include both format and content requirements.
- **DIDs may be tailored to fit unique program needs by excluding paragraphs/sections so that each DID invoked states only the minimum Government requirements**
 - DIDs may only be tailored downward - can not add requirements to a DID
- **Data Item Descriptions (DIDs) are now prepared on plain paper IAW MIL-STD-963B**
 - Many older DIDs are recorded on DD Form 1664

Searching for DIDs

http://www.assistdocs.com/search/search_basic.cfm



The screenshot shows the ASSIST Quick Search interface. The browser title is "ASSIST-QuickSearch - Mozilla Firefox" and the address bar shows "quicksearch.dla.mil". The page features a large "Quick Search ASSIST" header with a fighter jet graphic. Below the header, it states "Database last updated: Oct 08, 2013" and provides navigation links: Home, About ASSIST, ASSIST Online, assistdocs.com, ASSIST Shopping Wizard, and ASSIST Updates. The main content area explains that ASSIST Quick Search provides direct access to Defense and Federal specifications and standards available in the official DoD repository, the ASSIST database. It instructs users to enter search criteria in one or more of the search fields below to locate documents. There are two tabs: "Basic Search" (selected) and "Text Search". The search fields include: Document ID, Document Number, Word(s) In Title, and FSC/Area (a dropdown menu). The Status section has checkboxes for All (checked), Active, Inactive, and Canceled/Withdrawn. There are "Submit" and "Reset" buttons. A note below the buttons states: "You may enter search criteria in more than one search field; however, Quick Search will then only find documents that satisfy all of the specified search criteria. If you don't yield the results you expected, please try again using only one search parameter, such as the Document Number." At the bottom, there are links for About ASSIST, ASSIST Online, assistdocs.com, and ASSIST Shopping Wizard. The footer contains the DLA Document Services address (Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094), contact information (215-697-8398 [DSN: 442-8398]), and links for Privacy and Security Information, Section 508 Compliance Information, and ASSIST Feedback. A warning at the very bottom states: "WARNING: UNAUTHORIZED ACCESS TO THIS UNITED STATES GOVERNMENT COMPUTER SYSTEM AND SOFTWARE IS PROHIBITED BY PUBLIC LAW 99-474 (THE COMPUTER FRAUD AND ABUSE ACT OF 1986) AND CAN RESULT IN ADMINISTRATIVE, DISCIPLINARY OR CRIMINAL PROCEEDINGS."

Suggest searching here. Try "test plan" for example...

Developmental Testing

- **Does the system meet the specification?**
- **Did we build it right?**
- **Was the end product realized?**
- **Did we get what we paid for?**
- **Are we ready for OT?**

**Mission Success NOT
Guaranteed!**

Operational Testing



Operational Test

- **Production Representative Test Articles**
- **“Typical” Users and Maintainers**
- **Realistic/validated threat**
- **Operational Environment**
- **CONOPS**

Initial Operational Test

- **Initial operational test (IOT) - The dedicated field test, under realistic combat conditions to determine operational effectiveness, suitability, and survivability.**
 - IOT is conducted on production or production-representative items operated by typical users under realistic conditions (such as combat and representative threat).
- **Section 2399, title 10, U.S. Code, requires initial operational test and evaluation (IOT&E) before a major defense acquisition program proceeds beyond LRIP.**
- **The system evaluation in support of the FRP decision review will use data resulting from the IOT (when conducted), as a major data source integrated with other credible data sources as defined in the System Evaluation Plan.**

Live Fire Testing



10 U.S. Code § 2366 - Major systems and munitions programs: survivability testing and lethality testing required before full-scale production

Live Fire testing (Lethality, Vulnerability, Survivability)

- **Testing of “covered” weapon system performance under combat conditions**
- **Lethality: Can the “covered” weapon system defeat the stated threat under combat conditions?**
- **Vulnerability: Is the “covered” weapon system vulnerable to defeat by the stated threat?**
- **Survivability: In the event of damage to the “covered” weapon system, are provisions made to minimize the possibility of crew injury or death?**

- **Definition of integrated testing: Integrated testing is the collaborative planning and collaborative execution of test phases and events to provide shared data in support of independent analysis, evaluation and reporting by all stakeholders; particularly the developmental (both contractor and government) and operational test and evaluation communities. (April 25, 2008 Memo, signed by DOT&E and DUSD(A&T))**
- **T&E shall be conducted in an appropriate continuum of live, virtual, and constructive system and operational environments. Developmental and operational test activities shall be integrated and seamless throughout the EMD phase. (DoDI 5000.02, Paragraph 6d(6))**

Combined vs. Concurrent Testing

- **Combined Testing – A single event that produces data to answer developmental and operational system issues. For the case where a single phase can be used to simultaneously meet developmental and operational issues, this testing will be referred to as Integrated DT/OT. (Extracted from AR 73-1 Glossary Definition)**
- **Concurrent Testing – DT and OT take place at the same time as two parallel, but separate & distinct, activities (Extracted from Jan 2005 ed of DAU T&E Management Guide, Section 9.1)**

Benefits of Integrated Testing

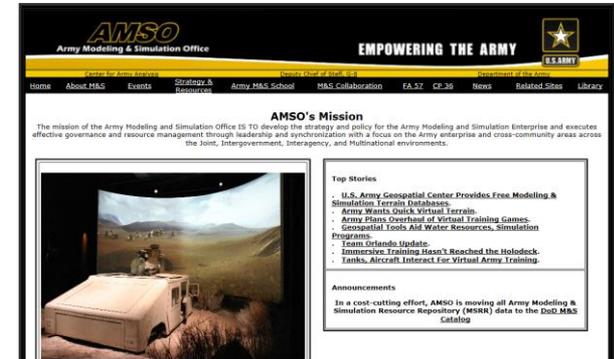
- **Benefits of combined or integrated testing a.k.a. Combined DT/OT:**
 - **May achieve greater test efficiency, reduced cost, and schedule & resource savings**
 - **Combines test requirements, test events, and test processes & products where possible; seeks to eliminate duplication of effort**
 - **Earlier OTA involvement increases OTA familiarity with the system, and can also increase the likelihood of successful IOT&E**
 - **Use of contractor data (where possible) may lead to even greater cost & schedule savings**
 - **Expanded use of M&S may lead to even greater cost & schedule savings**

- **Risks / limitations of combined or integrated testing:**
 - It is difficult to design tests to meet both DT and OT requirements - Need to ensure the objectives & needs of the participating test organizations are not compromised
 - Requires extensive, early coordination
 - Need to ensure full collaboration & mutual support of the involved organizations / test organizations
 - Use of contractor data adds more risk. (Government should verify contractor test conditions, test results, conclusions, etc., if possible)
 - Expanded use of M&S adds more risk (may NOT achieve cost & schedule savings, and may NOT achieve desired results)

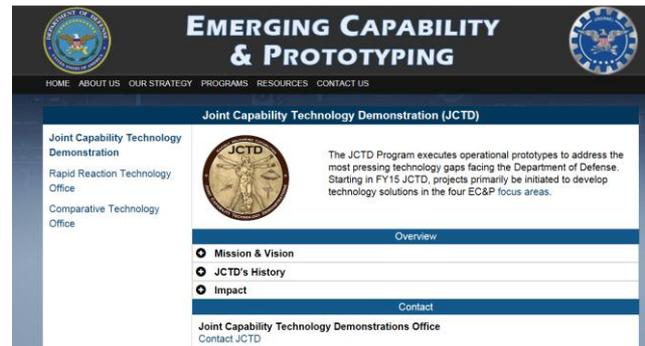
Other forms of “test”



Experiments



Modeling and Simulation



Demonstrations

Questions?

V/R



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**Operational Testing... "Where The Truth And Future Come
Together." US Army TEXCOM motto, mid 1990s.**



DT&E Versus OT&E

- **DT&E**
 - Does it meet the specification?
 - Did we build it right?
 - Was the end product realized?

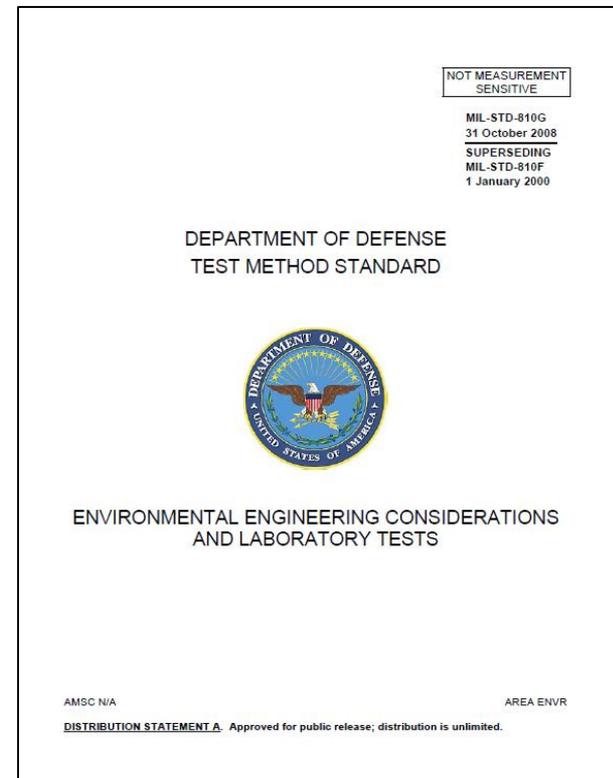
- **OT&E**
 - Does it meet the users needs?
 - Did we build the right thing?
 - Was the right product realized?
 - Are the KPP's, MOE's and MOS's satisfied?

Part and component qualification testing

- **Ensure that components meet technical performance requirements**
- **Examples: Structural static and dynamic test of rotor system dynamic components or rocket motor components;**

Environmental testing

- **Testing to ensure successful operation of the system within its expected environment:**
 - **Heat/Cold**
 - **Vibration**
 - **Electromagnetic**
 - **Sand/Dust**
 - **Humidity/Rain**
 - **MIL-STD-810G**



Integration Testing

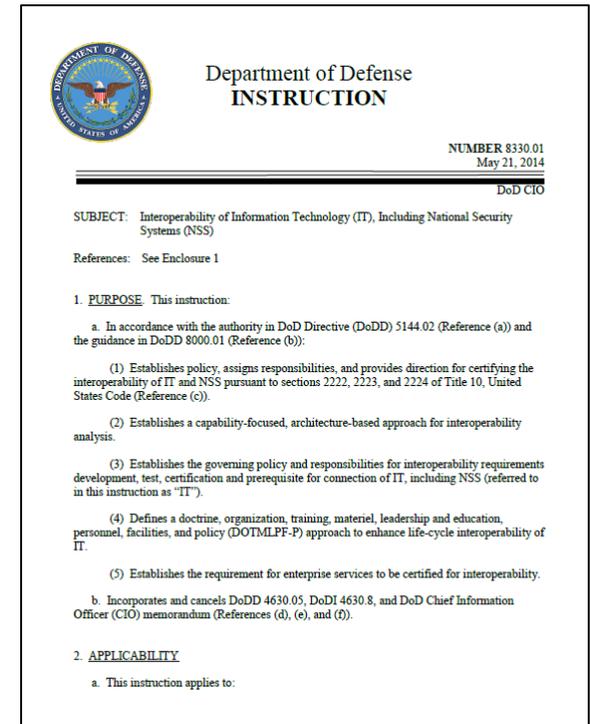
- **Integration Testing – Testing in which software and/or hardware components are combined and tested progressively until the entire system has been integrated**
- **Risks in integrating components built by different vendors:**
 - **Poor system performance & reliability (middleware and/or adaptors are sometimes needed, to obtain adequate performance)**
 - **If integration problems occur, it can be expensive and/or cause schedule delays to fix the problems**
 - **It can be difficult to determine (based on test results) whether the problem is in the interface, or in the components**
 - **It may be more difficult to define the test methodology**

Subsystem testing

- **Performance testing of a subset of a major system to develop capability and ensure proper operation.**
 - **Rocket motor performance testing**
 - **Bench testing of aircraft flight controls system**
 - **Bench testing of electrical power generation and distribution system**
 - **Bench testing of hydraulic systems**
 - **Bench testing of mechanical drive systems**

Interoperability testing

- **Testing to ensure interoperability with all systems within the modern electronic communications environment**
 - **Digital and voice communications networks**
 - **SATCOM**
 - **Intraservice and across DOD**
 - **DODI 8330.01**



Supportability Testing

- **Testing to ensure the system meets reliability requirements and is supportable within the service's maintenance system**
- **Conducted using “green suit” maintainers to the extent practicable**
 - **Maintainability**
 - **Reliability**
 - **Testing of maintenance training**
 - **Verification and validation of maintenance manuals**

Full scale system test

- **Technical performance testing of the full system**
- **Verification of performance to specification requirements**

Production Verification Test (PVT)

- ***Production Verification Tests (PVT) are system-level tests conducted to verify that the production item meets CTPs & contract specifications, to determine the adequacy and timeliness of any corrective action indicated by previous (pre-FRP) tests, and to validate manufacturer's facilities, procedures, and processes.***
- **A PVT also provides a baseline for the test requirements in the technical data package, for post-production T&E.**
- **The PVT is accomplished during the first limited production or full-scale production contract.**
- **The PVT may include tests that are not included in the data package or contract (for example, environmental extremes and test-to-failure) when necessary to obtain engineering data for corrective action verification, to support a materiel release decision, or to meet another purpose.**

First Article Test (FAT)

- **The First Article Test may be required for quality assurance purposes to qualify a new manufacturer or procurements from a previous source out of production for an extended period (usually 2 years) and to produce assemblies, components, or repair parts conforming to requirements of the technical data package.**
- **Requirements for first-article testing may be invoked in production contracts by citing the applicable FAR first article inspection and approval clause.**
- **First article tests may be conducted at Government facilities or at contractor facilities when observed by the Government.**

Acceptance Tests

- ***Quality conformance (acceptance) inspection.*** This inspection examines and verifies tests that are normally prescribed in the technical data package for performance by the contractor and that are subject to performance or witnessing by the onsite quality assurance representative on the items, lots of items, or services to be offered for acceptance under a contract or purchase order.
- These examinations and tests include, as necessary, in-process and final measurements or comparisons with technical quality characteristics required to verify that the materiel meets all the terms of the contract and should be accepted by the Government.

- **Developmental testing after the system is deployed includes the following:**
 - **Testing to determine the adequacy of corrective action indicated by previous (pre-FRP) testing**
 - **Testing needed for system modifications**
 - **Surveillance and reconditioning tests to measure the ability of the materiel (in the field, in storage, and after maintenance actions) to meet user requirements**
- **Test objectives, functions and responsibilities may be scaled down depending on the number, magnitude and complexity of the modifications being tested.**

- **A system-level DT conducted post-MS C that**
 - **ensures design integrity over the specified operational and environmental range.**
 - **It must be completed using low-rate initial production (LRIP) assets, when available, prior to the FRP decision review**

Early User Test (EUT)

- **The EUT, a generic term, encompasses all system tests employing representative user troops during the MSA and TD phases, or early in the EMD phase.**
- **The EUT may test a materiel concept, support planning for training and logistics, identify interoperability problems, and/or identify future testing requirements.**
- **EUT provides data for the System Evaluation Report (SER) in support of MS B.**

Limited User Test (LUT)

- **The LUT is any type of RDTE funded OT normally conducted during system acquisition, other than the IOT.**
- **The LUT for materiel systems may be conducted to provide a data source for the system evaluation in support of the LRIP decision (MS C) and for reviews conducted before IOT.**
- **The LUT may be conducted to verify fixes to problems discovered in IOT that must be verified prior to the FRP decision review (that is, the fixes are of such importance that verification cannot be deferred to the FOT).**
- **Typical LUT objectives:**
 - **Estimate potential operational effectiveness & suitability**
 - **Examine / assess key risk areas, & COIs that need to be resolved earlier than IOT&E**
 - **Help identify best design; examine operational aspects of system design, adequacy of CONOPS, etc.**
 - **LUTs often support the MS C Review (may also support decisions concerning readiness for IOT&E and/or readiness for production)**

- **OBJECTIVES**
 - **VERIFY SYSTEM CONTINUES TO MEET OPERATIONAL REQUIREMENTS**
 - **EVALUATE LIMITATIONS / CORRECTED DEFICIENCIES**
 - **DEVELOP TACTICS & DOCTRINE**
 - **TRAIN OPERATORS & MAINTAINERS**
- **CONTINUED THROUGHOUT LIFE CYCLE**

OT&E AFTER FRPD