Evaluating the Mission – Translating System Performance to Unit Capabilities

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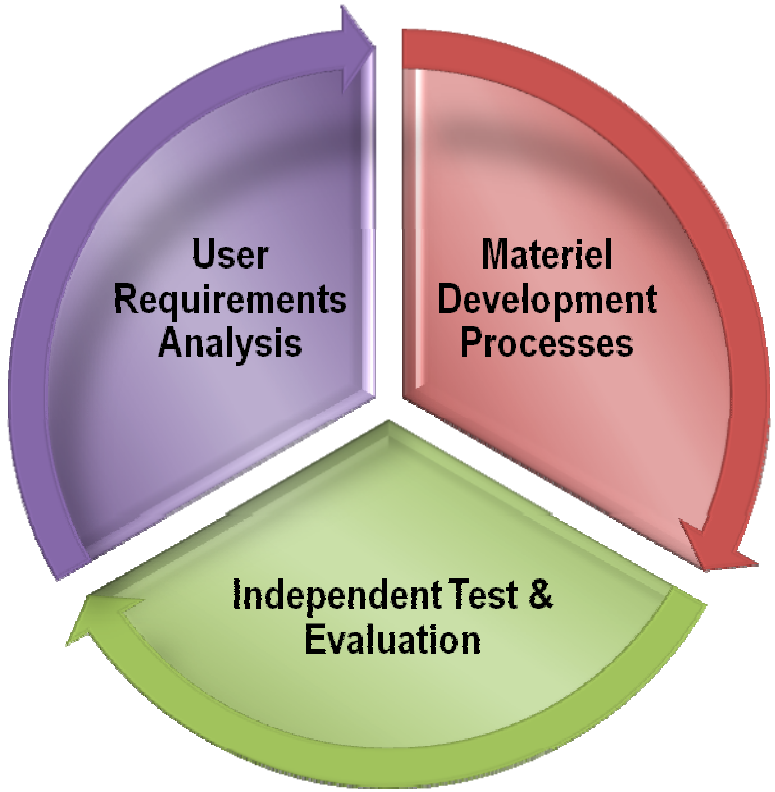
RoundTable Defense, LLC

Agenda

- Purpose
- Background
- MBT&E Fundamentals
- SE Approach
- Example
- Summary

Purpose

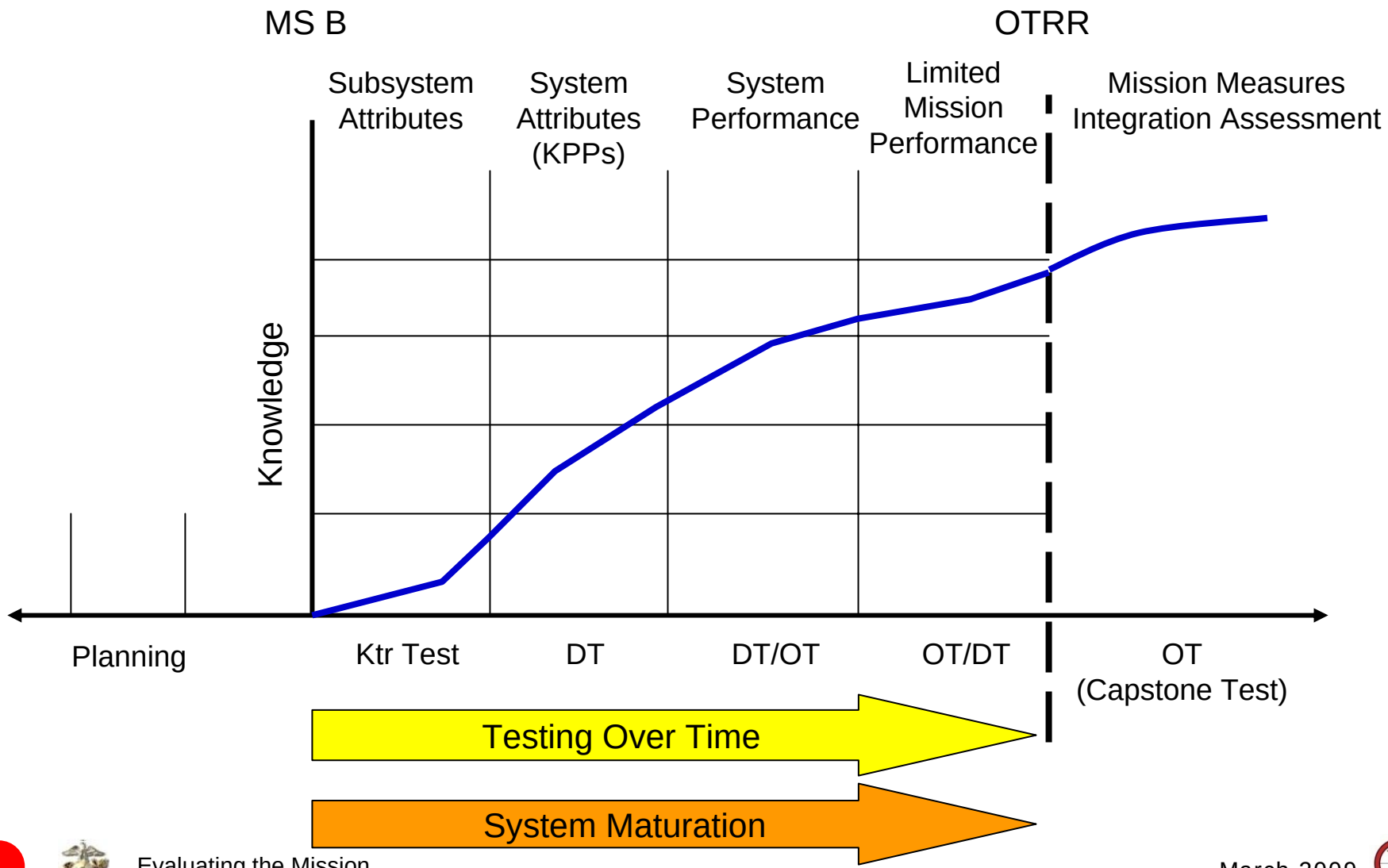
- Identify a Systems Engineering Approach that may be useful in translating system performance to unit capabilities
- Present a methodology that integrates the test & evaluation function with requirements analysis and materiel development



Background

- Some factors driving MBT&E:
  - McQueary-Young Memo (Dec 2007)
  - Section 231 Report (July 2007)
  - CJCSI 3170.01F JCIDS Process
- ATEC, MCOTEA, COMOPTEVFOR and AFOTEC developing approaches
  - Similarities in the Mission Task identification and decomposition process
  - Key differences are in the complexity of the evaluation methodology
- Integrated Testing (DT & OT) provides a continuum of knowledge throughout System development

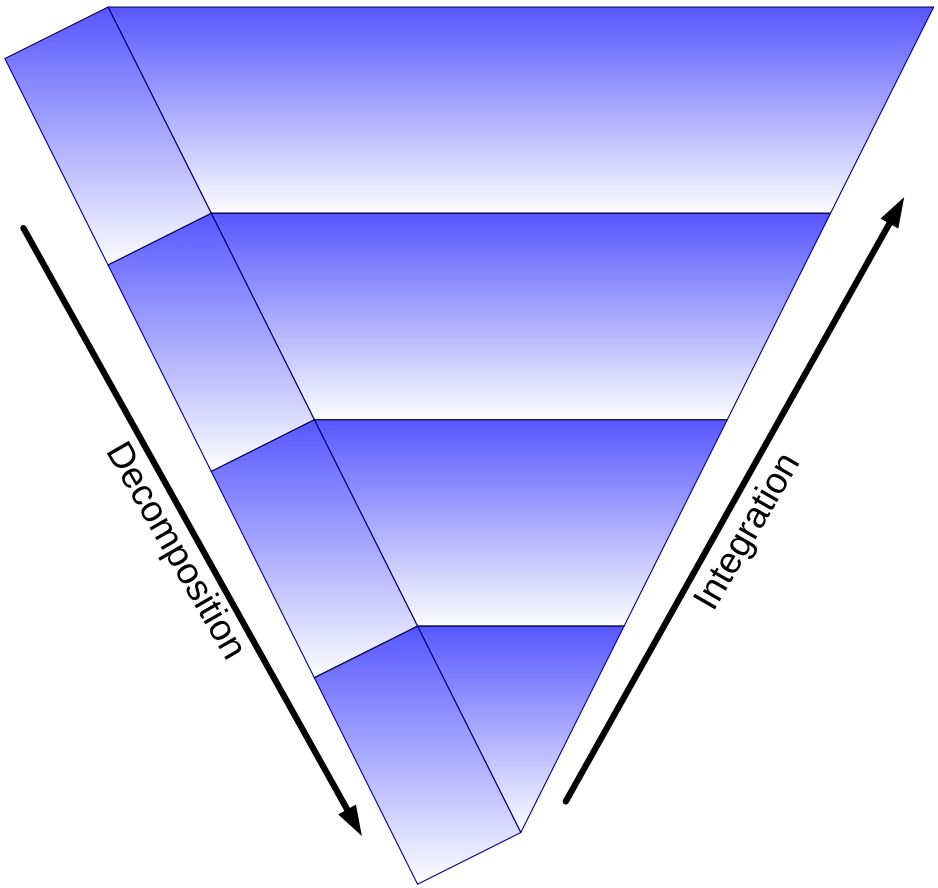
Integrated Test Approach



MBT&E Fundamentals

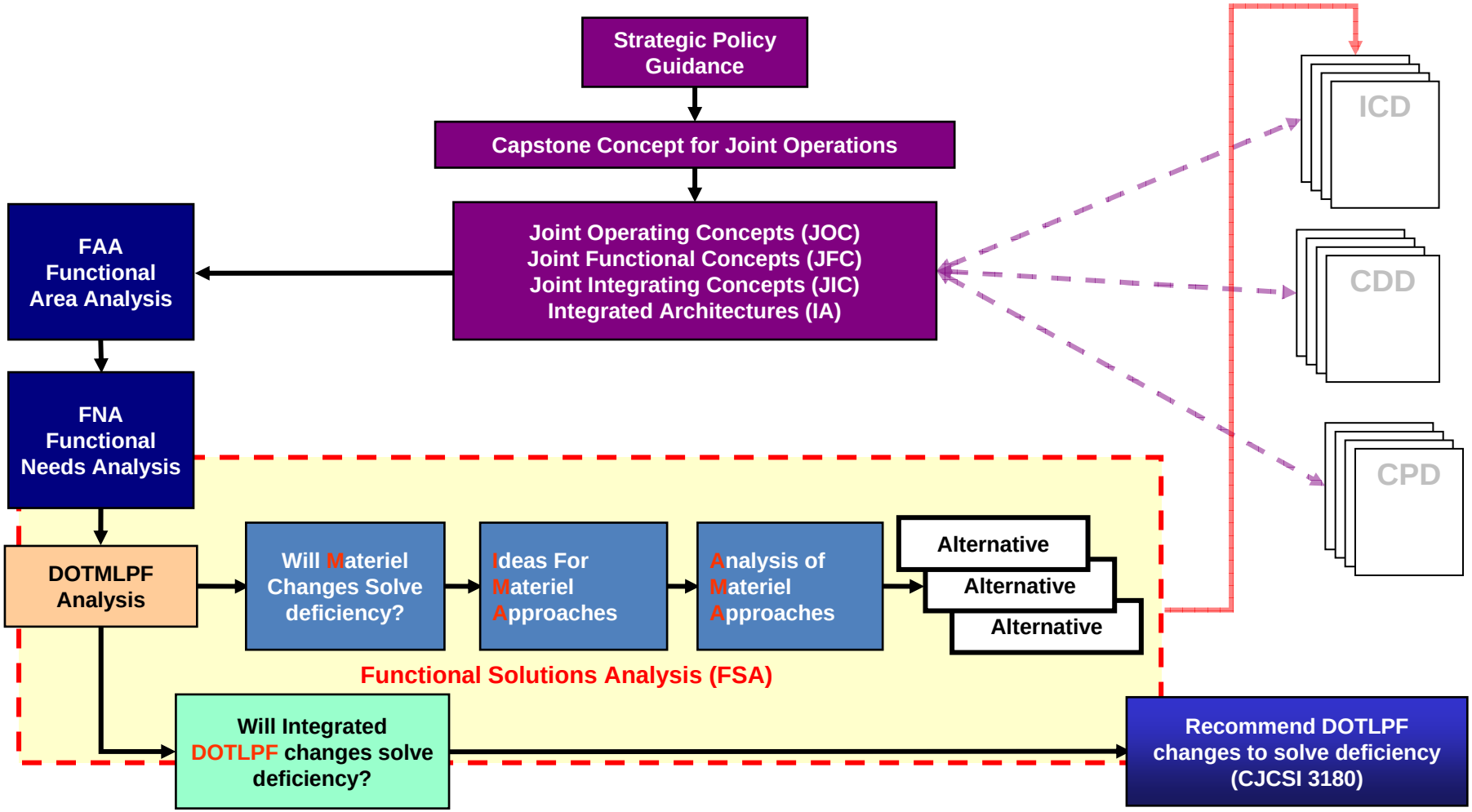
- In order to gather data that accurately answer the Critical Operational Issues (COI) and illustrate capabilities and limitations of the system, the test process must begin and end with a paradigm that ties system Attributes to operational tasks or missions at the unit level.
- Mission Based Test & Evaluation (MBT&E) represents a thought process to guide the evaluators in developing the T&E strategy
  - Must take advantage of work done before by other agents in the Acquisition process
  - Understanding the documented missions for the System vice recreating mission and task analysis
- Definitions (For the purpose of this brief)
  - **Effectiveness** – Capability of the Unit to accomplish the Mission
  - **Suitability** – Factors that Impact the Unit's Mission Capability

SE Approach



- What Mission Tasks was the System developed to perform?
- What System Functions are required to perform those Tasks?
- What Attributes, defined in the CDD and delivered in the System, enable the function?
- Which measures in the Evaluation Matrix were identified in the JCIDS process that convinced leadership to develop the System?

JCIDS Gap Analysis Process



FAA & FNA JCIDS Analysis

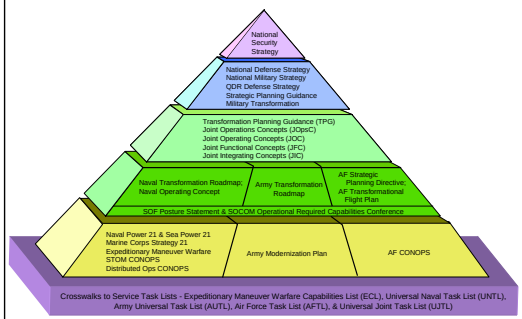
FAA

- Joint Concepts
- Threat & Environment
- Military Objectives

Required Joint Capabilities

FNA

\- Current & Programmed Joint Capabilities = Required Capability Gaps → Attributes of Solutions to Gap → MOE



Strategy-to-Task

Priority	Subtasks	Benefit Value	Legacy	Program 1	Program 2	Program 3	Program 4
1	Subtasks 12	55	40%	20% Solution		10% Solution	
2	Subtasks 21	46.7	60%		35%		
3	Subtasks 13	29.4	Gap – No solution				
4	Subtasks 9	14.4	30%	15%			43%
5	Subtasks 1	10.3	90%	No Major Gap – Existing DOTMLPF meets need			
6	Other Subtasks	…		…	…	…	…
…	Subtask x	1.2	100%	No Gap – Existing DOTMLPF meets need			

Gap Analysis

Attributes & MOE

Defining the Solution Set

Provides the Foundation for the Functional Solutions Analysis (FSA) & Ultimately, the ICD

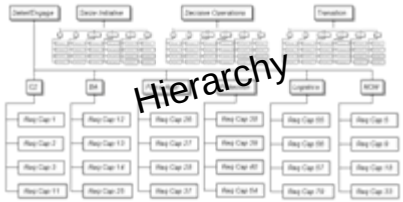
Mission Task Hierarchy

War (MCO)

MOOTW w/ Force

MOOTW w/o Force

Joint Operations



Deter/Engage

Seize Initiative

Decisive Operations

Transition

Activity Model

C2

BA

Force Appl

Protection

Logistics

NCW

Joint Functional Concepts

Task 1

Task 2

Task 3

Task 12

Task 13

Task 14

Task 25

Task 26

Task 27

Task 28

Task 37

Task 38

Task 39

Task 40

Task 54

Task 55

Task 56

Task 57

Task 79

Task 5

Task 9

Task 18

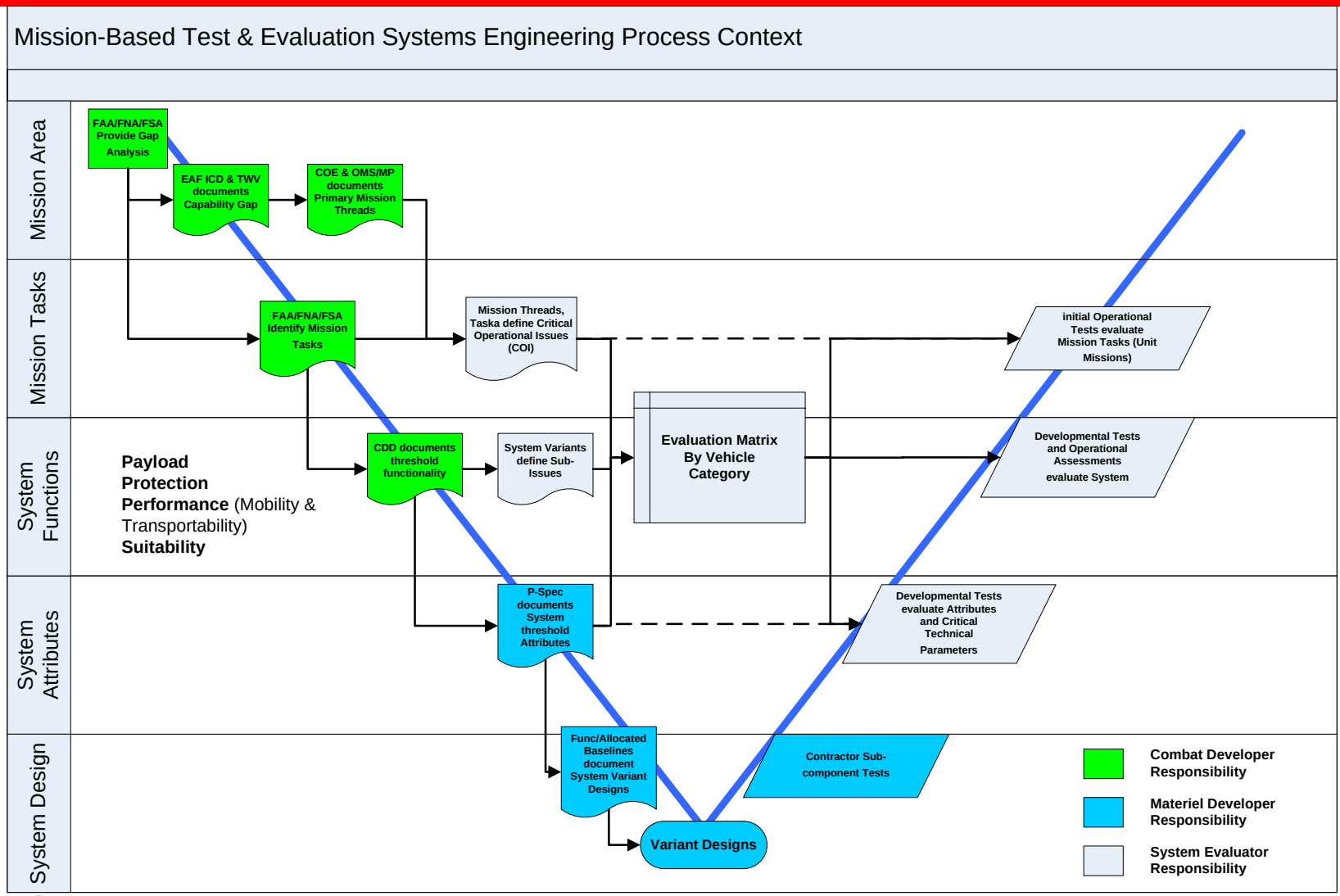
Task 33

Joint Tasks

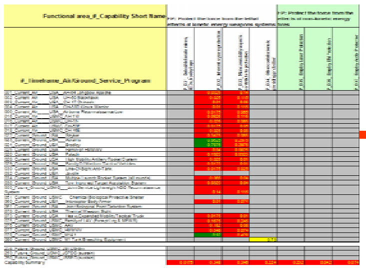
MBT&E Planning Process

- Four Basic Elements:
  - Mission analysis (Critical Operational Issue (COI) definition)
  - System performance measures (attribute traceability to functions)
  - Operating conditions (test scenario/environment description)
  - Test variables (controlled and uncontrolled)
- These items form the basis for the Scope of Test and resource requirement estimates that are included in the TEMP

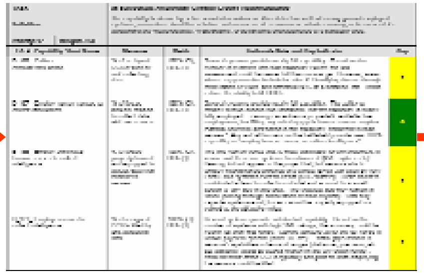
MBT&E Process Responsibilities



Gap Assessment Process Flow



1. Analysis Results



2. Subtask Gap Assessment

Detailed Assessment Across Operational Scenarios 36 Battlespace Awareness: Conduct Ground Reconnaissance	Overall Assessment of Task by Capability	War		MOOTW w/ High Probability of Threat		MOOTW w/ Low Probability of Threat	
		Air	Grnd	Air	Grnd	Air	Grnd
	B_166	N/A	Y-	N/A	Y-	N/A	Y
	B_167	N/A	G	N/A	G	N/A	G
	B_168	N/A	Y	N/A	Y	N/A	Y
	B_169	N/A	Y	N/A	Y	N/A	Y
	B_170	N/A	Y	N/A	Y	N/A	Y
	B_171	N/A	Y	N/A	Y	N/A	Y
	B_172	N/A	G	N/A	G	N/A	G
	B_173	N/A	Y	N/A	Y	N/A	Y

Comments by Capability (note on changes from basic rating above):
B_166 (Collect combat intelligence): Though systems exist that nearly fulfill this need, there are critical gaps within the capability: (1) war/ground - the inability to detect NBC threats at a distance, and (2) MOOTW w/high threat – inability to locate & identify threats through obscuration/walls. The capability is not red, due to the overall high level of accomplishment in other aspects of the capability.

3. Gap Assessment Across Operational Scenarios

Comment/Conclusion:

36 Battlespace Awareness: Conduct Ground Reconnaissance

Overall Assessment of Task: Ground Recon	War	MOOTW w/ High Probability of Threat	MOOTW w/ Low Probability of Threat
Air	N/A	N/A	N/A
Ground	Y	Y	Y

General Comments: Lessons learned in Iraq identify shortfalls in the insurgency environment. Items for consideration include:
- The need to improve the ability to collect intelligence and employ enhanced human senses.
- The need to improve robotics to conduct recon in high-risk situations.
- The need to address sensor to shooter capability in net-centric warfare.
- The effects of urban environment and insurgents on the force's ability to collect intel.

Forces aboard all ground vehicles afford opportunity to conduct ground recon. Training is an essential element to ensure forces properly observe, record, and report.

4. Gap Assessment at Task Level

Attributes of gaps

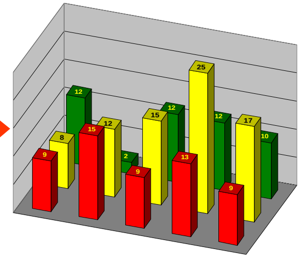
36 Battlespace Awareness: Conduct Ground Reconnaissance

Capability	Gap	Describe solution to the gap in terms of attributes	Attribute(s)	Joint Attribute
B_166_ Collect combat/intelligence	Y	Units conducting intel collection during ground recon are unable to fill all assigned CCIRs due to a lack of full reach to achieve effects under all conditions and lack sufficient spectrum to provide systems to achieve those effects. Systems are needed to locate & identify threats through obscuration or walls, detect CBNRE threats at a distance, etc.	Spectrum: increased system capabilities Reach: application of effects under all conditions	Spectrum (Range) & Reach
B_168_ Employ enhanced human senses to collect intelligence	Y	Systems to enhance human senses lack the spectrum and reach to address all senses. Though vision is enhanced through NVG, there is a lack of ability to achieve effects in all conditions and a lack of variety of systems. This gap would be mitigated by adding systems to 'see' through walls and obscuration. Other senses are more severely lacking, but have less impact as vision. Improving the sensitivity and selectivity of microphones and 'sniffers' would enhance senses needed for conducting ground recon. Taste and feel have limited affect on the gap.	Spectrum: increased system capabilities Reach: application of effects under all conditions	Spectrum (Range) & Reach
B_169_ Employ sensors to collect intelligence	Y	Existing sensors cover all spectra but lack range (distance) and precision. In this case, range refers specifically to the distance from which the sensors can achieve effects. Precision is required to make information more useful. These preclude the ability to fill all CCIRs.	Spectrum: distance Precision: targetable info on specific threats	Spectrum & Precision
B_170_ Conduct recon w/o being detected/captured	Y	Ground recon elements need greater survivability from their systems, this includes being 'quieter' (noise, IR, RF, etc). Supporting systems such as micro-UAV/UGV technology will help, but currently there is a lack in variety of such systems. Recon elements' ability to remain undetected and avoid capture also affects information security.	Persistence: survivability Spectrum: variety of systems Security: avoiding capture	Persistence, Spectrum, & Security
B_171_ Employ robotics in high-risk situations	Y	Robotics in high risk situations currently lack mobility which limits their reach. Increasing mobility to handle all conditions (stairs, walls, soil conditions, debris, etc) would increase the situations where the robots could be employed and close this gap.	Reach: robot mobility	Reach
B_173_ Report collected intelligence/information /data	Y	Reporting of collected intelligence/information/data could be quicker. Improving sensor-to-shooter capability would improve timeliness and sharing of information flow to the decision-maker to improve percent of information available in a usable format.	Timeliness: speed of sensor-to-shooter reporting Sharing: accessibility of info	Timeliness & Sharing

5. Attributes for Gap Solutions

Task	Wt	Pri	Subtask	Measure	Metric	Summary Gap	War	MOOTW-Hi	MOOTW-Lo	Rationale	Gap Solution	Attribute	Joint Attribute	EEL	JOC	JFC
13 Engagement: Deliver effective and sustained direct lethal, fires integrated with maneuver	62.6	1	E_054_ Deliver autonomous or semi-autonomous direct fires	% of acquired targets, of certain target types, within a specified range, engaged with autonomous or semi-autonomous direct fire weapons systems, while achieving the commander's desired effects	Effects Achieved 90% (T) Range: 0-2 km (T) 0-5 km (O)	R	R	R	R	No existing system had this capability. Of future systems, only FCS, UAVs and TUGVs were deemed to provide any capability in this area but at a very low level.	Develop autonomous or semiautonomous direct fire systems	Range, effects radius, probable error, precision, response time.	Discriminating Agile Persistent Survivable Effective	Applicable EMW Enhancements	Applicable Joint Capabilities	Applicable Joint Attributes
09 Man: Breech obstacles, both natural and man-made, as encountered	55.8	2	M_023_ Breach buildings	Maximum time that obstacle delays movement of the force	Obj: 0.5 hr Th: 1 hr	R	R	R	G	Capability uniformly rated red across all rated systems. Only the MERS provide a marginal capability in this area. This is a gap to fill.	The USMC does not meet the threshold requirement to breach a building within the time required. This can be solved by providing equipment to aid in building breaching operation and in training Marines to improvise methods to breach buildings.	• Number and size of buildings cleared to facilitate unit maneuver • Time to breach a building and allow forces to enter	Effective Agile			

6. Compiled Gap Assessment



7. Prioritized & Grouped Results

Gap 1: Conduct Fire and Maneuver

- *EO Gap 1 Description:* The EAF combat elements cannot move rapidly & safely as a cohesive force while executing deep operational maneuver
- *EAF must be able to: Conduct/support extended ops w/ armor*
  - Move light armor by air: Employ, via air, the light armor elements of EAF to achieve positional advantage; 110nm in 8 hrs (TH), 6 hrs (Obj)
  - Breach obstacles, manmade and natural: Combat element must maneuver through or around any obstruction designed or employed to disrupt, fix, turn or block movement without delaying the force longer than 1 hr (TH), .5 hr (Obj).
  - Protect the force from the lethal effects of kinetic energy weapons systems: Detect & protect the force against blast, flame, thermal, fragmentation and ballistic effects by equipping 75% of the force (TH); equipping & training 100% of the force (Obj).
  - Provide Combat ID: Attain an accurate characterization of detected objects – friend, enemy, neutral - in the battlespace by employing Active Recognition and Tracking Systems and Passive Tracking Systems in 100% of the force (TH & Obj).
- *Characteristics of the Gap*
  - No capability to reposition light armor by air
  - Lack of mobility for vertical lift forces
  - Weight of inherent protection for combat systems adversely impacts EAF mobility
  - Unacceptable limitations in the EAF's combat forces' ability to detect/detonate explosive obstacles
  - Lack of active recognition and active tracking systems for employment with assault, CS or CSS elements of the EAF

Example Mission Task (COI)

Issue: Move Light Infantry (Airborne/Air assault) via ground.

- (Sub-Issue) The JLTV Payload Category B Vehicle will support…(based on unit T/E)
  - Payload Characteristics
    - Transport 9-man team
      - P-Spec Attributes
  - Performance Characteristics
    - Air Transport
      - P-Spec Attributes
    - Mobility
      - P-Spec Attributes
  - Protection Characteristics
    - Ballistic Survivability
      - P-Spec Attributes
    - IA
      - P-Spec Attributes
  - Suitability Characteristics
    - Availability
      - P-Spec Attributes
    - Safety
      - P-Spec Attributes
- (Sub-Issue) the JLTV Payload Category C Vehicle will support…(based on unit T/E)
  - Payload Characteristics
    - Transport Unit Shelters
      - P-Spec Attributes
  - Performance Characteristics
    - Air Transport
      - P-Spec Attributes
    - Mobility
      - P-Spec Attributes
  - Protection Characteristics
    - Ballistic Survivability
      - P-Spec Attributes
    - IA
      - P-Spec Attributes
  - Suitability Characteristics
    - Availability
      - P-Spec Attributes
    - Safety
      - P-Spec Attributes

Mission Evaluation

System Functions	Vehicle Category A	B	C
Payload	3500	4000/4500	5100
Performance	4 man speed range acceleration braking etc	6 man 9 man speed range acceleration braking etc	2 man speed range
Protection	Ballistics CBRNE etc.	Ballistics CBRNE etc.	
Transportability	CH 47/53 2 x IAT C130	CH 47/53 1 x IAT C130	
Suitability	Availability Safety etc.	Availability Safety etc.	

	Sub-Configurations (Varient) Matrix C2OTM	AMB	HVY Guns	Utility
Performance	4 man C2 suite speed range acceleration braking etc	3 man 2 x liter speed range acceleration braking etc	4 plus Gunner speed range acceleration braking etc	2 man cargo etc.
Protection	Ballistics CBRNE etc.	Ballistics CBRNE etc.	Ballistics CBRNE etc.	
Transportability	CH 47/53 2 x IAT C130	CH 47/53 1 x IAT C130	CH 47/53 1 x IAT C130	CH 47/53 x IAT C13
Suitability	Availability Safety etc.	Availability Safety etc.	Availability Safety etc.	

Mission-Based COICs

- **Move Light Infantry (Airborne/Air assault) via ground**
  - Payload Category B Attributes
  - Payload Category A Attributes

  (Category mix based on Unit T/E)
- **Move Combat Support forces via ground**
- **Etc.**

Mission-Based ROIs

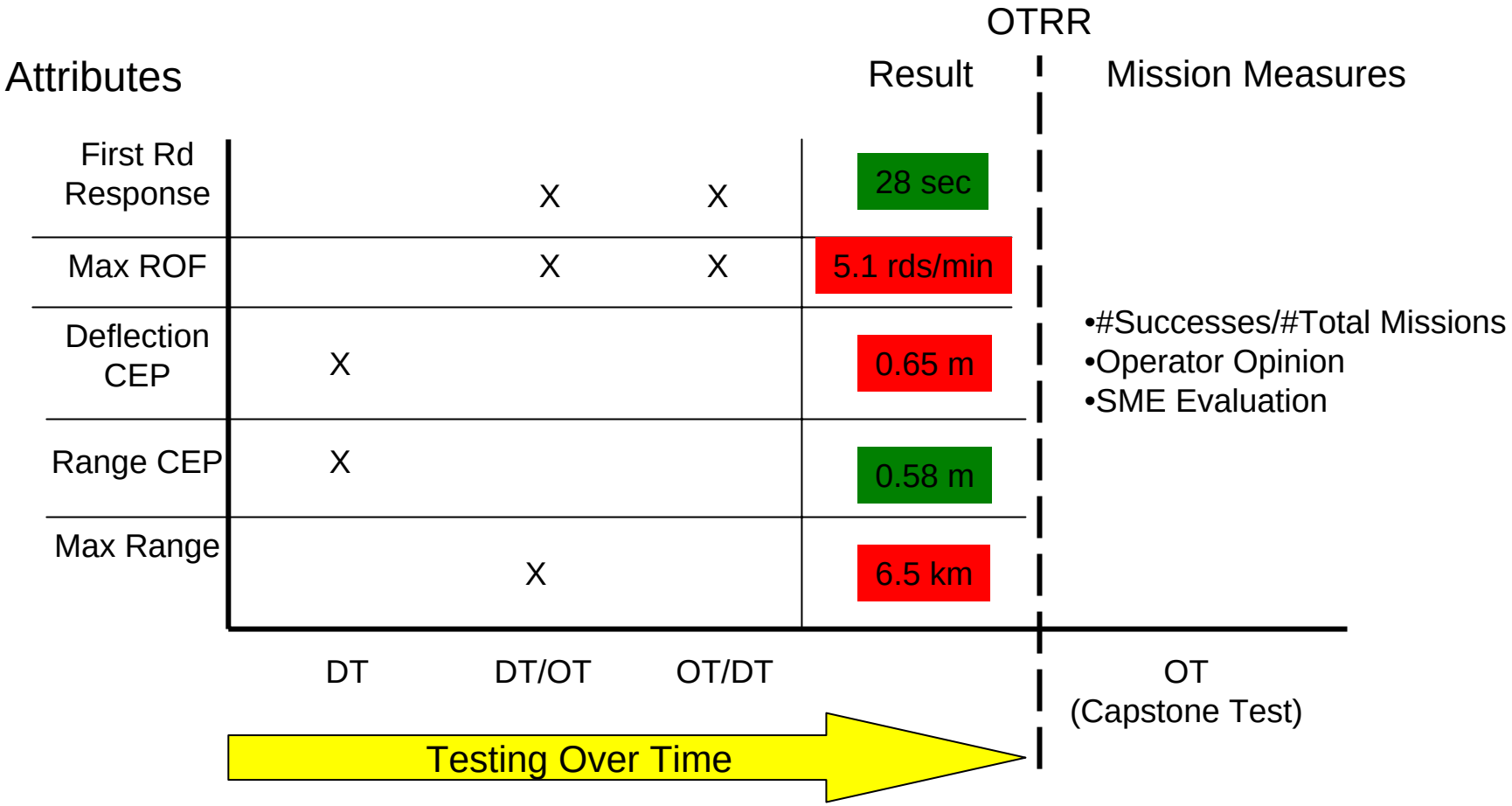
- **Add other Mission Tasks only as necessary based on planned tests (e.g., C2)**

Risk Analysis for TD Phase

- Vehicle capabilities indicate potential to meet COI/ROI
- Vehicle limitations indicate risk area to meeting COI/ROI

Knowledge Management

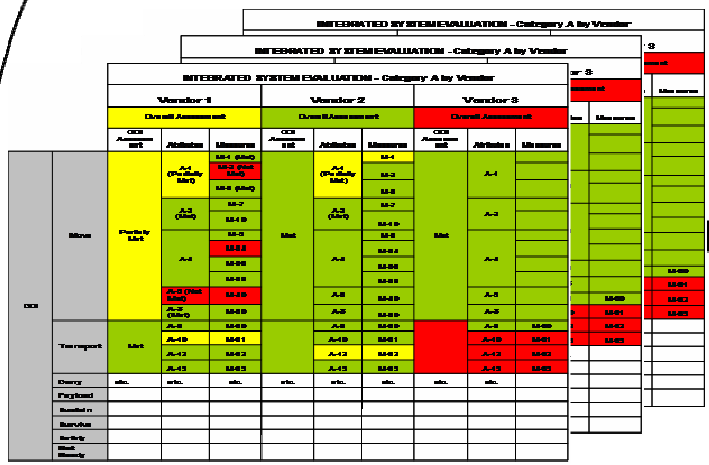
Task: *What are the lethality capabilities and limitations of the EFSS when performing suppression missions?*



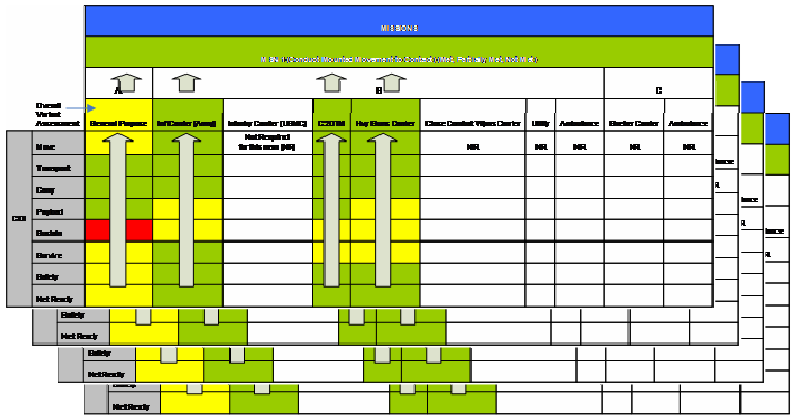
Conceptual Evaluation Process (Table Version)

Test Results

System Capability Evaluation (by Category)

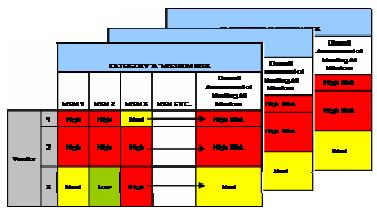


Mission Capability Assessment

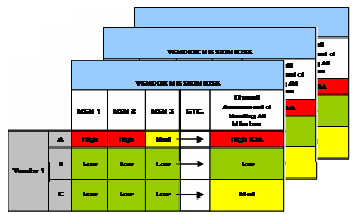


Technology Risk Assessment

Mission Assessment



(By Category)



(By Vendor)

System Capability Evaluation Table (Each Category by Vendor)

- Use Measure results to evaluate Attributes and support COI Evaluation as Met, Partially Met, or Not Met
- Overall System Assessment based on weighted COI "performance"

INTEGRATED SYSTEM EVALUATION - Category A by Vendor

		Vendor 1			Vendor 2			Vendor 3		
		Overall Assessment			Overall Assessment			Overall Assessment		
		COI Assessment	Atributes	Measures	COI Assessment	Atributes	Measures	COI Assessment	Atributes	Measures
COI	Move	Partially Met	A-1 (Partially Met)	M-1 (Met)	Met	A-1 (Partially Met)	M-1	Met	A-1	
				M-2 (Not Met)			M-2			
				M-3 (Met)			M-3			
			A-2 (Met)	M-7		A-2 (Met)	M-7		A-2	
				M-10			M-10			
			A-4	M-5		A-4	M-5		A-4	
				M-34			M-34			
				M-36			M-36			
				M-39			M-39			
			A-5 (Not Met)	M-40		A-5	M-40		A-5	
			A-8 (Met)	M-50		A-8	M-50		A-8	
	Transport	Met	A-9	M-60		A-9	M-60		A-9	M-60
			A-10	M-61		A-10	M-61		A-10	M-61
			A-12	M-62		A-12	M-62		A-12	M-62
			A-13	M-63		A-13	M-63		A-13	M-63
	Carry	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	
	Payload									
	Sustain									
	Survive									
	Safety									
	Net Ready									

Mission Capability Evaluation Table

- COIs assessment (previous table) feeds Mission Capability Evaluation
- Evaluate COIs in the context of supporting individual Mission Capabilities (limit missions to most critical/probable?)
- Across all participating variants, evaluate impact on each Mission Capability as Met, Partially Met, or Not Met

		MISSIONS									
		MSN 1 (Conduct Mounted Movement to Contact) (Met, Partially Met, Not Met)									
		A				B				C	
	Overall Variant Assessment	General Purpose	Inf Carrier (Army)	Infantry Carrier (USMC)	C2OTM	Hvy Guns Carrier	Close Combat Wpns Carrier	Utility	Ambulance	Shelter Carrier	Ambulance
COI	Move			Not Required for this msn (NR)			NR	NR	NR	NR	NR
	Transport										
	Carry										
	Payload										
	Sustain										
	Survive										
	Safety										
	Net Ready										

Summary (1 of 2)

- Significant analysis is conducted in the requirements development process
  - Mission Tasks, Gaps and MOEs identified
  - Alternatives selected based on performance against thresholds
- Relationship between Mission Tasks and System Functions established in JCIDS analysis is maintained during the SE decomposition
  - Mission Profile analysis is key to evaluating Suitability characteristics
- Test develops system knowledge over time
  - All phases of test support evaluation of system “maturity”
  - Operational Test evaluates the effect of the System on the Unit Mission performance

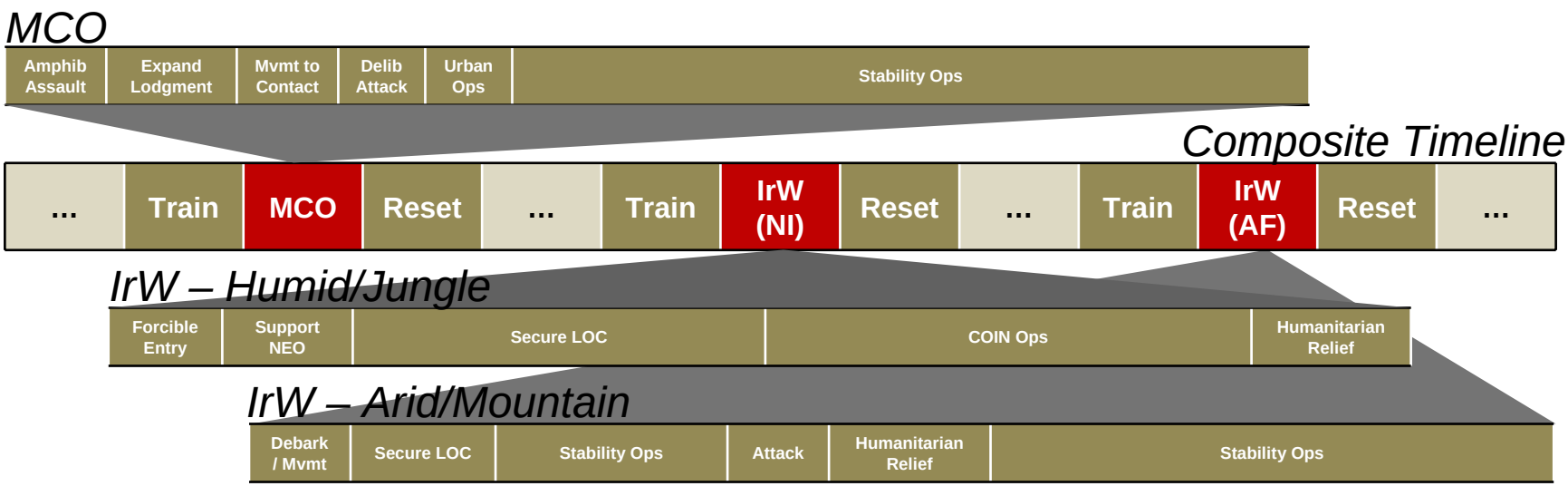
Summary (2 of 2)

- Fiscal and schedule realities typically drive testing to focus on COIs and KPPs
  - System evaluation focuses on Gap Missions and System Functions/Attributes that support mission effectiveness
  - Evaluate Critical Tasks and Issues to identify risk and scope of unknown performance
- Potentially, test results would be used to validate early M&S assumptions and analysis
- Did the system deliver the expected capability?

QUESTIONS

BACKUP

Mission Profile – Operational Context



Operational Context

•MPCs arrive in theater aboard MPF shipping ; move ship to shore at SPOD or via connector (e.g. LCAC)

•Support infantry battalion with three variants:

•Support infantry battalion across ROMO

- Offensive Ops: patrolling, movement in support of maneuver, urban ops
- Defensive Ops: patrolling, support by fire positions
- Stability: patrolling, security ops, QRF, checkpoints, convoy security

Summary

•MCO oriented on forces initially; then control of key areas (APODs / SPODs / Forward Bases / Key Cities) and routes between those areas

•Both IrW scenarios oriented on control of key areas / routes and restoring host nation capability

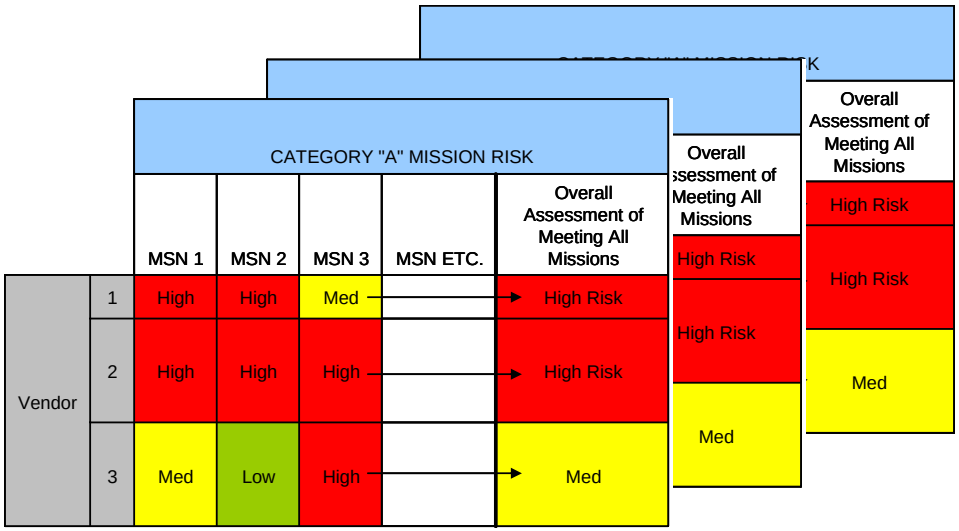
•Even during MCO, large % of operations = stability operations

•Stability operations drives larger % of on-road; wider variety of mission use

Roll Up Mission Risk Tables

- Assess the risk consequence and probability to effectively support the designated missions capabilities.

By Category



By Vendor