

The Knowledge-based Digital Platform Concept for Advanced Air Mobility Research and Development

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Conference Name, Conference Dates

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Outline

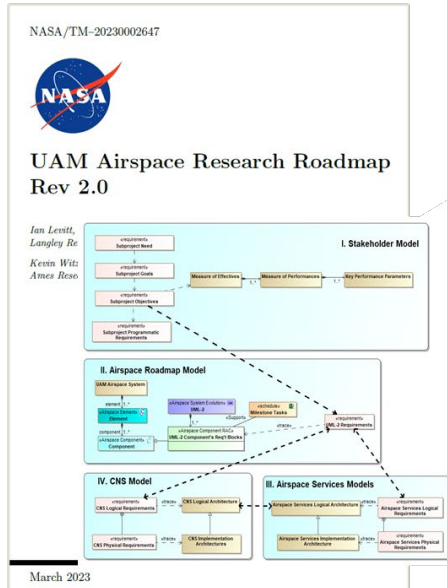
- Introduction
- Knowledge-based Digital Platform (KbDP) Concept and Implementation
- KbDP User Stories
 - Systems Engineer Persona Story: Literature Review
 - Project Manager Persona Story: Research Planning
 - Systems Engineer Persona Story: Requirement Change Management
- Conclusion and Future Works

Introduction

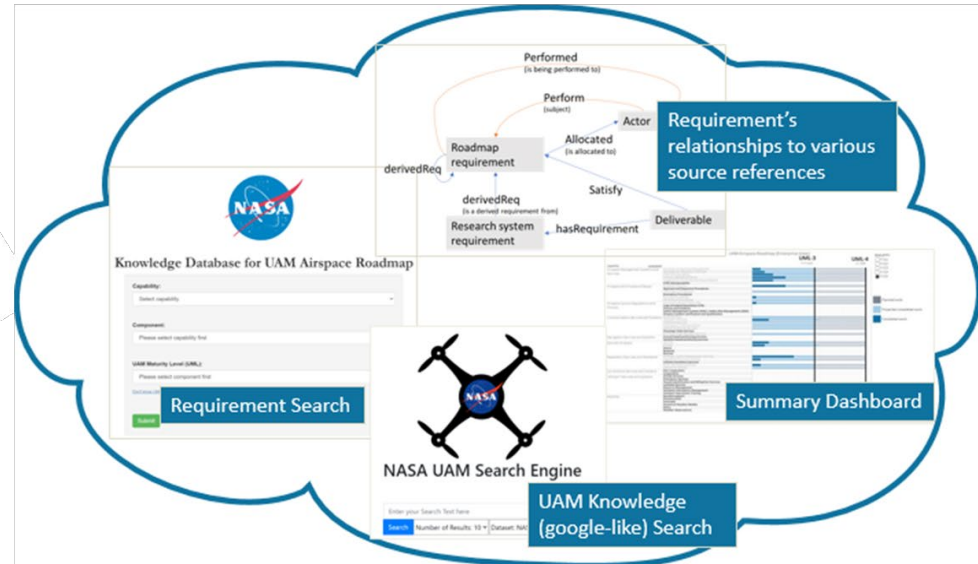
- *Advanced Air Mobility (AAM) encompasses a range of innovative operational and technological changes to aviation that transform aviation's role in the everyday movement of people and goods.*
- *These AAM operations must integrate with traditional Air Traffic Management (ATM) operations and non-aviation modes of transportation and logistics.*
- *To integrate, communicate, and facilitate the research of multi-modal transportation systems, NASA is spearheading an innovative digital engineering approach through a Knowledge-based Digital Platform (KbDP) concept.*
- *The KbDP envisions any user to access the latest AAM research and development (R&D) architecture, concepts, and requirements, including supporting technical reports and standards from which the R&D contents were derived.*

Notional KbDP Concept of Use and Implementation

From Document-based, Model-Based



To Digital/Cloud-based



Tools and Methods:

Systems Engineering: SE processes, SysML

Data Science: graph theory and algorithm, machine learning, data visualization, experimental design

Software Development and Infrastructure: web/software development, Google Cloud Platform, Amazon Web Service

Systems Engineer Persona Story: Literature Review

Challenges:

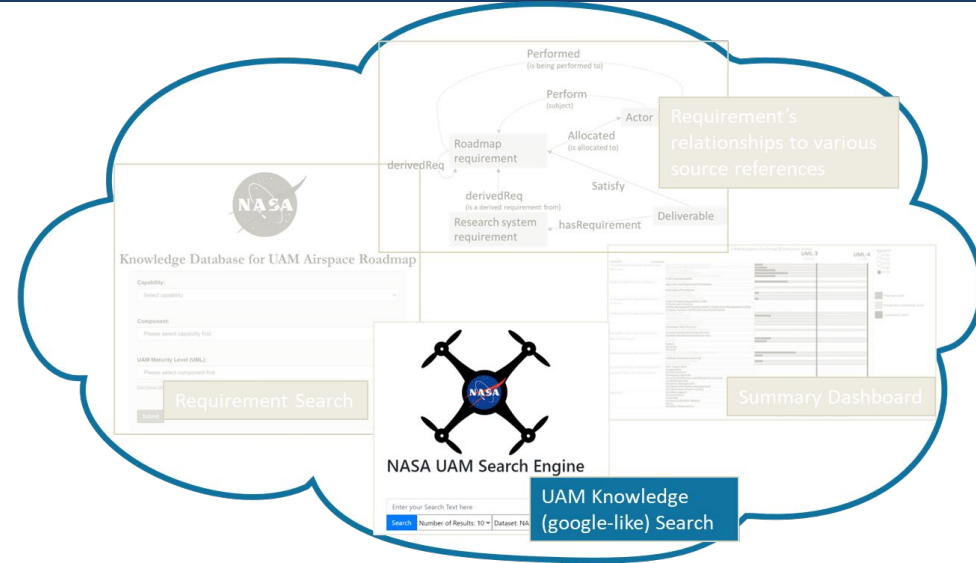
- Review 20 PDFs (ranging from 20 to hundreds of pages) for requirement's rationales.
- Identify requirement's dependencies.

Solution:

- Machine Learning Natural Language Process web-portal

Impact:

- For UAM project, reduce from one year of work (**1,040 hours**) to one day of work (**8 hours**).

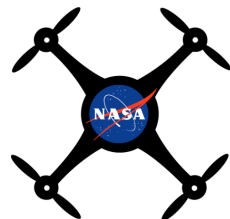


Tools and Methods:

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NASA UAM Search Engine

Search box allows keywords, sentences, or paragraphs for content search

Drop-down menu to limit top results shown

Drop-down menu to select targeted corpus

The FAA develops or modifies regulations to support UAM operations. The FAA may also provide guidelines for CBRs and will approve CBRs to ensure that the FAA authority is maintained (e.g., NAS safety, equal access to airspace, and security). The FAA [Search](#) Number of Results: 10 ▼ Dataset: UAM ConOps ▼

Relevant Documents:

[UAM_ConOps_v1.0 4.3.1.1 FAA Regulatory](#)

Returned result is a particular section of a document in the selected corpus

The FAA is the federal authority over aircraft operations in all airspace and the regulatory and oversight authority for civil operations in the NAS. The FAA maintains an operating environment that ensures airspace users have access to the resources needed to meet specific operational objectives and that shared use of the airspace can be achieved safely and equitably. The FAA develops or modifies regulations to support UAM operations. The FAA may also provide guidelines for CBRs and will approve CBRs to ensure that the FAA authority is maintained (e.g., NAS safety, equal access to airspace, and security). The FAA will define, maintain, and make publicly available UAM Corridor definitions and will manage the performance requirements of UAM Corridors.

Project Manager Persona Story: Research Planning

Challenges:

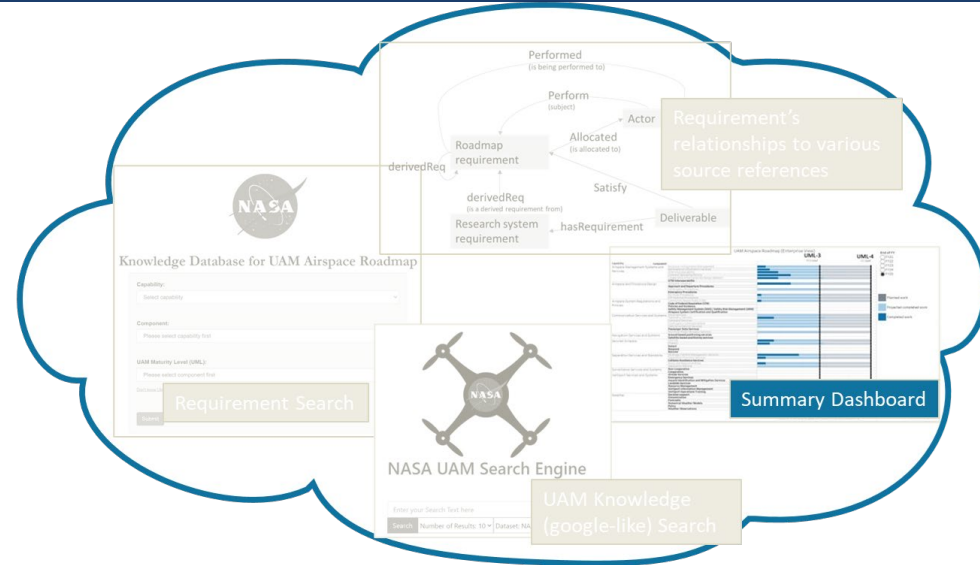
- Manage and track several milestone deliverables from each research focus area teams over the 5-year timeline toward the project's technical success.

Solution:

- Progress Indicator Dashboard web-portal

Impact:

- No Programmatic-Technical dashboard exist.
- Successfully adopted as a standard dashboard for the Program annual portfolio review.



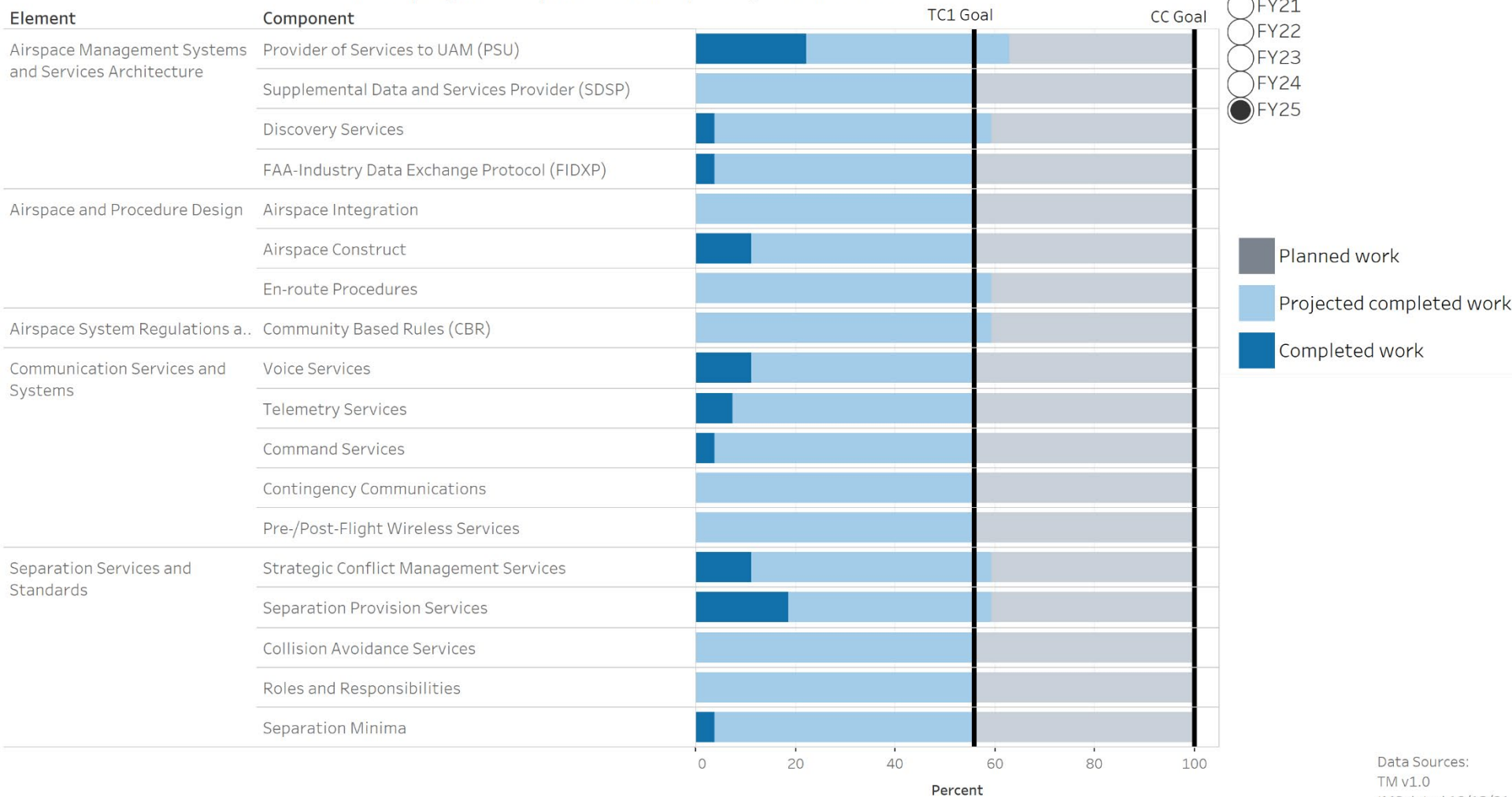
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UAM Subproject Airspace Roadmap Progress Indicator



Systems Engineer Persona Story: Requirement Change Management

Challenges:

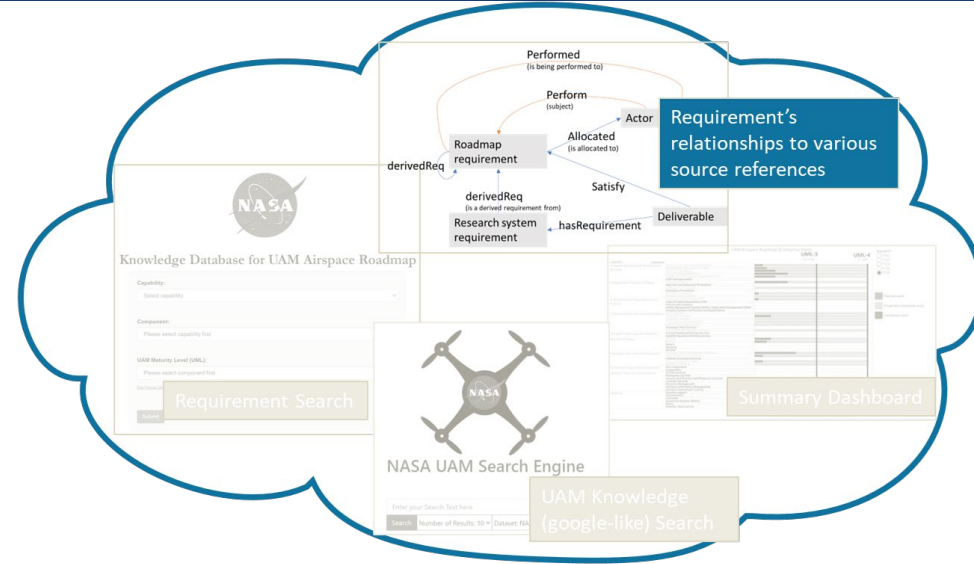
- Assess change impact to existing requirement.

Solution:

- Dependency tree via web-portal

Impact:

- Observe **20X faster** to review the dependency tree than traditional MBSE model.
- Anyone can access it without knowing MBSE software.



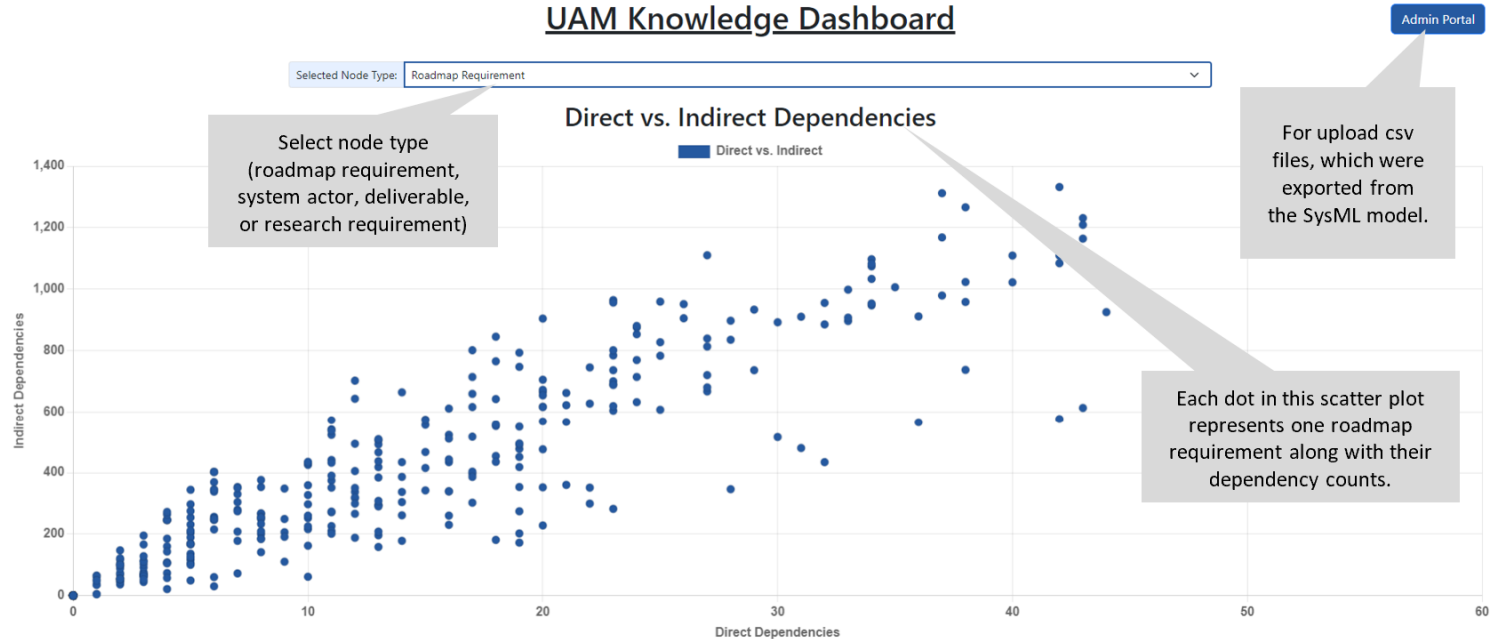
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UAM Knowledge Dashboard



Description Table

Click on a Roadmap Requirement's ^① name to view its dependency tree.

Copy Table to Clipboard Export Table as CSV Print Table Show 25 rows ▾

Name ^①	Direct Dependencies ^②	Indirect Dependencies ^③			Description ^④		Search	Rationale ^⑤
100 UML-4.2.M	12	317	01_AM, Airspace Management Systems and Services	0.0	The Vertipoint Operator ^⑥ should establish vertipoint ^⑦ arrival and departure configurations.			The Vertipoint Operator ^⑥ performing vertipoint ^⑦ resource management and scheduling service is responsible for determining vertipoint ^⑦ (arrival and departure) configurations, implementing business rules, enforcing community and government-imposed requirements, and responding to resource requests to strategically manage constraints at the vertipoint ^⑦ . (Ref. [8] ^⑧ , Section 4.4.2)
101 UML-3.AD	20			3.57	The FAA ^⑨ should approve airspace constructs ^⑩ that support increasing the tempo of UAM ^⑪ operations.			UAMS ^⑫ in controlled airspace will increase situational awareness requirements for the controllers managing that airspace. Setting up airspace constructs ^⑩ for UAM ^⑪ traffic will make it easier for ATC ^⑬ to maintain situational awareness (and increase predictability) of the presence of UAM ^⑪ aircraft to help them separate JFR ^⑭ traffic in their airspace. (Ref. [29] ^⑮) From Trinh, Tan - 0442 - MITLL <tan.trinh@il.mit.edu>, this requirement can be broken down further into several specific requirements to address the following: Transition from

User can export as-seen table to a file, print as pdf, or copy to clipboard.

Dynamic “node type” per user selection from previous image.

Search and filter in the table for specific word(s).

Select the requirement to generate tree diagram, the corresponding tree is shown in (c).

Traceability Tree

Tree Depth: 3
Reset Tree Position
Download tree as CSV
Toggle instructions

Select the tree depth from 1 to 3.

Download the current tree to a file.

Filterable node and link icons. Filterable by key word(s)

Filter Nodes By Name:

Filter Nodes By Type:

- ☒ Deliverable
- ☐ Research System Requirement
- ☐ Roadmap Requirement
- ☐ System Actor
- ☐ Undefined

Filter Nodes By Relationship:

- Allocated
- Has Requirement
- DeriveReq
- Satisfy
- Satisfied By
- Miscellaneous

Tree for the selected requirement, with partially collapsed nodes.

Full description of the selected requirement.

Selected Roadmap Requirement: [100 UML-4.AM](#)

Capability

01_AM. Airspace Management Systems and Services

Description

The [Vertiport Operator](#) should establish [vertiport](#) arrival and departure configurations.

Rationale

The [Vertiport Operator](#) performing [vertiport](#) resource management and scheduling service is responsible for determining [vertiport](#) (arrival and departure) configurations, implementing business rules, enforcing community and government-imposed requirements, and responding to resource requests to strategically manage constraints at the [vertiport](#). (Ref. [8], Section 4.4.2)

Reference

https://nasa-wam.ndc.nasa.gov/downloads/Ref_08_20210016168_MJohnson_VertiportAtmtnConOpsRptl_final_corrected.pdf

[Close](#)

Conclusion and Future Works

Conclusion

- Three user stories show promising benefits to Project Managers, Principal Investigators, and Systems Engineers

Future Works

- Rich database, with highly complex interrelationships
- Opportunity to explore advanced graph data science and AI capability



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