



A Process Model of Situating Cognition in Military Command and Control

Collaboration and Knowledge Management
Workshop

11 - 13 January 2005
San Diego, CA



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Agenda

- ❑ Situation Awareness versus Situated Cognition
- ❑ A Process Model of Situated Cognition
- ❑ The *USS Stark*: A Case Study (Individual)
- ❑ Team versus Shared Situation Awareness
- ❑ The *USS Stark*: A Case Study (Distributed)
- ❑ Measurement Methods and Metrics



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)

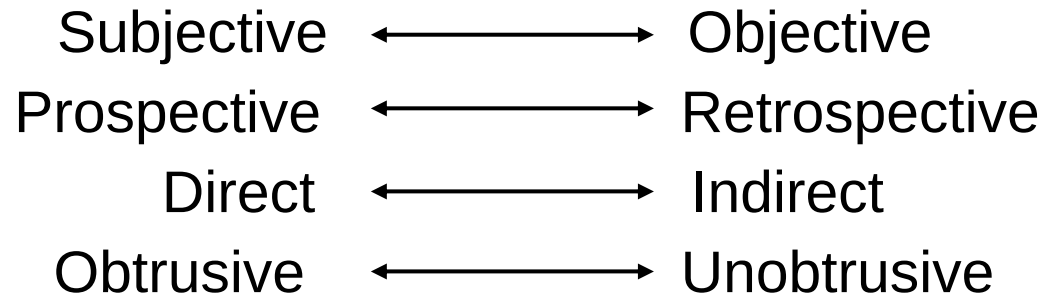
“Where am I? Where’s my buddy?
Where’s the enemy?” (An Army Officer)

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

State
Thing
Product
Information



Methods for Measuring SA



- ❑ 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 tend to measure:

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



An Alternative to Situation Awareness



What is needed is a model and a methodology 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

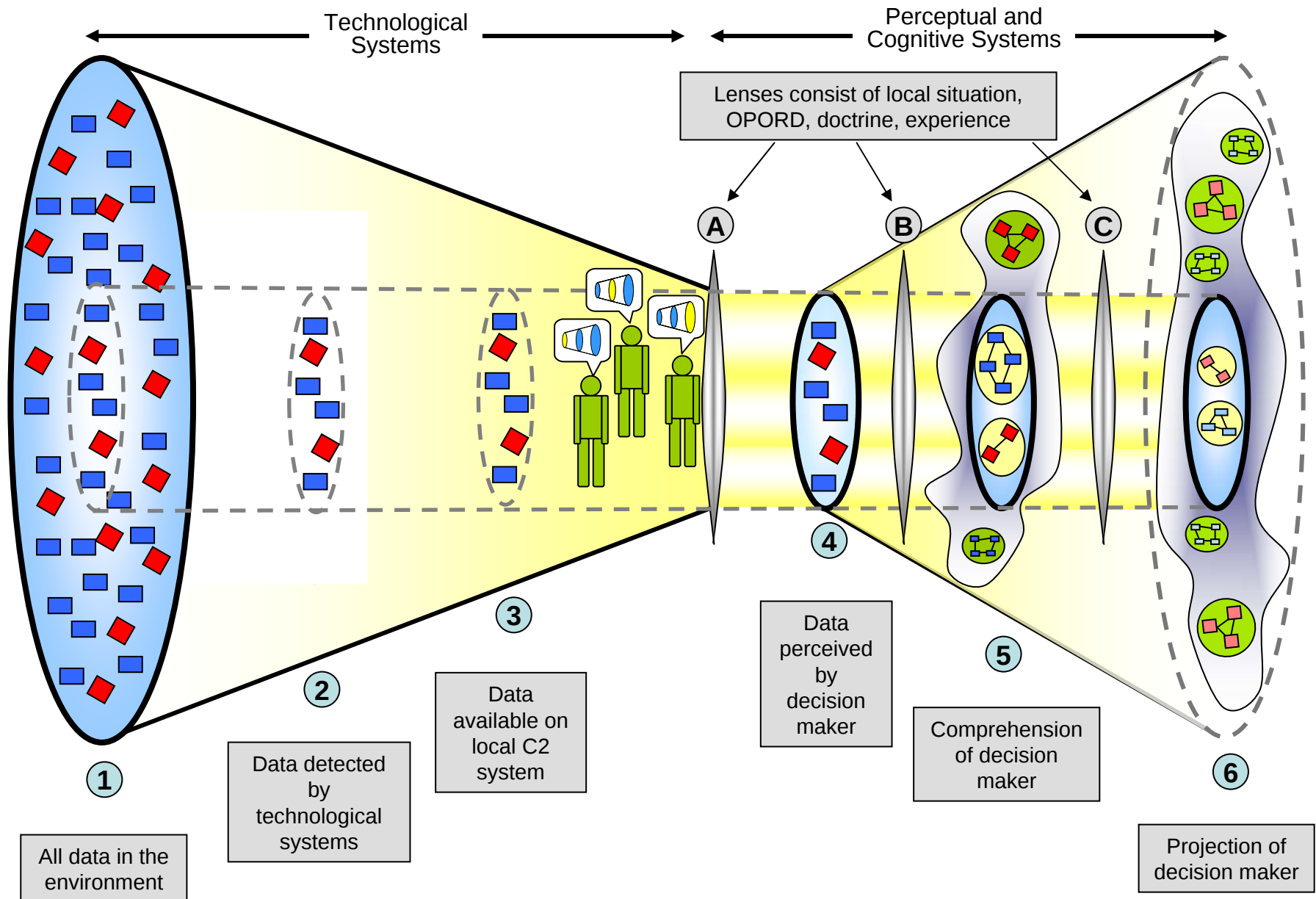


Situated Cognition

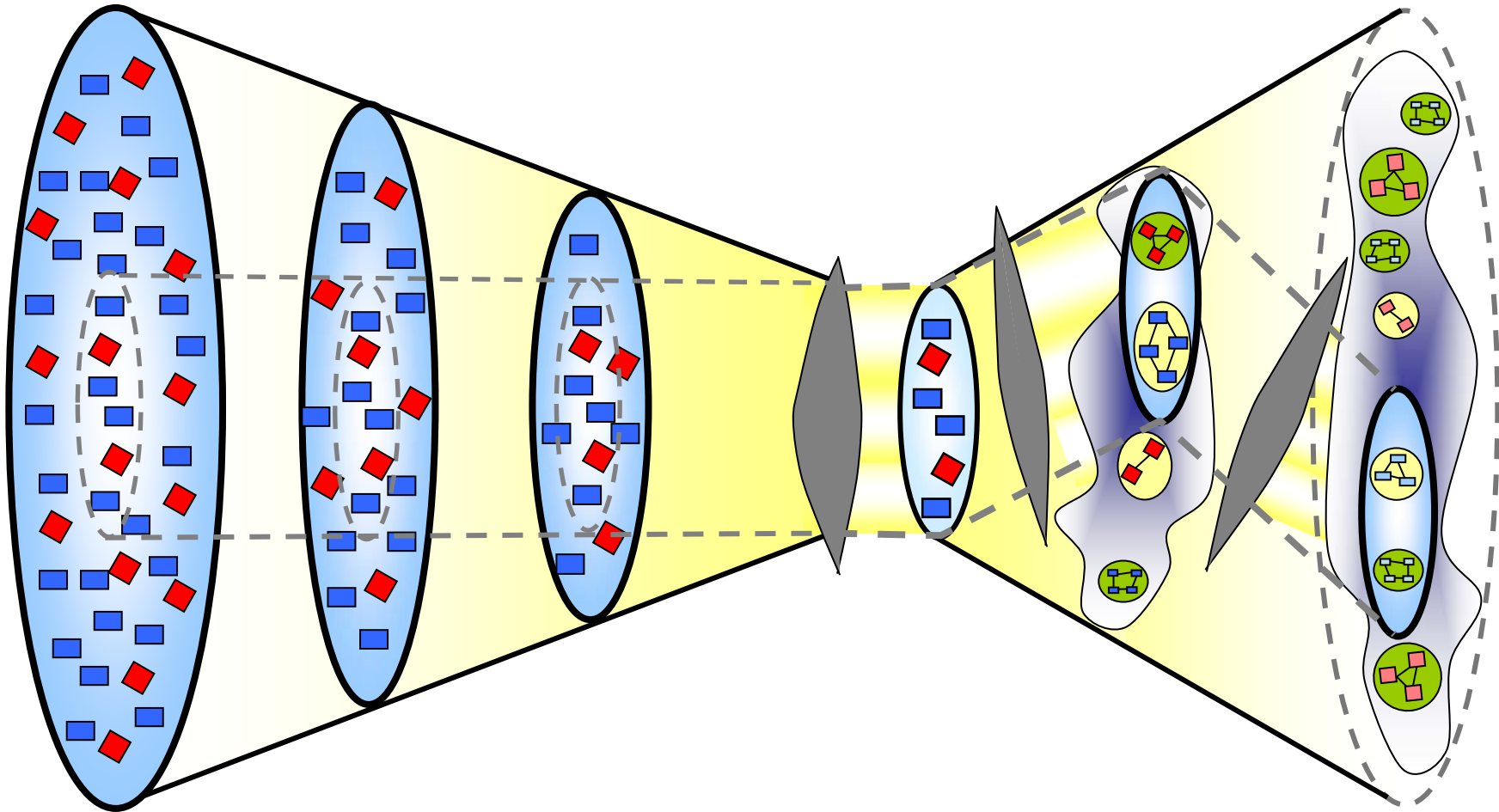


- ❑ Borrowed from the learning and linguistics literature
- ❑ Includes mental activities ***embedded in an evolving context***
- ❑ Includes ***human and machine agents***
- ❑ Involves ***collaborative activities***
- ❑ ***Goal-directed***

A Process Model of Situated Cognition

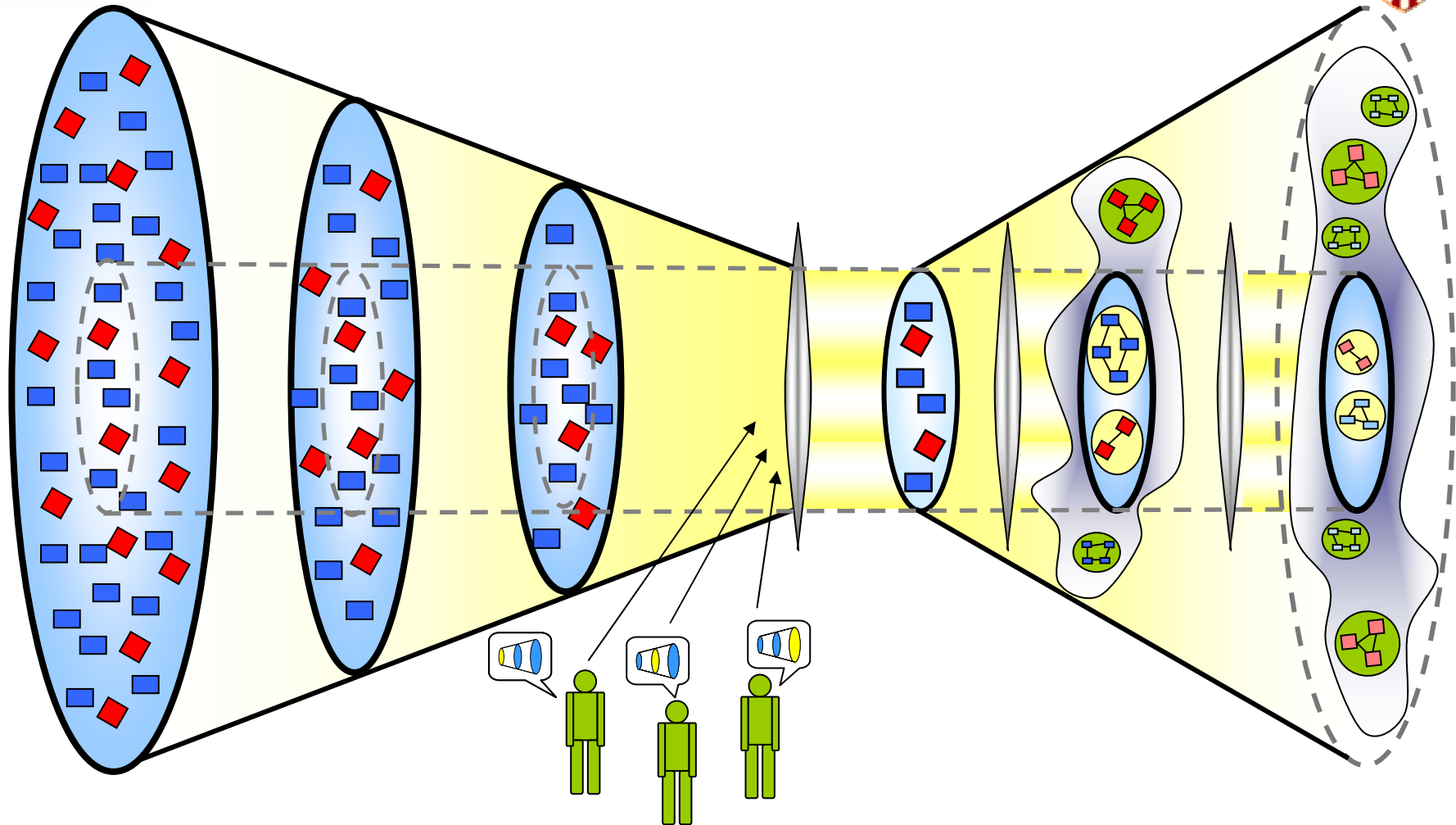


***Misshaped lenses* will skew a decision maker's perceptions, comprehensions, and projections**



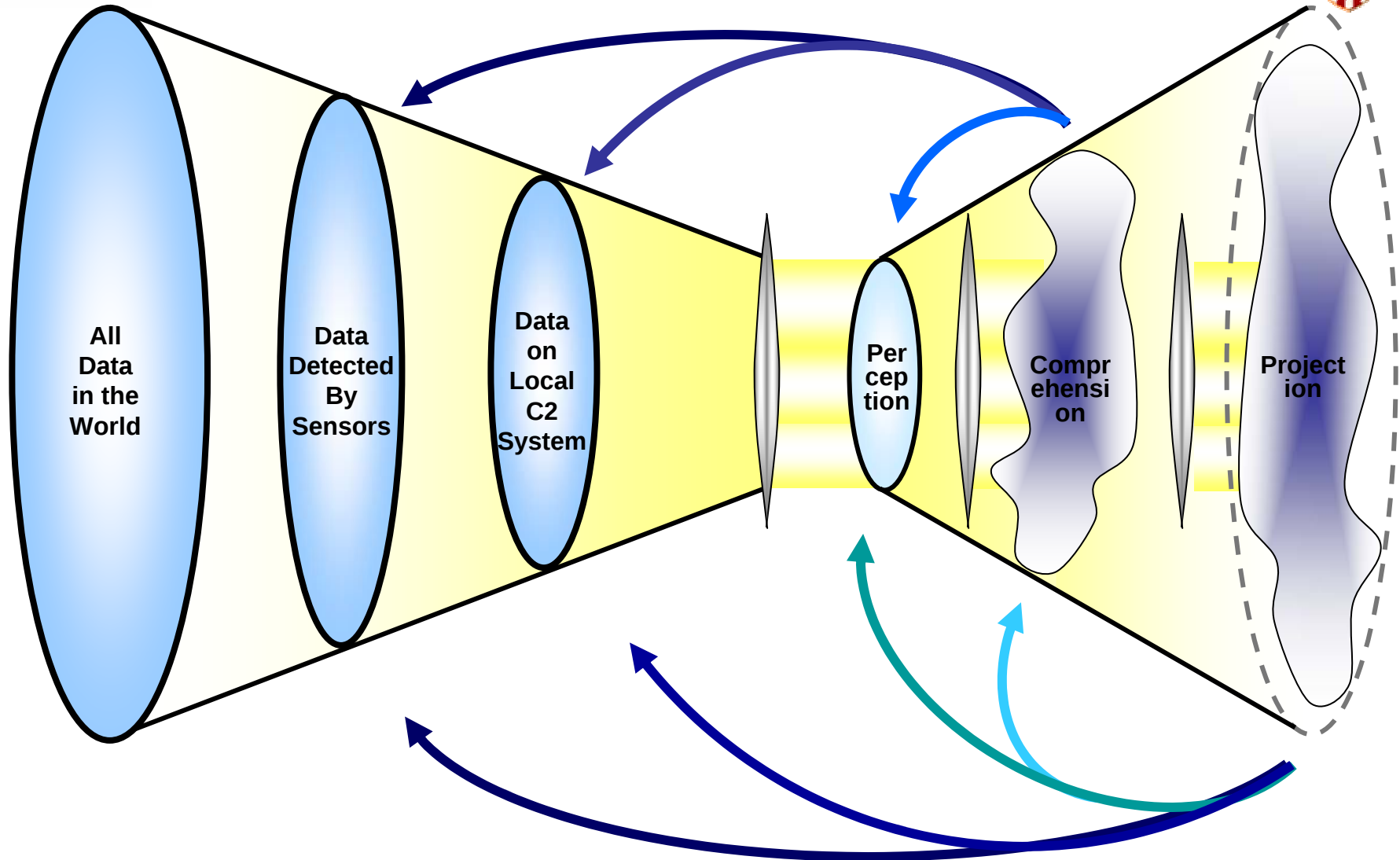


A Process Model of Situated Cognition



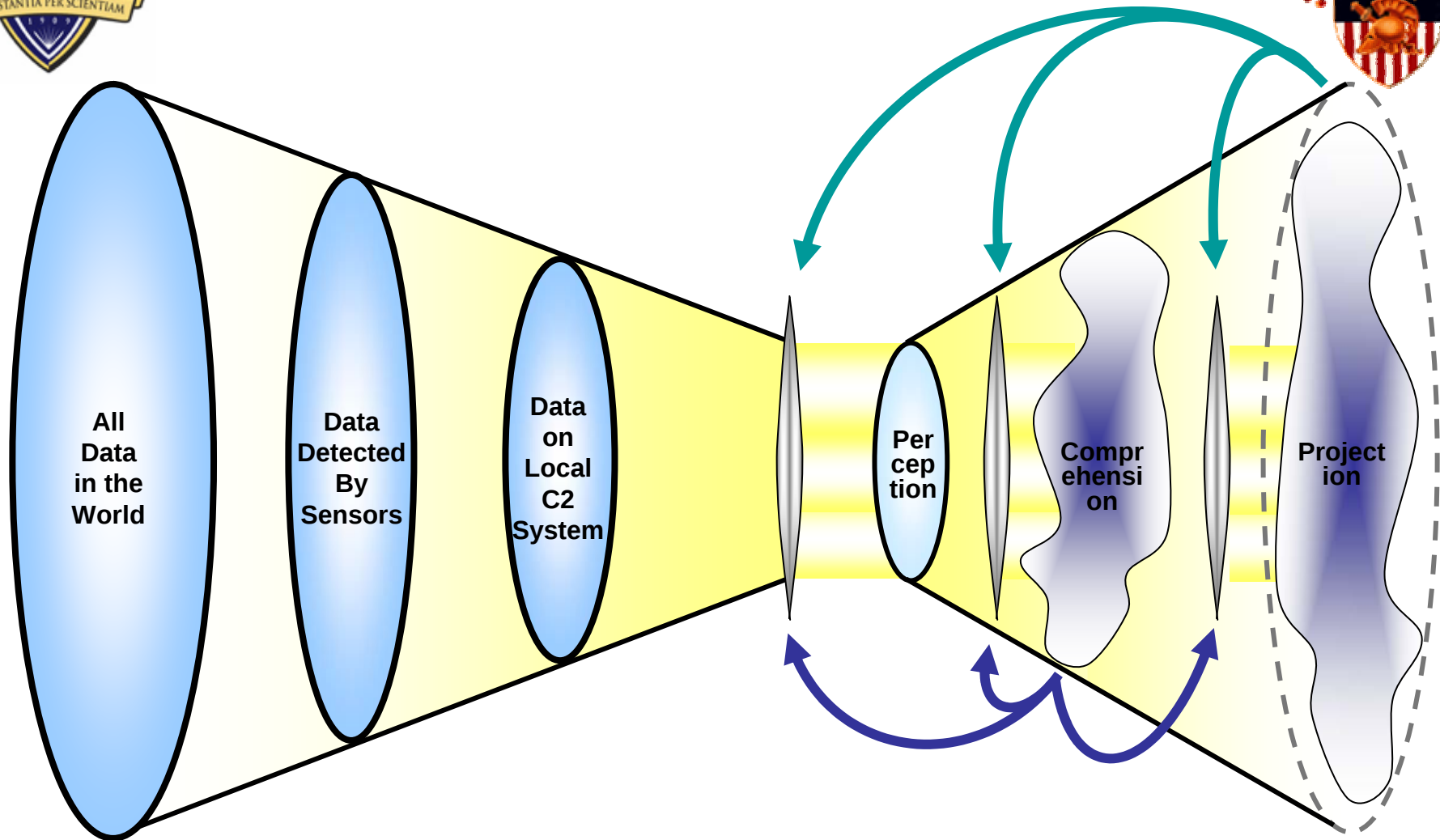


Feedback Loops in the Model

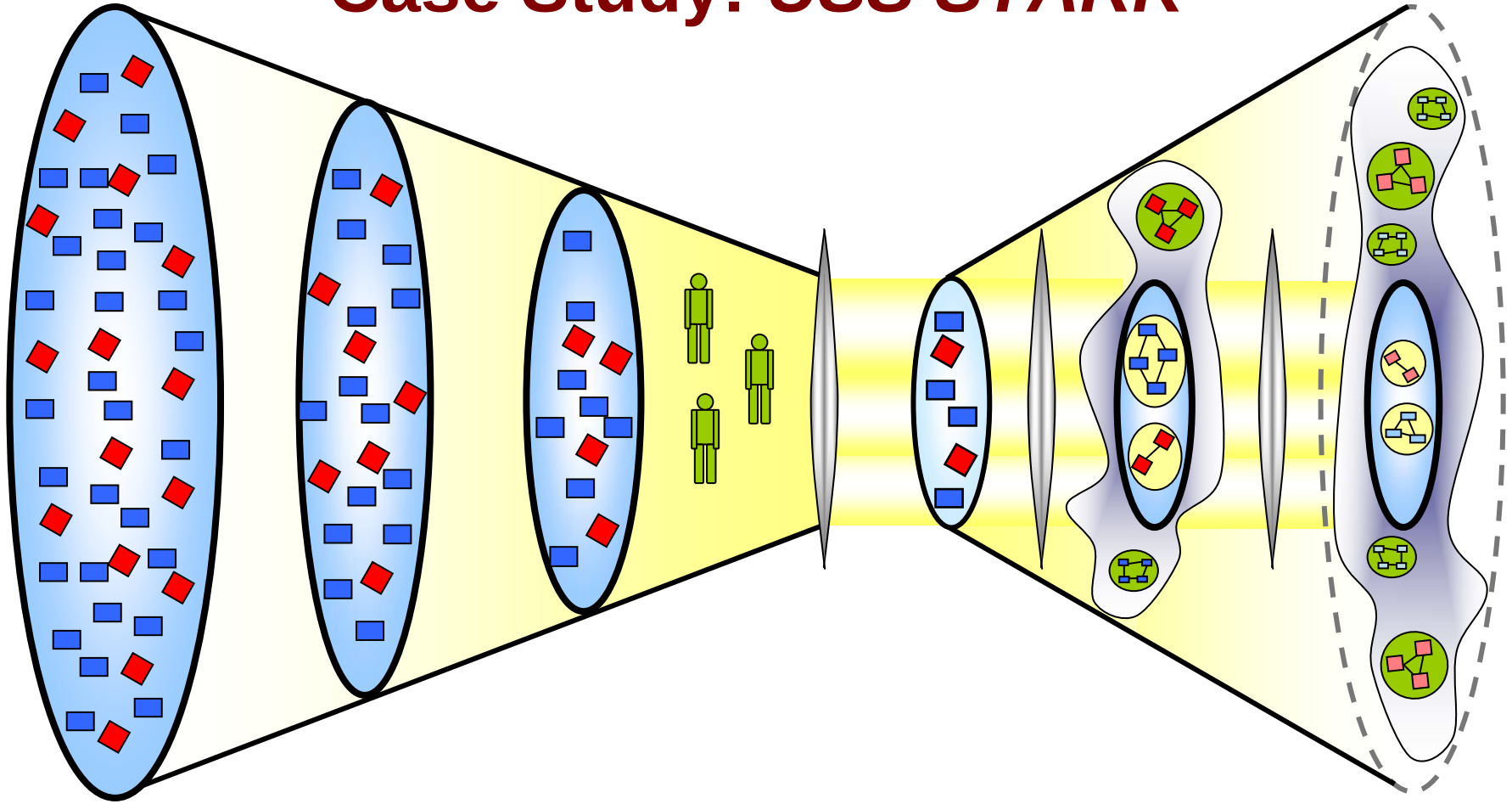




Feedback Loops in the Model



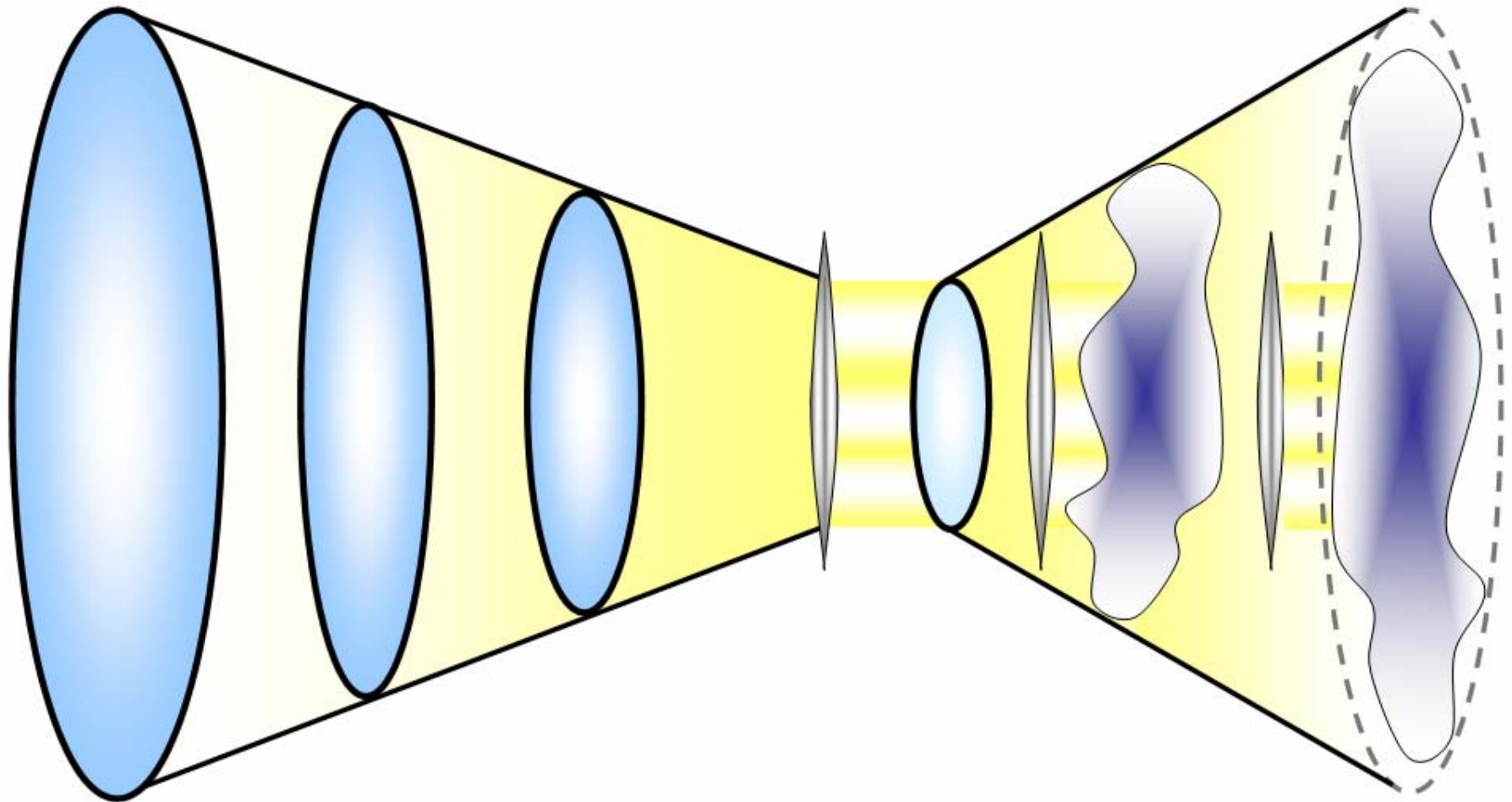
Case Study: *USS STARK*



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.



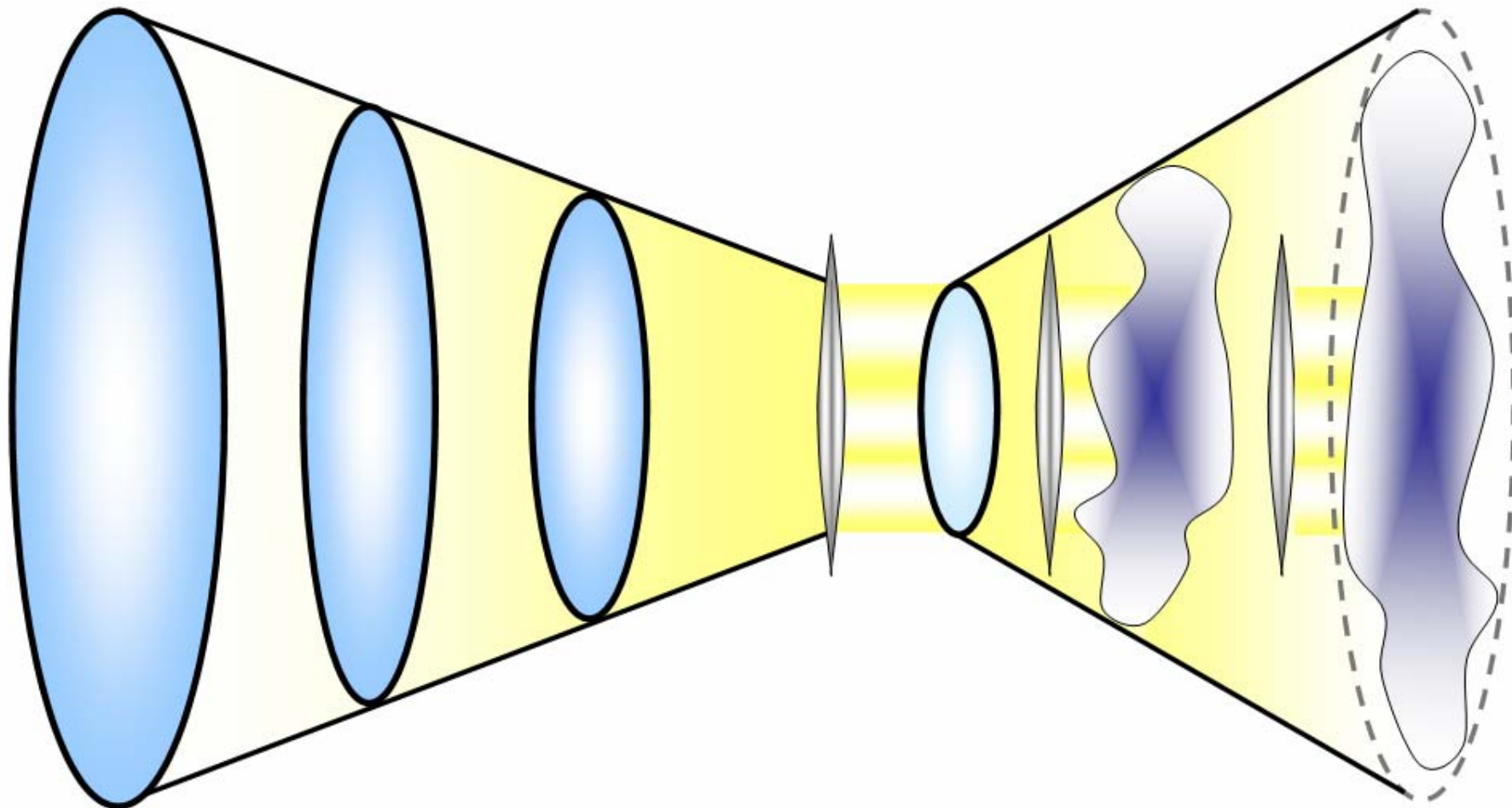
Oval 1: Ground Truth





Oval 1: Ground Truth

Stark is 12nm west of Iraqi exclusion zone.

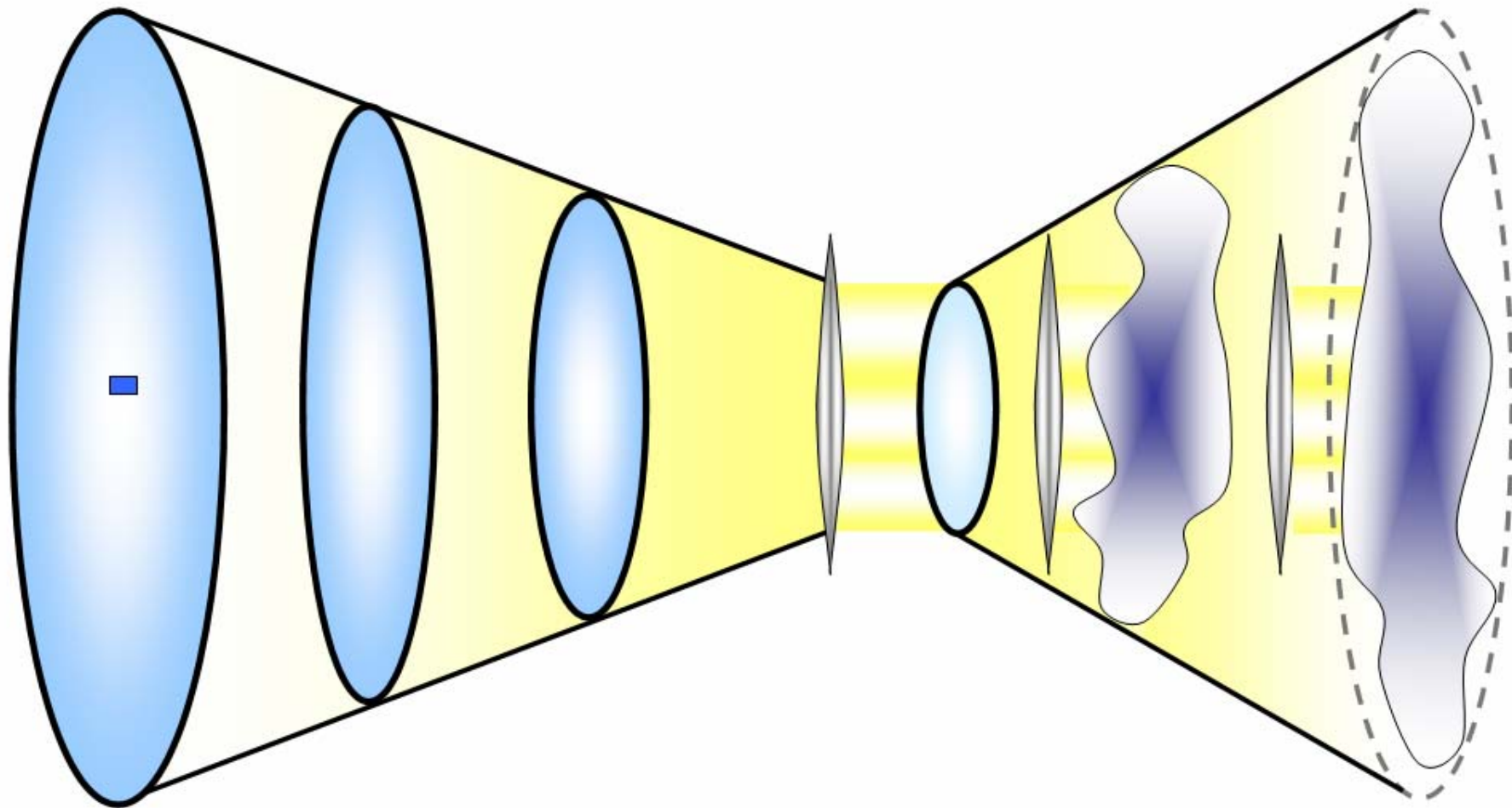




Oval 1: Ground Truth



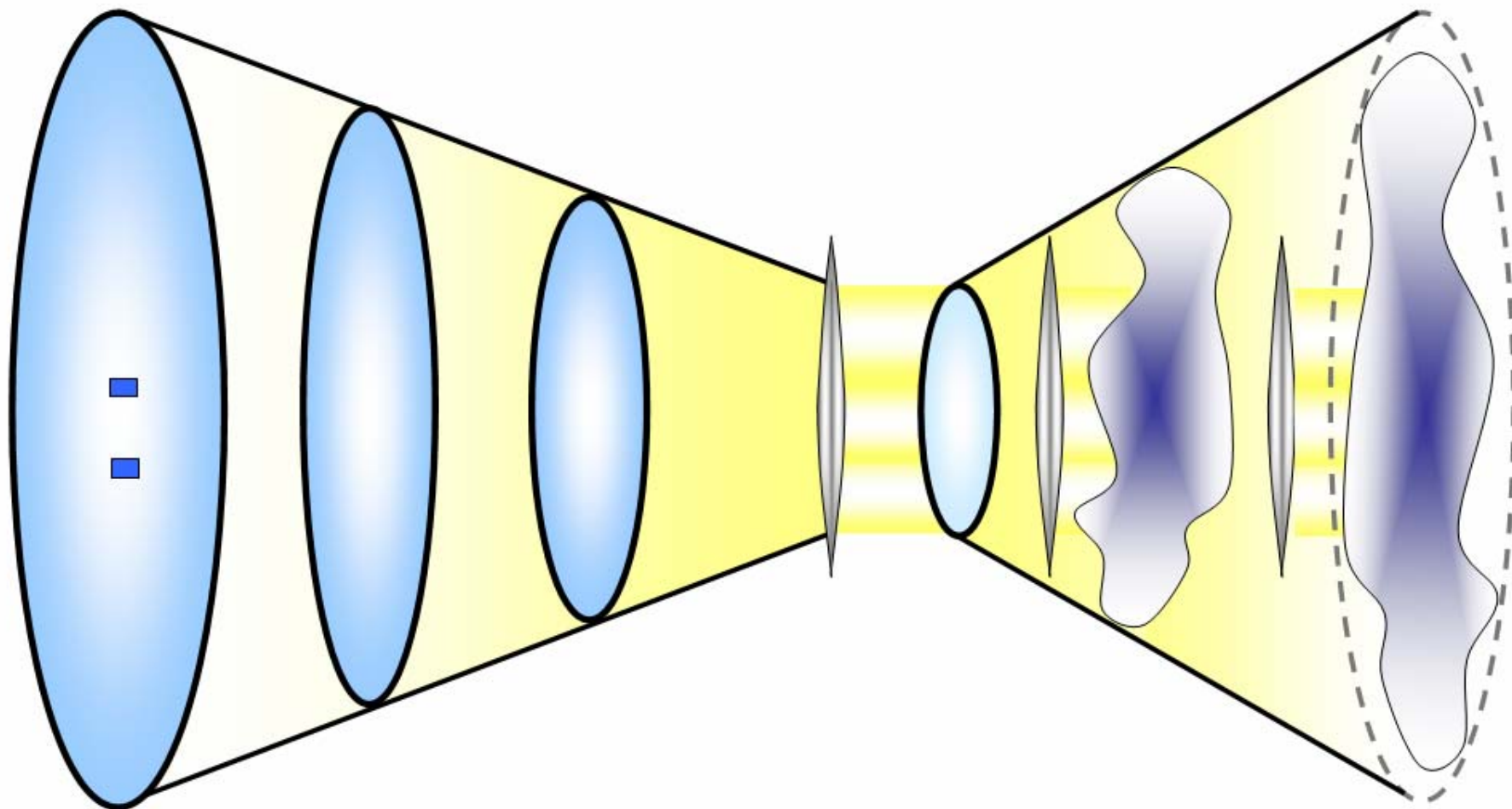
AWACS is aloft.





Oval 1: Ground Truth

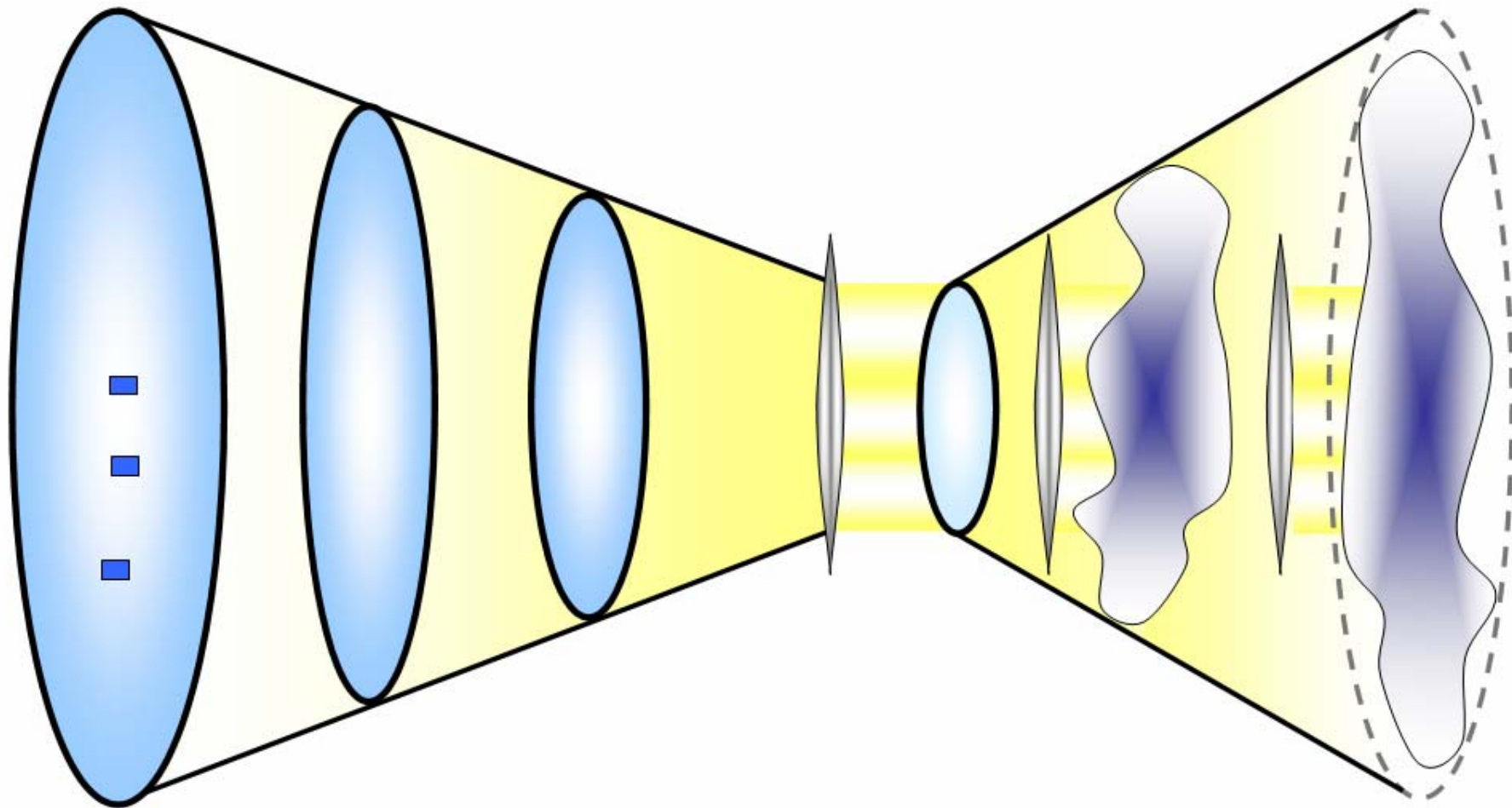
Other USN vessels are in the area.





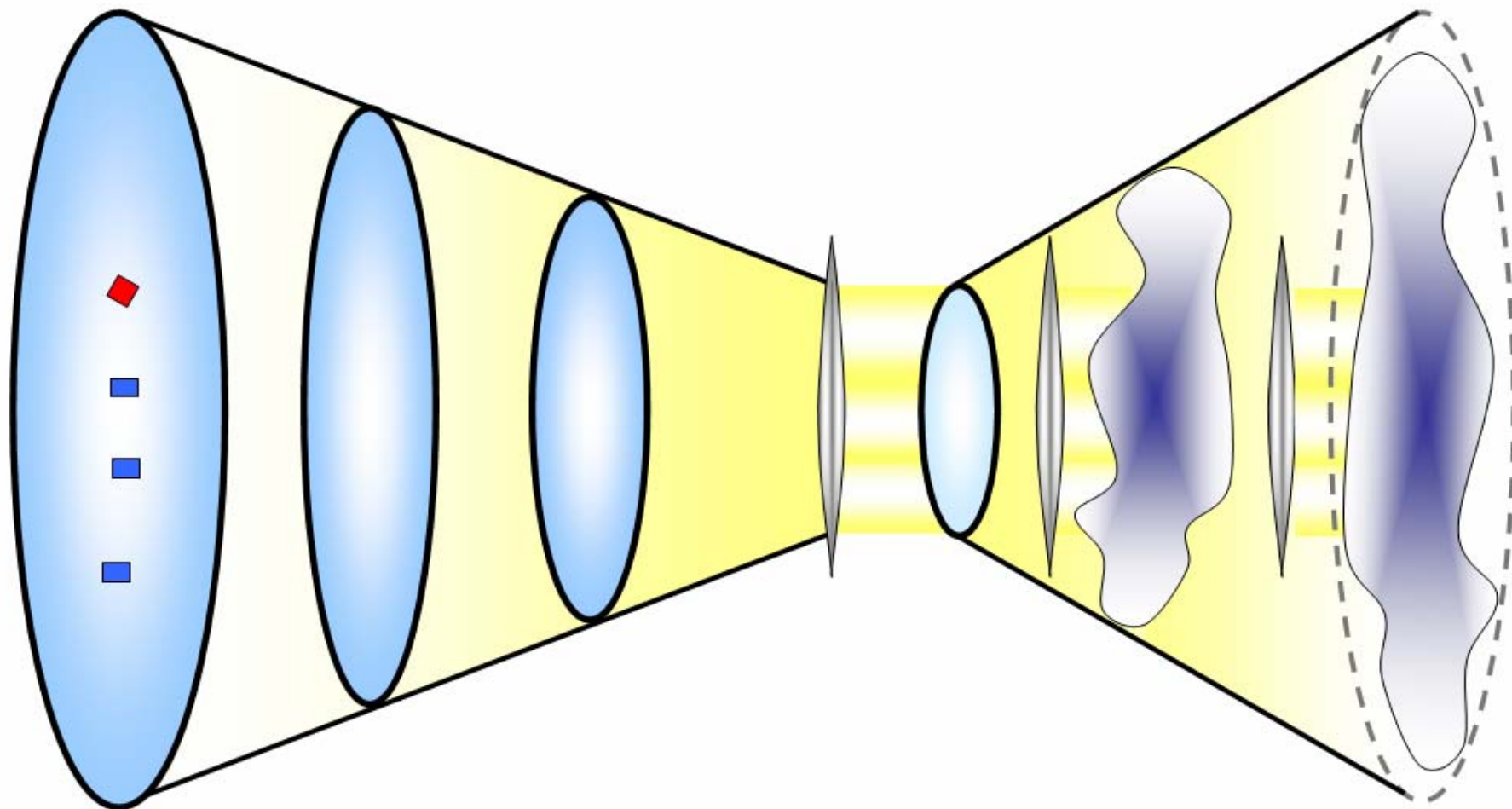
Oval 1: Ground Truth

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





Oval 1: Ground Truth





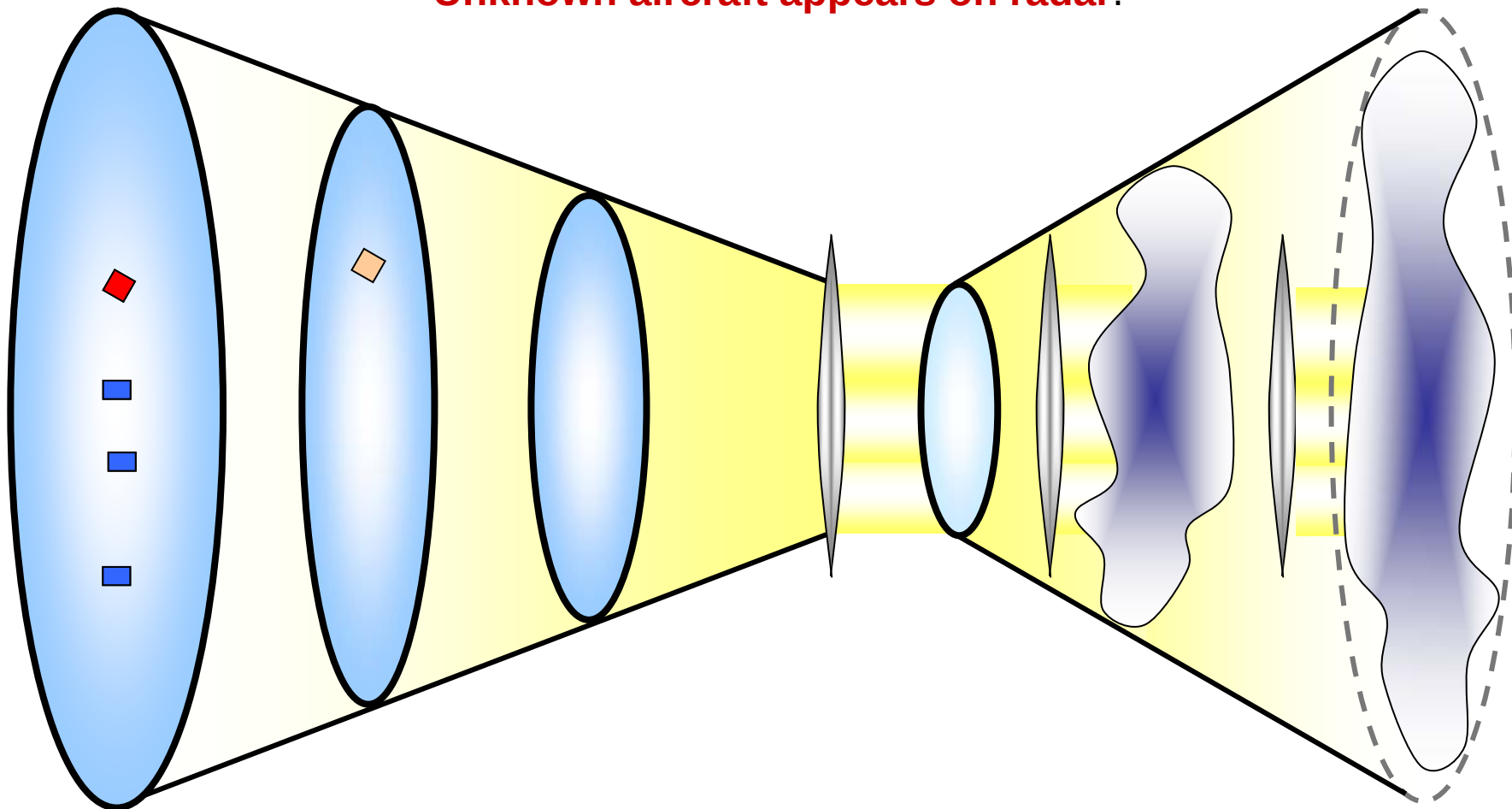
Oval 2: Sensor Coverage

USS Stark is 12 nm from Iraqi exclusion zone.

AWACS is aloft.

Other USN vessels in the area.

Unknown aircraft appears on radar.





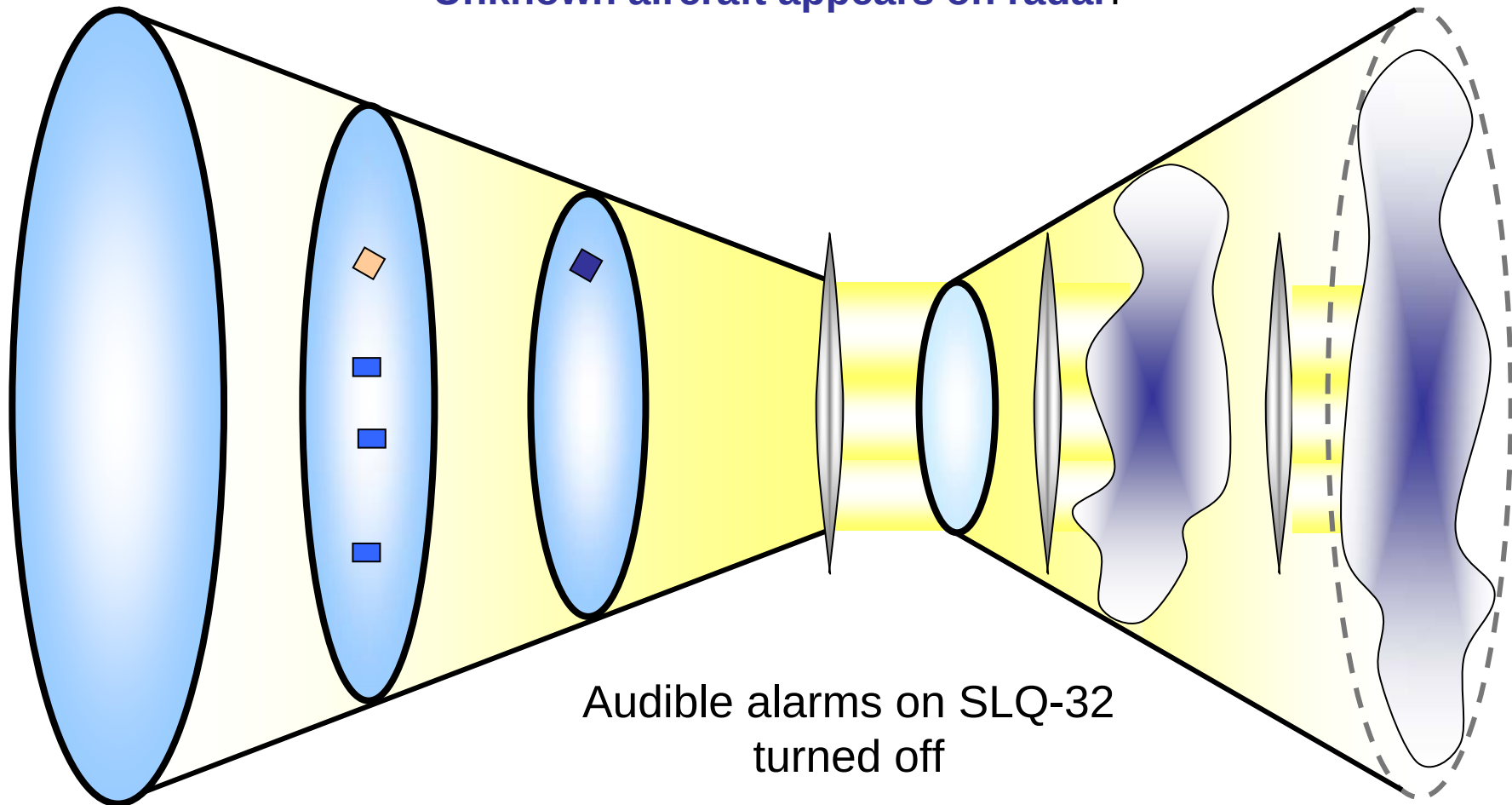
Oval 3: Workstation Display

USS Stark is 12 nm from Iraqi exclusion zone.

AWACS is aloft.

Other USN vessels in the area.

Unknown aircraft appears on radar.

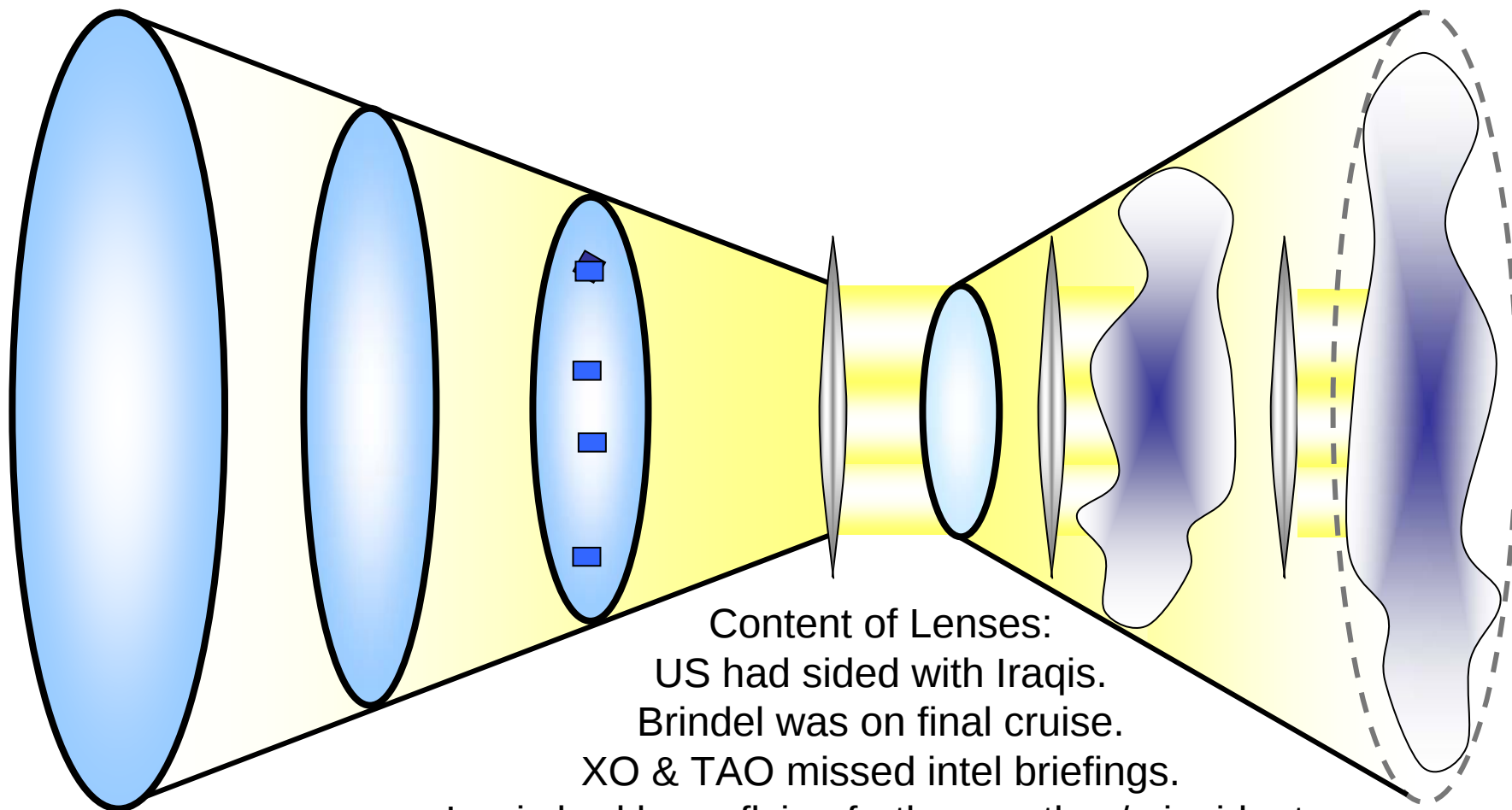


Audible alarms on SLQ-32
turned off



Oval 4: Perception

Aircraft on detected on radar.
Aircraft tagged as friendly.

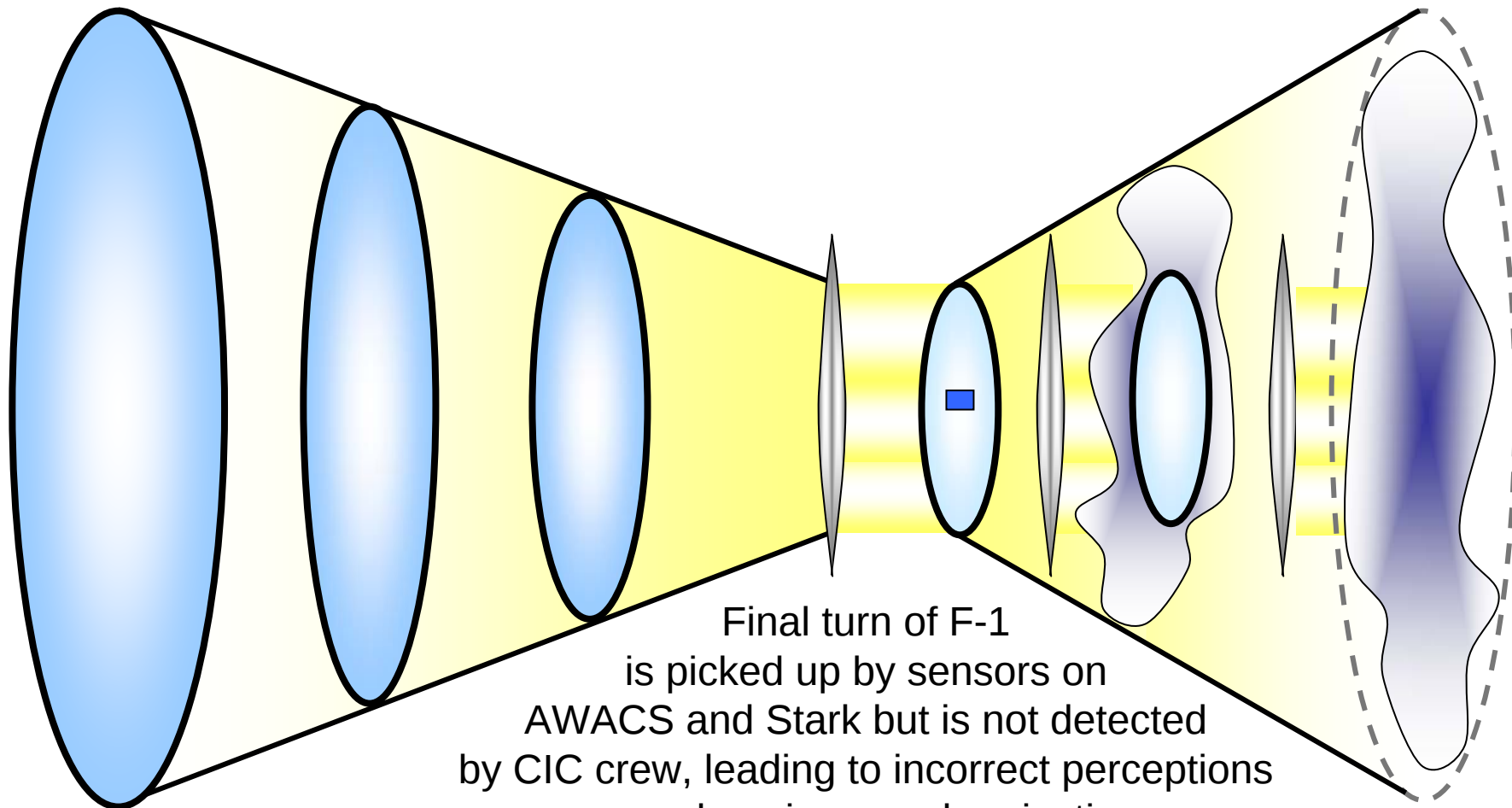


Content of Lenses:
US had sided with Iraqis.
Brindel was on final cruise.
XO & TAO missed intel briefings.
Iraqis had been flying farther south w/o incident.



Oval 5: Comprehension

Aircraft is no threat to *USS Stark*.

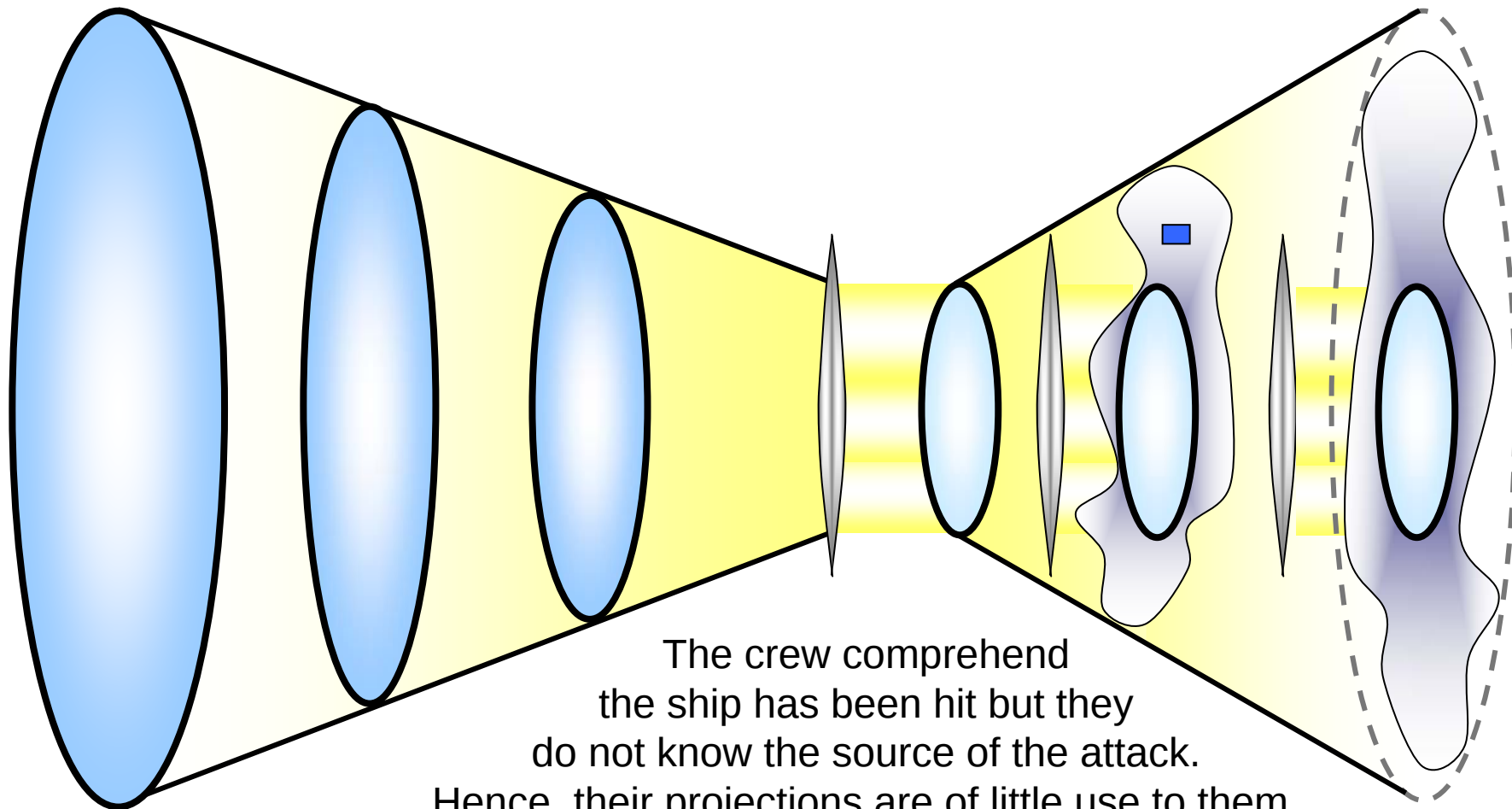


Final turn of F-1
is picked up by sensors on
AWACS and Stark but is not detected
by CIC crew, leading to incorrect perceptions
comprehensions, and projections.



Oval 6: Projection

Aircraft will turn away from *USS Stark*.

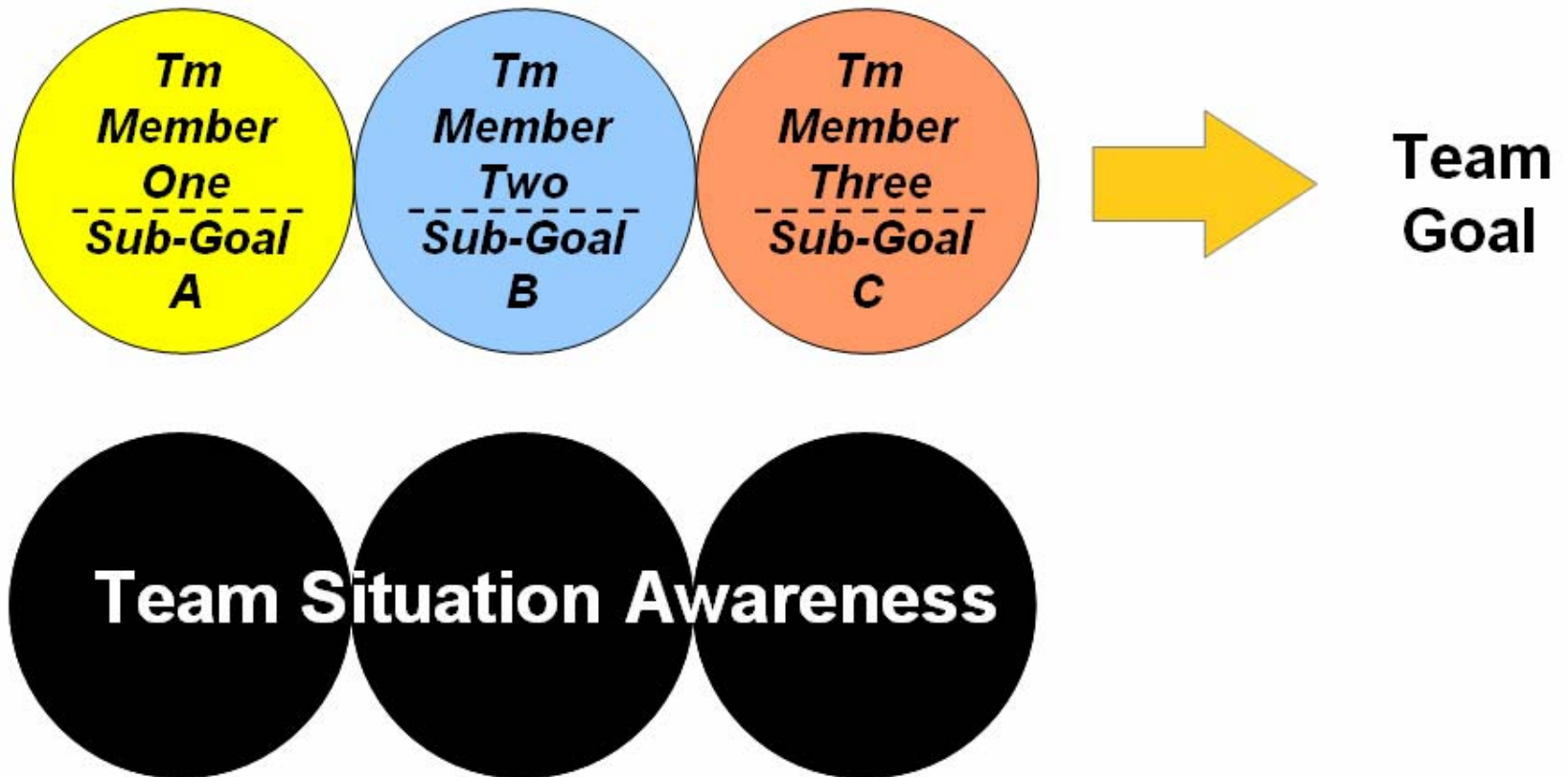


The crew comprehend
the ship has been hit but they
do not know the source of the attack.
Hence, their projections are of little use to them.



Team Situation Awareness

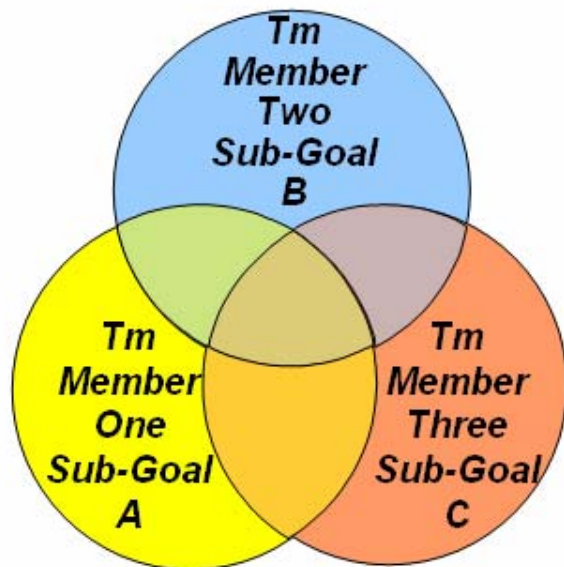
The degree to which all team members possess the SA required for their jobs.





Team Situation Awareness

The degree to which all team members possess the SA required for their jobs.



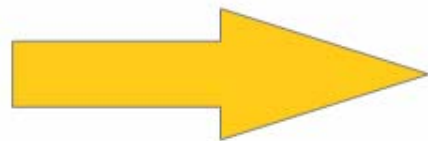
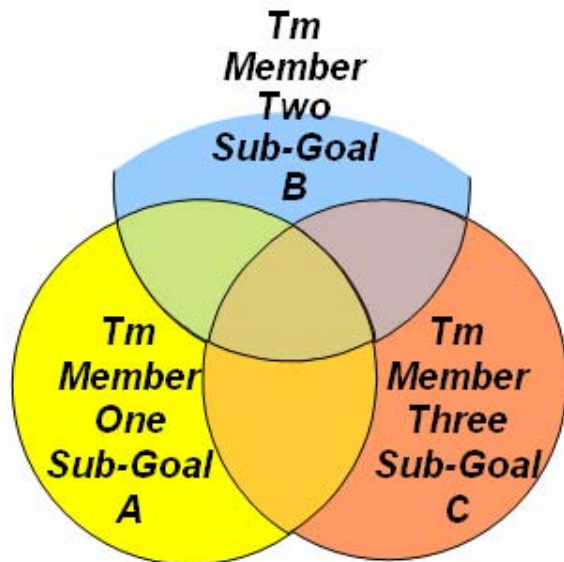
Team Goal





Team Situation Awareness

The degree to which all team members possess the SA required for their jobs.



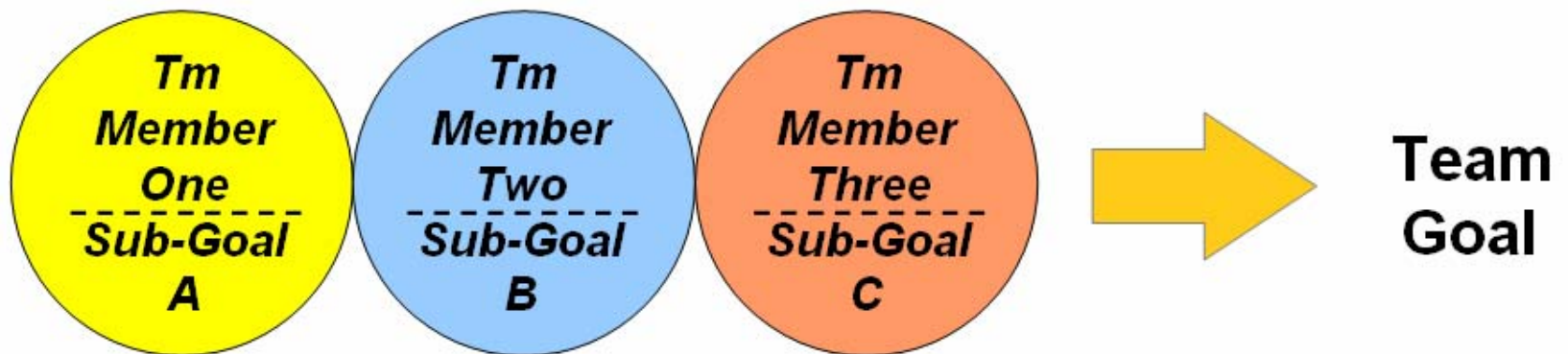
Team Goal???





Shared Situation Awareness

The degree to which team members possess the same SA.

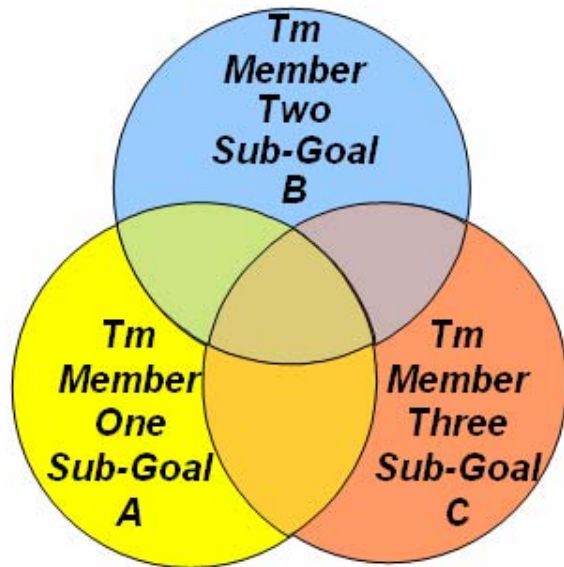


No Shared Situation Awareness



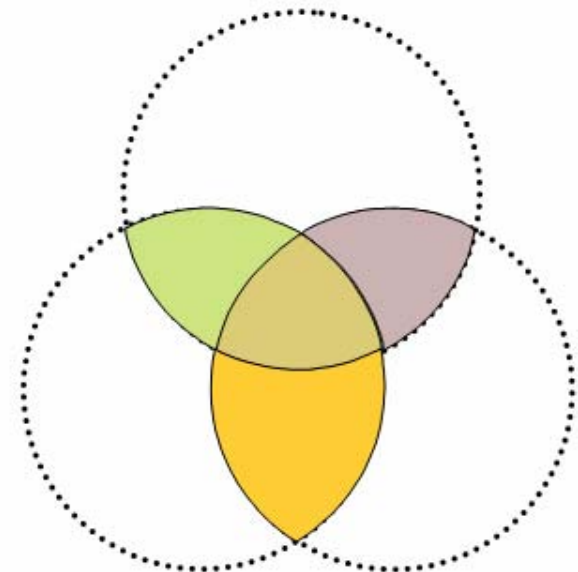
Shared Situation Awareness

The degree to which team members possess the same SA.



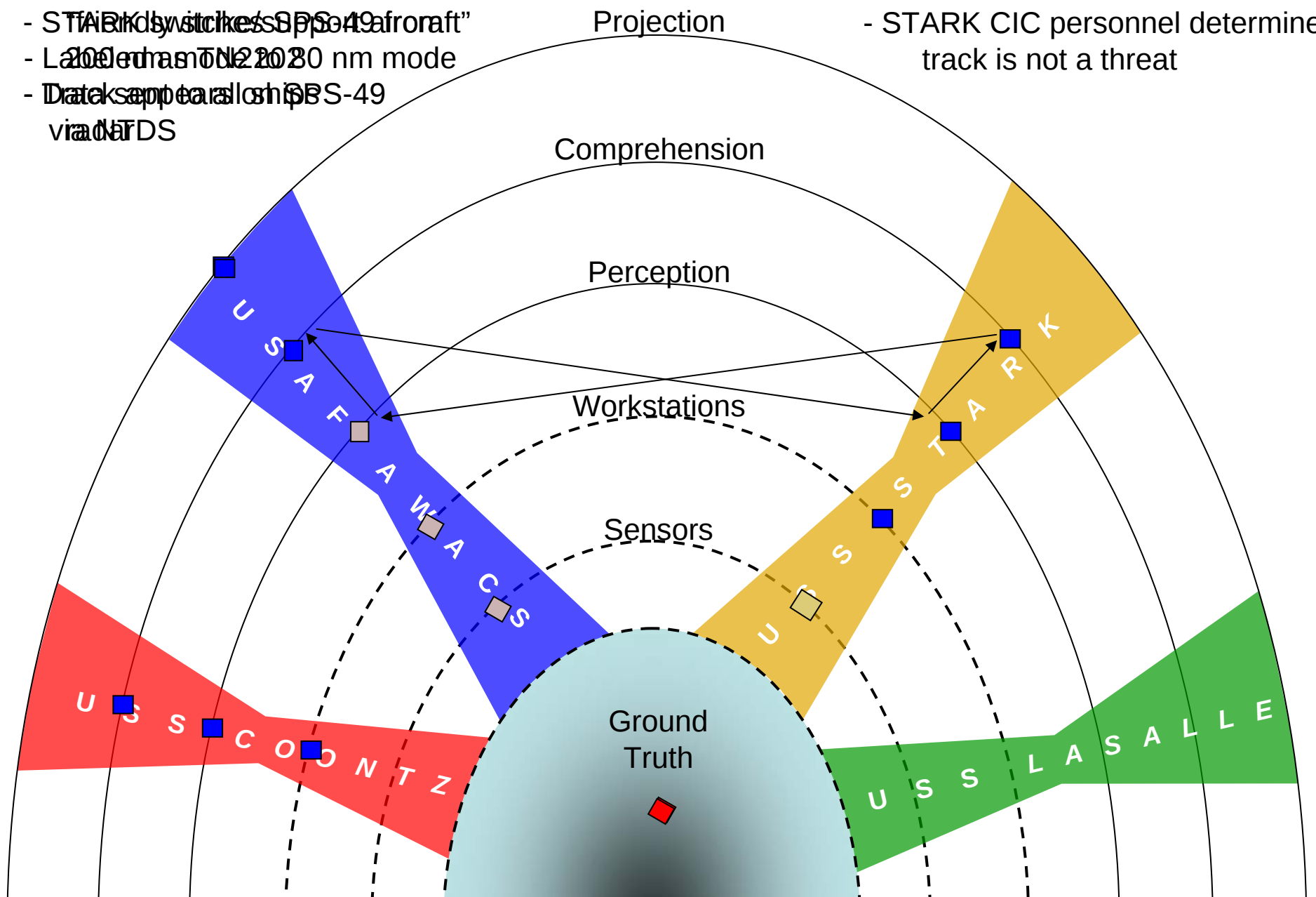
Team Goal

**Shared
Situation
Awareness**



1955001 CONTZ also detects track
- CONTZ acquires ONE7
- AWACS track evaluates as
- STARK switches SPS-49 from
- Lantech to TNE22020 nm mode
- Data appears on SPS-49
via NATDS

- STARK CIC detects track
- STARK CIC confirms track with
AWACS
- STARK CIC personnel determine
track is not a threat





Process Tracing

- ❑ Maps out how the incident unfolded
- ❑ Focuses on how a given outcome came about
- ❑ Externalizes internal processes
- ❑ Uses data from multiple sources
- ❑ Describes the sequence of information flow and knowledge activation

(After Woods, 1993)



Metrics for Situated Cognition



Technological side of model:

- Playback of ground truth using various sources (e.g., database queries, screen captures)

Human side of model:

- Individual characteristics of sensemakers
 - Experience and training (including proficiency with computers and technology)
 - Personality, Intellect
 - Index of Learning Styles
- Behavioral Analysis (direct observation, voice and A/V Recordings)
Noldus System for Behavioral Capture and Analysis
- Physiological measures of participants (Head and Eye movements, heart rate variability, EEGs)
- Geographical Recall and Analysis of Data in the Environment (GRADE)
- Cued Retrospective Interviews



Evaluating Data Sources

Subjective

SART

SWAG-C

GRADE

Retro Interviews

Objective

Audio/Video

Wrist Monitors

HR Monitors

Dbase Queries

Obtrusive

GRADE

SART

Unobtrusive

Retro Interviews

SWAG-C

Wrist Monitors

HR Monitors

Audio/Video

Dbase Queries

Data

Dbase Queries

Oval

1, 2

Audio/Video

2, 3, 4, 5, 6

GRADE

4, 5, 6

Retro Interviews

4, 5, 6

Data

SWAG-C

Oval

4, 5

HR Monitors

4, 5

SART

4, 5, 6

Wrist Monitors

4



GRADE

(Geographical Recall and Analysis of Data in the Environment)

- Not a memory test. A way to gauge where the officer is focused at that moment.
- Facilitates comparison between Oval 3 (what is displayed on local workstation) and Oval 4 (what is perceived by the decision maker).
- On cue participants turn away from the screen.
- “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.”
- Flip an acetate overlay
- “Tell me what the battlespace will look like 30 minutes from now.”
- Number and timing of GRADE events based on scenario.

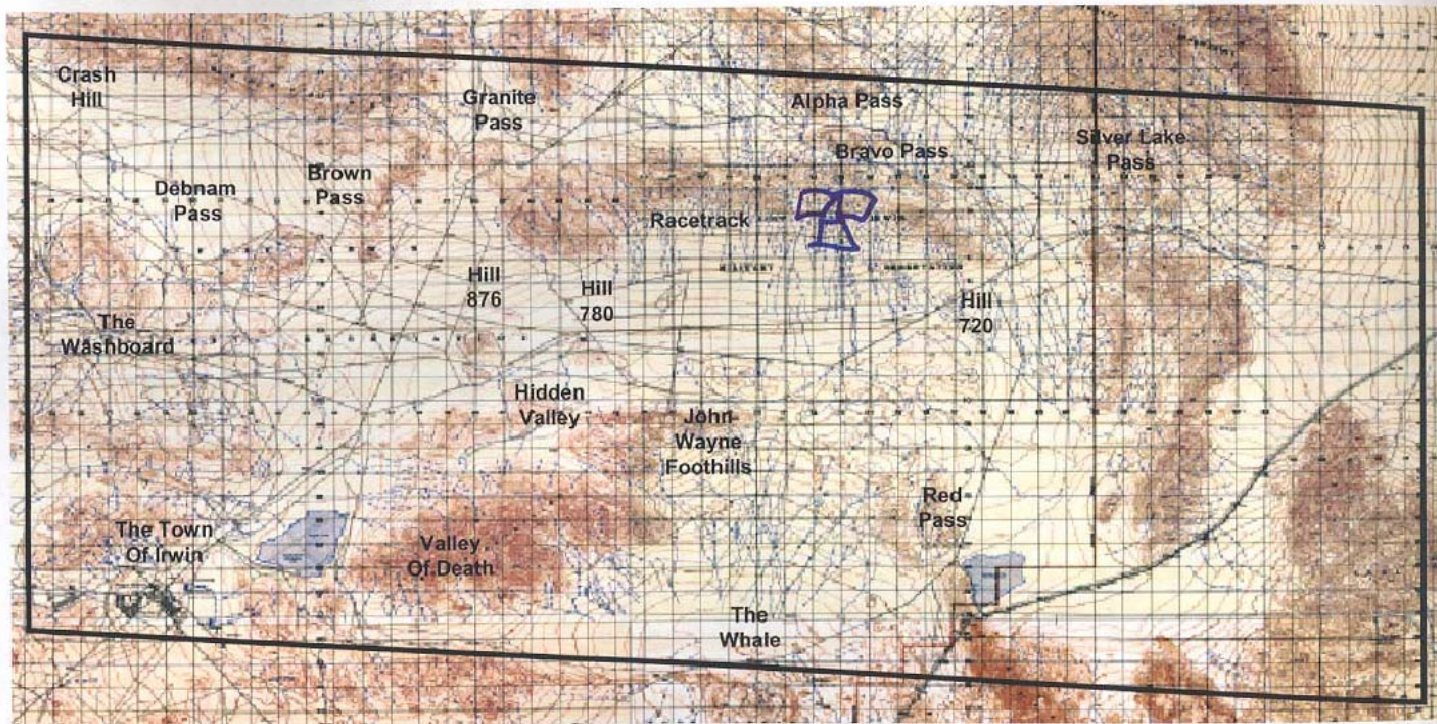


Sample GRADE



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.



Demand (1 to 7) 2

Supply (1 to 7) 6

Understanding (1 to 7) 2



Sample GRADE



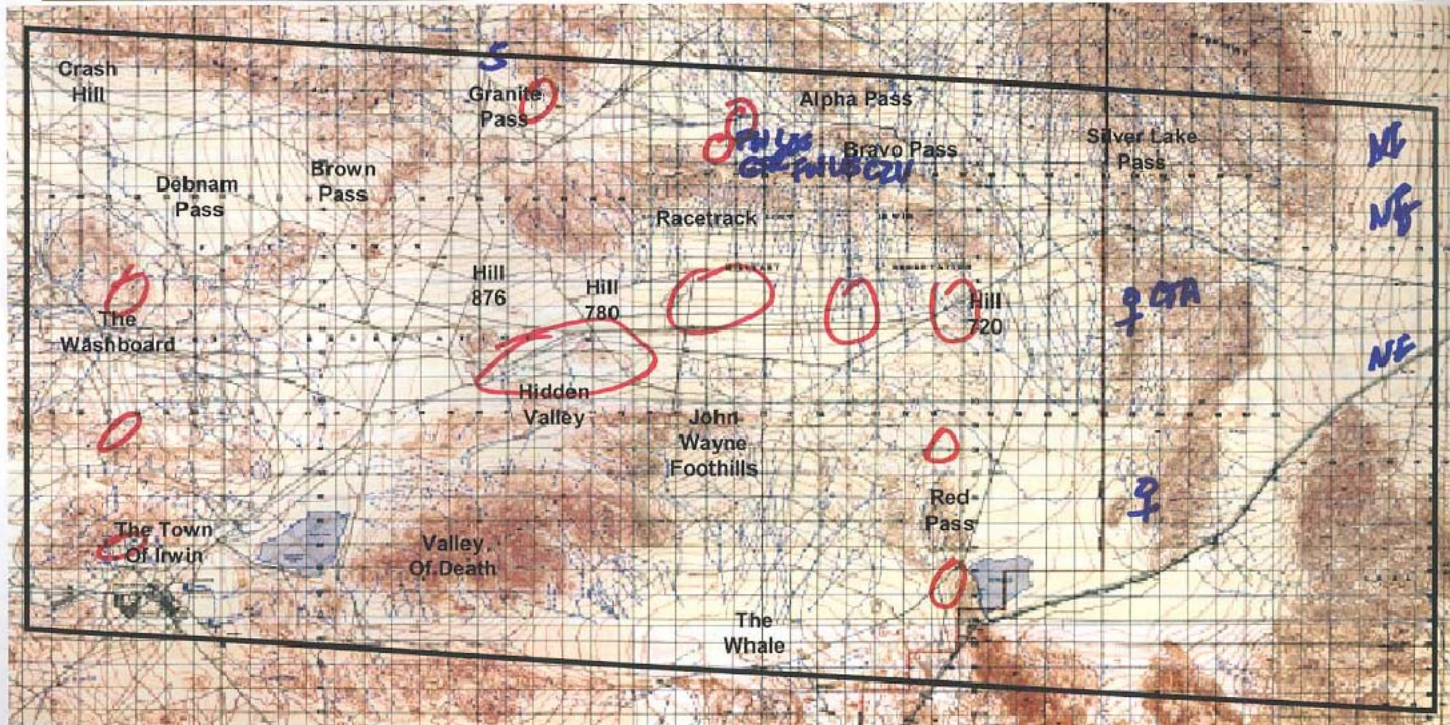
Seat ____

Date: ____

Time: ____

INSTRUCTIONS

1. Fill in your SART ratings below. (Refer to descriptions on the inside cover of this binder if necessary.)
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.



Demand (1 to 7) 5

Supply (1 to 7) 6

Understanding (1 to 7) 5



GRADE

(Adapted for Trident Warrior '04)

Experimental Design

USS TARAWA

USS JPJONES

USS Pearl Harbor

TAO

ESG

PHIBRON

	1	2	3
A			
B			
C			

TAO

ESG

PHIBRON

	1	2	3
A			
B			
C			

TAO

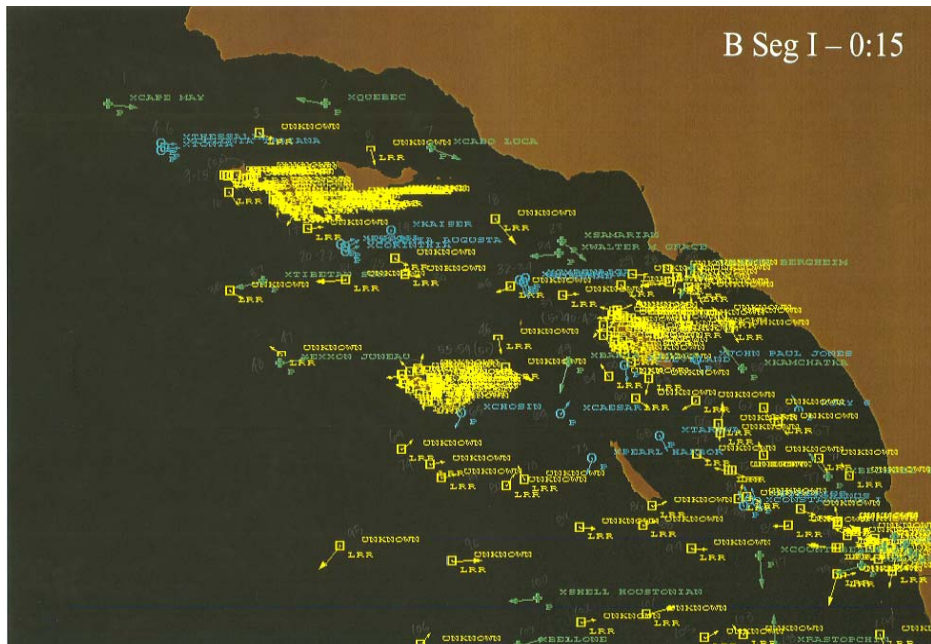
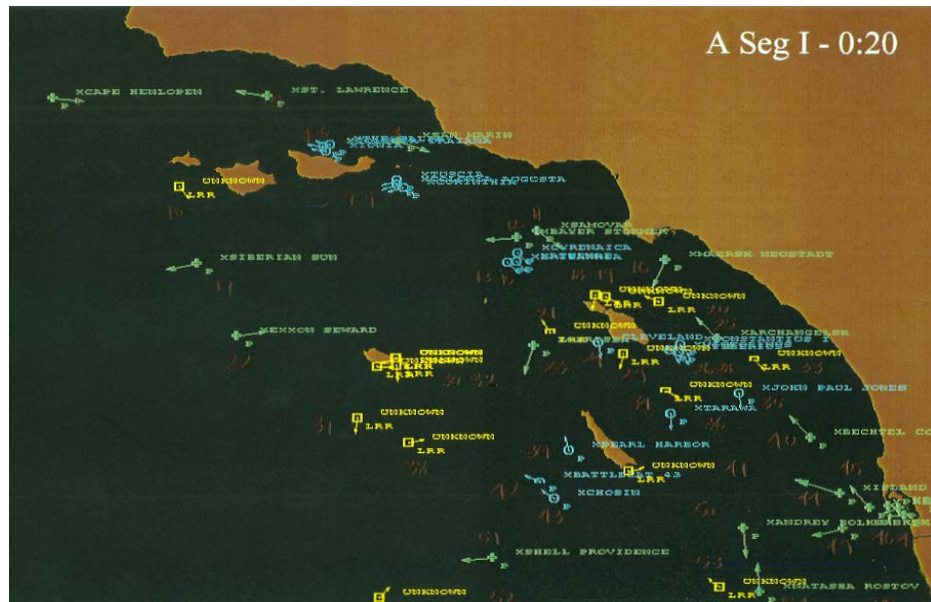
ESG

PHIBRON

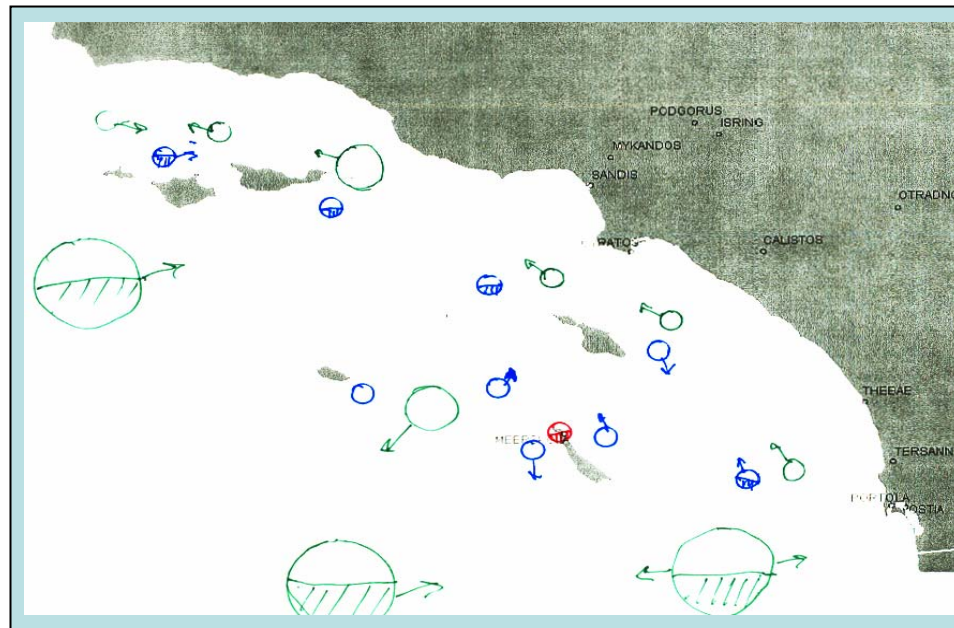
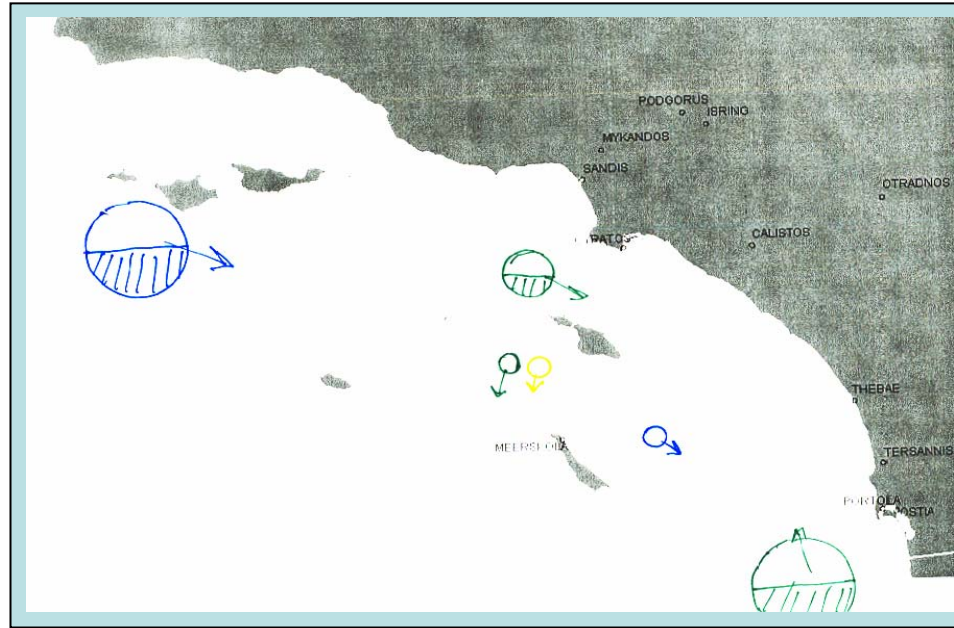
	1	2	3
A			
B			
C			

4 Data Pauses within each Segment (1/2/3) of each Scenario (A/B/C)

Ground Truth

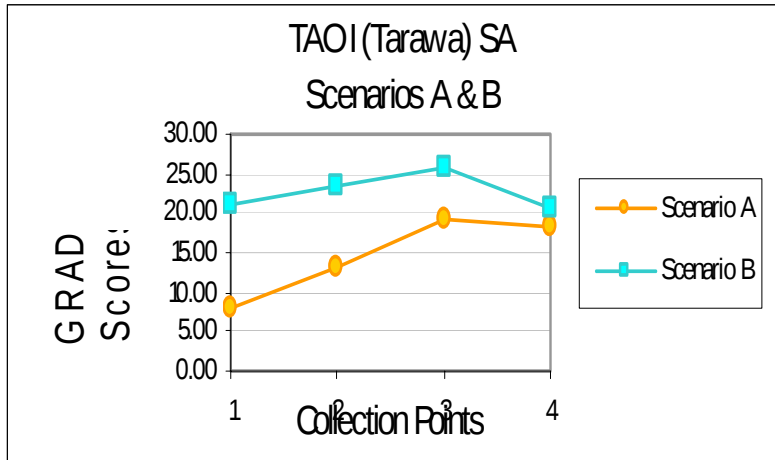


GRADE

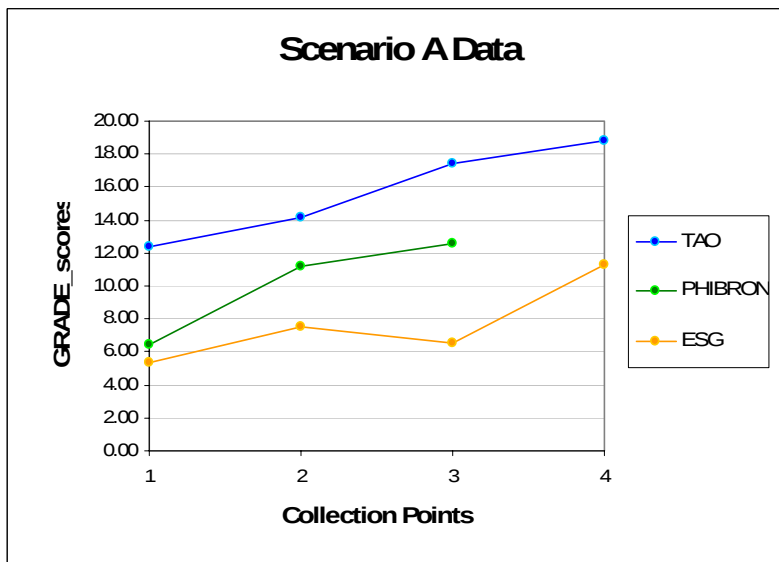




Results



- **Chart I** – progression of GRADE scores from Scenarios A to B



- **Chart II** – variation in GRADE scores among different watch stations (TAO/ESG/PHIBRON)

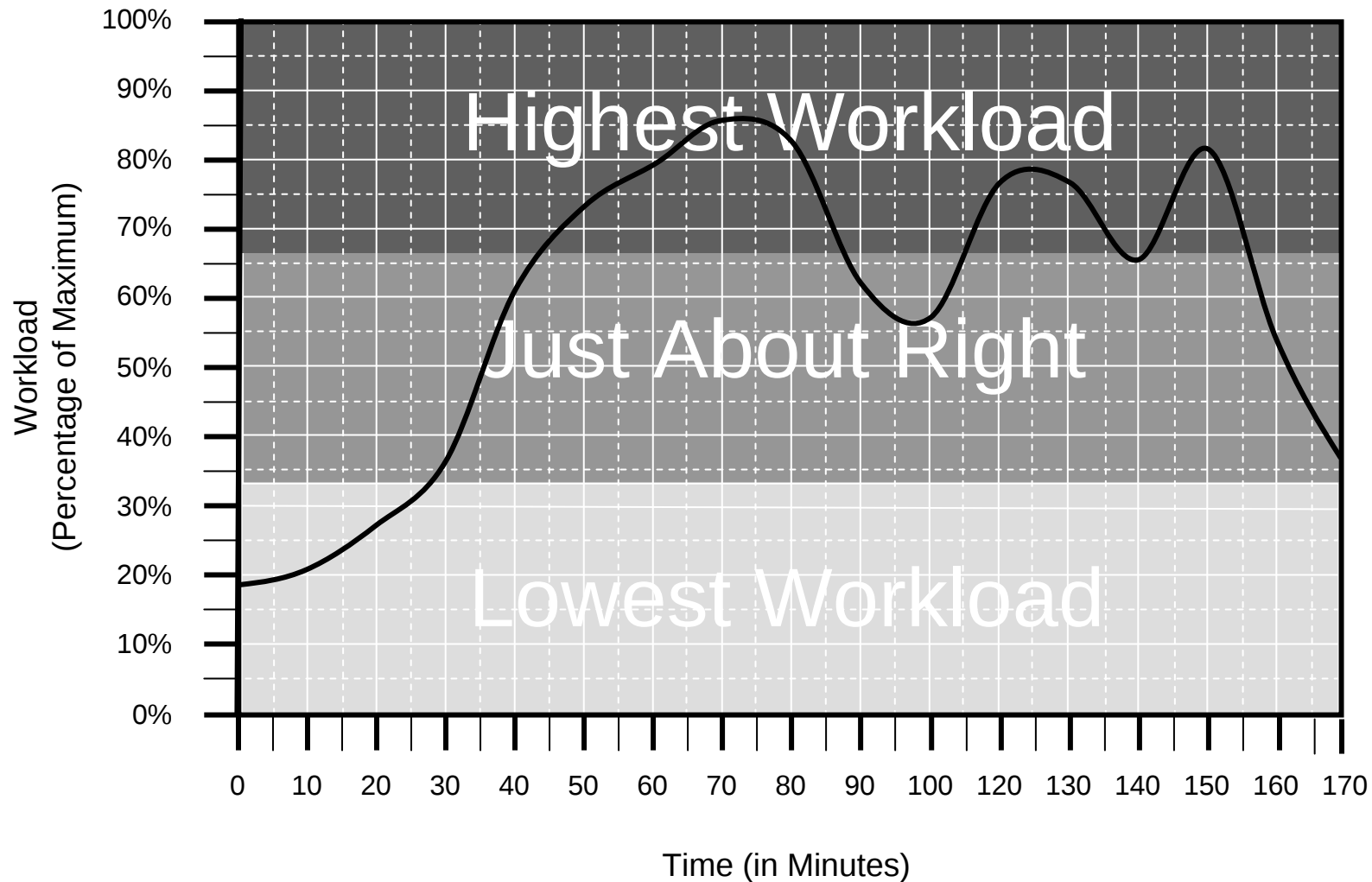


Sample Heart Rate Variability





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





Summary



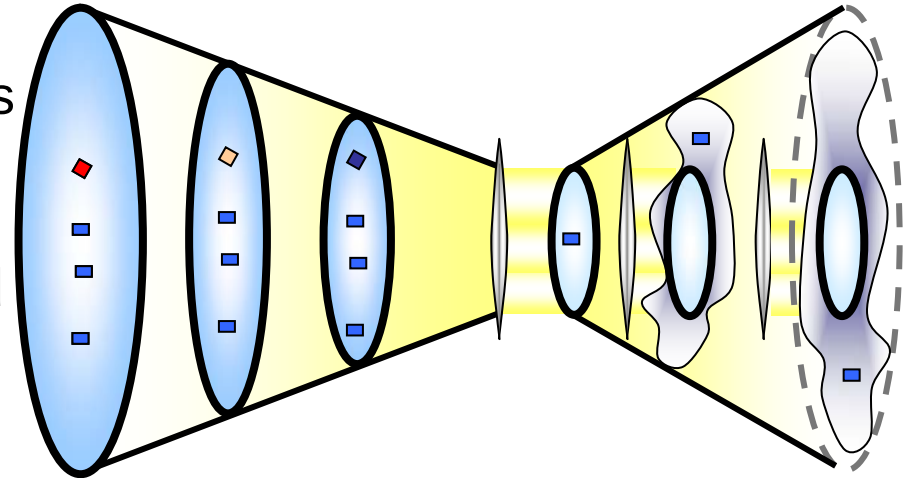
❑ The case of the *USS Stark* illustrates the **utility of the process model** of situated cognition as a descriptive and explanatory tool for both individual and collaborative activities.

❑ 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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