

Vulkanised 2025

The 7th Vulkan Developer Conference
Cambridge, UK | February 11-13, 2025

New Extensions and Developments in Vulkan Video

Srinath Kumarapuram, NVIDIA



Outline

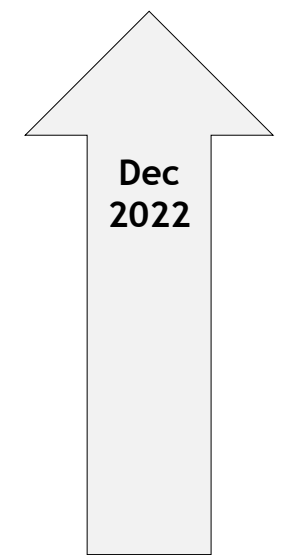
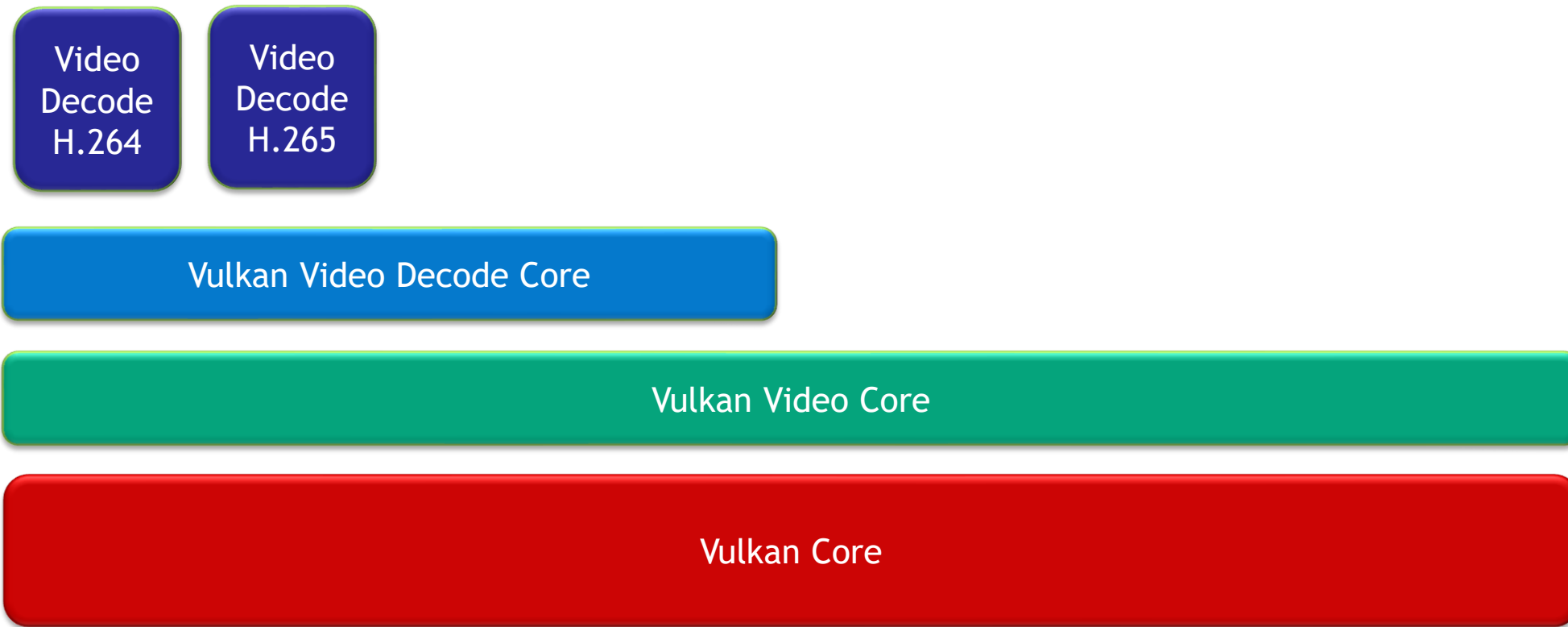
- Introduction
- New video extensions
- Ecosystem updates
- TSG roadmap for 2025



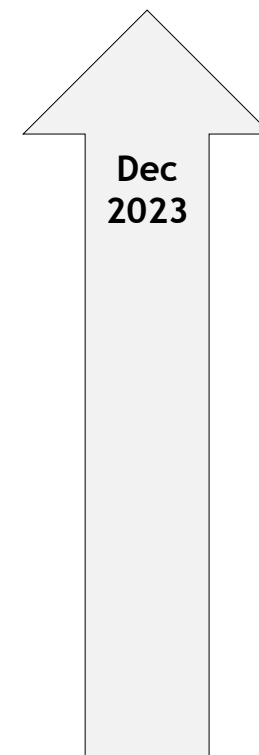
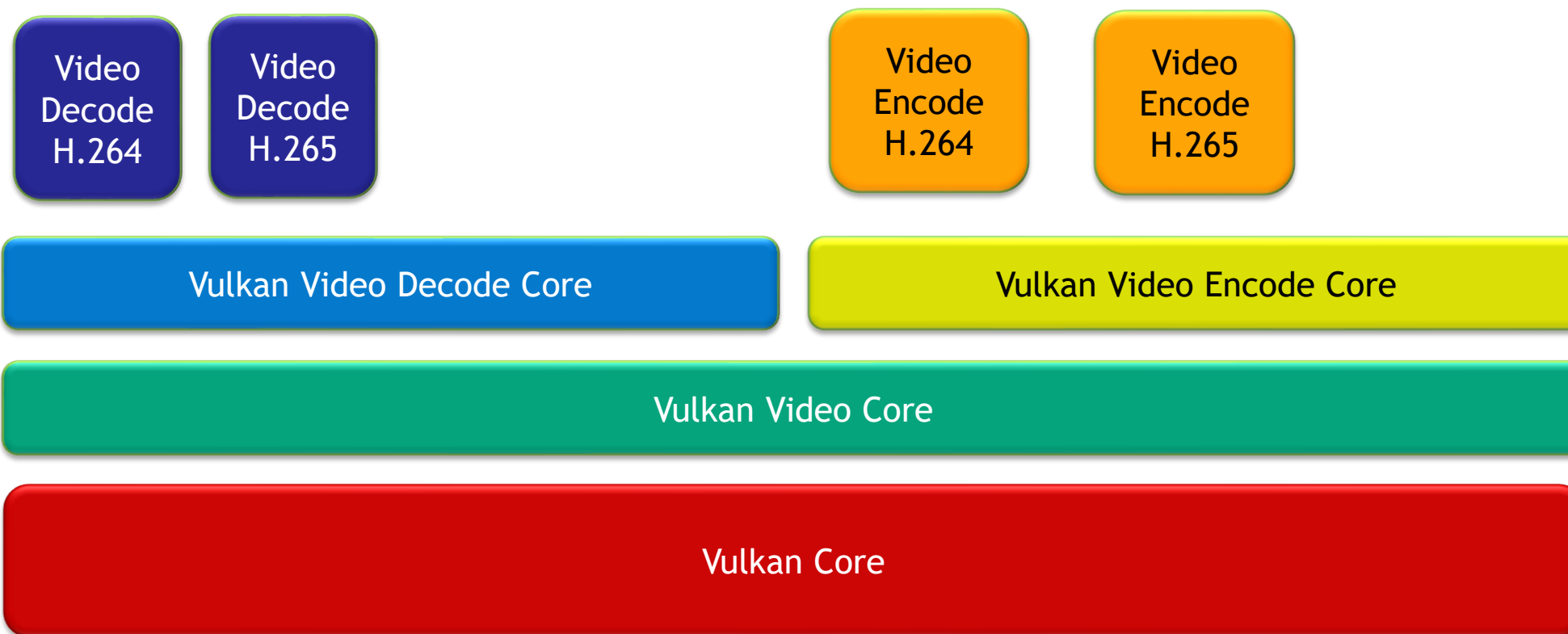
Vulkan Video Extension Hierarchy



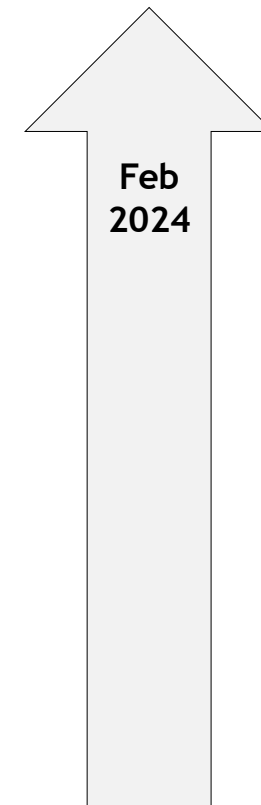
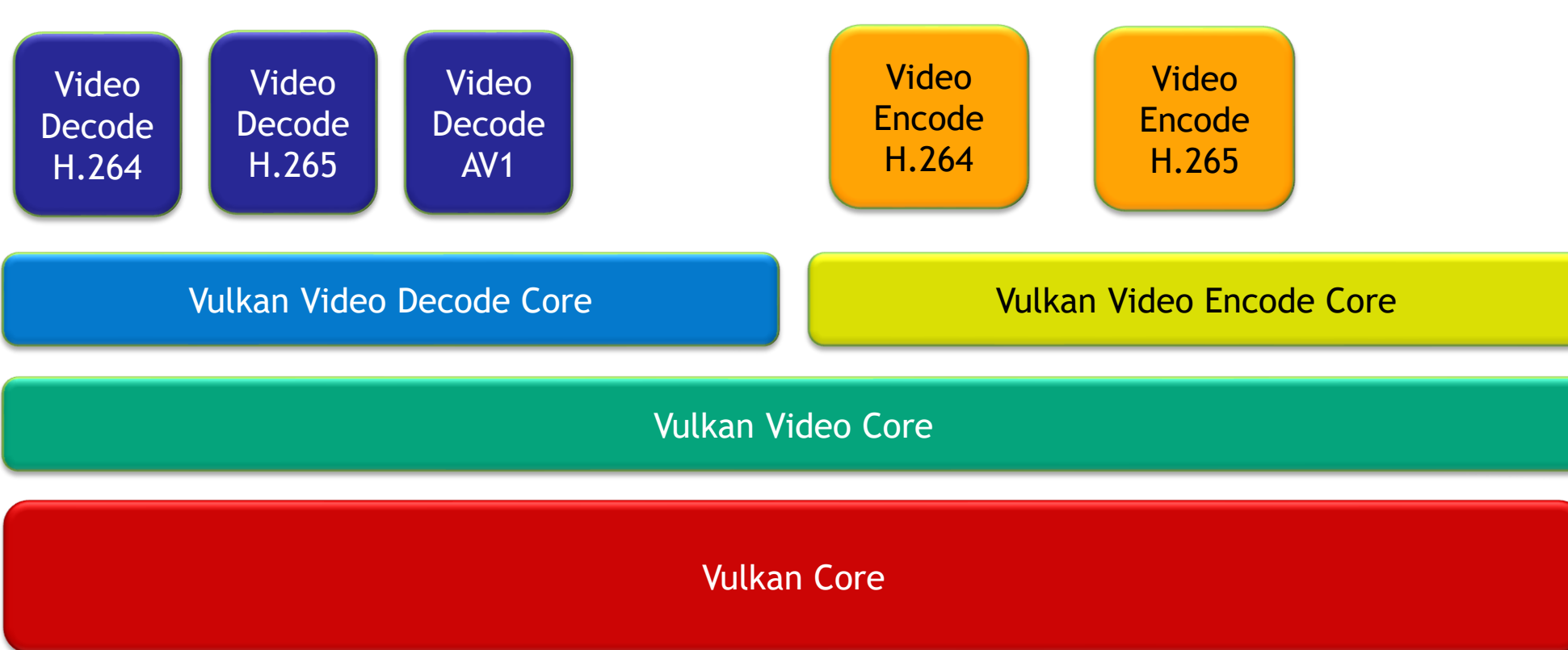
Vulkan Video Extension Hierarchy



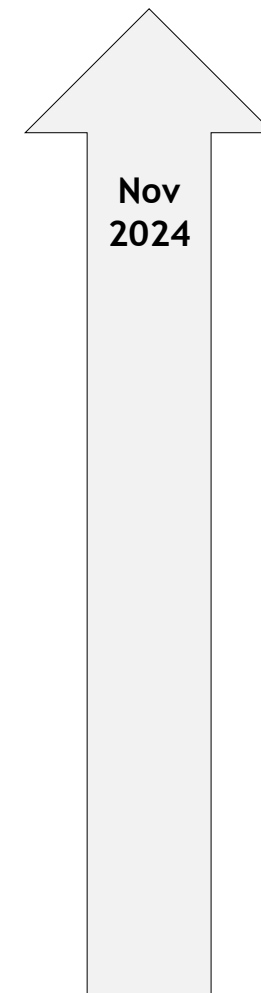
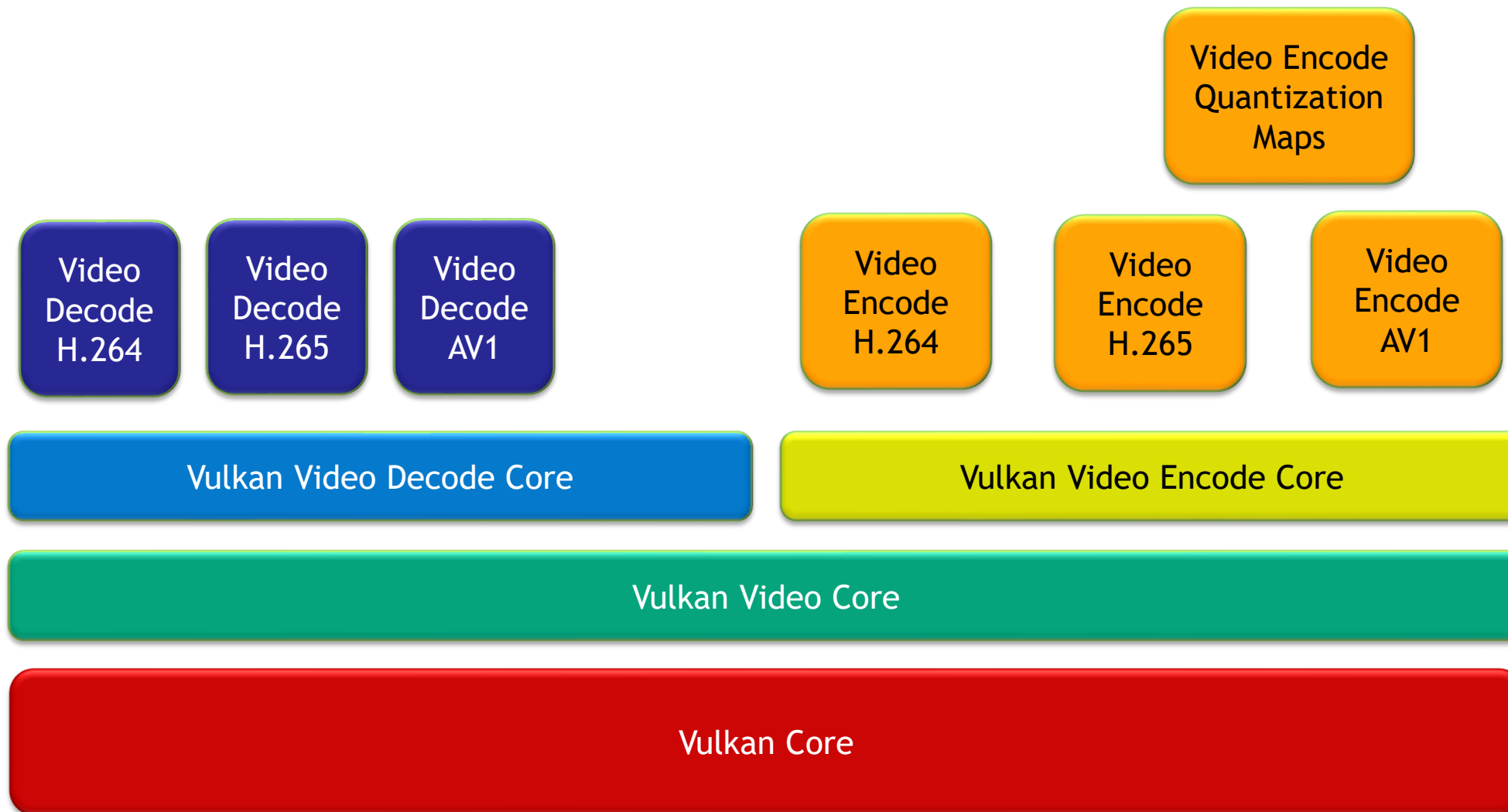
Vulkan Video Extension Hierarchy



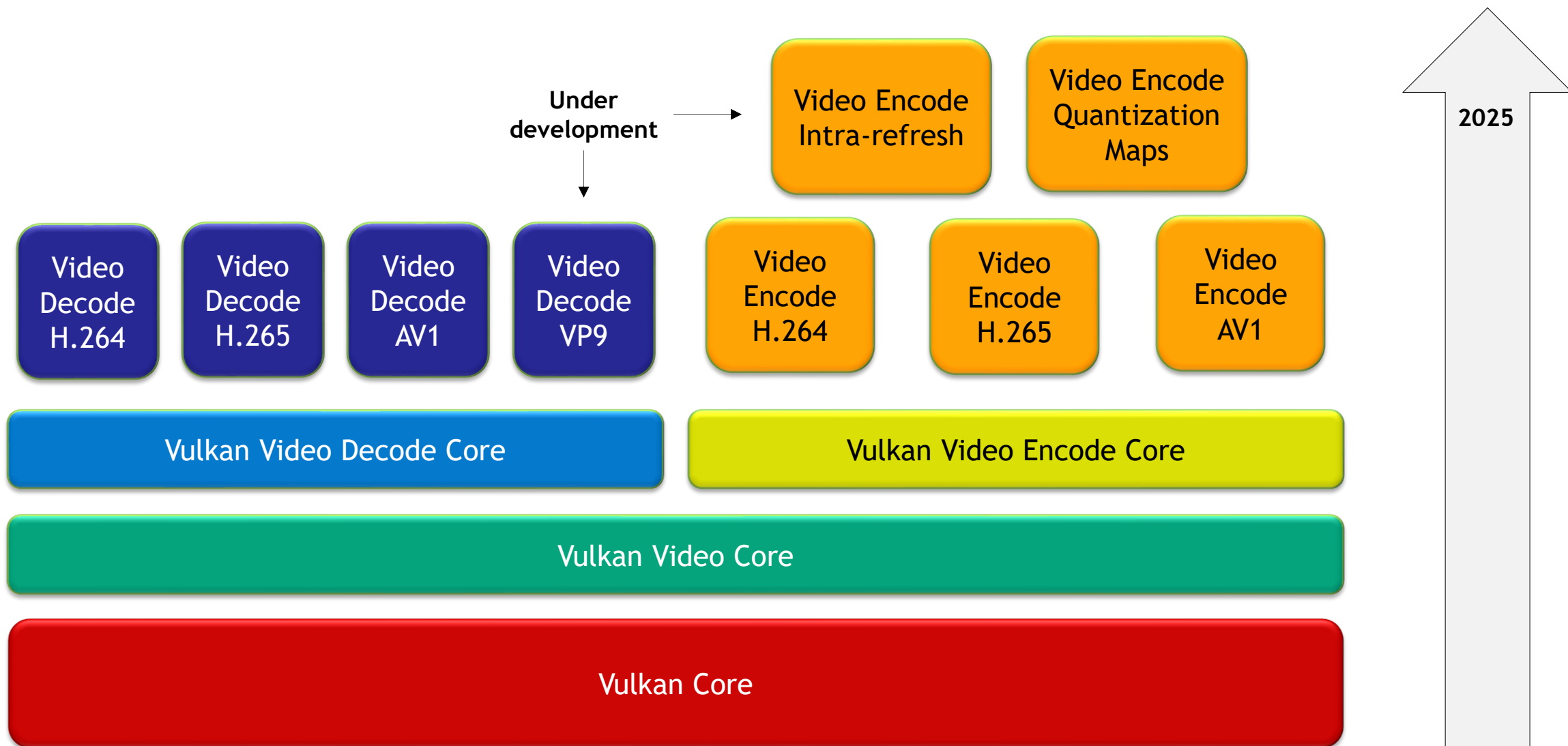
Vulkan Video Extension Hierarchy



Vulkan Video Extension Hierarchy



Vulkan Video Extension Hierarchy



New Extensions

AV1 Encode

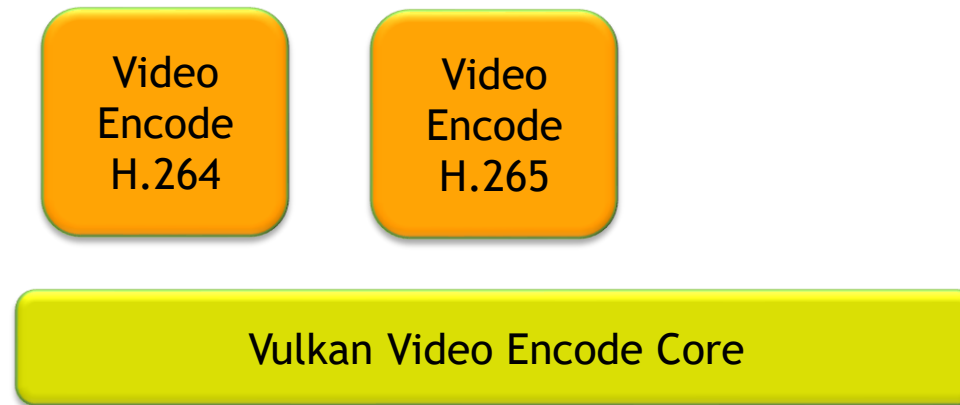
VK_KHR_video_encode_av1

- Hardware acceleration for AV1 encoding

AV1 Encode

VK_KHR_video_encode_av1

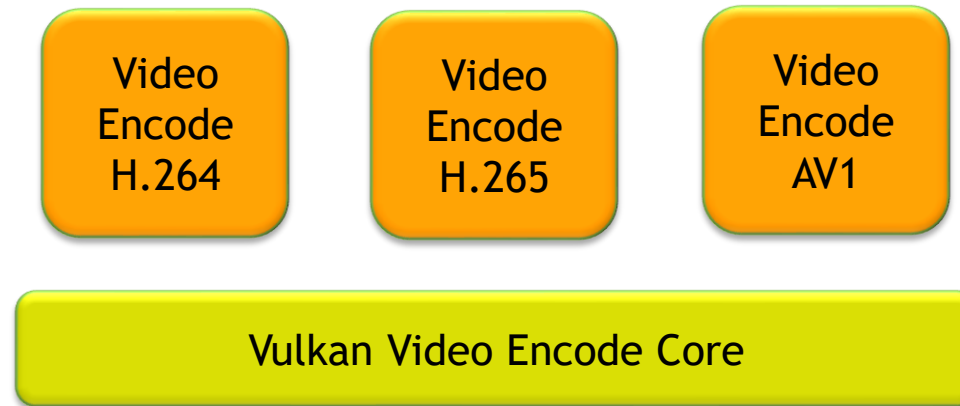
- Hardware acceleration for AV1 encoding



AV1 Encode

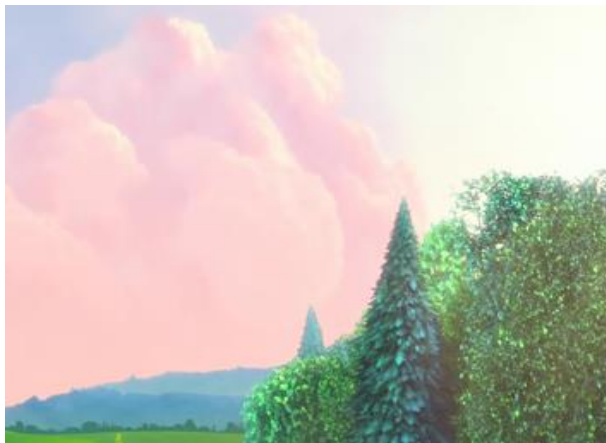
VK_KHR_video_encode_av1

- Hardware acceleration for AV1 encoding
- [Released](#) in November 2024



Quantization Maps

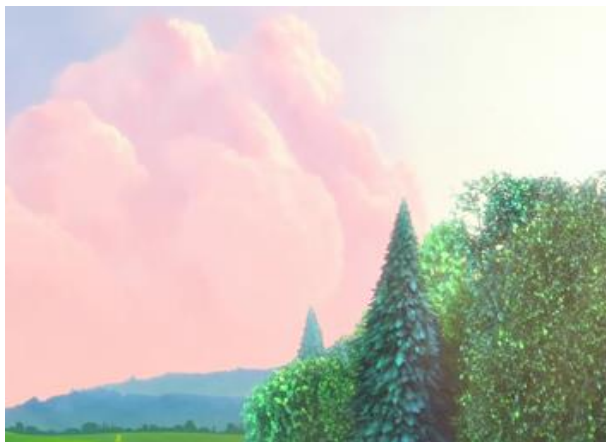
VK_KHR_video_encode_quantization_map



Input frame

Quantization Maps

VK_KHR_video_encode_quantization_map



Input frame

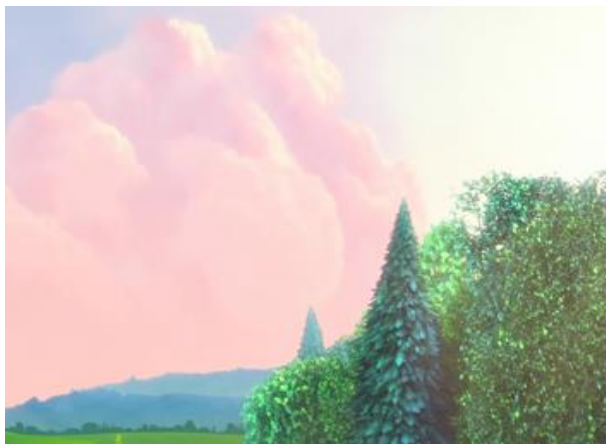
-4	-7	-6	-1	-6	-5	-10	-10	-12	-12	-12
-7	-4	-9	-6	-7	-4	-8	-12	-12	-12	-12
-5	-5	-5	-8	-3	-5	-5	-12	-12	-12	-12
-7	-12	-6	-8	-6	-4	-5	-6	2	2	2
-6	-7	-11	-11	-11	-8	-3	4	4	4	4
-9	-10	-11	-9	-12	-11	2	4	4	3	3
-12	-12	-12	-12	-12	1	4	4	2	4	4
-11	-1	-2	-6	0	4	3	3	2	2	2
3	-2	-2	-2	3	3	3	3	3	3	3

Quantization map

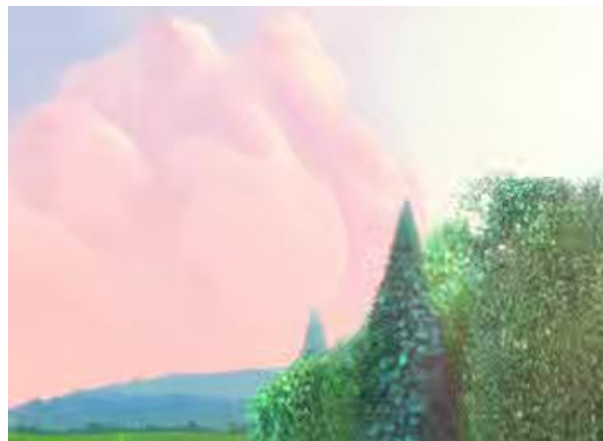
* The map on the right is a specific type of quantization map, called a “quantization delta map”

Quantization Maps

VK_KHR_video_encode_quantization_map



Input frame



Output

-4	-7	-6	-1	-6	-5	-10	-10	-12	-12	-12
-7	-4	-9	-6	-7	-4	-8	-12	-12	-12	-12
-5	-5	-5	-8	-3	-5	-5	-12	-12	-12	-12
-7	-12	-6	-8	-6	-4	-5	-6	2	2	2
-6	-7	-11	-11	-11	-8	-3	4	4	4	4
-9	-10	-11	-9	-12	-11	2	4	4	3	3
-12	-12	-12	-12	-12	1	4	4	2	4	4
-11	-1	-2	-6	0	4	3	3	2	2	2
3	-2	-2	-2	3	3	3	3	3	3	3

Quantization map

* The map on the right is a specific type of quantization map, called a “quantization delta map”

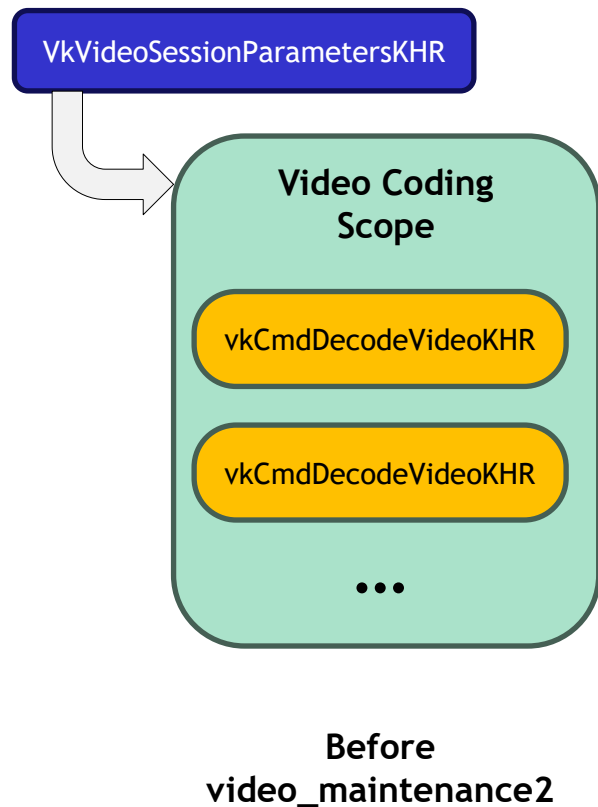
Video Maintenance

VK_KHR_video_maintenance2

Video Maintenance

VK_KHR_video_maintenance2

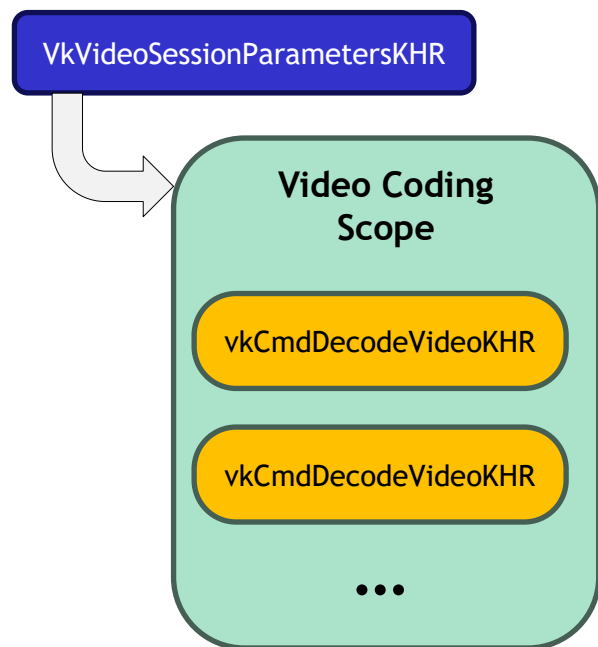
- * `vkCmdBeginVideoCodingKHR()` starts a video coding scope
- * Session parameters: sequence- and/or picture-level parameters



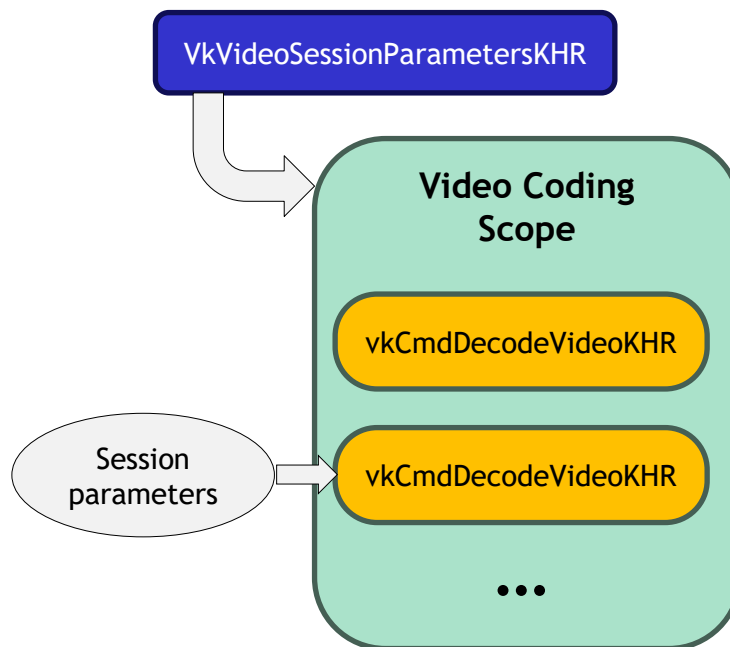
Video Maintenance

VK_KHR_video_maintenance2

- * `vkCmdBeginVideoCodingKHR()` starts a video coding scope
- * Session parameters: sequence- and/or picture-level parameters



Before
`video_maintenance2`



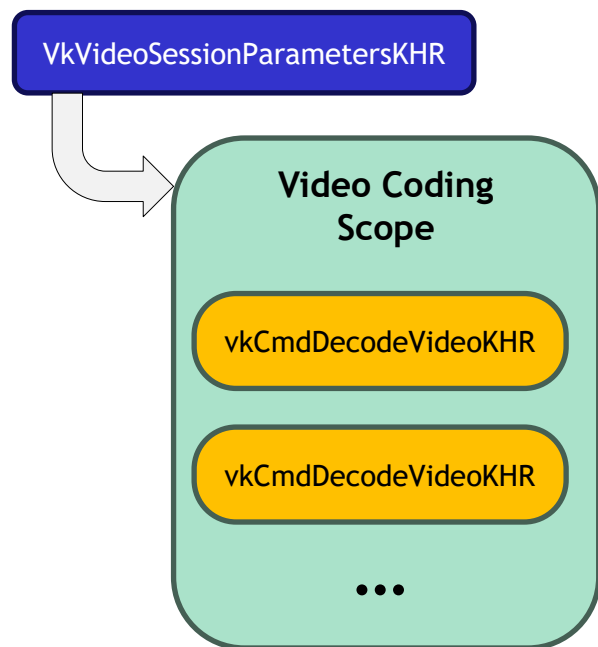
(A)

With `video_maintenance2`

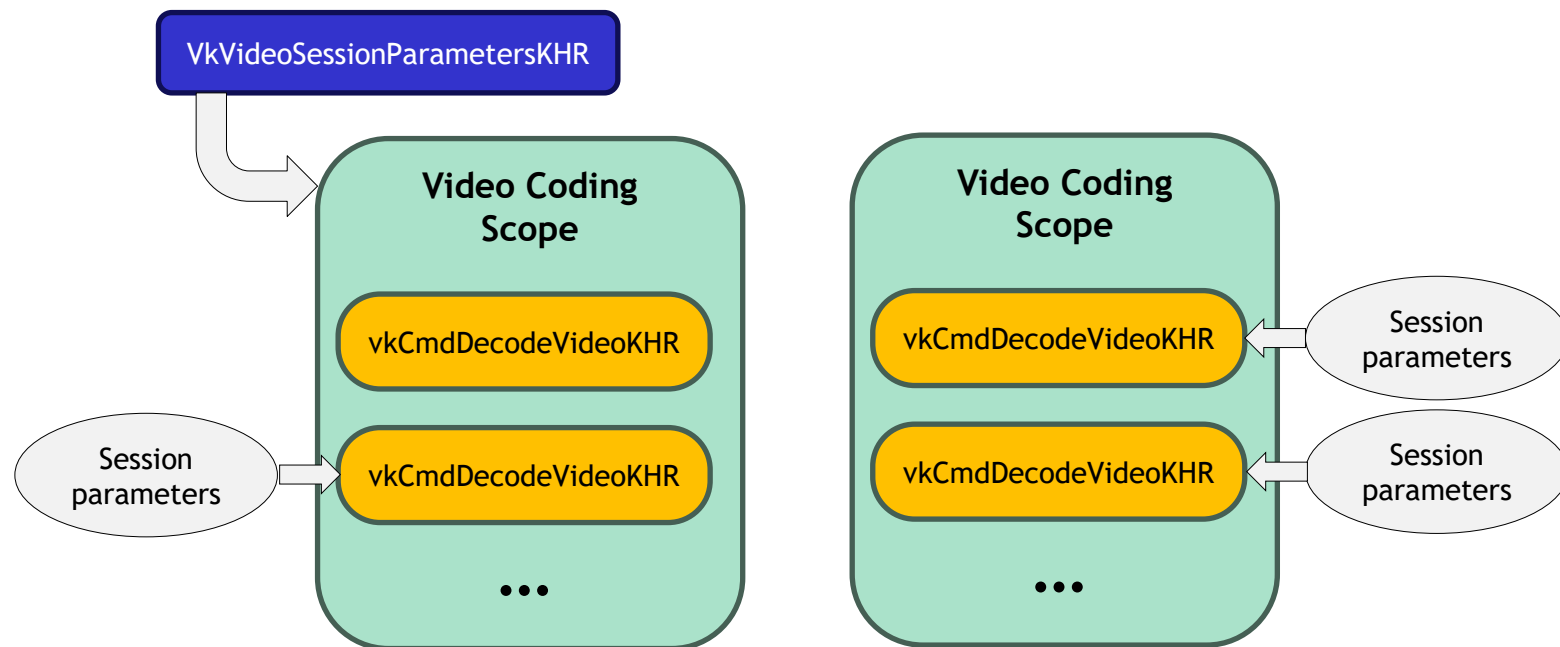
Video Maintenance

VK_KHR_video_maintenance2

- * `vkCmdBeginVideoCodingKHR()` starts a video coding scope
- * Session parameters: sequence- and/or picture-level parameters



Before
`video_maintenance2`



(A)

(B)

With `video_maintenance2`

Intra-refresh (WIP)

VK_KHR_video_encode_intra_refresh

Intra-refresh (WIP)

VK_KHR_video_encode_intra_refresh

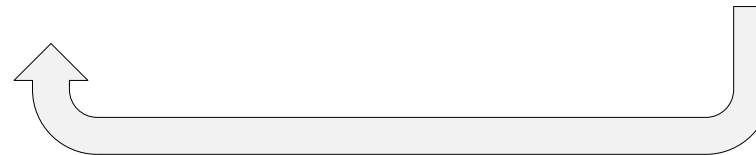
Decoding of a stream received over a regular (less noisy) channel



frame N



frame N + 1

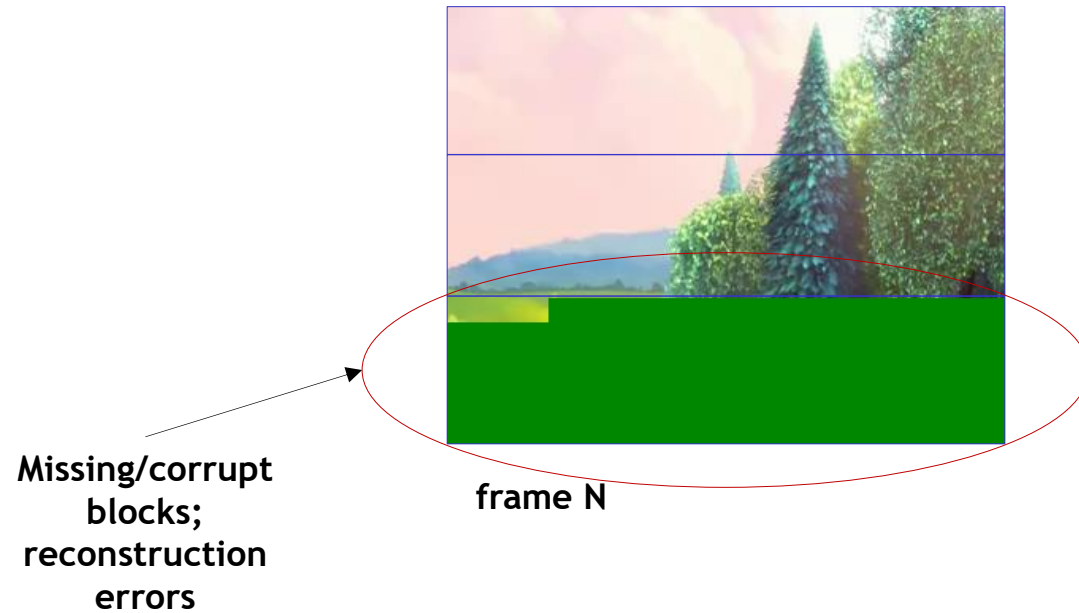


frame N + 1 refers to frame N

Intra-refresh (WIP)

VK_KHR_video_encode_intra_refresh

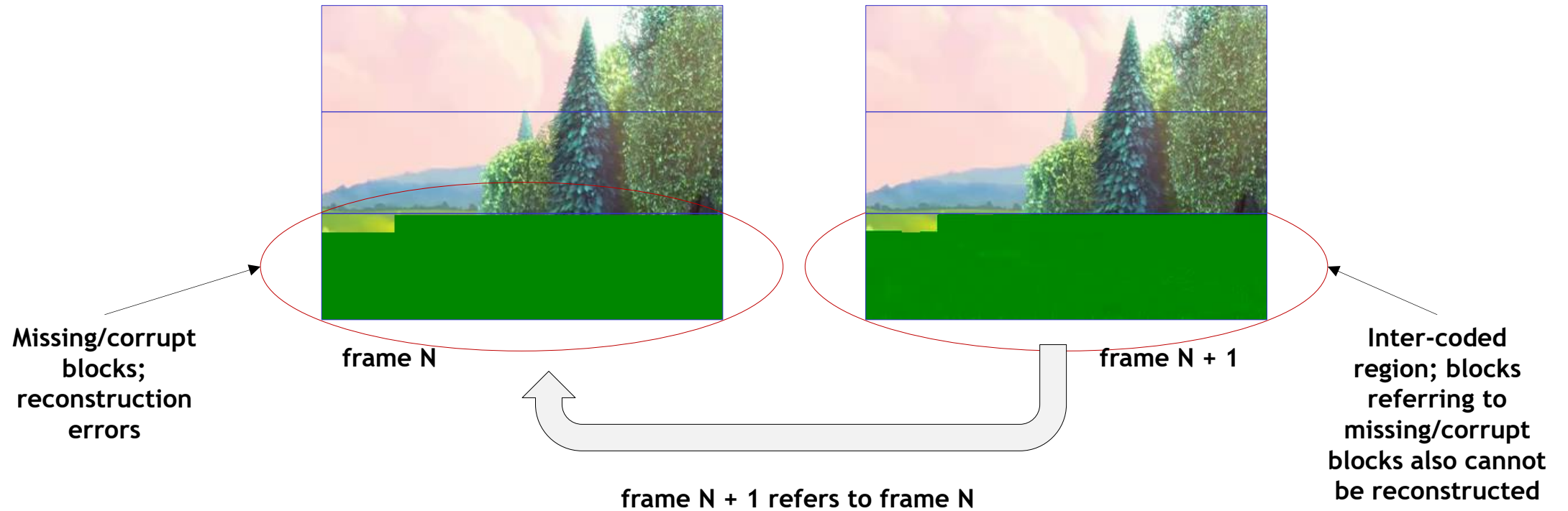
Decoding of a stream received
over a noisy channel



Intra-refresh (WIP)

VK_KHR_video_encode_intra_refresh

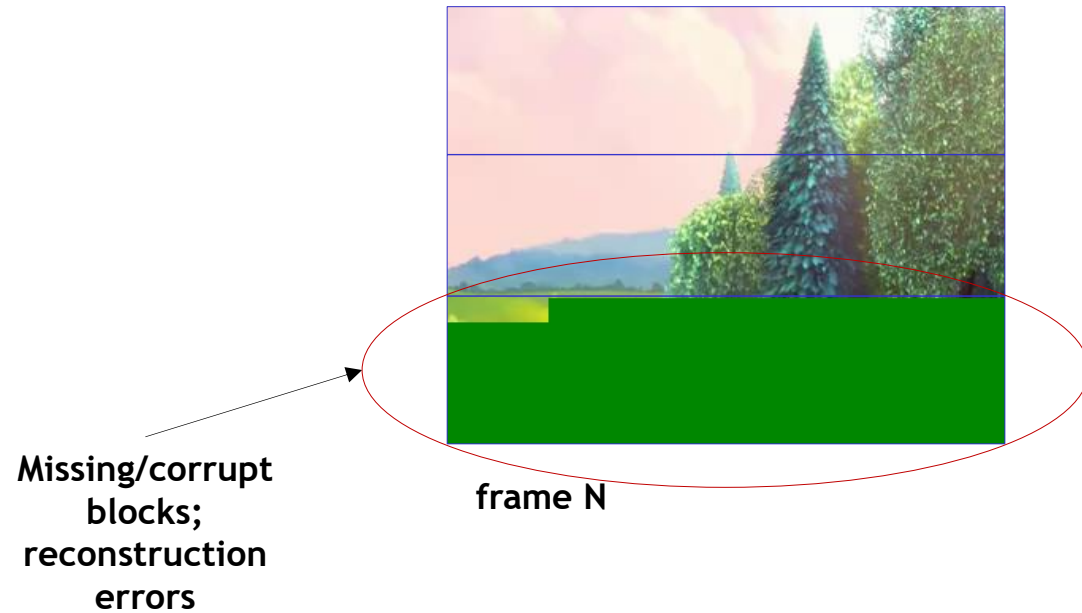
Decoding of a stream received over a noisy channel



Intra-refresh (WIP)

VK_KHR_video_encode_intra_refresh

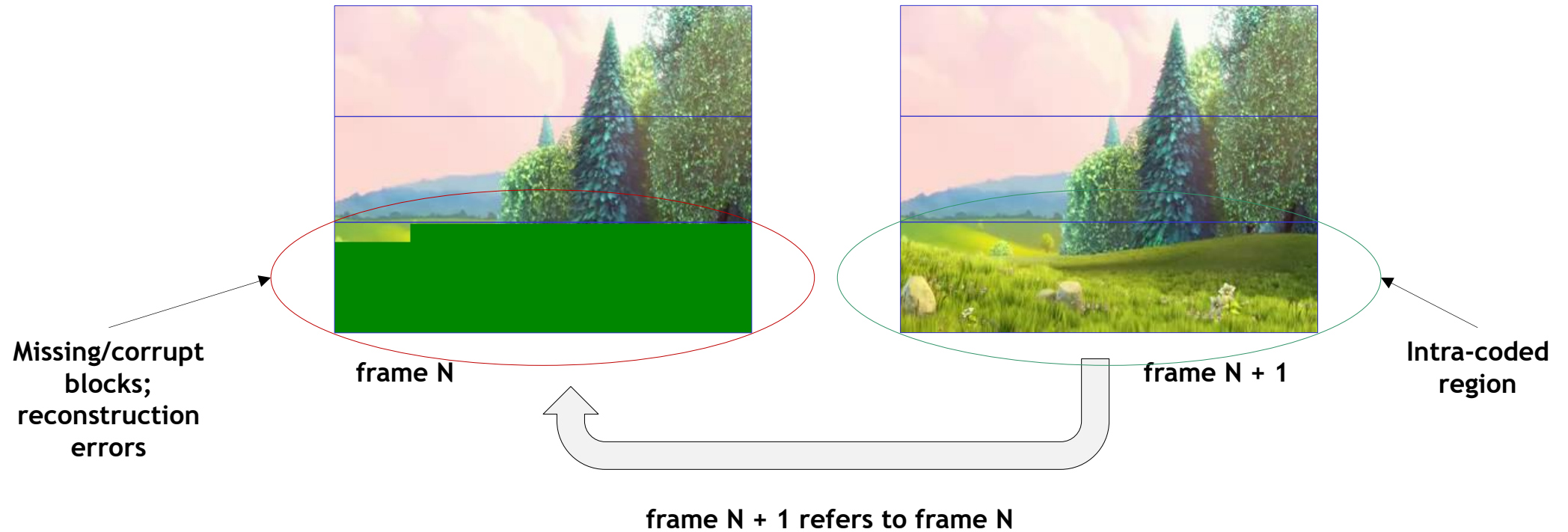
Decoding of a stream received over a
noisy channel
[stream encoded with intra-refresh]



Intra-refresh (WIP)

VK_KHR_video_encode_intra_refresh

Decoding of a stream received over a
noisy channel
[stream encoded with intra-refresh]



VP9 Decode (WIP)

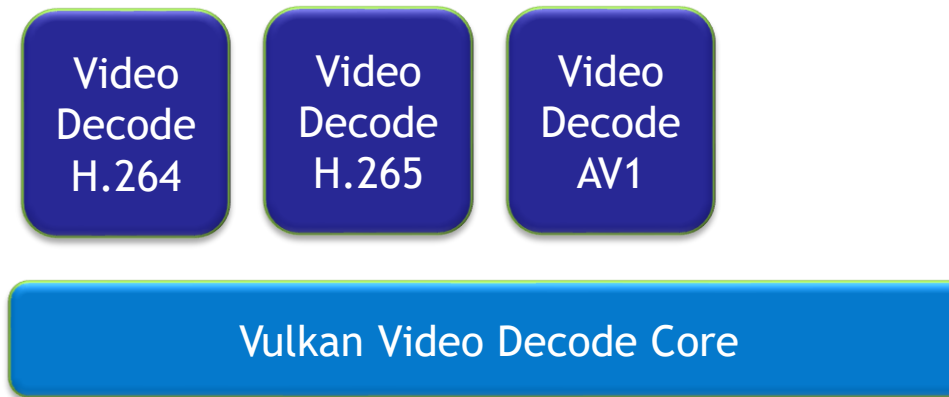
VK_KHR_video_decode_vp9

- Hardware acceleration for VP9 decoding

VP9 Decode (WIP)

VK_KHR_video_decode_vp9

- Hardware acceleration for VP9 decoding



VP9 Decode (WIP)

VK_KHR_video_decode_vp9

- Hardware acceleration for VP9 decoding



Ecosystem Updates

Vulkan Validation Layers

- [Validation layers](#) support all video extensions

Vulkan Validation Layers

- [Validation layers](#) support all video extensions
- Vulkan API usage is validated

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- Vulkan API usage is validated
 - ⇒ No codec parameter validation

Vulkan Validation Layers

- [Validation layers](#) support all video extensions
- Vulkan API usage is validated
 - ⇒ No codec parameter validation
- Applications expected to follow codec rules

Vulkan Profiles

- Support for video functionality in Vulkan Profiles

Vulkan Profiles

- Support for video functionality in Vulkan Profiles
- Target specific collection of video properties and capabilities

Vulkan Profiles

- Support for video functionality in Vulkan Profiles
- Target specific collection of video properties and capabilities

```
"videoProfiles": [  
  {  
    "profile": {  
      "VkVideoProfileInfoKHR": {  
        "videoCodecOperation": "VK_VIDEO_CODEC_OPERATION_DECODE_H264_BIT_KHR",  
        "chromaSubsampling": [  
          "VK_VIDEO_CHROMA_SUBSAMPLING_420_BIT_KHR"  
        ],  
        "lumaBitDepth": [  
          "VK_VIDEO_COMPONENT_BIT_DEPTH_8_BIT_KHR"  
        ],  
        "chromaBitDepth": [  
          "VK_VIDEO_COMPONENT_BIT_DEPTH_8_BIT_KHR"  
        ]  
      },  
      "VkVideoDecodeH264ProfileInfoKHR": {  
        "stdProfileIdc": "STD_VIDEO_H264_PROFILE_IDC_MAIN",  
        "pictureLayout": "VK_VIDEO_DECODE_H264_PICTURE_LAYOUT_PROGRESSIVE_KHR"  
      }  
    },  
    "formats": [  
      {  
        "VkVideoFormatPropertiesKHR": {  
          "format": "VK_FORMAT_G8_B8R8_2PLANE_420_UNORM",  
          "imageCreateFlags": [  
            "VK_IMAGE_CREATE_MUTABLE_FORMAT_BIT",  
            "VK_IMAGE_CREATE_EXTENDED_USAGE_BIT"  
          ],  
          "imageType": "VK_IMAGE_TYPE_2D",  
          "imageUsageFlags": [  
            "VK_IMAGE_USAGE_VIDEO_DECODE_DST_BIT_KHR",  
            "VK_IMAGE_USAGE_SAMPLED_BIT",  
            "VK_IMAGE_USAGE_TRANSFER_SRC_BIT",  
            "VK_IMAGE_USAGE_TRANSFER_DST_BIT"  
          ]  
        }  
      }  
    ]  
  }  
]
```

Vulkan Tools

- vulkaninfo now shows extra video-related information

Vulkan Tools

- vulkaninfo now shows extra video-related information
- Use --show-video-props (see [Vulkan-Tools #1055](#))

```
▼ H.264 Decode (4:2:0 8-bit) Baseline progressive
  ▼ Video Profile Definition
    ▼ VkVideoProfileInfoKHR
      ▶ videoCodecOperation = VIDEO_CODEC_OPERATION_DECODE_H264_BIT_KHR
      ▼ chromaSubsampling: count = 1
        ▶ VIDEO_CHROMA_SUBSAMPLING_420_BIT_KHR
      ▼ lumaBitDepth: count = 1
        ▶ VIDEO_COMPONENT_BIT_DEPTH_8_BIT_KHR
      ▼ chromaBitDepth: count = 1
        ▶ VIDEO_COMPONENT_BIT_DEPTH_8_BIT_KHR
    ▼ VkVideoDecodeH264ProfileInfoKHR
      ▶ stdProfileIdc = STD_VIDEO_H264_PROFILE_IDC_BASELINE
      ▶ pictureLayout = VIDEO_DECODE_H264_PICTURE_LAYOUT_PROGRESSIVE_KHR
  ▼ Video Profile Capabilities
    ▼ VkVideoCapabilitiesKHR
      ▶ flags
      ▶ minBitstreamBufferOffsetAlignment = 0x00000100
      ▶ minBitstreamBufferSizeAlignment = 0x00000100
      ▶ pictureAccessGranularity
      ▶ minCodedExtent
      ▶ maxCodedExtent
      ▶ maxDpbSlots = 17
      ▶ maxActiveReferencePictures = 16
      ▼ stdHeaderVersion
        ▶ extensionName = VK_STD_vulkan_video_codec_h264_decode
        ▶ specVersion = 4194304
    ▼ VkVideoDecodeCapabilitiesKHR
      ▼ flags: count = 1
        ▶ VIDEO_DECODE_CAPABILITY_DPB_AND_OUTPUT_COINCIDE_BIT_KHR
```

Vulkan Video Sample Applications

- Demonstrate usage of video extensions

Vulkan Video Sample Applications

- Demonstrate usage of video extensions
- Modular code

Vulkan Video Sample Applications

- Demonstrate usage of video extensions
- Modular code
- Upcoming additions:
 - Better default settings for video encode
 - Support recent/new extensions

Roadmap

TSG Roadmap for 2025

- Finalize and release:
 - VK_KHR_video_decode_vp9
 - VK_KHR_video_encode_intra_refresh

TSG Roadmap for 2025

- **Finalize and release:**
 - VK_KHR_video_decode_vp9
 - VK_KHR_video_encode_intra_refresh
- **Improvements in:**
 - Sample application code
 - Conformance tests
 - Vulkan Video tools support

References & Quick Links

- [Vulkanised 2023: A deep dive into Vulkan video \(slides\)](#)
- [Vulkanised 2024: Vulkan Video Encode APIs \(slides\)](#)
- [Vulkan Video sample applications](#)
- [Vulkan-Docs issues page](#)
- [Vulkan Events](#)



Thank you!

Questions?