What VirtIO can do for multi-OS integration in the vehicle

Coupling HVs and Classic AUTOSAR

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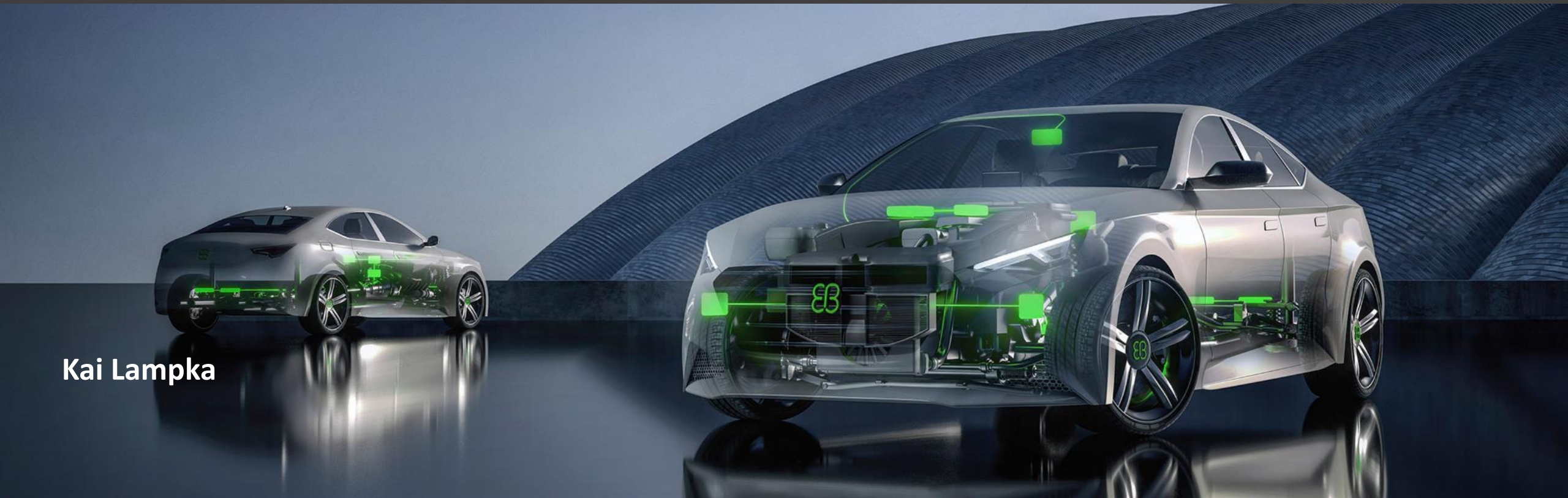
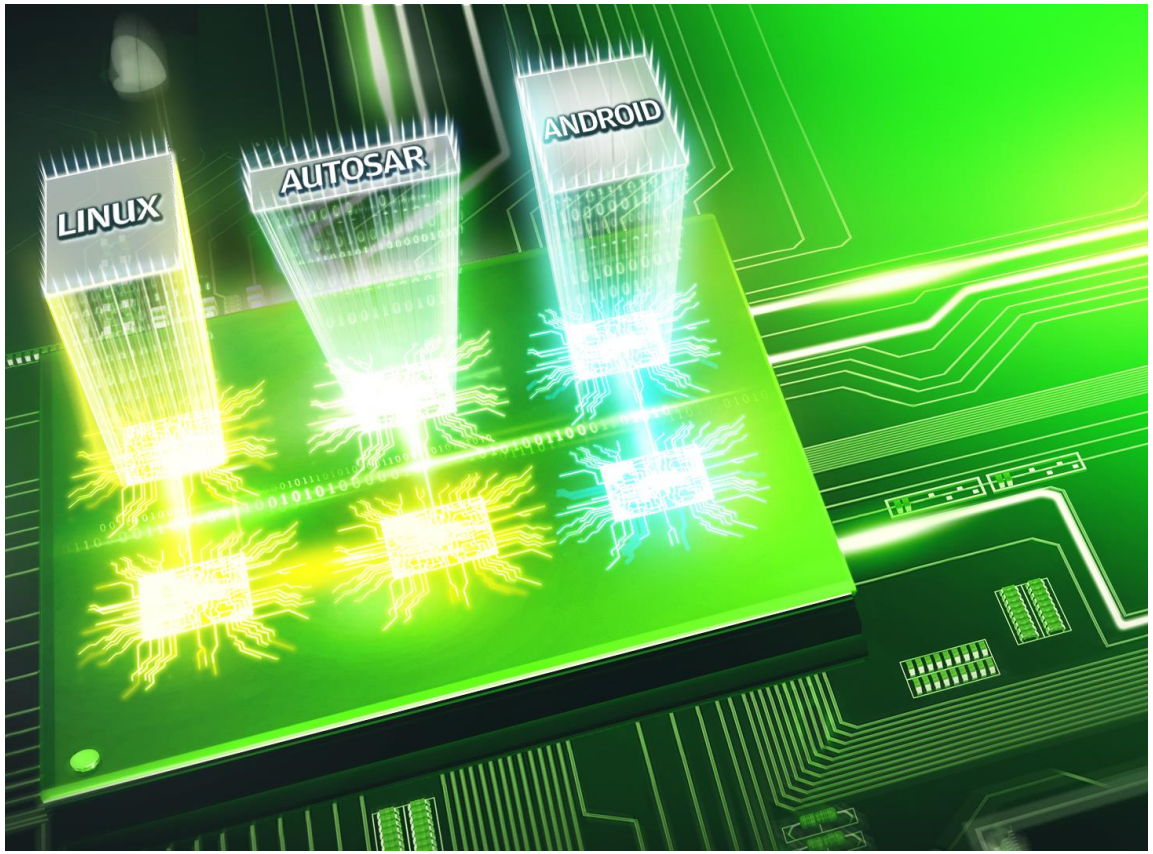


Kai Lampka

Agenda

I. **Introduction**
II. Device sharing across partitions, here ETH AVB
III. Conclusion



On the road today

Past

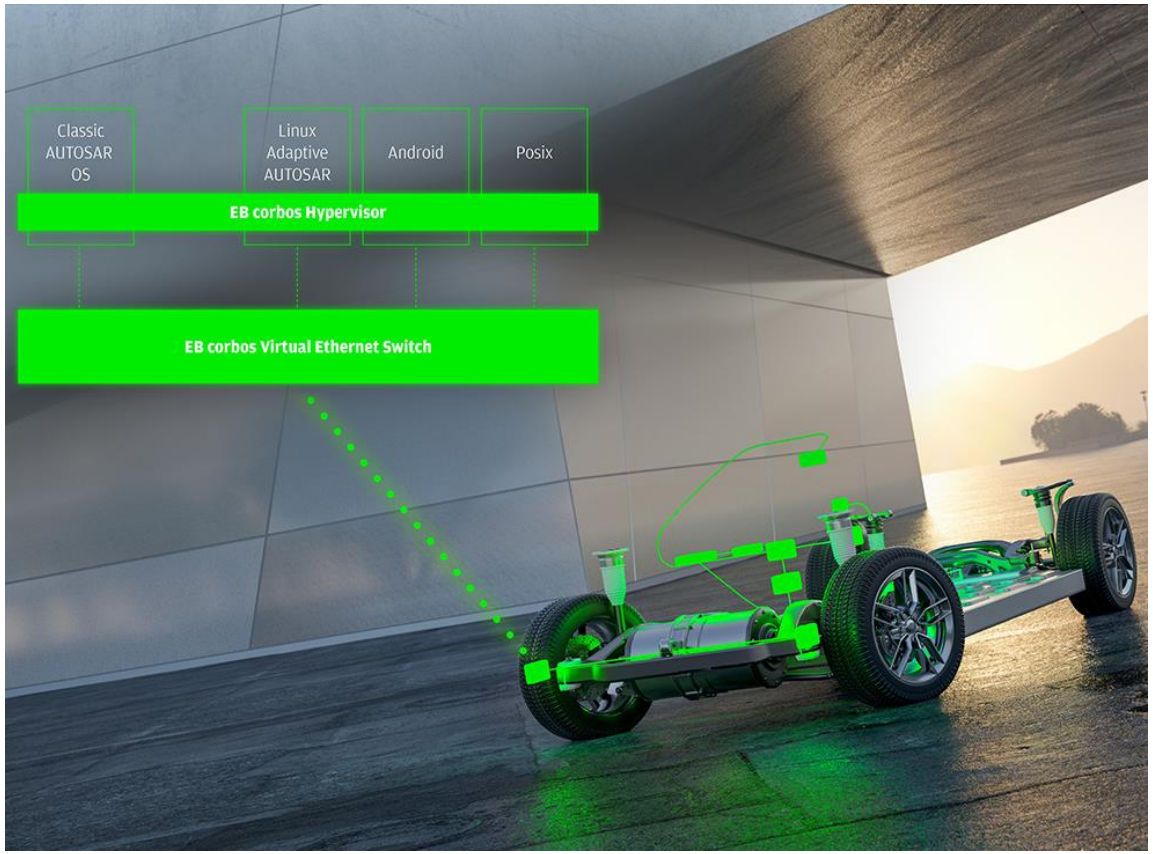
- 70-150 distributed **single core** ECUs
- Each ECU features a small set of separated functions, e.g. window lifter…
- Classic ProOSEK, AUTOSAR OS
- Multiple deterministic network stacks in use (CAN, FlexRay, LIN, etc.)

Today

- More single and few multi-core ECUs running multiple functions
- High degree of predictability / hardware reliability
- Multicore version of **Classic** OSEK / AUTOSAR OS
- **No hardware virtualization support**

Upcoming

- **Performance-centric multi-core SoC (x86, ARM, and GPU-architectures) as known from consumer electronics**
- Networking via real-time Ethernet



Platform spectrum

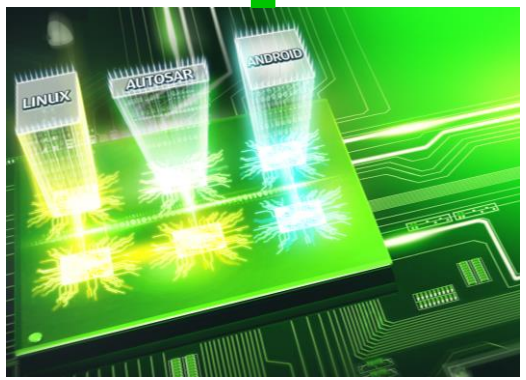
Predictability- and reliability-oriented designs

Performance-oriented designs

Applications with highest timing & availability demands

Model-based control

- Few sensors and few actors
- Well understood control systems



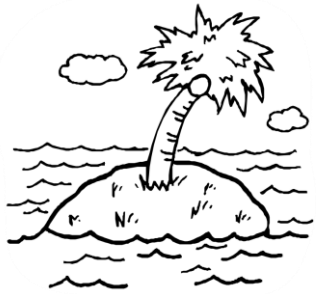
Applications with highest computing demands

Complex decision models

- Many sensors & actors
- Not well understood algorithms

Prerequisites for tomorrow's in-car (composed) SW stacks

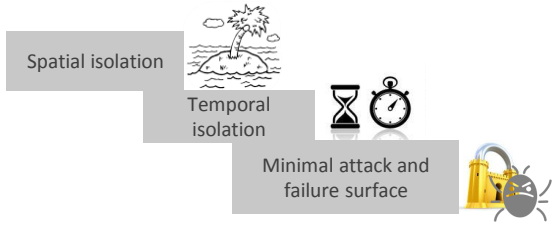
Spatial isolation for correct behavior



Temporal isolation for predictable behavior

Minimal attack and failure surface

Conflict: SoC vs. goals



1) Unsecured software and unsecured devices

- Flash devices are external devices, i.e. accessible with a proper set of tools
- Execute-in-place (XiP) on Flash not necessarily possible, i.e. images need to be copied into SDRAM
- **Parallel executing software (when booting a software stack) on different cores (who is doing what and when?)**

2) **Resources which are obviously shared**

- SDRAM, cores, and GPUs
- **Ethernet controller, CAN controller**
- **QSPI-Flash/eMMC-Flash/Hyperflash**
- Arm Trustzone/OpTEE (single threaded)

3) Resources which are implicitly shared among computing elements

- Common SoC Infrastrucutre, e.g. AXI-Bus, Caches

4) Running third-party software potentially at privilege level of the OS (e.g. device drivers from third parties)

- Different OS in a single SoC, e.g. Linux, Android, Classic AUTOSAR, QNX, etc. (who is the master, who is the servant?)

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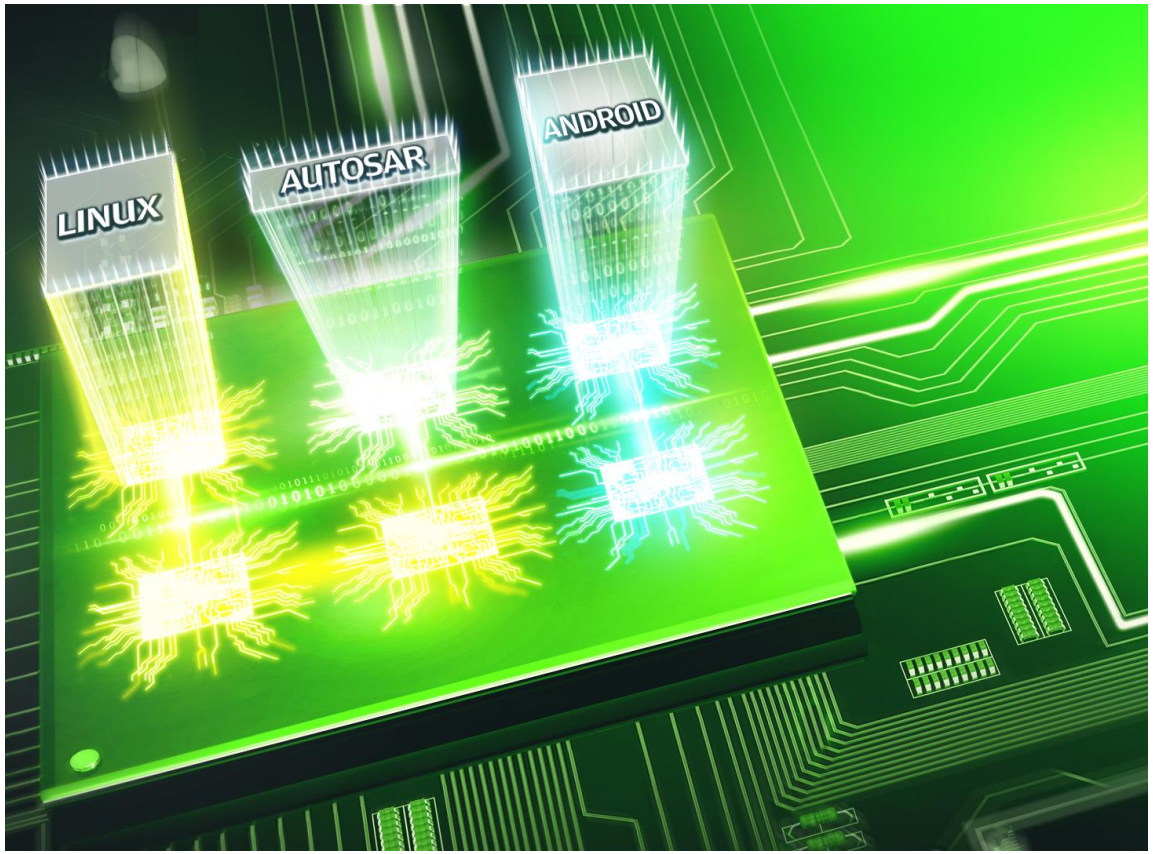
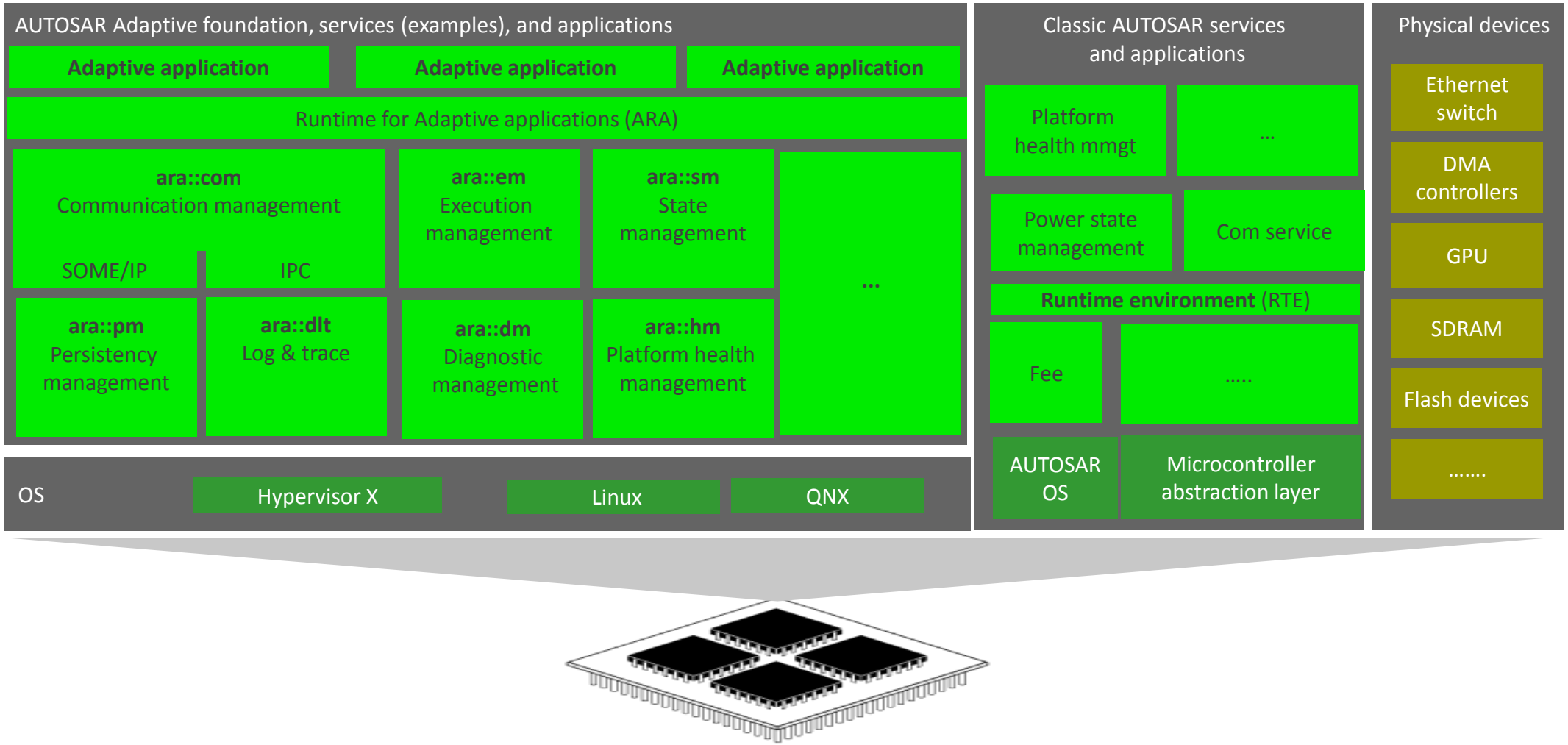


SW stack integration with (heterogneous) multi-cores



Means of interaction in a nutshell

Several mechanisms

- Inside OS:
  - Inter process communication (IPC),
  - shared memory+ notification
  - IRQs
- ***Node ↔ node: shared memory, notifications***

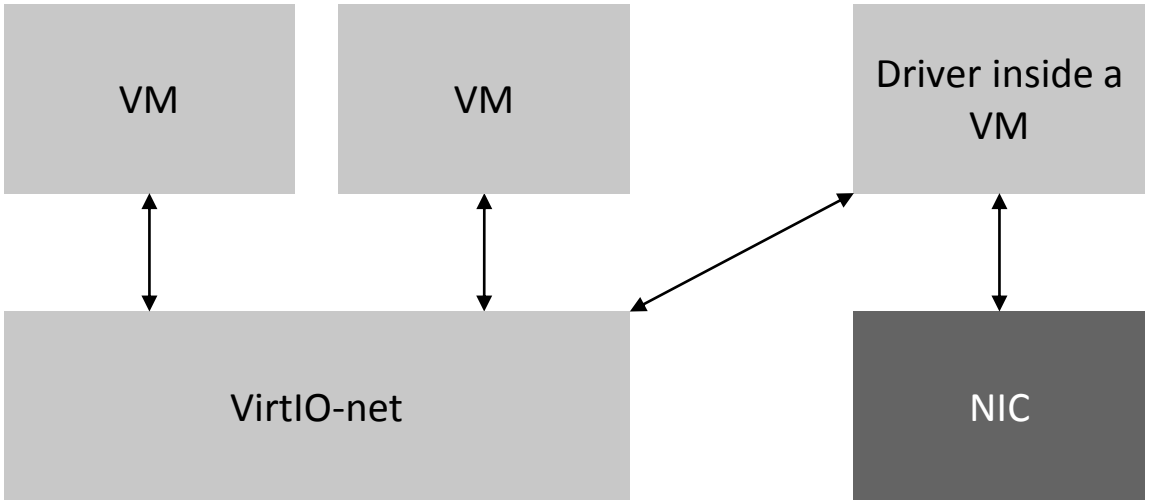
Generic approach for VM interaction: VirtIO

(already discussed in the morning session)

- Official standard
- Wide availability of guest drivers (Linux, *BSD, Windows, …)
- Used to share: Block devices, Network, GPUs ……..
  - …..

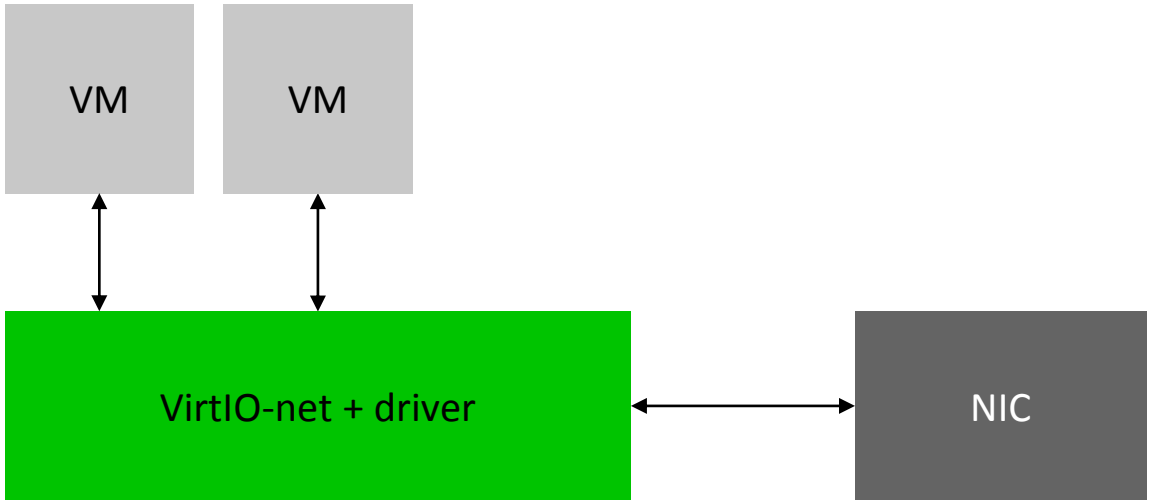
VirtIO—in action: Virtual networking

Default approach: VirtIO-net



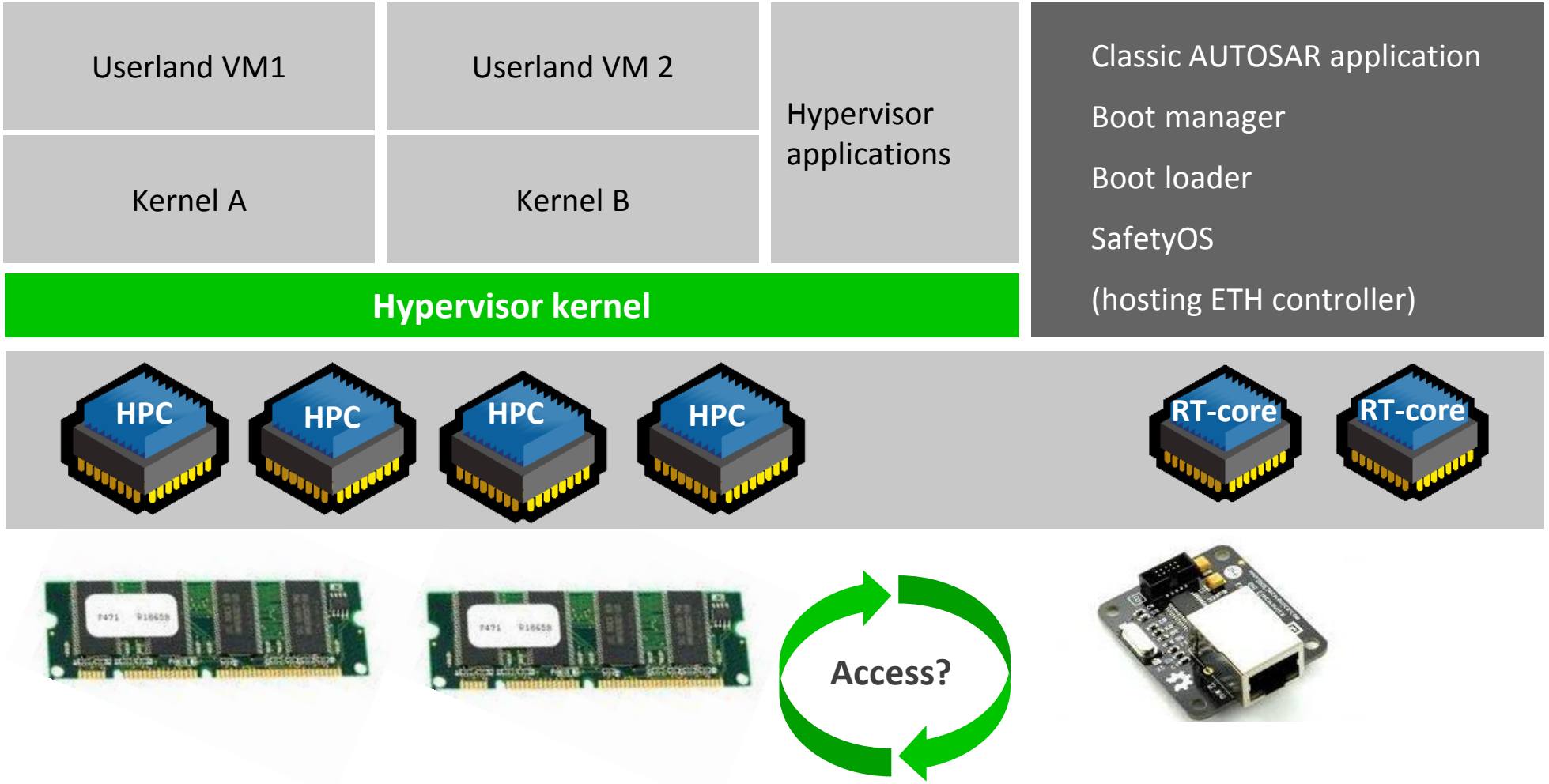
- Common OSs have VirtIO-net drivers
- Host needs to provide VirtIO-net component

Optimized solution

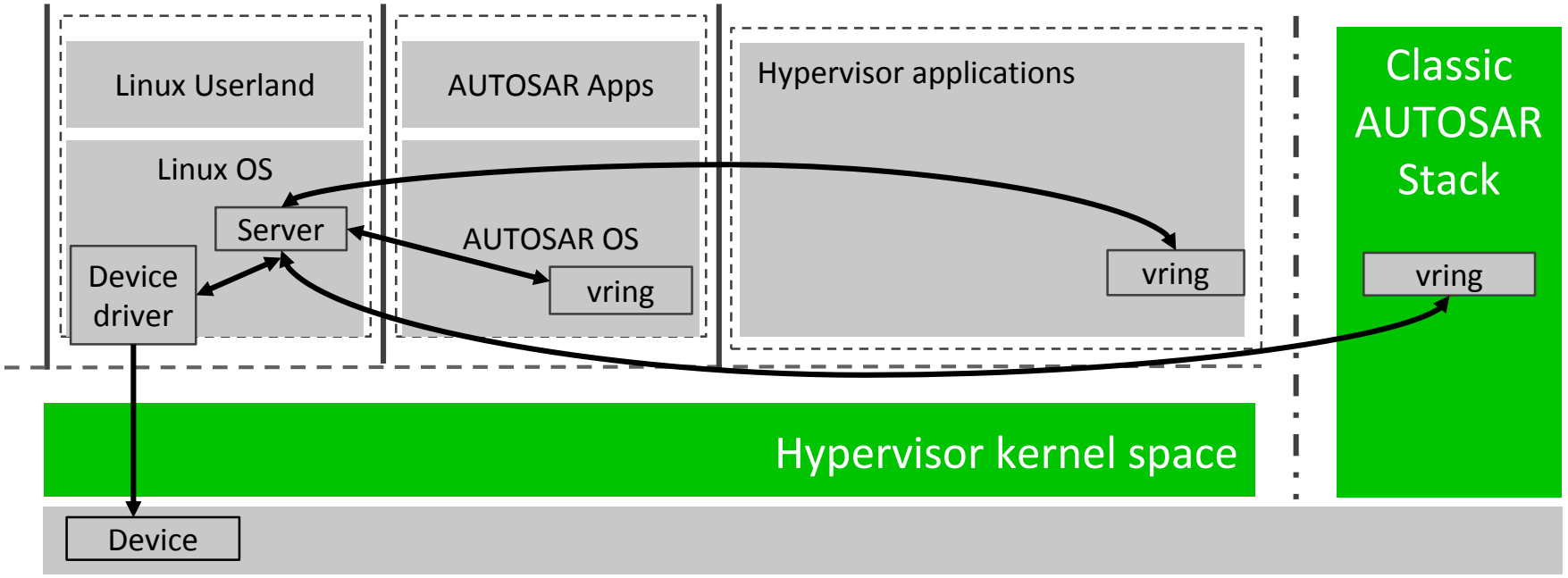


- Driver included

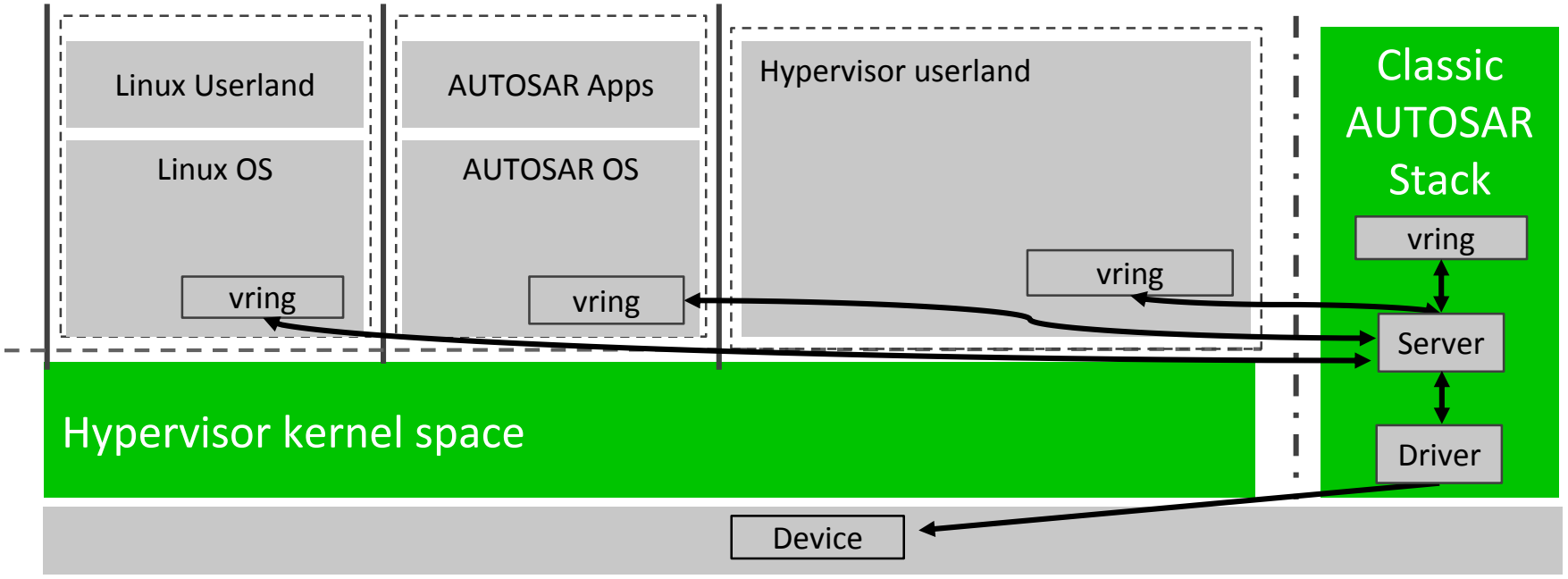
Inside an example



Hosting the device inside the HV partition



Hosting the device outside



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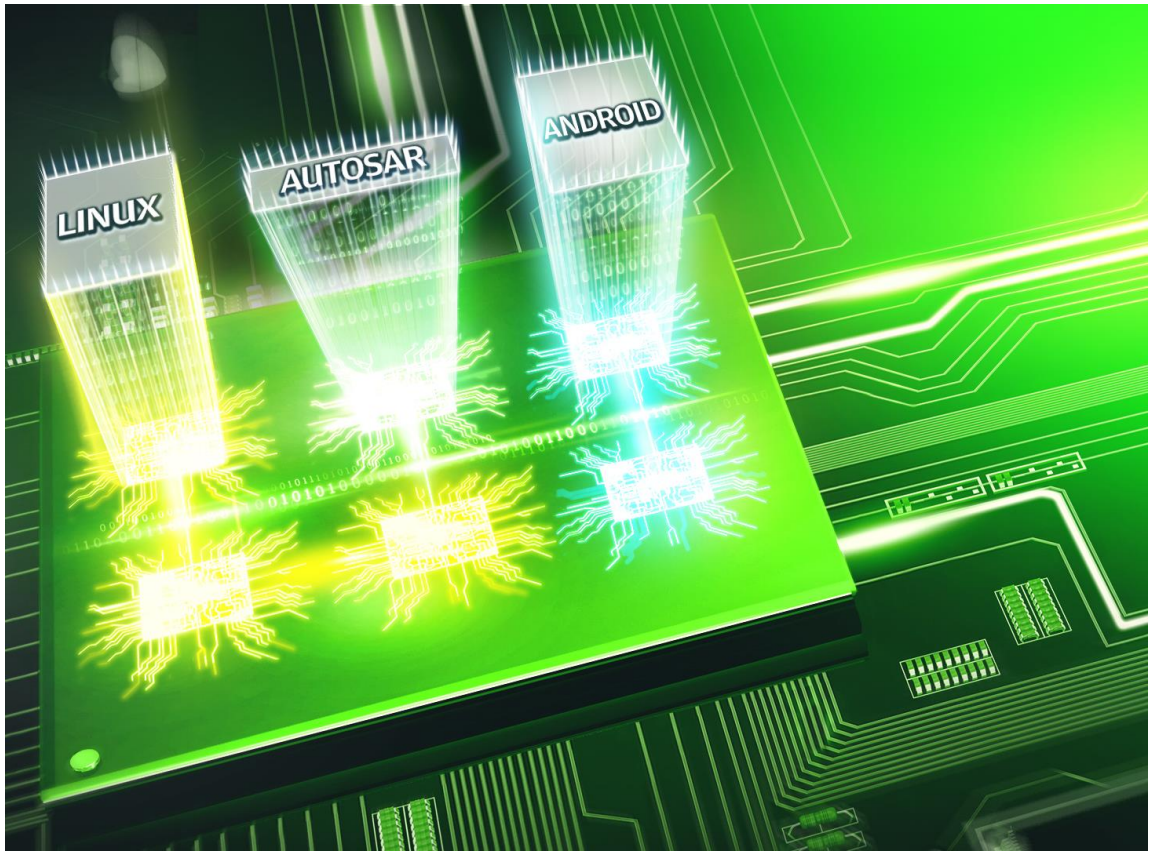

Conclusion

Benefits

- VirtIO device support is available in Linux, Android, and many other operating systems
- Builds upon the kernel user space interface of Linux and allows large flexibility, because the devices themselves make no assumption about the hardware
- Implement VirtIO-based devices that follow either existing standards or specify new ones

Most prominent use cases

- VirtIO Net
- VirtIO Block device
- VirtIO Console (character device)

VirtIO suitable for cross-partition device sharing.

Thank you.
Get in touch!

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