Interoperability for Situation Management and Decision Making

A Personal Narrative

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What?

- Request for Information (RFI)
- What does interoperability mean for situation management and decision making?
- Is there a need for interoperability?
  - If so, then how could it be achieved?
  - If not, are there some subdomains where it is needed?
- Is it the right time for interoperability standards?
  - Standards fail if they are too early or too late.
- What products and tools exist?
- What standards exist?

Why?

- CogSIMA related research and development projects
  - Interdisciplinary
  - Highly valued
  - Could split into unconnected “silos”
- Teams must communicate
  - Members have different skills
  - Communication requires at least a partial shared understanding
- Connecting the silos
  - Standard terminology
  - Formal models (ontologies)
  - Could become their own silos
- Terminology and ontologies need to be consistent with one another

Who?

- **Ken Baclawski** *A Personal Narrative*
- **Hans Polzer** *NCOIC NATO IPT Work in 2008 on Friendly Force Tracking Interoperability*
- **Barry Smith** speaking about situations

The strands of the narrative

- Ontology
- Situation Awareness and Management
- Decision Making
- Decision Rationales
- Explanation
- Context
- Uncertainty

- Self-Awareness
- Cognition
- Teaming
- Fusion
- Machine Learning

Ontology

- Approaches to interoperability
  - Microtheories
  - Ontology alignment
  - Hierarchical (hub and spoke)
- Kinds of ontology
  - Application
  - Domain
  - Reference
  - Foundational (Upper or Top-Level Ontology)
- BFO is the most commonly used foundational ontology.

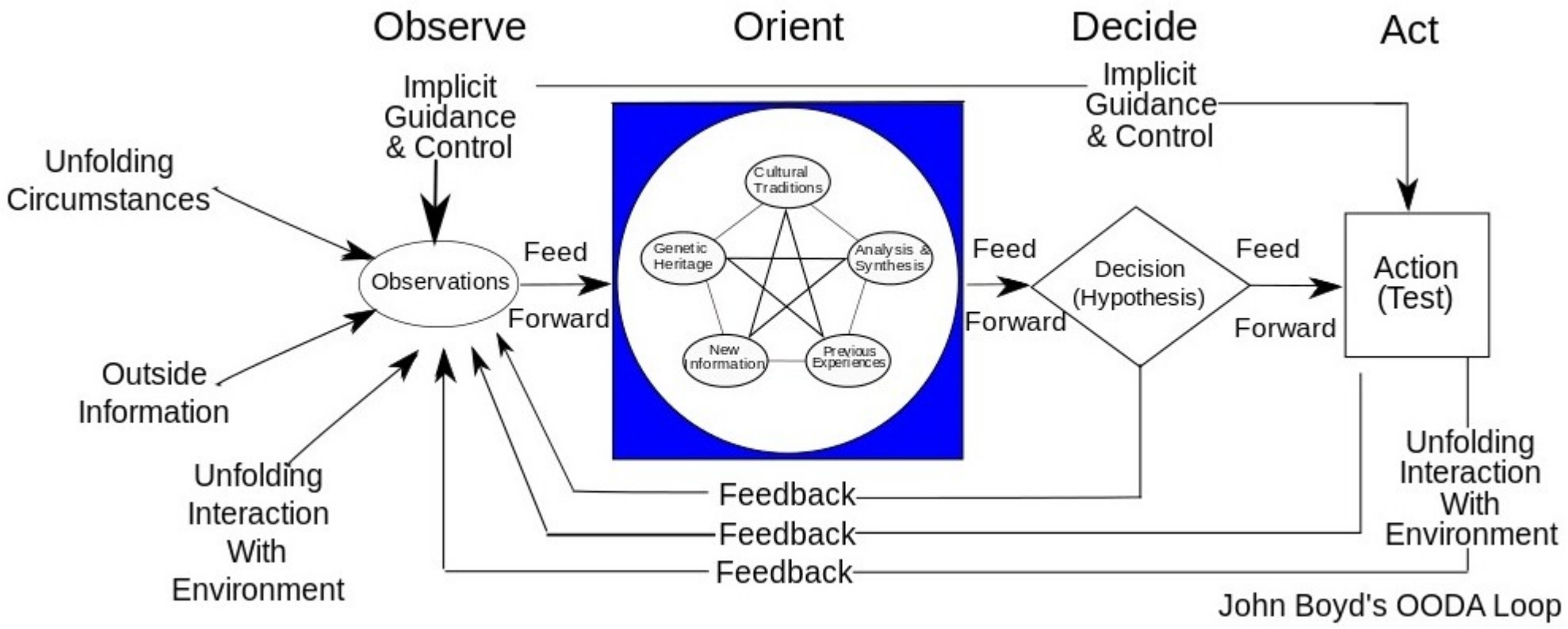
Situation Awareness and Management

- Situation theory was developed by Barwise and Perry, later extended by Devlin.
- The Situation Theory Ontology (STO) expresses situation theory as an ontology.
- STO is a reference ontology, but was not integrated with any foundational ontology.

Decision Making

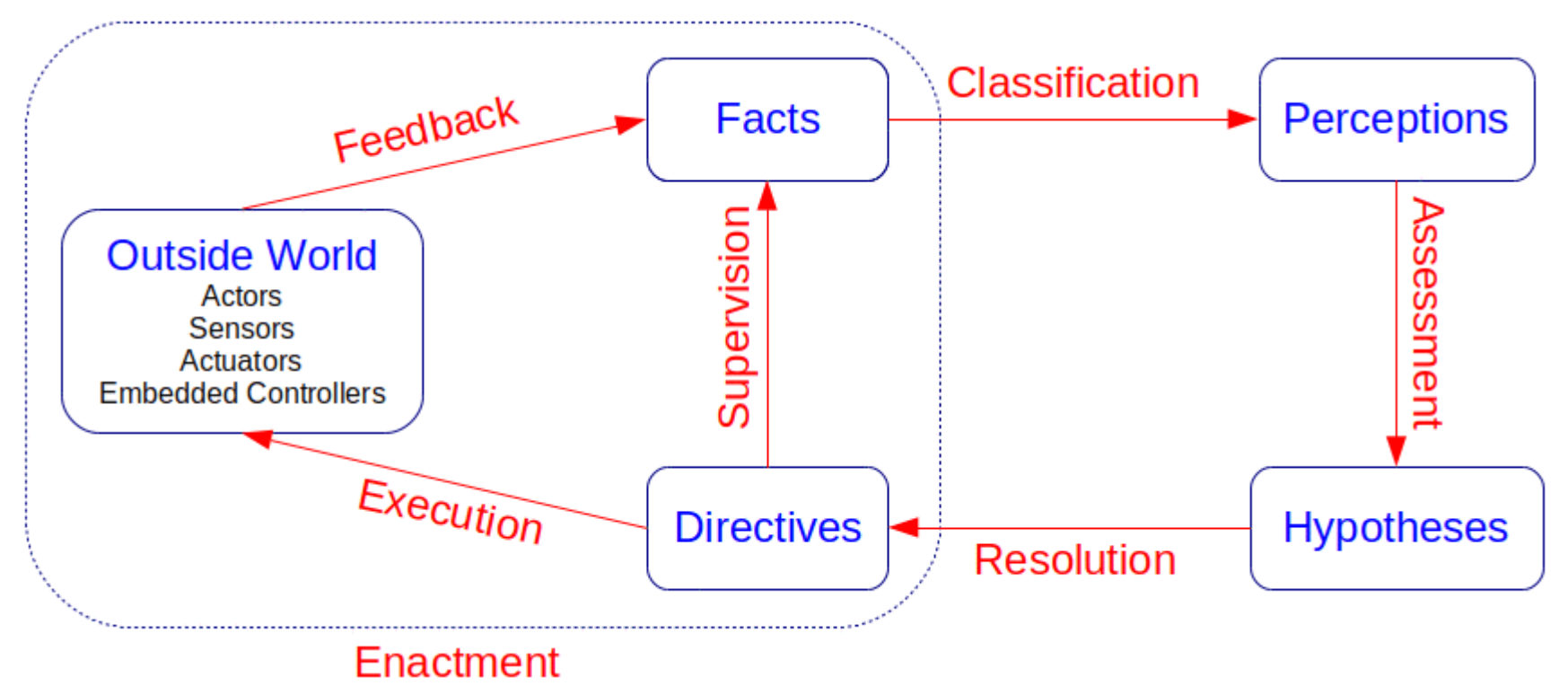
- Situation awareness and decision making are closely related.
- Decision making is a very general
  - People make decisions constantly
  - Every “if” statement makes a decision
  - Should be more specific about what decision processes are in scope
- Some standards exist
  - Military Decision Making Process (MDMP)
  - OMG Decision Model and Notation (DMN)
    - Primarily for business decisions
    - Not a decision loop
    - Not related to situation awareness

OODA Loop


Observe
Orient
Decide
Act
Implicit Guidance & Control
Implicit Guidance & Control
Unfolding Circumstances
Observations
Feed Forward
Cultural Traditions
Genetic Heritage
Analysis & Synthesis
New Information
Previous Experiences
Feed Forward
Decision (Hypothesis)
Feed Forward
Action (Test)
Outside Information
Unfolding Interaction With Environment
Feedback
Feedback
Feedback
Unfolding Interaction With Environment
John Boyd's OODA Loop

KIDS Ontology

- The Knowledge Intensive Data System
  - Reference ontology for the OODA loop.
  - Represents the process of decision making

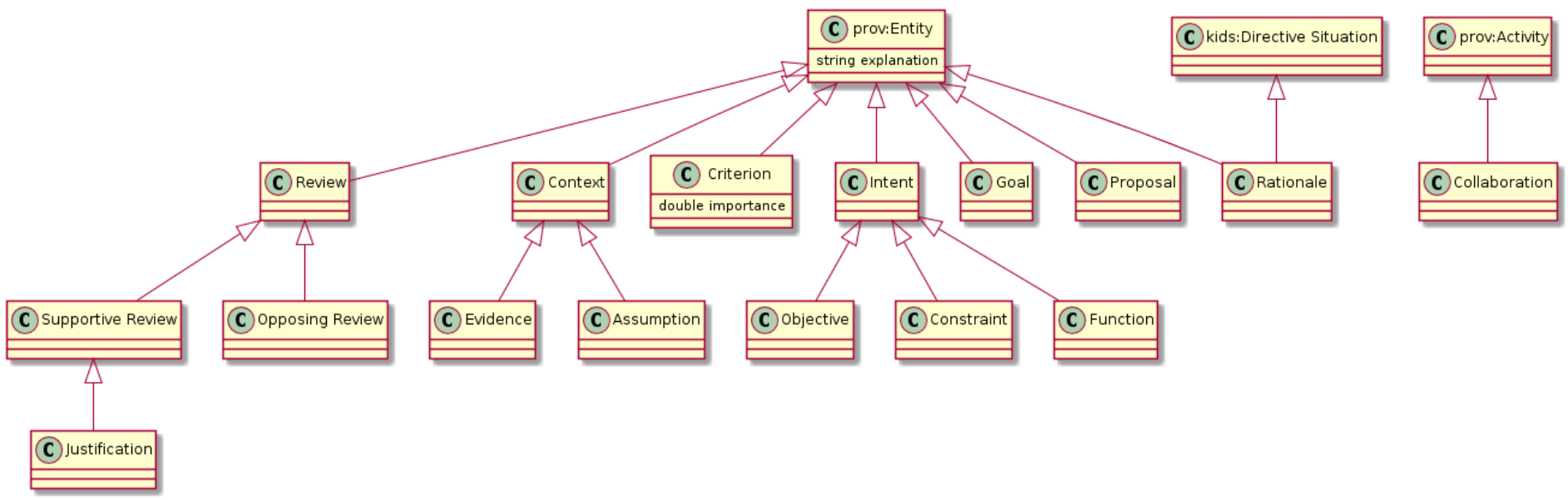


Decision Rationales

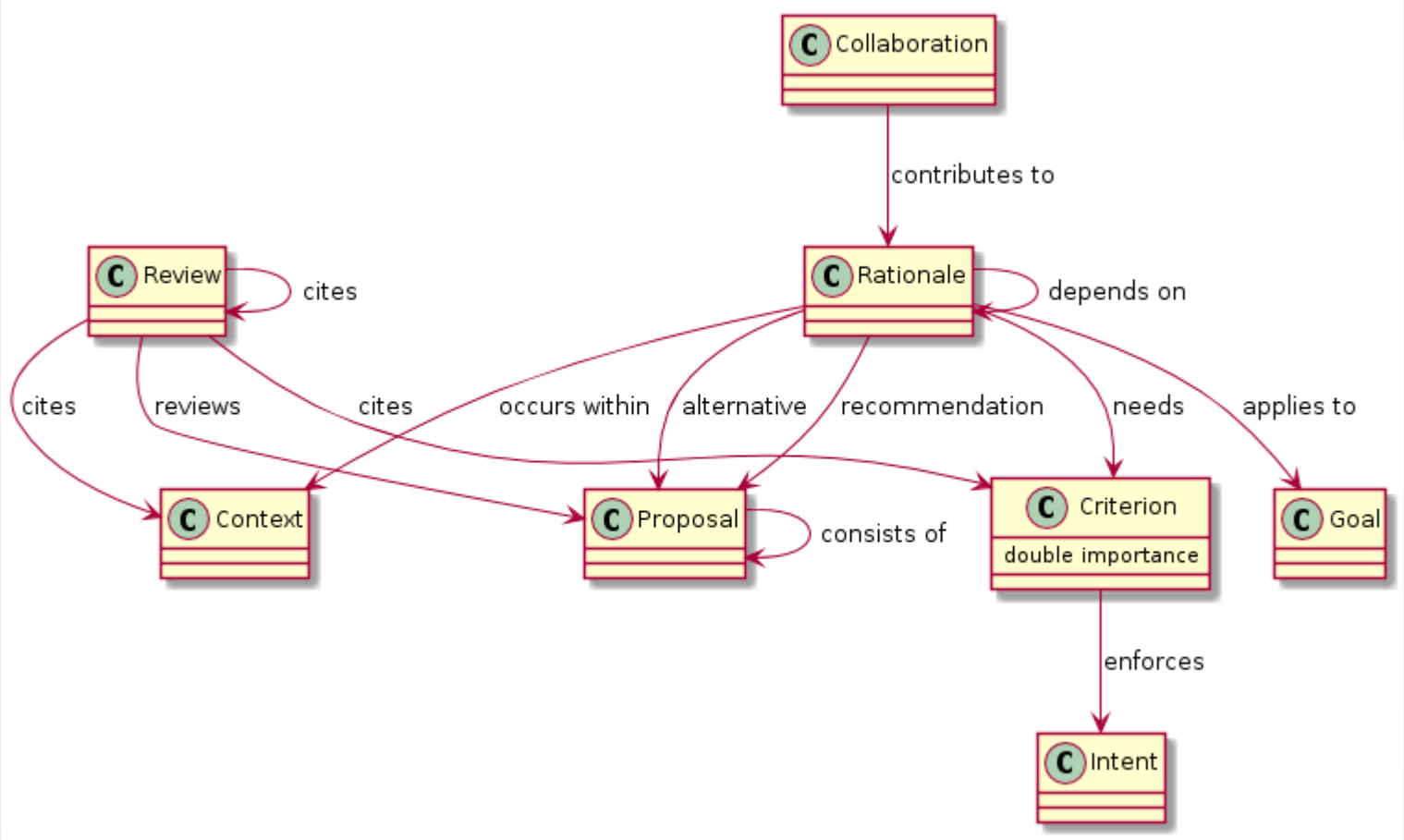
- A decision rationale describes the reasons for a decision.
- Capturing decision rationales has many advantages.
- Domains where they are used include:
  - Engineering design
  - Legal arguments
- There are tools for managing decision rationales.
- The Rationale Ontology is based on the Design Recommendation and Intent Model (DRIM)

Decision Rationale Ontology

- Provides for: facts, claims, reasoning, refutations, justifications, conclusions, provenance, and explanations.



Decision Rationale Ontology



Explanation

- An explanation is the answer to a “Why” or “Why not” question as well as follow up questions.
- Explanations can be extracted from decision rationales:
  - The justification of the decision answers “Why”
  - The refuted proposals/claims answer “Why not”
  - Citations to provenance and other rationales answer follow up questions
- Does this solve the problem of explainability?

Explanations depend on roles

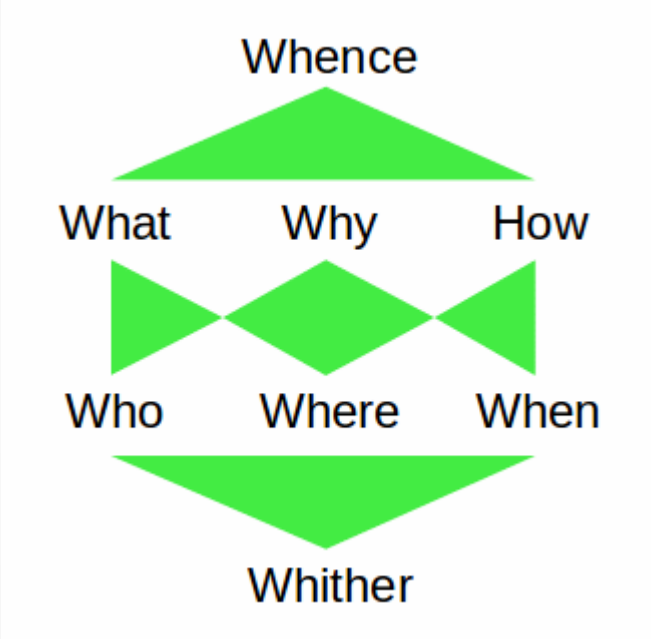
- Three explanations for “Why was my application for a loan denied?"
  - “The account balance covariate in the logistic regression model used to make decisions explains 89.9% of residual variance.”
  - “The system denies loan applicants with low bank account balances.”
  - “The system does not want to approve loans to those who do not show evidence of being able to pay them off.”

Context

- From CogSIMA 2012:
  - “Everyone agrees that meaning depends on context, but not everyone agrees what context is … any theory of meaning will focus on some of the things that influence it, and whatever is left over gets to be called the ‘context’ so the ‘context’ gets to be a trash-can term. It means all the rest, whatever that is.” (Pat Hayes 2012)
- From the Ontology Summit 2018:
  - “It seems that, while context is important, all one can say in general about a context is that it is at a metalevel relative to the subject matter and that the context affects the interpretation of the subject matter.”
  - “However, there could be guidelines to help make explicit some aspects of a context when using a particular development methodology. Moreover, pragmatic considerations should, ultimately, drive the development of research and development of approaches to contexts. We now consider some of the motivations for why contexts should be formalized.”

Context and Provenance

- One guideline for context: Answer the “Wh” questions
- Another guideline is the 7-Dimensional Framework proposed by Mary Freiman
- The PROV ontology includes many aspects of context but not projection into the future (whither)



Uncertainty

- There are many kinds of uncertainty.
- In the third tutorial, Paulo Costa described the URREF ontology.
  - Covers many kinds of uncertainty
  - Does not model complex stochastic processes

Whither?

- Try to answer the questions on the What? slide as well as others related to interoperability.
- Weave the strands together into a more coherent narrative.
- How can this effort continue in the future?