# Assessments of IT's Support of C2

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# Outline

SLAD ARL

1. Introduction, motivation and core issues
2. Traditional Human-in-the-Loop (HITL) Assessment Methods of IT's support to C2 and their disadvantages
3. Use of M&S in IT assessments
4. Fundamental concepts of modeling for credible IT assessments
5. Objective measurement of modeled C2 processes
6. Conclusions

# Introduction



- DoD's Transformation roadmap is focused on Information Superiority, Agility via Focus and Convergence
- Consequently recent Future Force acquisitions emphasize IT developments; large portion of budget devoted to IT spending e.g. BFT, JTRS, UAS and UGS, etc.
- IT advances historically suggest C2 advances
  - WWI: telegraph
  - WWII: radios in Tanks
  - Current:  NCW, agility and
- Whereas the METT-TC problem-solving factors remain largely unchanged

# Motivation



- Goal of Information Superiority and focus on IT acquisitions presents an analytic challenge: how to assess IT's support to C2 (IT's *raison d'être*)
- The root problem is to identify those universal and relevant features of the consumers' cognitive domains that lend themselves
  - to quantification, and
  - to objective assessments of IT's support of C2

# Core IT Assessment Issues

- It is a tremendous challenge to generalize the vast IT and C2 Domains to allow for interpretation into a variety of uncertain problem contexts
- Difficulty with cognitive domain that IT supports:
  - Cognitive domain much less transparent than physical science/engineering domains
  - Many micro-theories; no unified theory (Newell)

# Traditional HITL Assessment Methods



- Observer/Controller (O/C) Team paradigm used during HITL experiments at CTCs
  - BCT assessments start with training objectives (identification of study plan), then analysis plan formed
  - O/C teams are staffed to track every key leader in a BCT
  - O/C teams collect data of many types: SA, performance MOPs; use tracking technologies

# HITL Issues



- Despite importance of O/C teams to CTC assessments, there are limitations, esp. re: objectivity
  - O/Cs are human, with typical cognitive limitations: collect, process, store, interpret, recall
  - don't have access to ground truth, and cannot see through the players they are assessing
  - In addition to the subjects' inability to fully reconstruct a previously held belief, the public nature of AAR and subjects' pride can limit the disclosure of (internally) confused states in *ex post facto* accounts of operations
- Cost issues: only a few experiments can be produced, very expensive, never identical

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# An Effective Alternative IT Assessment Method

- Idea: *employ M&S technologies to assess IT's support of C2*
- Advantages gained:
  - Produce **objective** assessments
  - Simple variability and Repeatability
  - Cost saving: time and money
  - Broad and persistent transparency and accessibility
- **But**…huge ontology for M&S representation; *fidelity (i.e. V&V and A) always in question*

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# Fundamental M&S Concepts

- **Existence**: identification of the referent(s)
- **Intention**: reason for the representation
- **Representation**: determining what model stands in for the real thing
- **Causality & determination**: how state changes to the representation are handled
- **Logical inference**: the creation of new knowledge from the representation (analysis)

Waite, W.F., Fundamental Concepts of Modeling. In the *Proceedings of the Thirty-Sixth Southeastern Symposium on System Theory, 2004; pp.366-373.*

# Fundamental Requirements

- We must solve the problems of:
  1. identifying the *ideal phenomena* to measure,
  2. in the *most appropriate context,*
  3. and how to *objectively measure* that phenomena
- To evaluate IT's support of C2, our solution is:
  1. To quantify *universal* C2 products that represent the consumer's integration of the METT-TC factors
  2. in an *operational* context (represented via M&S),
  3. using a *self-referential comparison* method that avoids subjective judgments

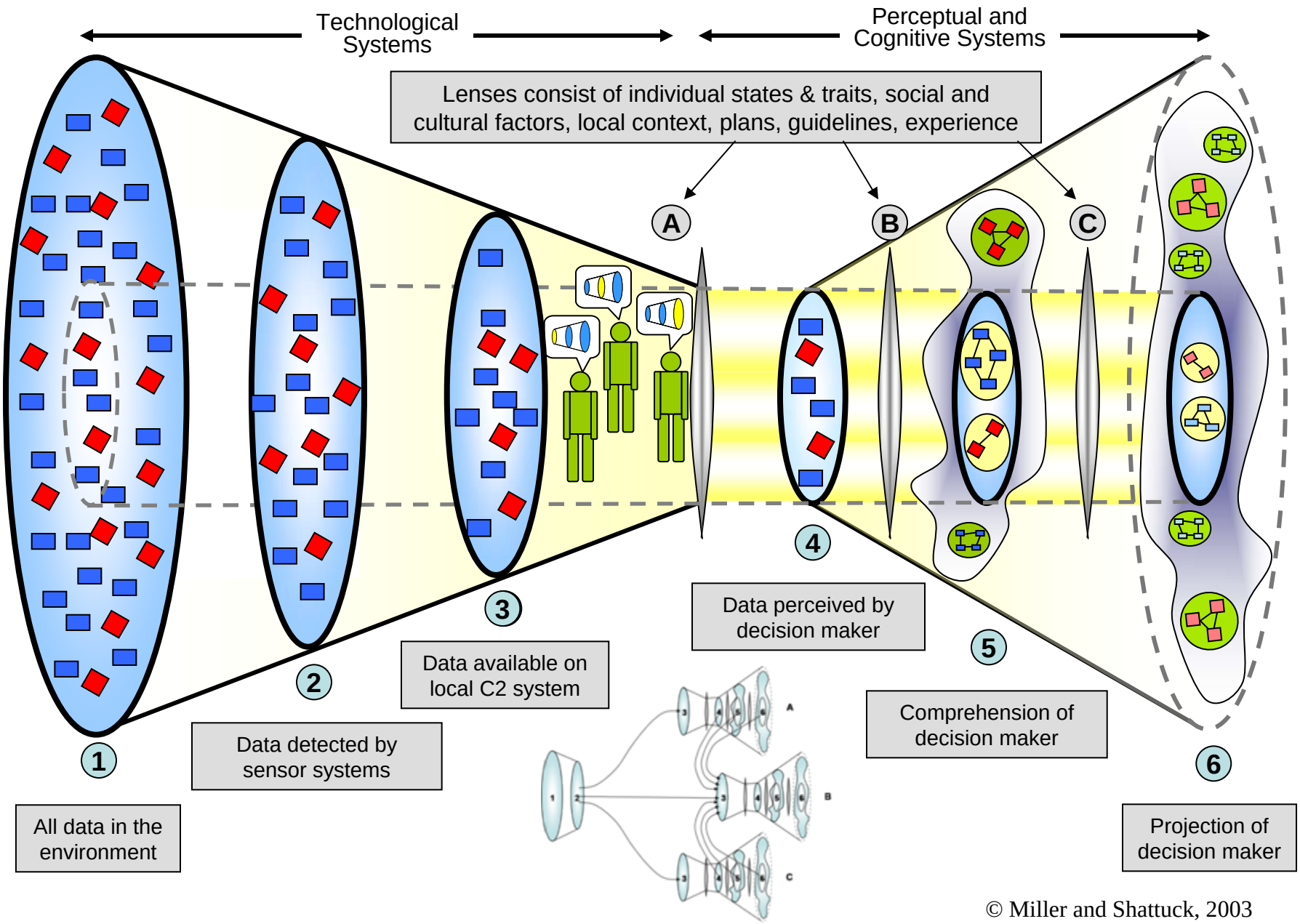
# Fundamental Requirements

- Two *universal* C2 products that represent the consumer's integration of the METT-TC factors are SA and SU
  - Situation Awareness (SA) – pre-integration
  - Situation Understanding (SU) – post-integration

METT-TC Universal:
"Know the enemy and know yourself; in a hundred battles you will never be in peril. …." -- Sun Tzu,

SA and SU products:
"'Sweeny worked to paint a picture of Al Qaida's network of safe houses, transportation nodes and escape routes out…" (Naylor, 2005, p. 25)

# Ideal Phenomena



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# Ideal Context For Measurement

A dynamic competitive *operational scenario* employing naturalistic decision makers is an ideal context:

- It provides naturally occurring situational variation essential for measuring the C2 products of the subject agents (esp. robustness)
- It provides a cost effective and realistic way of generating the interchange of information across a network that constitutes the primary function of IT

[Contrast these features with behaviors and interactions produced by scripting or fixed rule bases]

# Conceptualization of Objective Measurement

- Objectively measure SA and SU, the cognitive products arising before and after a consumer's integration of METT-TC factors
- By comparing the decision maker's products with those he would have produced with an alternative (improved) data stream
- Thereby avoiding the natural tendency to judge tactics based on the analysts'/SME's own experience

# Quantification of the Concept



- The method is called the Objective Information System Assessment Method (OISA)
- The comparison central to OISA is produced by a software clone (of the subject simulation agent) that uses the exact same decision algorithms but operates with an alternative data stream, e.g.
  - Ground Truth Agent, vs. simulation agent, or
  - Perfect Communications Agent, vs. simulation agent
- With this method, we have 100% certainty that the clone agent knows EXACTLY *what the subject agent would have done* (contrast with HITL)

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# *Implementation of the Concept*

- Implementation is not onerous and does not depend upon particular simulation details
- The analyst need only establish comparisons between the SA and SU products produced by the subject simulation agents and corresponding clones
- OISA has been implemented in S4: Bernstein, et al., 2006;  Davidson, Pogel, Smith, 2008; Hudak, Mullen, Pogel, 2008

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# Conclusions

- Key is objective assessments of IT support to C2
- M&S an effective alternative to HITL
- Significant obstacles to representing a massive domain
- Overcome obstacles through fundamental modeling concepts and use of OISA
- Future Work:  move from concept development and initial implementation to full implementation in M&S