## Workload Consolidation with ACRN<sup>TM</sup> Hypervisor

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ACRN Based Reference Stack for Workload Consolidation
ACRN Update: 1.0 Release and 2.0 Roadmap
Introduction of Celadon – Open Source Android Stack for IA

#### **Overview of Workload Consolidation**

Modern OS -> Multiple App/Process

Linux Container -> Multiple Linux based System

Kata Container -> Hardware Backed Security

KVM, XEN -> Different OS

Why ACRN -> Heterogeneous Workload Consolidation Functional Safe World and Non-Safe World Hard Real Time and Rich Graphics

### **Open** Source Fusion Stack from Intel Service OS Safety Critical Guest Operating Systems RTOS **Clear Linux**\* Celadon Zephyr<sup>™</sup> (ISO 26262 ASIL D)

Functionally Safe and Real Time Capable Hypervisor (ISO 26262 ASIL D)

Intel Hardware

\*Other names and brands may be claimed as the property of others. The nominative use of third party logos serves only the purposes of description and identification.

#### **Core Components of Intel Reference Stack**



Clear Linux\* OS is an open source, rolling release Linux distribution optimized for performance and security, from the Cloud to the Edge, designed for customization, and manageability



The Zephyr<sup>™</sup> Project is a scalable real-time operating system (RTOS) supporting multiple hardware architectures, optimized for resource constrained devices, and built with safety and security in mind



Celadon is an open source Android\* software reference stack for Intel architecture. It builds upon a vanilla Android stack and incorporates open sourced components that are optimized for the hardware

ACRN<sup>™</sup> is a flexible, lightweight reference hypervisor, built with real-time and safetycriticality in mind, optimized to streamline embedded development through an open source platform

#### Usage Example – In-Vehicle Experience



### **Neusoft Automotive C4-Alfus Pro System**

#### Cluster Traditional Cluster Safety Alert

90 km/h





### IVI – Up Screen

Focus on display to driver

## Conserver Conserver

### **IVI – Bottom Screen**

Focus on operationVoice control

#### Passenger Screen (option)

**ADAS** Display

Assist driver on complex operation
 Entertainment

### **Neusoft C4-Alfus Pro Hardware Architecture**



#### Usage Example – Industry

#### **PLC Consolidation Use-Case**







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## Introduction

ACRN<sup>™</sup> is a flexible, open-source, lightweight hypervisor - intended to enable consolidation of heterogeneous workloads, and to streamline IoT edge development.

- A Linux Foundation Project Launched in March 2018
- Version 1.0 released in May 2019



https://projectacrn.org

### **ACRN Value Proposition**





#### **Small Footprint**

- Optimized for IOT class solutions
- Significantly smaller footprint than cloud/data center targeted hypervisors



#### **Functional Safety and Hard Real time**

- Heterogeneous Workload Consolidation
- Real time & HMI
- Functional Safety & Unsafe

#### **Open-source with Flexible Licensing**

- BSD license enables proprietary Guest OS
- True Open source with a vibrant Community

ACRN reduces system deployment complexity, enables heterogeneous architectures, and provide TCO advantages

## **ACRN 1.0**



#### Main Usage: In-Vehicle Experience



#### **Ready for Production**

- Fast Boot and Performance KPI
- 100% CTS Pass for Android Guest

#### **Key Features**

- Safety and Security Isolation (Cluster + IVI)
- Extensive Sharing Capabilities
- Multiple OS Support
- MISRA-C Compliance

### Released in May 2019 @github.com/projectacrn/

### Architecture Overview





## Looking Forward – ACRN 2.0



## Roadmap (2019-20)

#### Updated Q2-2019

#### **SECURE CONTAINERS**

- Kata Containers as VMs
- Kubernetes support for Kata

#### **Foundational Characteristics**

- Heterogeneous Workloads consolidation
- Small Footprint (sub-50K lines)
- Open-source with a flexible licensing (BSD)
- Shared & Partitioned frameworks
- Beyond-Compute (IOs, Accelerators, Graphics/Media sharing)
- Designed for IOT market (Industrial, Automotive and beyond)

#### **GUEST OS EXPANSION**

- Microsoft Windows
- Celadon Open source Android
- Automotive Grade Linux
- Wind River VxWorks

#### **DEEP ISOLATION**

- Partition mode
- Open source Zephyr RTOS in Partition mode

#### **TODAY:** ADVANCED SHARING

- Linux based Open source Service OS
- Linux, Android Guest OS's
- Multiple Guest VMs in Sharing Mode
- Sharing of various IO's





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RETAIL

an Android\* open source platform for Intel<sup>®</sup> architecture.



Android\* on IA that just works

**AUTOMOTIVE** 

**SMART CITIES** 

CELADON an Android\* ope for Intel® archi

an Android\* open source platform for Intel® architecture.

**ACCELERATE** DEVELOPMENT

open platform enablement speeds build time lowering time to market

ANDROID

CELADON HARDWARE ABSTRACTION LAYER

LINUX KERNEL & FIRMWARE

#### **DEVELOP ON LATEST ANDROID\* RELEASES**

IMPROVE EFFICIENCY





**SCALE** RELIABLY



(intel) XEON' inside

intel ATOM Inside CORE Inside !• **"** 



## ACCELERATE DEVELOPMENT WITH CELADON







### Refreshed

### Optimized

## IA Ready

supports a wide range of hardware components enhanced for Intel® architecture making it easy for rapid prototyping and building new applications full compatibility is verified using the Android\* Compatibility Test Suite (CTS), ensuring consistent experiences across application and hardware environments

Verified

continued upgrades & security mitigations provide opportunities to realize and scale new features when developing on the latest Android\* dessert

open platform enabling extends adaptability, helping developers speed Time to Market (TTM) across a variety of segments

DOWNSTREAM

Google Android Android Open Source Project (AOSP) Android Runtime (ART) Latest Android Dessert

> Intel Patches Intel Board Support Package

> Intel<sup>®</sup> Architecture Support Fully Automated Operations Cross Test Suite Compliant

> > **Project Celadon**

Product Quality Software Special Feature Access Fast Boot, Hibernation Machine Learning...

## PROJECT CELADON DELIVERY MODEL

open platform enabling helps developers speed Time to Market (TTM) across a variety of segments

### Celadon Demos





Intel NUC NUC7i5DNHE (Intel CORE)



Intel NUC NUC6CAYH (Intel ATOM)

## IMPROVE EFFICIENCY WITH INTEL® HARDWARE

	Dessert P	REGULARLY REFRESHED UPGRADES		Dessert Q			Dessert R
Functionality	Dual Audio & Playbaci	o Machine Learning k with Movidius	Dual Video & Display	Dual Display with Touch	Ethernet Audio Video Bridging Hibernation	Android Enterprise Fast Boot over USB debug capability (DbC)	
	Multi-Camera	Accelerated Ve	hicle Hardware ostraction Layer Emulator	Computer Vision & Depth Perception			
	Accelerated Media	Graphics AC					
	Security	urity Android* swap		Exterio	terior View Machine Learning		
ERAGE HARDWARE ACCELERATION	Intel <sup>®</sup> Optane			OpenVino + MyriadX			
	OpenVino + Movidius OpenVino + MKL-DNN		Intel <sup>®</sup> Active Management Technology				
	/ /				X	X	
Intel®				** Lake Future	Platform		
Processor Family	Kaby Lake						
			Apollo La	ko			

## SCALE RELIABLY ACROSS NEW MARKETS



### RETAIL

Personalized Shopping Experiences Inventory Management Precision Marketing In-store Path to Purchase



### AUTOMOTIVE

In-Vehicle Infotainment Enhanced Diagnostics Maintenance & Safety Vehicular Interaction



### EDGE

Advanced Analytics Workload Consolidation Security & Manageability



### **SMART CITIES**

Safety & Security Resident Engagement Smart Parking

Traffic Flow Monitoring



### **CLOUD GAMING**

High Performance Gaming Social Identity Mapping AI & Graphics Interactive Lobby

### **PROJECT CELADON + DEVELOPER COMMUNITY ENABLES INNOVATION**

## **CELADON USE CASES**

## CELADON RETAIL USAGE CASE DIGITAL SIGNAGE

#### CHALLENGES

Providing flexible Android\* OS implementations on performant hardware

Bringing lower cost devices to large digital signage applications at rapid speeds

Providing security & support to innovative visual messaging



**DIGITAL SIGNAGE** 

#### SOLUTION



## **LEVERAGE INTEL HARDWARE**

"Project Celadon allowed us to focus on building our portion of a solution for our customers. Previously, I would have needed a significant budget for BSP and other hardware related tasks before even being close to building a product."

- Customer Testimonial

## CELADON RETAIL USAGE CASE Smart terminal

#### **SOLUTION**



## ACCELERATE DEVELOPMENT

Using AI and wireless technology, achieve real time security with 99.8% accuracy in face recognition with Project Celadon

#### CHALLENGE

Rapid Segment Scaling Quickly develop IoT applications for security & facial authentication at smart terminals



SOLUTION Smart Terminal

## CELADON AUTOMOTIVE USAGE CASE IN-VEHICLE INFOTAINMENT

#### CHALLENGE

Innovative Automotive Applications



## **SHIFT & EVOLVE DEPLOYMENTS**

Tier1s and Car OEMs can start their product development with Celadon on a standard Intel NUC HW platform, then shift the SW stack to Intel's Automotive Platform, Gordon Ridge MRB developer kit.

## HOW DO I CONTRIBUTE TO THE CELADON COMMUNITY?

References

Frequently Asked Questions

#### Visit our Guides and Tutorials https://01.org/projectceladon/documentation

# Celadon ABOUT TUTORIALS SOFTWARE COMMUNITY Documentation Home / Documentation Home / Documentation Celadon is an open source Android software reference > Guides and Tutorials Celadon is an open source Android software reference stack for the Android community to bring ideas to life

while developing on the latest Android release and the latest Intel hardware platforms

#### Profiling System Power Consumption on Celadon using Intel® SoC Watch

Overview Intel® SoC Watch is a command line tool for monitoring system power consumption on Intel platforms. The tool monitors active and low power states re...

#### READ MORE

#### Build Celadon from source

System requirements Though Android is typically built with a GNU/Linux or Mac OS operating system, we recommend you build the Celadon images on a 64-bit deve... Q

#### READ MORE

## **CONTACT US**





#### Learn More

https://01.org/projectceladon

https://github.com/projectceladon

FAQ

#### **Win Customers**

Determine if Android\* on Intel architecture is a good fit for your customers

Suggest Project Celadon for customer product POC use

#### **Stay Connected**

Join the <u>mailing list</u> to stay inform on community discussions

https://lists.01.org/mailman/listinfo/celadon

## **THANK YOU!**