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JDL - Data Fusion Group

VISIONEERING - **Applications to Human Issues in Data Fusion**

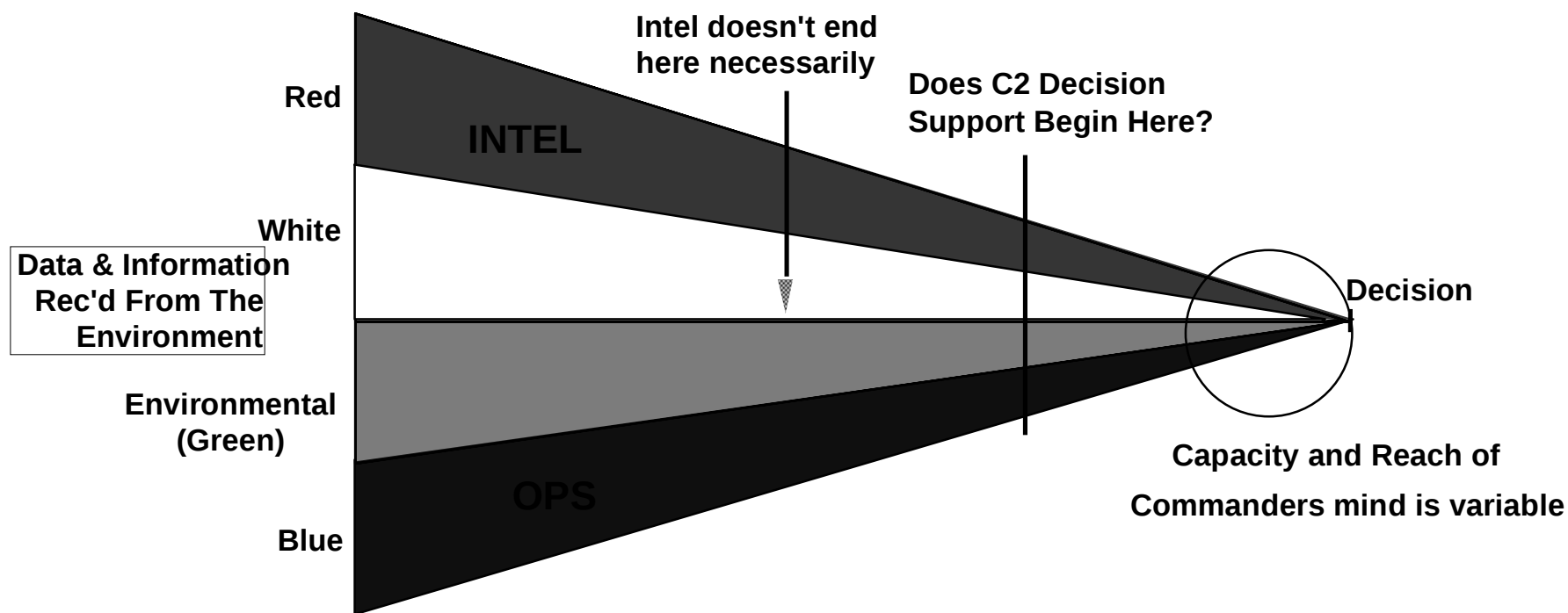
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Data Fusion: Transforms Data into Information and Knowledge

*The Key is Seamless FLOW to the Commander - A Person
Our "Boxes" can become artificial restrictions to the Flow*



FW-600a

Data → Information → Knowledge → Understanding

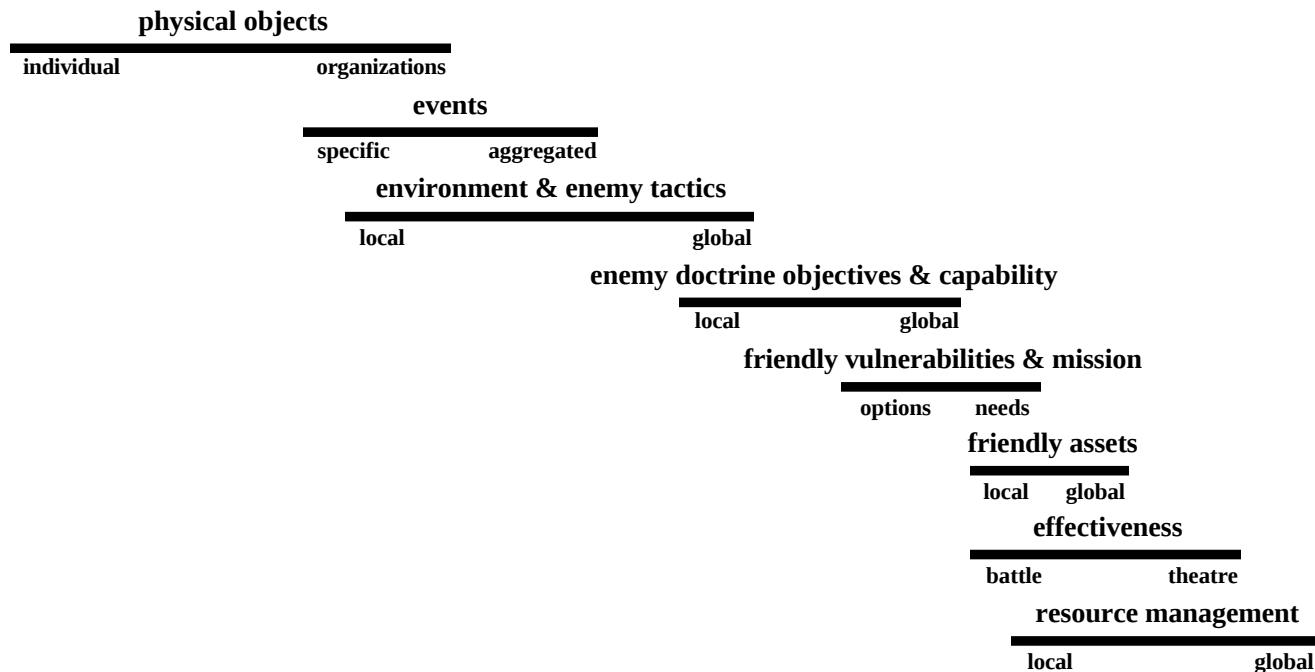
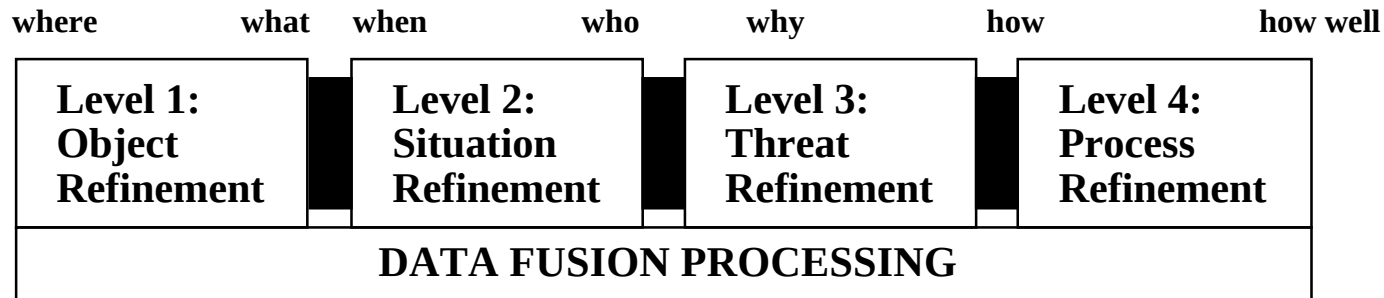
Fusion Success Requirements

To develop a successful Fusion process (automated or manual) a good understanding of the following is required:

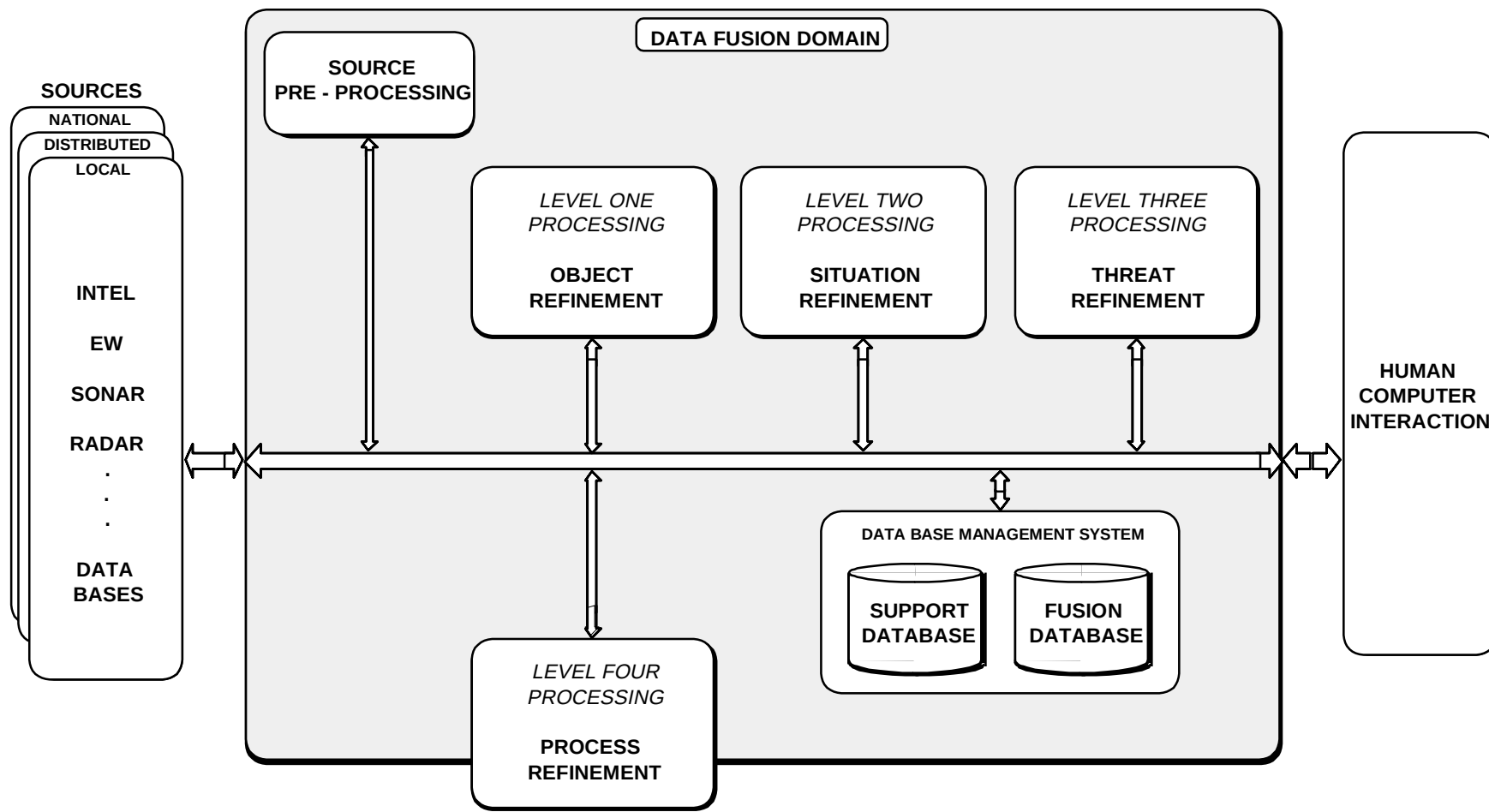
- 1. Physics of the Sensor/Collector AND the Phenomena**
- 2. Data Fusion Processes**
- 3. Warfare Mission Area**
- 4. Customer/User**

Acknowledgment: Capt W. Walls

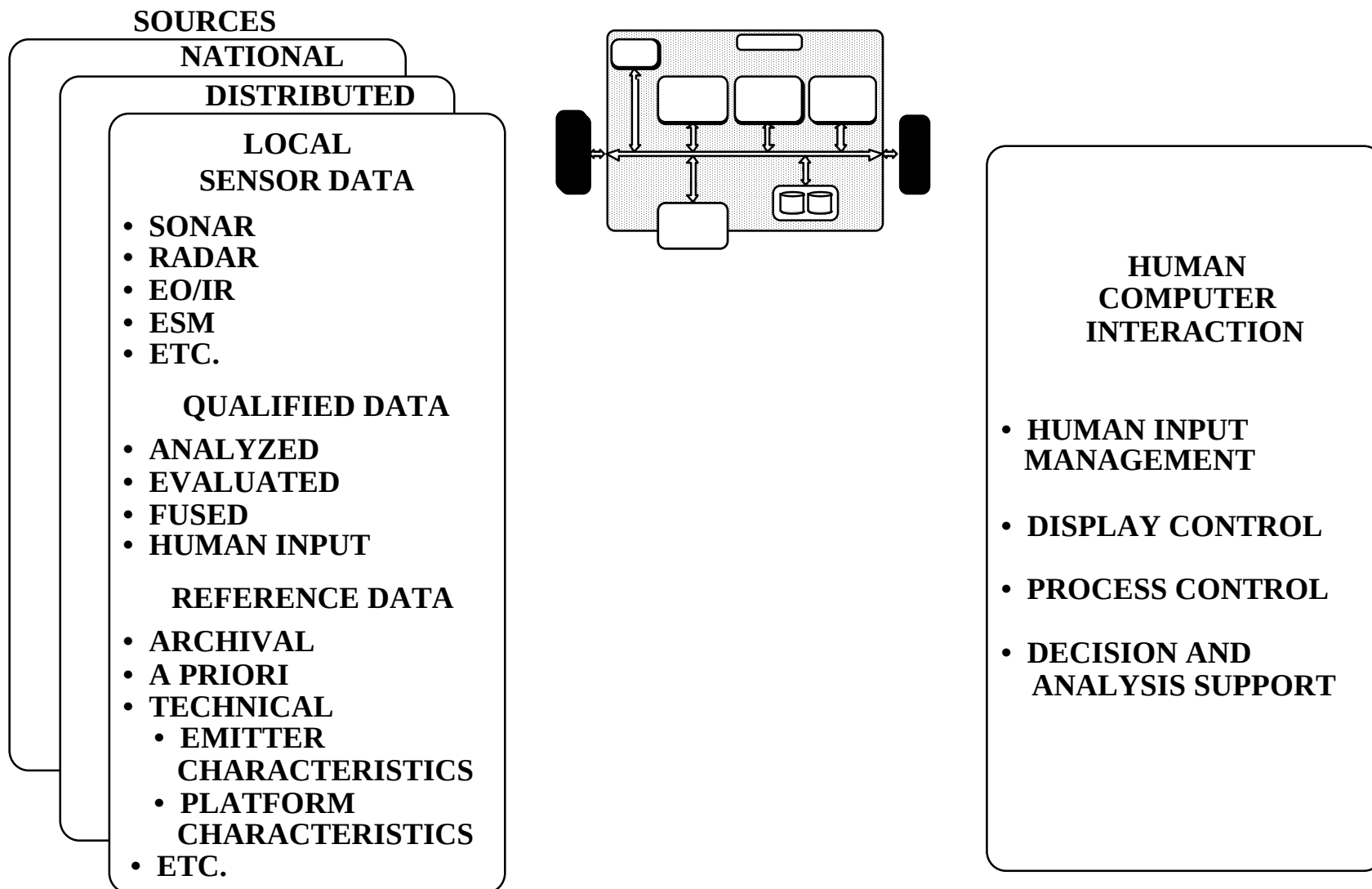
DATA FUSION: MULTILEVEL INFERENCE



DATA FUSION PROCESS



ROLE OF DATA FUSION



The “ Human Problem”

- **In Visioneering the CCOF Fusion and Broader Analysis Functions Are Transparent**
 - ◆ The dependence of the overall C² and execution processes on fusion and analysis is not evident
 - ◆ Their importance is minimized
- **Conceptually and Technically**

Operations - Technical Boundary Issue



Fusion as a Factor in “Real Life” Decisionmaking

- Real Life = High Stakes, organizations, action-feedback, training
- Emphasis on Descriptive vice rational or prescriptive
 - ◆ Meta-cognition - strategy selection
 - ◆ Sequential vice comparative/analytical decisions
 - ◆ Satisficing & the role of heuristics
 - ◆ Stress effects
- Humans Use 2 Key Strategies
 - ◆ Recognition Primed Decisionmaking(RBD)
 - ◆ Explanation Based Reasoning (EBR)

Recognition Primed Decision Strategy

(Klein et al)

- **Focus on situation assessment vice response**
- **First option considered is usually workable**
- **Serial vice comparative, generation of options**
- **Satisficing not optimal**
- **Reliance on mental simulation not analysis**
- **Progressive deepening of selected option**
- **Creates expectancies**

Explanation Based Reasoning Strategy

(Pennington and Hastie)

- Construct stories (causal models) to explain events and event relationships
- Decisionmakers reason about the evidence
- Evaluate possible explanations for
 - ◆ Consistency
 - ◆ Completeness
 - ◆ Plausibility
- Make explicit assumptions that must be accepted

Boundary Issue

- **Data Fusion Requirements - Derived**
- **Systems Development and Evaluation (Particularly at Higher DF Levels) Needs to be Derived from Measures of Merit of Importance at the Operator Level**
 - ◆ Specifically, *“What Matters in Making a Decision”*

I.E. *Operators MUST Work With the Technical Fusion People During the Fusion Requirements Phase AND the Measure of Effectiveness Phase*

“Trust” Within the Process

**Fusion Can't Be Done Perfectly - So We Must
Address “Satisfactory” Levels of Quality in a
Context of Decision Support to an Operator in
a Mission Environment**

**The Test and Evaluation Issue Goes to the Heart of Trust
in the Data Fusion Process and Trust in the Automation of
the Process. The Decision Maker Must *Understand* and
Believe the Process and the Product**

**In Today's Information Environment Wrestling with this
Issue is a Important**

Stress and The Fusion Process

■ Stress (High Arousal) Causes

- ◆ Work Pressure
- ◆ Performance Pressure
- ◆ Environmental pressure

■ Effects Observed

- ◆ Hyper-vigilance (impulsiveness)
- ◆ Intolerance for ambiguity
- ◆ Tunnel Vision
- ◆ Forgetting Secondary tasks
- ◆ Reduced communication
- ◆ Short-term memory degradation
- ◆ Conceptual Rigidity

The Human Factor in the Data Fusion Process

- Fusion Is a Fundamental Human Process in Decision Making
- As a Community We Must Understand Decisionmaking in Making Better Fusion Tools
- Need to Know More About
 - ◆ Strategies
 - ◆ Biases
 - ◆ Stress
 - ◆ Culture
- Need Better Models
- Need Measures of Merit (MOPs, MOEs, MOFEs)

Why Is This Knowledge Important to Our Understanding

- **Bounded Rationality (Simon)**
- **Hueristics and Biases (Kahneman and Tversky)**
 - ◆ **Framing**
 - ◆ **Availability**
 - ◆ **Anchoring**
 - ◆ **Confirmation**
 - ◆ **Order Effects Primacy/Recency**
 - ◆ **Representativeness**

Bias Examples

■ Primacy/Recency

◆ Hypotheses Formed Early May Lead to a Confirmation Bias

- Information/Product which confirms the initial hypothesis is sought out
- Confirming evidence is considered more conclusive than dis-confirming evidence

◆ Hypotheses Formed Late May Result in an Availability Bias

■ Framing

◆ Significant Shifts in Preference Occur When an Outcome Is Framed As a Loss Rather Than a Gain

How Fusion Process Automation Interfaces to This Decision Process Can Be a Major Factor in Its Success or Failure

Approach

- **Set Standards for Trust**
- **Invest in Decision Research and Fusion Interaction**
- **Establish Categorization and Classification of Failure Modes**
- **Involve the Operator - Operators Must Take A Stand**
 - ◆ **What Level of Failure is Acceptable**
 - ◆ **What Problems are Really Critical**
 - ◆ **What Error Budget can be Accepted**
 - ◆ **How Can Fusion Best Impact Their Decision Process**