System Boot from NAND Flash
Contact Information

- Wesley A. Prouty
- Micron Technology, Inc.
- Senior Applications Engineer
- waprouty@micron.com
System Considerations

- Although generic is some aspects, this presentation covers a typical boot process for a system with the following characteristics:
  - ARM9 or ARM11 processor core with internal ROM code and SRAM to support boot.
  - Processor includes NAND controller hardware.
  - No specific operating system but Linux OS is implied for this presentation.
Boot from NAND Steps

- The stage 3 Boot Loader code is referred to as U-boot in this presentation.

- The stage 2 Boot-strap code is referred to as x-loader in this presentation.
NAND Flash Considerations

- NAND flash is not an eXecute In Place (XIP) memory so when booting from NAND, code must be copied (or shadowed) from NAND to RAM before it can be executed.
- Designers must also consider how the code will be initially programmed to NAND flash.
Writing code to NAND Flash:
Step 1 - Load and run “u-boot” in DRAM

Processor SRAM

Micron DDR

Host PC

Terminal

uboot

uboot

Serial

JTAG
Writing code to NAND Flash: Step 2 - Write x-load to NAND

- **Micron DDR**
- **uboot**
- **TFTP Server**
- **X-load**
- **Host PC**
- **Terminal**

**Diagram:**
- **Micron NAND Flash**
  - **Blk 0 = x-load**
  - **Program**
  - **uboot**
  - **X-load**
  - **TFTP**
Writing code to NAND Flash: Step 3 - Write u-boot to NAND

- **Micron NAND Flash**
  - x-load
  - u-boot

- **Micron DDR**
  - u-boot
  - u-boot

- **Processor SRAM**
  - u-boot

- **Host PC**
  - Terminal
  - u-boot

- **TFTP Server**
  - u-boot

- **TFTP**

Connections:
- Serial connection from Processor SRAM to Host PC
- TFTP connection between Host PC and TFTP Server
- Program connection from TFTP Server to Micron NAND Flash

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Writing code to NAND Flash: Step 4 - Write OS kernel to NAND

- **Micron NAND Flash**: x-load, u-boot, u-boot environment data, Kernel
- **Processor SRAM**: u-boot, kernel
- **Micron DDR**: u-boot
- **Terminals**: Host PC
- **TFTP Server**: Terminal, Kernel

Diagram:
- Program flow from Host PC to Micron NAND Flash, Processor SRAM, Micron DDR, and TFTP Server.
- TFTP protocol for data transfer.
Writing code to NAND Flash:
Step 5 - Write File System to NAND

- x-load
- uboot
- uboot environment
- data
- Kernel
- File System
- Processor SRAM
- Micron DDR
- Root file system
- TFTP
- Host PC
- Terminal
- uboot
- TFTP Server
- Root file system
- Serial
- Program
- TFTP

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Boot from NAND Process

Micron NAND Flash
- x-load
- uboot environment data
- Kernel

Processor ROM
- ROM Code

Processor SRAM
- x-load

Micron DDR
- uboot
- Kernel

File System
Recommendations to Maximize Boot Code Reliability

- Program each page of NAND flash in a single program operation.
- Compare boot code in NAND flash against original binary image to ensure programming was successful.
- Maximize error correction in code storage areas of NAND flash.
- Avoid excessive reads to blocks of NAND Flash which store code.
Biography

- Wes Prouty is a Sr. Applications Engineer for Micron Technology, Inc and is responsible for NAND flash wireless and software applications. He has a BSME from University of Idaho and an MSEE from Boise State University. Wes has 10 years of experience in design and test of embedded applications and memory devices.