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
- Fine remote control, configuration and monitoring
- Offers tight integration of the programmable logic (PL) with the processing system (PS)

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 a proxy, e.g., puppet
- Same user database (slapd, 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 Filer

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

Hardware Issues
- Reliable, fault tolerant booting mechanism
- Automatic failure 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)

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?

Linux Kernel boot starts
- Random MAC address is written to ZYNQ Hardware
- TFTP server IP
- Device IP assignment
- 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.