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Connecting Mission Engineering, System of Systems, Systems Engineering and Test & Evaluation

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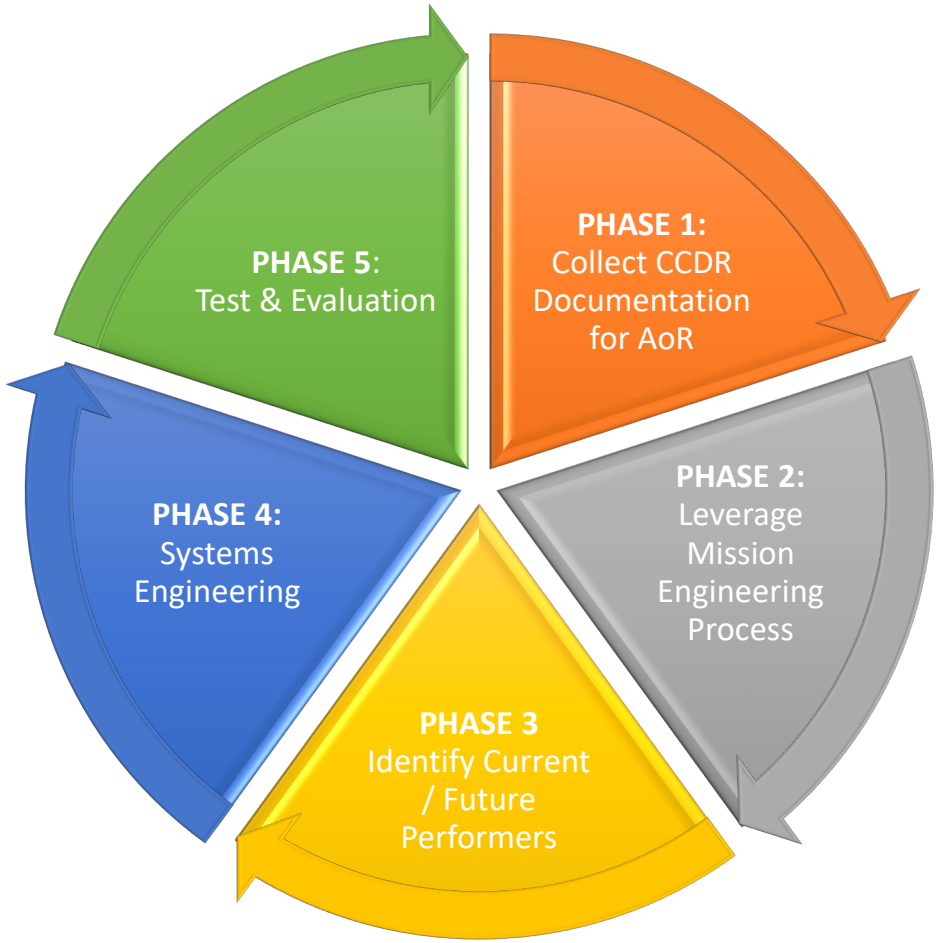
BLUF

- Understanding Mission Breakdown to actionable and testable Mission Threads is critical
  - Clearly defined roles for Mission Engineering, Systems Engineering, System of Systems are needed
- Leverage current Mission Engineering Process
  - Understanding data flow from the Mission (problem statement) to proposed solutions (systems engineering and Program of Record) back through to Mission Engineering

Connecting Mission Engineering, Systems Engineering and Test & Evaluation Process Flow



PHASE 1: Combatant Commander Area of Responsibility (AoR)

PHASE 1:
Collect CCDR Documentation for AoR

- Understanding the responsibilities of the Combatant Commander will help to scope and categorize efforts
- Combatant Commanders (COCOMs) are responsible for:
  - **Campaign Plans**
    - Day to Day Operations
  - **Contingency Plans**
    - Prepared in advance to address an anticipated crisis
  - **Integrated Priority List (IPL)**
    - List of priority requirements

Area of Operations

PHASE 1:
Collect CCDR Documentation for AoR

- Understanding Campaign Plans, Contingency Plans, and Integrated Priority Lists helps planners visualize and scope the day-to-day operations, contingency plans, and needs of the Combatant Commander within the respective AoR
- These documents serve as a guide to scope the work which needs to be accomplished in an AoR
  - **Campaigns**:
    - A campaign is a series of related military operations to achieve strategic and operational objectives in a given time and space
    - include the campaign plan and all of its subordinate and supporting plans
  - **Operations**:
    - Sequence of tactical actions with a common purpose or unifying theme
    - An operation may entail the process of carrying on combat, including movement, supply, attack, defense, and maneuvers needed to achieve the objective of any battle or campaign
  - **Missions**:
    - The joint force's mission is the ***task*** or set of ***tasks***, together with the purpose, that clearly indicates the action to be taken and the reason for doing so
    - Mission analysis is used to study the assigned ***tasks*** and to identify all other ***tasks*** necessary to accomplish the mission

Mission Engineering

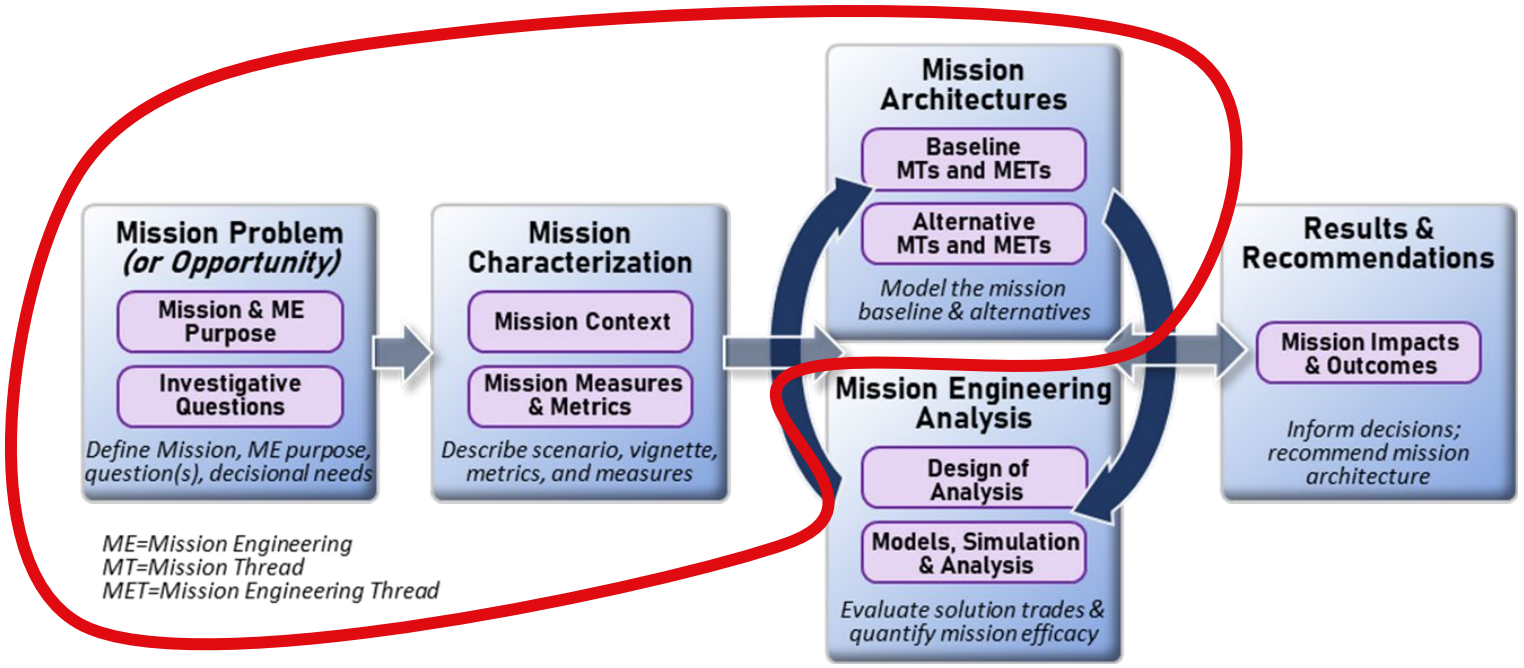
PHASE 2: Leverage Mission Engineering Process

- Mission Engineering (ME) is a top-down approach that delivers engineering results to identify enhanced capabilities, technologies, system interdependencies, and architectures to guide development, prototypes, experiments, and System of Systems (SoS) to achieve reference missions and close mission capability gaps
- ME should leverage the data provided by Combatant Commanders (COCOMS) through Campaign Plans, Contingency Plans and Integrated Priority Lists
- ME uses systems and SoS in an operational mission context to inform stakeholders about building the right things, not just building things right, by guiding capability maturation to address warfighter mission needs

The Mission Engineering Process

PHASE 2: Leverage Mission Engineering Process

- The Mission Engineering Process is used to create Mission Engineering Studies
- Utilizing the first portion of the process will help identify key Program of Record (PoR) Measures for use in Systems Engineering and Test & Evaluation
- The other steps in the ME process can be utilized by PoR's for future acquisition



ME STEP 1: Problem Statement – Identifying Mission & Purpose

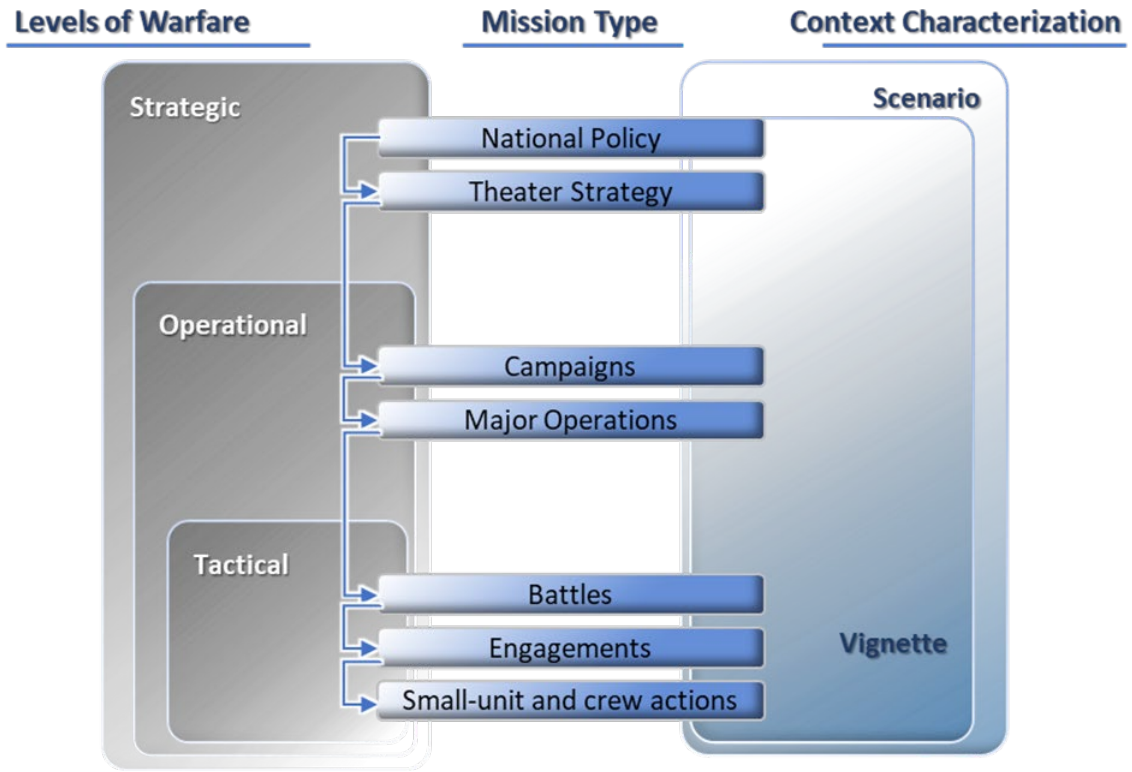
PHASE 2: Leverage Mission Engineering Process

- Mission engineering starts by identifying answers to two foundational questions:
  - What is the mission?
  - What is to be investigated about that mission?
- Have a clear understanding of what goal or decision will be informed as a result
- ME Studies take on one of four forms:
  - Explore mission cause-and-effect relationships—sensitivity analysis—to gain deeper understanding of the factors affecting mission outcomes
  - Discover potential gaps and quantify shortfalls in the ability to achieve desired mission outcomes
  - Evaluate trade space of potential solutions to address known gaps within the mission
  - Investigate mission impact of new opportunities, which can include changes to or the integration of new technologies, capabilities, or concepts of operations

ME STEP 2: Mission Characterization

PHASE 2: Leverage Mission Engineering Process

- Missions are composed of purpose-specified ***tasks*** and actions to achieve a specific objective



ME STEP 2: Mission Characterization

PHASE 2: Leverage Mission Engineering Process

- **Develop Mission Context**
  - Physical environment
  - Operational environment
  - Functional elements and relationships
  - Information environment
  - Mission purpose
  - Time epoch or time frame
  - Mission location
  - Mission participants
  - Sequence of operations
- **Define Mission Measures & Metrics**
  - Measures of Success (MOS's)
  - Measures of Effectiveness (MOE's)
  - Measures of Performance (MOPs)

Scenario: Part of an overall campaign, comprising multiple operations, each with its own set of missions and objectives

Provides:

- Conflict timeframe (near, mid, far)
- Geo-political set-up
- Strategic mission objectives
- Mission area definitions (i.e., groupings of similar campaign operations)

Example authoritative sources:

- **Defense Planning Scenarios (DPS)**
- **Joint Force Operating Scenarios (JFOS)**
- **Why use:**
  - Standardizes future theater threat laydown and conflict for DoD planning
  - Provides top-level MOSs
  - Common starting point for mission engineering activities and leadership decisions

Vignette: Subset of a scenario to focus the scope, details, and tactical objectives to address the needs of the mission problem or opportunity

- Setting, objective(s), commander's intent
- Baseline forces, threats / intel, and order of battle
- Details of blue, green, and red CONOPS; Rules of engagement and operational tasks
- Clutter (e.g., neutral forces), contested, etc.
- Vignette measures (i.e., MOEs)
- Refining assumptions and conditions

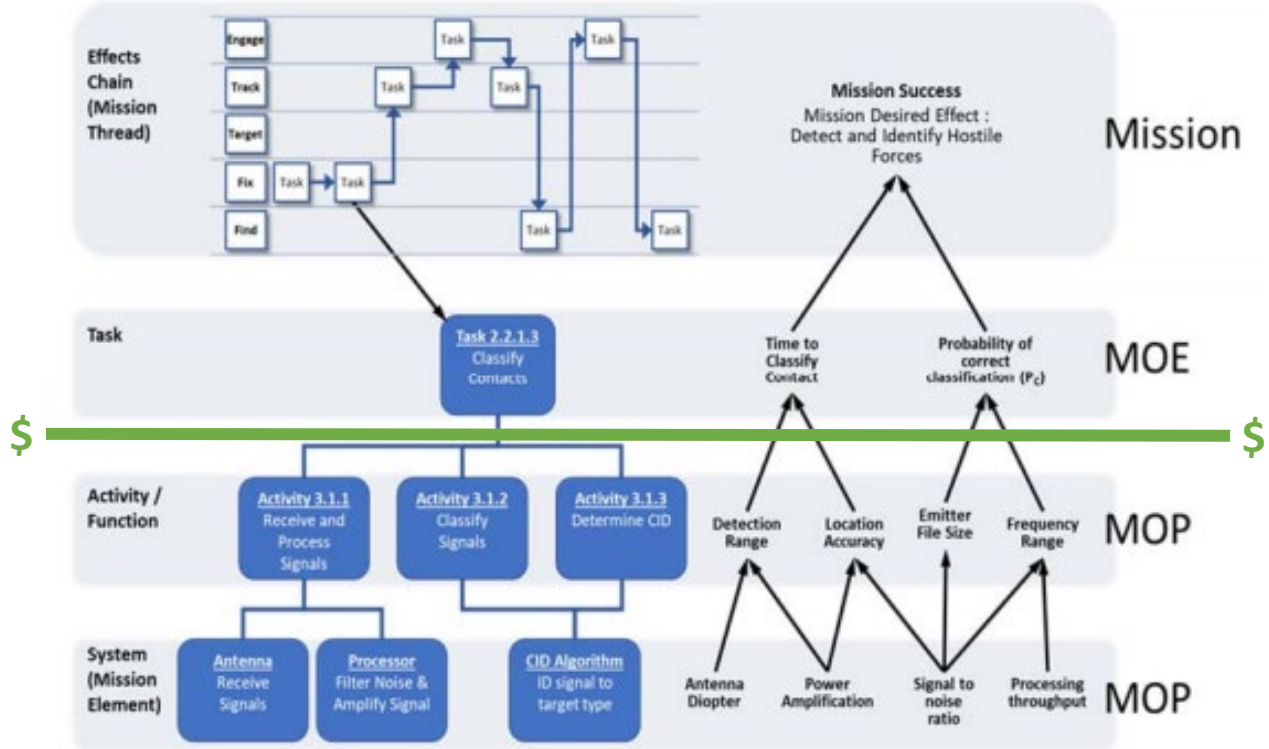
Many vignettes can be derived from a single scenario

MOS = Measure of Success MOE = Measure of Effectiveness CONOPS= Concept of Operations

Relationship of Measures

PHASE 2: Leverage Mission Engineering Process

- The “Green Line” Represents program funding
- Above the Green Line is a problem statement or ***Task*** to be accomplished (MOEs)
  - ***Task*** is assigned to a **Platform** and Human **performer**
- Below the Green Line is a possible solution using a **System** (MOPs)
  - Function of a System to determine if the ***Tasks*** can be met



ME STEP 3: Mission Architectures

PHASE 2: Leverage Mission Engineering Process

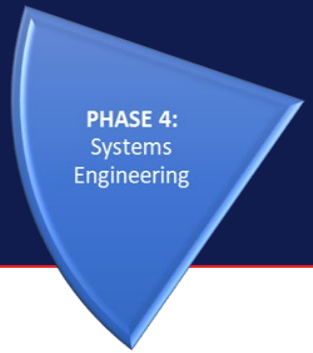
- **Develop Mission Architectures**
  - Architecture of a mission captures the structure of:
    - What ***tasks*** and activities are essential to the mission and how these activities are executed to achieve end-to-end mission objectives
    - Mission architectures capture the relationships, sequencing, execution, information exchanges, DOTMLPF-P considerations, and nodal linkages of a mission
  - Document a mission architecture to describe mission threads
    - BPMN, UML, SysML, UAFML, or other DoD standard architecture views
  - Mission Threads
    - characterize the sequence of ***tasks***, activities, decisions, and interactions in an end-to-end mission approach to achieve an operational mission objective.
    - Mission threads are distinct in that they describe the task execution sequence in a chain of events, **not** how or by whom each activity within the flow is to be accomplished.
    - Universal Joint Task List (UJTL), the Joint Common System Function List (JCSFL), and Service-specific ***task*** lists

PHASE 3: Identify Current / Future Performers

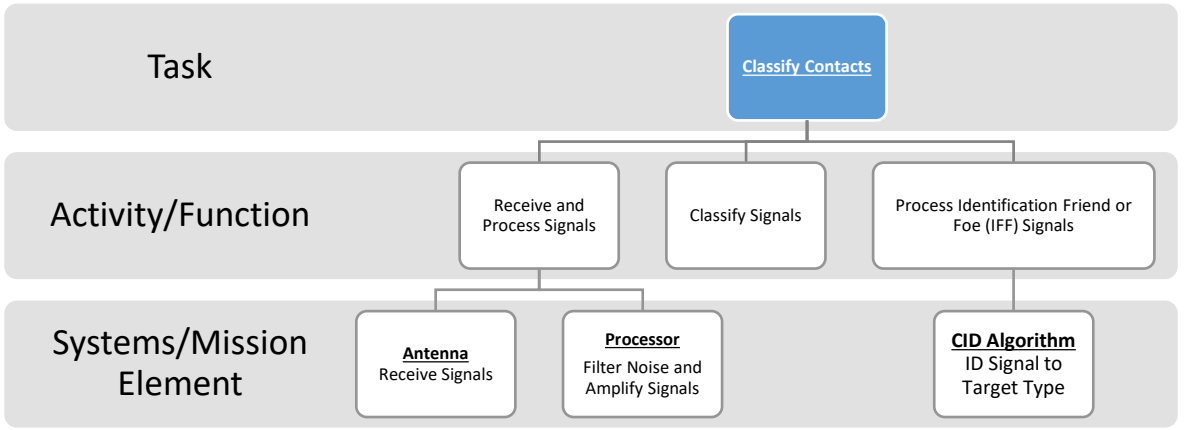
- Using current or constructed Mission Threads as created during the first 3 phases of the process will help identify potential performers of each specified ***task*** within a Mission Thread
- Determine Platforms, Weapons, Communications, Networks, Sensors, and Software (PWCNSS) that are able to perform specific ***task*** from a Mission Thread to meet the MOPs as outlined in ME Step 2 for the specified time epoch
- Compilation of MOPs will ultimately answer MOEs of the performers ability to complete the ***task***
- This process will help identify gaps in capability for future acquisition

Recommendation: Use of Joint Common Systems Function List (JCSFL) will allow common language for Tasks for each Mission Thread

PHASE 4: Program of Record Systems Engineering



- PoR Systems Engineering will breakdown the assigned ***task*** into functions and systems which allow the performer to accomplish the ***task***
- The functions are broken down into Systems or Elements (PWCNSS) needed
- Measures of Performance can then determine how well the function is met



Understanding Mission Engineering Threads or "Kill Chains"

PHASE 4: Systems Engineering

FIND **FIX** **TRACK** **TARGET** **ENGAGE** **ASSESS**

- Many Platforms across Domains, Services and Foreign partners are performing the Find, Fix, Track tasks almost continuously every day
- Output of these tasks and how this information will be received by the Target / Engage platform(s)

Possible Weapons / Target Pair #1

Possible Weapons / Target Pair #2

Possible Weapons / Target Pair #3

Possible Weapons / Target Pair #4

- Many Platforms across Domains, Services and Foreign partners can perform the Assess task

PHASE 5: Program of Record T&E / Feedback

PHASE 5:
Test & Evaluation

- PoR's will provide feedback data to ME to show ability to perform ***task***
- One of three situations:
  - Test has been performed, data is collected and provided
  - Test will be performed on xx date and data will be provided on xx date
  - Data will **not** be collected or provided and therefore a risk will be generated

- PoR T&E provides results as aligned to SE breakdown of ***task***
- Feedback provided back to provide ME to analyze gap closure or observation of gaps not already identified

Assessment Level Views

PHASE 5: Test & Evaluation

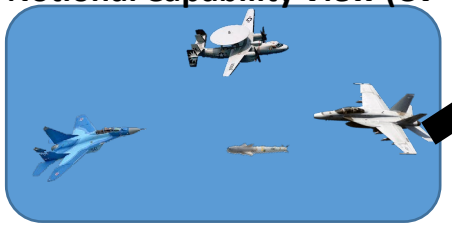
SCENARIO

Mission Assessment Report

Capability View(s)

VIGNETTE

Notional Capability View (CV-4)



Find, Fix, Track, Target, Engage, Assess

TASK
Measures (MOEs)
Conditions
Joint Conditions List (JCL)

Notional Capability View (CV-4)

Find, Fix, Track, Target, Engage, Assess

Program, Service & Cost Agnostic

Notional Platform Mission Task View

Prepare/Configure
TASK: Launch Aircraft

Engage
TASK: Attack Enemy Aircraft and Missiles (OCA)

TASK: Attack Surface Targets

Post Mission Tasks
Task: Recover Aircraft

Program & Cost Specific

1. Measures of Performance (MOPs)
2. Air Worthiness / Chamber
3. Software Integration

Platform Mission Task View

1. Measures of Performance (MOPs)
2. Air Worthiness / Chamber
3. Software Integration

Note: Each Platform in a Capability View would have its own PMT View

Notional System Task Enabler View

TASK: Attack Enemy Aircraft & Missiles			
Find, Fix, Track, Target, Engage, Assess			
F-35	EA-18G	F/A-18 C/D	**F/A-18 E/F**
○	●	●	●

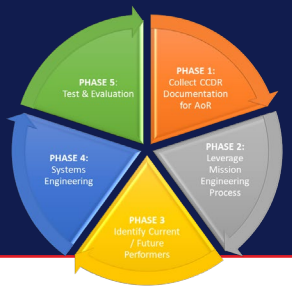
STEV may have tasks internal to the System

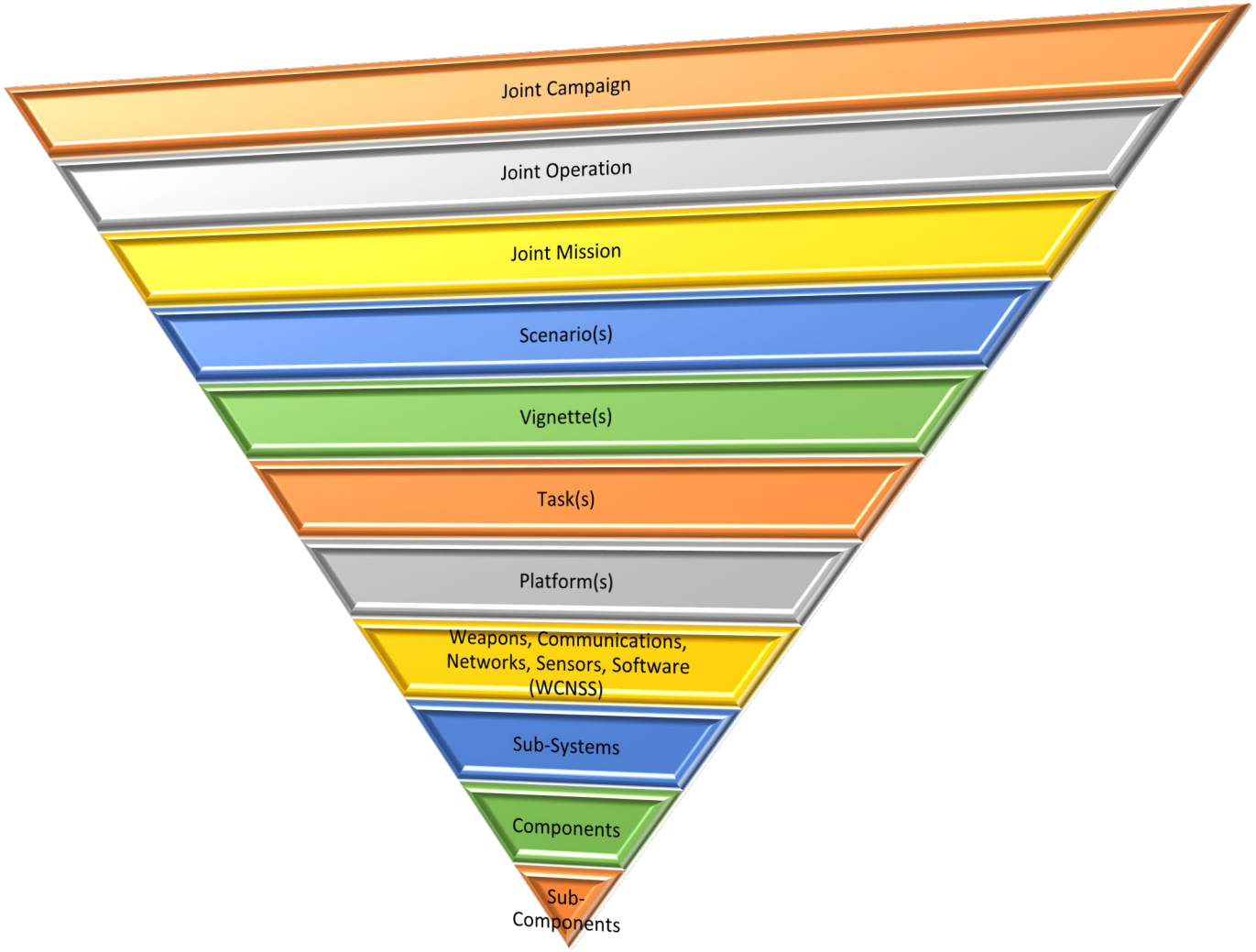
Notional System Task Enabler View

TASK: Attack Surface Targets		
Find, Fix, Track, Target, Engage, Assess		
AF B-1	P-8	**F/A-18 E/F**
○	○	●

System Task Enabler View(s)

ME, SE, T&E Connection Modeling Pyramid





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