

# Device Virtualization Architecture for Automotive

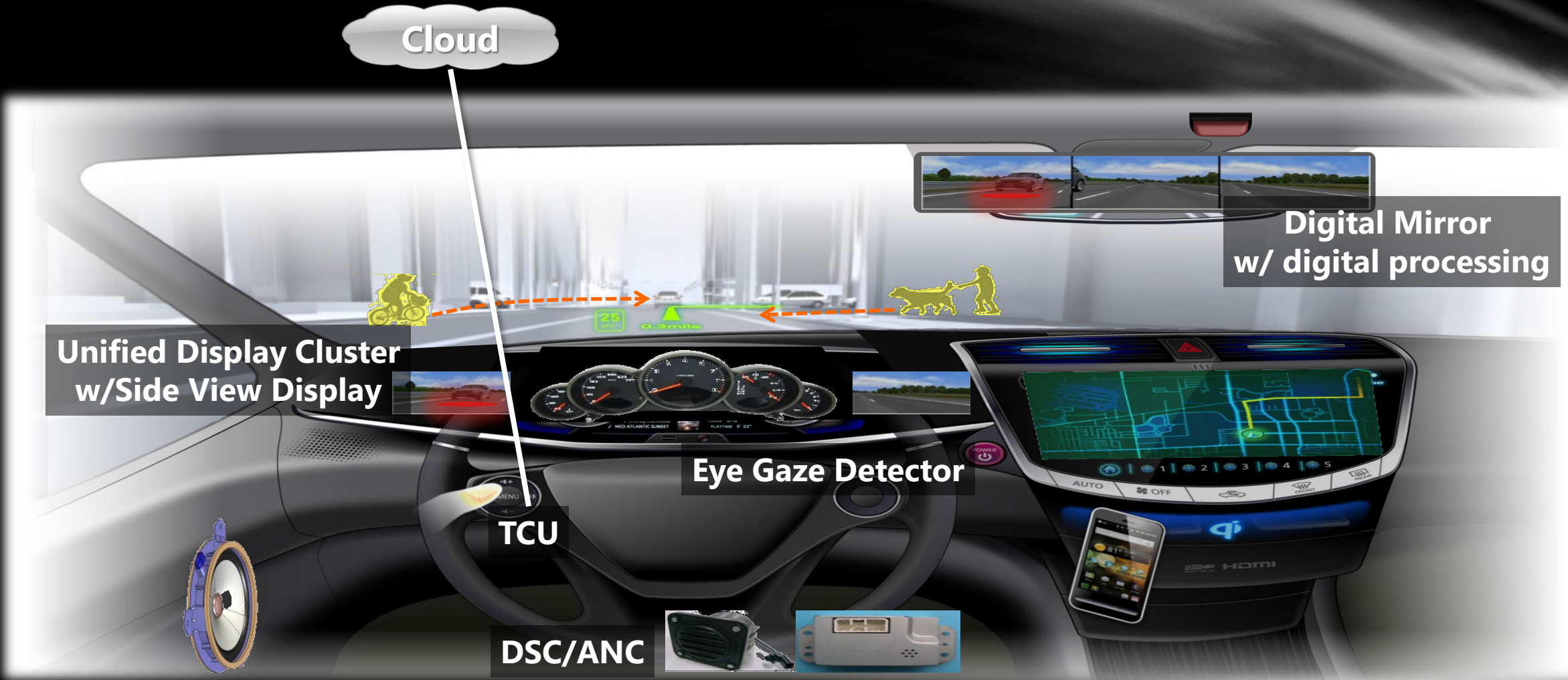
*Nov. 2020*

*Masashige Mizuyama, CTO, Automotive Company, Panasonic Corporation*

# VirtIO: A Reference Device Virtualization Framework for AGL

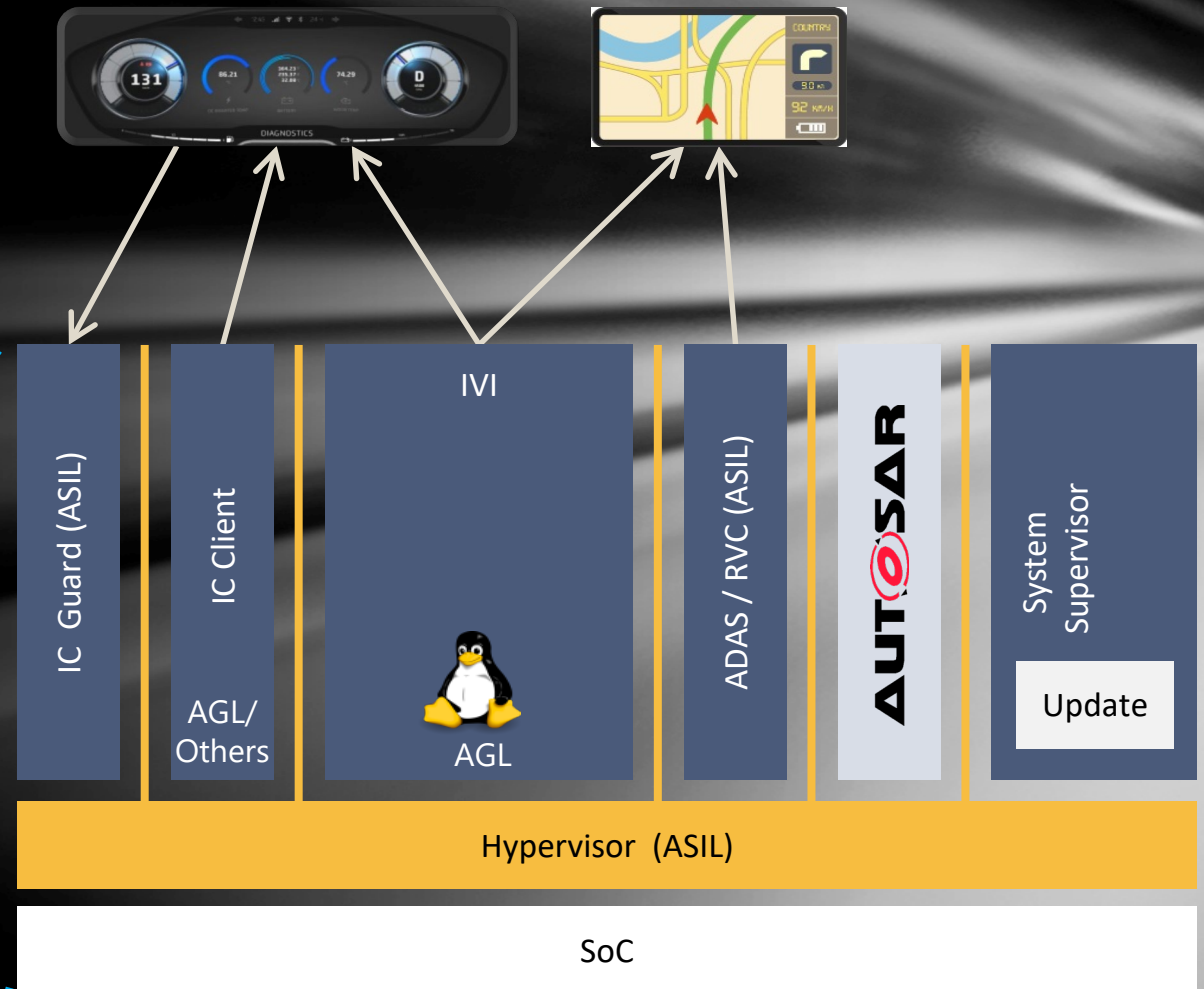
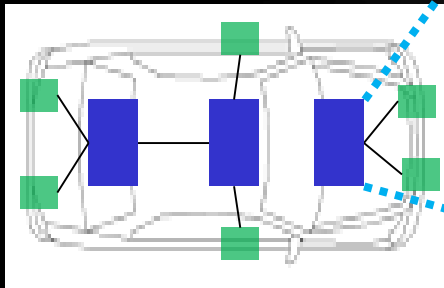
# Cockpit Digital Transformation

Cockpit is going to be filled with digital instruments.



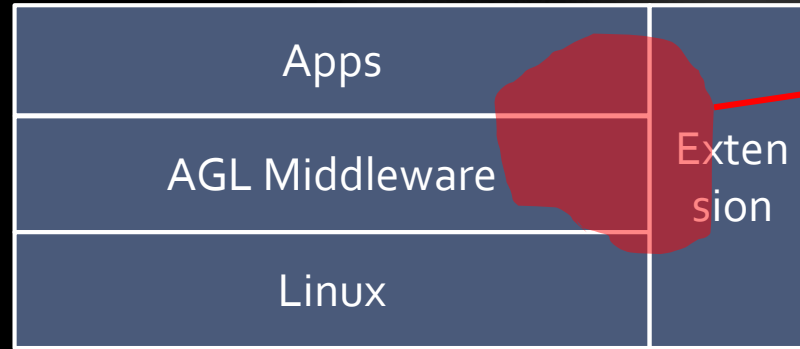
# ASIL/Security Partitioning with Virtualization ...

- Computing in a vehicle is going to be performed by a smaller number of ECUs.
- Hypervisor separates functions with different operating systems, different requirements on real-time behavior and functional safety
- Safety-critical functions (e.g. displaying tell-tales and local ADAS functions) that underlie ASIL requirements run isolated in a separate VM.



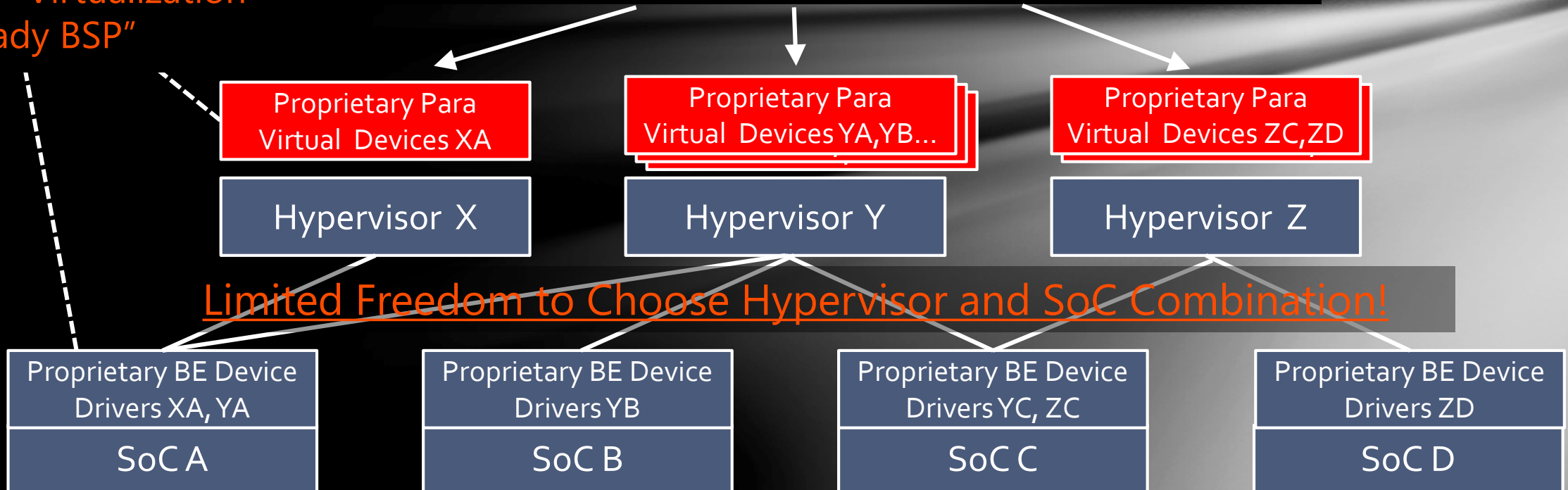
# Today's Pain Point: Unhealthy Ecosystem Around Virtualization

Fragmentation=  
Serious Barrier  
For "Virtualization  
Ready BSP"



Dependency on  
Specific Virtualization  
Solution

Must Adapt to Every Single Incompatible Interface!

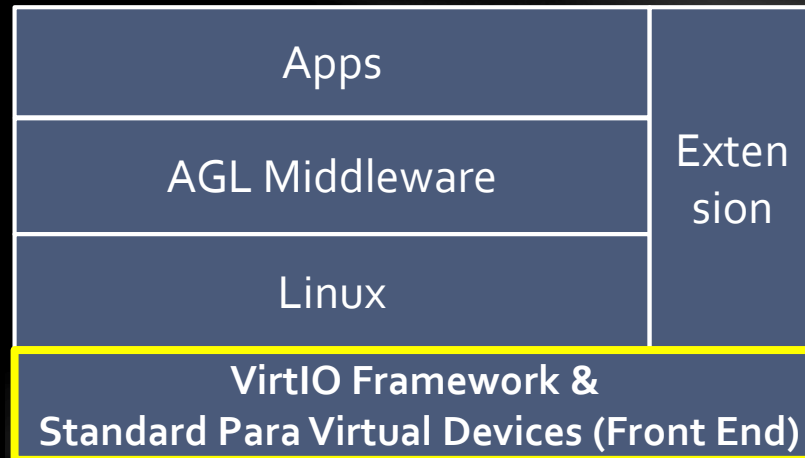


Limited Freedom to Choose Hypervisor and SoC Combination!



# Proposal: Assume VirtIO as Common Framework

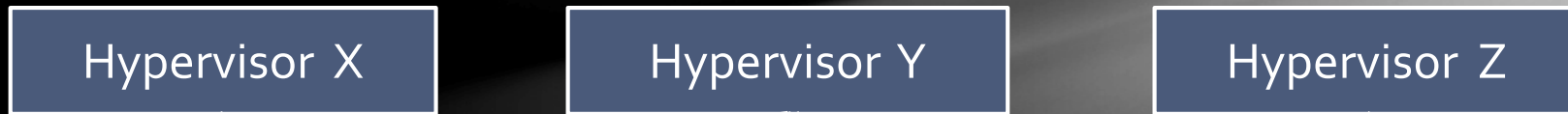
Limited Fragmentation=  
Common Interface defined by  
VirtIO largely improves community  
and encourages  
"Virtualization Ready BSP"



VirtIO interface may work  
as "well-defined low level  
HAL" for (even non-virtual)  
AGL

## Common Interface

✓ **Healthy  
Competition**  
✓ **Efficiency**



## Enhanced Freedom to Choose Hypervisor and SoC Combination

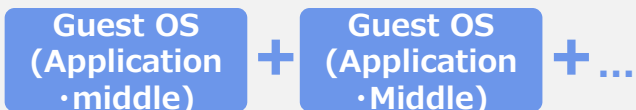


# Automotive Needs Richer Ecosystem

Mature Technologies in certain areas such as Cloud Server.

Virtualization of various peripherals for automotive is unexplored area and needs enhanced ecosystem.

## Server



Utilizing unused resources, cost saving, great resistance to interference etc.

### Shared Devices



### Virtualization with suitable number of peripherals

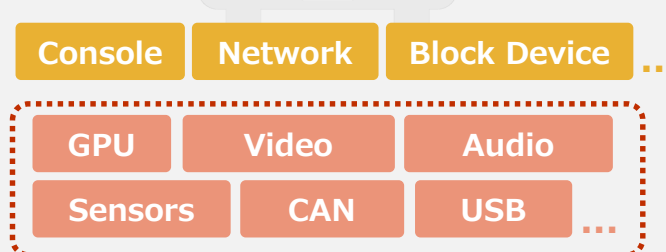
Improving quality by Virtualized hardware within ARM ARCHv8 (Virtualization Extension)

## Automotive



Network connection service, easy to create UI, reusability of previous software assets etc.

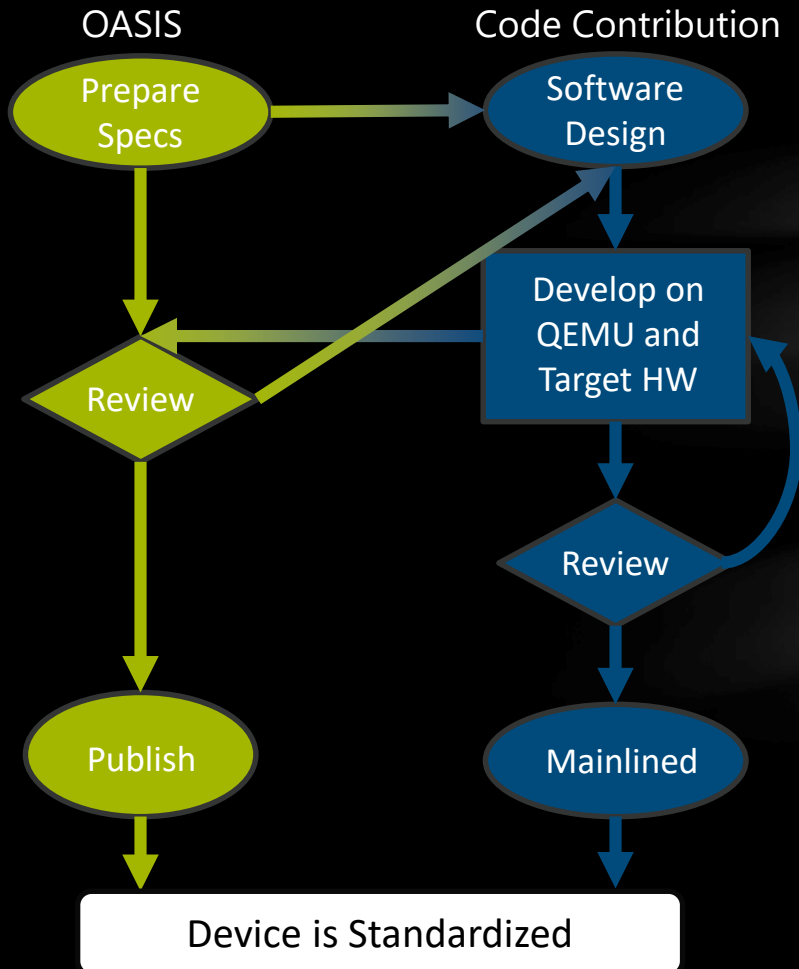
### Shared Devices



If peripheral devices were shared, an issue that occurs only under virtual environment might be identified.

# Progress of Development for “Automotive Ready” and Our Contribution

Still needing some work though, implementation steadily makes progress.



<b>virtio-blk</b> VIRTIO: 1.1 LX DRV: upstream	<b>virtio-net</b> VIRTIO: 1.1 LX DRV: upstream	<b>virtio-console</b> VIRTIO: 1.1 LX DRV: upstream	<b>virtio-crypt</b> VIRTIO: 1.1 LX DRV: upstream
<b>virtio-input</b> VIRTIO: 1.1 LX DRV: upstream	<b>virtio-vsock</b> VIRTIO: 1.1 LX DRV: upstream	<b>virtio-entropy</b> VIRTIO: 1.1 LX DRV: upstream	<b>virtio-GPU(2D)</b> VIRTIO: 1.1 LX DRV: upstream

## *Our Main Contribution Area*

<b>virtio-GPU(3D)</b> VIRTIO: 1.2 LX DRV: upstream	<b>virtio-audio</b> VIRTIO: 1.2 LX DRV: review	<b>virtio-video</b> VIRTIO: - LX DRV: -	<b>virtio-camera</b> VIRTIO: - LX DRV: -
<b>virtio-npu</b> VIRTIO: - LX DRV: -	<b>virtio-scmi</b> VIRTIO: - LX DRV: -	<b>virtio-iommu</b> VIRTIO: - LX DRV: -	<b>virtio-...</b> USB, CAN, more sensors, actuators

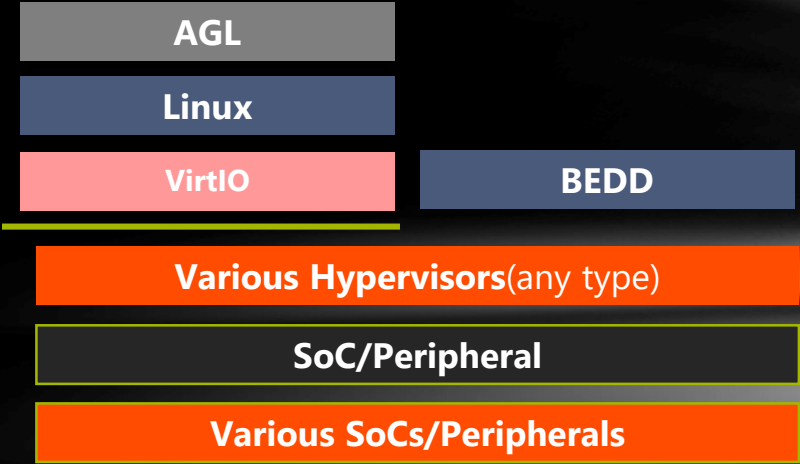


# “Virtualization Ready” AGL with Various SoC Support with Modular Reference Hardware will Keep Fragmentation away!

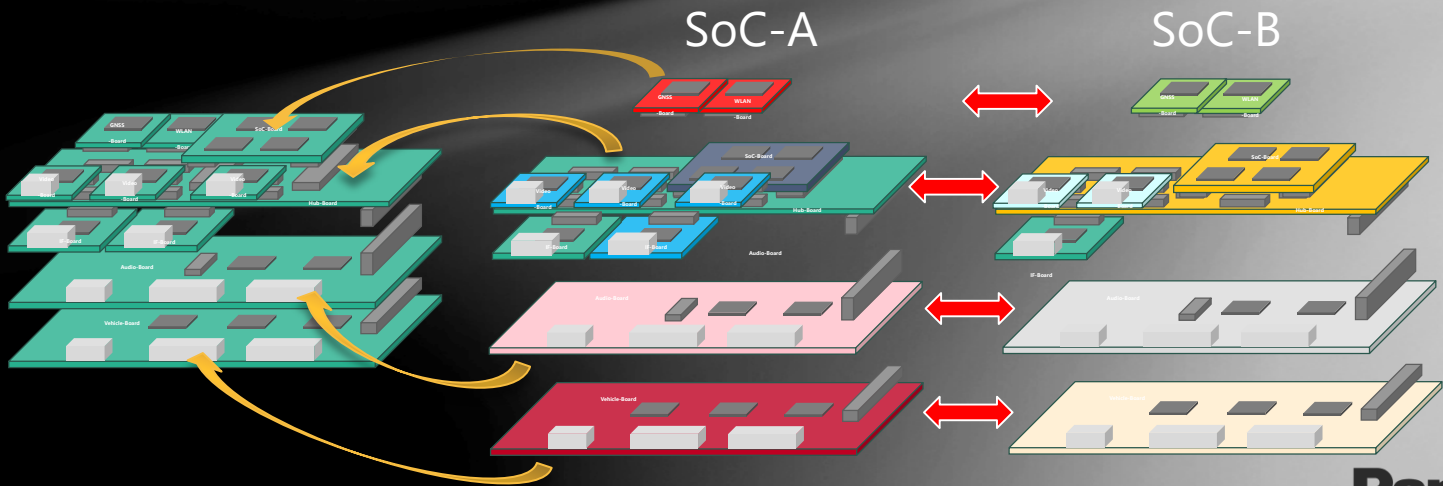
“VirtIO Ready”  
AGL UCB



AGL Reference  
“Interchangeable”  
Hardware



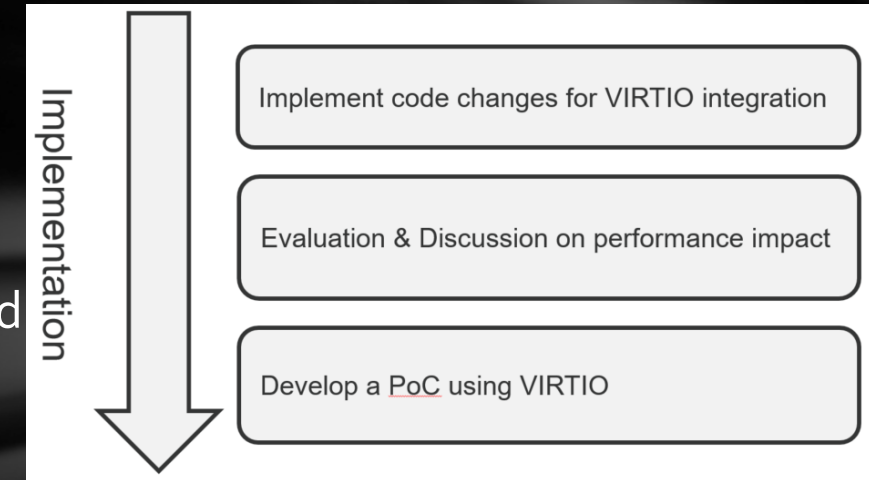
We can establish the environment where various hypervisors, SoCs and peripherals are available.



# AGL Virtualization Expert Group

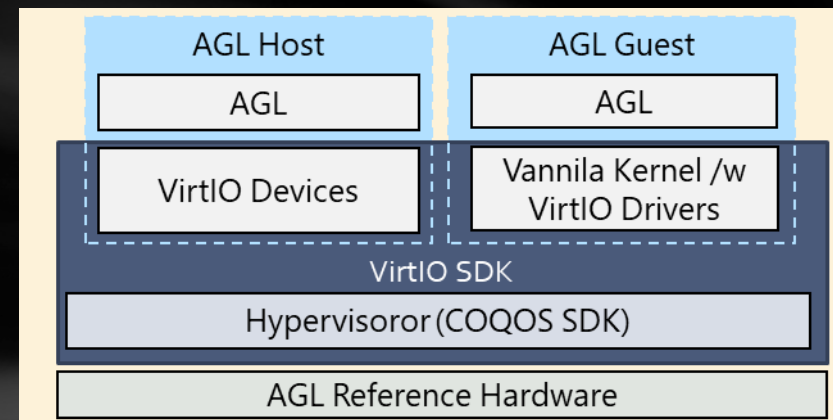
Panasonic has started to serve as the new lead of the AGL Virtualization EG since April to start the VirtIO related discussion

- Quite Nice Diversity of Involvement:  
17 companies, 36 members
- Active Discussion & Progress:  
10 Member speeches about work on VirtIO done/planned
- Consensus:  
Work together in EG to support VirtIO in AGL
- Target: Achieve VirtIO Support in AGL KK (2021/2)  
freedom choice: virt. vs non-virt. with AGL UCB configuration

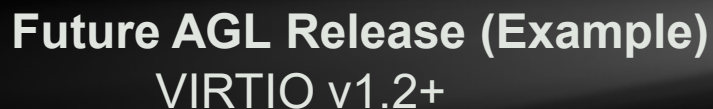
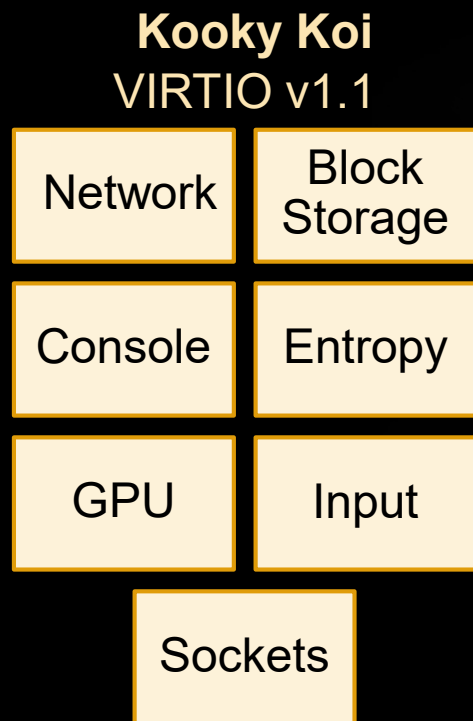


# Current Progress of AGL Virtualization EG

- VirtIO Porting in the next AGL version Kooky Koi:
  - VirtIO porting for AGL Kooky Koi will be completed before Dec 2
  - Reference implementation of VirtIO on AGL reference board will be provided after KK porting
- Next Step Discussion:
  - Discuss what other VirtIO devices are needed in AGL for automotive uses.
  - Discuss about standardization of VirtIO backend



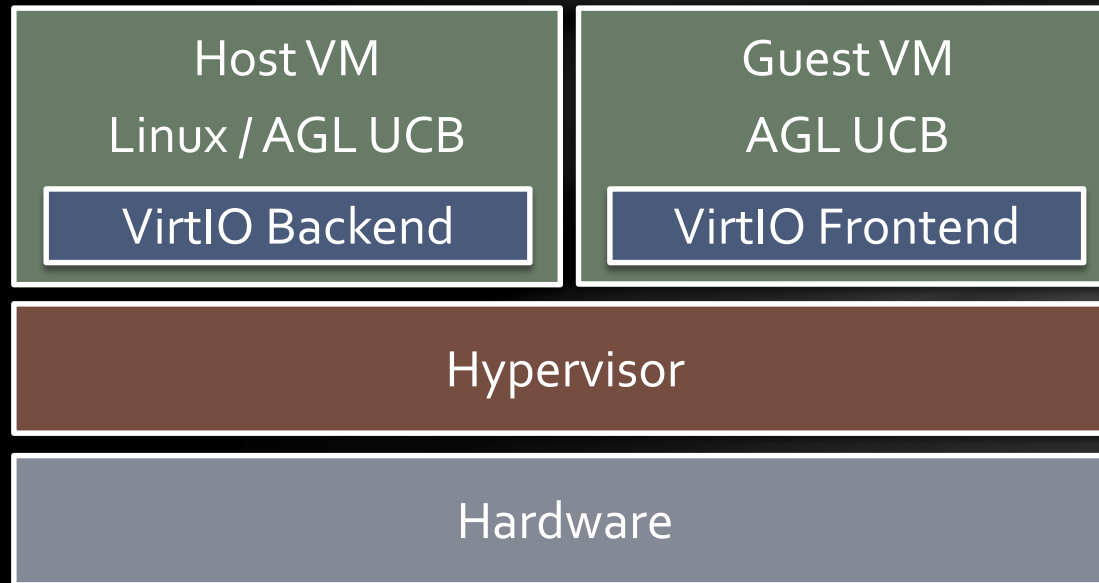
VirtIO Reference Implementation



Exact set of Virtio devices will be identified and discussed in EG-Virt

# Advance Notice: AGL Virtualization EG Presentation in ALS2020

- Virtualization EG Presentation in ALS2020 (Dec 02)
  - Attend ALS2020 to present EG work for VirtIO
  - Show VirtIO+AGL PoCs from EG member OpenSynergy & Linaro
    - Multiple hypervisors & SoCs to be used to prove the hypervisor & SoC switch-ability brought by VirtIO



EG PoC Block Diagram

# Further More on Device Virtualization



# Historical Trend of General Computing Architecture



## Centralized Computing

(Mainframe)

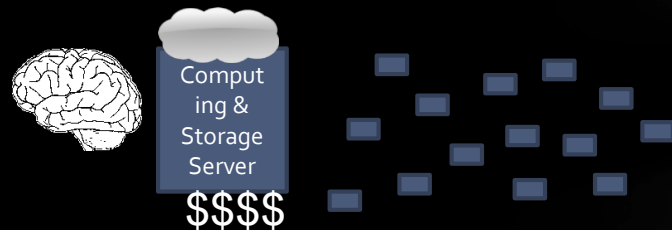
- Expensive computing hardware
- Text terminals on Low-speed network



## Distributed Computing

(Server / Client)

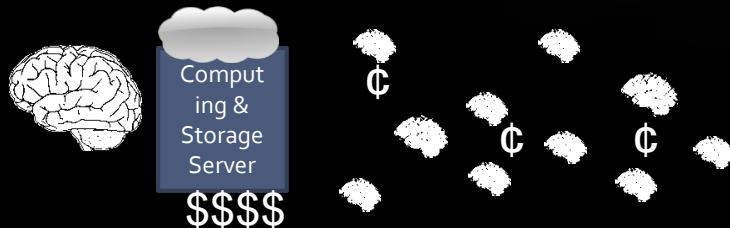
- Cheaper computing hardware (Workstation + Server)
- GUI terminals on Mid-speed network



## Cloud Computing

(IoT /Thin Client+ Service on Cloud Server)

- Shared expensive computing hardware (Cloud Server)
- X as a "SERVICE" on High-speed wireless network



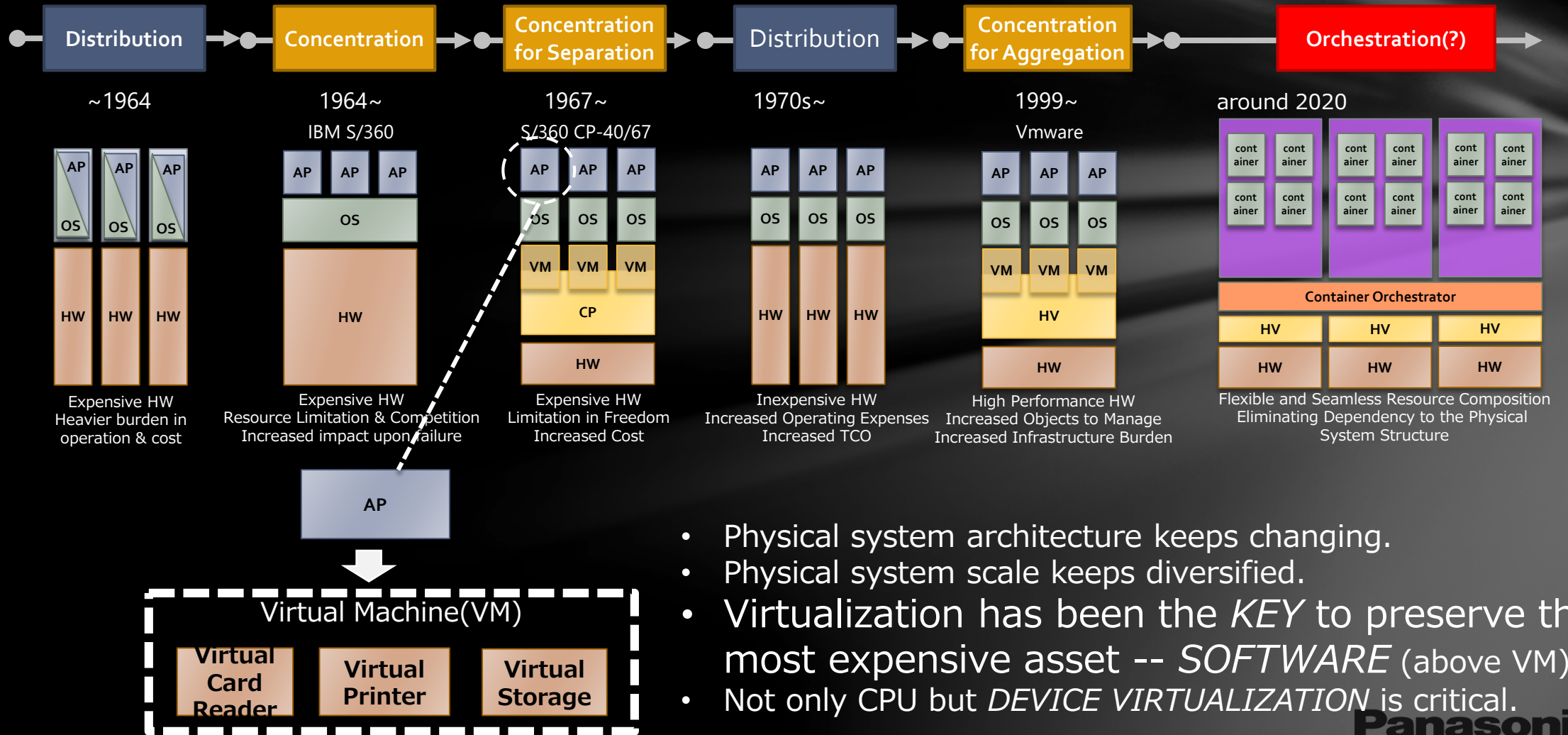
## Edge-Heavy Computing

(IoT + FOG + Deep Learning)

- Distributed cheaper computing hardware
- Intelligence on FOG layer

# Historical Trend of General Computing Architecture

Reference: [https://blogs.itmedia.co.jp/itsolutionjuku/2015/06/post\\_90.html](https://blogs.itmedia.co.jp/itsolutionjuku/2015/06/post_90.html)

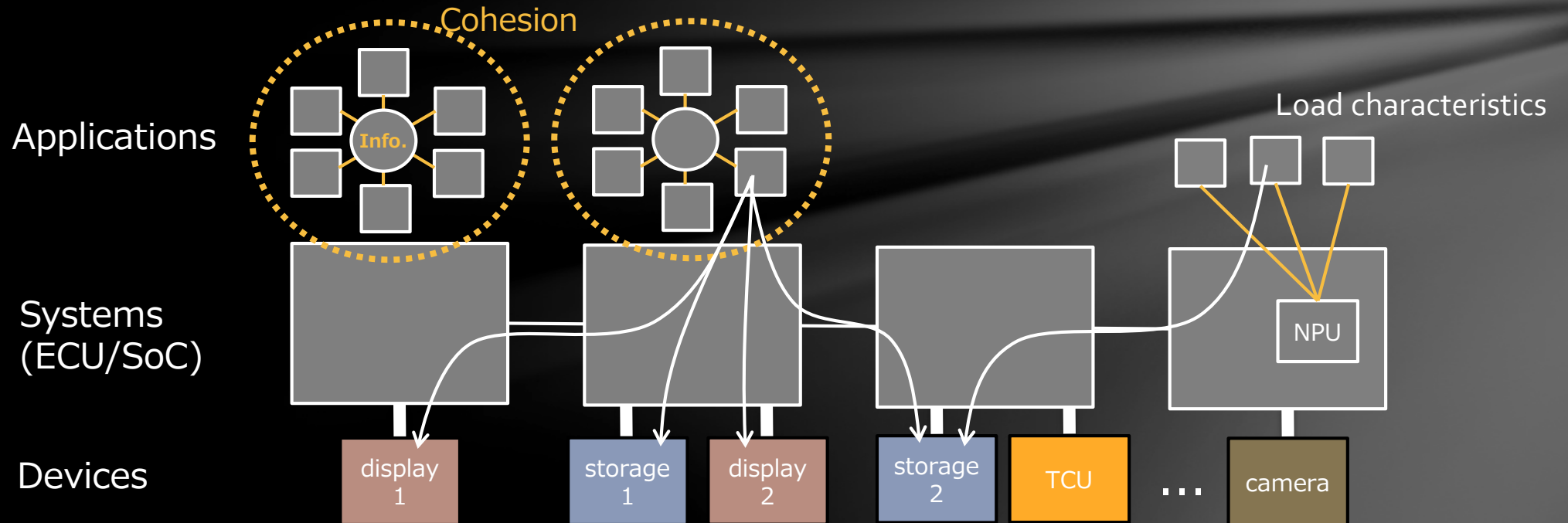


- Physical system architecture keeps changing.
- Physical system scale keeps diversified.
- Virtualization has been the *KEY* to preserve the most expensive asset -- *SOFTWARE* (above VM).
- Not only CPU but *DEVICE VIRTUALIZATION* is critical.

# Device Virtualization: Specific Necessity in Automotive

**Common abstraction of diverged devices among car models and location transparency of devices** are especially critical for application software asset.

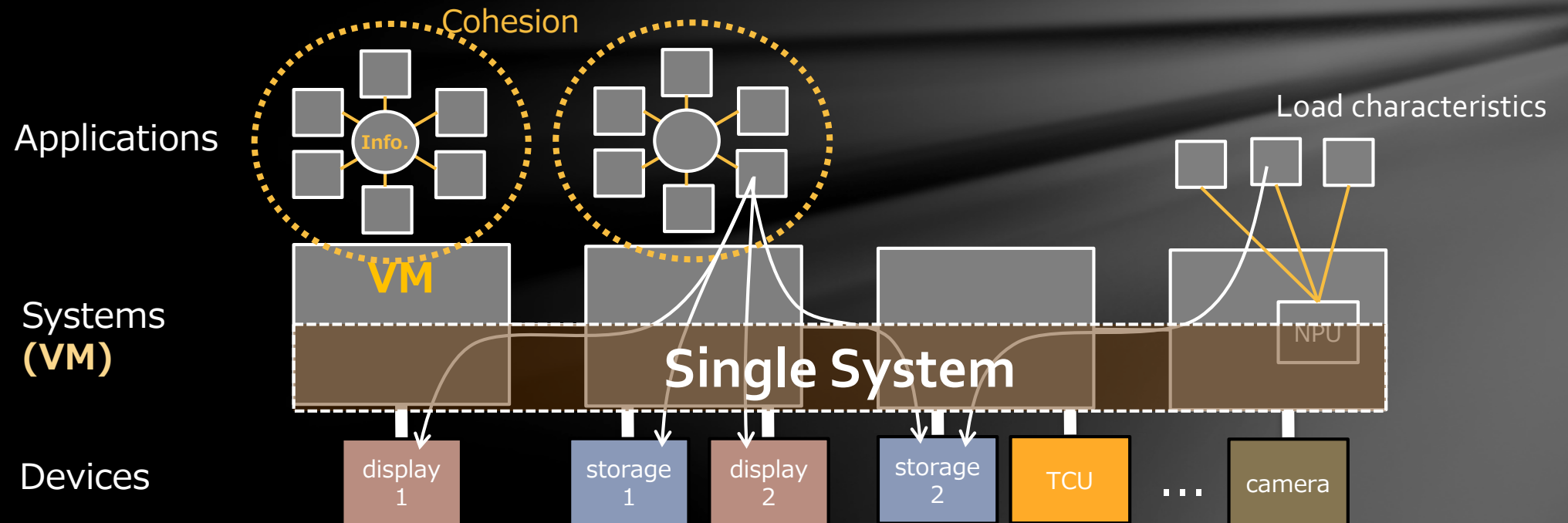
- Diversity of Devices due to Various Car Models
- Highly Distributed Architecture
- Conflicts between optimized allocation policies of applications and devices



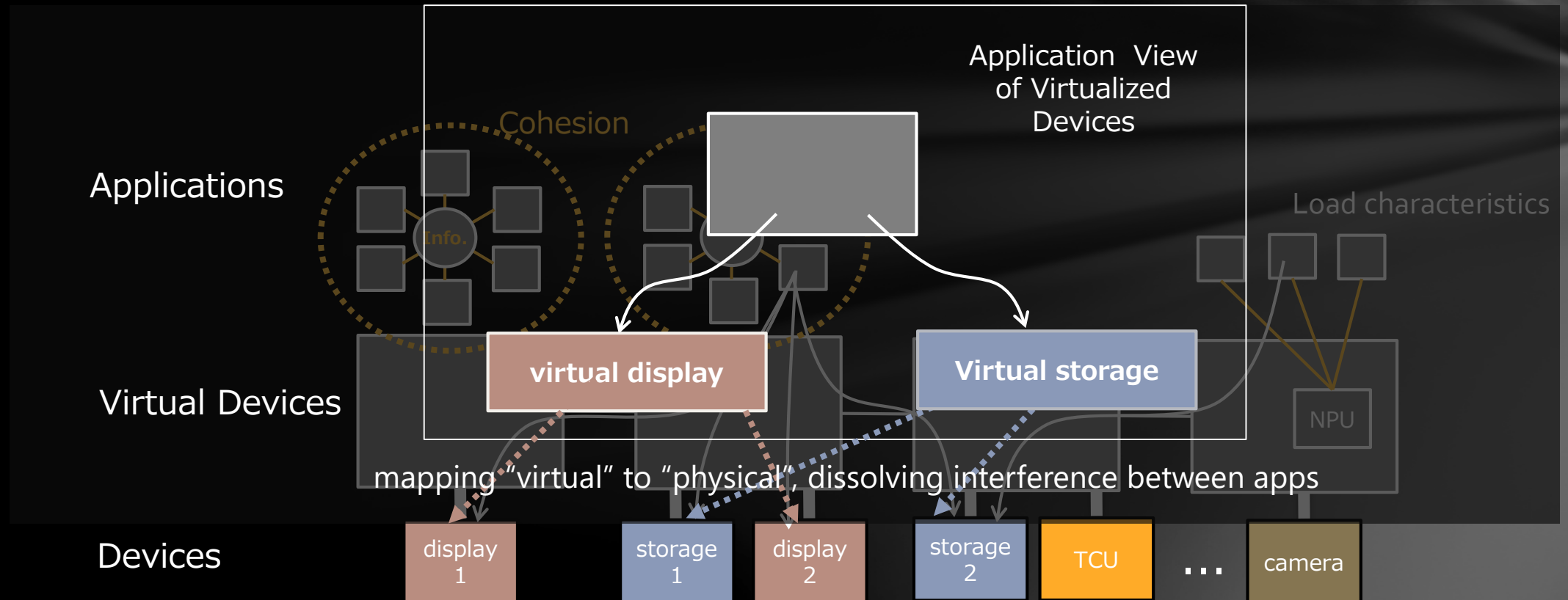
# Device Virtualization: Specific Necessity in Automotive

**Common abstraction of diverged devices among car models and location transparency of devices** are especially critical for application software asset.

- **Even for centralized ECU, the same argument applies because the system inside is divided to multiple VMs**



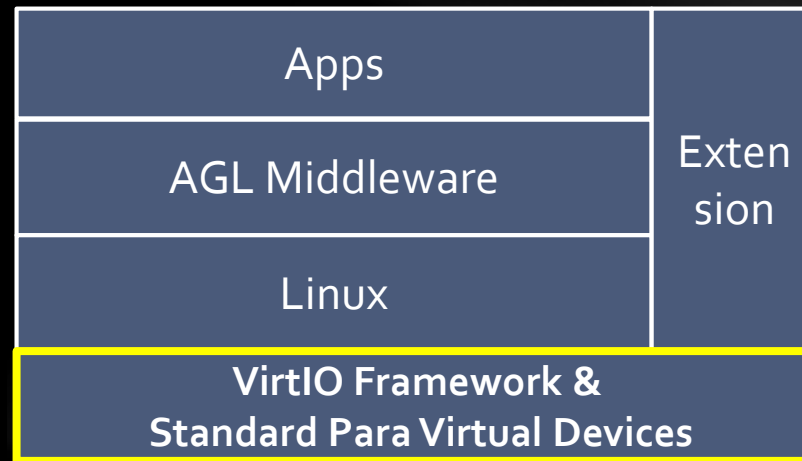
# Device Virtualization: Specific Necessity in Automotive





# Proposal: Assume VirtIO as Common Framework

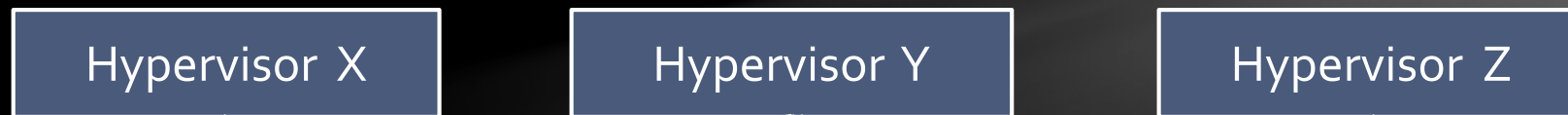
Limited Fragmentation=  
Common Interface defined by  
VirtIO largely improves community  
and encourages  
"Virtualization Ready BSP"



VirtIO interface may work  
as "well-defined low level  
HAL" for (even non-virtual)  
AGL

Common Interface

✓ **Healthy  
Competition**  
✓ **Efficiency**

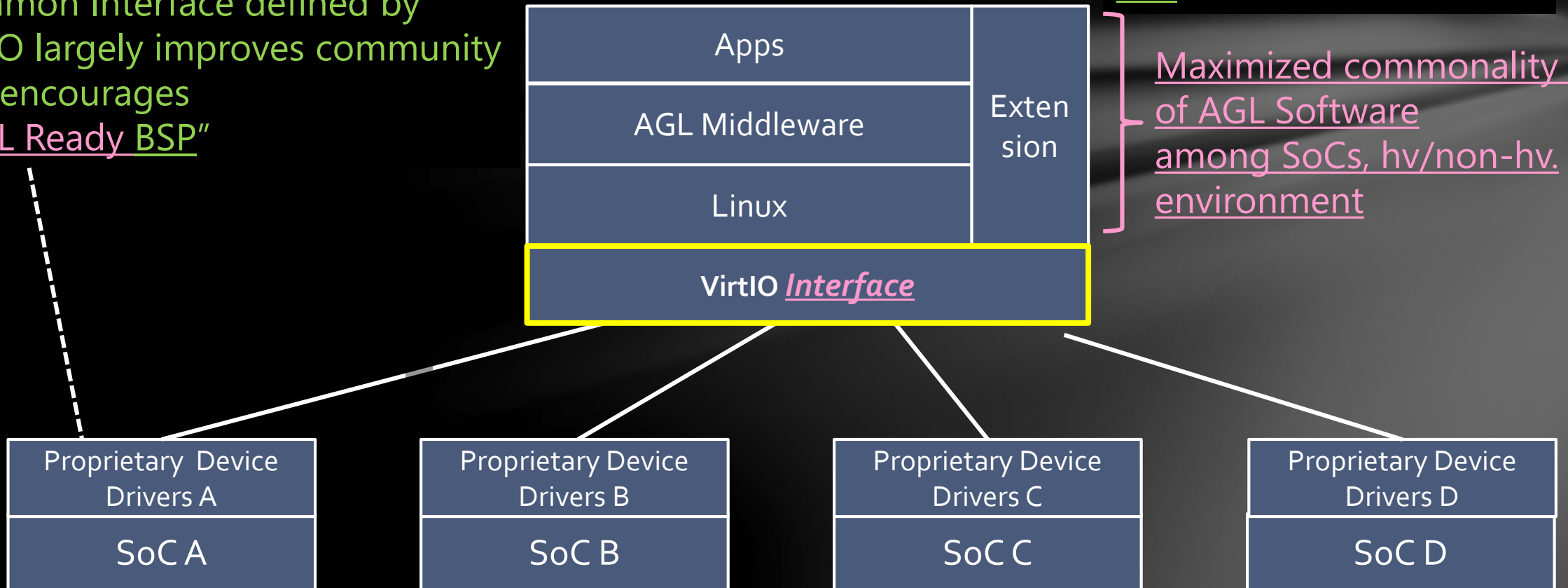


Enhanced Freedom to Choose Hypervisor and SoC Combination



# Proposal#2: Assume VirtIO as Ref. Std. Device Interface also for non-hv

Limited Fragmentation=  
Common Interface defined by  
VirtIO largely improves community  
and encourages  
"AGL Ready BSP"



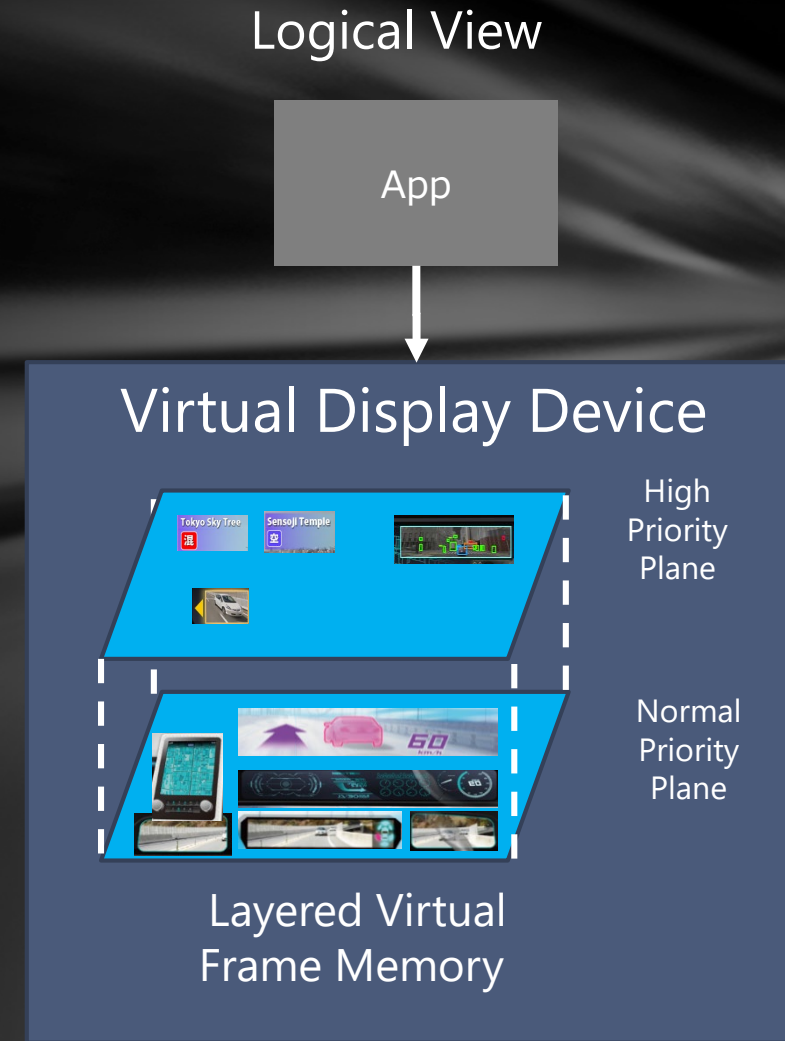
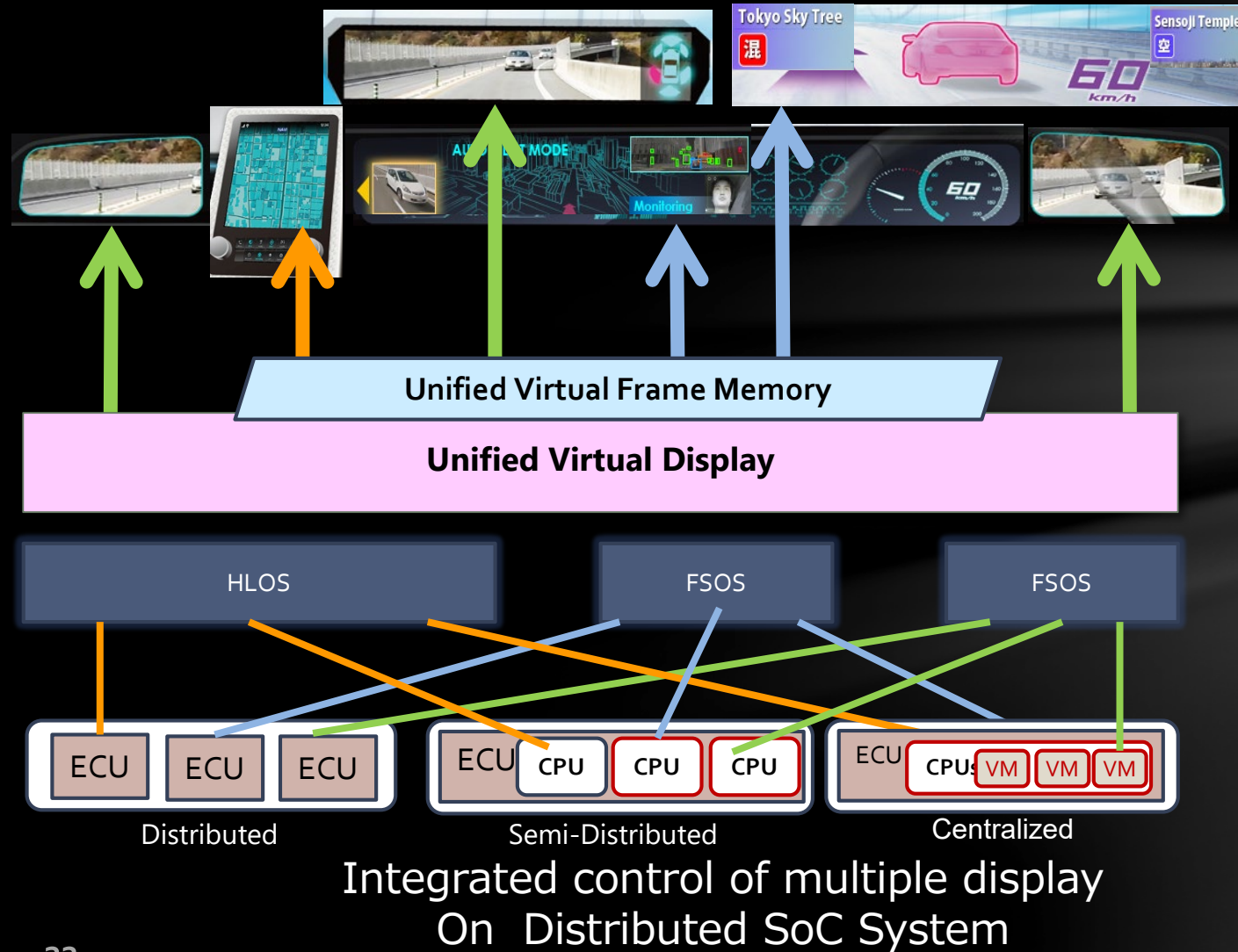
# Another Aspect of Device Virtualization: Location Transparency



- Application renders information on arbitrary optimal displays (CID, Cluster, HUD)
- Mixed contents on single display
- Number, size, location and/or aspect ratio of displays vary among car models.

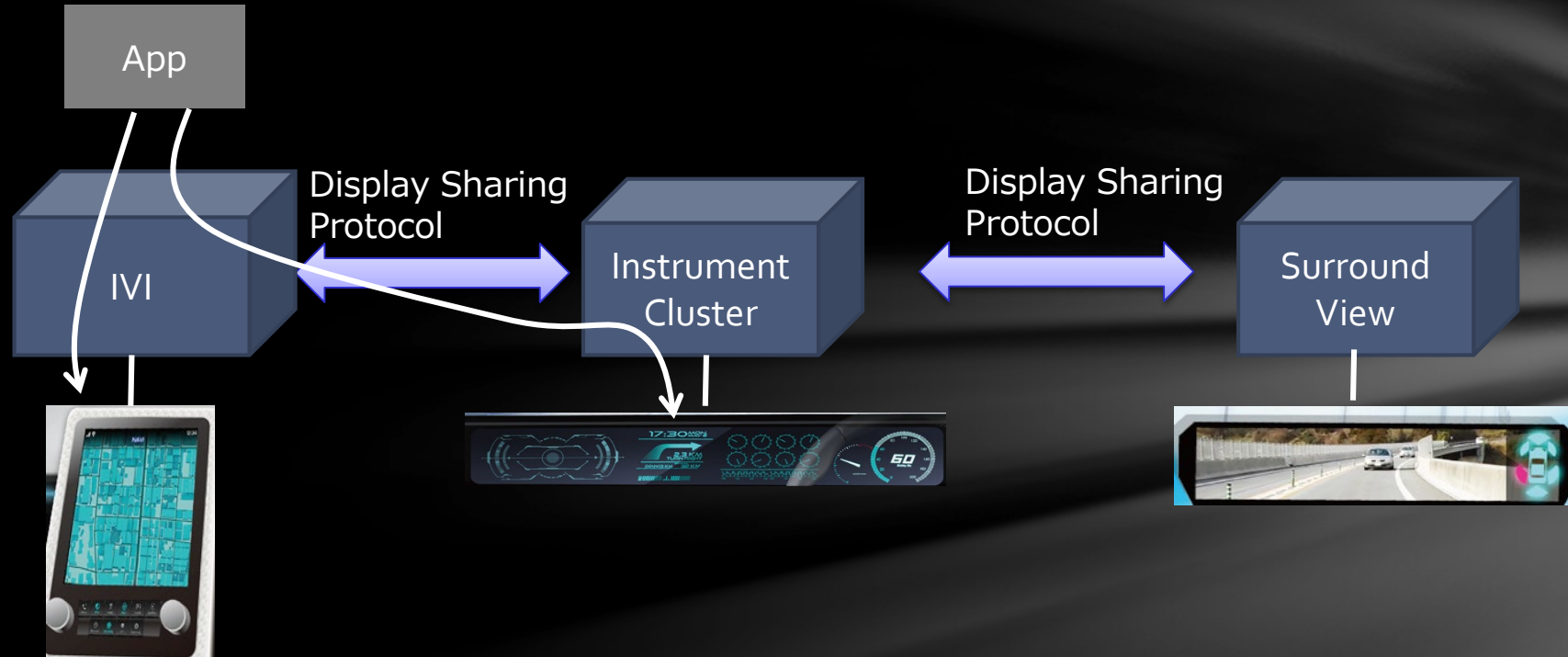
Multiple Displays on Integrated Cockpit System

# Unified HMI Technology : Display Virtualization for Supreme Flexibility





# Interoperability among the industry is the *Key*

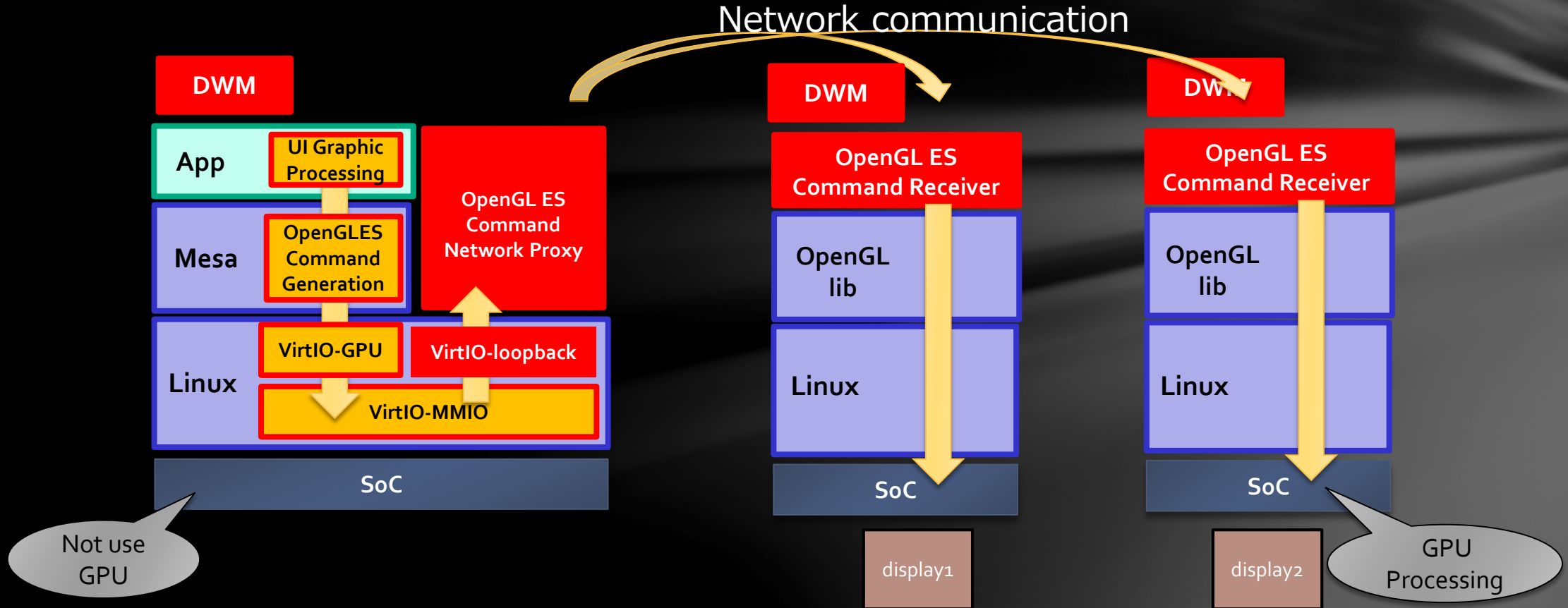


- Standardization of the Protocol and Proprietary Software?
- Open Source Development?



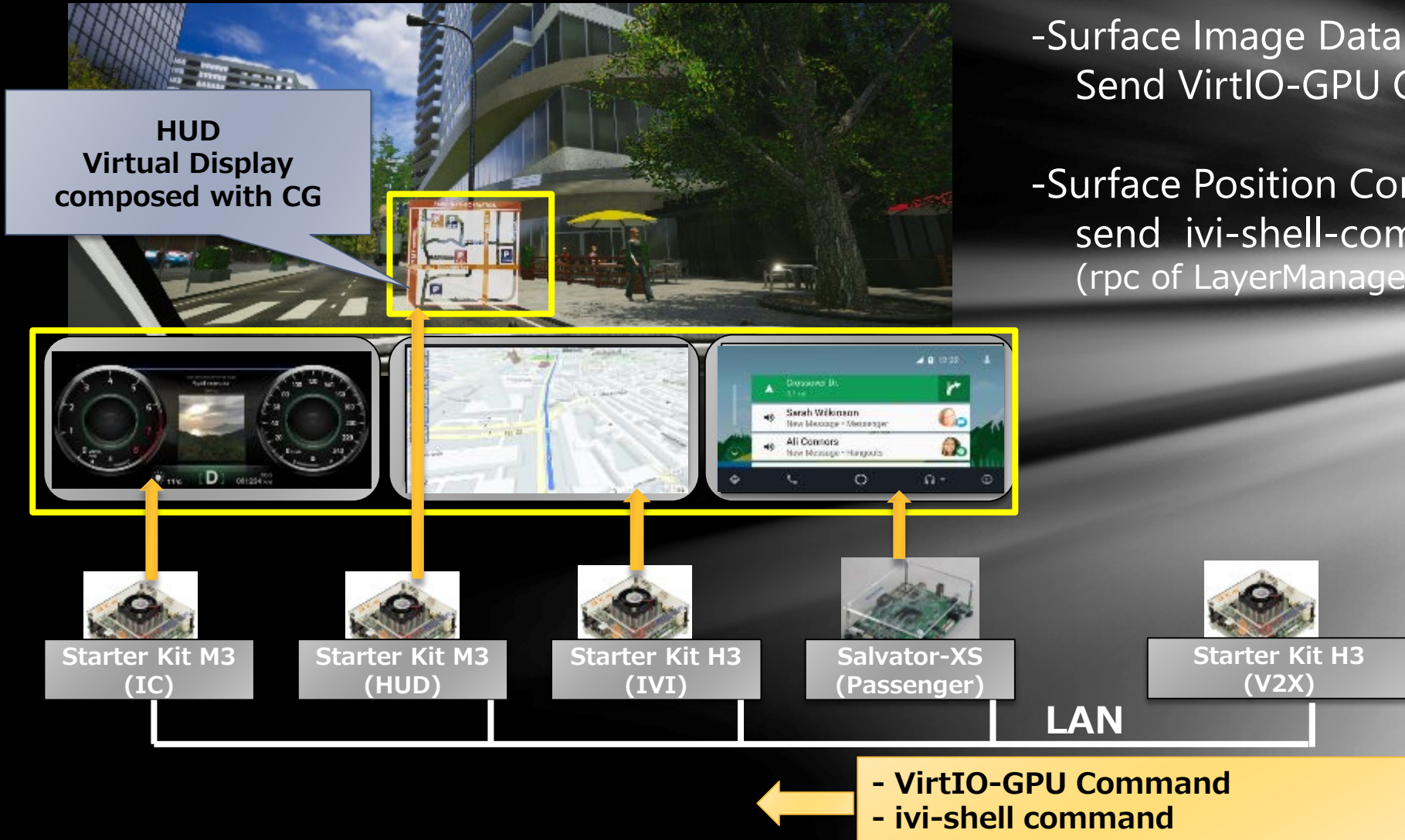
# What we need as the key piece?

## Proposal: VirtIO Network Extension of VirtIO-GPU



DWM: Distributed Window Management

# Proof of Concept of Unified HMI ~ Block Diagram ~



# Proof of Concept of Unified HMI ~ Movie ~





# Discussion with AGL members about Unified HMI

- BOF session in AGL AMM

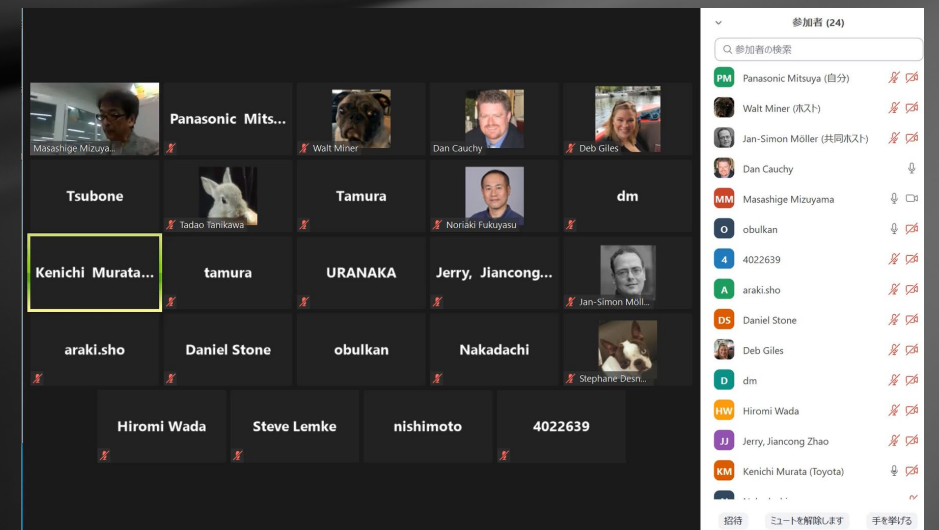
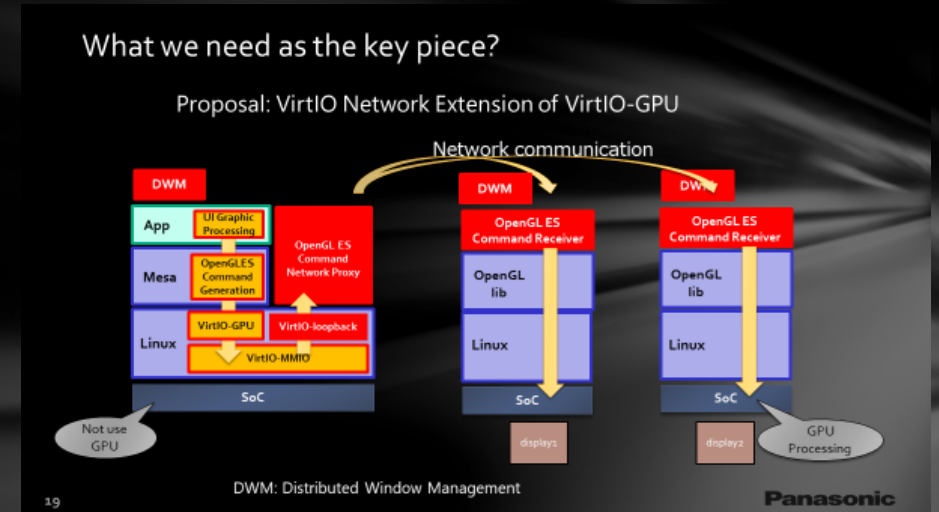
Over 20 members attended.

Collabora, Mentor Graphics showed great interest.

- SAT Meeting.

How to apply into AGL UCB

Issues: Big Resource, Context Recovery



Join the AGL Virtualization EG to  
discuss and contribute  
Virtualization Architecture  
for Automotive together with us!



The background of the slide is a dark, abstract composition featuring several bright, diagonal light rays or streaks that originate from the right side and fan out towards the left, creating a sense of depth and movement.

# Thank You!