12 Years of AUTOSAR
Enabling Innovation with Model-Based Design

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MathWorks
AUTOMOTIVE CONFERENCE 2015

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```
switch(braindump)
{
```

```
case ‘AUTOSAR Acronym’:
```

AUTOSAR
means

① **AUTO**mobile **S**earch **A**nd **R**escue

② **AUT**hentic **S**portscar **A**spect **R**atio

③ **AUT**omotive **O**pen **S**ystem **Ar**chitecture

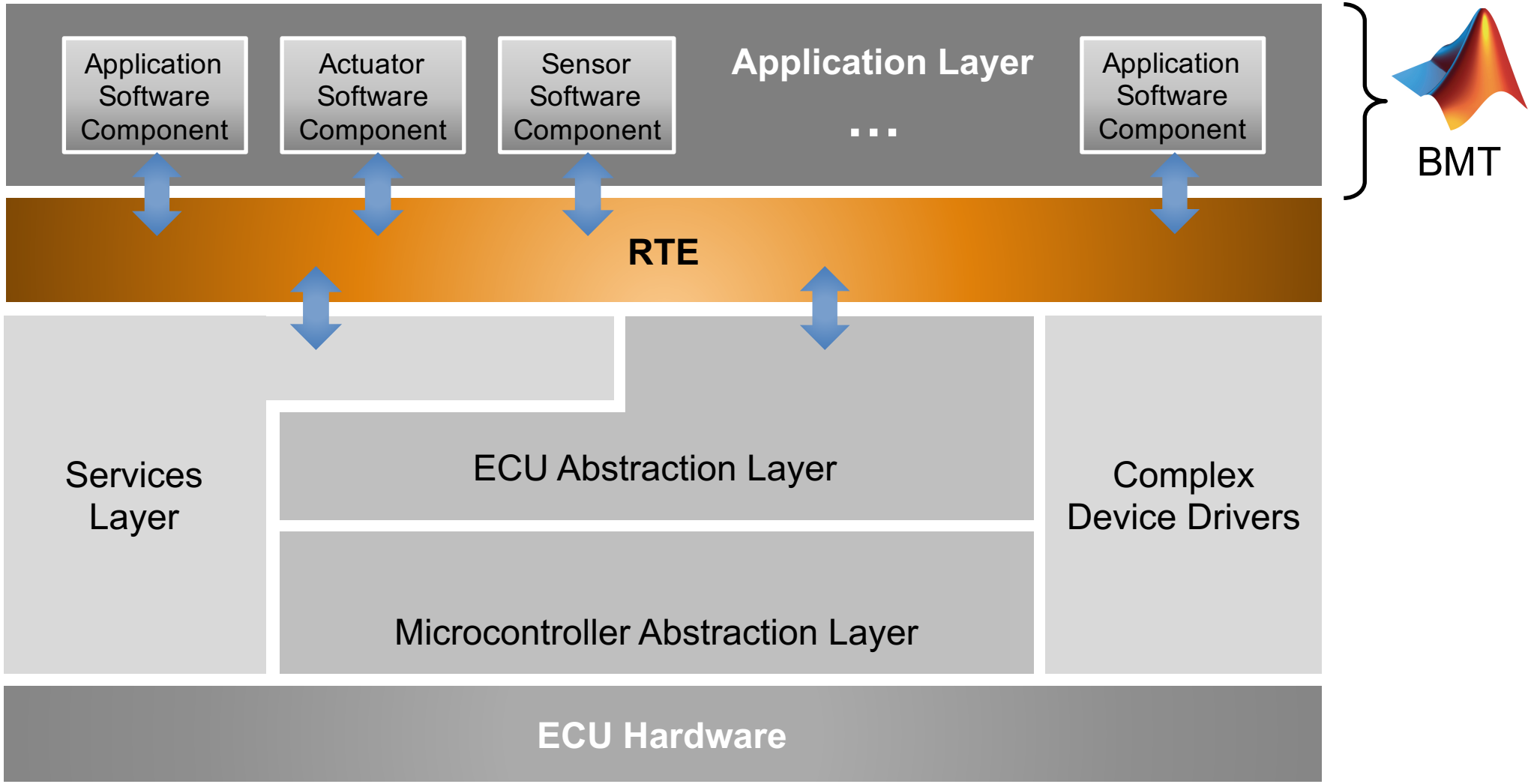
④ **AUT**ocar **O**ccupant **S**pecific **A**version **R**ate

⑤ **AUTO**recovery **S**oftware **A**bstraction **R**eloaded

```
default :
   printf("Wrong session?");
}
```

AUTOSAR_Overview();

AUTOSAR – 3-layered Architecture

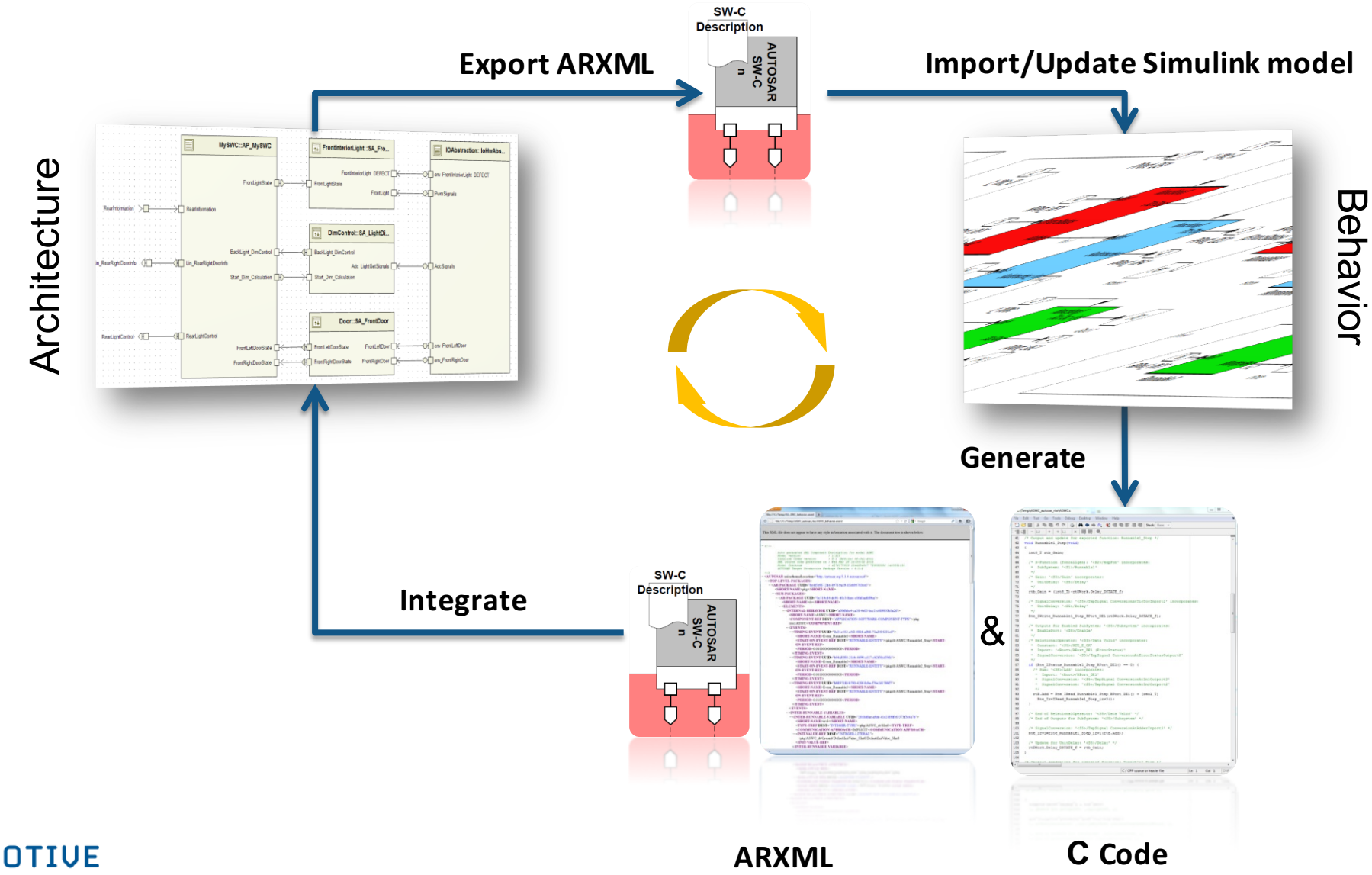


MathWorks AUTOSAR Approach

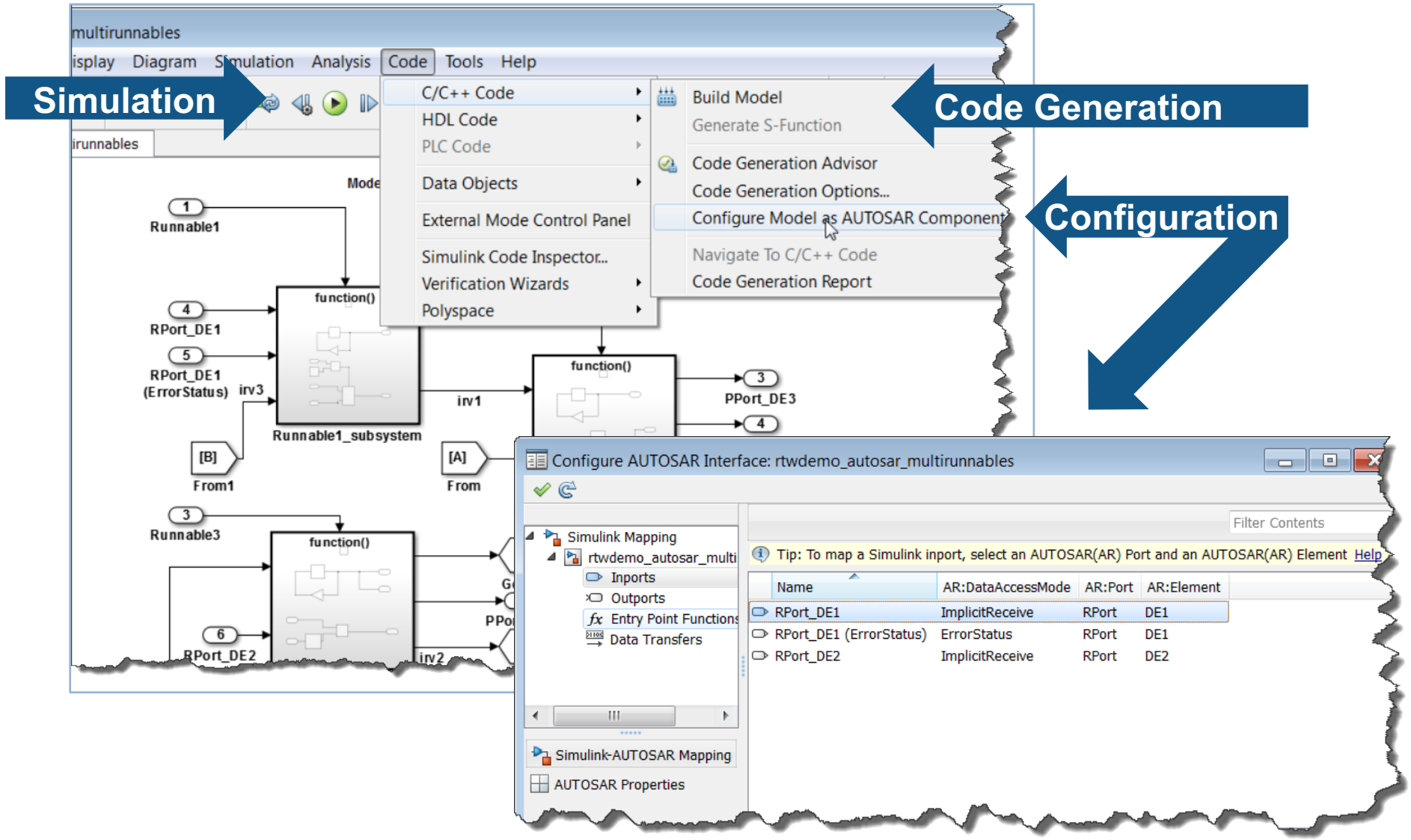
No separate AUTOSAR Blockset needed	• Code-generation through Mapping
AUTOSAR Software Component Approach with Simulink	• Simulink for developing behavior • Import and Export of SW Component Description Files (ARXML)
Simultaneous generation of C-code and ARXML-Files	• Consistency between C code and ARXML SW-C description files
AUTOSAR Support Package for Embedded Coder	• Available via web download* • Allows more frequent updates and fixes

* http://www.mathworks.com/hardware-support/autosar.html

Support for AUTOSAR Workflows



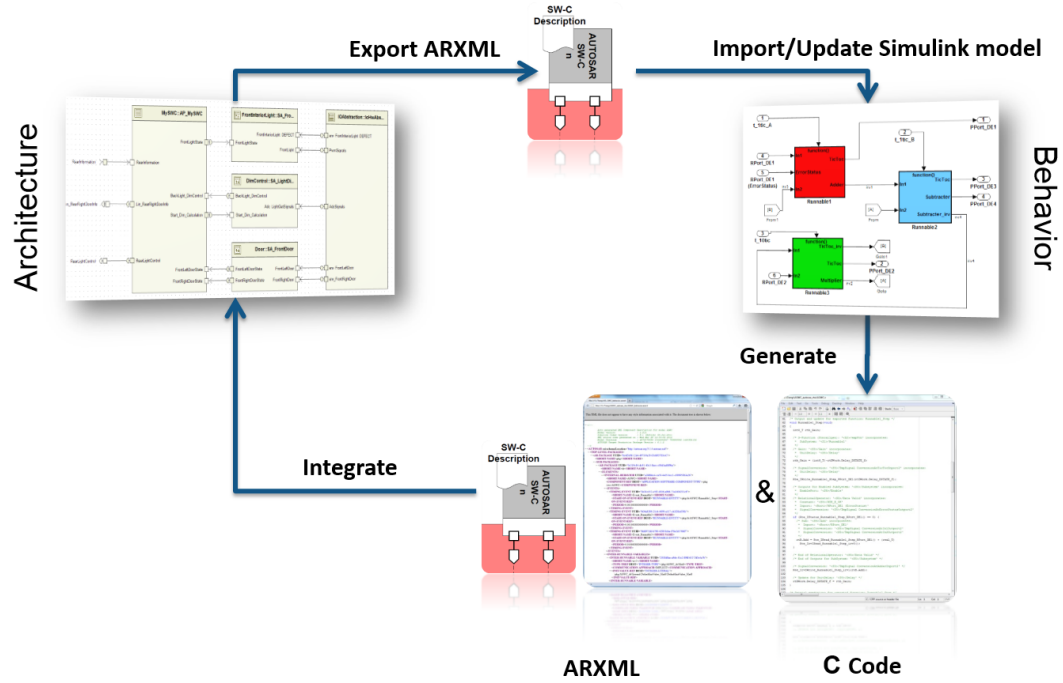
Capabilities



Getting Started

- **Bottom-Up Approach**
  Start with an existing Simulink model

- **Top-Down Approach**
  Start with ARXML files containing AUTOSAR Component descriptions



```
switch(topics)
{
```

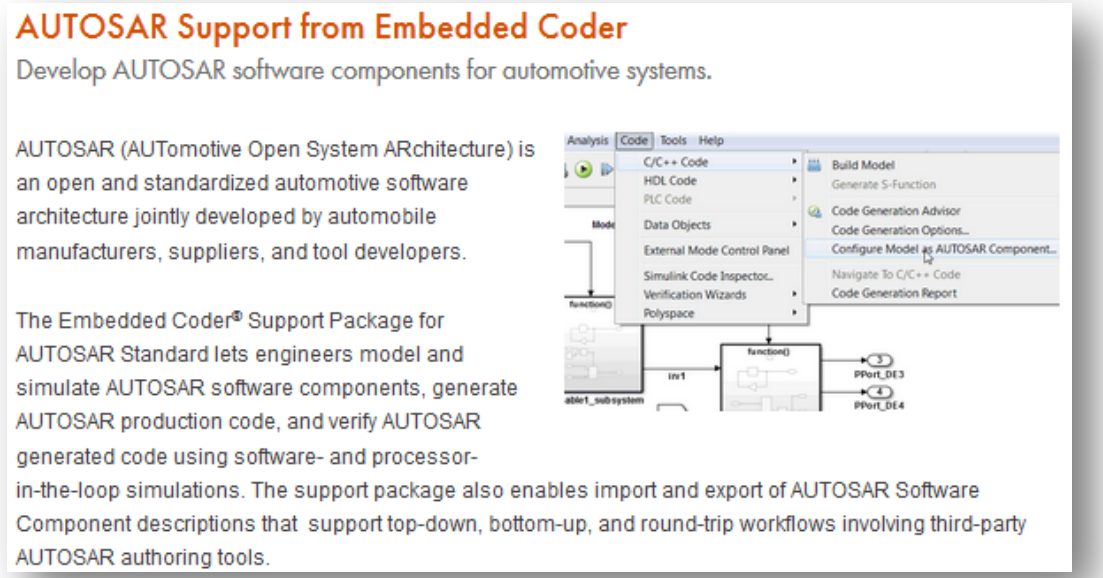
case ‘AUTOSAR – Top 5’:

Embedded Coder® Support Package for AUTOSAR Standard

Embedded Coder® Support Package for AUTOSAR Standard

Embedded Coder ® add-on support for the AUTOSAR standard

- Flexible infrastructure to introduce important new capabilities, also in-between half-yearly MathWorks Release cycle
- Perform a wide range of AUTOSAR-related workflows in Simulink®, including:
  - Create and modify an AUTOSAR configuration for a model
  - Model AUTOSAR elements
  - Generate ARXML and AUTOSAR-compatible C code from a model



http://de.mathworks.com/hardware-support/autosar.html

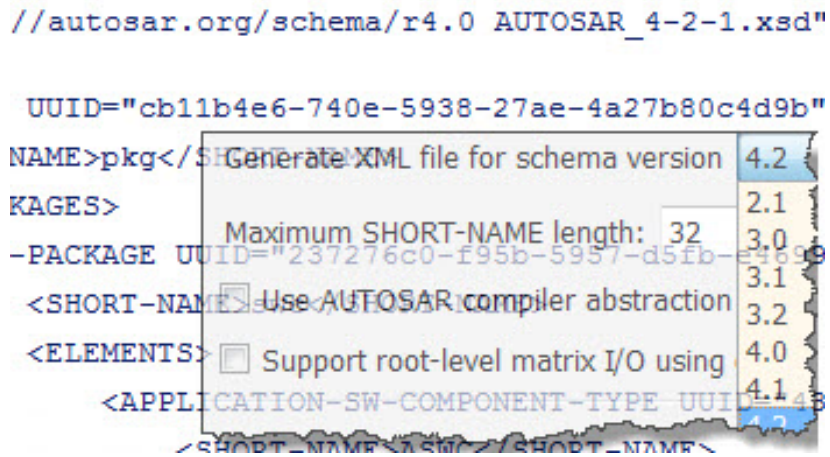
AUTOSAR 4.1.3 / 4.2.1

AUTOSAR 4.1.3 / 4.2.1

Seamless support for AUTOSAR Release 4.2.1 and 4.1.3 schema

- Import detects AUTOSAR 4.2.1 release from ARXML file
- User selects AUTOSAR release from configuration set options for code generation and ARXML export
- AUTOSAR 4.1+ features
  - PRPortPrototype
  - InitEvent
  - …

R2015b



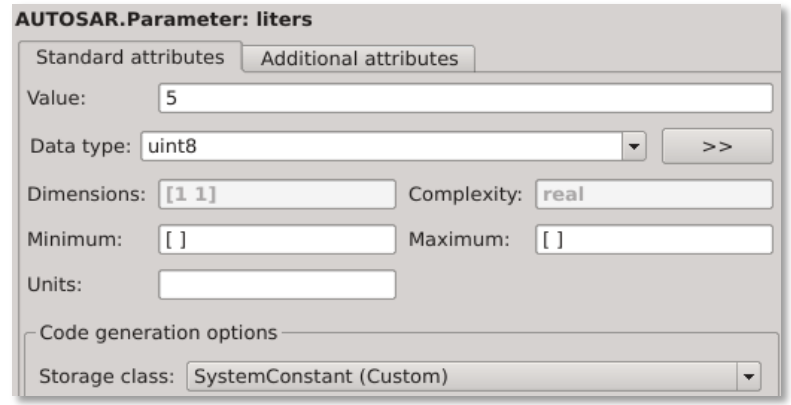
AUTOSAR Variant Handling

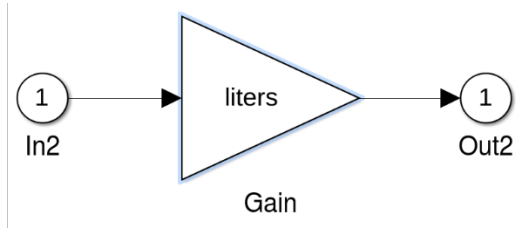
AUTOSAR Variant Handling

R2015a

Model AUTOSAR variants in Simulink

- VariationPointProxy with
  - Condition Access – `Simulink Variant Subsystem`
  - Value Access – `AUTOSAR.Parameter` with CSC `System Constant`
    - VariationPointProxy objects automatically generated
    - System constant definitions generated in separate ARXML file






```
<VARIATION-POINT-PROXYS>
  <VARIATION-POINT-PROXY UUID="10594079-04
    <SHORT-NAME>vpp_liters</SHORT-NAME>
    <VALUE-ACCESS BINDING-TIME="PRE-COM
  </VARIATION-POINT-PROXY>
</VARIATION-POINT-PROXYS>
```

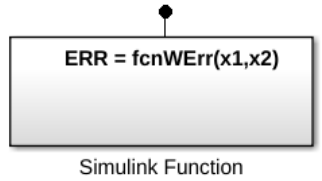
```
/* Gain: '<Root>/Gain' */
if (Rte_SysCon_vpp_liters > 7) {
  tmp = MAX_uint8_T;
} else {
  tmp = (uint8_T)(Rte_SysCon_vpp_liters << 5);
}
```

AUTOSAR Client-Server Semantics

AUTOSAR Client-Server Semantics

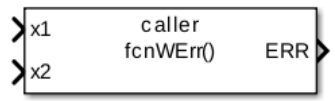
Leverage Simulink Functions for AUTOSAR Client/Server

- ARXML import and update support for AUTOSAR Client/Server
  - AUTOSAR client port and operation represented as Function Caller
  - AUTOSAR server runnable represented as Simulink Function
- Use AUTOSAR APPLICATION-ERROR status for C/S communication
  - Helps to Communicate with AUTOSAR basic software that use error status, e.g. Diagnostic Event Manager (DEM)



Simulink Function

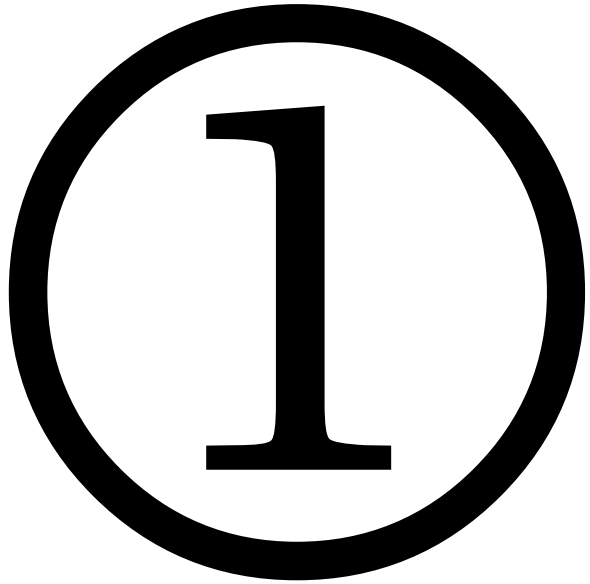
R2015b



Function Caller

```
Std_ReturnType fcnWErr(int8 x1, int8 x2)
{
   if (uh_oh) {
      return RTE_E_NOT_OK;
   }
   ..
   return RTE_E_OK;
}
```

```
<POSSIBLE-ERRORS>
   <APPLICATION-ERROR>
      <SHORT-NAME>E_OK</SHORT-NAME>
      <ERROR-CODE>0</ERROR-CODE>
   </APPLICATION-ERROR>
   <APPLICATION-ERROR>
      <SHORT-NAME>E_NOT_OK</SHORT-NAME>
      <ERROR-CODE>1</ERROR-CODE>
   </APPLICATION-ERROR>
</POSSIBLE-ERRORS>
```



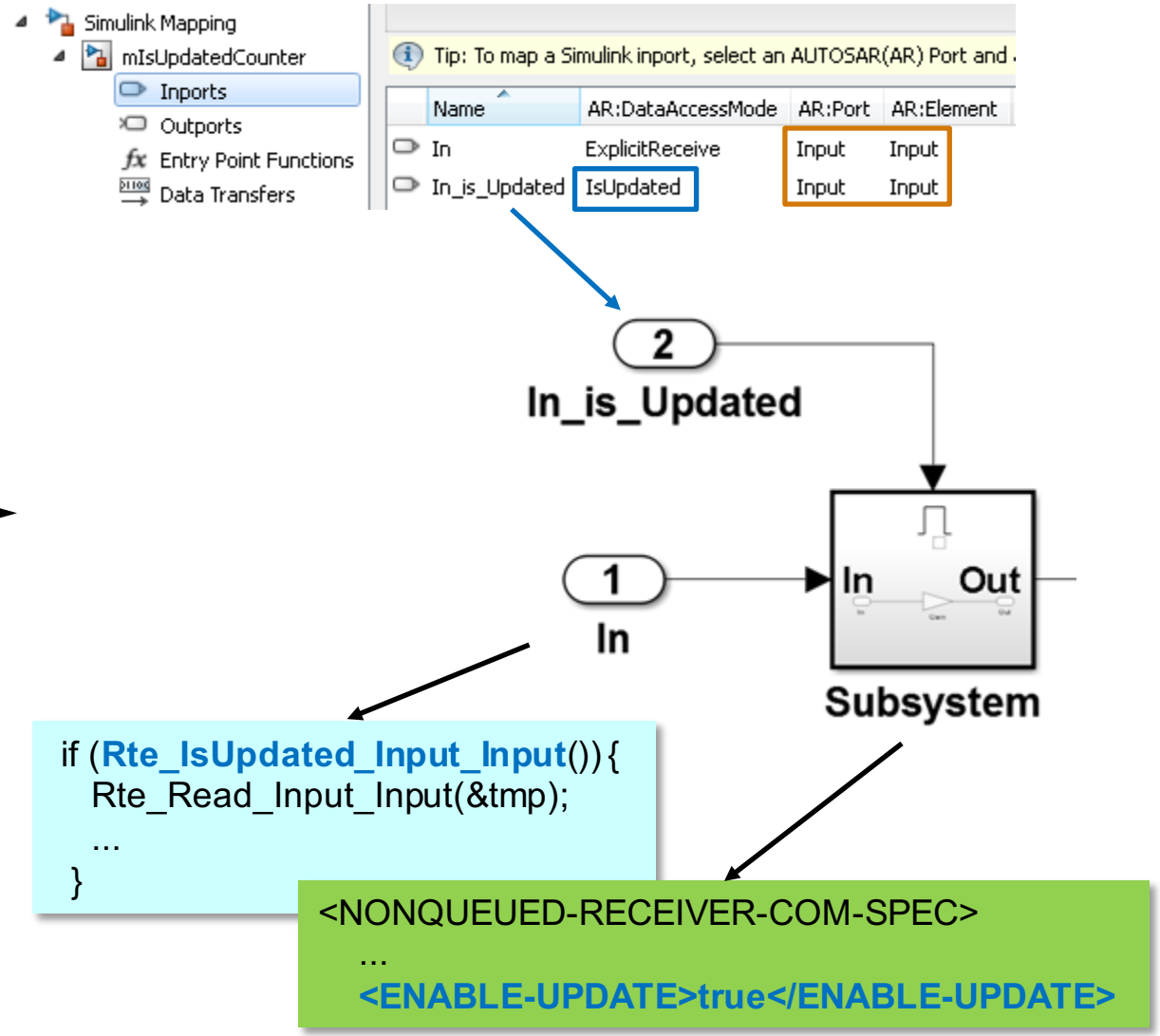
Advanced AUTOSAR APIs

Advanced AUTOSAR APIs

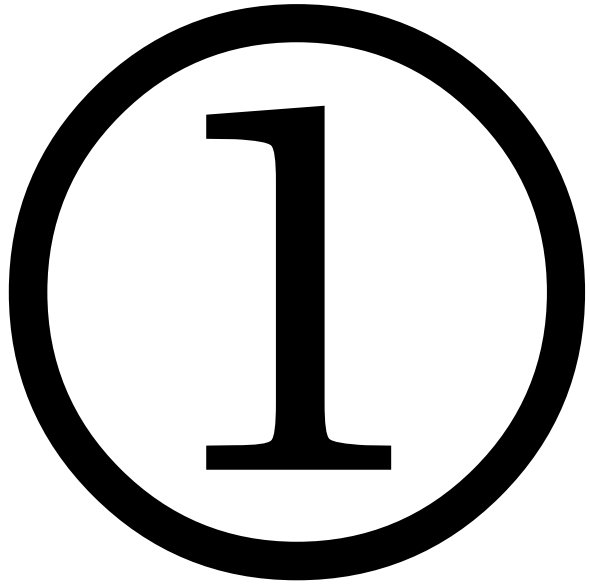
R2015b

Simulink modeling and ARXML roundtrip support for

- RTE APIs
  - Conditional Rte_Read / Rte_Write
  - Rte_IsUpdated
  - Rte_Invalidate
- Asynchronous NvM Service calls
  - NvM_WriteBlock, NvM_ReadBlock, …
- E2E wrapper
- MFX / MFL / IFX / IFL Library Routines
- ReferenceBase Support
- …



case ‘AUTOSAR – Best Practices’:

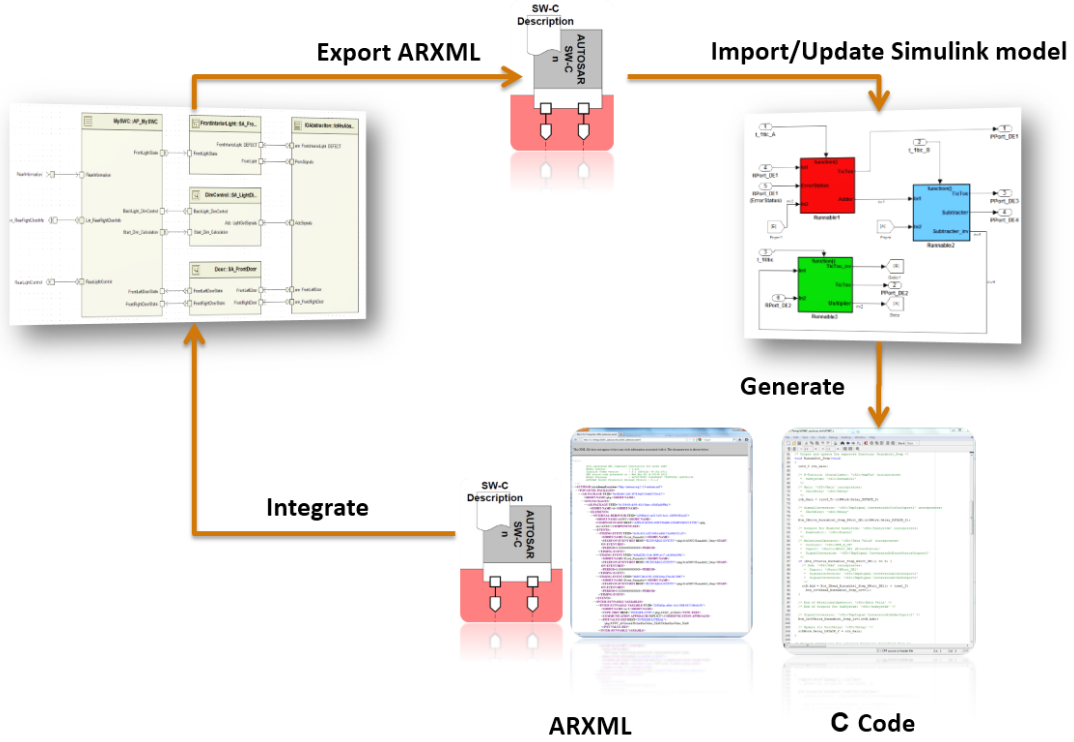


Use one AUTOSAR workflow

#1 Use one AUTOSAR workflow

- Select top-down or bottom-up approach
- Round-trip works best with one clear owner of data

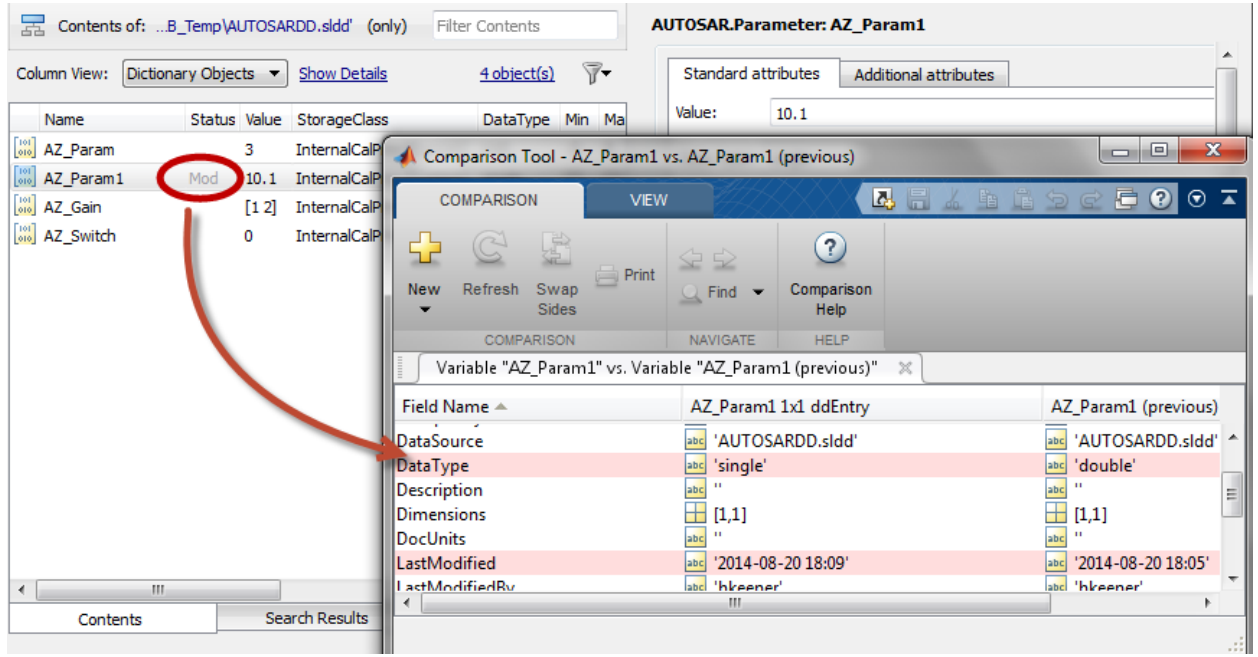
- Select tools that best support your workflow and AUTOSAR concepts
- Select simplest approach for applying AUTOSAR configuration to your Simulink model



Decide data management

#2 Decide data management

- Will Simulink or AUTOSAR tools manage data?
- Will projects or teams define and manage data?
- How will change management be handled?

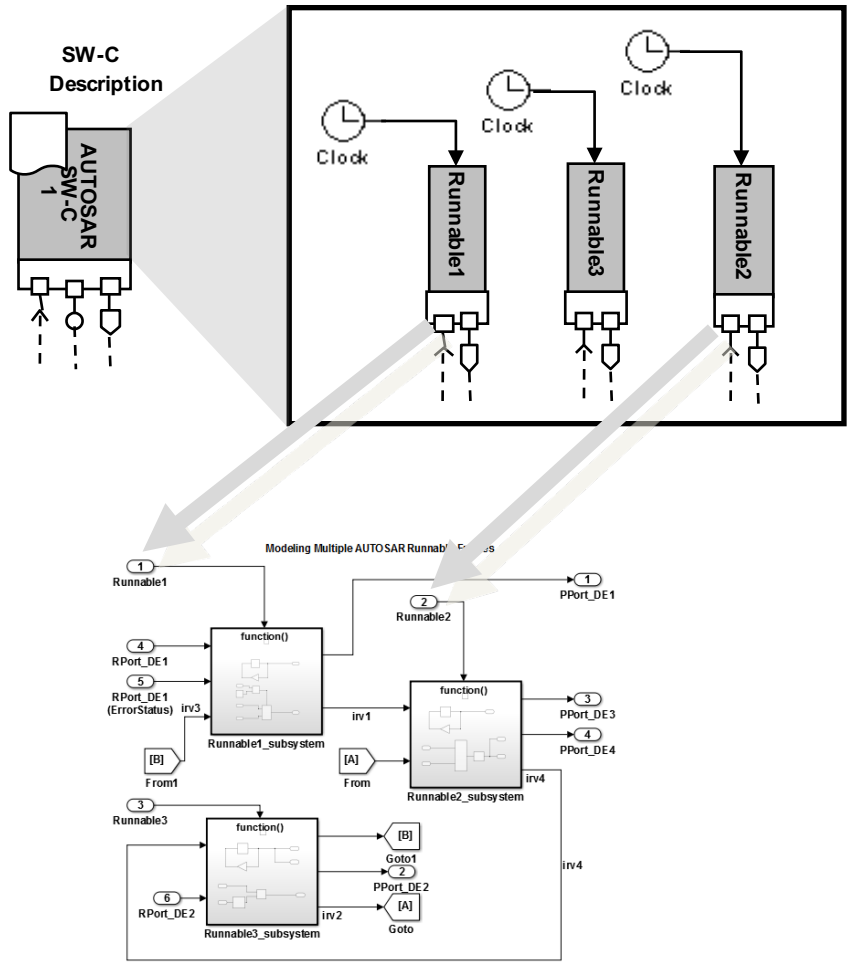


Establish modeling standards

#3 Establish modeling standards

- For Simulink and AUTOSAR

- Base it on your workflow and data management
- Use Simulink Model Advisor to enforce modeling style early in model development

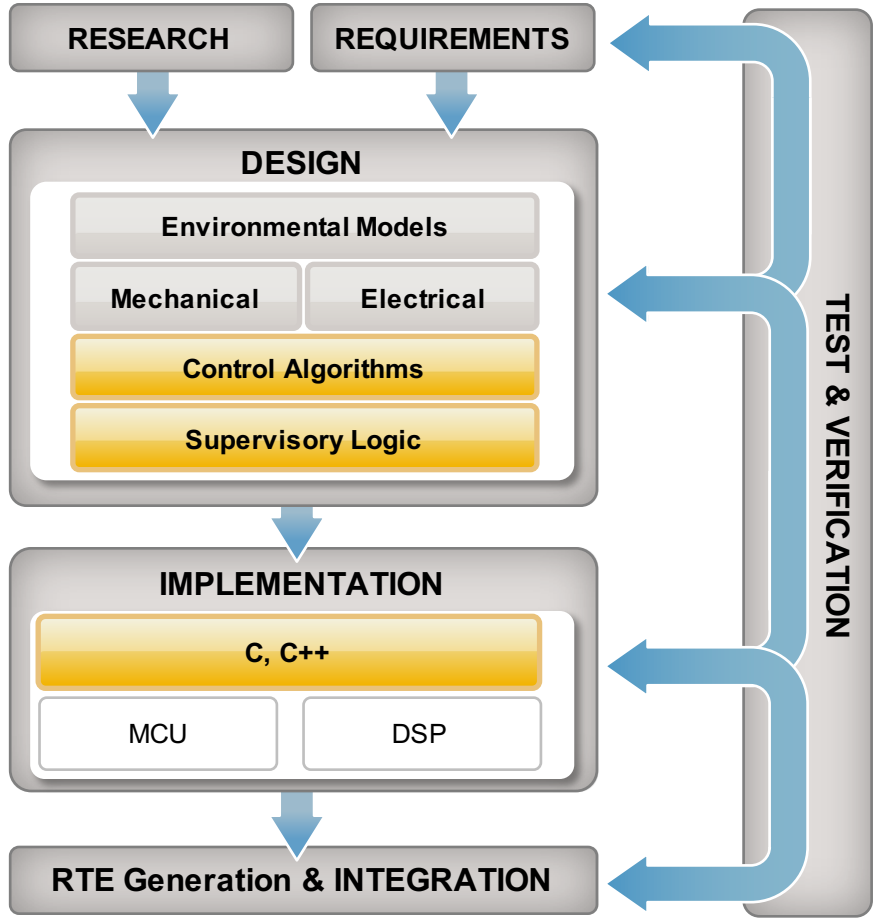


Simulate before you generate code

#4 Simulate before you generate code

- Take advantage of early verification through simulation

- Make sure SWC implementation is correct early
- Simulate multiple SWC's together in Simulink before code integration
- Use SIL and PIL to verify generated code at the unit level before RTE generation

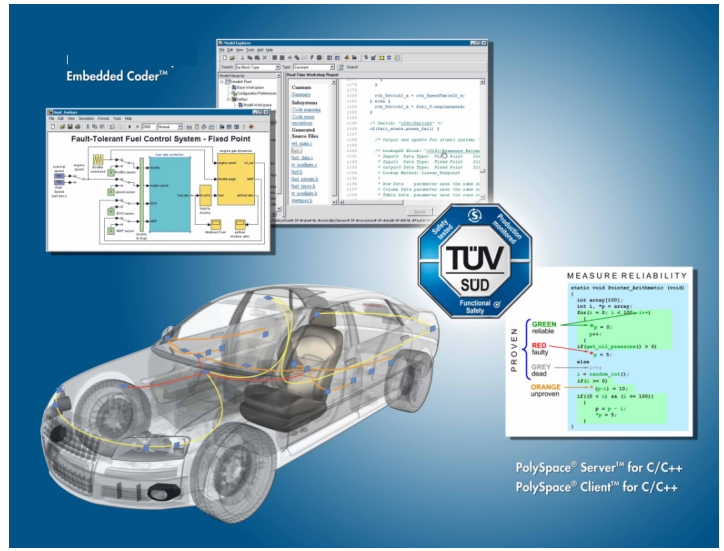


Plan ahead for ISO 26262

#5 Plan ahead for ISO 26262

- Determine how your AUTOSAR process will address safety-standards

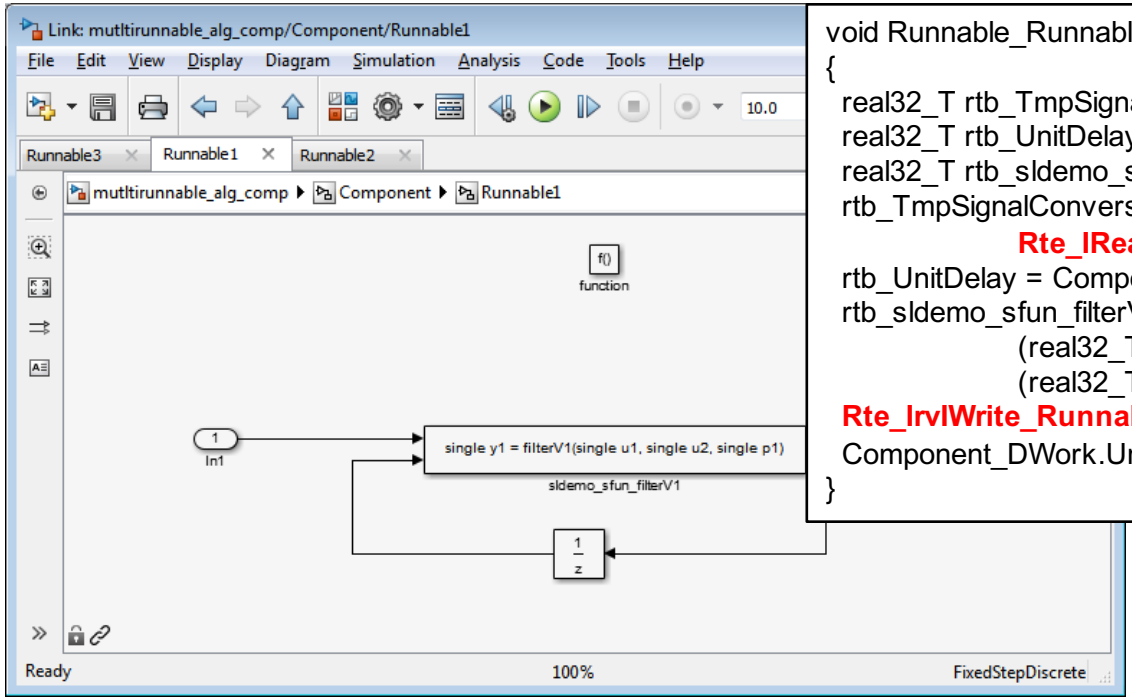
- **Products supported for ISO 26262 tool qualification include:**
  - Embedded Coder
  - Simulink V&V
  - Simulink Design Verifier
  - PolySpace Code Verifiers
- **Artifacts certified by TÜV SÜD**
  - Requires use of V&V workflow
- **ISO 26262 Advisory Service available**



Use Simulink to help migrate your legacy code to AUTOSAR

#6 Use Simulink to help migrate your legacy code to AUTOSAR

- Reuse of Legacy Code
  - Integration for simulation, production code generation
  - Can generate AUTOSAR RTE API access points




```
void Runnable_Runnable1(void)
{
  real32_T rtb_TmpSignalConversionAtIn1Out;
  real32_T rtb_UnitDelay;
  real32_T rtb_sldemo_sfun_filterV1;
  rtb_TmpSignalConversionAtIn1Out =
                    Rte_IRead_Runnable_Runnable1_Fast_in_Fast_in();
  rtb_UnitDelay = Component_DWork.UnitDelay_DSTATE;
  rtb_sldemo_sfun_filterV1 = filterV1( (real32_T)rtb_TmpSignalConversionAtIn1Out,
                    (real32_T)rtb_UnitDelay,
                    (real32_T)Component_P.sldemo_sfun_filterV1_p1);
  Rte_IrvIWrite_Runnable_Runnable1_a(rtb_sldemo_sfun_filterV1);
  Component_DWork.UnitDelay_DSTATE = rtb_sldemo_sfun_filterV1;
}
```

Automate, automate, automate

#7 Automate, automate, automate

- Use API's for workflow automation!

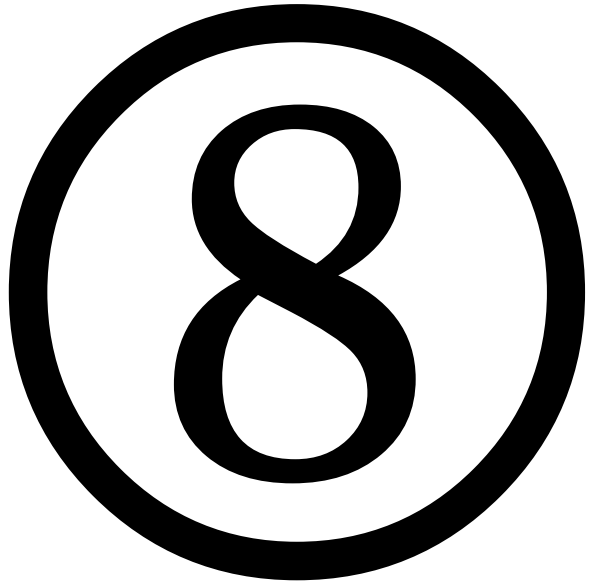
- **Manual process difficult due to:**
  - The complexity of the standard, naming conventions
  - Iterative work cycles with AUTOSAR
  - Complex code APIs and XML file definitions

- Use documented MATLAB APIs to configure SWCs in Simulink

```
%% Setup AUTOSAR Configuration
programmatically

model = 'rtwdemo_autosar_counter';

% Modify AUTOSAR Properties
autosarProps =
autosar.api.getAUTOSARProperties(model);
set(autosarProps, 'Input', 'IsService',
true);
set(autosarProps, 'XmlOptions',
'ArxmlFilePackaging','SingleFile');
```



Use production code generation

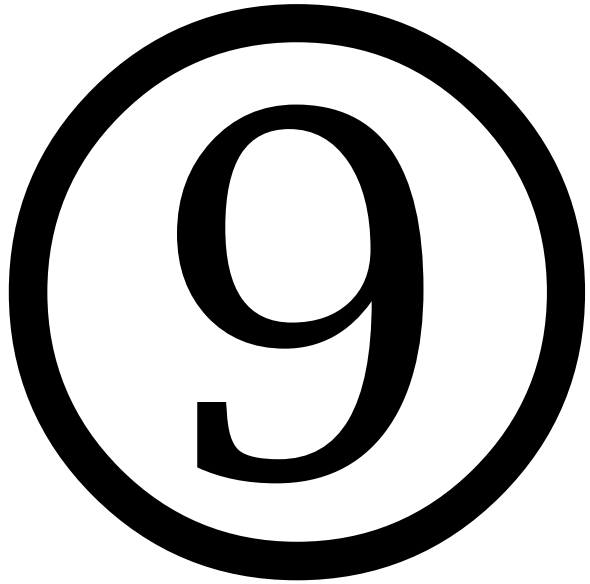
#8 Use production code generation

- Hand coding AUTOSAR is painful

```
void Runnable_simple_alg_Step(void)
{
  real_T rtb_Gain;
  real_T rtb_Delay;
  real_T rtb_Delay1;
  real_T rtb_TmpSignalConversionAtFast_i;
  if (simple_alg_M->Timing.TaskCounters.TID[1]  == 0) {
    Rte_Receive_Fast_in_Fast_in(&rtb_TmpSignalConversionAtFast_i);
    rtb_Delay = simple_alg_DWork.Delay_DSTATE;
    rtb_Delay1 = simple_alg_DWork.Delay1_DSTATE;
    rtb_Gain = simple_alg_DWork.Delay2_DSTATE;
    rtb_Gain = (((rtb_TmpSignalConversionAtFast_i  + simple_alg_DWork.Delay_DSTATE)  +  simple_alg_DWork.Delay1_DSTATE)  + rtb_Gain) * simple_alg_P.Gain_Gain;
    if (simple_alg_M->Timing.TaskCounters.TID[2]  == 0) {
      simple_alg_B.RateTransition  = rtb_Gain;
    }
     simple_alg_DWork.Delay_DSTATE   = rtb_TmpSignalConversionAtFast_i;
    simple_alg_DWork.Delay1_DSTATE   = rtb_Delay;
    simple_alg_DWork.Delay2_DSTATE   = rtb_Delay1;
  }
   if (simple_alg_M->Timing.TaskCounters.TID[2]  == 0) {
    Rte_IWrite_Runnable_simple_alg_Step_Out1_Out1(simple_alg_B.RateTransition
                    + Rte_IRead_Runnable_simple_alg_Step_Slow_in_Slow_in());
  }
…
```

```
…
<RUNNABLE-ENTITY UUID="aef16585-a355-494f-accd-1a548ca22e27">
  <SHORT-NAME>Runnable_simple_alg_Step</SHORT-NAME>
    <MINIMUM-START-INTERVAL>0</MINIMUM-START-INTERVAL>
     <CAN-BE-INVOKED-CONCURRENTLY>false</CAN-BE-INVOKED-CONCURRENTLY>
     <DATA-READ-ACCESSS>
      <VARIABLE-ACCESS>
        <SHORT-NAME>IN_Slow_in_Slow_in</SHORT-NAME>
          …
</RUNNABLE-ENTITY>
…
```

```
…
<SENDER-RECEIVER-INTERFACE>
  <SHORT-NAME>Out1</SHORT-NAME>
    <IS-SERVICE>false</IS-SERVICE>
    <DATA-ELEMENTS>
      <VARIABLE-DATA-PROTOTYPE>
        <SHORT-NAME>Out1</SHORT-NAME>
          …
      </VARIABLE-DATA-PROTOTYPE>
  </DATA-ELEMENTS>
</SENDER-RECEIVER-INTERFACE>
…
```

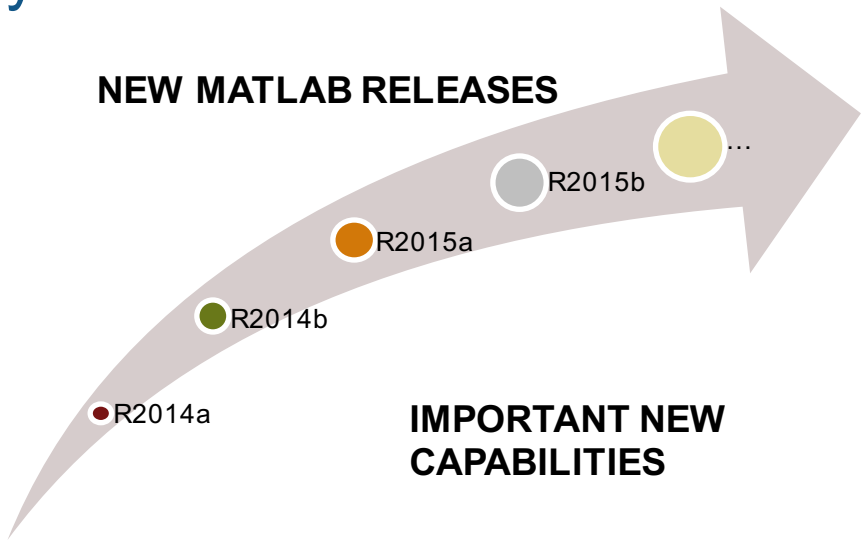


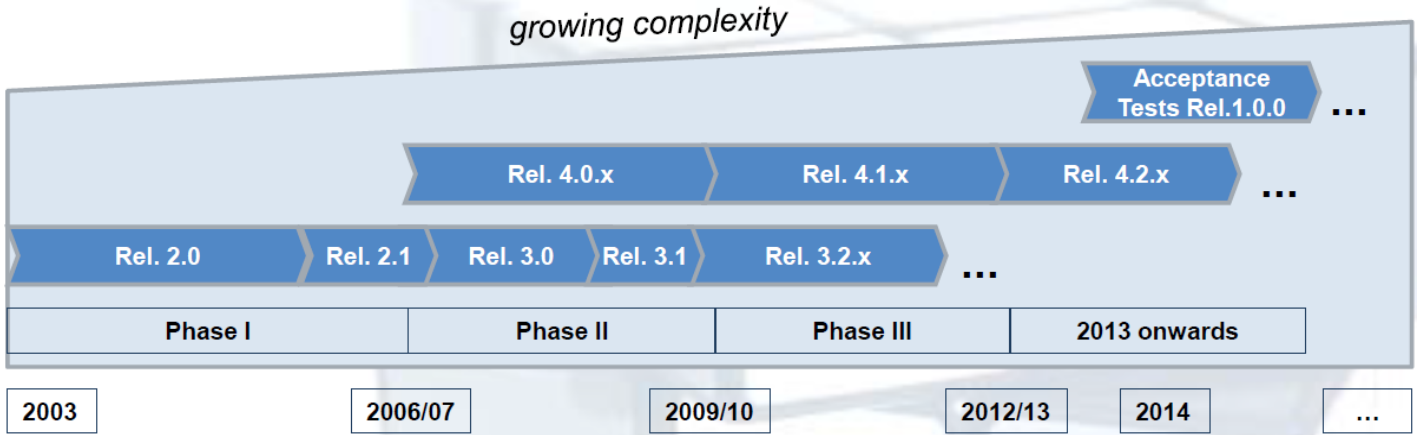
Actively plan for migration

#9 Actively plan for migration

- Tools and standards are changing rapidly

- Account for:
  - New versions of AUTOSAR
  - New versions of Simulink
- Consider:
  - How often to upgrade
  - What will drive upgrade





Source: 7th AUTOSAR Open Conference, 22.10.2014

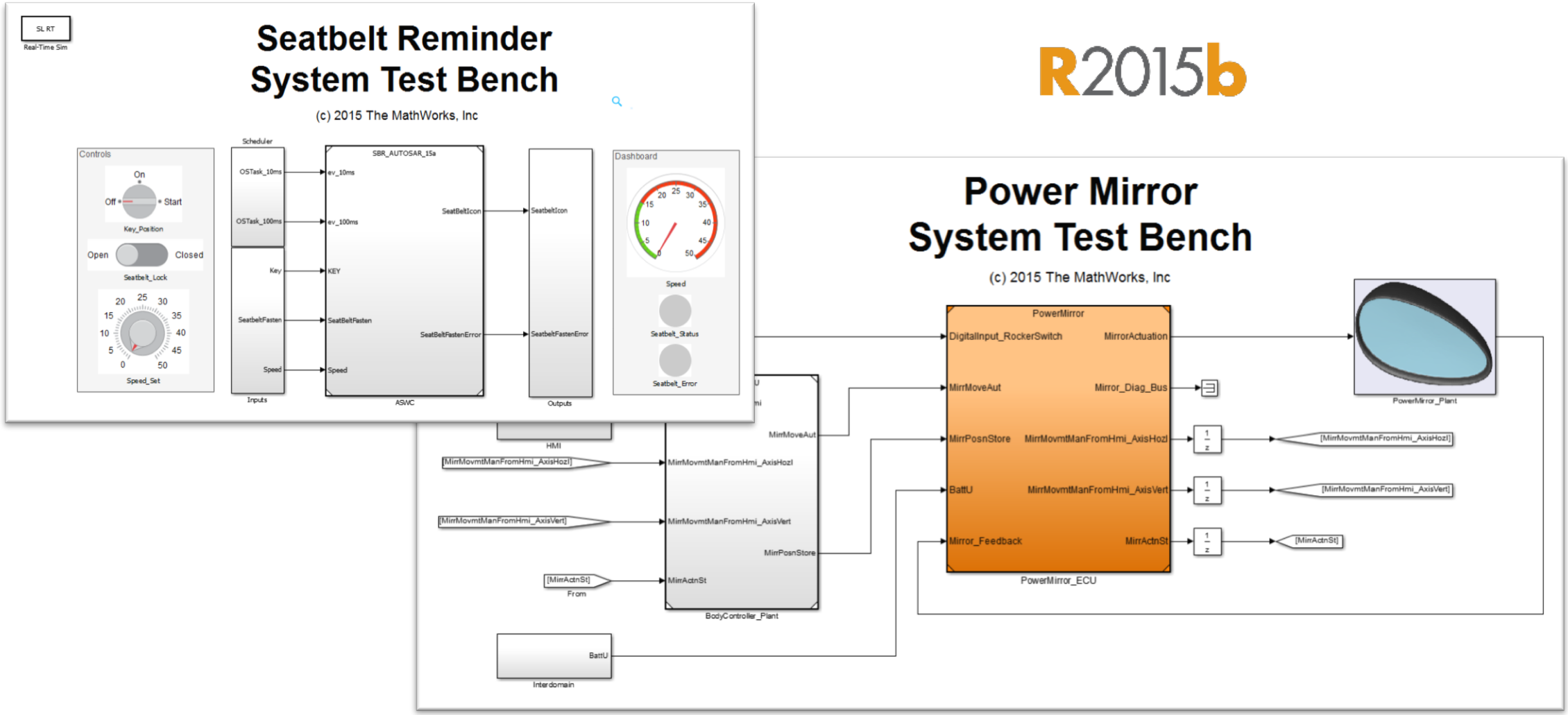
```
case ‘Assistance’:
```

Training Services

Developing Embedded Targets Advisory Service

```
case 'AUTOSAR Demo Pod':
```

Model. Code. Production.



```
default :
   printf("Brain up-to-date!");
}
```

And one last thing …
AUTOSAR – Antagonizing the „German Coast Guard“ Effect

Source: https://youtu.be/zkalf0odHs8 German Coast Guard Commercial 'We are Sinking' [HD]