Strengthening Teamwork for Robust Operations with Novel Groups (STRONG)

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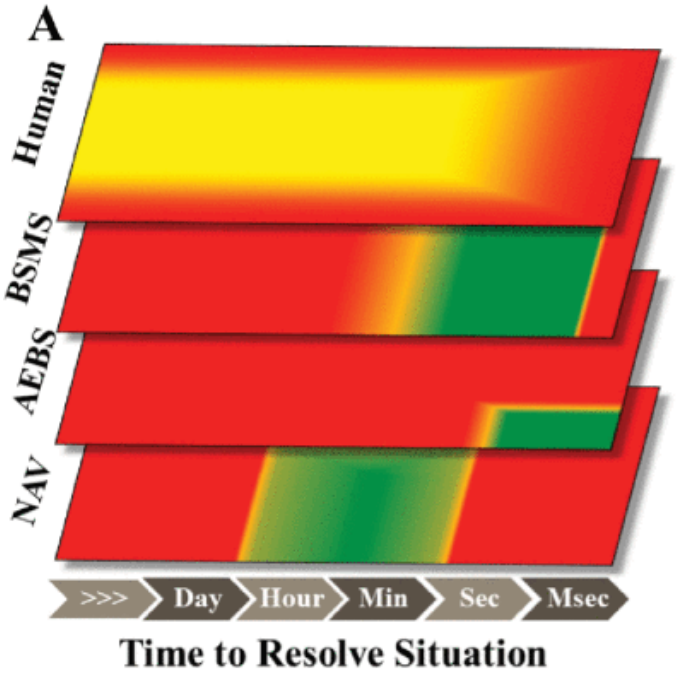
FRAMEWORK FOR CURRENT AND FUTURE HUMAN-AGENT PARTNERSHIPS

Can the capabilities of human and machine intelligence be characterized in a generalizable manner? Can such a generalization drive expected relationships in realistic real-world environments and conditions?

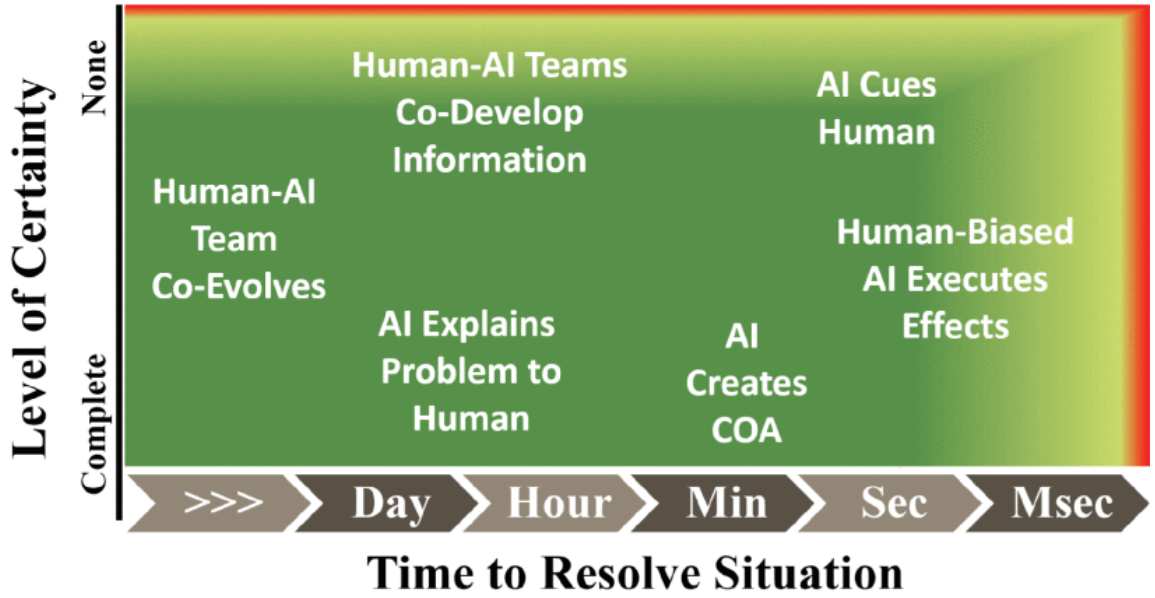
Metcalfe et al, (2021) “Systemic Oversimplification Limits the Potential for Human-AI Partnerships” IEEE Access

Characterizing Human and Machine Intelligence Capabilities for a Complex Realistic Mission



Performance of Humans or Intelligent Technology alone in *Complex* Tasks

Expected Human Agent Teaming Relationships as a Function of Criticality of **Time in Mission, Mission Complexity and Information Uncertainty**



Performance of Humans and Intelligent Technology Together in *Complex* Tasks

PARADIGM SHIFT

Systemic Oversimplification Fails in Complex Man-Machine Sociotechnical Systems*

- AI will make humans obsolete
- Human intelligence is unique and irreplaceable by AI

Human Intelligence Effectively Partnered with Machine Intelligence Will Win the Intelligence Race

- Create effective, adaptive, moral human-technology unions that outpace and outlast other forms of technology.

** Metcalfe et al (in press), "Systemic Oversimplification Limits the Potential for Human-AI Partnerships" IEEE Access.*

DEVELOP A NEW PARADIGM FOR HUMAN MACHINE TEAMING

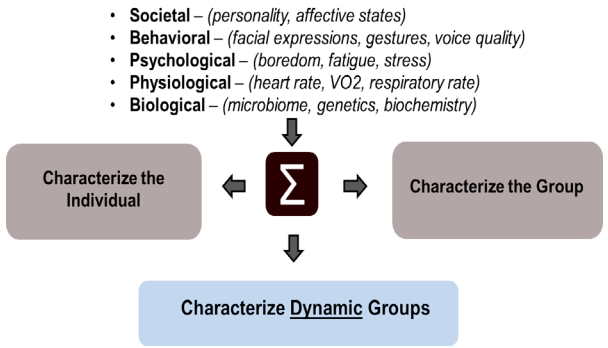
Bridge the gap between Human Sciences and AI development to Focus on Team capabilities

Metcalfe et al, "Systemic Oversimplification Limits the Potential for Human-AI Partnerships" IEEE Access

CAPABILITY AIM POINTS FOR STRONG

STRONG will create future capabilities to:

- *Form new team capabilities in the field*
- *Rapidly adapt to novel mission challenges with lower Soldier burden*
- *Reconfigure human-intelligent technology teams for any mission.*
- *Enable rapid adaptation as necessary for injury or degradation*



TIMELINE

EVENT	ESTIMATED DATE/TIMEFRAME
Opportunity released	April 2022
Opportunity Webinar	20 April 2022
Deadline for Questions on Funding Opportunity	5 May 2022
Proposals due for Cycle 4	16 May 2022
Cycle 4 Awards	June 2022 (Expected)
Cycle 4 Innovation Summit	July/August 2022
Cycle 4 Follow On Presentations	January 2023

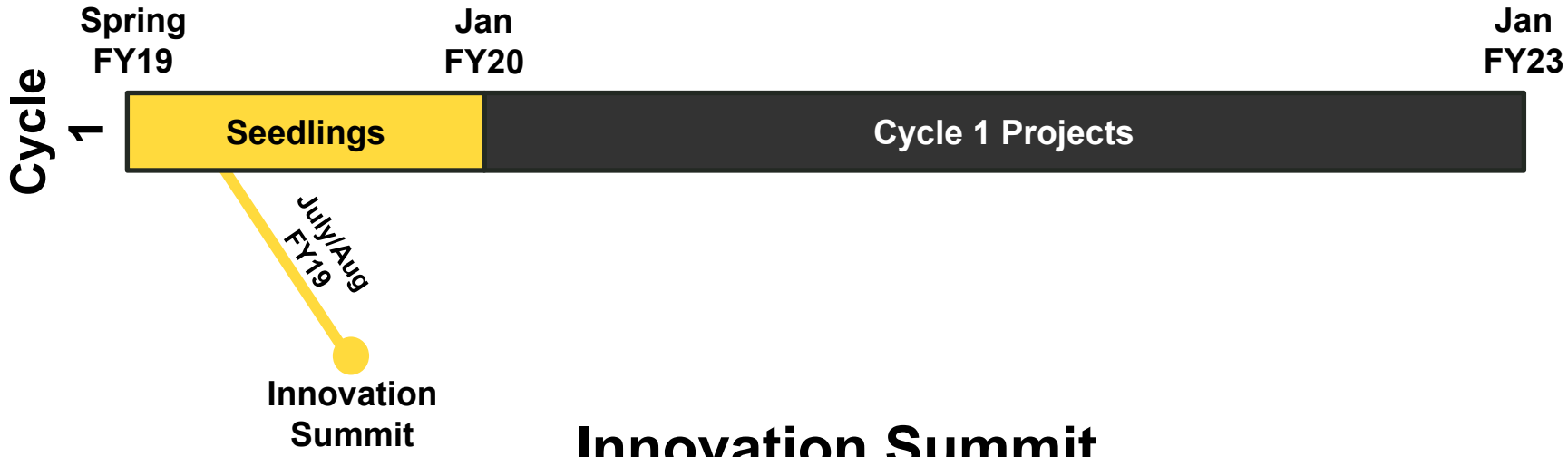
CORE STRONG MECHANISM

Seedlings

New Topics Yearly
Up to 1 Year of Funding
Up to 100k

Projects

Developed During Innovation Summit
Up to 3 Years of Funding
Up to 500k/year



Innovation Summit

Multi-disciplinary Workshop with
Academics, Industry, Government,
Military

CYCLE 4

Topic: Abstracting the brain's sub-architectures to enable rapid adaptation and reconfiguration in future human machine teams

1) if machine learning embedding high resolution mammalian sub-architecture neuro-mimicry is associated with more effective human-intelligent agent interactions than other forms of machine learning;

2) if embedding high-resolution mammalian sub-architectures other than visual processing (e.g., *spatial reasoning* neuro-mimicry) into human-guided machine learning can outperform deep learning for non-visual processing tasks (e.g., spatial reasoning tasks) that require adaptation;

3) how mammalian brain sub-architecture neuro-mimicry based machine learning can be integrated with humans to enhance performance on complex, dynamic tasks that require team adaptation.

CYCLE 4 CRITICAL BACKGROUND

Neuro-mimicry: Current deep networks are based on visual system. Have problems with novelty, flexibility. Brain doesn't use visual system to provide novelty, and flexibility it uses other systems, for instance mapping relationships in spatial reasoning subsystems. Maybe by importing features from these other brain regions we can improve responses.

Human Intelligent Agent Teaming: Literature posits that improvements in trust/explainability come at a cost in performance (Rao). But maybe we don't have to make this trade off, i.e. what happens if trust and explainability happen for free because the system is based off of the same computational principles that humans/mammals use to solve the same problems.

STRONG Collaborations and Adaptive Performance: Can these improvements take place within contexts that show promise for adaptation using techniques like HGML.

CYCLE 4

Cycle 4 “Seedlings” are expected to demonstrate the potential to answer one or more of the following three primary questions **(bolded)**, while Cycle 4 “Multi-Year Options” are expected to address all three primary questions **(bolded)**. Sub-questions are included to help inspire thought but do *not* need to be addressed specifically.

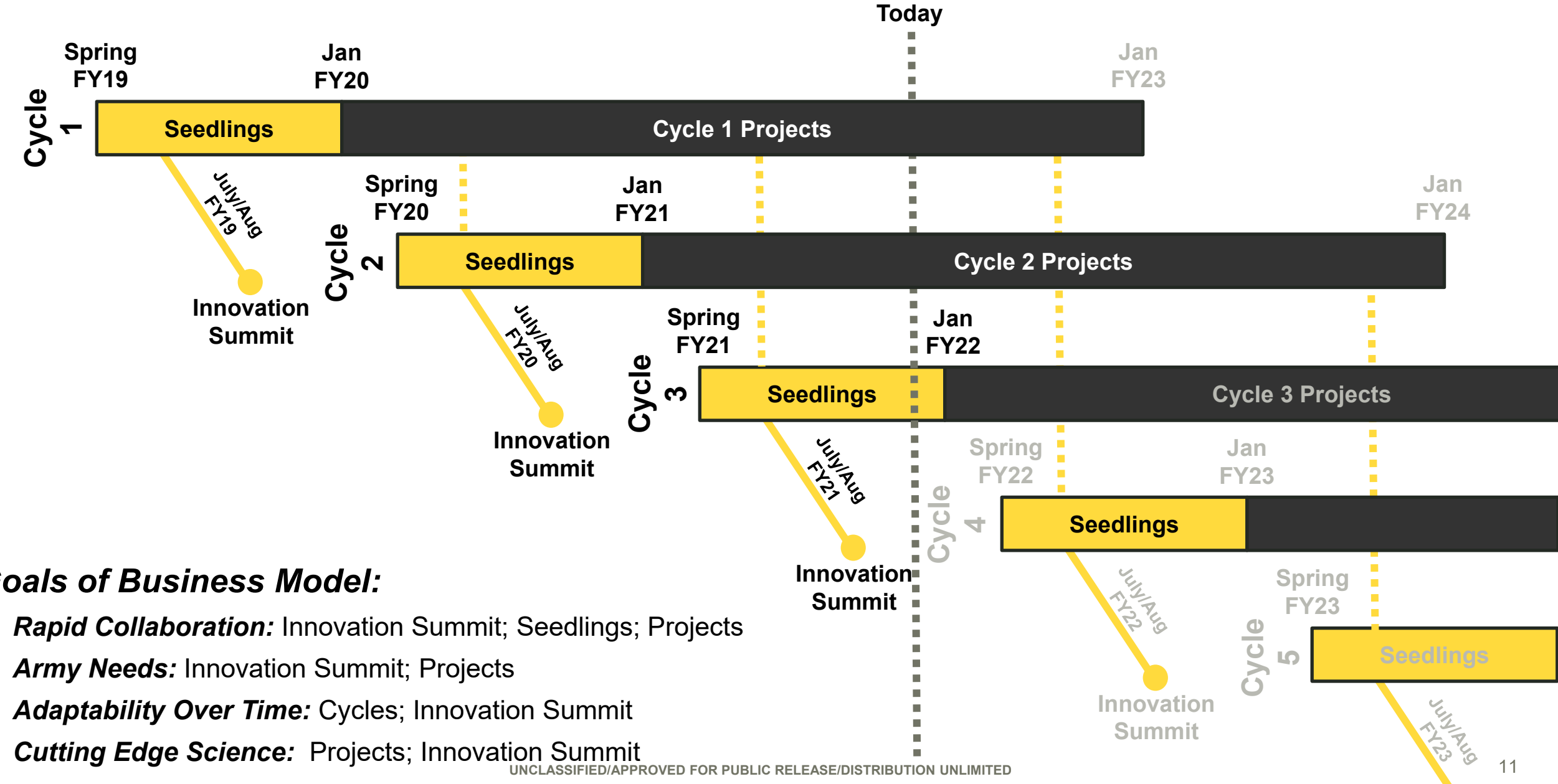
- **Is machine learning with an embedded high resolution mammalian sub-architecture neuro-mimicry associated with more effective human-intelligent agent interactions than other forms of machine learning?**

CYCLE 4

- **Does embedding high-resolution mammalian sub-architectures other than visual processing (e.g., *spatial reasoning* neuro-mimicry) into human-guided machine learning outperform deep learning for non-visual processing tasks (e.g., spatial reasoning tasks) that require adaptation?**

- **Can mammalian brain sub-architecture neuro-mimicry-based machine learning can be integrated within teams of humans and agents to enhance overall performance on complex, dynamic tasks that require team adaptation?**

CORE STRONG MECHANISM



Goals of Business Model:

- ***Rapid Collaboration:*** Innovation Summit; Seedlings; Projects
- ***Army Needs:*** Innovation Summit; Projects
- ***Adaptability Over Time:*** Cycles; Innovation Summit
- ***Cutting Edge Science:*** Projects; Innovation Summit

SUMMER INNOVATION SUMMIT

Create a multi-disciplinary ecosystem to develop cutting edge basic research for the Army

- Shaped critical research questions, hypotheses, and research plans with input from academic researchers, entrepreneurs, industry representatives, military experts, and cross-service DoD researchers
- Integrated internal and external expertise in collaborative research, technology development and transition, entrepreneurship.
- Hosted in person at ARL Northeast in FY19, and Virtually in FY20 and FY21.
- Attended by +100 in person FY19 and up to +130 attendees Virtually in FY20 and FY21
- Provided extended opportunities for recipients of seedling Cooperative Agreements to work collaboratively (together and with government) to develop follow-on research in incubator-like atmosphere

PRELIMINARY INNOVATION SUMMIT SCHEDULE

Activity	Approximate Time Frame
• Hackathon Announced	~June 30th
• In Person Demos/Seedlings	~Week of July 11th
• Virtual Meetings/Presentations	~Weeks of July 18th and 25th
• In Person Hackathon	~Week of August 8th
• Follow On Presentations	~January 2023

FOLLOW ON PERFORMERS FROM BOTH HUMAN AND AI SCIENCES

Fellows in the Following Organizations:

American Association for the Advancement of Science AAAS

International Communication Association, ICA

American Psychological Association, APA

Association for Psychological Science, APS

The Society for Industrial and Organizational Psychology

National Communication Association, NCA

Social Science Research Council, SSRC

Institute of Electrical and Electronics Engineers, IEEE

American Institute for Medical and Biological Engineering, AIMBE

European Physical Society, EPS

Association for the Advancement of Artificial Intelligence, AAAI

President of the International Communication Association

President of IEEE Engineering Medicine Biology and Society

DEVELOPED MULTI-DISCIPLINARY TEAMS AND PROJECTS AT INNOVATION SUMMIT

Provide a theoretical and empirical foundation linking individual dynamics to team-level processes for heterogeneous human-agent teams

Cycle 1 research is focused on identifying and characterizing emergent properties in team behavior through identification of human and machine roles that lead to improved team performance.

Northwestern University

Northeastern University

Cornell University

University of Pittsburgh

Carnegie Mellon University

Columbia University in the City of New York

Rensselaer Polytechnic Institute

Massachusetts Institute of Technology

University of Georgia

Cycle 2 research is focused on how human traits, status, and perceived competence, as well as agent traits, impact trust and performance in mixed teams of humans and intelligent system. (5 Government Collaborators)

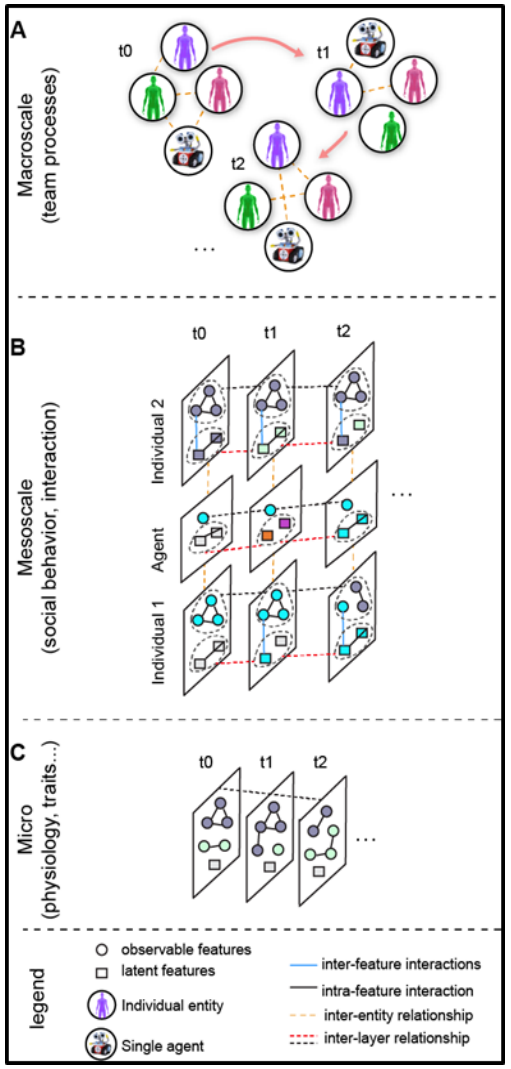
UMASS Lowell

dcscorp

University of Delaware

University of Colorado Boulder

Columbia University in the City of New York



CYCLE 3 FOLLOW ON PROJECTS

Developing new experimental paradigms that account for future human system interactions is critical for the future Army.

Cycle 3 Innovation Summit Outcomes:

Worked with STRONG performers to develop proposals that use experimental platforms that are informed by future interactions.

a. Consider future roles of humans and autonomy.

b. Allow for measurement of impact of human capabilities for Rapid Team Reconfiguration within future interactions.

c. Create adaptable systems that off-load many of the roles filled by humans s today while retaining humans in roles that only humans can perform.

d. Create new team interaction modalities which go beyond simple reward to understand intent and co-evolve team member capabilities.