Virtualization in Embedded / Automotive Systems

By GlobalLogic

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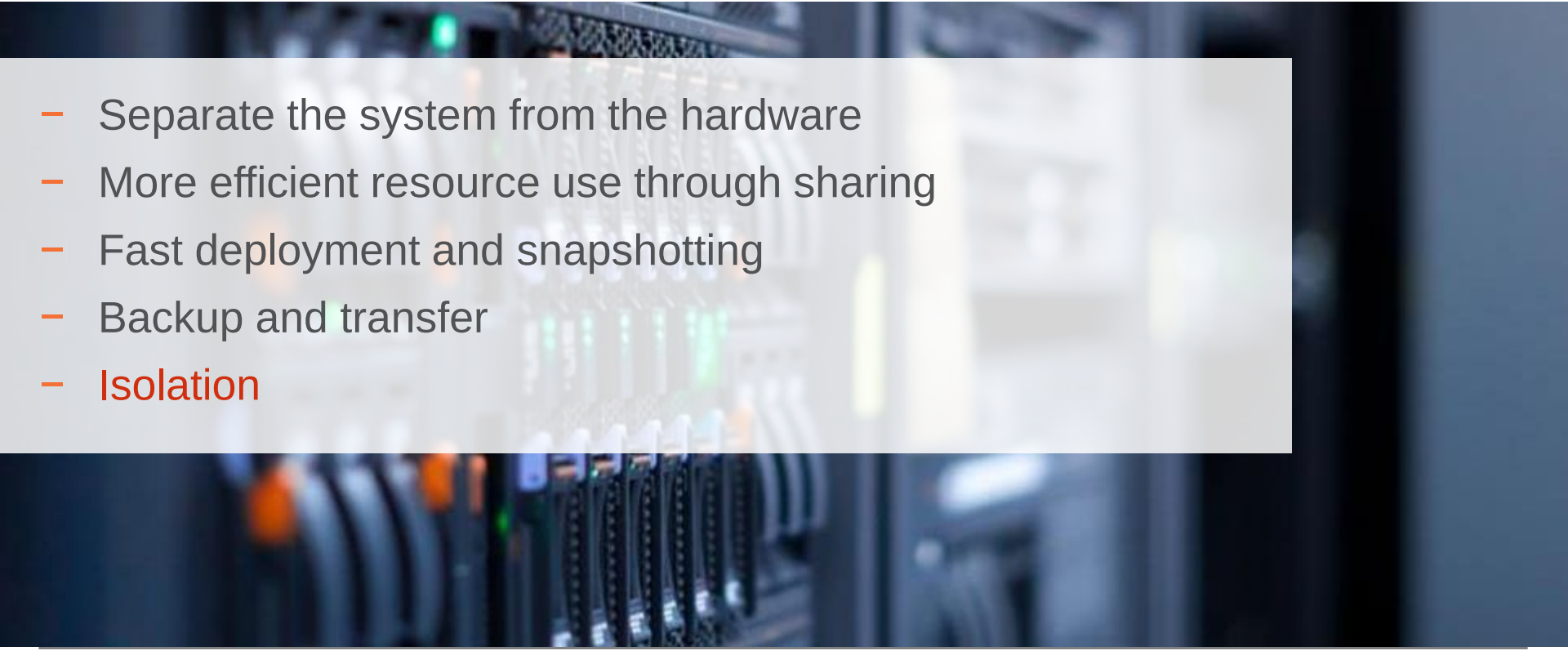
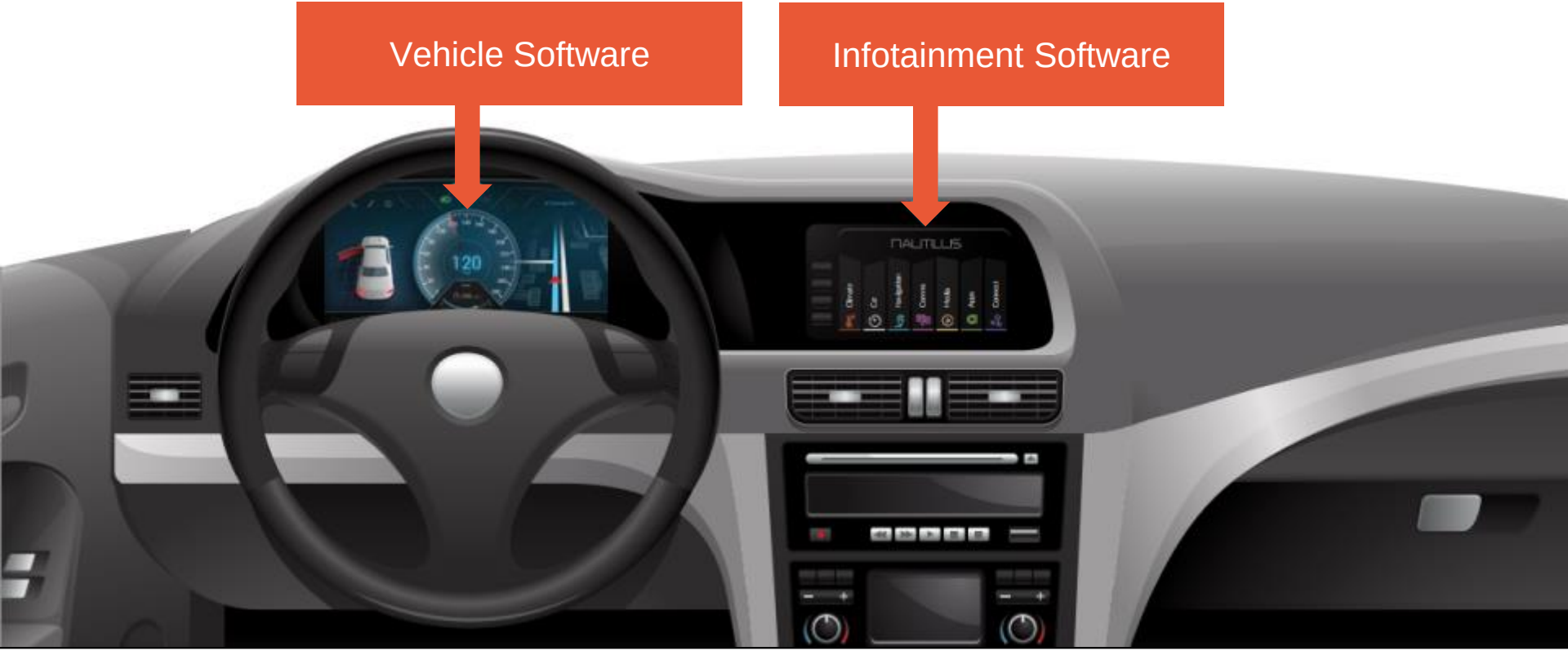
What are the main use cases for virtualization?



- Separate the system from the hardware
- More efficient resource use through sharing
- Fast deployment and snapshotting
- Backup and transfer
- Isolation

Use Case Example: Automotive IVI & Display Systems



Why Xen?

- Best in class Type 1 Hypervisor
- Flexible virtualization modes
- Driver disaggregation available
- Strong ARM platforms support
- Open Source, part of Linux Foundation
- Compact code snapshot on ARM
- Mature since 2003 in general computing virtualization

Poor Performance
Scope for Improvement
Optimal Performance

P = Paravirtualized
VS = Software Virtualized (QEMU)
VH = Hardware Virtualized

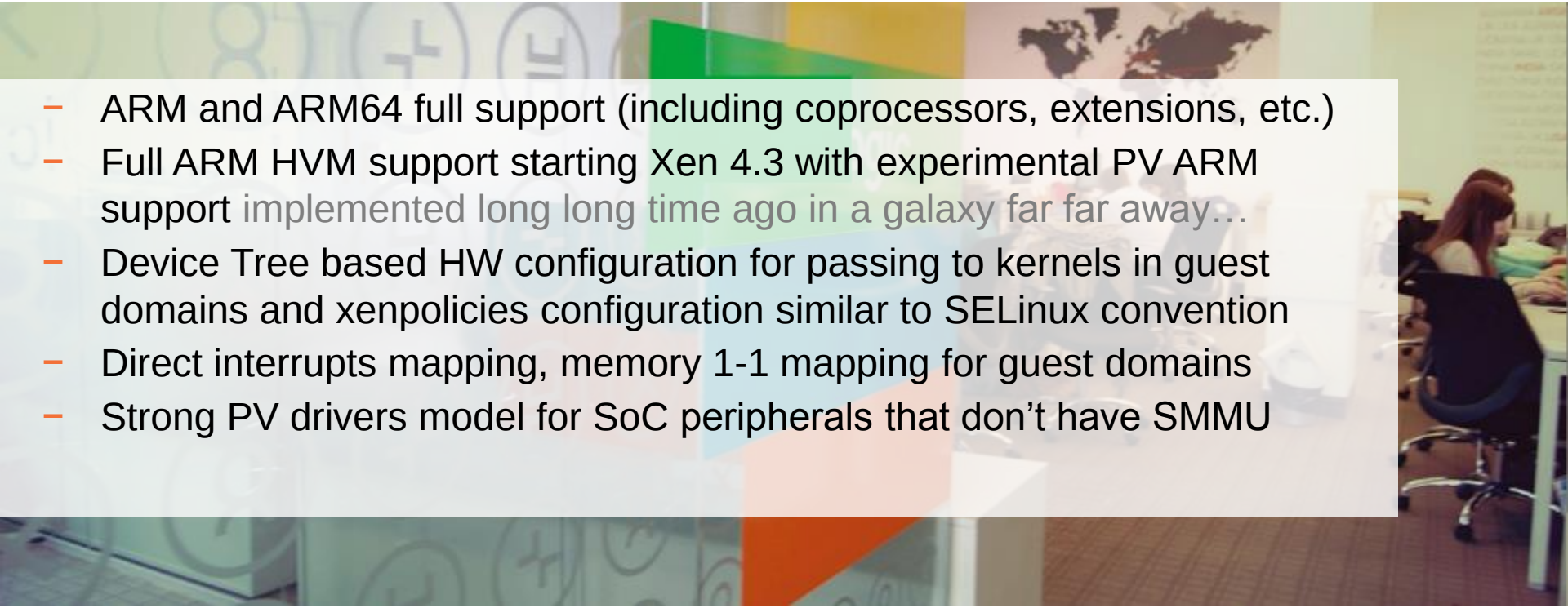
Shortcut	Mode	With	Disk and Network	Interrupts & Timers	Emulated Motherboard, Legacy Boot	Privileged Instructions, Page Tables	
HVM / Fully Virtualized	HVM		VS	VS	VS	VH	Windows
HVM + PV drivers	HVM	PV Drivers	P	VS	VS	VH	Windows
PVHVM	HVM	PVHVM Drivers	P	P	VS	VH	Linux, BSDs, ...
PVH	PV	pvh=1	P	P	P	VH	Linux, BSDs, ...
PV	PV		P	P	P	P	Linux, BSDs, ...

Xen PVH Mode

- No emulated devices
- No compatibility code
- No shadow pagetables

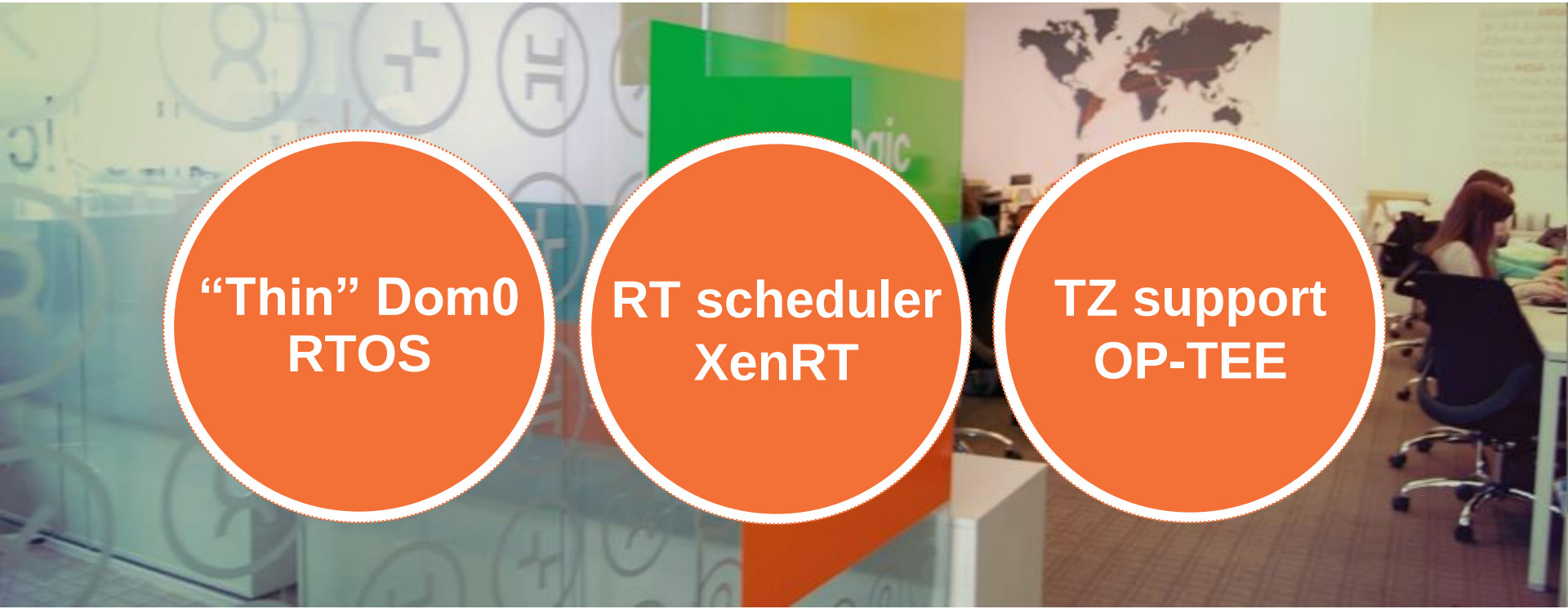
no need for qemu

Xen in Embedded has all natural features…

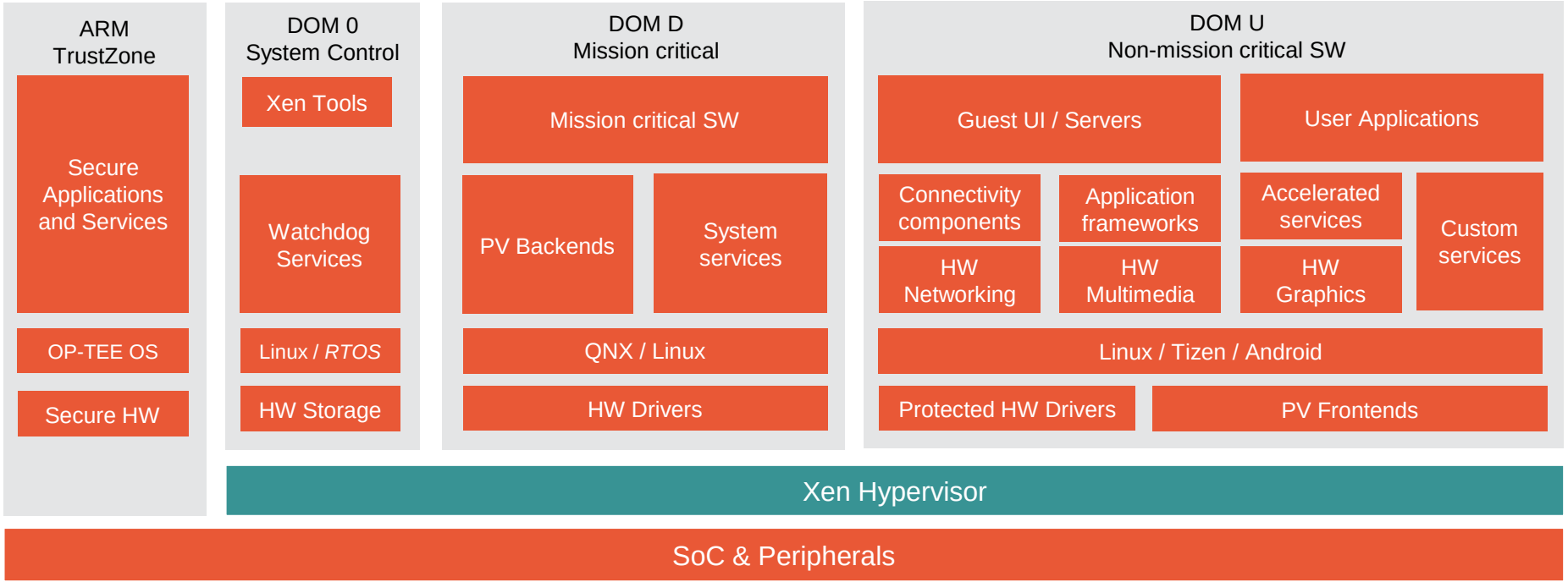


- ARM and ARM64 full support (including coprocessors, extensions, etc.)
- Full ARM HVM support starting Xen 4.3 with experimental PV ARM support implemented long long time ago in a galaxy far far away…
- Device Tree based HW configuration for passing to kernels in guest domains and xenpolicies configuration similar to SELinux convention
- Direct interrupts mapping, memory 1-1 mapping for guest domains
- Strong PV drivers model for SoC peripherals that don’t have SMMU

… and few Superpowers



Automotive Nautilus Solution Example

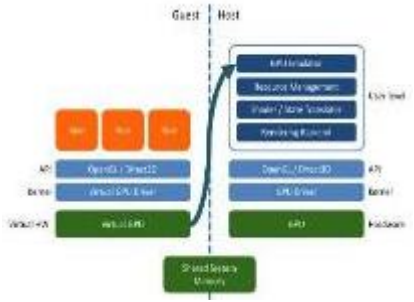


TECHNICAL DETAILS

Common GPU Virtualization Approaches

Driver Split

- **match**: isolation, parallelism, safety
- no match: robustness, performance on embedded systems, high cost

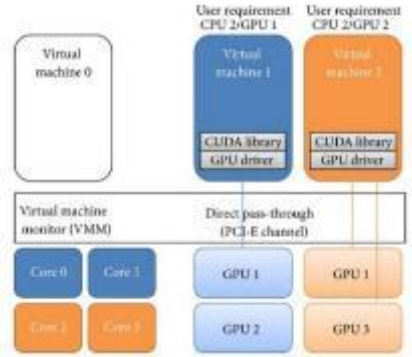


Full GPU Emulation

- Registers & VRAM virtualized
- Every single one access is trapped & emulated
- Not even considered as solution

Direct pass-through

- **match:** safety, performance, robustness
- no match: isolation, parallelism



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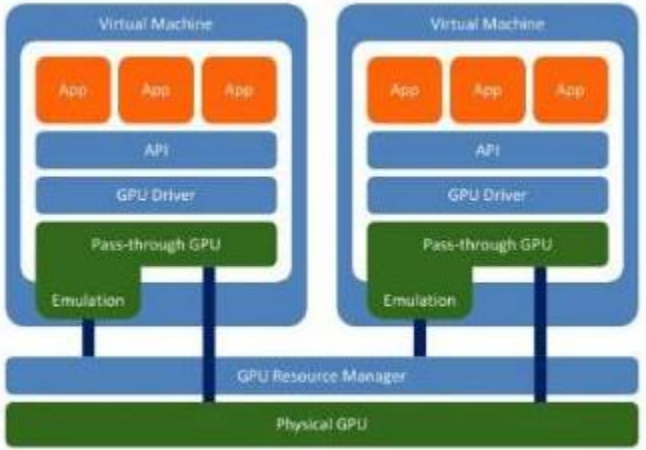
The Right Solution

Mediated pass-through

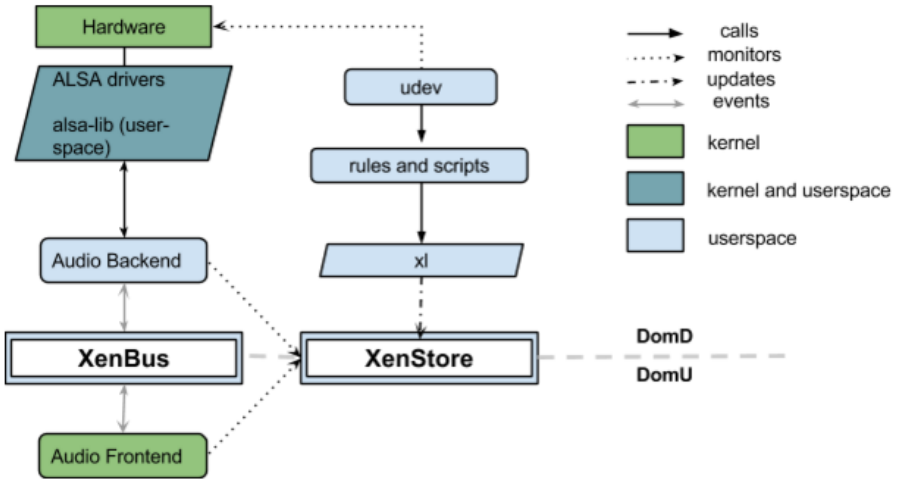
- **match:** isolation, parallelism, safety, robustness
- not quite match: performance

- Implementation similar to Intel's XenGT
- Modifications on the GPU firmware, hypervisor, kernel GPU driver and even userspace libraries



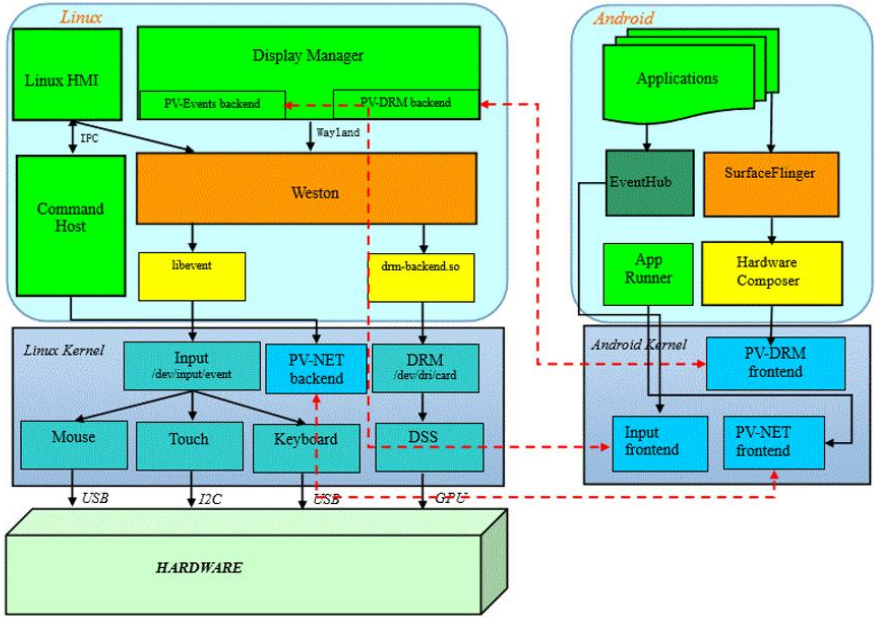
Virtual Audio Architecture

- Udev config handles appearing devices and passes them to xl (libxl) as virtual audio devices
- Libxl handles virtual audio in the standard manner and stores device's configurations into XenStore. Audio-manager (if present and not ad hoc'ed by udev) monitors XenStore for real device nodes and calls libxl to mark those as slaves for particular virtual channel (according to rules)
- Backends monitor for changes in device configuration and reconfigure underlying implementation (ALSA).



Virtual Display Architecture

- Weston client application performs DRM rendering and handling event to/from the User Domain
- Display Manager includes DRM backend port and perform either copying of the User Domain framebuffers the to the Wayland shared memory buffer using Wayland Shared Memory protocol or the mapping of user space buffers from the Driver Domain PV-DRM backend to the User Domain kernel frontend driver
- Display Manager also handles the events from the input subsystem and route them via PV-events backend to the User Domain input front-end device vkbd



Performance numbers

Quadrant-Professional-Edition-2.1.1.apk GL													
	Native 6AK.1.2						Nautilus-20160205						% of 6AK.1.2
						AVG						AVG	
Total	5049	5005	5089	5107	5100	5070	5209	5111	5088	5246	5319	5194.6	**102.46%**
CPU	13212	12857	12889	12824	12914	12939.2	12581	12520	11498	12584	12581	12352.8	**95.47%**
Mem	7547	7435	7833	7957	7798	7714	7499	7612	7467	7798	7850	7645.2	**99.11%**
IO	1747	1802	1794	1849	1852	1808.8	3353	3192	3374	3354	3253	3305.2	**182.73%**
2D	500	500	500	501	500	500.2	385	417	476	450	357	417	**83.37%**
3D	2240	2430	2431	2402	2436	2387.8	2227	1816	2625	2042	2556	2253.2	**94.36%**

Thank you

Questions?

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Also, become a member of Xen community @ http://xenproject.org