GRUB2 and Yeeloong

From BIOS bootloader to MIPS firmware
GRUB2 history

- 1995: Start of GRUB Legacy
- 1999: GRUB Legacy becomes GNU project
- 2002: PUPA (Yoshinori K Okuji)
- 2004: GRUB2
- 2004-2005: PowerPC and Sparc64 ports
- 2007: LinuxBIOS (now Coreboot) port
- 2009: Yeeloong second-stage bootloader
- 2010: Yeeloong firmware bootloader
Design principles

- Memory heap.
- POSIX-like.
- Modularisation.
- Portablity.
- Supporting both firmware and direct hardware access functions.
- GRand and Unified.
- Configurability.
- Bash-like scripting support.
Design principles

- Autogenerated config in most cases.
- Unicode support.
- Single-threaded.
- User interaction.
Supported platforms

- Coreboot
- EFI on i386 and amd64.
- OLPC
- BIOS
- QEMU
- PowerPC
- Sparc64
- Yeeloong
- Itanium? (branch available, nobody to test it)
What is Yeeloong

- Chinese thrive for informational independence. (to cut loose from foreign patents)
- MIPSel-based netbook
- It's libre (well except EC firmware. Wish luck to Reinder de Haan. New coders are welcome)
Libre firmware

- Proprietary firmware is a security threat. (master passwords, backdoors)
- Proprietary BIOS bugs.
- Flexibility is limited
- Boot time
- Coreboot project
- Various non-x86 firmwares (U-Boot, …)
What is firmware?

- The first thing to be executed on main CPU.
- Initialises all the hardware.
- Loads the next stage.
- Passes the hardware information.
- Provides helper functions.
GRUB as bootloader on Yeeloong

- Bootable from pmon.
- Supports Linux (probably OpenBSD too) loading.
- Multiboot2 support.
- AFFS, AtheOS fs, BeFS, cpio, Linux ext2/ext3/ext4, FAT12/FAT16/FAT32, HFS, HFS+, ISO9660, JFS, Minix fs, NILFS2, NTFS, ReiserFS, SFS, tar, UDF, UFS, UFS2, XFS and ZFS.
- Acorn, apple, msdos, sunpc, amiga, bsdlabel, GPT, sun and LVM.
- Internal HD, USB HD and SD cards.
Menuentries are fake. Ubuntu and SuSE have no Yeeloong support.
Boot Menu

This is the Winter theme ... brought to you by GRUB!

Select an item with the arrow keys and press Enter to boot.
Press 'c' for command line; '1' to switch to non-graphical menu.

GNU GRUB  version 1.97

OpenSUSE
Gentoo Linux
Ubuntu 8.04
Kubuntu 8.04
Linux Mint
Sabayon
Debian
Windows XP
从硬盘的第一主分区启动
Bitmap graphics test
Switch to text menu
Switch to graphical menu

Use the ↑ and ↓ keys to select which entry is highlighted.
Press enter to boot the selected OS, 'e' to edit the commands before booting or 'c' for a command-line.
GRUB as bootloader on Yeeloong

- Gettext support.
- RTL-capable rendering.
- Multiterminal (e.g. serial and local)
Multiboot specification

- Originally written by Erich Boleyn.
- ELF-based with additional headers but non-ELF kernels can be loaded with multiboot too.
- Meant for cooperation between bootloaders and kernels on x86.
- Adopted by Solaris, NetBSD, Hurd, Haiku (bl) memtest and ReactOS (bl) among others.
- Outdated, inadequate for non-x86, many mistakes.
- Multiboot2 specification is being written. Make your suggestion at grub-devel@gnu.org
Notable differences with i386-bios.

- No functions supplied by firmware. At last bug-free API
- Alignment enforcements:
  
  ```c
  *(grub_uint32_t *)0x8000001 = 1; /* Crashes. */
  ```

- Referencing NULL.
- 31 general-purpose registers.
- Branch delay slot.
- Bonito PCI bridge.
- Cache maintaining.
Cache coherence

- RAM
- L2 cache
- L1 instruction cache
- L1 data cache
- Core
Advantages of GRUB firmware

- Very customizable.
- Faster boot times.
- SHA-512 PBKDF passwords.
- Actively maintained.
- Serial console.
- Direct Linux loading.
Yeeloong architecture
/* Find CS5536 controller. */
/* $t4 chooses device in priority encoding. */
/* Resulting value is kept in GRUB_MACHINE_PCI_CONF_CTRL_REG.
This way we don't need to sacrifice a register for it. */
/* We have only one bus (0). Function is 0. */

1:
and $t4, $t4, ((1 << GRUB_PCI_NUM_DEVICES) - 1)
beql $t4, $zero, fatal
addiu $a0, $a0, %lo(no_cs5536)
sw $t4, %lo(GRUB_MACHINE_PCI_CONF_CTRL_REG_ADDR) ($t0)
lw $t2, (%lo(GRUB_MACHINE_PCI_CONFSPACE) + GRUB_PCI_REG_PCI_ID) ($t1)
bnel $t2, $t3, 1b
sll $t4, $t4, 1

/* Initialise SMBus controller. */
/* Set GPIO LBAR. */
lui $a0, %hi(GRUB_CS5536_MSR_GPIO_BAR)
addiu $a0, $a0, %lo(GRUB_CS5536_MSR_GPIO_BAR)
ori $a1, $zero, GRUB_CS5536_LBAR_GPIO
/* Set mask to 0xf and enabled bit to 1. */
bal wrmsr
ori $a2, $zero, ((GRUB_CS5536_LBAR_MASK_MASK |
GRUB_CS5536_LBAR_ENABLE) >> 32)
Initialisation
Initialisation
Installation into flash

- Select modules (0.5M out of 1.2M)
- Create config
- Generate image
  
  ```
  ./grub-mkimage -O mipsel-yeeloong-flash -o grub.img -d . ata part_msdos ext2 reboot halt lspci ohci usbtest usbms linux fat xfs part_gpt multiboot2 minicmd configfile gcry_md5 hashsum
  ```
- Burn it with flashrom.
GRUB CS5536 at 00000200SMBus controller enabled.
00000080Caches enabled
Welcome to GRUB!

error: ATA timeout.
error: ATA timeout.
GNU GRUB version 1.98

Minimal BASH-like line editing is supported. For the first word, TAB lists possible command completions. Anywhere else TAB lists possible device or file completions.

grub> multiboot2 (usb0,msdos1)/kernel
grub> boot
entry: mips_init()
[...]
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Remaining TODOs

- USB 2.0
- USB hotplug
- Networking
- Fuloong and Lynloong support
- Compression support.
- Signatures support
- LUKS
Links

♦ US distributor: http://freedomincluded.com/
♦ European distributor: http://tekmote.nl
♦ Lemote: http://lemote.com
♦ http://wiki.gnewsense.org/Projects/GNewSenseToMIPS
Questions?