

AI in systems engineering, education and skills development

Current AI&SE Work

SELMA

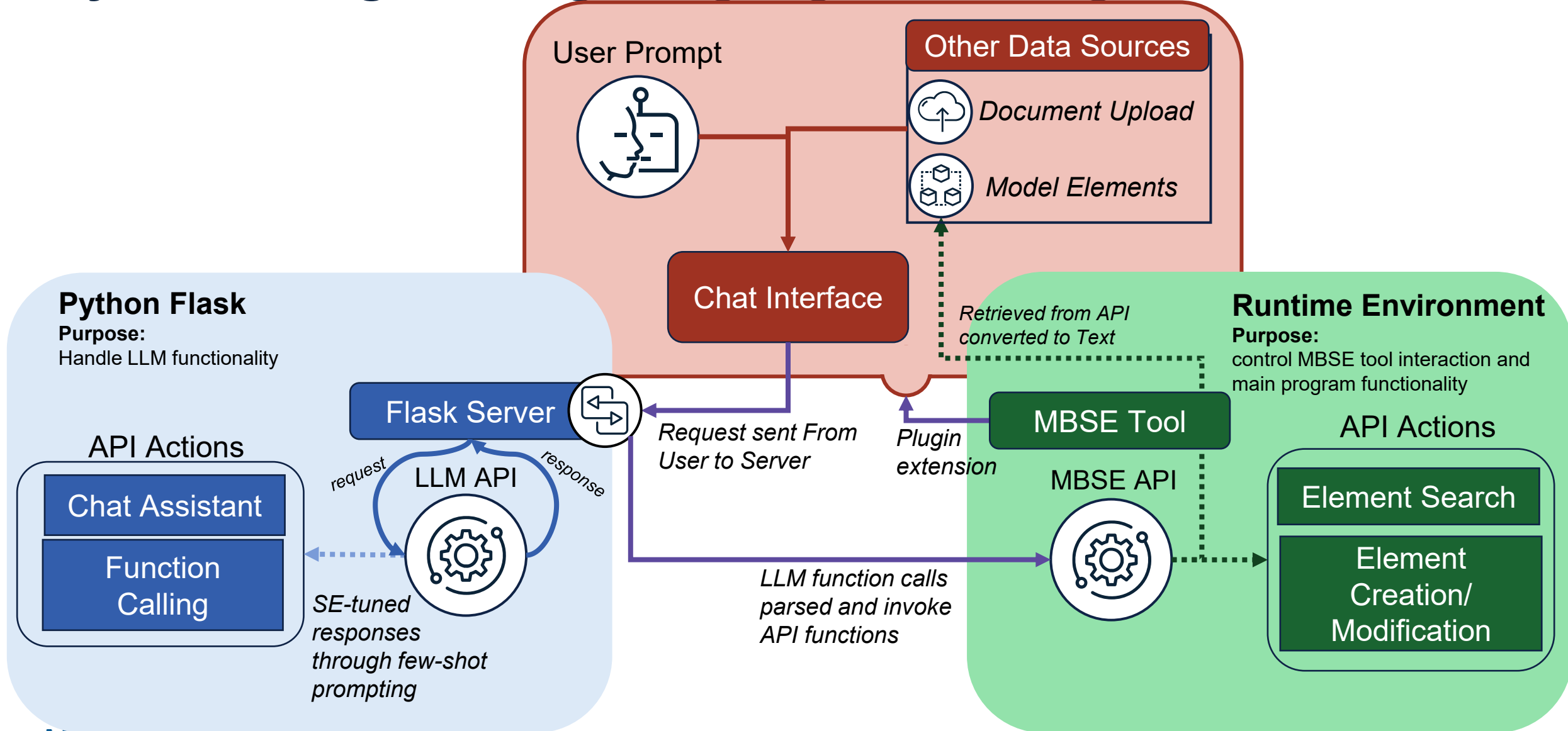
MITRE's Systems Engineering Language Modeling Assistant (SELMA)

For more detailed information on MITRE's site:
[Systems Engineering Language Modeling Assistant](#)

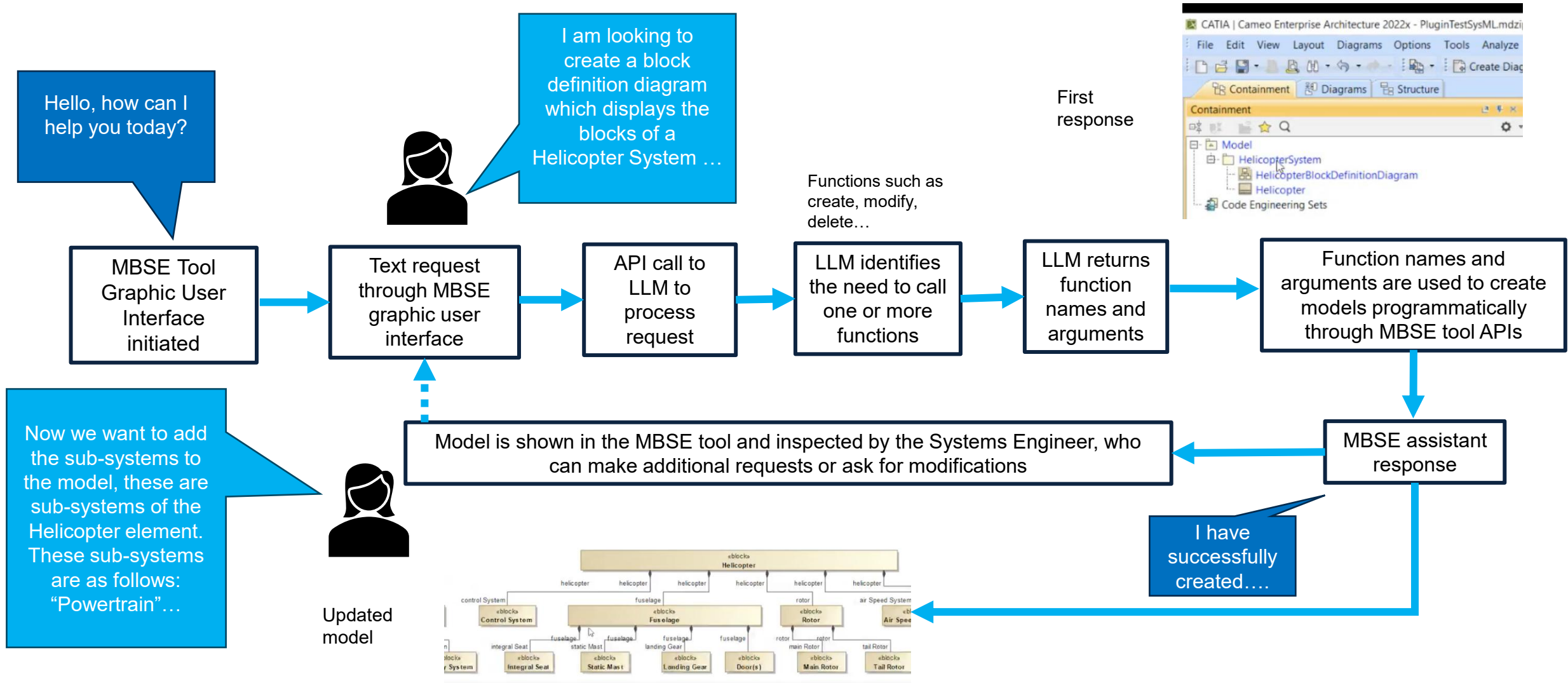
For licensing options, contact the MITRE Technology Transfer Office at:
techtransfer@mitre.org

Or:
 MITRE SELMA

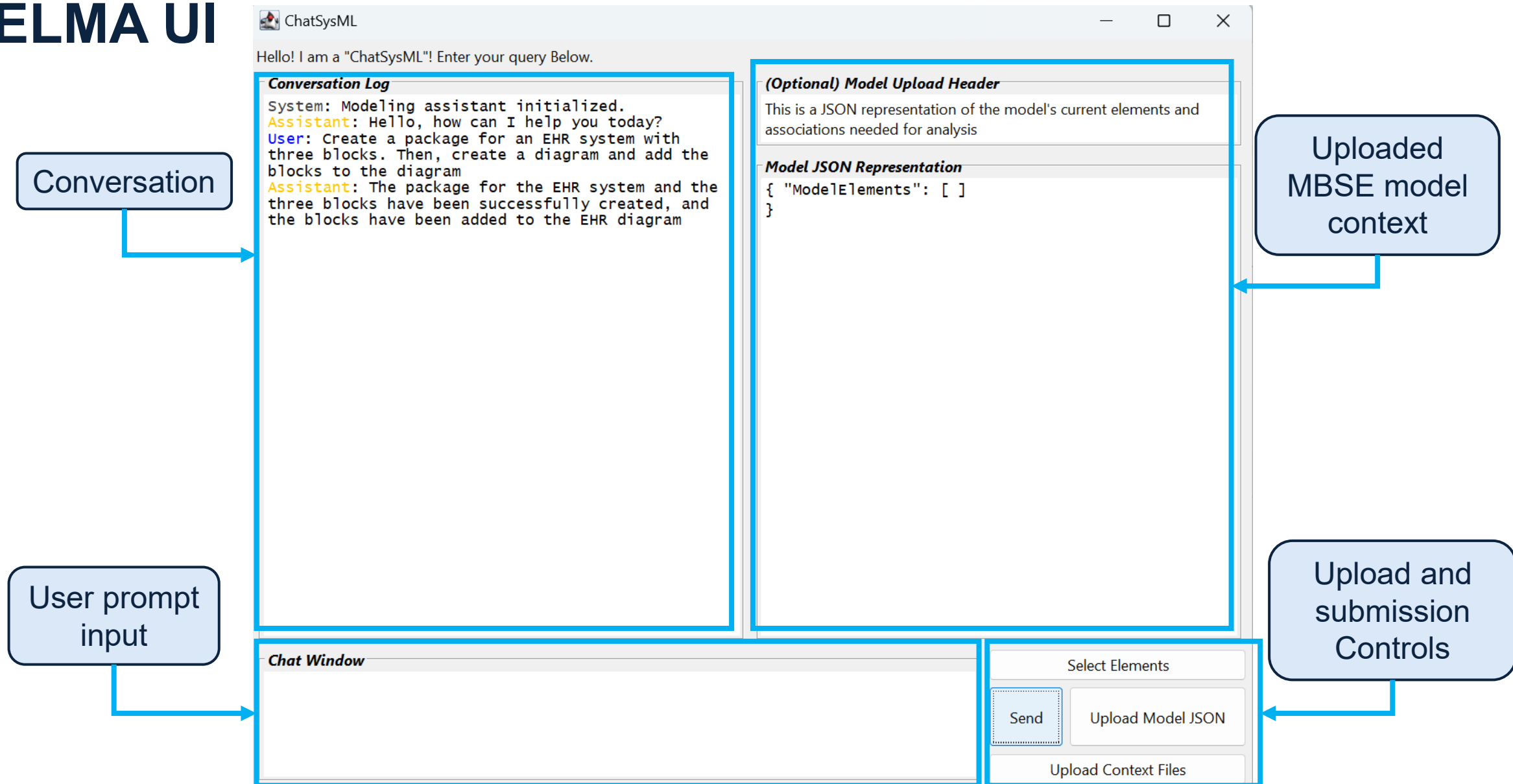
Systems Engineering Language Modeling Assistant



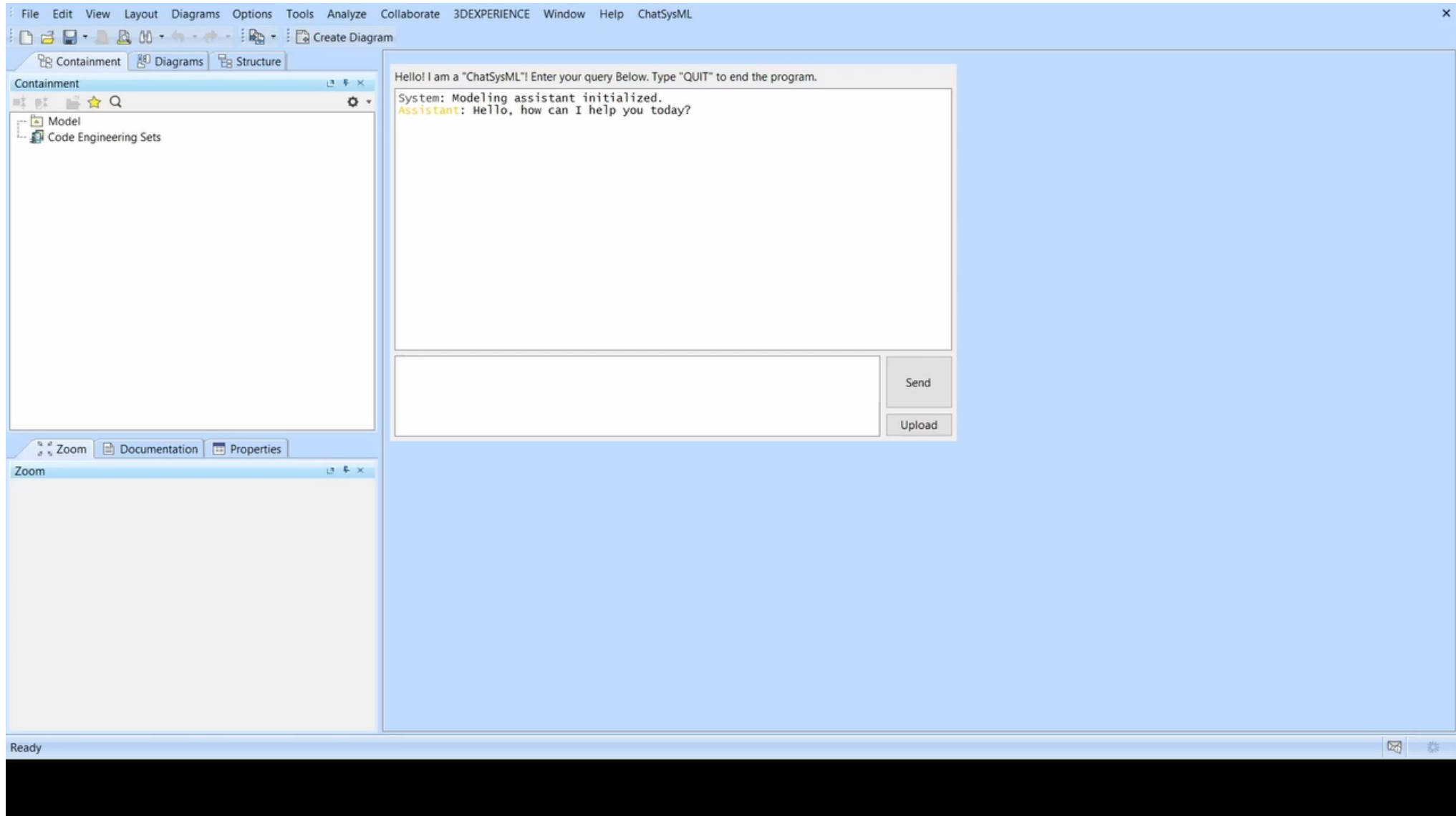
Text-to-Model Process Flow



SELMA UI

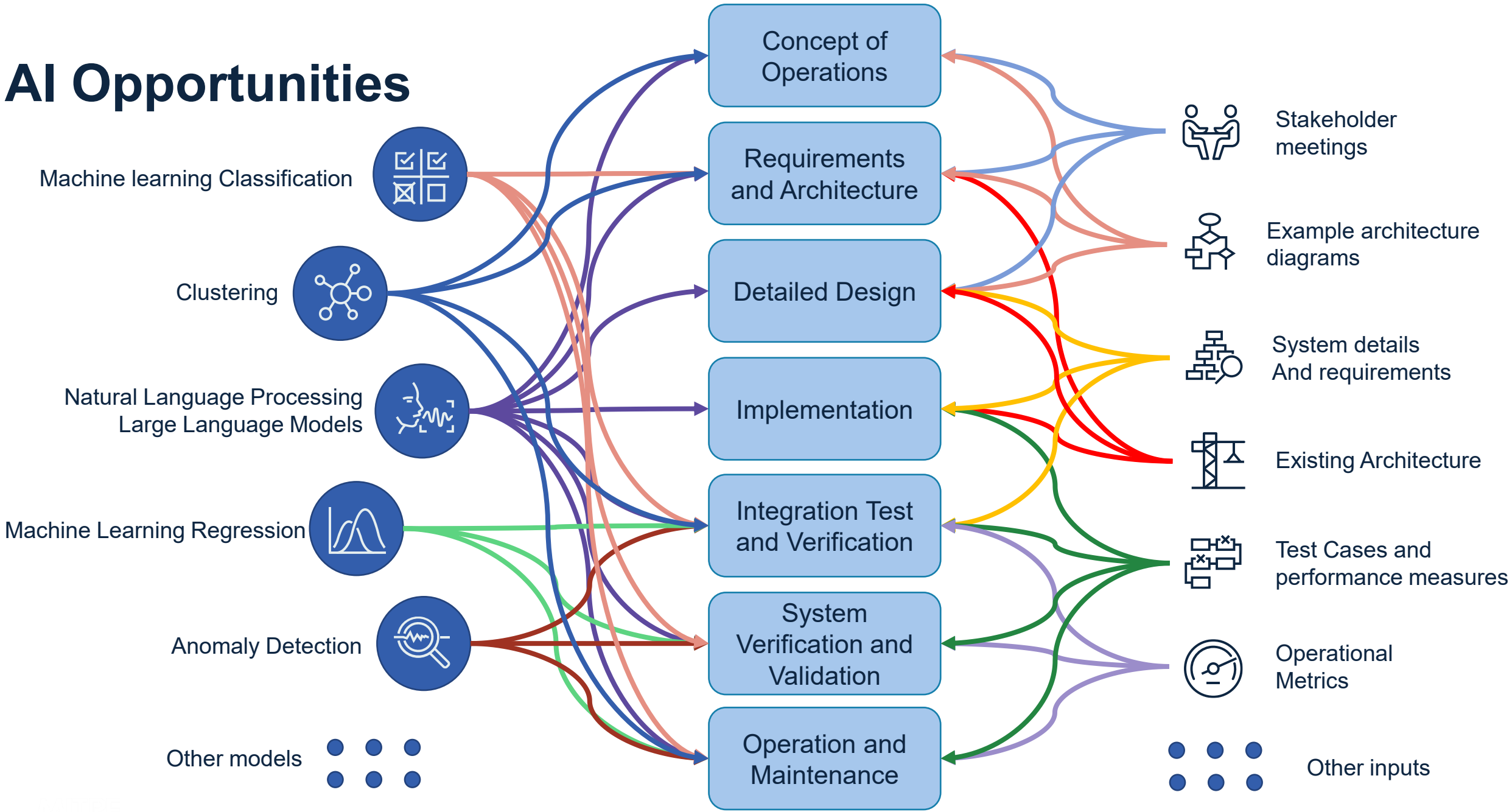


SELMA Demonstration (Helicopter)



Skills needed in academia to prepare the workforce

AI Opportunities



AI Opportunities in SE lifecycle

Lifecycle	Activities	Pain Points	Where AI can help	AI Skills
Concept of Operations	<ul style="list-style-type: none"> - Define system objectives and scope - Identify stakeholders and their needs - Develop operational scenarios - Draft Concept of Operations document 	<ul style="list-style-type: none"> - Difficulty in gathering comprehensive stakeholder requirements - Ambiguity and inconsistency in defining operational scenario - Time-consuming document drafting and review process - Hidden relationship and dependency due to name variations and different terminology 	<ul style="list-style-type: none"> - Initial Data Analysis: AI can analyze stakeholder data and operational scenarios to identify and validate system objectives. - Concept of Operations Generation: AI-powered tools can assist in drafting, reviewing, and ensuring consistency in the Concept of Operations document or identify and categorize initiatives and themes 	Natural Language Processing, generative AI (LLMs) Data clustering, classification (K-means) Data visualization (Matplotlib, Power BI) Semantic search, information retrieval (retrieval augmented generation)
Requirements and Architecture	<ul style="list-style-type: none"> - Elicit and document requirements - Develop system architecture - Perform trade-off analysis - Validate requirements and architecture 	<ul style="list-style-type: none"> - Incomplete or conflicting requirements - Difficulty in prioritizing requirements - Time-consuming trade-off analysis 	<ul style="list-style-type: none"> - Requirements Elicitation and Generation: AI can generate and analyze stakeholder inputs and historical data to gather and prioritize requirements. - Automated Consistency Checking: AI can identify inconsistencies, redundancies, and conflicts in requirements. - Architecture Creation: AI algorithms can aid in generation and evaluation of multiple design alternatives and find the best system architecture. 	Natural Language Processing, generative AI (LLMs) Sentiment analysis (LLMs, LLM-based models) Generative AI (LLMs), information retrieval (RAG) Machine learning (decision trees, ranking algorithms) Anomaly detection Optimization algorithms Graph neural networks
Detailed Design	<ul style="list-style-type: none"> - Develop detailed design specifications - Create design models and diagrams - Review and validate designs - Selection of tools and products 	<ul style="list-style-type: none"> - Complexity in translating high-level requirements into detailed designs - Time-consuming design validation process - Risk of design errors 	<ul style="list-style-type: none"> - Design Automation: AI-driven tools can automate the creation of schematics or code from high-level specifications. - Design Validation: AI can validate designs against requirements and constraints, identifying potential issues early. - Tool Selection: AI can assist in identifying a list of tools/products and vendors suited for the task 	Generative AI (LLMs), information retrieval Anomaly detection Machine learning (predictive modeling) Recommender systems

AI Opportunities in SE lifecycle

Lifecycle	Activities	Pain Points	Where AI can help	AI Skills
Implementation	<ul style="list-style-type: none"> - Develop and integrate system components - Write and review code - Perform unit testing 	<ul style="list-style-type: none"> - Manual coding errors - Time-consuming code reviews - Incomplete unit testing 	<ul style="list-style-type: none"> - Code Generation: AI can assist in code generation from models or specifications, reducing manual coding effort and errors. - Unit Testing Support: AI-driven static and dynamic analysis tools can help identify bugs, security vulnerabilities, and performance bottlenecks. 	<ul style="list-style-type: none"> Generative AI Natural language processing Anomaly detection Predictive analytics Optimization
Integration Test and Verification	<ul style="list-style-type: none"> - Integrate system components - Develop and execute test cases - Analyze test results 	<ul style="list-style-type: none"> - Integration issues due to component incompatibility - Time-consuming test case development - Difficulty in analyzing large volumes of test data 	<ul style="list-style-type: none"> - Automated Testing: AI can assist in the creation and execution of test cases, analyzing results, and identifying areas needing further testing. - Fault Detection: Machine learning algorithms can detect anomalies and predict potential integration issues. 	<ul style="list-style-type: none"> Reinforcement learning Supervised learning Unsupervised learning Anomaly detection Time series analysis
System Verification and Validation	<ul style="list-style-type: none"> - Verify system against requirements - Validate system performance in real-world scenarios - Document verification and validation results 	<ul style="list-style-type: none"> - Ensuring comprehensive verification and validation - Difficulty in simulating real-world scenarios - Time-consuming documentation process 	<ul style="list-style-type: none"> - AI-driven Verification and Validation: AI can assist in verifying and validating subsystems outputs by comparing it against requirements/architecture and design - Simulation and Emulation: AI can enhance simulation tools to test the system under various conditions and scenarios. 	<ul style="list-style-type: none"> Natural language processing Graph neural networks Reinforcement learning Predictive modeling
Operation and Maintenance	<ul style="list-style-type: none"> - Monitor system performance - Perform maintenance and updates - Provide user support 	<ul style="list-style-type: none"> - Unplanned system downtime - Difficulty in identifying performance bottlenecks - Time-consuming user support 	<ul style="list-style-type: none"> - System Maintenance: AI can predict component failures, allowing for proactive system maintenance and upgrades. - Performance Monitoring: AI can continuously monitor system performance, identifying inefficiencies and suggesting modifications. - User Support: AI-driven chatbots and virtual assistants can provide real-time support to users. 	<ul style="list-style-type: none"> Time series analysis Anomaly detection Reinforcement learning Predictive modeling Generative AI Information retrieval

Evolving Skills for AI-Driven Systems Engineering

- **New Core Skills:**

AI, machine learning, data science, digital twins, Model Based Systems Engineering

- **Essential Mindsets:**

Agility, adaptability, security & risk awareness

- **AI's Impact:**

Automates tasks, enhances decision-making, drives interdisciplinary collaboration

- **Challenges:**

AI inaccuracies, security vulnerabilities

- **Education Priorities:**

Integrate AI tools & courses, reinforce programming/analytics

- **Collaboration Needed:**

Industry-academia partnerships for curriculum, internships, and research

Jyotirmay Gadewadikar, Chief – AI and Systems Engineering

jgadewadikar@mitre.org



@JyoGadewadikar



<https://www.linkedin.com/in/JyoMIT>