RUHR-UNIVERSITÄT BOCHUM

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A Hardware/Software Co-Design Approach for Control Applications with Static Real-Time Reallocation

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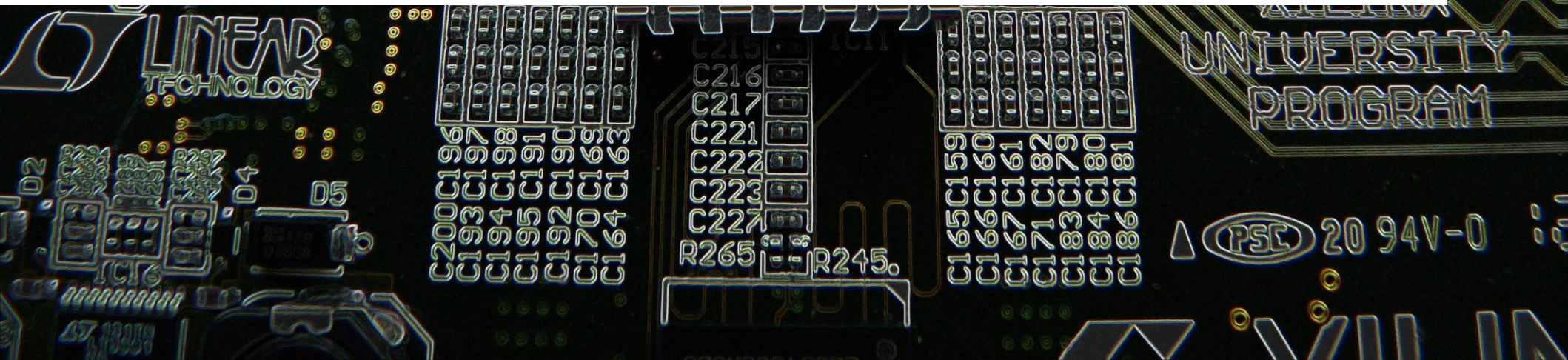
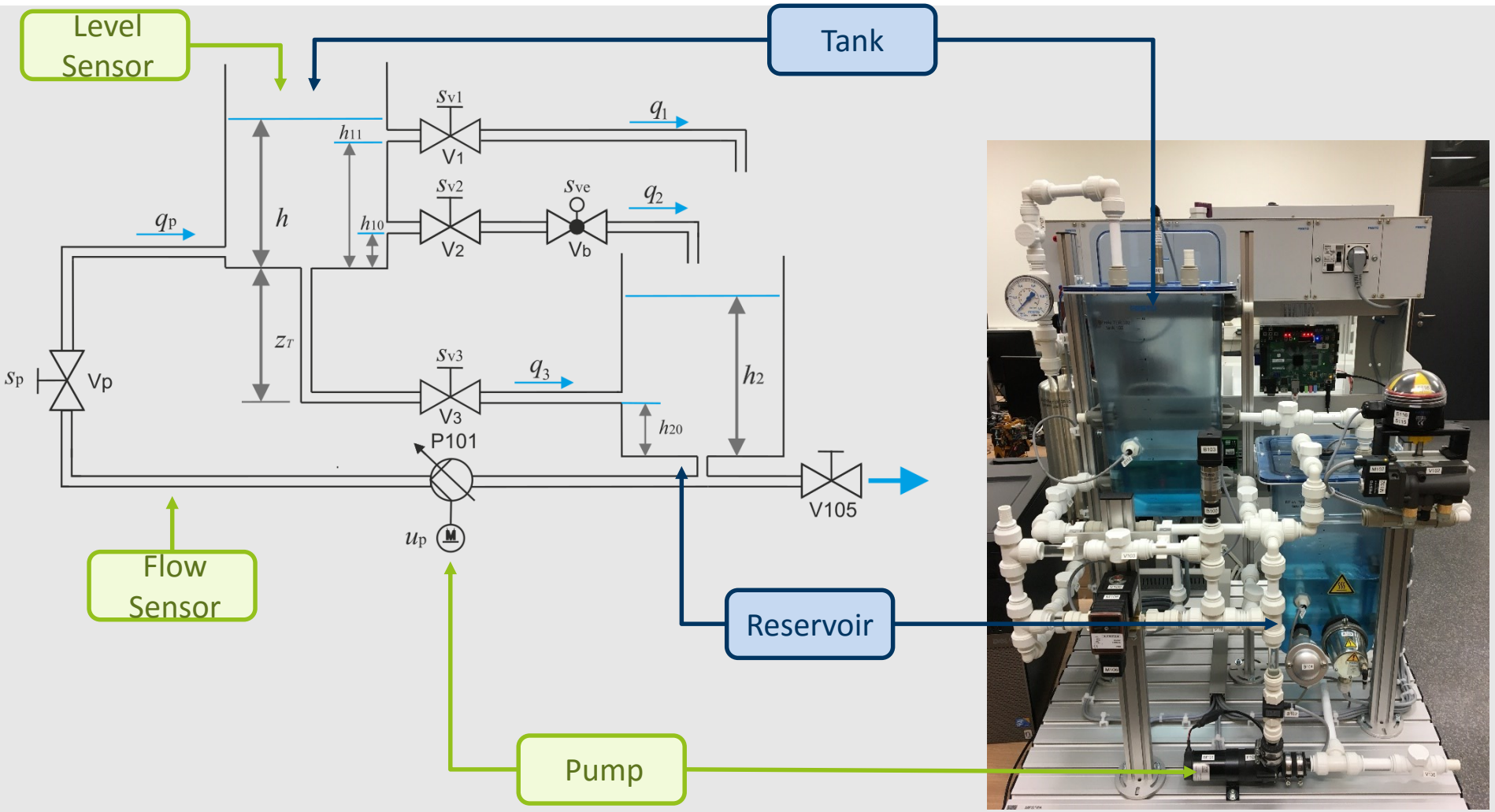


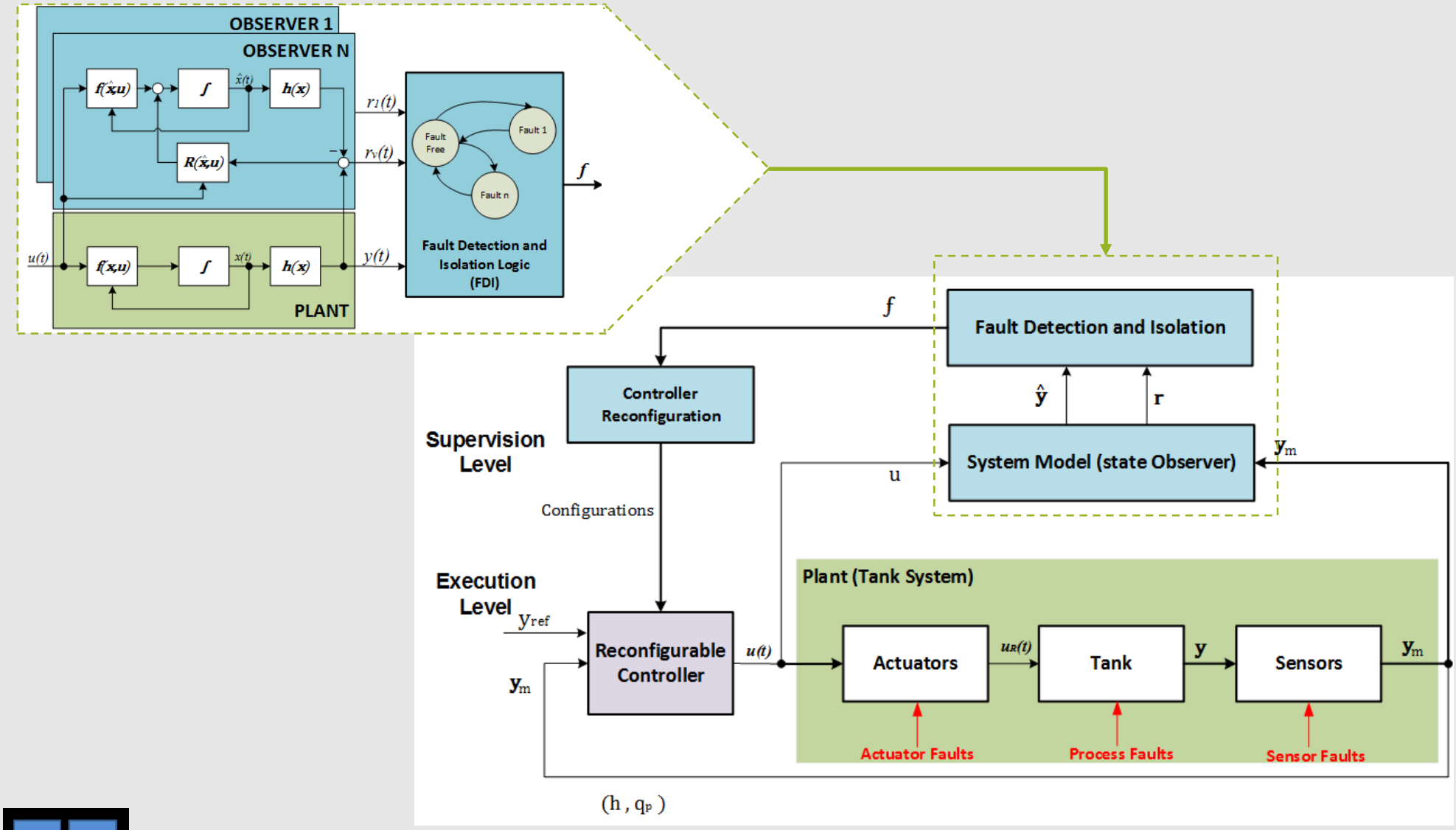
Motivation

- Control Sytem Design
  - Usually done in Mathworks Matlab
  - Critical component that should be fault tolerant
- Hardware/Software Co-Design for Fault-Tolerant Controller
  - High-Level Synthesis based development flow approach
  - Seamless control algorithm reallocation between hardware and software domain
    - Load balacing during run-time
    - Handling of faulty components

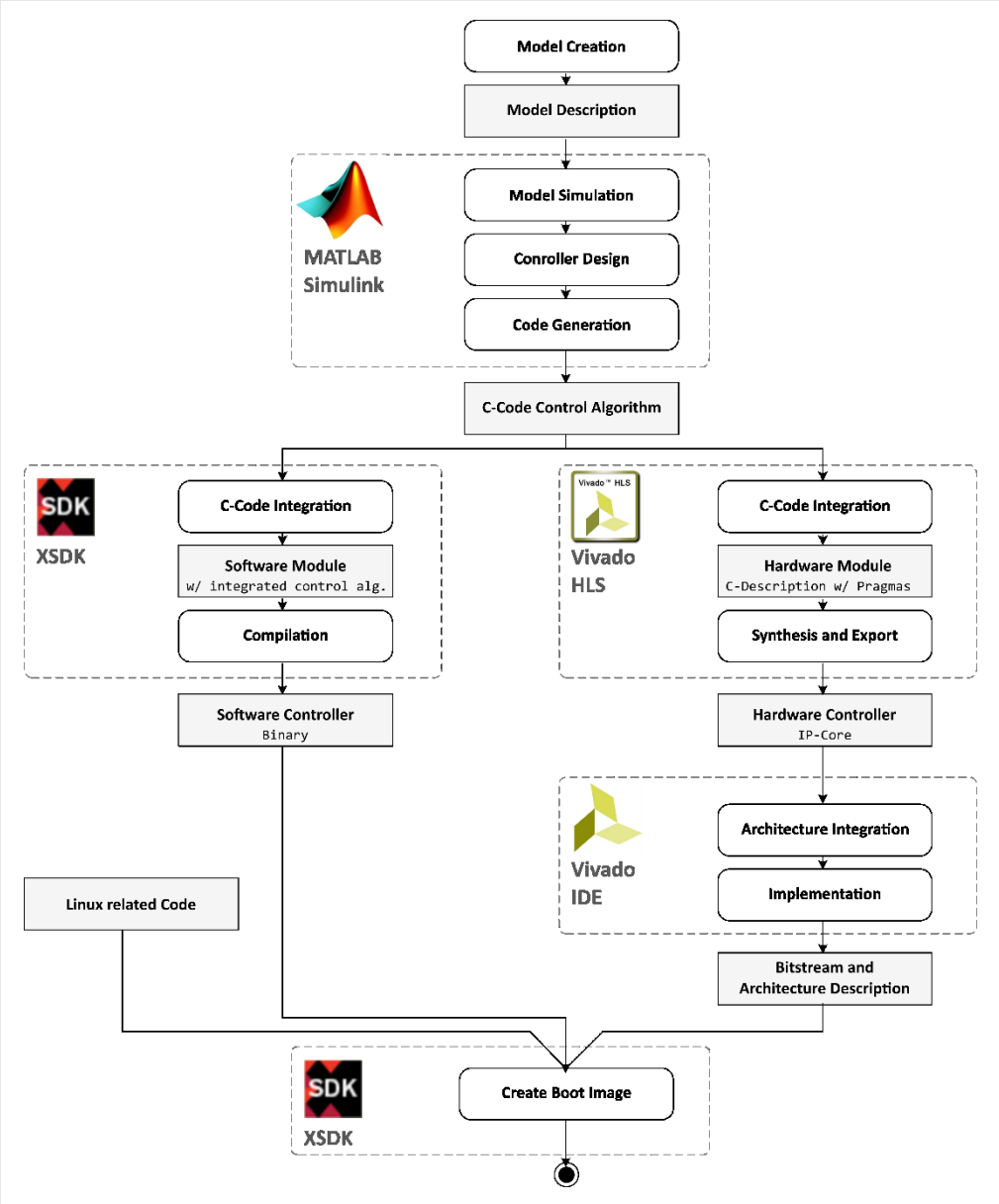
Controlled System



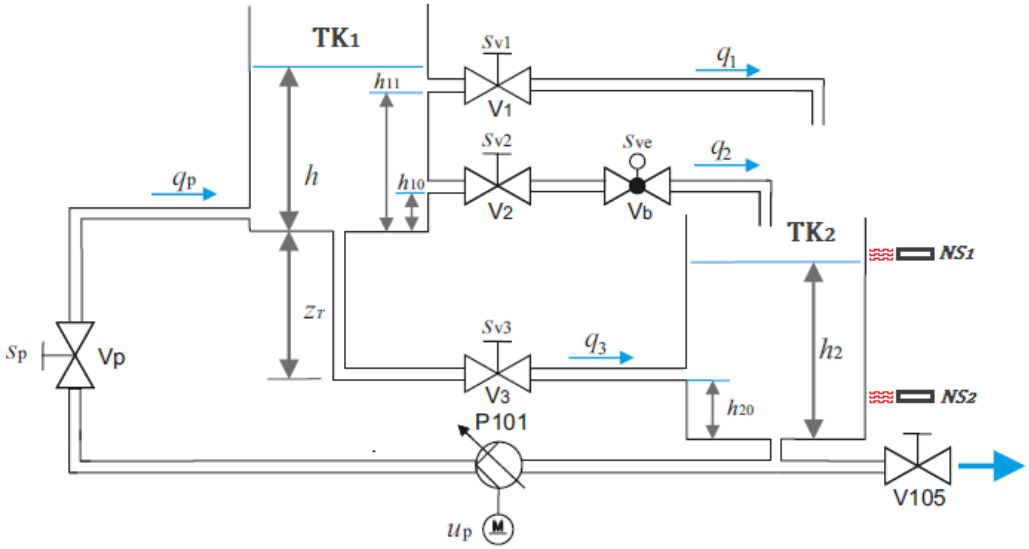
Controller and Supervisor

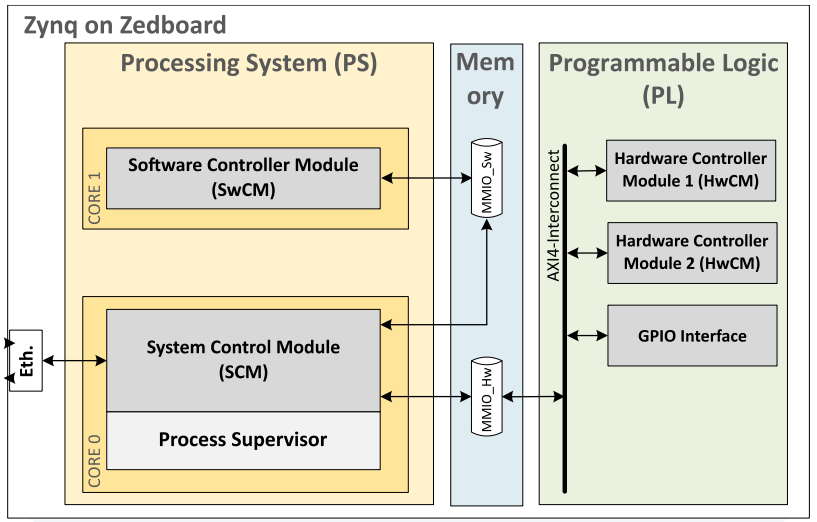


Design Flow


Model Creation
Model Description
MATLAB
Simulink
Model Simulation
Conroller Design
Code Generation
C-Code Control Algorithm
SDK
XSDK
C-Code Integration
Software Module
w/ integrated control alg.
Compilation
Software Controller
Binary
Vivado HLS
C-Code Integration
Hardware Module
C-Description w/ Pragmas
Synthesis and Export
Hardware Controller
IP-Core
Vivado
IDE
Architecture Integration
Implementation
Bitstream and
Architecture Description
Linux related Code
SDK
XSDK
Create Boot Image

System Architecture



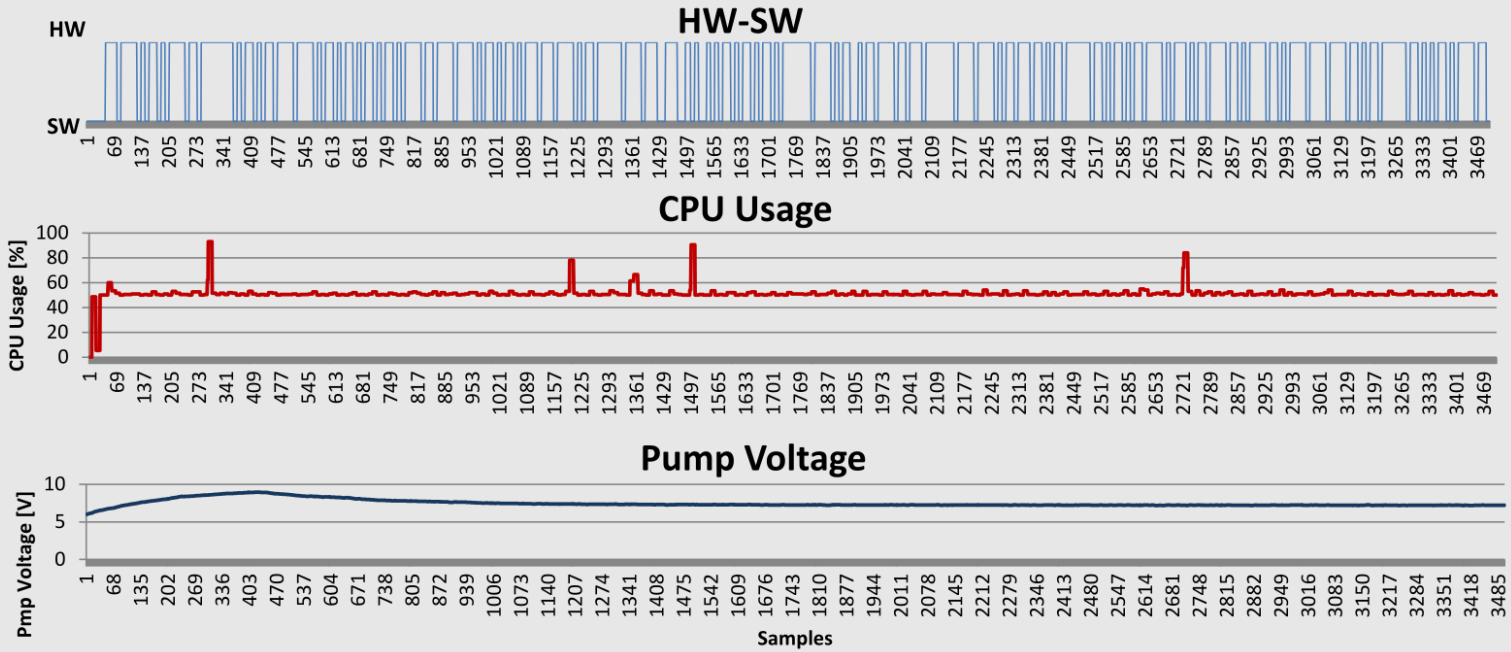


Source:
Festo Didactic

MPS PA Workstation

Bridge

Avnet Zedboard

Evaluation

- Cycle time 100ms
  - Dynamic reallocation during run-time
- Resource usage
  - PS: ~3% (workload), Slices: 5% , BRAM: 0% , DSP48E1: 2%