i.MX51 Applications Processor and Linux Hands on

March-2010
Shailendra Miglani
Senior Field Applications Engineer
Agenda

- Roadmap
- Features of i.Mx51 Processor
- i.MX51 Website
- i.MX51 EVK
- Linux BSP release packages
- Installing and Building LTIB (Exercise 1)
- NFS on i.Mx51 (Exercise 2)
- Creating a hello world application from scratch (Exercise 3)
Freescale Applications Processor Value Proposition

► Performance (MHz & Memory Efficiency)

► Low Power (Audio < 18 mW system, HD720 Video < 250 mW)

► State of the art Audio, Video, Graphics and Codecs

► Consistent and scalable architecture

► Complete OS/SW platform

► Mixed signal integration
Freescale Mobile Consumer Leadership

► Pioneer in the portable media player market

► #1 market share in eBook application processors

► Shaping the smartbook product category

Source: ABI Research April 2009
i.MX51 Family Target Markets
Product Launch November 4

The i.MX51 brings a new level of performance and integration to the i.MX family from Freescale, while maintaining the family’s commitment to low power consumption, product accessibility and device longevity.

Consumer
- Smartbooks
- eBooks
- Portable Media Player
- Media Phone/Terminal
- Digital Photo Frame
- High-End Appliances
- Digital Signage
- Printers

Industrial
- Security and Surveillance
- Advanced HMI
- Medical
- Factory Automation

Automotive
- Infotainment Systems
- Navigation
- Telematics
- Instrument Cluster

Freescale extends its i.MX51 family to new markets with four processors based on ARM Cortex™-A8 technology

AUSTIN, Texas – Nov. 4, 2009
i.MX51 Key Advantages

Performance

► The i.MX51 family of processors runs on the powerful ARM Cortex-A8 core at speeds up to 800 MHz, which allows for roughly 2 MIPS per MHz. In addition, the i.MX51 processor offers flexible memory support for mDDR, SDRAM, SLC/MLC NAND, popular lower-cost DDR2, a NEON™ co-processor and VFPu. The high performance of the i.MX51 family of processors enables life-like video and 3-D graphics reproduction and quick response times needed for advanced user interfaces and sophisticated video processing - the building blocks to power the next great applications.

Integration

► The i.MX51 products integrates five engines including the ARM Cortex-A8 processor, Open VG™, OpenGL®-ES, D1 video encode/HD720 decode and ARM NEON™ technology. Depending on the intended application, different engines are enabled to achieve maximum performance/power ratios for each application space. This exceptional integration simplifies and shortens design time.

Low Power Consumption

► The i.MX51 delivers extreme performance and low power consumption, helping developers design products that meet today’s demands for energy efficiency. Advanced power management features used throughout the i.MX51 processor enable a rich suite of multimedia features and peripherals while maintaining minimal system power consumption in both active and low-power modes, which provides device end-users with long, long play times for hours of work or entertainment use.
### i.MX51 Applications Processor

#### System Control
- **Cortex A8 ARM-based CPU**
- SIMD/Neon
- Vector Floating Point Unit
- Memory Processing Unit
- Image Processing Unit
- 2D Graphics
- 3D Graphics

#### Connectivity

**ARM-based CPU**
- 800 MHz performance
- Open OS execution
- Web browsing
- Voice recognition
- Navigation map rendering
i.MX51 Applications Processor

- System Control
- Timers
- Memory
- Security
  - Cortex A8 ARM-based CPU
  - Neon/SIMD
  - Vector Floating Point Unit
  - Video Processing Unit
  - Image Processing Unit
  - 2D Graphics
  - 3D Graphics

Neon/SIMD DSP
- Audio and speech codecs
- Music playback and recording
- Speech recording
- Image processing
i.MX51 Applications Processor

Vector FP DSP
- Acoustic echo cancellation
- Noise suppression
# i.MX51 Applications Processor

## Video Processing Unit
- Multi-standard video playback/record
- Video telephony
- Video transcoding
- You Tube, Skype, Hulu

<table>
<thead>
<tr>
<th>System Control</th>
<th>Cortex A8 ARM-based CPU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timers</td>
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<td>Memory</td>
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<tr>
<td>Security</td>
<td>Video Processing Unit</td>
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<td>Image Processing Unit</td>
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<td></td>
<td>2D Graphics</td>
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<td>3D Graphics</td>
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</table>

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### i.MX51 Applications Processor

#### System Control
- Cortex A8 ARM-based CPU

#### Timers
- SIMD/Neon
- Vector Floating Point Unit

#### Memory
- Video Processing Unit

#### Security
- Image Processing Unit
- 2D Graphics
- 3D Graphics

#### Connectivity

### Image Processing Unit
- Image processing routines like scaling, rotation and post-processing
- Photo editing
- Multiple display output
- Multiple camera input
i.MX51 Applications Processor

2D Graphics
- Open VG support
- VG accelerated web browsing (both Flash lite/silverlight and page render)
- Map display with both 3D and VG views
- Enhanced Music and album visualization
- X window system acceleration
- Ebook PDF
## i.MX51 Applications Processor

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<th>System Control</th>
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</tr>
<tr>
<td>Security</td>
<td>Image Processing Unit</td>
</tr>
</tbody>
</table>

### Connectivity

#### 3D Graphics
- OpenGL ES support
- Advanced UI
- Flash 10 acceleration
- 3D navigation
- Gaming
- Excellent Youtube experience
### i.MX51 Applications Processor

<table>
<thead>
<tr>
<th>System Control</th>
<th>Connectivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cortex A8 ARM-based CPU</td>
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<tr>
<td>SIMD/Neon</td>
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<tr>
<td>Security</td>
<td>2D Graphics</td>
</tr>
<tr>
<td></td>
<td>3D Graphics</td>
</tr>
</tbody>
</table>

#### Security
- Hardware security accelerators
- Secure boot
- Cryptographic accelerators
- Tamper detection
- Secure financial transactions
# i.MX51 Family: 3-Digit Part Numbering

<table>
<thead>
<tr>
<th>Feature</th>
<th>i.MX512</th>
<th>i.MX513</th>
<th>i.MX514</th>
<th>i.MX515</th>
<th>i.MX516</th>
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<tbody>
<tr>
<td><strong>Target Markets</strong></td>
<td>Consumer, Industrial</td>
<td>Consumer &amp; Industrial</td>
<td>Automotive</td>
<td>Industrial &amp; Consumer</td>
<td>Automotive</td>
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<tr>
<td><strong>Target Segments</strong></td>
<td>![Factory Automation (Ethernet)]</td>
<td><img src="image" alt="HMI" /> <img src="image" alt="Portable/Tethered Printers" /> <img src="image" alt="Medical devices" /> <img src="image" alt="Ebooks" /></td>
<td><img src="image" alt="IP Camera" /> <img src="image" alt="Media Phones" /> <img src="image" alt="Digital Signage" /> ![HMI (home appliances, etc)]</td>
<td><img src="image" alt="Navigation" /> <img src="image" alt="Advanced HMI" /> <img src="image" alt="Instrument Cluster" /> <img src="image" alt="Telematics" /></td>
<td><img src="image" alt="Smartbook" /> <img src="image" alt="Mobile internet devices" /> <img src="image" alt="Secure Devices" /> <img src="image" alt="Advanced HMI" /> <img src="image" alt="High-end PDAs" /></td>
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<tr>
<td><strong>Core</strong></td>
<td>Cortex™-A8</td>
<td>Cortex™-A8</td>
<td>Cortex™-A8</td>
<td>Cortex™-A8</td>
<td>Cortex™-A8</td>
</tr>
<tr>
<td><strong>CPU Speed</strong></td>
<td>Consumer: up to 800 MHz Industrial: up to 600 MHz</td>
<td>Consumer: up to 800 MHz Industrial: up to 600 MHz</td>
<td>Up to 600 MHz</td>
<td>Consumer: up to 800 MHz Industrial: up to 600 MHz</td>
<td>Up to 600 MHz</td>
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<tr>
<td><strong>Key Differences</strong></td>
<td><img src="image" alt="DDR2" /> <img src="image" alt="Integrated USB Phy’s" /> <img src="image" alt="Vector Floating Point" /> <img src="image" alt="HD 720 TV-Out" /></td>
<td>![i.MX512 + <img src="image" alt="HW Video Codec: Multi-format D1 video encode &amp; multi-format HD720 decode" /></td>
<td>![i.MX512 + <img src="image" alt="OpenGL ES 2.0 3D accelerator" /> <img src="image" alt="OpenVG 1.1 graphics accelerator" /> <img src="image" alt="Security: Sahara v4 &amp; Trust Zone" /></td>
<td>![i.MX513 + <img src="image" alt="OpenGL ES 2.0 3D accelerator" /> <img src="image" alt="OpenVG 1.1 graphics accelerator" /> <img src="image" alt="Security: Sahara v4 &amp; Trust Zone" /></td>
<td>![i.MX514 + <img src="image" alt="HW Video Codec: Multi-format D1 video encode &amp; multi-format HD720 decode" /></td>
</tr>
<tr>
<td><strong>Package</strong></td>
<td>0.8mm 529BGA 0.5mm 527BGA</td>
<td>0.8mm 529BGA 0.5mm 527BGA</td>
<td>0.8mm 529BGA 0.5mm 527BGA</td>
<td>0.8mm 529BGA 0.5mm 527BGA</td>
<td>0.8mm 529BGA 0.5mm 527BGA</td>
</tr>
<tr>
<td><strong>Positioning</strong></td>
<td>High end processor</td>
<td>Video supported</td>
<td>Automotive support for graphics and security</td>
<td>Full featured: Video, graphics and security</td>
<td>Full featured: Video, graphics and security</td>
</tr>
<tr>
<td><strong>10KU Suggested Disty Resale 2010</strong></td>
<td>Contact FSL Sales</td>
<td>Contact FSL Sales</td>
<td>Contact FSL Sales</td>
<td>Contact FSL Sales</td>
<td>Contact FSL Sales</td>
</tr>
<tr>
<td><strong>OS</strong></td>
<td>Linux, WinCE RTOS</td>
<td>Linux, WinCE RTOS</td>
<td>Linux, WinCE, RTOS</td>
<td>Linux, WinCE, RTOS</td>
<td>Linux, WinCE, RTOS</td>
</tr>
</tbody>
</table>

Because of an order from the United States International Trade Commission, BGA-packaged product lines and part numbers indicated here currently are not available from Freescale for import or sale in the United States prior to September 2010: i.MX51 0.5 mm pitch packages

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i.MX51 Family Applications Processor

Specifications:
- **CPU:** Cortex A8, up to 800MHz
- **Process:** 65nm, LP/GP
- **Core Voltage:** 0.8-1.15V
- **Package:** 19x19 0.8mm
- **Temp Range:** -20 to 70°C* (consumer)
- **Temp Range:** -40 to 85°C* (industrial)
- **Temp Range:** -40 to 85°C* (Auto)

* See Datasheet for case/junction temperatures

Key i.MX515 Features and Advantages
- High performance CPU: Cortex A8
- Low power multimedia
- Delivers rich graphics and UI in HW
  - OpenGL ES 2.0 3D accelerator (AMD Z430)
  - OpenVG 1.1 graphics accelerator (AMD Z160)
  - Neon Vector floating point co-processor
  - Display up to WXGA
- Drives high resolution video in HW
  - Multi-format D1 video encode
  - Multi-format HD720 video decode
- Mixed signal integration - HD720 TV out and high speed USB with embedded PHY

Available Parts
- i.MX512, i.MX513, i.MX514, i.MX515, i.MX516

Availability:
- **Market:** Consumer, Industrial & Auto
- **Sample:** Now
- **Production:** Now (C), April’10 (A) May’10 (I)
**i.MX51 Applications Processor**

### CPU
- ARM Cortex-A8 w/ Neon
- 32KB L1 (Instruction and Data cache)
- 256KB L2 cache

### Connectivity
- High speed USB OTG w/ embedded Phy, Host HS x3
- MobileDDR, DDR2 (Up to 200MHz bus speed)
- SLC/MLC NAND Flash 8/16-bit, NAND/NOR
- High speed MMC\SDIO, UART, I2C, SPI
- ATA-6
- 3.3V support on HD, SDIO, and SIM I/F
- Ethernet controller

### Security *
- TrustZone
- AES, DES/3DES, SHA-1, SHA-224, SHA-256
- Run time integrity checker (RTICv3)
- Secure High Assurance Boot
- Security Controller (SCC), including Secure RAM and Security Monitor
- Random Number Generator Accelerator (RNGA)
- Secure JTAG Controller (with electrical fuses)
- Secure real-time clock
- Universal Unique Identification
- Tamper Detection

### Multimedia *
- Encode – D1 30fps (MPEG4 SP, H.264 BP, MJPEG)
- Decode – HD720 30fps (MPEG2 MP, MPEG4 ASP, H.264 HP, VC-1 AP, DivX, RV10)
- Graphics – OpenVG1.1, OpenGL ES 2.0 @ 27M Tri/sec
- TV Encoder – Component, Composite or S-Video out at 720p

### Camera
- Camera sensor I/F (x2)
- Up to 8Mpixel @ 15fps, Up 133Mpixel/sec
- Resizing, Inversion, Rotation
- Color Space conversion, video/graphics combining

### Display
- Up to WXGA display - 24 bit @ 60fps
- Secondary Display Support

### Power Management
- Advanced power management (DVFS)
- State retention power gating
- Multiple independent clock and power domains

* Dependent on processor
Best in Class Balance of High Performance and Low Power

► SoC
  • 65nm technology
  • Mix of Low Power (low leakage) and General Purpose (high performance) transistors
  • Allows high performing CPU with minimal SoC power consumption
  • Hardware acceleration of all performance intensive multimedia tasks independent of CPU

► ARM CPU design
  • High speed (up to 800MHz @ 1.15V)
  • Low operating voltage (down to 0.8V, 167MHz)
  • State Retention Power Gating to reduce leakage in GP process
  • L2 cache for minimized access to external memory, reducing the power consumption and increasing performance

► Dynamic Voltage & Frequency Scaling (DVFS)
  • Two independent domains with h/w monitoring: CPU, Peripherals

► Hardware Accelerator Power Gating
  • Unused accelerators can be dynamically power gated to reduce leakage current
i.MX51 Graphics

► **Native OpenGL ES 2.0** 3D based on ATI/AMD Unified Shader Architecture
  - Same architecture and same content tools as in *Xbox 360* and AMD’s PC graphics chips
  - Licensed by several industry leaders, providing for a strong foundation for a content creation ecosystem
  - Binning architecture provides for low memory/power requirements
  - 27 M triangles / sec
  - 166 M pixels / sec raw performance (1 pixel / clock)
    - 500 M pixels / sec (effective w/ 3x overdraw)

► **A native OpenVG 1.1** 2D hardware implementation
  - Driving high-quality UIs and Flash based internet browsing with extremely low power consumption
  - Free 16x antialiasing for very high-quality fonts and graphics
  - Capable of delivering a full 3D user interface experience beyond anything on the market today with a fraction of the power consumption compared to any other solution
  - 166 M pixels / sec raw performance (1 pixel / clock)
MC13892 Power Management & User Interface IC

For questions, please work with your local Freescale sales person

POWER & BATTERY
- 4 multi-mode buck switchers – 1.05A, 3x800mA programmable outputs, 2 with DVS/DPTC interface
- 2 boost switchers – 5V, 28V adaptive
- 12 LDO regulators, 4 GPOs, power gating
- Main battery & coin cell chargers, GP ADC
- Series WLED backlight drivers (main/aux, keypad)
- 1 bank RGB drivers, charger LED drive
- Standalone battery charging with auto disable if battery is out of temperature range
- Standby / user off configurations
- Coulomb counter

INTERFACE & CONTROL
- SPI / I2C control & register interface
- Resistive touch screen
- 32KHz crystal oscillator, real time clock / calendar alarms
- Package
  - 7x7mm BGA, 0.5mm pitch, 139 pins
  - 12x12mm BGA, 0.8mm pitch, 186 pins

Part Numbers
MC13892JVK 7x7 mm
MC13892JVL 12x12 mm
## MC13892 Key Features, Benefits & Advantages

<table>
<thead>
<tr>
<th>Features</th>
<th>Advantage</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>High level of integration</td>
<td>Reduces size, weight and design time to speed time to market. Integrates both user interface and power functions</td>
<td>Reduces the need for separate design and allows the use of cost effective display technologies</td>
</tr>
<tr>
<td>Optimized for use with the i.MX family of processors</td>
<td>Freescale’s mixed signal process technology allows for analog, digital and power circuitry on the same IC</td>
<td>Created with input from i.MX design engineers the device is ideal for use with i.MX35 and i.MX51 applications processors. Meets systems expectations for power and software.</td>
</tr>
</tbody>
</table>
i.MX51 Evaluation Kit (EVK) - $699 Resale

<table>
<thead>
<tr>
<th>Single Board Development Platform – Price, Performance, Personality</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>i.MX51 Evaluation Kit Features</strong></td>
</tr>
<tr>
<td>► i.MX51 Applications Processor</td>
</tr>
<tr>
<td>(529 BGA)</td>
</tr>
<tr>
<td>► 4 x 128MB DDR2</td>
</tr>
<tr>
<td>► 4MB SPI NOR</td>
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<tr>
<td>► PMIC – Atlas APL</td>
</tr>
<tr>
<td>(MC13892JV or MC13892JVL)</td>
</tr>
<tr>
<td>► NAND and EIM Header</td>
</tr>
<tr>
<td>► Debug Serial Port</td>
</tr>
<tr>
<td>► JTAG</td>
</tr>
<tr>
<td>► Reset, boot switches</td>
</tr>
<tr>
<td>► Debug LED</td>
</tr>
<tr>
<td>► Power Source</td>
</tr>
<tr>
<td>► Power on/off button</td>
</tr>
<tr>
<td>► Power Measurement Header</td>
</tr>
<tr>
<td>► 7” WVGA Touchscreen LCD Display (add-on module)</td>
</tr>
<tr>
<td>► Expansion board (add-on module)</td>
</tr>
<tr>
<td>► 2 LVDS connectors</td>
</tr>
<tr>
<td>► DVI-I connector</td>
</tr>
<tr>
<td>► 2 SD/MMC Card Slots</td>
</tr>
<tr>
<td>► USB Host x2 / USB OTG x1</td>
</tr>
<tr>
<td>► Ethernet Port</td>
</tr>
<tr>
<td>► Mini PCIe</td>
</tr>
<tr>
<td>► SATA HDD connector</td>
</tr>
<tr>
<td>► SIM Card connector</td>
</tr>
<tr>
<td>► Keyboard connector</td>
</tr>
<tr>
<td>► Mic input, stereo headphone output (jack), V2IP Headphone</td>
</tr>
<tr>
<td>► Speaker connector</td>
</tr>
<tr>
<td>► USB Camera connector</td>
</tr>
<tr>
<td>► PS-2 TP connector</td>
</tr>
<tr>
<td>► RGB output through DVI-I connector</td>
</tr>
<tr>
<td>► Expansion Header</td>
</tr>
<tr>
<td>► Ambient light sensor footprint</td>
</tr>
<tr>
<td>► FM receiver footprint</td>
</tr>
</tbody>
</table>

Board size = 5” x 5”

MCIMX51EVKJ
www.freescale.com/imx51evk
i.MX51 LCD & Expansion Board

- i.MX51 LCD module
- MCIMX51LCD
- $250 Resale
- CPT 7” WVGA with resistive touch screen

- i.MX51 Expansion Board
- MCIMX51EXP
- $200 Resale
- Features
  - CMOS Camera
  - TV out
  - Keypad
  - UART

Assembled with EVK
Available now
MCIMX51EVKJ : A True SBC (Single Board Computer)
Can Smartbooks bring back innovation and excitement to the computing industry by effectively seeding a new category combining the best of two worlds?
i.MX Web Resource


- Could send information request to: support@freescale.com
i.MX51 Information

http://www.freescale.com/webapp/sps/site/taxonomy.jsp?code=IMX51_FAMILY

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• http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=i.MX515&fpsp=1&tab=Documentation_Tab
i.MX51 EVK(Babbage)

- i.MX51 EVK(Babbage)
  http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=i.MX515

**Features**

- **CPU Complex**
  - 800 MHz ARM Cortex-A8 CPU
  - 32KB instruction and data caches
  - Unified 256KB L2 cache
  - NEON SIMD media accelerator
  - Vector floating point co-processor

- **Multimedia**
  - OpenGL ES 2.0 and OpenVG 1.1 hardware accelerators
  - Multi-format HD 720p video decoder and D1 video encoder hardware engine
  - 24-bit primary display support up to WXGA resolution
  - 18-bit secondary display support
  - Analog HD720p component TV output
  - High quality hardware video de-interlacing
  - Image and video resize, inversion, and rotation hardware
  - Alpha blending and color space conversion
  - Video/graphics combining; four planes plus hardware cursor
  - Display quality enhancement: color correction, gamut mapping, gamma correction

- **External Memory Interface**

**Featured Documentation**

- IMX51CONINDFS: i.MX51 Consumer and Industrial Fact Sheet
- IMX51EVKKITFS: i.MX51 EVK Fact sheet
- IMX51CEC: i.MX51 Applications Processors for Consumer and Industrial Products Data Sheet

**Current Updates & Releases**

- MCIMX51EVKJ: i.MX51 Evaluation Kit

**Target Applications**

- Smartbooks
- Mobile Internet Devices
- PMPs
- Gaming consoles
- Secure Devices
- Advanced HMI
- High-end PDAs
i.MX51EVK (Pis refer to BBG3.0 HW UG)
MCIMX51EVKJ: PCB Top

- DVI-I Connector (DVI and VGA support)
- JTAG
- UART
- 5VDC Jack
- Ethernet
- NAND and EIM Header
- USB Host ports (1 and 2)
- MMC/SD-2
- Reset
- Compact Flash
- Power Measurement Header
- Display Expansion Header
- LVDS Connector-1
- Resistive Touch Header
- Mini-PCIe
- Power On/Off
- Expansion Header
- V2IP Headphone
- Stereo Headphone
- USB-OTG
- UART
- JTAG
MCIMX51EVKJ: PCB Bottom

- UART (DB9-F)
- JTAG Connector
- LVDS Con-2
- SATA HDD Connector
- SIM Card connector
- Mic conn.
- Speaker Conn.
- USB Camera conn.
- SD/MMC-1
- Key-board connector
- PS-2 TP connector
Freescale Member Registration for web resource download

1. For first time user, register to Freescale WEB site using this link and press “Register Now”

2. Input your email address and choose your login password and then press “Next” to continue:

Linux BSP
Linux BSP on Freescale website

- [Link to Freescale website](http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=MCIMX51EVKJ&nodeId=0162468rH31143ZrDR633B&fpsp=1&tab=Design_Tools_Tab)

### Downloads

<table>
<thead>
<tr>
<th>ID and Description</th>
<th>Type</th>
<th>Format</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMX_ATK_TOOLKIT_R168</td>
<td>Board Support Packages</td>
<td>exe</td>
<td>IDE - Debug, Compile and Build Tools for downloading, programing, dumping and...</td>
</tr>
<tr>
<td>IMX51_LINUX UBUNTU_DEMO</td>
<td>Board Support Packages</td>
<td>gz</td>
<td>IDE - Debug, Compile and Build Tools for downloading, programing, dumping and...</td>
</tr>
<tr>
<td>IMX51_SDK16_LINUX_BSP_VALIDATION</td>
<td>Board Support Packages</td>
<td>zip</td>
<td>IDE - Debug, Compile and Build Tools for downloading, programing, dumping and...</td>
</tr>
<tr>
<td>IMX51_SDK16_LINUX_DEMO</td>
<td>Board Support Packages</td>
<td>gz</td>
<td>IDE - Debug, Compile and Build Tools for downloading, programing, dumping and...</td>
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<tr>
<td>Linux 2.6.28 Binary Demo Files Release 1.6</td>
<td>Board Support Packages</td>
<td>gz</td>
<td>IDE - Debug, Compile and Build Tools for downloading, programing, dumping and...</td>
</tr>
<tr>
<td>IMX51_SDK16_LINUX_BSP</td>
<td>Board Support Packages</td>
<td>zip</td>
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</tr>
<tr>
<td>IMX51_SDK16_WINCE6_DEMO</td>
<td>Board Support Packages</td>
<td>gz</td>
<td>IDE - Debug, Compile and Build Tools for downloading, programing, dumping and...</td>
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<tr>
<td>Windows Embedded CE 6.0 Binary Demo Files Release 1.6</td>
<td>Board Support Packages</td>
<td>zip</td>
<td>IDE - Debug, Compile and Build Tools for downloading, programing, dumping and...</td>
</tr>
</tbody>
</table>
Ubuntu Image on Freescale website

Linux BSP document on Freescale website

- http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=MCIMX51EVKJ&fpsp=1&tab=Documentation_Tab
Linux BSP release packages

Source package (L2.6.28_4.5.1_SDK_Aug2009_source.tar.gz)
- LTIB
- Boot loader sources (redboot) and toolchain
- Kernel and driver sources (kernel.org code + FSL patches)
- User space packages
- Compiler/Linker and friends (GNU ARM, currently 4.1.2 eABI/VFP)

Documentation (L2.6.28_4.5.1_SDK_Aug2009_docs.tar.gz)
- BSP release note, user guide and reference manual
- Resolved and Unresolved Defects status
- Feature matrix for each supported chip/HW

Binary Image package (L2.6.28_4.5.1_SDK_Aug2009_FormallImage_MX51.tar.gz)
- Kernel binary (zImage) for each supported chip/HW
- Root file system image for each supported chip/HW
- Boot loader binary image for each supported chip/HW
BSP License

► All Freescale kernel code is open source
  • No Freescale proprietary code
  • All Freescale code is licensed under the GPL

► Some Freescale user space code is proprietary
  • The Multimedia codecs
  • The graphical user interface (MESH)
    ⇒ binary only in release

► The rest of the Freescale user’s space code is open source
  • Gstreamer plugins, licensed under LGPL

► Some 3\textsuperscript{rd} party code can not be released
  • Example: CSR BT/WiFi driver
    ⇒ binary only in release
VMWARE Player install

- VMWARE is virtual machines, which can run multiple OS on one PC
- Install VMWARE on your PC(VMware-player-2.5.2-156735.exe)
- username / password for ubuntu image:william/william
Open ubuntu using VMWARE Player

VMware Player

Commands

Browse for available virtual machines. When you select a virtual machine, it opens in this VMware Player window.

- Open

Download a virtual appliance from VMware Virtual Appliance Marketplace. You can then open it in VMware Player.

- Download

Recent Virtual Machines

- Ubuntu
- Ubuntu
- Ubuntu
- Ubuntu
- Ubuntu
- Ubuntu

Featured Virtual Appliance

FalconStor Network Server Storage

FalconStor (NSS) is a pre-configured, production ready virtual machine that is cost-effective, with rich virtual SAN solutions for SMB & remote sites.
Open ubuntu image using VMWARE Player (Cont.)
Commands

- User name – william
- Password - william
- Username – root
- Password- Freescale123
  - `# ifconfig eth2 10.29.244.101`
  - `# ifconfig eth2 netmask 255.255.255.0`
  - `# ifconfig eth2 broadcast 10.29.244.255`
  - `#/etc/init.d/xinetd restart`
  - `#/etc/init.d/nfs-common restart`
LTIB instruction

► Stands for Linux Target Image Builder

► is an open source tool run by Freescale, under the GNU General Public License V2 or later (GPL).

► is made up of PERL scripts

► a number of embedded target platforms including PowerPC, ARM, Coldfire.

► builds flashable root file system images (jffs2 for MX51)

► has been successfully run on Fedora, Ubuntu and Suse.
LTIB Instruction (Cont.)

More information on LTIB:

- Main web site: [http://www.bitshrine.org/](http://www.bitshrine.org/)
- Freescale Internal: [http://twiki.freescale.net/bin/view/DEVTECH/LtibHome](http://twiki.freescale.net/bin/view/DEVTECH/LtibHome)
- Project web site: [http://savannah.nongnu.org/projects/ltib](http://savannah.nongnu.org/projects/ltib)
- Documentation provided with each release
Configure Host Linux Environment

Setup a Ubuntu 9.04 Linux host for LTIB

► NFS
1. sudo apt-get install nfs-kernel-server nfs-common portmap
2. sudo vi /etc/exports
3. sudo /etc/init.d/nfs-kernel-server restart
4. sudo exportfs

► TFTP
► Samba (File sharing)
► K-scope (Code editing in Linux)
► Meld (file/directory comparison tool)
sudo apt-get install meld
► Gparted (GNOME partition editor)
sudo apt-get install gparted
Setup a Ubuntu 9.04 Linux host for LTIB(Cont.)

- LTIB can work under Ubuntu 9.04 with following packages installed. (sudo apt-get install …)
  - bison
  - g++
  - gettext
  - libbeecrypt6
  - libglib2.0-dev
  - libncurses5-dev
  - librpm4.4
  - m4
  - patch
  - rpm
  - tcl
  - tcl8.4
  - zlib1g-dev
To install and compile Linux BSP

1. Create a folder
   
   ```
   mkdir test
   ```

2. Copy source into test folder
   
   ```
   cd test
   cp ../L2.6.28_4.3.0_ER_Jun2009_source.tar.gz .
   ```

3. Enter the following commands:
   
   ```
   tar -zxvf L2.6.28_4.3.0_ER_Jun2009_source.tar.gz
   ./ L2.6.28_4.3.0_ER_Jun2009_source/install
   ```
   You will be prompted to continue.

4. Type “Y”.
   The EULA is displayed.
To install and compile Linux BSP (cont.)

```
vmuser@vmuser-desktop:~$ cd test/L2.6.28_4.5.1_SDK_Aug2009_source/
vmsuser@vmuser-desktop:~/test/L2.6.28_4.5.1_SDK_Aug2009_source$ ./install

You are about to install the LTIB (GNU/Linux Target Image Builder).

Before installing LTIB, you must read and accept the EULA (End User License Agreement) which will be presented next.

Do you want to continue? Y|n
```
To install and compile Linux BSP

3. Press the space bar to scroll through the EULA (End User License Agreement). You will be asked if you have read and accept the EULA.

4. Type yes. You will be prompted to supply a pathname for the installation.
To install and compile Linux BSP (cont.)

The Board Support Package includes software and hardware developed by Cambridge Silicon Radio, Inc. ("CSR"). You must separately obtain rights beyond evaluation and demonstration in connection with the Board Support Package from CSR.

CTS
The Board Support Package includes software or technology developed by Coding Technologies, AB ("CTS"). You only have the right to use the CTS software in connection with the Freescale System.

I have read and accept the EULA (yes|no):

yes

To direct input to this VM, click inside or press Ctrl+G.
5. Specify the pathname. The system will create an LTIB folder in the specified location and install the packages needed for the build.
To install and compile Linux BSP

5. Enter the following commands:
   cd <your ltib install path>/ltib
   unset KBUILD_OUTPUT

6. Run the following command, not as root:
   ./ltib –m config

```
ubuntu@ubuntu:/home/samba/ltib$: ./ltib -m config
Installing host support packages.
This only needs to be done once per host, but may take up to an hour to complete ...
If an error occurs, a log file with the full output may be found in: /home/samba/ltib/host_config.log
```
To install and compile Linux BSP (Cont.)

8. Press <Enter> and select “Freescale iMX reference boards” as the platform choice. Exit saving changes. Another menu will pop up to select the board.
To install and compile Linux BSP (Cont.)
8. Use the arrow keys to select <Platform type>.
Use the arrow keys to select <Packages Profile>. The default is a minimal rootfs. After saving changes, another menu will pop up to change config options for the selected board. Make any desired changes, and then exit, saving the changes.

To start a build, run:

```bash
./ltib
```

LTIB will build the kernel, modules, and a rootfs.
To install and compile Linux BSP (Cont.)

Processing: makegs

Processing deployment operations

making filesystem image file
staging directory is /home/samba/ltib/rootfs.tmp
removing the boot directory and files
removing man files and directories
removing info files
removing /usr/share/locale directory
removing static libraries
removing target rpm database
stripping binaries and libraries

Filesystem stats, including padding:

    Total size          = 48876k
    Total number of files = 3303

Ended: Thu Sep 24 21:50:22 2009
Elapsed: 214 seconds

Build Succeeded
To install and compile Linux BSP (Cont.)

► Uboot configuration

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LTIB Tips

- LTIB help
  ./ltib –help

- To switch to a different board, enter the following command
  ./ltib –selectype

- To select an alternate set of userspace packages. (Under ltib/config/profile)
  ./ltib –profile profile name

- Build the package only
  ./ltib –p package name

- IP Address: 10.29.244.102 (target)
- Netmask.255.255.255.0
- Gate way: 10.29.244.101
- Host IP address: 10.29.244.101 (host)
Embedded Linux® System Components
Basic Embedded Linux System

• Bootloader

• Kernel

• File System:
  • Kernel Modules
  • Shared Libraries
  • Applications
  • Miscellaneous system files
BOOTLOADERS

• Used to initialize the board
• Provides mechanism for initial interaction with board
• Provides mechanism to boot kernel
• Configured and built for specific board

• Common bootloaders
  ▪ ColdFire → Colilo, u-boot, dBUG
  ▪ Power Architecture™ → u-boot
  ▪ ARM → blob, redboot, u-boot
KERNEL

• Continued initialization of the board

• Provides mechanism to interact with devices (drivers)

• Provides underlying protocol support (TCP/IP) and OS

• The Linux kernel configuration allows many features to be selected and configured
**KERNEL_MODULES**

- Implement device drivers

- Provide additional functionality to kernel

- Reside in the file system and can be loaded and unloaded from the kernel
FILE SYSTEM

- Protected by Memory Management Unit (MMU) (user land)

- Applications live here

- Common Embedded File System Types
  - EXT2/3
  - Journaling Flash File System version 2 (JFFS2)
  - CRAMFS
  - YAFFS
**Basic Embedded Linux® System**

**File Systems - NFS (Network File System)**

- Kernel mounts the root file system over the network
- The file system resides on host PC
- Files copied into the exported file system become instantaneously available on the target
- For development only, not for product
Basic Embedded Linux® System File Systems - Ramdisk File System

- Kernel mounts file system memory image that has been loaded into RAM by the boot loader
- File system is writeable, but non-persistent
- Must create and deploy new ramdisk image to make changes persistent
The file system resides on target board flash

Kernel mounts the root file system from a specified partition of flash

File system is writeable

File system is persistent (changes written to flash)

JFFS2 driver handles interaction with flash
GLIBC - UCLIBC

- Provides mechanism for user land to interact with the kernel
- Resides in the file system
- Can be used by multiple applications (re-entrant)
• User commands (ping, ls, cd, cat)
• Provides functionality to the system
• Resides in the file system.
• Accesses kernel functionality via the shared libraries.
• Cannot access kernel space (protected memory) directly.
• Must be compiled against the same version of shared library that is located on the embedded system.
Linux® System Boot Process
Linux System Boot Process

• Bootloader
  ▪ Initializes board
  ▪ Loads and starts kernel

• Kernel
  ▪ Continued board initialization
  ▪ Mounts file system
  ▪ Starts an application called “init”

• File System
  ▪ init runs a set of scripts that:
    ▪ setup/configure the Linux system
    ▪ starts a shell
    ▪ gives a login prompt
  ▪ User logs into the system
LTIB
Kernel and RFS Configuration
Freescale GNU/Linux Target Image Builder is a tool created by Freescale, that is used to build Linux target images, composed of a set of packages

- A mechanism to deliver Linux board support packages (BSP)
- A wrapper around tool chains and standard Linux commands (`cp`, `make`, `objcopy`, `tar`, `gcc`, ...)

It provides...

- a known working configuration for a target board
- functionality to configure and build Linux system components (kernel, bootloader, busybox, ........)
- functionality to configure and build the Linux target system (network configuration, type of file system to use, .......)
LTIB Philosophy

► LTIB has been released under the terms of the GNU General Public License (GPL)

► “Standard Linux” look and feel (make menuconfig)

► More than 200 applications – originating from open source projects and is RPM based

► LTIB BSPs draw packages from a common pool. All that needs to be provided for an LTIB BSP is:

1. cross compiler  
2. boot loader sources  
3. kernel sources  
4. kernel configuration  
5. top level config file ... main.lkc  
6. BSP config file ... defconfig
LTIB Web Resources
http://sourceforge.freescale.net/projects/lhib

Linux Target Image Builder - Summary

This is a simple Linux Board Support Package development/runtime tool.

Project Trove Categorization
- Development Status: 1 - Planning
- Environment: Console (Text Based)
- License: GNU General Public License (GPL)
- Operating System: Linux
- Organization: Linux Solutions group, SPS NCSG - Networking and Computing Systems Group
- Programming Language: Perl, Unix Shell
- Target system, device, or product: Infrastructure device
- Topic: Build Tools

Project Status
- Registered: 2003-Feb-01 11:00 NST
- Activity Percentile: 99% [View project activity statistics]

Messages
Looking for useful code or tools? Check out the Code Snippets!

Latest File Releases
This Project Has Not Released Any Files
Freescale Linux Board Support Packages
Freescale Linux BSPs

http://www.freescale.com/webapp/sps/site/overview.jsp?code=CW_BSP&srch

Linux Board Support Packages

Linux Board Support Packages (BSPs) for Freescale Silicon are tested, certified and frozen, ensuring a fully operational tool chain, kernel and board specific modules that are ready to use together within a fixed configuration for specific hardware reference platforms. These BSPs, combined with CodeWarrior tools, provide the foundation you need to begin your project quickly.

All Freescale Linux BSPs include:

- Linux kernel & Device drivers
- Applications/Services
- Libraries
- GNU Tools (compilers, linkers, etc.)
- Deployment mechanisms

Some features of a chip or an evaluation board may not be enabled by a Linux BSP. Please review the features listed in the “Devices Support” section of each Linux BSP information page. Each Linux BSP link provides detailed information on the version of the kernel, glibc, gcc, etc., as well as information about which applications and services are included within a specific BSP.

BSPs are offered free of charge. “AS IS.” Please review the Linux Technology Support Policies for more information.

- BSPs for Power Architecture Technology
- BSPs for Coldfire Architectures
  Linux Board Support Packages (BSPs) for Freescale Silicon are tested, certified and frozen, ensuring a fully operational tool chain, kernel and board specific modules that are ready to use together...
- BSPs for ARM Architectures
- BSPs for Other Architectures
  For HP Thin Client support, please contact HP or HP Support.
Freescale Linux BSPs

Typically contain:

- Tools
  - LTIB

- Toolchains
  - Compilers/Linkers

- Source Code
  - Bootloaders (most)
  - Kernel and drivers
  - Applications

- Deployment
  - Automated or instructions

- Documentation
  - BSP usage and hardware docs
  - Device driver docs
  - START_HERE on iso
GNU Toolchains

- Compilers
  - GCC
  - G++

- Libraries
  - GLIBC
  - libc++
  - Match to target system libs

- Binutils
  - ld (linker)
  - as (assembler)
Freescale Linux BSPs

► Freescale Linux Board Support Packages

• BSPs are starting points (also for our 3rd party BSP Linux vendors)
  ▪ Provide basic functionality on listed set of devices
  ▪ They are not production tested or fully optimized
  ▪ They are not intended to be final solutions

• Support Limitations
  ▪ Engineering is 100% engaged in current road map to facilitate new silicon
  ▪ Bugs are verified and accepted
  ▪ Fixes/Patches are worked into future revs of the specific BSP

• Professional Services / Third party developers
  ▪ Feature requests or driver enhancement
  ▪ Training
  ▪ Driver / Application development
  ▪ Support
Load and Run the Image on the Target

► **Boot from SD**
It is a quite common use case, especially useful for demo and test. Put all (bootloader, kernel and root file system) into a removable SD card and boot board from SD card.

► **Boot from tftp/NFS**
During developing phase, it's quite common to load built kernel image via tftp server and then kernel will mount rootfs and other file system image via NFS. In this case, you need put bootloader in SD, NAND or SPI Nor flash, boot the board from SD, NAND or SPI Nor flash, then configure bootloader to load kernel from tftp server and mount the rootfs from NFS.

► **Boot from Nor flash**
In production phase, we need load bootloader and kernel from in-device storage like Nor flash. In this case, you need put bootloader and kernel, and the file system image into external low-cost large storage (NAND, PATA, SD).

► **Boot from NAND (Available for i.MX51 PDK only)**
In production phase, we need load all (bootloader, kernel and rootfs file system) directly from in-device storage like NAND flash. In this case, you need put not only bootloader but also kernel and file system image into NAND. This is done by using ATK tool.

No matter which method you will use, the 1st thing you need do is to program the bootloader into the board (SPI Nor, NAND or SD).
## Kernel boot parameters

<table>
<thead>
<tr>
<th>kernel parameter</th>
<th>meaning</th>
<th>typical value</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>console</td>
<td>where to output kernel log by printk</td>
<td>console=ttymx0, 115200</td>
<td>COM1 port and 115200bps in default</td>
</tr>
<tr>
<td>init</td>
<td>tell kernel where is the &quot;init&quot; file</td>
<td>init=/init or noinitrd</td>
<td>All case Android, &quot;init&quot; in Android is located in &quot;/&quot; instead of in &quot;/sbin&quot;</td>
</tr>
<tr>
<td>ip</td>
<td>tell kernel how/whether to get IP address</td>
<td>ip=none, dhcp or static_ip_address</td>
<td>&quot;ip=dhcp&quot; or &quot;ip=static_ip_address&quot; is mandatory in &quot;boot from TFTP/NFS&quot;</td>
</tr>
<tr>
<td>mem</td>
<td>how much physical memory can be managed by kernel</td>
<td>mem=456M</td>
<td>All case for Android. In the top of physical memory, 24M is reserved for pmem_adsps (used by VPU driver) and 32M is reserved for pmem_gpus (used by GPU driver). 456M = 512M - 24M - 32M</td>
</tr>
<tr>
<td>nfsroot</td>
<td>where is NFS server/directory</td>
<td>rootfs=ip_address:/opt/nfsroot</td>
<td>Used in &quot;boot from tftp/NFS&quot; together with &quot;root=/dev/nfs&quot;</td>
</tr>
<tr>
<td>root</td>
<td>indicate where is the root file system</td>
<td>root=/dev/nfs or root=/dev/mmcblk0p1</td>
<td>Used in &quot;boot from tftp/NFS&quot; (i.e. root=/dev/nfs); Used in &quot;boot from SD&quot; (i.e. root=/dev/mmcblk0p1)</td>
</tr>
<tr>
<td>rootfstype</td>
<td>indicate file system type of root fs</td>
<td>rootfstype=ext2, ext3 or jffs2</td>
<td>Used in &quot;boot from SD&quot; (if no ramdisk is used for root fs) together with &quot;root=/dev/mmcblk0p1&quot;</td>
</tr>
<tr>
<td>video</td>
<td>tell kernel/driver which resolution/depth and refresh rate should be used</td>
<td>video=mxcfb:1024x768-16M@60</td>
<td>Used when display on DVI (i.MX51 BBG2.5 board)</td>
</tr>
<tr>
<td>wvga</td>
<td>tell kernel/driver using WVGA panel</td>
<td>wvga</td>
<td>Used when display on WVGA panel (i.MX51 BBG2.5 board)</td>
</tr>
<tr>
<td>calibration</td>
<td>tell kernel/driver to do touch panel calibration when 1st boot</td>
<td>calibration</td>
<td>Used when touch panel is needed, i.e. when you display everything on DVI, no need for this.</td>
</tr>
</tbody>
</table>
Adding rootdelay

Mounting the root file system on some MMC/SD cards or hard disks may fail.

Ans: this issue might be related to the timing of rootfs storage. Adding “rootdelay=5” command option in kernel boot parameter. It can ensure additional time is reserved for storage initialization before mounting the rootfs. Or, slow down the DRAM clock by redboot command.
Commands

- **IP Address**: 10.29.244.102 (target)
- **Netmask**: 255.255.255.0
- **Gateway**: 10.29.244.101
- **Host IP address**: 10.29.244.101 (host)

- **Cp zImage to /tftpboot**

- **load –r –b 0x100000 zImage**
- **Fis create kernel**

- **fis load kernel**
- **exec -c "noinitrd console=ttymx0 root=/dev/nfs nfsroot=10.29.244.101:/tftpboot/ltib ip=10.29.244:102:10.29.244.101:255.255.255.0"**
Boot board from filesystem on PC(NFS)

- ./ltib –m shell
- Mkdir hello
- Cd hello
- Vi hello.c
- Gcc hello.c –o hello
- Exit
- Copy the hello executable from hello folder to rootfs

- ./hello