Evolution of Simulink for Signal and SOA based Applications

Oct 10, 2023 | MAC, Chennai

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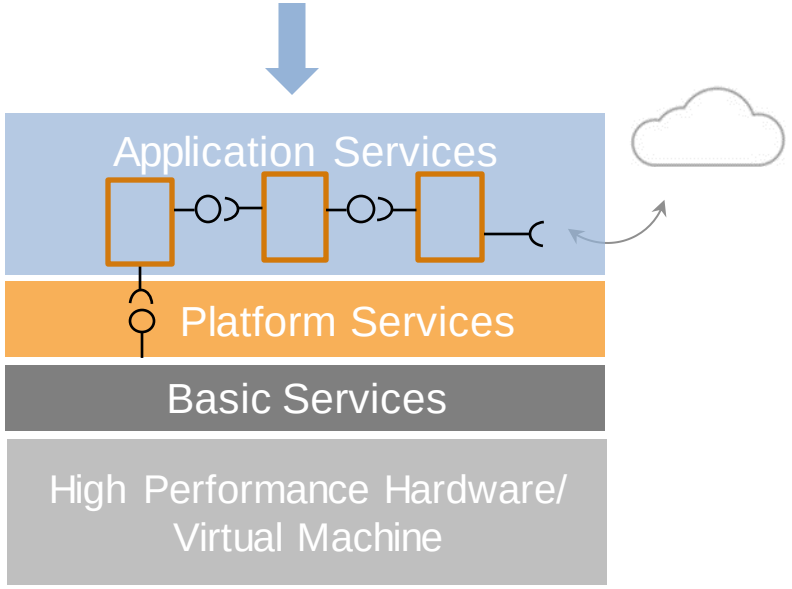
In the era of Software-Defined Vehicle

- Automotive industry is embracing Service-Oriented Architectures (SOA) as a new paradigm to design modern applications like Software-Defined Vehicles (SDVs)

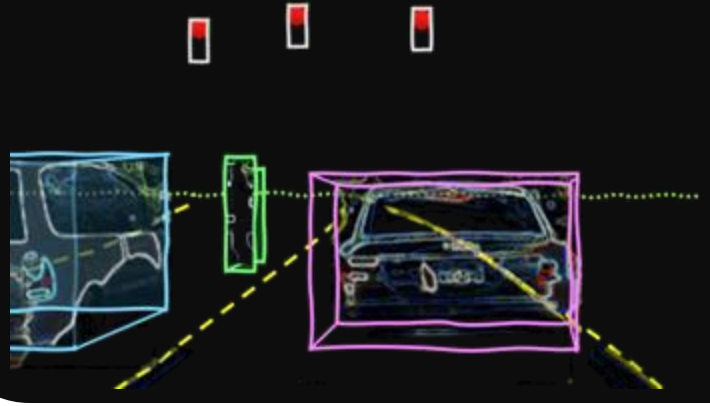
SW updates
- Frequent
- Selective
- Over-the-air



Higher HW abstraction:
Service-oriented architectures

Automakers are increasingly building software in-house with SOA based design

Software Defined Vehicle

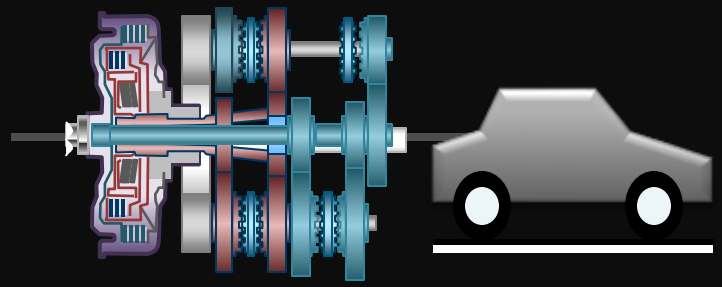


Autonomy
Connectivity
AI

Steering,
Braking

Speed,
Velocity

Traditional Vehicle



Controls
Real-time
CAN

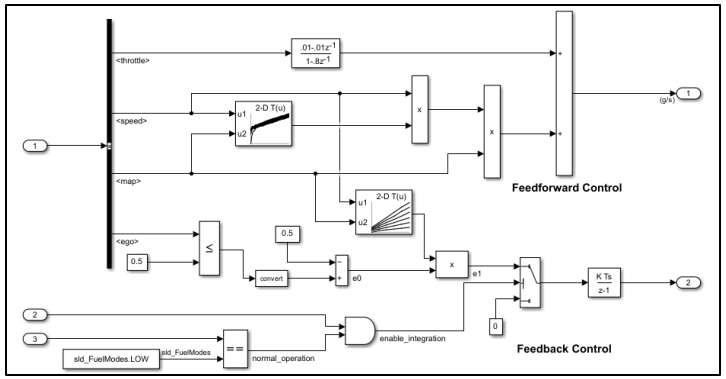
SOA based standards

AUTOSAR Adaptive Platform

ROS

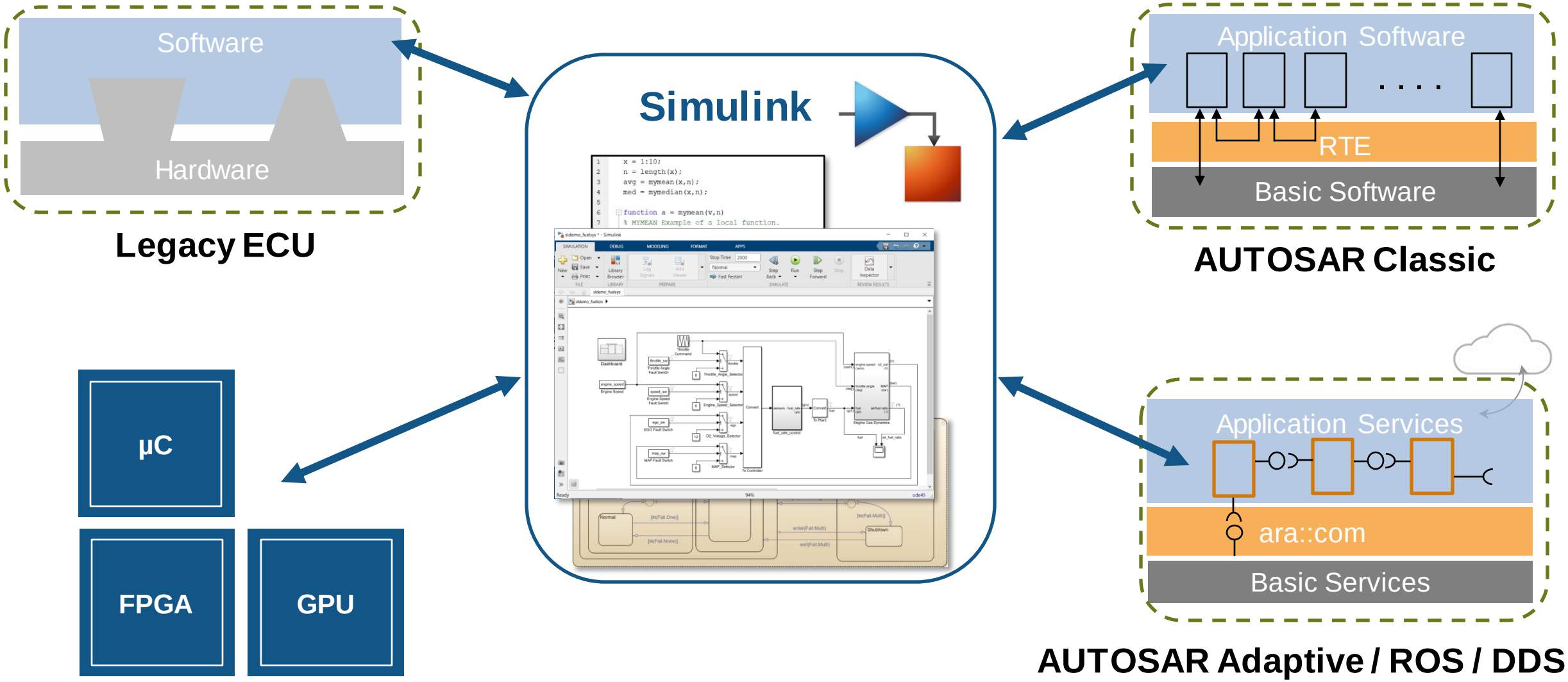
DDS

Model-Based Design



AUTOSAR

Simulink: deploy software to different targets and standards



Agenda

- Advanced Simulink semantics for the development of services
- Software architecture modeling
- Conclusions and key takeaways

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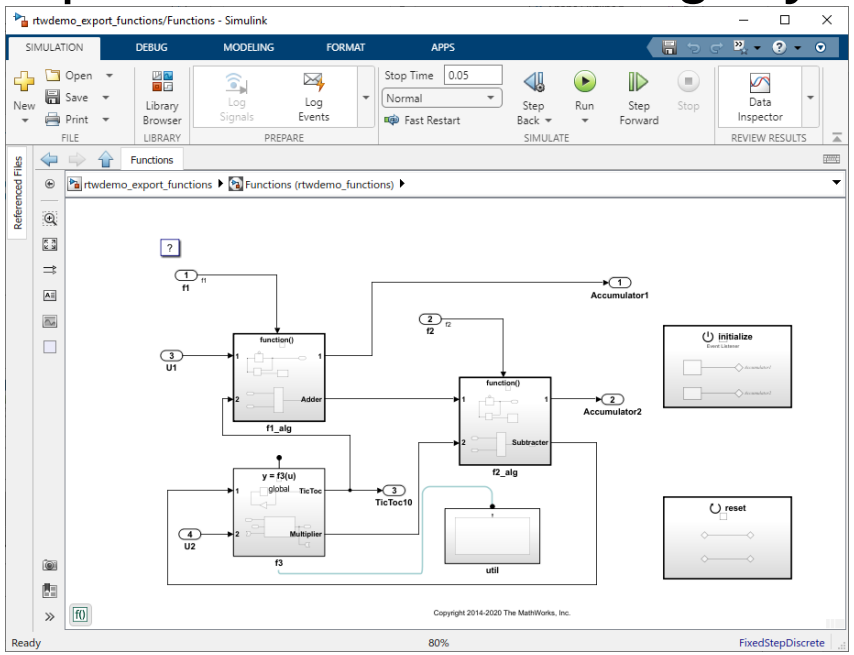
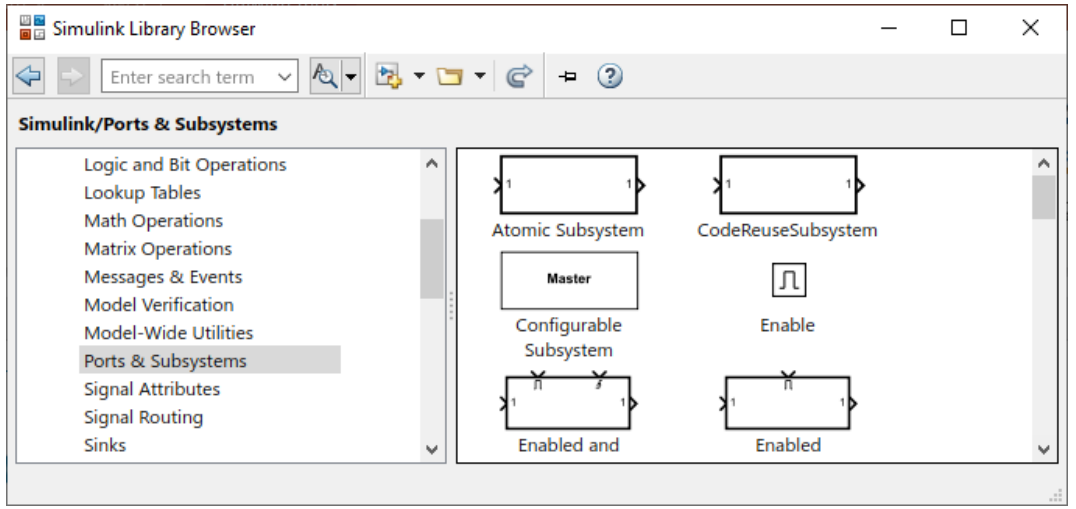
Simulink Supports Exporting Callable Functions Well

- Export Function Modeling style

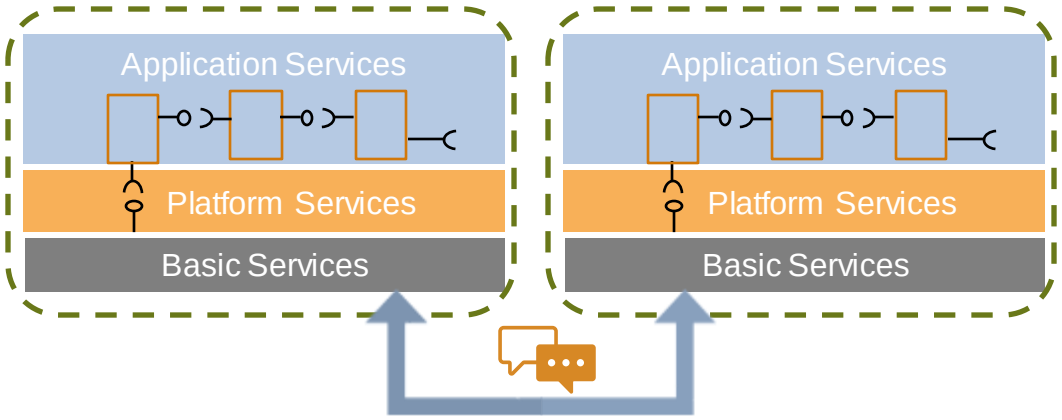


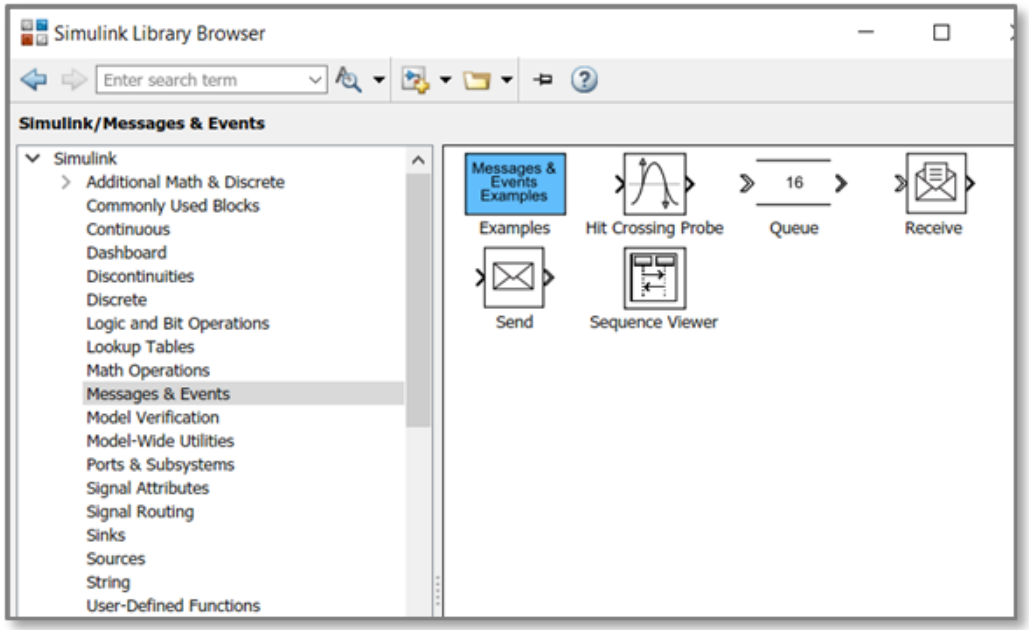
rtwdemo_export_functions

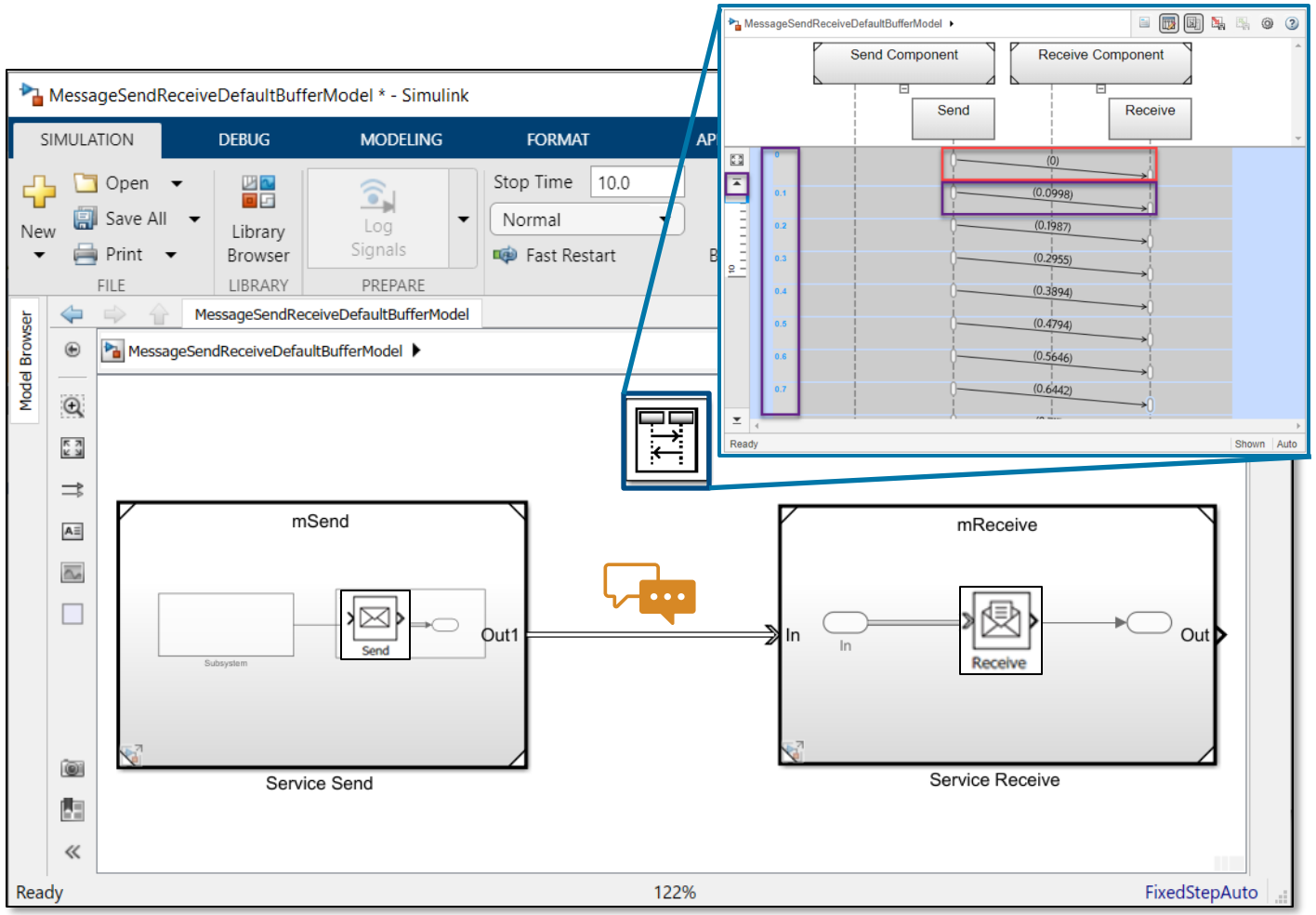


Ports and Subsystems

Service-Oriented Behavior Modeling with Simulink Messages





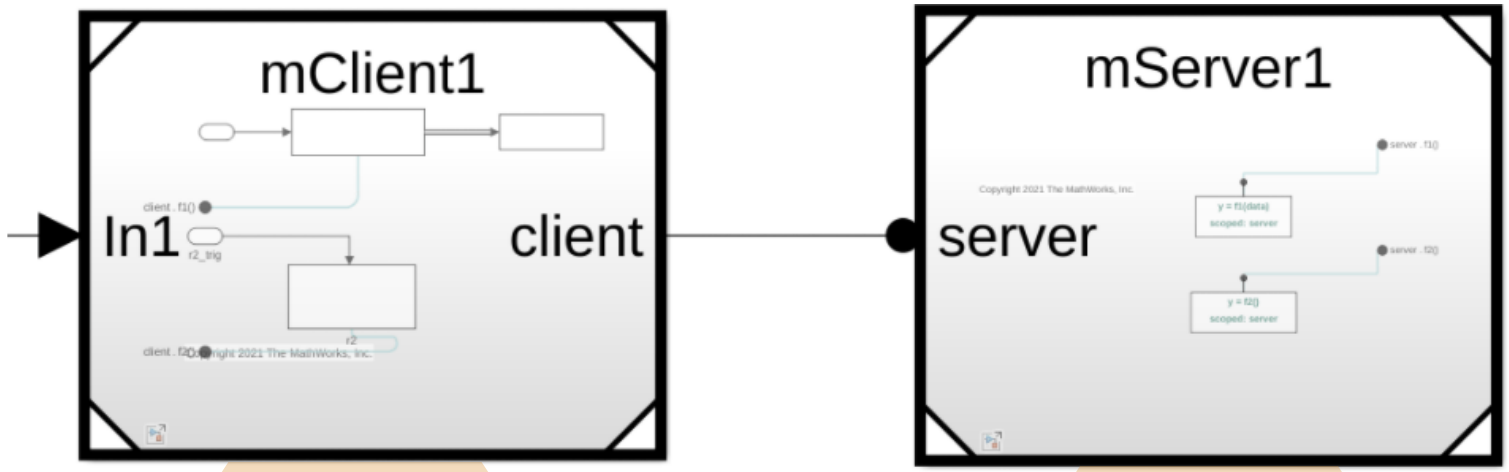


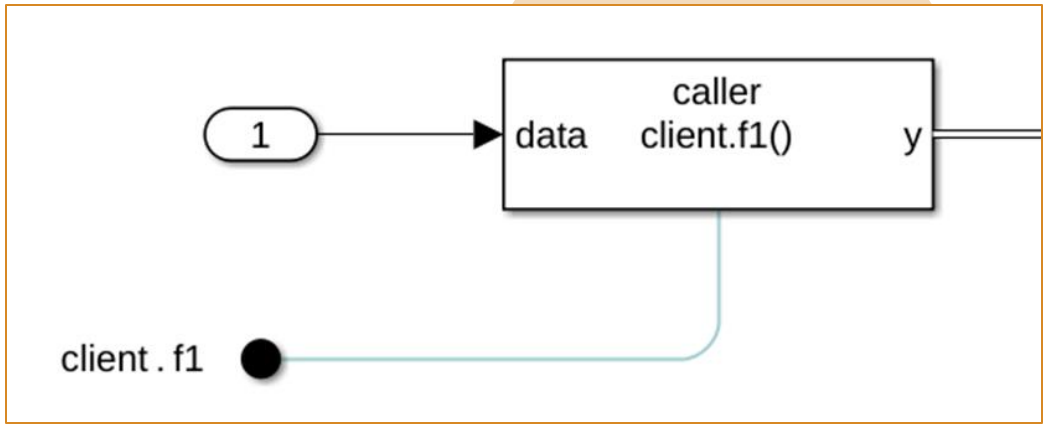
You can model service-oriented communication using messages (Send/Receive)

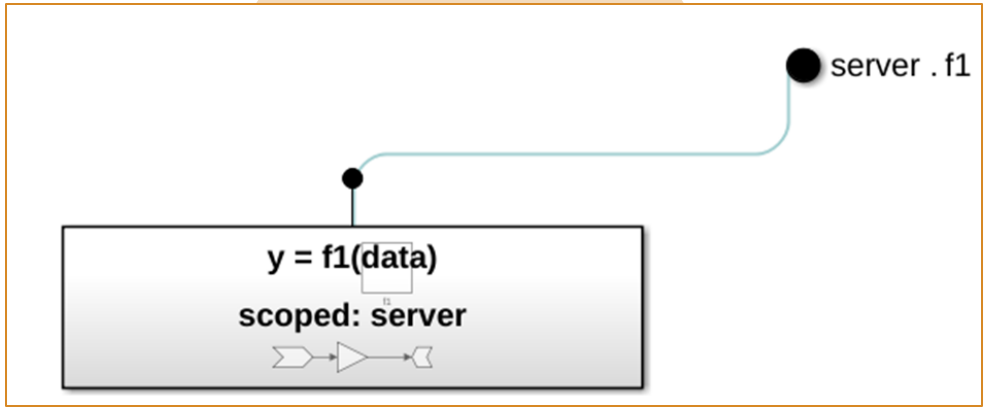
https://www.mathworks.com/help/simulink/ug/simulink-messages-overview.html

Service-Oriented Behavior Modeling with Service-Based Functions

Function Ports for SOA



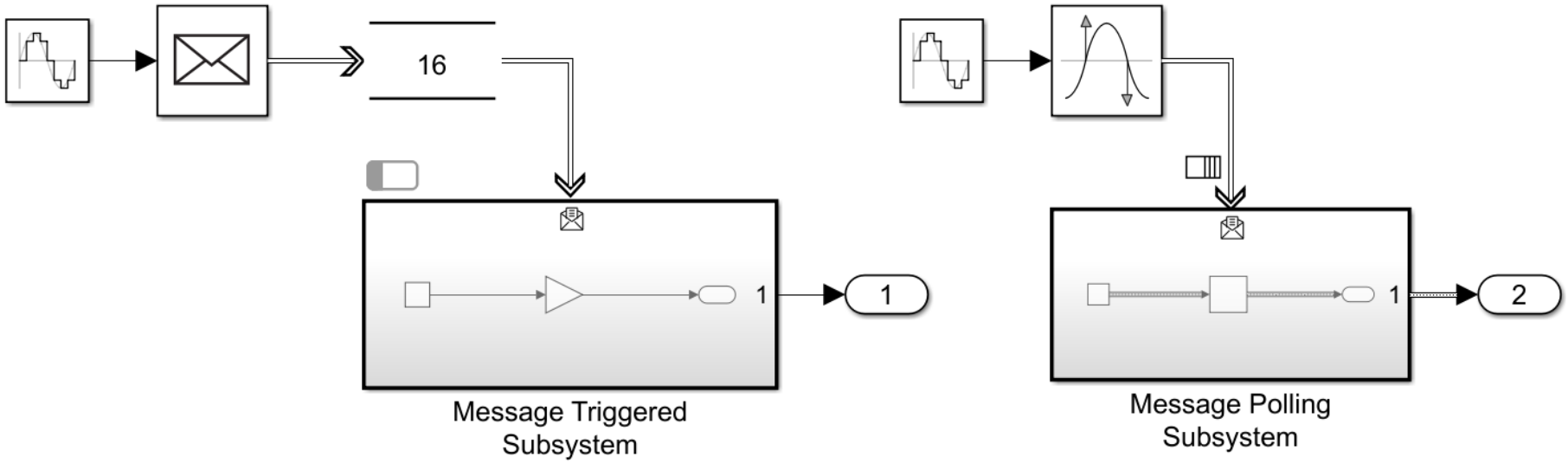




Model client and server components to facilitate data sharing using a functional interface between component models

https://www.mathworks.com/help/simulink/ug/call-simulink-functions-in-other-models-using-function-ports.html

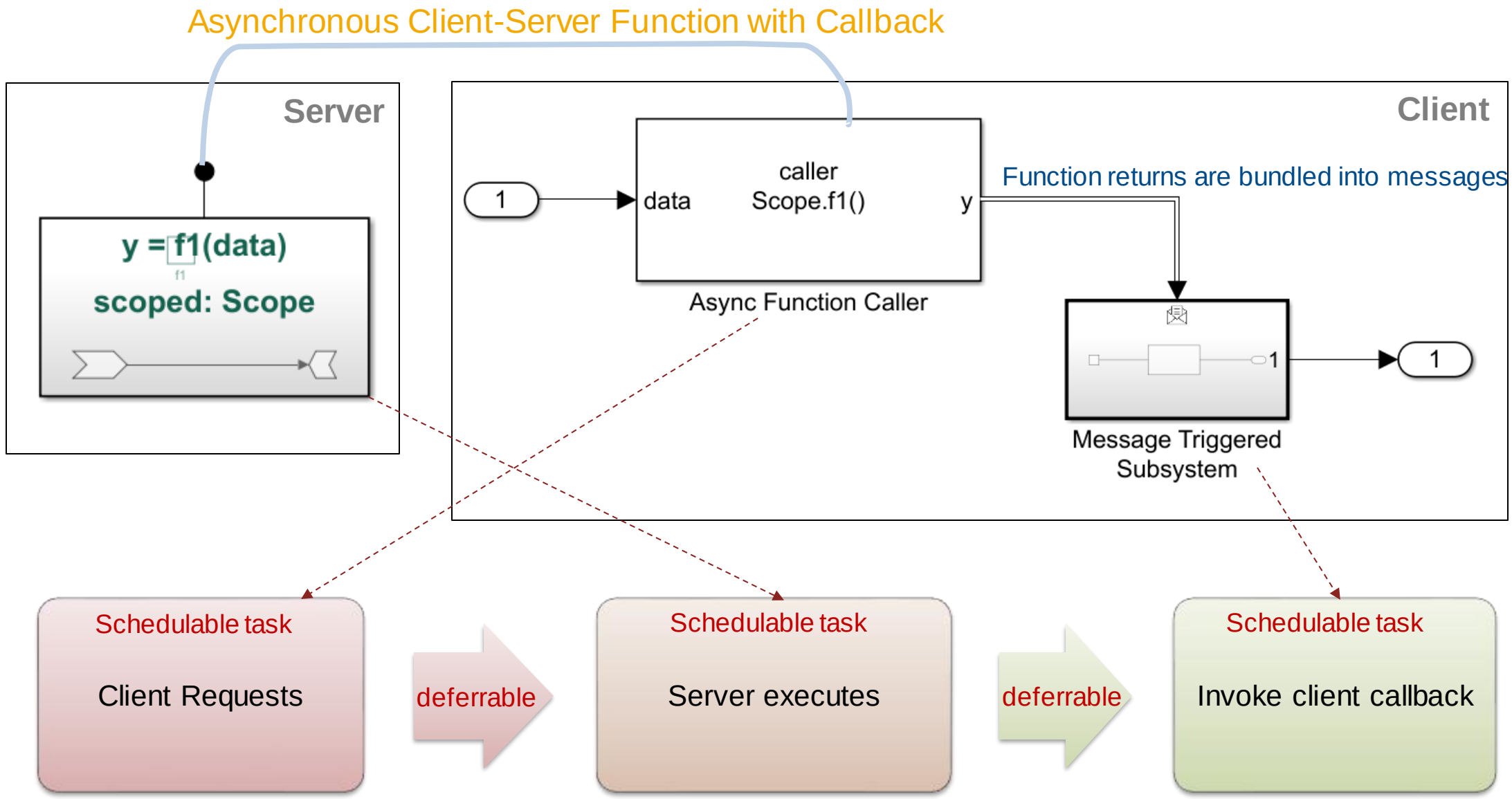
Service-Oriented Behavior Modeling with Message Triggered/Polling Subsystem



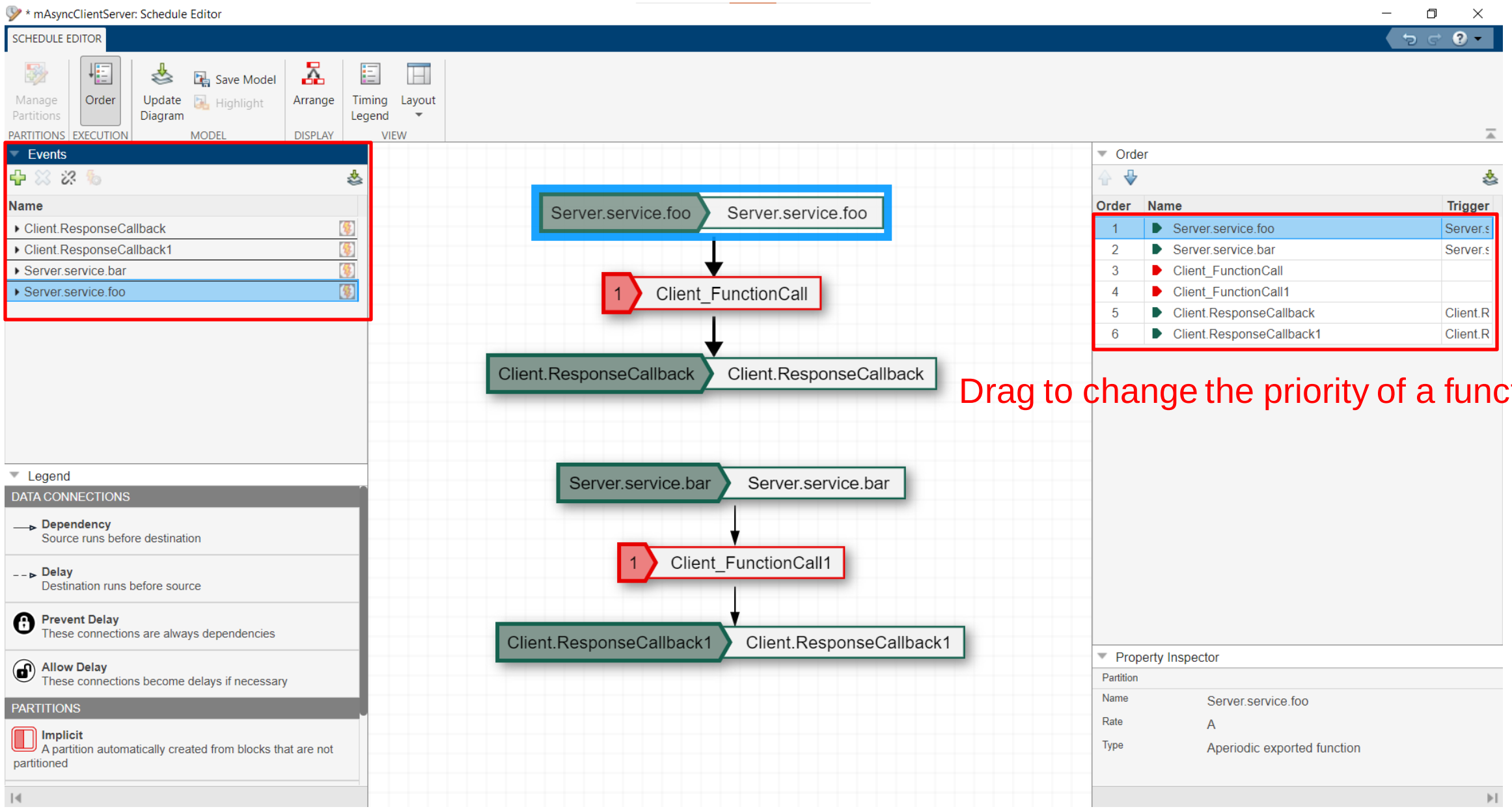
- New blocks to process messages by executing subsystem when message is available
- Model and generate code for components that are executed on message arrival

https://www.mathworks.com/help/simulink/ug/message-triggered-and-message-polling-subsystems.html

Service-Oriented Behavior Modeling with Service-Based Functions



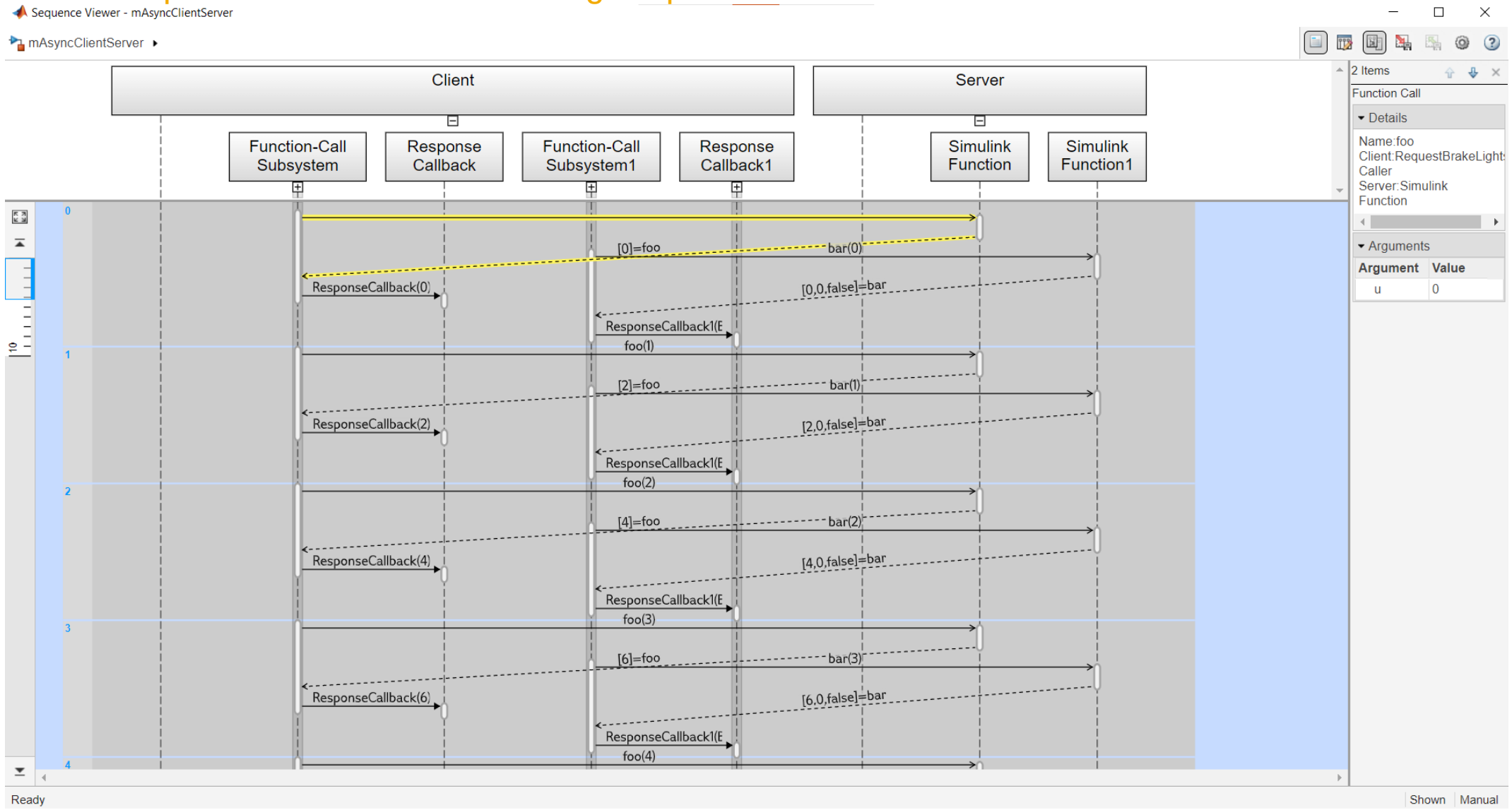
Service-Oriented Behavior



https://www.mathworks.com/help/simulink/ug/schedule-editor-overview.html

Service-Oriented Behavior Modeling

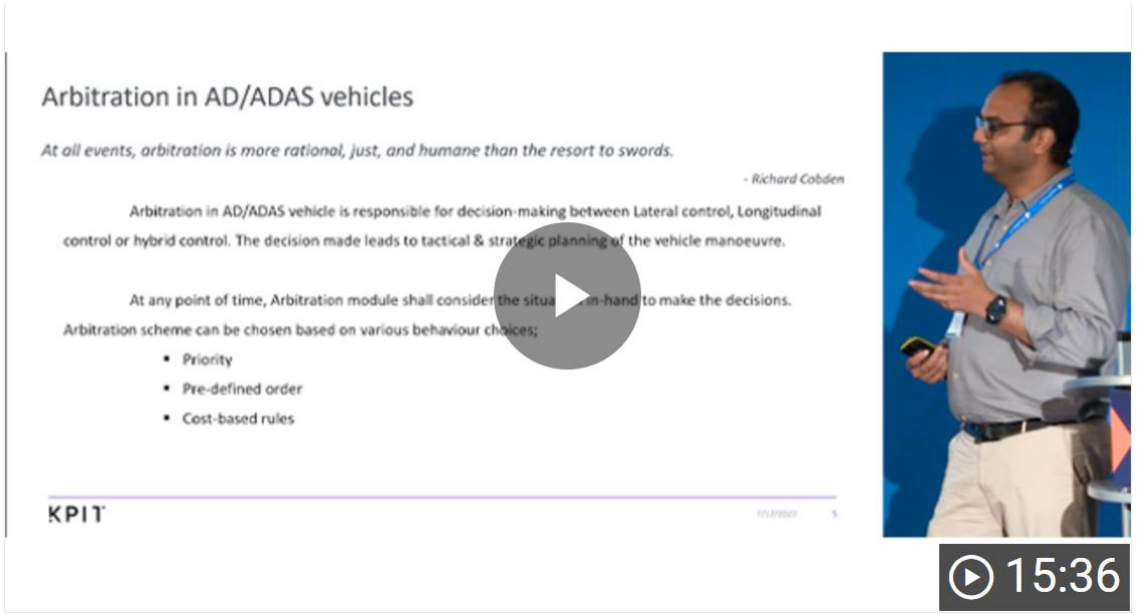
Visualize Sequence of Service Calls Using Sequence Viewer



https://www.mathworks.com/help/systemcomposer/ref/sequenceviewertool.html

User Presentations on SOA

[Zeekr - Using Model-Based Design to Develop SOA Applications for In-Vehicle OS]



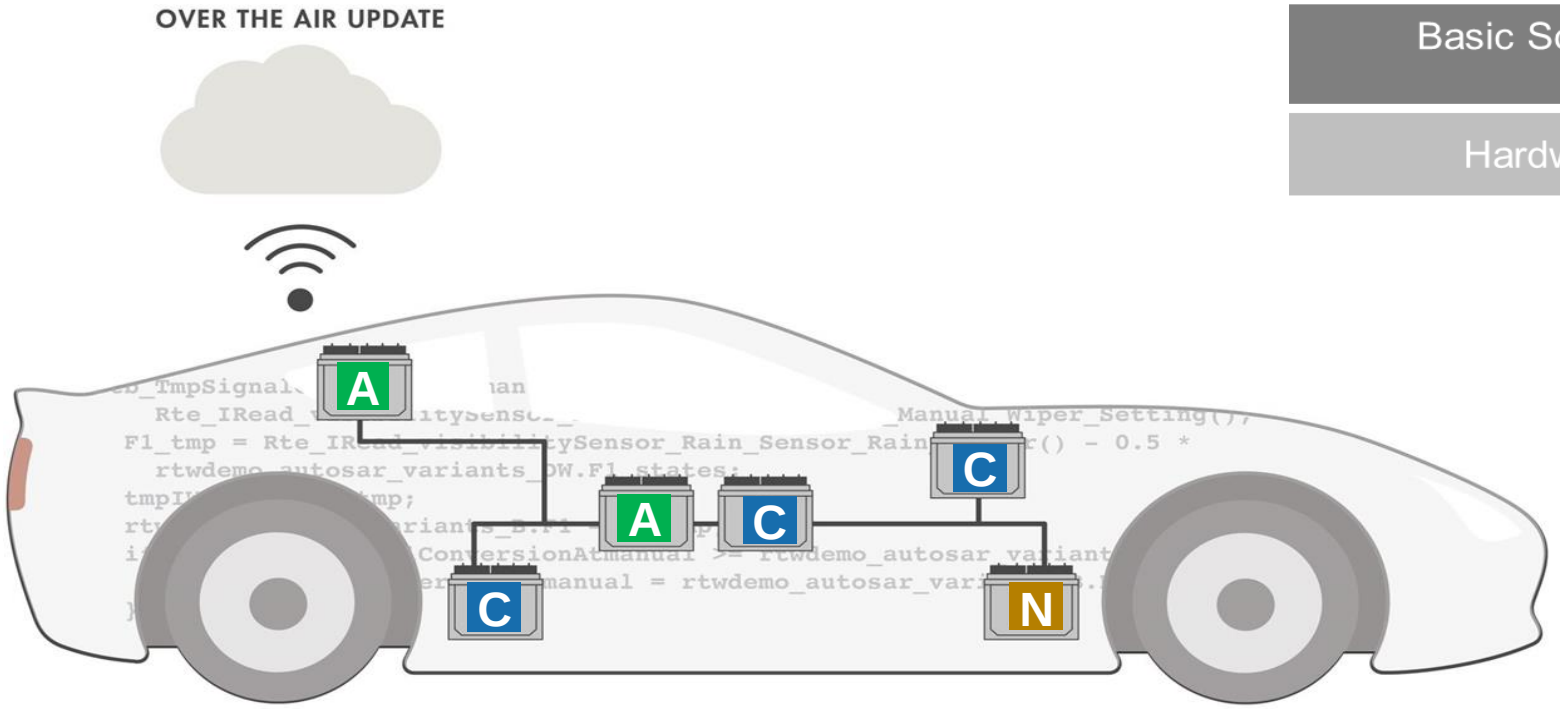
[KPIT - Service-Oriented Arbitration of ADAS Features with Model-Based Design]

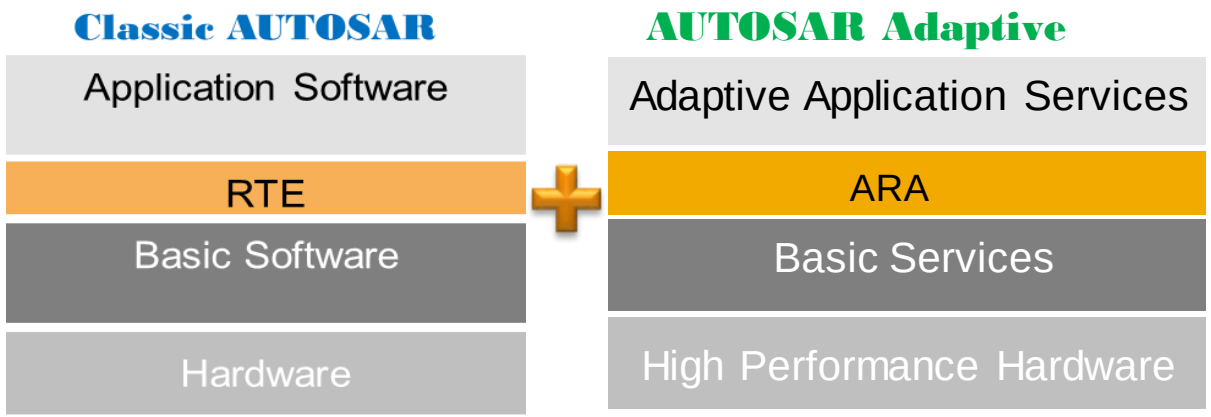
Agenda

- Advanced Simulink semantics for the development of services
- Software architecture modeling
  - AUTOSAR Classic – signal based
  - AUTOSAR Adaptive – services based
- Conclusions and key takeaways

AUTOSAR Classic & Adaptive

AUTOSAR® (**AUT**omotive **O**pen **S**ystem **AR**chitecture) is an open and standardized automotive software architecture





N Non - AUTOSAR

C Classic - AUTOSAR

A Adaptive - AUTOSAR

embeddedworld2022
Exhibition&Conference
...it's a smarter world

Develop and Integrate AUTOSAR Classic and Adaptive Applications Based on SOME/IP

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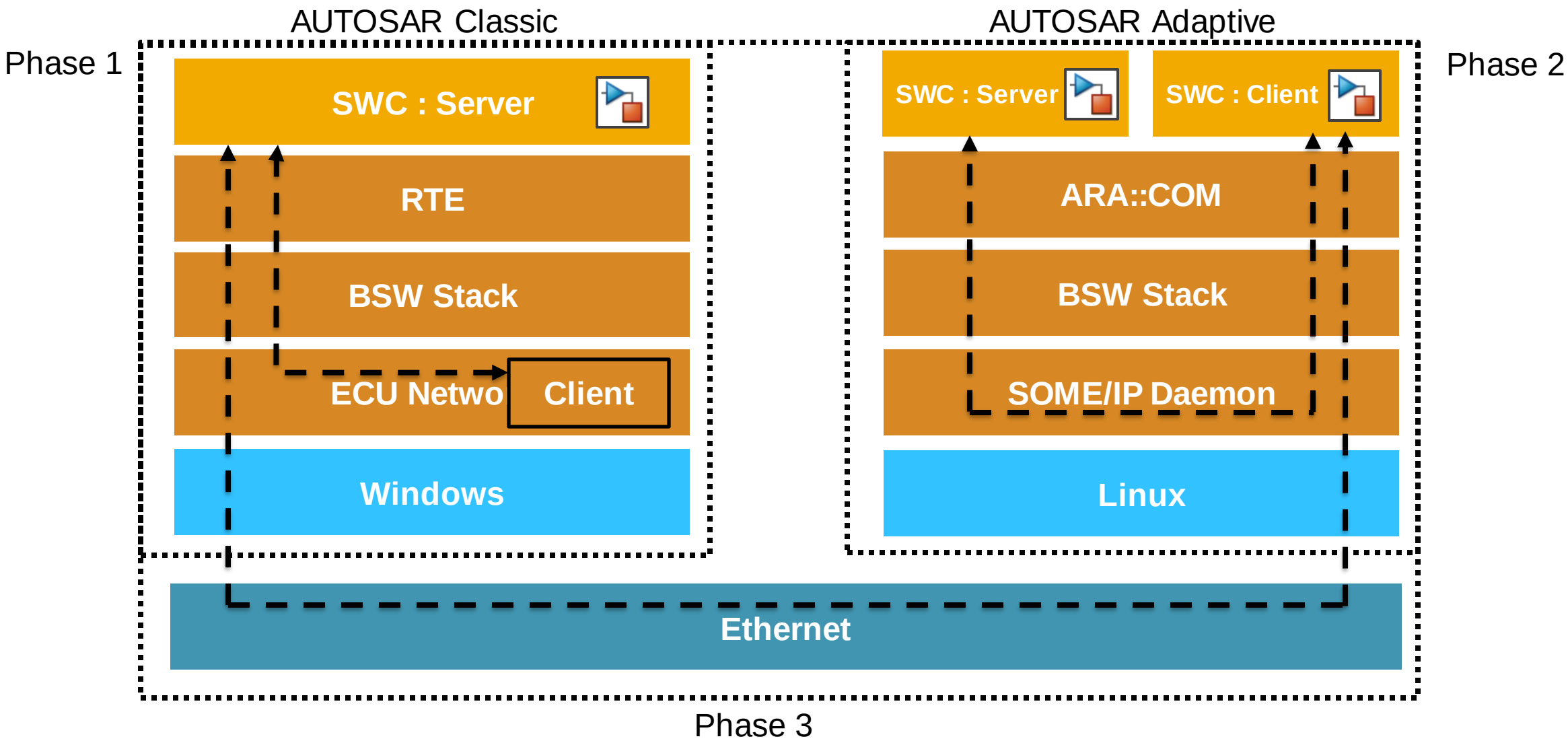
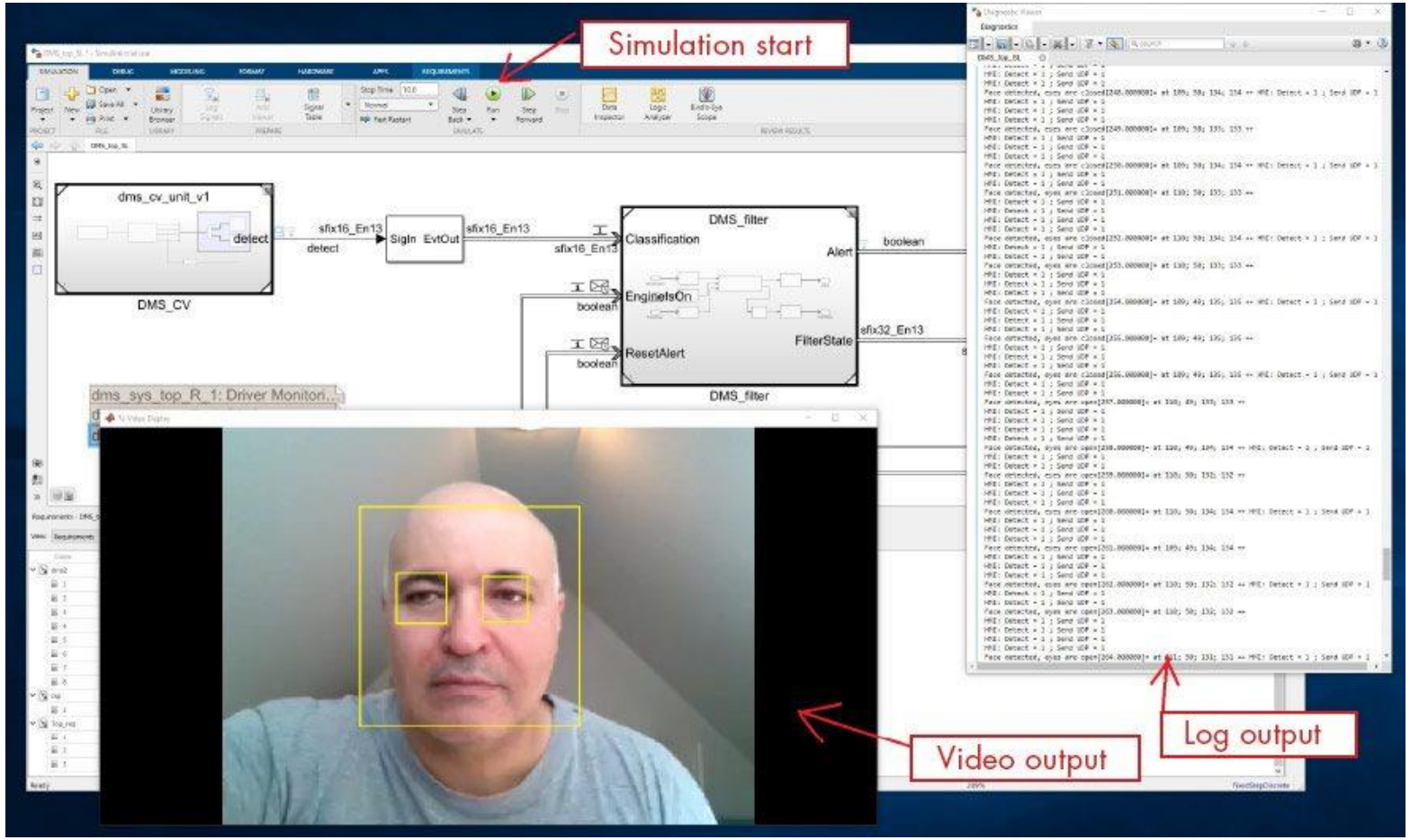
https://www.mathworks.com/content/dam/mathworks/conference-or-academic-paper/develop-and-integrate-autosar-classic-and-adaptive-applications-based-on-some-ip.pdf

Structure of Proof-of-Concept



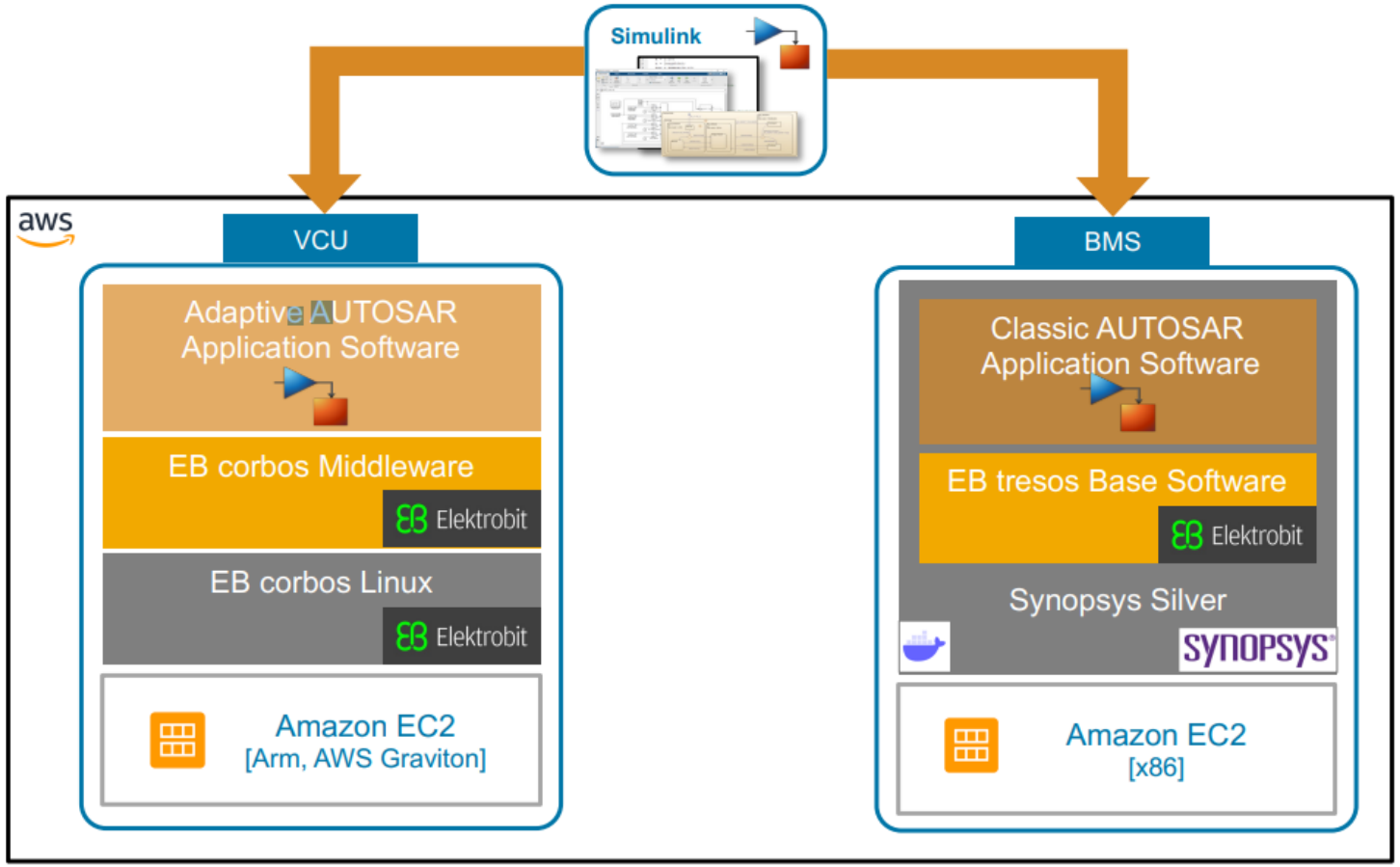
AUTOSAR Adaptive User Article

Elektrobit - Developing AUTOSAR Adaptive Software for a Driver Monitoring System with Model-Based Design

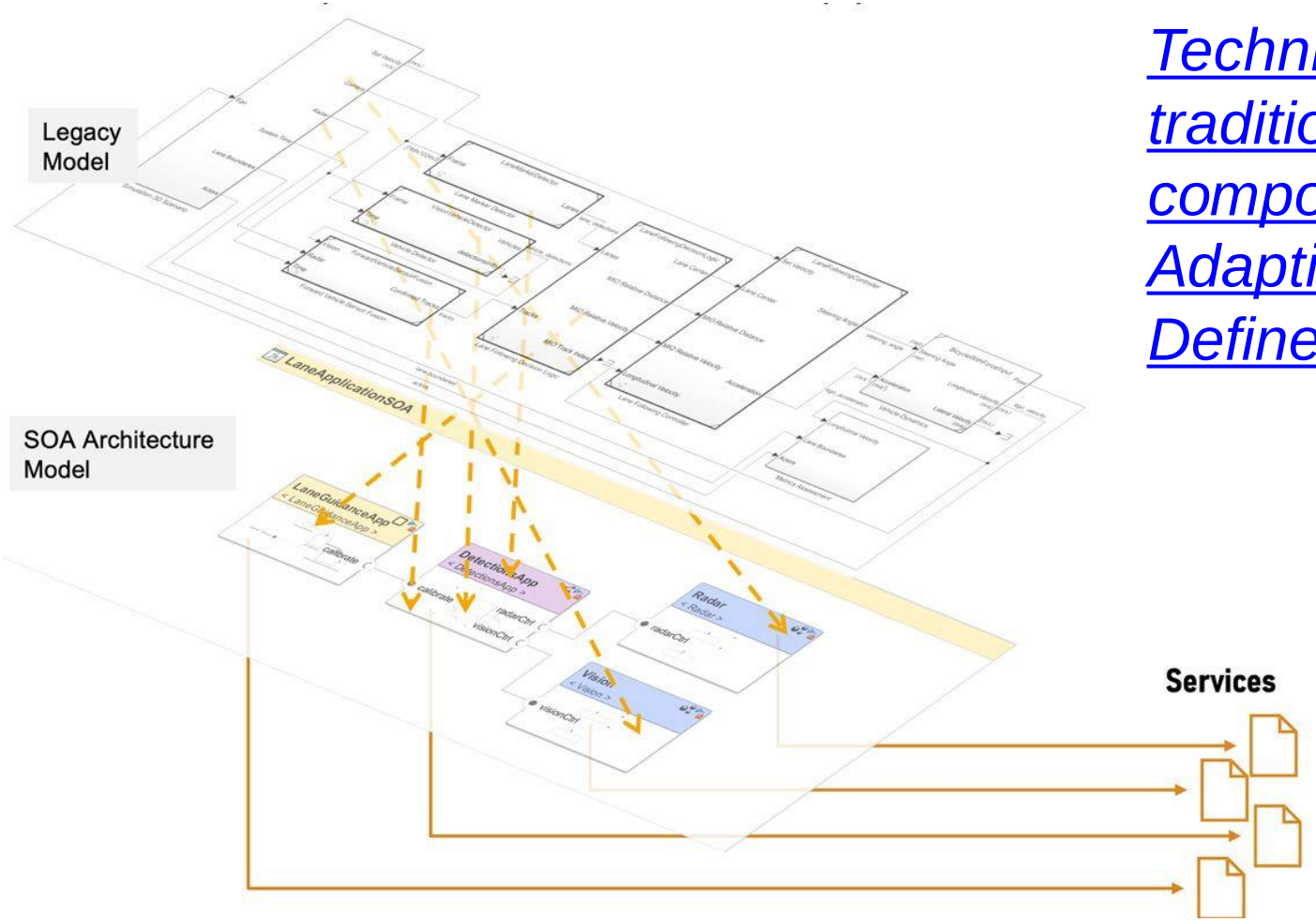


"Model-Based Design could accelerate development of end-to-end, AUTOSAR Adaptive software systems"

Cloud Deployment workflow with MBD

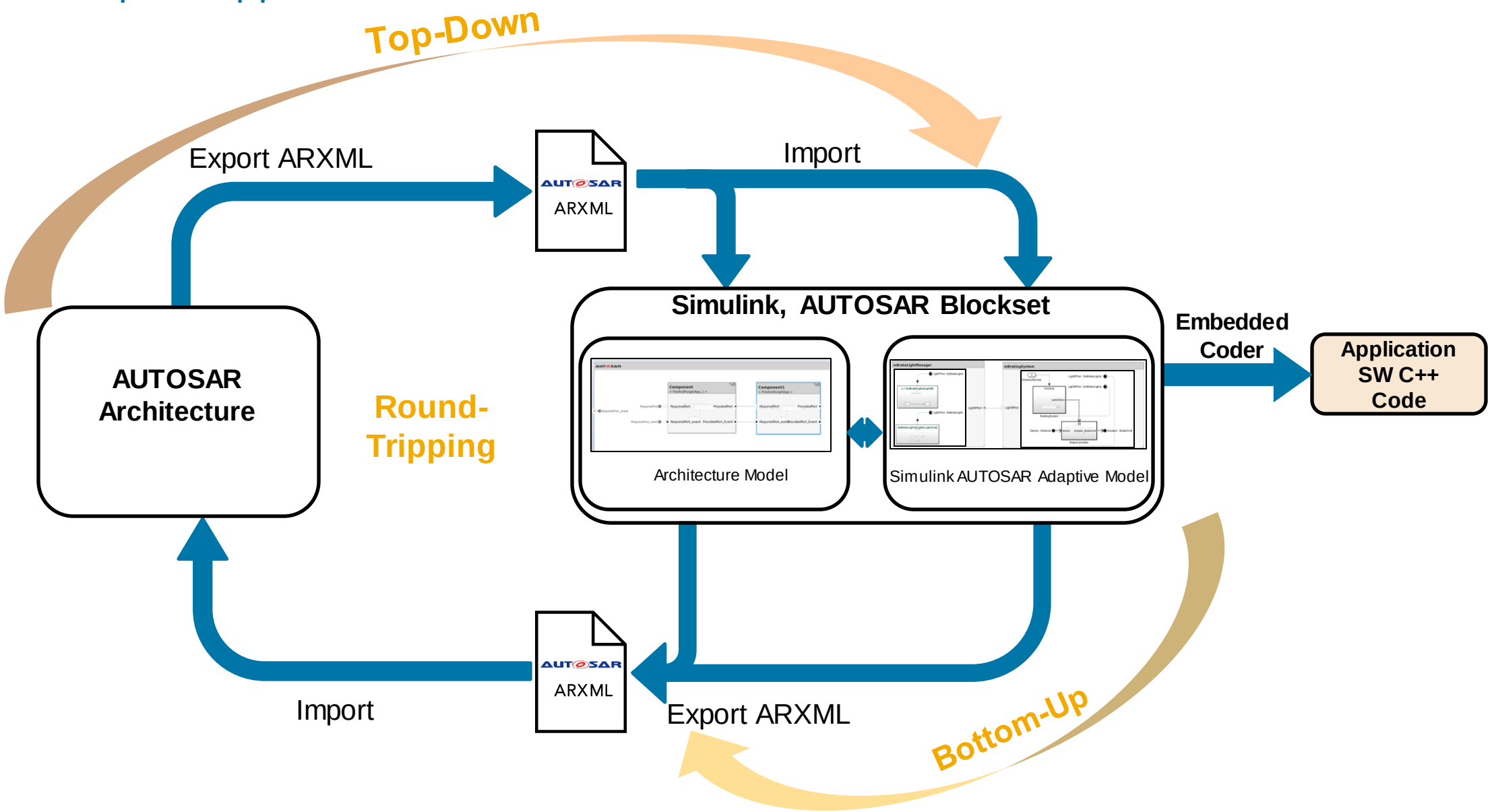


MathWorks presentation at AUTOSAR Open Conference 2023, May 11-12, San Diego, USA

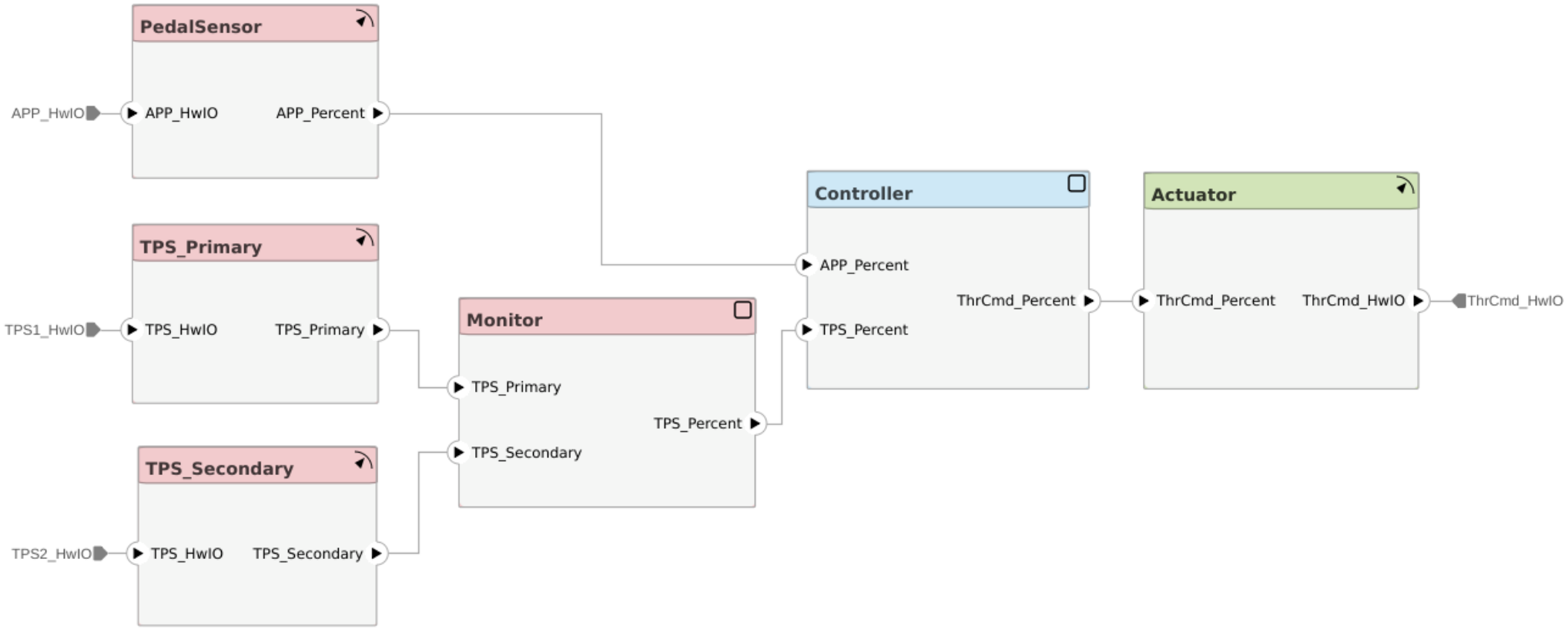


Technical Article - Migrating traditional automotive application compositions to AUTOSAR Adaptive services for Software Defined Vehicles

AUTOSAR Workflows - Importing and Exporting AUTOSAR Descriptions for Classic and Adaptive applications



Let's build the next AUTOSAR **Classic** based throttle position control system using System Composer and AUTOSAR Blockset



System Composer Architecture Model Templates

Standard Architecture Model Template

- Generic architecture design
  - Logical, functional, physical
  - Can have physical interfaces
  - Can compose software and AUTOSAR nodes in the architecture

Software Architecture Model Template

- Generic software architecture design
  - Can have client/server interfaces
  - Functions Editor

AUTOSAR Architecture Model Template

- AUTOSAR software architecture design
  - “is-a” software arch model
  - Purpose built canvas and resources for AUTOSAR
  - Out of the box support for **Classic** and **Adaptive** platforms

System Composer Architecture Model Templates

Standard Architecture Model Template

Software Architecture Model Template

AUTOSAR Architecture Model Template

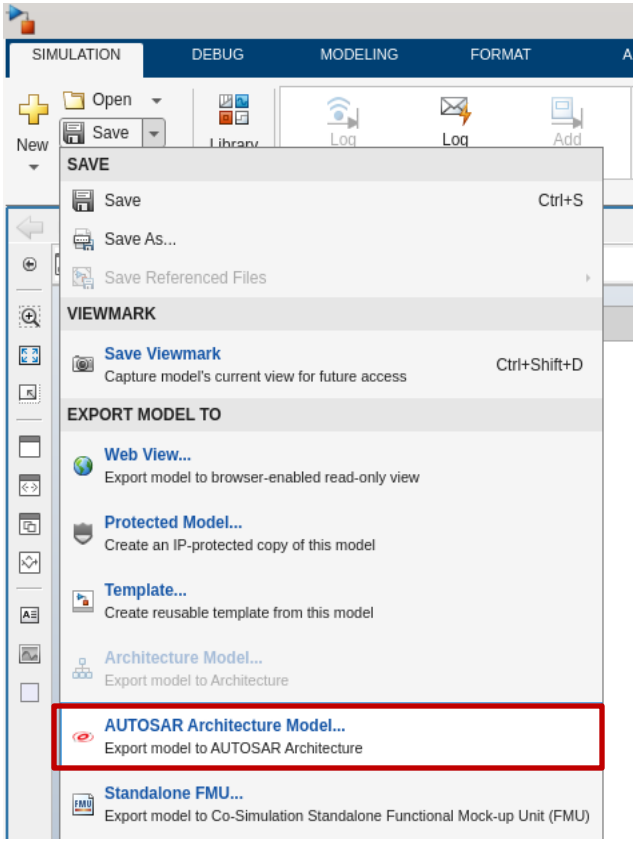
Export

- We support 2 workflows
  - Model AUTOSAR architectures directly
  - Export existing architecture model to AUTOSAR

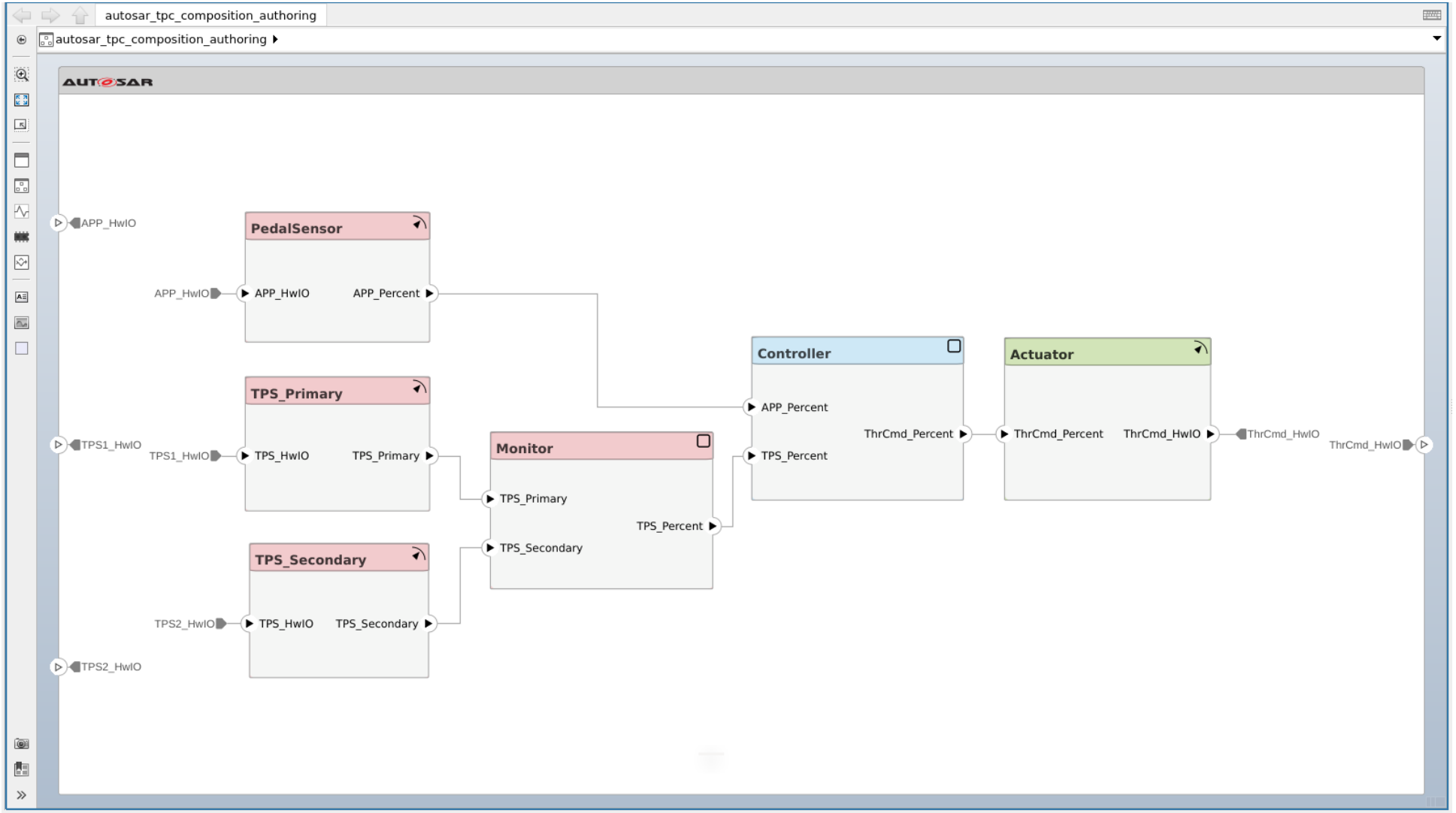
Let's use this workflow

R2019b

R2023b



Use Composition blocks to manage complexity



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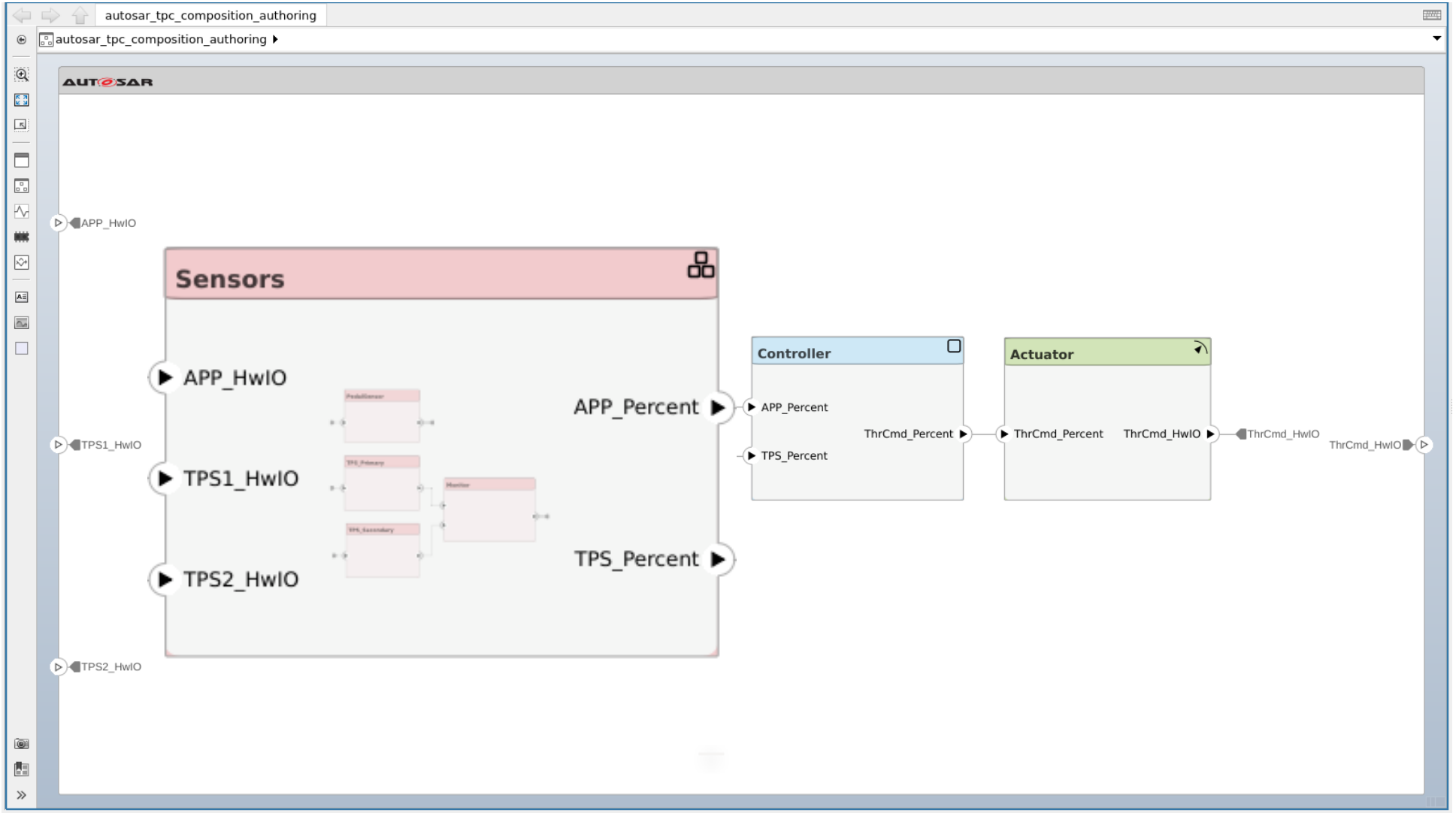
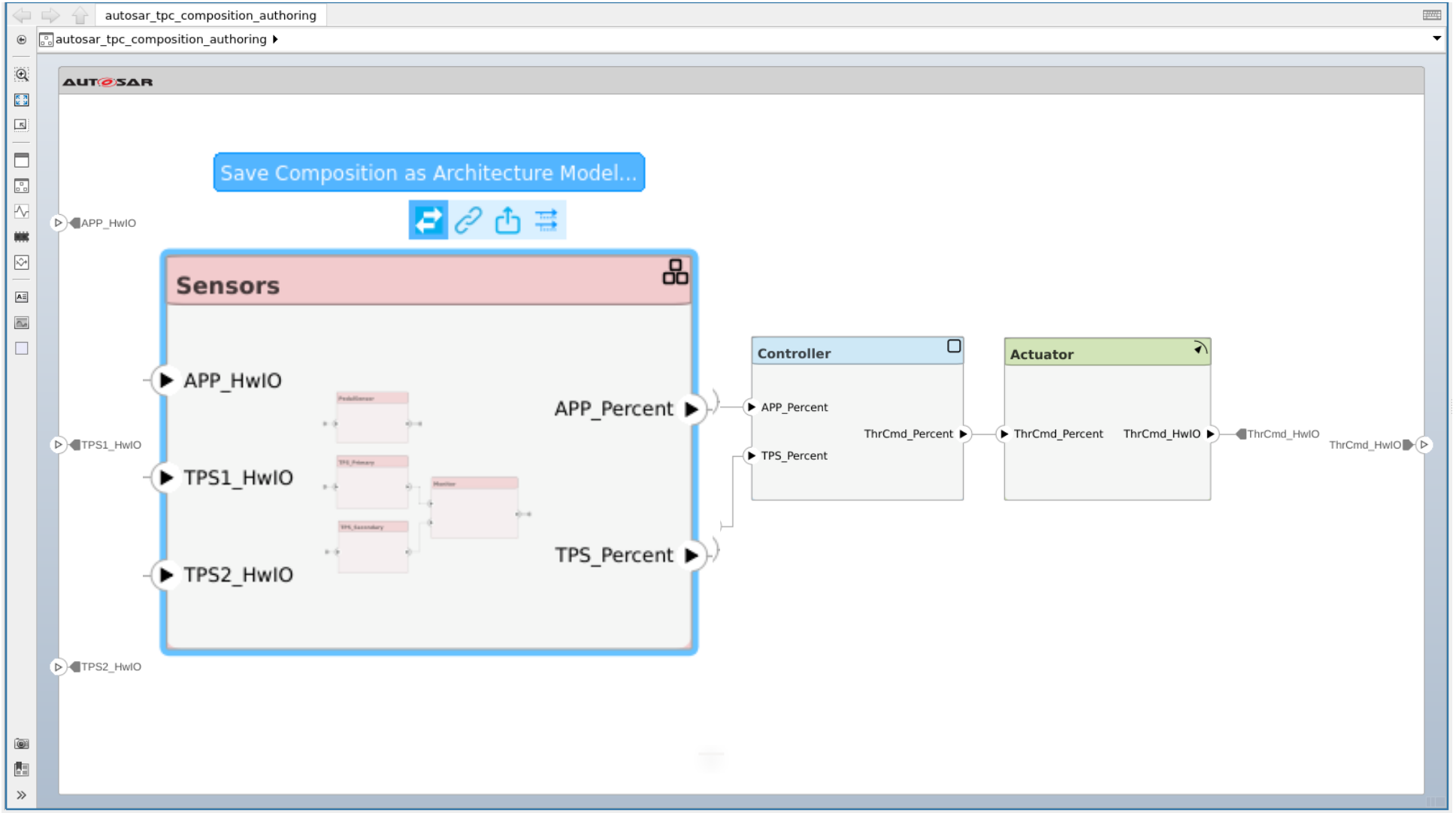


Save composition block as a separate AUTOSAR Architecture model

R2023b



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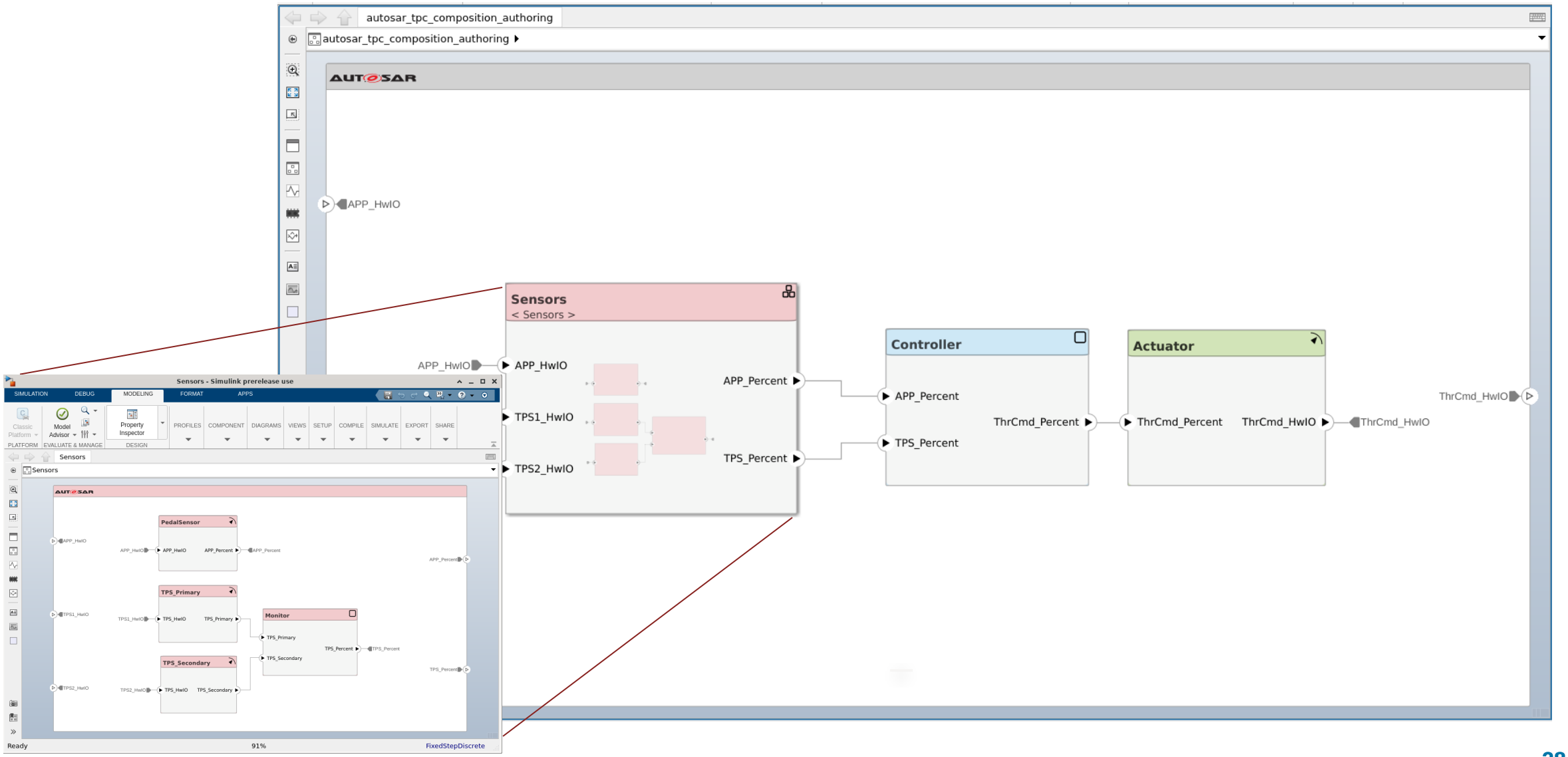
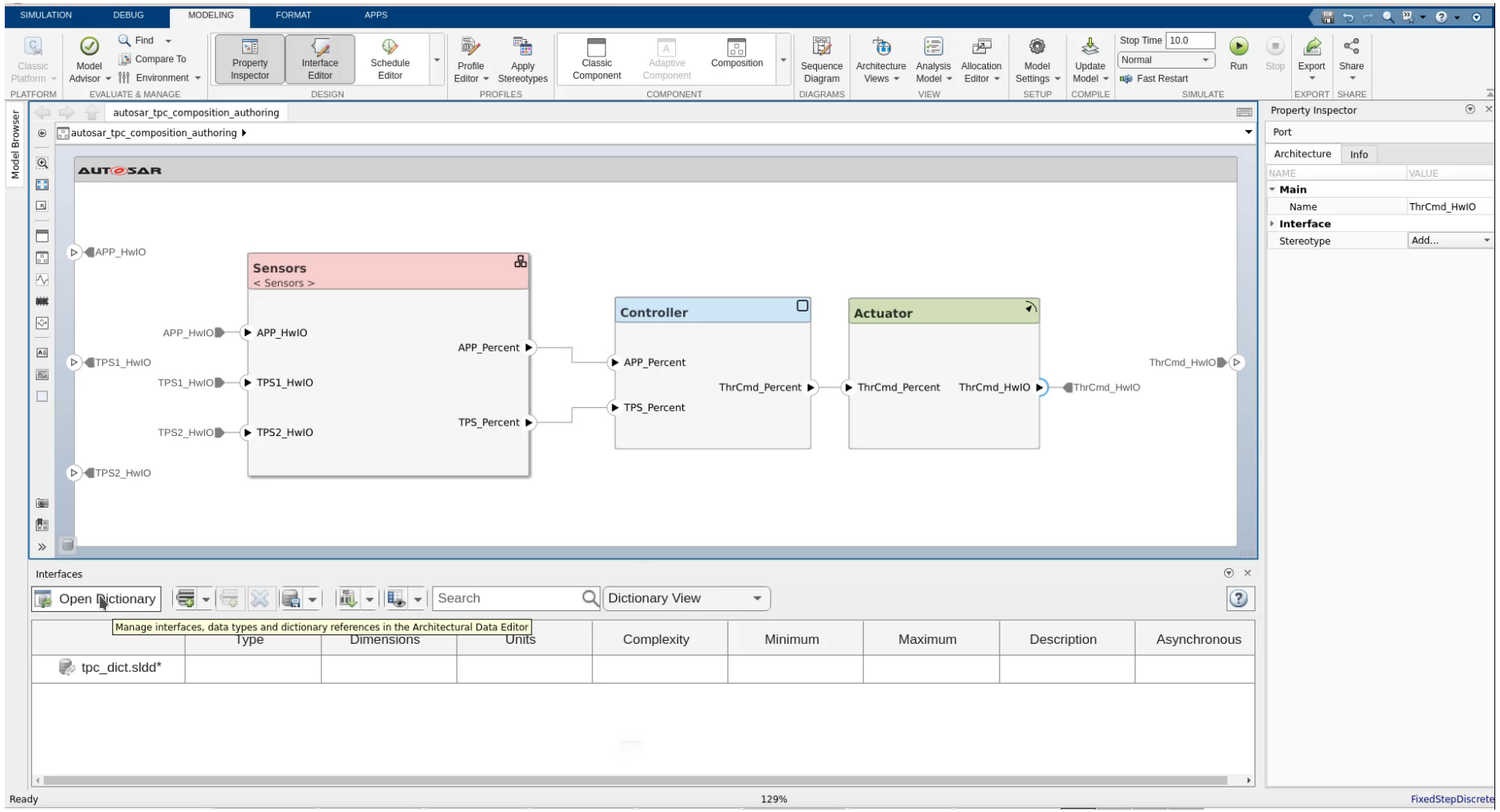


Use “Architectural Data” section in SLDD to manage interfaces and datatypes across architecture and algorithm models (Video)



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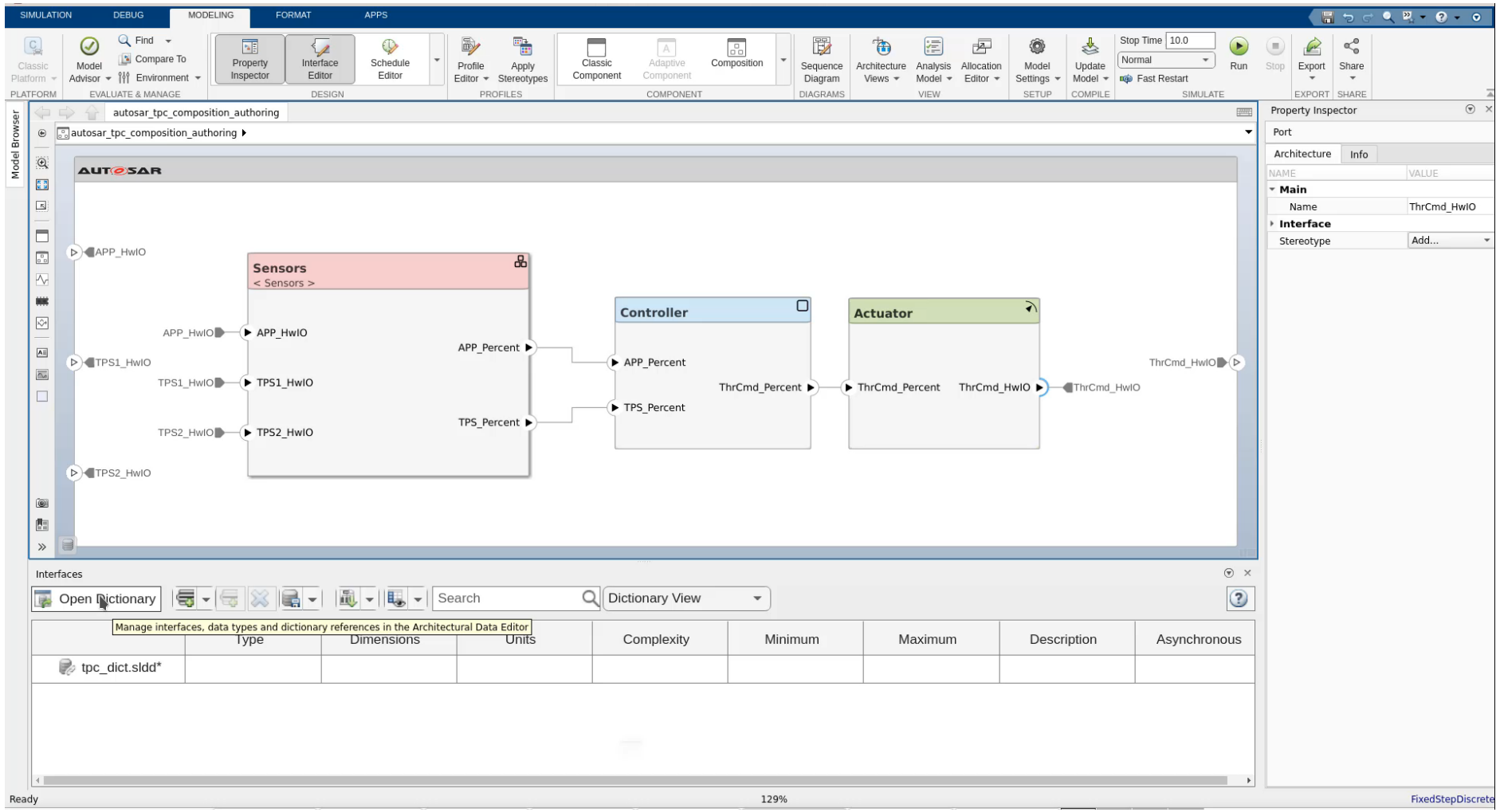
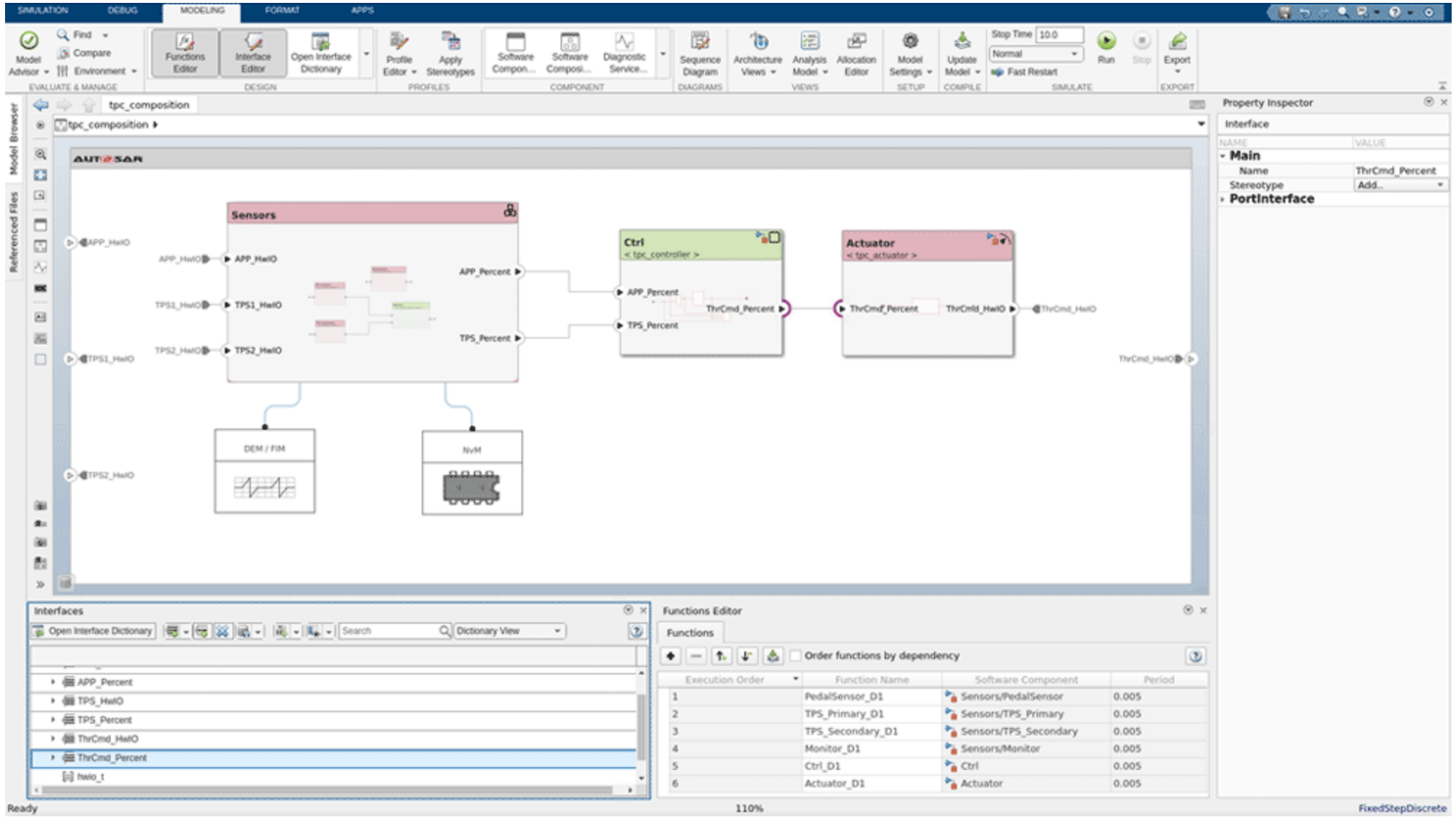
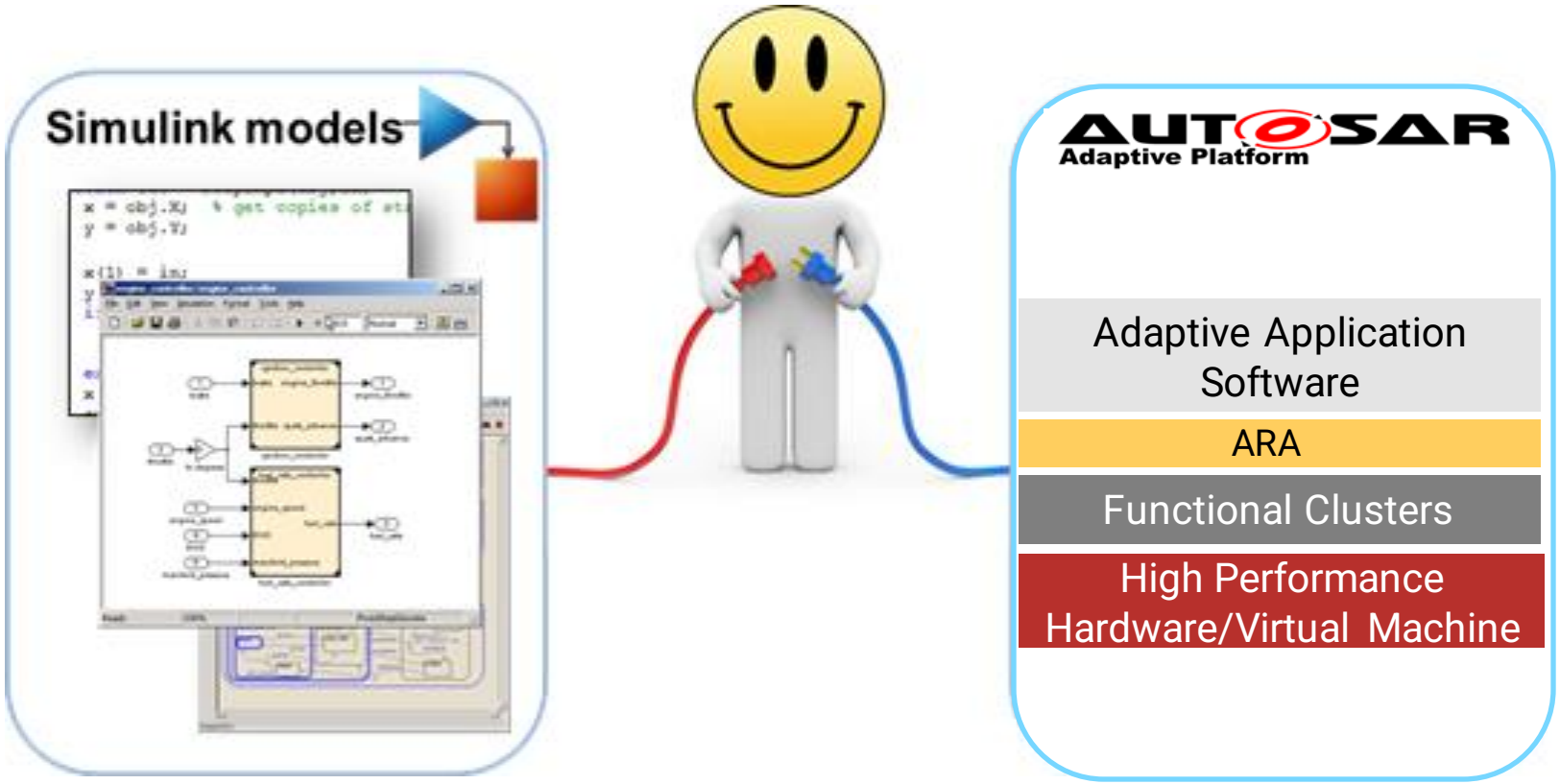


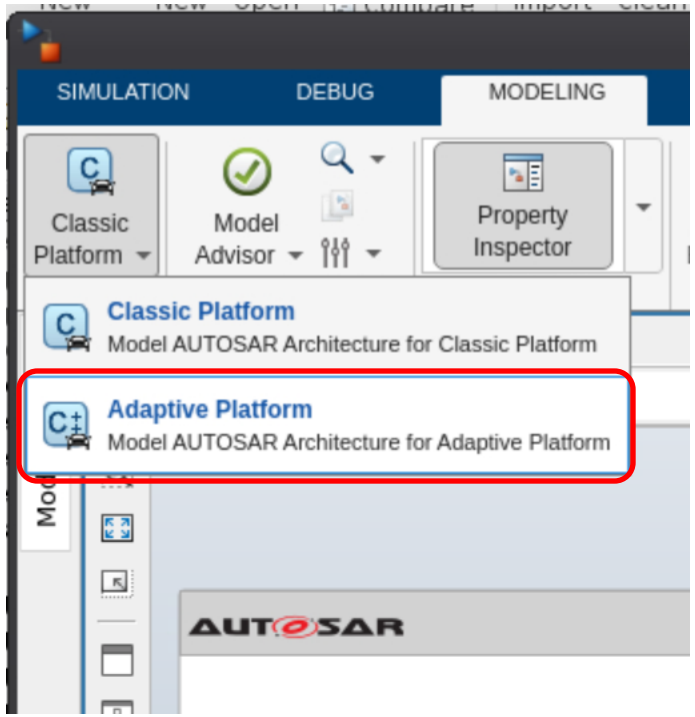
Simulate AUTOSAR Architecture

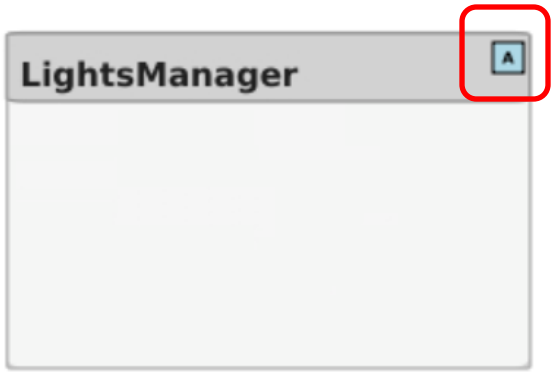


Plug your Simulink SOA models into the AUTOSAR Adaptive Platform



Develop Adaptive AUTOSAR Architectures





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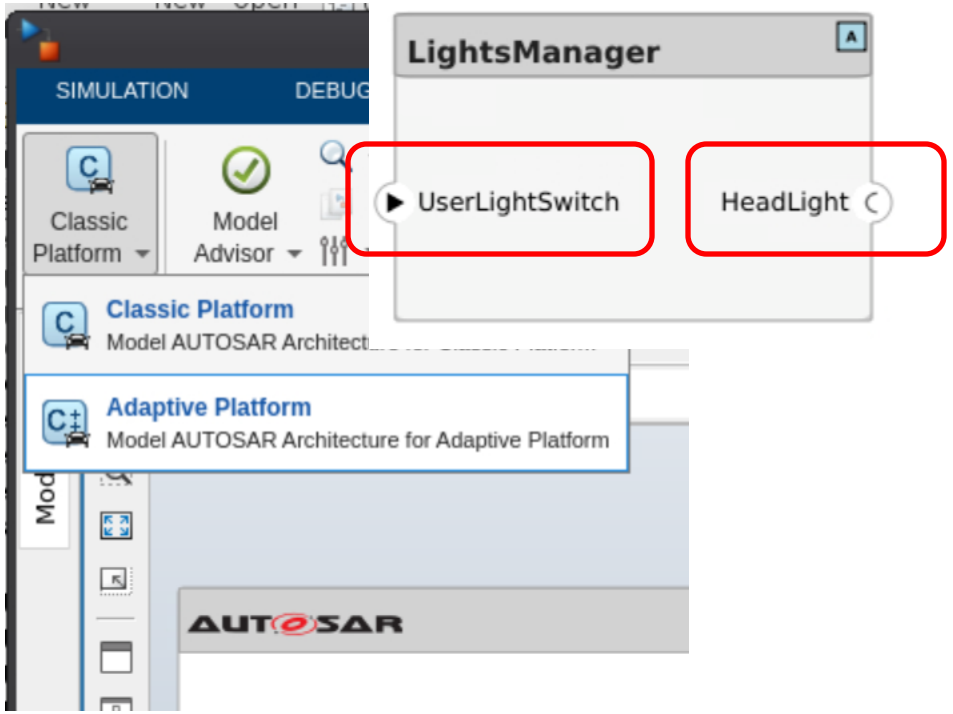

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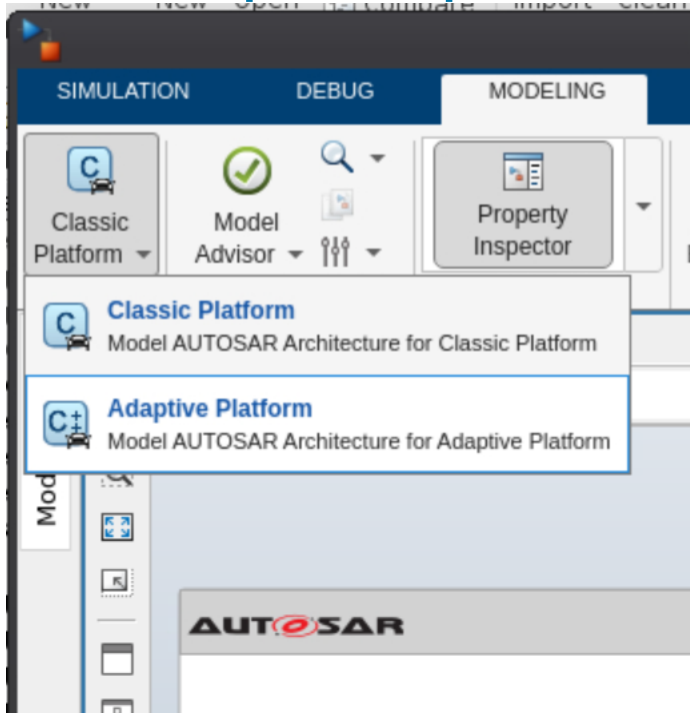
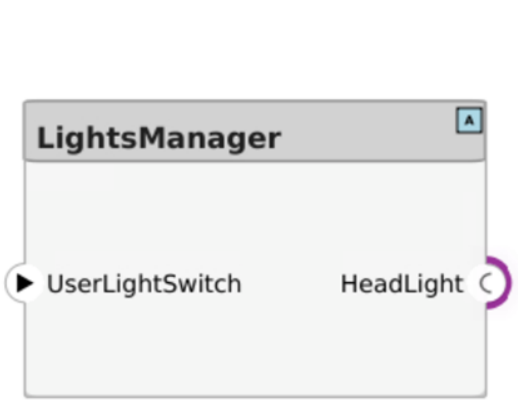
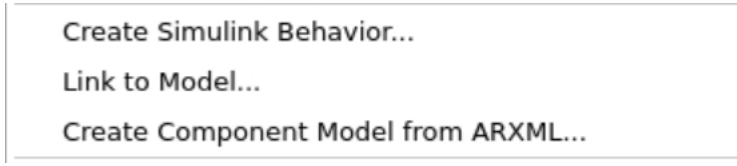
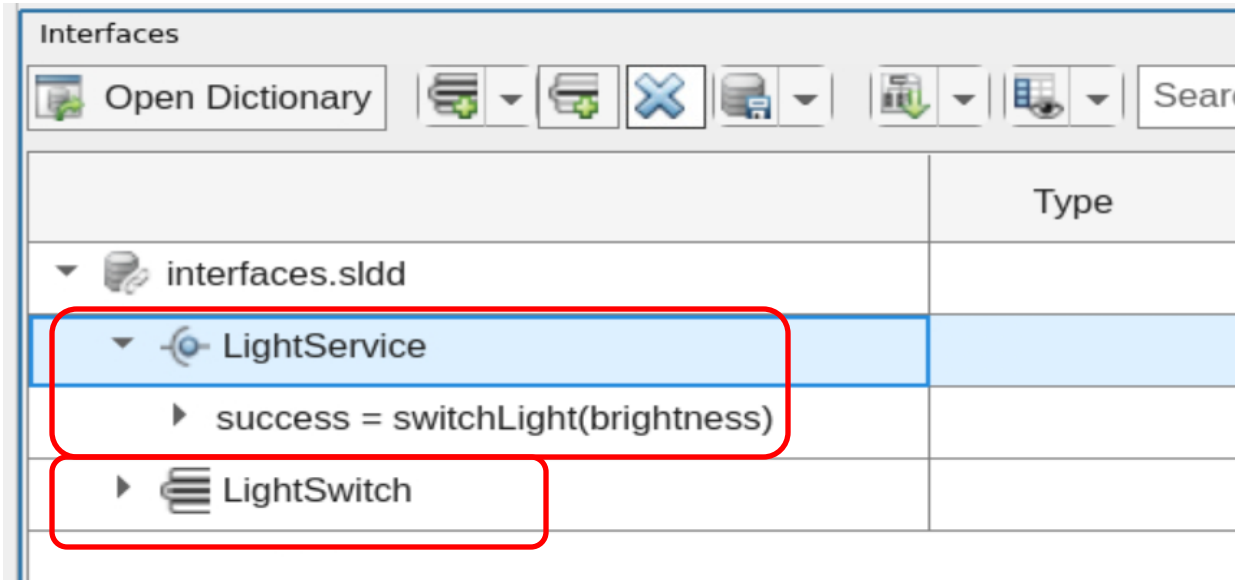
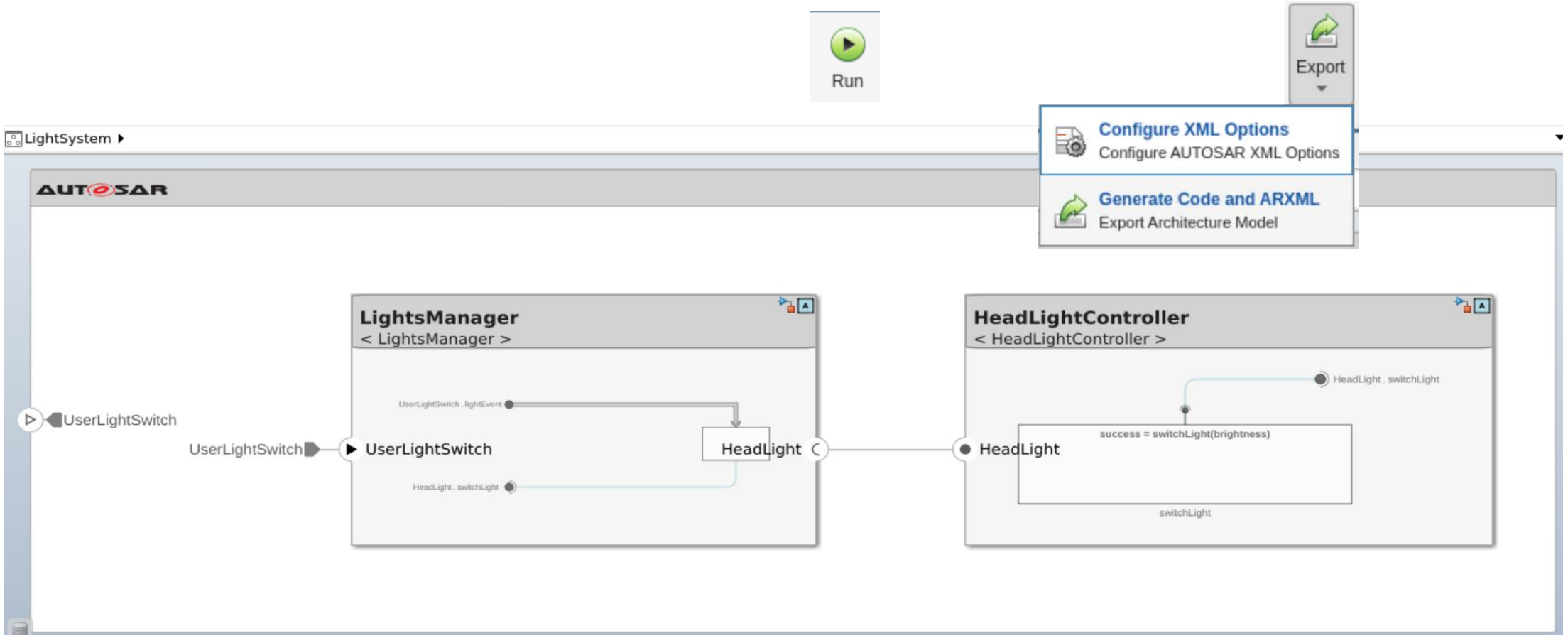




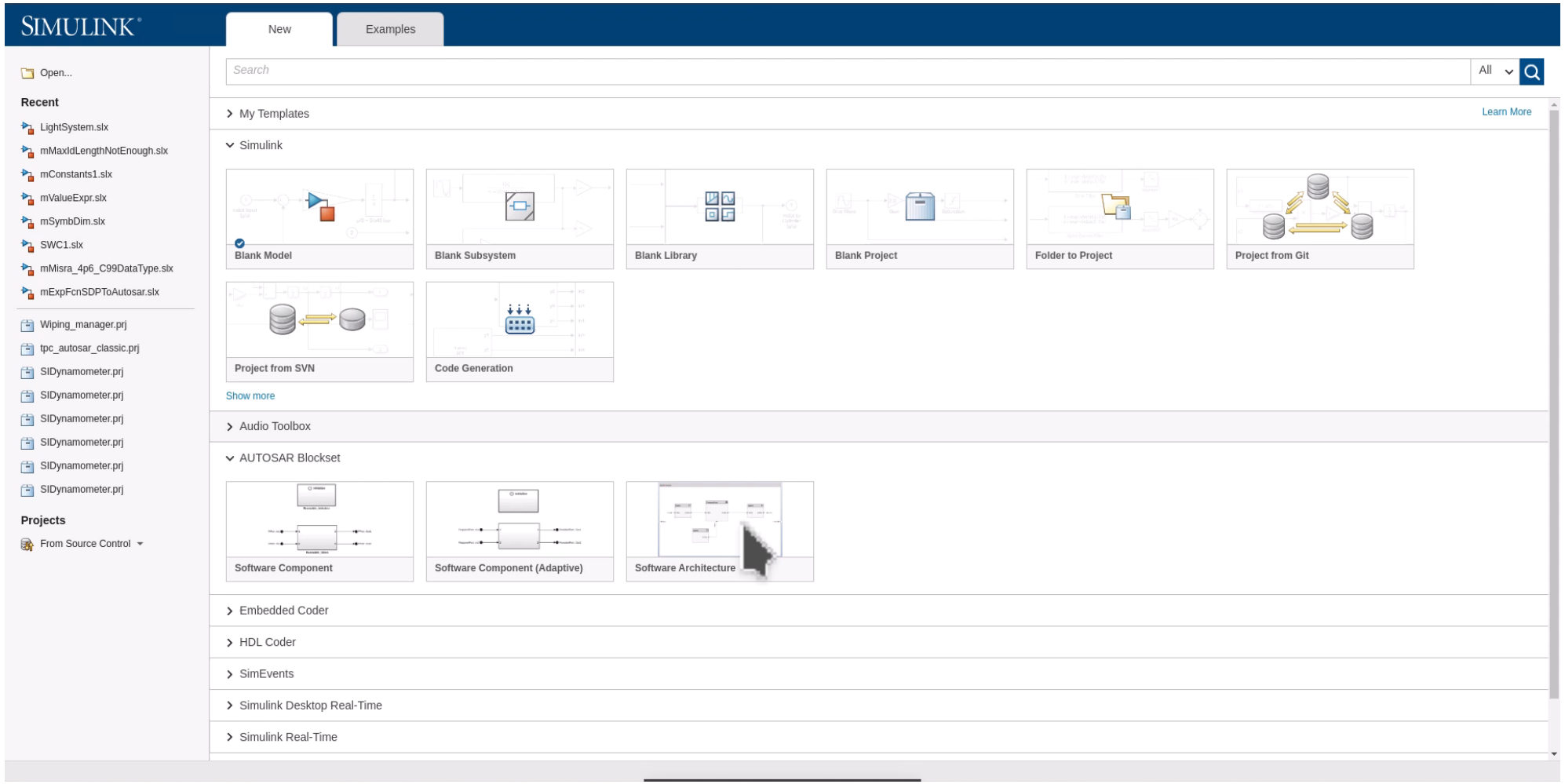




Export your Adaptive Architecture Models



Model Adaptive AUTOSAR Architectures in System Composer



Generated Code and ARXML for your system ready for deployment

- HeadLightController_autosar_adaptive
- LightsManager_autosar_adaptive

Editor - LightsManager.cpp | Project - sl4ap

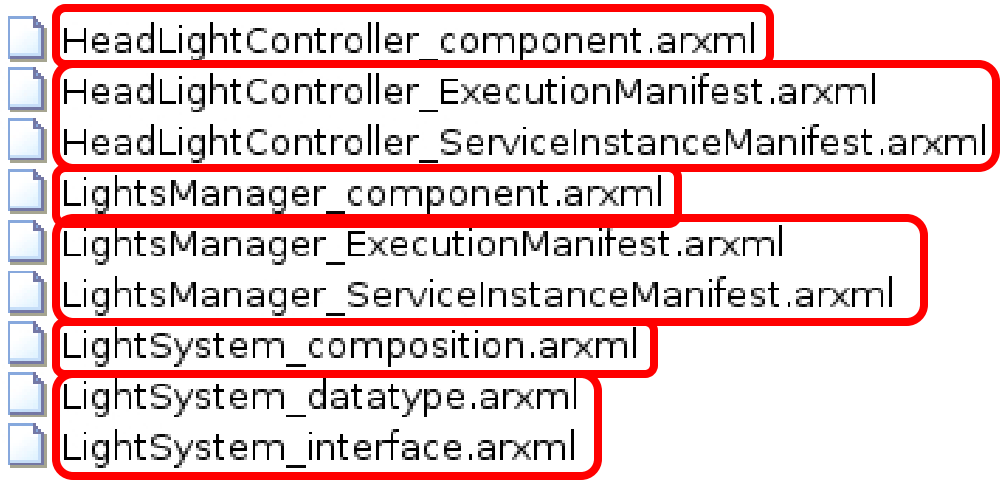
LightsManager.cpp

```
// Model step function
void LightsManager::MessageTriggeredSubsystem()
{
  ara::core::Future<proxy::methods::SwitchLight::Output> switchLightFuture;
  if (UserLightSwitch) {
    std::shared_ptr<ara::core::Result<size_t>> resultPtr;
    resultPtr = std::make_shared< ara::core::Result<size_t> >
      (UserLightSwitch->lightEvent.GetNewSamples(std::move(std::bind
         (&LightsManager::UserLightSwitchlightEventReceive, this, std::
          placeholders::_1)), 1U));
    if ((resultPtr->ValueOrThrow() > 0U) && HeadLight) {
      std::shared_ptr<ara::core::Result<proxy::methods::SwitchLight::Output>>
        switchLightResultPtr;

      // Received new event data
      // Outputs for Function Call SubSystem: '<Root>/Message Triggered Subsystem'
      // FunctionCaller: '<S1>/switchLight Caller'
      switchLightFuture = HeadLight->switchLight(LightsManager_B.Trigger);

      // End of Outputs for SubSystem: '<Root>/Message Triggered Subsystem'
      // Retrieve result on method switchLight's completion
      switchLightResultPtr = std::make_shared< ara::core::Result<proxy::methods::
        SwitchLight::Output> >(switchLightFuture.GetResult());

      // Check if method switchLight completed successfully and returned valid results
      if (switchLightResultPtr->HasValue()) {
        // Retrieve return arguments from method switchLight's Result container
        switchLightResultPtr->Value();
      }
    }
  }
}
```

LightsManager.cpp | main.cpp | HeadLightController.cpp

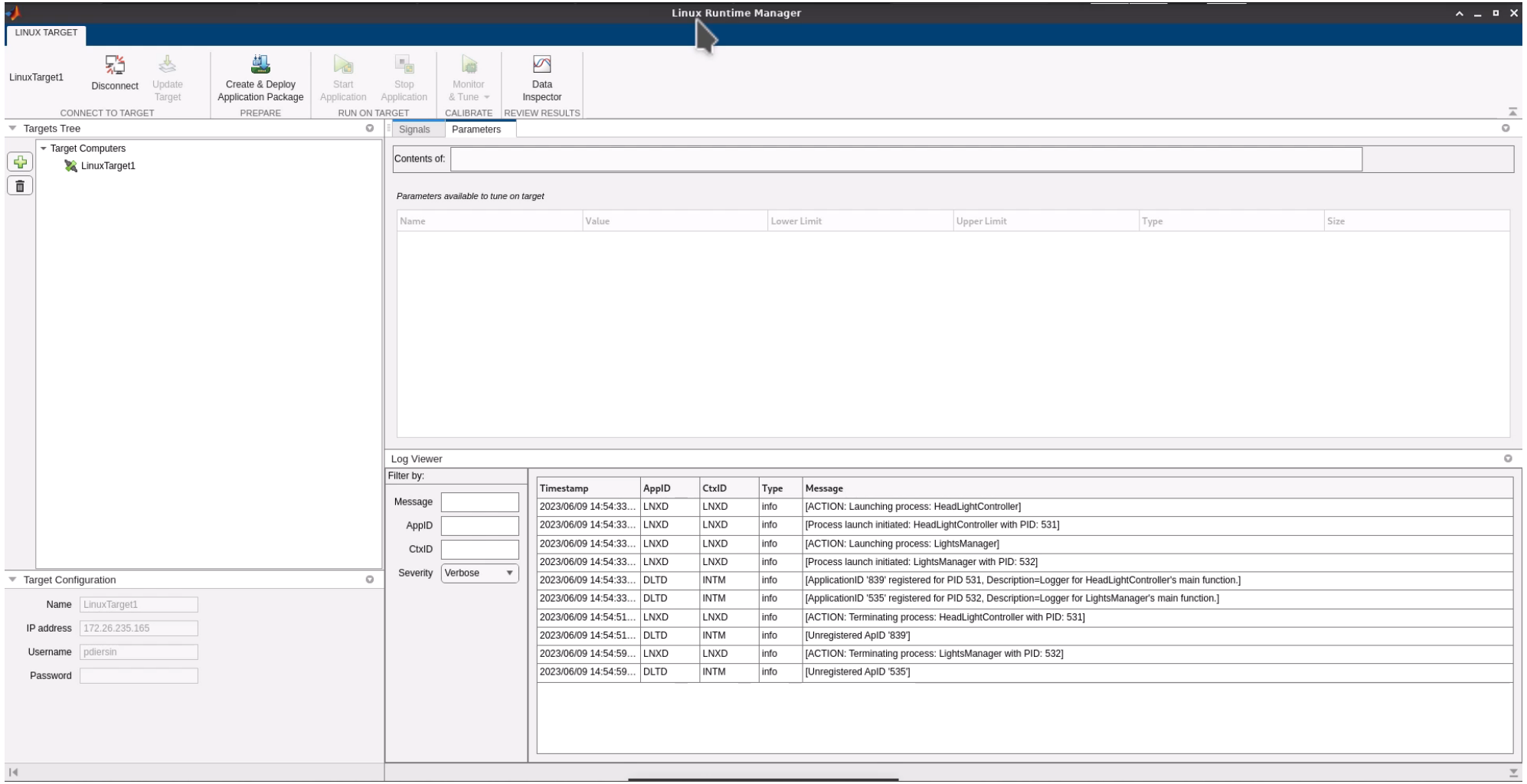
```
#include <stdbool.h>

// Model step function
void HeadLightController::switchLight(uint8_t brightness, bool *success)
{
  UNUSED_PARAMETER(brightness);

  // Outputs for Function Call SubSystem: '<Root>/switchLight'
  // SignalConversion generated from: '<S1>/success'
  *success = false;

  // End of Outputs for SubSystem: '<Root>/switchLight'
}

// Model initialize function
void HeadLightController::initialize()
{
  // Initialize service provider instance - HeadLight
  HeadLight = std::make_shared< skeleton::LightServiceSkeletonImpl >(ara::com::
    InstanceIdentifier(ara::core::StringView("1")), ara::com::
    MethodCallProcessingMode::kEventSingleThread);

  // Bind HeadLightController class implementation of switchLight method to service instance's implementation
  HeadLight->setFuncObjswitchLight(std::bind(&HeadLightController::switchLight,
    this, std::placeholders::_1, std::placeholders::_2));
  HeadLight->OfferService();
}
```

Generated Code and ARXML for your system ready for deployment



- Component Descriptions
- Composition Descriptions
- Data Types and Interfaces
- Deployment Configurations

Deploy Adaptive Architecture Models to Linux Targets



Conclusions

Challenges

- Development of SOA applications require a **change of mindset**
- **Centralize, re-architect** existing applications and partition in processes and services

Solutions

- **Design, simulate and generate** code to deploy Signal based AUTOSAR Classic and service-oriented AUTOSAR Adaptive in **Simulink**
- **Reuse your existing expertise and models** to mitigate the risk of migration to Adaptive applications