

LESSON SUMMARY

Lesson 18: Test and Evaluation Overview

Why Test and Evaluate?

Information is critical to managing an acquisition program. This includes information on the capabilities and limitations of the system and risks affecting system cost, development schedule, and performance. The overall goal of T&E is to reduce risk by providing crucial information to decision makers.

T&E Mandates

DODD 5000.01 provides principles and policies governing test and evaluation in the Defense Acquisition System.

DODI 5000.02 identifies the flow of the T&E activities within the development process and states that test activities shall be part of a Test and Evaluation strategy to:

- Provide information regarding risk and risk mitigation.
- Provide empirical data to validate models and simulations.
- Permit an assessment of the attainment of technical performance specifications and system maturity.

T&E Customers

These Customers:	Use T&E Information to:
Acquisition Managers	Evaluate the acquisition program for risk management. Determine if system performance meets thresholds. Determine if the system has the potential to meet objectives. Determine the technical changes needed to keep the program on track.

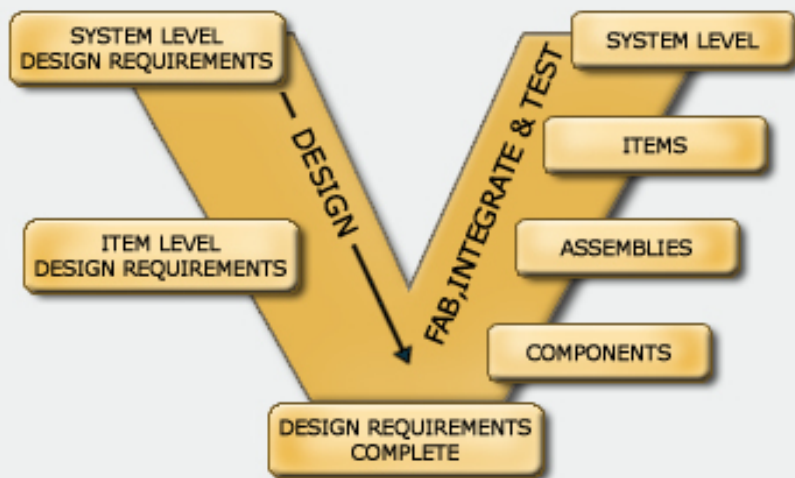
Designers and Engineers	Evaluate system design and performance. Identify if design changes are needed. Provide feedback into Systems Engineering Process. Update modeling and simulation.
End-users	Learn how the system performs under operational conditions. Utilize operational performance characteristics to improve tactics and warfighting capability. Obtain information to help plan for training and logistics support. Understand full performance envelope and capabilities.

Defining Test and Evaluate

TERM	DEFINITION
Test	<p>A program, procedure, or process to obtain, verify, or provide data for determining the degree to which a system (or subsystem) meets, exceeds, or fails to meet its stated requirements. These requirements can be stated in terms of thresholds and objectives. Testing:</p> <ul style="list-style-type: none"> Obtains raw data. Measures specific, individual performance factors (e.g., measuring range). Is resource intensive.
Evaluate	<p>Reviewing, analyzing, and assessing data obtained from testing to project system performance under operational conditions. Evaluating:</p> <ul style="list-style-type: none"> Produces analyzed information from test data, modeling and simulation, or other sources. Draws conclusions by looking at how the factors interact. Is intellectually intensive.

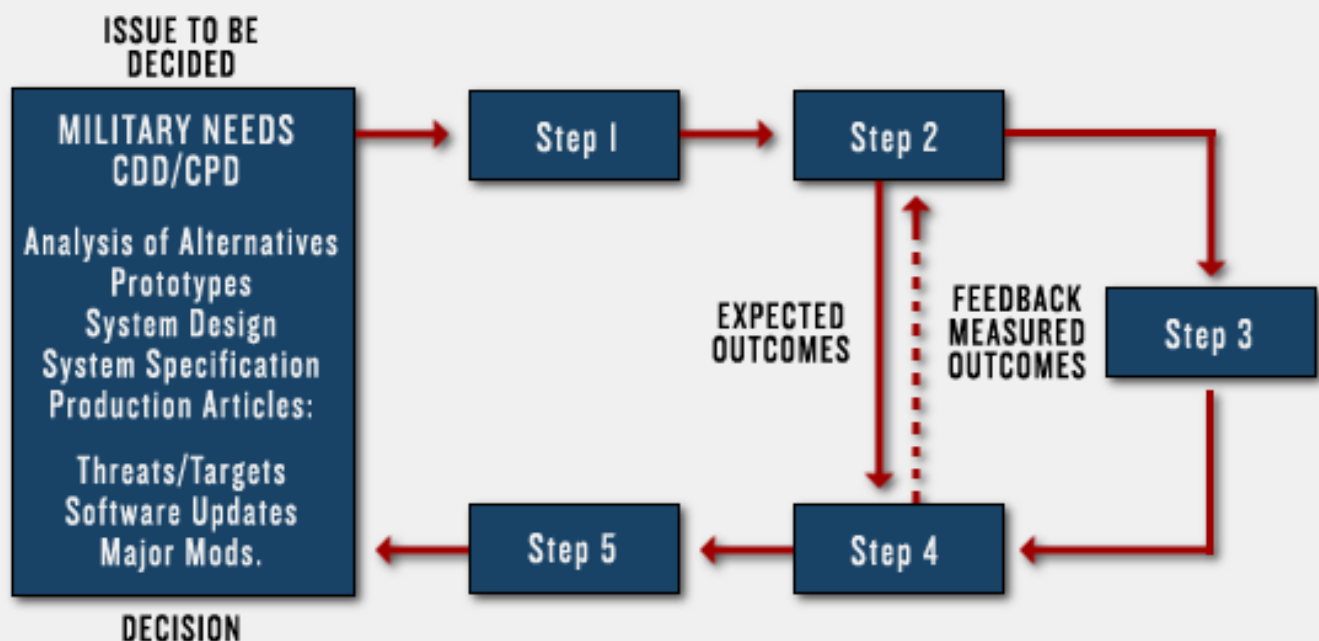
T&E Feedback Loop

T&E is the essential feedback loop contained within the Systems Engineering Process. T&E ensures that the system meets the capability needs. The T&E process is repeated as the system evolves from models to components to production articles and complete systems.



Test and Evaluation Process Overview

The T&E process has five steps that occur as we evaluate important information within the acquisition process.



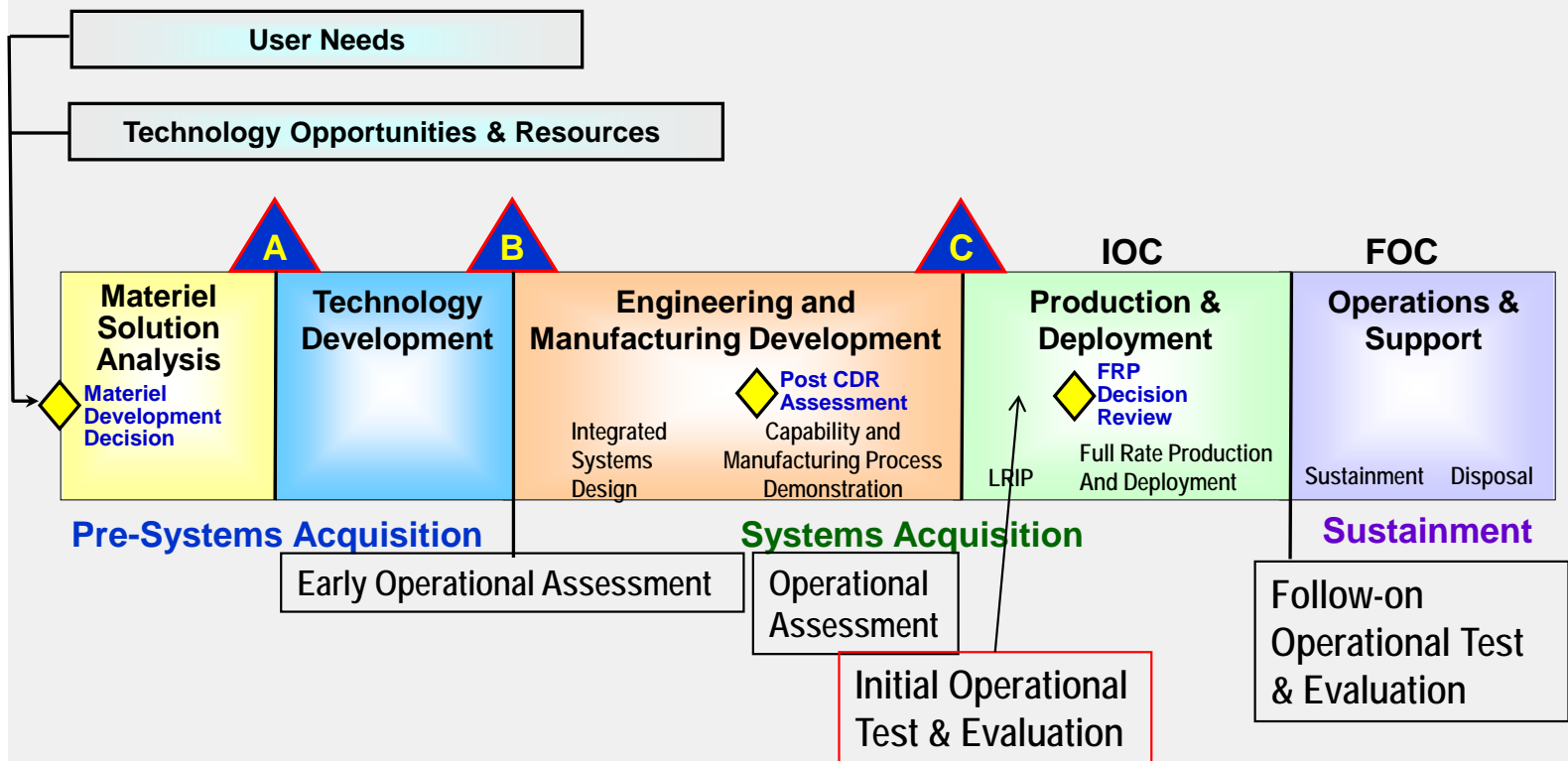
Five Steps in the T&E Process

STEP	DESCRIPTION
1	Identify critical issues and data requirements.
2	Pre-test engineering analysis by the evaluation and the development of an evaluation plan. Expected outcomes are predicted.
3	The test is planned and conducted. Data are retrieved and analyzed. Data may be collected from other means such as Modeling and Simulation (M&S), training, etc.

- 4 A post-synthesis step in which an evaluation report of data is compiled. Predictions from Step 2 are compared with actual measured outcomes.
- 5 T&E results are balanced with other available program information. The appropriate programming decision is made.

T&E and the Acquisition Life Cycle

T&E activities occur throughout the acquisition life cycle. T&E reveals information about a program and measures performance of a system against established capability needs. The PM coordinates T&E activities appropriate to each phase and milestone of an acquisition program.



Pre-Systems Acquisition and Milestone A

The Role of T&E in support of Milestone A:

No actual system testing occurs before Milestone A.

Projects that undergo a Milestone A decision have an evaluation strategy. The evaluation strategy addresses modeling & simulation, including identifying and managing associated risk, and early T&E strategy to evaluate system concepts against mission requirements.

The most promising system concepts are defined in terms of initial, broad objectives and an overall test and evaluation strategy (including Developmental Test and Evaluation (DT&E), Operational Test and Evaluation (OT&E), and, if applicable, Live Fire Test and Evaluation (LFT&E)).

The initial TEMP is developed during the Technology Development Phase. For ACAT I programs, the PM forms the T&E Working-Level Integrated Product Team (WIPT). A T&E WIPT is useful for Pre-Systems Acquisition activities that are likely to become acquisition programs. Immediately upon forming, the T&E WIPT develops an evaluation strategy that describes how the capabilities in the ICD will be evaluated once the system is developed. The evaluation strategy is approved by the Director, Operational Test & Evaluation (DOT&E).

Milestone B and the Engineering and Manufacturing Development & Demonstration Phase

At Milestone B, the MDA:

- Approves the acquisition strategy.
- Approves the acquisition program baseline.
- Approves low-rate initial production quantities (where applicable).
- Approves EMD exit criteria.
- Considers any early operational assessments or test and evaluation results.

The Role of T&E in Milestone B:

At Milestone B or beyond, a Test Evaluation Master Plan (TEMP) is required in lieu of the evaluation strategy. The TEMP focuses on the overall structure, major elements, and objectives of the T&E program. If applicable, the TEMP must contain a mature strategy that commits to full-up, system-level, live fire testing, or a waiver request is submitted and approved for an alternative Live Fire Test & Evaluation (LFT&E) plan. The TEMP is updated at program major decision points, when the program baseline has been breached, when the associated CDD/CPD has been significantly modified, or on other occasions when the program has changed significantly. Evolutionary acquisition programs may require additional updates to ensure that the TEMP reflects the currently defined program. The concept of early and integrated T&E emphasizes testing of prototypes or production representative articles during EMD. Early Operational Assessments may be included as appropriate. Results are reported to the Service Chief by the appropriate operational test activity and used by the MDA in support of decisions. System modeling, simulation, test, and evaluation activities are integrated into an efficient continuum planned and executed by a test and evaluation integrated product team (T&E IPT). Modeling, simulation, and development tests are under the direct responsibility of the PM or a designated test agency.

For ACAT I programs, the DOT&E and the cognizant Overarching Integrated Product Team Leader approve the TEMP (including the LFT&E strategy, if applicable) for all OSD test and evaluation oversight programs.

T&E personnel:

- Determine the testability of the exit criteria.

- Confirm that the phase exit criteria relative to T&E (if any) are met.

- Assist the program office in evaluating top-level system digital models that will be used and refined throughout system development.

Milestone C and the Production & Deployment Phase

At Milestone C the MDA:

- Approves the updated acquisition strategy.

- Approves an updated development acquisition program baseline.

- Approves exit criteria for Low-Rate Initial Production (LRIP) or limited deployment, and the acquisition decision memorandum.

- Reviews production representative article T&E and Operational Assessment results, and the approved TEMP.

The Role of T&E after Milestone C and during the LRIP work effort:

- Conduct Initial Operational Test & Evaluation (IOT&E).

- Conduct Live Fire Test & Evaluation (LFT&E), if applicable.

- Provide evaluation to support Full Rate Production Decision Review (FRPDR).

- Plan Follow-on Operational Test & Evaluation (FOT&E).

The Role of T&E during the Full Rate Production and Deployment work effort:

- Conduct Follow-on Operational Test & Evaluation (FOT&E), as appropriate.

Developmental T&E (DT&E)

DT&E includes the following purposes:

- Identifies technical capabilities and limitations of alternative concepts and design options under consideration.

- Stresses the system to ensure robust design.

- Assesses progress toward meeting critical technical parameters.

- Provides data and analysis to support the decision to certify the system is safe and ready for operational test and evaluation.

Performance and Environmental Factors

DT&E assesses performance under a number of environmental parameters. Listed below are examples of performance factors and environmental factors considered during DT&E.

Performance:

Accuracy
Maneuverability
Interoperability
Material Strength
Reliability
Maintainability
Software Integration
Software Functionality

Environmental:

Temperature
Pressure
Vibration
Shock
Humidity
Sea Salt Spray
Rain, Snow, Ice
Lightning

DT&E Requirements

The process begins when the Government establishes capability needs. These capability needs come from a variety of source documents, such as, the Capability Development Document (CDD)/Capability Production Document (CPD), System Threat Analysis (STA), Test and Evaluation Master Plan (TEMP), and Analysis of Alternatives (AoA).

Both the Government and contractors conduct DT&E. DT&E requirements are communicated to contractors through contract documents, such as, the Statement of Work (SOW) or Statement of Objectives (SOO), System Specifications, and Work Breakdown Structure (WBS).

Finally, the contractor establishes the subsystem DT&E requirements and communicates them to each subcontractor.

Contractor's Role in DT&E

Initial details of the contractor's planned testing can be found in the contractor's proposal (proposed SOW, system specification, etc.), and may include specific items from the WBS. The contractor's role in DT&E may include the following:

- Developing and delivering, for Government approval, an Integrated Test Plan (ITP) when required by the PM.
- Conducting sufficient testing before delivery to the Government.
- Providing technical support to Government T&E personnel.
- Correcting deficiencies discovered through testing.
- Helping to minimize testing redundancy.

Special Types of DT&E

Two specific types of DT&E are Production Acceptance T&E (PAT&E) and Live Fire T&E (LFT&E).

Production Acceptance T&E is used to verify that each production unit meets contract requirements. It is usually conducted at the contractor's facility. The Defense Contract Management Agency (DCMA)

may provide oversight. Other Government personnel representing the developer and/or the user may also observe this testing.

Live Fire T&E (LFT&E) provides a realistic assessment of weapon platform/crew vulnerability and lethality of conventional munitions/missiles.

LFT&E is:

- Required for certain ACAT I and II programs or modifications that impact the system's vulnerability or lethality in combat.

- Mandated by Congress (Title 10 USC 2366). (Results must be reported to Congress prior to a Full-Rate Production Decision Review).

- Funded by the program office.

The objective of LFT&E is to provide a timely and reasonable assessment of the vulnerability/lethality of a system as it progresses through its development and prior to full-rate production.

Operational T&E (OT&E)

Operational Test & Evaluation (OT&E) are field tests conducted under realistic operational conditions of any item (or key component) of weapons, equipment, or munitions to:

- Determine the effectiveness and suitability of the systems for use in combat by typical military users.

- Provide decision makers with an evaluation of such test results.

Operational Effectiveness and Suitability

Operational effectiveness is the degree of mission accomplishment achieved when a system is used by representative personnel in the environment planned or expected for operational employment of the system. When assessing operational effectiveness, T&E personnel must take into account the following factors.

- Organizational Aspects

- Doctrine

- Tactics

- Survivability

- Vulnerability

- Threat

Operational suitability is the degree to which a system can be placed satisfactorily in field use. When assessing operational suitability, T&E personnel must take into account the following factors:

- Reliability

- Supportability and Maintainability

Availability
Compatibility
Interoperability
Safety
Human Factors and Training
Transportability
Wartime Usage Rates
Documentation

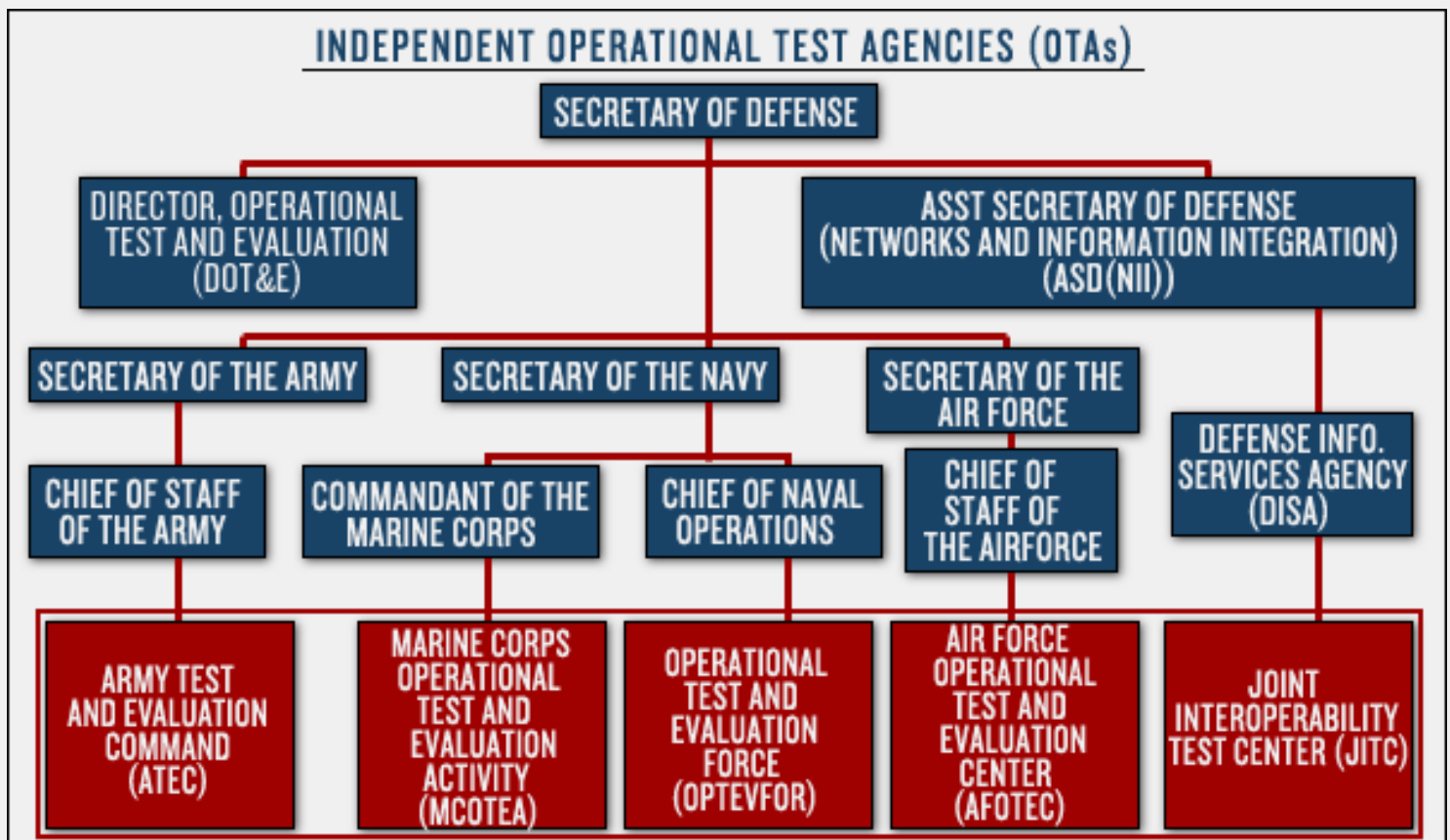
Importance of Independent T&E

While operational field personnel may perform OT&E activities under "typical" operational conditions, OT&E is overseen by an independent Operational Test Agency (OTA) within each service.

Independent assessment is critical to ensure objectivity in determining if operational performance effectiveness and suitability requirements specified in the CDD/CPD have been met.

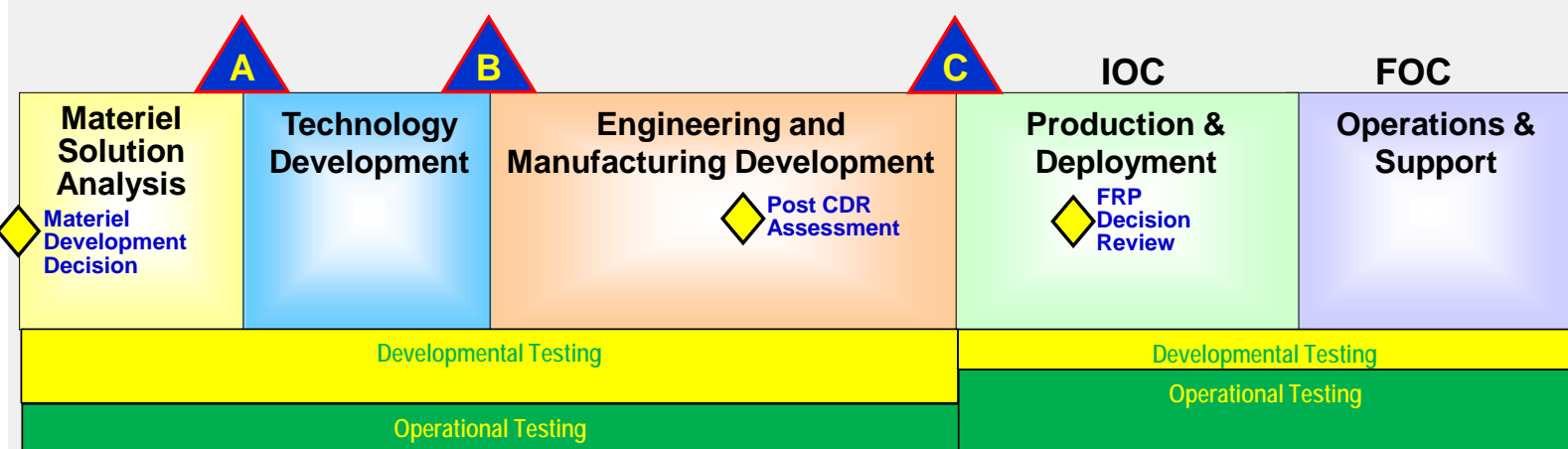
Independent Operational Test Agencies (OTAs)

The organizations in the bottom row of boxes oversee OT&E.



OT&E Process

The type of OT&E conducted depends on the maturity of the system design and acquisition strategy.



Type of OT&E Test	Description
Early Operational Assessment (EOA)	<p>Early Operational Assessment (EOA) may be conducted prior to Milestone B during Technology Development phase, or after Milestone B during the Integrated System Design effort.</p> <p>EOA is usually performed on prototype components during the Technology Development phase and early System Integration and Demonstration. The information is used to help decision makers assess the proposed concepts.</p>
Operational Assessment (OA)	<p>Operational Assessments (OA) may be conducted during the EMD phase on the selected production representative system(s).</p> <p>The purpose of an OA is to:</p> <ul style="list-style-type: none"> Assess the system's potential to meet mission capability needs. Support the Milestone C. Support a Low-Rate Initial Production (LRIP) decision.

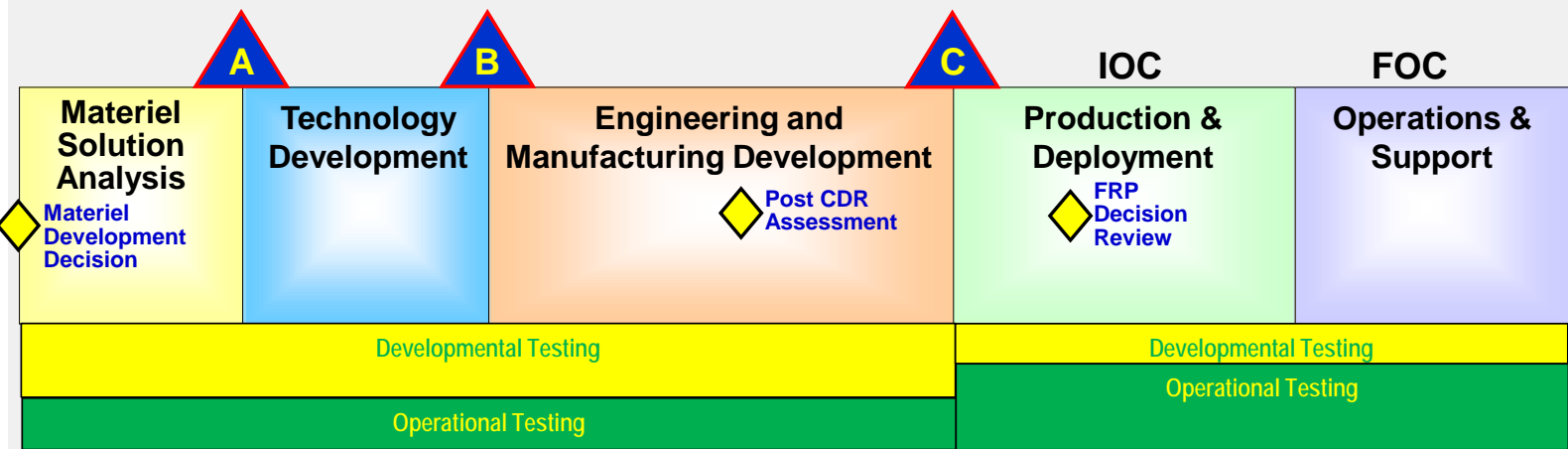
Initial Operational Test and Evaluation (IOT&E)	An Initial Operational Test and Evaluation (IOT&E) is conducted on production (or production representative articles) to support a Full-Rate Production (FRP) decision review for entering into full-rate production and deployment.
Follow-On Operational Test and Evaluation (FOT&E)	<p>Follow-On Operational Test and Evaluation (FOT&E) is conducted after the Full-Rate Production Decision Review, and may continue throughout the duration of the life cycle.</p> <p>The purposes of FOT&E are to:</p> <ul style="list-style-type: none"> Confirm correction of deficiencies noted in IOT&E. Develop tactics and doctrine for the new system. Evaluate major modifications and/or changes to the system.

Contrasting DT&E Versus OT&E

	DT&E	OT&E
What is Tested?	Measures technical performance against the design specifications in a controlled environment.	Determines operational effectiveness and suitability as defined in the Capability Development Document (CDD) and Capability Production Document (CPD).
Who Conducts Test?	Government and contractor	Government Independent
Who is Responsible?	Program Manager	Independent Operational Testing Agency (OTA)

Types of Testing and the Life Cycle

T&E is continuous throughout the life cycle with early emphasis on DT&E. Later, emphasis shifts to OT&E as the system design becomes more stable. Both types of testing can occur throughout the life cycle.



T&E Planning

Importance of T&E

T&E can be expensive and sometimes dangerous, so extensive planning is required. Typical T&E planning activities include:

- Determining types and quantity of data to be collected.
- Estimating the anticipated test risks/results through simulation and modeling.
- Establishing safe test procedures.
- Ensuring environmental protections are in place.
- Projecting resource and schedule requirements.

T&E Planning and Teamwork

T&E information helps the program office make a variety of decisions, including:

- Planning Decisions: What T&E should be performed?
- Management Decisions: Is the system ready for production?
- Design Decisions: How can we improve performance?
- Contractual Decisions: Does it work as specified?
- Logistical decisions: What types of operator training are needed?

T&E activities can also affect program office work schedules and resources. Therefore, T&E planning must be considered by IPT members.

Test and Evaluation Master Plan (TEMP)

The Test and Evaluation Master Plan (TEMP) provides an overall test management plan and framework within which detailed T&E plans are contained.

DODI 5000.02, Enclosure 6, requires that a TEMP be produced for all ACAT I and IA programs and other programs designated for OSD test and evaluation oversight. While TEMPs are not required for other programs, the TEMP format and procedures can be used at the discretion of the Milestone Decision Authority on these programs.

TEMP Requirements

The TEMP must:

- Integrate T&E with the overall acquisition strategy.

- Reflect the user's requirements and describe how these capability needs will be tested in DT&E and OT&E.

- Document the T&E program for the entire life cycle.

- Specify personnel, funding, and test range support requirements.

- Be developed prior to Milestone B Review and updated before each subsequent Program Decision Review.

TEMP Source Documents

For developing a TEMP, T&E personnel use such validated and approved program documents as the:

Initial Capabilities Document (ICD)

An Initial Capabilities Document (ICD) describes gaps in capability for a particular functional or mission area in accordance with the Chairman of the Joint Chiefs of Staff Instruction (CJCSI) 3170.01.

The ICD documents the evaluation of materiel approaches, and proposes a recommended approach that best satisfies the desired capability. The ICD supports the work required to refine the initial concept and to determine a strategy for technology development.

Capability Development Document (CDD)

The CDD is a formatted document that provides operational performance parameters necessary to design a proposed system. The CDD builds on the Initial Capabilities Document (ICD) and must be approved prior to Milestone B.

The CDD documents the user's operational performance capabilities in terms of thresholds (minimum acceptable value) and objectives. It also provides system-specific

requirements such as:

- Range
- Speed of data transmission
- Reliability

System Threat Analysis (STA)

The Systems Threat Analysis (STA) describes the threat to be countered and the projected threat environment at IOC and IOC + 10yrs. The STA is provided for the Milestone B review.

T&E personnel must also be aware of changes in the ongoing nature of the threat to determine whether the system operates effectively within the projected threat environment. Test scenarios and threat resources should be derived from the STA.

Acquisition Program Baseline (APB)

The Acquisition Program Baseline (APB) specifies system performance, cost, and schedule requirements that must be met to ensure the acquisition program remains on track. The APB provides key performance parameters (KPP) that the system is required to attain for deployed systems.

T&E personnel developing a TEMP can use the APB parameters as the most definitive statement of important system performance requirements that are drivers of operational effectiveness and suitability.

Analysis of Alternatives (AoA)

The Analysis of Alternatives (AoA) evaluates a range of proposed approaches to satisfy the mission need.

T&E personnel may use the system performance requirements stated within the AoAs as a source for selection of the T&E activities. The system performance requirements stated as functional objectives are broken down into measures of effectiveness, suitability, and performance. T&E personnel may use these measures to identify what elements can be evaluated, and select the specific tests required to demonstrate the required system performance. TEMP developers review these specific performance parameters to determine whether they are accurate and whether they can be evaluated.

TEMP Contents

The TEMP format, mandatory for ACAT I and OSD oversight programs, includes the following five parts:

Part I - System Introduction: Overview description, including key performance areas.

Part II - Test Program Management and Schedule: Overview of integrated T&E program.

Part III - Test and Evaluation Strategy: Overview of all T&E activities, both near-term and total life cycle; includes Critical Operational Issues (COI) used to assess effectiveness and suitability .

Part IV - Resource Summary: Lists all key resources required, including Government and contractor.

The estimates within the preliminary TEMP are updated and revised throughout the acquisition life cycle to reflect any changes in system concept, resource requirements, or threat assessments.

Unique TEMP Terms

Term	Definition
Critical Operational Issues (COIs)	<p>Critical Operational Issues (COIs) are the top-level issues that must be examined in OT&E to determine the system's capability to perform its mission. COIs are included in Part IV of the TEMP. There are two categories of COIs: effectiveness and suitability. COIs are typically phrased as a questions:</p> <p>Effectiveness: "Will the system detect the threat in a combat environment at adequate range to allow successful engagement?" Suitability: "Will the system be safe to operate in a combat environment?"</p> <p>The CDD is the primary source for developing COIs.</p>
Critical Technical Parameters (CTPs)	<p>Critical Technical Parameters (CTPs) are the engineering design factors that a system must meet or exceed to ensure that established performance thresholds are achieved. CTPs are derived from the CDD, critical system characteristics, APB and systems engineering documents. CTPs are listed in a matrix, along with the performance objectives and thresholds in Part I of the TEMP.</p> <p>An example of a CTP may be the weight of the system. The CTP is stated as a specific numerical value and may change as the system matures during development.</p> <p>The system should show improvement in the performance parameter over time.</p>

**Measures of Effectiveness
and Suitability (MOEs &
MOSs)**

Part III of the TEMP lists the Measures of Effectiveness (MOE) and Measures of Suitability (MOS). They are key in assessing the performance capabilities and characteristics identified in the CDD.

These measures (MOEs and MOSs) are used to determine the attainment of the top-level performance issues.

Examples of MOE

Maximum effective range

Land mobility speed

Examples of MOS

Interoperability

Mean time between operational mission failure