

Management, Mechanics, and Math (M3): An Enhanced Methodology for the Future T&E of Complex Information Systems

To: ITEA Symposium

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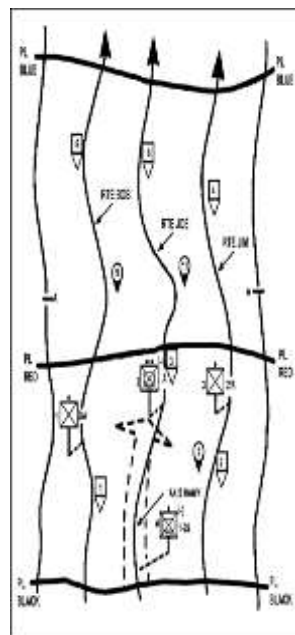
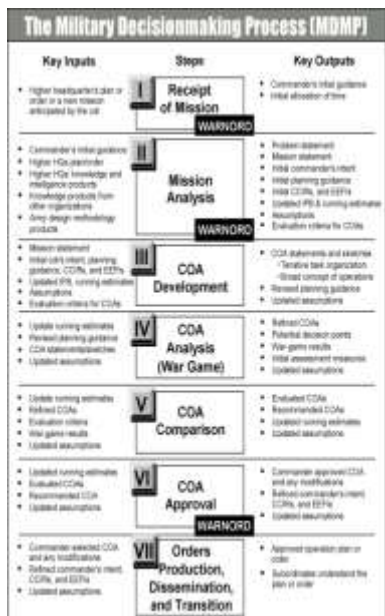
U.S. Army Test and Evaluation Command





Test and Evaluation

The fundamental purpose of integrated T&E is to provide information that adequately characterizes and assesses the Effectiveness, Suitability, and Survivability (ESS) of a system in terms of its ability to operate in its intended operational environment.



HVI DOE

Response Variable: Can injected truth in truth table be correctly discovered and entered into the Tactical Entity Database? (Yes/No)
Factors: Entity Type, INT
Constants: Test Event, Four Control Group HVIs as associations.

Entity Type	GENEV	COMENT	ELMENT	AB SECT/OSPT	Totals
Element				11	11
Equipment					
Event	0	0	0	0	24
Facility	0	0	0	0	24
Functional Processes					18
ILMINT Source					
ITD	0	0	0	0	24
Individual	0	0	0	0	18
Organization	0	0	0	0	24
Plan	0	0	0	0	24
Unit					
Vehicle	0	0	0	0	24
Totals	30	48	48	60	180

Notes:
 (1) Numbers in matrix are the minimum number of associations of that entity type with any of the four HVIs under a given INT. For example, Evaluation is asking for a minimum of 6 associations coming from GENEV which consist of an event associated with an ITD.
 (2) Scenario will distribute these requirements over the three record phases and between the four HVIs as equally as possible.
 (3) Align Control Group with known COAs/PSAs where applicable, if possible.
 (4) Test Design: Full Factorial with 4 replicates (arithmetic combinations removed)

Power calculated using JMP 10.0.0

Ref: BSSS: The Better Staff SMARTbook, 3rd Ed. (www.TheLightingPress.com)



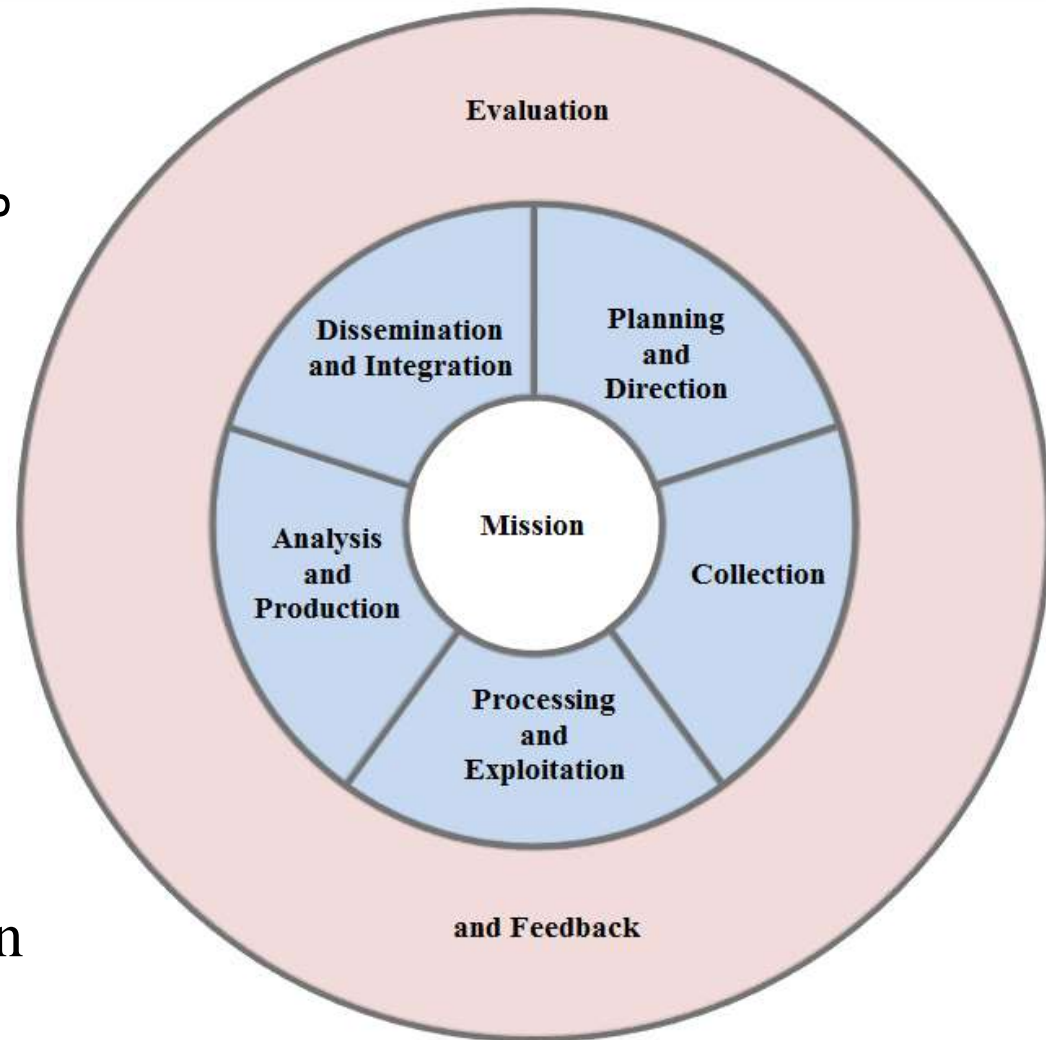


The Challenge

Blending Art (The Intelligence Cycle – JP 2.0) with Science (the rigors of testing)

Five distinctive but closely related steps

1. Planning & Direction
2. Collection
3. Processing & Exploitation
4. Analysis & Production
5. Dissemination & Integration



All concurrently with constant evaluation & feedback





Why explain the Management, Mechanics and Math (M³) of an Evaluation?

Management: the function that coordinates the efforts of people to accomplish goals and objectives by using available resources efficiently and effectively.

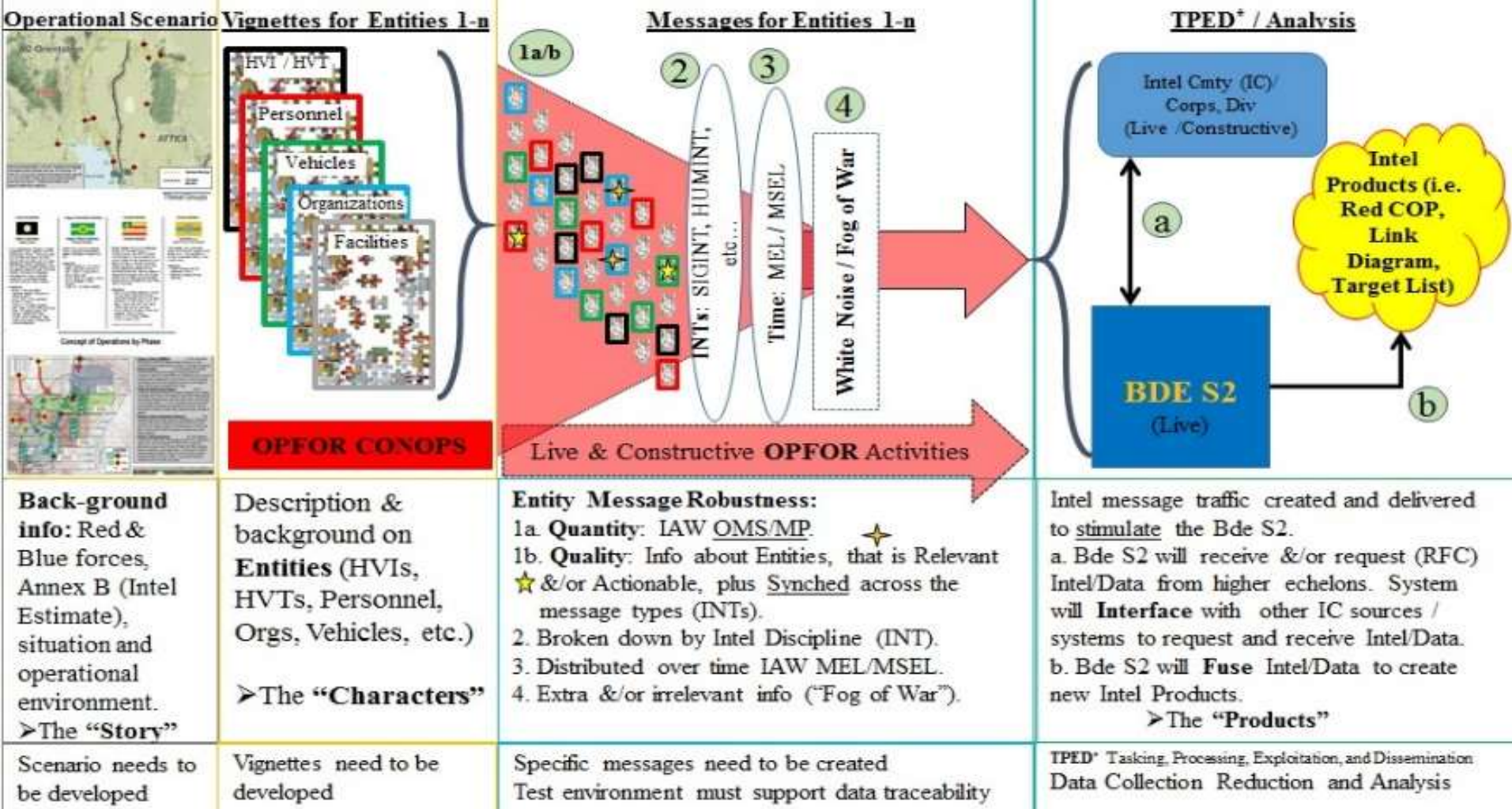
Mechanics: is an area of science concerned with the behavior of physical bodies when subjected to forces or displacements, and the subsequent effects of the bodies on their environment.

Math - Mathematics: The study of the measurement, relationships, and properties of quantities and sets, using numbers and symbols.





M3 Methodology



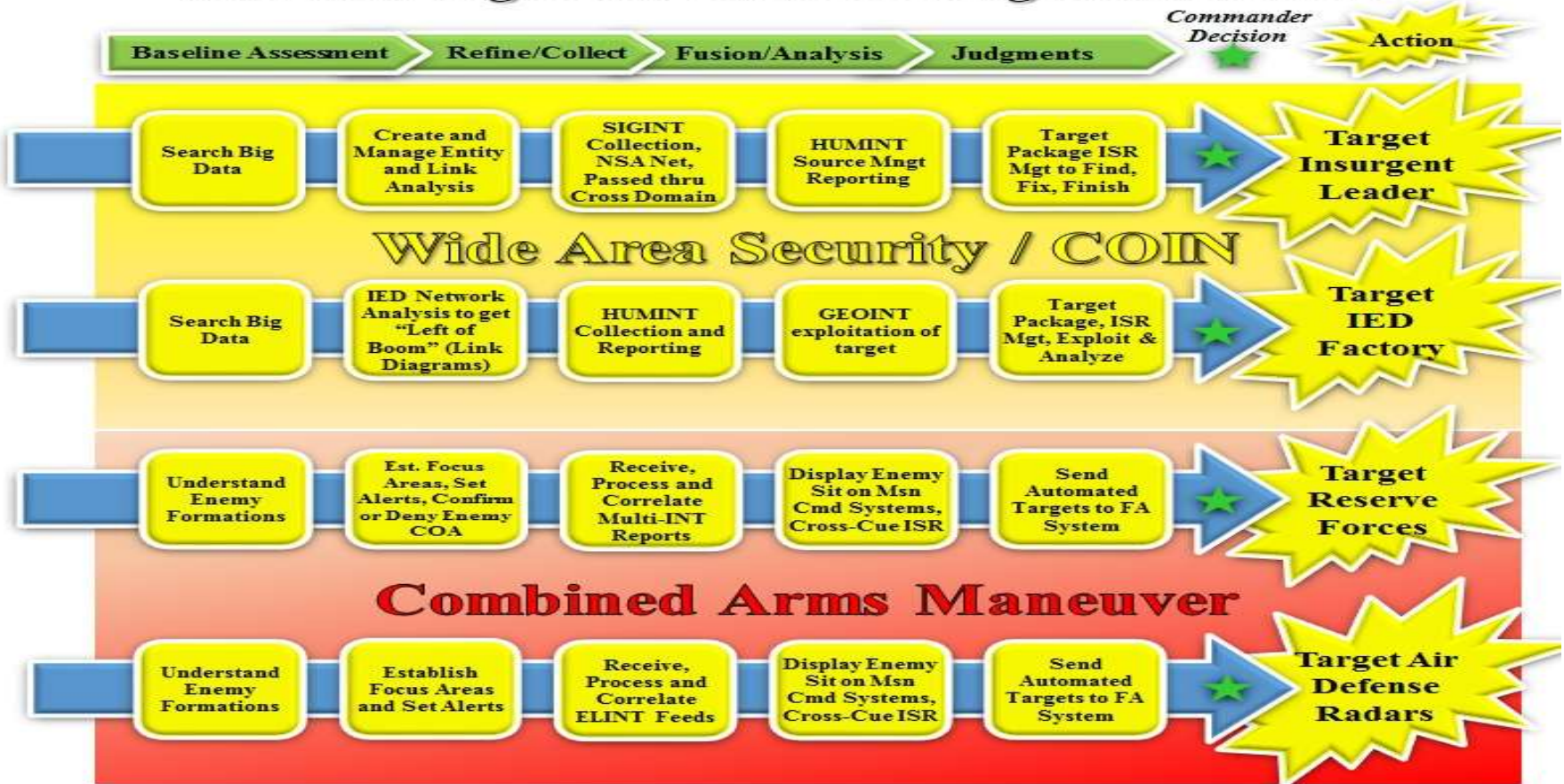
The *M3* methodology enables credibility addressing the inherent uncertainty that the “art” of evaluation introduces while allowing scientific analytical analysis.





Vignettes provide the key

Scenario Vignettes Drive Testing Environment



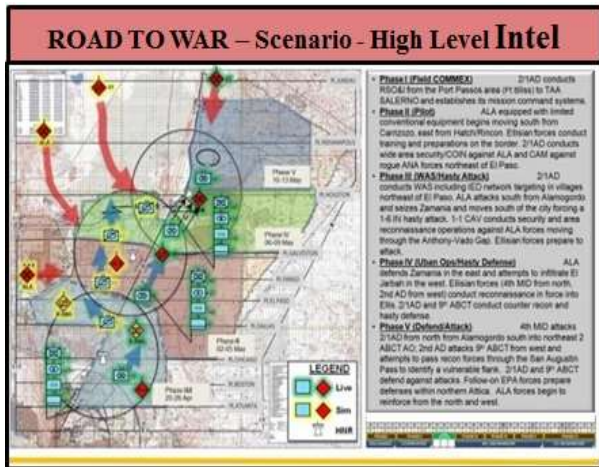
The M3 methodology Vignettes enable Units to conduct their Military tasks while allowing the data to be collected supporting the rigors of Testing.





Mechanics Driving Integrated Testing

Overall Exercise Scenario



Details of each Vignette

Example HVI – Vignettes

Sample HVI TRUTH TABLE

Record Day	0	1	2	3	4	5	6	Total
SIGINT	4	3	2	1	5	6	7	28
HUMINT	2	1	3	5	7	9	2	29
GEOINT	4	4	7	5	3	0	5	28
All-Source	2	4	6	8	10	12	14	56
JWICS	2	1	0	3	0	2	0	8
NSAnet	3	0	4	0	4	0	0	11
Fog of War	0	1	0	2	0	3	0	6

- Noise – unrelated volume of traffic
- Relevant Information - volumes of maneuver, intel, fires data flowing
- Actionable Information – supporting PIRs, taskings, evolution of link-node diagrams, etc.
- Fog of War

Intel Daily Message Count (Collateral) Pilot and Record Daily Average

Message Type		Collected over Net		
		Avg	OMS/MP	
		const	min	max
Maneuver OPS	Mission Command		113	227
	Combat Reports		182	418
All Source	Collaboration	10	41	454
	Weather	0	8	28
	Intel Products	12	15	94
	Collection Management	30	6	84
	Biometrics	Insufficient	44	477
GEOINT	Engineer Products	Insufficient	10	20
	Imagery Products	156	6	227
	FMV	confusion		
SIGINT	Moving Target Indicator	30	1	1280
	Operations	0	0	65
HUMINT/CI	Reporting	10	65	4680
	Operations	Insufficient	22	114
MASINT	Reporting	0	6	30
	MASINT	0	0	50

Message Count Status

- Acceptable Qty (Green)
- Did not meet MIN (Red)
- Over MAX (Red)

Example MSEL for Operational HVI Vignettes

Line	Event	Source	Summary	20-Apr-2015 Report DTG	Linked To
1					
2					
3					
4					
5	HVI-VT	Source	Summary	20-Apr-2015 Report DTG	Linked To
6	CPT of Assad Halabi (Rogue ANA) (Equipment, Event, Person)	TBOC	HVI reporting indicates that CPT Halabi, a rogue ANA CPT is responsible for and coordinating rogue ANA support for the Hassan Regional Command (i.e. Anthony, Vicks, Acoma, Janena)	HUMINT, SIGINT, OSINT, GEOINT, INTSUM	Mukhtaar Zubikar (Hassan Regional Commander) Saif Odein (Regional Commander) (Equipment, Event, Person)
7	Nasir Alaa		Nasir and Nahr discuss ANA soldiers - either they join the ALA or they die.		Killing ANA soldiers. (Event, Person)
8	Nahr Ibrahim bin-Mahmoud		Nahr and Ziyad discuss preparations.		Indicators for attack. (Event, Person)
9	Ziyad Kanazari	HUMINT Walk-In	Massing of military vehicles and equipment along Elibian and Altice border.	HUMINT, SIGINT, OSINT, GEOINT, INTSUM	The truck driver spoke with transport drivers from ALA. One of them mentioned Ziyad, a hero of the last fight now has a chance for revenge. (Equipment)
10	Anis Fadji	HUMINT Walk-In	Anis Fadji appeared at an ALA rally to exhort the young men of Carrizozo to join the ALA and fight to get the corrupt government of Altice out of power. He noted how much better life was in Carrizozo since the ALA took over the	HUMINT, SIGINT, OSINT, GEOINT, INTSUM	Troop movement, Recruiting (Event, Person)

Threat Synch Matrix | HVI Tracker | ONESAF Build

Daily Message Counts

Master Scenario Events List (MSEL)



Math: Design of Experiments

HVI DOE

Response Variable: Can injected truth in truth table be correctly discovered and entered into the Tactical Entity Database? (Yes/No)

Factors: Entity Type, INT

Constant: Test Event, Four Control Group HVIs as associations.

Entity Type	GEOINT	COMINT	HUMINT	All Source / OSINT	Totals
Document				12	12
Equipment					
Event	6	6	6	6	24
Facility	6	6	6	6	24
Financial Transaction		6	6	6	18
HUMINT Source					
IED	6	6	6	6	24
Individual		6	6	6	18
Organization	6	6	6	6	24
Place	6	6	6	6	24
Unit					
Vehicle	6	6	6	6	24
Totals	36	48	48	60	192

NOTE: Power does not include document as an entity level due to operational confounding

Power Analysis		
Significance Level	0.2	
Signal to Noise Ratio	1	
Error Degrees of Freedom	169	
Effect	Power Lower Bound	Numerator DF
Entity Type	0.795	7
INT	0.995	3

Power calculated
using JMP 10.0.0

Notes:

(1) Numbers in matrix are the minimum number of associations of that entity type with any of the four HVIs under a given INT. For example, Evaluation is asking for a minimum of 6 associations coming from GEOINT which consist of an event associated with an HVI.

(2) Scenario will distribute these requirements over the three record phases and between the four HVIs as equally as possible.

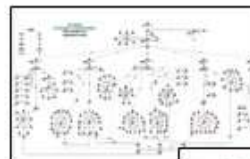
(3) Align Control Group with known CDR PIRs where applicable / possible.

(4) Test Design: Full Factorial with 6 replications (unrealistic combinations removed)



The Math; The Rigors of Testing; The Statistical Confidence

- Truth Table, HVI Tracker, and Threat Sync Matrix feed into the Scenario and Vignettes to produce products that can be analyzed
- Enables Evaluation and assists with determining Causality by comparing ground truth to unit developed products



Complete (White Cell) Product



BDE / BN Product

Link Diagram vs

GRINTSUM



Targeting



Red COP



Example HVI - Vignettes

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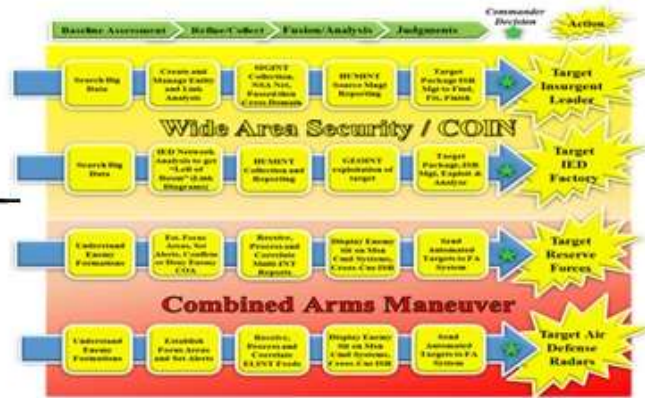
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- Fog of War

Threat Sync Matrix

Threat	Sync Matrix	HVI Tracker	ONESAF Build
...

HVI Tracker

Threat	HVI Tracker	ONESAF Build
...





Test and Evaluation Contributions

Contributions:

- Blends the “Art of War” with the Science of testing
- Provides an understandable logic trail for the evaluation of the risks and benefits of a complex system in a realistic environment
- Applicable to other complex test programs and not just information systems

