Non-Technical Obstacles to Effective M&S Connectivity in Support of T&E

Panel Chair: Mr. John Illgen

Northrop Grumman Simulation Technologies

Introduction

- **Greetings**
- **Introduction of Panel Members**
  - John Illgen, Northrop Grumman
  - Dr. Paul Deitz, ARL
  - Mr. Rick Cozby, DTC
  - Mr. Jack Sheehan, FCSCTO
  - Mr. Augie Ponturiero, Northrop Grumman

A Changing Landscape

- **Capabilities-Based Acquisition**
  - Warfighter-focused
  - New thought processes on WHY, WHAT, and HOW to develop new Systems/Families of Systems/Systems of Systems
- **New Systems/Families of Systems "Born Joint"**
  - Services working together at all levels to bring capabilities to the Warfighters
- **Funding Constraints**
  - New Developments vs Current Operations Support
  - Using more Virtual and Constructive entities for testing

    M&S more significant in Test and Evaluation

The Effect

- **Increased cooperation between Services and DoD Agencies at all levels**
- **Multi-Service and Joint Testing**
  - OSD-driven – “Testing in a Joint Environment Roadmap”
    - What is the impact to Service Acquisition efforts?
- **PM, T&E, Warfighters must work together across Service boundaries to field new systems**
  - T&E communities need to understand one another first!
- **T&E Communities forging closer working relationships**
  - Different priorities
  - “Cultural” and “Language” differences

Today's Discussion

- **Look at the Non-Technical issues affecting T&E**
- **T&E Communities forging closer working relationships**
  - Different priorities
  - "Cultural" and "Language" differences
- **Multi-Service and Joint Testing**
  - OSD-driven – "Testing in a Joint Environment Roadmap"
    - What is the impact to Service Acquisition efforts?
- **PMs, T&E, Warfighters must work together across Service boundaries to field new systems**
  - First Step: T&E Communities must work together and speak the same language

Non-Technical Factors Affecting T&E Interoperability

Mr. Augustine J. Ponturiero
Northrop Grumman Simulation Technologies

The Problem:
How to clarify Lifecycle issues in a T&E context?

PROGRAMS

Tactical Use Cas

M&S

Evaluation Matrix and Decomposition of Evaluation Framework

Functional Areas

Joint Interoperability

MMF

UA

Legacy Systems

DEP

Capabilities Based Architecture Process

24 TRADOC Integrated Processes

Test Operations Concepts

T&E Tasks

Engineering Process

UAMBL

TRADOC

Fiscal "Realities"

Tasks

Use Cases

3CE

SV's

M&S

Instrumentation

Testing

Warfighter Requirements

Elements

NCIE

Stimulation / Con

Measur

NETWORKS

JROC

GIG

DoD 5000.1

FoS, SoS

Development Plans

PPBS

Mission

Future Upgrades

JSBE

JTEM

C3T

OV's

PRIORITIES

Analysis Of Alternatives

ATEC

AFICE

Object Models

SoS Eng Strategy

RDECOM

FCS

Tactical "Realities"

Asymmetric Threats

Reconciliation and Recommendation

JCIDS Recommendation Capability Needs DOTMLPF Changes

Decision and Action

Science & Technology

Planning, Programming, and Budgeting System

Acquisition

Experimentation

[5]Chairman of the Joint Chiefs of Staff Instruction 3170

[4]Joint Capabilities Integration and Development System

Challenges

- **Systems of Systems (SOS)/Families of Systems (FOS)**
  - Network Enabled Systems
  - Network Centric Enterprise Services
  - Global Information Grid
  - Joint Command and Control (JC2)
  - Multi-National Information Sharing
- **Missions and Scenarios Paradigm Shift**
  - Transform from forces-based, materiel-centric Cold War to capabilities-based, mission centric asymmetric-warfare posture
- **Joint Focus**

What is the "force multiplier?" How do we define it?

Non-Technical Factors
T&E Community Issues

- **"Ad Hoc" Processes**
  - Rely on individuals, not processes, to successfully complete events
- **Common Tools**
  - Few
  - Not used effectively
  - Gap in tools available for collaboration and communication
- **Not familiar with other Services**
- **No effective Network Engineering Process**
- **Insufficient process maturity to be "repeatable"**

Must make a Cultural Change within the T&E Community

A Cultural Change

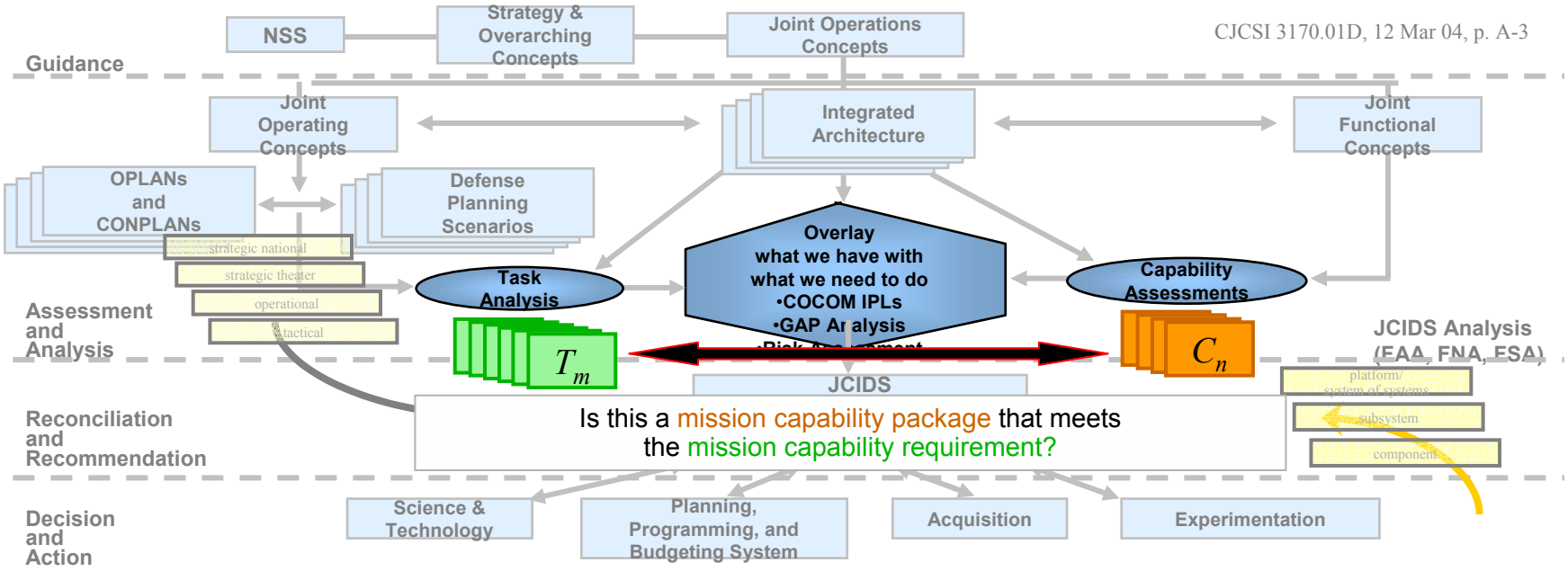
- **Joint vice Service focused testing**
- **Shared Models and Simulations**
  - "Users won't use the model correctly and it will reflect badly on me/us…"
- **Improved understanding of Joint Test environment including Network and Security strengths and limitations**
  - Navy = Air Force = Army = Marines
- **Improved community-wide methods and processes**
  - JTEM is taking the first steps
  - Sustainable, Repeatable, Consistent, Understandable results
  - Operations and Acquisitions context

The Benefit:
Better Info to Decision-Makers, Faster

- Operational and Acquisition Leadership
- Better analysis of alternatives for acquisition decisions
- Clearer understanding of test results across T&E and Operations Spectrum
- Shared data and information – faster analysis and recommendations
- Virtual Environment for testing
- Capability-based assessment of system
- Examination of proposed systems from a Doctrine/Operations/Training perspective early in development.
- Common “language”, data, and processes between Acquisition, T&E, and Ops Communities
- Common understanding between Acquisition, Ops, and T&E Communities

Capabilities-Based Development
The Missions and Means Framework

- The LINK between the Military Decision Making Process and the domain of DOTMLPF solutions
- A WARFIGHTER-FOCUSED STRUCTURE for rigorous, complete, and detailed analysis in crucial evaluation programs
- An ORGANIZING PRINCIPLE for requirements, test planning, and evaluation



Application of the Missions and Means Framework to Distributed Testing: Some Results From A Test

Mr. Richard S. Cozby
Chief, Technology Management Division
HQ, U.S. Army Developmental Test Command

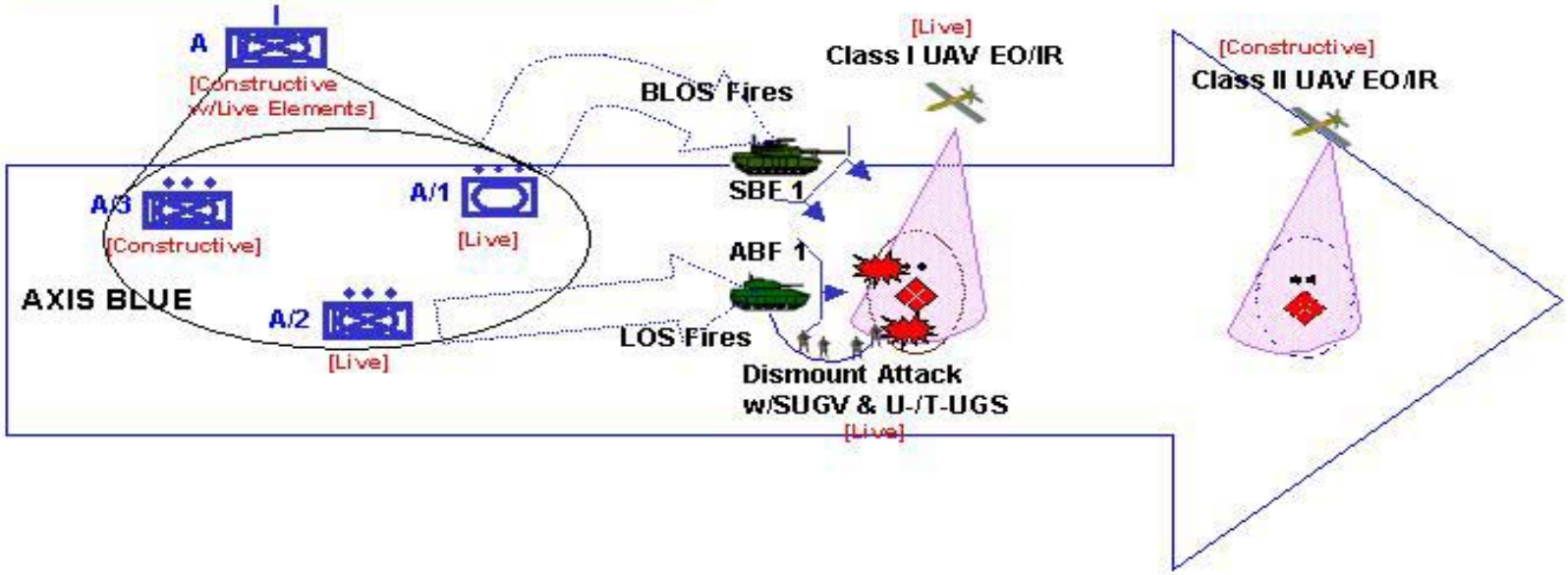
Distributed Test Event-5/Multi-Service Distributed Event

Event: August 2005

Mission Context: A Company Mounted Operation Supported by Platoon Dismounted Forces in an Urban Environment

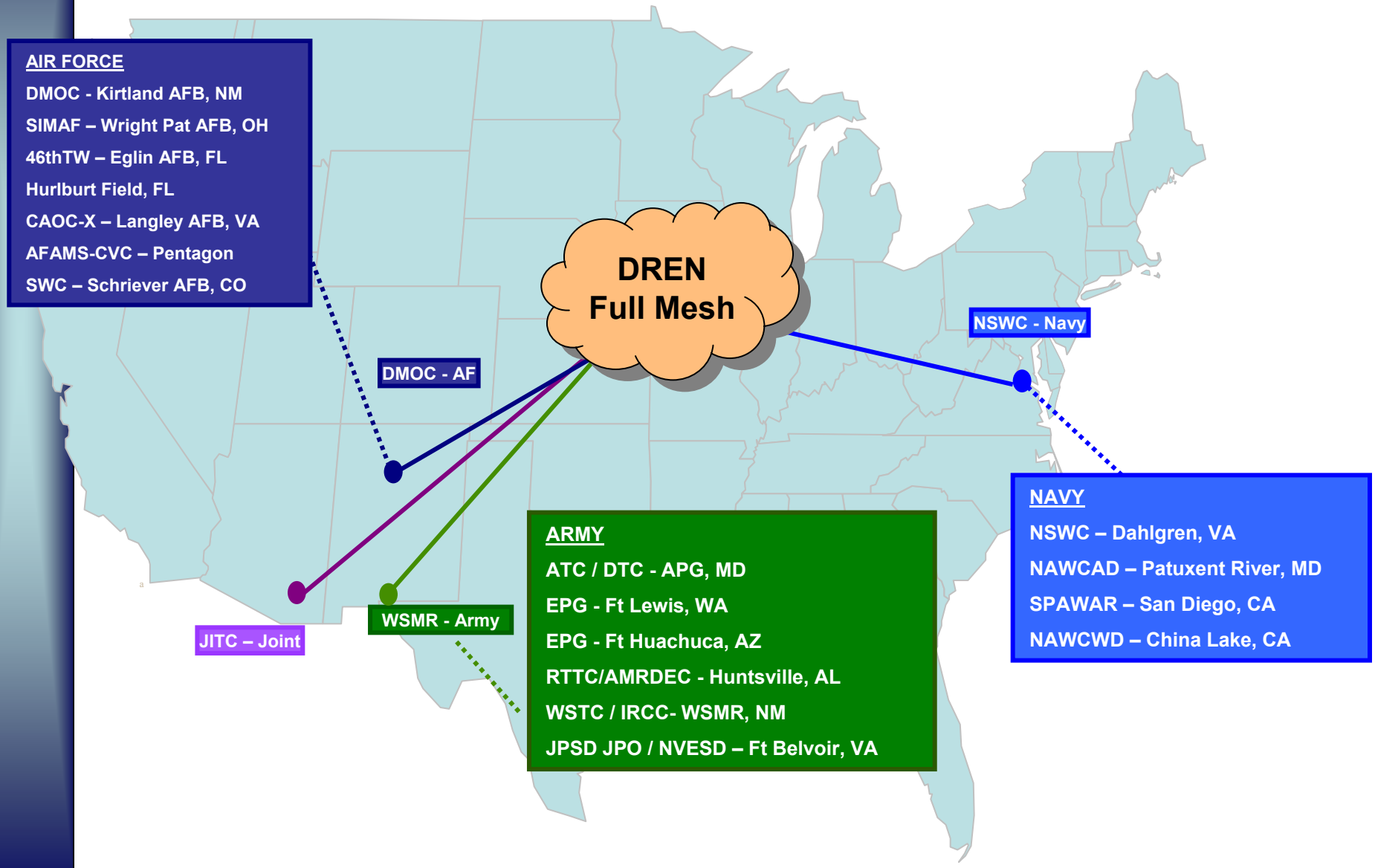
Step 1: Alpha Team (2 ICV & 1 MCS PLTs) moves along AXIS BLUE. Enemy dismount force is detected by A TM's Class II UAV in town. ICV PLT identifies enemy flank, and formulates & disseminates plan to all Soldiers. MCS PLT moves to SBF position. ICV PLT moves to secure locations & deploys Class I UAV, SUGV, and T-UGS. ICV PLT dismounts and attacks with direct fire & movement; deploys U-UGS. ICVs & weapons squads provide supporting LOS fires. MCS PLT provides supporting BLOS fires.

Step 2: Enemy force in town is defeated or captured. ICV PLT secures objective, and consolidates & reorganizes. Dismount PLT LDR transmits situation report & requests MEDEVAC support. MCS PLT covers dismount movement to ICV remount locations. ICV PLT quickly remounts ICVs. ICV PLT LDR updates SA for all Soldiers. MCS Class II UAV detects and identifies another dismounted force. Alpha Team continues attack along AXIS BLUE.

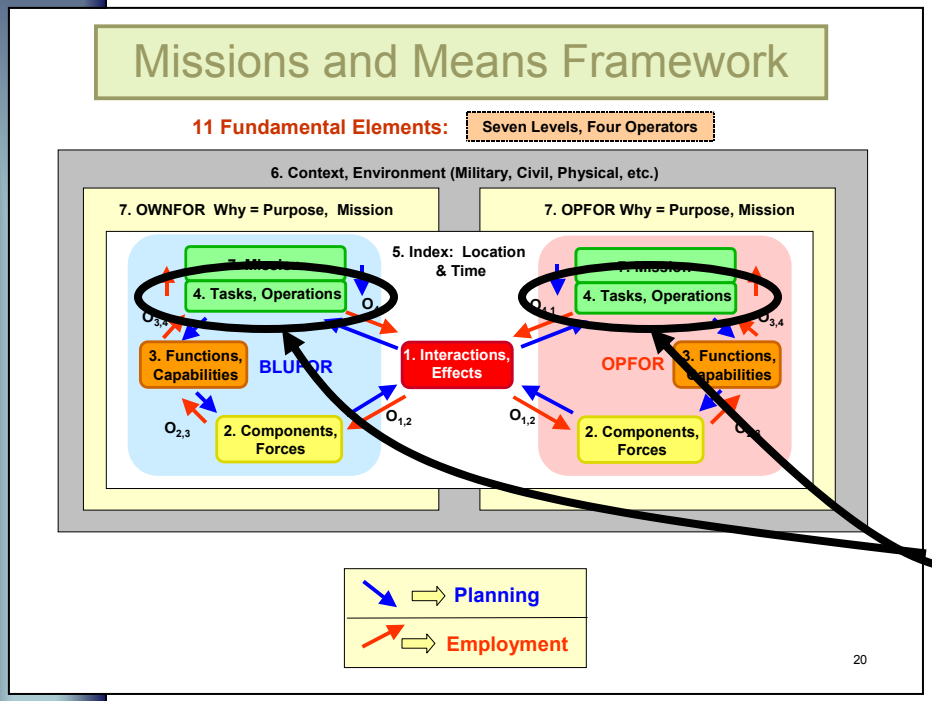


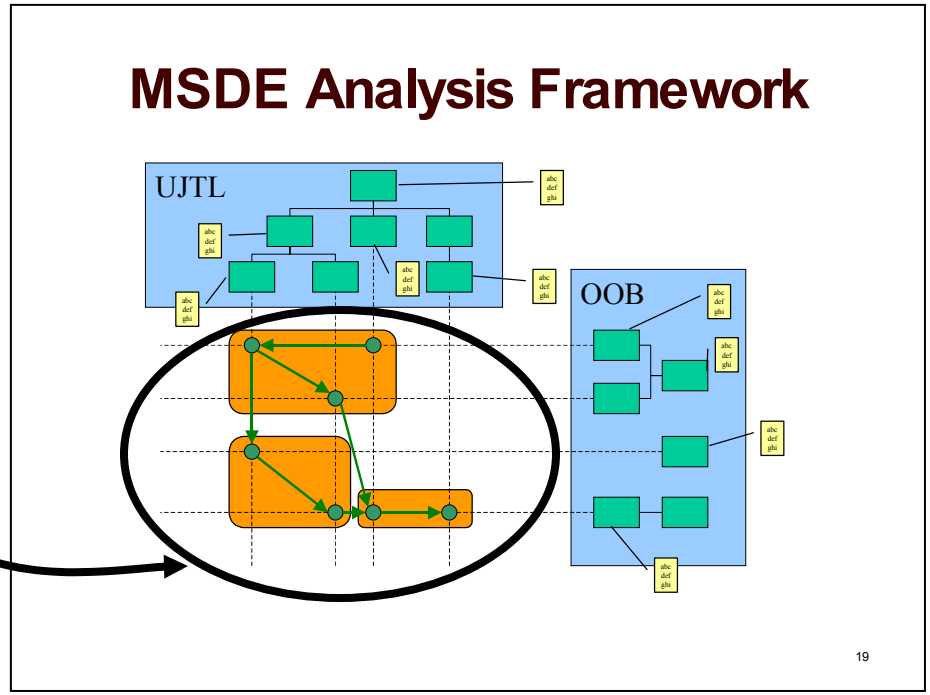
Event Joint Mission Context

Participants



Event Analysis Framework





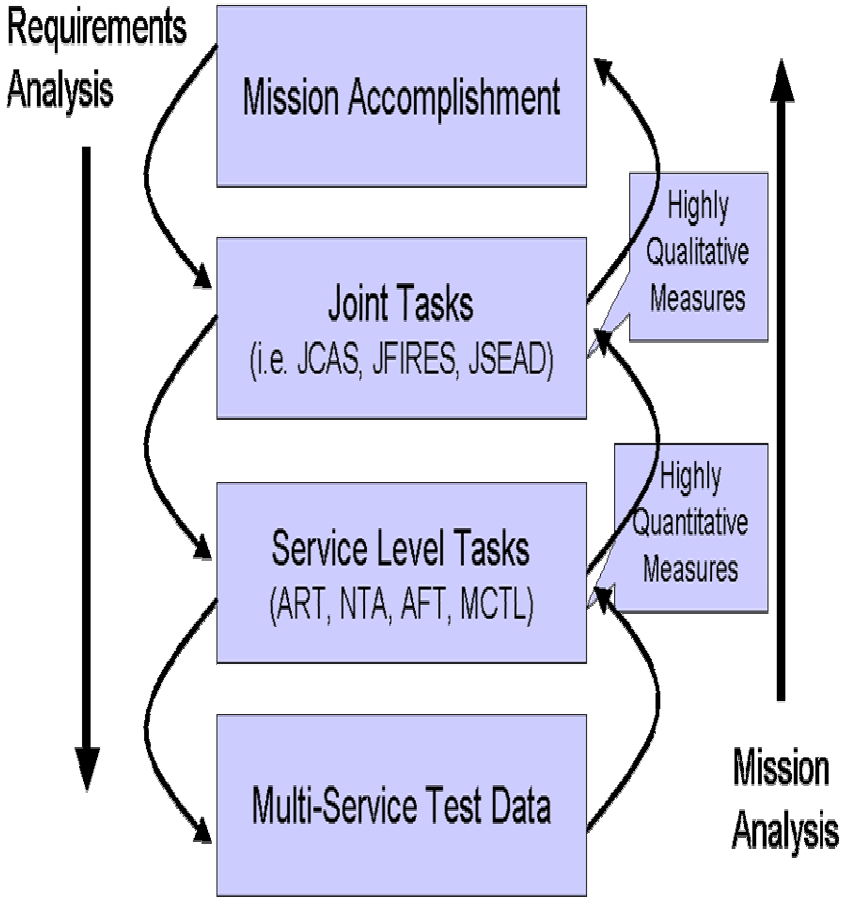
- Use Joint Tactical Tasks to define the operation
- Decompose the tasks to understand component-level influences
- Instrument the components to measure their activities
- Synthesize the tasks as a manifestation of component interactions

Event Analysis Methodology

ANALYSIS PRODUCTS

- Baseline analysis methodology for assessment of Joint Tasks
- Baseline set of Joint Task Measures associated with each Service Level Task (NTA, ART, AFT, MCTL)
  - Quantitative Data Examples
    - ART 1.4.3 - M3 - Time to make initial assessment of attacks after TOT
    - NTA 3.2.2 – M2 – Minutes after target ID to complete attack
    - AFT 2.1.1 – M1 – Time from the desired timing for lethal force to cause desired effects
- System level measures for respective service test objectives

MULTI-SERVICE JOINT TASK COMMON ANALYSIS METHODOLOGY



Results and Areas for Improvement

- **Demonstrated ability to execute a distributed L/V/C event with existing capabilities.**
- **Conducted system testing in the context of a Joint mission.**
- **Gained experience with multi-Service performance report generation using multiple tools.**
- **Gained experience in reporting complex Joint thread exercises with diverse data formats.**

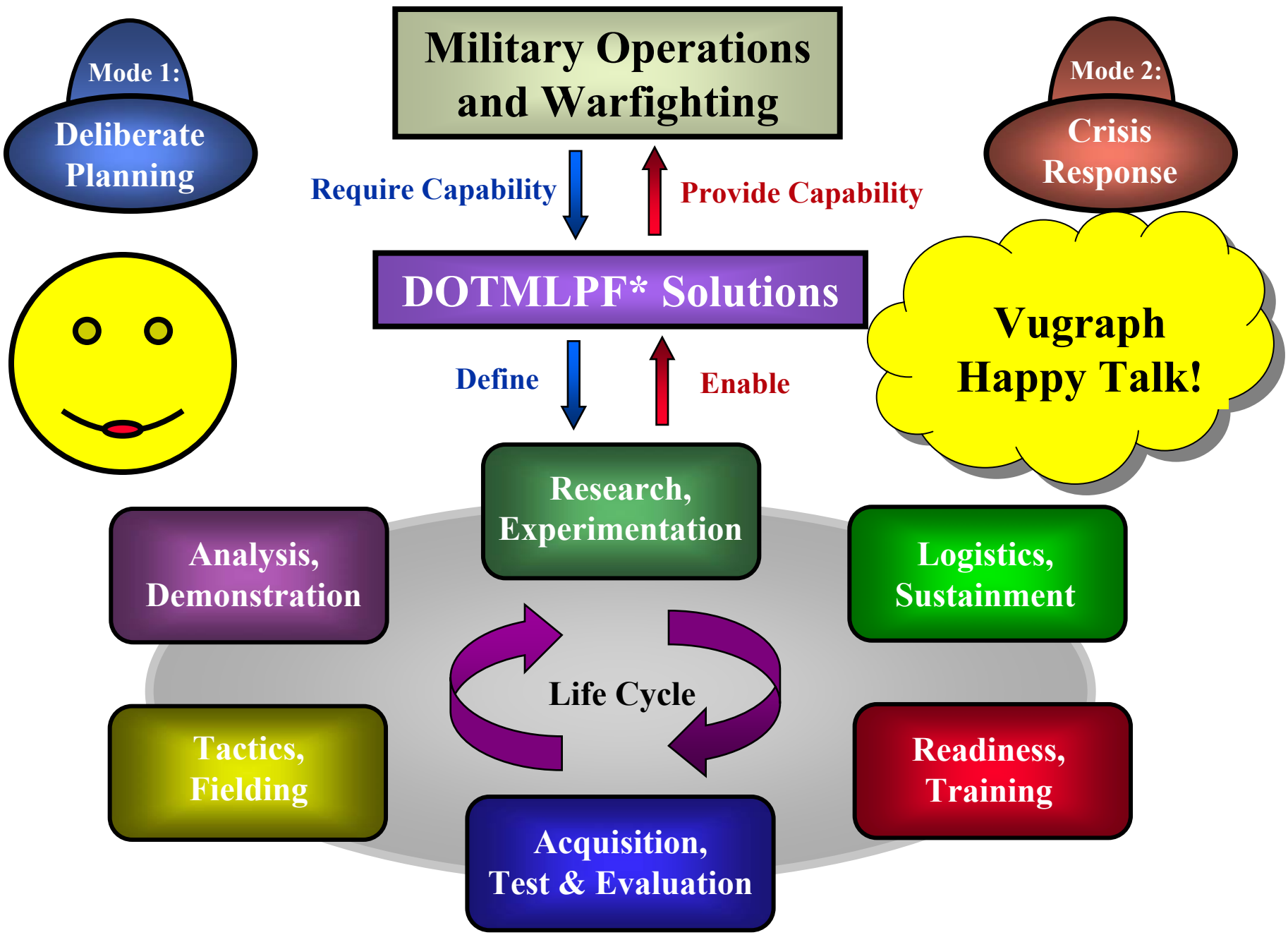
	Areas Requiring Improvement	Assessment
1	Ability to determine system contributions to the accomplishment of a Joint task.	
2	Ability to evaluate individual test item performance in L/V/C events.	
3	Ability to test multiple items in a Joint environment simultaneously and accomplish all test objectives.	
4	Ability to sufficiently gather, process, and analyze data (one set) from distributed L/V/C events.	
5	Determine capabilities and limitations associated with legacy systems in Joint L/V/C events.	
6	Integrate across a variety of environment models and coordinate systems.	
7	Assess and integrate multiple threat representations in a distributed L/V/C environment	

Getting Organized to Perform Evaluation

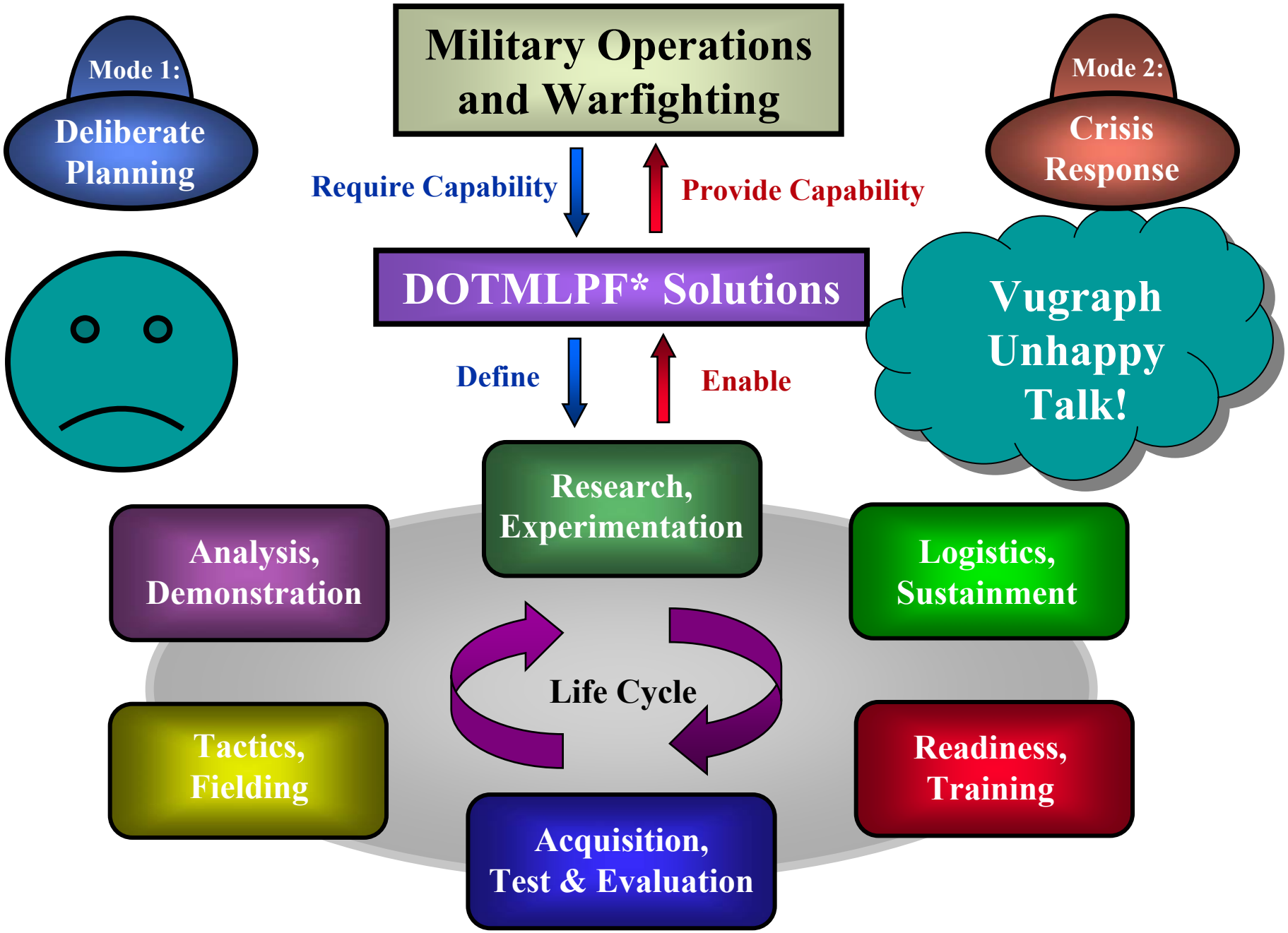
Dr. Paul H. Deitz

Director (A)

Human Research & Engineering Directorate,
U.S. Army Research Laboratory



* DOTMLPF: Doctrine, Organization, Training, Materiel, Leader Development, Personnel, Facilities



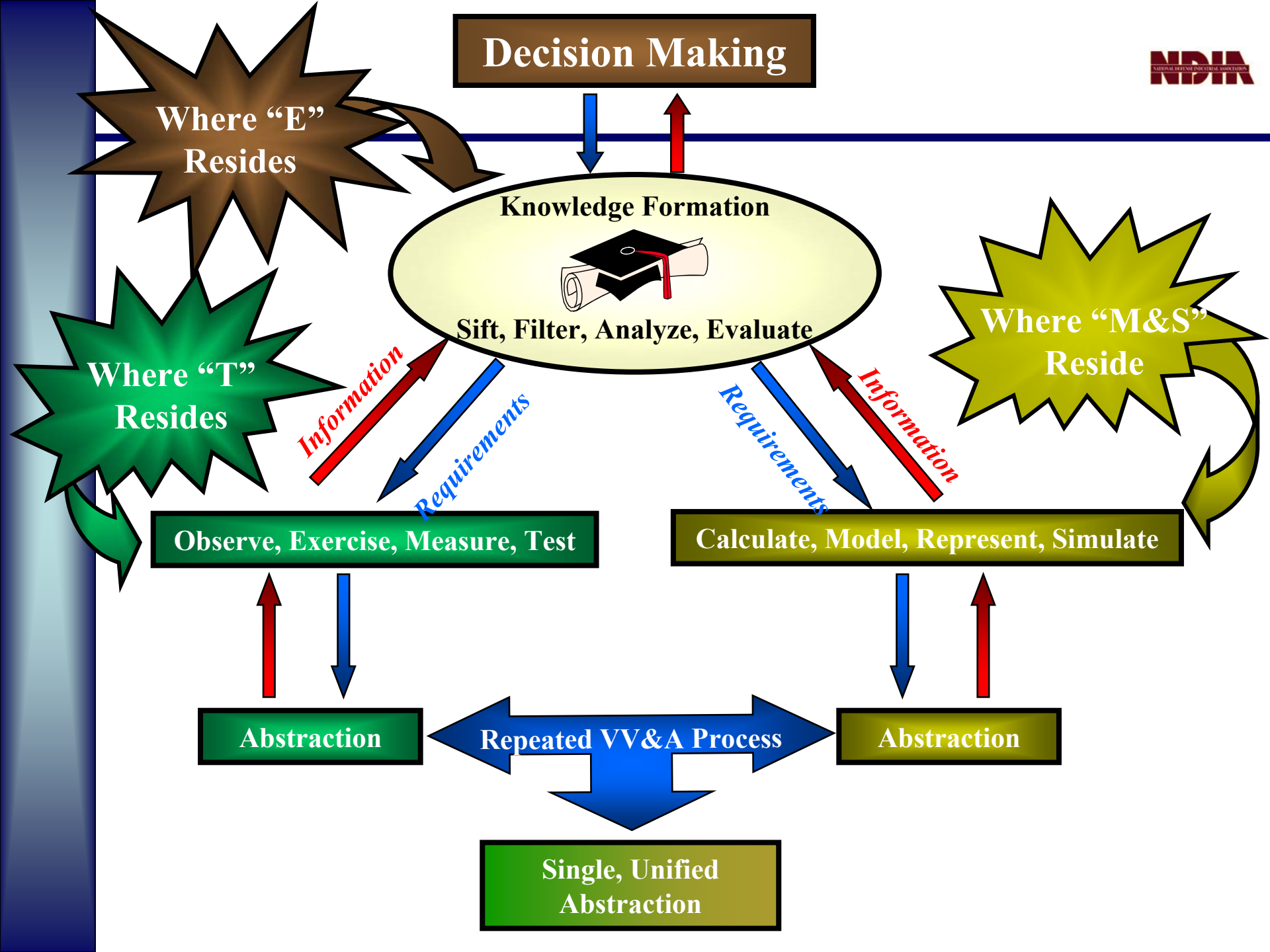
* DOTMLPF: Doctrine, Organization, Training, Materiel, Leader Development, Personnel, Facilities

The Russians Are Coming, The Russians Are Coming§

"Just got to get organized. We've got to get organized."

Jonathan Winters (Officer Norman Jones) to Ben Blue

§Metro-Goldwyn-Mayer, Inc., 1966


Decision Making
Where "E" Resides
Knowledge Formation
Sift, Filter, Analyze, Evaluate
Where "T" Resides
Where "M&S" Reside
Information
Requirements
Requirements
Information
Observe, Exercise, Measure, Test
Calculate, Model, Represent, Simulate
Abstraction
Repeated VV&A Process
Abstraction
Single, Unified Abstraction

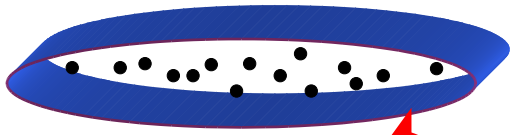
The Example:
Ballistic Live Fire Example - 1985

Mission Utility

Functional Capabilities

Post-Event Components

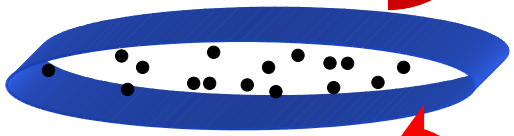
Interaction Conditions



Level 4

Operational Testing*

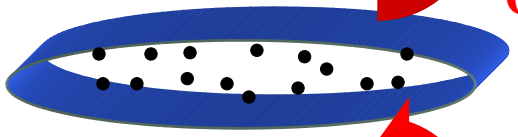
$O_{3,4}$ Operator



Level 3

Developmental Testing*

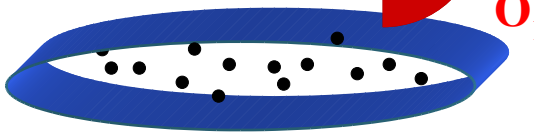
$O_{2,3}$ Operator



Level 2

Developmental Testing*

$O_{1,2}$ Operator



Level 1

* And/Or Modeling & Simulation

Direct Fire Validation‡

Shot	Threat	Perf or Non-Perf	Number of Components Killed	Personnel Casualties	System Evaluation Metrics: Discrete Distribution M-LoF	F-LoF	K-Kill
1	Threat A	■			Non-Perforation Correctly Predicted		
2	Threat A	■			Non-Perforation Correctly Predicted		
3	Threat A	◆	■	■	■	■	■
4	Threat A	◆	■	■	■	■	■
4*	Threat A	■			Non-Perforation Correctly Predicted		
5	Threat A	■	■	◆	●	◆	■
5*	Threat A	■	●	■	●	◆	■
6	Threat B	■			Non-Perforation Correctly Predicted		
7	Threat B	■			Non-Perforation Correctly Predicted		
8	Threat B	■	■	■	■	◆	■
9	Threat B	◆	■	■	■	■	■
10	Threat C	■	◆	■	■	■	■
10*	Threat C	■	■	■	■	■	■
11	Threat D	■	◆	■	■	■	✖
12	Threat C	■	●	●	✖	✖	■
13	Threat C	■	■	●	✖	●	■
14	Threat E	■	■	■	◆	■	■
15	Threat F	■	■	◆	■	◆	■
16	Threat F	■	■	■	◆	■	■

Perforations
- ■ ≥ 50%
- ◆ ≥ 5% & < 50%
- ● > 0% & < 5 %
- ✖ = 0%

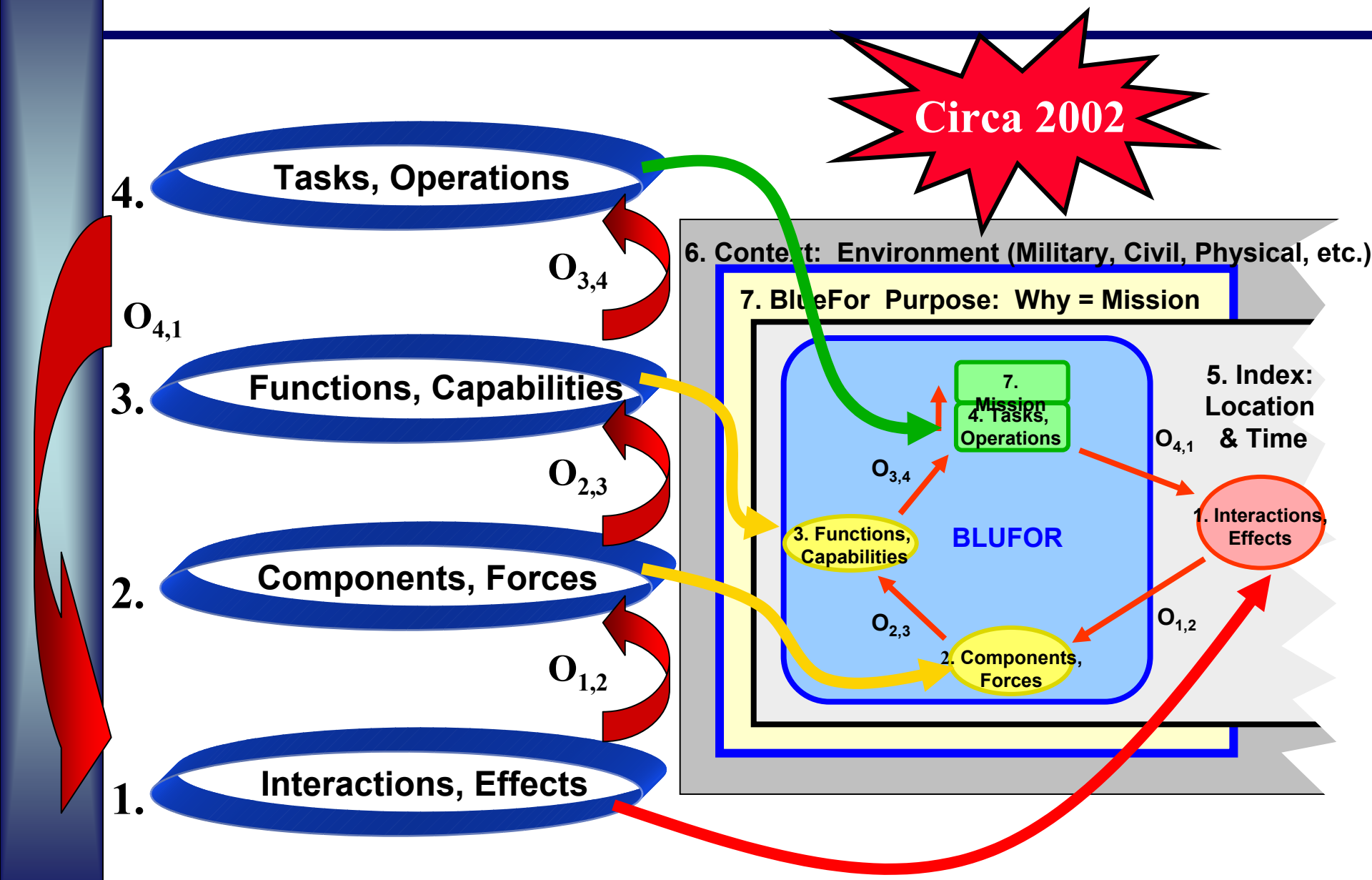
Component Criteria
- ■ ≥ 80%
- ◆ ≥ 50% & < 80%
- ● < 50%

Personnel Criteria
- ■ ≤ 1/2 Crew member
- ◆ > 1/2 & ≤ 1 crew member
- ● > 1 Crew member

Discrete Distribution
- ■ ≥ 50%
- ◆ ≥ 5% & < 50%
- ● > 0% & < 5 %
- ✖ = 0%

‡ From William E. Baker, Richard Saucier, Theodore M. Muehl, and Ricky L. Grote, 1998.

The MMF: Old


Circa 2002
4. Tasks, Operations
3. Functions, Capabilities
2. Components, Forces
1. Interactions, Effects
O3,4
O4,1
O2,3
O1,2
6. Context: Environment (Military, Civil, Physical, etc.)
7. BlueFor Purpose: Why = Mission
7. Mission
4. Tasks, Operations
3. Functions, Capabilities
BLUFOR
2. Components, Forces
1. Interactions, Effects
5. Index: Location & Time

Missions and Means Framework

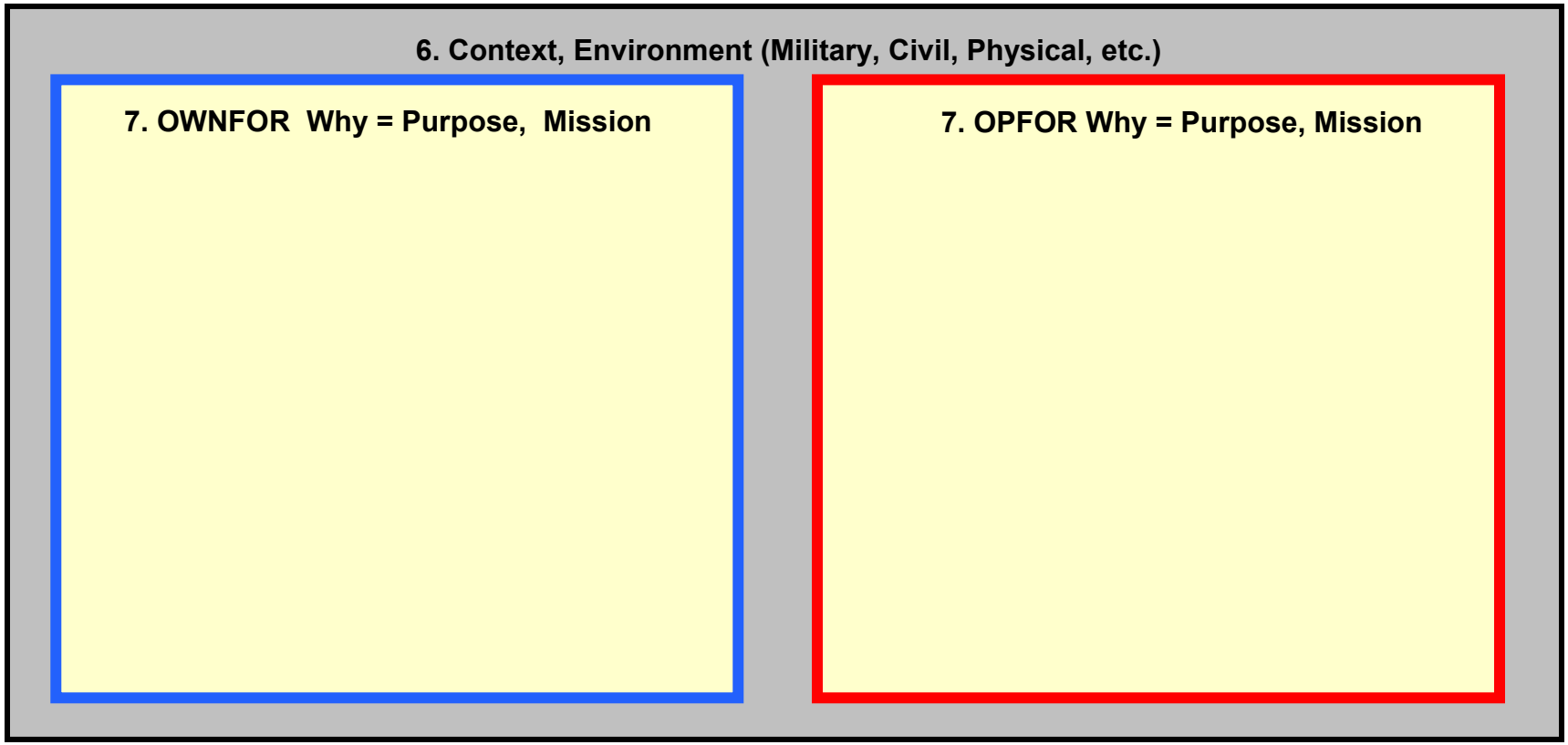
11 Fundamental Elements: Seven Levels, Four Operators

7. OWNFOR Why = Purpose, Mission	7. OPFOR Why = Purpose, Mission

7. Why, Wherefore, to What End

Missions and Means Framework

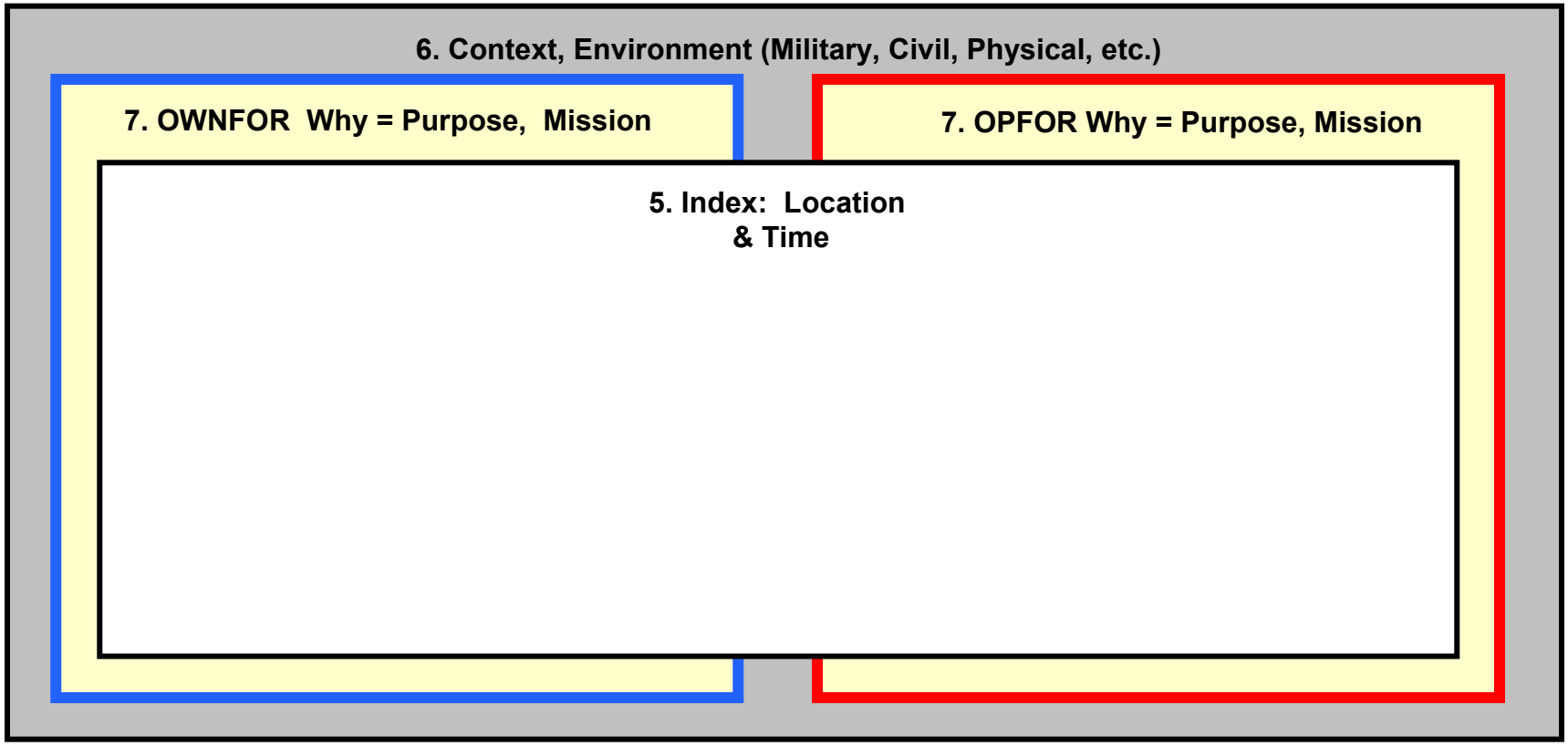
11 Fundamental Elements: Seven Levels, Four Operators



6. Under What Circumstances

Missions and Means Framework

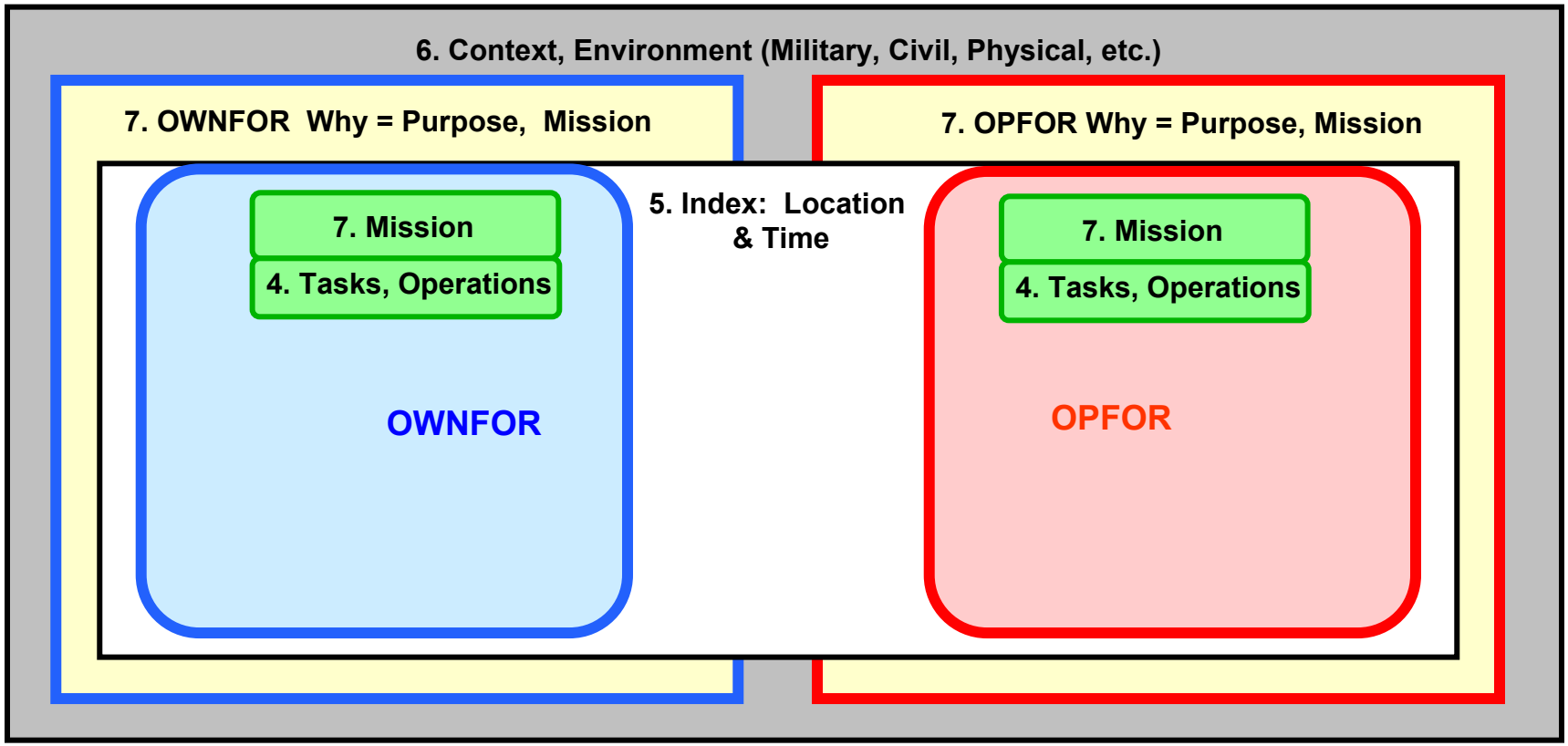
11 Fundamental Elements: Seven Levels, Four Operators



5. When and Where

Missions and Means Framework

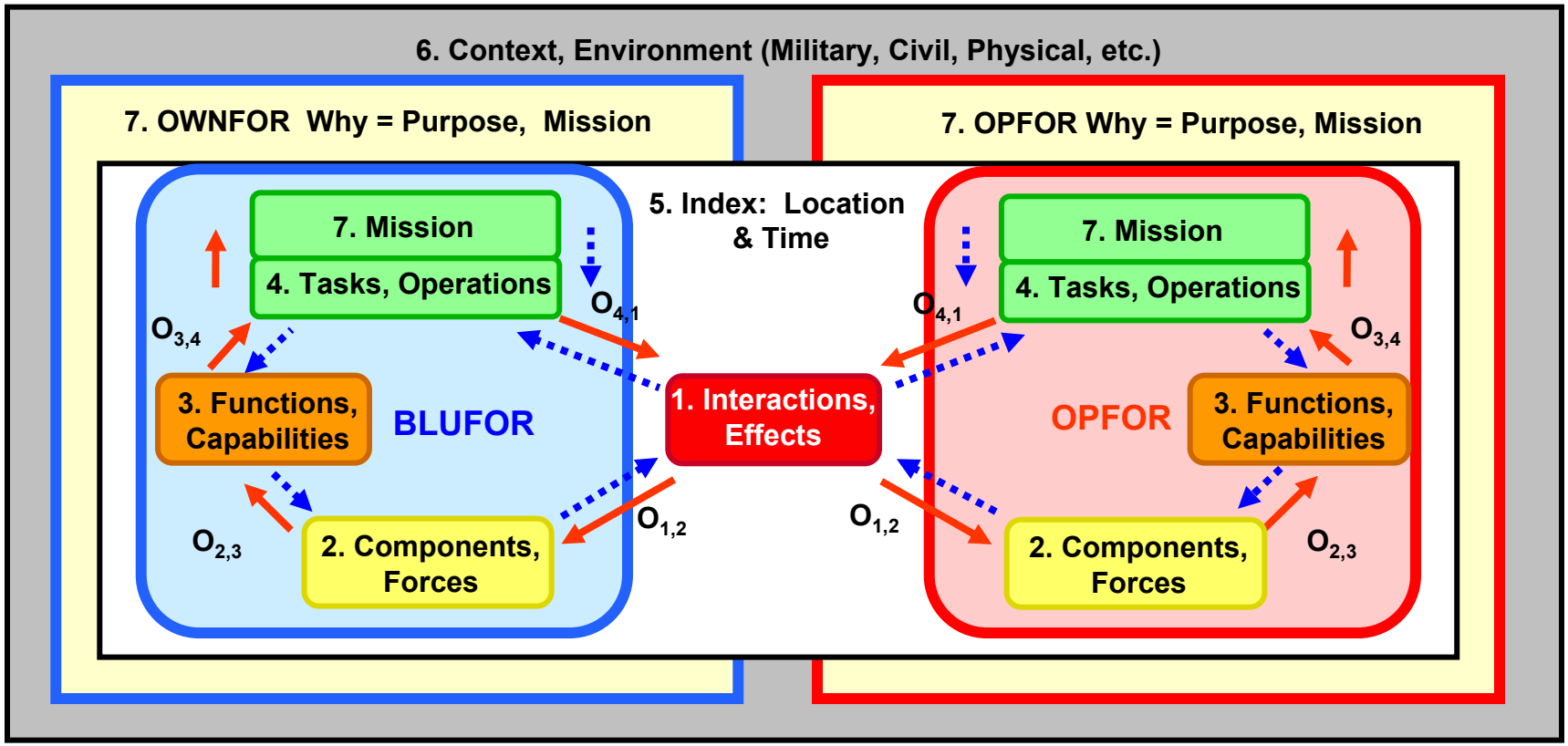
11 Fundamental Elements: Seven Levels, Four Operators



4. Activity-centric, named with a Verb, "Do What"

"The Playbook"

Missions and Means Framework



Planning

Employment

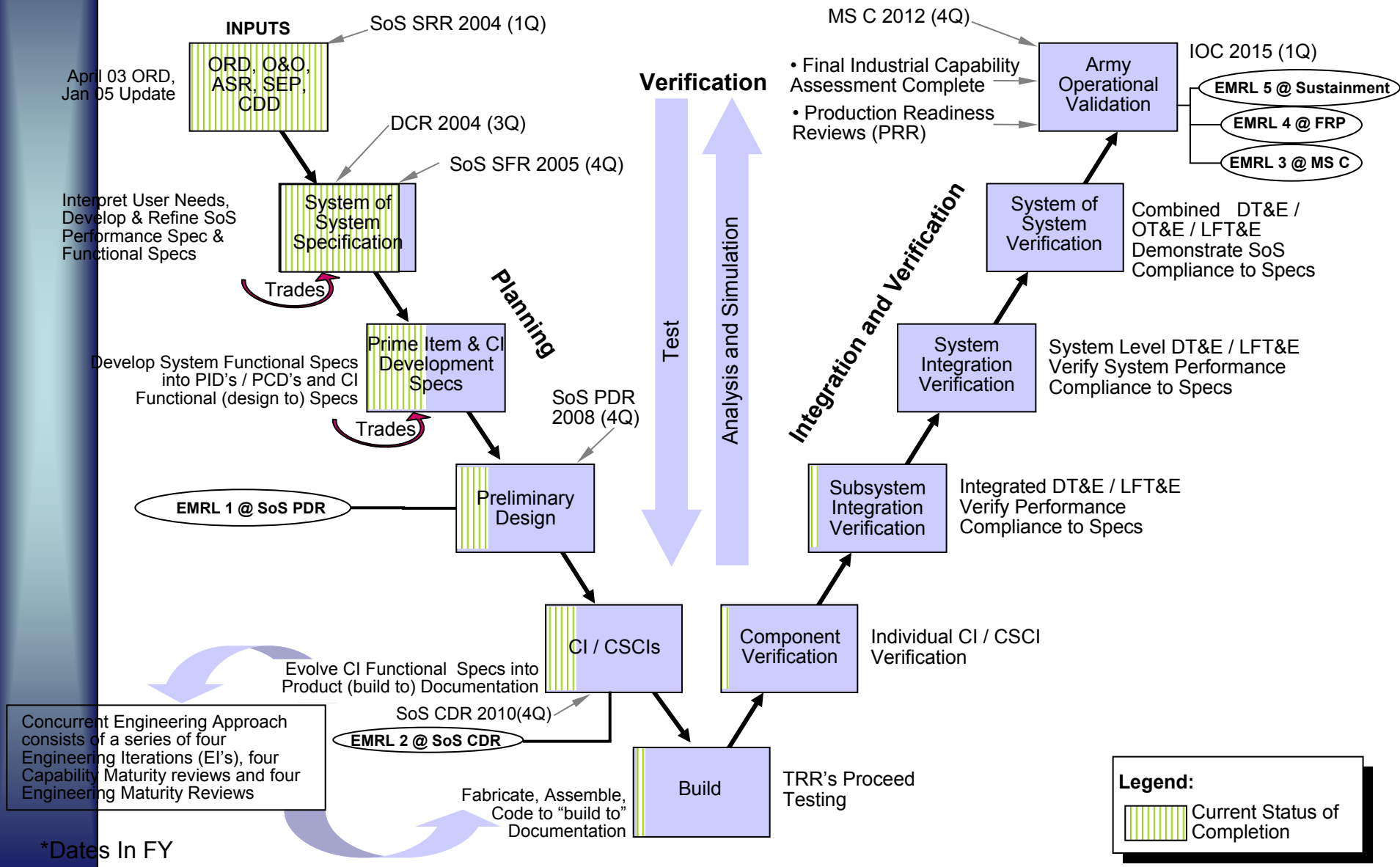
Architecture defines how Parts are assembled into Packages

Capabilities are relationships between Parts and Packages

MMF and FCS

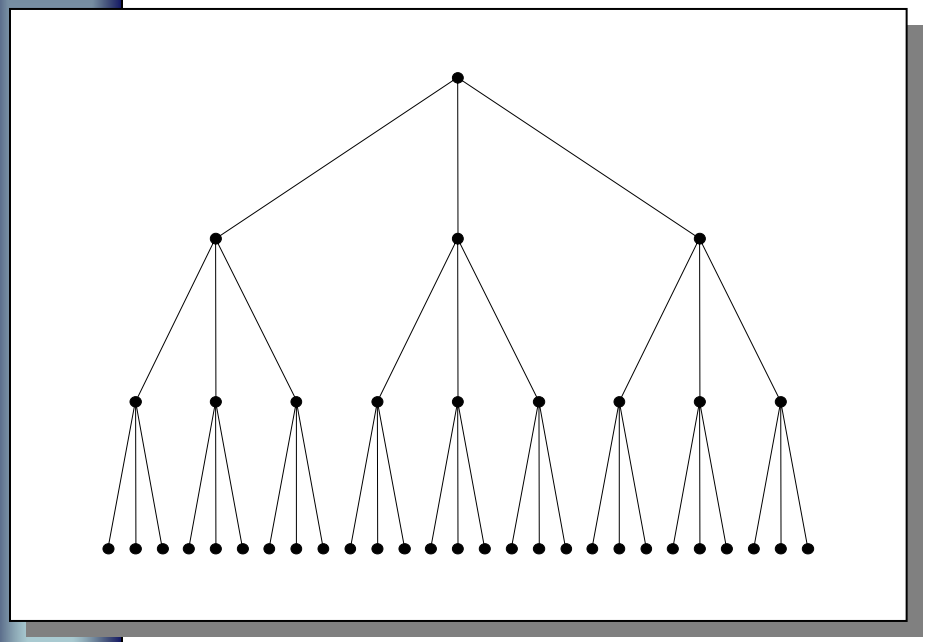
Mr. Jack Sheehan
Chief Engineer, Combined Test Organization
PM UA

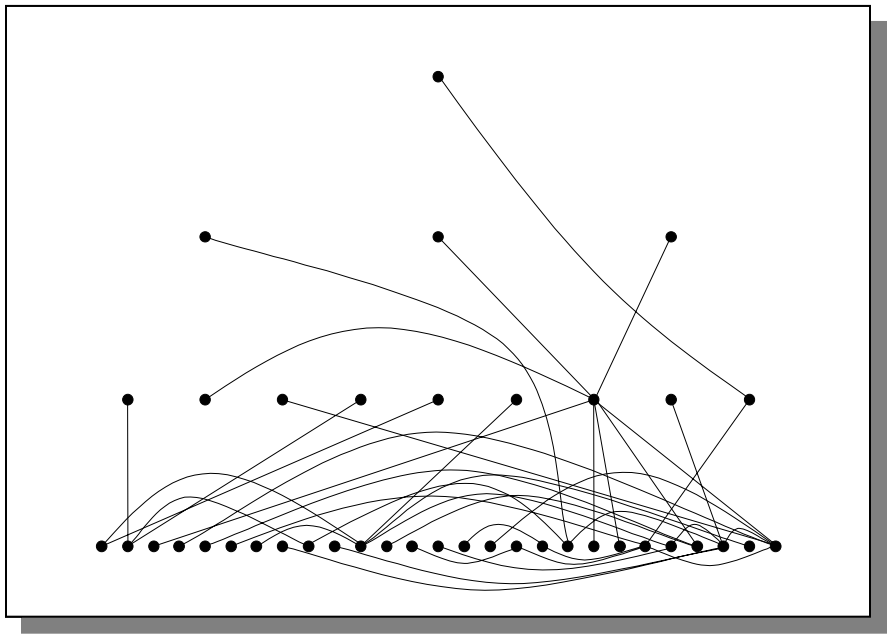
Systems of System Engineering



*Dates In FY

Chains versus Networks





Chain

Too brittle, simple pattern, simple control, scaled

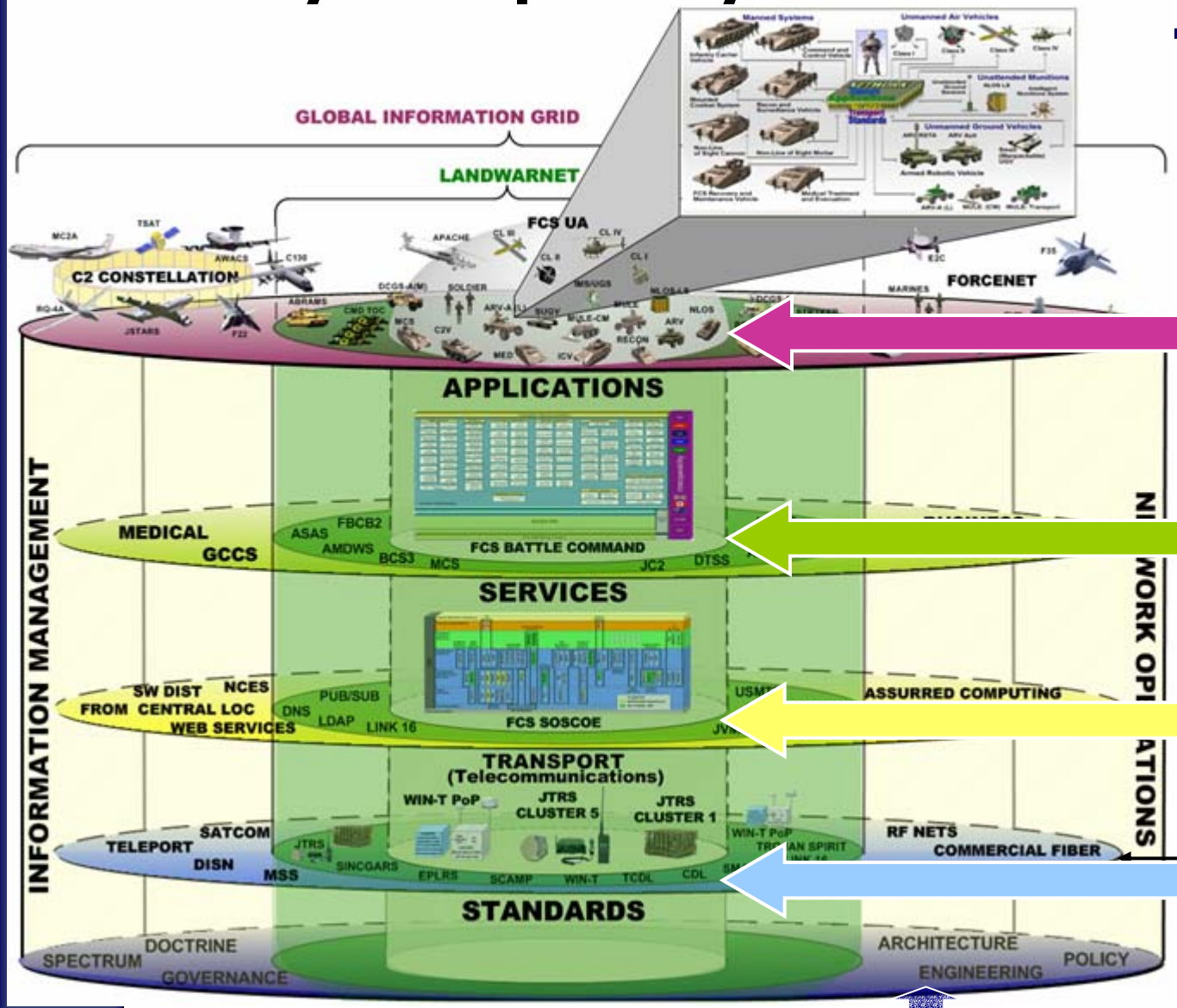
"business end" most poorly connected, hard to reconfigure or change flow

Network

Very robust, complex pattern, complex control, scale free

"business end" best connected, natural to reconfigure or change flow

The FCS BCT Integrates With Army Enterprise System Into the GIG



Integrated Warfighting Platforms: Lethality / Survivability enhanced by underlying network layers
Sensing Systems: motion, visual, audible, etc. ISR: Eyes and Ears of the Commander

BC Applications: assimilate info BC: C2 logic and reasoning based on information

System Services: Common Net-Centric Infrastructure SOSCOE: Tactical Net-Centric Middleware

Transport Systems: networked communications
Networked Communications: comms backbone and omms subnets from GIG to/from ground sensors

Standards: Common Net-Centric technical standards. Includes DoD guidance, policy, and direction

a-MIND™§ - "Automated Mission Relevant Situational Awareness"

What is done?

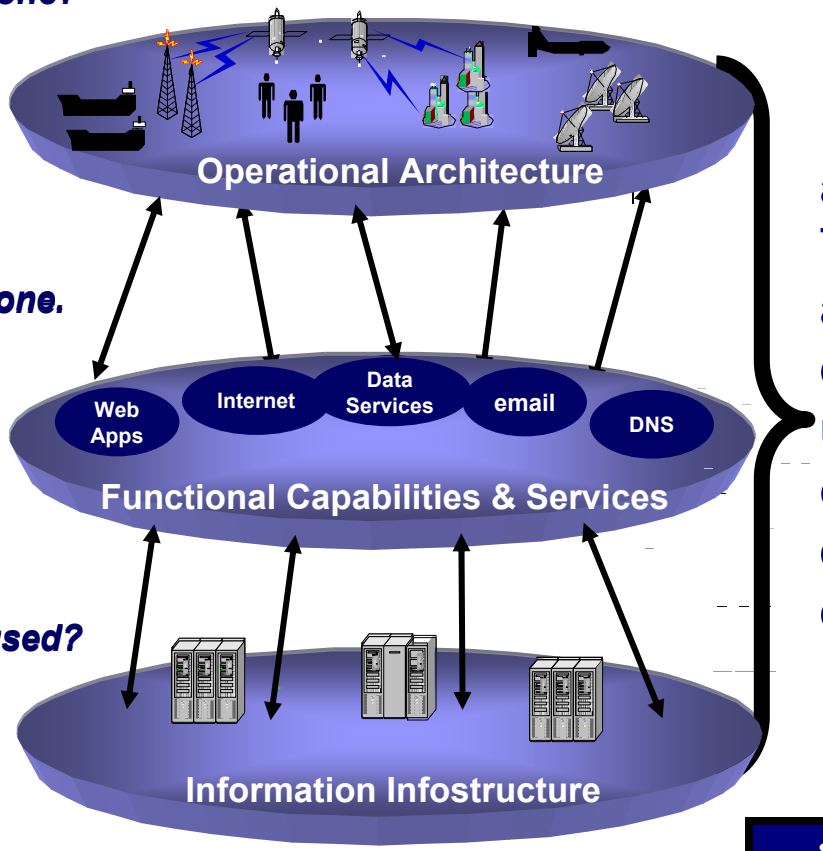
Operational Architecture/Operational Use Case Definition

How it's done.

Operational Use Cases Dependencies on Services Service Layer – Virtual Translator

What is used?

Infostructure Used to Provide Services



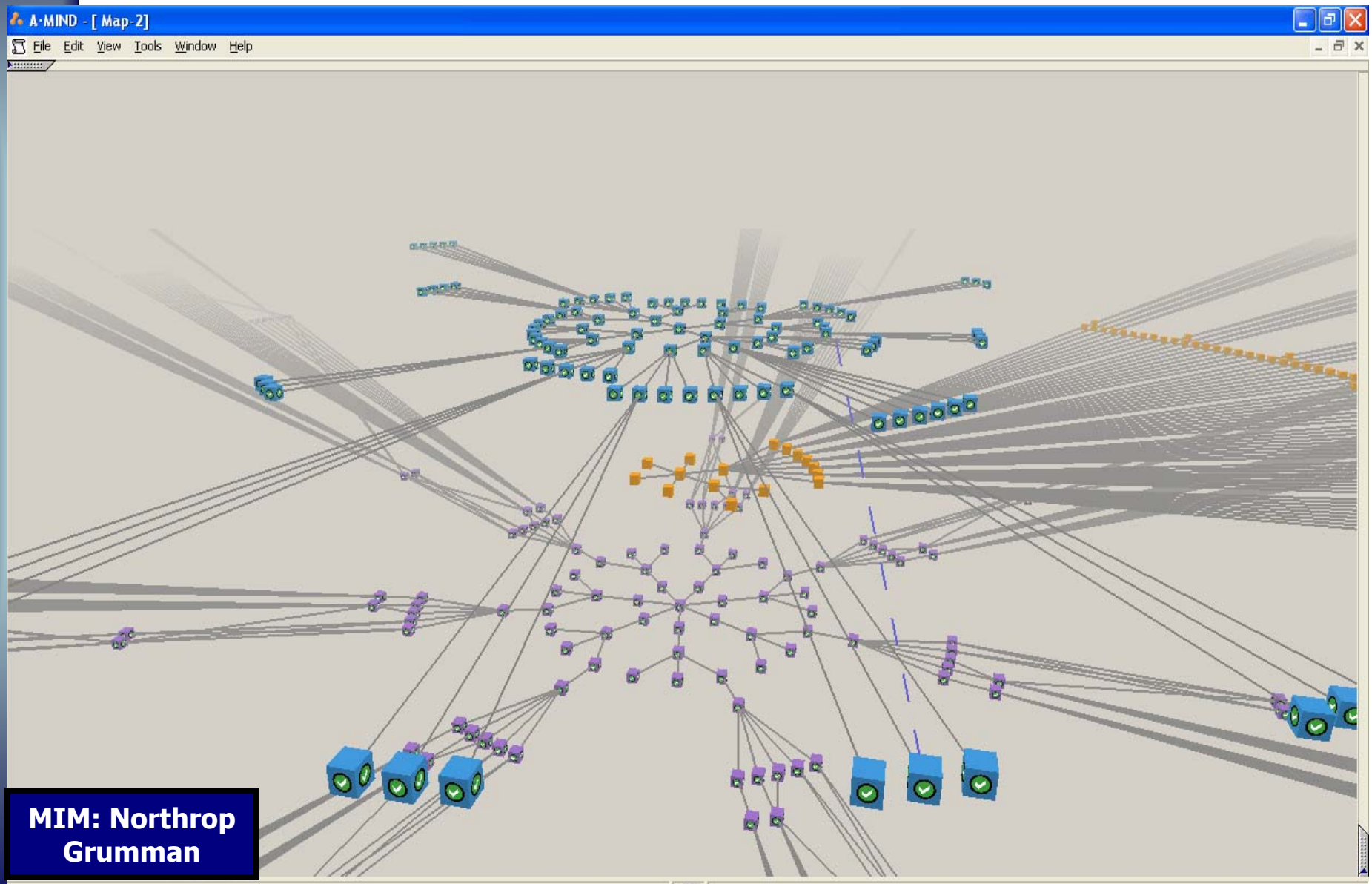
a-MIND Technology automates dependency understanding enabling analysis of Mission Impact of Infostructure Disruptions

- Proven ability to integrate COTS products
- Unique integration and analysis framework – patent filings

§ Mission Impact Management (MIM) Solution a Product of Northrop Grumman-Patent Pending

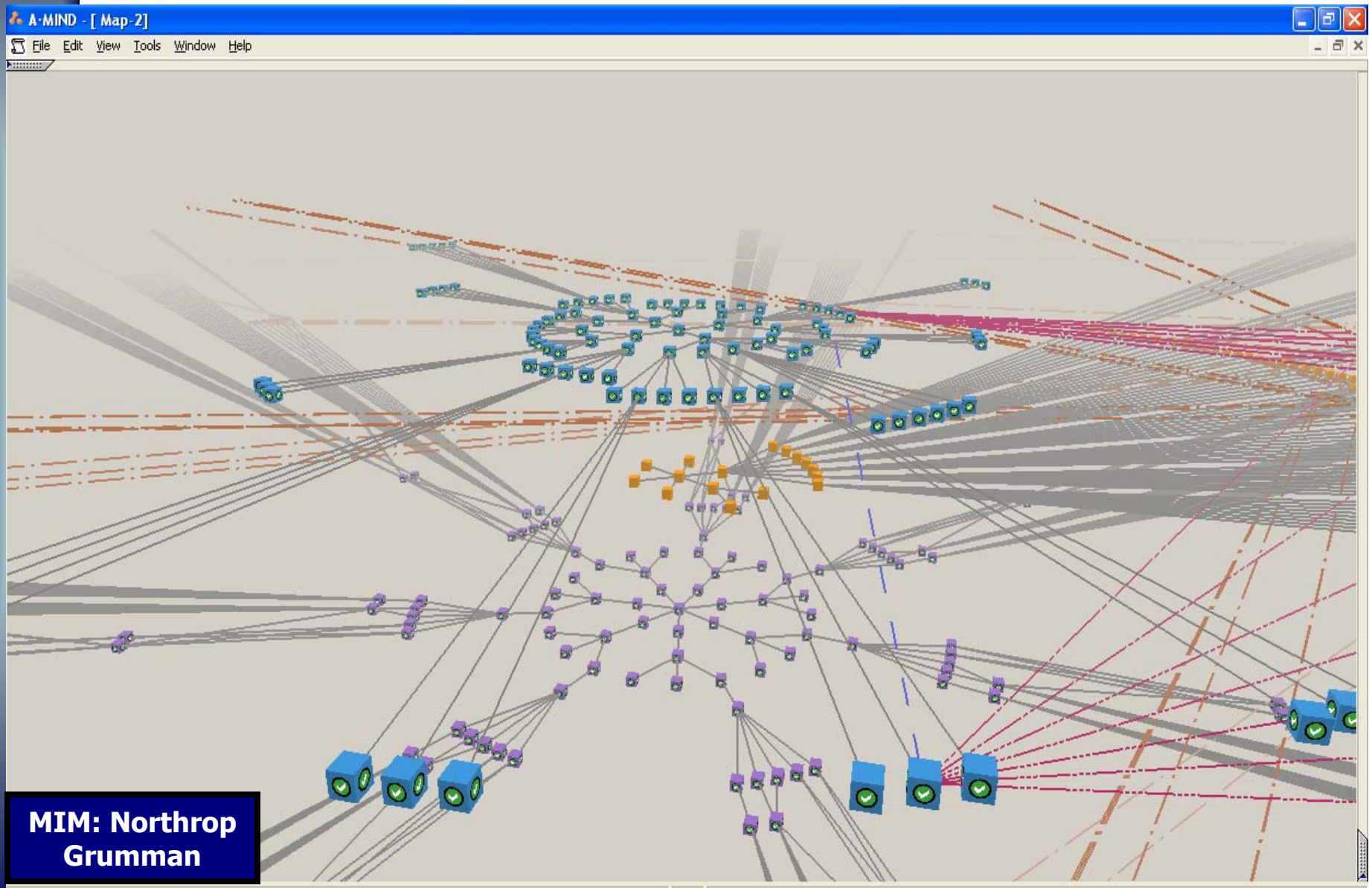
Dependencies

Map and view relationships within tiers . . .



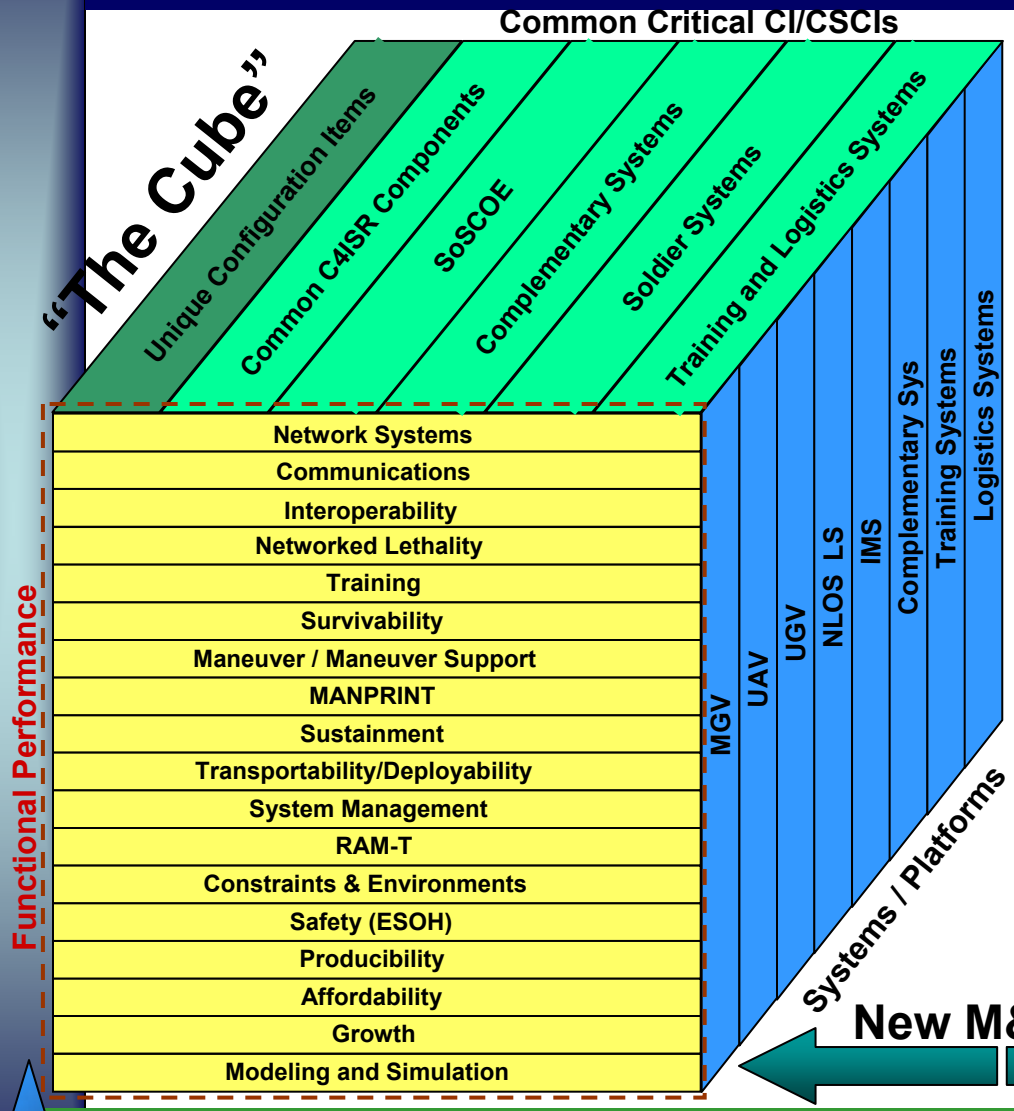
MIM: Northrop Grumman

Dependencies
. . . and between tiers



MIM: Northrop Grumman

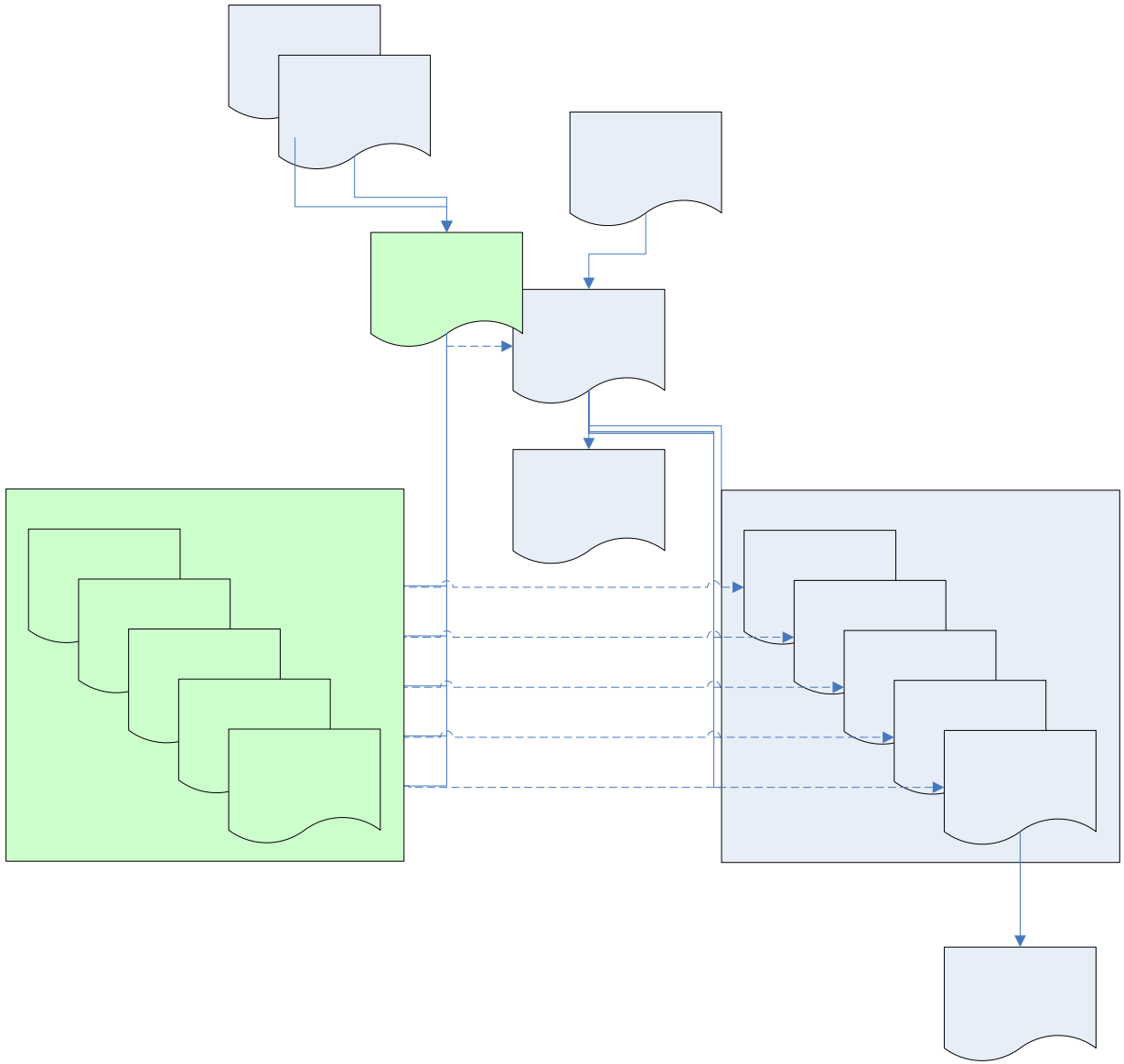
New M&S Requirements Module



- Requirements Modules Established Around the Front-Face of "the Cube"
- M&S Module is intended to enhance the integration and utilization of M&S across all aspects of the program.
- M&S Team is responsible for the application of M&S from "Cradle-to-Grave" and "Top-to-Bottom"

Multi-disciplined Teams including LSI, PM UA & TRADOC

Simple Tree – UGV Example



Panel Summary

Mr. John Illgen
Northrop Grumman Simulation Technologies

Conclusions

- **T&E and M&S have evolved and are managed asynchronously**
  - Adequate evaluation for today's complex SoSs in a Joint context requires extensive complimentary Test/M&S detailed planning and execution
- **Lack of common processes inhibits M&S sharing in the T&E community**
  - No standard "Standard" to assess M&S ability
    - What is a "High Fidelity Model"?
  - No common processes for using/sharing M&S
- **Common understanding through common languages, methods, and processes are crucial to achieving full T&E community integration**

Path Ahead

- **Crawl before Walking**
  - Develop a common understanding of what "Warfighter focused T&E" means to each Service and DoD Agency
  - Develop common language and practices for M&S use in T&E
  - Understand Service/Agency strengths and weaknesses in M&S in a T&E context
- **Community-wide Methods and Processes (M&P)**
  - Standard M&P for T&E across all Services and DoD Agencies
  - Links M&S use within DoD T&E communities
  - Good news: JTEM is making progress in this area

Path Ahead

- **Incorporate MMF as a community-wide T&E Process**
  - Global organizing schema covering both the mission definition and mission execution
  - Common understanding of T&E in Warfighter context
  - Without a global organizing schema covering both the mission definition and mission execution sides of the problem, the many pieces cannot be properly defined, instantiated, linked and executed

The Problem:
How to clarify Lifecycle issues in a T&E context?

MMF SOLVES THE PROBLEM

Points of Contact

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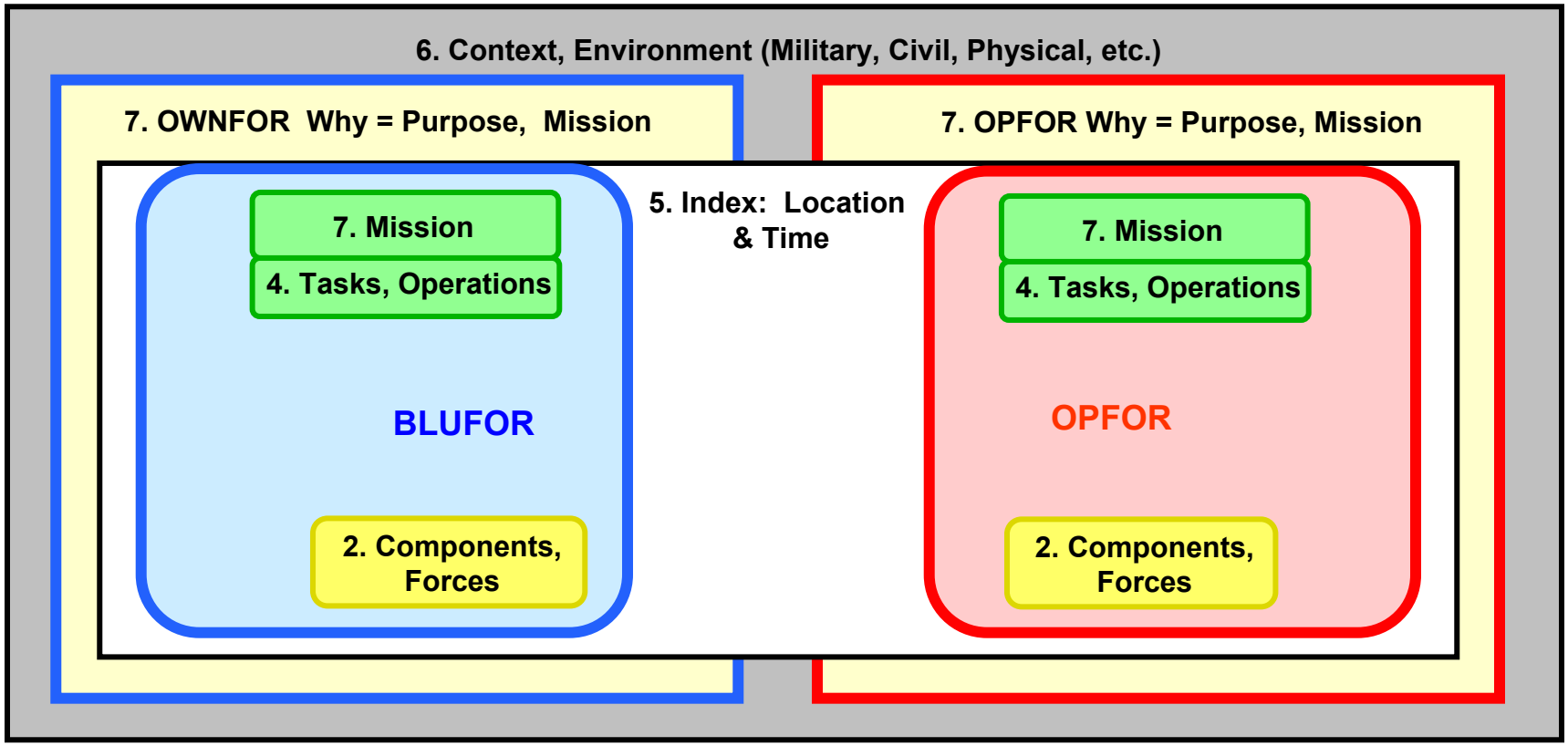
Questions?

Backup Slides

Missions and Means Framework

11 Fundamental Elements: Seven Levels, Four Operators

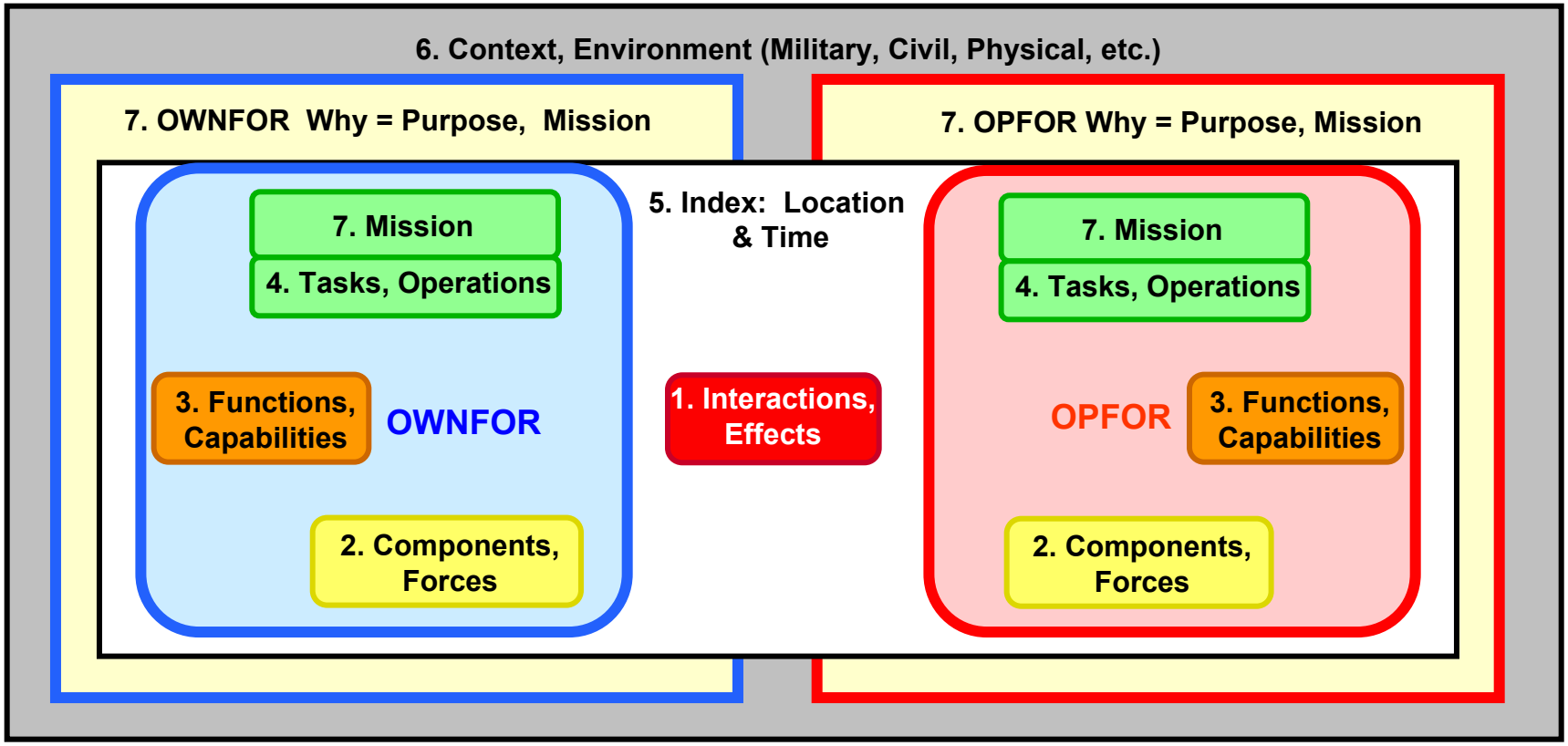


2. Entity-centric, named with a Noun "By Whom"

"The Players"

Missions and Means Framework

11 Fundamental Elements: Seven Levels, Four Operators

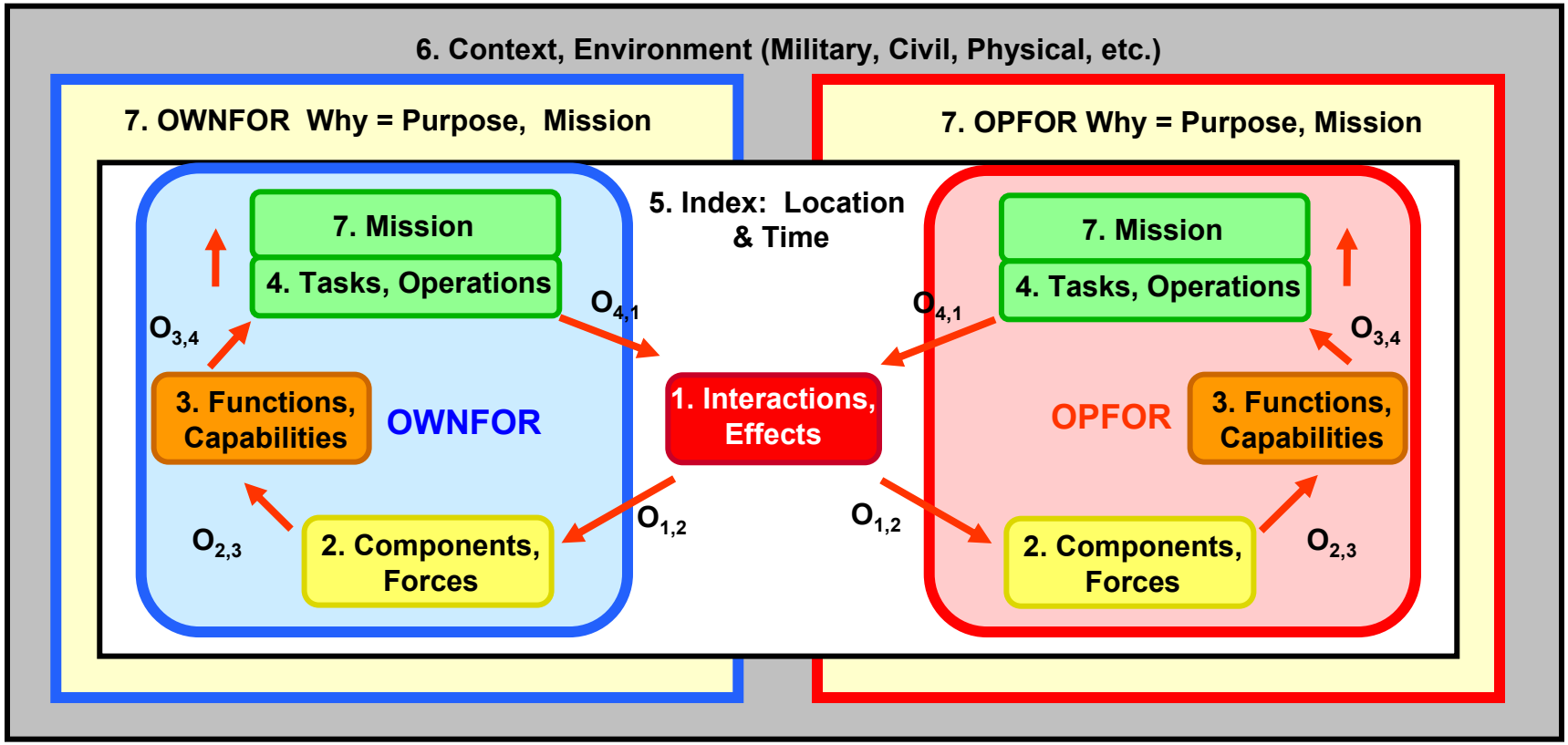


1. The (shared) Slings-and-Arrows of Outrageous Fortune -- Science

3. Condition-dependent "How Well" -- Engineering

Missions and Means Framework

11 Fundamental Elements: Seven Levels, Four Operators



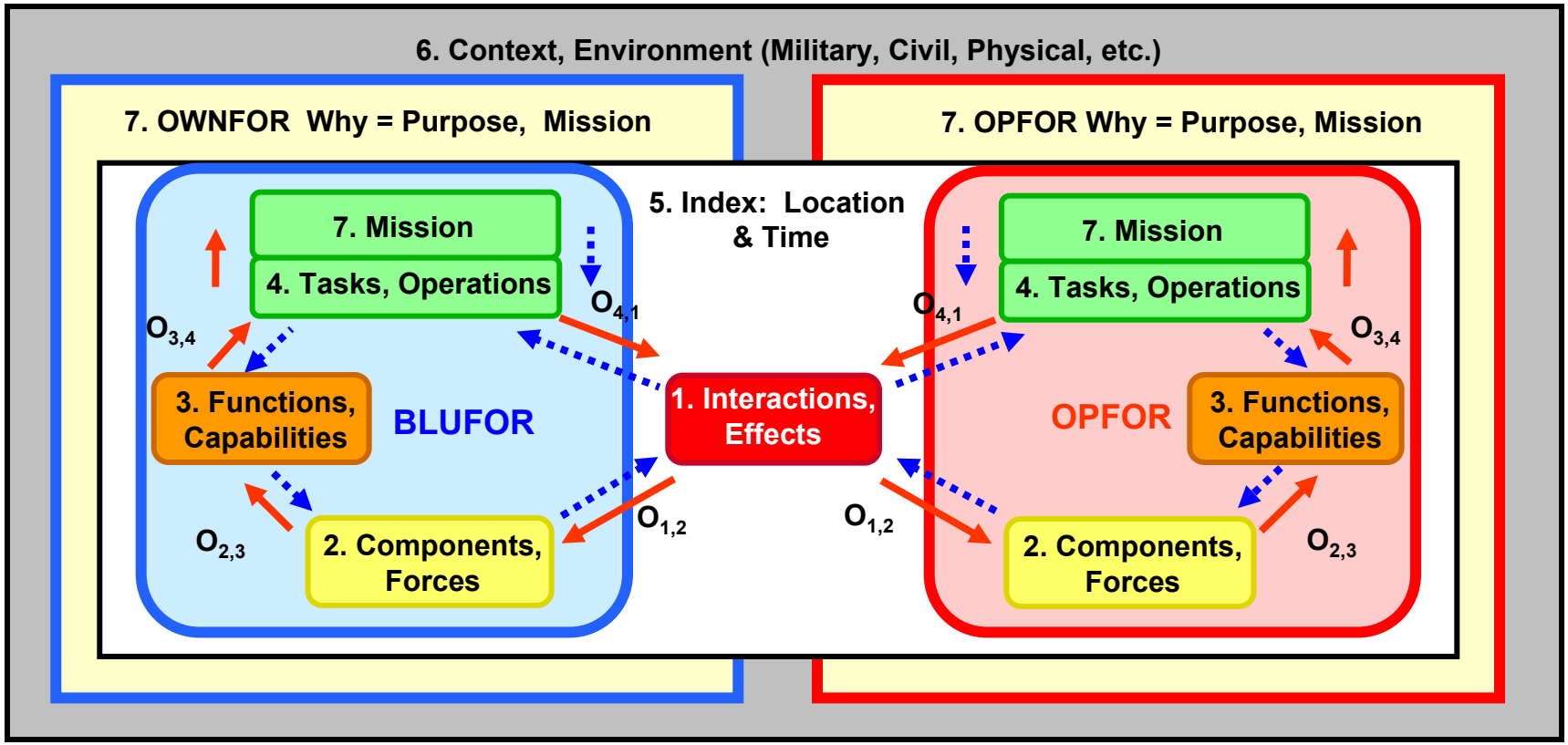
Planning

Employment

Bottom-up, Causal, Time-forward execution and adjudication of outcomes

Missions and Means Framework

11 Fundamental Elements: Seven Levels, Four Operators

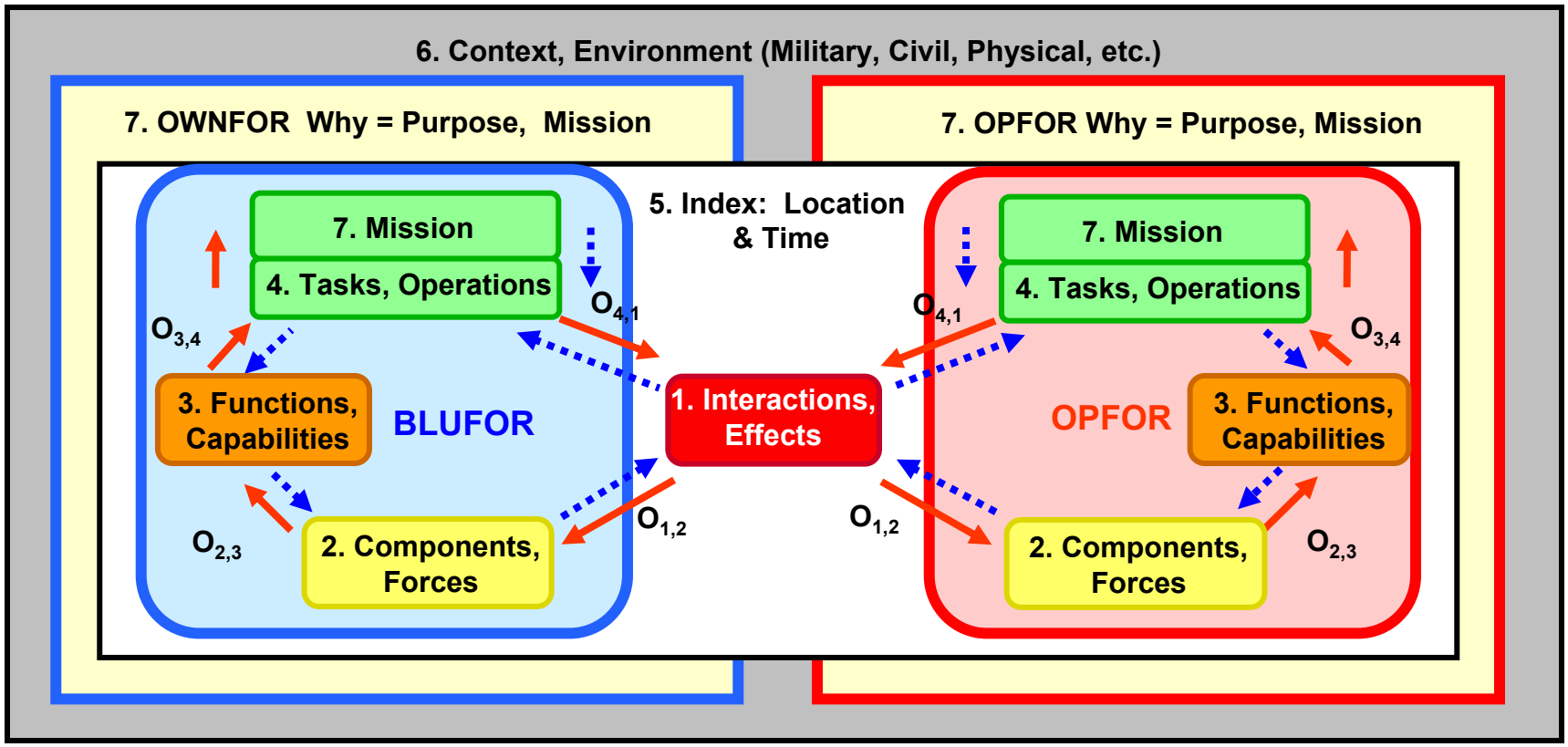


Planning

Employment

Top-Down, Concurrent Synthesis and Decision Making

Missions and Means Framework



Planning

Employment

Architecture defines how Parts are assembled into Packages

Capabilities are relationships between Parts and Packages