

DocWeb + DocGen + TeamWork + MagicDraw

# MBSE with Doctimus Prime

## Transforming system models into documents

David Noble, Software Systems Engineer  
Multimission Ground Systems and Services Office

National Aeronautics and Space Administration  
**Jet Propulsion Laboratory**  
**California Institute of Technology**  
Pasadena, California

Copyright 2012 California Institute of Technology. Government sponsorship acknowledged.



# Agenda

- Why is it valuable?
- Who does it help?
- What is it exactly?
- How mature is it?

# Context

Team's **systems engineers** are **modelers**

**Engineering** work is done in **models**

**Deliverables** are in the form of **documents**

Team's **stakeholders** are **not modelers**

# Context

Team's **systems engineers** are **modelers**

**Engineering** work is done in **models**



**Gap**



**Deliverables** are in the form of **documents**

Team's **stakeholders** are **not modelers**

# Context

Team's **systems engineers** are **modelers**

**Engineering** work is done in **models**



Software transforms **models** into **documents**

**Deliverables** are in the form of **documents**

Team's **stakeholders** are **not modelers**

# Context

Team's **systems engineers** are **modelers**

**Engineering** work is done in **models**

Software transforms **models** into **documents**

Stakeholders use web to **collaborate**

**Deliverables** are in the form of **documents**

Team's **stakeholders** are **not modelers**

# Value Proposition

## Use engineering work directly in documentation

- Reduce cost & time by preventing duplication of work (**leverage MBSE effort**)
- Reduce cost & time by using sophisticated automation
- Reduce risk by **preventing inconsistencies**

## Share documents in collaborative web application

- Reduce cost & time by **making information easily accessible**
- Reduce risk by enabling better collaboration

# Value Proposition

Use engineering work directly in documentation



- Reduce cost & time by preventing duplication of work (**leverage MBSE effort**)
- Reduce cost & time by using sophisticated automation
- Reduce risk by **preventing inconsistencies**

Share documents in collaborative web application



- Reduce cost & time by **making information easily accessible**
- Reduce risk by enabling better collaboration

# Value Proposition

More time can be invested in technical work

**Bonus**

- Products can be higher quality
  - Example: EHM wants to do statistical resource analysis that wouldn't have fit in schedule
- Managers can pay engineers to do engineering work,
- Engineers can be happier and smarter
  - Higher quality work products
  - Better professional development
  - Better personnel retention

# Case Studies

## EHM - MEL

### *Europa Habitability Mission - Master Equipment List*

- Subsystem engineers use DocWeb as **the reference for mass reports**
- Material generated by this system will be embedded in **final study report**

“DocGen and DocWeb have been **fundamental enablers** for the progress we’ve made on applying MBSE to the Europa Studies.”

“It is a **critical capability** for Europa...”

Value: "DocGen and DocWeb have been fundamental enablers for the progress we've made on applying MBSE to the Europa Studies. They provided us with an essentially free solution to what had been a significant risk, which was how to allow the rest of the project to interact productively with the SysML models. This is most true of the management stakeholders who need to see the current state of the concept when they ask for it. In the past we have had to manually update Powerpoint, Word and Excel packages to satisfy these requests – a very time-consuming and error-prone process. Now we simply give them the URL of the latest model report on DocWeb. It is not exaggerating to say that the web-accessible reports provided by DocGen and DocWeb, including the SysML block diagrams and the Master Equipment Lists, have played a key role in the success of MBSE on Europa."

Impact if Unavailable: "It is a critical capability for Europa, so if it were no longer available through MGSS OpsRev we would have to take it over and maintain it with our own funding."

- Todd Bayer

# Case Studies

## Ops Rev - First Review

- Initial DocGen was created by systems engineer with < 0.25 FTE allocation
- Tool investment paid for itself by the first review
  - Generated **full documentation and review products**
  - Turned around changes in < 24 hours from one day of review to the next day
  - Review was very well received

# Case Studies

## Ops Rev - Delivering the First MOS Service

- Developed 10 substantial documents within a month of elapsed time
  - 3-4 FTEs allocated for that month doing systems engineering
  - ~1 FTE allocated to developing frameworks, tooling, and patterns during that month
  - **Saved about 5 work-months of effort** in one calendar month
  - With conventional methodology, documents would have been inconsistent

# Case Studies

## Ops Rev - Remaining MOS Services

- Identified patterns in the first service's documents
- Refined our methodology
- Automated generation of model & document skeletons for remaining services
- Spent one week with 2 FTE allocation
- **Saved 16 work-months** of tedious effort

# Testimonials

## Team X

“DocGen / DocWeb is an **enabling technology** for enterprise-level model-based systems engineering ...”

“**Gained efficiencies** for Team X would be ~10-20 hours per study ...”

“DocGen / DocWeb is an enabling technology for enterprise-level model-based systems engineering and a grown-up approach to knowledge management as well as engineering team agility.”

“Gained efficiencies for Team X would be ~10-20 hours per study by being able to be assured of product technical consistency on generation (Deputy SE chair is currently report wrangler). Having consistent viewpoints in DocWeb 3 as an operational capability would be powerful for Explorer / Discovery / New Frontiers internal data products for major reviews (e.g., Baseline Commitment Review).”

- Bjorn Cole

# Testimonials

## AMMOS Catalog

[creating a Service Level Agreement] “takes one work week, with **at least a work day** dedicated to document creation. Using DocGen, the initial document that is fully populated with customer selections is **now generated in a matter of minutes.**”

Value: “It has been estimated by the Commitments Engineers that creating a Service Level Agreement or a Letter of Commitment takes one work week, with at least a work day dedicated to document creation. Using DocGen, the initial document that is fully populated with customer selections is now generated in a matter of minutes. The rest of the work effort can now be focused on negotiating with customers and minor tweaks to the document. This decrease in work time has been a major positive talking point for the task.”

Impact if Unavailable: “If DocGen/DocWeb were no longer available then I believe that my task would shun model based systems engineering and revert back to managing word documents and attempting to version-control excel spreadsheets. Without the reports of the model I would not have an effective way to communicate to my stakeholders the work I have done nor the benefits of completing this work in a model based manner. Having a gateway to the model where I can present the information in a form that looks like a similar document created in Word via DocGen/DocWeb provides an easy access point to the benefits of MBSE.”

- *Elyse Fosse*

# What is it?

## Doctimus Prime

System for creating documents from  
model-based systems engineering work  
and making them easily accessible

**MagicDraw + TeamWork + DocGen + DocWeb**

# What is it?

## Doctimus Prime

System for creating documents from model-based systems engineering work and making them easily accessible

- MagicDraw** - desktop tool for editing system models
- TeamWork** - repository for storing system models
- DocGen** - MagicDraw plugin for generating documents
- DocWeb** - web application for managing documents

# How does it work?

Create system models  
Create document models

MagicDraw  
+ DocGen

Store models centrally

TeamWork

Generate documents

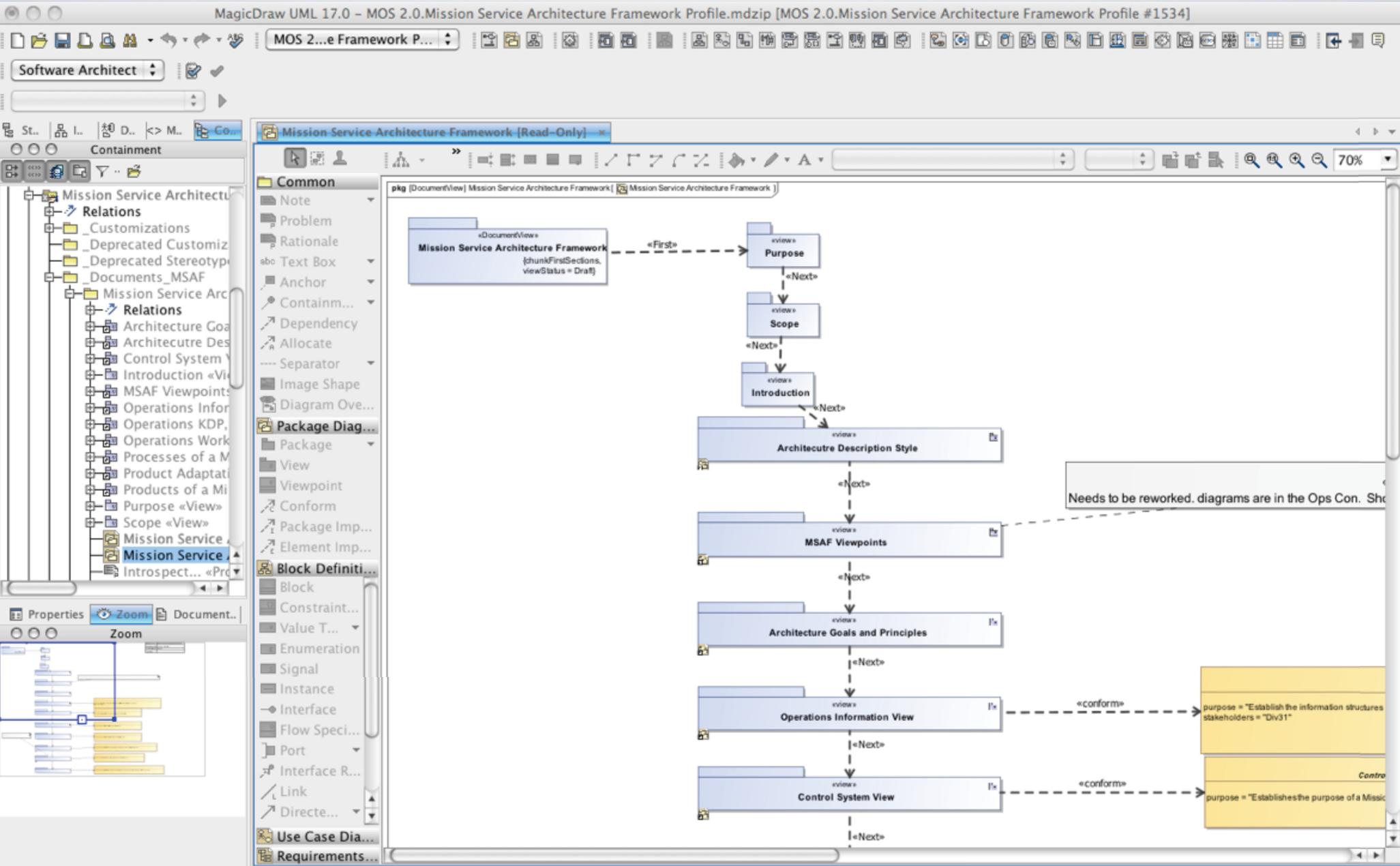
DocGen

Publish documents  
Read HTML and PDF documents  
Organize documents (tag, favorite)  
Add comments  
View history

DocWeb

[Screenshots in backup material]

# MagicDraw - document model



Messages Window

Logged in as:dnable

# MagicDraw - document section



The screenshot displays the MagicDraw UML 17.0 interface. The main workspace shows a UML diagram with the following elements:

- A box labeled «view» Operations Information View.
- A dashed arrow labeled «First» pointing to a document icon labeled «DGView» MOS Deployed View.
- A downward arrow labeled «Next» pointing to another document icon labeled «DGView» Timelines Generalization Sets View.
- A downward arrow labeled «Next» pointing to a third document icon labeled «DGView» Mission Service System Model Elaborated.
- A dashed arrow labeled «Next» pointing to a fourth document icon.

A green box with the text "Section text" is overlaid on the diagram, with a green arrow pointing to the documentation pane below.

The documentation pane, titled "Documentation of View Operations Information View [Read-Only]", contains the following text:

HTML

These views describe the end to end information used by the MOS when understood as a control system. The framework relies on the principle of timelines as representation of mission information. The timelines are flavored by control system concept which allows for the specification of critical information for Mission Operations to be used by control functions to do closed loop control.

At the bottom of the interface, the status bar shows "Logged in as: dnoble", "8 E, 122 W", and "351.8M of 899.3M".

# MagicDraw - diagram & model text

The screenshot displays the MagicDraw UML 17.0 interface. The main window shows a diagram titled "MOS Deployed View" with a metadata table:

Diagram name	MOS Deployed View
Modification date	4/11/12 3:43 PM
Last modified by	efosse
viewStatus	Needs Approval

The diagram itself is a nested structure:

- Outer container: **MOS [1..\*]**
- Inner container: **Mission Service [1..\*]**
- Elements inside Mission Service:
  - System Model [1..\*]**
  - Mission Service Timeline [1]**
- Comment box: `«comment»` with text "should this be performance or what?"

A green callout box labeled "Diagram text" points to the documentation area at the bottom. The documentation panel shows:

Documentation of DGView MOS Deployed View [Read-Only]

HTML

The deployed MOS shows the same control system-system under control pattern within an MOS context of Mission Services.

At the bottom of the window, the status bar shows "Logged in as: dnoble", "8 E, 122 W", and "346.5M of 899.3M".

# MagicDraw - document publishing



The screenshot displays the MagicDraw UML 17.0 interface for a document titled "MOS 2.0.Mission Service Architecture Framework Profile.mdzip [MOS 2.0.Mission Service Architecture Framework Profile #1534]". The main window shows a UML Package Diagram with a context menu open over a package named "Mission Service Architecture Framework". The context menu includes options such as "IMCE\_MENU", "DocGen", "Lock for Edit", "Specification", "Symbol(s) Properties...", "New Diagram", "Go To", "Refactor", "Select in Containment Tree", "Select in Structure Tree", "Related Elements", "Tools", "Stereotype", "Requirement ID Numbering...", "Apply Profiles", "Autosize", "Edit Compartment", "Show Stereotypes", "Show Constraints", "Show Tagged Values", "Show Owner", "Wrap Words", "Show Inner Elements List", "Header Position", "Make Sub Tree", "Simulation", "Appendix", "DocGen IEEE Viewpoint", and "Section".

The "DocGen" option is selected, opening a sub-menu with the following options:

- Generate DocGen 3 Document
- Validate DocGen 3 Document
- Preview DocGen 3 Document
- Publish to Docweb**
- Number View Dependencies

The interface also features a "Containment" tree on the left, a "Properties" window at the bottom left, and a "Messages Window" at the bottom. The status bar at the bottom right indicates "8 E, 122 W" and "415.3M of 899.3M".

# DocWeb - document page



Mission Service Architecture Framework

Mission Service Architecture Fr... x Mission Service Architecture Fr... x +

DLW docweb https://docweb/app/link/170/ ☆ Google

Dashboard Wiki JPL Dashboard 1.1.2... JPL jBPM and Guvno... httpurlconnectio... EHM Flyby Docu... JIRA JPL Bookmarks

**DocWeb** dnoble - log out

All F6 JPL Ref Bus MEA MGSS OpsRev

**Documents**

- Flight Ground Communications Service
- Flight System Engineering Service
- Mission Engineering Service
- Mission Operations System 2.0
- Mission Service Architecture Framework
- MSL
- Navigation Engineering Service
- Ops Rev Development
- Ops Rev Introductory Materials
- Ops Rev MBEE
- Science and Instruments Engineering Service
- Uncategorized
- Archive of documents generated with DocGen 1

**For Authors**

- Generated Documents
- On-Demand Requests
- Scheduled Requests
- Tags
- Users
- Recent Changes
- Projects
- About DocWeb

report bug / request feature

Home » Mission Service Architecture Framework (From Teamwork Project: MOS 2.0.Mission Service Architecture Framework Profile)

## Mission Service Architecture Framework

★ msaf [add tag]

### Latest Generated Products

- HTML Document - April 18, 2012, 4:06 p.m.
- PDF Document - April 18, 2012, 4:06 p.m.

[Log]

### History

Show 60 more generations [Purge All Previews](#)

April 18, 2012, 4:06 p.m. - 4 days, 18 hours ago

- HTML PDF Log
- ★ [add tag] [comments] [Delete this generation](#)

### Comments

[add comment]

None

### Scheduled Generation

[Add](#)

There are currently no regularly scheduled requests to generate this document.

### Immediate Generation

[Generate Now](#)

Create a new document with the current contents of the model.

# HTML - diagram & model text



Mission Service Architecture Framework

DocWeb Mission Service Architecture Framework April 18, 2012, 4:06 p.m. PDF close frame [X]

- Viewpoint
- 5.6. Operations KDP, Intelligence, and Reporting Viewpoint
- 5.7. Product Adaptation Training and VnV Viewpoint
- 6. Architecture Goals and Principles
  - 6.1. Principles
  - 6.2. Goals and Qualities
- 7. Operations Information View
  - 7.1. MOS Deployed View
  - 7.2. Timelines Generalization Sets View
  - 7.3. Mission Service System Model Elaborated
  - 7.4. Mission Service System Model Timeline Operations-Control System Synthesis
  - 7.5. Mission Service System Model Synthesis View
  - 7.6. Mission Service Timeline Elaborated
  - 7.7. Mission Service Operations-Control System Synthesis
  - 7.8. Mission Service Timeline Synthesis View
  - 7.9. Mission Service Performance Timelines
- 8. Control System View
  - 8.1. Mission Operations System Interface Composition View
  - 8.2. MOS To Multiple Systems Layers
  - 8.3. MOS To Multiple Systems Interaction
  - 8.4. MOS To Multiple Systems Context
  - 8.5. MOS To System Layers
  - 8.6. MOS To System Interaction
  - 8.7. MOS To System Interaction with Mission Service Delegation
  - 8.8. Elaborated MOS To System Interaction with Mission Service Delegation
  - 8.9. Mission Service To System Control View
  - 8.10. MOS Layer View
  - 8.11. MOS To Mission Service
  - 8.12. Mission Service To Mission Service View
  - 8.13. Mission Service To Mission Service Delegation View
  - 8.14. MOS To Mission Service To Platform Interaction
  - 8.15. MOS To Mission Service To Platform View
  - 8.16. Architectural Implications
- 9. Products of a Mission Operations System View
  - 9.1. Capabilities and Interfaces Overview
  - 9.2. MOS-System Agreement
  - 9.3. MOS-Project Agreement
  - 9.4. MOS-Flight System Agreement
  - 9.5. MOS-Ground Station Agreement
  - 9.6. Mission Service To Mission Service Agreement
  - 9.7. Mission Service - Software Platform Agreement
  - 9.8. Interface Times View

7.1. MOS Deployed View

7. Operations Information View

## 7.1. MOS Deployed View

Figure 7.1. MOS Deployed View

Diagram name	MOS Deployed View
Modification date	4/18/12 3:39 PM
Last modified by	efosse
viewStatus	Needs Documentation

```
classDiagram
    class MOS["MOS [1..*]"]
    class MissionService["Mission Service [1..*]"]
    class SystemModel["System Model [1]"]
    class MissionServiceTimeline["Mission Service Timeline [1]"]
    MOS -- MissionService
    MissionService -- SystemModel
    MissionService -- MissionServiceTimeline
```

«comment»  
should this be performance or what?

Diagram text

The deployed MOS shows the same control system-system under control pattern within an MOS context of Mission Services.

Prev Up Next  
7. Operations Information View Home | ToC 7.2. Timelines Generalization Sets View

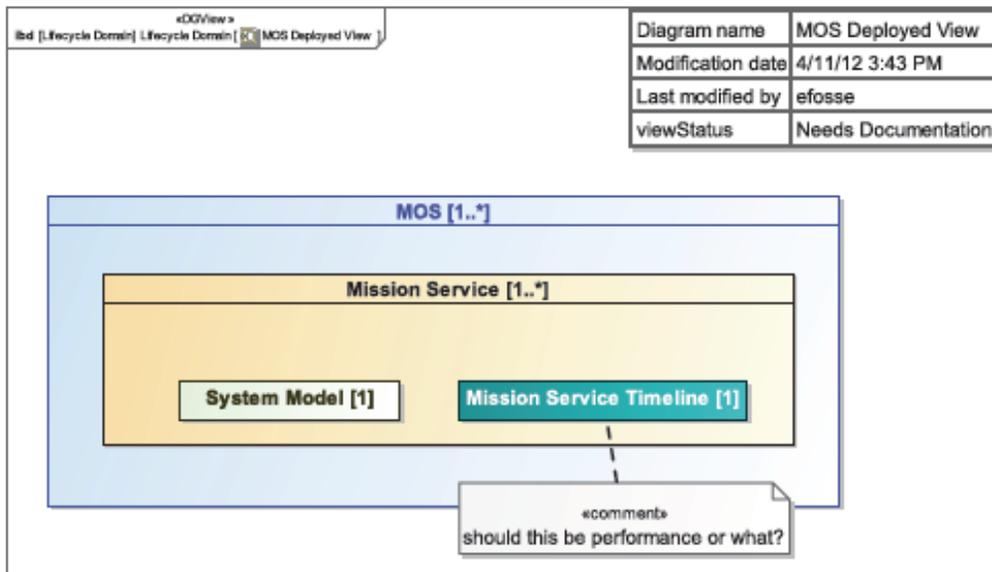
# PDF - diagram & model text

## 7. Operations Information View

These views describe the end to end information used by the MOS when understood as a control system. The framework relies on the principle of timelines as representation of mission information. The timelines are flavored by control system concept which allows for the specification of critical information for Mission Operations to be used by control functions to do closed loop control.

### 7.1. MOS Deployed View

Figure 7.1. MOS Deployed View



The deployed MOS shows the same control system-system under control pattern within an MOS context of Mission Services.

Section text

Diagram text

# MagicDraw - viewpoints



MagicDraw UML 17.0 – MOS 2.0.Mission Service Architecture Framework Profile.mdzip [MOS 2.0.Mission Service Architecture Framework Profile #1534]

Software Architect

Operations Information V... [Read-Only] MOS Deployed View [Read-Only] Architecture Goals and Principles [Read-Only]

Documentation

Documentation of View Goals and Qualities [Re...]

HTML

The following quality attributes will be used throughout the framework to assess the framework's adherence to the principles. These attributes have been retrieved directly from JPL's [Systems Engineering Practices \(DocID 75012\)](#).

Each quality describes consequences specific to the MOS. These are then evaluated as goals against the views describing aspects of the MOS.

Diagram name: Architecture G...  
Modification date: 4/12/12 2:52 P...  
Last modified by: efosse  
viewStatus:

Mission Service Architecture F...

«view» Architecture Goals and Principles «First» «view» Principles «conforms» «viewpoint» Architecture Principles Statements Table viewpoint «import» «view» AMMOS L3 Principles «viewpoint» Ops Revitalization Principles «Next» «view» Goals and Qualities «conforms» «viewpoint» Block Definitions Table viewpoint «import» «view» Quality Attributes

Section text

Viewpoint

Data

Properties Zoom

Messages Window

Logged in as: dnoble

8 E, 122 W 392.3M of 899.3M

# MagicDraw - viewpoint definition



The screenshot displays the MagicDraw UML 17.0 interface. The main window shows a diagram titled "DocGen3 [Activity] Block Definitions Table Viewpoint". The diagram consists of three yellow rounded rectangular blocks connected by arrows, starting from an initial node (black circle) and ending at a final node (white circle with a black border). The blocks are:

- «CollectByOwnedElements»  
{depth = 1}
- «FilterByStereotypes»  
{stereotypes = Block }
- «CombinedMatrix3»  
{includeDoc,  
useContextNameAsTitle}

The interface includes a "Containment" tree on the left, a "Properties" window at the bottom left, and a "Messages Window" at the bottom. The status bar at the bottom indicates "Logged in as: dnable", "8 E, 122 W", and "315.3M of 899.3M".

Make a table with names and descriptions of blocks in selected package

# HTML - viewpoints

The screenshot shows a web browser window with the address bar displaying 'https://docweb/app/generation/2583.html/'. The page title is 'Mission Service Architecture Framework [msaf]'. The main content area is titled '6.2. Goals and Qualities' and contains a table with the following data:

Name	Description
Affordability	The characteristics of the system architecture and design that enable it to be constructed, operated, and maintained without exceeding available resources.
Analyzability with Respect to Safety	The characteristics of a system architecture and design that support engineers in analyzing the system from the standpoint of its safety, including their ability to review performance, isolate critical functions, and ensure completeness of their analyses.
Buildability	A property of a system architecture and design that allows the system to be constructed from the architecture, including intellectual accessibility and manageability and appropriateness and availability of necessary components.
Determinism	The property of a system architecture and design that allows only one transition for each state or mode for any given initial state and set of inputs.
Evolvability	A property of a system architecture and design that easily allows the system to achieve its ultimate purpose gradually as new capabilities or new uses of existing capabilities arise.
Extensibility and Expandability	A property of a system architecture and design that easily allows the addition of new features or capabilities at a later time.
Intelligibility	The organization of design elements and the underlying principles that motivated their relationships are apparent and readily understood.
Monitorability	The ability of operators to gain insight into a system's operations while it is running.
Survivability	The characteristic of a system architecture and design that enables the system to tolerate single faults and to detect and take safe corrective action when experiencing multiple faults.
Sustainability	The ability of a system to support present stakeholder needs and planned and unplanned new needs that may arise in the future.
Testability	The extent to which the test strategy complements the system architecture style, the types of faults

Section text

Data

Section text

## 6.2. Goals and Qualities

The following quality attributes will be used throughout the framework to assess the framework's adherence to the principles. These attributes have been retrieved directly from JPL's

[Systems Engineering Practices \(DocID 75012\)](http://rules.jpl.nasa.gov/cgi/doc-gw.pl?docid=75012). [<http://rules.jpl.nasa.gov/cgi/doc-gw.pl?docid=75012>]

Each quality describes consequences specific to the MOS. These are then evaluated as goals against the views describing aspects of the MOS.

**Table 6.2. Goals and Qualities**

Name	Description
Affordability	The characteristics of the system architecture and design that enable it to be constructed, operated, and maintained without exceeding available resources.
Analyzability with Respect to Safety	The characteristics of a system architecture and design that support engineers in analyzing the system from the standpoint of its safety, including their ability to review performance, isolate critical functions, and ensure completeness of their analyses.
Buildability	A property of a system architecture and design that allows the system to be constructed from the architecture, including intellectual accessibility and manageability and appropriateness and availability of necessary components.
Determinism	The property of a system architecture and design that allows only one transition for each state or mode for any given initial state and set of inputs.
Evolvability	A property of a system architecture and design that easily allows the system to achieve its ultimate purpose gradually as new capabilities or new uses of existing capabilities arise.
Extensibility and Expandability	A property of a system architecture and design that easily allows the addition of new features or capabilities at a later time.
Intelligibility	The organization of design elements and the underlying principles that motivated their relationships are apparent and readily understood.
Monitorability	The ability of operators to gain insight into a system's operations while it is running.
Survivability	The characteristic of a system architecture and design that enables the system to tolerate single faults and to detect and take safe corrective action when experiencing multiple faults.
Sustainability	The ability of a system to support present stakeholder needs and planned and unplanned new needs that may arise in the future.
Testability	The extent to which the test strategy complements the system architecture style, the types of faults that the strategy can detect, and the ease of detecting and diagnosing faults.

Data

# How mature is it?

DocGen and DocWeb are highly capable beta-version software. They are usable by others, but not yet complete, and not polished operational products

# Key Takeaways

DocWeb and DocGen provide a powerful addition to JPL's MBSE tooling and infrastructure.

They are showing good return on investment and have become essential to Ops Rev and other MBSE projects.

# Credits

**Steve Jenkins** - *IMCE, foundational prototyping work*

**Chi Lin** - *IMCE Manager*

**Dave Linick** - *MGSS Manager, Ops Rev sponsor*

**Duane Bindschadler** - *Ops Rev project manager*

**Chris Delp** - *Ops Rev systems architect*

**David Noble** - *Ops Rev software architect*

**Doris Lam** - *DocGen/DocWeb developer*

**Ben Holden** - *DocWeb developer*

**Maddalena Jackson** - *DocGen developer*

**Louise Anderson** - *Methodology and pattern development*

**Elyse Fosse** - *Methodology and pattern development*

*Many thanks to all the DocGen and DocWeb users for their support and feedback*

# Backup Material

# Components

