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Submission to Defense University Webinar of Digital Engineering

14. ABSTRACT

Provide the Software Community best practices and guidance to support the implementation of Digital Engineering (Model Based System Engineering) into the DevSecOps pipelines. This approach seeks to shift engineering left in the software domain by describing more advanced methods of planning and modelling large integrated software products concurrent with code and system integration and operation takes place.

15. SUBJECT TERMS

Systems Engineering (General), MBSE; DevSecOps; digital engineering; Model Based Systems Engineering

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Digital Engineering **Shift Left** (MBSE and DevSecOps)

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Supported by
Shane Smith Mitre
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Lets Get Digital Webinar

22 June 2023

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Purpose

- Shift Left: Provide the Software Community best practices and guidance to support the implementation of Digital Engineering (Model Based System Engineering) into the DevSecOps pipelines. This approach seeks to shift engineering left in the software domain by describing more advanced methods of planning and modelling large integrated software products concurrent with code and system integration and operation takes place.

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What we have learned

- While there has been some Academic research in this subject but limited practice within the DOD
  - There is a lot of MBSE work in the DOD at the system level just not much in Agile and DevSecOps or Software intensive space
- There is some work in the commercial space in combining Models/MBSE with software development
  - IBM uses the MBSE tool Rhapsody to build part of the Rhapsody tool itself
  - There are several cases where companies build models to identify boundaries for guiding security testing
- The major limiting factor is model update to code change cycle time; i.e., how fast does the model and code diverge
  - This is shown how the loss of favor in the creation of UML models
- There are some potential use cases to consider:
  - Model Driven Pipeline
  - Security
  - Certifications
  - AutoCode Generation (to include API management)
  - Embedded Systems
  - Reverse Engineering

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What Have We Done

- Generated a dynamic process model (displayed as a set of interconnected webpages) of the DOD defined DevSecOps process with a “Best Practice” set of MBSE artifacts
- Identified programs currently executing (or planning to) MBSE with DevSecOps
- Have established a library of literature on the subject of DevSecOps and MBSE
- Coordinated a 3hr CIO DOD DSO COP meeting for MBSE on January 12, 2023
- Created DSO/MBSE Shift Left Playbook

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What do we have left to do

- Finalize Draft MBSE/DSO Playbook
- Update current DSO/MBSE model to enable simulation to perform an independent value to divergence analysis
- Piloting 1-2 plays from the playbook with programs by August 2023
- Final MTR for the project by September 2023

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DSO Process Model

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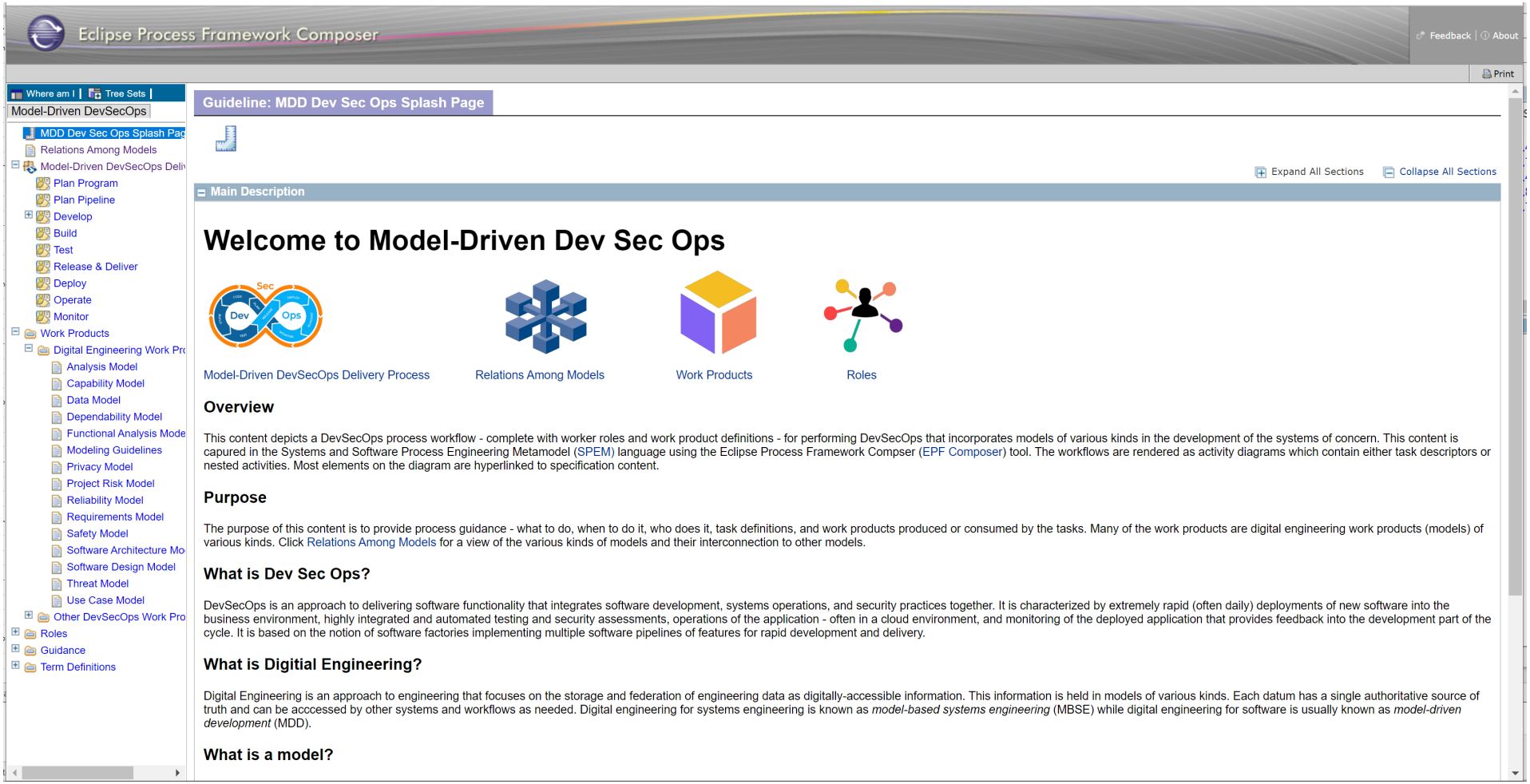
MDD DevSecOps Process Content – Front Page



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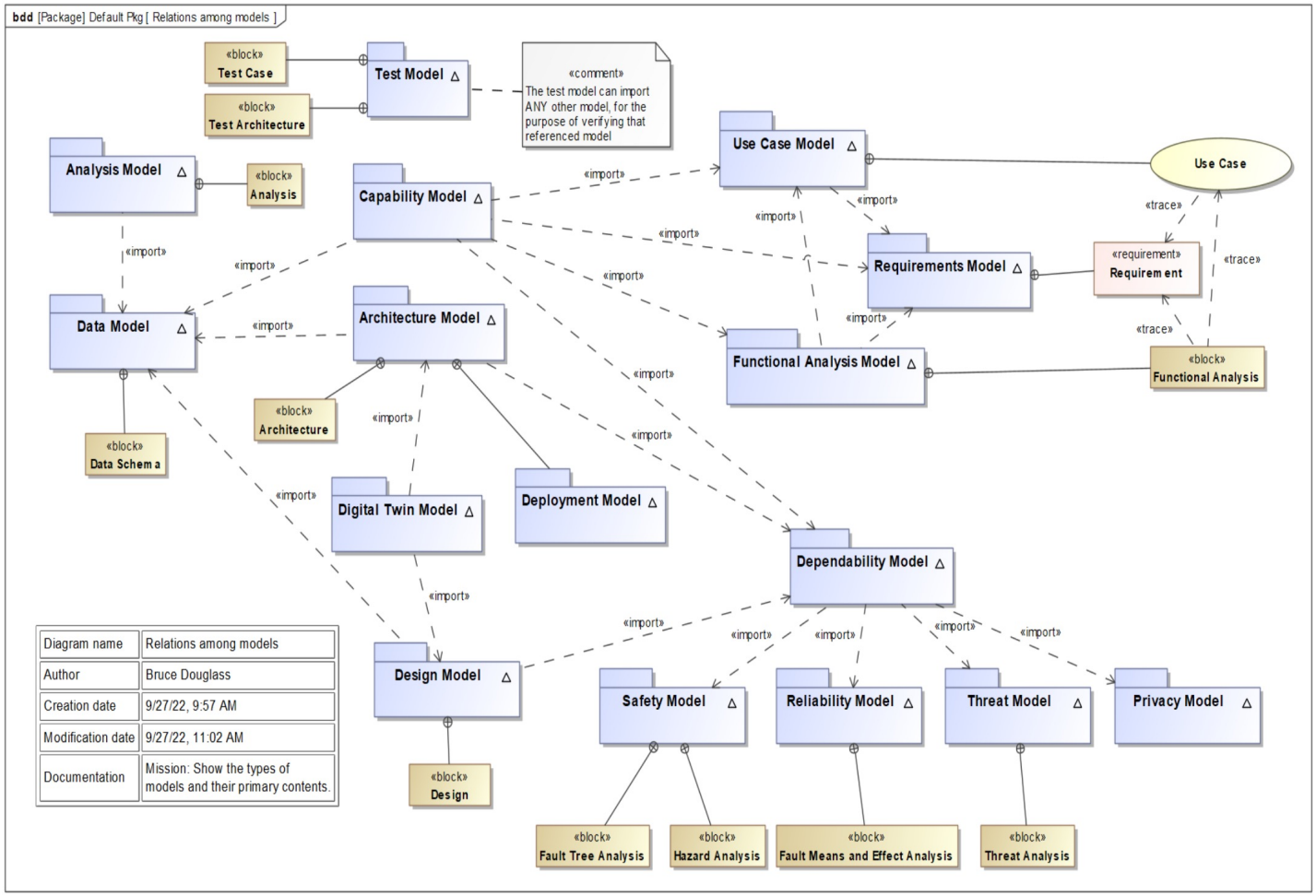
Types and Relations of Models in MDDSO



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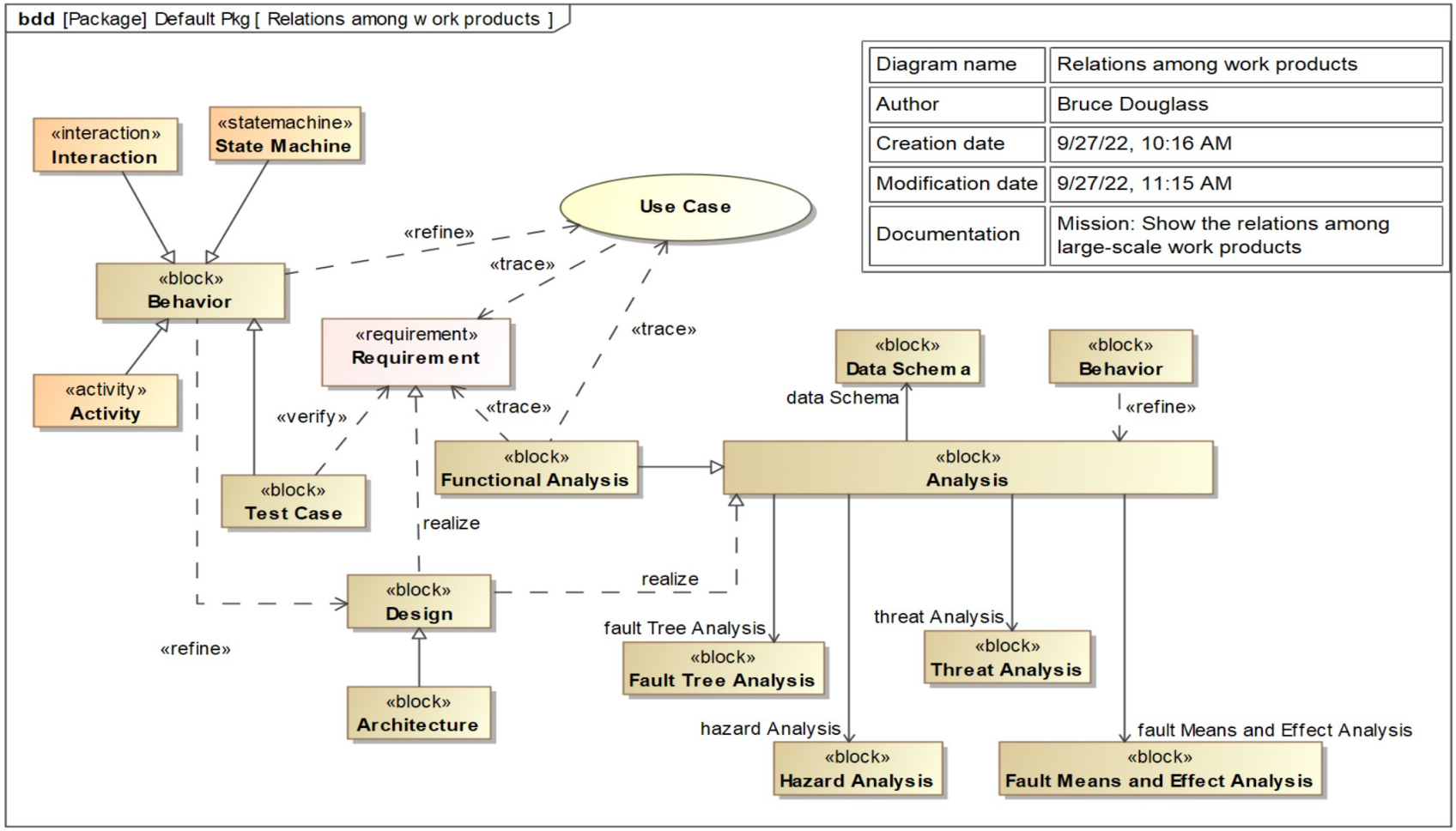
Relations Among Key MDD Work Products



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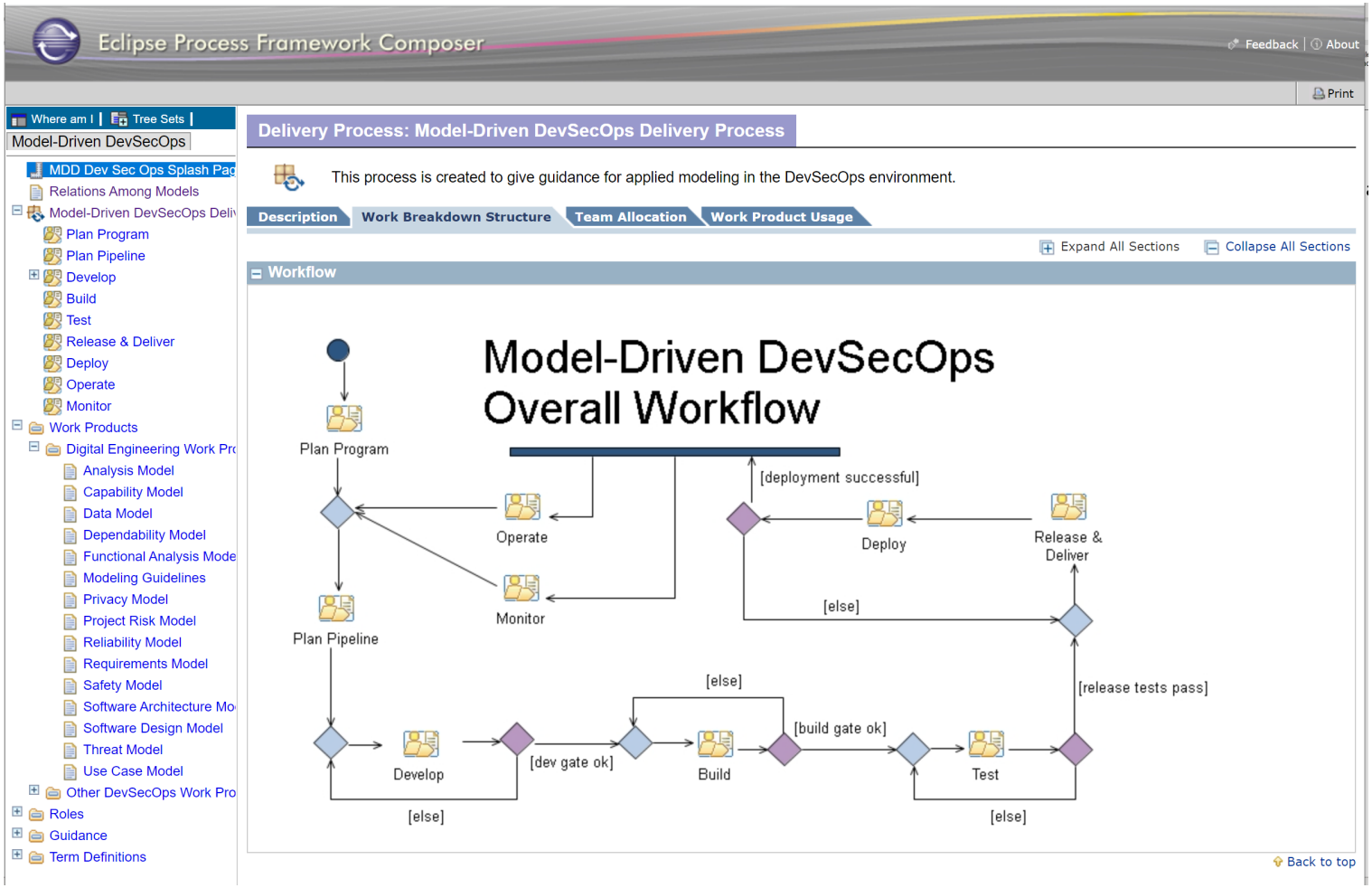
MDD DevSecOps Process Content – Main Page



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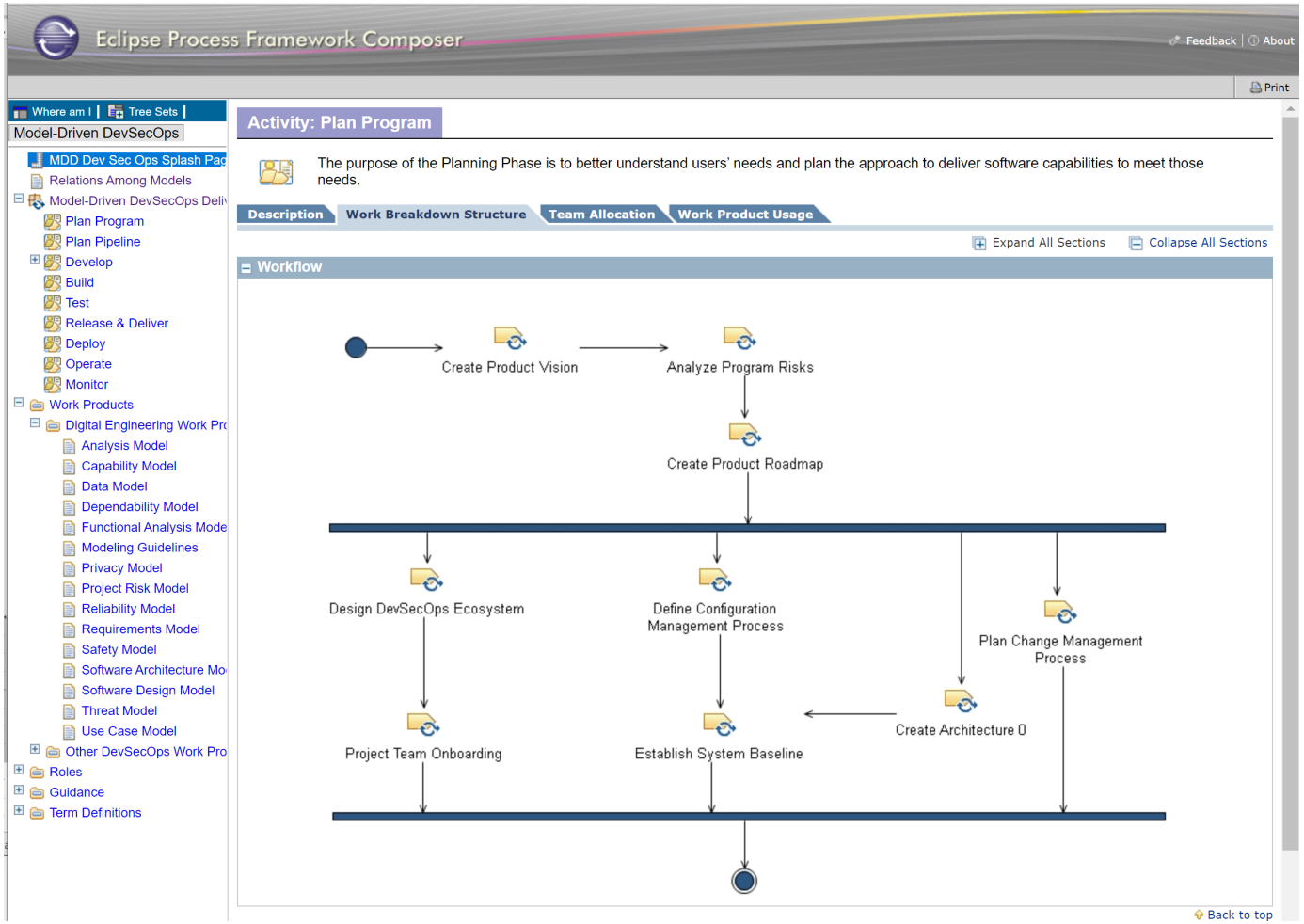
MDD DevSecOps Process Content – Workflow (Activity)



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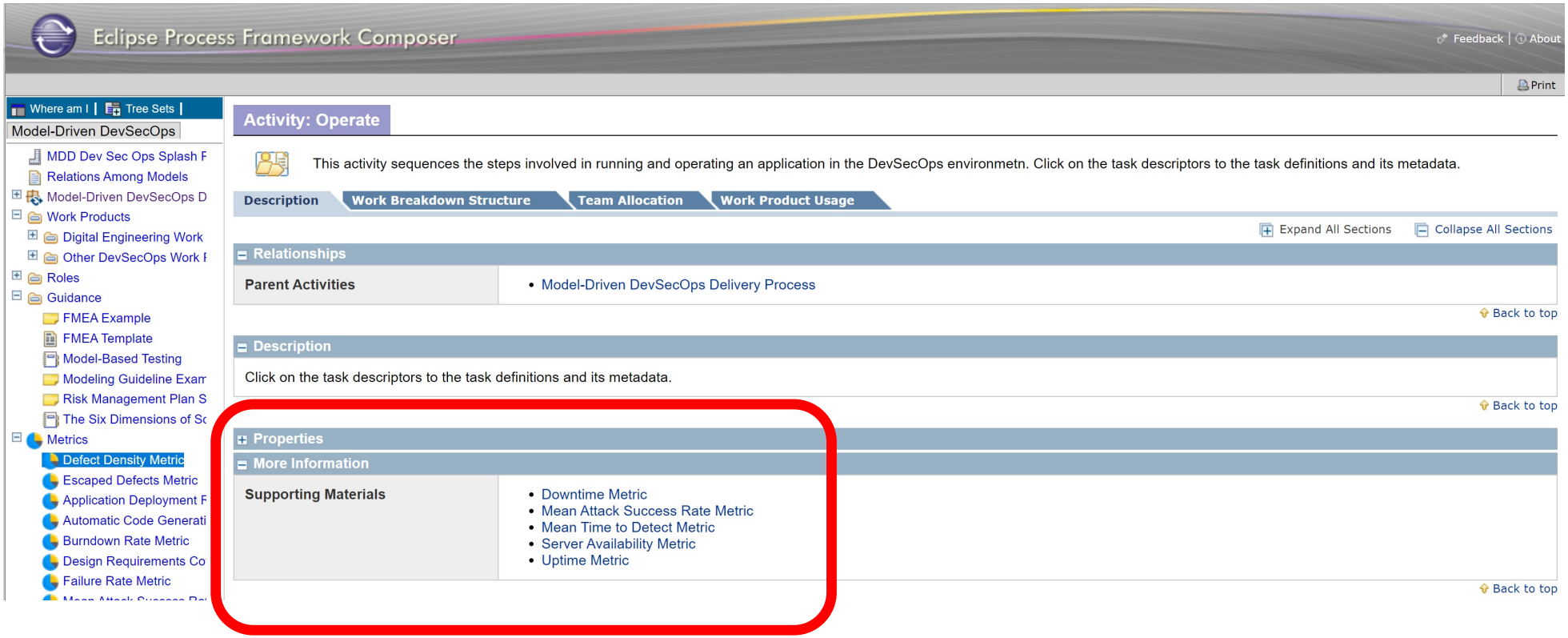
MDD DevSecOps Process Content – Workflow (Activity)



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MBSE DSO Playbook

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DSO/MBSE Playbook

- Plays
  - Model Driven Pipeline
  - Security
  - Certifications
  - Autocode Generation (to include API management)
  - Embedded Systems
  - Reverse Engineering

- Structure
  - *Overview*
  - *Goals and Objectives*
  - *Preconditions / Assumptions*
  - *Key tools or technologies in use in this play (if appropriate) (I'm thinking model-based threat analysis, code generation, …)*
  - *Key Models and their value*
  - *Specific workflow*
  - *Play-specific specializations*
  - *Process Flow Variants (if appropriate)*
  - *Measuring success (metrics)*

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Playbook Example – Automated Code Generation Play

- Overview
- The UML can used to create software designs. Given appropriate tooling, high-quality source code can be generated from appropriately specified designs. The Rhapsody tool from IBM is especially well-known in the real-time and embedded development space for this. There are many benefits from this including:
    - Strong coupling and synchronization between the software design and the software implementation
    - The ability to verify a system at the design level as well as at the code level
    - Enhanced capability to visualize complex designs
    - Improved maintenance of development work products
    - Ease of tracing among requirements, design, and code
    - Design-level verification
    - Ability to use Model-Based Testing methods
    - Faster development of high-quality software implementations

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Playbook Example – Automated Code Generation Play

- *Goals and Objectives*
- Specific goals and objectives of this play include:
  - Capture the design independently from the implementation to facilitate design understanding
  - Efficiently create software implementation from designs
  - Verify the design independent of software implementation detail
  - Ensure consistency between design and software implementation
- *Preconditions / Assumptions*
- To use this play, you must create high-quality designs with adequate precision to support the automatic generation of code. Additionally, your development environment must have a modeling tool capable of high-quality code generation. The developers must be sufficiently facile in the selected modeling language as well as in the target implementation language.
- *Key tools or technologies in use in this play*
- Modeling must be done in tools that can represent the selected design language and generate high-quality code in the target software implementation language. Rhapsody from IBM is a UML compliant tool that meets this need; Simulink from Mathworks is a control-theoretic modeling tool that is also commonly used.

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Playbook Example – Automated Code Generation Play

- *Key Models and their value*
- **Specification Model**
- The specification model represents the capabilities and requirements for the system of concern. Although not directly used to generate the software implementation, it drives the development of the design model. The key value of this model is that it supports requirements analysis and results in higher-quality requirements.
- **Architecture Model**
- *Architecture* may be thought of as the set of strategic design decisions that organize and optimize the system as a whole. The largest scale parts of the architecture – often referred to as subsystems or components – hold the lower-level software implementations. These architectural elements serve as a scaffolding to support the application.
- **Design Model**
- The design model identifies and specifies the software structures, including classes, functions, data, and interfaces. A design model typically provides structural, functional, behavioral, and parametric views of the software in an integrated fashion, from which the software may be generated. Since the design model abstracts away much of the implementation detail, it is far easier to focus on the correctness and completeness of the design.

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Playbook Example – Automated Code Generation Play

- *Play-specific specializations*
- Tools vary widely in their ability to support full code generation. It is common to require some or even a great deal of manual touch up to the implementation after code generation.
- Some tools support “round-trip engineering.” This refers to the ability of the tool to accept modification to a generated software implementation to update the design. This differs from reverse engineering in that the overall design and visualizations of the design are maintained as changes to the generated code are incorporated back into the design.

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Playbook Example – Automated Code Generation Play

Specific workflow

In principle, little is changed about the process flow itself (see Figure 1), but some of the tasks themselves are performed differently. Almost all of the differences occur in the Develop activity of the MDD DevSecOps Process

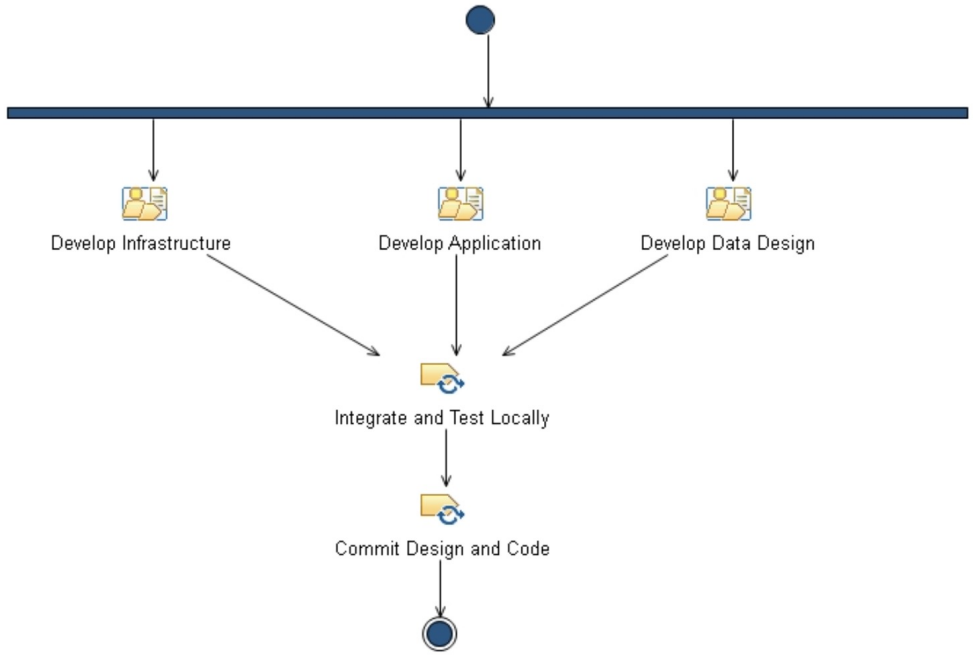

Figure 5: Develop Activity process flow

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Playbook Example – Automated Code Generation Play

The details of the three development subactivities are shown in the next three figures with the modified tasks highlighted in red.

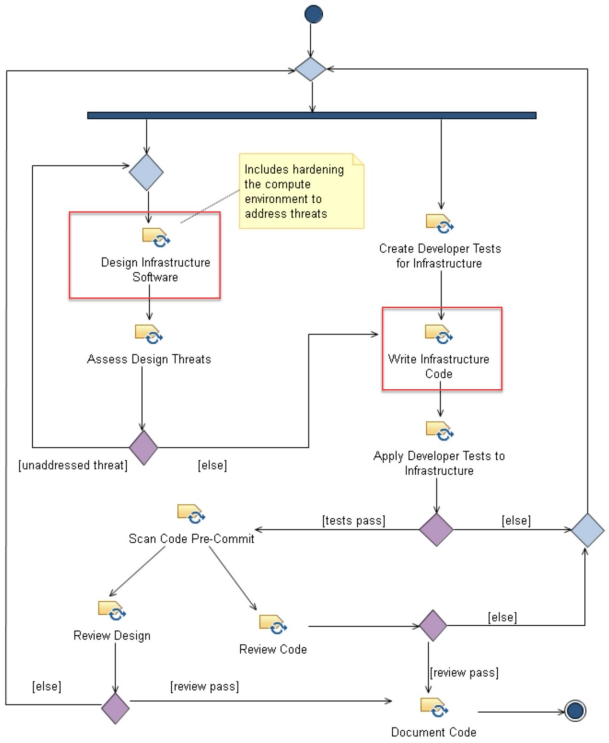

Figure 6: Develop Infrastructure Activity

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Playbook Example – Automated Code Generation Play

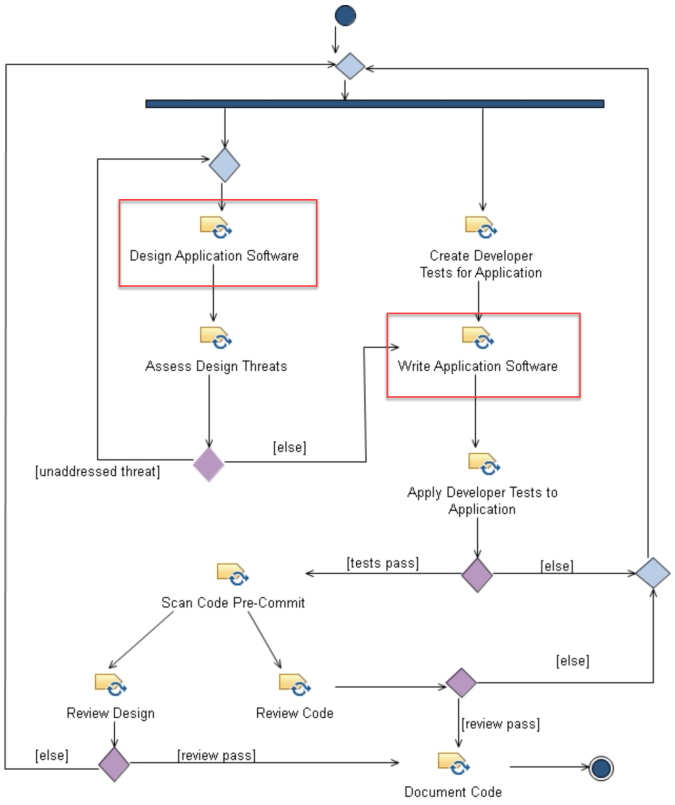

Figure 7: Develop Application Activity

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Playbook Example – Automated Code Generation Play

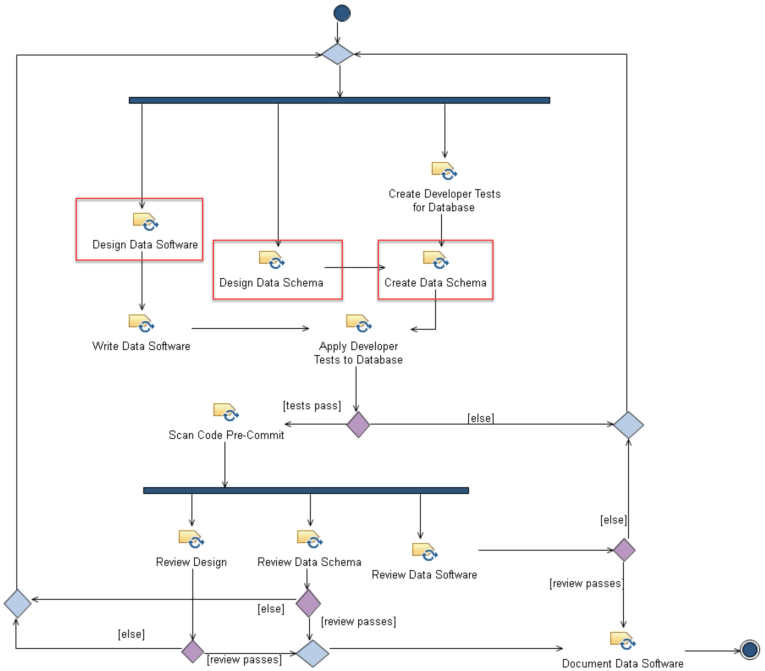

Figure 8: Develop Data Design Activity

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Playbook Example – Automated Code Generation Play

Process Flow Variants (if appropriate)

- For data-centric models, it may be possible to create APIs for data access directly from the data models. Some tools support this generally or for specific middleware such as the Data Description Service (DDS) or Common Object Request Broker Architecture (CORBA) standards.

Measuring success (metrics)

- Metrics for this play include Total Generated Code (generally stated in Kilo-lines of source code generated) and Percentage of Generated Code (the ratio of the number of generated source code lines divided by the total number of lines of code).

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Questions

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