A Process Model of Situated Cognition in Military Command and Control

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Agenda

- Situation Awareness versus Situated Cognition
- A Process Model of Situated Cognition
- Measurement Methods and Metrics
- The *USS Stark*: A Case Study

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))

Ideal SA; Achievable SA; Actual SA (Pew, 2000)

"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

Methods for Measuring SA

Subjective ↔ Objective
Prospective ↔ Retrospective
Direct ↔ Indirect
Obtrusive ↔ Unobtrusive

- SART: Situational Awareness Rating Technique
- SA-SWORD: Situation Awareness-Subjective Workload Dominance
- SARS: Situation Awareness Rating Scale
- MARS: Mission Awareness Rating
- SAGAT: Situational Awareness Global Assessment Technique
- SALIENT: SA Linked Instances Adapted to Novel Tasks
- SABARS: Situation Awareness Behaviorally Anchored Rating Scale

These methods measure:

- ***states***, **not processes!**
- ***humans***, **not systems!**

An Alternative to Situation Awareness

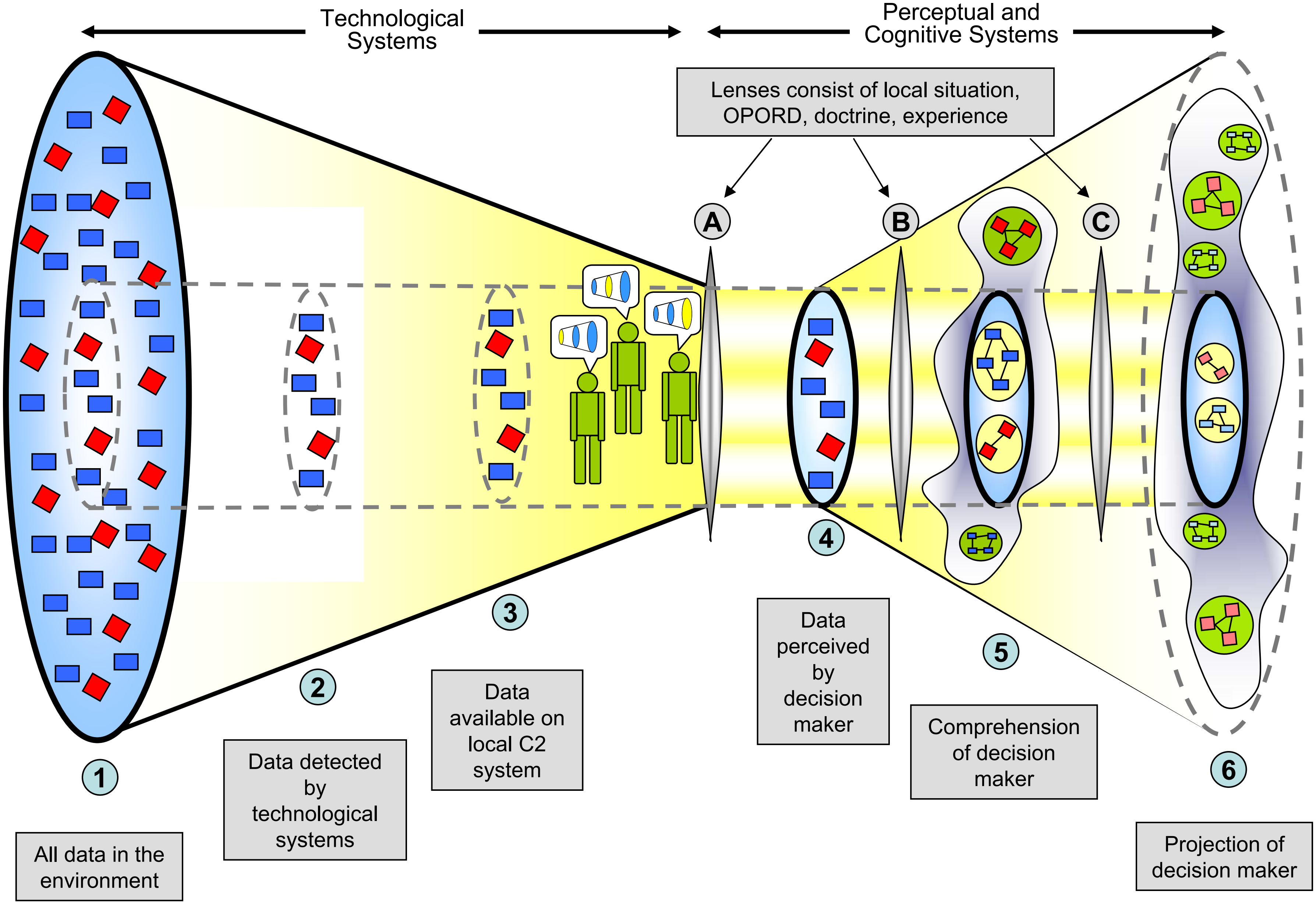
A model and a methodological approach that:

- ☐ 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***

A Process Model of Situated Cognition



Technological Systems
Perceptual and Cognitive Systems
Lenses consist of local situation, OPORD, doctrine, experience
A
B
C
1
2
3
4
5
6
All data in the environment
Data detected by technological systems
Data available on local C2 system
Data perceived by decision maker
Comprehension of decision maker
Projection of decision maker

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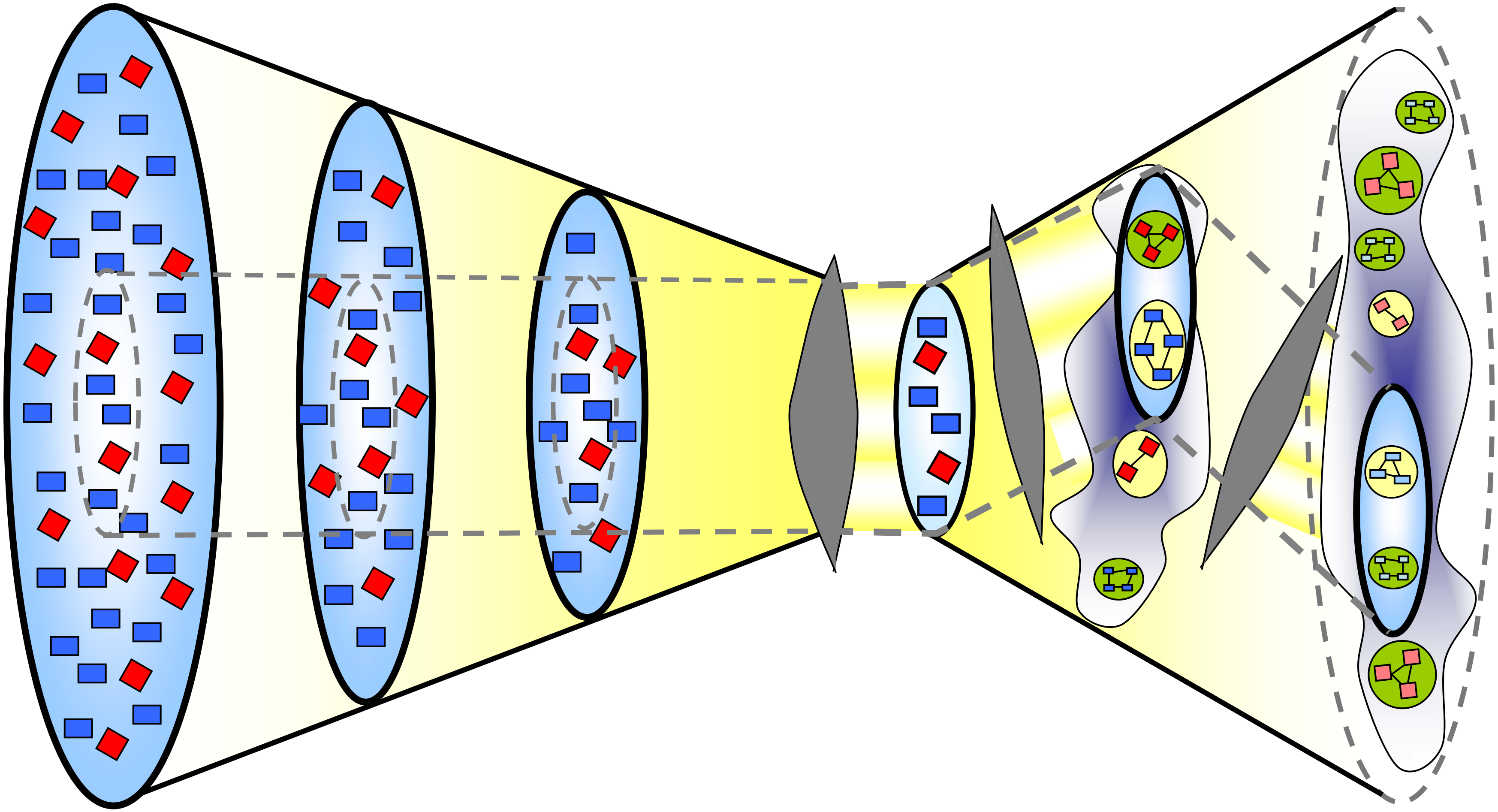
Misshaped lenses **will skew a decision maker's perceptions, comprehensions, and projections**



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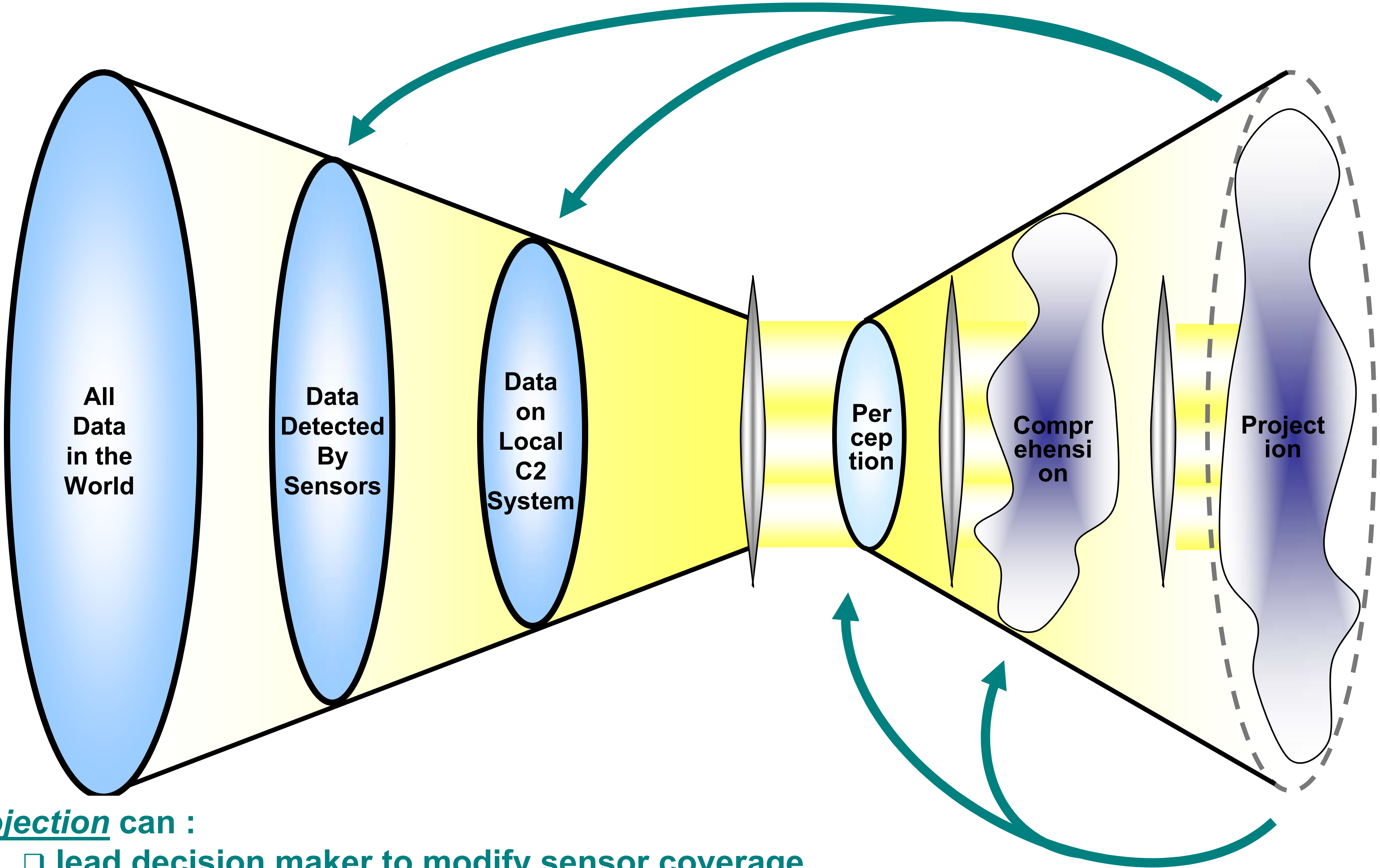
Feedback Loops in the Model


All Data in the World
Data Detected By Sensors
Data on Local C2 System
Per cep tion
Compr ehensi on
Project ion

Projection **can :**

- ☐ **lead decision maker to modify sensor coverage**
- ☐ **lead decision maker to modify local C2 display**
- ☐ **shift attention and influence perception of data**
- ☐ **influence comprehension of data**

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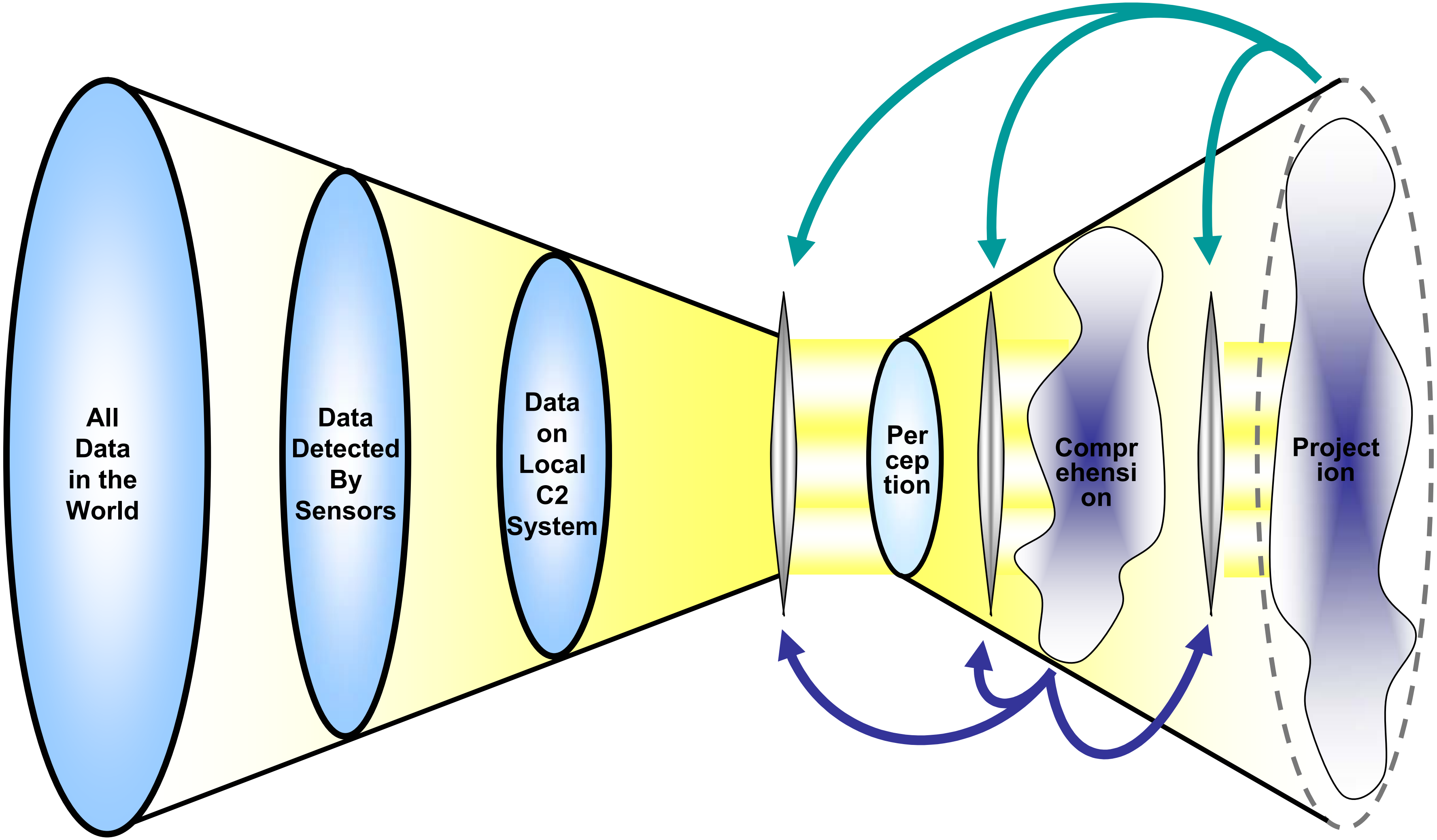
Feedback Loops in the Cone


All Data in the World
Data Detected By Sensors
Data on Local C2 System
Per cep tion
Compr ehensi on
Project ion

Comprehension can shape the contents (and contour) of the lenses.

Projection can shape the contents (and contour) of the lenses.

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Process Tracing Methodologies

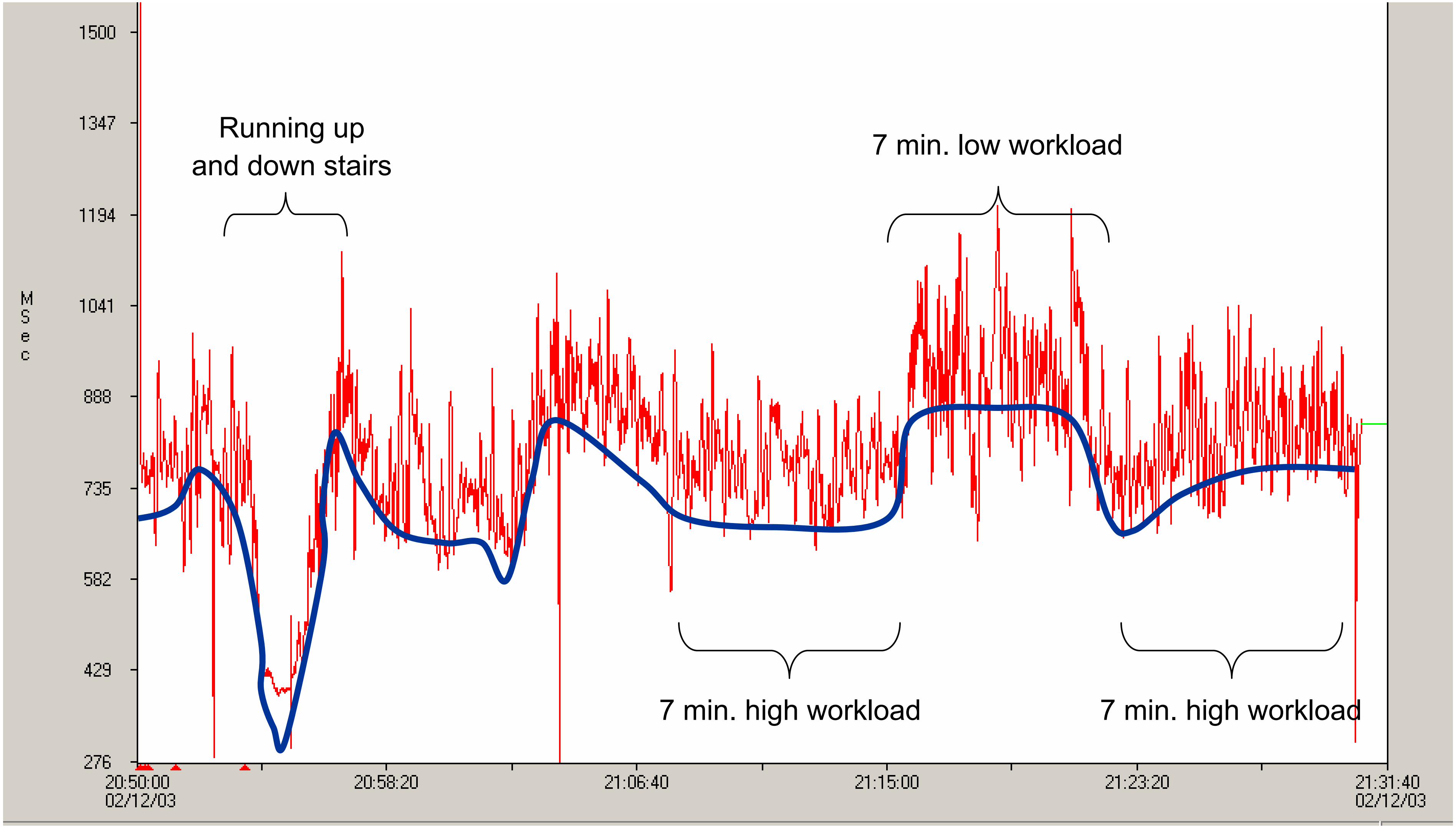
- ❑ Map out ***how an incident unfolded***, including:
  - ▪ Available cues
  - ▪ Those cues actually noted by participants
  - ▪ Participants' interpretation in immediate and larger contexts
- ❑ Focus on ***how a given outcome came about***
- ❑ Oriented towards externalizing internal processes
- ❑ Use 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)

Candidate Sources of Data

- Audio and video recordings
- Various database queries
- Heart Rate Variability Monitors
- Wrist Activity Monitors
- Retrospective Interviews
- Subjective Workload Assessment Graph-Cognitive (SWAG-C)
- Geographical Recall and Analysis of Data in the Environment (GRADE)
- Situation Awareness Rating Technique (SART)

Sample Heart Rate Variability



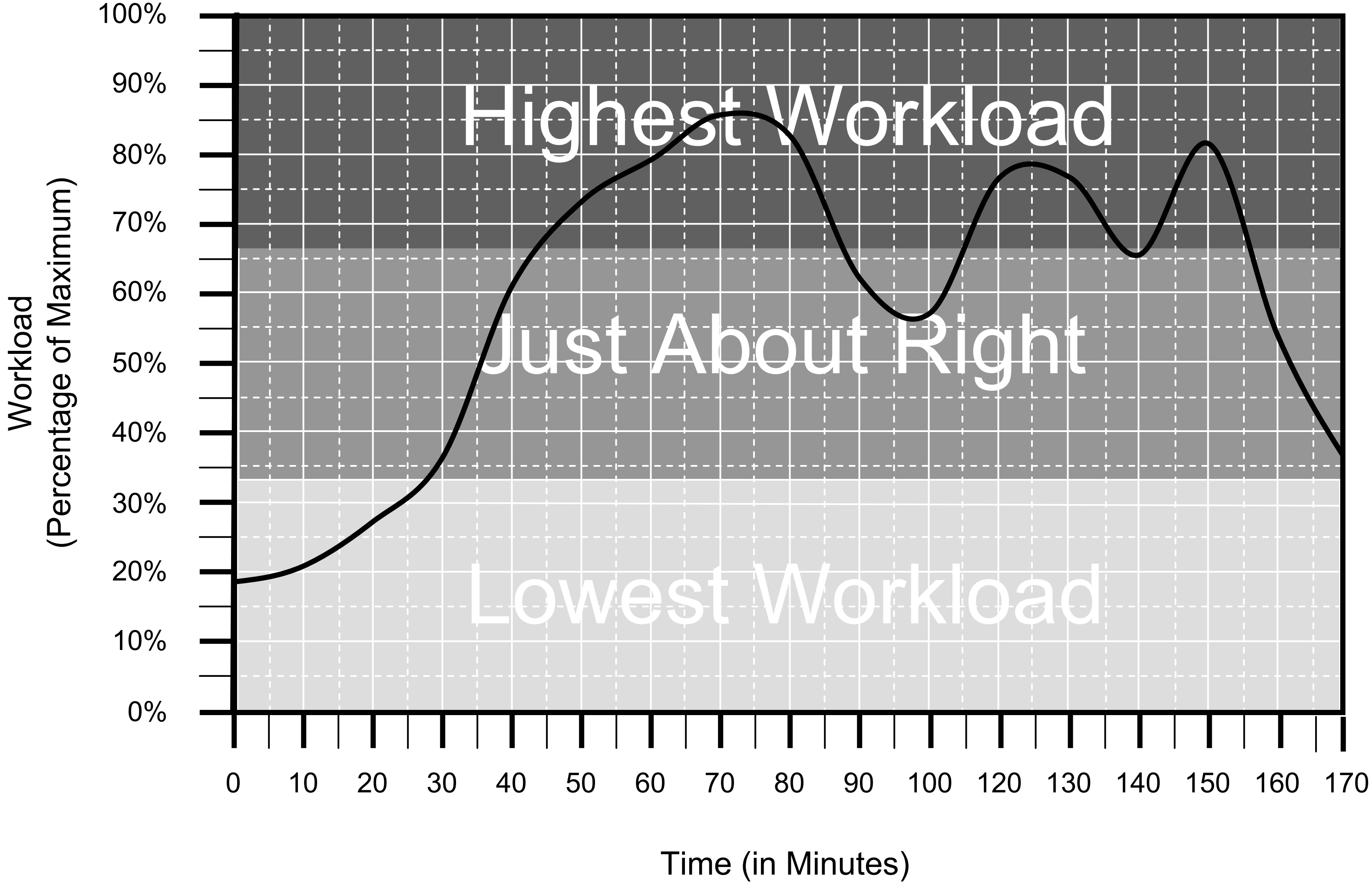
Running up and down stairs

7 min. low workload

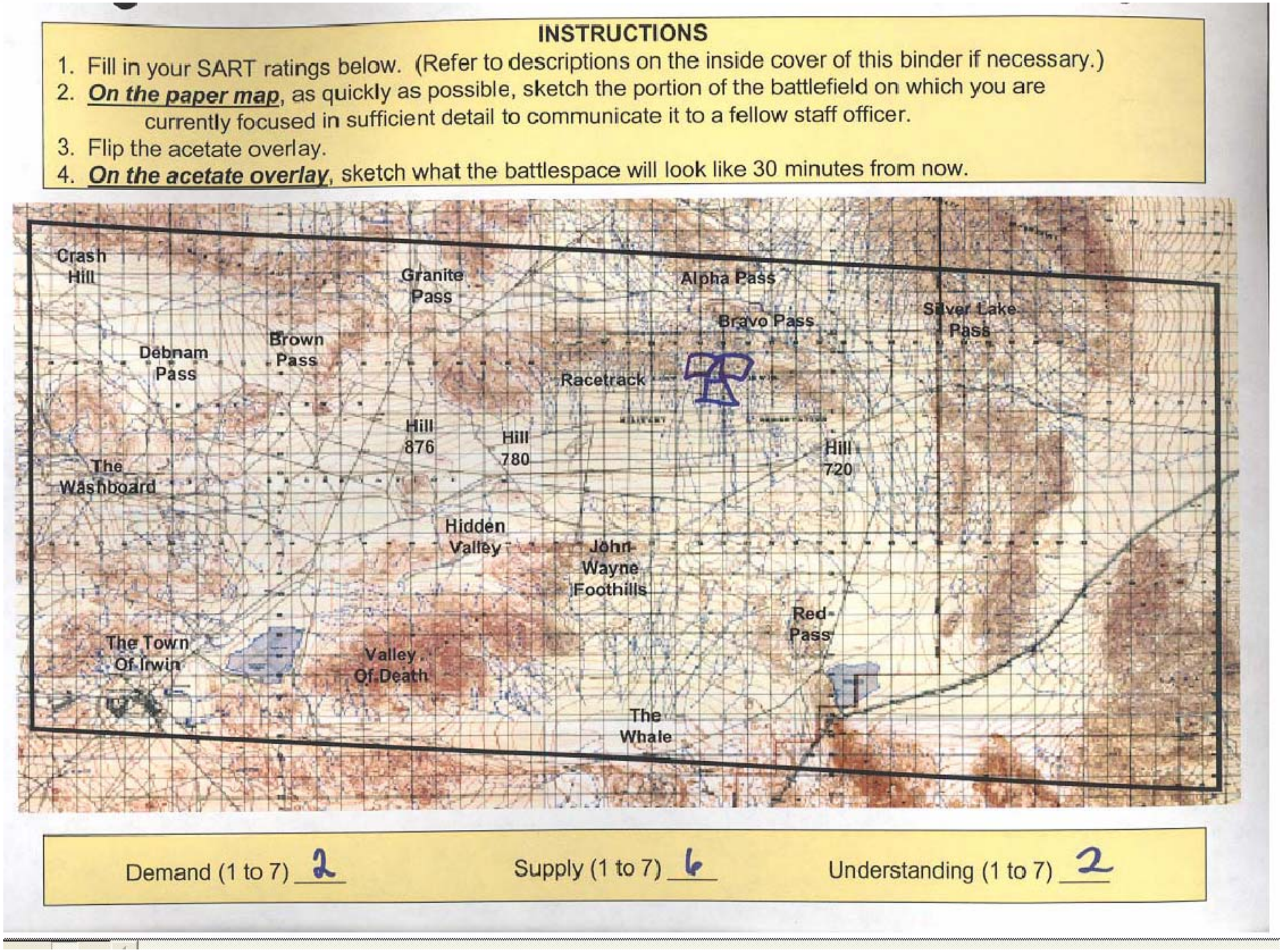
7 min. high workload

7 min. high workload

Subjective Workload Assessment Graph (Cognitive) (SWAG–C)



Sample GRADE



INSTRUCTIONS

1. Fill in your SART ratings below. (Refer to descriptions on the inside cover of this binder if necessary.)
2. ***On the paper map***, as quickly as possible, sketch the portion of the battlefield on which you are currently focused in sufficient detail to communicate it to a fellow staff officer.
3. Flip the acetate overlay.
4. ***On the acetate overlay***, sketch what the battlespace will look like 30 minutes from now.

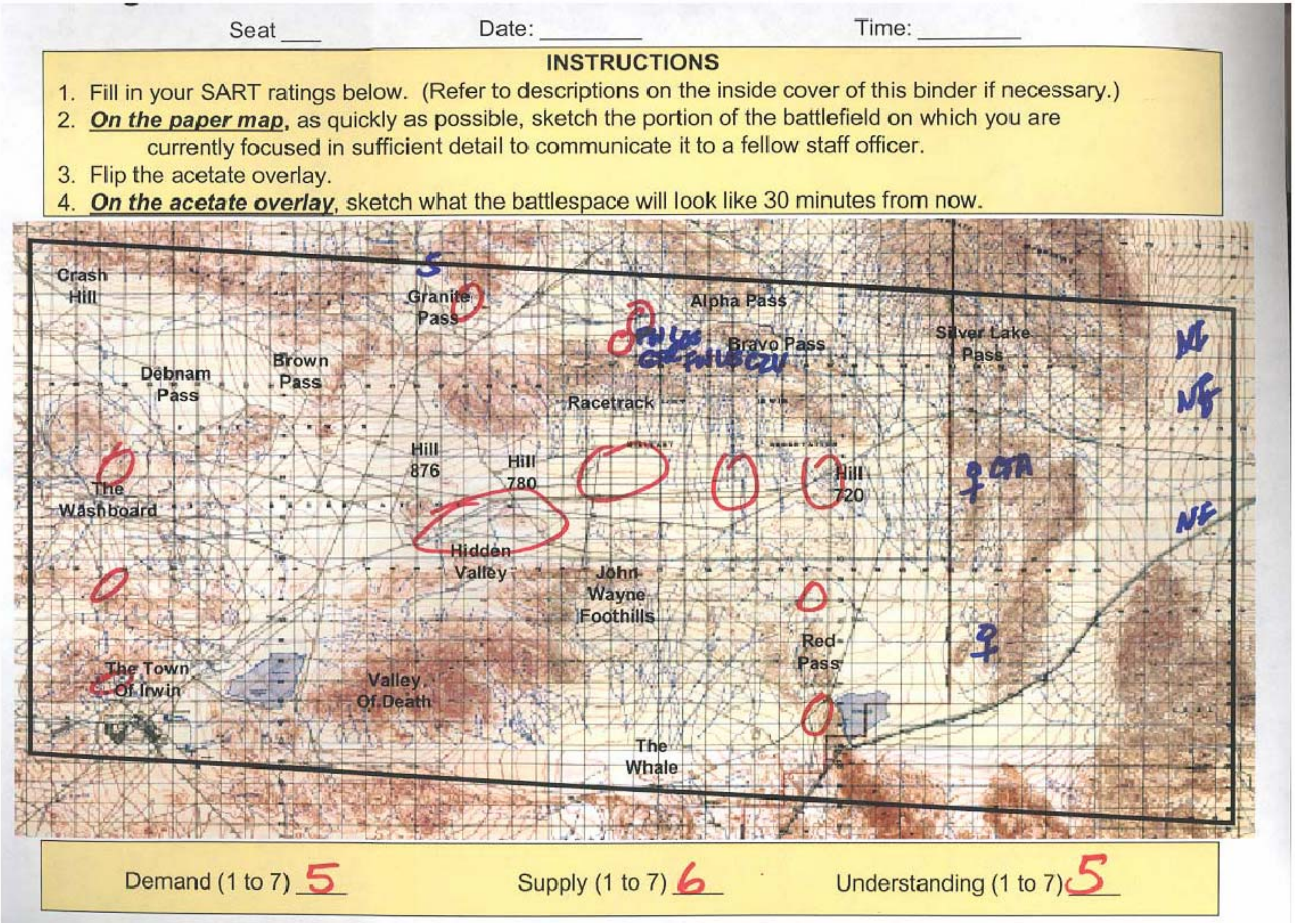
Crash Hill
Granite Pass
Alpha Pass
Bravo Pass
Silver Lake Pass
Debnam Pass
Brown Pass
Racetrack
Hill 876
Hill 780
Hill 720
The Washboard
Hidden Valley
John Wayne Foothills
Red Pass
The Town Of Irwin
Valley Of Death
The Whale

Demand (1 to 7) 2

Supply (1 to 7) 6

Understanding (1 to 7) 2

Sample GRADE



Seat ___ Date: ________ Time: ________

INSTRUCTIONS

1. Fill in your SART ratings below. (Refer to descriptions on the inside cover of this binder if necessary.)
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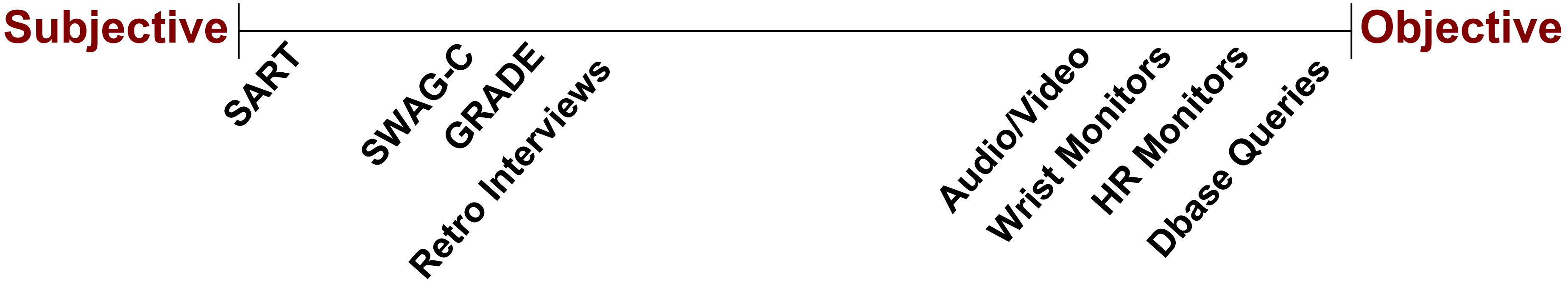
Crash Hill
5
Granite Pass
Alpha Pass
Bravo Pass
Silver Lake Pass
Debnam Pass
Brown Pass
Racetrack
Hill 876
Hill 780
Hill 720
The Washboard
Hidden Valley
John Wayne Foothills
Red Pass
The Town Of Irwin
Valley Of Death
The Whale

Demand (1 to 7) 5

Supply (1 to 7) 6

Understanding (1 to 7) 5

Evaluating Data Sources



Subjective

SART

SWAG-C

GRADE

Retro Interviews

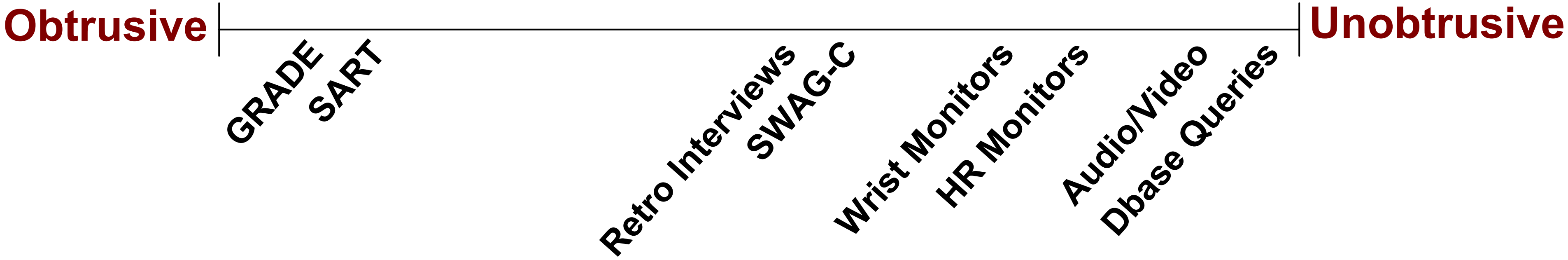
Audio/Video

Wrist Monitors

HR Monitors

Dbase Queries

Objective



Obtrusive

GRADE

SART

Retro Interviews

SWAG-C

Wrist Monitors

HR Monitors

Audio/Video

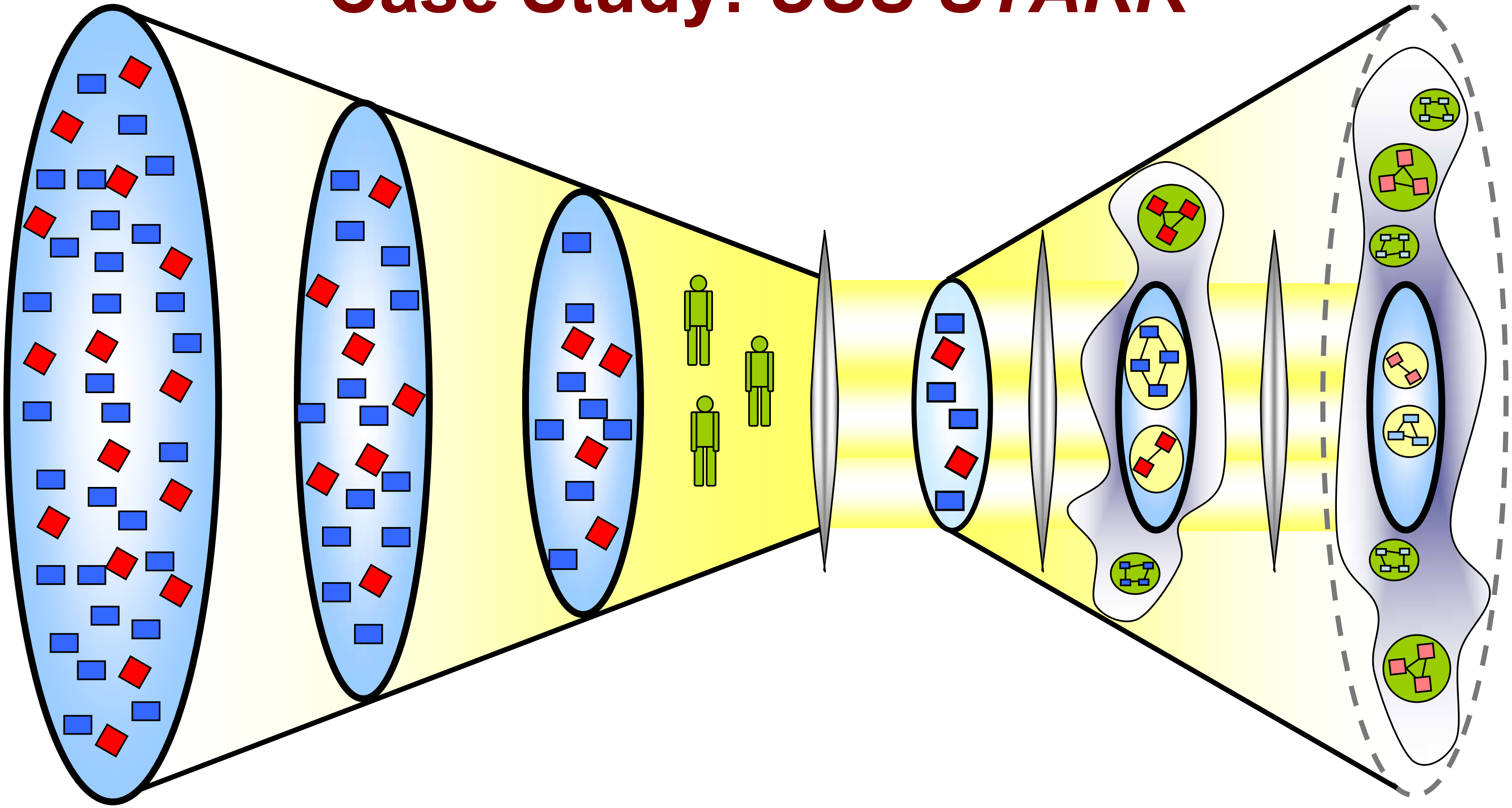
Dbase Queries

Unobtrusive

Data	Oval
Dbase Queries	1, 2
Audio/Video	2, 3, 4, 5, 6
GRADE	4, 5, 6
Retro Interviews	4, 5, 6

Data	Oval
SWAG-C	4, 5
HR Monitors	4, 5
SART	4, 5, 6
Wrist Monitors	4

Case Study: *USS STARK*



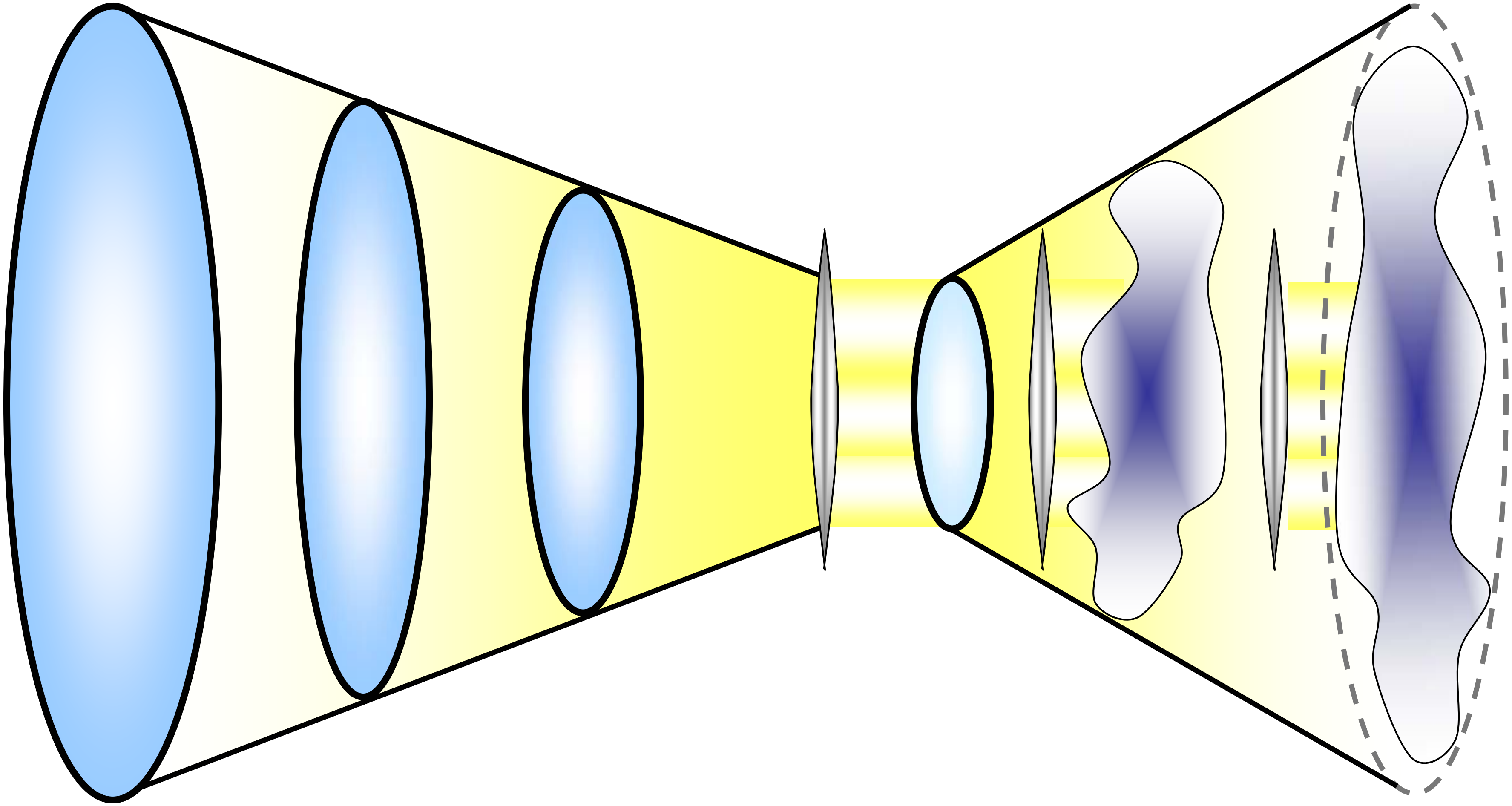
On the evening of May 17, 1987, the *USS Stark* was patrolling international waters in the Persian Gulf off the coast of Bahrain and Saudi Arabia. At 2109 that evening, the *USS Stark* was struck by the first of two Exocet AM-39 anti-ship cruise missiles, fired from an Iraqi F-1 Mirage fighter.

Oval 1: Ground Truth

Iraqi F-1 Mirage flying toward the *USS Stark*.

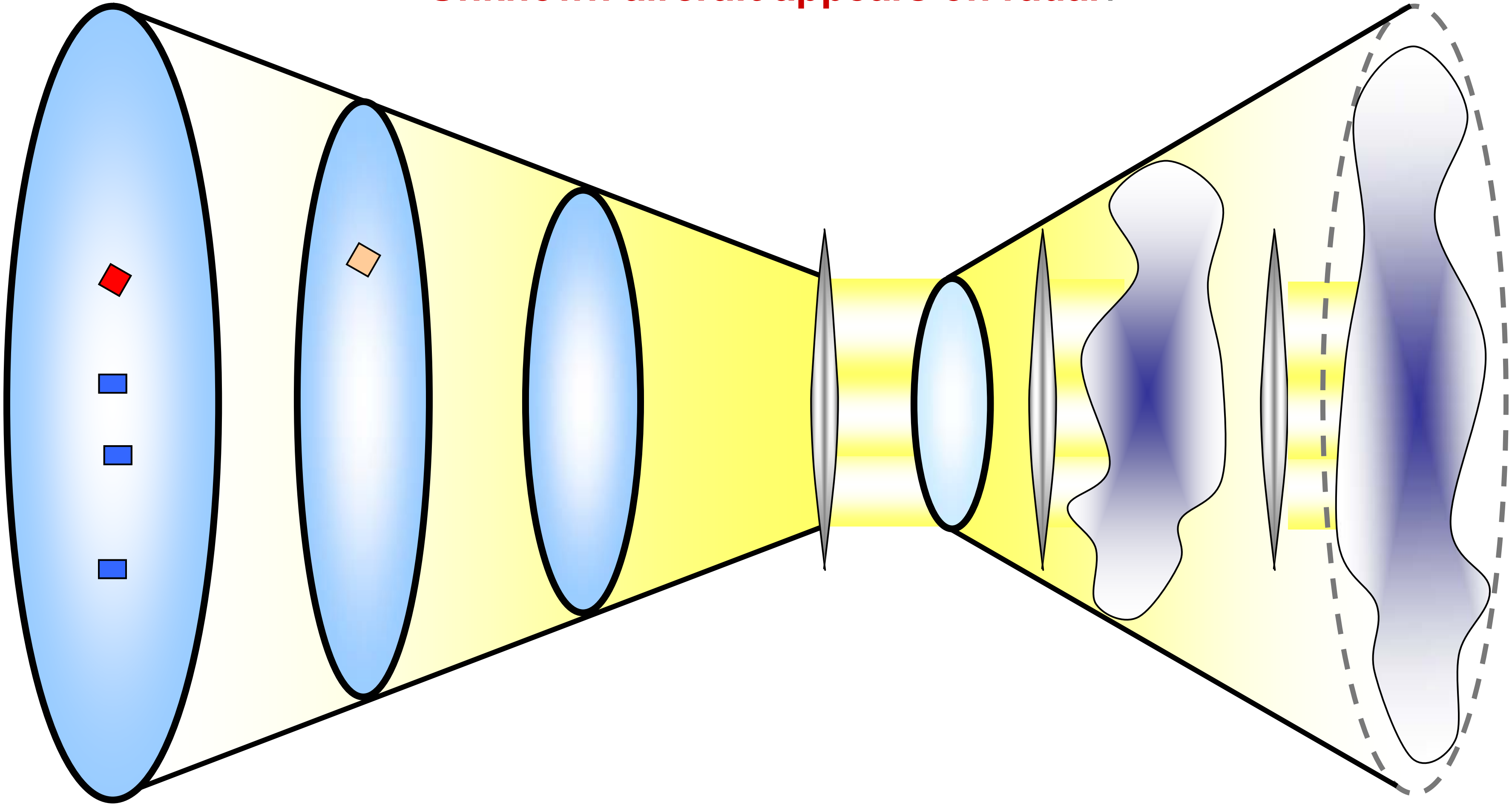
Other US vessels are in the area.

AWACS is alert.



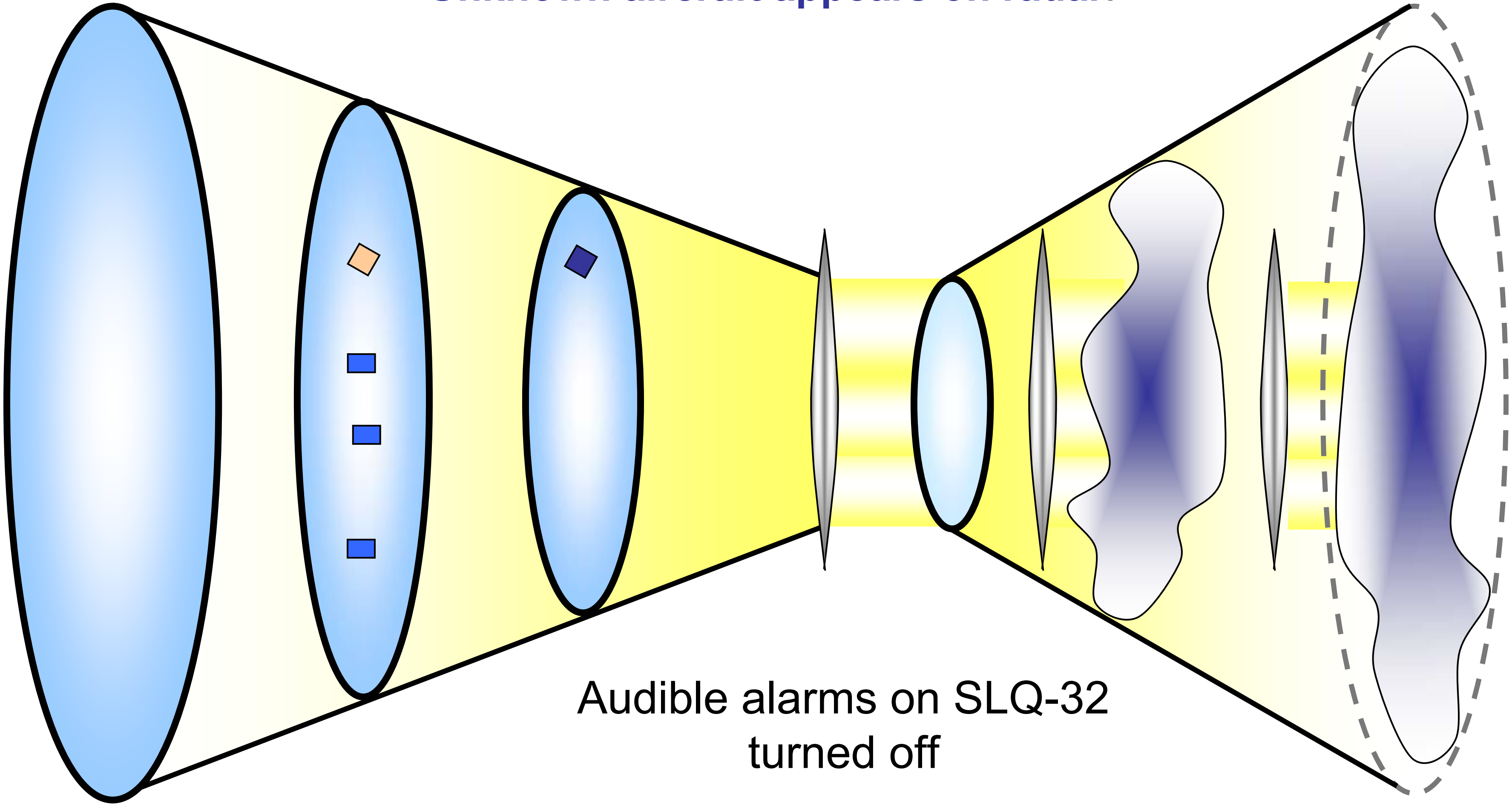
Oval 2: Sensor Coverage

USS Stark is 12 nm from Iraqi exclusion zone.
AWACS is aloft.
Other USN vessels in the area.
Unknown aircraft appears on radar.



Oval 3: Workstation Display

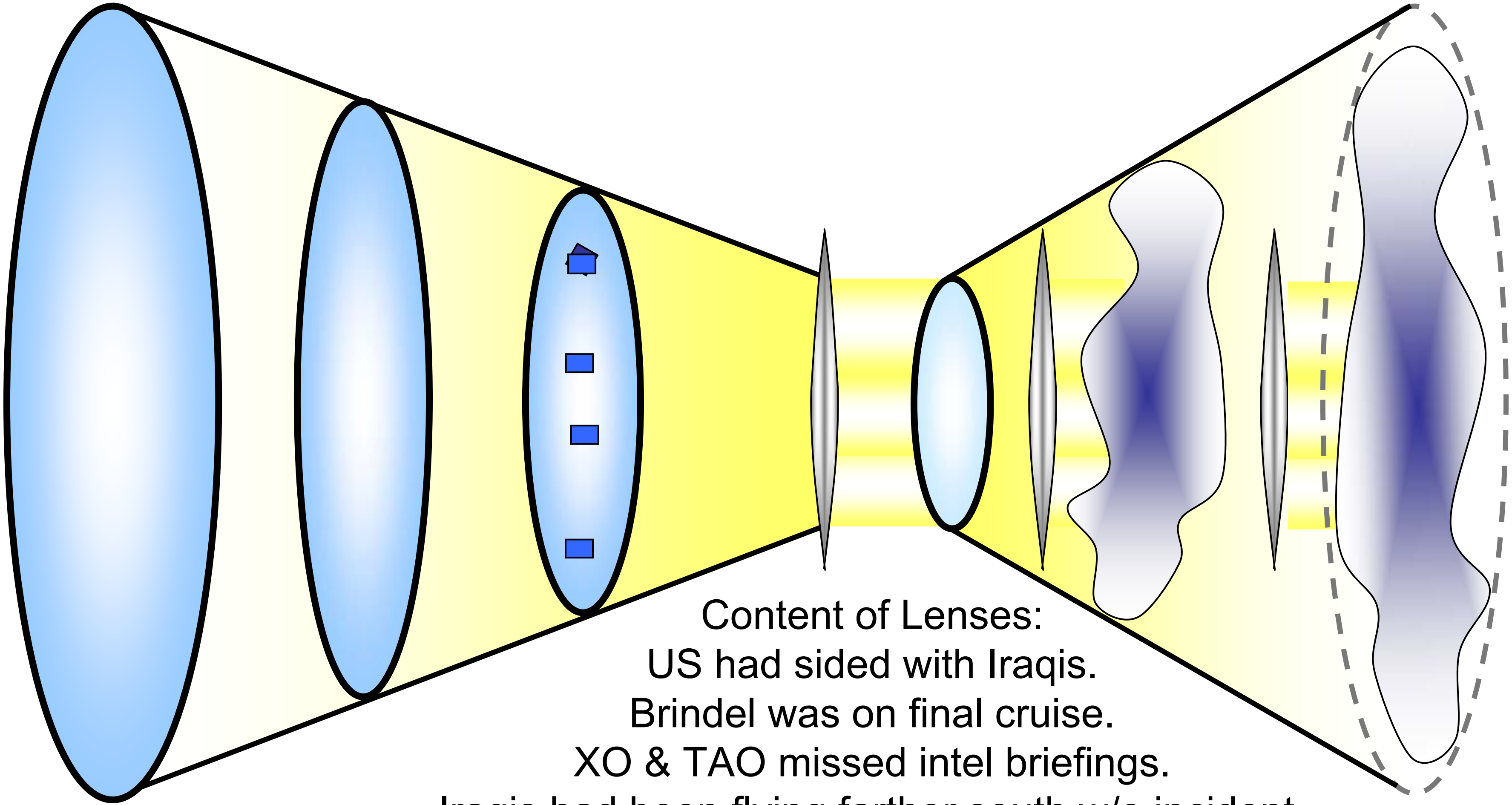
USS Stark is 12 nm from Iraqi exclusion zone.
AWACS is aloft.
Other USN vessels in the area.
Unknown aircraft appears on radar.



Audible alarms on SLQ-32
turned off

Oval 4: Perception

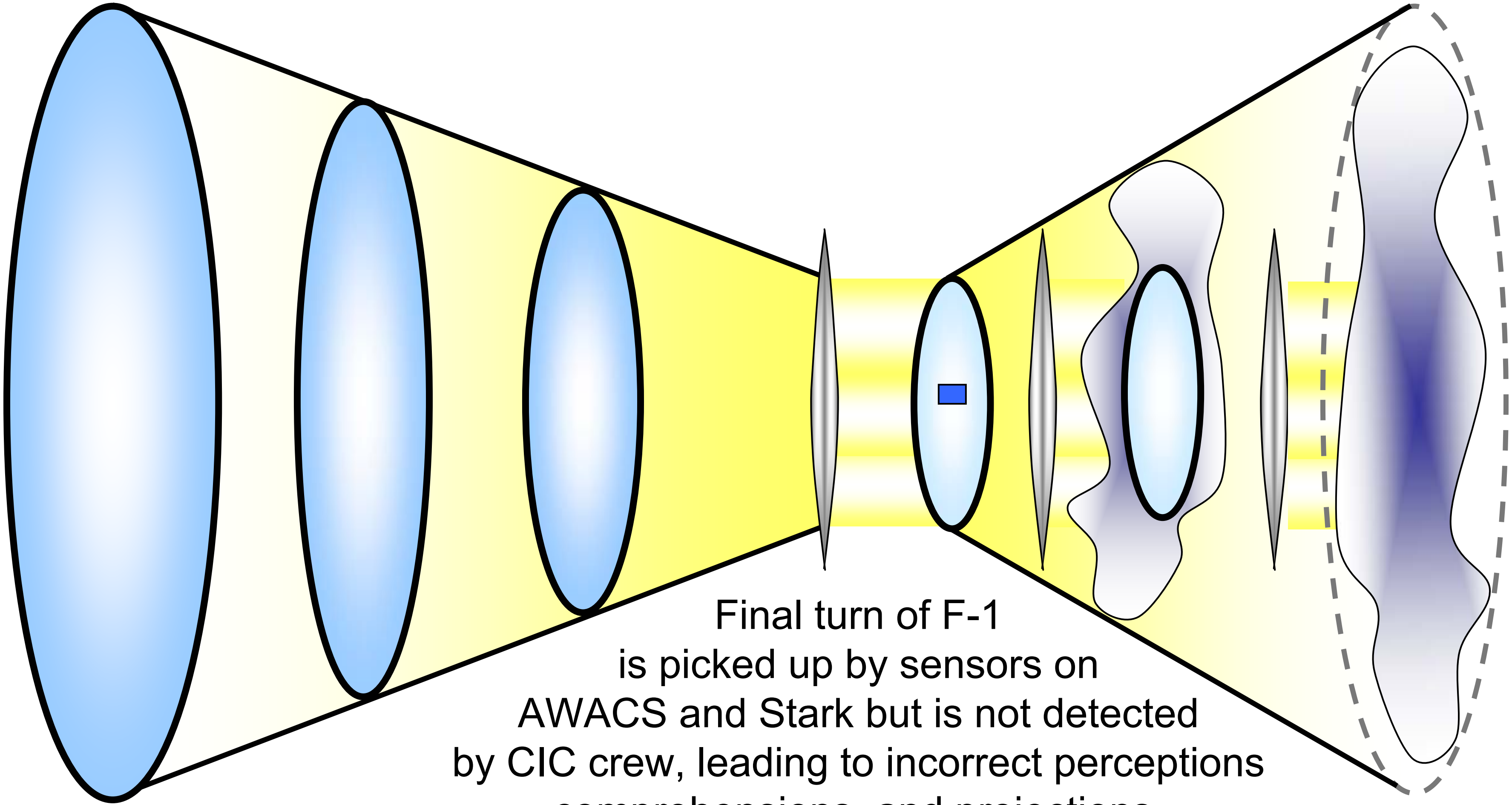
Aircraft on detected on radar.
Aircraft tagged as friendly.



Content of Lenses:
US had sided with Iraqis.
Brindel was on final cruise.
XO & TAO missed intel briefings.
Iraqis had been flying farther south w/o incident.

Oval 5: Comprehension

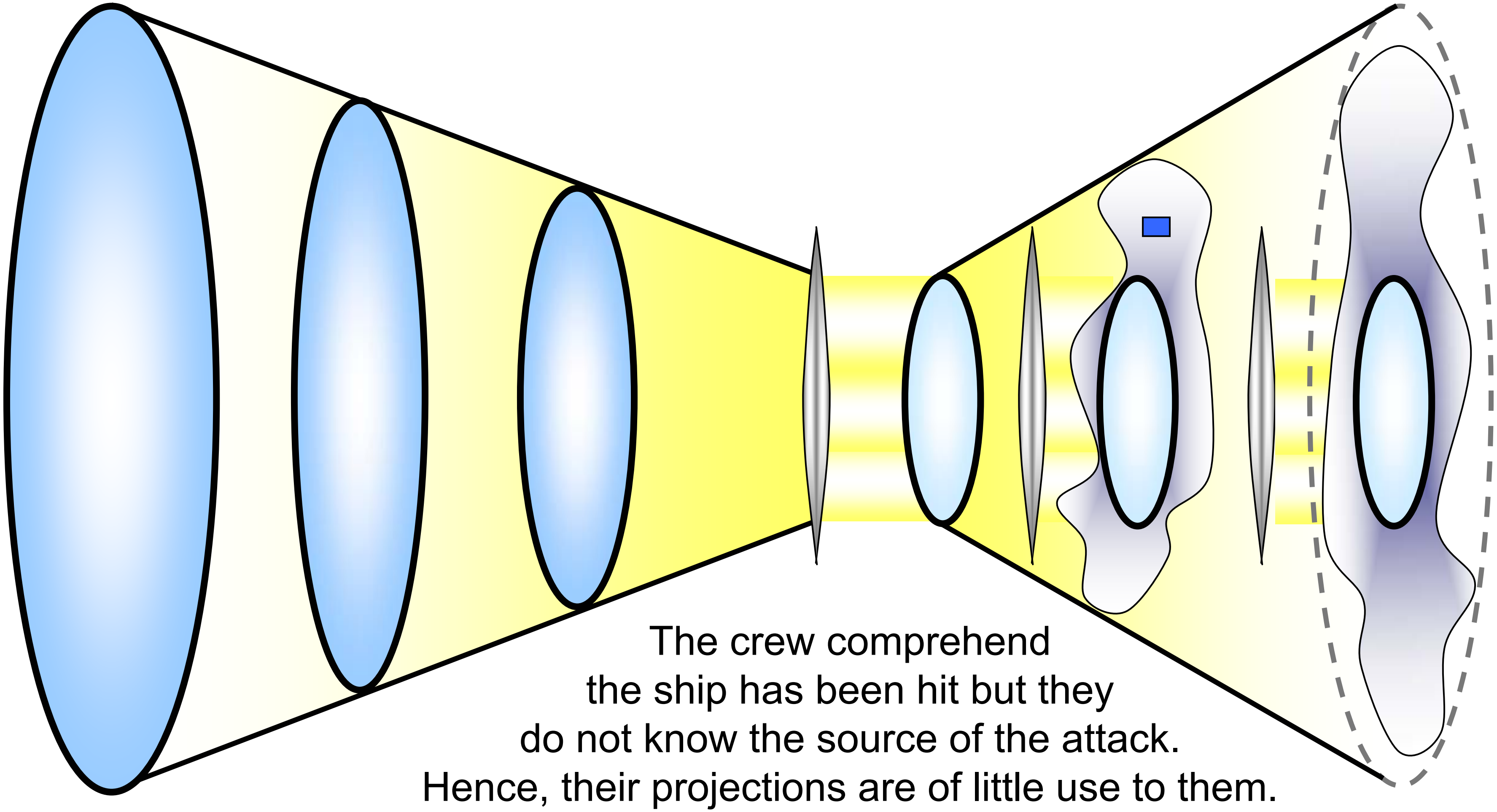
Aircraft is no threat to *USS Stark*.



Final turn of F-1
is picked up by sensors on
AWACS and Stark but is not detected
by CIC crew, leading to incorrect perceptions
comprehensions, and projections.

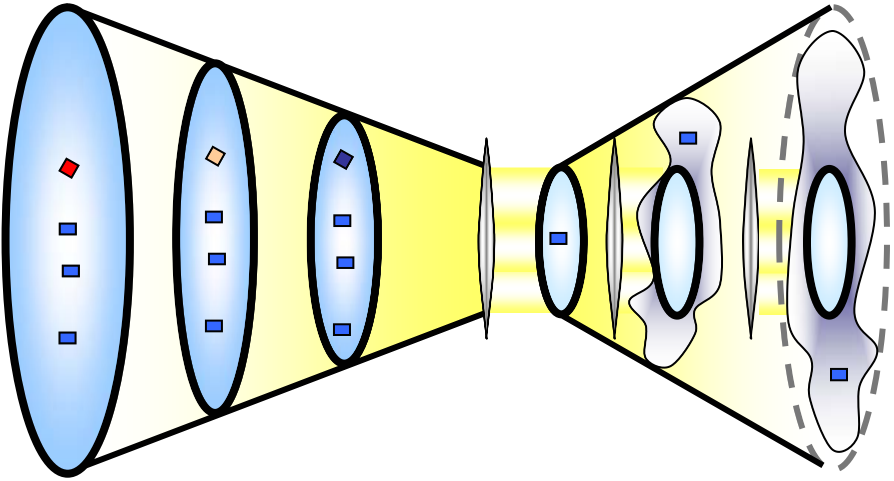
Oval 6: Projection

Aircraft will turn away from *USS Stark*.



The crew comprehend
the ship has been hit but they
do not know the source of the attack.
Hence, their projections are of little use to them.

Summary



- ❑ The case of the *USS Stark* illustrates the ***utility of the process model*** of situated cognition as a descriptive and explanatory tool.

- ❑ The model ***combines both human and machine*** system components.

- ❑ By employing multiple methods of data collection, ***the evolution of an event can be traced*** as data and information flow through the machine and human components of the system.

- ❑ The model ***facilitates determining when and how activities go awry***.

- ❑ Knowledge of how and when errors occur is ***critical to the design of new C2 systems*** and the re-design of existing systems.

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