



Autonomy Is The Answer; What Was The Question?

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Introduction and Research Aim

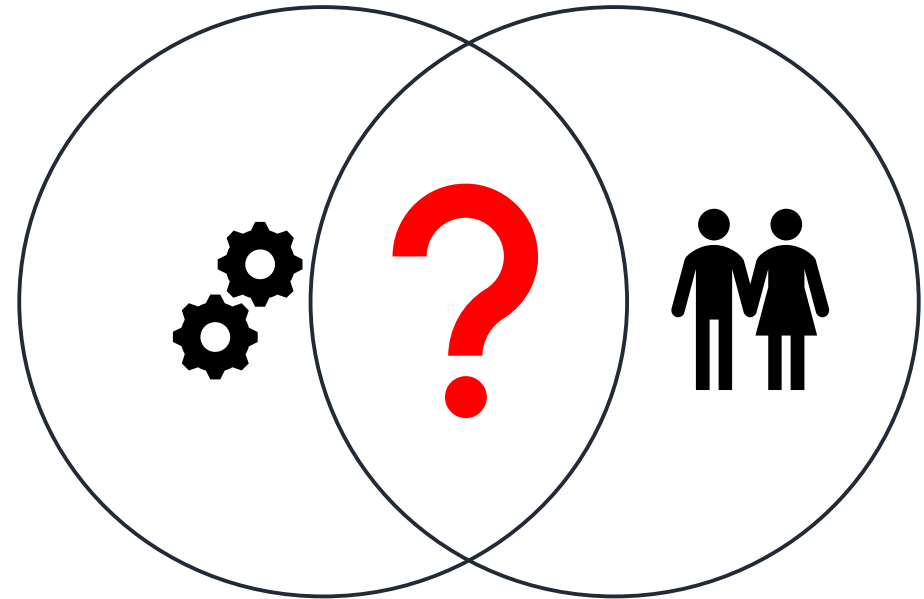
Develop an assurance framework to inform the Royal Navy how to operate Lethal Autonomous Weapon Systems safely.



Background

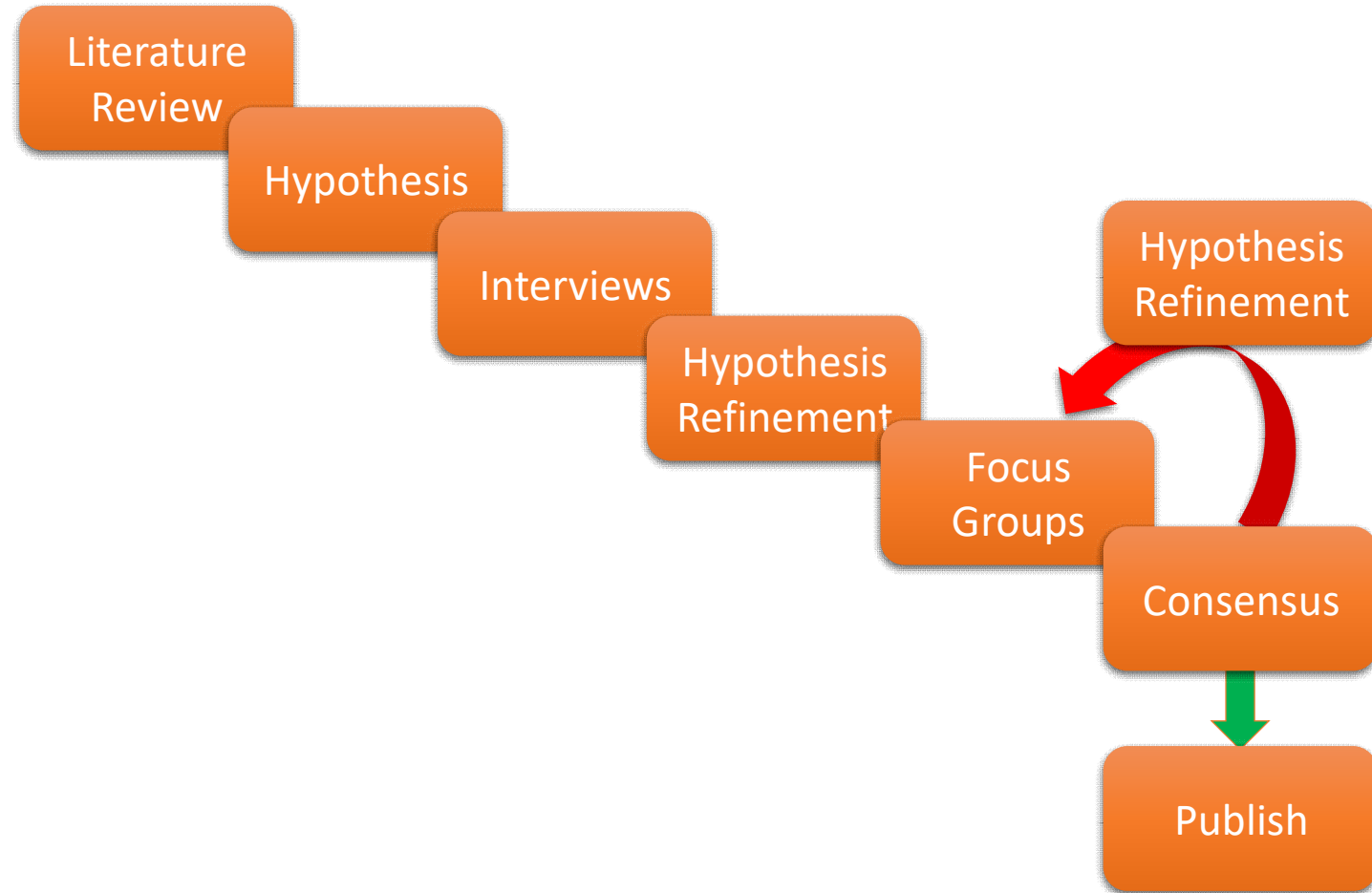
- Where does AI fit?
- Merging of Safe to Operate & Operate Safely to create
- Safe to Operate itself Safely

Lethal Autonomous Weapon Systems
(LAWS)



Methodology

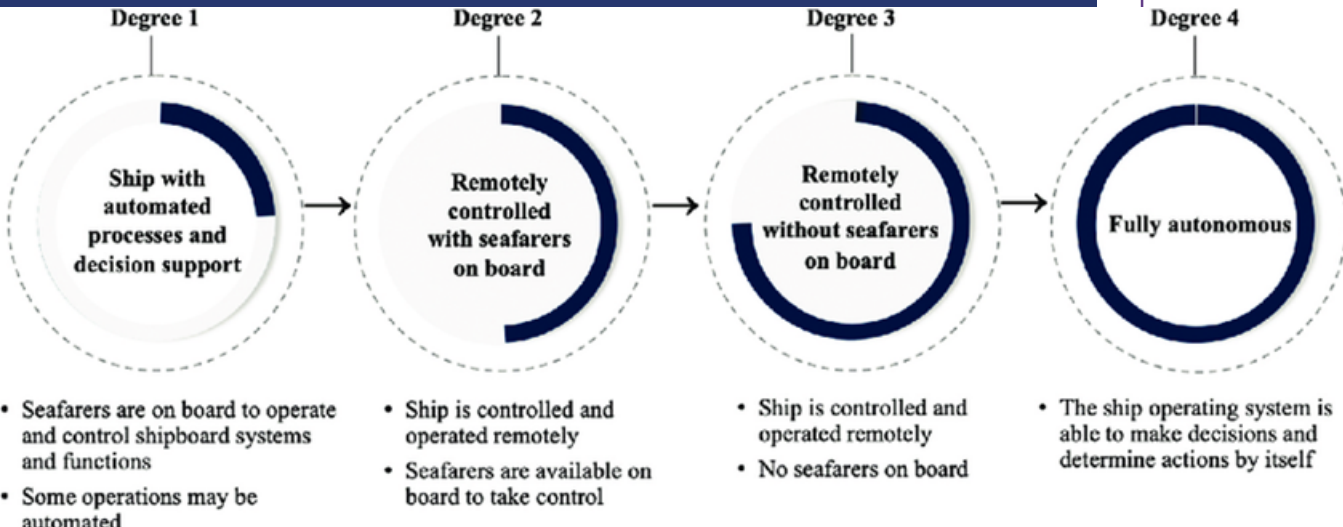
- Literature Review
- Semi Structured Interviews
- Workshops
- Framework Design and Testing



Literature Review

Defining 'Autonomous'

IMO Levels of Autonomy



Distinction	Description
Manual	A Manual Process
Automatic	A Mechanical or Electrical Cause and Effect
Automated	A sensed state informs software triggering a predefined output(s)
Autonomous	<p>A trained AI model analyses complex data from a fusion of sources and produces an output state that is unmappable to its input.</p> <p>Outputs may be unpredictable and can change based on input and contextual differences that are unrecognisable to human analysis.</p> <p>The output is very 'human' when comparing decision making and judgement calls in live situations compared to simulated training environments.</p> <p>(Car drivers may do silly things for unpredictable reason)</p>

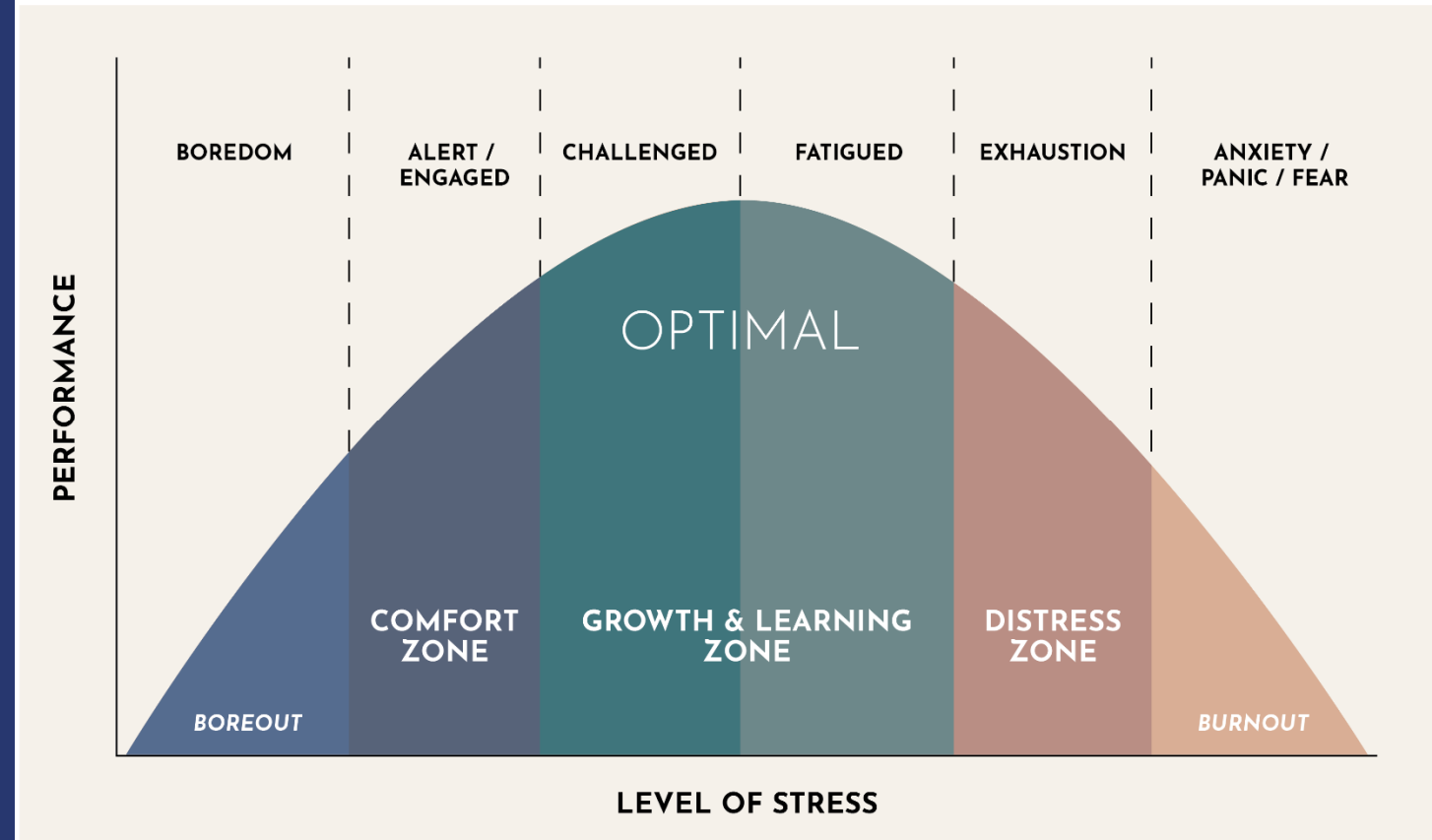
Literature Review

Autonomy is a STATE not a
CAPABILITY

Degree	Description
Manual	Manually Operated (Locally)
Remote	Manually Operated (Remotely)
Assisted	Very low level automation Eg. Cruise Control Considered Automatic
Partial	Increased automation with multiple inputs E.g. Adaptive Cruise Control Considered Automated
Conditional	AI based autonomy operating in restrictive environmental conditions. E.g. AI driven vehicle on a race track Human Override available
High	As above but operating in the world Human Override available (rarely needed)
Full	As above No human interaction required or possible

Literature Review

Yerkes-Dodson Law



Literature Review

Complexity x Autonomy



		Risk to Life				
		High	Med	Low	Med	High
Autonomy	Manual	High	Med	Low	Med	High
	Assisted	High	Med	Low	Med	High
	Partial	Med	Low	Low	Low	Med
	Conditional	Low	Low	Low	Low	Low
	High	Low	Low	Med	Low	Low
	Full	Low	Med	Med	Med	Low
		Benign (Boring)	2	3	4	High Stress (Danger)
		Complexity				

Table 3 – Autonomy / Complexity Risk Matrix

Literature Review

State Zero



State	Description
High Action (Uncrewed) 0	Utilised for very high risk operations, allowing a vessel to safely engage in combat where mass casualties would be expected.
Action (Crewed) 1	All positions locally crewed ready to respond to enemy action. Only sustainable for short periods.
Defence (Crewed) 2	50% closed up, ready to defend from enemy action. Due to internal crew rotation it is possible to sustain for long periods.
Cruising (Crewed) 3	General sailing, like civilian ship operation
Quiet Cruising (Uncrewed) 4	Uncrewed sailing, for very low risk and monotonous tasks, to better employ bored crew off ship.

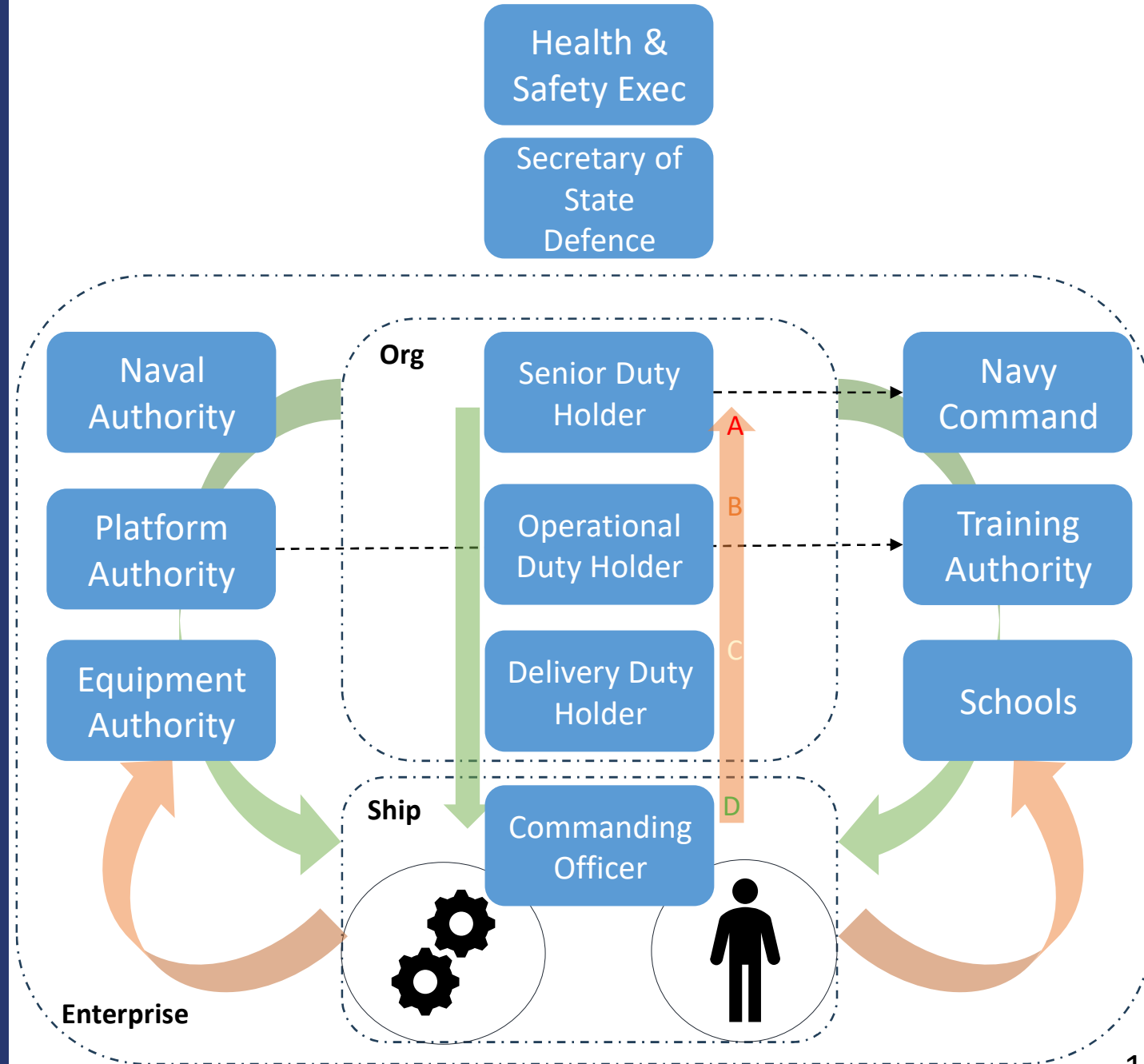
Literature Review

Risk Management



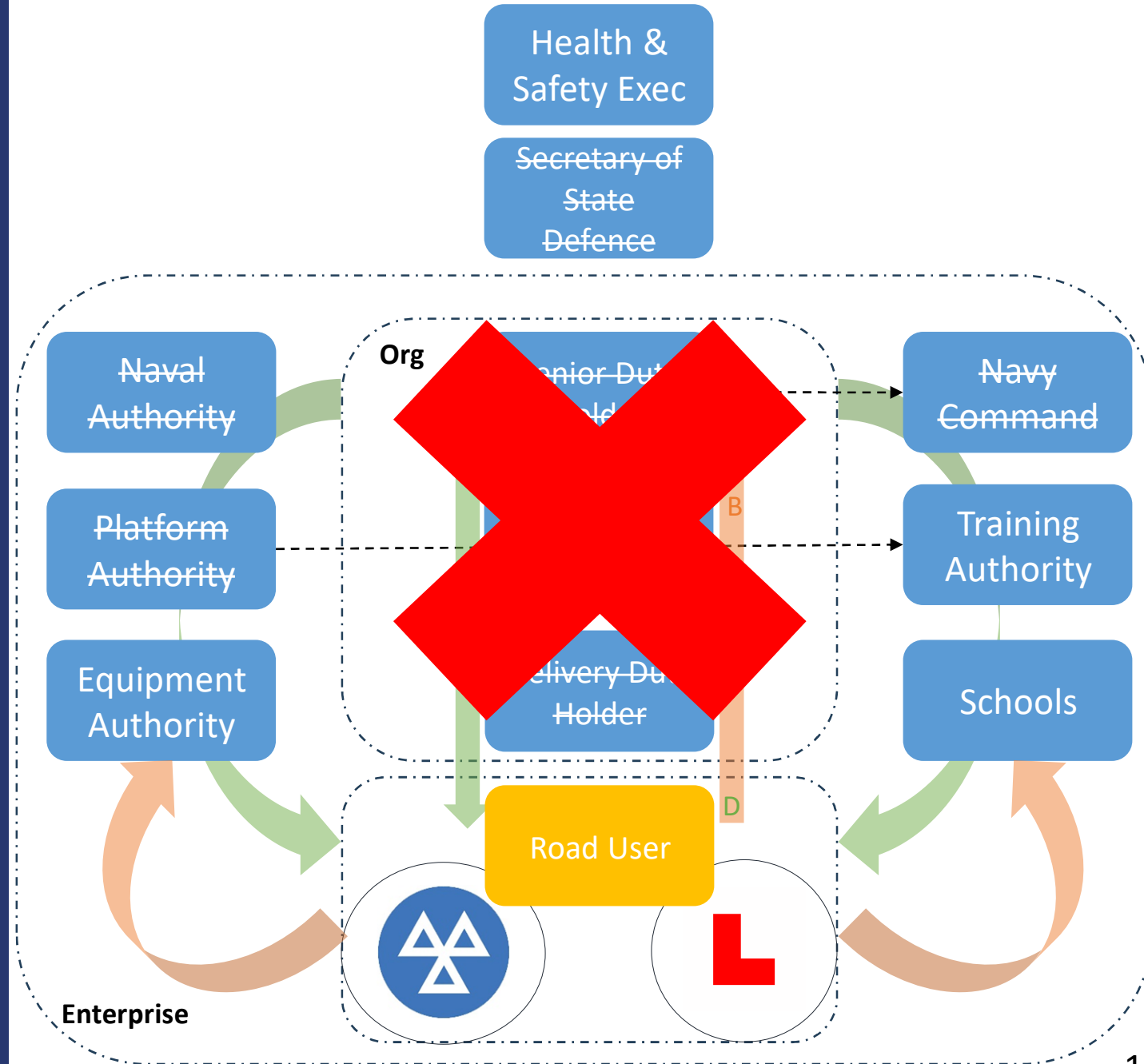
Literature Review

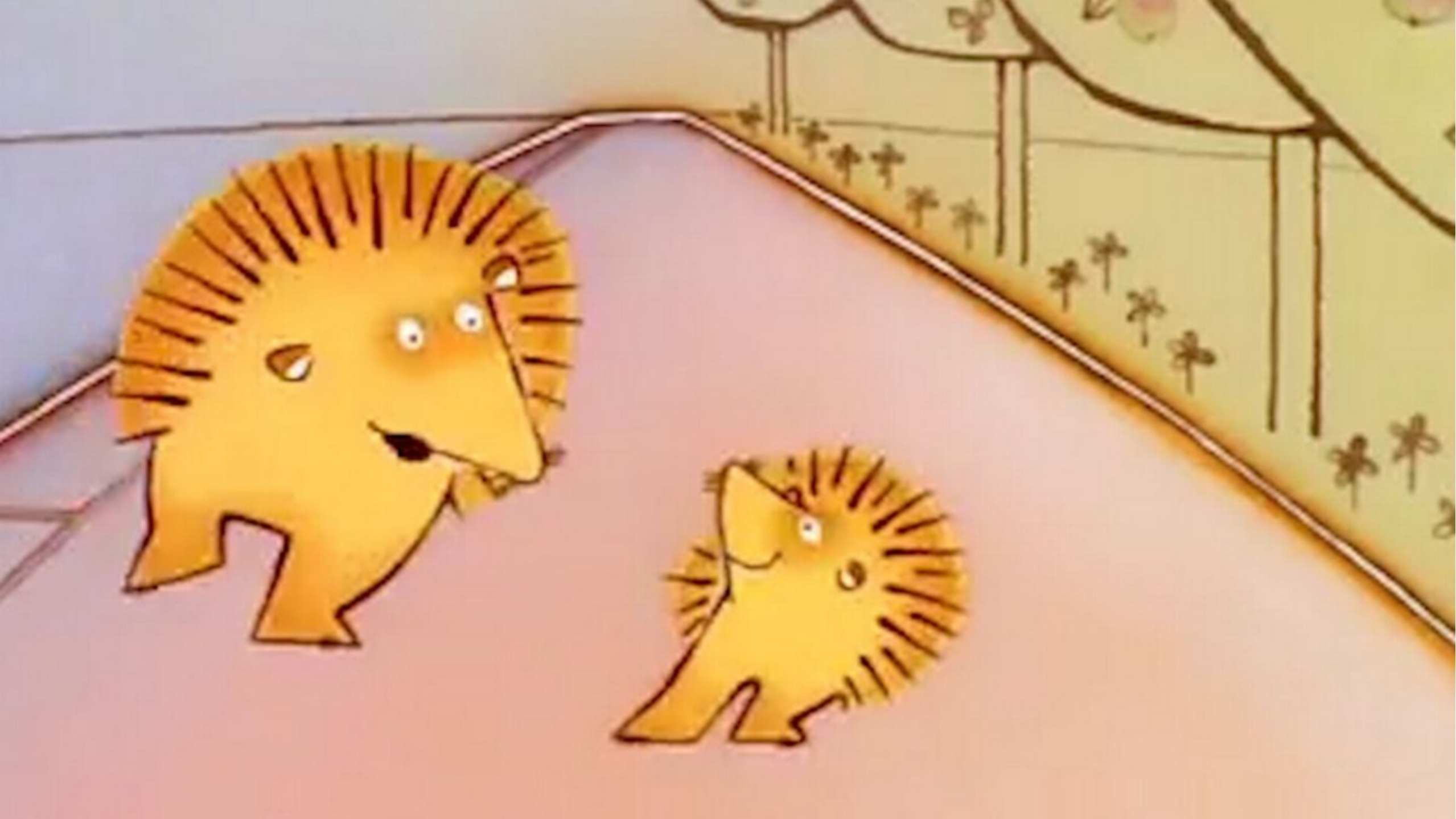
The Duty Holder Construct



Literature Review

The Duty Holder Construct

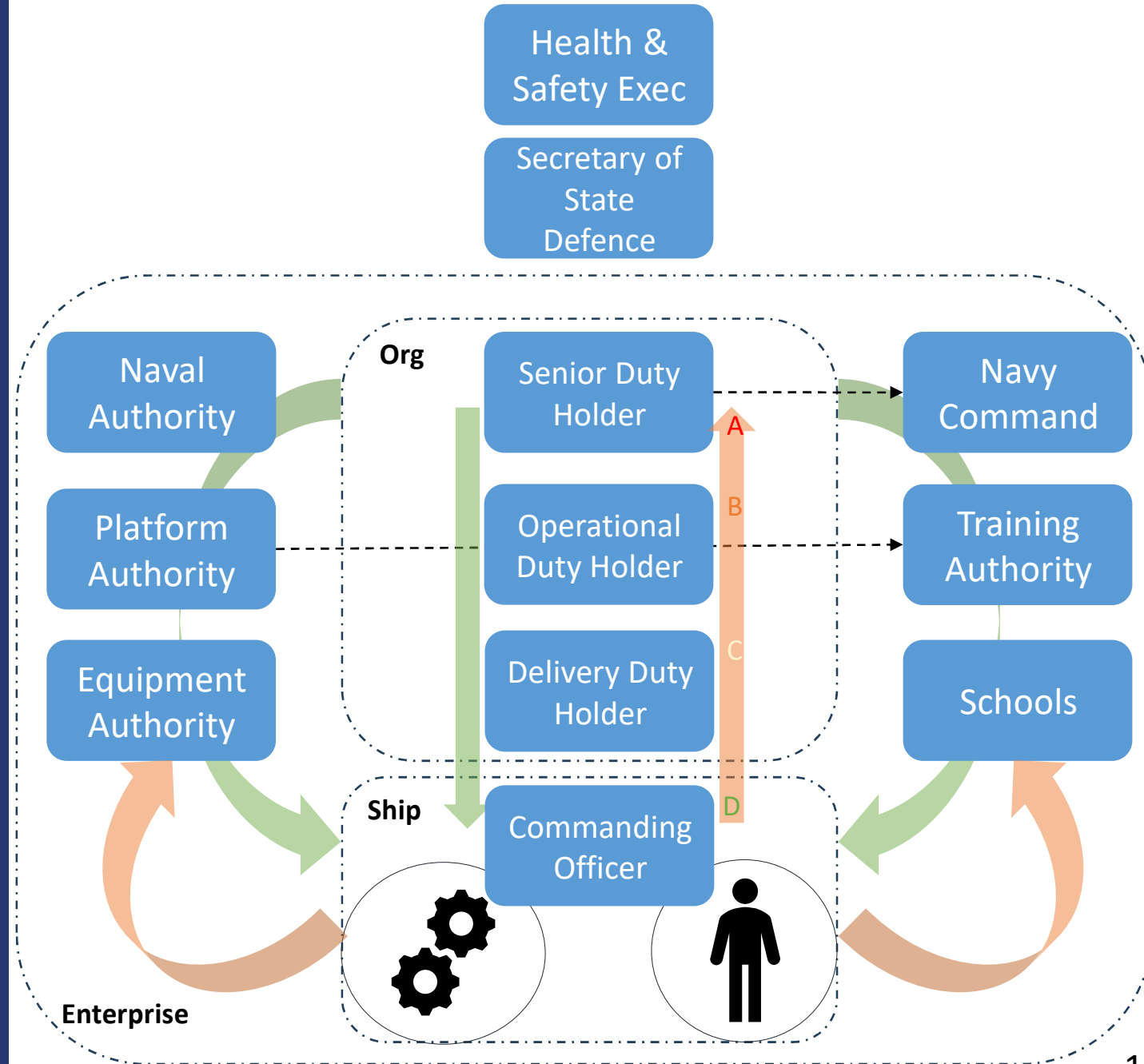




Literature Review

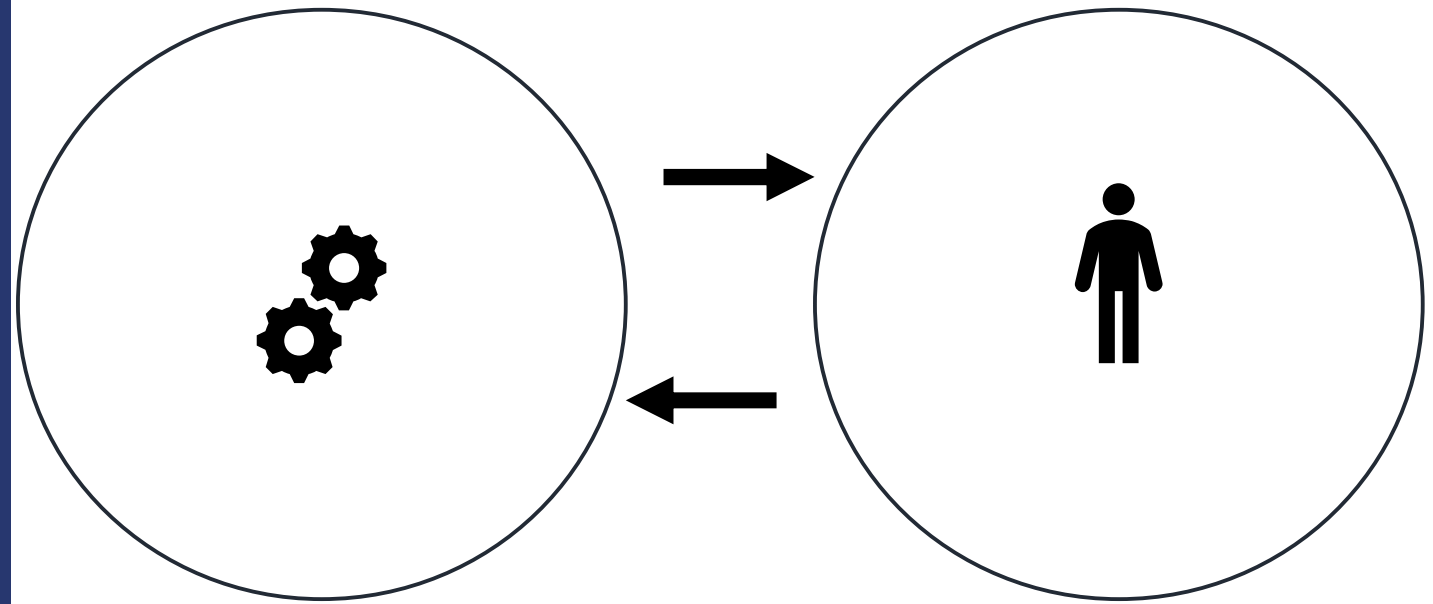
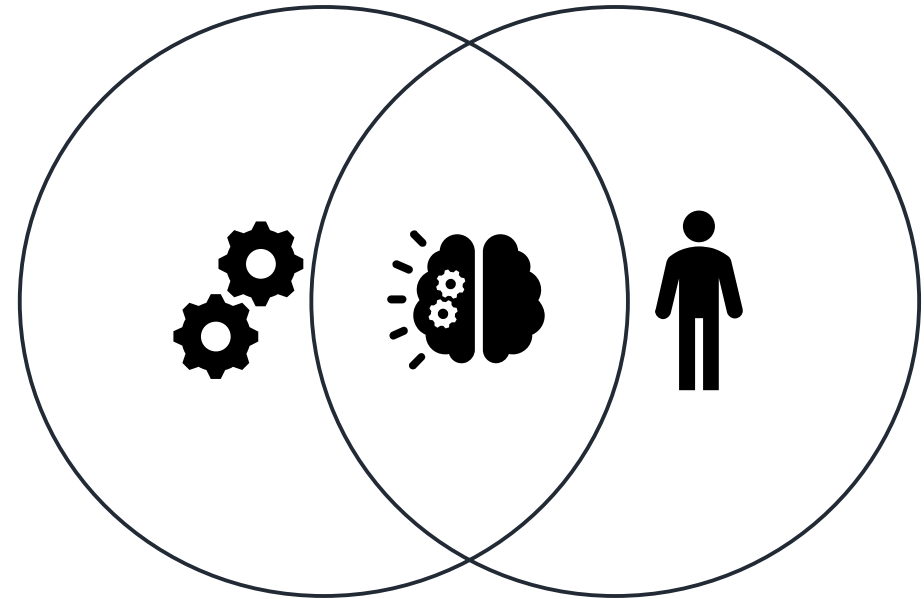
The Duty Holder Construct

AI Governing Authorities?



Safe to Operate Itself Safely Framework

Safe to Operate + Operate Safely
=
Safe to Operate Itself Safely



Safe to Operate Itself Safely Framework

Why do you **NEED** an autonomous system?



Solutions ▾

About ▾

Insights ▾

Home → Insights →

UK cancels Mosquito 'loyal wingman'

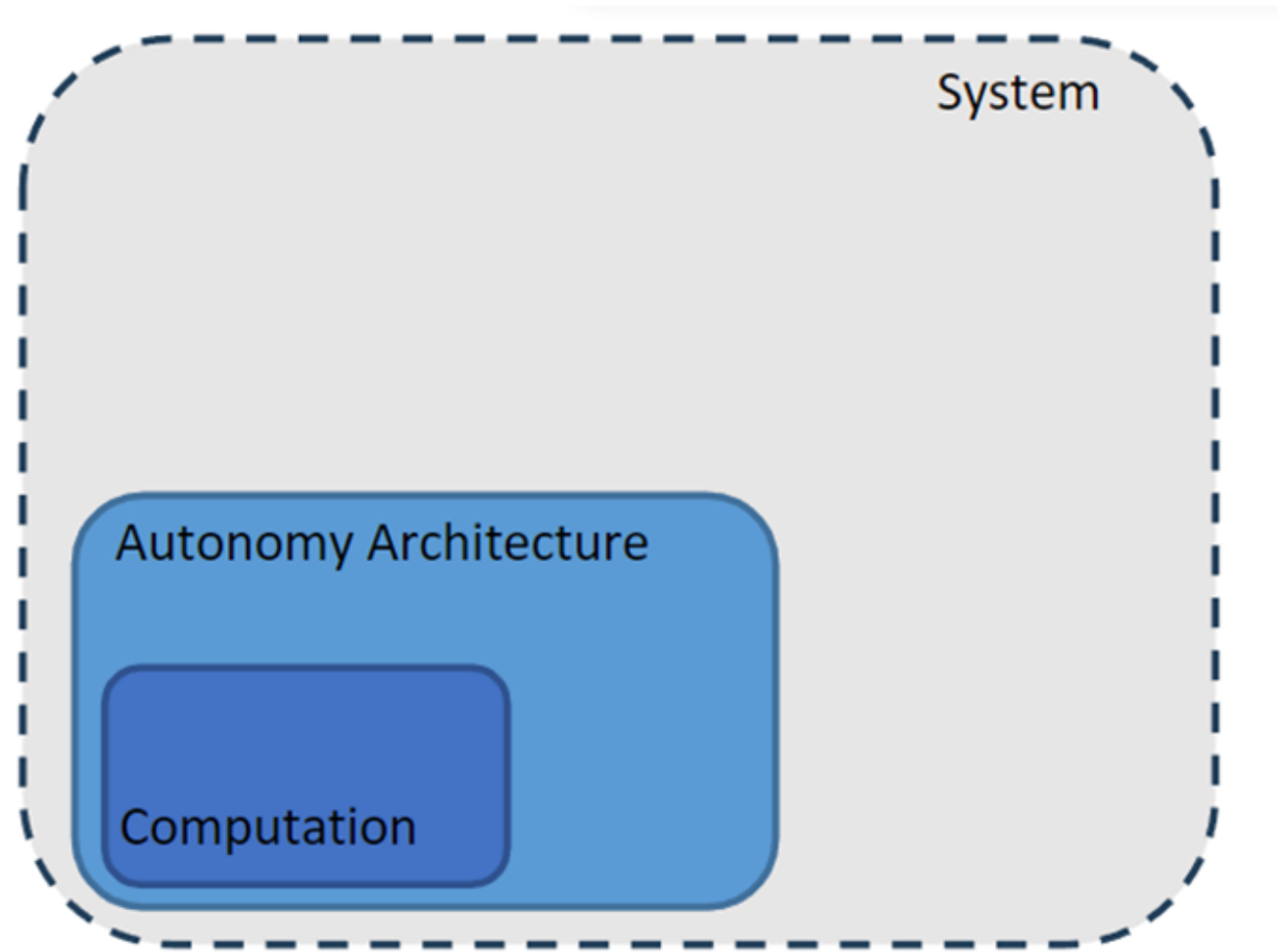
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Safe to Operate Itself Safely Framework

Assuring Autonomous Systems

1. Computation (There could be Billions!)
2. Software Architecture and AI Model(s)
3. The System (Platform)



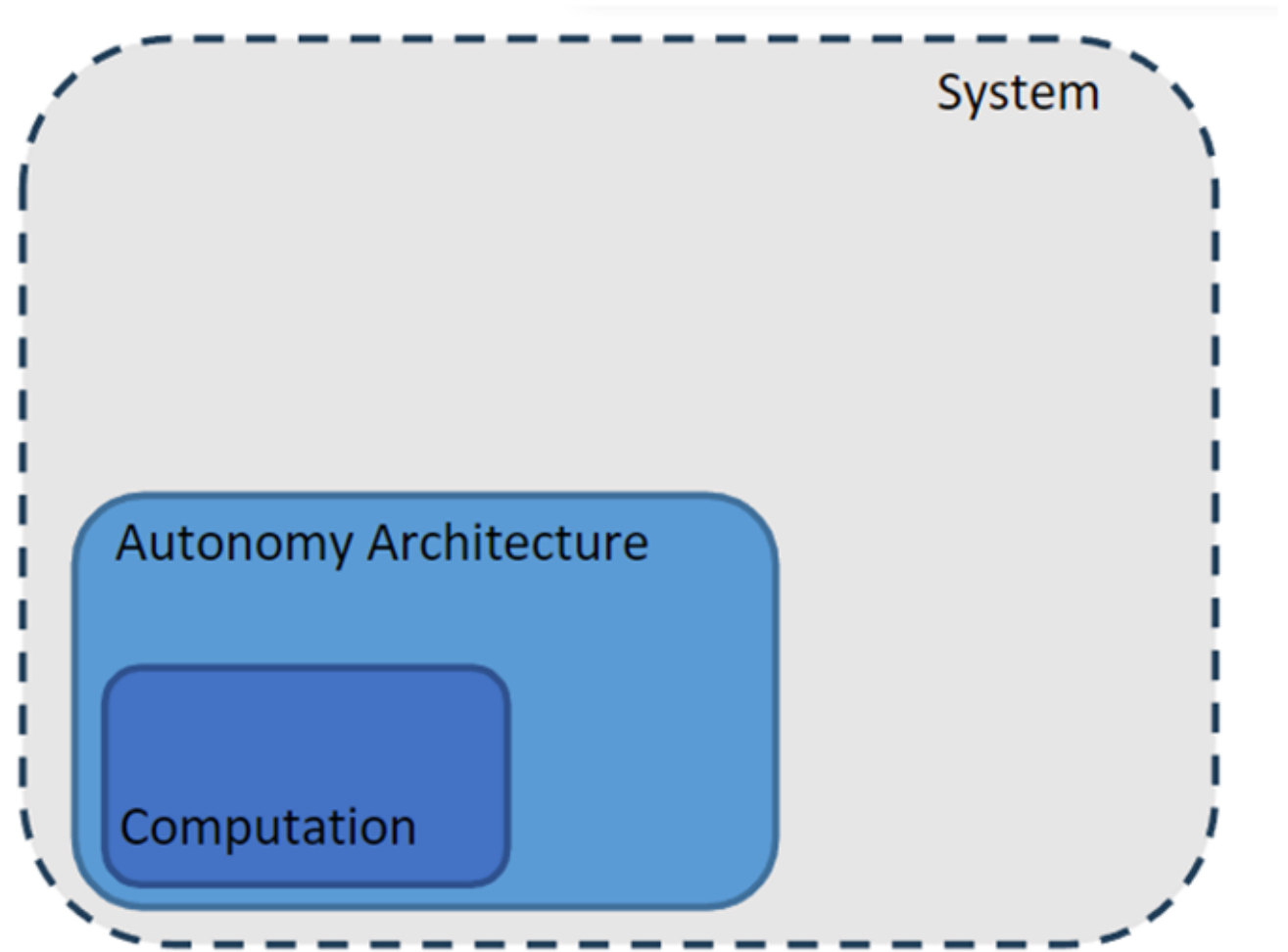
Safe to Operate Itself Safely Framework

ALTA Framework

(Assessment List of Trustworthy AI)

'TOPHEAD'

1. Technical Robustness
2. Oversight
3. Privacy
4. Human Agency
5. Explainability
6. Accountability
7. Diversity, Social and Environment



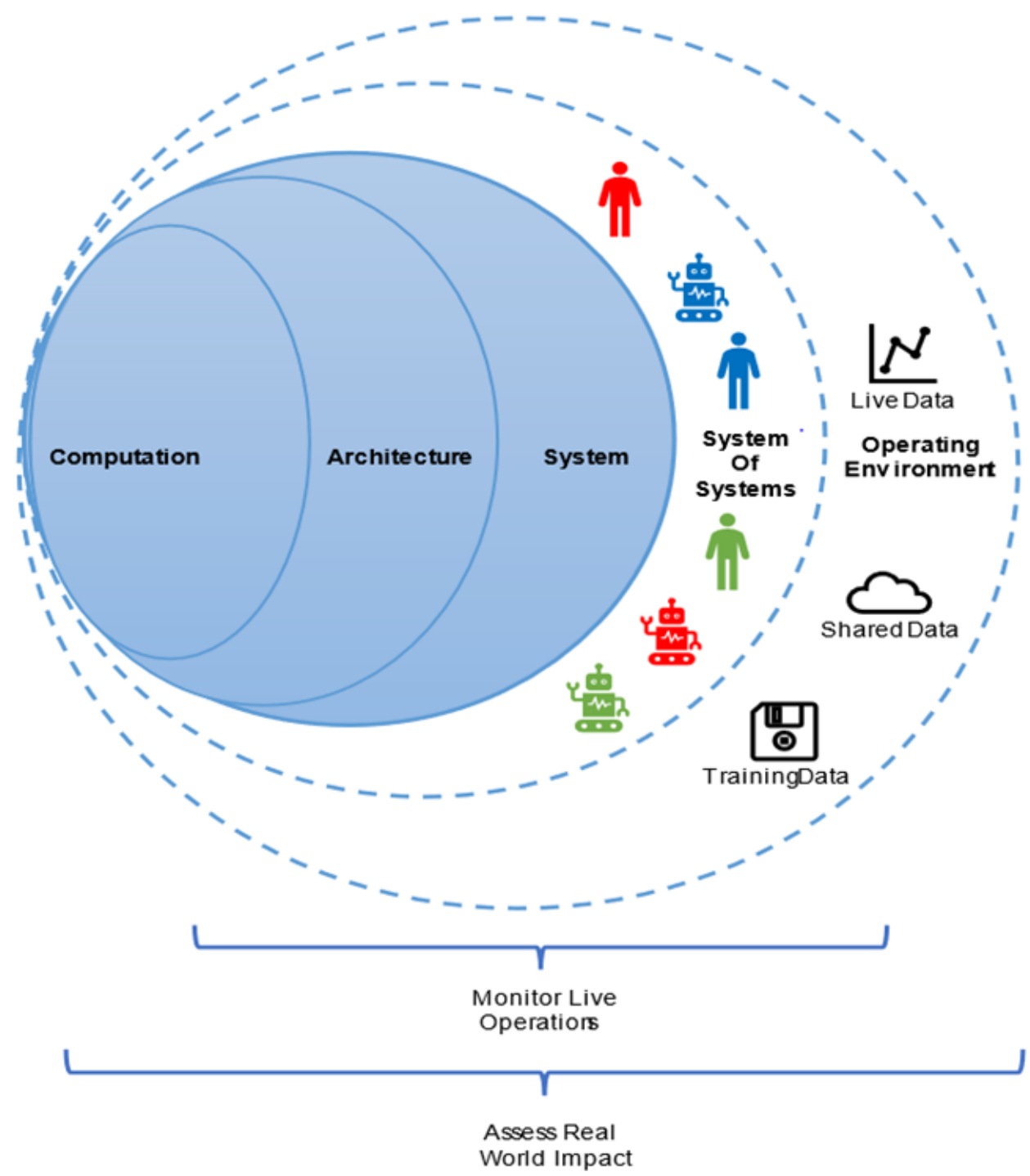
Safe to Operate Itself Safely Framework

ALTA X TEPIDOIL+

TEPIDOIL+

1. Training
2. Equipment
3. Personnel
4. Information
5. Development
6. Organisation
7. Infrastructure
8. Logistics

+ Integration, Safety, Climate Change,
Security, Regulation, TEVV, 3rd Party,
Political Social & Economic, Commercial,
Financial



Safe to Operate Itself Safely Framework

Interim accreditation only. But reliability is visually indicated.



Safe to Operate Itself Safely Framework

Multi Layer Assurance Model

Reverse Engineered

Layer	Description
-2 Computation	Identify and assure all computations (not practical)
-1 Architecture	Define the system architecture
0 Platform	Establish system boundaries
1 System of Systems	Identify intended and unintended SoS nodes
2 Operating Environment	Define Operating environment and data sources
2a Data	Assure and validate all data sources, especially training data
3 Deployment	Implement live monitoring, test and adjust based on feedback
4 Real World Impact	Evaluate the systems real world impact

Safe to Operate Itself Safely Framework

PREPATION

CARTOGRAPHY

ASSESSMENT

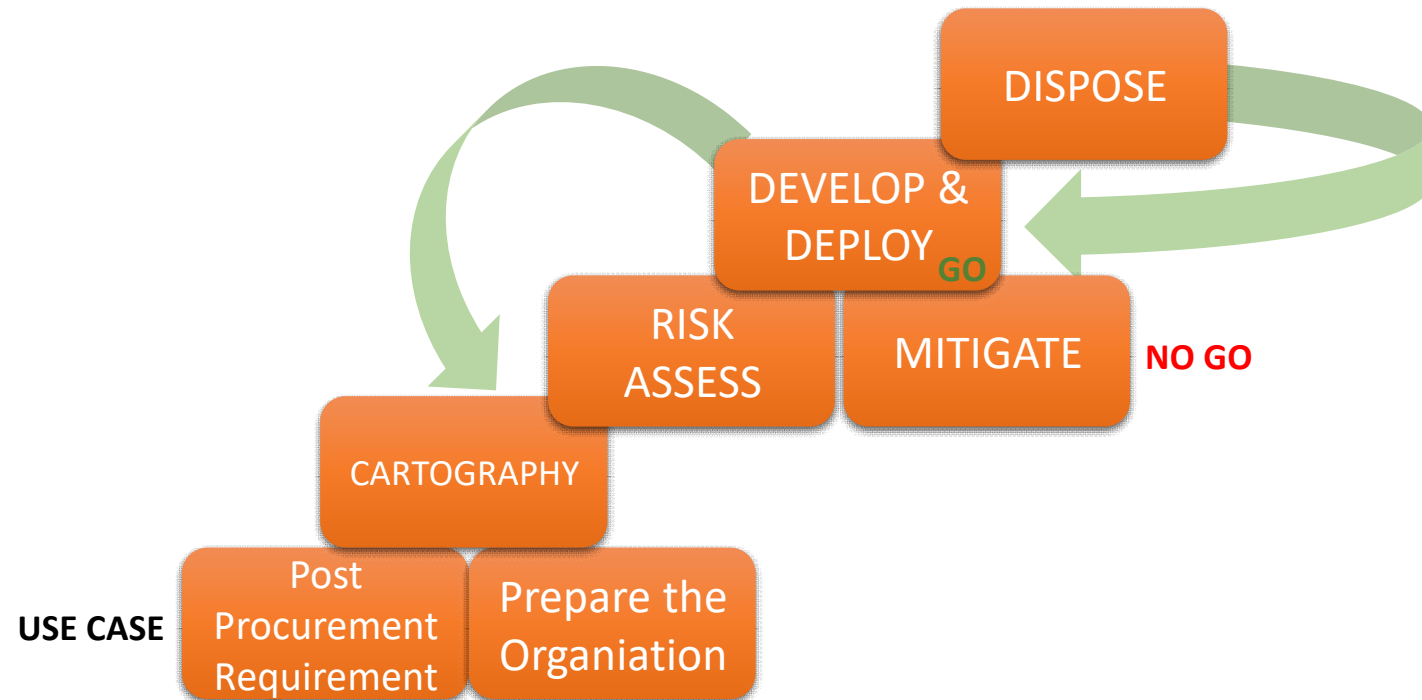
DECISION

MONITOR

DISPOSAL

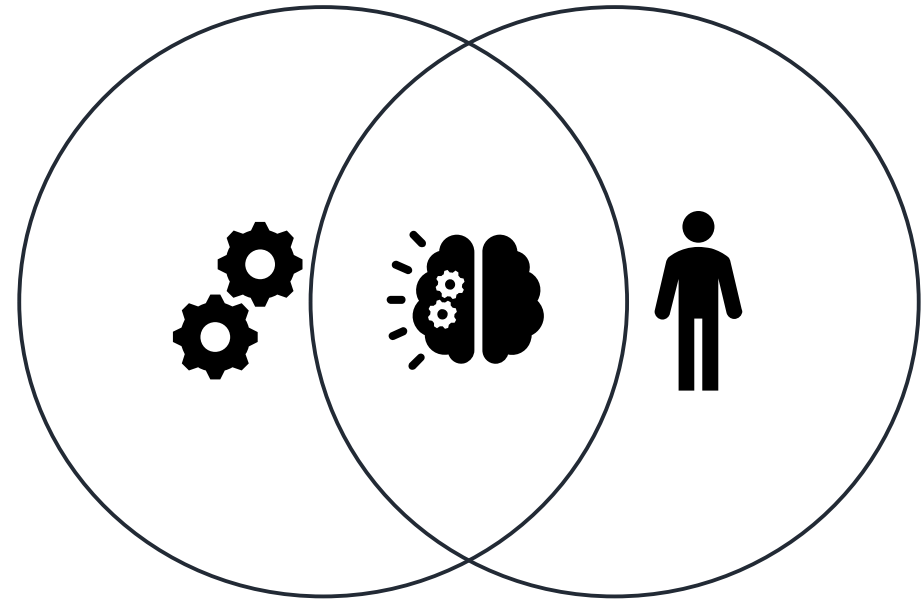
Layer	Description
1.1	Prepare requirements and procure
1.2	Prepare the organisation
2	Map requirements and broader requirements
3	Assess known and predicted risks in 3 dimensions (Autonomy level and controllability is the third dimension)
4	Go/No Go (Is Autonomy viable)
5	Active monitoring for Development, Model Training and Deployment
6	Disposal, Emergency and Planned. Figure out how best to recycle data.

Safe to Operate Itself Safely Framework



Conclusion & Discussion

- Autonomous Systems are more than
 - Safe to Operate &
 - Operate Safely
- Avoid the creation of a cottage industry
- Autonomy is not a complete solution
- Autonomy is a STATE not a CAPABILITY



Acknowledgements

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Interviewees from:

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Alan Turing Institute

& Industry Partners





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