Mixed-Critical Virtualization in Embedded Systems done right
Virtual Open Systems: Profile

- Virtual Open Systems (VOSyS) is a French fully independent & private software company created and operating since Jan 2011:
  - self-sustained, profitable
  - share capital of 505 400€, no debts

- The core activity is about design and implementation of high-performance mixed-critical virtualization solutions on low-power multi-core & heterogeneous platforms:
  - VOSyS has been the first company to port KVM on ARM in collaboration with Columbia University
  - VOSyS created and is leading the Automotive Grade Linux Virtualization Expert Group

- Operating in market vertical segments requiring virtualization technologies addressing mixed-criticality:
  - Automotive, Industrial, IoT-Edge Computing, energy Power-Breakers, Drones, NFV, ..
Foundation company statements

➢ **Mission** – Enable customers to gain competitive advantage

➢ **Values** – Believe in open source, industry standards, Customer satisfaction

➢ **Vision** – Become worldwide leader in mixed critical virtualization and accelerators virtualization

➢ **Strategy** – Continuous re-inforcement of activity for competitive mixed-critical virtualization hardware/software solutions in Safety-aware Automotive, IoT edge
Virtual Open Systems: Visibility

International Exposure

- Involvement in several **software open source** projects:
  - Linux kernel, PSCI, VFIO
  - KVM, QEMU, mttcg, eventfd, LibVirt, VirtIO
  - vhost-user, Snabb
  - OpenStack, OPNFV
  - AGL EG-Virt
- Partner in EU funded **research & innovation projects**
- Membership in international initiatives
- Several **scientific** papers & international events **dissemination**
- 5 filed **patents** in US, EU
Virtual Open Systems: research projects
Virtual Open Systems constantly disseminates its results through scientific publications at international conferences; it counts more than 40 publications, of which the most recent:

- Cloud and Edge Trusted Virtualized Infrastructure Manager (VIM) – Security and Trust in OpenStack, WCNC2019
- VOSYSVirtualNet: Efficient Inter-world Network Channel for Mixed-Criticality Systems, SIES2018
- The Next Generation Platform as a Service, Cloudifying Service Deployments in Telco-Operators Infrastructure, ICT2018
- FPGA virtualization with accelerators overcommitment for Network Function Virtualization, Reconfig17
- Paving the way towards a highly energy-efficient and highly integrated compute node for the Exascale revolution: the ExaNoDe approach, DSD2017
- Lightweight and Generic RDMA Engine Para-Virtualization for the KVM Hypervisor, HPCS2017
- VOSYSmonitor, a Low Latency Monitor Layer for Mixed-Criticality Systems on ARMv8-A, ECRTS2017
IP protection is a strategic investment at Virtual Open Systems. To date 5 patents:

- **Compute node supporting virtual machine and services (US grant, EU exam.)**
  - A computing system able to accelerate multiple OSes in a mixed criticality environment, enabling IVI and Cluster coexistence in a single HW platform

- **Virtualization manager for reconfigurable hardware accelerators (US/EU exam.)**
  - HW IP enabling FPGA accelerators virtualization in a smart re-configurable, orchestrated manner for computer vision, networking and ADAS applications

- **Interrupt controller for mixed criticality virtual machines (US grant, EU exam.)**
  - ARMv8 Interrupt controller designed to improve performance and reduce interrupt latency in mixed critical and virtualized environments (e.g., automotive, industrial ..)

- **vSwitch for multi compartment mixed critical network communication (US/EU grant)**
  - Accelerated virtual switch infrastructure for accelerated compute node OSes with mixed levels of criticality. It enables high performance and secure communication between different critical worlds

- **Disaggregated Computing Architecture (in embargo period)**
Innovation & International Visibility

- Innovation, open source and international exposure drives the company Services

Custom Design & Development services

- The company provides services in the virtualization domain on an international landscape to serve customers in different market segments
- Market segments includes telecommunications, networking, mixed-critical systems (e.g., energy power breaker, industrial, automotive, etc.)
- Customers include first tier companies from EU, Far-East, North America

Virtualization Know-how Productization

- The acquired know-how in virtualization is being used by the Company to develop its own Virtualization product roadmap, to serve mixed-critical market segment (with VOSySmonitor, VOSySmcs, VOSySiot) and NFV networking systems (VOSySwitch)
With major outcome as open source contributions

- KVM on ARM => **Paving the way towards virtualization in embedded systems**
- KVM and VCPU Hotplug for ARMv8 => **Better resource utilization in the Virtual Machines**
- VFIO, IOMMU for ARMv7/8 => **Support for device pass-through in Linux**
- Support of the VFIO framework on QEMU => **Support for device pass-through in QEMU**
- RFC for QEMU infrastructure for ACPI and VFIO => **Emulation of ARMv8 servers**
- Multithreaded TCG, atomic instruction emulation => **Real multi-core virtual machine emulation**
- Vhost-user => **fast networking switches**
Virtual Open Systems: Track Record
Industrial Product Engineering

- Energy management top-player customer cases:
  - VOSySmonitor **designed-win** in several customer products
  - Development of firmware management layer for low/medium voltage power breakers based on **VOSySmonitor**
  - Development of custom firmwares for Renesas RZ-N1D and Altera Cyclone V based on **VOSySmonitor**
Virtual Open Systems: Track Record
Automotive Product Engineering

- Automotive top-player customer cases:
  - VOSySmulator product **designed-in** at several **Tier-1** customers
  - Development of custom firmware for Renesas R-Car H3/M3, Xilinx UltraScale+ MPSoC, Nvidia Jetson TX1, Mediatek MT2712 based on **VOSySmulator**

  ![Renesas R-Car H3](image)
  ![Xilinx MPSoC US+](image)
  ![Mediatek MT2712](image)
  ![Nvidia Jetson TX1](image)
Virtual Open Systems: Track Record
Virtualized access to custom IPs

- Innovative solutions in cloud and consumer cases:
  - Full design and implementation of API remoting solutions for cloud servers integrating innovative optical accelerators
  - OpenGLv2 API remoting: Full 3D acceleration within virtual machines on Odroid ARM

Odroid XU4
Virtual Open Systems: Track Record
High performance virtualization designs

- Design and development of custom pass-through solutions of multimedia, graphics and networking devices for Set-Top box
  - Full 3D acceleration, 4K video playback and display management inside virtual machines

4K Playback inside VMs
Telechips TCC8995
Virtual Open Systems: Track Record
Emulation of custom Platforms & OSs

- Development services for custom KVM extensions to run bare-metal firmwares in QEMU virtual machines on Nvidia Jetson TX1 and TX2 boards
Product Activity

**VOSyS manager**
FPGA Virtualization for IoT, automotive, HPC, etc.

**VOSyS monitor**
is the foundation of VOSySmcs and VOSySIoT

**VOSySIoT** addresses Mixed criticality preprocessing in IoT edge nodes

**VOSyS switch**
High performance networking 5G, NFV, IoT, automotive, HPC, etc.

**VOSySmcs** extends infotainment and cluster consolidation with virtualization and ADAS functions

**EdgeVim**

**VOSyS manager**

**Integration services**

**VOSyS switch**

**VOSyS monitor**

**VOSyS IoT**

**VOSyS mcs**
Virtual Open Systems product: VOSySmonitor

VOSySmonitor is an ISO-26262 ASIL-C certified TrustZone based virtualization layer, to maximize safety with dedicated features in strictly isolated system architecture, thus guaranteeing best in class protection for the safety critical domain:

- **Superior isolation** building on top of ARM hw trustzone
- **Better latency** performance while serving RTOS tasks (no context switch overhead)
- **Power management** support
- **Scaleability** to better support to increasingly complex use cases (only pay-for-what-customer-uses)
The Company is active on AGL, which aims to build a **complete open source SW stack for automotive**. AGL shares components with the GENIVI Development Platform, but it is focused on development and testing.

- 100+ companies are part of AGL: Mercedes-Benz, Toyota, Nissan, Denso, Continental, Qualcomm, Panasonic, Renesas, etc.

- **Virtual Open Systems has started and is leading** the AGL Virtualization Expert Group (**AGL EG-Virt**):
  - Development, testing and documentation to enable open source virtualization
  - Defining plans and objectives through bi-weekly meeting with the community and presentations at international AGL events
  - Coordinated the work for the **first white paper** of the community presented at the AGL ALS meeting in Tokyo in June 2018
Virtual Open Systems product: VOSySiot

VOSySiot is an end-to-end IoT software stack product that enable mixed criticality applications to be run in IoT gateways:

- **Strong Security**
  - Trusted Computing
  - Remote attestation and authentication supported
  - Linux kernel integrity check

- **Mixed criticality**
  - Real time workloads to control actuators

*Use cases are: Small office Home office (SOHO), Industry 4.0, Cyber Physical Systems, healthcare, etc.*
Enhanced security, **hosts attestation** and sensitive data protection

- **Normal vs Secure World**: an isolation at the hardware level by leveraging VOSySmonitor and ARM TrustZone
- **VOSyS Trusted Open Stack Extensions**: attestation services running in the Normal World
- **VOSyS Security Services**: executed inside a Trusted Execution Environment (TEE)

**Use cases are**: **smart cities, healthcare, edge computing, NFV, etc.**
vFPGA manager is an FPGA virtualization framework designed for virtual machines, containers and unikernels:

- Enables high performance direct communication between the VMs and accelerators
- Supports FPGA overcommitment (a single accelerator can be shared between multiple guests for better efficiency)
- Supports existing VM and hardware accelerators

Use cases: *Cloud computing (OpenStack)*, *NFV*, *AI*, *Industry 4.0*
contact@virtualopensystems.com
Web: virtualopensystems.com
VOSySmcs: virtualopensystems.com/en/products/vosysmcs/
Demos: virtualopensystems.com/en/solutions/demos/
Guides: virtualopensystems.com/en/solutions/guides/
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