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Virtualization Solutions for the AUTOSAR Classic and Adaptive Platforms

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Global provider of software and services for **automotive embedded systems** to Tier-1 suppliers and OEMs

- Headquarters in **Berlin** (Germany), further locations in Munich, San Diego and Salt Lake City
- Platform **virtualization** software (COQOS, COQOS micro) as part of the product portfolio
- Focus on cockpit controller, connectivity (smart antenna) and ADAS systems
Outline

– Hardware Consolidation
– Software Consolidation
– AI for Autonomous Driving and Virtualization
  • Semantic Abstraction and Virtualization
  • Informational ADAS and Virtualization
– Hypervisor
– Inter-VM Communication
Hardware Consolidation

Silicon manufacturers tend to intensify the integration of IP blocks inside SoCs:

- Clusters of powerful homogeneous or heterogeneous CPU cores
- I/O interfaces (Ethernet AVB, CAN FD…)
- Acceleration blocks (video decoder, DSP…)
Software Consolidation

Why virtualization?
- Heterogeneous SW platforms onto a single SoC
- Efficient use of highly integrated SoC
- Extra SW layer between HW and OSs
- Reduced attack surface (limited API)
- Overall cost reduction
- Modular software update

Benefits
- Safety (real-time, freedom from interference)
- Enhanced security
- Use of automotive standards
- Low impact on performance
## Artificial Intelligence for Autonomous Driving

**Symbolic**
- Putative characteristics of cognition
- Information processing metaphor

**Subsymbolic**
- Inspired by neurobiology
- How cognition emerges from neurobiology

**Expert systems**
- Artificial Neural Networks
  - Deep Neural Networks (DNN)

I'm a Cartesian Dualist!

Deep Learning Architectures for Autonomous Driving

- **End-to-End**
  - Input Sensor Data
  - DNN
  - Output Vehicle Control

- **Semantic Abstraction**
  - Input Sensor Data
  - DNN / algo
  - Control
  - VD
  - PD
  - LD
  - Output Vehicle Control

Semantic Abstraction is superior to End-to-End architecture, for a given amount of training data. [4] demonstrates cases in which End-to-End requires exponentially greater number of examples. [5]
Semantic Abstraction enables running the different neural network and algorithmic components in different VMs, ensuring freedom from interference.
Efficient Informational ADAS through ADAS/IC/IVI Consolidation

Informational ADAS, helpful for societal, individual and even legal acceptance of AD [7], is easier and more efficiently realized on a system that integrates ADAS, IC and IVI functionality in separate VMs with mixed criticality.

– Decision explanation challenging for Subsymbolic AI, but see [6] for related work.

Examples of salient objects, inspired by [6], based on [3] for IP reasons.
Hypervisor

- Type-1 hypervisor
- CPU abstraction (multi-core capable)
- Containment and scheduling of VMs
- Highest CPU operation mode
- Non-monolithic architecture
- Access control to I/O
- Low footprint
A Hypervisor provides the low level communication mechanisms (multi-core capable) to set the foundation for high level communication frameworks (virtual Ethernet for example):

- Shared memory
- Hypercall

The communication properties may be similar to the AUTOSAR OS IOC (Inter-OS-Application Communicator):

- Event vs Last-is-Best semantic
- Triggering on data reception
Virtual Ethernet enables the use (or reuse) of an IP communication stack. Applications are able to perform high level inter-VM communication (BSD socket as kernel interface).
Use Case: Multi-AUTOSAR

- Time and space partitioning
- Cluster of VMs to implement multiple vECUs
- VM SW update granularity
- Different SW suppliers
- Easier development across multiple SW suppliers

Hypervisor
Classic AUTOSAR: Inter-VM Communication

- Data proxying overhead (CDD)
- Dedicated tooling required
- Not standardized
Classic AUTOSAR: Standardized Inter-VM Communication

Standardized Module (Proposal):
• Signal Interface to BSW and RTE
• “Last-is-Best” and “Event” semantics
• Polling or (virtual) interrupt driven
• Similar to OS IOC
• May be an extension of the IOC sub-module instead of a separate module
• Could pave the road for a distributed BSW across VMs
Classic AUTOSAR: Service-Oriented Inter-VM Communication

Possible Solution:
- PDU interface towards PduR and SD
- Inter-VM SD specific protocol
- No overhead of TCP, IP and Ethernet (OSI Layer 2)
Adaptive AR: Service-Oriented Inter-VM Communication

- Adaptive Application
  - ara::com
  - Inter-ECU binding
  - SOME/IP, DDS, etc.
  - inter-VM binding
- Adaptive AR Platform Instance
  - ara::com
  - Object Graph
  - ara::rest
  - HTTP/JSON
- Classic AR Platform Instance
  - Adaptive AR Platform Instance
  - Classic AR Platform Instance

Inter-VM Communication
Virtualization Layer
System-on-Chip
Ethernet
Standard interface for ara::com bindings on Adaptive AUTOSAR?

- Allows integration of binaries from Adaptive Application providers onto a project’s specific communication binding(s).
- Ease testing of application code using mock bindings.
Hypervisor Concept for AUTOSAR

– OpenSynergy aims to bring the hypervisor concept into AUTOSAR through the creation of a CONC document and related artifacts such as:
  • Methodology and metamodel
  • Software modules and APIs
– OpenSynergy welcomes the cooperation with other AUTOSAR members on this topic.
References

Thank you for your attention!

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