

# Evaluation of Linux Distributions for SoC Devices on Custom Electronics in the CMS Network



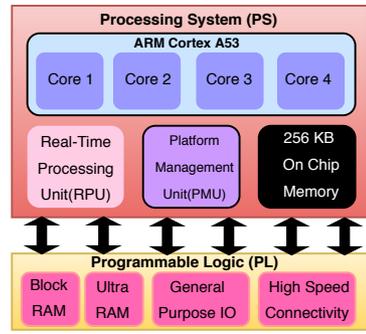
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on behalf of the CMS DAQ Group



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## Motivation: Embedded Systems in CMS Phase-2 Electronics

- Deployed at a scale of ~1000 devices
- Mostly based on Xilinx Zynq Ultrascale+
- Capable of running server-grade OS
- For remote control, configuration and monitoring
- Offers tight integration of the programmable logic (PL) with the processing system (PS)



## Hardware Issues

- Reliable, fault tolerant booting mechanism
- Automatic failover to golden image in case of failure to boot
- **HW address (MAC) in standard EEPROM for all board designs - support from board developers needed**
- Reliable and fault tolerant mechanism to update files on SD card (FSBL, U-Boot, and maybe firmware)

## Integration Issues

- Hardware not uniform due to the detector layout
- Devices need to be integrated into the CMS technical and control network
- Network specific settings: IP addresses, DHCP, DNS, NTP
- Sufficient network bandwidth for the primary task and for services (logging)

## System Administration Issues

- Centrally administered OS with regular updates and security patches
- Central Configuration Management System as for PCs: e.g. puppet
- Same user database (ldap, kerberos) across all platforms

## Scaling Issues

- **Root File System over NFS**
- Most files are the same and most space is used by files which are only read
- Use a Copy on Write; or a Read/Write overlay on top of a read-only file system like VMs or Docker images
- Root file system can be updated for a number of devices at once centrally
- Add NFS servers as needed for performance and scale; or use commercial appliance e.g. NetApp NFS File

## Logging

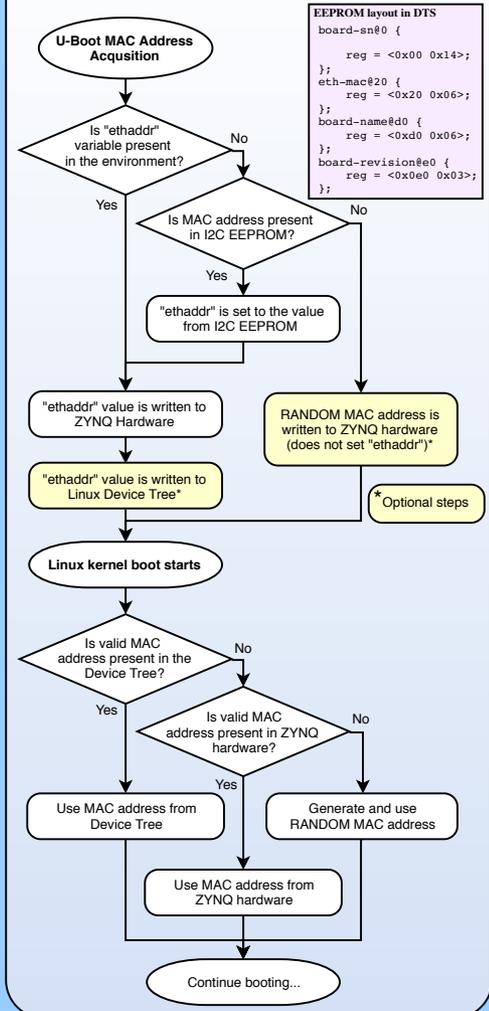
- No local storage on devices, NFS performance bottleneck if using root file system for log storage
- Propose central log server with local disks, and long term backup
- Maintain logs for all boards/devices in central location
- Access logs even if board crashes
- Add log servers as needed for performance and scale

## Software Issues

- Linux OS selection (ref. Linux from Xilinx: PetaLinux, Yocto, Arch, CentOS)
- Hardware developers may prefer various OS distributions or versions
- System Administrators may prefer to support only single OS version
- CERN is using CentOS (RHEL based Linux), can it be used with ZYNQ?
- Not supported by Xilinx
- Kernel from PetaLinux can be used
- CentOS root file system can be used as is
- CentOS default kernel would be preferred

## MAC Address Configuration

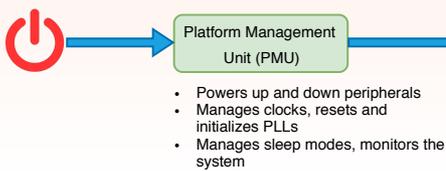
- Flow chart showing the retrieval and setting of MAC address on Xilinx evaluation board
- Propose all custom boards follow this algorithm



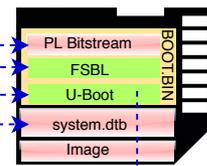
## CMS DAQ Proposed Solution for SoC hardware

- Utilize common knowledge and approach across CMS/CERN
- Minimize the manpower required for software development, integration and administration
- **Centrally managed Linux distribution**
- Based on CentOS 8 with minimum changes
- Full and fault tolerant network boot with automatic failover
- Minimum files required on SD card (FSBL, U-Boot), other files retrieved from network

## Power On Sequence

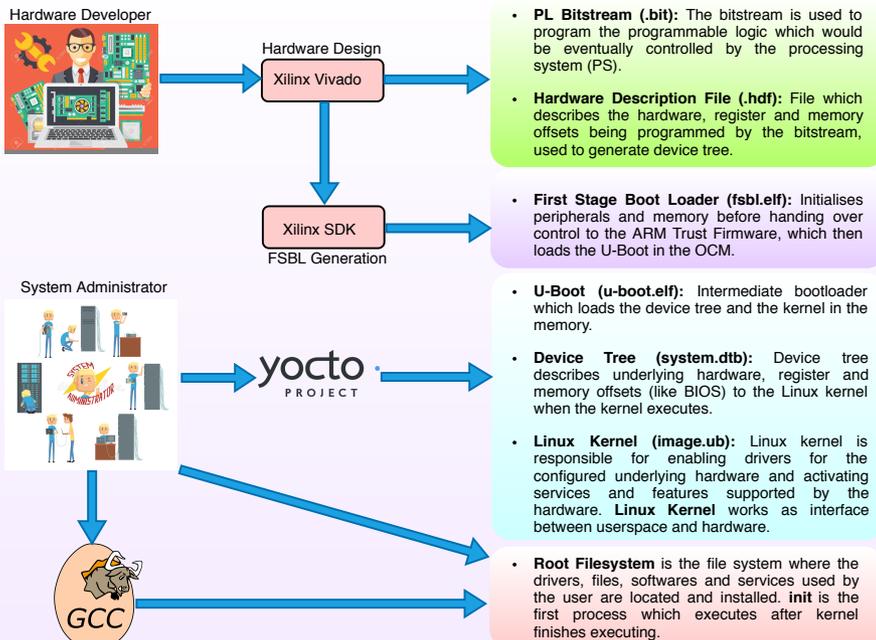


## Contents of SD Card

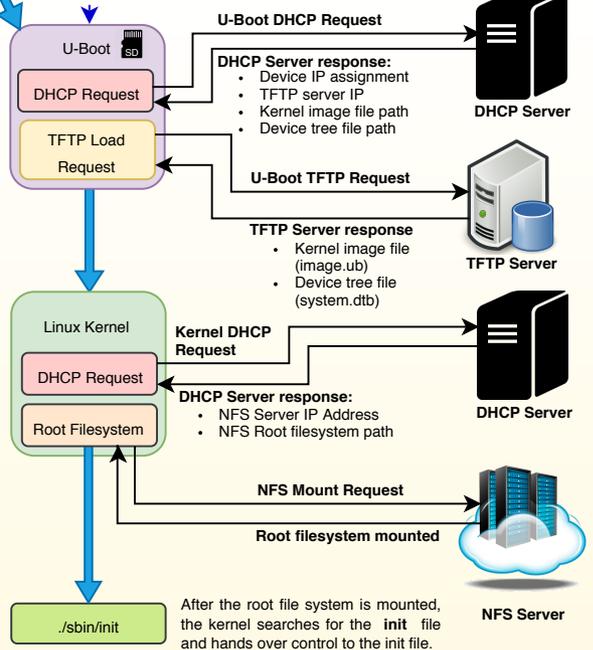


- For a complete boot from SD card, it must contain the **BOOT.BIN, system.dtb and Image** files.
- The Image file contains the **kernel image** and a compressed root file system.
- For network boot, only **BOOT.BIN** is required.

## Files used for booting Linux on Xilinx Zynq devices



## Linux Network Boot



After the root file system is mounted, the kernel searches for the **init** file and hands over control to the init file.