Development of a game-based assessment of systems thinking ability: Initial model and construct validation

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Human Aptitude Assessment Panel

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Purpose

The purpose of this research is to develop a game-based assessment of a complex cognitive construct- Systems Thinking Ability- for the U.S. Army.

Phase 1-Develop / Validate Tests of STA Antecedents	Phase 2- Develop and Validate STA Assessment Game	Follow-up- Support implementation and adoption by Army
Completed SEP2016	Target MAR2021	+24 Months

Army Sponsors

Cyber Center of Excellence
Signal Corps
Military Intelligence

Higher-order Cognitive Assessment

Cognitive tests, such as ASVAB, are useful but have limitations:

They measure a few core capabilities (e.g., mathematical reasoning, vocabulary)

Composite scores (e.g., Science & Technology) are aggregates of section scores and may not fully reflect test takers' capability in namesake domain

Direct Measure of higher-order cognitive capabilities has advantages

For some MOS, measurement of higher-level capabilities (e.g., Systems Thinking Ability) could better identify the best-suited for the field

Could allow differentiation of those with high general intelligence to ensure such Soldiers are best utilized (enhances Talent Management)

New technology is opening up new avenues to assessment of such capabilities, but much research is needed.

One higher-order capability with promise for utility is

Systems Thinking Ability (STA)

Systems Thinking Applications in the Army

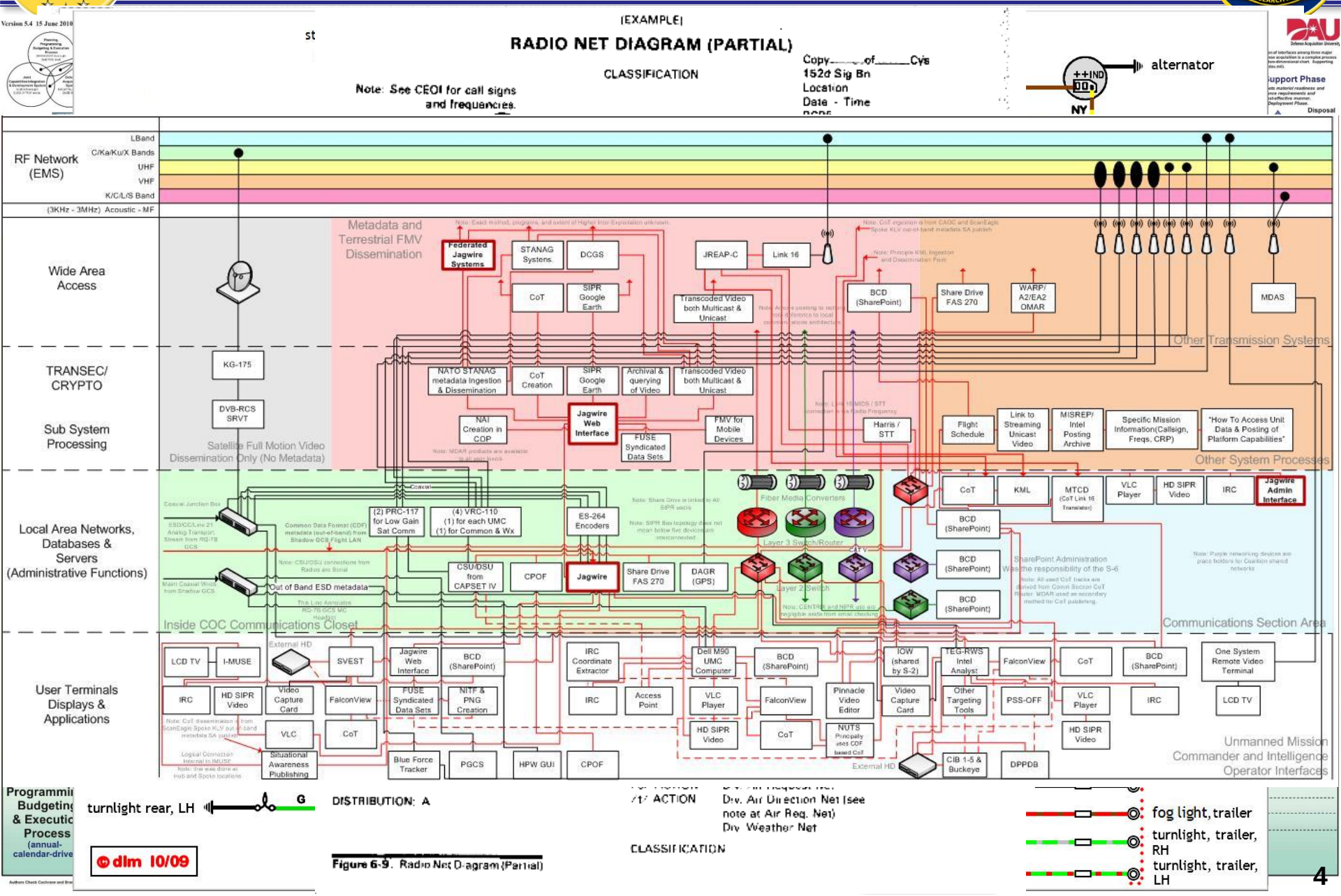
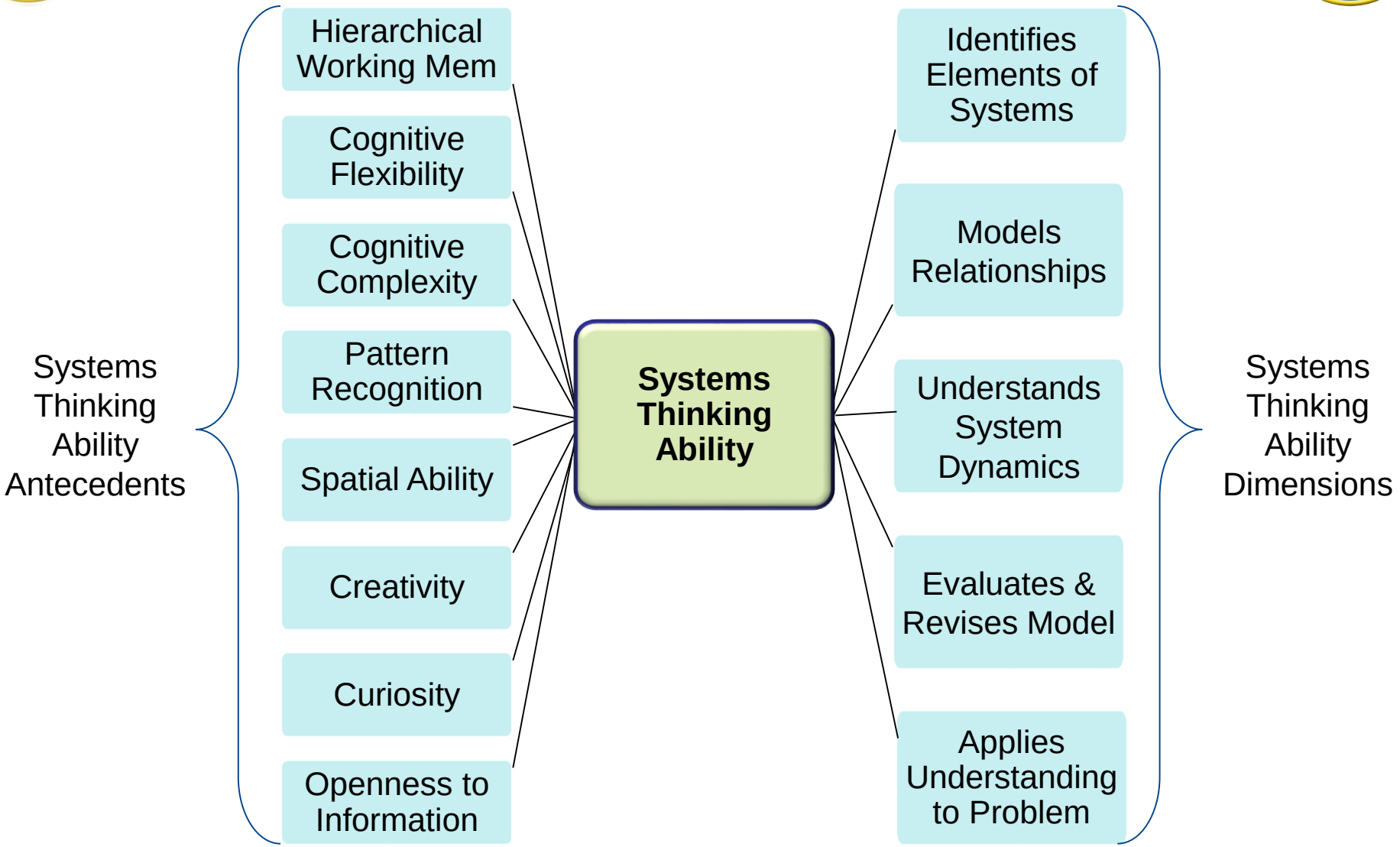


Figure 6-9. Radio Net Diagram (Partial)

Defining & Measuring STA



For a complex multi-faceted construct, traditional assessment media may be insufficient.

Game-based Assessment

ARI is exploring game-based assessment for measuring Systems Thinking Antecedences and Processes

Advantages of Game-based Assessment

- Intrinsically motivating / engaging
- Can observe and measure behavior and processes rather than just item response
- Secure (no items to expose)
- Discreet and covert measurement (test taker doesn't know what counts or how)
- Adaptable to individual test takers
- Customizable to different needs (e.g., selection for different MOS)

Research Questions / Challenges

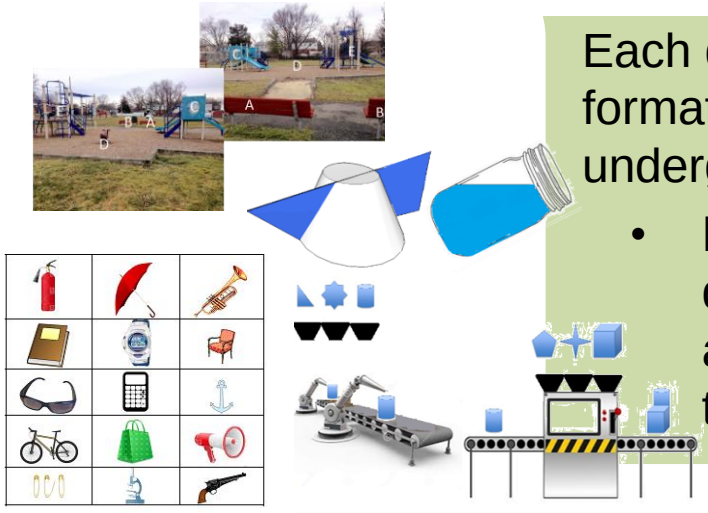
- What are the boundaries to what can be measured (e.g., response time, action efficiency, evidence of learning the game)?
- Can we design a system that can handle and use large amounts of data?
- How do we integrate large data pool into actionable assessment?
- What are the barriers to implementation (e.g., technology, measurement algorithms)?

Game Premise

About a month ago, a massive alien warship arrived at Earth, and sat menacingly on the horizon. Little is known about their intentions or capabilities. In the past few days, tensions between the aliens and the humans have been mounting. There have been isolated skirmishes and recent diplomatic and reconnaissance envoys have disappeared completely.

On a mission to investigate the alien ship more closely, your helicopter was captured and your entire unit was abducted by the aliens. The other members of your unit were quickly overtaken by alien mind control attacks, but somehow, you remain unaffected. You must fool your alien captors into believing you're under their control while you explore the ship searching for intel that the humans can use to overcome the invading aliens.

Measuring ST Antecedents



Each day on the ship, the player must join formation with the rest of the humans to undergo testing.

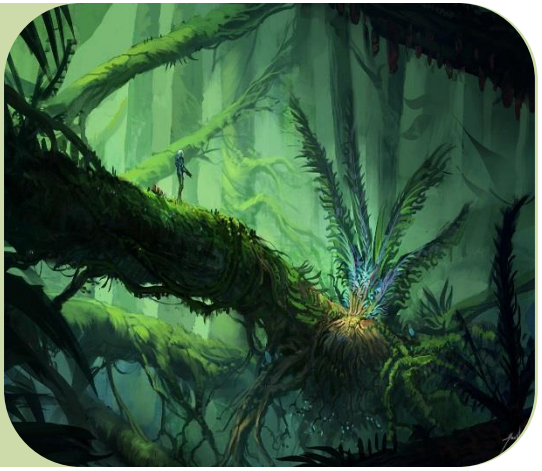
- Five ST "Antecedents" are captured during these daily activities, framed as alien experimentation or the aliens testing if their mind control is working.

- Hierarchical Working Mem
- Cognitive Flexibility
- Cognitive Complexity
- Pattern Recognition
- Spatial Ability

- Curiosity
- Creativity
- Openness to Information

User moves around the ship exploring alien objects and machinery, collecting intel, and avoiding detection.

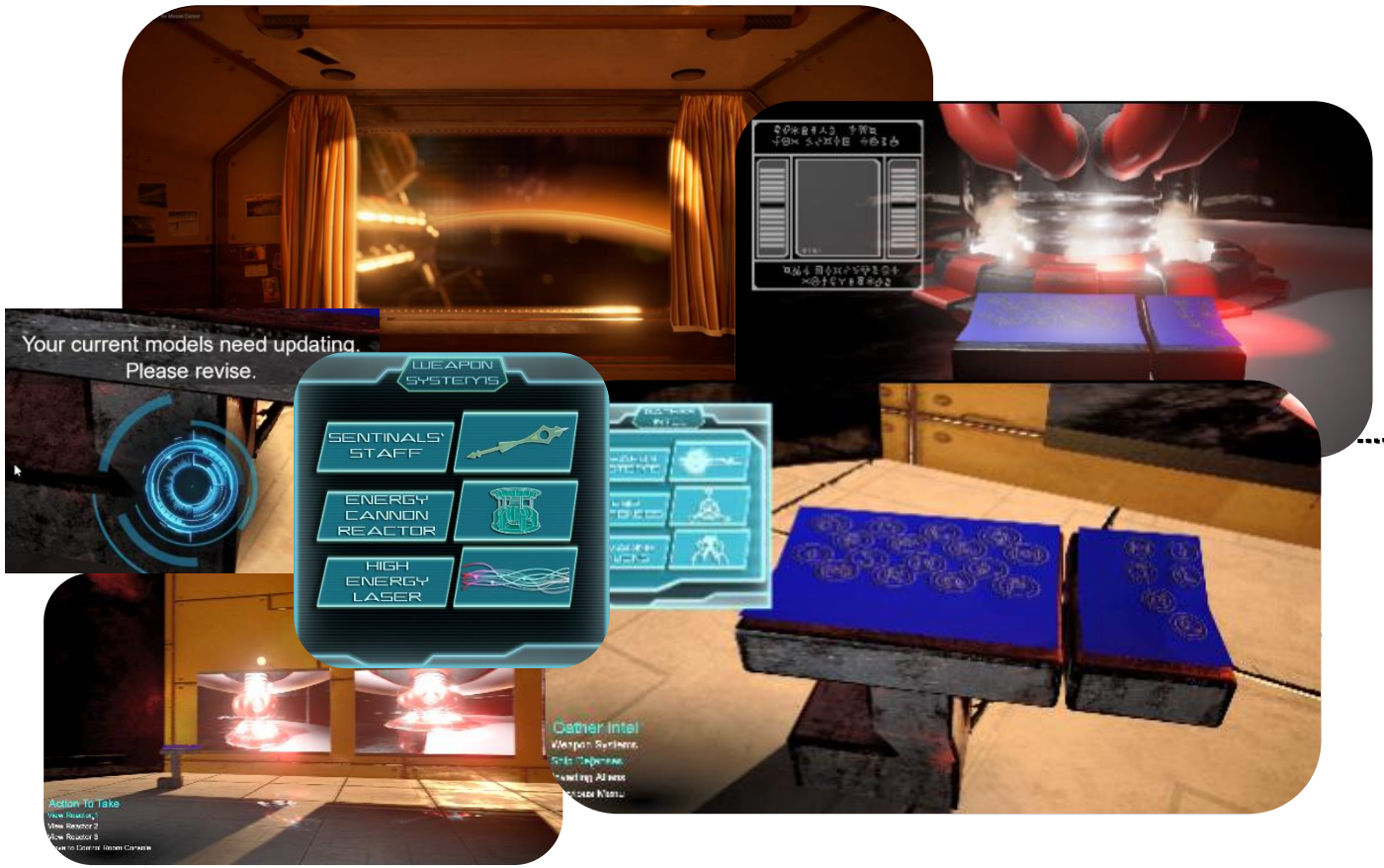
Three ST "Antecedents" are assessed through behavioral indicators collected as the user explores the ship, addressing the objectives and missions



Systems Thinking Ability Dimensions

When returning to the safe-room, the user can reflect on the systems s/he has seen.

Five Systems Thinking Ability Dimensions are captured from guided journaling, prompted activity, and via interaction with digital characters.



- Identifies Elements of Systems
- Models Relationships
- Understands System Dynamics
- Evaluates & Revises Model
- Applies Understanding to Problem

Summary

New technology is opening up new avenues to assessment of higher-order cognitive capabilities, but extensive research is needed

- Game-based assessment is one technology with promise to measure complex constructs

ARI is working on a game-based Systems Thinking Assessment

- Phase 1 developed and validated measures of 5 STA-related abilities
- Phase 2 will incorporate measures and will use in-game behaviors to look at traditionally hard-to-assess facets