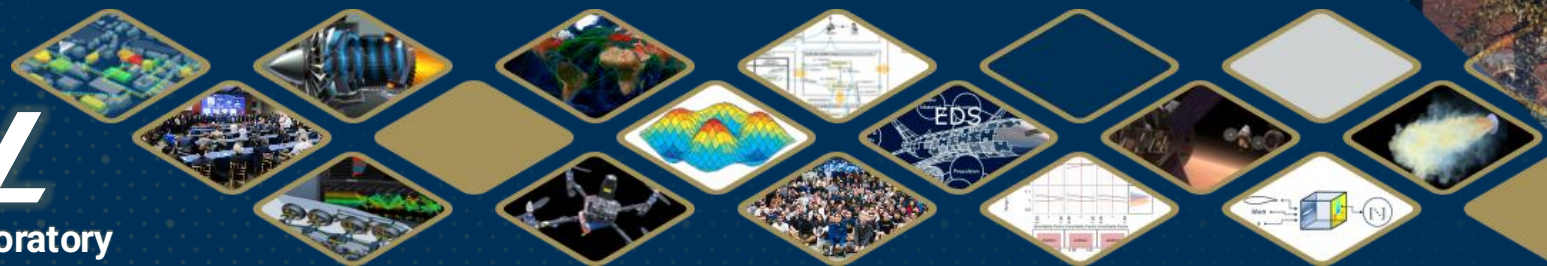
# Demonstrating SysML v2 API Interoperability with Model Management Dashboard

AE 8900 Final Review

Graduate Researcher: Eliezer Zavala Gonzalez

Technical Advisor: Adam Baker


ASDL

Aerospace Systems Design Laboratory

# Team Overview

## Academic Advisor

Prof. Dimitri Mavris

## Technical Advisor

Mr. Adam Baker

## Reviewer

Dr. Selcuk Cimtalay

## Graduate Researcher

Eliezer Zavala Gonzalez

Eliezer Zavala Gonzalez

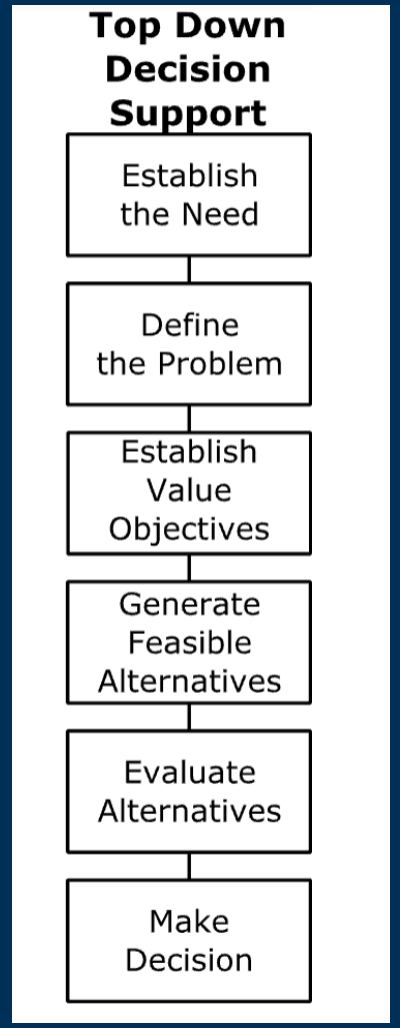


# Systems Engineering

**Engineering efforts are a top-down decision-making process**

**Systems Engineering (SE)** can be used to support the high-level goals and overall plan of an engineering effort

- Break down the main problem into many smaller problems for which the solutions are easier to define and attain
- Put together all solutions and check whether the collection achieves the goals and plan






1. 04_Systems and Systems Engineering Foundations.pdf

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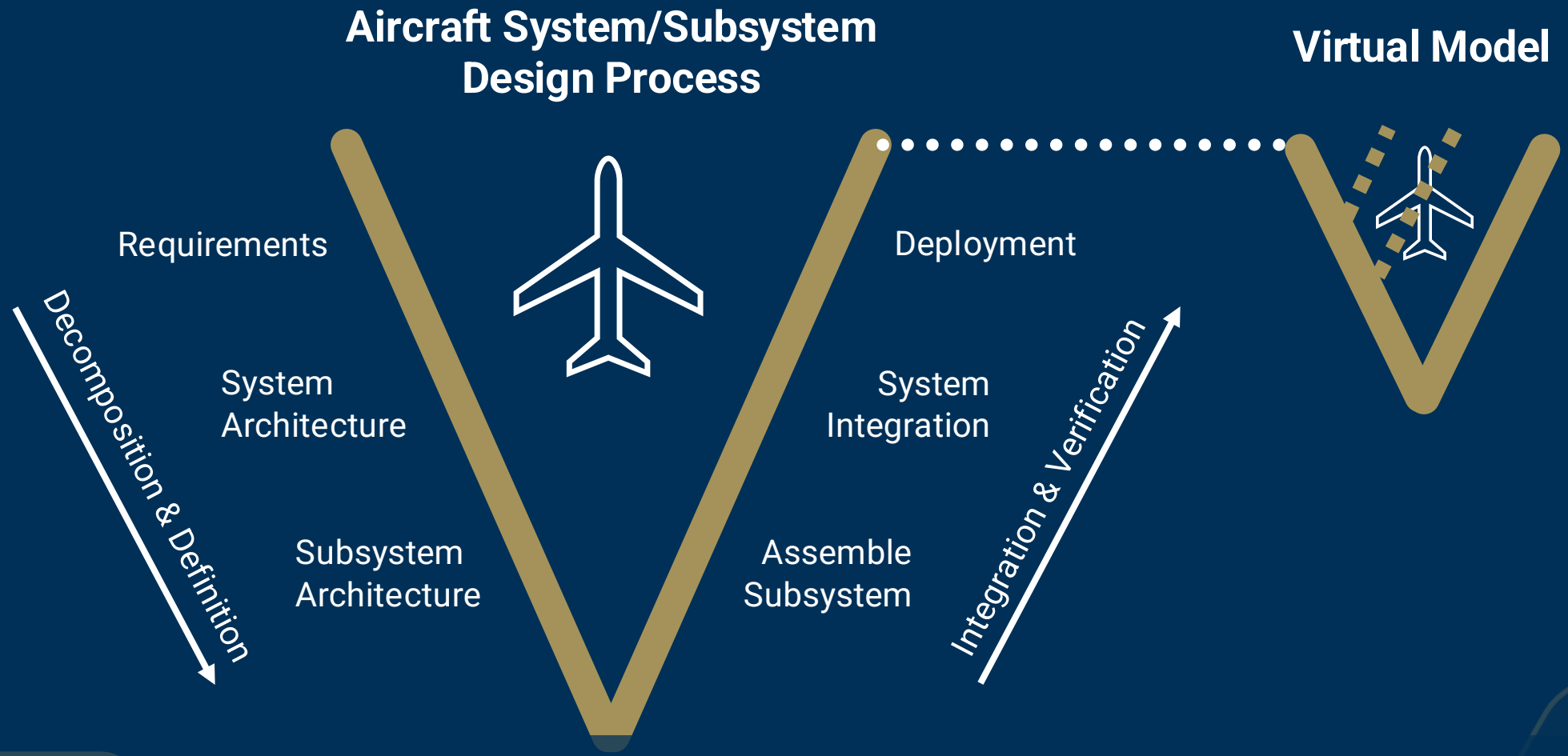
# Systems Engineering Process

**Systems Engineering brings structure to complex system design**








1. 10_MBSE_Introduction_092424.pdf

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# Systems Engineering Process

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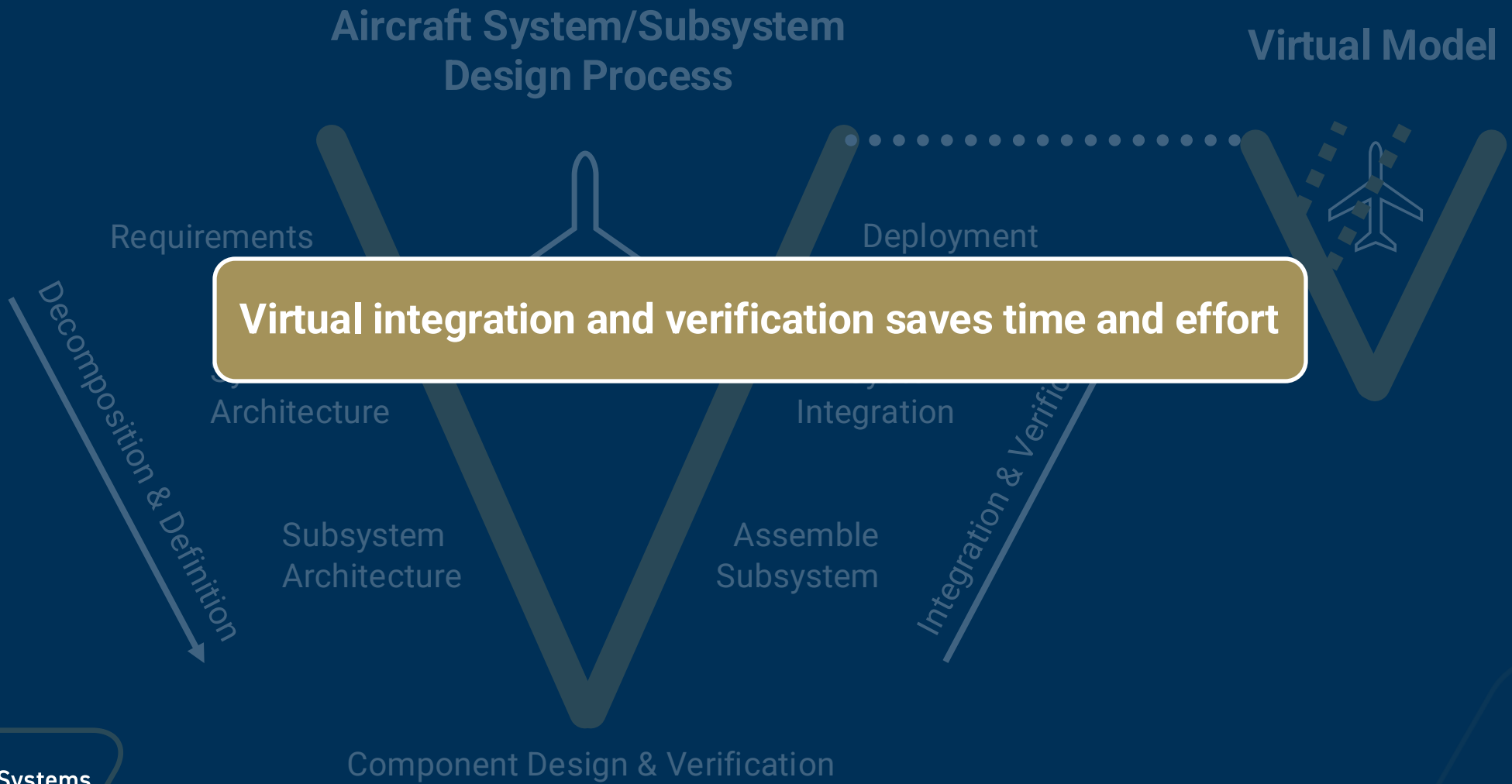


**Virtual integration and verification saves time and effort**

Eliezer Zavala Gonzalez



# Traditional vs. Model Based Systems Engineering

## Traditional

- Information is stored in **static documents** where manual updates can be **time-consuming**
- Any required changes need to be reflected in all relevant documents, **enabling the possibility of errors or absent information** across documents
- **Extensive human in the loop efforts are needed**

## Model-Based

- Emphasis on constructing a model that **captures all aspects of the system**
- Supports **automatic** requirements, design, analysis, verification, and validation activities
- Changes to information is reflected **instantaneously** throughout the model
- Model acts as an **"single source of truth"** across teams/disciplines



1. 10_MBSE_Introduction_092424.pdf

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# Traditional vs. Model Based Systems Engineering



## Traditional

- Decentralized documents
- Difficult to follow and prone to error
- Lacks the agility necessary to address new challenges

## Model-Based

**Aerospace systems are becoming more and more complex**

- Increases design and decision-making process complexity
- It is more difficult to select solutions



1. https://arc.aiaa.org/doi/abs/10.2514/6.2023-1895

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# Traditional vs. Model Based Systems Engineering



## Traditional

**Aerospace systems are becoming more and more complex**

- Increases design and decision-making process complexity
- It is more difficult to select solutions

## Model-Based

- **MBSE** is the use of modeling to support system requirements, design, analysis, verification, and validation through all stages of design
- Centralized documents
- Provides support for the development of complex systems
- **Allows knowledge capture for use by all stakeholders**



1. https://arc.aiaa.org/doi/abs/10.2514/6.2023-1895

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# Traditional vs. Model Based Systems Engineering



Traditional

Model-Based

**Aerospace systems are becoming more and more complex**

**MBSE** is the use of modeling to support system requirements, design, analysis, verification, and validation through all

**How is MBSE currently used in industry?**

Increases design and decision-making process complexity

It is more difficult to select solutions

Centralized documents

Provides support for the development of complex systems

**Allows knowledge capture for use by all stakeholders**



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# System Modeling Language (SysML)

**A model-based language is required to implement MBSE approach**

## SysML

- General-purpose modeling language for systems engineering applications, supporting specification, analysis, design, verification and validation efforts

## Drawbacks

- Lack of interactivity and interoperability
  - Requires model-based platform (e.g., MagicDraw)
  - Dependance on external tools to achieve them (e.g., third-party plugins or non-standardized APIs)
- Need a specific build for every type of implementation
- **Makes it difficult to adequately connect models with stakeholders**




1. https://arc.aiaa.org/doi/abs/10.2514/6.2023-1895
2. Martin Poretti 8900

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# System Modeling Language v2 (SysML v2)



**A model-based language is required to implement MBSE approach**

## SysML v2

- Provides improved precision, expressiveness, consistency, usability, interoperability, and extensibility over SysML v1[1]
- **Goal**: increase adoption and effectiveness of MBSE[2]

## Improvements

- **Standardized** API
  - Programming interface aimed to solve import/export, interaction, accessibility, and portability of models
  - Pilot Implementation: currently a separate API not integrated with applications; need to use native web app




1. https://www.omg.org/events/2023Q2/special-events/SysML-Session.htm
2. https://www.youtube.com/watch?v=yi_Xnxl3riw

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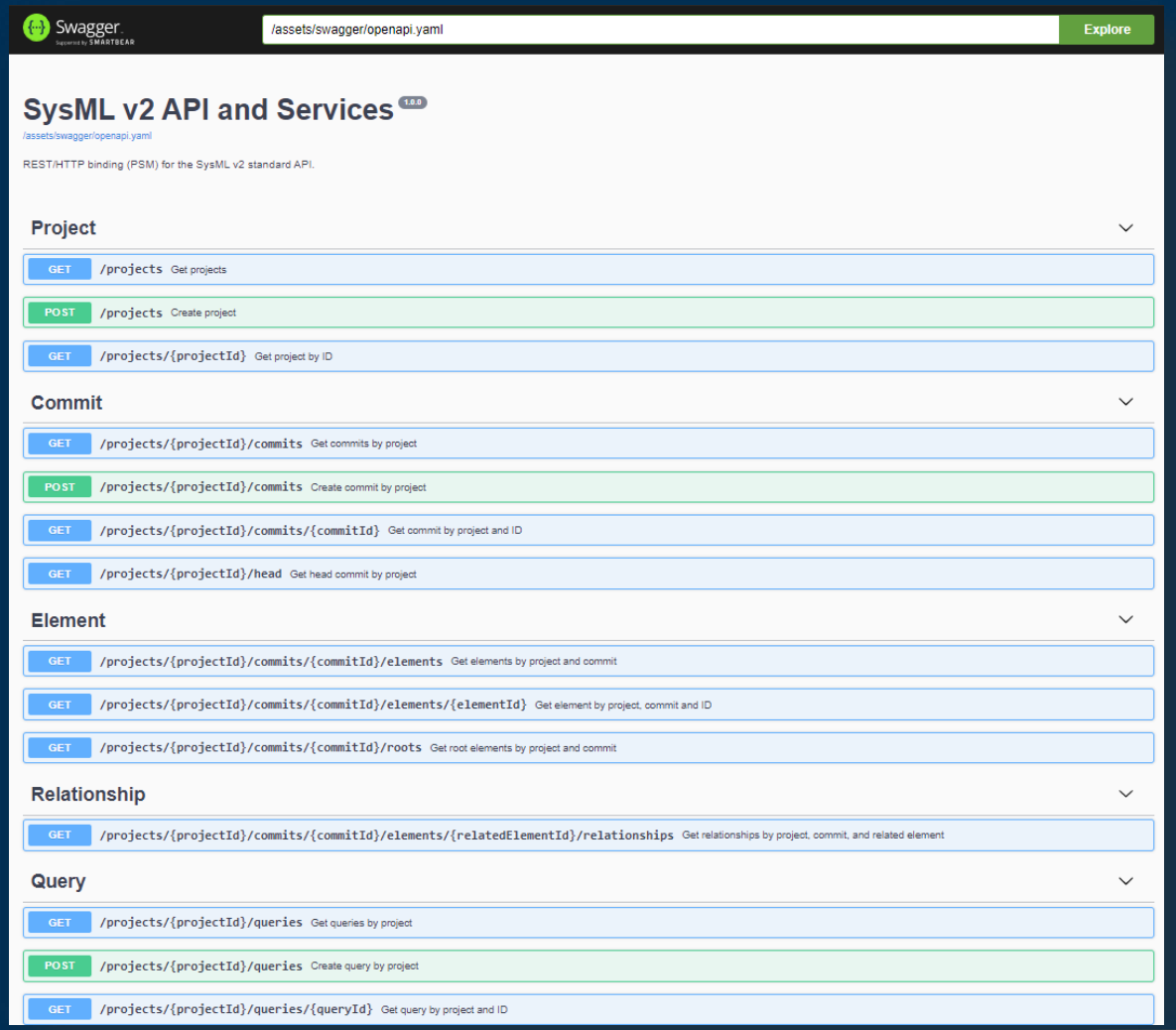
# SysML v2 – API Web App



## Swagger UI

- User performs REST/HTTP requests directly on web
- Create projects, add elements, perform commits, and more using GET or POST requests
- Requires step-by-step process of acquiring element information
  - **tedious and time-consuming**
- **Does not solve stakeholder accessibility issue**



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# SysML v2 – API Web App



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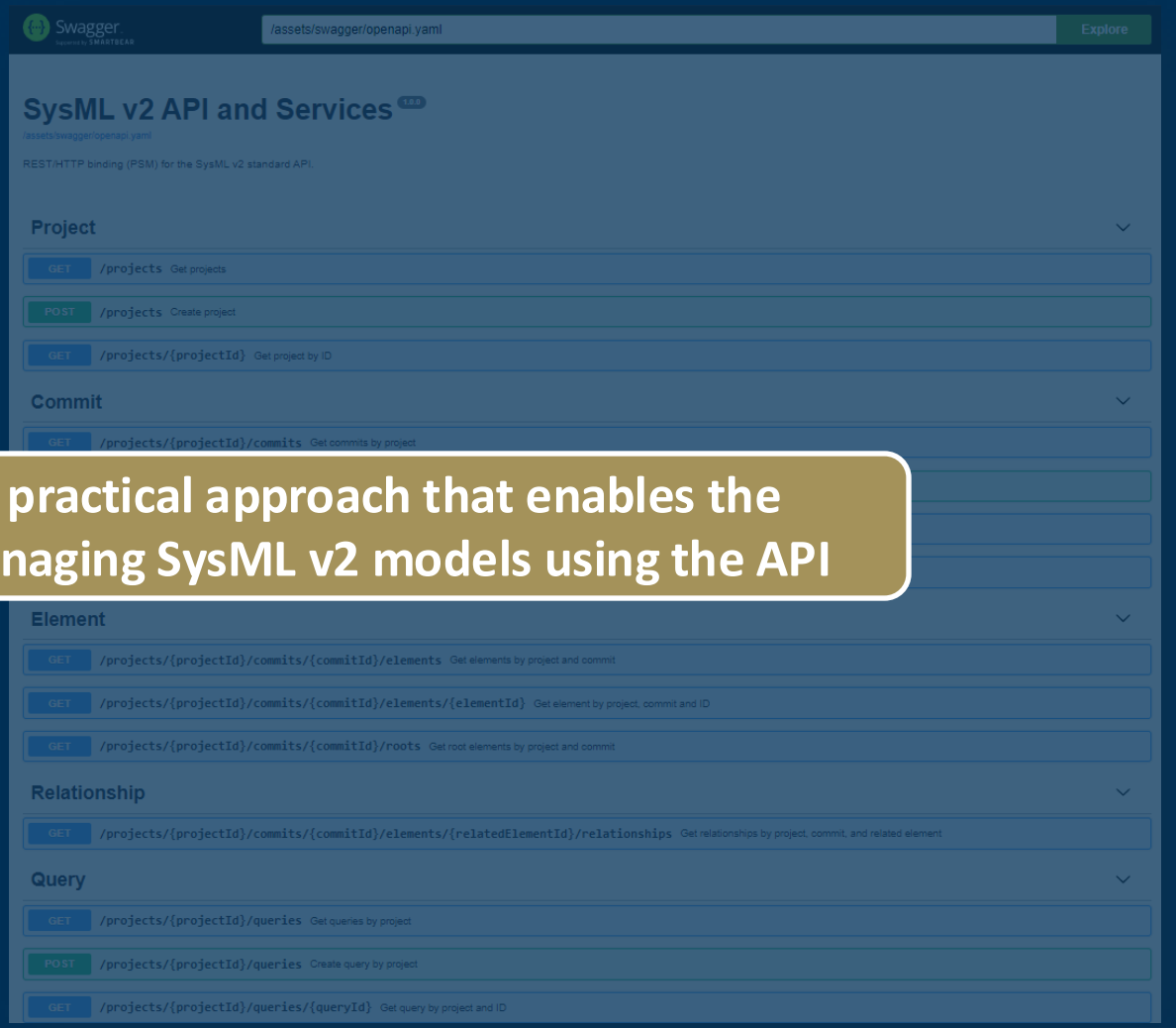


**There is a need for a more practical approach that enables the capability of viewing and managing SysML v2 models using the API**

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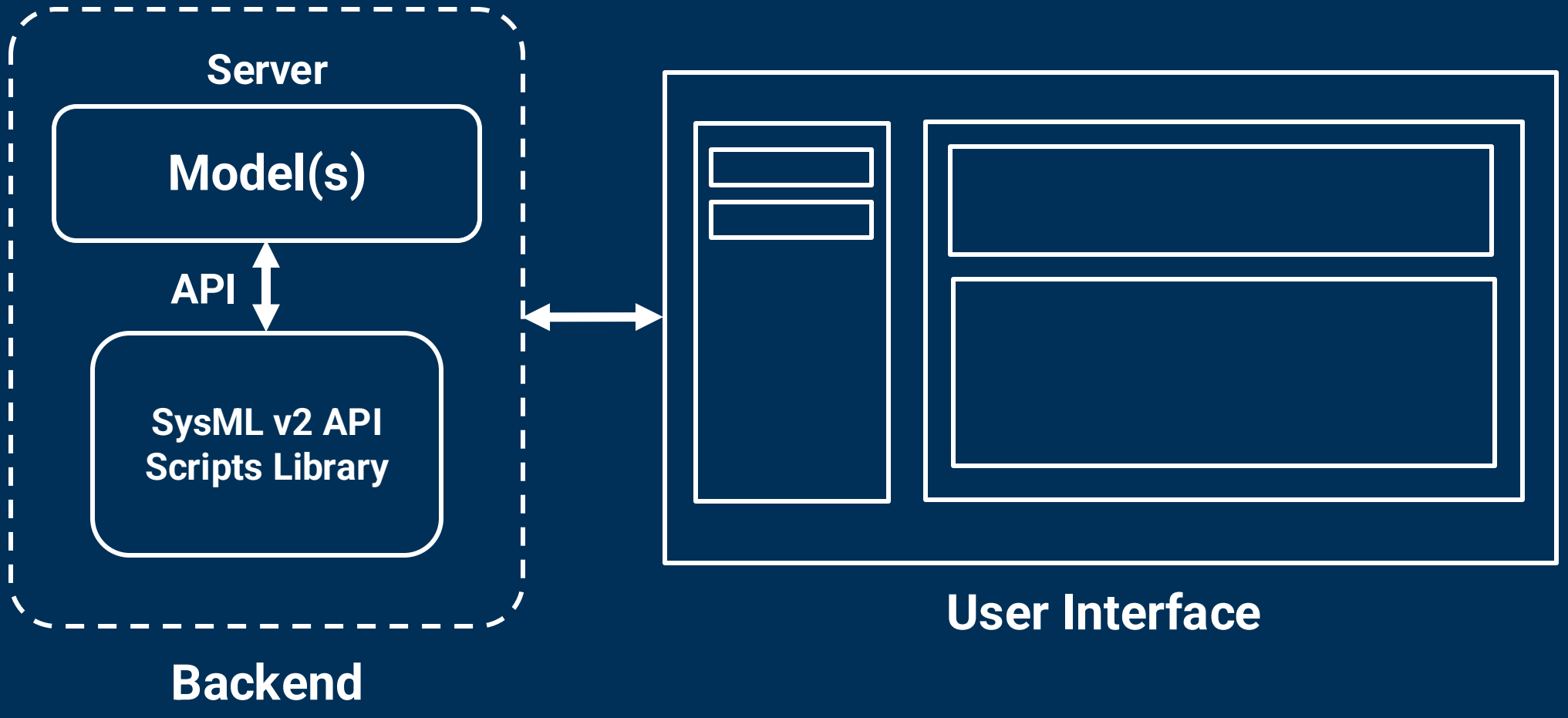
# Technical Approach






There is a need for a more practical approach that enables the capability of viewing and managing SysML v2 models using the API

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# SysML v2 API Scripts Library



Created Python library that allows for ease of access to and manipulation of one or more projects **by wrapping defined API calls with one-line functions**

- *Project* class – allows programmer to initiate and manipulate project with simple class methods

## Example: Create an Element

1. GET projects
2. Find project ID
3. GET project commits
4. Find the latest commit (not the first by default)
5. POST commit using precise template; add additional fields if necessary (e.g., owner)

**Convoluted – takes several minutes**

```
1. project = api_scripts.Project("Project Name")
2. project.create_element("Element Name", "Element Owner")
```

**Simple – takes seconds**

Eliezer Zavala Gonzalez

# SysML v2 API Scripts Library



Created Python library that allows for ease of access to and manipulation of one or more projects **by wrapping defined API calls with one-line functions**

- *Project* class – allows programmer to initiate and manipulate project with simple class methods

**Projects**

- Create Project

**Elements**

- Create Element
- Update Element
- Delete Element
- Extract Element

**Attributes**

- Create Attribute
- Update Attribute
- Delete Attribute
- Extract Attribute

**Requirements**

- Create Requirement
- Update Requirement
- Delete Requirement
- Extract Requirement

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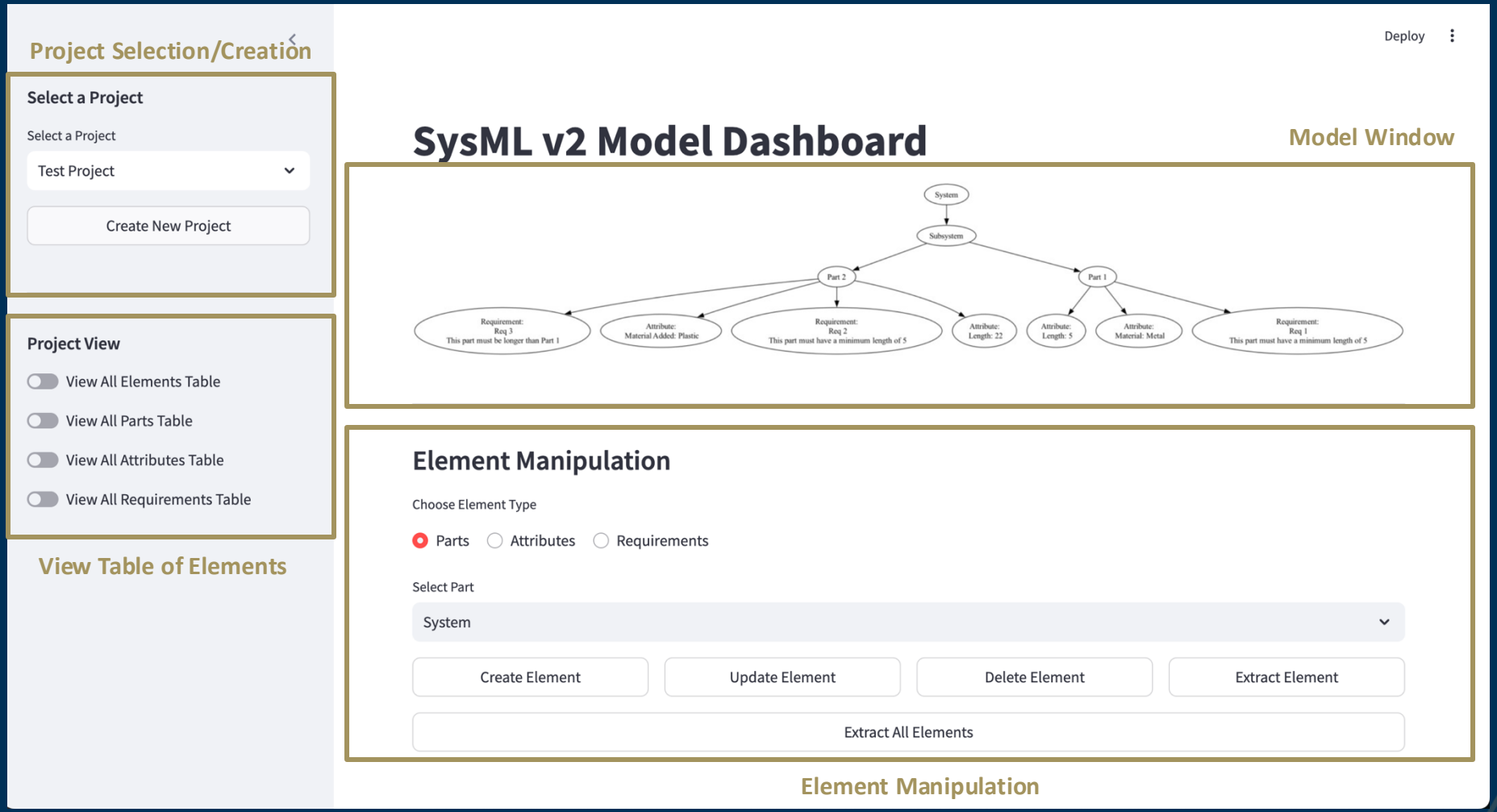
# Model Management Dashboard

Leverages API library to allow users/stakeholders to seamlessly interact with the server and its models





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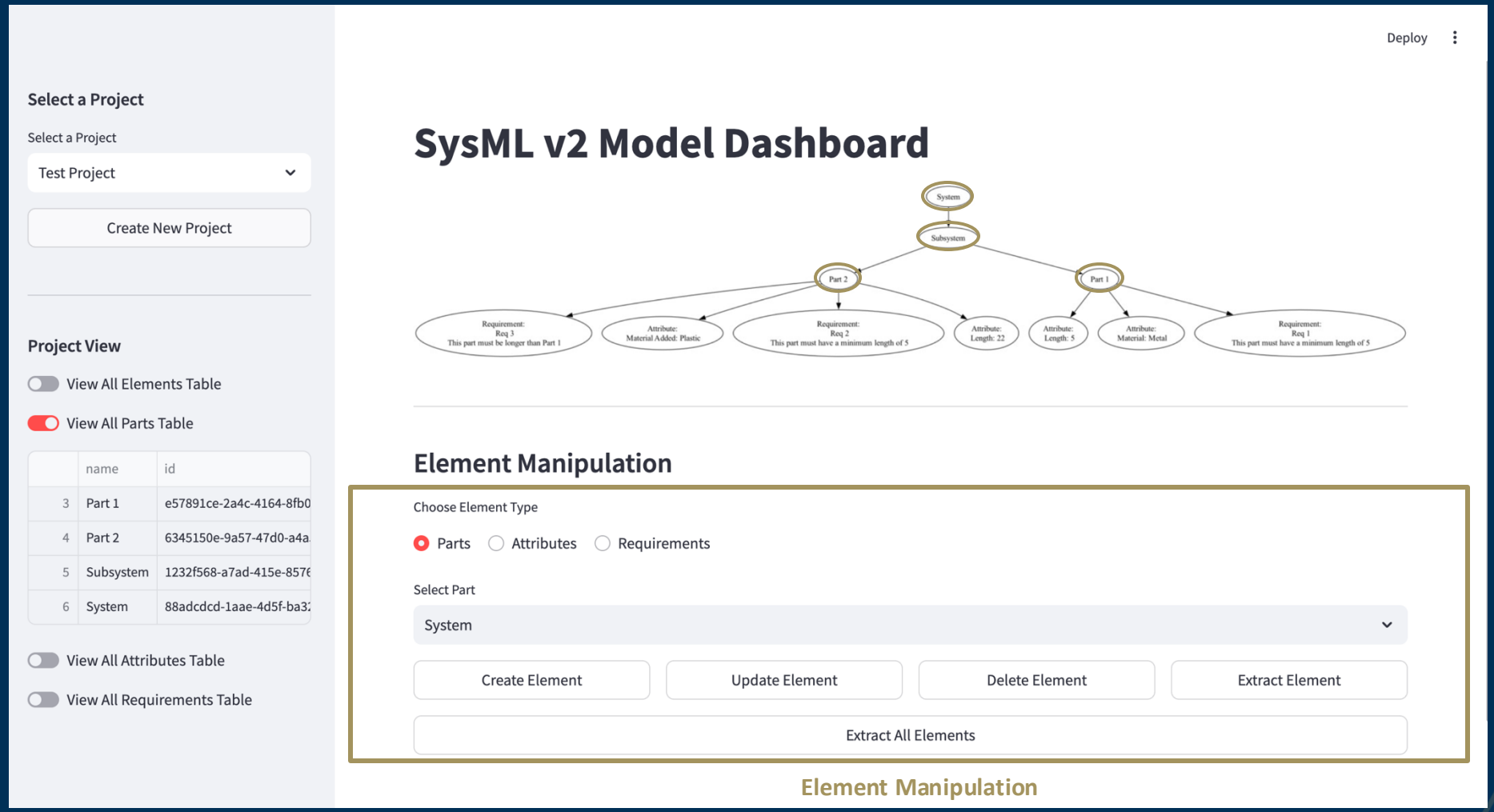
# Model Management Dashboard - Parts

Leverages API library to allow users/stakeholders to seamlessly interact with the server and its models






Element Manipulation

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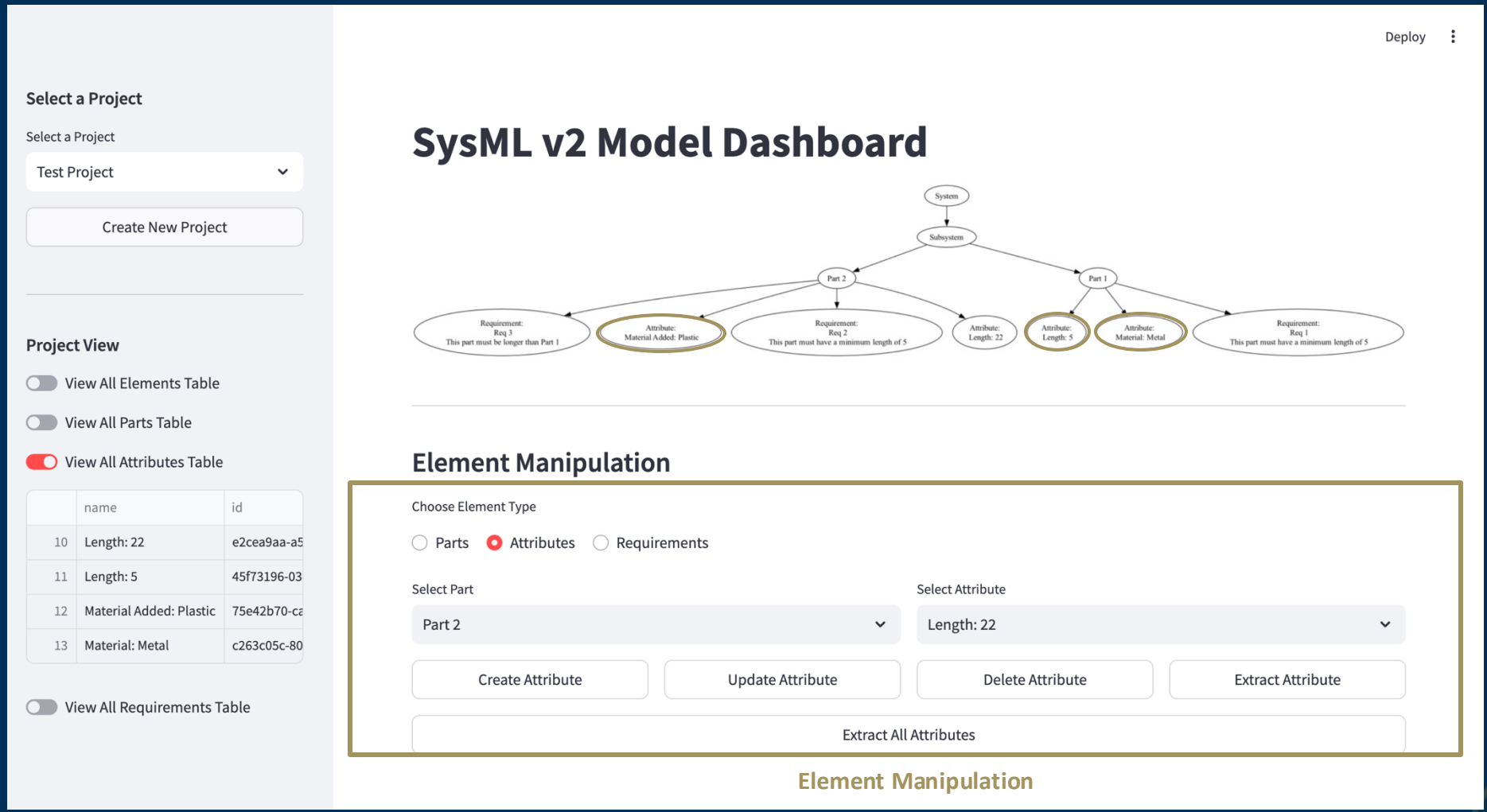
# Model Management Dashboard - Attributes

Leverages API library to allow users/stakeholders to seamlessly interact with the server and its models






Element Manipulation

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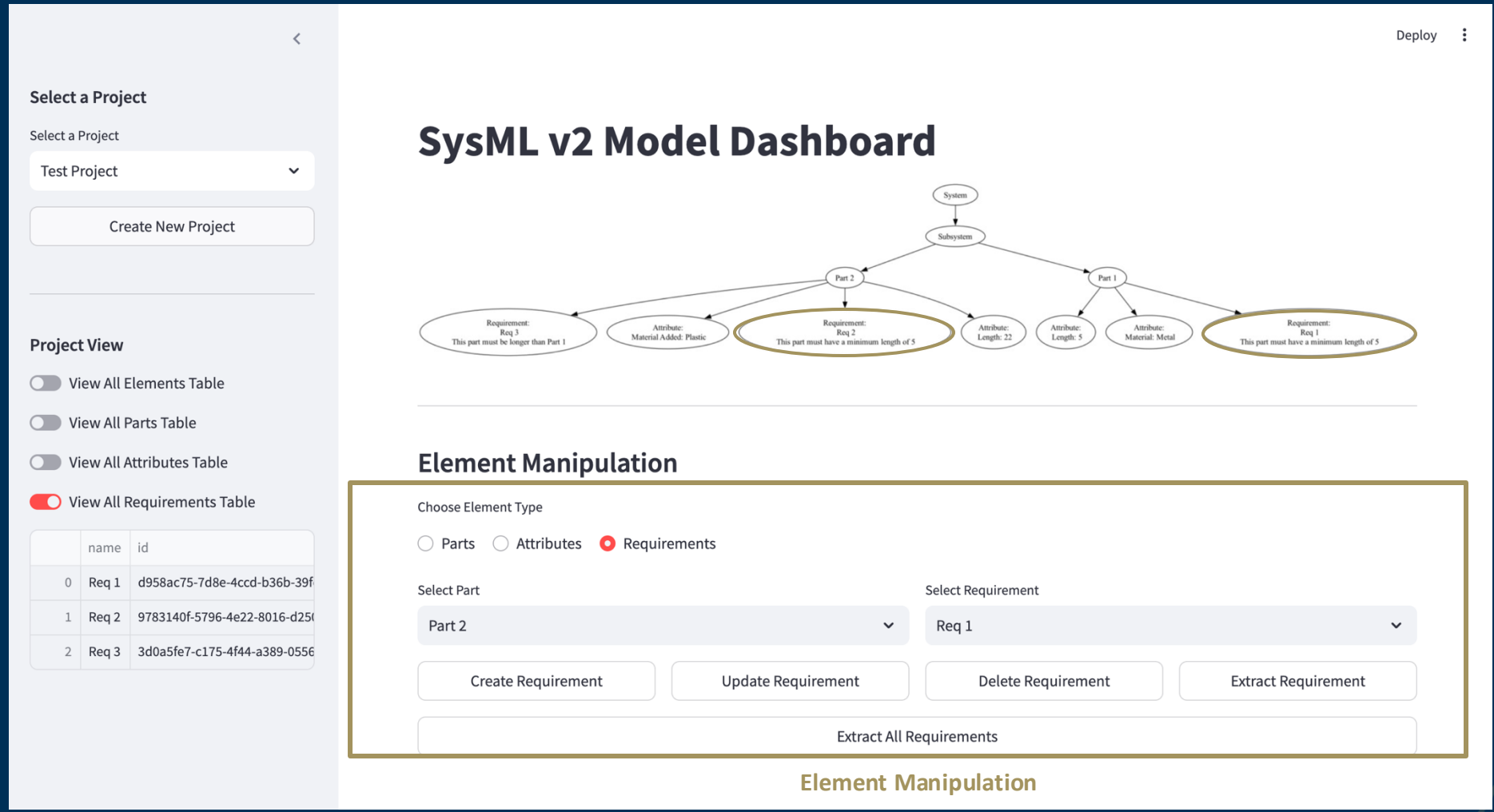
# Model Management Dashboard - Requirements

Leverages API library to allow users/stakeholders to seamlessly interact with the server and its models






Element Manipulation

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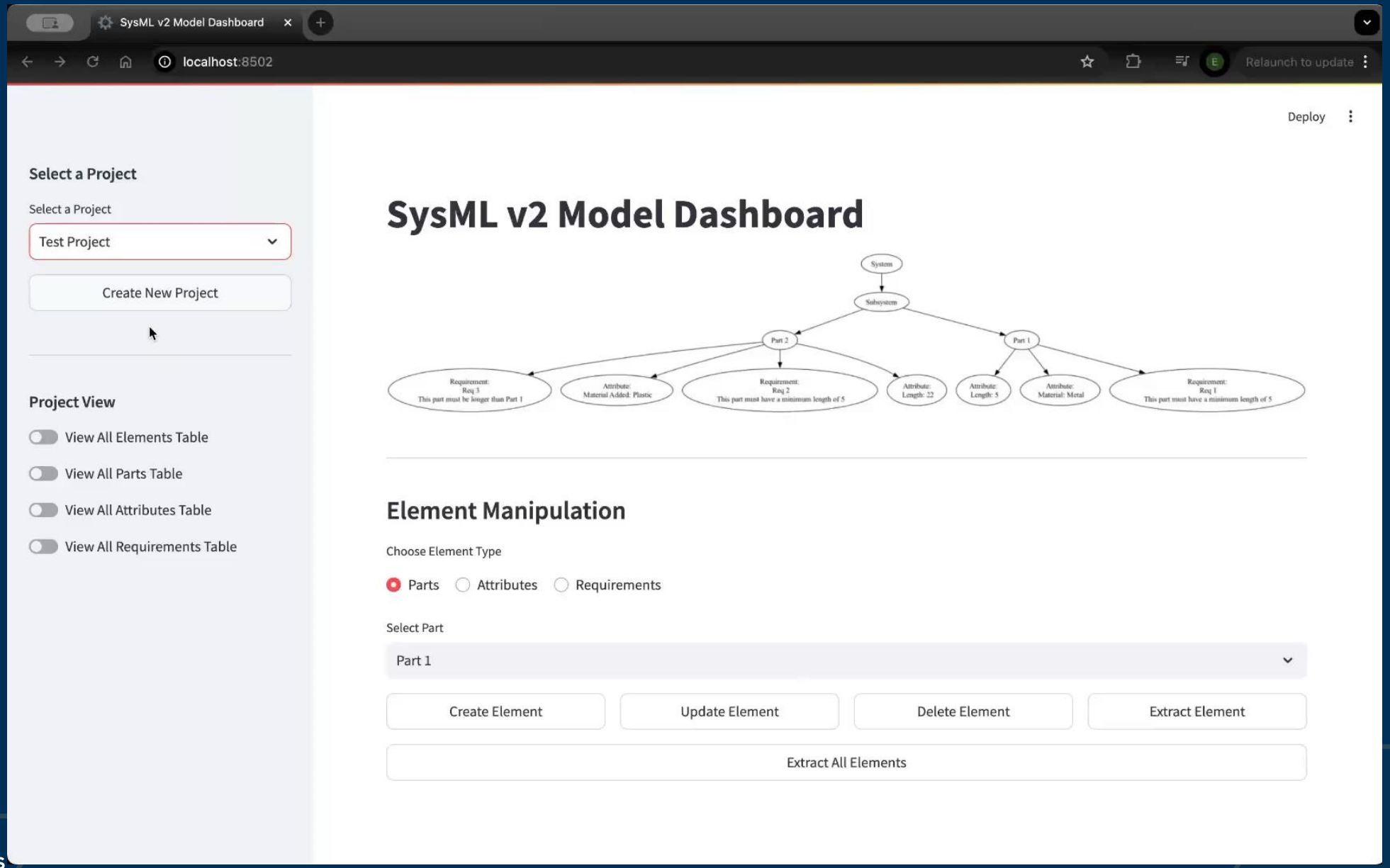
# Implementation





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# Conclusions

- **The API Scripts library** enables the interoperability and integration of SysML v2 models
- **Model Management Dashboard** showcases a successful use-case of library, highlighting its usefulness while nurturing ideas of how it can be expanded to enable more comprehensive/complex use-cases (e.g., mass-import elements, integration with third-party analysis tools, etc.)
- **Contributes to the development of SysML v2** by increasing the accessibility of stakeholders (programmers, project managers, general users, etc.) to SysML v2 server models via API without prior API knowledge required

# Thank you!


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