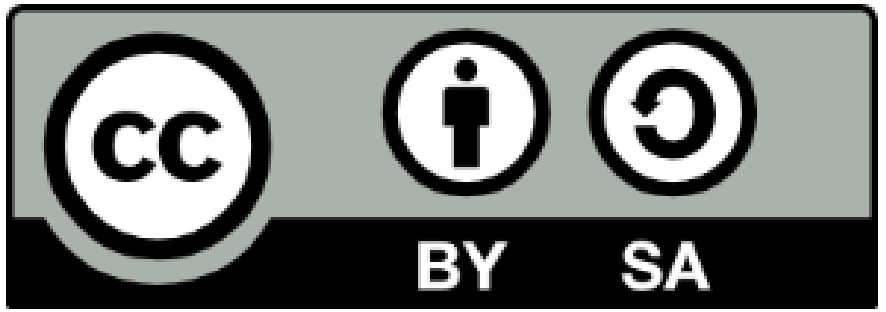

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eFMI® Tutorial – Agenda

Part 1: eFMI® motivation and overview (40 min)

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Coffee break (30 min)

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Tutorial leader:
Christoff Bürger

DASSAULT SYSTEMES

Presenter:
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BOSCH
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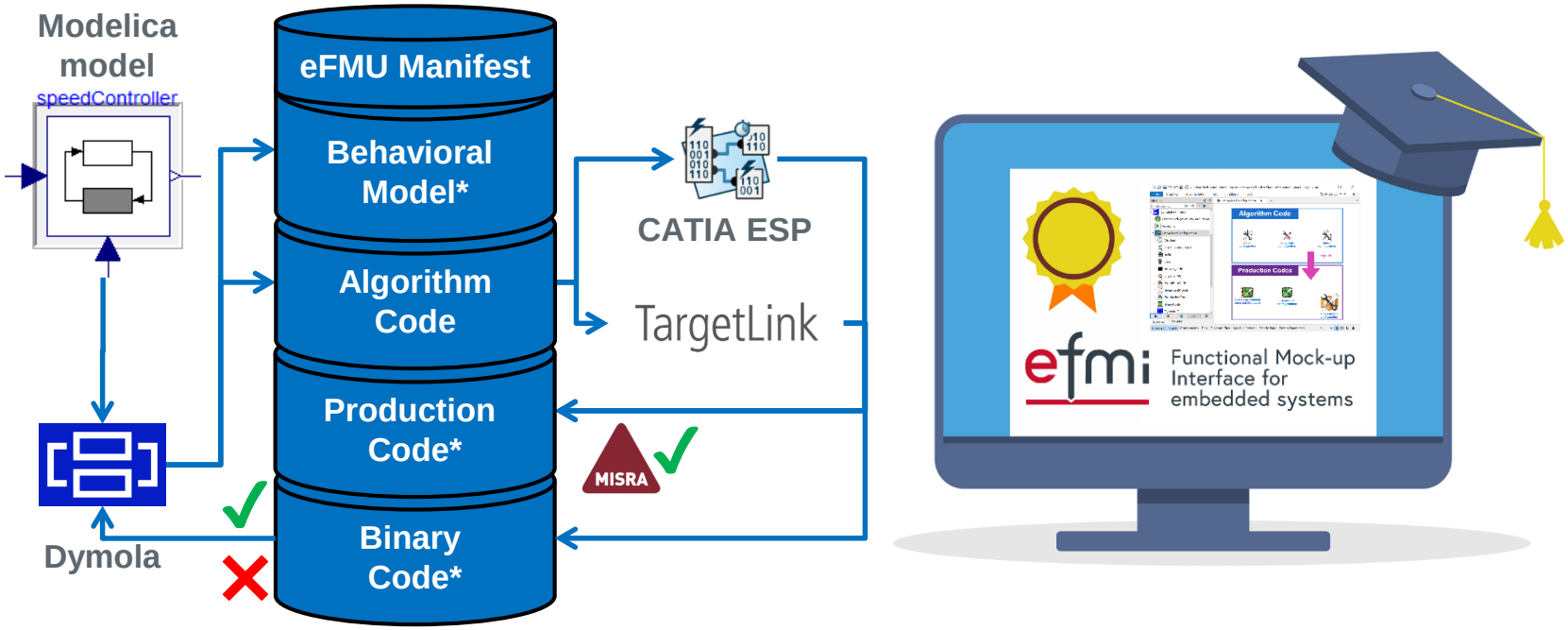
efmi Functional Mock-up Interface for embedded systems



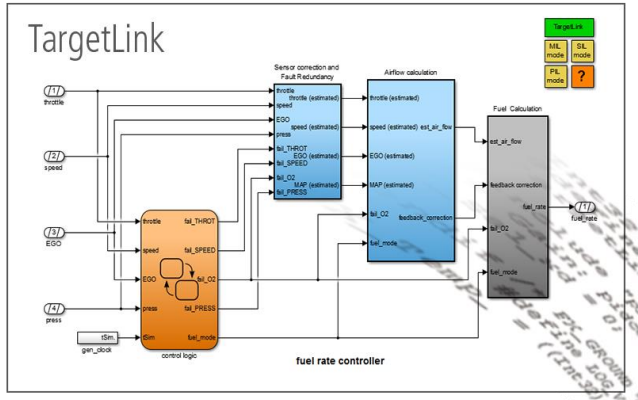
Part 4: Live demonstration in TargetLink

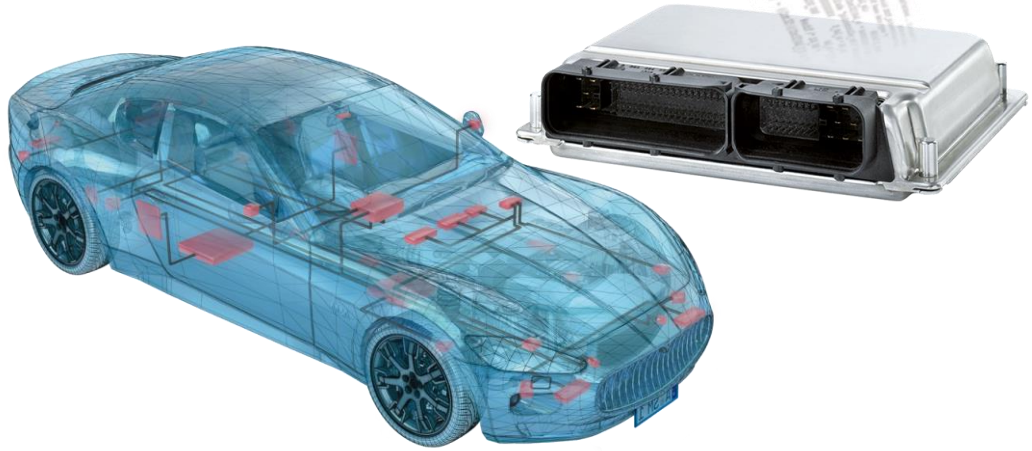
eFMI® Tutorial – 15th International Modelica Conference – 9th of October 2023

Jörg Niere
dSPACE GmbH
JNiere@dspace.de

TargetLink – Driving the Future with Autocode

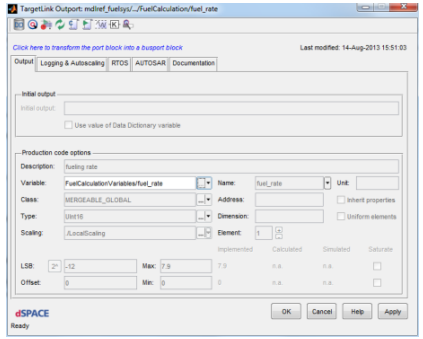
- High-quality production code generation directly from Simulink/Stateflow
  - Highly efficient for fixed-point and floating point
  - Well readable and traceable code
  - Highly configurable
- Powerful software design and testing features
  - MIL/SIL/PIL simulation concept
  - Push-button solution with integrated data logging and plotting concept
  - Code profiling, code coverage analysis and much more …
- High-performance, native AUTOSAR support
- Certified for IEC 61508, ISO 26262 and ISO 25119
- Powerful Ecosystem for model-based development
- TargetLink - Generates exactly the code that you want!



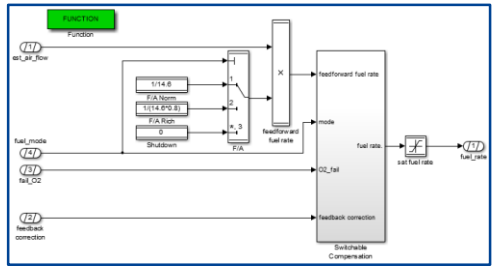


TargetLink Ecosystem – Powerful MBD Tool Chain

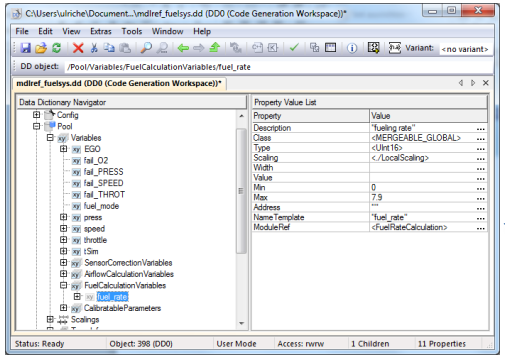
TargetLink Features (excerpt)



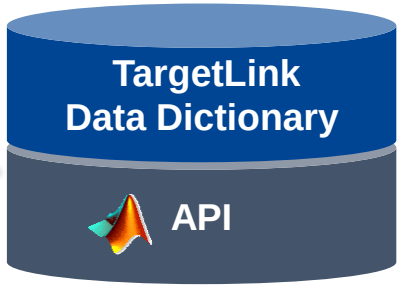
Block dialogs



Separation of model and data

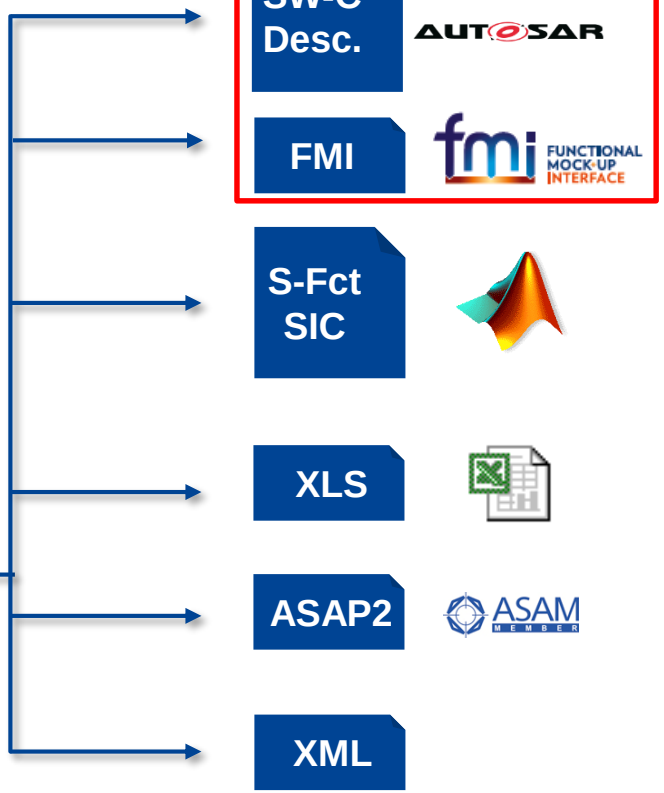


TargetLink Data Dictionary Manager



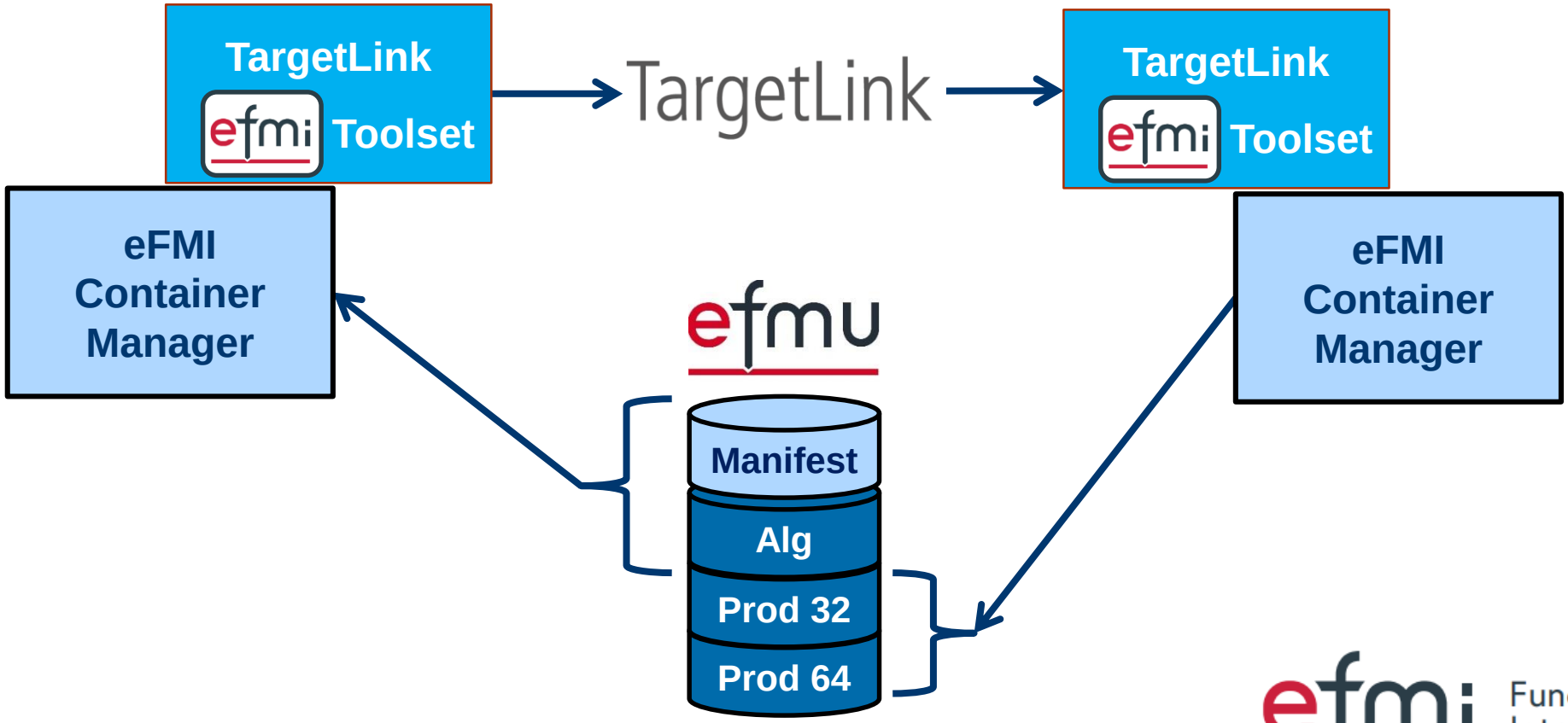
Import

Export



Dedicated support for AUTOSAR, FMI and other important automotive standards

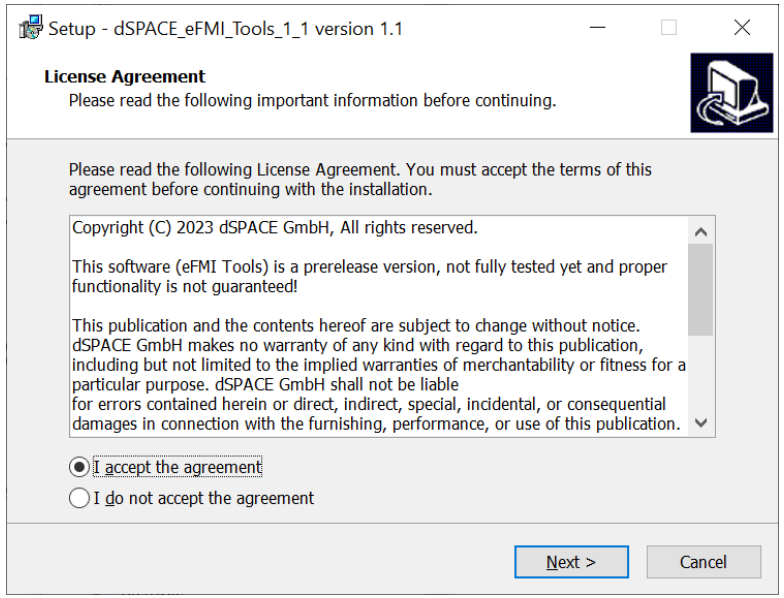
TargetLink eFMI Support



efmi Functional Mock-up Interface for embedded systems

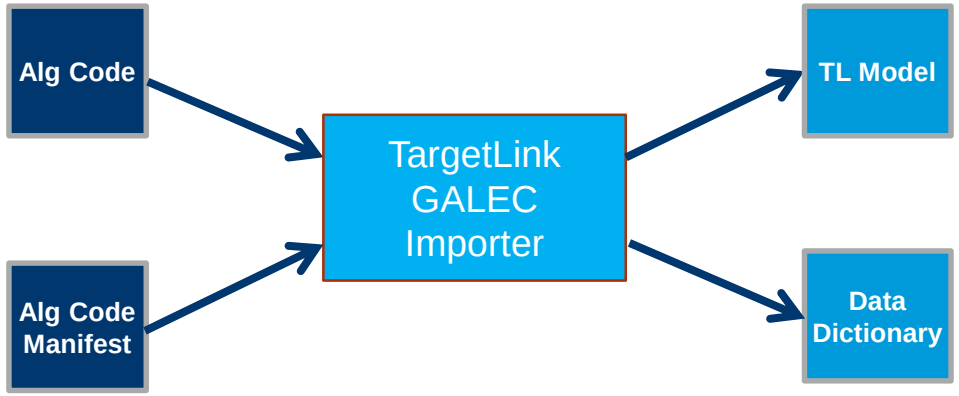
TargetLink eFMI Toolset

- How to get it?
  - Send mail to support@dspace.de or efmi-info@googlegroups.com
- Toolset based on TL22.1 Release/p4 or TL 23.1 Release
- Comes along as .zip file
  - Disclaimer
  - Involved 3rd party software
  - dSPACE Eula
  - Installer executable
- Installed toolset
  - Is portable, no registry entry or connection to TL version
  - C# CLI applications, easy integration into tool chain (e.g. Python scripts)
    - .NET framework 4.8 or higher is needed
- eFMI Container Manager needed (open source by MAP eFMI)



TargetLink GALEC Importer

- Input: GALEC code file and associated manifest file
- Output: Generated input for the TargetLink code generator

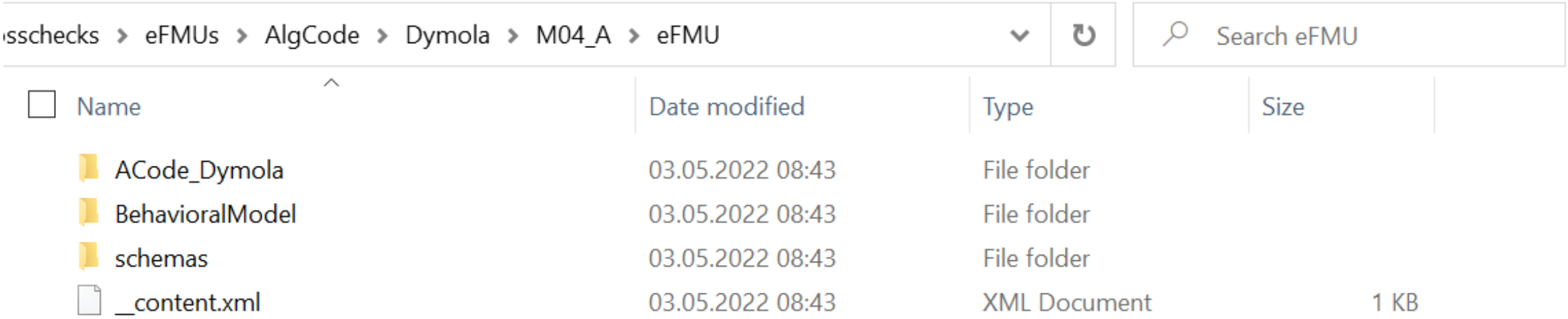


TargetLink Manifest Creator

- Input: Data Dictionary file augmented by TargetLink code generator
- Output: Manifest file for production code generated by TargetLink

- Consistency checks:
  - Generated XML tree is validated against the schema
  - References within the manifest are checked against the rules of the specification

Demo: Enhance eFMU with Production Code



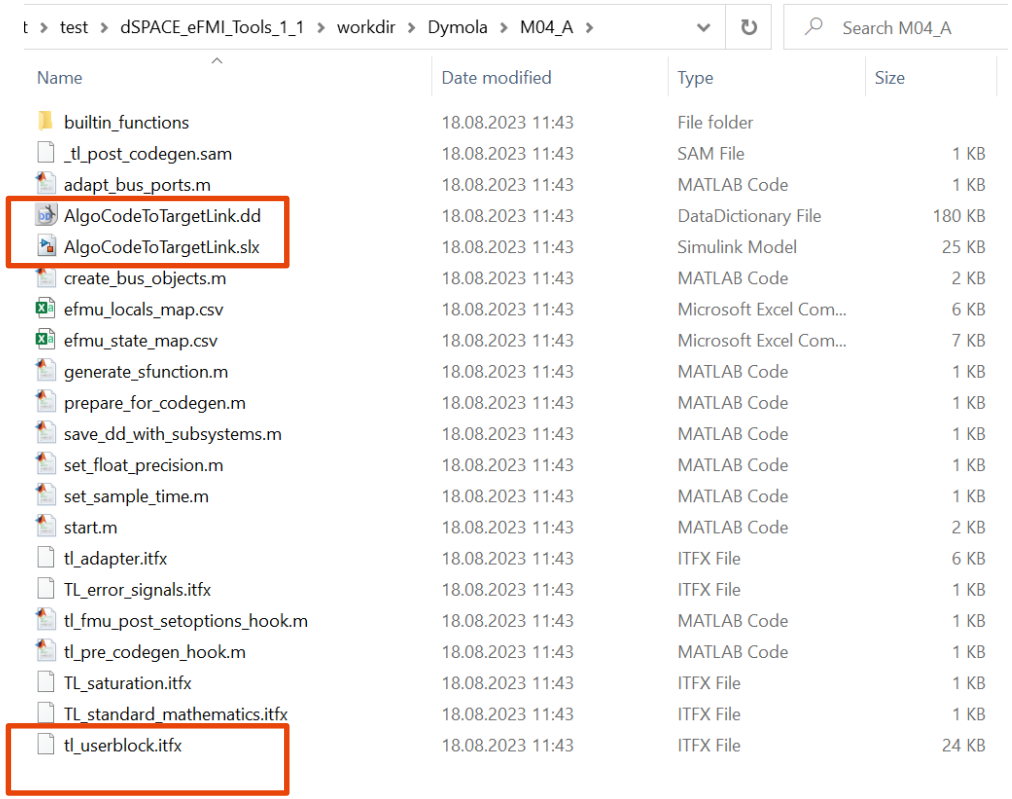
Demo: Extract and Compile Algorithm Code

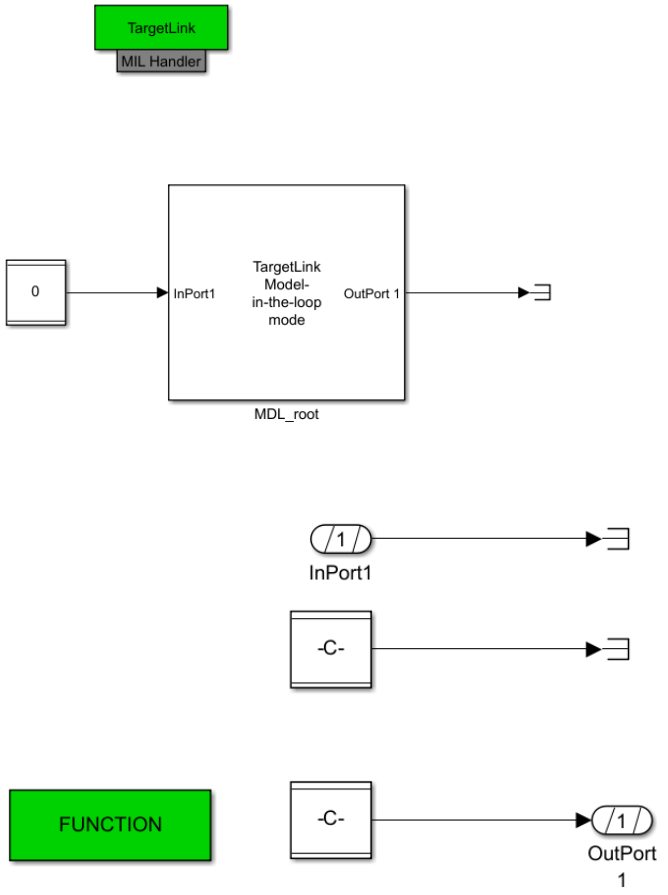
```
>>> Performing semantic analysis

>> Building intermediate code representation from AST (including name analysis)

>> Reading AlgoCode manifest
> Validating XML tree against schema (AlgoCode manifest file)
=> XML tree has been validated successfully
Warning: Found UnitDefinitions element in AlgoCode manifest, but it is not supported yet

>> Checking consistency between AST and manifest

>> Performing type analysis

>>> Generating code generation tree (CGT) from AST and intermediate code representation

>>> Performing analysis and optimization on CGT

>>> Generating input for TargetLink code generator
Generating files to directory: workdir\Dymola\M04_A
IntegrationMode is DISABLED

Note: Interprocedural optimization ignoring initializations in Startup() like constant propagation has been disabled, be
cause no manifest has been provided or some non-interface model variables are missing (maybe due to obfuscation)

Generating data dictionary ...
Generating model ...
```

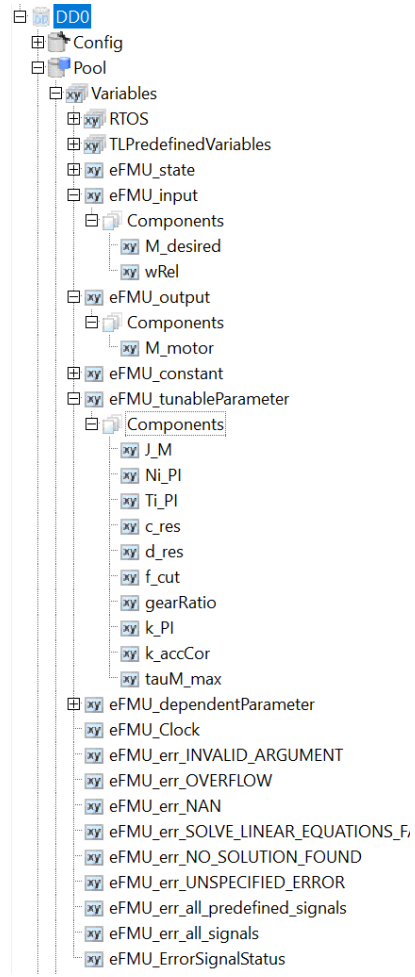
TargetLink GALEC Importer

Functional Mock-up Interface for embedded systems

Demo: Prepared TargetLink Model and Data Dictionary





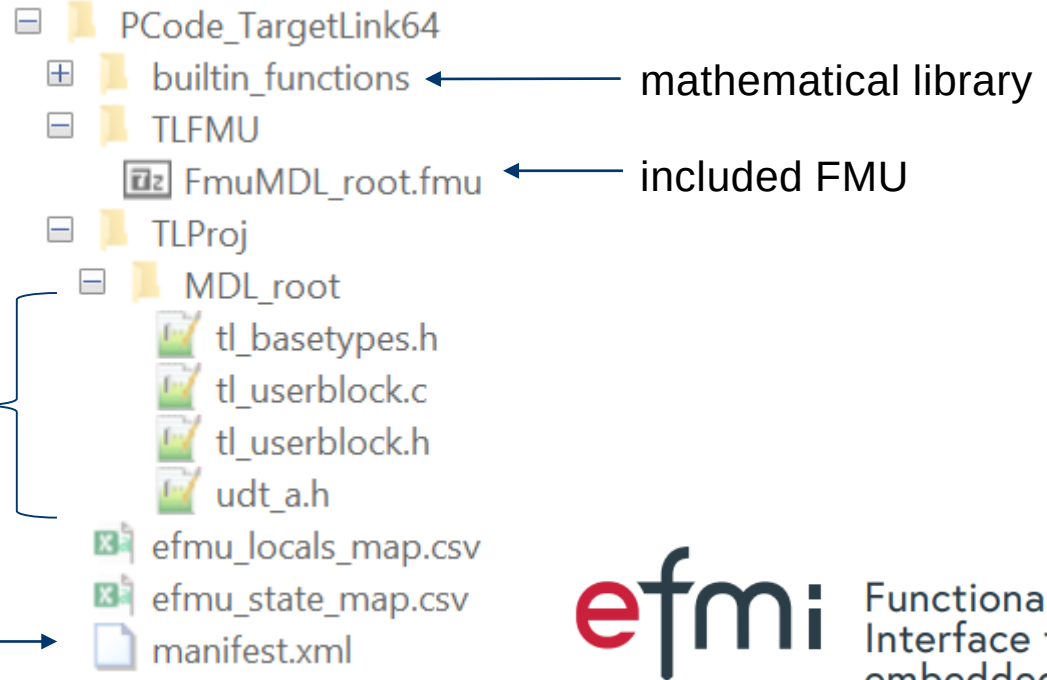


Demo: Enhanced eFMU with Production Code

MUs › ProdCode › TargetLink › from_Dymola › M04_A › eFMU ›

Name	Date modified
ACode_Dymola	18.08.2023 13:01
BehavioralModel	18.08.2023 13:01
PCode_TargetLink32	18.08.2023 13:01
PCode_TargetLink64	18.08.2023 13:01
schemas	18.08.2023 13:02
_content.xml	18.08.2023 13:01

TargetLink Manifest Creator

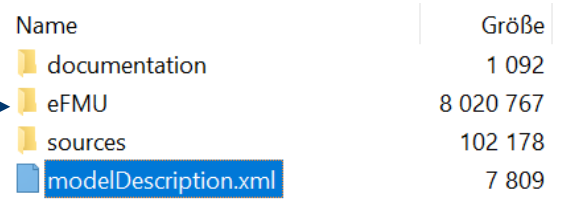


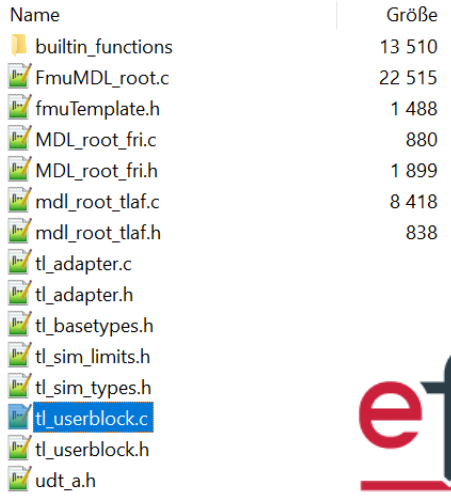
efmi Functional Mock-up Interface for embedded systems

Demo: Manifest with FMU entry

```
<?xml version="1.0" encoding="utf-8"?>
<Manifest efmiVersion="1.0.0" xsdVersion="0.17.0" id="{ee0d531e-3d0b-46b6-9ade-019cae7ef0de}" kind="ProductionCode" name="AlgoCodeToTargetLink" generationDateAndTime="2
  <ManifestReferences>
    <ManifestReference id="ID_MNFST_1" manifestRefId="{d447bd03-ec94-4ef6-b6d8-778fd76111c5}" checksum="08c46df1a3351dac864ab9b855acad0e5a373929" origin="true" />
  </ManifestReferences>
  <Files>
    <File id="ID_FILE_tl_basetypes.h_1" name="tl_basetypes.h" path="./TLProj/MDL_root/" needsChecksum="true" checksum="6c48b26c85a43185773e4f6179374896f6c3ca73" role="C
    <File id="ID_FILE_udt_a.h_2" name="udt_a.h" path="./TLProj/MDL_root/" needsChecksum="true" checksum="611d17bf0e156e8d68106b98c3d1dfd50006aaad" role="Code" />
    <File id="ID_FILE_tl_userblock.h_3" name="tl_userblock.h" path="./TLProj/MDL_root/" needsChecksum="true" checksum="26b7387d00056321a071ec36fc33defeb85a99bb" role="C
    <File id="ID_FILE_tl_userblock.c_4" name="tl_userblock.c" path="./TLProj/MDL_root/" needsChecksum="true" checksum="009558e9d38a18da2cf28e393f471c44533a79ff" role="C
    <File id="ID_FILE_TL_error_signals.h_5" name="TL_error_signals.h" path="./builtin_functions/" needsChecksum="true" checksum="f06af138be466b9ff95e603529da944d51efc7a
    <File id="ID_FILE_TL_error_signals.c_6" name="TL_error_signals.c" path="./builtin_functions/" needsChecksum="true" checksum="9fafe841e7610c505745246e6ae95dc5df77bfb
    <File id="ID_FILE_TL_saturation.h_7" name="TL_saturation.h" path="./builtin_functions/" needsChecksum="true" checksum="1f7a6a1f60892ba75872b1e0ef989145a7eb8270" rol
    <File id="ID_FILE_TL_standard_mathematics.h_8" name="TL_standard_mathematics.h" path="./builtin_functions/" needsChecksum="true" checksum="5f34c21ef63318c0d628e2f11
    <File id="ID_FILE_TL_standard_mathematics.c_9" name="TL_standard_mathematics.c" path="./builtin_functions/" needsChecksum="true" checksum="bb0dc80b2cf3fbde891e447f2
    <File id="ID_FILE_TL_float_precision.h_10" name="TL_float_precision.h" path="./builtin_functions/" needsChecksum="true" checksum="6188fe4cf59fc429d0894e061fd423b147
    <File id="ID_FILE_TL_primitive_types.h_11" name="TL_primitive_types.h" path="./builtin_functions/" needsChecksum="true" checksum="cc86ea69ab84280b7cf109a50c5272d919
    <File id="ID_FILE_FmuMDL_root.fmu_12" name="FmuMDL_root.fmu" path="./TLFMU/" needsChecksum="true" checksum="4cbed48abbeceea1412534748124acbf18d5ff01" role="FMU" />
  </Files>
```

eFMI Container Manager
unpackFMU





efmi Functional Mock-up Interface for embedded systems

What else to do with TargetLink?

- Simulate model in TargetLink (SIL) with data from Behavioral Model
  - E.g., single-precision vs. double-precision
- Reconfigure Data Dictionary to generate AUTOSAR Classic/Adaptive code
- Generate .a2l file to be used in calibration tools
- Generate Matlab S-function to be used in MIL mode
- Use block in other models
  - Copy
  - Library
  - Model referencing
- Use TargetLink Custom Code block to integrate generated code
- Generate V-ECU and simulate with dSPACE VEOS
- …

dSPACE

https://www.dspace.com/en/pub/home.cfm

TargetLink

https://www.dspace.com/en/pub/home/products/sw/pcgs/targetlink.cfm

TargetLink efmi Toolset

support@dspace.com

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