SYSTEMS ENGINEERING RESEARCH CENTER | AIRC ACQUISITION INNOVATION RESEARCH CENTER | SERC RESEARCH REVIEW 2026



Digital Engineering Using Ontologies

ART-022, WRT-1086, WRT-2502

US Army Armaments Center

Dr. Mark Blackburn

Cleared for public release

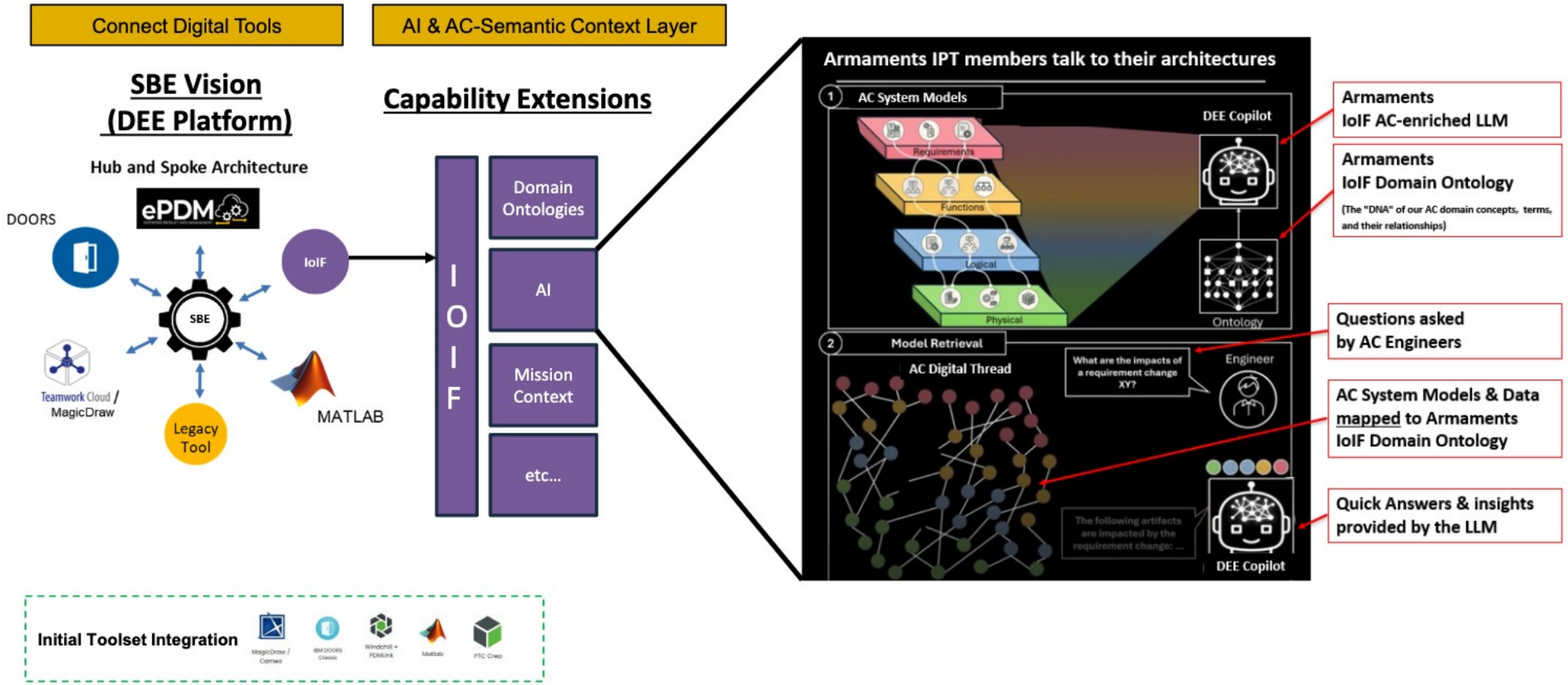
STEVENS INSTITUTE OF TECHNOLOGY

Information Contained in this Deck

- WHAT: Digital Engineering (DE) using Computationally-enabled Ontologies
- WHY: Characterizes Decision-making Methodology for Multi-domain Mission and System Tradespace Analysis
- HOW: DEVCOM plans for using Armaments Interoperability and Integration Framework (IoIF)
- DE Handbook transformed into a Knowledge Base using Large Language Model (LLM)
- Second LLM uses Knowledge Base to create a Help Desk/Chatbot
- Handbook describes operation of Interactive Service Dashboard that support Decision dashboard, Digital Thread Impact Analysis dashboard, and Well-formedness checking (to check that the models comply with the rules of the Methodology)

UNCLASSIFED

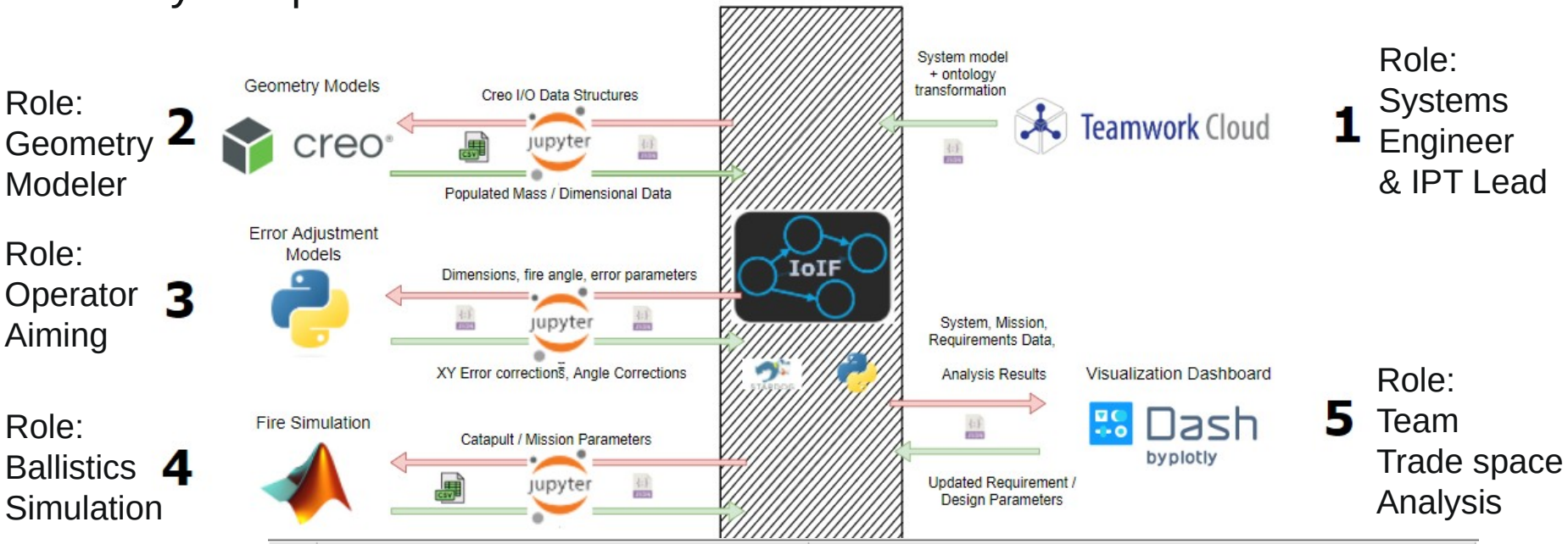
DIGITAL ENGINEERING ECOSYSTEM
TECHNICAL CONCEPT



IoIF Workflow Coordinates Simulations and Visualizations

- IoIF Workflows coordinate simulations for different roles for different subject matter experts and for different Analysis Types (called instances)

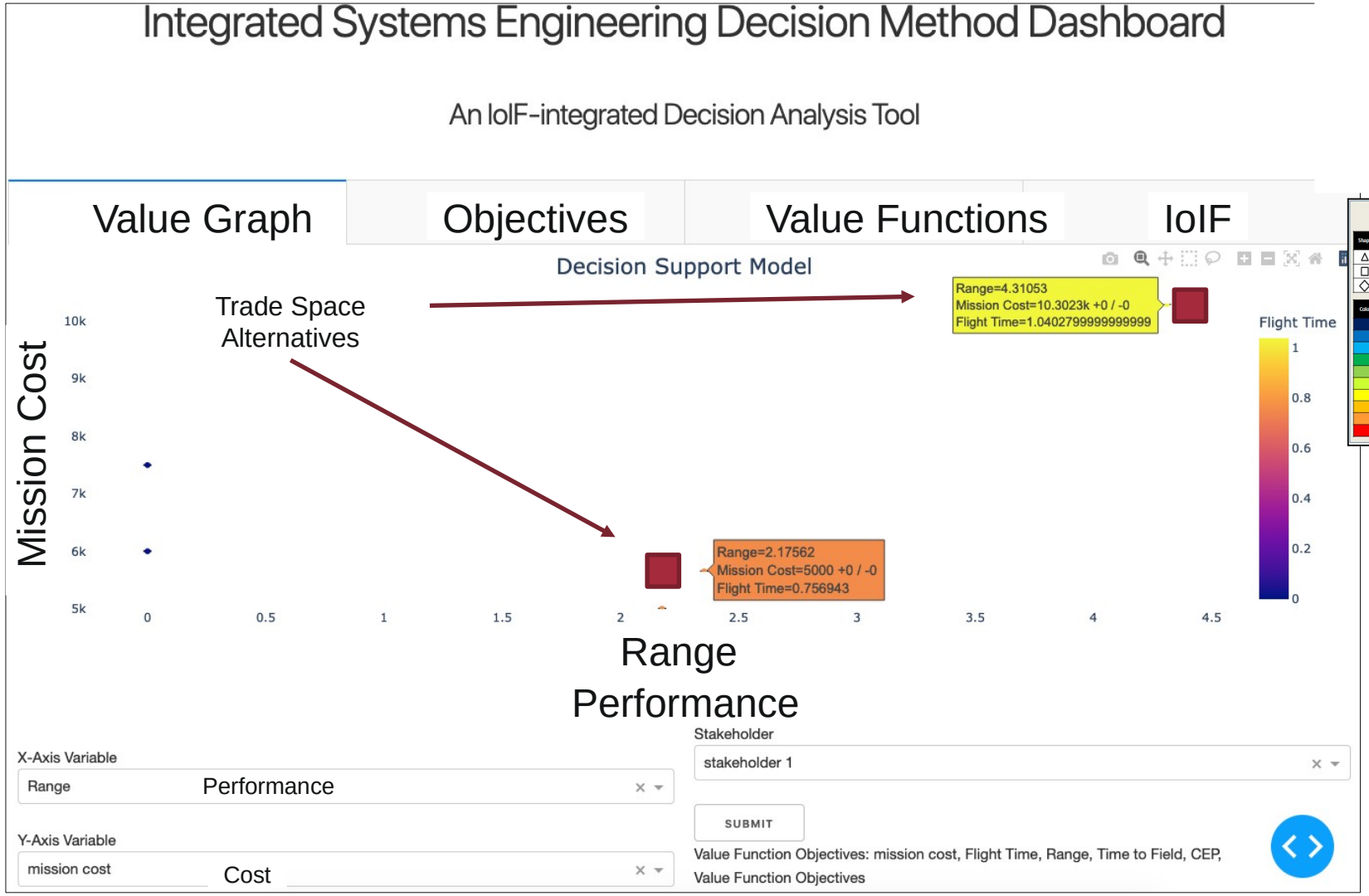
- DEVCOM successfully demonstrated to other Army Sponsors an Armaments Case Study and Workflow on Army computers and networks



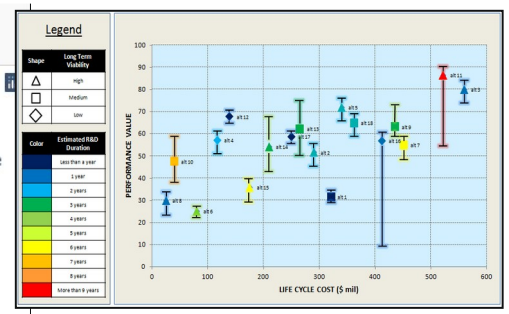
Analysis Type

#	Name	catapult Mission : Catapult Mission
1	Analysis as Designed	Mission as Designed : Catapult Mission
2	Analysis as Manufactured	Mission as Manufactured : Catapult Mission
3	Analysis Configuration Changed	Mission Configuration Changed : Catapult Mission
4	Analysis Requirement Changed	mission as required : Catapult Mission

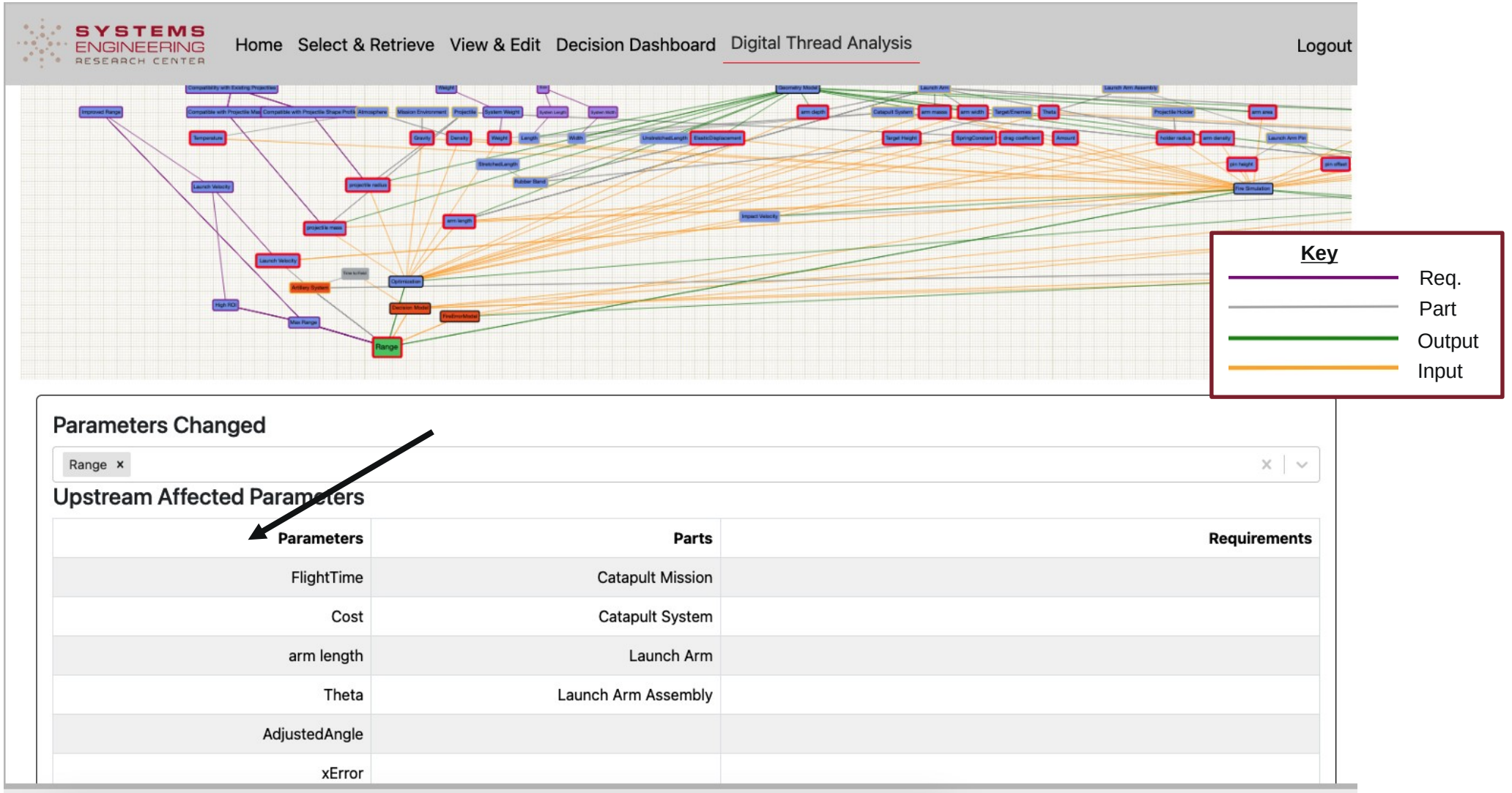
IoIF Decision Dashboard



Dashboard Implementation is Python-based Notional Rendering of Scatter Plot



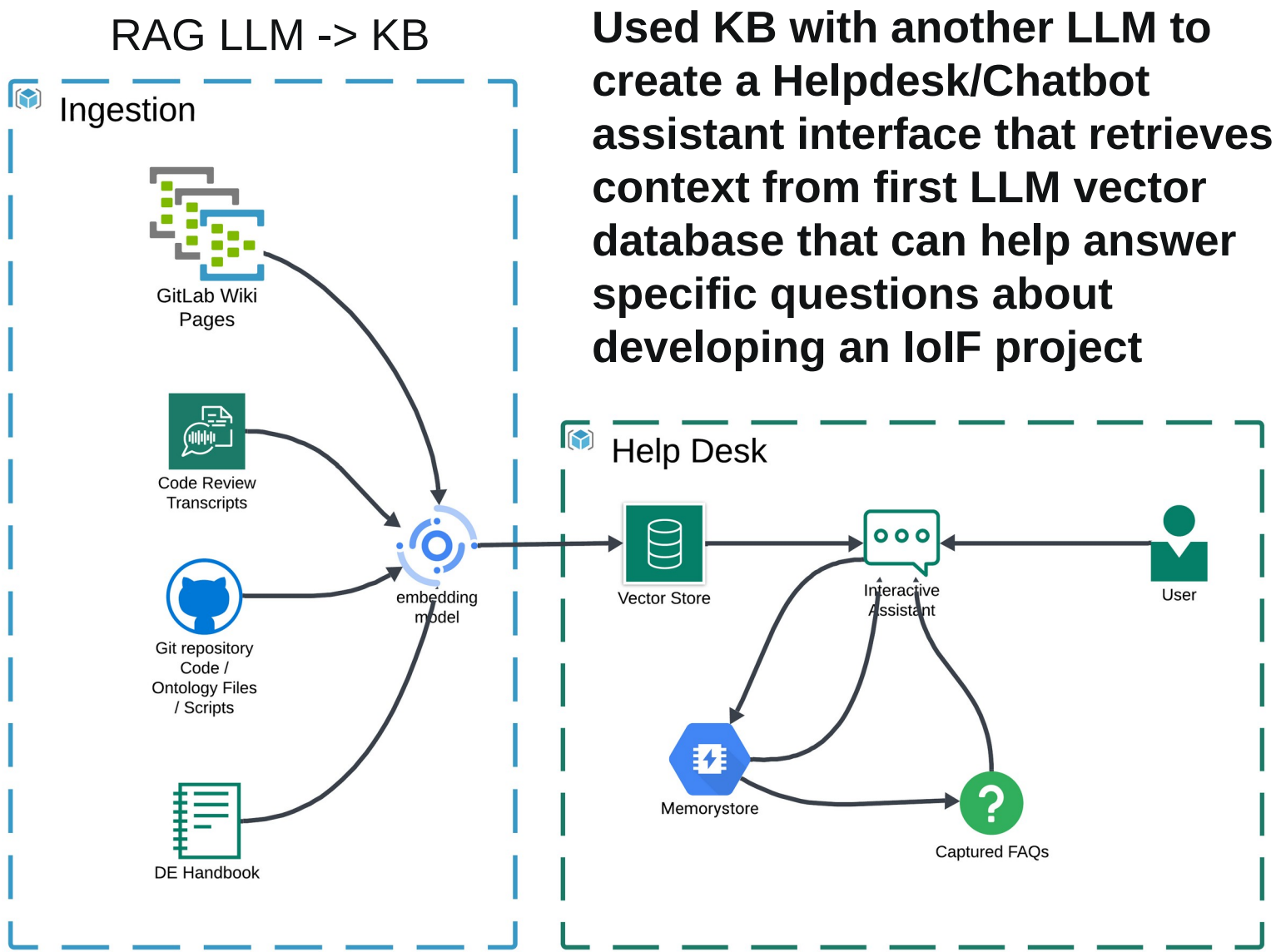
Digital Thread Impact Analysis Visualization



Digital Engineering (DE) Handbook using Ontologies



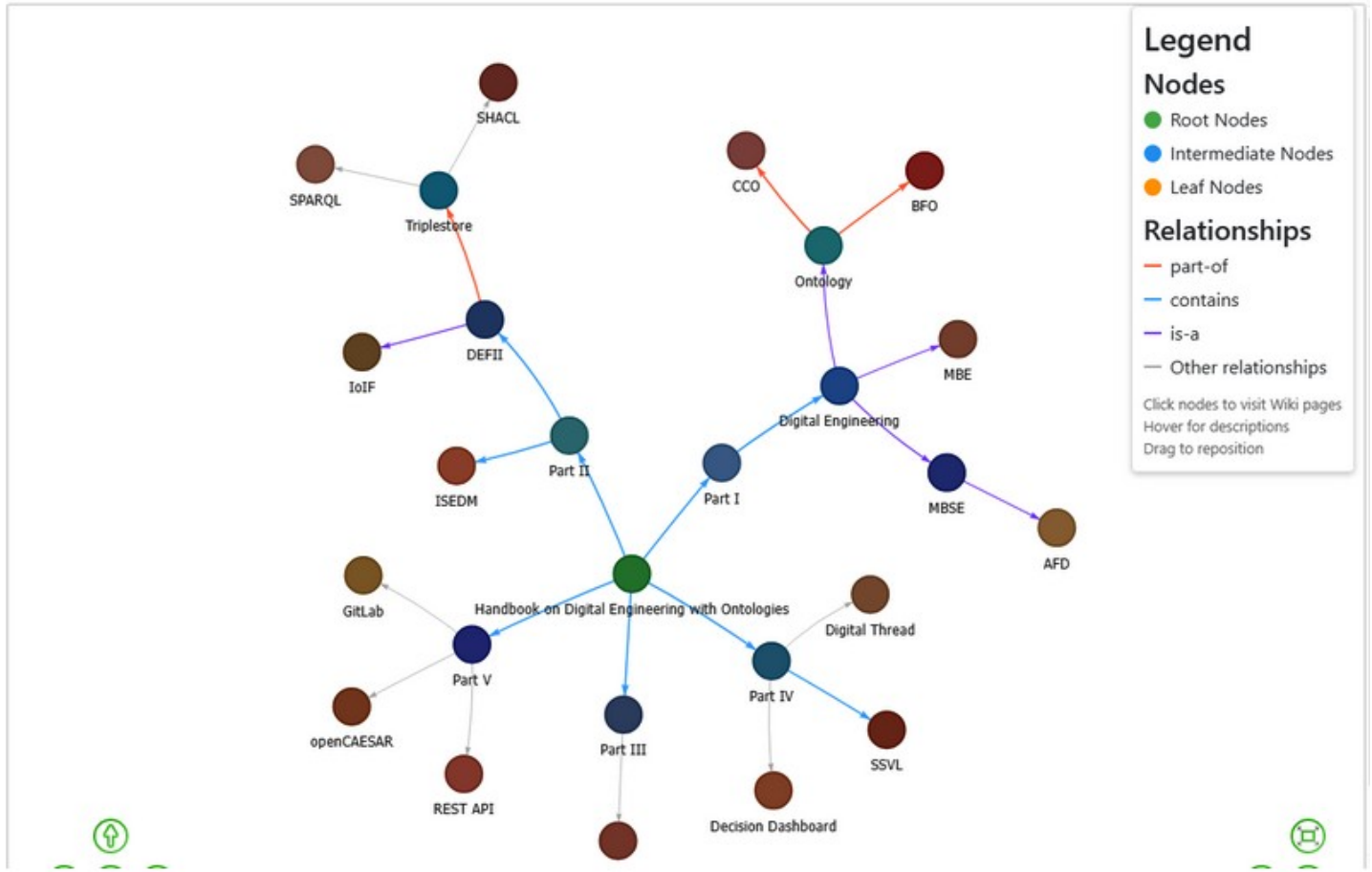
- DE Handbook using Ontologies v2 was input to generate Knowledge Base (KB) in a Gitlab repository using with Retrieval-Augmented Generation (RAG) Large Language Model
- KB holds information related to methodology for IoIF



Used KB with another LLM to create a Helpdesk/Chatbot assistant interface that retrieves context from first LLM vector database that can help answer specific questions about developing an IoIF project

Interactive Knowledge Graph generated by LLM

Interactive Knowledge Graph



Open Interactive Knowledge Graph in Full Window

Knowledge Hierarchy

Top-Level Concepts

- Handbook on Digital Engineering with Ontologies
  - Part I
  - Part II
  - Part III
  - Part IV
  - Part V

Other Important Concepts

DEFII
Decision Dashboard
Digital Engineering
Digital Thread
GitLab
MBSE
OML
Ontology
REST API
SHACL
SPARQL
openCAESAR