Collaboration in an Authoritative Source of Truth Environment using OpenMBEE

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Agenda

• Authoritative Source of Truth & Surrogate Pilot

• OpenMBEE: Lessons Learned
  — Model Development Kit (MDK) & DocGen
  — Model Management System (MMS)
  — View Editor

• Project Usage & Management

• Summary
• Authoritative Source of Truth (AST)
  — To provide consistent data in the format necessary for the given task
  — Implemented by OpenMBEE = Open Model Based Engineering Environment, developed by NASA/JPL

• Surrogate Pilot
  — Execution of NAVAIR’s Systems Engineering Transformation (SET) Framework
  — To simulate collaboration in an AST
  — To support new operational paradigm between government and industry
    o By elimination of paper artifacts and large-scale design reviews in favor of continuous insight/oversight via the digital collaborative environment
Surrogate Pilot Scenario: Skyzer UAS

Graphical CONOPS Scenario:
Search & Rescue

Airfoil designation for a similar Bell tilt-rotor (BA609)

Skyzer System & Mission Models developed using SysML
OpenMBEE: MDK, MMS & View Editor

MDK in Magicdraw: DocGen with View and Viewpoint Hierarchy

Model Management System (MMS)

View Editor: Provides Rich Web Interface

Visualization in View Editor
Model Development Kit (MDK)

• What is MDK?
  ― Plugin for Magicdraw, to support building system assemblies through modeling augmentation and validation, enable syncing with MMS and using the DocGen language for model-based document creation using views and viewpoints
  ― Content
    o Systems Reasoner
    o MMS Sync
    o DocGen

MDK: View and Viewpoint Hierarchy

View Editor: Provides Rich Web Interface
• **DocGen**
  
  — For model-based document creation based on Views and Viewpoints
  
  o To generate views for View Editor or pdfs
  o To guide modeling and development
MDK: DocGen Lessons Learned

• Viewpoint Modeling
  — Most viewpoint needs covered by the provided activity diagram elements and some OCL\(^1\) constraints
  — Difficult access on tagged values of custom stereotypes (e.g. for filtering)

• Viewpoint Library
  — Providing standardized viewpoints to quickly create consistent results
  — Few modelers need to create or know how to create viewpoints
  — Allowing pre-planned view hierarchies to define document structure and type of content prior to modeling
  — Included warning messages if no suitable elements are found
  — Requiring some modeling considerations to consistently find correct model elements to be exposed

1) OCL = Object Constraint Language
MDK: DocGen Modeling Guidelines

• Using a consistent model structure to allow model elements to be found by viewpoints

• Separate model content suited to be exposed and model content that should not get exposed
  — By using separate workspace package
  — By removing empty diagrams and unused model elements

• Keeping document creation in mind while modeling
  — Limiting the size of diagrams and tables, to be printable
  — Element (e.g. diagram) documentation to be used in documents
Model Management System (MMS)

• What is MMS?
  — A version control system for structured data, including versioning, workflow management, and controlled access through RESTful web services
  — Used as central data hub to facilitate multi-tool and multi-repository integration across engineering, computing, and management disciplines

• To store SysML model data
  — Capturing all model elements (e.g. classes, instances, relations, but not: diagram layout), including their change history and views for View Editor

MDK: View and Viewpoint Hierarchy

View Editor: Provides Rich Web Interface
• **What is the View Editor?**
  
  — A web app to provide consistent data from SysML models, to allow interaction with model elements without having to use the case tool
  
  — By utilizing exposed data from DocGen views and viewpoints through view instances and model elements on MMS

• **To improve communication with non-modelers via live data in stakeholder-specific documents from the AST**
View Editor: Commenting & Editing

Request for Information (RFI) with Views/Chapters

Exposed Diagram

Long Distance Emergency Delivery

Inserted Comment
Use Cases need to be checked prior to release.

Documentation of Diagram

Background: Family traveling from Los Angeles to Hawaii in a 1984 Catalina 36 has an emergency at sea. A 40 year old, diabetic father out of insulin, and is unresponsive. He is the main sail operator, his family is unable to sail the boat without him. They are adrift until medical assistance can arrive. Position of the sailboat is 200 nm from the USS Pinkney. USS Pinkney also has the needed medical equipment and UAV capabilities to transport the supplies in the required timeline. Modern ship based UAV and global positioning systems.
Government Computer Models

- Skyzer IM20 Mission Model (v.15) with Views in IM90-20 model (v.29)
- Skyzer IM30 System Model with own Views (v.39) and Views in IM90-30 model (v.35)
- Skyzer IM30 Evaluation Model with own Views (v.35) and Views in IM90-30 model (v.35)

Used tools:

- Magicdraw 18.5 SP3 or Cameo System Modeler 18.5 SP3
- MDK plugin v. 3.3.6
- MMS v.3.2.2
- View Editor v.3.2.1
- Teamwork Cloud 18.5 SP

3. Requirements
3.1 General

The work required by this contract shall be performed in accordance with System Requirements contained in Skyzer System Model (SM) and this Statement of Work (SOW). The contractor shall design, develop, fabricate, test and deploy the complete Skyzer Maritime SAR system in accordance with the detailed tasking in paragraph 3.2 Detail Tasks below. All contract activities are to be completed within 48 months after contract award.
• View Editor editing capability
  — Addition of presentation elements (e.g. text, images, videos) and comments
  — Editing names, values and documentation of SysML model elements
  — Limited creation of new model elements
    o Instead possible to adapt placeholder elements

• Traceability
  — Searching and cross-referencing of any other elements in MMS

• Creation of read-only Tags in the View Editor
  — E.g. to capture official RFI and RFP releases
  — TWC branches committed from SysML modeling tool
• Model-based document generation from AST
  —Access on consistent AST data without modeling tool or SysML knowledge
    o Enabling transition from document-based to model-based development
    o Enabling fast and useful design iterations
    o Glossary feature of modeling tool to define terms in MMS/View Editor
  —Flexible application of model-based document generation
    o Content created in SysML tool (e.g. textual SOW or System Model)
      as well as in the View Editor (e.g. most of RFI)
  —Include domain experts & stakeholders to define relevant views/documents
    o Model-generated reports supporting program leadership decisions
      by providing only relevant information to stakeholders
    o Only modelers will likely know/understand entire model
OpenMBEE Implementation

- OpenMBEE Implementation in Docker on AWS:
Project Usage & Management

• Project Usage Mechanism
  — For project modularization to separate distinct parts of the system
    o E.g. internal Evaluation Model separate from provided System Model
  — Allowing traceability linkages
    o E.g. System Model using Mission Model to trace mission requirements to system model elements
  — To reuse model libraries (e.g. viewpoints)
    o While hiding used profiles in separate MMS Org

• Issue Tracking in the View Editor
  — Issues captured in the View Editor and saved in MMS as AST
  — Allows to cross-reference model elements from used projects
    o E.g. directly using comments in other documents as issues
Project Usage & User Permissions: Example

- Editing & commenting in the Mission View Model, without permission to directly change exposed requirements from Mission Model
- Creating issues in Issue Tracking Model, e.g. using prior comments
**Summary & Future Work**

• **Promising application of OpenMBEE as an AST environment**
  — Technically feasible to develop everything as a model
    o Project usage for modularization, reuse, partitioning, traceability and user access
    o Quick and consistent model-based document generation through DocGen & Viewpoint Library
    o Enabling fast and useful design iterations
  — View Editor offering views on consistent data from MMS as AST
    o Improved communication between modelers, experts and other stakeholders
    o Included issue tracking with AST access

• **Future Work**
  — Model-centric source selection for RFP response including traceability towards non-SysML data, e.g. multi-physics simulations
  — Adoption of GitFlow\(^1\) workflow to define and standardize model branching
  — Addition of ontological reasoning on AST data

1) [https://www.atlassian.com/git/tutorials/comparing-workflows/gitflow-workflow](https://www.atlassian.com/git/tutorials/comparing-workflows/gitflow-workflow)
Further Information

  - GitHub: [https://github.com/Open-MBEE](https://github.com/Open-MBEE)
  - Google Group: [https://groups.google.com/d/forum/openmbee/](https://groups.google.com/d/forum/openmbee/)

- **Surrogate Pilot**
  - View Editor: [http://ime.sercuarc.org/alfresco/mmsapp/mms.html](http://ime.sercuarc.org/alfresco/mmsapp/mms.html) (Login instructions available on Apan)


Thank you!

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School of Systems & Enterprises
Systems Engineering Research Center
Stevens Institute of Technology
Use Cases for Surrogate Pilot

Surrogate Pilot using Authoritative Source of Truth (AST)

- Project Plan UC
- Mission Model UC
- System Model UC
- Contractor(s) System Model(s) UC
- Contractor Design Model UC

Source Selection UC & Models

Proposal for Design Models must be able to demonstrate aspects for Producability Decisions involving Multi-physics

Mission Models
System Models
Evaluation Model
Based on Standards

RFI
RFP
GFI
Proposal Extends GFI

Proposal for Design
Models

Objectives to Assess SE Framework

How we Collaborate in AST
Single Authoritative Source of Truth

The entire set of models and tools is held in a single repository and becomes the Single-Source-of-Truth for the duration of system development.

- **Ability to interrogate the design information** and extract data into the format necessary for the given task
  - Leverages formalism
  - Transformation rules are **reusable**
  - Provides **machine and human readable formats**
- Leverage the model by reviewing the **model itself**
- Stakeholders focus on the views of the **system model** that address their concerns
**OpenMBEE Implementation in Docker on AWS:**

1. **Domain Model**: Used to construct the **Modeling Tool (Magicdraw)**, which exposes the **SysML Profile**.
   - The **SysML Profile** is used to construct the **MDK Profile**.
   - The **MDK Profile** extends the **MDK Plugin**.
   - The **MDK Plugin** uses the **MDM** to store and retrieve model information.

2. **Teamwork Cloud**: Stores the **Teamwork Cloud** data, which is used by **OpenMBEE**.

3. **XSLT/FO Processor (oXygen)**: Produces **XSL Stylesheet .html .pdf**.
   - **Browser**: Displays view to user and gets back edited model information.

4. **View Editor**: Stores and retrieves model information.

5. **Server (AWS)**: Contains the **IoLF** and provides a connection to the **Client**.
Purpose: Support building system assemblies in SysML

- Augmented creation of child elements from imported CSV tables
- Augmented creation of specialization trees
  - Including propagation and redefinition of properties
- Aspect creation to avoid over-use of stereotypes with tagged values
- Model validation
“Specialize Structure Recursively”: modeling support to create sub-elements together with redefined properties and interrelations

New child elements to be renamed and detailed (e.g. going from logical to physical structure)
• **Model:** UAV block

• **View Hierarchy:**

• **Result:**
  — **XML file:**

    ```xml
    <tbody>
    <row>
    <entry><para>UAV</para></entry>
    </row>
    <entry><para>The unmanned air vehicle (UAV) has to navigate without a human pilot on board.</para></entry>
    </tbody>
    ```

  — **Converted PDF:**

**Table 1.1. UAV Structure**

<table>
<thead>
<tr>
<th>Model Element</th>
<th>Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>UAV</td>
<td>The unmanned air vehicle (UAV) has to navigate without a human pilot on board.</td>
</tr>
</tbody>
</table>
• MMS Sync
  — Purpose: Link to MMS (& View Editor)
  — Generating View instances for View Editor
  — Model validation on element level
  — Committing and receiving changes
"elements": [
    {
        "_modifier": "admin",
        "documentation": "",
        "mdExtensionsIds": [],
        "appliedStereotypeInstanceId": null,
        "editable": true,
        "type": "Slot",
        "ownerId": "_18_5_2_8db028d_1521039686311_347855_34924-slot-_18_5_2_8db028d_1521039686311_347855_34924",
        "_commitId": "191c6c7-50a3-4d5e-a309-550d83ab7851",
        "_nodeIds": {
            "master": null
        },
        "_creator": "admin",
        "syncElementId": null,
        "_created": "2018-08-15 19:42:42.616836363",
        "id": "_18_5_2_8db028d_1521039686311_347855_34924-slot-_18_5_2_8db028d_1521039686144_127895_33281",
        "_elasticId": "5lbz166g f13c 162c a5e4 a1567951a95b",
        "value": [
            {
                "visibility": null,
                "documentation": "",
                "mdExtensionsIds": [],
                "appliedStereotypeInstanceId": null,
                "templateParameterId": null,
                "type": "LiteralReal",
                "ownerId": "_18_5_2_8db028d_1521039686311_347855_34924-slot-_18_5_2_8db028d_1521039686144_127895_33281",
                "clientDependencyIds": [],
                "syncElementId": null,
                "name": "",
                "typeId": null,
                "id": "_18_5_2_8db028d_1521039686311_347855_34924-slot-_18_5_2_8db028d_1521039686144_127895_33281-slotvalue-0-1",
                "appliedDependencyIds": [],
                "value": 39.3096,
                "_appliedStereotypeIds": [],
                "nameExpression": null
            }
        ]
    }
]
MMS: Alfresco Content Manager

- For View Editor images and user access management:
Request for Information (RFI) with Views/Chapters

Documentation of Diagram

Cross-Reference to UAV term

Exposed Diagram

Use Cases need to be checked prior to release.

Background: Family traveling from Los Angeles to Hawaii in a 1984 Catalina 36 has an emergency at sea. A 40 year old, diabetic father out of insulin, and is unresponsive. He is the main sail operator, his family is unable to sail the boat without him. They are adrift until medical assistance can arrive. Position of the sailboat is 200 nm from the USS Pinkney. USS Pinkney also has the needed medical equipment and UAV capabilities to transport the supplies in the required timeline. Modern ship based UAV and global positioning technology has the potential to make the described scenario real today and in the future.
### 3 Skyzer Model Issues

**Creating of evaluation model**

In response to the need for parametrics in model issue, the proposal is to create a separate evaluation model that could take inputs from the various contractor-created models and output a summary comparison of the contractor design versus the constraining requirements.

**Create Modeling Guidelines for Surrogate Pilot**

There have been a few discussions about guidelines, such as table modularizations, how to define a KPP, formatting diagrams, etc. We ask the function lead about those guidelines and/or create our own specific to the Surrogate Pilot.

<table>
<thead>
<tr>
<th>Issue Element</th>
<th>Status</th>
<th>Description</th>
</tr>
</thead>
<tbody>
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<td>open</td>
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</tr>
</tbody>
</table>

**Cross-Reference to other Issue**

**Issue Elements or Referenced Comments from other Document**
View Editor: Editing Exposed Data

Exposed Model Element

Slot Value

Last Modification

Edit of Documentation

Exposed Model

Element

Documentation
View Editor: Branches and Tags

• Branches/ Tasks (similar to GitHub branches)
  – To create a separate workspace built by copying data at a specified time (any following changes do not affect the "master" branch)
  – Able to merge with TWC Branches of the same name
    o Merging only if created in Cameo! Or merging of single elements through comparison
    o New branches still include added presentation elements from View Editor

• Tags (sets of permanently saved read-only data with a timestamp)
  – To create "snapshots" of all the data on View Editor at specified times, e.g. for reviews

• Manage Branches/Tags
  – To Create, Delete & Switch between
  – Deleted branches leave data in Alfresco & cannot be recreated from Cameo
Project Usage & User Permissions: Example

- Permissions to edit/comment in the Development Branch of the Mission View Model, without being able to directly change requirements in Mission Model
- Addition of comments as issues in Issue Tracking Model Trunk branch
- No access on any System Model and Evaluation Model related information

Composition = Project Usage (Trunk branch for baseline model)
• What is Teamwork Cloud?
  — Server to work on the same Magicdraw/Cameo projects and merge the concurrent work of all modelers together

• Collaboration Features
  — Editing server projects locally and commit changes/receive updates
  — Locking elements for edit, to prevent simultaneous changes by other users
  — Project and Element History (including comparison between two versions)
  — Branching and Merging projects
MMS

- **Purpose:** A central structured data hub for multi-tool, multi-repository, and multi-discipline integration

- **Storing:**
  - All model elements of a project, including their change history; view instances and tags for VE
  - Non-Magicdraw data

- **Interfaces:**
  - RESTful web services
  - Login through Magicdraw, VE and Alfresco (for user/model mgmt)

TWC

- **Purpose:** Concurrent & distributed Magicdraw modeling, including versioning and branches

- **Storing:**
  - Magicdraw projects, including their branches, model versions and element history (e.g. for merging branches)
  - (Collaborator data stored separately)

- **Interfaces:**
  - REST API (by NoMagic)
  - Login through Magicdraw and Admin Console (& Alfresco for Collaborator)
View Editor vs. TWC: History Comparison

- **View Editor**: For quick checks with limited scope
  - History of single elements only
  - Including all added presentation elements
  - (Model validation in Cameo: open model vs. current state in MMS)

- **TWC**: For broad-scale merging of heavily changed models
  - Full model content history comparison
  - Without MMS specific information (i.e. added presentation elements from View Editor)