Vulkan SC 1.0 Launch

Growing Importance of Functional Safety

Demand for advanced GPU-accelerated graphics and compute is growing in an increasing number of industries where safety is paramount, such as automotive, autonomy, avionics, medical, industrial, and energy

1990s
Avionics

2010s
Automotive

2020s…
Everywhere

In safety-critical systems a compute or display system failure would pose a significant safety risk

Functional Safety Certification

Safety Certification

Performed at the system level

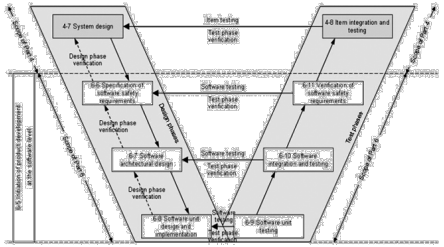
Development Process defined in safety-critical standards

1) Document system design, safety requirements, software architecture and software design
2) Test and verify at each level against design documentation
3) Provide certification evidence packages to demonstrate documentation and testing

Reducing certification effort and costs

System runtime components should:

1) Be streamlined as far as possible to reduce documentation and testing surface area
2) Have deterministic behavior to simplify design and testing
3) Implement robust and unambiguous fault handling



In the ISO 26262 V-Model system development process testing and verification occur in reverse order from design and implementation

ISO 26262

DO-178C

Industry safety-critical standards include

RTCA DO-178C Level A / EASA ED-12C Level A (avionics)
ISO 26262 ASIL D (automotive)
IEC 61508 (industrial)
IEC 62304 (medical)

Safety Certification and Open Standard APIs

Need for APIs to streamline system-level safety-critical certifications

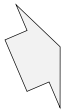
Streamlined
Deterministic
Robust

Growing need for embedded hardware acceleration

Advanced processing of multiple advanced sensors
Smart systems through machine learning and inferencing
Advanced displays and user interfaces

Growing need for well-defined hardware software interoperability in safety critical industry

Decoupling software and hardware for easier development and integration of new components
Cross-generation reusability
Cross-platform reusability
Field upgradability



Growing demand for state-of-the-art open, cross-vendor, acceleration API standards that are designed by and for the safety-critical industry

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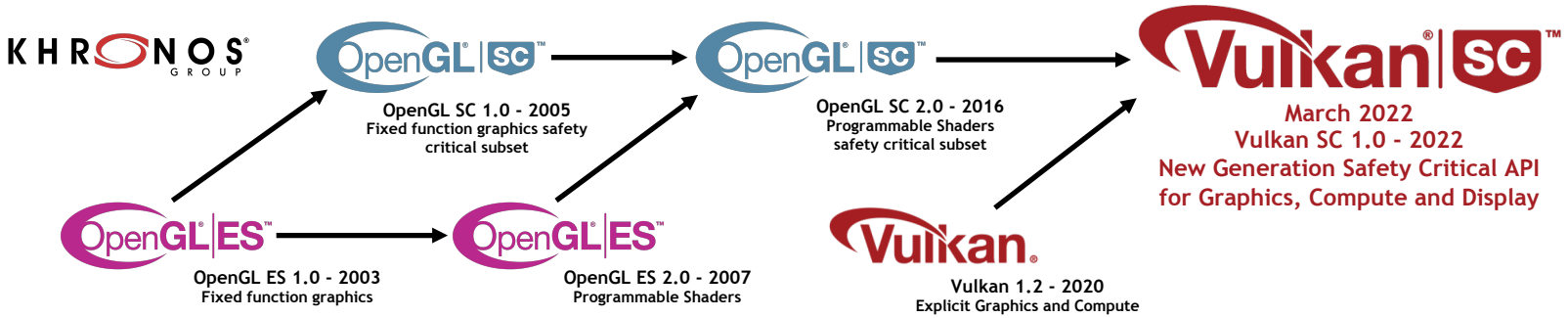
Khronos Safety Critical GPU API Evolution



Khronos has close to 20 years experience in adapting mainstream APIs for safety-critical markets

Leveraging proven mainstream APIs with shipping silicon implementations and developer tooling and familiarity

Vulkan SC targets any systems requiring safety critical graphics and/or compute

E.g., automotive, autonomy, avionics, medical, industrial, and energy

Vulkan SC has significantly higher performance and flexibility than OpenGL SC

Enabling new safety-critical markets requiring graphics and compute AND cross-platform standalone compute

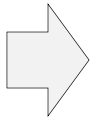
OpenGL SC will continue to be supported by Khronos, but new developments will focus on Vulkan SC

Vulkan SC 1.0 Design Philosophy

Vulkan

Vulkan 1.2 is a compelling starting point

Widely adopted, royalty-free open standard
Explicit control of device scheduling, synchronization and resource management
Smaller surface area than OpenGL
Not burdened by runtime debug functionality
Very little internal state
Well-defined thread behavior
Ingests SPIR-V IR – no runtime front-end compiler



Vulkan SC

Streamlined

Remove non-essential runtime functionality

Sparse memory
Descriptor update templates
Certain types of object deleters

Deterministic

Predictable execution times and results

Offline compilation of pipelines
Static memory allocation

Robust

Removing Ambiguity

No ignored parameters or undefined behaviors
Enhanced fault handling and reporting functionality
Rigorous conformance test suite
MISRA C alignment

Vulkan SC enables system implementers deploying GPU-accelerated graphics and compute to meet safety-critical obligations and provide certification evidence packages with reduced cost and effort

Vulkan SC can also be invaluable for real-time embedded applications, even if not formally safety-certified

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Vulkan SC Robustness

Fault Handling and Reporting

Application registers functions at device creation which the driver can call if a fault is detected
Application can interrogate type and level of a fault together with implementation-specific data

Vulkan SC Conformance Test Suite

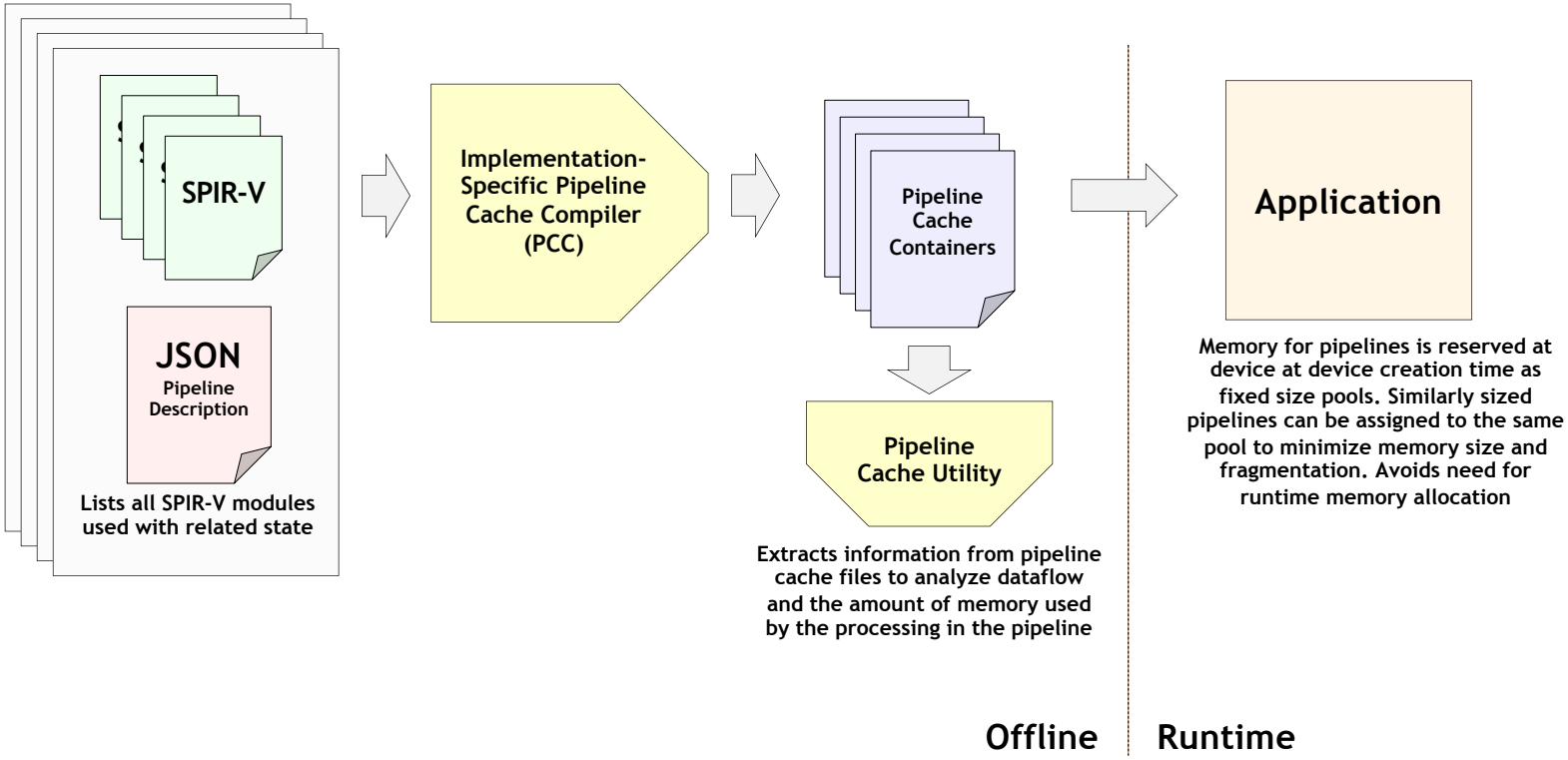
Freely available to all under Apache 2.0 open-source license
Leverages extensive Vulkan test suite with added SC-specific tests
System integrators can use to confirm and document Vulkan SC implementation compatibility

MISRA C

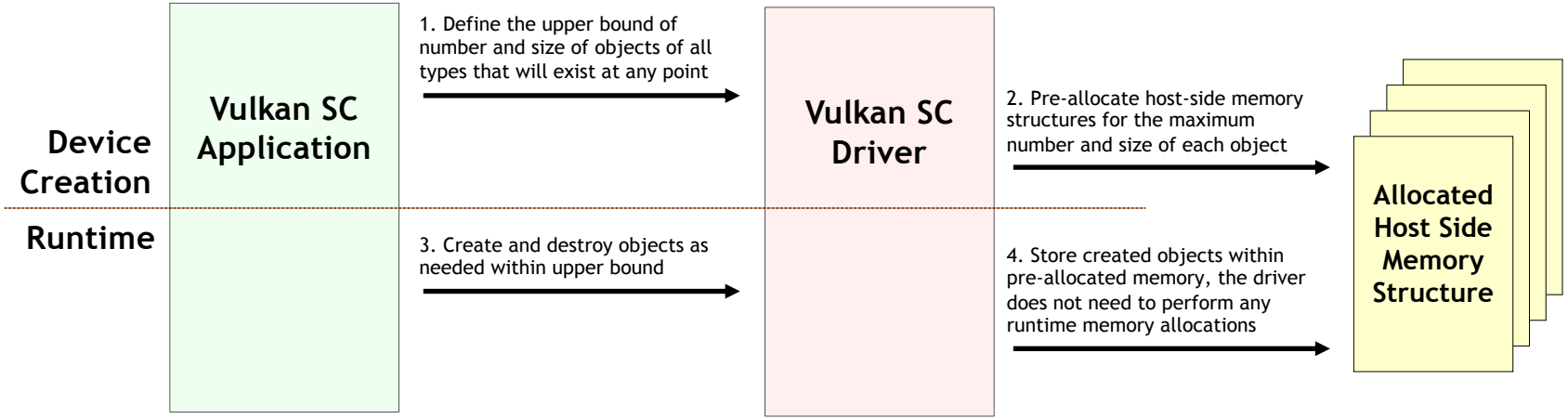
Vulkan SC 1.0 is aligned with MISRA C software development guidelines
Developed by the MISRA Consortium for embedded system code safety, security, portability and reliability and alignment with safety-critical standards

Vulkan SC Offline Compiled Pipelines

A Vulkan Pipeline defines how the GPU processes data

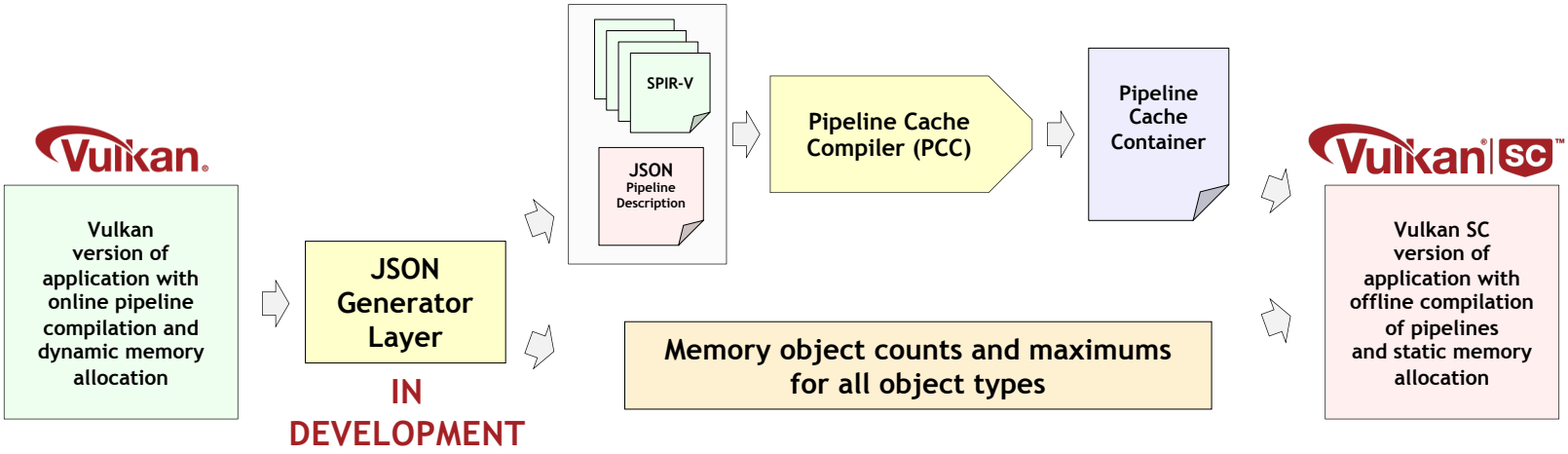


Vulkan SC Static Memory Allocation



Static memory allocation eliminates non-deterministic behavior caused by memory allocations, and possible memory allocation errors, happening at random times at runtime

Porting from Vulkan to Vulkan SC



Developers will be able to use desktop Vulkan for initial development and leverage widely available drivers and powerful development tools

JSON Generator Layer creates Pipeline Descriptions and memory object data for direct use by the Vulkan SC-ported version of the application

Call to Action!

- **Vulkan SC enables many levels of the safety-critical ecosystem**
  - Device Manufacturers of GPUs and SoCs
  - Driver Vendors, System Builders
  - Middleware Developers, Application Developers
- **Implementers**
  - Vulkan SC 1.0 specification and open-source Conformance Test Suite are freely available
- **Middleware, and Application Developers**
  - Ask your hardware vendor for Vulkan SC drivers
  - Conformant Implementations are running today on CoreAVI, and NVIDIA DRIVE and Jetson Platforms
- **System Builders**
  - Leverage Vulkan SC for high performance safety-critical graphics and compute
  - Use Vulkan SC in embedded real-time systems
- **Everyone**
  - Engage Vulkan SC working group and community at the Vulkan SC specification GitHub

Vulkan SC will broaden the adoption of GPU acceleration in safety-critical systems and real-time applications