
RADEON
TECHNOLOGIES GROUP
LIQUIDVR™ TODAY AND TOMORROW
GUENNADI RIGUER, SOFTWARE ARCHITECT
AMD

Bootstrapping the industry for better VR experience

Complimentary to HMD SDKs

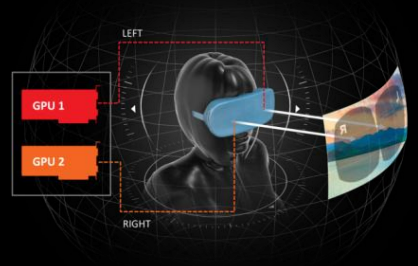
It’s all about giving developers the tools they want!

AMD LIQUIDVR™ FEATURES

Latest data latch

Efficient low-latency GPU head tracking

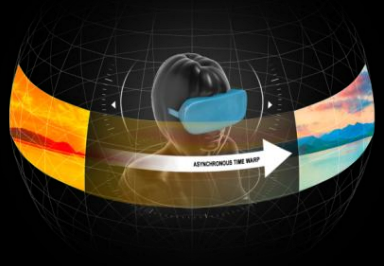
Affinity multi-GPU



Lower latency and increases quality with multiple GPUs

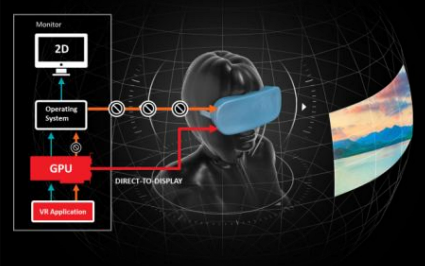
Content developers

Asynchronous shaders



Minimizes latency and stuttering

Direct-to-display



Delivers a seamless plug & play VR experience

HMD vendors

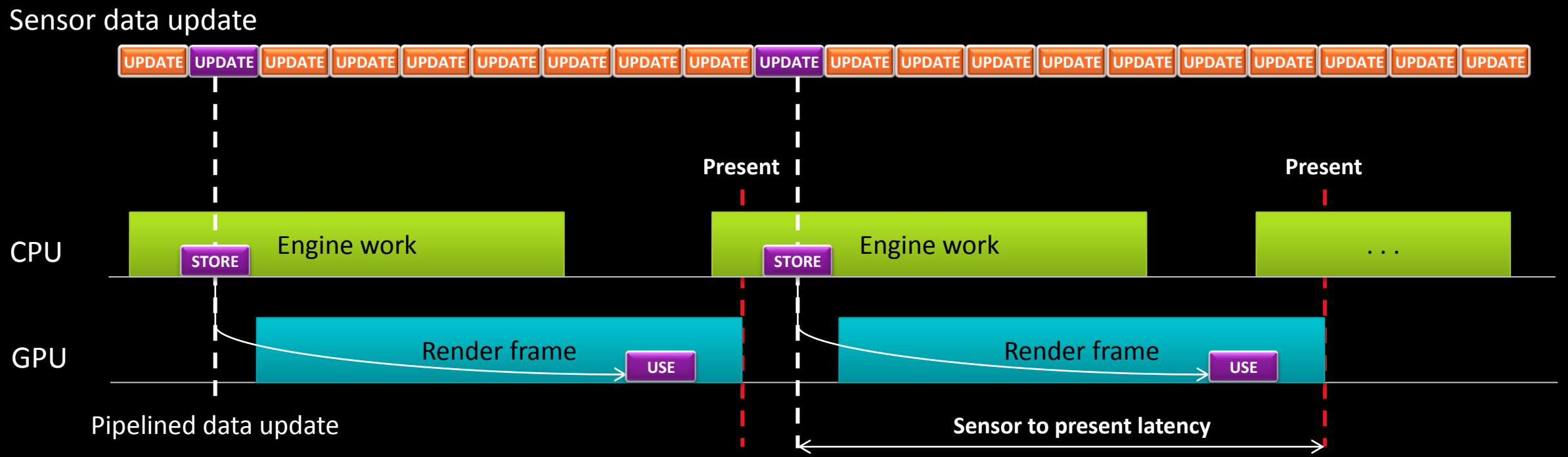
LATEST DATA LATCH

- Using up-to-date head tracking inputs for VR rendering and image warp

- Post-submission data update
  - GPU pull instead of CPU push

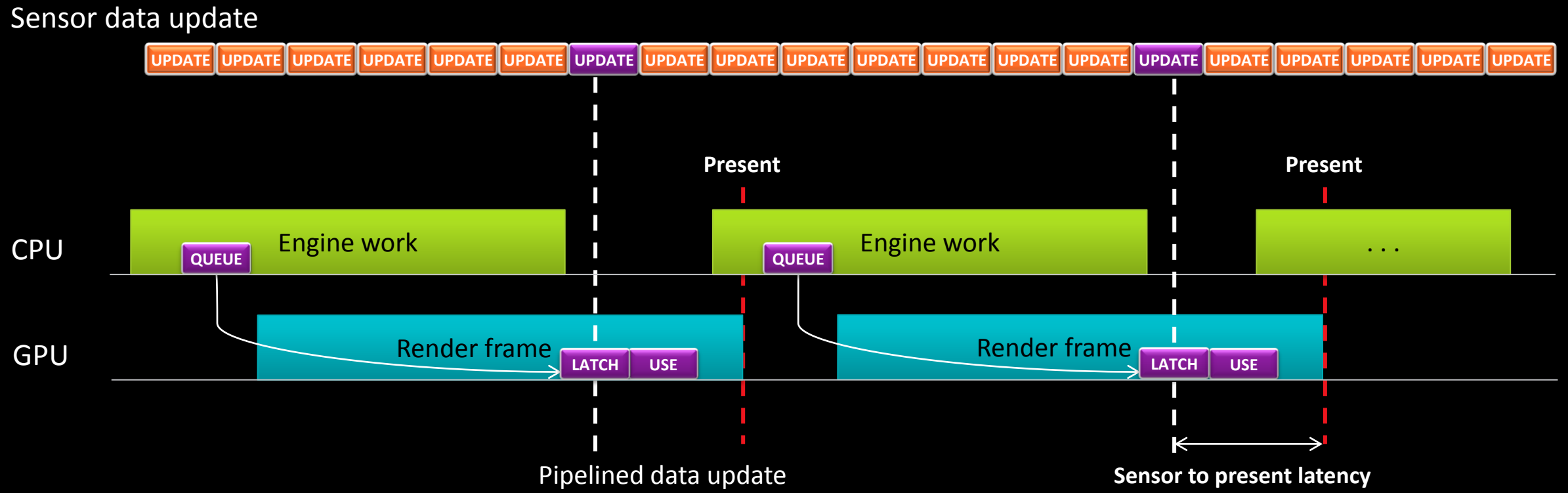
SENSOR DATA WITHOUT LATEST LATCH

- Data pipelined through API at frame building time



LATEST DATA LATCH

- Data latched right before use
- Latch is queued through rendering API



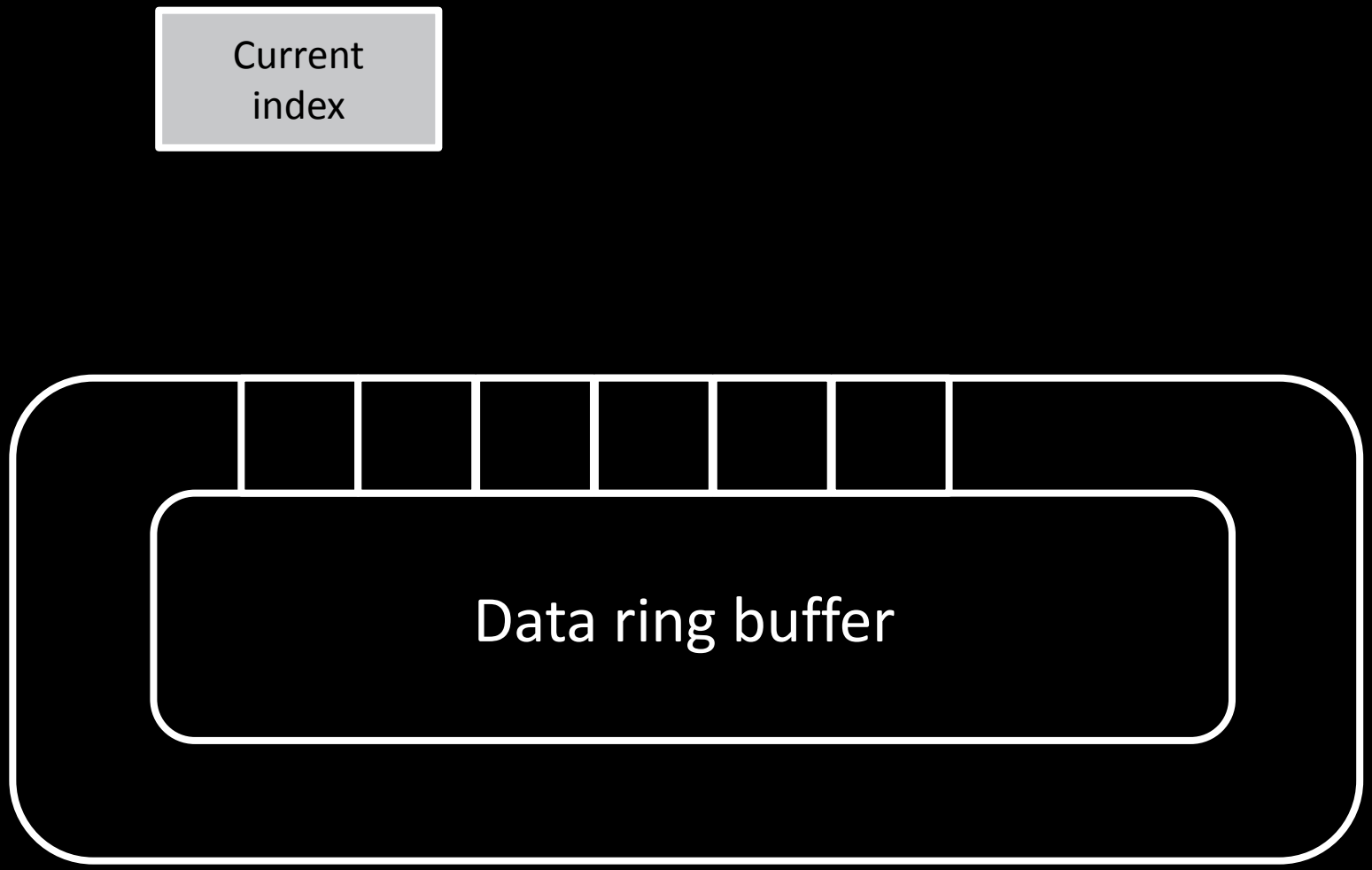
LATE LATCH OPERATION

```
// Setup late latch
ALVRLateLatchConstantBufferD3D11* pLatchBuf;
m_pLvrDevEx->CreateLateLatchConstantBufferD3D11(
    sizeof(HeadData), recordCount, 0, &pLatchBuf);

// Sensor update loop
while (updateSensor)
{
    HeadData latestData;
    GetSensorHeadData(&latestData);
    pLatchBuf->Update(&latestData, 0, sizeof(HeadData));
}
```

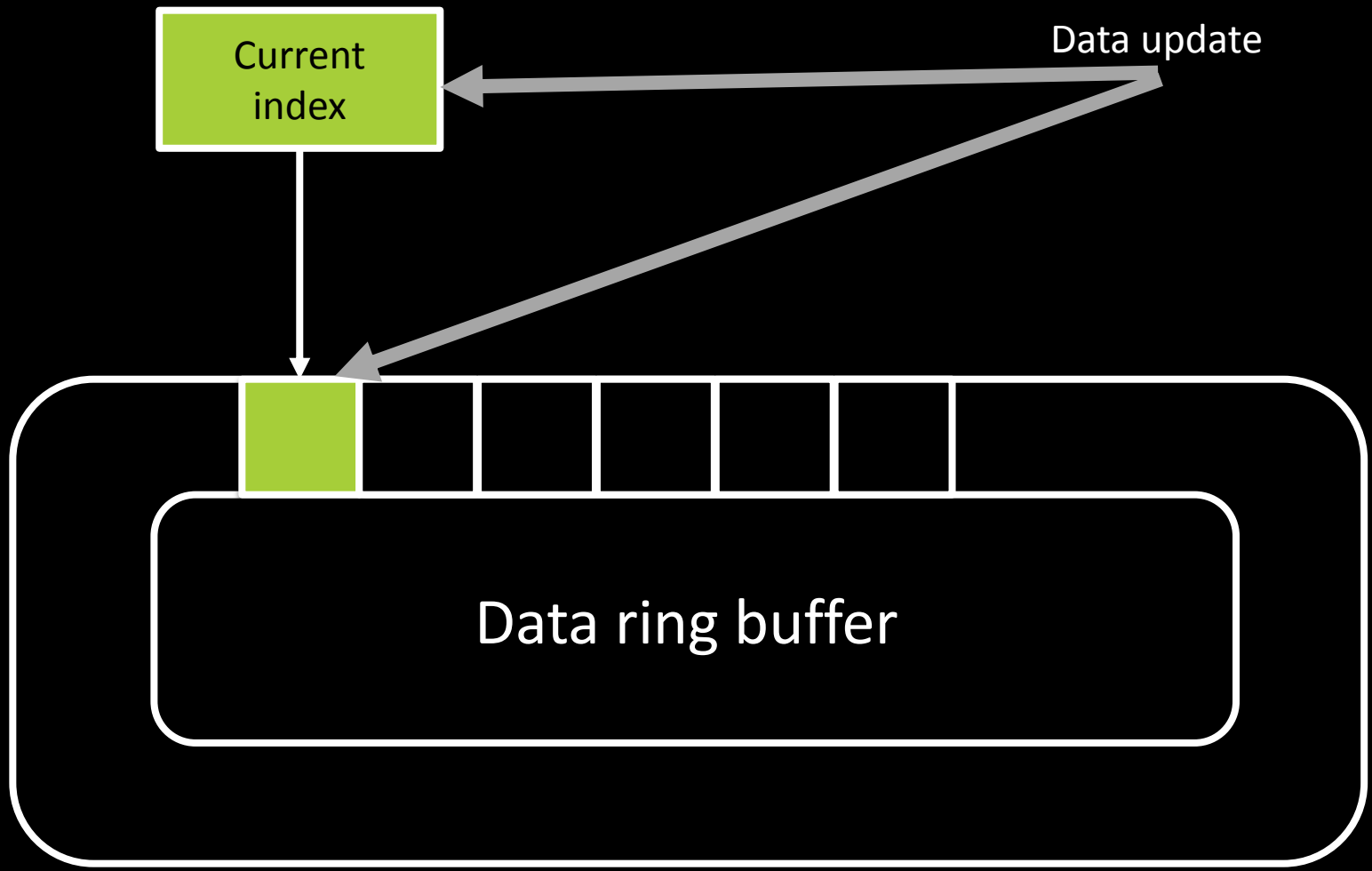
LATE LATCH OPERATION

GPU Queue



LATE LATCH OPERATION

GPU Queue



LATE LATCH OPERATION

GPU Queue

…

Latch

Shader data access

…

```
// Queue latch of latest index
pLatchBuf->QueueLatch();
// Const buffers for shader access of latched data
ID3D11Buffer* pDataCb  = pLatchBuf->GetDataD3D11();
ID3D11Buffer* pIndexCb = pLatchBuf->GetIndexD3D11();
pDxCtx->VSSetConstantBuffers(0, 1, &pIndexCb);
pDxCtx->VSSetConstantBuffers(1, 1, &pDataCb);
. . .
pDxCtx->Draw();
```

LATE LATCH OPERATION

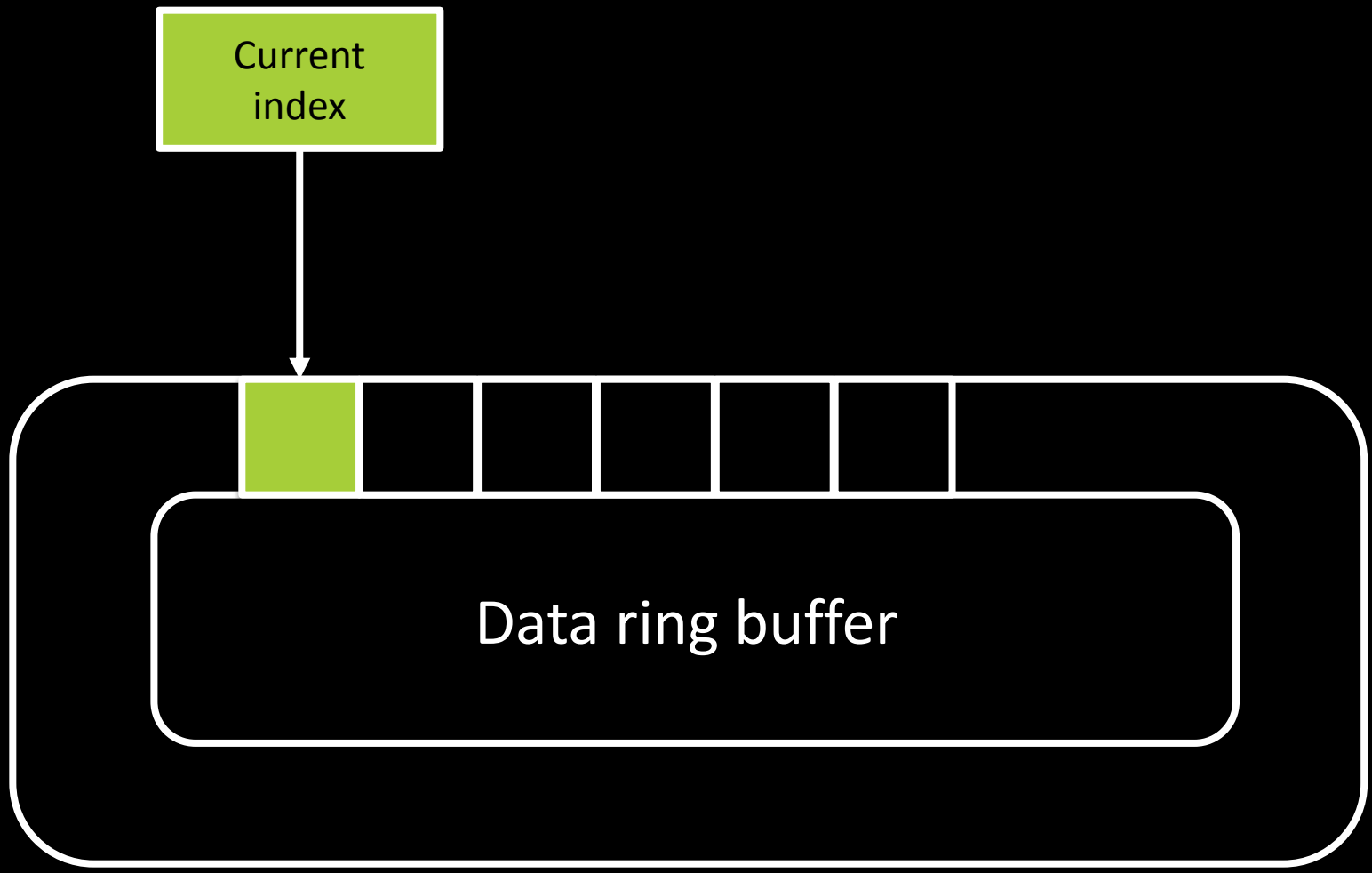
GPU Queue

…

Latch

Shader data access

…



LATE LATCH OPERATION

GPU Queue

…

Latch

Shader data access

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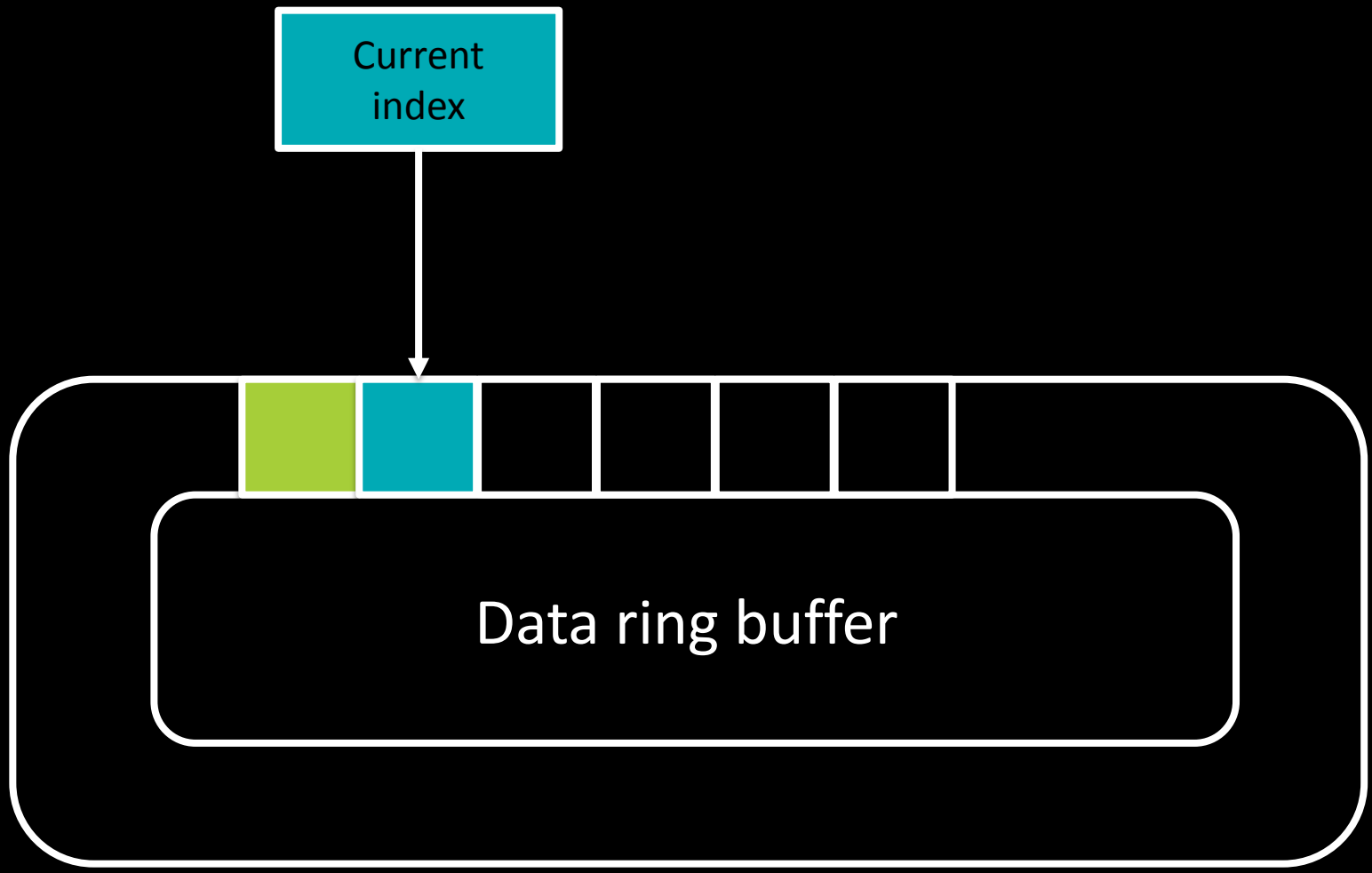

LATE LATCH OPERATION

GPU Queue

…

Latch

Shader data access

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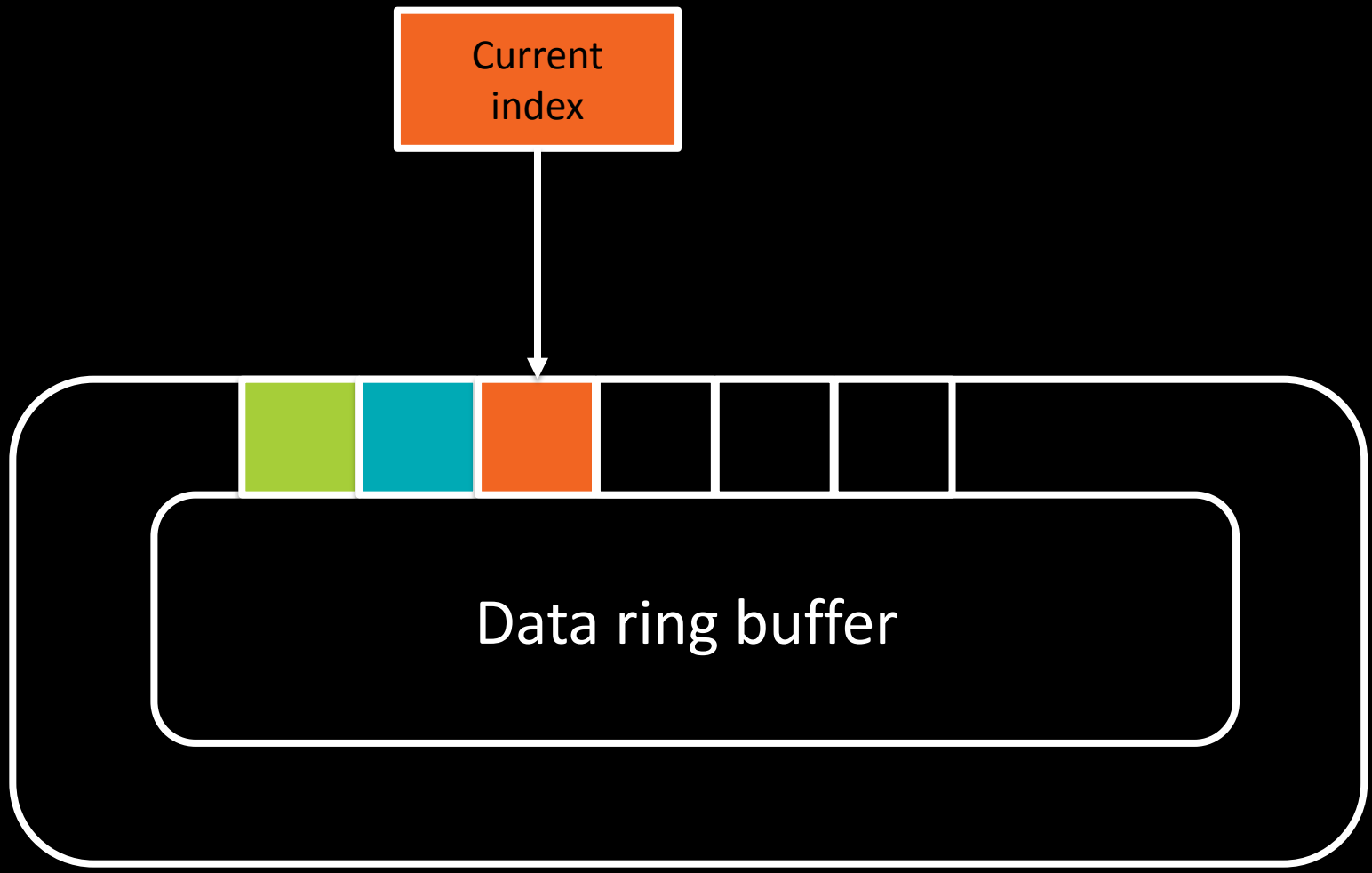


LATE LATCH OPERATION

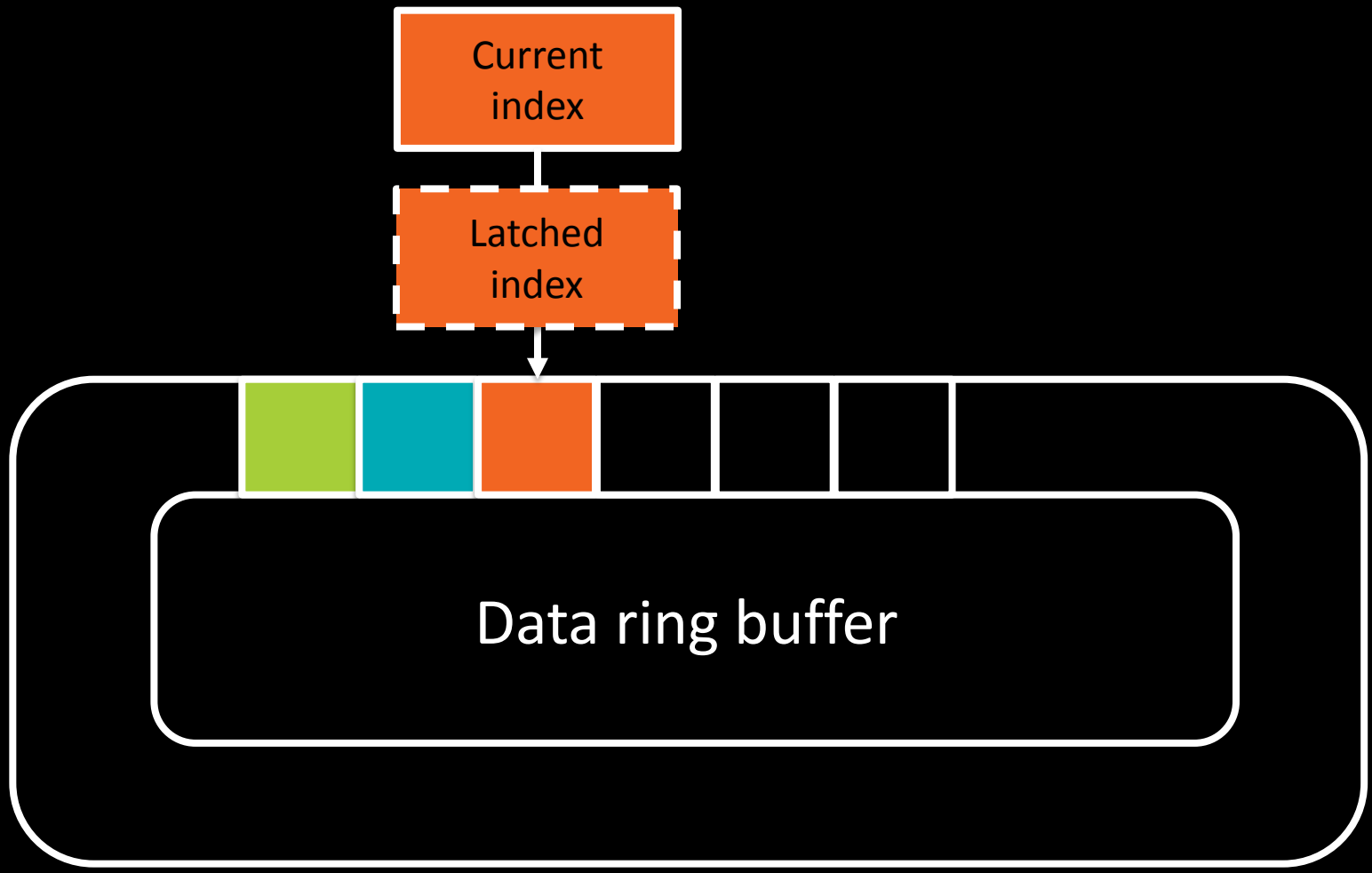
GPU Queue

…

Latch

Shader data access

…



LATE LATCH OPERATION

GPU Queue

…

Latch

Shader data access

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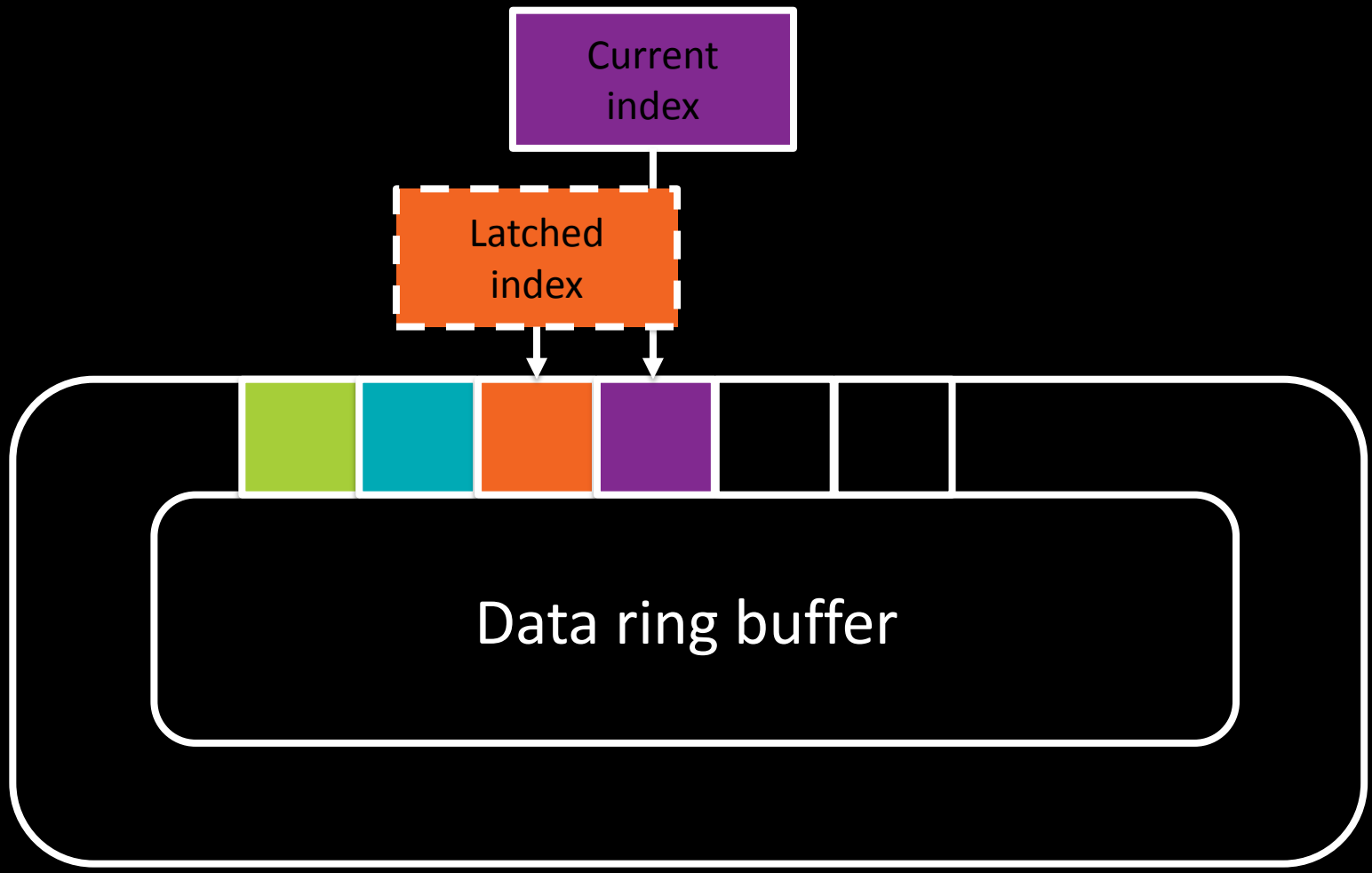


LATE LATCH OPERATION

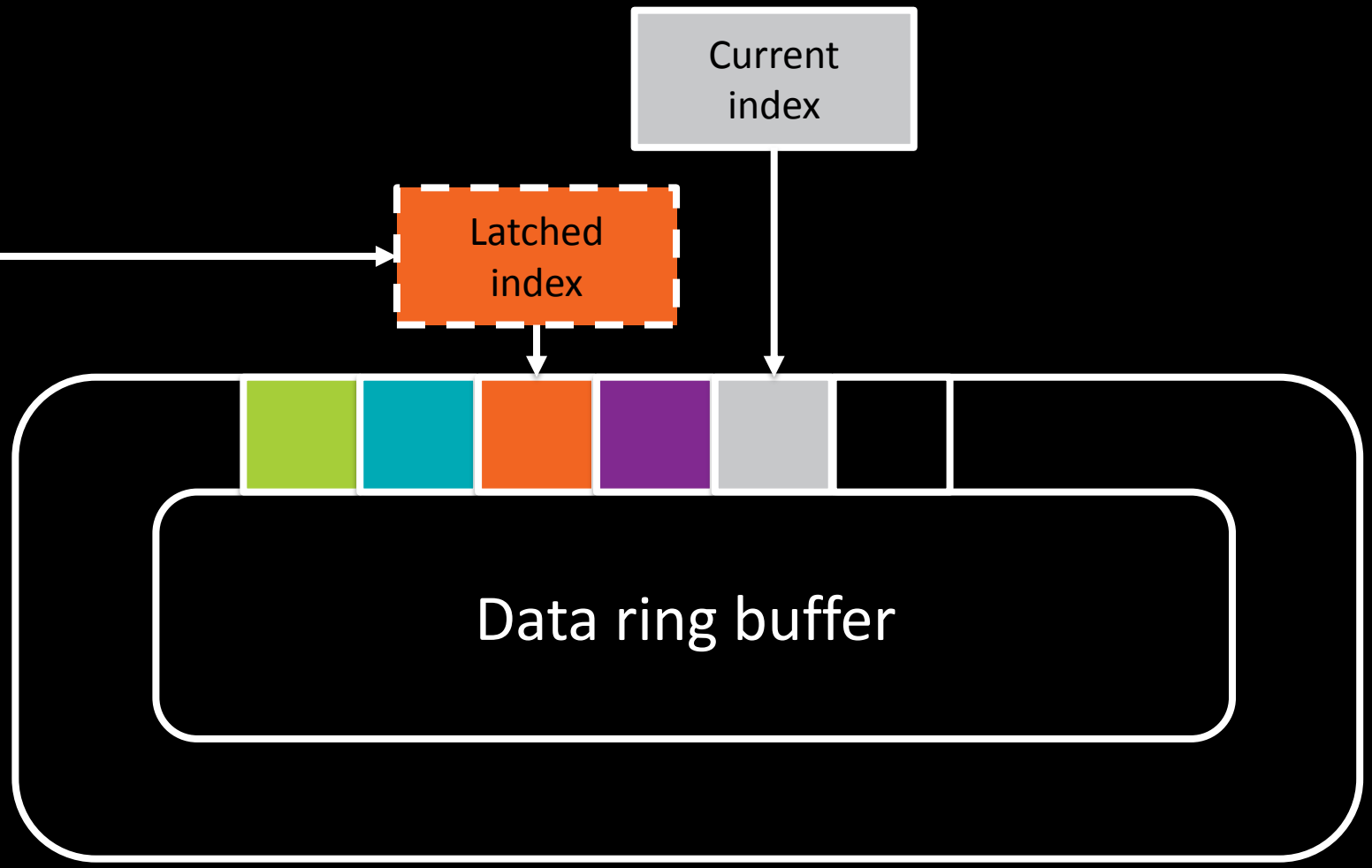
GPU Queue

...

Latch

Shader data access

...

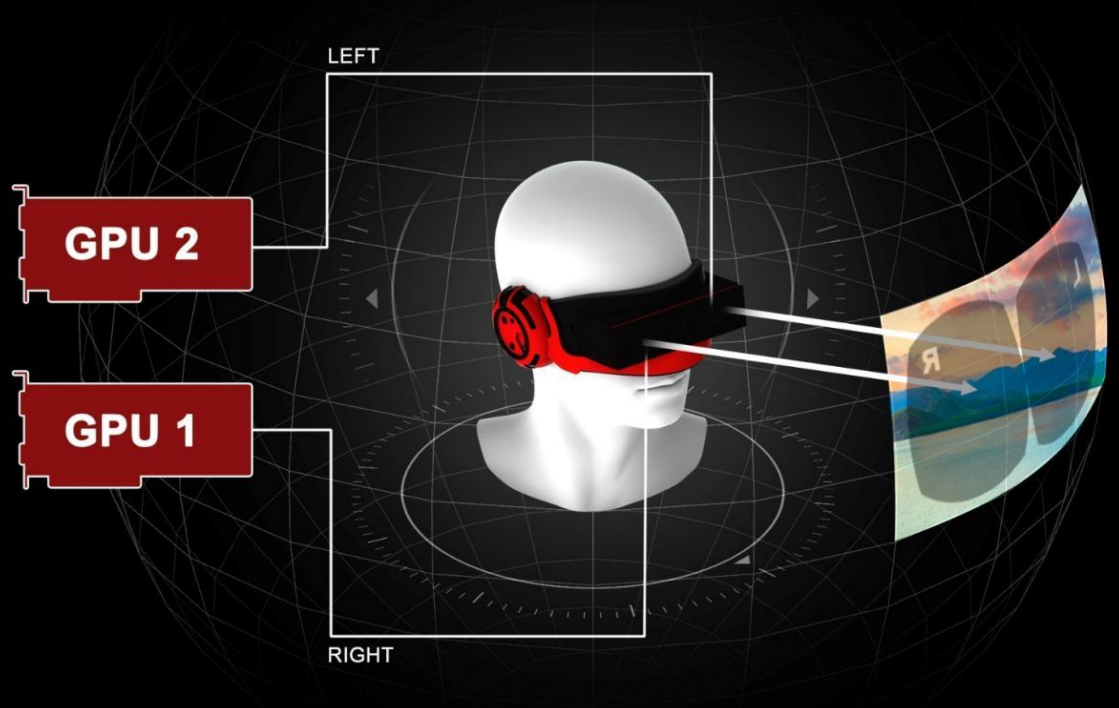


SHADER ACCESS OF LATCHED DATA

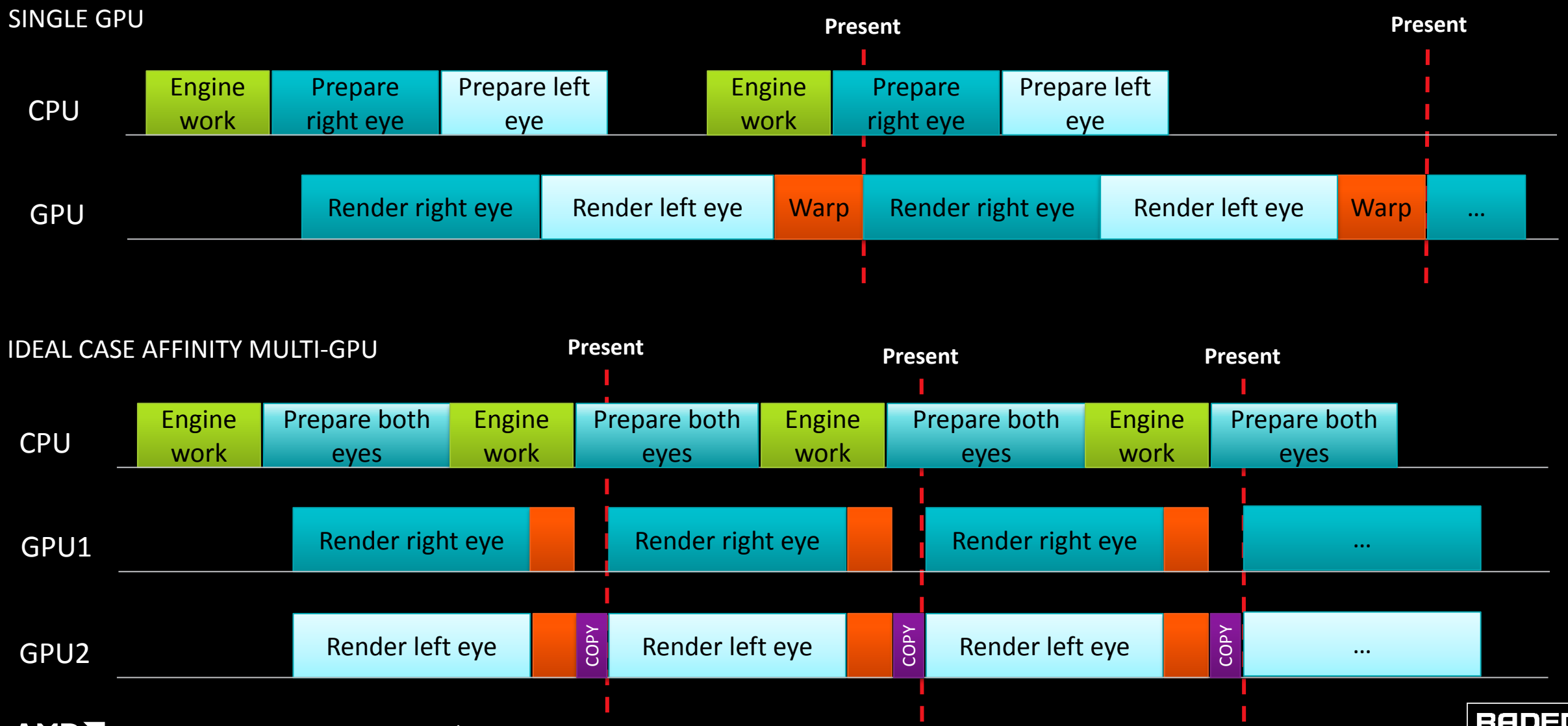
```
struct HeadData
{
    matrix xform;
};
cbuffer LatchIndexBuffer : register(b0)
{
    unsigned int dataIndex;
};
cbuffer LatchDataBuffer : register(b1)
{
    HeadData dataSlots[512];
};
VS_OUTPUT VSMain(VS_INPUT Input)
{
    VS_OUTPUT Output = (VS_OUTPUT)0;
    Output.Pos = mul(Input.Pos, dataSlots[dataIndex].xform);
    return Output;
}
```

AFFINITY MULTI-GPU

- Explicit control of GPUs
  - Broadcast API commands to GPUs
  - Application controls GPU affinity
  - Explicit transfers and synchronization
  - Control of resource instancing
- Assign a GPU per eye for 2 GPUs
- Supports more than 2 GPUs

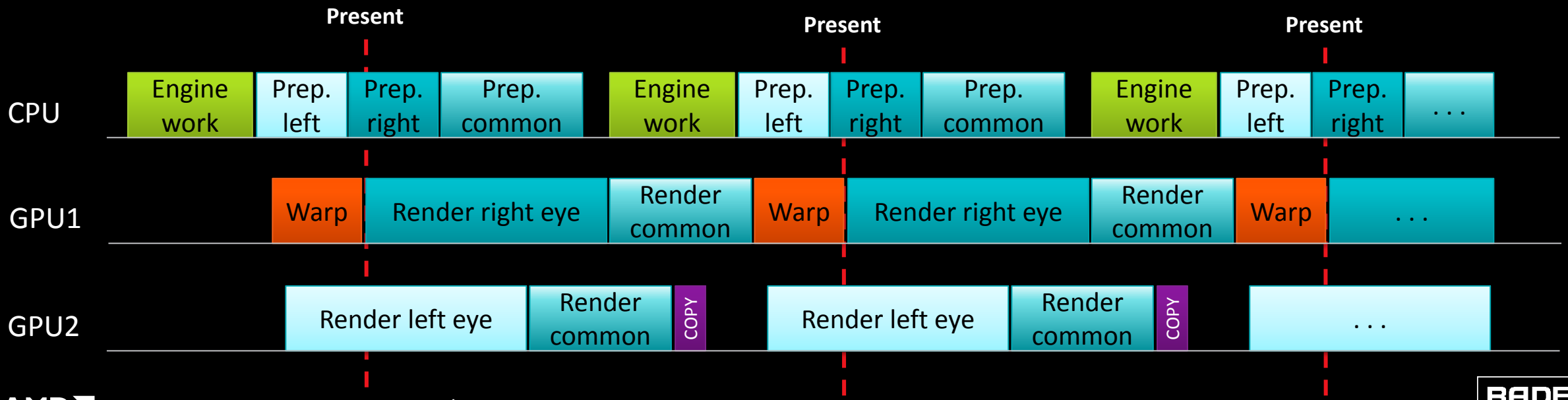


AFFINITY MULTI-GPU IDEAL SCENARIO



MORE TYPICAL MULTI-GPU SCENARIO

- Some inefficiencies due to:
  - Compositor work
  - Eye-independent work
- Illustrates some best practices…



AFFINITY MGPU BEST PRACTICES – DEVICE WRAPPING

- Must wrap device and context
- Can’t use original device and context once wrapped
- Don’t forget to disable prior to creation of non-affinity D3D11 device

AFFINITY MGPU BEST PRACTICES – EYE SWITCHING

- Avoid excessive switching between eyes
- Broadcast to both GPUs when possible

```
for (auto &obj : Scene)
{
    for (int eye = 0; eye < 2; i++)
    {
        pLvrDevEx->SetGpuRenderAffinity(1 << eye);
        pDxCtx->Map(pCb, ...);
        UpdateEyeXform(pCb, eye);
        pDxCtx->Unmap(pCb);
        DrawObject(obj, pCb);
    }
}
```

AFFINITY MGPU BEST PRACTICES – EYE SWITCHING

- Avoid excessive switching between eyes - √
- Broadcast to both GPUs when possible

```
for (int eye = 0; eye < 2; i++)
{
    pLvrDevEx->SetGpuRenderAffinity(1 << eye);
    pDxCtx->Map(pCb, ...);
    UpdateEyeXform(pCb, eye);
    pDxCtx->Unmap(pCb);
    for (auto &obj : Scene)
    {
        DrawObject(obj, pCb);
    }
}
```

AFFINITY MGPU BEST PRACTICES – EYE SWITCHING

- Avoid excessive switching between eyes - √
- Broadcast to both GPUs when possible - √

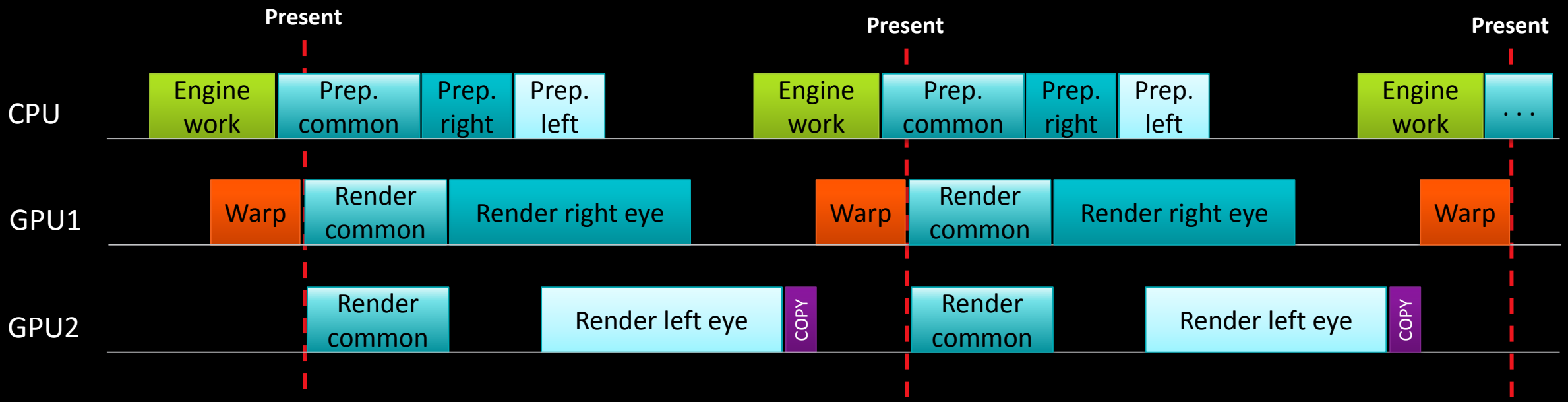
```
for (int eye = 0; eye < 2; i++)
{
    pLvrDevEx->SetGpuRenderAffinity(1 << eye);
    pDxCtx->Map(pCb, ...);
    UpdateEyeXform(pCb, eye);
    pDxCtx->Unmap(pCb);
}
pLvrDevEx->SetGpuRenderAffinity(0x3); // Broadcast to both eyes
for (auto &obj : Scene)
{
    DrawObject(obj, pCb);
}
```

AFFINITY MGPU BEST PRACTICES – CONST BUFFERS

- Minimize const buffers with eye-dependent data
- Minimize size of const buffers
- Max 64K const buffers

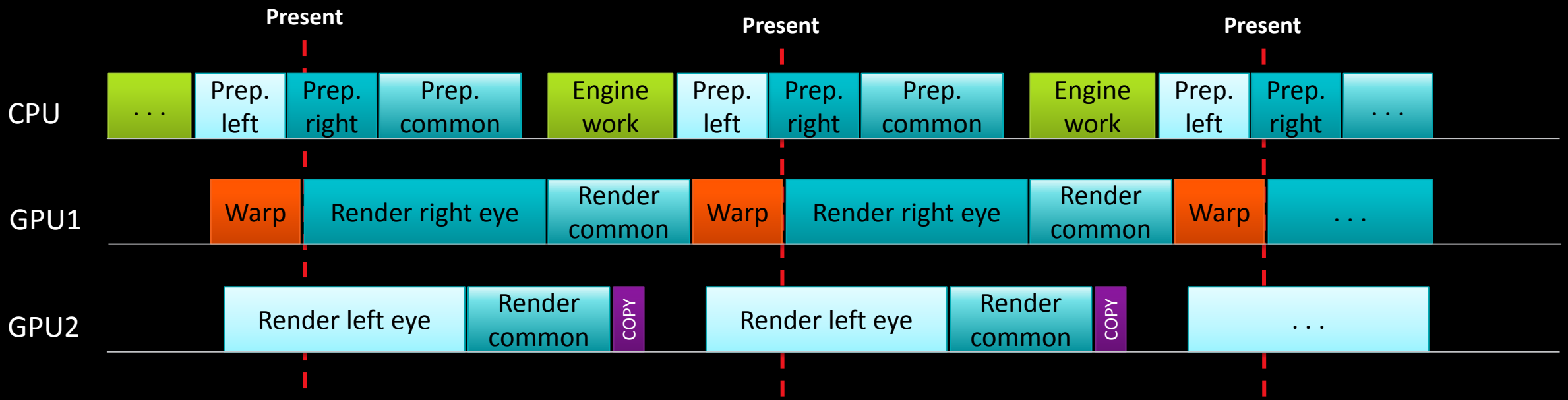
AFFINITY MGPU BEST PRACTICES – WORK ORDERING

- Ordering of operations matters



AFFINITY MGPU BEST PRACTICES – WORK ORDERING

- Push eye-independent work to end of frame
- Get slave running earlier to hide copy

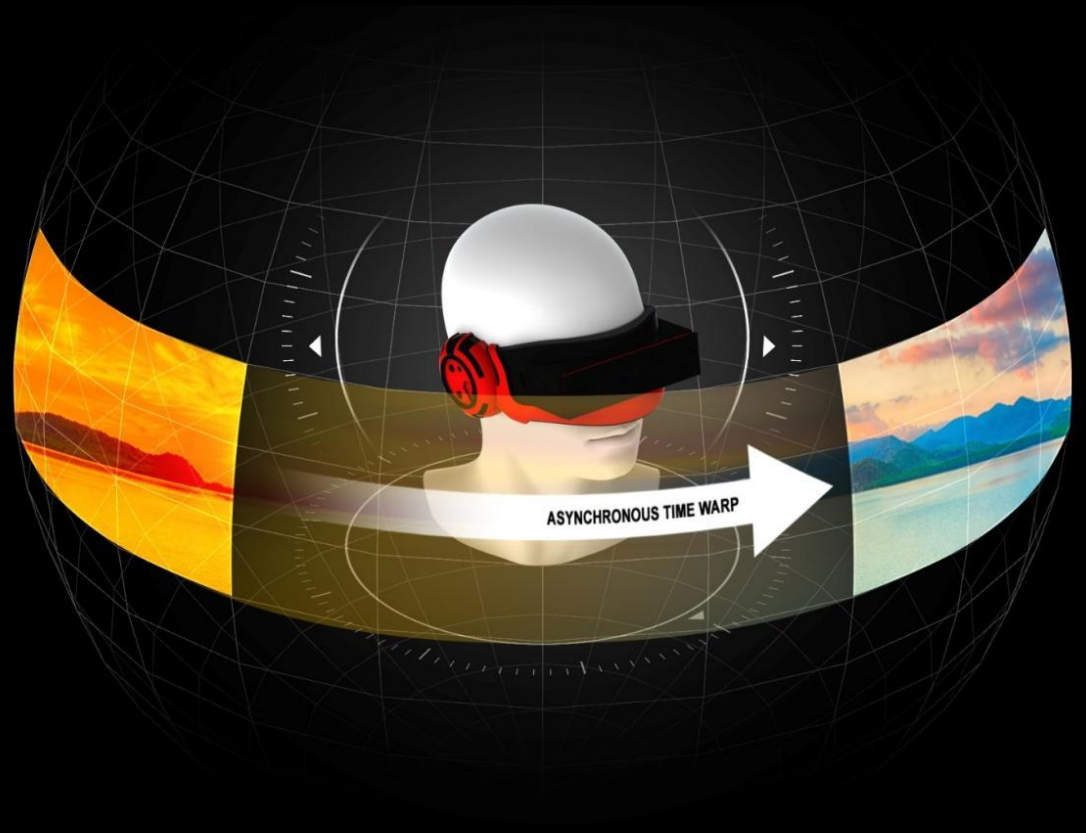


AFFINITY MGPU BEST PRACTICES - TRANSFERS

- Application's use of sync objects is more optimal
- 3D engine transfers are safer choice
  - –Supports partial subresource transfers
- DMA only for experts
  - –Supports whole subresource transfers

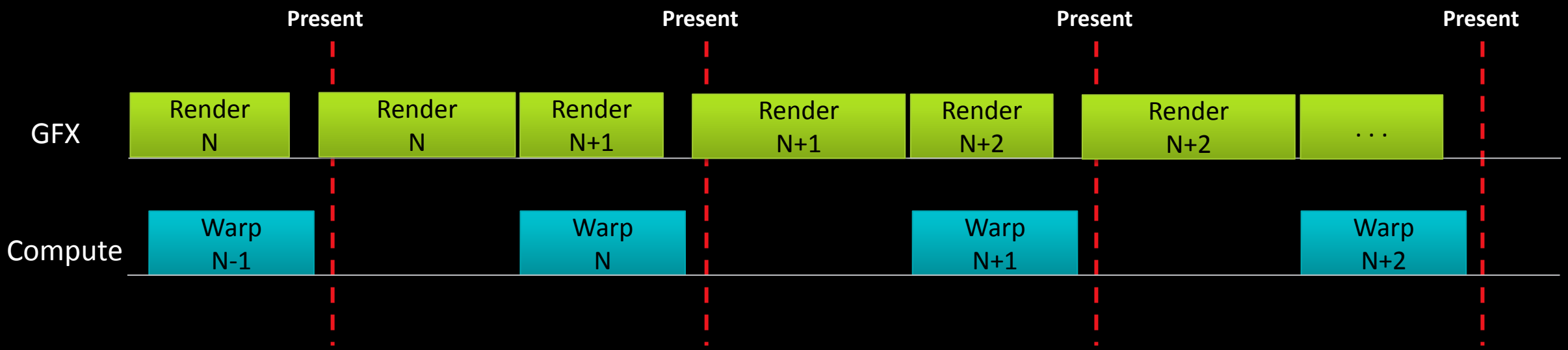
ASYNCHRONOUS COMPUTE FOR VR

- Execute VR image processing while rendering
- Creates superb VR experience
  - Minimizes latency
  - Eliminates judder
- Execution priority controls (QoS)



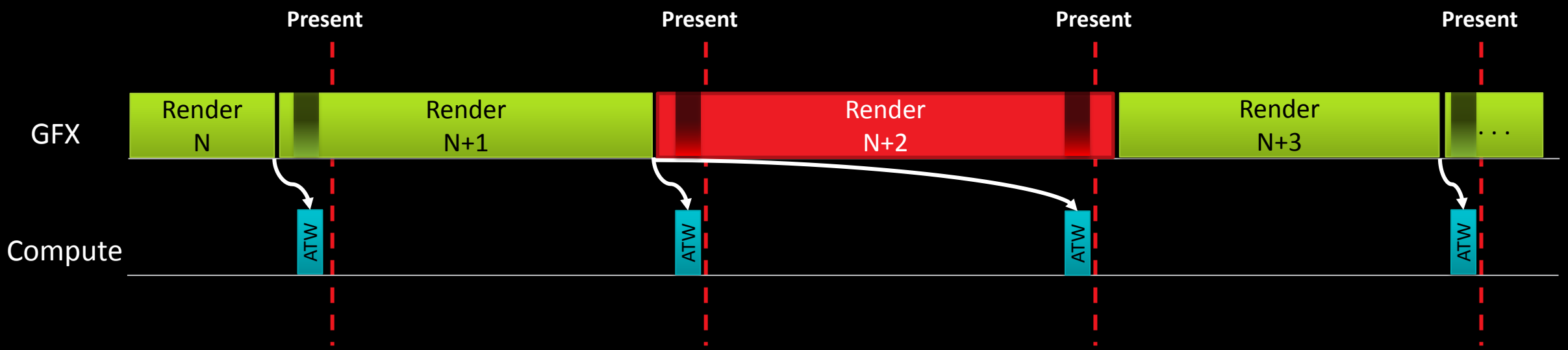
REGULAR PRIORITY COMPUTE

- Helps hide cost of image warp, but…
- No QoS = graphics could delay image warp
- Need knowledge and control of graphic workload



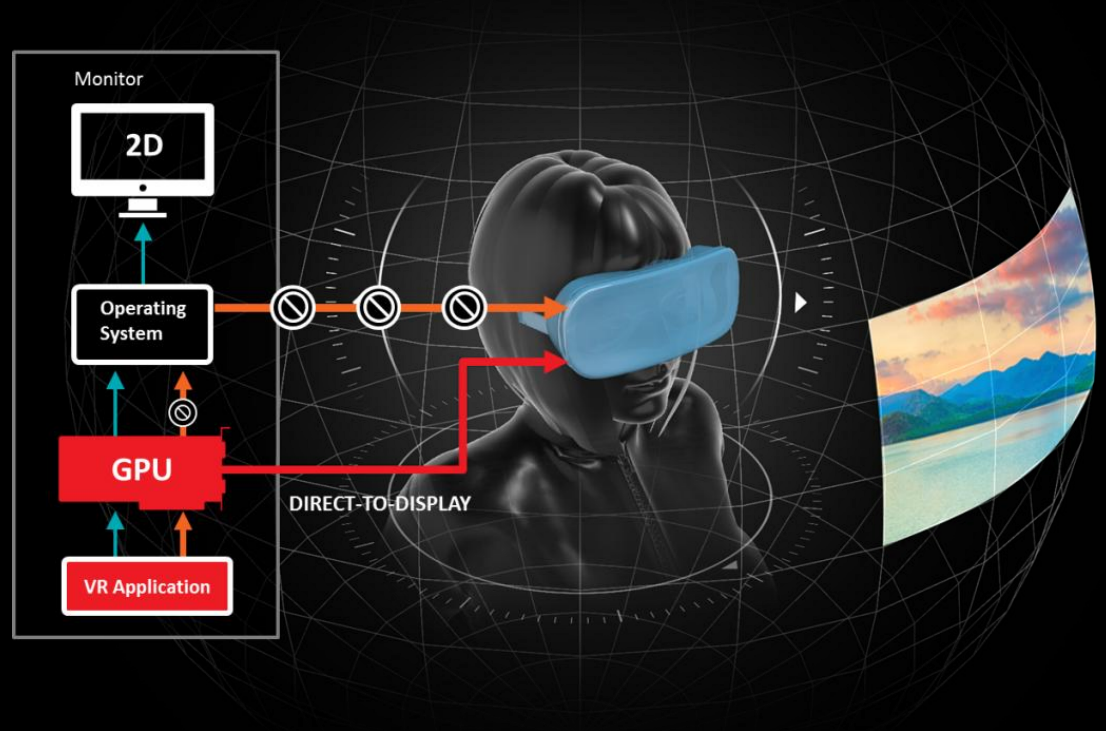
ASYNCHRONOUS COMPUTE QOS

- Favor compute vs. other workloads
- Better than draw call granularity
- Key for good asynchronous time-warp
  - –Judder compensation



DIRECT-TO-DISPLAY

- Brings native HMD support to OS
  - –Hide display from OS
  - –Doesn’t mess up desktop
- Lots of low level controls
  - –Perfect for embedded solutions
- Simplifies user experience



DIRECT-TO-DISPLAY

- Available to HMD vendors (under NDA)
- Contact us for more info…

MORE TOOLS FOR YOUR TOOLBOX

- API interoperability
- Synchronization
- Timeline building
- …


FUTURE DEVELOPMENTS

FUTURE DIRECTIONS

- Improving efficiency for lower end GPUs and mobile solutions
- Better API interoperability
- Untethered experience
- Sound integration

POWER MANAGEMENT

- Extended operation for mobile systems
- Thermal event avoidance
- Part of async compute QoS solution for guaranteed performance


RADEON
TECHNOLOGIES GROUP
TRUEAUDIO NEXT
CARL WAKELAND, FELLOW DESIGN ENGINEER
AMD

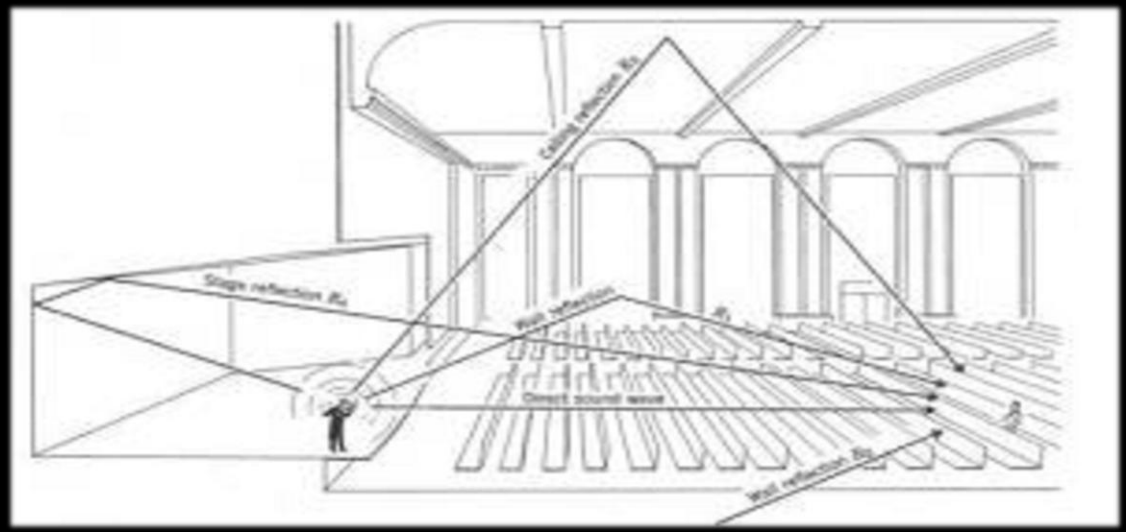
TRUEAUDIO NEXT

THE **RIGHT** NEXT STEP IN AUDIO RENDERING FOR VR

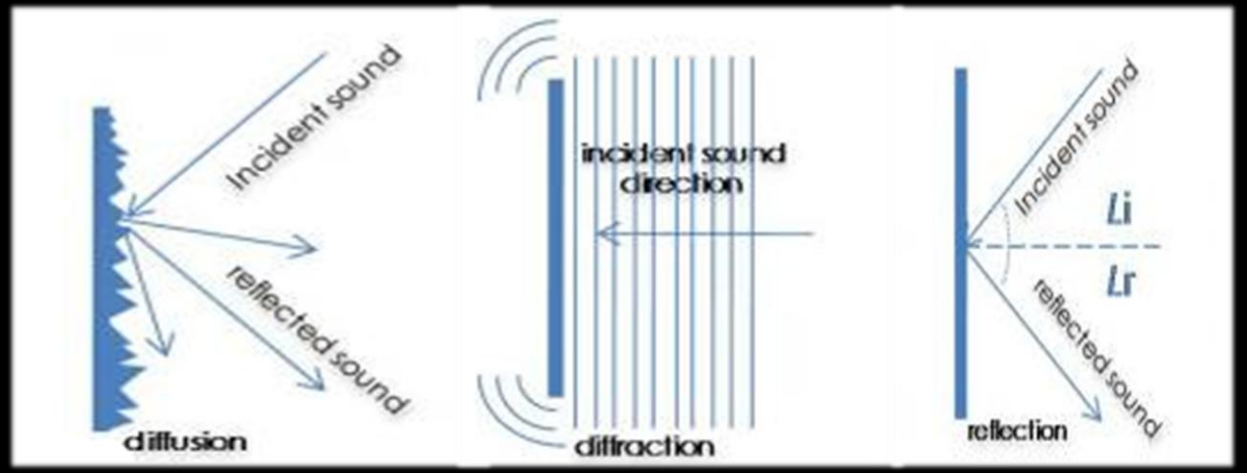
- 50% of consensus reality perception comes from what we hear.
- Studio-derived sound approximations are not reality, and our brains know it.
- We're ready to cross the chasm to full real-time physics-based audio rendering.
- TrueAudio Next is a future AMD technology that allows real-time audio to leverage the powerful resources of GPU Compute, safely coexisting with the world's best graphics, with performance not possible on CPU alone.
- TrueAudio Next is not an embedded DSP. VR Audio is gaining a seat at the grown-ups table -- GPU audio compute, with scalability.

CREATING PRESENCE IN VR REQUIRES PHYSICAL ACOUSTICS-BASED SOUND MODELING

- When we hear a sound in the real world, we hear a dynamic superposition of many reflected paths plus the direct path.

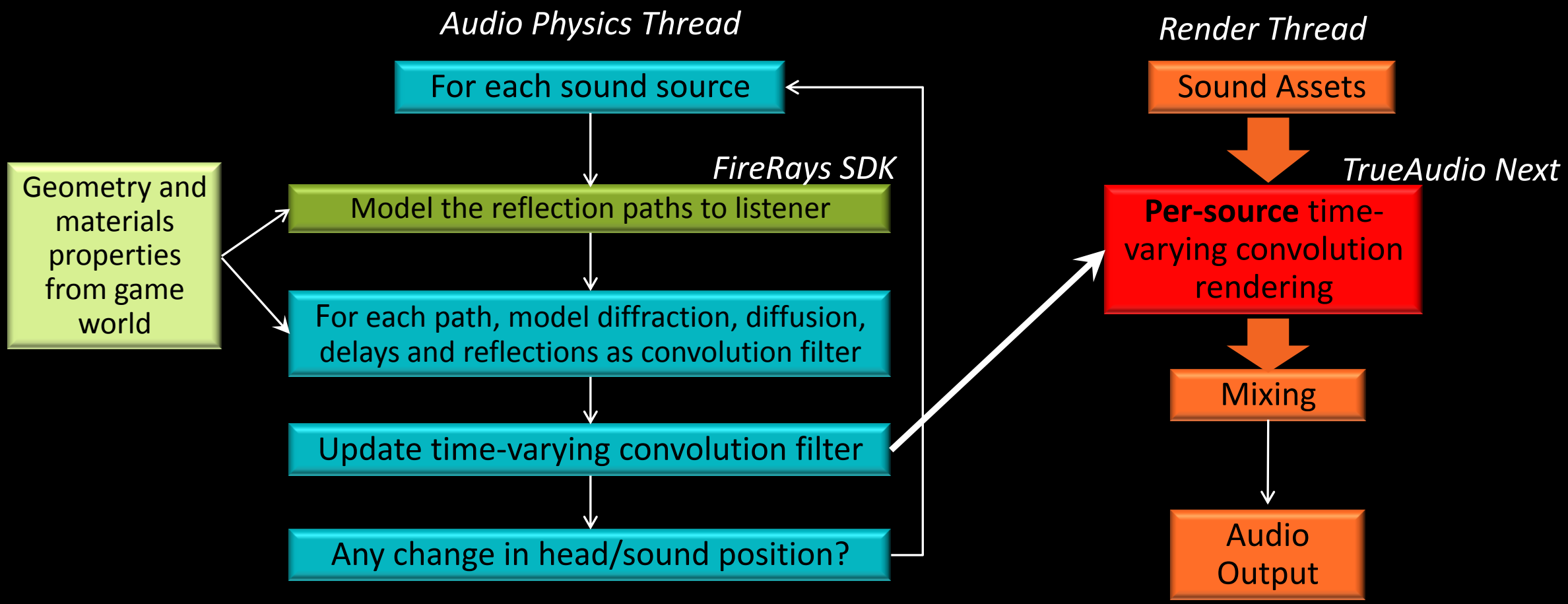


- Diffusion, diffraction and absorption/dampening by reflecting materials add more complexity to reflections



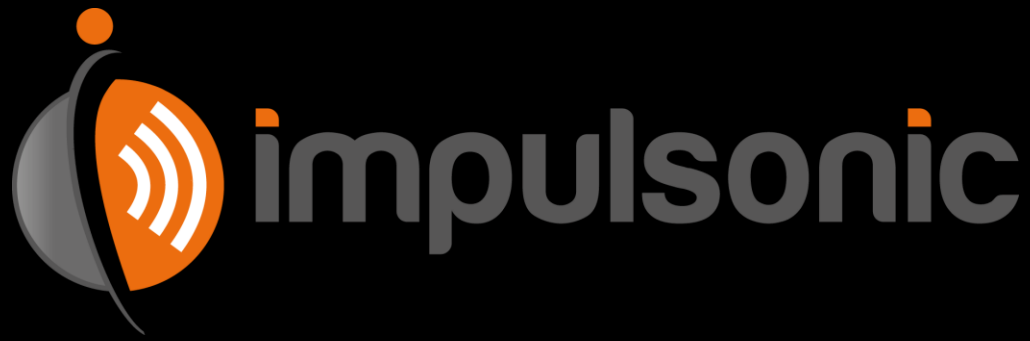
EXAMPLE OF VR AUDIO RENDERING

- Geometric acoustics adds **realistic physically modelled** real-time occlusion and acoustics to conventional binaural audio for VR



TRUEAUDIO NEXT PARTNERS

- TrueAudio Next cutting-edge partners are actively engaged, with more on the way. **Support our partners!**
- Ask us about plugin and engine integration – **be a partner!**
- Preview SDK available to NDA partners – **try it!**
- Get more details under NDA
- Hear the DEMOs



NEXT STEPS

- More features and optimizations
- Next generation APIs are great choice for VR
  - Not all pieces are there yet…
- **We want to hear from you!**


THANK YOU

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