Simulink to STM32

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Model-Based Design

- RESEARCH
- REQUIREMENTS
- DESIGN
  - Environment Models
  - Physical Components
  - Algorithms
- IMPLEMENTATION
  - C, C++
  - VHDL, Verilog
  - Structured Text
  - MCU, DSP, FPGA, ASIC, PLC
- INTEGRATION
- TEST AND VERIFICATION
  - Design as Executable Specification
  - Requirements Traceability
  - Continuous and early Verification
  - Document and Report Generation

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Coder Technology

Unified Code Generation

C Code
C++ Code
HDL Code
PLC Code
Hardware Support Packages are...

- Downloadable add-ons that provide hardware support
- Often updated independent of the product release cycle
- Used by Simulink and Embedded Coder to deliver targets
What does a TARGET do?

1. Optimizes generated code
2. Automates the build process
   - Generated Makefile
   - Compile > Link > Download > Execute
3. Verifies algorithms on hardware with real-time, real-world data
4. Deploys full systems as standalone applications
   - RTOS, Multi-core threads, Device drivers

/* S-Function (sdsp sine2): '<Root>/Sine Wave' */
updateVal = rtb_SineWave[j] =
ex_fircmsis_tut_mab2013_P.SineWave_Amplitude *
arm_sin_f32(ex_fircmsis_tut_mab2013_DW.SineWave_AccFreqNorm);
Simulink Targets
- for Educational Purposes

<table>
<thead>
<tr>
<th>Target</th>
<th>User Downloads (R2012a – R2014a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arduino</td>
<td>11,281</td>
</tr>
<tr>
<td>LEGO MINDSTORM NXT</td>
<td>3,727</td>
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<tr>
<td>Raspberry Pi</td>
<td>2,909</td>
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<tr>
<td>BeagleBoard</td>
<td>753</td>
</tr>
<tr>
<td>LEGO MINDSTORM EV3</td>
<td>202</td>
</tr>
<tr>
<td>Samsung Galaxy (Android)</td>
<td>164</td>
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<tr>
<td>PandaBoard</td>
<td>135</td>
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<tr>
<td>Gumstix Overo</td>
<td>63</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>19,234</strong></td>
</tr>
</tbody>
</table>

Simulink Targets do not require Coder products

As of June 2014
## Embedded Coder Targets

- for Prototyping and Deployment

As of June 2014

<table>
<thead>
<tr>
<th>Device</th>
<th>User Downloads (R2013a – R2014a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texas Instruments C2000</td>
<td>645</td>
</tr>
<tr>
<td>ARM Cortex-M</td>
<td>548</td>
</tr>
<tr>
<td>Xilinx Zynq-7000</td>
<td>350</td>
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<tr>
<td>ST Microelectronics F4 Discovery</td>
<td>243</td>
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<tr>
<td>ARM Cortex-A</td>
<td>141</td>
</tr>
<tr>
<td>Texas Instruments C6000</td>
<td>83</td>
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<tr>
<td>Analog Devices DSP</td>
<td>81</td>
</tr>
<tr>
<td>Green Hills MULTI</td>
<td>52</td>
</tr>
<tr>
<td>Wind River VxWorks</td>
<td>34</td>
</tr>
<tr>
<td>Total</td>
<td>2,177</td>
</tr>
</tbody>
</table>

Documented APIs available for building custom targets
STM32 Support Package

STM32-MAT/TARGET STM32 embedded target for MATLAB and Simulink (RN0087)

The STM32 Embedded Target enables you to quickly deploy your application models in MATLAB and Simulink to STM32 MCUs.

In a first step, it gives possibility to run Simulink application models on STM32 F4 target using Processor In The Loop (PIL) configuration and USART communication link.

The process from "C" code generation to programming STM32 F4 is fully automated. Code is built using one of three possible toolchains from Atollic, IAR or Keil.

Code generation report is automatically generated.

Code execution profiling report is automatically generated for PIL execution.

In a second step, STM32 Embedded Target provides a Simulink blockset library containing several STM32 F4 peripherals to set parameters and generate peripherals initialization "C" code.

Finally, generated code can be integrated to existing application or built and downloaded to target.

These capabilities and functionalities are easy to use and are available as soon as STM32F4xx product folder and subfolders are added to the MATLAB path.

All source files are provided.

www.st.com/stm32-mat-target
DEMO
Benefit of using the STM32 Support Package

- quickly deploy your application models in MATLAB and Simulink to STM32 MCUs

- Automate
  - the process from "C" code generation to programming STM32 F4 or STM32F30x
  - Code generation reporting
  - Code execution profiling reporting for PIL execution
Summary for STM32 embedded target for MATLAB and Simulink release 3.1:

- Supported MCUs: STM32 F4 and F30x series
- Automated Processor-in-the-Loop (PIL) Testing using USART communication link
- Support for
  - IAR EWARM
  - Atollic TrueSTUDIO
  - Keil MDK-ARM
- Peripheral driver blockset including ADCs, GPIOs, USARTs, and Timers
DEMO

Field-Oriented Control of Permanent Magnet Synchronous Machine System Test Bench
Processor-in-the-Loop (PIL)
Verify compiled object code matches simulation

Non-real-time execution: synchronized with simulation

- Verify numerical equivalence
- Assess execution time
- Collect code coverage
- Create certification artifacts

Software-In-the-Loop (SIL) can be leveraged as well
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