

MathWorks
**AUTOMOTIVE
CONFERENCE 2023**
Europe

CI/CD 2.0: From Scripted Jenkins Pipelines to Process Advisor

Martin Römpert, Continental Automotive Technologies GmbH



Agenda

- Continental Automotive Technologies GmbH
- Motivation
- Initial CI Pipeline
- CI Pipeline Customization
- Process Advisor
- Modular Software
- Conclusions and Outlook

Continental Automotive Technologies GmbH



Safety and Motion



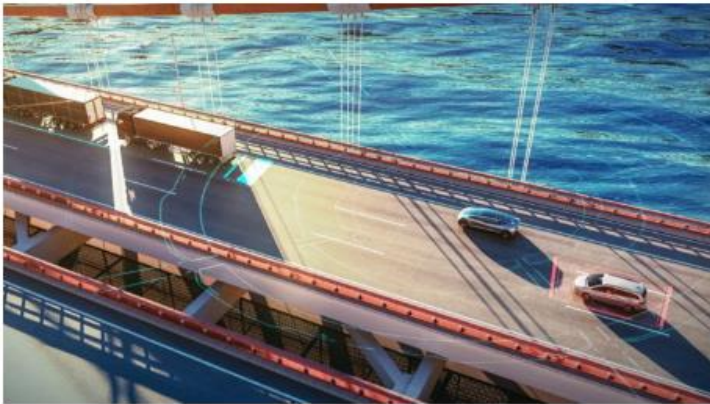
Architecture & Networking



User Experience



Smart Mobility



Autonomous Mobility

Continental Automotive Technologies GmbH

Safety and Motion

- **Dynamics & Comfort**
 - Electronic Air Suspension
 - Scalable Chassis Control Unit
- **Passive and Integrated Safety**
 - Airbag Control Units
- **Brakes**
 - Parking Brakes
 - Hydraulic
 - Electronic Brake Systems



Motivation

- **Continuous Integration**
 - Frequent merging of several small changes into a main branch.
- **Continuous Delivery**
 - When teams produce software in short cycles with high speed and frequency so that reliable software can be released at any time, and with a simple and repeatable deployment process when deciding to deploy.

[CI/CD - Wikipedia](#)

✓ **VED-MambaBasedDevelopment / MkcBbwState 65**

Pipeline

Änderungen

Tests

Artefakte



Einloggen



Pull Request: PR-14

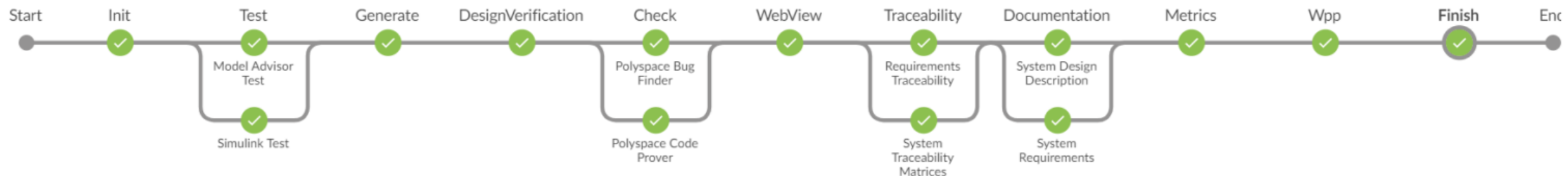
🕒 51m 4s

Änderungen von martin.roempert

Commit: e0b3083

🕒 a month ago

Replayed #64



Initial CI Pipeline - Jenkins

- Source Control
- Repository Handling
- Automation
- Implementation
- Artifacts Handling



git



✓ [VED-MambaBasedDevelopment / MkcBbwState 65](#)

Pipeline

Änderungen

Tests

Artefakte



Einloggen



Pull Request: PR-14

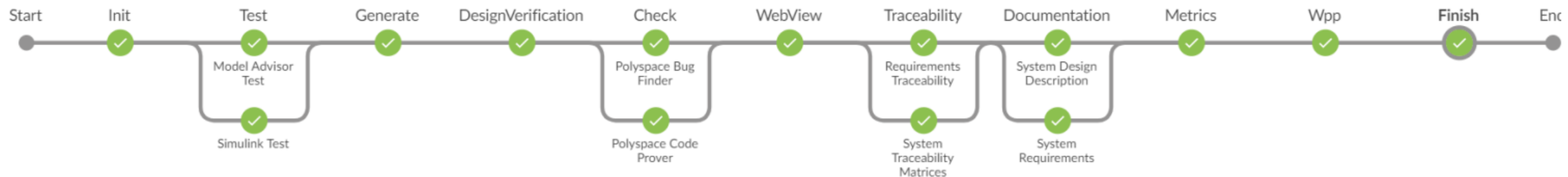
🕒 51m 4s

Änderungen von martin.roempert

Commit: e0b3083

🕒 a month ago

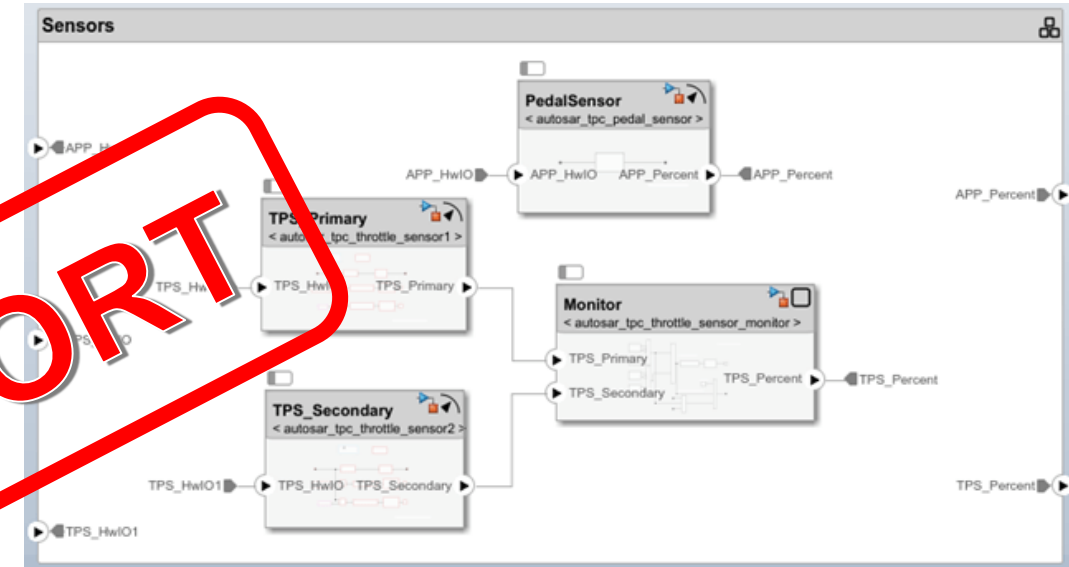
Replayed #64



CI Pipeline Customization - Jenkins



- Custom Stages
- Dependency Analysis
- Maturity Level Dependent Actions



HIGH EFFORT

✓ VED-MambaBasedDevelopment / MkcBbwState 65

Pipeline

Änderungen

Tests

Artefakte



Einloggen



Pull Request: PR-14

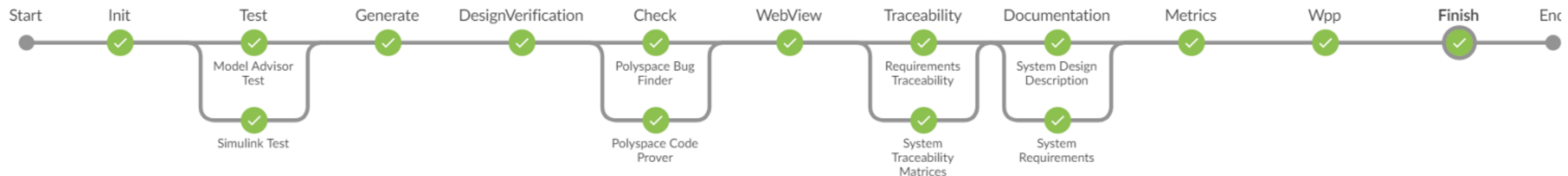
51m 4s

Änderungen von martin.roempert

Commit: e0b3083

a month ago

Replayed #64



Process Advisor

- Tasks
- Input Artifacts
 - Queries
- Output Artifacts
- Assessments
- Relations

- Interactivity
- Digital Thread
- Staleness



▼	✔ Generate Simulink Web View		✔ 1
	✔ ComponentA.slx		✔ 1
▼	✔ Check Modeling Standards (MLC40)		
	✔ ComponentA.slx		
▼	✔ Run Tests - MiL		
	✔ ComponentA.slx		
▼	✔ Detect Design Errors		
	✔ ComponentA.slx		
▼	✔ Generate Conan Package for Model (Top)		
	✔ ComponentA.slx		
▼	✔ Generate SDD Report		
	✔ ComponentA.slx		✔ 1

Outputs:

[ComponentA_webview.html](#)

Inputs:

[ComponentA.slx](#)

Dependencies:

[ComponentA.sidd](#)

[ComponentA.slx](#)

[InterfaceA.sidd](#)

[processmodel.m](#)

Process Advisor

- Artifact Handling



- Package Manager



- Repository Handling

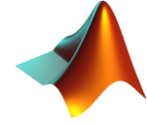


- Source Control

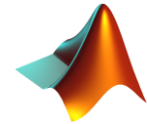


- Bring everything into MATLAB!

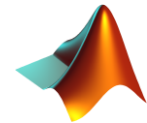
System Calls



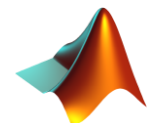
System Calls



File Exchange

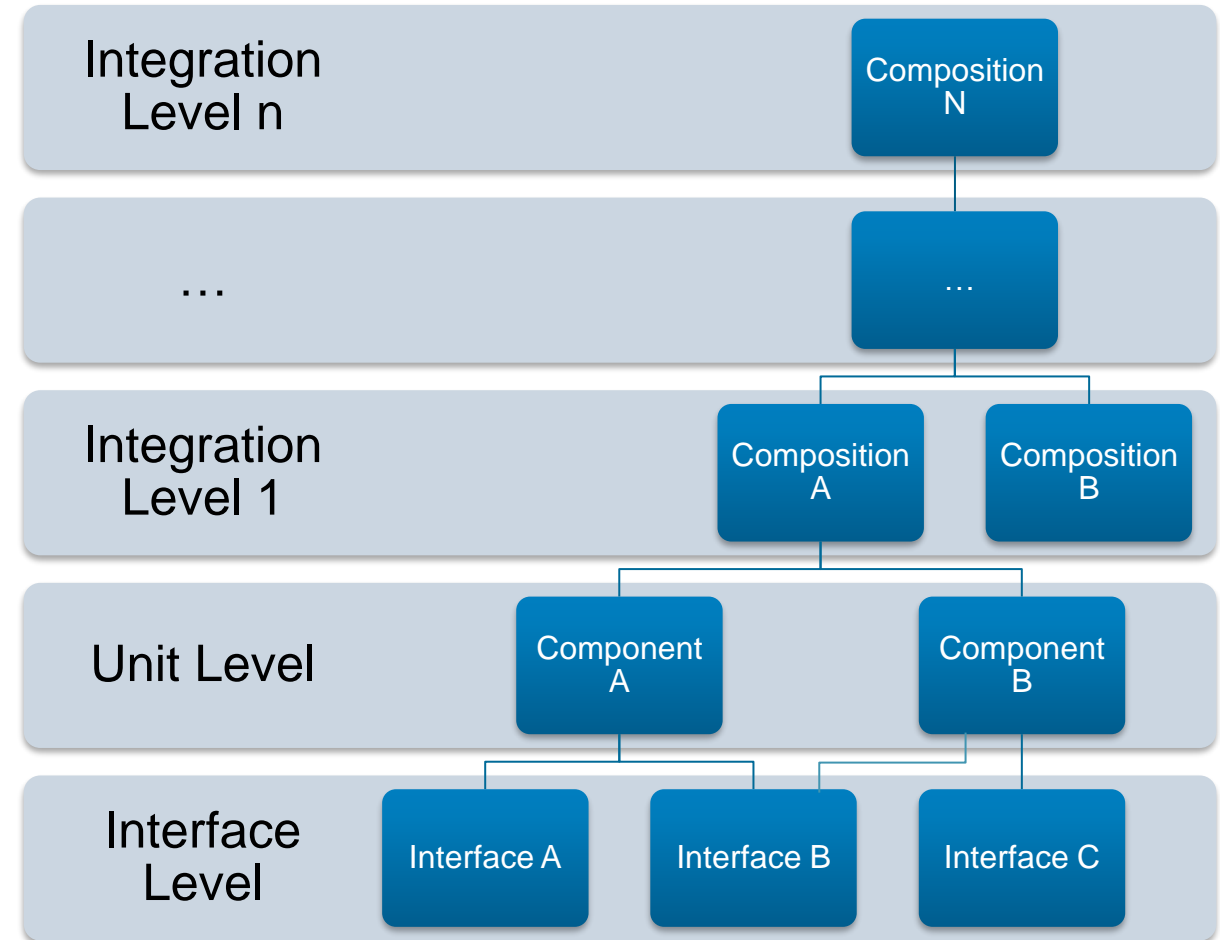


File Exchange

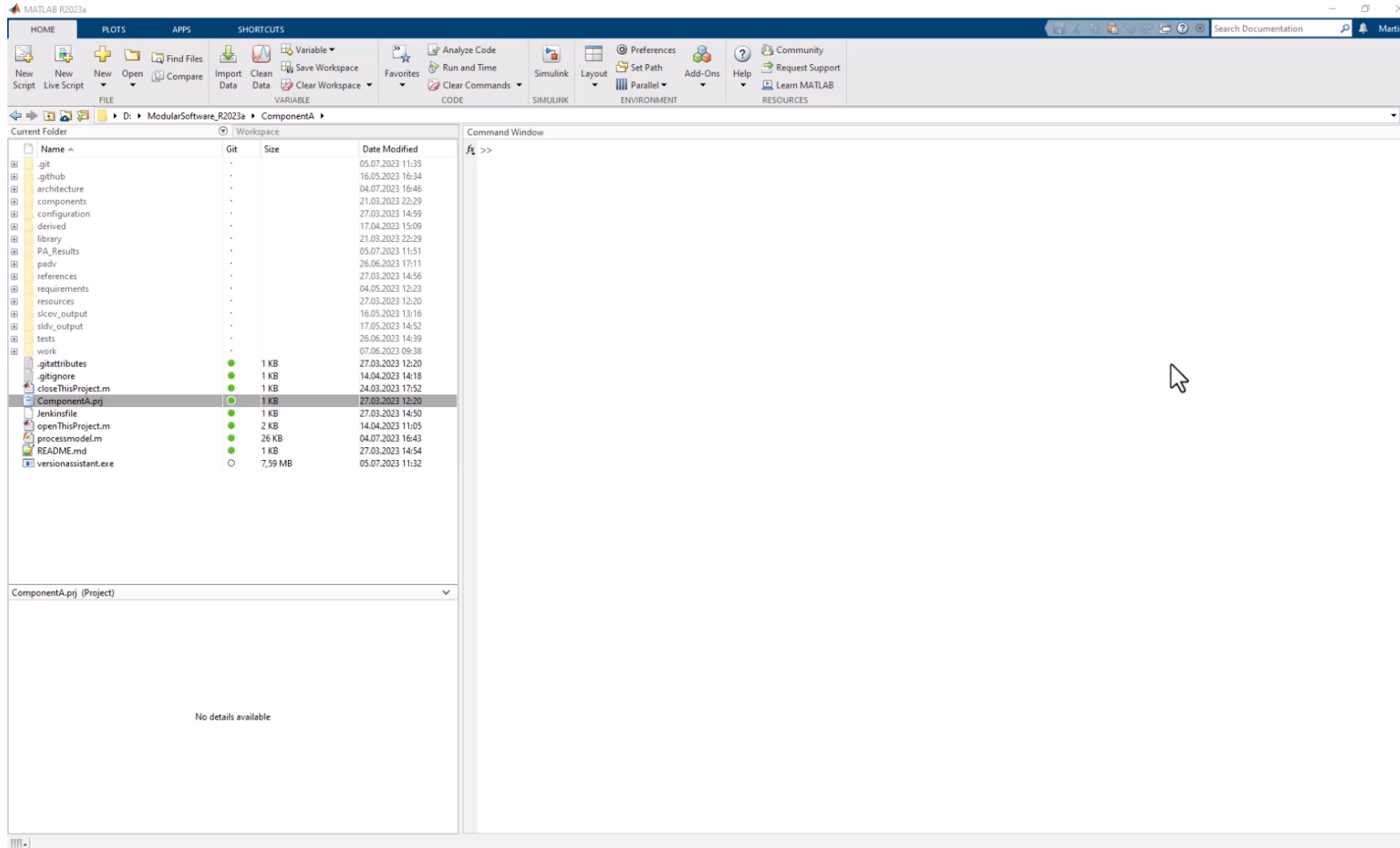


Modular Software

- **Goals**
 - Scalability
 - Reuseability
 - AUTOSAR Compatibility
- **Design Decisions**
 - Multiple Repositories
 - Repository Management
 - Package Manager
 - Process Advisor
 - CI / CD System



Modular Software

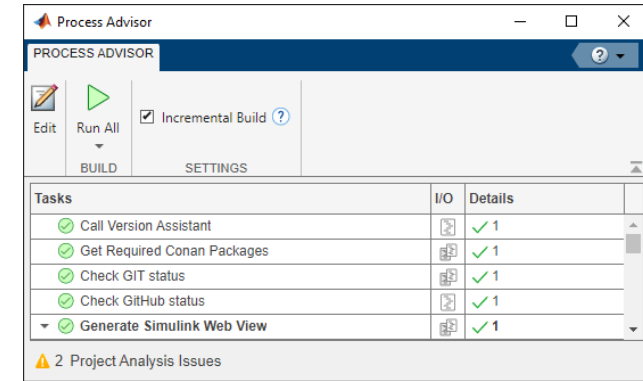


The screenshot displays the MATLAB R2023a software interface. The top menu bar includes options like HOME, PLOTS, APPS, and SHORTCUTS. Below the menu, there are various toolbars for file operations, workspace management, and code execution. The main workspace area is divided into two panes: 'Current Folder' and 'Command Window'. The 'Current Folder' pane shows a file explorer view of the 'ComponentA' directory, listing various files and folders with their sizes and modification dates. The 'Command Window' pane is currently empty, showing the prompt 'fx >>'. A mouse cursor is visible over the Command Window area.

Name	Git	Size	Date Modified
.git	-	-	05.07.2023 11:35
.github	-	-	16.05.2023 16:34
architecture	-	-	04.07.2023 16:46
components	-	-	21.03.2023 22:29
configuration	-	-	27.03.2023 14:59
derived	-	-	17.04.2023 15:09
library	-	-	21.03.2023 22:29
PA_Results	-	-	05.07.2023 11:51
padv	-	-	26.06.2023 17:11
references	-	-	27.03.2023 14:56
requirements	-	-	04.05.2023 12:23
resources	-	-	27.03.2023 12:20
slcov_output	-	-	16.05.2023 13:16
sldv_output	-	-	17.05.2023 14:52
tests	-	-	26.06.2023 14:39
work	-	-	07.06.2023 09:38
.gitattributes	●	1 KB	27.03.2023 12:20
.gitignore	●	1 KB	14.04.2023 14:18
closeThisProject.m	●	1 KB	24.03.2023 17:52
ComponentA.prj	●	1 KB	27.03.2023 12:20
Jenkinsfile	●	1 KB	27.03.2023 14:50
openThisProject.m	●	2 KB	14.04.2023 11:05
processmodel.m	●	26 KB	04.07.2023 16:43
README.md	●	1 KB	27.03.2023 14:54
versionassistant.exe	○	7,99 MB	05.07.2023 11:32

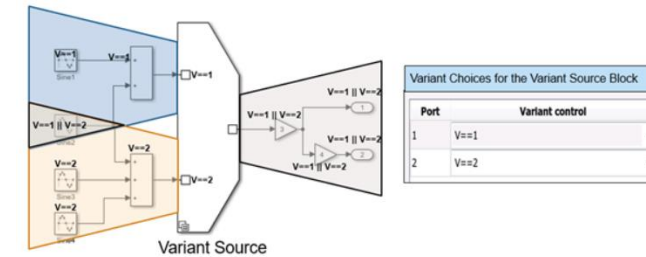
Conclusions

- Process Modeling Framework
- Digital Thread
- Independency from CI / CD system
- Package Manager
- Collaboration with MathWorks

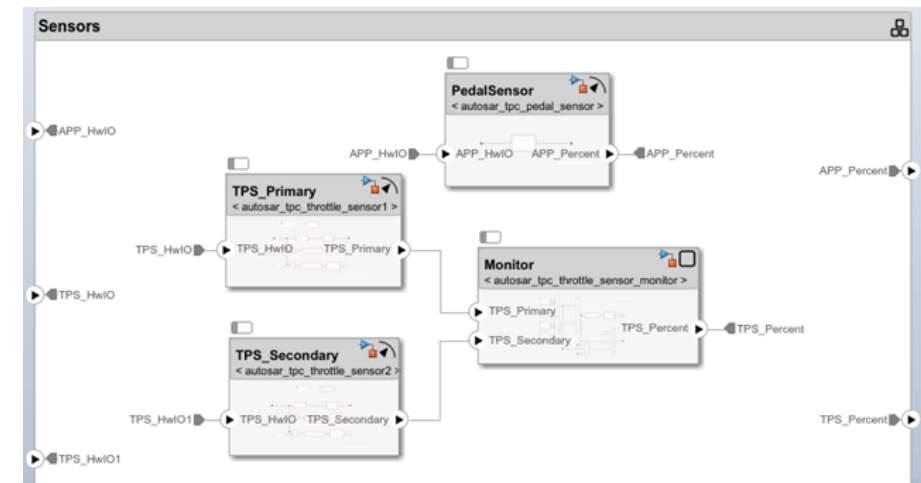


Outlook

- Modular Software Process Library
 - Variants
 - Handwritten C-Code
 - Complex Device Drivers
-
- Scaling it up ...
 - More than 500 Interfaces
 - More than 1000 Sw-Components
 - More than 100 Sw-Compositions



AUTOSAR



Thank you for your attention!

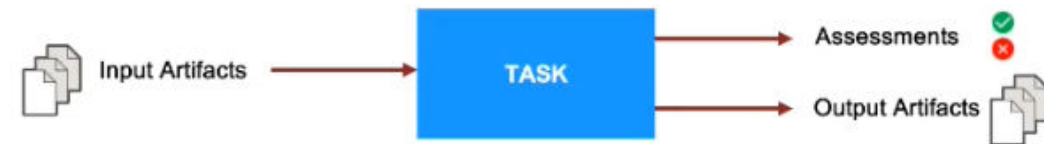
- Questions?

▼ <input checked="" type="checkbox"/> Generate Simulink Web View		<input checked="" type="checkbox"/> 1
<input checked="" type="checkbox"/> ComponentA.slx		<input checked="" type="checkbox"/> 1
▼ <input checked="" type="checkbox"/> Check Modeling Standards (MLC40)		
<input checked="" type="checkbox"/> ComponentA.slx		
▼ <input checked="" type="checkbox"/> Run Tests - MiL		
<input checked="" type="checkbox"/> ComponentA.slx		
▼ <input checked="" type="checkbox"/> Detect Design Errors		
<input checked="" type="checkbox"/> ComponentA.slx		
▼ <input checked="" type="checkbox"/> Generate Conan Package for Model (Top)		
<input checked="" type="checkbox"/> ComponentA.slx		
▼ <input checked="" type="checkbox"/> Generate SDD Report		
<input checked="" type="checkbox"/> ComponentA.slx		<input checked="" type="checkbox"/> 1

Outputs:
[ComponentA_webview.html](#)

Inputs:
[ComponentA.slx](#)

Dependencies:
[ComponentA.sidd](#)
[ComponentA.slx](#)
[InterfaceA.sidd](#)
[processmodel.m](#)



Backup

Process Advisor

- Customizable process modeling system to define your build and verification process
- Build system to generate and optimally execute the process in your CI system
- Process Advisor app to deploy and automate your prequalification process
- Examples for integration with common CI systems

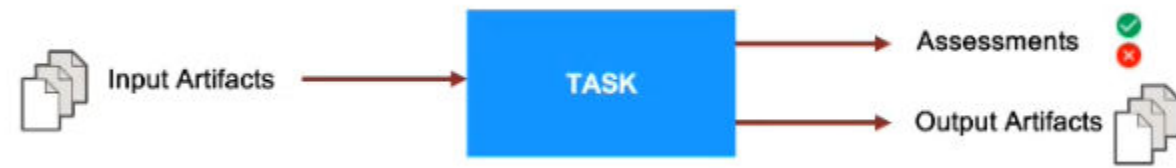


CI/CD Automation for Simulink Check

by MathWorks Model Verification and Validation Team **STAFF**

Simplify adoption and optimize Continuous Integration/Continuous Delivery (CI/CD) workflows for Simulink

Process Advisor



- Input Artifacts
 - Input / Iteration Queries
 - Predefined Queries
 - Custom Queries
- Tasks
 - Predefined Tasks
 - Custom Tasks
- Output Artifacts
 - E.g. HTML, PDF ...
- Assessments
 - Pass, Fail, Warning
- Depends On
- Runs After

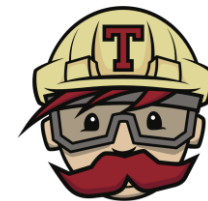
Query Instance	Description
<code>padv.builtin.query.FindArtifacts</code>	Returns each of the artifacts in project that meet the specified criteria For information, enter: <code>help padv.builtin.query.FindArtifacts</code>
<code>padv.builtin.query.FindFilesWithLabel</code>	Returns each of the files in the project that have the specified project label and project label category
<code>padv.builtin.query.FindFileWithAddress</code>	Returns the file at the specified address in the project

Task Title	Task Name and Source Code File	Description
Check Coding Standards	<ul style="list-style-type: none"> • Name: "padv.builtin.task.AnalyzeModelCode" • File: AnalyzeModelCode.m 	Returns each of the models, including System Composer models, in the project
Check Modeling Standards	<ul style="list-style-type: none"> • Name: "padv.builtin.task.RunModelStandards" • File: RunModelStandards.m 	Returns each of the models in the project that have the specified project label and project label category
Detect Design Errors	<ul style="list-style-type: none"> • Name: "padv.builtin.task.DetectDesignErrors" • File: DetectDesignErrors.m 	Returns each of the models that are associated with a test case
Generate Code	<ul style="list-style-type: none"> • Name: "padv.builtin.task.GenerateCode" • File: GenerateCode.m 	Returns the project file
Generate SDD Report	<ul style="list-style-type: none"> • Name: "padv.builtin.task.GenerateSDDReport" • File: GenerateSDDReport.m 	Returns each of the referenced models in the project
Generate Simulink Web View	<ul style="list-style-type: none"> • Name: "padv.builtin.task.GenerateSimulinkWebView" • File: GenerateSimulinkWebView.m 	Returns each of the requirement sets within a project
Inspect Code	<ul style="list-style-type: none"> • Name: "padv.builtin.task.RunCodeInspection" • File: RunCodeInspection.m 	Returns each of the requirement links associated with a model
Merge Test Results	<ul style="list-style-type: none"> • Name: "padv.builtin.task.MergeTestResults" • File: MergeTestResults.m 	Returns each of the test cases associated with the models in the project
Run Tests	<ul style="list-style-type: none"> • Name: "padv.builtin.task.RunTestsPerModel" • File: RunTestsPerModel.m 	Returns each of the top models in the project
Run Tests	<ul style="list-style-type: none"> • Name: "padv.builtin.task.RunTestsPerTestCase" • File: RunTestsPerTestCase.m 	Returns the dependent artifacts for the specified artifact

<code>padv.builtin.query.GetIterationArtifact</code>	Returns the artifact that the task is iterating over
--	--

Process Advisor

- [Digital Thread](#)
 - The digital thread is a set of metadata information about the artifacts in a project, the artifact structure, and the traceability relationships between artifacts.
- Run Process Advisor locally or in [CI](#)



Process Advisor

- Local Execution
 - GUI / API
- Jenkins
 - Jenkinsfile
- GitHub Actions
 - .github/workflows

The screenshot shows a Jenkins build failure for a job named 'VED-SW-Modular / Mbd-ComponentA'. The build failed 9 days ago in 1m 28s. The error message is 'Fix error in callVersionAssistant.m if environment variable 'PR_NUMBE... Process Advisor - Force True #12'. The console output shows a MATLAB script execution that fails at the 'callVersionAssistant' step.

```

#####
12 ## Starting Process Advisor build at 25-May-2023 18:54:38
13 ##>> requireDependencies: 1
14 ##>> force: 1
15 ##>> tests to run:
16 ##>> (Call Version Assistant)::ComponentA.prj
17 ##>> Get Required Conan Packages::ComponentA.prj
18 ##>> Check GIT status::ComponentA.prj
19 ##>> Check GitLab status::ComponentA.prj
20 ##>> mbd_buildin_task_generateModelFrom::components/ComponentA/ComponentA.six
41 ##>> Check Modeling Standards (MLC8)::components/ComponentA/ComponentA.six
42 ##>> Nil_Test::components/ComponentA/ComponentA.six
43 ##>> mbd_buildin_task_detectDesignErrors::components/ComponentA/ComponentA.six
44 ##>> Generate Conan Package For Model (Top)::components/ComponentA/ComponentA.six
45 ##>> mbd_buildin_task_generateSQRReport::components/ComponentA/ComponentA.six
46 ##>> Generate Code as Top Model::components/ComponentA/ComponentA.six
47 ##>> Nil_Test::components/ComponentA/ComponentA.six
48 ##>> Nil_Test::components/ComponentA/ComponentA.six
49 ##>> mbd_buildin_task_MergeTestResults::components/ComponentA/ComponentA.six
50 ##>> Analyze Top Model::components/ComponentA/ComponentA.six
51 ##>> Prove Top Model::components/ComponentA/ComponentA.six
52 ##>> Generate Conan Package For Code (Top)::components/ComponentA/ComponentA.six
53 ##>> Generate Conan Package For Report::ComponentA.prj
54 #####
55 ## Starting task Call Version Assistant::ComponentA.prj
56 ## Task: Call Version Assistant
57 ##>> Input Artifacts:
58 ##>> Dependent Artifacts:
59 ##>> processmodel.m
60 ##>> Output Artifacts:
61 ##>> Pass: 0
62 ##>> Name: 0
63 ##>> Fail: 1
64 ##>> Start: 25-May-2023 18:54:38
65 ##>> End: 25-May-2023 18:54:48
66 ##>> Duration: 00:00:10
67 ##>> Task Status: Error
68 ##>> Completed task Call Version Assistant::ComponentA.prj
69 #####
70 #####
71 ## Starting task Get Required Conan Packages::ComponentA.prj
72 ## Task: Get Required Conan Packages
73 ##>> Input Artifacts:
74 ##>> Dependent Artifacts:
75 ##>> processmodel.m
76 ##>> Output Artifacts:
  
```

At the bottom of the screenshot, there is a notification: '3 Project Analysis Issues'.