

ACRN

ACRN™: A Big Little Hypervisor for IoT Development

V0.2 Status Update

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What is ACRN

ACRN is a Big Little Hypervisor for IoT Development !

Usage Difference: From Server to IoT



	Server Usage	IoT Usage
Open/Close Platform	Open	Mostly Closed
System Software Distribution	One binary for a variety of product, and/or with add-on hardware	Customized per product
Real Time	No	Yes for many systems
Functional Safety	No	Yes for some usages
Video (including Camera)	No	Yes for many usages
Audio	No	Yes for many usages
Performance	Yes	Yes
Isolation	Yes	Yes
Security	Yes	Yes
Migration	Very Important	Yes for some usages

IoT Virtualization would be largely different with that of Server virtualization

ACRN Focus



Small Footprint



Built for IoT



Adaptability



Built for Real-Time



Safety Criticality

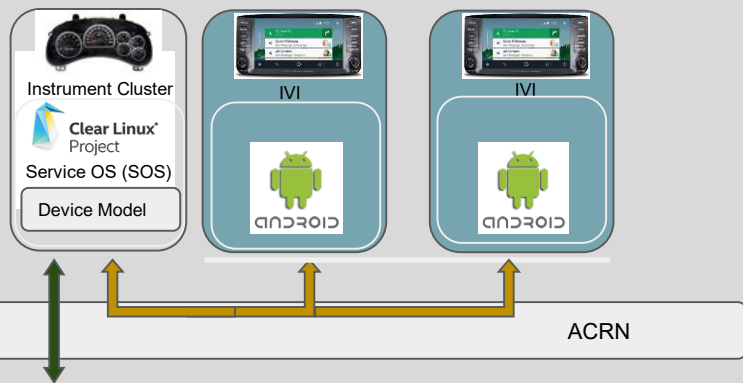


Truly Open Source

Sharing Mode & Partition Mode



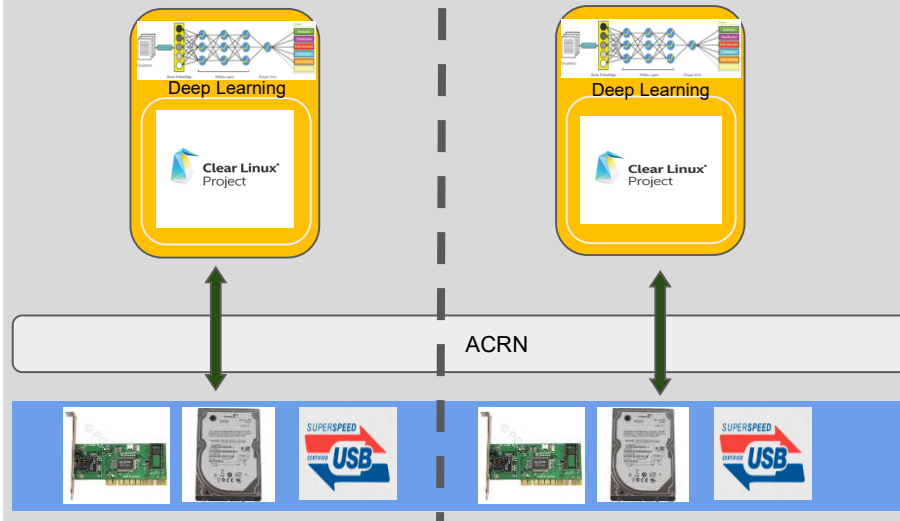
Sharing Mode



Sharing Mode

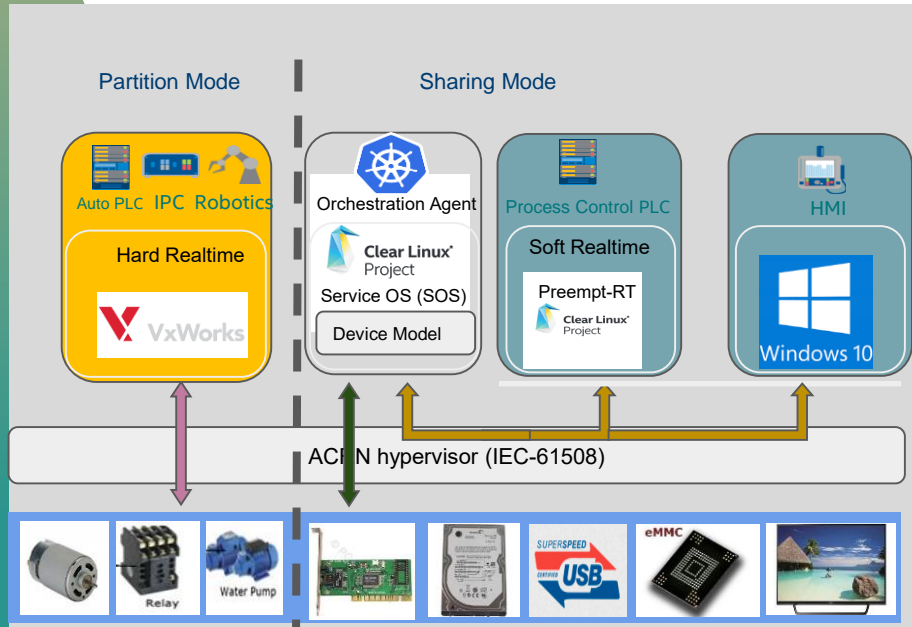
Partition Mode

Partition Mode

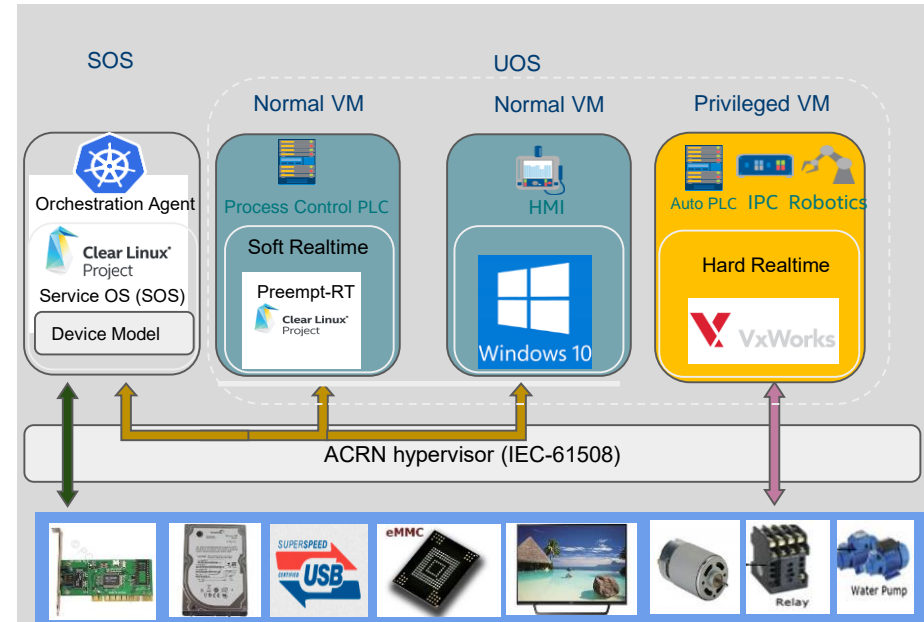


SOS-Less Partition Mode

Hybrid Mode

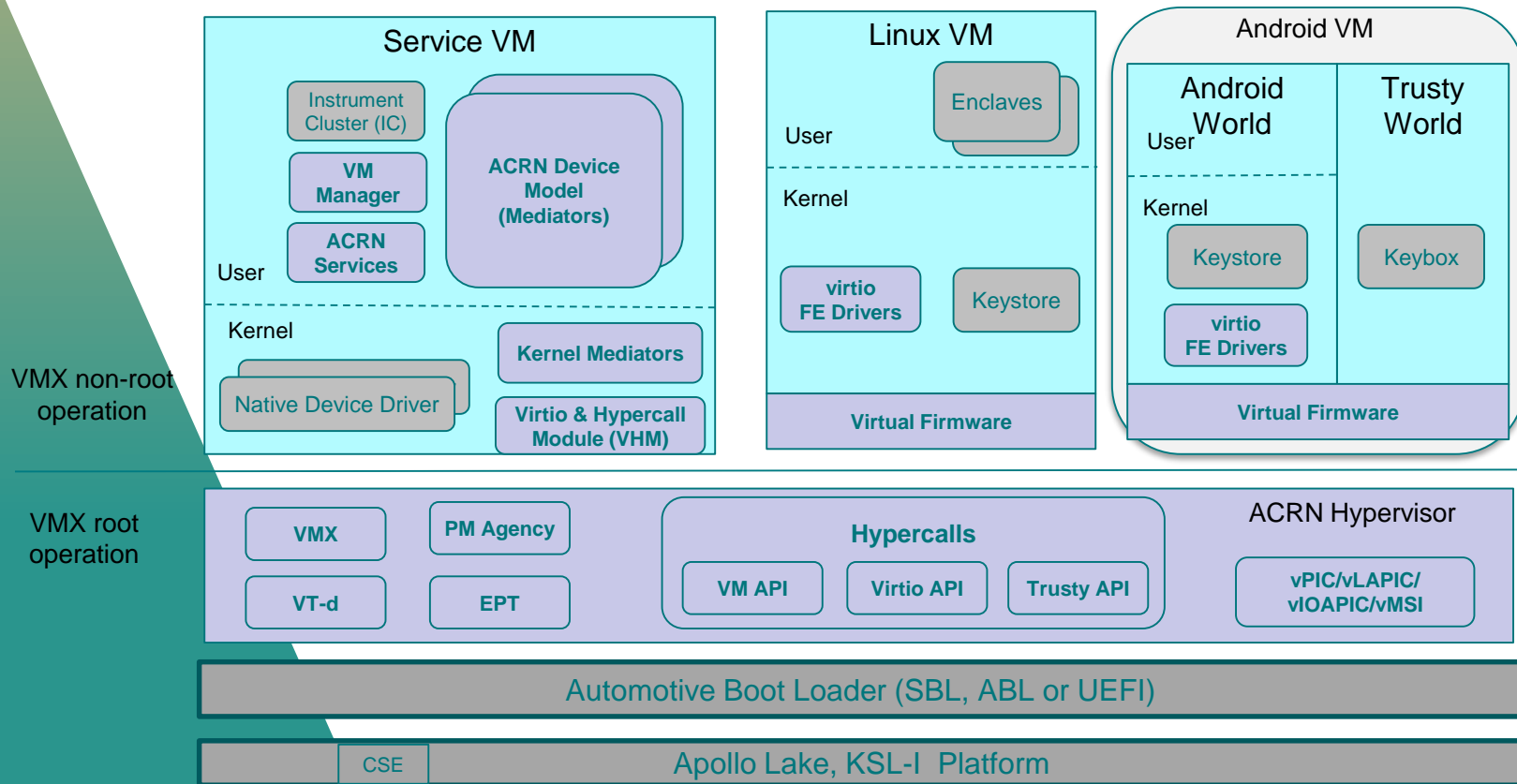


Privileged VM, loaded by Hypervisor
Completely independent of SOS

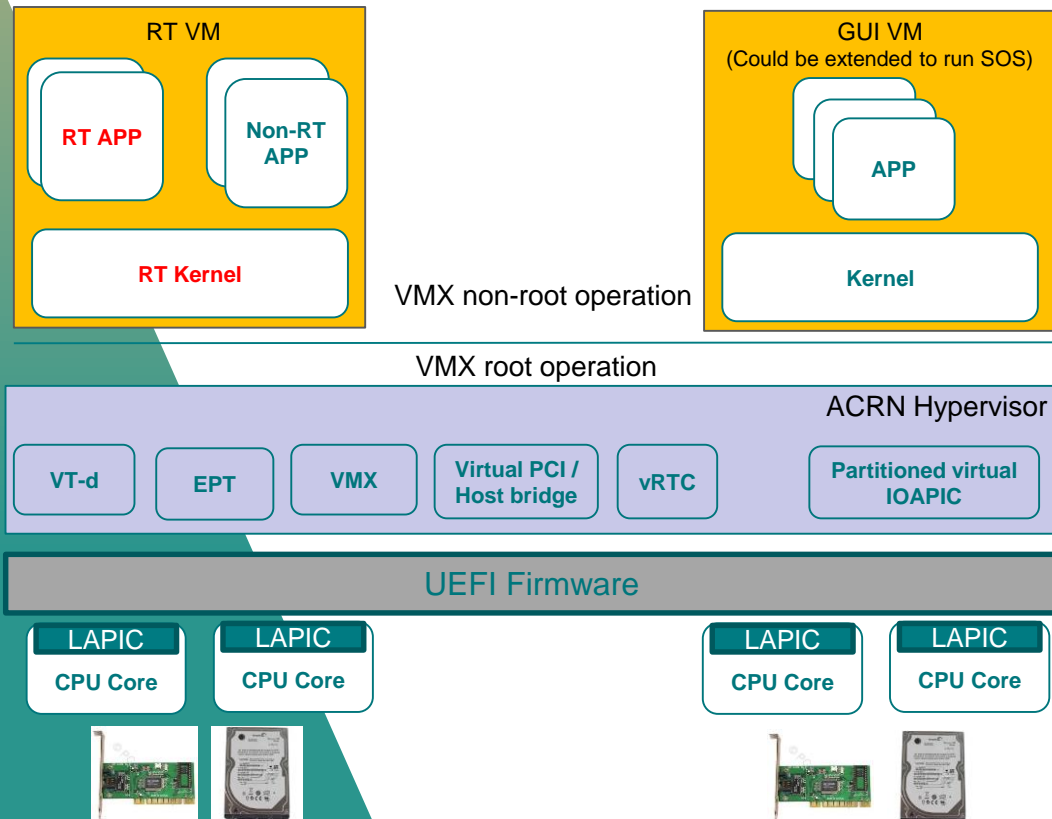


Privileged VM, loaded by SOS
But independent of SOS at Runtime

ACRN Sharing Mode for IVI Usage



ACRN Partition Mode for Industrial Usage



RT VM uses dedicated hardware resources (CPU/Memory/Devices)

- LAPIC Passthru for exit-less MSI interrupt / Timer
- IOAPIC partition with global vectoring
- Cache Partitioning

Minimal in-hypervisor devices

- Virtual RTC
- Virtual PCI controller and host bridge

GUI VM can be extended as SOS to support more VMs

- Hybrid model

Hypervisors Feature Comparison



Features	ACRN	KVM	XEN
Hypervisor	Type 1	Type 2	Type 1
Lines of Code (LOC)	28K	10M+	~299K
Functional Safety Capable	Yes (**)	No	No
MISRA	Yes	No	No
USB	Host + Device	Host only	Host only
Device sharing	Yes	Yes	Yes
Virtio	Yes	Yes	No (Xen specific PV)
Vhost	WIP	Yes	No
VM management	Yes	Yes (libvirt)	Yes (libvirt)
Nested virtualization	No	Yes	Yes
VM migrations	No	Yes	Yes
CPU hotplug	No	Yes	Yes

Edge/ IoT Devices



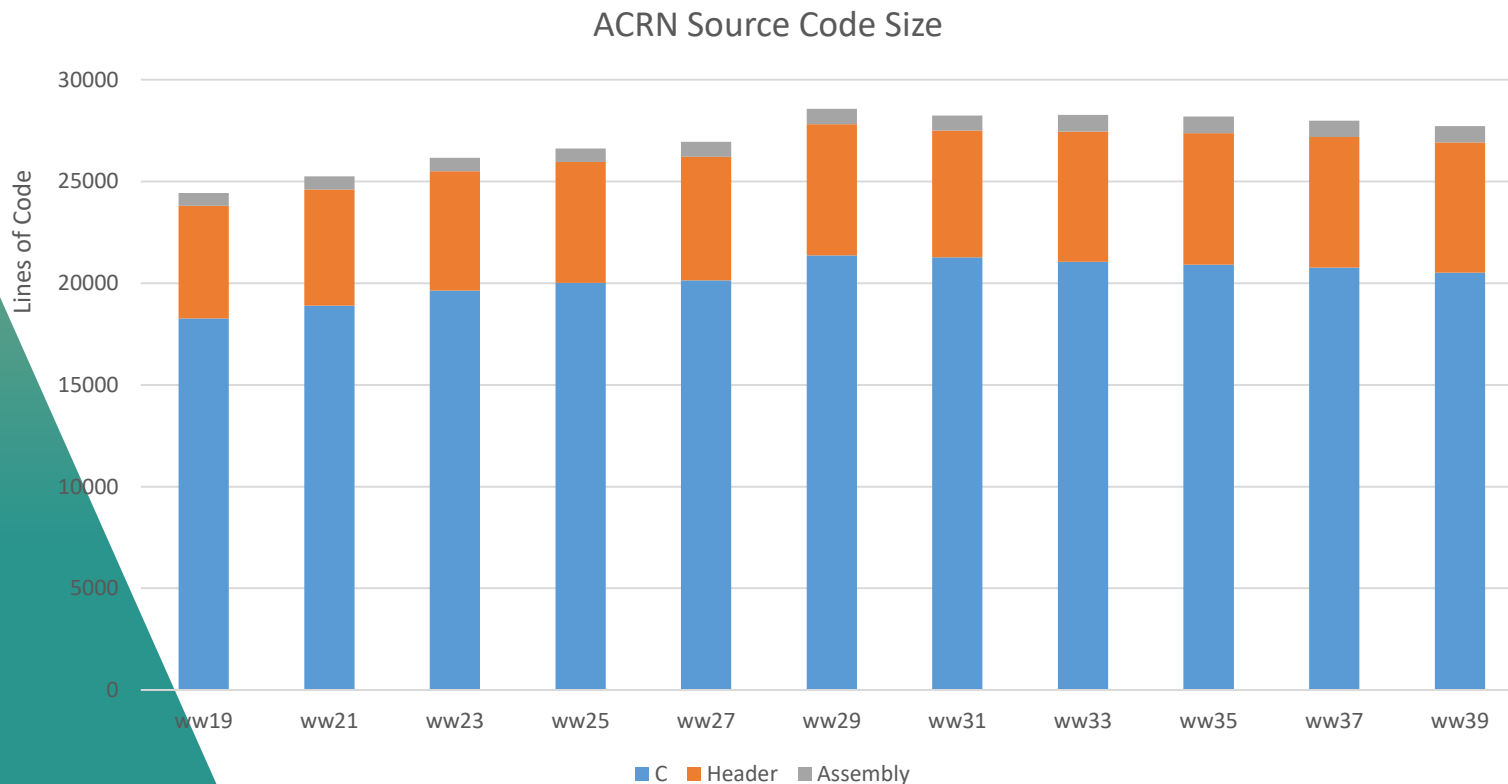
Data Center/Servers

***Lines of source code is collected by running cloc to parse the hypervisor directory

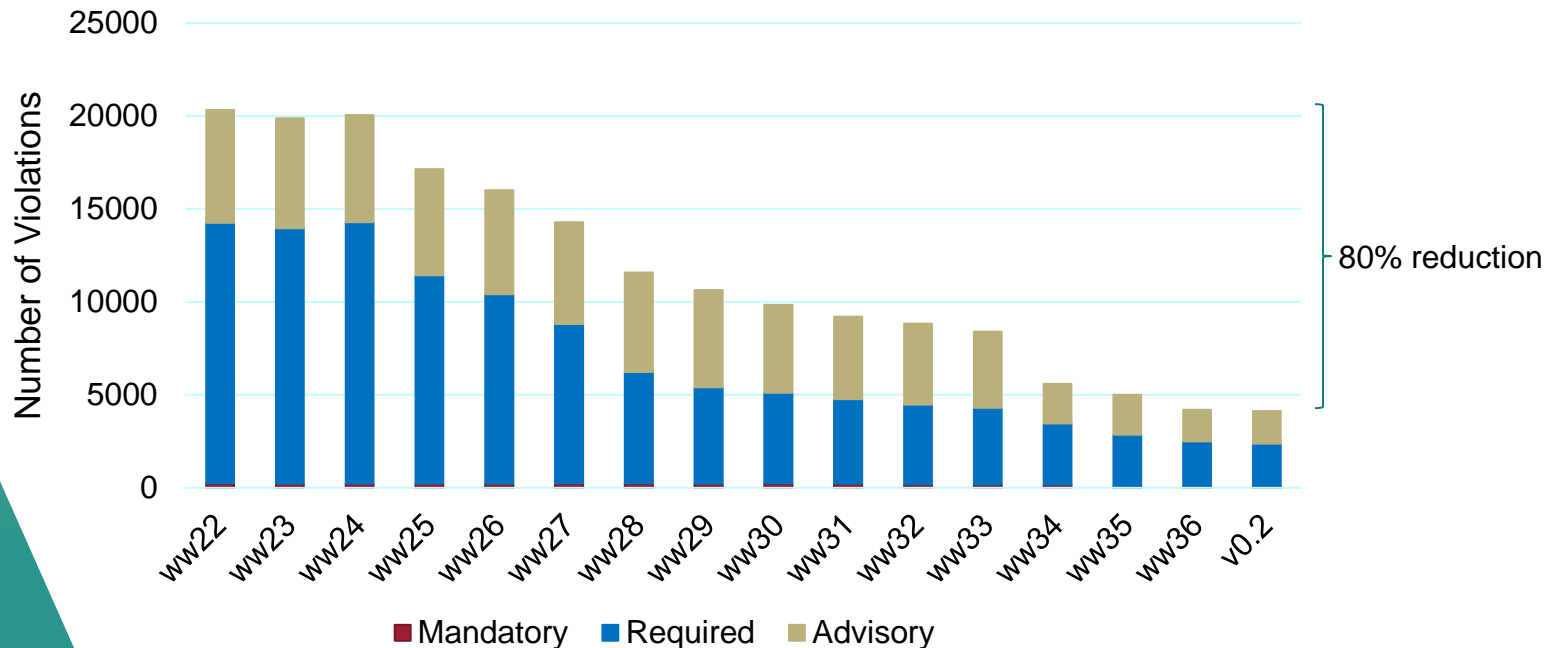
ACRN: As of Sep 25 (open source V0.2 Release)

XEN: As of Oct 10 (commit: 92666fdd6e0afab989b2d89759d9b43f2c645ae7)

ACRN Lines of Code

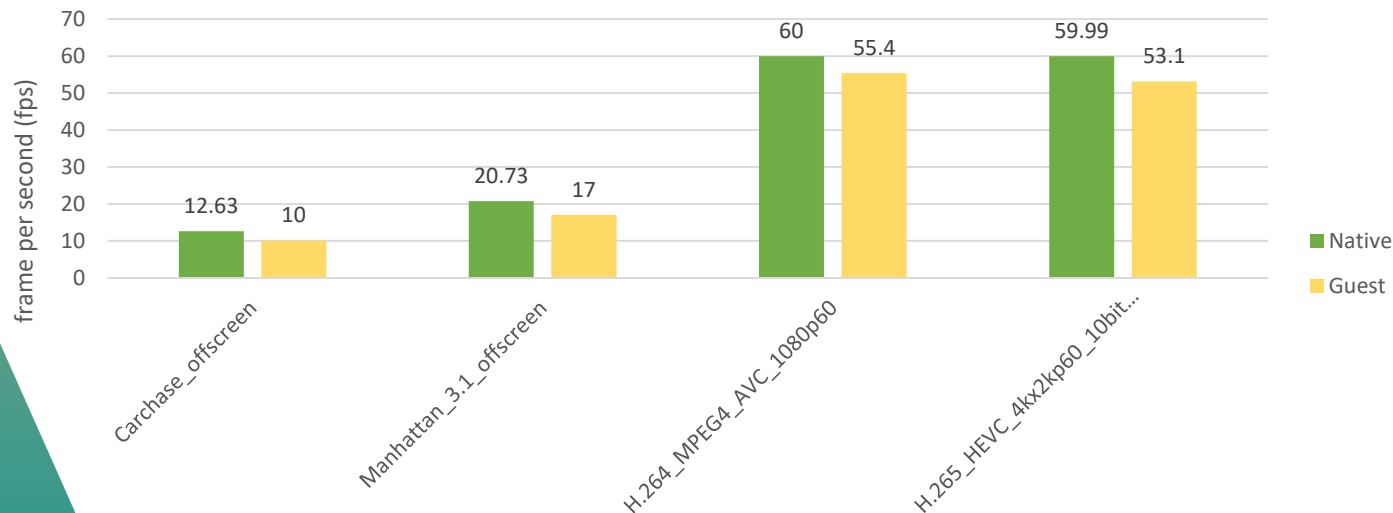


Towards MISRA-C Compliance



- Statistics from commercial safety-qualified checker.
- False positives and intended deviations tracked in weekly-updated sheets.
- Pull requests are scanned hunting for new violations.

Preliminary GPU Performance on Apollo Lake



Performance Test Cases in Android	Native	Guest	Guest VS Native
Carchase_offscreen	12.63	10	79.18%
Manhattan_3.1_offscreen	20.73	17	82.01%
H.264_MPEG4_AVC_1080p60	60	55.4	92.33%
H.265_HEVC_4kx2kp60_10bits_playback	59.99	53.1	88.51%

Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance. Buyers should consult other sources of information to evaluate the performance of systems or components they are considering purchasing. For more information on performance tests and on the performance of Intel products, visit [Intel Performance Benchmark Limitations](#).

Configuration for Real Time Latency



Common

- Dell-7050 (i7-7700), 3.6GHZ, 8MB Cache
- ACRN with hybrid mode
- Service VM uses Clearlinux, running SCP

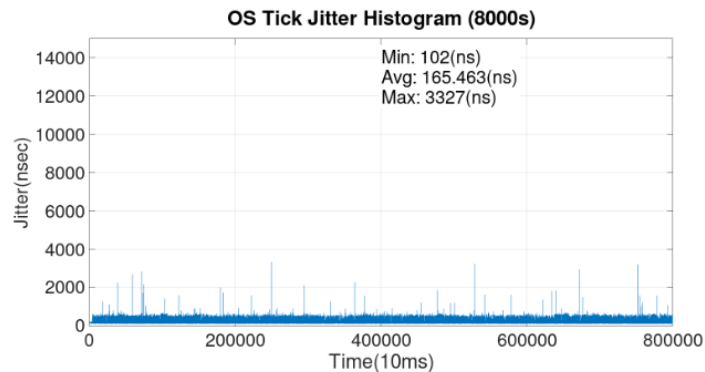
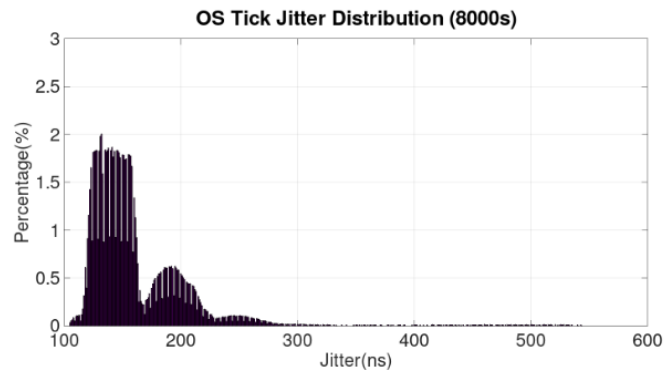
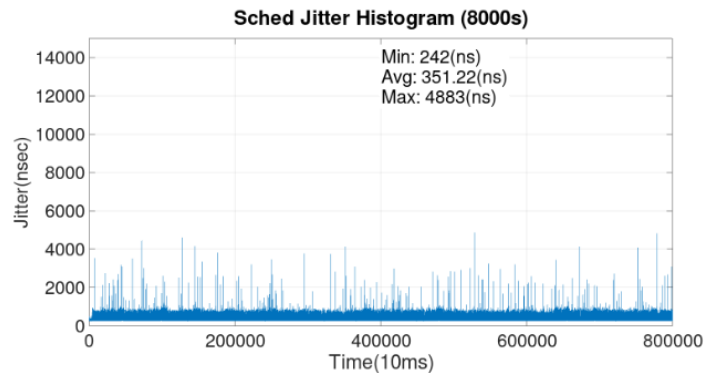
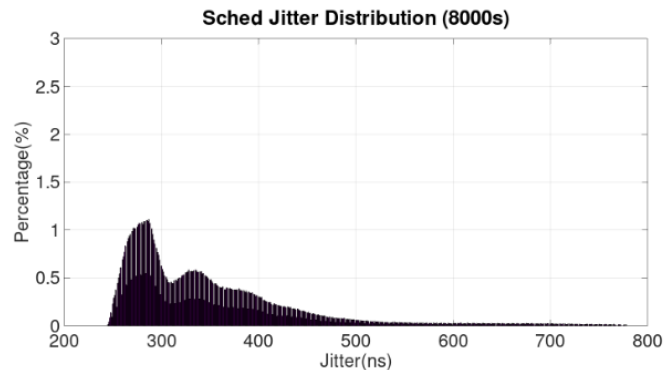
Configuration 1

- RT-VM runs tickles Zephyr with 64KB memory
- Cyclic Test to measure the scheduler jitter & OS Tick latency

Configuration 2

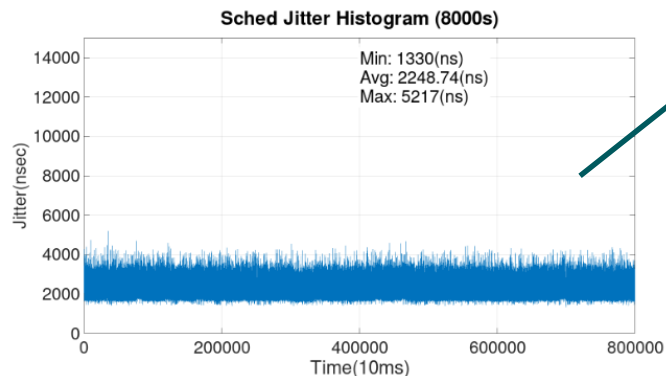
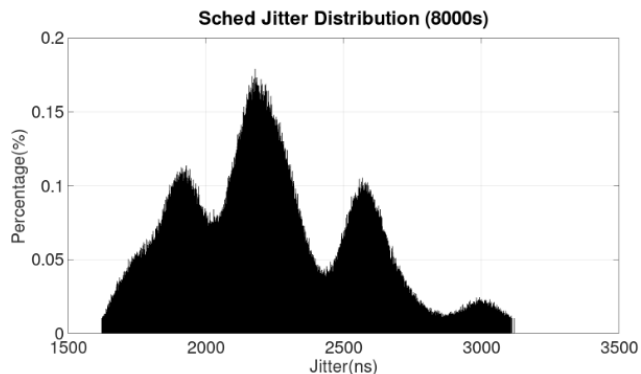
- RT-Linux (4.14) with 1GB memory
- Cyclic Test to measure the scheduler jitter between native and VM

Preliminary Jitter with Zephyr

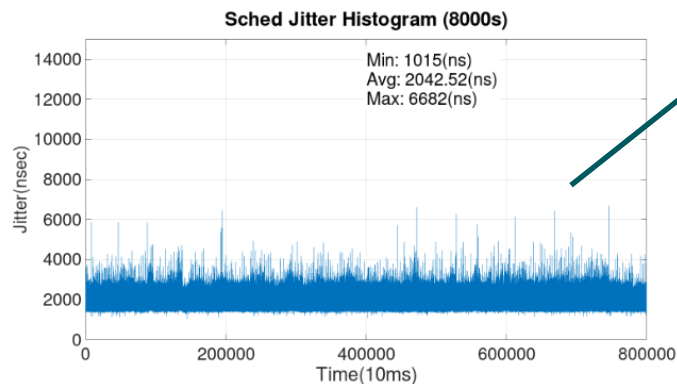
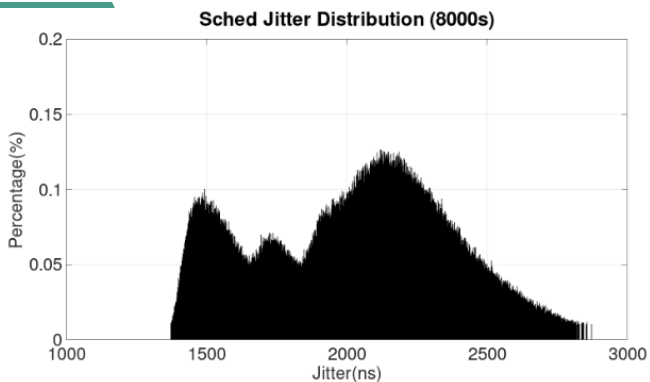


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Preliminary Jitter with RT-Linux



Native Jitter



Jitter as a
VM

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ACRN Roadmap



Dates below are for reference only and subject to change					
Area	v0.1@Q2'18	v0.2@Q3'18	V0.5@Q4'18	V1.0@Q1'19	V1.x@2019
HW	<ul style="list-style-type: none"> • APL NUC (UEFI) • APL UP2 (UEFI) 	<ul style="list-style-type: none"> • APL NUC (UEFI) • APL UP2 (UEFI) 	<ul style="list-style-type: none"> • APL NUC (UEFI) • KBL NUC (UEFI) • APL UP2 (UEFI) 	<ul style="list-style-type: none"> • APL NUC (UEFI) • KBL NUC (UEFI) • APL UP2 (UEFI) 	<ul style="list-style-type: none"> • APL NUC (UEFI) • KBL NUC (UEFI) • APL UP2 (UEFI) • ARM
Hypervisor	<ul style="list-style-type: none"> • VT-x • VT-d • CPU static-partitioning • memory partitioning • Virtio (v0.95) • VHM • EFI boot • Clear Linux as guest 	<ul style="list-style-type: none"> • Virtio (v1.0) • Power Management (Px/Cx) • VM management • ACRN debugging tool • vSBL 	<ul style="list-style-type: none"> • Android as guest • AliOS as guest • Zephyr as guest • MISRA C compliance • Logical partitioning without Service OS • Trusty (Security) • SBL boot 	<ul style="list-style-type: none"> • vHost • Power Management (S3/S5) 	<ul style="list-style-type: none"> • Real Time • Windows as guest • VxWorks as guest • Functional Safety capable • CPU sharing • OVMF • ARM
I/O virtualization	<ul style="list-style-type: none"> • Storage • Ethernet • USB host controller (PT) • USB device controller (PT) • Audio (PT) • WiFi (PT)* • Touch (PT) 	<ul style="list-style-type: none"> • GPU Sharing: • GPU Surface Sharing • IPU Sharing* 	<ul style="list-style-type: none"> • GPU Prioritized Rendering • Touch sharing • IOC sharing* • Audio sharing • USB host controller Sharing • USB DRD virtualization 	<ul style="list-style-type: none"> • GPIO virtualization 	<ul style="list-style-type: none"> • HECI sharing (Security) • CSME/DAL sharing (Security) • TPM Sharing (Security) • eAVB/TSN Sharing • SR-IOV*



Call for Participation

<https://projectacrn.github.io/index.html>

<https://projectacrn.org>

Joining ACRN Community Today!!!