TTCP Autonomy Strategic Challenge

"Controlling different autonomous platforms like this is a game changer. Like getting lions, tigers and bears to hunt as one species."

CMDR Paul Hornsby

Mark Draper, Allen Rowe & Jessica Bartik

AIRMAN SYSTEMS DIRECTORATE

Autonomy Strategic Challenge (ASC)

TTCP The Technical Cooperation Program

Mission

To enhance, demonstrate, and evaluate the military utility of autonomous systems for future five-eyes (FVEYS) littoral operations

Objectives

- ***Force Multiplication*** by small teams of human operators controlling a large fleet in a dynamic threat environment.
- ***Interoperability*** *architecture* to provide guidelines for innovation.
- ***Integration*** of autonomy technologies for faster and more informed.
- ***Agility*** by merging tactical and operational control for faster military decision cycles.

C2 Autonomy Technologies

UV-Combat System integration (MAPLE)

Effective & flexible human management of multiple simultaneous UV missions (IMPACT).

Policy management (COMPACT).

Authority Pathway.

Machine recommends multiple action 'plays' learned via online operator feedback.

Platform Autonomy Technologies

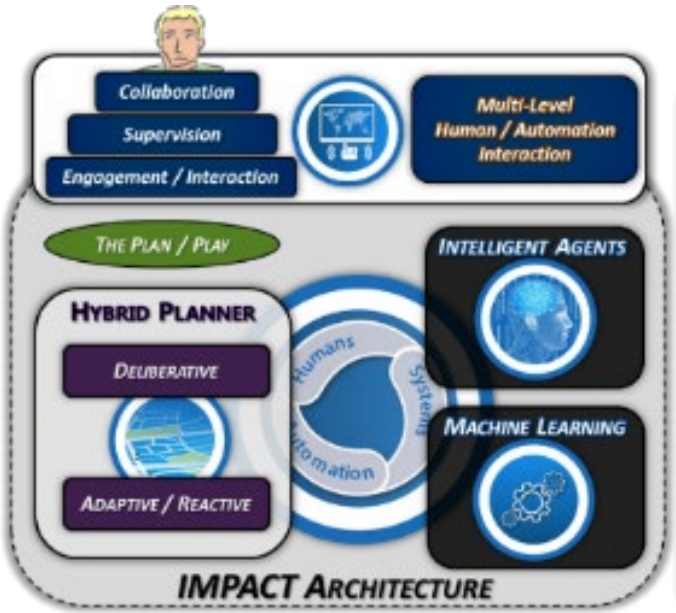
Unmanned Vehicle team coordination software
Unmanned Vehicle Mission Oriented Operating Suite (MOOS) integration

+ Industry Platform Autonomy Contributions

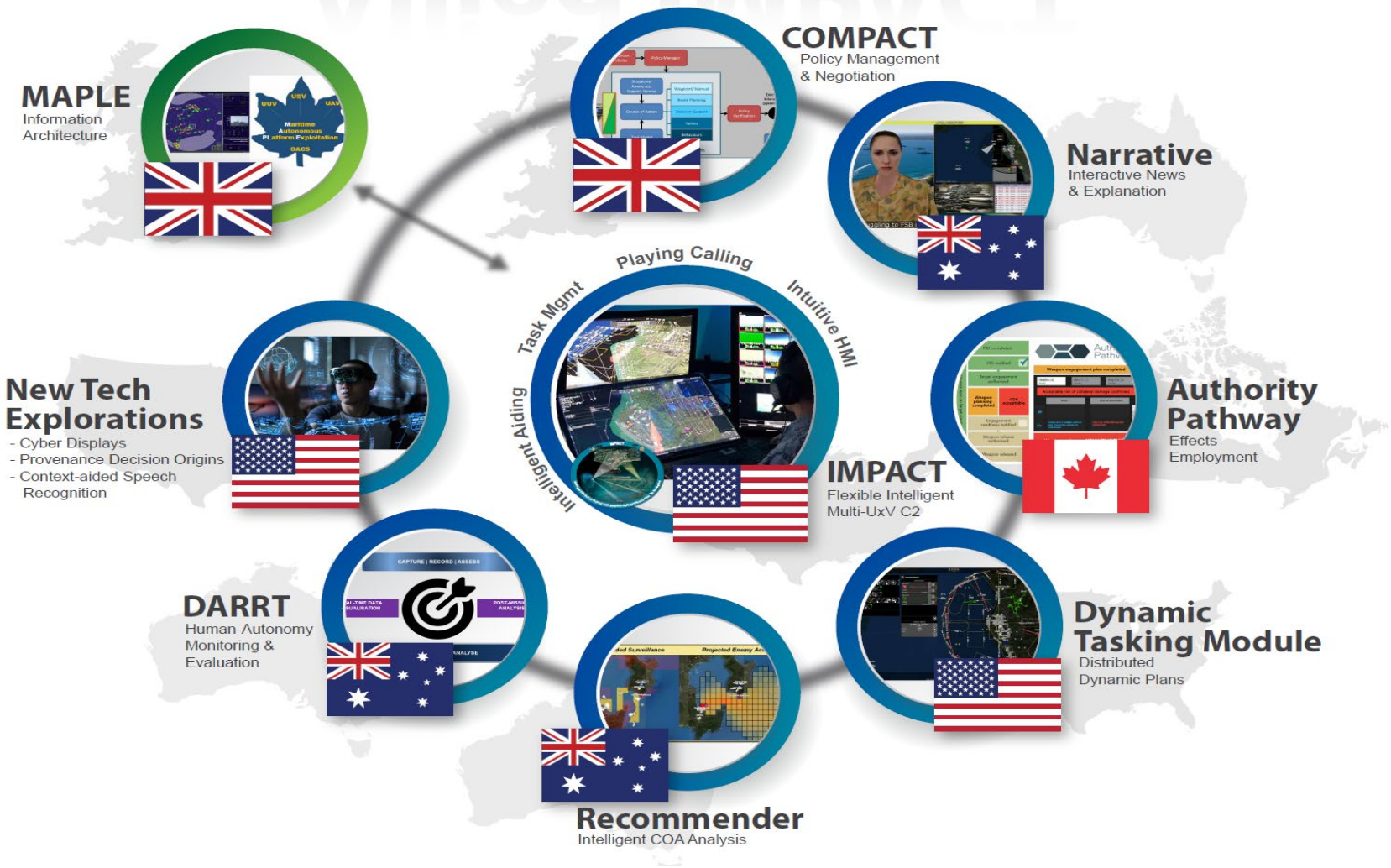
IMPACT: Intelligent Multi-UxV Planner w/Adaptive Collaborative Control Technologies

Multi-UxV command & control capability with tools for enhanced decision-making

- Tri-service research effort with force multiplication capability focus
- Enables single operator to manage up to 12 vehicles (air, ground, sea)
- Includes:
  - ***Flexible play calling***
  - ***Intelligent decision-aids***
  - ***Cooperative control algorithms***
  - ***Intuitive human-machine interfaces***
  - ***Autonomics monitoring***



Allied IMPACT

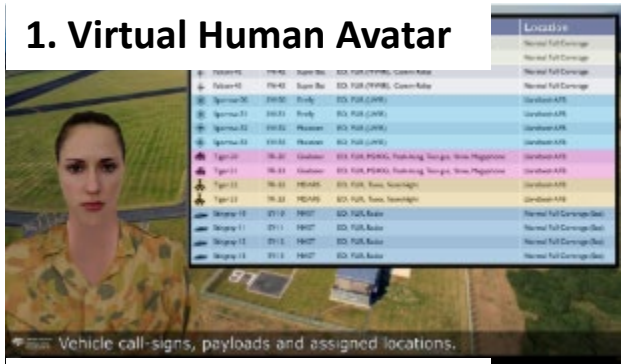


Narrative

Multimedia Narration for naturalistic interaction and enhanced situation awareness

- Context and time sensitive
- Implementation:
  - Adaptive mission briefings for operators
  - Multimodal Q&A and notifications
  - Platform status reports on demand
  - Recommendation and plan explanation on demand
  - Provenance reporting on demand

1. Virtual Human Avatar



2. Geospatial Tile

3. Explanation Specific Application Tile

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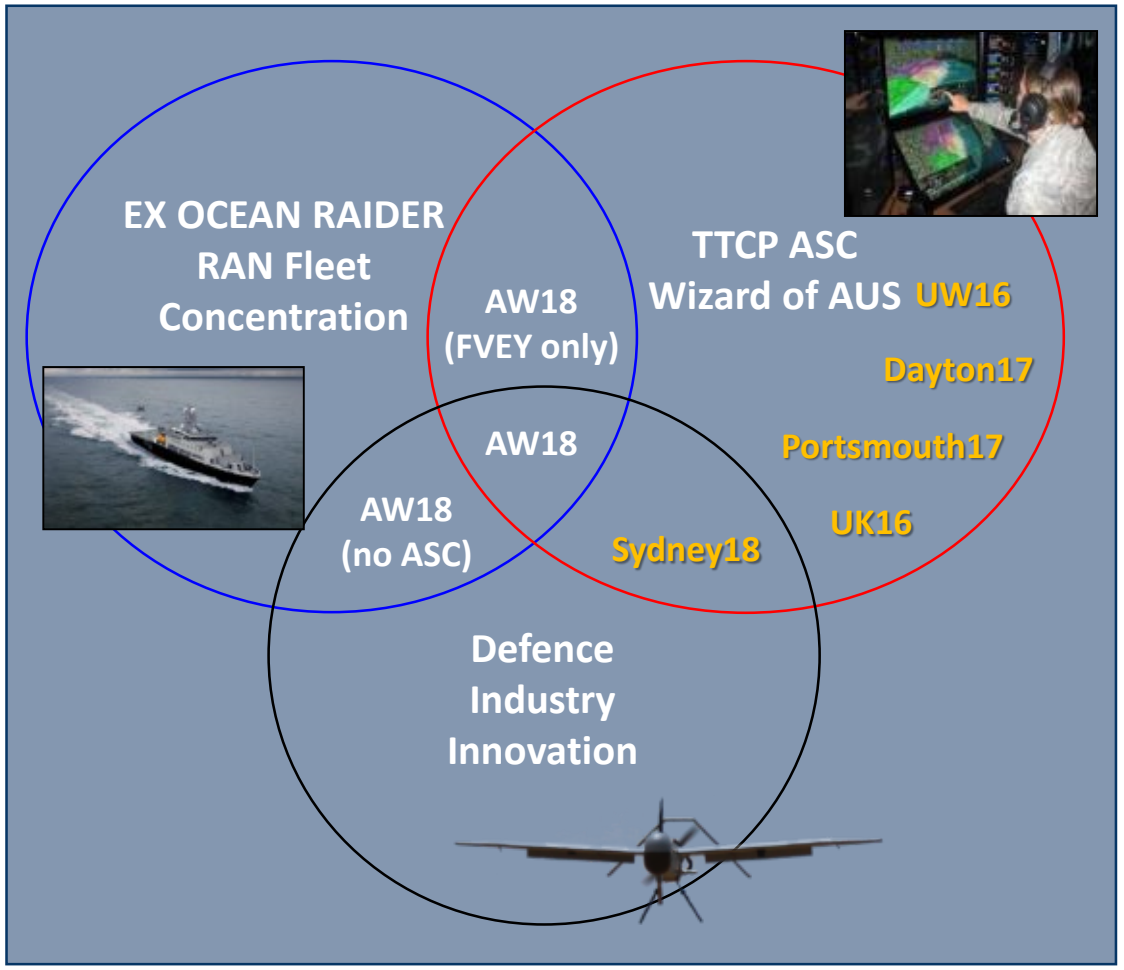
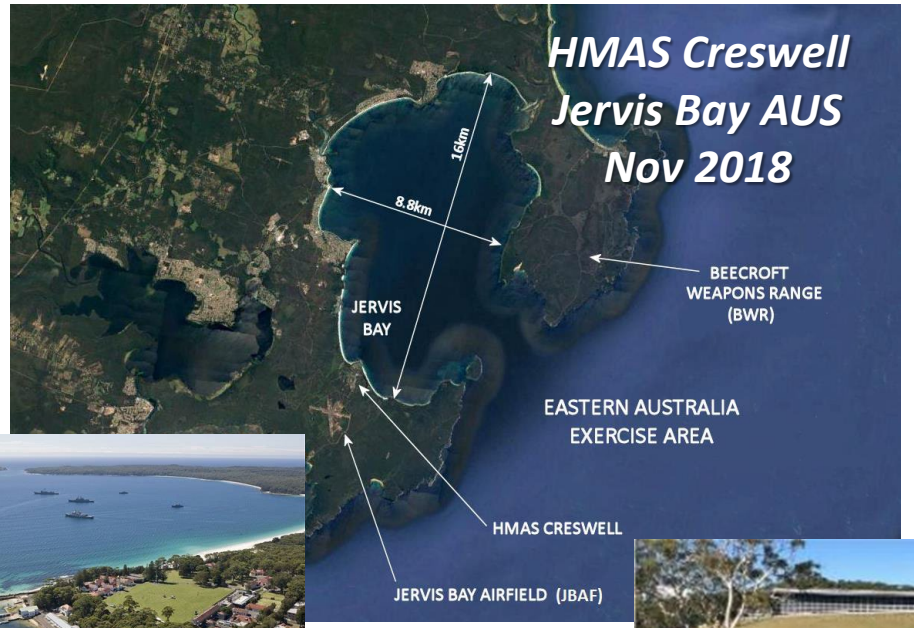
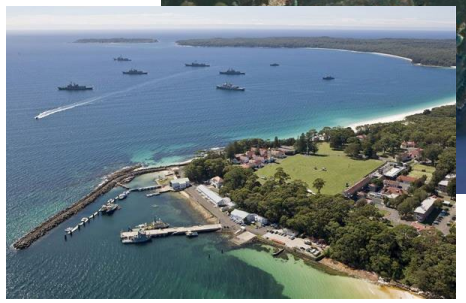
Capstone Event

Team of **100+ scientists** from **5 nations** & **8 research labs** demonstrated & evaluated military assessment of AIM







Evaluation Structure

1. Live Trials

- Dedicated AIM station
- Experienced AIM operator at the controls
- Opportunity for SMEs to observe, comment & rate AIM system performance

2. Synthetic Trials

- Redundant AIM system
- SMEs at the controls
- Opportunity for SMEs to use system & collect objective/subjective performance data

3. Quick Hit Assessments

- Intended for short visits by senior leaders & additional SMEs
- One page questionnaire
- Captures background, key comments, feedback, benefits & risks

Metrics

Objective

- # of assets managed by single operator
- % mission completeness
- Response time
  - Intruder events
  - Commander queries
- Commander query accuracy
- # of plan monitor and/or COMPACT violations
- Weapon engagement accuracy

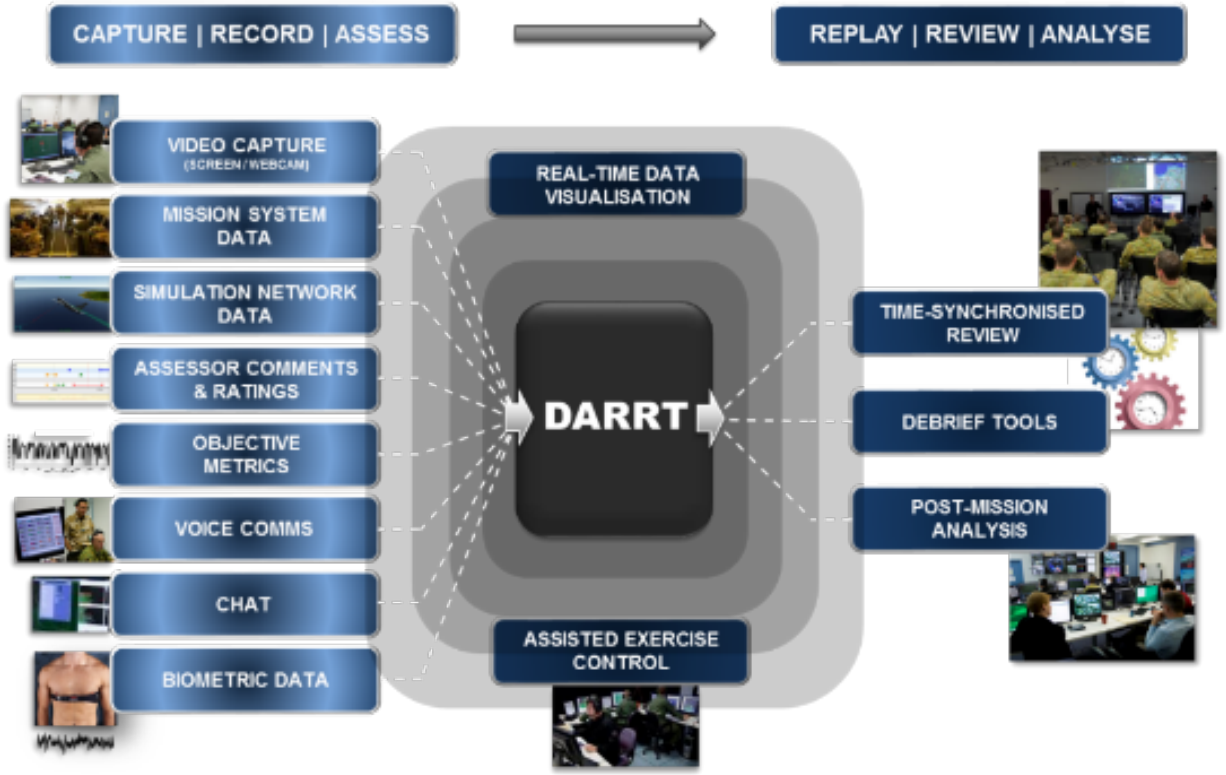
Subjective

- System Usability Scale
- Human-autonomy teaming heuristics
  - Observability
  - Predictability
  - Directability
  - Directing attention
  - Exploring the solution space
  - -Adaptability
  - -Calibrated trust
  - -Common ground
  - -Information presentation
- Situation awareness
- Workload
- Trust
- Risks

DARRT: DSTG Assessment & Review Research Tool

A human-autonomy teaming assessment tool that supports real-time data analysis and rapid, focused after-action reviews

- Calculate, store, and display key mission performance metrics
- Present real-time status and mode of autonomous platforms
- Deliver multi-media after-action review of mission performance



Synthetic Use Case

- **1 hour trial combining elements from all 3 live use cases**
- **Consisted of 4 event types & 35 tasks:**
  1. Queries
  2. Random Anti-Terror Measures
  3. Normal Base Defense Events
  4. Intruder Events

Event	Reponse
Queries	How soon can Super Bat 3 get to the Flight Line Center? What is the status of ongoing plays? What is the status of the threat at Point Alpha? How soon can you get an IR sensor to the Main Gate? What is the point of origin of the artillery fire? How many air vehicles are available for tasking? What is emphasized in the intel based background behavior? What is the status of Riot Response Team 2? How is RAM 1 progressing? Which vehicles are getting low on fuel? What is Super Bat 1's altitude?
Random Anti-Terror Measures (RAMS)	RAM 1: Take imagery of Chow Hall every 10 mins between 10 and 50 mins RAM 1: Take imagery of Chow Hall every 10 mins between 10 and 50 mins RAM 1: Take imagery of Chow Hall every 10 mins between 10 and 50 mins RAM 1: Take imagery of Chow Hall every 10 mins between 10 and 50 mins RAM 2: Conduct LPOP in NAI 2 for 5 mins between 0 and 15 mins RAM 3: Conduct Show of Force at Main Gate for 8 mins between 30 and 45 mins RAM 4: Conduct 360 of Building 99 at 54 minutes
Suspicious Watercraft	Air Shadow of Suspicious Watercraft
Escort Riot Response Teams 1 & 2	Air & Ground Escort of Riot Response Team 1 Air & Ground Escort of Riot Response Team 2
Provenance	Point Inspect at Point Alpha
Mortar Fire	Air Sector Search at Fang Rock Lighthouse Air Point Inspect of Artillery Impact Point
Cyber Event	Point Inspect of Building 16
Perimeter Breach	Air Sector Search of South Sector Air Point Inspect at Perimeter Breach Location
Weapon Engagement	Air Point Inspect of Radio Tower Weapon Engagement at Radio Tower
Suspicious Surface Vessel	Air Shadow of Suspicious Surface Vessel Surface Blockade of Surface Vessel
Inspect Route/Escort Supply Vessel	Air Route Inspect of Route Arcadia Air & Surface Escort of Supply Vessel
Building Alarm	Air Expanding Square at Building 99 Point Inspect at Building 99

High Level Accomplishments:

- Improved interoperability of emerging FVEYS autonomous systems
  - Full integration of 22 components developed by 14 organizations from all 5 TTCP countries
- Enabled single operator to manage 17 unmanned assets (6 live inclusive of air, sea & ground platforms)
- Successfully used novel data logging capability for rapid, interactive after-action reviews

"The system is an absolute game changer as we advance towards Human-Machine Teaming" – SME 6

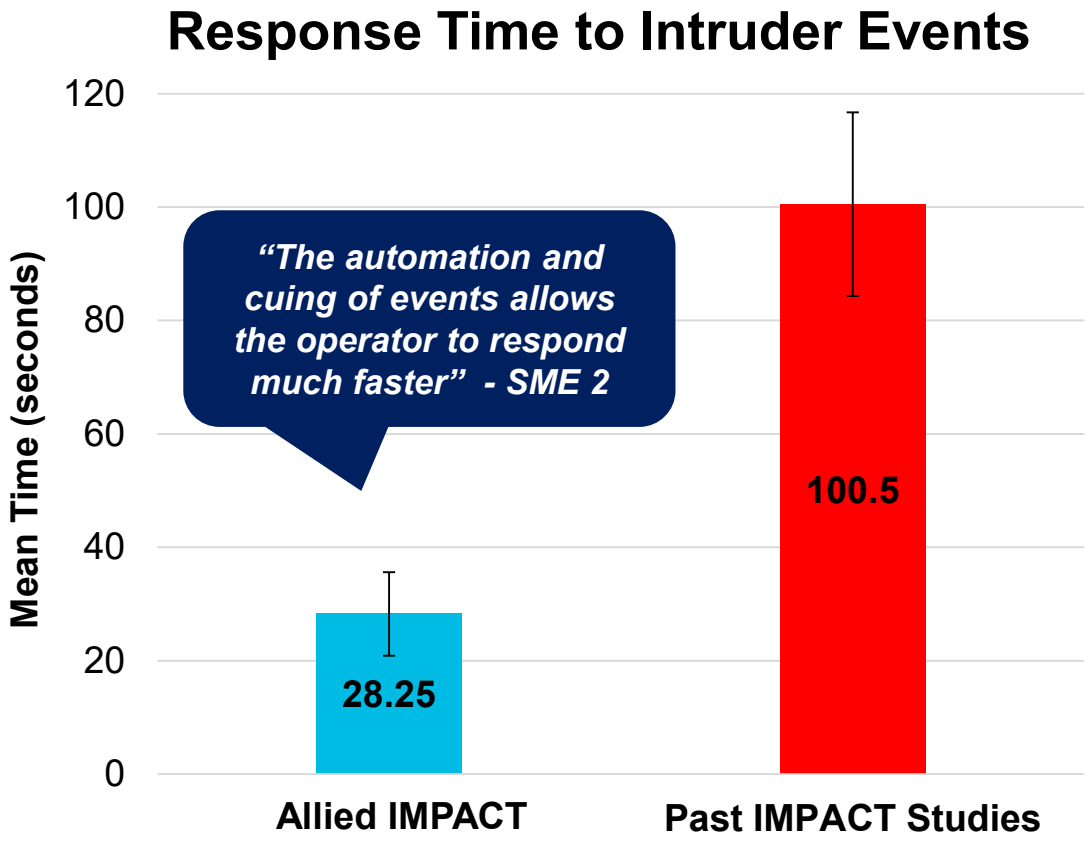
Objective Data

Mission Completeness

- Mean **% mission completeness** across 7 SMEs = **91.6%**
  - 100% of “high priority” intruder events addressed
  - Majority of omitted tasks (17/20) were queries and/or RAMs which were trained as lower priority

Response Time

- Mean **time to respond** to intruder events was **faster** in comparison to past IMPACT studies
  - 7/7 SMEs indicated that AIM would reduce response time to mission events



Subjective Data

Workload

- On average, SMEs rated **overall workload** as **"Moderate"**
  - All mission tasks can be achieved with acceptable level of workload
  - Some shedding/delays of minor tasks

"At times I had more tasks than I could do at once but I was able to prioritize the tasks and accomplish what I needed to do" – SME 5

Situation Awareness

- On average, SMEs rated **overall situation awareness** as **"High"**
  - Significant knowledge of system state
  - Good comprehension of tactical environment/mission
  - Some ability to anticipate/accommodate trends

"I always felt like I had good situational awareness and could easily figure out what my assets were doing at a given time" – SME 2

Summary

- Throughout an intensive week of data collection, AIM proved to be ***"an absolute game changer"***
  - Enabled single operator to simultaneously manage 17 unmanned assets inclusive of air, ground, and sea in support of 4 scenarios
  - Average SME mission task completeness score of 91% despite complex, event dense operational scenarios & limited training
  - Demonstrated a significant reduction in response times to unexpected events
  - Maintained acceptable levels of SME workload & situation awareness