UNSW: Trusted human-autonomy teaming in teleoperations

Study Aim & Method:

Develop methodologies for improving, and metrics for measuring, **mission effectiveness of human-machine teams**.

Teleoperation

- Removes soldiers from danger to reduce risks for the operator and reduces cost
- **Challenges:**
  - Operators' cognitive performance may limit mission effectiveness.
  - Factors impacting cognitive performance: fatigue, multi-tasking, switching from the civilian to the war-fighting setting, uncertainty about environment

Project Research Questions:

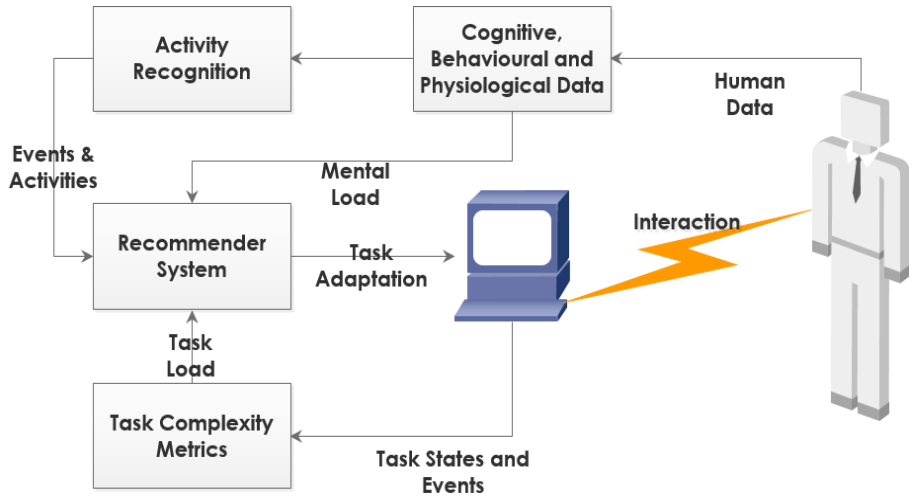
1. How to **automatically recognise** human cognitive performance during teleoperation?
   - Examples of sensors include: Kinect, EEG, ECG, physiological, speech, and IMUs.
2. What is an appropriate set of indicators for humans, and the task, to load-balance the distribution of sub-tasks among human and non-human actors?
3. What is an appropriate methodology for **real-time load balancing**?
4. How to assure **trustworthiness** in a team made of humans and autonomous systems during teleoperation?

Project Design

1 Hypotheses

1. Real-time human and autonomy indicators → are appropriate to adapt distribution of tasks
2. Adapting the distribution of tasks → will balance load on humans and autonomy
3. Balancing load on humans and autonomy → improve effectiveness and efficiency of mission
4. Improving effectiveness and efficiency of missions → improve commander's trust in autonomy

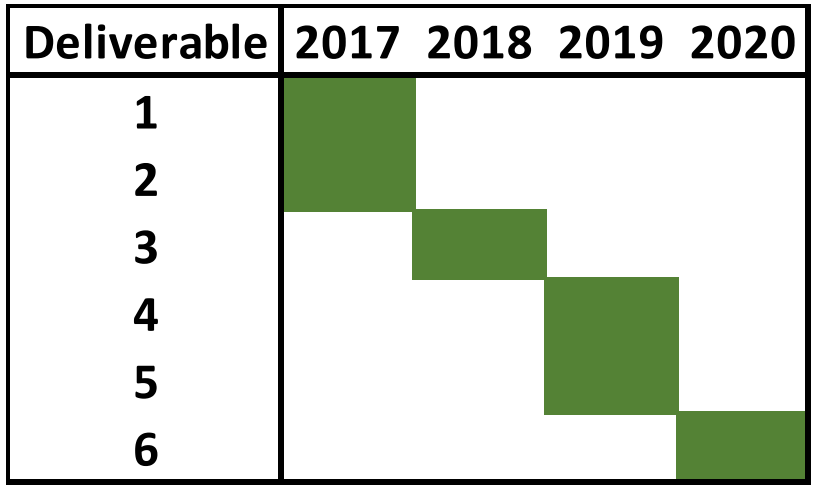
2 Framework



3 Deliverables

1. Research Plan + Preliminary Report on Activity Recognition + Preliminary Report on Cognitive and Behavioral Metrics
2. Activity Recognition Software
3. Cognitive Load Software
4. Closed Loop System
5. Trust-aware Closed Loop System
6. Fully-integrated Closed Loop System

4 Timelines



Progress, challenges, lessons learnt, opportunities, insights

Research Products

(1) A methodology for assessing the trustworthiness of a human-autonomy team
(2) A prototype load balancing system for ensuring a manageable load on humans and a trustworthy human-autonomy team

Payoff

Improved understanding of the potential of AI to enhance human-autonomy teaming
Refinement and development of a dynamic multi-modal approach for assessing trustworthiness

Progress

1) Distributed Simulation Facility in the TA lab at UNSW
2) Data Capture System from VBS
3) Data Collection and Synchronisation from human
4) Comprehensive review of the literature of cognitive workload modelling techniques with focus on multi-modal approaches
5) One academic paper published, one paper submitted, and one close to submission
6) Approved Ethics Clearance Application

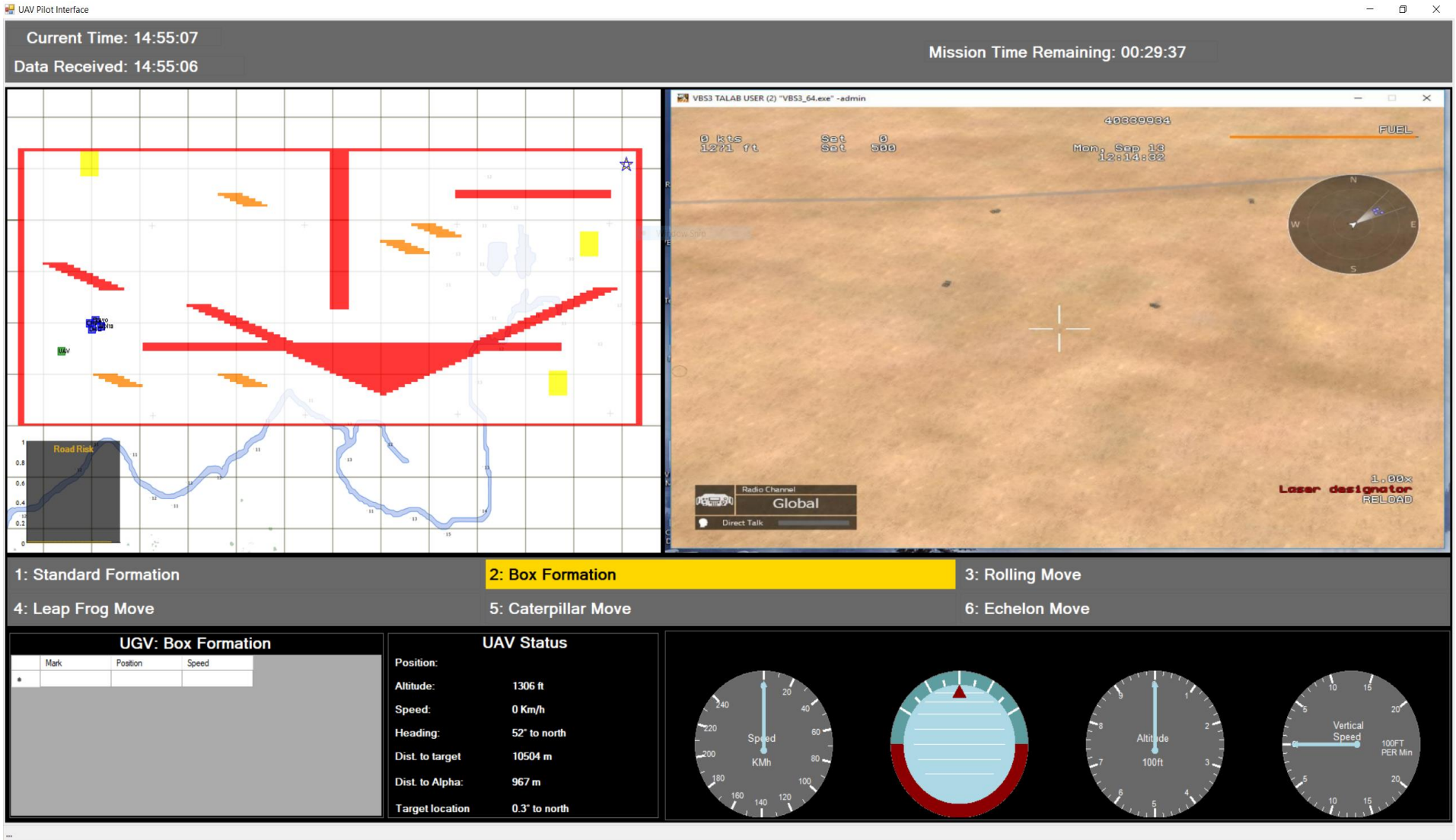
Challenges

Delays in recruitment
VBS

Opportunities

New Fully Distributed Simulation Facility at UNSW-Canberra for Human Autonomy Teaming, VBS, and Cognitive Performance

Tele-operator Interface



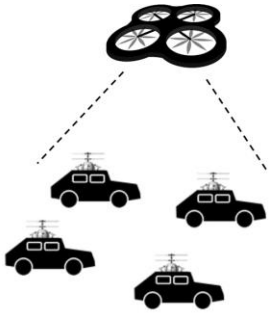
Human-Autonomy Interaction

Collect Human Data

Process Signals

Extract Features

Map Features into Mental States



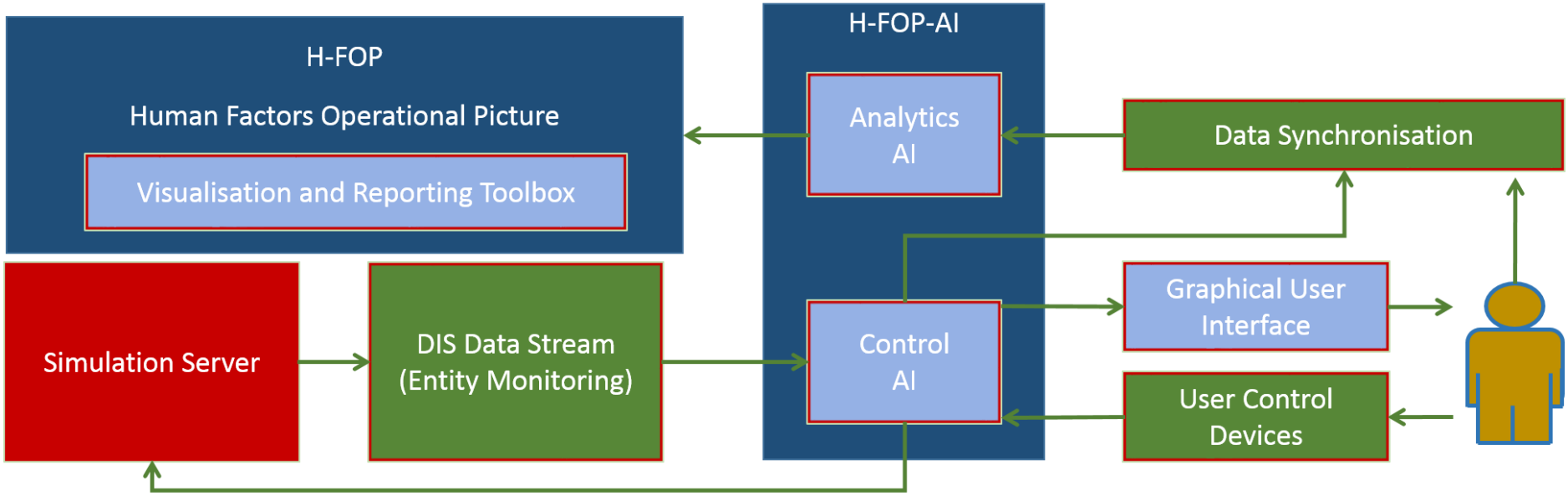
Collect Task Data

Process Signals

Extract Features

Map Features into Environmental States

Human Factors Operational Picture (H-FOP)

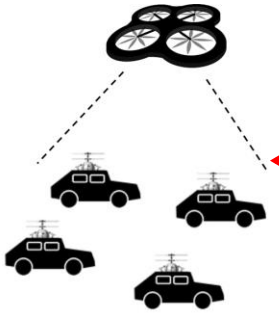


"*Quantifying and Predicting Human Performance for Effective Human-Autonomy Teaming*", Ma-Wyatt, Anna and Fidock, Justin and Abbass, Hussein A

Trusted Closed-Loop Human-Autonomy Interaction

Collect Human Data

Collect Task Data



Process Signals

Process Signals

Map Features into Mental States

Extract Features

Extract Features

Map Features into Environmental States

Adaptive Allocation Logic
Learn + Optimise + Trust

List of Publications

- "***Quantifying and Predicting Human Performance for Effective Human-Autonomy Teaming***", Anna Ma-Wyatt, Justin Fidock, and Hussein Abbass. International Conference on Science and Innovation for Land Power, 2018.

- "***Multi-Modal Fusion for Objective Cognitive Workload Assessment: A Review***", Essam Debie, Raul Fernandez Rojas, Justin Fidock, Michael Barlow, Kathryn Kasmarik, Sreenatha Anavatti, Matthew Garratt, and Hussein Abbass (Under Review).

- "***Workload and Situational Awareness in Ground-Aerial Interaction Under Information Latency and Dropout Scenarios***", Essam Debie, Raul Fernandez Rojas, Justin Fidock, Michael Barlow, Kathryn Kasmarik, Sreenatha Anavatti, Matthew Garratt, and Hussein Abbass (In Preparation).

Thank You for Your Attention

Questions?