

The Growing Scope of M&S Use for T&E

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Outline

- Introduction
- Challenges for M&S Use in T&E
- Theoretical Basis
- A Joint Framework of T&E and M&S
- Summary

Introduction

- ❑ M&S Use in T&E, advanced M&S systems extend scope of T&E beyond classical methods toward VV&A
- ❑ T&E in the context of M&S and M&S in the context of T&E (Bair & Jackson, 2013)
- ❑ Major relationships between M&S and T&E (Glasow, Borowski, Allen, Burleson, & Moles 1998)
- ❑ Taxonomy of verification approaches in T&E (Baldwin 2013)
- ❑ A need to better understand boundaries of T&E and M&S
 - ❖ New approaches
 - ❖ Guidelines

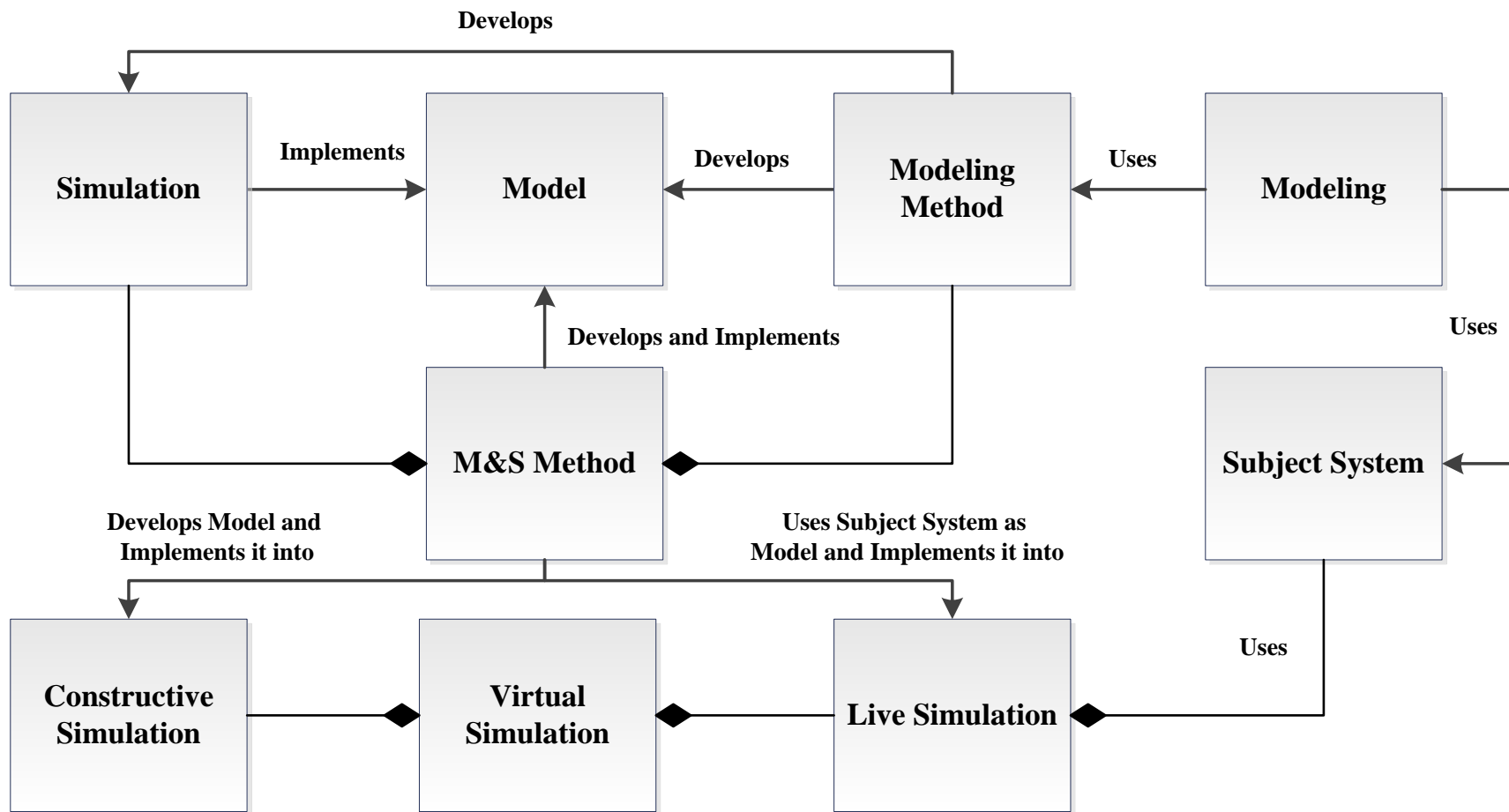
Challenges for M&S Use in T&E

- ❑ **Increased use of M&S in T&E: model-test-model process** (Hill, Ahner, and Gutman 2014; Haase, Hill, and Hodson 2011)
- ❑ **LVC to T&E System of Systems (SoS) slow to gain acceptance in the DoD T&E** (Haase, Hill, and Hodson 2011)
- ❑ **M&S-based intelligent components as a part of the system – self-organizing systems** (Dobson et al. 2006; Sengul, Viana, and Ziviani 2012)

Challenges for M&S Use in T&E

- ❑ Knowledge gap in T&E of unmanned autonomous SoS, evolutionary test capabilities needed (Deonandan, Valerdi, Lane, and Macias 2010; Scheidt, D'Amico, and Lutz 2014)
- ❑ A need for a research of new experimental designs and frameworks, T&E techniques must evolve (Nichols 2014)
- ❑ A smaller distance between real systems and simulations

Theoretical Basis: System of M&S Definitions



(DoD 1996; Balaban 2015; DoD 2007; IEEE 2010; Gross 1999)

Theoretical Basis: Verification Matrix in T&E

System Engineer/Tested System	Passive	Active
Passive	Inspection	Demonstration
Active	Analysis	Test

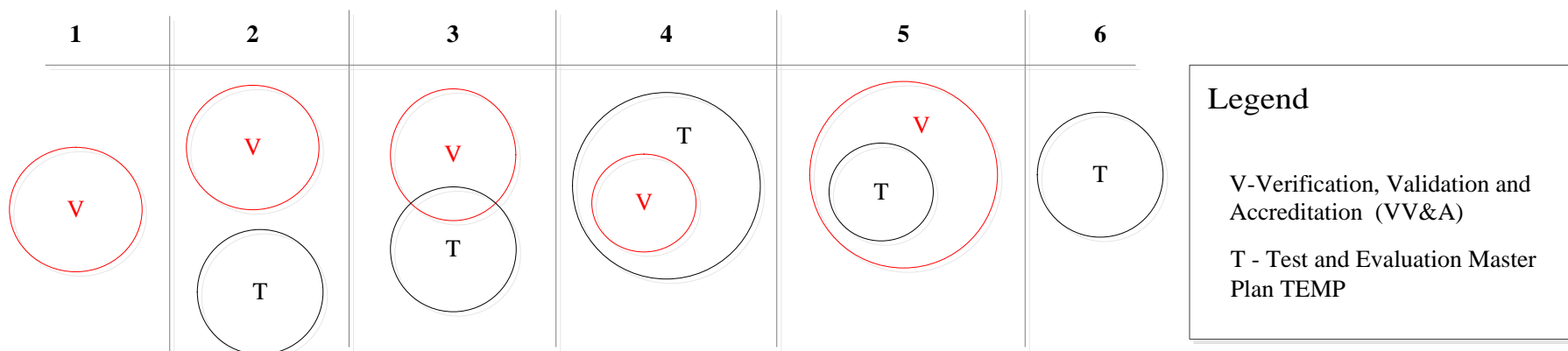
(Baldwin 2013)

- ❑ Test - a procedure designed to obtain, verify, or provide data for the evaluation
- ❑ Evaluation - a process where data are logically assembled, analyzed, and compared to expected performance

(DoD, 2012)

Theoretical Basis: Overlap of M&S and T&E?

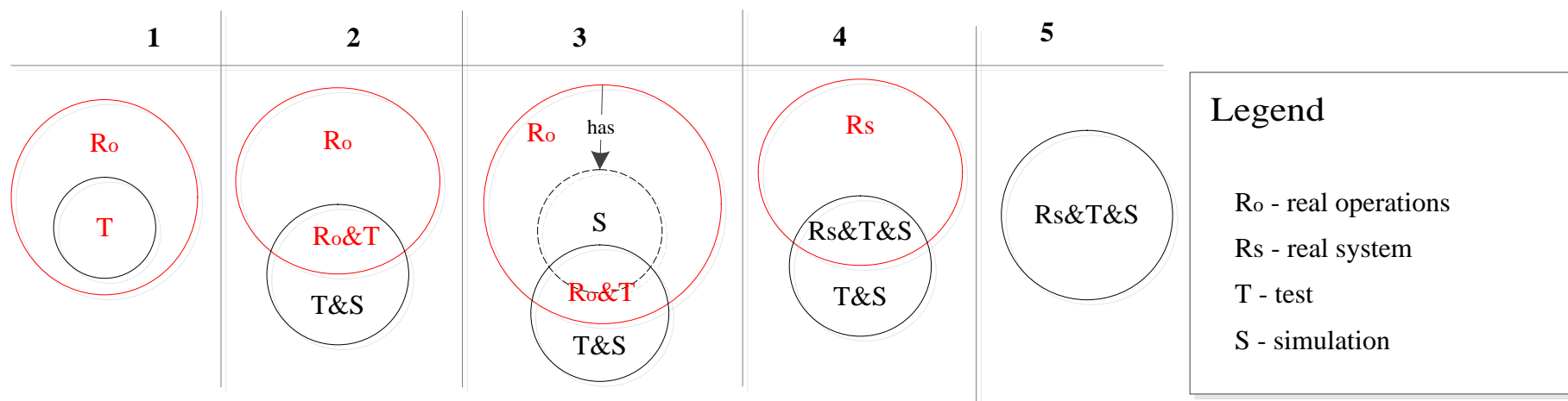
- ❑ Relationships between VV&A of M&S and TEMP (Glasow et al. 1998)
- ❑ 1) VV&A only, 2) no interaction, 3) overlap, 4) VV&A embedded in TEMP, 5) TEMP embedded in VV&A, and 6) no M&S is employed



- ❑ Evolutional character of the acquisition system than actual fundamental relationships between T&E and M&S

Theoretical Basis: Overlap of M&S and T&E?

- Is a testing activity always a simulation?
- Purpose of the system itself, multipurpose activities e.g. testing during real operations?



- Both testing and a simulation can use a real system or a representation of a real system, but simulation limits the activity to notional missions

A Joint Framework of T&E and M&S

- ❑ A passive entity does not act while an active entity does act in the considered context
- ❑ A proactive entity can anticipate possible future situations
- ❑ Proactive human capabilities and cognitive systems (Noor, 2015)
- ❑ Framework extends view of T&E verification-matrix proposed by Baldwin (2013) as T&E V&V matrix
- ❑ Replaces a system engineer with a broader T&E strategy term and introduces a proactive type

A Joint Framework of T&E and M&S

T&E Verification and Validation Matrix

		System		
		A: Passive	B: Active	C: Proactive
T&E Strategy	1: Passive	Inspection	Demonstration	Monitoring Diagnostics
	2: Active	Analysis	Test	Parallel test Simulation
	3: Proactive	Modeling DoE	Parallel test Simulation	Parallel test Optimization

Diagrammatic elements within the table cells:

- Vertical arrows pointing down from 1: Passive to 2: Active, and from 2: Active to 3: Proactive in the A: Passive column.
- Horizontal double-headed arrows between Analysis and Test, and between Modeling DoE and Parallel test Simulation.
- Vertical arrows pointing down from Test to Parallel test Simulation, and from Monitoring Diagnostics to Parallel test Simulation.
- A horizontal arrow pointing from Test to Parallel test Simulation.

- ❑ Ordinal scale for evaluation of a T&E strategy
- ❑ Proactivity as the highest possible level of T&E strategy
- ❑ Qualify, describe feasibility of testing various proactive systems (T&E readiness), and support concerns related to T&E budget within a program life-cycle

Summary

- ❑ Challenges to evolve T&E of systems that heavily rely on M&S within their components
- ❑ M&S has an important growing function for the T&E community
- ❑ Iterative knowledge generation based on repetitive model-test-model phases can be accelerated
- ❑ Integration of constructive simulation and distributed LVC T&E environment will drive the future of T&E
- ❑ Mutual benefits to T&E in discovery and disambiguation of emergent behaviors of intelligent autonomous systems and to M&S to improve its capabilities
- ❑ Need for methods for obtaining data from real operations

Thank You

Q&A

Back up slides