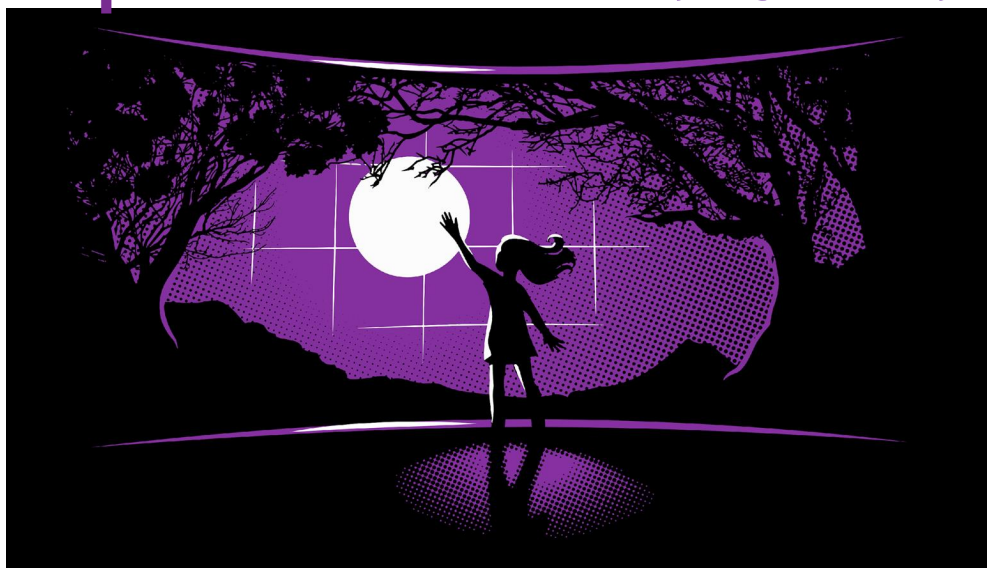
OpenXR™

KHRONOS GROUP

OpenXR™ Unifying Reality



KHRONOS® GROUP

OpenXR 1.0!

Brent E. Insko, PhD
Lead XR Architect at Intel & OpenXR Working Group Chair

SIGGRAPH, July 2019

OpenXR 1.0 Release is Here!

Khronos Releases OpenXR 1.0 Specification Establishing a Foundation for the AR and VR Ecosystem

Final specifications and shipping implementations freely available today;
Growing adoption from XR industry and expanding ecosystem support

July 29, 2019 – 6:00 AM PT – SIGGRAPH, Los Angeles – Today, The Khronos® Group, an open consortium of leading hardware and software companies creating advanced acceleration standards, announces the ratification and public release of the OpenXR™ 1.0 specification together with publicly available implementations and substantial ecosystem momentum. OpenXR is a unifying, royalty-free, open standard that provides high-performance, cross-platform access to virtual reality (VR) and augmented reality (AR)— collectively known as XR—platforms and devices. The new specification can be found on the Khronos website and via GitHub.

"The working group is excited to launch the 1.0 version of the OpenXR specification, and the feedback from the community on the provisional specification released in March has been invaluable to getting us to this significant milestone," said **Brent Insko, OpenXR working group chair and lead XR architect at Intel.** "Our work continues as we now finalize a comprehensive test suite, integrate key game engine support, and plan the next set of features to evolve a truly vibrant, cross-platform standard for XR platforms and devices. Now is the time for software developers to start putting OpenXR to work."

After gathering feedback from the XR community during the public review of the provisional specification, improvements were made to the OpenXR input subsystem, game engine editor support, and loader. With this 1.0 release, the working group will evolve the standard while maintaining full backwards compatibility from this point onward, giving software developers and hardware vendors a solid foundation upon which to deliver incredible, portable, user experiences.

Press announcement

Updated landing page

Agenda

- What is OpenXR?
- A Brief History of the Standard
- What are the Problems we are trying to Solve
- OpenXR Timeline of Development
- Brief Overview
- Demos
- What's Next?
- Recap

A Brief Aside…

- **Talk assume that you know:**
  - A little bit about VR and AR
  - A little bit about programming and very basic real-time rendering
  - Nothing about the specification process
  - Nothing about any of the other Khronos specifications

What is OpenXR?

OpenXR is a royalty-free, open standard that provides high-performance access to Augmented Reality (AR) and Virtual Reality (VR)—collectively known as XR—platforms and devices.

A Brief History of OpenXR

- **Among the first VR hardware available 2016**

- **Need applications…**
  - Each platform provided an SDK to interface with the hardware
  - Each was different from the other

XR Ecosystem Fragmentation

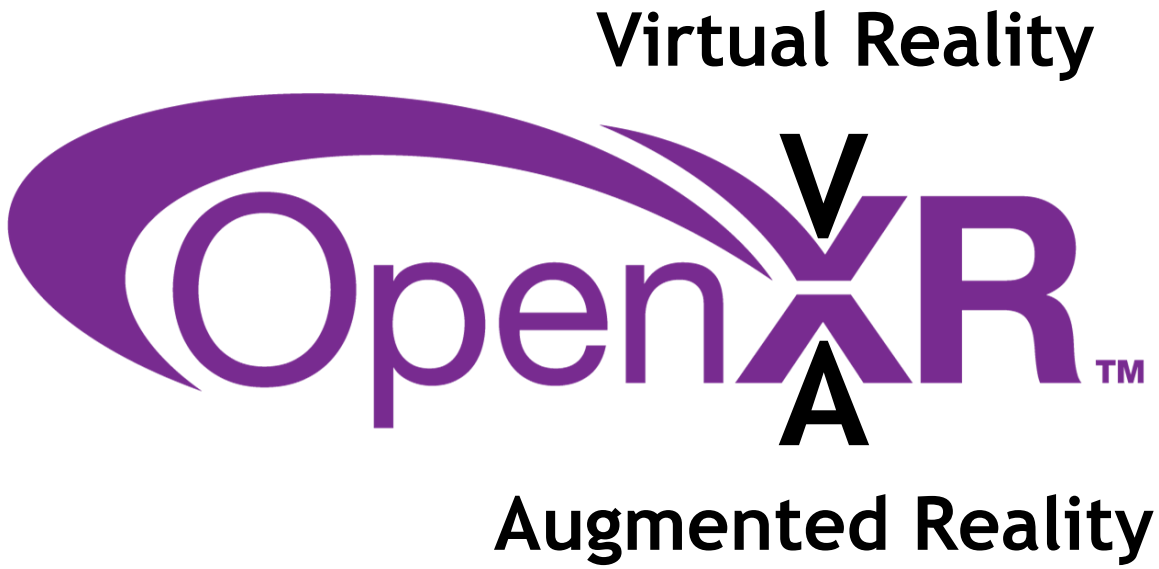
- Increased development time and therefore cost.
- Increased validation overhead and therefore cost.
- Time and resources spent developing one title, impacts developers' ability to create more titles.

Major XR Runtimes

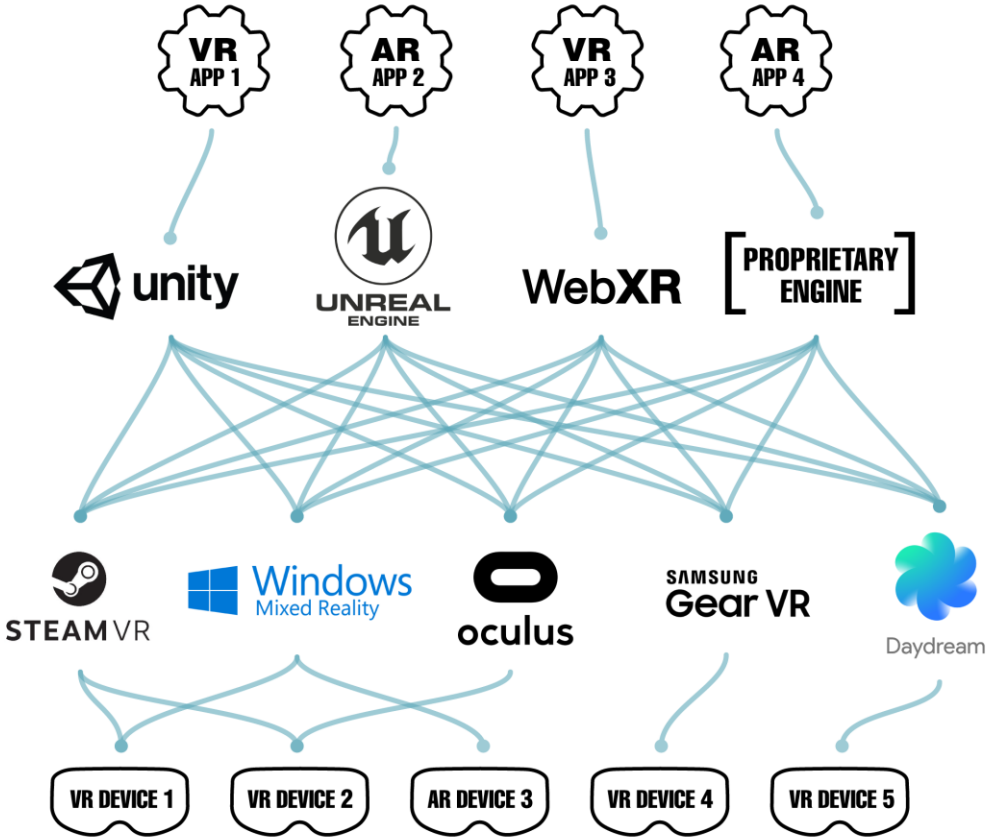
	Virtual Reality						Augmented Reality				Console VR
	PC			AIO	Mobile		AIO		Mobile		
	Oculus Rift	**SteamVR**	**Mixed Reality**	**Oculus Go**	**Daydream**	**GearVR**	**Hololens**	**ML1**	**ARKit**	**ARCore**	**PSVR**
Company	Facebook	Valve	Microsoft	Facebook	Google	Samsung Oculus	Microsoft	Magic Leap	Apple	Google	Sony
OS support		 									

OpenXR

- Recognizing the problem, several companies got together in late 2016 / early 2017 and formed the OpenXR working group in Khronos.



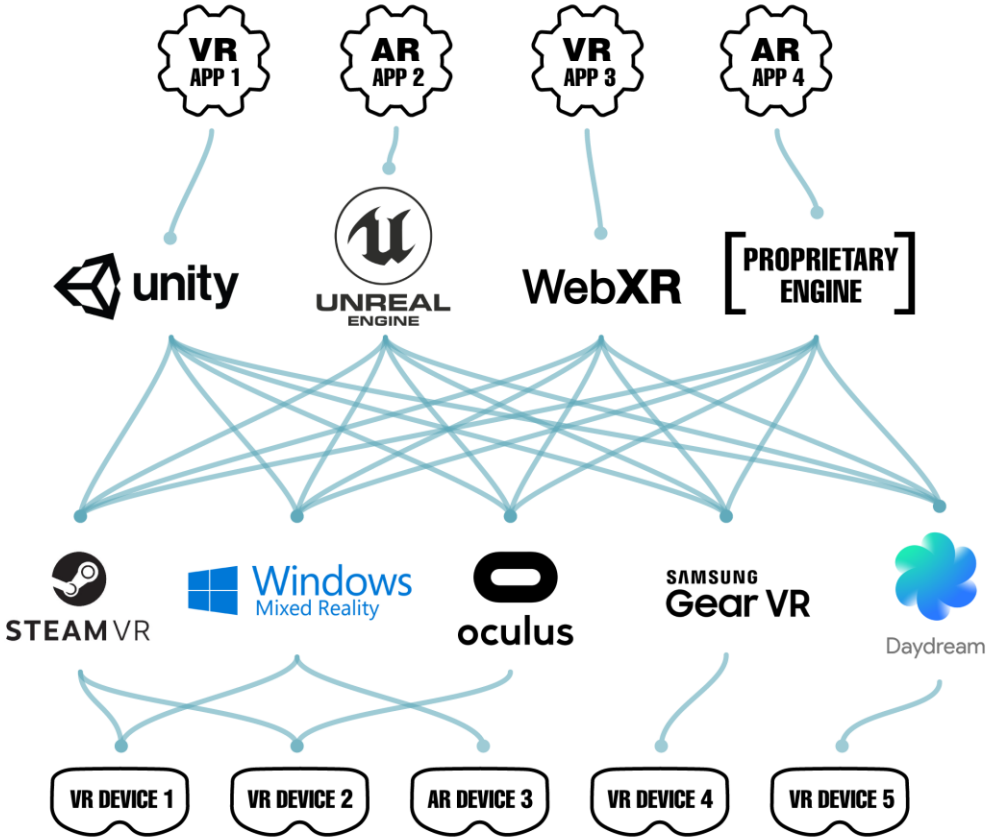
OpenXR - Solving XR Fragmentation



Before OpenXR

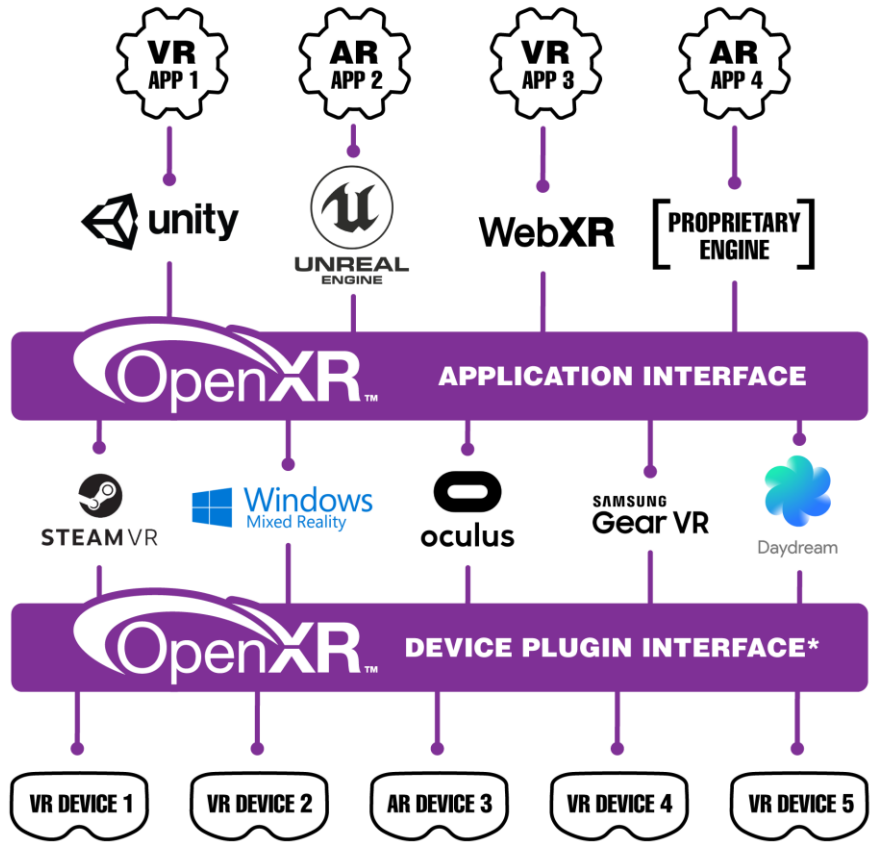
XR Market Fragmentation

OpenXR - Solving XR Fragmentation



Before OpenXR

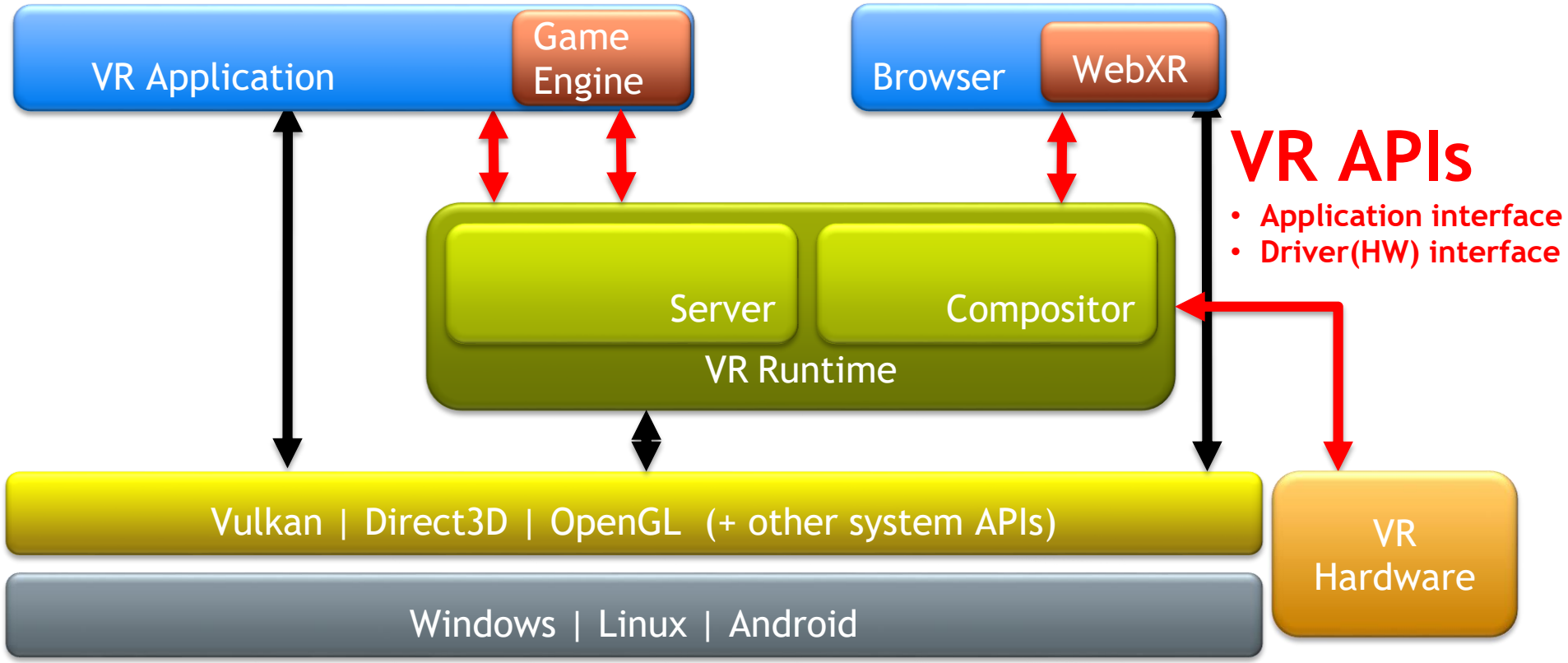
XR Market Fragmentation



After OpenXR

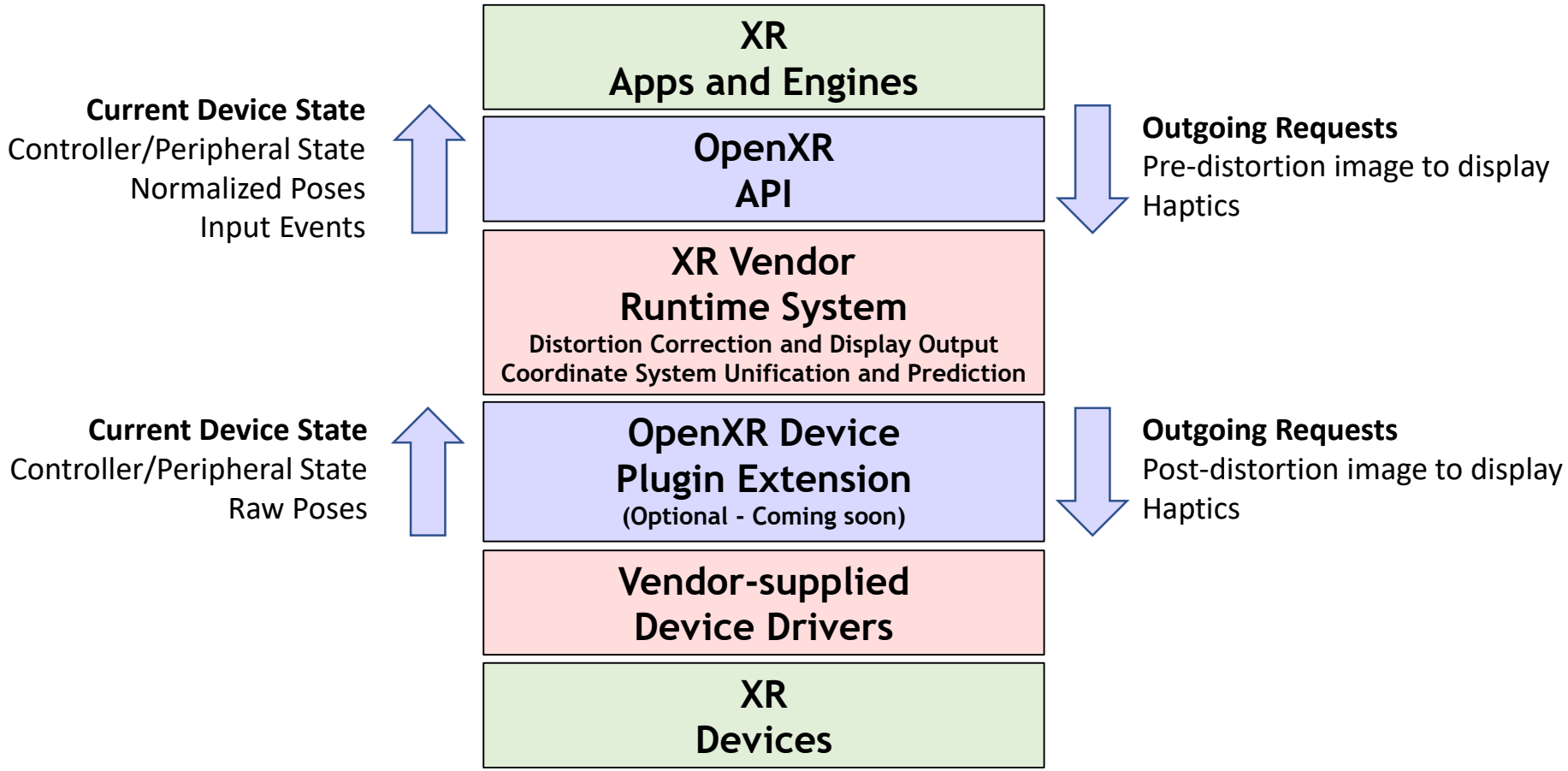
Wide interoperability of XR apps and devices

VR Software Stack (Example)

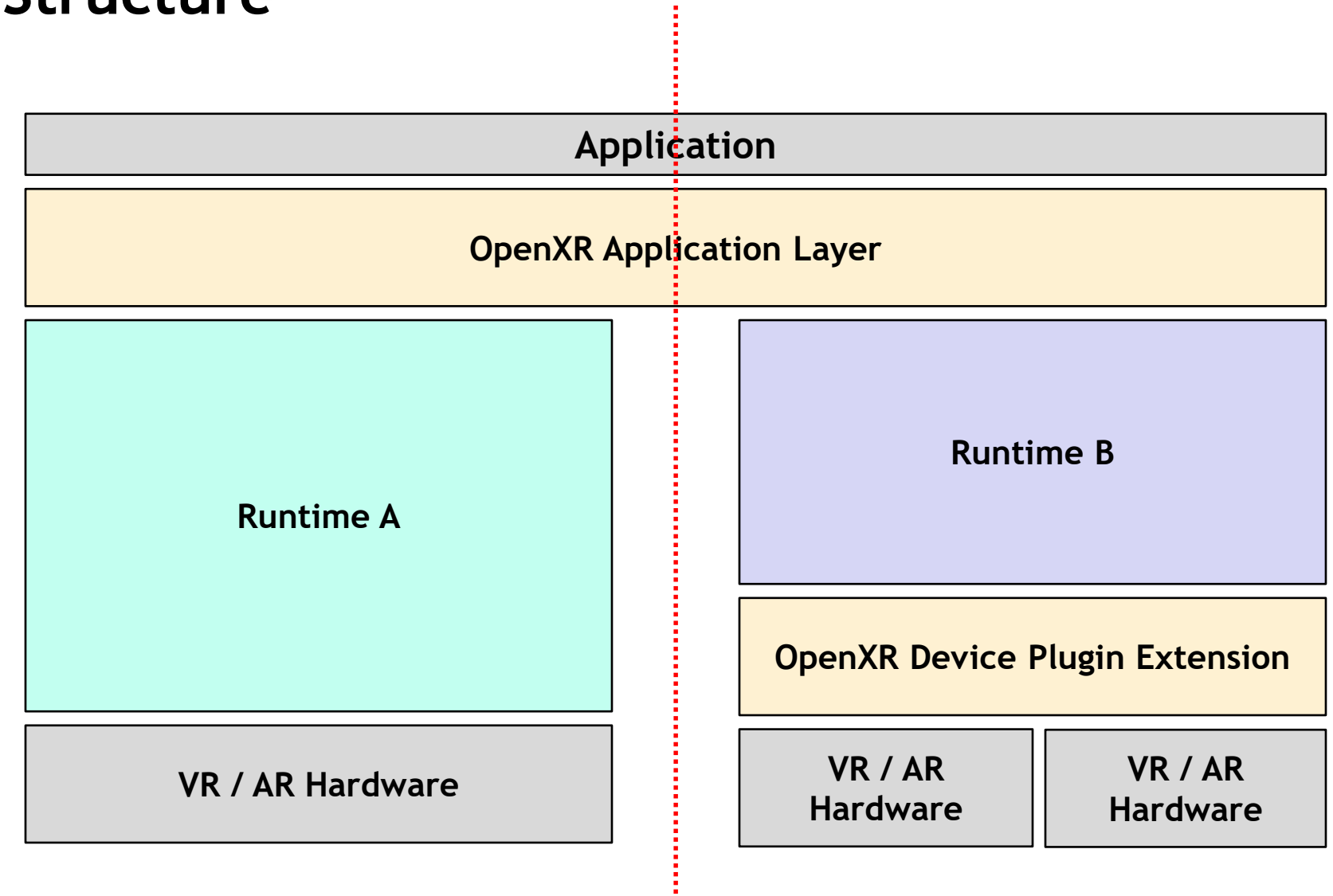


OpenXR Architecture

OpenXR does not replace XR Runtime Systems!
It enables any XR Runtime to expose CROSS-VENDOR APIs to access their functionality



The Structure



OpenXR Philosophies

1

Enable both VR and AR applications

The OpenXR standard will unify common VR and AR functionality to streamline software and hardware development for a wide variety of products and platforms

2

Be future-proof

While OpenXR 1.0 is focused on enabling the current state-of-the-art, the standard is built around a flexible architecture and extensibility to support rapid innovation in the software and hardware spaces for years to come

3

Do not try to predict the future of XR technology

While trying to predict the future details of XR would be foolhardy, OpenXR uses forward-looking API design techniques to enable engineers to easily harness new and emerging technologies

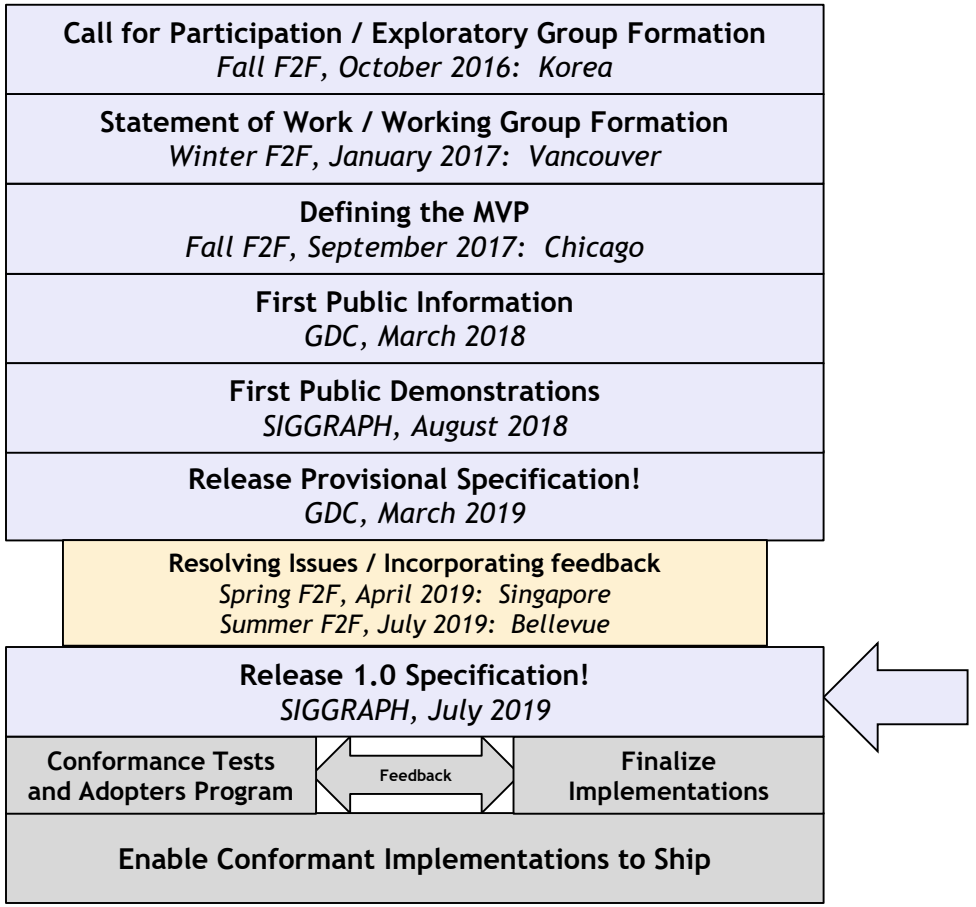
4

Unify performance-critical concepts in XR application development

Developers can optimize to a single, predictable, universal target rather than add application complexity to handle a variety of target platforms

KHRONOS GROUP

Where are we on the timeline?



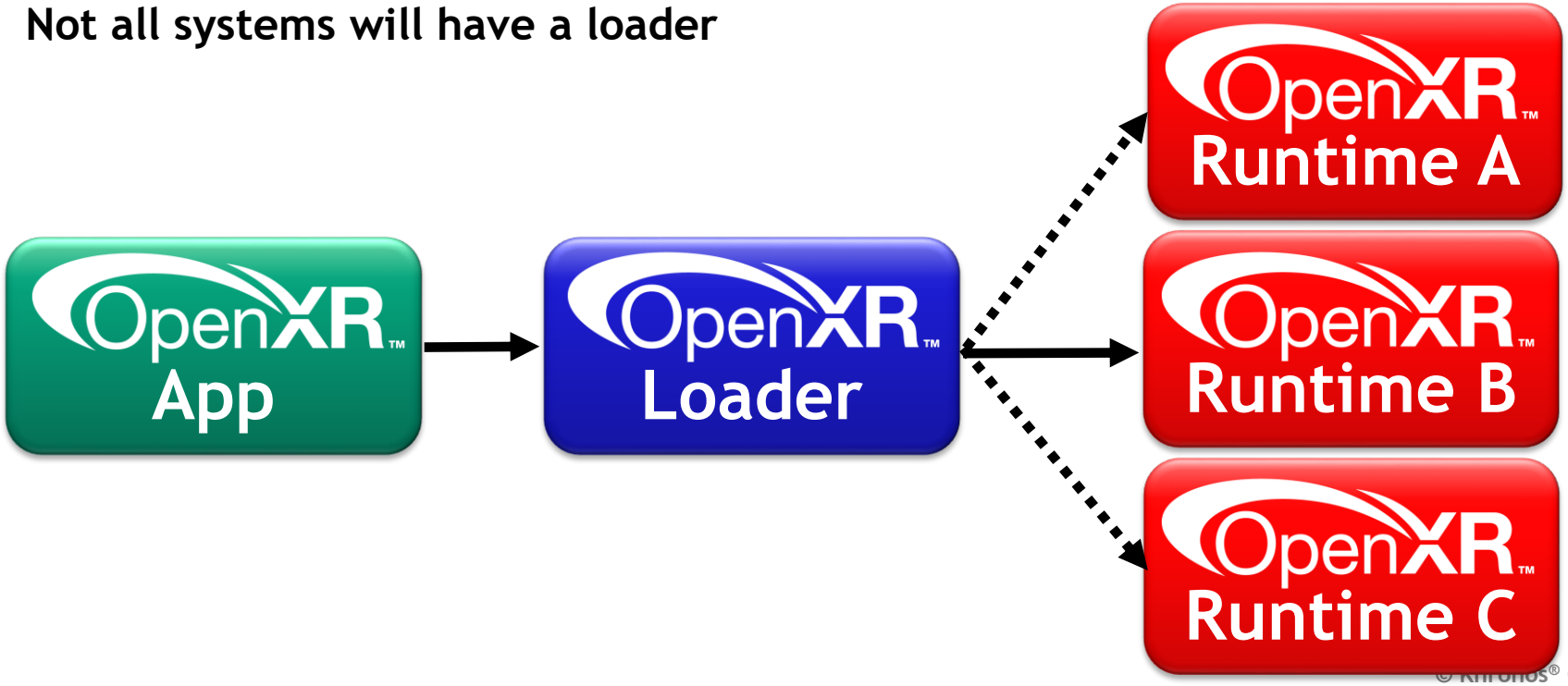
OpenXR™ Unifying Reality

OpenXR 1.0 Specification Released

OpenXR API High Level Concepts

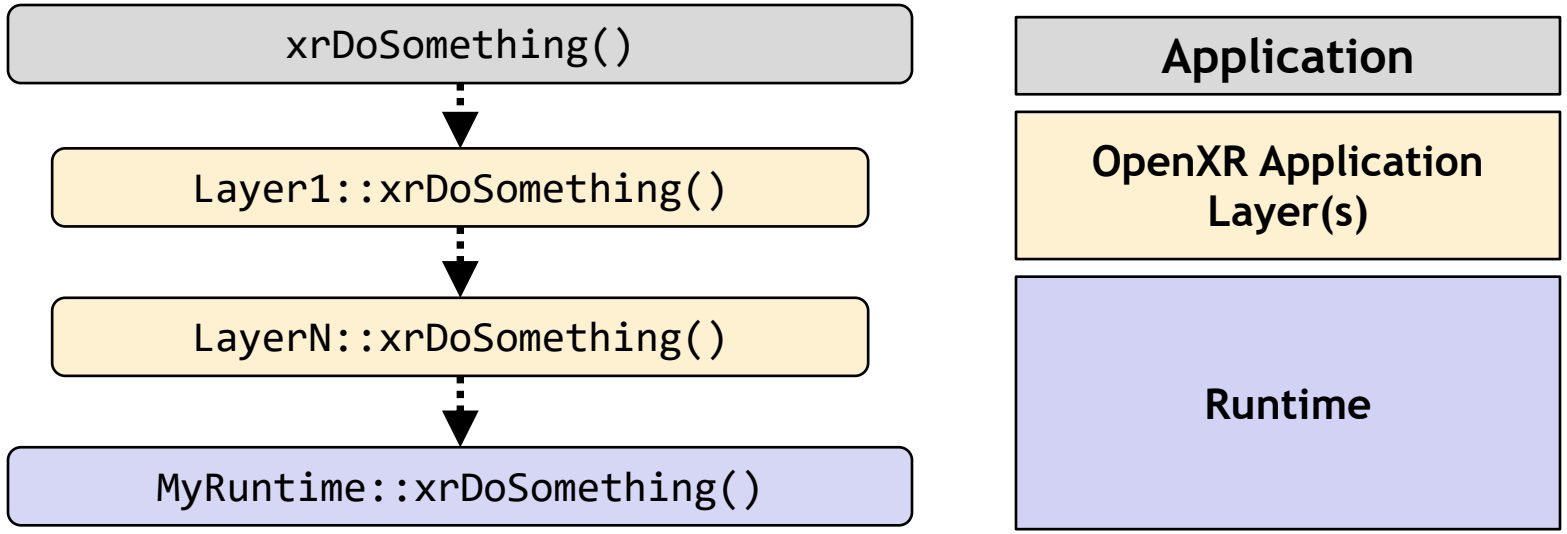
The OpenXR Loader

- A separate component for supporting multiple runtimes on a single system
- Similar mechanism to other Khronos APIs
- Loader determines the runtime to use for the requesting application
- Complexity can vary from “just pick one” to more intelligent decisions based on user factors, hardware, running apps, etc
- Not all systems will have a loader



Initial steps: API Layers & Extensions

- API Layers

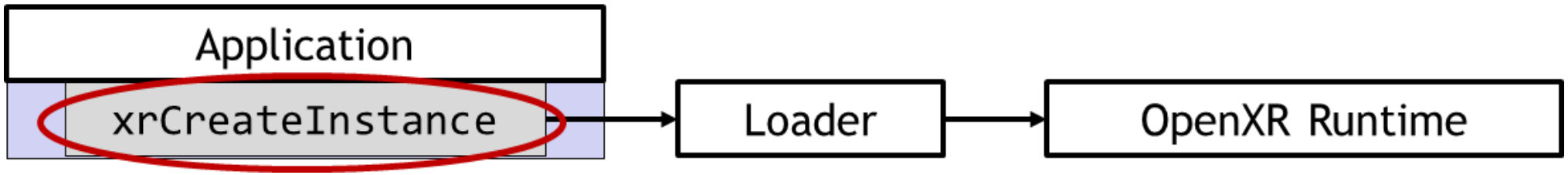


- Extensions
  - `xrEnumerateInstanceExtensionProperties()`

The Instance

`XrInstance`:

- The `XrInstance` is basically the application's representation of the OpenXR runtime
- Can create multiple `XrInstances`, if supported by the runtime
- `xrCreateInstance` specifies app info, layers, and extensions

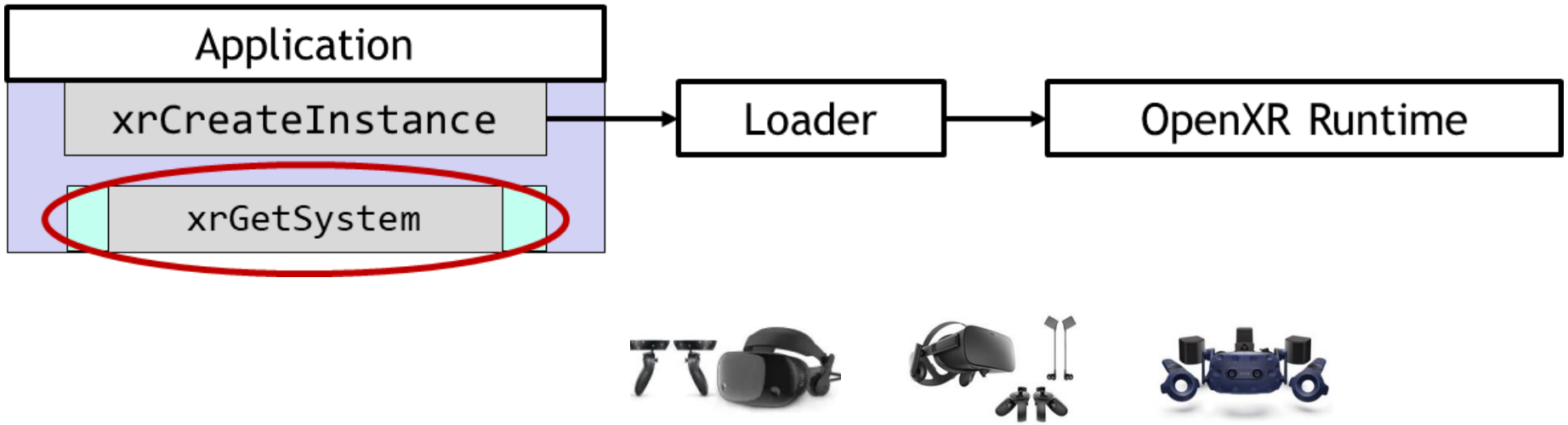


The System

`XrSystem`:

- OpenXR groups physical devices into logical systems of related devices
- `XrSystem` represents a grouping of devices that the application chooses to use (e.g. HMD and controllers)
- `XrSystems` may have display, input, tracking, etc.

- `xrGetSystem` also returns the type of form factor to be used



Form Factors

- **Currently two `XrFormFactors` in the specification:**
  - `XR_FORM_FACTOR_HANDHELD_DISPLAY`
  - `XR_FORM_FACTOR_HEAD_MOUNTED_DISPLAY`

Camera Passthrough AR	Stereoscopic VR / AR	Projection CAVE-like
		
		Photo Credit: Dave Pape
One View	Two View (one per eye)	Twelve Views (six per eye)
`XR_FORM_FACTOR_HANDHELD_DISPLAY`	`XR_FORM_FACTOR_HEAD_MOUNTED_DISPLAY`	`(future support)`

View Configurations

- **Currently two `XrViewConfigurations` in the specification:**
  - `XR_VIEW_CONFIGURATION_TYPE_PRIMARY_MONO`
  - `XR_VIEW_CONFIGURATION_TYPE_PRIMARY_STEREO`

Camera Passthrough AR	Stereoscopic VR / AR	Projection CAVE-like
		
		Photo Credit: Dave Pape
One View	Two View (one per eye)	Twelve Views (six per eye)
`XR_FORM_FACTOR_HANDHELD_DISPLAY`	`XR_FORM_FACTOR_HEAD_MOUNTED_DISPLAY`	`(future support)`
`XR_VIEW_CONFIGURATION_TYPE_PRIMARY_MONO`	`XR_VIEW_CONFIGURATION_TYPE_PRIMARY_STEREO`	`(future support)`

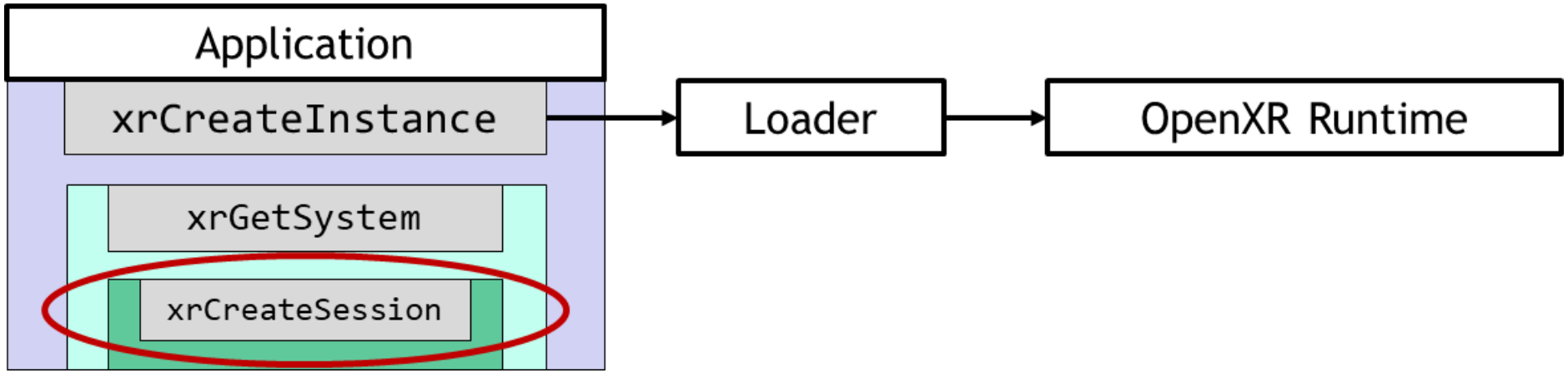
The Session

Session:

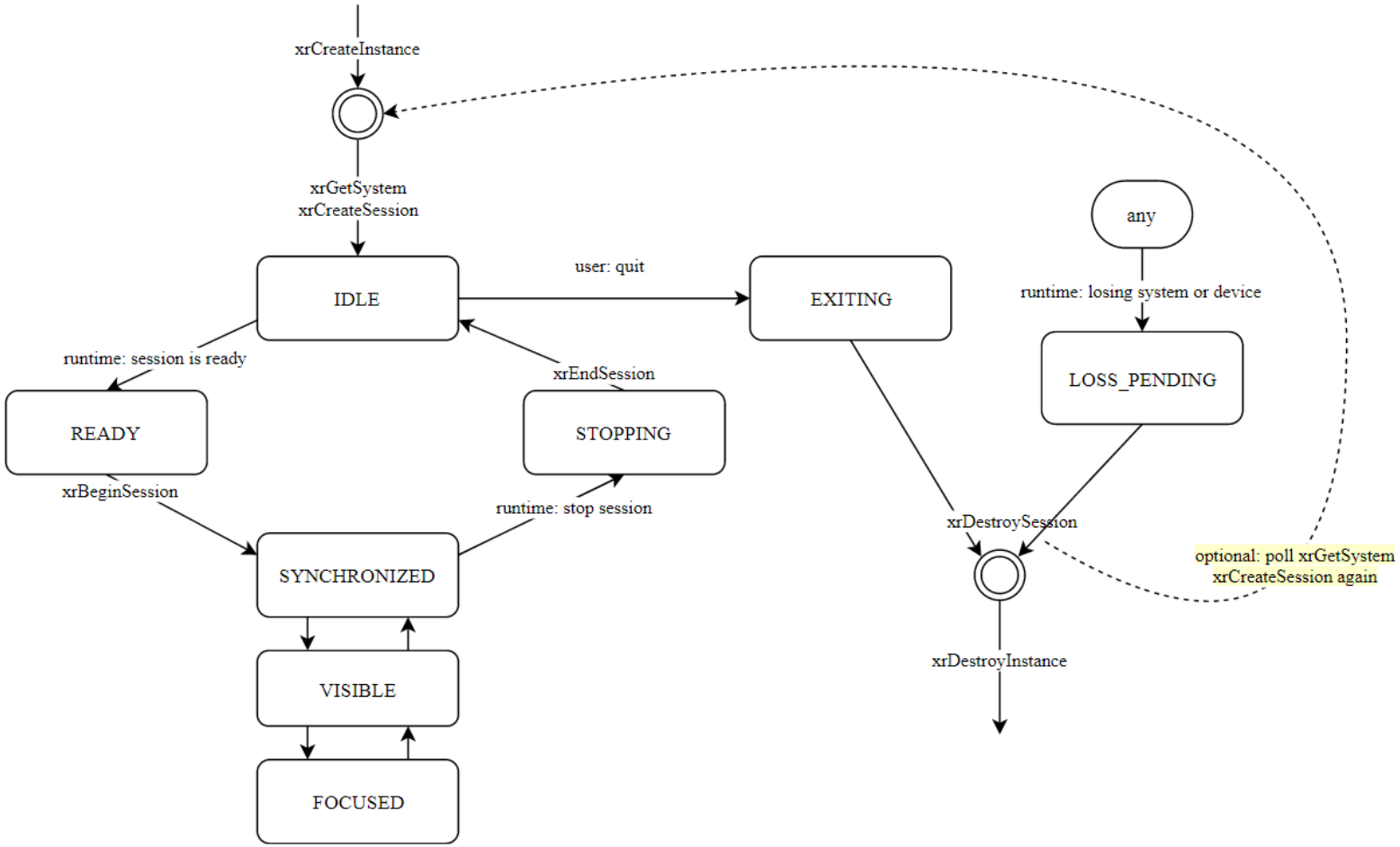
- A session is how an application indicates it wants to render and output VR / AR frames

- An app tells the runtime it wants to enter an interactive state by beginning a session with `xrBeginSession` and ending it with `xrEndSession`

- No session, no frames.



Session Lifecycle

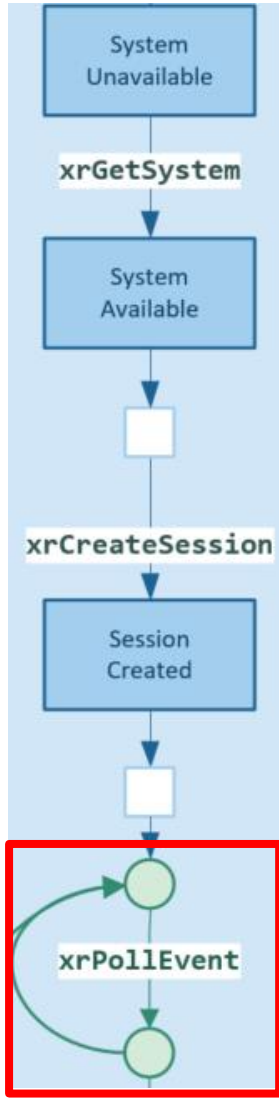


Spec page 119

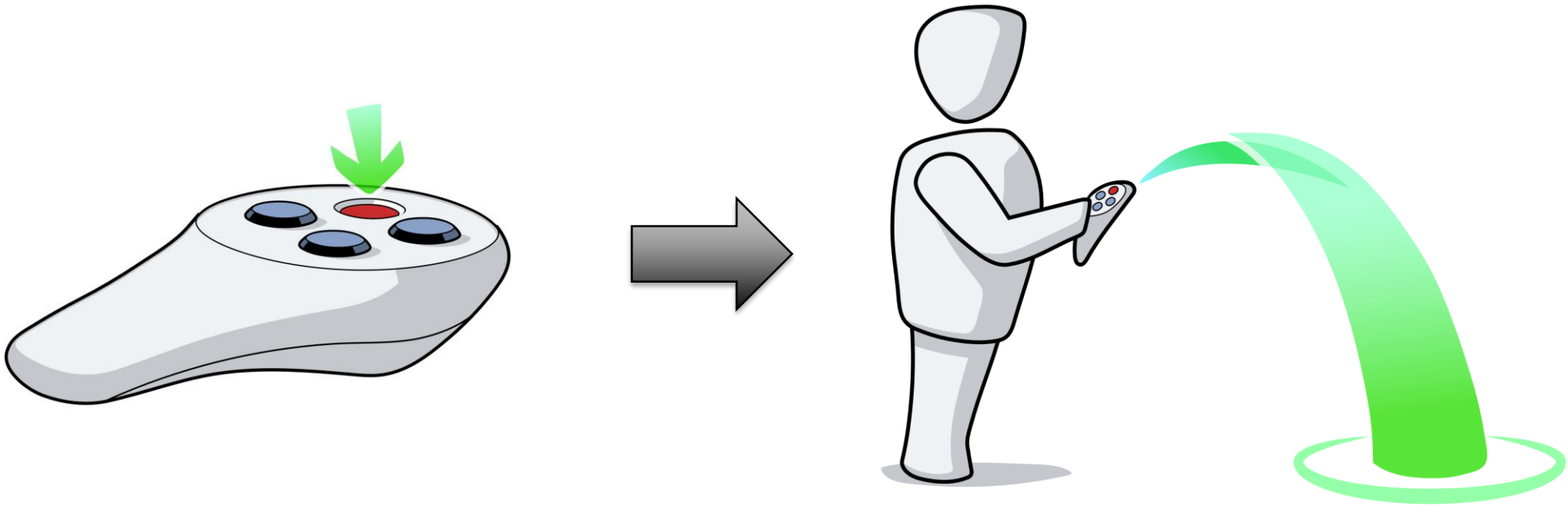
Events

Events are messages sent from the runtime to the application. They're put into a queue by the runtime, and read from that queue by the application using `xrPollEvent`

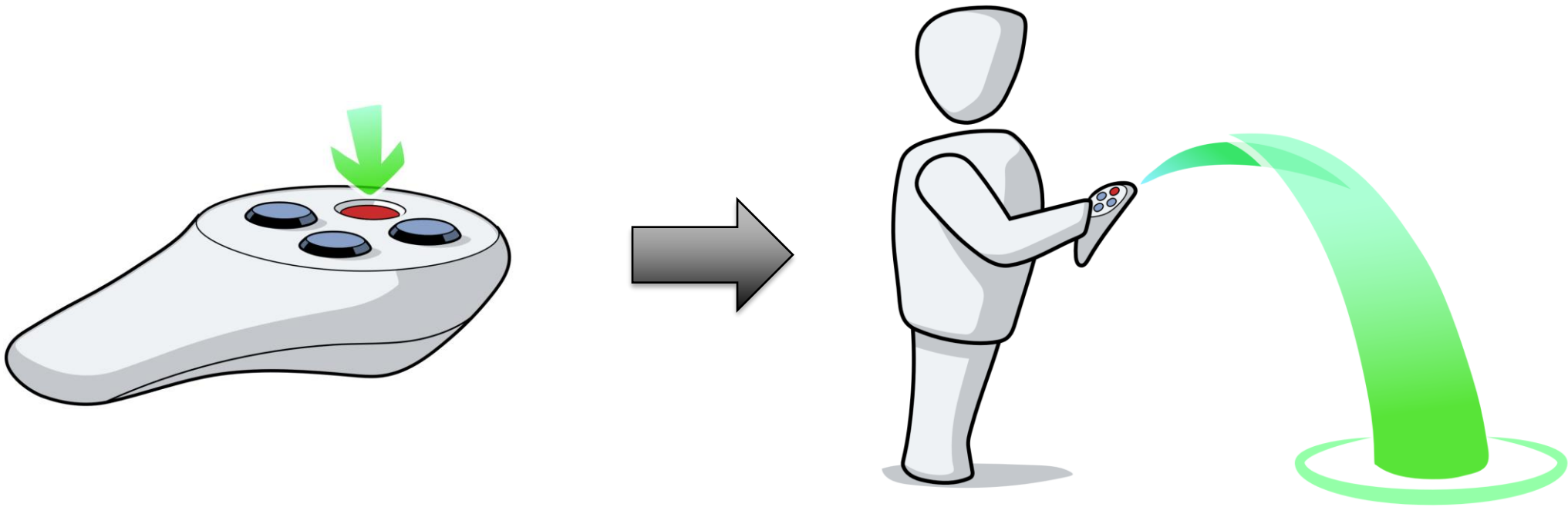
Event	Description
XrEventDataEventsLost	event queue has overflowed and some events were lost
XrEventDataInstanceLossPending	application is about to lose the instance
XrEventDataInteractionProfileChanged	active input form factor for one or more top level user paths has changed
XrEventDataReferenceSpaceChangePending	runtime will begin operating with updated space bounds
XrEventDataSessionStateChanged	application has changed lifecycle state



Input and Haptics



Input and Haptics

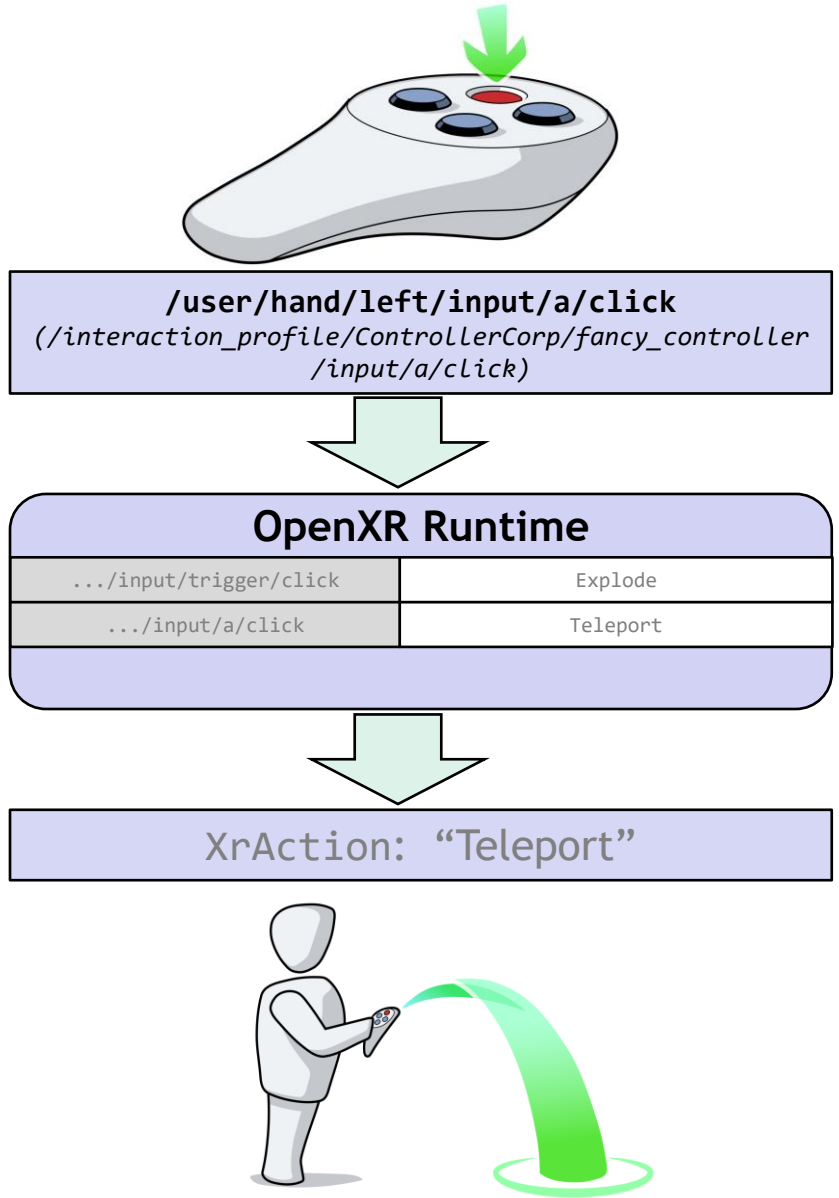


When user clicks button “a” it results in the user teleporting

Input and Haptics

Input in OpenXR goes through a layer of abstraction built around Input Actions (`XrActions`). These allow application developers to define input based on resulting action (*e.g. "Grab", "Jump," "Teleport"*) rather than explicitly binding controls

While the application can suggest recommended bindings, it is ultimately up to the runtime to bind input sources to actions as it sees fit (application's recommendation, user settings in the runtime's UI, etc)



Input and Haptics - Interaction Profiles

- Collections of input and output sources on physical devices
- Runtimes can support multiple interaction profiles

ControllerCorp's Fancy_Controller:

- /user/hand/left
- /user/hand/right

- /input/a/click
- /input/b/click
- /input/c/click
- /input/d/click
- /input/trigger/click
- /input/trigger/touch
- /input/trigger/value
- /output/haptic

example

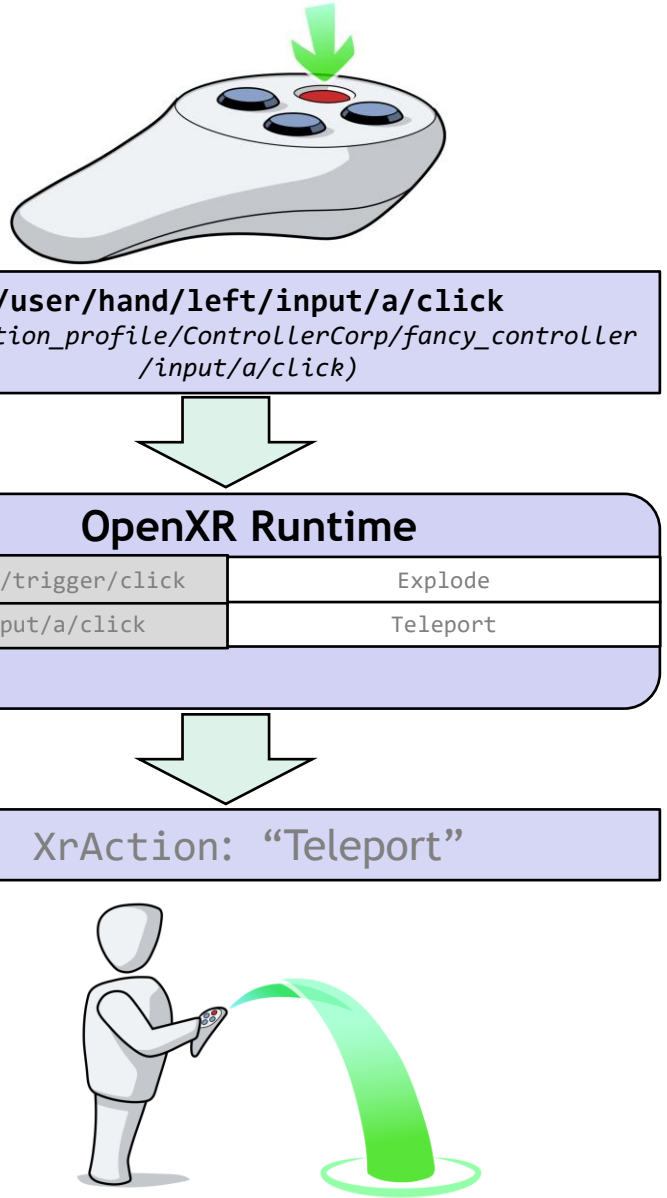
Input and Haptics - Predefined Interaction Profiles

- **Interaction profiles for many current products are predefined in the OpenXR specification including:**
  - Google Daydream* controller
  - HTC Vive and Vive Pro* controllers
  - Microsoft* Mixed reality motion controllers
  - Microsoft* Xbox controller
  - Oculus Go* controller
  - Oculus Touch* controllers
  - Valve Index* controllers

Input and Haptics - Runtime Binding Decision - Why?

- **Runtime ultimately decides the bindings**
  - "dev teams are ephermal, games last forever"
  - More likely the runtime is updated than individual games
- **Reasons for selecting different bindings:**
  - 1. this runtime does not have ControllerCorp's fancy_controller currently attached, but it knows how to map the inputs and outputs to the controllers that *are* attached
  - 2. Some runtimes can support user mapping of inputs such that the controls per game can be customized by the user, such as swapping trigger and button 'a', this enables customization without the original application knowing about it
  - 3. Some future controller is developed but the application is not updated for it, a new interaction profile can help map the actions to the new inputs
  - 4. Accessibility devices can be used and input mapped appropriately

Input and Haptics



Input and Haptics

Haptics build upon the same `XrAction` system, and have their own Action Type: `XR_HAPTIC_VIBRATION`. Just like other XrActions, they can be used with `XrActionSets`, but unlike inputs, they are activated with `xrApplyHapticFeedback`

Currently, only `XrHapticVibration` is supported:

- Start Time
- Duration (s)
- Frequency (Hz)
- Amplitude (0.0 – 1.0)

xrStopHapticFeedback can also be called to immediately end haptic feedback

We expect that many more haptic types will be added through extensions as the technology develops

That’s it for Core API coverage today

Extensions

Core Standard

Core concepts that are fundamental to the specification for all use cases

Examples: Instance management, tracking, frame timing

KHR Extensions

Functionality that a large class of runtimes will likely implement

Examples: Platform support , Graphic API Extensions

EXT Extensions

Functionality that a few runtimes might implement

Examples: Performance Settings, Thermals, Debug Utils

Vendor Extensions

Functionality that is limited to a specific vendor

Examples: Device specific functionality

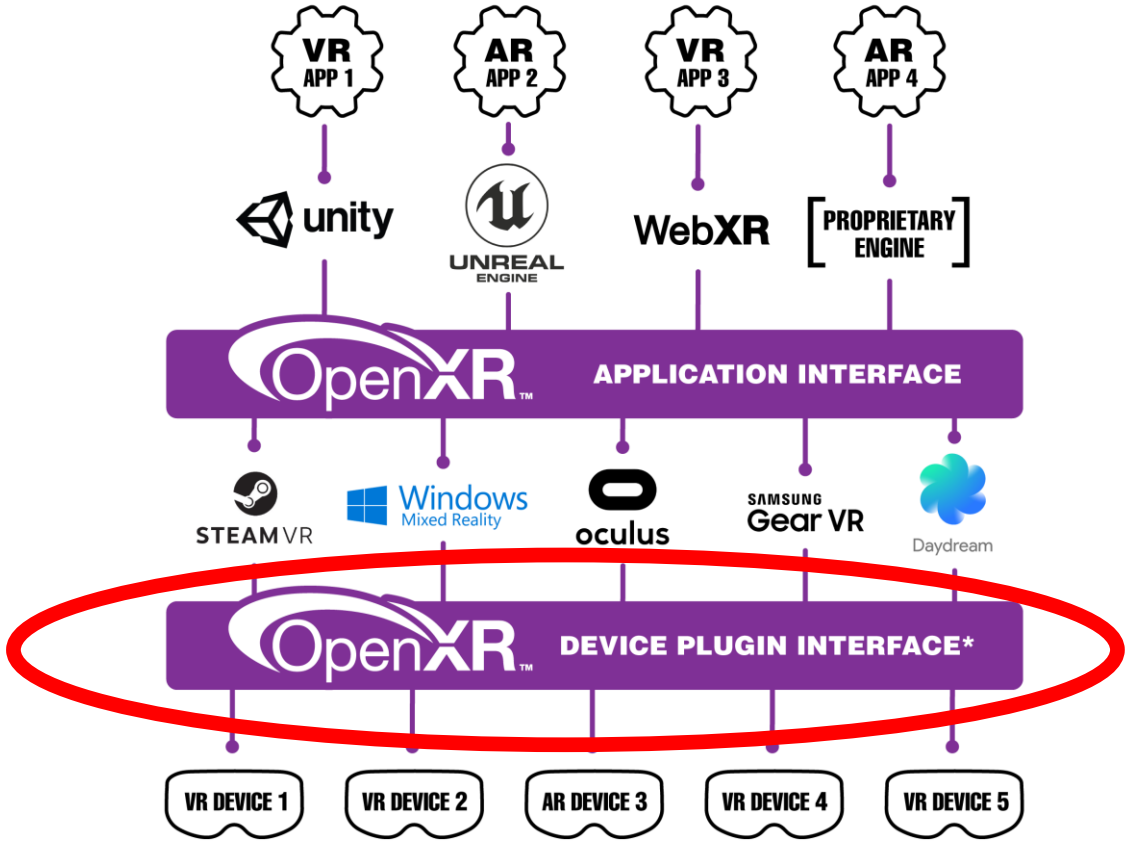
Current KHR Extensions

- **Platform-specific support:**
  - KHR_android_create_instance
  - KHR_android_surface_swapchain
  - KHR_android_thread_settings
- **Graphics API support:**
  - KHR_D3D11_enable
  - KHR_D3D12_enable
  - KHR_opengl_enable
  - KHR_opengl_es_enable
  - KHR_vulkan_enable
  - KHR_vulkan_swapchain_format_list
- **Support for specific XR layer types:**
  - KHR_composition_layer_cube
  - KHR_composition_layer_cylinder
  - KHR_composition_layer_depth
  - KHR_composition_layer_equirect
- **Performance improvement by masking non-visible portions of the display:**
  - KHR_visibility_mask
- **Time Conversion functions:**
  - KHR_convert_timespec_time
  - KHR_win32_convert_performance_counter_time

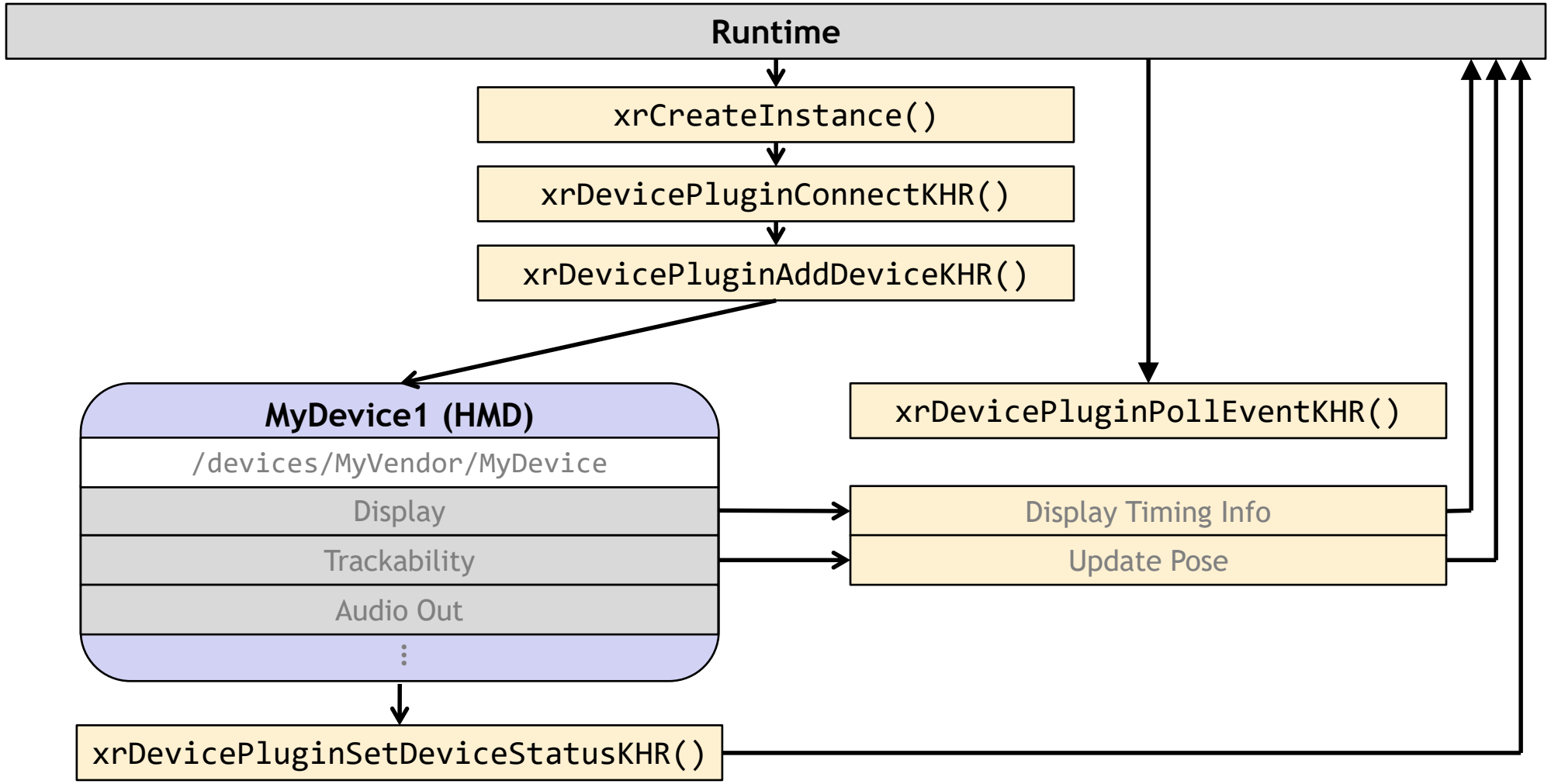
What hasn’t made it in?

What hasn't made it in?

- Top priority: solve application fragmentation



Device Plugin Extension

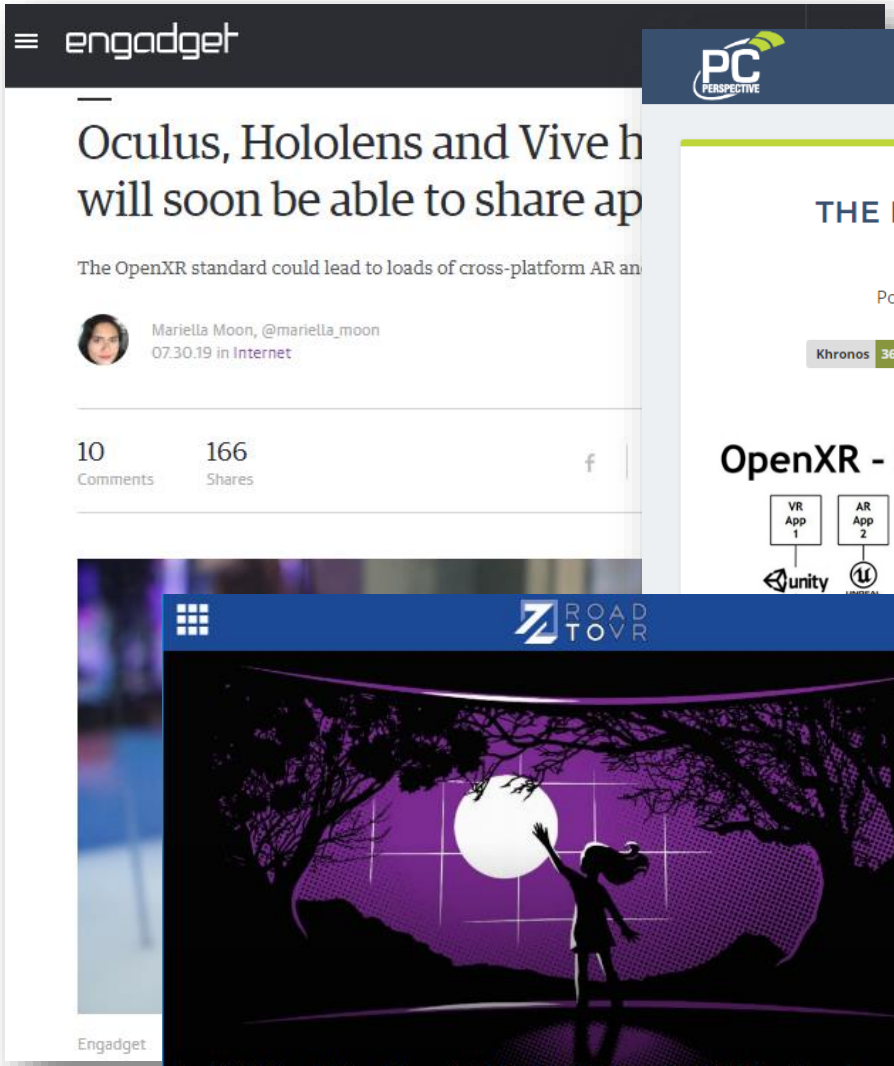


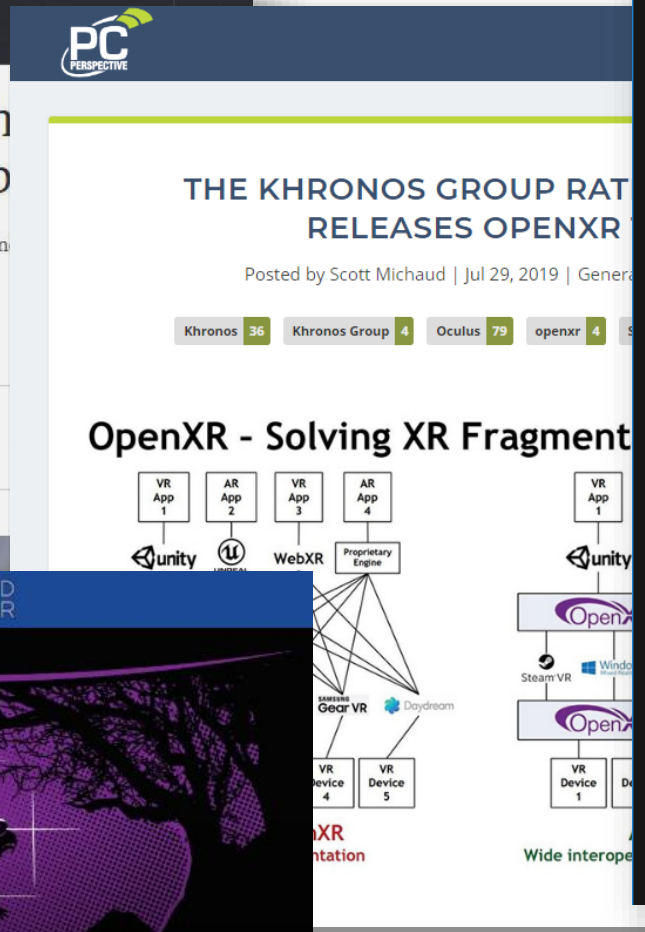
There are a list of things to consider for 1.1 and for additional extensions

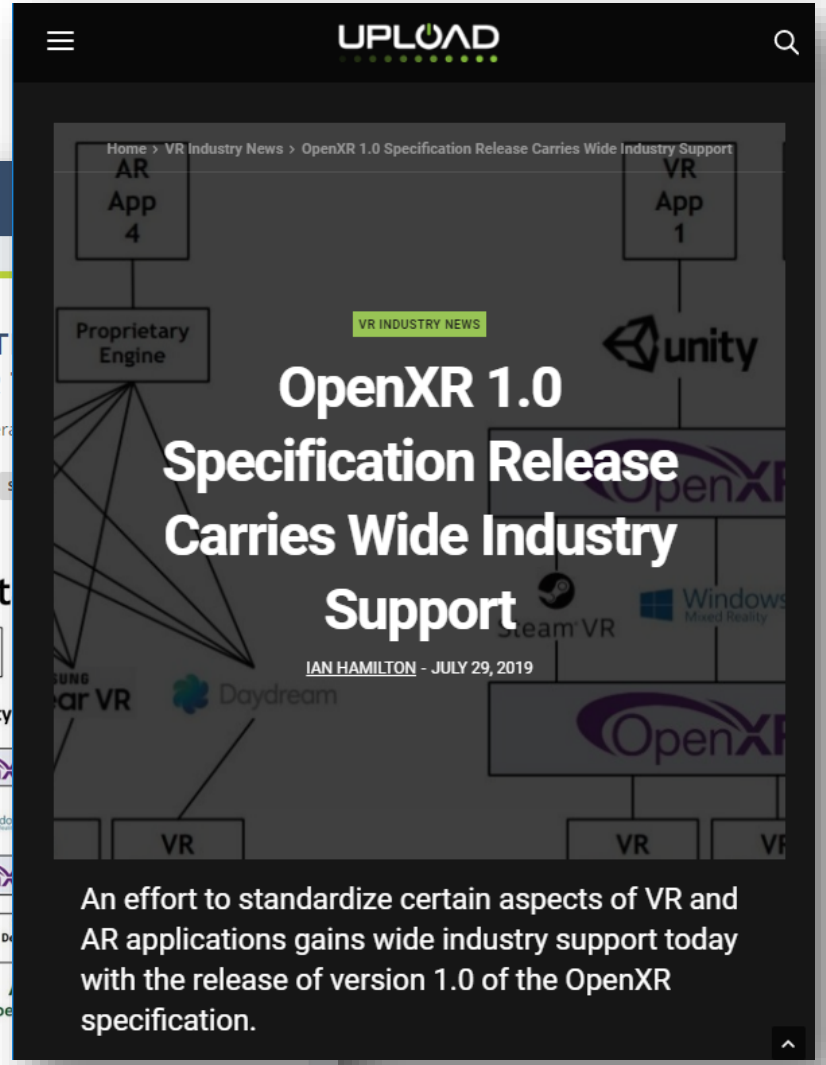
- Many of the items on the list are obvious next steps in the progress of AR and VR development
- Won't list them here ☺
- But feel free to send us you list of requests in via the feedback channels we'll provide in a sec

OpenXR in Action… Time for Demos

OpenXR 1.0 Release is Here!







https://www.engadget.com/2019/07/30/openxr-1-launch/
https://www.roadtovr.com/openxr-1-0-release-microsoft-hololens-vr-oculus-rift-quest/
https://uploadvr.com/openxr-specification-standard/
https://pcper.com/2019/07/the-khronos-group-ratifies-and-releases-openxr-1-0/

“OpenXR 1.0 release is a huge milestone and AMD is proud to have been a member in its creation. The expanding XR industry and ecosystem continues to be a key focus for AMD and we are excited by the potential for market growth that OpenXR 1.0 enables. As always, AMD is a proponent of open industry standards,” said **Daryl Sartain, Director of XR at AMD.**

“Arm is focused on developing technology innovations that power the next generation of untethered, standalone AR/VR devices. The release of the OpenXR 1.0 specification will further enable us to break barriers for cross-platform XR applications, while bringing the performance and efficiency required to support these complex, immersive use cases,” said **Roger Barker, director of IP solutions, Immersive Experience Group, Arm.**

“As part of its unwavering commitment to open source and open standards, Collabora is proud to be part of bringing OpenXR 1.0 to life. We are pioneering the Monado open source runtime for OpenXR to ensure the future of XR is truly open and accessible to all hardware vendors. As the OpenXR specification editor, I am grateful for the diligent efforts of the working group, as well as the community feedback that shaped this release,” said **Ryan Pavlik, OpenXR Specification Editor, XR Principal Software Engineer at Collabora**.

“OpenXR 1.0 steers us toward an alignment of many crucial emerging interface platforms. CTRL-labs is excited to contribute to this important step forward and to give developers the tools they need to explore neural interfaces.” said **Attila Maczak, Software Architect at CTRL-labs**.

"We're thrilled to support the OpenXR 1.0 release, along with all of the Khronos Group members who have worked tirelessly to create the standard. Unreal Engine led the way with support for the OpenXR 0.9 provisional specification, and we're excited to move the 1.0 revision forward in collaboration with our hardware partners releasing at the same time. Epic believes that open standards are essential to driving technology and bridging the gaps between digital ecosystems,” said **Jules Blok, Epic Games.**

“Facebook and Oculus continue to believe in the value the OpenXR standard delivers to users and developers. We plan to provide runtime support for apps built on OpenXR 1.0 on the Rift and Quest platforms,” said **Nate Mitchell, Oculus Co-founder and head of VR product, Facebook**.

"WebXR relies on APIs like OpenXR to provide the communication layer between browsers and virtual reality or augmented reality devices. The Immersive Web Working Group is excited for OpenXR support to become widely available because it has the potential to reduce the development and maintenance burden for WebXR implementers while increasing the range of supported hardware,” said **Brandon Jones, WebXR Spec Editor.**

“HTC VIVE is committed to creating a viable ecosystem for the XR industry which is why we are proud to support OpenXR,” said **Vinay Narayan, vice president, platform strategy, HTC.** “Bringing the community together to help define standards and best practices, allows all of us to move forward, together.”

“The mobile era of computing was defined and ultimately constrained by closed ecosystems. With mixed reality, the next wave of computing must be and will be open,” said **Don Box, Technical Fellow at Microsoft.** “Today, Microsoft is proud to release the first OpenXR 1.0 runtime that supports mixed reality, for all Windows Mixed Reality and HoloLens 2 users. We are excited to now work with the OpenXR community to design the key extensions that will bring mixed reality to life, with full support by end of year for HoloLens 2 hand tracking, eye tracking, spatial mapping and spatial anchors.”

“Congratulations to the OpenXR team on this important 1.0 release. The flexible, extensible design of OpenXR 1.0 will support innovative, next-generation graphics technologies that accelerate XR applications and even enable new XR use-cases,” said **David Weinstein, Director of Virtual Reality at NVIDIA**.

“OpenXR provides a solid foundation for developers to more easily support a broader range of platforms and devices. 1.0 is an exciting milestone and it is just the beginning. This release will open new doors for developers to experiment and extend the capabilities, pushing the VR and AR industry into the future.” said **Jared Cheshier, CTO at Pluto VR.**

“It’s great to see this important milestone finally completed and we are excited by the promise OpenXR holds for lowering the barrier for creating XR applications across a wide array of devices. Now that the stable 1.0 release of OpenXR is out and we are beginning to see industry adoption, Tobii will work diligently to unlock support for eye tracking through OpenXR extensions for eye gaze interaction and foveated rendering.” said **Denny Rönngren, architect at Tobii.**

"Unity is committed to being an open and accessible platform and we remain supportive of open standards for XR applications and devices," said **Ralph Hauwert, vice president of platforms at Unity Technologies**. "To that end, we're excited about OpenXR and believe this is a significant step towards a more open ecosystem."

“OpenXR is an important milestone for VR. This API will allow games and other applications to work easily across a variety of hardware platforms without proprietary SDKs. Valve is happy to have worked closely with other VR industry leaders to create this open standard, and looks forward to supporting it in SteamVR,” said **Joe Ludwig, programmer at Valve.**

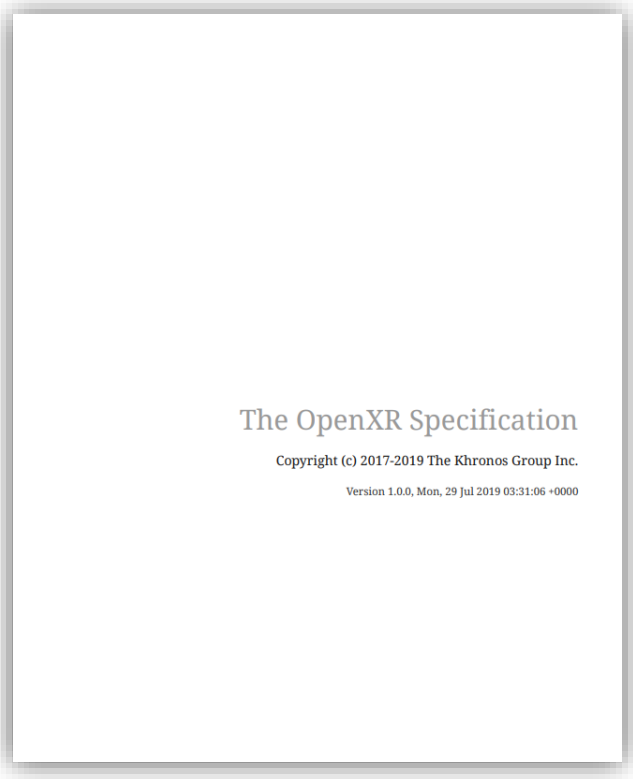
“Varjo is creating the world’s most groundbreaking VR/AR/XR hardware and software by merging the real and digital worlds seamlessly together in human-eye resolution. We're excited for the release of the OpenXR 1.0 specification because it ensures the enterprise community has compatible, easy access to the best XR technology on the market today while removing barriers to future innovation,” said **Rémi Arnaud, principal architect at Varjo.**

What Resources Are Available?

What Resources Are Available?

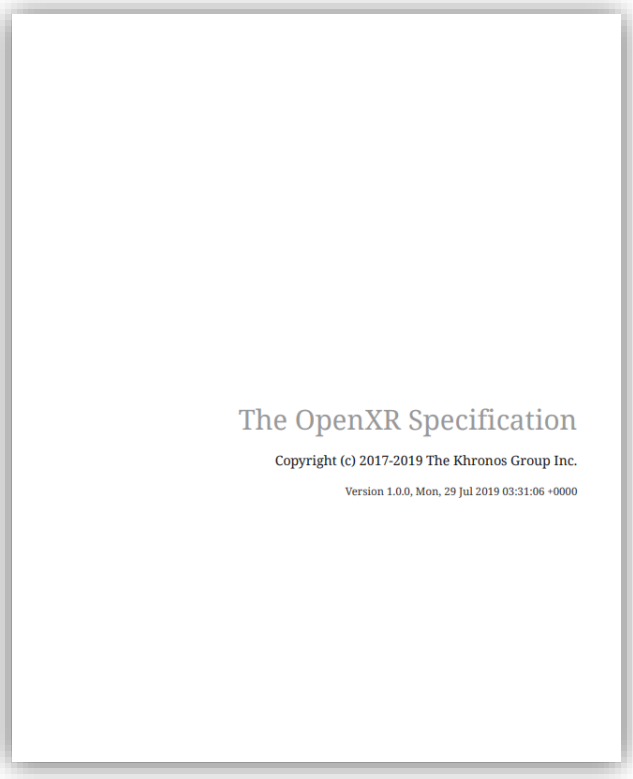
- **Fair warning:**
  - This is our working group's first ever 1.0 release
  - Much of the effort and time leading to the release was completing the release, the supporting software and infrastructure may be lagging
  - We think everything is complete, but let us know if we've missed something

What Resources Are Available?

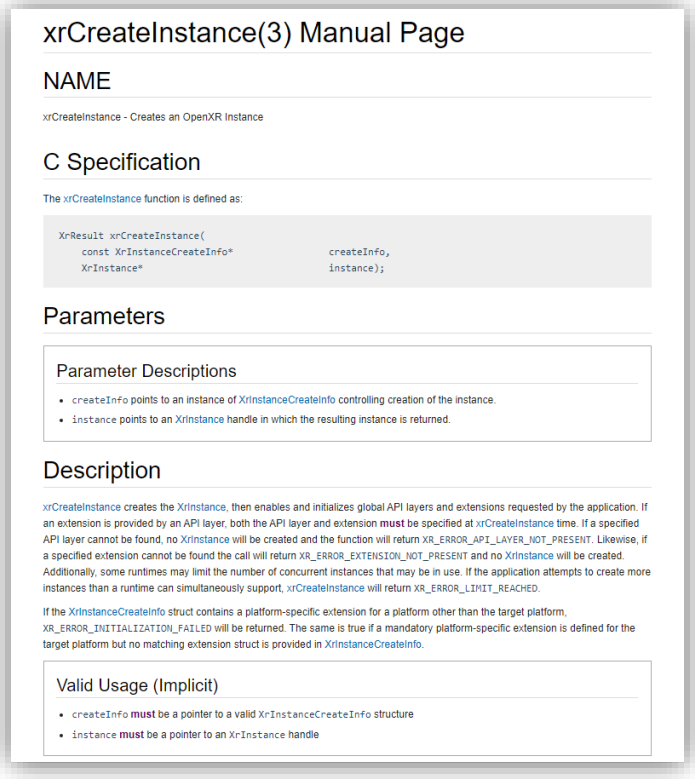


200+ page specification

What Resources Are Available?

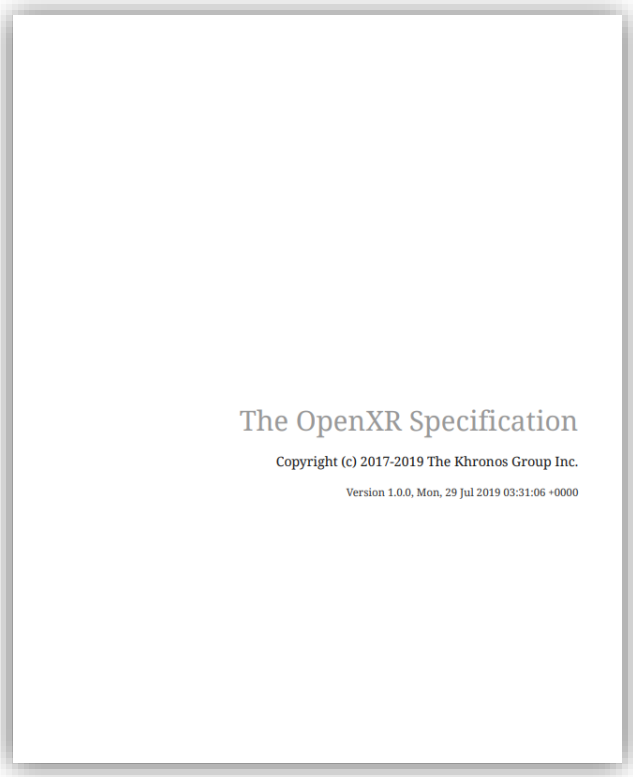


200+ page specification



Reference Pages

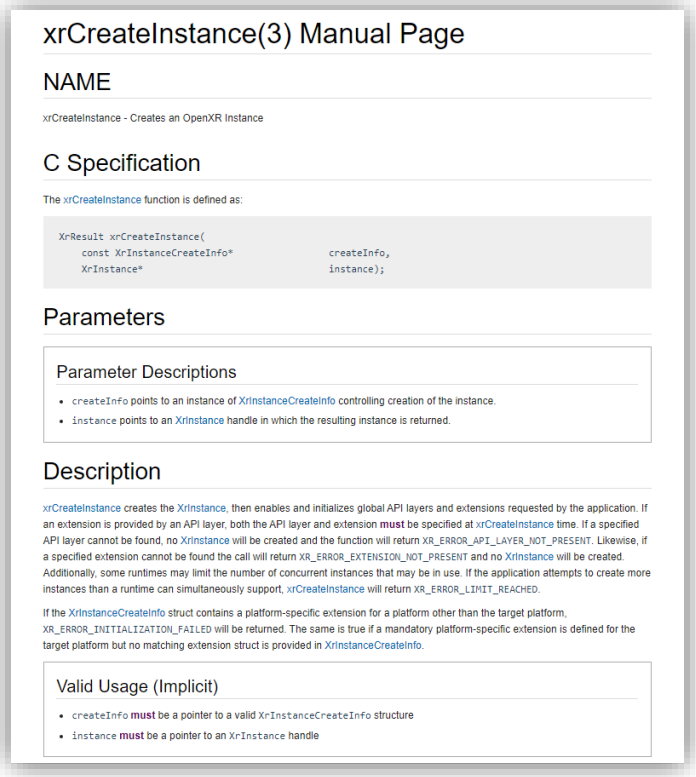
What Resources Are Available?


The OpenXR Specification

Copyright (c) 2017-2019 The Khronos Group Inc.

Version 1.0.0, Mon, 29 Jul 2019 03:31:06 +0000

200+ page specification


xrCreateInstance(3) Manual Page

NAME

xrCreateInstance - Creates an OpenXR Instance

C Specification

The xrCreateInstance function is defined as:

```
XrResult xrCreateInstance(
    const XrInstanceCreateInfo*                 createInfo,
    XrInstance*                                 instance);
```

Parameters

Parameter Descriptions

- createInfo points to an instance of XrInstanceCreateInfo controlling creation of the instance.
- instance points to an XrInstance handle in which the resulting instance is returned.

Description

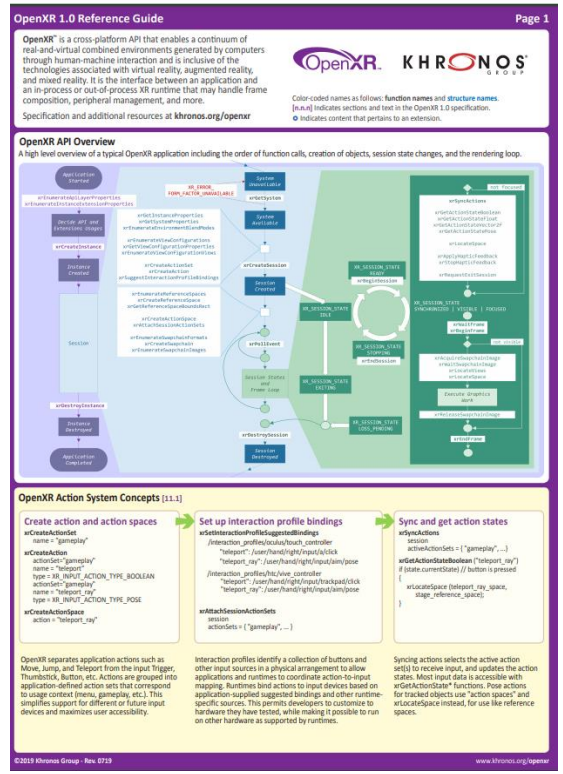
xrCreateInstance creates the XrInstance, then enables and initializes global API layers and extensions requested by the application. If an extension is provided by an API layer, both the API layer and extension **must** be specified at xrCreateInstance time. If a specified API layer cannot be found, no XrInstance will be created and the function will return XR_ERROR_API_LAYER_NOT_PRESENT. Likewise, if a specified extension cannot be found the call will return XR_ERROR_EXTENSION_NOT_PRESENT and no XrInstance will be created. Additionally, some runtimes may limit the number of concurrent instances that may be in use. If the application attempts to create more instances than a runtime can simultaneously support, xrCreateInstance will return XR_ERROR_LIMIT_REACHED.

If the XrInstanceCreateInfo struct contains a platform-specific extension for a platform other than the target platform, XR_ERROR_INITIALIZATION_FAILED will be returned. The same is true if a mandatory platform-specific extension is defined for the target platform but no matching extension struct is provided in XrInstanceCreateInfo.

Valid Usage (Implicit)

- createInfo **must** be a pointer to a valid XrInstanceCreateInfo structure
- instance **must** be a pointer to an XrInstance handle

Reference Pages



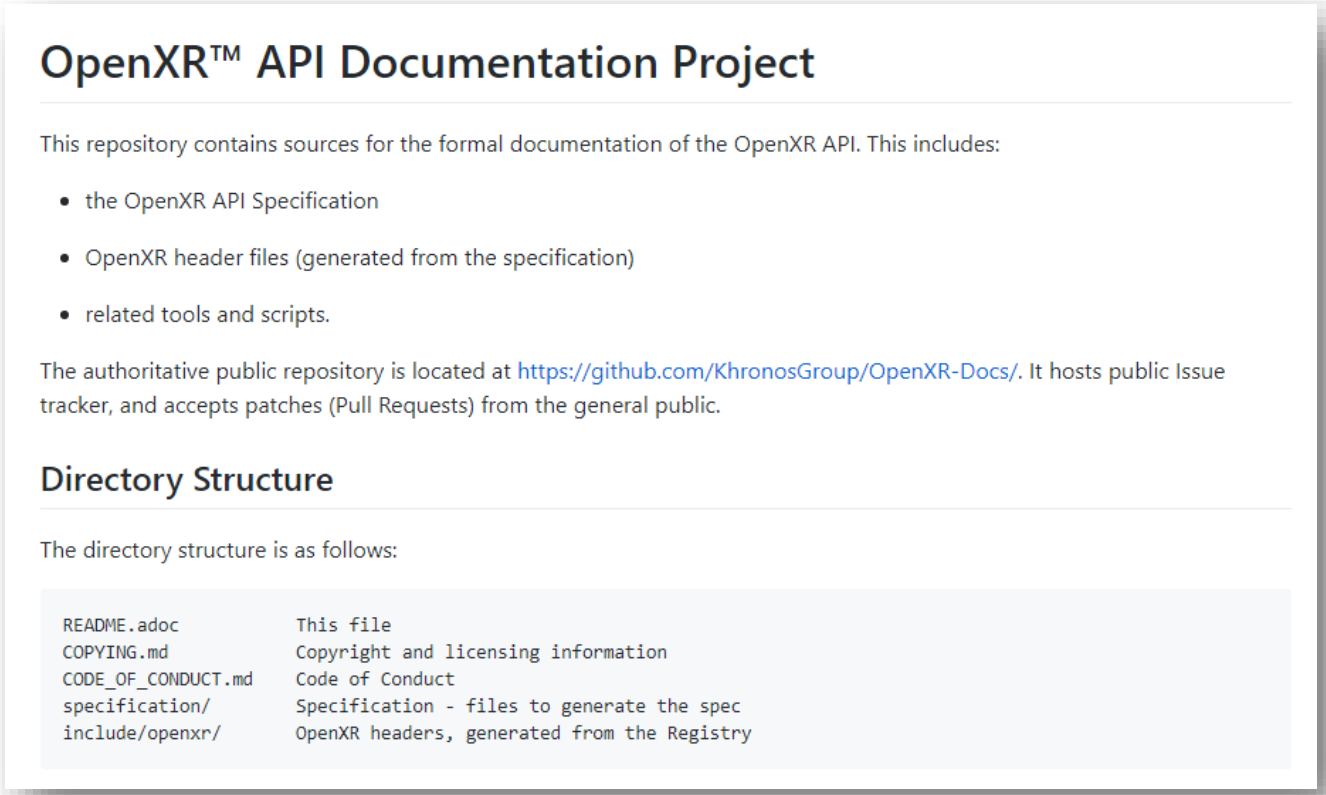
Overview Guide

What Resources Are Available?

- https://github.com/KhronosGroup/OpenXR-Docs

- Contains the source for generating the specification document and reference pages, scripts to be added soon

- Contains the openxr header files



OpenXR™ API Documentation Project

This repository contains sources for the formal documentation of the OpenXR API. This includes:

- the OpenXR API Specification
- OpenXR header files (generated from the specification)
- related tools and scripts.

The authoritative public repository is located at https://github.com/KhronosGroup/OpenXR-Docs/. It hosts public Issue tracker, and accepts patches (Pull Requests) from the general public.

Directory Structure

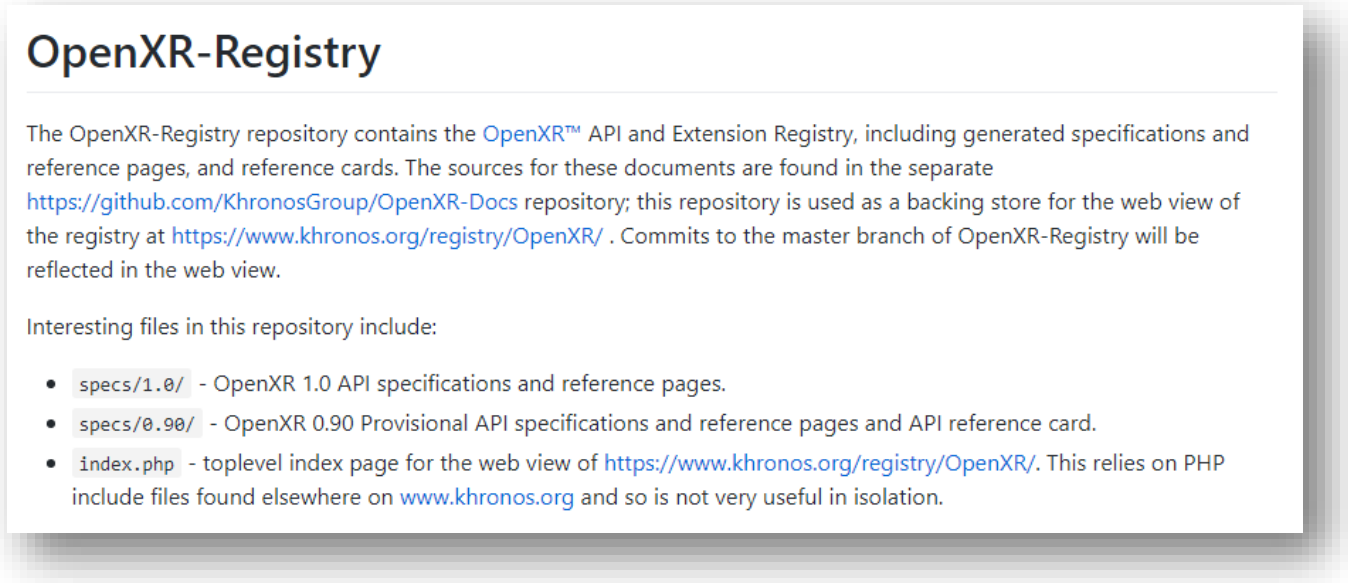
The directory structure is as follows:

```
README.adoc           This file
COPYING.md            Copyright and licensing information
CODE_OF_CONDUCT.md    Code of Conduct
specification/        Specification - files to generate the spec
include/openxr/       OpenXR headers, generated from the Registry
```

What Resources Are Available?

- https://github.com/KhronosGroup/OpenXR-Registry

- **Contains the specification, reference pages, and overview guide**



OpenXR-Registry

The OpenXR-Registry repository contains the OpenXR™ API and Extension Registry, including generated specifications and reference pages, and reference cards. The sources for these documents are found in the separate https://github.com/KhronosGroup/OpenXR-Docs repository; this repository is used as a backing store for the web view of the registry at https://www.khronos.org/registry/OpenXR/ . Commits to the master branch of OpenXR-Registry will be reflected in the web view.

Interesting files in this repository include:

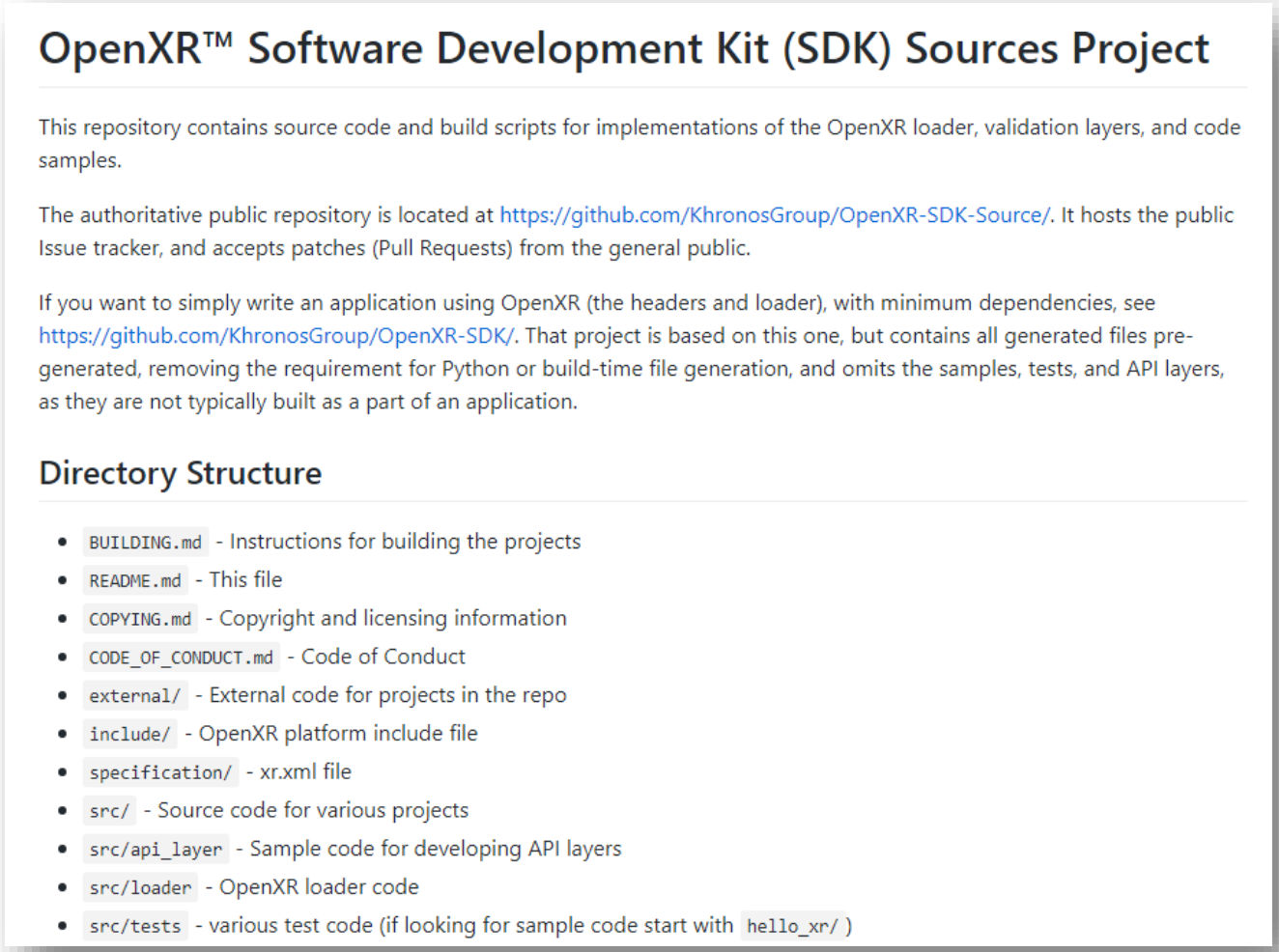
- `specs/1.0/` - OpenXR 1.0 API specifications and reference pages.
- `specs/0.90/` - OpenXR 0.90 Provisional API specifications and reference pages and API reference card.
- `index.php` - toplevel index page for the web view of https://www.khronos.org/registry/OpenXR/. This relies on PHP include files found elsewhere on www.khronos.org and so is not very useful in isolation.

What Resources Are Available?

- https://github.com/KhronosGroup/OpenXR-SDK-Source

- **Contains the source for:**
  - Loader
  - Some basic API layers
  - Test sample

- **For the current best example code, see: src/tests/hello_xr**



OpenXR™ Software Development Kit (SDK) Sources Project

This repository contains source code and build scripts for implementations of the OpenXR loader, validation layers, and code samples.

The authoritative public repository is located at https://github.com/KhronosGroup/OpenXR-SDK-Source/. It hosts the public Issue tracker, and accepts patches (Pull Requests) from the general public.

If you want to simply write an application using OpenXR (the headers and loader), with minimum dependencies, see https://github.com/KhronosGroup/OpenXR-SDK/. That project is based on this one, but contains all generated files pre-generated, removing the requirement for Python or build-time file generation, and omits the samples, tests, and API layers, as they are not typically built as a part of an application.

Directory Structure

- `BUILDING.md` - Instructions for building the projects
- `README.md` - This file
- `COPYING.md` - Copyright and licensing information
- `CODE_OF_CONDUCT.md` - Code of Conduct
- `external/` - External code for projects in the repo
- `include/` - OpenXR platform include file
- `specification/` - xr.xml file
- `src/` - Source code for various projects
- `src/api_layer` - Sample code for developing API layers
- `src/loader` - OpenXR loader code
- `src/tests` - various test code (if looking for sample code start with `hello_xr/`)

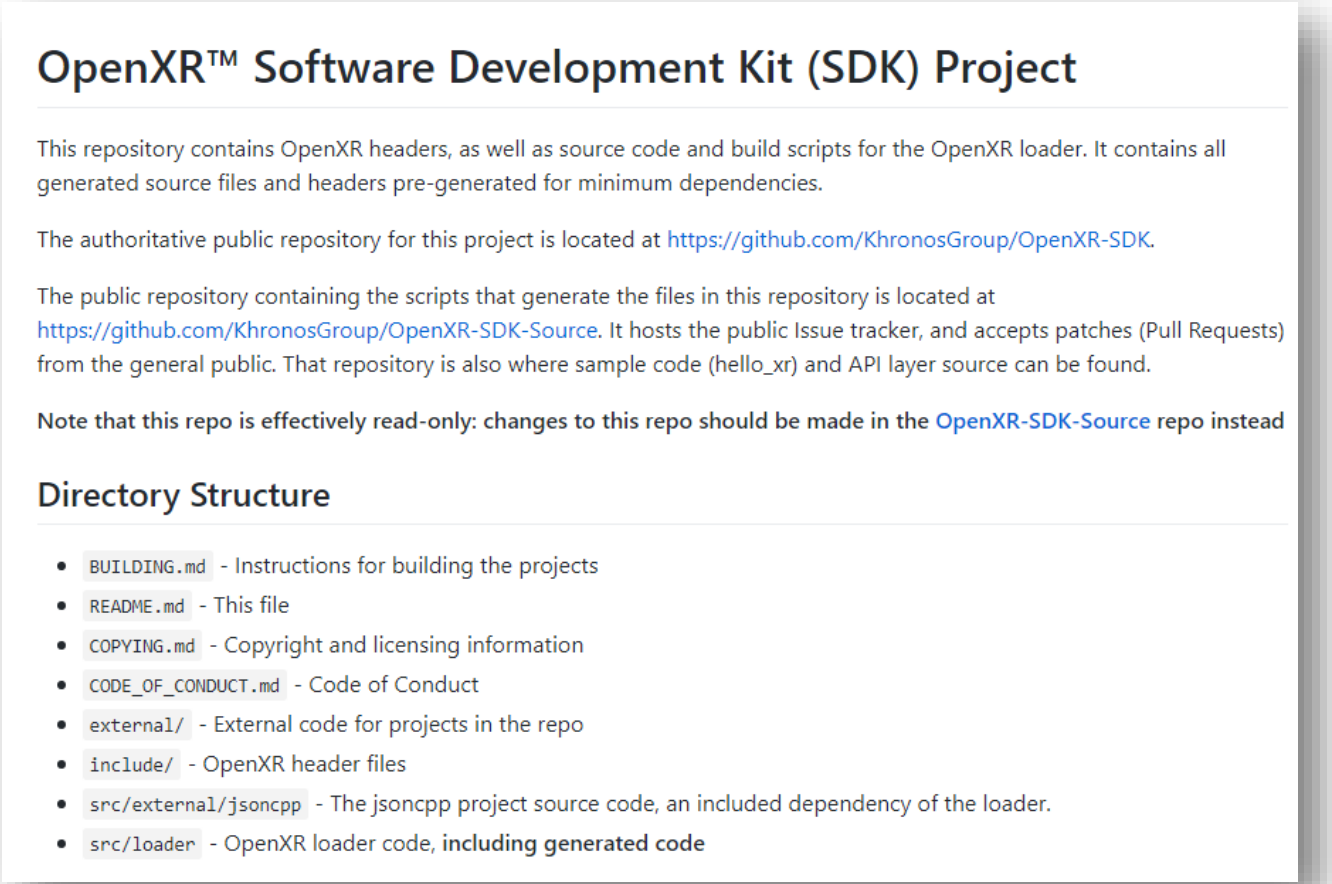
What Resources Are Available?

- https://github.com/KhronosGroup/OpenXR-SDK

- Contains Generated Files

- Use for building on Windows and Linux

- Embed this in your projects



OpenXR™ Software Development Kit (SDK) Project

This repository contains OpenXR headers, as well as source code and build scripts for the OpenXR loader. It contains all generated source files and headers pre-generated for minimum dependencies.

The authoritative public repository for this project is located at https://github.com/KhronosGroup/OpenXR-SDK.

The public repository containing the scripts that generate the files in this repository is located at https://github.com/KhronosGroup/OpenXR-SDK-Source. It hosts the public Issue tracker, and accepts patches (Pull Requests) from the general public. That repository is also where sample code (hello_xr) and API layer source can be found.

Note that this repo is effectively read-only: changes to this repo should be made in the OpenXR-SDK-Source repo instead

Directory Structure

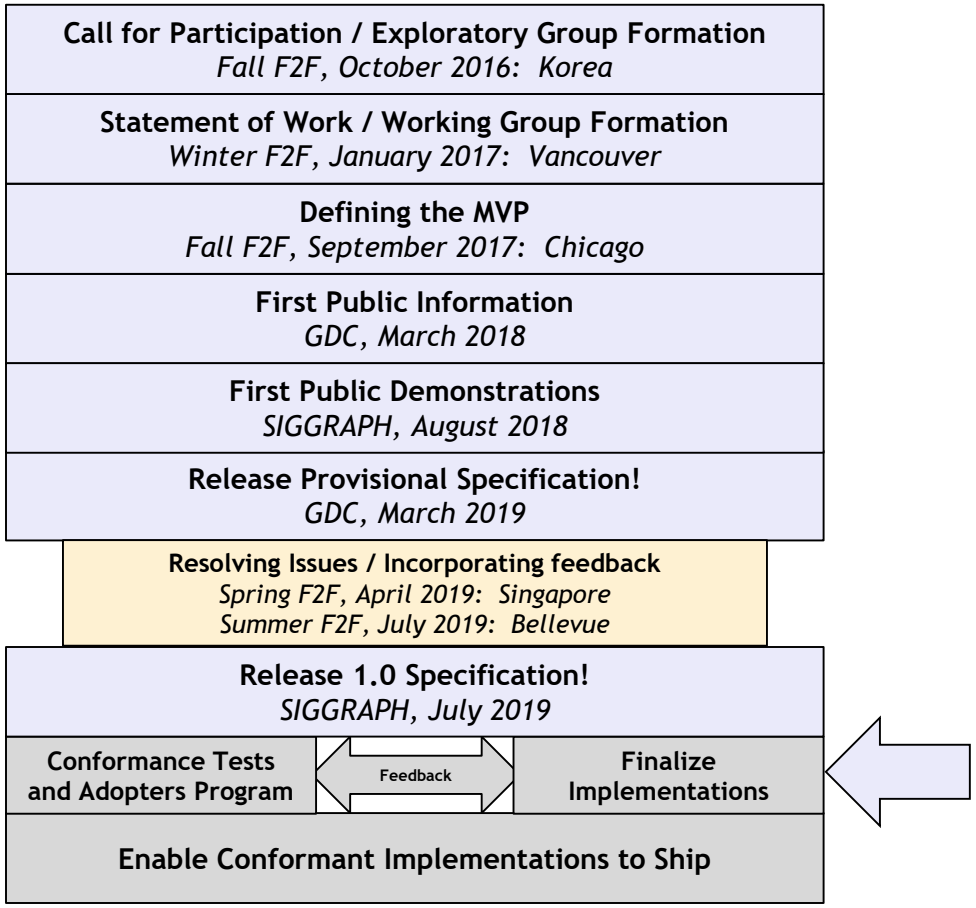
- `BUILDING.md` - Instructions for building the projects
- `README.md` - This file
- `COPYING.md` - Copyright and licensing information
- `CODE_OF_CONDUCT.md` - Code of Conduct
- `external/` - External code for projects in the repo
- `include/` - OpenXR header files
- `src/external/jsoncpp` - The jsoncpp project source code, an included dependency of the loader.
- `src/loader` - OpenXR loader code, **including generated code**

Additional Resources

- **OpenXR Landing Page - Specification, Reference Pages, Sample Code, Overview**
  - https://www.khronos.org/openxr
- **OpenXR Forum and Slack Channel**
  - Forum: https://khr.io/openxrfeedback
  - Discussion: https://khr.io/slack
- **Vendor preview implementations and integration**
  - Collabora: open source implementation
    http://monado.dev
  - Microsoft: OpenXR runtime for Windows Mixed Reality headsets
    https://aka.ms/openxr
  - Epic Games: Unreal Engine 4.23 Preview 4 with OpenXR 1.0 plugin
    https://www.unrealengine.com
- **Khronos SIGGRAPH Sessions – including OpenXR Presentation and demos**
  - https://www.khronos.org/events/2019-siggraph

What's Next?

What's Next?



OpenXR™ Unifying Reality

Finish Conformance Suite and Release Conformant Implementations

Thanks!

- To these companies for enabling their engineers to dedicate time to OpenXR!

Thanks to the Engineers!

Adam Gousetis, Google | Alex Turner, Microsoft | Andreas Loeve Selvik, Arm | Andres Rodriguez, Valve Software | Armelle Laine, Qualcomm Technologies, Inc | Blake Taylor, Magic Leap | Brad Grantham, Google | Brandon Jones, Google | Brent E. Insko, Intel | Brent Wilson, Microsoft | Bryce Hutchings, Microsoft | Cass Everitt, Facebook | Charles Egenbacher, Epic Games | Christoph Haag, Collabora | Craig Donner, Google | Dan Ginsburg, Valve Software | Dave Houlton, LunarG | Dave Shreiner, Unity Technologies | Denny Rönngren, Tobii | Dmitriy Vasilev, Samsung | Doug Twileager, ZSpace | Ed Hutchins, Facebook | Gloria Kennickell, Facebook | Gregory Greeby, AMD | Guodong Chen, Huawei | Jakob Bornecrantz, Collabora | Jared Cheshier, PlutoVR | Javier Martinez, Intel | Jeff Bellinghausen, Valve Software | Jiehua Guo, Huawei | Joe Ludwig, Valve Software | Johannes van Waveren, Facebook | Jon Leech, Khronos | Jonathan Wright, Facebook | Juan Wee, Samsung | Jules Blok, Epic Games | Karl Schultz, LunarG | Kaye Mason, Google | Krzysztof Kosiński, Google | Lachlan Ford, Microsoft | Lubosz Sarnecki, Collabora | Mark Young, LunarG | Martin Renschler, Qualcomm Technologies, Inc. | Matias Koskela, Tampere University of Technology | Matt Wash, Arm | Mattias Brand, Tobii | Mattias O. Karlsson, Tobii | Michael Gatson, Dell | Minmin Gong, Microsoft | Mitch Singer, AMD | Nell Waliczek, Microsoft | Nick Whiting, Epic Games | Nigel Williams, Sony | Paul Pedriana, Facebook | Peter Kuhn, Unity Technologies | Peter Peterson, HP Inc. | Pierre-Loup Griffais, Valve Software | Rajeev Gupta, Sony | Remi Arnaud, Starbreeze | Remy Zimmerman, Logitech | River Gillis, Google | Robert Memmott, Facebook | Robert Menzel, NVIDIA | Robert Simpson, Qualcomm Technologies, Inc. | Robin Bourianes, Starbreeze | Ryan Pavlik, Collabora | Ryan Vance, Epic Games | Sam Martin, Arm | Satish Salian, NVIDIA | Scott Flynn, Unity Technologies | Sophia Baldonado, PlutoVR | Sungye Kim, Intel | Tom Flynn, Samsung | Trevor F. Smith, Mozilla | Vivek Viswanathan, Dell | Yin Li, Microsoft | Yuval Boger, Sensics

Recap

- What is OpenXR?
- A Brief History of the Standard
- What are the Problems we are trying to Solve
- OpenXR Timeline of Development
- Brief Overview
- Demos
- What's Next?
- Recap

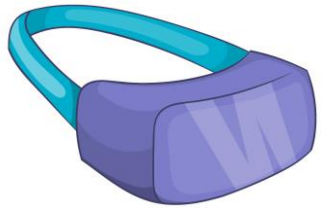
OpenXR Win-Win-Win

XR End-Users

Can run the apps they want on their system – reducing market confusion and increasing consumer confidence

XR Vendors

Can bring more applications onto their platform by leveraging the OpenXR content ecosystem



OpenXR™

XR ISVs

Can easily ship on more platforms for increased market reach

Khronos APIs for XR

Application or Engine

High-performance, low-latency 3D rendering and composition*
- Multiview
- Context priority
- Front buffer rendering
- Tiled rendering (beam racing)
- Variable rate rendering

Display, composition and optical correction parameters

Cross-platform access to XR HMDs and sensors
- XR application lifecycle
- Frame timing and display composition
- Sensor tracking and pose calculation
- Input device discovery and events
- Haptics Control

Vulkan®

OpenXR™

* OpenXR can be used with other 3D APIs such as Direct3D, OpenGL and OpenGL ES

Before we go…

Before we go… as always give us Feedback!

- Tell us:
  - What should be in the spec
  - What shouldn’t be in the spec
  - How things need to be added for your application/runtime/hardware/OS/…

Join Khronos!

- Get more involved
- Have direct impact on the direction of the API
- Be part of the effort to deliver OpenXR 1.1!

Quick reminder…

- Khronos networking reception tonight, here @ 5:30
- Demos will be shown

Thank You!