NVIDIA DriveOS 7.0 Features

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Platform and Device Support

NVIDIA DriveOS 7.0 includes support for:

- Thor U Pre-QS device.
- DRIVE AGX Thor C-sample, D-sample, and GA Devkits.
- Thor-X SKU PS devices.

System Configuration and Performance

Board SKU Capabilities

- An interface in the Guest VM for applications to read hardware board strap GPIO.
- Mechanisms to choose different Guest OS DTS settings based on hardware board strap GPIO readings at boot time.
- Mechanisms to choose different pinmux and BPMP DTB settings based on hardware board strap GPIO readings at boot time.

Clocks/Profiles

- Enables full production clocks for Thor U (TA1890SA) for NSR production and development, including MaxP-A-1080-D-01-S.
- Enables the full production clocks for Thor X (TA1090SA) clocks/profiles for NSR production and development, MaxP-A-1090-D-01-S.
- Supports flashing profiles for Thor X (MaxP-A-1090-D-01-S) and Thor U (MaxP-A-1080-D-01-S) with Linux non-Safety builds.

DriveOS Core Elimination

DriveOS eliminates its need for a dedicated core, allowing all system cores to be fully utilized by Guest OS VMs, which then delegate cycles to DriveOS services as needed. This includes GPU server support and FSI feature enhancements.

GPU Hardware Scheduler in a Single VM

Supports scheduling of high, medium, and low priority tasks in the GPU.

PCIe, EMC, Timestamp synchronization

Mechanism to support measurement of PCIe utilization: DriveOS in Standard and extended Safety debug overlay builds provides a mechanism to measure the bandwidth per PCIe root port. The measured bandwidth depends on data generated by the endpoint driver associated with the root port.

Support for EMC bandwidth measurement.

Provides a mechanism to measure timestamp with sync objects for 2D, VI, DLA, NVENC, OFA, ICP, ISP, IOFST, IEP, iGPU, PVA, CUDLA.

Connectivity and Communication

- **Chip-2-Chip data transfers between two Thor SoCs**: Supports transfers where Thor can be in either RP or EP mode to another Thor in RP or EP mode.
- **I2C multi-primary support between Tegra and sMCU for VMON and TMON**: DriveOS supports I2C multi-primary access by SoC and MCU, including after SoC boot-up for device and board temperature sensors and VRS10/11 devices.
- **Multicast image data to multiple SoCs**: DriveOS provides multicast image streaming across-SoC over PCIe.
- **Ethernet interface concurrent timestamp API - Thor boards**: DriveOS provides an API to read and provide concurrent timestamps across the Thor 10 Gbps MGBE interfaces. These interfaces are connected to external switches for sensors and to an external GTM for PTP time sync.
- **Ethernet Virtualization**: DriveOS provides ethernet virtualization for isolation amongst mixed critical workloads within one Guest OS VM (AV+L) .
- Enabled Ethernet driver with traffic shaping functionality.
- PCIE C2C Reconnection support:
    - Support for C2C stack (KMD and UMD) re-initialization when PCIE link recovery occurs without rebooting local SoC.
    - Support for NvSciStream-based streaming after C2C stack re-initialization without rebooting local SoC.
- Boot sequence support between EPs and RPs among the SoC in C2C PCIE interconnect.
- Adding/removing consumers to NvStream.

Security and Data Integrity

- **Filesystem protection against rollback**: DriveOS verifies the filesystem version against a ratchet value when checking its cryptographic integrity.
- **Support provisioning of tuned GR register values**: DriveOS supports interfaces to enable provisioning of tuned values in production images and on production fused boards.
- Supports and verifies the filesystem version against a ratchet value when checking its cryptographic integrity.
- Principle of least privilege while running DriveOS Linux user space processes:
    - Each DriveOS Linux user space process shall drop root privileges including unneeded POSIX capabilities.
    - DriveOS Linux root processes shall drop their privileges at their process startup phase.
    - DriveOS user space processes shall only have read and write file access permissions as required by their functionality.
- **Linux Security Hardening**: The following features are supported for production builds:
    - Disable Guest OS Shell Access.
    - Disable SSH Daemon.
    - Disable Telnet Daemon.
    - Disable the Guest OS UART Serial Console.
    - Enable DriveOS Linux ASLR (Address Space Layout Randomization).
    - Enabling DriveOS Linux Kernel module signing.
    - Removal of debug tools and interfaces from DriveOS Linux production images.
    - Linux Guest OS Arm PA (Pointer Authentication) support.
    - Enable stack canaries (kernel and user space) with random canary values.
    - Enable RELRO (RELocation Read-Only) for DriveOS Linux executables.

    - Enable DriveOS Linux user space Arm PA (Pointer Authentication) support.
    - Prevent sensitive information leakage from the DriveOS Linux kernel.
    - Improve DriveOS Linux network security by mitigating known DoS and MiTM attacks.
    - Mitigations against Branch History Buffer Speculation Attacks.
    - Mitigations against Straight Line Speculation Attacks.
    - Enable DriveOS Linux KASLR (Kernel Address Space Layout Randomization) for randomizing core kernel and kernel module virtual addresses.
    - Enable memory randomization of DriveOS Linux user space stand alone executables and shared libraries.
- Support for control flow integrity protection using pointer authentication codes.
- PKCS#11 support for allowing writing FSI tokens from CCPLEX.

Debugging and Error Handling

- Support to provide verbose and user-friendly RCE logs.
- **Supports unified logging framework and associated client support**: This framework includes guestVM, serverVMs, and HyperVisor to capture system-level events, error codes, and verbose logs.
- FSI feature enhancements:
    - Supports disabling specific error codes through a configuration mechanism for individual reporter ID and error code pairs.
    - Ability to obtain and report EC index for HSM error from error collator by default.
- **Error injection utility for HSM reported hardware errors**: DriveOS supports an error injection utility to simulate and inject HSM reported errors to test MCU error handlers.
- **Enhance GPU error debug methods**: DriveOS provides a mechanism to identify the kernel, instruction, or CUDA program line/function name causing an exception when it occurs in a user kernel.

Camera and Vision Processing

- **Ability to re-program/re-trigger Camera Fsync for Camera Modules**: DriveOS can phase-shift the absolute start time of frame synchronization signals at run-time upon user application request.
- **Linear interpolation in case of scaling images using 2D engine**: DriveOS supports linear interpolation for scaling images using the internal 2D Engine.
- Camera authentication support including:
    - Report Camera Message Integrity Violation.
    - Verify Message Authenticity.
    - Preserve Message Ordering.
    - Report Dropped Messages.
    - Assign Unique Party Identifiers.
    - Immutable Party Identifiers.
    - Restrict Sessions to a Communication Set.
    - Unique Session Identifiers.
    - Camera Communication Plane Isolation.
    - Authenticate Camera Sensor.
    - Detecting Message Corruption.
    - Drop Corrupted Messages.
- Flash Firmware Updater (FFU) for DRIVE platform storage devices:
    - Supports update of firmware for eMMC/UFS storage devices from the target GOS.
    - Applies cryptographic integrity checks, anti-rollback, and replacement protections of eMMC/UFS firmware used for updates.
- Frozen and delayed frames detection and reporting on Camera capturing and processing by ISP.

- Supports linear interpolation in case of scaling images using the internal 2D engine.
- **Supports ability to re-program/re-trigger Camera Fsync for Camera Modules**: When the user application requests to phase-shift the absolute start time of frame synchronization signals at runtime, DriveOS shifts the phase of running frame synchronization pulse.
- Offers a software interface to select a region of interest (ROI) with maximum resolution.
- Support for anonymization of personally identifiable information within video streams.
- DriveOS SIPL provides a mechanism to customize the I2C address assignment method.
- Support for configurable absolute start time of frame synchronization signals.

Development Tools and Environment

- **GCC 13.2 Host Cross - Compile tools**: The DriveOS host development environment supports GCC 13.2 for cross-compiling kernel components, libraries, binaries, and applications for Linux on the Thor Ubuntu 24.04 target environment, compatible with Canonical Ubuntu 24.04 LTS.
- **C++ 17**: DriveOS supports C++17 for non-Safety related development and uses compatible GCC/G++ toolchains.
- **Open box FSI sample app**: DriveOS packages generators for MCALs and CDDs and a sample ECU extract for Open Box FSI solution.

Linux Safety Extensions

- **Support VMON and TMON in NSR builds**: DriveOS verifies Tegra SoC power sequences and enables VMON to report voltage errors to an external Safety MCU. It also enables internal and external thermal sensors, providing an API on the Guest OS for temperature readings and reporting over-temperature events to the external Safety MCU.
- THOR SoC K(IST) (Beta quality).
- Supports reporting SoC hardware errors to external MCU.
- Supports error injection utility to simulate and inject software detected hardware errors to test customer side of MCU error handlers.
- Supports error injection utility to simulate and inject HSM reported errors to test customer MCU error handlers.

System Management and Power

- Support for suspend to ram (SC7).
- Support for graceful platform shutdown.
- sMCU fan control for automotive boards.

Boot, Platform Support and Capabilities

- Support for MCU and UFS firmware update in flashing tools.
- The safety MCU firmware deliverable supports the management of more than one System-on-Chip (SoC).
- Support for managing 2x Thor in safety MCU firmware deliverable.
- Secure boot supports XMSS (PQC) verification of all boot images, including Guest OS Virtual Machines.
- Multi Tegra support in DRIVE Update.
- Support for asymmetric boot chain flashing via bootburn tool and DRIVE Update, including secure provisioning.
- Support for a customizable, Linux-based recovery VM that supports DRIVE Update.
- Supports ability to update board-specific customer data fields in BR-BCT with DRIVE Update.
- Support for addition/deletion of partitions and resizing of partitions in DRIVE Update.
- DRIVE Update package authentication.
- Allow boot chain C to be disabled.
- Support for configuring I/O interface tuning parameters for CSI and GMSL.
- **Recovery Boot Chain in QSPI**: DriveOS provides a customizable recovery boot-chain (chain-C) resident entirely in QSPI storage to support the ability to boot from QPSI and recover the system when UFS is unavailable or corrupted.

Memory Management

- Support for patrol scrubbing on external DRAM for non-Safety-related builds.
- Support for DRAM ECC page retirement such that pages with uncorrected errors are tracked and taken out of use. Ensures security of bad page information by enabling authenticated and encrypted read/write.
- Supports initiation of a HSM reset upon the detection of an uncorrected DRAM ECC error.

DRAM ECC Error Detection and Correction

- Supports DRAM ECC with alt-link ECC as the default mechanism on automotive T264-based platforms.
- Enables detection and correction of single-bit DRAM errors and detection of double-bit DRAM errors. For Thor devices, alt-link ECC is the default supported ECC mechanism for all profiles, with no DRAM penalty/use for ECC storage.

Debugging and Tools

- Error injection utility for software detected hardware errors.
- Reduced lib size for DriveOS builds to meet load time KPIs during boot.

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