Soar Technology
Thinking *inside* the box.

Tools to Support Knowledge Design and Explanation (VISTA update)

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VISTA Goals

- Reduce costs in developing, fielding, and using Human Behavior Representations
  - Approach: provide a generic explanation capability that can be used by various HBRs
  - Specifically: Enhance the 'explanation' capability within the existing VISTA system
    - User-driven/interactive
    - Bring to bear multiple knowledge sources in explanation
    - Develop a design paradigm that supports explanation
    - Employ multi-modal explanation

Challenges

- What kinds of explanation are useful?
- What knowledge is available to generate explanations?
- How to reduce burden on system developer to producing explanations?

Approach

- Intelligent User Interface for Multi-Modal Explanations
  - Take advantage of multiple information modalities (e.g., graphics & text) for explanation
  - Use intelligent agent to mediate user interactions and generate contextually-relevant explanations
    - Agent contains domain-independent knowledge for generating explanations, discourse, display, and interaction
    - Agent imports domain-specific knowledge for the performing agent whose actions will be explained
  - Merge multiple knowledge sources to generate different types of explanations for different contexts or different users

Design Tradeoff

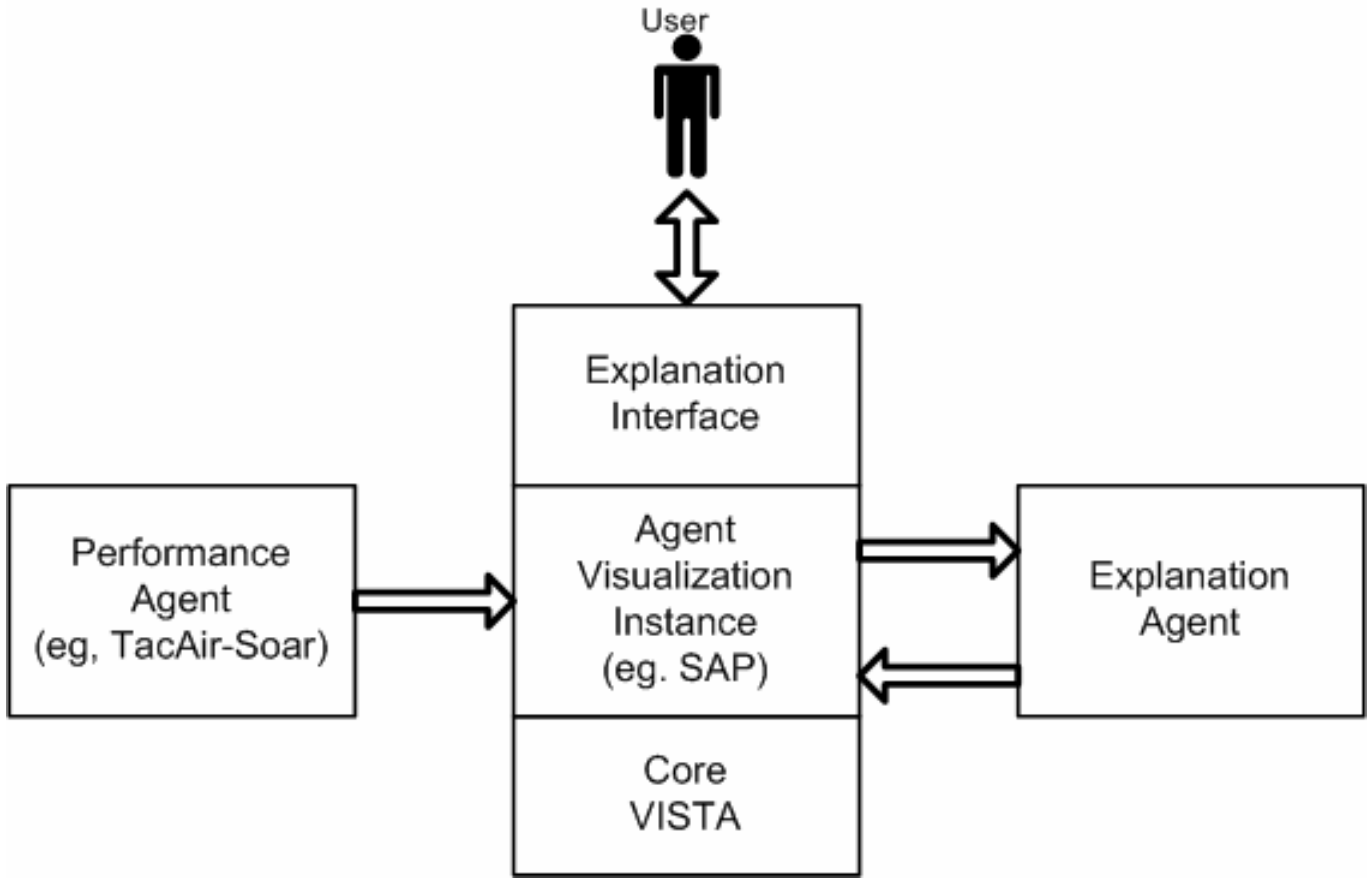
Where to place 'explanation' capabilities?

	Performance Agent	Explanation Agent
Pros	▪ Immediate access to agent knowledge	▪ **Generality across agent systems/architectures/ domains** ▪ Depends only on general VISTA knowledge representation primitives
Cons	▪ **Solution specific to agent and architecture** ▪ Adds extra-task burden on agent	▪ No direct access to performance agent knowledge ▪ Requires intermediate representation

No free lunch

TakeHome: *Generality* of solution is the driving requirement; but efficiency is also important – long-term savings trump short-term

High-level Architecture



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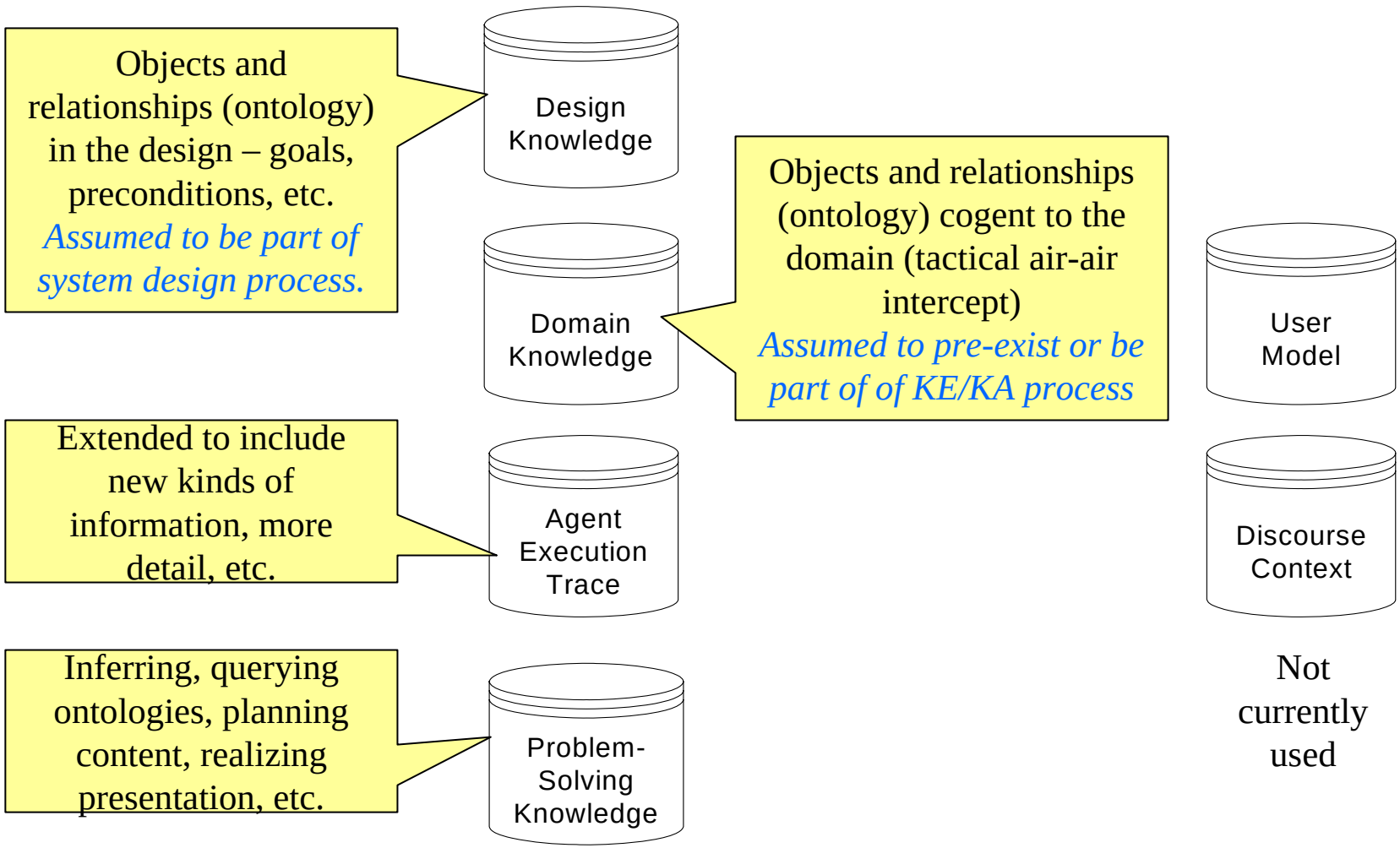
What Knowledge is available?



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Explanation Knowledge

- Can use ontology information as-is, where supplied
- Can take advantage of special encodings in ontologies for hypertext:
  - GetMissileLarGoal.description = "…such that the sitref:@target is …"
  - Display: "The purpose of get-missile-lar is to maneuver such that the target is within the launch acceptability region…"

- Some domain-neutral knowledge
  - How to query ontologies
  - How to structure output into a document
- Some domain-specific
  - Distinctions between primitive or domain-specific types (goals, objects)
  - What attributes to use in explanation
  - How to order explanation content

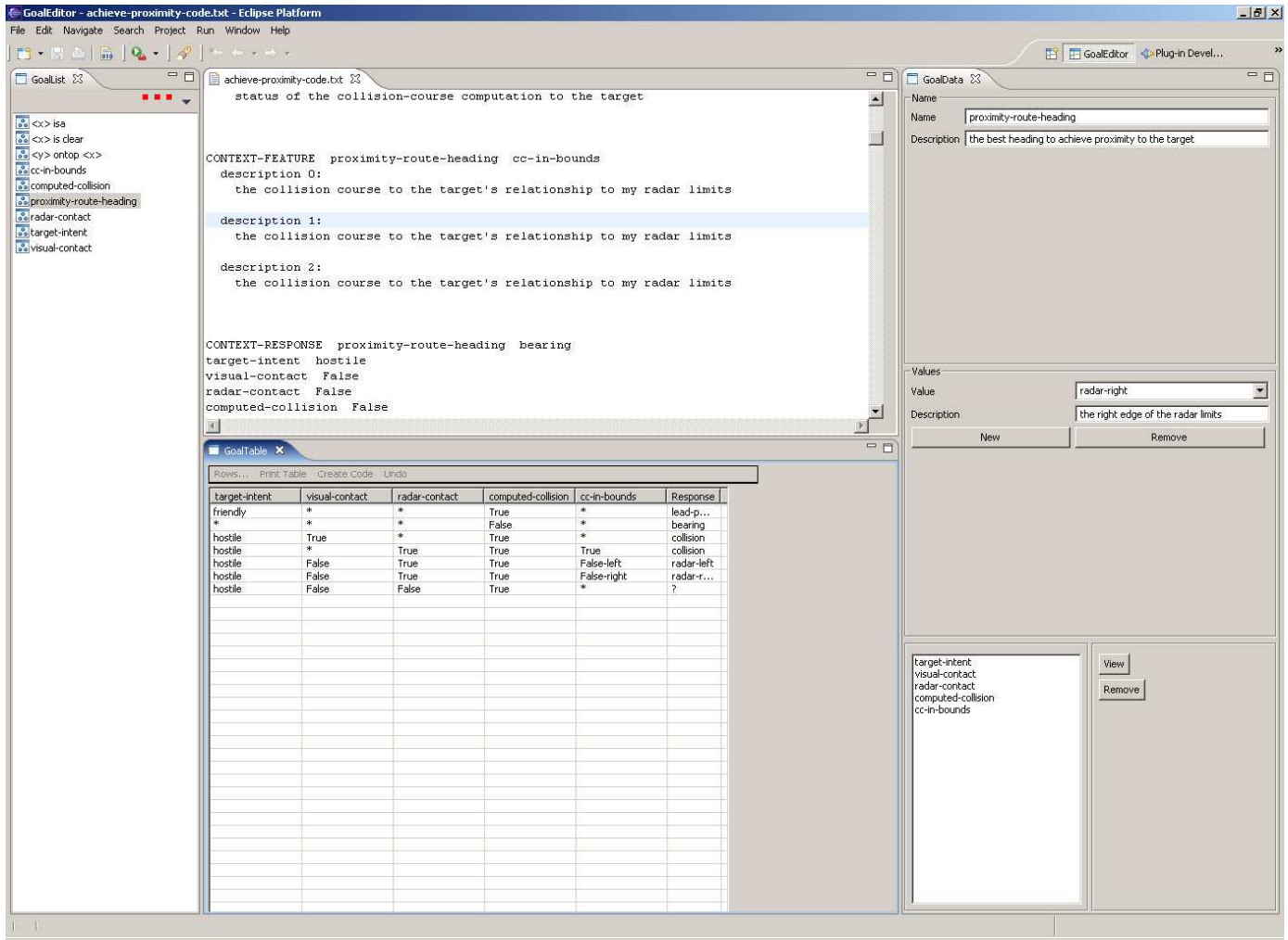
Adding Explanation Capability to HBMs: Process

- Define design, domain as ontologies
- Define decision-making contexts to organize performing agent and question-answering interactions
- Annotate knowledge structures with documentation elements
  - VISTA will automatically generate lower-quality explanatory elements if necessary
- Mark situation knowledge to export from *performance agent*
- If desired, create graphical representations of knowledge elements

How to reduce burden of explanation on developer?

- Re-use of existing knowledge bases
  - From the design and knowledge acquisition processes
  - From extant knowledge bases (SUMO ontology, C2IEDM, etc.)
- Common/standard formats
  - Ontology languages (OWL)
- COTS tools
  - Ontology specification tools, ontology translators, etc.
  - Protégé, Onto2Soar
- API for adding domain-specific knowledge into explanations
- Improved knowledge design tools
  - HERBAL, Contextual Knowledge Editor, HLSR

Knowledge Editor to Build Design Ontologies from Domain Ontologies (Eclipse Plugin)



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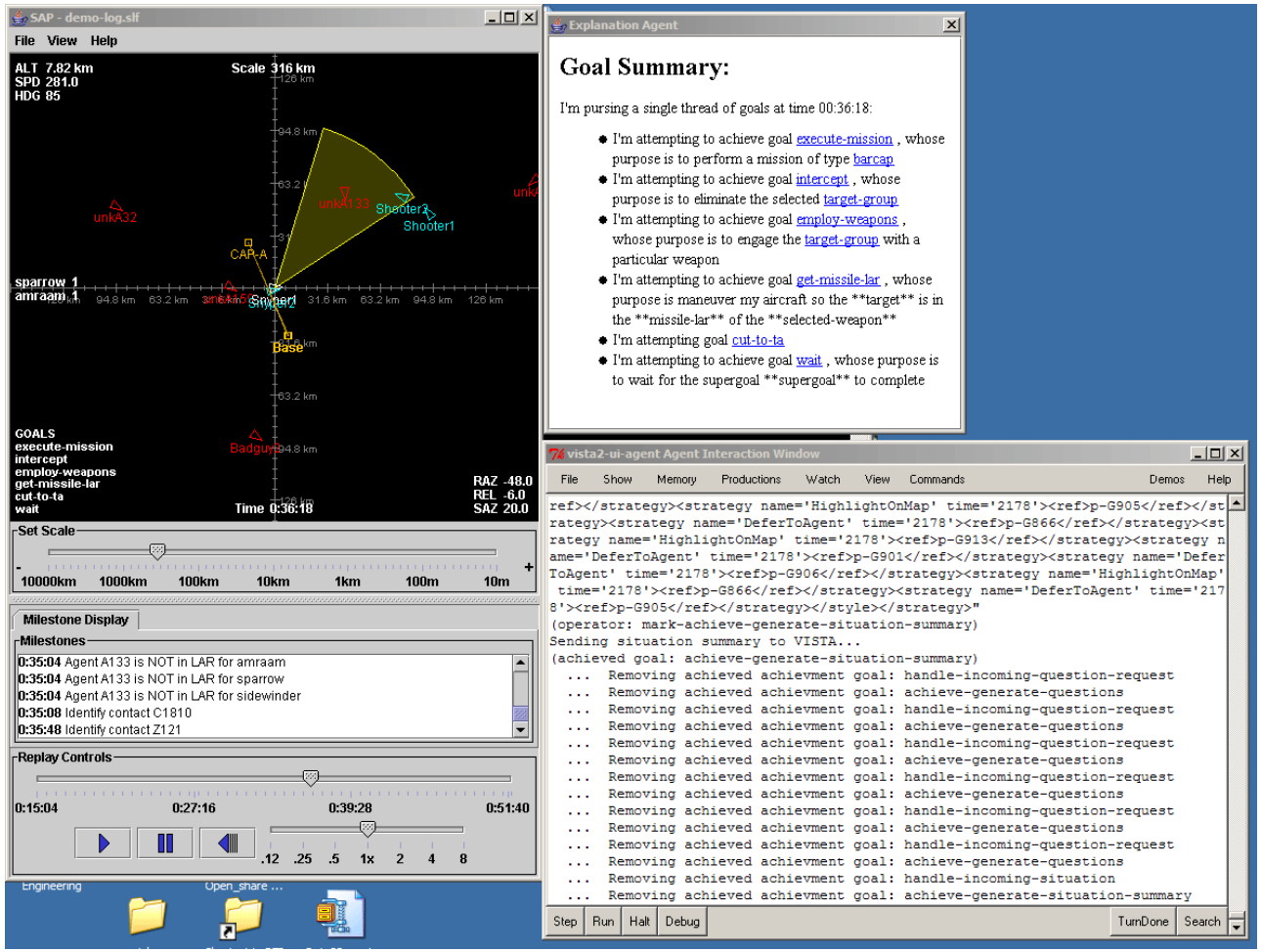
VISTA with Explanation Agent



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Synergy

- HERBL
  - Provides user interface for defining domain and some design knowledge, together with mappings to Soar architectural elements
- TRACE
  - Provides low-level architectural ontology which could be used to drive design-knowledge editors and displays
- Architectural abstractions
  - Provides mid-level language for domain and design ontologies
- Contextual Knowledge Editor
  - Provides context-driven engineering of design knowledge at an architecture-neutral level
- HLSR
  - Provides architecture-neutral language for representing domain and design knowledge

Gold

- We have greatly expanded the kinds of information available to a user of HBMs using VISTA
- We have improved the usability/interactivity of getting information from VISTA
- We use multi-modal explanation to take advantage of VISTA graphical channels as well as text-based explanation
- Maintained generality across different agent systems
- Parallel development of a space of related tools and technologies is providing opportunities for the design of agent-oriented Integrated Development Environments to ease development of performing and explaining agents

Coal

- Hard to measure benefit of explanations
- Generating explanations still imposes an additional burden on the model developer
- There are a number of interesting tools and technologies emerging, but they require integration