11th ICCRTS
Coalition Command and Control in the Networked Era Workshop

26th September 2006
Cambridge

'Impact of Cultural Attributes on Decision Structures and Interfaces

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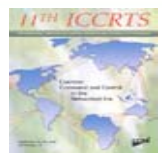


Overview of Presentation

- Autonomous v Automated Systems
- Culture/cultural values/cultural attributes
- The project: hypothesis, aims & challenges
- Examples of work in progress
- Conclusions and future work

Automated V Autonomous Systems

- Oxford English Dictionary defines AUTOMATION as

"the use of electronic or mechanical devices to replace human labour"

- Oxford English Dictionary defines AUTONOMY as

"the condition or quality of being autonomous, independent …… self governing…"

DTC project is concerned with Semi/Autonomous Systems

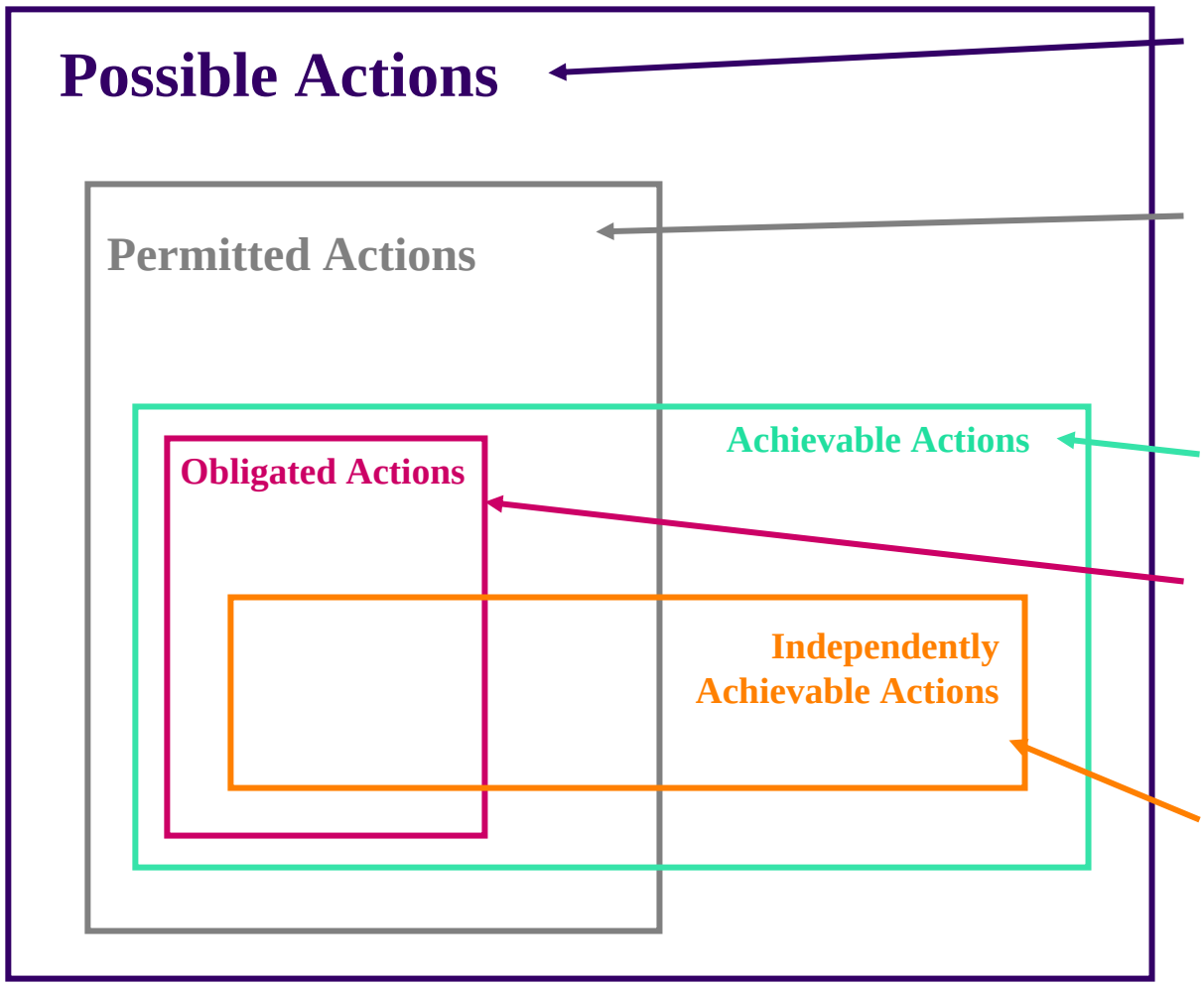
- which could comprise combinations of human (non-technical) and technical sub-systems & components

Autonomy: the Locus of Control & Decision Making

- The computer offers no assistance, human must decide all
- The computer offers a complete set of action alternatives
- *And* narrows the selection down to a few, *or*
- Suggests one,
- *And* executes that suggestion if the human approves, *or*
- Allows the human a restricted time to veto before automatic execution, *or*
- Executes automatically, then necessarily informs the human, *or*
- Informs the human after execution only if it is asked, *or*
- Informs the human after execution if the computer decides to do so
- The computer decides everything and acts autonomously, ignoring the human

Sheridan 1994

Limits on Agent Autonomy



Range of theoretically possible actions by maximally autonomous Agent with complete set of capabilities, unqualified permission and no obligations

Agents autonomy affected by policy: larger the range of permitted actions the more freely the agent can act

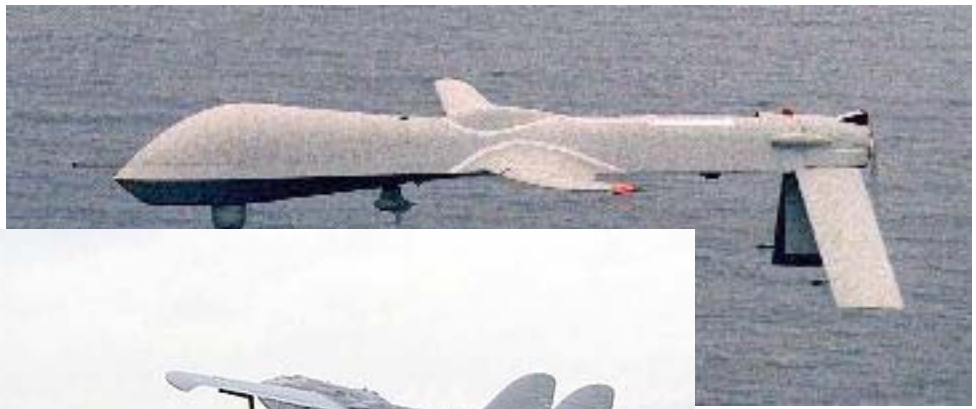
Larger set of actions it is expected that an Agent can achieve in concert with others

Agents autonomy affected by things it has to do: smaller the range of obligated actions more freely the agent can act

Sub- set of possible actions it is expected that an Agent can achieve independently

Autonomous System???

Autonomous System???



Autonomous System???

© Geoffrey H Lee, Eurofighter

ROYAL AIR FORCE

Autonomous System???

What Is Culture? A human attribute?

"The collective programming of the mind which distinguishes the members of one human group from another. ... includes systems of values; and values are among the building blocks of culture"

3 Key Contributors to Cultural Values

- National: power distance, individualism, proceduralism, risk taking, communication, education, rules
- Organisational: Formal, surface, visible structures e.g. members' uniforms, symbols, routines, documents etc v Informal, inner, invisible layer e.g. values, beliefs, subconscious assumptions.
- Professional: shared expertise/knowledge/jargon, norms for behaviour, ethical values, self regulation, stove-piping

Three Base-line Assumptions

- Cultural attributes and/or values impact on the way work is done
- Cultural attributes and/or values can influence the way doctrine, strategies & policies are interpreted into operational actions.
- Actions can be instantiated in formal and informal procedures and interactions and result in 'effects' and 'outcomes'

Combining Cultures

WESTERN VALUES	NON-WESTERN VALUES	COMBINED EFFECT
Individualism	Collectivism	+
Egalitarianism	Hierarchy	-
Winning	Collaboration	+
Specific	Holistic	+
Tasks	Loyalty	-
Directness	Indirectness	-

Excerpt from Anbari et al, *Cross-cultural differences and their implications for managing international projects*

From Karen Carr BAES: NEC The Human Dimension; Preparing for Coalition

Culture and System Performance

- 'Culture-as-a-variable versus culture-as-a-metaphor' debate:
  - *Variable = culture is an objective reality that can be measured and changed*
  - *Metaphor = culture is a mental state that has to be tolerated since it is incapable of being changed*

- Workshop 'Introducing Innovation and Risk: Implications of Transforming the Culture of DoD':
  - *Culture is learned from experience and the interpretation of experience*
  - *Culture operates at different levels of awareness: values, attitudes & behaviour*
  - *Each Service has a different culture/subcultures, reflecting different historical antecedents and differences in operating environments*
  - *Culture looks more similar from the outside than from the inside (e.g. military vs. civilian, Army vs. Navy, conventional vs. special forces)*
  - *Change is characteristic of military culture (e.g. evolution of doctrine; integration of the races and sexes)*
  - *There are levers for changing culture: training, personnel / reward systems, changing organisational structures / processes etc*

Culture and System Performance

- 'Culture-as-a-variable versus culture-as-a-metaphor' debate:
  - Variable = culture is an objective reality that can be measured and changed;
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- Workshop 'Introducing Innovation and Risk: Implications of Transforming the Culture of C2'.
  - Culture is learned from experience and the interpretation of experience.
  - Culture shapes and reflects levels of analysis: values, attitudes, and behaviour.
  - Each Service has a different culture and subcultures, reflecting different historical antecedents and differences in operating environments.
  - Culture looks more similar from the outside than from the inside (e.g., military vs. civilian, Army vs. Navy, conventional vs. special forces).
  - Change is characteristic of military culture (e.g., evolution of doctrine and social issues such as volunteer force and integration of the races and sexes.
  - There are levers for changing culture such as training, personnel and reward systems, changing organisational structures and processes etc.

Culture is learned and is <u>not</u> innate.

Hence culture can be relearned.

Cultural Attributes/Values

Attributable to human (non-technical) agents	Individualism	Collectivism
	Inner Focus	Outer Focus
	Power by Achievement	Power by Status
	Masculinity	Femininity
Attributable to both human (non-technical) and technical agents	Orthodox	Proactive
	Information Analysis	Information Integration
	Time Sequence	Time Synchronisation
	Low Power Distance	High Power Distance
	High Risk Taking	Low Risk Taking

Cultural Attributes/Values

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Generic characteristics

- Attributes can be held by individuals, groups and organisational systems / sub- systems
- Attributes can relate to a perception of self, the group or the organisational (sub)system
- Some attributes can be embedded in technical system components

Humans/Systems and Cultural Attributes

- Each pair defines a range, with a description of the likely beliefs, perceptions manifested at each extreme end
- Individuals et al will select (or have selected) a position towards one end or the other, but rarely occupy the absolute extremes in all contexts
- Note that cultural attributes per se are not right or wrong – rather relative positions on each of the spectra will be more or less suitable for particular contexts

Research Hypothesis and Aims

Hypothesis

- S/AS need to exhibit a range of desired behaviours commensurate with the operating environment, tasks set and the degree of autonomy desired

- Different configurations of cultural attributes may facilitate/impede S/AS in making, communicating and implementing decisions + imply requirement for structural change - *applies to both technical and non-technical components*

Aims

- Identify cultural attribute pairings applicable generically and within CSAR decision-making scenarios

- Investigate the implications of these pairings on (a) S/AS decision making behaviours and (b) system performance, organisational behaviours and system structures.

- Explore alternative cultural attribute configurations which may facilitate required S/AS decision making behaviour and any implications for organisational/system change.

- Develop a prototype Cultural Attributes Tool (CAT) which enables
  - ❖ identification of conflicts in cultural attribute configurations within an S/AS
  - ❖ assessment of impact of different configurations of attributes on required S/AS decision making behaviours and ability of S/AS to operate in different environmental conditions

Research Challenges

- What is the requirement for transformation into new organisational/system forms?
  (eg *flatter hierarchies, decentralised decision-making, greater capacity for tolerance of ambiguity, permeable internal and external boundaries, empowerment of individuals, capacity for renewal, self-organising units, and self-integrating coordination mechanisms.*

- What is the combination of S/AS behaviours required in different contexts?
  (*e.g. adaptability, flexibility, being able to make sense out of complex and sometimes contradictory information flows; being capable of dealing with ambiguity and with the lethality and accuracy of the new technology, being comfortable with change and with information sharing; having the freedom and ability to innovate and take risks etc*).

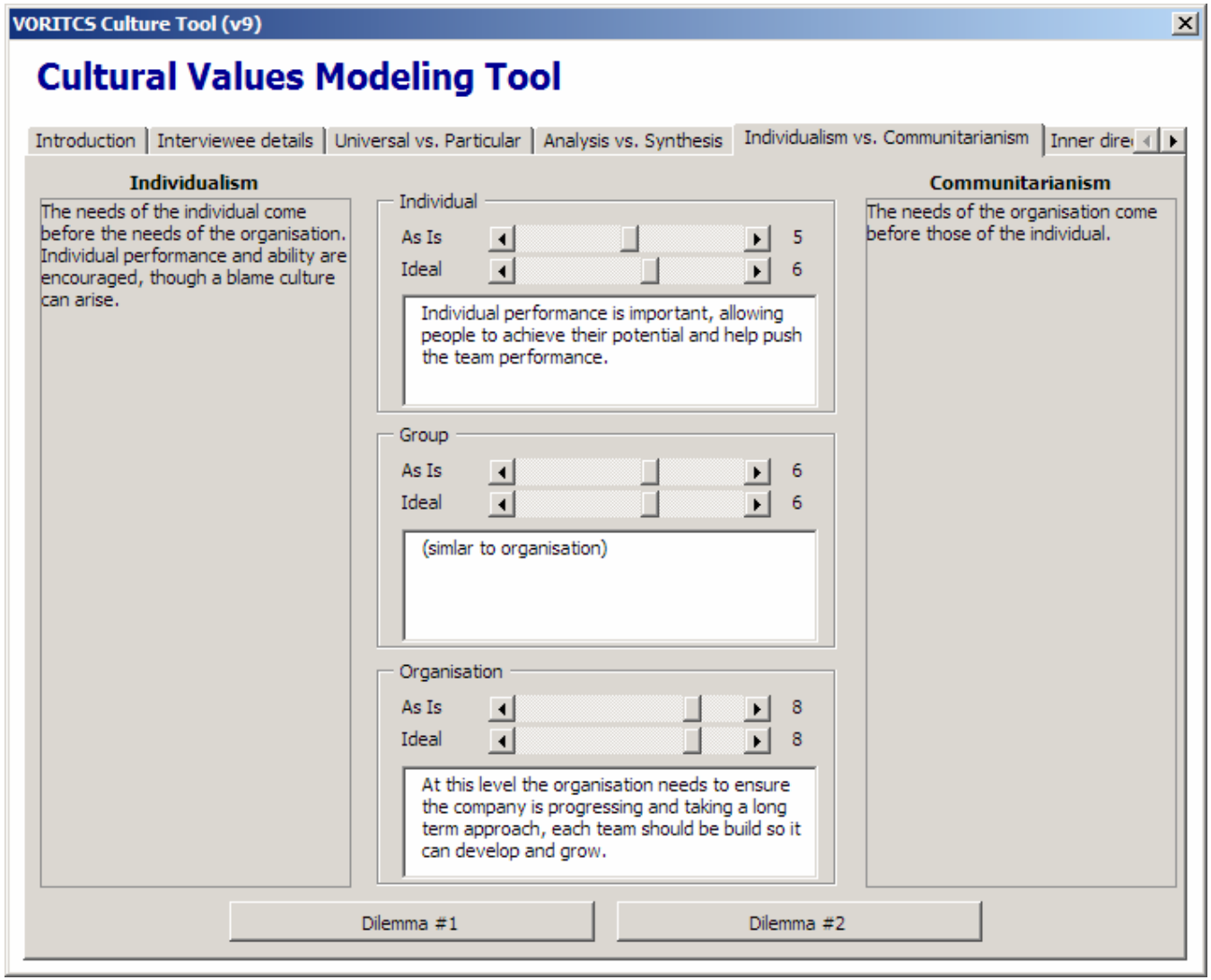
- Which cultural attributes will facilitate or impede these behaviours to ensure that the appropriate level of S/AS autonomy and performance can be defined?

- What is the relationship between the environment in which the S/AS operates and the attributes the S/AS possesses?
  (eg if command and control environment is 'control free', then an S/AS which exhibits attributes such as 'high power distance' or 'universal' tendencies will not be able to operate autonomously).

Output 1: Cultural Modeling Tools: CVMT

- CVMT = Cultural Values Modeling Tool
- Flexible prototype tool developed in VBA for VORTICS
- Captures the existing ('as is') and desired ('ideal') configurations of cultural value pairs at 3 levels:
  - Individual
  - Group
  - Organisational
- Outputs captured data to MS Excel spreadsheet
- Enables identification of existing conflicts that occur between:
  - 'as is' and 'ideal'
  - Individual/ Group/ Organisational level
- Needs moving into military domain and expanded to cope with non-technical agents and sub systems

Cultural Modeling Tools: CVMT



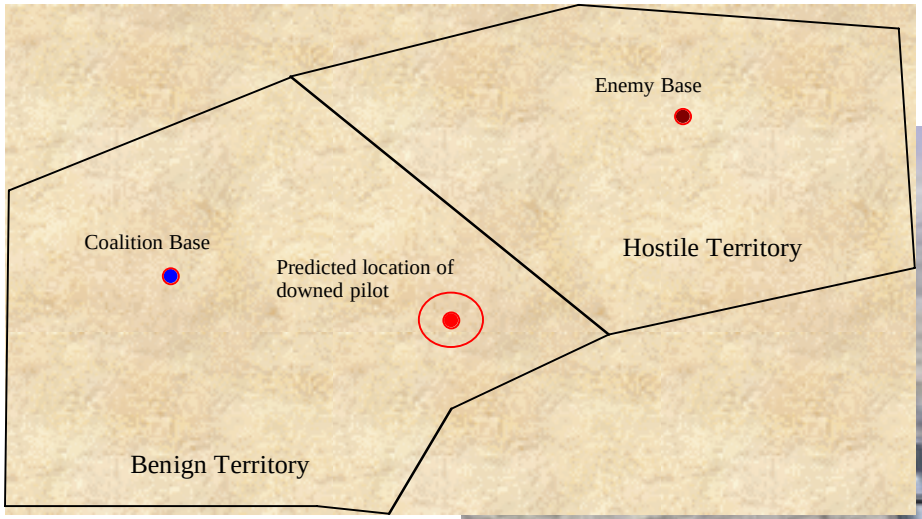
Output 2: Cultural Attribute Framework - Desired behaviours

Skill class	Desired behaviour	UNIVERSAL	PARTICULAR	ANALYSIS	SYNTHESIS	HIGH POWER DISTANCE	LOW POWER DISTANCE
Communication /interaction skills	Effectively interact with other system agents					N	Y
	Handle conflict						
	Trust						
	Collaboration/ Cooperation						
	Transparent/ open						
Information processing	Speed					N	Y
	Deal with ambiguity	N	Y	N	Y		
	Deal with complexity			N	Y		
	Deal with contradictions	N	Y	N	Y		
	Deal with uncertainty			N	Y		
	Deal with incomplete info			N	Y		
	Prioritise information			N	Y		
	Sharing information					N	Y
Decision making	Risk tolerance	N	Y			N	Y
	Receptivity to new info (open or closed)					N	Y
	Deal with variable time pressures	N	Y			N	Y
	Act autonomously	N	Y			N	Y
	Error retrieval	N	Y			N	Y
Command and Control	Cyclic	Y	N	Y	N	Y	N
	Interventionist	Y	N	Y	N	Y	N
	Problem-solving			Y	N	N	Y
	Problem-bounding			N	Y	N	Y
	Selective control	N	Y	N	Y	N	Y
	Control Free	N	Y	N	Y	N	Y
Innovation	Risk taking					N	Y
	Self organising	N	Y	N	Y	N	Y
	Self integrating	N	Y	N	Y	N	Y
	Self-learning						
	Re-configurability	N	Y			N	Y

Output 2: Cultural Attribute Framework - Environment

Environment Category	Environment sub-category	Sub Category Attribute	UNIVERSAL	PARTICULAR	HIGH POWER DISTANCE	LOW POWER DISTANCE
STRUCTURES	Command structure	*Flat*			N	Y
		Hierarchical			Y	N
STYLE	Command style	*Collaborative*			N	Y
		Authoritative			Y	N
	Communication structure	*Formal*			Y	N
		Informal			N	Y
	Leadership style	*Strong*				
		Weak			Y	
		Individual				
		Group concensus			N	Y
DISTRIBUTION PATTERN	Function distribution	*Stovepiped*	Y	N		
		Dispersed	N	Y		
	Authority distribution	*Centralised*	Y	N	Y	N
		Delegated	N	Y	N	Y
	Skills distribution	*Specialist*				
		Multiskilled				
INTER-OPERABILITY	Systems interop	*Heterogenous*	N	Y		
		Homogenous	Y	N		
	Process interop	*Heterogenous*	N	Y		
		Homogenous	Y	N		
UNCERTAINTY	Role definition	*Clear*				
		Fuzzy	Y	N		
	Operating space size	*Large*				
		Small				
		Bounded				
		Unbounded				
	Degree of change	*High*				

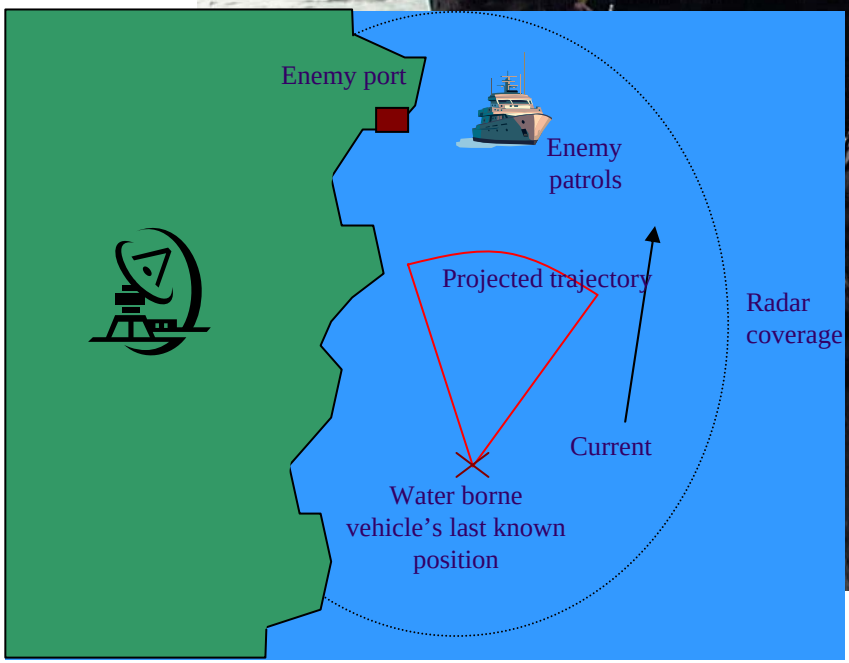
Context focus: CSAR Scenario 1

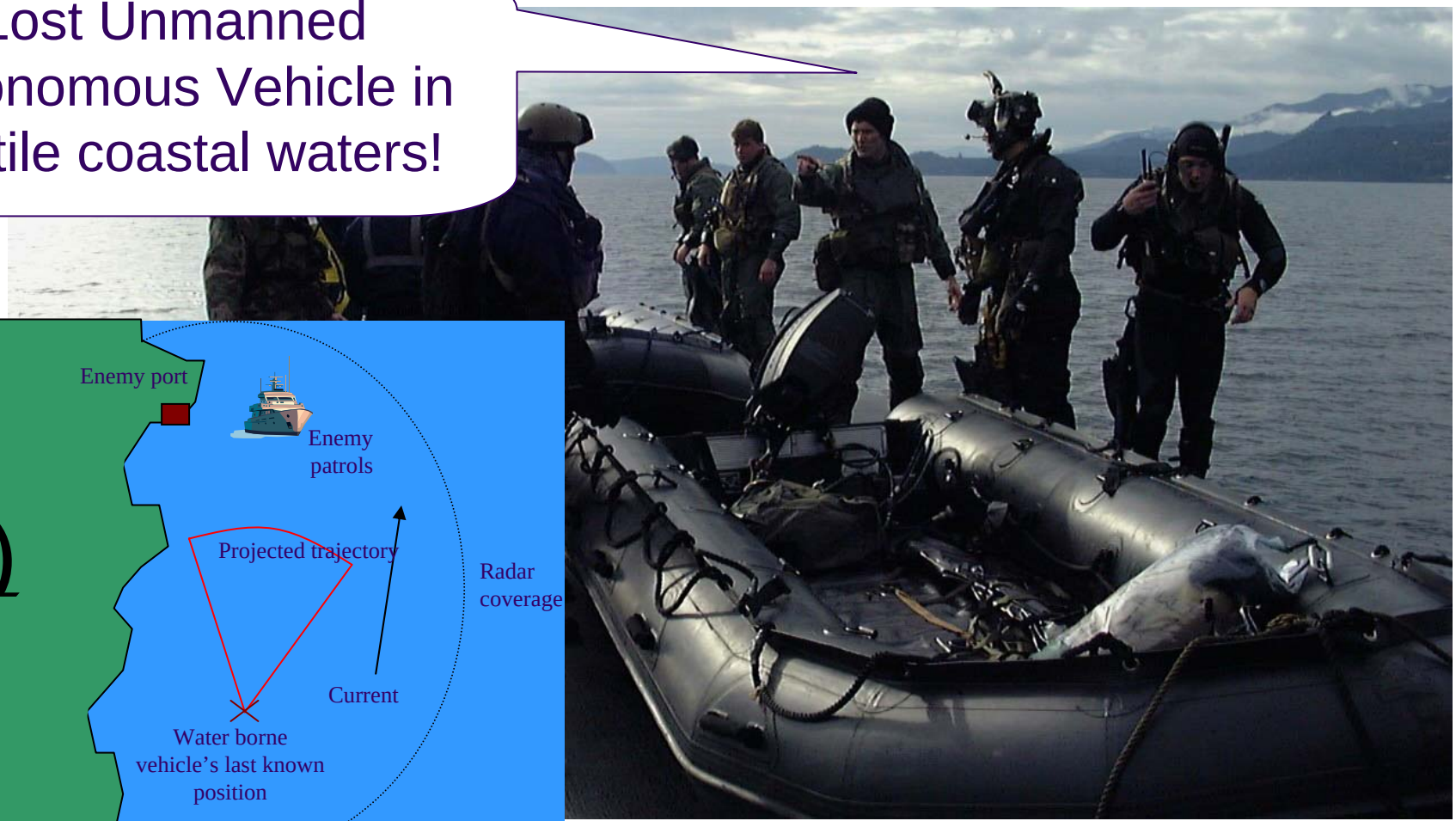


Downed airmen behind enemy lines in a desert environment

Context focus: CSAR Scenario 2

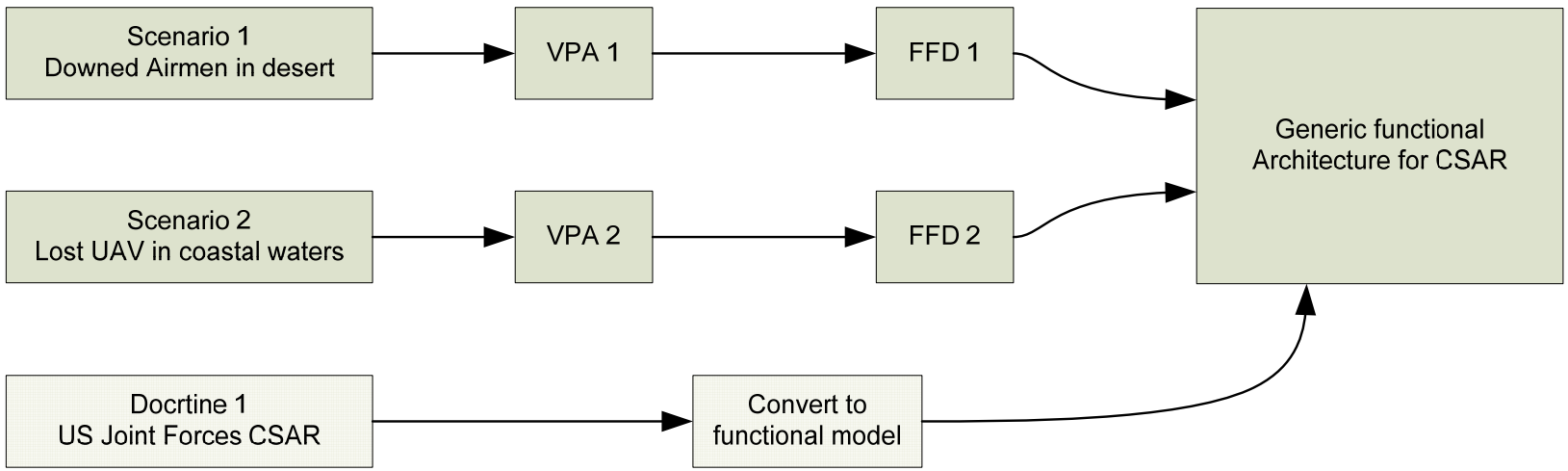
Lost Unmanned Autonomous Vehicle in hostile coastal waters!





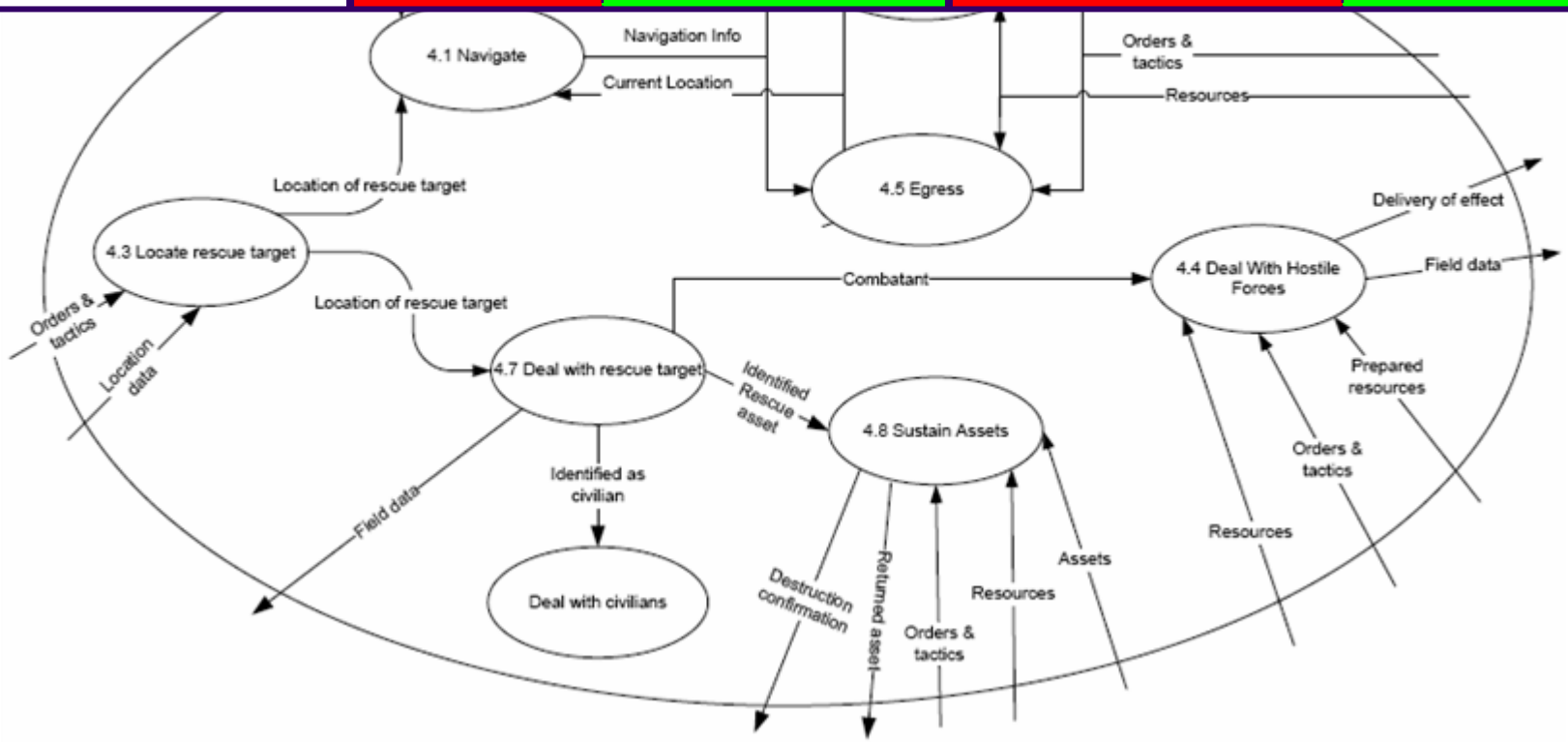
Output 3: CSAR Generic Functional Model

- By looking at the two scenario specific functional models, we were able to develop a generic model, applicable to a variety of CSAR missions.
- The generic model represents our current understanding of CSAR and will continue to mature as the research progresses.



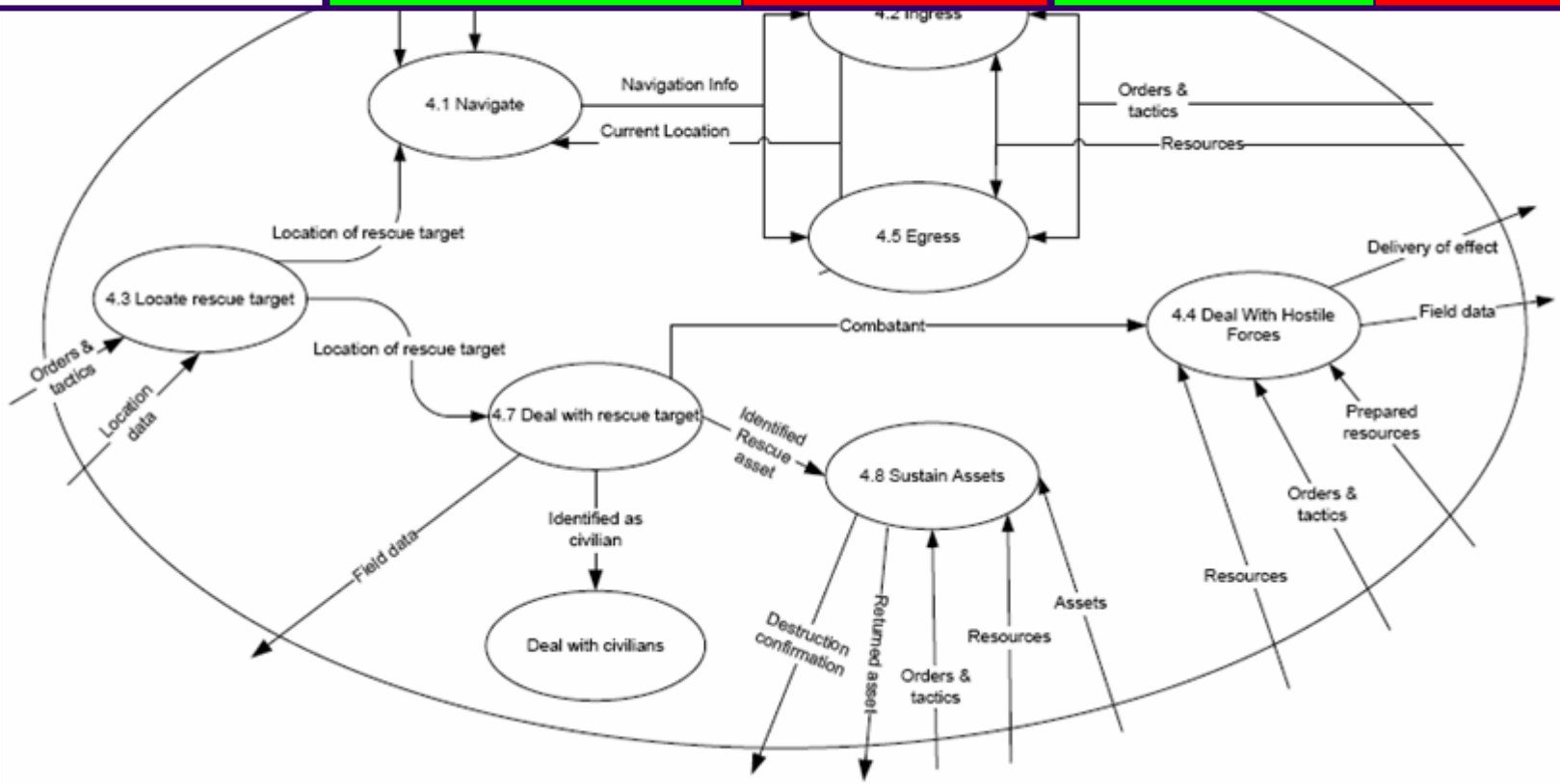
CSAR Scenario (1 of 3): Information processing

Info Processing behaviour required	Cultural attributes required			
Deal with uncertainty	Analysis	Synthesis	High Risk Taking	Low Risk Taking
Sharing information	Individualism	Collectivism	High Power Distance	Low Power Distance



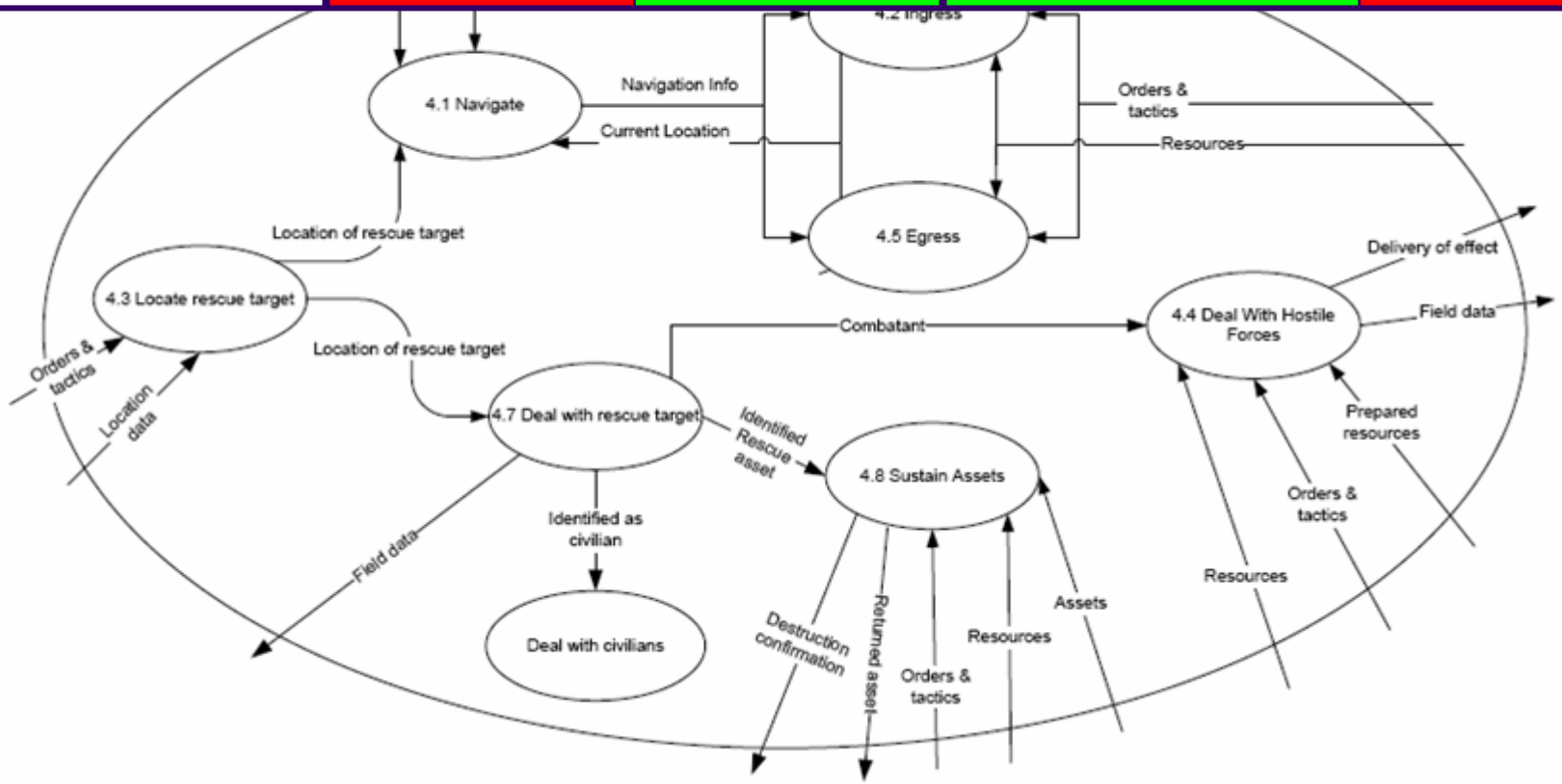
CSAR Scenario (2 of 3): Decision making

Decision Making behaviour required	Cultural attributes required			
Act autonomously	Orthodox	Pro-active	Masculinity	Femininity
Risk tolerance	Power by Achievement	Power by Status	High Risk Taking	Low Risk Taking

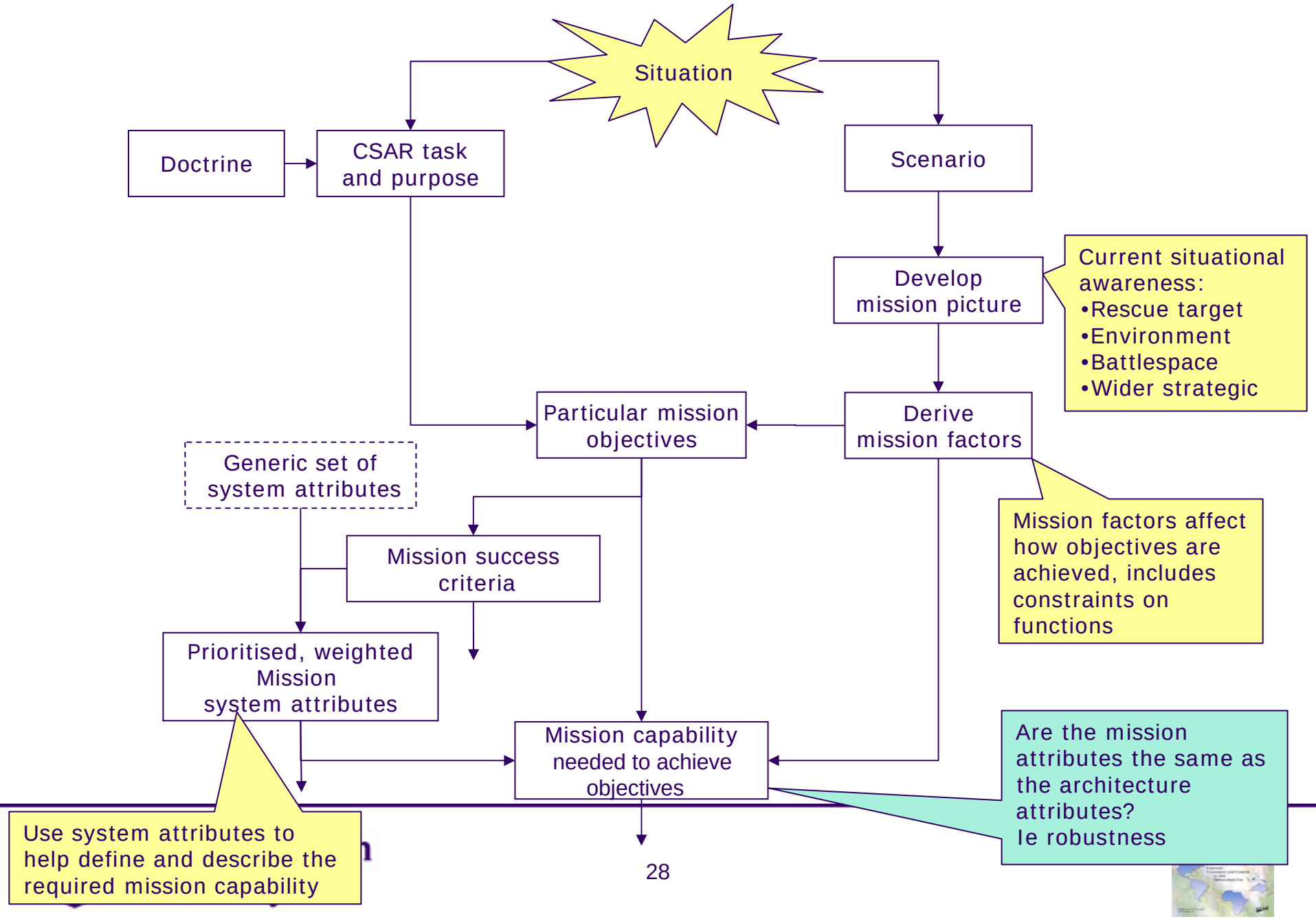


CSAR Scenario (3 of 3): Adaptability

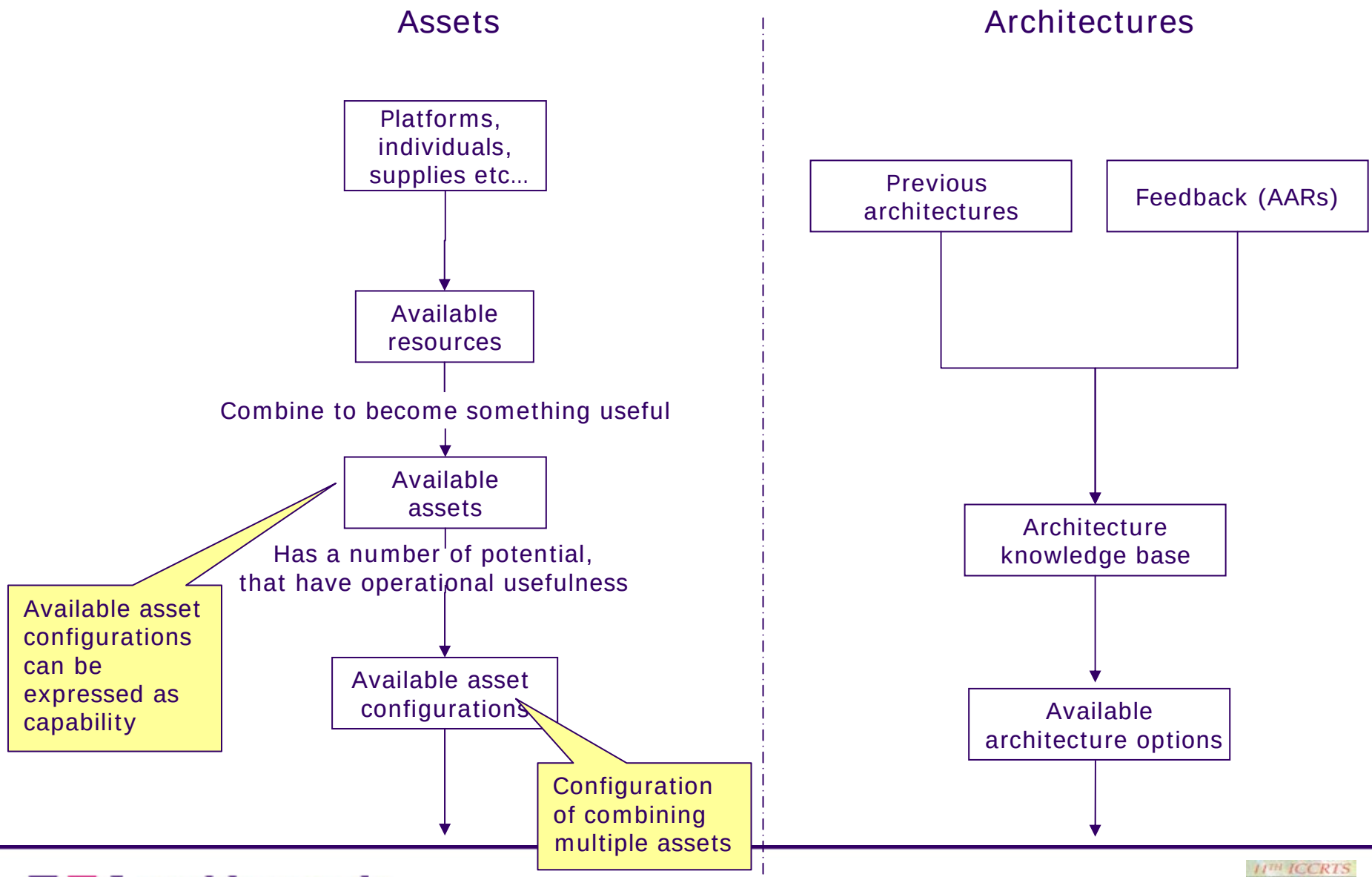
Adaptable behaviour required	Cultural attributes required			
Responsiveness	Analysis	Synthesis	Inner-focus	Outer-focus
Adaptability	Orthodox	Pro-active	Power by Achievement	Power by Status



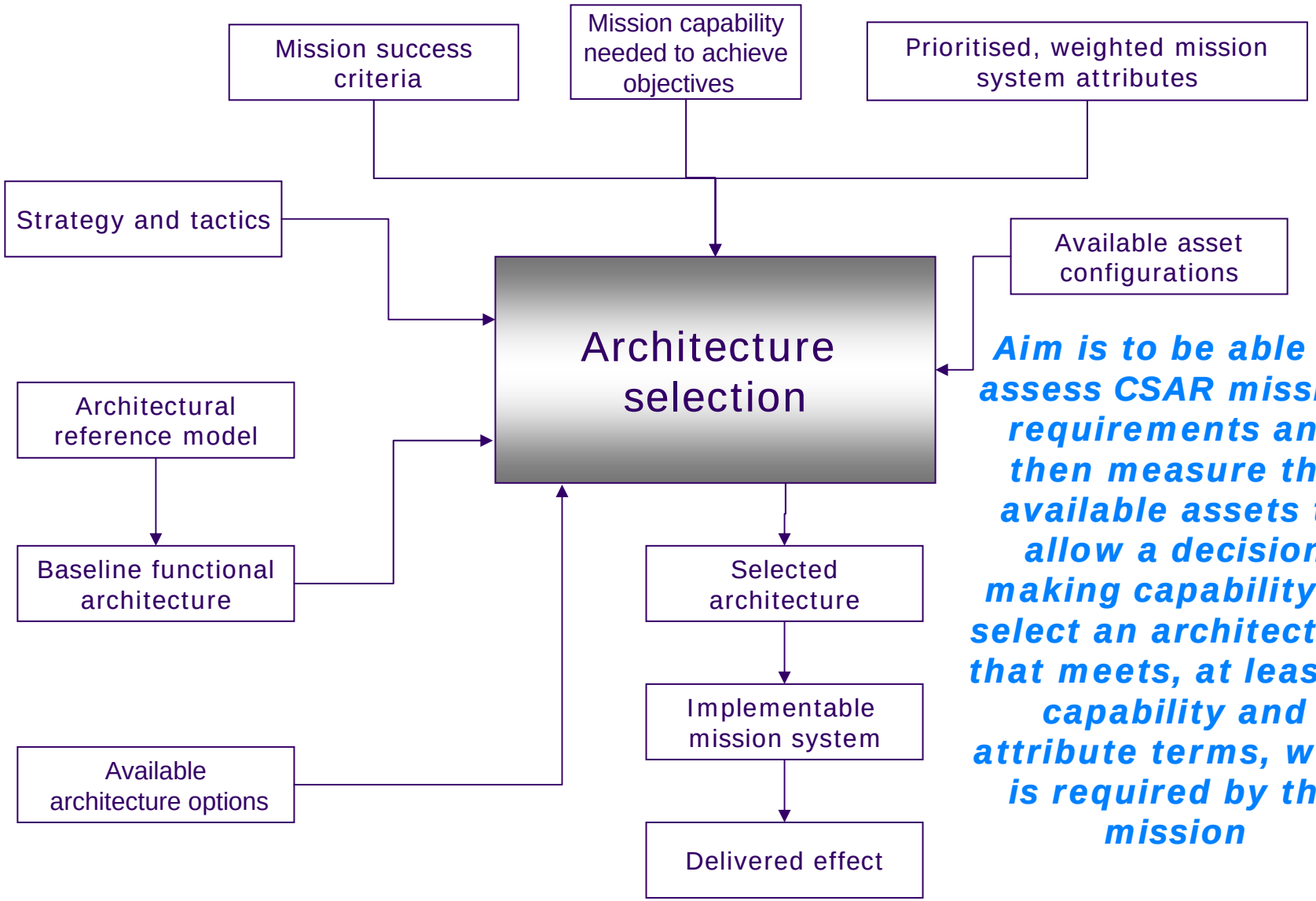
Output 4: DSS - What We Need



Output 4: DSS - What We've Got

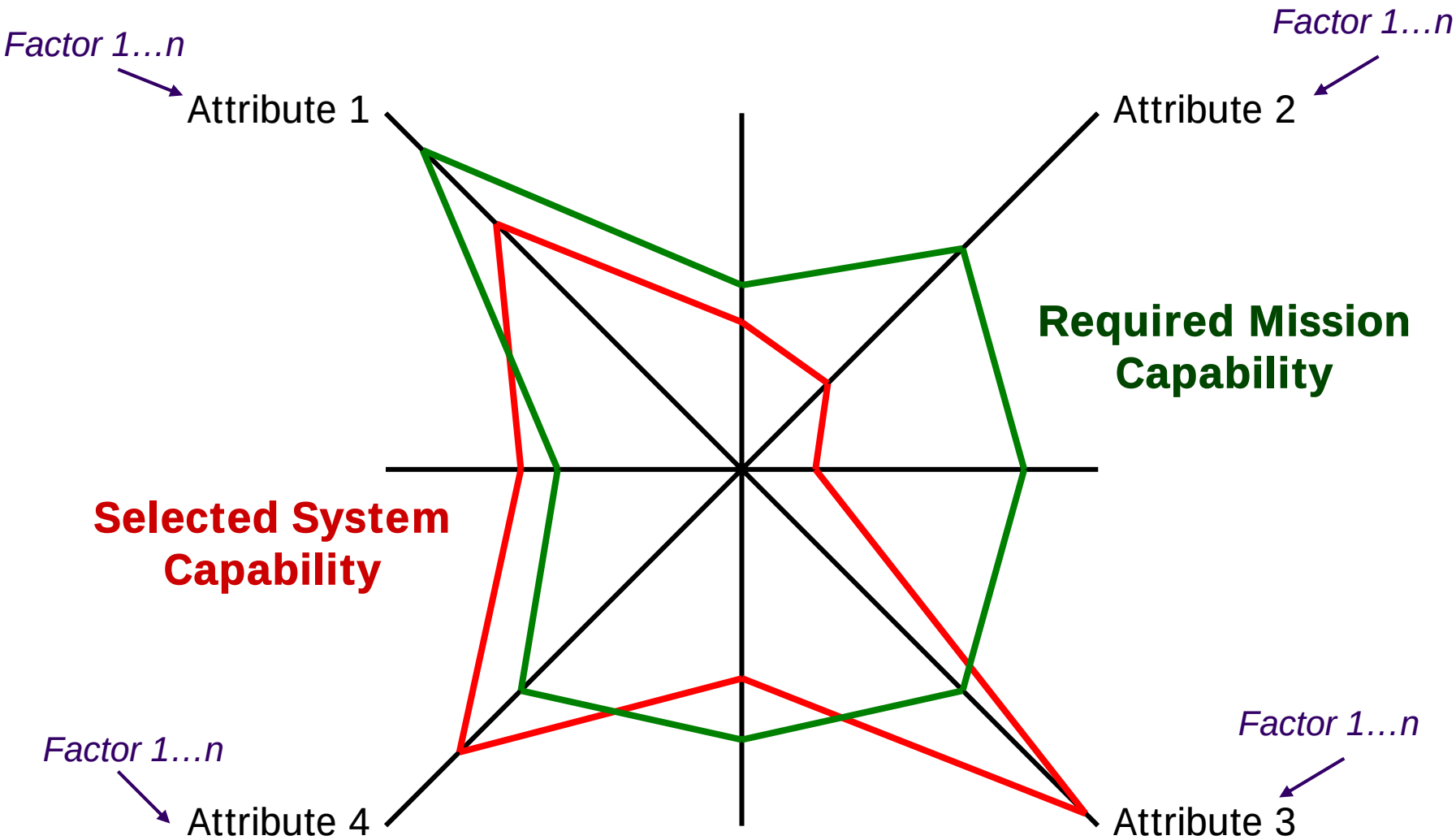


Output 4: DSS - Architecture Selection



Aim is to be able to assess CSAR mission requirements and then measure the available assets to allow a decision making capability to select an architecture that meets, at least in capability and attribute terms, what is required by the mission

Decision Support – Matching Whole System Capability To Mission Attributes



CSAR Mission Requirements x System Function

Requirements \ Functions	4. Execute action							
	4.1 Navigate	4.2 Ingress	4.3 Locate rescue target	4.4 Deal With Hostile Forces	4.5 Egress	4.6 Deal with civilians	4.7 Deal with rescue target	4.8 Sustain Assets
Must be able to call on resources of allies for assistance	Y	Y	Y	Y	Y	N	Y	N
Must be able to collate relevant rescue information	Y	N	Y	N	N	N	Y	N
Minimise unnecessary damage to civilian property	N	Y	N	Y	Y	N	N	N
Maintain safety	N	Y	Y	Y	Y	Y	Y	Y
Maintain cultural awareness	Y	Y	N	Y	Y	Y	N	N
Must preserve life	Y	Y	Y	Y	Y	Y	Y	Y
Must be reliable	Y	N	Y	Y	N	Y	Y	Y
Must have adequate intelligence	Y	N	Y	Y	N	Y	Y	N
Team must have adequate training	Y	Y	Y	Y	Y	Y	Y	N
Team must have adequate capability	Y	Y	Y	Y	Y	Y	Y	Y
Must have identifiable benefit	N	N	N	Y	N	Y	Y	Y
Must be empowered	Y	N	N	Y	N	Y	Y	N
Must be responsible	Y	Y	Y	Y	Y	Y	Y	Y
Team must be adaptive	Y	Y	N	Y	Y	Y	Y	Y
Rescue team must survive	N	N	N	N	N	N	N	Y
Team must be 'timely'	Y	Y	Y	Y	Y	Y	Y	Y
Must conform to the rules of engagement	N	N	N	Y	N	N	N	N
Must respect geopolitical agreements	Y	Y	N	N	Y	N	N	N
Must preserve civilian life	N	N	N	Y	N	Y	N	N
Must trust other system agents	Y	Y	Y	Y	Y	Y	Y	Y
Must minimise cost	Y	Y	N	Y	Y	Y	N	Y
Must have required documentation	Y	N	Y	N	N	N	Y	N

CSAR System Function x System Attributes

Functions \ Attributes	Timeliness	Interoperability	Confidentiality	Information processing	Decision making	Command and Control
1.1 Receive distress call	Y	N	N	Y	N	N
1.2 Collate distress information	N	N	N	Y	N	N
1.3 Validate distress information	Y	N	Y	Y	Y	N
1.4 Acknowledge receipt	Y	N	N	N	N	N
2.1 Vet information for security	N	Y	Y	Y	Y	N
2.2 Transfer knowledge	Y	Y	Y	N	N	N
2.3 Negotiate assistance	N	Y	N	N	Y	N
3.1 Assess situation	N	Y	N	Y	Y	N
3.2 Plan rescue	Y	N	Y	Y	Y	Y
3.3 Select appropriate resources	N	N	N	Y	Y	Y
3.4 Prepare resources	Y	N	Y	N	N	N
3.5 Conform to the law of war	N	N	N	N	N	N
4.1 Navigate	N	N	N	Y	N	N
4.2 Ingress	N	N	N	N	N	Y
4.3 Locate rescue target	Y	Y	N	Y	Y	Y
4.4 Deal With Hostile Forces	Y	Y	N	Y	Y	Y
4.5 Egress	N	N	N	N	N	Y
4.6 Deal with civilians	N	Y	N	Y	Y	Y
4.7 Deal with rescue target	Y	Y	N	Y	Y	Y
4.8 Sustain Assets	N	Y	N	N	Y	Y
5.1 Gather information	N	Y	Y	Y	N	Y
5.2 Monitor progress	N	Y	Y	Y	N	N
5.3 Make decision	Y	Y	N	Y	Y	Y
5.4 Disseminate information	Y	Y	Y	Y	N	N
6.1 Debrief Pilot	N	N	Y	Y	N	N
6.2 Debrief Team	N	N	Y	Y	N	N
6.3 Evaluate Mission Performance	N	N	Y	Y	N	N
6.4 Generate Lessons Learnt	N	N	Y	Y	Y	N
6.5 Recommend Doctrine Update	N	N	Y	Y	Y	N

CSAR System Attributes x Factors

Attributes \ Factors	Orthodox	Proactive	Time sequence	Time syncronocity	Low power distance	High power distance	Information analysis	Information integration
Autonomy	N	Y	Y	N	Y	N	N	Y
Robustness	N	Y						
Resilience	N	Y						
Endurance	N	Y						
Mobility	N	Y						
Timeliness			N	Y				
Availability			Y	N				
Survivability	N	Y					N	Y
Maintainability	N	Y	Y	N			Y	N
Interoperability	Y	N	N	Y			N	Y
Confidentiality	Y	N						
Integrity	Y	N						
Accuracy	Y	N					Y	N
Information processing	N	Y					Y	N
Decision making	N	Y			N	Y	N	Y
Command and Control	Y	N	N	Y	N	Y	N	Y
Innovation	N	Y			Y	N	N	Y
Situational awareness	Y	N			Y	N	N	Y
Adaptability	N	Y			Y	N		
Error management	N	Y	Y	N			Y	N

Key Issues for Consideration

Metrics for decision support

- How to measure a factor or property; how do you define it?
- How to measure the confidence/uncertainty in that measurement!
- How to combine, and by what proportions, a number of factors or properties to produce a measurement of an attribute
- How to validate those combinations such that the measurement of mission factors is directly comparable to the measurement of system properties

  …….

Architecture scope

- Different architectural templates/system configurations for different phases of the mission?
- How to determine when a mission moves from one phase to the next?
- Back-up architectures for “what-if” situations (contingency planning)
- Reach back architectures (if necessary) to support the mission

  …….

Conclusions & Future Work

Conclusions to date

- Semi/Autonomous Systems (S/AS) comprise technical & non-technical components
- System Performance/Behaviour/Structure is influenced by cultural attributes/values
- Attribute conflicts will impair system performance
- Attributes can be manipulated to acquire the appropriate set

Future work

- Develop CSAR scenario to extract decision making behaviours and environmental characteristics and key cultural factor pairings
- 'Militarise' the CVMT & include human and technical agents
- Identify key CSAR mission requirements and CSAR generic system functions, enablers, attributes and factors
- Investigate relationships between cultural factors and system attributes & develop weightings for cultural factors > system attributes and > environment attributes
- How to evaluate a mission in terms of measurable factors
- Develop and validate all elements with CSAR stakeholders