

# **Issues and Solutions for applying Window System to In-Vehicle Infotainment System**

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# Introduction of Window System

1. Provide a Window for each Application.

2. Function...



1. Displaying Windows
2. Compositing Windows
3. Providing Window effects

3. Example ...



Wayland/Weston

# Trend of Window System

		X	DirectFB	Wayland / Weston
1	<u>Light-weight Structure</u>	N	D	O
2	<u>Easy to realize multi-window</u>	O	D	O
3	<u>Support Client Side Renderer</u> OpenGL ES™	O	D	O

**Choice!**

O: OK.  
D: Depend.  
N: Not OK.

# Introduction of In-Vehicle Infotainment System

## In-Vehicle Display Device having Information and Entertainment Applications

### 1. Information Applications

- Car Navigation, Rear View Camera, Driving Information,...



### 2. Entertainment Applications

- Audio, Apple CarPlay, MirrorLink, MiraCast,...



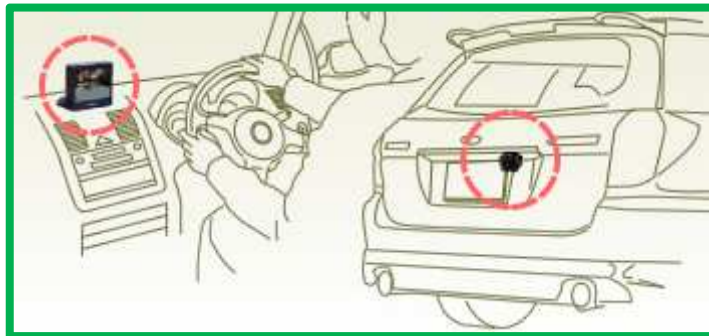
# Requirements for Window System

## 1. Multi-Window, Multi-Display



- Various Application
- HMI animation 30fps
- Video 60fps
- and so on...

## 2. Stable Displaying for ensuring safety

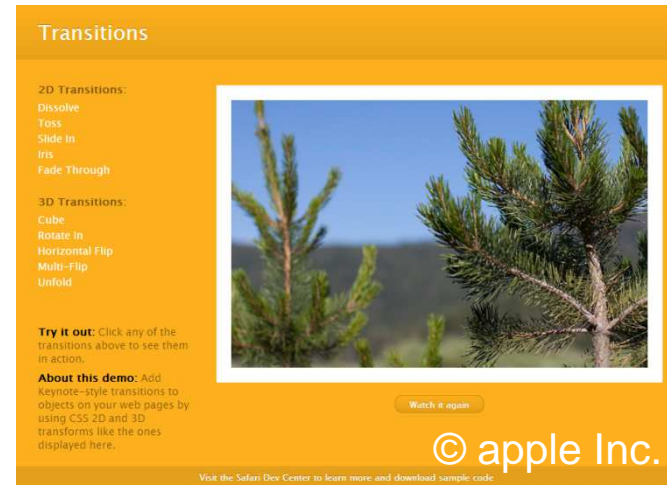


- Rear View Camera
- Real-time Driving Information

# Evaluation of Wayland/Weston

## 1. Functionality


- Multi-Window
- Multi-Display
- Window Animation (Transition)



## 2. Performance

- HMI Animation, Video
- at single-window, multi-window
- frame-rate, stability of display, real-time operation

# Evaluation Result Functionality

		 Wayland/ Weston
1	<b>Multi-Window</b>	<input type="radio"/>
2	<b>Multi-Display</b>	<input type="radio"/>
3	<b>Window 2D Animation</b>	<input type="radio"/>
4	<b>Window 3D Animation</b>	<input type="radio"/>




O: OK.  
D: Depend.  
N: Not OK.

**Meets All Requirements of Functionalities**

# Evaluation Result: Performance/Stability

## Evaluation Under our H/W and S/W

		 Wayland/ Weston
1	HMI Animation 30fps at Single Window	O
2	HMI Animation 30fps at Multi-Window	N
3	Video Camera 60fps at Single Window	O
4	Video Camera 60fps at Multi-Window	N




O: OK.  
D: Depend.  
N: Not OK.

**Not Meet Performance Requirements at Multi-Window**




# Analysis of Performance Bottleneck

## load rate of Processor.

		 Wayland/ Weston
1	GPU load rate	<i>over100%</i>
2	CPU load rate	<i>under50%</i>

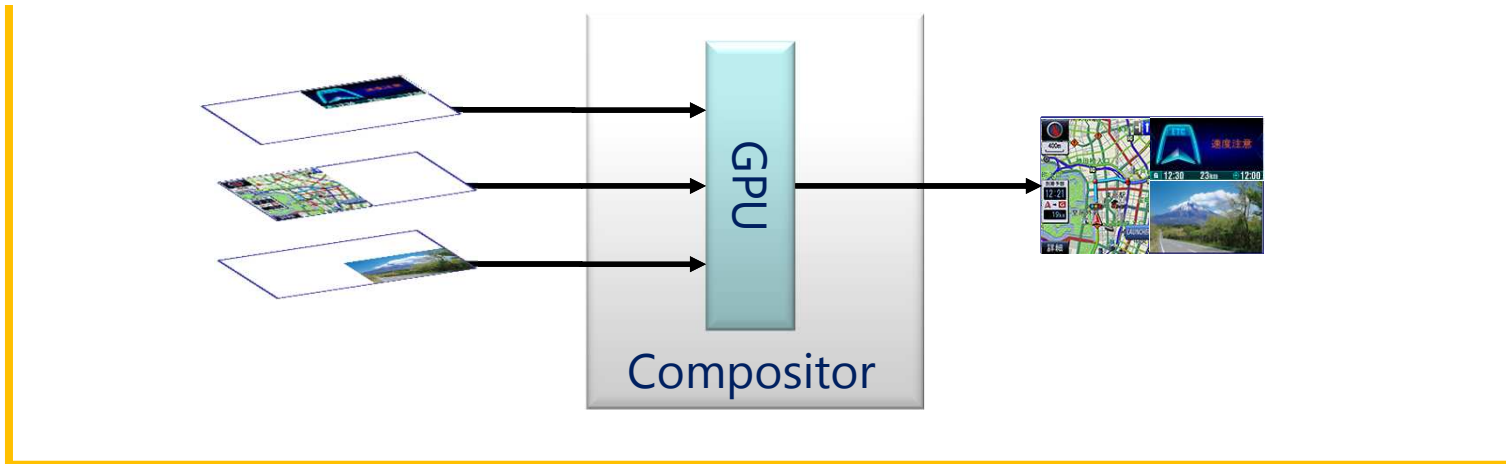
## GPU load rate of Process.

		 Wayland/ Weston
1	Car Navigation App.	<b>25%</b>
2	Compositor	<b>50%</b>
3	HMI App.	<b>10%</b>

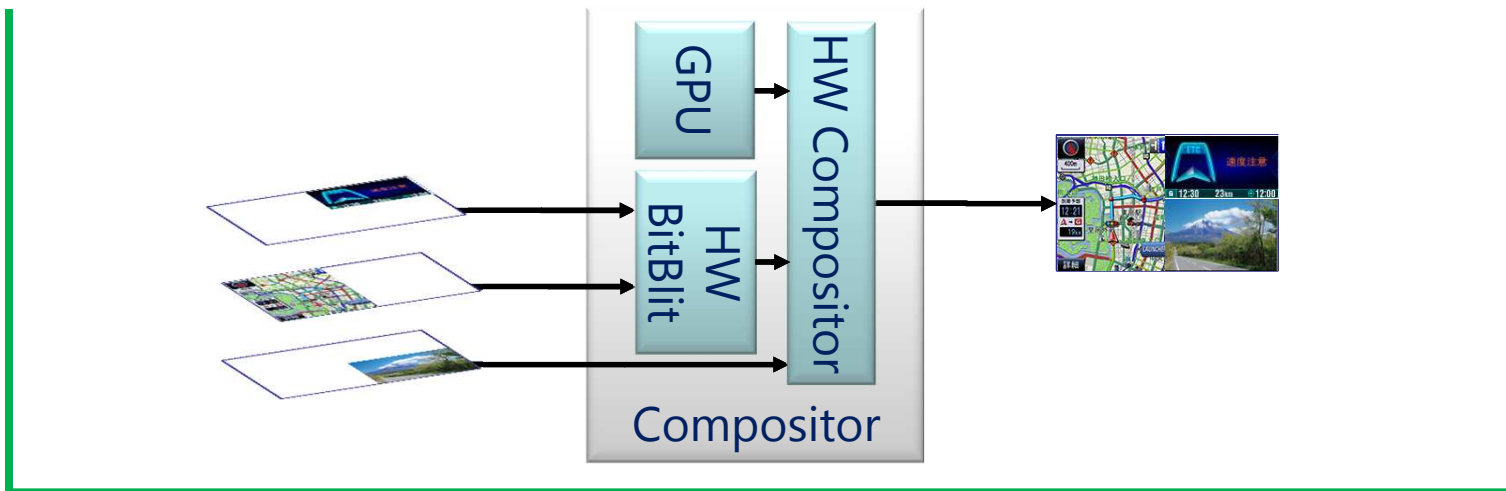
**GPU heavily loaded by Compositor**

# Issue & Solution

## Issue GPU heavily loaded by Compositor



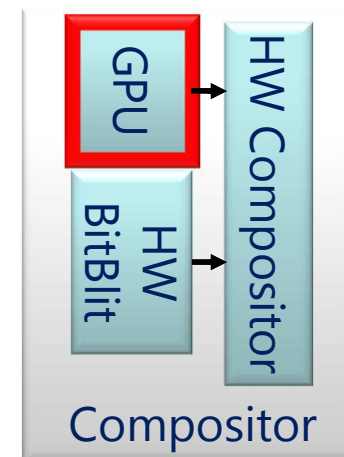
## Solution Reduce GPU loaded by hybrid Compositor



# Solution: Hybrid Compositor

## Compositor Specification

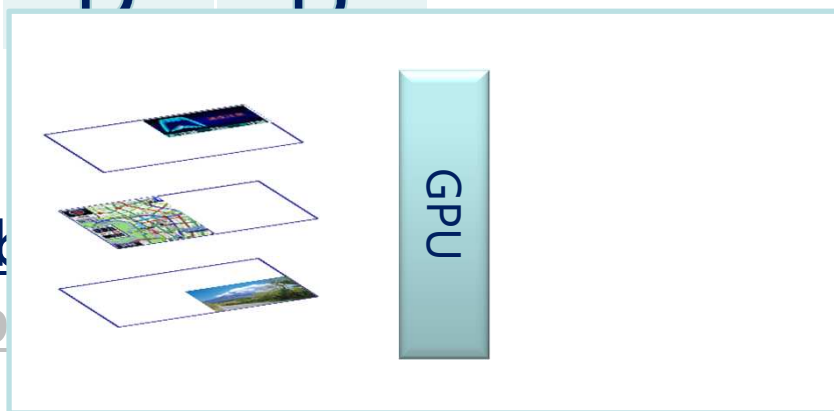
		GPU	HW Comp.	HW BitBlit
1	<b>Multi-Window Composition</b>	D	N	D
2	<b>High performance</b>	D	O	D
3	<b>Stable Displaying</b>	D	O	D
4	<b>3D Animation</b>	O	N	N
5	<b>2D Animation</b>	O	D	D



O: OK.  
D: Depend.  
N: Not OK.

## Effect

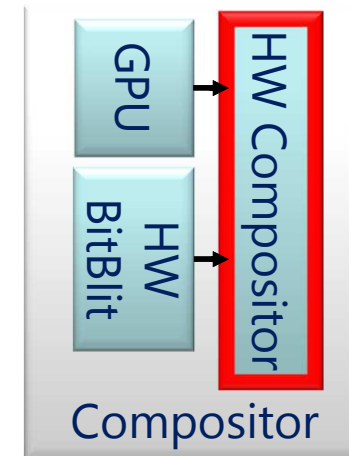
- 1. 3D Animation available**
- 2. High Speed and Stable**
- 3. GPU Load Reduction**



# Solution: Hybrid Compositor

## Compositor Specification

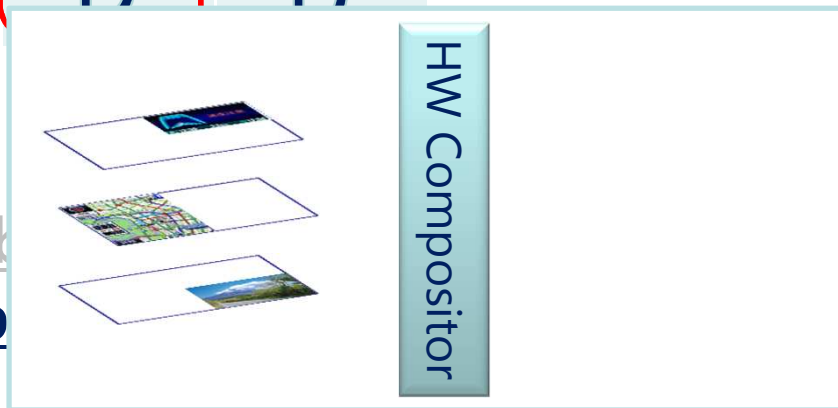
		GPU	HW Comp.	HW BitBlit
1	<b>Multi-Window Composition</b>	D	N	D
2	<b>High performance</b>	D	O	D
3	<b>Stable Displaying</b>	D	O	D
4	<b>3D Animation</b>	O	N	N
5	<b>2D Animation</b>	O	D	D



O: OK.  
D: Depend.  
N: Not OK.

## Effect

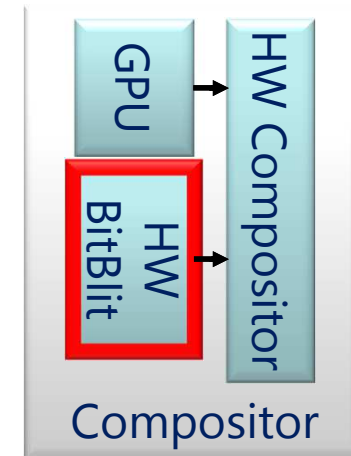
1. 3D Animation available
2. High Speed and Stable
3. GPU Load Reduction



# Solution: Hybrid Compositor

## Compositor Specification

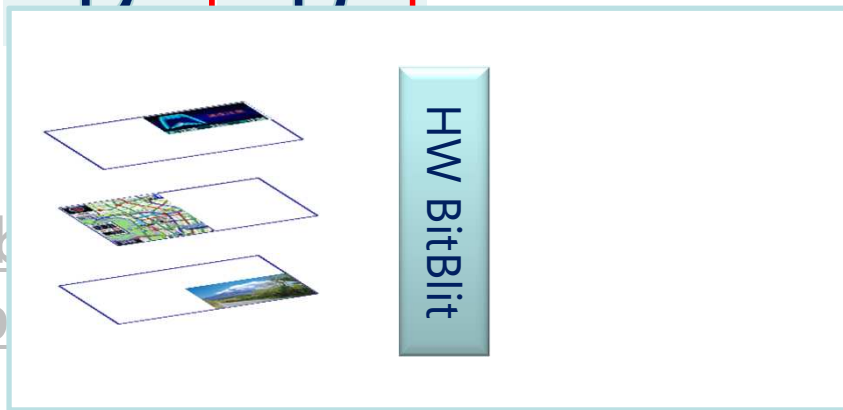
		GPU	HW Comp.	HW BitBlit
1	<b>Multi-Window Composition</b>	D	N	D
2	<b>High performance</b>	D	O	D
3	<b>Stable Displaying</b>	D	O	D
4	<b>3D Animation</b>	O	N	N
5	<b>2D Animation</b>	O	D	D



O: OK.  
D: Depend.  
N: Not OK.

## Effect

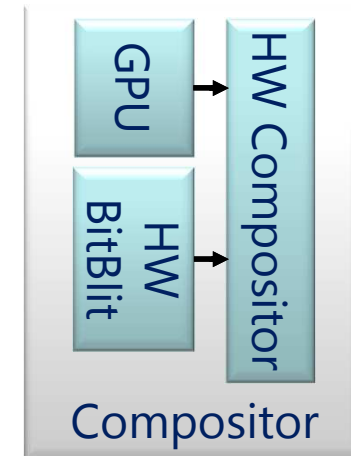
1. 3D Animation available
2. High Speed and Stable
3. GPU Load Reduction



# Solution: Hybrid Compositor

## Compositor Specification

		GPU	HW Comp.	HW BitBlit
1	<b>Multi-Window Composition</b>	D	D	D
2	<b>High performance</b>	D	O	D
3	<b>Stable Displaying</b>	D	O	D
4	<b>3D Animation</b>	O	N	N
5	<b>2D Animation</b>	O	D	D



O: OK.  
D: Depend.  
N: Not OK.

## Effect

- 3D Animation available**
- High Speed and Stable Displaying**
- GPU Load Reduction**

# Conclusion

1. **In-Vehicle Infotainment System requires High-Performance and Stable Displaying.**
2. **Weston couldn't meet Performance Requirements at the time of a Multi-Window.**
3. **We extend Weston Compositor to Hybrid Compositor.**
  - Composited by GPU, HW Compositor, HW BitBlit Engine.

# Next...

## 1. More Safety Window System

- Secure Displaying

## 2. High-resolution representation Window System

- 3D Window Animation with shader programming



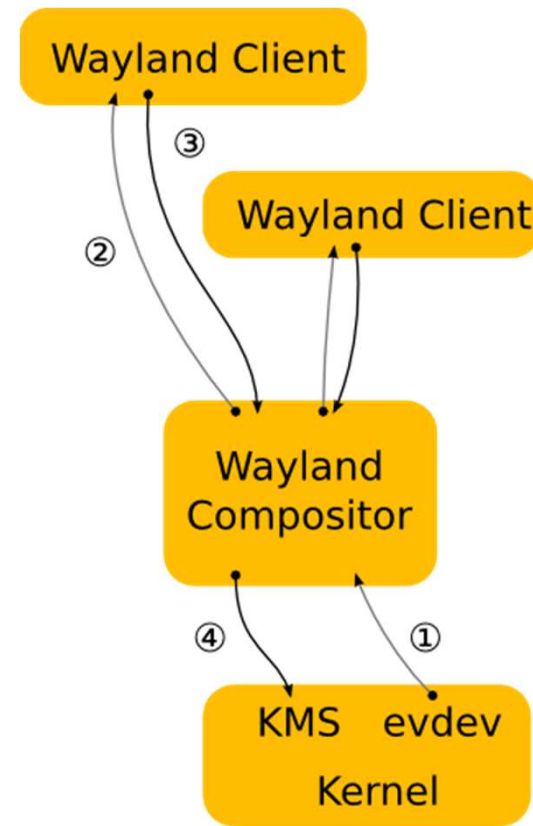
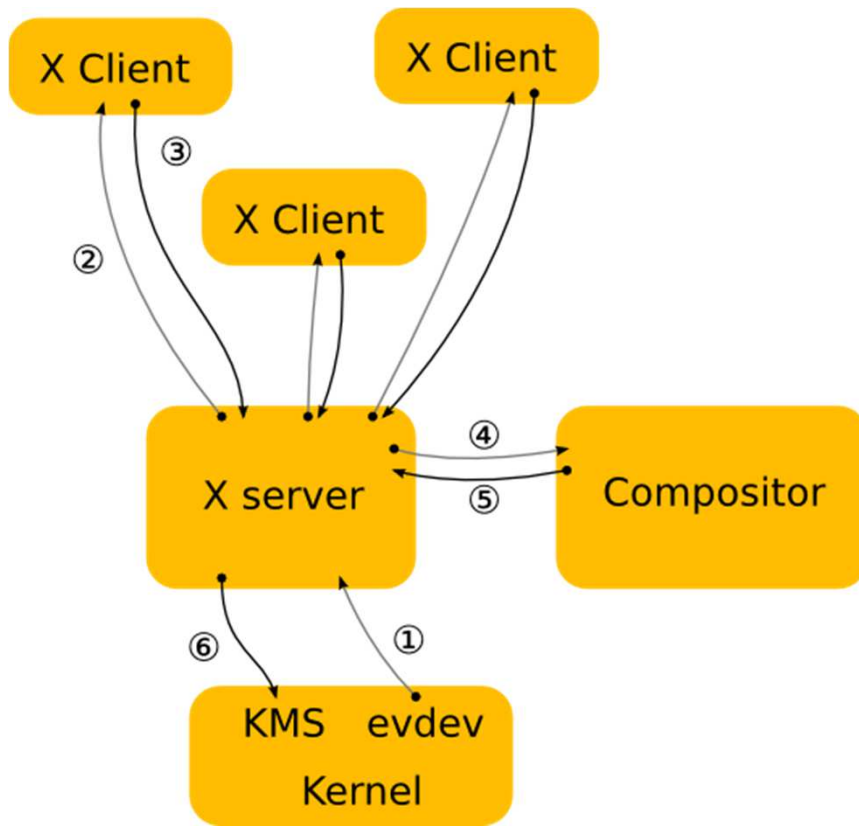
The Panasonic logo is displayed in white, bold, sans-serif font on a blue rectangular background. The background has a subtle gradient, being darker at the top and lighter at the bottom.

Thank you!

## Appended Information

- Wayland/Weston
  - <http://wayland.freedesktop.org/>

# X and Wayland



# XWayland

