



Optimized Configuration Management for SEU mitigation in Xilinx Virtex-4 FPGA and Self-Scrubbing

Motivation for self hosting scrubber

- Cost
 - Shift part or all function back to FPGA allows smaller or elimination of external scrubber part
- Design complexity
 - Less parts involved
 - Less PCB board routes
- Risk Mitigation
 - Update to the latest scrubbing algorithm

Proven Track

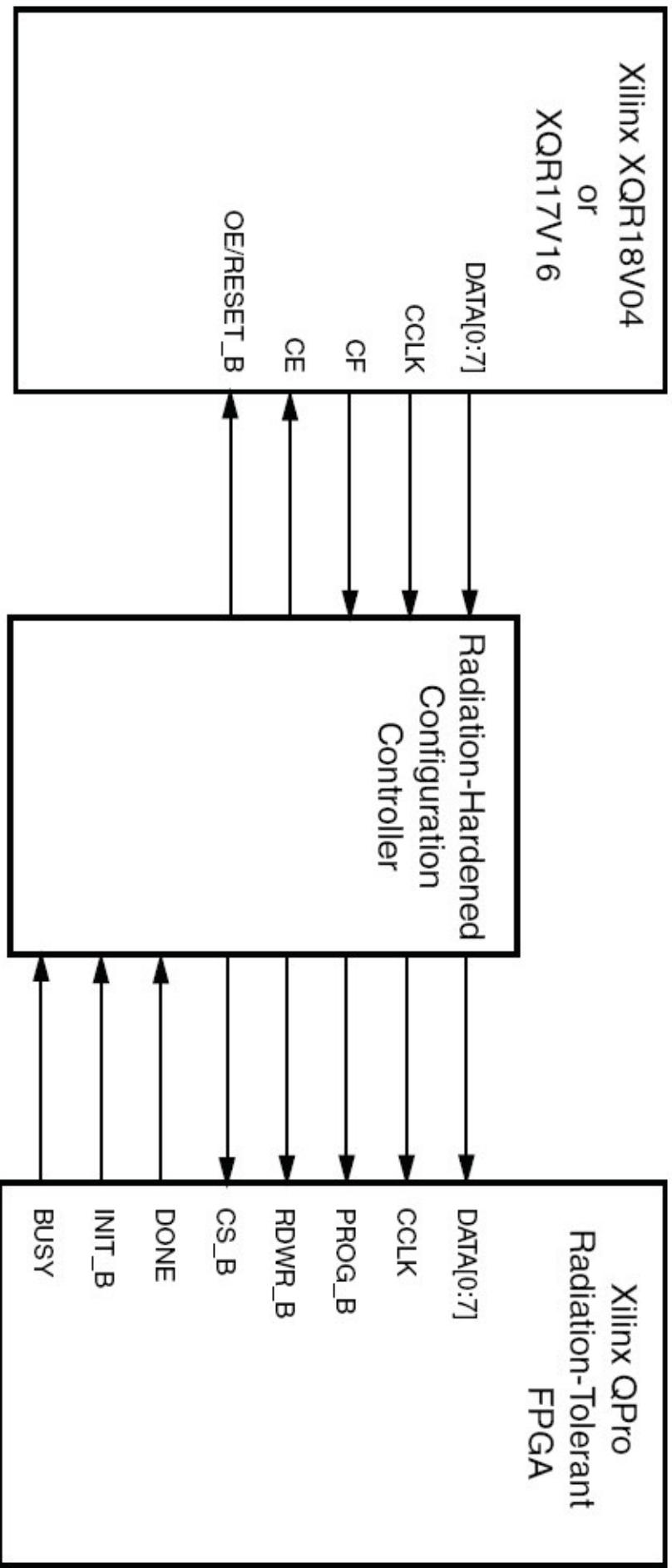
- Self Scrubber tests
 - V2/2P tested with heavy ions
- Optimized scrubber tests
 - V4 version tested with heavy ions
 - All SEFI checks performed
 - FAR, SMAP, DONE, Global Signals
 - Readback and scrub only when necessary
 - SRL16/LUTRAM implementation allowed
 - BRAM data integrity area scrubbed
 - Full blown visibility version ~1200 V2P slices
 - Optimized version ~400 V2P slices
 - Targeted reduction to less than 200 slices
 - V4SX55 has ~25,000 slices

Self Scrubber Setup

- Hardware Setup
 - PCB layout
 - Components selection
 - Once laid out, no need to re-spin board
- Soft Setup
 - IP Core
 - Can be updated until the last minute

Hardware setup

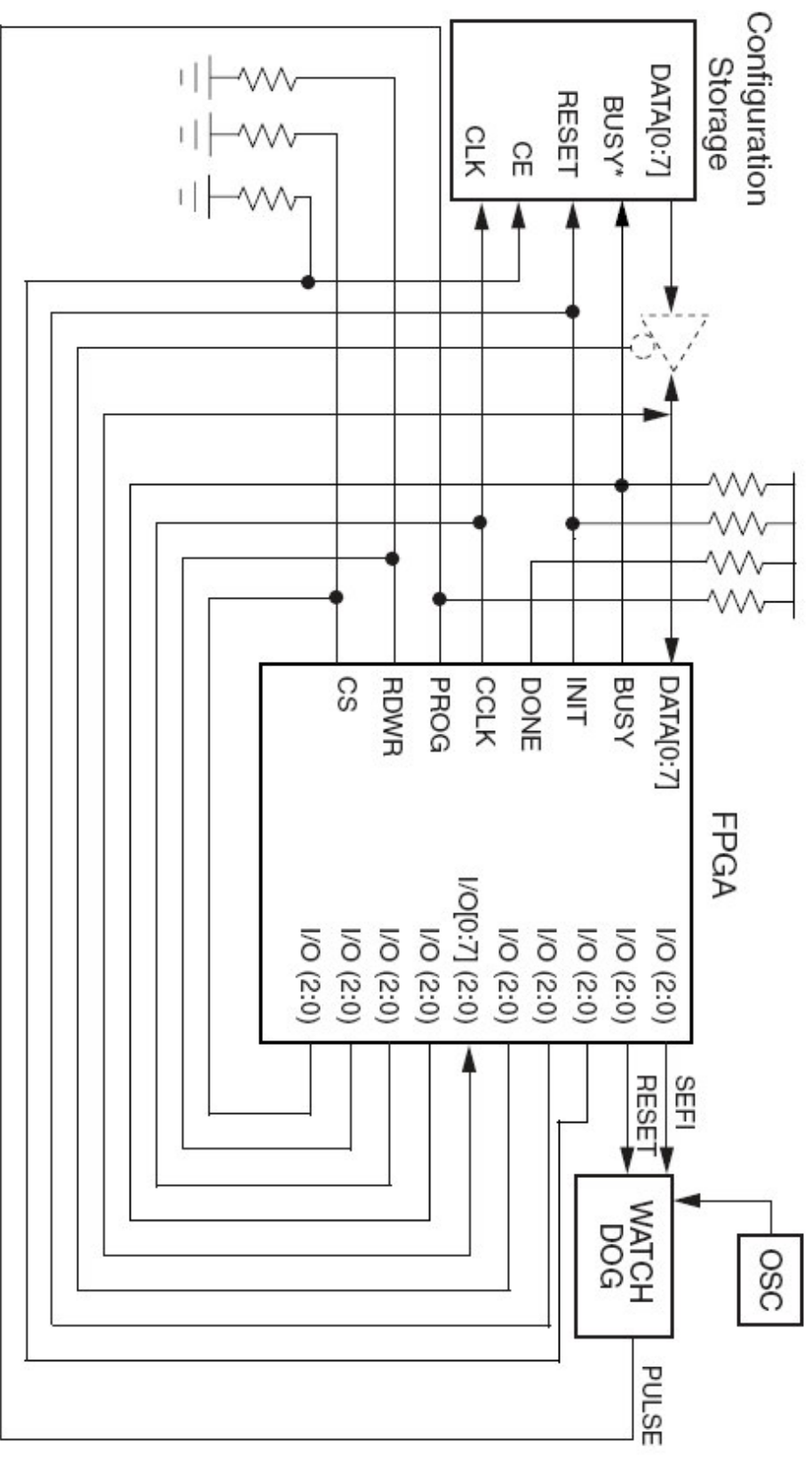
- Block Diagrams



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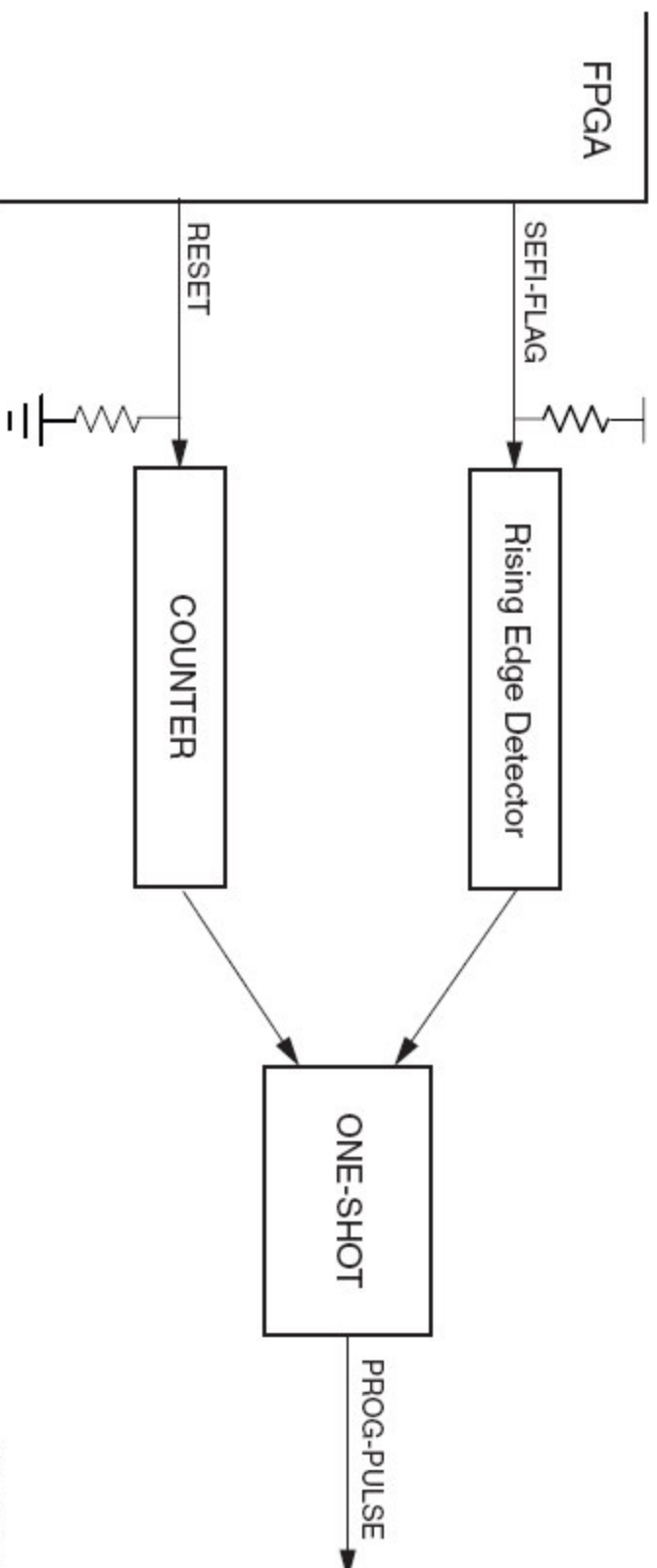
Figure 1: Overview of External Device Hosting Configuration Management for a Single Xilinx FPGA





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Figure 2: Overview of single FPGA, in Master SelectMAP Mode, Self-Hosting a Triplicated Configuration Management

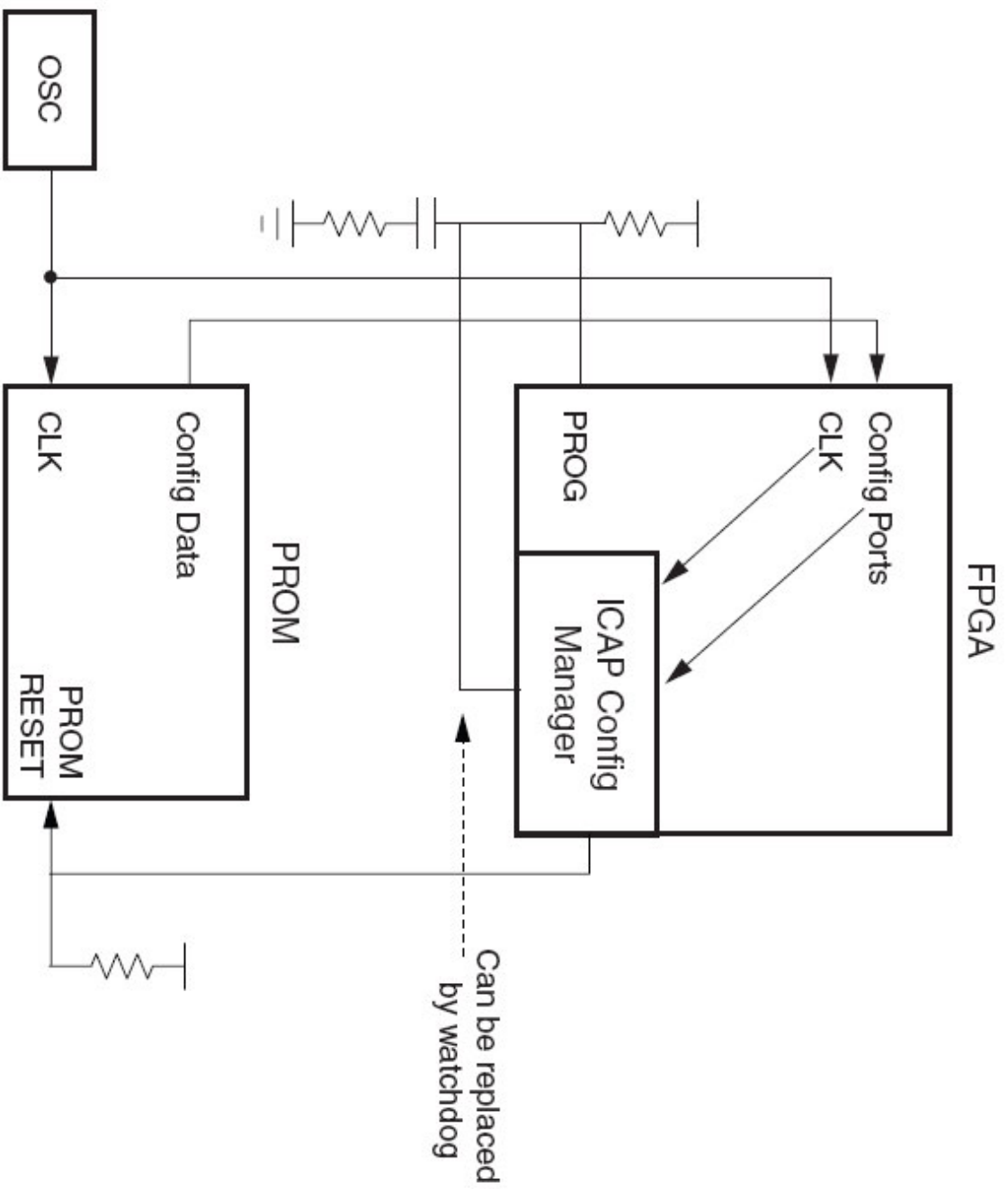


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Notes:

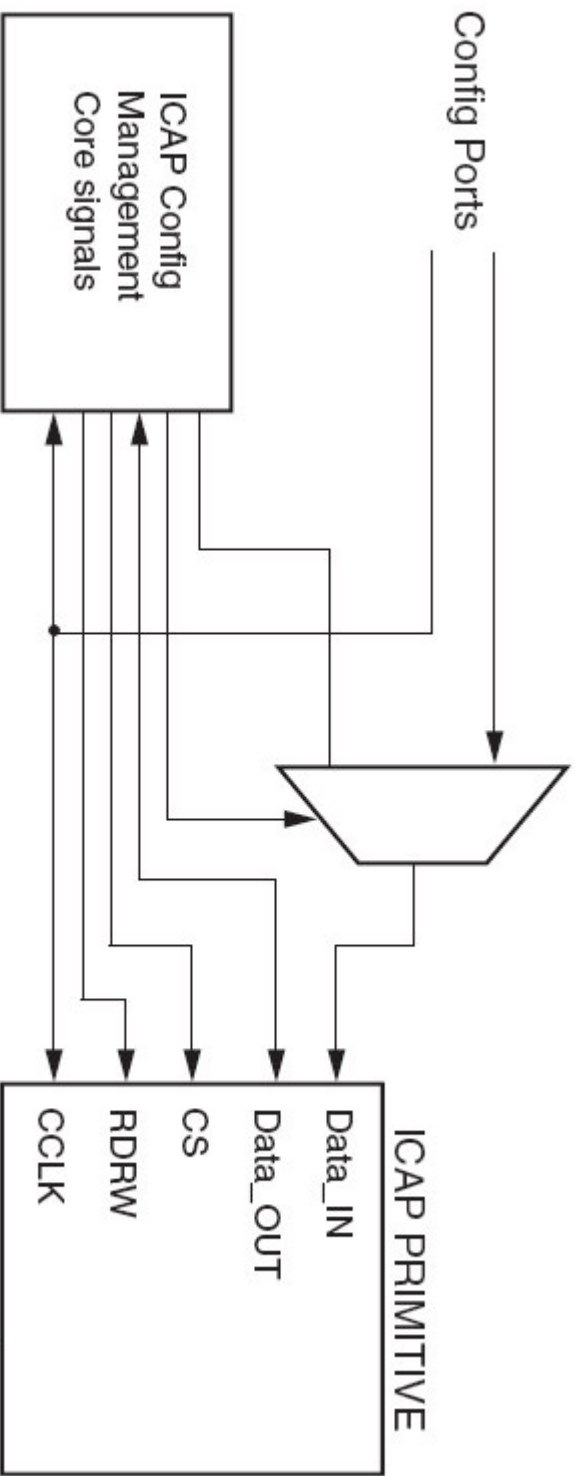
1. The one-shot pulses the FPGA PROG pin when SEFI-FLAG is raised and COUNTER is not reset in time.

Figure 3: Detailed Overview of Watchdog Circuit



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Figure 4: Single Device Self Configuration with no External Circuitry



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Figure 5: Interface of the ICAP Configuration Management Core

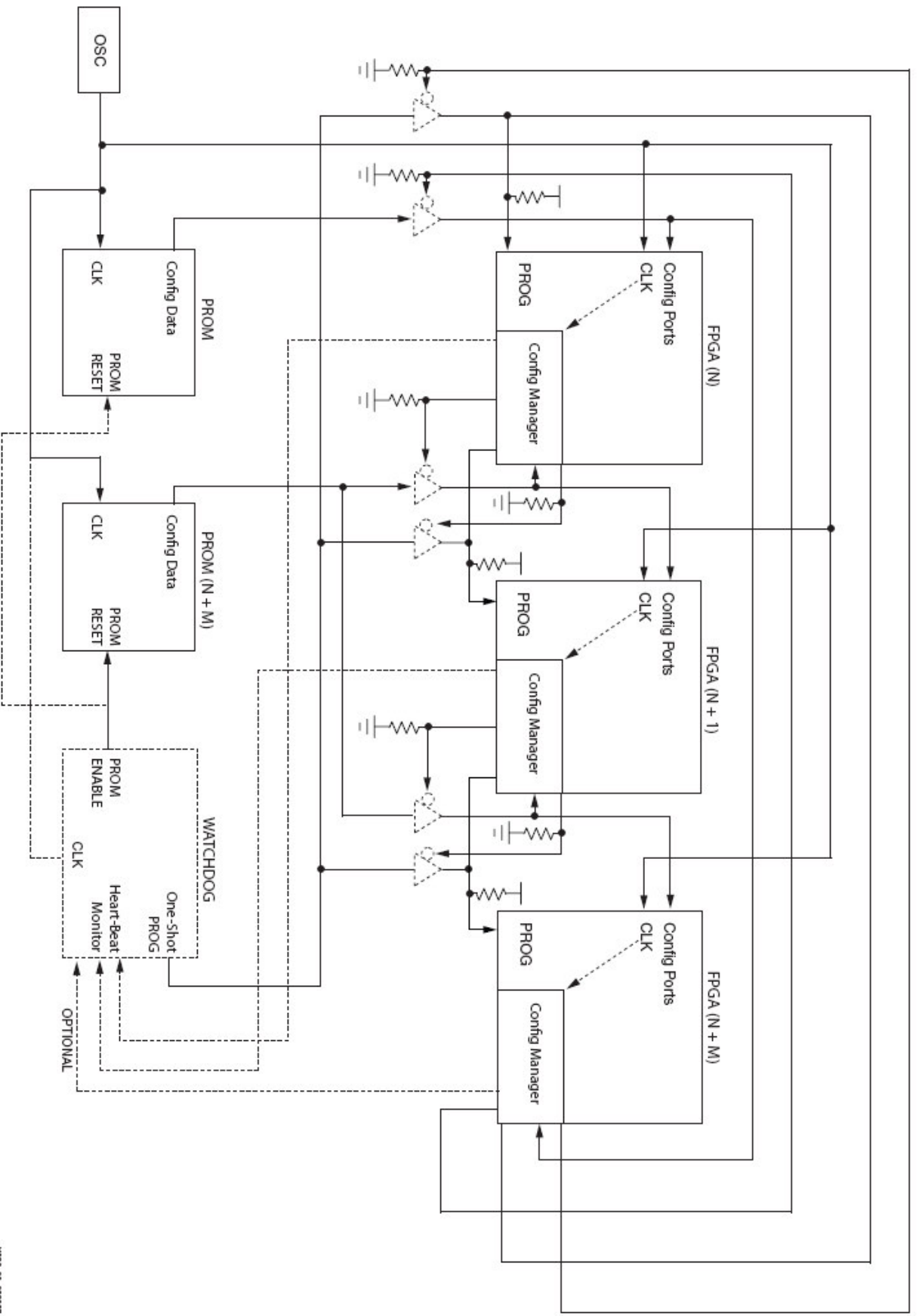
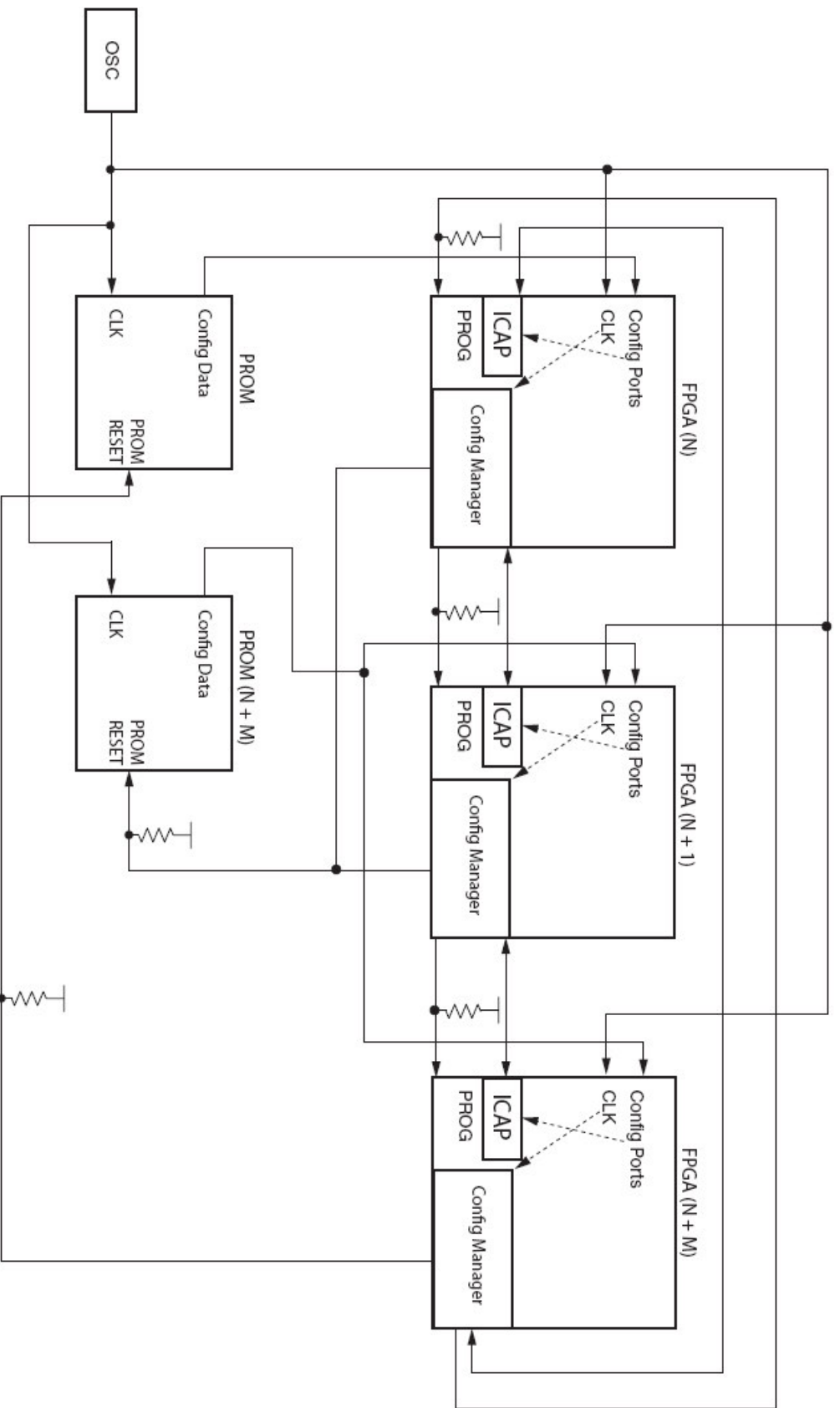
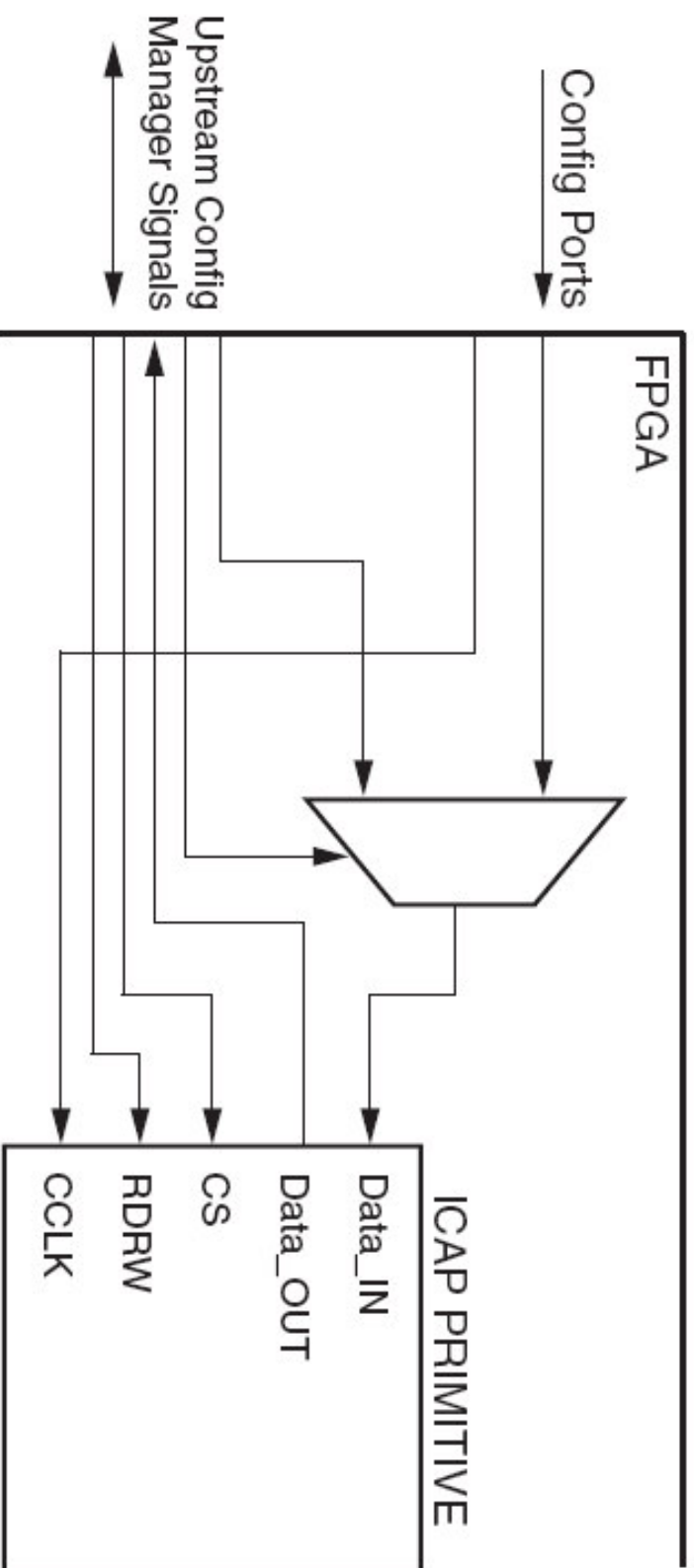


Figure 6: Overview of Multiple FPGAs, in Slave SelectMAP Mode, Self-Hosting Configuration Managements





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Figure 8: Interface of the ICAP Configuration Management Core

Soft Setup

- IP design consideration

Self Hosting Scrubber consideration

- Heart Beat
 - Declare self scrub failure or upset to the core itself
- All FD must be refreshed
 - FD value doesn't get scrubbed. The set/reset does.
- Primitives to avoid
 - DCM, LUTRAM, SRL16, BRAM
- Eliminate single point of failure
 - Usage of ICAP / FRAME_ECC
- SEFI detection and recovery
 - Optimize SEFI detection
 - What checks are really needed?
 - Combine SMAP SEFI check into FAR SEFI check

Self Hosting Scrubber consideration

- Footprint
 - Small/Optimized
 - Triplication
 - Floorplan
- Readback vs Scrub
- External device help
 - Current clamp
 - Watch dog

Questions/Follow Ups?

- General parts, parts availability questions
 - Your friendly neighborhood Xilinx FAEs
- Application specific questions
 - tcw@xilinx.com

References

- Xilinx XAPP988
- Xilinx XAPP989