

# Capturing Variability in Human Capability

In Mission Models for Human Autonomy Teams

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# Teamwork during information overflow and deficiencies

- Autonomous functions are inevitable in the battlefield
- Agents' adaptability to dynamic environments yields accuracy and safety
- Mission planning is key for optimal use
- BUT: Modelling dynamics between autonomous functions and humans is challenging
- THEREFORE: Model humans as special class of sensors
- SO THAT: We can plan for unpredicted conditions





*SAAB?*

# Svenska Aeroplan AktieBolaget Swedish Aeroplanes Ltd

Swedish Air Force 35C Draken

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# The Story Of How A Small Submarine From Sweden 'Sunk' A U.S. Navy Aircraft Carrier

1949

By Stavros Atlamazoglou Published October 29, 2021



## SAAB in numbers

- Four Business Areas: Aeronautics, Dynamics, Surveillance, Kockums
- 19k employees, of which 10k engineers
- Three Business Units of Dynamics: Underwater, Missiles and Ground Combat



# *Future Combat Air System*

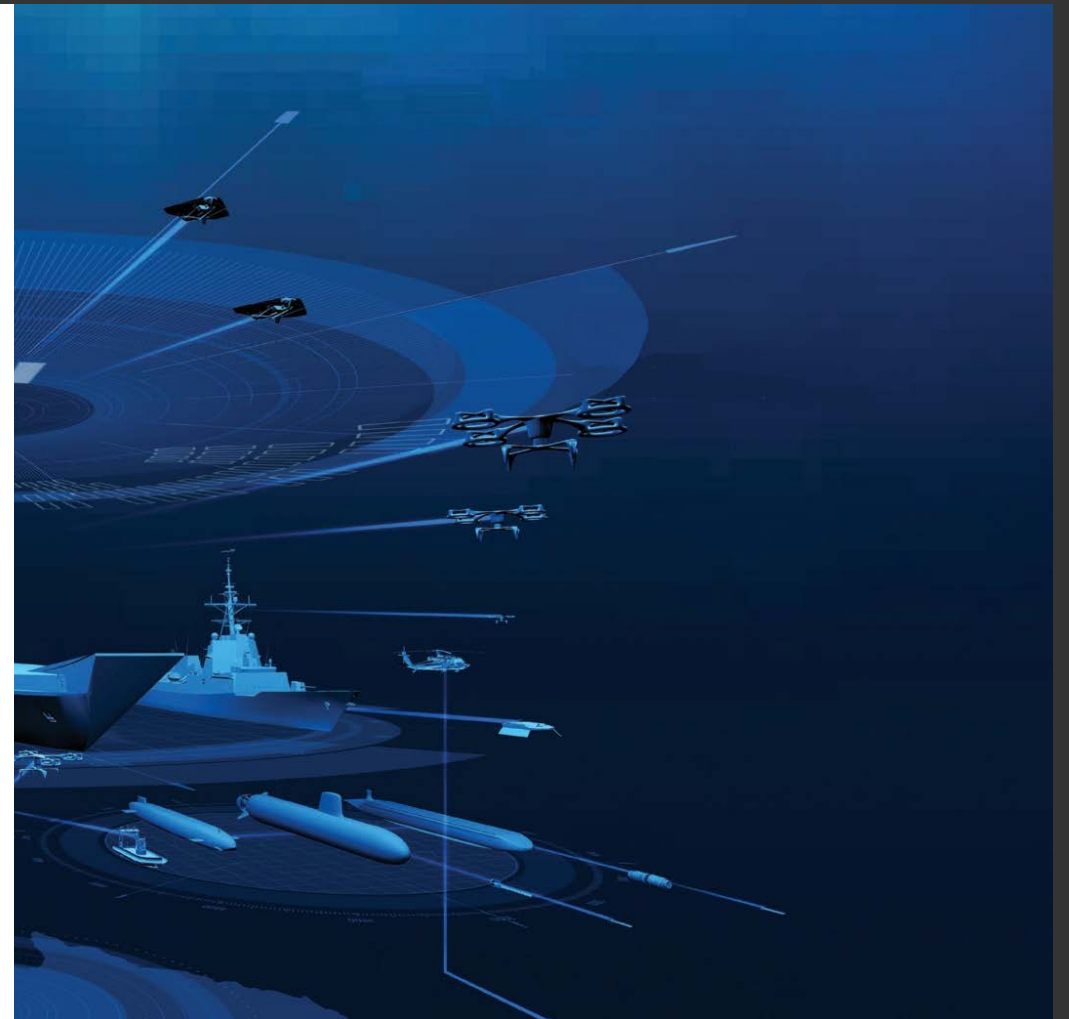
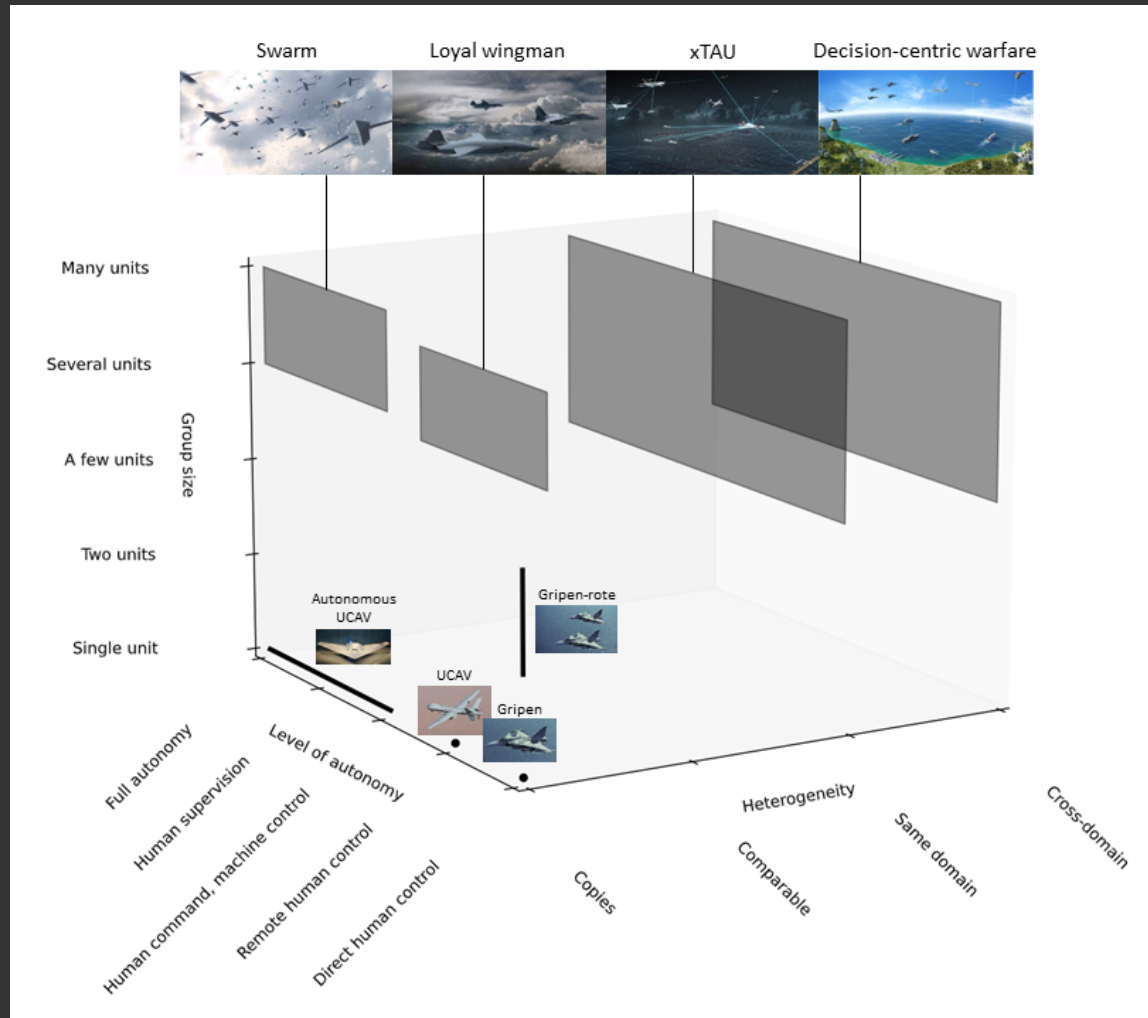
# Capability and mandate to make decisions

Capacity to reason and act according to doctrine

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# Collaborative systems

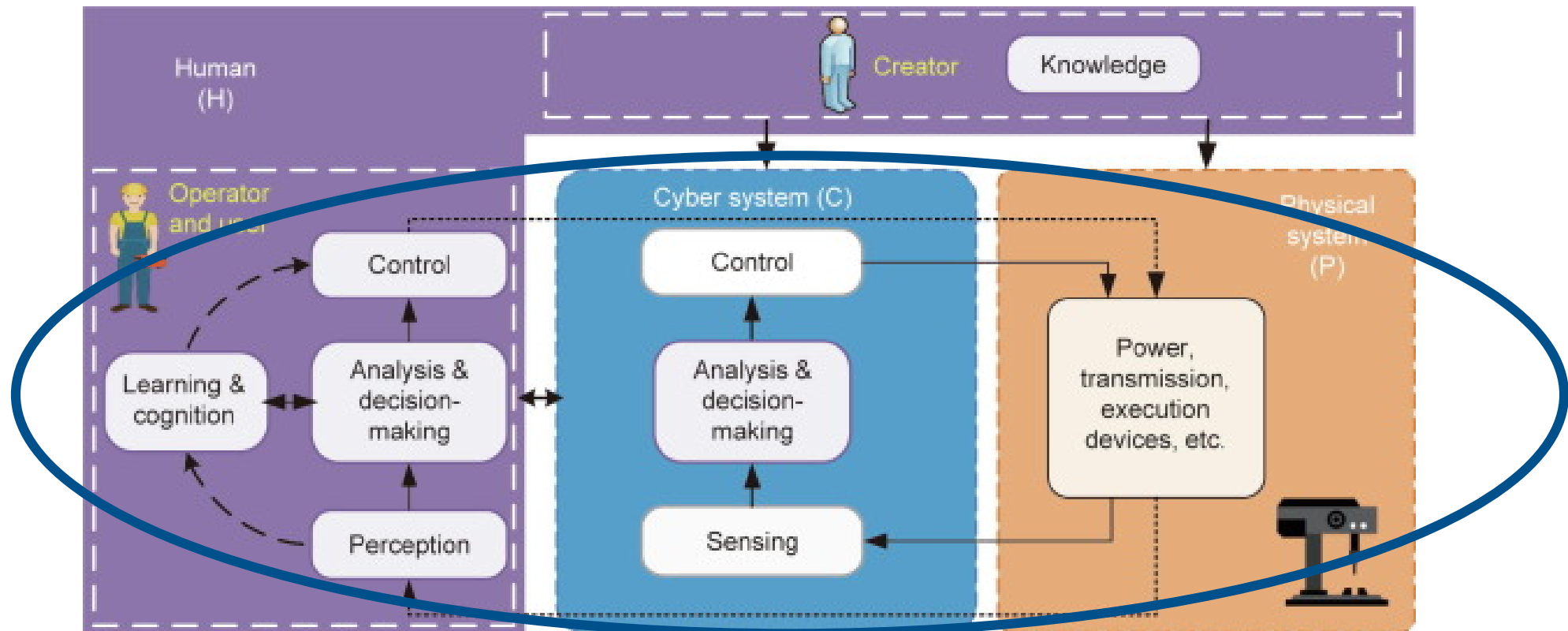






*Machines are no longer mere tools, but instead competent team members*

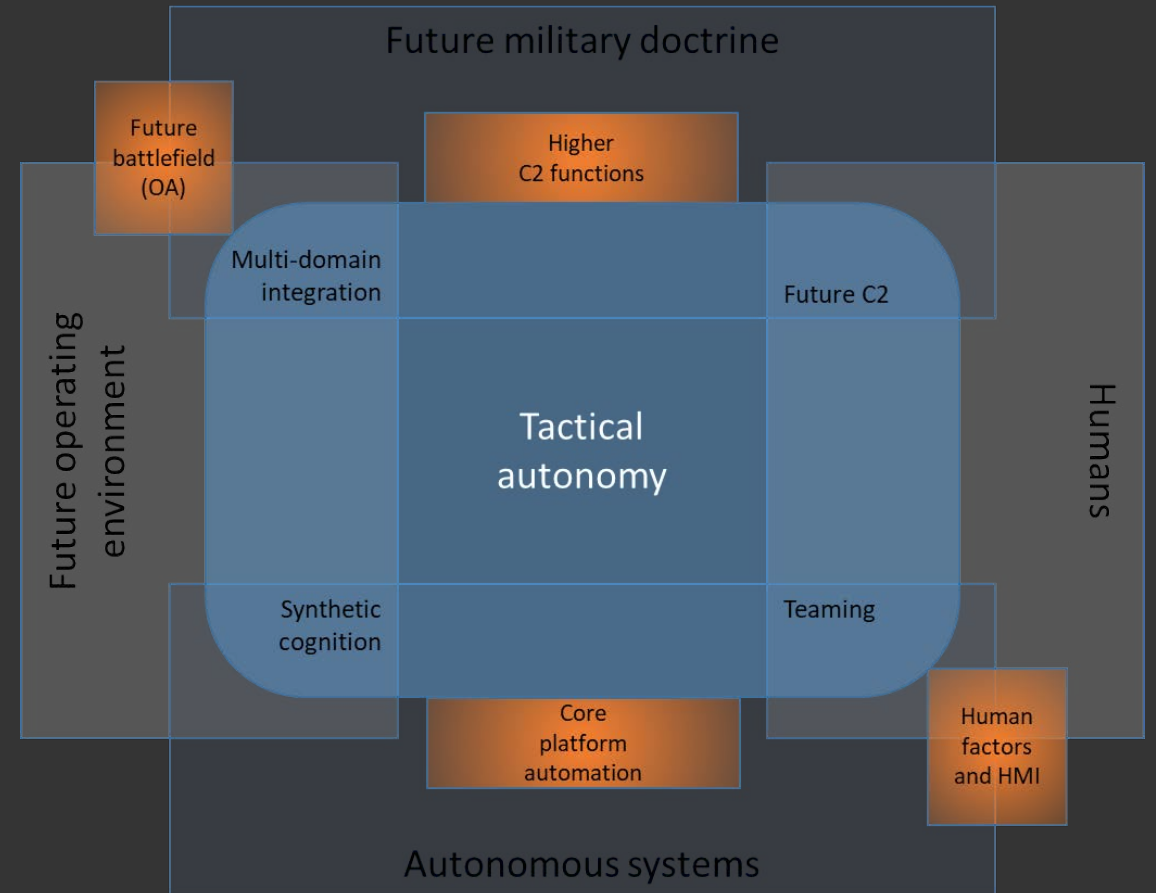
# Human Cyber Physical Systems



Zhou, Ji, et al. "Human–cyber–physical systems (HCPSs) in the context of new-generation intelligent manufacturing." *Engineering* 5.4 (2019): 624-636.

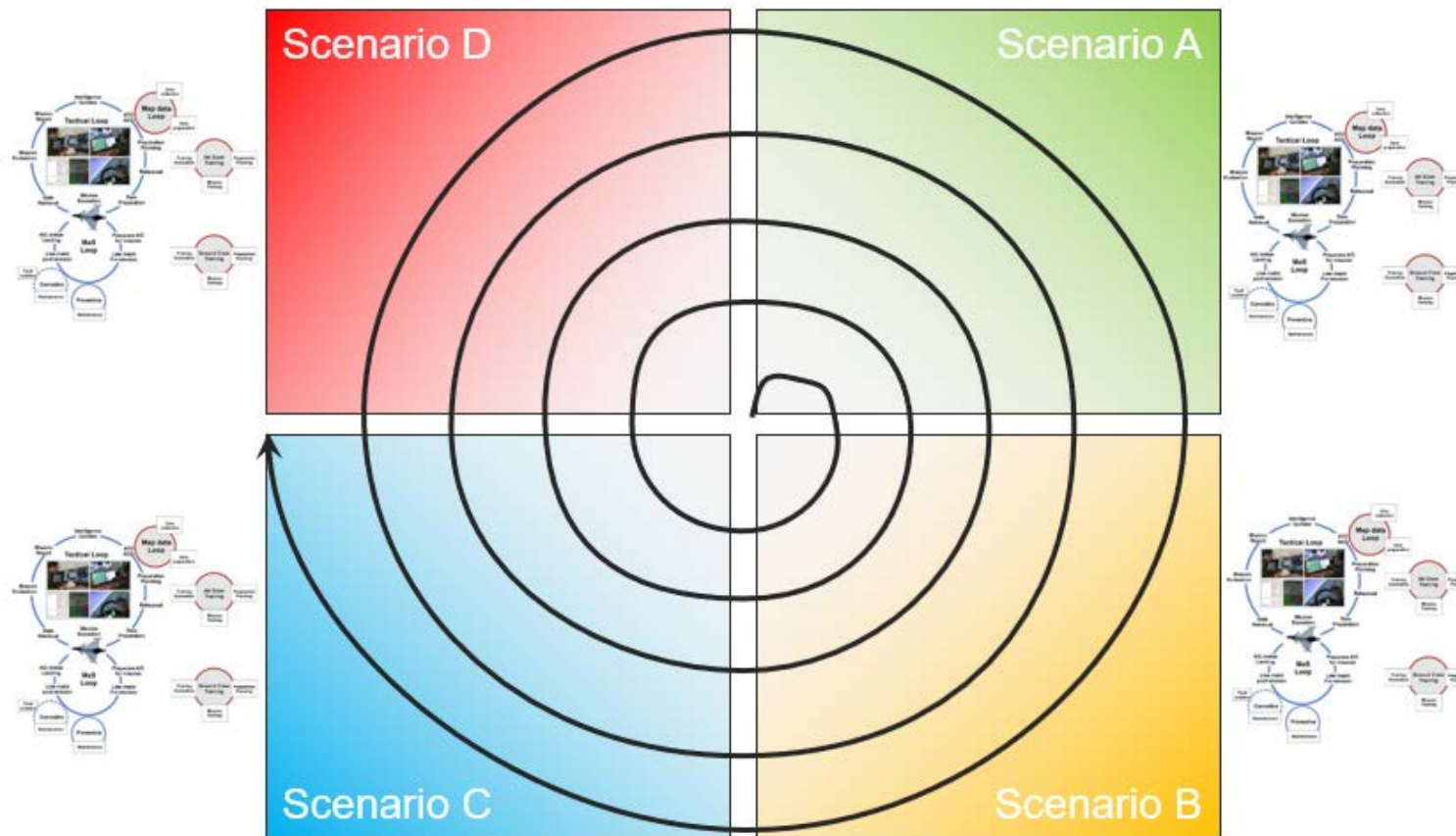
# Mission autonomy

A process of coordinated and goal-oriented tactical reasoning built upon the capabilities and assigned mandate of entities. This domain-agnostic process requires the ability of each tactical entity to translate perception and knowledge of its mission, environment, resources, and bounds into an adaptive course of action aimed at a common goal.



# Scenario-driven development

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*Plan for the  
unpredictable*

# Capability and mandate to make decisions

Capacity to reason and act according to doctrine

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# Human Autonomy Teams

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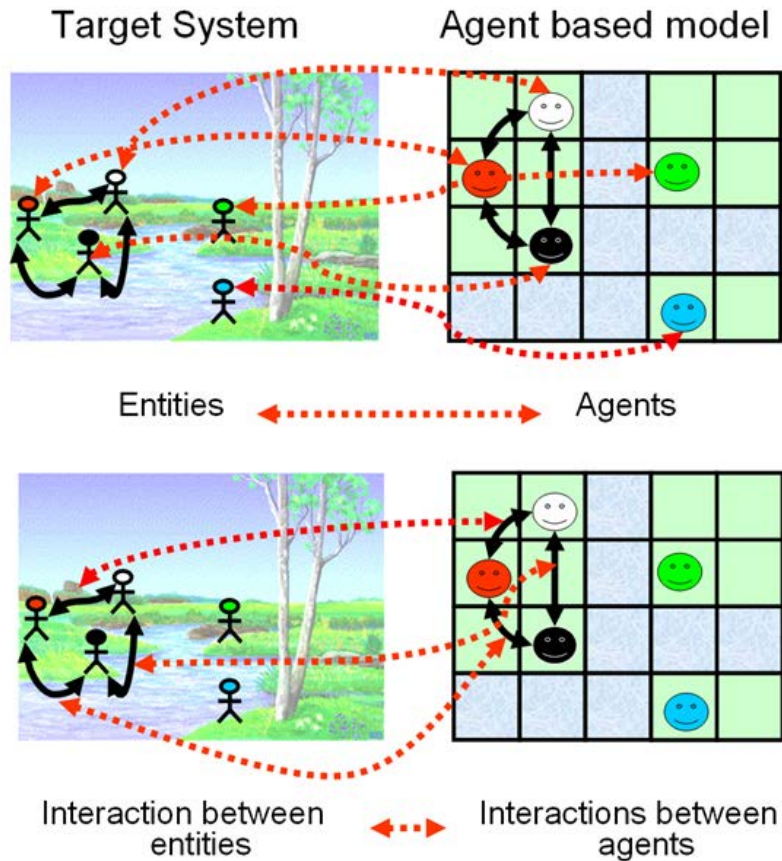
*“Interdependence in activity and outcomes involving one or more humans and one or more autonomous agents, wherein each human and autonomous agent is recognized as a unique team member occupying a distinct role on the team, and in which the members strive to achieve a common goal as a collective”*

National Library of Medicine

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9284085/#:~:text=HAT%20can%20be%20defined%20as,common%20goal%20as%20a%20collective.>







## Representing human capabilities

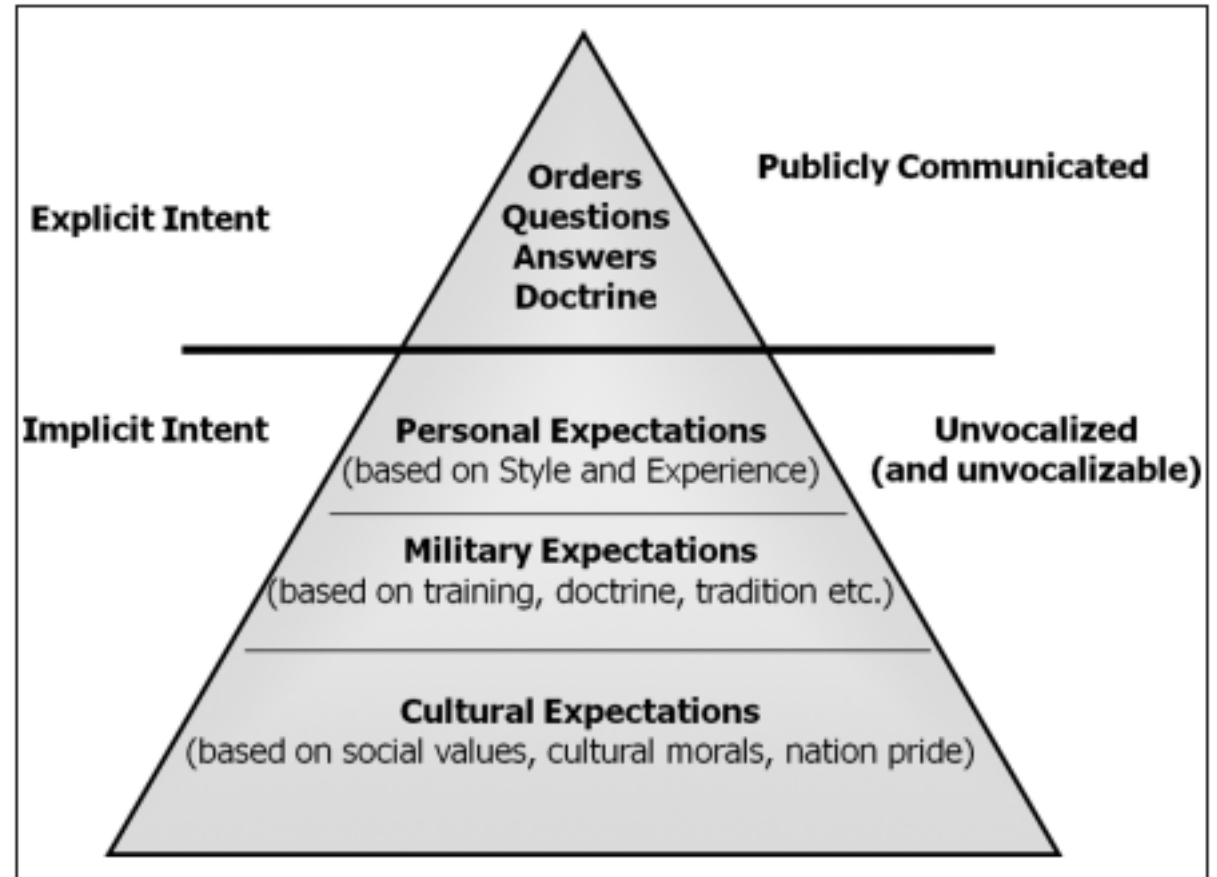
- Agent-based modeling, individuals represented as autonomous agents with specific behaviors and rules.
- System dynamics modeling, feedback loops and interactions in complex systems.
- Monte Carlo simulations, random sampling to model uncertainty and variability in human behavior and decision-making.
- Bayesian decision networks that model probabilistic decision-making.



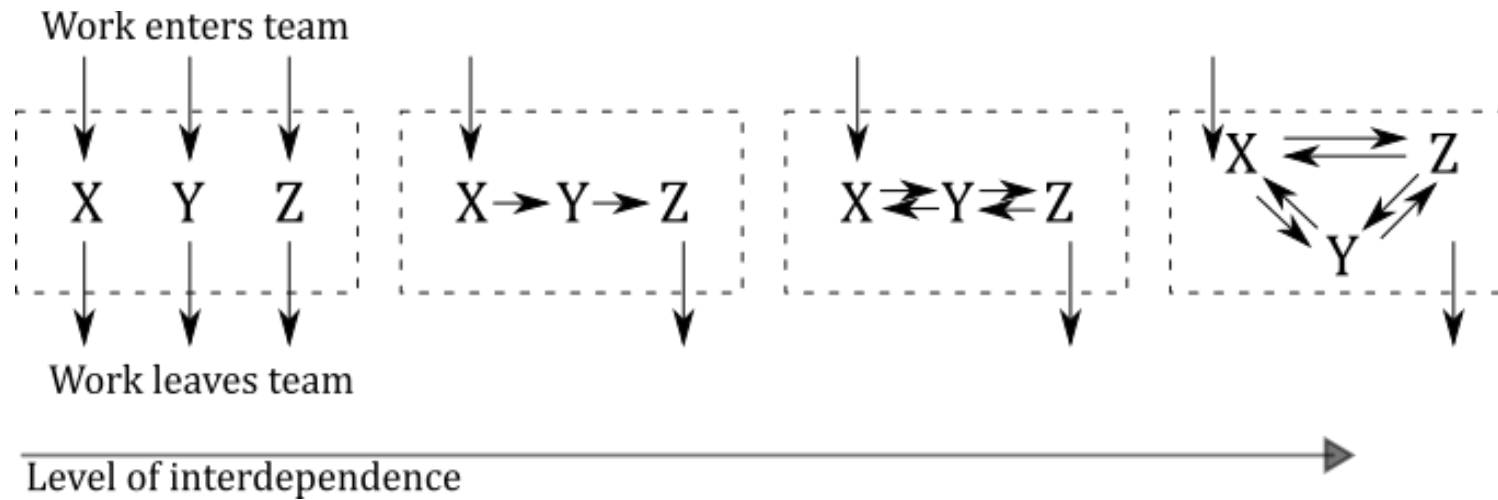
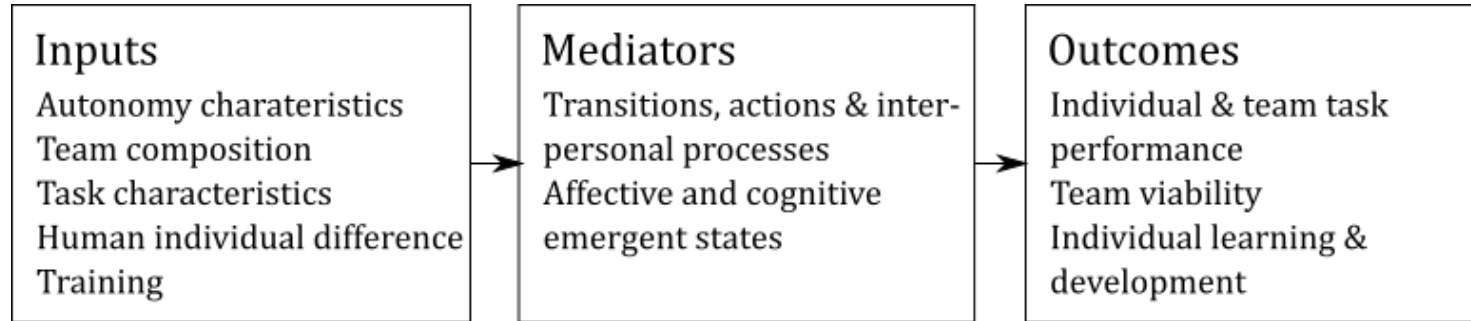
# Interpretation of intent

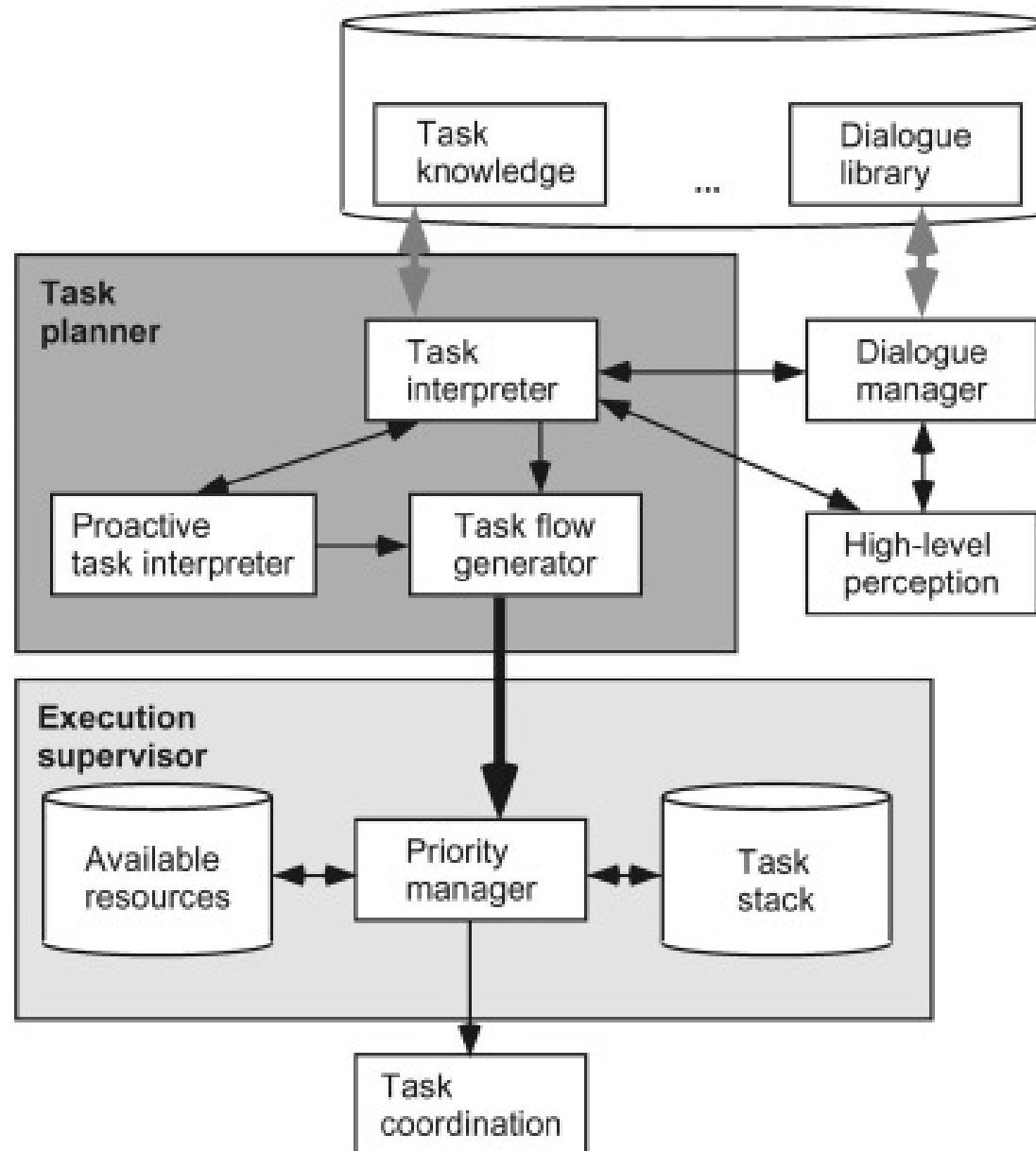
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- **Conceptual Diagrams:** Visual representations, such as concept maps or flowcharts to illustrate the relationships between different elements of the mission, including goals, priorities, and desired end states.
- **Decision Trees:** Hierarchical representation breaking down the mission into a series of decisions and outcomes.
- **SMART Objectives:** Specific, Measurable, Achievable, Relevant, Time-bound criteria.
- **War Gaming and Scenario Modeling:** Simulate different courses of action.



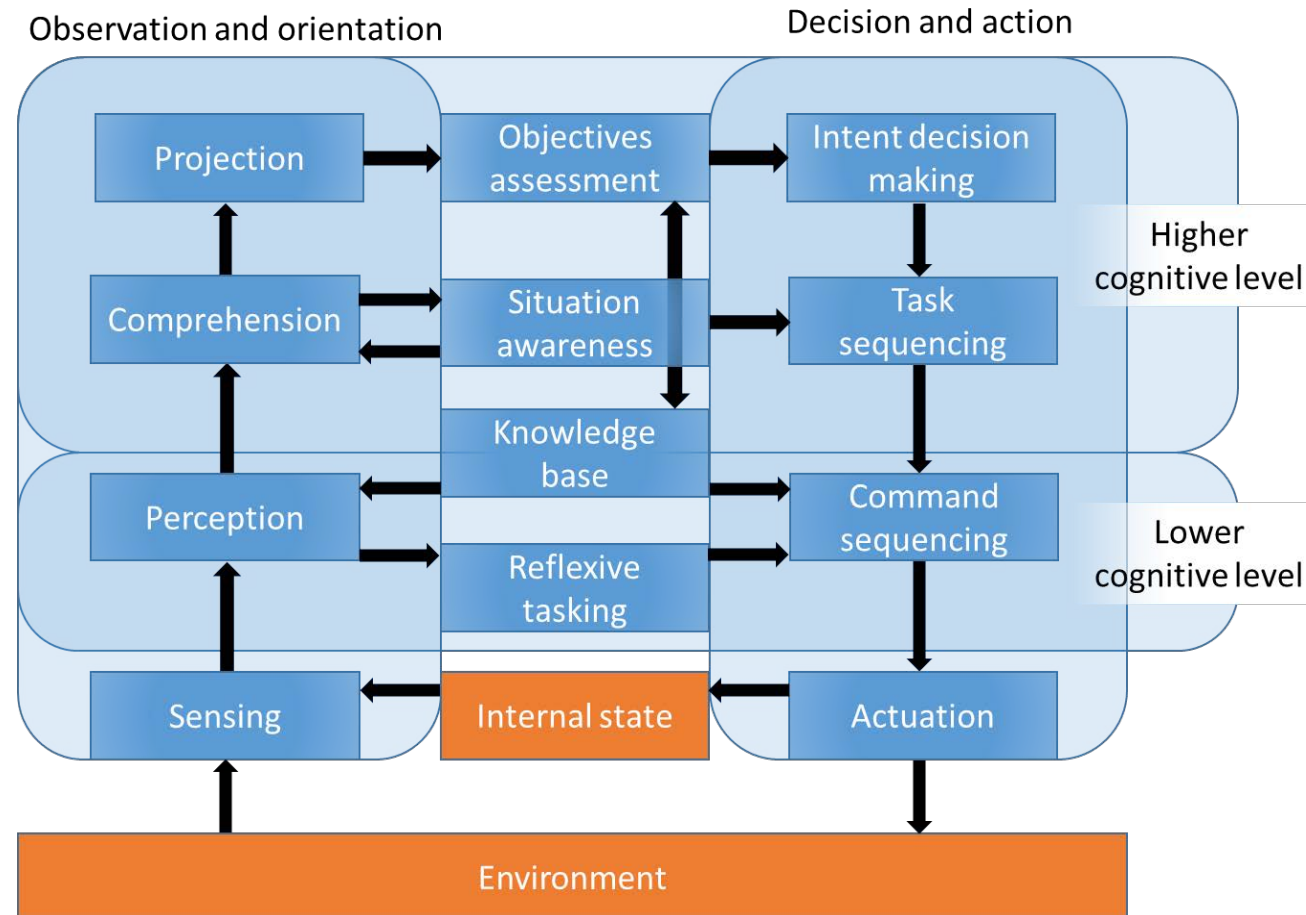
# Team dynamics





*Team task execution*

# Synthetic cognition

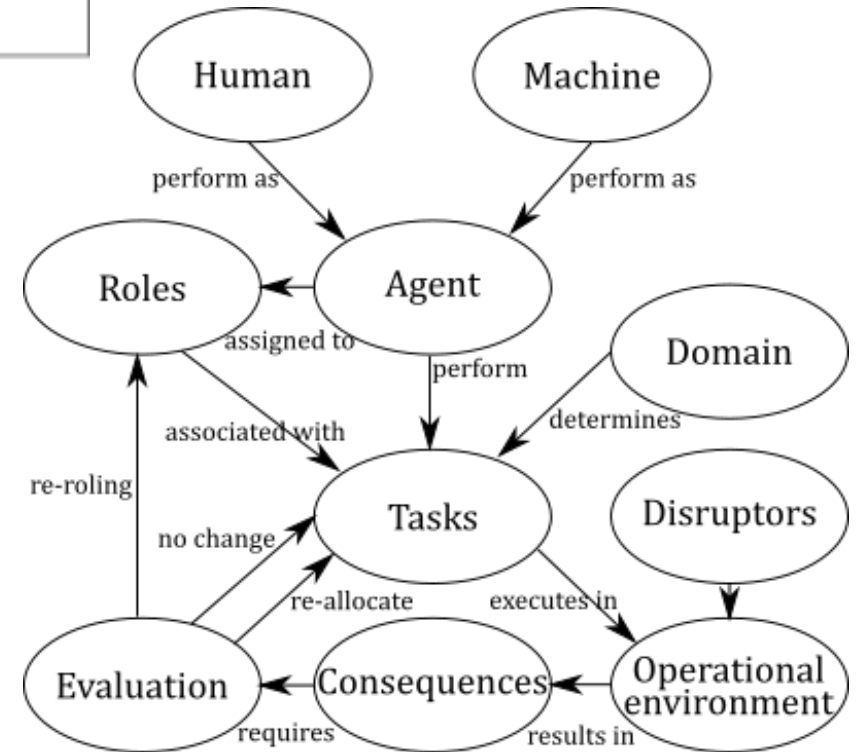




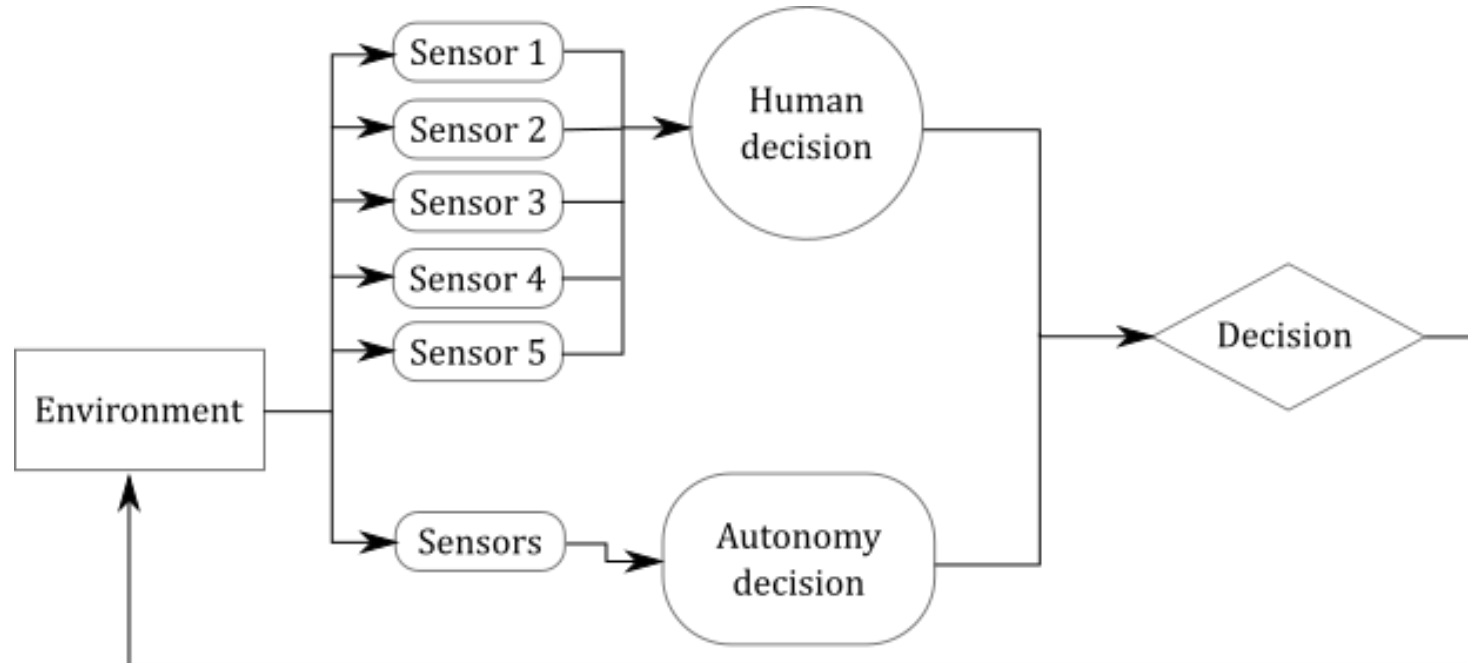
# Mission model



The interpretation is key to evaluating incremental objective assessment



# Approach: humans as special class of sensors

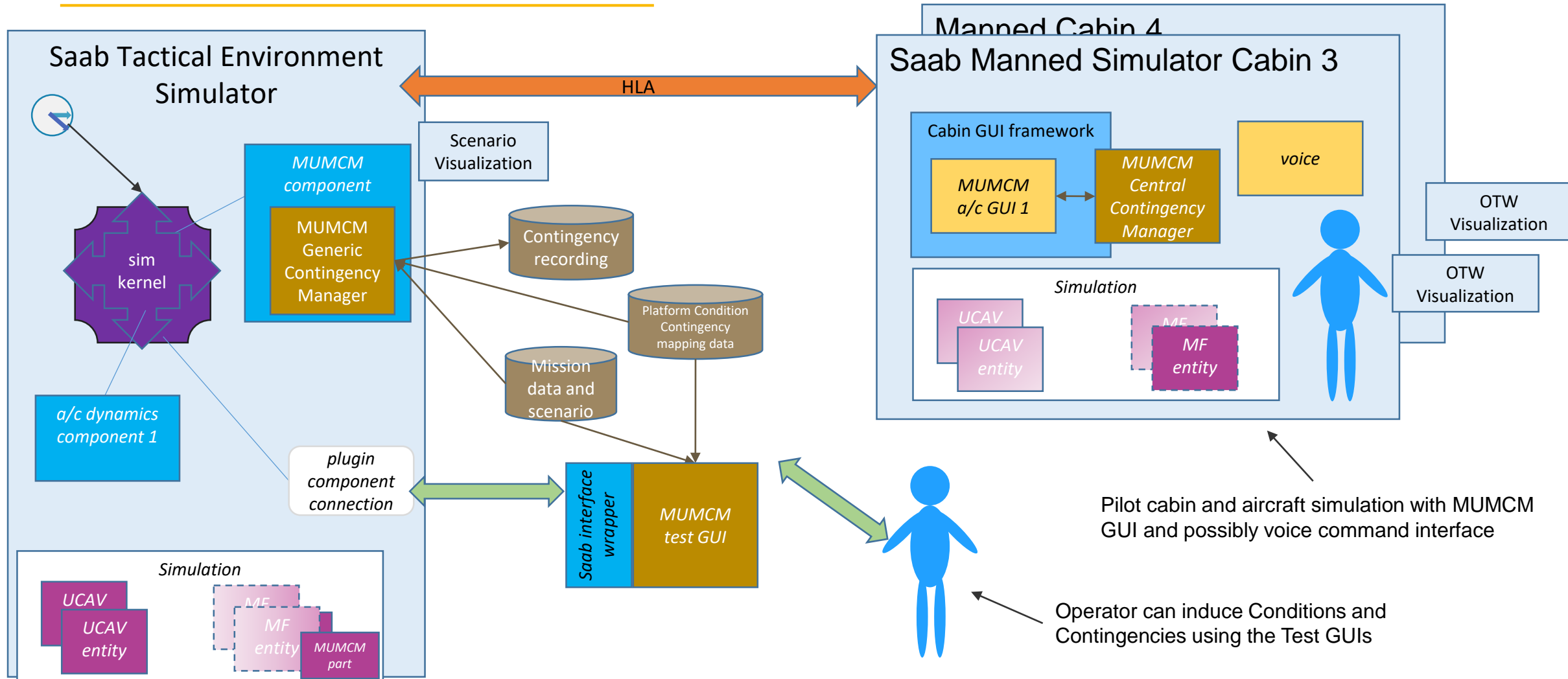


# Experiment: Legacy manned simulation and Command Modern Operation

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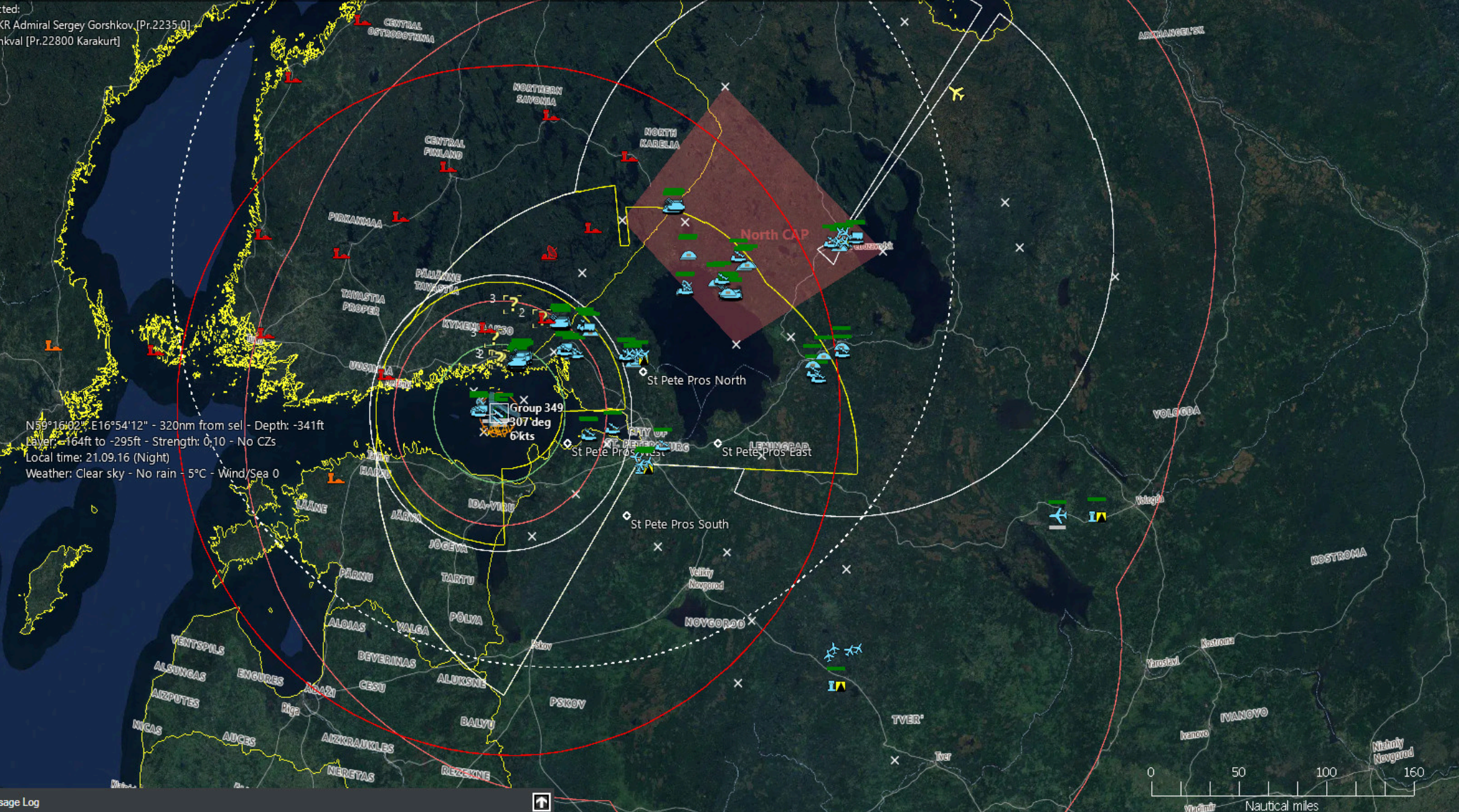
- Mission Planning and Deployment: A mission is planned to gather information on adversary's activities in given scenario (mission involves deploying an HAT)
- Human Capability Variability Sensors: Each operator in manned simulation monitored to record cognitive load, stress levels, and environmental factors. The data collected from these sensors is then transmitted to a centralized AI system to represent humans as sensors
- Mission Execution and Adaptive Decision-Making: HAT mission executed in CMO and decisions recorded
- Adaptive Resource Allocation: As the mission unfolds, the AI system identifies improvements through reallocation using The Human Capability Variability Model
- Real-time Feedback and Support: Based on the information from the Human Capability Variability Model, the AI system provides real-time feedback to each operator, offering suggestions to manage their stress levels and optimize their performance

# Manned simulation setup






Time: Thursday, 20 November 2031 - Zulu: 20:09:16 - Local: 22:09:16 - 23 hr 50 min to go - Camera Alt: 1087487m



Coordinates: N59°16'02", E16°54'12" - 320nm from sel - Depth: -341ft  
 Layer: -164ft to -295ft - Strength: 0-10 - No CZs  
 Local time: 21.09.16 (Night)  
 Weather: Clear sky - No rain - 5°C - Wind/Sea 0

**GROUP STATUS**

Group 349



Surface Group (3 units)  
 Surface Group

Group Composition:

- Shkval [Pr.22800 Karakurt] (Shkval [Pr.22800
- Shkval [Pr.22800 Karakurt] (Shkval [Pr.22800
- SKR Admiral Sergey Gorshkov [Pr.2235.0] (S

Russia  
 Course: 306.8 deg  
 Speed: 6.4 kts (Full)  
 (Reducing speed to regroup)  
 Altitude: 0 ft  
 Group Lead can slow down (group reform)  
 Aircraft: 0/0

[Edit hosted AC](#)

Status: Engaged Offensive  
 Mission: SAG (Sea Control Patrol)

Sensors Weapons

**GROUP ALT / SPEED**

GROUP

Throttle

- Stop
- Creep
- Cruise
- Full
- Flank

**GROUP WEAPONS**

- 32x SA-N-21d Growler [9M96D]
- 128x SA-N-22 Greyhound [57E6]
- 32x SS-N-27 Sizzler [3M54T Kalibr]
- 440x 12.7mm/50 MG Burst [10 rmds]
- 140x 130mm/54 A-192 Frag
- 110x 130mm/54 A-192 HE
- 230x 14.5mm MG Burst [20 rmds]
- 128x 30mm Twin Gatling Gsh-6-30KD [375
- 800x 76mm HE
- 108x PK-10 Chaff [SR-50]
- 52x PK-10 Flare [SO-50]
- 8x Paket-NK IM-15 Anti-Torpedo Torpedo]
- 12x Paket-NK [MTT ASW]
- 20000x 5P-42 Filin laser-dazzler



# Conclusions and future work

- Sensor input and subsequent actuator output can be modelled in a blackbox, unsupervised manner
- Humans modelled as sensors provides a robust way to introduce human factors
- Model lacks stochastic, irrational response and precise interpretation of intent
- Future work:
  - Investigate LLMs to use for interpretation of intent
  - Map human response to wider range of input (record data and feed to AI)



# Thank You!

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