Getting Started with Machinekit on SoC+FPGA

How to create and customize a working system

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Agenda

- Quick Start Guide

- What are all the pieces

- Customizing the software

- Customizing the hardware

- Questions

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Quick Start Guide
Using a development board and uSD image

- Start with a development board

  - Terasic DE0-Nano-SoC (Cyclone-V)

  - MYIR Z-turn (Zynq)

  - Zedboard MicroZed (Zynq)

- Download and burn an OS image to uSD

  - http://deb.mah.priv.at/uploads/de0-nano/

  - http://deb.mah.priv.at/uploads/zynq/

- Enjoy!

- More details online (see references)

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Component Pieces

- Boot Loader (U-Boot)

- Kernel (Linux)

- OS (Debian Jessie)

- Application (Machinekit)

- FPGA Hardware

- Interface Hardware

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Software Customization

- U-Boot:

  - Vendor provided snapshots available
  - Mainline supports Altera and Xilinx parts

- Linux:

  - Mainline supports Altera and Xilinx parts
  - Vendor provided branches available

- OS (Debian):

  - apt get install
  - Tweak image generation scripts (based on debootstrap and RCN's scripts)

- Application (Machinekit)

  - Install from source or packages
  - Edit code (source) or send a PR (packages)

Hardware Customization (FPGA)
The Basics

- Naming conventions
  - Project and config directories named after the platform
    - Platform is base design (ie: DE0-Nano-SoC) plus any I/O board (ie: DB25)
  - Pin files named after targeted hardware (ie: 7i76, 7i85, etc)

- The hostmot2 VHDL is very flexible and can be configured at compile time to support nearly endless combinations of features

- Features are defined by generics passed to the hostmot2 instance

- Card ID and physical details are defined in a VHDL package (card file)

- Logic features and I/O specifics are contained in a separate VHDL package (PIN file)

- The appropriate card and PIN packages are referenced via "use work.<package>.all"

- The HostMot2 component is instantiated and passed details from the selected libraries as generics

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Hardware Customization (FPGA)
Making Changes

- Pin and card package files are in mksocfpga/HW/hm2/<project>

- Create a new "PIN" package file describing the logic and I/O

  - ModuleID controls what logic gets instantiated

    - Add and remove module types

    - Change the number of instances

  - PinDesc controls how signals are connected to I/O pins

    - Available functions depend on the modules defined by ModuleID

- Use the existing PIN files as examples

- **LOTS** more examples available from Mesanet.com (*.zip files for the various FPGA cards)

- No automated tools exist for generating PIN files

- User is responsible for correctness and consistency

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Hardware Customization (Interface Hardware)

- Example Interface Board: DE0-Nano-DB25:
  https://github.com/cdsteinkuehler/bobc_hardware/tree/CRAMPS/DE0-Nano_DB25

- Details will depend on the end use application

- Standard schematic/PCB design/layout task

Hardware Customization (New Platform)

- Design the board or obtain details for the new platform (dev-kit)

- Create a new "card" package file describing the hardware
    - Clock Frequencies!
    - Board Name

- Create a new "PIN" package file describing the logic and I/O

- Create a new Quartus/Vivado project using your new packages

- Update the HPS/PS (ARM system) if needed using the FPGA tools

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Build configurations used for uSD images

- These are provided for reference, it is recommended you build using a current mainline source tree or a recent vendor branch, however referring to the existing build scripts will likely make it much easier to get started.

- U-Boot:
  https://jenkins.machinekit.io/job/u-boot-socfpga/
  https://jenkins.machinekit.io/job/u-boot-xilinx/

- Linux:
  https://jenkins.machinekit.io/job/socfpga-kernel-4.1-ltsi-rt/
  https://jenkins.machinekit.io/job/xilinx-kernel-4.4-rt/

- Debian rootfs (contains RIP Machinekit build):
  https://jenkins.machinekit.io/job/oib-cyclonev/
  https://jenkins.machinekit.io/job/oib-zynq/

- FPGA bit files:
  https://jenkins.machinekit.io/job/mksocfpga-quartus/
  https://jenkins.machinekit.io/job/mksocfpga-vivado/

- FPGA packages:
  https://jenkins.machinekit.io/job/mksocfpga-packaging-quartus/
  https://jenkins.machinekit.io/job/mksocfpga-packaging-vivado/

- uSD Image:
  https://jenkins.machinekit.io/job/oib-cyclonev-sd-build/
  https://jenkins.machinekit.io/job/oib-zynq-sd-build/

References

- M. Haberler DE0-Nano-SoC instructions
  https://gist.github.com/mhaberler/89a813dc70688e35d8848e8e467a1337

- Mesa Electronics:
  http://www.mesanet.com/

- Machinekit build infrastructure:
  http://www.machinekit.io/docs/infra/repositories/

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