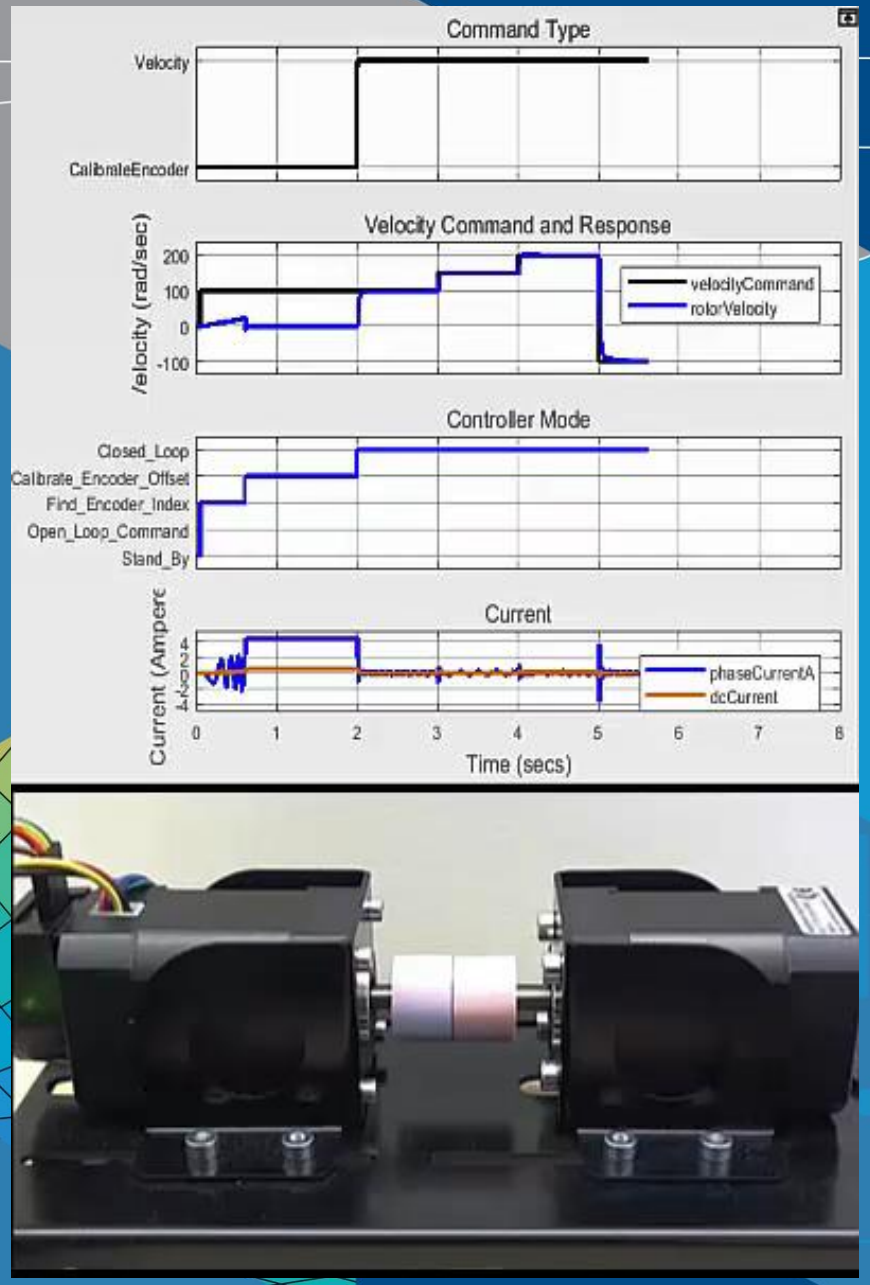
MATLAB EXPO 2017

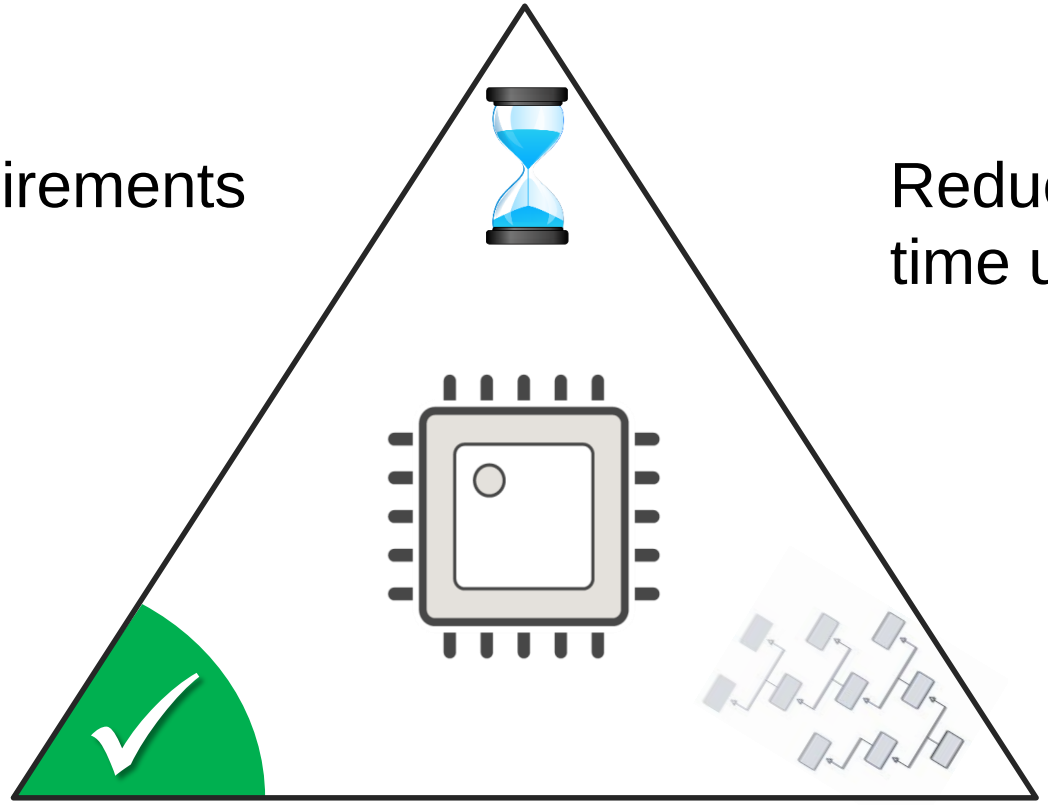
Motor Controls Implementation on Systems-On-Chip

Jorik Caljouw



Key Takeaways

Meet stringent requirements and reduce costs



Reduce hardware testing time up to 5x

Manage design complexity and improve team collaboration

Punch Powertrain develops complex SoC-based motor control

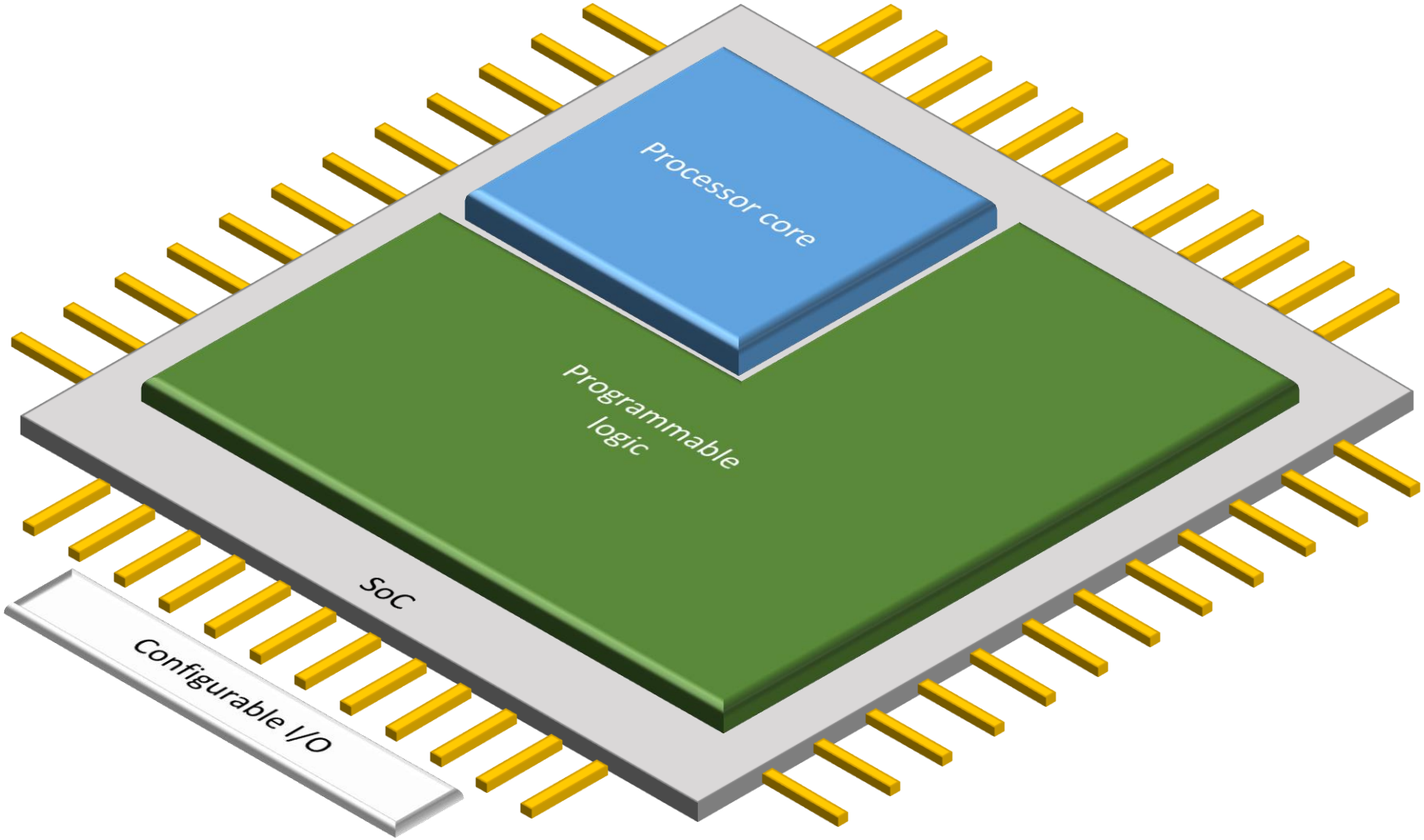
- Powertrains for hybrid and electric vehicles
- Hardware choice through simulations
- Traditional microcontroller too slow
- No experience designing FPGAs!

- ✓ Designed integrated E-drive: Motor, power electronics and software
- ✓ 4 different control strategies implemented
- ✓ Done in 1.5 years with 2FTE’s
- ✓ Models reusable for production
- ✓ Smooth integration and validation due to development process

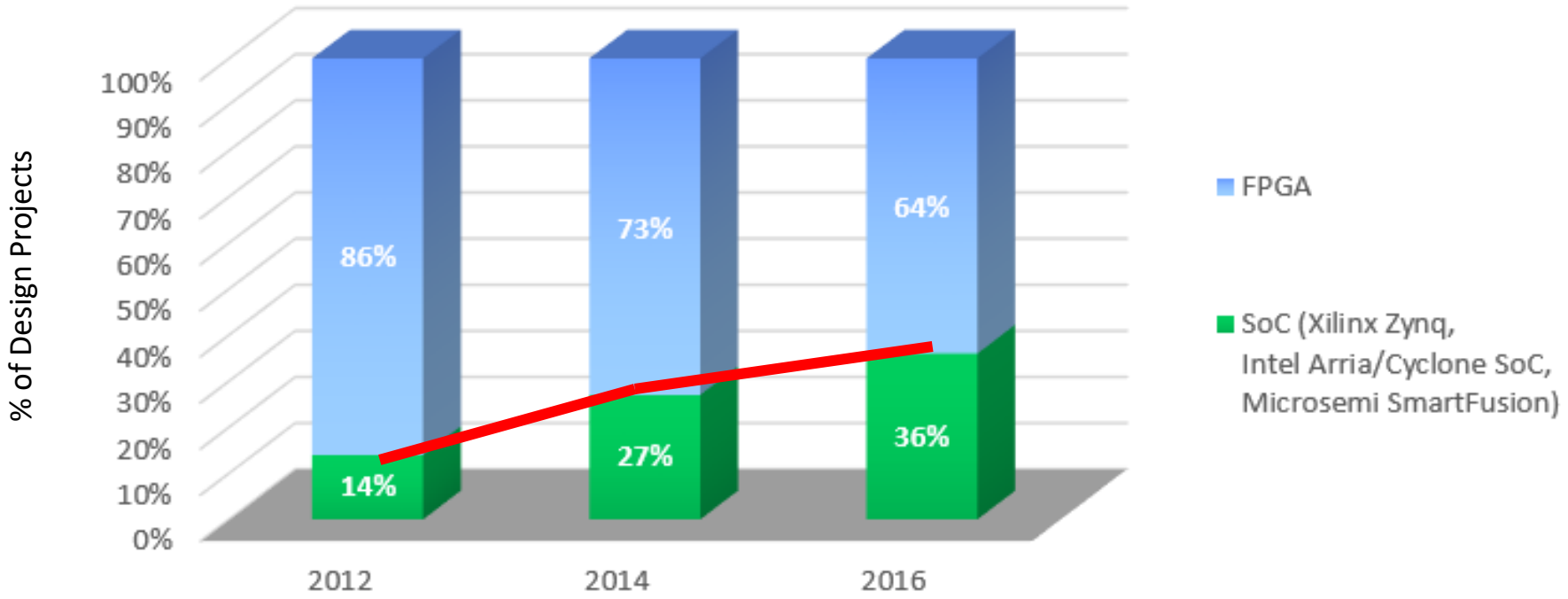
Link to video

Key trend: Increasing demands from motor drives

Systems-on-Chip for motor control

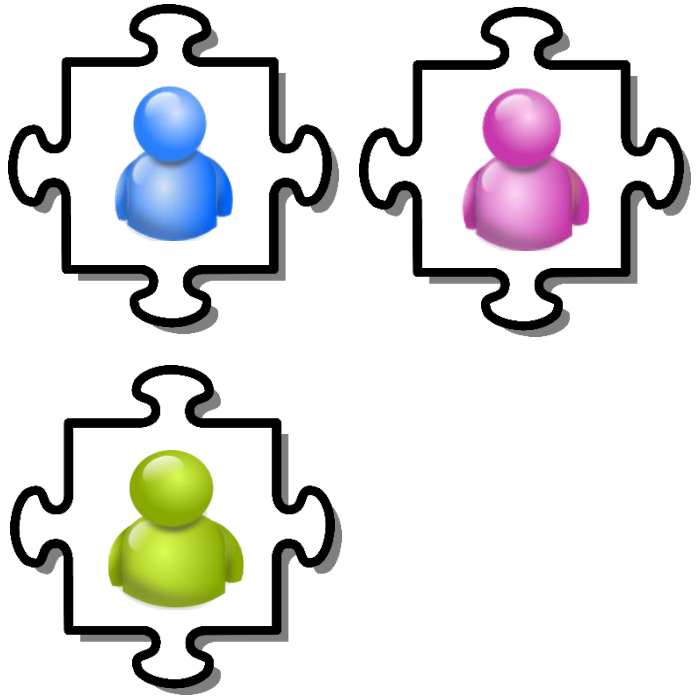


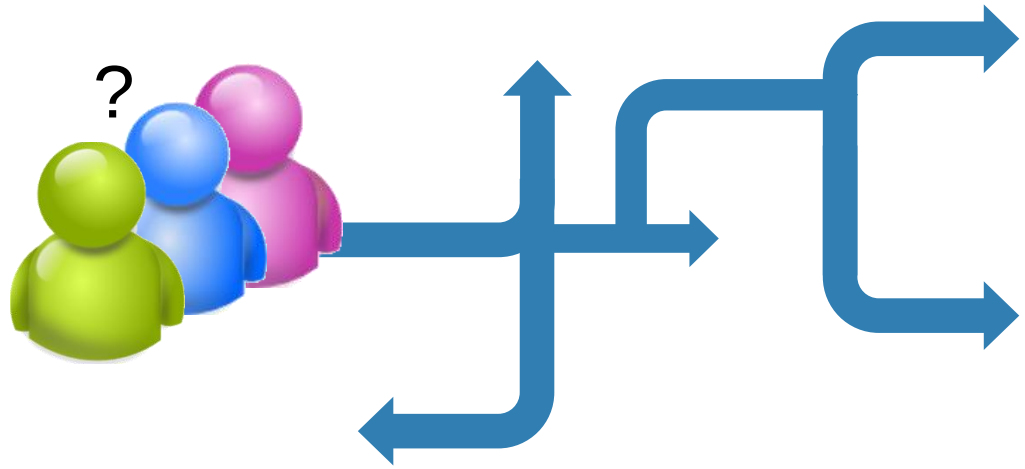
Key Trend: SoCs are now used in 36% of new FPGA projects



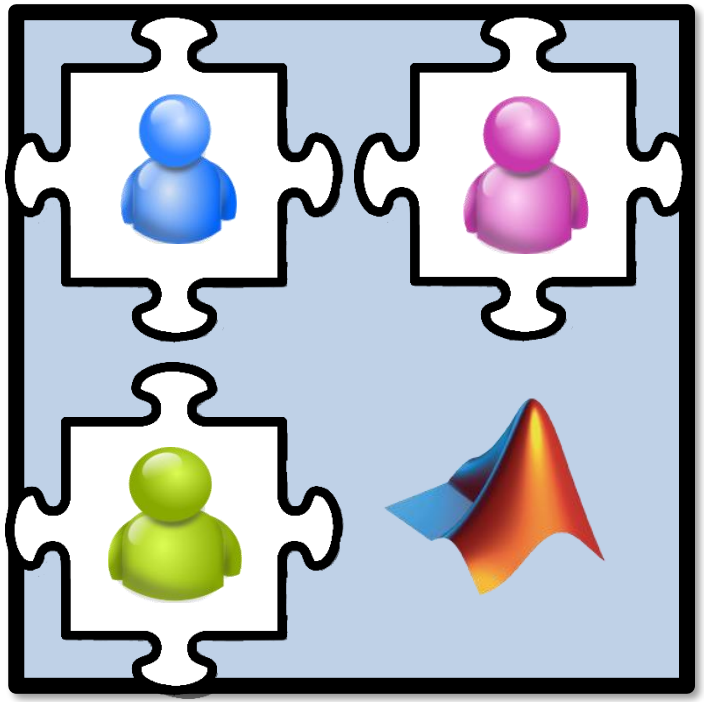
Source: Wilson Research Group and Mentor Graphics, 2016 Functional Verification Study

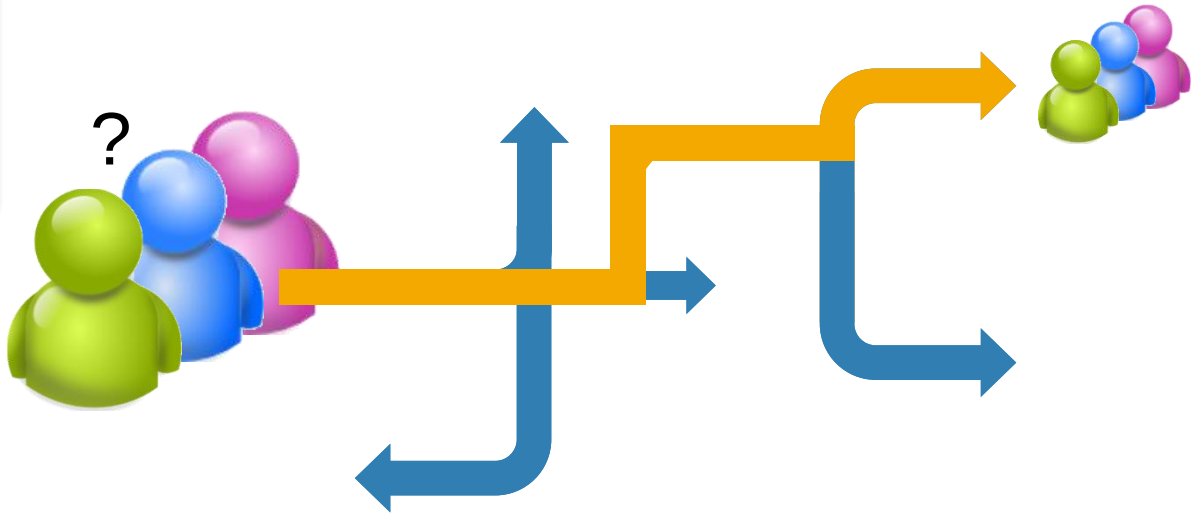
Challenges in using SoCs for Motor and Power Control





Why use Model-Based Design to develop motor control applications on SoCs?



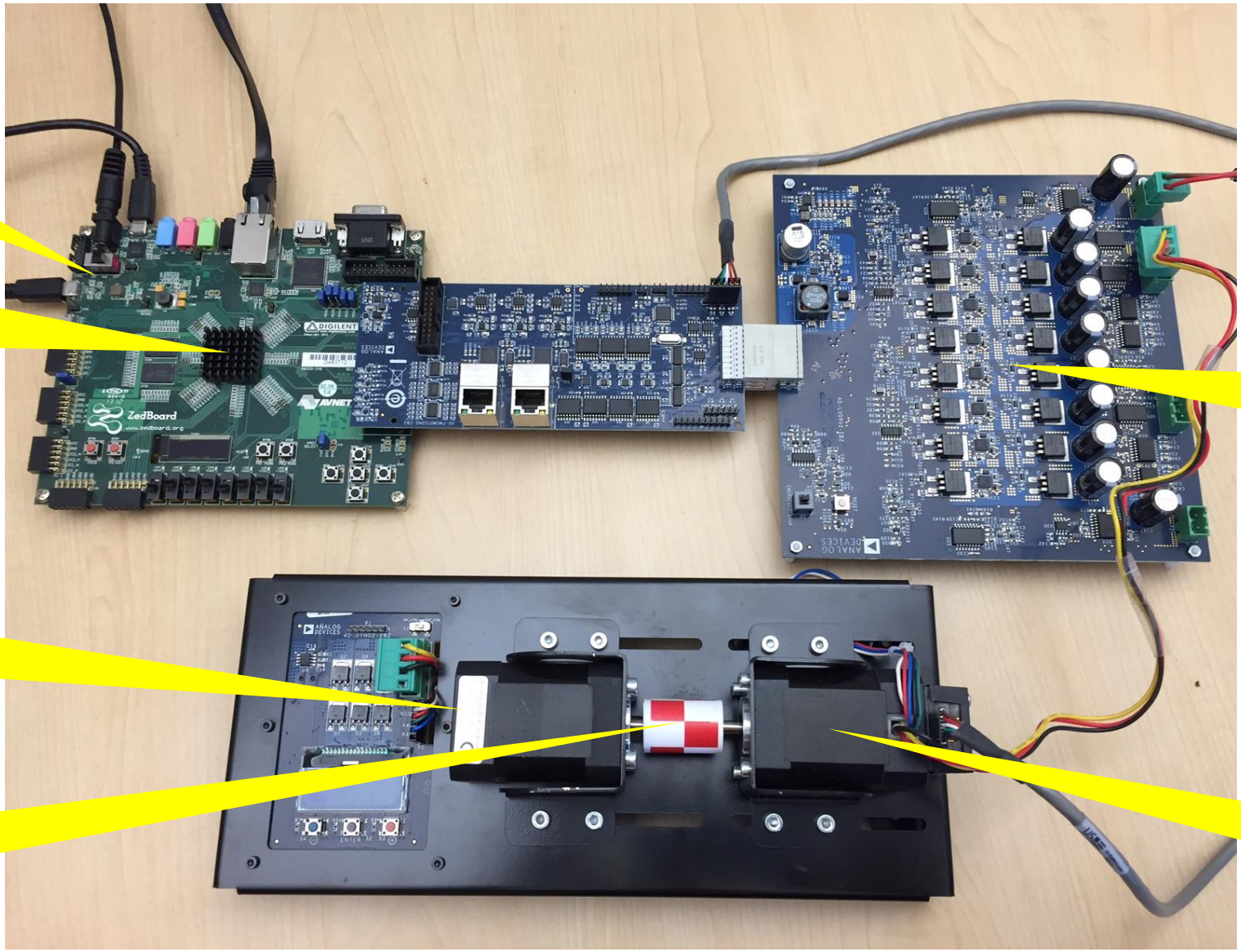


ZedBoard

Zynq SoC
(XC7Z020)

Load motor

Mechanical coupler



FMC module: control board + low-voltage board

Motor under test (with encoder)

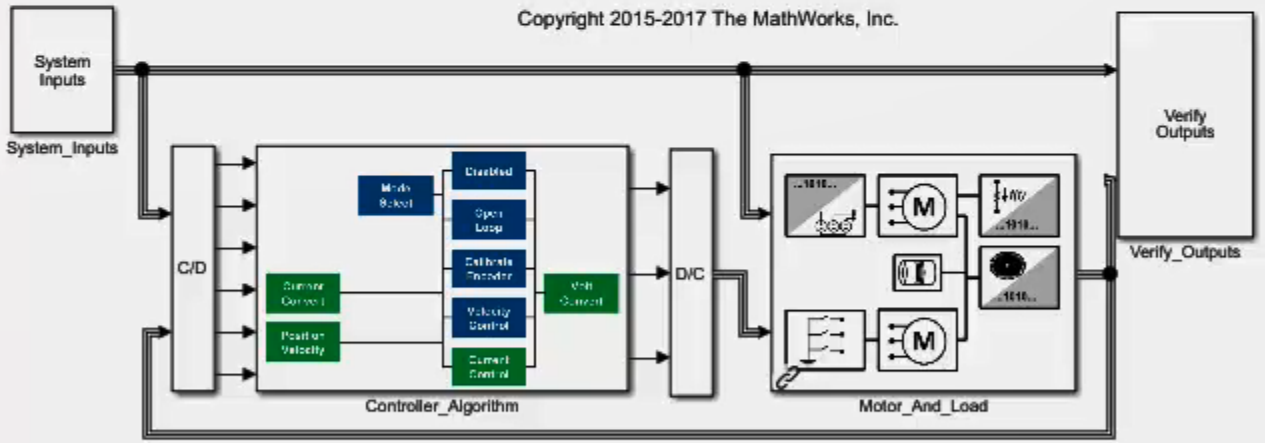
focZynqTestBench - Simulink

File Edit View Display Diagram Simulation Analysis Code Tools Help

focZynqTestBench

focZynqTestBench

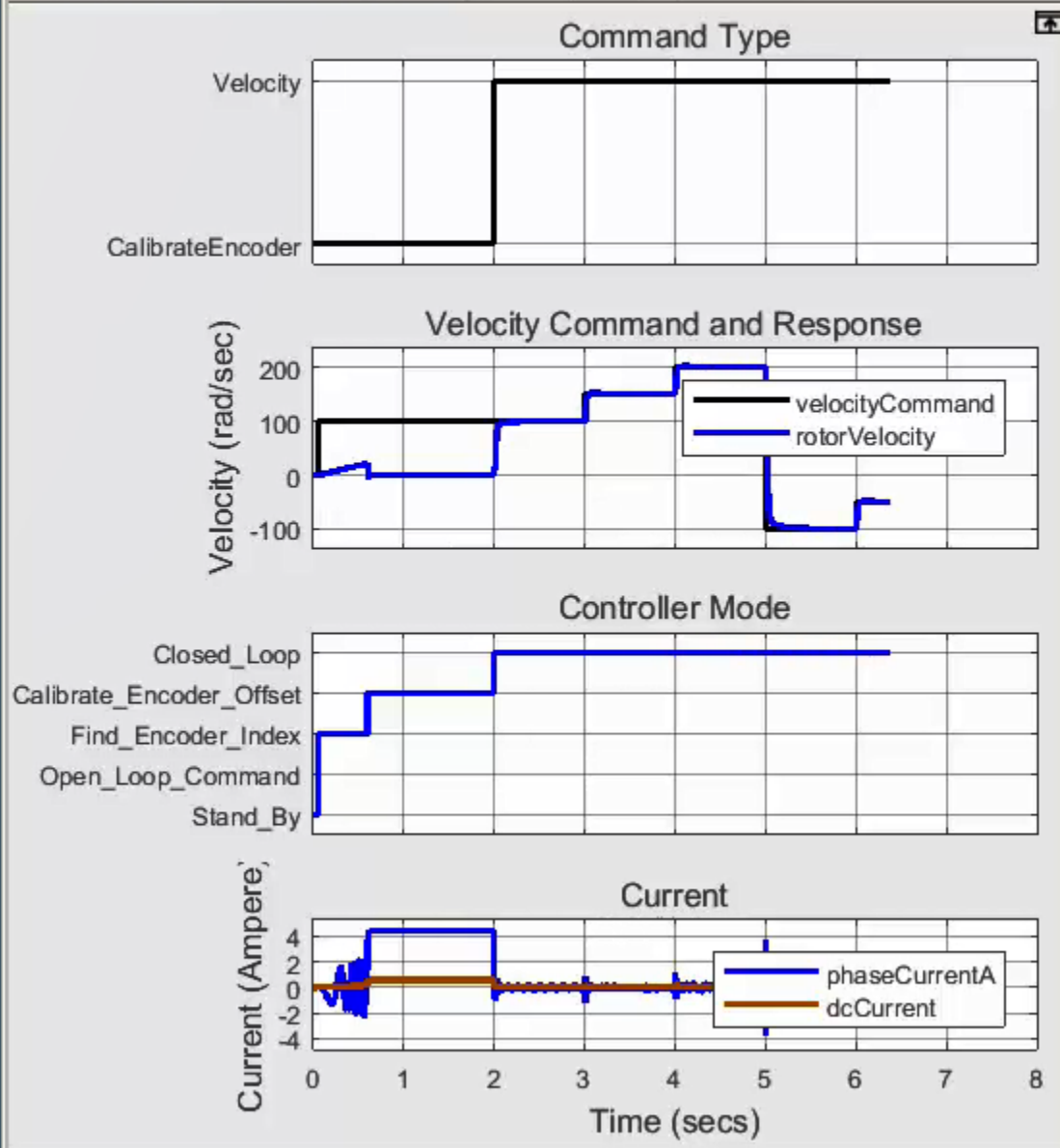
Field-Oriented Control of Velocity
Hardware/Software Test Bench



Running | View diagnostics 68% T=6.239 | auto(ode45)

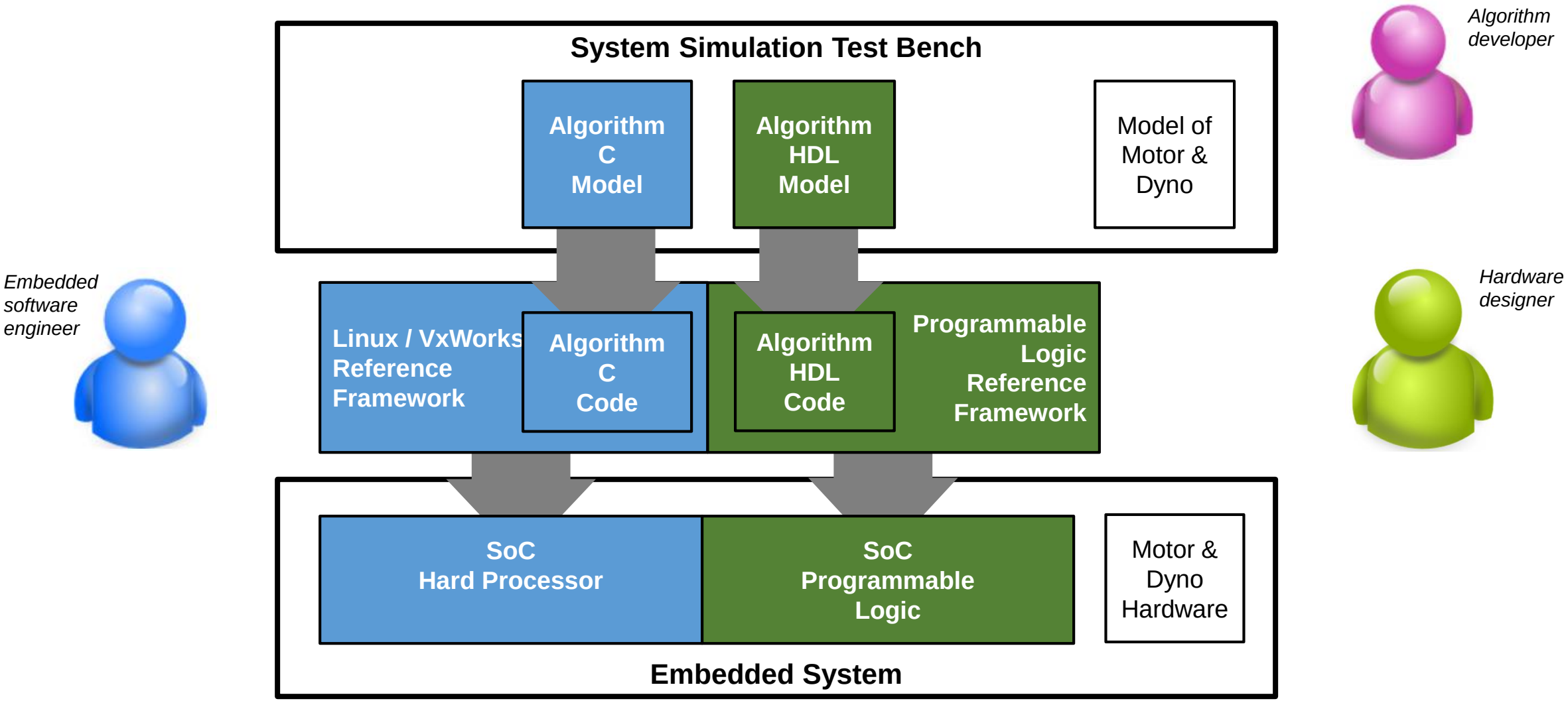
System_Response

File Tools View Simulation Help

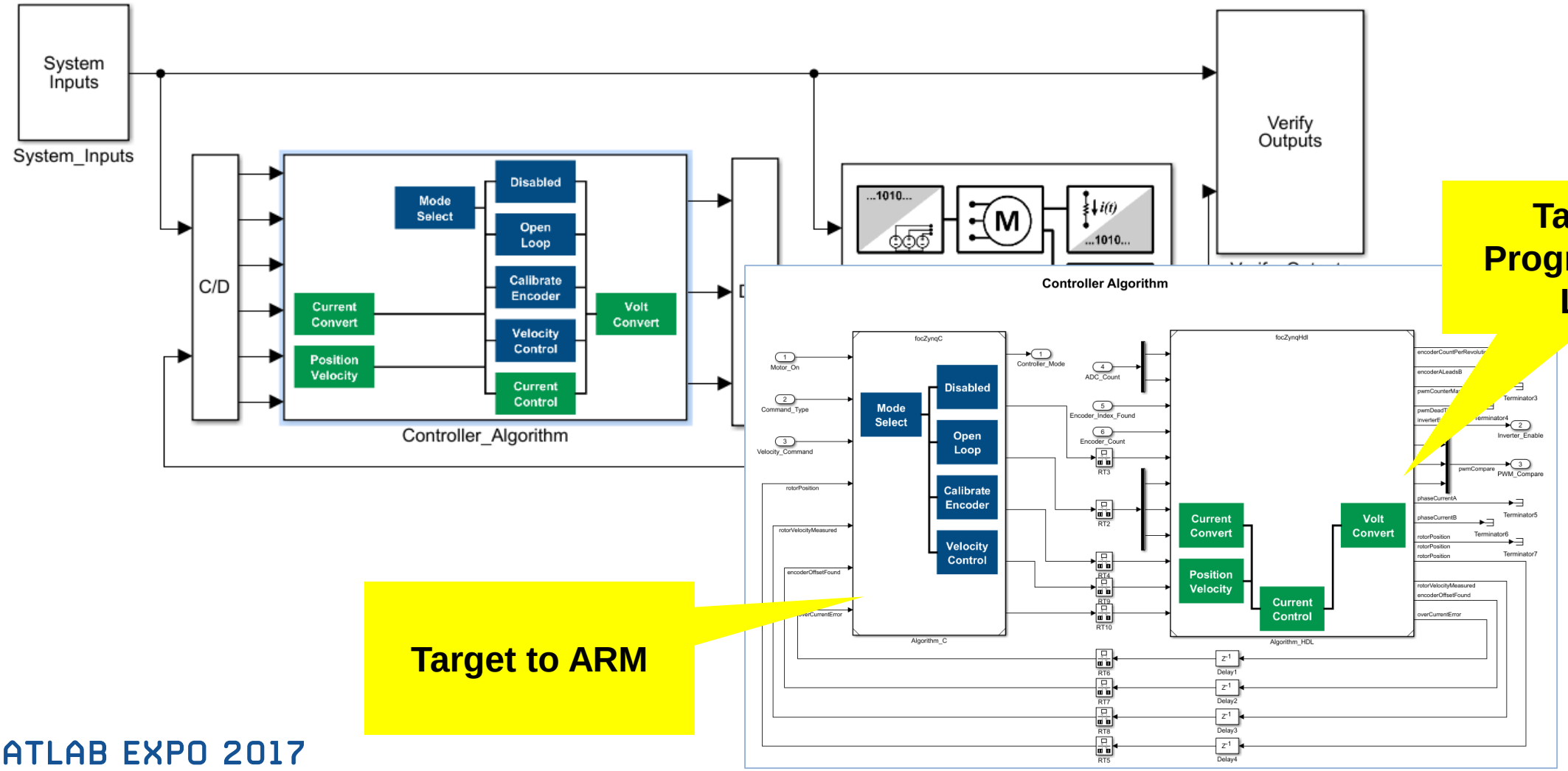


Running | Sample based | T=6.220

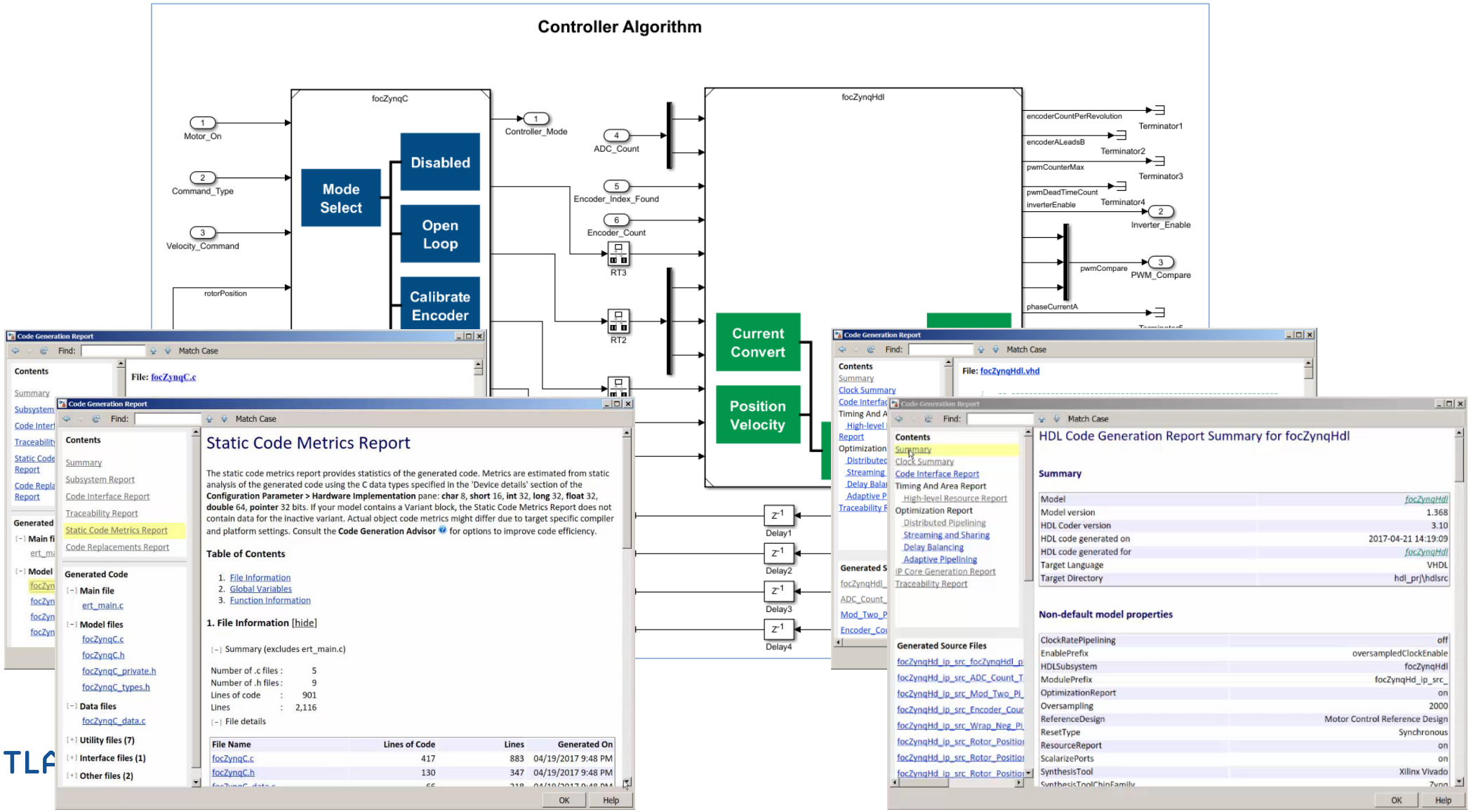
Conceptual workflow targeting SoCs

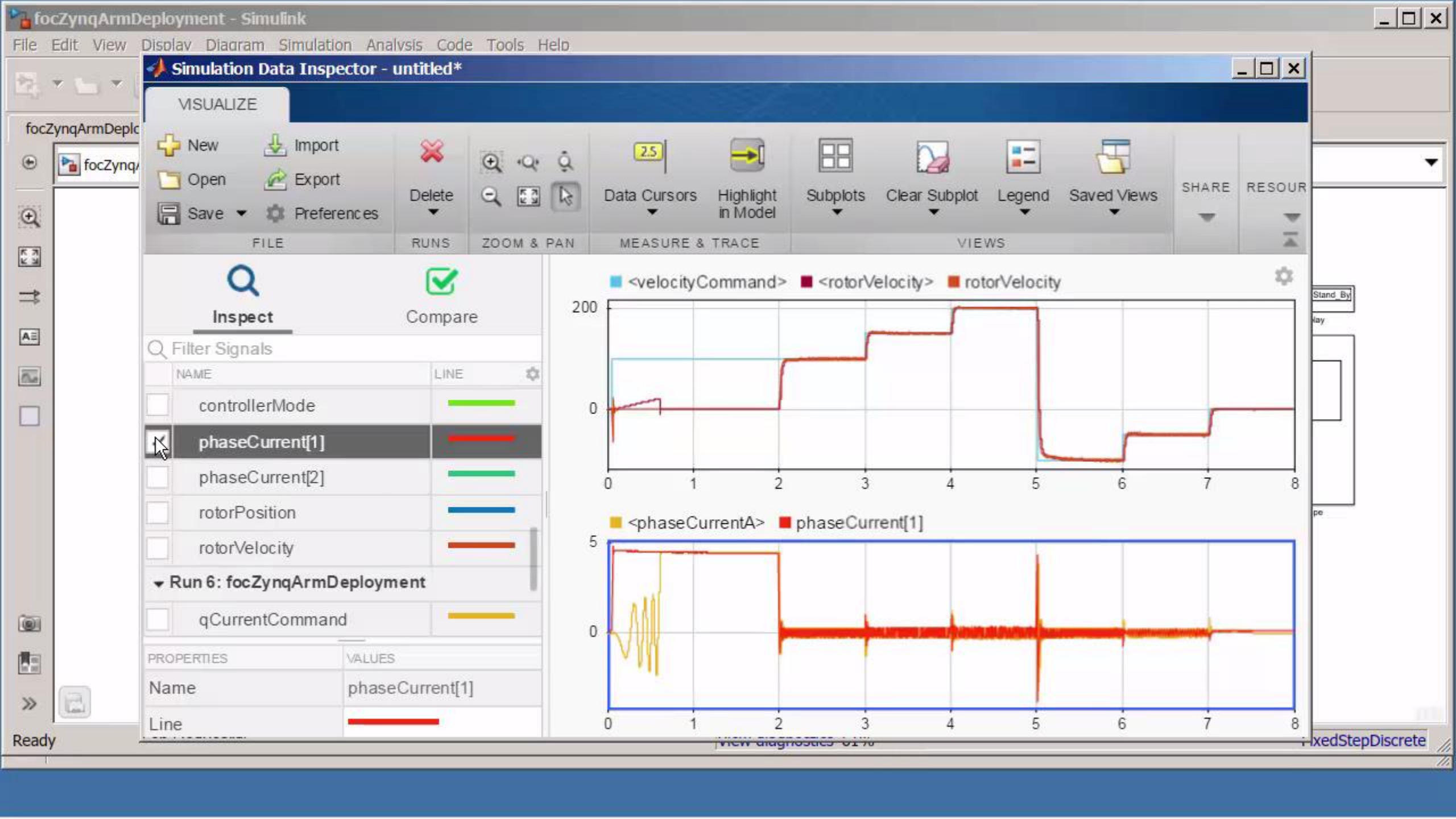


Hardware/software partitioning



Code Generation




focZynqArmDeployment - Simulink
File Edit View Display Diagram Simulation Analysis Code Tools Help
Simulation Data Inspector - untitled*
VISUALIZE
New
Open
Save
Import
Export
Preferences
FILE
Delete
RUNS
ZOOM & PAN
Data Cursors
Highlight in Model
MEASURE & TRACE
Subplots
Clear Subplot
Legend
Saved Views
VIEWS
SHARE
RESOUR
Inspect
Compare
Filter Signals
NAME
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controllerMode
phaseCurrent[1]
phaseCurrent[2]
rotorPosition
rotorVelocity
Run 6: focZynqArmDeployment
qCurrentCommand
PROPERTIES
VALUES
Name
phaseCurrent[1]
Line
<velocityCommand> <rotorVelocity> rotorVelocity
200
0
0 1 2 3 4 5 6 7 8
<phaseCurrentA> phaseCurrent[1]
5
0
0 1 2 3 4 5 6 7 8
Ready
FixedStepDiscrete

3T Develops Robot Emergency Braking System with Model-Based Design

Challenge

Design and implement a robot emergency braking system with minimal hardware testing

Solution

Model-Based Design with Simulink and HDL Coder to model, verify, and implement the controller

Results

- Cleanroom time reduced from weeks to days
- Late requirement changes rapidly implemented
- Complex bug resolved in one day

A SCARA robot.

"With Simulink and HDL Coder we eliminated programming errors and automated delay balancing, pipelining, and other tedious and error-prone tasks. As a result, we were able to easily and quickly implement change requests from our customer and reduce time-to-market."

Ronald van der Meer

3T

Link to user story

Key Takeaways

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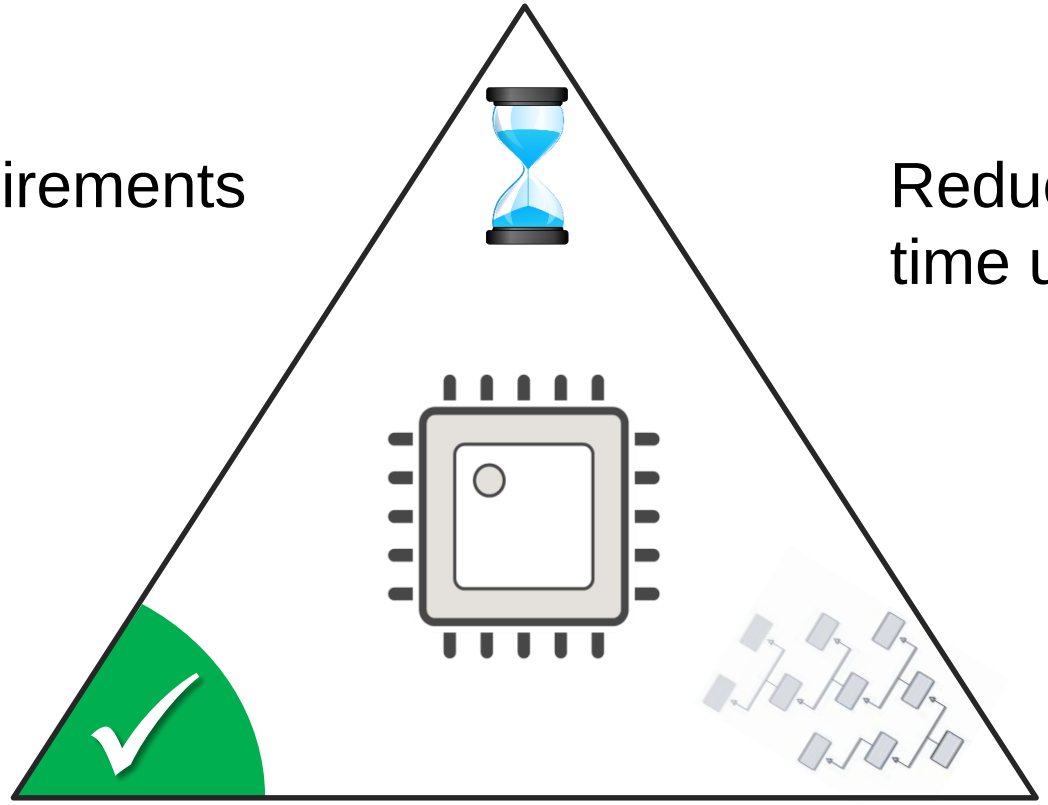

Reduce hardware testing time up to 5x

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Learn More

- Get an in-depth demo in the Technology Showcase
  - New: see award-winning Native Floating Point in HDL Coder!
- Videos
  - HDL Coder: Native Floating Point
- Webinars
  - Prototyping SoC-based Motor Controllers on Intel SoCs with MATLAB and Simulink
  - How to Build Custom Motor Controllers for Zynq SoCs with MATLAB and Simulink
- Articles
  - How Modeling Helps Embedded Engineers Develop Applications for SoCs (MATLAB Digest)
  - MATLAB and Simulink Aid HW-SW Codesign of Zynq SoCs (Xcell Software Journal)
- Tutorials:
  - Define and Register Custom Board and Reference Design for SoC Workflow
  - Field-Oriented Control of a Permanent Magnet Synchronous Machine on SoCs

How to get started?

- Embedded Systems
- FPGA Design
- Xilinx Zynq SoCs

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Code Generation
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Embedded Systems
FPGA Design
Generating HDL Code
Xilinx Zynq SoCs
AUTOSAR

Code Integration
Integrating C and MATLAB

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https://nl.mathworks.com/services/training.html