NVIDIA Jetson Linux Driver Package Software Features

Application Note

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Software Features

This topic describes the software features for NVIDIA® Jetson™ products supported in this release.

Jetson Nano Software Features

NVIDIA® Jetson™ Linux Driver Package (L4T) supports the following software features, which provide users a complete package to bring up Linux on targeted NVIDIA® Jetson Nano™ devices.

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

Bootloaders

Bootloader	Feature	Notes
nvboot	Boot Device	SKU 0000: SD Card
	2nd Stage Load Device	SKU 0020: eMMC
CBoot	Storage devices	SKU 0000: SD Card SKU 0020: eMMC
	Display: Splash/Menu	HDMI
U-Boot	Storage Device Support	SKU 0000: SD Card, NFS SKU 0020: eMMC, SD Card
	Display: Console	UART
	I/O Bus Support	SKU 0000: I2C, SD Card, USB (device) SKU 0020: I2C, USB (device)

Toolchain

Feature	Tool Chains	Notes
Aarch64	gcc-7.3-glibc-2.25	For 64-bit Kernel, Userspace, and U-Boot

System

Feature
Reboot support
Shutdown support
SC7
Cpuidle
Wake from Idle
Wake from Sleep
CPU hotplug
DVFS

CPU/GPU frequency governor
EMC Bandwidth Manager
Power Monitor
Clock & thermal management
initrd support
System boot with ATF as secure monitor
Precision Time Protocol (PTP)

Kernel

Interface	Feature
Linux-kernel	Version 4.9.140

I/O

Interface	Feature	Notes
DSI	DSI Display Support	-
	DSI Ganged Mode	-
	PWM Backlight	-
	DC Continuous Mode	-
	Dual Display	-
	Run Time Power Management	-
HDMI™	EDID Support	-
	Hot-Plug Detection Mechanism	-
	HDMI 1.4	480p, 720p, 1080p, RGB 444 4K @ 30 Hz
	Driver Suspend/Resume for Low Power	-
	HDMI as Primary Display	-
	Dual Display (HDMI+DP)	-
	HDMI: 1.4b compliance	Certified
	HDMI: 2.0 compliance	Certified
	Audio Support	-
Display Port (DP)	DP 1.2 support	
	Supported link rates 1.62, 2.7, and 5.4 Gb/second	HBR3 (8.1 Gb/second) not supported
	Full Link Training	
	Hotplug detection	
	Driver Suspend/Resume for Low Power	
	Plug/Unplug Wake from LP0	
	DP as primary display	

	Dual display (HDMI+DP)	
	Audio not supported	
	Deep color not supported	
	DP Alt-Mode not supported	
Ethernet	10/100/1000 BASE	-
	MAC Filtering	-
PWM	Speed Control from sysfs	-
	Control from Temperature Variation	-
I2C	Master Mode	-
Camera support (CSI input support)	V4L2 Media-Controller (V4L2 API bypasses ISP)	CSI0, CSI1, CSI2, CSI3, CSI4, CSI5
Peripheral devices	INA support	Current monitoring for: CPU/ GPU/VDD_IN
SPI	Max Bus Speed	SPI1: 65 MHz
		SPI2: 65 MHz
	Chip Select	SPI1: 0/1
		SPI2: 0/1
	Packed/Unpacked	SPI1, SPI2
	Full Duplex Mode	SPI1, SPI2
	Both Enable Bit	SPI1, SPI2
	Both Enable Byte	SPI1, SPI2
	Bi-directional	SPI1, SPI2
	Least Significant Bit	SPI1, SPI2
	Least Significant Byte First	SPI1, SPI2
	Software or Hardware Chip Select Polarity Section	SPI1, SPI2
	Supported Modes 1/2/3/4	SPI1, SPI2
	Purpose/Client	SPI1: Audio
		SPI2: Cam/Display
QSPI-NOR	Master	Not available on SKU 0020
	Clock Polarity and Phase (Mode 0)	
	DDR or SDR mode	
	Dual or Quad mode	
SDMMC	I/O Speeds (Clock speed)	SDMMC1: 204 MHz (SKU 0000 only)
		SDMMC3: 204 MHz
		SDMMC4: 200 MHz (SKU 0020 only)
	Hot Plug Support	SDMMC1
	SD High Speed Mode	SDMMC1, SDMMC3

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		SDR50	SDMMC1, SDMMC3, SDMMC4
		SDR104	SDMMC1, SDMMC3
		HS533	SDMMC4
		HS400	SDMMC4
		HS200	SDMMC4
		DDR Mode	SDMMC1, SDMMC3, SDMMC4
		Voltage Switching	SDMMC1, SDMMC3
		Frequency Tuning	SDMMC1, SDMMC3, SDMMC4
		Packed Commands	SDMMC3, SDMMC4
		Cache Control	SDMMC4
		Discard	SDMMC4
		Sanitize	SDMMC4
		RPMB	SDMMC4
		HPI	SDMMC4
		BKOPS	SDMMC4
		Power Off Notification	SDMMC4
		Sleep	SDMMC4
		Field Firmware Upgrade	SDMMC4
		CMD Queuing	-
		Device Life Estimation Type A	SDMMC4
		Device Life Estimation Type B	SDMMC4
		PRE EOL Information	SDMMC4
		Power Management	SDMMC1, SDMMC3, SDMMC4
I2C		Master	I2C GEN1, I2C GEN2, I2C GEN3, I2C DDC, I2C PWR, I2C6
			Standard mode (SM – 100Kbps) Fast mode (FM – 400Kbps) Fast mode plus (FM+ - 1Mbps) High speed mode. (HS - 3.4Mbps)
			7-bit or 10-bit slave addressing
			Lost arbitration detect
			Only Packet mode
			Dynamic clock gating
			Multi-master support
			PIO mode: For I2C message length <= 20 bytes DMA mode: For I2C message length > 20 bytes
			Clock always ON feature for device which need faster responses

		Message split if message size is greater than 4K bytes
		Runtime I2C bus clock frequency changes through sysfs
		Bit banging through GPIOs
		Clubbing 2 transactions and program their packets together.
		Bus clear support
USB 2.0	Device Mode	USB0
	OTG Mode	USB0
	Host Mode	USB0, USB1
	Host - Low Speed Devices	USB0
	Host - Full Speed Devices	USB0
	Host - High Speed Devices	USB0, USB1
	Host - Auto Suspend Support	USB0
USB 3.0	Speeds	USB0: HS/480 Mbps
		USB1: SS/5 Gbps
	Lanes	USB1: pex5
	USB 3.0 Support	USB1
	Connector	USB0: Micro AB
		USB1: TYPE A
	USB 2.0 Support	USB0, USB1
	Remote Wakeup Support	USB0: USB 2.0
		USB1: USB 2.0/3.0
	Host - Auto Suspend Support	USB0, USB1
	OTG Support	USB0
	Class Support	Mass storage (USB0, USB1)
		USB video class (USB0, USB1)
		HID (USB0, USB1)
		USB audio class (USB0, USB1)
		MTP (USB0, USB1)
		CDC - NCM/ECM (USB0, USB1)
GPIO LED supportGPIO	Pinmux Configuration	-
	GPIO configuration And programming	-
	GPIO LED support	PWR LED can be controlled
	GPIO interrupt support	-
UART	Speed	UART0: 115200
		UART2: 921600
		UART3: 3000000

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		Hardware Flow Control	UART2, UART3
		PIO Mode	UART0, UART2, UART3
		DMA Mode	UART0, UART2, UART3
		FIFO Mode	UART0, UART2, UART3
PCIe	Speed		PCIe 0: Gen1/Gen2
			PCIe 1: Gen1/Gen2
	Lane Width		PCIe 0: x1, x2, x4
			PCIe 1: x1
	Host Controller Features		Lanes Xbar config (X4_X1, X2_X1)
			Extended Config Space
			Hardware Clock Gating
			Deep Power Down (DPD)
	PCIe Features		Message Signaled Interrupts
			Vendor Specific Messages
			MSI-X
	PCIe Device Capabilities		Max Payload size 128 bytes
			Extended Tag Field Support
			Role-Based Error Reporting
			Maximum Link Speed; Supports Up to Gen2 Speeds
			Maximum Link Width; Supports Up to X4 Link Width
			ASPM Support (L0s and L1)
			L1 Clock Power Management
			Data Link Layer Link Active Reporting Capable
			Link Bandwidth Notification Capability
	Link Control		Read Completion Boundary
	Root Control		System Error on Correctable Error
			System Error on Non-Fatal Error
			System Error on Fatal Error
			PME Interrupt Enable
	Extended Capabilities		Advanced Error Reporting (AER)
			Latency Tolerance Reporting (LTR)
	L1 PM Substates		L1.1
			L1.2
	Misc Features		Dynamic Voltage Frequency (DVPS)

		Tegra Low Power Mode (LP0)
		Runtime PM
JTAG	JTAG Attach	Need HW rework on test point-
	JTAG Halt/Step/Go	-
Tegra Watchdog	Watchdog reboot from hang	
	Watchdog kick	
PMIC Watchdog	Watchdog reboot from hang	
	Watchdog kick	
RTC	Alarm	
	Wakeup from SC7	
eMMC		

> **Note:** **PCIe: Jetson Nano does not have any path from AHB-DMA or APB-DMA engines to PCIe IP as PCIe is connected directly to MSELECT and AHB-DMA and APB DMA engines only interact with IPs connected to respective AHB and APB buses. So it is not possible to use either AHB or APB engines for PCIe.**

CUDA

Feature	Version
CUDA	Version 10.0.166

Graphics

Graphics APIs	Notes
OpenGL	4.5
OpenGL-ES	3.2
Vulkan	1.0.2
EGL	1.5
GLX	
GLVnd Version of EGL	Vendor neutral functionality
NVDC - Direct Rendering Manager (DRM)	Compatibility with DRM 2.0
EGL Stream	
X11 ABI-20	Legacy from 24.2 using Ubuntu 16.04
API Support	**Notes**
GL + EGL	
EGL without X11	Content display without X11 usage
Vulkan loader version release 1.0.66 is verified to be working properly on this release. Consult https://developer.nvidia.com/embedded/vulkan for details.	

EGL and OpenGL ES Support

EGL is an interface between Khronos rendering APIs, such as OpenGL ES, and the underlying native platform window system. It handles graphics context management, surface/buffer binding, and rendering synchronization. EGL enables high-performance, accelerated, mixed-mode 2D and 3D rendering using other Khronos APIs.

L4T supports the EGL 1.5 specification, Khronos Native Platform Graphics Interface (EGL 1.5 Specification).

The OpenGL ES driver in this release supports the following OpenGL ES specifications:

- OpenGL ES Common Profile Specification 2.0
- OpenGL 4.5

For more information on OpenGL ES, see the Khronos OpenGL ES API Registry.

Video Decoders

Video Decode	Output Formats	Sampling Frequency and Bit rate/ Frame rate	Notes
H.264	NV12, NVMM:NV12	3840 x 2160 at 60 fps Up to 120 Mbps	Full-frame, Disable-DPB, Skip-Frames, enable-error-check, enable-frame-type-reporting
H.265	NV12, NVMM:NV12	3840 x 2160 at 60 fps Up to 160 Mbps	Decode Support in Gstreamer 1.4.5 and later Full-frame, Disable-DPB, Skip-Frames, enable-error-check, enable-frame-type-reporting
JPEG	I420, NVMM:I420	600 MP/sec	-
VP8	NV12, NVMM:NV12	3840 x 2160 at 60 fps Up to 140 Mbps	Full-frame, Disable-DPB, Skip-Frames, enable-error-check, enable-frame-type-reporting
VP9	NV12, NVMM:NV12	3840 x 2160 at 60 fps Up to 120 Mbps	Full-frame, Disable-DPB, Skip-Frames, enable-error-check, enable-frame-type-reporting
MPEG4	NV12, NVMM:NV12	1920×1080 at 240 fps Up to 120 Mbps	Full-frame, Disable-DPB, Skip-Frames, enable-error-check, enable-frame-type-reporting

Video Encoders

Video Encode	Input Formats	Sampling Frequency and Bit rate/Frame rate	Notes
H.264	I420, NV12, NVMM:I420, NVMM:NV12	3840×2160 at 30 fps Up to 120 Mbps	Supported features include: • control-rate • Bitrate • Peak-bitrate • Iframeinterval • SliceIntrarefreshEnable • Sliceintrarefreshinterval • Bit-Packetization • VBV-Size • Temporal-tradeoff • EnableMVBufferMeta • qp-range • MeasureEncoderLatency • EnableTwopassCBR • Preset-level • EnableStrimgentBitrate • Insert-SPS-PPS • Num-B-Frames • Slice-Header-Spacing • Profile • insert-aud • insert-vui • Force-IDR
JPEG	I420, NVMM:I420	600 MP/sec	-
H.265	I420, NVMM:I420, NVMM:NV12	3840×2160 at 30 fps Up to 100 Mbps	Supported features include: • control-rate • Bitrate • Peak-bitrate • Iframeinterval • SliceIntrarefreshEnable • Sliceintrarefreshinterval • Bit-Packetization • VBV-Size • Temporal-tradeoff • EnableMVBufferMeta • qp-range • MeasureEncoderLatency • EnableTwopassCBR • Preset-level • EnableStrimgentBitrate • Insert-SPS-PPS • Num-B-Frames

Video Encode	Input Formats	Sampling Frequency and Bit rate/Frame rate	Notes
			• Slice-Header-Spacing • Profile • insert-aud • insert-vui • Force-IDR
VP8	I420, NV12, NVMM:I420, NVMM:NV12	3840×2160 at 30 fps Up to 120 Mbps	Supported features include: • control-rate • Bitrate • Peak-bitrate • Iframeinterval • SliceIntrarefreshEnable • Sliceintrarefreshinterval • Bit-Packetization • VBV-Size • Temporal-tradeoff • EnableMVBufferMeta • qp-range • MeasureEncoderLatency • EnableTwopassCBR • Preset-level • EnableStrimgentBitrate • Insert-SPS-PPS • Num-B-Frames • Slice-Header-Spacing • Profile • insert-aud • insert-vui • Force-IDR

> **Note:** Use the `gst-inspect-1.0` utility to understand feature details. For example, the `gst-inspect-1.0 omxh264enc` command or the `gst-inspect-1.0 nvv4l2h264enc` command provides feature details of the H.264 encoder.

Display Outputs

nveglglessink	nvoverlaysink
X11 Window	Panel Overlay
-	Overlay
-	Overlay-Depth
-	Overlay-X

-	Overlay-Y
-	Overlay-W
-	Overlay-H

Conversion, Scaling, Cropping, and Rotation Formats

Input Formats	Output Formats	Notes
I420	I420	Flip-Method, interpolation-method, crop, Format conversion.
UYVY	UYVY	
YUY2	YUY2	
YVYU	YVYU	
NV12	NV12	
GRAY8	GRAY8	
BGRx	BGRx	
RGBA	RGBA	
NVMM:I420	NVMM:I420	
NVMM:I420_10LE	NVMM:I420_10LE	
NVMM:NV12	NVMM:NV12	

For additional information about supported features, see the following sections of Accelerated GStreamer User Guide:

- Video Format Conversion with Gstreamer-1.0
- Video Scaling with Gstreamer-1.0
- Video Cropping with Gstreamer-1.0
- Video Rotation with Gstreamer-1.0

CSI and USB Camera Features

Feature	Notes
Basic Camera Functionality	Supported sensors: IMX219. Can be demonstrated by the Argus Camera app and the Nvgstcapture app. For more details on Argus, refer to Applications Using libargus Low-level APIs in the topic Camera Development. Capture validated up to 3280x2464.
TNR Support	Option to switch between two types of noise reduction: • VICs-based temporal noise reduction: compromises on image quality due to low power consumption). To select this option, enable tnr.v1 in camera_overrides.isp. • GPU-based temporal noise reduction: improves image quality at the cost of high power consumption. Especially effective in low light scenes. To select this option, enable tnr.v2 in camera_overrides.isp.
USB Camera (UVC)	Supports UVC compliant USB2.0 and USB3.0 cameras.

For additional information about CSI and USB Camera supported features, see the "Nvgstcapture-1.0 Option Reference" section of [Accelerated Gstreamer User Guide](#).

Audio

Feature	Notes
HDA for HDMI	Supports PCM playback for stereo, 5.1, and 7.1 channel configurations. Supports sample sizes of 16 bits (S16_LE) and 24 bits (S24_LE), and sample rates of 32, 44.1, 48, 88.2, 96, 176.4, and 192 kHz. Note that 24#bit samples are stored as 32#bit data, with data in the upper 24 bits of each sample. Supports one output stream.
DMIC Support	Supports stereo capture. Supports sample sizes of 16 bits (S16_LE), 24 bits (S32_LE), OSR 64, 128, and 256, and sample rates of 8, 16, 44.1, and 48 kHz. Note that 24#bit samples are stored as 32#bit data, with data in the upper 24 bits of each sample. Supports interfaces DMIC1 and DMIC2.
I2S Support	Supports audio playback, capture, and loopback. Supports sample sizes of 8 bits (S8), 16 bits (S16_LE), 24 bits (S24_LE), and 32 bits (S32_LE), and sample rates of 8, 16, 44.1, 48, 96, and 192 kHz. Supports normal stereo I2S as well as TDM modes (DSP A and DSP B) with up to 16 channels. Each I2S interface can be configured as master or slave. Does not support u#Law or A#Law compression/decompression. Supports interfaces I2S3 and I2S4.
USB Audio	Supports stereo PCM playback and capture. Supports sample sizes of 16 bits (S16_LE) and 24 bits (S24_3LE), sample rates of 8, 16, 44.1, 48, 96, and 192 kHz. Supports up to eight channels on an eight-port USB DAC.
Audio Demultiplexer (ADX)	Supports PCM audio demultiplexing of one input stream with 2 to 16 channels into 1 to 4 output streams with up to 16 channels each. Supports sample sizes of 16 bits (S16_LE) and 32 bits (S32_LE), and sample rates of 8, 16, 44.1, 48, 96, and 192 kHz. Supports two ADX instances, ADX1 and ADX2.
Audio Multiplexer (AMX)	Supports PCM audio multiplexing of up to four input streams with up to 16 channels each into one output stream with up to 16 channels. Supports sample sizes of 16 bits (S16_LE) and 32 bits (S32_LE), and sample rates of 8, 16, 44.1, 48, 96, and 192 kHz. Supports two AMX instances: AMX1 and AMX2.

Sampling Frequency Converter (SFC)	Supports sampling frequency conversion of PCM audio streams of up to two channels. Supports sample sizes of 16 bits (S16_LE) and 32 bits (S32_LE), and sample rates of 8, 16, 44.1, 48, 96, and 192 kHz. Supports four SFC instances: SFC1, SFC2, SFC3, and SFC4.
Master Volume Control (MVC)	Supports gain or attenuation in range –120dB to +40dB. Supports sample sizes of 16 bits (S16_LE) and 32 bits (S32_LE), and sample rates of 8, 11.05, 16, 22.05, 24, 32, 44.1, 48, 88.2, 96, 176.4, and 192 kHz. Supports up to eight stream channels. Supports two MVC instances: MVC1 and MVC2.
Audio Mixer	Supports mixing up to 10 input streams. Supports five outputs, each of which can have any combination of 10 input streams. Supports sample sizes 16 bits (S16_LE) and 32 bits (S32_LE), and sample rates of 8, 11.025,16, 22.05, 24, 32, 44.1, 48, 88.2, 96, 176.4, and 192 kHz. Supports up to eight stream channels. Supports one AMIXER instance.

Low Memory Warning Feature

Feature	Notes
Notify user when current available memory is very low	Ubuntu Desktop issues a warning when available memory falls below a threshold limit. This helps make the user aware of any new process may lead to oom-killer or cause system sluggishness. The threshold limit is user-configurable.

Jetson AGX Xavier Software Features

NVIDIA$^{®}$ Jetson™ Linux Driver Package (L4T) supports these software features, which provide users a complete package to bring up Linux on targeted NVIDIA$^{®}$ Jetson AGX Xavier™ devices.

Note:	Check the *Release Notes* for constraints related to these features.

Bootloader

Bootloader Binary	Feature	Notes
BPMP processor boot binaries (MB1 & nvtboot-bpmp)	Storage location	Cold boot: eMMC
		RCM boot: Downloaded over USB recovery port
	Next stage storage location	Cold boot: eMMC
		RCM boot: Downloaded over USB recovery port
	Next stage	CBoot
	Storage device support	eMMC
	Partition table support	GPT (with protective MBR)
	Filesystem support	None
	I/O bus support	I2C
	Console UART	
CBoot	Execution CPU	CCPLEX
	Storage location	Cold boot: eMMC
		RCM boot: Downloaded over USB recovery port
	Next stage storage location	Cold boot: eMMC
		RCM boot: Downloaded over USB recovery port
	Next stage	Kernel
	Storage device support	eMMC, SD card, & USB drive (no hub support)
	Partition table support	GPT (with protective MBR)
	Filesystem support	None
	I/O bus support	I2C
	Console	UART
	Kernel boot	
	QSPI-NOR as primary boot device	
	UFS as primary boot device	Using CBoot as CPU-BL
	RCM boot	Using nvboot-cpu as CPU-BL

Bootloader Binary	Feature	Notes
	XUSB boot support (2.0, bulk only)	Reading files from GPT partition. **Note**: There is no hub driver support. The pen drive must be connected directly to the root port.
	SD Card boot support	Reading files from GPT partition
	Ethernet boot support using EQOS controller and Marvell phy	TFTP, DHCP & NFS
	Removable boot device selection based on priority	Hard-coded priority: SD card, USB, eMMC, network; configurable via CBO
	Display (text and splash images)	HDMI™ over HDMI connector; seamless on HDMI
	Plug-in manager support	Kernel DTB; BL DTB
	T19x CBoot source	Buildable outside of the Jetson Board Support Package using an ARM64 toolchain
	SDMMC HS400 mode support for all boot binaries	

Toolchain

Feature	Tool Chains	Notes
Aarch64	gcc-7.3-glibc-2.25	For 64-bit Kernel and Userspace

Kernel

Interface	Feature
Linux-kernel	Version 4.9.140

Debug Interface

Interface	Feature
JTAG	JTAG Attach
	JTAG Halt/Step/Go

Camera Interface

Interface	Feature	Notes
Camera support (CSI input support)	V4L2 Media-Controller (V4L2 API bypasses ISP)	CSI0, CSI1, CSI2, CSI3, CSI4, CSI5

LSIO

Feature	Feature	Notes
UART	PIO mode	FIFO access using CPU
	DMA mode	FIFO access using DMA
	Hardware/software based flow control	Flow control line toggling from hardware/software
	Buffer throttling	Flow control based on data in receive buffer
	Rx and Tx DMA mode selection	DMA mode transfer on Rx and Tx or on only one path
	Interrupt mode	Data transfer complete handling through interrupt
	Polling mode	Data transfer complete handling through polling
	MCR control	Modem control access
	Baud rate/port configuration	Changing port configuration
	Baud rate adjustment	Adjusting baud rate to fall within tolerance range
I2C Master	Speed mode (Standard, FM, FM+)	Speed mode (Standard, FM, FM+)
	Repeat start	Repeat start on transfer of data
	No Start	No address cycle after repeat start
	Packet mode	Packet mode
	7-bit/10-bit addressing mode	7-bit/10-bit addressing mode
	DMA mode	APB/GPC DMA for FIFO access
	Clock gating and clock always ON	Clock control after each transfer for power saving
	Runtime PM	Runtime power management
	Dynamic clock speed change	Change speed of the bus
	Interrupt based	Transfer complete handling using interrupt
	Bit banging for data transfer	Use GPIO APIs for data transfer
	Multiple transfer request	Multiple transfer request
	Bus clear support	Bus clear handling when bus is held by device
	>64k on software based split	>64K on software based split
	Non-interruptible transfer	Non-interruptible transfer
SPI Master	Packed/unpacked	Data can be put on FIFO in packed or unpacked format. Packed format reduces the number of I/O accesses on FIFO.
	Full Duplex Mode	Device can read and write data simultaneously
	Least Significant Bit	Option to send least significant bit first from packets
	Dual SPI	SPI MISO/MOSI can act as Rx and Tx
	Least Significant Byte First	Option to send least significant byte first from packets

Feature	Feature	Notes
	Hardware based CS control and CS setup/hold time	Hardware control the CS and maintain CS setup and hold time
	Software or hardware Chip Select Polarity Section	Chip select can be active high or active low based on the external device property
	Supported Modes 0/1/2/3	SPI communication support Mode 0, 1, 2, or 3
	DMA mode	Data written/read to/from FIFO using DMA mode
	PIO (non-DMA) mode	CPU access the FIFO for read/write
	GPIO based Chip select	CS line is controlled by the GPIO APIs
	SPI different clock rates	Set the interface clock speed based on what device can support
	Prod configuration	Platform/chip specific configuration of controller/interface
	Clock delay between packets	Provision for delay between packets
	Clock gating and clock always ON	Dynamic clock enable/disable for power save
	Runtime PM	Runtime power management
	Interrupt based	Transfer done handling through interrupt
	Different packet bit length	Different packet bit length
	Multiple transfer request	Multiple SPI transfer request from single call
GPIO	GPIO request/free	GPIO access permission
	Pinmux integration with GPIOS	GPIO APIs call pinmux for required pin configuration
	Direction set/get	GPIO direction configuration
	Value set/get	GPIO value set/get to/from pin
	Interrupt support from all pins	Interrupt support from all pins
	Wakeup support for SC7	Wakeup support for SC7
	GPIO register dump	GPIO register dump
	GPIO framework sysfs support	GPIO framework sysfs support
	Suspend/resume	Suspend/resume
Pinmux	Function configuration	Pinmux function configuration
	Pinmux config configuration	Pinmux different properties like pull up/down, input, tristate etc. configuration
	Suspend/resume	Save and restore of pinmux context
	Drive strength	Drive strength configuration of pins
	Prod setting	Prod setting
	Static pinmux configuration	Static pinmux configuration
	Dynamic pinmux configuration	Dynamic pinmux configuration
	Pinmux register dump	Pinmux register dump

NVIDIA Jetson Linux Driver Package Software Features

Feature	Feature	Notes
	Pinmux configuration dumping	Pinmux configuration dumping
	Pinmux-GPIO integration	Pinmux-GPIO integration
APBDMA/GPCDMA	Memory to memory	Memory to memory transfer
	Memory to I/O	Memory to I/O
	I/O to memory	IO to memory
	Cyclic-once mode	Cyclic mode
	Transfer done through interrupt mode	Transfer done on interrupt
	Multiple transfer request	Queue mechanism of the transfer request
Tegra WDT	Watchdog framework support	Registration with WDT framework
	System reset on CPU hang	System reset on WDT expiry
	Suspend/resume support	Suspend/resume handling
	Watchdog interrupt support	WDT reset on ISR
	Watchdog polling/ping support	WDT start/stop/pin from user space
PWM	PWM ops	PWM registration to framework
	Clock accuracy calculation	Clock calculation
PMC	Controlling I/O PAD voltage (PWR_DETECT)	Pad voltage configuration by software
	I/O DPD configuration	Deep power down configuration
	Read/write PMC registers	PMC register access interface
	PMC config for bootrom I2C	PMC configuration for bootrom I2C/MMIO command
BPMP I2C Master	Speed mode (Standard, FM, FM+)	Bus speed configuration
	Packet mode	I2C controller configuration in packet mode
	7-bit/10-bit addressing mode	7 and 10 bit addressing
	Bus clear support	Bus clear handling when bus is held by device
SPE-UART	PIO mode	FIFO access using CPU
	Hardware flow control	Flow control line toggling from hardware/software
	FIFO mode	FIFO mode of UART controller
SPE DMA	Memory to memory	Memory to memory transfer
	Memory to I/O	Memory to I/O
	I/O to Memory	I/O to memory
	Continuous mode support	Cyclic mode
I2C SLAVE	Normal/Byte mode	I2C controller configuration on byte mode
	FIFO mode	I2C controller configuration on FIFO mode
	7-bit addressing	7-bit addressing
	10-bit addressing	10-bit addressing
	Repeat start	Repeat start on transfer of data
	Clock stretching	Clock line stretching

HDMI

Feature	Details
EDID support	Read and parse EDID
Hot-Plug Detection	Hot-Plug detection with HDMI monitors and TV
HDMI 1.4 (480p/720p/1080p, 4K@30Hz)	Support for HDMI1.4 with following modes 480p/720p/1080p/ 4k@30Hz
HDMI 2.0(4K @ 30HZ, 4K @ 60HZ)	Support for HDMI 2.0 with 4K @ 30 H, 4K @ 60 Hz resolution
Driver Suspend/Resume	Driver Suspend/Resume for low power
HDMI - 4K @ 60 Hz - 8-Bit - YUV 420	HDMI - 4K @ 60 Hz - 8-Bit - YUV 420
HDMI as Primary Display	Support HDMI as primary display
Dual display	Mirroring support
HDMI 1.4b compliance	HDMI 1.4b compliance
HDMI 2.0 compliance	HDMI 2.0 compliance
Seamless display	Seamless display
Deep color support (12 bits/cell RGB and YUV444)	Deep color support (12 bits/cell RGB and YUV444; 10 bits/cell RGB is not supported)
Deep color support (10/12 bits/ cell YUV422)	Deep color support (10/12 bits/cell RGB and YUV422)
Sideband information	Send sideband information to the panel during video refresh; info frames and audio data

DP

Feature	Details
EDID	Read and parse EDID
DP Hot Plug support	Hot-Plug detection with DP monitors or TV
DP 4K @ 60 Hz	4K mode in DP
DP 4K @ 120 Hz or 8K @ 30 hz	HBR3 support at beta level (may have compatibility issues)
Seamless display	Seamless display
Enhanced framing	Error recovery methods
Full Link Training	Handshake signaling between host and device
HPD_IRQ event	Feedback from the panels in case of link synchronization loss
Driver Suspend/Resume	Driver suspend/resume for low power
Primary display	Support DP as primary display
Dual display	Mirroring support
Link rates 1.62, 2.7, 5.4 Gbps	Various link rates supported by the driver up to HBR2
Link rate 8.1 Gbps	HBR3 support at beta level (may have compatibility issues)
DP Alt Mode/Type-C	Support for outputting DP signaling over the Type-C interface
Aux link	Support DP aux link
Sideband information	Send sideband information to the panel during video refresh

PCIE

Feature	Details
Controllers with x8 link width	Max x8 link width (C0 and C5)

Feature	Details
Controllers with x4 link width	Max x4 link width (C4)
Controllers with x1 link width	Max x1 link width (C1,C2,C3)
Legacy interrupts	Applicable to all controllers
MSI & MSI-X interrupts	Applicable to all controllers
128 byte Maximum Payload Size	Applicable to all controllers
256 byte Maximum Payload Size	Applicable to all controllers
Gen-1 speed	Applicable to all controllers
Gen-2 speed	Applicable to all controllers
Gen-3 speed	Applicable to all controllers
Gen-4 speed	Applicable to all controllers
ASPM - L0s	Applicable to all controllers (enabled by default only on C1 controller)
ASPM - L1	
ASPM - L1.1	
ASPM - L1.2	
Wake support	Applicable to all controllers
Advanced Error Reporting (AER)	Applicable to all controllers
End Point mode support	C0,C4,C5

SDMMC

Feature	Notes
DDR50	eMMC interface running in DDR mode at 50 MHz
HS200	eMMC interface running in SDR mode at 200 MHz
HS400	eMMC interface running in DDR mode at 200 MHz
HS533	eMMC interface running in DDR mode at 267 MHz
HW tuning	Supports tuning in SDMMC controller
Packed Commands	Read & write commands can be packed in groups (either all read or all write) that transfer data for all commands in the group in one transfer on the bus, to reduce overhead
Cache	Similar to CPU cache, but implemented in eMMC; helps improve performance
Discard	Erases data if necessary during background erase events
Sanitize	Physically removes data from unmapped user address space
RPMB	Secure access
BKOPS	Allows execution of back ground operations when host is not being serviced
HPI	High priority interrupt to stop ongoing bkops/reliable writes
Power Off Notification	Allows device to prepare itself to power off properly and improve user experience during power-on
Sleep	Minimizes power consumption of the eMMC device
RTPM	Software feature to save power by switching off clocks when there is no transactions on the bus
Field Firmware Upgrade	Update eMMC firmware
Device Life Estimation Type A Device Life Estimation Type B	Device Health is a mechanism to get vital NAND flash program/erase cycles information as a percentage of useful flash lifespan.

Feature	Notes
	Type A: SLC device health information
	Type B: MLC device health information
PRE EOL Information	Provides indication about device lifetime reflected by average reserved blocks
Hardware Command Queue	Performed by SD/MMC controller
Enhanced Strobe Mode (ESM) in HS400 mode	Optional for devices; indicated by STROBE_SUPPORT[184] register of EXT_CSD
eMMC CQ CQIC feature	Generates coalesced interrupts when the interrupt coalescing mechanism is enabled
Suspend/resume and shutdown	

SATA

Feature	Notes
Gen1	Interface speed 1.5 Gbps
Gen2	Interface speed 3 Gbps
HIPM	Low power mode initiated by host
NCQ	Native Command Queue support
DEVSLP	Device sleep mode
Transfer mode	PIO or DMA
Port Multiplier Support	Hub for SATA
Runtime time power management	Driver can enable clock & rail only when active transactions happen with device
Bad block detection	

SATA-Marvel (over PCIe)

Feature	Notes
Gen1	Interface speed 1.5 Gbps
Gen2	Interface speed 3 Gbps
Gen3	Interface speed 6 Gbps
HIPM	Low power initiated by host
DIPM	How power initiated by device
NCQ	Native Command Queue support
DEVSLP	Device sleep mode
Transfer mode	PIO or DMA
Hot plug support	SATA drives may be removed and connected while system is active
Message Signaled Interrupts (MSI)	An alternative in-band method of signaling an interrupt
Port multiplier support	Hub for SATA
Runtime time power management	Driver can enable clock & rail only when active transactions happen with device

UFS

Feature	Notes
PWM-G1	UFS (m-phy) interface runs in low performance
PWM-G2	(PWM-Gx) modes

Feature	Notes
PWM-G3 PWM-G4 PWM-G5 PWM-G6	
HS-G1 HS-G2 HS-G3	UFS (m-phy) interface runs in high performance (HS-Gx) modes
Native Command Queue support	
Hibernation	Low power state
Runtime time power management	Driver issues software hibernation entry in runtime suspend, and hibernation exit in runtime resume
Auto hibernation	Hibernation triggered by controller
PWM SLOW modes	
PWM SLOW_AUTO modes	
HS FAST modes	
HS FAST_AUTO modes	
HS RATE_A series	
HS RATE_B series	

Security Engine

Feature	Notes
CBC-AES / Host1x	Cipher block chaining
EBC-AES / Host1x	Electronic Code Book
OFB-AES / Host1x	Output feedback
CTR-AES / Host1x	Counter mode
CMAC-AES / Host1x	Cipher-based Message Authentication Code
XTS-AES / Host1x	XEX-based tweaked-codebook mode with ciphertext stealing
DRBG (RNG) / Host1x	Deterministic random bit generator
SHA / Host1x	Secure Hash Algorithm variants: SHA1/224/256/384/512
RSA / Host1x	RSA Public Key Algorithm sizes 512/1024/1536/2048
RNG	Random number generator
TRNG	True random number generator
RSA/APB	RSA Public Key Algorithm sizes 3072/4096
Montgomery precomputation	Montgomery operations
Modular addition	Modular operations
Modular division	
Modular subtraction	
Modular inversion	
Modular reduction	
Modular multiplication	
ECC point addition	Elliptic curve cryptography operations
ECC point double	
ECC point multiplication	
ECC point verification	
Bit serial modular reduction double precision	Modular operations

Feature	Notes
ECC Shamir Trick	Elliptic curve cryptography operations
ECC-521 (Weierstrass) point multiplication	
ECC-521 (Weierstrass) point addition	
ECC-521 (Weierstrass) point double	
ECC-521 (Weierstrass) point verification	
ECC-521 (Weierstrass) Shamir's Trick	
Non-modular multiplication	Modular operations
C25519 point multiplication	X25519 operations
C25519 modular exponentiation	
C25519 modular multiplication	
C25519 modular square	
Ed25519 point multiplication	Edwards curve operations
Ed25519 modular addition	
Ed25519 Shamir's Trick	
DH	Diffie-Hellman algorithm
ECDH	Elliptic curve Diffie-Hellman algorithm
ECDSA	Elliptic curve digital signature algorithm
EdDSA	Edwards curve digital signature algorithm

USB 3.0

Feature	Notes
Super Speed Plus Host	USB host in 3.1 Gen2 mode (10 Gbps)
Super Speed Host	USB host in 3.0 mode (5 Gbps)
High Speed Host	USB host in 2.0 mode (480 Mbps)
Full Speed Host	USB host in 2.0 or 1.2 mode (12 Mbps)
Low Speed Host	USB host in 2.0 or 1.2 mode (1.5 Mbps)
Auto Suspend	USB host suspends the port/connected device if there is no activity
Remote Wakeup	USB host resumes the port/connected device if there is wakeup triggered by the device.
Auto Resume	USB host resumes the port/connected device if there is wakeup triggered by the host
ELPG for xUSB HS partition	Engine level power gating support for xUSB HS partition
ELPG for xUSB SS partition	Engine level power gating support for xUSB SS partition
Lower power state (U3 state)	
LPM states (U1, U2 states)	
Hot Plug Support	USB drives may be removed and connected while system is active
Port multiplier support	Hub for USB
Host Mass storage	Protocol for storage devices
Host USB video class	Protocol for camera devices
Host USB ECM	Protocol for ethernet over USB
Host USB audio class	Protocol for audio over USB
Host USB Modem—NCM	NCM protocol support for modem functionality
USB HID protocol	Human interface devices
Super Speed Device (xUSB)	USB device in 3.0 mode

NVIDIA Jetson Linux Driver Package Software Features

Feature	Notes
High Speed Device (xUSB)	USB device in 2.0 mode
BC1.2 Charging support	Support for battery charging per BC1.2 spec
Apple charger	Support for detecting Apple charger
MTP device mode	MTP protocol support for data transfer
ADB device mode	ADB protocol support for data transfer
RNDIS device mode	RNDIS protocol support for data transfer
OTG	USB host and device (cable based detection)

Ethernet

Feature
Ping
Remote wakeup
NFS boot
Suspend/resume support over NFS

Ethernet Controller Features (EQOS)

Feature
Speed mode change through ethtool
10/100 Mbps support
1000 Mbps support
Half-duplex support
arp offload
IEEE 1588-2008 (PTP)
Energy-Efficient Ethernet
Transmit checksum offload
Receive checksum offload
TCP segmentation offload
Jumbo frame support (up to 9 KB (9018 B untagged, or 9022 B tagged)
Flow control/PAUSE frame support
EAVB support
Up to 4 TX/RX queue/channels with 4 KB size
VLAN (insertion/stripping of VLAN tag in hardware. VLAN tag-based filtering supported for only 1 VLAN tag)

Power Modes (Profiles)

Feature
10W / 15W / 30W profiles provided
NVPModel interface for mode selection and custom mode creation

RTC

Feature
Alarm
Wakeup from SC7

Watchdog

Feature	Notes
Tegra Watchdog	Watchdog reboot from hang
Tegra Watchdog	Watchdog kick
PMIC Watchdog	Watchdog reboot from hang
PMIC Watchdog	Watchdog kick

System

Feature
Reboot support
Shutdown support
SC7
Cpuidle
Wake from Idle
Wake from Sleep
CPU hotplug
DVFS
CPU/GPU frequency governor
EMC Bandwidth Manager
Power Monitor
Clock & thermal management
initrd support
System boot with ATF as secure monitor

CUDA

Feature	Version
CUDA	Version 10.0.166

Graphics

Graphics APIs	Notes
OpenGL	4.6.0
OpenGL-ES	3.2.5
Vulkan	1.1.1 *
EGL	1.5
GLX	
GLVnd Version of EGL	Vendor neutral dispatch library for GL [†]
NVDC - Direct Rendering Manager (DRM)	Compatibility with DRM 2.0
EGL Stream	
X11 ABI-24	
Wayland	1.14 [‡]
Weston	3.0
API Support	**Notes**

Graphics APIs	Notes
GL + EGL, EGL without X11	Extensions supported for getting these components to work

* Vulkan loader version release 1.1.73 is verified to be working properly on this release. See https://developer.nvidia.com/embedded/vulkan for details.

† See https://github.com/NVIDIA/libglvnd for details on GLVnd.

‡ Experimental support for the GNOME-Wayland Desktop Shell. See the *Release Notes* for instructions to enable GNOME-Wayland support.

EGL Details

EGL is an interface between Khronos rendering APIs, such as OpenGL ES, and the underlying native platform window system. It handles graphics context management, surface/buffer binding, and rendering synchronization. EGL enables high-performance, accelerated, mixed-mode 2D and 3D rendering using other Khronos APIs.

Jetson Linux Driver Support supports the EGL 1.5 specification, Khronos Native Platform Graphics Interface (EGL 1.5 Specification).

GL and Vulkan Details

The OpenGL driver in this release supports OpenGL4.6, https://www.khronos.org/registry/OpenGL/specs/gl/glspec46.core.pdf. All details related to GL/GLX and other related specifications can be found at https://www.khronos.org/registry/OpenGL/index_gl.php. Conformance details for both X11 and Wayland Windowing System are at https://www.khronos.org/conformance/adopters/conformant-products/opengl.

The OpenGL ES driver in this release supports OpenGL ES Common Profile Specification 3.2. For more information on OpenGL ES, see the Khronos OpenGL ES API Registry. Conformance details for both X11 and Wayland Windowing System are at https://www.khronos.org/conformance/adopters/conformant-products/opengles.

The Vulkan driver in this release supports VK1.1.1.1, https://www.khronos.org/registry/vulkan/specs/1.1/pdf/vkspec.pdf. All details related to the specification can be found at https://www.khronos.org/registry/vulkan/. Conformance details are at https://www.khronos.org/conformance/adopters/conformant-products/vulkan.

Multimedia

The following topics list several classes of multimedia features.

Video Decoders

Video Decode	Output Formats	Sampling Frequency and Bit Rate/Frame Rate	Notes
H.264	NV12, NVMM:NV12	3840 x 2160 at 60 fps Up to 120 Mbps	Full-frame, Disable-DPB, Skip-Frames, enable-error-check, enable-frame-type-reporting
H.265	NV12,	7680 x 4320 at 30 fps	Full-frame, Disable-DPB,

Video Decode	Output Formats	Sampling Frequency and Bit Rate/Frame Rate	Notes
	NVMM:NV12, NVMM:I420_10LE	Up to 240 Mbps	Skip-Frames, enable-error-check, enable-frame-type-reporting
JPEG	I420, NVMM:I420	600 MP/sec	-
VP8	NV12, NVMM:NV12	3840 x 2160 at 60 fps Up to 120 Mbps	Full-frame, Disable-DPB, Skip-Frames, enable-error-check, enable-frame-type-reporting
VP9	NV12, NVMM:NV12	3840 x 2160 at 60 fps Up to 160 Mbps	Full-frame, Disable-DPB, Skip-Frames, enable-error-check, enable-frame-type-reporting
MPEG4	NV12, NVMM:NV12	1920×1080 at 60 fps Up to 120 Mbps	Full-frame, Disable-DPB, Skip-Frames, enable-error-check, enable-frame-type-reporting

Video Encoders

Video Encode	Input Formats	Sampling Frequency and Bit rate/Frame rate	Notes
H.264	I420, NV12, NVMM:1420, NVMM:NV12	3840 x 2160 at 60 fps Up to 120 Mbps	Supported features include: • control-rate • Bitrate • Peak-bitrate • Iframeinterval • SliceIntrarefreshEnable • Sliceintrarefreshinterval • Bit-Packetization • VBV-Size • Temporal-tradeoff • EnableMVBufferMeta • qp-range • MeasureEncoderLatency • EnableTwopassCBR • Preset-level • EnableStrimgentBitrate • Insert-SPS-PPS • Num-B-Frames • Slice-Header-Spacing • Profile • insert-aud • insert-vui • Force-IDR

Video Encode	Input Formats	Sampling Frequency and Bit rate/Frame rate	Notes
JPEG	I420, NVMM:I420	600 MP/sec	-
H.265	I420, NVMM:I420, NVMM:NV12, NVMM:I420_10LE	3840 x 2160 at 60 fps Up to 120 Mbps	Supported features include: • control-rate • Bitrate • Peak-bitrate • Iframeinterval • SliceIntrarefreshEnable • Sliceintrarefreshinterval • Bit-Packetization • VBV-Size • Temporal-tradeoff • EnableMVBufferMeta • qp-range • MeasureEncoderLatency • EnableTwopassCBR • Preset-level • EnableStrimgentBitrate • Insert-SPS-PPS • Num-B-Frames • Slice-Header-Spacing • Profile • insert-aud • insert-vui • Force-IDR
VP9	I420, NV12, NVMM:I420, NVMM:NV12	3840 x 2160 at 30 fps Up to 140 Mbps	Supported features include: • control-rate • Bitrate • Peak-bitrate • Iframeinterval • SliceIntrarefreshEnable • Sliceintrarefreshinterval • Bit-Packetization • VBV-Size • Temporal-tradeoff • EnableMVBufferMeta • qp-range • MeasureEncoderLatency • EnableTwopassCBR • Preset-level • EnableStrimgentBitrate • Insert-SPS-PPS • Num-B-Frames • Slice-Header-Spacing

Video Encode	Input Formats	Sampling Frequency and Bit rate/Frame rate	Notes
			• Profile • insert-aud • insert-vui • Force-IDR

> **Note:** Use the gst-inspect-1.0 utility to understand feature details. For example, the `gst-inspect-1.0 omxh264enc` command or the `gst-inspect-1.0 nvv4l2h264enc` command provides feature details of the H.264 encoder.

Display Outputs

nveglglessink		nvoverlaysink	nvoverlaysink
X11 Backend	**Wayland Backend**		
X11 window	Wayland-Weston window	Panel overlay	Panel overlay
		Overlay	Overlay
		Overlay-depth	Overlay-depth
		Overlay-X	Overlay-X
		Overlay-Y	Overlay-Y
		Overlay-W	Overlay-W
		Overlay-H	Overlay-H

Conversion, Scaling, Cropping, and Rotation Formats

Input Formats	Output Formats	Notes
I420	I420	Flip-method, interpolation-method, crop, format conversion.
UYVY	UYVY	
YUY2	YUY2	
YVYU	YVYU	
NV12	NV12	
GRAY8	GRAY8	
BGRx	BGRx	
RGBA	RGBA	
NVMM:I420	NVMM:I420	
NVMM:I420_10LE	NVMM:I420_10LE	
NVMM:NV12	NVMM:NV12	
NVMM:RGBA	NVMM:RGBA	

For additional information about supported features, see the following sections of Accelerated GStreamer User Guide:

• Video Format Conversion with Gstreamer-1.0

• Video Scaling with Gstreamer-1.0

• Video Cropping with Gstreamer-1.0

- Video Rotation with Gstreamer-1.0

CSI and USB Camera Features

Feature	Notes
Basic Camera Functionality	Supported sensors: OV5693 and IMX274. Can be demonstrated by the Argus Camera app. For more details on Argus, refer to Applications Using libargus Low-Level APIs in the topic Camera Development.
Infinite Timeout	Support for the use case in which CSI sensor stops streaming indefinitely and the camera stack goes idle. When the CSI sensor resumes streaming the camera stack resumes working. For more information about this use case, see Infinite Timeout Support in the topic Camera Software Development Solution.
GMSL Camera and VC Support	GMSL camera and VC support is validated for two simultaneous IMX390 sensors using the same CSI port. For details, see the citation of *NVIDIA GMSL Camera Framework in* Related Documentation. The official reference driver code for IMX390 will included in a future release.
DOL WDR	Support for DOL sensors. Validated with Sony IMX274. For more information on DOL sensors, see https://www.sony-semicon.co.jp/products_en/IS/sensor2/technology/dol-hdr.html.
CPHY Sensor	Support for MIPI CPHY interface sensors. Validated with Sony IMX 318 reaching performance of 30 frames/second for preview.
PWL WDR	Support for HDR using PWL WDR technology. Validated with Sony IMX185.
TNR Support	VIC-based temporal noise reduction effective in low light scenes.
Two 4K Preview at 60 FPS	Preview performance of 60 frames/second for 4K (3840×2160) resolution with two IMX274 sensors running simultaneously.
Six Camera Preview at 30 FPS	Preview performance of 30 frames/second for 1920×1440 resolution with six OV5693 sensors running simultaneously.
USB Camera (UVC)	Supports UVC compliant USB2.0 and USB3.0 cameras.

For additional information about CSI and USB Camera supported features, see the "Nvgstcapture-1.0 Option Reference" section of Accelerated Gstreamer User Guide.

BPMP I2C Master

Feature	Notes
Speed mode (Standard, FM, FM+)	Bus speed configuration
Packet mode	I2C controller configuration on packet mode
7-bit/10-bit addressing mode	
Bus clear support	Bus clear handling when bus is held by device

SPE-UART

Feature	Notes
PIO mode	FIFO access using CPU
Hardware flow control	Flow control line toggling from hardware/software
FIFO mode	FIFO mode of UART controller

SPE DMA

Feature	Notes
Memory to memory	Memory to memory transfer
Memory to I/O	Memory to I/O transfer
I/O to memory	I/O to memory transfer
Continuous mode support	Cyclic mode

I2C Slave

Feature	Notes
Normal/Byte mode	I2C controller configuration on byte mode
FIFO mode	I2C controller configuration on FIFO mode
7-bit addressing	
10-bit addressing	
Repeat start	Repeat start on transfer of data
Clock stretching	Clock line stretching

CAN

Feature	Notes
CAN 2.0 A	Basic or Standard CAN with 11 bit message identifiers, originally specified to operate at a maximum frequency of 250 Kbps. Maximum signal frequency: 1 Mbps.
CAN FD	CAN FD increases the maximum data throughput to ~3.7 Mbps. 10 Mbps over 10 meters. Maximum signal frequency: 15 Mbps.
TTCAN	Conforms with CAN protocol version 2.0 part A, B and ISO 11898-1, -4. CAN FD with up to 64 data bytes supported.

Audio

Feature	Notes
HDA for HDMI/DP	Supports PCM playback for stereo, 5.1 and 7.1 channel configurations. Supports sample sizes of 16 bits (S16_LE) and 24 bits (S32_LE) sizes, and sample rates of 32, 44.1, 48, 88.2, and 96 kHz for DisplayPort interfaces, and 32, 44.1, 48, 88.2, 96, 176.4, and 192 kHz for HDMI interfaces.

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	Note that 24-bit samples are stored as 32-bit data, with data in the upper 24 bits of each sample. Supports up to three output streams.
DMIC Support	Supports stereo capture. Supports sample sizes of 16 bits (S16_LE), 24 bits (S32_LE), OSR 64, 128 and 256, and sample rates of 8, 16, 44.1, and 48 kHz. Note that 24-bit samples are stored as 32-bit data, with data in the upper 24 bits of each sample. Supports interfaces DMIC2 and DMIC3.
DSPK Support	Supports stereo playback. Supports sample sizes of 16 bits (S16_LE), 24 bits (S32_LE), and OSR 64, 128 and 256, and sample rates of 8, 16, 44.1, and 48 kHz. Note that 24-bit samples are stored as 32-bit data, with data in the upper 24-bits of each sample. Supports interface DSPK1.
I2S Support	Supports audio playback, capture, and loopback. Supports sample sizes of 8 bits (S8), 16 bits (S16_LE), 24 bits (S24_LE), and 32 bits (S32_LE), and sample rates of 8, 11.025, 16, 22.05, 24, 32, 44.1, 48, 88.2, 96, 176.4, and 192 kHz. Supports normal stereo I2S as well as TDM modes (DSP#A and DSP#B) with up to 16 channels. Each I2S interface can be configured as master or slave. Does not support u#Law or A#Law compression/decompression. Supports interfaces I2S1, I2S2, I2S4 and I2S6.
Audio Demultiplexer (ADX)	Supports PCM audio demultiplexing of one input stream with 2 to 16 channels into 1 to 4 output streams with up to 16 channels each. Supports sample sizes of 16 bits (S16_LE) and 32 bits (S32_LE), and sample rates of 8, 16, 44.1, 48, 96, and 192 kHz. Supports four ADX instances, ADX1, ADX2, ADX3 and ADX4.
Audio Multiplexer (AMX)	Supports PCM audio multiplexing of up to 4 input streams with up to 16 channels each into one output stream with up to 16 channels. Supports sample sizes of 16 bits (S16_LE) and 32 bits (S32_LE), and sample rates of 8, 16, 44.1, 48, 96, and 192 kHz. Supports four AMX instances, AMX1, AMX2, AMX3 and AMX4.
USB Audio	Supports stereo PCM playback and capture. Supports sample sizes of 16 bits (S16_LE) and 24 bits (S24_3LE), and sample rates of 8, 16, 44.1, 48, 96, and 192 kHz. Supports up to eight channels on an eight-port USB DAC.
Sampling Frequency Converter (SFC)	Supports sampling frequency conversion of PCM audio streams of up to two channels. Supports sample sizes of 16 bits (S16_LE) and 32 bits (S32_LE), and sample rates of 8, 16, 44.1, 48, 96, and 192 kHz. Supports four SFC instances: SFC1, SFC2, SFC3, and SFC4.
Master Volume Control (MVC)	Supports gain or attenuation in range −120dB to +40dB. Supports sample sizes of 16 bits (S16_LE) and 32 bits

	(S32_LE), and sample rates of 8, 11.05, 16, 22.05, 24, 32,44.1, 48, 88.2, 96, 176.4, and 192 kHz. Supports up to eight stream channels. Supports two MVC instances: MVC1 and MVC2.
Audio Mixer	Supports mixing up to 10 input streams. Supports 5 outputs, each of which can contain any combination of 10 input streams. Supports sample sizes 16 bits (S16_LE) and 32 bits (S32_LE), and sample rates of 8, 11.025,16, 22.05, 24, 32, 44.1, 48, 88.2, 96, 176.4 and 192 kHz. Supports stream channels up till 8. Supports one AMIXER instance.

Jetson TX2 Series Software Features

NVIDIA® Jetson™ Linux Driver Package (L4T) supports these software features, which provide users a complete package to bring up Linux on targeted NVIDIA® Jetson™ TX2 series devices.

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

Bootloaders

Bootloader	Feature	Notes
nvtboot-bpmp	Execution CPU	BPMP
	Storage location	Cold boot: eMMC
		RCM boot: Downloaded over USB recovery port
	Next stage storage location	Cold boot: eMMC
		RCM boot: Downloaded over USB recovery port
	Next stage	cboot
	Storage device support	eMMC
	Partition table support	GPT (with protective MBR)
	Filesystem support	None
	I/O bus support	I2C
	Console UART	
cboot	Execution CPU	CCPLEX
	Storage location	Cold boot: eMMC
		RCM boot: Downloaded over USB recovery port
	Next stage storage location	Cold boot: eMMC
		RCM boot: Downloaded over USB recovery port
	Next stage	U-boot or Linux kernel
	Storage device support	eMMC
	Partition table support	GPT (with protective MBR)
	Filesystem support	None
	I/O bus support	I2C
	Console	UART
U-Boot	Execution CPU	CCPLEX
	Storage location	Cold boot: eMMC
	Next stage storage location	Cold boot: eMMC

Next stage	Linux kernel
Storage device support	eMMC, SD card
Partition table support	GPT (with protective MBR), DOS MBR
Filesystem support	ext2/3/4. FAT
I/O bus support	I2C, PCIe

Toolchain

Feature	Tool Chains	Notes
Aarch64	gcc-7.3-glibc-2.25	For 64-bit Kernel, Userspace, and U-Boot

Kernel

Feature	Version
Linux-kernel	Version 4.9.140

Debug Interface

Feature	Tool Chains	Notes
JTAG	JTAG Attach	Debugging capability
	JTAG Halt/Step/Go	Debugging capability

Camera Interface

Interface	Features	Notes
Camera support (CSI input support)	V4L2 Media Controller (V4L2 API bypasses ISP)	CSI0, CSI1, CSI2, CSI3, CSI4, CSI5
	Cameras supported: 6	
	Maximum resolution & frame rate for 6 cameras: 1920×1080 @ 30 frames/sec.	

Kernel I/O Interfaces

Interface	Feature	Notes
DSI	DSI Display Support	
	DSI Ganged Mode	
	PWM Backlight	
	DC Continuous Mode	
	Dual Display	
	Run Time Power Management	
HDMI™	EDID Support	
	Hot-Plug Detection mechanism	
	Support for HDMI 1.4	

	(480p/720p/1080p/RGB 444 4K @ 30 Hz)	
	Driver Suspend/Resume for low power	
	Support HDMI as primary display	
	Multi display	
	HDMI 1.4b compliance	
	HDMI 2.0 compliance	
	Audio support	
	Support HDMI 2.0 (4K @ 60 HZ)	
DP	EDID Support	
	Support for DP	
	Driver Suspend/Resume for low power	
	Support eDP as primary display	
	Multi display	
	DP Wake Support	
	DP compliance	
PWM	PWM operations	PWM registration to framework
	Prod setting	Jetson-specific controller configuration
	Clock accuracy calculation	Clock calculation
I2C	DMA mode	
	Bus clear support	
	Multi-master support	
	Normal/Byte Mode	
	General support	
PCIe	Physical Port: PCI-E 0	Speed: Gen1/Gen2, Lane Width X1, X2, X4
	Physical Port: CPI-E 1	Speed: Gen1/Gen2, Lane Width X1, X2, X4
	Physical Port: CPI-E 2	General Support
	Host Controller Features	Lanes Xbar config (X4_X0_X1, X2_X1_X1, X1_X1_X1) Hot-plug (using GPIO)
	PCI Features	Message Signaled Interrupts
	PCIe Link Capabilities	ASPM Support (L0s and L1) L1 Clock Power Management
		ASPM Support (L1.1 and L1.2)
	Root Control	PME Interrupt Enable
	Extended Capabilities	Advanced Error Reporting (AER)
	Miscellaneous Features	Dynamic Voltage Frequency (DVFS) Tegra Low Power Mode (LP0) Runtime PM
	L1 PM Substates	Rest All Capabilities
Bluetooth *Not supported by TX2i*	Bluetooth 4.0	BCM4354
	BLE 4.0	No BCM4354 (BlueZ limitation)
Peripheral devices	INA support	Current monitoring for: CPU/ GPU/VDD_IN
Platform support	P3310-B00 C03	
Wi-Fi	Multi-region support	Region Support: default (lowest-common-denominator)

Not supported by TX2i	Dual-band 2.4 GHz/5 GHz	BCM 4354
	STA Mode	BCM 4354
	AP Mode	BCM 4354
	IBSS Mode	BCM 4354
	WPA2 Security	BCM 4354
SPI	Physical Port: SPI1	Maximum bus speed: 65 MHz
	Physical Port: SPI2	Maximum bus speed: 65 MHz
	Physical Port: SPI 0/3	Maximum bus speed: N/A
	Packed/Unpacked	
	Full Duplex Mode	
	Both Enable Bit	
	Both Enable Byte	
	Bidirectional	
	Least Significant Bit	
	Least Significant Byte First	
	Software or Hardware Chip Select Polarity Section	
	Supported Modes 1/2/3/4	
	Dual SPI	SPI MISO/MOSI can act as Rx and Tx
	Multiple transfer request	Multiple SPI transfer request from single call
	Physical Port: SPI1	Maximum bus speed: 65 MHz
	Physical Port: SPI2	Maximum bus speed: 65 MHz
SDMMC	I/O Speeds (Clock speed)	SDMMC1 (SD card): 204 MHz
		SDMMC4 (eMMC): 200 MHz
	Hot Plug Support	SDMMC1 (SD card)
	SD High Speed Mode	SDMMC1 (SD card)
	SDR50	SDMMC1 (SD card), SDMMC4 (eMMC)
	SDR104	SDMMC1 (SD card)
	HS400	SDMMC4 (eMMC)
	HS200	SDMMC4 (eMMC)
	DDR Mode	SDMMC1 (SD card), SDMMC4 (eMMC)
	Voltage Switching	SDMMC1 (SD card)
	Frequency Tuning	SDMMC1 (SD card), SDMMC4 (eMMC)
	Packed Commands	SDMMC4 (eMMC)
	Cache Control	SDMMC4 (eMMC)
	Discard	SDMMC4 (eMMC)
	Sanitize	SDMMC4 (eMMC)
	RPMB	SDMMC4 (eMMC)
	HPI	SDMMC4 (eMMC)
	BKOPS	SDMMC4 (eMMC)
	Power Off Notification	SDMMC4 (eMMC)
	Sleep	SDMMC4 (eMMC)
	Field Firmware Upgrade	SDMMC4 (eMMC)
	Device Life Estimation Type A	SDMMC4 (eMMC)
	Device Life Estimation Type B	SDMMC4 (eMMC)
	PRE EOL Information	SDMMC4 (eMMC)
	Power Management	SDMMC4 (eMMC)
SATA	Speed	GEN1

		GEN2
	AHCI Mode	1.3.1
	SATA Specification	3.1
	HIPM	Yes
	NCQ	Yes
	Port Multiplier Support	CBS
	Link Power Management States	Partial
		Slumber
	Device Power Management States	D0
		D1
		D2
	Runtime Time Power Management	Yes
	S.M.A.R.T	Self-Monitoring Analysis and Reporting Technology
	Dev Sleep Support	
USB3.0	Speeds	USB0: HS/480 Mbps, USB1: SS/5 Gps
	Lanes	USB 0: N/A, USB1: Lane Muxing and sharing with PCIe
	USB 3.0 Support	
	Connector	USB0: Micro AB, USB1: Type A
	USB 2.0 Support	
	Remote Wakeup Support	
	Host - Auto Suspend Support	
	XOTG Support	
	XUSB SS/HS/FS/LS Host Mode	
	XUSB SS/HS/FS/LS Device Mode	
	XUSB Device Port U1/U2/U3 Transition	
	XUSB Host Port U1/U2/U3 Transition	
	XUSB Device ELPG	
	XUSB Host ELPG	
	Class Support	Mass storage
		USB video class
		HID
		USB video class
		MTP
		Ethernet
		Thumb/Hard Drive
		Mouse
		CDC - NCM/ECM
UART	Speed	UART Controllers UART0 (Debug: 115200) UART1 (Camera/GPIO Expansion Header): Not Used UART2 (M2 Connector): 921600 UART3 (Bluetooth Only): 3000000
	Hardware Flow Control for Debug	
	PIO Mode	
	DMA Mode	
	FIFO Mode	

EQOS	Ping	
	Speed	
	LP_IDDQ Mode Support	
	Suspend Resume over NFS Support	
	NFS Boot	

Ethernet Controller Features (EQOS)

Feature
Speed mode change through ethtool
10/100 Mbps support
1000 Mbps support
Half-duplex support
arp offload
IEEE 1588-2008 (PTP)
Energy-Efficient Ethernet
Transmit checksum offload
Receive checksum offload
TCP segmentation offload
Jumbo frame support (up to 9 KB (9018 B untagged, or 9022 B tagged)
Flow control/PAUSE frame support
EAVB support
Up to 4 TX/RX queue/channels with 4 KB size
VLAN (insertion/stripping of VLAN tag in hardware. VLAN tag-based filtering supported for only 1 VLAN tag)

Max-Q and Max-P

Feature
Power Efficiency
NVPModel

RTC

Feature
Alarm
Wakeup from SC7

Watchdog

Feature	Notes
Tegra Watchdog	Watchdog reboot from hang
Tegra Watchdog	Watchdog kick
PMIC Watchdog	Watchdog reboot from hang
PMIC Watchdog	Watchdog kick

GPIO

Feature

NVIDIA Jetson Linux Driver Package Software Features

System Programable GPIO Support
System Programable Pinmux SupportWakeable GPIO
Timestamping GPIO

System

Feature
UCM1 4/4/16
UCM2 24x7
Reboot Support
Shutdown Support
SC7
Wake from Idle
Wake from Sleep
cpuidle
cpufreq
DVFS
CPU Hotplug
EMC Scaling
initrd Support
CPU Load Behavior
System Boot with ATF as Secure Monitor

CUDA

Feature	Version
CUDA	Version 10.0.166

Graphics

Graphics APIs	Notes
OpenGL	4.6.0
OpenGL-ES	3.2.5
Vulkan	1.1.1 *
EGL	1.5
GLX	
GLVnd Version of EGL	Vendor neutral dispatch library for GL [†]
NVDC - Direct Rendering Manager (DRM)	Compatibility with DRM 2.0
EGL Stream	
X11 ABI-20	
Wayland	1.14 [‡]
Weston	3.0
API Support	**Notes**
GL + EGL, EGL without X11	Extensions supported for getting these components to work

* Vulkan loader version release 1.1.73 is verified to be working properly on this release. See https://developer.nvidia.com/embedded/vulkan for details.

† See https://github.com/NVIDIA/libglvnd for details on GLVnd.

EGL and OpenGL ES Support

EGL is an interface between Khronos rendering APIs, such as OpenGL ES, and the underlying native platform window system. It handles graphics context management, surface/buffer binding, and rendering synchronization. EGL enables high-performance, accelerated, mixed-mode 2D and 3D rendering using other Khronos APIs.

L4T supports the EGL 1.5 specification, Khronos Native Platform Graphics Interface (EGL 1.5 Specification).

The OpenGL ES driver in this release supports the following OpenGL ES specifications:

- OpenGL ES Common Profile Specification 2.0
- OpenGL 4.5

For more information on OpenGL ES, see the Khronos OpenGL ES API Registry.

Video Decoders

Video Decode	Output Formats	Sampling Frequency and Bit rate/Frame rate	Notes
H.264	NV12, NVMM:NV12	3840 x 2160 at 60 fps Up to 120 Mbps	Full-frame, Disable-DPB, Skip-Frames, enable-error-check, enable-frame-type-reporting
H.265	NV12, NVMM:NV12, NVMM:I420_10LE	3840 x 2160 at 60 fps Up to 160 Mbps	Decode Support in Gstreamer 1.4.5 and later Full-frame, Disable-DPB, Skip-Frames, enable-error-check, enable-frame-type-reporting
JPEG	I420, NVMM:I420	600 MP/sec	-
VP8	NV12, NVMM:NV12	3840 x 2160 at 60 fps Up to 140 Mbps	Full-frame, Disable-DPB, Skip-Frames, enable-error-check, enable-frame-type-reporting
VP9	NV12, NVMM:NV12	3840 x 2160 at 60 fps Up to 120 Mbps	Full-frame, Disable-DPB, Skip-Frames, enable-error-check, enable-frame-type-reporting
MPEG4	NV12, NVMM:NV12	1920×1080 at 240 fps Up to 120 Mbps	Full-frame, Disable-DPB, Skip-Frames, enable-error-check, enable-frame-type-reporting

Video Encoders

Video Encode	Input Formats	Sampling Frequency and Bit rate/Frame rate	Notes
H.264	I420, NV12, NVMM:I420, NVMM:NV12	3840 x 2160 at 30 fps Up to 120 Mbps	Supported features include: • control-rate • Bitrate • Peak-bitrate • Iframeinterval • SliceIntrarefreshEnable • Sliceintrarefreshinterval • Bit-Packetization • VBV-Size • Temporal-tradeoff • EnableMVBufferMeta • qp-range • MeasureEncoderLatency • EnableTwopassCBR • Preset-level • EnableStrimgentBitrate • Insert-SPS-PPS • Num-B-Frames • Slice-Header-Spacing • Profile • insert-aud • insert-vui • Force-IDR
JPEG	I420, NVMM:I420	600 MP/sec	-
H.265	I420, NVMM:I420, NVMM:NV12, NVMM:I420_10LE	3840 x 2160 at 30 fps Up to 100 Mbps	Supported features include: • control-rate • Bitrate • Peak-bitrate • Iframeinterval • SliceIntrarefreshEnable • Sliceintrarefreshinterval • Bit-Packetization • VBV-Size • Temporal-tradeoff • EnableMVBufferMeta • qp-range • MeasureEncoderLatency • EnableTwopassCBR • Preset-level • EnableStrimgentBitrate • Insert-SPS-PPS • Num-B-Frames • Slice-Header-Spacing

Video Encode	Input Formats	Sampling Frequency and Bit rate/Frame rate	Notes
			• Profile • insert-aud • insert-vui • Force-IDR
VP8	I420, NV12, NVMM:I420, NVMM:NV12	3840 x 2160 at 30 fps Up to 120 Mbps	Supported features include: • control-rate • Bitrate • Peak-bitrate • Iframeinterval • SliceIntrarefreshEnable • Sliceintrarefreshinterval • Bit-Packetization • VBV-Size • Temporal-tradeoff • EnableMVBufferMeta • qp-range • MeasureEncoderLatency • EnableTwopassCBR • Preset-level • EnableStrimgentBitrate • Insert-SPS-PPS • Num-B-Frames • Slice-Header-Spacing • Profile • insert-aud • insert-vui • Force-IDR
VP9	I420, NV12, NVMM:I420, NVMM:NV12	3840 x 2160 at 30 fps Up to 120 Mbps	Supported features include: • control-rate • Bitrate • Peak-bitrate • Iframeinterval • SliceIntrarefreshEnable • Sliceintrarefreshinterval • Bit-Packetization • VBV-Size • Temporal-tradeoff • EnableMVBufferMeta • qp-range • MeasureEncoderLatency • EnableTwopassCBR • Preset-level • EnableStrimgentBitrate • Insert-SPS-PPS

Video Encode	Input Formats	Sampling Frequency and Bit rate/Frame rate	Notes
			• Num-B-Frames • Slice-Header-Spacing • Profile • insert-aud • insert-vui • Force-IDR

> **Note:** **Use the gst-inspect-1.0 utility to understand feature details. For example, the `gst-inspect-1.0 omxh264enc` command or the `gst-inspect-1.0 nvv4l2h264enc` command provides feature details of the H.264 encoder.**

Display Outputs

nveglglessink	nvoverlaysink
X11 Window	Panel Overlay
-	Overlay
-	Overlay-Depth
-	Overlay-X
-	Overlay-Y
-	Overlay-W
-	Overlay-H

Conversion, Scaling, Cropping, and Rotation Formats

Input Formats	Output Formats	Notes
I420	I420	Flip-Method, interpolation-method, crop, format conversion.
UYVY	UYVY	
YUY2	YUY2	
YVYU	YVYU	
NV12	NV12	
GRAY8	GRAY8	
BGRx	BGRx	
RGBA	RGBA	
NVMM:I420	NVMM:I420	
NVMM:I420_10LE	NVMM:I420_10LE	
NVMM:NV12	NVMM:NV12	

For additional information about supported features, see the following sections of Accelerated GStreamer User Guide:

- Video Format Conversion with Gstreamer-1.0

- Video Scaling with Gstreamer-1.0

- Video Cropping with Gstreamer-1.0

- Video Rotation with Gstreamer-1.0

CSI and USB Camera Features

Feature	Notes
Basic Camera Functionality	Default reference sensor: OV5693. Can be demonstrated by the Argus Camera app. For more details on Argus, refer to Applications Using libargus Low-level APIs in the topic Camera Development.
Infinite Timeout	Support for use case in which the CSI sensor stops streaming indefinitely and the camera stack goes idle. When the CSI sensor resumes streaming the camera stack resumes working.
GMSL Camera and VC Support	GMSL camera and VC support is validated for two simultaneous IMX390 sensors using the same CSI port. For details, see the citation of *NVIDIA GMSL Camera Framework* in Related Documentation. The official reference driver code for IMX390 is included in this release.
DOL WDR	Support for DOL sensors. Validated with Sony IMX274. For more information on DOL sensors, see https://www.sony-semicon.co.jp/products_en/IS/sensor2/technology/dol-hdr.html.
PWL WDR	Support for HDR using PWL WDR technology. Validated with Sony IMX185.
TNR Support	Option to switch between two types of noise reduction: • VIC-based temporal noise reduction: compromises on image quality due to low power consumption. To select this option, enable `tnr.v1` in `camera_overrides.isp`. • GPU-based temporal noise reduction: improves image quality at the cost of high power consumption. Especially effective in low light scenes. To select this option, enable `tnr.v2` in `camera_overrides.isp`.
Six Camera Preview at 30 FPS	Preview performance of 30 frames/second for 1920×1440 resolution with six OV5693 sensors running simultaneously.
USB Camera (UVC)	Supports UVC compliant USB2.0 and USB3.0 cameras.

For additional information about CSI and USB Camera supported features, see the "Nvgstcapture-1.0 Option Reference" section of Accelerated Gstreamer User Guide.

Audio

Feature	Notes
HDA for HDMI/DP	Supports PCM playback for stereo, 5.1 and 7.1 channel configurations. Supports sample sizes of 16 bits (S16_LE) and 24 bits (S32_LE) sizes, and sample rates of 32, 44.1, 48, 88.2, and 96 kHz for DisplayPort interfaces, and 32, 44.1, 48, 88.2, 96, 176.4, and 192 kHz for HDMI interfaces. Note that 24-bit samples are stored as 32-bit data, with data in the upper 24 bits of each sample.

	Supports up to three output streams.
DMIC Support	Supports stereo capture. Supports sample sizes of 16 bits (S16_LE), 24 bits (S32_LE), OSR 64, 128 and 256, and sample rates of 8, 16, 44.1, and 48 kHz. Note that 24-bit samples are stored as 32-bit data, with data in the upper 24 bits of each sample. Supports interfaces DMIC1, DMIC22 and DMIC3.
DSPK Support	Supports stereo playback. Supports sample sizes of 16 bits (S16_LE) and 24 bits (S32_LE), and sample rates of 8, 16, 44.1, and 96 kHz. Note that 24-bit samples are stored as 32-bit data, with data in the upper 24-bits of each sample. Supports interface DSPK2.
I2S Support	Supports audio playback, capture, and loopback. Supports sample sizes of 8 bits (S8), 16 bits (S16_LE), 24 bits (S32_LE), and sample rates of 8, 11.025, 16, 22.05, 24, 32, 44.1, 48, 88.2, 96, 176.4, and 192 kHz. Supports normal stereo I2S as well as TDM modes (DSP A and DSP B) with up to 16 channels. Each I2S interface can be configured as master or slave. Does not support u#Law or A#Law compression/decompression. Supports interfacs I2S1, I2S2, I2S3, I2S4, I2S5, and I2S6.
Audio Demultiplexer (ADX)	Supports PCM audio demultiplexing of one input stream with 2 to 16 channels into 1 to 4 output streams with up to 16 channels each. Supports sample sizes of 16 bits (S16_LE) and 32 bits (S32_LE), and sample rates of 8, 16, 44.1, 48, 96, and 192 kHz. Supports four ADX instances: ADX1, ADX2, ADX3, and ADX4.
Audio Multiplexer (AMX)	Supports PCM audio multiplexing of up to 4 input streams with up to 16 channels each into one output stream with up to 16 channels. Supports sample sizes of 16 bits (S16_LE) and 32 bits (S32_LE), and sample rates of 8, 16, 44.1, 48, 96, and 192 kHz. Supports four AMX instances, AMX1, AMX2, AMX3, and AMX4.
USB Audio	Supports stereo PCM playback and capture. Supports sample sizes of 16 bits (S16_LE) and 24 bits (S24_3LE), and sample rates of 8, 16, 44.1, 48, 96, and 192 kHz. Supports up to eight channels on eight#port USB DAC.
Sampling Frequency Converter (SFC)	Supports sampling frequency conversion of PCM audio streams of up to two channels. Supports sample sizes of 16 bits (S16_LE) and 32 bits (S32_LE), and sample rates of 8, 16, 44.1, 48, 96, and 192 kHz. Supports four SFC instances: SFC1, SFC2, SFC3, and SFC4.
Master Volume Control (MVC)	Supports gain or attenuation in range −120dB to +40dB. Supports sample sizes of 16 bits (S16_LE) and 32 bits (S32_LE), and sample rates of 8, 11.025, 16, 22.05, 24, 32, 44.1, 48, 88.2, 96, and 192 kHz. Supports two MVC instances: MVC1 and MVC2.
Audio Mixer	Supports mixing up to 10 input streams. Supports

	5 outputs, each of which can contain any combination of 10 input streams. Supports sample sizes 16 bits (S16_LE) and 32 bits (S32_LE), and sample rates of 8, 11.025,16, 22.05, 24, 32, 44.1, 48, 88.2, 96, 176.4, and 192 kHz. Supports up to eight stream channels. Supports one AMIXER instance.

Jetson TX1 Software Features

NVIDIA® Jetson™ Linux Driver Package (L4T) supports the following software features, which provide users a complete package to bring up Linux on targeted NVIDIA® Jetson™ TX1 devices.

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

Boot Loaders

Boot Loader	Feature	Notes
nvboot	Boot Device	eMMC
	2nd Stage Load Device	eMMC
U-Boot	Storage Device Support	eMMC (no CQ), SD card, USB (HS)
	Display: Console	UART
	Display: Splash/Menu	UART
	I/O Bus Support	I2C, USB (HS), USB (device)

Toolchain

Feature	Tool Chains	Notes
Aarch64	gcc-4.8.2-glibc-2.17	For 64-bit Kernel, Userspace, and U-Boot

Kernel

Feature	Tool Chains
Linux-kernel	Version 4.9.140

Debug Interface

Feature	Tool Chains	Notes
JTAG	JTAG Attach	Debugging capability
	JTAG Halt/Step/Go	Debugging capability

Kernel I/O Interfaces

Interface	Feature	Notes
DSI	DSI Display Support	-
	DSI Ganged Mode	-

	PWM Backlight	-
	DC Continuous Mode	-
	Dual Display	-
	Run Time Power Management	-
HDMI	EDID Support	-
	Hot-Plug Detection Mechanism	-
	HDMI 1.4	480p, 720p, 1080p, RGB 444 4K @ 30 Hz
	Driver Suspend/Resume for Low Power	-
	HDMI as Primary Display	-
	Dual Display	-
	HDMI: 1.4b compliance	Pending certification
	HDMI: 2.0 compliance	Pending certification
	Audio Support	-
Ethernet	10/100/1000 BASE	-
	MAC Filtering	-
PWM	Speed Control from sysfs	-
	Control from Temperature Variation	-
I2C	Master Mode	-
Wifi	Wake on Wifi	BCM4354
	Dual-band 2.4 GHz/5 GHz	BCM4354
	STA mode	BCM4354
	AP mode	BCM4354
	IBSS mode	BCM4354
	WPA2 security	BCM4354
Bluetooth	Bluetooth 4.0	BCM4354
Camera support (CSI input support)	V4L2 Media-Controller (V4L2 API bypasses ISP)	CSI0, CSI1, CSI2, CSI3, CSI4, CSI5 Note: The media-controller driver model is adopted in the 24.1 release. the Soc_camera driver is provided, but deprecated.
Peripheral devices	INA support	Current monitoring for: CPU/GPU/ VDD_IN
Platform support	Baseboard: P2597 Jetson module: P2180	
SPI	Max Bus Speed	SPI4: 65 MHz
		SPI1: 65 MHz
		SPI2: 65 MHz
	Chip Select	SPI4: 0

		SPI1: 0/1
		SPI2: 0/1
	Packed/Unpacked	SPI4, SPI1, SPI2
	Full Duplex Mode	SPI4, SPI1, SPI2
	Both Enable Bit	SPI4, SPI1, SPI2
	Both Enable Byte	SPI4, SPI1, SPI2
	Bi-directional	SPI4, SPI1, SPI2
	Least Significant Bit	SPI4, SPI1, SPI2
	Least Significant Byte First	SPI4, SPI1, SPI2
	Software or Hardware Chip Select Polarity Section	SPI4, SPI1, SPI2
	Supported Modes 1/2/3/4	SPI4, SPI1, SPI2
	Purpose/Client	SPI4: Touch
		SPI1: Audio
		SPI2: Cam/Display
SDMMC	I/O Speeds (Clock speed)	SDMMC1: 204 MHz
		SDMMC4: 200 MHz
		SDMMC (M.2/SDIO): 204 MHz
	Hot Plug Support	SDMMC1
	SD High Speed Mode	SDMMC1, SDMMC (M.2/SDIO)
	SDR50	SDMMC1, SDMMC4, SDMMC (M.2/SDIO)
	SDR104	SDMMC1, SDMMC (M.2/SDIO)
	HS533	SDMMC4
	HS400	SDMMC4
	HS200	SDMMC4
	DDR Mode	SDMMC1, SDMMC4, SDMMC (M.2/SDIO)
	Voltage Switching	SDMMC1, SDMMC (M.2/SDIO)
	Frequency Tuning	SDMMC1, SDMMC4, SDMMC (M.2/SDIO)
	Packed Commands	SDMMC4, SDMMC (M.2/SDIO)
	Cache Control	SDMMC4
	Discard	SDMMC4
	Sanitize	SDMMC4
	RPMB	SDMMC4
	HPI	SDMMC4
	BKOPS	SDMMC4
	Power Off Notification	SDMMC4
	Sleep	SDMMC4
	Field Firmware Upgrade	SDMMC4
	CMD Queuing	-

	Device Life Estimation Type A	SDMMC4
	Device Life Estimation Type B	SDMMC4
	PRE EOL Information	SDMMC4
	Power Management	SDMMC1, SDMMC4, SDMMC (M.2/SDIO)
SATA	Speed	GEN1
		GEN2
	AHCI Mode	1.3.1
	SATA Specification	3.1
	HIPM	-
	DIPM	-
	NCQ	-
	Port Multiplier Support	CBS
	Link Power Management States	Partial
		Slumber
	Device Power Management States	D0
		D1
		D2
	Runtime Time Power Management	-
	S.M.A.R.T	-
	ATA Error Logging	-
I2C	Master	I2C GEN1, I2C GEN2, I2C GEN3, I2C DDC, I2C PWR, I2C6
		Standard mode (SM – 100Kbps) Fast mode (FM – 400Kbps) Fast mode plus (FM+ - 1Mbps) High speed mode. (HS - 3.4Mbps)
		7-bit or 10-bit slave addressing
		Lost arbitration detect
		Only Packet mode
		Dynamic clock gating
		Multi-master support
		PIO mode: For I2C message length <= 20 bytes DMA mode: For I2C message length > 20 bytes
		Clock always ON feature for device which need faster responses
		Message split if message size is greater than 4K bytes

		Runtime I2C bus clock frequency changes through sysfs
		Bit banging through GPIOs
		Clubbing 2 transactions and program their packets together.
		Bus clear support
USB 2.0	Device Mode	USB0
	OTG Mode	USB0
	Host Mode	USB0, USB1
	Host - Low Speed Devices	USB0
	Host - Full Speed Devices	USB0
	Host - High Speed Devices	USB0, USB1
	Host - Auto Suspend Support	USB0
USB 3.0	Speeds	USB0: HS/480 Mbps
		USB1: SS/5 Gbps
	Lanes	USB1: pex5
	USB 3.0 Support	USB1
	Connector	USB0: Micro AB
		USB1: TYPE A
	USB 2.0 Support	USB0, USB1
	Remote Wakeup Support	USB0: USB 2.0
		USB1: USB 2.0/3.0
	Host - Auto Suspend Support	USB0, USB1
	OTG Support	USB0
	Class Support	Mass storage (USB0, USB1)
		USB video class (USB0, USB1)
		HID (USB0, USB1)
		USB audio class (USB0, USB1)
		MTP (USB0, USB1)
		CDC - NCM/ECM (USB0, USB1)
GPIO	Pinmux Configuration	-
	GPIO Configuration And Programming	-
	GPIO Interrupt Support	-
UART	Speed	UART0: 115200
		UART2: 921600
		UART3: 3000000
	Hardware Flow Control	UART2, UART3
	PIO Mode	UART0, UART2, UART3

	DMA Mode	UART0, UART2, UART3
	FIFO Mode	UART0, UART2, UART3
PCIe	Speed	PCIe 0: Gen1/Gen2
		PCIe 1: Gen1/Gen2
	Lane Width	PCIe 0: x1, x2, x4
		PCIe 1: x1
	Host Controller Features	Lanes Xbar config (X4_X1, X2_X1)
		Extended Config Space
		Hardware Clock Gating
		Deep Power Down (DPD)
	PCIe Features	Message Signaled Interrupts
		Vendor Specific Messages
		MSI-X
	PCIe Device Capabilities	Max Payload size 128 bytes
		Extended Tag Field Support
		Role-Based Error Reporting
		Maximum Link Speed; Supports Up to Gen2 Speeds
		Maximum Link Width; Supports Up to X4 Link Width
		ASPM Support (L0s and L1)
		L1 Clock Power Management
		Data Link Layer Link Active Reporting Capable
		Link Bandwidth Notification Capability
	Link Control	Read Completion Boundary
	Root Control	System Error on Correctable Error
		System Error on Non-Fatal Error
		System Error on Fatal Error
		PME Interrupt Enable
	Extended Capabilities	Advanced Error Reporting (AER)
		Latency Tolerance Reporting (LTR)
	L1 PM Substates	L1.1
		L1.2
	Misc Features	Dynamic Voltage Frequency (DVPS)
		Tegra Low Power Mode (LP0)
		Runtime PM

Note: PCIe: Jetson TX1 does not have any path from AHB-DMA or APB-DMA engines to PCIe IP as PCIe is connected directly to MSELECT and AHB-DMA and APB DMA engines only interact with IPs connected to respective AHB

	and APB buses. So it is not possible to use either AHB or APB engines for PCIe.

CUDA

Feature	Version
CUDA	Version 9.0.252

Graphics

Graphics APIs	Notes
OpenGL	4.5
OpenGL-ES	3.2
Vulkan	1.0.2 *
EGL	1.5
GLX	
GLVnd Version of EGL	Vendor neutral functionality
NVDC - Direct Rendering Manager (DRM)	Compatibility with DRM 2.0
EGL Stream	
X11 ABI-20	Legacy from release 24.2 using Ubuntu 16.04
API Support	**Notes**
GL + EGL	
EGL without X11	Content display without X11 usage

* Vulkan loader version release 1.0.66 is verified to be working properly on this release. See https://developer.nvidia.com/embedded/vulkan for details.

EGL and OpenGL ES Support

EGL is an interface between Khronos rendering APIs, such as OpenGL ES, and the underlying native platform window system. It handles graphics context management, surface/buffer binding, and rendering synchronization. EGL enables high-performance, accelerated, mixed-mode 2D and 3D rendering using other Khronos APIs.

L4T supports the EGL 1.5 specification, Khronos Native Platform Graphics Interface (EGL 1.5 Specification).

The OpenGL ES driver in this release supports the following OpenGL ES specifications:

- OpenGL ES Common Profile Specification 2.0

- OpenGL 4.5

For more information on OpenGL ES, see the Khronos OpenGL ES API Registry.

Video Decoders

Video Decode	Output Formats	Sampling Frequency and Bit rate/Frame rate	Notes
H.264	NV12, NVMM:NV12	3840 x 2160 at 60 fps Up to 120 Mbps	Full-frame, Disable-DPB, Skip-Frames, enable-error-check, enable-frame-type-reporting.
H.265	NV12, NVMM:NV12	3840 x 2160 at 60 fps Up to 160 Mbps	Decode Support in Gstreamer 1.4.5 and later. Full-frame, Disable-DPB, Skip-Frames, enable-error-check, enable-frame-type-reporting.
JPEG	I420, NVMM:I420	600 MP/sec	—
VP8	NV12, NVMM:NV12	3840 x 2160 at 60 fps Up to 140 Mbps	Full-frame, Disable-DPB, Skip-Frames, enable-error-check, enable-frame-type-reporting.
VP9	NV12, NVMM:NV12	3840 x 2160 at 60 fps Up to 120 Mbps	Full-frame, Disable-DPB, Skip-Frames, enable-error-check, enable-frame-type-reporting.

Video Encoders

Video Encode	Input Formats	Sampling Frequency and Bit rate/Frame rate	Notes
H.264	I420, NV12, NVMM:1420, NVMM:NV12	3840 x 2160 at 30 fps Up to 120 Mbps	Supported features include: • Control-rate • Bitrate • Peak-bitrate • Iframeinterval • SliceIntrarefreshEnable • Sliceintrarefreshinterval • Bit-Packetization • VBV-Size • Temporal-tradeoff • EnableMVBufferMeta • qp-range • MeasureEncoderLatency • EnableTwopassCBR • Preset-level • EnableStrimgentBitrate • Insert-SPS-PPS • Num-B-Frames • Slice-Header-Spacing

Video Encode	Input Formats	Sampling Frequency and Bit rate/Frame rate	Notes
			• Profile • insert-aud • insert-vui • Force-IDR
JPEG	I420, NVMM:I420	600 MP/sec	-
H.265	I420, NVMM:I420, NVMM:NV12	3840 x 2160 at 30 fps Up to 100 Mbps	Supported features include: • control-rate • Bitrate • Peak-bitrate • Iframeinterval • SliceIntrarefreshEnable • Sliceintrarefreshinterval • Bit-Packetization • VBV-Size • Temporal-tradeoff • EnableMVBufferMeta • qp-range • MeasureEncoderLatency • EnableTwopassCBR • Preset-level • EnableStrimgentBitrate • Insert-SPS-PPS • Num-B-Frames • Slice-Header-Spacing • Profile • insert-aud • insert-vui • Force-IDR
VP8	I420, NV12, NVMM:I420, NVMM:NV12	3840 x 2160 at 30 fps Up to 120 Mbps	Supported features include: • control-rate • Bitrate • Peak-bitrate • Iframeinterval • SliceIntrarefreshEnable • Sliceintrarefreshinterval • Bit-Packetization • VBV-Size • Temporal-tradeoff • EnableMVBufferMeta • qp-range • MeasureEncoderLatency • EnableTwopassCBR • Preset-level

Video Encode	Input Formats	Sampling Frequency and Bit rate/Frame rate	Notes
			• EnableStrimgentBitrate • Insert-SPS-PPS • Num-B-Frames • Slice-Header-Spacing • Profile • insert-aud • insert-vui • Force-IDR
Applies to TX2: VP9	I420, NV12, NVMM:I420, NVMM:NV12	3840 x 2160 at 30 fps Up to 120 Mbps	Supported features include: • control-rate • Bitrate • Peak-bitrate • Iframeinterval • SliceIntrarefreshEnable • Sliceintrarefreshinterval • Bit-Packetization • VBV-Size • Temporal-tradeoff • EnableMVBufferMeta • qp-range • MeasureEncoderLatency • EnableTwopassCBR • Preset-level • EnableStrimgentBitrate • Insert-SPS-PPS • Num-B-Frames • Slice-Header-Spacing • Profile • insert-aud • insert-vui • Force-IDR

> **Note:** Use the `gst-inspect-1.0` utility to display feature details. For example, the `gst-inspect-1.0 omxh264enc` command displays feature details of the H.264 encoder.

Display Outputs

nveglglessink	nvoverlaysink
X11 Window	Panel Overlay
-	Overlay
-	Overlay-Depth
-	Overlay-X

NVIDIA Jetson Linux Driver Package Software Features

	Overlay-Y
-	Overlay-Y
-	Overlay-W
-	Overlay-H

Conversion, Scaling, and Rotation Formats

Input Formats	Output Formats	Notes
I420	I420	Flip-Method, interpolation-method, crop, Format conversion
UYVY	UYVY	Flip-Method, interpolation-method, crop, Format conversion
YUY2	YUY2	Flip-Method, interpolation-method, crop, Format conversion
YVYU	YVYU	Flip-Method, interpolation-method, crop, Format conversion
NV12	NV12	Flip-Method, interpolation-method, crop, Format conversion
GRAY8	GRAY8	Flip-Method, interpolation-method, crop, Format conversion
BGRx	BGRx	Flip-Method, interpolation-method, crop, Format conversion
RGBA	RGBA	Flip-Method, interpolation-method, crop, Format conversion
NVMM:I420	NVMM:I420	Flip-Method, interpolation-method, crop, Format conversion
NVMM:I420_10LE	NVMM:I420_10LE	Flip-Method, interpolation-method, crop, Format conversion
NVMM:NV12	NVMM:NV12	Flip-Method, interpolation-method, crop, Format conversion

CSI and USB Camera Formats

Feature	Notes
Basic Camera Functionality	Default reference sensor: OV5693. Use can be demonstrated with Argus Camera app. For more information about Argus, see Applications Using libargus Low-Level APIs in the topic Camera Development.
PWL WDR	Support for HDR using PWL WDR technology. Validated with Sony IMX185.
TNR Support	Option to switch between two types of noise reduction: • VIC-based temporal noise reduction: compromises on image quality due to low power consumption). To select this option, enable `tnr.v1` in `camera_overrides.isp`. • GPU-based temporal noise reduction: improves image quality at the cost of high power consumption. Especially effective

	in low light scenes. To select this option, enable `tnr.v2` in `camera_overrides.isp`.
Six Camera Preview at 30 FPS	Achieves preview performance of 30 frames/second for 1920×1440 resolution with six OV5693 sensors running simultaneously.
USB Camera (UVC)	Supports UVC-compliant USB2.0 and USB3.0 cameras.

Audio

Feature	Notes
HDA for HDMI	Supports PCM playback for stereo, 5.1, and 7.1 channel configurations. Supports sample sizes of 16 bits (S16_LE) and 24 bits (S24_LE), and sample rates of 32, 44.1, 48, 88.2, 96, 176.4, and 192 kHz. Note that 24#bit samples are stored as 32#bit data, with data in the upper 24 bits of each sample. Supports one output stream.
DMIC Support	Supports stereo capture. Supports sample sizes of 16 bits (S16_LE), 24 bits (S32_LE), OSR 64, 128, and 256, and sample rates of 8, 16, 44.1, and 48 kHz. Note that 24#bit samples are stored as 32#bit data, with data in the upper 24 bits of each sample. Supports interfaces DMIC1, DMIC2 and DMIC3.
I2S Support	Supports audio playback, capture, and loopback. Supports sample sizes of 8 bits (S8), 16 bits (S16_LE), 24 bits (S24_LE), and 32 bits (S32_LE), and sample rates of 8, 16, 44.1, 48, 96, and 192 kHz. Supports normal stereo I2S as well as TDM modes (DSP A and DSP B) with up to 16 channels. Each I2S interface can be configured as master or slave. Does not support u#Law or A#Law compression/decompression. Supports interfaces I2S1, I2S2, I2S3, I2S4 and I2S5.
USB Audio	Supports stereo PCM playback and capture. Supports sample sizes of 16 bits (S16_LE) and 24 bits (S24_3LE), sample rates of 8, 16, 44.1, 48, 96, and 192 kHz. Supports up to eight channels on an eight-port USB DAC.
Audio Demultiplexer (ADX)	Supports PCM audio demultiplexing of one input stream with 2 to 16 channels into 1 to 4 output streams with up to 16 channels each. Supports sample sizes of 16 bits (S16_LE) and 32 bits (S32_LE), and sample rates of 8, 16, 44.1, 48, 96, and 192 kHz. Supports four ADX instances: ADX1, ADX2, ADX3, and ADX4.
Audio Multiplexer (AMX)	Supports PCM audio multiplexing of up to four input streams with up to 16 channels each into one output stream with up to 16 channels. Supports sample sizes of 16 bits (S16_LE) and 32 bits

	(S32_LE), and sample rates of 8, 16, 44.1, 48, 96, and 192 kHz. Supports four AMX instances: AMX1, AMX2, AMX3, and AMX4.
Sampling Frequency Converter (SFC)	Supports sampling frequency conversion of PCM audio streams of up to two channels. Supports sample sizes of 16 bits (S16_LE) and 32 bits (S32_LE), and sample rates of 8, 16, 44.1, 48, 96, and 192 kHz. Supports four SFC instances: SFC1, SFC2, SFC3, and SFC4.
Master Volume Control (MVC)	Supports gain or attenuation in range –120dB to +40dB. Supports sample sizes of 16 bits (S16_LE) and 32 bits (S32_LE), and sample rates of 8, 11.05, 16, 22.05, 24, 32, 44.1, 48, 88.2, 96, 176.4, and 192 kHz. Supports up to eight stream channels. Supports two MVC instances: MVC1 and MVC2.
Audio Mixer	Supports mixing up to 10 input streams. Supports five outputs, each of which can have any combination of 10 input streams. Supports sample sizes 16 bits (S16_LE) and 32 bits (S32_LE), and sample rates of 8, 11.025,16, 22.05, 24, 32, 44.1, 48, 88.2, 96, 176.4, and 192 kHz. Supports up to eight stream channels. Supports one AMIXER instance.

Legal Information

NVIDIA Jetson Linux Driver Package Software Features