



Mine Counter Measures: The Human-Autonomous System Balance

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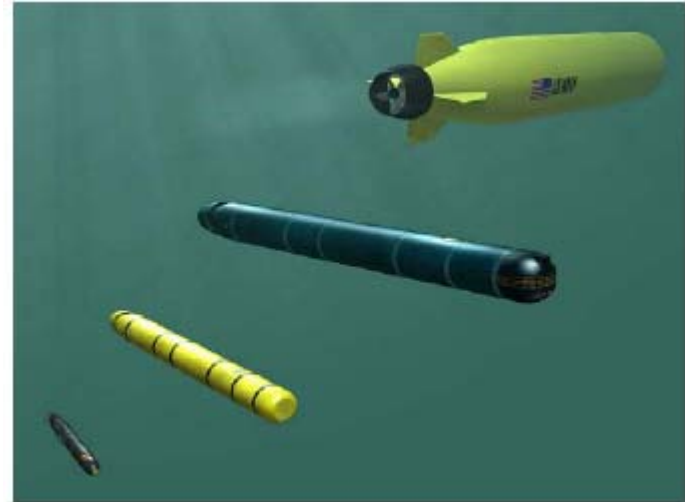
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The issue with Unmanned Vehicle Decision Making

- As technology advances Unmanned Vehicles are becoming increasingly able to act autonomously and make their own decisions.
- Confusion of terms:
 - Remote
 - Unmanned
 - Autonomous
- In an operational mission involving Unmanned Vehicles, how do we determine whether each decision should be made by:
 - A human?
 - An Unmanned Vehicle?
 - Or a combination of both?



Background to Decision Making Framework

- The Mission Planning and Decision Making theme (of the SEAS DTC) tasked CORDA with undertaking a study to investigate the allocation of decisions between humans and autonomous systems
- To respond to this requirement the Decision Making Framework was developed:

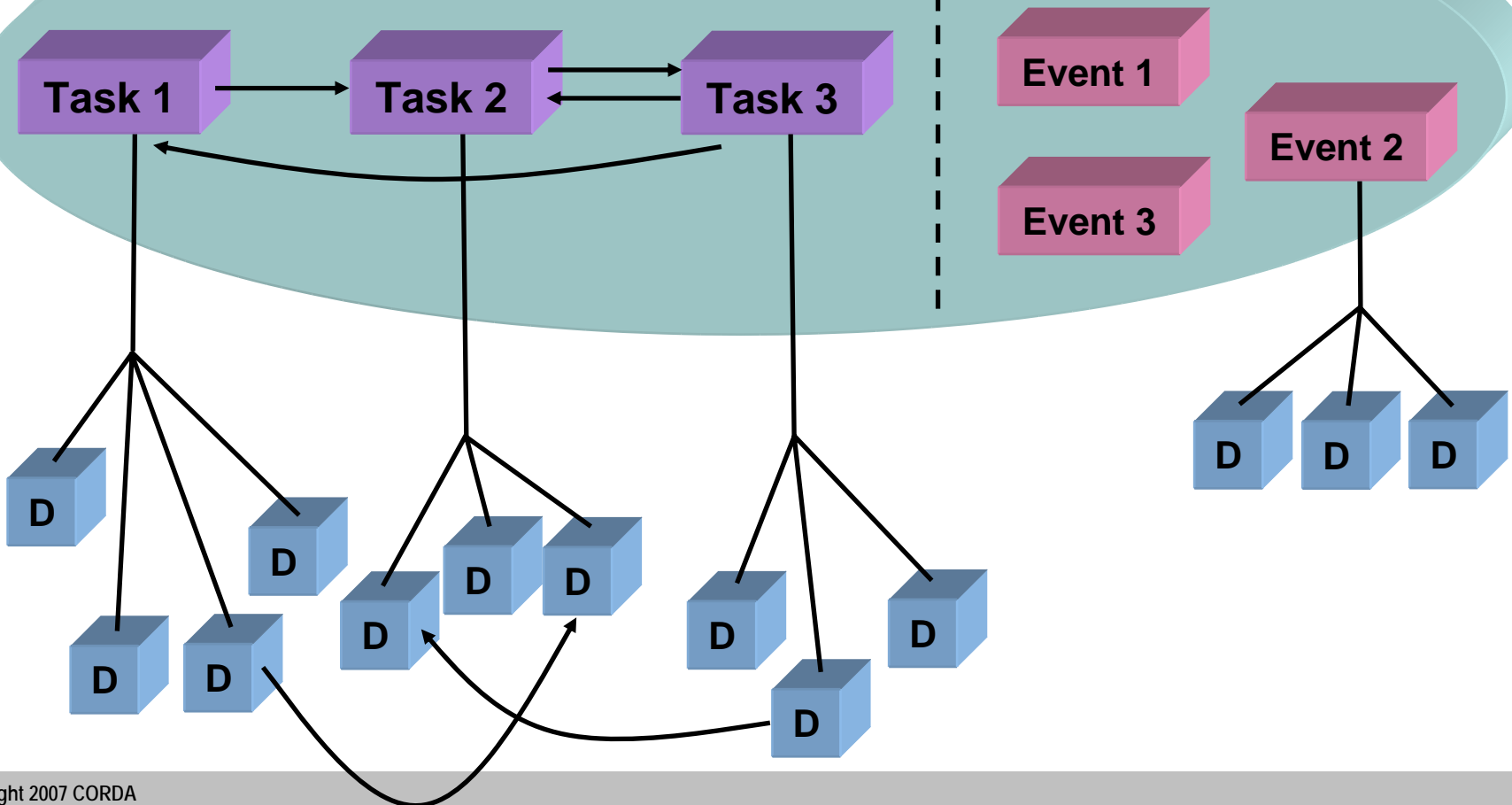
Definition of Decision Making Framework

“A construct that examines the range and types of decisions, and the relationships between them, in the planning and management of operational missions”

- Initially developed for a UAV Ground Attack Mission but can be applied to other operational missions and autonomous systems

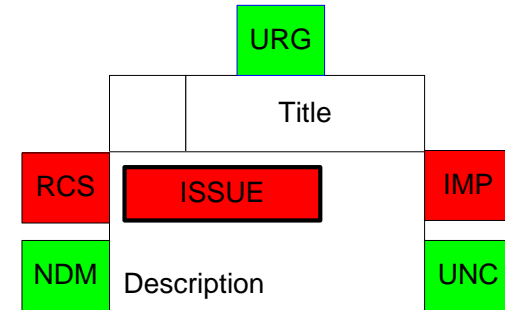
Decision Making Framework - Structure

Operational Mission



Decision Attributes

- Attributes are used to distinguish between decisions
- Explicitly represented for each decision
 - Urgency
 - Importance
 - Uncertainty
 - Complexity of decision in terms of
 - Rational Choice Strategy (RCS)
 - Naturalistic Decision Making (NDM)
- Legal issues and wider scenario impact highlighted for some decisions



Key references:

- *"Sources of Power: How People Make Decisions"* Gary Klein
- *"NATO Code of Best Practice for Command and Control Assessment"*

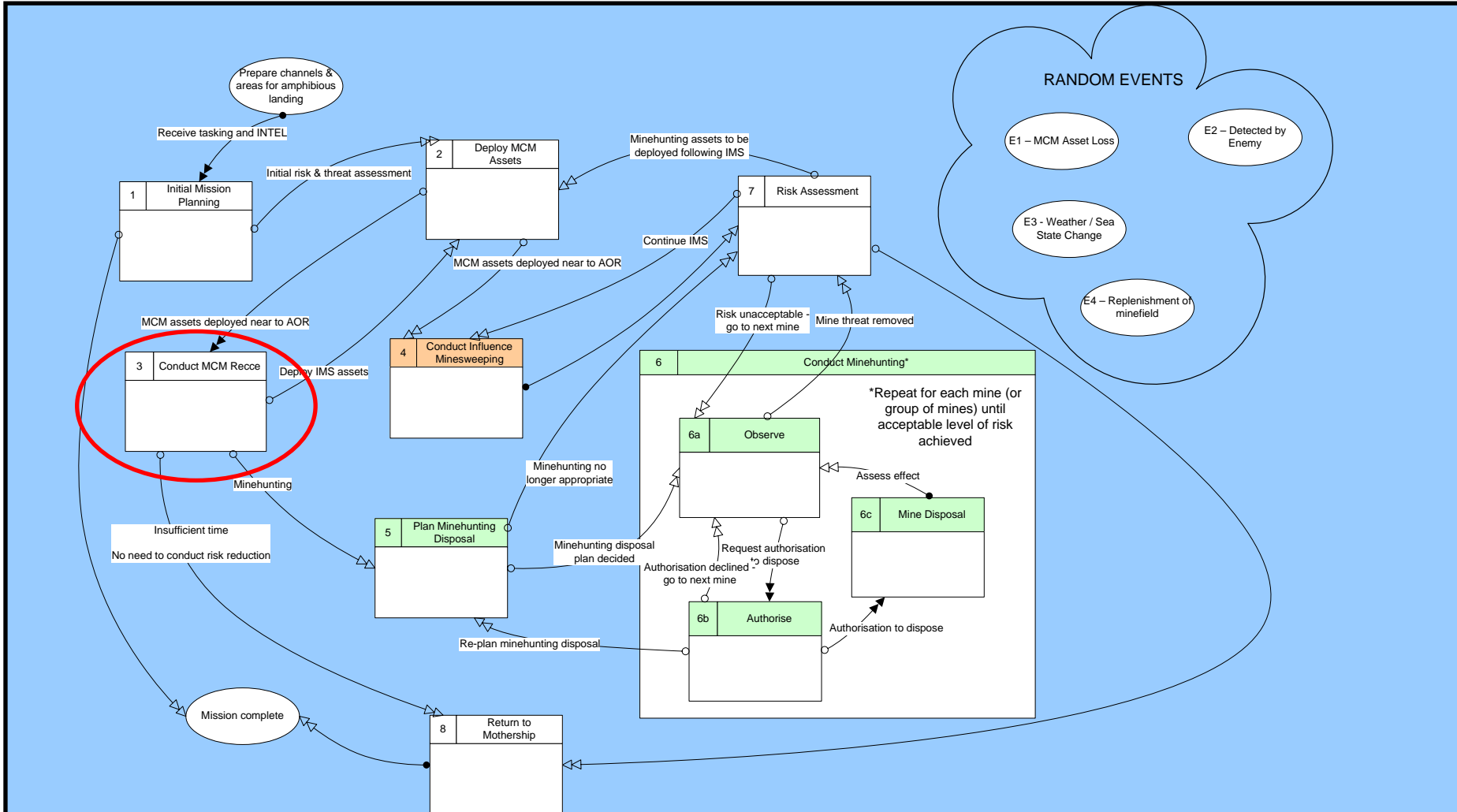
DEC(UWE) Study – TIN 30 Autonomy Levels Appropriate to MCM

- **Aim:** To evaluate the level of autonomy appropriate to a portfolio of MCM missions taking account the decision complexity and information requirements of the missions
- **Subtask 1 – Specify MCM Missions**
- **Subtask 2 – Develop DMFs**
 - Operational tasks and decisions, random events
 - Determine information requirements for each decision
 - Score attributes
- **Subtask 3 – Determine Decision Making Requirements**
 - Apply hypotheses
 - Sensitivity analysis

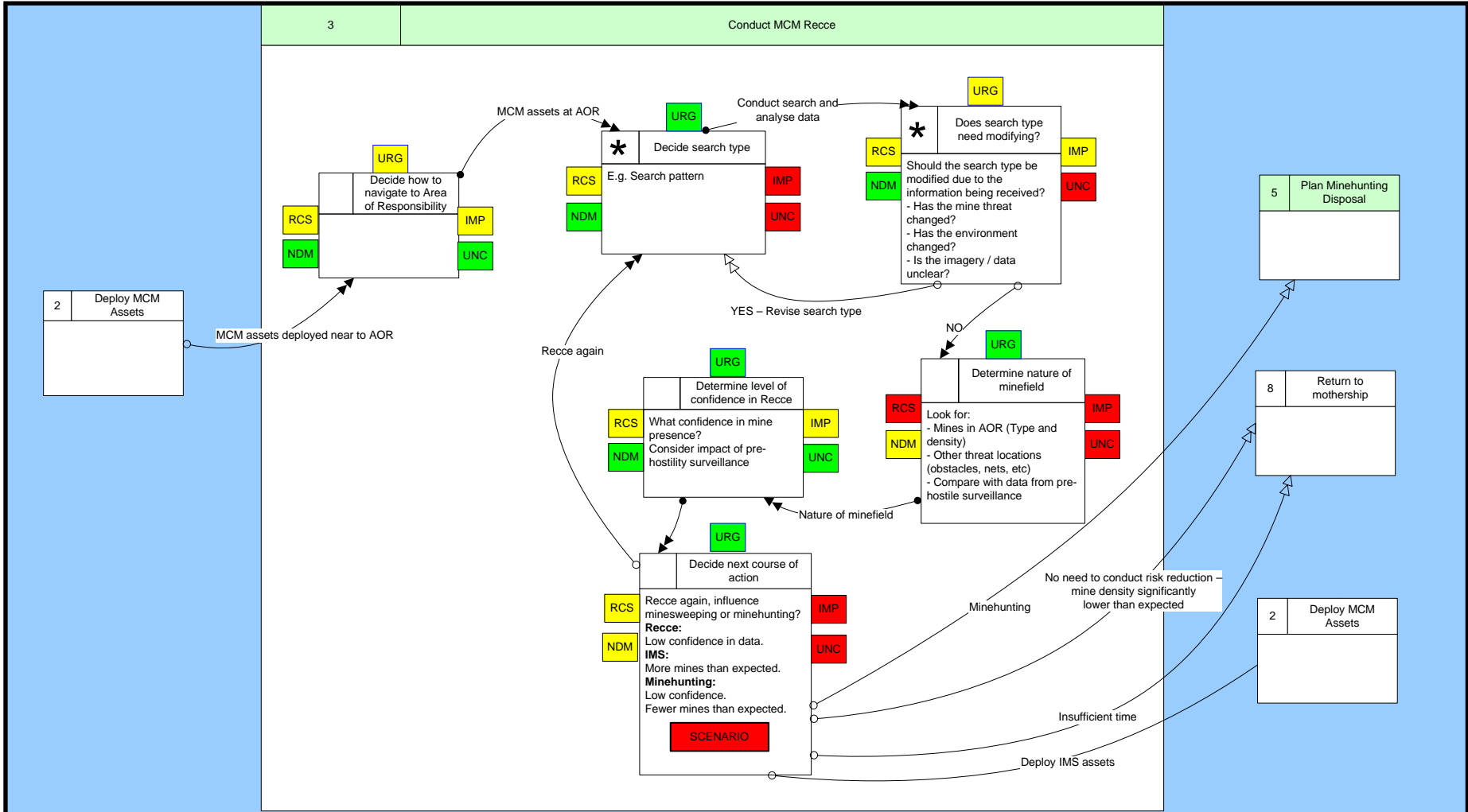
Subtask 1 – Specify MCM Missions

- Assessment of scenario information
- **Vignette 2b – Amphibious Landing in Territorial Waters**
 - Coalition forces require access to a landing area
 - OPFOR have deployed and activated mines around the VSW and sea lanes
- **Vignette 6a – Transit through a choke point in International Waters**
 - UK Task Group needs to pass through a choke point
 - OPFOR have deployed and activated mines at either end of the choke point
- **MCM forces are deployed to assess the situation and possibly provide risk reduction measures**
- **Concept: Transportable MCM UUV system – UUVs supported by a ‘Mothership’. Two types of UUV, one for detection and one for disposal. UUVs are under the control of the ‘Mothership’ which directs operations and maintains the system**

Subtask 2 - DMF Amphibious Landing (2b)



Amphibious Landing (2b) – Task 'Conduct MCM Recce'



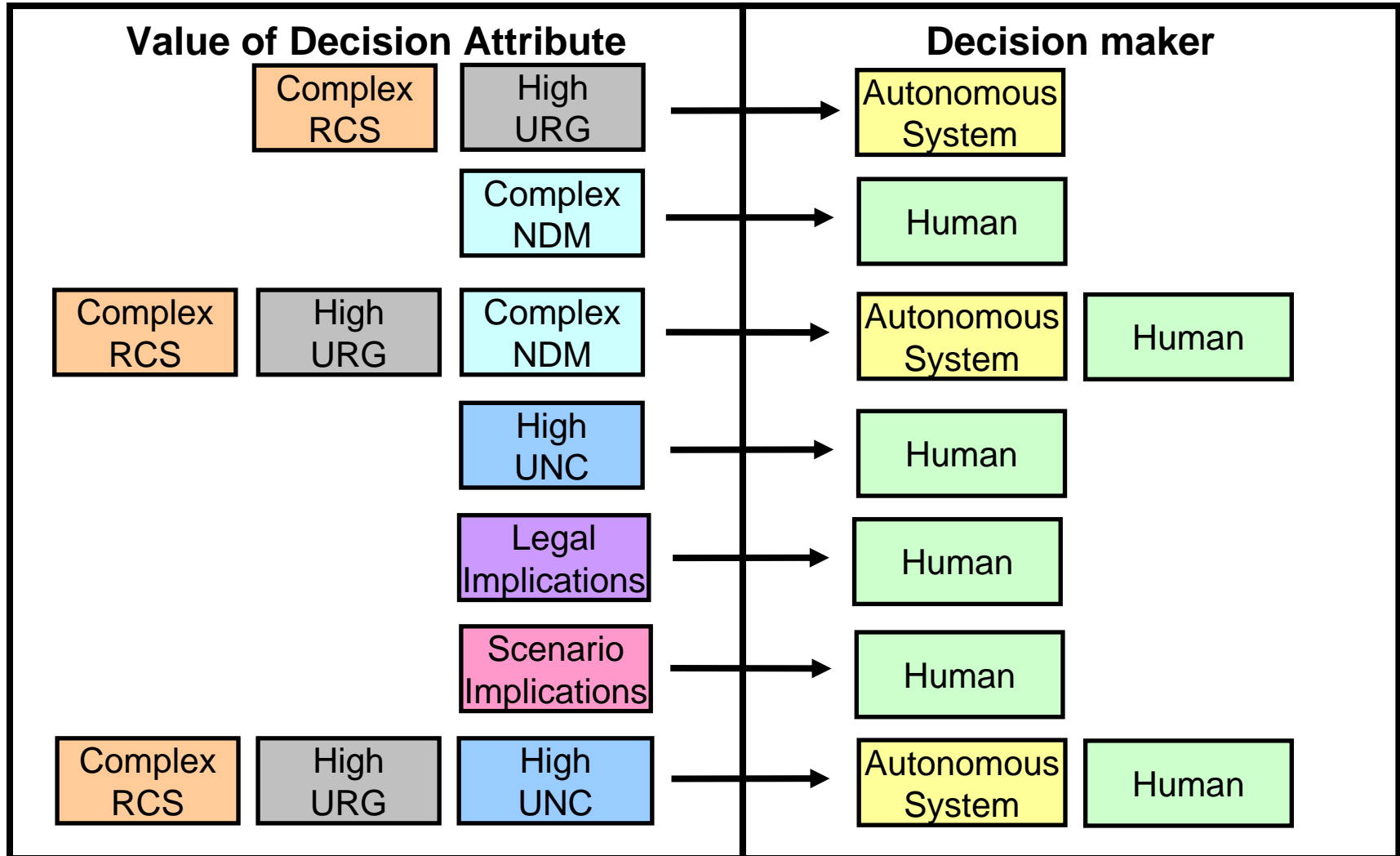
Subtask 3 – Determine Decision Making Requirements

- Decision Making Characteristics of MCM missions
- Comparison of MCM DMFs
- Determining Decision Maker (using hypotheses)
- Sensitivity Analysis
 - Impact of repeated decisions
 - Impact of pre-hostilities surveillance
 - Analysis of Underwater Communications

Decision Making Characteristics of MCM missions

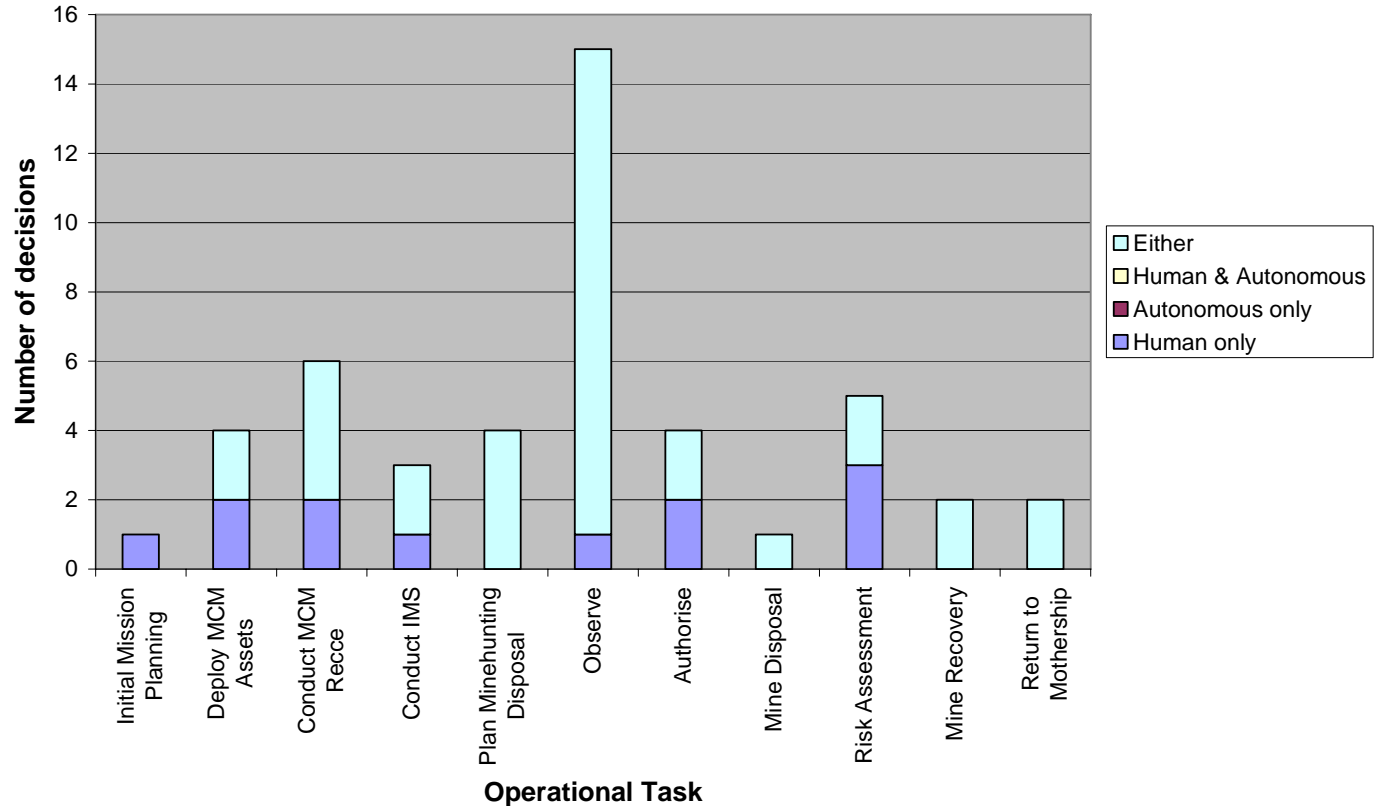
- Examined decision attributes values across both missions
- Findings
 - Due to the pace of MCM missions decisions do not need to be made that quickly
 - Due to clear objectives and constraints and well defined procedures the missions are relatively process driven
 - There are only two complex NDM decisions per mission
 - Underwater environment is the main cause of uncertainty in information
 - No legal issues
 - As MCM is an enabler, several decisions have wider scenario impact

Determining the decision maker - Hypotheses



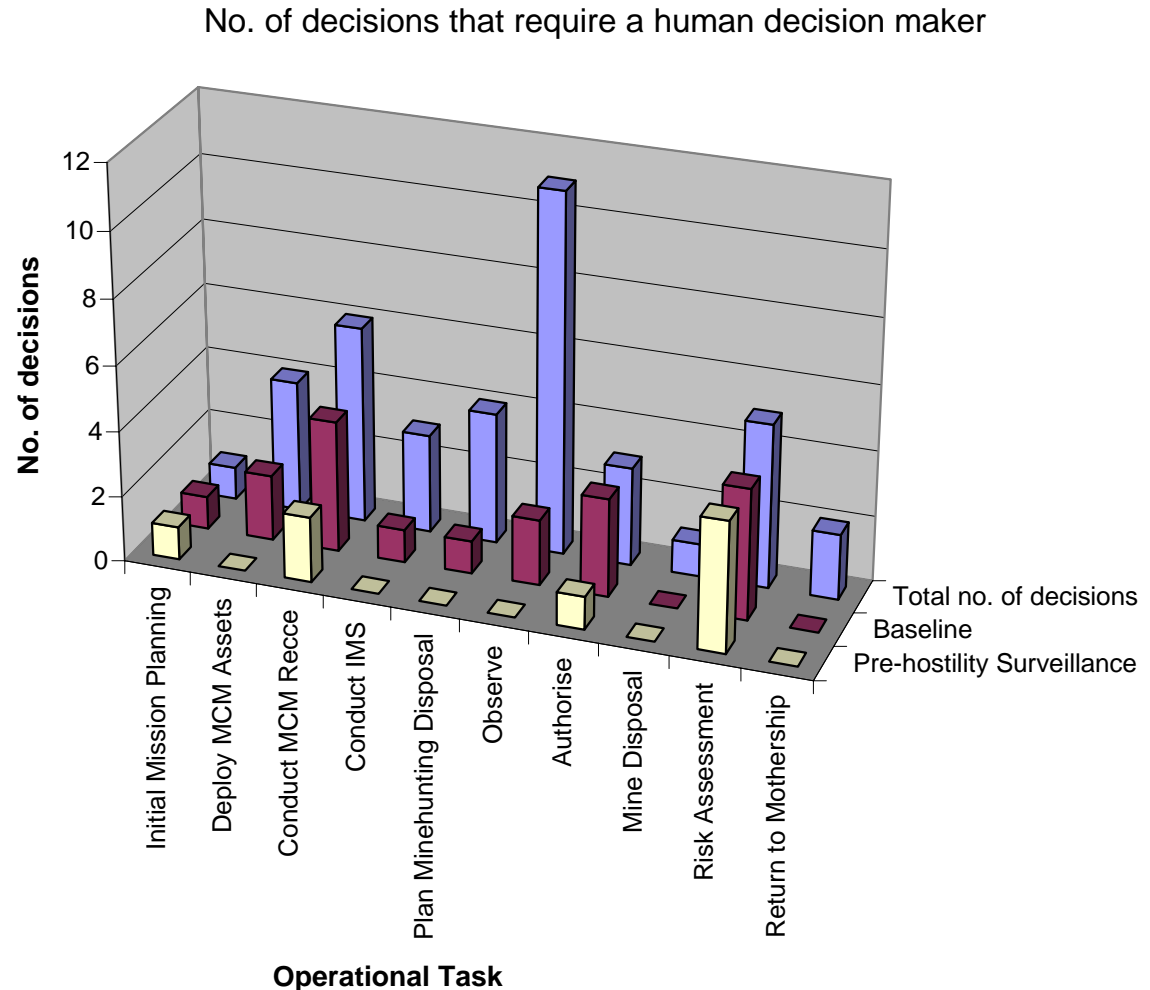
Determining the decision maker – Baseline Vignette 6a

- Most operational tasks have some requirement for a human decision maker
- Significant number of decisions that are candidates for autonomy
- Vignette 6a has fewer human decisions as lower uncertainty in environment



Sensitivity Analysis – Impact of pre-hostilities surveillance Vignette 2b

- Some reduction in uncertainty in information
- Requirement for human decision maker is now localised to certain tasks
- Results in little difference between two missions



Conclusions

- **Decision Making Characteristics of MCM missions**
 - Low urgency of decision making due to pace of missions
 - Decisions are more complex in RCS than NDM due to clear objectives and defined procedures
 - Decisions in mission 2b have a higher uncertainty in information than mission 6a due to the high clutter environment
- **Missions have some requirement for a human decision maker but also a significant number of decisions which are candidates for autonomy**
 - Mission 2b: 45% of decisions require a human, 55% candidates for autonomy
 - Mission 6a: 30% of decisions require a human, 70% candidates for autonomy
- **Pre-hostility surveillance**
 - reduces the requirement for a human decision maker
 - reduces the requirement for underwater communications to a few key decisions

Questions ?