Model-Based Design: Generating Embedded Code for Prototyping or Production

Ruth-Anne Marchant
Application Engineer
MathWorks

ABB Accelerates Application Control Software Development for Power Electronic Controller

AC 800PEC controller.

Challenge

Adopt a more efficient development process using tools that accelerate the design of new application software for a high-powered electronic controller for power converters

Solution

Use MathWorks tools to design and validate their control algorithms while streamlining the application software development process for the controller

Results

- Development times and costs reduced
- Development process improved
- Highly accurate code generated

“Our system engineers can program, simulate, and verify the AC 800PEC controller’s regulation software very rapidly in MATLAB and Simulink.”

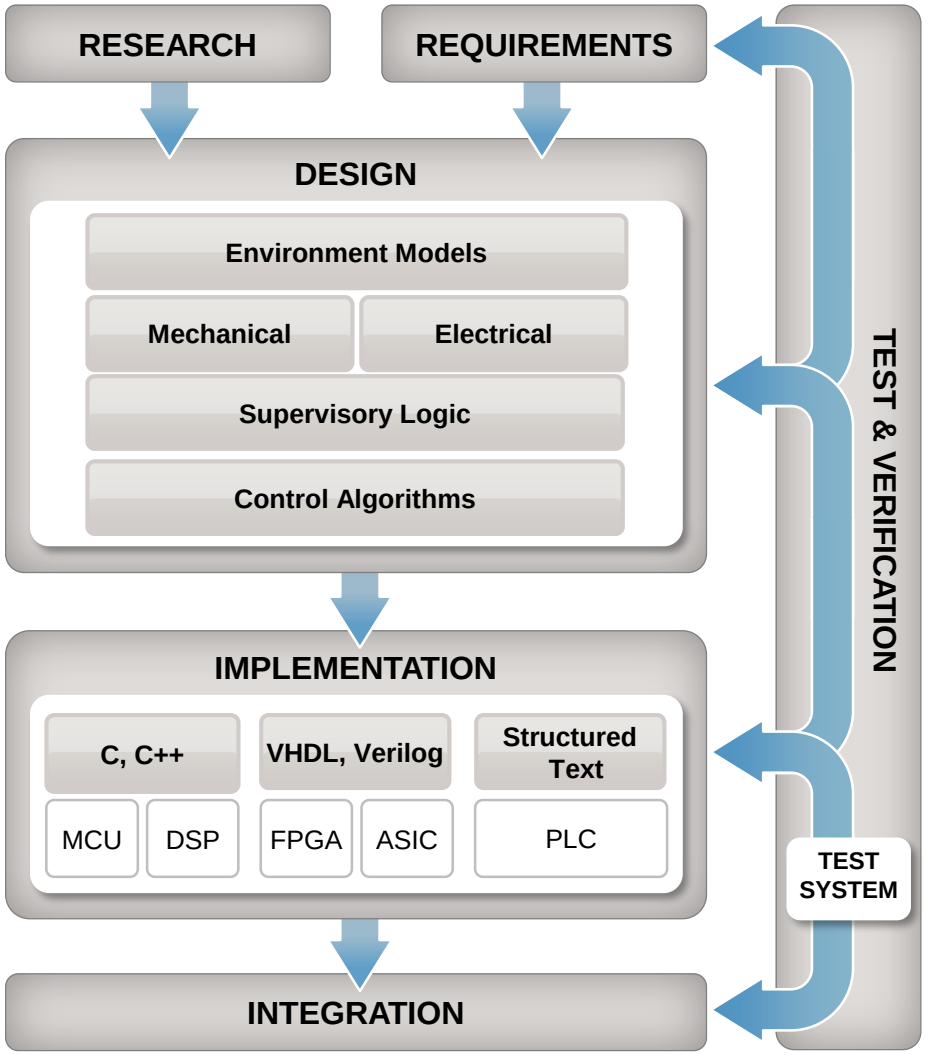
Fritz Wittwer
ABB

Link to user story

Outline

- Recap of Model-Based Design
- Generating code for rapid prototyping
- Generating code for production software
  - Preparing Model for Embedded Code Generation
  - Evolving Model for Fixed Point Implementation
- Summary

Adopting Model-Based Design



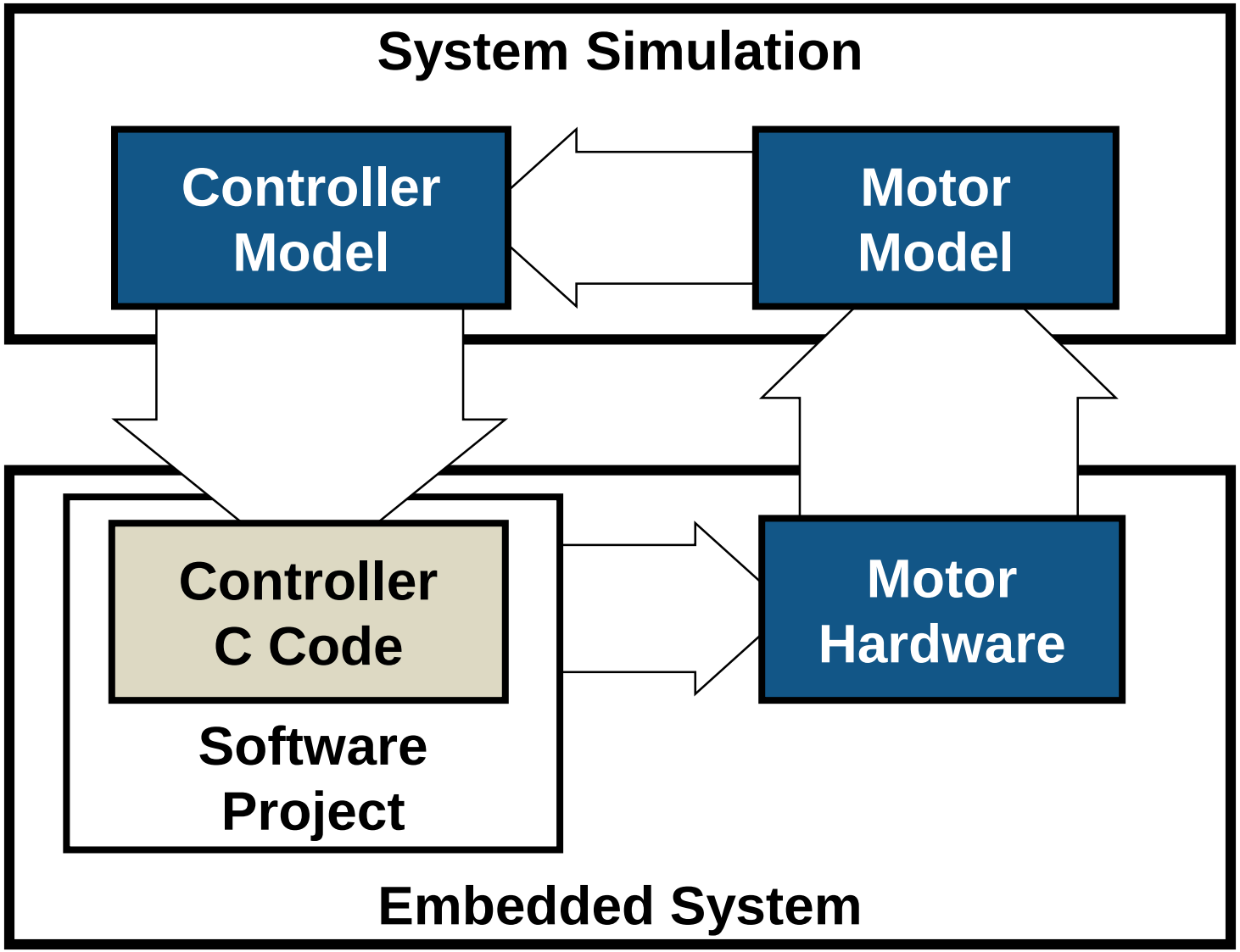
Executable Specifications

Design with Simulation

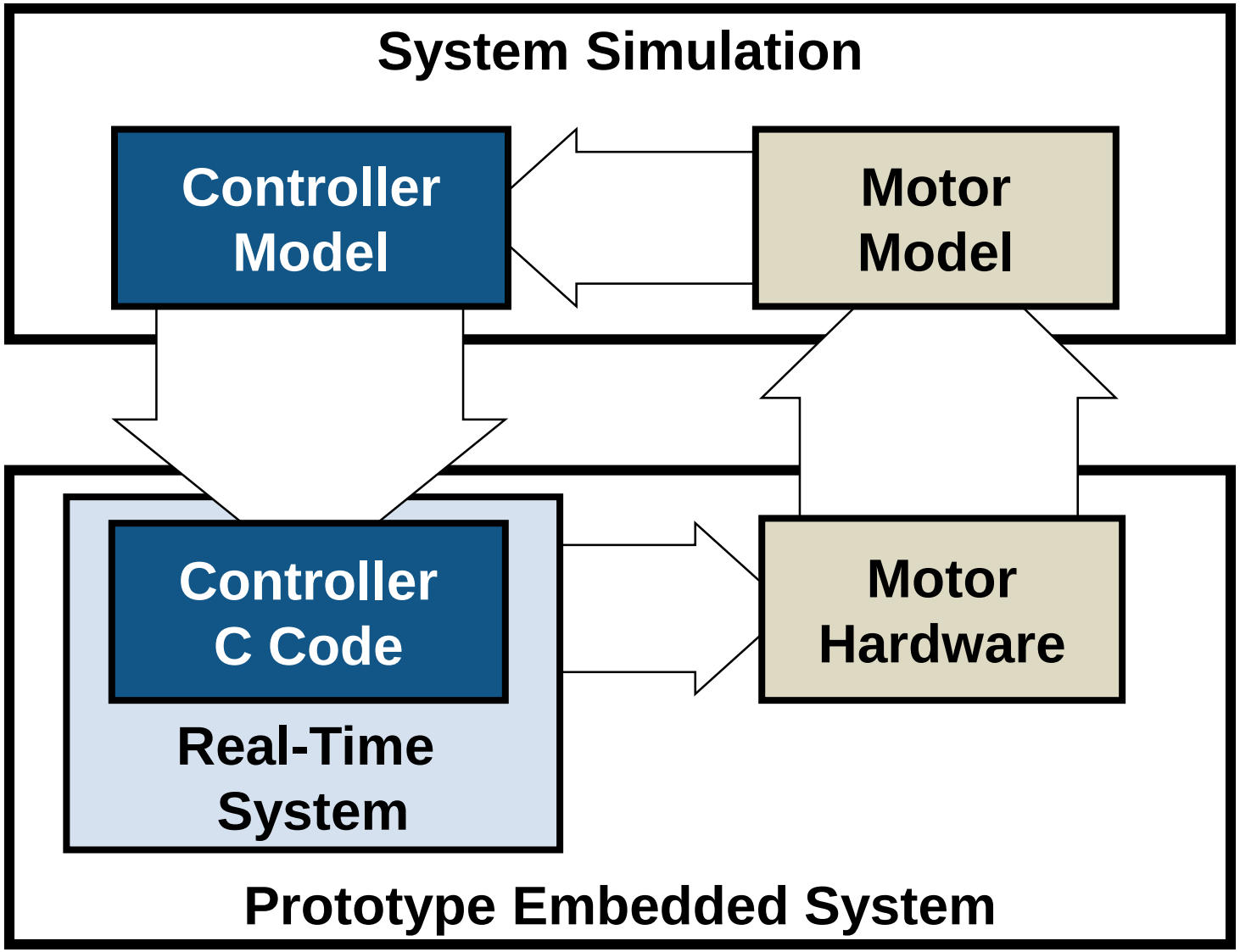
Automatic Code Generation

Continuous Test and Verification

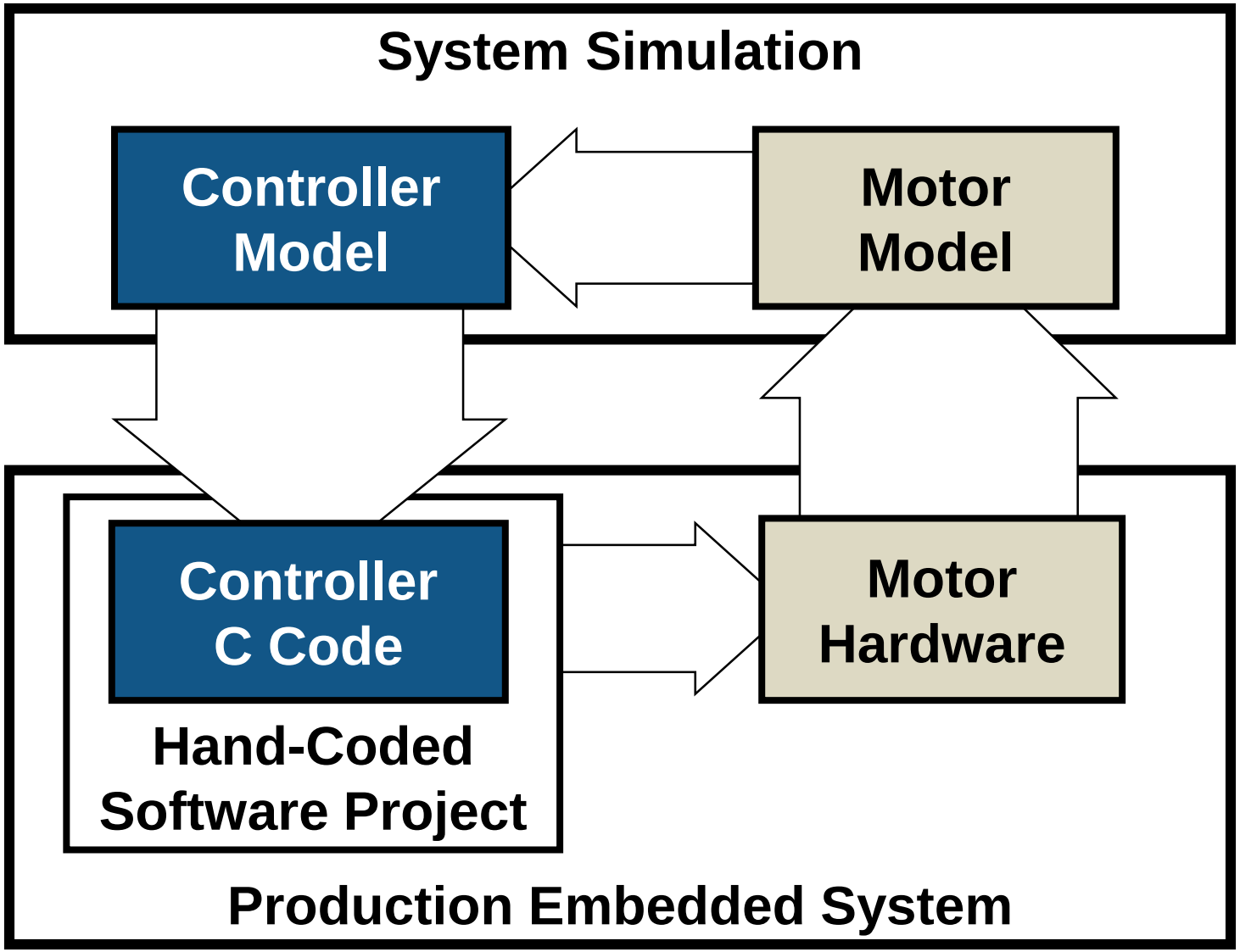
Motor Control System Design



Automatic Code Generation: Prototype on real-time hardware



Automatic Code Generation: Generate code for production

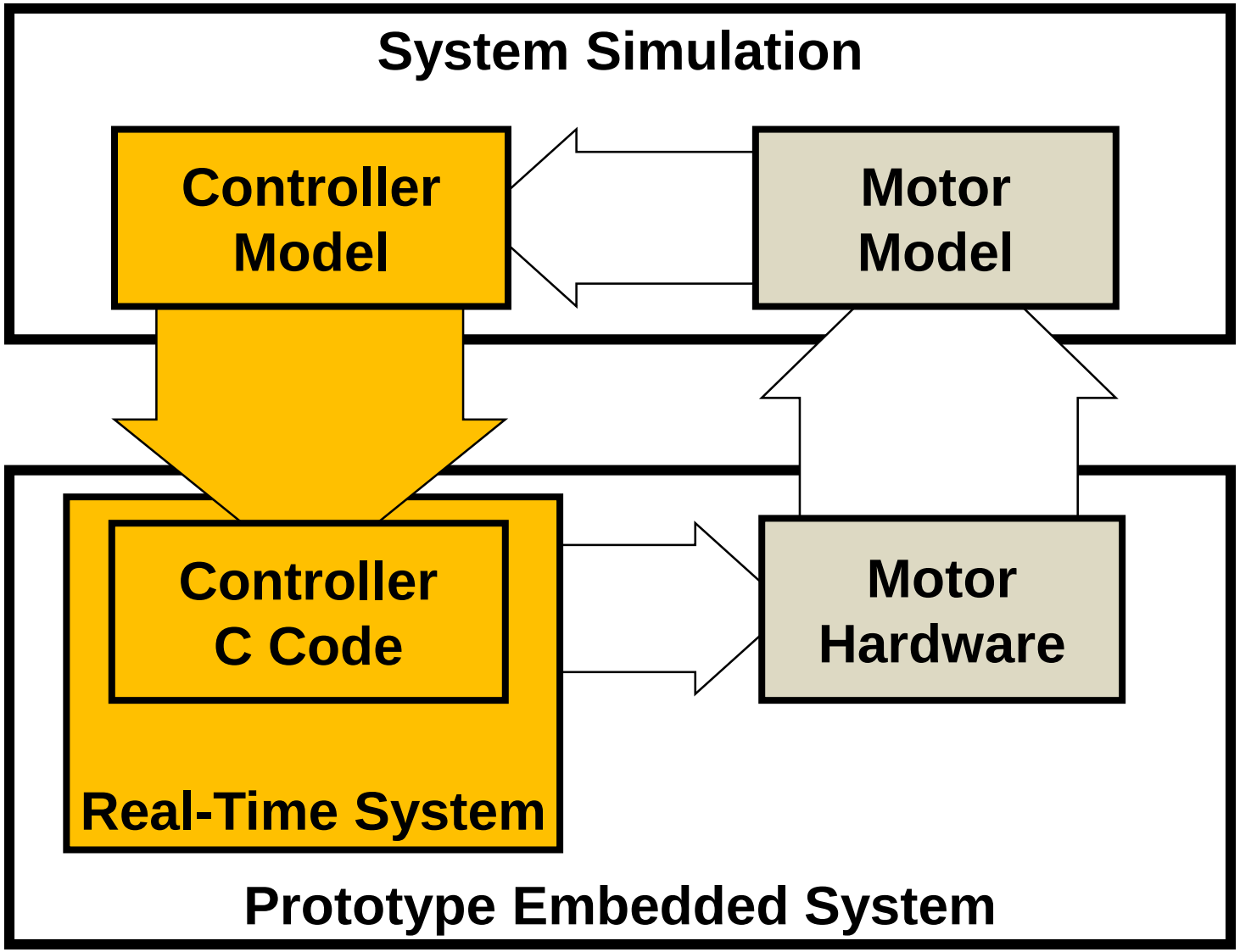


Outline

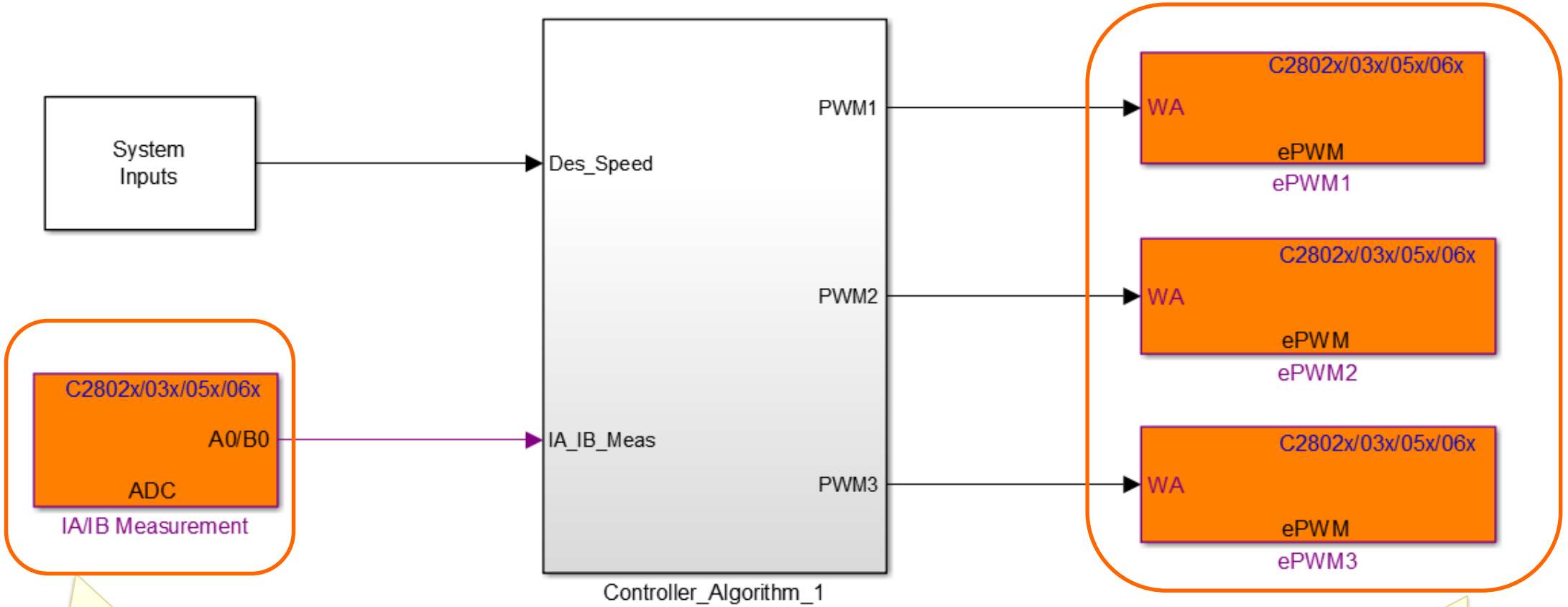
- Recap of Model-Based Design
- Generating code for rapid prototyping
- Generating code for production software
  - Preparing Model for Embedded Code Generation
  - Evolving Model for Fixed Point Implementation
- Summary

Automatic Code Generation with Simulink

Prototype on real-time hardware



Rapid Prototyping Model for Texas Instrument C2000 F28069M LaunchPad™ Development Kit

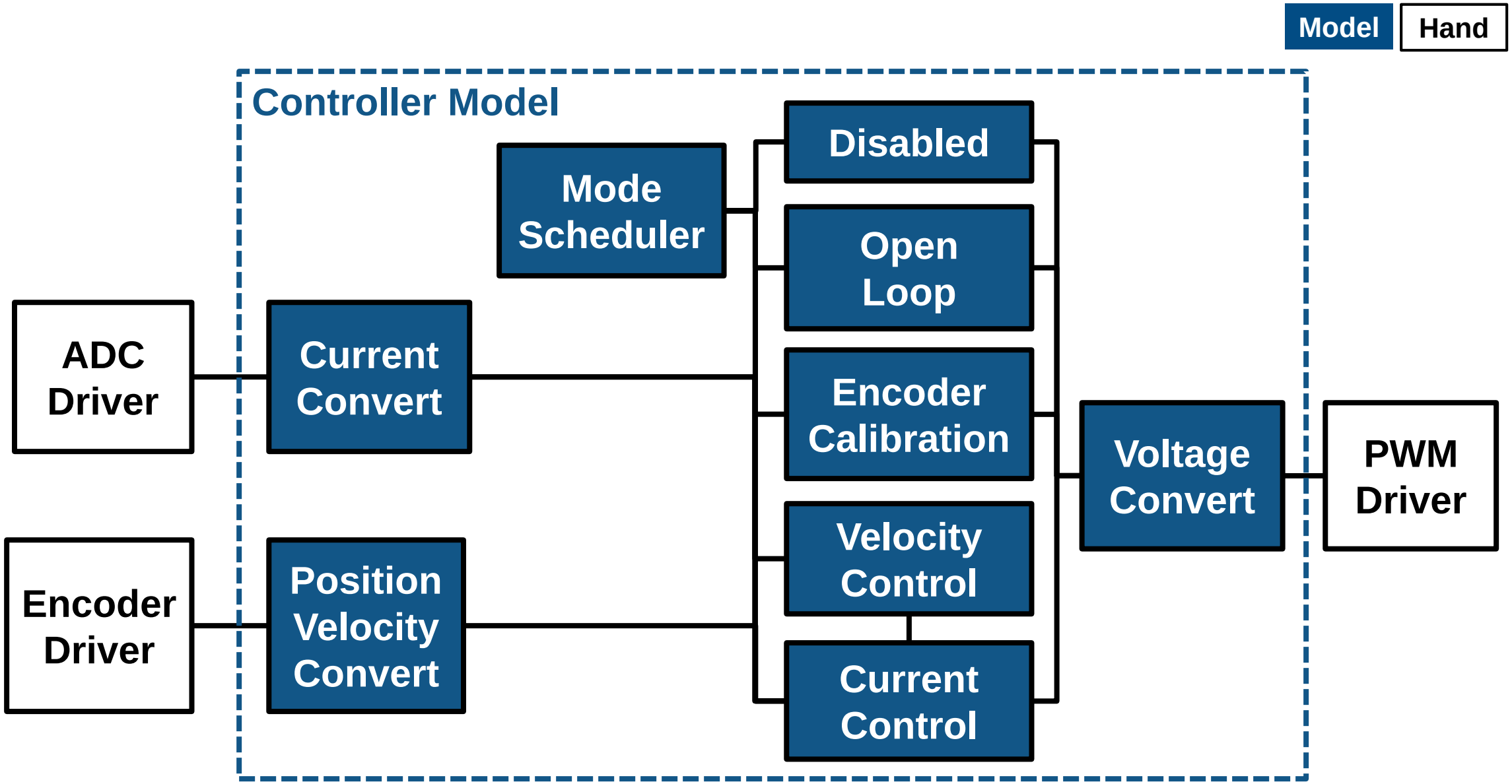


DEMO: Motor control using Embedded Coder Support Package for Texas Instruments C2000 Processors

Outline

- Recap of Model-Based Design
- Generating code for rapid prototyping
- Generating code for production software
  - Preparing Model for Embedded Code Generation
  - Evolving Model for Fixed Point Implementation
- Summary

Controller Model for Production Code Generation



Integrate generated controller code with your hand-coded software project

Model | Hand

Embedded Software Project Pseudo-Code

```
main()
{
    adcInit();
    encoderInit();
    pwmInit();

    controllerInit();

    while(1) {
    }
}
```

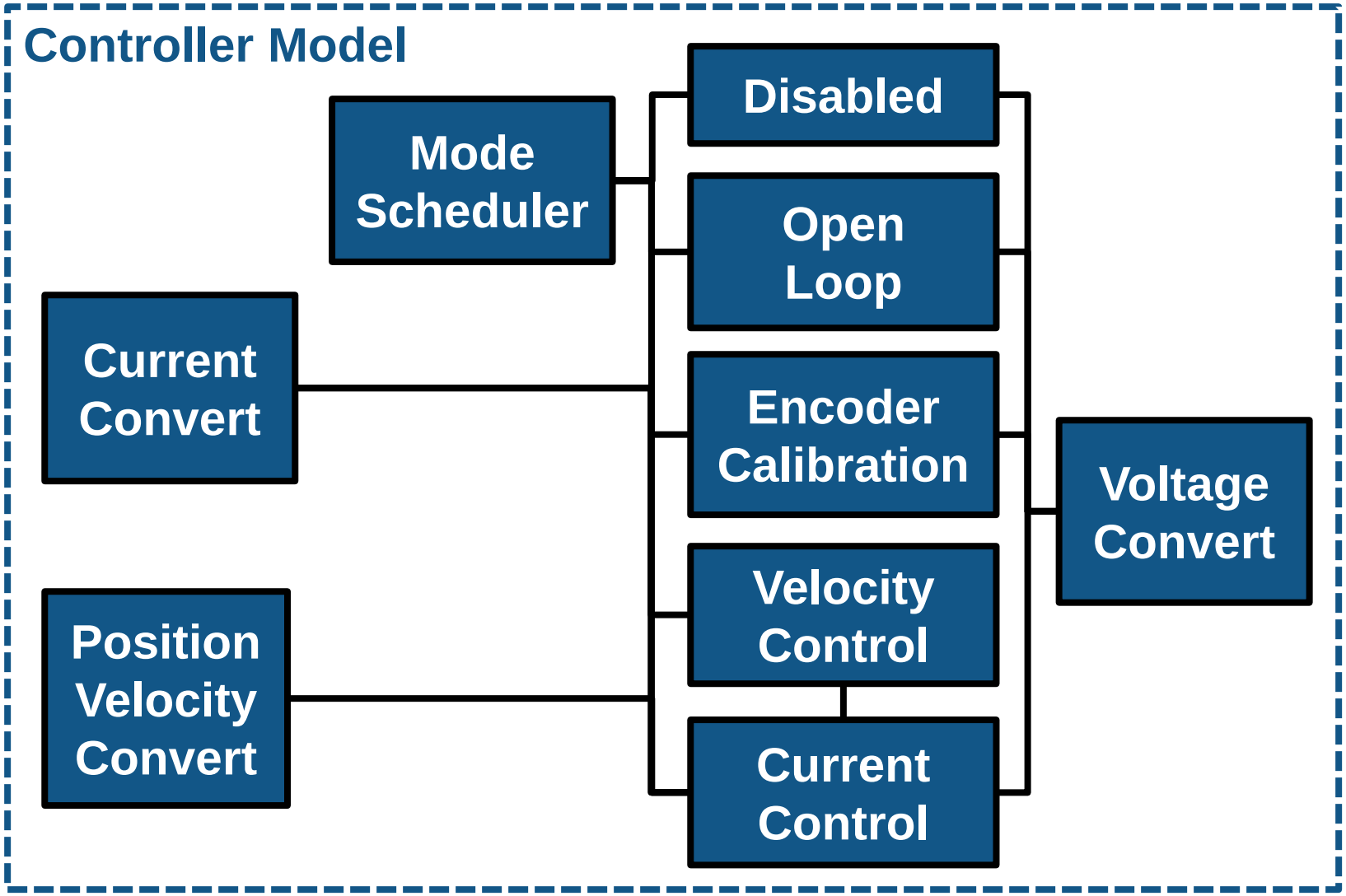
```
interruptServiceRountine()
{
    readAdcCountFromDriver();
    readEncoderCountFromDriver();

    controller();

    writePwmCountToDriver();
}
```

DEMO: Prepare algorithm model to generate embedded code and specify code interface

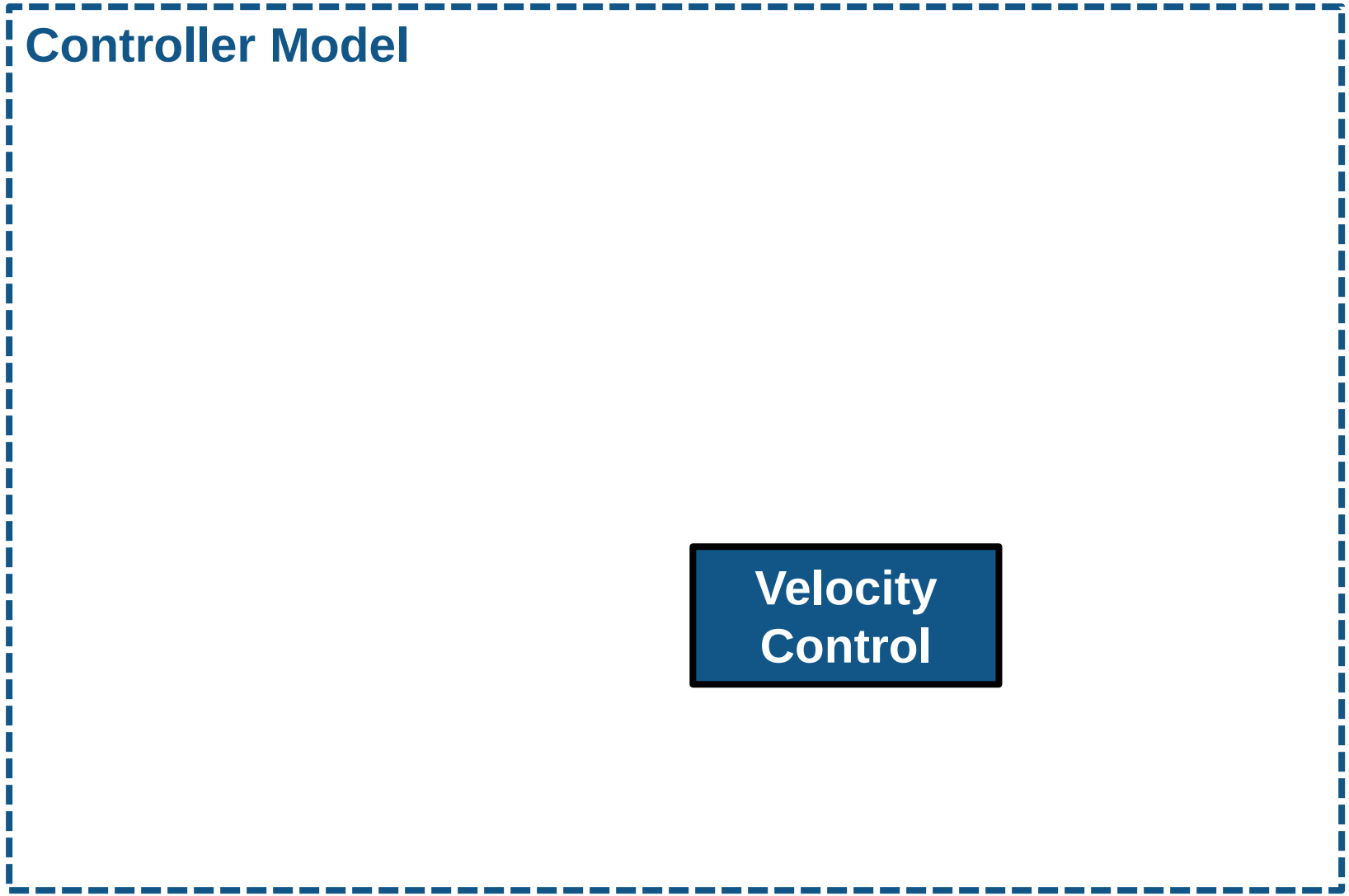
Outline

- Recap of Model-Based Design
- Generating code for rapid prototyping
- Generating code for production software
  - Preparing Model for Embedded Code Generation
  - Evolving Model for Fixed Point Implementation
- Summary

Design for fixed-point implementation

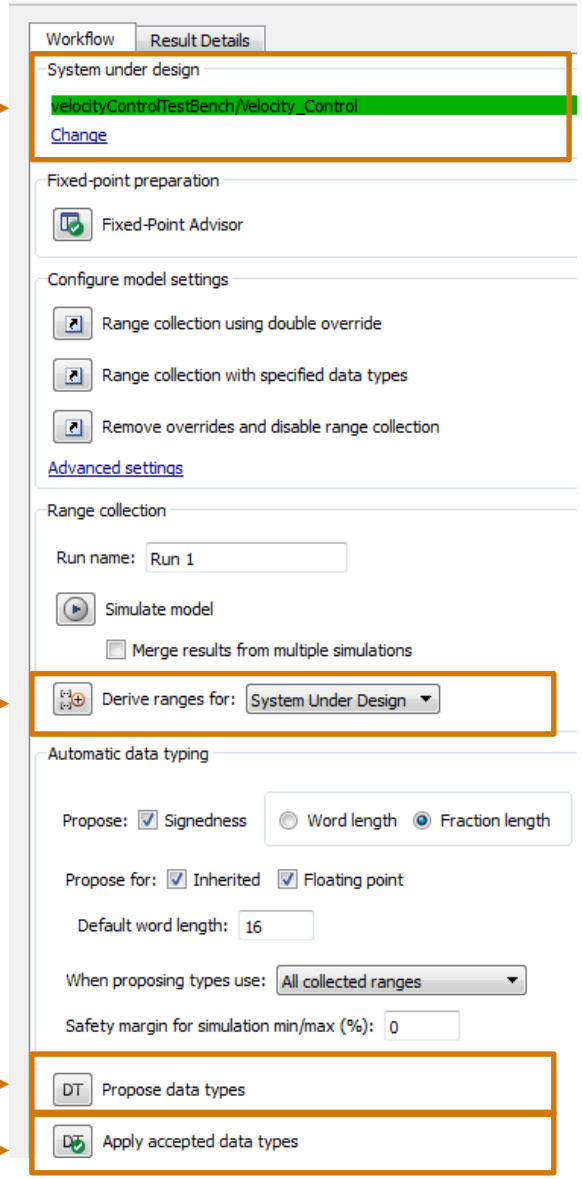


Design for fixed-point implementation at component level



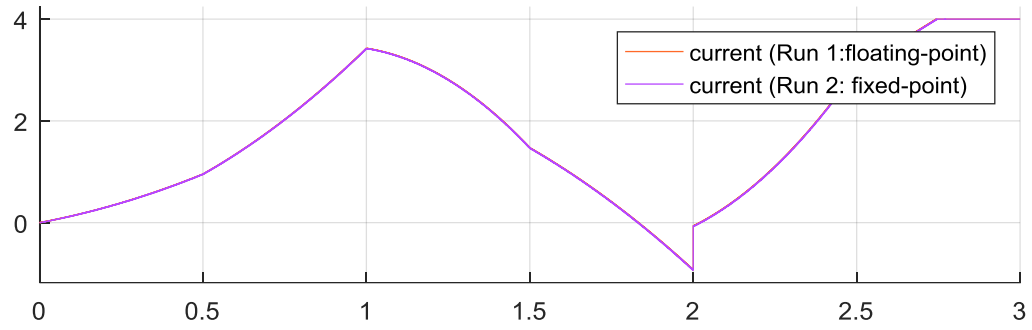
Design for Fixed-Point Implementation - Workflow

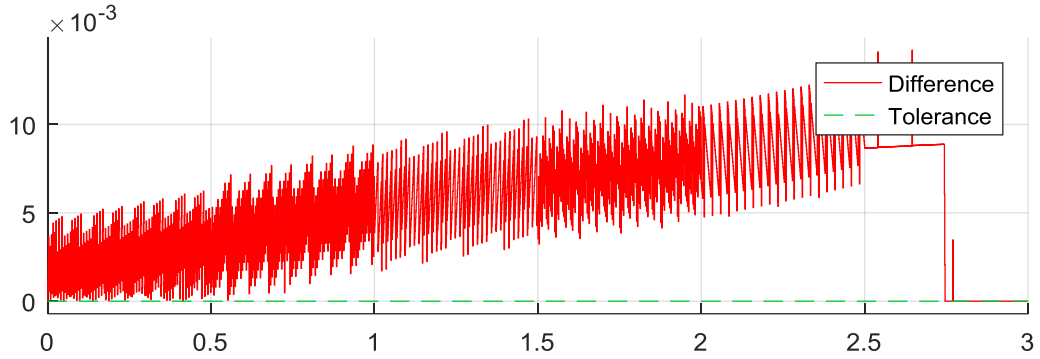
- Set up model to use Fixed-Point Tool
  - Specify minimum and maximum values on model inputs
- Using Fixed-Point Tool:
  - Select system under design
  - Derive minimum and maximum values
  - Propose data types
    - Determined based on range data
  - Apply proposed data types



Design for Fixed-Point Implementation - Workflow

- Compare against baseline floating point design
  - Simulate fixed-point design and compare against floating-point design
- Explore trade-offs in design decisions
  - Test 16 vs 32 bit fixed point designs
- Integrate component design into system-level simulation to validate design decisions





Outline

- Recap of Model-Based Design
- Generating code for rapid prototyping
- Generating code for production software
  - Preparing Model for Embedded Code Generation
  - Evolving Model for Fixed Point Implementation
- Summary

Key Points

- Simulink is a multi-domain modelling and simulation environment that supports Model-Based Design

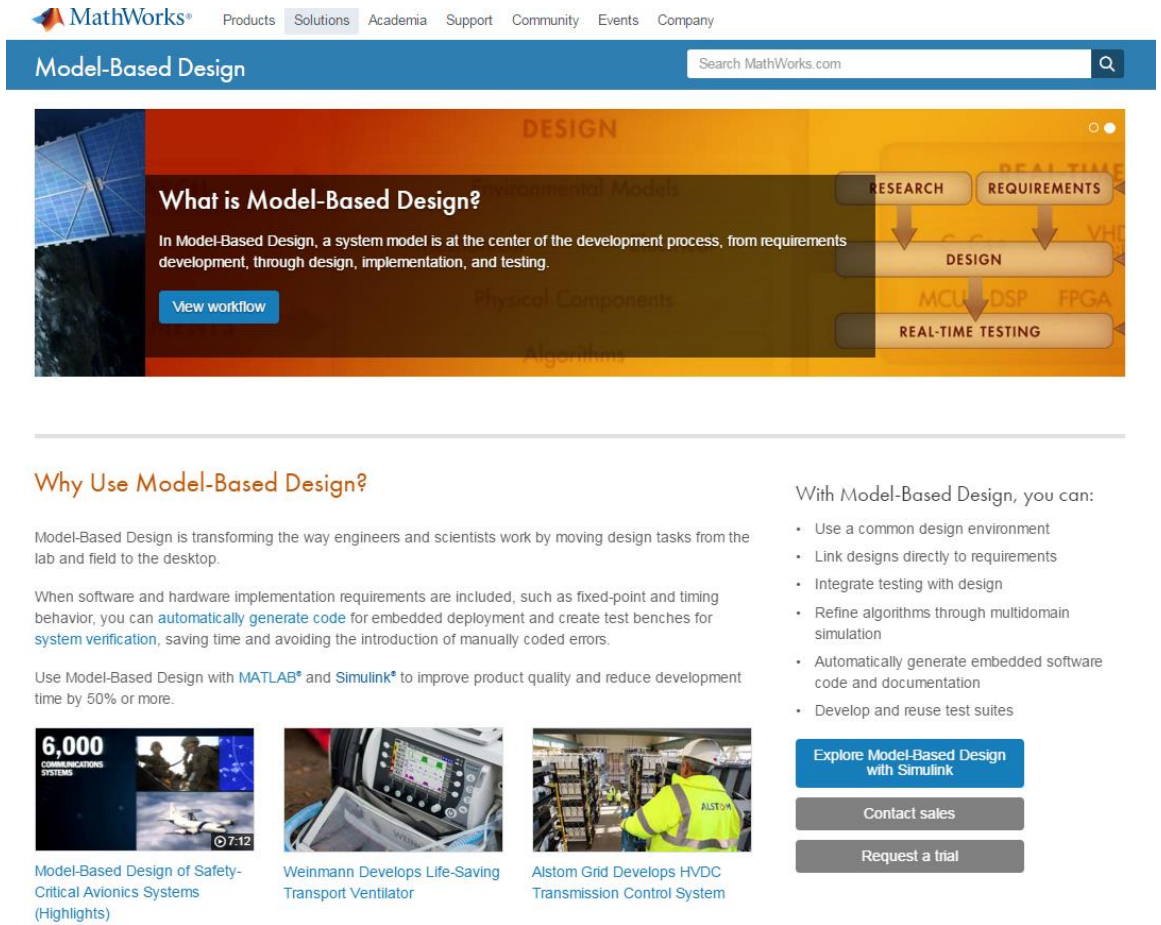
- Code generation technology can be used to
  - Quickly perform design iterations and deploy to prototyping hardware
  - Eliminate hand-coding errors in production code
  - Remove barriers to communication between teams

Call to Action

Learn more about Model-Based Design with Simulink

- Explore our website
  - au.mathworks.com

- Contact me:
  - Ruth-Anne Marchant
    - ruth-anne.marchant@mathworks.com.au



Q & A