Firmware Upgrade Framework for MTCA.4

Piotr Perek, Dariusz Makowski 1)
Łukasz Butkowski 2)

1) Department of Microelectronics and Computer Science
   Lodz University of Technology, Poland

2) Deutsches Elektronen-Synchrotron, Hamburg, Germany

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Firmware Upgrade for MTCA.4

Piotr Perek

Agenda

1. Introduction
2. Requirements
3. Firmware Upgrade Framework
4. Summary
Programmable devices in MTCA.4

- Module Management Controllers (MMCs)

- Payload devices
  - Field Programmable Gate Arrays (FPGAs)
  - Digital Signal Processors (DSPs)
  - Microcontrollers (MCUs)
Programmable devices in MTCA.4

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- Payload devices
  - Field Programmable Gate Arrays (FPGAs)
  - Digital Signal Processors (DSPs)
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<table>
<thead>
<tr>
<th>Device Type</th>
<th>Memory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microcontrollers</td>
<td>tens of kB – a few MB</td>
</tr>
<tr>
<td>FPGAs</td>
<td>tens of MB</td>
</tr>
<tr>
<td>DSPs</td>
<td>a few kB — a few MB</td>
</tr>
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</table>
Programmable devices in LLRF system
Programmable devices in LLRF system

Number of MTCA.4 crates for LLRF at XFEL – 58
Number of FPGAs for LLRF at XFEL – ~550
Programmable devices in LLRF system

Programmable devices on DAMC-TCK7 — DRTM-VM2 boards

- MMC
- FPGA
- JTAG
- I2C bus
- Init
- Status
- Bus (SPI, parallel)
- P1
- P2
- CS
- PCIe
- DAMC-TCK7
- DRTM-VM2
Firmware Upgrade Methods for FPGA

- Dedicated programmers with JTAG interface
- Direct bitstream upload
- Indirect programming
- HPM.1 firmware upgrade
- JTAG switch module (NAT)
Requirements

- Universal framework for remote memory programming
- Support for both SPI and Platform FLASH memories
- Support for all modules used in LLRF system:
  - DAMC-TCK7
  - VM
  - SIS8300L
- Programming interface - PCIe
Framework Components

- **Firmware**
  - Memory programming core
    - provides PCIe interface to access and program an on-board memory

- **Software**
  - Firmware Upgrade Agent
    - implements algorithms ensuring an execution of the firmware upgrade procedure for SPI and Platform FLASH memories
  - Firmware Upgrade Scripts
    - supporting scripts for board-specific operations e.g. memory/revision selection, FPGA reloading etc.
FPGA resources utilization (Spartan6 xc6slx45t):
- Slice Registers – 390/54576 (0.7%)
- Slice LUTs – 401/27288 (1.5%)
Firmware Upgrade Procedure

SPI FLASH
- Create .bit file
- Convert to .mcs
- Convert to .xsvf
- Select mem. bank
- Erase mem.
- Program mem.
- Verify mem.
- Firmware Upgrade Agent
- PCIe power down
- Reload FPGA
- PCIe power up

PLATFORM FLASH
- Create .bit file
- Select revision
- PCIe power down
- Reload FPGA
- PCIe power up

Supporting script

Department of Microelectronics and Computer Science
Tests

Framework has been tested with the following modules:

- DAMC-TCK7 (CM045)
- uTC
- SIS8300L
- FMC20
- DRTM-VM2
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Time required for memory reprogramming:

<table>
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<tr>
<th>Module</th>
<th>FUF</th>
<th>Xilinx programmer</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAMC-TCK7 (SPI)</td>
<td>70 s</td>
<td>1800 s</td>
</tr>
<tr>
<td>SIS8300L (SPI)</td>
<td>60 s</td>
<td>450 s</td>
</tr>
<tr>
<td>DRTM-VM2 (JTAG)</td>
<td>230 s</td>
<td>100 s</td>
</tr>
</tbody>
</table>
Summary

- Firmware Upgrade Framework – allows reprogramming of all LLRF system modules in an unified way
- Allows remote, parallel programming of SPI and Platform FLASH memories
- Working on various FPGA devices – Spartan 6 (FMC20), Virtex 6 (SIS8300L), Kintex 7 (DAMC-TCK7)
- Can be easily adapted to other FPGAs and MTCA.4 modules
- Programming time for SPI memories much faster than with standard JTAG programmer