ACRN

ACRN™: A Big Little Hypervisor for IoT Development

V0.4 status update & beyond V0.4

Jack Ren, Intel Open Source Technology Center

Key contributors: Eddie Dong

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What is ACRN

ACRN is a Big Little Hypervisor for IoT Development !

Usage Difference: From Server to IoT

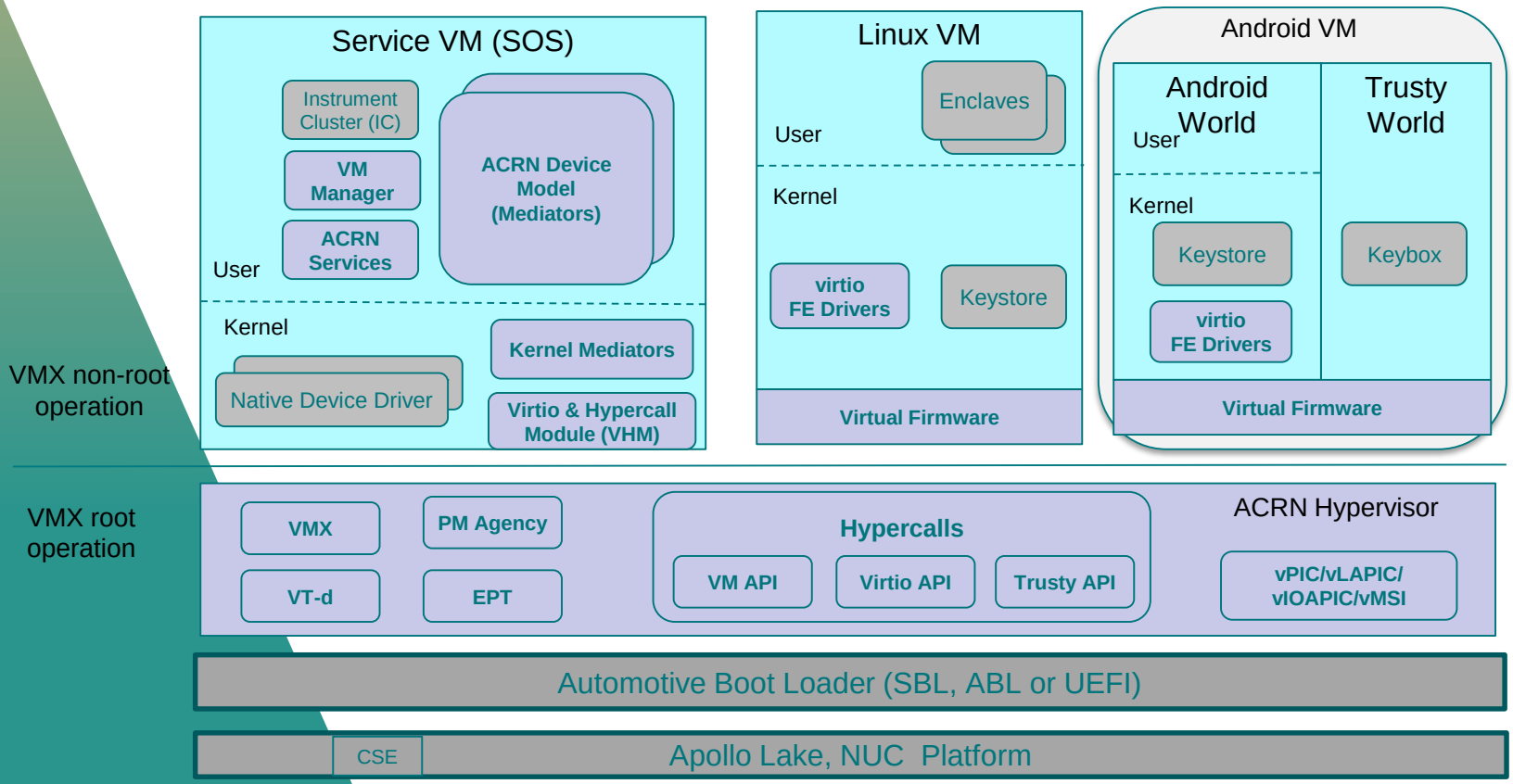
	Server Usage	IoT Usage
Real Time	No	Yes for many systems
Functional Safety	No	Yes for some usages
Open/Close Platform	Open	Mostly Closed
System Software Distribution	One binary for a variety of product, and/or with add-on hardware	Customized per product
Video (including Camera)	Minor	Yes for many usages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

ACRN Sharing Mode for IVI Usage



V0.4 Status Update

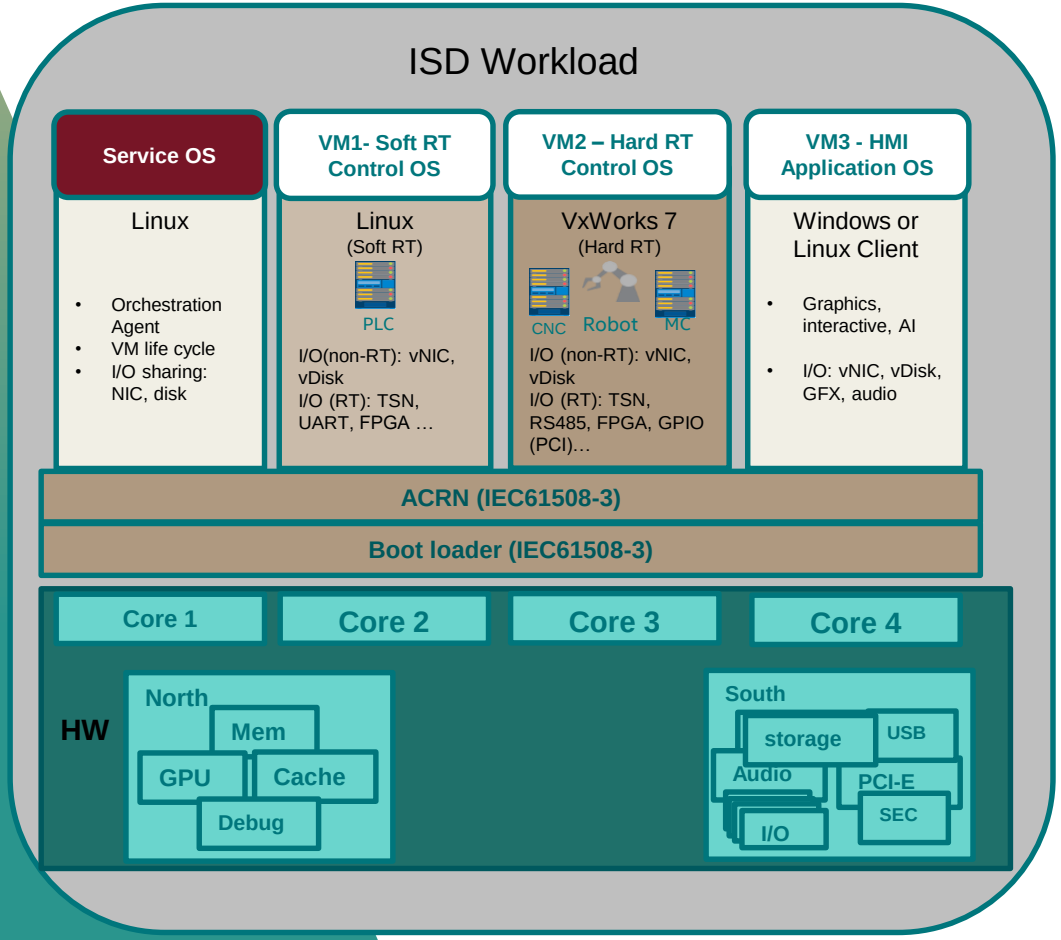
	Dates below are for reference only and subject to change			
Area	**v0.1@Q2'18**	**v0.2@Q3'18**	**V0.4@Q4'18**	**…**
HW	• APL NUC (UEFI) • APL UP2 (UEFI)	• APL NUC (UEFI) • APL UP2 (UEFI)	• APL NUC (UEFI) • KBL NUC (UEFI) • APL UP2 (UEFI)	
Hypervisor	• VT-x • VT-d • CPU static-partitioning • memory partitioning • Virtio (v0.95) • VHM • EFI boot • Clear Linux as guest	• Virtio (v1.0) • Power Management (Px/Cx) • VM management • ACRN debugging tool • vSBL	• AliOS as guest • MISRA C compliance • Logical partitioning without Service OS • Trusty (Security) • Power Management (S3/S5)	
I/O virtualization	• Storage • Ethernet • USB host controller (PT) • USB device controller (PT) • Audio (PT) • WiFi (PT)* • Touch (PT)	• GPU Sharing: • GPU Surface Sharing • IPU Sharing*	• GPU Prioritized Rendering • Touch sharing • IOC sharing* • Audio sharing • USB host controller Sharing • USB DRD virtualization	

Beyond V0.4

Will support Industrial Automation:

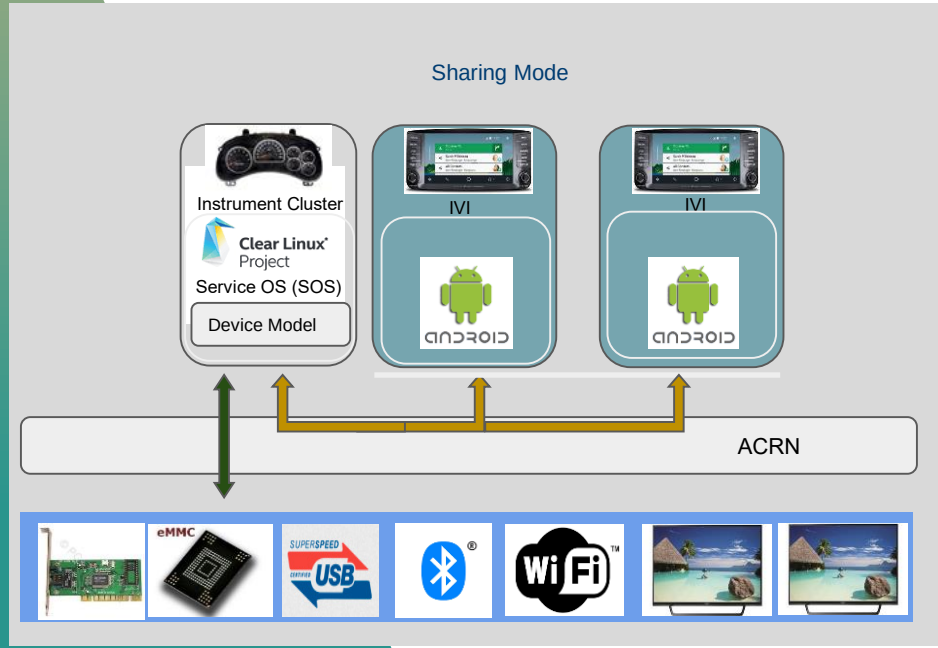
- ❑ Post-launched Hybrid Mode
- ❑ Real-Time VM
- ❑ Zephyr as guest
- ❑ VxWorks as guest
- ❑ VLAN (802.1Q)
- ❑ PMD viritio

Industrial Usage Case: RT + HMI

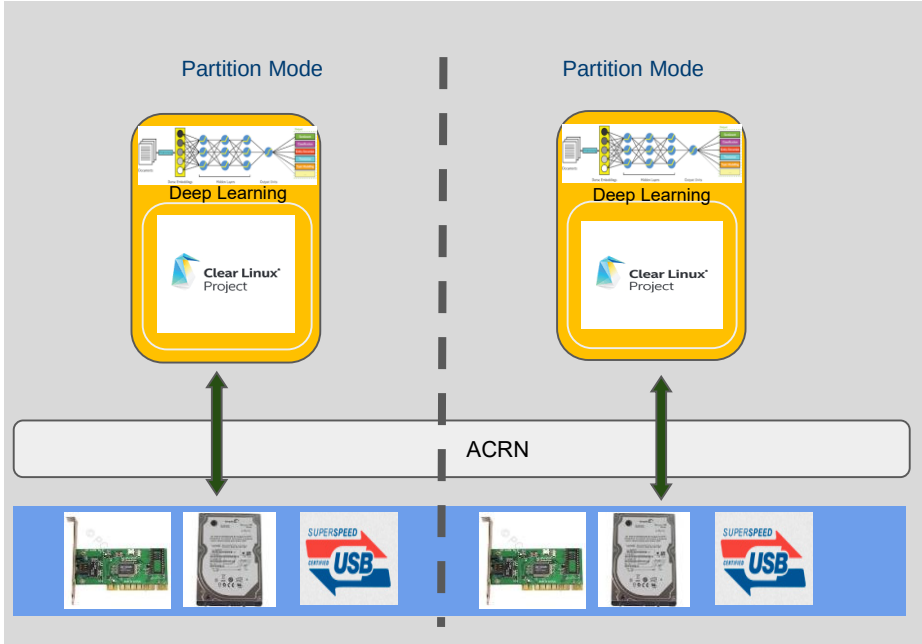


- ❑ Service OS:
  - ▪ OS: Linux/VxWorks
  - ▪ Orchestration
  - ▪ VM life cycle management
  - ▪ I/O mediation
- ❑ Control OS (Hard RT)
  - ▪ OS: VxWorks
  - ▪ I/O sharing: virtual NIC, virtual Disk
  - ▪ I/O PT: TSN, UART, FPGA
  - ▪ RT KPI:
    - ✓ GBE packet IO control loop < 12us
    - ✓ MSI interrupt latency < 4us
    - ✓ Cyclictest jitter: < 30us or < 10us
- ❑ Control OS (Soft RT):
  - ▪ OS: Linux
- ❑ HMI:
  - ▪ OS: Linux/Window10
  - ▪ I/O PT: GFX, Audio
  - ▪ I/O sharing: virtual NIC,virtual Disk
- ❑ Profiling & trace
- ❑ HW:
  - ▪ KBL

Sharing Mode & Partition Mode



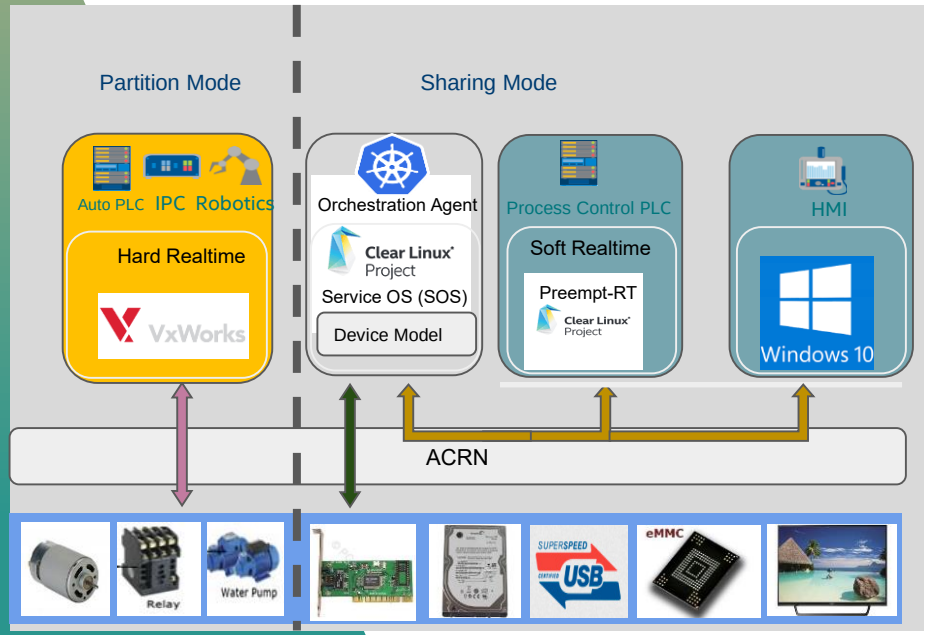
Sharing Mode



SOS-Less Partition Mode

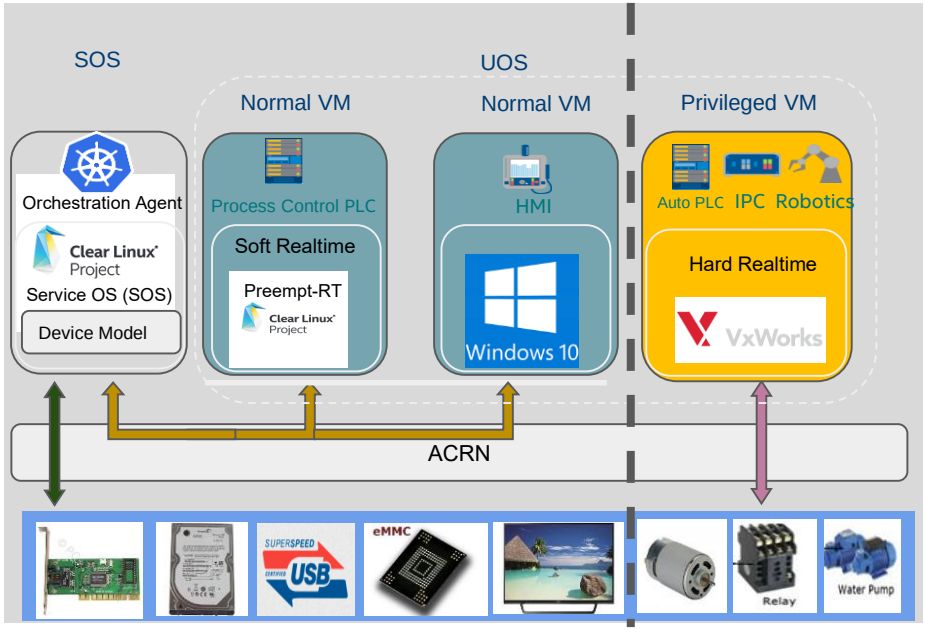
Hybrid Mode

Pre-launched Hybrid mode



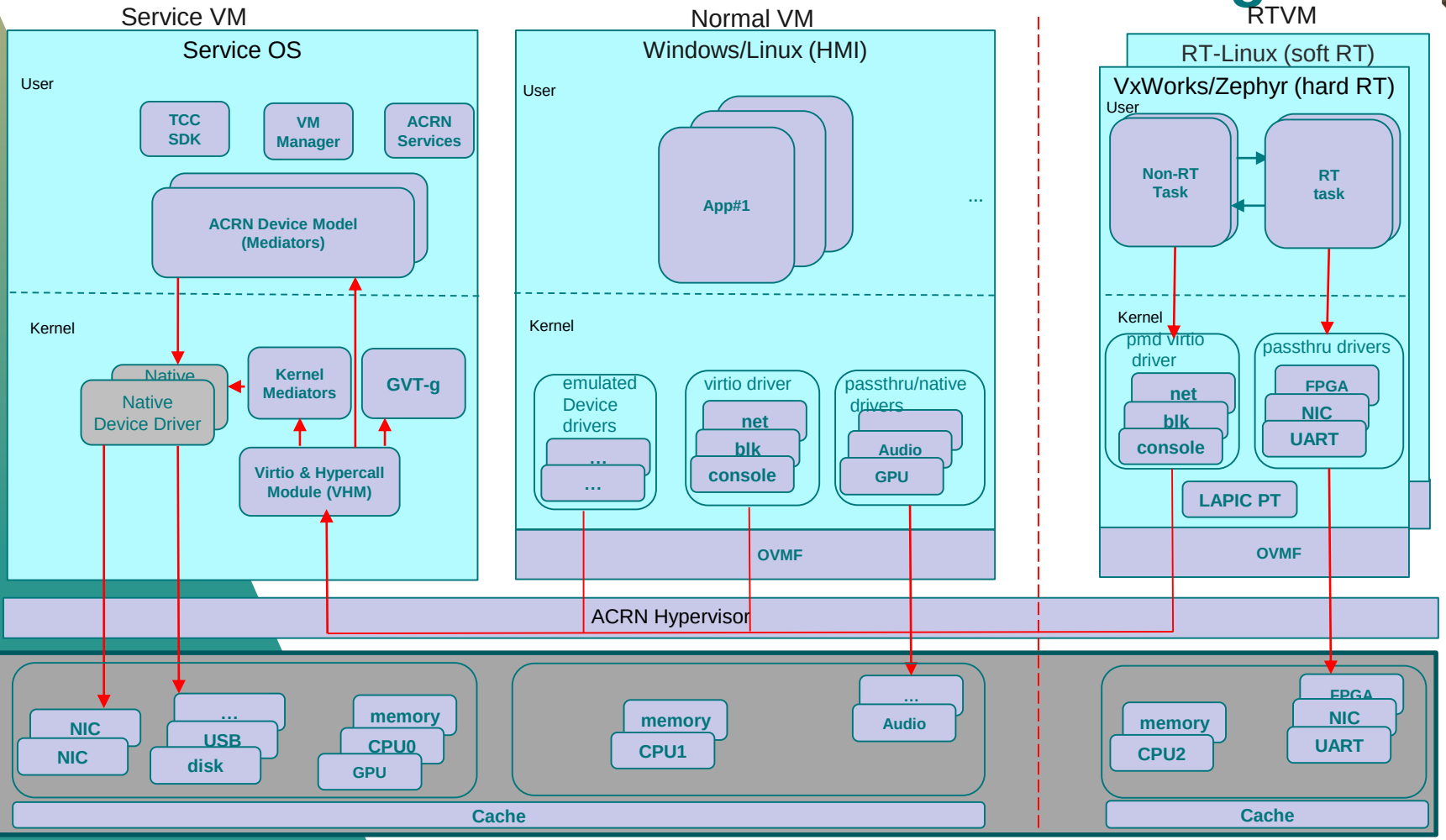
Privileged VM, loaded by Hypervisor
Completely independent of SOS

Post-launched Hybrid mode



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

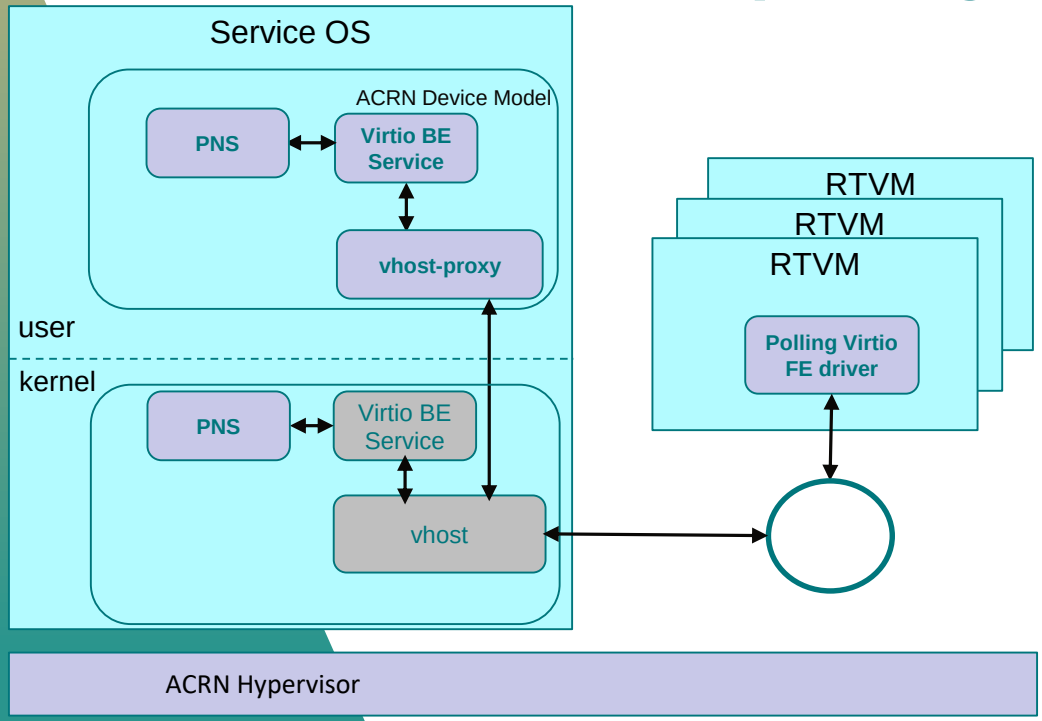
ACRN Architecture for Industrial Usage



Device Mapping Table

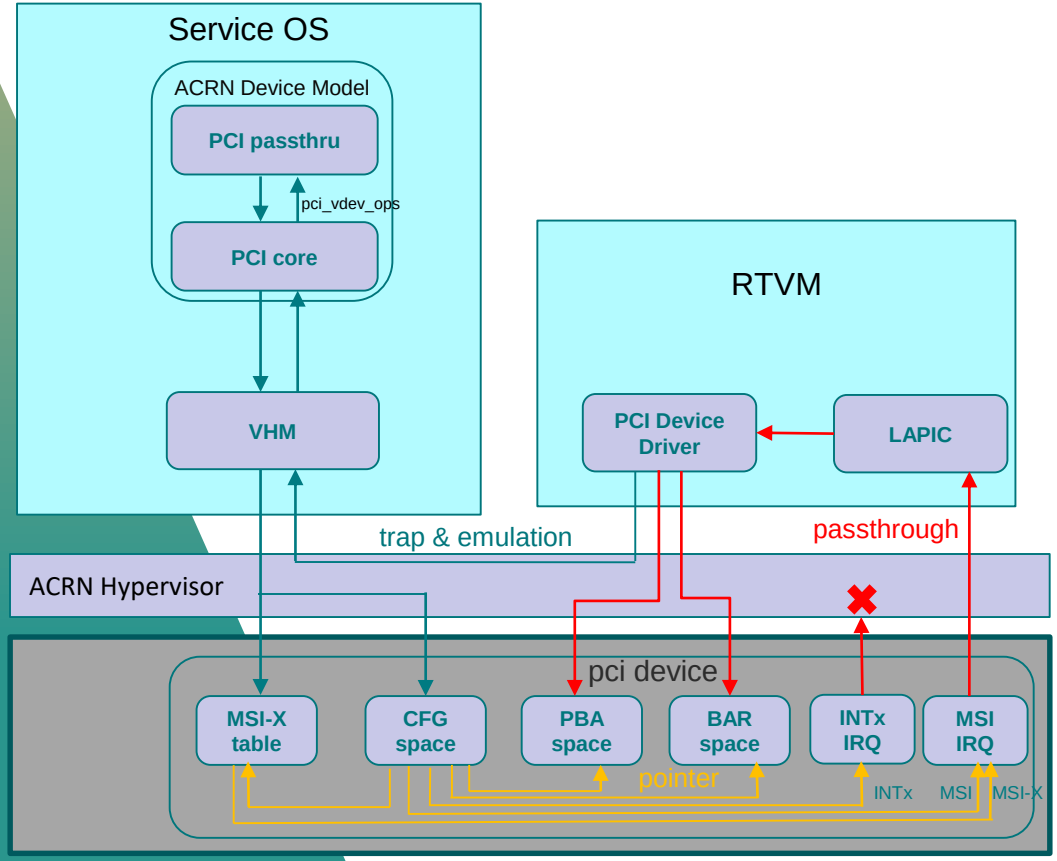
Devices	RTVM (RT Linux)	RTVM (VxWorks)	HMI (Windows/Linux)
RTC	Virtual	Virtual	Virtual
PCI	Virtual	Virtual	Virtual
UART	Passthru (polling mode)	Passthru (polling mode)	Virtual/Passthru
HPET	N/A	N/A	N/A
PIT	N/A	N/A	N/A
GBE Network	Virtual /Passthru	Virtual /Passthru	Virtual
TSN (i210)	Passthru	Passthru	N/A
Storage	Virtual /Passthru	Virtual /Passthru	Virtual
FPGA	Passthru	Passthru	N/A
UART	Passthru	Passthru	Virtual/Passthru
GPU	N/A	N/A	Passthru/Sharing
Audio	N/A	N/A	Passthru
USB	N/A	N/A	Virtual
Watchdog	N/A	N/A	Virtual

RTVM: polling mode Virtio



- Due to LAPIC PT, Virtio FE needs to use polling mode
- Virtio FE: working in polling mode
- Virtio BE: declare its cap as VRING_USED_F_NO_NOTIFY
- PNS (Pseudo Notification Source): periodic timer to notify the virtio BE to process the virtqueue data

Real-Time VM: PCI device passthrough



- ❑ VMexit-less PCI device passthrough
- ❑ PCI device resource:
  - RTVM should not access CFG space and MSI-X stable during runtime
  - INTx IRQ: not supported

ACRN Roadmap today

	Dates below are for reference only and subject to change					
Area	**v0.1@Q2'18**	**v0.2@Q3'18**	**V0.4@Q4'18**	**V0.5@Q1'18**	**V1.0@Q2'19**	**V1.x@2019**
HW	• APL NUC (UEFI) • APL UP2 (UEFI)	• APL NUC (UEFI) • APL UP2 (UEFI)	• APL NUC (UEFI) • KBL NUC (UEFI) • APL UP2 (UEFI)	• APL NUC (UEFI) • KBL NUC (UEFI) • APL UP2 (SBL)	• APL NUC (UEFI) • KBL NUC (UEFI) • APL UP2 (UEFI)	• APL NUC (UEFI) • KBL NUC (UEFI) • APL UP2 (UEFI) • ARM
Hypervisor	• VT-x • VT-d • CPU static-partitioning • memory partitioning • Virtio (v0.95) • VHM • EFI boot • Clear Linux as guest	• Virtio (v1.0) • Power Management (Px/Cx) • VM management • ACRN debugging tool • vSBL	• AliOS as guest • MISRA C compliance • Logical partitioning without Service OS • Trusty (Security) • Power Management (S3/S5)	• Post-launched Hybrid Mode • Real-Time VM • Zephyr as guest • VxWorks as guest • SBL Boot	• vHost • Android as guest • OVMF	• Windows as guest • Functional Safety capable • CPU sharing • ARM
I/O virtualization	• Storage • Ethernet • USB host controller (PT) • USB device controller (PT) • Audio (PT) • WiFi (PT)* • Touch (PT)	• GPU Sharing: • GPU Surface Sharing • IPU Sharing*	• GPU Prioritized Rendering • Touch sharing • IOC sharing* • Audio sharing • USB host controller Sharing • USB DRD virtualization	• VLAN (802.1Q) • PMD viritio	• GPIO virtualization	• 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!!!