



# Hypervisor Market Overview

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# Hypervisor Market Overview

## What you can expect

- Quick introduction of SYSGO AG
- What are the market trends for hypervisor?
- Market size and main vendors
- Which use cases can be addressed?
- Which Hypervisor types are visible in the market?
  - With focus on MMU (less MPU)
- Which impact on Certification in automotive?
- Summary & Outlook

# SYSGO AG

## Embedded Software Technology Leader

### Mission

*“Be the leading European Operating System provider for devices in the Internet of Things: wherever safety and security matter, certified whenever needed.”*



### Founded

1991 (Mainz, Germany)

>80% Engineers have safety certification competences

Since 2012 independent entity from the Thales Group



### Local

Facilities in Germany, France, Czech Republic, UK

### Global

Worldwide distribution and support network



# The Market - Automotive Market Trends

**Security is not an option – Security is an integral system property**



## Cluster

- High Safety
- High Security
- High Real-Time
- High Graphics
- Fast Boot
- Certification



## ADAS/Gateway

- High Safety & Security
- Artificial Intelligence
- High Real-Time
- Low/No Graphics
- High Image Processing
- AUTOSAR
- Certification



## IVI

- Low Safety
- High Security
- Medium Real-Time
- High Graphics
- High Connectivity
- Open OS (Android, Linux)
- No Certification

## ECU Consolidation

- Safety/Security
- Legacy AUTOSAR
- Interconnect CAN, LIN, FlexRay, ETH
- Certification



## Virtual ECU

- Safety/Security
- Certification
- Multicore
- High performance

# Hypervisor Market Overview

## Global Market Overview



\* Global Revenue of Embedded Hypervisors & Secure Operating Systems and Related Services (Millions of Dollars)  
Source: VDC Research, 2016



# Hypervisor Market Overview

## Main vendors visible in the embedded market

### Open source

- EPAM on XEN
- General Dynamics (Oklabs)
- HIS (Wittenstein OpenRTOS)
- Intel ACRM
- Kernkonzept
- KVM Linux
- Micrium (Micro COS3)
- Siemens Jailhouse
- Sierraware on ARM
- Real-time Linux
- Perseus 32bit on XEN
- XEN-project

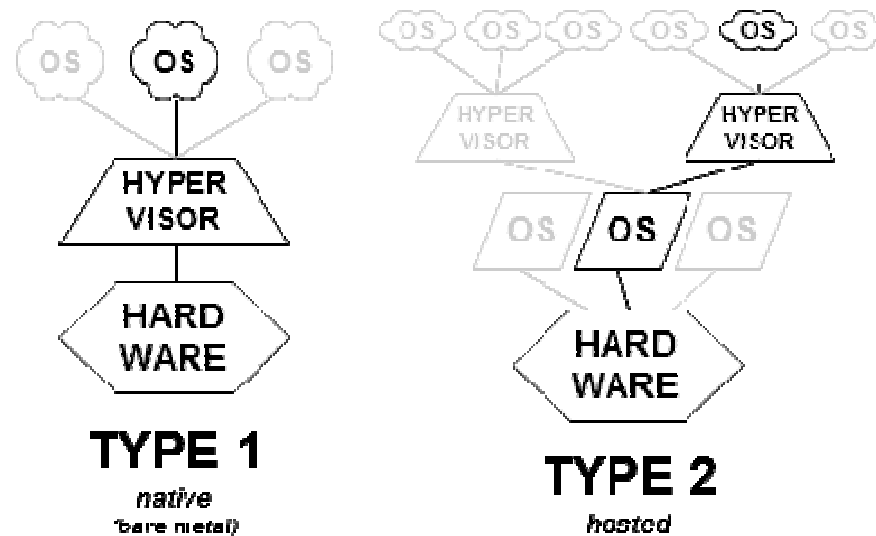
### Proprietary

- DDC-I (DEOS)
- eSOL (eT-kernel)
- Greenhills (Integrity)
- Harman/Samsung (Red Bend)
- LynxOS
- Mentor Graphics (Nucleus)
- Open Synergy (COQOS)
- Perseus 64bit on ARM
- QNX (Neutrino)
- Real-time Systems
- SYSGO AG (PikeOS)
- Wind River (VxWorks 653)

# Hypervisor Market Overview

## What is a Hypervisor?

- Virtual Machine Monitor
- Runs one or more virtual machines
- Each virtual machine is called a guest machine or personality
- Has a guest operating systems with a virtual operating platform
- Manages the execution of the guest operating systems



Acc. To Wikipedia

# Hypervisor Market Overview

## Hypervisor main use cases in automotive 1/2

- **Space / Weight / Power reduction by consolidation**
  - e.g. digital cluster and IVI on one hardware
- **Re-use of legacy code**
  - Use existing code of ECUs for new projects
- **Fast boot / Secure boot**
  - Boot via RTOS to get early access on e.g. CAN network
- **Configuration of Personalities**
  - Running open source stacks (Android/Linux) and/or RTOS in different partitions
  - Configure time schedules and memory allocation



# Hypervisor Market Overview

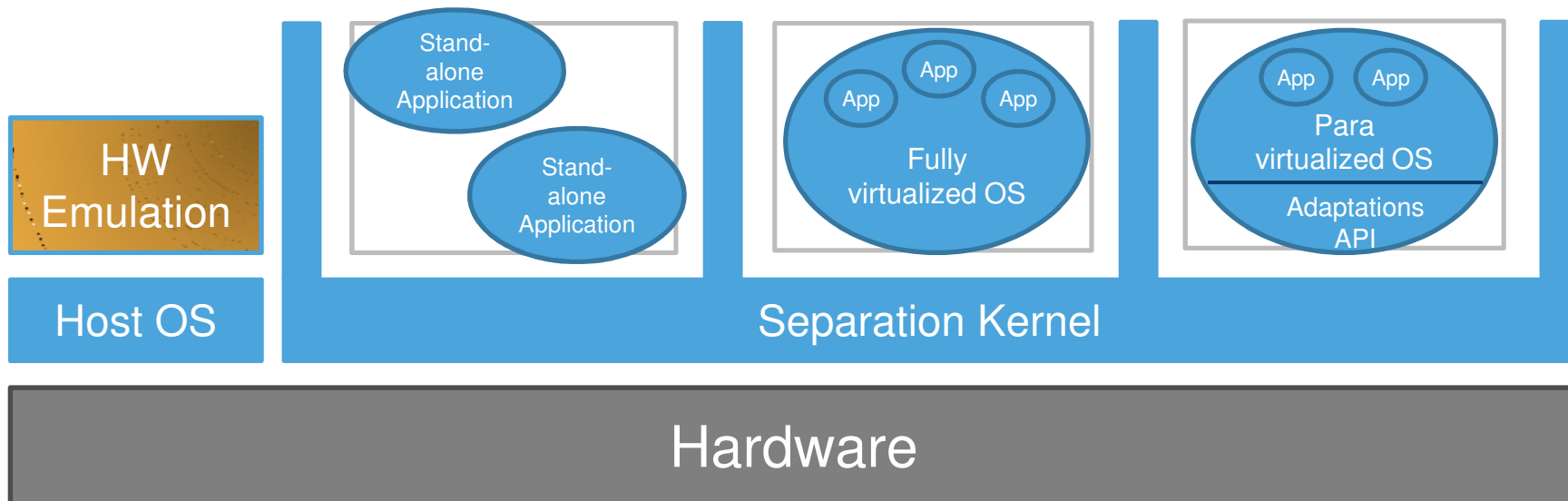
## Hypervisor main use cases in automotive 2/2

- **Safety use cases**
  - Define and separate safe from un-safe partitions
- **Security use cases**
  - Define communication flow and separate un-secure partitions
- **Use of open source in a safe and secure environment**

# Hypervisor Market Overview

## Some basics

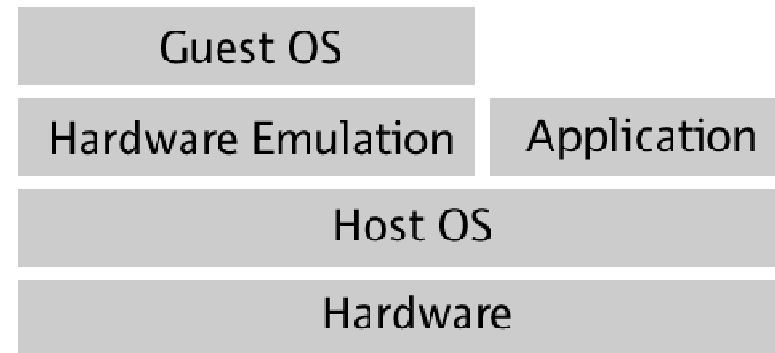
- Emulation
- Applications running directly on hypervisor
- Fully virtualized OS with applications
- Para virtualized OS with API



# Hypervisor Market Overview

## Emulation

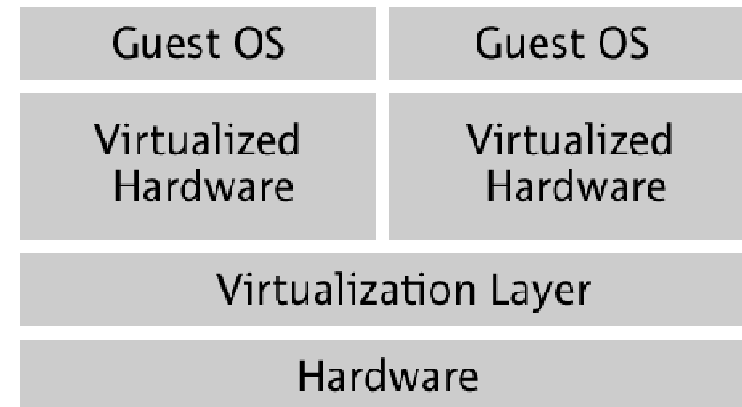
- Complete hardware emulation
- Different hardware platforms can be emulated
- Main drawbacks :
  - performances impacted
  - I/O are emulated
  - MMU is emulated
  - all in supervisor mode is emulated, ...
- Ex.: Bochs, Qemu, ...



# Hypervisor Market Overview

## Classical virtualization

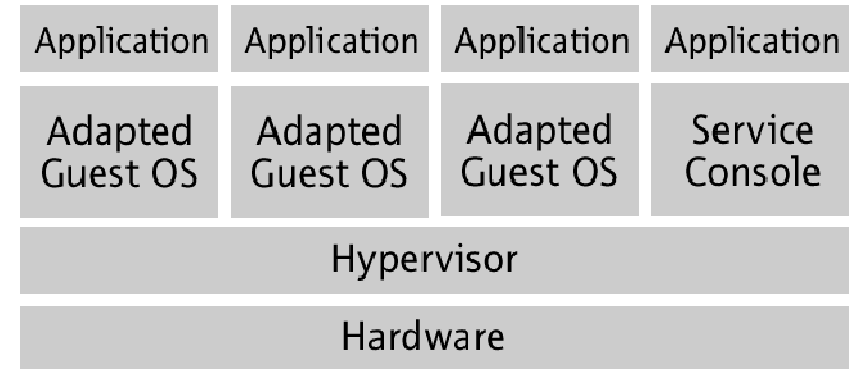
- Hardware virtualization but without any processor emulation
  - target processor must be identical to virtualized processor
- Allow some Operating Systems (Guest OS) to be hosted with no modification
- Main drawbacks: same as emulation
- Ex.: VMWare, VirtualBox, Adeos, ...



# Hypervisor Market Overview

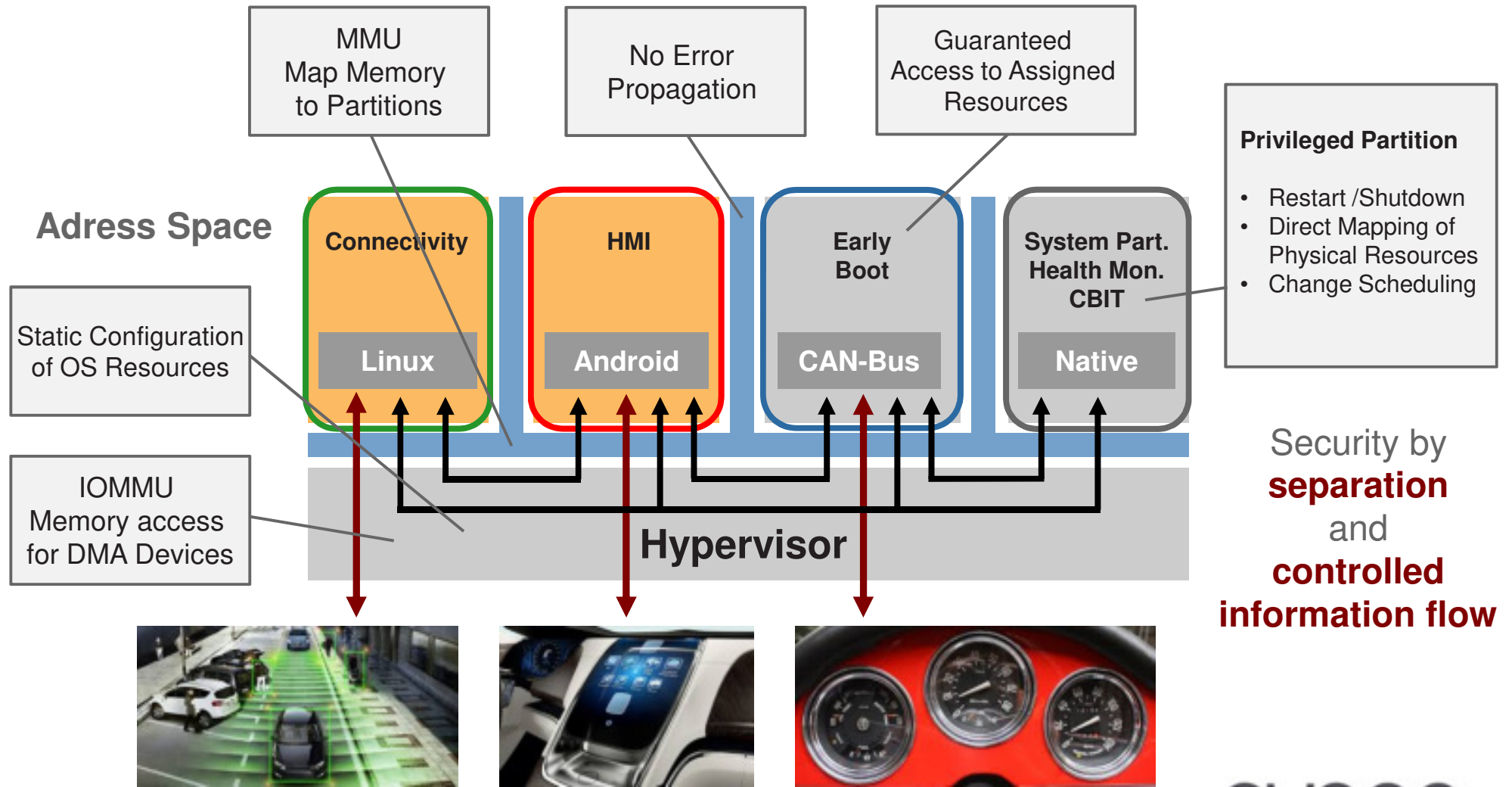
## Para-virtualization

- GuestOSs must be adapted
- How to communicate safely between Operating Systems?
- Need to host a Real-Time Kernel as a GuestOS when real-time is required
  - some solutions do not offer real-time support at all with a micro-kernel
- Main drawbacks:
  - no hard real-time support possible
  - solution barely suitable for critical embedded systems, ...
- Ex.: XEN, z/VM, VLX, ...



# Hypervisor Market Overview

## Example of Space Separation



# Hypervisor Market Overview

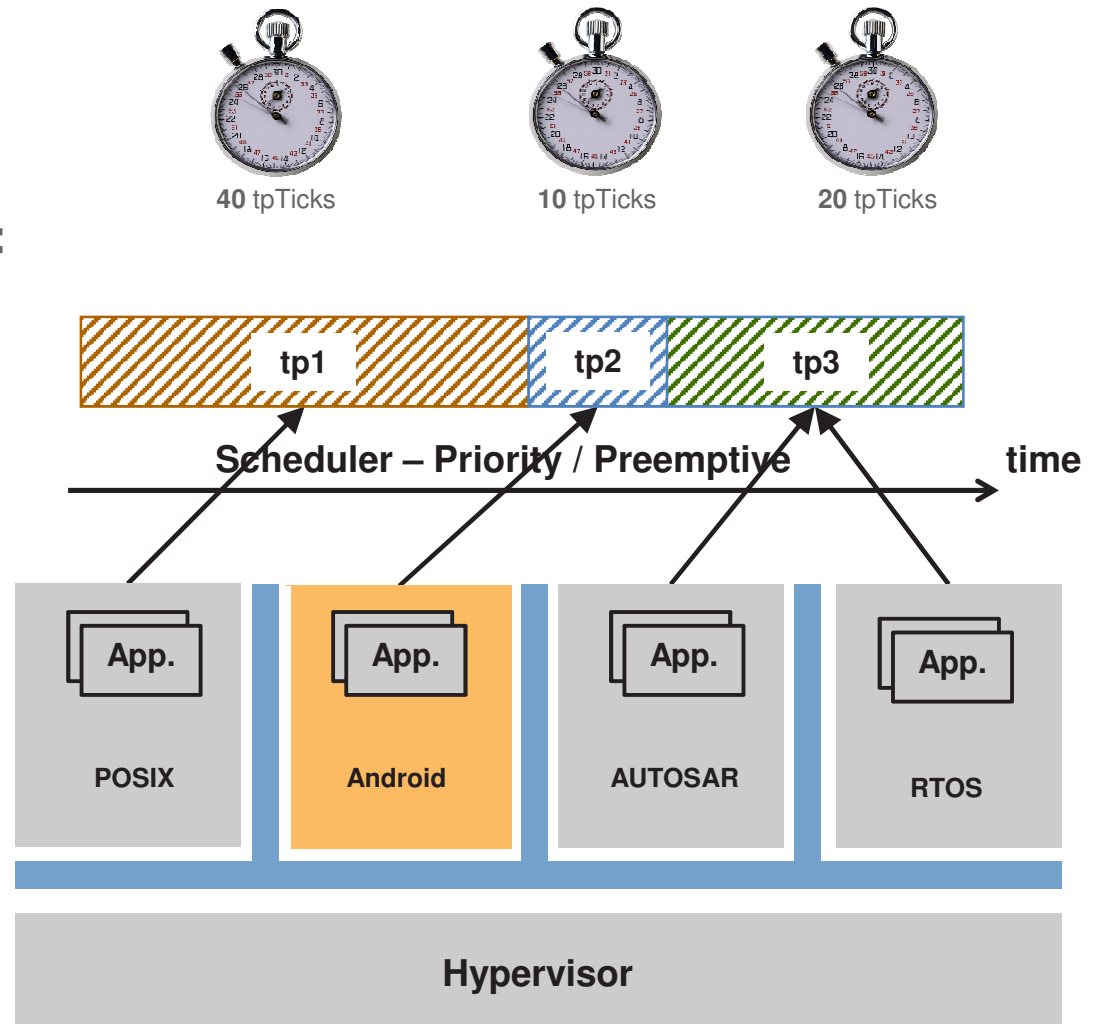
## Time Partitioning

### A) Priority based scheduler

- **Static or dynamic configuration of:**
  - Execution order
  - Duration
- **Deterministic Hard Real-time**
- **Shortest response time**
  - Dedicated thread with superior priority
- **Best possible CPU usage**

### B) Cyclic scheduler

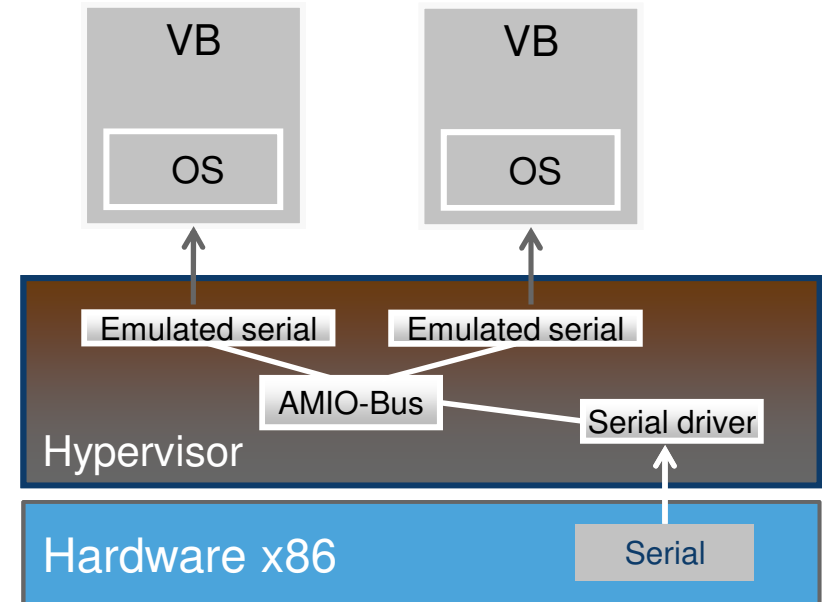
- E.g. Round Robin



# Hypervisor Market Overview

## Multiplexed Virtual Serial

- **Every virtual board has access to serial port**
  - On Intel with emulated devices, other arches with stub drivers
- **IDE can show all tabs**
  - IO to each guest individually
- **Easy way of bringing up guests**





# Hypervisor Market Overview

## Linux based hypervisor

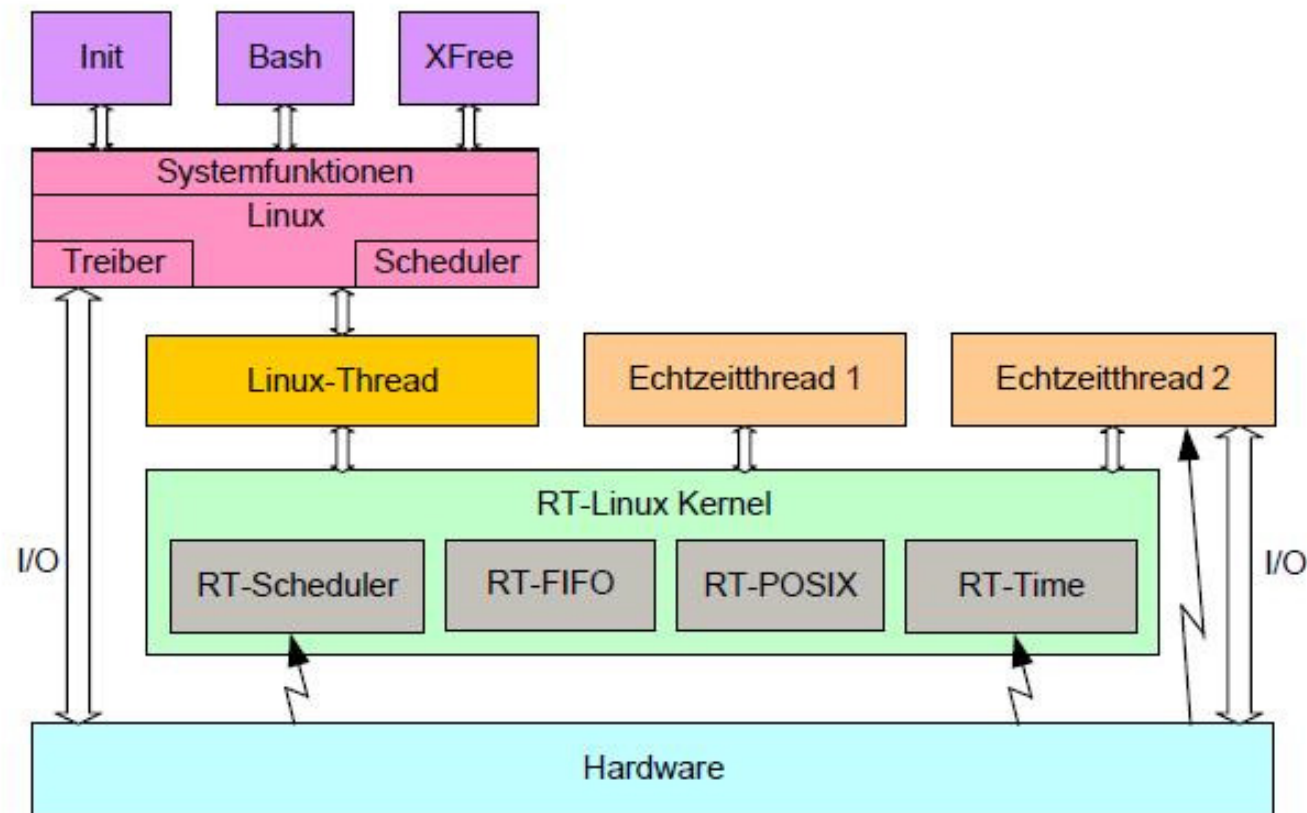
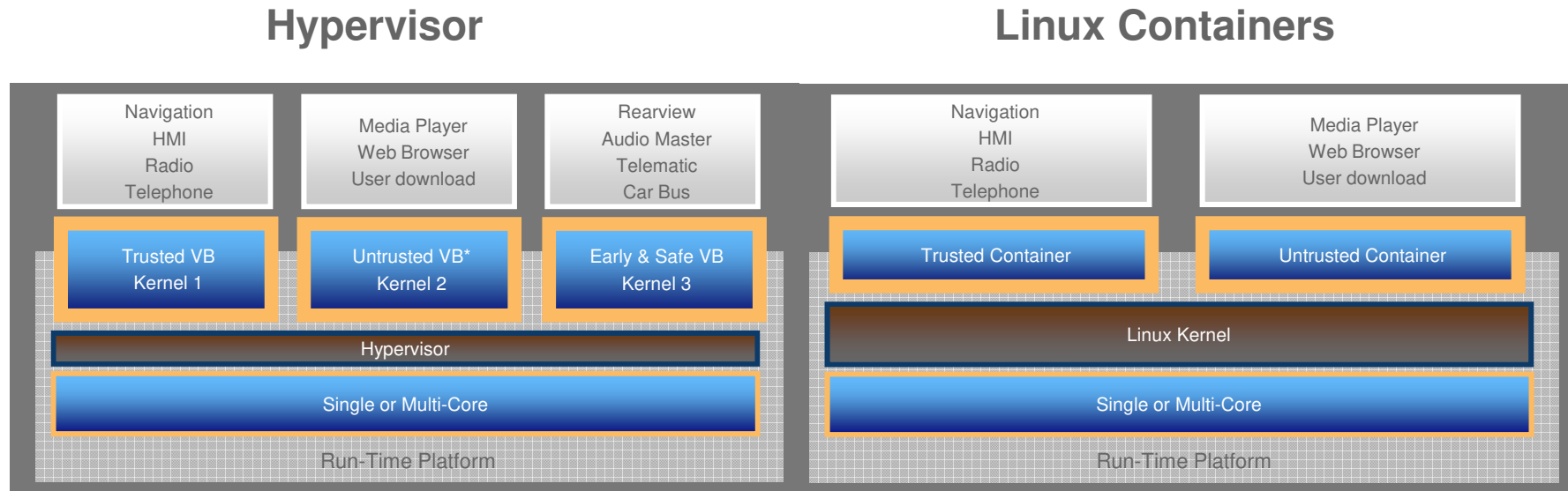


Abbildung 3.1-1: Aufbau von RT-Linux

Acc. To Prof. Frank Golatowski

# Hypervisor Market Overview

## Hypervisor versus Linux Containers

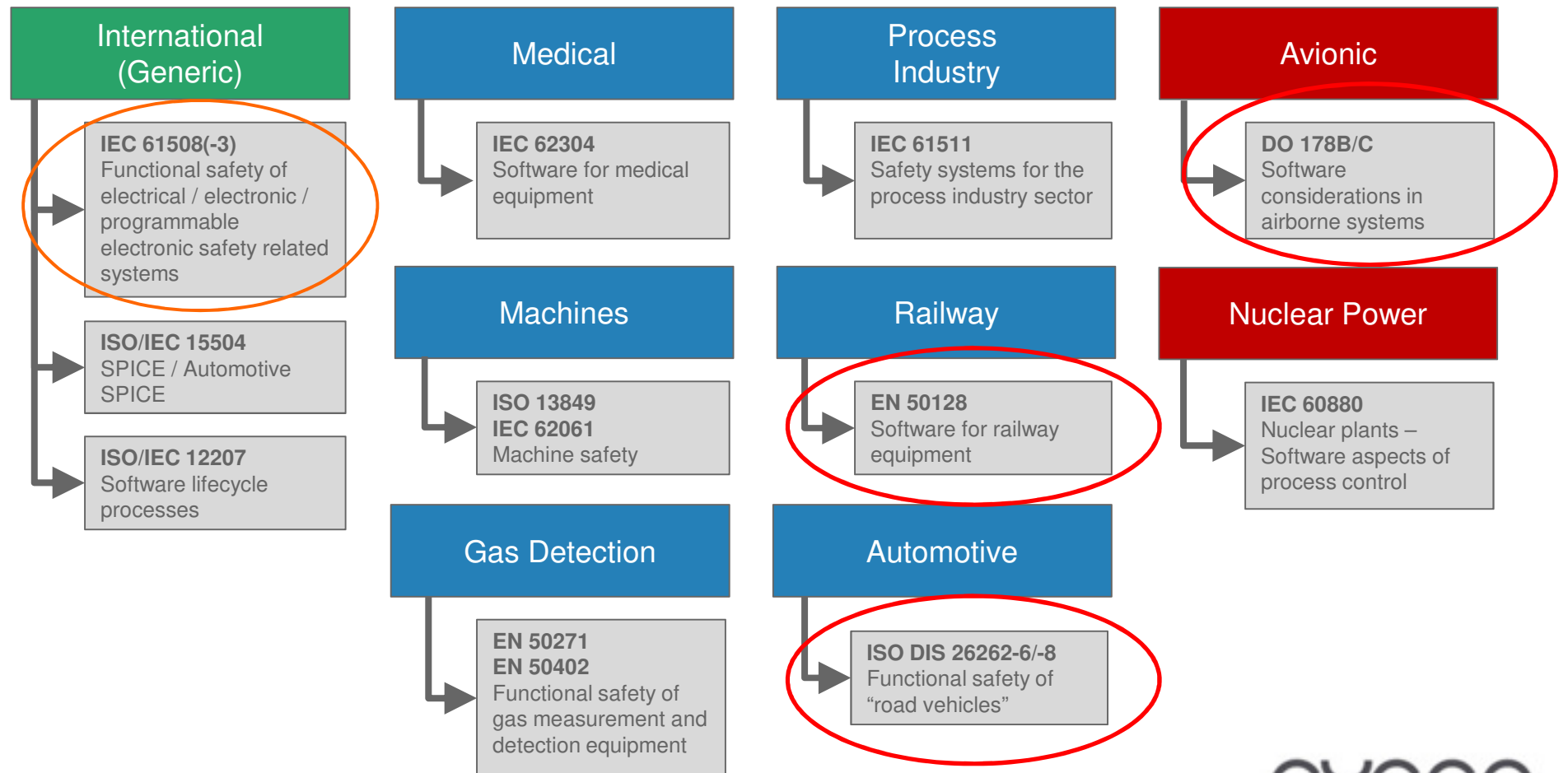


\* Another Linux or Android OS

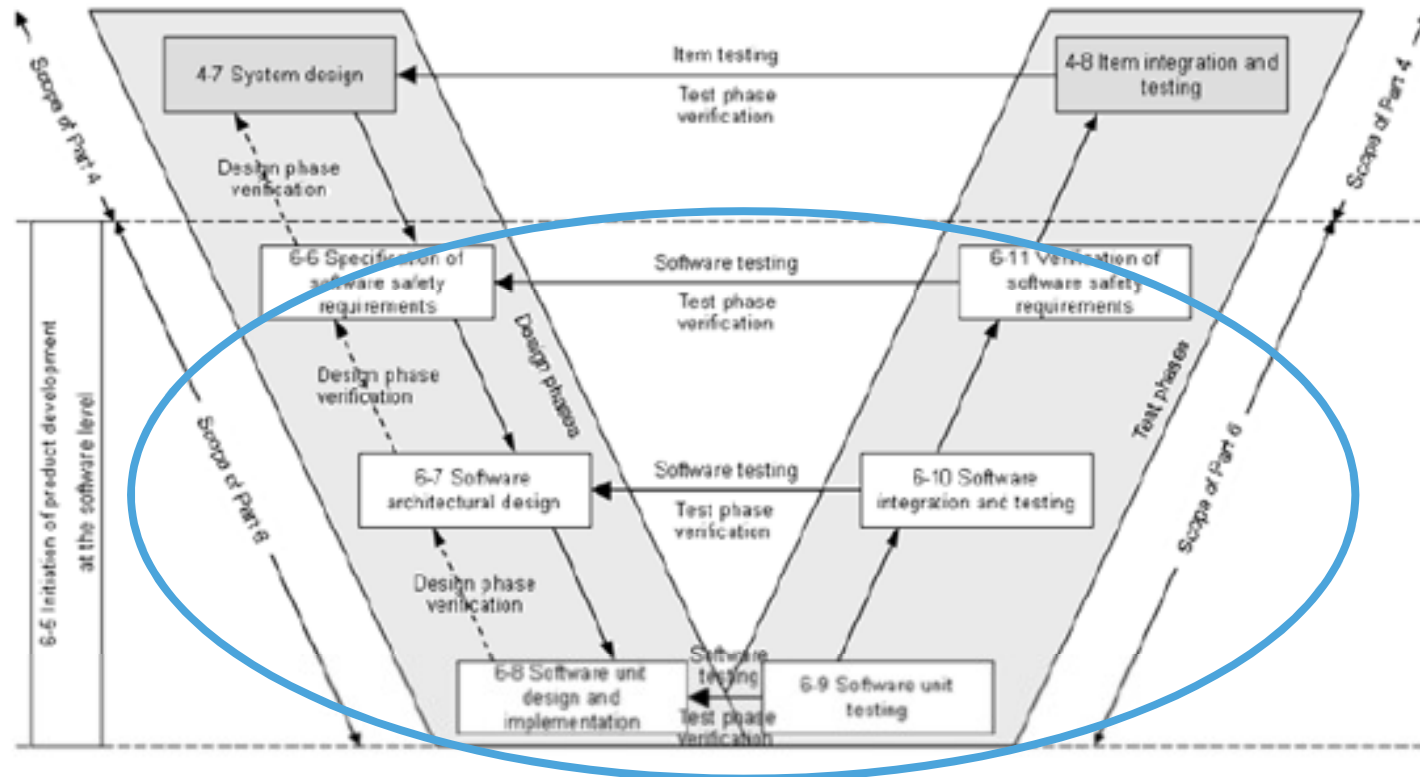
- Hypervisor allows real-time with a virtual machine monitor  
(**Note:** Linux containers do not protect from user to kernel privilege escalation attacks)
- It allows Linux or other OS to run in one of the partitions as a guest OS
- It virtually allows that any and all real-time tasks have priority over Linux kernel tasks
- Secure boot scenarios are possible with low boot times

# System Safety

## Software Standards for Safety Related Systems



# Compliance to the ISO 26262 SW Phase Model



NOTE Within the figure, the specific clauses of each part of ISO 26262 are indicated in the following manner: "m-n", where "m" represents the number of the part and "n" indicates the number of the clause, e.g. "4.7" represents Clause 7 of ISO 26262-4.

Figure 2 — Reference phase model for the software development

# Hypervisor Market Overview

## Summary & Outlook

- Hypervisors have a major play in safe and secure embedded systems
- Wide set of use cases are possible
- There are many different HV variants
- Automotive market is just starting to use HV
- The market density of hypervisor vendors is increasing
- They are often combined with an RTOS offering (partially included)
- Hypervisors vary on
  - Supported architectures and number of BSPs
  - Time and/or space separation
  - MMU or MPU support
  - Feature details and specification
  - Configuration in the tool chain
  - Supported levels of safety and security software standards

# Hypervisor Market Overview

## Questions?

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