MATLAB EXPO 2021

使用Simulink设计和部署面向服务的架构

龚小平， MathWorks

MathWorks

内容

- 软件定义汽车时代的行业挑战
- Simulink开发面向服务的架构(SOA)
- Simulink对SOA行业标准的支持
  - Simulink对AUTOSAR Adaptive的支持
  - Simulink对数据分发服务 (DDS)的支持
- 总结及如何获取更多相关信息

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软件时代来临

From the news...

Adds 3,000 New Tech Jobs to Boost Virtual Testing and Software Expertise

Continental and Amazon Web Services Create Platform for Automotive Software

Boss Warns the Troops: We Don't Want to End Up Like Nokia

BOSCH Consolidates All Automotive Software And Electronics Into New Division

DAIMLER to Cut Out Suppliers to Fund Software Hiring Spree

https://media.gm.com/media/us/en/gm/home.detail.html/content/Pages/news/us/en/2020/nov/1109-techjobs.html
https://www.bloomberg.com/news/articles/2020-11-06/vw-s-boss-warns-the-troops-we-don-t-want-to-end-up-like-nokia
https://www.ft.com/content/6173af2c-2ea8-4e90-876a-5cc189e3342b
https://www.continental.com/en/press/press-releases/20210415-continental-and-amazon-web-services-251210
https://www.forbes.com/sites/samabuelsamid/2020/07/21/bosch-consolidates-all-automotive-software-and-electronics-into-new-division/?sh=46032fb81320

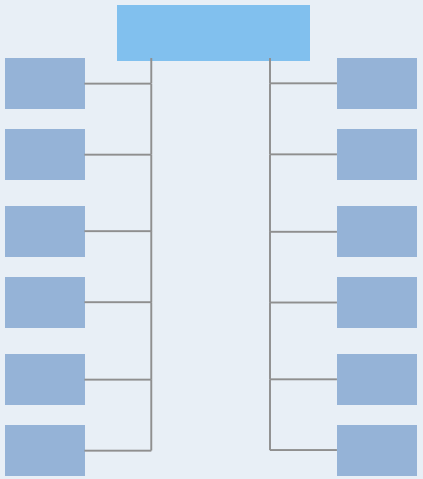
汽车行业趋势

软件定义汽车

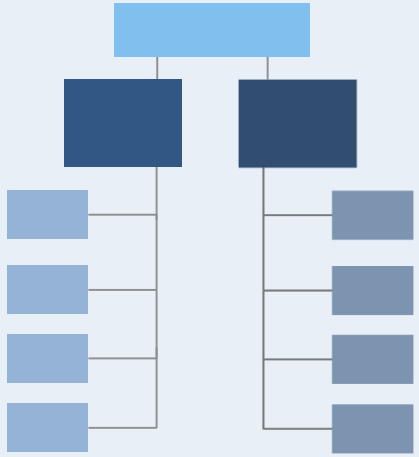
关键赋能因素:

1. 算力向高性能车载计算机集中
2. 新的电子电气和软件架构设计理念

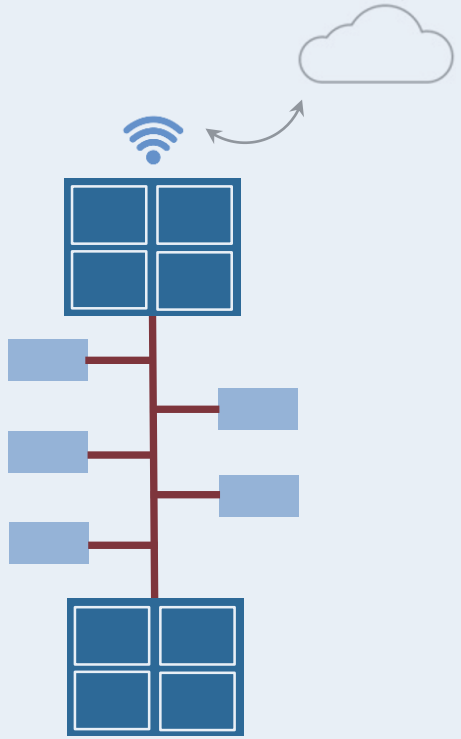
电子电气架构进化



- ~100 ECUs
- 1个功能对应1个 ECU
- 繁复的线束



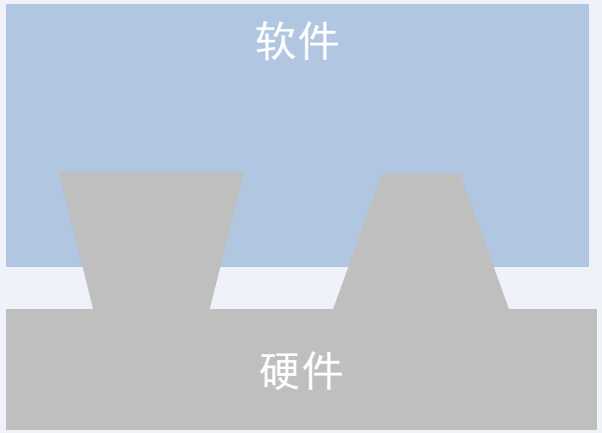
- 域控制器
- 多核 ECUs
- 网关和网络



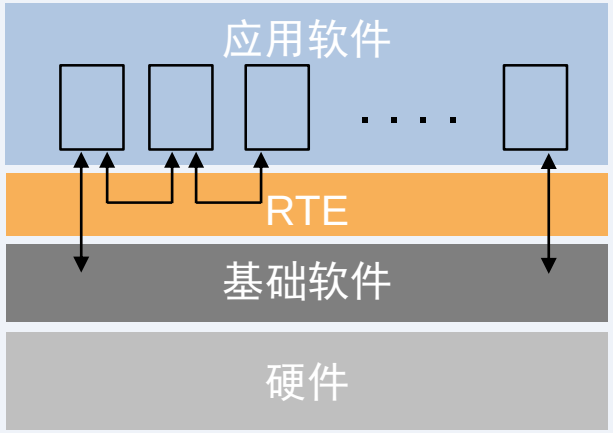
- 车辆/区域控制器
- 多核异构（CPU/GPU/FPGA）
- 高速以太网

分布 → 集中 → 高性能高连接

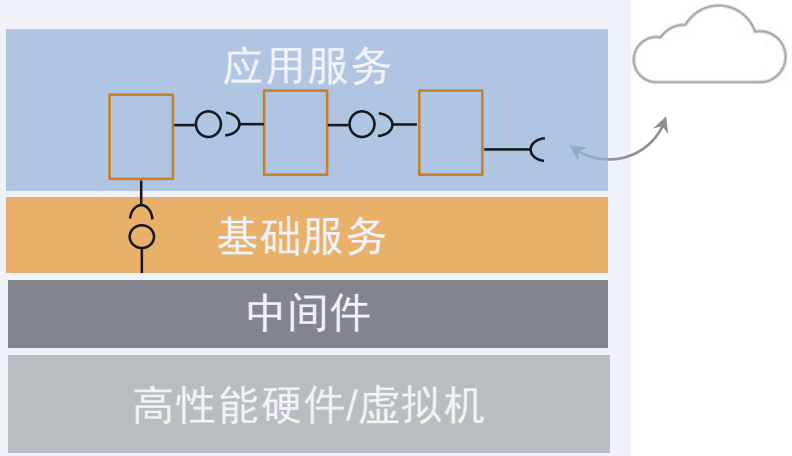
软件架构演变



- 软硬件高度耦合
- 没有标准 APIs
- 软件复用程度低



- 静态软件组件分配
- 基于信号通讯
- 硬件抽象
- 整体升级



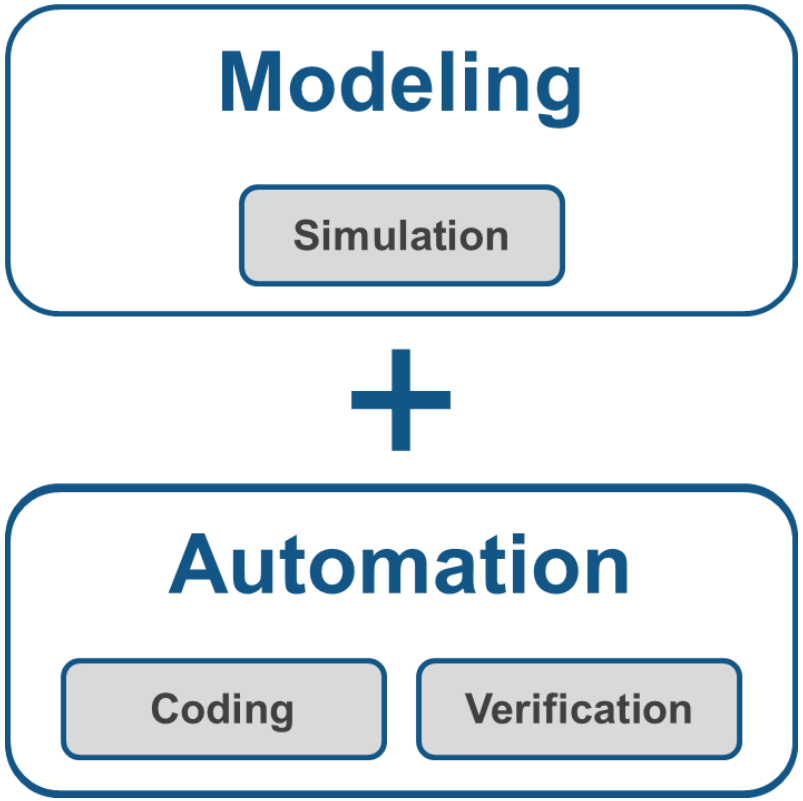
- 动态服务发现
- 面向服务的通讯
- 更高级别的硬件抽象
- 选择性升级(OTA)

软硬耦合 → 基于组件 → 面向服务

关键挑战

- 面向服务的应用对于汽车行业仍是个新事物
- 已有架构和面向服务的架构将长期共存
- 知识经验、工作流程和软件资产的重用

解决方案 – 面向SOA的基于模型设计



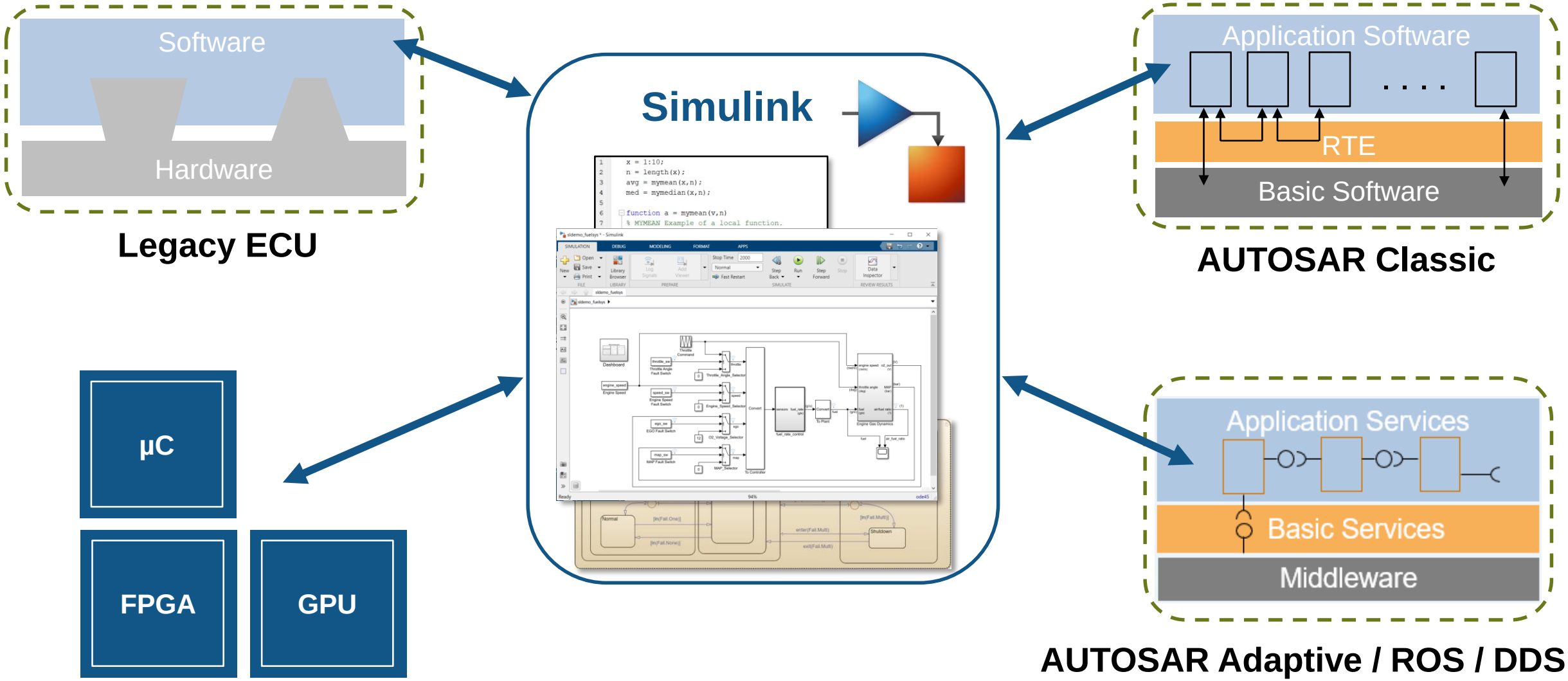
设计和仿真SOA应用

- 图形化的直观协同软件架构设计环境
- Simulink提供语义支持建模和仿真SOA应用

加强自动代码生成和验证支持

- 行业标准支持
- 异构目标硬件平台
- 集成人工智能算法

关键概念 – 以算法为中心


Software
Hardware
Legacy ECU
Simulink
Application Software
RTE
Basic Software
AUTOSAR Classic
µC
FPGA
GPU
Application Services
Basic Services
Middleware
AUTOSAR Adaptive / ROS / DDS

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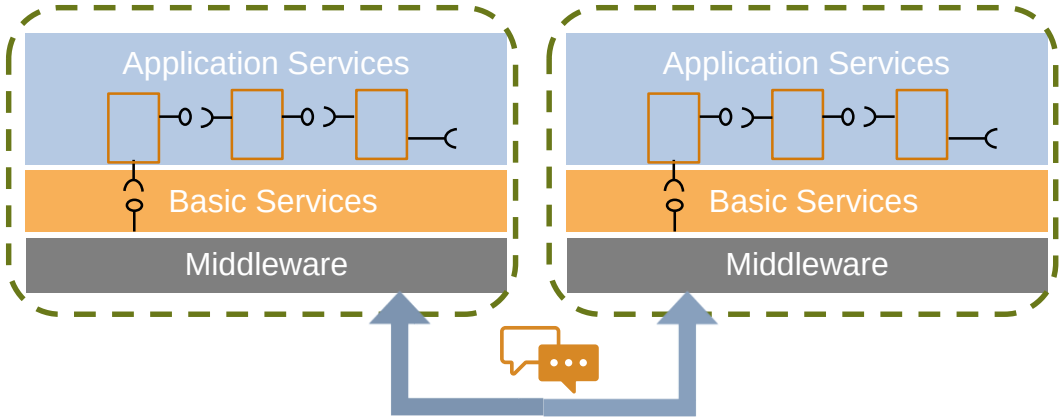
面向服务的通讯建模支持 – Simulink Messages



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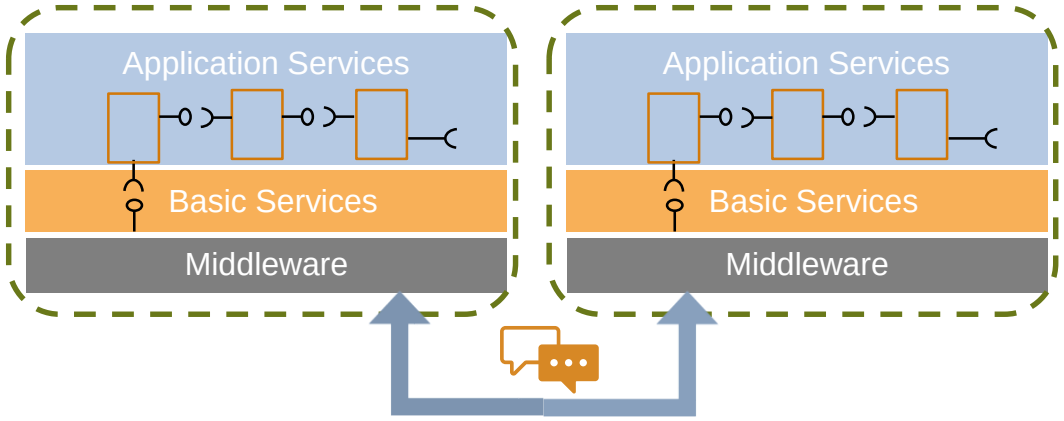

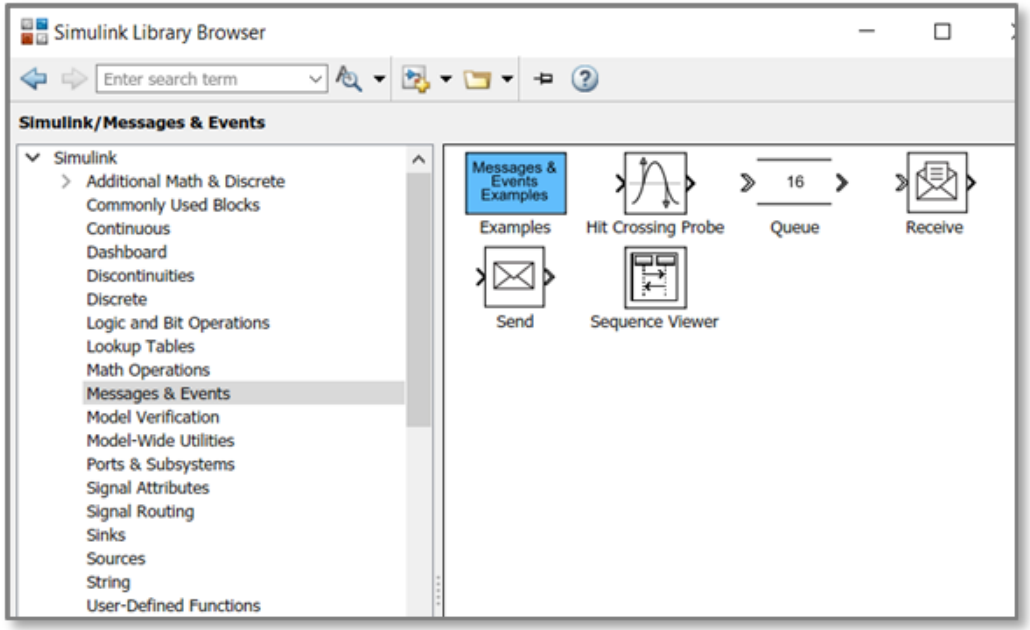

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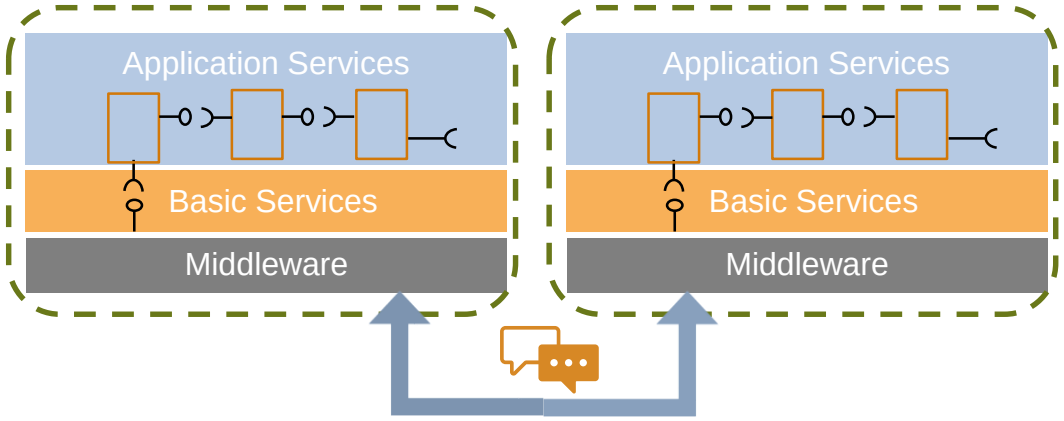

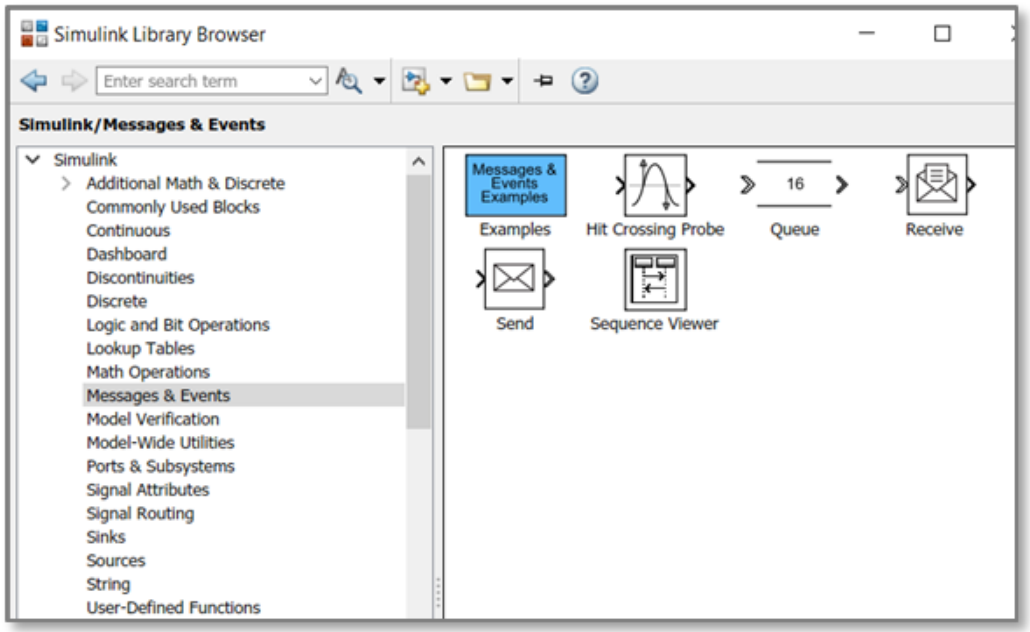

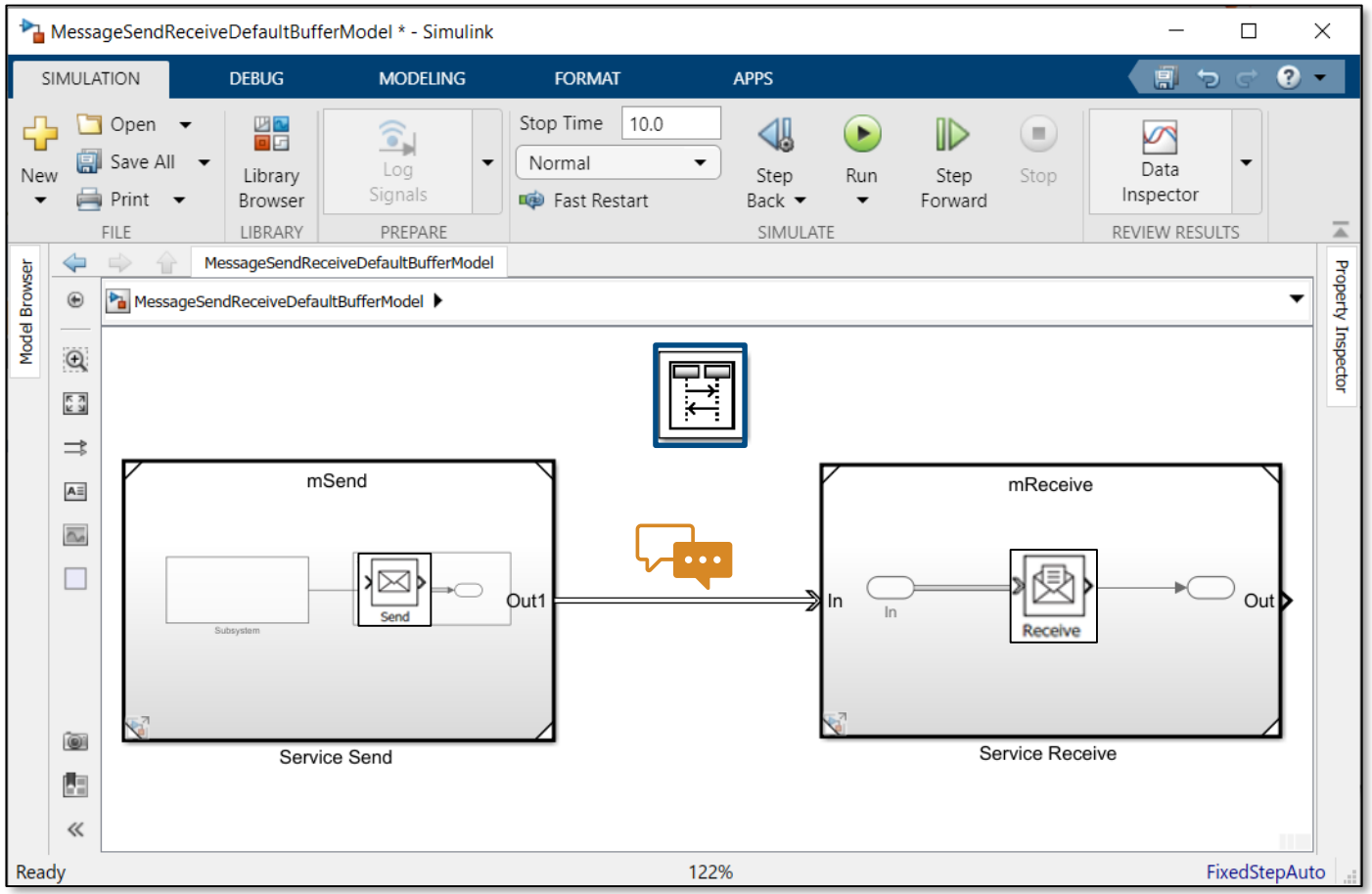

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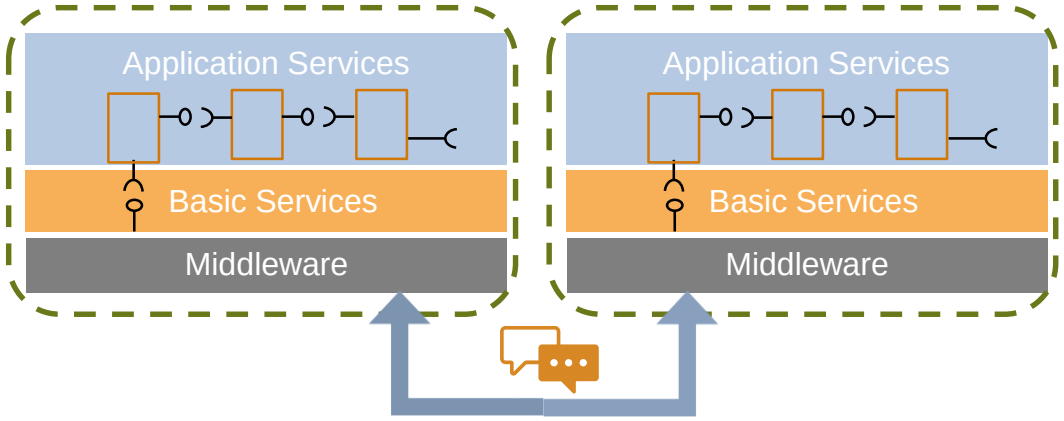
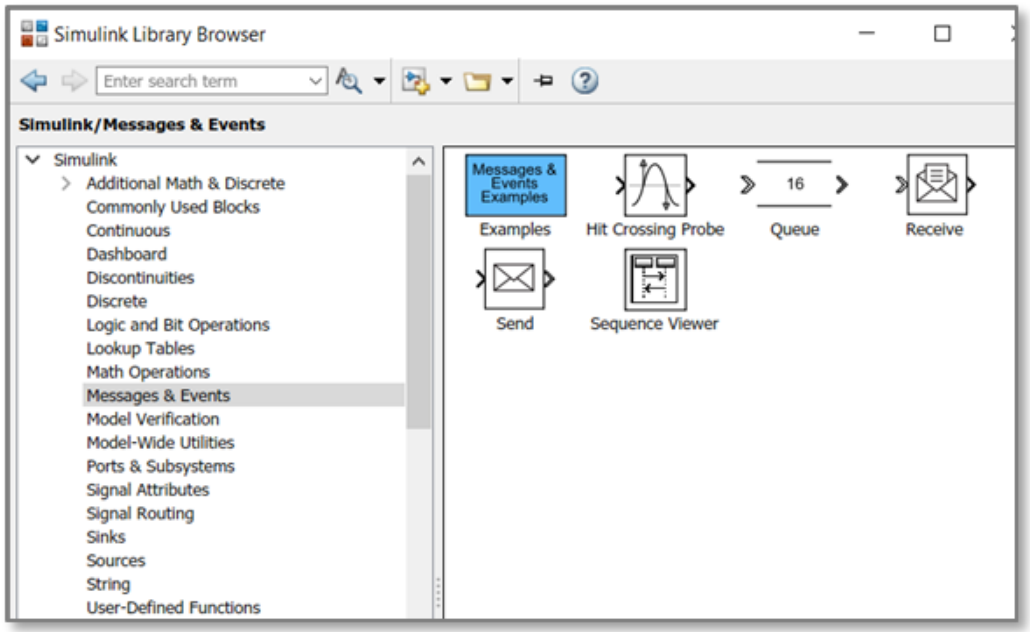
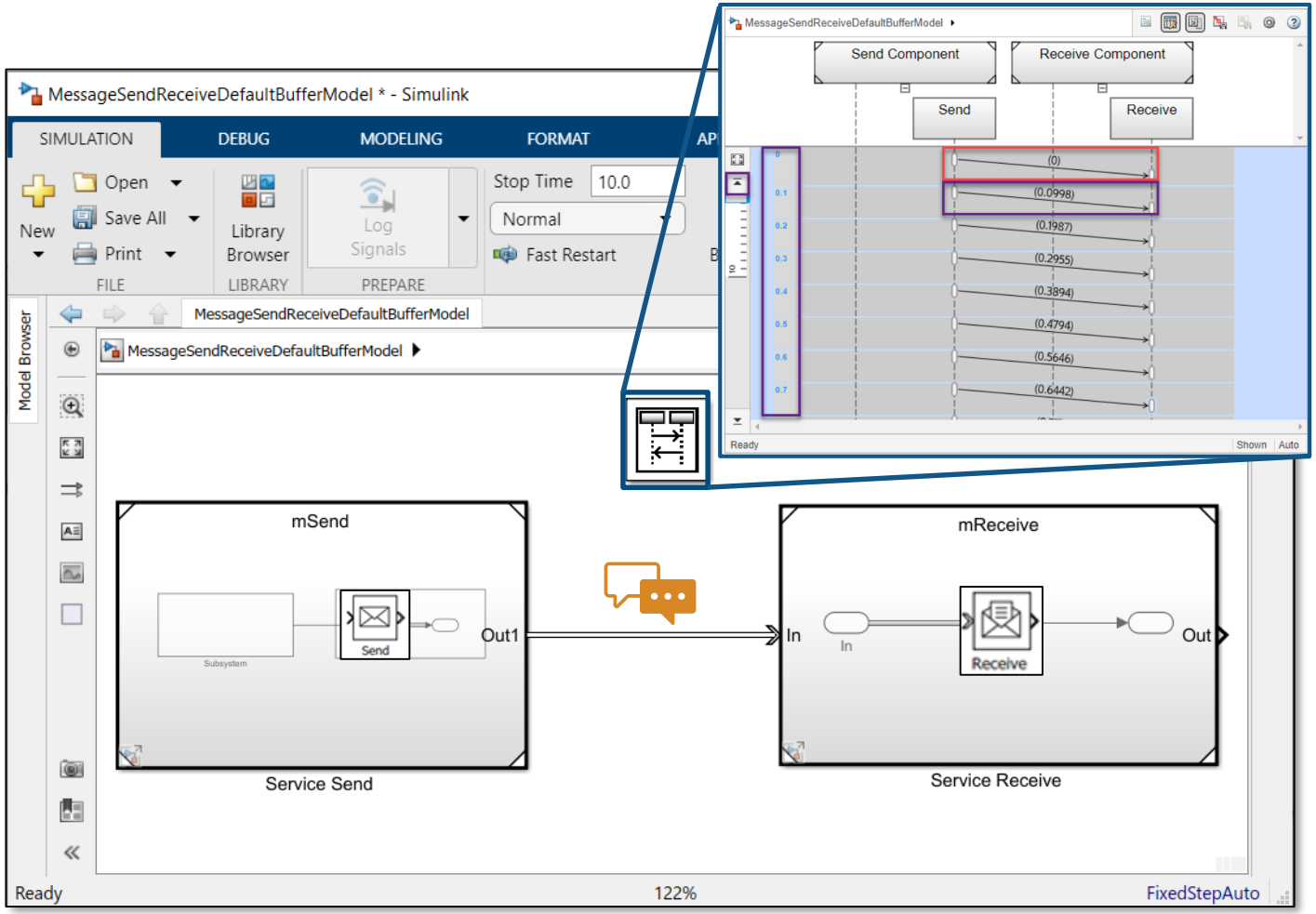


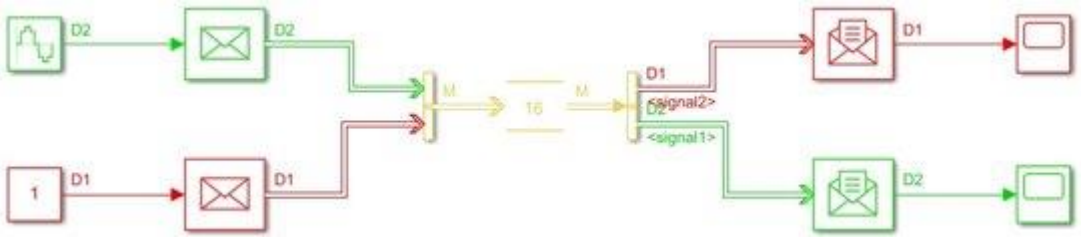




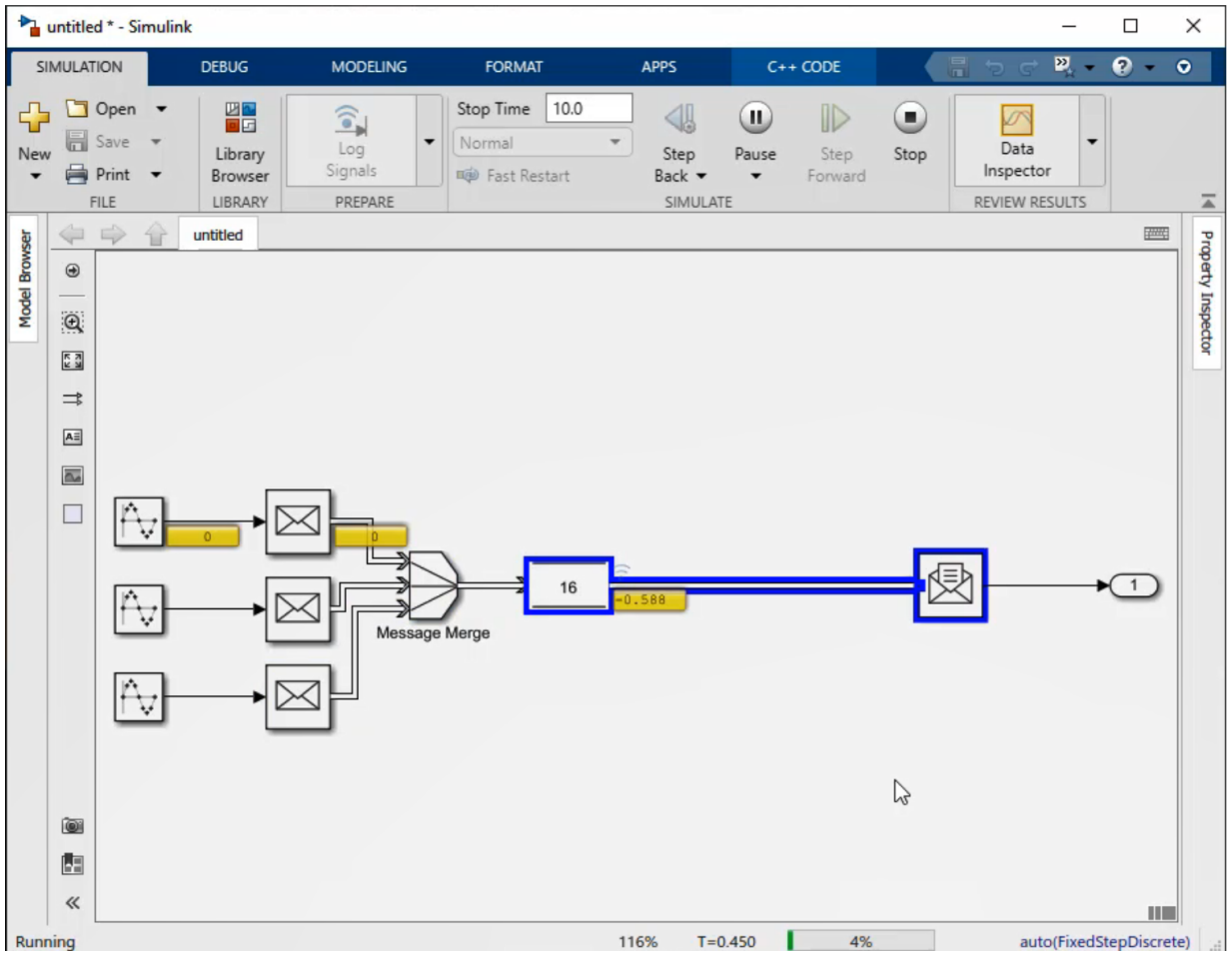
使用消息发送和接收模块建模面向服务的通讯

消息建模的新功能

- 消息线可以合并为非虚拟或虚拟总线
- 将多个消息线合并为一个消息线



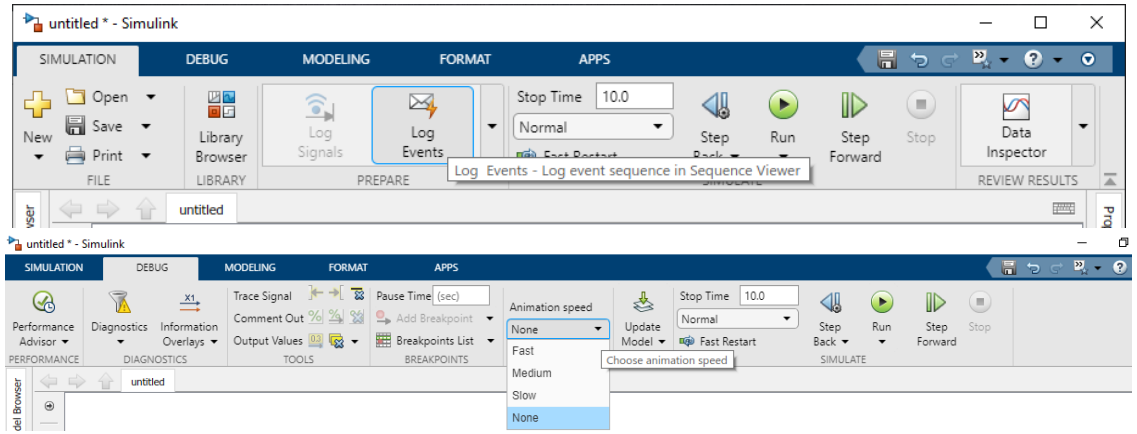
R2020b

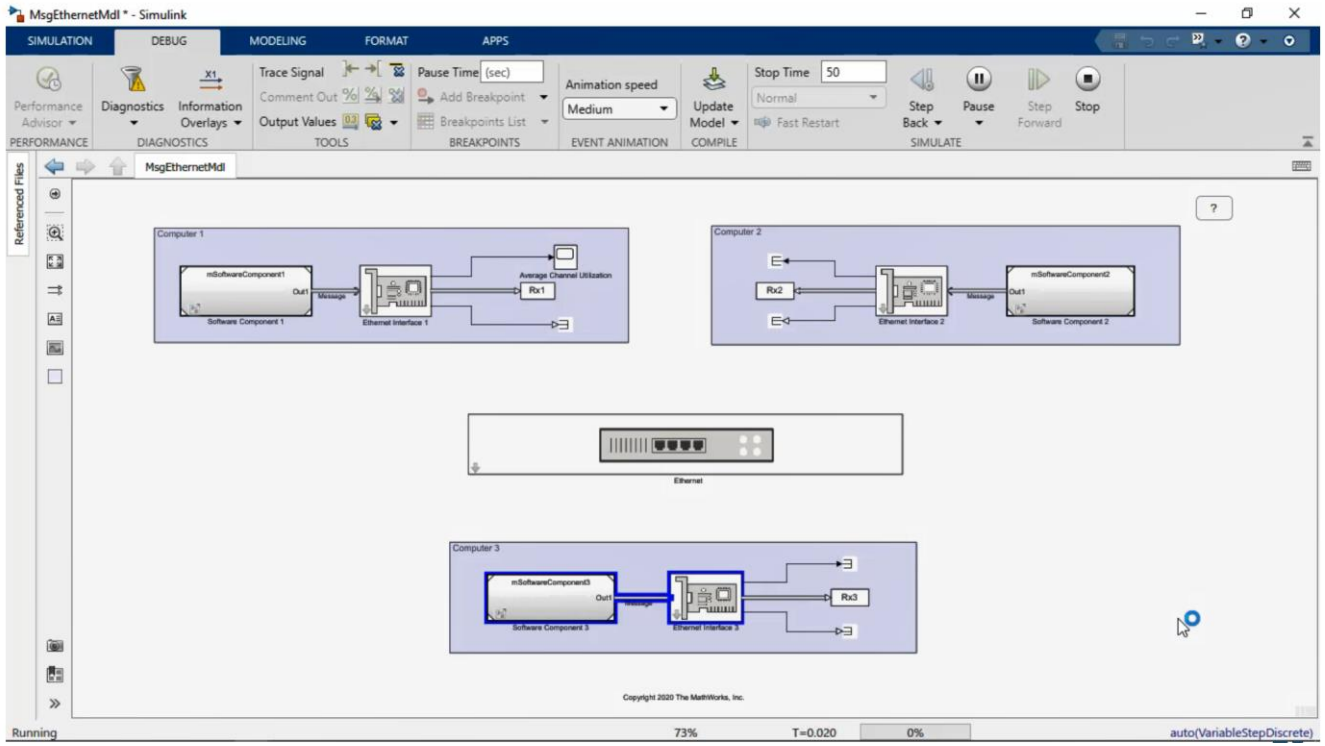


R2021a

理解复杂系统 – 基于事件的记录和动画

- 查看模型中涉及到以下模块的事件
  - Function-Call 子系统
  - Simulink 消息
  - Simulink 函数
- 用于
  - 事件记录
  - 事件动画
  - 时序观测工具





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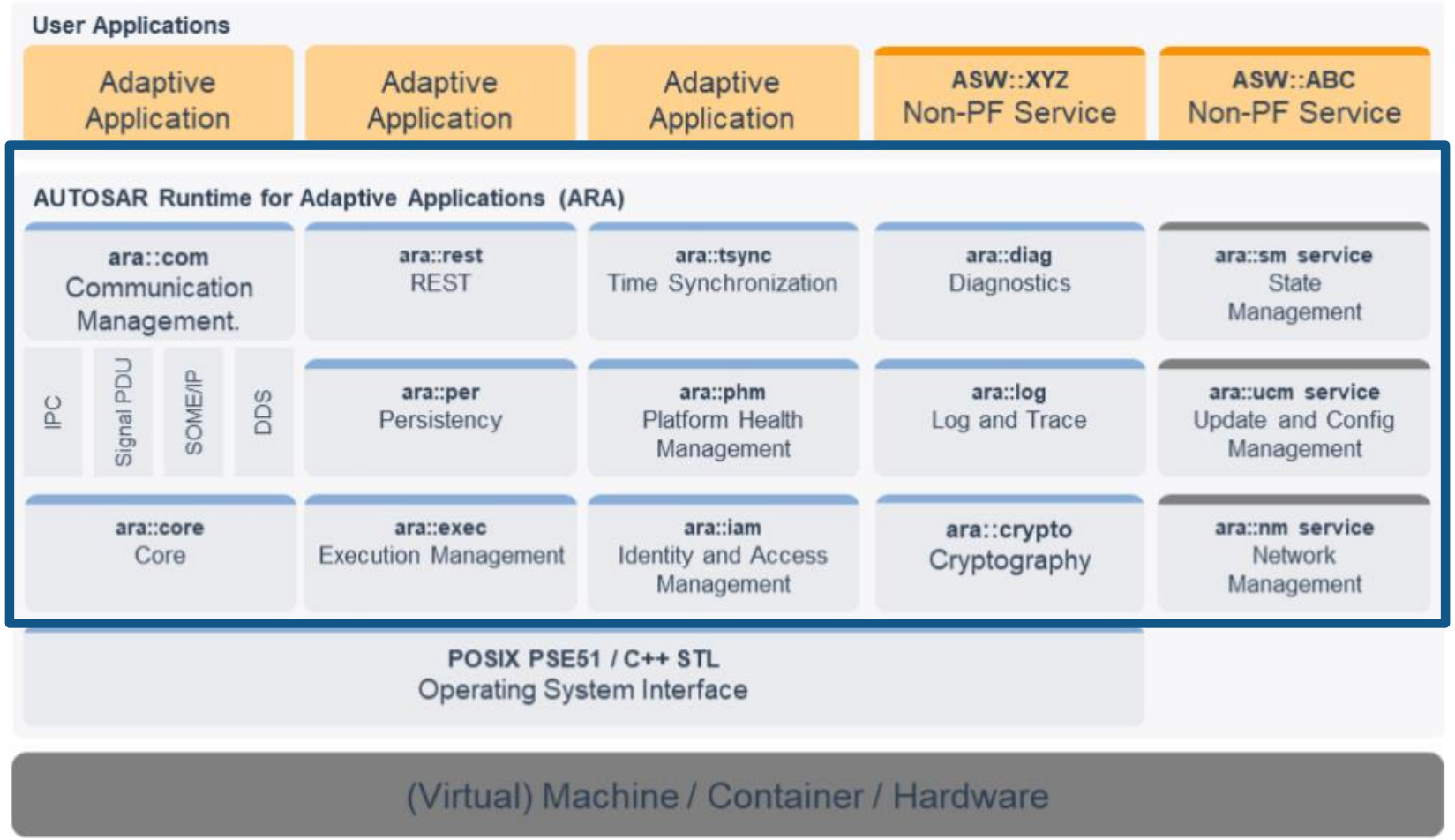
AUTOSAR Adaptive 概述

AUTOSAR Adaptive

- 服务和接口(ARA)

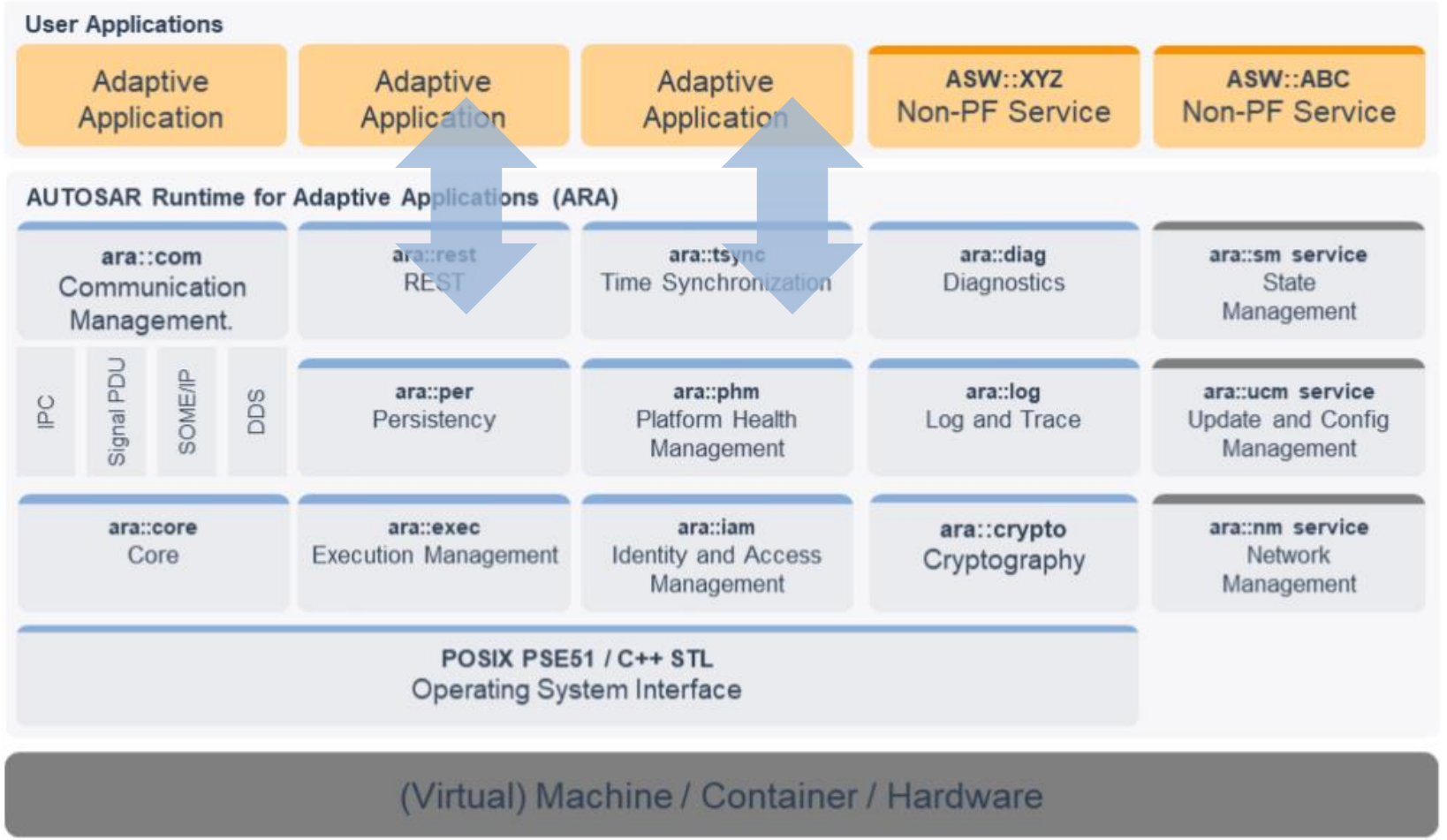


Source: www.autosar.org

AUTOSAR Adaptive 概述

AUTOSAR Adaptive

- 服务和接口(ARA)
- 客户端（应用）和服务器的运行时动态链接

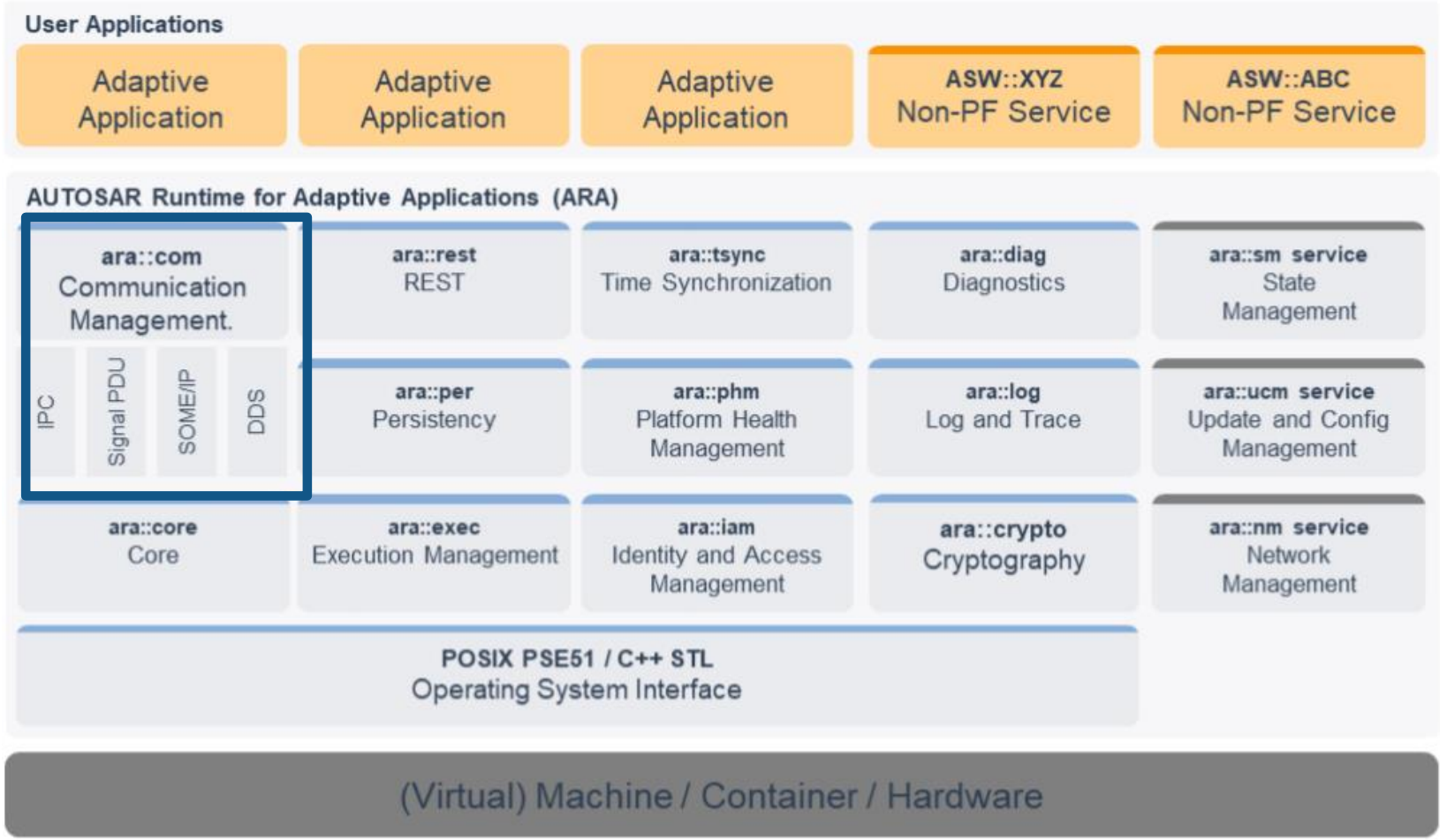


Source: www.autosar.org

AUTOSAR Adaptive 概述

AUTOSAR Adaptive

- 服务和接口(ARA)
- 客户端（应用）和服务器的运行时动态链接
- 通讯中间件：SOME/IP 和 DDS



Source: www.autosar.org

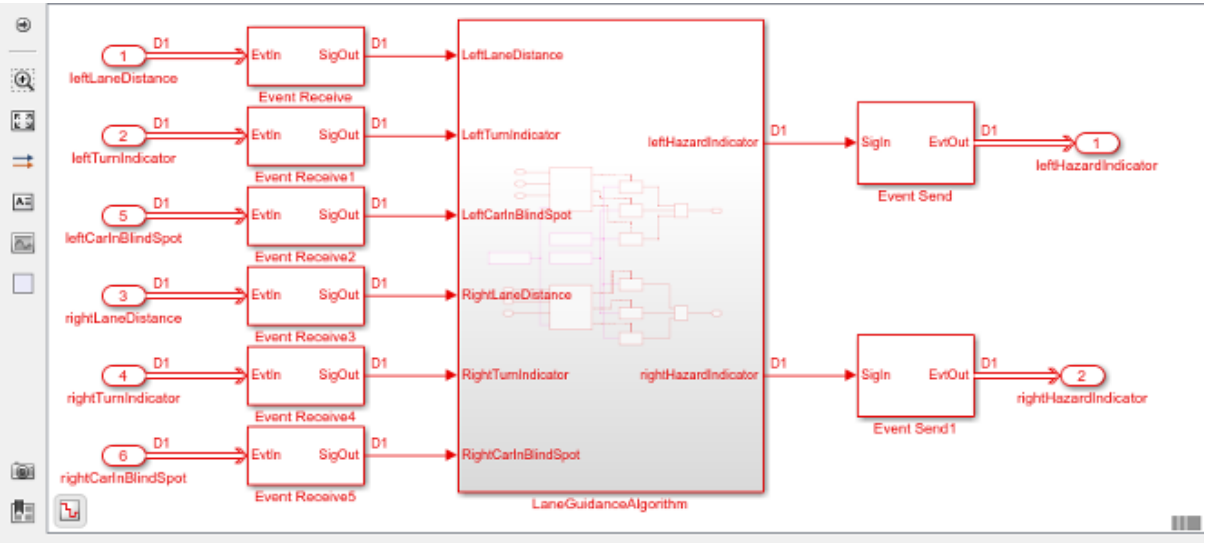
AUTOSAR Adaptive 支持 – AUTOSAR Blockset

AUTOSAR Adaptive平台实现了汽车行业Adaptive应用的AUTOSAR Runtime

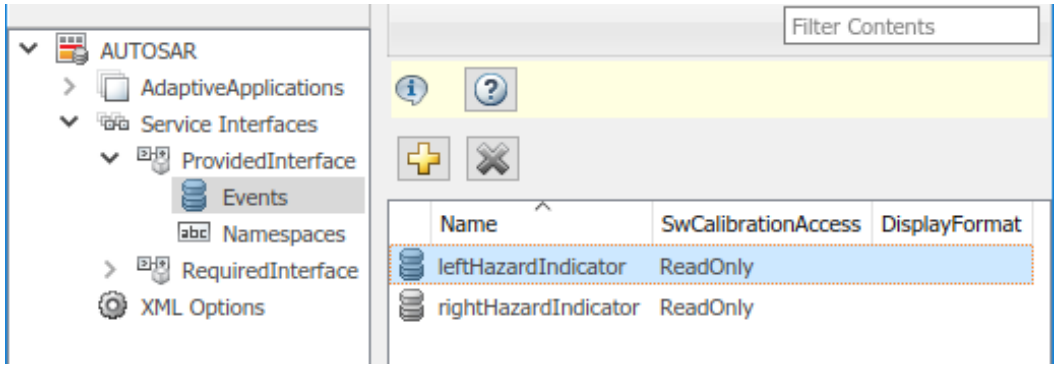
在Simulink中对AUTOSAR Adaptive应用进行建模、仿真、测试和生成代码

使用Simulink开发AUTOSAR Adaptive

- AUTOSAR Adaptive的服务通讯机制:
  - Events
  - Methods
  - Fields



- Simulink中Events可以采用消息建模及配置生成代码



AUTOSAR Adaptive 软件架构

Radar Service Interface

```
"Radar" : {
    // events
    "event" : {
        "leftLaneDistance"
        "leftTurnIndicator"
        "leftCarInBlindSpot"
        "rightLandDistance"
        "rightTurnIndicator"
        "rightCarInBlindSpot"
    },
    // methods
    "method" : {
        "Calibrate"
        "Adjust"
    },
    // fields
    "field" : {
        "updateRate"
    }
}
```

Hazard Service Interface

```
"Hazard" : {
    // events
    "event" : {
        "leftHazardIndicator"
        "rightHazardIndicator"
    },
    // methods
    "method" : { },
    // fields
    "field" : { }
}
```

AUTOSAR Adaptive 应用建模

AUTOSAR

Adaptive Application

RequiredPort

```
"Radar" : {
    // events
    "event" : {
        "leftLaneDistance"
        "leftTurnIndicator"
        "leftCarInBlindSpot"
        "rightLandDistance"
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    // fields
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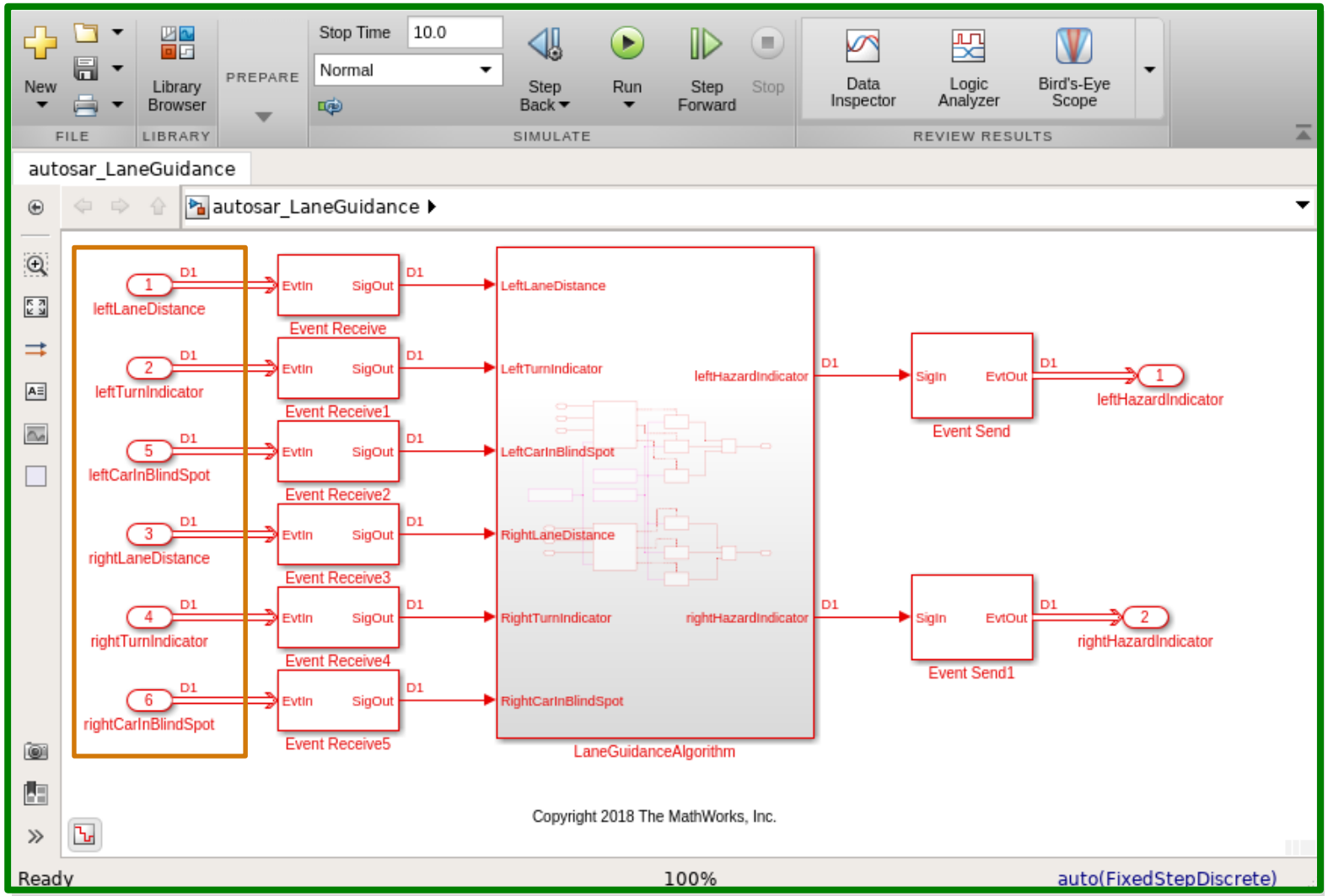


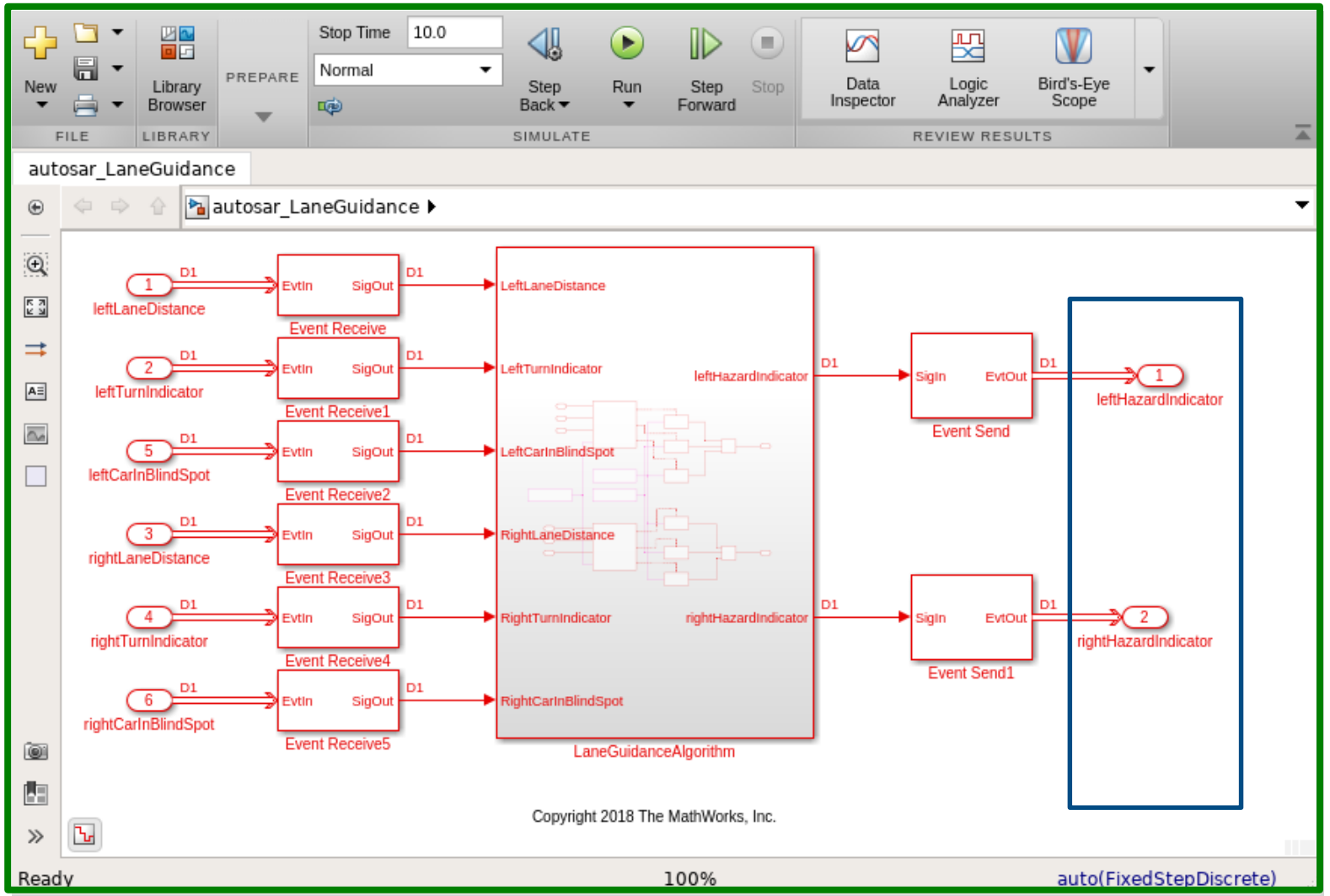
AUTOSAR Adaptive 应用建模

AUTOSAR

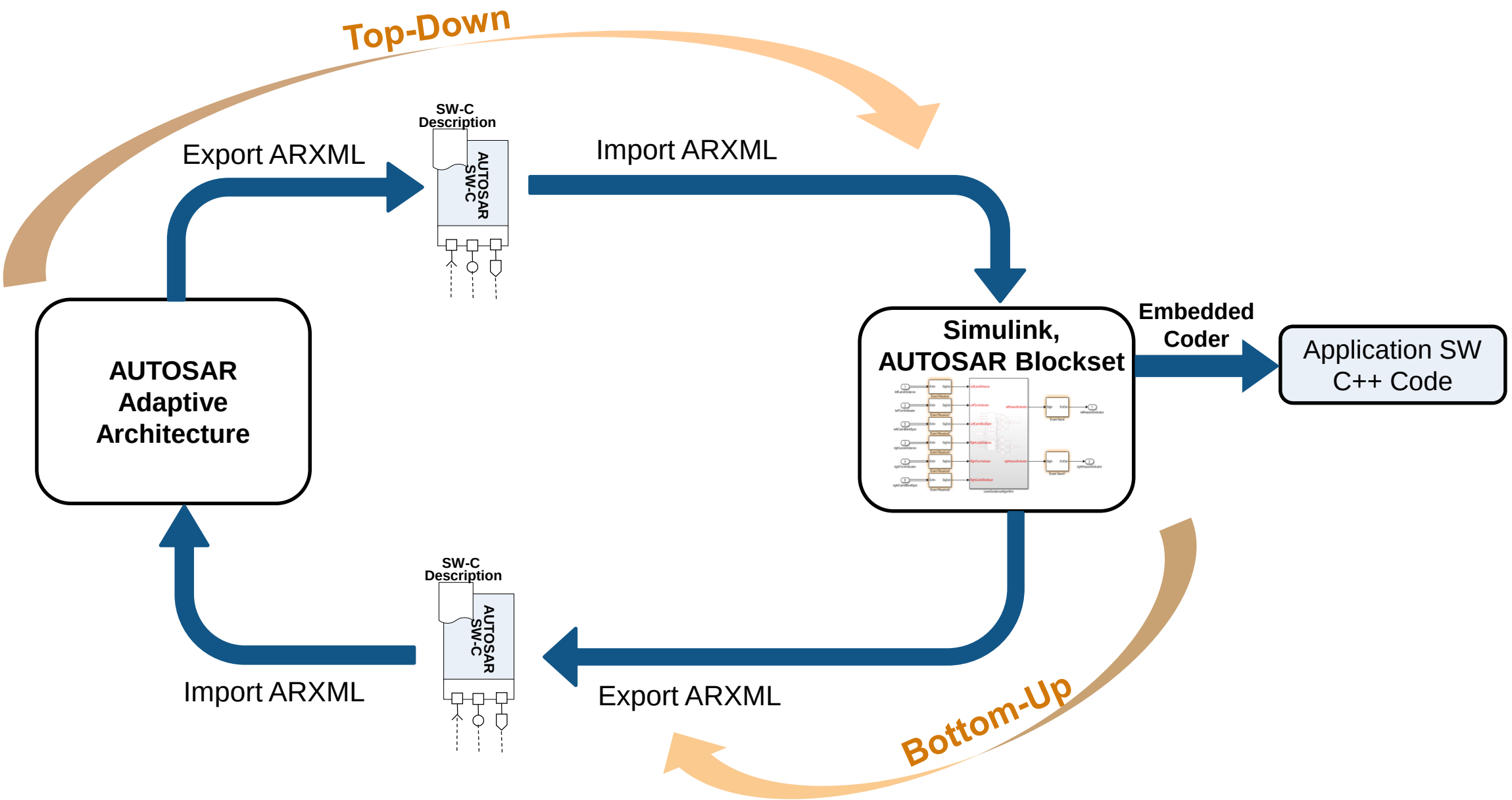
Adaptive Application

ProvidedPort

```
"Hazard" : {
    // events
    "event" : {
        "leftHazardIndicator"
        "rightHazardIndicator"
    },
    // methods
    "method" : { },
    // fields
    "field" : { }
}
```

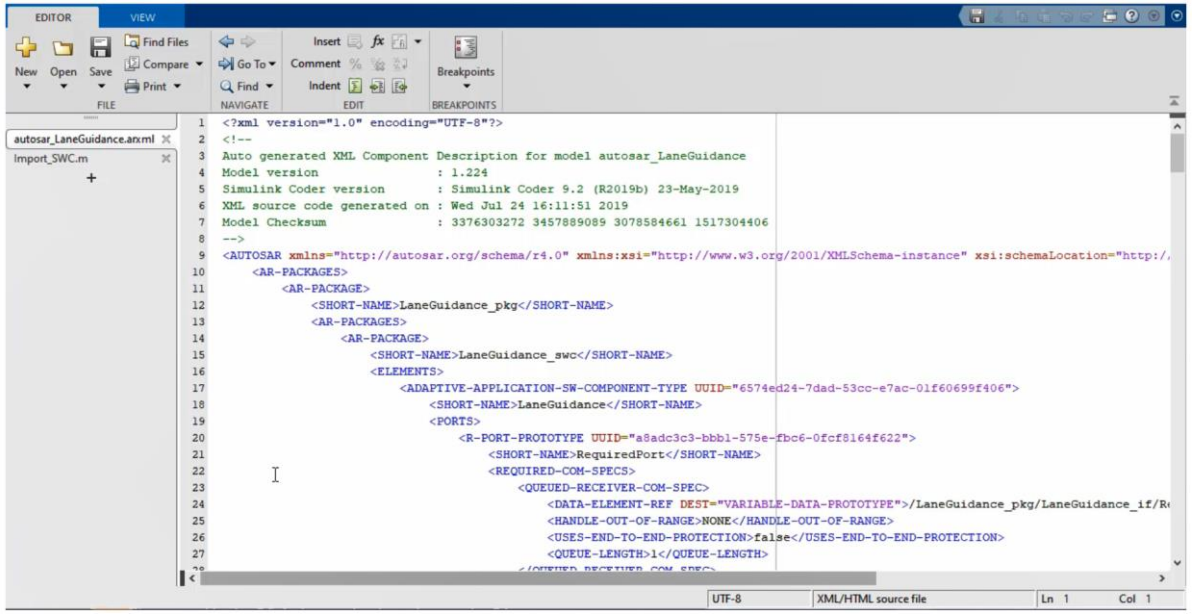


AUTOSAR Adaptive 工作流程



AUTOSAR Adaptive 开发步骤

- 导入ARXML创建模型框架



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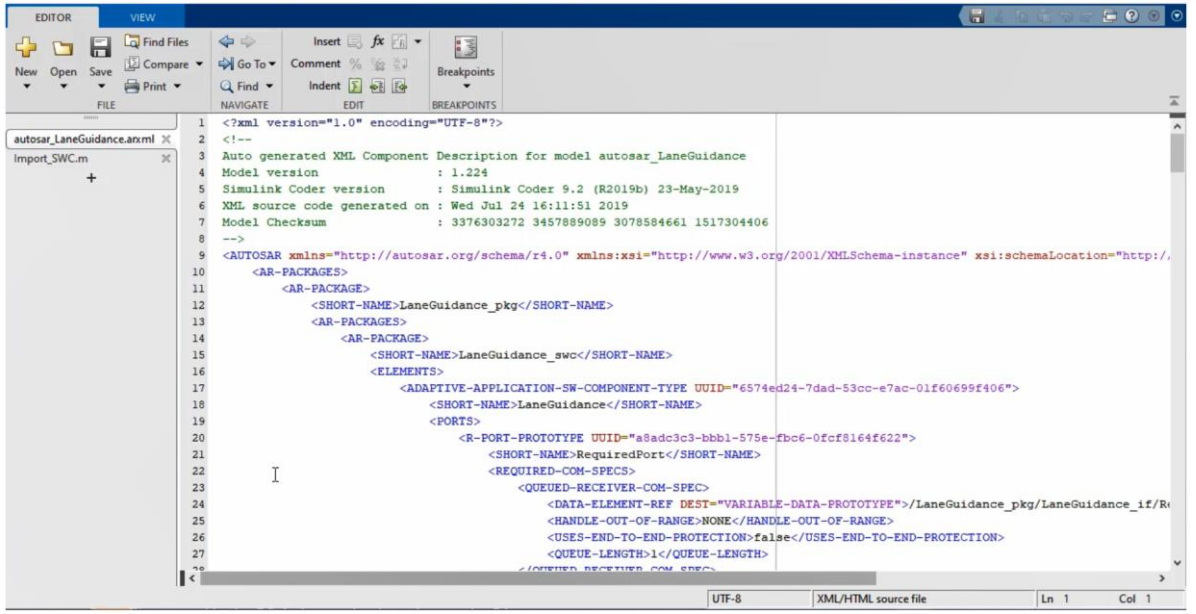

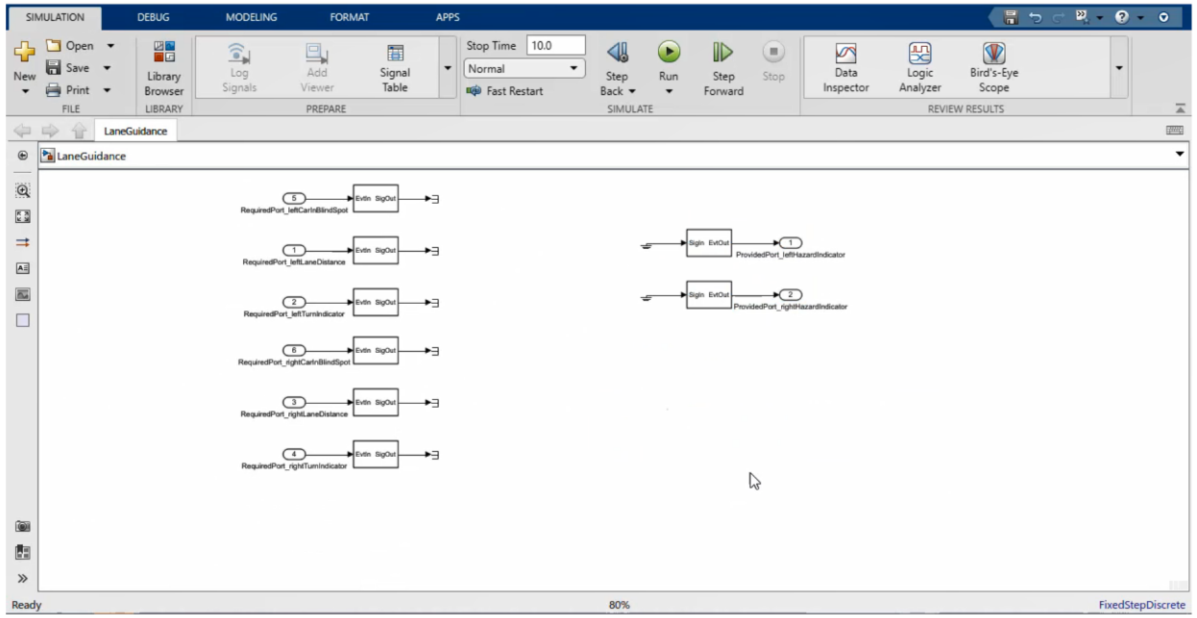

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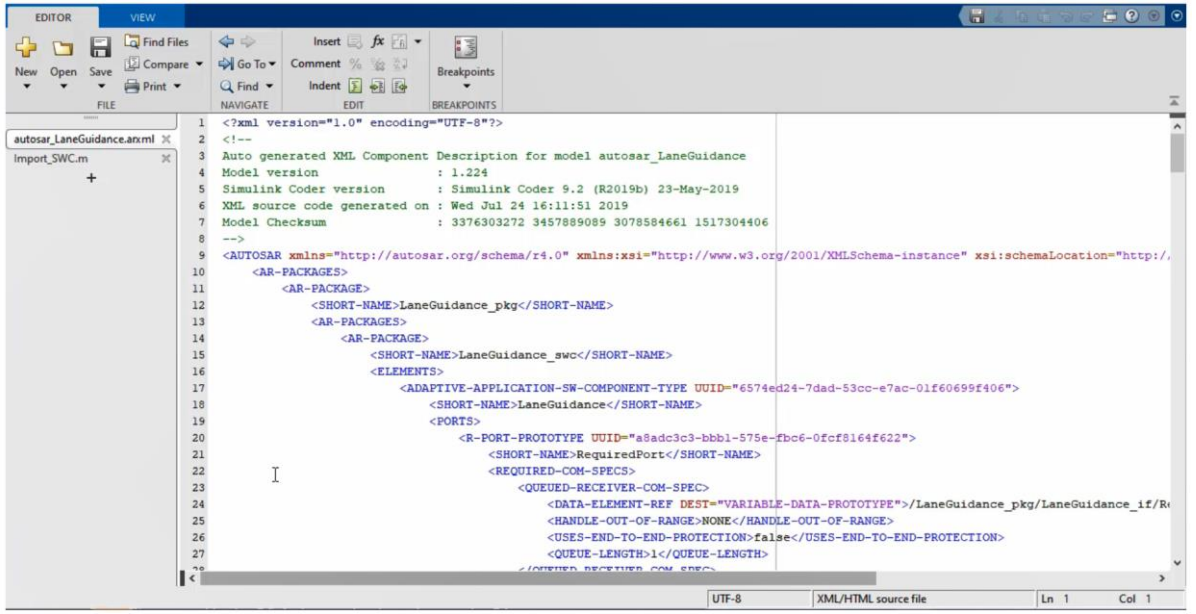
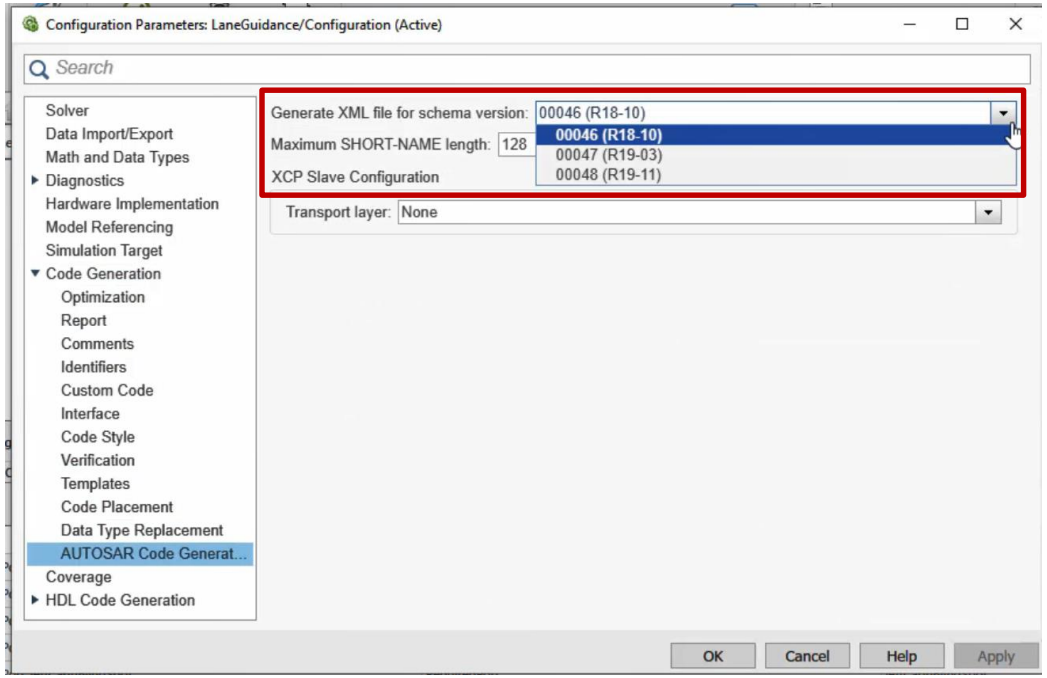
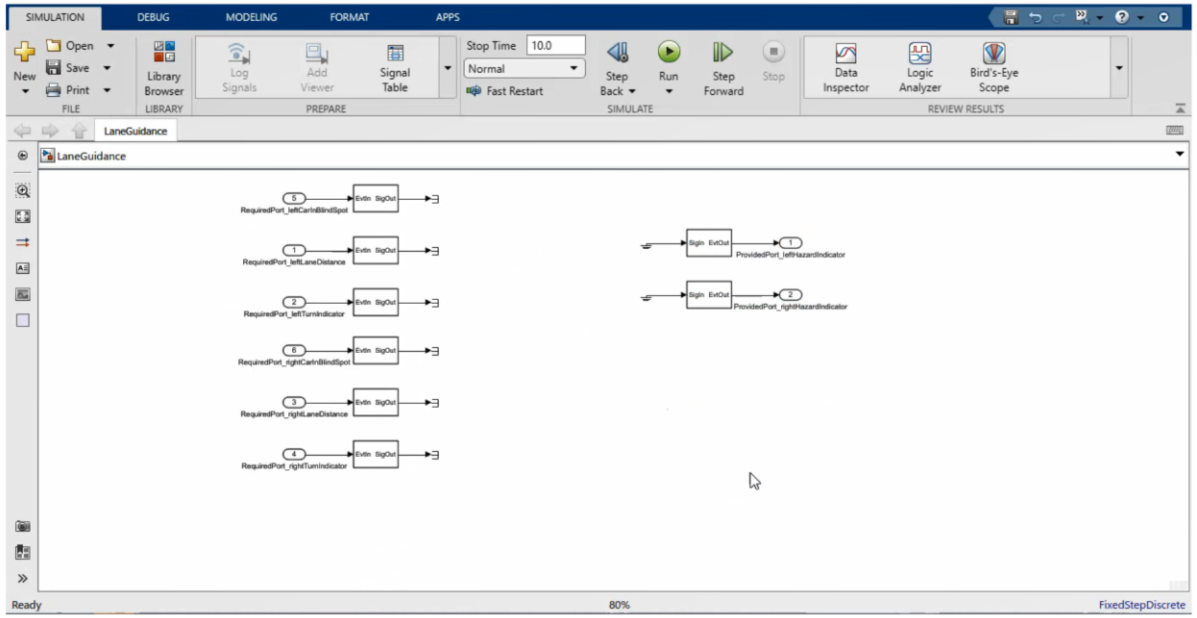
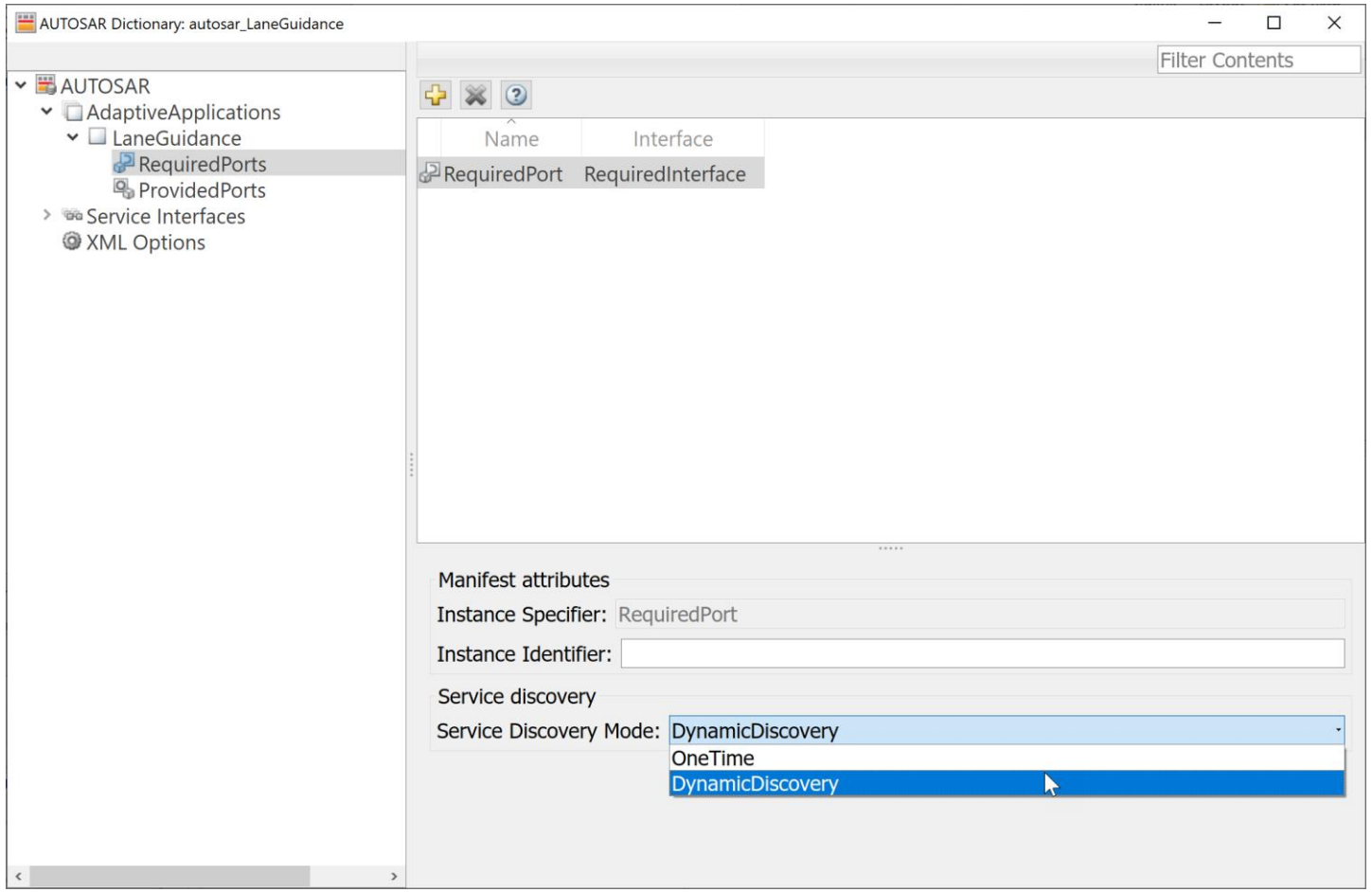






AUTOSAR Adaptive 开发步骤

- 导入ARXML创建模型框架
- 配置服务发现机制

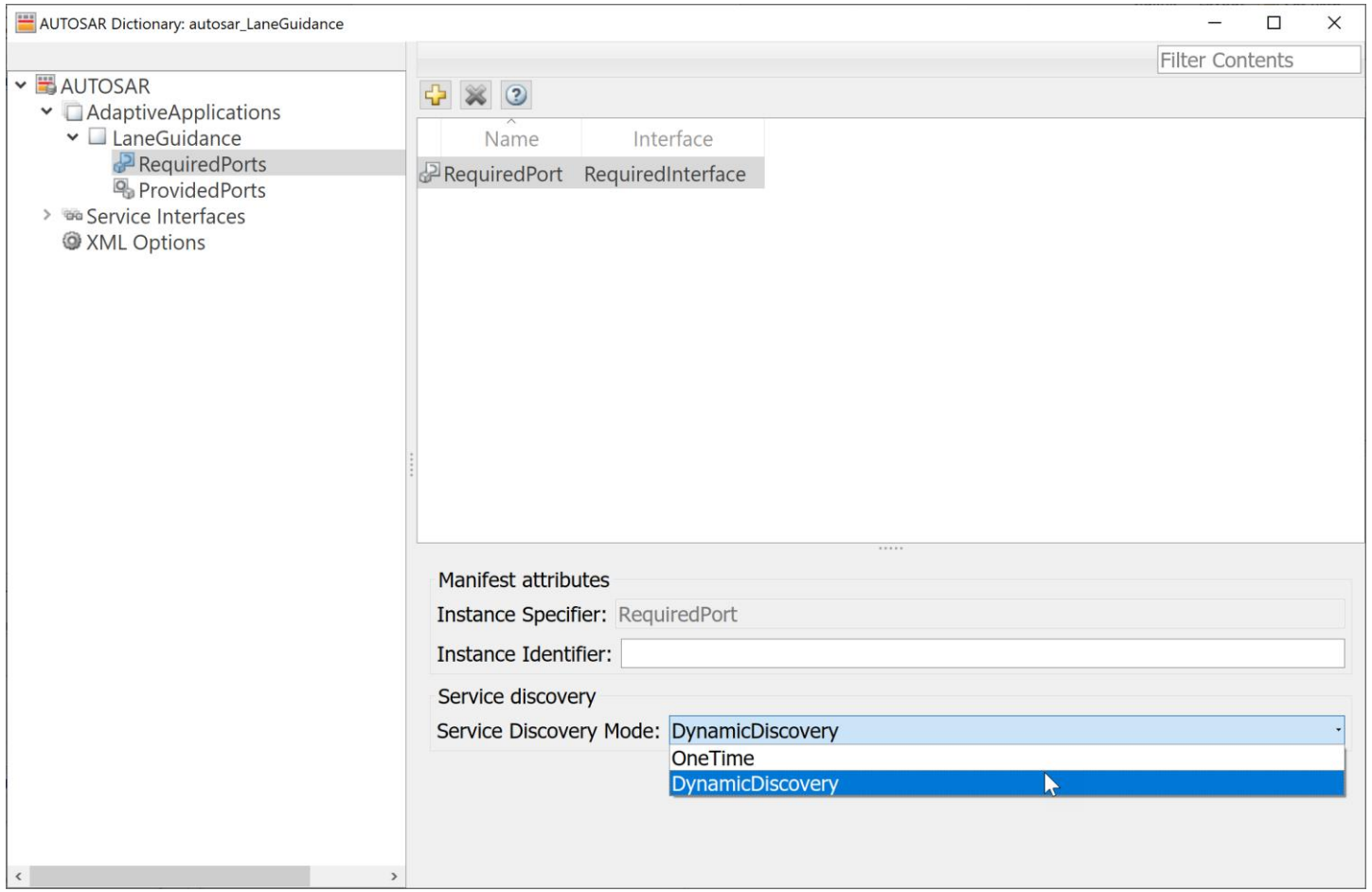


AUTOSAR Adaptive 开发步骤

- 导入ARXML创建模型框架

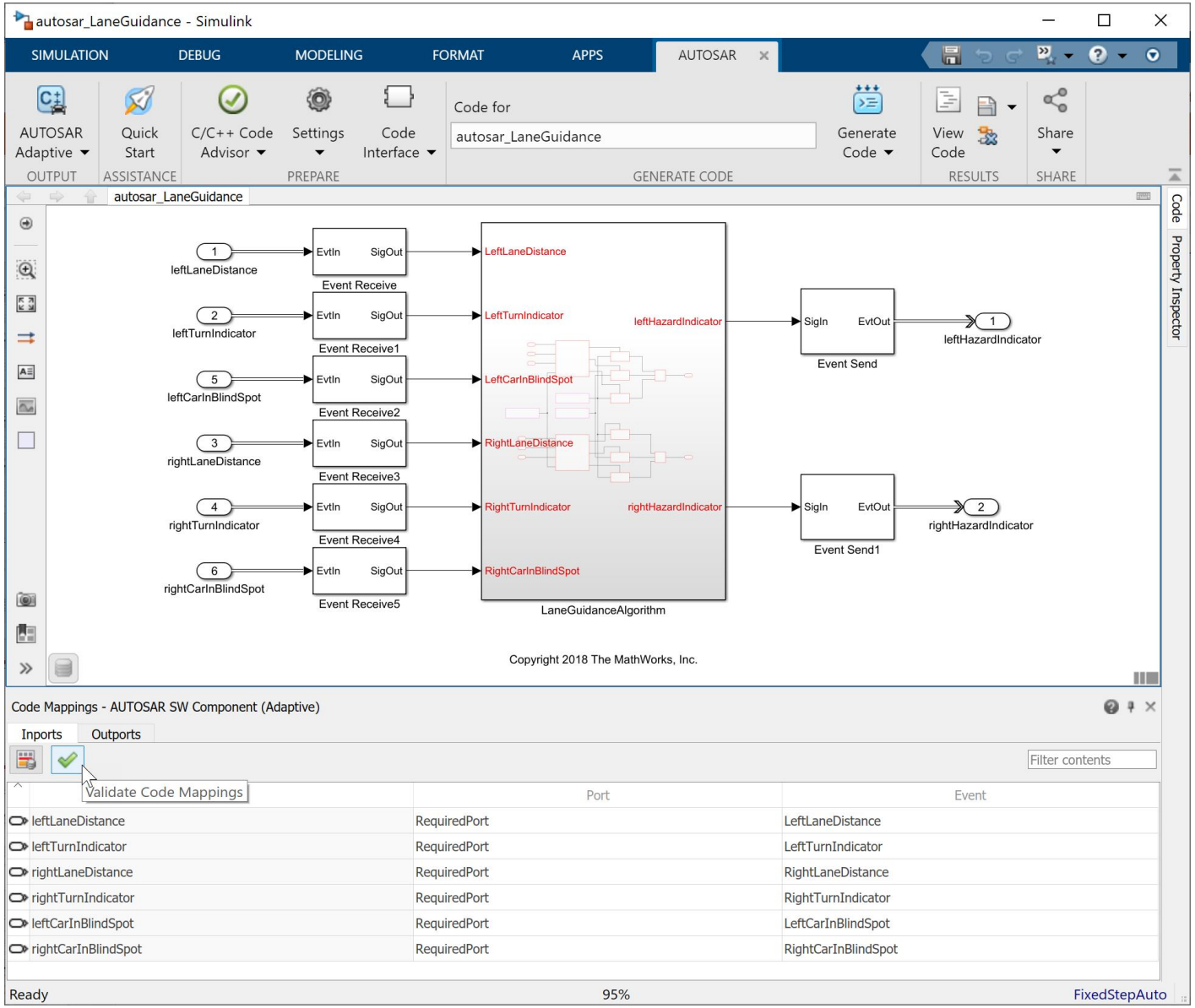
- 配置服务发现机制

  订阅自适应服务
  - 只在启动时, 或
  - 在其可用时动态发现



AUTOSAR Adaptive 开发步骤

- 导入ARXML创建模型框架
- 配置服务发现机制
- 确认AUTOSAR属性



AUTOSAR Adaptive 开发步骤

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- 配置服务发现机制
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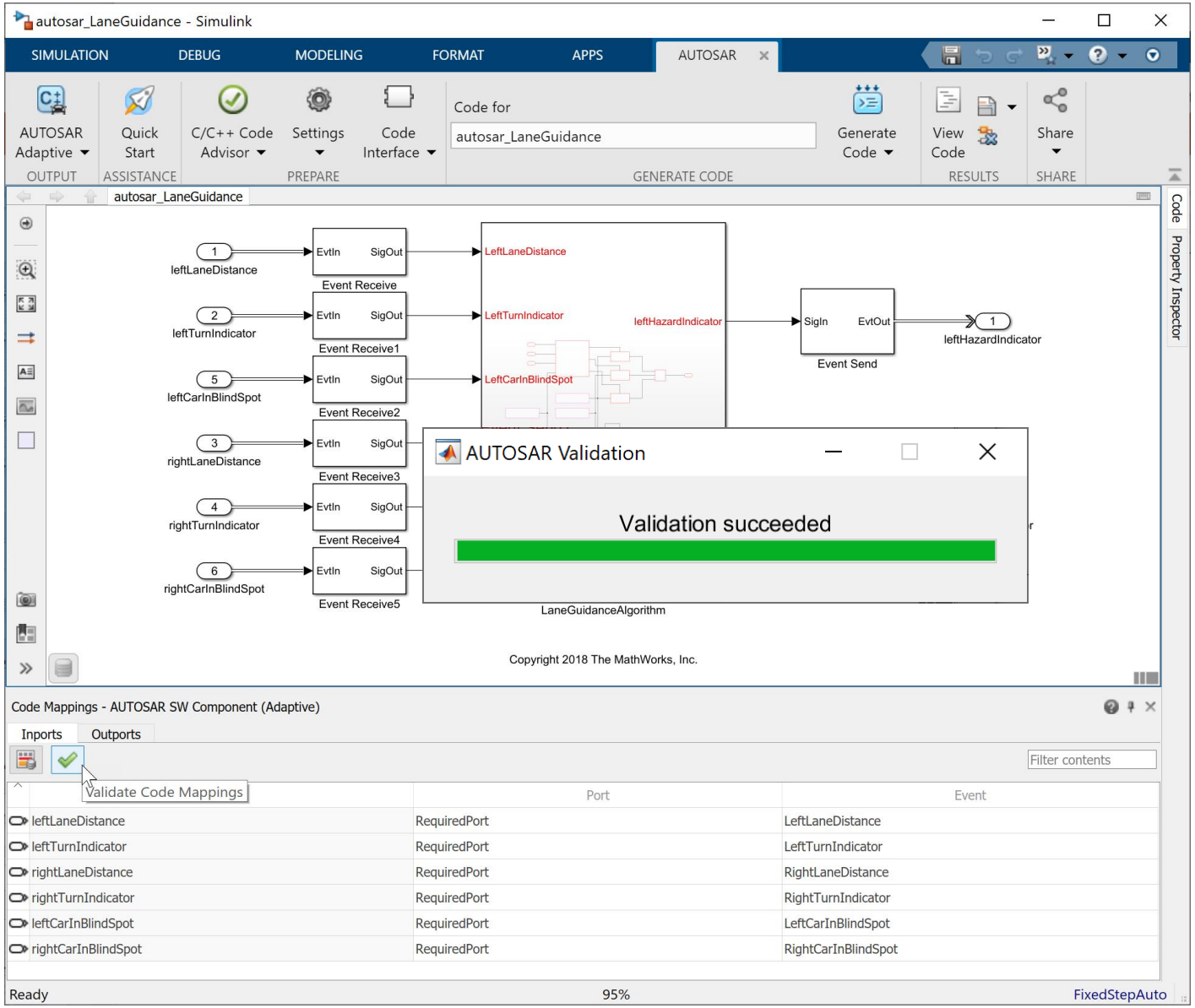
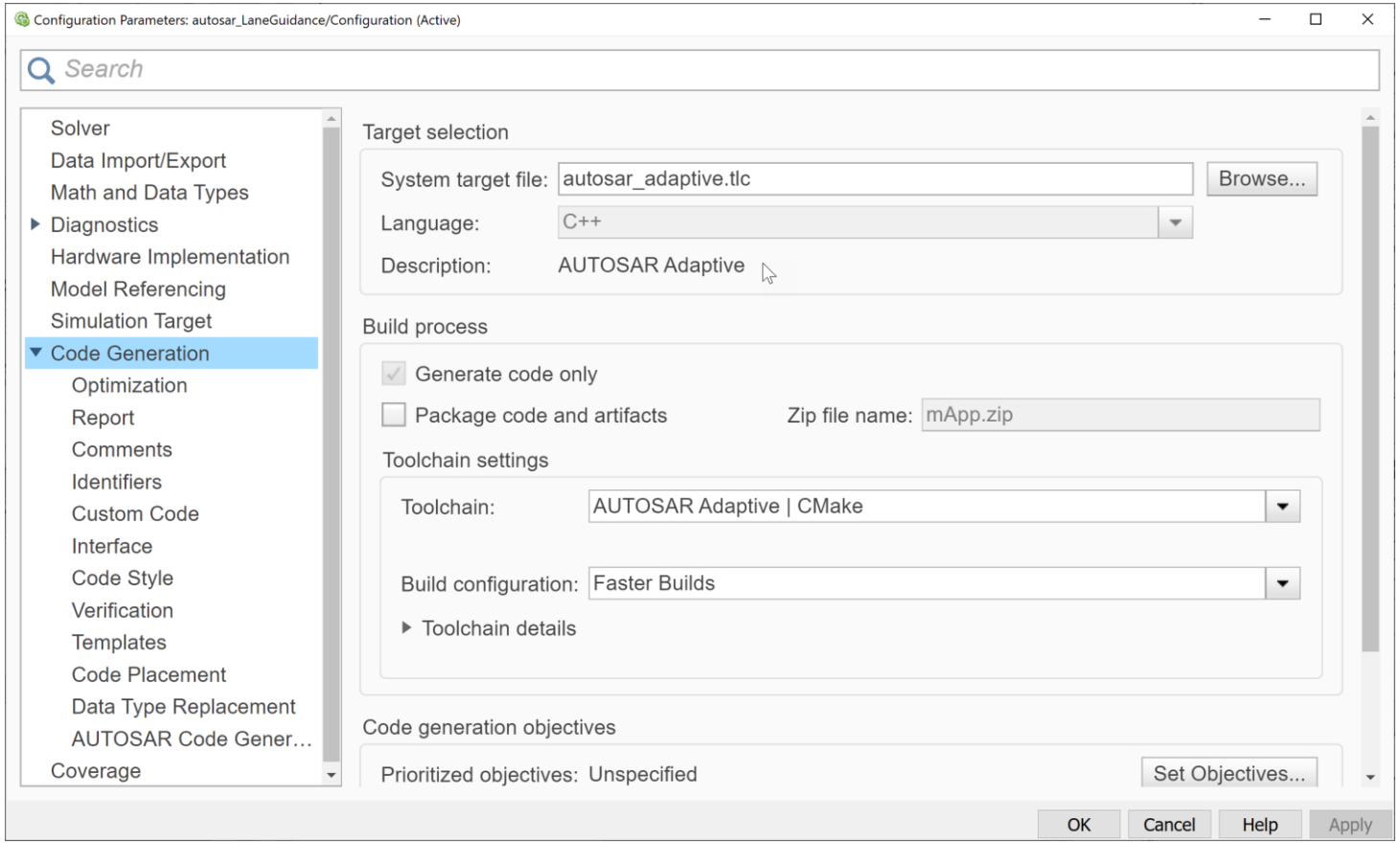


AUTOSAR Adaptive 开发步骤

- 导入ARXML创建模型框架
- 配置服务发现机制
- 确认AUTOSAR属性
- 生成代码



AUTOSAR Adaptive 开发步骤

- 导入ARXML创建模型框架
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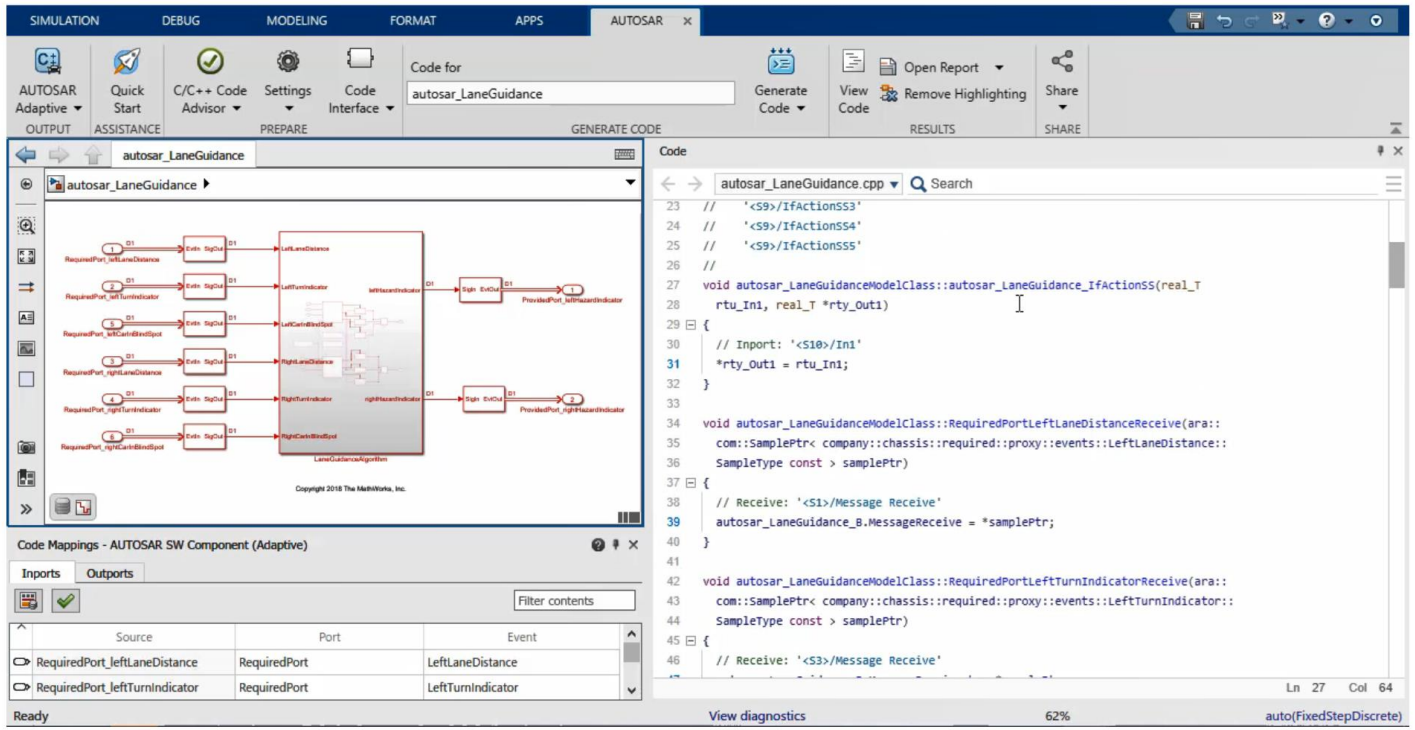
- 生成代码



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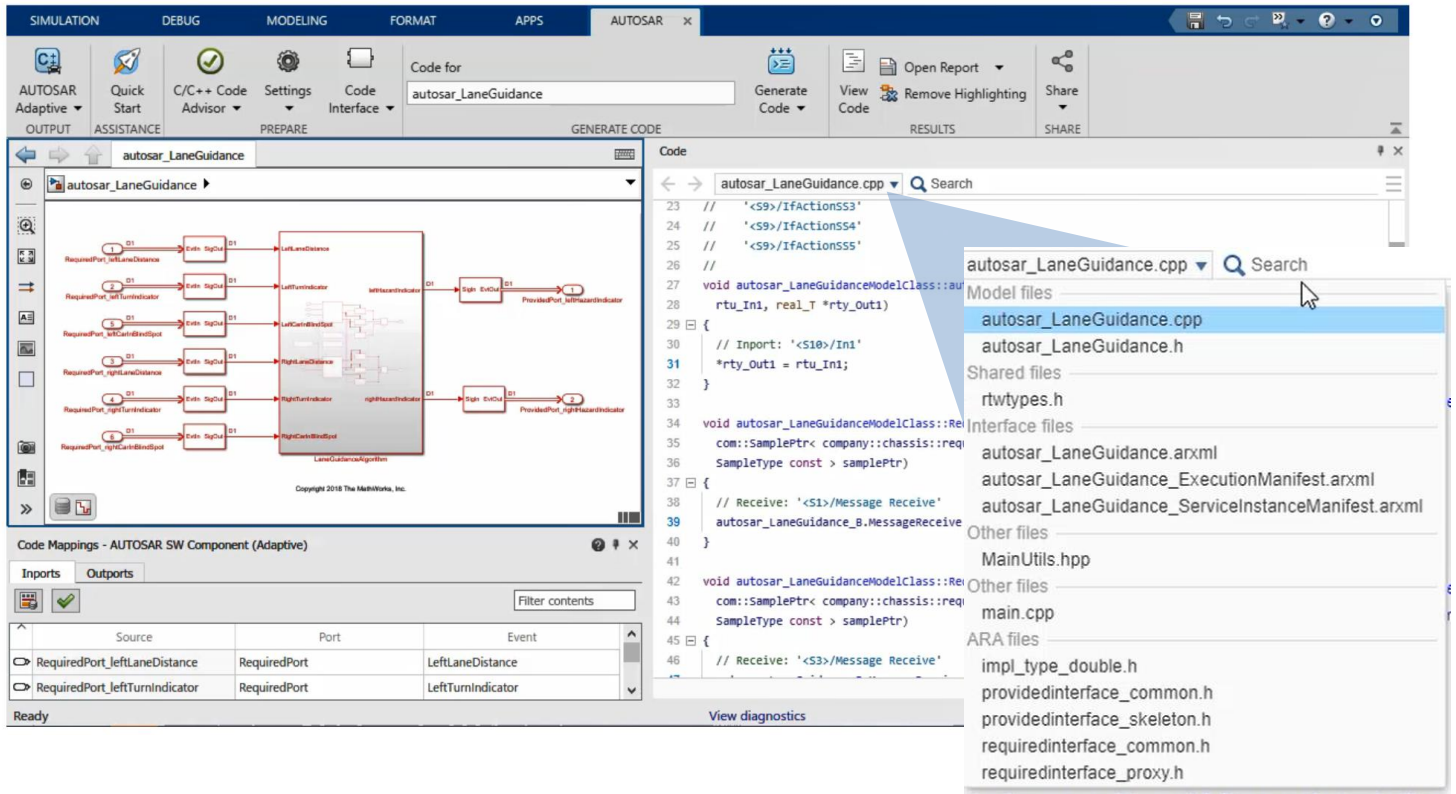

内容

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- Simulink对SOA行业标准的支持
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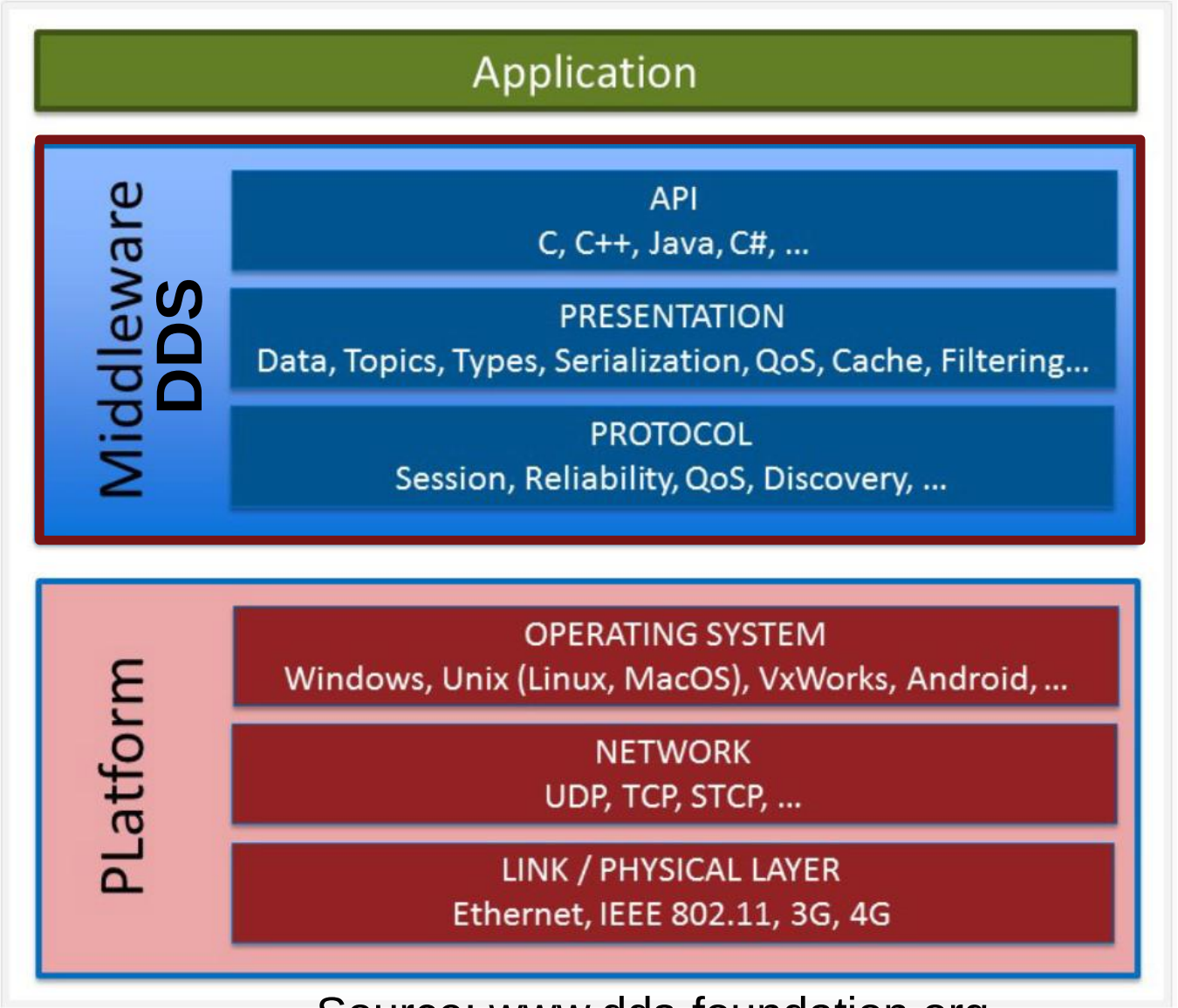
- 总结及如何获取更多相关信息

DDS概述

数据分发服务 (DDS)

- 从网络、数据格式和操作系统的细节中将应用抽象出来
- 数据中心通讯（发布-订阅）
- 服务质量和动态发现



Source: www.dds-foundation.org

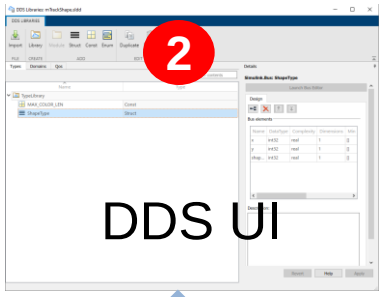
DDS支持 – DDS Blockset

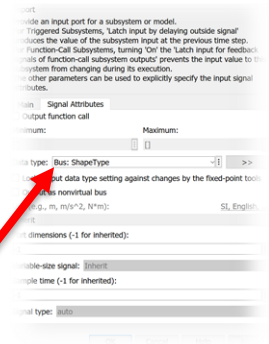
数据分发服务(DDS)采用SOA方法论解决实时和嵌入式系统的发布/订阅的通讯问题

DDS面向航空、国防、汽车和机器人等行业的实时数据交换应用需求

R2021a

DDS开发流程

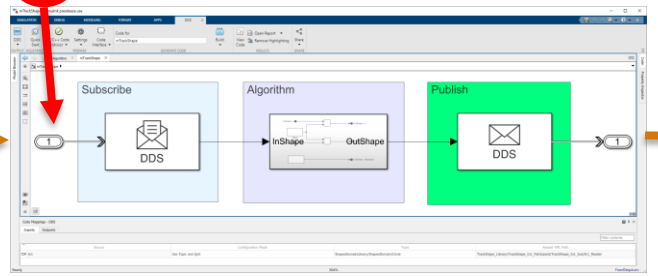




Import

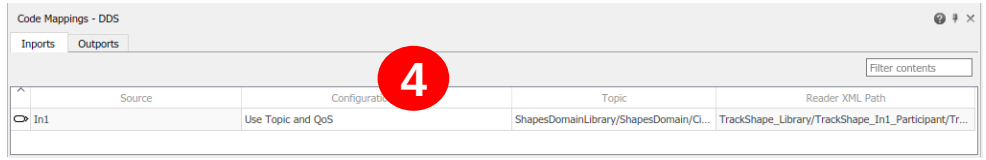
1

Simulink Data Dictionary



5

Generate

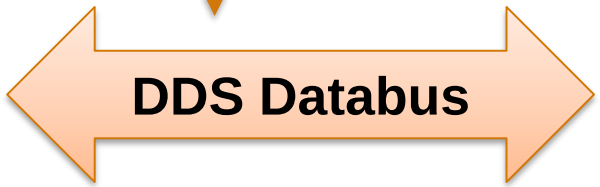


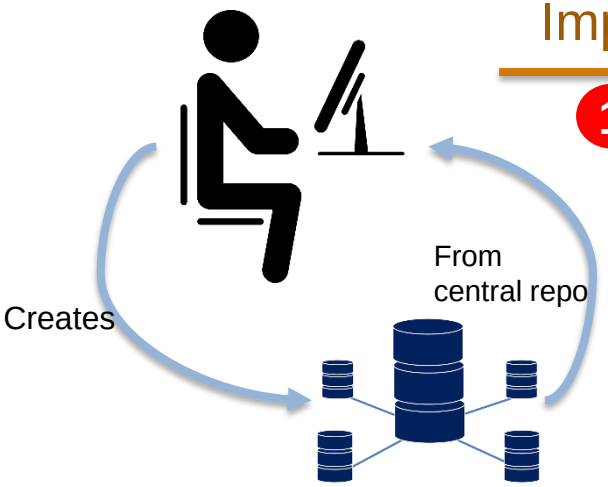
4

6

Deploy

IDL/XML
+
第三方
工具支持

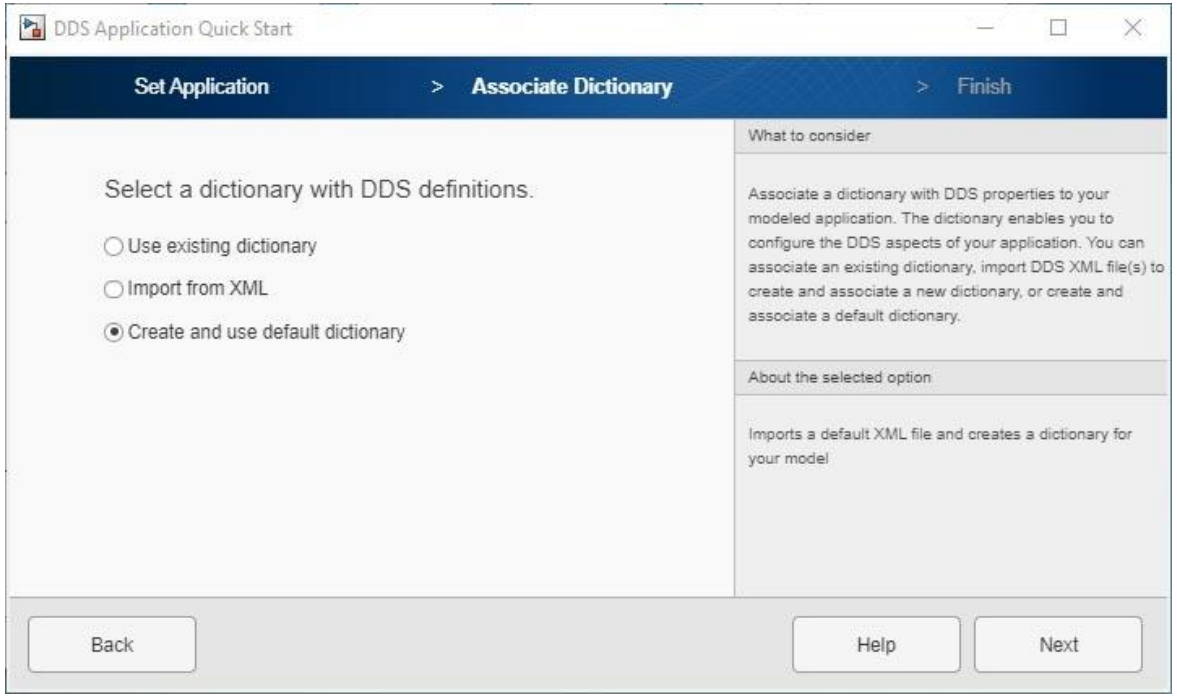




接口定义
QoS定义
(XML)

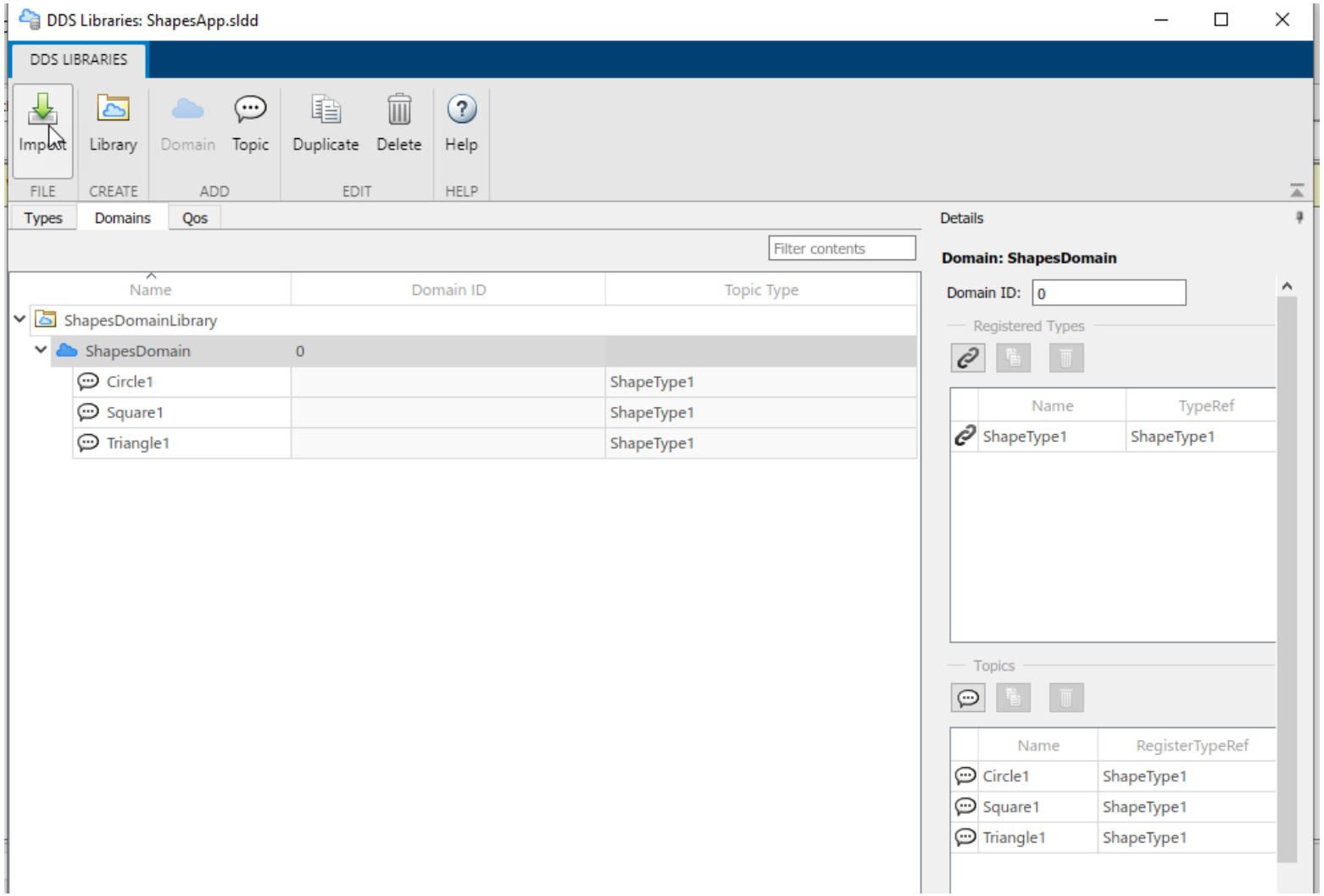
DDS 应用快速上手

- DDS 应用快速上手功能可以
  - 创建默认的DDS定义
  - 从XML文件导入DDS定义
  - 使用在模型中创建好的预定义数据



DDS数据词典

- 导入XML
- 定义/修改
  - 话题类型
  - 域
  - 服务质量策略

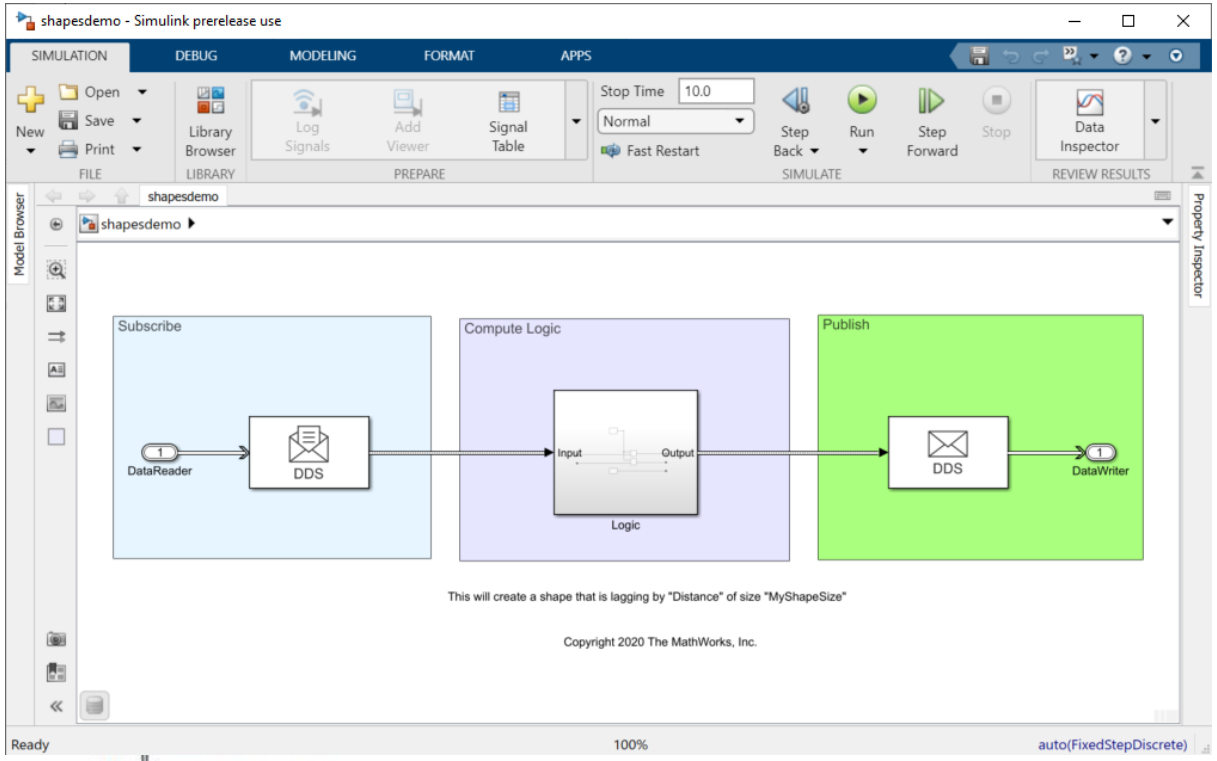


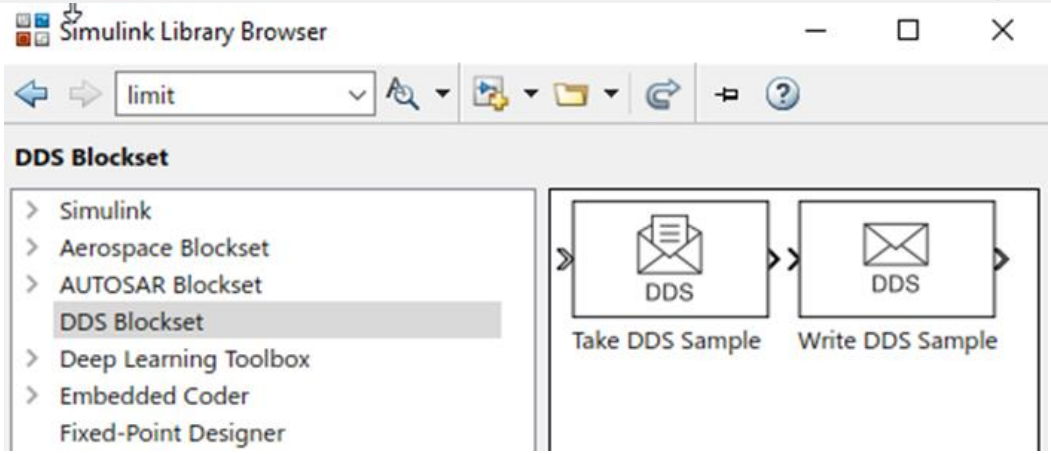
DDS建模模块

使用DDS模块建模发布或订阅机制

DDS Blockset 提供基本模块用于建模DDS应用

- 接收 DDS 采样
- 写入 DDS 采样



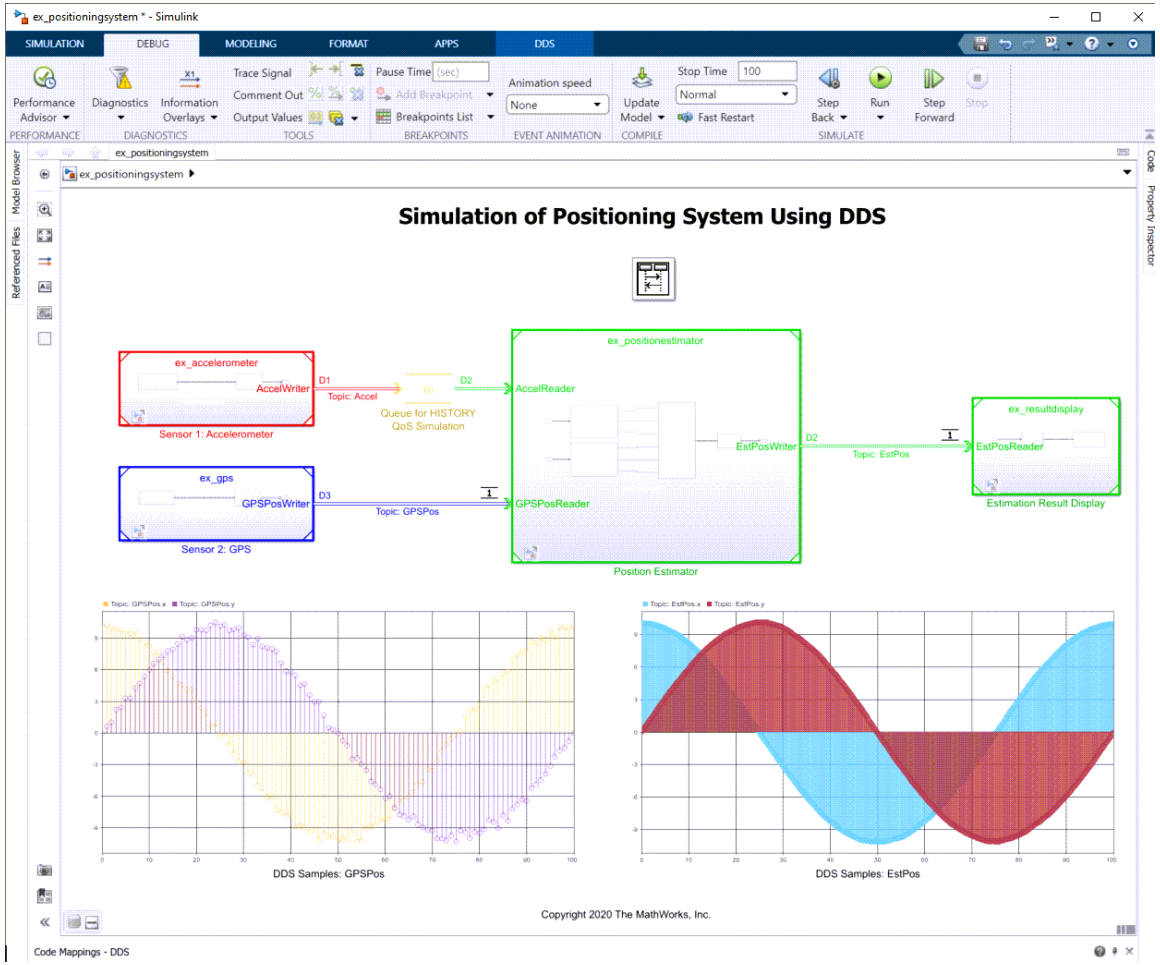



```
» open_system('shapesdemo');
```

DDS应用仿真

仿真DDS Simulink模型及其服务质量

使用Simulink建模和仿真包括历史数据在内的服务质量策略以验证运行时行为



» Live script demo

DDS代码生成和部署

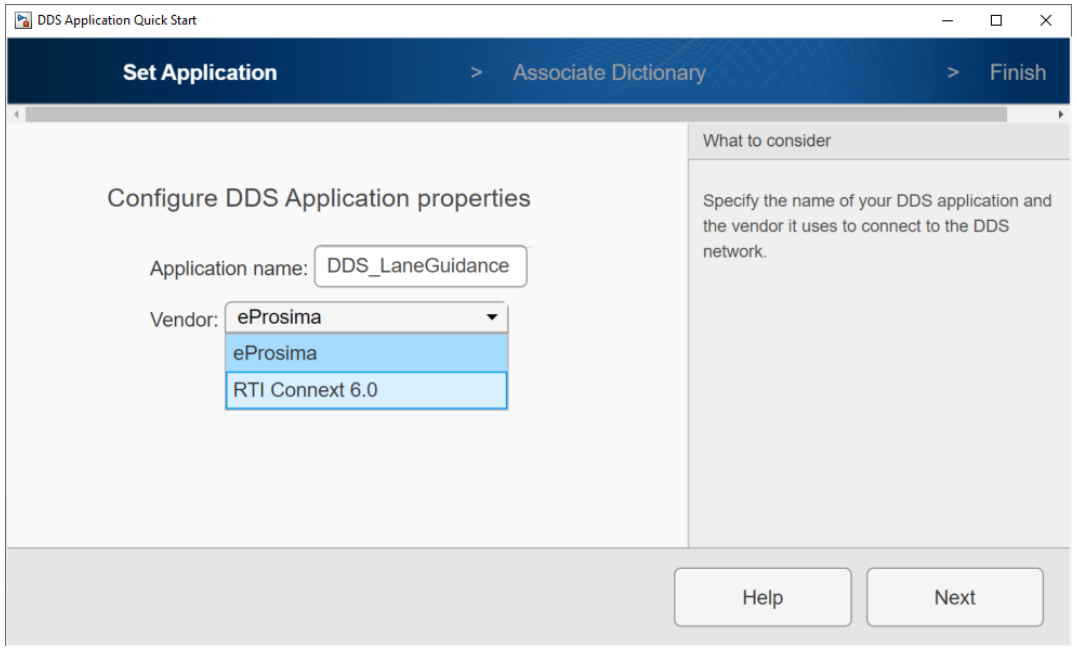
生成DDS可执行文件并部署到DDS网络

- 使用Embedded coder生成
  - 带DDS API的C++产品级代码
  - 用于部署的XML或IDL文件

```
bool writeWithWriter(const PosType* data, std::string participantName, std::string wr
    DDS_DataWriter* writer = getWriter(writerName, participantName);
    PosTypeDataWriter* fooWriter = PosTypeDataWriter_narrow(writer);
    if(!fooWriter) {
        return false;
    }
    const DDS_ReturnCode_t ret = PosTypeDataWriter_write((PosTypeDataWriter*)writer,
    return (ret == DDS_ReturnCode_t::DDS_RETCODE_OK);
};
bool createParticipant(std::string participantName) {
    if (participants.find(participantName) == participants.end()) {
        DDS_DomainParticipant* participant =
            DDS_DomainParticipantFactory_create_participant_from_config(
            DDS_TheParticipantFactory, participantName.c_str());
        if(!participant) {
            return false;
        }
        participants[participantName] = participant;
    }
    return true;
};
```

与第三方DDS栈集成

DDS Blockset 与第三方DDS栈 (如RTI Connext 和 eProsima Fast DDS)完全集成



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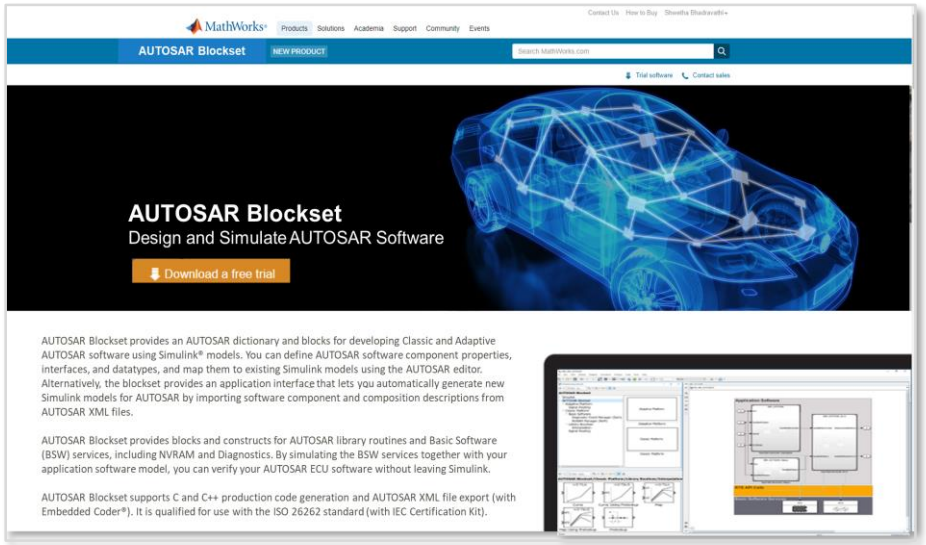
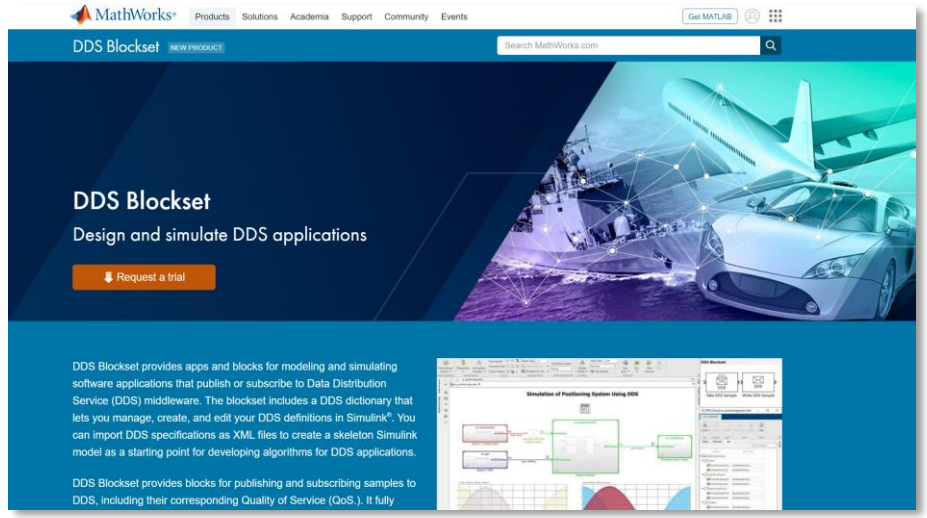
总结

- 高级的功能需求推动了汽车行业电子电气和软件架构的进化
- 软件的复杂管理和频繁升级要求引入了面向服务的架构
- Simulink支持设计、仿真、生成和部署面向服务的应用
- 最大化的复用已有模型和经验有助于降低迁移至SOA应用的风险

更多相关信息 – 产品主页和演示

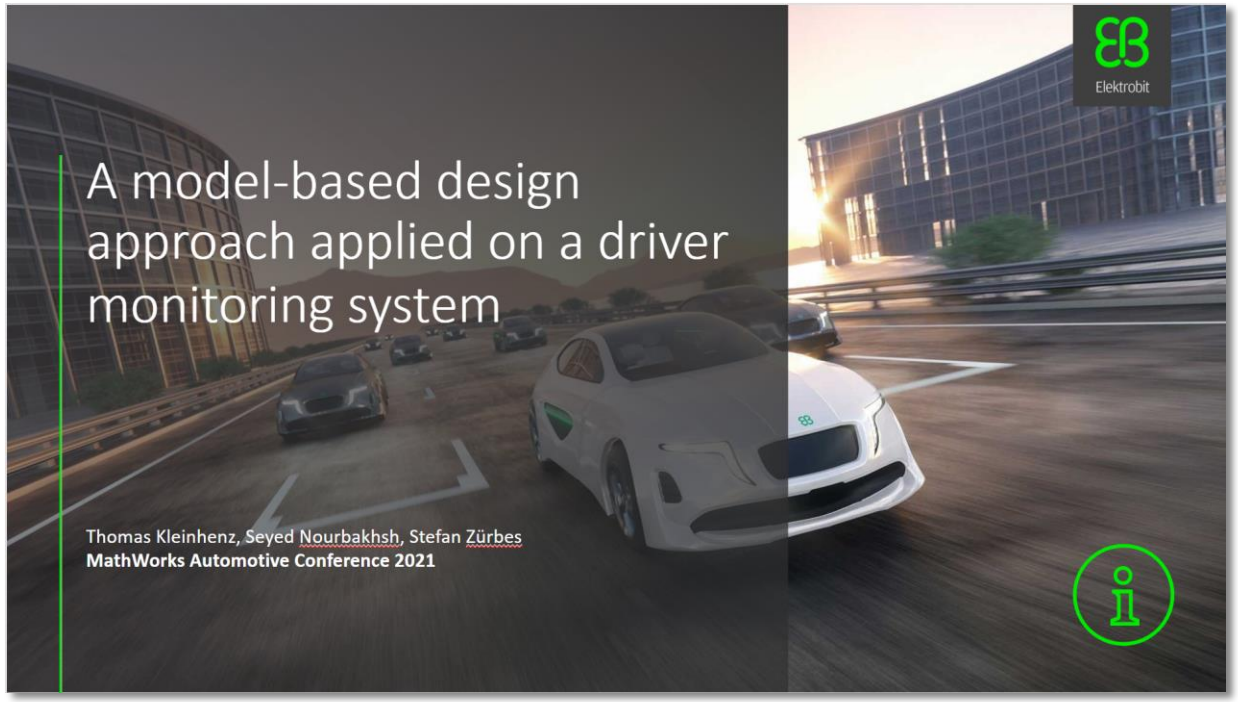


www.mathworks.com/products/autosar.html



www.mathworks.com/products/dds.html

更多相关信息 – 与第三方栈的集成



Elektrobit – A model-based design approach applied on a driver monitoring system (using Adaptive AUTOSAR)

Vector – The evolution of E/E Architecture and the Impact on Future Software Development.

MATLAB EXPO 2021

感谢参会！

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