Combining the Power of DAVE™ and Simulink®

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Concept Engineering for Industrial Microcontrollers

Developer Days

Infineon

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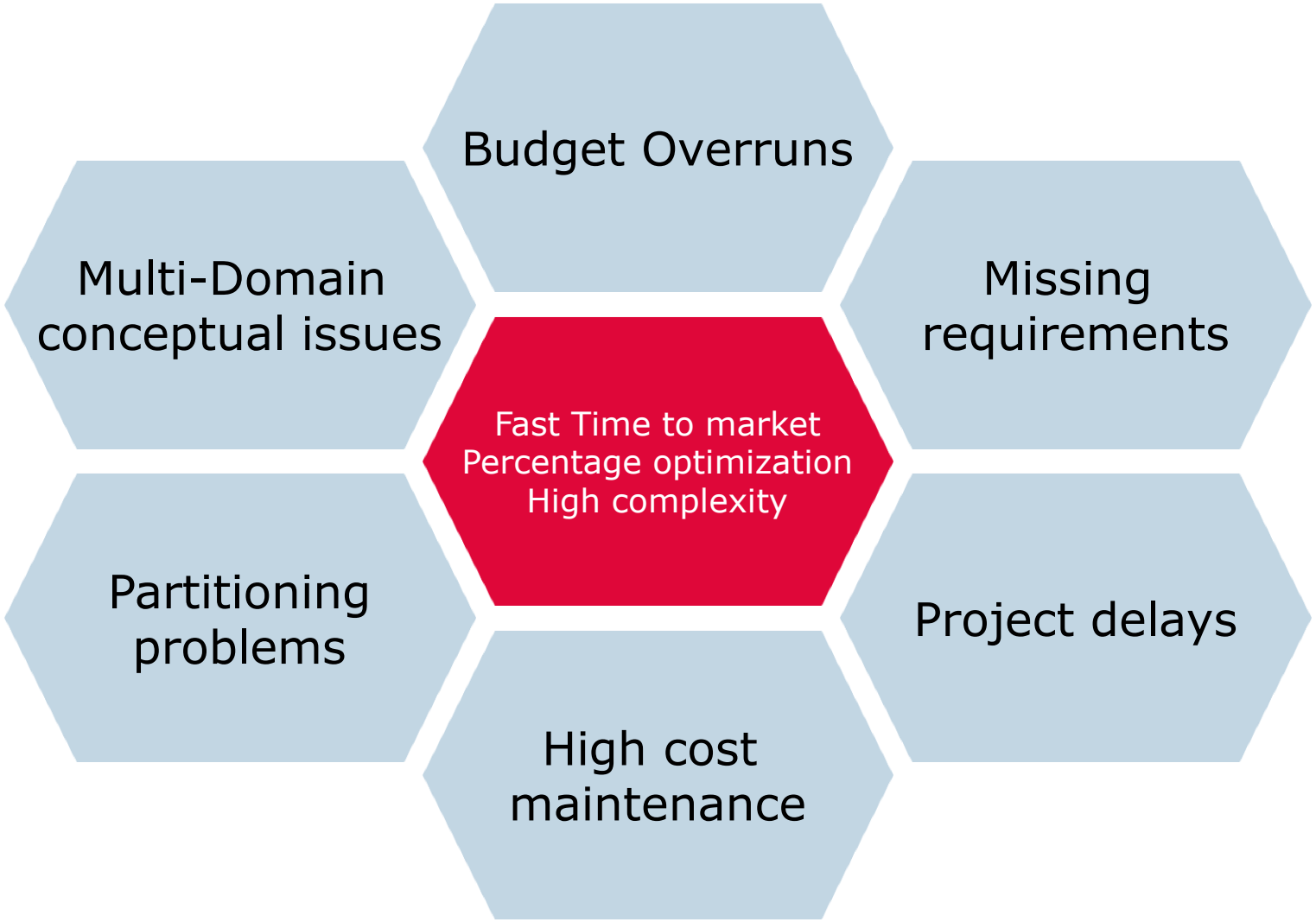
State of the Art Embedded Applications
-Types and Demands-

- State of the art systems comprise state of the art microcontrollers like the **Infineon XMC** for their **control algorithms**:
  - Motor control + Motion Control
  - Power conversion
  - Lighting control
  - …
- These applications demand:
  - Fast time to market
  - Efficiency optimization
  - High algorithm complexity

State of the Art Embedded Applications

-From High Demands to Problems-



State of the Art Embedded Applications
-The Model-Based Development-

- Model-Based Development:
  - Links design with requirements
  - Integrates testing and design
  - Enables algorithm optimization in multi-domain systems
  - Allows automatic embedded code generation

And this is translated into…

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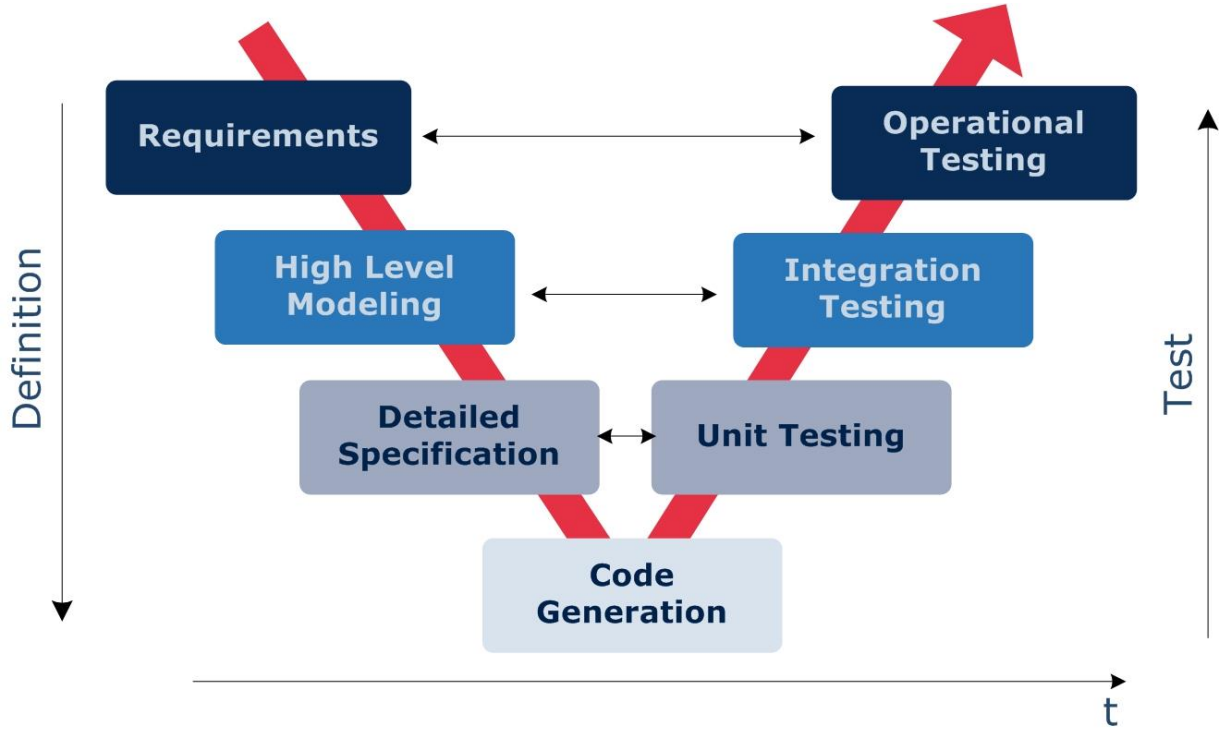
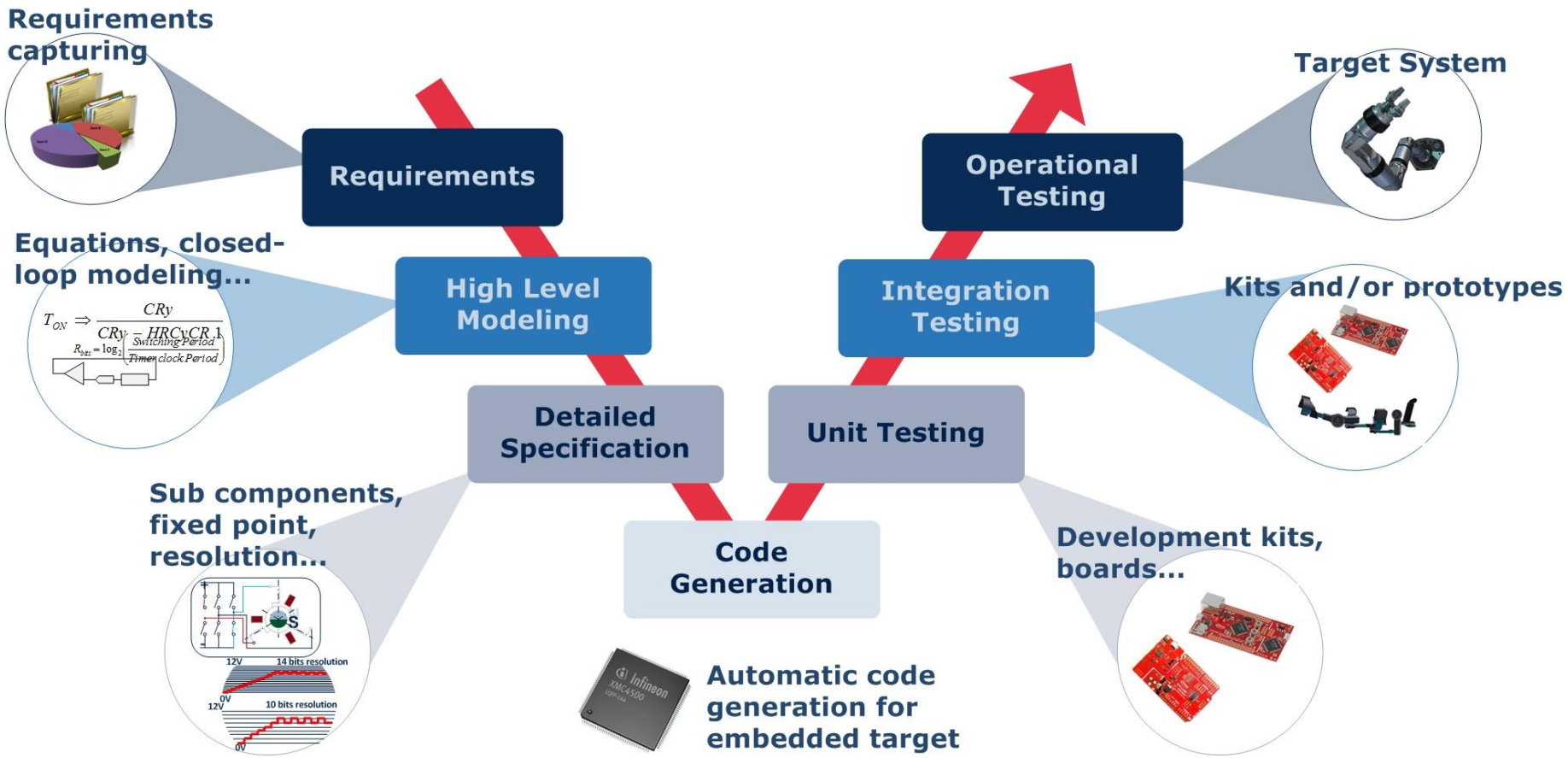
Model-Based Development Overview

-The current flow-

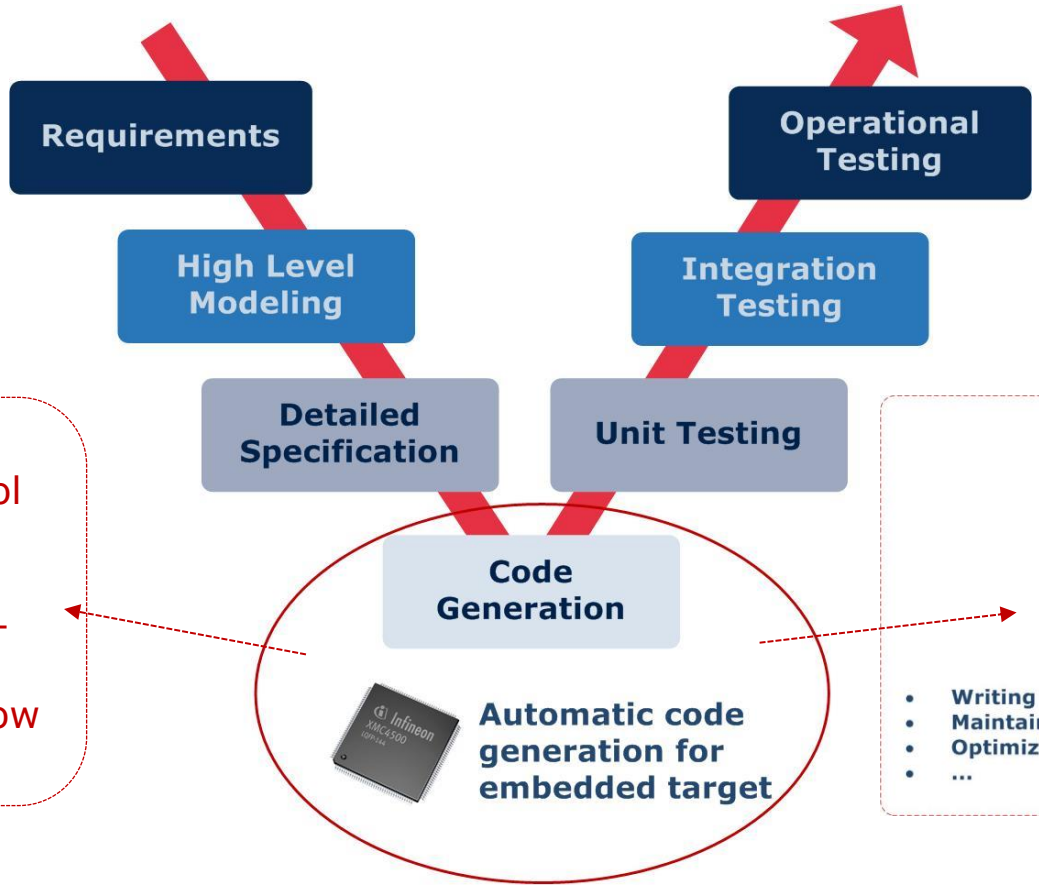


Model-Based Development Overview

-The current flow-



Model-Based Development Overview
-Current caveats-

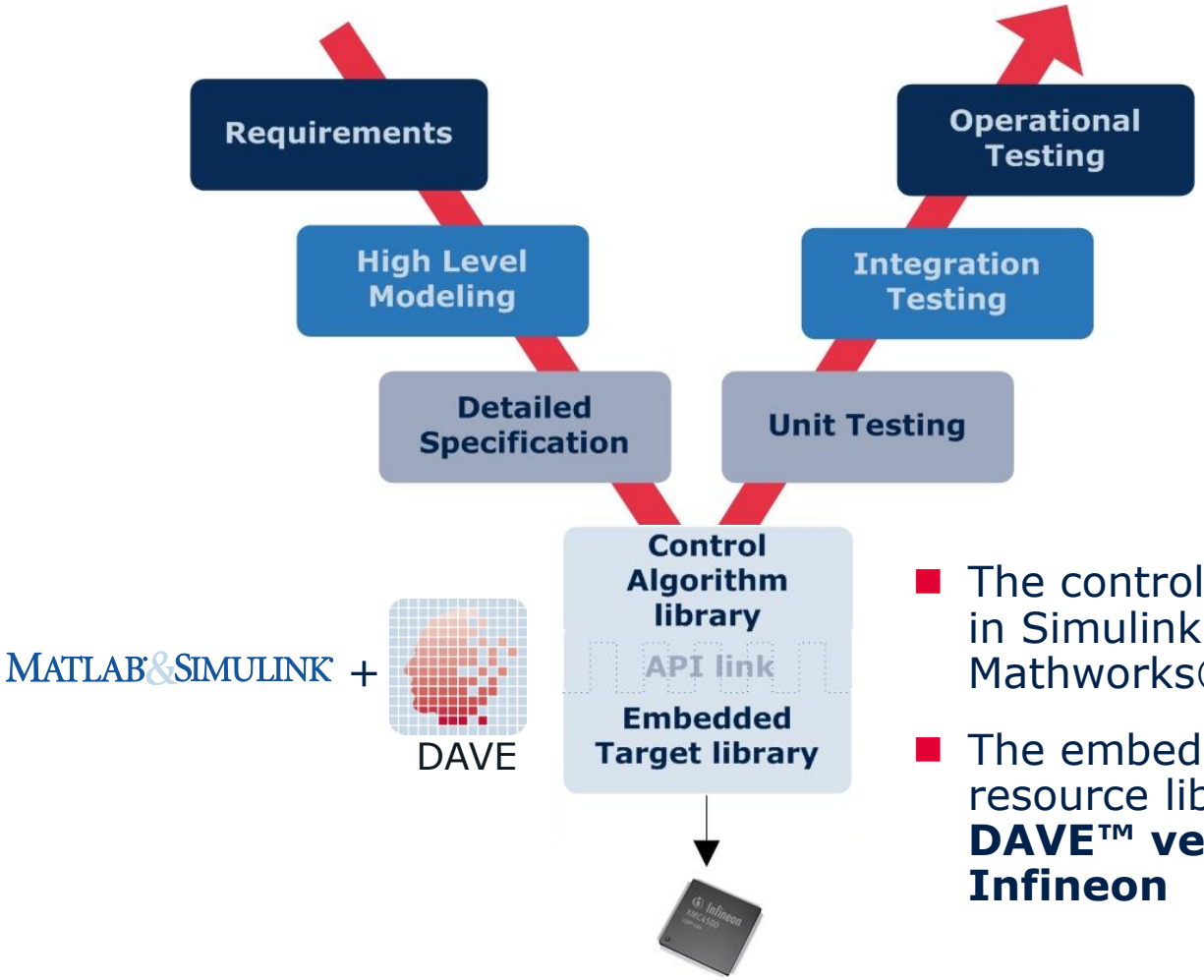


Only the control algorithm is optimized in current Model-Based Development flow

- Writing efficient peripheral drivers
- Maintaining a conflict free resource allocation
- Optimizing the pin mapping
- ...

Model-Based Development Flow

-Solving it with XMC and DAVE-



- The control library is created in Simulink® from Mathworks®
- The embedded target resource library is created in **DAVE™ version 3 of Infineon**

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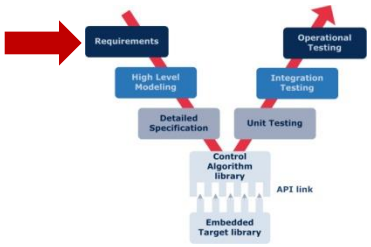
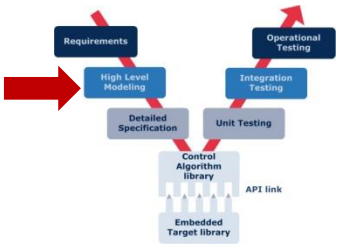
New Flow Demonstration
-Defining the Requirements-

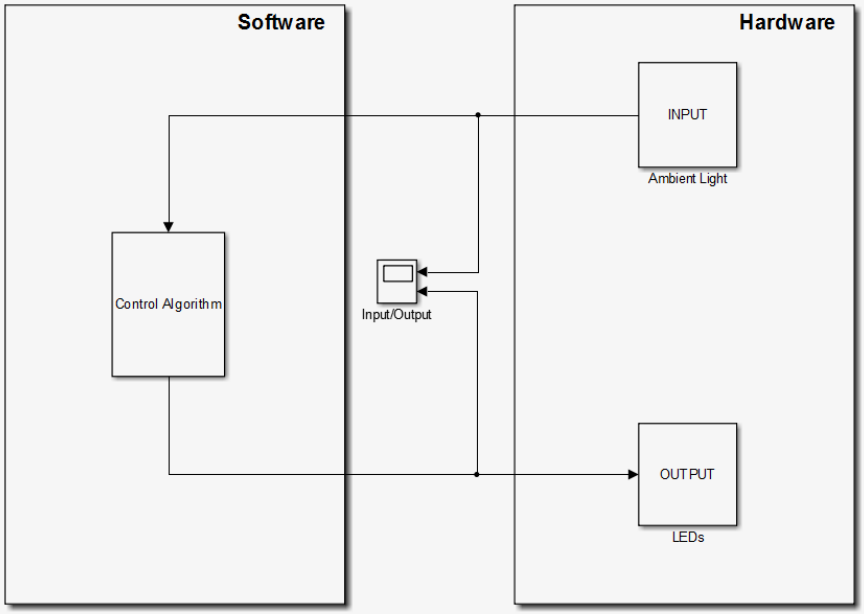


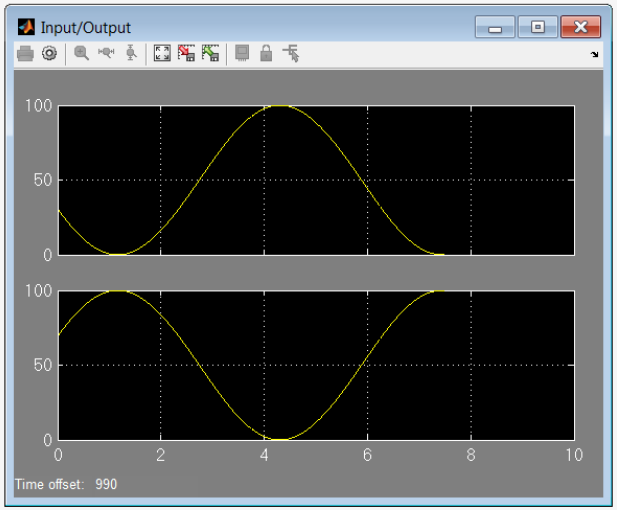
- **Application/System Requirements:**
  - Lighting application
  - An external sensor converts the light intensity into an analog signal
  - An Analog-to-Digital Converter is used to interface with the sensor
  - An external LED matrix responds inversely to the light intensity
  - Transition on the LED matrix needs to be smooth (flicker free)
  - The control algorithm runs in a **XMC1300** Infineon Microcontroller

New Flow Demonstration
-Simulink High Level Modeling-

- A high level mapping of the system is implemented
- Simulation is used to check that the algorithm is working accordingly



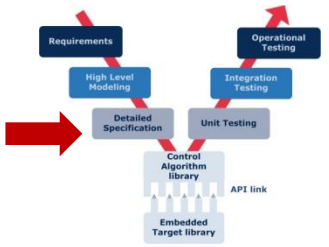


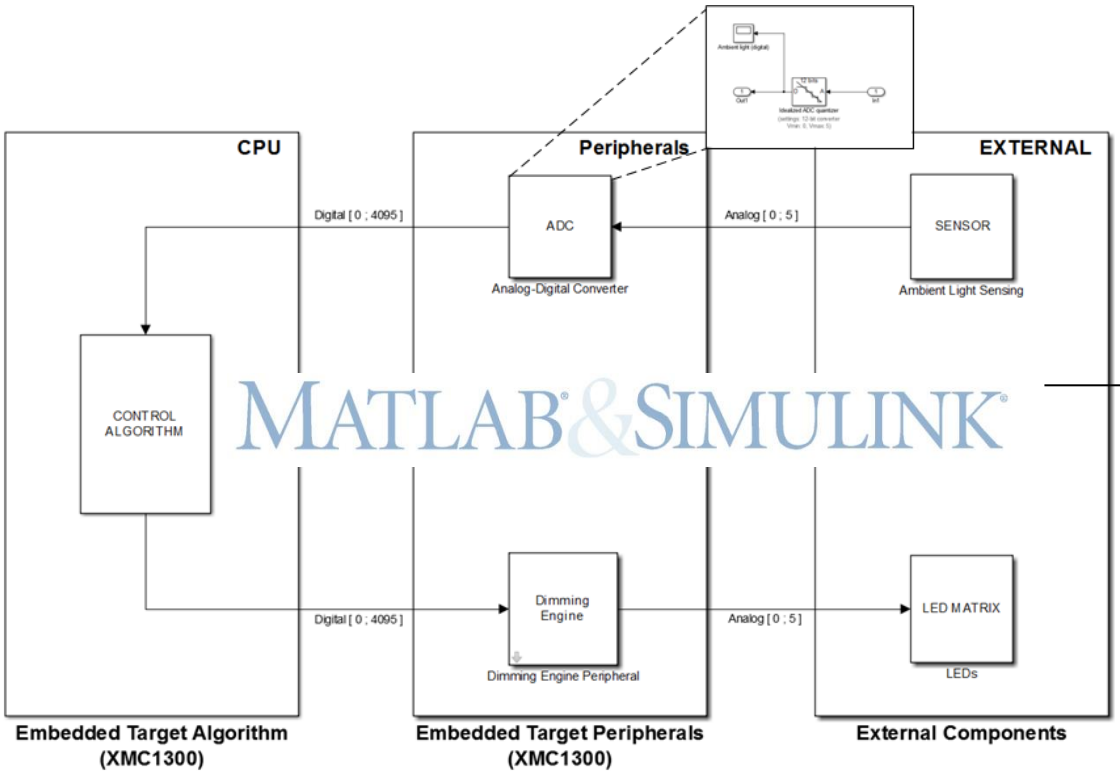


MATLAB & SIMULINK

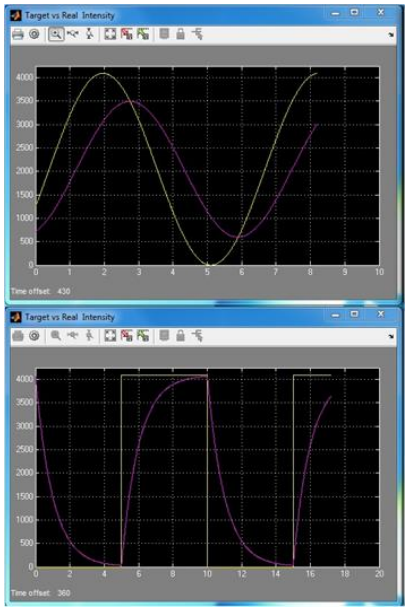
New Flow Demonstration
-Simulink Detailed Specification-

- In this stage all the subcomponents are modeled and taken into consideration
- Errors, e.g. from the ADC finite resolution, are evaluated at this development stage

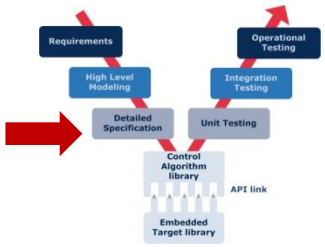




Simulation

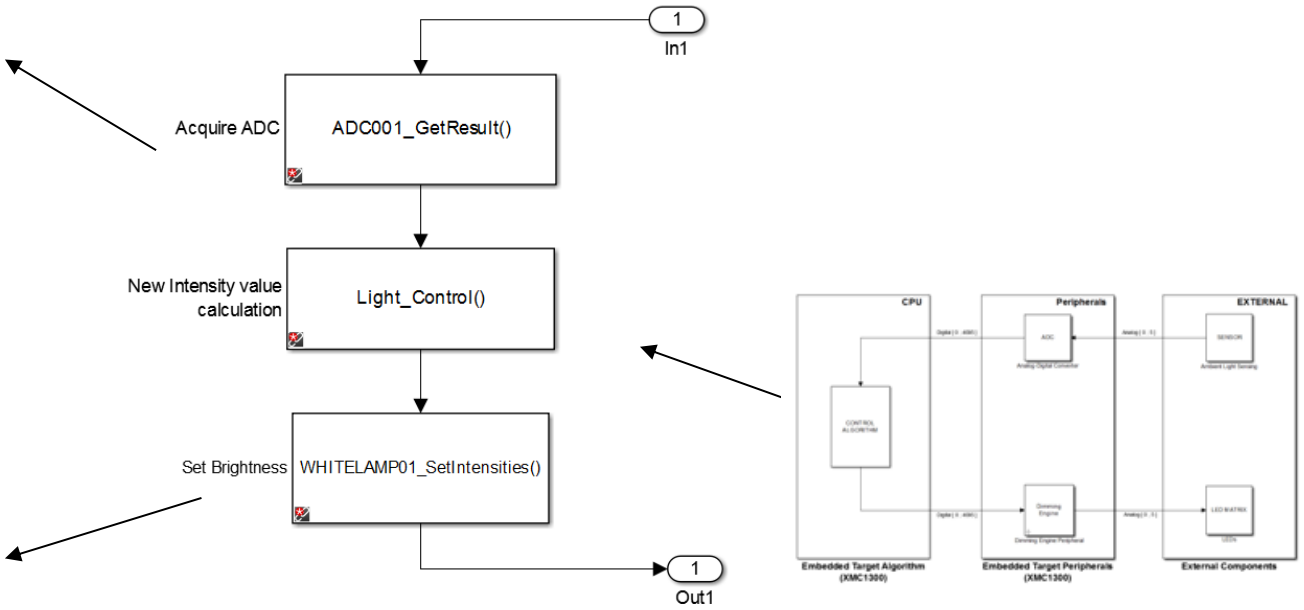


New Flow Demonstration
-API Link Creation-



- Two S-Functions are introduced in the control algorithm:
  - To get the ADC result
  - To update the BCCU peripheral value
- During Simulation the S-Functions are simply a data pass through

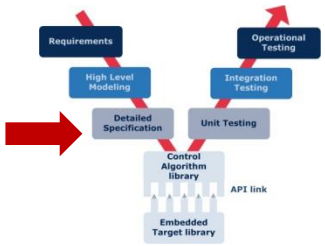
API link for getting the ADC result

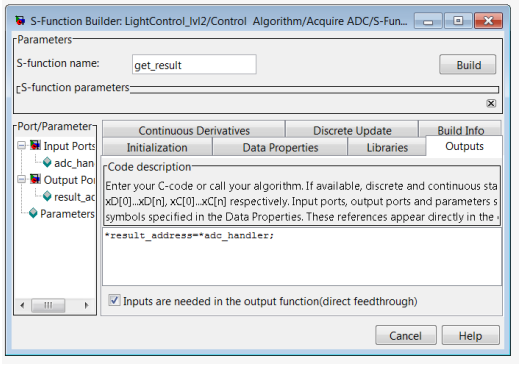


API link for updating the new value into the BCCU peripheral

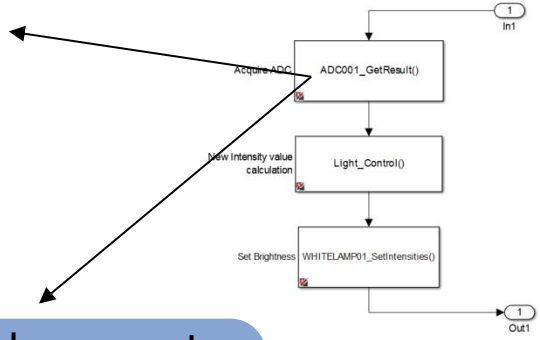
New Flow Demonstration
-API Link Creation-

- The *.tlc* file of each S-Function contains the code that is going to be inserted during the algorithm library generation





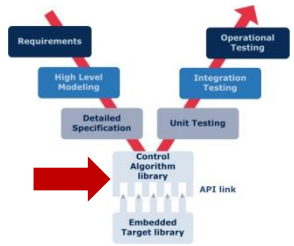
S-Function Pass through during simulation



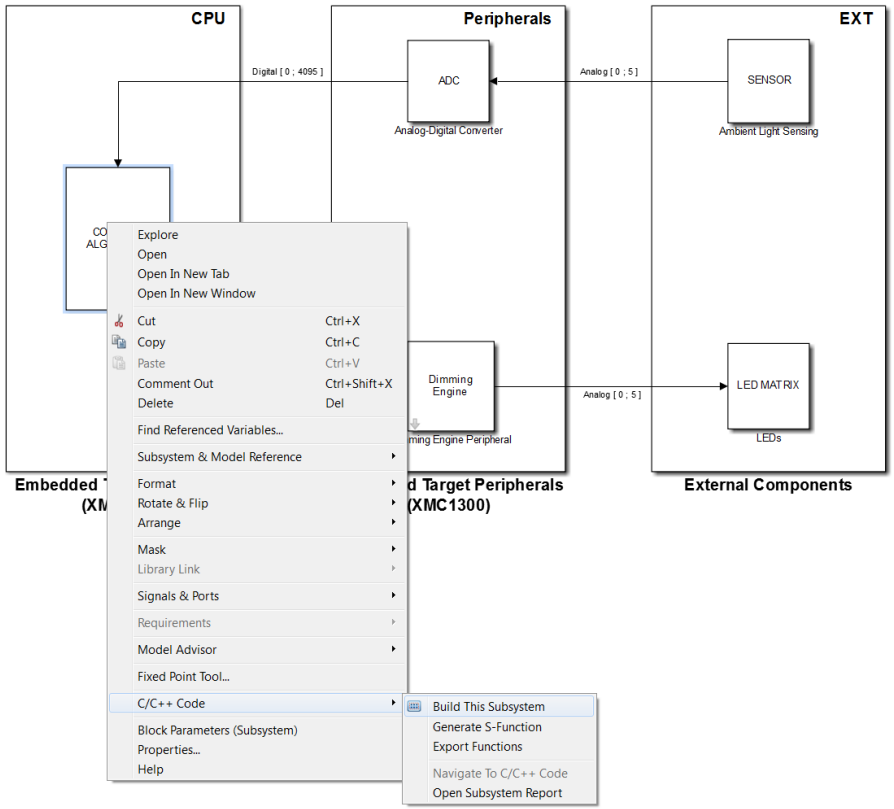

```
%% Function: Outputs ======================================================
%%
%% Purpose:
%%      Code generation rules for mdlOutputs function.
%%
%function Outputs(block, system) Output

  uint16_t target_brightness;
  ADC001_ResultHandleType result;

  ADC001_GetResult(&ADC001_Handle0, &result);

%endfunction
```

Code replacement creates the API link for getting the result from the ADC

New Flow Demonstration
-API Link Creation-

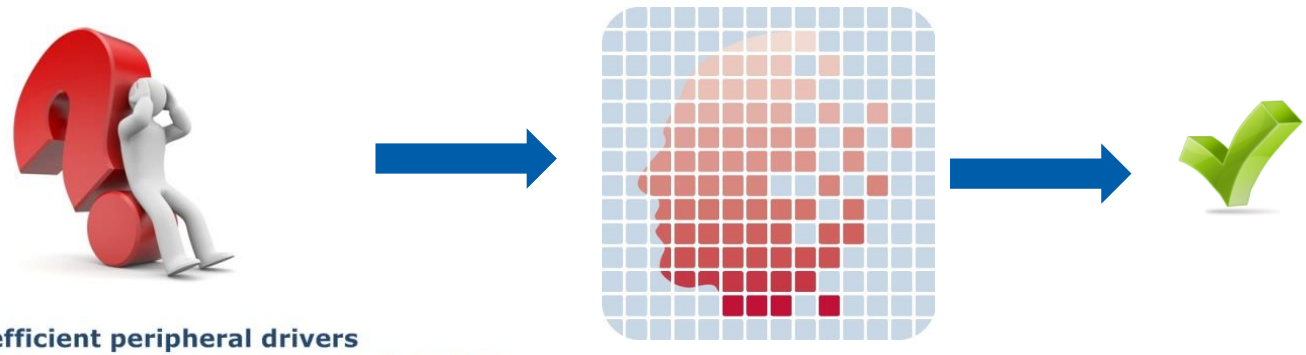


- Now the Control algorithm library is generated from Simulink®
- The *.tlc* files of the S-Functions will then "place" the API link on the generated files



New Flow Demonstration
-DAVE Intro-

- DAVE™ version 3 from Infineon enables automatic code generation based on oriented software components – DAVE Apps
- DAVE™ version 3 is capable of optimizing the resource allocation via the DAVE Solver:
  - Determining which timer can be connected to the ADC
  - Determining which pins can be used with a given ADC channel
  - …



- **Writing efficient peripheral drivers**
- **Maintaining a conflict free resource allocation**
- **Optimizing the pin mapping**
- **…**

DAVE

New Flow Demonstration

-DAVE Intro-

Start with DAVE™

Select the appropriate DAVE™ App from a library of > 170 DAVE Apps

Configure the DAVE™ Apps with a GUI and compose them as needed

Map the required HW resources to the available chip resources

Generate the library source code

Continue with DAVE™

Utilize the generated code via APIs

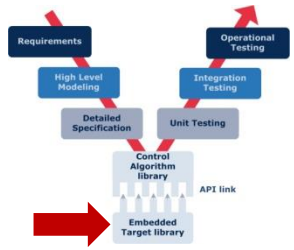
Compile, build and debug

Continue with a 3rd party tool

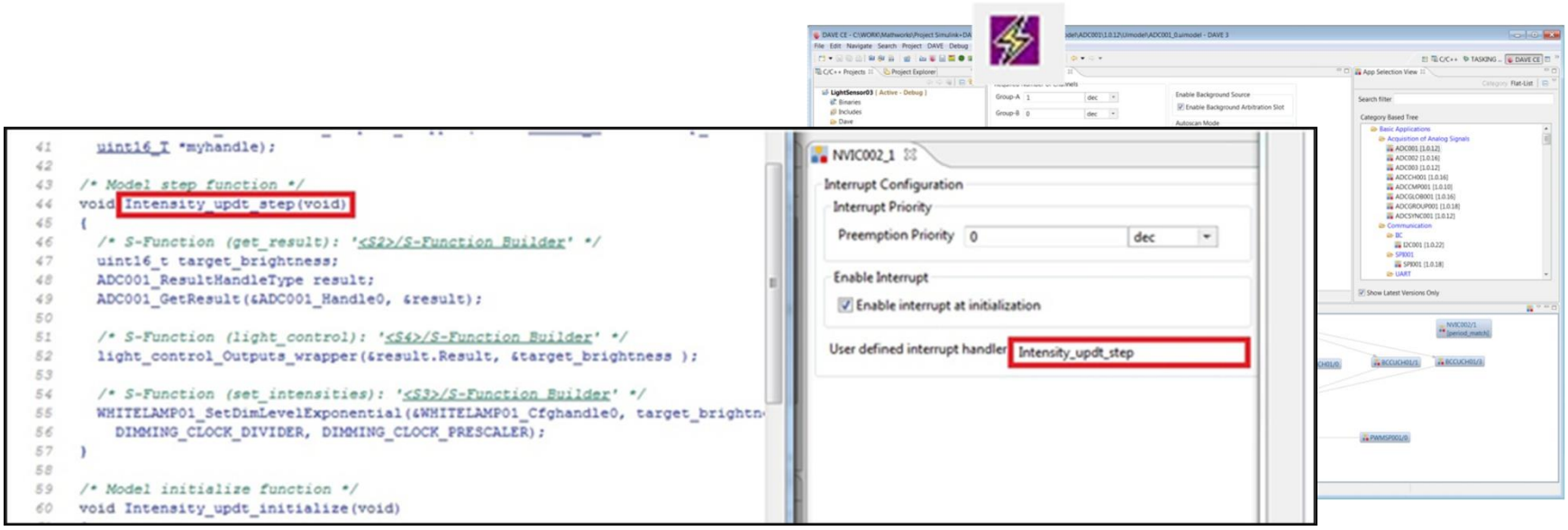
Utilize the generated code via APIs

Compile, build and debug

New Flow Demonstration
-Creating the resource library-

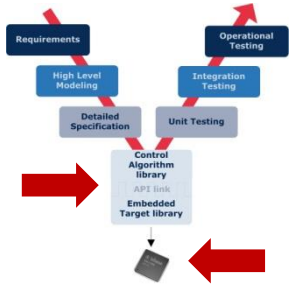


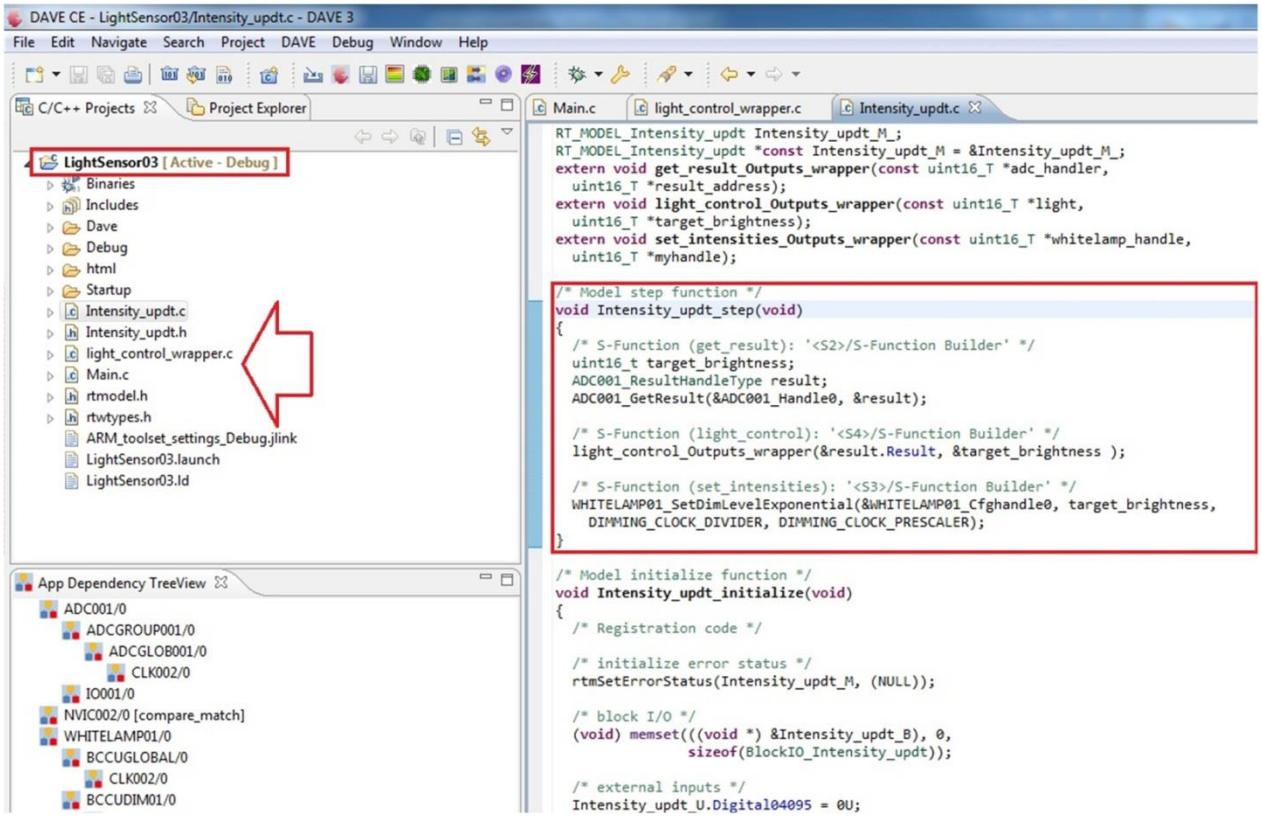
- In a DAVE project we then "dump" the needed Embedded Target Resources:
  - Analog-to-Digital Resource (ADC001)
  - Dimming engine resource (BCCU)
  - Interrupt resource (NVIC002)
- Configure the resources
- And press the generate code button…



New Flow Demonstration
-Merging the libraries-

- Copy the generated files from Simulink into the DAVE project and flash it into the XMC1300 target

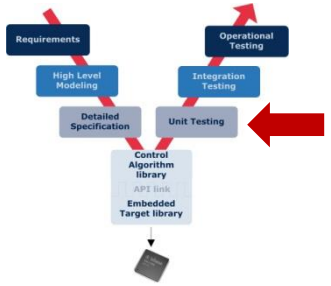


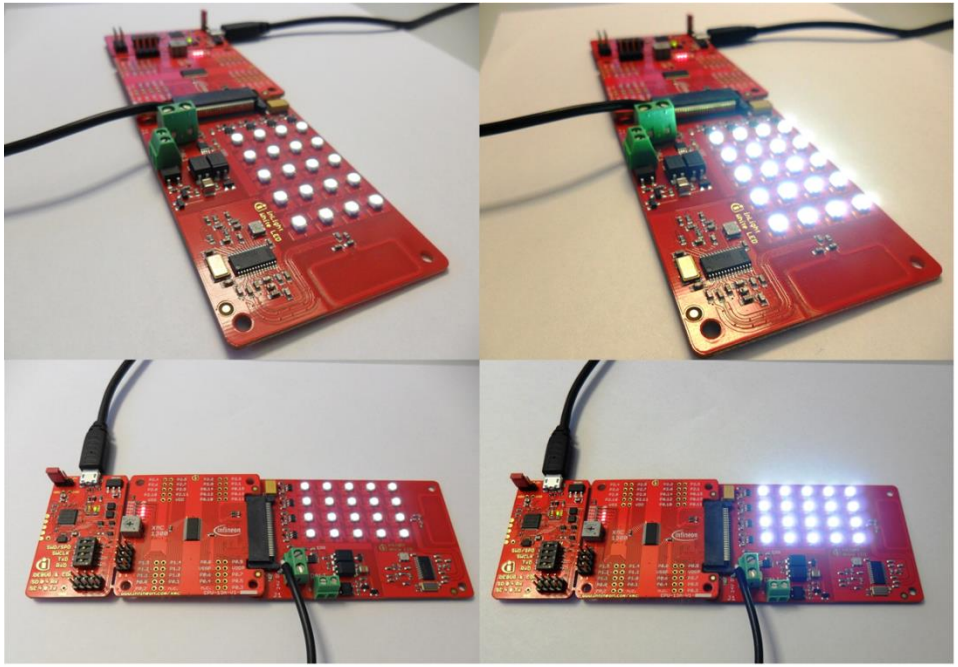


Libraries are merged.
We can perform our first unit testing

New Flow Demonstration
-Unit Testing-

- XMC1300 boot kit together with the LED Lighting Application kit from Infineon are used for testing
- We are now testing two optimized libraries that were seamlessly integrated in DAVE





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Summary

- **We have:**
  - Addressed the advantages of using a Model-Based Development Flow for Embedded Applications
  - Addressed the problems on optimizing embedded targets in current Model-Based Development
  - Presented a flow where these limitations are overcome by using Simulink+DAVE

Thank you…

Questions?

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