

Agentic AI for Lifecycle Traceability

A Digital Thread Architecture for Adaptive, Context-Aware Systems Engineering

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Systems Engineering

Managing complexity across the entire lifecycle:

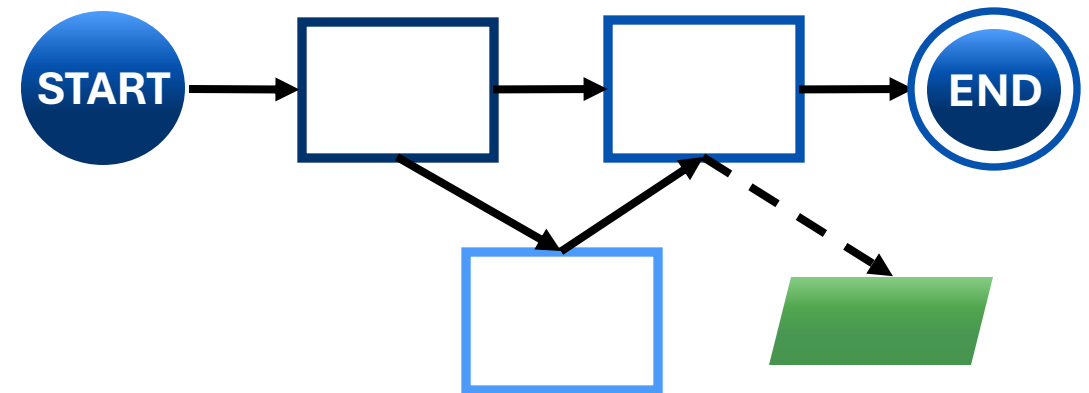
concept → requirements → design → implementation → test → operations → retirement.

Traditional Document Based Systems Engineering



Disconnected Documents
Manual Traceability
(Silos, Spreadsheets, Reviews)

Model Based Systems Engineering (MBSE)



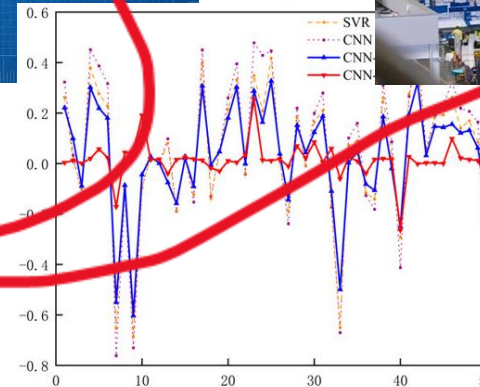
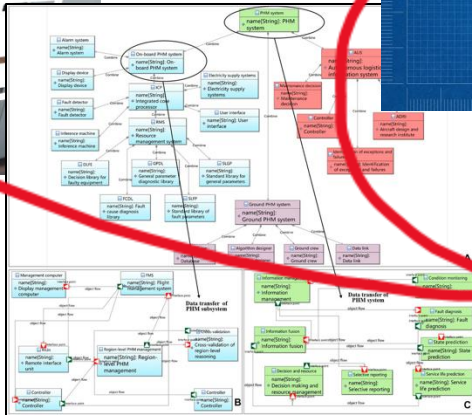
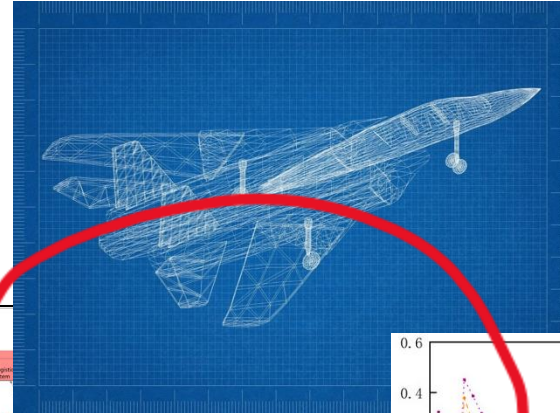
Connected Models
Built-in Traceability
(Linked Requirements, Design, Tests)

MBSE Enables the Digital Thread

Simulations

Manufacturing

Requirements



Design

Test Results

Operations

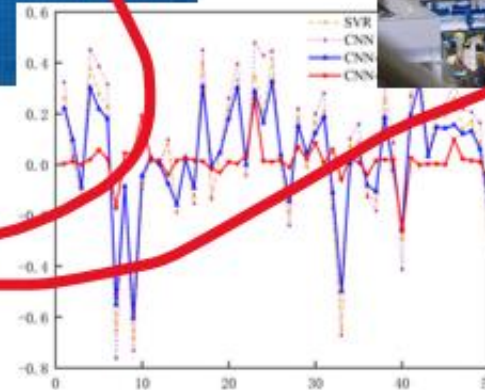
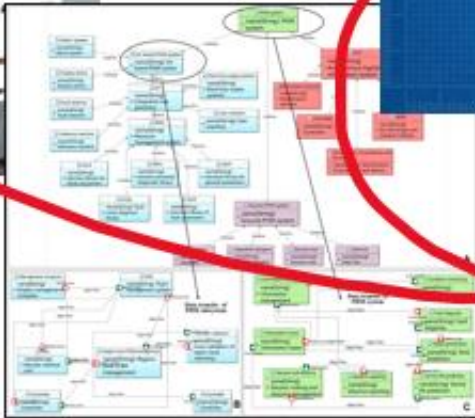
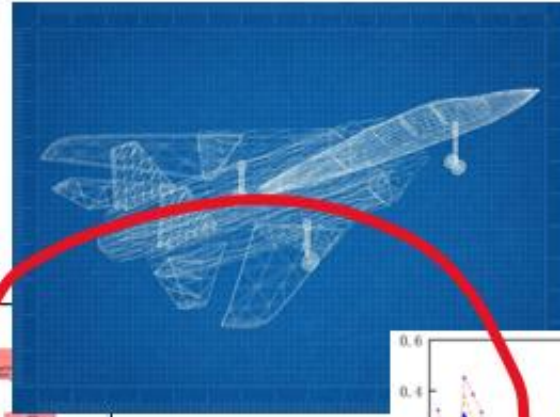
A digital thread traces what was asked for, what was built, how it was tested, and how it performs.

MBSE Enables the Digital Thread

Simulations

Manufacturing

Requirements



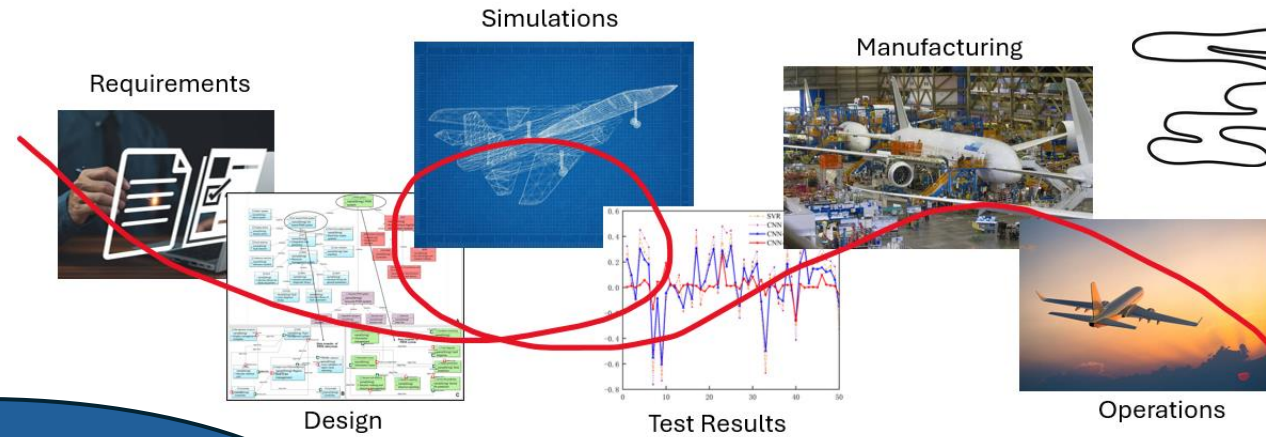
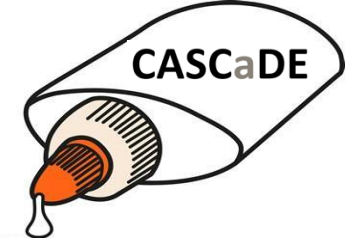
Design

Test Results

Operations



MBSE Enables the Digital Thread



This sensor is jittering in flight — why?

Telemetry points to Subsystem C. It traces to Design Rev 3.1, which had thermal issues. See Test Report 55.

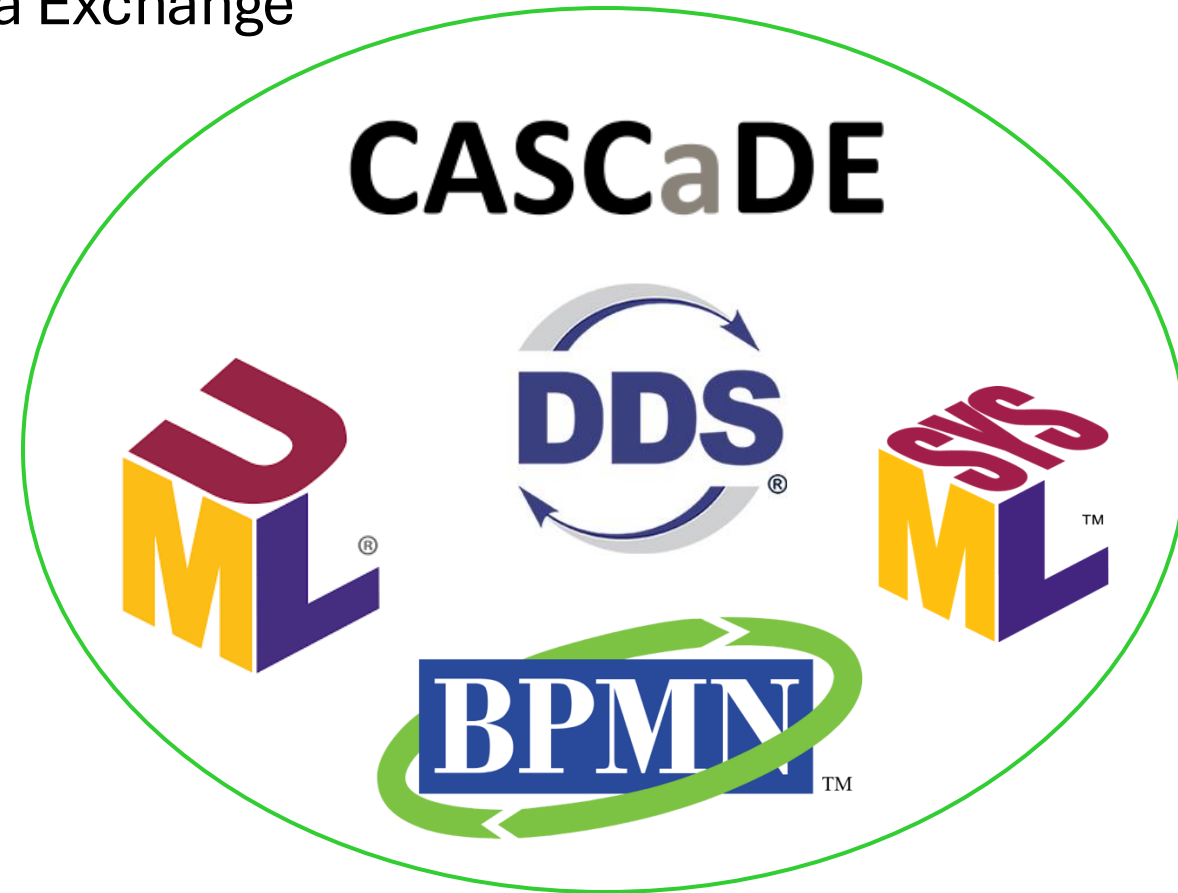
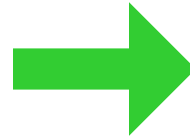


Agent AI



CASCaDE

Collaborative Artifact, Specification,
Context and Data Exchange



- CASCade is an **emerging OMG standard**
(same group behind SysML, UML, DDS, and BPMN)
- CASCade is positioned to become a recognized part of the systems engineering toolchain.



CASCaDE

Collaborative Artifact, Specification,
Context and Data Exchange

Tool-neutral integration

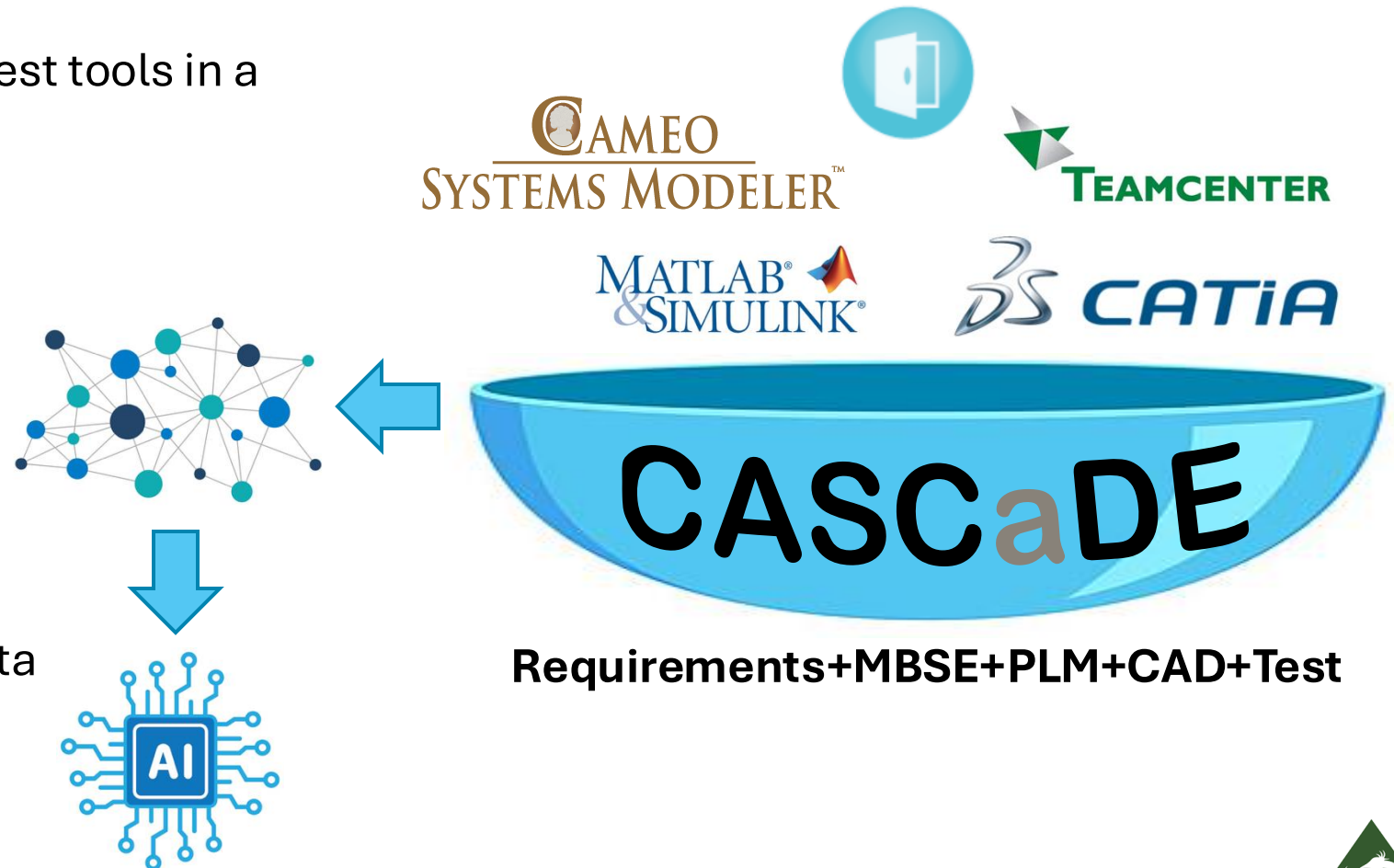
Connects MBSE, PLM, CAD, and test tools in a common standard.

Single source of truth

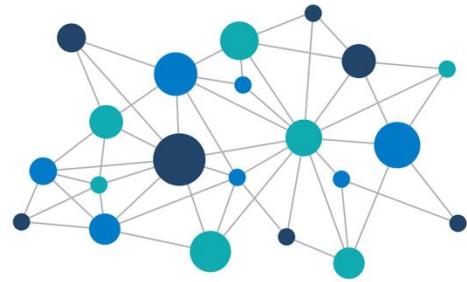
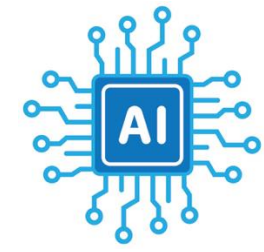
Unifies models into a traceable knowledge graph.

Enabler for AI reasoning

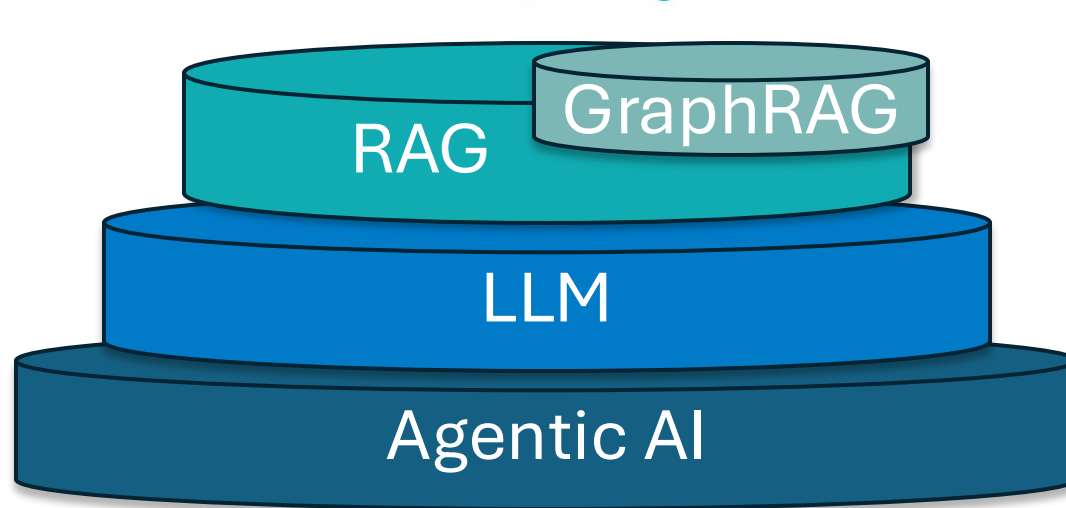
Provides the structured, linked data layer that makes AI usable across the lifecycle.



How does the AI side of this work?



CASCaDE
Knowledge Graph



Reasoning Stack

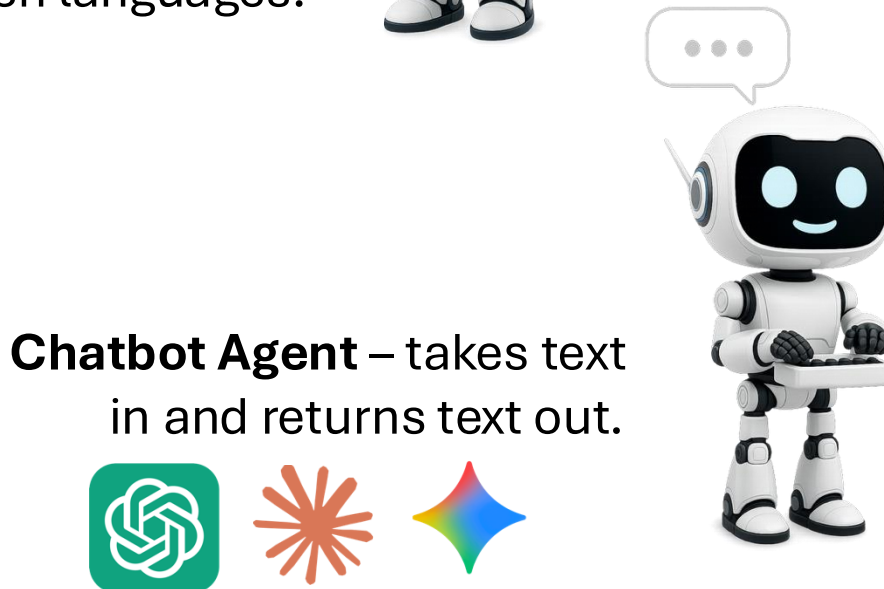
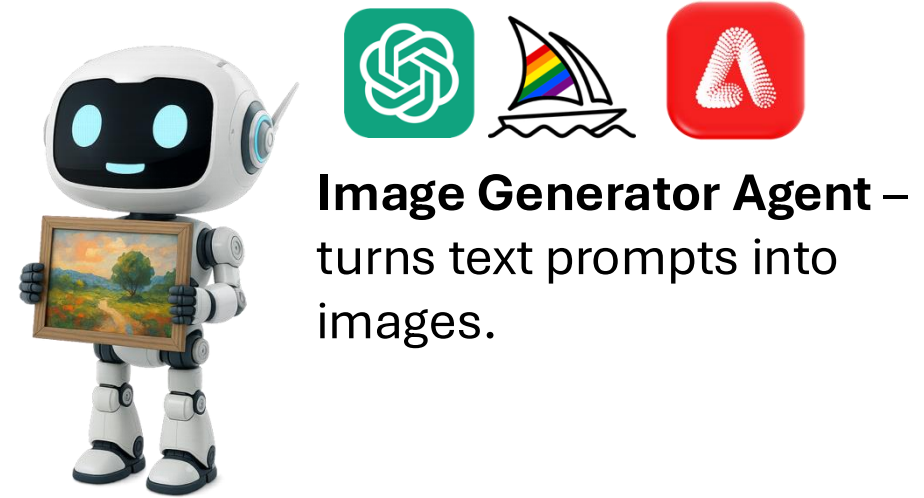


Agentic AI

Pursues goals by
choosing and
coordinating tools,
and reasoning with
oversight.

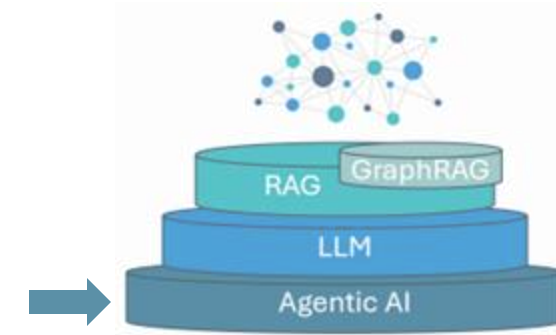


AI Agents (not Agentic AI)



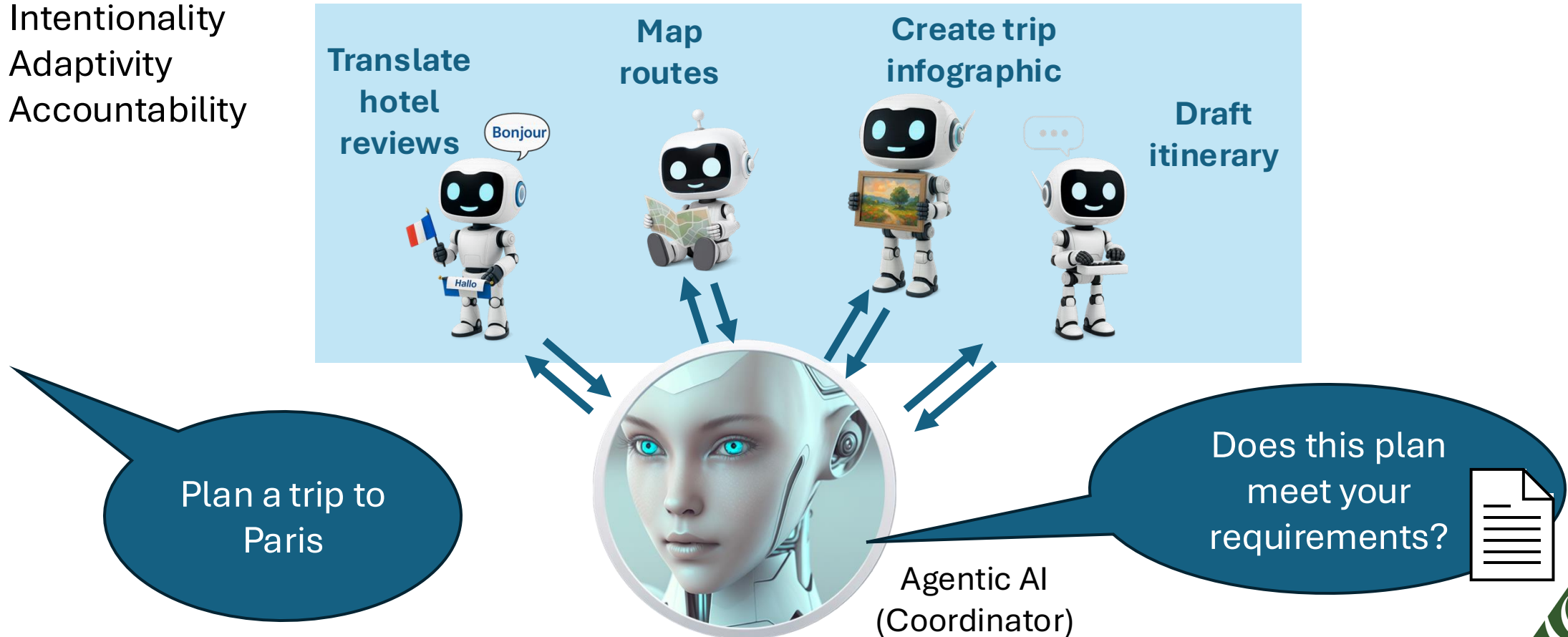
So what *is* Agentic AI?

Agentic = capacity to make choices and act towards goals.



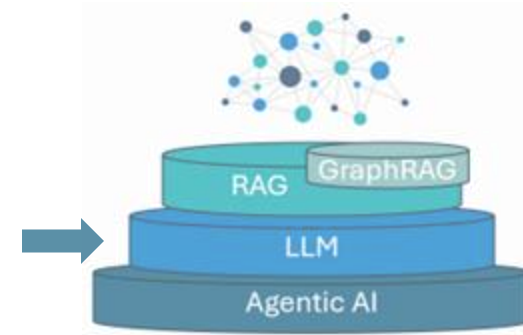
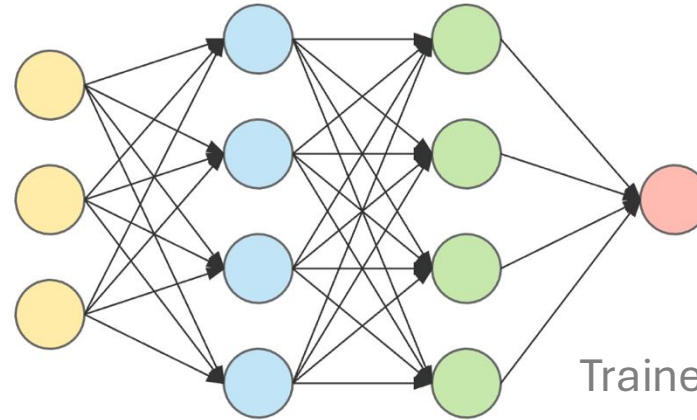
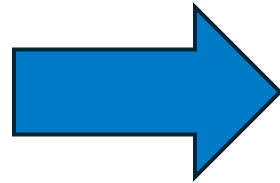
Key Elements of Agency

1. Autonomy
2. Intentionality
3. Adaptivity
4. Accountability



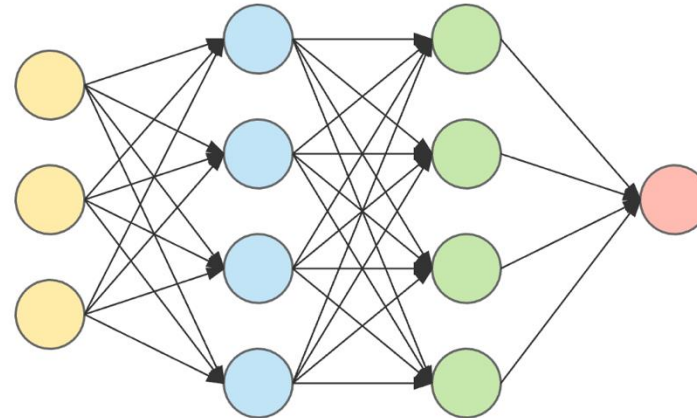
Large Language Model (LLM)

Step 1:
Training
the LLM



Step 2:
Inference

Who won the
Super Bowl
this year?
(2025)



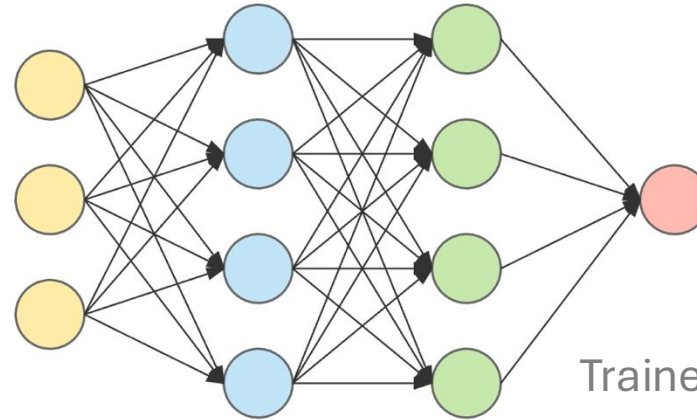
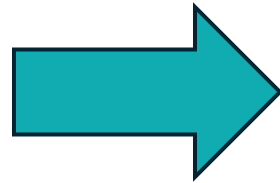
The Kansas
City Chiefs
(2024)

Key Point: The LLM only knows about what it was trained on.
It makes things up when it doesn't know the answer (hallucinations).

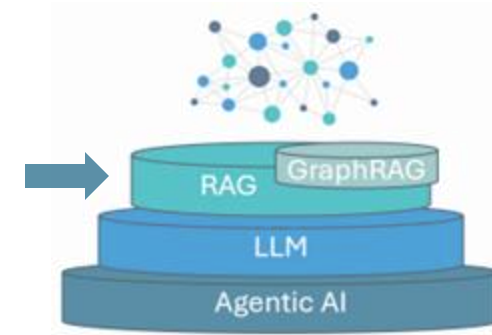


Retrieval Augmented Generation (RAG)

Step 1:
Training
the LLM

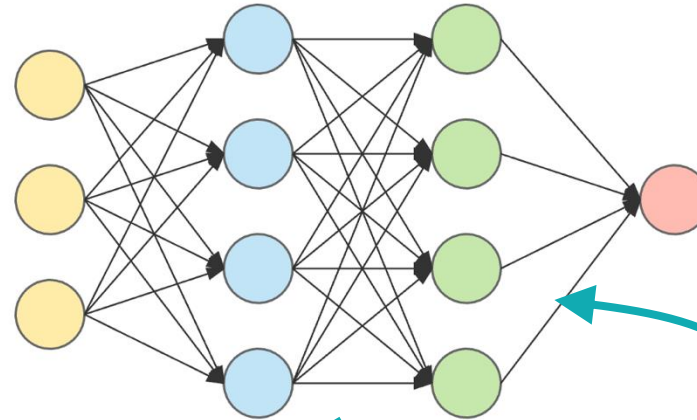


Trained in 2024



Step 2:
Inference

Who won the
Super Bowl
this year?
(2025)



The
Philadelphia
Eagles
(2025)

RAG = an LLM with retrieval from external sources such as a database or the internet.

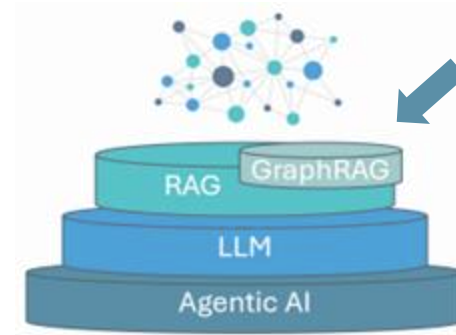
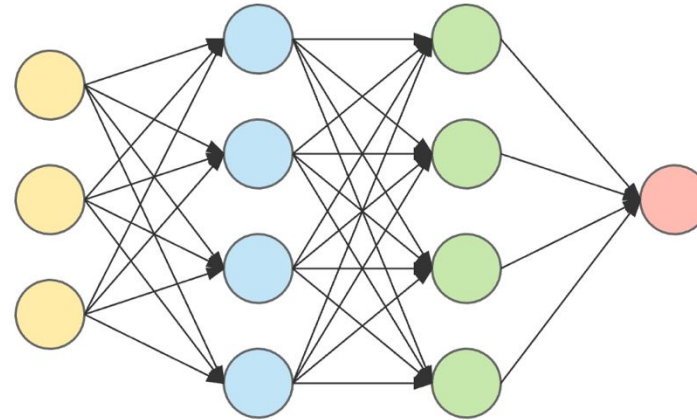
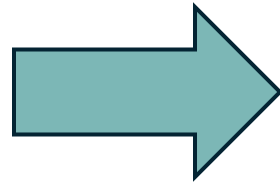


Updated today



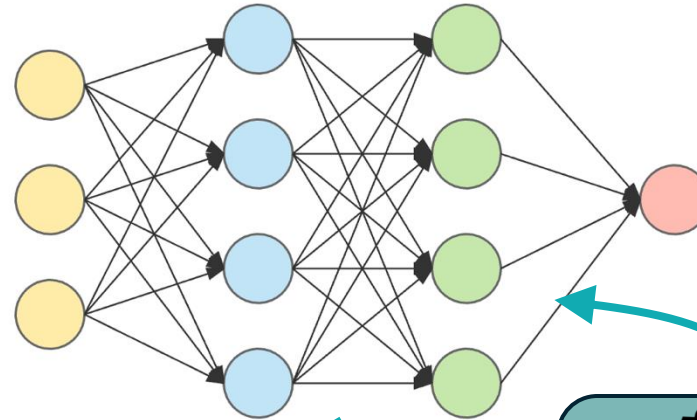
GraphRAG

Step 1:
Training
the LLM



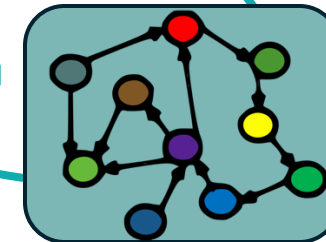
Step 2:
Inference

Which system
requirements
have not been
tested yet?



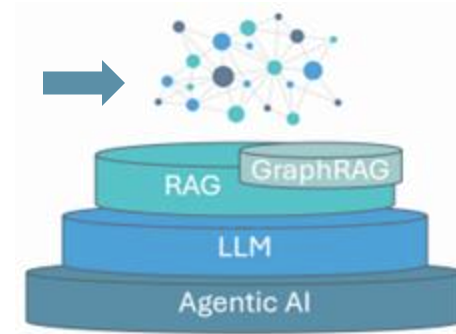
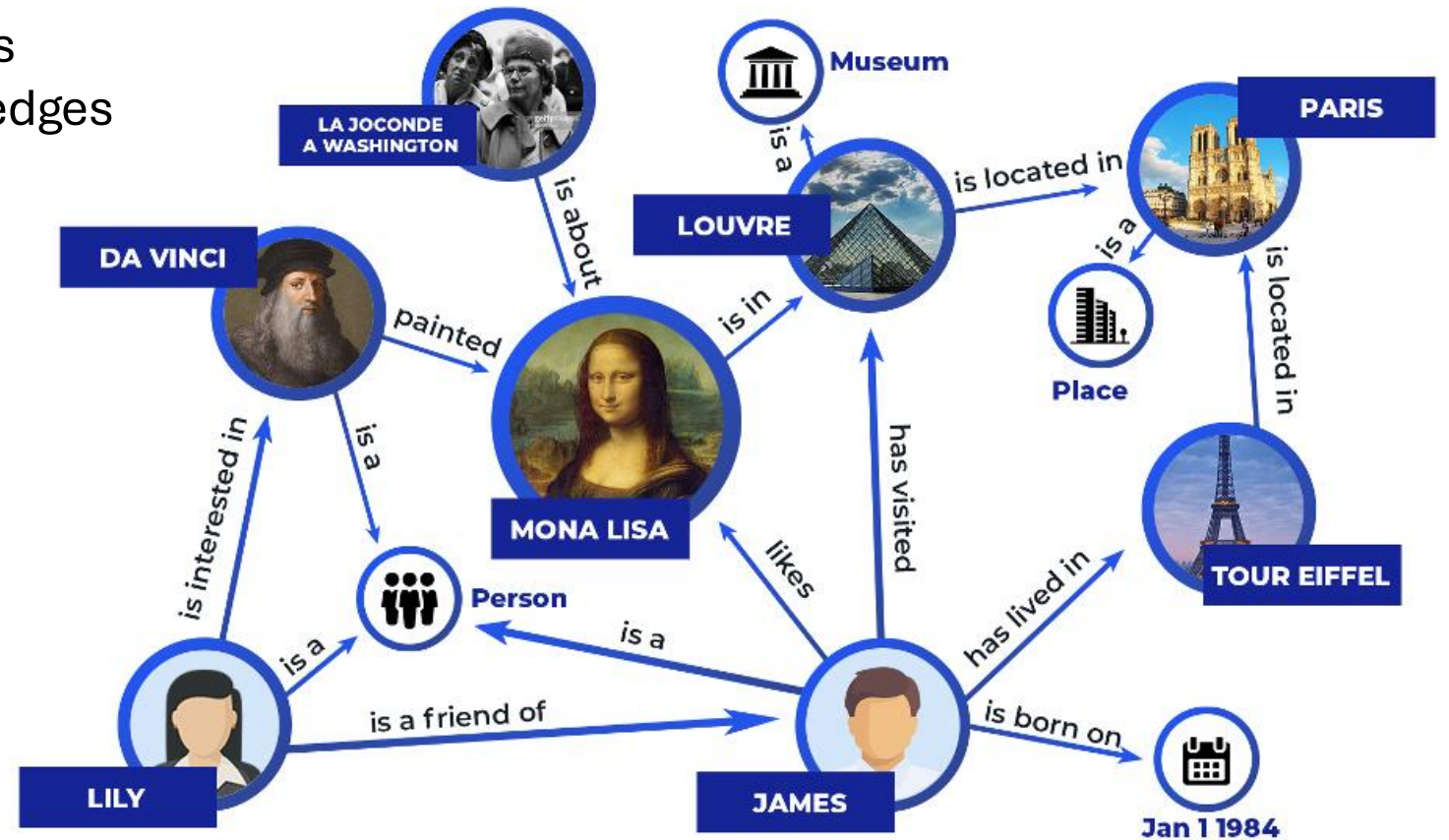
SR-305 and
SR-412

GraphRAG = an LLM with retrieval from a graph-
database, such as a knowledge graph.

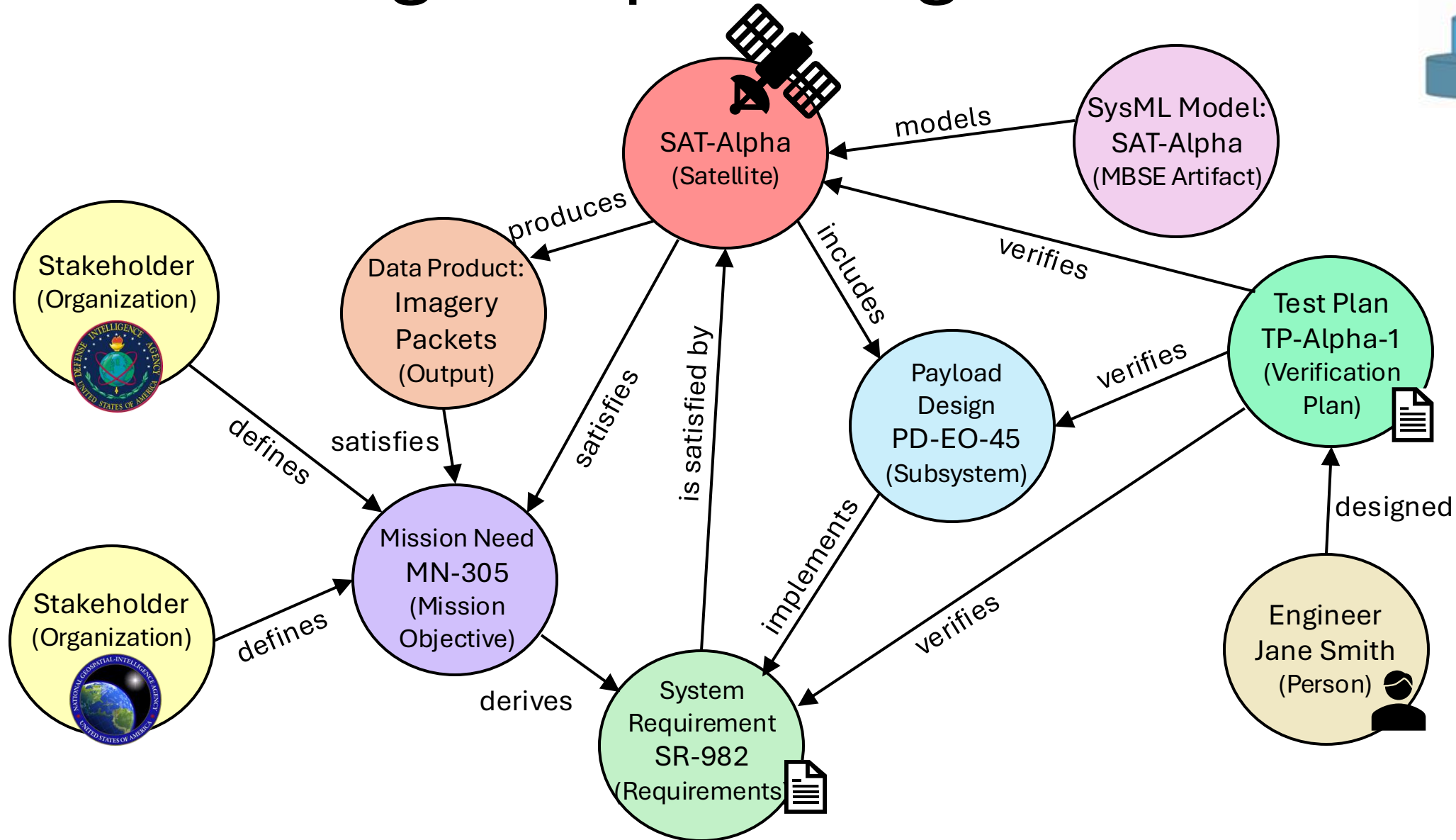
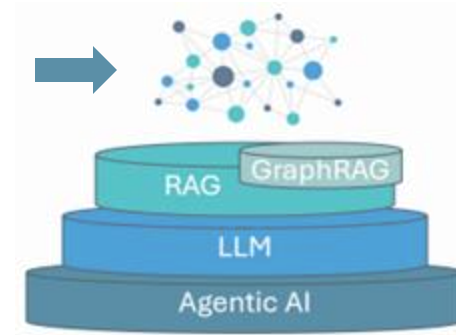


Knowledge Graph

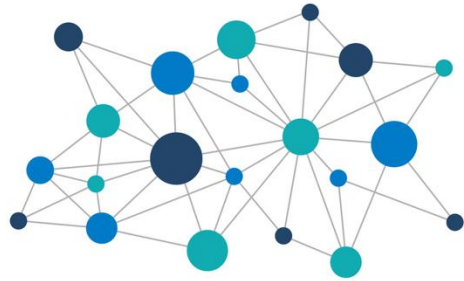
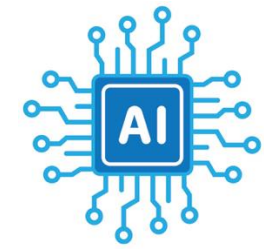
- **Knowledge Graph:** Structured data linking things and how they relate.
 - **Entities** are represented with nodes
 - **Relationships** are represented by edges
- **CASCaDE** uses RDF
- **RDF format** uses triples:
subject → predicate → object



Knowledge Graph as Digital Thread

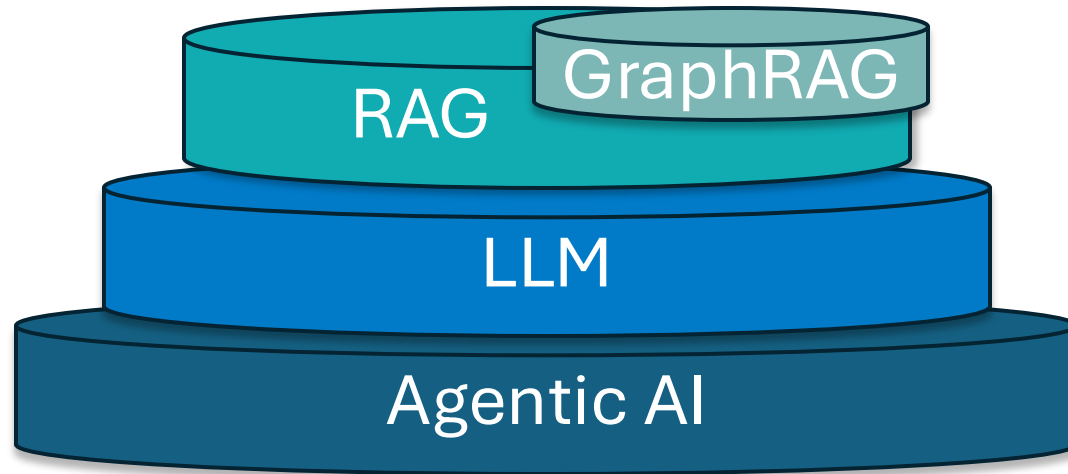


How does the AI side of this work?



CASCaDE
Knowledge Graph

CASCaDE + Agentic AI =
trusted, explainable
reasoning across the
digital thread.



Agentic AI

Thank you!

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