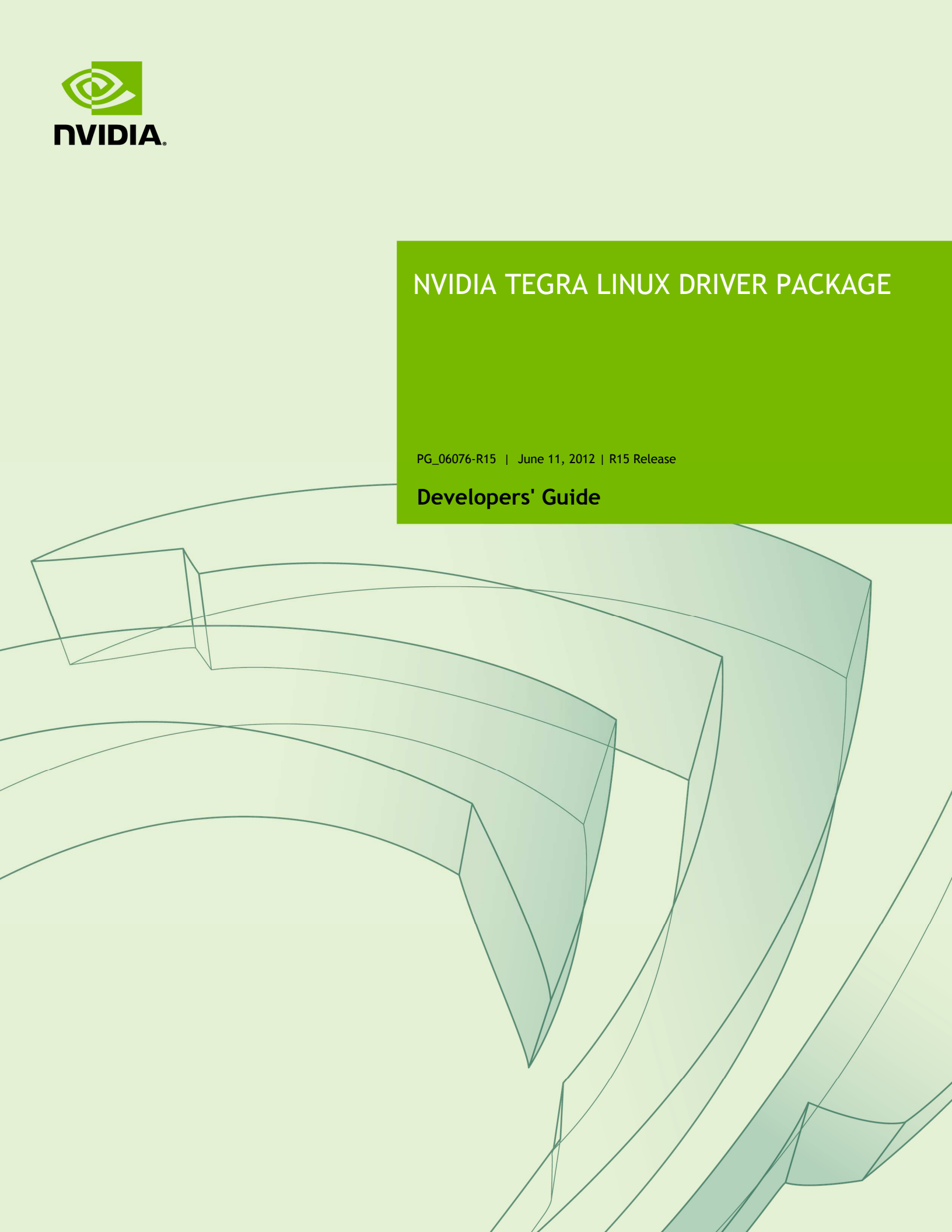

# NVIDIA TEGRA LINUX DRIVER PACKAGE

PG_06076-R15 | June 11, 2012 | R15 Release

## Developers' Guide

**Note**: Apparent hyperlinks in this document are a legacy of the HTML version and may not operate as expected in the PDF version.

# Overview

Welcome to *NVIDIA Tegra Linux Driver Package Developers' Guide*. Engineers can use this document to learn about working with NVIDIA® Tegra® Linux Driver Package, sometimes referred to as Linux for Tegra (L4T).

> **Important**: This documentation is preliminary and subject to change. Please see your NVIDIA representative for additional information and to request documentation updates.

Read the following sections to get started using Tegra Linux Driver Package.

- Package Manifest—describes the top level directories and files installed when expanding the release TAR file.
- Getting Started—provides requirements and set up information to help you get started using the package.
- U-Boot Guide—describes the U-Boot implementation for L4T.
- Software Features—describes the software features supported by the release.
- Licenses—provides license information for Tegra and 3rd-party software.
- FAQ—provides answers to frequently asked questions.
- Glossary—provides definitions of key terms.

# Package Manifest

The NVIDIA® Tegra® Linux Driver Package is provided in the following tar file:

`<platform>_Tegra-Linux-R15.1.0_<release_type>.tbz2`

where <release_type> is `armel` (for softfp ABI) or `armhf` (for hard-float ABI).

The following table lists the top level directories and files that are created when you expand the tar file.

| Filename | Description |
|---|---|
| ./rootfs | Directory used as a staging directory for the root filesystem |
| ./rootfs/README.txt | This file explains how to copy the sample file system here. |
| ./kernel | Directory containing the kernel images and kernel modules |
| ./bootloader | Directory containing the boot loader and related components. |
| ./bootloader/<platform> | Directory containing platform-specific files |
| ./bootloader/<platform>/BCT | Directory containing the platform-specific BCT files |
| ./bootloader/<platform>/cfg | Directory containing the appropriate cfg files. |
| ./nv_tegra | Directory containing the NVIDIA drivers and sample applications. |
| ./nv_tegra/nv_sample_apps | Directory containing the NVIDIA sample applications. |
| ./nv_tegra/nv_sample_apps/nvgst | Directory containing the nvgstplayer and nvgstcapture sample applications. |
| ./source_sync.sh | A script that downloads kernel and uboot source |
| ./apply_binaries.sh | A script to apply `nv_tegra` components. |
| ./flash.sh | A script that flashes the boot loader and kernel from the package. |
| ./zImage_to_uimg.sh | A script that creates the vmlinux.uimg with mkimage for use as the kernel image for u-boot |

**Note**: The <platform> in /bootloader/<platform> specifies the development system. For Tegra 3 series, the code-name is "cardhu", for Tegra 2 series, the code-name is "ventana".

### Documentation

Tegra Linux Driver Package (L4T) also includes the following documentation:

- Tegra_Linux_Driver_Package_Release_Notes_<ver>.pdf
- Tegra_Linux_Driver_Package_Documents_<ver>.tar

  Where <ver> is the version of the release, such as R15. Both the "armel" and "armhf" software versions are documented.

### Section Overview

This section provides information about the contents of the L4T tar file and includes the following topics:



# Kernel

This section describes the major components included in the ./kernel directory.

| Filename | Description |
|---|---|
| ./zImage | A kernel binary image. |
| ./LICENSE | A license file for "GNU GENERAL PUBLIC LICENSE". |
| ./kernel_supplements.tbz2 | Loadable kernel modules specific to the included kernel zImage built with the defconfig enabled for the device. |
| ./kernel/vmlinux.uimg | A u-boot kernel binary image. |

# Boot Loader

This section describes the files provided in the ./bootloader directory.

| Filename | Description |
|---|---|
| ./mkbootimg | A tool used for img creation. |
| ./nvflash | The NVIDIA flashing tool. |
| ./LICENSE.mkbootimg_and_mkubootscript | A license file for the mkbootimg and mkbootscript tools. |
| LICENSE.u-boot_and_mkimage | A license file for u-boot and the mkimage tool. |
| ./mkimage | A u-boot tool for vmlinux.uimg creation. |
| ./mkubootscript | A tool for flashing u-boot |
| ./<platform> | <platform> specifies the development system, cardhu for Tegra3, or ventana for Tegra 2 devices. |
| ./<platform>/fastboot.bin | The Fastboot-versioned boot loader binary file. |
| ./<platform>/<platform>_emmc.hush | The local storage device u-boot hush file. |
| ./<platform>/<platform>_net.hush | The network u-boot hush file. |
| ./<platform>/u-boot.bin | The u-boot binary image. |
| ./<platform>/BCT | Platform-specific BCT directory. |
| ./<platform>/BCT/ cardhu_12Mhz_H5TC2G83BFR_333Mhz_1GB_emmc_SDIN5C2-16G_x8.bct | BCT for Cardhu. |
| ./<platform>/BCT/ E1186_Hynix_1GB_H5TC2G83BFR-PBA_375MHz_110622_sdmmc4_x8.bct | BCT for Cardhu. |
| ./<platform>/BCT/ ventana_A03_12MHz_EDB8132B1PB6DF_300Mhz_1GB_emmc_THGBM1G6D4EBAI4.bct | BCT for Ventana. |
| ./<platform>/cfg | Platform-specific CFG directory. |
| ./<platform>/cfg/gnu_linux_fastboot_emmc_full.cfg | Platform-specific CFG file. |
| ./<platform>/cfg/gnu_linux_fastboot_emmc.cfg | Platform-specific CFG file. |

# NV Tegra

This section describes the major components included in the `./nv_tegra` directory.

| Filename | Description |
|---|---|
| ./LICENSE | Tegra software license. |
| ./LICENSE.gst-openmax | License file for libgstomx.so included in base.tgz. |
| ./base.tgz | The NVIDIA driver components. |

| | |
|---|---|
| ./nv_sample_apps/nvgst/nvgstapps.tgz | The nvgstplayer and nvgstcapture multimedia test applications. |

# Base TGZ

This section describes the files included in the `./base.tgz` file.

| Filename | Description |
|---|---|
| ./etc | - |
| ./home | - |
| ./lib | - |
| ./usr | - |
| ./etc/init | - |
| ./etc/init/nv.conf | An NVIDIA-specific init script. |
| ./etc/init/ttyS0.conf | An init script for getty on ttyS0. |
| ./etc/nv_tegra_release | The tegra driver versioning file. |
| ./etc/udev | - |
| ./etc/udev/rules.d | - |
| ./etc/udev/rules.d/99-tegra-devices.rules | Sets permissions for Tegra devices. |
| ./etc/X11 | - |
| ./etc/X11/xorg.conf | The xorg configuration file. |
| ./home/ubuntu | - |
| ./lib/firmware/ | - |
| ./lib/firmware/nvavp_os_*.bin | NVIDIA AVP Kernel firmware. |
| Restricted codec: ./lib/firmware/nvavp_vid_ucode_alt.bin | NVIDIA video decoders. |
| Restricted codec: ./lib/firmware/nvmm_jpegenc.axf | JPEG Encoder. Not included in the base release; available through a separate software license agreement. |
| Restricted codec: ./lib/firmware/nvmm_manager.axf | Multimedia Manager Kernel driver. Not included in the base release; available through a separate software license agreement. |
| Restricted codec: ./lib/firmware/nvmm_aacdec.axf | AAC decoder. Not included in the base release; available through a separate software license agreement. |
| Restricted codec: ./lib/firmware/nvmm_adtsdec.axf | ADTS decoder running on AVP. Not included in the base release; available through a separate software license agreement. |
| Restricted codec: ./lib/firmware/nvmm_mp3dec.axf | MP3 decoder. Not included in the base release; available through a separate |

| | |
|---|---|
| | software license agreement. |
| Restricted codec: ./lib/firmware/nvmm_mpeg4dec.axf | MPEG-4 video decoder. Not included in the base release; available through a separate software license agreement. |
| ./lib/firmware/nvrm_avp.bin | AVP kernel firmware. |
| Restricted codec: ./lib/firmware/nvmm_h264dec.axf | H.264 video decoder. Not included in the base release; available through a separate software license agreement. |
| Restricted codec: ./lib/firmware/nvmm_h264dec2x.axf | H.264 video decoder driver. Not included in the base release; available through a separate software license agreement. |
| Restricted codec: ./lib/firmware/nvmm_service.axf | NVIDIA multimedia services firmware. Not included in the base release; available through a separate software license agreement. |
| Restricted codec: ./lib/firmware/nvmm_jpegdec.axf | JPEG image decoder. Not included in the base release; available through a separate software license agreement. |
| Restricted codec: ./lib/firmware/nvmm_wavdec.axf | WAV decoder. Not included in the base release; available through a separate software license agreement. |
| ./lib/firmware/nvrm_avp*.bin | AVP kernel firmware. |
| ./lib/modules/ | - |
| ./usr | - |
| ./usr/lib | - |
| ./usr/lib/xorg | - |
| ./usr/lib/gstreamer-0.10/libgstomx.so | OpenMax Driver. |
| ./usr/lib/libcgdrv.so | NVIDIA Tegra OpenGL ES 2.0 shader compiler. |
| ./usr/lib/libEGL.so | OpenGL ES driver file. |
| ./usr/lib/libGLESv1_CM.so | OpenGL ES driver file. |
| ./usr/lib/libGLESv2.so | OpenGL ES driver file. |
| ./usr/lib/libjpeg.so | Accelerated libjepeg library for Tegra. |
| ./usr/lib/libKD.so | OpenKODE driver. |
| ./usr/lib/libnvapputil.so | Host (x86) shared object for application utilities. |
| ./usr/lib/libnvavp.so | User-space interface to the AVP for audio/video acceleration via the nvavp kernel driver. |
| ./usr/lib/libnvcwm.so | Compositing Window Manager library. |
| ./usr/lib/libnvdc.so | DC driver file. |
| ./usr/lib/libnvddk_2d.so | DDK 2D. |
| ./usr/lib/libnvddk_2d_v2.so | DDK 2D. |
| ./usr/lib/libnvddk_blockdevmgr.so | NVIDIA block device driver. |
| ./usr/lib/libnvddk_disp.so | Display abstraction driver file. |

| | |
|---|---|
| ./usr/lib/libnvddk_kbc.so | NVIDIA keyboard controller driver. |
| ./usr/lib/libnvddk_mipihsi.so | High-speed interface for MIPI. |
| ./usr/lib/libnvddk_nand.so | NVIDIA NAND driver. |
| ./usr/lib/libnvddk_sdio.so | NVIDIA MMC driver. |
| ./usr/lib/libnvddk_se.so | NVIDIA Security Engine driver. |
| ./usr/lib/libnvddk_snor.so | NVIDIA SNOR driver. |
| ./usr/lib/libnvddk_spif.so | NVIDIA SPIF driver. |
| ./usr/lib/libnvddk_usbphy.so | NVIDIA USB phy driver. |
| ./usr/lib/libnvdioconverter.so | Multimedia DIO converter. |
| ./usr/lib/libnvdispatch_helper.so | NvRM daemon dispatch helper. |
| ./usr/lib/libnvdispmgr_d.so | Display Manager interface. |
| ./usr/lib/libnvdispmgr_impl_d.so | Server-side Display manager driver file. |
| ./usr/lib/libnvflash.so | NvFlash helper library. |
| ./usr/lib/libnvmm_audio.so | Audio codecs and components. |
| ./usr/lib/libnvmedia_audio.so | Interface for audio decoder. |
| ./usr/lib/libnvmm_camera.so | Multimedia camera driver file. |
| ./usr/lib/libnvmm_contentpipe.so | Content pipe implementation (file source abstraction). |
| ./usr/lib/libnvmm_image.so | Image codecs. |
| ./usr/lib/libnvmm_manager.so | Multimedia Manager kernel driver. |
| ./usr/lib/libnvmm_parser.so | Parser. |
| ./usr/lib/libnvmm_service.so | Multimedia Framework kernel services HAL. |
| ./usr/lib/libnvmm.so | NVIDIA Multimedia Framework. |
| ./usr/lib/libnvmm_utils.so | Multimedia Framework utilities. |
| ./usr/lib/libnvmm_video.so | NVIDIA Multimedia Framework. |
| ./usr/lib/libnvmm_writer.so | 3GP writer block on CPU. |
| /usr/lib/libnvmmlite.so | NVIDIA Multimedia driver. |
| /usr/lib/libnvmmlite_audio.so | NVIDIA Multimedia audio driver. |
| /usr/lib/libnvmmlite_image.so | NVIDIA Multimedia image driver. |
| /usr/lib/libnvmmlite_utils.so | NVIDIA Multimedia utilities. |
| /usr/lib/libnvmmlite_video.so | NVIDIA Multimedia video driver. |
| ./usr/lib/libnvodm_disp.so | ODM kit display driver. |
| ./usr/lib/libnvodm_dtvtuner.so | Applies to: Ventana and Cardhu releases: Tegra development platform ODM adaptation for digital TV tuner. |
| ./usr/lib/libnvodm_hdmi.so | ODM kit HDMI driver. |
| ./usr/lib/libnvodm_imager.so | Tegra development platform ODM adaptation for imager. |
| ./usr/lib/libnvodm_misc.so | ODM kit. |
| ./usr/lib/libnvodm_query.so | ODM Query interface. |

| | |
|---|---|
| ./usr/lib/libnvomxilclient.so | OpenMAX IL client. |
| ./usr/lib/libnvomx.so | OpenMAX IL implementation. |
| ./usr/lib/libnvos.so | NVIDIA OS abstraction library. |
| /usr/lib/libnvparser.so | Parser used for NVIDIA NvMMlite. |
| ./usr/lib/libnvrm_graphics_impl.so | API layer in RM daemon. |
| ./usr/lib/libnvrm_graphics.so | Resource Manager (NvRM) graphics host, AVP communication library, and graphics drivers. |
| ./usr/lib/libnvrm_impl.so | NVIDIA Resource Manager (NvRm). |
| ./usr/lib/libnvrm.so | Resource Manager kernel interface. |
| ./usr/lib/libnvsm.so | NVIDIA shader manager library. |
| ./usr/lib/libnvtestio.so | Target (ARM) shared object for test I/O utilities. |
| ./usr/lib/libnvtestresults.so | Test results shared object. |
| ./usr/lib/libnvtvmr.so | Multimedia Tegra video mixer/renderer. |
| ./usr/lib/libnvwinsys_kd.so | OpenKODE winsys interface. |
| ./usr/lib/libnvwinsys.so | Winsys library. |
| ./usr/lib/libnvwsi.so | NVIDIA windowing system integration for EGL. |
| ./usr/sbin | - |
| ./usr/lib/xorg/modules/drivers/tegra_drv.abi*.so | Tegra X ABI drivers. |

# Getting Started

This section contains information to help you get started using this pre-release of NVIDIA® Tegra® Linux Driver Package. It covers the following topics:



## Requirements

The following lists the requirements to use this Tegra Linux Driver Package (L4T) release:

- Host PC running Linux. Ubuntu 10.04 is used in examples in this document, but other distributions should also work.
- A kernel image (zImage). L4T does contain a kernel image (zImage), and you can also download and rebuild from source. After you have a zImage, you can create the `vmlinux.uimg` that is used for U-Boot booting. For more information, see Synchronizing Kernel Sources in this guide.
- Boot loader. This can be Fastboot or U-Boot. Flashing on Tegra 3 series (code-named Cardhu) and Tegra 2 series (code-named Ventana) developer boards requires a boot loader. This boot loader can be either the Fastboot utility or U-Boot, both of which are included in this release.

- A rootfs device which can be an SD card, a USB hard disk, or USB stick formatted to EXT3.It is also possible to use the target device's internal memory, or your Linux Host PC hard-drive through NFS.
- (Cardhu) A USB Micro-B plug to USB Std A female cable to plug into the board's recovery port.
- (Ventana) A USB Micro-B plug to Std A female cable to plug into the board's recovery port [J10].

  **Note:** The NVIDIA binaries provided for Tegra 2 devices code-named "Ventana" may be able to support the Tegra 2 devices code-named "Harmony".

# Boot Options

It is currently possible to boot L4T on the Tegra 2 series Ventana developer board, as well as Tegra 3 series Cardhu with a root file system from:

- USB stick or USB hard disk
- SD card
- eMMC
- Network file system (NFS)

# Setting Up Your Environment

The following subsections contain information to help you get started using this pre-release of L4T. They cover the following topics:



## Extracting Tegra Linux Driver Package

**Note**: The procedures in this document assume you extract the release package in ~/.

### To extract Tegra Linux Driver Package

- Extract the package manually by executing the following command:

```
$ sudo tar -vxjf <platform>_Tegra-Linux-
R15.1.0_<release_type>.tbz2
```

  where <release_type> is `armel` (for softfp ABI) or armhf (for hardfp ABI).

## Setting Up Your Board

L4T requires a Tegra 2 series developer board (Ventana), or a Tegra 3 series (Cardhu) as well as a host PC running Linux. Please consult your board documentation for steps on how to setup and configure your board.

**Prerequisites**

- You have a device specified above in the "Boot Options" topic (formatted to EXT3). (It can also be a memory card with a USB adapter.)
- You have a mini-B USB male-to-USB Std A female cable to plug into the board's recovery port [J3].
- In your environment for the developer board, if your developer board is Ventana you have set:

  ```
  $ export TARGET_BOARD=ventana
  ```

  Or, if your developer board is Cardhu you have set:

  ```
  $ export TARGET_BOARD=cardhu
  ```

# Setting Up Your File System

This section describes the steps for setting up your file system. You must set up the root file system and copy the file system to your boot device.



## About the Root File System

To replicate the sample file system, `ttyS0.conf`, `nv.conf`, and other files have been added to the base Linux release and will be copied alongside the drivers. Both are accessible from `base.tgz`, should you decide to replicate the rootfs.

The provided sample root file system was created with Rootstock 0.1.99.4 using this command:

```
$ sudo rootstock --fqdn tegra-ubuntu --login ubuntu --password
ubuntu --imagesize 1G -d natty --seed ubuntu-minimal,xserver-
xorg-core,xinit,xterm,alsa-utils,wireless-
```

```
tools,wpasupplicant,x11-xserver-utils,openssh-client,openssh-
server
```

This creates a file system with the hostname `tegra-ubuntu`, the username `ubuntu`, and the password `ubuntu`.

**Note**: The provided sample target file system does not come with pre-generated ssh host keys. These host keys can be re-generated with the following command:

```
$ ssh-keygen -t rsa -f /etc/ssh/ssh_host_rsa_key
```

View the `ssh-keygen` man page for other `-t` options.

We have also made the following changes:

- Added: `/etc/init/{ttyS0.conf, nv*, wpa_supplicant.conf}, ./etc/udev/rules.d/99-tegra-devices.rules`
- Modified: `/etc/{init/ssh.conf, X11/Xwrapper.conf, resolve.conf}`
- Deleted: `/etc/ssh/ssh_host_*`

To replicate these changes in your own rootstock file-system, copy or make similar modifications from those files to your own rootstock file system.

The following packages are installed by default:

- ubuntu-minimal
- xserver-xorg-core
- x11-xserver-utils
- xinit
- xterm
- alsa-utils
- wireless-tools
- wpasupplicant
- opens-client
- openssh-server

## Setting Up the Root File System

The next step in booting the target board is to configure the root file system. Follow the procedures in this section to set up the rootfs and to copy the file system to the rootfs device.

**Note**: The instructions below use the sample file system that is provided by NVIDIA as the base. If you would like to use your own, set the

LDK_ROOTFS_DIR environment variable to point to where your rootfs is located and skip Steps 1 and 2.

### To set up the rootfs

1. Download the following file to your home directory:

   `Tegra-Linux-Sample-Root-Filesystem_<release_type>.tar.gz`

   where <release_type> is `armel` (for softfp ABI) or armhf (for hardfp ABI).

   This file contains the NVIDIA-provided sample root file system.

2. Extract the compressed file as follows:

   - Navigate to the rootfs directory for the extracted NVIDIA driver package with this command:

     ```
     $ cd <your_L4T_root>/Linux_for_Tegra/rootfs
     ```

     where `<your_L4T_root>` is your L4T root directory, which is assumed to be your home directory (~).

     For more information, see Extracting Tegra Linux Driver Package in this section.

   - Extract the sample file system to the rootfs directory with this command:

     ```
     $ sudo tar zxpf ../../Tegra-Linux-Sample-Root-
     Filesystem_<release_type>.tar.gz
     ```

3. Run the `apply_binaries.sh` script to copy the NVIDIA user space libraries into the target file system:

   ```
   $ sudo ./apply_binaries.sh
   ```

   **Note**: The `apply_binaries.sh` installs the appropriate default version, for the provided sample file system, of the Tegra X driver by creating a sym-link to point to the proper ABI. The script installs the sym-link to the following location in the rootfs:

   ```
   ./usr/lib/xorg/modules/drivers/tegra_drv.so
   ```

   If you are using a different rootfs, or if you already have configured your rootfs, you can apply the NVIDIA user space libraries by setting the LDK_ROOTFS_DIR environment variable to point to your rootfs. Then run the script, as shown above, to copy the binaries into your target file system.

   To install a different ABI:

   - Use the `apply_binaries.sh` script and pass the `–abi <number>` flag by executing:

     ```
     $ sudo ./apply_binaries.sh --xabi <number>
     ```

where <number> is the ABI version to install, either 5, 6, 7, 8, 10, 11, or 12. The ABI default value for the X driver is 'X ABI version 10' and it is the version that is compatible with the provided sample file system. You can find the version to use in the sample file system by following the directions listed below.

To determine the X driver ABI of the X server used in the root file system:

- Start X once on the Tegra device.
- Examine the resulting file `/var/log/Xorg.0.log`, which will contain something like the following:

```
(II) Module ABI versions:
X.Org ANSI C Emulation: 0.4
X.Org Video Driver: 8.0
```

The X.Org Video Driver line reports the ABI version. The sample Ubuntu 11.04-based root file system uses X driver ABI 10.

If the `apply_binaries.sh` script is installed correctly, the last message output from the script is "Success!".

4. Load the target file system that you have generated onto the first partition of a device (either a USB stick, an SD card, or a USB hard drive) and attach that device to the target board.
5. Power on the target board and the image should load.
6. Set up access to the board over a serial port by opening a terminal on the host PC and setting:
   - 115200 baud
   - 8-bit
   - Parity none
   - 1 stop bit

### To copy the file system to the external rootfs device

1. Plug your rootfs device into the host PC.
2. If your device is not formatted as Ext3, enter the following command to format it with an Ext3 file system:

   ```
   $ sudo mkfs.ext3 /dev/sd<port>1
   ```

   where <port> is the port your device is mounted. You can use the `dmesg` command to determine the port.
3. If needed, mount your device with the following command:

   ```
   $ sudo mount /dev/sdX1 <mntpoint>
   ```

   where <mntpoint> is your rootfs device's mount point.

4. Copy the file system. If LDK_ROOTFS_DIR is set, execute these commands:

   ```
   $ cd ${LDK_ROOTFS_DIR}
   $ sudo tar -cpf - * | ( cd <mntpoint> ; sudo tar -xpf - )
   ```

   If it is not set, copy the rootfs directory that is included in the release by executing the following commands:

   ```
   $ cd <your_L4T_root>/rootfs
   $ sudo tar -cpf - * | ( cd <mntpoint> ; sudo tar -xpf - )
   ```

Once you have flashed your board, you can then unmount the disk and plug it to the board. For more information about flashing, see the Flashing the Boot Loader and Kernel topic in this section. For information about configuring your board setup, see the hardware documentation for your developer board.

## Updating Drivers on an Existing Target System

These instructions are for the situation where there was a previous release or driver package loaded onto a target board and that target device is booted.

### Prerequisite

You must attach an Ethernet cable to the device through either the Ethernet port (if available) or through the USB Ethernet adaptor. Alternatively, you can connect through Wi-Fi if the appropriate driver and firmware are enabled and installed.

### To update drivers on an existing target system

1. Log into the target device.
2. Download the NVIDIA Tegra Linux driver release and the additional support packages (for example the codec's package) from the `nvidia.com` links with `wget`. For example, to download the last (not the latest) release do the following:

   ```
   wget
   http://developer.nvidia.com/sites/default/files/akamai/tools/f
   iles/l4t/r15_beta/cardhu_Tegra-Linux-R15.beta.1.0_armel.tbz2
   wget
   http://developer.nvidia.com/sites/default/files/akamai/tools/f
   iles/l4t/r15_beta/cardhu_Tegra-Linux-codecs-
   R15.beta.1.0_armel.tar.gz
   ```

   **Note**: The release shown in this example is a previous release and not the current release.

3. Extract the release. For more information, see Extracting Tegra Linux Driver Package in this section.

4. Set the LDK_ROOTFS_DIR variable to point to the root '/' directory.

   ```
   $ export LDK_ROOTFS_DIR=/
   $ echo ${LDK_ROOTFS_DIR}
   ```

5. Go into the Linux_for_Tegra directory.

   ```
   $ cd Linux_for_Tegra
   ```

6. Run the `apply_binaries.sh` script to install the NVIDIA drivers onto your target board. For more information, see Setting Up the Root File System in this section.

7. (Optional) Change your X driver ABI as a variable passed into apply_binaries. For more information, see Setting Up the Root File System in this section.

8. For the codecs, or other additional packages, extract the files, being sure to extract them to your root '/' directory. For more information, see Installing Additional Packages in this section.

## Determining the Success of a Driver Update

You can determine whether a driver update went successfully.

**To determine the success of a driver update**

- Execute the following command on a booted target device:

  ```
  $ cat /etc/nv_tegra_release | grep -v -P '^#.*$' | sha1sum -c
  ```

## Increasing the Internal Memory Partition Size for the Root File System

The suggested rootfs partition size for Ventana and Cardhu is 1073741824 bytes and is specified by default in the `flash.sh` script. This 1 GB reserved in internal memory for the rootfs partition may be insufficient for installation of additional packages. Packages such as ubuntu-desktop, gst, and other gnome plug-ins may require additional space.

The "`-S <size-in-bytes>`" argument to `flash.sh` can be used to change the partition size.

**To flash for a larger partition**

- Execute the following command:

  ```
  $ sudo ./flash <target_device> -S <size_in_bytes> <rootdev>
  ```

  Where:

- <target_device> is either cardhu or ventana.
- <size_in_bytes> is the desired size for the partition.
- <rootdev> is the rootfs partition's internal memory, for example mmcblk0p1.

# Installing Additional Packages

This section explains how to install the additional NVIDIA packages, additional Ubuntu packages, and Google Chrome.

## Installing Additional NVIDIA Packages

Additional NVIDIA packages may be posted alongside the release. To make full use of the features in the release, these additional packages must be installed. These may include the following packages:

- restricted_codecs.tbz2, which is included in the <target_board>_Tegra-Linux-codecs-<version>_<release_type>.tar.gz
- wifi.tbz2 file

Directly after the "apply_binaries" step in Setting Up the Root File System, you can install the package into the configured rootfs.

**To install an NVIDIA package when the rootfs is already installed on the device**

1. Mount the target rootfs device to /mnt:

   ```
   $ sudo mount <device> /mnt
   ```

   where <device> is the device such as /dev/sda1.

2. Install the package:

   ```
   $ tar -C /mnt -xjf <path-to>/$<package_name>
   ```

   where <package_name> is one of the packages.

   For example, if you have the restricted_codecs.tbz2 file located in:

   ```
   <home>/restricted_codecs.tbz2
   ```

   then your line will look like:

   ```
   $ tar -C /mnt -xjf <home>/restricted_codecs.tbz2
   ```

3. Unmount the device with this command:

   ```
   $ sudo umount <device>
   ```

   and attach the device to the target board.

## Installing Additional Ubuntu Packages

This section explains how to install additional packages from Ubuntu by using the provided sample file-system. For example, you may wish to download the following packages:

- `openssh-server` for remotely logging in
- `ubuntu-desktop` for the standard Ubuntu graphical user interface

You can receive notifications from Update Manager when new Ubuntu packages are available.

**Note:** L4T is tested with base Ubuntu packages only. No updated packages have been tested.

### To receive notifications

1. Locate and edit the following file:

   `/etc/apt/sources.list`

2. Add the following line:

   ```
   deb http://ports.ubuntu.com/ubuntu-ports <distribution>-
   updates main universe
   ```

   Where `<distribution>` is the name of the Ubuntu distribution your rootfs is based on. For example, add the line:

   ```
   deb http://ports.ubuntu.com/ubuntu-ports natty-updates main
   universe
   ```

   for a rootfs based on the Natty Narwhal distribution of Ubuntu.

### Prerequisite

You have attached an Ethernet cable to the device through either the Ethernet port (if available) or through the USB Ethernet adaptor, or connect through Wi-Fi if the appropriate driver and firmware are enabled and installed.

### To install more packages

1. Boot the target device.
2. Turn on networking by executing:

   ```
   $ sudo dhclient
   ```

   **Note**: You may need to specify eth0/eth1 and other parameters to assign an IP address to the appropriate interface.

3. Install packages using `apt-get`. For example, to install `wget` execute this command:

   ```
   $ sudo apt-get install wget
   ```

## Installing Google Chrome

You can install Google Chrome from the command line, without using a browser.

**Note**: These installation procedures are untested.

### To install Google Chrome from the command line

1. Download and install a Linux-repository public key from Google:

   ```
   $ wget -q -O - https://dl-
   ssl.google.com/linux/linux_signing_key.pub | sudo apt-key add
   -
   ```

2. Add the key to the repository:

   ```
   $ sudo add-apt-repository 'deb
   http://dl.google.com/linux/chrome/deb/ stable main'
   ```

3. Update the repository and install the browser:

   ```
   $ sudo apt-get update
   ```

4. Install the Google Chrome Stable version with:

   ```
   $ sudo apt-get install google-chrome-stable
   ```

   Or install the beta version (latest version) with:

   ```
   $ sudo apt-get install google-chrome-beta
   ```

   For instructions on installing Google Chrome, see:

   http://www.ubuntuupdates.org/ppa/google_chrome

# Configuring NFS Root on the Linux Host

To boot the target device from NFS, you must provide an NFS root mount point on your Linux host machine. The procedure in this section describes the basic steps to do so.

### Prerequisites

- You must have Ethernet connection to install packages on the host.
- You must have an Ethernet connection on the target, as well.

### To configure NFS root on the Linux host

1. Install the `nfs` components on your host machine:

   ```
   $ sudo apt-get install nfs-common nfs-kernel-server
   ```

2. The NFS server needs to know which directories you want to 'export' for clients. This information is specified in the `/etc/exports` file.

   - Modify `/etc/exports` to look somewhat like this:

     ```
     $ /nfsroot
     *(rw,nohide,insecure,no_subtree_check,async,no_root_squash)
     ```

   - After adding the entry, restart using the following command:

     ```
     $ sudo /etc/init.d/nfs-kernel-server restart
     ```

3. Create an `/nfsroot` directory on your Linux host machine:

   ```
   $ sudo mkdir /nfsroot
   ```

4. Copy the file system to the `nfsroot` directory:

   ```
   $ cd ./rootfs
   $ sudo tar -cpf - * | ( cd /nfsroot ; sudo tar -xpf - )
   ```

5. Export the root point:

   ```
   $ sudo exportfs -a
   ```

   Alternatively, you can export or un-export all directories by using the `-a` and `-u` flags. The following command un-exports all directories:

   ```
   $ sudo exportfs -au
   ```

6. (Optional) If the Ubuntu firewall blocks NFS root access, it must be disabled depending upon your configuration. You can do so with the following command:

   ```
   $ sudo ufw disable
   ```

7. If there are issues performing the NFS boot, to separately verify everything on the 'host' machine is configured properly, you can perform the following step on a booted target board through USB/SD/internal eMMC. It should be possible to mount the host NFS root point on the target device:

   ```
   $ mkdir rootfs
   $ sudo mount -v -o nfsvers=3 <IP-ADDR>:/nfsroot rootfs
   ```

   Where `<IP-ADDR>` is the IP address of the Linux Host machine as taken from the "ifconfig" command. This proves that the host configuration is correct.

   **Note**: You must install `the nfs-common` package using the following command prior to executing the mount command on the target machine:

   ```
   $ sudo apt-get install nfs-common
   ```

To boot the target with the NFS root point, see the Flashing the Boot Loader and Kernel topic in this section and be sure to include the `-N` option for the nfs root point.

# Setting Power Saving Options

This section explains how to enable the hotplug driver and the Tegra CPU power-gated state (LP2) for power savings on the target board.

## Enabling the Auto-Hotplug Driver

The auto-hotplug driver implements the policy for when to bring cores online/offline. The auto-hotplug driver also implements the policy for when to switch clusters, i.e. when to switch from companion CPU to main CPU or vice versa. Cluster switching is transparent to the OS. The switch happens when software enters a power-gated state on one CPU core and hardware resumes the execution on a different physical CPU core.

**To enable the auto-hotplug driver**

- Enter the following command:

```
$ echo 1 > /sys/module/cpu_tegra3/parameters/auto_hotplug
```

## Enabling the Tegra CPU Power-Gated State (LP2)

With the LP2 power state, the CPU core is power-gated if supported by the hardware. If all CPU cores on the VDD_CPU power rail are in LP2, Tegra hardware signals the PMIC to turn off the regulator.

**To enable the LP2 power state**

- Enter the following command:

```
$ echo Y > /sys/module/cpuidle/parameters/lp2_in_idle
```

# Flashing the Boot Loader and Kernel

This section describes the steps that must be taken to boot the target board (Ventana or Cardhu) and provides usage information for the `flash.sh` script.

## Flash Procedure

The first step is to flash the board with the boot loader and kernel.

### Prerequisites

The following directories must be present:

- /bootloader—boot loader plus flashing tools (NvFlash, CFG, BCTs, etc.)
- /kernel—a kernel zImage/vmlinux.uimg plus scripts to sync/build the kernel
- /rootfs—the root file system that you download
- /nv_tegra—NVIDIA® Tegra® user space binaries

You must also have the USB cable connected to the recovery port prior to running the commands listed below. For more information, see the Requirements topic in this section.

### To flash the boot loader and kernel

1. You must first put the target board into reset/recovery mode. Do so by first powering on the board and then holding the recovery button and pressing the reset button.
2. Now run the `flash.sh` script that is in the top level directory of this release. The script must be supplied with the device name that it will have in the root file system:

   ```
   $ sudo ./flash.sh <target_board> <rootdev>
   ```

   - If the root file system will be on a USB disk, execute the script as follows:

     ```
     $ sudo ./flash.sh <target_board> sda1
     ```

     Otherwise, if the root file system will be on an SD card, execute the script as follows:

     ```
     $ sudo ./flash.sh <target_board> mmcblk1p1
     ```

     Where `<target_board>` is `ventana` or `cardhu`, depending upon your target device.

   The above examples are for fastboot. For U-Boot, add the following argument:

   ```
   -L <PATH_TO_U-BOOT_BIN_FILE>
   ```

   For example:

   ```
   $ sudo ./flash.sh –L bootloader/<target_board>/u-boot.bin
   <target_board> <rootdev>
   ```

   The boot loader and kernel will load.

   For more information on U-Boot see the U-Boot Guide chapter of this document.

# Flash Script Usage

You can find the most up-to-date usage information by running `flash.sh –h` (using the `flash.sh` script included in the release). The basic usage information is as follows.

### Usage

```
sudo ./flash.sh [options] <target_board> <rootdev>
```

Where you specify the required parameters and one or more of the options shown in the following table.

| Parameters | Description | |
|---|---|---|
| <target_board> | Is one of ventana or cardhu. | |
| <rootdev> | Is one of following: | |
| | **For Ventana** | |
| | mmcblk0p1 | Specifies internal eMMC. |
| | mmcblk1p1 | Specifies external SDCARD. |
| | sda1 | Specifies external USB device (such as, USB memory stick or HDD). |
| | eth0 | Specifies nfsroot via external USB Ethernet interface. |
| | **For Cardhu** | |
| | mmcblk0p1 | Specifies internal eMMC. |
| | mmcblk1p1 | Specifies external SDCARD. |
| | sda1 | Specifies external USB device (such as, USB memory stick or HDD). |
| | eth0 | Specifies nfsroot via external USB Ethernet interface. |
| **Options** | **Description** | |
| -h | Specifies to print this usage information. | |
| -b <bctfile> | Specifies the NvFlash Boot Configuration Table (BCT) file. | |
| -c <cfgfile> | Specifies the NvFlash configuration file. | |
| -f <flashapp> | Path to flash application: nvflash or tegra-rcm. | |
| -k <partition id> | Specifies the kernel partition ID to be updated (minimum = 5). | |
| -n <nfs args> | Specifies the static NFS network assignments:<br><Client IP>:<Server IP>:<Gateway IP>:<Netmask> | |
| -o <odmdata> | Specifies the ODM data value:<br>0x30098011 (ventana)<br>0x80080105 (Cardhu A01)<br>0x40080105 (Cardhu A02) | |
| -s <ubootscript> | HUSH bootscript file for U-Boot. | |

| | |
|---|---|
| -F <flasher> | Flash server such as fastboot.bin. |
| -L <bootloader> | Specifies the boot loader, such as fastboot.bin. |
| -C <cmdline> | Specifies the kernel command line. **Warning:** This manual kernel command line should be *FULL SET*. Upon detecting the manual command line, the boot loader overrides the entire kernel command line with this <cmdline> input. |
| -i | Specifies the kernel command line as-is. |
| -D <boot Device> | Specifies eMMC or NAND. |
| -K <kernel> | Specifies the kernel image, such as zImage. |
| -I <initrd> | Specifies `initrd` file. Null `initrd` is the default. |
| -R <rootfs dir> | Specifies the sample rootfs directory. |
| -N <nfsroot> | Specifies the nfsroot, for example: `<my IP addr>:/my/exported/nfs/rootfs` |
| -S <size> | Specifies the rootfs size in bytes. This is valid only for internal rootdev. |
| -B <tegra binary> | Specifies the Tegra binary TGZ file. |
| -X <xabi tgz> | Specifies the X driver ABI TBZ2 file. |
| -O <xrog.conf file> | Specifies the `xorg.conf` file to override the default. |

# Synchronizing the Kernel Sources

You can manually rebuild the kernel used for this package. Internet access is required to do so. All the related scripts are located in the kernel directory.

### Prerequisites

- You have installed Git. This can be done on Ubuntu 10.04 by running the following command:

  ```
  $ sudo apt-get install git-core
  ```

- Your system has the default Git port 9418 open for outbound connections.

### To rebuild the kernel

1. Get the kernel source by running the `source_sync.sh` script:

   ```
   $ ./source_sync.sh -k
   ```

   Which will prompt you to enter a 'tag' name, which is provided in the release notes. Alternatively, you can provide the 'tag' name when calling the script. For example:

```
$ ./source_sync.sh -k<TAG_NAME>
```

—Or—

You can also manually sync the sources, as follows:

```
$ cd <myworkspace>
$ git clone git://nv-tegra.nvidia.com/linux-2.6.git
kernel_sources
$ cd kernel_sources
$ git checkout <TAG_NAME>
```

where <TAG_NAME> is the 'tag' name that is available in the release notes.

You can sync to any Linux tag you would like, but the tag provided in the release notes will sync the sources to the same sources the release binary was built from. To see a list of the available release tags, use:

```
$ git tag –l 'tegra-l4t*
```

# Building the NVIDIA Kernel

Follow the steps in this procedure to build the NVIDIA kernel.

### Prerequisites

- You have downloaded the kernel source code.

### To build the Tegra Kernel

1. Export the following environment variables:

   ```
   $ export CROSS_COMPILE=<crossbin>
   $ export TEGRA_KERNEL_OUT=<outdir>
   $ export ARCH=arm
   ```

   where:

   - <crossbin> is the prefix applied to form the path to the tool chain for cross compilation, e.g., gcc. For a CodeSourcery tool chain, it will look something like:

     ```
     <csinstall>/arm-2009q1-203-arm-none-linux-gnueabi/bin/arm-
     none-linux-gnueabi-
     ```

   - <outdir> is the desired destination for the compiled kernel.

2. Execute the following commands:

   ```
   $ cd <myworkspace>/kernel
   $ mkdir $TEGRA_KERNEL_OUT
   ```

   - For Tegra 3, Cardhu, use:

     ```
     $ make O=$TEGRA_KERNEL_OUT tegra3_defconfig
     ```

- For Tegra 2 Ventana use:

  ```
  $ make O=$TEGRA_KERNEL_OUT tegra_defconfig
  ```

Where <myworkspace> is the parent of the Git root.

# Configuring ALSA

This topic documents how to configure the Advanced Linux Sound Architecture (ALSA) to enable playback. It pertains to both the Cardhu and Ventana boards.

### To playback using board speaker

- Execute the following commands:

```
amixer cset numid=46 2
amixer cset numid=47 2
amixer cset numid=44 63,63
amixer cset numid=49 1
amixer cset numid=50 1
amixer cset numid=51 1
amixer cset numid=52 1
amixer cset numid=53 1
amixer cset numid=54 1
amixer cset numid=63 1
amixer cset numid=64 1
amixer cset numid=33 120,120
amixer cset numid=48 63,63
```

# OpenGL/EGL Gears Test Application

If you would like to run a sample OpenGL/EGL test application, you can run the open-source Gears application.

### To install and run Gears test application

1. Boot the target system with Ethernet connection and install the `mesa-utils-extra` package.

   ```
   $ sudo apt-get install mesa-utils-extra
   ```

2. Manually create the sym-links in the target root file-system for `/usr/lib/libEGL.so.1` and `/usr/lib/libGLESv2.so.2`.

   ```
   $ mv /usr/lib/libEGL.so /usr/lib/libEGL.so.1
   $ mv /usr/lib/libGLESv2.so /usr/lib/libGLESv2.so.2
   $ ln -s /usr/lib/libEGL.so.1 /usr/lib/libEGL.so
   $ ln -s /usr/lib/libGLESv2.so.2 /usr/lib/libGLESv2.so
   ```

3. At this point you should be able to run the application with the following steps:

```
$ export DISPLAY=:0
$ X&
$ /usr/bin/es2gears
```

# GStreamer-based Multimedia Playback (NvGstPlayer)

You can use the GStreamer open source multimedia framework and the NvGstPlayer utility for testing multimedia local playback and HTTP/RTSP streaming playback use cases. The NvGstPlayer can be used as a reference implementation.

This section tells you how to install and use these applications. This section includes the following sub-topics.



## Installing GStreamer

You install GStreamer from the Internet directly on the target. There is a wrapper library called `gst-openmax` that is an interface between GStreamer and OpenMAX, which enables accelerated NVIDIA plug-ins in the GStreamer framework

For more information about GStreamer, see the following website:

`http://gstreamer.freedesktop.org`

NvGstPlayer is a multimedia player test application.

**To install GStreamer on the target**

1. Execute:

```
$ sudo apt-get -y install gstreamer-tools
$ sudo apt-get -y install gstreamer0.10-plugins-good
$ sudo apt-get -y install gstreamer0.10-plugins-bad
$ sudo apt-get -y install gstreamer0.10-plugins-ugly
$ sudo apt-get install gstreamer0.10-plugins-base
$ sudo apt-get -y install alsa-utils
$ sudo apt-get -y install gstreamer0.10-alsa
$ sudo apt-get –y install gstreamer0.10-ffmpeg # required for
nvgstcapture
```

2. Once this is installed you can see if the installation is complete by typing the following:

```
gst-inspect | grep qtdemux
```

### To install GStreamer-0.10 on Cardhu

- Before starting NvGstPlayer, execute the following commands:

```
xinit &
export DISPLAY=:0
```

## Using NvGstPlayer

NvGstPlayer is a command line media file player. It will play audio/video files encapsulated in MP4, 3GP, AVI, ASF, WMA, MKV, M2TS, WEBM, and MOV. NvGstPlayer supports local file playback and playback over RSTP, HTTP, and UDP. This section describes NvGstPlayer usage, runtime commands, default settings, and important notes.

### Usage

```
./nvgstplayer [OPTIONS]
```

### Options

For the complete list of options, see the Help menu.

```
./nvgstplayer  --help
```

Most options are self-explanatory. Some of the more complicated commands are described in the following sections:



## Simple Execution

```
./nvgstaplayer -i <uri>
```

### Examples

```
./nvgstplayer -i /home/test.mp4
./nvgstplayer -i file:///home/test.mp4
```

```
./nvgstplayer -i udp://192.168.2.5:123
```

## Operating Modes

NvGstPlayer operates in two modes:

- Playbin2 (option: `--use-playbin`)
- Decodebin2 (option: `--use-decodebin`; this is more flexible, allowing users to choose the elements of their choice)

## Audio/Video Decoder Chain (--sad/--svd)

The audio/video decoder chain usage takes in a decode chain for a particular URI, either through the `-i` or `-u` option URI file.

### Examples

```
--sad=”ffdec_mp3”
--sad=”amrdec; variant=1 ! audioresample ! audioconvert”
--sad=”aacparse ! faad; min-latency=4000000”
--svd=”ffdec_h264; prop=val; prop2=val2”
```

**Note**: Use of the colon (;) delimiter and the exclamation mark (!) after every token.

## Audio/Video Post-Process Chain (--sac/--svc)

The audio/video post-process chain usage takes in a post-process chain for a particular URI, either through the `-i` or `-u` option URI file.

### Examples

```
--sac=”audioconvert ! audioresample”
--svc= “my_video_postprocess; prop1=val1 ! ffmpegcolorspace !
videoscale”
```

**Note**: Use of the colon (;) delimiter and the exclamation mark (!) after every token.

### To include this in your pipeline

- Ensure you have the `–disable-anative` and `--disable-vnative` option.

  —Or—

  Through the URI file `native_video=0` and `native_audio=0`.

## Audio/Video Render Chain (--sas/--svs)

The audio/video render chain usage takes in a render chain for a particular URI, either through the `-i` or `-u` option URI file.

### Examples

```
--sas=”alsasink; device=hw:0,0”
--sas=”audioconvert ! alsasink”
--svs= “xvimagesink”
--svs = “ffmpegcolorspace ! videoscale ! ximagesink; sync=0”
```

**Note**: Use of the colon (;) delimiter and the exclamation mark (!) after every token.

## Elements File (--elemfile/-e)

The elements file usage is an input file containing the elements: sources, decoders, parsers, post-process, sinks.

### Decoders/Parsers Chain Format

The following shows the format for audio and video decoder/parser chains:

```
[capabilties]
type=val <val>
pipe=<my_chain>
```

where <val> is `sad` or `svd.`

### Post-Process/Render Chain Format

The following shows the format for post-process and render chains:

```
[type]
pipe=<my_chain>
```

### Example

```
[video/x-h264]
type=svd
pipe=h264parse ! my_h264_dec; prop1=val1

[svs]
pipe=xvimagesink

[sas]
pipe=audioconvert ! osssink; device=/dev/dsp1; latency-
time=20000;
```

```
[video/mpeg, mpegversion=4]
type=svd
pipe= ffdec_mpeg4

[audio/mpeg, mpegversion=1, layer=3]
type=sad
pipe= mp3parse ! mad

[audio/mpeg, mpegversion=4]
type=sad
pipe=faad

[svc]
pipe= ffmpegcolorspace; qos=0 ! videoscale
```

## Command Sequence Expression (--cxpr/-x)

The command sequence expression option (as a string) provides a series of commands in an expression format. The following table shows the commands that can be inserted in the expression.

| Options | Description |
|---|---|
| r<val> | Plays for <val> seconds until next command in the expression. |
| p<val> | Pauses for <val> seconds until next command in the expression. |
| z<val> | Stops for <val> seconds until next command in the expression. |
| w<val> | Does nothing for <val> seconds until next command in the expression. |
| s<val> | Seeks to absolute time <val> seconds. |
| v<val> | Seeks to absolute time <val> in % of duration. |
| f<val> | Seeks to relative time <val> seconds from current position. |
| > | Seeks forward by 10 seconds. |
| < | Seeks backward by 10 seconds. |
| ] | Goes to the next track. |
| [ | Goes to the previous track. |
| c | Resets the current track. |

### Examples

```
r10.5,s80,w5,p7,r
```

Does the following, in the following order:

- Plays the media for 10.5 seconds.
- Seeks to 80 milliseconds from the start of the media.
- Waits, doing nothing (not playing or pausing or performing any other action) for 5 seconds.
- Pauses for 7 seconds.

- Plays the media continuously.

This iterates the expression 2 times:

```
2{p10,r,w7,s90.55,w2,p,w10,r2}
```

This iterates the expression 2 times:

```
2{r20,s10,w5,p10, 2{s10,w6,r9}, 3{r10, p20}}
```

This iterates the expression 5 times:

```
5{r8, p10, s90, w10}, 8{s10, w2, p20}
```

## Random Command Sequence Expression (--cxpr=*)

Use `cxpr` as "*"for a random command sequence expression.

### Example

This generates a random command sequence expression of up to 100 characters.

```
./nvgstplayer -i <uri> --cxpr=*
```

## URI File (--urifile/-u)

The URI file is a file containing a list of URIs. The player plays all URIs listed in the file. The options for the URI listed in the URI file override the same options set by the application through command line arguments for that particular URI.

### URI File Format

The following shows the format for a URI file:

```
[uri1]
option1=val1
option2=val2
..........
..........

[uri2]
option1=val1
..........
..........
```

### URI File Options

The following table shows the possible options for URIs inside the URI file.

| Options | Description |
|---|---|
| cxpr=<val> | Command expression for the URI. |
| nop=<val> | If `1`, disables the global `cxpr`, if given as command-line argument. |
| start=<val> | Starts playback time in seconds or percentage of URI duration. |
| startper=<val> | `1` indicates that the `start` option will be a % value. |
| duration=<val> | Desired playback time in seconds. |
| repeats=<val> | Playback iterations. |
| audio=<val> | 0/1 to disable/enable audio in the URI. |
| video=<val> | 0/1 to disable/enable video in the URI. |
| native_video=<val> | 0/1 to disable/enable native video rendering. |
| native_audio=<val> | 0/1 to disable/enable native audio rendering. |
| sync=<val> | 1/0 to enabling/disabling AV sync. |
| use-buffering=<val> | 1/0 to enable/disable buffering. |
| low-percent=<val> | Low threshold for buffering in %. |
| high-percent=<val> | High threshold for buffering in %. |
| max-size-bytes=<val> | Maximum size of bytes in queue for buffering. |
| max-size-buffers=<val> | Maximum size of buffers in queue for buffering. |
| max-size-time=<val> | Maximum size time in queue for buffering. |
| image-display-time=<val> | Image display time in seconds, if URI is an image file. |
| tags=<val> | 0/1 disable/enable tags print. |
| svd=<val> | Video decoding chain. |
| sad=<val> | Audio decoding chain. |
| svc=<val> | Video post-processing chain. |
| sac=<val> | Audio post-processing chain. |
| svs=<val> | Video rendering chain. |
| sas=<val> | Audio rendering chain. |
| shttp=<val> | HTTP source chain. |
| srtsp=<val> | RTSP source chain. |
| sudp=<val> | UDP source chain. |
| sfsrc=<val> | File source chain. |

### Example

```
./nvgstplayer -u TestURIfile
```

Where `TestURIfile` contains:

```
[/home/user/test.avi]
cxpr=2{p5, r, w10, s20.5, w6.6, p3, 2 {r, w10, p4}}
start=10.45
```

```
repeats=3
audio=0
native_video=0
svd=my_h264dec
svc=ffmpegcolorspace ! my_pp; prop1=shuba; prop2=val2; !
videoscale

[/home/user/test.mp3]
sas=audioconvert ! alsasink

[/home/user/test.mp4]
nop=1
video=0
```

**Note**: The elements can be provided through various methods, such as:

- Elements file.
- Command line arguments, which will be applicable to all the streams in the `urifile`, or `-i` option.

  This overrides the value inside the elements file, if present.

- URI file, where we specify each URI.

  This overrides the command line argument, if given, as well as the value inside the elements file, if present.

**Example**

The URI list can be looped forever by providing `--loop-forver` option.

```
./nvgstplayer -u <uri_file> --loop-forever
```

# Gstreamer-based Camera Capture (NvGstCapture)

The NvGstCapture application supports GStreamer version 0.10.32. NvGstCapture can capture audio and video data using microphone and camera and encapsulate encoded A/V data in the container file.

## Installing NvGstCapture

Follow these steps to install the `nvgstcapture` application.

**To install nvgstcapture**

1. Follow installation steps for in Installing GStreamer in this section.

2. Verify the device is running GStreamer version 0.10.32 by executing the following command:

   ```
   $ gst-inspect --version
   ```

3. Start X Windows, and execute:

   ```
   $ export DISPLAY=:0
   $ xinit &
   ```

4. To enable audio capture using the built-in microphone on cardhu, set the following amixer settings:

   ```
   $ amixer cset numid=82 on
   $ amixer cset numid=71 1
   $ amixer cset numid=1 on
   $ amixer cset numid=4 on
   $ amixer cset numid=77 0
   $ amixer cset numid=74 on
   $ amixer cset numid=42 63,63
   $ amixer cset numid=2 31,31
   $ amixer cset numid=5 31,31
   ```

5. Run nvgstcapture application:

   ```
   $ nvgstcapture
   ```

6. When `nvgstcapture` is running you can type commands to do video and camera capture.

   **Note**: At this point, the `nvgstcapture` application does not look like it is accepting input but it is.

### Additional Notes

- The output image/video files (JPG/MP4) are generated in the same directory as the nvgstcapture application.
- The filenames are named as `nvgsttest(%d).jpg` or `nvgsttest(%d).mp4`.The `%d` indicates a counter starting from 0 every time the application is launched.

  **CAUTION**: Be sure to backup the recorded files if you need them before launching the application again; otherwise, if you start `nvgstcapture` and take an image, then close it and restart and take another image, the image taken originally taken is overwritten.

- To encode H.263, you must use either 3GP or AVI container formats, as the MP4 container is not supported for H.263 encode.
- The `nvgstcapture` application also supports camerabin2 and GstPhotography, with the pre-requisite that GStreamer is version 0.10.36 at minimum. To use GstPhotography and camerabin2, you must compile and install GStreamer version 0.10.36 on device.

# Using NvGstCapture

NvGstCapture supports both command-line and runtime options.

### Usage

```
./nvgstcapture [OPTIONS]
```

### Options

```
./nvgstcapture –help
```

This section includes the following topics:



## Command-Line Options

The following table shows the command-line options for NvGstCapture.

| Options | Description | Examples |
|---|---|---|
| -V, --vcap_res | Video capture width and height | -V 720x480 |
| -I, --icap_res | Image capture width and height | -I 720x480 |
| -m, --mode | Capture mode value (2=video 1=still) | -m 2 |
| -e, --exposure | Capture exposure value | -e 0 |
| -i, --iso | Capture ISO value | -i 200 |
| -n, --contrast | Capture contrast value | -n 33 |
| -f, --flicker | Capture flicker value | -f 2 |
| -b, --brightness | Capture brightness value | -b 33 |
| -s, --saturation | Capture saturation value | -s 33 |
| -h, --hue | Capture hue value | -h 33 |
| -y, --edgeenhancement | Capture edge enhancement value | -y 0 |
| -g, --imagefilter | Capture image filter value | -g 0 |
| -w, --whitebalance | Capture white balance value | -w 0 |
| -d, --stereo | Stereo mode (0=Off 1=Left Only 2=Right Only 3=Stereo full) | -d 1 |
| -v, --video_enc | Video encoder type (0=h264 1=h263 2=mpeg4) | -v 0 |
| -u, --audio_enc | Audio encode type (0=aac 1=amr) | -u 0 |
| -k, --file_type | Container file type (0=mp4 1=3gp 2=avi) | -k 0 |
| -x, --voice_control | Voice control value (1=on 0=off) | -x 0 |
| -q, --sensorid | Camera sensor ID (0=Primary(Left-back) | -q 0 |

| | | |
|---|---|---|
| | 1=Secondary(Front) 3=stereo) | |

| Notes |
|---|
| The `-d` option is only valid if `sensorid=3` is set, for example:<br>`./nvgstcapture -q 3 -d 2` |

## Runtime Options

The following table shows the runtime options for NvGstCapture. Most of the options are simple to understand (use `--help`).

| Options | Command |
|---|---|
| Quit | `q` |
| Set capture mode | `mo:<val>`<br>`(2): video`<br>`(1): image` |
| Get capture mode | `gmo` |
| Capture | Enter `j`, or<br><br>Followed by a timer (`jx5000` to capture after 5 seconds), or<br><br>Followed by multishot count (`j:6` to capture 6 images).<br><br>Timer/multishot values are optional; capture defaults to a single shot with timer=0s. |
| Start recording | Enter `1` |
| Stop recording | Enter `0` |
| Set zoom value | `z:<val> eg z:1.5` |
| Get zoom value | `gz` |
| Set container file type (0=mp4 1=3gp 2=avi) | `k:<val> eg k:0` |
| Get container file type | `gk` |
| Set image capture resolution (only in image mode | `icr:<w>x<h> eg icr:640x480` |
| Get image capture resolution | `gicr` |
| Set video capture resolution (only in video mode) | `vcr:<w>x<h> eg vcr:640x480` |
| Get video capture resolution | `gvcr` |

| | |
|---|---|
| Set flash | xx:<val><br>(0) : auto<br>(1) : off<br>(2) : on<br>(3) : fill-in (Not supported)<br>(4) : red-eye (Not supported)<br>(5) : torch (Not supported) |
| Get flash | gxx |
| Rotation preview | px:<val>, val=0,90,180,270 |
| Rotation capture | cx:<val>, val=0,90,180,270 |
| Set exposure | ex:<val>, Range val= -1 - 2147483647, 0=auto |
| Get exposure | gex |
| Set white balance | wb:<val><br>(0) : auto<br>(1) : daylight<br>(2) : cloudy<br>(3) : sunset<br>(4) : tungsten<br>(5) : fluorescent<br>(6) : shade<br>(7) : incandescent<br>(8) : flash<br>(9) : horizon<br>(10) : off |
| Get white balance | gwb |
| Set iso mode | io:<val>, val= 100,200,400,800, 0=auto |
| Get iso mode | gio |
| Set metering | mt:<val>,<br>(0) : average<br>(1) : spot<br>(2) : matrix |
| Get metering | gmt |
| Set ev compensation | ev:<val>, Range = -2.5 - 2.5 |
| Get ev compensation | gev |
| Set brightness | bt:<val>, Range val= 0 - 100 |
| Get brightness | gbt |
| Set saturation | st:<val>, Range val= -100 - 100 |

| | |
|---|---|
| Get saturation | `gst` |
| Set contrast | `ct:<val>, Range val= 0 - 100` |
| Get contrast | `gct` |
| Set hue | `ht:<val>, Range val= 0 - 100` |
| Get hue | `ght` |
| Set flicker control | `fl:<val>`<br>`(0) : off`<br>`(1) : 50Hz`<br>`(2) : 60Hz`<br>`(3) : auto` |
| Get flicker control | `gfl` |
| Set color-tone mode control | `ft:<val>`<br>`(0) : normal`<br>`(1) : sepia`<br>`(2) : negative`<br>`(3) : grayscale(Not supported)`<br>`(4) : natural(Not supported)`<br>`(5) : vivid(Not supported)`<br>`(6) : colorswap(Not supported)`<br>`(7) : solarize`<br>`(8) : out-of-focus(Not supported)`<br>`(9) : sky-blue(Not supported)`<br>`(10) : grass-greeen(Not supported)`<br>`(11) : skin-whiten(Not supported)`<br>`(12) : noise(Not supported)`<br>`(13) : emboss`<br>`(14) : sketch(Not supported)`<br>`(15) : oilpaint(Not supported)`<br>`(16) : hatch(Not supported)`<br>`(17) : gpen(Not supported)`<br>`(18) : antialias(Not supported)`<br>`(19) : dering(Not supported)`<br>`(20) : posterize`<br>`(21) : bw`<br>`(22) : manual`<br>`(23) : aqua` |
| Get color-tone mode control | `gft` |
| Set scene mode | `scm:<val>`<br>`(0) : Manual`<br>`(1) : Closeup(Not supported)`<br>`(2) : Portrait`<br>`(3) : Landscape`<br>`(4) : Sports`<br>`(5) : Night`<br>`(6) : Auto`<br>`(7) : Action` |

| | |
|---|---|
| | (8) : Beach<br>(9) : Candlelight<br>(10) : Fireworks<br>(11) : NightPortrait<br>(12) : Party<br>(13) : Snow<br>(14) : Sunset<br>(15) : Theatre<br>(16) : Barcode |
| Get scene mode | gscm |
| Set noise-reduction mode | nr:<val>,<br>(1) : on<br>(0) : off |
| Get noise-reduction mode | gnr |
| Set edge enhancement | ee:<val> Range = -1.0 - 1.0, |
| Get edge enhancement | gee |
| Set stereo mode (only applicable if sensorid=3) | stm:<val><br>(0) : Off<br>(1) : Left Only<br>(2) : Right Only<br>(3) : Stereo Full |
| Get stereo mode | gstm |
| Set audio encoder | ae:<val>, val= 0(aac),1(amr) |
| Get audio encoder | gae |
| Set video encoder | ve:<val>, val= 0(h264), 1(h263), 2(mpeg4) |
| Get video encoder | gve |

## Capture Resolution Support

The following shows the supported capture resolutions.

### Image Encode

- 176 x 144
- 320 x 240
- 480 x 480
- 640 x 480
- 800 x 600
- 720 x 480
- 1280 x 720

- 1280 x 960 (1 MP)
- 1600 x 1200 (2 MP)
- 2048 x 1536 (3 MP)
- 2240 x 1680 (4 MP)
- 2560 x 1920 (5 MP)

### Video Encode

H.264 / MPEG-4 (supports mp4/3gp/avi containers)

- 176 x 144
- 320 x 240
- 640 x 480
- 720 x 480
- 1280 x 720
- 1920 x 1080

H.263 (supports 3gp/avi containers)

- 176 x 144 (QCIF)
- 352 x 288 (CIF)
- 704 x 576 (4CIF)

# U-Boot Guide

This document describes the U-Boot implementation for NVIDIA® Tegra® Linux Driver Package. It covers the following topics:



## Requirements

This topic provides software requirements and prerequisites, including Linux kernel options that are required for Tegra Linux Driver Package (L4T).

- U-Boot.

  Functionality was validated using an Ubuntu 10.04 host system; however, later versions or alternative Linux distributions may work with host-specific modifications.

- Tegra Linux Driver Package (L4T).

  Download the latest L4T package from the Tegra Developer Zone and follow the installation instructions in the user documentation. You can find L4T on the Tegra Developer Zone:

  `http://developer.nvidia.com/linux-tegra`

- Flex and Bison.

  The U-Boot makefiles require flex and bison to parse various configuration files. If flex and bison are not already installed on your host machine, you can install them with the following command:

```
$ sudo apt-get install flex bison
```

- Device Tree Compiler (dtc).

  You must either ensure that dtc is available to be passed in as a variable to the U-Boot make system or make it available in the host machine's local command path. Most of the dtc packages available from standard Linux distribution package management systems (like `apt`) are not yet updated with a version of dtc with the features required by the U-Boot makefile. Therefore, an example of building dtc from source is included in this section. For the procedure, see the Using Device Tree Compiler topic in this section.

- mkimage Image Tool (mkimage).

  The U-Boot image tool must be installed on the host machine. This tool is what generates the `vmlinux.uimg` from the kernel zImage. If `mkimage` is not installed, it can be obtained by building the top-level U-Boot make target. For more information on building U-Boot, see Downloading and Building U-Boot in this section. The `mkimage` tool can then be found in the U-Boot source directory at:

  ```
  ./tools/mkimage
  ```

- Cross Compiler for ARM.
- U-Boot source.

  For more information, see the Downloading and Building U-Boot topic in this section.

- Kernel source.

  For information, see the following sections in the Getting Started chapter:

  - Setting Up Your Environment
  - Synchronizing the Kernel Sources
  - Building the NVIDIA Kernel

  Also, see the Adding a Compiled Kernel to the Root File System topic in this section.

# Using Device Tree Compiler

This topic provides an example of building the Device Tree Compiler (dtc) from source to include the features required by the U-Boot makefile.

### To build dtc from source

1. If you do not want to pass in dtc as a parameter to the U-Boot environment, ensure a local command path (such as `./usr/local/bin` or another choice) is at the beginning of the shell command path.

   ```
   $ export PATH=<local_command_path>:${PATH}
   ```

   **Note**: The dtc makefile installs the binary into the first entry of shell PATH variable, so it is important that the local command path is at the beginning of the shell PATH variable.

2. Create a directory to contain the dtc source code and change directories into it:

   ```
   $ mkdir -p <dtc_src_dir>
   $ cd <dtc_src_dir>
   ```

3. Download dtc source code by executing the following `git clone` command:

   ```
   $ git clone http://git.jdl.com/software/dtc.git
   ```

   **Note**: At time of publication, the tested commit ID for dtc is:

   ```
   a6e6c60e3a97a6b3a033cd052bb3740fd53cbf4c
   ```

4. Build and optionally install dtc by executing:

   ```
   $ cd <dtc src dir>/dtc
   $ make
   ```

   Or, alternatively, if you want it installed on your local host file system execute:

   ```
   $ make install
   ```

   **Note**: if you specified just `make` be sure to pass in the following to the U-Boot make system:

   ```
   DTC=${PATH_TO_DTC_TOOL_BINARY}
   ```

   Where PATH_TO_DTC_TOOL_BINARY is the location of the dtc binary, such as:

   ```
   <dtc_src_dir>/dtc/dtc
   ```

# Downloading and Building U-Boot

This topic provides the steps to follow when downloading and building U-Boot to use as a boot loader for the Tegra device.

### To download and build U-Boot

1. Download the L4T U-Boot source code by executing the following commands:

   ```
   $ mkdir -p <uboot_src_dir>
   $ cd <uboot_src_dir>
   $ git clone -n git://nv-tegra.nvidia.com/3rdparty/u-boot.git
   ```

   Alternatively, you can use the `source_sync.sh` script that is provided in the release directory and skip Step 2 below.

   When running `source_sync.sh -u`, if no parameters are provided, the script prompts for the `<TAG_NAME>`, which is provided in the release notes. Also, you can run the script by passing the `<TAG_NAME>` in as follows:

   ```
   $ source_sync.sh –u <TAG_NAME>
   ```

   This will sync the source to `<source_sync.sh_location>/sources/u-boot_source`. Use that path below in Step 4.

2. Check out the git tag name:

   ```
   $ cd u-boot
   $ git checkout -b mybranchname <tag_name>
   ```

   where `<tag_name>` is provided in the Release Notes.

3. Set the build environment:

   ```
   $ export ARCH=arm
   $ export CROSS_COMPILE=<toolchain>/…/bin/arm-none-linux-
   gnueabi-
   $ export CONFIG_L4T=1
   $ export USE_PRIVATE_LIBGCC=yes
   $ export DTC=<dtc_binary_location>
   ```

4. Build U-Boot by executing:

   ```
   $ cd <uboot_src_dir>/u-boot
   $ make distclean
   $ make cardhu_config
   $ make
   ```

5. Copy U-Boot for flashing to the device:

   ```
   $ cp u-boot.bin
   <L4T_path>/Linux_for_Tegra/bootloader/<platform>
   ```

   **Note**: Before copying U-Boot, it is recommended that you back up the `u-boot.bin` file in this directory.

6. If using network booting, perform the following steps.

   **Note**: You can use any tftp daemon, but you must use the `/tftpboot` directory of the host machine specifically to perform the tftp boot.

   - Execute the following command:

```
$ sudo apt-get install tftpd
```

- Locate and edit the following file:

  ```
  /etc/inetd.conf
  ```

  Ensure it has following line:

  ```
  tftp dgram udp wait nobody /usr/sbin/tcpd/usr/sbin/in.tftpd
  /tftpboot
  ```

- Execute the following commands:

  ```
  $ cd /etc/init.d; ./openbsd-inetd restart
  $ cp <L4T_path>/Linux_for_Tegra/bootloader/<platform>
  /tftpboot
  ```

# Adding a Compiled Kernel to the Root File System

This topic describes the steps to create and install into the sample file system the kernel image that U-Boot needs.

### Prerequisites

- You have compiled the kernel as described in Getting Started in this guide.

### To configure a file system for U-Boot

- Use `the zimage_to_uimg.sh` script to create the `vmlinux.uimg` from your kernel zImage by executing the following commands:

  ```
  $ cd <l4t path>/Linux_for_Tegra
  $ ./zimage_to_uimg.sh –zImage <path>/zImage
  ```

  With default values, `zimage_to_uimg.sh` writes `vmlinux.uimg` to the kernel directory of the extracted L4T release. Run `zimage_to_uimg.sh –h` for description of other parameters.

  The `zimage_to_uimg.sh` script runs `mkimage` with the appropriate parameters to create the `vmlinux.uimg` file in the kernel directory. The apply_binaries script copies the `vmlinux.uimg` in the kernel directory into the `rootfs` directory in the `/boot` folder. You can then install the `rootfs` directory onto your device. For information on installing the `rootfs` directory onto your device, see Setting Up the Root File System in the Getting Started chapter.

  If you have already installed your rootfs onto a device, you can manually copy the `vmlinux.uimg` file created by the `zImage_to_uimg.sh` script to the previously installed root file system.

**To configure a network file system for U-Boot**

- For a network RootFS, use the `--dest` option to specify the path to the host machine's `nfs` root directory with the "LDK_ROOTFS_DIR" variable. It will look as follows:

  ```
  $ ./zImage_to_uimg.sh --zImage <path to zImage>/zImage --dest
  ${LDK_ROOTFS_DIR}/boot
  ```

  Use the `rootfs` with the updated `vmlinux.uimg` file and configure NFS boot as described in the Configuring NFS Root on the Linux Host topic in the Getting Started chapter.

**To configure a file system installed in the internal eMMC**

1. Copy the compiled zImage kernel over the current L4T release kernel by executing the following command:

   ```
   $ cp arch/arm/boot/zImage <L4T_path>/Linux_for_Tegra/kernel
   ```

   **Note:** Optionally, rename existing release kernel to avoid overwriting it with the copy.

2. Run the `flash.sh` script to install the `rootfs` directory onto internal eMMC.

# Flashing U-Boot

This section presents the theory of usage for flashing U-Boot followed by the commands used to flash. It contains the following topic:

- eMMC Partition as Script Partition
- Fastboot Creation of GPT
- Example eMMC Layout with Script Partition
- Flash Commands

## eMMC Partition as Script Partition

Because you use the standard NvFlash Utility and the `fastboot.bin` flash application, U-Boot shares the same internal eMMC partition layout as fastboot does. The only difference is that L4T U-Boot does not use the `kernel` partition in the usual fashion: U-Boot uses the `kernel` partition as its **boot-script partition**. Additionally, U-Boot expects the kernel file named `vmlinux.uimg` in the following directory:

```
<rootfs>/boot
```

## Fastboot Creation of GPT

Fastboot creates the GPT partition, which contains the secondary GUID Partition Table (GPT) that must be located in the last 512-byte (B) sector of the boot device.

**Note**: The boot device is not necessarily the same as the rootfs device.

The logical block addressing (LBA) of the last-512-B sector varies from device to device. Both U-Boot and the kernel know how to query the hardware to obtain the LBA of the last 512-B sector.

## Example eMMC Layout with Script Partition

This topic provides an example eMMC layout showing the script partition and configuration (CFG) file contents.

U-Boot shares the same layout as fastboot; the layout is described in the following released configuration file:

```
gnu_linux_fastboot_emmc_full.cfg
```

The kernel partition (name=LNX) gets used as the script partition.

### Example CFG Contents

```
[device]
type=sdmmc
instance=3

[partition]
name=BCT
id=2
type=boot_config_table
allocation_policy=sequential
filesystem_type=basic
size=4194304
file_system_attribute=0
partition_attribute=0
allocation_attribute=8
percent_reserved=0

[partition]
name=PT
id=3
type=partition_table
allocation_policy=sequential
filesystem_type=basic
size=2097152
file_system_attribute=0
partition_attribute=0
allocation_attribute=8
percent_reserved=0
```

```
[partition]
name=EBT
id=4
type=bootloader
allocation_policy=sequential
filesystem_type=basic
size=2097152
file_system_attribute=0
partition_attribute=0
allocation_attribute=8
percent_reserved=0
filename=fastboot.bin

[partition]
name=SOS
id=5
type=data
allocation_policy=sequential
filesystem_type=basic
size=6291456
file_system_attribute=0
partition_attribute=0
allocation_attribute=8
percent_reserved=0
#filename=recovery.img

[partition]
name=LNX
id=6
type=data
allocation_policy=sequential
filesystem_type=basic
size=8388608
file_system_attribute=0
partition_attribute=0
allocation_attribute=8
percent_reserved=0
filename=boot.img

[partition]
name=GP1
id=7
type=GP1
allocation_policy=sequential
filesystem_type=basic
size=2097152
file_system_attribute=0
partition_attribute=0
allocation_attribute=8
percent_reserved=0

[partition]
name=APP
id=8
type=data
allocation_policy=sequential
```

```
filesystem_type=basic
size=1073741824
file_system_attribute=0
partition_attribute=0
allocation_attribute=8
percent_reserved=0
filename=system.img

[partition]
name=CAC
id=9
type=data
allocation_policy=sequential
filesystem_type=basic
size=4194304
file_system_attribute=0
partition_attribute=0
allocation_attribute=8
percent_reserved=0

[partition]
name=MSC
id=10
type=data
allocation_policy=sequential
filesystem_type=basic
size=2097152
file_system_attribute=0
partition_attribute=0
allocation_attribute=8
percent_reserved=0

[partition]
name=USP
id=11
type=data
allocation_policy=sequential
filesystem_type=basic
size=4194304
file_system_attribute=0
partition_attribute=0
allocation_attribute=8
percent_reserved=0

[partition]
name=UDA
id=12
type=data
allocation_policy=sequential
filesystem_type=basic
size=0xFFFFFFFFFFFFFFFF
file_system_attribute=0
partition_attribute=0
allocation_attribute=0x808
percent_reserved=0

[partition]
```

```
name=GPT
id=13
type=GPT
allocation_policy=sequential
filesystem_type=basic
size=0xFFFFFFFFFFFFFFFF
file_system_attribute=0
partition_attribute=0
allocation_attribute=8
percent_reserved=0
```

## Flash Commands

This topic provides the commands to use to flash U-Boot so that you can boot the device either from internal eMMC, from an SD Card, or from an IP network.

### To flash U-Boot to boot from internal eMMC

- Execute the following command:

  ```
  $ sudo ./flash.sh –L bootloader/<platform>/u-boot.bin
  <platform> mmcblk0p1
  ```

  Where `<platform>` is the device, such as cardhu for Tegra 3 or ventana for Tegra 2.

### To flash U-Boot to boot from an SD Card

- Execute the following command:

  ```
  $ sudo ./flash.sh –L bootloader/<platform>/u-boot.bin
  <platform> mmcblk1p1
  ```

  Where `<platform>` is the device, such as cardhu for Tegra 3 or ventana for Tegra 2.

### To flash U-Boot to boot from an IP network

- Execute the following command:

  ```
  $ sudo ./flash.sh –L bootloader/<platform>/u-boot.bin –N
  <IPA>:/<platform> [-n <target IPA>:<host IPA>:<gateway
  IPA>:<netmask>] <platform> eth0
  ```

  Where `<platform>` is the device, such as `cardhu` for Tegra 3 or `ventana` for Tegra 2.

# RootFS Tested By Device

This topic provides the results of testing the root file system location by device. The "Y" citations shown in the following table indicate that proper U-Boot initialization and hand-off to the kernel occurred, but this does not guarantee a fully-functional system.

| RootFS Location | Cardhu | Ventana |
|---|---|---|
| mmcblk0p1 | Y | Y |
| mmcblk1p1 | Y | Y |
| sda1 | Y | Y |
| eth0 | Y | Y |
| eth1 | Y | Not tested |
| usb0 | Not tested | Not tested |
| mtdblock1 | Unsupported | Unsupported |

# Example Hush Boot Scripts

This section provides example boot scripts for eMMC, SD Card, USB, and Network booting.

To minimize the foot print of the binary, U-Boot is designed to be configured by compile-time switches; however, in the Tegra Linux Driver (L4T) environment, it is desirable to have flash-time switches available to accommodate various L4T use cases. Therefore, to support flash-time switching, L4T implements a **script partition** concept, and the script partition can be edited and flashed to alter the U-Boot environment variables and boot parameters.

There are two example Hush Shell script files supplied in Tegra Driver for Linux release: `<platform>_emmc.hush` and `<platform>_net.hush`. Hush is a command line shell similar to Bourne Shell. L4T uses Hush as a Borne Shell-like U-Boot command-line interpreter.

## eMMC Hush Script

The eMMC Hush script handles booting with boot order from all local storage devices, such as internal eMMC, SD Card, and USB devices. This script checks the USB device first, the SD Card next, and then the internal eMMC memory. During these checks, if U-Boot finds a valid `vmlinux.uimg` kernel image file, it boots off of the device where it found the kernel image.

The Hush script can be edited to set desired U-Boot boot strapping characteristics. You can find the eMMC Hush script at the following location:

```
bootloader/<platform>/<platform>_emmc.hush
```

where `<platform>` is the device, such as cardhu for Tegra 3 or ventana for Tegra 2.

### Example Script Contents

The following shows the contents of the eMMC Hush script.

```
#
# U-boot environment for local storage boot.
#
usbname=sda
pn=1
#
# Static env:
#
board=cardhu
mmcname=mmcblk
loadaddr=0x80408000
baudrate=115200
bootdelay=3
bootfile=vmlinux.uimg
console=ttyS0,115200n8
stderr=serial,lcd
stdin=serial,tegra-kbc
stdout=serial,lcd
user=user
videospec=tegrafb
serial#=1
#
# Board Specific variable env:
#
# tegra_fbmem: handled by u-boot runtime.
lp0_vec=0x00002000@0x9C406000
#
# Multi purpose env containers:
#
platform_extras=vmalloc=128M mem=1024M@2048M
extra_bootargs=usbcore.old_scheme_first=1 core_edp_mv=1300
panel=lvds tegraid=30.1.2.0.0 debug_uartport=lsport smp
#
# Local Storage Boot Scripts:
#
regen_all=setenv common_bootargs console=${console}
console=tty1 lp0_vec=${lp0_vec} video=${videospec}
${platform_extras} ${dev_extras} noinitrd; setenv bootargs
${common_bootargs} ${extra_bootargs} ${bootdev_bootargs}
mmc_setup=setenv bootdev_bootargs
root=/dev/${mmcname}${mmcdev}p${pn} rw rootwait gpt; run
regen_all
```

```
mmc_boot=run mmc_setup; mmc rescan ${mmcdev}; ext2load mmc
${mmcdev}:${pn} ${loadaddr} /boot/${bootfile}; bootm
${loadaddr}
mmc0_boot=setenv mmcdev 0; run mmc_boot
mmc1_boot=setenv mmcdev 1; run mmc_boot
usb_setup=setenv bootdev_bootargs root=/dev/${usbname}${pn} rw
rootwait; run regen_all
usb_boot=usb start; run usb_setup; ext2load usb 0:${pn}
${loadaddr} /boot/${bootfile}; bootm ${loadaddr}
bootcmd=run usb_boot; run mmc1_boot; run mmc0_boot
```

## Net Hush Script

The Net Hush script handles booting from the Network File System (NFS). You can find the Net Hush script at the following location:

```
bootloader/<platform>/<platform>_net.hush
```

where `<platform>` is the device, such as cardhu for Tegra 3 or ventana for Tegra 2.

### Example Script Contents

The following shows the contents of the Net Hush script.

```
#
# U-boot environment for network boot.
#
#
# Static env:
#
board=cardhu
mmcname=mmcblk
loadaddr=0x80408000
baudrate=115200
bootdelay=3
bootfile=vmlinux.uimg
console=ttyS0,115200n8
stderr=serial,lcd
stdin=serial,tegra-kbc
stdout=serial,lcd
user=user
videospec=tegrafb
serial#=1
#
# All CAP nfs info tokens need to be replaced with proper
values as follow:
# IPADDR ----- 172.17.187.71
# SERVERIP --- 172.17.186.62
# GATEWAYIP -- 172.17.186.62
# NETMASK ---- 255.255.252.0
# NFSARGS ---- ip=:::::eth0:on or
ip=cip:sip:gip:mask::eth0:off
# NFSROOT ---- 172.17.187.62:/cardhu_nfsroot
```

```
#
ipaddr=IPADDR
serverip=SERVERIP
gatewayip=GATEWAYIP
netmask=NETMASK
tftppath=TFTPPATH
nfsbootargs=root=/dev/nfs NFSARGS nfsroot=NFSROOT
#
# Board Specific variable env:
#
# tegra_fbmem: handled by u-boot runtime.
lp0_vec=0x00002000@0x9C406000
#
# Multi purpose env containers:
#
platform_extras=vmalloc=128M mem=1024M@2048M
extra_bootargs=usbcore.old_scheme_first=1 core_edp_mv=1300
panel=lvds tegraid=30.1.2.0.0 debug_uartport=lsport smp
#
# Local Storage Boot Scripts:
#
regen_all=setenv common_bootargs console=${console}
console=tty1 lp0_vec=${lp0_vec} video=${videospec}
${platform_extras} ${dev_extras} noinitrd; setenv bootargs
${common_bootargs} ${extra_bootargs} ${bootdev_bootargs}

regen_net_bootargs=setenv bootdev_bootargs rw ${nfsbootargs} ;
run regen_all

nfs_setup=setenv autoload n; run regen_net_bootargs
nfs_boot=run nfs_setup; dhcp; tftpboot ${loadaddr}
${tftppath}; bootm ${loadaddr}

bootcmd=usb start; run nfs_boot
```

# Debugging U-Boot Environment

This section provides some debugging tips for your U-Boot environment. The examples shown, however, do not represent a comprehensive listing for U-Boot functionality. For a full listing of supported commands and their usage by U-Boot, see the U-Boot documentation and source.

For example, one common problem that can occur is when you create your own kernel and U-Boot has trouble finding it. To verify that U-Boot can read the device and also see the files in the file system, the commands listed in examples in this section may be beneficial. If a boot device is not found or the device has trouble booting with kernel other than the reference kernel provided in the L4T release, check the examples in this section for debug assistance.

## Interrupting U-Boot

You can interrupt U-Boot during boot.

### To interrupt U-Boot

- Press any key during boot.

## Getting Help

On the U-Boot terminal screen, you can type `help` at any time for the list of supported commands from the U-Boot terminal.

### To see the U-Boot Help screen on Tegra 3

- Enter:

  ```
  Tegra3 # help
  ```

  The below shows example Help information printed when executing `help` on a Tegra 3 device.

```
?       - alias for 'help'
base    - print or set address offset
bdinfo  - print Board Info structure
boot    - boot default, i.e., run 'bootcmd'
bootd   - boot default, i.e., run 'bootcmd'
bootm   - boot application image from memory
bootp   - boot image via network using BOOTP/TFTP protocol
cls     - clear screen
cmp     - memory compare
coninfo - print console devices and information
cp      - memory copy
crc32   - checksum calculation
dcache  - enable or disable data cache
dhcp    - boot image via network using DHCP/TFTP protocol
echo    - echo args to console
editenv - edit environment variable
env     - environment handling commands
exit    - exit script
ext2load- load binary file from a Ext2 filesystem
ext2ls  - list files in a directory (default /)
false   - do nothing, unsuccessfully
fatinfo - print information about filesystem
fatload - load binary file from a dos filesystem
fatls   - list files in a directory (default /)
fdt     - flattened device tree utility commands
go      - start application at address 'addr'
gpio    - GPIO access
help    - print command description/usage
i2c     - I2C sub-system
icache  - enable or disable instruction cache
```

```
iminfo  - print header information for application image
imxtract- extract a part of a multi-image
itest   - return true/false on integer compare
loadb   - load binary file over serial line (kermit mode)
loads   - load S-Record file over serial line
loady   - load binary file over serial line (ymodem mode)
loop    - infinite loop on address range
md      - memory display
mm      - memory modify (auto-incrementing address)
mmc     - MMC sub system
mmcinfo - display MMC info
mtest   - simple RAM read/write test
mw      - memory write (fill)
nm      - memory modify (constant address)
ping    - send ICMP ECHO_REQUEST to network host
printenv- print environment variables
reset   - Perform RESET of the CPU
run     - run commands in an environment variable
saveenv - save environment variables to persistent storage
setenv  - set environment variables
sf      - SPI flash sub-system
showvar - print local hushshell variables
sleep   - delay execution for some time
source  - run script from memory
sspi    - SPI utility command
test    - minimal test like /bin/sh
tftpboot- boot image via network using TFTP protocol
time    - run a command and report its run time
true    - do nothing, successfully
usb     - USB sub-system
usbboot - boot from USB device
version - print monitor, compiler and linker version
```

## Listing a Directory Structure

You can list the directory structure of a particular device. For example, you can list the directory structure of sda1 in U-Boot by typing: `usb 0:1` (for USB device 0 partition 1).

### To list the directory structure

- Execute the following command:

  ```
  Tegra3 # ext2ls usb 0:1
  ```

  **Note**: This works on EXT3 file systems, as well.

  Example output follows:

  ```
  <DIR>       4096 .
  <DIR>       4096 ..
  <DIR>       4096 bin
  <DIR>       4096 boot
  <DIR>       4096 dev
  ```

```
<DIR>       4096 etc
<DIR>       4096 home
<DIR>       4096 lib
<DIR>       4096 lost+found
<DIR>       4096 media
<DIR>       4096 mnt
<DIR>       4096 opt
<DIR>       4096 proc
<DIR>       4096 root
<DIR>       4096 sbin
<DIR>       4096 selinux
<DIR>       4096 srv
<DIR>       4096 sys
<DIR>       4096 tmp
<DIR>       4096 usr
<DIR>       4096 var
```

## Listing the Contents of a Directory

You can list the contents of any directory.

**To list contents of a directory**

- Execute following command:

  `Tegra3 # ext2ls usb 0:1 $DIRECTORY`

  where `$DIRECTORY` is an expected path on the device.

  For example, to list contents of the `/boot` directory where the `vmlinux.uimg` file should be, execute:

  `Tegra3 # ext2ls usb 0:1 /boot`

## Printing the U-Boot Environment

You can print the entire U-Boot environment.

**To print the U-Boot environment**

- Execute the following command:

  `Tegra3 # printenv`

## Printing/Setting Environment Variables

You can print and set variables in the environment.

### To print a variable in the environment

- Execute the following command:

  ```
  Tegra3 # printenv $ENV_VARIABLE
  ```

  where `$ENV_VARIABLE` refers to an environment variable in U-Boot.

  For example, to print the boot device partition number, execute:

  ```
  Tegra3 # printenv pn
  ```

  Output can be as follows:

  ```
  pn=1
  ```

### To set a variable in the environment

- Execute the following command:

  ```
  Tegra3 # setenv $ENV_VARIABLE $NEW_VALUE
  ```

  where `$ENV_VARIABLE` refers to an environment variable in U-Boot and `$NEW_VALUE` is the new value for that variable.

  For example, to set the partition number variable, enter the following command:

  ```
  Tegra3 # setenv pn 1
  ```

# Software Features

This section describes the software features expected to be supported with this release of NVIDIA® Tegra® Linux Driver Package, which provides users with a complete package to bring up Linux on certain Tegra devices.

This release supports NVIDIA® Tegra® 3 series code-name Cardhu and NVIDIA® Tegra® 2 series code-name Ventana devices.

> **Note**: Always check the *Release Notes* for constraints related to these features.

Read the following sections to learn more about supported features in this release.

# Linux

| Kernel | Notes |
|---|---|
| Linux Kernel | 3.1 |
| **Kernel Native Drivers** | **Notes** |
| Audio | ALSA |
| External SD card | - |
| USB | Keyboard/mouse,<br>mass storage device (MSD) |
| Wi-Fi | Firmware provided separately |
| **Boot Devices** | **Notes** |
| eMMC | - |
| External boot media | USB flash devices and hard-drives, SD Cards |
| Network file-system (NFS) boot | - |
| **Additional Notes** | |
| Unless otherwise noted, all features pertain to Cardhu and Ventana. | |

# Graphics and Multimedia

| Media APIs | Notes |
|---|---|
| EGL 1.4 with EGLImage | - |
| GStreamer OpenMAX-IL plug-in | Both for A/V playback and A/V capture |
| Open GL ES path extensions | - |
| OpenGL ES 1.1 | - |
| OpenGL ES 2.0 | For automatic stereo support |
| OpenMAX IL 1.1 decoding | Planned to be deprecated in a later release |
| OpenMAX IL 1.1 encoding | Planned to be deprecated in a later release |
| X11 | ABI: 5, 6, 7, 8, 10, 11, 12 |
| X Resize, Rotate and Reflect Extension (RandR) 1.3 | - |
| **Additional Notes** | |
| Unless otherwise noted, all features pertain to Cardhu and Ventana. | |

# Decoders

## Audio Decoders (Tegra 3/Tegra 2)

The features in this table are supported by both Tegra 3 and Tegra 2.

| Audio Decode | Profile | Sampling | Bitrate |
|---|---|---|---|
| AAC+ | AAC-LC with SBR; mono, stereo, and 2-channel mixing only | Up to 48 kHz | Up to 320 kilobits per second (Kbps) |
| AAC-LC | Mono, stereo, and 2-channel [5.1] | Up to 48 kHz | Up to 320 Kbps |
| eAAC+ | AAC-LC with SBR+PS; mono, stereo, and 2-channel mixing only | Up to 48 kHz | Up to 320 Kbps |
| AMR-NB | 1 channel | Up to 8 kHz | Up to 12.2 Kbps |
| AMR-WB | 1 channel | Up to 16 kHz | Up to 23.85 Kbps |
| MP3 | 2 channel | Up to 48 kHz | Up to 320 Kbps |
| MPEG-2 (MPEG-1 Layer 2) | 2 channel | Up to 48 kHz | Up to 320 Kbps |
| Vorbis | Ogg Audio | Up to 48 kHz | Up to 256 Kbps |
| WAV linear PCM | 16-bit, 2 channels | Up to 48 kHz | - |
| WMA 9 Std. | Standard 2-channel | Up to 48 kHz | Up to 384 Kbps |
| WMA Lossless | Lossless: Up to N1 Profile; WMA 10: 2 channel | Up to 48 kHz | - |
| WMA Pro LBR 10 | M2 Profile; 2 channel [5.1] | Up to 96 kHz | Up to 768 Kbps |

## Image Decoders (Tegra 3/Tegra 2)

The features in this table are supported by both Tegra 3 and Tegra 2.

| Image Decode | Profile | Resolution | Notes |
|---|---|---|---|
| JPEG | Baseline | Up to 20 MP | Gstreamer JPEG decoder supported by default |

# Video Decoders (Tegra 3 only)

The features in this table are supported by Tegra 3.

| Video Decode | Profile and Level | Sampling Frequency and Bit rate/Frame rate | Notes |
|---|---|---|---|
| DivX 4/5/6 | 1080p HD Profile | Up to 1080p @ 30 fps Up to 10 Mbps | - |
| DivX 4/5/6 | PlusHD | Up to 1080p @ 30 fps Up to 20 Mbps | - |
| H.263 | Baseline Profile 0 | Standard H.263 picture formats up to 4CIF @ 30 fps Up to 8 Mbps | Baseline Profile 0 Tools; Also supports custom formats at any resolution |
| H.264 AVC | Baseline Profile, Main Profile High Profile @ L4.1 | Up to 720p @ 60 fps Up to 40 Mbps | - |
| H.264 AVC | Baseline Profile Main Profile High Profile @ L4.1 | Up to 720p @ 60 fps Up to 40 Mbps | - |
| H.264 AVC | Baseline Profile Main Profile High Profile @ L4.1 | Up to 1080i @ 60 fps Up to 40 Mbps | - |
| H.264 AVC | Baseline Profile Main Profile High Profile @ L4.1 | Up to 1140p @ 30 fps Up to 40 Mbps | - |
| H.264 AVC (SEI) | High Profile | Up to 1080p @ 30 fps Up to 40 Mbps | - |
| MPEG-2 Video | Main Profile @ High Level | Up to 720p @ 60p Up to 80 Mbps | - |
| MPEG-2 Video | Main Profile @ High Level | Up to 1080p @ 30p/1080i 60 fps Up to 80 Mbps | - |
| MPEG-4 | Advanced Simple Profile @ L5 | Up to 1080p @ 30 fps Up to 10 Mbps | - |

| | | | |
|---|---|---|---|
| VC-1/WMV | Simple Profile | Up to 1080p @ 30 fps Up to 45 Mbps | - |
| VC-1/WMV | Main Profile | Up to 1080p @ 30 fps Up to 45 Mbps | - |
| VC-1/WMV | Advanced Profile | Up to 1080p @ 30 fps Up to 45 Mbps | - |
| Xvid | Highdef Profile | Up to 1080p @ 30 fps Up to 10 Mbps | - |

# Video Decoders (Tegra 2)

The features in this table are supported by Tegra 2.

| Video Decode | Profile and Level | Sampling Frequency and Bit rate/Frame rate | Notes |
|---|---|---|---|
| DivX 4/5/6 | 1080p HD | Up to 1080p 30 fps Up to 10 Mbps | - |
| H.263 | Baseline Profile 0 | Standard H.263 formats up to 4CIF 30 fps Up to 8 Mbps peak | Standard H.263 picture formats = SQCIF, QCIF, CIF, 4CIF; Also supports custom formats at any resolution |
| H.264 | Baseline Profile @ L4 | Up to 1080p 30 fps Up to 20 Mbps peak | |
| H.264 Dynamic Resolution Change (DRC) | - | - | AP20 only |
| H.264 | Main Profile @ L2.2 | Up to 576i 60 fps Up to 4 Mbps | CABAC; MBAFF; Interlaced |
| H.264 | Main Profile @ L3.1 | Up to 720p 30 fps Up to 4 Mbps | CAVLC; With weighted prediction |
| H.264 | Main Profile @ L3.1 | Up to 720p 30 fps Up to 5 Mbps | CABAC; CAVLC; No weighted prediction |
| H.264 | High Profile @ L2.2 | Up to 576i 60 fps Up to 4 Mbps | CABAC; MBAFF; Interlaced |

| | | | |
|---|---|---|---|
| H.264 | High Profile @ L3.1 | Up to 720p<br>30 fps<br>Up to 4 Mbps | CAVLC; With weighted prediction |
| H.264 | High Profile @ L3.1 | Up to 720p<br>30 fps<br>Up to 5 Mbps | CAVLC; CABAC; No weighted prediction |
| MPEG-4 | Advanced Simple Profile @ L5 | Up to 1080p<br>30 fps<br>Up to 10 Mbps | - |
| VC-1 | Simple Profile | Up to 1080p<br>30 fps<br>Up to 10 Mbps | - |
| VC-1 | Main Profile | Up to 1080p<br>30 fps<br>Up to 10 Mbps | - |
| VC-1 | Advanced Profile | Up to 1080p<br>30 fps<br>Up to 10 Mbps | - |
| Xvid | Highdef Profile | Up to 1080p<br>30 fps<br>Up to 10 Mbps | - |

# Encoders

## Audio Encoders (Tegra 3/Tegra 2)

The features in this table are supported by both Tegra 3 and Tegra 2.

| Audio Encode | Profile | Resolution | Bit Rates |
|---|---|---|---|
| AAC-LC | - | - | Up to 320 kbps |

## Image Encoders (Tegra 3/Tegra 2)

The features in this table are supported by both Tegra 3 and Tegra 2.

| Image Decode | Profile | Resolution | Bit Rates |
|---|---|---|---|
| JPEG | Exif | Up to 14 MP | Q-100 |

## Video Encoders (Tegra 3)

The features in this table are supported by Tegra 3 only.

| Video Encode | Profile and Level | Sampling Frequency and Bit rate/Frame rate | Notes |
|---|---|---|---|
| H.264 | Baseline Profile | Up to 1080p<br>30 fps<br>Up to 20 Mbps | - |
| MPEG4 | Simple Profile | Up to 30fps | - |
| H.263 | Baseline Profile | Up to 30fps | - |

## Video Encoders (Tegra 2)

The features in this table are supported by Tegra 2 only.

| Video Encode | Profile and Level | Sampling Frequency and Bit rate/Frame rate | Notes |
|---|---|---|---|
| H.264 | Baseline Profile | Up to 1080p<br>24 fps<br>Up to 14 Mbps | - |

# Container Formats

Codes are provided by GStreamer. You can download GStreamer codecs from the gstreamer opensource project at:

`http://gstreamer.freedesktop.org`

Or you can use `apt-get` in the provided Ubuntu-derived sample file system.

Hardware codecs are not included in the base release but can be provided separately under a software license agreement.

# Streaming Protocols

Streaming protocols are provided by GStreamer. You can download GStreamer codecs from the gstreamer opensource project at:

`http://gstreamer.freedesktop.org`

Or you can use `apt-get` in the provided Ubuntu-derived sample file system.

Hardware codecs are not included in the base release but can be provided separately under a software license agreement.

| Protocol | Notes |
|---|---|
| HTTP 1.0 | ASF, AVI,3GP, MOV, MP3, MP4, WMA, WMV |
| HTTP 1.1 | ASF, AVI,3GP, MOV, MP3, MP4, WMA, WMV |
| RTP/RTSP/RTCP | 3GP, MP3 |
| SDP (RFC 4566) | 3GP |

# Displays

| Feature | Description | | Notes |
|---|---|---|---|
| HDMI 1.4a | Up to 1080p | | - |
| Internal LCD | - | | - |
| **Feature** | **Mode No.** | **Resolution** | **Rate** |
| 3HDMI supported modes | 1 | 640 X 480 | 60 |
| | 2 | 640 X 480 | 72 |
| | 3 | 640 X 480 | 74 |
| | 4 | 720 x 480 | 59 |
| | 5 | 720 X 576 | 50 |
| | 6 | 800 X 600 | 59 |
| | 7 | 800 X 600 | 72 |
| | 8 | 800 X 600 | 74 |
| | 9 | 1024 X 768 | 60 |
| | 10 | 1024 X 768 | 70 |
| | 11 | 1024 X 768 | 74 |
| | 12 | 1152 X 864 | 74 |
| | 13 | 1280 X 720 | 60 |
| | 14 | 1280 X 1024 | 74 |
| | 15 | 1280 X 1024 | 59 |
| | 16 | 1680 X 1050 | 59 |
| | 17 | 1920 X 1080 | 50 |
| | 18 | 1920 X 1080 | 60 |
| **Feature** | **Description** | | **Notes** |
| HDMI DDC modesetting support | - | | - |
| Dual display (LVDS + HDMI) | Mirror mode,<br>Extended mode | | - |
| **Additional Notes** | | | |
| DC fallback mode (640x480 @ 60Hz) is the default video mode for an HDMI monitor when using an fb_console device. See the *Release Notes* for known issues. | | | |

# Playback

| General | Notes |
|---|---|
| NvGstPlayer application | Supports the following functionality:<br>· Basic local playback<br>· Streaming playback with HTTP and RTSP<br>· Trick modes<br>· Audio/video synchronization<br>· Automation for batch mode execution<br>· Playbin2 support<br>· Native pipeline support |

# Camera

| Application | Feature | Notes |
|---|---|---|
| NvGstCapture application | Bayer camera sensor | - |
| | Camera capture mode selection | - |
| | Still image capture | - |
| | Video record | - |
| | Camera focus position control | - |
| | Camera exposure control | - |
| | Camera ISO control (exposure control) | - |
| | Camera contrast control | - |
| | Camera flash control | - |
| | Camera zoom control | - |
| | Camera pre-capture converge control | - |
| | Camera half press with 3A control | - |
| | Camera brightness control | - |
| | Camera saturation control | - |
| | Camera hue control | - |
| | Camera white balance control | - |
| | Image multishot | - |
| | Camera image filter control (color effect) | - |
| | Camera pause preview after capture | - |
| | Camera EV compensation Control | - |
| | Camera flicker control | - |
| | Camera edge enhancement control | - |
| | Camera meter mode control (exposure control) | - |
| | Camera preview rotate control | - |
| | Camera capture rotate control | - |
| | Camera timer control (delay capture) | - |
| | Camera scene mode control (non-standard modes) | - |
| | Camera noise reduction | - |
| | Camera still capture resolution | - |
| | Camera video capture resolution | - |
| | Camera video encoder selection | - |
| | Voice control | - |

| Application | Feature | Notes |
|---|---|---|
| | Camerabin2 support | GStreamer 10.36 only |
| | GstPhotography support | GStreamer 10.36 only |

# Power

| General | Notes |
|---|---|
| DVFS | - |
| **Tegra Active Power Management** | **Notes** |
| Dynamic voltage scaling for core | - |
| Dynamic voltage scaling for CPU | - |
| Dynamic frequency scaling for CPU | - |
| Dynamic frequency scaling for memory controller | - |
| Dynamic frequency scaling for AVP | - |
| Dynamic frequency scaling for system buses | - |
| Low power idle state (LP2) | Cardhu only |
| Frequency-boosted burst modes | Cardhu only;<br>CPU running at higher frequencies in single-core mode |
| EDP support | Cardhu only |
| External temperature sensing | - |
| CPU hotplug support | Cardhu only |
| Switch to ULP CPU mode | Cardhu only |
| Dynamic thermal throttling | Software with hardware fail-safe |
| DRAM self-refresh | |
| Ultra-Low Power Standby | Notes |
| Suspend (LP1) | - |
| Deep Sleep (LP0) | - |
| USB Suspend during Deep Sleep | - |
| Wake with power button and RTC | - |
| Peripheral Power Management | Notes |
| NVIDIA Pixel Rendering Intensity and Saturation Management (PRISM) | Cardhu only;<br>Display driver |
| Additional Notes | |
| Unless otherwise noted, all features pertain to Cardhu and Ventana. | |

# Boot Loaders

| General | Notes |
|---|---|
| Fastboot | Supports booting from USB, SD card, internal memory (eMMC), and network file-system (NFS) boot |
| U-Boot | Source code available.<br>Supports booting from USB, SD card, internal memory (eMMC), network file-system (NFS) boot, and Trivial File Transfer Protocol (TFTP) boot |

# Licenses

This section provides license information for the following:



## NVIDIA Software

**Note**: This software license applies to software in the "nv_tegra" directory (NVIDIA binary drivers and supporting software).

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# Sample File System

The sample root file system is derived from Ubuntu Linux, version 11.04.

Information on re-creating the root file system is provided in the T*egra Linux Driver Package Developers' Guide*. The license agreement for each software component is located in the software component's source code, made available from the same location from which this software was downloaded, or by request to oss-requests@nvidia.com.

# Package Codecs

**Note**: This software license applies to codec package of NVIDIA® Tegra® Linux Driver Package.

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(c) Licensee shall not grant third parties, excluding Affiliates or Contractors, access to the source code of the Licensed Materials;

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Confidential Information, and shall promptly notify the other party of any such actual or threatened unauthorized disclosure or use. If any Confidential Information must be disclosed to any third party by reason of legal, accounting or regulatory requirements beyond the reasonable control of the disclosing party, the disclosing party shall promptly notify the other party of the order or request and permit the other party (at its own expense) to seek an appropriate protective order.

For the sake of clarity, the parties agree that, notwithstanding the preceding paragraph, any and all information identified as Confidential Information (as defined in the NDA) by the disclosing party in connection with this Agreement shall also be protected under the NDA; provided, however, that in the event of any conflict between the confidentiality obligations pursuant to this Agreement and the obligations pursuant to the NDA with regard to any Confidential Information (as defined in the NDA) in connection with this Agreement, including, without limitation, the source code to the Licensed Materials, the terms of this Agreement shall prevail.

**6. TERM; TERMINATION**

6.1 Term. This Agreement and the licenses granted hereunder shall be effective as of the date Licensee first uses the Licensed Materials ("Effective Date") and continue for a period of one (1) year (the "Initial Term"), unless terminated in accordance with Section 6.2. Unless either party notifies the other party of its intent to terminate this Agreement at least one (1) month prior to the end of the Initial Term or the applicable renewal period ("Renewal Period(s)"), this Agreement will be automatically renewed for one (1) year Renewal Periods, provided however that this Agreement will automatically expire at such time when Licensee no longer intends to use the Licensed Materials for the authorized purposes described in this Agreement, at this time Licensee will comply with the termination provisions in Section 6.2 below.

6.2 Termination. Either party may terminate this Agreement immediately upon written notice for the material breach of the other party, which material breach is curable and has remained uncured for a period of thirty (30) days from the date of delivery of written notice thereof to the other party. Upon the termination or expiration of this Agreement,

(a) Licensee shall (i) immediately cease using the Licensed Materials for any purpose whatsoever; (ii) immediately destroy or return to NVIDIA all materials belonging to NVIDIA, including without limitation all copies of the Software and NVIDIA Confidential Information then in

Licensee's possession or control; and (iii) certify to NVIDIA in writing that it has done so; and

(b) NVIDIA shall (i) immediately destroy or return to Licensee all materials belonging to Licensee that were provided to NVIDIA pursuant to this Agreement, including without limitation, Licensee's Confidential Information then in NVIDIA's possession or control; and (ii) certify to Licensee in writing that it has done so. These remedies shall be cumulative and in addition to any other remedies available to NVIDIA.

6.3 Survival. Those provisions in this Agreement, which by their nature need to survive the termination or expiration of this Agreement, The following Sections shall survive termination or expiration of the Agreement, including but not limited to Sections 1, 2.2, 2.3, 2.4, 3, 4, 5, 6.2 , 6.3, 7, 8, 9 and Exhibit A.

**7. WARRANTIES**

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(A) Licensee represents and warrants that it has, or will have prior to the commercial release of the Licensee Products, a valid and current license to all the Third Party Components referenced in the exhibits of this Agreement, for use in connection with Licensed Materials provided pursuant to this Agreement and Licensee Products.

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IN NO EVENT SHALL:

(A) NVIDIA BE LIABLE FOR ANY CONSEQUENTIAL, INDIRECT, INCIDENTAL, PUNITIVE OR SPECIAL DAMAGES, OF ANY KIND OR CHARACTER, INCLUDING LOST PROFITS, LOST REVENUE, FAILURE TO REALIZE SAVINGS OR OTHER BENEFITS, LOSS OF DATA OR USE,

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9. GENERAL

9.2 Governing Law. This Agreement shall be governed in all respects by the laws of the United States and of the State of Delaware, without regard to the conflicts of laws principles thereof.

9.3 Jurisdiction. The state and/or federal courts residing in Santa Clara County, California shall have exclusive jurisdiction over any dispute or claim arising out of this Agreement.

9.4 Severability. If for any reason a court of competent jurisdiction finds any provision of this Agreement, or portion thereof, to be unenforceable, that provision of the Agreement will be enforced to the maximum extent permissible so as to affect the intent of the parties, and the remainder of this Agreement will continue in full force and effect. This Agreement has been negotiated by the parties and their respective counsel and will be interpreted fairly in accordance with its terms and without any strict construction in favor of or against either party.

9.5 Amendments. The Agreement shall not be modified except by a written agreement that names this Agreement and any provision to be modified, is dated subsequent to the Effective Date, and is signed by duly authorized representatives of both parties.

9.6 No Waiver. No failure or delay on the part of either party in the exercise of any right, power or remedy under this Agreement or under law, or to insist upon or enforce performance by the other party of any of the provisions of this Agreement or under law, shall operate as a waiver thereof, nor shall any single or partial exercise of any right, power or remedy preclude other or further exercise thereof, or the exercise of any other right, power or remedy; rather the provision, right, or remedy shall be and remain in full force and effect.

9.7 No Assignment. This Agreement, and each party's rights and obligations herein, may not be assigned, subcontracted, delegated, or otherwise transferred by either party without the other party's prior written consent, and any attempted assignment, subcontract, delegation, or transfer in violation of the foregoing will be null and void. The terms of this Agreement shall be binding upon assignees.

9.8 Independent Contractors. NVIDIA's relationship to Licensee is that of an independent Contractor, and neither party is an agent or partner of the other. Neither party will have, and will not represent to any third party that it has, any authority to act on behalf of the other party.

9.9 Export Restrictions. The parties acknowledge that the Licensed Materials are subject to U.S. export control laws and regulations. The parties agree to comply with all applicable international and national laws that apply to the Licensed Materials, including the U.S. Export Administration Regulations, as well as end-user, end-use and destination restrictions issued by U.S. and other governments.

9.10 U.S. Government Legend. If Licensee is a branch or agency of the United States Government, the following provision applies. Any software provided under this Agreement, including any releases are comprised of "commercial computer software" and "commercial computer software documentation" as such terms are used in 48 C.F.R. 12.212 and are provided to the Government (i) for acquisition by or on behalf of civilian agencies, consistent with the policy set forth in 48 C.F.R. 12.212; or (ii) for acquisition by or on behalf of units of the Department of Defense, consistent with the policies set forth in 48 C.F.R. 227.7202-1 and 227.7202-3.

9.11 Headings. The headings in this Agreement are for the sole purpose of convenience of reference and shall not in any way limit or affect the meaning or interpretation of any of the terms or provisions of this Agreement.

9.12 Counterparts. This Agreement may be executed in counterparts, each of which shall be deemed an original, and all of which together shall constitute one instrument.

9.13 No Third Party Beneficiaries. This Agreement is solely between NVIDIA and Licensee. There are no third party beneficiaries, express or implied, to this Agreement.

9.14 Entire Agreement. This Agreement constitutes the entire agreement between the parties with respect to the subject matter

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# Exhibit A

**1. Coding Technologies/AAC+**

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gst-openmax (libgstomx.so)

**Version 2.1, February 1999**

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# FAQs

*How do I use 64-bit Ubuntu with NVIDIA® Tegra® Linux Driver Package?*

If you are running a 64-bit Ubuntu installation on the host PC, this release requires that you have 32-bit runtime support installed as well. The simple steps for installing 32-bit support on an Ubuntu host use the apt-get command.

**To install 32-bit runtime support**

- Execute the following commands:

  ```
  $ sudo apt-get update
  $ sudo apt-get install ia32-libs
  ```

  **Note**: If ia32-libs is not installed, flashing the boot loader with the kernel (and, possibly, other steps in the process) will fail.

*How do I use display mode and resolution configuration with the X RandR application?*

You can use the X Resize, Rotate and Reflect Extension (RandR) extension to manipulate and configure the attached displays (both the internal panel and any externally connected HDMI® panel). The `xrandr(1)` utility is the most common way to do this.

A tutorial on xrandr can be found on the following website:

`http://www.thinkwiki.org/wiki/Xorg_RandR_1.2`

*Are there generated ssh host keys for the sample file system?*

There are no keys in the `/etc/ssh` directory of the provided sample file system. For information about creating the ssh host keys, see the `ssh-keygen` man page. For more information, see the About the Root File System topic in the Getting Started chapter.

*How do I determine the X driver ABI of the X server used in the root file system?*

All `tegra_drv.abi*.so` files are in the driver package. By default the he `apply_binaries.sh` script creates a sym-link from `tegra_drv.so` to the X

ABI driver compatible with the provided sample file system. For more information, see the Setting Up the Root File System topic in the Getting Started chapter.

*How do I install Ubuntu Desktop?*

The default sample file-system that is provided with the release was created with minimal packages pre-installed. For more information on which packages are present, see the Setting Up Your File System topic in the Getting Started chapter.

Please note the possible space constraints with the default partition size specified in the `flash.sh` that is referenced in this document. To increase the partition size so that it can accommodate additional packages, see the Increasing the Internal Memory Partition Size for the Root File System topic in the Getting Started chapter.

**To install the full Ubuntu desktop**

1. First follow the instructions from the Installing Additional Packages topic in the Getting Started chapter.
2. Execute the following command:

   ```
   $ sudo apt-get install ubuntu-desktop
   ```

   **Note**: For the default username and password, see the About the Root File System topic in the Getting Started chapter.

*Can I install a different X driver Application Binary Interface (ABI)?*

Yes. For more information, see the Setting Up the Root File System topic in the Getting Started chapter.

*How do I disable the Ubuntu firewall which is blocking NFS root access?*

See the Configuring NFS Root on the Linux Host topic in the Getting Started chapter.

*What is the sample rootfs log-in password?*

The username is `ubuntu` and the password `ubuntu`. For more information about the sample file system, see the Setting Up Your File System topic in the Getting Started chapter.

*How do I prevent the system display from blanking out?*

Linux kernel 3.1 adds a power saving feature that blanks an idle system display, even when an application is running. The feature is called console blank (screen saver). It is defined as:

`consoleblank= [KNL]`

Where `[KNL]` is the console blank (screen saver) timeout in seconds. This defaults to `10*60 = 10 mins`. A value of `0` disables the blank timer.

By passing arguments to the kernel command line, you can:

- Disable this feature, or
- Set the timeout to a longer interval.

With the `flash.sh` script, you can override the kernel command line options passed from fastboot to the kernel. For more information, see the Flash Script Usage topic in the Getting Started chapter.

**To disable the console blank (screen saver) from the kernel command line**

1. Add the following line to the kernel parameters in the grub configuration:
   `consoleblank=0`
2. View the current `consoleblank` value with the following command:
   `$ cat /sys/module/kernel/parameters/consoleblank`

**To disable the console blank feature with an escape sequence**

- Enter the following escape sequence:
  `$ echo -ne "\033[9;0]"`

**To change the console blank timeout value with an escape sequence**

- Enter the following escape sequence:
  `$ echo -ne "\033[9;<timeout>]"`

  where `<timeout>` is the timeout in seconds.

For more information on this escape sequence, see the `console_codes(4)` man page documents. For information on the input/output controls that provide some of the same functionality, see the `console_ioctl(4)` man page.

*How do I prevent the file system from becoming read-only on resume if an SD card is in the Card Reader?*

If the device resumes from Suspend (LP1) while an SD card is in a connected card reader device, the file system is mounted as read-only resulting in a card reader read/write error and a system reboot is required. The workaround is to install the udisks utility (Debian package name `udisks_1.0.2-4ubuntu_armel.deb`).

*Can I use an SD card with a card reader already connected to the device?*

If the user connects the card reader to the device before inserting the SD card into the card reader, the SD card is not detected. The SD card and card reader must be connected to the device simultaneously. The workaround is to install the udisks utility (Debian package name `udisks_1.0.2-4ubuntu_armel.deb`).

# Glossary

[3] [4] [A] [B] [C] [D] [E] [F] [G] [H] [I] [J] [K] [L] [M] [N] [O] [P] [Q] [R] [S] [T] [U] [V] [W] [X] [Y] [Z]

## 3

**3G**

Third generation mobile phone standard/technology, based on standards defined by the International Telecommunication Union (ITU).

**3G2**

A standard for 3GP format for CDMA-based phones (3GPP2) and container format with filename extension (.3gp).

**3GP**

Simplified version of MPEG-4 Part 14 (.mp4) container format.

**3GPP**

3rd Generation Partnership Project. A collaboration among telecommunications associations to define globally applicable third generation (3G) mobile phone system specifications. For more information, see http://www.3gpp.org.

**3P**

Platform Programming Protocol, developed by NVIDIA for client-server communications between PC and device.

# 4

**4CIF**

4 x CIF (704 x 576), Common International Format (CIF) for horizontal and vertical resolutions of YCbCr.

# A

**A2DP**

Advanced Audio Distribution Profile. For streaming stereo or mono audio from one device to another over Bluetooth. For more information, see http://www.atheros.com/.

**AAC**

Advanced Audio Coding. A lossy compression and encoding standard for digital audio.

**AAC-LC**

Advanced Audio Coding-Low Complexity. A standardized, lossy compression and encoding scheme for digital audio.

**AAC+**

Advanced Audio Coding Plus, or aacPlus. Same as High Efficiency AAC (HE-AAC), which extends the Low Complexity AAC (AAC LC) optimized for low-bit rate applications such as streaming audio.

**ABI**

Application Binary Interface. A low-level interface between applications and other applications or the operating system.

**ADB**

Android Debug Bridge. A client-server tool for managing an emulator instance or Android-based device. For more information, see http://developer.android.com/guide/developing/tools/adb.html.

**ADMA**

Advanced Direct Memory Access.

**ADPCM**

Adaptive DPCM (differential pulse-code modulation).

**AE**

Auto exposure.

**AES**

Advanced Encryption Standard.

**AF**

Auto focus.

**AGC**

Automatic gain control.

**ALSA**

Advanced Linux Sound Architecture.

**AMR**

Adaptive multi-rate. An audio data compression scheme optimized for speech coding.

**AMR-NB**

Adaptive multi-rate (AMR) narrow band.

**AMR-WB**

Adaptive multi-rate wide band.

**ANR**

In Android, "Application Not Responding" error.

In camera, advanced noise reduction.

**AP**

Application Processor. An application processor is a computer that processes data (as opposed to one that controls data flow, like a database server). The Tegra® series application processors offer low power, high performance ARM® processors that handle 2D, 3D, audio, and high-definition (HD) video

data streams. These decoding and encoding functionalities are provided by a set of interfaces including multiple memory, storage, video, audio, and peripheral interfaces.

**AVC**

Advanced Video Coding.

**AVI**

Audio Video Interleave. A multimedia container format, special-case Resource Interchange File Format (RIFF) file that can contain both audio and video data; this format enables synchronous audio-with-video playback. For more information, see http://msdn.microsoft.com/en-us/library/ms779631(VS.85).aspx.

**AWB**

Container format for AMR-WB speech encoding with filename extension (.awb).

# B

**BCB**

Boot Control Block.

**BCT**

NVIDIA Boot Configuration Table.

**bitblt**

A graphics operation that combines several bitmap patterns into one, typically using a raster operator.

**Bpp**

Bytes per pixel, used to specify pixel depth (color depth).

**bpp**

Bits per pixel, used to specify pixel depth (color depth).

**Bluetooth**

Wireless standard for data exchange over short distances. For more information, see http://www.bluetooth.com/English/Pages/default.aspx.

**BSAC**

Bit Sliced Arithmetic Coding. An MPEG-4 standard (ISO/IEC 14496-3 subpart 4) for scalable audio coding.

**BusyBox**

Utility providing small versions of common UNIX utilities in a single executable. For more information, see http://www.busybox.net.

# C

**CABAC**

Context-adaptive binary arithmetic coding. A type of entropy coding used in H.264/MPEG-4 AVC video encoding.

**CBR**

Constant bit rate.

**CDC**

USB Communications Device Class.

**CDMA**

Code division multiple access. Channel access method for radio communication.

**CE**

NVIDIA customer engineer.

**Cg**

C for Graphics. A high-level shading language for programming vertex and pixel shaders, created by NVIDIA Corporation.

### CIF

Common International Format (352 x 288), standardizes horizontal/vertical resolutions for video.

### color space

Specifies how color is represented, such as YUV, RGB, or gray scale.

## D

### D3DM

Microsoft Direct3D Mobile technologies.

### DCC

Debug communications channel.

### DCT

Discrete cosine transform. A Fourier-related transform similar to the discrete Fourier transform (DFT), but using only real numbers.

### DDI

Device driver interface for Windows CE.

### DDK

NVIDIA® Driver Development Kit.

### deprecated

This feature is slated to be removed at a later release. Developers should begin to remove dependencies on this feature in preparation for its eventual removal.

### development system

Board with NVIDIA® Tegra® processor used to do engineering work, which is typically focused on firmware/software development. Development boards have a user manual but may or may not include detailed documents, like schematics.

**DFS**

Dynamic frequency scaling.

**DIDIM**

Dynamic Image-based Display Intensity Modulation, which has been renamed pixel rendering intensity and saturation management (PRISM) since CES 2012.

**DivX**

Codec by DivX, Inc., that uses lossy MPEG-4 Part 2 compression to compress lengthy video into small sizes with high visual quality and is often used for "ripping". For more information, see http://www.divx.com.

**DMO**

Microsoft DirectX Media Object. For more information, see http://msdn2.microsoft.com/en-us/library/ms783356.aspx.

**DPB**

In H.264, Decode Picture Buffer.

**DRC**

Dynamic range compression.

**DSI**

Display Serial Interface a communication protocol specification by the Mobile Industry Processor Interface (MIPI) Alliance for reducing cost of displays in mobile devices.

**DVB-H**

Digital video broadcasting—handheld.

**DVB-T**

Digital video broadcasting—terrestrial.

**DVFS**

Dynamic voltage frequency scaling.

### DVS

Dynamic voltage scaling.

## E

### eAAC+

Enhanced AAC+. Combines HE-AAC v1 (or AAC+) coupled with Parametric Stereo to 3GPP.

### ECI

NVIDIA Embedded Controller Interface. Communication interface between NVIDIA® Tegra® processor and an embedded controller (EC) for netbook/smartbook applications.

### EGL

Embedded-Systems Graphics Library. For OpenGL ES.

### eMMC

Embedded MMC. Developed by JEDEC and MMCA for embedded flash memory applications.

### EQ

Equalizer.

### Escape code base + value

Microsoft supports definition of additional driver-specific escape codes, starting at an `ESCAPECODEBASE` of decimal value 100,000. So an NVIDIA-defined escape code whose value is 7 is actually 100007. (`100000 + 7 = 100007`)

### Exif

Exchangeable image file format. A specification for digital camera image file formats.

### Ext2

Second extended file system for the Linux kernel, designed to replace the extended file system (ext).

### Ext3

Third extended file system. A journaling file system often used by the Linux kernel, the default file system for some distributions.

### Ext4

Fourth extended file system. A journaling file system often used by the Linux kernel. It is the successor to Ext3.

## F

### Fastboot

Software supporting a protocol for updating flash file systems and unsigned partition images for Android-based devices.

### Flash 11

Adobe multimedia platform enabling animation and interactivity on Web pages. For more information, see http://get.adobe.com/flashplayer.

### FMO

Flexible macroblock ordering. Technique for restructuring the ordering of the representation of the fundamental regions in pictures, known as macroblocks. FMO is also referred to as slice groups and arbitrary slice ordering (ASO).

### FOV

In photography, field of view.

## G

### GLES

See OpenGL ES.

### GLSL

OpenGL Shading Language. A high level, C-language shading language.

### GPIO

General purpose input/output. This is a generic pin on a chip whose behavior can be controlled with software.

### GPS

Global positioning system.

### GPU

Graphics processing unit.

## H

### H.263

A video codec standard for low-bit rate compressed format videoconferencing, designed by the ITU-T in a project ending in 1995/1996. For more information, see http://en.wikipedia.org/wiki/H.263.

### H.264

A standard for video compression, also known as MPEG-4 Part 10, or AVC (for Advanced Video Coding). For more information, http://en.wikipedia.org/wiki/H.264/MPEG-4_AVC.

### HD

High-definition.

### HDCP

High-bandwidth Digital Content Protection. Digital copy protection technology developed by Intel Corporation to protect digital audio and video content as it travels across connections. For more information, see http://www.digital-cp.com.

### HDMI

High-Definition Multimedia Interface. A compact audio/video connector interface used to connect HDMI-enabled digital audio devices for transmitting uncompressed digital streams. NVIDIA® Tegra® BSP incorporates support for HDMI® technology.

**HID**

Human interface device. A computer device that receives human input and may deliver output.

**HSMMC**

High-speed MultiMediaCard (MMC).

**HTTP**

Hypertext transfer protocol. A client-server communications protocol used for hyperlinked text documents on the Internet.

## I

**I2C**

Inter-Integrated Circuit. A serial computer bus used to attach low-speed peripherals to an embedded system or cell phone.

**I2S**

Inter-IC Sound (or Integrated Interchip Sound). A serial bus interface standard for connecting to digital audio devices.

**ID3**

Metadata container typically used with MP3 formatted content.

**IIR**

Infinite impulse response, a property of signal processing systems.

**ISDB-T**

Terrestrial Integrated Services Digital Broadcasting.

**ISP**

File extension for NVIDIA Image Signal Processing pipeline (.isp) configuration files.

**ISV**

Independent software vendor.

# J

### JPEG

Method for compressing photographic images. For more information, see http://www.jpeg.org.

### JTAG

Joint Test Action Group (JTAG). Common term used for the IEEE 1149.1 standard "Standard Test Access Port and Boundary-Scan Architecture" for testing printed circuit boards. In embedded development, in-circuit emulators use JTAG as a transport mechanism to provide a way into the embedded system for debugging.

# K

### Kconfig

Linux kernel configuration files, which are present in almost each directory. Kconfig syntax is documented in the `Documentation/kbuild/kconfig-language.txt` file.

# L

### LBR

Low bit rate.

### LCD

Liquid crystal display.

### LP

Low power, or low power filter bank.

# M

### M4A

Multimedia MPEG-4 container format file extension (.m4a), first popluarized by Apple to assure presence of audio/video content as distinguished from .mp4 files which may or may not have video content.

### M4B

Multimedia MPEG-4 container format file extension (.m4b) for audio book and podcast files. Typically contain metadata for chapters, images, and hyperlinks.

### Meebo

An instant messaging program based on Ajax and libpurple free/open source library. For more information, see http://www.meebo.com and http://www.pidgin.im.

### MIDI

Musical instrument digital interface. For synchronization of electronic musical instrument and computer communications of digital data events (such as for pitch and volume) in realtime.

### MIO

Modular input/output. Enables adding peripheral cards to laser printers. For more information, see http://www.hp.com/.

### MJPEG

Motion JPEG (M-JPEG) are video formats where video frames/ interlaced fields in digital video is compressed separately as a JPEG image.

### MLC

Multilevel cell. Flash memory that stores more than one bit per cell by using voltage levels.

### MMC

MultiMediaCard. Removable solid-state memory card for use in mobile devices.

**MOV**

File format for QuickTime that functions as a multimedia container file containing one or multiple tracks that stores audio, video, effects, or text.

**moviNAND**

High-density MLC NAND Flash combined with MMC controller.

**MP**

Megapixel.

**MP3**

MPEG-1 Audio Layer 3. Also the container format or filename extension (.mp3) for MPEG-1 Audio Layer 3 files.

**MP4**

Container format or filename extension (.mp4) for MPEG-4 Part 14 files.

**MPEG-2**

Generic coding standard for movies, which specifies a combination of lossy video compression and lossy audio compression (audio data compression).

**MPEG-4**

MPEG-4 Part 2 video compression technology. A DCT compression standard belonging to the MPEG-4 ISO/IEC standard (ISO/IEC 14496-2). For more information, see http://www.mpeg.org.

**MPIO**

Multi-purpose input output. This is a type of pin-mux pad that can be configured as GPIO or SFIO.

**MSC**

Mass storage device class. USB Implementers Forum computing communications protocols for the Universal Serial Bus (USB). For more information, see http://www.usb.org/developers/devclass_docs/usb_msc_overview_1.2.pdf.

**MSD**

Mass storage device.

**MSDN**

Microsoft Developer Network. For more information, see http://msdn2.microsoft.com/en-us/default.aspx.

**MTD**

Memory technology device, used by Linux to interact with flash memory.

**MVC**

Multiview Video Coding (MVC), amends H.264/MPEG-4 AVC standard to enable encoding simultaneously from multiple cameras using a single video stream.

# N

**NAND**

Type of flash memory, typically used in USB devices and memory cards.

**NB**

Narrow band.

**NDK**

Android toolset enabling embedded components to use native code in Android applications. For more information, see http://developer.android.com/sdk/ndk/overview.html.

**Netflix**

Provides rental-by-mail of digital video content as well as Internet streaming on demand. For more information, see https://www.netflix.com.

**NFS**

Network File System, an open standard protocol.

**Nv3P**

NVIDIA platform programming protocol (includes 3P server and 3P client).

**NvBL**

NVIDIA Boot Library.

**NvBlob**

A Python script for producing blob files for updating hidden partitions, like for boot loader or microboot. OTA or Fastboot uses these blobs to perform the updates.

**NvDDK**

NVIDIA Driver Development Kit.

**NVIDIA production mode**

This is the mode in which Tegra chips are provided from NVIDIA. In this mode, fuses can still be programmed via recovery mode. Boot configuration tables (BCTs) and boot loaders are signed with a key of all 0's, but are not encrypted.

**NvFlash**

NVIDIA application for flashing devices over USB connections.

**NvRM**

NVIDIA Resource Manager.

**NvSBK tool**

NVIDIA application for producing blob objects for flashing ODM secure mode devices. The NvFlash tool uses these blobs to flash devices.

# O

**OAL**

OEM adaptation layer for Windows CE.

**ODM**

Original design or device manufacturer.

**ODM non-secure mode**

This is the mode in which ODMs ship products without stringent security mechanisms; however, in this mode, fuses can no longer be programmed. As in NVIDIA production mode, boot configuration tables (BCTs) and boot loaders are signed with a key of all 0's and not encrypted. This mode is sometimes called ODM production mode.

**ODM secure mode**

This is the mode in which ODMs ship products with strict security measures in force. Fuses cannot be programmed, and all boot configuration tables (BCTs), boot loaders, and microboots must be signed and encrypted with the secure boot key (SBK).

**OEM**

Original equipment manufacturer.

**OGA**

Container for Vorbis audio-only files. For more information, see http://xiph.org.

**Ogg**

Container for Vorbis codec. For more information, see http://xiph.org.

**Ogg Vorbis**

A free/open source, lossy audio codec (Vorbis) and its container (Ogg). For more information, see http://xiph.org.

**OGM**

Early file format for embedding video into Ogg. Use of this format is currently discouraged by Xiph. For more information, see http://xiph.org.

**ONFI**

Open NAND Flash Interface, an industry workgroup that build, design-in, or enable NAND Flash memory.

**OpenAL**

Free cross-platform audio API (resembling OpenGL API style) for efficient rendering of multichannel three dimensional positional audio.

**OpenGL ES**

A subset of OpenGL 3D graphics API designed for embedded systems, defined by the Khronos Group. For more information, see http://www.khronos.org.

**OpenKODE**

A set of APIs for handheld games and media applications providing a cross-platform abstraction layer for other "open" media technologies. For more information, see http://www.khronos.org.

**OpenSL ES**

Open Sound Library for Embedded Systems. A royalty-free, cross-platform, hardware-accelerated audio API for 2D and 3D audio. For more information, see http://www.khronos.org.

**OpenMAX**

An application programming interface that provides abstractions for routines especially useful for computer graphics, video, and sound, defined by the Khronos Group. For more information, see http://www.khronos.org.

**OpenMAX IL**

OpenMAX Integration Layer. Provides an abstraction layer API between a media framework, such as DirectShow, and a set of multimedia components, such as audio and video codecs. For more information, see http://www.khronos.org.

**OpenVG**

A standard API for hardware-accelerated 2D vector graphics, defined by the Khronos Group. For more information, see http://www.khronos.org.

**OTA**

Over-the-air or wireless.

**OTG**

USB On-The-Go.

# P

**platform**

The code-name of an NVIDIA® Tegra® development system, such as `kai`, `cardhu` and, `enterprise` for a Tegra 3 family device, or `ventana` or `whistler` for Tegra 2 family.

**PAN**

Personal area networking. A Bluetooth profile. For more information, see http://www.atheros.com/.

**PCM**

Pulse-code modulation.

**PIP**

Picture-in-picture.

**PMU**

Power Management Unit.

**pixel depth**

Number of bits per pixel (bpp).

**PRISM**

NVIDIA Pixel Rendering Intensity and Saturation Management (PRISM) display technology (formerly known as DIDIM). To save battery life, PRISM separates color and backlight intensity while preserving fidelity, so the amount of backlighting needed is reduced without making images appear dim.

**PS**

Parametric stereo.

# Q

**QCELP**

Qualcomm Code Excited Linear Prediction, also known as Qualcomm PureVoice. Speech codec that increases the speech quality of the IS-96A codec used in CDMA. For more information, see http://www.qualcomm.com/qct.

**QP**

Quantization Parameter.

### QuickTime

Apple multimedia framework for digital multimedia, text, animation, etc., playback/streaming. For more information, see http://www.apple.com/quicktime/download.

## R

### RCK

Recovery kernel.

### RCM

Recovery mode messages.

### RFC

Request for Comments.

### RIL

Radio Interface Layer.

### RNDIS

Remote NDIS. A specification for network devices on buses such as USB. For more information, see http://www.microsoft.com/whdc/device/network/NDIS/rmNDIS.mspx.

### ROP

Raster operator.

### RTC

Real-time clock.

### RTP

Real-time transport protocol for delivering A/V content over the Internet.

### RTSP

Real time streaming protocol allowing clients to issue transport commands and control a streaming media server remotely.

# S

**SBC**

Sub-band codec. For breaking signals into different frequency bands to encode them independently.

**SBK**

Secure boot key.

**SBR**

Spectral band replication.

**scan code**

The physical key on the keypad.

**SCO**

Synchronous Connection Oriented link. For a mono, PCM audio channel.

**SD**

Secure Digital card. Non-volatile memory card. For more information, see http://www.sdcard.org/home.

**SDHC**

Secure Digital High Capacity. For more information, see http://www.sdcard.org/home.

**SDHCI**

Secure Digital Host Controller Interface.

**SDIO**

Secure Digital Input Output. SD card combined with an I/O device. For more information, see http://www.sdcard.org/home.

**SDRAM**

Synchronous dynamic random access memory.

**SDP**

Session Description Protocol, an IETF Proposed Standard that describes streaming communication sessions to announce and invite the session and to negotiate parameters.

**secure boot**

A common term used to refer to a boot loader that uses enhanced security, such as asymmetric encryption (public key encryption). For more information, see the Windows CE 6.0 Technical Article "Secure Download Boot Loader in Windows Embedded CE" at http://msdn2.microsoft.com/en-us/library/bb643805.aspx.

**SFIO**

Special function input output. This term is a category of roles that MPIO pads can be configured with.

**SHOUTcast**

Cross-platform media-streaming server (freeware), developed by Nullsoft, which enables Internet radio network creation. For more information, see http://www.shoutcast.com.

**SIP**

Session Initiation Protocol. Signaling protocol from the Internet Engineering Task Force (IETF) used to control multimedia communication sessions for voice and video over Internet protocol (VoIP).

**S-LINK**

Simple link interface. A high-performance data acquisition standard where data will be collected and stored by computers at both ends of the link. For more information, see http://hsi.web.cern.ch/HSI/s-link.

**SLC**

Single-level cell. Flash memory that stores one bit per cell.

**SMP**

Symmetric multiprocessing.

**SMS**

Short Message Service. Allows sending short text messages between mobile telephone devices.

**SNR**

Signal-to-noise ratio.

**Sorenson**

Sorenson codec used in Apple's QuickTime and in Adobe Flash. For more information, see http://www.sorensonmedia.com.

**SOC**

System-on-chip, which integrates computer components and other electronics into a single integrated circuit or chip. Also SoC.

**S/PDIF**

Sony/Philips Digital Interface.

**SPI**

Serial Peripheral Interface bus. A full-duplex mode, synchronous serial data link.

**SPI flash**

Small, low-power flash memory that uses a serial interface (usually SPI) for sequential data access.

**SRC**

Sample rate conversion.

**SSK**

Unique, per-chip Secure Storage Key used to protect customer-defined data. Typically a 128-bit key computed from the following fuse settings:

- 128-bit customer-programmed SBK.
- 32-bit customer-programmed Device Key (DK).
- 64-bit NVIDIA-programmed Unique ID (UID), which is different for every chip.

### Stagefright

Media framework new in Android 2.2. For more information see http://developer.android.com/sdk/android-2.2-highlights.html#PlatformTechnologies.

## T

### Tegra

The world's first mobile super chip. The families of Tegra chipsets for mobile devices include:

- Tegra 3
- Tegra 2
- Tegra APX

### THD

Total harmonic distortion.

### TVO

Television output.

## U

### UART

Universal asynchronous receiver/transmitter. Computer hardware that translates data between parallel and serial forms, usually used for computer or peripheral device serial communications over a serial port.

### U-Boot

Das U-Boot, a free (GNU GPL software) bootstrap loader for embedded systems. For more information, see http://www.denx.de/wiki/U-Boot.

### Ubuntu

Supported Linux operating system by certain Tegra-based development products. For the specific Ubuntu version supported, see your *Release Notes*. For more information about Ubuntu, see http://www.ubuntu.com.

**UIP**

Update Image Partition.

**ULP**

Ultra low power.

**USB**

Universal serial bus. A standard that allows connections of many peripherals via a standardized interface socket. For more information, see http://www.usb.org.

**USBNET**

Linux usbnet driver. For more information, see http://www.linux-usb.org/usbnet/.

**USP**

Update Staging Partition.

# V

**VAD**

Voice activation detection.

**VBO**

An OpenGL extension for faster rendering of triangles.

**VBR**

Variable bit rate.

**VC-1**

Common name of the SMPTE 421M video codec standard from Microsoft. For more information, see http://www.microsoft.com/windows/windowsmedia/howto/articles/vc1techoverview.aspx.

**VoIP**

Voice-over-Internet protocol. Transmits voice through the Internet or other packet-switched networks.

**Vorbis**

A free/open source, lossy audio codec (Vorbis). For more information, see http://xiph.org.

**VP6**

TrueMotion VP6 video codec developed by On2 Technologies used in broadcasting, as well as by Adobe Flash and Flash Video files. For more information, see http://www.on2.com.

# W

**WAV**

Microsoft and IBM waveform audio format for storing audio bitstreams.

**WEP**

Wired Equivalent Privacy. Secures IEEE 802.11 wireless networks.

**WMA**

Microsoft Windows Media Audio technologies. Also the compressed audio file format (.wma).

**WMA Lossless**

Microsoft Window Media Audio lossless audio codec, provides duplication of original audio so that no data are lost.

**WMA Pro**

Microsoft Windows Media Audio Professional technologies.

**WMA Pro LBR**

Low bit rate mode of Microsoft Windows Media Audio Professional technologies.

### WMV

Microsoft Windows Media Video technologies. Also the compressed video file format (.wmv).

### WPA

Wi-Fi Protected Access. Certified security for wireless computer networks.

## X

### Xvid

Free video codec library based on the MPEG-4 standard. Xvid uses MPEG-4 Advanced Simple Profile (ASP) compression with video encoded with MPEG-4 ASP video, and so can be decoded by all MPEG-4 ASP-based decoders. For more information, see http://www.xvid.org.

## Y

### YAFFS

Yet Another Flash File System. The first file system designed for NAND flash.

## Z

### zImage

Conventional (but not required) name for the uncompressed kernel boot image file in Linux. **bzImage** is the compressed or "big" zImage file for systems requiring the kernel image to be under a certain size.

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