



A Dynamic Process Model for the Design and Assessment of Network Centric Systems

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Agenda

- ❑ **Challenging the Status Quo**
 - **Network Centric Operations & Warfare (NCOW)**
 - **Situation Awareness (SA)**
- ❑ **Dynamic Model of Situated Cognition (DMSC)**
- ❑ **Applying the DSMC to the Design of NCOW**



Tenets of NCW

- A ***robustly networked force*** improves information sharing
- ***Information sharing and collaboration*** enhances the quality of information and shared situational awareness
- Shared situational awareness enables ***collaboration and self synchronization***, and enhances sustainability and speed of command
- These in turn dramatically increase ***mission effectiveness***

(from Alberts & Hayes, 2003; Garstka & Pattillo, 2003)

Domains of Warfare

Physical Domain: Where strike, protect, and maneuver take place across different environments

Information Domain: Where information is created, manipulated and shared

Cognitive Domain: Where perceptions, awareness, beliefs, and values reside and where, as a result of sensemaking, decisions are made

Social Domain: Where force entities interact

Ecological Domain: Where emergent behaviors manifest as changes in capabilities of a system with respect to changes in other systems and the environment



NCW Framework



- Identifies key variables in NCW value chain
- Explicitly incorporates the Social Domain into the framework
- “Top Level” conceptual framework links the force, key variables, and outcomes and illustrates the role of the physical, information, cognitive and social domains
- Each variable is evaluated by a vector of attributes
- Important “classes of attributes” are identified
- Each attribute is measured with a specific metric

(from Garstka & Pattillo, 2003)

The Network Centric Conceptual Framework:

“...is best understood as a generic process model.”

(from Evidence Based Research, 2003)



**Descriptions
of Situation
Awareness**

“The **perception of elements** in the environment within a volume of time and space, the **comprehension of their meaning**, and **their status** in the near future.” (Endsley, 1988)

“**A common, relevant picture** of the battlefield scaled to specific levels of interests and special needs.”
(TRADOC Pamphlet 525-5)

“The **product** of applying analysis and judgment to the common operational picture...” (FM 3-0 (Operations))

“Where am I? Where’s my buddy? Where’s the enemy?” (An Army Officer)

“That’s my SA (pointing to his FBCB2 screen).” (An Enlisted Soldier)

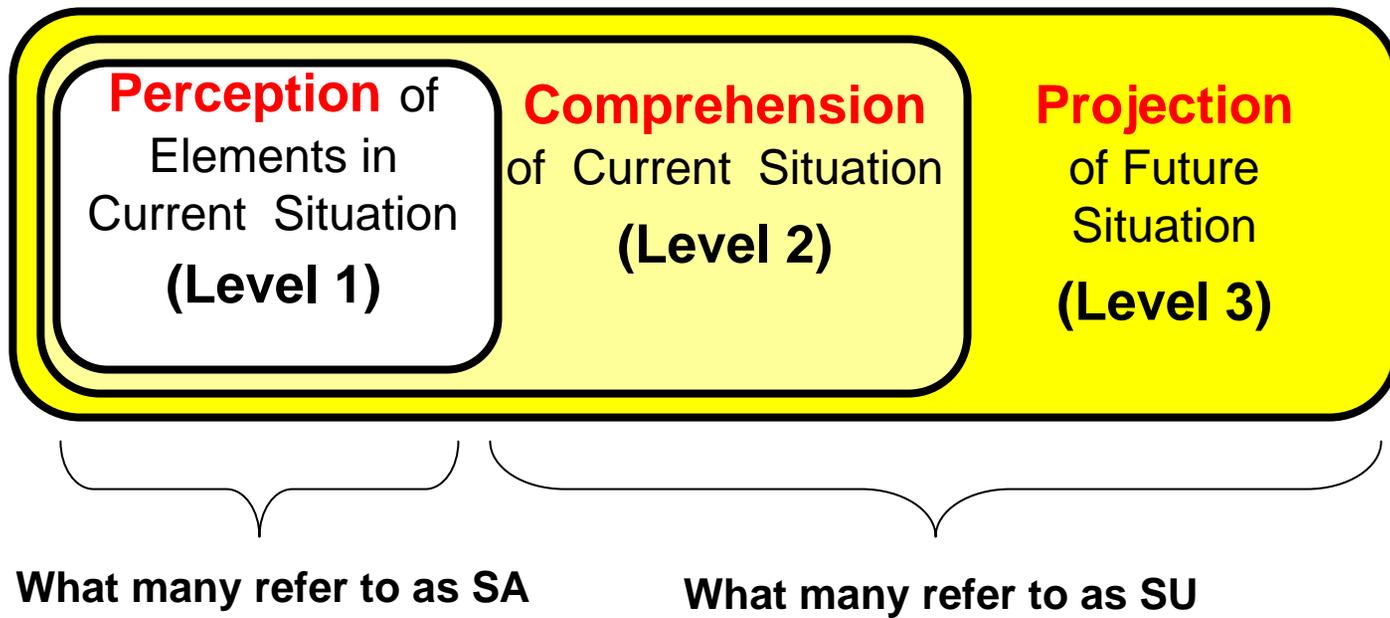
**State
Thing
Product
Information**



Situation Awareness



A Scientific Definition: Situation Awareness is the perception of elements in the environment within a volume of time and space, the comprehension of their meaning, and their status in the near future (Endsley, 1988)



The Challenge of Measuring Situation Awareness



SAGAT
SART
SABARS
SARS
SALIENT

≠

**Spock's Vulcan
Mind Meld**



An Alternative to Situation Awareness

A model and a methodological approach that:

- ❑ focuses on **processes** rather than states
- ❑ includes both **human and machine** 'components' of a system
- ❑ is oriented on assessing **human-system performance**
- ❑ tracks the **evolution** of activities and cognition

Situated Cognition:

- ❑ is borrowed from the learning and linguistics literature
- ❑ includes mental activities are **embedded in an evolving context**
- ❑ includes **human and machine agents**
- ❑ involves **collaborative activities**
- ❑ is **goal-directed**



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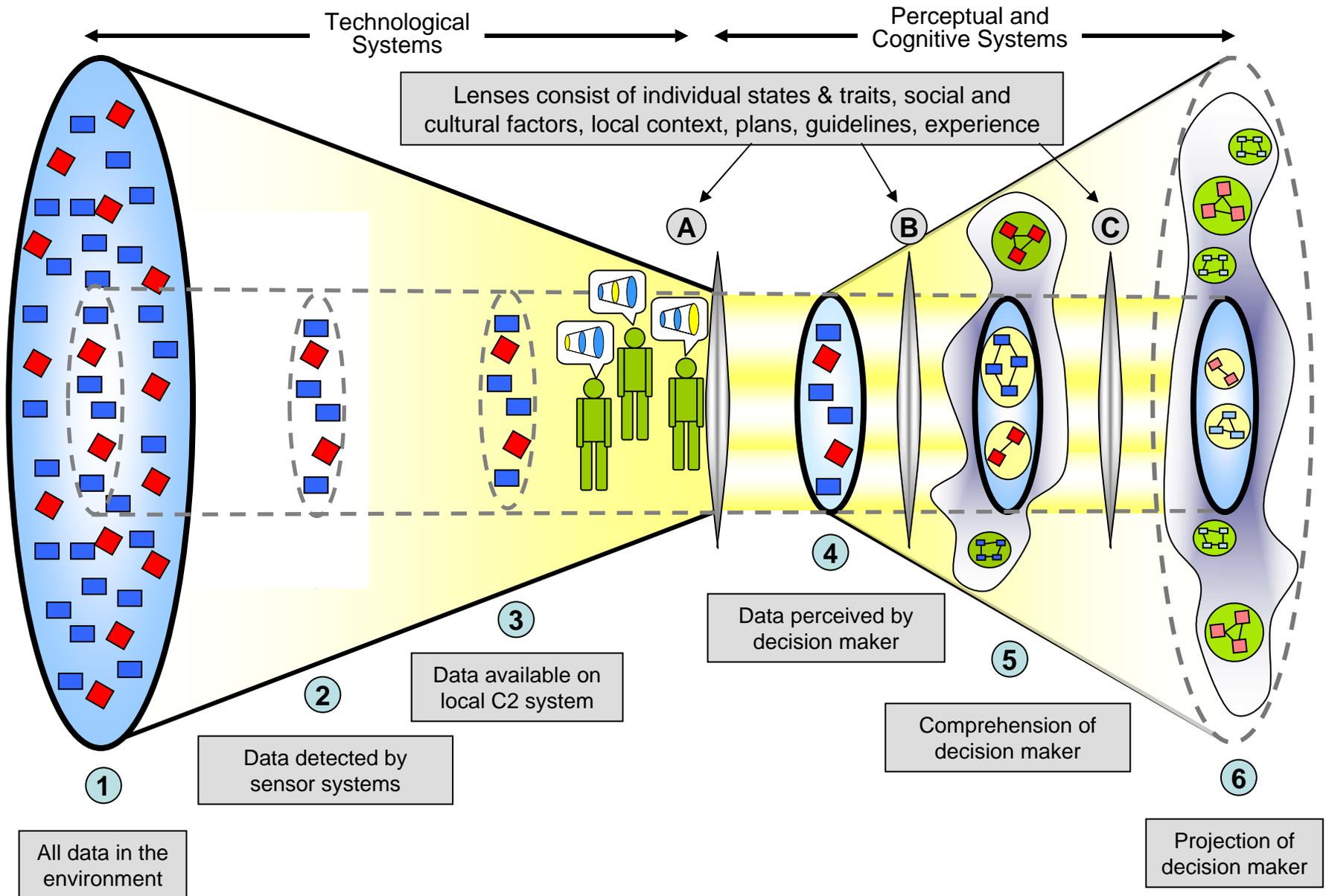
“All models are wrong, but some models are useful.”

George Box, 1979

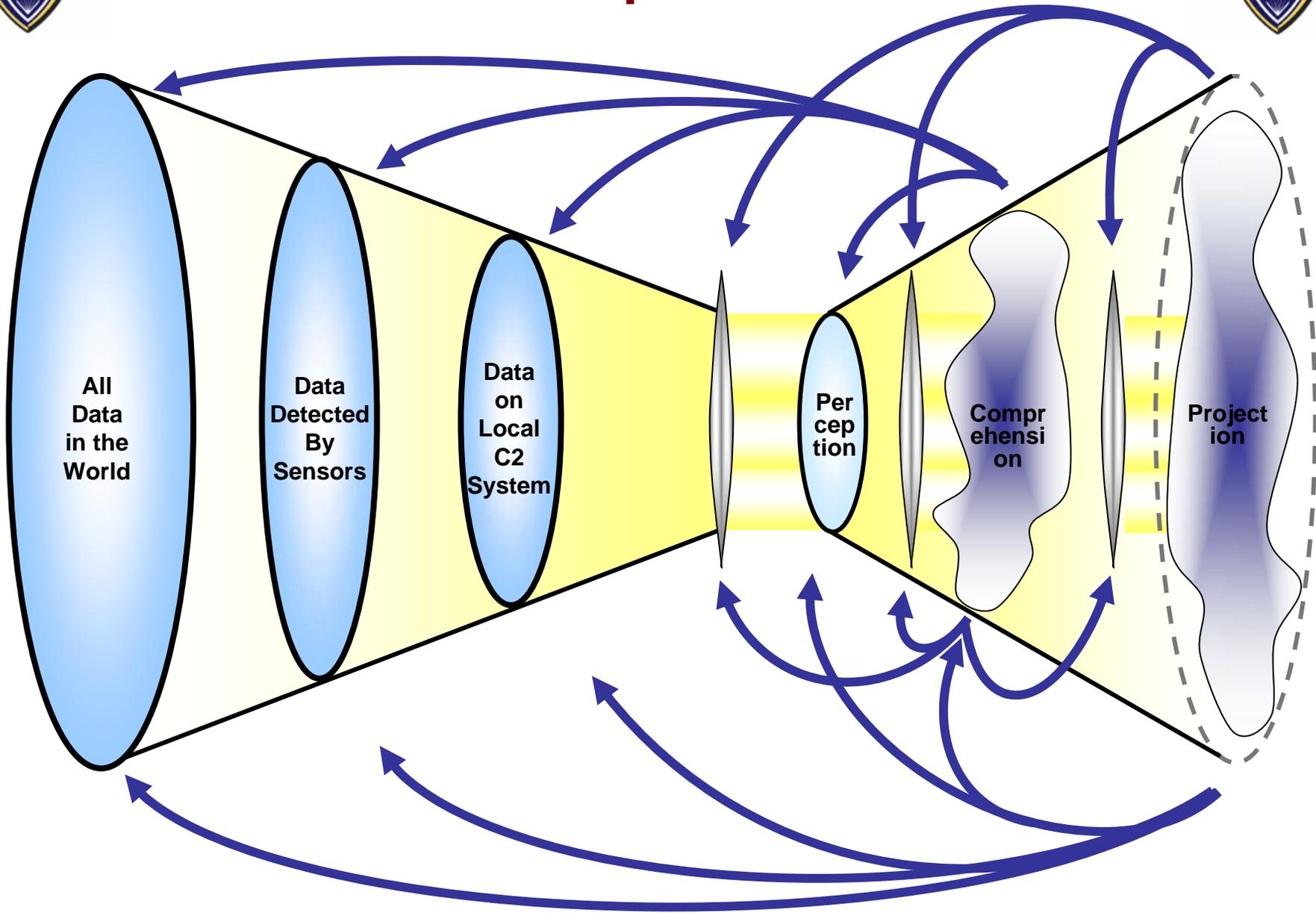
“We know we didn’t get it right, but with your help we can make it better!”

Miller & Shattuck, 2006

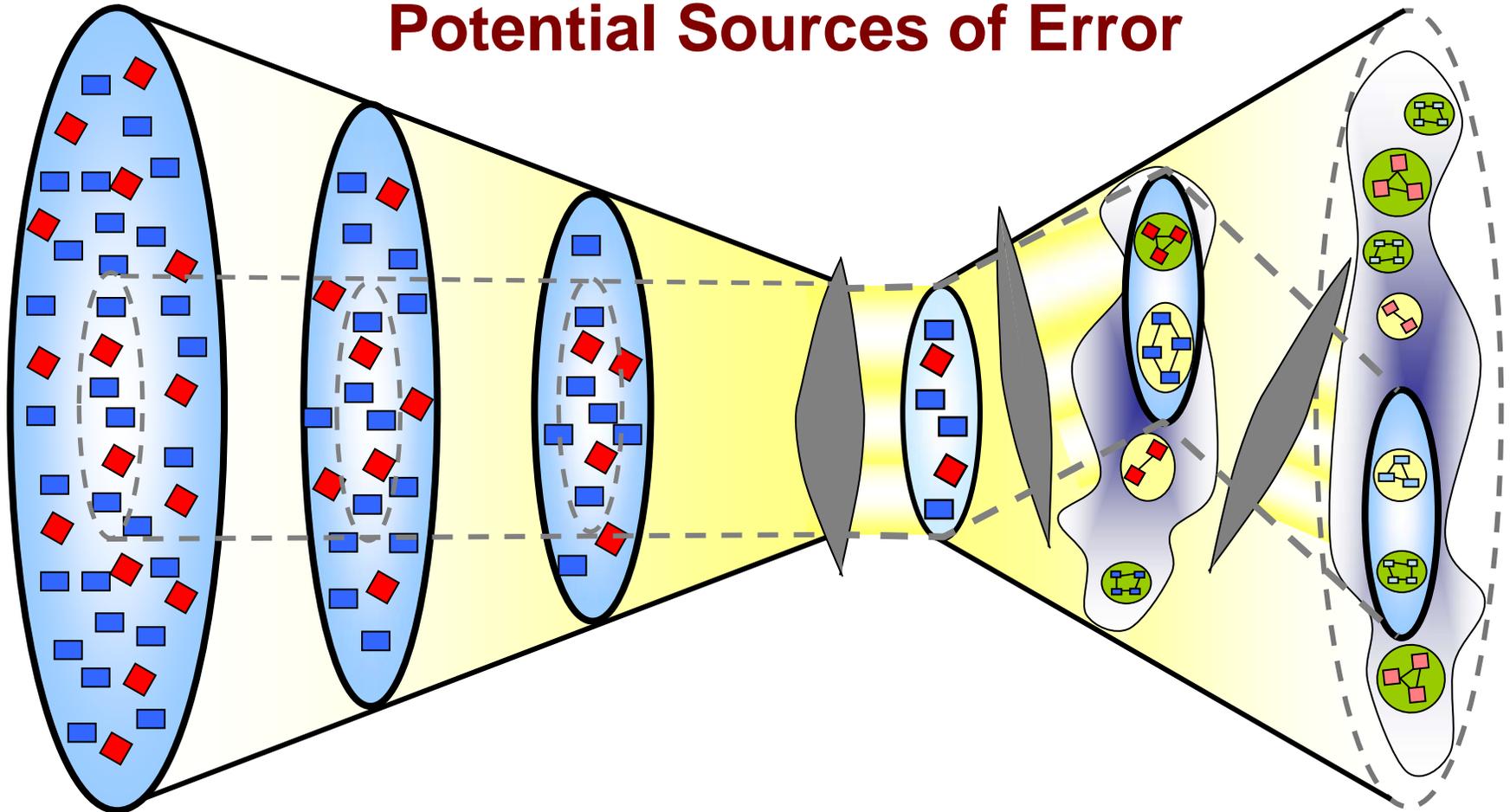
The Dynamic Model of Situated Cognition



Feedback Loops in the Model



Potential Sources of Error



Flow of data from Oval 1 to Ovals 2 & 3

Accurate

Inaccurate

Missed

Misidentified

Sensors:

- Insufficient quantity
- Malfunction
- Lack of sensitivity
- Lack of specificity

- Flawed algorithm
- Spoofing

Other Sources of Error

- Data elements 'drop out' at various points.
- Erroneous data are inserted or existing data are morphed.
- Misshaped lenses skew perceptions, comprehensions, and projections.
- Feedback loops are erroneous or absent.



Process Tracing Methodologies



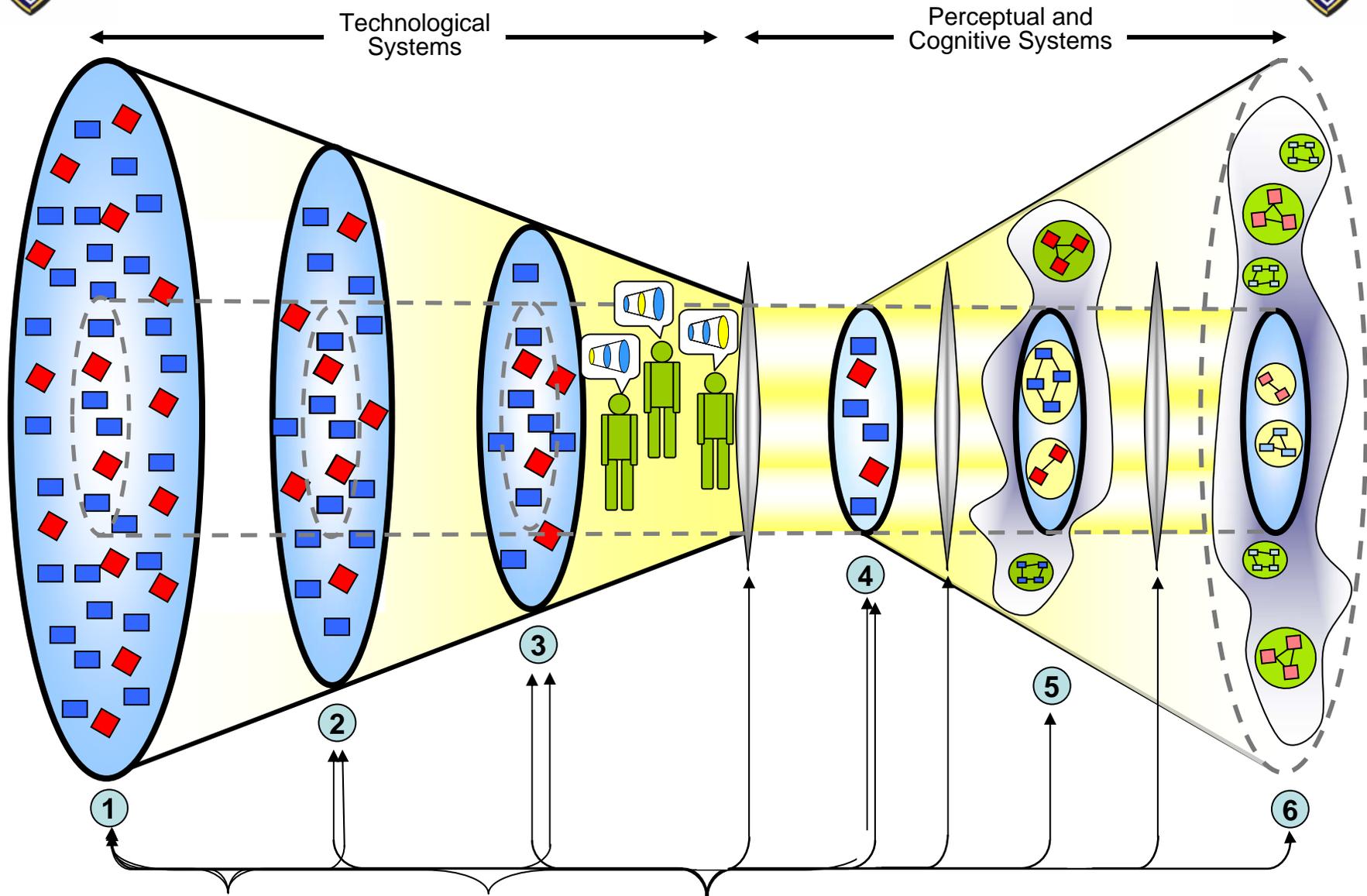
“The goal in these methods is to map out how the incident unfolded including available cues, those cues actually noted by participants, and participants’ interpretation in both the immediate and in the larger institutional and professional contexts. This is called process tracing or protocol analysis method because it focuses on how a given outcome came about.”

“The specific techniques within this family are all oriented towards **externalizing internal processes or producing external signs that support inferences about internal workings.**”

“Process-tracing techniques primarily use data from verbal reports or from records of problem-solver behavior to **build protocols that describe the sequence of information flow and knowledge activation.**”

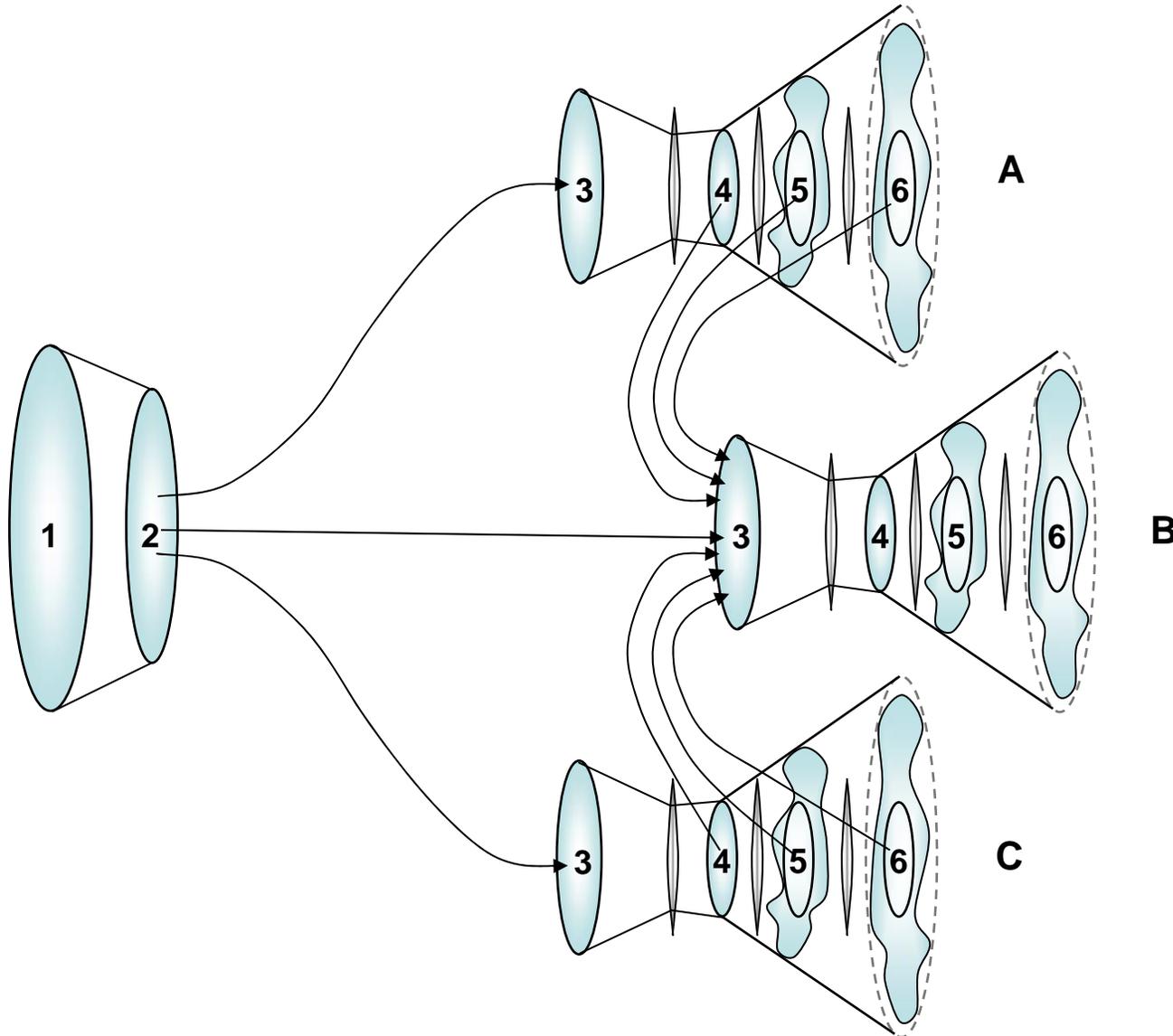
(Woods, 1993)

The Dynamic Model of Situated Cognition

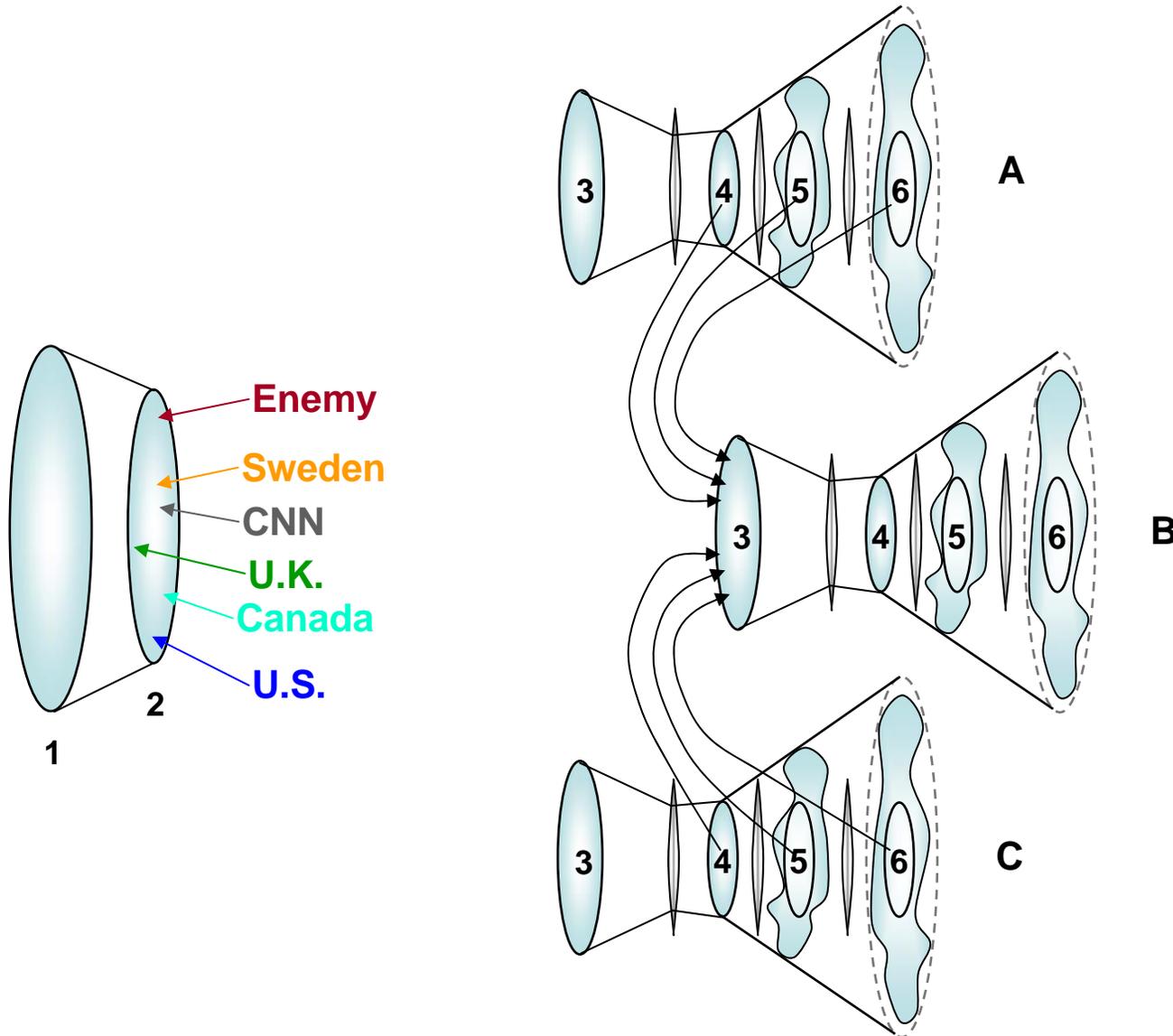


Measuring Technological Awareness
 Measuring Human Awareness
 Measuring SA By Using Process Tracing

The Model Applied to Teams



The Model Applied to Coalition Forces

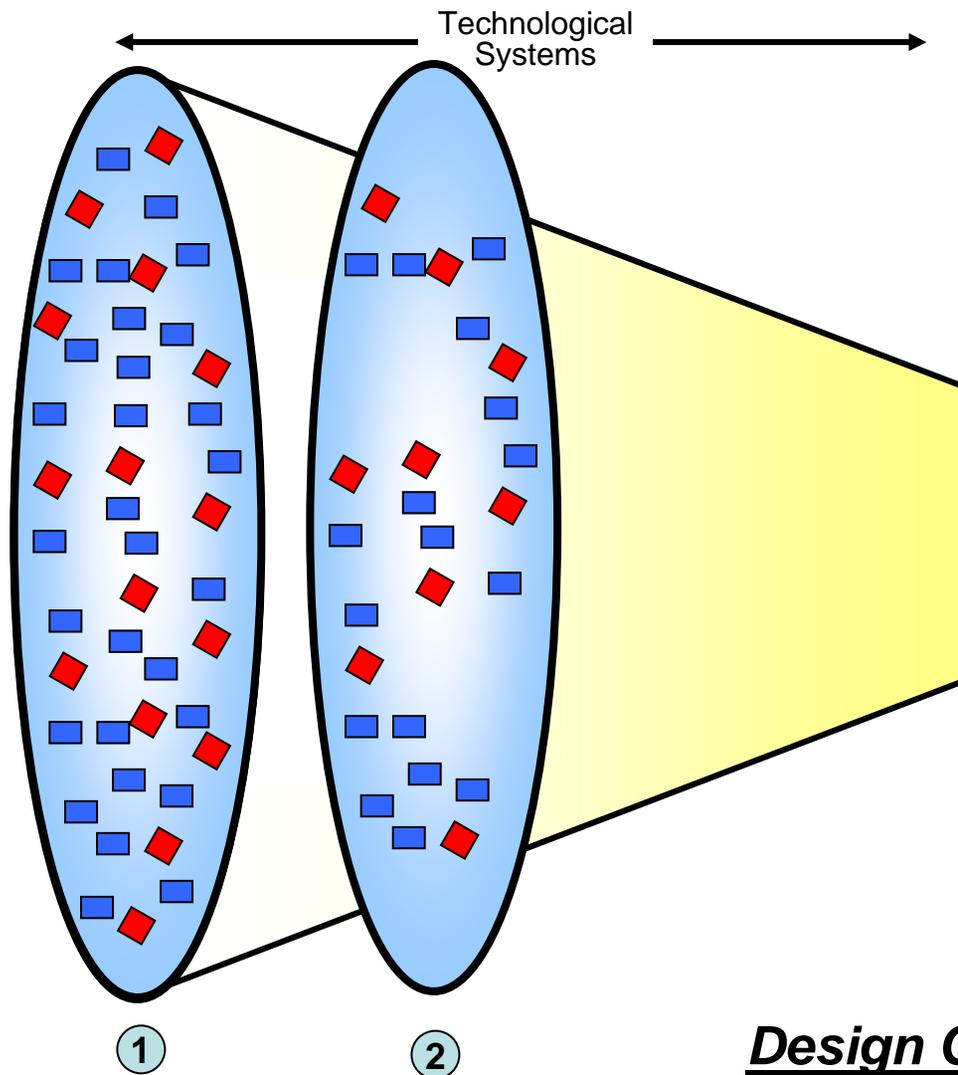




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Number, Type, and Location of Sensors



All data in the environment

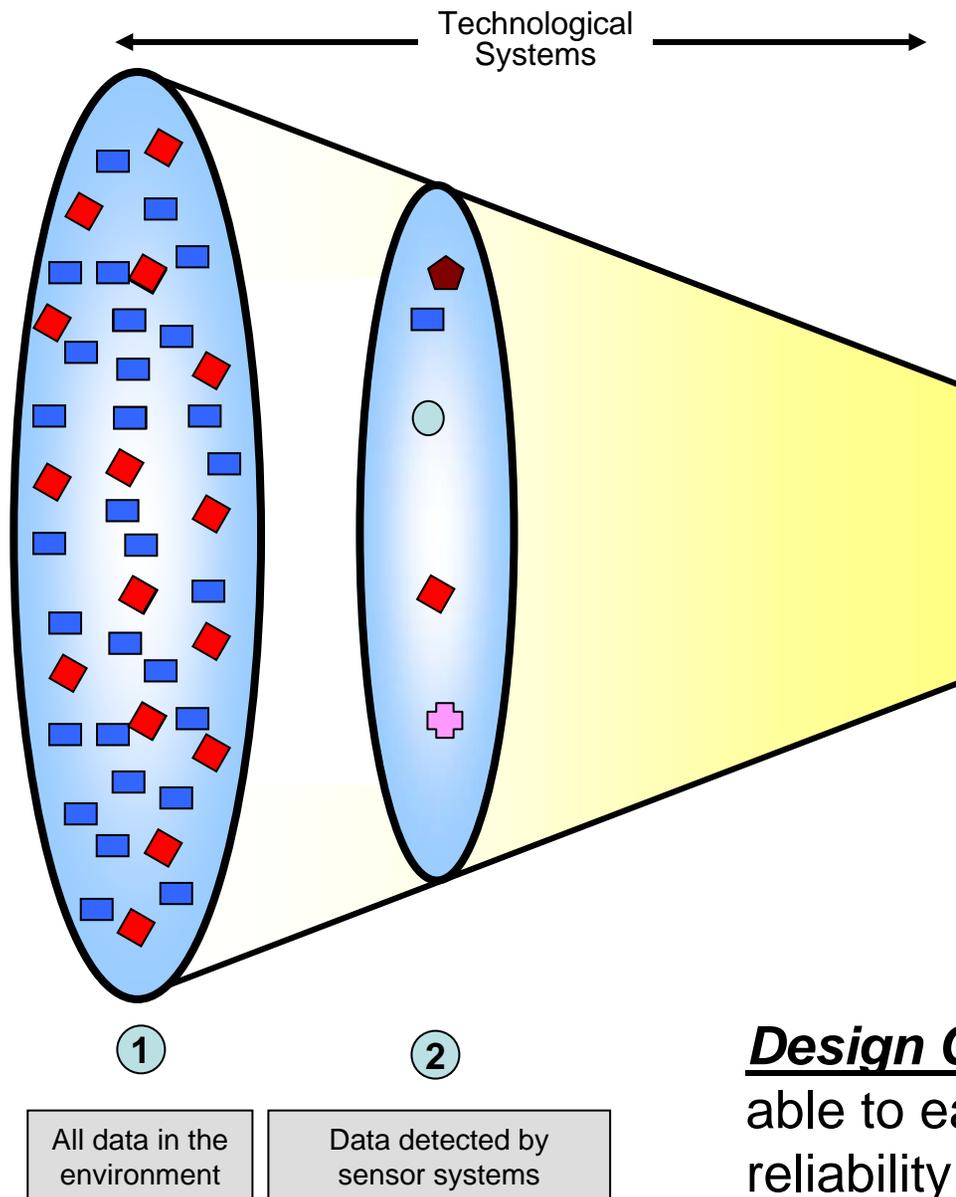
Data detected by sensor systems

Sufficient number, type, and location of sensors

- gaps in coverage
- move, change size & shape

Design Concept: Sensor systems must be sufficient in terms of both type and number and operators must know where the coverage is located at all times.

Accuracy and Reliability of Sensors



Human and technological sensors will not be accurate all of the time.

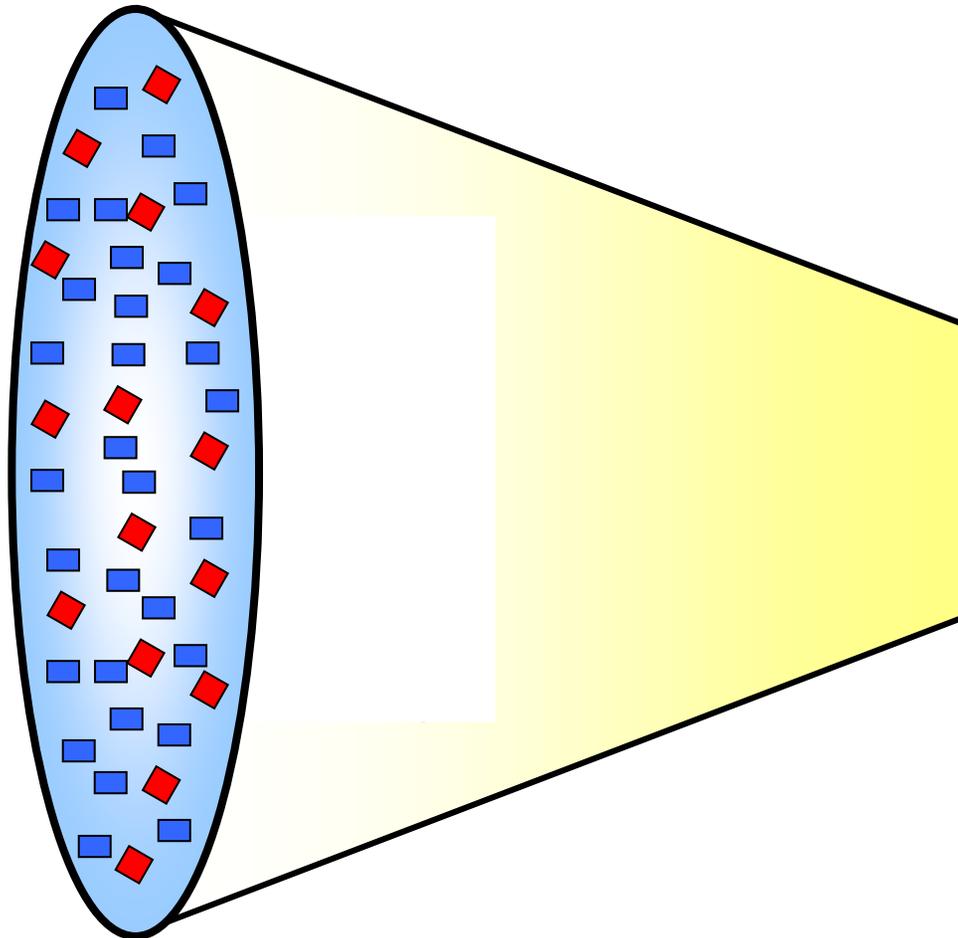
Inaccuracy will:

- differ across sensor types.
- vary in humans based on states and traits.
- not always be detectable.

Sensors will also vary with respect to reliability due to states and traits (in humans) or to design or system failure (in technology).

Design Concept: Operators should be able to easily discern the accuracy and reliability of the sensors.

Spoofting of Sensor Systems



1

All data in the environment

2

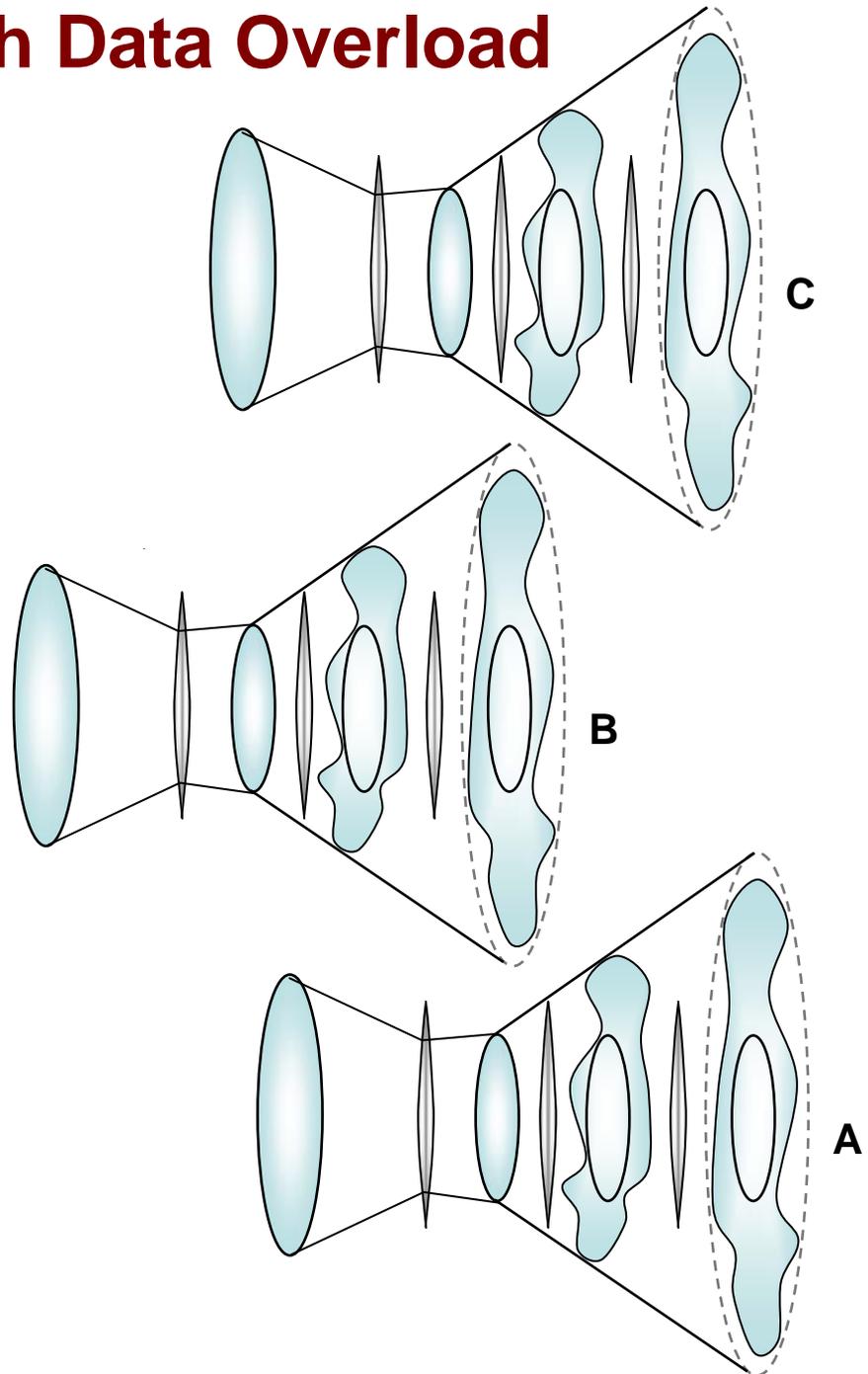
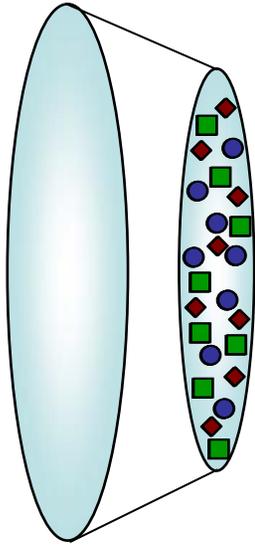
Data detected by sensor systems

The enemy can spooft friendly sensors by either masking or deceiving the sensors as to the type, number, and location of enemy systems in the battlespace.

Design Concept: Sensor systems must be sophisticated enough to detect spoofing activities.

Coping With Data Overload

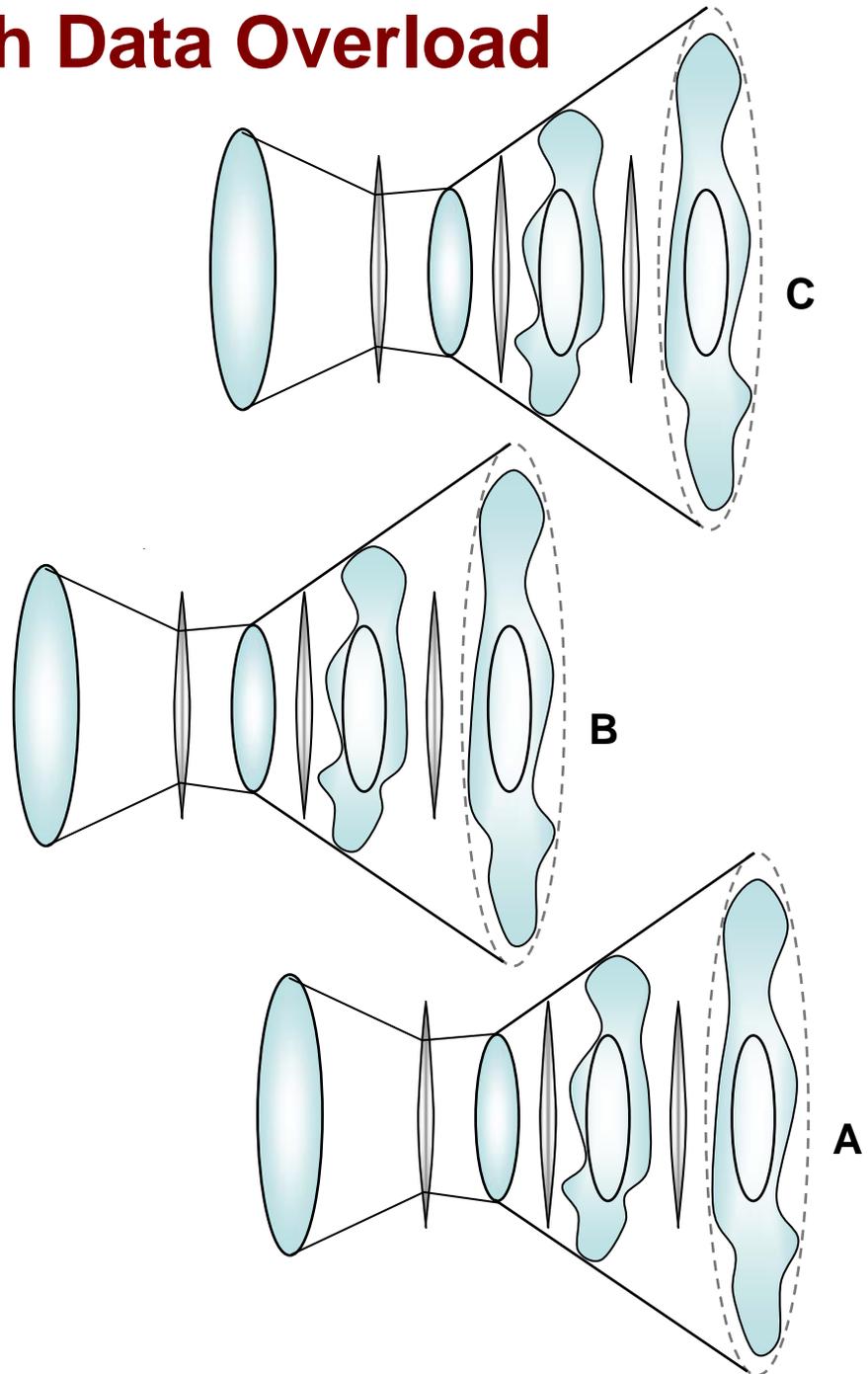
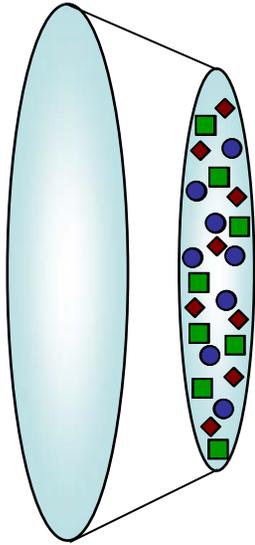
If all data in Oval 2 were displayed on Oval 3, users would be overloaded.



Coping With Data Overload

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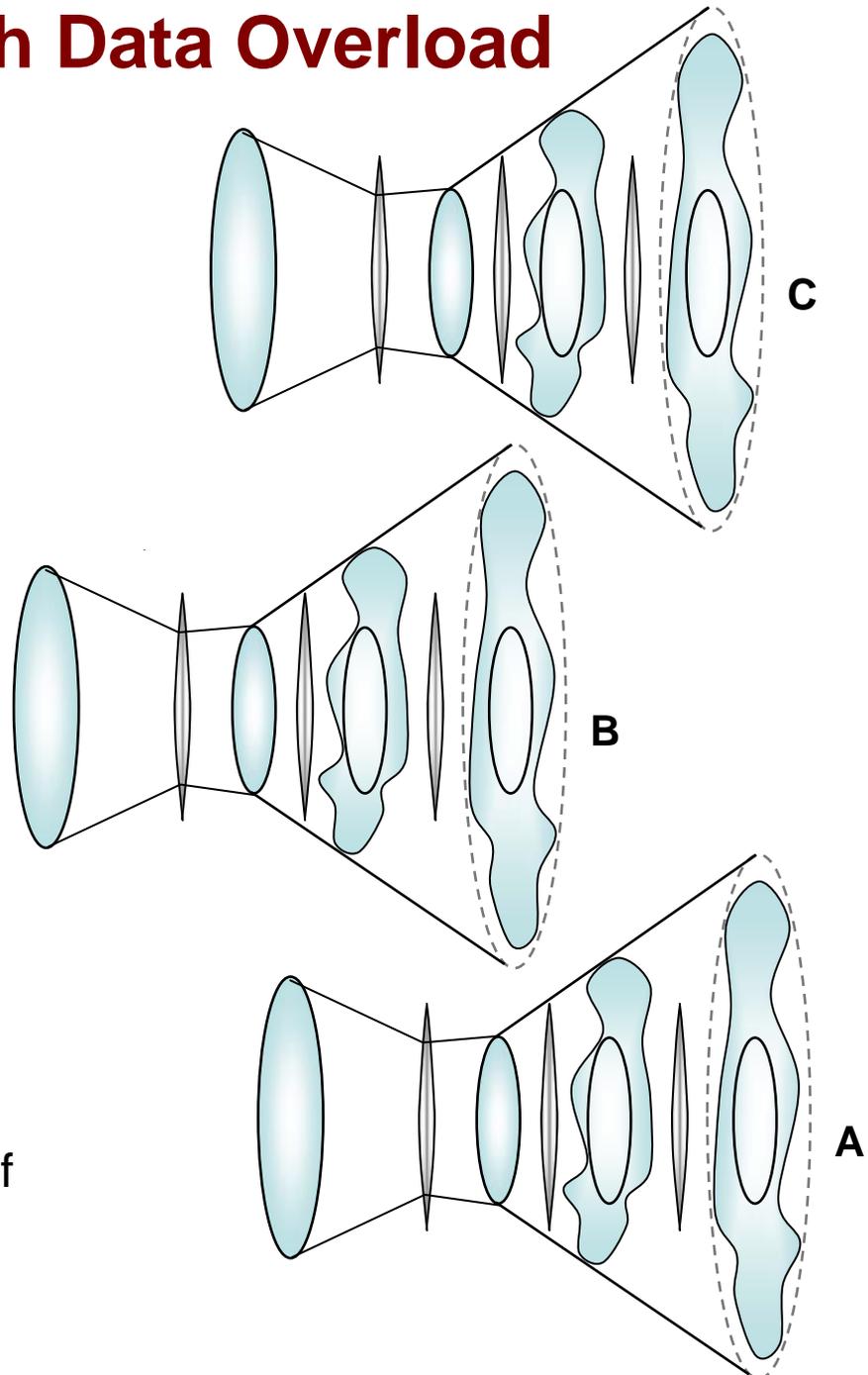
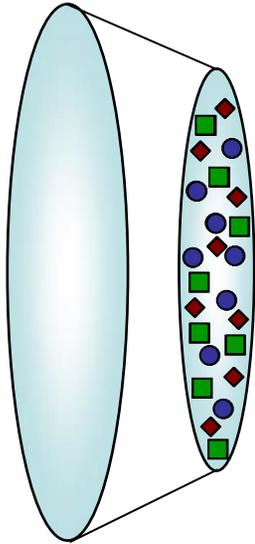
If users develop their own filtering strategies data can be unnecessarily redundant or missed altogether.



Coping With Data Overload

If all data in Oval 2 were displayed on Oval 3, users would be overloaded.

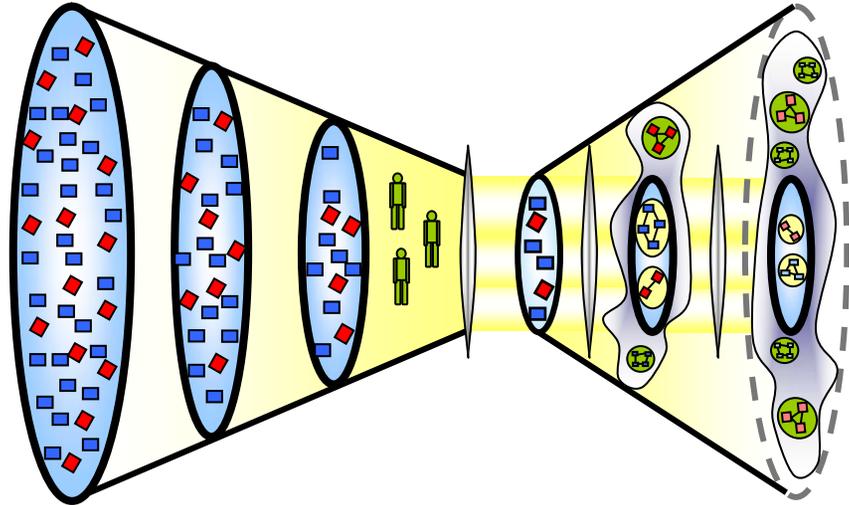
If users develop their own filtering strategies data can be unnecessarily redundant or missed altogether.



Design Concept: Filtering strategies must be designed from the perspective of the team; strategies must be managed closely to ensure all necessary data are made available to users.

Summary

- ❑ The assessment and design of Network Centric Operations and Warfare can be facilitated with a ***process model***.
- ❑ The ***dynamic model of situated cognition*** addresses ***both human and machine*** system components.
- ❑ The ***dynamic model of situated cognition*** can be used as a tool for examining all domains of warfare: physical, information, cognitive, social and ecological.
- ❑ The model ***helps designers understand how network environments function***.





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