



SURVICE
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Evaluation Conference
Hilton Head, SC
12-15 March, 2012



TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Application of the Missions and Means Framework to Combat System Requirements, Development, and Refinement

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Abstract Reference #13724

10 March 2012

Conference Focus

— The 28th Annual National T&E Conference Focus —

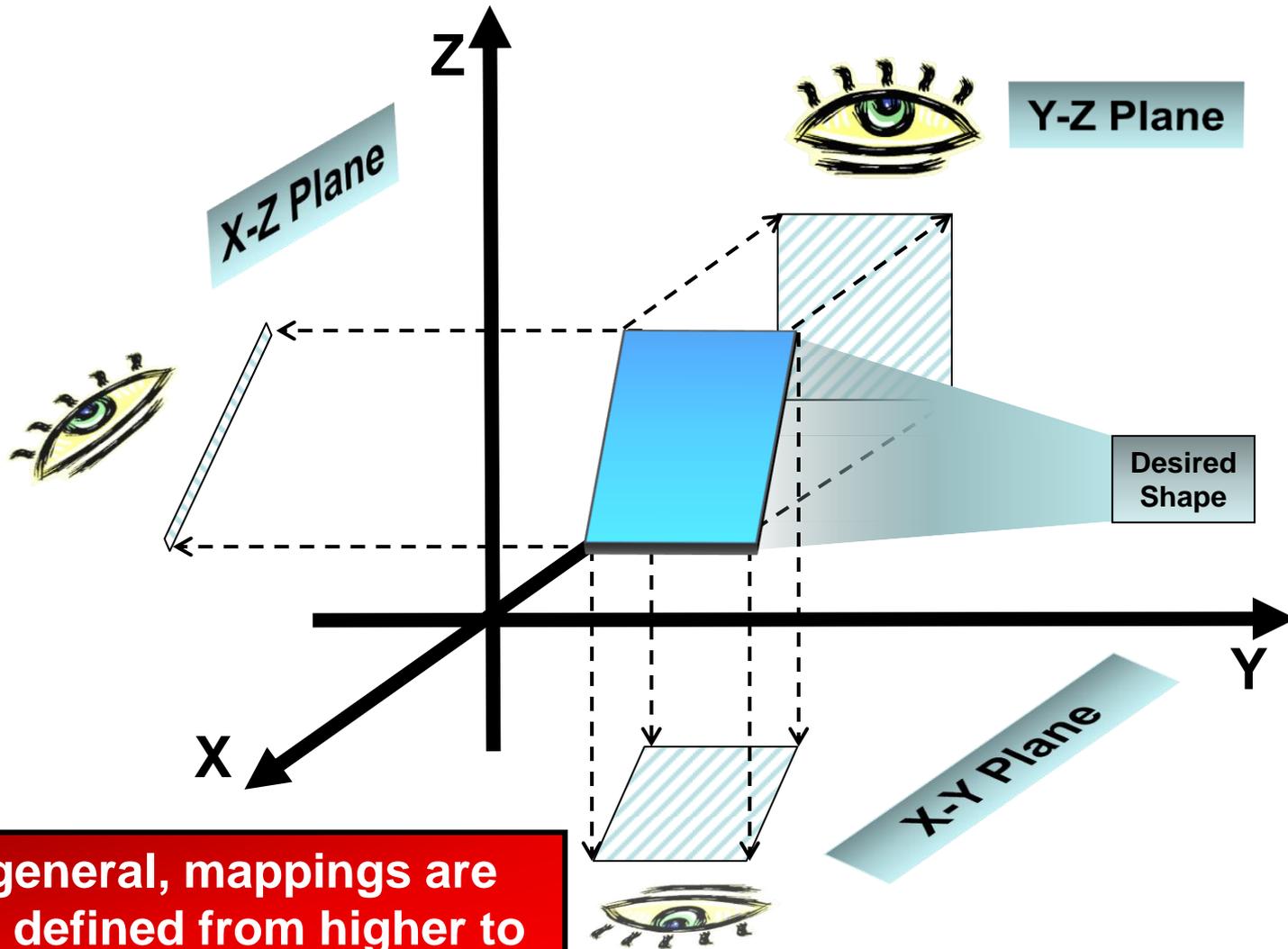
- Proper role of T&E in our Defense System
Requirements Process
- What constitutes a set of valid, measureable, realistic and achievable requirements?
- How can the T&E Community best engage the Defense Community at large?

Implications?

- This requires Defense-wide language, framework, and processes common to all participants
- Establish how the pieces fit together
- Since it's about mission success, better start with the mission
- Objective elements [facts!] – inherently quantifiable
- Subjective elements [opinions!] – must be quantitatively framed

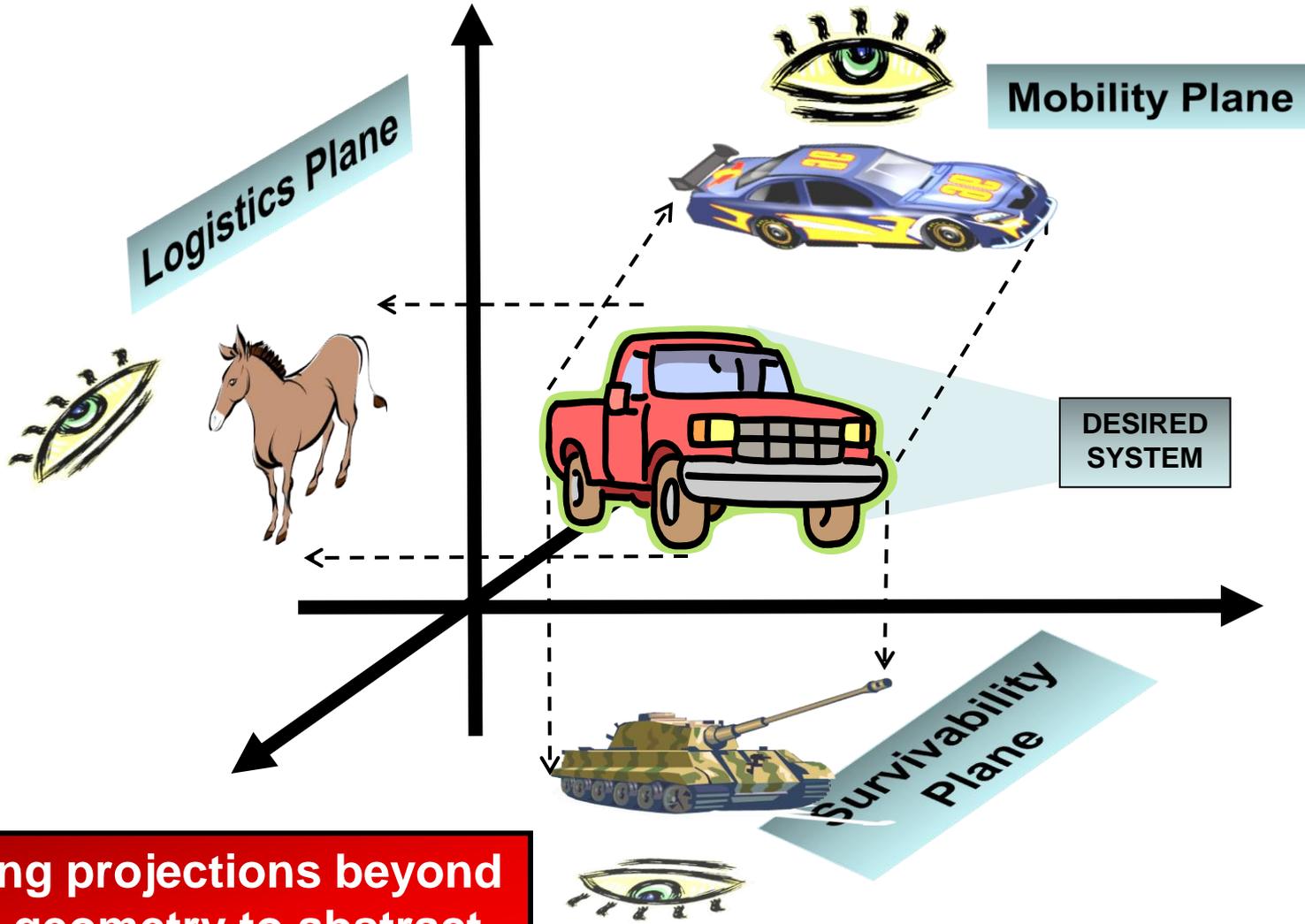
Everyone is entitled to his own opinions, but not his own facts!

Three Mappings from 3-D to 2-D Spaces



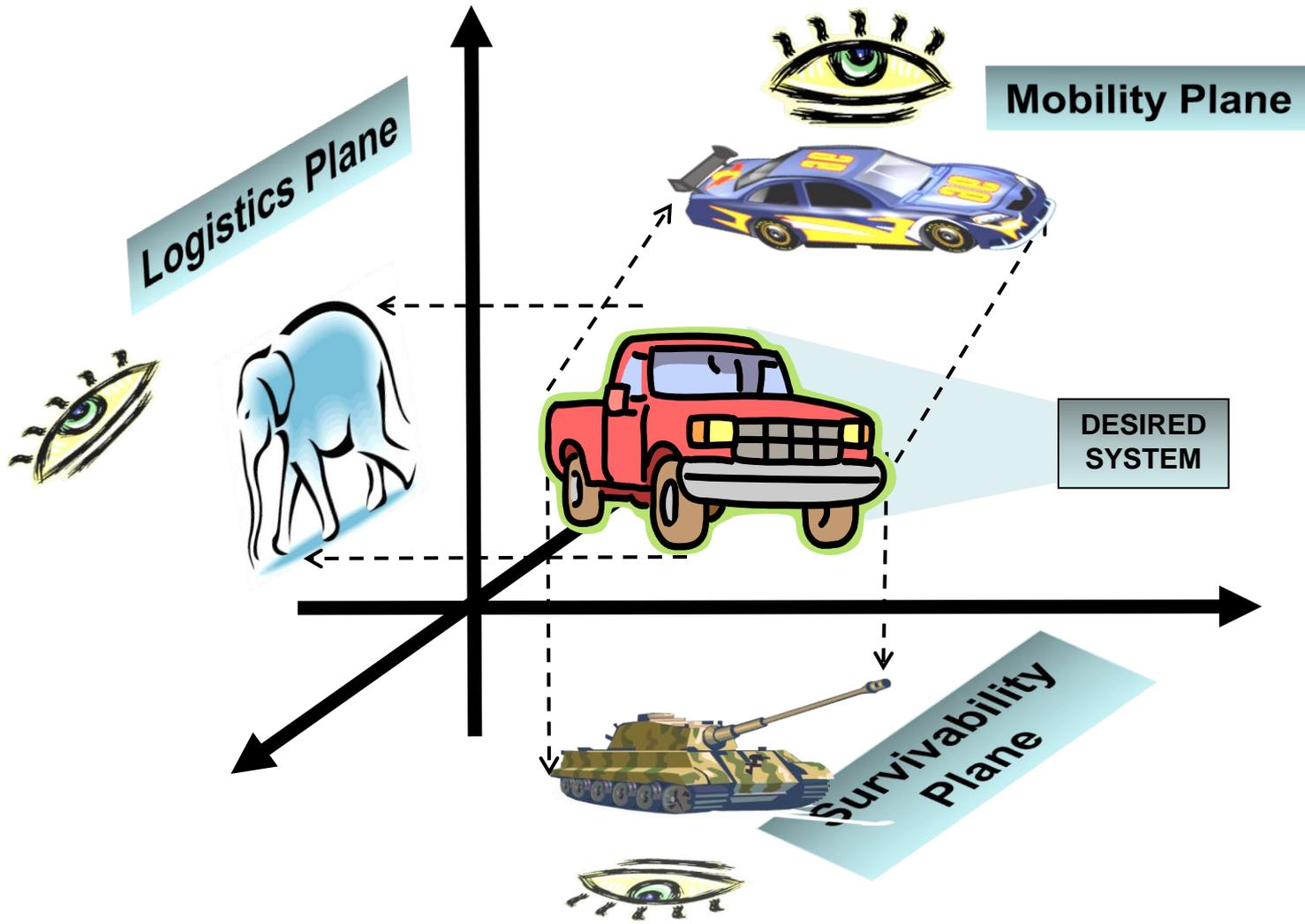
In general, mappings are only defined from higher to lower spaces!

Materiel in n Space



**Taking projections beyond
3-D geometry to abstract
spaces!**

Materiel in n Space‡



‡ An alternate GOP view!

How is warfare prosecuted?

- How do the professionals do it?
- For many years, warfighters have used the Military Decision-Making Process [MDMP] as the underlying structure for planning, structuring, organizing, and executing all manner of missions (whether “kinetic” or not).

MDMP Structure

MOUT Mission Decomposition‡

NATIONAL

Conduct Strategic Deployment and Redeployment
SN 1

Foster Multinational And Interagency relations
SN 8

Support Peace Operations
SN 8.1.3

Conduct Foreign Humanitarian Assistance and Humanitarian and Civic Assistance
SN 8.1.5

Cooperate with and Support NGO's and PVO's
SN 8.1.9

STRATEGIC

Foster Alliance and Regional Relations and Security Arrangements
ST 8.1

Coordinate Humanitarian and Civic Assistance Programs
ST 8.2.4

Cooperate With and Support Nongovernmental Organizations (NGOs) in Theater
ST 8.2.11

Cooperate With and Support Private Voluntary Organizations (PVOs) in Theater
ST 8.2.12

OPERATIONAL

Concentrate Forces in Theater of Operations
OP 1.2.3

TACTICAL

Concentrate Tactical Forces
BT 1.2.1

Top-Down Linkages

Receive Enemy Fire
U-ART 1.2.2.3.3.1

Gunner Returns Fire
U-ART 1.2.6.1.1.2.1.1

Order to Cease Fire
U-ART 1.2.6.1.1.2.1.2

Report of Civilian Casualties
U-ART 1.2.6.1.1.2.1.3

Order to Break Contact
U-ART 1.2.6.1.1.2.1.4

Evacuation of Civilian Casualties
U-ART 4.5.1.1.1

Horizontal Linkages

‡ Mission build by Dynamics Research Corporation, Nov 2000

The Military Decision-Making Process [MDMP]

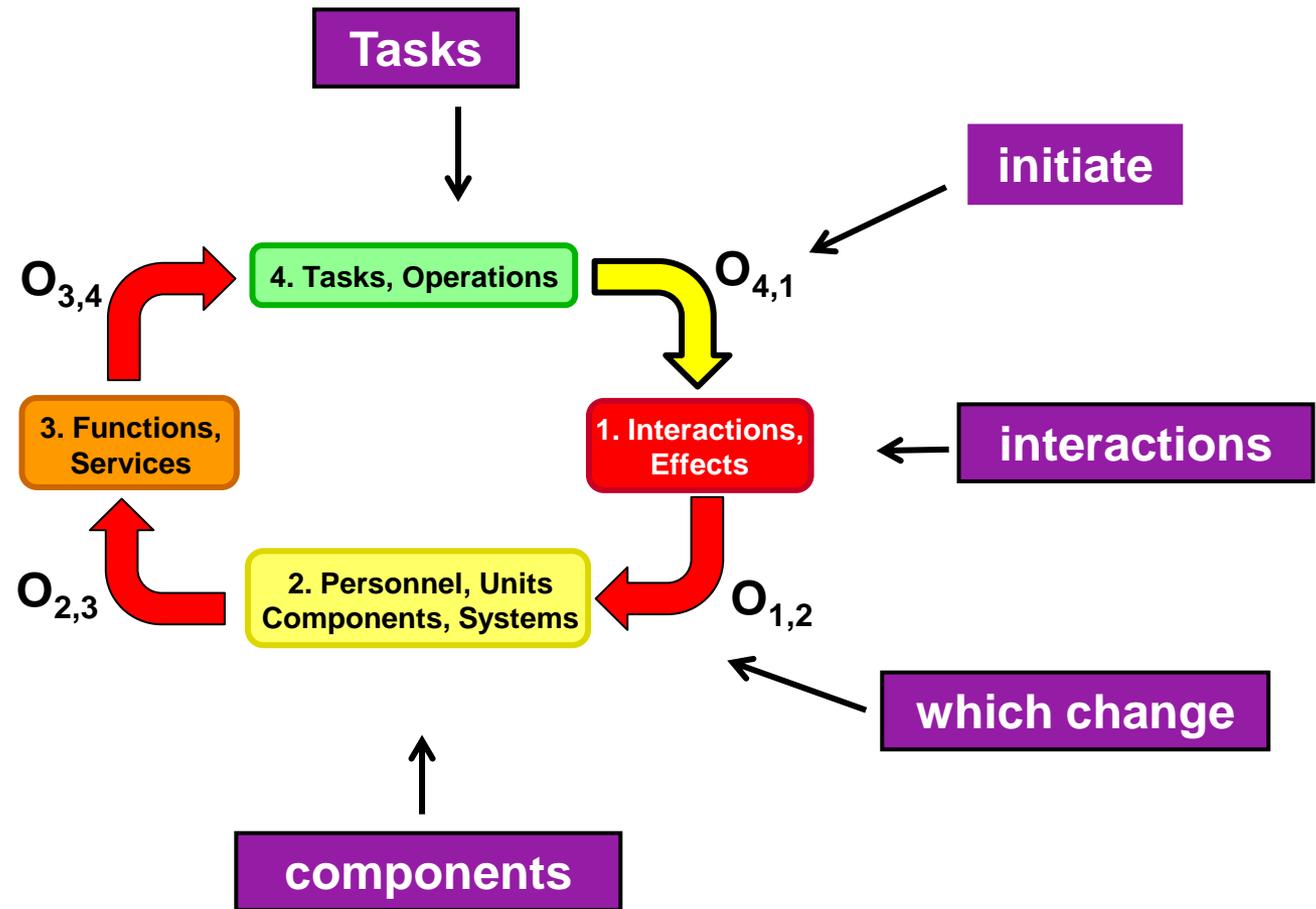
- The MDMP is all about task execution! Tasks are ubiquitous!
- When informed by key *reference missions*, the MDMP should serve as the single integrating framework for the community.
- Materiel Requirements should derive from successful task execution, under appropriate conditions and standards.



The MDMP & MMF

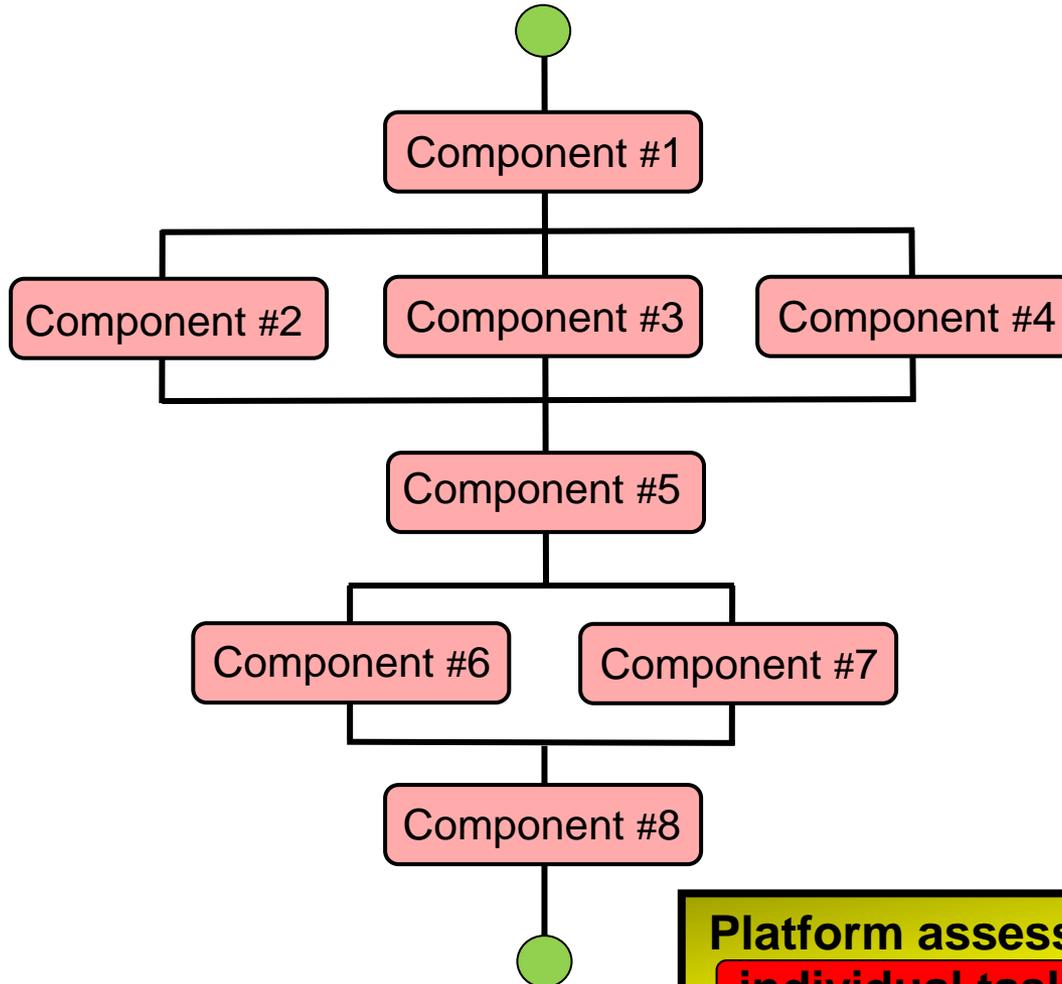
- Since the LF programs of the 1980s, Army V/L modelers have searched for supporting frameworks/data structures
- An early structure, the “V/L Taxonomy”, was developed in 1985
- The “Missions & Means Framework” [MMF] followed in 2002
 - MMF is merely an attempt to formalize the MDMP!
 - Some of the MMF structure and symbolism will be used in what follows

So how are Tasks executed? [1/4]



Interplatform Component Linkage

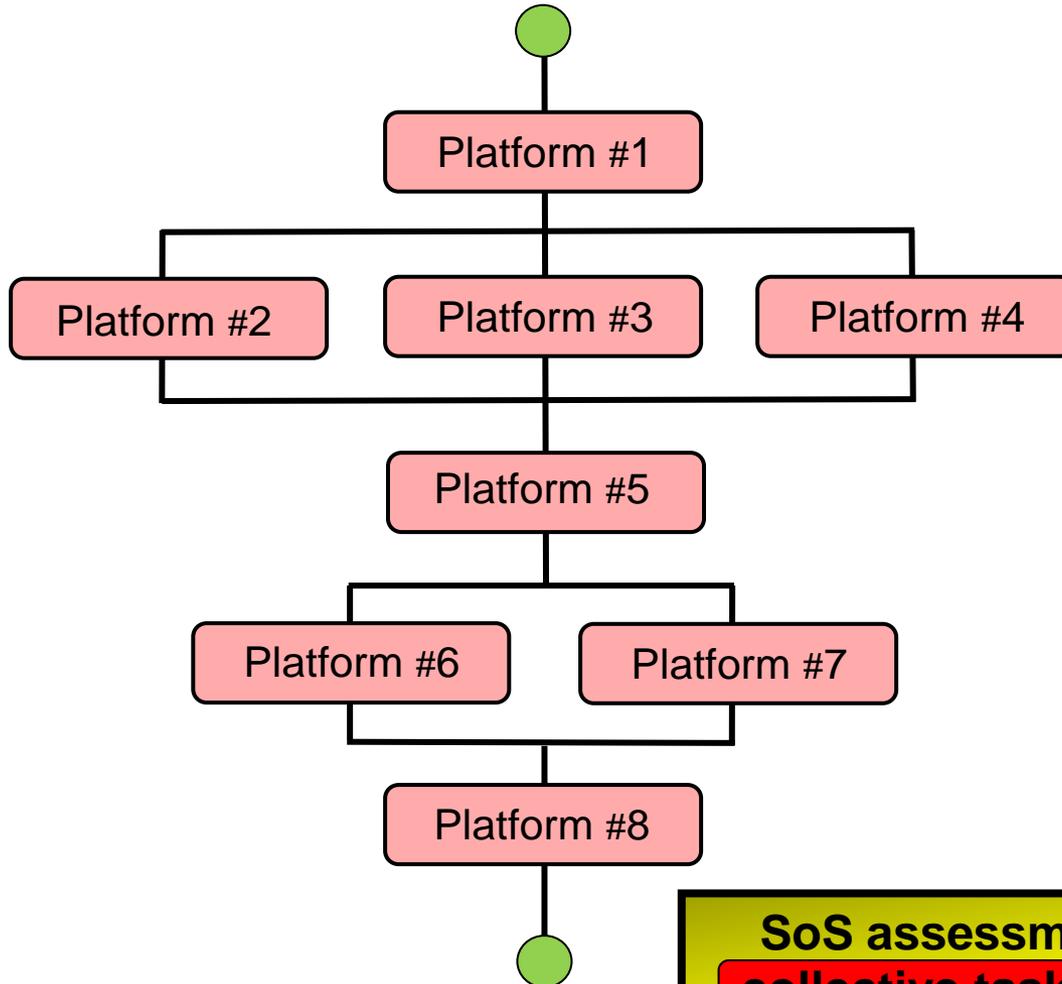
2. Personnel, Units
Components, Systems



**Platform assessment based on
individual task performance!**

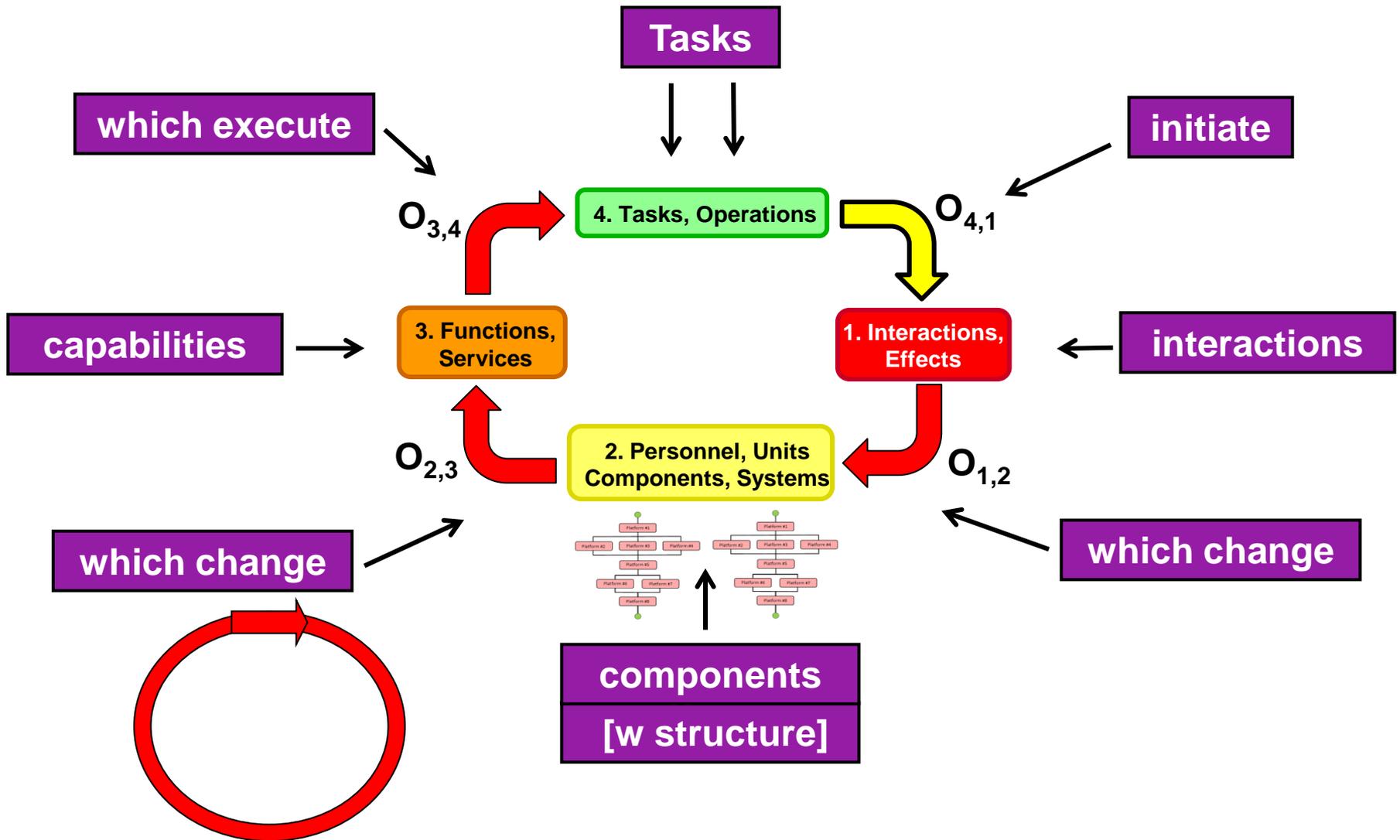
Intraplatform Linkage: Key SoS Construct

2. Personnel, Units
Components, Systems



**SoS assessment based on
collective task performance!**

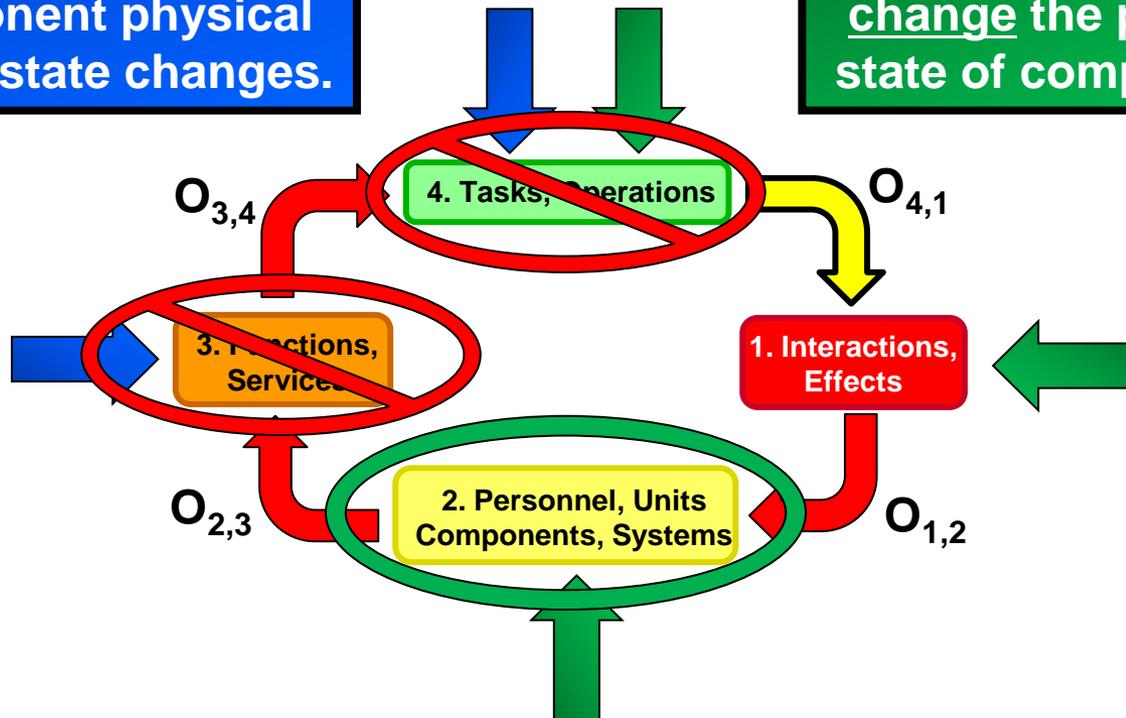
So how are Tasks executed? [4/4]



Important Takeaway [1/2]

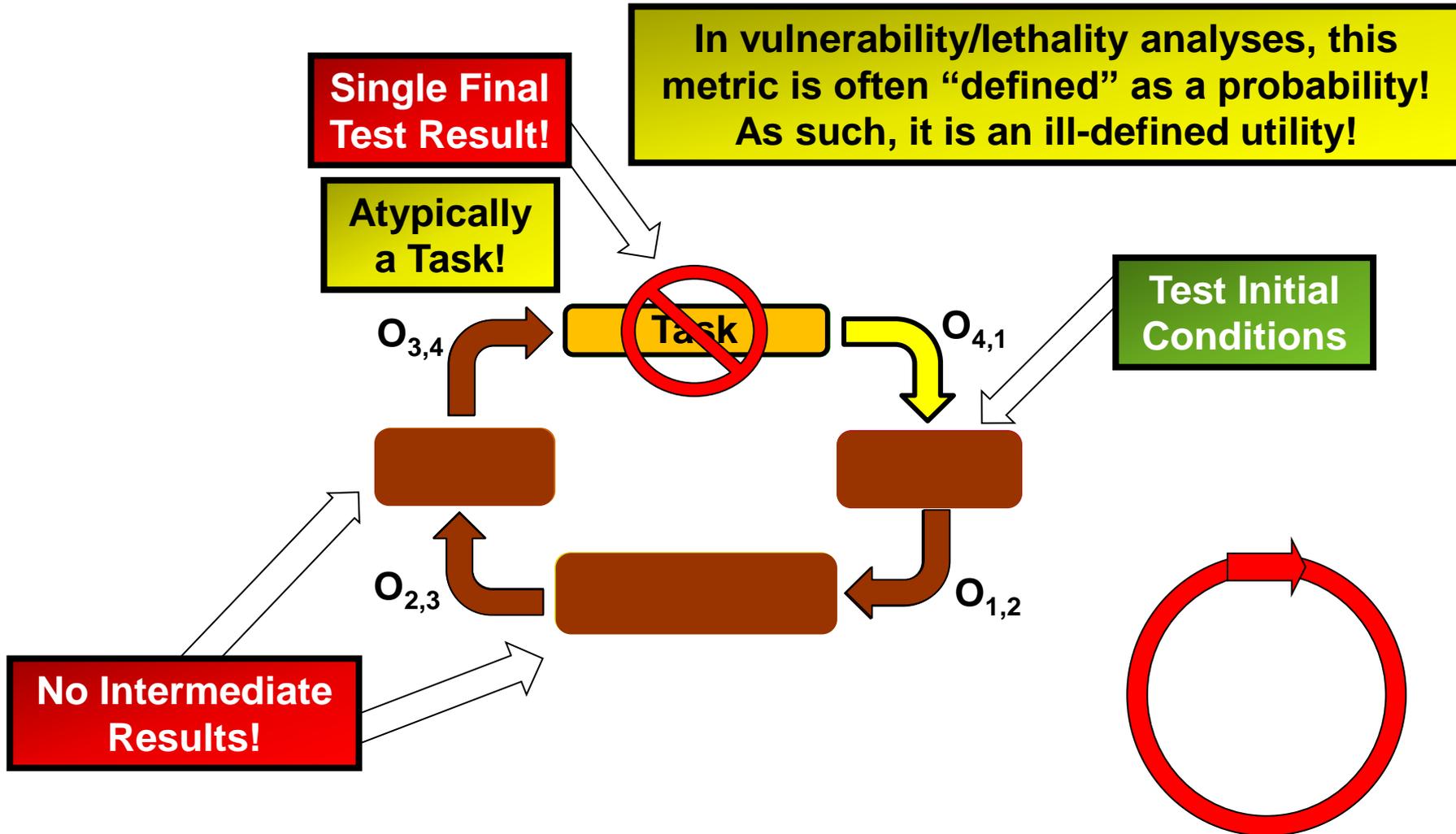
Capabilities (Functions) & Tasks (i.e., Utilities) derive from component physical & functional state changes.

Note: Tasks initiate events which directly change the physical state of components!



Aggregation/integration of multiple interactions/effects must take place at **Level 2**, NOT **Levels 3** or **4**!

Typical Lumped-Task Simulation [1/2]



Typical Lumped-Task Simulation [2/2]

- Lumped metrics are problematic wrt both interpretation and integration with other parameters!
- Without context and intermediate results, the contribution of each of the three components (physical state change, capability change, change in mission challenge) cannot be apportioned to create data extensibility.
- The inability to define the “PK” metrics objectively/quantitatively as well as lack of objective intermediate damage and performance metrics contributed greatly to the Live Fire Program issues in the 1980s.

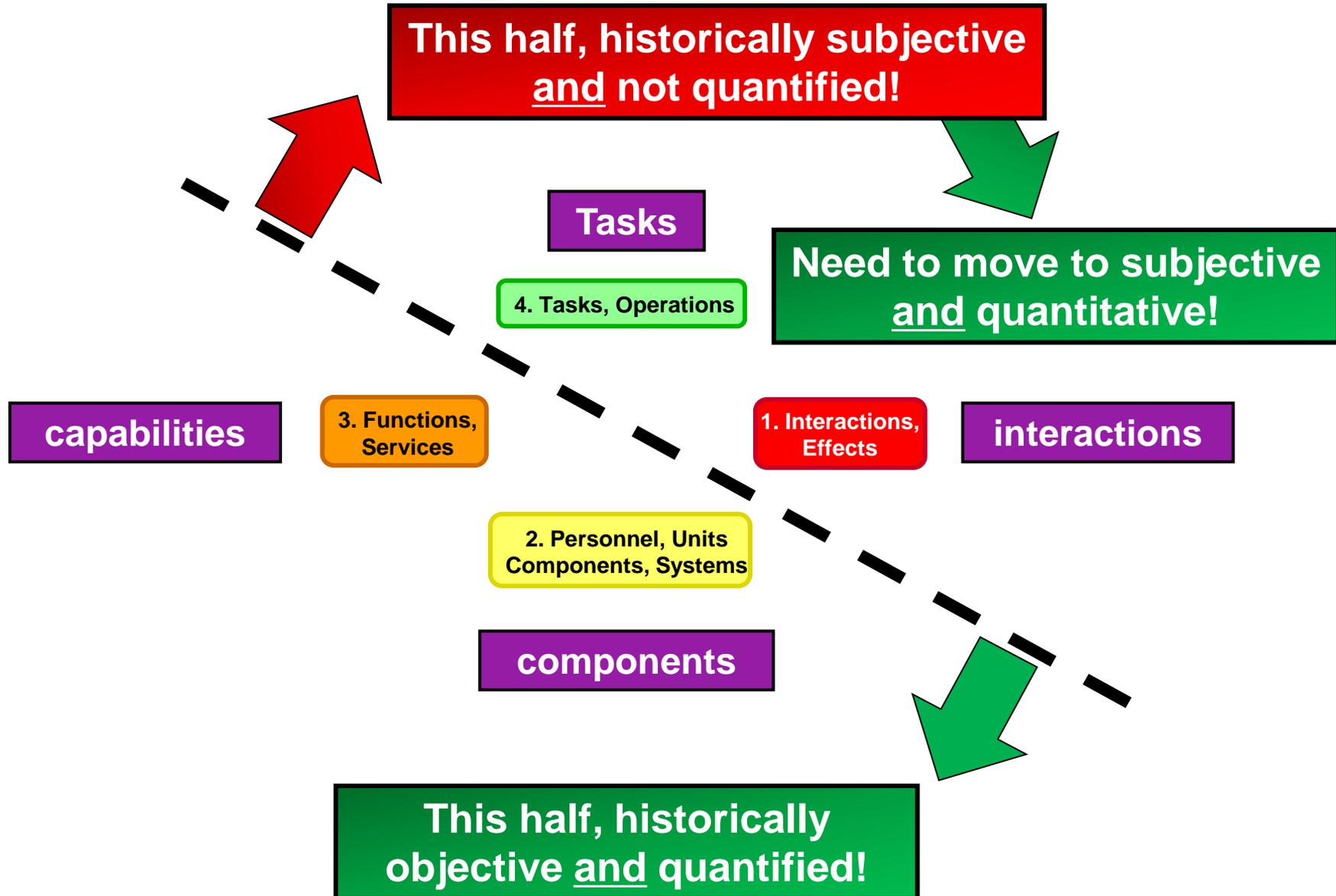
Important Takeaway [2/2]

However for a fifty years, vulnerability analysts and modelers have been taking Level 4., so-called “probabilities”, and combining them using the Survivor Sum Rule,[‡] e.g.:

Ballistic Vulnerability Example

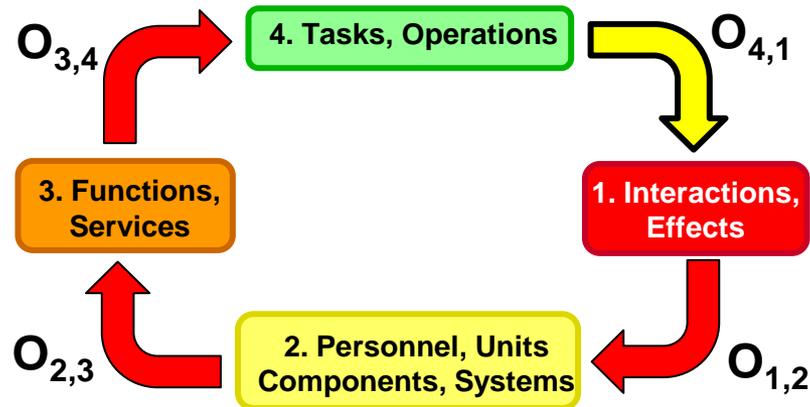
[‡] Caveat Emptor: The Survivor Sum Rule applies only when metrics are both true probabilities and independent! Here, neither condition accrues! Sorry, and good luck!

So how do Tasks get generated?



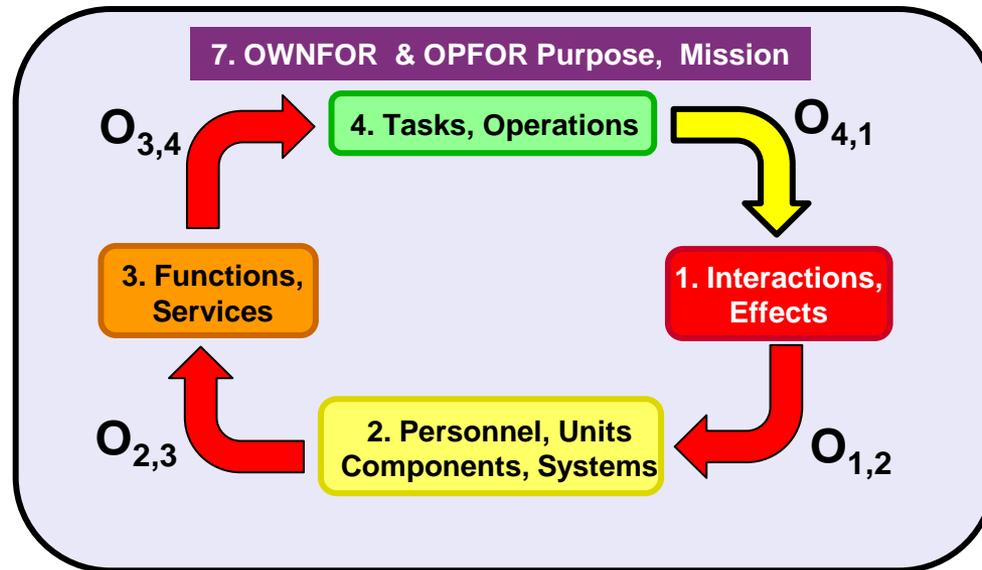
Supporting Contexts [1/4]

The Principal Elements are necessary, but not sufficient, to define a full representation of the MDMP.



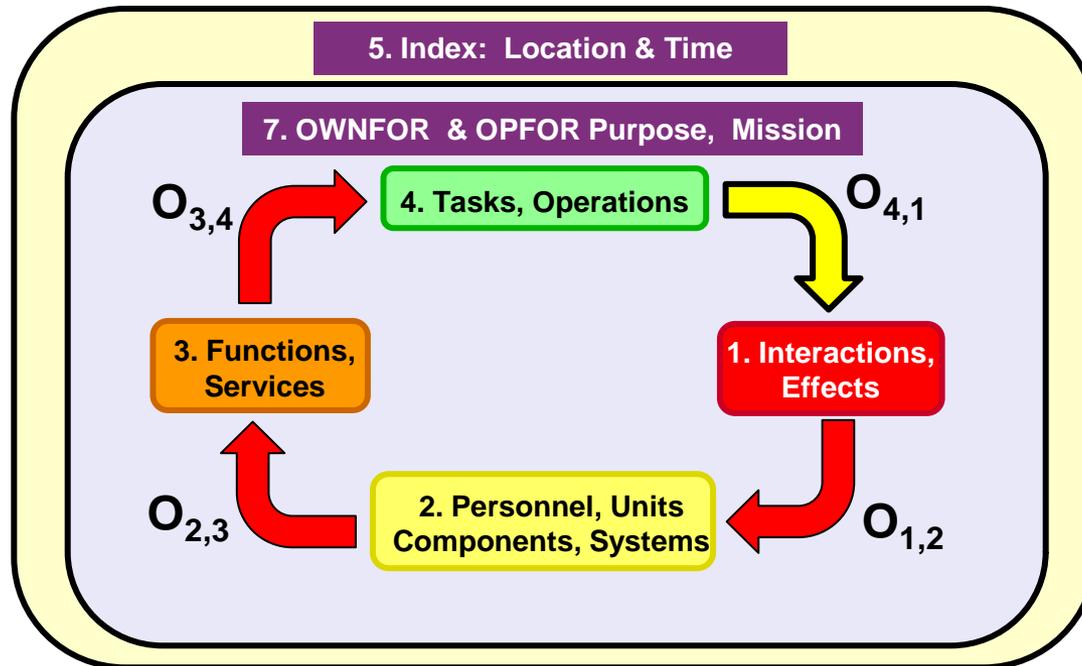
Supporting Contexts [2/4]

Level 7: OWNFOR & OPFOR Purpose, Mission



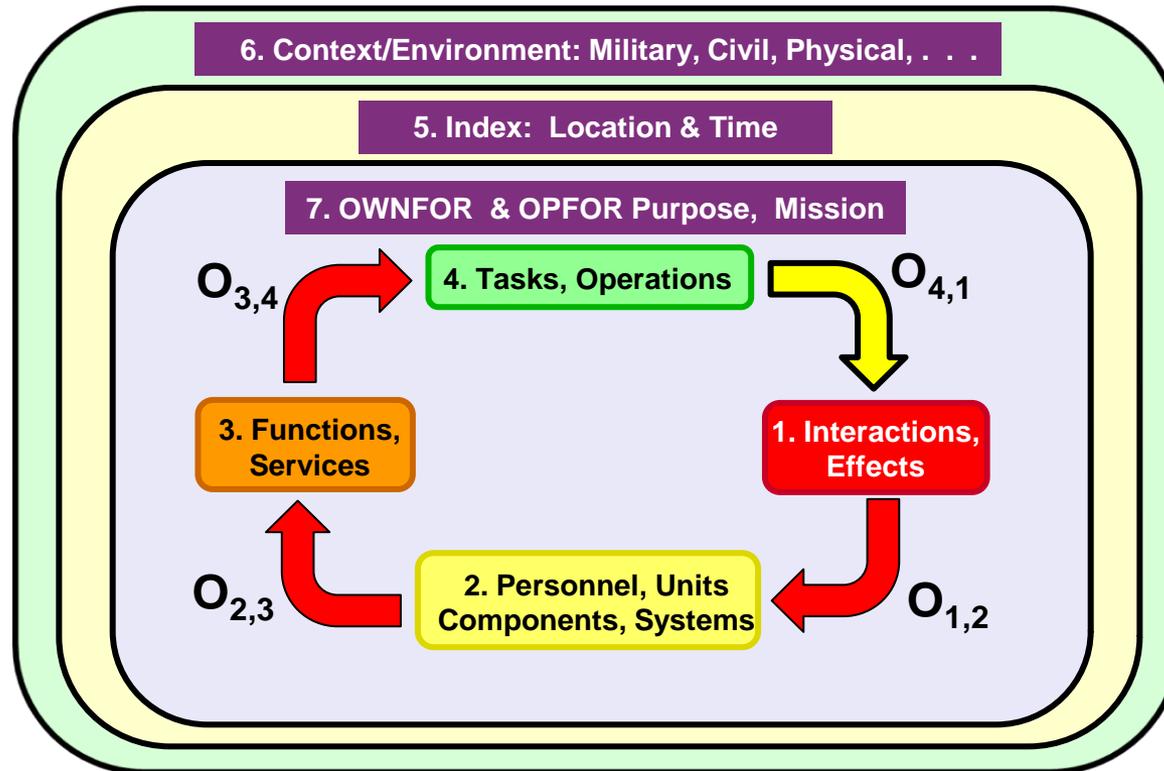
Supporting Contexts [3/4]

Level 5: Index- Location & Time



Supporting Contexts [4/4] ‡

Level 6: Environment- Military, Civil, Physical, . . .



‡ The OPFOR is not shown!

Context is critical for all mapping levels!

A "Lego" Collection of Mission/Performance Elements

Ability to Mix & Match Levels & Operators

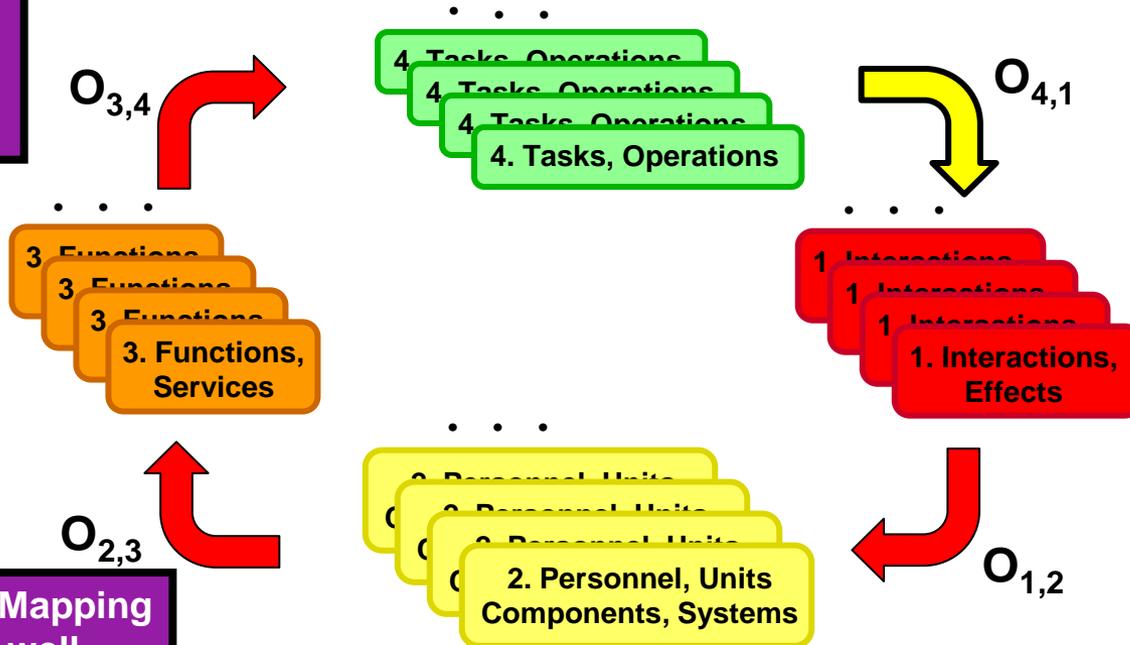
Capabilities described in task-compatible metrics

- ≈ 2200 Universal Joint Tasks
 - ≈ 350 Condition Descriptors
 - ≈ 4 Standards per Task
- ≈ 680 Army Universal Tasks
 - ≈ 350 Condition Descriptors
 - ≈ 4 Standards per Task

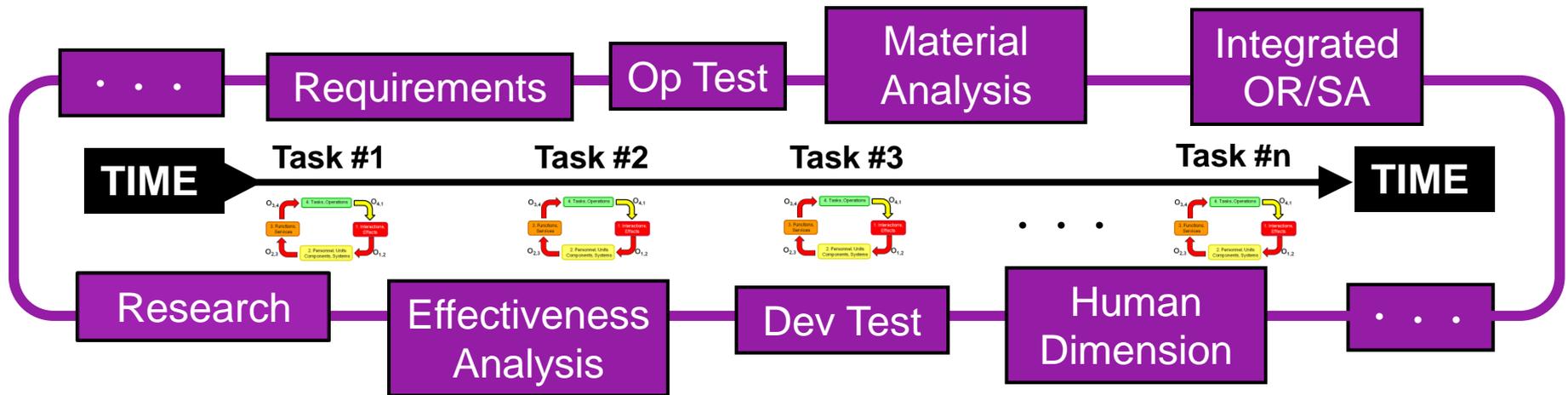
- Ballistic Effects
- Jamming
- Damage Repair
- Chemical
- Resupply
- Repair
- Laser Damage
- Sleep
- Directed Energy
- Nuclear
- Physics of Failure
- Logistics Burdens
- Reliability
- Fair Wear & Tear
- Fatigue
- Heat Stress
- ...
- ...

Degraded States Mapping Methodology well established

Unlimited geometric & material configurations/structures



Sequence of Task Cycles Forms TOEL

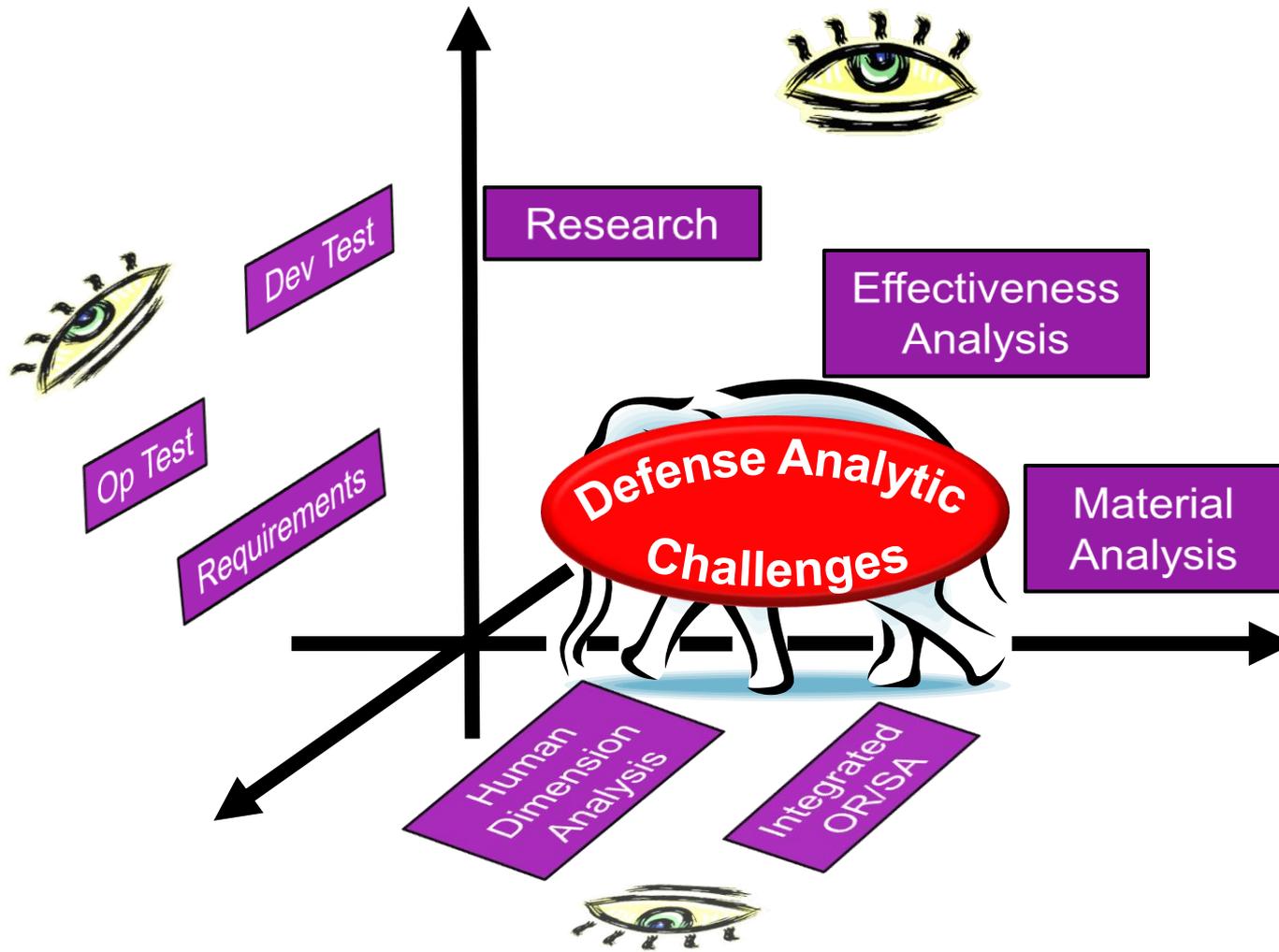


- Missions are composed of task sequences
- Following task initiation, an event cycle occurs
- As a result, material, capability, and utility changes may follow
- The “lego” elements can be combined endlessly with great extensibility
- All communities of interest can focus on the specific elements with clarity, define sharing or exclusivity with others, understand precedence, dependencies, . . .

Are the Venn data sets  or  or  ?

Today's World: The Blind Men & the Elephant?

— Metrics in an *ad hoc*, “bottom-up” world —

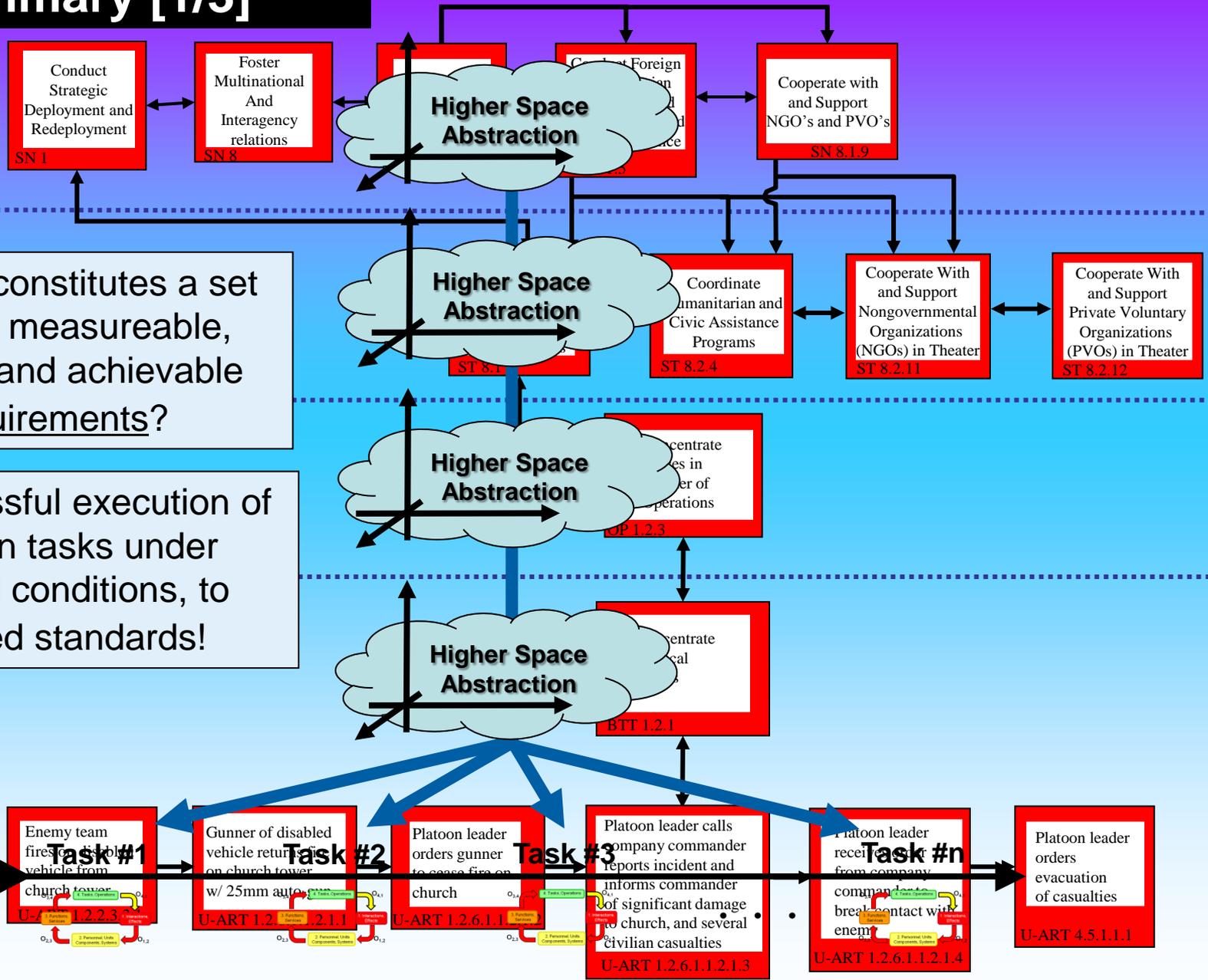


Single Reference Object: Multiple Perceived Projections

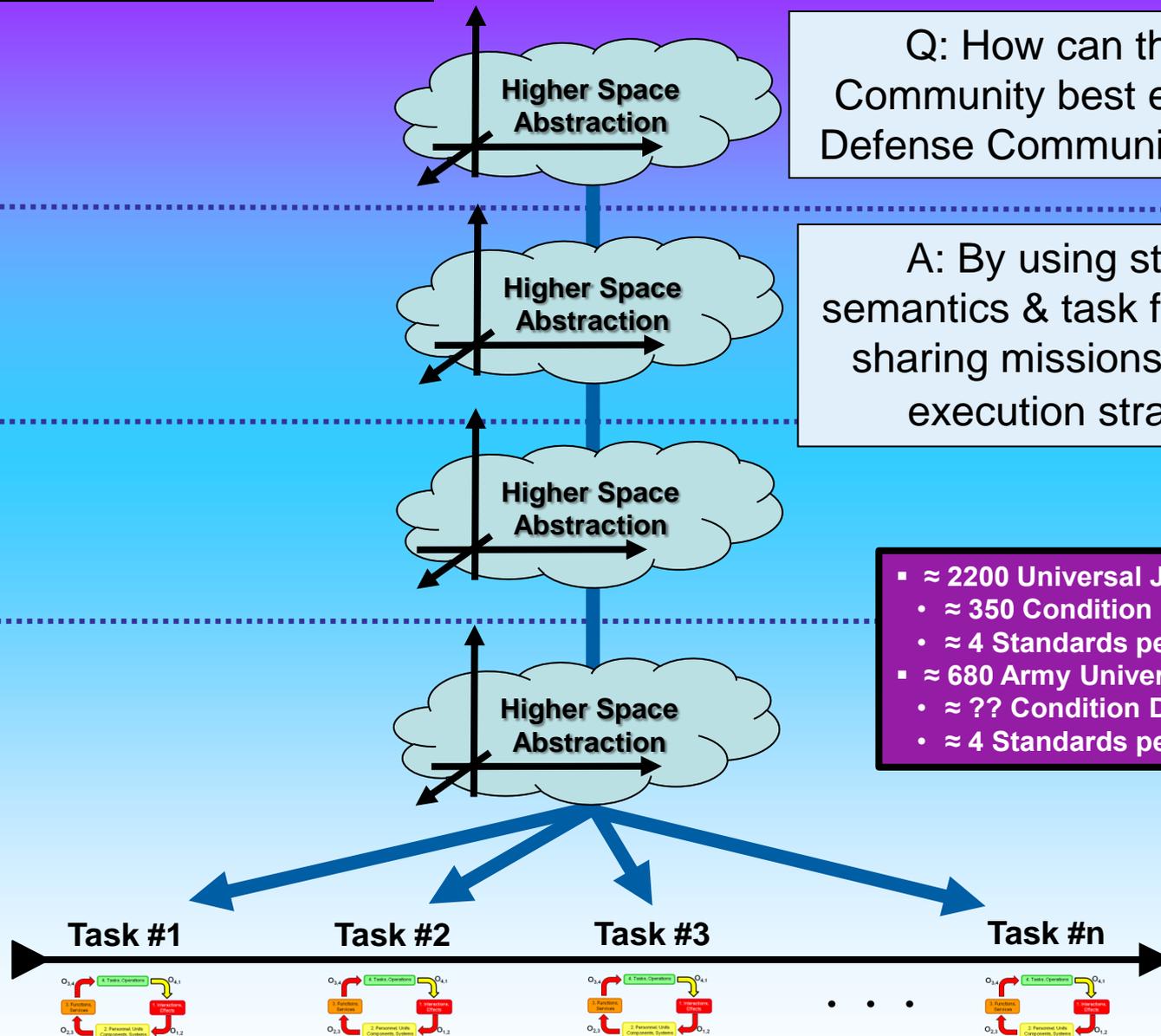
Summary [1/3]

Q: What constitutes a set of valid, measurable, realistic and achievable requirements?

A: Successful execution of mission tasks under defined conditions, to defined standards!



Summary [2/3]



Q: How can the T&E Community best engage the Defense Community at large?

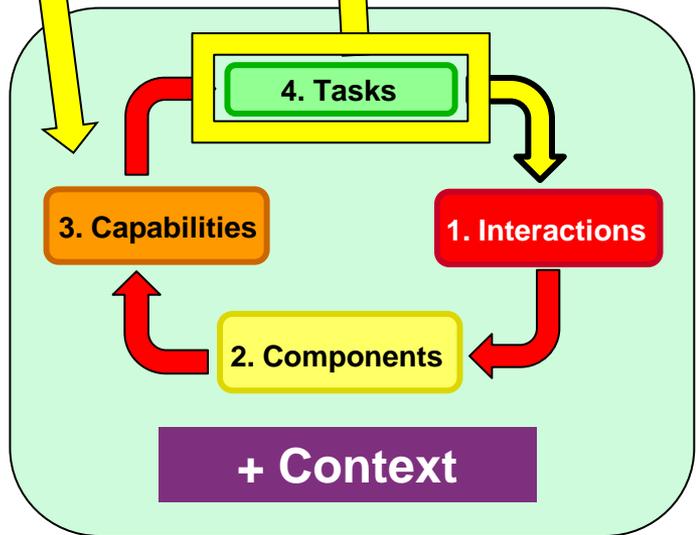
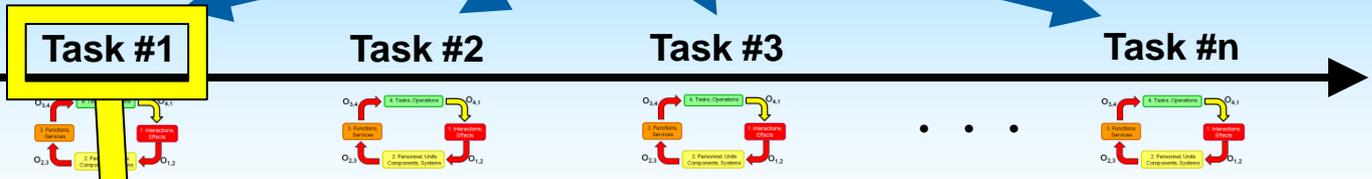
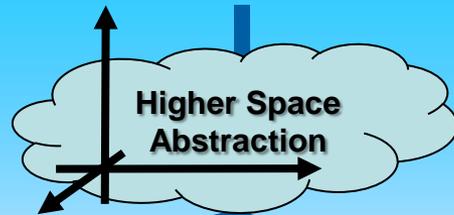
A: By using standard semantics & task frameworks, sharing missions and task-execution strategies.

- ≈ 2200 Universal Joint Tasks
- ≈ 350 Condition Descriptors
- ≈ 4 Standards per Task
- ≈ 680 Army Universal Tasks
- ≈ ?? Condition Descriptors
- ≈ 4 Standards per Task

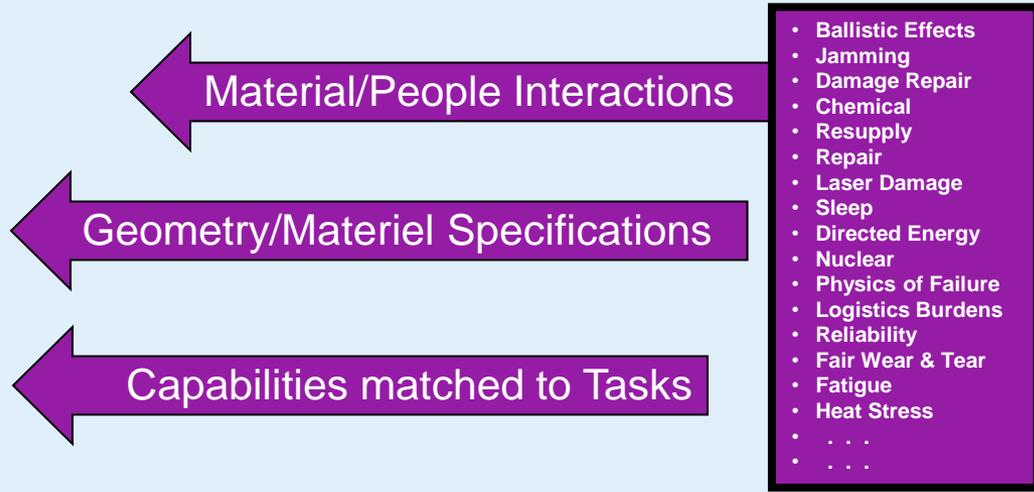
Summary [3/3]

Q: How can the T&E Community best engage the Defense Community at large?

Capabilities described in task-compatible metrics



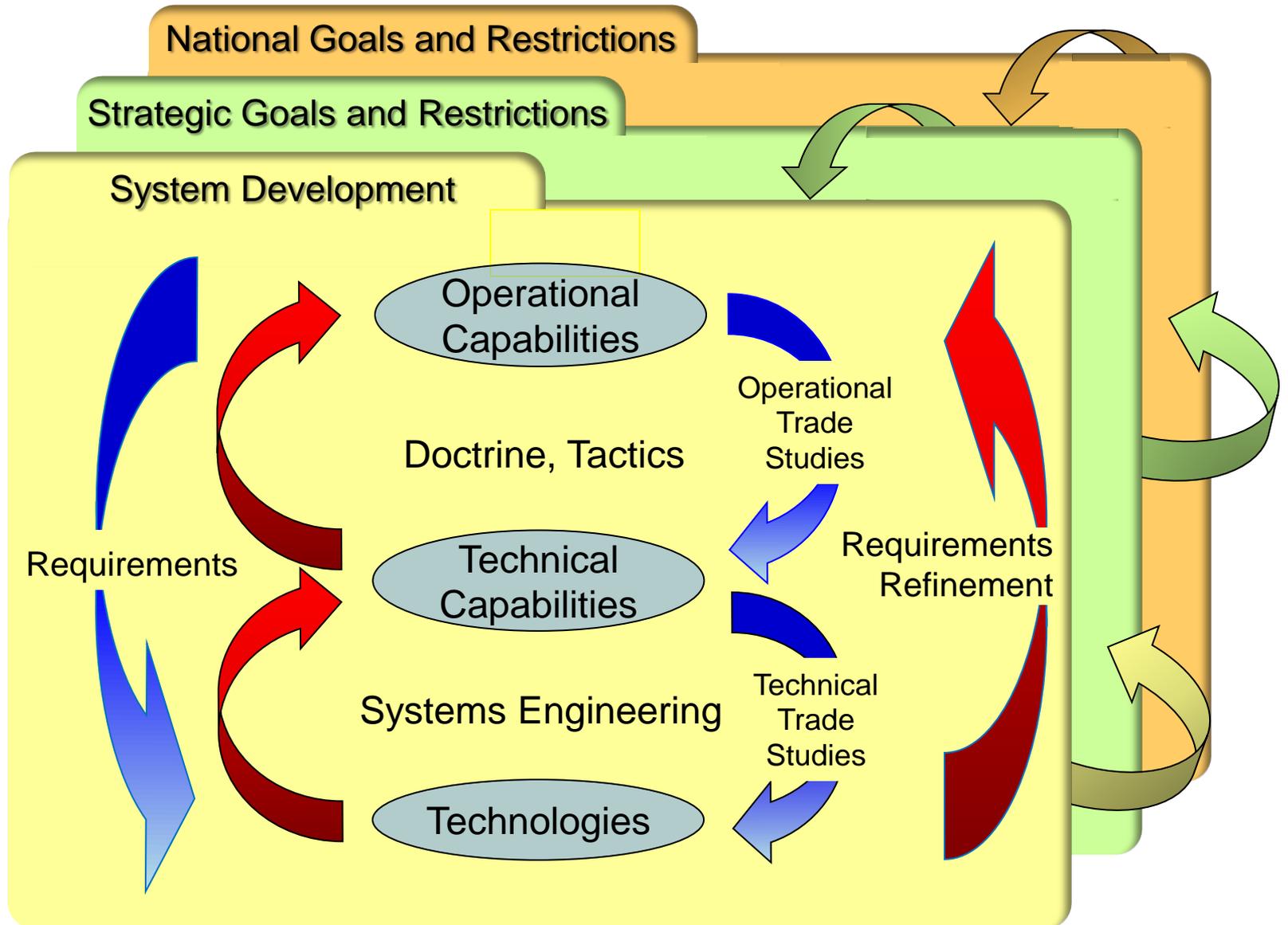
A: ■ Link Task Definition to Task Execution
 ■ Share Task Execution methods, measures & data structures across the Community



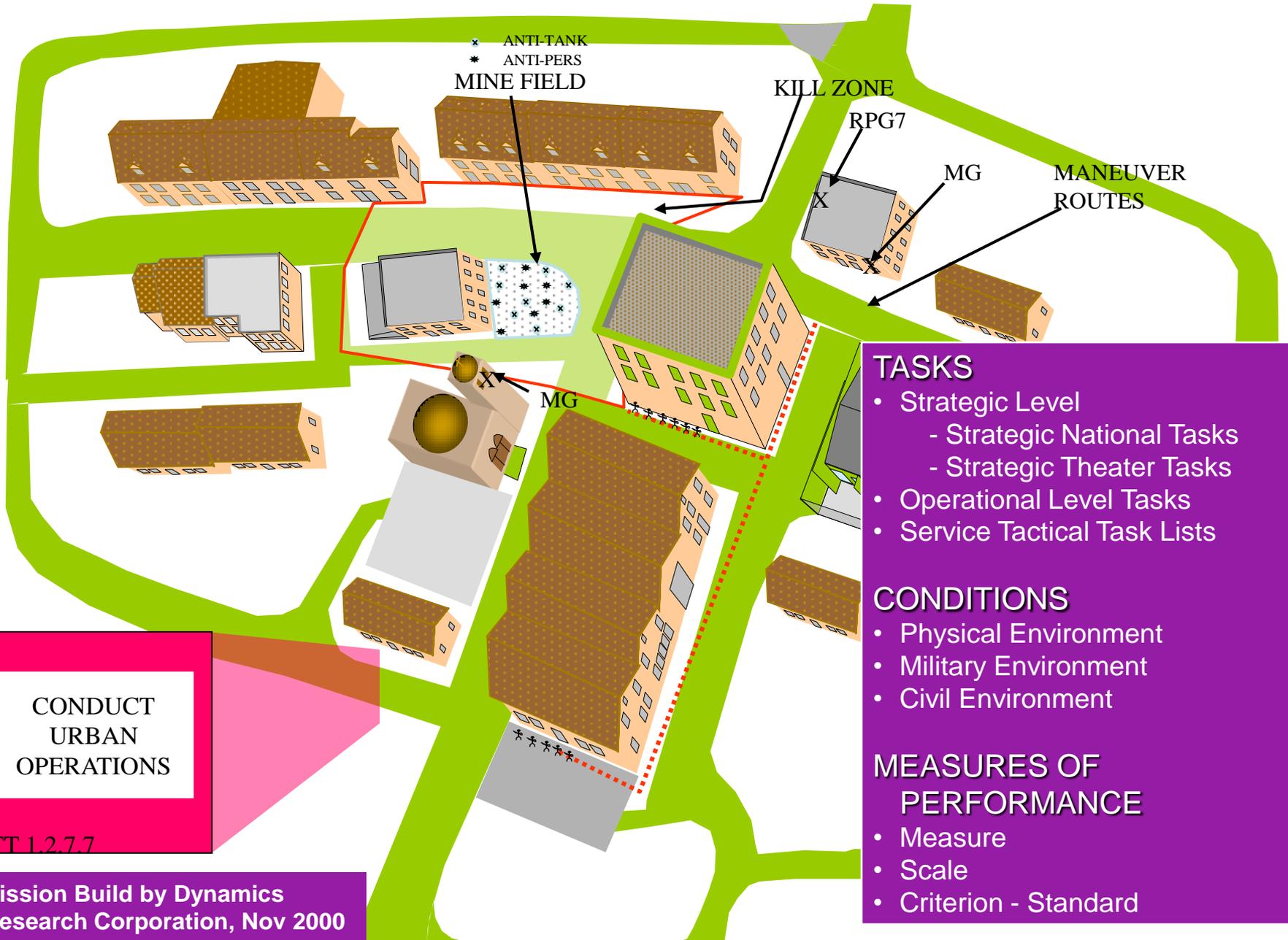
- Ballistic Effects
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- Fatigue
- Heat Stress
- . . .
- . . .
- . . .

End

A Requirements Development Model

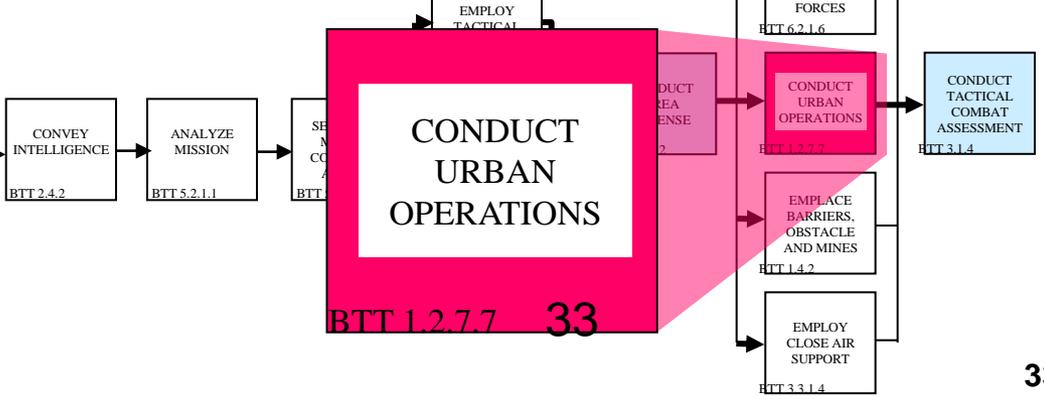
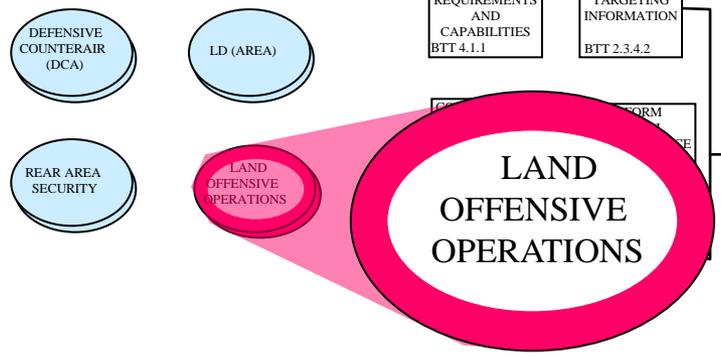
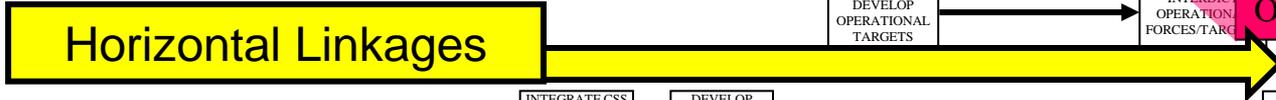
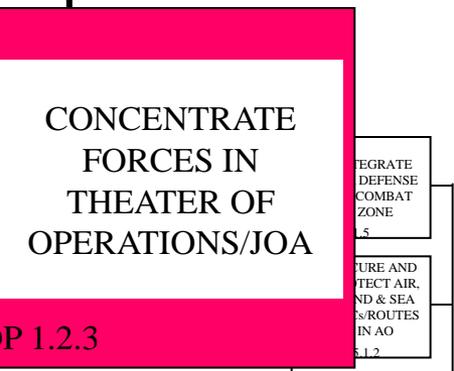
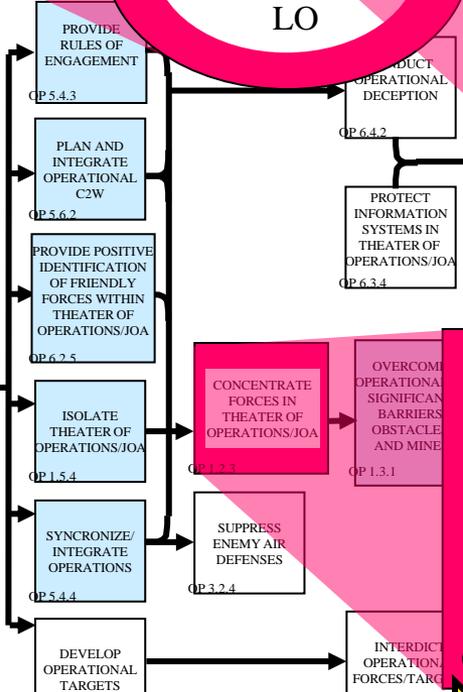
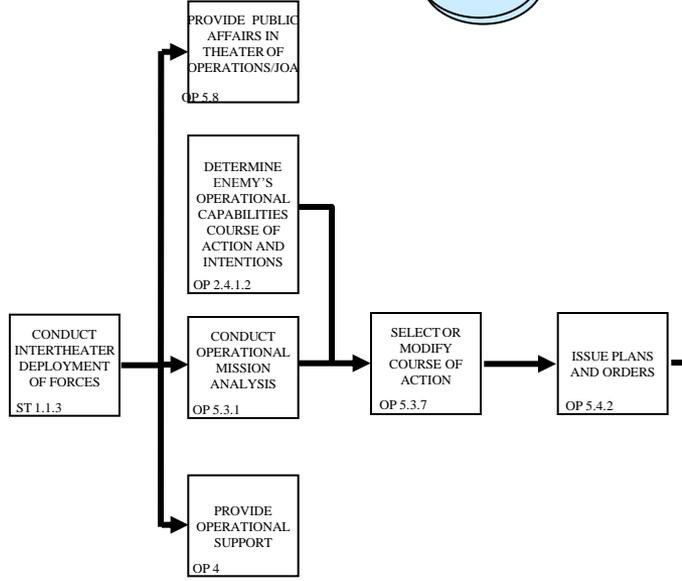
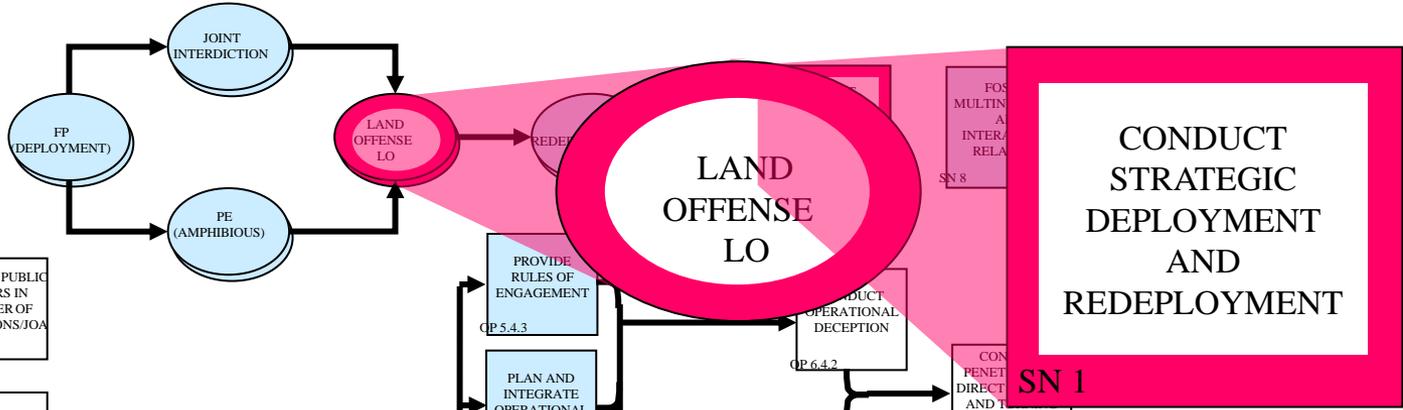
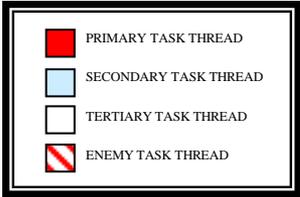


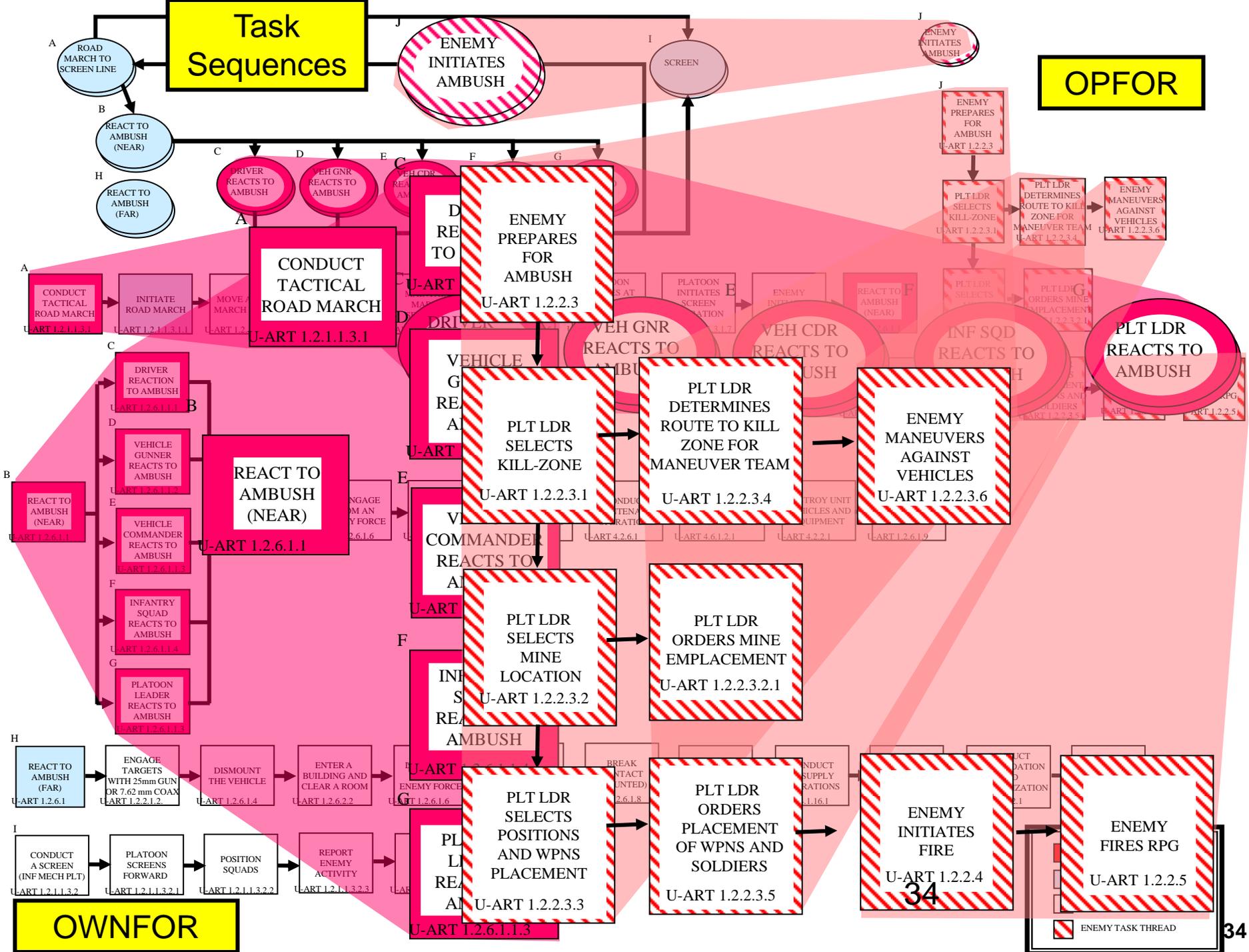
Structuring a Military Mission‡ using the MDMP



BTT 1.2.7.7

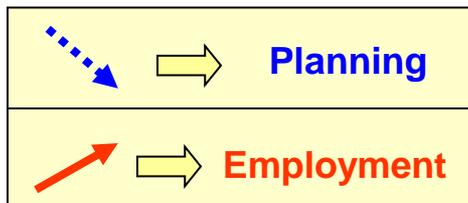
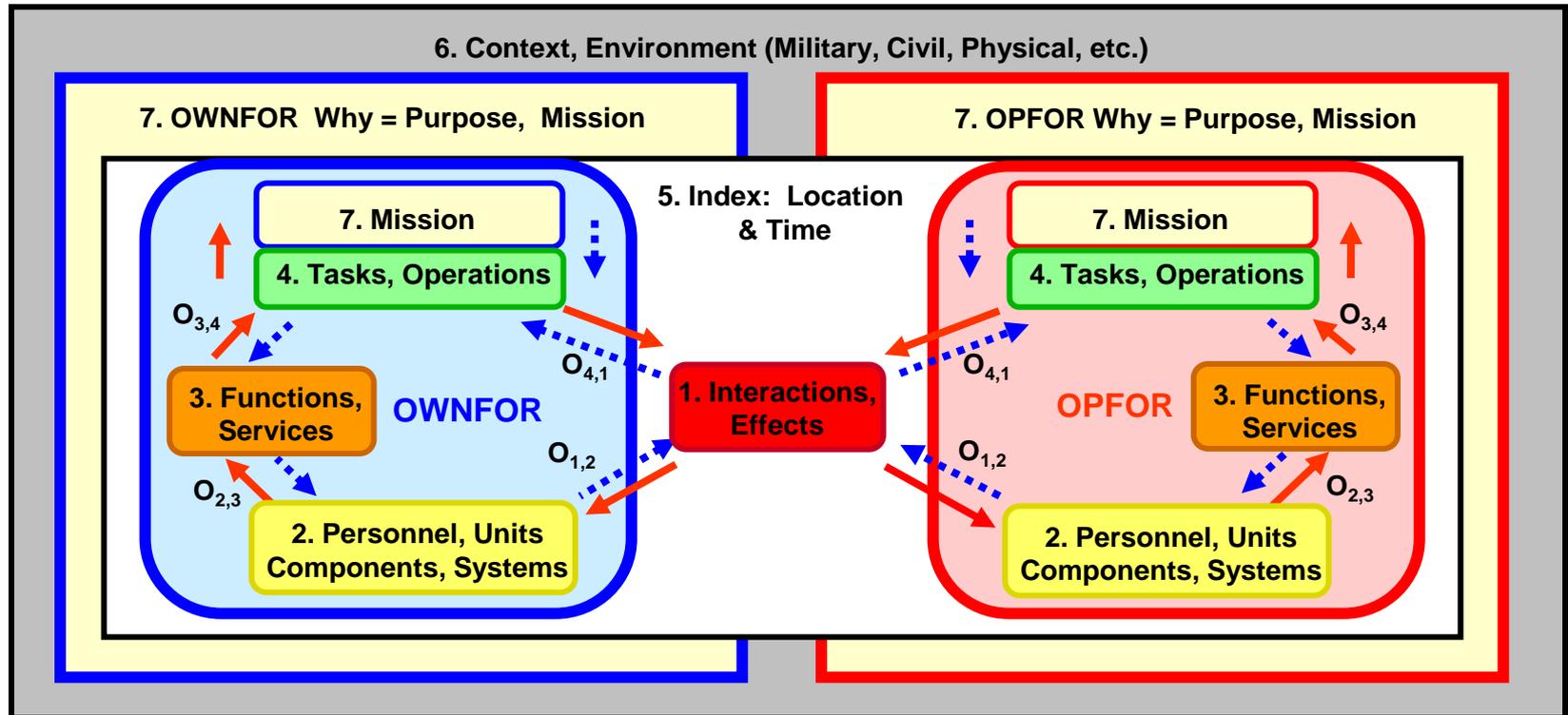
‡ Mission Build by Dynamics
Research Corporation, Nov 2000





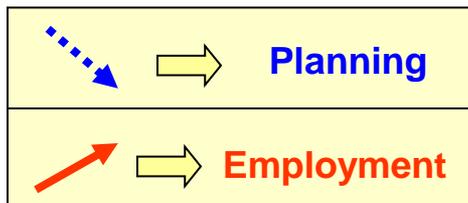
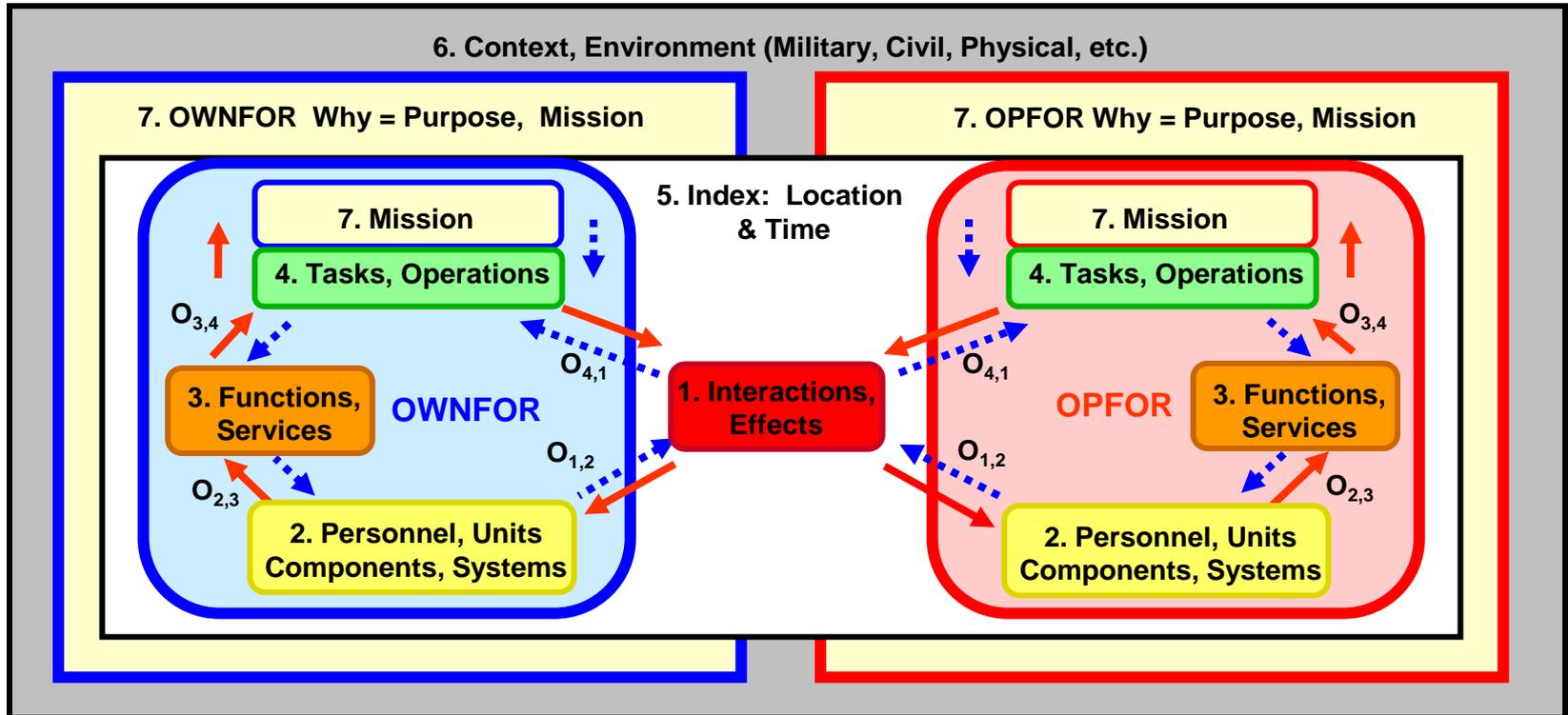
MMF Iconic Representation

11 Fundamental Elements: 7 Levels, 4 Operators



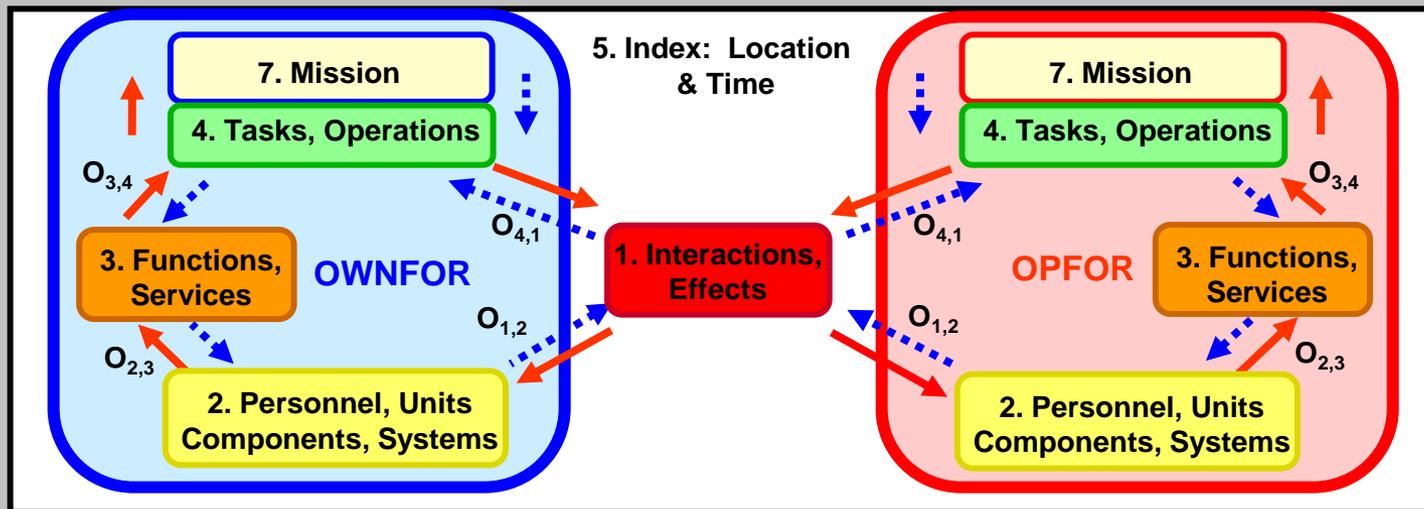
JCIDS via MMF Representation [1/3]

11 Fundamental Elements: 7 Levels, 4 Operators

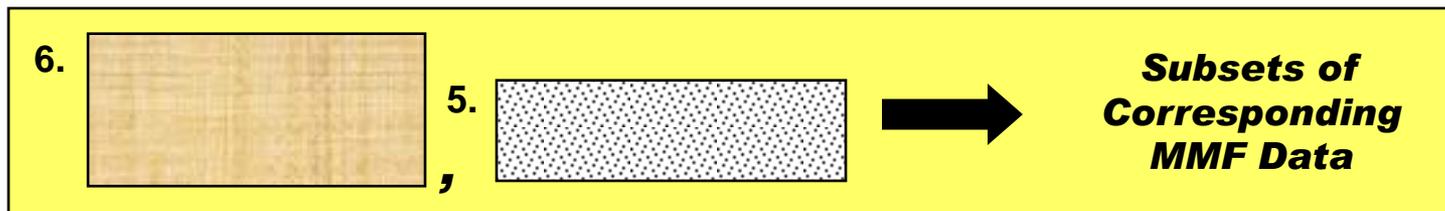
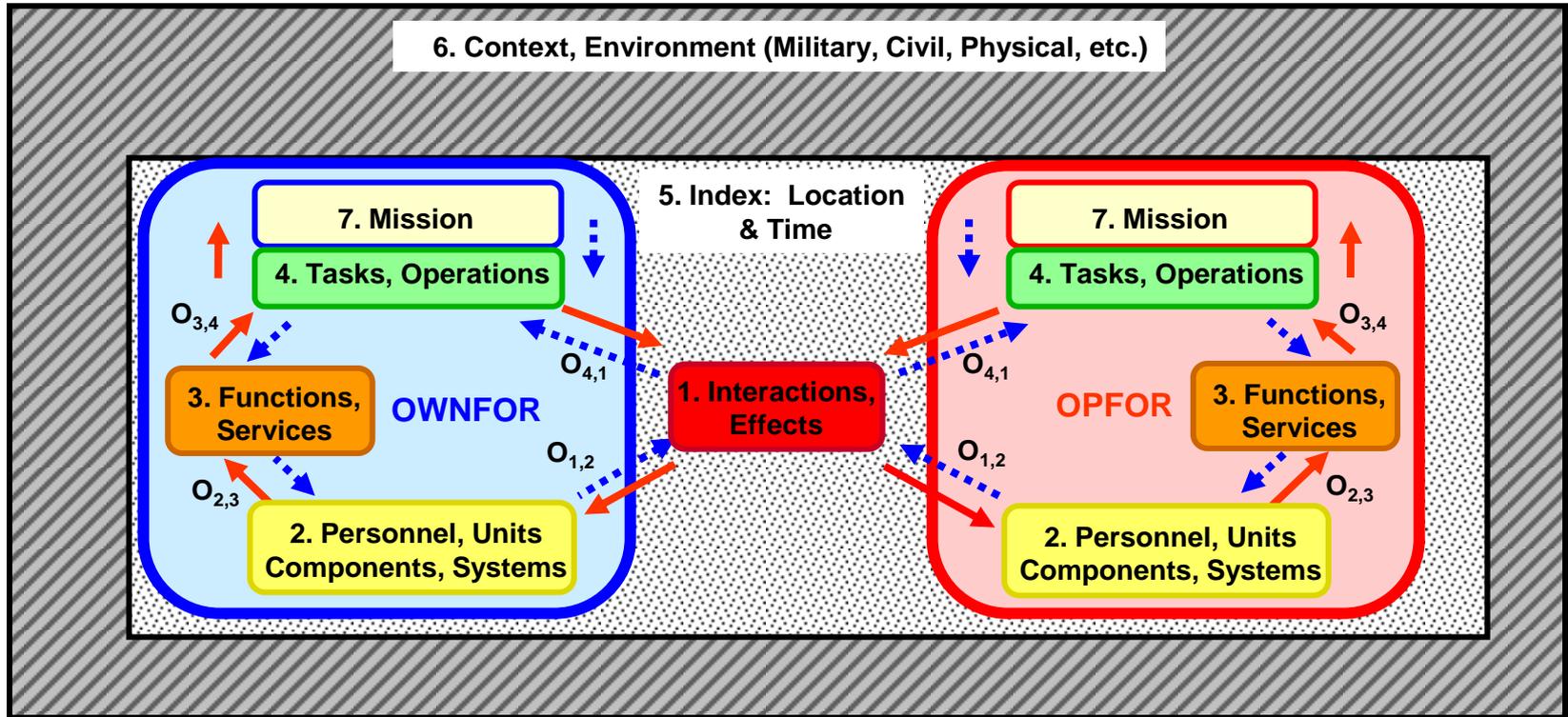


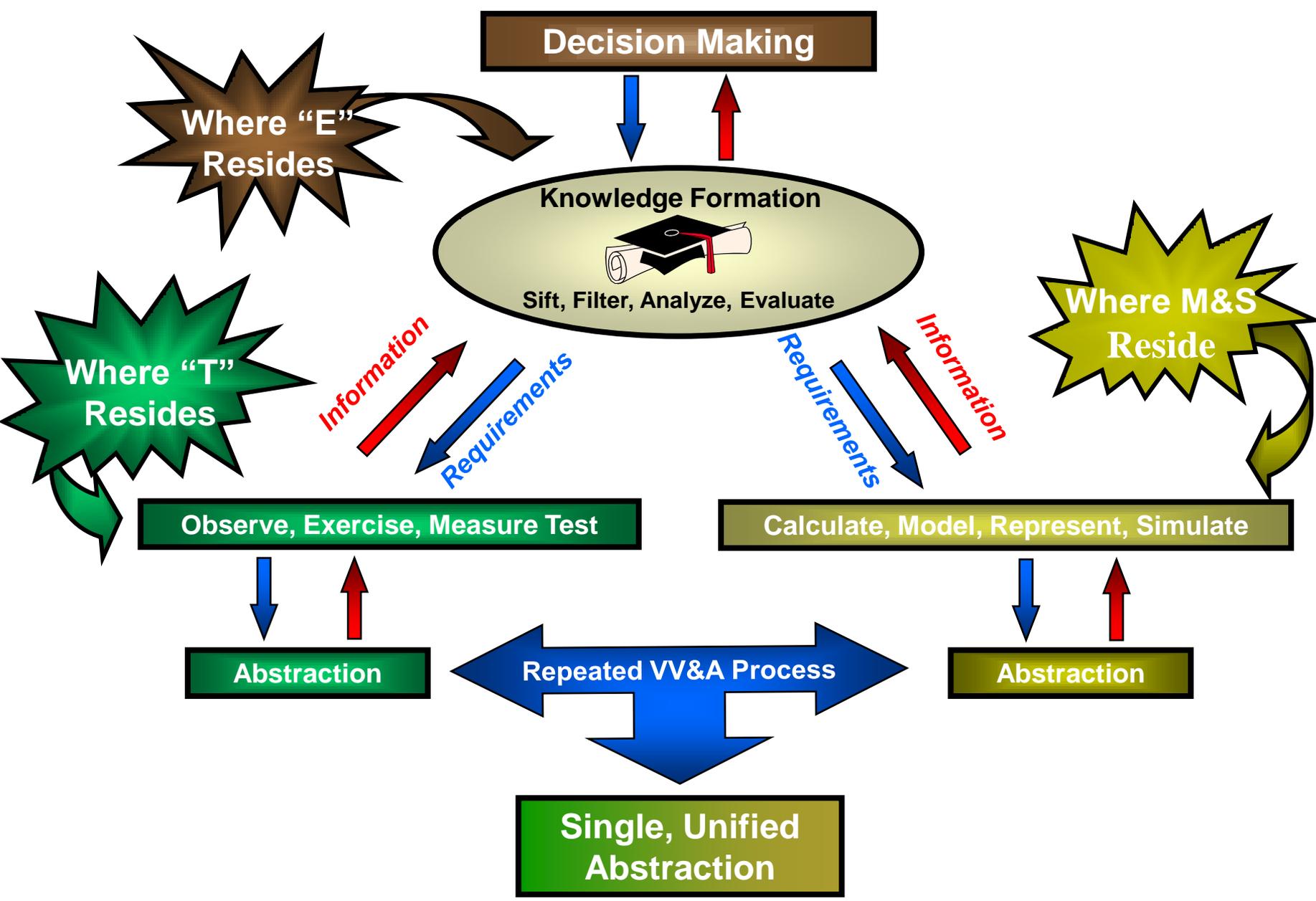
JCIDS via MMF Representation [2/3]

6. Context, Environment (Military, Civil, Physical, etc.)



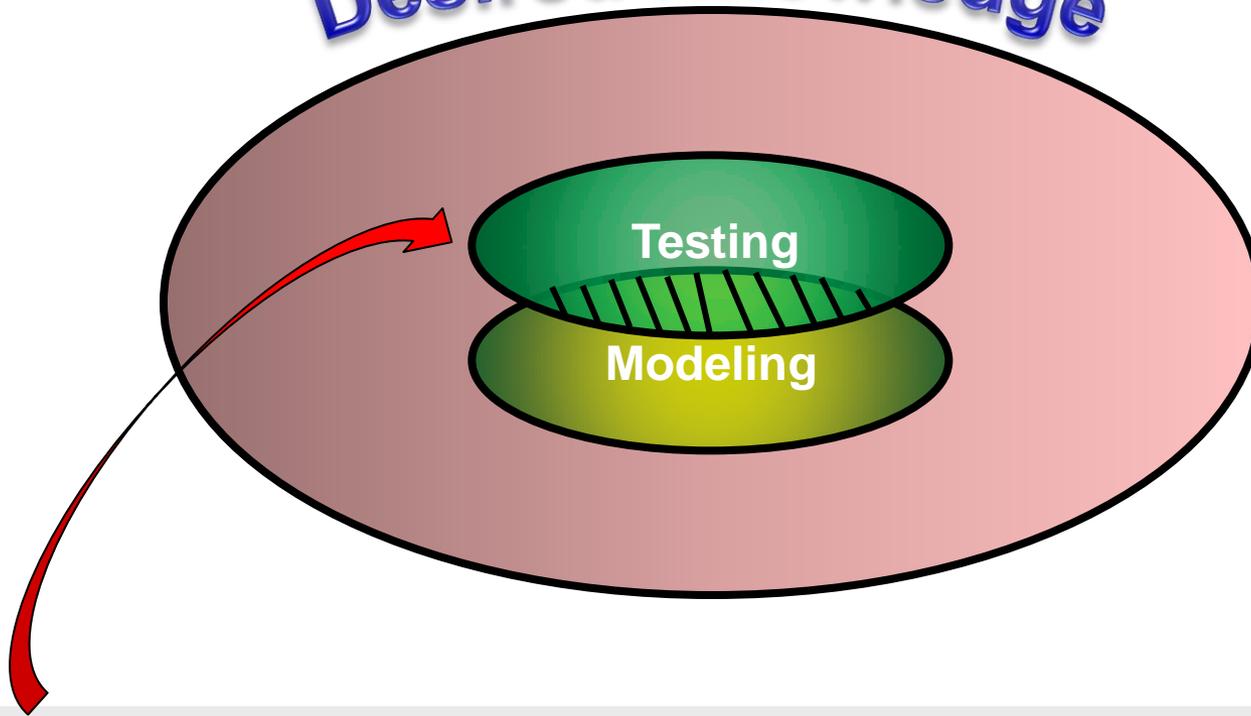
JCIDS via MMF Representation [3/3]





Knowledge

Desired Knowledge



Note:

- The logical intersection is a small subset of the logical union
- The intersection is the only domain in which Validation can take place!

Important Takeaway [2/2]

However for a fifty years, vulnerability analysts and modelers have been taking Level 4., so-called “probabilities”, and combining them using the Survivor Sum Rule,[‡] e.g.:

Ballistic Vulnerability Example

Total P_K for an n-shot ballistic volley:

$$P_{K_{\text{Total}}} = 1 - \{ [1 - P_{K1}] \times [1 - P_{K2}] \times \dots [1 - P_{Kn}] \}$$

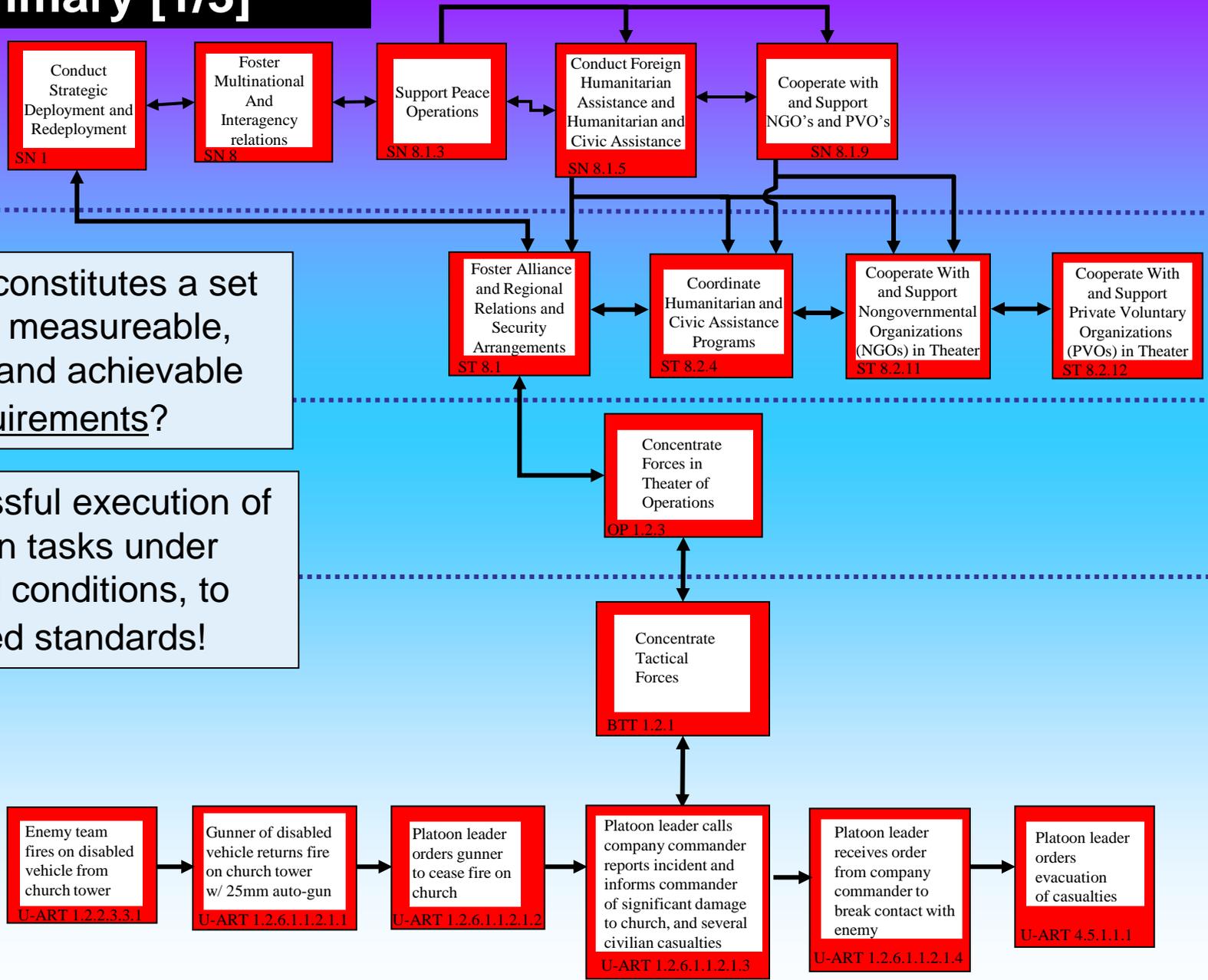
Survivability Example

Total P_S for n survivability-related events (e.g., encounter, engagement, hit, damage, kill):

$$P_{S_{\text{Total}}} = 1 - \{ [1 - P_{E1}] \times [1 - P_{E2}] \times \dots [1 - P_{En}] \}$$

[‡] Caveat Emptor: The Survivor Sum Rule applies only when metrics are both true probabilities and independent! Here, neither condition accrues! Sorry, and good luck!

Summary [1/3]



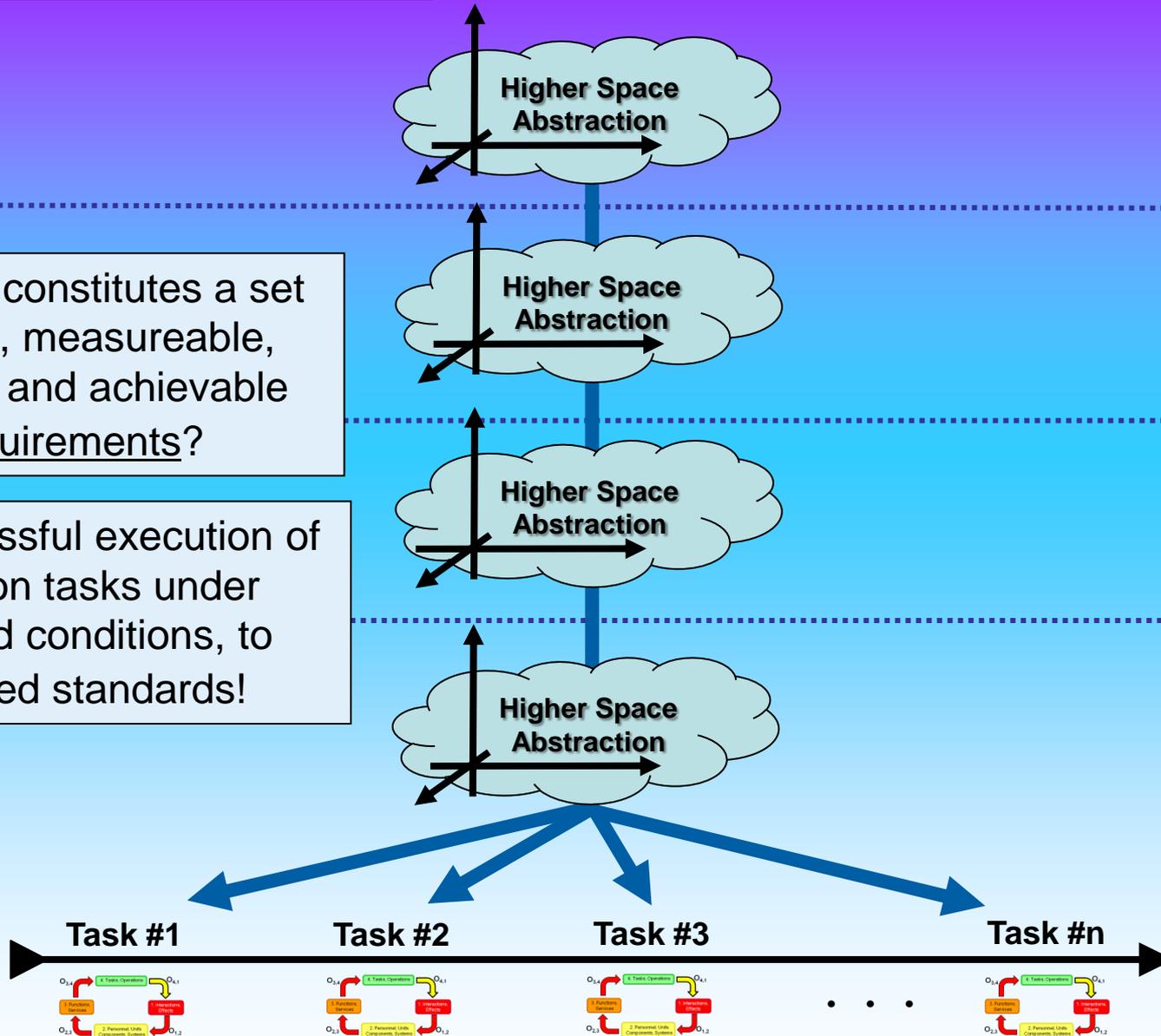
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Summary [2/3]

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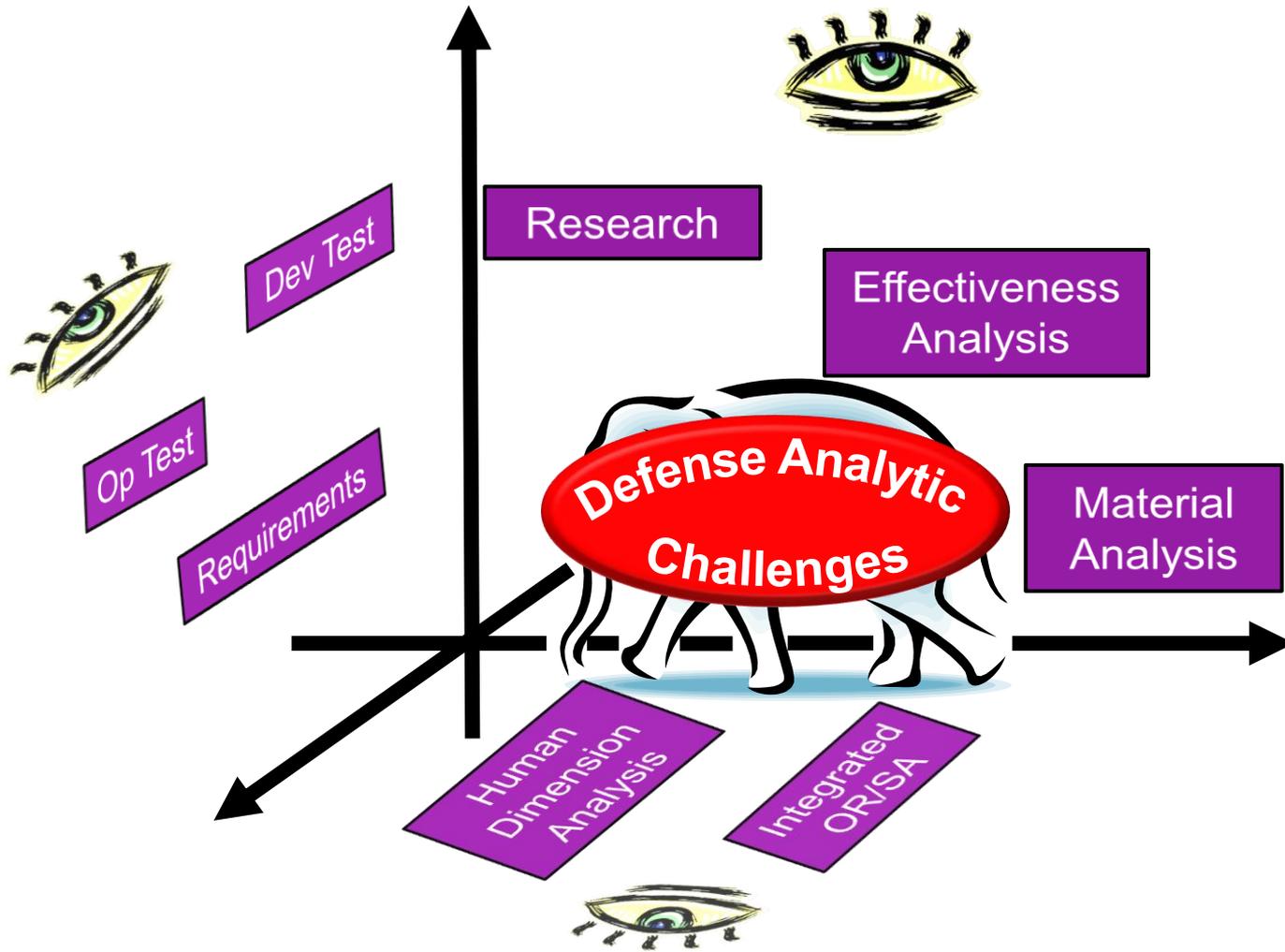
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Today's World: The Blind Men &

— Metrics in an *ad hoc*, “bottom-up” world —

Defense Analytic
Challenges



Single Reference Object: Multiple Perceived Projections