



# Seven Issues on Distributed Situation Awareness Measurement in Complex Socio-technical Systems

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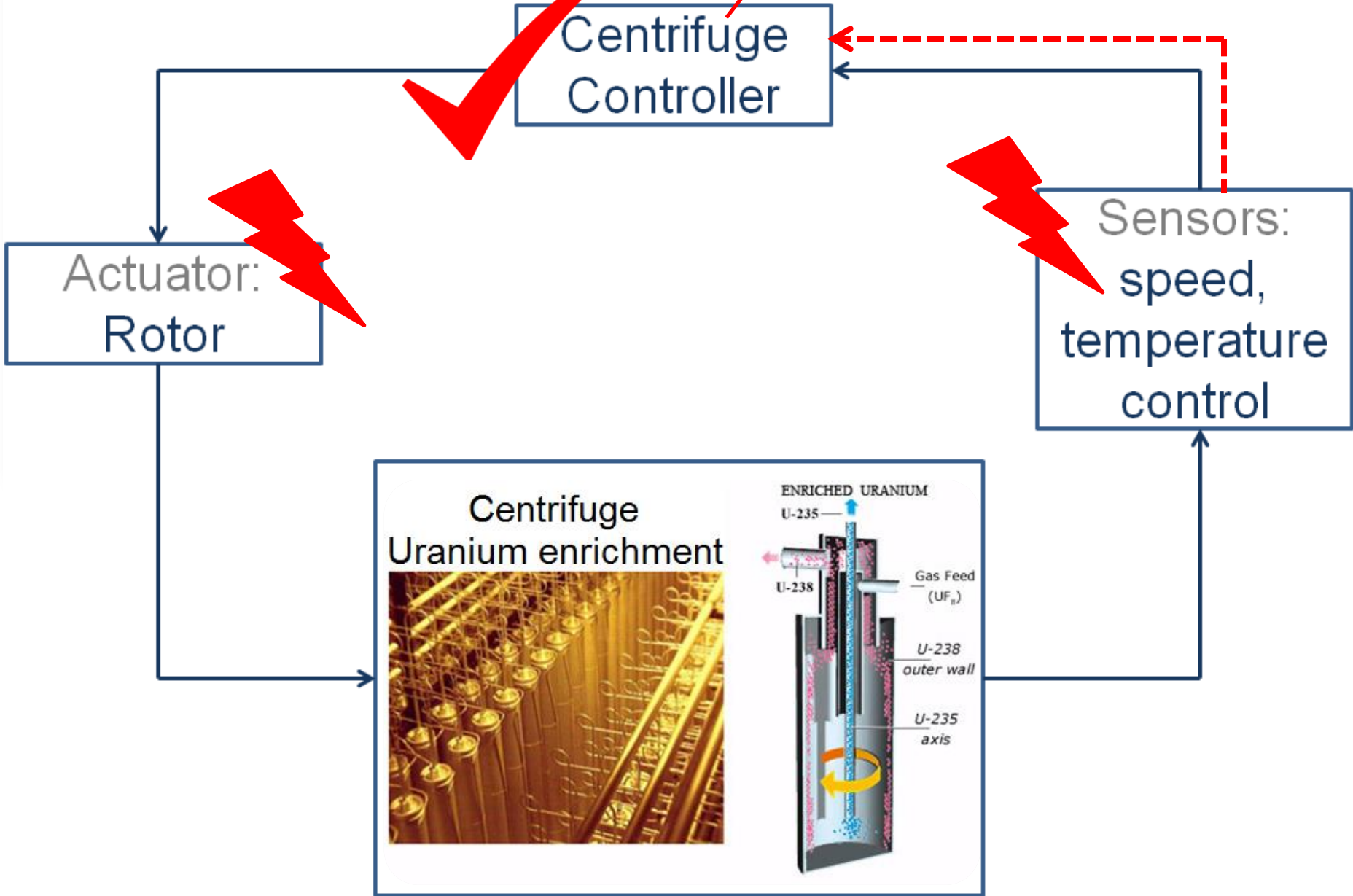
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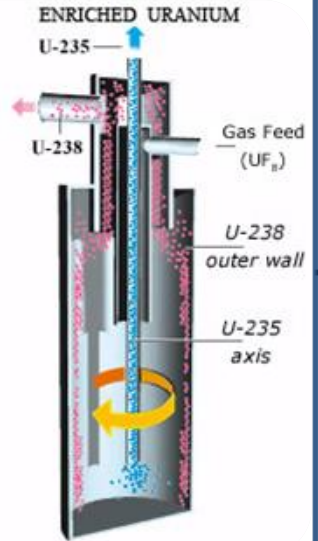
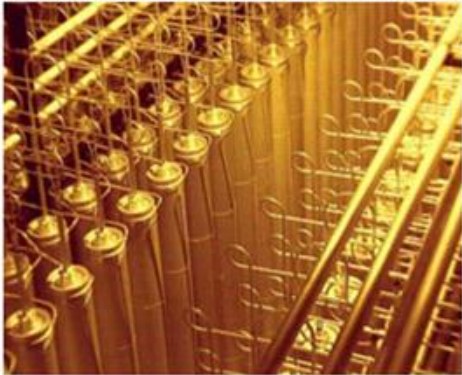
Democritus University of Thrace, Xanthi, Greece

# Safety and Awareness

No awareness → deterioration of **safety**



Centrifuge Uranium enrichment

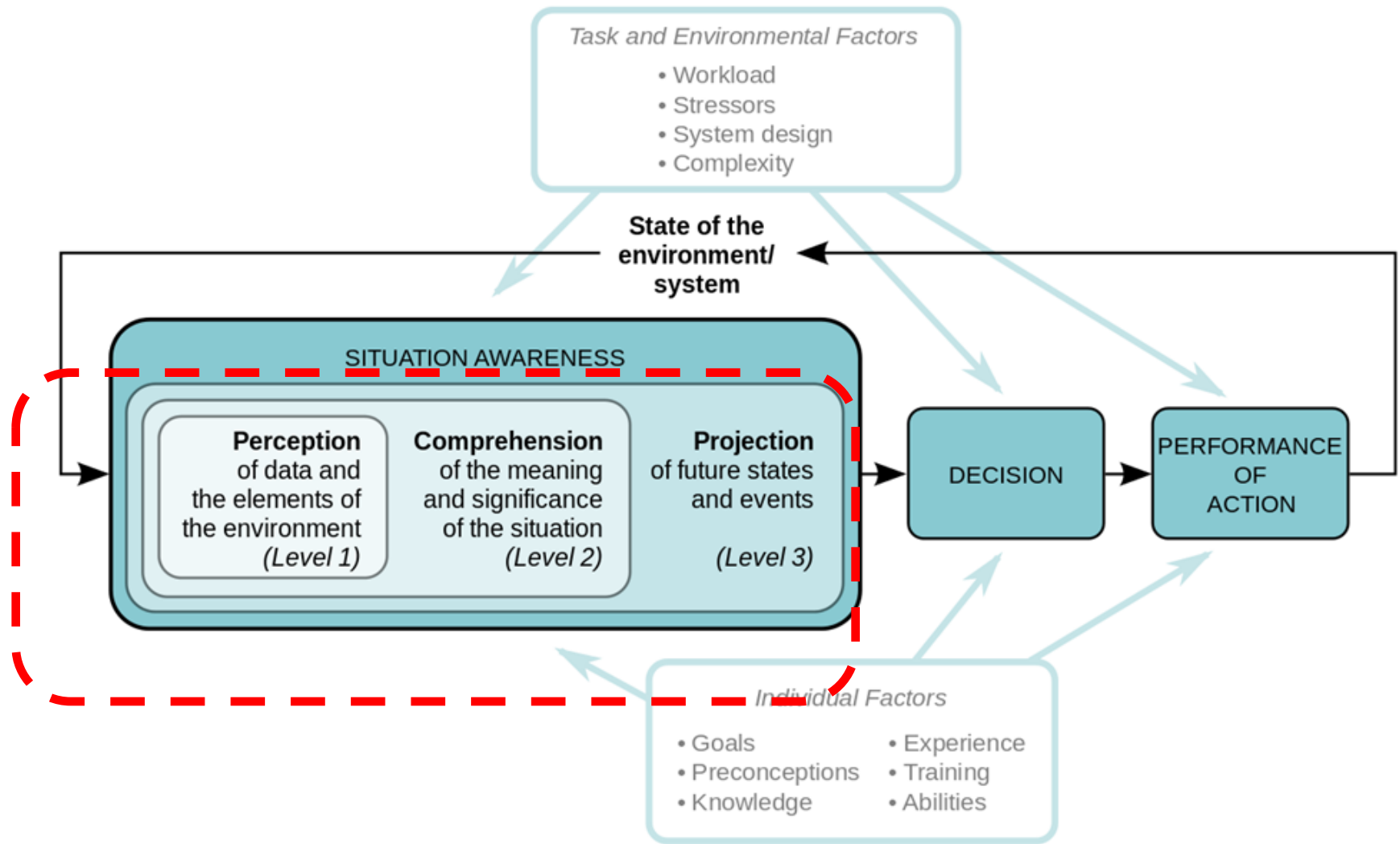


# What is Situation Awareness (SA)?

- Over 30 definitions
- 3 different approaches
  - (i) psychological/social, (ii) engineering/technical, (iii) ergonomics/socio-technical (st)
- 3 different perspectives
  - (i) product, (ii) process, (iii) both

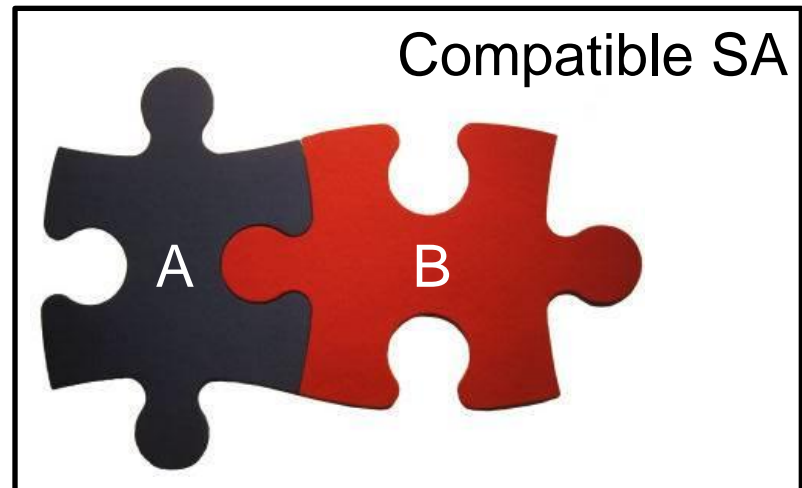
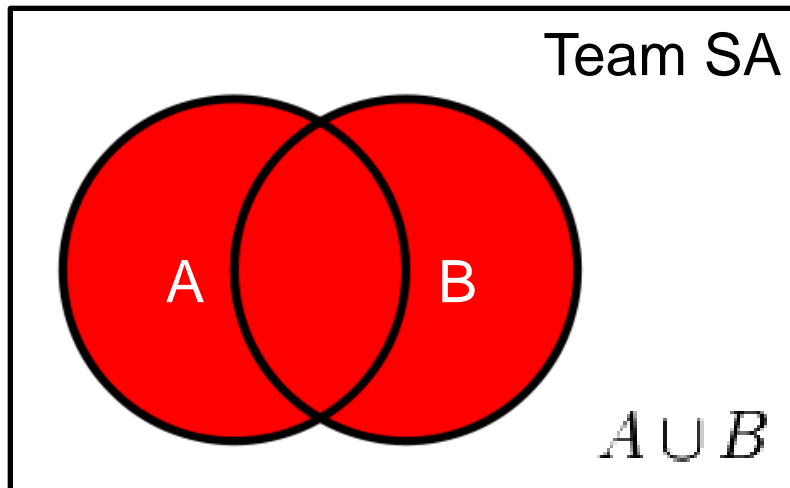
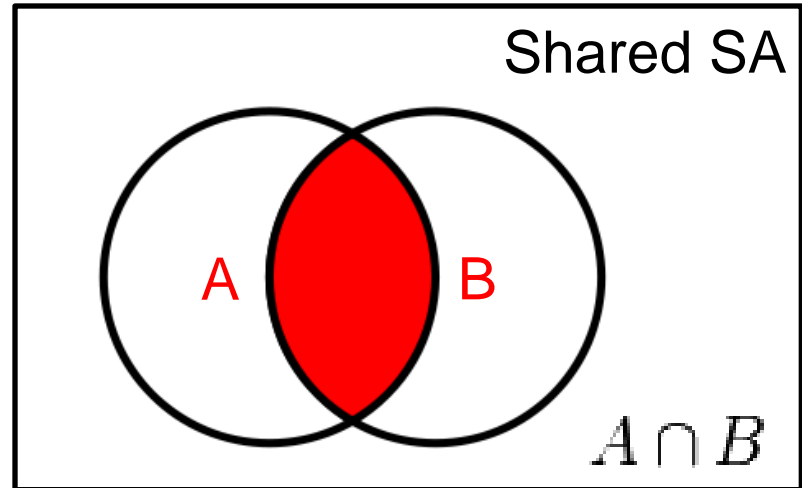
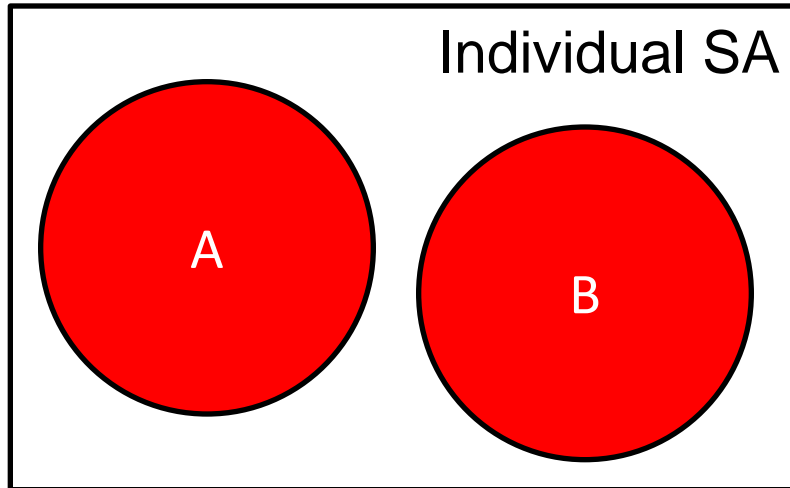
Ambiguity & Vagueness

# Individual SA

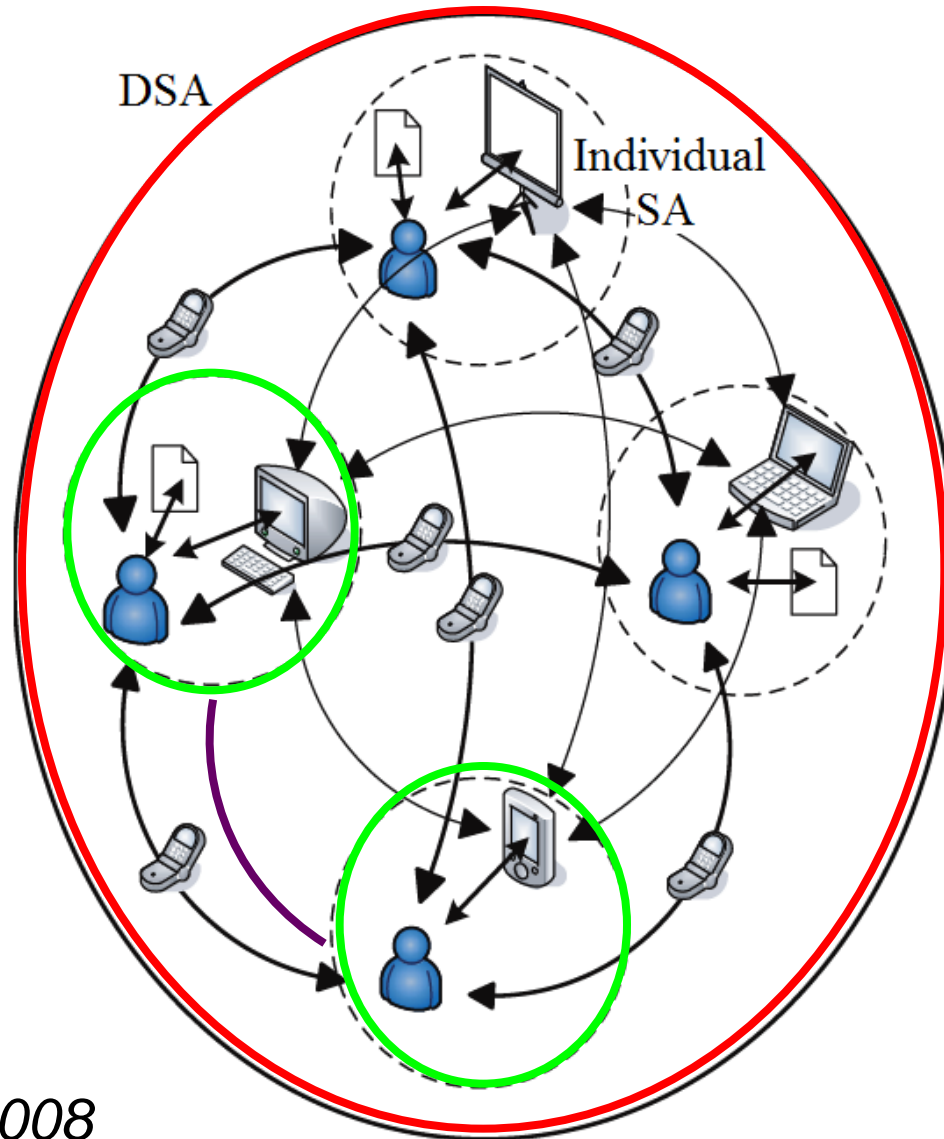


Endsley 1995

# Types of SA



# Distributed Situation Awareness (DSA)



*Salmon et al. 2008*

# Problem Statement

- ❖ based on blueprints
- ❖ come up with “something” as a means of...
- ❖ measuring **to what extent** the system will be **able to perceive, comprehend & project** the presence of its **threats and vulnerabilities** and
- ❖ estimate how this may **affect safety**

Can I achieve this with the existing techniques?

# SA Measurement Techniques

- 30 SA measurement techniques
  - 6 categories for **individual** SA
  - 3 categories for **team** SA
- + 1 **DSA**-oriented: EAST (Event Analysis of Systemic Teamwork)



# SAGAT

- *Endsley 1995*: Situation Awareness Global Assessment Technique (SAGAT)
- Individual-additive perspective: snapshot of the **contents of operator's mind**
- » Produces a score of participant's **ability to recall elements** in the environment, their associated **properties**, and their **likely actions** in the future

# SART

- *Taylor 1990*: Situation Awareness Rating Technique (SART)
- **10 dimensions** to measure operator's SA, e.g. familiarity of the situation, focusing of attention, information quantity & quality, concentration of attention
- » Produces a score of **how aware the participant felt** he/she was during task performance

# Categorisation of Measurement Techniques (individual)

	A - category	B - description
1	freeze probe e.g. SAGAT, SALSA	random activity freeze and questionnaire answering, based on agents' knowledge and understanding of the situation
2	real-time probe e.g. SPAM, SASHA	on-line and real-time, observers take into account both the content of responses and the time to respond
3	self-rating e.g. SART, SARS	post-trial subjective measurement of agents' SA [5]

4	observer-rating e.g. SABARS	SMEs observe participants in action and score their performance via predefined "benchmarking" behaviour
5	performance measures	measuring relevant aspects of participants performance, e.g. 'kills' and 'hits' imply the success or the failure of the mission [5]
6	process indices e.g. eye trackers and software	measurement of cognitive processes employed by participants to develop and maintain their SA

# Categorisation of Measurement Techniques (> individual)

7*	team probe-recall	SA related questions are posed to all team members, one-by-one, during freezes in task performance
8*	observer-rating team SA	observers observe team performance and rate each individual team member about his/her SA as well as the shared awareness
9*	team task performance e.g. CAST	examines responses to changes in team processes and environment, i.e. how aware the entire team and each individual, within the team, are
10	DSA network-based approach	connections are important to explain SA in terms of collaborative systems. DSA is a set of information elements [3]

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# The 7 Issues

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# Issue 1 – **Unclear context** and definition of system boundaries

✗ Assumptions: aviation systems, army models, confined (sub)systems

- ✓ Set system boundaries
- ✓ Define level and depth of analysis
- ✓ Clarify the roles

*“My team has created a very innovative solution, but we’re still looking for a problem to go with it”*

if *“measure shared SA”*  
then *“consider both individual and team roles”*

## Issue 2 – SA models depict the individual's **in-the-mind** process

- ✗ In-the-mind processes affected by interactions with elements in the environment
- ✗ Measure SA on a system level? Individual SA → incorrect evaluation
- ✓ DSA: Focus on the system as an entity!

team probe-recall: agents may have low individual SA, BUT efficient level of SA acting as team members

# Issue 3 – ‘Blurred’ perception of what is going to be measured

- ✗ Attention capture equivalent to being (fully) aware?
- ✓ Theory exemplifies what is going to be measured, BUT...  
measurement's output  $\neq$  OR  $\approx$  objective

performance measures: SA-performance positive correlation  
→ acting in an acceptable way = being aware?

freeze probe: agents describe what they see happening  
→ is it consistent to what really happens?



# Issue 4 – **Information** as the only factor that determines SA levels

- ✗ The more the information the more the SA? Yes, BUT...
  - information triggers awareness, it does not entirely shape it
  - not necessarily proportional
  - updated & compatible **mental models**?
- ✓ DSA: NOT (only) memory BUT comprehension

team probe recall: team members “in isolation”

- same questions to all team members (individually)
- shared, collective, compatible understanding?

## Issue 5 – Researchers apply SA measurement techniques when the system is **already operating**

- ✗ Precautionary measure: enhance and preserve the awareness of system's possible future states - **NONE!**
- ✓ Design: Desirable elements and properties to **enhance the system's awareness** of threats and vulnerabilities beforehand
  - **Self-aware!**
- ✓ Operation: **Less flaws** and/or problematic safety constraints
  - **Less vulnerable!**

## Issue 6 – All SA measurement techniques arrive at **qualitative** conclusions

- ✘ Not quantitative but numerical designation and estimation of qualitative characteristics, e.g. cognition, behaviour
- ✘ Subjective interpretation of output

SART (self-rating): “*How familiar are you with the situation? Do you have a great deal of relevant experience (High) or is it a new situation (Low)?*” (1-7 scale)

# Issue 7 – The **means** to implement measurement techniques

- ✗ Limit the scope of SA – individuals' opinions
  - underestimate system's technical parts
  - loss of information
  - misunderstandings
- ✓ Understandable wording and question formation
- ✓ What does the question try to elicit from the respondents?

# 7 Issues...“Think outside the box”

- Get rid of **sweeping generalities** about weaknesses
- Look **deeper** into the “fragility” of the existing SA measurement techniques
- **Doubt** about the context and the reasoning behind approaches and measurement techniques

# Conclusion

- Existing context: **SA measurement techniques** alone are **not sufficient** to obtain an estimate of DSA in complex systems
- Current technological basis (e.g. EEG device/biosensors): **cannot constantly monitor human brain** functions and reactions to stimuli

Cognitive and distributed “character” of DSA renders direct measurement quite challenging

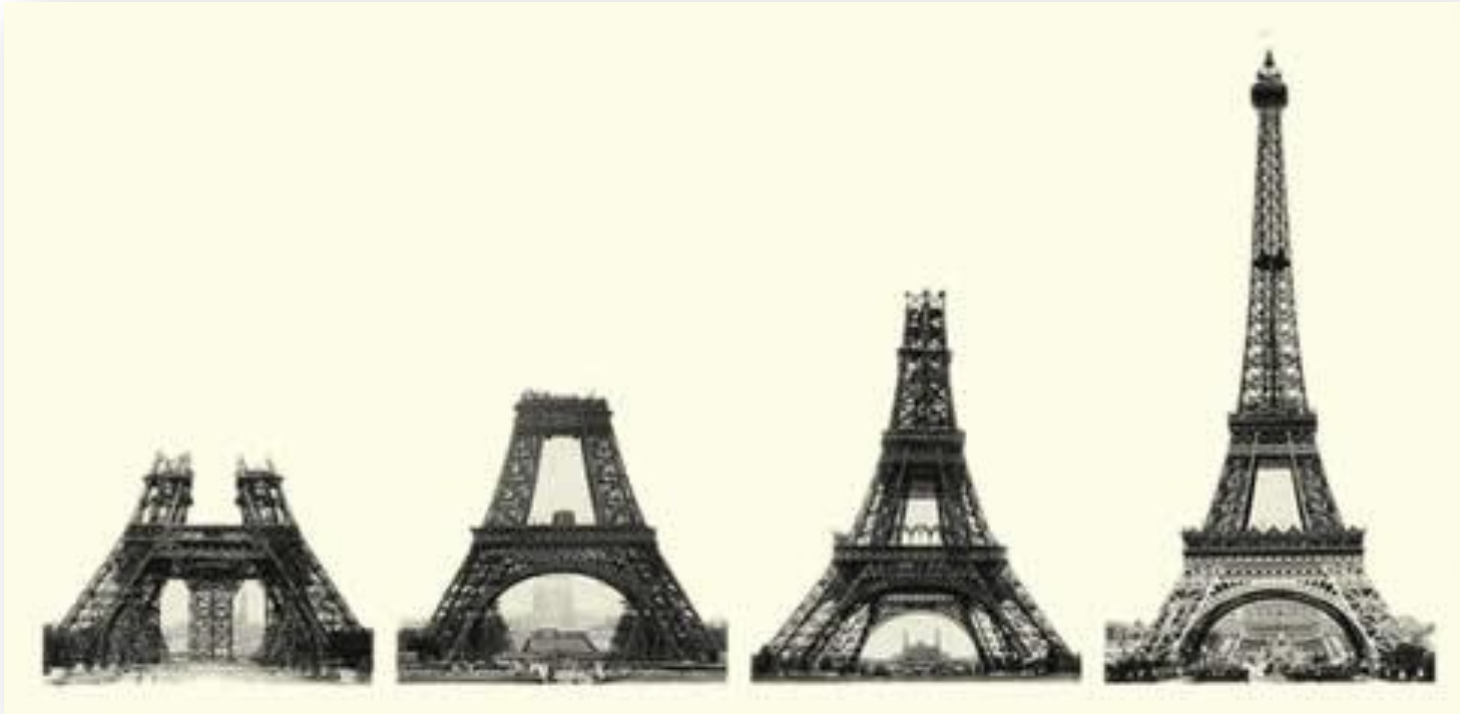
# Feasible Solution

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Instead of measuring – Let's assess

- ✓ Development of a **DSA assessment approach**
  - based on **tangible** system elements and characteristics, as well as **behaviours**
  - that **ideally should** constitute the system
  
- ▶ In a manner that the system becomes aware of its threats and vulnerabilities
  - Self-aware & less vulnerable

# It takes long to reach the goal...



Merci Bien!

Questions...

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