SYCL SC State of the Union IWOCL'24

April 10, 2024

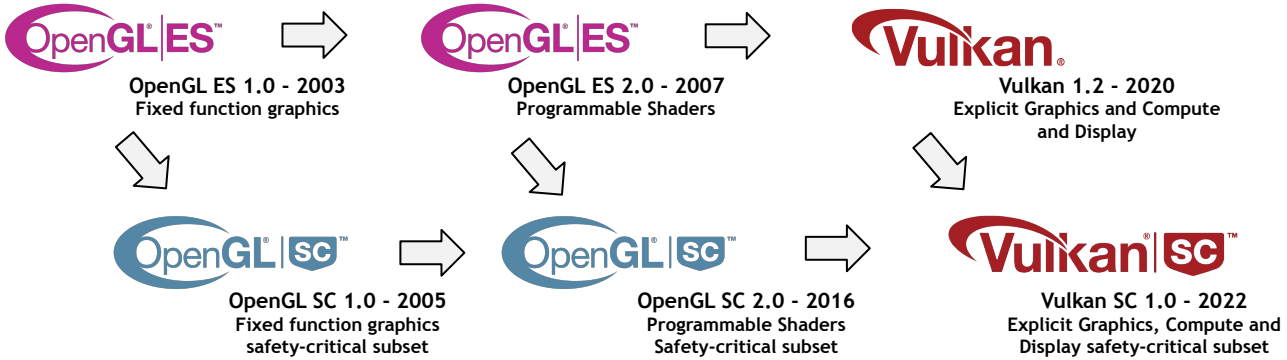
Victor Perez & Hugh Delaney

On behalf of the SYCL SC WG

Agenda

- Background
- Highlights of last 12 months
- Ecosystem

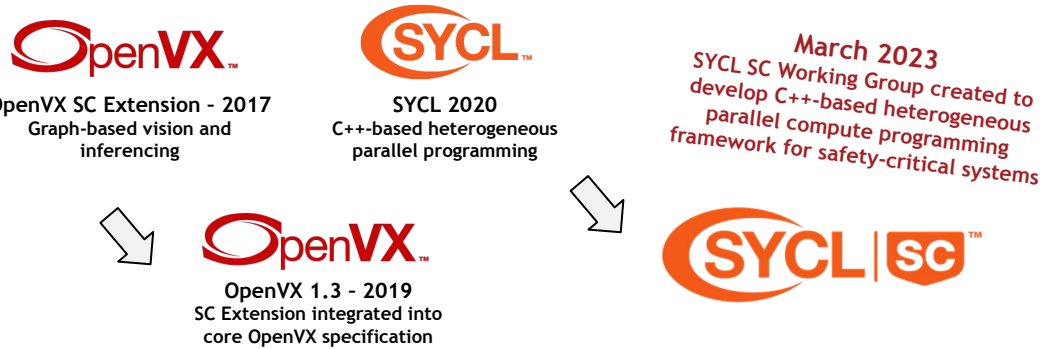
Khronos Safety Critical Standards Evolution



Khronos has 20 years experience in standards for safety-critical markets

Leveraging proven mainstream standards with shipping implementations and developer tooling and familiarity

A choice of abstraction levels to suit different markets and developer needs



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KHRONOS GROUP

SYCL SC Working Group Regular Members

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KHRONOS GROUP

What is “Safety-Critical”?

- **A system is *Safety-Critical* if its failure could result in harm/death of people**
- **SC industries:** automotive, avionics, medical, rail, atomic
- **Often certified according to standards**
  - Automotive: ISO 26262
  - Avionics: DO-178C
  - Medical: IEC 62304
- **Standards define safety levels:** ASIL A-D / DAL A-E / Class A-C
- **Require *Functional Safety***
  - Absence of unreasonable risk caused by malfunction

  => Risk has been analyzed, mitigated to a reasonable level, proven
  - A system property
  - More than just language safety

SYCL SC

- **Why?**
  - SC industries increasingly require *acceleration* of software, due to
    - Rising popularity of **AI** algorithms
    - Proliferation of **heterogeneous** computing
    - Increasing demand for **performance**
- **What?**
  - Based on SYCL 2020
  - Modifications to ease safety-certification
    - Of the implementation of the standard
    - Of the SYCL application

What SYCL SC is Not

SYCL SC will not

- Tell you how to implement a “safe” application
- Guarantee a safe application
- Tell you how to implement a “safe” SYCL SC runtime
- Guarantee a safe runtime
- Tell you how to apply any industry process or standard
- Be certified (as a standard)
- Make your hardware safe

SYCL SC will be compatible with you doing the above, but cannot do it for you.

SYCL SC assumes that you are using safe HW, e.g. incorporating redundancy, EDC/ECC, watchdogs.

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Online Compilation

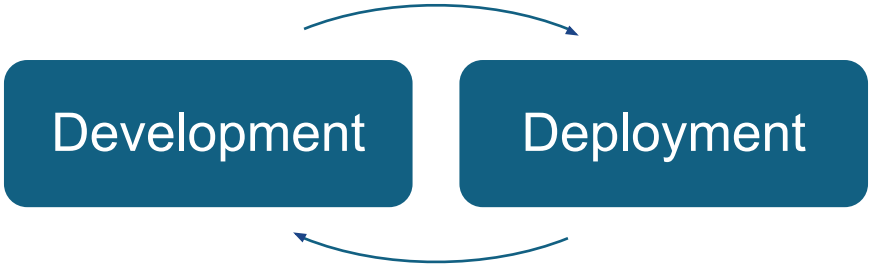
- **A SYCL implementation can do one or both of:**
  - Online compilation of kernels at run-time
  - Offline compilation of kernels
- **Some SYCL features rely on online compilation, e.g.**
  - Specialization constants
  - Parts of kernel_bundle

- **All deployed SW needs to be safety certified**
- **Safety certification is expensive**
  - Follow strict processes
  - Write code in a careful way (e.g. follow guidelines)
  - Perform exhaustive testing
  - …
- **Don’t want to certify a compiler!**
- **Offline compilation allows verification of binary during development phase**

Implies: Focus on offline compilation only in SYCL SC.

Development vs. Deployment

Traditional SW development



Safety critical SW development

Development vs. Deployment Features

Examples:

Development Feature	Deployment Feature
profiling support	queues
stream class	buffers/accessors

All deployed code must be safety certified

Certification is expensive

Remove development features ➡️ Lower certification costs

Development features can still be implemented outside of the spec!

Expect:

- Debug & Release builds of SYCL SC runtime OR
- Use SYCL implementation for development, move to SYCL SC for deployment

Implies: Make it easy for a SYCL SC application to run on a SYCL runtime

Additional Discussion Items

The WG has also started discussing

Avoiding Dynamic Memory on Host

- Dynamic memory in C++ is not deterministic
- All memory allocation typically static or up-front in SC applications
- Finding a balance between determinism and algorithm flexibility

Deterministic Error Management

- SYCL uses C++ exception
- Timing of exception handling not deterministic in common compilers
- Some custom compilers support this
- Challenge: Keep the difference to Base SYCL small

Outreach

embedded world Exhibition&Conference

11:30 AM - 12:00 PM
Information

Dr. Erik Tomusk
Codeplay Software

Safety Critical Open Standards for Accelerated Heterogeneous Computing

We have seen an explosion in Machine Learning and AI solutions over the past decade due in part to the ecosystem of open standard libraries and frameworks that enable engineers to prototype ideas quickly. Now, as the need increases for safety-critical APIs that can meet application engineers at levels of abstraction that they are familiar with, open standards for high-level abstraction in safety-critical heterogeneous computing such as SYCL Safety Critical and those that facilitate low-level access to GPU acceleration for advanced graphics and compute applications, such as Vulkan Safety Critical are enabling applications in safety-critical markets such as automotive, avionics, industrial, and medical. This session will also discuss how OpenVX provides a safety profile for deploying discrete vision algorithms and Neural Network inferencing. This session explores how these safety-critical standards adhere to MISRA C++ guidelines and align with safety-critical standards such as such as RTCA DO-178C Level A / EASA ED-12C (avionics), ISO 26262/21448 (automotive), IEC 61508 (industrial), and IEC 62304 (Medical).

Khronos APIs for Heterogeneous Compute and Safety: SYCL and SYCL SC - CppCon 2023

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In addition to member presentations

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Unified Acceleration Foundation (UXL)

UXL
Unified Acceleration Foundation

Mission

- Build a **multi-architecture multi-vendor software ecosystem** for all accelerators
- **Unify** the heterogeneous compute ecosystem **around open standards**
- Build on and expand **open source projects for accelerated computing**

oneAPI
Specification

Level Zero
Hardware Interface

oneDPL
Data Parallel C++ Library

oneDNN
Deep Neural Network Library

oneCCL
Collective Communications Library

oneDAL
Data Analytics Library

oneTBB
Threading Building Blocks

oneMKL
Math Kernel Library

www.uxlfoundation.org

New Safety Critical SIG

UXL
Unified Acceleration Foundation

Aim:

Enable/accelerate integration of UXL projects into safety critical systems

Potential activities:

- Analyse/Suggest changes to make projects easier to safety certify;
- Communicate SC-specific requirements;
- Discuss certification/integration strategies;
- Collaborate on SYCL SC porting & safety artefacts.

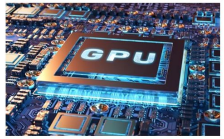
Open to anyone

To join: https://lists.uxlfoundation.org/g/Safety-Critical-SIG

Khronos AUTOSAR Liaison: SYCL Demonstrator

Motivation

Currently there is no native AUTOSAR functionality to utilize hardware accelerators for high performance computation.
Only way is to integrate 3rd party libraries which can affect safety.



At the same time there is a challenge for AUTOSAR Adaptive Platform to cover cutting-edge functionality like:

- AD/ADAS systems
- Performing heavy algorithms
- AI
- etc.

Thank you to AUTOSAR and Intellias

intellias
Intelligent Software Engineering

The main aim: creation of generic API in AUTOSAR, which allows to utilize hardware acceleration for computation efficiency improvement. SYCL is the best candidate to be used under the hood. Moreover, SYCL SC will potentially add required safety compatibility.

AUTOSAR

The main goal of this concept is to enable parallel heterogeneous programming, using standardized C++ based API, for solving issue of high performance computing.

Important part of the concept is to consider ISO-26262 Standard without sacrificing of performance.

ISO 26262

Get Involved!

Excited about getting your hands on this?

Are you piqued by the challenge?

Get in contact!

Member of Khronos? Join the Working Group!

Not a member? Look out for Advisory Panels!

Visit	www.khronos.org/syclsc
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