A Model-Based Design approach for embedded system development on STM32 microcontrollers

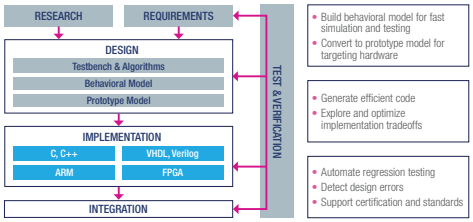
AUTHORS: Loubna Belhamel, Arturo Buscarino, Luigi Fortuna, Gaetano Rascona'

OBJECTIVES

A new software tool that supports Model Based Design (MBD) is presented. It is suitable for running Simulink® application models for STM32 MCUs. The first Simulink® blockset library for STM32 peripherals allows us to implement Processor In the Loop (PIL) configuration and automatic code generation. The second Simulink® blockset includes extensive Math and Motor control functions based on the STM32 Motor control library.

MODEL-BASED DESIGN WORKFLOW

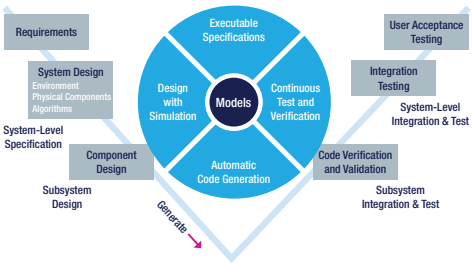
MBD modifies traditional methods adopted in model development processes and introduces a better way to implement the following workflow:



DEVELOPMENT PROCESS

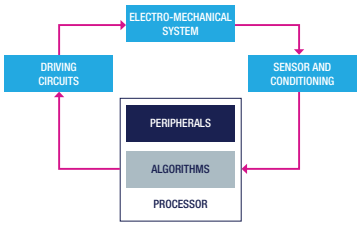
MBD employs the V-model development process illustrated below in its various phases. The V-model allows:

- Executable Specifications
- Design with Simulation
- Continuous Test and Verification
- Automatic Code Generation



SYSTEM MODEL PARTITIONING

The key for building a successful MBD platform is partitioning the system model and the embedded software code.

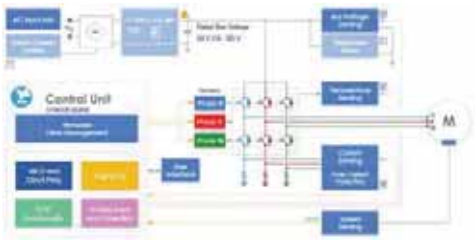


Block		Description	Simulation	Code generation
Electromechanical system		Averaged functional model	✓	✗
• Sensor and conditioning • Driving circuit		Fine-grained function model	✓	✗
Processor	Peripherals	Fine-grained function model	✓	✓
	Algorithms	Core algorithm	✓	✓

L.Belhamel with Dipartimento di Ingegneria Elettrica Elettronica e Informatica, University of Catania,95125, Catania, Italy (email: loubna.belhamel@unict.it).
L. Fortuna and A.Buscarino are with the Dipartimento di Ingegneria Elettrica Elettronica eInformatica, University of Catania, 95125, Catania, Italy andwith CNR-IASI, Italian National Research Council - Institute for Systems Analysis and Computer Science "A. Ruberti", Rome,Italy. (email: luigi.fortuna@unict.it ,arturo.buscarino@unict.it)

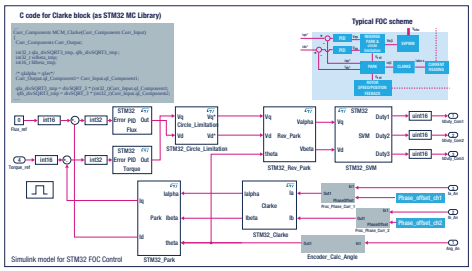
G.Rascona' is with the STMicroelectronics, Catania site, 95121 ITALY (phone: +39 0947404283; e-mail: gaetano.rascona@st.com).

MBD FITS STM32 ECOSYSTEM FOR FOC CONTROL OF PMSM MOTORS

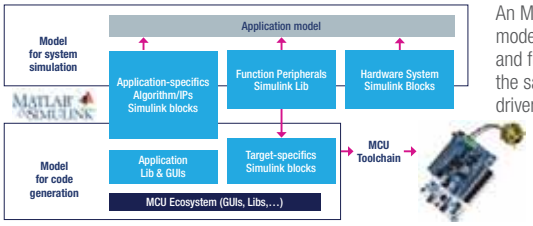


STM32 MC motor control firmware (X-CUBE-MCSDK) also includes the Permanent-magnet synchronous motor (PMSM) firmware library (FOC control) widely used in high-performance drives.
The Simulink® library provided by ST is based on C legacy code firmware to optimize runtime execution and memory footprint.

The STM32 Motor Control Workbench PC software tool reduces the design time and effort needed for STM32 PMSM FOC firmware configuration. The project file is generated through the GUI and then used to configure the whole Motor Drive system model.

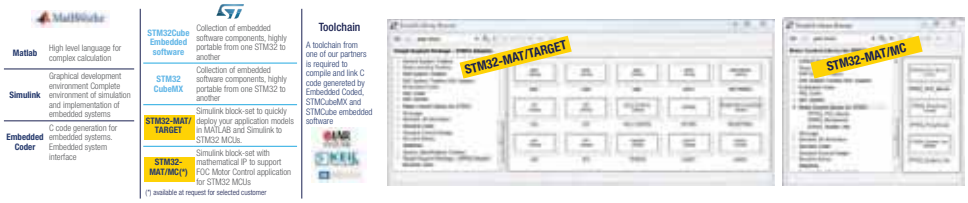


PARTITIONING PRINCIPLE FOR EMBEDDED SYSTEM MODELING

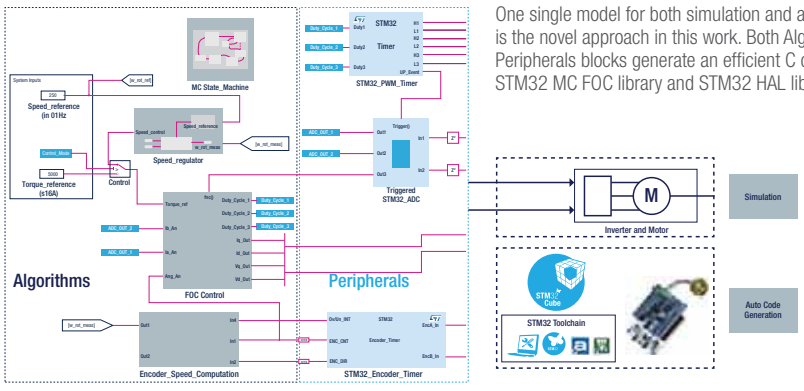


An MBD system can be conceptually divided into two main models: one is for simulation, based on algorithm/math blocks and functional emulation peripherals; the second is based on the same algorithm blocks plus the target-oriented peripheral driver blocks to generate auto-code.

MBD TOOLS FOR STM32 MCUS AND FOC MOTOR CONTROL



ONE MODEL FOR SIMULATION AND AUTO-CODE GENERATION



One single model for both simulation and autocode generation is the novel approach in this work. Both Algorithms and Peripherals blocks generate an efficient C code based on STM32 MC FOC library and STM32 HAL libraries, respectively.

CONCLUSION