



**U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT
COMMAND
SOLDIER CENTER**

**Integrating Experiential Simulation and Multi-
Modal Analytics into a Distributed Ecosystem**

25 APRIL 2024

Benjamin Goldberg, PhD
Senior Scientist / Lead
Adaptive and Intelligent Training Systems Branch
U.S. Army DEVCOM - Soldier Center
Simulation and Training Technology Center

Benjamin.s.Goldberg.civ@army.mil

NORDEFCO 12th Annual ADL Conference
Halmstad, SWEDEN

AGENDA



- **Introduction**

- **STTC's Adaptive & Intelligent Training Systems Team**
- **Army Learning Concept 2030 – 2040**

- **Competency Based Experiential Learning**

- **Connecting Experiential Learning with an Ecosystem**

- **Introduction of the STE Experiential Learning for Readiness (STEELR) Data Strategy**

- **Use Cases**

- **Competency Assessment for STE Training in Live Environments (CASTLE)**
- **Medical Competency Framework (TEMPEST)**
- **STEEL-R in eXercises (STEELRx)**



Adaptive and Intelligent Training Systems Branch

Mission: Transform Soldier readiness and effectiveness with adaptive and intelligent training technologies



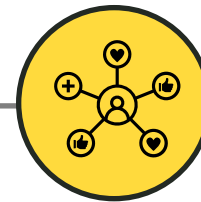
Team

Army civilians with expertise in learning sciences, team training, human factors, and artificial intelligence



Research

AI-driven training
Learner modeling
Synthetic training
Multimodal analytics
Automated feedback
Team effectiveness



Stakeholders

STE-CFT
PEO STRI
TRADOC
ADL
NATO
USMA WEST POINT



Outcomes

Programs and guidelines that demonstrate the effectiveness of next-generation training systems.



USES CASES



Integrating Live & Virtual



Experiential Classroom



Competency Modeling



Scenario Generation



Intelligent Coaching



AI-Driven Assessment



Supporting a Forward Vision of Training & Education



Army Learning Concept 2030 – 2040

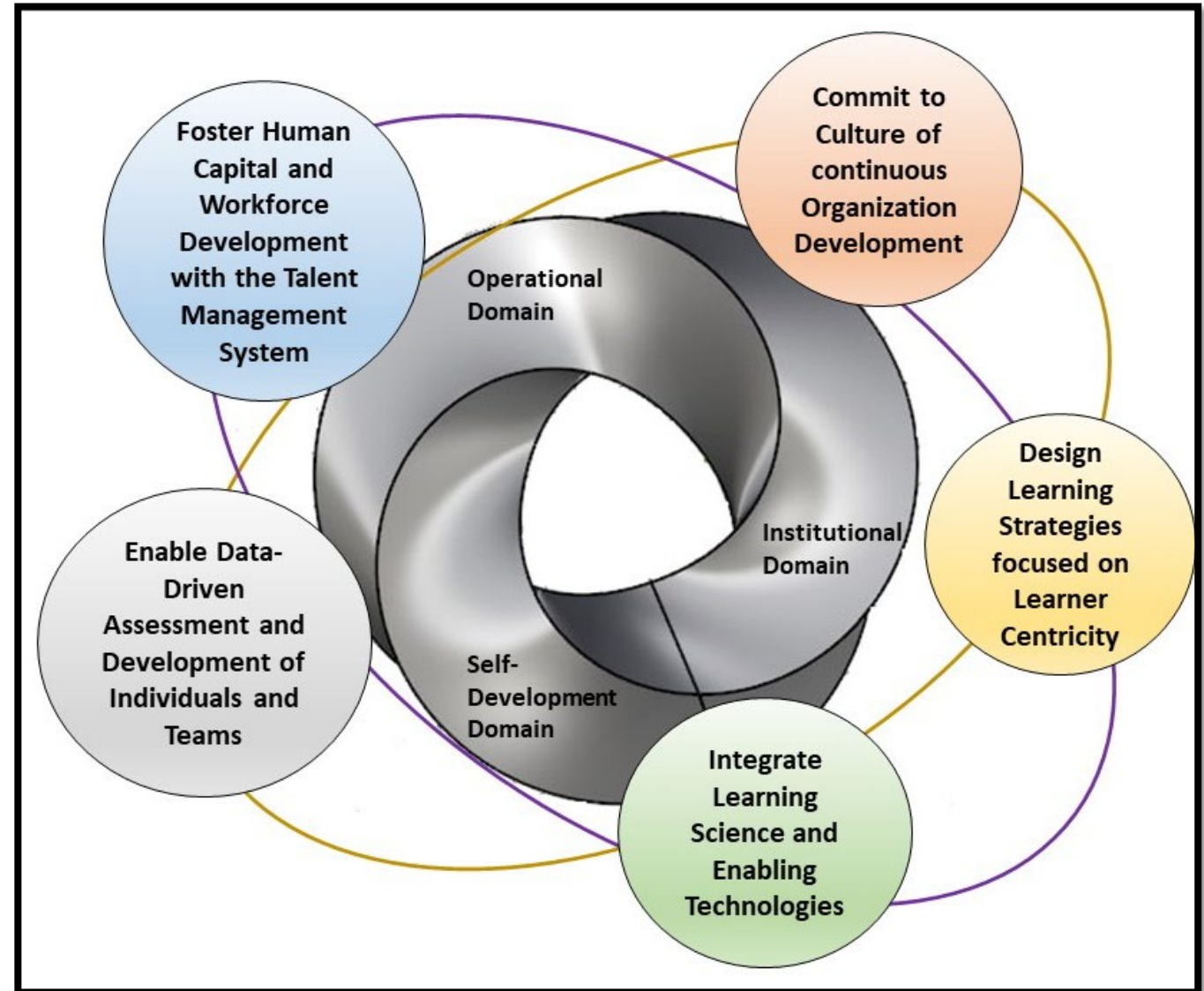
Published Feb2024



ARMY LEARNING CONCEPT (TP 525-8-2) SOLUTION COMPONENTS



1. **Optimize the Army as a learning organization**
2. **Invest in proven learning strategies**
3. **Invest in enabling technologies and use learning science to guide their employment**
4. **Build the Army's data-informed learning infrastructure**
5. **Foster human capital and workforce development**



ALC RESEARCH NEED STATEMENTS ALIGNED TO OUR S&T INVESTMENTS



- 1. Invest in enabling technologies and use learning science to guide their employment**
 - **Strategies for blended instructional models that incorporate adaptive instructional systems with existing methods**
 - **Support relevant “learning-centered” competencies to enable more efficient learning**
 - **Linking Formative and Summative Assessment types to developmental feedback provided through emerging learning technologies**

- 2. Build the Army’s data-informed learning infrastructure**
 - **Techniques for creating/managing evolving proponent competency frameworks**
 - **Define developmental trajectories across ecosystem resources for novel competency requirements aligned to an evolving technological environment**
 - **Develop probabilistic Decision Support Tools that provide recommendations across all learning modalities and prescribe specific learning experiences**



RESEARCH PROGRAM ALIGNED TO THE ALC:

Competency Based Experiential Learning (CBEL)
for Multi-Domain Operations



Competency-Based Education

CBE
is a model



**Centered on
the student**

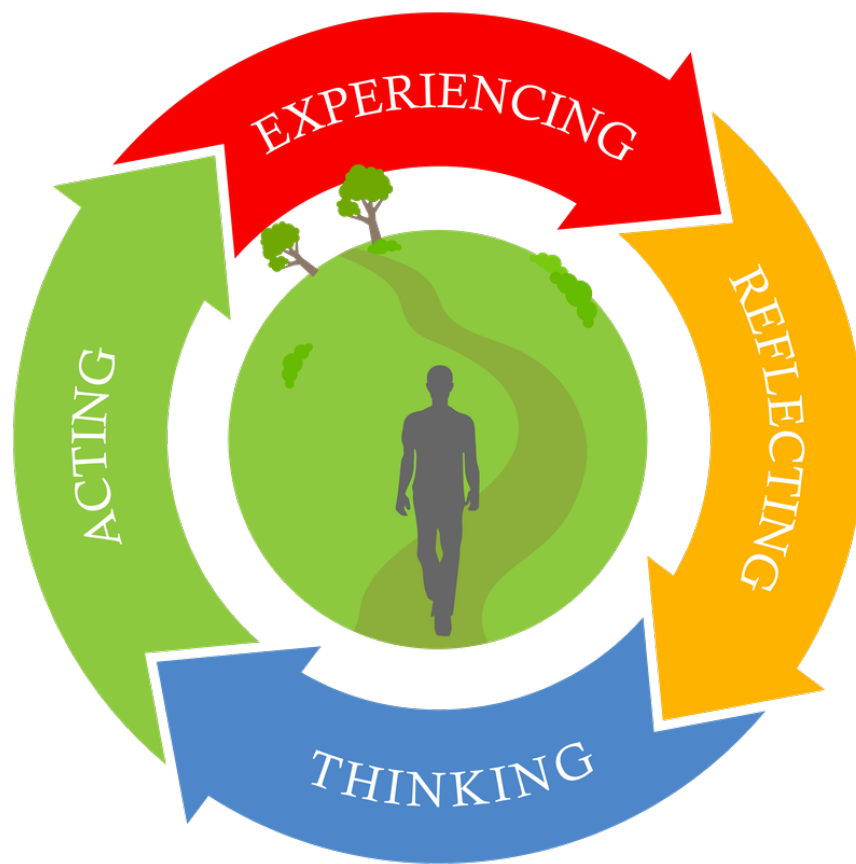


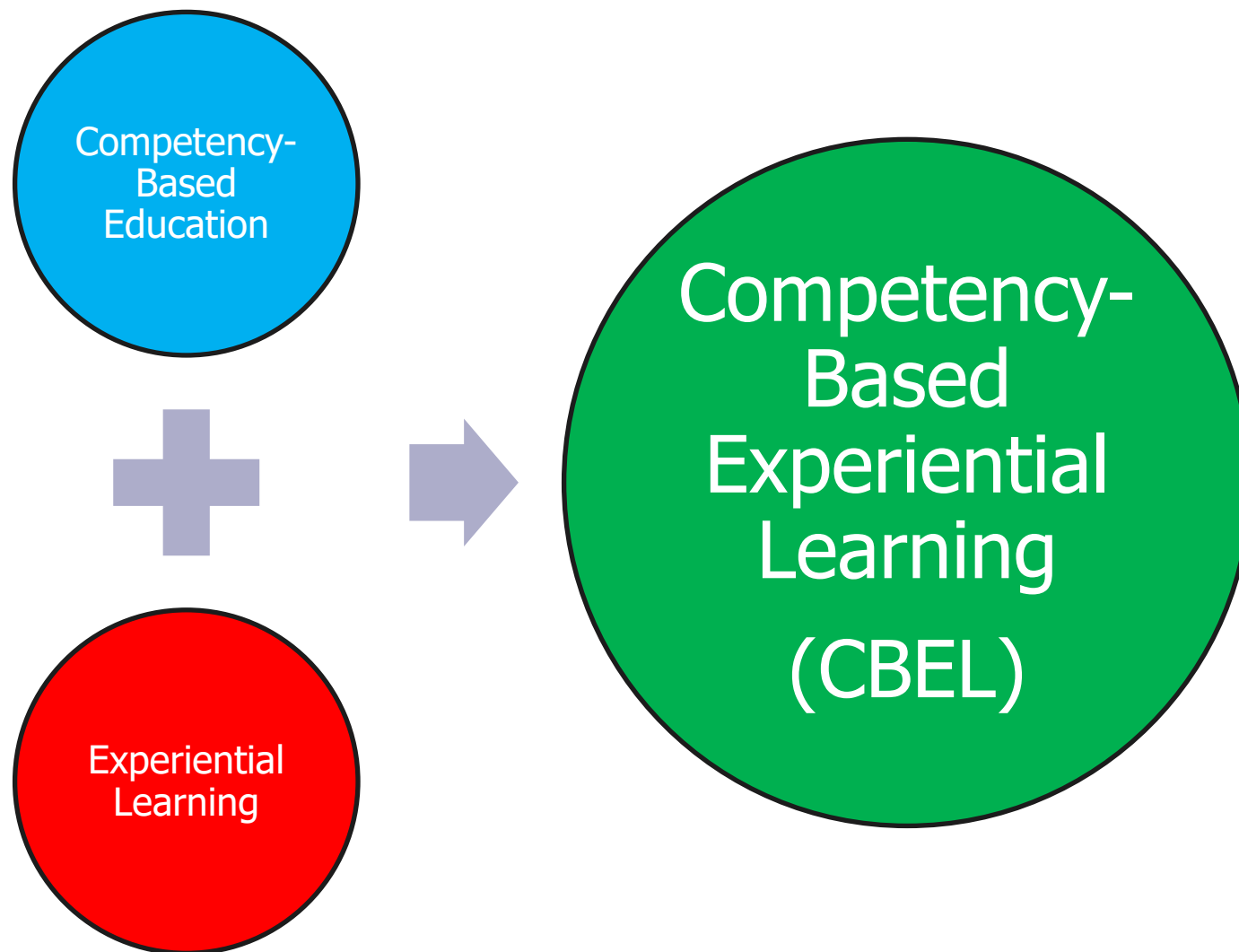
**Focused on
mastery of
competencies**



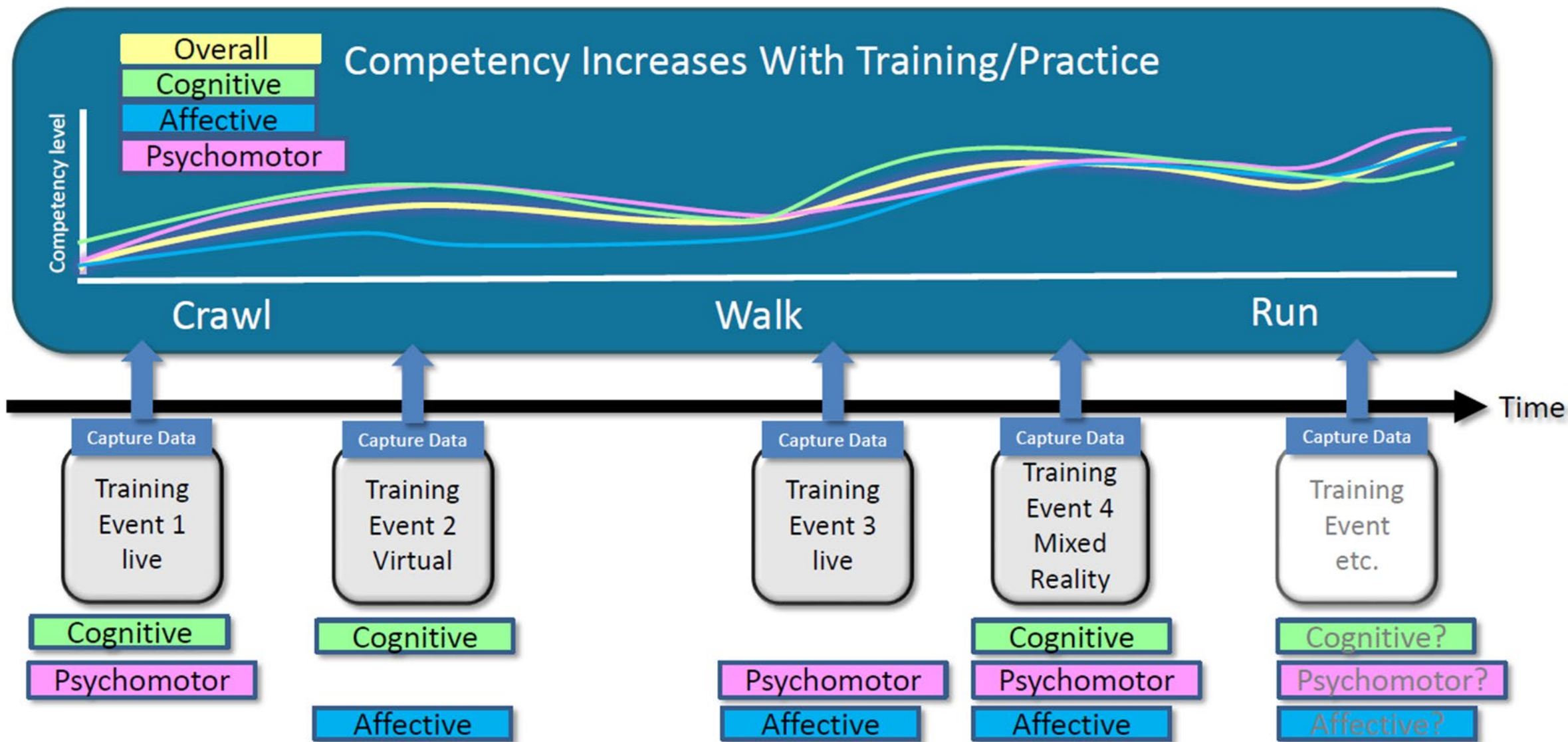
**Based on
learning
outcomes**

Experiential Learning





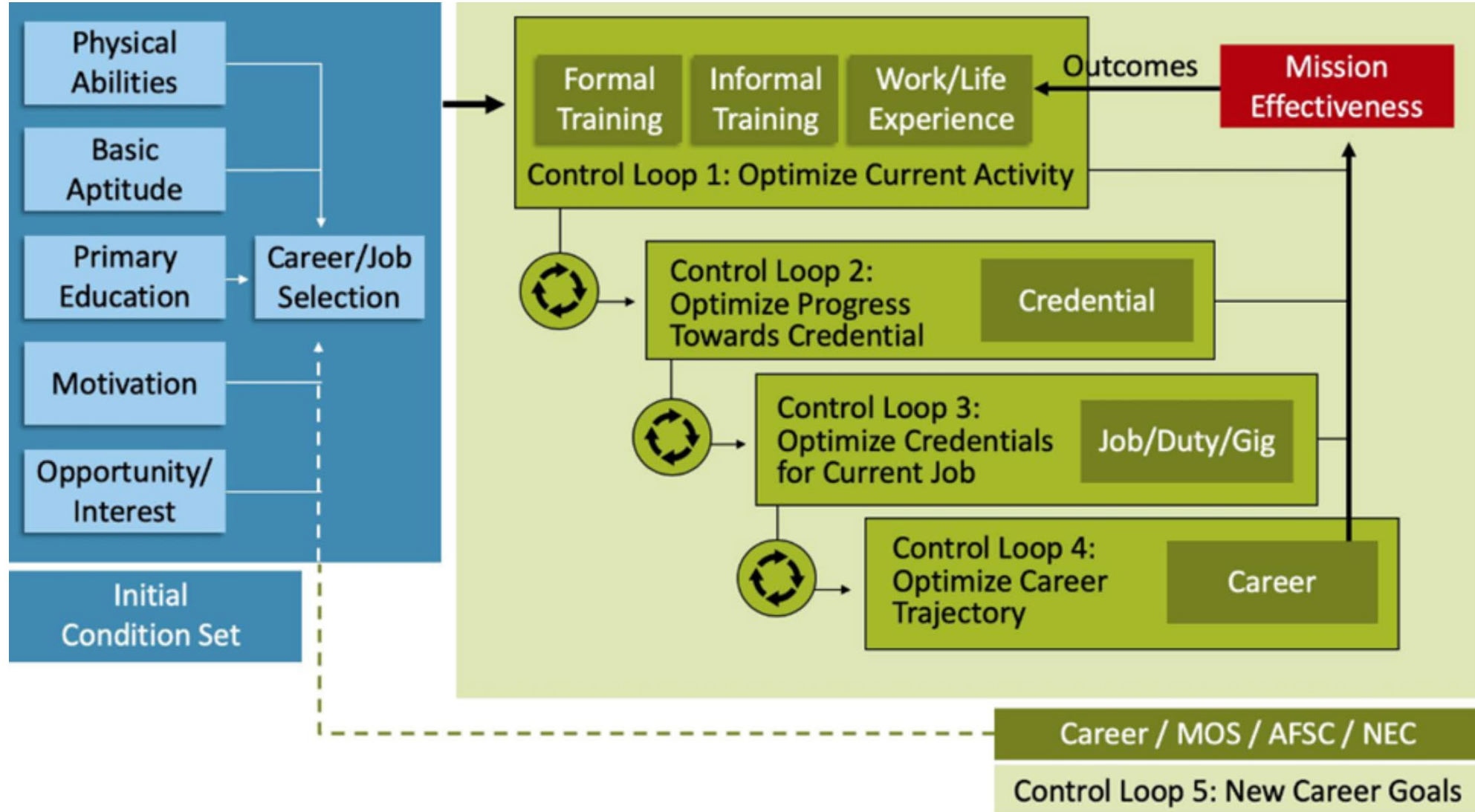
- Focused on developing skills and improving competence in those skills
- Skill development and proficiency require practice across multiple episodes and variations/conditions
- Proficiency develops longitudinally and decays without recency





Building a Community of Practice through the TOTAL LEARNING ARCHITECTURE (TLA)

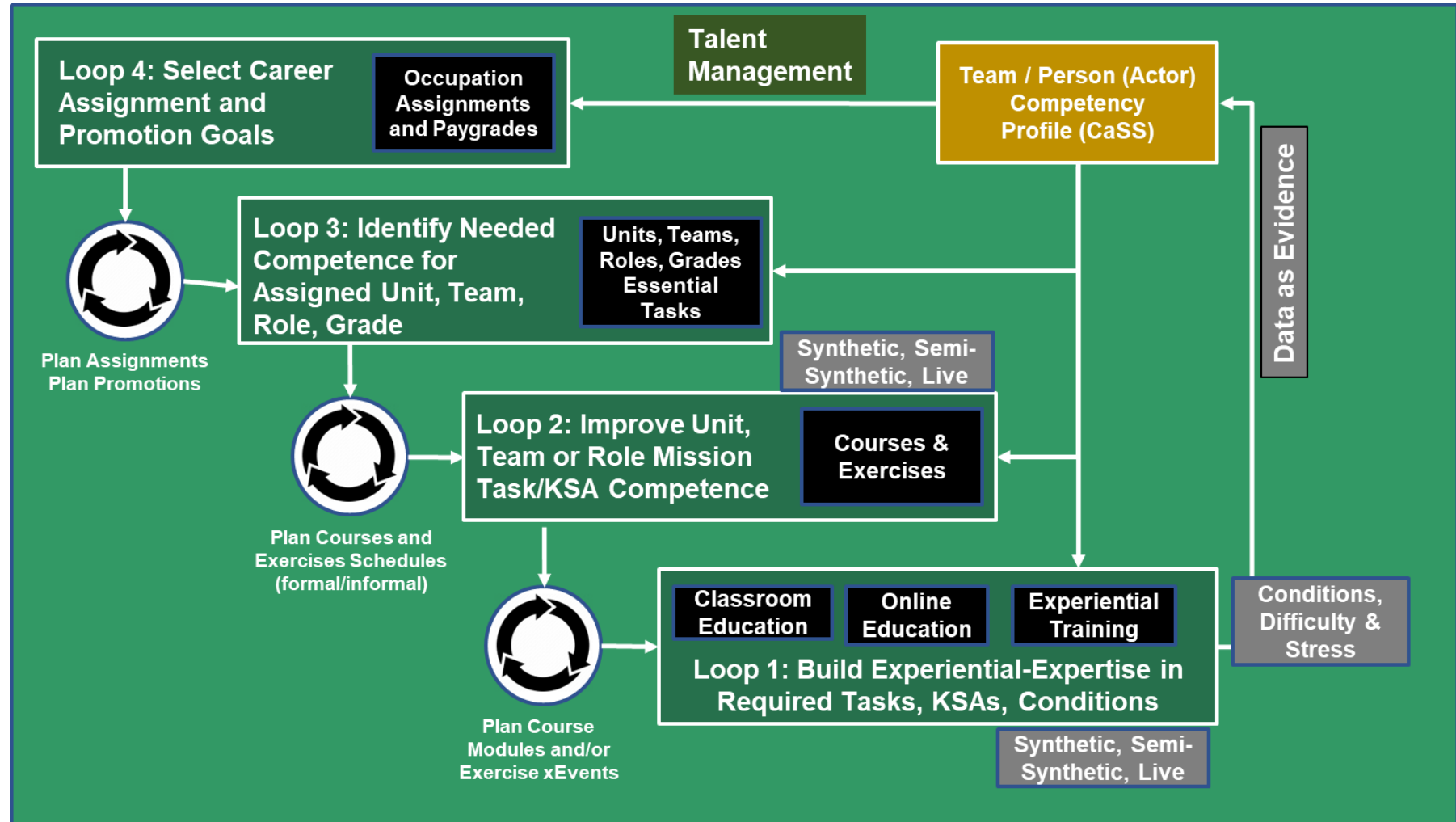
2019 ADL INITIATIVE TLA REPORT CONTROL LOOPS



TLA EXTENSION TO DRIVE COMPETENCY DEVELOPMENT THROUGH EXPERIENTIAL LEARNING



Utilizing data as evidence at all levels
 Generating assertions from that evidence
 Establishing a trusted probabilistic competency profile



Hernandez, M., Goldberg, B., Robson, R., Owens, K., Blake-Plock, S., Welch, T., & Ray, F. (2022). Enhancing the total learning architecture for experiential learning. In *Interservice/Industry Training, Simulation, and Education Conference (IITSEC)*.



CBEL High-Level Exemplar



Individual & Unit Training Experiences Selected for Competency Development

Basic Domain Education	Virtual / Synthetic Task Practice	Semi-Synthetic / Live Application	Blended STX & Tactical Practice	Live Practice	Live Qualification
<i>Institutional Learning & Assessment</i>	<i>RVCT S/G/A, EST/SVT, AGTS/BATS, TRACR</i>	<i>SIVT, AGTS, BATS, TRACR / ACE</i>	<i>RCVT, Live STX Range, CITA, TRACR / ACE</i>	<i>Live STX Range, CITA, TRACR / ACE</i>	<i>Live Ranges MILES/HITS2/CITA</i>
<u>INDIVIDUAL</u>	<u>INDIVIDUAL/TEAM</u>	<u>TEAM/CREW</u>	<u>TEAM/CREW</u>	<u>TEAM/CREW</u>	<u>UNIT/TEAM/CREW</u>
Declarative Knowledge, Procedural Knowledge, Values Evaluation	Procedural Skills, Knowledge Application, Cognitive Evaluation	Live Procedural Skill, Psychomotor Evaluation	Tacit Knowledge Development Teamwork Development	Tacit Knowledge Development Teamwork Development	Combined Arms Combat Readiness Evaluation

Training Strategy & Focus

Capture Data

Capture Data

Capture Data

CRAWL

WALK

RUN

Orchestrate Training

Orchestrate Training

Orchestrate Training

STE Experiential Learning for Readiness (STEEL-R)

Data Strategy



WHAT IS STEEL-R?



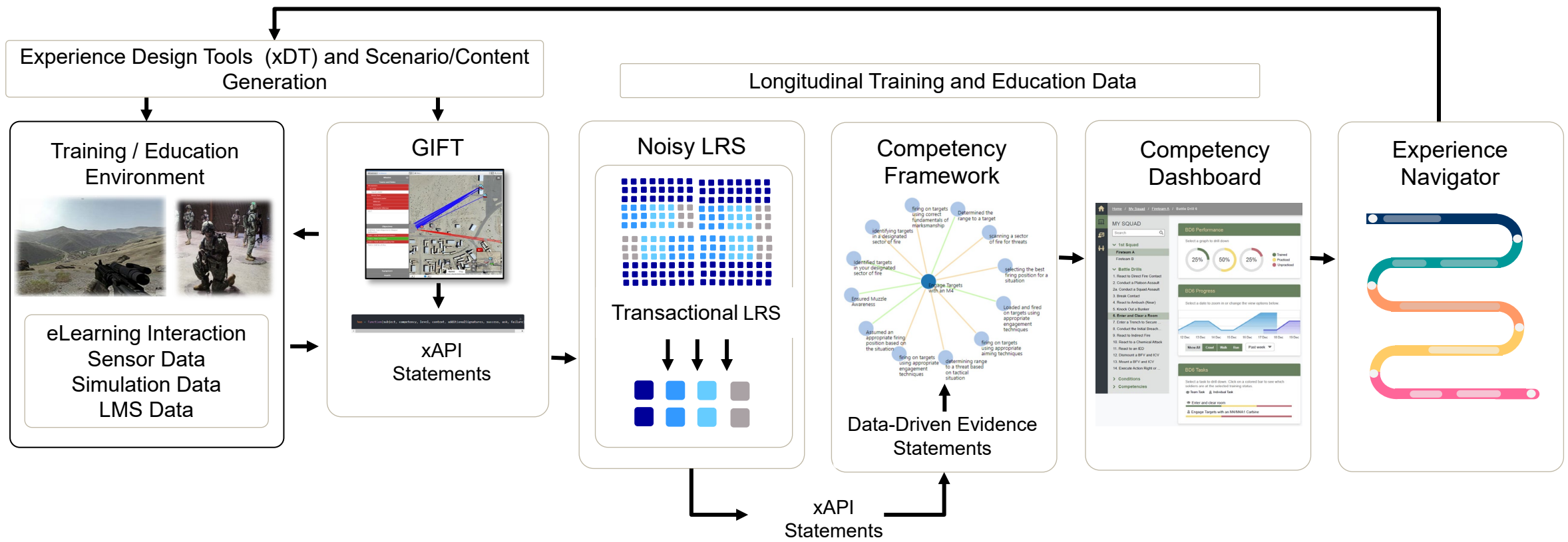
STEEL-R:

Adaptive Training Management from a Data Strategy Perspective

Designed to Harness Data through
Adaptive Instructional Services
and
Learning Engineering Principles



A DATA STRATEGY TO DRIVE OUR RESEARCH



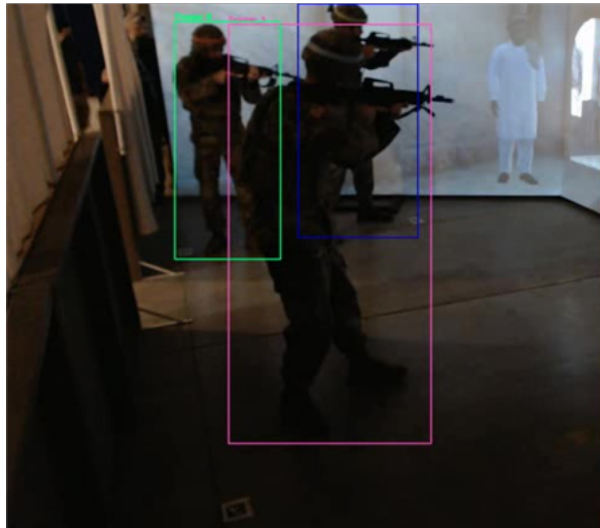
STE Experiential Learning for Readiness (STEEL-R; Goldberg et al., 2021)

MULTIMODAL DATA FRAMEWORK AND FUNCTIONS FOR EXPERIENTIAL LEARNING

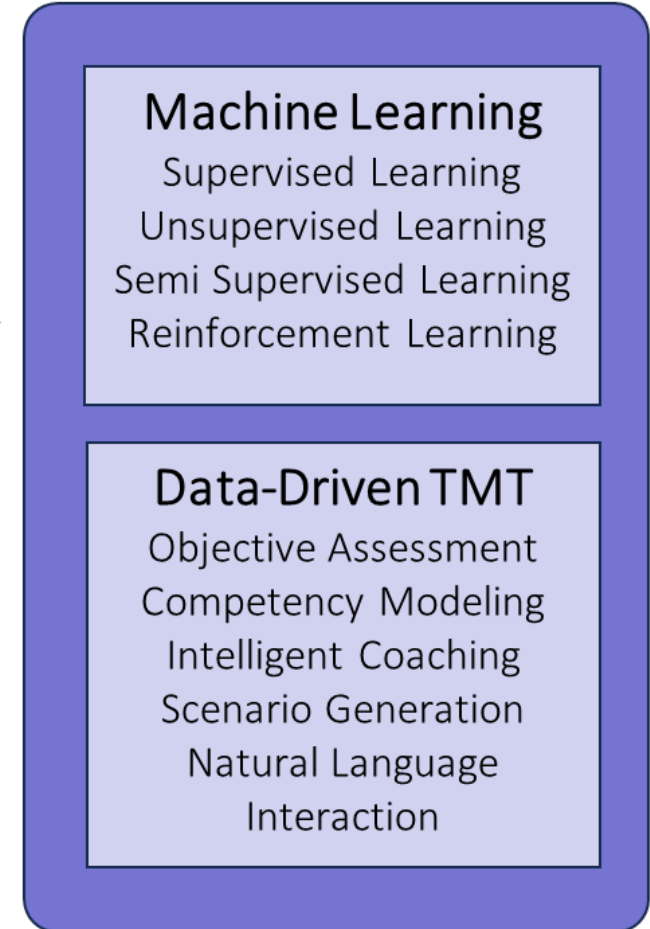


Multimodal Training Data from Simulation

Data-Driven Training Management Functions



- Speech
- Video
- Eye Tracking
- Biometric
- Movement
- Simulation Data



Assessment Data and Input

- Performance Ratings
- Questionnaires
- AAR
- Peer Assessments

STEEL-R TECHNOLOGIES



Generalized Intelligent Framework for Tutoring (GIFT)

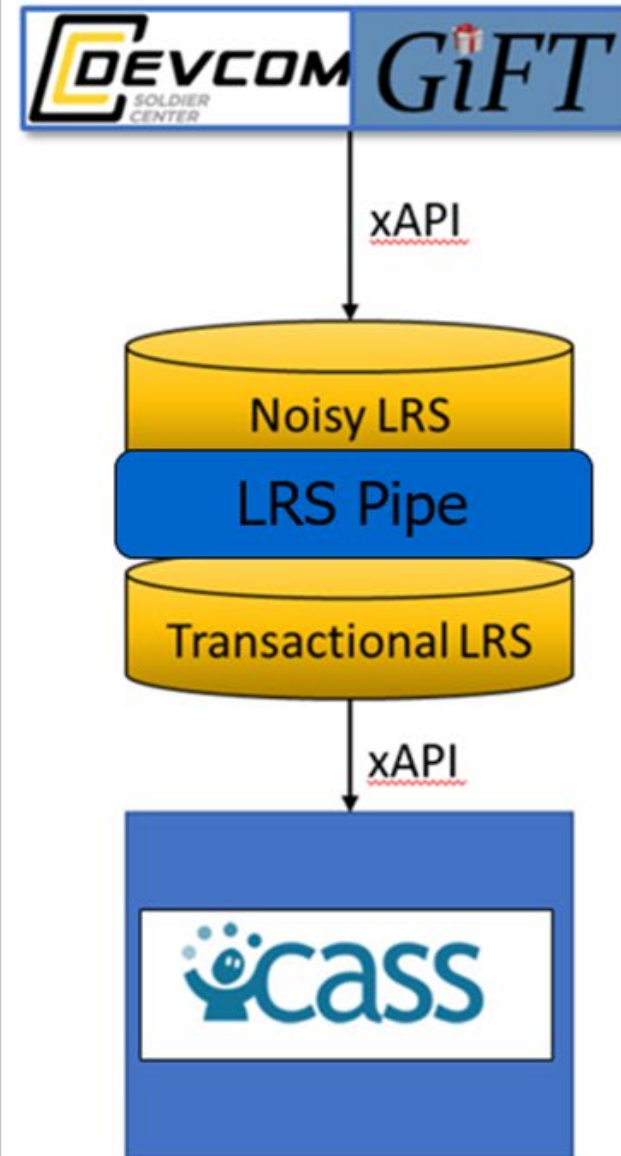
- Establishes real-time data capture with training environments
- Manages data and observer-driven assessments
- Interoperates with existing military training experiences and commercial assessment engines
- Emits evidence-centered xAPI Statements

Learning Record Store

- Noisy LRS captures all xAPI data
- (i.e., formative and summative assessments from GIFT, data from other xAPI generating systems)
- LRS Pipe filters Noisy data for populating the Transactional LRS based on the STEEL-R xAPI Profile

Competency and Skills System (CaSS)

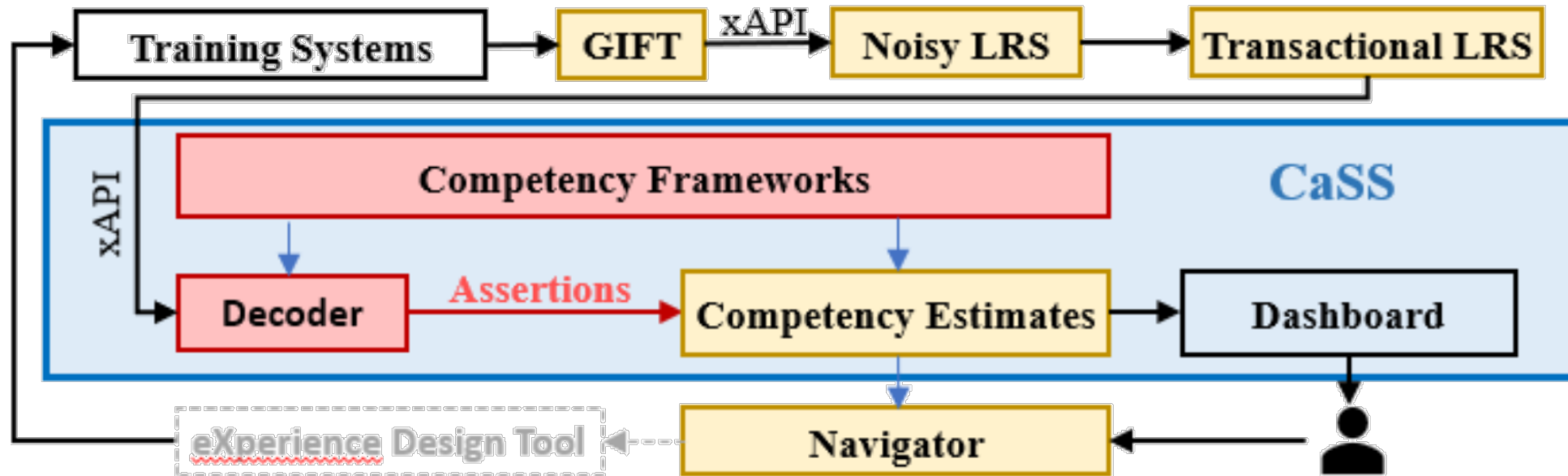
- Processes xAPI statements into evidence-based Assertions
- Maintains competency frameworks built with linked-data
- Computes learner and team profiles
- Provides core data for the adaptive STEEL-R Navigator
- Visualizes learner and team profiles for the STEEL-R dashboard



DIGITALIZATION IN STEEL-R



Performance Measures Competencies and KSAs* Competency Assertions



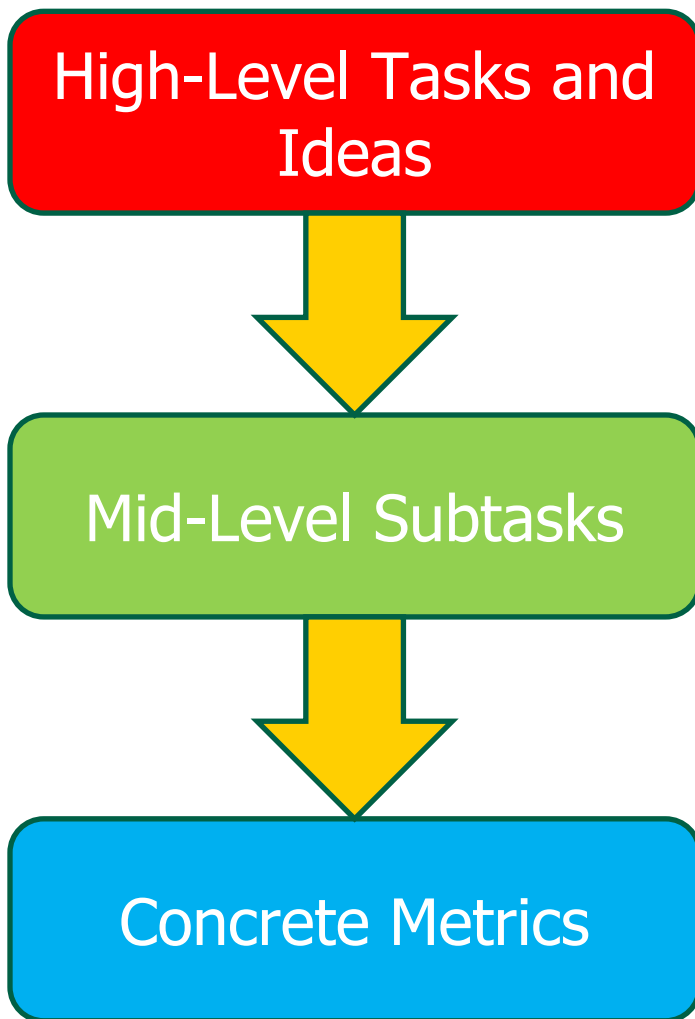
Training Opportunities Learner Progression Learner States

*Knowledge, Skills, Abilities [Attitudes]



STEEL-R COMPETENCY FRAMEWORKS

Bayesian Propagation



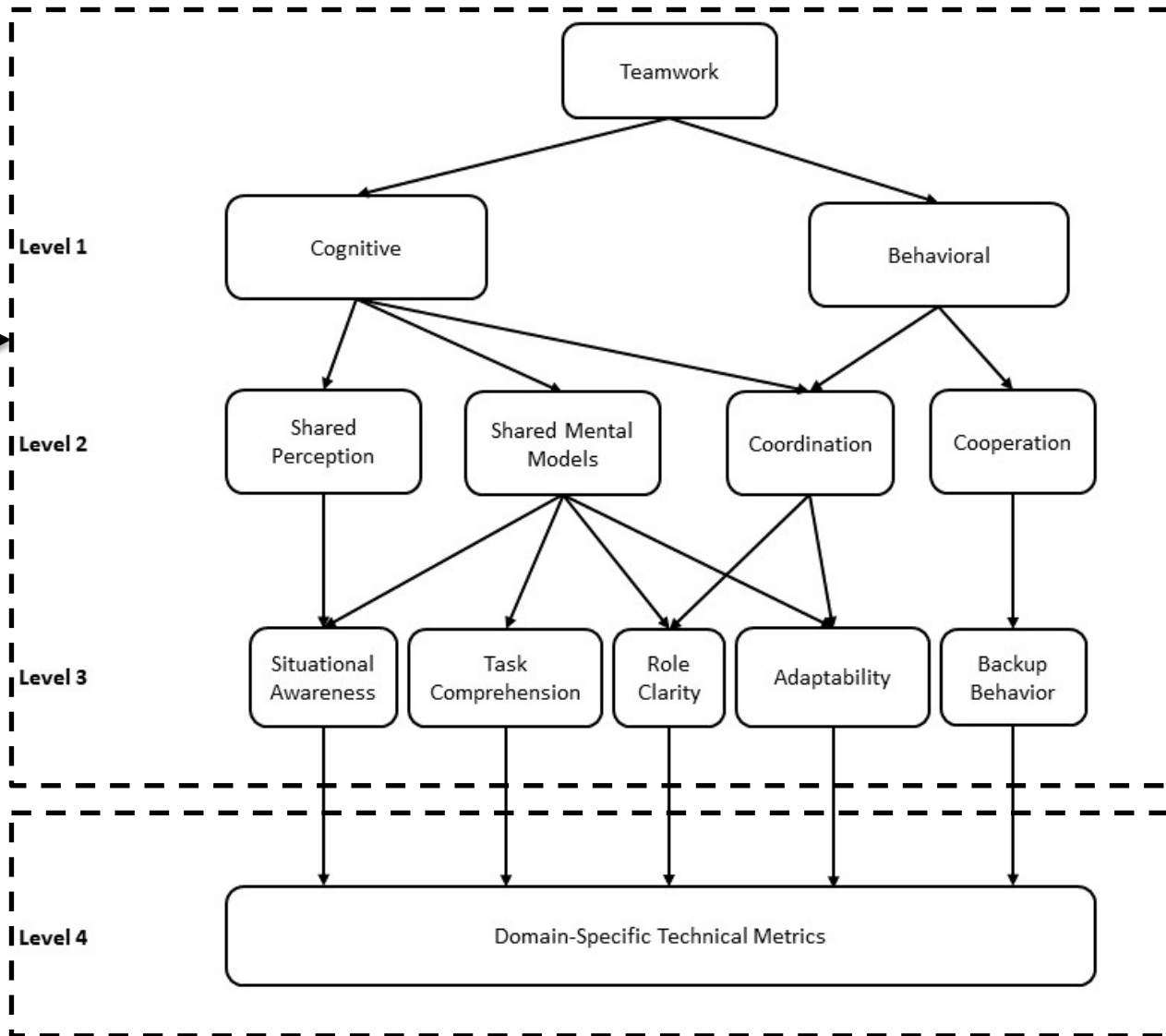
Hierarchical Competency Models

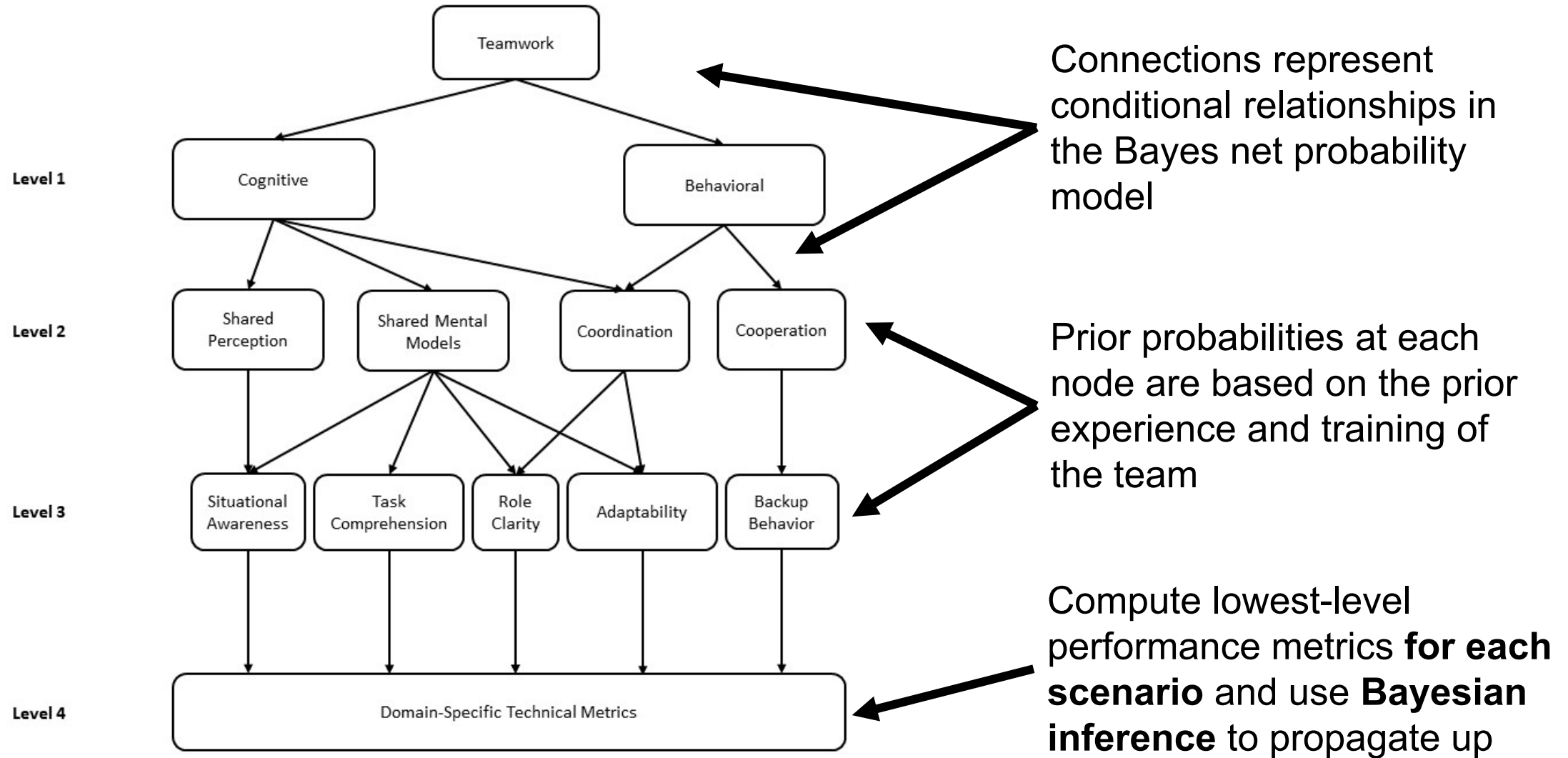


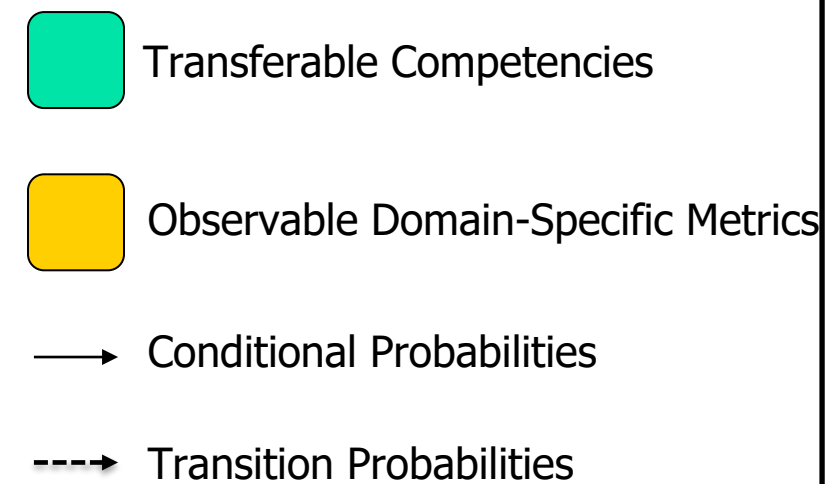
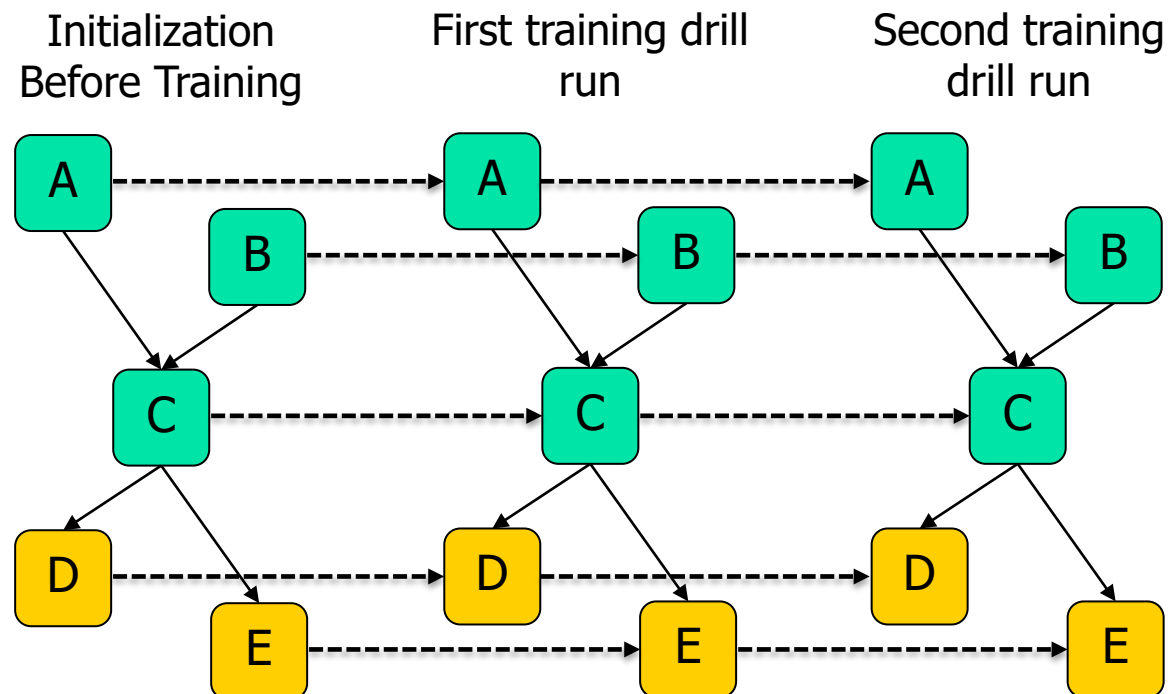


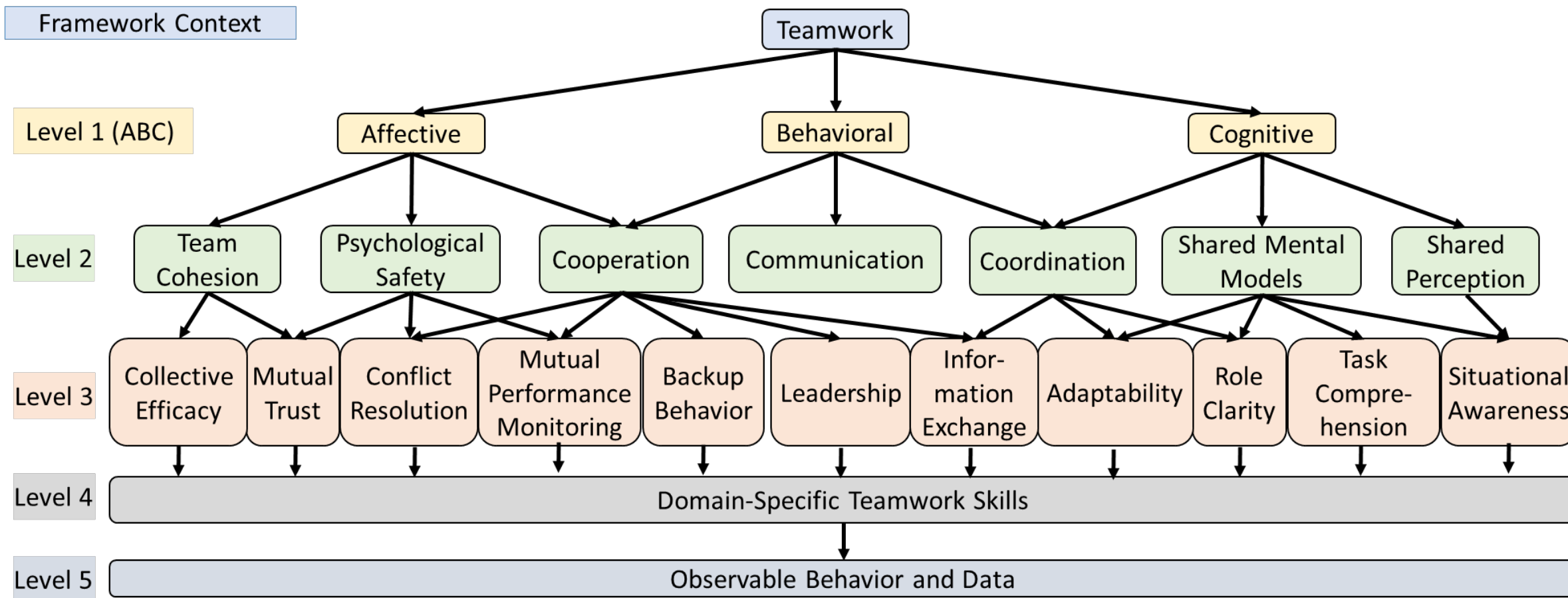
Stays the same across each scenario

Changes dependent on the scenario











USE CASES

CASTLE: Competency Assessment for STE Training in Live Environments

CASTLE: COMPETENCY ASSESSMENT FOR STE TRAINING IN LIVE ENVIRONMENTS



Aim: Investigate how to capture, store, and manage small unit performance data from live and synthetic training into a squad-level competency model using STEEL-R.

Training Performance

Measurement/Assessment

Competency

BD6 Performance

Select a graph to drill down

25%

Trained

50%

Practiced

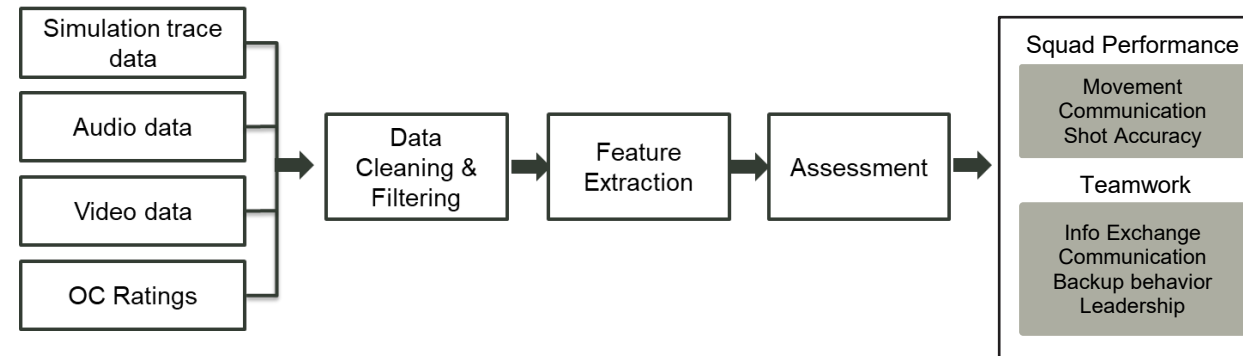
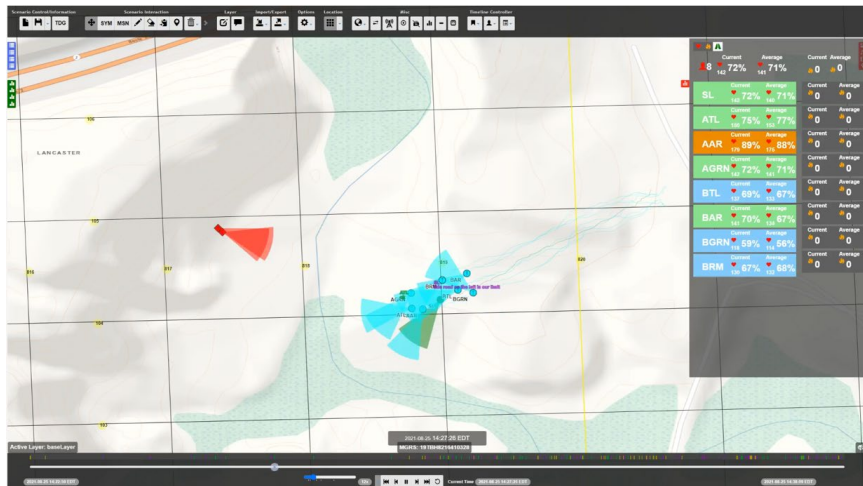
25%

Unpracticed

Soldier	Team	Position	Status
Johathan Merrick	A	Team Leader	Trained
Amanda Bearing	A	Rifleman	Practiced
Brandon Towers	A	Rifleman	Unpracticed
Candice Samuels	A	Rifleman	Unpracticed

Competency is: Data Driven Prediction of proficiency in:

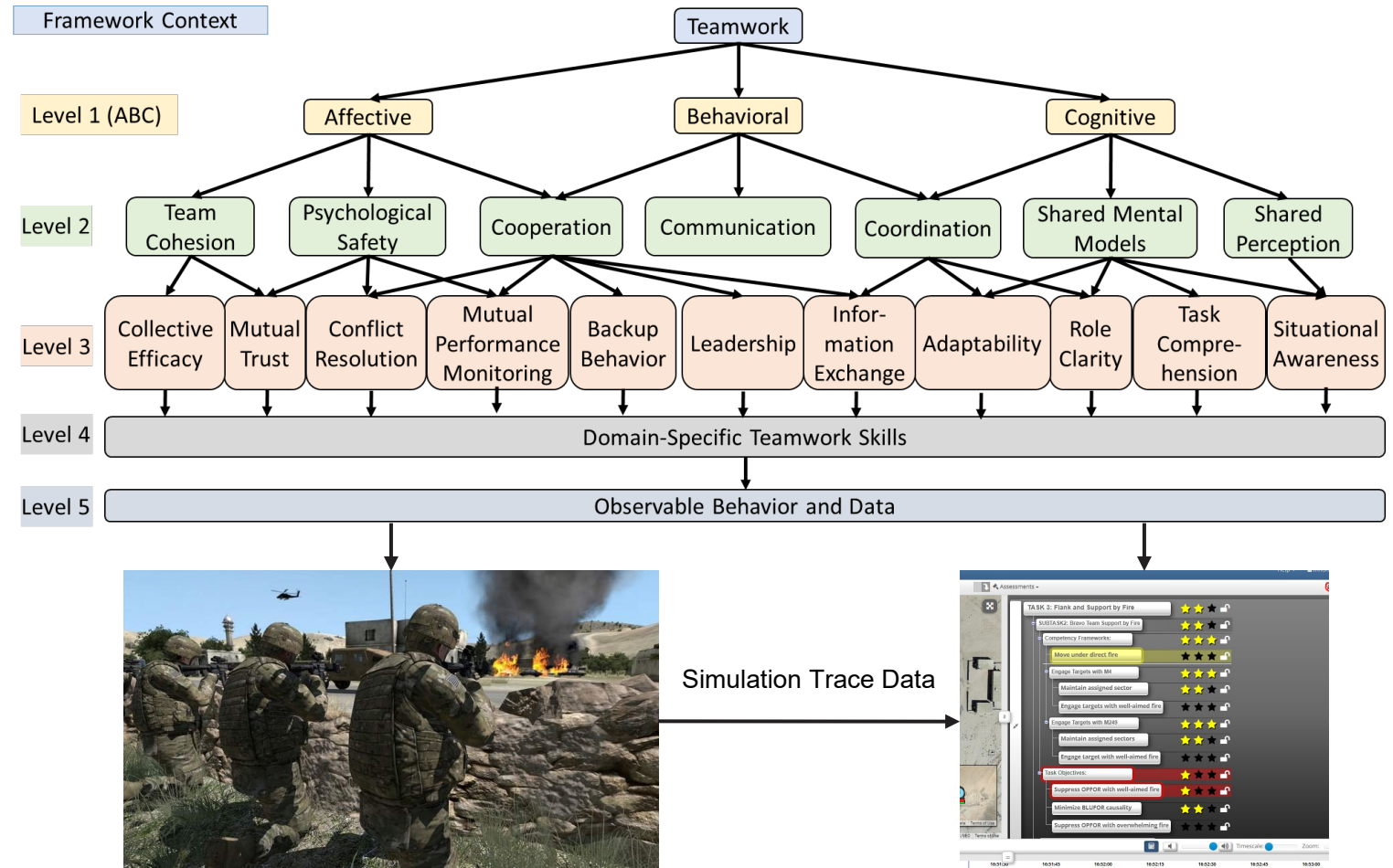
- Knowledge
- Skill
- Ability
- Task



CASTLE: COMPETENCY MODELING



- Design and iteratively refine Infantry Squad Competency Framework
 - Based on theories of team development
 - Represented in Competency and Skills System
 - Uses statistical models to estimate and track competency development
- Design and develop prototype dashboards and interfaces for Longitudinal Performance Tracking





USE CASES

STEEL-R in Exercises (STEELRx)

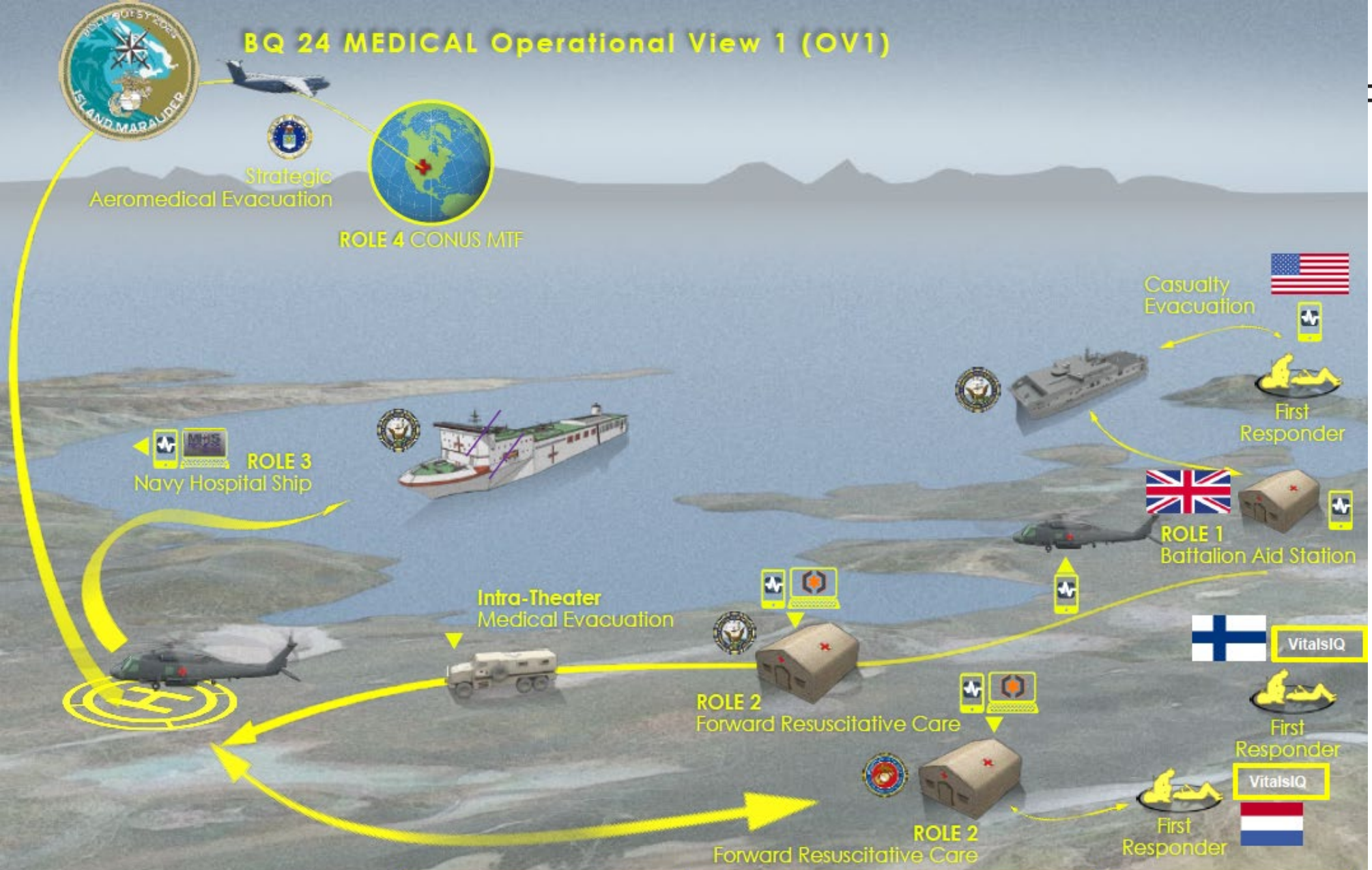




FIELD-BASED VALIDATION TESTING OF STEEL-R WITH EXERCISE PLANNERS, OBSERVER/TRAINERS, AND TRAINEES

- Targeting Multi-National Joint Training Exercises and Experimentation
- Influence assessment thinking into exercise planning and scenario design
- Empower commanders with intuitive, relevant analytics to inform decision making
- Improve the quality and utility of performance assessment aligned to long-range training objectives and competencies
- Promote adoption of interoperable learning analytics standards and best practices (e.g., xAPI) aligned to Experiential Learning Theory

BQ 24 MEDICAL Operational View 1 (OV1)



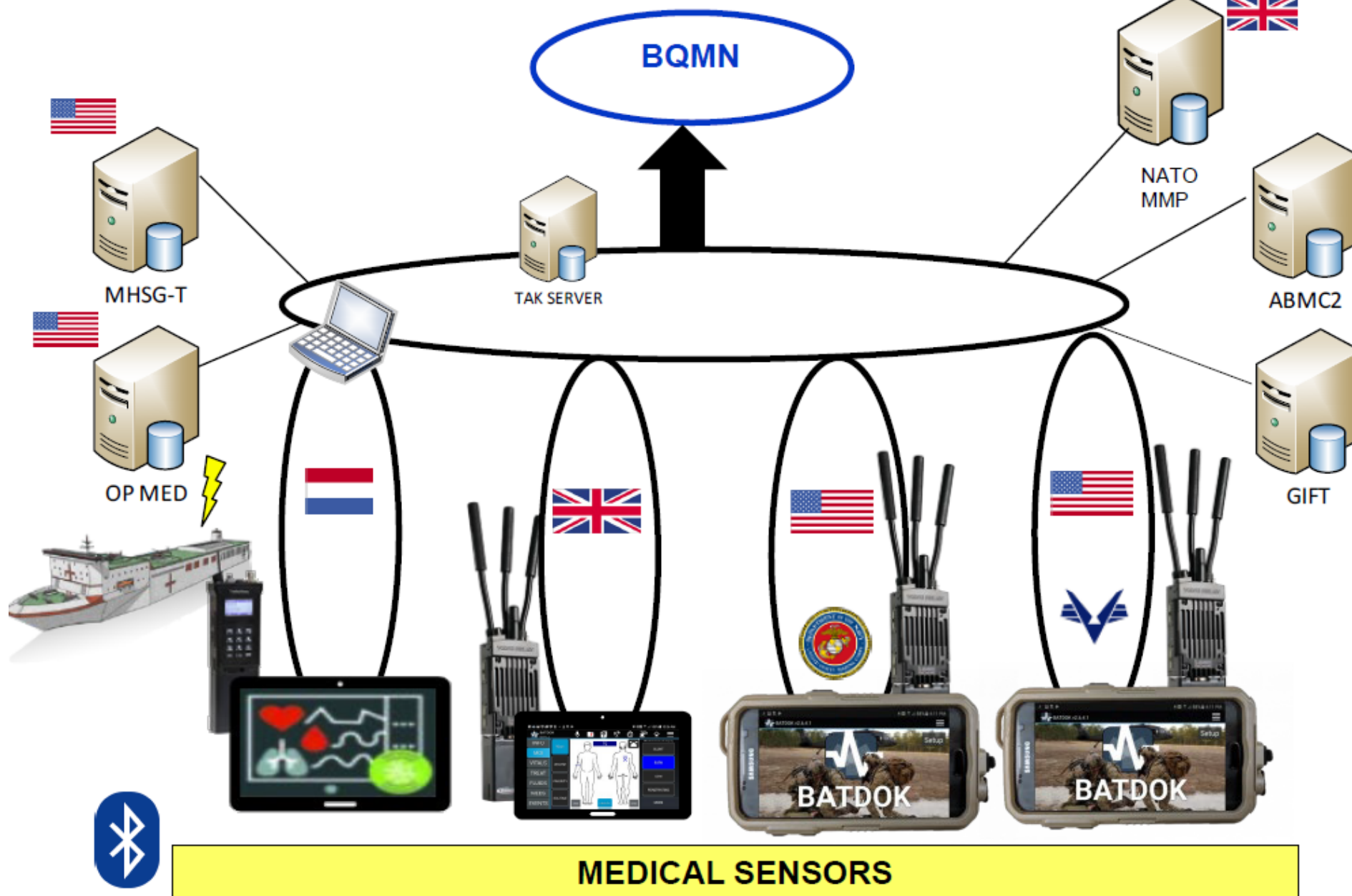
Current as of 08 MAR 2024

MHS GENESIS MHS Genesis-Theater: R3/Hospitalization Solution

OpMed Care Delivery Platform: R1/R2 Disease, Non-Battlefield injury, Medical Readiness, Damage Control Resuscitation & Damage Control Surgery Solution

BATDOK: First Responder & Enroute Care Mobile Solution

BQ24 MEDICAL NETWORK

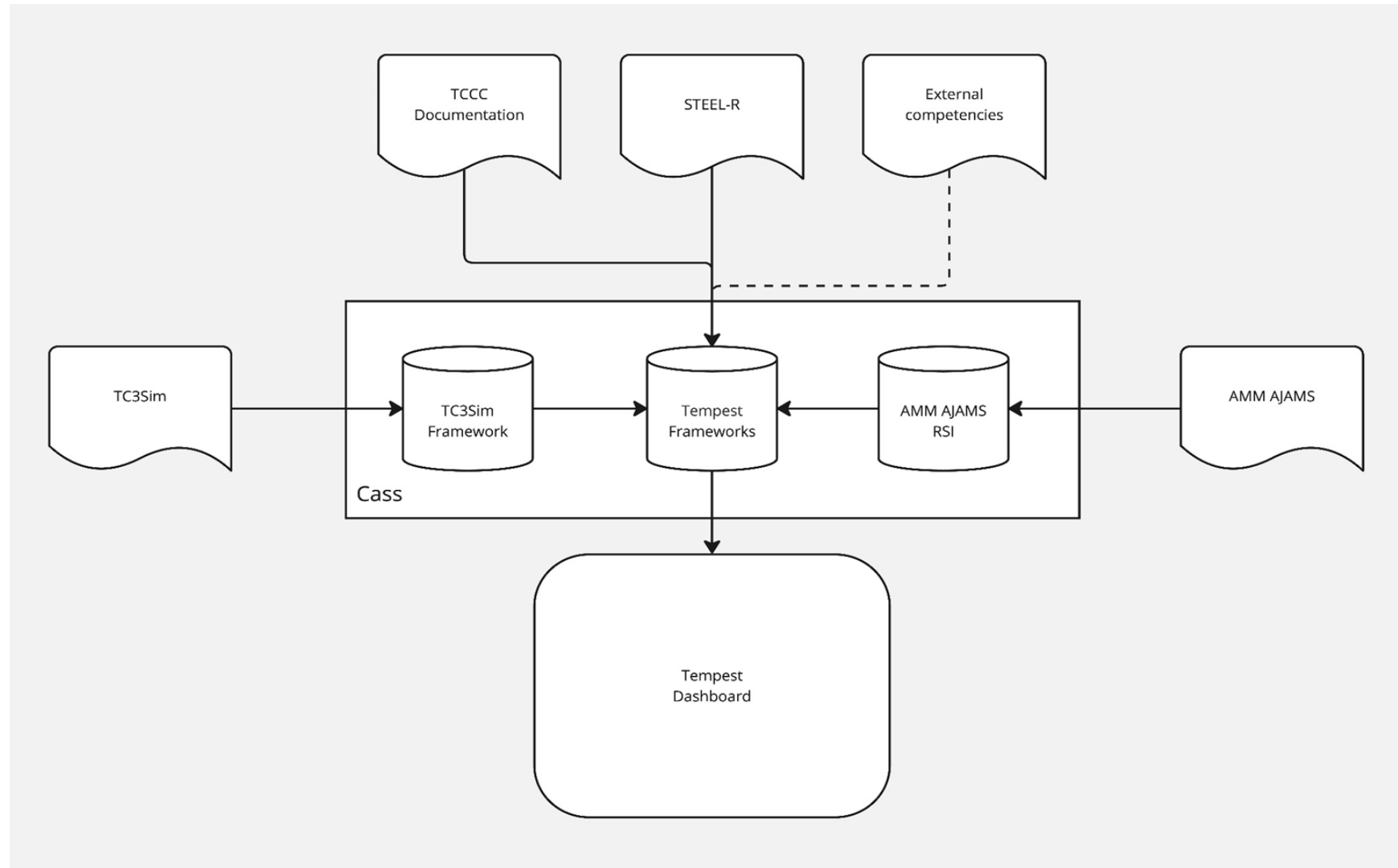


CONNECTING A MEDICAL COMPETENCY FRAMEWORK (TEMPEST)

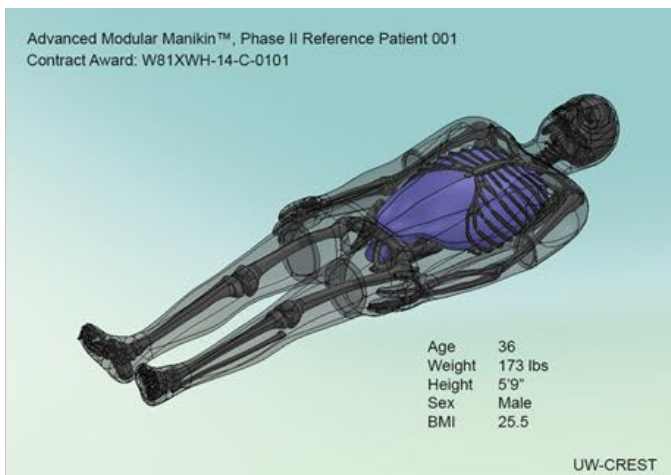


TC3Sim and Airway Manikin specific frameworks developed for prototype

High Level Competencies included for demonstration of scale and extensibility



PI: Matthew Hackett, PhD; matthew.g.hackett.civ@army.mil

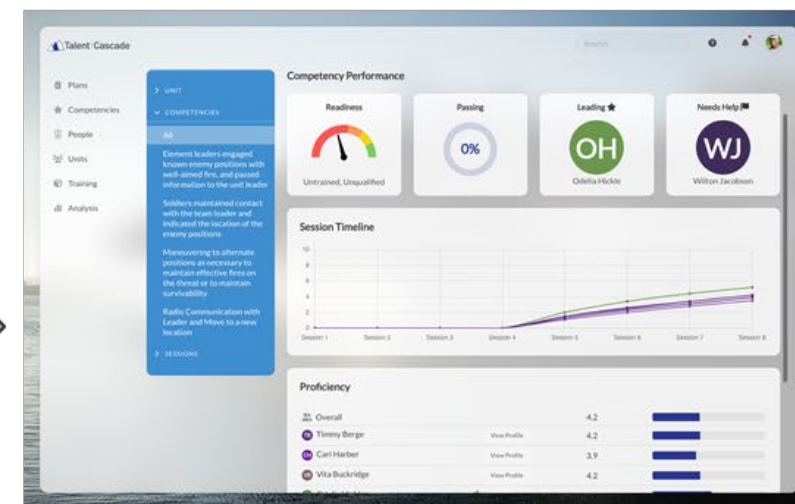


Phase 1 Concept

1. Frameworks for TC3Sim and AMM in CaSS
2. CaSScader simulates assertions
3. TIDES Vision dashboards represent simulated competencies

Training Settings

Competency	Unit	Role	Score	Success Rate
1. Squad Entrance	Unit_001	Carl Harber	1.0	100%
2. Squad Communications with Leader and/or in Squad	Unit_001	Timmy Berge	1.0	100%
3. Squad Search	Unit_001	Carl Harber	1.0	100%
4. Squad Control	Unit_001	Carl Harber	1.0	100%
5. Squad Search	Unit_001	Carl Harber	1.0	100%
6. Squad Search	Unit_001	Vita Buckridge	1.0	100%





THANK YOU.



BACKUPS

HIERARCHICAL COMPETENCY FRAMEWORK ANALYSIS



	A	B	C	D	E	F	G
1	Measure	Level 1 Competency	Level 2 Competency	Level 3 Competency	Level 3 Sub-competency	Who is this for	Data source
2	Assault team calls last man	Behavioral	Communication	Information Exchange	Situational Awareness	ind	Comms - assault team last man calls last man
3	Assault team calls LOA	Behavioral	Communication	Information Exchange	Situational Awareness	ind	Comms - LOA is called when reached by assault team
4	Fire team picks up and assaults through the objective eliminating any remaining OPFOR	Behavioral	Cooperation	Backup Behavior	Mutual Performance Monitoring	team	GPS - soldier movement MILES - hits and kills (if there are any remaining OPFOR)
5	Fire team calls last man	Behavioral	Communication	Information Exchange	Situational Awareness	ind	Comms - fire team last man calls last man
6	Fire team calls LOA	Behavioral	Communication	Information Exchange	Situational Awareness	ind	Comms - LOA is called when reached by fire team GPS - soldier location
7	After the assault, the squad establishes security	Cognitive	Shared Mental Models	Role Clarity	Situational Awareness	team	IMU - helmet and weapon orientation
8	The SL directs the fire team to move up to designated positions	Behavioral	Communication	Leadership	Information Exchange	leader	Comms - SL directs fire team movement GPS - soldier movement and location
9	The squad places out observation posts to warn of enemy counterattacks	Behavioral	Cooperation	Mutual Performance Monitoring	Backup Behavior	team	IMU - helmet orientation
10	The SL assigns sectors of fire for each element	Behavioral	Communication	Leadership	Information Exchange	leader	IMU - helmet and weapon orientation toward each soldier's sector of fire Observed assessment- soldiers are in position to address any new threats
11	The soldiers establish hasty fighting positions	Cognitive	Shared Mental Models	Situational Awareness		ind	
12	The SL positions key weapons to cover the most dangerous avenue of approach	Behavioral	Cooperation	Leadership	Situational Awareness	leader	IMU - weapon orientation toward most hostile location GPS - soldier movement Comms - soldiers are calling out weapons and retrieving intel
13	Squad conducts search of EPW	Behavioral	Cooperation	Information Exchange	Role Clarity	team	Comms - intel, weapons, and belongings are reported to the SL by the EPW team
14	After EPW, the squad reports to the SL everything they found on the enemy	Behavioral	Communication	Information Exchange		team	
15	The SL reports enemy search to PL	Behavioral	Communication	Leadership	Information Exchange	leader	Comms - SL reports to PL Comms - team leaders get LACE report from their team
16	The TLs conduct ACE/LACE reports with their teams	Behavioral	Communication	Leadership	Mutual Performance Monitoring	leader	soldiers push up LACE to their leader
17	The TLs report ACE/LACE reports to SL	Behavioral	Communication	Leadership	Information Exchange	leader	Comms - team leaders report LACE to SL



U.S. ARMY