

FY25 Strategic University Research Partnership (SURP)

MBSE CoPilot for Small Projects

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Total Funding: \$60,000

Background

To boost mission efficiency and reduce risk, JPL must advance its systems engineering practices, especially by rigorously specifying system behavior. JPL's openCAESAR framework supports ontology-based modeling and has been successfully deployed in flagship missions like Europa Clipper and Psyche. Such framework still requires a steep learning curve that large projects can absorb but smaller ones cannot due to their limited resources, defaulting to document-based methods.

Objectives

This project seeks to lower barriers to Model-Based Systems Engineering (MBSE) adoption by introducing an AI-powered natural language interface (NLI), called CoPilot, as an alternative to traditional user and programmatic interfaces.

Key Goals:

- Enable engineers to author and analyze system models through text prompts
- Reduce the need for expertise in MBSE languages, methodologies, and tools
- Validate capabilities on small flight projects demonstrating ability to add rigor via MBSE even in the presence of limited resources

Results

Year 1 Achievements:

- Completed trade study and selected base LLM base model (Llama v3.3)
- Evaluated three training approaches: Continuous Pre-Training, RAG, and Fine-tuning
- Selected Continue extension to integrate LLM with VS Code workbench
- Established IMCE vocabularies with open-source models as a training dataset
- Built a collaborative framework with University of Arizona team

Path Forward: Year 1 focused on exploration and path finding. Years 2-3 will concentrate on solution building, extension to other vocabularies like F Prime Prime and SysML v2, and validation in context of small projects.

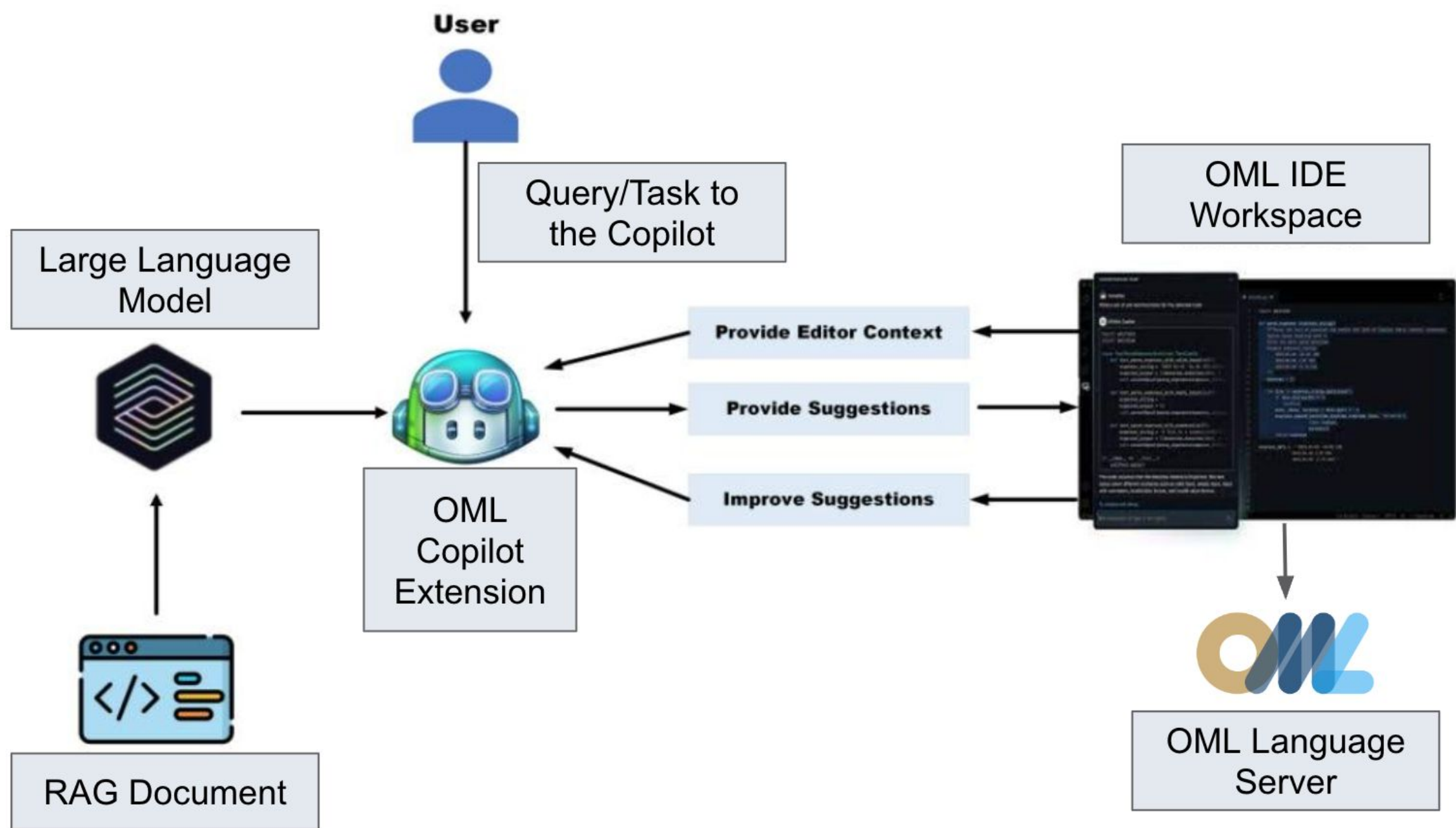


Figure 1. Proposed Architecture Diagram for the OML CoPilot

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Approach

We selected JPL's openCAESAR framework with its Ontological Modeling Language (OML) for its agility, rigor, readability, and VS Code integration.

Three Parallel Objectives:

- **Training LLM for OML authoring:** Selected Llama v3.3 as foundation model and chose fine-tuning approach for accuracy and permanence
- **Workbench integration:** Adopted Continue extension for VS Code enabling prompt-based interactions and code completion
- **Case study validation:** Pivoted from F Prime Prime to IMCE vocabularies for immediate training material availability

Significance & Benefits to JPL and NASA

Immediate Impact:

- Reduces barrier to entry for MBSE adoption across JPL projects
- Enables smaller teams to leverage rigorous modeling practices
- Accelerates modeling workflows through AI assistance
- Leverages investment in openCAESAR framework

Strategic Value:

- Sets foundation for future AI-powered modeling environments
- Enhances mission efficiency and risk reduction capabilities
- Strengthens university partnerships and workforce development
- Positions JPL as leader in AI-enhanced systems engineering

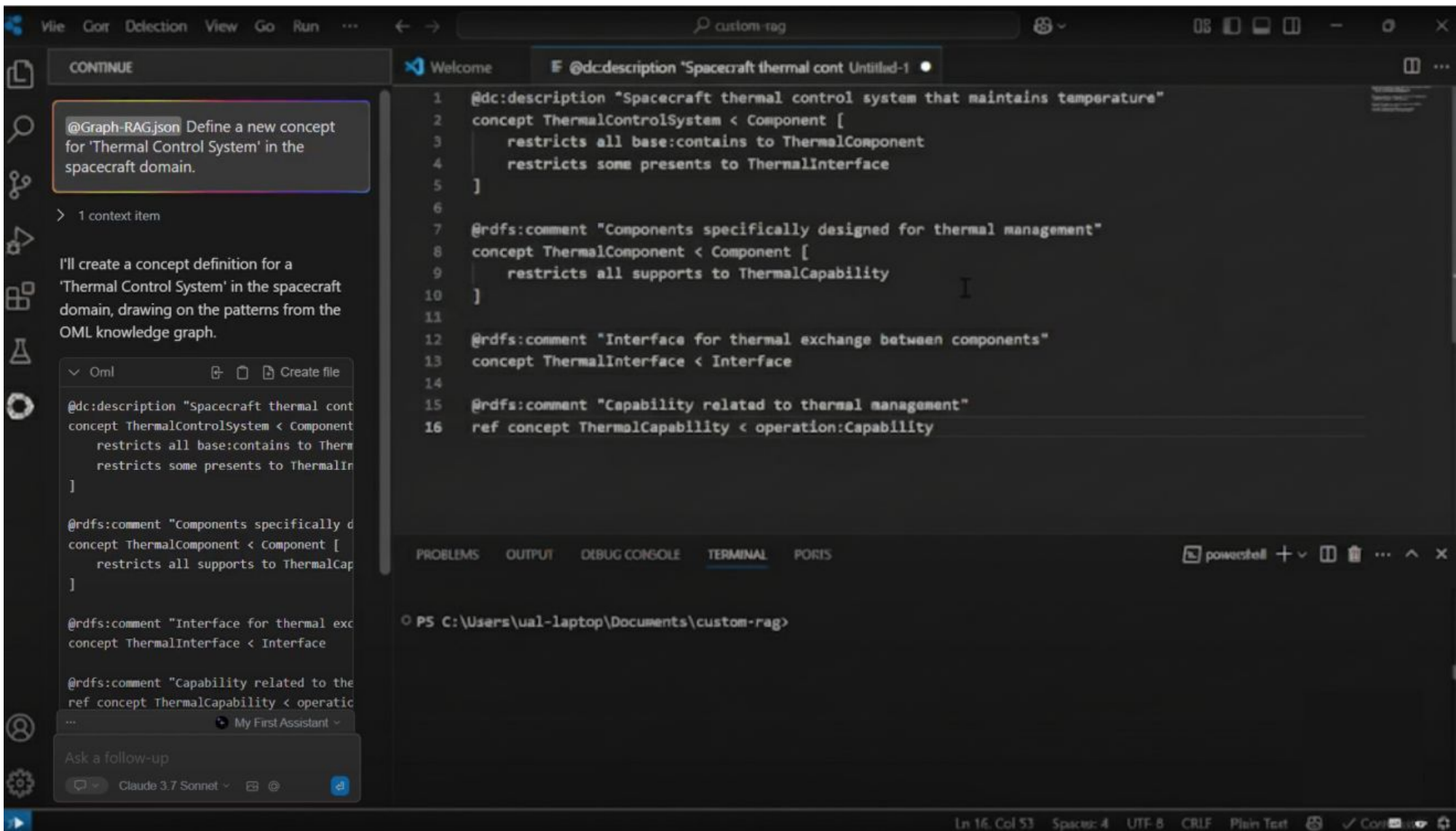


Figure 2. Screenshot of OML CoPilot in VS Code

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