MATLAB EXPO

5月28日, 2024 | 北京

基于Simulink平台的AUTOSAR软件架构设计和软件实现

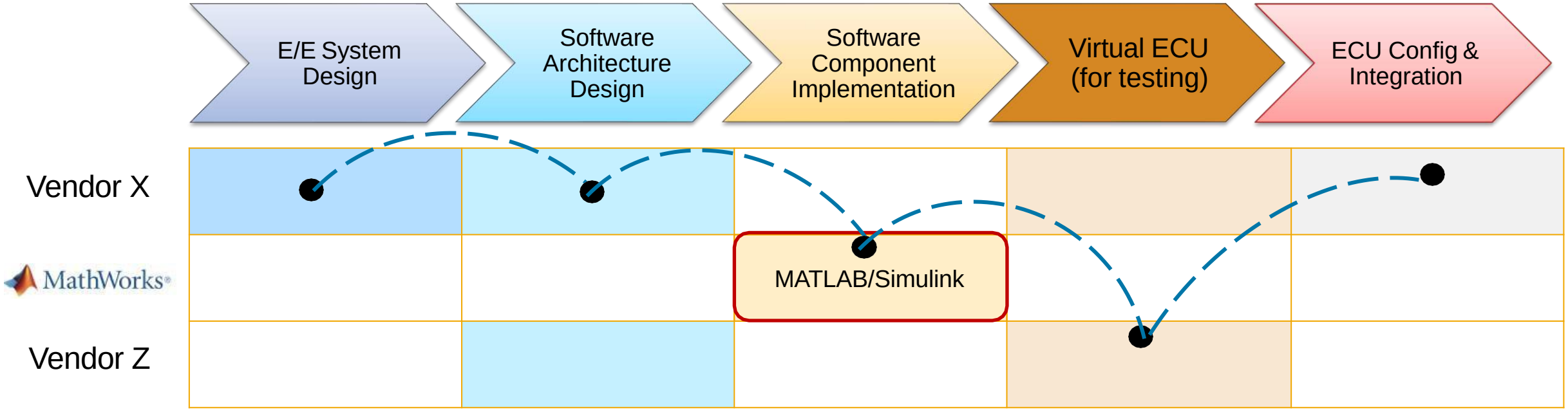
董淑成　*MathWorks*

MathWorks

主要内容

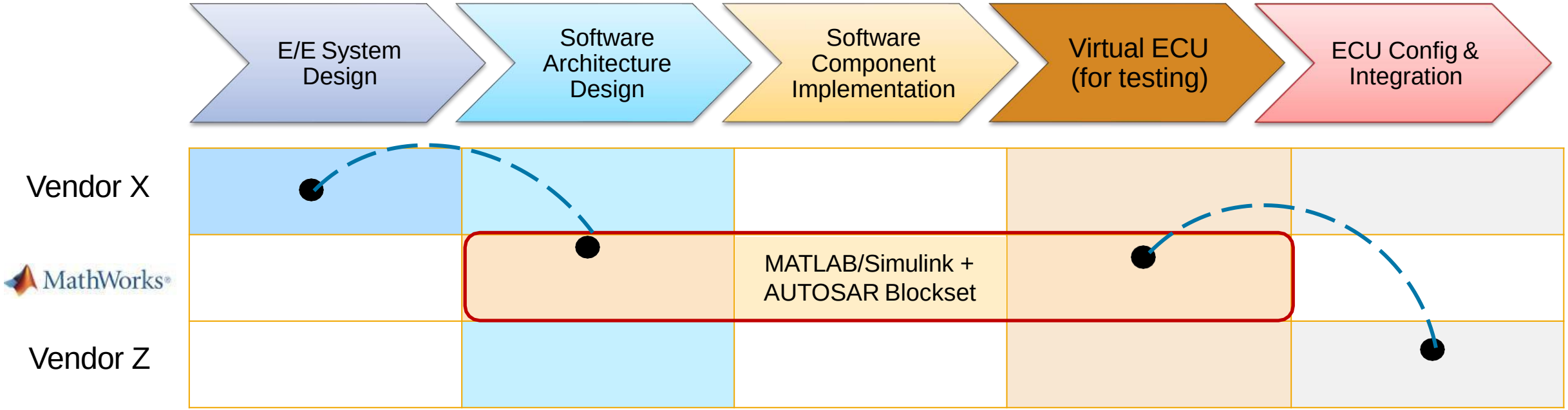
- AUTOSAR解决方案的进化
- System Composer实现软件架构设计
- SWC的Simulink实现
- 基于Excel的AUTOSAR架构设计

AUTOSAR 软件开发中的挑战



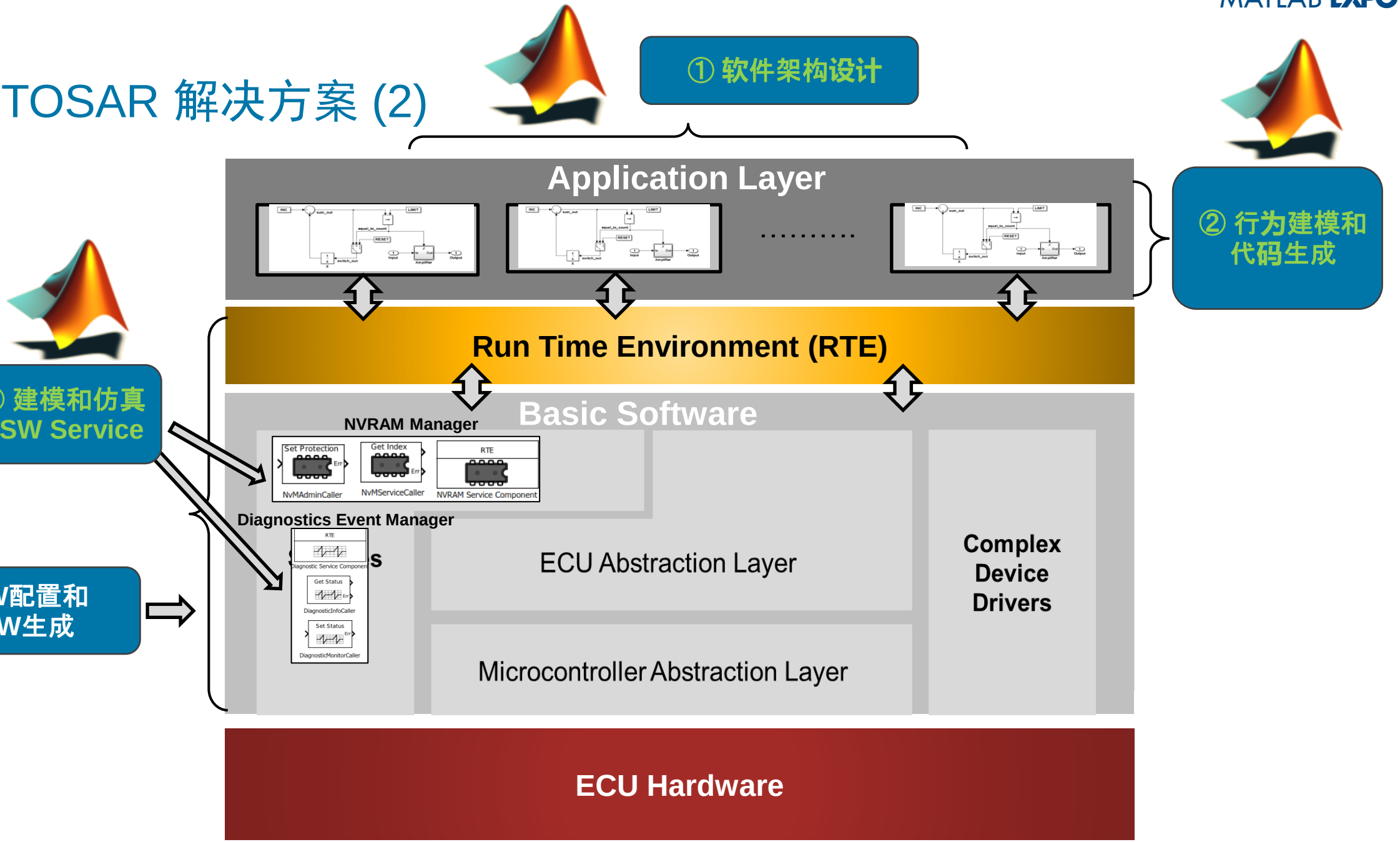
- 过多的交接点影响了开发效率
- 不同工具覆盖不同的标准子集

AUTOSAR 解决方案 (1)



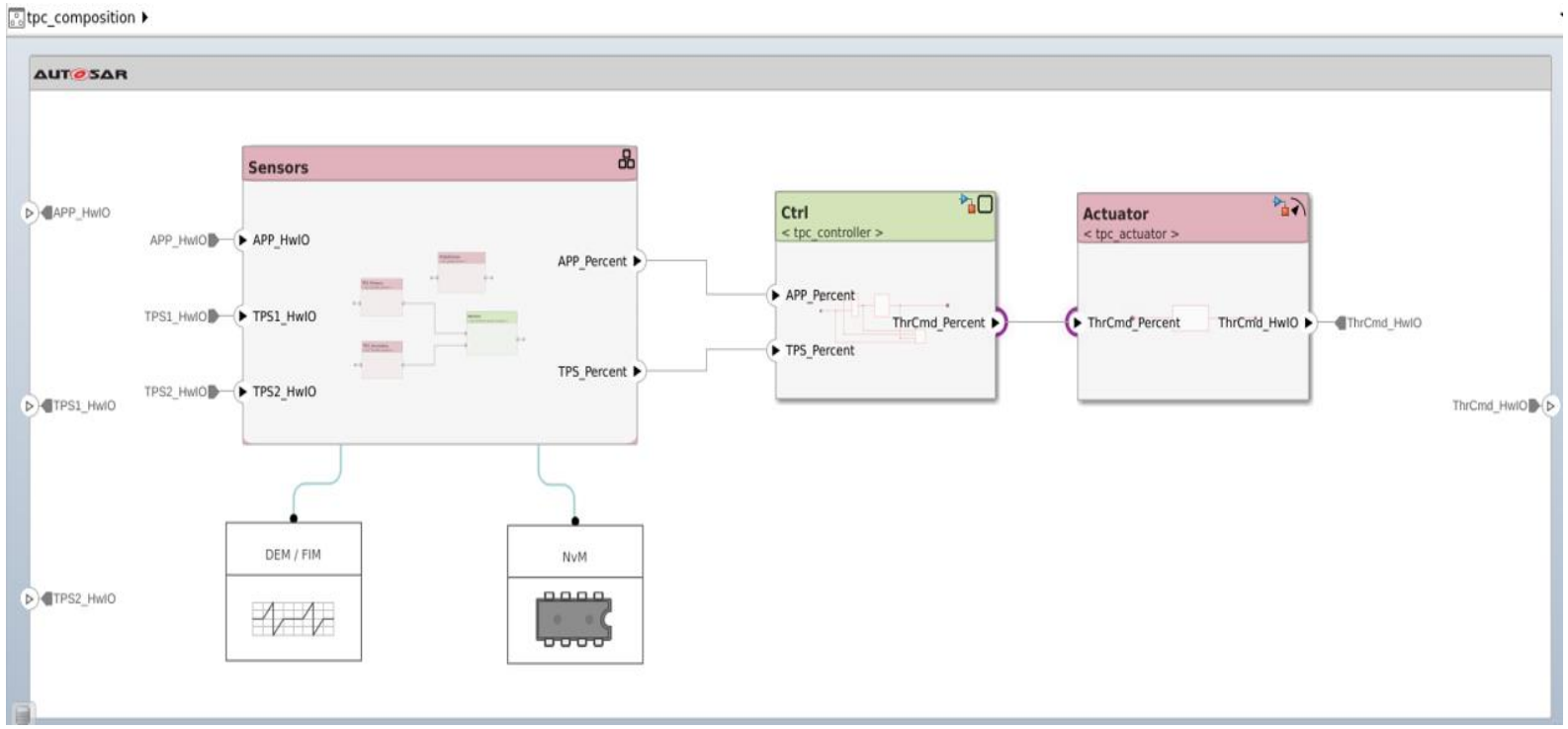
- 简化端到端的工作流程
- 减少流程中的数据交接
- 提升功能设计交付质量

AUTOSAR 解决方案 (2)



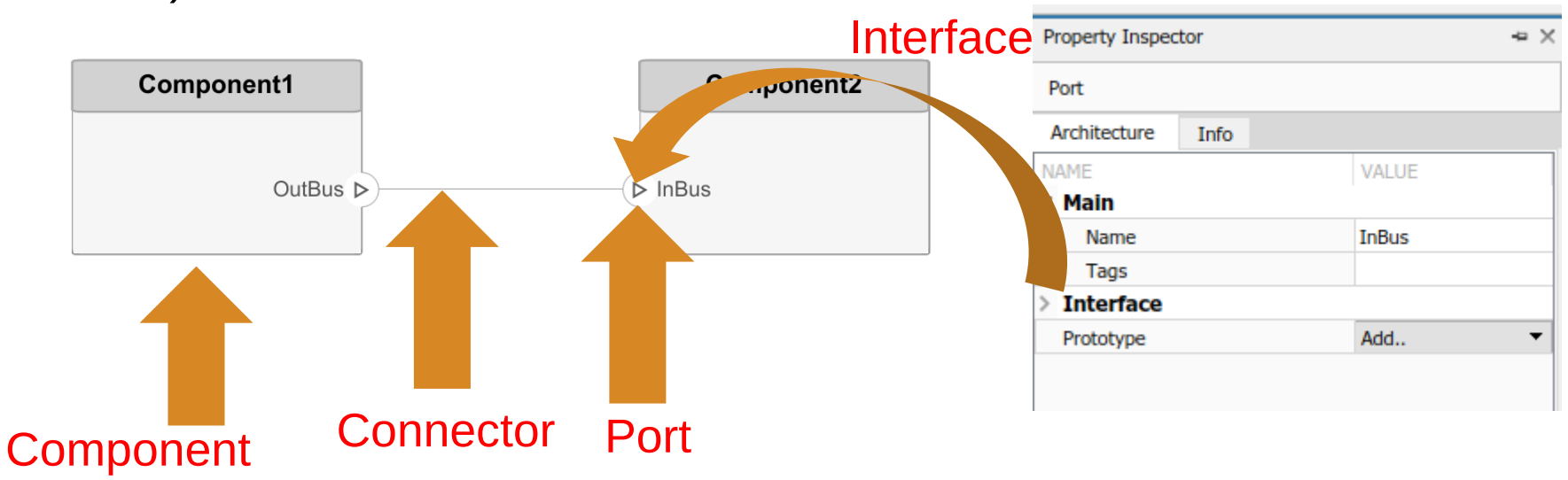
System Composer实现软件架构设计

- System Composer是系统架构和软件架构设计工具
- System Composer + AUTOSAR Blockset 实现AUTOSAR架构



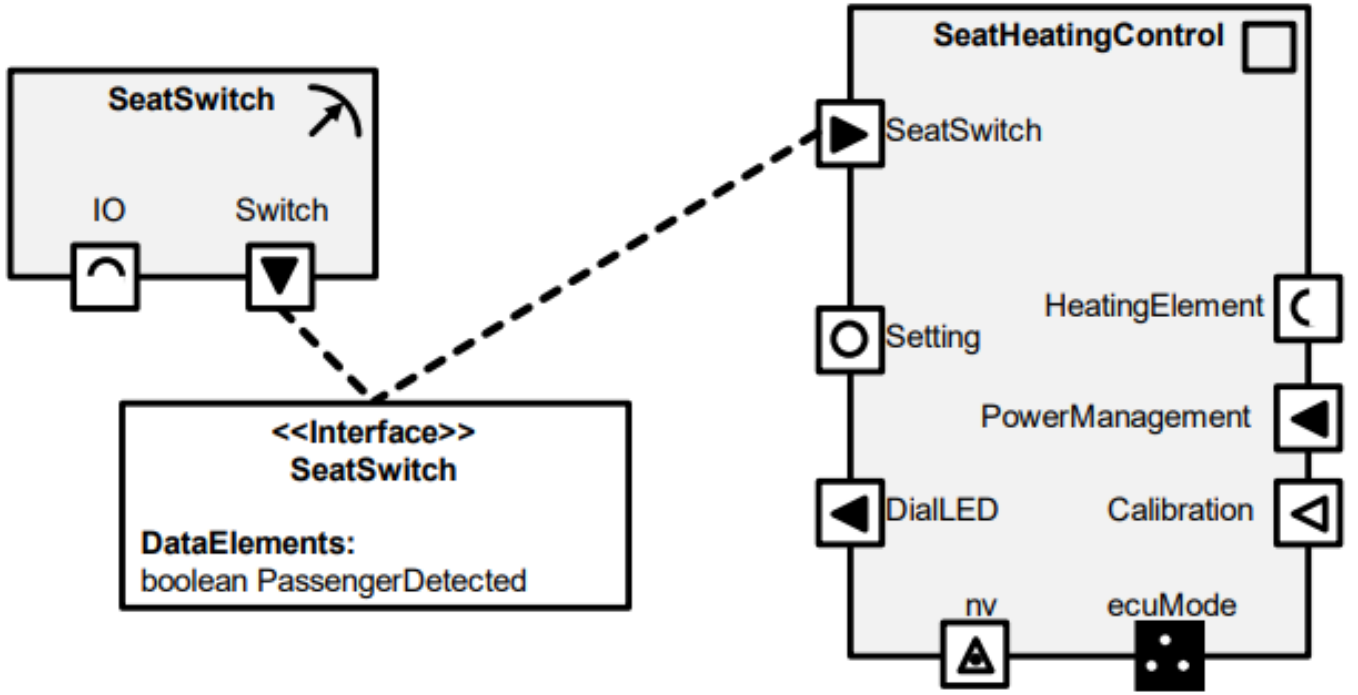
基本的架构设计元模型

- 架构设计的基本元素
  - 组件 (Component)
  - 端口 (Port)
  - 接口 (Interface)
  - 连接 (Connector)



AUTOSAR软件架构的基本元素

- 软件组件 SWC
  - SWC
  - Composition
- 端口 Port
  - PPort
  - RPort
  - PRPort
- 接口 PortInterface
  - Sender-Receiver
  - Client-Server
- 连接 Connector
  - Data transmission
  - Operation invocation

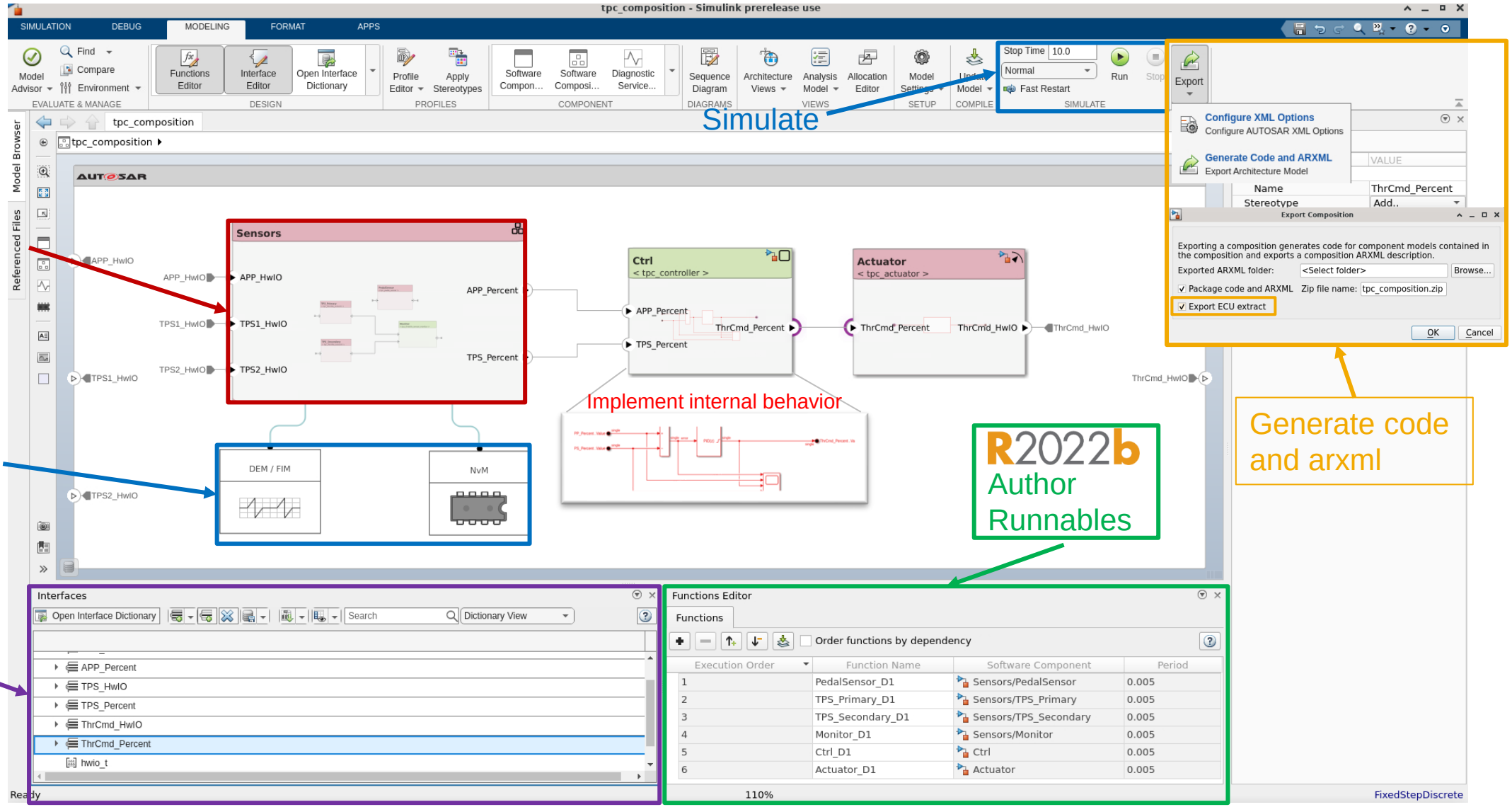


AUTOSAR 软件架构设计

Author Components & Composition hierarchy

Simulate calls to BSW

Author interfaces R2022b

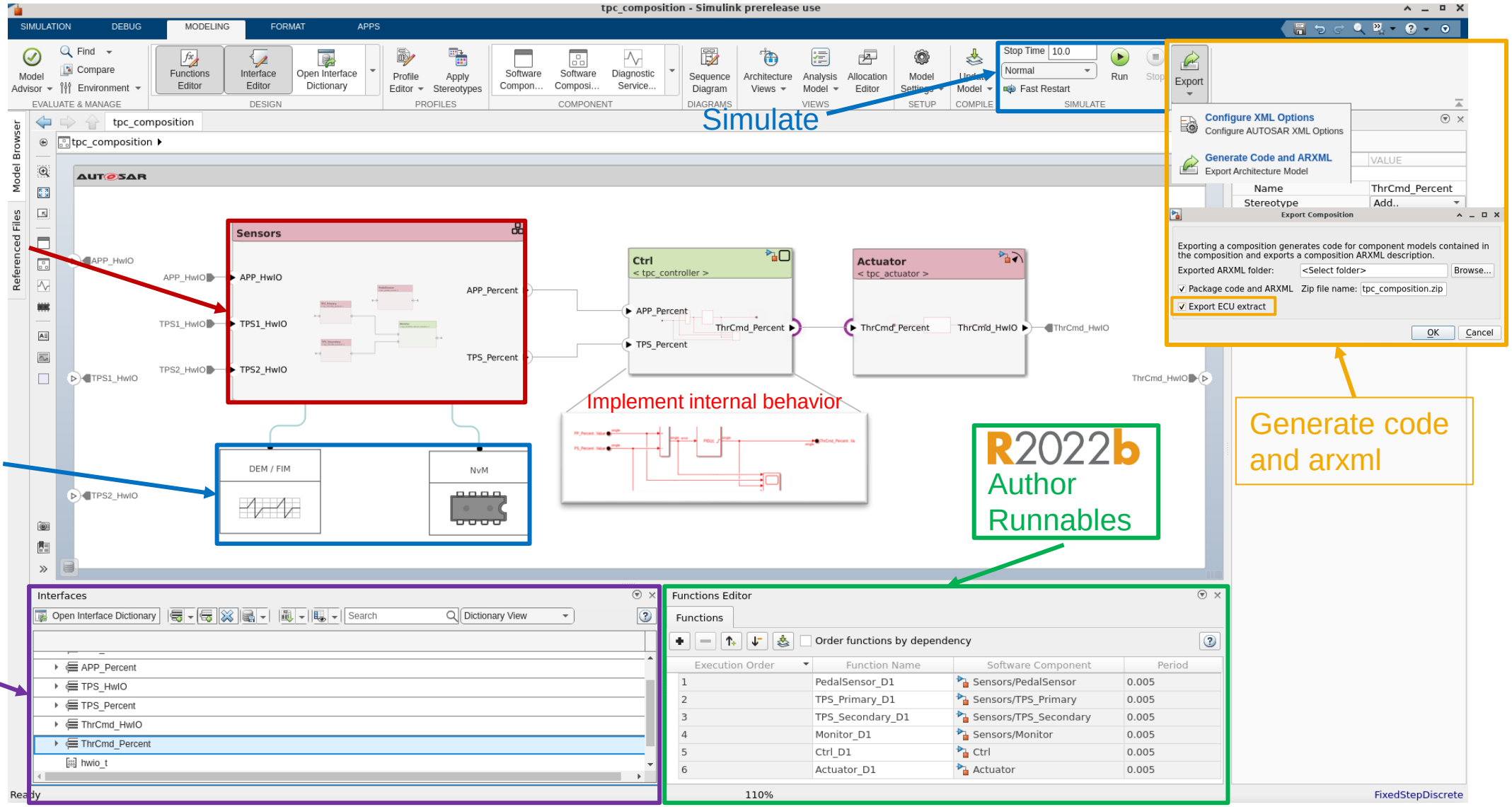


AUTOSAR 软件架构设计 —— Runnable 定义

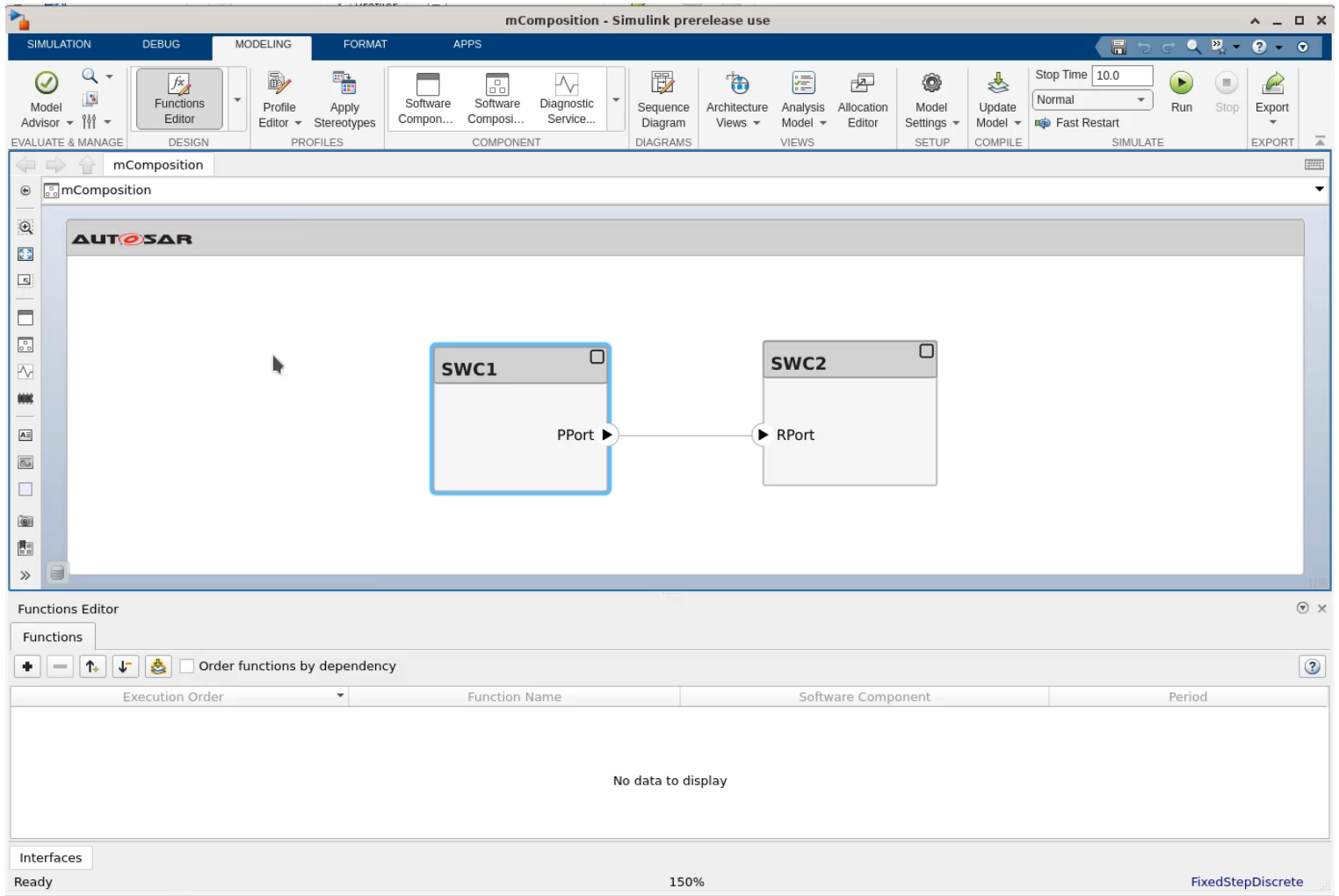
Author Components & Composition hierarchy

Simulate calls to BSW

Author interfaces R2022b



Function Editor —— 为 SWC 添加 Runnable



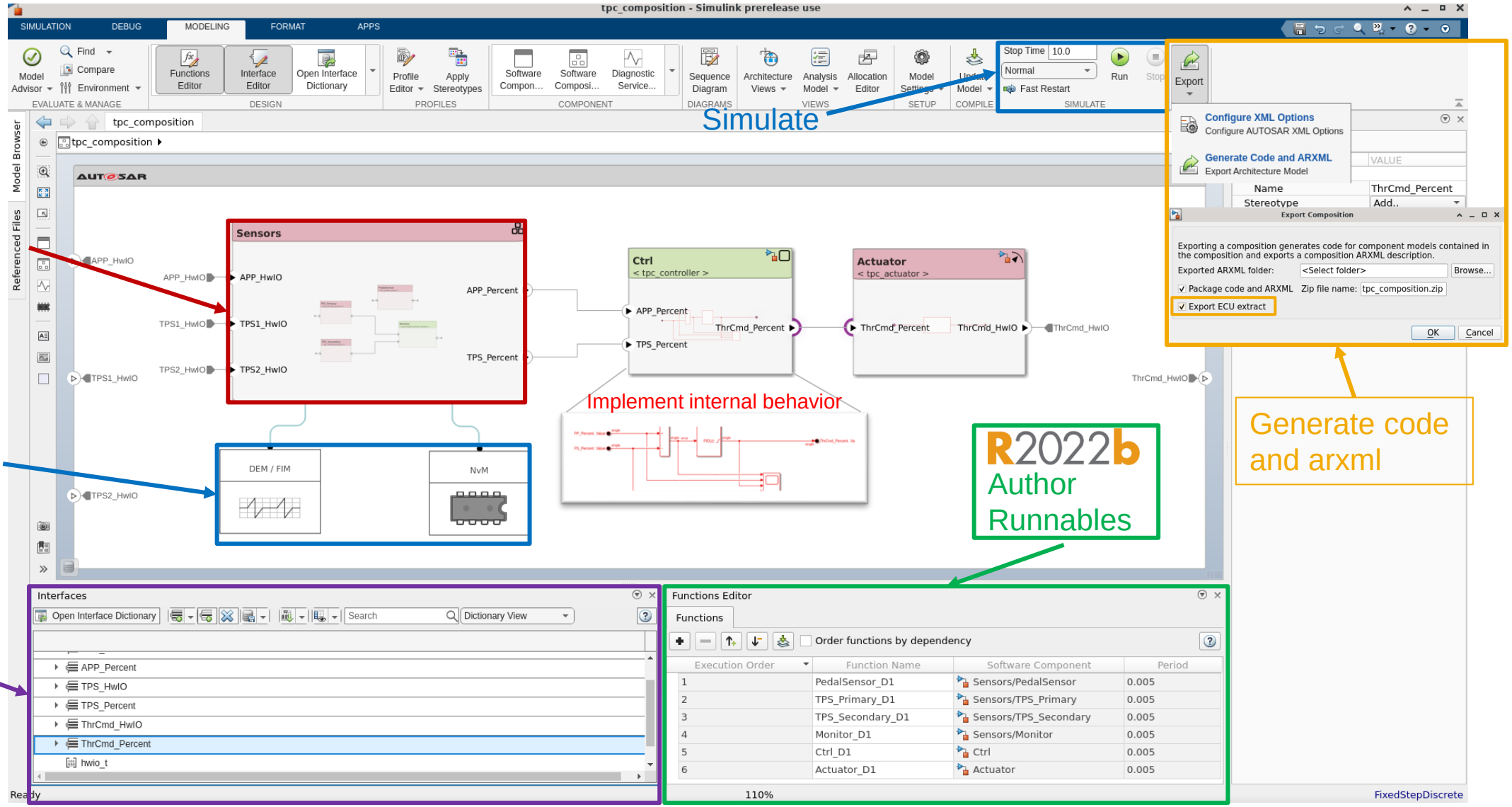
R2022b

AUTOSAR 软件架构设计 —— 接口定义

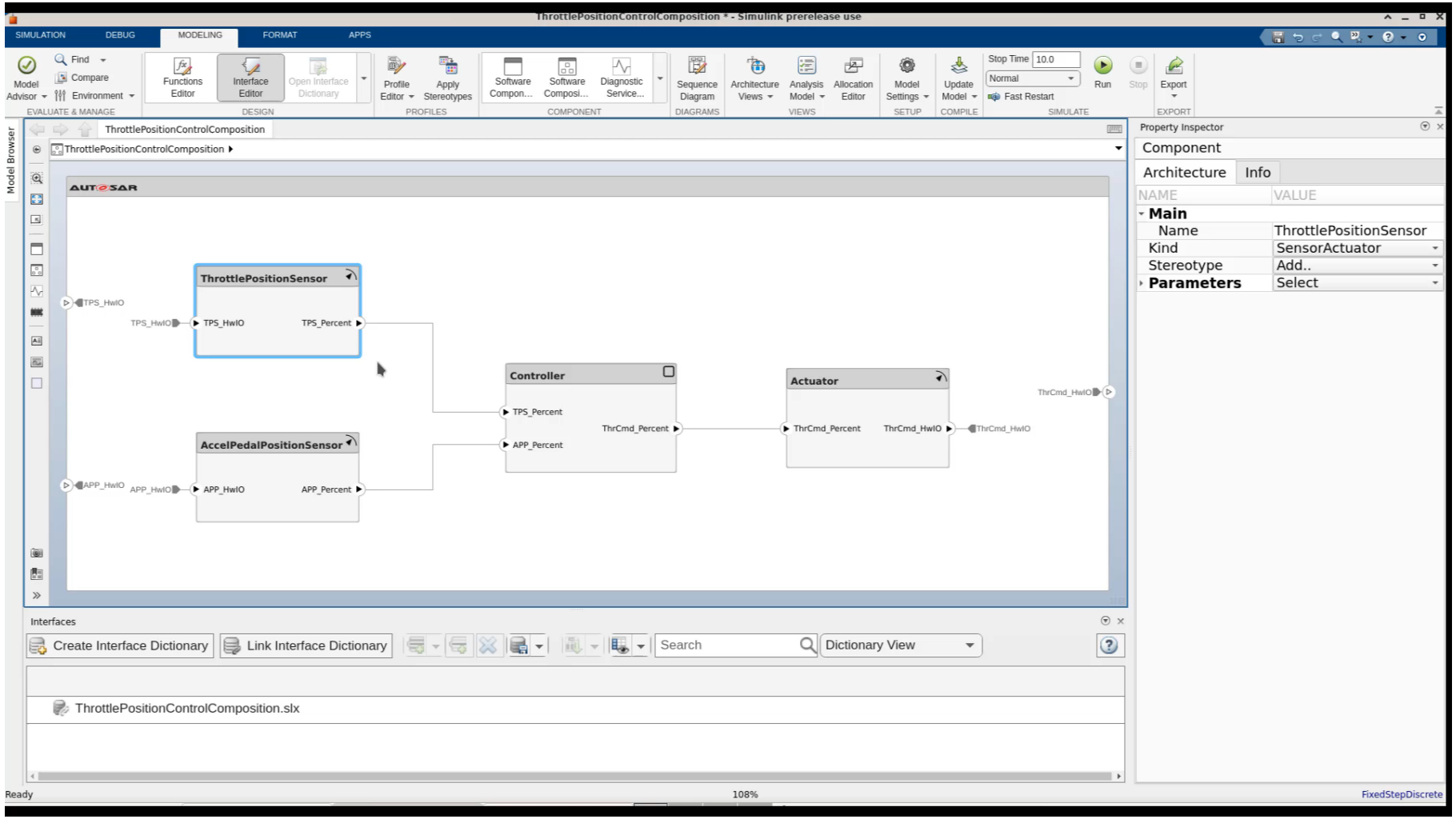
Author Components & Composition hierarchy

Simulate calls to BSW

Author interfaces R2022b



Interface Editor —— 定义 AUTOSAR 接口

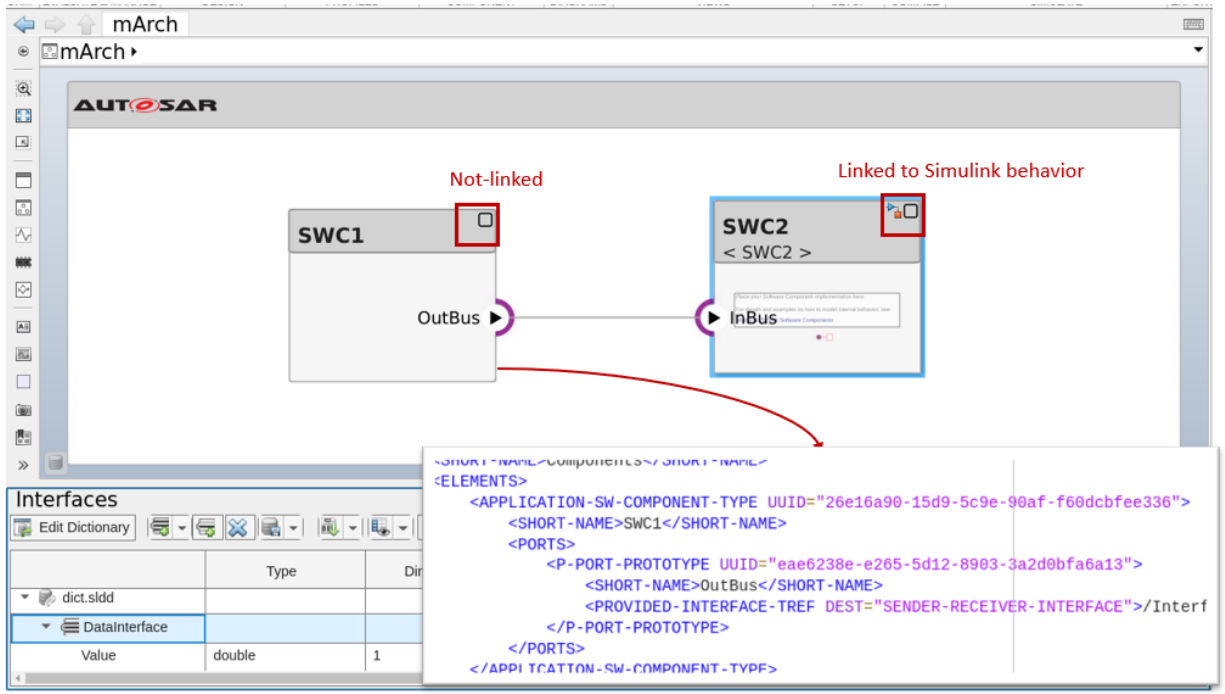


R2022b

为空组件导出 ARXML 文件

Export non-linked components from AUTOSAR architecture model

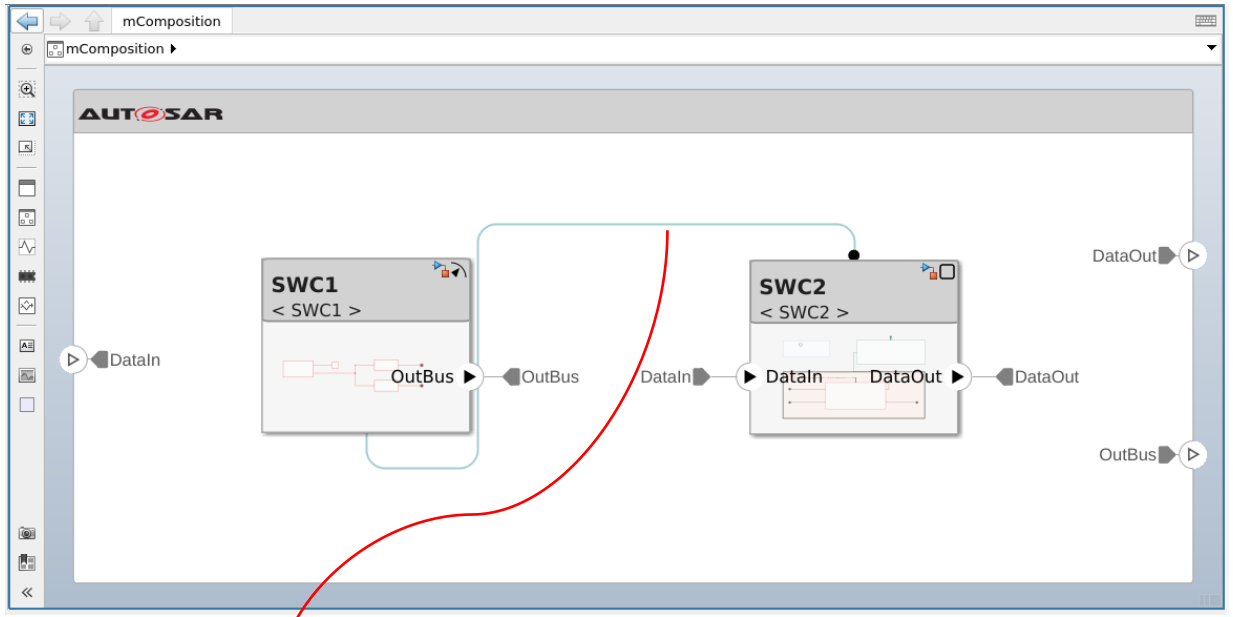
- Export component blocks even when they are not linked to Simulink behavior model to ARXML
- Export non-linked Components ports and interfaces
- Allows incremental workflows where internal behavior can be specified later



导出 C/S Connectors 到 ARXML

Export Client Server Connectors from AUTOSAR architecture model

- Export to ARXML the client-server connectors describing call between Function Callers and global Simulink Functions
- Use command line API with *ExportUnmodeledClientServerConnectors* argument
- Supports calls across composition hierarchy. Requires client/server interface names to match in the AUTOSAR dictionary.




```
<ASSEMBLY-SW-CONNECTOR UUID="8c7fcc77-e1d1-5d5c-2354-59627e3c3c20">
    <SHORT-NAME>SWC2_SrvPort_SWC1_readData_client</SHORT-NAME>
    <PROVIDER-IREF>
        <CONTEXT-COMPONENT-REF DEST="SW-COMPONENT-PROTOTYPE">/Components/mComposition/SWC2</C
        <TARGET-P-PORT-REF DEST="P-PORT-PROTOTYPE">/Components/ASWC/SrvPort</TARGET-P-PORT-RE
    </PROVIDER-IREF>
    <REQUESTER-IREF>
        <CONTEXT-COMPONENT-REF DEST="SW-COMPONENT-PROTOTYPE">/Components/mComposition/SWC1</C
        <TARGET-R-PORT-REF DEST="R-PORT-PROTOTYPE">/Components/Component1/readData_client</TA
    </REQUESTER-IREF>
</ASSEMBLY-SW-CONNECTOR>
```

```
>> archModel = autosar.arch.loadModel(modelName);
>> archModel.export('ExportUnmodeledClientServerConnectors', true);
```

导出 C/S Connectors 到 ARXML (2)

```
% Open example model autosar_tpc_composition for reference
open_system('autosar_tpc_composition')
archModel = autosar.arch.loadModel('autosar_tpc_composition');
archModel.export('PackageCodeAndARXML','R2023a_cnctor_autosar_tpc_composit:
    'ExportECUExtract',true, ...
    'ExportUnmodeledClientServerConnectors', true);
```

C:\...\R2023a_pm_autosar_tpc_composition\arxml\autosar_tpc_composition_composition.arxml

2023/3/21 13:55:41 6,473 字节 其它一切 UTF-8 PC

```
                    </PROVIDER-IREF>
                    <REQUESTER-IREF>
                        <CONTEXT-COMPONENT-REF DEST="SW-COMPONENT-PRO
                        <TARGET-R-PORT-REF DEST="R-PORT-PROTOTYPE">/C
                    </REQUESTER-IREF>
                </ASSEMBLY-SW-CONNECTOR>
                <DELEGATION-SW-CONNECTOR UUID="cbd69324-71c8-55dc-330
                    <SHORT-NAME>Actuator_ThrCmd_HwIO_ThrCmd_HwIO</SHO
                    <INNER-PORT-IREF>
                        <P-PORT-IN-COMPOSITION-INSTANCE-REF>
                            <CONTEXT-COMPONENT-REF DEST="SW-COMPONENT
                            <TARGET-P-PORT-REF DEST="P-PORT-PROTOTYPE
                        </P-PORT-IN-COMPOSITION-INSTANCE-REF>
                    </INNER-PORT-IREF>
                    <OUTER-PORT-REF DEST="P-PORT-PROTOTYPE">/Componen
                </DELEGATION-SW-CONNECTOR>
                <DELEGATION-SW-CONNECTOR UUID="9811e4cf-14ea-52e8-634
                    <SHORT-NAME>TPS_Percent_Ctrl_TPS_Percent</SHORT-N
```

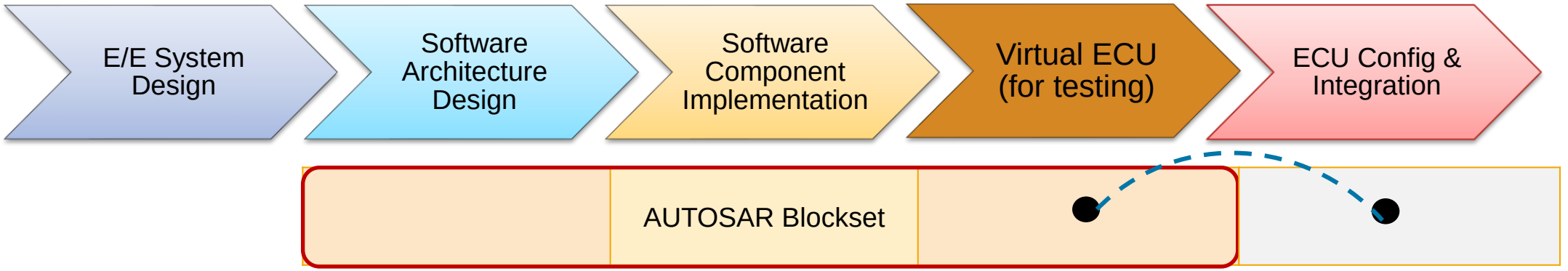
C:\...\arxml\autosar_tpc_composition_composition.arxml

2023/3/21 13:58:31 7,464 字节 其它一切 UTF-8 PC

```
                    </PROVIDER-IREF>
                    <REQUESTER-IREF>
                        <CONTEXT-COMPONENT-REF DEST="SW-COMPONENT-PRO
                        <TARGET-R-PORT-REF DEST="R-PORT-PROTOTYPE">/C
                    </REQUESTER-IREF>
                </ASSEMBLY-SW-CONNECTOR>
                <ASSEMBLY-SW-CONNECTOR UUID="ce5602fe-25ea-5426-a9f2-
                    <SHORT-NAME>Ctrl_my_func_Actuator_my_func_client<
                    <PROVIDER-IREF>
                        <CONTEXT-COMPONENT-REF DEST="SW-COMPONENT-PRO
                        <TARGET-P-PORT-REF DEST="P-PORT-PROTOTYPE">/C
                    </PROVIDER-IREF>
                    <REQUESTER-IREF>
                        <CONTEXT-COMPONENT-REF DEST="SW-COMPONENT-PRO
                        <TARGET-R-PORT-REF DEST="R-PORT-PROTOTYPE">/C
                    </REQUESTER-IREF>
                </ASSEMBLY-SW-CONNECTOR>
                <DELEGATION-SW-CONNECTOR UUID="99a1f02f-6de7-5ab0-fe5
                    <SHORT-NAME>Actuator_ThrCmd_HwIO_ThrCmd_HwIO</SHO
                    <INNER-PORT-IREF>
                        <P-PORT-IN-COMPOSITION-INSTANCE-REF>
                            <CONTEXT-COMPONENT-REF DEST="SW-COMPONENT
                            <TARGET-P-PORT-REF DEST="P-PORT-PROTOTYPE
                        </P-PORT-IN-COMPOSITION-INSTANCE-REF>
                    </INNER-PORT-IREF>
                    <OUTER-PORT-REF DEST="P-PORT-PROTOTYPE">/Componen
                </DELEGATION-SW-CONNECTOR>
                <DELEGATION-SW-CONNECTOR UUID="f088e0ab-e817-5fa8-d57
                    <SHORT-NAME>TPS_Percent_Ctrl_TPS_Percent</SHORT-N
```

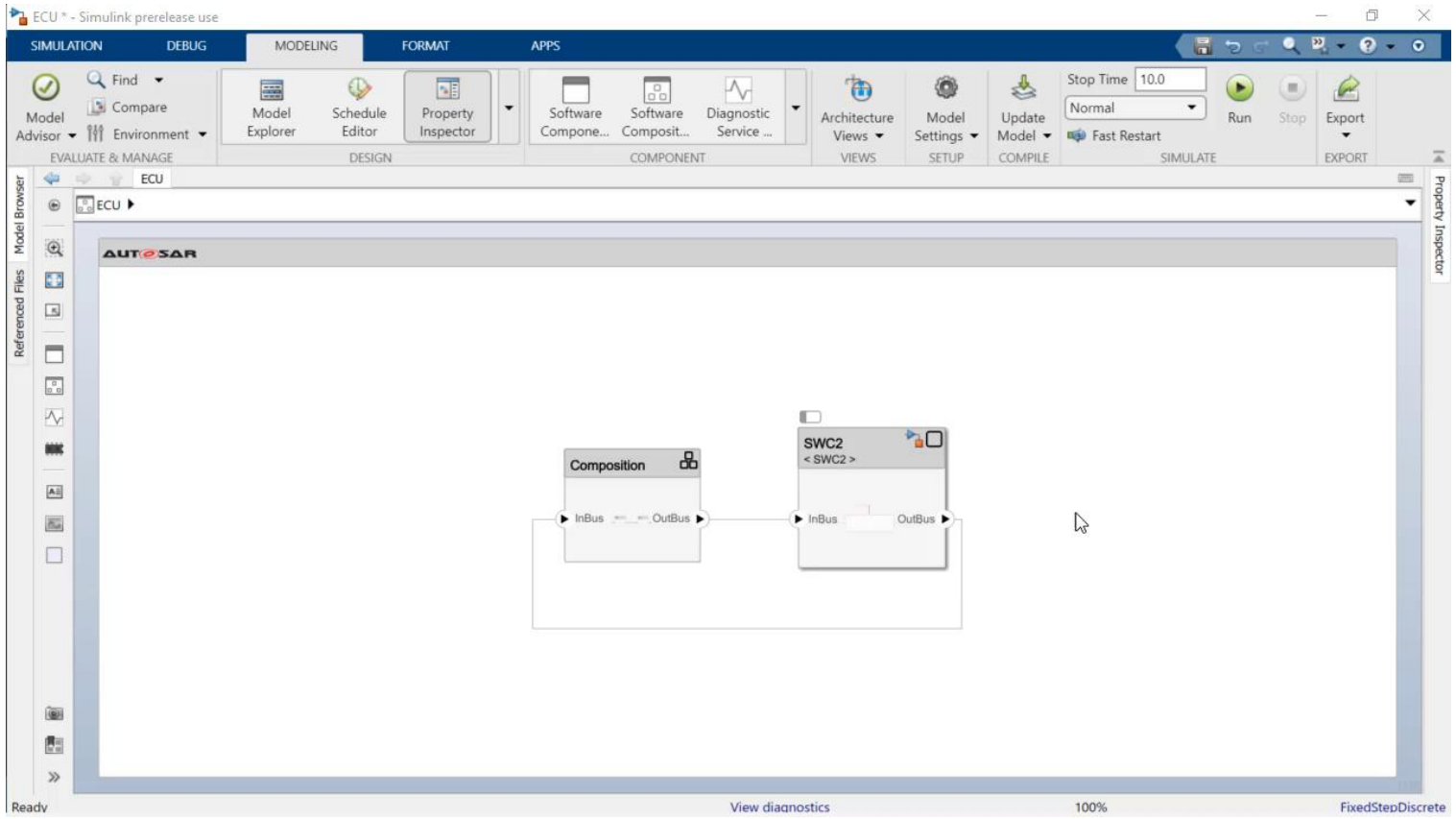
52: 8 默认文本

导出 ECU extract 与 timing ARXML



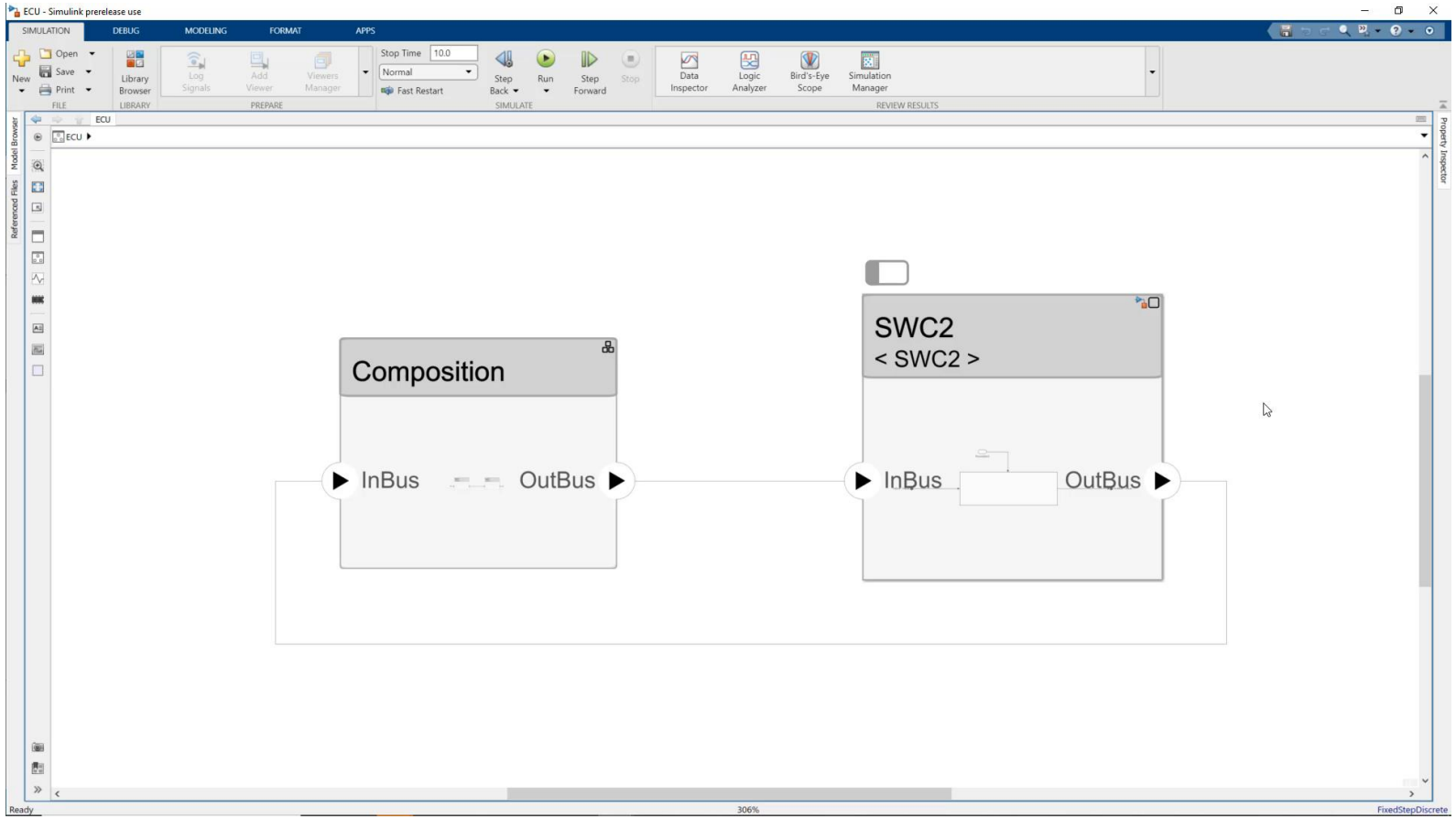
- Exporting an ECU extract – sets you up for AUTOSAR ECU configuration
- Exporting a timing model – guide runnable to task mapping

导出 ECU extract ARXML 文件示例



- ✓ Export flattened topology
- ✓ Automatic mapping of SWCs to an ECU
- ✓ Sets you up for AUTOSAR ECU configuration

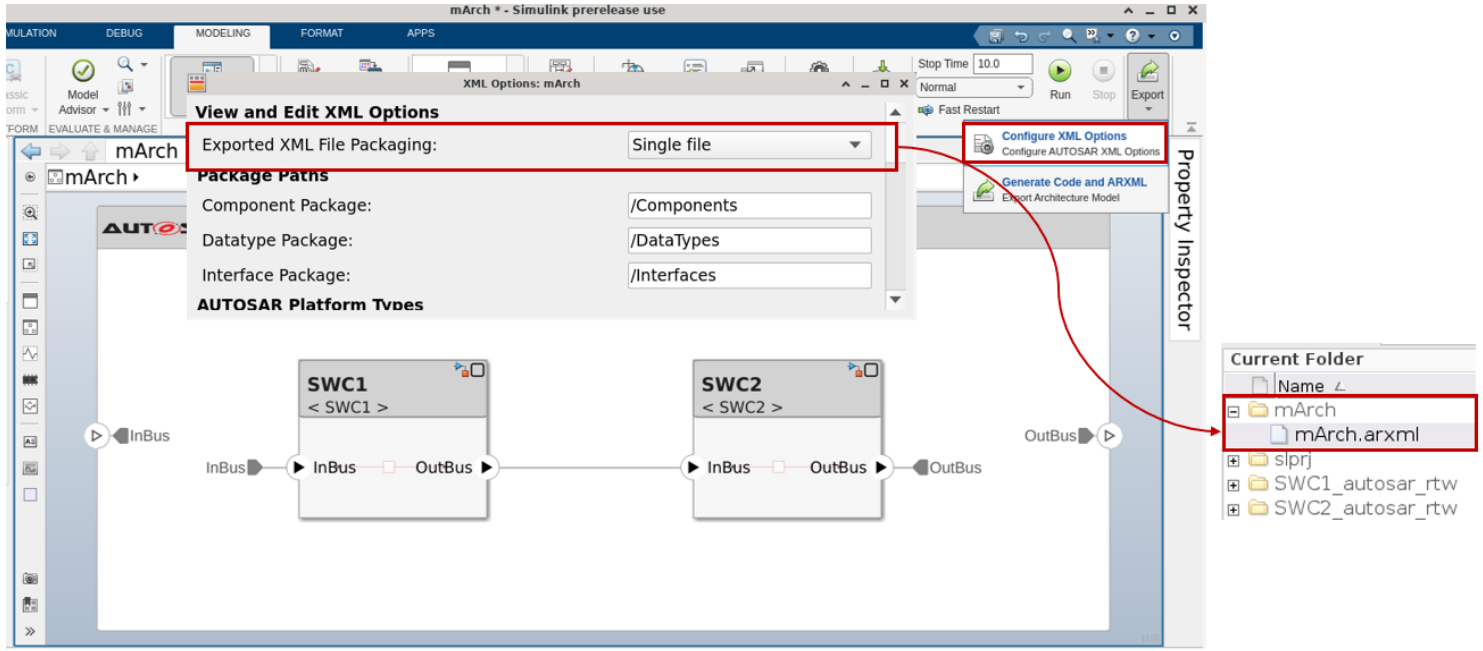
导出 timing ARXML 文件示例



- ✓ Exporting a timing model
- ✓ Guide runnable to task mapping
- ✓ Preserve simulated behaviour

把 SW-Composition 导出为单个 ARXML 文件

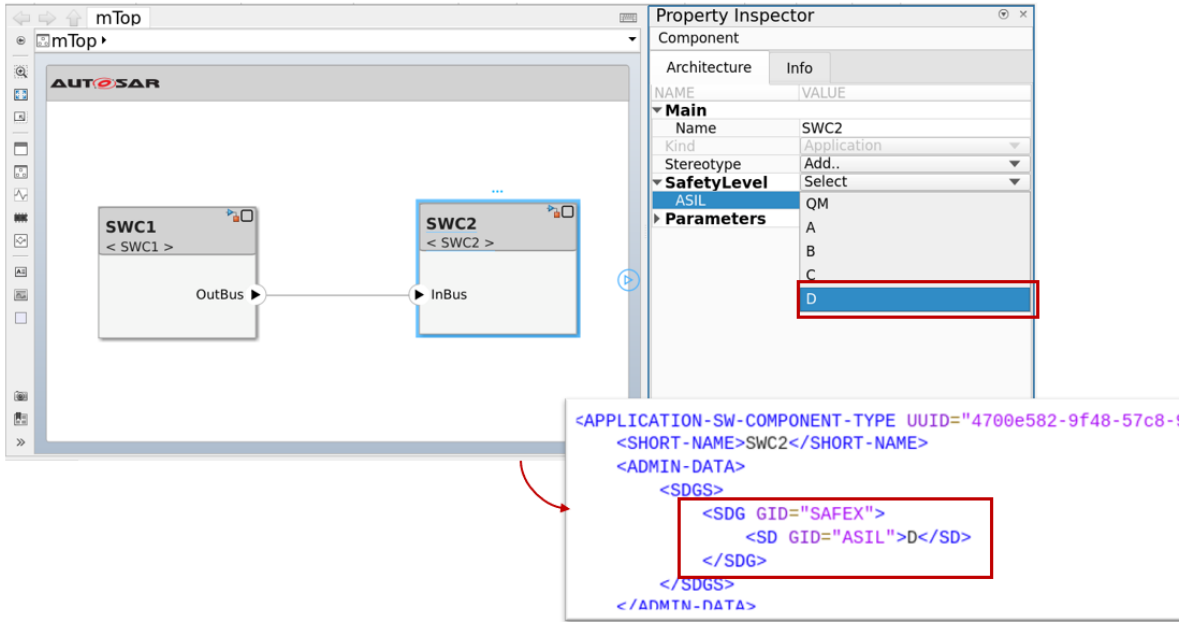
- Control file packaging for exported ARXML from AUTOSAR architecture model
- Support both SingleFile and Modular ARXML file packaging
- Use XmlOptions in AUTOSAR architecture model toolstrip to specify packaging



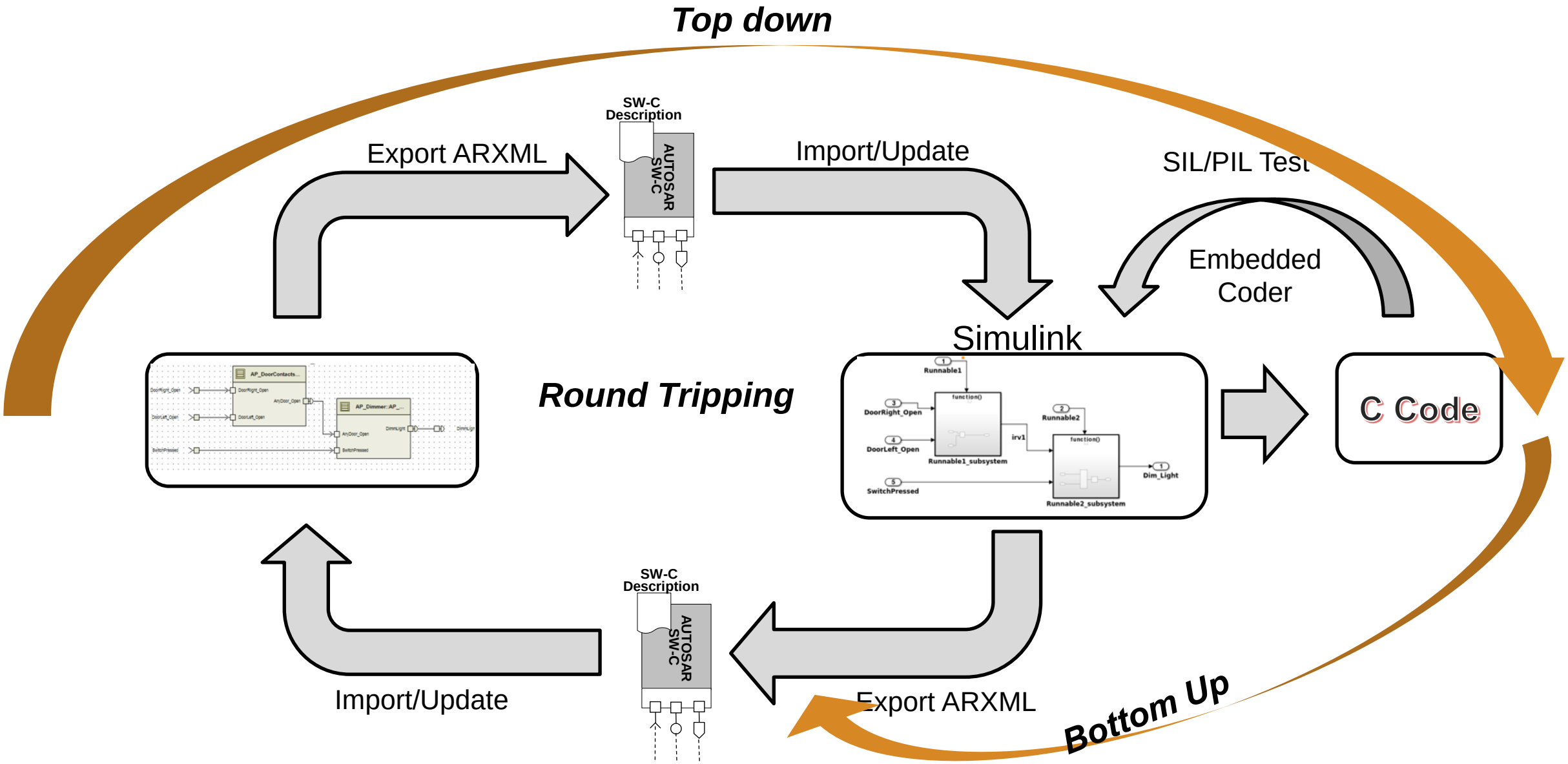
导入/导出/编辑 ASIL 属性

Export and Import ASIL information from AUTOSAR architecture model

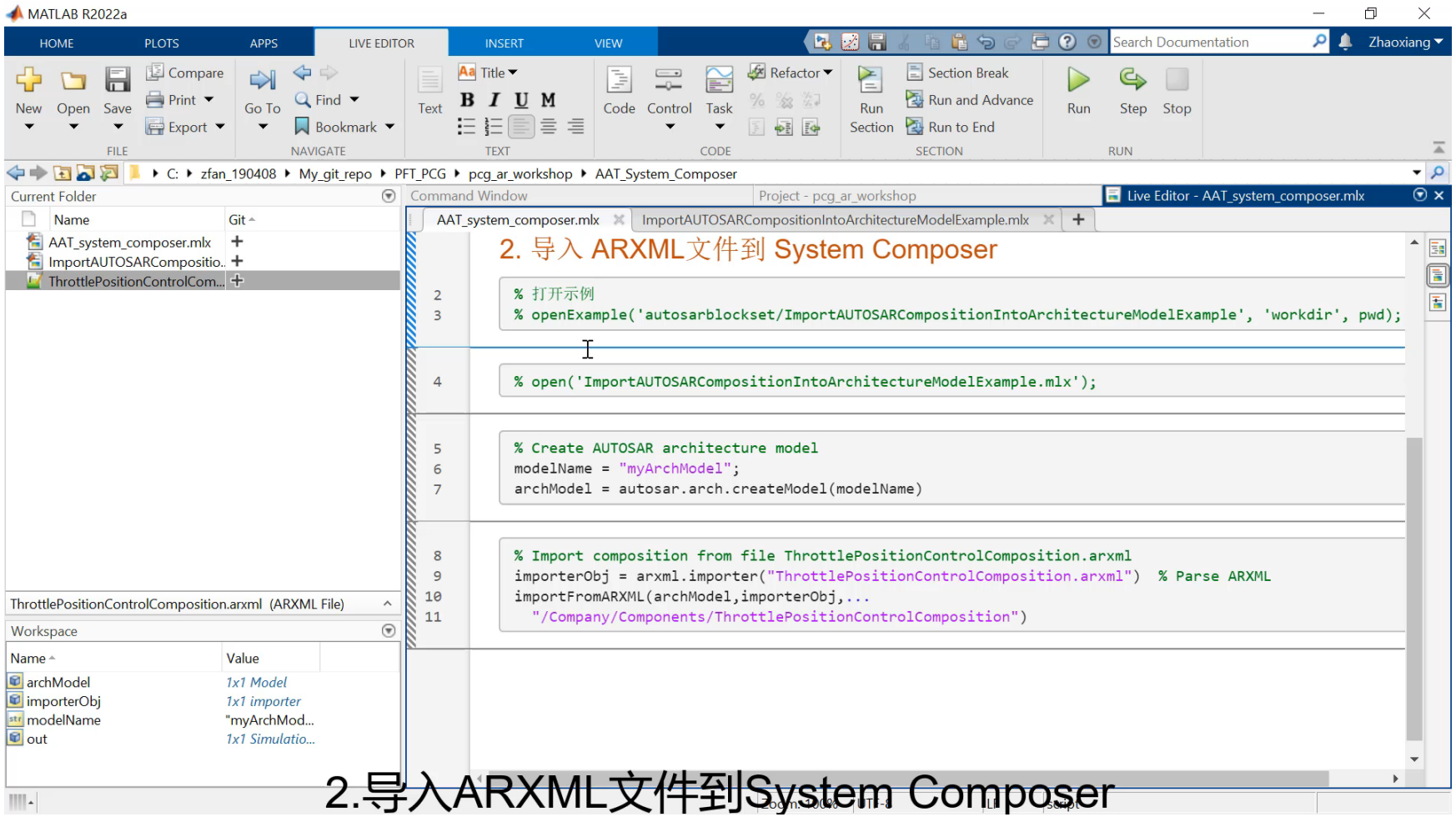
- Specify ASIL safety level (QM, A, B, C, D) for Composition blocks, Component blocks and Ports
- Validation will flag any inconsistencies when outport has higher safety level than owning atomic component
- Information is exported to AUTOSAR AdminData in arxml per AUTOSAR_TPS_SafetyExtensions.pdf
- Import from ARXML to AUTOSAR architecture model will also import ASIL information



支持 AUTOSAR 3 种工作流开发模式

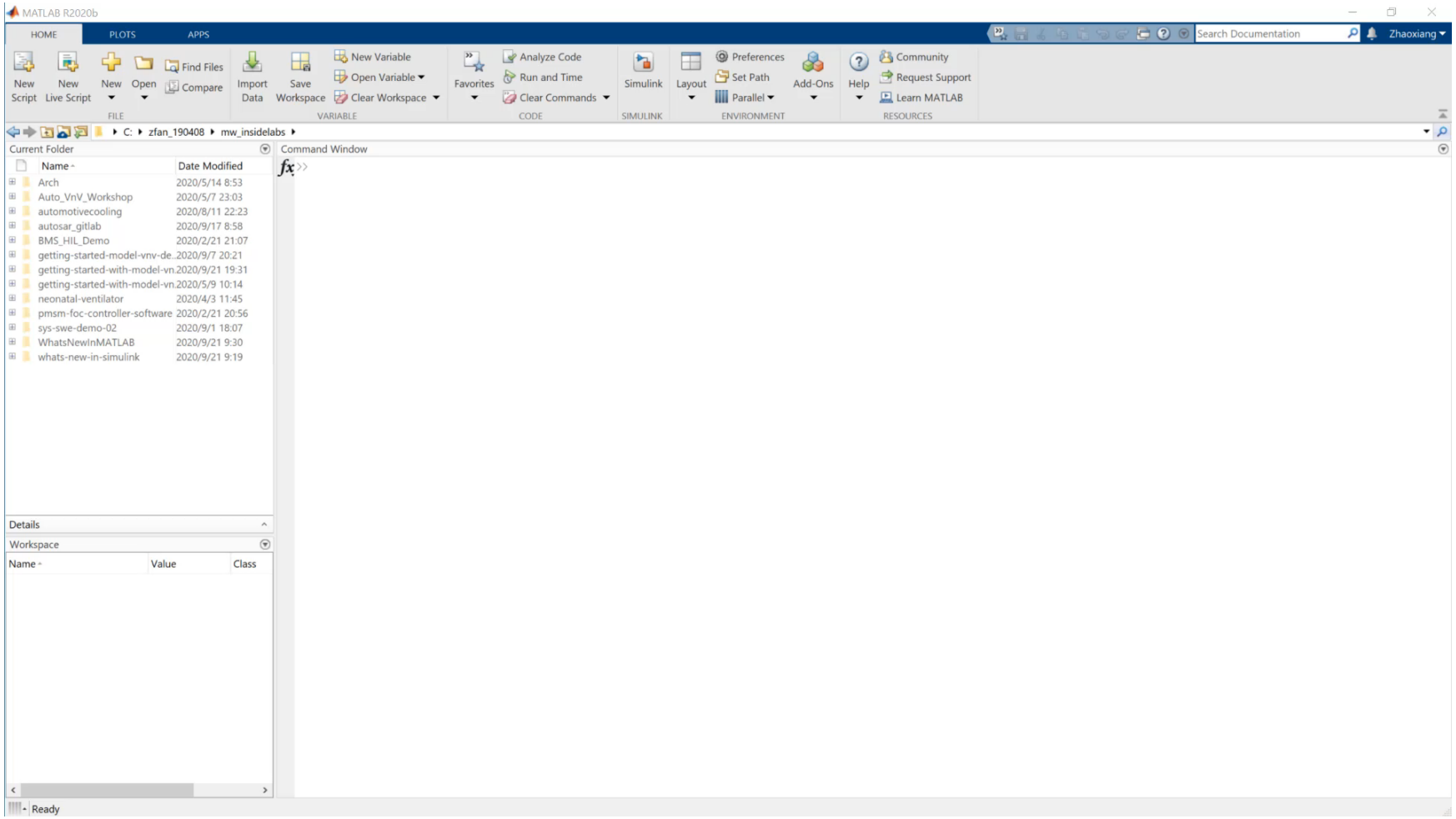


AUTOSAR 架构设计工作流 —— ARXML 导出/导入工作流

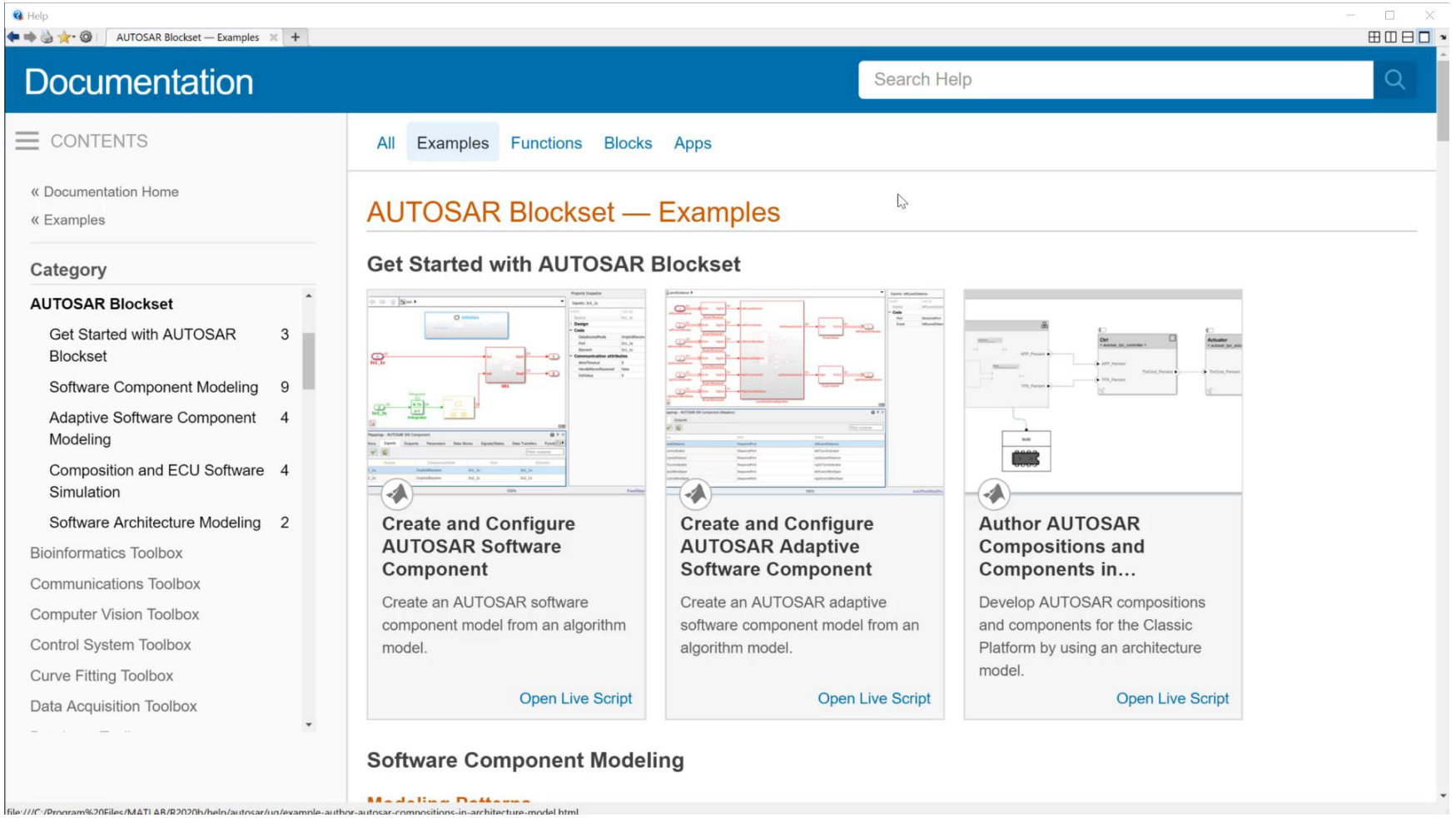


2.导入ARXML文件到System Composer

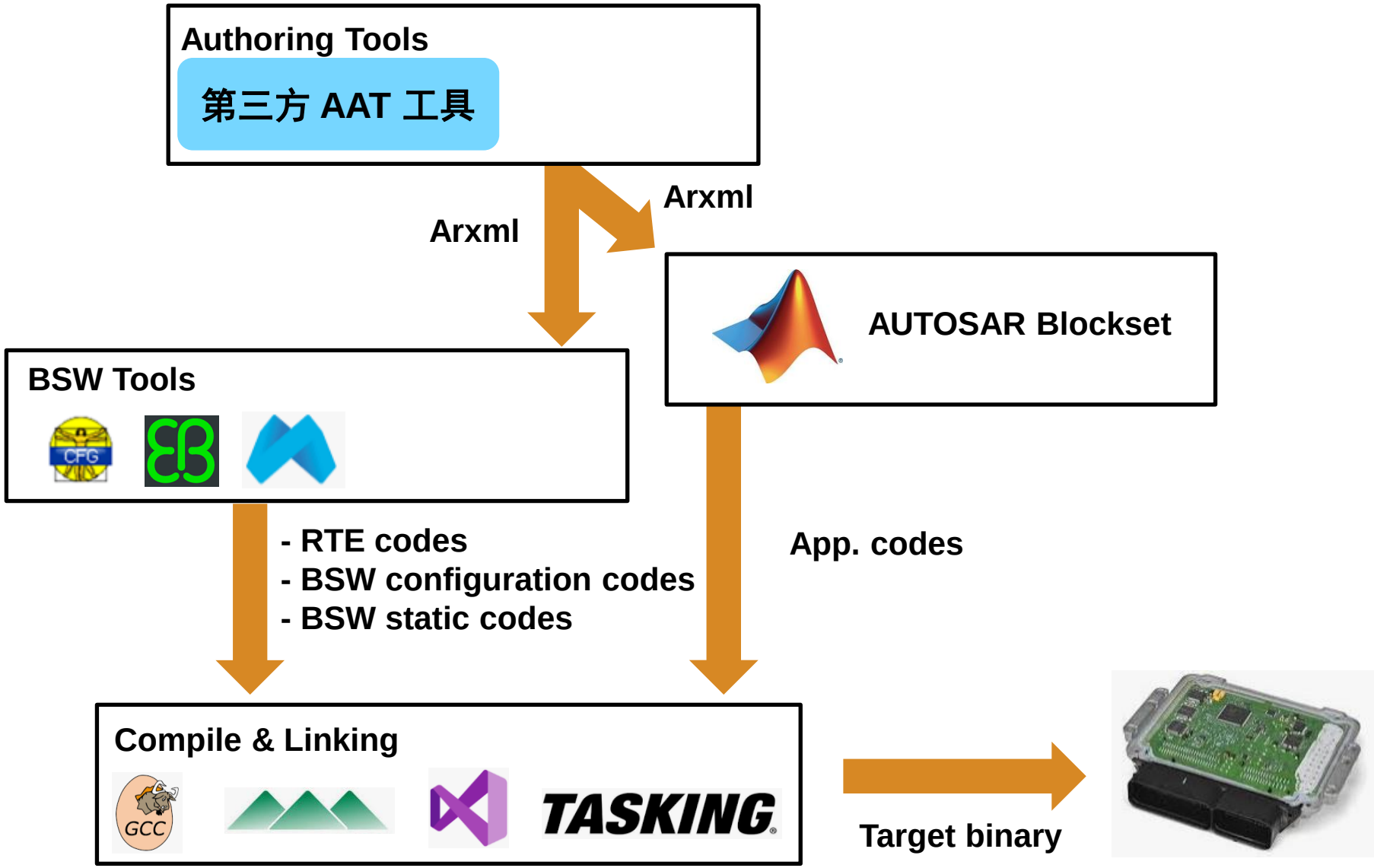
SWC 实现 —— AUTOSAR自上而下(*Top down*)工作流演示



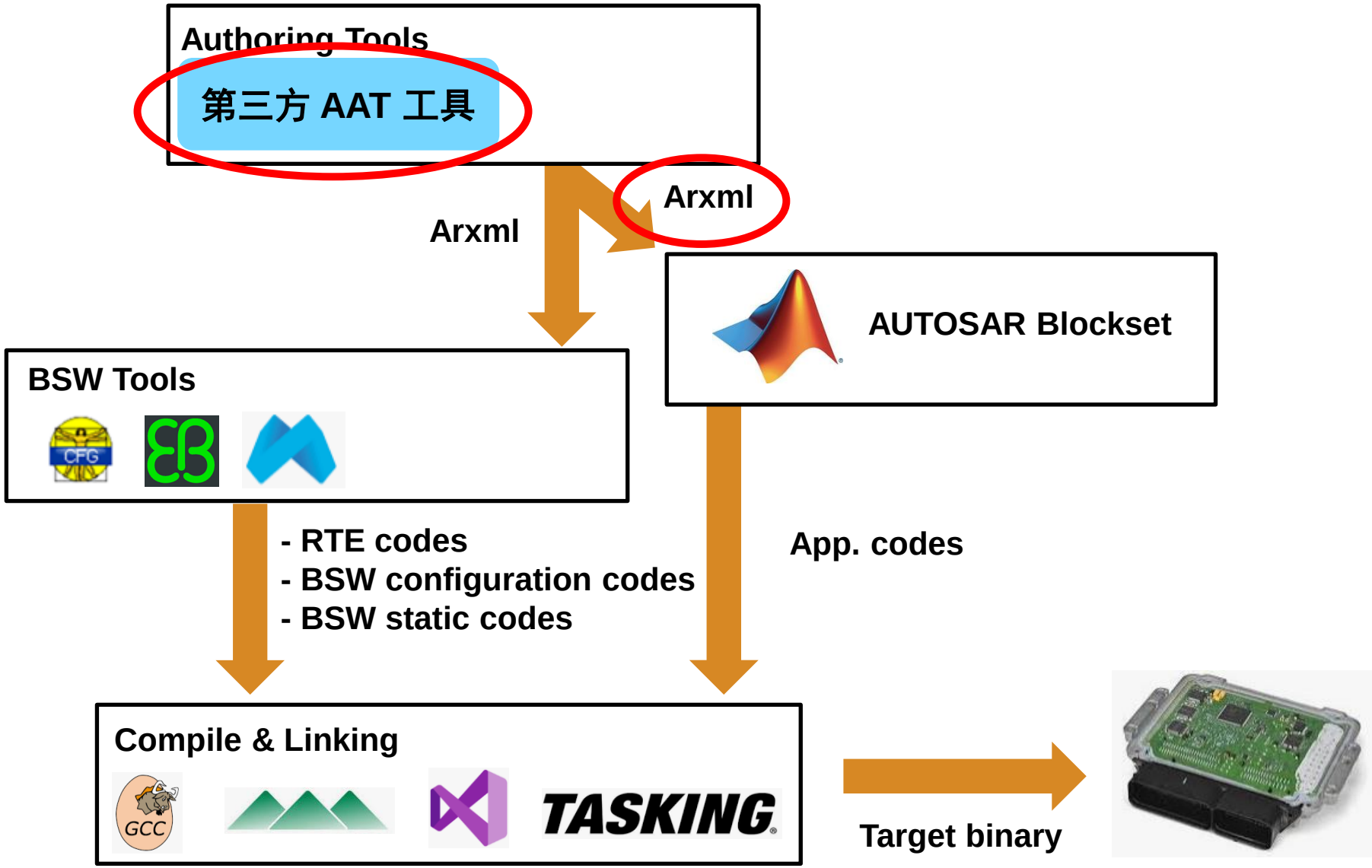
SWC 实现 —— AUTOSAR自下而上(*Bottom Up*)工作流演示



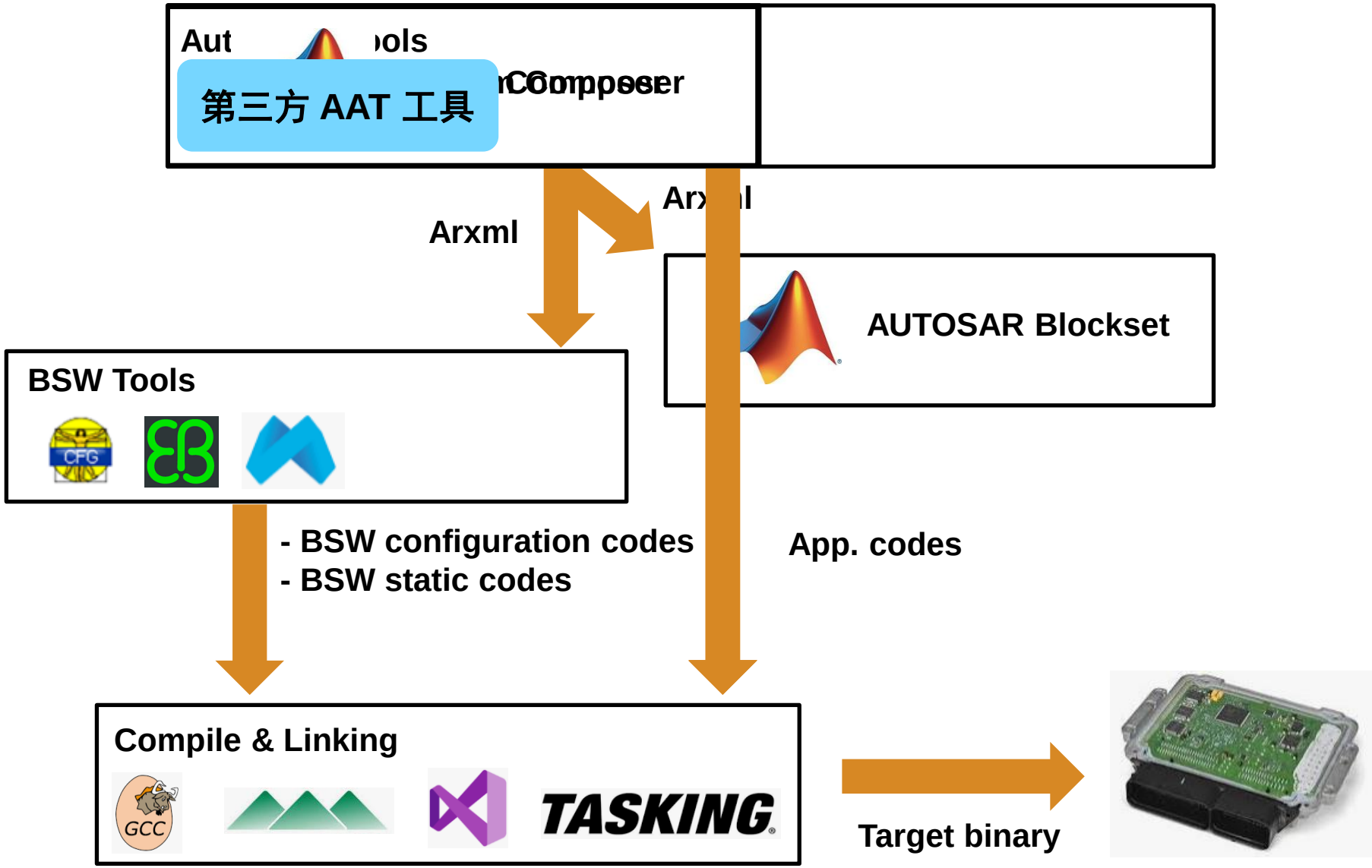
使用第三方 AAT 工具的 MBD Workflow (1)



使用第三方 AAT 工具的 MBD Workflow (2)

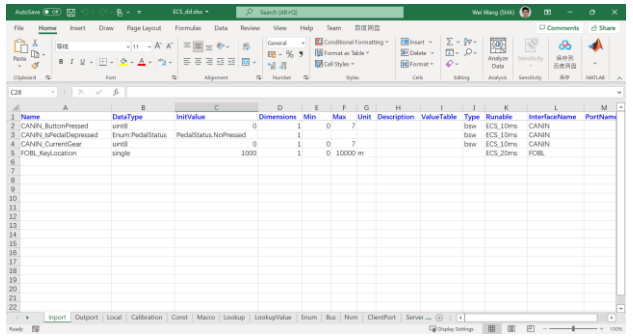


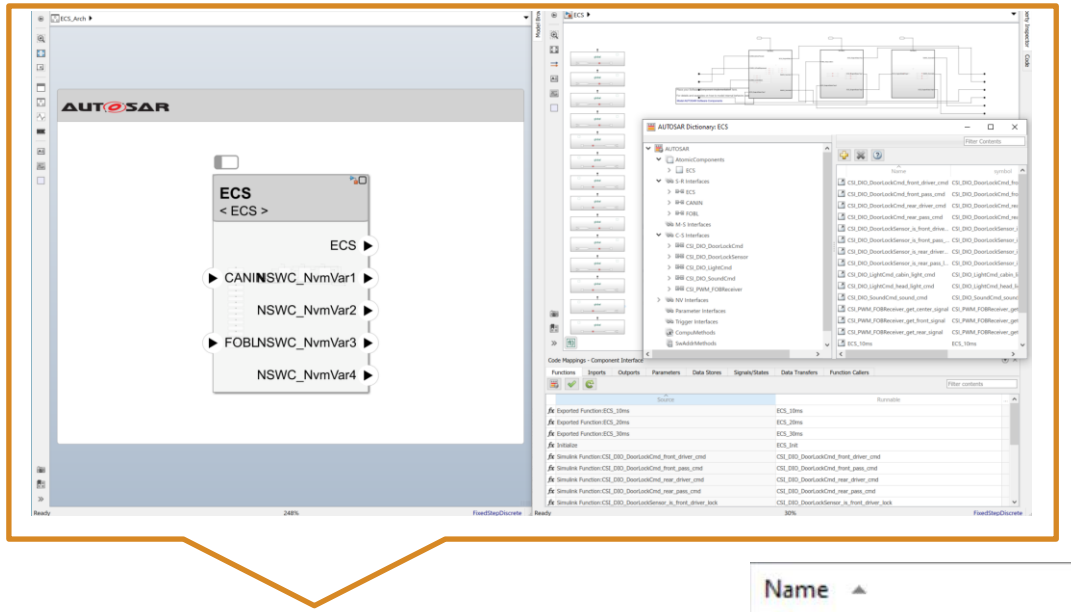
使用 System Composer 的 MBD Workflow (2)



基于 Excel 生成 AUTOSAR 架构导出 ARXML 文件

- 解析EXCEL数据，并基于MATLAB AUTOSAR架构设计工具System Composer自动创建AUTOSAR架构设计模型，然后导出AUTOSAR架构设计文件ARXML；





脚本

基于MATLAB API

Name	Size	Item type	Date modified
ECS_Arch_composition.arxml	1.26 KB	ARXML File	2022/5/9 22:50
ECS_Arch_datatype.arxml	11.4 KB	ARXML File	2022/5/9 22:50
ECS_Arch_interface.arxml	32.2 KB	ARXML File	2022/5/9 22:50
ECS_Arch_timing.arxml	3.79 KB	ARXML File	2022/5/9 22:50
ECS_component.arxml	64.0 KB	ARXML File	2022/5/9 22:50
ECS_implementation.arxml	8.01 KB	ARXML File	2022/5/9 22:50
ECS_timing.arxml	12.3 KB	ARXML File	2022/5/9 22:50

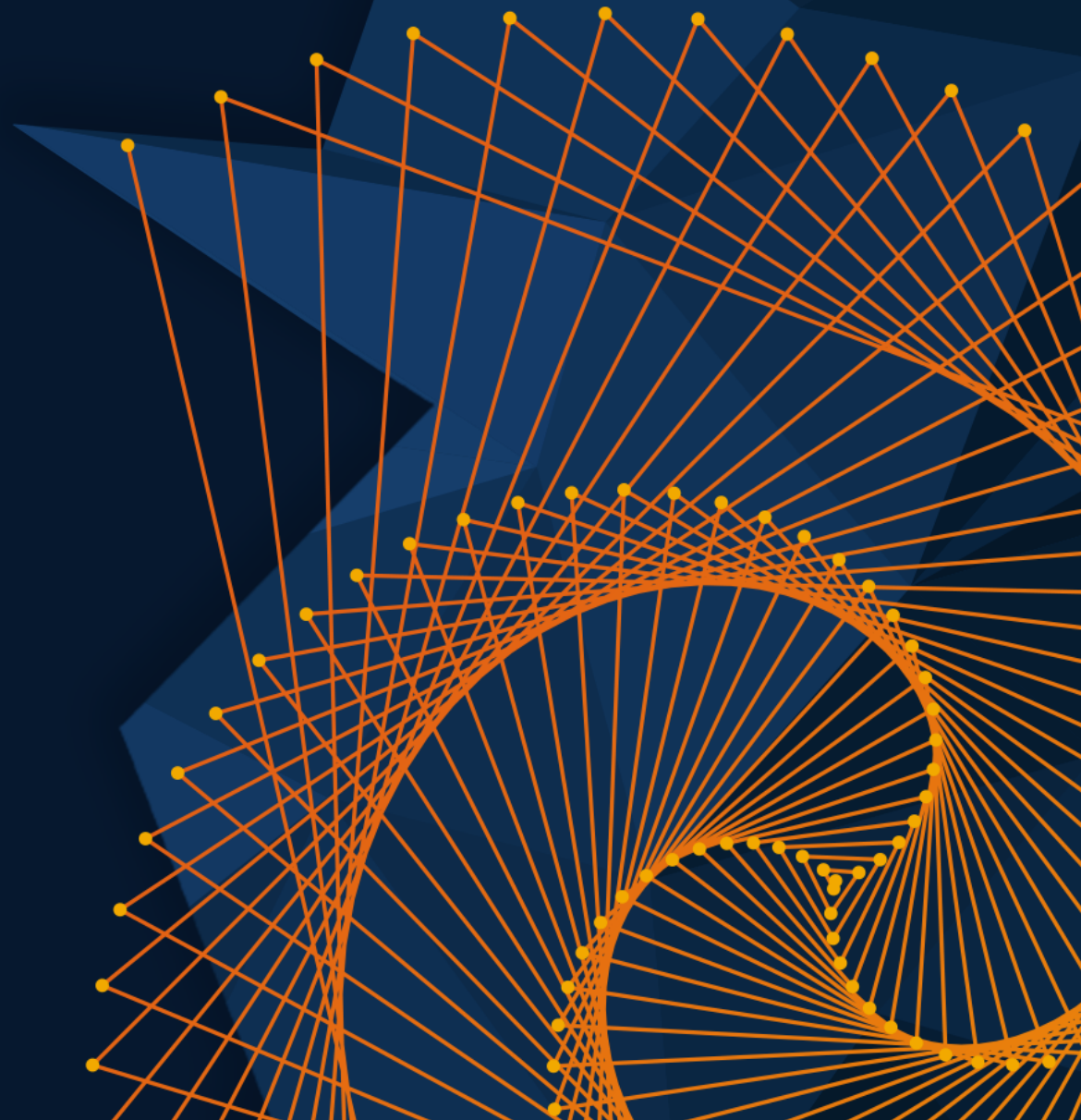
System Composer
AUTOSAR Blockset

主要内容

- AUTOSAR解决方案的进化
- System Composer实现软件架构设计
- SWC的Simulink实现
- 基于Excel的AUTOSAR架构设计

MATLAB EXPO

Thank you



MathWorks®