Rapid Firmware Prototyping with Matlab/Simulink for MicroTCA.4

Introducing the Rapid-X toolset for fast prototyping for the MTCA.4 platform

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Outline

➤ Motivation

➤ Overview

➤ Example

➤ Current applications

➤ Conclusions
Motivation

➤ MTCA.4 – („MORE BANDWIDTH!!!” – Vollrath Dirksen)

➤ Allows faster and more robust application algorithms

but...

➤ Requires new firmware components
  ▪ Board Support Packages
  ▪ Interface support (e.g. PCIe)
  ▪ Modules for application algorithms

➤ Requires HDL knowledge for prototyping

➤ Problem: Significant workload for FPGA Developers
Idea

- Matlab/Simulink used by application engineers for modelling and simulation
- Generate the application code directly from this model

- Xilinx SysGen allows netlist generation

Main Advantages:
- Shift workload from FPGA developers to application engineers
- Very fast from idea to prototype
- Simulation will show real behavior (finite word length, delays, etc…)
Disadvantages

- No interfaces to BSP
- No distinction of signal types (ADC input, parameter, etc.)
- No possibility to easily re-use previously designed HDL modules
Solution – Rapid-X toolset with custom library components

Example Application: SISO-Controller
Block Representation of Hardware Components
**Project flow**

1. Generate netlists based on the model (Xilinx SysGen)
2. Populate interfaces between BSP and application (Rapid-X)
3. Generate mapfile (Rapid-X)

1. Synthesis, translation, mapping, PAR, bitfile generation (Xilinx ISE)
Application Engineers Point of View

Developer PC

Bitfile

Mapfile

SSH

MTCA4 Create

PCIe

MTCA4U Library

Developer Tools

Control System
Example: Data Acquisition and Analysis

Requirements:

- Sample raw ADC data with 81MHz to DDR-RAM
- Store the highest value in one channel of the RAM
- Store the smallest value in another channel of the RAM
- Start acquisition on command from the CPU
Example: Data Acquisition and Analysis
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1. Build the XISE Project

2. Generate the bitfile

3. Upload the bitfile to the FPGA and the mapfile to the crate CPU (automatic upload not supported currently)
Example: Data Aquisition and Analysis

%% Data Aquisition Test
%

m = mtca4u(); % initialize MicroTCA4 Matlab Tools
SISL8300_init(m, 'SISL'); % initialize SISL board
m.write('SISL', 'WORD_RESET_N', 1); % activate board

%%

m.write('SISL','WORD_START', 1, 'WORD_START', '0'); % Trigger the sampling
pause(1);

plot(m.read_dma('SISL',1,256)); % Plot the raw data
Current Application @ DESY

- Link Stabilizing Unit in Laboratory Setup

- Controller for the Master Laser Oscillator in development

- Beam charge stabilization with Pockels Cell
Conclusion

- Rapid prototyping **with virtually no** knowledge of VHDL

- **Workload shift**: VHDL developer → application engineer

- **Real behavior modelled** using tools known to application engineers

- Easily extendable with **new modules** optimized by VHDL developers

- **Separation** between hardware (board) and application

- Rapid-X models **migratable** to different boards

- **No external tools** - everything is coded in Matlab and tcl scripts
Thank you for your attention

Comments?
Questions?