The 11th International workshop on OpenCL and SYCL

IWOCL & SYCLcon 2023

What's New in SYCL SC™ (SYCL for Safety Critical Systems)

Erik Tomusk, Codeplay Software

Verena Beckham, Codeplay Software

April 18-20, 2023 | University of Cambridge, UK iwocl.org

Introduction

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- Follow-up to last year's presentation
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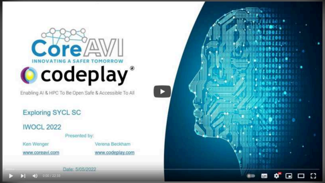

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Exploring SYCL SC

IWOCL 2022

Presented by:

Ken Wenger
www.coreavi.com

Verena Beckham
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Date: 5/05/2022

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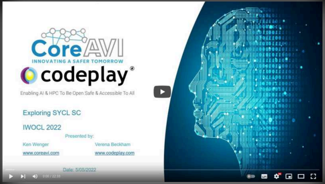

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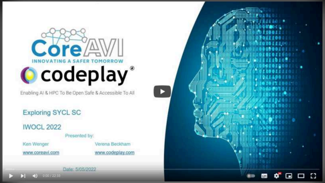

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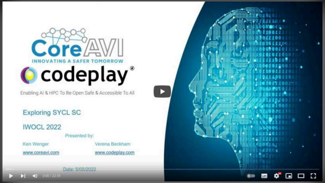

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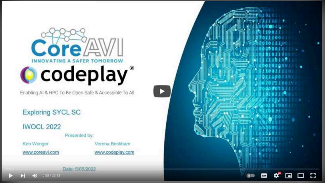

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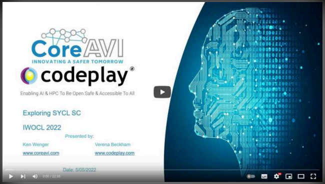
  - EF finished; now there is a working group (WG)



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Industry Support

The deployment of autonomous systems is increasingly dependent on open standards and a robust software and hardware ecosystem that places safety as its top priority.

Tom Conway
(Sr. Director, Product Management, Automotive)

arm

Mercedes-Benz Research & Development North America is delighted to join the SYCL SC Working Group to strengthen industry adoption of safety-critical development standards, as ADAS/AD systems harness heterogeneous computing hardware.

Sundararajan Ramalingam
(VP Autonomous Driving)

Mercedes-Benz
Research & Development North America

SYCL Safety Critical extends open accelerator programming to applications where safety critical standards apply.

Joe Curly
(VP Software Products)

intel

AMD

BSC Barcelona Supercomputing Center
Centro Nacional de Supercomputación

Qualcomm

intellias

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https://www.khronos.org/news/press/khronos-to-create-sycl-sc-open-standard-for-safety-critical-c-based-heterogeneous-compute

Outline

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1. Background
2. Summary of SYCL SC EF activities
3. Technical lessons learned
   - SYCL SC Scope
   - SC dynamic memory
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- Caveats:
    - Speaking as a Codeplay employee
    - Not representing Khronos
    - Not representing SYCL SC EF or SYCL SC WG
    - SYCL SC EF was under NDA

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- For software, a safety-critical domain is one where a software malfunction could cause serious damage
  - To people
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- Domains include
  - Automotive
  - Aerospace
  - Medical
  - Nuclear
  - Rail
  - …

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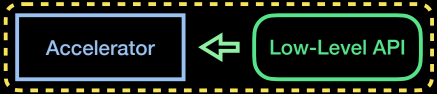

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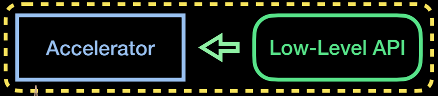

Much faster than CPU for some tasks

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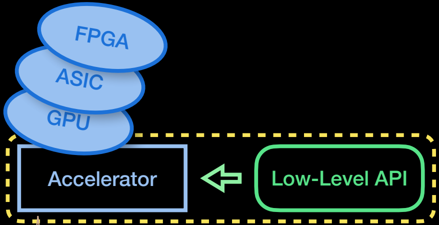

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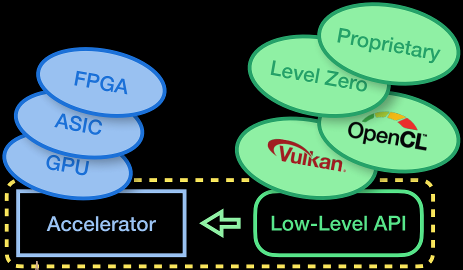

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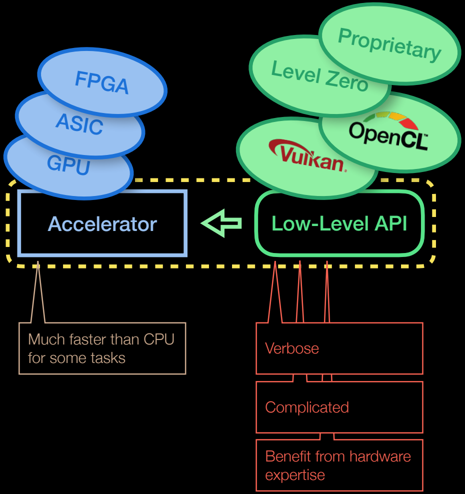

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Verbose

Complicated

Benefit from hardware expertise

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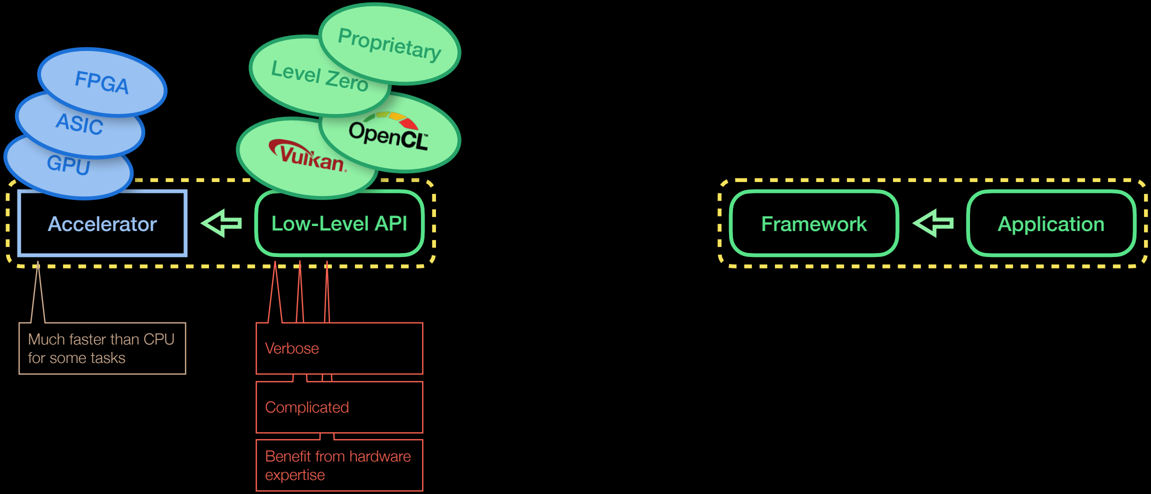

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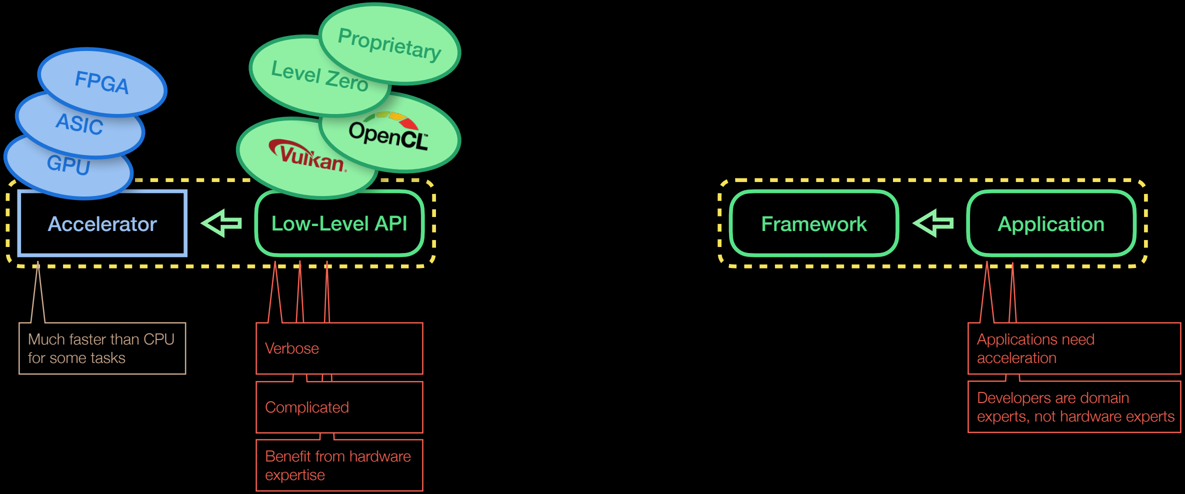

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Applications need acceleration

Developers are domain experts, not hardware experts

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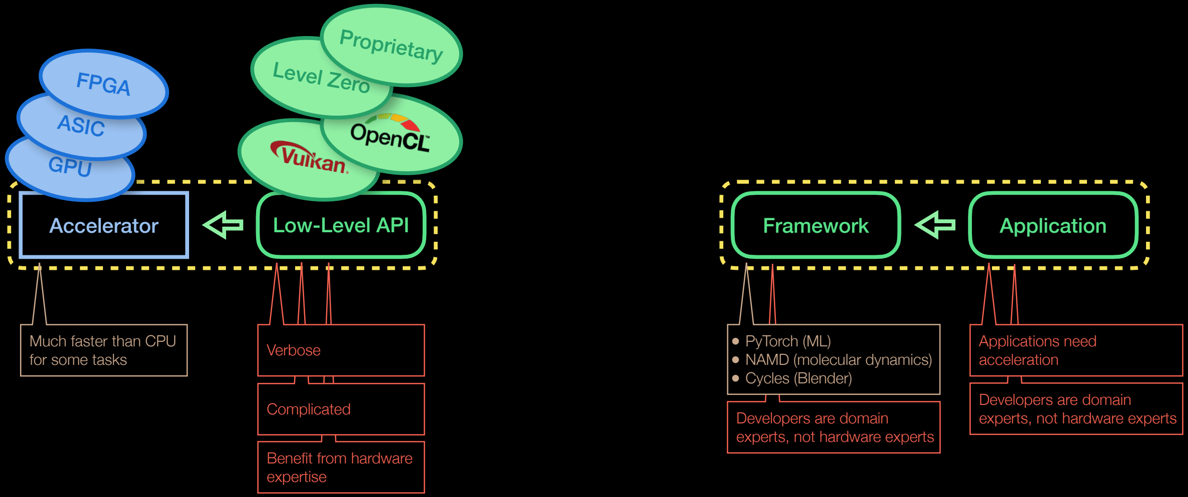

Accelerator ⇦ Low-Level API

Framework ⇦ Application

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Benefit from hardware expertise

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- NAMD (molecular dynamics)
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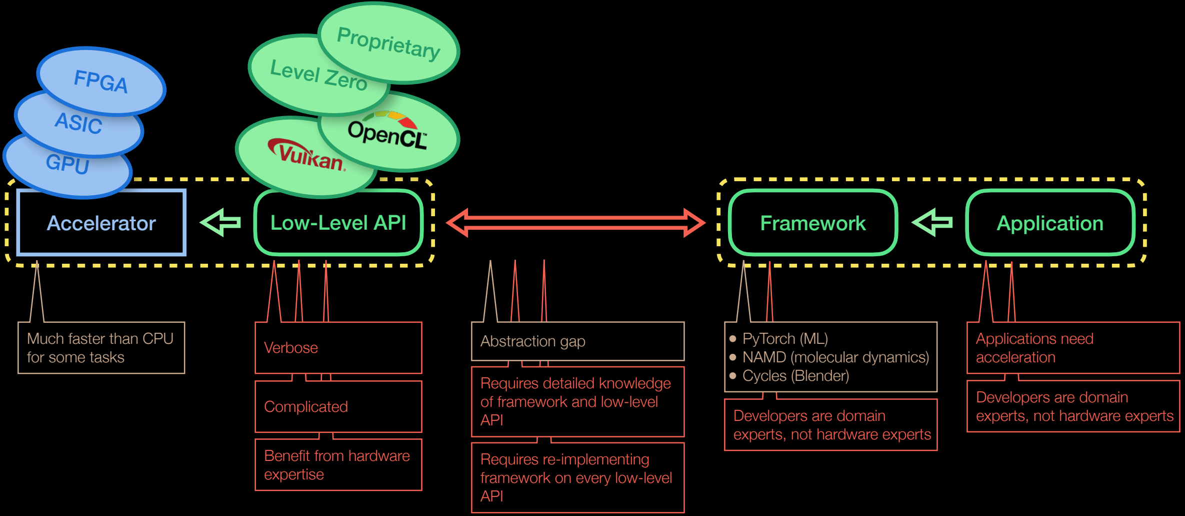

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Abstraction gap

Requires detailed knowledge of framework and low-level API

Requires re-implementing framework on every low-level API

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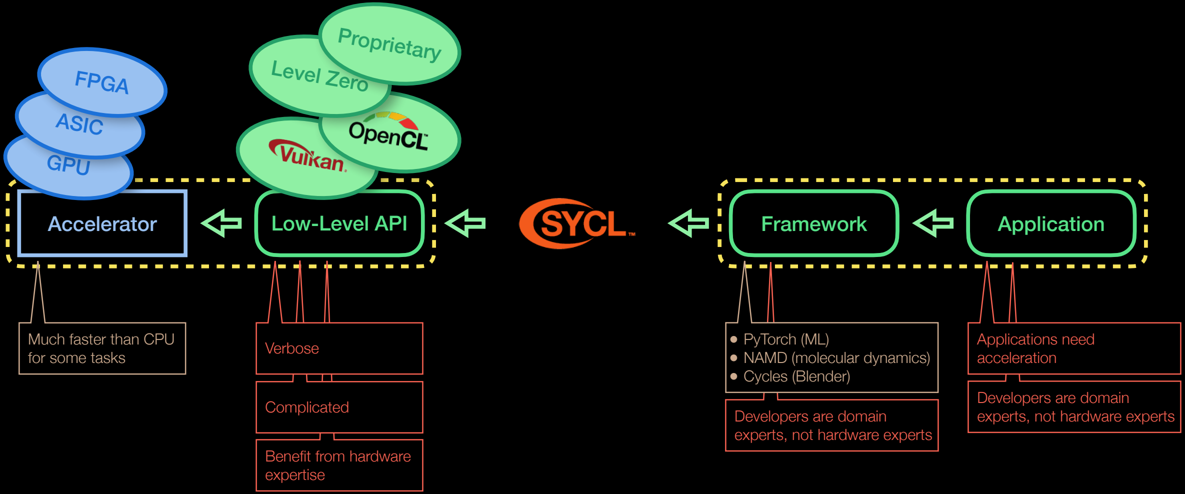

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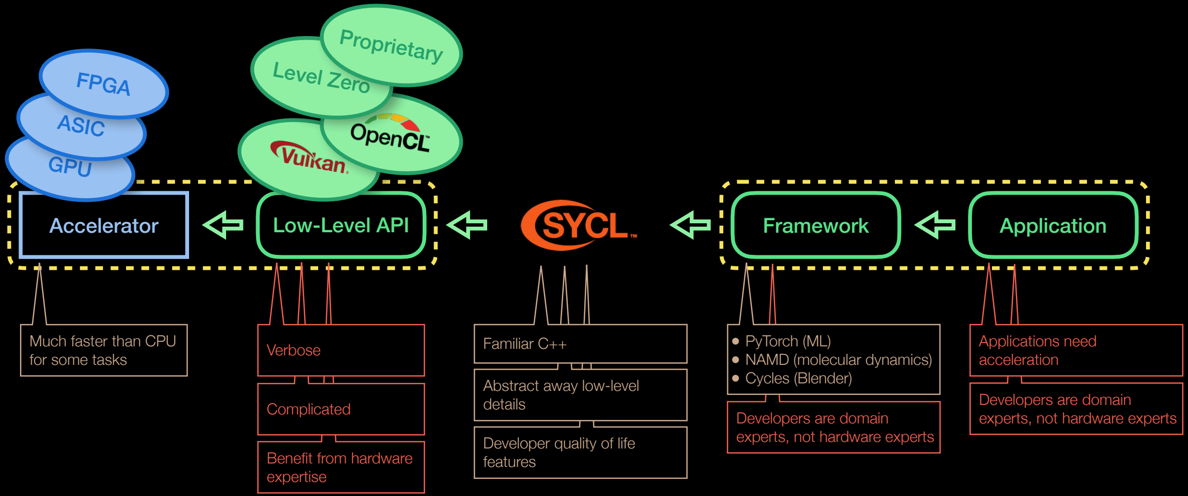

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Benefit from hardware expertise

Familiar C++

Abstract away low-level details

Developer quality of life features

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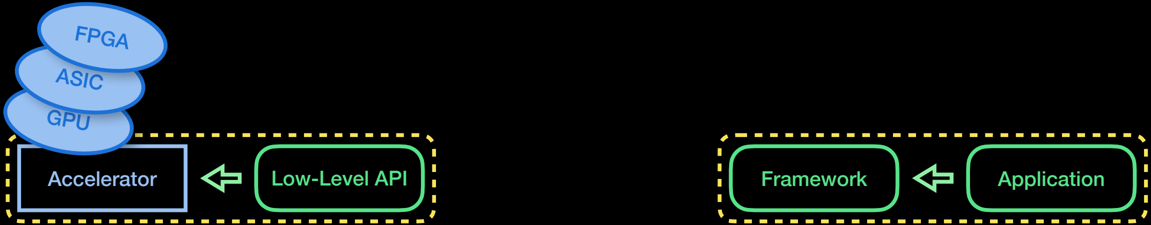

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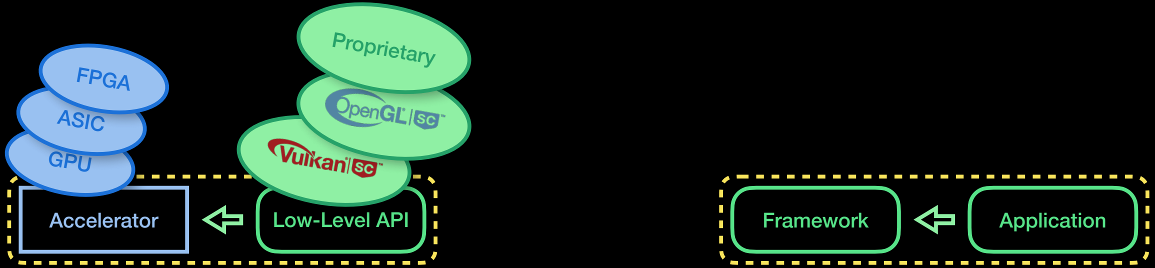

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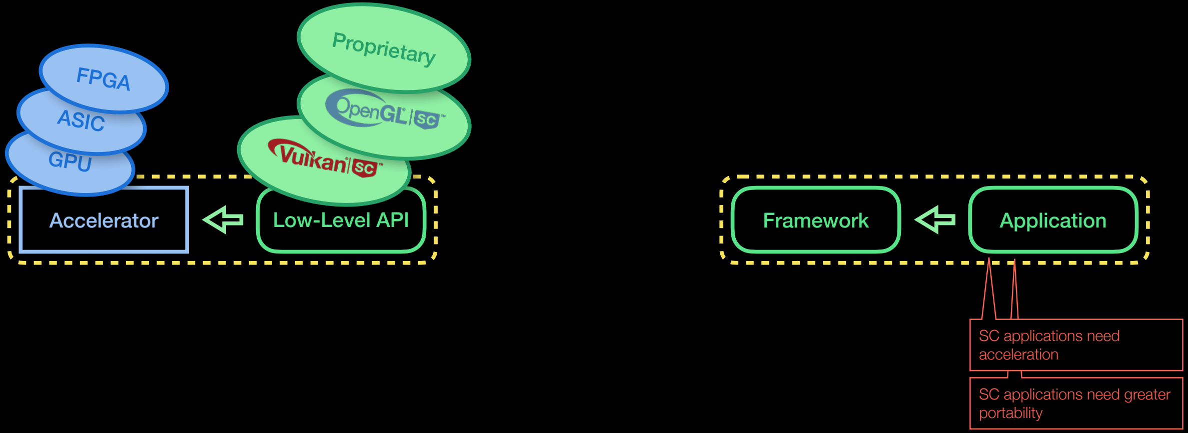

SC applications need acceleration

SC applications need greater portability

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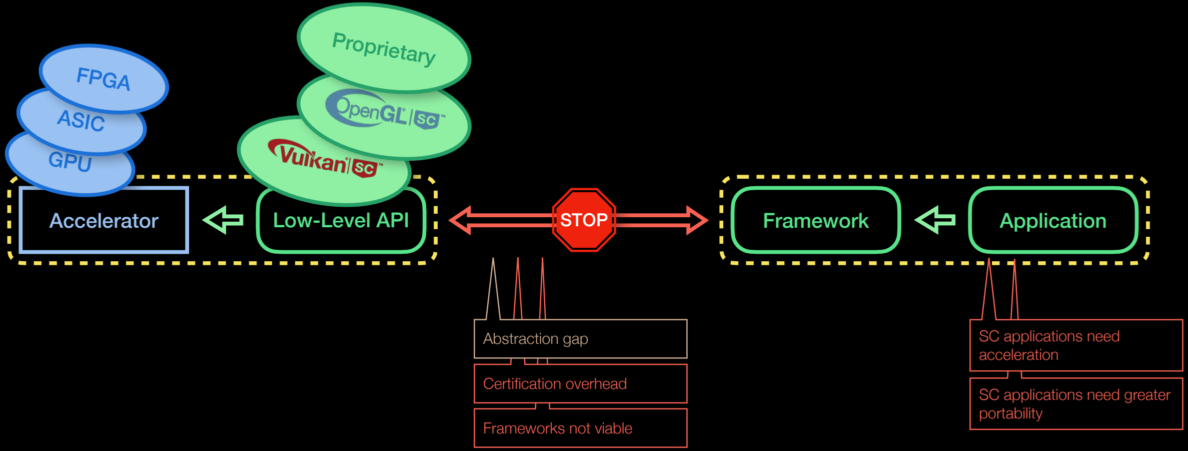

Abstraction gap

Certification overhead

Frameworks not viable

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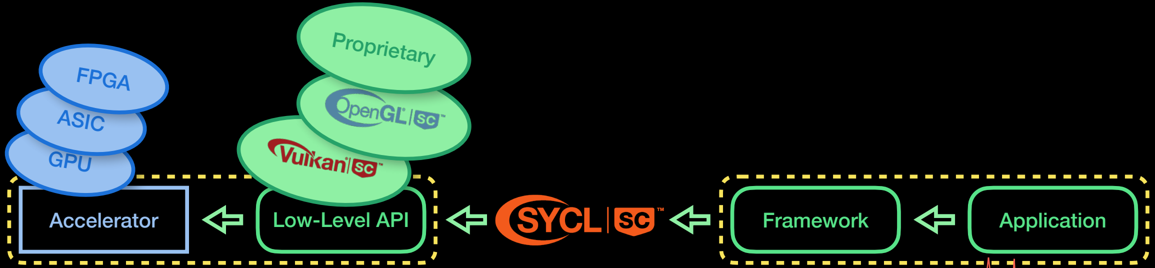

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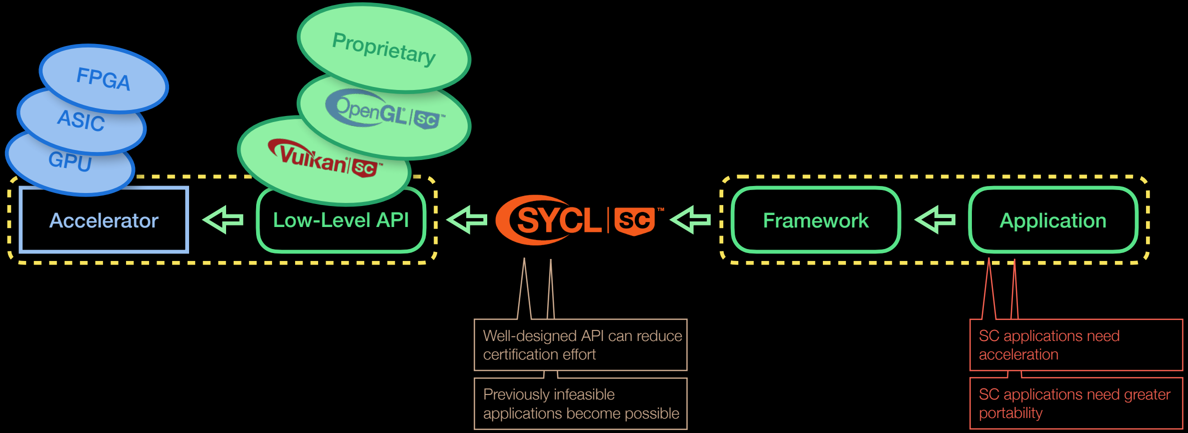

Well-designed API can reduce certification effort

Previously infeasible applications become possible

SC applications need acceleration

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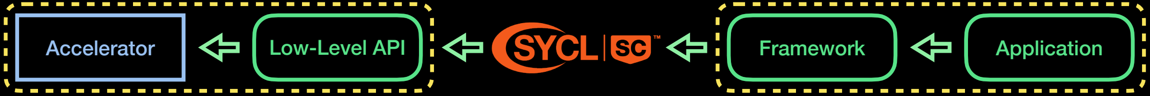
Background: Why not just SYCL?



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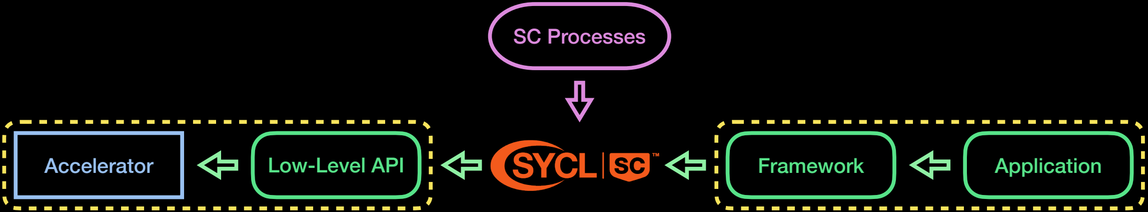

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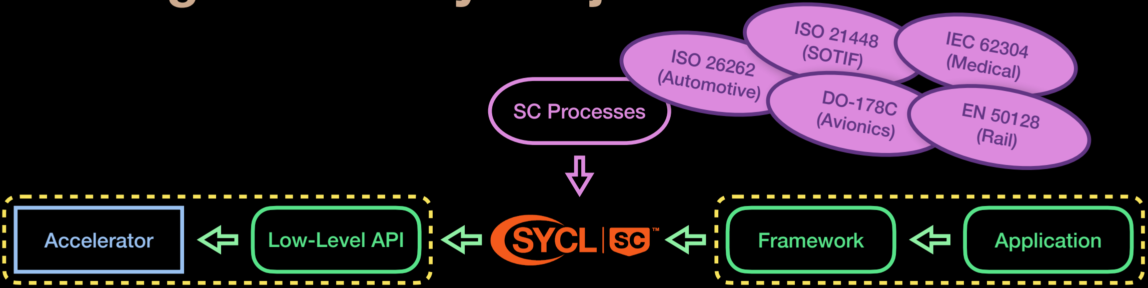

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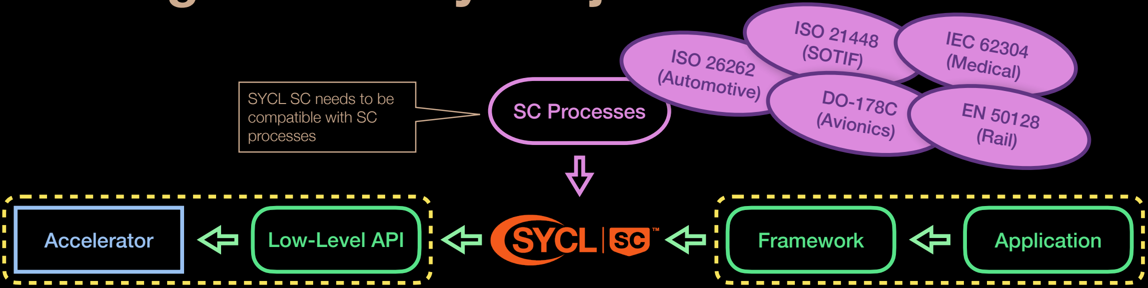

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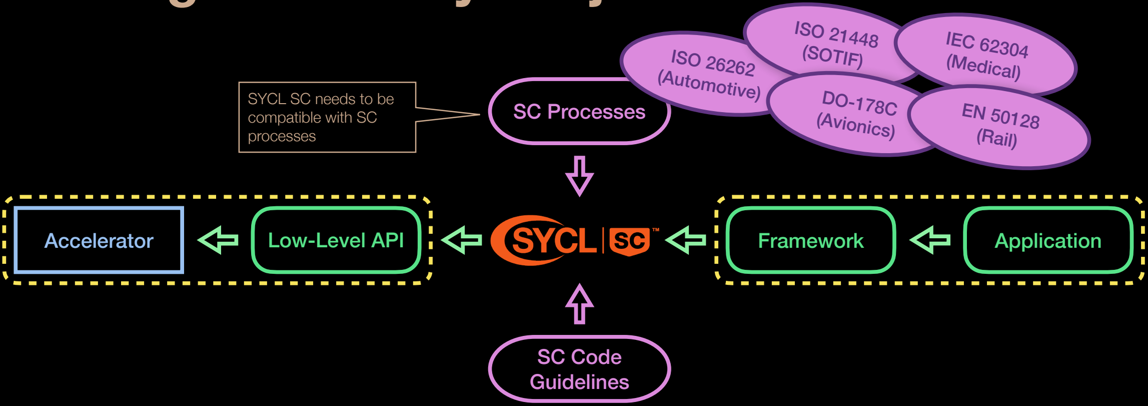

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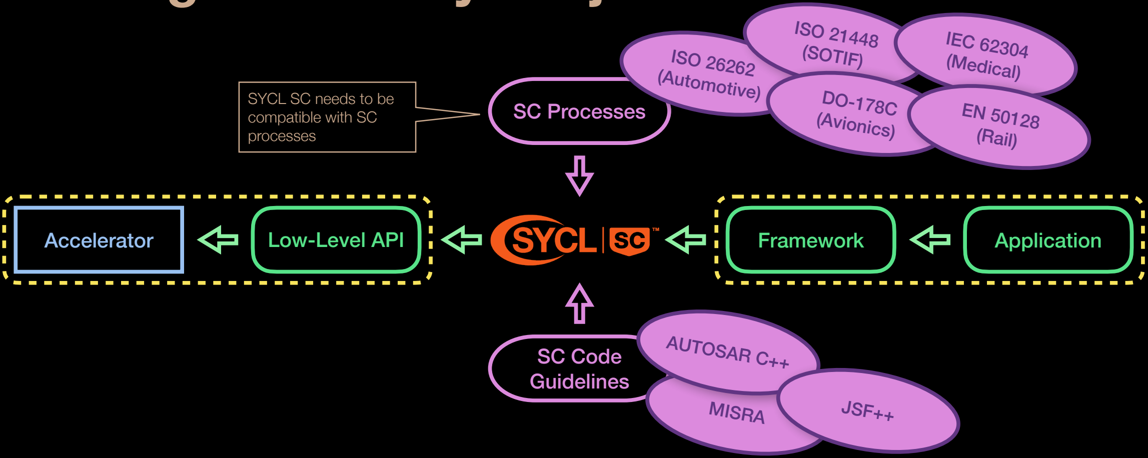

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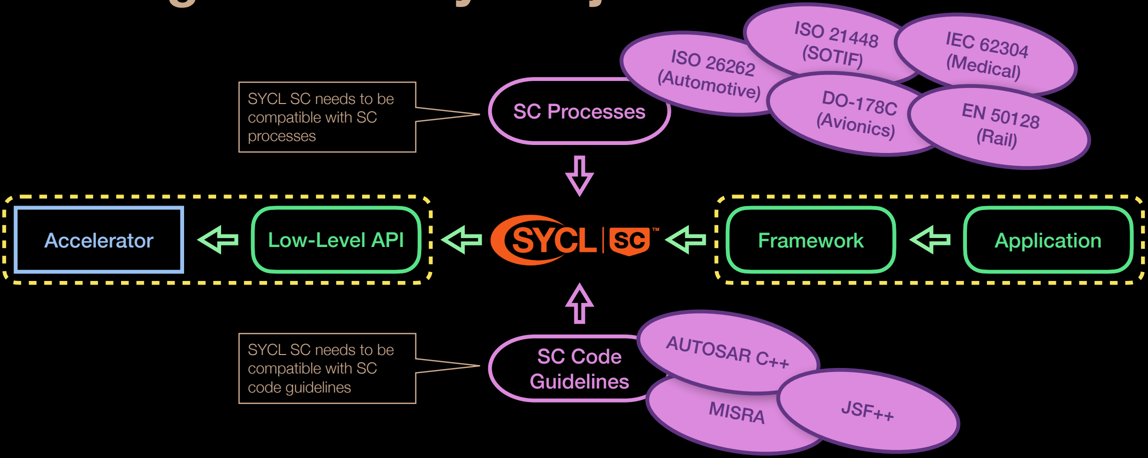

SYCL SC needs to be compatible with SC processes

SC Processes

ISO 26262 (Automotive)

ISO 21448 (SOTIF)

IEC 62304 (Medical)

DO-178C (Avionics)

EN 50128 (Rail)

Accelerator

Low-Level API

SYCL SC™

Framework

Application

SYCL SC needs to be compatible with SC code guidelines

SC Code Guidelines

AUTOSAR C++

MISRA

JSF++

Background: Why not just SYCL?

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- SYCL SC philosophy

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- First-order priorities for SYCL SC, but lower priorities for SYCL

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  - Produce any certified code (tools or runtime)
    - Code snippets in SYCL SC specification will need to be *certifiable*
- SYCL SC will be *compatible* with you doing the above, but cannot do it for you

Outline

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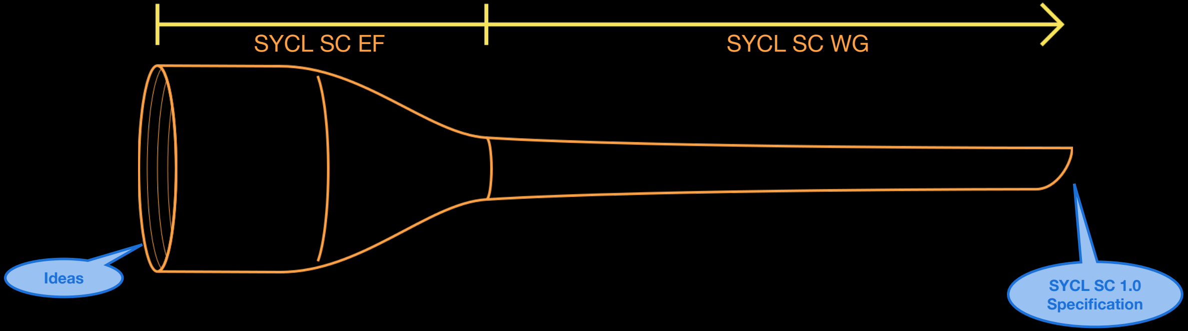
2. **Summary of SYCL SC EF activities**
3. Technical lessons learned
   - SYCL SC Scope
   - SC dynamic memory
4. Conclusions

SYCL SC EF: Process



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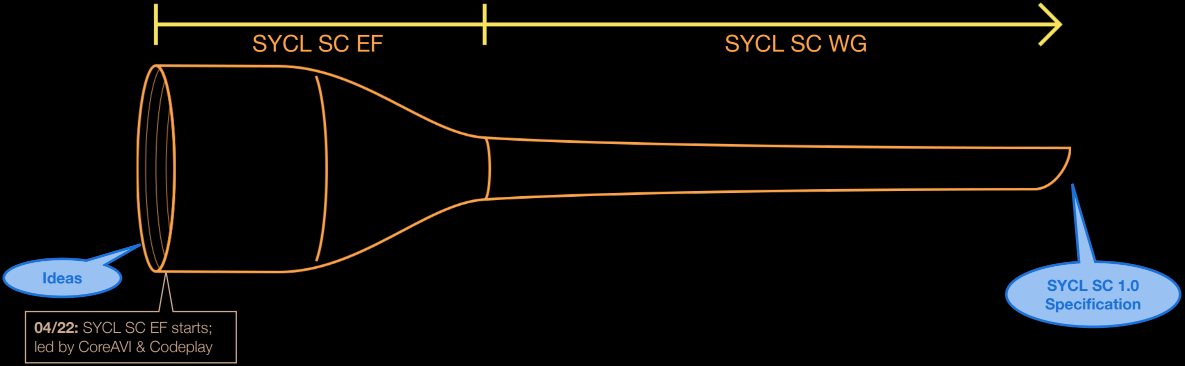

04/22: SYCL SC EF starts; led by CoreAVI & Codeplay

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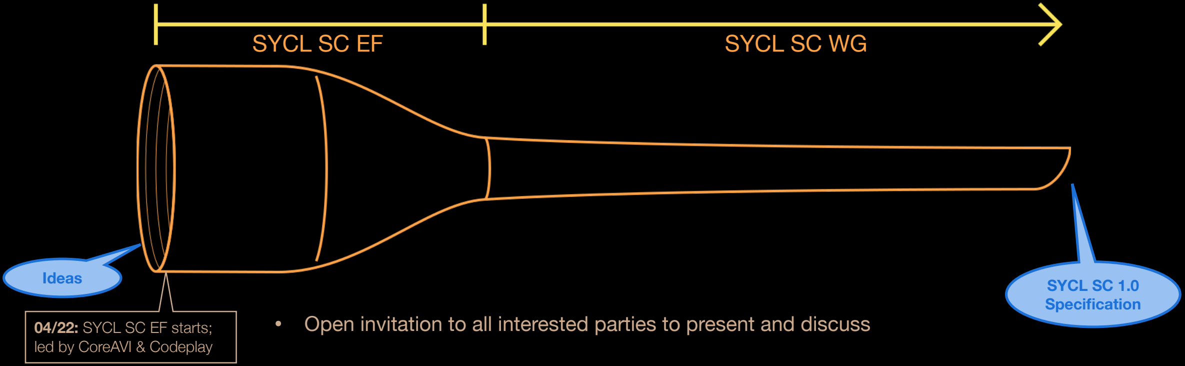

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- Open invitation to all interested parties to present and discuss

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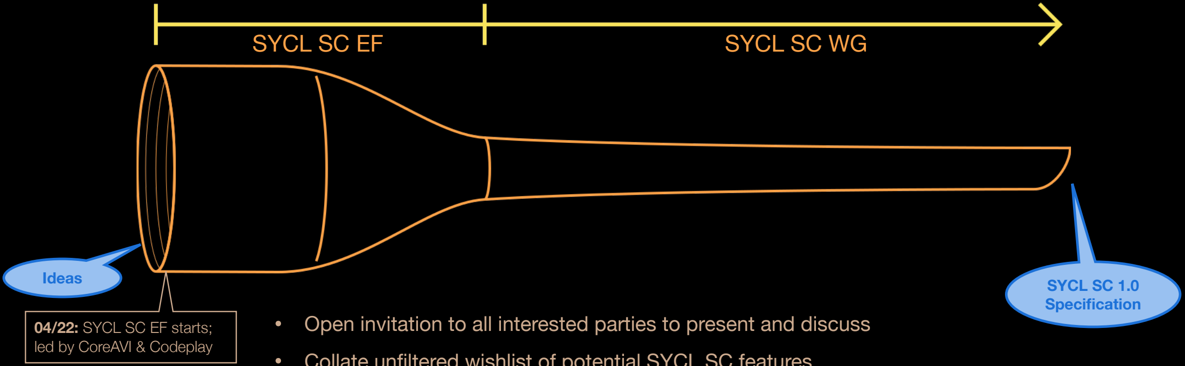

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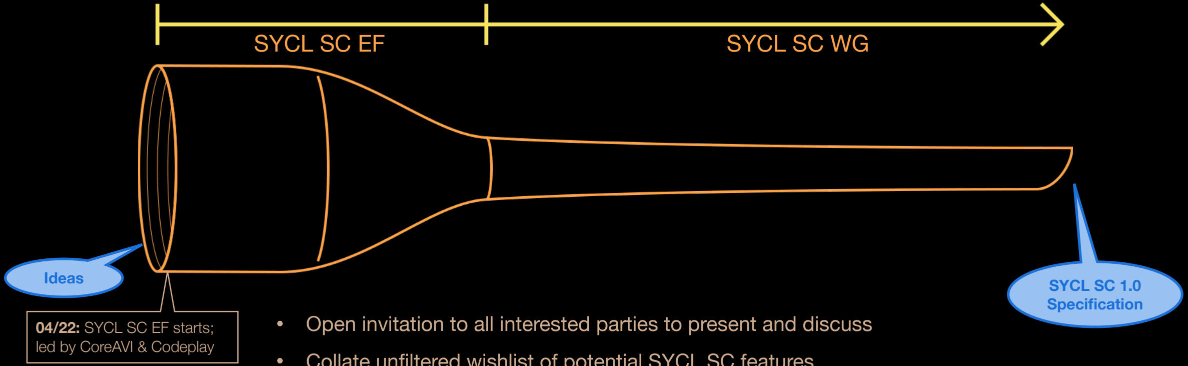

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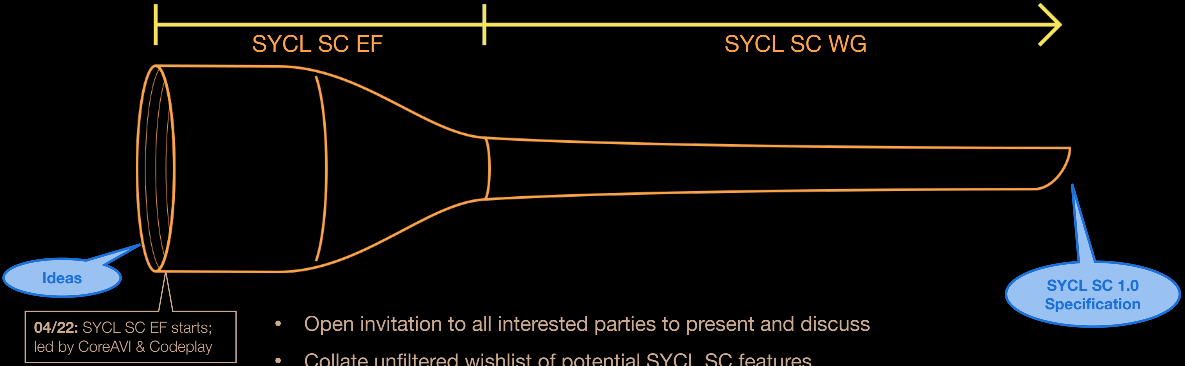
- Collate unfiltered wishlist of potential SYCL SC features
  - **Goal:** Determine if there is a need for a standard like SYCL SC

SYCL SC EF: Process



04/22: SYCL SC EF starts; led by CoreAVI & Codeplay

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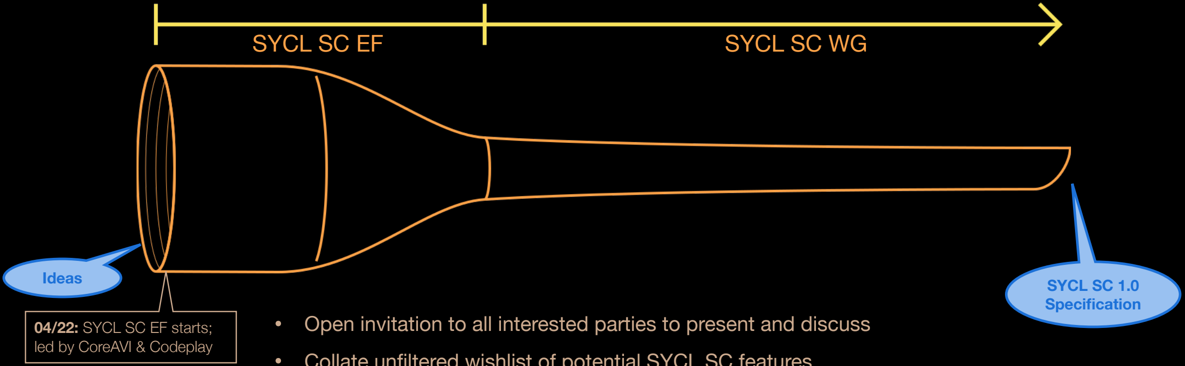

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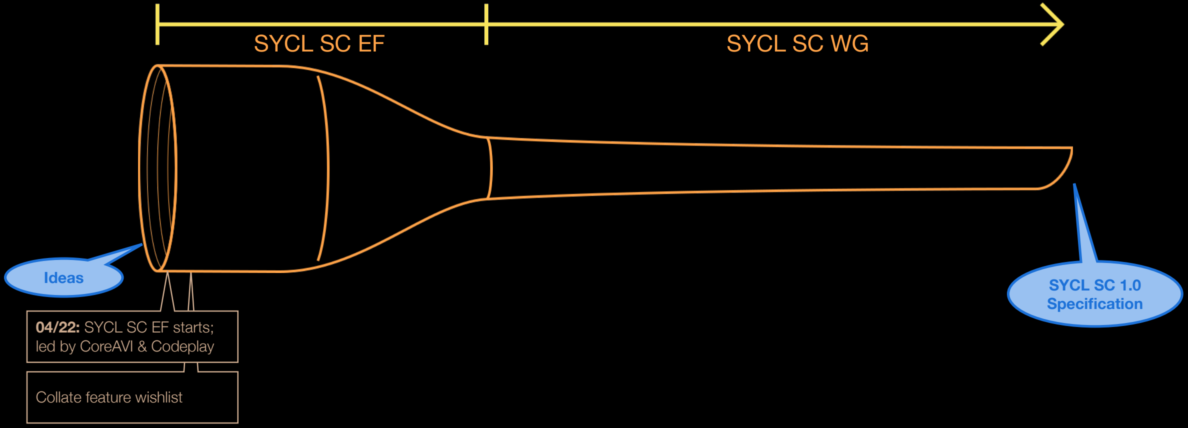

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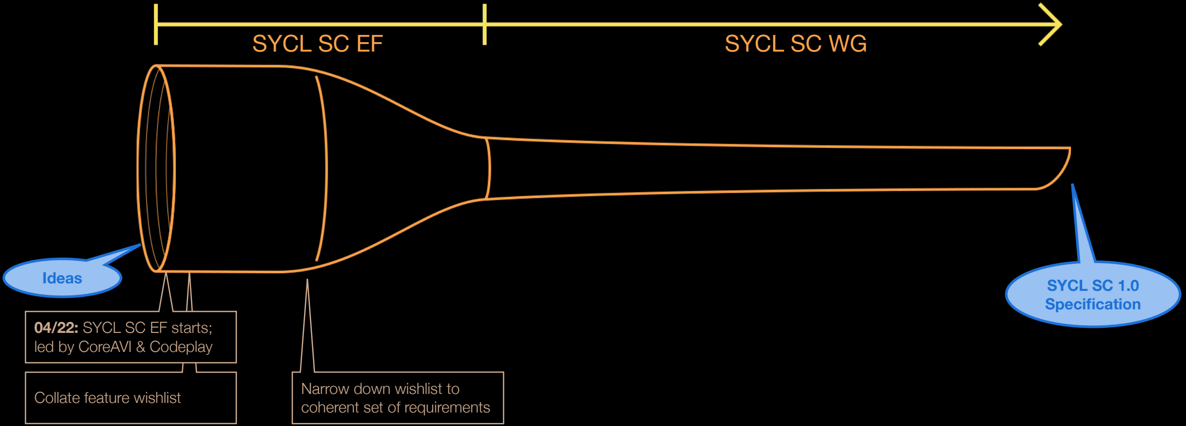

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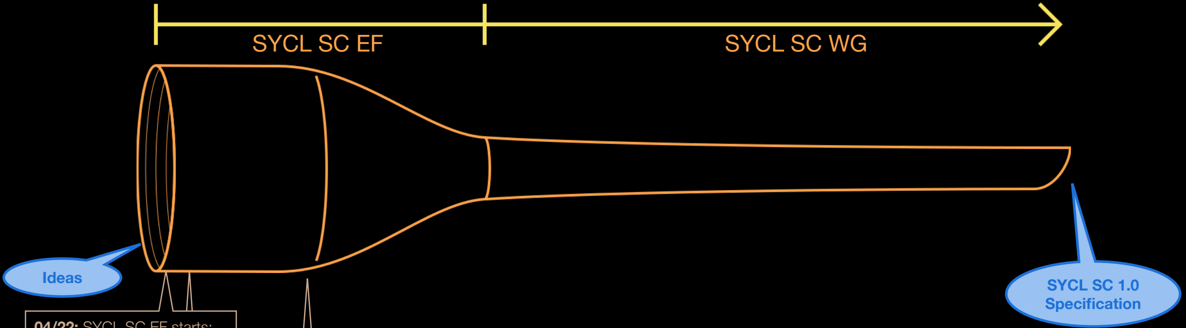

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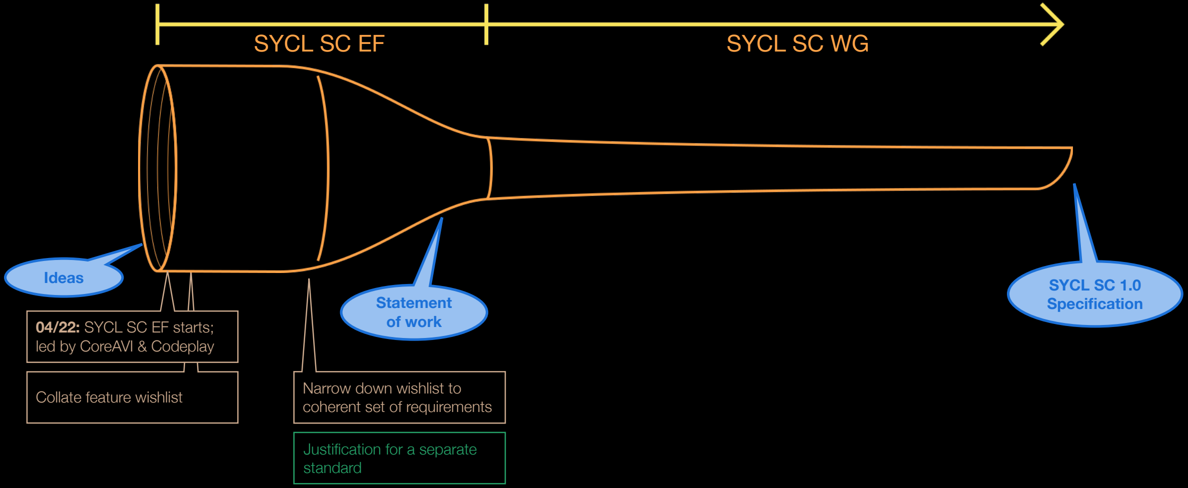

SYCL SC EF

SYCL SC WG

Ideas

04/22: SYCL SC EF starts; led by CoreAVI & Codeplay

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Statement of work

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SYCL SC 1.0 Specification

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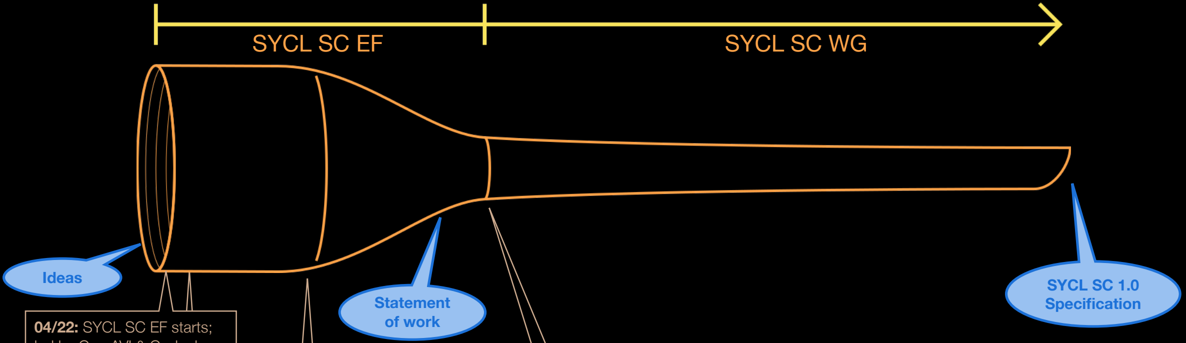

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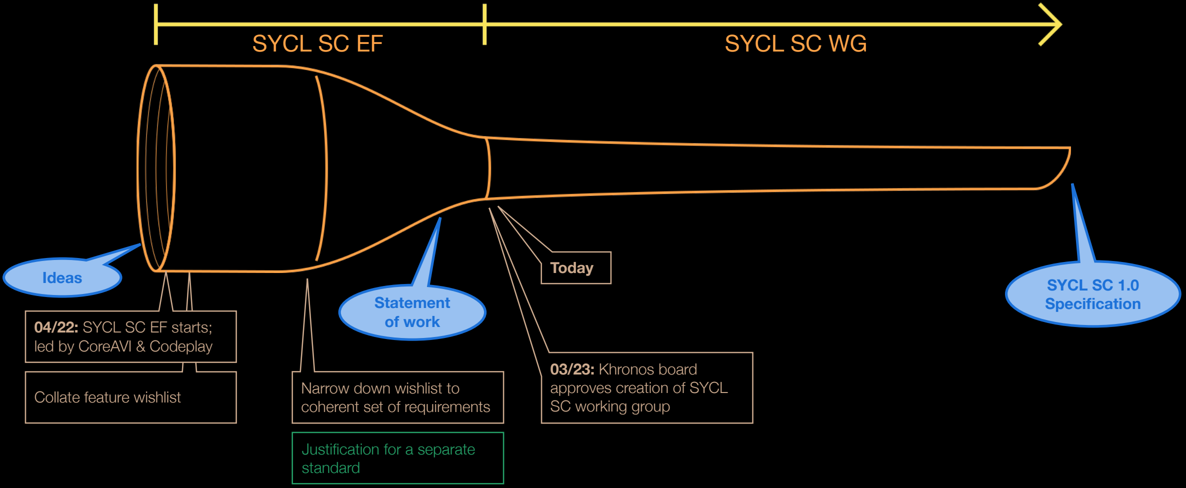

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Outline

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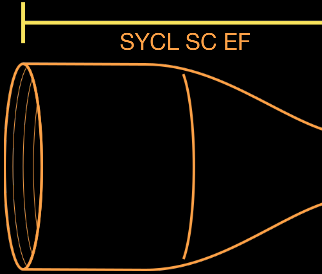
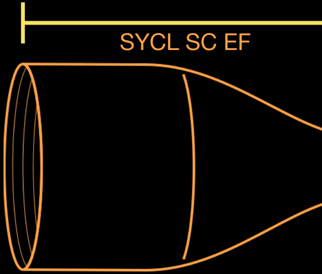
2. Summary of SYCL SC EF activities
3. **Technical lessons learned**
   - SYCL SC Scope
   - SC dynamic memory
4. Conclusions

Technical Takeaway: SYCL SC Scope



Technical Takeaway: SYCL SC Scope

- Plenty of discussion around the “usual suspects,” like exceptions



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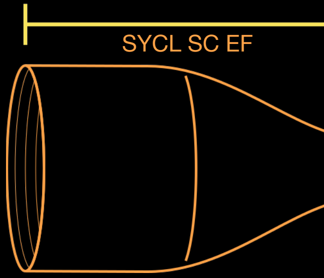

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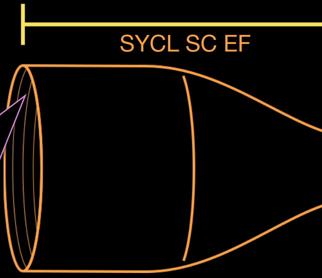

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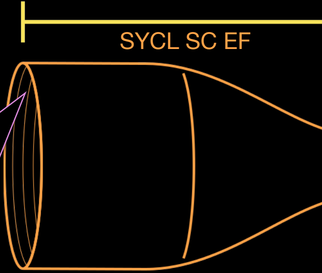

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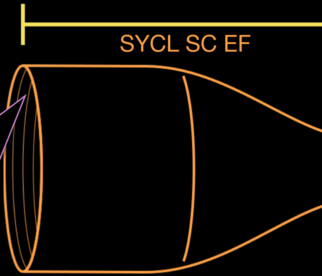

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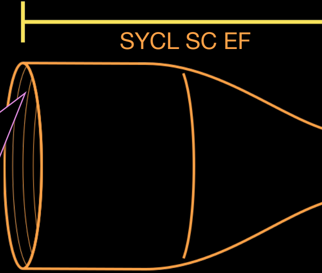

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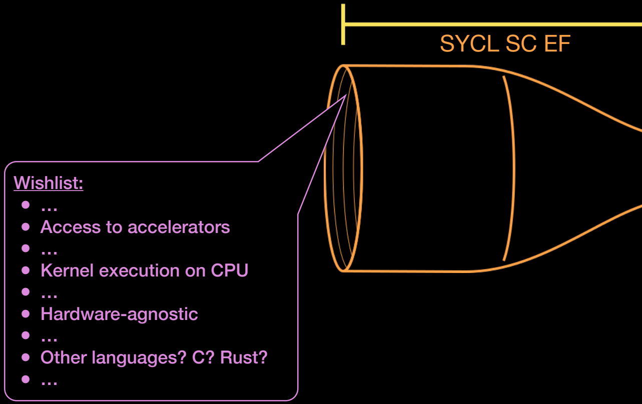

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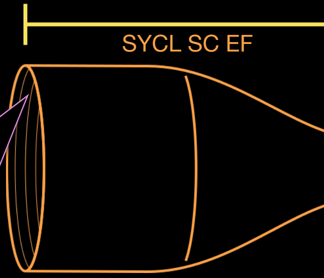

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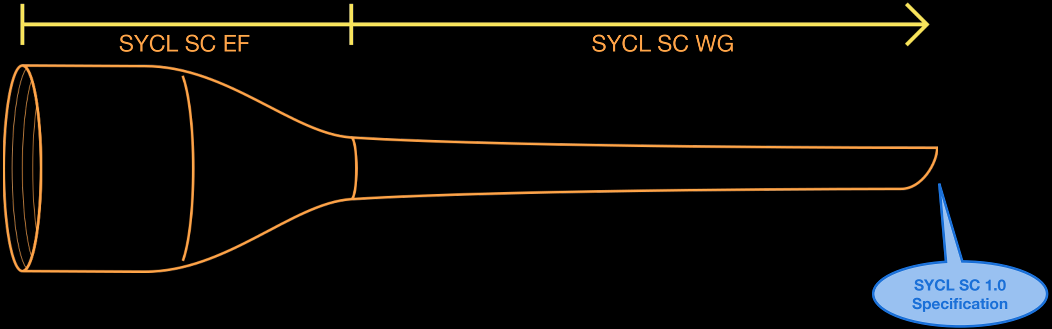

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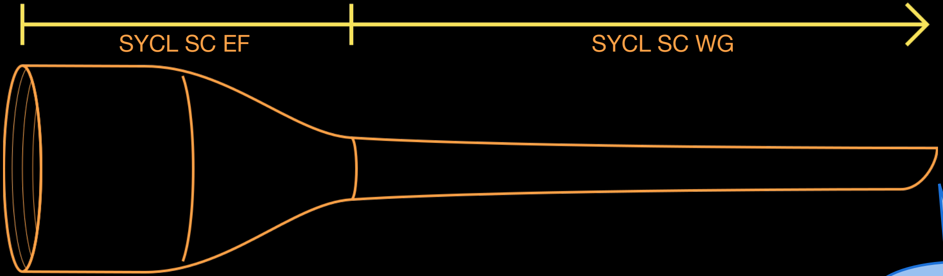

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SYCL SC 1.0 Specification

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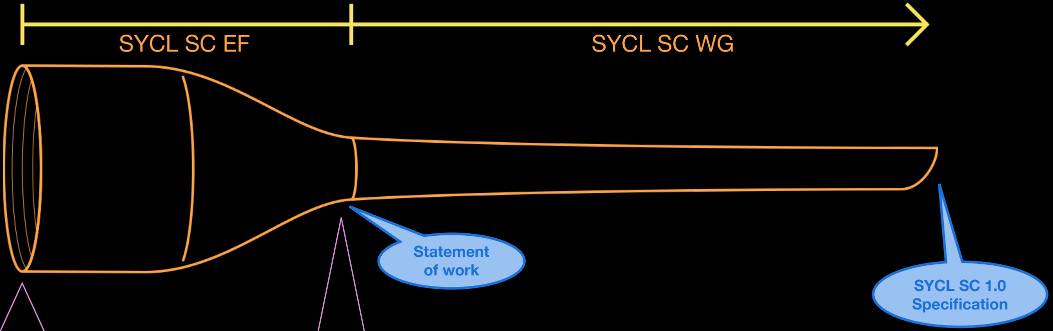
Technical Takeaway: Dynamic Memory



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The 11th International workshop on OpenCL and SYCL

IWOCL & SYCLcon 2023

What’s New in SYCL SC™ (SYCL for Safety Critical Systems)

Erik Tomusk, Codeplay Software erik@codeplay.com

Verena Beckham, Codeplay Software verena@codeplay.com

April 18-20, 2023 | University of Cambridge, UK

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