NVIDIA TEGRA LINUX DRIVER PACKAGE

PG_06706-R21 | July 6, 2016 | R21.5 Release

Development Guide

TABLE OF CONTENTS

Overview

Welcome to the *NVIDIA Tegra Linux Driver Package Development Guide*. It is written for software engineers who wish to understand the NVIDIA® Tegra® Linux Driver Package, sometimes called Linux for Tegra (L4T). Here they will learn how to set up L4T and get started developing systems software and applications that target compatible reference hardware from NVIDIA.

> **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 you expand 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.
- Lauterbach Debugging Scripts—lists and describes the Lauterbach debugging scripts for L4T.
- Building Crosstool-ng Toolchain and glibc—provides instructions to build the cross toolchain suite version 4.5.3 and the glibc suite with an Ubuntu host machine.
- Downloads—links to the downloads available in this release.
- Licenses—provides license information for Tegra and 3rd-party software.
- Appendix—provides an example configuration file for the crosstool-NG toolchain.
- Glossary—provides definitions of key terms.

Package Manifest

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

```
Tegra<SOC>_Linux_<release_num>.<version_num>_<release_type>.tbz2
```

Where:

- <release_num> is the branch number of the release, such as R21.
- <version_num> is the version number of the build, such as 3.0 for the third build.
- <release_type> is armel (for softfp ABI) or armhf (for hard-float ABI).

The following table lists the top level directories (denoted by a trailing slash /) and files that are created when you expand the tar file.

Directory or Filename	Description
<platform>.conf	Configuration file(s) for flash.sh specific to the development platform represented by <platform>.
rootfs/	Staging directory for the root filesystem.
rootfs/README.txt	Read Me instructing you to copy the sample file system here.
kernel/	Kernel images and kernel modules.
kernel/dtb/	Kernel Device Tree Binary (DTB) files for the particular SoC.
bootloader/	Boot loader and related components.
bootloader/<board>/	Platform-specific files.
bootloader/<board>/BCT/	Platform-specific Boot Configuraiton Table (BCT) files.
bootloader/<board>/cfg/	Configuration files for specific <board>
nv_tegra/	NVIDIA drivers and sample applications.
nv_tegra/nv_sample_apps/	NVIDIA sample applications.
source_sync.sh	Script to download kernel and U-Boot source.

apply_binaries.sh	Script to apply nv_tegra components.
flash.sh	Script to flash the boot loader and kernel from the package.
zImage_to_uimg.sh	Script to create the vmlinux.uimg with mkimage for use as the kernel image for U-Boot.

Note: The <platform> variable specifies the development system, such as jetson-tk1.

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 R21.3.

Kernel

The kernel directory contains the following directories (denoted by a trailing slash /) and files.

Directory or Filename	Description
dtb/	SoC-specific kernel Device Tree Binary (DTB) files.
dtb/tegra124-*.dtb	DTB files specific to various board types.
dtc	Device-tree-compiler binary.
zImage	Kernel binary image.
LICENSE	GNU General Public License (GPL).
LICENSE.dtc	GNU General Public License (GPL) for the device-tree-compiler binary.
kernel_headers.tbz2	Kernel header files needed for compiling kernel modules. You can download these headers and sources from the nv_tegra git server.
kernel_supplements.tbz2	Loadable kernel modules specific to the included kernel zImage that was built with the defconfig enabled for the device.

Boot Loader

The bootloader directory contains the following directories (denoted by a trailing slash /) and files.

Directory or Filename	Description
ardbeg/	Configuration files for ardbeg, the development board for Tegra K1 32 Bit (T12x) devices.
ardbeg/<platform >_extlinux.conf.emmc	U-Boot config file for booting off the internal EMMC.
ardbeg/<platform>_extlinux.conf.nfs	U-Boot config file for booting off the nfs root.
ardbeg/<platform>_extlinux.conf.sdcard	U-Boot config file for booting off the SD card.
ardbeg/<platform>_extlinux.conf.usb	U-Boot config file for booting off USB flash storage device.
ardbeg/BCT	Platform-specific BCT directory.
ardbeg/BCT/E1780_Hynix_2GB_H5TC4G63AFR_RDA_408Mhz.cfg	Boot Configuration Table (BCT) for Jetson TK1.
ardbeg/BCT/E1780_Hynix_2GB_H5TC4G63AFR_RDA_792Mhz.cfg	BCT for Jetson TK1.
ardbeg/BCT/E1780_Hynix_2GB_H5TC4G63AFR_RDA_924Mhz.cfg	BCT for Jetson TK1.
ardbeg/BCT/E1780_Hynix_4GB_H5TC8G63AMR_PBA_792Mhz.cfg	BCT for Jetson TK1.
ardbeg/BCT/PM358_Hynix_2GB_H5TC4G63AFR_RDA_792MHz.cfg	BCT for Jetson TK1.
ardbeg/BCT/PM358_Hynix_2GB_H5TC4G63AFR_RDA_924MHz.cfg	BCT for Jetson TK1.
ardbeg/BCT/PM359_Hynix_2GB_H5TC4G63AFR_RDA_102MHz.cfg	BCT for Jetson TK1.
ardbeg/BCT/PM359_Hynix_2GB_H5TC4G63AFR_RDA_732MHz.cfg	BCT for Jetson TK1.
ardbeg/BCT/PM359_Hynix_2GB_H5TC4G63AFR_RDA_792MHz.cfg	BCT for Jetson TK1.
ardbeg/BCT/PM374_Hynix_2GB_H5TC4G63AFR_RDA_102MHz.cfg	BCT for Jetson TK1.
ardbeg/BCT/PM374_Hynix_2GB_H5TC4G63AFR_RDA_792MHz.cfg	BCT for Jetson TK1.
ardbeg/BCT/PM374_Hynix_2GB_H5TC4G63AFR_RDA_924MHz.cfg	BCT for Jetson TK1.
ardbeg/BCT/PM375_Hynix_2GB_H5TC4G63AFR_RDA_792MHz.cfg	BCT for Jetson TK1.
ardbeg/BCT/PM375_Hynix_2GB_H5TC4G63AFR_RDA_924MHz.cfg	BCT for Jetson TK1.
ardbeg/BCT/PM375_Hynix_4GB_H5TC8G63AMR_PBA_792Mhz.cfg	BCT for Jetson TK1.
ardbeg/BCT/PM377_Hynix_4GB_H5TC4G83MFR_RDA_792MHz.cfg	BCT for Jetson TK1.
ardbeg/cfg/	Platform-specific configuration files.
ardbeg/cfg/gnu_linux_fastboot_emmc_full.cfg	Platform-specific configuration file.

ardbeg/fastboot.bin	Fastboot-versioned boot loader binary.
ardbeg/u-boot.bin	U-Boot binary image.
LICENSE	Tegra software license.
LICENSE.mkbootimg_and_mkubootscript	License for the `mkbootimg` and `mkbootscript` tools.
LICENSE.mkgpt	License file for the `mkgpt` tool.
LICENSE.mksparse	License file for the `mksparse` tool.
LICENSE.u-boot_and_mkimage	License for `u-boot` and `mkimage`.
mkbootimg	Tool for img creation.
mkgpt	Tool that encodes both primary and secondary GPT into flashable binary image files.
mkimage	U-Boot tool for `vmlinux.uimg` creation.
mksparse	Sparse image flashing with the bootloader.
mkubootscript	Tool for flashing U-Boot.
nvflash	NVIDIA flashing tool.

NV Tegra

The `nv_tegra` directory contains the following directories (denoted by a trailing slash /) and files.

Direcotry or Filename	Description
config.tbz2	Configuration files specific to the sample filesystem.
LICENSE	Tegra software license.
nvidia_drivers.tbz2	NVIDIA driver components.
nv_sample_apps/	NVIDIA sample applications.
nv_sample_apps/LICENSE.gstegl	MIT license for `libgstnveglglessink.so` included in nvgstapps.tbz2.
nv_sample_apps/LICENSE.gst-openmax	License for the `libgstomx.so`, `libgstnvegl-1.0.so.0`, and `libnvgstjpeg.so` libraries included in `nvgstapps.tbz2`.

nv_sample_apps/nvgstapps.tbz2	NVIDIA gstreamer components and applications.
nv_sample_apps/nvgstcapture-<version>_README.txt	Read Me for Nvidia Gstreamer-based camera capture application (nvgstcapture).
nv_sample_apps/nvgstplayer-<version>_README.txt	Read Me for Nvidia Gstreamer-based multimedia player (nvgstplayer).
nv_tools.tbz2	The `tegrastats` application. Refer to the *Development Guide* for usage.

Nvgstapps TBZ2

The following table lists the directories (denoted by a trailing slash /) and files available upon decompressing the `nvgstapps.tbz2` archive, located at:

```
nv_tegra/nv_sample_apps/nvgstapps.tbz2
```

Filename	Description
usr/bin/nvgstcapture-<version>	Multimedia capture camera application.
usr/bin/nvgstplayer-<version>	Multimedia video player application.
usr/lib/arm-linux-gnueabi[hf]/gstreamer-<version>/	Plug-ins and drivers for gstreamer.
usr/lib/arm-linux-gnueabi[hf]/gstreamer-<version>/libgstnvvidconv.so	NVIDIA proprietary GStreamer conversion plug-in library.
usr/lib/arm-linux-gnueabi[hf]/gstreamer-<version>/libgstomx.so	OpenMax driver.
usr/lib/arm-linux-gnueabi[hf]/gstreamer-<version>/libnvgstjpeg.so	Accelerated libjpeg based jpeg decoding and encoding library.
usr/lib/arm-linux-gnueabi[hf]/gstreamer-1.0/libgstnveglglessink.so	Accelerated Egl based renderer element.
usr/lib/arm-linux-gnueabihf/libgstnvegl-1.0.so.0	Modified gst-egl library.
usr/lib/arm-linux-gnueabihf/gstreamer-1.0/libgstnvcamera.so	Camera driver.

Config TBZ2

The following table lists the contents available upon decompressing the config.tbz2 archive, located at:

```
nv_tegra/config.tbz2
```

Filename	Description

etc/asound.conf.tegramax98090	ALSA library configuration file for MAX98090.
etc/asound.conf.tegrart5639	ALSA library configuration file for RT5639.
etc/enctune.conf	Default multimedia encoding parameters for NVIDIA reference platforms.
etc/init/nv.conf	NVIDIA-specific initialization script.
etc/init/nvfb.conf	NVIDIA specific first-boot script.
etc/init/nvwifibt.conf	NVIDIA bluetooth/wifi init script.
etc/init/ttyS0.conf	Initialization script for getty on ttyS0.
etc/modules	Lists bluedroid as a supporting module for Bluetooth.
etc/nv/nvfirstboot	Control file used for for first boot.
etc/pulse/daemon.conf	Configuration file for the PulseAudio daemon.
etc/pulse/default.pa.hdmi	PulseAudio configuration file.
etc/pulse/default.pa.orig	PulseAudio configuration file.
etc/sysctl.d/90-tegra-settings.conf	Control file for sysrq.
etc/udev/rules.d/90-alsa-asound-tegra.rules	Rules configuration for proper asound.conf selection.
etc/udev/rules.d/91-xorg-conf-tegra.rules	Rules configuration for proper xorg.conf selection.
etc/udev/rules.d/92-hdmi-audio-tegra.rules	Rules configuration for proper /etc/pulse/default.pa selection.
etc/udev/rules.d/99-nv-wifibt.rules	Rules configuration for Wi-Fi and Bluetooth.
etc/udev/rules.d/99-tegra-devices.rules	Permission setting for Tegra devices.
etc/udev/rules.d/99-tegra-mmc-ra.rules	SD card read_ahead_kb configuration.
etc/wpa_supplicant.conf	Sample WPA supplicant.
etc/X11/xorg.conf	Configuration file for xorg.
etc/X11/xorg.conf.jetson-tk1	Configuration file for Jetson TK 1 specific xorg.

NVIDIA Drivers TBZ2

The following table lists the contents available upon decompressing the `nvidia_drivers.tbz2` archive, located at:

```
nv_tegra/nvidia_drivers.tbz2
```

Filename	Description
etc/ld.so.conf.d/nvidia-tegra.conf	Ldconf file for tegra directories.
etc/nv_tegra_release	Tegra driver versioning file.
lib/firmware/nvavp_os_*.bin	NVIDIA AVP Kernel firmware.
lib/firmware/nvavp_vid_ucode_alt.bin	NVIDIA video decoders.
lib/firmware/tegra12x/	Firmware files for `jetson-tk1` and other Tegra K1 32 bit (T12x) devices.
lib/firmware/tegra12x/fecs.bin	GPU FECS firmware.
lib/firmware/tegra12x/gpccs.bin	GPU GPCCS firmware.
lib/firmware/tegra12x/gpmu_ucode.bin	GPU PMU ucode firmware
lib/firmware/tegra12x/NETB_img.bin	GPU device hardware description.
lib/firmware/tegra12x/ nvhost_msenc031.fw	Tegra K1-specific nvhost firwmware file for msenc.
lib/firmware/tegra12x/nvhost_tsec.fw	Firmware file nvhost for tsec.
lib/firmware/tegra12x/vic03_ucode.bin	VIC ucode binary (VIC for pre or post processing.)
lib/firmware/tegra_xusb_firmware	Firmware file for XUSB.
usr/bin/nvidia-bug-report-tegra.sh	NVIDIA bug reporting script. Run for usage tips.
usr/lib/arm-linux-gnueabi[hf]/tegra-egl/ ld.so.conf	Ldconf file for tegra-egl directories.
usr/lib/arm-linux-gnueabi[hf]/tegra-egl/ libEGL.so.1	OpenGL ES driver file.
usr/lib/arm-linux-gnueabi[hf]/tegra-egl/ libGLESv1_CM.so.1	OpenGL ES driver file.
usr/lib/arm-linux-gnueabi[hf]/tegra-egl/ libGLESv2.so.2	OpenGL ES driver file.
usr/lib/arm-linux-gnueabi[hf]/tegra/ libcuda.so.1.1	CUDA library.
usr/lib/arm-linux-gnueabi[hf]/tegra/ libGL.so.1	GL graphics support library.

usr/lib/arm-linux-gnueabi[hf]/tegra/ libglx.so	GLX extension module for X. Module is used by the X server to provide server-side GLX support.
usr/lib/arm-linux-gnueabi[hf]/tegra/ libjpeg.so	Accelerated libjepeg library for Tegra.
usr/lib/arm-linux-gnueabi[hf]/tegra/ libnvapputil.so	Host (x86) shared object for application utilities.
usr/lib/arm-linux-gnueabi[hf]/tegra/ libnvavp.so	User-space interface to the AVP for audio/ video acceleration via the nvavp kernel driver.
usr/lib/arm-linux-gnueabi[hf]/tegra/ libnvdc.so	DC driver file.
usr/lib/arm-linux-gnueabihf/tegra/ libnvddk_2d_v2.so	DDK 2D.
usr/lib/arm-linux-gnueabi[hf]/tegra/ libnvddk_vic.so	DDK VIC.
usr/lib/arm-linux-gnueabi[hf]/tegra/ libnvidia-eglcore.so.21.4	EGL core library.
usr/lib/arm-linux-gnueabi[hf]/tegra/ libnvidia-glcore.so. 21.4	OpenGL core library. This library is implicitly used by libGL and by libglx, and contains the core accelerated 3D functionality.
usr/lib/arm-linux-gnueabi[hf]/tegra/ libnvidia-glsi.so. 21.4	OpenGL System Interaction library.
usr/lib/arm-linux-gnueabi[hf]/tegra/ libnvidia-rmapi-tegra.so. 21.4	Utility library that implements common code for using kernel-level graphics drivers on Tegra.
usr/lib/arm-linux-gnueabi[hf]/tegra/ libnvidia-tls.so. 21.4	NVIDIA tls libraries.
usr/lib/arm-linux-gnueabi[hf]/tegra/ libnvmm_camera_v3.so	Core camera v3 framework library.
usr/lib/arm-linux-gnueabi[hf]/tegra/ libnvmm_contentpipe.so	Content pipe implementation (file source abstraction).
usr/lib/arm-linux-gnueabi[hf]/tegra/ libnvmmlite_audio.so	NVIDIA Multimedia audio driver.
usr/lib/arm-linux-gnueabi[hf]/tegra/ libnvmmlite_image.so	NVIDIA Multimedia image driver.
usr/lib/arm-linux-gnueabi[hf]/tegra/ libnvmmlite.so	NVIDIA Multimedia driver.

usr/lib/arm-linux-gnueabi[hf]/tegra/libnvmmlite_utils.so	NVIDIA Multimedia utilities.
usr/lib/arm-linux-gnueabi[hf]/tegra/libnvmmlite_video.so	NVIDIA Multimedia video driver.
usr/lib/arm-linux-gnueabi[hf]/tegra/libnvmm_parser.so	Parser.
usr/lib/arm-linux-gnueabi[hf]/tegra/libnvmm.so	NVIDIA Multimedia Framework.
usr/lib/arm-linux-gnueabi[hf]/tegra/libnvmm_utils.so	Multimedia Framework utilities.
usr/lib/arm-linux-gnueabi[hf]/tegra/libnvodm_imager.so	Tegra development platform ODM adaptation for imager.
usr/lib/arm-linux-gnueabi[hf]/tegra/libnvodm_query.so	ODM Query interface.
usr/lib/arm-linux-gnueabi[hf]/tegra/libnvomxilclient.so	OpenMAX IL client.
usr/lib/arm-linux-gnueabi[hf]/tegra/libnvomx.so	OpenMAX IL implementation.
usr/lib/arm-linux-gnueabi[hf]/tegra/libnvos.so	NVIDIA OS abstraction library.
usr/lib/arm-linux-gnueabi[hf]/tegra/libnvparser.so	Parser used for NVIDIA NvMMlite.
usr/lib/arm-linux-gnueabi[hf]/tegra/libnvrm_graphics.so	Resource Manager (NvRM) graphics host, AVP communication library, and graphics drivers.
usr/lib/arm-linux-gnueabi[hf]/tegra/libnvrm.so	Resource Manager kernel interface.
usr/lib/arm-linux-gnueabi[hf]/tegra/libnvsm.so	NVIDIA shader manager library.
usr/lib/arm-linux-gnueabi[hf]/tegra/libnvtestio.so	Target (ARM) shared object for test I/O utilities.
usr/lib/arm-linux-gnueabi[hf]/tegra/libnvtestresults.so	Test results library.
usr/lib/arm-linux-gnueabi[hf]/tegra/tegra/libnvtnr.so	Temporal Noise Reduction (TNR) interface.
usr/lib/arm-linux-gnueabi[hf]/tegra/libnvtvmr.so	Multimedia Tegra video mixer/renderer.
usr/lib/arm-linux-gnueabi[hf]/tegra/libnvwinsys.so	Winsys library.

usr/lib/arm-linux-gnueabi[hf]/tegra/libtegrav4l2.so	V4L2 driver for Tegra.
usr/lib/xorg/	X Windows System libraries and drivers
usr/lib/xorg/modules/drivers/nvidia_drv.so	Tegra X driver.
usr/lib/xorg/modules/extensions/libglx.so	Symbolic link pointing to /usr/lib/arm-linux-gnueabi[hf]/tegra/libglx.so in the rootfs.

Getting Started

To ensure success with NVIDIA® Tegra® Linux Driver Package (L4T), please review this entire chapter before you start developing. L4T software drivers require setup and configuration before use.

This guide describes L4T functions only: setting up L4T on your host system, building the kernel, flashing binary images, installing test, multimedia, and bug reporting programs, and so on. The reference board has its own documentation.

Reference Board Preparation

When developing systems and application software with L4T, you run and test your code on an actual reference platform from NVIDIA, such as Tegra K1 32 Bit series Jetson reference board (known as Jetson TK1). Your code targets this hardware directly, rather than a software simulator or emulator.

Accordingly, you must acquire and set up your reference board before using L4T. Please consult your board documentation for guidance on setting up and configuring your board.

Although the reference board supports a variety of peripheral devices, you can start developing on L4T with a board that has only the following:

- One of the storage devices specified in Boot Options in this chapter.
- A USB cable to plug into the board's recovery port.

Boot Options

You can boot L4T on the Jetson TK1 reference board from a root file system (rootfs) on integrated, attached, or network-accessible storage. Boot options include the following:

- USB stick (formatted to EXT4)
- USB hard disk (formatted to EXT4)

- SD card (formatted to EXT4)
- Internal eMMC
- SATA (Fastboot only)
- Network File System (NFS)

Linux Host System Prerequisites

Using L4T on a Linux host system has the following hardware and software prerequisites:

- Host PC running Linux. The examples in this document use Ubuntu 12.04, although other distributions should also work.
- A kernel image (zImage). L4T contains a kernel image (zImage) for your use. Alternatively, you can download and rebuild the kernel image from source.
- Boot loader. Flashing on a Tegra K1 32 Bit series (Jetson TK 1) developer board requires a boot loader, which can be the Fastboot utility or U-Boot. Both are included in this release.
- NFS if you intend to boot L4T on the reference board from your Linux host system or a network-accessible server.
- A USB cable to plug into the recovery port.

Extracting Tegra Linux Driver Package

Follow the steps below to extract your L4T package.

To extract Tegra Linux Driver Package

- Extract the package manually by executing the following command:

```
$ sudo tar -vxjf Tegra<SOC>_Linux_<release_num>.<version_num>_<release type>.tbz2
```

Where:

- <release_num> is the branch number of the release, such as R21.
- <version_num> is the revision number of the build such as 3.0 for the third build.
- <release_type> is armhf (for hardfp ABI).

Note: Commands in the examples in this chapter assume you extracted the release package in ~/.

Setting Up Your File System

L4T requires its own root file system. You must create one on your Linux host system and then copy it to your reference board, as described in this section.

Sample Root File System

L4T comes with a pre-built sample root file system that was created on a Jetson TK1 reference board. If you wish to create the sample root file system for yourself, follow these steps.

To create the sample file system

1. Install `debootstrap` with the following command.

```
$ sudo apt-get install debootstrap
```

2. Run the following command as root.

```
$ debootstrap --verbose --no-check-gpg --arch=armhf --variant=minbase --include=ubuntu-
```

The hostname used in this procedure is `tegra-ubuntu`, where the username is `ubuntu`, and the password is `ubuntu`.

Note: The provided sample target file system does not come with pre-generated SSH host keys. You can generate host keys using the following command:

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

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

If you are using your own Linux distribution, please also view the files included in:

```
~/Linux_for_Tegra/nv_tegra/config.tbz2
```

Modify the files to suit your root file system.

The following packages are installed by default:

- ubuntu-minimal
- xserver-xorg
- xserver-xorg-core
- x11-xserver-utils
- xinit
- xterm
- alsa-utils
- wireless-tools
- wpasupplicant
- openssh-client
- bzip2

- less
- iputils-ping
- isc-dhcp-client
- net-tools
- lsb-release
- sudo
- vim
- iw
- bluez
- gdisk
- wget
- language-pack-en-base
- xfonts-base
- ntp

Setting Up the Root File System

Before you can boot the target board you must configure the root file system (rootfs), which requires the following steps:

- Setting up the rootfs
- Copying it to the rootfs on the device

Step 1: Set Up the Root File System

This procedure uses the sample file system provided by NVIDIA as the base. If you would like to use your own file system, set the LDK_ROOTFS_DIR environment variable to point to the location of your rootfs 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>.tbz2
   ```

   Where `<release_type>` is `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 of 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 jxpf ../../Tegra-Linux-Sample-Root-Filesystem_<release_type>.tbz2
```

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

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

   If you are using a different rootfs, or if you have already 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.

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

4. (Optional)Load optional packages as shown in Installing Additional Packages in this guide.
5. Follow the steps in the Flashing the Boot Loader and Kernel section of this guide.
6. 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. Alternatively, you can use the `flash.sh` script to flash the root file system to the internal eMMC. In this case proceed with the following steps, and then and follow the internal eMMC instructions.
7. Power on the target board.
8. Optionally, use an RS232 serial cable (not included in the development kit) to connect the RS232 port on Jetson TK1 to the Linux host PC to access the debug console. Set up the terminal on the host PC as follows:
   - 115200 baud
   - 8-bit
   - Parity none
   - 1 stop bit

Step 2: Copy the rootfs to the Device

Follow the steps below to copy the file system (that you that set up in the previous topic) to your Tegra device.

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 Ext4, enter the following command to format it with an Ext4 file system:

```
$ sudo mkfs.ext4 /dev/sd<port><device number>
```

   Where:

   - `<port>` is the port to which your device is mounted.
   - `<device_number>` is the device number of the device attached to the port. 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 the mount point on the host system for your rootfs device.

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

```
$ cd ${LDK_ROOTFS_DIR}
$ sudo cp -a * <mntpoint> && sync
```

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

```
$ cd <your_L4T_root>/Linux_for_Tegra/rootfs
$ sudo cp -a * <mntpoint> && sync
```

After copying the content to the external disk or device, you can unmount the disk and connect it to the board. For more information about flashing, see Flashing the Boot Loader and Kernel in this chapter. For information about configuring your board setup, see the hardware documentation for your reference board.

To copy the file system to the internal eMMC

- For flashing to internal eMMC, see the Flashing the Boot Loader and Kernel topic in this section.

Determining the Success of a Driver Update

After updating drivers on a target board, it is important to verify that the update completed successfully.You can determine the success or failure of a driver update by using the following commands.

To determine the success of a driver update

- Execute the following command on a booted target device:

```
$ sha1sum -c /etc/nv_tegra_release
```

If the driver update succeeded, the output displays the word *OK* after the file name. A typical success message looks like this:

```
/usr/lib/xorg/modules/drivers/nvidia_drv.so: OK
```

The driver update will fail if the file is missing. A typical error message will look like this:

```
sha1sum: /usr/lib/xorg/modules/drivers/nvidia_drv.so: No such file or directory
/usr/lib/xorg/modules/drivers/nvidia_drv.so: FAILED open or read
```

The driver update will also fail if the new file is not the same as the existing file, producing an error such as:

```
/usr/lib/xorg/modules/drivers/nvidia_drv.so: FAILED
```

Increasing Internal Memory Partition for the Root File System

The suggested rootfs partition size for the Jetson TK1 platform is 1503238553 bytes and is specified by default in the `<target_board>.conf` file used by the `flash.sh` script.

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.sh -S <size> <platform> <rootdev>
```

Where:

- `<platform>` is `jetson-tk1`.
- `<size>` is the desired size for the partition, such as 8589934592 (or 8 GiB) for 8 GB, if you want to decrease the size of the partition.
- `<rootdev>` is the rootfs partition's internal memory, for example mmcblk0p1.

Installing Additional Packages

L4T comes with additional NVIDIA packages, including packages for Ubuntu 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, you should install these additional packages.

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

Installing Additional Ubuntu Packages

You can install additional packages from Ubuntu, using the provided sample file system. You might wish to download the following packages:

- `openssh-server` for remotely logging in
- `ubuntu-desktop` for the standard Ubuntu graphical user interface (if not pre-installed)

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

Note: L4T is tested with the provided sample file system 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, for a rootfs based on the Trusty Tahr distribution of Ubuntu, add the line:

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

Prerequisite

You have attached an Ethernet cable to the device through either the Ethernet port (if available) or through the USB Ethernet adapter.

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
   ```

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. Following are the general steps for configuring an NFS root on the Linux host.

Prerequisites

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

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 must 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 cp –a * /nfsroot
   ```

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: Prior to executing the mount command on the target machine, you must install the `nfs-common` package using the following command:

```
$ 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

You can reduce the power consumption of the reference board in the following ways:

- Enabling the Auto-Hotplug driver
- Enabling the Tegra CPU power-gated state (LP2)

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 auto-hotplug

- Enter the following command:

```
echo 1 > /sys/devices/system/cpu/cpuquiet/tegra_cpuquiet/enable
echo "balanced" > /sys/devices/system/cpu/cpuquiet/current_governor
```

To disable auto-hotplug

- Enter the following command:

```
echo 0 > /sys/devices/system/cpu/cpuquiet/tegra_cpuquiet/enable
```

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/power_down_in_idle
```

Controlling Display State

The Linux kernel 3.1 (and later) adds a power saving feature that may blank the display of an idle system even when applications are 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.

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.

Flashing the Boot Loader and Kernel

This section describes the steps required to boot the target board (Jetson TK1 platform) by flashing the kernel and boot loader. It also provides usage information for the `flash.sh` helper script.

Flash Procedure

First, flash the board with the boot loader and kernel, and, optionally, flash the rootfs to internal eMMC.

Prerequisites

The following directories must be present:

- /bootloader—boot loader plus flashing tools (NvFlash, CFG, BCTs, etc.)
- /kernel—a kernel zImage /vmlinux.uimg, DTB files, and kernel modules
- /rootfs—the root file system that you download (This directory starts empty and you populate it with the sample file system.)
- /nv_tegra—NVIDIA® Tegra® user space binaries and sample applications

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

To flash the boot loader and kernel

1. Put the target board into reset/recovery mode. Do so by first powering on the board and then holding the recovery button, and then pressing the reset button as described in the *Quick Start Guide* for the board.
2. Run the `flash.sh` script that is in the top level directory of this release. The script must be supplied with the target board (`jetson-tk1`) for the root file system:

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

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

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

     Note: If a SATA device is connected, that device enumerates as `sda1`.

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

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

   - If the root file system will be on the internal eMMC, execute the script as follows:

     ```
     $ sudo ./flash.sh <platform> mmcblk0p1
     ```

Where <platform> is `jetson-tk1`.

The above examples are for u-boot. For fastboot, add the following argument:

```
-L <PATH_TO_FASTBOOT_BIN_FILE>
```

For example:

```
$ sudo ./flash.sh -L bootloader/<platform>/fastboot.bin <platform> <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] <platform> <rootdev>
```

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

Parameters	**Description**	
<platform>	Is `jetson-tk1`.	
<rootdev>	Is one of following:	
	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.	
-d <dtbfile>	Optionally specifies a device tree file to use instead of the default.	
-e <emmc_file>	Specifies the eMMC size of the target device.	
-f <flashapp>	Specifies the path to flash application: nvflash or tegra-rcm.	
-i	Specifies to pass the user kernel command line to the kernel as-is.	
-k <partition id>	Specifies the kernel partition ID to be updated (minimum = 5).	

-n <nfs args>	Specifies the static NFS network assignments: `<Client IP>:<Server IP>:<Gateway IP>:<Netmask>`
-o <odmdata>	Specifies the ODM data value.
-p	Total eMMC HW boot partition size.
-r	Specifies to skip building and reuse existing `system.img`.
-s <ubootscript>	Specifies the boot script file for U-Boot.
-C <cmdline>	Specifies the kernel command line. **Warning**: Each option in this kernel command-line gets higher precedence over the same option from fastboot. In case of NFS booting, this script adds NFS booting related arguments if the -i option is omitted.
-F <flasher>	Specifies the flash server, such as `fastboot.bin`.
-I <initrd>	Specifies `initrd` file. Null `initrd` is the default.
-K <kernel>	Specifies the kernel image, such as zImage.
-L <bootloader>	Specifies the full path to the boot loader, such as `fastboot.bin` or `u-boot.bin`.
-P <end_of_PPT_plus_1>	Specifies the sum of the primary GPT start address, the size of PPT, plus 1.
-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. KiB, MiB, GiB style shorthand is allowed. For example, 1GiB signifies 1024 * 1024 * 1024 bytes.
-T <ITS file>	ITS file name. Valid only for u-boot.

Synchronizing the Kernel Sources

You can manually rebuild the kernel used for this package. Internet access is required to do so.

Prerequisites

- You have installed Git. Install Git with 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.

—Or—

You can also manually sync the sources, as follows:

```
$ cd <myworkspace>
$ git clone git://nv-tegra.nvidia.com/linux-3.10.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 source point of time 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-
```

Note: This example requires GCC 4.4 or above.

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

2. Execute the following commands to create the .config:

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

Where <kernel_source> directory containing kernel sources.

- For Tegra K1 32 Bit, Jetson TK 1, use:

```
$ make O=$TEGRA_KERNEL_OUT tegra12_defconfig
```

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

3. Execute the following commands to build the kernel:

```
$ make O=$TEGRA_KERNEL_OUT zImage
```

4. Execute the following command to create the kernel device tree components:

```
$ make O=$TEGRA_KERNEL_OUT dtbs
```

5. Execute the following commands to build the kernel modules (and optionally install them)

```
$ make modules DESTDIR=<your_destination>
$ make modules_install INSTALL_MOD_PATH=<your_destination>
```

6. Copy the kernel zImage over the one present in the 'kernel' directory of the release.
7. Archive the kernel modules created in Step 4 using the `tar` command and the filename that is used for the kernel modules TAR file in the same kernel directory of the release. When both of those TAR files are present, you can follow the instructions provided in this document to flash and load your newly built kernel.

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 an Ethernet connection.
2. Enable package download from the "universe" repository by editing /etc/apt/sources.list as root:

```
$ sudo vi /etc/apt/sources.list
```

3. Uncomment the following line in the file by removing the leading # character:

```
# deb http://ports.ubuntu.com/ubuntu-ports/ trusty universe
```

4. Update the repository:

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

5. Install the `mesa-utils` and `mesa-utils-extra` packages:

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

6. 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 this application. This section includes the following sub-topics.

- Installing GStreamer
- Using NvGstPlayer

For more information about the NvGstPlayer application, refer to the readme file included with the release.

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.

Complete prerequisite steps in the file `nvgstcapture_README.txt` before running the NvGstPlayer and NvGstCapture applications.

Instructions for installing GStreamer are also included in that text file.

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. For information about NvGstPlayer runtime commands, default settings, and important notes see the `nvgstplayer_README.txt` file included in the release.

Gstreamer-based Camera Capture (NvGstCapture)

The NvGstCapture application supports GStreamer version 0.10.36 by default. NvGstCapture can capture audio and video data using microphone and camera and encapsulate encoded A/V data in the container file.

For NvGstCapture installation and usage information, see the `nvgstcapture-<VERSION>_README.txt` file included with the release at `~Linux_for_Tegra/nv_tegra/nv_sample_apps`.

NVIDIA Bug Reporting Script

Attaching the log file to communication about issues found with the release is beneficial. Use the `nvidia-bug-report-tegra.sh` script to generate log files.

To generate a log file for bug reporting

- Log into the target board and enter the below command:

```
$ sudo /usr/bin/nvidia-bug-report-tegra.sh
```

To generate a log file for bug reporting with extended logging mode

- Log into the target board and enter the below command:

```
$ sudo /usr/bin/nvidia-bug-report-tegra.sh –e
```

By default the logfile generated by both procedures above is located at `$HOME/nvidia-bug-report-tegra.log`.

> **Note:** Attach a log file when reporting any bugs to NVIDIA, whether through email or the forums.

U-Boot Guide

U-Boot is the default boot loader for NVIDIA® Tegra® Linux Driver Package (L4T). It replaced Fastboot as of the R21.1 release. If you used an earlier release of L4T, check that your environment is fully updated for the new boot loader before compiling and flashing the boot loader and the kernel.

Requirements

The software requirements for Tegra Linux Driver Package (L4T) include:

- Linux-based Host System

  Functionality of the U-Boot build and flashing utilities was validated using an Ubuntu 12.04 host system. Later versions of Ubuntu 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

  To parse various configuration files, the U-Boot makefiles require Fast Lexical Analyzer (Flex) and Bison, a GNU general purpose parser generator. If Flex and Bison are not already installed on your host system, you must install them. On Ubuntu, use the following command:

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

- Device Tree Compiler (DTC)

  The U-Boot make system must have the full path to the DTC binary. Pass the path as a variable or include the dtc directory in the local command path of the host machine. Most of the DTC packages available from standard Linux distribution package management systems (like apt) are not yet updated with a version of DTC supporting the features required by the U-Boot makefile. Therefore, an example of building DTC from source is included in this chapter. For the procedure, see Building Device Tree Compiler.

  A pre-built DTC compiler is also included in the kernel directory of the release. This DTC compiler is built from the kernel sources in this release. The sources are located in the `scripts/dtc` directory. You build the DTC compiler by building the kernel `dtbs` target.

- ARM tool chain for cross compilation

  For more information, see Building Crosstool-ng Toolchain and glibc in this guide.

- U-Boot source

  For more information, see Downloading and Building U-Boot in this chapter.

- Kernel source

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

  - Setting up the Root File System
  - Synchronizing the Kernel Sources
  - Building the NVIDIA Kernel

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

Downloading and Building U-Boot

Before flashing U-Boot to your reference platform, you must download and build it on the Linux host system. NVIDIA offers a Git repository containing the source code for a U-Boot build suitable for L4T.

Prerequisite

Before copying U-Boot, back up the original `u-boot.bin` file in:

```
<top>/Linux_for_Tegra/bootloader/<platform>/u-boot.bin
```

Where `<platform>` is the Tegra hardware platform, such as `ardbeg`.

To download and build U-Boot

1. Download the L4T U-Boot source code:

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

   Alternatively, use the `source_sync.sh` script in the L4T release.

   When running `source_sync.sh –u` without parameters, the script prompts for the `<TAG_NAME>`, which is provided in the release notes.

   The "-k" option to `source_sync` syncs only the kernel sources. A space between the `–u` and `–k` options is allowed. By default, if no option is provided, the script syncs both kernel and u-boot sources.

   Additionally, you can run the script by passing the `<TAG_NAME>` as follows:

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

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

This syncs the source to:

```
<source_sync.sh_location>/sources/u-boot_source.
```

The <uboot_src_dir> directory becomes:

```
<your_L4T_root>/Linux_for_Tegra/sources/u-boot_source.
```

2. Check out the Git tag name:

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

Where:

- <branch_name> is the name of your local branch.
- <tag_name> is the release tag name provided in the *Release Notes*.

3. Set the build environment:

```
$ export ARCH=arm
$ export CROSS_COMPILE=<your_toolchain_location>
$ export DTC=<dtc_binary_location>
```

4. Build U-Boot by executing:

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

Where <target_board> is the device, such as code-name jetson-tk1 for Jetson TK1.

Flashing U-Boot

You must flash U-Boot to internal eMMC only. During flashing, U-Boot fetches the boot script and kernel and mounts the rootfs, which may reside on one of the following storage devices:

- Internal eMMC
- An SD card
- An USB storage device
- An IP network

When executing the script that flashes U-Boot, you must specify a command-line option appropriate to the storage device containing the boot script, kernel, and rootfs. The following sections describe the script command for each configuration.

Support for BOARDID

NVIDIA uses the Board ID scheme to identify each board and the boot process checks for its ID to proceed. However, for some of the partners designing their own board, Board ID is not used and, thus, setting it should be skipped so the boot code knows not to check its ID and refuse booting if the check fails.

However, executing `BOARDID` should be uncommented in the `jetson-tk1.conf` file before executing `flash.sh` when you don't have an EEPROM with a correctly flashed Board ID and you want to pass a custom, or known, Board ID while flashing. Doing so overrides the EEPROM value, if present. For example:

```
BOARDID="0x177 0x00 0x03";
```

Note: When booting from external media, you must run the `flash.sh` script as the last step when deploying/configuring the target. This is because the `flash.sh` script copies the appropriate `extlinux.conf` file and the only way to know that it is the proper file is when we know which device is being flashed during `flash.sh`.

To flash U-Boot and mount the rootfs from internal eMMC

- Use the following command to fetch the boot script and kernel and mounts rootfs from internal eMMC:

```
$ sudo ./flash.sh <target_board> mmcblk0p1
```

Where `<target_board>` is `jetson-tk1` for Jetson TK1.

Note: Check that your environment is fully updated for this change in boot loader before compiling and flashing the boot loader and the kernel.

To flash U-Boot and mount the rootfs from an SD card

- Use the following command to fetch the boot script and kernel and mounts rootfs from an SD card:

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

Where `<target_board>` is `jetson-tk1` for Jetson TK1.

To flash U-Boot and mount the rootfs from a USB storage device

- Use the following command to fetch the boot script and kernel and to mount the rootfs from a USB storage device, such as a Pen Drive.

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

Where `<target_board>` is `jetson-tk1` for Jetson TK1.

Note: The U-Boot boot loader only detects USB external storage. The kernel detects both USB external storage and external SCSI_SATA storage.

Use only 1 external USB storage device at a time. If using more than 1 external device, a random device may be chosen as root device.

To flash U-Boot and mount the rootfs from an IP network

- Use the following command to fetch the boot script and kernel and mount the rootfs from an IP network:

```
$ sudo ./flash.sh –N <IPA>:/<nfs directory> [-n <target IPA>:<host IPA>:<gateway IPA>:<
```

Where:

- <target_board> is jetson-tk1 for Jetson TK1.
- <interface name> is eth0 for RJ45 connector and eth1 for USB Ethernet dongle.
- <IPA> is the NFS server hosting the rootfs.
- <nfs_directory> is the full path name of exported rootfs.
- <target IPA> is the static IP address for the target device.
- <host IPA> is the static IP address for the NFS server.
- <gateway IPA> is the static IP address for the gateway.
- <netmask> is the static netmask for the local network.

Note: The -n option is only recommended on point-to-point network connections where no DHCP server is configured.

Flashing Just U-Boot

You can find instructions for flashing the full L4T image to the reference platform in Flashing U-Boot in this chapter. If, however, you wish to flash just U-Boot, proceed as follows.

To copy U-Boot for flashing to the reference platform

- Execute the following on your Linux host system:

```
$ cp <uboot_src_dir>/u-boot/u-boot-dtb-tegra.bin <your_L4T_root>/Linux_for_Tegra/bootlo
```

To flash just new U-Boot

- Execute the following:

```
$ sudo ./flash.sh -k EBT <target_board> mmcblk0p1
```

Where <target_board> is jetson-tk1 for Jetson TK1.

Changing the eMMC Partition Layout

The following information is based on eMMC hardware and software layout information in the following files:

- <target_board>.conf
- <top>/Linux_for_Tegra/bootloader/<platform>/cfg/gnu_linux_fastboot_emmc_full.cfg

Where <top> is the L4T root, where flash.sh generates the internal eMMC partition layout. When you use the NvFlash utility and the fastboot.bin flash application, L4T U-Boot does not use the kernel partition.

Applies to:R21.2 and earlier releases: Aside from this difference with respect to the kernel partition, U-Boot has the same internal eMMC partition layout as that used by Fastboot.

eMMC IC Parameter

The eMMC IC parameter is defined by 2 variables in the `<target_board>.conf` file. They limit the size of the total usable data area and determine the location of GPT partitions.

- The BOOTPARTSIZE parameter specifies the eMMC boot partition size (boot0 partition size + boot1 partition size)
- The EMMCSIZE parameter specifies the eMMC usable data size (BOOTPARTSIZE + user partition size)

  Note: boot0, boot1, and user partition size can be obtained from the eMMC device data sheet.

RootFS Size

The rootfs partition is the largest of the partitions, and its size is one of the key factors in partition layout determination. By default, `flash.sh` sets the rootfs size at 14 GB. You can change this by modifying the value of the `ROOTFSSIZE` variable in the `<target_board>.conf` file.

Note: The total space used by all partitions cannot exceed `EMMCSIZE`.

GPT Partitions

The `flash.sh` script creates the primary and secondary GPT partitions automatically, based on the internal eMMC partition layout. The Protective MBR contains device information to prevent traditional boot loaders from performing destructive actions. The primary GPT partition contains the GUID Partition Table. The secondary GPT partition contains the same information as the primary GPT and serves as the backup. The Protective MBR is located at LBA 0, the primary GPT is located at LBA 1, and the secondary GPT is located at the last LBA of the boot device. The last Logical Block Address (LBA) varies from device to device. Both U-Boot and the kernel are able to obtain the last LBA.

LNX Partition

Normally, the LNX partition is not used by U-Boot; however, for compatibility, an empty LNX partition is allocated.

APP Partition

If rootfs storage is in eMMC, the rootfs is flashed to this partition. U-Boot expects boot script, kernel, and DTB files in the `<rootfs>/boot` directory; consequently, `flash.sh` flashes the following kernel files in the APP partition:

- kernel (`zImage`)
- device_tree_blob (`tegra124-jetson_tk1-pm375-000-c00-00.dtb`)
- `sysboot_config` (`extlinux.conf`)

  Note: The`flash.sh` script treats the rootfs-on-IP-network configuration as a special case and also flashes these kernel files in the `<APP partition>:/boot` directory.

Example Full Internal eMMC Partition Layout

An eMMC layout configuration file (cfg) generally has the following contents. The actual configuration file is named: `gnu_linux_fastboot_emmc_full.cfg` file.

Note: Under default settings, U-Boot does not use the kernel partition (LNX).

```
[device]

type=sdmmc
```

```
instance=3

[partition]
name=BCT
id=2
type=boot_config_table
allocation_policy=sequential
filesystem_type=basic
size=2097152  #BCTSIZE
file_system_attribute=0
partition_attribute=0
allocation_attribute=8
percent_reserved=0

[partition]
name=PPT
id=3
type=data
allocation_policy=sequential
filesystem_type=basic
size=8388608  #PPTSIZE
file_system_attribute=0
partition_attribute=0
allocation_attribute=8
percent_reserved=0
#filename=ppt.img

[partition]
name=PT
id=4
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=5
type=bootloader
allocation_policy=sequential
filesystem_type=basic
size=4194304
file_system_attribute=0
partition_attribute=0
allocation_attribute=8
percent_reserved=0
filename=fastboot.bin

[partition]
name=LNX
id=6
type=data
allocation_policy=sequential
filesystem_type=basic
size=16777216
file_system_attribute=0
partition_attribute=0
allocation_attribute=8
percent_reserved=0
filename=boot.img

[partition]
name=SOS
id=7
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=NVC
id=8
type=data  #TEGRABOOT
allocation_policy=sequential
filesystem_type=basic
size=2097152
file_system_attribute=0
partition_attribute=0
allocation_attribute=8
percent_reserved=0
#filename=nvtboot.bin

[partition]
name=MPB
id=9
type=data  #MTSPREBOOT
allocation_policy=sequential
filesystem_type=basic
size=6291456
file_system_attribute=0
partition_attribute=0
allocation_attribute=8
percent_reserved=0
#filename=mts_preboot_si

[partition]
name=MBP
id=10
type=data  #MTSBOOTPACK
allocation_policy=sequential
filesystem_type=basic
size=6291456
```

```
file_system_attribute=0
partition_attribute=0
allocation_attribute=8
percent_reserved=0
#filename=mts_si

[partition]
name=GP1
id=11
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=12
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=DTB
id=13
type=data
allocation_policy=sequential
filesystem_type=basic
```

```
size=4194304
file_system_attribute=0
partition_attribute=0
allocation_attribute=8
percent_reserved=0
#filename=tegra.dtb

[partition]
name=EFI
id=14
type=data
allocation_policy=sequential
filesystem_type=basic
size=67108864  #EFISIZE
file_system_attribute=0
partition_attribute=0
allocation_attribute=8
percent_reserved=0
#filename=efi.img

[partition]
name=USP
id=15
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=TP1
id=16
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=TP2
id=17
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=TP3
id=18
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=WB0
id=19
type=data #WB0BOOT
allocation_policy=sequential
filesystem_type=basic
```

```
size=2097152
file_system_attribute=0
partition_attribute=0
allocation_attribute=8
percent_reserved=0
#filename=nvtbootwb0.bin

[partition]
name=UDA
id=20
type=data
allocation_policy=sequential
filesystem_type=basic
size=2097152
file_system_attribute=0
partition_attribute=0
allocation_attribute=0x808
percent_reserved=0

[partition]
name=GPT
id=21
type=GPT
allocation_policy=sequential
filesystem_type=basic
size=0xFFFFFFFFFFFFFFFF
file_system_attribute=0
partition_attribute=0
allocation_attribute=8
percent_reserved=0
#filename=spt.img
```

Testing RootFS By Device

You must test the root file system location by device. A Y in the output indicates that correct U-Boot initialization and hand-off to the kernel occurred.

RootFS Location	Jetson TK1

mmcblk0p1	Y
mmcblk1p1	Y
sda1	Y
eth0	Y
eth1	Y

Building Device Tree Compiler

Build the Device Tree Compiler (DTC) from source code included in L4T, specifying the features required by the U-Boot makefile.

> **Note**: In the following procedure, 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. Furthermore, if you execute:
>
> `$ make install`
>
> The dtc makefile installs the binary into the first entry of shell PATH variable. Therefore, it is important that the local command path is at the beginning of the shell PATH variable.

To build DTC from source

1. Execute the following commands:

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

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 git://git.kernel.org/pub/scm/utils/dtc/dtc.git
```

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
```

Adding a Compiled Kernel to the Root File System

Adding a new Kernel

U-Boot requires a kernel image on the rootfs. First you must configure the file system for U-Boot. Then you add the kernel image to the rootfs.

Prerequisite

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

To configure a file system for U-Boot

1. Use the `apply_binaries` script to copy the `zImage` in the kernel directory into the `rootfs` directory in the `/boot` folder.
2. Install the `rootfs` directory onto your device.

   For U-Boot to function properly, there must be `zImage` and `dtb` files in the `/boot` directory of the target file system.

   For more information on installing the `rootfs` directory onto your device, see Setting Up the Root File System in the Getting Started chapter.

3. If you have already installed your rootfs onto a device, manually copy the `zImage` file and `dtb` files to the installed root file system.

To configure a file system installed in the internal eMMC

1. Optionally, backup the existing release kernel and dtb files to avoid overwriting.
2. Copy the compiled `zImage` and `dtb` files over the current L4T release kernel directory by executing the following commands:

   ```
   $ cp arch/arm/boot/zImage <L4T_path>/Linux_for_Tegra/kernel
   $ cp arch/arm/boot/dts/tegra124-jetson_tk1-pm375-000-c00-00.dtb <L4T_path>/Linux_for
   ```

   `flash.sh` automatically copies the `zImage` to the internal eMMC rootfs.

Adding a new Kernel

After U-Boot has been flashed as the default boot loader, you can replace the kernel. The procedure you should follow depends on the kind of storage device from which your device boots.

To replace the kernel in systems that boot from internal eMMC

1. Boot the Jetson TK1 system and log in.
2. Copy the new kernel files (using `scp`) into the `/boot` directory.
3. Reboot the Jetson TK1 system.

To replace the kernel in systems that boot from an SD Card or USB Pen Drive

1. Connect the SD Card or USB Pen Drive to your host system.
2. Copy the new kernel files to a `/boot` directory on the SD Card or USB Pen Drive.
3. Disconnect the SD Card or USB Pen Drive from the host system.
4. Connect the SD Card or USB Pen Drive to the Jetson TK1 system.
5. Reboot the Jetson TK1 system.

To replace the kernel in systems that boot from an IP network

1. Boot the Jetson TK1 system and log in.
2. On the target system enter the following command:

```
$ sudo mount /dev/mmcblk0p1 /mnt
```

3. Copy the new kernel files (using `scp`) to the `mnt/boot` directory.
4. Reboot the Jetson TK1 system.

Example Sysboot Configuration Files

eMMC Sysboot extlinux.conf File

For external media, you must copy the rootfs to the device **after** running the `flash.sh` command. Then you attach the device.

The U-Boot functionality includes a default booting scan sequence. It scans bootable devices in the following order:

- External SD Card
- Internal eMMC
- USB Device
- NFS Device

It looks for an `extlinux.conf` configuration file in the following directory of the bootable device:

```
<rootfs>/boot/extlinux
```

Upon finding the `extlinux.conf` file, U-Boot does the following.

- Uses the `sysboot` command to read out boot configuration from `extlinux.conf`,
- Loads kernel `zImage` file and device tree file, and then
- Boots the kernel.

The `zImage` and device tree files are all user-accessible in the `<rootfs>/boot` location after booting. The `extlinux.conf` file is user accessible in the `<rootfs>/boot/extlinux` location. Users can easily change these files to test their own kernel without flashing.

The file `extlinux.conf` is a standard text-format sysboot configuration file that contains all boot information. It indicates the U-Boot kernel image filename, the device tree blob filename, and the kernel boot command line. There are four example `extlinux.conf` files provided in the L4T release:

```
<target_board>_extlinux.conf.emmc
<target_board>_extlinux.conf.sdcard
<target_board>_extlinux.conf.usb
<target_board>_extlinux.conf.nfs
```

During flashing, `flash.sh` copies the appropriate variant to the following location:

```
<rootfs>/boot/extlinux/extlinux.conf
```

The `extlinux.conf` files are very similar except for different kernel boot command lines. You can find the `extlinux.conf` files in the following location:

```
bootloader/<platform>/
```

Where `<platform>` is `ardbeg` for Jetson TK1.

eMMC Sysboot extlinux.conf File

The `extlinux.conf` file has the following contents.

```
TIMEOUT 30
DEFAULT primary

MENU TITLE Jetson-TK1 eMMC boot option

LABEL primary
      MENU LABEL primary kernel
      LINUX zImage
      FDT /boot/tegra124-jetson_tk1-pm375-000-c00-00.dtb
      APPEND console=ttyS0,115200n8 console=tty1 no_console_suspend=1
lp0_vec=2064@0xf46ff000 video=tegrafb mem=1862M@2048M memtype=255
ddr_die=2048M@2048M section=256M pmuboard=0x0177:0x0000:0x02:0x43:0x00
vpr=151M@3945M tsec=32M@3913M otf_key=c75e5bb91eb3bd947560357b64422f85
usbcore.old_scheme_first=1 core_edp_mv=1150 core_edp_ma=4000
tegraid=40.1.1.0.0 debug_uartport=lsport,3 power_supply=Adapter
audio_codec=rt5640 modem_id=0 android.kerneltype=normal
usb_port_owner_info=0 fbcon=map:1 commchip_id=0 usb_port_owner_info=0
lane_owner_info=6 emc_max_dvfs=0 touch_id=0@0
tegra_fbmem=32899072@0xad012000
board_info=0x0177:0x0000:0x02:0x43:0x00 root=/dev/mmcblk0p1 rw
rootwait tegraboot=sdmmc gpt
```

Different boot methods have different APPEND strings in the `extlinux.conf` file. Check each file for details.

Note: NFS booting also uses eMMC as boot device. `<rootfs>/boot` is flashed into to eMMC but kernel mounts NFS device as `rootfs`.

Debugging U-Boot Environment

Listing the Contents of a Directory
Printing the U-Boot Environment
Printing/Setting Environment Variables

Use these debugging tips to help you debug your U-Boot environment. These examples do not represent a comprehensive listing of U-Boot functionality. For a full list of supported commands and their usage by U-Boot, consult U-Boot documentation and source.

When creating your own kernel, U-Boot sometimes has trouble finding it. To eliminate this issue, use the commands in these examples to verify that U-Boot can read the device and can see the files in the system. If a boot device is not found, or the device has trouble booting with a kernel other than the reference kernel provided in the L4T release, review these examples for debugging purposes.

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

To see the U-Boot Help text

- To see the U-Boot help text enter the following command:

```
# help
```

The following example Help information is printed when executing help on a Jetson TK1 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'
bootelf - Boot from an ELF image in memory
bootm   - boot application image from memory
bootp   - boot image via network using BOOTP/TFTP protocol
bootvx  - Boot vxWorks from an ELF image
bootz   - boot Linux zImage image from memory
cmp     - memory compare
coninfo - print console devices and information
cp      - memory copy
crc32   - checksum calculation
dfu     - Device Firmware Upgrade
dhcp    - boot image via network using DHCP/TFTP protocol
dm      - Driver model low level access
echo    - echo args to console
editenv - edit environment variable
enterrcm- reset Tegra and enter USB Recovery Mode
```

```
env     - environment handling commands
exit    - exit script
ext2load- load binary file from a Ext2 filesystem
ext2ls  - list files in a directory (default /)
ext4load- load binary file from a Ext4 filesystem
ext4ls  - 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    - query and control gpio pins
help    - print command description/usage
i2c     - I2C sub-system
imxtract- extract a part of a multi-image
itest   - return true/false on integer compare
load    - load binary file from a filesystem
loadb   - load binary file over serial line (kermit mode)
loads   - load S-Record file over serial line
loadx   - load binary file over serial line (xmodem mode)
loady   - load binary file over serial line (ymodem mode)
loop    - infinite loop on address range
ls      - list files in a directory (default /)
md      - memory display
mii     - MII utility commands
mm      - memory modify (auto-incrementing address)
mmc     - MMC sub system
mmcinfo - display MMC info
mw      - memory write (fill)
nm      - memory modify (constant address)
part    - disk partition related commands
pci     - list and access PCI Configuration Space
ping    - send ICMP ECHO_REQUEST to network host
printenv- print environment variables
pxe     - commands to get and boot from pxe files
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
size    - determine a file’s size
sleep   - delay execution for some timesource  - run script from memorysspi    - SPI
sysboot - command to get and boot from syslinux files
test    - minimal test like /bin/sh
tftpboot- boot image via network using TFTP protocol
true    - do nothing, successfully
ums     - Use the UMS [User Mass Storage]
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, to list the directory structure of sda1 in U-Boot by type: `mmc 0:1` (for eMMC device 0 partition 1).

To list the directory structure

- To list the directory structure enter the following command:

```
# ext2ls mmc 0:1
```

This also functions correctly on EXT3/EXT4 file systems.

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 the contents of a directory

- List directory contents with the following command:

```
# ext2ls mmc 0:1 <directory>
```

Where <directory> is an expected path on the device.

For example, to list contents of the /boot directory where the zImage file should be, (as shown in the example output below), use the following command:

```
# ext2ls mmc 0:1 /boot
<DIR>       1024 .
<DIR>       1024 ..
           34642 tegra124-pm375.dtb
             908 extlinux.conf
         5910248 zImage
```

Printing the U-Boot Environment

You can print the entire U-Boot environment.

To print the U-Boot environment

- Execute the following command:

```
# printenv
```

Printing/Setting Environment Variables

You can print and set environment variables.

To print an environment variable

- Execute the following command:

```
# printenv <environment_variable>
```

Where <environment_variable> refers to an environment variable in U-Boot.

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

```
# printenv pn
```

Output can be as follows:

```
pn=1
```

To set an environment variable

- Execute the following command:

```
# setenv <environment_variable> <new_value>
```

Where `<environment_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:

```
# setenv pn 1
```

To save the modified environment

- Execute the following command:

```
# saveenv
```

The saved modified environment is preserved in case of resets and reboots.

Lauterbach Debugging Scripts

Setting Up the Lauterbach Debugging Scripts Environment

The following table describes the Lauterbach scripts supplied with this release.

Script	Description
adsp_attach.cmm	Configures to attach to aDSP but otherwise do not change the system state
adsp_kernel_attach.cmm	Attaches to aDSP with OS symbols loaded
adsp_menu_setup.cmm	Installs on start-up aDSP-side menu buttons
avp_attach.cmm	Attaches the AVP
avp_boot_attach.cmm	Attaches the AVP for Ethernet boot
avp_boot_ml.cmm	Attach to AVP for mini-loader debug
avp_boot_tb.cmm	Debugs TegraBoot binary loaded into IRAM by this script
avp_init_cpu.cmm	Powers the up the CPU from the AVP
avp_menu_setup.cmm	Installs AVP-side menu buttons
avp_power_cpu.cmm	Powers the up the CPU from the AVP
avp_uboot_attach.cmm	Boots AVP with U-BOOT loaded into SDRAM by this script without resetting the chip
config_avp.t32	Provides environment variable settings
config_cpu.t32	Provides environment variable settings
config_cpu_win.t32	Provides environment variable settings
cpu_attach.cmm	Attaches to CPU on Tegra <platform> BSP for kernel
cpu_boot_sdram_noload.cmm	Boots CPU with various configurations
cpu_boot_attach.cmm	Attaches to CPU on Tegra <platform> BSP for Ethernet boot
cpu_dcc_setup.cmm cpu_dcc_swi_setup.cmm	Configures DCC for the CPU
cpu_disable_mmu.cmm	Disables the CPU MMU and caches
cpu_kernel_attach.cmm	Attaches to CPU with kernel symbols loaded

cpu_lk.cmm	Reconfigures for boot loader-to-kernel hand-off
cpu_menu_setup.cmm	Installs CPU-side menu buttons
cpu_mp_attach.cmm	Sets up CPU for complex core/ multiprocessor settings
cpu_uboot-attach.cmm	Boots CPU on with U-Boot already present in SDRAM
csite_cpu.cmm	Dumps CoreSight CPU apertures
install_customer_scripts	Installs scripts to the `$T32SYS` (Android) `C:\T32` (Windows) directory, and then prompts the user to customize the configuration script
physical_setup.cmm	Reconfigures for boot loader physical addressing mode
setup_customer_environment.cmm	Sets up paths and global environment variables used by other scripts
t32.cmm	Initializes TRACE32
t32_customer.cmm	Default startup program for TRACE32
t32adsp	Specifies TRACE32 instance is aDSP for start up
t32avp	Specifies TRACE32 instance is AVP for start up
t32cpu	Specifies TRACE32 instance is CPU for start up
toolbar_setup.cmm	Sets up common toolbar items
user_config_customer.cmm	Sets user-specific parameters, such as script variables
virtual_setup.cmm	Reconfigures virtual addressing mode for kernel
windows.cmm	Provides Windows settings
t21x/t21x_adsp_jtag_setup.cmm	Configures JTAG for the aDSP

Setting Up the Lauterbach Debugging Scripts Environment

Four sets of commands must be run to set up the environment to execute the Lauterbach scripts. These are detailed below.

To setup to run Lauterbach

1. Add these variables to `~/.bashrc`:

```
$ export T32SYS=<directory you chose as your Trace32 install directory>
$ export T32TMP=/tmp
$ export T32ID=T32
$ export PATH=$PATH:$T32SYS/bin/pc_linux:$T32SYS
```

2. In your build directory, set the following:

```
$ export TEGRA_TOP=$(pwd)
$ export TARGET_BOARD=t210ref
$ export TARGET_OS_SUBTYPE=gnu_linux
```

3. Download the tar ball of Lauterbach scripts from the link to them under the "Downloads" button and extract them.

   The correct paths for zImage and vmlinux are setup in the `user_config_customer.cmm` script.

4. Copy the required files to your t32 directory:

```
$ cd $TEGRA_TOP/lauterbachscripts
$ sudo -E ./install_customer_scripts
$ cp user_config_customer.cmm /opt/t32/user_config.cmm
$ cp ./setup_customer_environment.cmm ./setup_environment.cmm
```

5. Execute the following command on the host system:

```
$ t32cpu &
```

6. Execute the following commands on the device:

```
$ echo 0 > /sys/devices/system/cpu/cpuquiet/tegra_cpuquiet/enable
$ echo 1 > /sys/kernel/debug/cpuidle_t210/fast_cluster_states_enable
$ echo 1 > /sys/kernel/debug/cpuidle_t210/slow_cluster_states_enable
```

Video for Linux User Guide

This document provides information on use of the MIPI Camera Serial Interface (CSI) on NVIDIA® Tegra® X1, using software from the NVIDIA® Tegra® Linux Driver Package (also referred to as L4T). The MIPI CSI protocol, V4L2 API, Tegra X1 system architecture and method of attaching a CSI camera to Jetson TX1 are outside the scope of this document.

The V4L2 software implementation bypasses the Tegra ISP, and is suitable for use when Tegra ISP support is not required, such as with sensors or input devices that provide data in YUV format.

References to additional resources are provided, but the reader should already be familiar with Tegra X1, and have access to the *Tegra Technical Reference Manual* (TRM) and other documentation available at the Jetson Embedded Platform portal:

http://developer.nvidia.com/embedded-computing

V4L2/SOC_CAMERA Overview

V4L2 is the second version of Video4Linux or V4L, a video capture and output device API and driver framework in the Linux kernel. It supports many USB webcams, TV tuners, and other devices and is closely integrated with the Linux kernel. For a description of the APIs, see Linux Media Infrastructure APIs.

`soc-camera` is a set of drivers and a core module, that implement V4L2 functionality on embedded devices; typically a video-enabled embedded device: SoC with a capture interface and video data sources. The `soc-camera` includes host driver such as the Tegra V4L2 camera driver and client drivers (sensor drivers).

Note:	**Software releases after R23: `soc_camera` driver is deprecated and replaced with the media-controller driver. The media-controller driver framework is V4L2-compatible and provides greater functionality than the `soc_camera` driver. Existing V4L2 sensor drivers require minor modifications to be compatible with media-controller. Plan your software development for this transition.**

V4L2 on Jetson TX1

Jetson TX1 is a powerful embedded development board including the NVIDIA® Tegra® X1 processor. Tegra X1 processors have a video input interface (VI) and camera serial interface (CSI), so Tegra X1 can communicate with the external video input sources, such as camera sensor module or other MIPI CSI compatible devices. VI/CSI of Tegra X1 also has two test pattern generators that can generate some data patterns like color bricks for testing purpose. You can find out more about this development board at:

http://elinux.org/Jetson_TX1

On the software side, Linux for Tegra (L4T) latest release R23 provides a Tegra V4L2 camera driver and sample drivers for a camera sensor and a built-in test pattern generator (TPG). With an open source V4L2 user space tool like Yavta, users can capture data from the TPG and sensors. For more information about Yavta, see:

http://git.ideasonboard.org/yavta.git

Test Pattern Generator

The test pattern generator is a configurable resource introduced to improve hardware verification capability for the Tegra CSI. There are two separate test pattern generators that can be configured to provide for the generation of synthetic image data, which is delivered to the PPA and PPB input FIFOs. The image data is multiplexed into the CSI data patch between lane-merging logic and the data FIFOs.

L4T provides a virtual V4L2 `soc_camera` sensor driver for exposing TPG functionality (`soc_camera_platform driver`). It can generate 1280x720 resolution RGBA32 color bricks data. There is no need to rebuild the kernel and the `soc_camera_platform driver` is provided as a loadable module.

To verify the TPG

1. Remove the `nvhost_vi` module, an incompatible non-V4L2 VI driver used for other purposes and outside the scope of this document:

   ```
   $ sudo rmmod nvhost_vi
   ```

2. Install V4L2 driver modules:

   ```
   $ sudo modprobe soc_camera_platform
   $ sudo modprobe tegra_camera tpg_mode=2
   ```

3. Use the yavta application to capture data (other V4L2 applications can be used, if preferred)

   ```
   $ ./yavta /dev/video0 -c1 -n1 -s1280x720 -fRGB32 -Ftpg.rgba
   ```

4. Copy over `tpg.rgba` to host and use ImageMagick to show the picture:

   ```
   $ display -size 1280x720 -depth 8 tpg.rgba
   ```

Example Sensor: OV5693

L4T provides a sample V4L2 sensor driver for the OmniVision OV5693 Bayer sensor. This driver can be used as a reference in creating a custom V4L2 sensor driver. NVIDIA provides a reference OV5693 camera module E3326, with Jetson TX1.

The driver for OV5693 is neither built into the kernel nor built as module. Please try the following steps to test OV5693 in L4T on Jetson TX1.

Hardware setup:

- Jetson TX1
- OV5693 camera module

To test OV5693 in L4T on Jetson TX1

1. Apply patches on top of L4T release.

   L4T 23.1 Release (19 patches)

```
$ tar xfz r23.1_v4l2.tgz

$ ls r23.1/
0001-drivers-soc_camera-add-ov23850-OTP-controls.patch
0002-drivers-soc_camera-sensor-drivers-update.patch
0003-drivers-media-platform-tegra-get-gpio-pwr-info.patch
0004-drivers-media-soc_camera-IMX230-driver-to-gain.patch
0005-drivers-Restructure-GRHOST_VI.patch
0006-media-v4l2-core-Migration-from-upstream.patch
0007-media-soc_camera-add-ov13860-v4l2-driver.patch
0008-drivers-media-platform-ov5693-gpio-warning.patch
0009-media-tegra_camera-support-YUV-CSI-input.patch
0010-kernel-changes-for-implementing-sensor-cropping.patch
0011-drivers-soc_camera-give-default-hdr_en.patch
0012-media-tegra_camera-fix-syncpoint-time-out-issue.patch
0013-media-soc-camera-actually-use-default-resolution.patch
0014-media-soc_camera-add-tc358840-v4l2-driver.patch
0015-media-soc_camera-vi2-support-gang-mode.patch
0016-media-camera-common-export-symbols-for-modules.patch
0017-media-tegra_camera-init-mipi-bias-pad.patch
0018-ARM64-t210-add-E3326-camera-and-camera_common.patch
0019-ARM64-adding-OV5693-V4L2-on-E3326-jetson_cv.patch

$ git am r23.1/*
```

   L4T R23.2 Release (1 patch)

```
$ git am 0001-ARM64-adding-OV5693-V4L2-on-E3326-jetson_cv.patch
```

2. Enable OV5693 kernel driver and disable `soc_camera_platform`.
   - CONFIG_SOC_CAMERA_OV5693=m
   - CONFIG_VIDEO_TEGRA_VI=m

- Disable CONFIG_SOC_CAMERA_PLATFORM
- Disable CONFIG_SOC_CAMERA_OV13860
- Disable CONFIG_SOC_CAMERA TC358840

3. Build kernel, flash Jetson TX1 and boot the Linux OS.
4. Use Yavta to capture a frame.

```
$ sudo rmmod nvhost-vi
$ sudo modprobe ov5693_v4l2
$ sudo modprobe tegra_camera
$ ./yavta /dev/video0 -c1 -n1 -s1920x1080 -fSRGGB10 -Fov.raw
```

5. Use `raw2bmp` to convert raw data to BMP file.

```
$ ./raw2bmp ov.raw ov.bmp 1920 1080 16 3
```

V4L2 Tegra Driver Overview

As V4L2 is a kernel video input framework, Tegra V4L2 stack contains several components. It controls hardware such as the Tegra VI/CSI hardware controller and external sensors. Additionally, it exports a generic device node named `/dev/video<N>` to user space, where `<N>` is a numeric value. User space applications can use V4L2 standard API to control real hardware via `/dev/video<N>`.

This section focuses on Tegra X1-related drivers and code in L4T kernel source.

Tegra V4L2 Camera Driver

Tegra V4L2 camera driver is a part of soc_camera and acts as a host driver. It directly controls Tegra X1 VI/CSI hardware. Normally users don't need to modify this driver, but developers should become familiar with it; it may require customization for some use cases.

- Source code

```
drivers/media/platform/soc_camera/Kconfig
drivers/media/platform/soc_camera/Makefile
drivers/media/platform/soc_camera/tegra_camera/*
include/media/tegra_v4l2_camera.h
```

- Kernel config

```
CONFIG_VIDEO_TEGRA=m
```

- `tegra_camera.ko` module

  The module name is `tegra_camera.ko` and it won't be loaded by default after booting into L4T.

There is another driver named `nvhost_vi.ko` installed by default and is mutually-exclusive with `tegra_camera.ko`, so users must remove the `nvhost_vi.ko` before loading `tegra_camera.ko`.

- Input data format

  Tegra X1 VI/CSI hardware supports 3 major input data formats: YUV, RGB, and Bayer RAW. However in this driver only the following have been tested:

  - RGB888
  - RAW8
  - RAW10
  - YUV422

Note:	Some other formats are also supported by hardware, but software support is not present in the driver. Please refer to the Tegra TRM for details on supported input formats.

Please study the source code then add new input data formats not listed here.

Tegra V4L2 Sensor Driver

V4L2 sensor driver normally is an I2C device driver and in L4T it is also a V4L2 `soc_camera` client driver. It has several I2C register tables for different resolutions like 1920x1080, 1280x720, etc. When a user space application opens `/dev/video<N>`, the sensor driver powers on the sensor hardware and programs it with the register table via I2C.

- Real sensor code

```
drivers/media/i2c/soc_camera/ov5693_v4l2.c
drivers/media/i2c/soc_camera/ov5693_mode_tbls.h
include/media/ov5693.h
drivers/media/i2c/soc_camera/Kconfig
drivers/media/i2c/soc_camera/Makefile
```

- Test Pattern Generator virtual sensor driver source code

```
drivers/media/platform/soc_camera/soc_camera_platform.c
```

  The `soc_camera_platform` driver does not perform any real hardware operations like power control and I2C transactions. It is just a virtual driver to enable use of the TPG for testing.

- Kernel configs

```
CONFIG_SOC_CAMERA_OV5693
CONFIG_SOC_CAMERA_PLATFORM
```

- Power controls

  Each sensor has its own power on/off sequence, clock settings and other hardware specific operations. L4T sensor driver puts these power controls in the sensor driver itself. For more flexible driver design, these power controls must go to board files since each hardware board may have different power controls. Then, the sensor driver itself can be more generic. Normally, power controls include:

- GPIO for sensor reset, power on or power down
- Regulators for sensor power supply
- Clocks for sensor running like mclk or sensor local clock

Board File

Before fully moving to device tree binding, a board file is the only way to describe platform-specific configurations within the Linux kernel. Beginning in L4T R23 releases, most hardware devices use device tree binding, but V4L2 `soc_camera` still uses a board file approach.

- Source code

  ```
  arch/arm64/mach-tegra/board-t210ref-camera.c
  ```

- TPG board configs

  `soc_camera_platform_info` defines data format and resolution which must be matched with our TPG hardware.

  ```
  static struct soc_camera_platform_info t210ref_soc_camera_info = {
          .format_name = "RGB4",
          .format_depth = 32,
          .format = {
                  .code = V4L2_MBUS_FMT_RGBA8888_4X8_LE,
                  .colorspace = V4L2_COLORSPACE_SRGB,
                  .field = V4L2_FIELD_NONE,
                  .width = 1280,
                  .height = 720,
          },
          .set_capture = t210ref_soc_camera_set_capture,
  };
  ```

  `tegra_camera_platform_data` is the most important data structure to describe the sensor connection. `.port` indicates which CSI port the sensor connects to:

  TEGRA_CAMERA_PORT_CSI_A means the sensor uses CIL_A.

  TEGRA_CAMERA_PORT_CSI_B means the sensor uses CIL_B.

  TEGRA_CAMERA_PORT_CSI_C means the sensor uses CIL_C.

  TEGRA_CAMERA_PORT_CSI_D means the sensor uses CIL_D.

  TEGRA_CAMERA_PORT_CSI_E means the sensor uses CIL_E.

TEGRA_CAMERA_PORT_CSI_F means the sensor uses CIL_F.

Tegra X1 internally has 6 CSI channels (CSI_A to CSI_F). CSI A/C/E channel can support 1, 2 and 4 data lane sensors and CSI B/D/F can support 1 and 2 data lane sensors..

```
static struct tegra_camera_platform_data t210ref_camera_platform_data = {
        .flip_v                 = 0,
        .flip_h                 = 0,
        .port                   = TEGRA_CAMERA_PORT_CSI_A,
        .lanes                  = 4,
        .continuous_clk         = 0,
};
```

- OV5693 board file configs

  Real sensors do not require that sensor resolution or data format information be put into the board file like TPG `soc_camera_platform` driver, because that information is in the sensor driver itself.

  - OV5693 connects to port CSI_C via 2 data lanes:

    ```
    static struct tegra_camera_platform_data
    t210ref_ov5693_e3326_camera_platform_data = {
            .flip_v                 = 0,
            .flip_h                 = 0,
            .port                   = TEGRA_CAMERA_PORT_CSI_C,
            .lanes                  = 2,
            .continuous_clk         = 0,
    };
    ```

  - OV5693 uses I2C bus 6 and it’s I2C address is 0x36:

    ```
    static struct camera_common_pdata t210ref_ov5693_e3326_data = {
            .regulators = {
                    .avdd = "vana",
                    .iovdd = "vif",
            },
            .reset_gpio = 148, /* TEGRA_GPIO_PS4 */
            .pwdn_gpio = 151, /* TEGRA_GPIO_PS7 */
    };

    static struct i2c_board_info t210ref_ov5693_e3326_camera_i2c_device = {
            I2C_BOARD_INFO("ov5693_v4l2", 0x36),
    };
    ```

```
static struct soc_camera_link ov5693_e3326_iclink = {
        .bus_id          = 0, /* This must match the .id of tegra_vi01_device */
        .board_info      = &t210ref_ov5693_e3326_camera_i2c_device,
        .module_name     = "ov5693_v4l2",
        .i2c_adapter_id = 6, /* VI2 I2C controller */
        .power           = t210ref_ov5693_power,
        .priv            = &t210ref_ov5693_e3326_camera_platform_data,
        .dev_priv        = &t210ref_ov5693_e3326_data,
};
```

- Register OV5693 soc_camera platform device:

```
platform_device_register(&t210ref_ov5693_e3326_soc_camera_device);
```

Device Tree File

Device tree provides regulator information required by the V4L2 sensor driver. OV5693 sensor driver use 2 regulators: `vana` and `vif`. They are defined in:

```
arch/arm64/boot/dts/tegra210-platforms/tegra210-jetson-e-pmic-p2530-0930-e03.dtsi
arch/arm64/boot/dts/tegra210-platforms/tegra210-jetson-e-power-fixed-p2530-0930-e03.dts
```

Writing and Integrating a Sensor Driver for L4T

Developers can write their own sensor driver for their specific device. Sensor drivers usually have very similar structures but different I2C register tables. Modification of the board file and the device tree file is required for different boards.

Sensor Driver Development

The OV5693 sensor drivers are a good starting point for writing a new sensor driver. The following steps are recommended for developing a new driver:

- Import new I2C register tables

  Sensor vendors provide I2C register settings as tables, which must be added to sensor driver. The following struct is a good example:

```
static const ov5693_reg *mode_table[] = {
        [OV5693_MODE_2592X1944]                  = mode_2592x1944,
        [OV5693_MODE_2592X1458]                  = mode_2592x1458,
```

```
        [OV5693_MODE_1920X1080]                 = mode_1920x1080,
        [OV5693_MODE_1296X972]                  = mode_1296x972,
        [OV5693_MODE_1280X720_120FPS]           = mode_1280x720_120fps,
        [OV5693_MODE_2592X1944_HDR]             = mode_2592x1944_HDR_24fps,
        [OV5693_MODE_1920X1080_HDR]             = mode_1920x1080_HDR_30fps,
        [OV5693_MODE_1296X972_HDR]              = mode_1296x972_HDR_30fps,

        [OV5693_MODE_START_STREAM]              = ov5693_start,
        [OV5693_MODE_STOP_STREAM]               = ov5693_stop,
        [OV5693_MODE_TEST_PATTERN]              = tp_colorbars,
};
```

- Power controls

  Different boards have different sensor power controls. It is better put those power controls into a board file. But it is simpler to implement them in a sensor driver. Please take a look at `OV5693_power_on()` and `OV5693_power_off()` functions.

- `soc_camera` and I2C interface

  The sensor driver implements `soc_camera_ops` functions as well as I2C device probing/removing functions. Normally these are quite similar across different sensor drivers—just reuse them in your driver and use `OV5693_v4l2.c` as an example.

- KConfig and Makefile

  Add a `SOC_CAMERA_OV5693` entry into the `Kconfig` and `Makefile` files.

- Header file `include/media/ov5693.h`

  This header contains some information for non-V4L2 NVIDIA camera stacks. The following structures can be reused if necessary:

```
struct ov5693_regulators {
        const char *avdd;
        const char *dvdd;
        const char *dovdd;
};

struct ov5693_platform_data {
        unsigned cfg;
        unsigned num;
        const char *dev_name;
        unsigned gpio_count; /* see nvc.h GPIO notes */
        struct nvc_gpio_pdata *gpio; /* see nvc.h GPIO notes */
```

```
        struct nvc_imager_static_nvc *static_info;
        bool use_vcm_vdd;
        int (*probe_clock)(unsigned long);
        int (*power_on)(struct ov5693_power_rail *);
        int (*power_off)(struct ov5693_power_rail *);
        const char *mclk_name;
        struct nvc_imager_cap *cap;
        struct ov5693_regulators regulators;
        bool has_eeprom;
        bool use_cam_gpio;
};
```

Board File and Device Tree File Updates

A new project or new hardware board may have a new board file such as board-`t210ref*.c` for Jetson TX1. If so, the new board file must include those settings for sensor drivers. Follow this template in the board file and replace `SENSOR` with your sensor name:

```
#if IS_ENABLED(CONFIG_SOC_CAMERA_SENSOR)
static int t210ref_sensor_power(struct device *dev, int enable)
{
        return 0;
}
// NOTE: power controls can go here instead of sensor driver itself.

struct sensor_platform_data t210ref_sensor_data;

static struct i2c_board_info t210_sensor_camera_i2c_device = {
        I2C_BOARD_INFO("sensor_v4l2_driver_name", sensor_i2c_address),
        // sensor_v4l2_driver_name should match the sensor driver’s module name
        .platform_data = &t210ref_sensor_data,
};

static struct tegra_camera_platform_data t210ref_sensor_camera_platform_data = {
        .flip_v                 = 0,
        .flip_h                 = 0,
        .port                   = TEGRA_CAMERA_PORT_CSI_X_for_sensor,
        .lanes                  = number_of_sensor_data_lanes,
        .continuous_clk         = 0,
```

```
};

static struct soc_camera_link sensor_iclink = {
        .bus_id         = 0,
        .board_info     = &t210ref_sensor_camera_i2c_device,
        .module_name    = "sensor_v4l2_driver_name",
        .i2c_adapter_id = sensor_i2c_bus_number,
        .power          = t210ref_sensor_power,
        .priv           = &t210ref_sensor_camera_platform_data,
};

static struct platform_device t210ref_sensor_soc_camera_device = {
        .name   = "soc-camera-pdrv",
        .id     = 0,
        .dev    = {
                .platform_data = &sensor_iclink,
        },
};
#endif
```

- Finally register the platform device in `t210ref_camera_init()`:

```
#if IS_ENABLED(CONFIG_SOC_CAMERA_SENSOR)
        platform_device_register(&t210ref_sensor_soc_camera_device);
#endif
```

- Device tree update

  Find the new device tree file for the new board and update regulator information appropriate to the hardware configuration of the new board. A good example to look at is:

```
arch/arm64/boot/dts/tegra210-platforms/tegra210-jetson-e-pmic-p2530-0930-e03.dtsi
arch/arm64/boot/dts/tegra210-platforms/tegra210-jetson-e-power-fixed-p2530-0930-e03.dts
```

Troubleshooting

The following tips can help you troubleshoot the specified issue.

I2C transaction timeout error

- Is I2C information wrong?

  Check the sensor I2C bus number and the sensor I2C device address in the board file.

- Is sensor power control sequence wrong?

  Check sensor MCLK setting.

  Check regulator operations.

  Check GPIO settings.

Sync point timeout without error

This means Tegra VI/CSI does not receive any data but no error occurs. Verify that the sensor is powered on and streaming data correctly before debugging the Tegra driver.

Change settle time value to see if there if some error shows up. These registers must be configured with the right values to get data from the sensor.

```
cil_regs_write(vi2_cam, chan, TEGRA_CSI_CIL_PHY_CONTROL, 0xA);
```

Sync point timeout with error

Capture the error message and look it up in Tegra X1 TRM for further debugging.

Resources

Good resources for V4L integration are:

- Kernel documentation located in:

  ```
  Documentation/video4linux/
  ```

- Linux TV website:

  http://www.linuxtv.org/

- soc-camera slides:

  http://elinux.org/images/f/f2/Soc-camera.pdf

- Yavta user space V4L2 tool

  http://git.ideasonboard.org/yavta.git

- Jetson Embedded Platform page

  http://developer.nvidia.com/embedded-computing

Building Hardfp Crosstool-ng Toolchain and glibc

The NVIDIA® Tegra® Linux Driver Package contains the source code for the Crosstool-NG toolchain suite version 4.5.3 and the glibc suite. The Cross-NG toolchain suite resembles the toolchain NVIDIA uses to produce the L4T binaries.

This topic describes how to build Crosstool-NG and glibc on your Ubuntu host system.

Note: For a sample Crosstool-NG configuration file, see Appendix: Crosstool-NG Configuration File..

Toolchain Information

The toolchain contains following components:

- Crosstool-NG reference (http://crosstool-ng.org/)
- Cross Toolchain Version : 4.5.3
- glibc Version : 2.11

Host System Requirements

System requirements for the Ubuntu host systems includes:

- Ubuntu 10.04 32-bit distribution (64-bit distribution is not supported for building the toolchain)
- Fast host CPU such as Core 2 Duo (to reduce build time)
- 1GB Free space on HDD
- 2GB SDRAM

Dependent Packages

The Ubuntu host system must have the following packages installed:

- mercurial
- bison
- flex
- gperf
- texinfo
- m4
- libtool

- automake

Verify that the host system is connected to the internet, and run the following command to install the packages:

```
$ sudo apt-get install mercurial bison flex gperf texinfo m4 libtool automake
```

Building the Toolchain Suite

To build the toolchain you must:

- Set the `TOP_DIR` environment variable and create a directory tree
- Install autoconf-2.68
- Configure crosstool-NG
- Invoke the build

To set the TOP_DIR environment variable and create directories

1. To set the `TOP_DIR` variable to `${HOME}/crosstool` enter the following command:

```
$ export TOP_DIR="${HOME}/crosstool"
```

2. In the `${TOP_DIR}` directory, create the following subdirectories:

```
$ mkdir depends
$ mkdir crosstool-ng
$ cd depends
$ mkdir src
$ mkdir install
$ cd src
$ mkdir autoconf
$ mkdir ct-ng
```

To install autoconf-2.68

1. Change to the `autoconf` directory. Then download `autoconf-2.68.tar.bz2` by executing the following commands:

```
$ cd ${TOP_DIR}/depends/src/autoconf
$ wget http://ftp.gnu.org/gnu/autoconf/autoconf-2.68.tar.bz2
```

2. Extract and configure `autoconf-2.68`:

```
$ tar xf autoconf-2.68.tar.bz2
$ cd autoconf-2.68
$ ./configure --prefix=${TOP_DIR}/depends/install/autoconf_install/autoconf-2.68-instal
```

3. Make and install `autoconf-2.68`:

```
$ make
```

```
$ make install
```

To configure crosstool-NG

1. Change to the `ct-ng` directory:

   ```
   $ cd ${TOP_DIR}/depends/src/ct-ng
   ```

2. Add the autoconf-2.68-install directory to your path:

   ```
   $ export PATH=${TOP_DIR}/depends/install/autoconf_install/autoconf-2.68-install/bin:${P
   ```

3. Clone the `crosstool-ng` repository:

   ```
   $ hg clone http://crosstool-ng.org/hg/crosstool-ng
   ```

4. Configure `crosstool-ng`:

   ```
   $ cd crosstool-ng
   $ ./bootstrap
   $ ./configure --prefix=${TOP_DIR}/depends/install/ct-ng_install/crosstool-ng-hg-install
   ```

5. Make and install `crosstool-ng`:

   ```
   $ make
   $ make install
   ```

6. Create the `${TOP_DIR}/crosstool-ng/src` directory for locally saving downloaded packages:

   ```
   mkdir ${TOP_DIR}/crosstool-ng/src
   ```

To invoke the build

1. Change to the `/crosstool-ng-hg-install/bin` directory:

   ```
   $ cd ${TOP_DIR}/depends/install/ct-ng_install/crosstool-ng-hg-install/bin
   ```

2. Copy the following content of `.config` from the Sample Crosstool-ng Configuration File appendix to this guide to a file called `.config`.

   ```
   Note: .config is a hidden file. After creating it, confirm it exists in the
   correct location by running ls -a in the directory.
   ```

3. Build `ct-ng` using 8 parallel paths:

   ```
   $./ct-ng oldconfig
   $./ct-ng build.8
   ```

   This will build the complete suite and install the binary components in `${TOP_DIR}/crosstool-ng/install`.

Verifying the Build

After a successful build, the `${TOP_DIR}/crosstool-ng/install` directory contains the following tree structure, as reported by the `tree` application (where available):

```
$ tree -L 2

|-- arm-cortex_a9-linux-gnueabi
|   |-- bin
|   |-- debug-root
|   |-- include
|   |-- lib -> sysroot/lib
|   |-- lib32 -> lib
|   |-- lib64 -> lib
|   `-- sysroot
|-- bin
|   |-- arm-cortex_a9-linux-gnueabi-addr2line
|   |-- arm-cortex_a9-linux-gnueabi-ar
|   |-- arm-cortex_a9-linux-gnueabi-as
|   |-- arm-cortex_a9-linux-gnueabi-c++
|   |-- arm-cortex_a9-linux-gnueabi-cc -> arm-cortex_a9-linux-gnueabi-gcc
|   |-- arm-cortex_a9-linux-gnueabi-c++filt
|   |-- arm-cortex_a9-linux-gnueabi-cpp
|   |-- arm-cortex_a9-linux-gnueabi-ct-ng.config
|   |-- arm-cortex_a9-linux-gnueabi-g++
|   |-- arm-cortex_a9-linux-gnueabi-gcc
|   |-- arm-cortex_a9-linux-gnueabi-gcc-4.5.3
|   |-- arm-cortex_a9-linux-gnueabi-gccbug
|   |-- arm-cortex_a9-linux-gnueabi-gcov
|   |-- arm-cortex_a9-linux-gnueabi-gprof
|   |-- arm-cortex_a9-linux-gnueabi-ld
|   |-- arm-cortex_a9-linux-gnueabi-ldd
|   |-- arm-cortex_a9-linux-gnueabi-nm
|   |-- arm-cortex_a9-linux-gnueabi-objcopy
|   |-- arm-cortex_a9-linux-gnueabi-objdump
|   |-- arm-cortex_a9-linux-gnueabi-populate
|   |-- arm-cortex_a9-linux-gnueabi-ranlib
|   |-- arm-cortex_a9-linux-gnueabi-readelf
|   |-- arm-cortex_a9-linux-gnueabi-size
|   |-- arm-cortex_a9-linux-gnueabi-strings
|   `-- arm-cortex_a9-linux-gnueabi-strip
|-- build.log.bz2
```

```
|-- include
|-- lib
|   |-- gcc
|   |-- ldscripts
|   `-- libiberty.a
|-- libexec
|   `-- gcc
`-- share
    `-- gcc-4.5.3
```

Licenses

This section provides license information for the NVIDIA® Tegra® Linux Driver Package. Different components of NVIDIA® Tegra® Linux Driver Package involve different licenses, granted variously by NVIDIA, other vendors, and GPL copyright holders. Please read the following carefully so you understand your rights and obligations under these licenses.

NVIDIA Software

Note: This software license applies to software in the "nv_tegra" directory (NVIDIA binary drivers and supporting software), the files in the “nv_tegra/nv_sample_apps” directory: “nvgstcapture”, “nvgstplayer”, and “libgstnvvidconv.so” (those files included in the nvgstapps.tbz2 file), and the files “bootloader/mkgpt”, “bootloader/mkbootimg”, and “bootloader/mkubootscript”.

License For Customer Use of NVIDIA Software

IMPORTANT NOTICE -- READ CAREFULLY: This License For Customer Use of NVIDIA Software ("LICENSE") is the agreement which governs use of the software of NVIDIA Corporation and its subsidiaries ("NVIDIA") downloadable, including computer software and associated printed materials ("SOFTWARE"). By downloading, installing, copying, or otherwise using the SOFTWARE, you agree to be bound by the terms of this LICENSE. If you do not agree to the terms of this LICENSE, do not download the SOFTWARE.

RECITALS

Use of NVIDIA's products requires three elements: the SOFTWARE, the hardware on a graphics controller board, and a personal computer. The SOFTWARE is protected by copyright laws and international copyright treaties, as well as other intellectual property laws and treaties. The SOFTWARE is not sold, and instead is only licensed for use, strictly in accordance with this document. The hardware is protected by various patents, and is sold, but this agreement does not cover that sale, since it may not necessarily be sold as a package with the SOFTWARE. This agreement sets forth the terms and conditions of the SOFTWARE LICENSE only.

1. DEFINITIONS

1.1 Customer.

Customer means the entity or individual that downloads the SOFTWARE.

2. GRANT OF LICENSE

2.1 Rights and Limitations of Grant.

NVIDIA hereby grants Customer the following non-exclusive, non-transferable right to use the SOFTWARE, with the following limitations:

2.1.1 Rights.

Customer may install and use one copy of the SOFTWARE on a single computer, and except for making one back-up copy of the Software, may not otherwise copy the SOFTWARE. This LICENSE of SOFTWARE may not be shared or used concurrently on different computers.

2.1.2 Linux/FreeBSD Exception.

Notwithstanding the foregoing terms of Section 2.1.1, SOFTWARE designed exclusively for use on the Linux or FreeBSD operating systems, or other operating systems derived from the source code to these operating systems, may be copied and redistributed, provided that the binary files thereof are not modified in any way (except for unzipping of compressed files).

2.1.3 Limitations.

No Reverse Engineering. Customer may not reverse engineer, decompile, or disassemble the SOFTWARE, nor attempt in any other manner to obtain the source code.

No Separation of Components. The SOFTWARE is licensed as a single product. Its component parts may not be separated for use on more than one computer, nor otherwise used separately from the other parts.

No Rental. Customer may not rent or lease the SOFTWARE to someone else.

3. TERMINATION

This LICENSE will automatically terminate if Customer fails to comply with any of the terms and conditions hereof. In such event, Customer must destroy all copies of the SOFTWARE and all of its component parts.

Defensive Suspension. If Customer commences or participates in any legal proceeding against NVIDIA, then NVIDIA may, in its sole discretion, suspend or terminate all license grants and any other rights provided under this LICENSE during the pendency of such legal proceedings.

4. COPYRIGHT

All title and copyrights in and to the SOFTWARE (including but not limited to all images, photographs, animations, video, audio, music, text, and other information incorporated into the SOFTWARE), the accompanying printed materials, and any copies of the SOFTWARE, are owned by NVIDIA, or its suppliers. The SOFTWARE is protected by copyright laws and international treaty provisions. Accordingly, Customer is required to treat the SOFTWARE like any other copyrighted material, except as otherwise allowed pursuant to this LICENSE and that it may make one copy of the SOFTWARE solely for backup or archive purposes.

5. APPLICABLE LAW

This agreement shall be deemed to have been made in, and shall be construed pursuant to, the laws of the State of California.

6. DISCLAIMER OF WARRANTIES AND LIMITATION ON LIABILITY

6.1 No Warranties.

TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, THE SOFTWARE IS PROVIDED "AS IS" AND NVIDIA AND ITS SUPPLIERS DISCLAIM ALL WARRANTIES, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

6.2 No Liability for Consequential Damages.

TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, IN NO EVENT SHALL NVIDIA OR ITS SUPPLIERS BE LIABLE FOR ANY SPECIAL, INCIDENTAL, INDIRECT, OR CONSEQUENTIAL DAMAGES WHATSOEVER (INCLUDING, WITHOUT LIMITATION, DAMAGES FOR LOSS OF BUSINESS PROFITS, BUSINESS INTERRUPTION, LOSS OF BUSINESS INFORMATION, OR ANY OTHER PECUNIARY LOSS) ARISING OUT OF THE USE OF OR INABILITY TO USE THE SOFTWARE, EVEN IF NVIDIA HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

7. MISCELLANEOUS

The United Nations Convention on Contracts for the International Sale of Goods is specifically disclaimed. If any provision of this LICENSE is inconsistent with, or cannot be fully enforced under the law, such provision will be construed as limited to the extent necessary to be consistent with and fully enforceable under the law. This agreement is the final, complete and exclusive agreement between the parties relating to the subject matter hereof, and supersedes all prior or contemporaneous understandings and agreements relating to such subject matter, whether oral or written. Customer agrees that it will not ship, transfer or export the SOFTWARE into any country, or use the SOFTWARE in any manner, prohibited by the United States Bureau of Export Administration or any export laws, restrictions or regulations. This LICENSE may only be modified in writing signed by an authorized officer of NVIDIA.

Sample File System

The sample root file system is derived from Ubuntu Linux, version 14.04 for the hardware floating point (hardfp) release. 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.

GST OpenMAX

GNU LESSER GENERAL PUBLIC LICENSE
How to Apply These Terms to Your New Libraries

The software listed below is licensed under the terms of the LGPLv2.1 (see below). To obtain source code, contact oss-requests@nvidia.com.

gst-openmax (libgstomx.so, libgstegl-1.0.so.0, and libnvgstjpeg.so)

Version 2.1, February 1999

Copyright (C) 1991, 1999 Free Software Foundation, Inc. 51 Franklin Street, Fifth Floor, Boston, MA 02110-1301

USA Everyone is permitted to copy and distribute verbatim copies of this license document, but changing it is not allowed.

[This is the first released version of the Lesser GPL. It also counts as the successor of the GNU Library Public License, version 2, hence the version number 2.1.]

Preamble

The licenses for most software are designed to take away your freedom to share and change it. By contrast, the GNU General Public Licenses are intended to guarantee your freedom to share and change free software--to make sure the software is free for all its users.

This license, the Lesser General Public License, applies to some specially designated software packages--typically libraries--of the Free Software Foundation and other authors who decide to use it. You can use it too, but we suggest you first think carefully about whether this license or the ordinary General Public License is the better strategy to use in any particular case, based on the explanations below.

When we speak of free software, we are referring to freedom of use, not price. Our General Public Licenses are designed to make sure that you have the freedom to distribute copies of free software (and charge for this service if you wish); that you receive source code or can get it if you want it; that you can change the software and use pieces of it in new free programs; and that you are informed that you can do these things.

To protect your rights, we need to make restrictions that forbid distributors to deny you these rights or to ask you to surrender these rights. These restrictions translate to certain responsibilities for you if you distribute copies of the library or if you modify it.

For example, if you distribute copies of the library, whether gratis or for a fee, you must give the recipients all the rights that we gave you. You must make sure that they, too, receive or can get the source code. If you link other code with the library, you must provide complete object files to the recipients, so that they can relink them with the library after making changes to the library and recompiling it. And you must show them these terms so they know their rights. We protect your rights with a two-step method: (1) we copyright the library, and (2) we offer you this license, which gives you legal permission to copy, distribute and/or modify the library. To protect each distributor, we want to make it very clear that there is no warranty for the free library. Also, if the library is modified by someone else and passed on, the recipients should know that what they have is not the original version, so that the original author's reputation will not be affected by problems that might be introduced by others.

Finally, software patents pose a constant threat to the existence of any free program. We wish to make sure that a company cannot effectively restrict the users of a free program by obtaining a restrictive license from a patent holder. Therefore, we insist that any patent license obtained for a version of the library must be consistent with the full freedom of use specified in this license.

Most GNU software, including some libraries, is covered by the ordinary GNU General Public License. This license, the GNU Lesser General Public License, applies to certain designated libraries, and is quite different from the ordinary General Public License. We use this license for certain libraries in order to permit linking those libraries into non-free programs.

When a program is linked with a library, whether statically or using a shared library, the combination of the two is legally speaking a combined work, a derivative of the original library. The ordinary General Public License therefore permits such linking only if the entire combination fits its criteria of freedom. The Lesser General Public License permits more lax criteria for linking other code with the library.

We call this license the "Lesser" General Public License because it does Less to protect the user's freedom than the ordinary General Public License. It also provides other free software developers Less of an advantage over competing non-free programs. These disadvantages are the reason we use the ordinary General Public License for many libraries. However, the Lesser license provides advantages in certain special circumstances.

For example, on rare occasions, there may be a special need to encourage the widest possible use of a certain library, so that it becomes a de-facto standard. To achieve this, non-free programs must be allowed to use the library. A more frequent case is that a free library does the same job as widely used non-free libraries. In this case, there is little to gain by limiting the free library to free software only, so we use the Lesser General Public License.

In other cases, permission to use a particular library in non-free programs enables a greater number of people to use a large body of free software. For example, permission to use the GNU C Library in non-free programs enables many more people to use the whole GNU operating system, as well as its variant, the GNU/Linux operating system.

Although the Lesser General Public License is Less protective of the users' freedom, it does ensure that the user of a program that is linked with the Library has the freedom and the wherewithal to run that program using a modified version of the Library.

The precise terms and conditions for copying, distribution and modification follow. Pay close attention to the difference between a "work based on the library" and a "work that uses the library". The former contains code derived from the library, whereas the latter must be combined with the library in order to run.

GNU LESSER GENERAL PUBLIC LICENSE

TERMS AND CONDITIONS FOR COPYING, DISTRIBUTION AND MODIFICATION

0. This License Agreement applies to any software library or other program which contains a notice placed by the copyright holder or other authorized party saying it may be distributed under the terms of this Lesser General Public License (also called "this License"). Each licensee is addressed as "you".

A "library" means a collection of software functions and/or data prepared so as to be conveniently linked with application programs (which use some of those functions and data) to form executables.

The "Library", below, refers to any such software library or work which has been distributed under these terms. A "work based on the Library" means either the Library or any derivative work under copyright law: that is to say, a work containing the Library or a portion of it, either verbatim or with modifications and/or translated straightforwardly into another language. (Hereinafter, translation is included without limitation in the term "modification".)

"Source code" for a work means the preferred form of the work for making modifications to it. For a library, complete source code means all the source code for all modules it contains, plus any associated interface definition files, plus the scripts used to control compilation and installation of the library.

Activities other than copying, distribution and modification are not covered by this License; they are outside its scope. The act of running a program using the Library is not restricted, and output from such a program is covered only if its contents constitute a work based on the Library (independent of the use of the Library in a tool for writing it). Whether that is true depends on what the Library does and what the program that uses the Library does.

1. You may copy and distribute verbatim copies of the Library's complete source code as you receive it, in any medium, provided that you conspicuously and appropriately publish on each copy an appropriate copyright notice and disclaimer of warranty; keep intact all the notices that refer to this License and to the absence of any warranty; and distribute a copy of this License along with the Library.

You may charge a fee for the physical act of transferring a copy, and you may at your option offer warranty protection in exchange for a fee.

2. You may modify your copy or copies of the Library or any portion of it, thus forming a work based on the Library, and copy and distribute such modifications or work under the terms of Section 1 above, provided that you also meet all of these conditions:

a) The modified work must itself be a software library.

b) You must cause the files modified to carry prominent notices stating that you changed the files and the date of any change.

c) You must cause the whole of the work to be licensed at no charge to all third parties under the terms of this License.

d) If a facility in the modified Library refers to a function or a table of data to be supplied by an application program that uses the facility, other than as an argument passed when the facility is invoked, then you must make a good faith effort to ensure that, in the event an application does not supply such function or table, the facility still operates, and performs whatever part of its purpose remains meaningful.

(For example, a function in a library to compute square roots has a purpose that is entirely well-defined independent of the application. Therefore, Subsection 2d requires that any application-supplied function or table used by this function must be optional: if the application does not supply it, the square root function must still compute square roots.)

These requirements apply to the modified work as a whole. If identifiable sections of that work are not derived from the Library, and can be reasonably considered independent and separate works in themselves, then this License, and its terms, do not apply to those sections when you distribute them as separate works. But when you distribute the same sections as part of a whole which is a work based on the Library, the distribution of the whole must be on the terms of this License, whose permissions for other licensees extend to the entire whole, and thus to each and every part regardless of who wrote it.

Thus, it is not the intent of this section to claim rights or contest your rights to work written entirely by you; rather, the intent is to exercise the right to control the distribution of derivative or collective works based on the Library.

In addition, mere aggregation of another work not based on the Library with the Library (or with a work based on the Library) on a volume of a storage or distribution medium does not bring the other work under the scope of this License.

3. You may opt to apply the terms of the ordinary GNU General Public License instead of this License to a given copy of the Library. To do this, you must alter all the notices that refer to this License, so that they refer to the ordinary GNU General Public License, version 2, instead of to this License. (If a newer version than version 2 of the ordinary GNU General Public License has appeared, then you can specify that version instead if you wish.) Do not make any other change in these notices.

Once this change is made in a given copy, it is irreversible for that copy, so the ordinary GNU General Public License applies to all subsequent copies and derivative works made from that copy.

This option is useful when you wish to copy part of the code of the Library into a program that is not a library.

4. You may copy and distribute the Library (or a portion or derivative of it, under Section 2) in object code or executable form under the terms of Sections 1 and 2 above provided that you accompany it with the complete

corresponding machine-readable source code, which must be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange.

If distribution of object code is made by offering access to copy from a designated place, then offering equivalent access to copy the source code from the same place satisfies the requirement to distribute the source code, even though third parties are not compelled to copy the source along with the object code.

5. A program that contains no derivative of any portion of the Library, but is designed to work with the Library by being compiled or linked with it, is called a "work that uses the Library". Such a work, in isolation, is not a derivative work of the Library, and therefore falls outside the scope of this License.

However, linking a "work that uses the Library" with the Library creates an executable that is a derivative of the Library (because it contains portions of the Library), rather than a "work that uses the library". The executable is therefore covered by this License.

Section 6 states terms for distribution of such executables.

When a "work that uses the Library" uses material from a header file that is part of the Library, the object code for the work may be a derivative work of the Library even though the source code is not. Whether this is true is especially significant if the work can be linked without the Library, or if the work is itself a library. The threshold for this to be true is not precisely defined by law.

If such an object file uses only numerical parameters, data structure layouts and accessors, and small macros and small inline functions (ten lines or less in length), then the use of the object file is unrestricted, regardless of whether it is legally a derivative work. (Executables containing this object code plus portions of the Library will still fall under Section 6.) Otherwise, if the work is a derivative of the Library, you may distribute the object code for the work under the terms of Section 6.

Any executables containing that work also fall under Section 6, whether or not they are linked directly with the Library itself.

6. As an exception to the Sections above, you may also combine or link a "work that uses the Library" with the Library to produce a work containing portions of the Library, and distribute that work under terms of your choice, provided that the terms permit modification of the work for the customer's own use and reverse engineering for debugging such modifications. You must give prominent notice with each copy of the work that the Library is used in it and that the Library and its use are covered by this License. You must supply a copy of this License. If the work during execution displays copyright notices, you must include the copyright notice for the Library among them, as well as a reference directing the user to the copy of this License. Also, you must do one of these things:

a) Accompany the work with the complete corresponding machine-readable source code for the Library including whatever changes were used in the work (which must be distributed under Sections 1 and 2 above); and, if the work is an executable linked with the Library, with the complete machine-readable "work that uses the Library", as object code and/or source code, so that the user can modify the Library and then relink to produce a modified executable containing the modified Library. (It is understood that the user who changes the contents of definitions files in the Library will not necessarily be able to recompile the application to use the modified definitions.)

b) Use a suitable shared library mechanism for linking with the Library. A suitable mechanism is one that (1) uses at run time a copy of the library already present on the user's computer system, rather than copying library functions into the executable, and (2) will operate properly with a modified version of the library, if the user installs one, as long as the modified version is interface-compatible with the version that the work was made with.

c) Accompany the work with a written offer, valid for at least three years, to give the same user the materials specified in Subsection 6a, above, for a charge no more than the cost of performing this distribution.

d) If distribution of the work is made by offering access to copy from a designated place, offer equivalent access to copy the above specified materials from the same place.

e) Verify that the user has already received a copy of these materials or that you have already sent this user a copy.

For an executable, the required form of the "work that uses the Library" must include any data and utility programs needed for reproducing the executable from it. However, as a special exception, the materials to be distributed need not include anything that is normally distributed (in either source or binary form) with the major components (compiler, kernel, and so on) of the operating system on which the executable runs, unless that component itself accompanies the executable.

It may happen that this requirement contradicts the license restrictions of other proprietary libraries that do not normally accompany the operating system. Such a contradiction means you cannot use both them and the Library together in an executable that you distribute.

7. You may place library facilities that are a work based on the Library side-by-side in a single library together with other library facilities not covered by this License, and distribute such a combined library, provided that the separate distribution of the work based on the Library and of the other library facilities is otherwise permitted, and provided that you do these two things:

a) Accompany the combined library with a copy of the same work based on the Library, uncombined with any other library facilities. This must be distributed under the terms of the Sections above.

b) Give prominent notice with the combined library of the fact that part of it is a work based on the Library, and explaining where to find the accompanying uncombined form of the same work.

8. You may not copy, modify, sublicense, link with, or distribute the Library except as expressly provided under this License. Any attempt otherwise to copy, modify, sublicense, link with, or distribute the Library is void, and will automatically terminate your rights under this License. However, parties who have received copies, or rights, from you under this License will not have their licenses terminated so long as such parties remain in full compliance.

9. You are not required to accept this License, since you have not signed it. However, nothing else grants you permission to modify or distribute the Library or its derivative works. These actions are prohibited by law if you do not accept this License. Therefore, by modifying or distributing the Library (or any work based on the Library), you indicate your acceptance of this License to do so, and all its terms and conditions for copying, distributing or modifying the Library or works based on it.

10. Each time you redistribute the Library (or any work based on the Library), the recipient automatically receives a license from the original licensor to copy, distribute, link with or modify the Library subject to these terms and conditions. You may not impose any further restrictions on the recipients' exercise of the rights granted herein. You are not responsible for enforcing compliance by third parties with this License11. If, as a consequence of a court judgment or allegation of patent infringement or for any other reason (not limited to patent issues), conditions are imposed on you (whether by court order, agreement or otherwise) that contradict the conditions of this License, they do not excuse you from the conditions of this License. If you cannot distribute so as to satisfy simultaneously your obligations under this License and any other pertinent obligations, then as a consequence you may not distribute the Library at all. For example, if a patent license would not permit royalty-free redistribution of the Library by all those who receive copies directly or indirectly through you, then the only way you could satisfy both it and this License would be to refrain entirely from distribution of the Library.

If any portion of this section is held invalid or unenforceable under any particular circumstance, the balance of the section is intended to apply, and the section as a whole is intended to apply in other circumstances. It is not the purpose of this section to induce you to infringe any patents or other property right claims or to contest validity of any such claims; this section has the sole purpose of protecting the integrity of the free software distribution system which is implemented by public license practices. Many people have made generous contributions to the wide range of software distributed through that system in reliance on consistent application of that system; it is up to the author/donor to decide if he or she is willing to distribute software through any other system and a licensee cannot impose that choice.

This section is intended to make thoroughly clear what is believed to be a consequence of the rest of this License.

12. If the distribution and/or use of the Library is restricted in certain countries either by patents or by copyrighted interfaces, the original copyright holder who places the Library under this License may add an explicit geographical distribution limitation excluding those countries, so that distribution is permitted only in or among countries not thus excluded. In such case, this License incorporates the limitation as if written in the body of this License.

13. The Free Software Foundation may publish revised and/or new versions of the Lesser General Public License from time to time. Such new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns. Each version is given a distinguishing version number. If the Library specifies a version number of this License which applies to it and "any later version", you have the option of following the terms and conditions either of that version or of any later version published by the Free Software Foundation. If the Library does not specify a license version number, you may choose any version ever published by the Free Software Foundation.

14. If you wish to incorporate parts of the Library into other free programs whose distribution conditions are incompatible with these, write to the author to ask for permission. For software which is copyrighted by the Free Software Foundation, write to the Free Software Foundation; we sometimes make exceptions for this. Our decision will be guided by the two goals of preserving the free status of all derivatives of our free software and of promoting the sharing and reuse of software generally.

NO WARRANTY

15. BECAUSE THE LIBRARY IS LICENSED FREE OF CHARGE, THERE IS NO WARRANTY FOR THE LIBRARY, TO THE EXTENT PERMITTED BY APPLICABLE LAW. EXCEPT WHEN OTHERWISE STATED IN WRITING THE COPYRIGHT HOLDERS AND/OR OTHER PARTIES PROVIDE THE LIBRARY "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE ENTIRE RISK AS TO THE QUALITY AND PERFORMANCE OF THE LIBRARY IS WITH YOU. SHOULD THE LIBRARY PROVE DEFECTIVE, YOU ASSUME THE COST OF ALL NECESSARY SERVICING, REPAIR OR CORRECTION.

16. IN NO EVENT UNLESS REQUIRED BY APPLICABLE LAW OR AGREED TO IN WRITING WILL ANY COPYRIGHT HOLDER, OR ANY OTHER PARTY WHO MAY MODIFY AND/OR REDISTRIBUTE THE LIBRARY AS PERMITTED ABOVE, BE LIABLE TO YOU FOR DAMAGES, INCLUDING ANY GENERAL, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE THE LIBRARY (INCLUDING BUT NOT LIMITED TO LOSS OF DATA OR DATA BEING RENDERED INACCURATE OR LOSSES SUSTAINED BY YOU OR THIRD PARTIES OR A FAILURE OF THE LIBRARY TO OPERATE WITH ANY OTHER SOFTWARE), EVEN IF SUCH HOLDER OR OTHER PARTY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

END OF TERMS AND CONDITIONS

How to Apply These Terms to Your New Libraries

If you develop a new library, and you want it to be of the greatest possible use to the public, we recommend making it free software that everyone can redistribute and change. You can do so by permitting redistribution under these terms (or, alternatively, under the terms of the ordinary General Public License).

To apply these terms, attach the following notices to the library. It is safest to attach them to the start of each source file to most effectively convey the exclusion of warranty; and each file should have at least the "copyright" line and a pointer to where the full notice is found.

<one line to give the library's name and a brief idea of what it does.>

Copyright (C) <year> <name of author>

This library is free software; you can redistribute it and/or modify it under the terms of the GNU Lesser General Public License as published by the Free Software Foundation; either version 2.1 of the License, or (at your option) any later version.

This library is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU Lesser General Public License for more details.

You should have received a copy of the GNU Lesser General Public License along with this library; if not, write to the Free Software Foundation, Inc., 51 Franklin Street, Fifth Floor, Boston, MA 02110-1301 USA

Also add information on how to contact you by electronic and paper mail.

You should also get your employer (if you work as a programmer) or your school, if any, to sign a "copyright disclaimer" for the library, if necessary. Here is a sample; alter the names:

> Yoyodyne, Inc., hereby disclaims all copyright interest in the library `Frob' (a library for tweaking knobs) written by James Random Hacker.
>
> <signature of Ty Coon>, 1 April 1990
>
> Ty Coon, President of Vice

That's all there is to it!

GST EGL

GStreamer EGL/GLES Sink

GStreamer EGL/GLES Sink

Copyright (C) 2012 Collabora Ltd.

> @author: Reynaldo H. Verdejo Pinochet <reynaldo@collabora.com>
>
> @author: Sebastian Dröge <sebastian.droege@collabora.co.uk>

Copyright (c) 2014, NVIDIA CORPORATION. All rights reserved.

Permission is hereby granted, free of charge, to any person obtaining a copy of this software and associated documentation files (the "Software"), to deal in the Software without restriction, including without limitation the rights to use, copy, modify, merge, publish, distribute, sublicense, and/or sell copies of the Software, and to permit persons to whom the Software is furnished to do so, subject to the following conditions:

The above copyright notice and this permission notice shall be included in all copies or substantial portions of the Software.

THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM, OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.

Linux Kernel

GNU GENERAL PUBLIC LICENSE

The Linux kernel in this release is licensed under the terms of the GPLv2 (see below). The revision of Linux kernel source code used to build this binary can be retrieved by running the 'source_sync.sh' script or by request to oss-requests@nvidia.com.

The device-tree-compiler (dtc) binary located in the “kernel” directory was built from the Linux kernel source code provided by this release. It also is licensed under the terms of the GPLv2 (see below). The revision of the Linux kernel source code which was used to build this dtc binary can be retrieved by request to oss-requests@nvidia.com.

GNU GENERAL PUBLIC LICENSE

Version 2, June 1991

Copyright (C) 1989, 1991 Free Software Foundation, Inc., 51 Franklin Street, Fifth Floor, Boston, MA 02110-1301 USA Everyone is permitted to copy and distribute verbatim copies of this license document, but changing it is not allowed.

Preamble

The licenses for most software are designed to take away your freedom to share and change it. By contrast, the GNU General Public License is intended to guarantee your freedom to share and change free software--to make sure the software is free for all its users. This General Public License applies to most of the Free Software Foundation’s software and to any other program whose authors commit to using it. (Some other Free Software Foundation software is covered by the GNU Lesser General Public License instead.) You can apply it to your programs, too.

When we speak of free software, we are referring to freedom, not price. Our General Public Licenses are designed to make sure that you have the freedom to distribute copies of free software (and charge for this service if you wish), that you receive source code or can get it if you want it, that you can change the software or use pieces of it in new free programs; and that you know you can do these things.

To protect your rights, we need to make restrictions that forbid anyone to deny you these rights or to ask you to surrender the rights. These restrictions translate to certain responsibilities for you if you distribute copies of the software, or if you modify it.

For example, if you distribute copies of such a program, whether gratis or for a fee, you must give the recipients all the rights that you have. You must make sure that they, too, receive or can get the source code. And you must show them these terms so they know their rights.

We protect your rights with two steps: (1) copyright the software, and (2) offer you this license which gives you legal permission to copy, distribute and/or modify the software.

Also, for each author's protection and ours, we want to make certain that everyone understands that there is no warranty for this free software. If the software is modified by someone else and passed on, we want its recipients to know that what they have is not the original, so that any problems introduced by others will not reflect on the original authors' reputations.

Finally, any free program is threatened constantly by software patents. We wish to avoid the danger that redistributors of a free program will individually obtain patent licenses, in effect making the program proprietary. To prevent this, we have made it clear that any patent must be licensed for everyone's free use or not licensed at all.

The precise terms and conditions for copying, distribution and modification follow.

GNU GENERAL PUBLIC LICENSE
TERMS AND CONDITIONS FOR COPYING, DISTRIBUTION AND MODIFICATION

0. This License applies to any program or other work which contains a notice placed by the copyright holder saying it may be distributed under the terms of this General Public License. The "Program", below, refers to any such program or work, and a "work based on the Program" means either the Program or any derivative work under copyright law: that is to say, a work containing the Program or a portion of it, either verbatim or with modifications and/or translated into another language. (Hereinafter, translation is included without limitation in the term "modification".) Each licensee is addressed as "you".

Activities other than copying, distribution and modification are not covered by this License; they are outside its scope. The act of running the Program is not restricted, and the output from the Program is covered only if its contents constitute a work based on the program (independent of having been made by running the Program). Whether that is true depends on what the Program does.

1. You may copy and distribute verbatim copies of the Program's source code as you receive it, in any medium, provided that you conspicuously and appropriately publish on each copy an appropriate copyright notice and disclaimer of warranty; keep intact all the notices that refer to this License and to the absence of any warranty; and give any other recipients of the Program a copy of this License along with the Program.

You may charge a fee for the physical act of transferring a copy, and you may at your option offer warranty protection in exchange for a fee.

2. You may modify your copy or copies of the Program or any portion of it, thus forming a work based on the Program, and copy and distribute such modifications or work under the terms of Section 1 above, provided that you also meet all of these conditions:

a) You must cause the modified files to carry prominent notices stating that you changed the files and the date of any change.

b) You must cause any work that you distribute or publish, that in whole or in part contains or is derived from the Program or any part thereof, to be licensed as a whole at no charge to all third parties under the terms of this License.

c) If the modified program normally reads commands interactively when run, you must cause it, when started running for such interactive use in the most ordinary way, to print or display an announcement including an appropriate copyright notice and a notice that there is no warranty (or else, saying that you provide a warranty) and that users may redistribute the program under these conditions, and telling the user how to view a copy of this License. (Exception: if the Program itself is interactive but does not normally print such an announcement, your work based on the Program is not required to print an announcement.)

These requirements apply to the modified work as a whole. If identifiable sections of that work are not derived from the Program, and can be reasonably considered independent and separate works in themselves, then this License, and its terms, do not apply to those sections when you distribute them as separate works. But when you distribute the same sections as part of a whole which is a work based on the Program, the distribution of the whole must be on the terms of this License, whose permissions for other licensees extend to the entire whole, and thus to each and every part regardless of who wrote it.

Thus, it is not the intent of this section to claim rights or contest your rights to work written entirely by you; rather, the intent is to exercise the right to control the distribution of derivative or collective works based on the Program.

In addition, mere aggregation of another work not based on the Program with the Program (or with a work based on the Program) on a volume of a storage or distribution medium does not bring the other work under the scope of this License.

3. You may copy and distribute the Program (or a work based on it, under Section 2) in object code or executable form under the terms of Sections 1 and 2 above provided that you also do one of the following:

a) Accompany it with the complete corresponding machine-readable source code, which must be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange; or,

b) Accompany it with a written offer, valid for at least three years, to give any third party, for a charge no more than your cost of physically performing source distribution, a complete machine-readable copy of the corresponding source code, to be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange; or,

c) Accompany it with the information you received as to the offer to distribute corresponding source code. (This alternative is allowed only for noncommercial distribution and only if you received the program in object code or executable form with such an offer, in accord with Subsection b above.)

The source code for a work means the preferred form of the work for making modifications to it. For an executable work, complete source code means all the source code for all modules it contains, plus any associated interface definition files, plus the scripts used to control compilation and installation of the executable. However, as a special exception, the source code distributed need not include anything that is normally distributed (in either source or binary form) with the major components (compiler, kernel, and so on) of the operating system on which the executable runs, unless that component itself accompanies the executable.

If distribution of executable or object code is made by offering access to copy from a designated place, then offering equivalent access to copy the source code from the same place counts as distribution of the source code, even though third parties are not compelled to copy the source along with the object code.

4. You may not copy, modify, sublicense, or distribute the Program except as expressly provided under this License. Any attempt otherwise to copy, modify, sublicense or distribute the Program is void, and will automatically terminate your rights under this License. However, parties who have received copies, or rights, from you under this License will not have their licenses terminated so long as such parties remain in full compliance.

5. You are not required to accept this License, since you have not signed it. However, nothing else grants you permission to modify or distribute the Program or its derivative works. These actions are prohibited by law if you do not accept this License. Therefore, by modifying or distributing the Program (or any work based on the

Program), you indicate your acceptance of this License to do so, and all its terms and conditions for copying, distributing or modifying the Program or works based on it.

6. Each time you redistribute the Program (or any work based on the Program), the recipient automatically receives a license from the original licensor to copy, distribute or modify the Program subject to these terms and conditions. You may not impose any further restrictions on the recipients' exercise of the rights granted herein. You are not responsible for enforcing compliance by third parties to this License.

7. If, as a consequence of a court judgment or allegation of patent infringement or for any other reason (not limited to patent issues), conditions are imposed on you (whether by court order, agreement or otherwise) that contradict the conditions of this License, they do not excuse you from the conditions of this License. If you cannot distribute so as to satisfy simultaneously your obligations under this License and any other pertinent obligations, then as a consequence you may not distribute the Program at all. For example, if a patent license would not permit royalty-free redistribution of the Program by all those who receive copies directly or indirectly through you, then the only way you could satisfy both it and this License would be to refrain entirely from distribution of the Program.

If any portion of this section is held invalid or unenforceable under any particular circumstance, the balance of the section is intended to apply and the section as a whole is intended to apply in other circumstances.

It is not the purpose of this section to induce you to infringe any patents or other property right claims or to contest validity of any such claims; this section has the sole purpose of protecting the integrity of the free software distribution system, which is implemented by public license practices. Many people have made generous contributions to the wide range of software distributed through that system in reliance on consistent application of that system; it is up to the author/donor to decide if he or she is willing to distribute software through any other system and a licensee cannot impose that choice.

This section is intended to make thoroughly clear what is believed to be a consequence of the rest of this License.

8. If the distribution and/or use of the Program is restricted in certain countries either by patents or by copyrighted interfaces, the original copyright holder who places the Program under this License may add an explicit geographical distribution limitation excluding those countries, so that distribution is permitted only in or among countries not thus excluded. In such case, this License incorporates the limitation as if written in the body of this License.

9. The Free Software Foundation may publish revised and/or new versions of the General Public License from time to time. Such new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns.

Each version is given a distinguishing version number. If the Program specifies a version number of this License which applies to it and "any later version", you have the option of following the terms and conditions either of that version or of any later version published by the Free software Foundation. If the Program does not specify a version number of this License, you may choose any version ever published by the Free Software Foundation.

10. If you wish to incorporate parts of the Program into other free programs whose distribution conditions are different, write to the author to ask for permission. For software which is copyrighted by the Free software Foundation, write to the Free Software Foundation; we sometimes make exceptions for this. Our decision will be guided by the two goals of preserving the free status of all derivatives of our free software and of promoting the sharing and reuse of software generally.

NO WARRANTY

11. BECAUSE THE PROGRAM IS LICENSED FREE OF CHARGE, THERE IS NO WARRANTY FOR THE PROGRAM, TO THE EXTENT PERMITTED BY APPLICABLE LAW. EXCEPT WHEN OTHERWISE STATED IN WRITING THE COPYRIGHT HOLDERS AND/OR OTHER PARTIES PROVIDE THE PROGRAM "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER

EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE ENTIRE RISK AS TO THE QUALITY AND PERFORMANCE OF THE PROGRAM IS WITH YOU. SHOULD THE PROGRAM PROVE DEFECTIVE, YOU ASSUME THE COST OF ALL NECESSARY SERVICING, REPAIR OR CORRECTION.

12. IN NO EVENT UNLESS REQUIRED BY APPLICABLE LAW OR AGREED TO IN WRITING WILL ANY COPYRIGHT HOLDER, OR ANY OTHER PARTY WHO MAY MODIFY AND/OR REDISTRIBUTE THE PROGRAM AS PERMITTED ABOVE, BE LIABLE TO YOU FOR DAMAGES, INCLUDING ANY GENERAL, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE THE PROGRAM (INCLUDING BUT NOT LIMITED TO LOSS OF DATA OR DATA BEING RENDERED INACCURATE OR LOSSES SUSTAINED BY YOU OR THIRD PARTIES OR A FAILURE OF THE PROGRAM TO OPERATE WITH ANY OTHER PROGRAMS), EVEN IF SUCH HOLDER OR OTHER PARTY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

END OF TERMS AND CONDITIONS

How to Apply These Terms to Your New Programs

If you develop a new program, and you want it to be of the greatest possible use to the public, the best way to achieve this is to make it free software which everyone can redistribute and change under these terms.

To do so, attach the following notices to the program. It is safest to attach them to the start of each source file to most effectively convey the exclusion of warranty; and each file should have at least the "copyright" line and a pointer to where the full notice is found.

> <one line to give the program's name and a brief idea of what it does.>
>
> Copyright (C) <year> <name of author>
>
> This program is free software; you can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation; either version 2 of the License, or (at your option) any later version.
>
> This program is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU General Public License for more details.
>
> You should have received a copy of the GNU General Public License along with this program; if not, write to the Free Software Foundation, Inc., 51 Franklin Street, Fifth Floor, Boston, MA 02110-1301 USA.

Also add information on how to contact you by electronic and paper mail.

If the program is interactive, make it output a short notice like this when it starts in an interactive mode:

> Gnomovision version 69, Copyright (C) year name of author
> Gnomovision comes with ABSOLUTELY NO WARRANTY; for details type `show w'. This is free software, and you are welcome to redistribute it under certain conditions; type `show c' for details.

The hypothetical commands `show w' and `show c' should show the appropriate parts of the General Public License. Of course, the commands you use may be called something other than `show w' and `show c'; they could even be mouse-clicks or menu items--whatever suits your program.

You should also get your employer (if you work as a programmer) or your school, if any, to sign a "copyright disclaimer" for the program, if necessary. Here is a sample; alter the names:

Yoyodyne, Inc., hereby disclaims all copyright interest in the program `Gnomovision' (which makes passes at compilers) written by James Hacker.

<signature of Ty Coon>, 1 April 1989
Ty Coon, President of Vice

This General Public License does not permit incorporating your program into proprietary programs. If your program is a subroutine library, you may consider it more useful to permit linking proprietary applications with the library. If this is what you want to do, use the GNU Lesser General Public License instead of this License.

mkbootimg and mkubootscript

Apache License
Copyright: WIDE Project
GNU General Public License
Copyright: Regents of the University of California

mkbootimg and mkubootscript are provided under the following terms:

Copyright 2007, The Android Open Source Project

Apache License

Apache License
Version 2.0, January 2004
http://www.apache.org/licenses/

TERMS AND CONDITIONS FOR USE, REPRODUCTION, AND DISTRIBUTION

1. Definitions.

"License" shall mean the terms and conditions for use, reproduction, and distribution as defined by Sections 1 through 9 of this document.

"Licensor" shall mean the copyright owner or entity authorized by the copyright owner that is granting the License.

"Legal Entity" shall mean the union of the acting entity and all other entities that control, are controlled by, or are under common control with that entity. For the purposes of this definition, "control" means (i) the power, direct or indirect, to cause the direction or management of such entity, whether by contract or otherwise, or (ii) ownership of fifty percent (50%) or more of the outstanding shares, or (iii) beneficial ownership of such entity.

"You" (or "Your") shall mean an individual or Legal Entity exercising permissions granted by this License.

"Source" form shall mean the preferred form for making modifications, including but not limited to software source code, documentation source, and configuration files.

"Object" form shall mean any form resulting from mechanical transformation or translation of a Source form, including but not limited to compiled object code, generated documentation, and conversions to other media types.

"Work" shall mean the work of authorship, whether in Source or Object form, made available under the

License, as indicated by a copyright notice that is included in or attached to the work (an example is provided in the Appendix below).

"Derivative Works" shall mean any work, whether in Source or Object form, that is based on (or derived from) the Work and for which the editorial revisions, annotations, elaborations, or other modifications represent, as a whole, an original work of authorship. For the purposes of this License, Derivative Works shall not include works that remain separable from, or merely link (or bind by name) to the interfaces of, the Work and Derivative Works thereof.

"Contribution" shall mean any work of authorship, including the original version of the Work and any modifications or additions to that Work or Derivative Works thereof, that is intentionally submitted to Licensor for inclusion in the Work by the copyright owner or by an individual or Legal Entity authorized to submit on behalf of the copyright owner. For the purposes of this definition, "submitted" means any form of electronic, verbal, or written communication sent to the Licensor or its representatives, including but not limited to communication on electronic mailing lists, source code control systems, and issue tracking systems that are managed by, or on behalf of, the Licensor for the purpose of discussing and improving the Work, but excluding communication that is conspicuously marked or otherwise designated in writing by the copyright owner as "Not a Contribution."

"Contributor" shall mean Licensor and any individual or Legal Entity on behalf of whom a Contribution has been received by Licensor and subsequently incorporated within the Work.

2. Grant of Copyright License. Subject to the terms and conditions of this License, each Contributor hereby grants to You a perpetual, worldwide, non-exclusive, no-charge, royalty-free, irrevocable copyright license to reproduce, prepare Derivative Works of, publicly display, publicly perform, sublicense, and distribute the Work and such Derivative Works in Source or Object form.

3. Grant of Patent License. Subject to the terms and conditions of this License, each Contributor hereby grants to You a perpetual, worldwide, non-exclusive, no-charge, royalty-free, irrevocable (except as stated in this section) patent license to make, have made, use, offer to sell, sell, import, and otherwise transfer the Work, where such license applies only to those patent claims licensable by such Contributor that are necessarily infringed by their Contribution(s) alone or by combination of their Contribution(s) with the Work to which such Contribution(s) was submitted. If You institute patent litigation against any entity (including a cross-claim or counterclaim in a lawsuit) alleging that the Work or a Contribution incorporated within the Work constitutes direct or contributory patent infringement, then any patent licenses granted to You under this License for that Work shall terminate as of the date such litigation is filed.

4. Redistribution. You may reproduce and distribute copies of the Work or Derivative Works thereof in any medium, with or without modifications, and in Source or Object form, provided that You meet the following conditions:

(a) You must give any other recipients of the Work or Derivative Works a copy of this License; and

(b) You must cause any modified files to carry prominent notices stating that You changed the files; and

(c) You must retain, in the Source form of any Derivative Works that You distribute, all copyright, patent, trademark, and attribution notices from the Source form of the Work, excluding those notices that do not pertain to any part of the Derivative Works; and

(d) If the Work includes a "NOTICE" text file as part of its distribution, then any Derivative Works that You distribute must include a readable copy of the attribution notices contained within such NOTICE file, excluding those notices that do not pertain to any part of the Derivative Works, in at least one of the following places: within a NOTICE text file distributed as part of the Derivative Works; within the Source form or documentation, if provided along with the Derivative Works; or, within a display generated by the Derivative Works, if and wherever such third-party notices normally appear. The contents of the NOTICE file are for informational purposes only and do not modify the License. You may add Your own attribution notices within Derivative Works that You distribute, alongside or as an addendum to the NOTICE text from the Work, provided that such additional attribution notices cannot be construed as modifying the License.

You may add Your own copyright statement to Your modifications and may provide additional or different license terms and conditions for use, reproduction, or distribution of Your modifications, or for any such Derivative Works as a whole, provided Your use, reproduction, and distribution of the Work otherwise complies with the conditions stated in this License.

5. Submission of Contributions. Unless You explicitly state otherwise, any Contribution intentionally submitted for inclusion in the Work by You to the Licensor shall be under the terms and conditions of this License, without any additional terms or conditions. Notwithstanding the above, nothing herein shall supersede or modify the terms of any separate license agreement you may have executed with Licensor regarding such Contributions.

6. Trademarks. This License does not grant permission to use the trade names, trademarks, service marks, or product names of the Licensor, except as required for reasonable and customary use in describing the origin of the Work and reproducing the content of the NOTICE file.

7. Disclaimer of Warranty. Unless required by applicable law or agreed to in writing, Licensor provides the Work (and each Contributor provides its Contributions) on an "AS IS" BASIS, WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied, including, without limitation, any warranties or conditions of TITLE, NON-INFRINGEMENT, MERCHANTABILITY, or FITNESS FOR A PARTICULAR PURPOSE. You are solely responsible for determining the appropriateness of using or redistributing the Work and assume any risks associated with Your exercise of permissions under this License.

8. Limitation of Liability. In no event and under no legal theory, whether in tort (including negligence), contract, or otherwise, unless required by applicable law (such as deliberate and grossly negligent acts) or agreed to in writing, shall any Contributor be liable to You for damages, including any direct, indirect, special, incidental, or consequential damages of any character arising as a result of this License or out of the use or inability to use the Work (including but not limited to damages for loss of goodwill, work stoppage, computer failure or malfunction, or any and all other commercial damages or losses), even if such Contributor has been advised of the possibility of such damages.

9. Accepting Warranty or Additional Liability. While redistributing the Work or Derivative Works thereof, You may choose to offer, and charge a fee for, acceptance of support, warranty, indemnity, or other liability obligations and/or rights consistent with this License. However, in accepting such obligations, You may act only on Your own behalf and on Your sole responsibility, not on behalf of any other Contributor, and only if You agree to indemnify, defend, and hold each Contributor harmless for any liability incurred by, or claims asserted against, such Contributor by reason of your accepting any such warranty or additional liability.

END OF TERMS AND CONDITIONS

APPENDIX: How to apply the Apache License to your work.

To apply the Apache License to your work, attach the following boilerplate notice, with the fields enclosed by brackets "[]" replaced with your own identifying information. (Don't include the brackets!) The text should be enclosed in the appropriate comment syntax for the file format. We also recommend that a file or class name and description of purpose be included on the same "printed page" as the copyright notice for easier identification within third-party archives.

```
Copyright [yyyy] [name of copyright owner]

Licensed under the Apache License, Version 2.0 (the "License"); you may not use this fi

http://www.apache.org/licenses/LICENSE-2.0

Unless required by applicable law or agreed to in writing, software distributed under t
```

Copyright: WIDE Project

FIPS pub 180-1: Secure Hash Algorithm (SHA-1)
based on: http://csrc.nist.gov/fips/fip180-1.txt
implemented by Jun-ichiro itojun Itoh <itojun@itojun.org>

GNU General Public License

For the complete text of this license, see GNU GENERAL PUBLIC LICENSE in this section.

Copyright: Regents of the University of California

U-Boot and mkimage

U-Boot is Free Software. It is copyrighted by Wolfgang Denk and many others who contributed code (see the actual source code for details). You can redistribute U-Boot and/or modify it under the terms of version 2 of the GNU General Public License as published by the Free Software Foundation. Most of it can also be distributed, at your option, under any later version of the GNU General Public License -- see individual files for exceptions.

NOTE! This license does *not* cover the so-called "standalone" applications that use U-Boot services by means of the jump table provided by U-Boot exactly for this purpose - this is merely considered normal use of U-Boot, and does *not* fall under the heading of "derived work" -- see file Licenses/Exceptions for details.

Also note that the GPL and the other licenses are copyrighted by the Free Software Foundation and other organizations, but the instance of code that they refer to (the U-Boot source code) is copyrighted by me and others who actually wrote it.

-- Wolfgang Denk

Like many other projects, U-Boot has a tradition of including big blocks of License headers in all files. This not only blows up the source code with mostly redundant information, but also makes it very difficult to generate License Clearing Reports. An additional problem is that even the same licenses are referred to by a number of slightly varying text blocks (full, abbreviated, different indentation, line wrapping and/or white space, with obsolete address information, ...) which makes automatic processing a nightmare.

To make this easier, such license headers in the source files will be replaced with a single line reference to Unique License Identifiers as defined by the Linux Foundation's SPDX project [1]. For example, in a source file the full "GPL v2.0 or later" header text will be replaced by a single line:

SPDX-License-Identifier: GPL-2.0+

Ideally, the license terms of all files in the source tree should be defined by such License Identifiers; in no case a file can contain more than one such License Identifier list.

If a "SPDX-License-Identifier:" line references more than one Unique License Identifier, then this means that the respective file can be used under the terms of either of these licenses, i. e. with

SPDX-License-Identifier: GPL-2.0+ BSD-3-Clause

you can chose between GPL-2.0+ and BSD-3-Clause licensing.

We use the SPDX Unique License Identifiers here; these are available at [2].

[1] http://spdx.org/

[2] http://spdx.org/licenses/

Full Name	SPDX ID	OSI approved	File Name	URI
GNU General Public License v2.0 only	GPL-2.0	Y	gpl-2.0.txt	http://www.gnu.org/licenses/gpl-2.0.txt
GNU General Public License v2.0 or later	GPL-2.0+	Y	gpl-2.0.txt	http://www.gnu.org/licenses/gpl-2.0.txt
GNU Library General Public License v2 or later	LGPL-2.0+	Y	lgpl-2.0.txt	http://www.gnu.org/licenses/old-licenses/lgpl-2.0.txt
GNU Lesser General Public License v2.1 or later	LGPL-2.1+	Y	lgpl-2.1.txt	http://www.gnu.org/licenses/old-licenses/lgpl-2.1.txt
eCos license version 2.0	eCos-2.0		eCos-2.0.txt	http://www.gnu.org/licenses/ecos-license.html
BSD 2-Clause License	BSD-2-Clause	Y	bsd-2-clause.txt	http://spdx.org/licenses/BSD-2-Clause
BSD 3-clause "New" or "Revised" License	BSD-3-Clause	Y	bsd-3-clause.txt	http://spdx.org/licenses/BSD-3-Clause#licenseText
IBM PIBS (PowerPC Initialization and Boot Software) license	IBM-pibs	-	ibm-pibs.txt	

ISC License	ISC	Y	isc.txt	https://spdx.org/licenses/ISC
X11 License	X11	-	x11.txt	https://spdx.org/licenses/X11.html

GNU GENERAL PUBLIC LICENSE, Version 2, June 1991

For the complete text of this license, see GNU GENERAL PUBLIC LICENSE in this section.

mkbctpart

The mkbctpart library is covered by the License For Customer Use of NVIDIA Software. For the complete text of that license, see License For Customer Use of NVIDIA Software in this section.

brcm_patchram_plus

The brcm_patchram_plus is installed at the following location:

```
/usr/sbin/brcm_patchram_plus
```

Copyright (C) 2009-2011 Broadcom Corporation

Licensed under the Apache License, Version 2.0 (the "License"); you may not use this file except in compliance with the License. You may obtain a copy of the License at

http://www.apache.org/licenses/LICENSE-2.0

Unless required by applicable law or agreed to in writing, software distributed under the License is distributed on an "AS IS" BASIS, WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied. See the License for the specific language governing permissions and limitations under the License.

For the complete text of the Apache license, see Apache License in this section.

libnvcam_imageencoder.so

Copyright (c) 2015, NVIDIA CORPORATION. All rights reserved.

NVIDIA CORPORATION and its licensors retain all intellectual property and proprietary rights in and to this software, related documentation and any modifications thereto. Any use, reproduction, disclosure or distribution of this software and related documentation without an express license agreement from NVIDIA CORPORATION is strictly prohibited.

This product incorporates software provided under the following terms:

==

NOTICE file in this case for the JPEGcode.

==

The authors make NO WARRANTY or representation, either express or implied, with respect to this software, its quality, accuracy, merchantability, or fitness for a particular purpose. This software is provided "AS IS", and you, its user, assume the entire risk as to its quality and accuracy.

This software is copyright (C) 1991-1998, Thomas G. Lane.

All Rights Reserved except as specified below.

Permission is hereby granted to use, copy, modify, and distribute this software (or portions thereof) for any purpose, without fee, subject to these conditions:

(1) If any part of the source code for this software is distributed, then this README file must be included, with this copyright and no-warranty notice unaltered; and any additions, deletions, or changes to the original files must be clearly indicated in accompanying documentation.

(2) If only executable code is distributed, then the accompanying documentation must state that "this software is based in part on the work of the Independent JPEG Group".

(3) Permission for use of this software is granted only if the user accepts full responsibility for any undesirable consequences; the authors accept NO LIABILITY for damages of any kind.

These conditions apply to any software derived from or based on the IJG code, not just to the unmodified library. If you use our work, you ought to acknowledge us.

Permission is NOT granted for the use of any IJG author's name or company name in advertising or publicity relating to this software or products derived from it. This software may be referred to only as "the Independent JPEG Group's software".

We specifically permit and encourage the use of this software as the basis of commercial products, provided that all warranty or liability claims are assumed by the product vendor.

See also RECITALS in NVIDIA Software.

libscf

ZLIB DATA COMPRESSION LIBRARY

libscf is covered by the NVIDIA license. For the complete text of this license, see License For Customer Use of NVIDIA Software in this section.

Portions of this software are provided under the following terms:

This folder contains libraries and headers of a few very popular still image codecs used by highgui module. The libraries and headers are preferably to build Win32 and Win64 versions of OpenCV. On UNIX systems all the libraries are automatically detected by configure script. In order to use these versions of libraries instead of system ones on UNIX systems you should use BUILD_<library_name> CMake flags (for example, BUILD_PNG for the libpng library).

----

libjpeg 8d (8.4) - The Independent JPEG Group's JPEG software.

Copyright (C) 1991-2012, Thomas G. Lane, Guido Vollbeding.

See IGJ home page http://www.ijg.org for details and links to the source code

HAVE_JPEG preprocessor flag must be set to make highgui use libjpeg. On UNIX systems configure script takes care of it.

----

libpng 1.5.12 - Portable Network Graphics library.

Copyright (c) 2004, 2006-2012 Glenn Randers-Pehrson. See libpng home page http://www.libpng.org for details and links to the source code

HAVE_PNG preprocessor flag must be set to make highgui use libpng. On UNIX systems configure script takes care of it.

----

libtiff 4.0.2 - Tag Image File Format (TIFF) Software

Copyright (c) 1988-1997 Sam Leffler

Copyright (c) 1991-1997 Silicon Graphics, Inc.

See libtiff home page http://www.remotesensing.org/libtiff/ for details and links to the source code

HAVE_TIFF preprocessor flag must be set to make highgui use libtiff. On UNIX systems configure script takes care of it. In this build support for ZIP (LZ77 compression) is turned on.

----

zlib 1.2.7 - General purpose LZ77 compression library

Copyright (C) 1995-2012 Jean-loup Gailly and Mark Adler.

See zlib home page http://www.zlib.net for details and links to the source code

No preprocessor definition is needed to make highgui use this library - it is included automatically if either libpng or libtiff are used.

----

jasper-1.900.1 - JasPer is a collection of software (i.e., a library and application programs) for the coding and manipulation of images. This software can handle image data in a variety of formats. One such format supported by JasPer is the JPEG-2000 format defined in ISO/IEC 15444-1.

The JasPer license can be found in src/libjasper.

OpenCV on Windows uses pre-built libjasper library (lib/libjasper*). To get the latest source code, please, visit the project homepage: http://www.ece.uvic.ca/~mdadams/jasper/

----

openexr-1.7.1 - OpenEXR is a high dynamic-range (HDR) image file format developed by Industrial Light & Magic for use in computer imaging applications.

The project homepage: http://www.openexr.com

----

ffmpeg-0.8.0 - FFmpeg is a complete, cross-platform solution to record, convert and stream audio and video. It includes libavcodec - the leading audio/video codec library, and also libavformat, libavutils and other helper libraries that are used by OpenCV (in highgui module) to read and write video files.

The project homepage: http://ffmpeg.org/

==

== LICENSE file ==

== ==

== in this case for the Open Computer Vision code. ==

==

IMPORTANT: READ BEFORE DOWNLOADING, COPYING, INSTALLING OR USING.

By downloading, copying, installing or using the software you agree to this license.

If you do not agree to this license, do not download, install, copy or use the software.

License Agreement for Protocol Buffers

This license applies to all parts of Protocol Buffers except the following:

- Atomicops support for generic gcc, located in:

  ```
  src/google/protobuf/stubs/atomicops_internals_generic_gcc.h.
  ```

  This file is copyrighted by Red Hat Inc.

- Atomicops support for AIX/POWER, located in

  ```
  src/google/protobuf/stubs/atomicops_internals_power.h.
  ```

  This file is copyrighted by Bloomberg Finance LP.

Copyright 2014, Google Inc. All rights reserved.

Redistribution and use in source and binary forms, with or without modification, are permitted provided that the following conditions are met:

- Redistributions of source code must retain the above copyright notice, this list of conditions and the following disclaimer.
- Redistributions in binary form must reproduce the above copyright notice, this list of conditions and the following disclaimer in the documentation and/or other materials provided with the distribution.
- Neither the name of Google Inc. nor the names of its contributors may be used to endorse or promote products derived from this software without specific prior written permission.

THIS SOFTWARE IS PROVIDED BY THE COPYRIGHT HOLDERS AND CONTRIBUTORS "AS IS" AND ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE DISCLAIMED. IN NO EVENT SHALL THE COPYRIGHT OWNER OR CONTRIBUTORS BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

Code generated by the Protocol Buffer compiler is owned by the owner of the input file used when generating it. This code is not standalone and requires a support library to be linked with it. This support library is itself covered by the above license.

License Agreement for Open Source Computer Vision Library

Copyright (C) 2000-2008, Intel Corporation, all rights reserved.

Copyright (C) 2008-2011, Willow Garage Inc., all rights reserved.

Third party copyrights are property of their respective owners.

Redistribution and use in source and binary forms, with or without modification, are permitted provided that the following conditions are met:

- Redistributions of source code must retain the above copyright notice, this list of conditions and the following disclaimer.
- Redistributions in binary form must reproduce the above copyright notice, this list of conditions and the following disclaimer in the documentation and/or other materials provided with the distribution.
- The name of the copyright holders may not be used to endorse or promote products derived from this software without specific prior written permission.

This software is provided by the copyright holders and contributors "as is" and any express or implied warranties, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose are disclaimed. In no event shall the Intel Corporation or contributors be liable for any direct, indirect, incidental, special, exemplary, or consequential damages (including, but not limited to, procurement of substitute goods or services; loss of use, data, or profits; or business interruption) however caused and on any theory of liability, whether in contract, strict liability, or tort (including negligence or otherwise) arising in any way out of the use of this software, even if advised of the possibility of such damage.

License Agreement for OpenCV Tutorial Library

```
/*                           License Agreement
 *                       For OpenCV Tutorial Library
 *                     http://computer-vision-talks.com
 *
 * Third party copyrights are property of their respective owners.
 *
 * Redistribution and use in source and binary forms, with or without
 * modification, are permitted provided that the following conditions
 * are met:
 *
 * Redistribution's of source code must retain the above copyright
 * notice, this list of conditions and the following disclaimer.
 *
 * Redistribution's in binary form must reproduce the above copyright
 * notice, this list of conditions and the following disclaimer in the
 * documentation and/or other materials provided with the distribution.
 *
 * The name of the copyright holders may not be used to endorse or
 * promote products derived from this software without specific prior
 * written permission.
 *
 * This software is provided by the copyright holders and contributors
 * "as is" and any express or implied warranties, including, but not
```

```
* limited to, the implied warranties of merchantability and fitness
* for a particular purpose are disclaimed.
* In no event shall the Intel Corporation or contributors be liable
* for any direct, indirect, incidental, special, exemplary, or
* consequential damages (including, but not limited to, procurement of
* substitute goods or services; loss of use, data, or profits; or
* business interruption) however caused and on any theory of
* liability, whether in contract, strict liability, or tort (including
* negligence or otherwise) arising in any way out of the use of this software, even if advised
*/
```

==

NOTICE file in this case for the Open Computer Vision code.

==

IMPORTANT: READ BEFORE DOWNLOADING, COPYING, INSTALLING OR USING.

By downloading, copying, installing or using the software you agree to this license. If you do not agree to this license, do not download, install, copy or use the software.

License Agreement for Open Source Computer Vision Library

Copyright (C) 2000-2008, Intel Corporation, all rights reserved.
Copyright (C) 2008-2011, Willow Garage Inc., all rights reserved.
Third party copyrights are property of their respective owners.

Redistribution and use in source and binary forms, with or without modification, are permitted provided that the following conditions are met:

- Redistributions of source code must retain the above copyright notice, this list of conditions and the following disclaimer.
- Redistributions in binary form must reproduce the above copyright notice, this list of conditions and the following disclaimer in the documentation and/or other materials provided with the distribution.
- The name of the copyright holders may not be used to endorse or promote products derived from this software without specific prior written permission.

This software is provided by the copyright holders and contributors "as is" and any express or implied warranties, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose are disclaimed. In no event shall the Intel Corporation or contributors be liable for any direct, indirect, incidental, special, exemplary, or consequential damages (including, but not limited to, procurement of substitute goods or services; loss of use, data, or profits; or business interruption) however caused and on any theory of liability, whether in contract, strict liability, or tort (including negligence or otherwise) arising in any way out of the use of this software, even if advised of the possibility of such damage.

==

NOTICE file in this case for the OpenCV Tutorial code.

==

License Agreement for OpenCV Tutorial Library

```
/*                           License Agreement
 *                      For OpenCV Tutorial Library
 *                    http://computer-vision-talks.com
 *
 * Third party copyrights are property of their respective owners.
 *
 *  Redistribution and use in source and binary forms, with or without
 *  modification,are permitted provided that the following conditions
 *  are met:
 *
 *  Redistribution's of source code must retain the above copyright
 *  notice, this list of conditions and the following disclaimer.
 *
 *  Redistribution's in binary form must reproduce the above copyright
 *  notice, this list of conditions and the following disclaimer in the
 *  documentation and/or other materials provided with the
 *  distribution.
 *
 *  The name of the copyright holders may not be used to endorse or
 *  promote products derived from this software without specific prior
 *  written permission.
 *
 *  This software is provided by the copyright holders and contributors
 *  "as is" and any express or implied warranties, including, but not
 *  limited to, the implied warranties of merchantability and fitness
 *  for a particular purpose are disclaimed.
 *  In no event shall the Intel Corporation or contributors be liable X
 *  limited to, the implied indirect, incidental, special, exemplary,
 *  or consequential damages (including, but not limited to,
 *  procurement of substitute goods or services;
 *  loss of use, data, or profits; or business interruption) however
 *  caused and on any theory of liability, whether in contract, strict
 *  liability,or tort (including negligence or otherwise) arising in
 *  any way out of the use of this software, even if advised of the
 *  possibility of such damage.
```

```
*/
```

This package was debianized by Christopher L Cheney <ccheney@debian.org> on Fri, 22 Aug 2003 01:33:34 -0500.

The current maintainer is Roland Stigge <stigge@antcom.de>

It was downloaded from http://www.ece.uvic.ca/~mdadams/jasper/

Upstream Author: Michael Adams <mdadams@ece.uvic.ca>

License:

JasPer License Version 2.0

Copyright (c) 1999-2000 Image Power, Inc.

Copyright (c) 1999-2000 The University of British Columbia

Copyright (c) 2001-2003 Michael David Adams

All rights reserved.

Permission is hereby granted, free of charge, to any person (the "User") obtaining a copy of this software and associated documentation files (the "Software"), to deal in the Software without restriction, including without limitation the rights to use, copy, modify, merge, publish, distribute, and/or sell copies of the Software, and to permit persons to whom the Software is furnished to do so, subject to the following conditions:

1. The above copyright notices and this permission notice (which includes the disclaimer below) shall be included in all copies or substantial portions of the Software.
2. The name of a copyright holder shall not be used to endorse or promote products derived from the Software without specific prior written permission.

THIS DISCLAIMER OF WARRANTY CONSTITUTES AN ESSENTIAL PART OF THIS LICENSE. NO USE OF THE SOFTWARE IS AUTHORIZED HEREUNDER EXCEPT UNDER THIS DISCLAIMER. THE SOFTWARE IS PROVIDED BY THE COPYRIGHT HOLDERS "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT OF THIRD PARTY RIGHTS. IN NO EVENT SHALL THE COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, OR ANY SPECIAL INDIRECT OR CONSEQUENTIAL DAMAGES, OR ANY DAMAGES WHATSOEVER RESULTING FROM LOSS OF USE, DATA OR PROFITS, WHETHER IN AN ACTION OF CONTRACT, NEGLIGENCE OR OTHER TORTIOUS ACTION, ARISING OUT OF OR IN CONNECTION WITH THE USE OR PERFORMANCE OF THIS SOFTWARE. NO ASSURANCES ARE PROVIDED BY THE COPYRIGHT HOLDERS THAT THE SOFTWARE DOES NOT INFRINGE THE PATENT OR OTHER INTELLECTUAL PROPERTY RIGHTS OF ANY OTHER ENTITY. EACH COPYRIGHT HOLDER DISCLAIMS ANY LIABILITY TO THE USER FOR CLAIMS BROUGHT BY ANY OTHER ENTITY BASED ON INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS OR OTHERWISE. AS A CONDITION TO EXERCISING THE RIGHTS GRANTED HEREUNDER, EACH USER HEREBY ASSUMES SOLE RESPONSIBILITY TO SECURE ANY OTHER INTELLECTUAL PROPERTY RIGHTS NEEDED, IF ANY. THE SOFTWARE IS NOT FAULT-TOLERANT AND IS NOT INTENDED FOR USE IN MISSION-CRITICAL SYSTEMS, SUCH AS THOSE USED IN THE OPERATION OF NUCLEAR FACILITIES, AIRCRAFT NAVIGATION OR COMMUNICATION SYSTEMS, AIR TRAFFIC CONTROL SYSTEMS, DIRECT LIFE SUPPORT MACHINES, OR WEAPONS SYSTEMS, IN WHICH THE FAILURE OF THE SOFTWARE OR SYSTEM COULD LEAD DIRECTLY TO DEATH, PERSONAL INJURY, OR SEVERE PHYSICAL OR ENVIRONMENTAL DAMAGE ("HIGH RISK ACTIVITIES"). THE COPYRIGHT HOLDERS SPECIFICALLY DISCLAIM ANY EXPRESS OR IMPLIED WARRANTY OF FITNESS FOR HIGH RISK ACTIVITIES.

JasPer License Version 2.0

Permission is hereby granted, free of charge, to any person (the "User") obtaining a copy of this software and associated documentation files (the "Software"), to deal in the Software without restriction, including without limitation the rights to use, copy, modify, merge, publish, distribute, and/or sell copies of the Software, and to permit persons to whom the Software is furnished to do so, subject to the following conditions:

1. The above copyright notices and this permission notice (which includes the disclaimer below) shall be included in all copies or substantial portions of the Software.

2. The name of a copyright holder shall not be used to endorse or promote products derived from the Software without specific prior written permission.

THIS DISCLAIMER OF WARRANTY CONSTITUTES AN ESSENTIAL PART OF THIS LICENSE. NO USE OF THE SOFTWARE IS AUTHORIZED HEREUNDER EXCEPT UNDER THIS DISCLAIMER. THE SOFTWARE IS PROVIDED BY THE COPYRIGHT HOLDERS "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT OF THIRD PARTY RIGHTS. IN NO EVENT SHALL THE COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, OR ANY SPECIAL INDIRECT OR CONSEQUENTIAL DAMAGES, OR ANY DAMAGES WHATSOEVER RESULTING FROM LOSS OF USE, DATA OR PROFITS, WHETHER IN AN ACTION OF CONTRACT, NEGLIGENCE OR OTHER TORTIOUS ACTION, ARISING OUT OF OR IN CONNECTION WITH THE USE OR PERFORMANCE OF THIS SOFTWARE. NO ASSURANCES ARE PROVIDED BY THE COPYRIGHT HOLDERS THAT THE SOFTWARE DOES NOT INFRINGE THE PATENT OR OTHER INTELLECTUAL PROPERTY RIGHTS OF ANY OTHER ENTITY. EACH COPYRIGHT HOLDER DISCLAIMS ANY LIABILITY TO THE USER FOR CLAIMS BROUGHT BY ANY OTHER ENTITY BASED ON INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS OR OTHERWISE. AS A CONDITION TO EXERCISING THE RIGHTS GRANTED HEREUNDER, EACH USER HEREBY ASSUMES SOLE RESPONSIBILITY TO SECURE ANY OTHER INTELLECTUAL PROPERTY RIGHTS NEEDED, IF ANY. THE SOFTWARE IS NOT FAULT-TOLERANT AND IS NOT INTENDED FOR USE IN MISSION-CRITICAL SYSTEMS, SUCH AS THOSE USED IN THE OPERATION OF NUCLEAR FACILITIES, AIRCRAFT NAVIGATION OR COMMUNICATION SYSTEMS, AIR TRAFFIC CONTROL SYSTEMS, DIRECT LIFE SUPPORT MACHINES, OR WEAPONS SYSTEMS, IN WHICH THE FAILURE OF THE SOFTWARE OR SYSTEM COULD LEAD DIRECTLY TO DEATH, PERSONAL INJURY, OR SEVERE PHYSICAL OR ENVIRONMENTAL DAMAGE ("HIGH RISK ACTIVITIES"). THE COPYRIGHT HOLDERS SPECIFICALLY DISCLAIM ANY EXPRESS OR IMPLIED WARRANTY OF FITNESS FOR HIGH RISK ACTIVITIES.

This package was debianized by Christopher L Cheney <ccheney@debian.org> on

Fri, 22 Aug 2003 01:33:34 -0500.

The current maintainer is Roland Stigge <stigge@antcom.de>

It was downloaded from http://www.ece.uvic.ca/~mdadams/jasper/

Upstream Author: Michael Adams <mdadams@ece.uvic.ca>

License:

JasPer License Version 2.0

Copyright (c) 1999-2000 Image Power, Inc.

Copyright (c) 1999-2000 The University of British Columbia

Copyright (c) 2001-2003 Michael David Adams

All rights reserved.

Permission is hereby granted, free of charge, to any person (the "User") obtaining a copy of this software and associated documentation files (the "Software"), to deal in the Software without restriction, including without limitation the rights to use, copy, modify, merge, publish, distribute, and/or sell copies of the Software, and to permit persons to whom the Software is furnished to do so, subject to the following conditions:

1. The above copyright notices and this permission notice (which includes the disclaimer below) shall be included in all copies or substantial portions of the Software.

2. The name of a copyright holder shall not be used to endorse or promote products derived from the Software without specific prior written permission.

THIS DISCLAIMER OF WARRANTY CONSTITUTES AN ESSENTIAL PART OF THIS LICENSE. NO USE OF THE SOFTWARE IS AUTHORIZED HEREUNDER EXCEPT UNDER THIS DISCLAIMER. THE SOFTWARE IS PROVIDED BY THE COPYRIGHT HOLDERS "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT OF THIRD PARTY RIGHTS. IN NO EVENT SHALL THE COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, OR ANY SPECIAL INDIRECT OR CONSEQUENTIAL DAMAGES, OR ANY DAMAGES WHATSOEVER RESULTING FROM LOSS OF USE, DATA OR PROFITS, WHETHER IN AN ACTION OF CONTRACT, NEGLIGENCE OR OTHER TORTIOUS ACTION, ARISING OUT OF OR IN CONNECTION WITH THE USE OR PERFORMANCE OF THIS SOFTWARE. NO ASSURANCES ARE PROVIDED BY THE COPYRIGHT HOLDERS THAT THE SOFTWARE DOES NOT INFRINGE THE PATENT OR OTHER INTELLECTUAL PROPERTY RIGHTS OF ANY OTHER ENTITY. EACH COPYRIGHT HOLDER DISCLAIMS ANY LIABILITY TO THE USER FOR CLAIMS BROUGHT BY ANY OTHER ENTITY BASED ON INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS OR OTHERWISE. AS A CONDITION TO EXERCISING THE RIGHTS GRANTED HEREUNDER, EACH USER HEREBY ASSUMES SOLE RESPONSIBILITY TO SECURE ANY OTHER INTELLECTUAL PROPERTY RIGHTS NEEDED, IF ANY. THE SOFTWARE IS NOT FAULT-TOLERANT AND IS NOT INTENDED FOR USE IN MISSION-CRITICAL SYSTEMS, SUCH AS THOSE USED IN THE OPERATION OF NUCLEAR FACILITIES, AIRCRAFT NAVIGATION OR COMMUNICATION SYSTEMS, AIR TRAFFIC CONTROL SYSTEMS, DIRECT LIFE SUPPORT MACHINES, OR WEAPONS SYSTEMS, IN WHICH THE FAILURE OF THE SOFTWARE OR SYSTEM COULD LEAD DIRECTLY TO DEATH, PERSONAL INJURY, OR SEVERE PHYSICAL OR ENVIRONMENTAL DAMAGE ("HIGH RISK ACTIVITIES"). THE COPYRIGHT HOLDERS SPECIFICALLY DISCLAIM ANY EXPRESS OR IMPLIED WARRANTY OF FITNESS FOR HIGH RISK ACTIVITIES.

The Independent JPEG Group's JPEG software

==

README for release 6b of 27-Mar-1998

====================================

This distribution contains the sixth public release of the Independent JPEG Group's free JPEG software. You are welcome to redistribute this software and to use it for any purpose, subject to the conditions under LEGAL ISSUES, below.

Serious users of this software (particularly those incorporating it into larger programs) should contact IJG at jpeg-info@uunet.uu.net to be added to our electronic mailing list. Mailing list members are notified of updates and have a chance to participate in technical discussions, etc.

This software is the work of Tom Lane, Philip Gladstone, Jim Boucher, Lee Crocker, Julian Minguillon, Luis Ortiz, George Phillips, Davide Rossi, Guido Vollbeding, Ge' Weijers, and other members of the Independent JPEG Group.

IJG is not affiliated with the official ISO JPEG standards committee.

DOCUMENTATION ROADMAP

This file contains the following sections:

OVERVIEW General description of JPEG and the IJG software.

LEGAL ISSUES Copyright, lack of warranty, terms of distribution.

REFERENCES Where to learn more about JPEG.

ARCHIVE LOCATIONS Where to find newer versions of this software.

RELATED SOFTWARE Other stuff you should get.

FILE FORMAT WARS Software *not* to get.

TO DO Plans for future IJG releases.

Other documentation files in the distribution are:

User documentation:

install.doc How to configure and install the IJG software.

usage.doc Usage instructions for cjpeg, djpeg, jpegtran, rdjpgcom, and wrjpgcom.

*.1 Unix-style man pages for programs (same info as usage.doc).

wizard.doc Advanced usage instructions for JPEG wizards only.

change.log Version-to-version change highlights.

Programmer and internal documentation:

libjpeg.doc How to use the JPEG library in your own programs.

example.c Sample code for calling the JPEG library.

structure.doc Overview of the JPEG library's internal structure.

filelist.doc Road map of IJG files.

coderules.doc Coding style rules --- please read if you contribute code.

Please read at least the files install.doc and usage.doc. Useful information can also be found in the JPEG FAQ (Frequently Asked Questions) article. See ARCHIVE LOCATIONS below to find out where to obtain the FAQ article.

If you want to understand how the JPEG code works, we suggest reading one or more of the REFERENCES, then looking at the documentation files (in roughly the order listed) before diving into the code.

OVERVIEW

This package contains C software to implement JPEG image compression and decompression. JPEG (pronounced "jay-peg") is a standardized compression method for full-color and gray-scale images. JPEG is intended for compressing "real-world" scenes; line drawings, cartoons and other non-realistic images are not its strong suit. JPEG is lossy, meaning that the output image is not exactly identical to the input image. Hence you must not use JPEG if you have to have identical output bits. However, on typical photographic images, very good compression levels can be obtained with no visible change, and remarkably high compression levels are possible if you can tolerate a low-quality image. For more details, see the references, or just experiment with various compression settings.

This software implements JPEG baseline, extended-sequential, and progressive compression processes. Provision is made for supporting all variants of these processes, although some uncommon parameter settings aren't implemented yet. For legal reasons, we are not distributing code for the arithmetic-coding variants of JPEG; see LEGAL ISSUES. We have made no provision for supporting the hierarchical or lossless processes defined in the standard.

We provide a set of library routines for reading and writing JPEG image files, plus two sample applications "cjpeg" and "djpeg", which use the library to perform conversion between JPEG and some other popular image file formats. The library is intended to be reused in other applications.

In order to support file conversion and viewing software, we have included considerable functionality beyond the bare JPEG coding/decoding capability; for example, the color quantization modules are not strictly part of JPEG decoding, but they are essential for output to colormapped file formats or colormapped displays. These extra functions can be compiled out of the library if not required for a particular application. We have also included "jpegtran", a utility for lossless transcoding between different JPEG processes, and "rdjpgcom" and "wrjpgcom", two simple applications for inserting and extracting textual comments in JFIF files.

The emphasis in designing this software has been on achieving portability and flexibility, while also making it fast enough to be useful. In particular, the software is not intended to be read as a tutorial on JPEG. (See the REFERENCES section for introductory material.) Rather, it is intended to be reliable, portable, industrial-strength code. We do not claim to have achieved that goal in every aspect of the software, but we strive for it.

We welcome the use of this software as a component of commercial products. No royalty is required, but we do ask for an acknowledgement in product documentation, as described under LEGAL ISSUES.

LEGAL ISSUES

============

In plain English:

1. We don't promise that this software works. (But if you find any bugs, please let us know!)

2. You can use this software for whatever you want. You don't have to pay us.

3. You may not pretend that you wrote this software. If you use it in a program, you must acknowledge somewhere in your documentation that you've used the IJG code.

In legalese:

The authors make NO WARRANTY or representation, either express or implied, with respect to this software, its quality, accuracy, merchantability, or fitness for a particular purpose. This software is provided "AS IS", and you, its user, assume the entire risk as to its quality and accuracy.

This software is copyright (C) 1991-1998, Thomas G. Lane.

All Rights Reserved except as specified below.

Permission is hereby granted to use, copy, modify, and distribute this software (or portions thereof) for any purpose, without fee, subject to these conditions:

(1) If any part of the source code for this software is distributed, then this README file must be included, with this copyright and no-warranty notice unaltered; and any additions, deletions, or changes to the original files must be clearly indicated in accompanying documentation.

(2) If only executable code is distributed, then the accompanying documentation must state that "this software is based in part on the work of the Independent JPEG Group".

(3) Permission for use of this software is granted only if the user accepts full responsibility for any undesirable consequences; the authors accept NO LIABILITY for damages of any kind.

These conditions apply to any software derived from or based on the IJG code, not just to the unmodified library. If you use our work, you ought to acknowledge us.

Permission is NOT granted for the use of any IJG author's name or company name in advertising or publicity relating to this software or products derived from it. This software may be referred to only as "the Independent JPEG Group's software".

We specifically permit and encourage the use of this software as the basis of commercial products, provided that all warranty or liability claims are assumed by the product vendor.

ansi2knr.c is included in this distribution by permission of L. Peter Deutsch, sole proprietor of its copyright holder, Aladdin Enterprises of Menlo Park, CA. ansi2knr.c is NOT covered by the above copyright and conditions, but instead by the usual distribution terms of the Free Software Foundation; principally, that you must include source code if you redistribute it. (See the file ansi2knr.c for full details.) However, since ansi2knr.c is not needed as part of any program generated from the IJG code, this does not limit you more than the foregoing paragraphs do.

The Unix configuration script "configure" was produced with GNU Autoconf. It is copyright by the Free Software Foundation but is freely distributable. The same holds for its supporting scripts (config.guess, config.sub, ltconfig, ltmain.sh). Another support script, install-sh, is copyright by M.I.T. but is also freely distributable.

It appears that the arithmetic coding option of the JPEG spec is covered by patents owned by IBM, AT&T, and Mitsubishi. Hence arithmetic coding cannot legally be used without obtaining one or more licenses. For this reason, support for arithmetic coding has been removed from the free JPEG software. (Since arithmetic coding provides only a marginal gain over the unpatented Huffman mode, it is unlikely that very many implementations will support it.) So far as we are aware, there are no patent restrictions on the remaining code.

The IJG distribution formerly included code to read and write GIF files. To avoid entanglement with the Unisys LZW patent, GIF reading support has been removed altogether, and the GIF writer has been simplified to produce "uncompressed GIFs". This technique does not use the LZW algorithm; the resulting GIF files are larger than usual, but are readable by all standard GIF decoders.

We are required to state that

"The Graphics Interchange Format(c) is the Copyright property of CompuServe Incorporated. GIF(sm) is a Service Mark property of CompuServe Incorporated."

REFERENCES

==========

We highly recommend reading one or more of these references before trying to understand the innards of the JPEG software.

The best short technical introduction to the JPEG compression algorithm is

Wallace, Gregory K. "The JPEG Still Picture Compression Standard",

Communications of the ACM, April 1991 (vol. 34 no. 4), pp. 30-44.

(Adjacent articles in that issue discuss MPEG motion picture compression, applications of JPEG, and related topics.) If you don't have the CACM issue handy, a PostScript file containing a revised version of Wallace's article is available at ftp://ftp.uu.net/graphics/jpeg/wallace.ps.gz. The file (actually a preprint for an article that appeared in IEEE Trans. Consumer Electronics) omits the sample images that appeared in CACM, but it includes corrections and some added material. Note: the Wallace article is copyright ACM and IEEE, and it may not be used for commercial purposes.

A somewhat less technical, more leisurely introduction to JPEG can be found in "The Data Compression Book" by Mark Nelson and Jean-loup Gailly, published by M&T Books (New York), 2nd ed. 1996, ISBN 1-55851-434-1. This book provides good explanations and example C code for a multitude of compression methods including JPEG. It is an excellent source if you are comfortable reading C code but don't know much about data compression in general. The book's JPEG sample code is far from industrial-strength, but when you are ready to look at a full implementation, you've got one here...

The best full description of JPEG is the textbook "JPEG Still Image Data Compression Standard" by William B. Pennebaker and Joan L. Mitchell, published by Van Nostrand Reinhold, 1993, ISBN 0-442-01272-1. Price US $59.95, 638 pp. The book includes the complete text of the ISO JPEG standards (DIS 10918-1 and draft DIS 10918-2). This is by far the most complete exposition of JPEG in existence, and we highly recommend it.

The JPEG standard itself is not available electronically; you must order a paper copy through ISO or ITU. (Unless you feel a need to own a certified official copy, we recommend buying the Pennebaker and Mitchell book instead; it's much cheaper and includes a great deal of useful explanatory material.) In the USA, copies of the standard may be ordered from ANSI Sales at (212) 642-4900, or from Global Engineering Documents at (800) 854-7179. (ANSI doesn't take credit card orders, but Global does.) It's not cheap: as of 1992, ANSI was charging $95 for Part 1 and $47 for Part 2, plus 7% shipping/handling. The standard is divided into two parts, Part 1 being the actual specification, while Part 2 covers compliance testing methods. Part 1 is titled "Digital Compression and Coding of Continuous-tone Still Images, Part 1: Requirements and guidelines" and has document numbers ISO/IEC IS 10918-1, ITU-T T.81. Part 2 is titled "Digital Compression and Coding of

Continuous-tone Still Images, Part 2: Compliance testing" and has document numbers ISO/IEC IS 10918-2, ITU-T T.83.

Some extensions to the original JPEG standard are defined in JPEG Part 3, a newer ISO standard numbered ISO/IEC IS 10918-3 and ITU-T T.84. IJG currently does not support any Part 3 extensions.

The JPEG standard does not specify all details of an interchangeable file format. For the omitted details we follow the "JFIF" conventions, revision 1.02. A copy of the JFIF spec is available from:

Literature Department

C-Cube Microsystems, Inc.

1778 McCarthy Blvd.

Milpitas, CA 95035

phone (408) 944-6300, fax (408) 944-6314

A PostScript version of this document is available by FTP at ftp://ftp.uu.net/graphics/jpeg/jfif.ps.gz. There is also a plain text version at ftp://ftp.uu.net/graphics/jpeg/jfif.txt.gz, but it is missing the figures.

The TIFF 6.0 file format specification can be obtained by FTP from ftp://ftp.sgi.com/graphics/tiff/TIFF6.ps.gz. The JPEG incorporation scheme found in the TIFF 6.0 spec of 3-June-92 has a number of serious problems. IJG does not recommend use of the TIFF 6.0 design (TIFF Compression tag 6). Instead, we recommend the JPEG design proposed by TIFF Technical Note #2 (Compression tag 7). Copies of this Note can be obtained from ftp.sgi.com or from ftp://ftp.uu.net/graphics/jpeg/. It is expected that the next revision of the TIFF spec will replace the 6.0 JPEG design with the Note's design. Although IJG's own code does not support TIFF/JPEG, the free libtiff library uses our library to implement TIFF/JPEG per the Note. libtiff is available from ftp://ftp.sgi.com/graphics/tiff/.

ARCHIVE LOCATIONS

=================

The "official" archive site for this software is ftp.uu.net (Internet address 192.48.96.9). The most recent released version can always be found there in directory graphics/jpeg. This particular version will be archived as ftp://ftp.uu.net/graphics/jpeg/jpegsrc.v6b.tar.gz. If you don't have direct Internet access, UUNET's archives are also available via UUCP; contact help@uunet.uu.net for information on retrieving files that way.

Numerous Internet sites maintain copies of the UUNET files. However, only ftp.uu.net is guaranteed to have the latest official version.

You can also obtain this software in DOS-compatible "zip" archive format from the SimTel archives (ftp://ftp.simtel.net/pub/simtelnet/msdos/graphics/), or on CompuServe in the Graphics Support forum (GO CIS:GRAPHSUP), library 12 "JPEG Tools". Again, these versions may sometimes lag behind the ftp.uu.net release.

The JPEG FAQ (Frequently Asked Questions) article is a useful source of general information about JPEG. It is updated constantly and therefore is not included in this distribution. The FAQ is posted every two weeks to Usenet newsgroups comp.graphics.misc, news.answers, and other groups. It is available on the World Wide Web at http://www.faqs.org/faqs/jpeg-faq/ and other news.answers archive sites, including the official news.answers archive at rtfm.mit.edu: ftp://rtfm.mit.edu/pub/usenet/news.answers/jpeg-faq/. If you don't have Web or FTP access, send e-mail to mail-server@rtfm.mit.edu with body send usenet/news.answers/jpeg-faq/part1

send usenet/news.answers/jpeg-faq/part2

RELATED SOFTWARE

================

Numerous viewing and image manipulation programs now support JPEG. (Quite a few of them use this library to do so.) The JPEG FAQ described above lists some of the more popular free and shareware viewers, and tells where to obtain them on Internet.

If you are on a Unix machine, we highly recommend Jef Poskanzer's free PBMPLUS software, which provides many useful operations on PPM-format image files. In particular, it can convert PPM images to and from a wide range of other formats, thus making cjpeg/djpeg considerably more useful. The latest version is distributed by the NetPBM group, and is available from numerous sites, notably ftp://wuarchive.wustl.edu/graphics/graphics/packages/NetPBM/. Unfortunately PBMPLUS/NETPBM is not nearly as portable as the IJG software is; you are likely to have difficulty making it work on any non-Unix machine.

A different free JPEG implementation, written by the PVRG group at Stanford, is available from ftp://havefun.stanford.edu/pub/jpeg/. This program is designed for research and experimentation rather than production use; it is slower, harder to use, and less portable than the IJG code, but it is easier to read and modify. Also, the PVRG code supports lossless JPEG, which we do not. (On the other hand, it doesn't do progressive JPEG.)

FILE FORMAT WARS

================

Some JPEG programs produce files that are not compatible with our library. The root of the problem is that the ISO JPEG committee failed to specify a concrete file format. Some vendors "filled in the blanks" on their own, creating proprietary formats that no one else could read. (For example, none of the early commercial JPEG implementations for the Macintosh were able to exchange compressed files.)

The file format we have adopted is called JFIF (see REFERENCES). This format has been agreed to by a number of major commercial JPEG vendors, and it has become the de facto standard. JFIF is a minimal or "low end" representation. We recommend the use of TIFF/JPEG (TIFF revision 6.0 as modified by TIFF Technical Note #2) for "high end" applications that need to record a lot of additional data about an image. TIFF/JPEG is fairly new and not yet widely supported, unfortunately.

The upcoming JPEG Part 3 standard defines a file format called SPIFF. SPIFF is interoperable with JFIF, in the sense that most JFIF decoders should be able to read the most common variant of SPIFF. SPIFF has some technical advantages over JFIF, but its major claim to fame is simply that it is an official standard rather than an informal one. At this point it is unclear whether SPIFF will supersede JFIF or whether JFIF will remain the de-facto standard. IJG intends to support SPIFF once the standard is frozen, but we have not decided whether it should become our default output format or not. (In any case, our decoder will remain capable of reading JFIF indefinitely.)

Various proprietary file formats incorporating JPEG compression also exist. We have little or no sympathy for the existence of these formats. Indeed, one of the original reasons for developing this free software was to help force convergence on common, open format standards for JPEG files. Don't use a proprietary file format!

TO DO

=====

The major thrust for v7 will probably be improvement of visual quality. The current method for scaling the quantization tables is known not to be very good at low Q values. We also intend to investigate block boundary smoothing, "poor man's variable quantization", and other means of improving quality-vs-file-size performance without sacrificing compatibility.

In future versions, we are considering supporting some of the upcoming JPEG Part 3 extensions --- principally, variable quantization and the SPIFF file format.

As always, speeding things up is of great interest.

Please send bug reports, offers of help, etc. to jpeg-info@uunet.uu.net.

This copy of the libpng notices is provided for your convenience. In case of any discrepancy between this copy and the notices in the file png.h that is included in the libpng distribution, the latter shall prevail.

COPYRIGHT NOTICE, DISCLAIMER, and LICENSE:

If you modify libpng you may insert additional notices immediately following

this sentence.

This code is released under the libpng license.

libpng versions 1.2.6, August 15, 2004, through 1.5.12, July 11, 2012, are Copyright (c) 2004, 2006-2012 Glenn Randers-Pehrson, and are distributed according to the same disclaimer and license as libpng-1.2.5 with the following individual added to the list of Contributing Authors

Cosmin Truta

libpng versions 1.0.7, July 1, 2000, through 1.2.5 - October 3, 2002, are Copyright (c) 2000-2002 Glenn Randers-Pehrson, and are distributed according to the same disclaimer and license as libpng-1.0.6 with the following individuals added to the list of Contributing Authors

Simon-Pierre Cadieux

Eric S. Raymond

Gilles Vollant

and with the following additions to the disclaimer:

There is no warranty against interference with your enjoyment of the library or against infringement. There is no warranty that our efforts or the library will fulfill any of your particular purposes or needs. This library is provided with all faults, and the entire risk of satisfactory quality, performance, accuracy, and effort is with the user.

libpng versions 0.97, January 1998, through 1.0.6, March 20, 2000, are Copyright (c) 1998, 1999 Glenn Randers-Pehrson, and are distributed according to the same disclaimer and license as libpng-0.96, with the following individuals added to the list of Contributing Authors:

Tom Lane

Glenn Randers-Pehrson

Willem van Schaik

libpng versions 0.89, June 1996, through 0.96, May 1997, are Copyright (c) 1996, 1997 Andreas Dilger Distributed according to the same disclaimer and license as libpng-0.88, with the following individuals added to the list of Contributing Authors:

John Bowler

Kevin Bracey

Sam Bushell

Magnus Holmgren

Greg Roelofs

Tom Tanner

libpng versions 0.5, May 1995, through 0.88, January 1996, are Copyright (c) 1995, 1996 Guy Eric Schalnat, Group 42, Inc.

For the purposes of this copyright and license, "Contributing Authors" is defined as the following set of individuals:

Andreas Dilger

Dave Martindale

Guy Eric Schalnat

Paul Schmidt

Tim Wegner

The PNG Reference Library is supplied "AS IS". The Contributing Authors and Group 42, Inc. disclaim all warranties, expressed or implied, including, without limitation, the warranties of merchantability and of fitness for any purpose. The Contributing Authors and Group 42, Inc. assume no liability for direct, indirect, incidental, special, exemplary, or consequential damages, which may result from the use of the PNG Reference Library, even if advised of the possibility of such damage.

Permission is hereby granted to use, copy, modify, and distribute this source code, or portions hereof, for any purpose, without fee, subject to the following restrictions:

1. The origin of this source code must not be misrepresented.

2. Altered versions must be plainly marked as such and must not be misrepresented as being the original source.

3. This Copyright notice may not be removed or altered from any source or altered source distribution.

The Contributing Authors and Group 42, Inc. specifically permit, without fee, and encourage the use of this source code as a component to supporting the PNG file format in commercial products. If you use this source code in a product, acknowledgment is not required but would be appreciated.

A "png_get_copyright" function is available, for convenient use in "about" boxes and the like:

printf("%s",png_get_copyright(NULL));

Also, the PNG logo (in PNG format, of course) is supplied in the files "pngbar.png" and "pngbar.jpg (88x31) and "pngnow.png" (98x31).

Libpng is OSI Certified Open Source Software. OSI Certified Open Source is a certification mark of the Open Source Initiative.

Glenn Randers-Pehrson

glennrp at users.sourceforge.net

July 11, 2012

USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

==

== LICENSE file ==

== ==

== in this case for the Threading Building Blocks code ==

==

GNU GENERAL PUBLIC LICENSE

For the complete text of this license, see GNU GENERAL PUBLIC LICENSE in this section.

Threading Building Blocks

The source code of Threading Building Blocks is distributed under version 2 of the GNU General Public License, with the so-called "runtime exception," as follows (or see any header or implementation file):

As a special exception, you may use this file as part of a free software library without restriction. Specifically, if other files instantiate templates or use macros or inline functions from this file, or you compile this file and link it with other files to produce an executable, this file does not by itself cause the resulting executable to be covered by the GNU General Public License. This exception does not however invalidate any other reasons why the executable file might be covered by the GNU General Public License.

ZLIB DATA COMPRESSION LIBRARY

zlib 1.2.7 is a general purpose data compression library. All the code is thread safe. The data format used by the zlib library is described by RFCs (Request for Comments) 1950 to 1952 in the files http://tools.ietf.org/html/rfc1950 (zlib format), rfc1951 (deflate format) and rfc1952 (gzip format).

All functions of the compression library are documented in the file zlib.h (volunteer to write man pages welcome, contact zlib@gzip.org). A usage example of the library is given in the file test/example.c which also tests that the library is working correctly. Another example is given in the file test/minigzip.c. The compression library itself is composed of all source files in the root directory.

To compile all files and run the test program, follow the instructions given at the top of Makefile.in. In short "./configure; make test", and if that goes well, "make install" should work for most flavors of Unix. For Windows, use one of the special makefiles in win32/ or contrib/vstudio/ . For VMS, use make_vms.com.

Questions about zlib should be sent to <zlib@gzip.org>, or to Gilles Vollant <info@winimage.com> for the Windows DLL version. The zlib home page is http://zlib.net/ . Before reporting a problem, please check this site to verify that you have the latest version of zlib; otherwise get the latest version and check whether the problem still exists or not.

PLEASE read the zlib FAQ http://zlib.net/zlib_faq.html before asking for help.

Mark Nelson <markn@ieee.org> wrote an article about zlib for the Jan. 1997 issue of Dr. Dobb's Journal; a copy of the article is available at http://marknelson.us/1997/01/01/zlib-engine/ .

The changes made in version 1.2.7 are documented in the file ChangeLog.

Unsupported third party contributions are provided in directory contrib/ .

zlib is available in Java using the java.util.zip package, documented at http://java.sun.com/developer/technicalArticles/Programming/compression/ .

A Perl interface to zlib written by Paul Marquess <pmqs@cpan.org> is available at CPAN (Comprehensive Perl Archive Network) sites, including http://search.cpan.org/~pmqs/IO-Compress-Zlib/ .

A Python interface to zlib written by A.M. Kuchling <amk@amk.ca> is available in Python 1.5 and later versions, see http://docs.python.org/library/zlib.html .

zlib is built into tcl: http://wiki.tcl.tk/4610 .

An experimental package to read and write files in .zip format, written on top of zlib by Gilles Vollant <info@winimage.com>, is available in the contrib/minizip directory of zlib.

Notes for some targets:

- For Windows DLL versions, please see win32/DLL_FAQ.txt

- For 64-bit Irix, deflate.c must be compiled without any optimization. With -O, one libpng test fails. The test works in 32 bit mode (with the -n32 compiler flag). The compiler bug has been reported to SGI.

- zlib doesn't work with gcc 2.6.3 on a DEC 3000/300LX under OSF/1 2.1 it works when compiled with cc.

- On Digital Unix 4.0D (formerly OSF/1) on AlphaServer, the cc option -std1 is necessary to get gzprintf working correctly. This is done by configure.

- zlib doesn't work on HP-UX 9.05 with some versions of /bin/cc. It works with other compilers. Use "make test" to check your compiler.

- gzdopen is not supported on RISCOS or BEOS.

- For PalmOs, see http://palmzlib.sourceforge.net/

Acknowledgments:

The deflate format used by zlib was defined by Phil Katz. The deflate and zlib specifications were written by L. Peter Deutsch. Thanks to all the people who reported problems and suggested various improvements in zlib; they are too numerous to cite here.

Copyright notice:

gstvideocuda

bpmp and tos-img

The bpmp and tos-img libraries are covered by the following copyrights and license. This information is also provided in the `LICENSE.bpmp_and_tos-img` file.

Appendix: Crosstool-NG Configuration File

The following is a sample `.config` file for the Crosstool-NG toolchain. For more information, see Building Crosstool-ng Toolchain and glibc in this guide.

```
# Automatically generated make config: don't edit
# crosstool-NG hg+-11c23aa9c9f9 Configuration
# Tue Aug 21 15:05:23 2012
#
CT_CONFIGURE_has_xz=y
CT_CONFIGURE_has_cvs=y
CT_CONFIGURE_has_svn=y
CT_MODULES=y

#
# Paths and misc options
#

#
# crosstool-NG behavior
#
# CT_OBSOLETE is not set
CT_EXPERIMENTAL=y
# CT_DEBUG_CT is not set

#
# Paths
#
CT_LOCAL_TARBALLS_DIR="${TOP_DIR}/crosstool-ng/src"
CT_SAVE_TARBALLS=y
CT_WORK_DIR="${TOP_DIR}/crosstool-ng/work"
CT_PREFIX_DIR="${TOP_DIR}/crosstool-ng/install"
CT_INSTALL_DIR="${CT_PREFIX_DIR}"
CT_RM_RF_PREFIX_DIR=y
CT_REMOVE_DOCS=y
CT_INSTALL_DIR_RO=y
CT_STRIP_ALL_TOOLCHAIN_EXECUTABLES=y
```

```
#
# Downloading
#
# CT_FORBID_DOWNLOAD is not set
# CT_FORCE_DOWNLOAD is not set
CT_CONNECT_TIMEOUT=10
# CT_ONLY_DOWNLOAD is not set
# CT_USE_MIRROR is not set

#
# Extracting
#
# CT_FORCE_EXTRACT is not set
CT_OVERIDE_CONFIG_GUESS_SUB=y
# CT_ONLY_EXTRACT is not set
CT_PATCH_BUNDLED=y
# CT_PATCH_LOCAL is not set
# CT_PATCH_BUNDLED_LOCAL is not set
# CT_PATCH_LOCAL_BUNDLED is not set
# CT_PATCH_BUNDLED_FALLBACK_LOCAL is not set
# CT_PATCH_LOCAL_FALLBACK_BUNDLED is not set
# CT_PATCH_NONE is not set
CT_PATCH_ORDER="bundled"

#
# Build behavior
#
CT_PARALLEL_JOBS=1
CT_LOAD=0
CT_USE_PIPES=y
CT_EXTRA_FLAGS_FOR_HOST=""
# CT_CONFIG_SHELL_SH is not set
# CT_CONFIG_SHELL_ASH is not set
CT_CONFIG_SHELL_BASH=y
# CT_CONFIG_SHELL_CUSTOM is not set
CT_CONFIG_SHELL="${bash}"
```

```
#
# Logging
#
# CT_LOG_ERROR is not set
# CT_LOG_WARN is not set
# CT_LOG_INFO is not set
CT_LOG_EXTRA=y
# CT_LOG_ALL is not set
# CT_LOG_DEBUG is not set
CT_LOG_LEVEL_MAX="EXTRA"
# CT_LOG_SEE_TOOLS_WARN is not set
CT_LOG_PROGRESS_BAR=y
CT_LOG_TO_FILE=y
CT_LOG_FILE_COMPRESS=y

#
# Target options
#
CT_ARCH="arm"
CT_ARCH_SUPPORTS_BOTH_MMU=y
CT_ARCH_SUPPORTS_BOTH_ENDIAN=y
CT_ARCH_SUPPORTS_32=y
CT_ARCH_SUPPORTS_WITH_ARCH=y
CT_ARCH_SUPPORTS_WITH_CPU=y
CT_ARCH_SUPPORTS_WITH_TUNE=y
CT_ARCH_SUPPORTS_WITH_FLOAT=y
CT_ARCH_SUPPORTS_WITH_FPU=y
CT_ARCH_SUPPORTS_SOFTFP=y
CT_ARCH_DEFAULT_HAS_MMU=y
CT_ARCH_DEFAULT_LE=y
CT_ARCH_DEFAULT_32=y
CT_ARCH_ARCH="armv7-a"
CT_ARCH_CPU="cortex-a9"
CT_ARCH_TUNE="cortex-a9"
CT_ARCH_FPU=""
# CT_ARCH_BE is not set
CT_ARCH_LE=y
```

```
CT_ARCH_32=y
CT_ARCH_BITNESS=32
CT_ARCH_FLOAT_HW=y
# CT_ARCH_FLOAT_SW is not set
CT_TARGET_CFLAGS=""
CT_TARGET_LDFLAGS=""
# CT_ARCH_alpha is not set
CT_ARCH_arm=y
# CT_ARCH_avr32 is not set
# CT_ARCH_blackfin is not set
# CT_ARCH_m68k is not set
# CT_ARCH_mips is not set
# CT_ARCH_powerpc is not set
# CT_ARCH_s390 is not set
# CT_ARCH_sh is not set
# CT_ARCH_sparc is not set
# CT_ARCH_x86 is not set
CT_ARCH_alpha_AVAILABLE=y
CT_ARCH_arm_AVAILABLE=y
CT_ARCH_avr32_AVAILABLE=y
CT_ARCH_blackfin_AVAILABLE=y
CT_ARCH_m68k_AVAILABLE=y
CT_ARCH_mips_AVAILABLE=y
CT_ARCH_powerpc_AVAILABLE=y
CT_ARCH_s390_AVAILABLE=y
CT_ARCH_sh_AVAILABLE=y
CT_ARCH_sparc_AVAILABLE=y
CT_ARCH_x86_AVAILABLE=y

#
# Generic target options
#
# CT_MULTILIB is not set
CT_ARCH_USE_MMU=y
CT_ARCH_ENDIAN="little"

#
```

```
# Target optimisations
#
# CT_ARCH_FLOAT_SOFTFP is not set
CT_ARCH_FLOAT="hard"

#
# arm other options
#
CT_ARCH_ARM_MODE="arm"
CT_ARCH_ARM_MODE_ARM=y
# CT_ARCH_ARM_MODE_THUMB is not set
# CT_ARCH_ARM_INTERWORKING is not set
CT_ARCH_ARM_EABI=y

#
# Toolchain options
#

#
# General toolchain options
#
CT_FORCE_SYSROOT=y
CT_USE_SYSROOT=y
CT_SYSROOT_NAME="sysroot"
CT_SYSROOT_DIR_PREFIX=""
CT_WANTS_STATIC_LINK=y
CT_STATIC_TOOLCHAIN=y
CT_TOOLCHAIN_PKGVERSION=""
CT_TOOLCHAIN_BUGURL=""

#
# Tuple completion and aliasing
#
CT_TARGET_VENDOR="cortex_a9"
CT_TARGET_ALIAS_SED_EXPR=""
CT_TARGET_ALIAS=""
```

```
#
# Toolchain type
#
# CT_NATIVE is not set
CT_CROSS=y
# CT_CROSS_NATIVE is not set
# CT_CANADIAN is not set
CT_TOOLCHAIN_TYPE="cross"

#
# Build system
#
CT_BUILD=""
CT_BUILD_PREFIX=""
CT_BUILD_SUFFIX=""

#
# Misc options
#
# CT_TOOLCHAIN_ENABLE_NLS is not set

#
# Operating System
#
CT_KERNEL_SUPPORTS_SHARED_LIBS=y
CT_KERNEL="linux"
CT_KERNEL_VERSION="2.6.36.4"
# CT_KERNEL_bare_metal is not set
CT_KERNEL_linux=y
CT_KERNEL_bare_metal_AVAILABLE=y
CT_KERNEL_linux_AVAILABLE=y
# CT_KERNEL_V_3_5 is not set
# CT_KERNEL_V_3_4_7 is not set
# CT_KERNEL_V_3_3_8 is not set
# CT_KERNEL_V_3_2_25 is not set
# CT_KERNEL_V_3_1_10 is not set
# CT_KERNEL_V_3_0_39 is not set
```

```
# CT_KERNEL_V_2_6_39_4 is not set
# CT_KERNEL_V_2_6_38_8 is not set
# CT_KERNEL_V_2_6_37_6 is not set
CT_KERNEL_V_2_6_36_4=y
# CT_KERNEL_V_2_6_33_20 is not set
# CT_KERNEL_V_2_6_32_59 is not set
# CT_KERNEL_V_2_6_31_14 is not set
# CT_KERNEL_V_2_6_27_62 is not set
# CT_KERNEL_LINUX_CUSTOM is not set
CT_KERNEL_mingw32_AVAILABLE=y

#
# Common kernel options
#
CT_SHARED_LIBS=y

#
# linux other options
#
CT_KERNEL_LINUX_VERBOSITY_0=y
# CT_KERNEL_LINUX_VERBOSITY_1 is not set
# CT_KERNEL_LINUX_VERBOSITY_2 is not set
CT_KERNEL_LINUX_VERBOSE_LEVEL=0
CT_KERNEL_LINUX_INSTALL_CHECK=y

#
# Binary utilities
#
CT_ARCH_BINFMT_ELF=y

#
# GNU binutils
#
# CT_BINUTILS_V_2_22 is not set
# CT_BINUTILS_V_2_21_53 is not set
# CT_BINUTILS_V_2_21_1a is not set
CT_BINUTILS_V_2_20_1a=y
```

```
# CT_BINUTILS_V_2_19_1a is not set
# CT_BINUTILS_V_2_18a is not set
CT_BINUTILS_VERSION="2.20.1a"
CT_BINUTILS_2_20_or_later=y
CT_BINUTILS_2_19_or_later=y
CT_BINUTILS_2_18_or_later=y
CT_BINUTILS_HAS_HASH_STYLE=y
CT_BINUTILS_GOLD_SUPPORTS_ARCH=y
CT_BINUTILS_HAS_PKGVERSION_BUGURL=y
CT_BINUTILS_FORCE_LD_BFD=y
CT_BINUTILS_LINKER_LD=y
CT_BINUTILS_LINKERS_LIST="ld"
CT_BINUTILS_LINKER_DEFAULT="bfd"
CT_BINUTILS_EXTRA_CONFIG_ARRAY=""
# CT_BINUTILS_FOR_TARGET is not set

#
# C compiler
#
CT_CC="gcc"
CT_CC_VERSION="4.5.3"
CT_CC_gcc=y
# CT_CC_GCC_SHOW_LINARO is not set
# CT_CC_V_4_7_1 is not set
# CT_CC_V_4_7_0 is not set
# CT_CC_V_4_6_3 is not set
# CT_CC_V_4_6_2 is not set
# CT_CC_V_4_6_1 is not set
# CT_CC_V_4_6_0 is not set
CT_CC_V_4_5_3=y
# CT_CC_V_4_5_2 is not set
# CT_CC_V_4_5_1 is not set
# CT_CC_V_4_5_0 is not set
# CT_CC_V_4_4_7 is not set
# CT_CC_V_4_4_6 is not set
# CT_CC_V_4_4_5 is not set
# CT_CC_V_4_4_4 is not set
```

```
# CT_CC_V_4_4_3 is not set
# CT_CC_V_4_4_2 is not set
# CT_CC_V_4_4_1 is not set
# CT_CC_V_4_4_0 is not set
# CT_CC_V_4_3_6 is not set
# CT_CC_V_4_3_5 is not set
# CT_CC_V_4_3_4 is not set
# CT_CC_V_4_3_3 is not set
# CT_CC_V_4_3_2 is not set
# CT_CC_V_4_3_1 is not set
# CT_CC_V_4_2_4 is not set
# CT_CC_V_4_2_2 is not set
CT_CC_GCC_4_2_or_later=y
CT_CC_GCC_4_3_or_later=y
CT_CC_GCC_4_4_or_later=y
CT_CC_GCC_4_5=y
CT_CC_GCC_4_5_or_later=y
CT_CC_GCC_HAS_GRAPHITE=y
CT_CC_GCC_HAS_LTO=y
CT_CC_GCC_HAS_PKGVERSION_BUGURL=y
CT_CC_GCC_HAS_BUILD_ID=y
CT_CC_GCC_USE_GMP_MPFR=y
CT_CC_GCC_USE_MPC=y
CT_CC_GCC_USE_LIBELF=y
# CT_CC_LANG_FORTRAN is not set
CT_CC_SUPPORT_CXX=y
CT_CC_SUPPORT_FORTRAN=y
CT_CC_SUPPORT_JAVA=y
CT_CC_SUPPORT_ADA=y
CT_CC_SUPPORT_OBJC=y
CT_CC_SUPPORT_OBJCXX=y

#
# Additional supported languages:
#
CT_CC_LANG_CXX=y
# CT_CC_LANG_JAVA is not set
```

```
# CT_CC_LANG_ADA is not set
# CT_CC_LANG_OBJC is not set
# CT_CC_LANG_OBJCXX is not set
CT_CC_LANG_OTHERS=""

#
# gcc other options
#
CT_CC_ENABLE_CXX_FLAGS=""
CT_CC_CORE_EXTRA_CONFIG_ARRAY="--with-float=hard"
CT_CC_EXTRA_CONFIG_ARRAY="--with-float=hard"
CT_CC_STATIC_LIBSTDCXX=y
# CT_CC_GCC_SYSTEM_ZLIB is not set

#
# Optimisation features
#
# CT_CC_GCC_USE_GRAPHITE is not set
CT_CC_GCC_USE_LTO=y

#
# Settings for libraries running on target
#
CT_CC_GCC_ENABLE_TARGET_OPTSPACE=y
# CT_CC_GCC_LIBMUDFLAP is not set
# CT_CC_GCC_LIBGOMP is not set
# CT_CC_GCC_LIBSSP is not set

#
# Misc. obscure options.
#
CT_CC_CXA_ATEXIT=y
# CT_CC_GCC_DISABLE_PCH is not set
CT_CC_GCC_SJLJ_EXCEPTIONS=m
CT_CC_GCC_LDBL_128=m
# CT_CC_GCC_BUILD_ID is not set
```

```
#
# C-library
#
CT_LIBC="glibc"
CT_LIBC_VERSION="2.11"
# CT_LIBC_eglibc is not set
CT_LIBC_glibc=y
# CT_LIBC_uClibc is not set
CT_LIBC_eglibc_AVAILABLE=y
CT_LIBC_glibc_AVAILABLE=y
CT_LIBC_GLIBC_TARBALL=y
# CT_LIBC_GLIBC_V_2_14_1 is not set
# CT_LIBC_GLIBC_V_2_14 is not set
# CT_LIBC_GLIBC_V_2_13 is not set
# CT_LIBC_GLIBC_V_2_12_2 is not set
# CT_LIBC_GLIBC_V_2_12_1 is not set
# CT_LIBC_GLIBC_V_2_11_1 is not set
CT_LIBC_GLIBC_V_2_11=y
# CT_LIBC_GLIBC_V_2_10_1 is not set
# CT_LIBC_GLIBC_V_2_9 is not set
# CT_LIBC_GLIBC_V_2_8 is not set
CT_LIBC_mingw_AVAILABLE=y
CT_LIBC_newlib_AVAILABLE=y
CT_LIBC_none_AVAILABLE=y
CT_LIBC_uClibc_AVAILABLE=y
CT_LIBC_SUPPORT_THREADS_ANY=y
CT_LIBC_SUPPORT_NPTL=y
CT_THREADS="nptl"

#
# Common C library options
#
CT_THREADS_NPTL=y
CT_LIBC_XLDD=y
CT_LIBC_GLIBC_MAY_FORCE_PORTS=y
CT_LIBC_glibc_familly=y
CT_LIBC_GLIBC_EXTRA_CONFIG_ARRAY=""
```

```
CT_LIBC_GLIBC_CONFIGPARMS=""
CT_LIBC_GLIBC_EXTRA_CFLAGS=""
CT_LIBC_EXTRA_CC_ARGS=""
# CT_LIBC_ENABLE_FORTIFIED_BUILD is not set
# CT_LIBC_DISABLE_VERSIONING is not set
CT_LIBC_OLDEST_ABI=""
CT_LIBC_GLIBC_FORCE_UNWIND=y
CT_LIBC_GLIBC_USE_PORTS=y
CT_LIBC_ADDONS_LIST=""
# CT_LIBC_LOCALES is not set
# CT_LIBC_GLIBC_KERNEL_VERSION_NONE is not set
CT_LIBC_GLIBC_KERNEL_VERSION_AS_HEADERS=y
# CT_LIBC_GLIBC_KERNEL_VERSION_CHOSEN is not set
CT_LIBC_GLIBC_MIN_KERNEL="2.6.36.4"

#
# glibc other options
#

#
# WARNING !!!
#

#
#   For glibc >= 2.8, it can happen that the tarballs
#

#
#   for the addons are not available for download.
#

#
#   If that happens, bad luck... Try a previous version
#

#
#   or try again later... :-(
```

```
#

#
# Debug facilities
#
# CT_DEBUG_dmalloc is not set
# CT_DEBUG_duma is not set
# CT_DEBUG_gdb is not set
# CT_DEBUG_ltrace is not set
# CT_DEBUG_strace is not set

#
# Companion libraries
#
CT_COMPLIBS_NEEDED=y
CT_GMP_NEEDED=y
CT_MPFR_NEEDED=y
CT_MPC_NEEDED=y
CT_LIBELF_NEEDED=y
CT_COMPLIBS=y
CT_GMP=y
CT_MPFR=y
CT_MPC=y
CT_LIBELF=y
# CT_GMP_V_5_0_2 is not set
# CT_GMP_V_5_0_1 is not set
CT_GMP_V_4_3_2=y
# CT_GMP_V_4_3_1 is not set
# CT_GMP_V_4_3_0 is not set
CT_GMP_VERSION="4.3.2"
# CT_MPFR_V_3_1_0 is not set
# CT_MPFR_V_3_0_1 is not set
# CT_MPFR_V_3_0_0 is not set
CT_MPFR_V_2_4_2=y
# CT_MPFR_V_2_4_1 is not set
# CT_MPFR_V_2_4_0 is not set
CT_MPFR_VERSION="2.4.2"
```

```
# CT_MPC_V_0_9 is not set
# CT_MPC_V_0_8_2 is not set
CT_MPC_V_0_8_1=y
# CT_MPC_V_0_7 is not set
CT_MPC_VERSION="0.8.1"
CT_LIBELF_V_0_8_13=y
# CT_LIBELF_V_0_8_12 is not set
CT_LIBELF_VERSION="0.8.13"

#
# Companion libraries common options
#
# CT_COMPLIBS_CHECK is not set

#
# Companion tools
#

#
# READ HELP before you say 'Y' below !!!
#
# CT_COMP_TOOLS is not set

#
# Test suite
#
# CT_TEST_SUITE_GCC is not set
```

FAQ

Linux FAQs

This section provides answers to frequently asked questions about your release. Use it as the first step in troubleshooting problems. You can also try searching the Index in this document, contacting your support engineer, or filing a bug.

Linux FAQs

Are ARMv7 binaries compatible with aarch64 binaries?

No, while the kernel supports both ARMv7 (32bi) and aarch64 binaries, distros currently are exclusively aarch64 or ARMv7. ARMv7 binaries are not compatible in an aarch64 distro. The NVIDIA PDK supports aarch64 distro where ARMv7 binaries are not compatible.

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.

You can find a tutorial on xrandr 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.

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 `apply_binaries.sh` script creates a sym-link from `tegra_drv.so` to the X ABI driver compatible with the provided sample file system.

How do I prevent the system display from blanking out?

Linux kernel 3.1 added a power saving feature that may blank the display of an idle system even when applications are 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.

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

1. In the grub configuration add the following line to the kernel parameters:

```
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.

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.

Auto-Hotplug

See CPUQuiet.

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.

BIT

Boot Information Table. The status table created by the boot ROM in the Internal RAM (IRAM) when it executes.

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.

Cluster Switch

A transition from the companion CPU cluster to the main CPU cluster or the reverse. Triggered automatically by the Tegra-specific CPUquiet driver or manually via sysfs.

CMS

NVIDIA Color Management System display technology. Tegra BSP includes software enabling you to calibrate and tune CMS.

color space

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

CPUquiet

A framework for dynamically adjusting the number of CPU cores active within an SMP cluster-based on workload. Comprises the core framework, pluggable governors, and a Tegra-specific low level driver. Replaces Auto-Hotplug from earlier releases.

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.

device tree

A tree-structure data format that represents information about the devices on a board.

DFS

Dynamic frequency scaling.

DIDIM

Obsolete. See PRISM. 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.

EDP

Electrical Design Point. The amount of current that a regulator must supply to handle the current consumed by the worst-case load (e.g. a CPU running a stress test).

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 boot loader, also called Fastboot

Default boot loader for Tegra BSP devices, except for devices used with Nvidia Vibrante. This customizable boot loader runs on AVP to initialize the CPU, after which it runs on CPU and starts the OS. The Fastboot boot loader supports the Fastboot protocol. In addition to booting the device, this boot loader can interact with NvFlash to flash binary images on appropriate storage media.

Fastboot host application

Host software supporting the Fastboot protocol for updating flash file systems and unsigned partition images for Android-based devices. It is used for the second stage in two-stage downloads to Tegra devices.

Fastboot protocol

A Google protocol for updating the flash file system in Android devices. The update is from a host over a USB connection. For more information, see http://source.android.com/index.html.

FCPU cluster

Applies to: This definition applies to Tegra 4/T11x devices.

Includes one or more of the four CPUs running at a higher operating frequency and with greater power consumption. For Tegra e devices, see G cluster.

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

G cluster

Applies to: This definition applies to Tegra 3 devices.

Includes one or more of the four CPUs running at a higher operating frequency and with greater power consumption. *G* reflects the use of G transistors for a block of high performance hardware logic in Tegra 3 devices. For Tegra 4/T11x devices, see FCPU cluster.

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.

HCI

Host Controller Interface. The software connection between a host OS and a Bluetooth controller.

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® Board Support Package (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.

LMP

Link Management Protocol. Controls the radio link between 2 Bluetooth devices.

LP cluster

Applies to: This definition applies to Tegra 3 devices.

Includes CPU 0 running at a lower operating frequency and with lower power consumption. *LP* reflects the use of LP transistors for a block of low power hardware logic in Tegra 3 devices. For Tegra 4/T11x devices, see SCPU cluster.

M

M4A

Multimedia MPEG-4 container format file extension (.m4a), first popularized 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 real time.

MIO

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

MIPI BIF

MIPI Alliance along with its Battery Interface working group devised the first complete battery communication interface standard for mobile devices. For more information on the MIPI BIF specification, see http://www.mipi.org/specifications/battery-interface. Tegra 4i (T14x) releases introduced support for MIPI BIF.

Miracast

Wireless display connection certification. Miracast devices use a Wi-Fi connection to stream audio and video content from one device (source) to another (sink) wirelessly. (Formerly called Wi-Fi Display.)

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. For more information, see http://en.wikipedia.org/wiki/MultiMediaCard.

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

Host-side application that sends binary images to Tegra devices that are in Tegra recovery mode. Fastboot uses those images to flash the device. NvFlash communicates with devices over USB or wireless connections.

NvRM

NVIDIA® Resource Manager.

NvSBKtooll

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

NVSI

NVIDIA® Secure Interface.

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

PAN

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

PCM

Pulse-code modulation.

PIP

Picture-in-picture.

pixel depth

Number of bits per pixel (bpp).

platform

The baseboard board, other boards, and VCM that that support a particular VCM.

PMIC

Power-management IC.

PMU

Power Management Unit.

PolarSSL

Tool that simplifies including cryptographic and SSL/TLS capabilities in (embedded) products. For more information, see https://polarssl.org.

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.

Quickboot boot loader

Default boot loader for Tegra devices for NVIDIA Vibrante. This boot loader is optimized for embedded/automotive use. The Quickboot boot loader does **not** support the Fastboot protocol.

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

USB recovery mode, which is a boot mode. Tegra devices transition to RCM when the boot ROM detects certain error conditions or when certain platform buttons are pressed. This is mode is used to perform system image updates.

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.

RNG

Random Number Generator. A computational device, implemented in hardware, that is designed to generate a sequence of numbers that lacks any pattern.

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.

SCPU cluster

Applies to: This definition applies to Tegra 4/T11x devices.

Includes CPU 0 running at a lower operating frequency and with lower power consumption. For Tegra 3 devices, see LP cluster.

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.

SNOR

Synchronous NOR.

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.

TLK

Trusted Little Kernel.

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.

VCM

Visual Computing Modules (VCM). Used in NVIDIA Vibrante products.

VDE

Video decoder.

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://en.wikipedia.org/wiki/VP6.

VPR

Video Protection Region. New feature in Tegra 4 (T11x) releases provides a carveout heap with no CPU read access between the hardware video decoder and the display, thereby providing hardware-level pixel protection.

W

WAV

Microsoft and IBM waveform audio format for storing audio bitstreams.

WEP

Wired Equivalent Privacy. Secures IEEE 802.11 wireless networks.

Wi-Fi Direct

The underlying peer-to-peer connection mechanism used by Miracast.

Wi-Fi Display

Obsolete term. See Miracast.

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.

YUV

A color space. Y stands for the luma (brightness) component, and U and V are the chrominance (color) components.

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.

Legal Information

Notice

ALL NVIDIA DESIGN SPECIFICATIONS, REFERENCE BOARDS, FILES, DRAWINGS, DIAGNOSTICS, LISTS, AND OTHER DOCUMENTS (TOGETHER AND SEPARATELY, "MATERIALS") ARE BEING PROVIDED "AS IS." NVIDIA MAKES NO WARRANTIES, EXPRESS, IMPLIED, STATUTORY, OR OTHERWISE WITH RESPECT TO THE MATERIALS, AND ALL EXPRESS OR IMPLIED CONDITIONS, REPRESENTATIONS AND WARRANTIES, INCLUDING ANY IMPLIED WARRANTY OR CONDITION OF TITLE, MERCHANTABILITY, SATISFACTORY QUALITY, FITNESS FOR A PARTICULAR PURPOSE AND ON-INFRINGEMENT, ARE HEREBY EXCLUDED TO THE MAXIMUM EXTENT PERMITTED BY LAW.

Information furnished is believed to be accurate and reliable. However, NVIDIA Corporation assumes no responsibility for the consequences of use of such information or for any infringement of patents or other rights of third parties that may result from its use. No license is granted by implication or otherwise under any patent or patent rights of NVIDIA Corporation. Specifications mentioned in this publication are subject to change without notice. This publication supersedes and replaces all information previously supplied. NVIDIA Corporation products are not authorized for use as critical components in life support devices or systems without express written approval of NVIDIA Corporation.

Trademarks

NVIDIA, the NVIDIA logo, CUDA, Tegra, and Vibrante are trademarks or registered trademarks of NVIDIA Corporation in the United States and other countries. Other company and product names may be trademarks of the respective companies with which they are associated.

The Android robot is reproduced or modified from work created and shared by Google and used according to terms described in the Creative Commons 3.0 Attribution License.

HDMI, the HDMI logo, and High-Definition Multimedia Interface are trademarks or registered trademarks of HDMI Licensing LLC.

ARM, AMBA, and ARM Powered are registered trademarks of ARM Limited. Cortex, MPCore and Mali are trademarks of ARM Limited. All other brands or product names are the property of their respective holders. "ARM" is used to represent ARM Holdings plc; its operating company ARM Limited; and the regional subsidiaries ARM Inc.; ARM KK; ARM Korea Limited.; ARM Taiwan Limited; ARM France SAS; ARM Consulting (Shanghai) Co. Ltd.; ARM Germany GmbH; ARM Embedded Technologies Pvt. Ltd.; ARM Norway, AS and ARM Sweden AB.

Copyright

Index

O

P

R

S