Consolidated Display System with XenGT

22OCT15/9:00 | Open Source Projects

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1. Background

- The smart space for users is expanding over home and especially car, which is the second most friendly space

- The automotive cockpit is constantly challenged to deliver optimum solutions which can effectively provide valuable support to driving and help create a comfortable and safe environment inside the vehicle.

2. Automotive Cockpit Trend

| Stand-alone	Connected	Integrated
• Separated Functionality • No Information Sharing • Straightforward HMI*	• Cross-function Multiple Display • Information Sharing • Complicated HMI	• Free form Large Display • Multiple information Integrated • Intuitive HMI

* HMI: Human Machine Interface

3. Advantages & Requirements of Consolidated Display System

- **Advantages**

| HMI	UX/UI Integration
	Display Integration
System	OS Consolidation
	SoC Consolidation
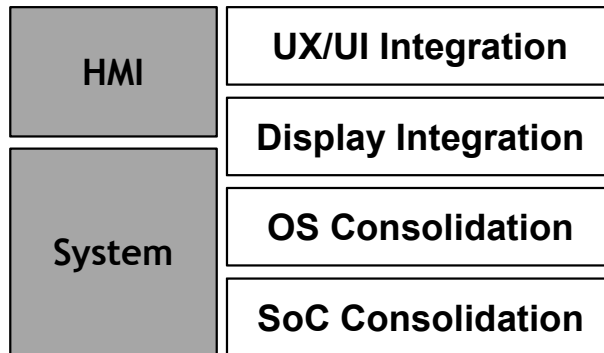
- **Benefits**

❐ OEM Collaboration for UX Differentiation

❐ Full Re-configurable value creation

❐ Safety & Convenience with Reliability

❐ Efficient Resource Management (CPU & GPU)

- **Requirements**
  - Cluster and IVI can be concurrently displayed on one display.
  - Cluster and IVI system can share GPU to show graphical and multiple infotainment.
  - They can communicate with each other for display consistency.
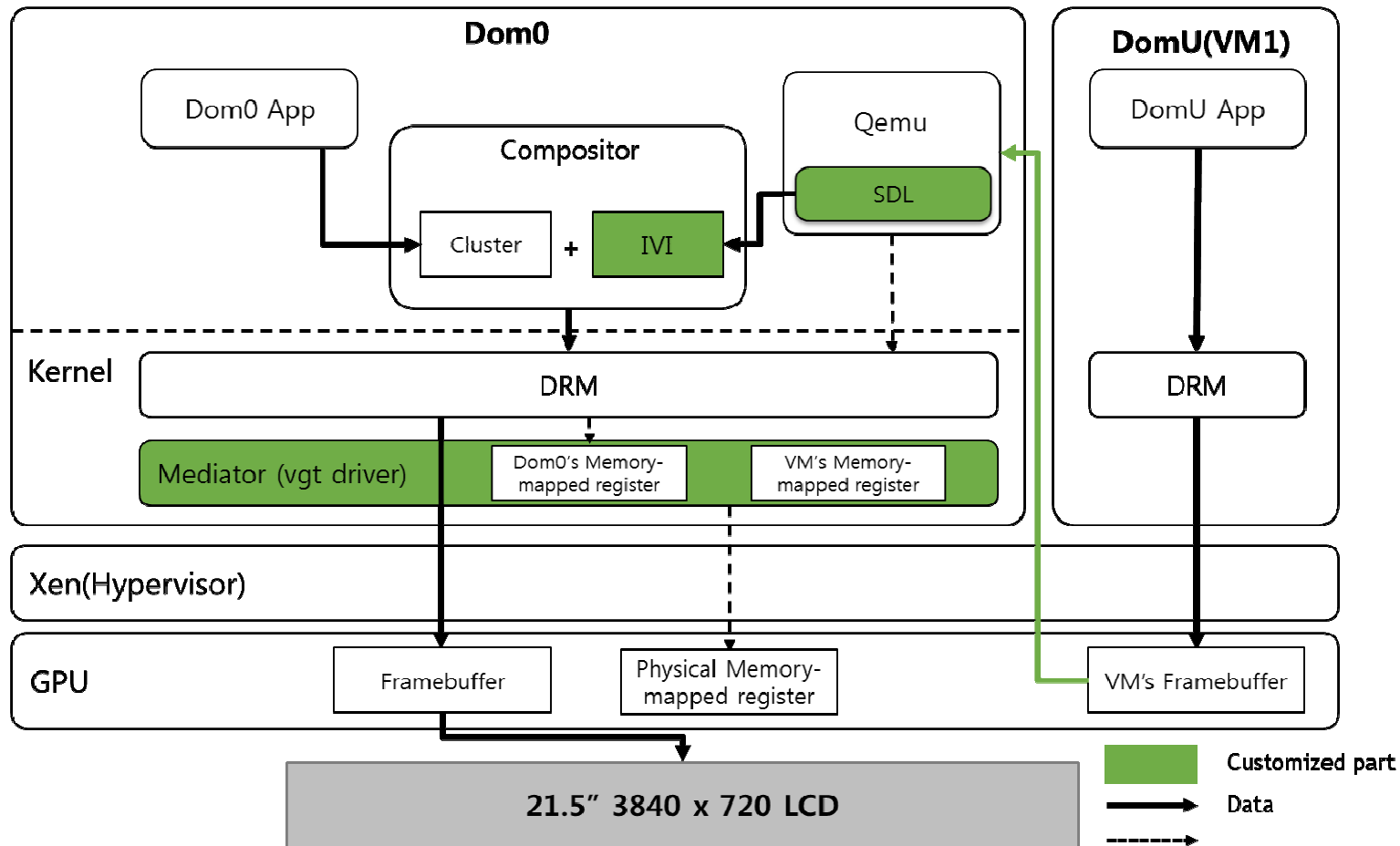 - IVI can exploit HMI such as touch.

4. GPU virtualization of XenGT

- **XenGT is a GPU Virtualization Technology.**
    - **Qemu** is a emulator that supports virtualization when executing under the Xen hypervisor. The Xen uses Qemu to emulate PC hardware, including BIOS, IDE disk controller.
    - **Dom0** is a privileged domain which contains drivers for hardware, as well as the toolstack to control VMs. Domain 0 is often referred to as Dom0.
    - **VM** is unprivileged domain with no access to the hardware.
    - **Xen** is an open-source (GPL) type-1 or baremental hypervisor.
- **XenGT implements a mediated pass-through architecture, running a native graphic driver in VMs to achieve high performance.**
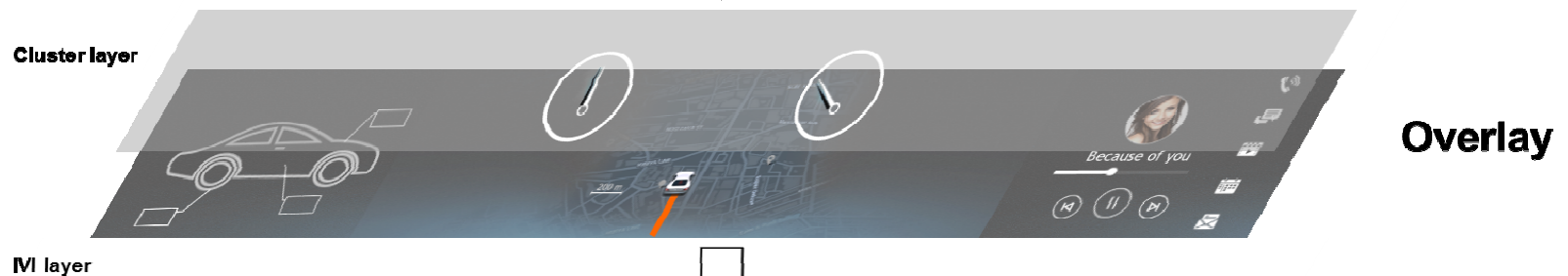

https://01.org/xen/blogs/srclarkx/2013/graphics-virtualization-xengt
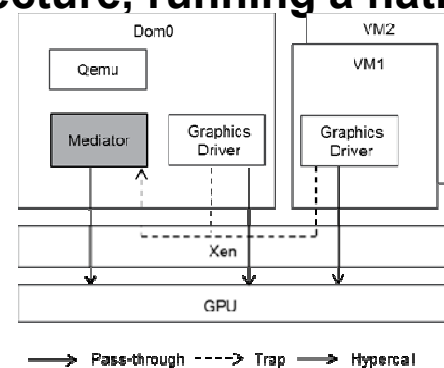
5. Graphic overlay architecture using XenGT
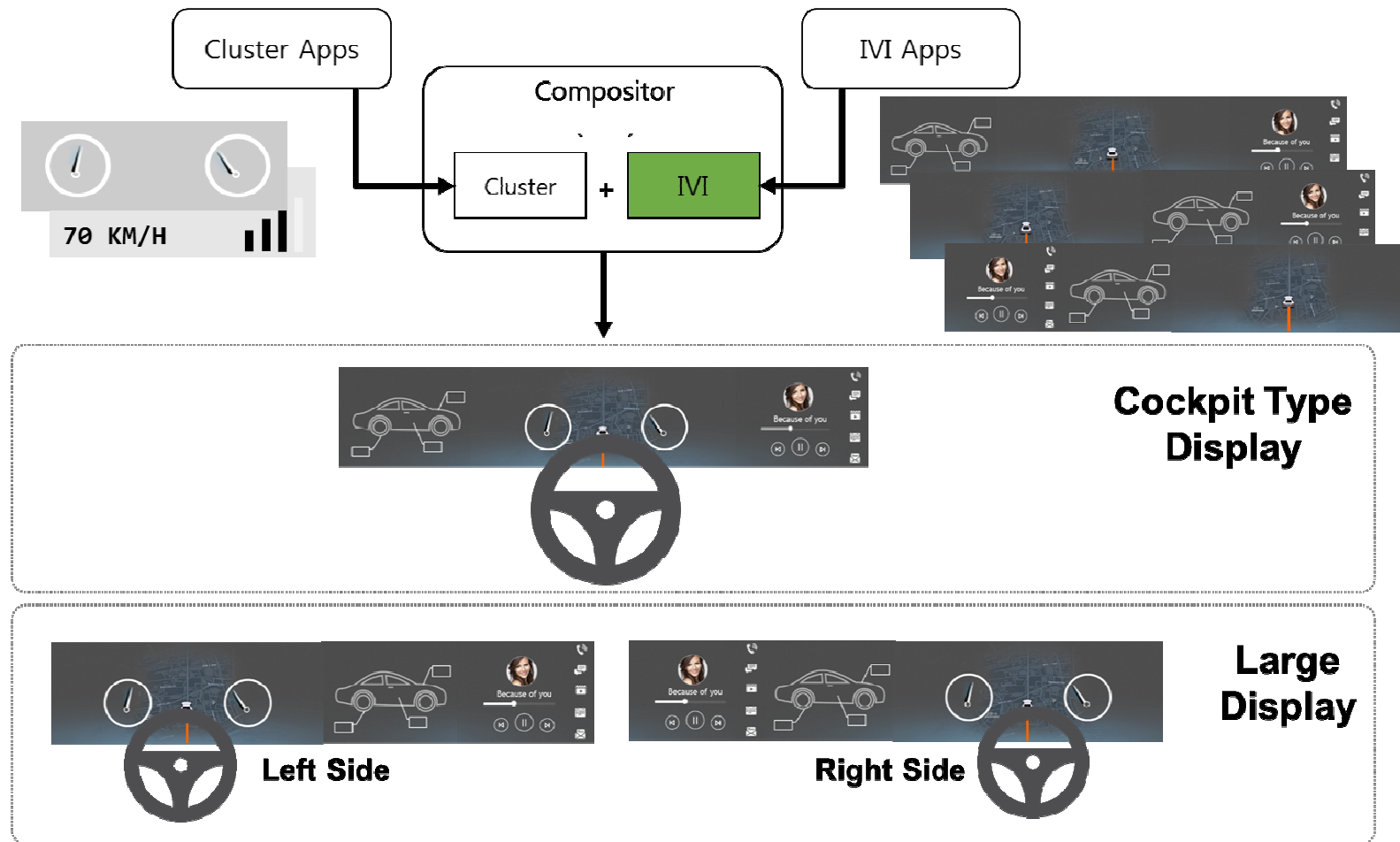

Factor	Feature
CPU	Intel Core i3-4010U
Mem	8G RAM
Hyp	XEN 4.3.1 (73.11.6)
OSs	Ubuntu 14.04

Dom0

Dom0 App

Compositor

Cluster + IVI

Qemu

SDL

DomU(VM1)

DomU App

Kernel

DRM

Mediator (vgt driver) | Dom0's Memory-mapped register | VM's Memory-mapped register

DRM

Xen(Hypervisor)

GPU

Framebuffer

Physical Memory-mapped register

VM's Framebuffer

21.5" 3840 x 720 LCD

Customized part

Data

6. Overlay

※ This figure is not real image because the output is a LGE confidential.

Output Image

touch area

Cluster layer

Overlay

IVI layer

Car Status App.

Navigation App.

Communication App.

IVI Apps.

Cluster Apps

IVI Apps

Compositor

Cluster + IVI

70 KM/H

Cockpit Type Display

Large Display

Left Side

Right Side

8. What else?

- **Communicate between Cluster and IVI, to support various Input systems**

For Sync, Sharing

Input

Steering Wheel Button   Center Console Button   Touch Input
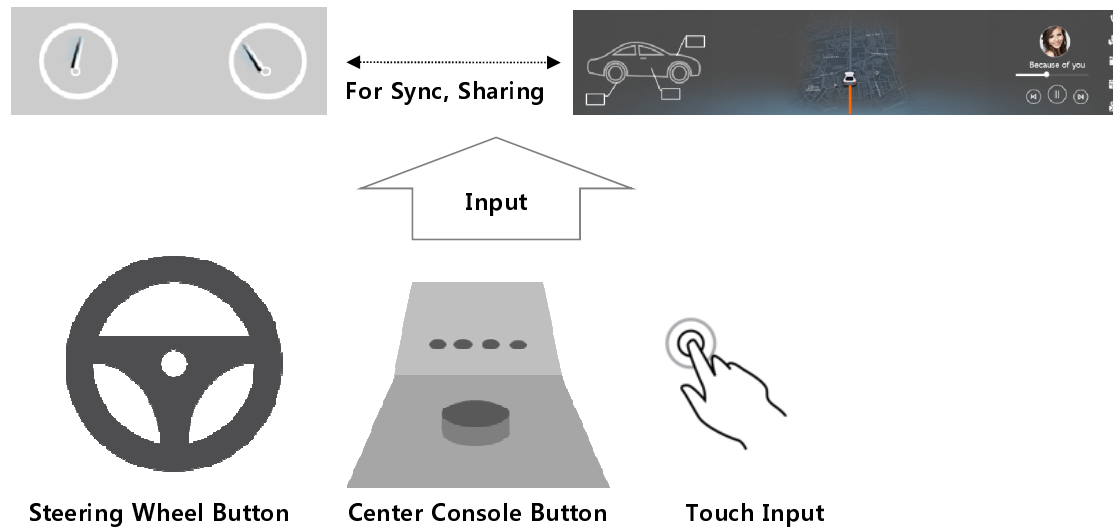
- **Why X11?**
  - ✓ **At that time prefer quick feasibility about consolidation display**
  - ✓ **Technical restriction that is SDL version.**

- **Finally, replacement to Wayland on desktop shell. But there are some issues.**
  - ✓ **Window bar, Z-order and offset setting.**

9. Reloaded Apps

- **Reboot scenario of IVI System**

Reboot

Re-arrange Apps

Z-Order

Transparent

Window Offset

Expected Result

Bad Result
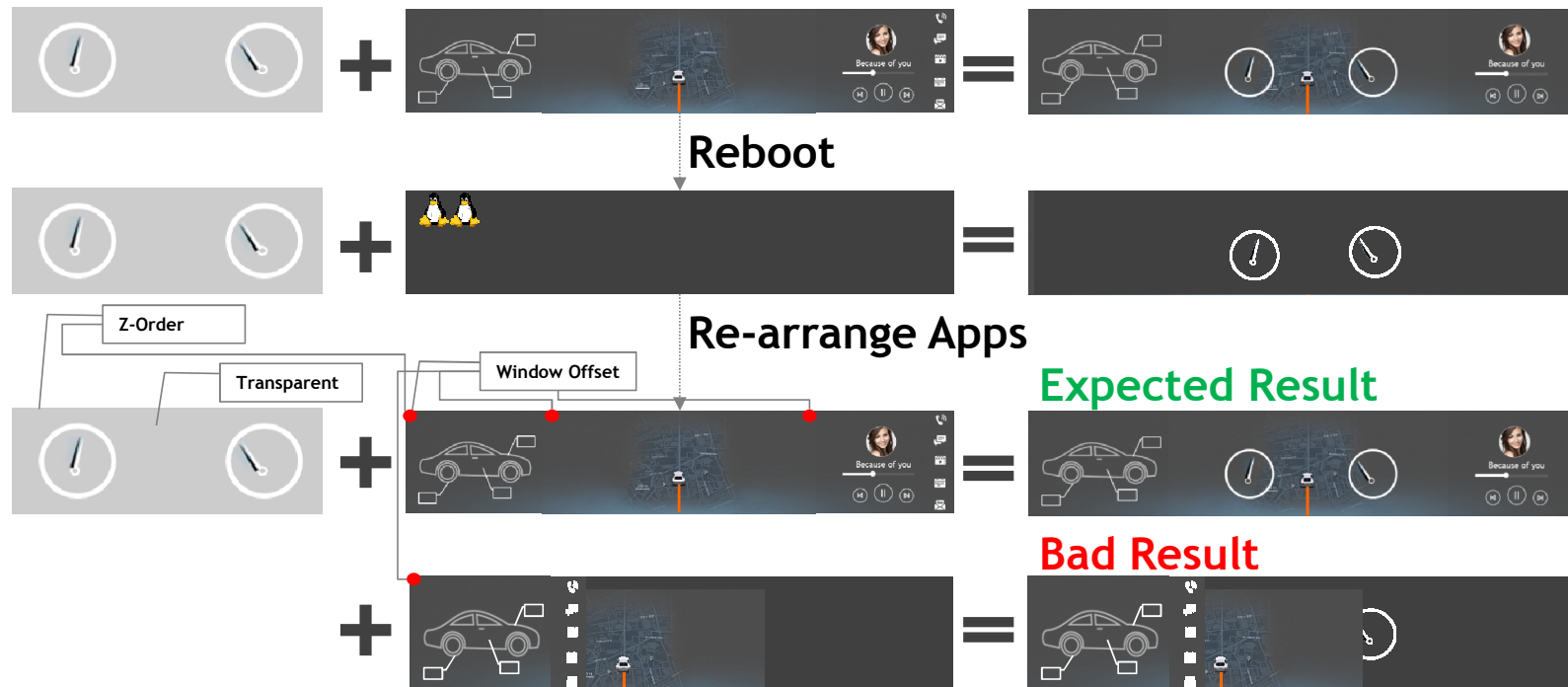
- **Failover of IVI on top of virtualization**
  - ✓ **Weston on Cluster system**
  - ✓ **Reload apps of IVI after reboot**

10. Conclusion

- **Composite system is very important for rich UI/UX and reconfiguration.**
  - Transparent, Windows Offset and Z-Order

- **Light weight compositor for reduce the resource of system.**

- **Consolidated display system is based on virtualization technology.**

- **Cluster and IVI system can directly access to GPU for graphical and multiple information integration.**
  - GPU Virtualization for graphic performance between Cluster and IVI.

- **The cluster and IVI screen are overlaid, it allows us to use digital cluster and IVI at the same time.**

- **Next Step for Feasibility of affordable consolidation display system**
  ARM SoC / Hypervisor / GPU Virtualization / Wayland, Weston, IVI Extension