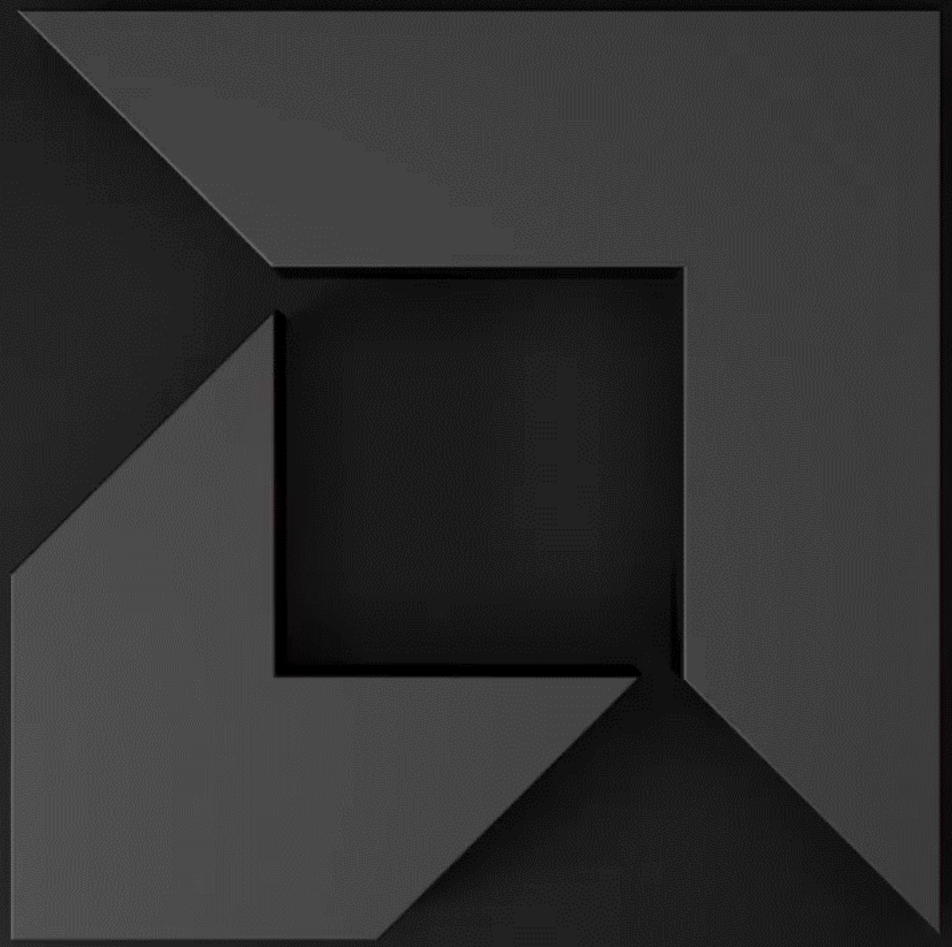

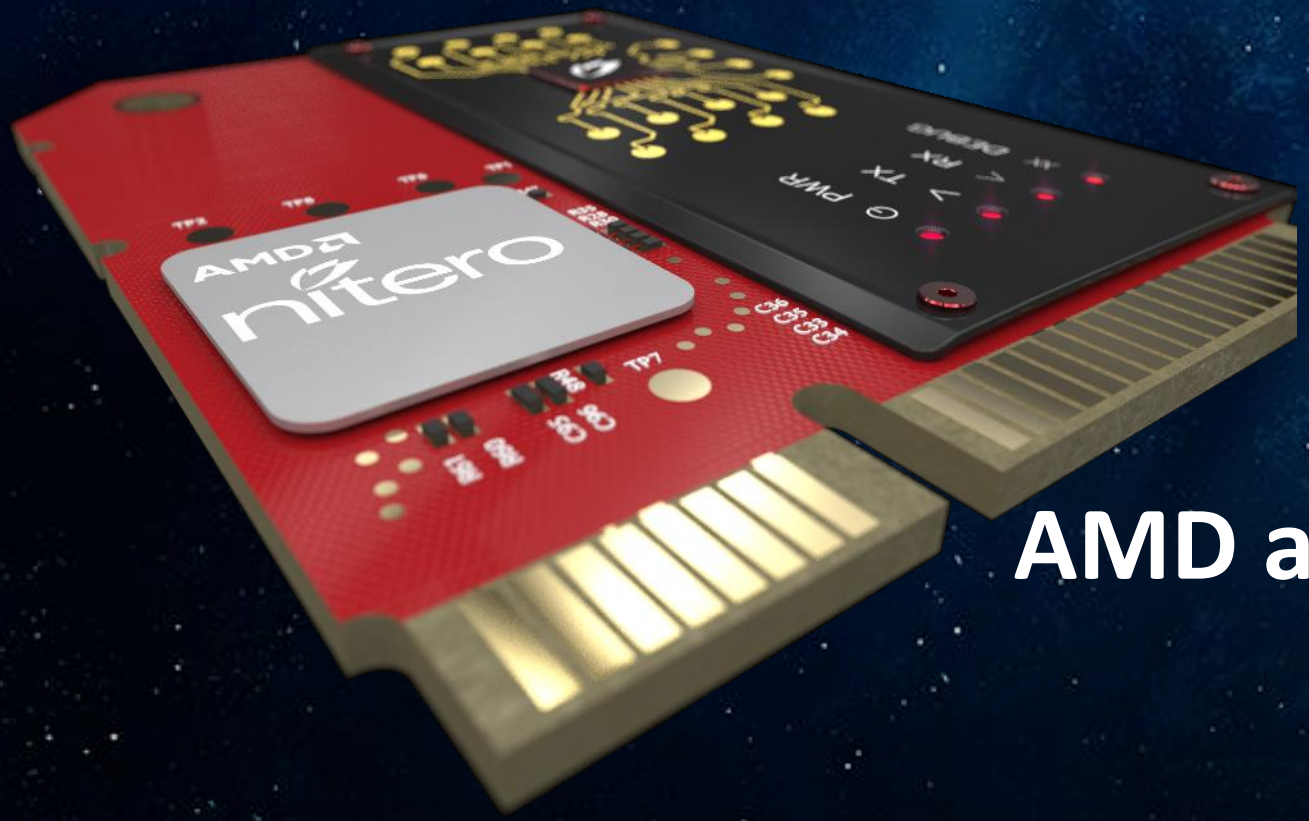

AMD acquires Wireless VR IP

AMD | RADEON | RYZEN

AMD powers the top game consoles

AMD | RADEON | RYZEN

AMD teams with Apple

AMD | RADEON | RYZEN

Enter the near future for VR
2017 – 2020

David Naegle
AMD Fellow, VR, Display & GPU Roadmap Team

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2016

1994

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Towards an Immersive Future

Level of Presence

Basic 2D Rendering

Basic 3D Rendering

Shaders

Immersive 2D Displays

Physically Based Rendering

VR

Photorealism in VR

Full Presence

1000 TFLOPS

Need
>Million Times
Acceleration

100s of GFLOPS

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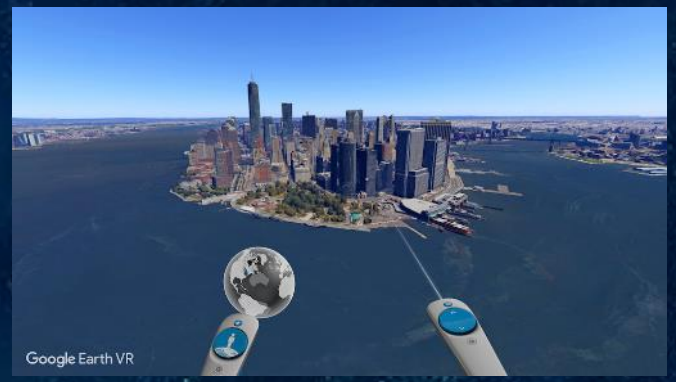
2016 was a great year for VR

Sony, HTC, Oculus, Deepoon ship mass volumes of headsets. $895M*

Imax opened first VR center.



Google Earth VR launched.

Dr. Shafi Ahmed performs first VR surgery.
London, April 2016

VR used to recreate crime scenes.
Emblematic ; One Dark Night

Survios Raw Data launches in 32 countries.

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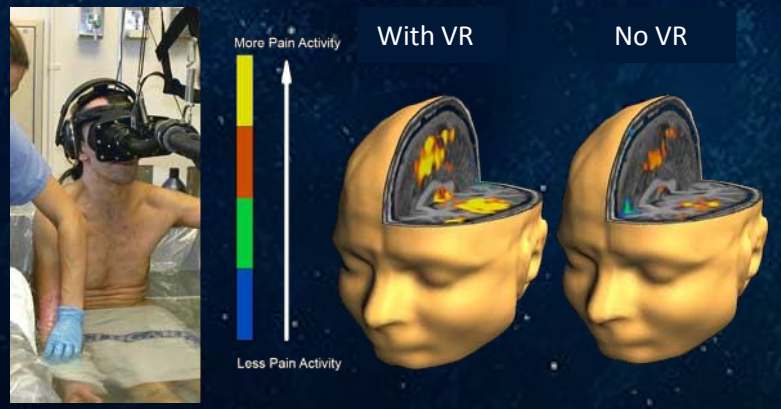
http://www.wired.co.uk/article/wired-health-virtual-reality-surgery-shafi-ahmed

*https://venturebeat.com/2016/04/07/vr-headsets-to-generate-895m-in-revenue-in-2016/

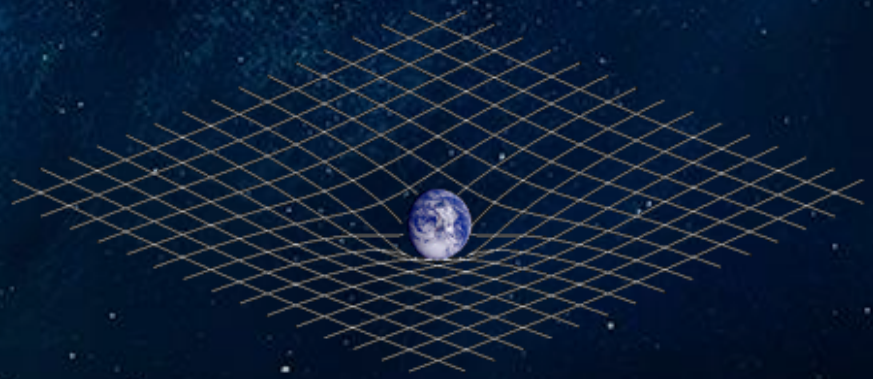
Our Understanding is Accelerating VR Development

It continues to get better

We are beginning to understand its impact.



With profound consequences.



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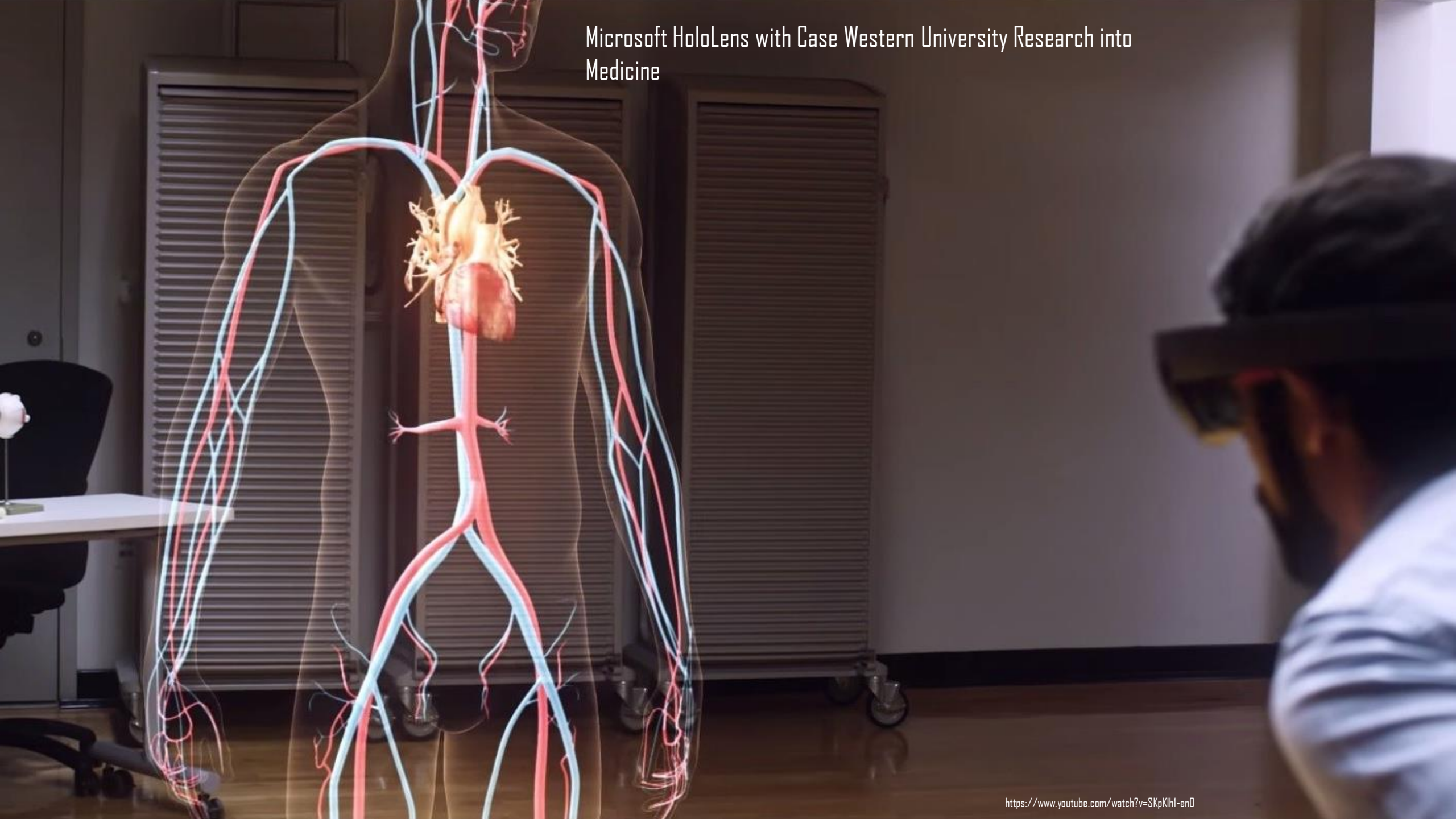
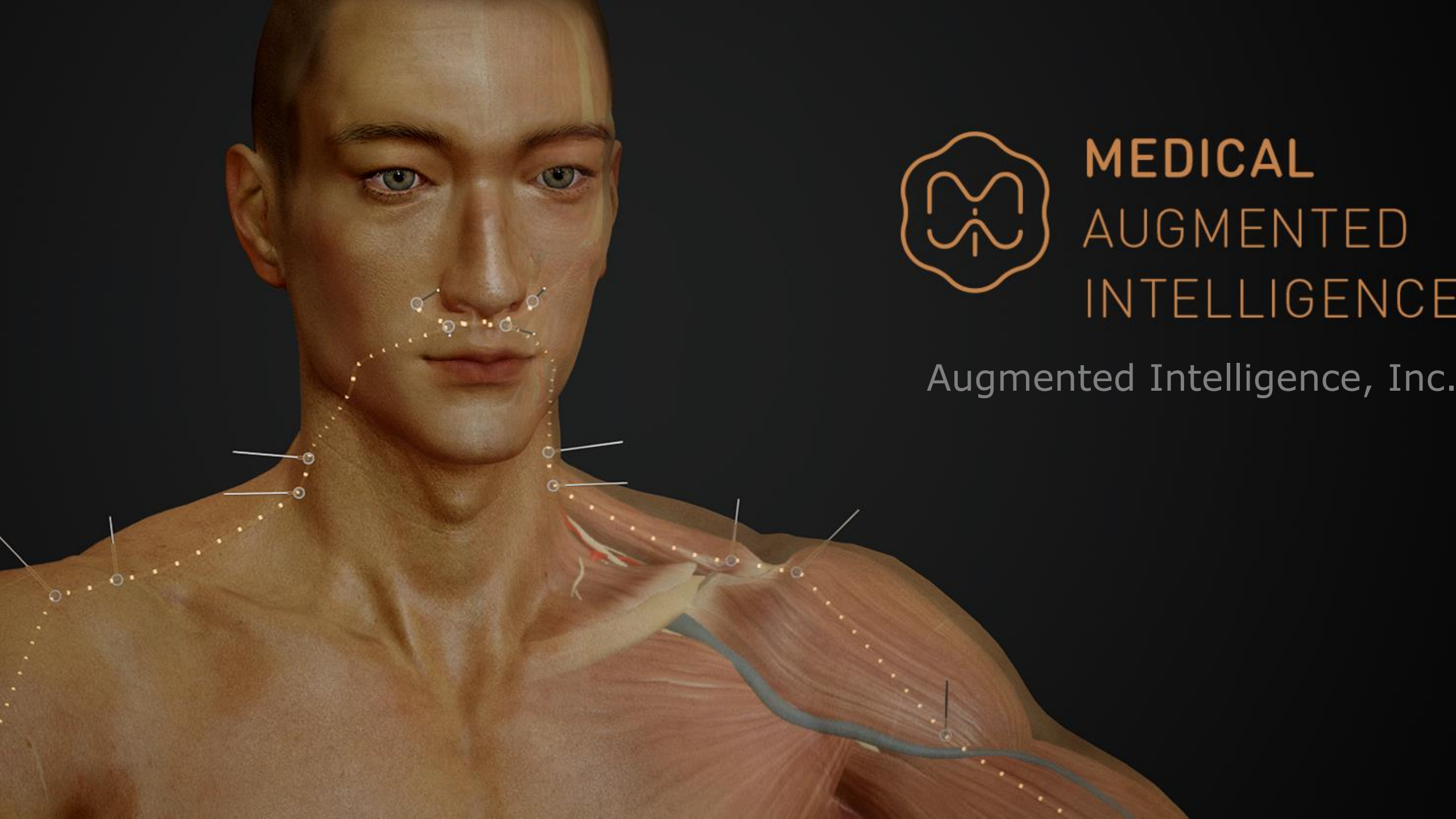

Microsoft HoloLens with Case Western University Research into Medicine
https://www.youtube.com/watch?v=SKpKIhI-en0



MEDICAL AUGMENTED INTELLIGENCE

Augmented Intelligence, Inc.

Epson Moverio BT-300
https://www.anyline.io/blog/tag/epson/

2017-2020 Content

Great games

New movement solutions

Dramatically better CPU/GPU

Richer deeper content

VR Leadership 2017-2020

World class CPU
World class GPU
World class wireless

XBOX

With 6 Teraflops, 326GB/s of Memory Bandwidth and advanced, custom silicon, the Scorpio Engine is the world's most powerful console gaming processor.

iMac Pro

External Graphics Development Kit

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Cores. Threads. Entities.

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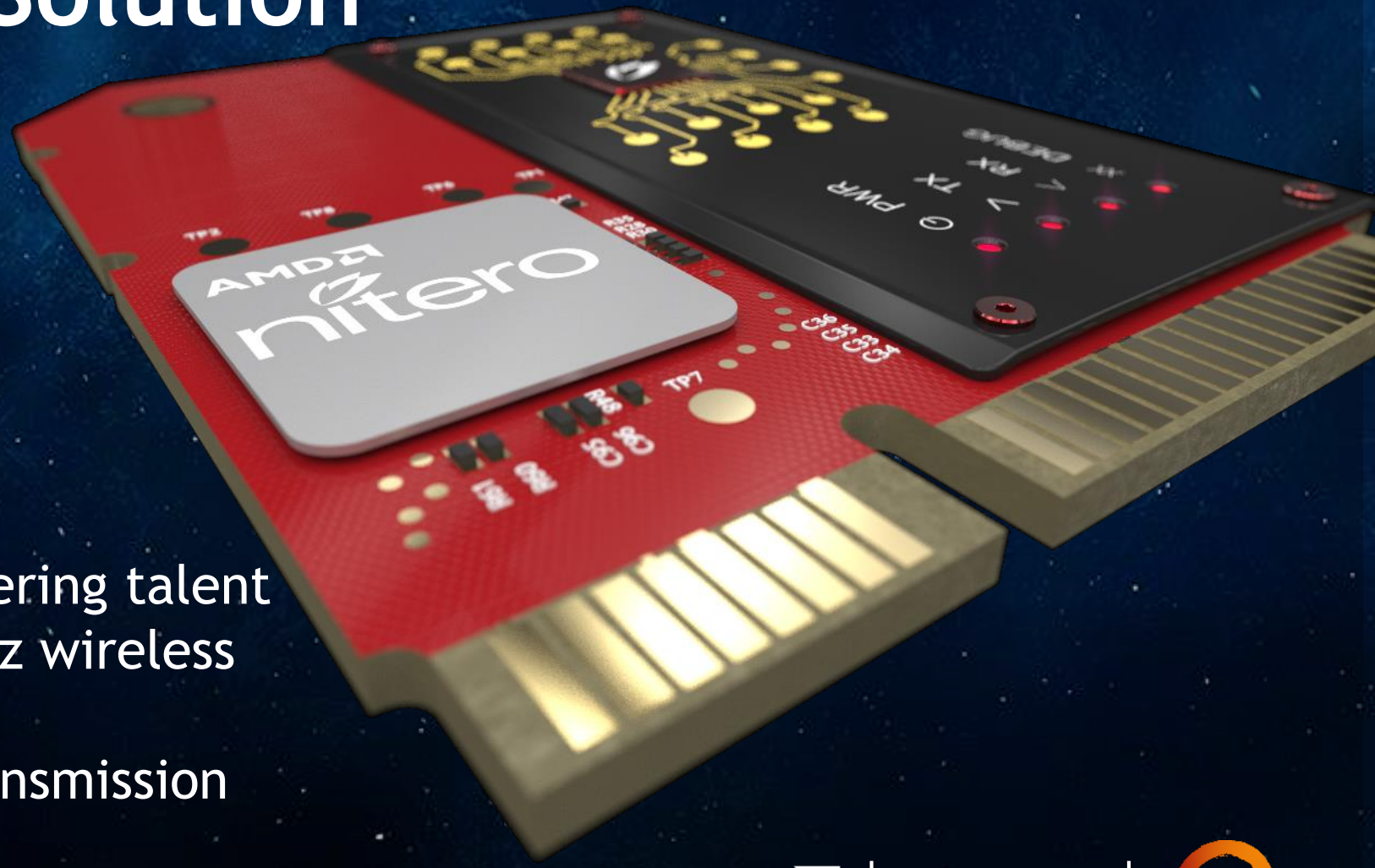
The Promise of Wireless VR

AMD Wireless Solution



Pioneer in wireless VR
Acquired IP and key engineering talent
Highest performance 60 GHz wireless
Phased array beam forming
Multigigabit low latency transmission

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AMD and Nitero.

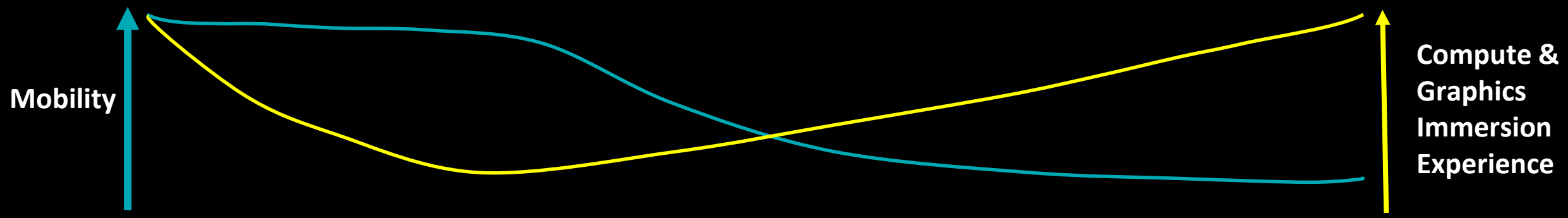
No wires.
No limits.
No line of sight restriction.
Fast.
A huge step forward for VR.

Nitero Acquisition by AMD

- AMD acquired substantially all of Nitero's assets and employees
- New Wireless IP division - Technology and Engineering (T&E) organization
  - Led by Pat Kelly (Nitero CEO/co-founder)
- AMD continues Nitero Wireless VR mission
  - Seamless transition with continuity in personnel, strategy
  - Wireless VR a key enabling technology across AMD businesses
  - Funding to finish product with key strategic partners
- Integration process going well, continuing momentum
  - Roadmap planning process underway

VR FORM FACTORS VS EXPERIENCE

AMD



"Wireless HMD"

- **Full freedom of movement**
- **Wireless tether to DT**
- **Full Immersive Experience**

Cell Phone in HMD / APU in HMD

- Full freedom of movement
- Self Contained HMD
- Limited Immersive Experience

NB Back Pack Tethered HMD

- Partial freedom of movement
- Back pack size, weight, thermals
- Better Immersive Experience

Desktop Tethered HMD

- **Limited freedom of movement**
- **Tethered to DT via cables**
- **Best Immersive Experience**

Wireless VR has potential to deliver both <u>mobility</u> and <u>high immersion</u>…best of both worlds

WIRELESS VR ROADMAP CONCEPT

AMD

"Enable Radeon to address 100% of HMD pixels across wired and wireless connectivity "

- **High Bandwidth WVR**
  - *WiGig Connectivity*
  - *Foveated freq domain codec*
  - *H.264 I-frame codec (4:2:0)*
- **Low Bandwidth WVR**
  - *Wi-Fi 2x2ac Connectivity*
  - *H.264/H265 standard codec*

HMD Class

High End HMD:

Oculus Rift

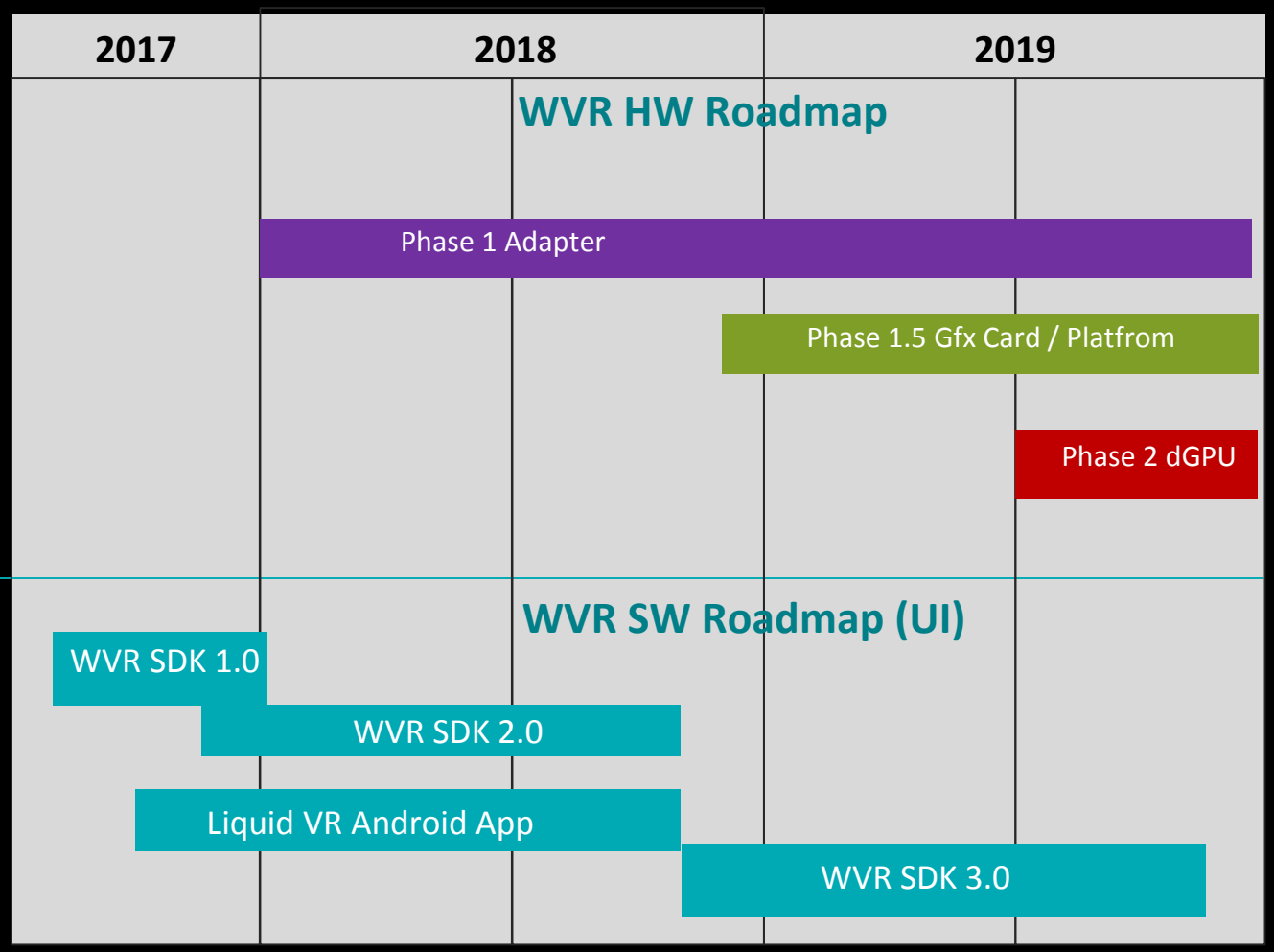
VIVE

Sulon

Phone HMD:

GearVR

Daydream



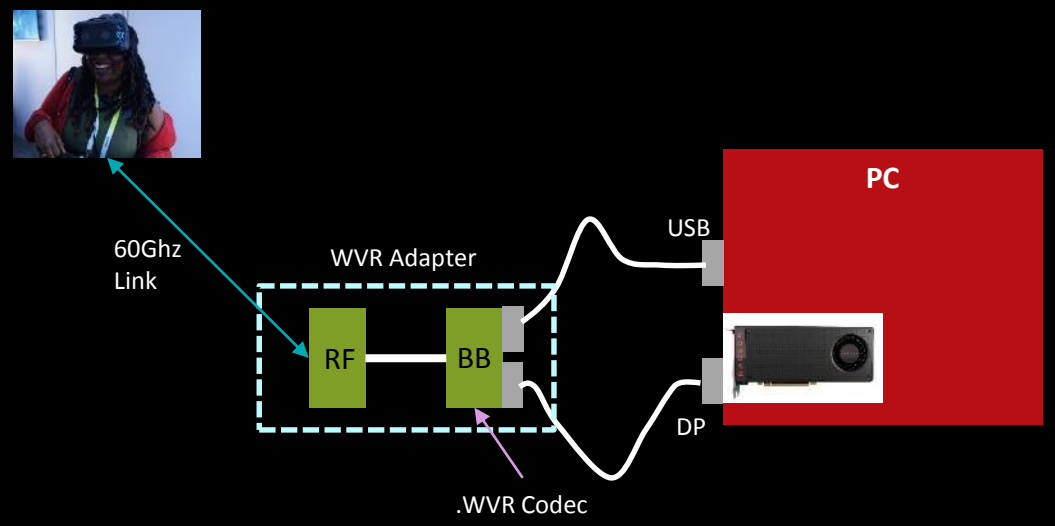
Software | External Adapter for Codec and Radio | dGPU Codec | APU Codec

WIRELESS VR TOP LEVEL SPECS

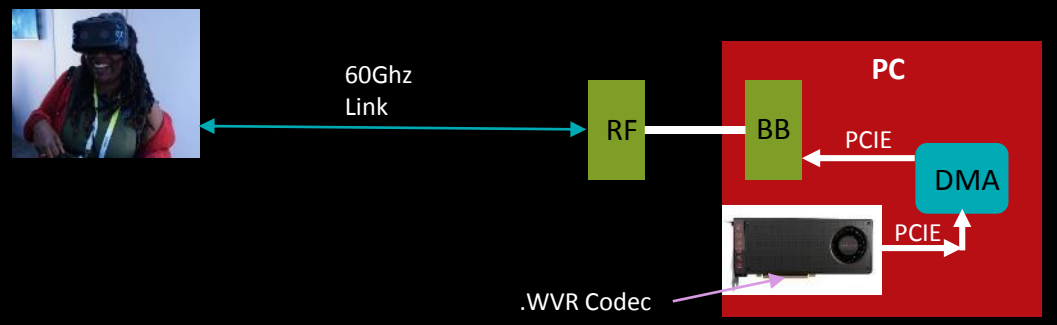
- **Display Resolution**: 4320 x 2160@90hz ; 3840x2160@120hz
- **CODEC**: Low-latency, frequency domain .WVR
- **Supported Modes**: 4, 8, 12, 16, 24:1 for dynamic bandwidth & error resiliency
- **Display Latency**: <1.5ms
- **NT4630 RF Config**: 16 TX, 16 RX
- **NT4630 BB Config**: USB 3.0, DP 1.3, PCIE Gen 2
- **802.11ad MCS**: MCS-12
- **NLOS coverage:** 5 x 5 meter enclosed area
- **TX (16X) Peak Power**: 1.95W
- **RX (16X) Peak Power**: 1.05W

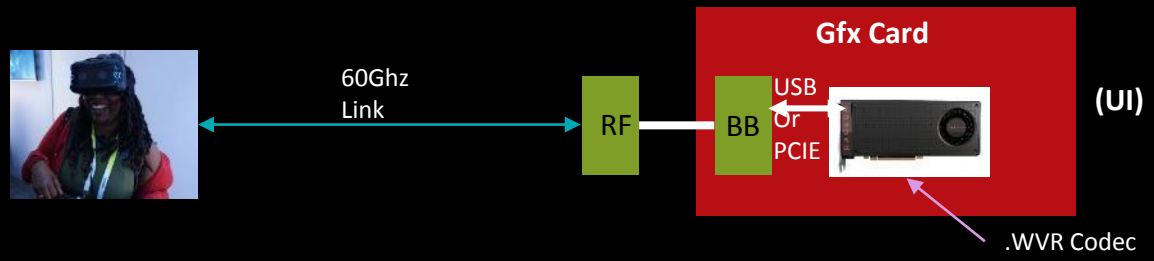
WVR PRODUCT PHASES (UI)

Phase 1 - Adapter

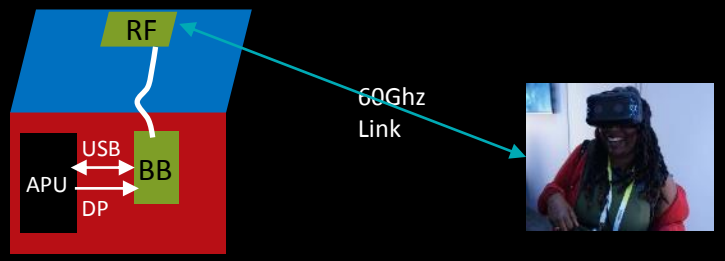


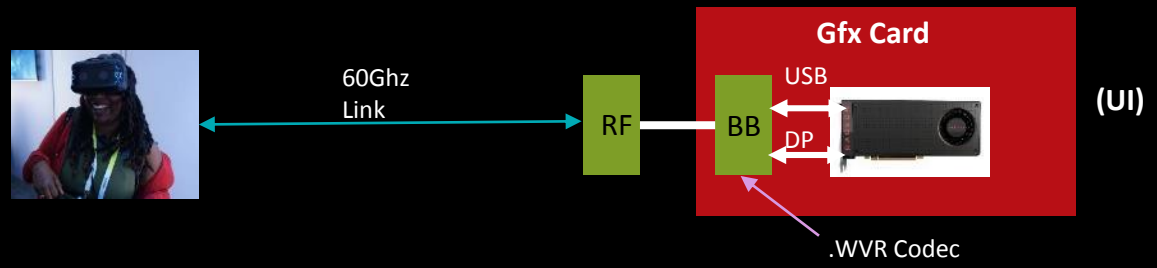
Phase 2 – dGPU Integration





Phase 1.5 – Board Integration (UI)





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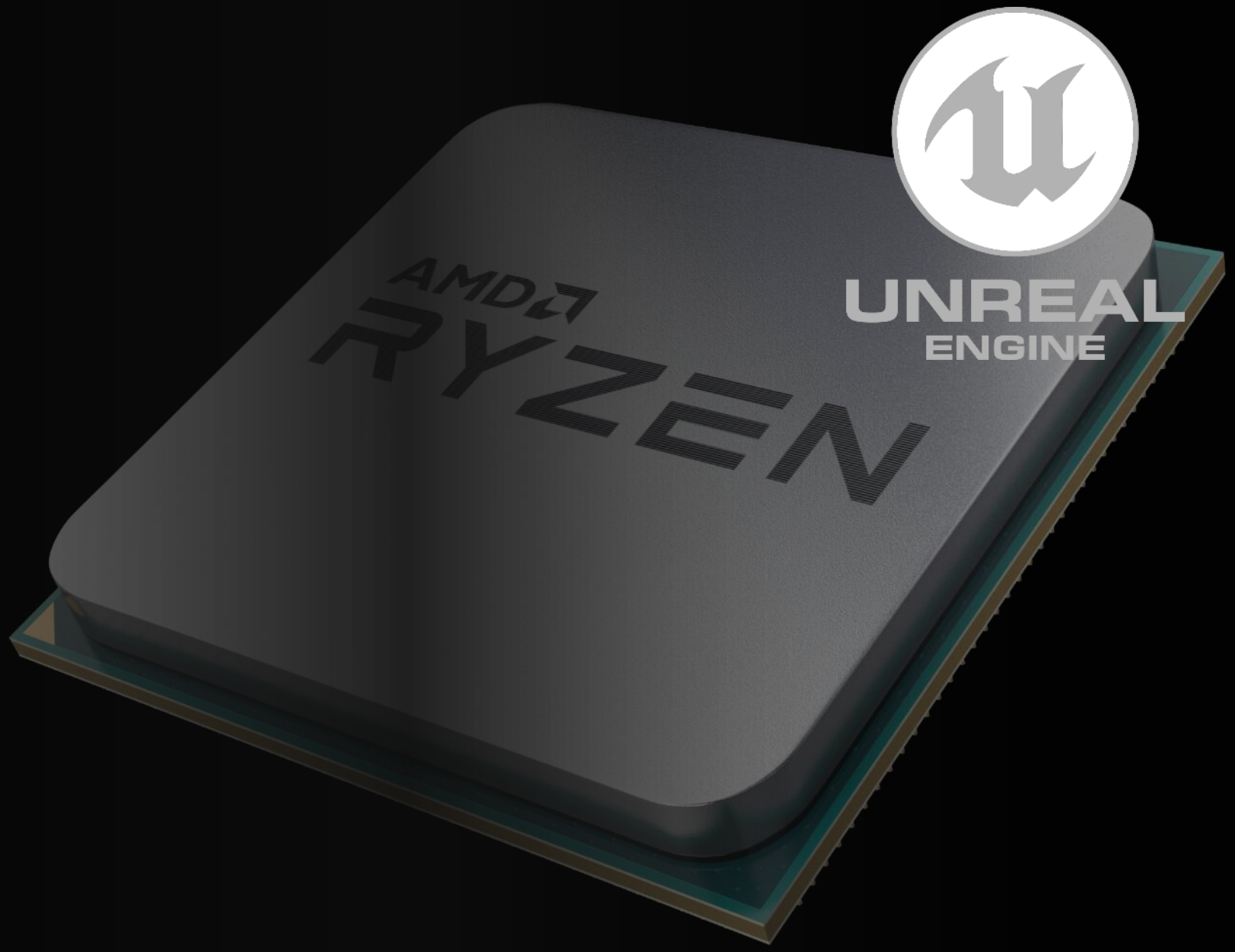
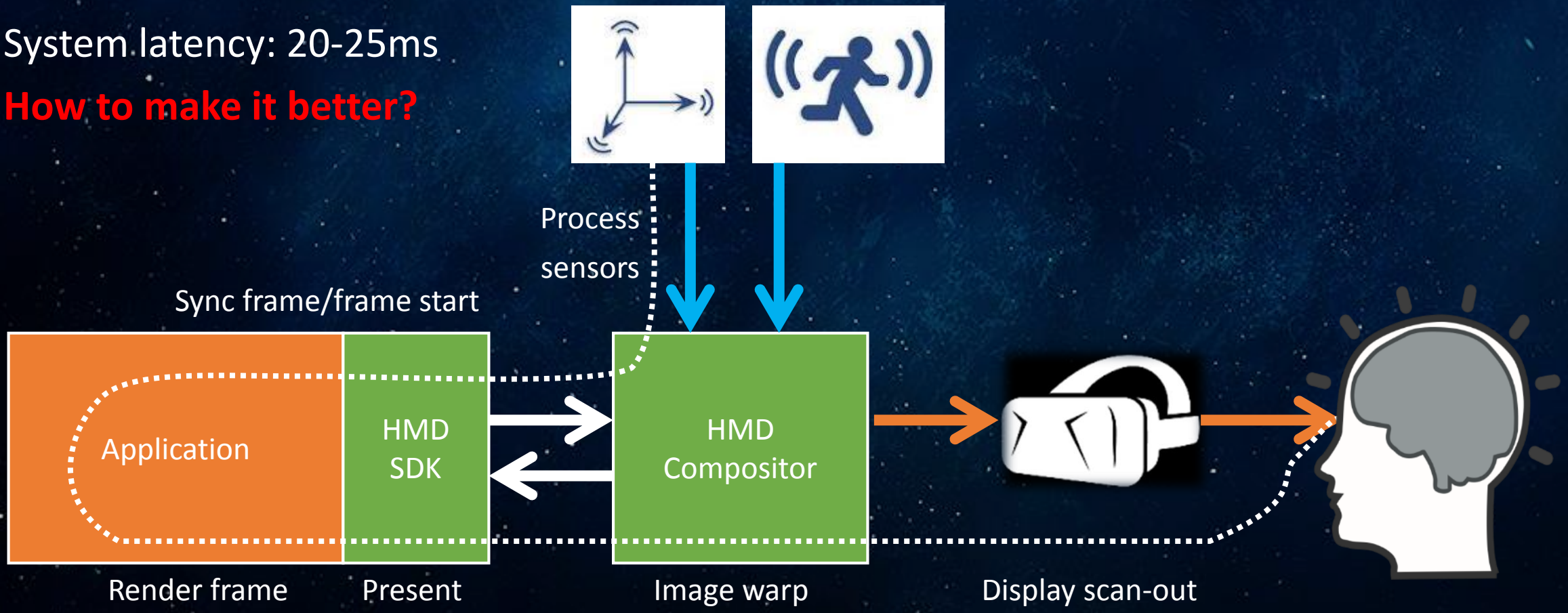

AMD
RYZEN
UNREAL
ENGINE

MultiGPU	HDR	AMD FreeSync ™ Technology	Multi-rate shading	DirectX®12 and Vulkan ®
TrueAudio Next	OpenVX	AI	Tools	Compilers

Practical Problem - Latency

System latency: 20-25ms

How to make it better?



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The Rock / Paper / Scissors of Interactive VR

120+

FPS

Billions

ENTITIES

16k

GRAPHICS

AMD Liquid VR ™ Technology

LiquidVR provides developers a DirectX® based interface for their applications to get access to VR Ready Graphic Cards.

The LiquidVR runtime is automatically installed by Radeon Software to support any application or games that a developer integrates with LiquidVR.

Existing Features:

- TrueAudio Next
- Asynchronous Shaders
- Affinity Multi-GPU
- Latest Data Latch
- Direct-to-Display
- GPU-to-GPU Resource Copies

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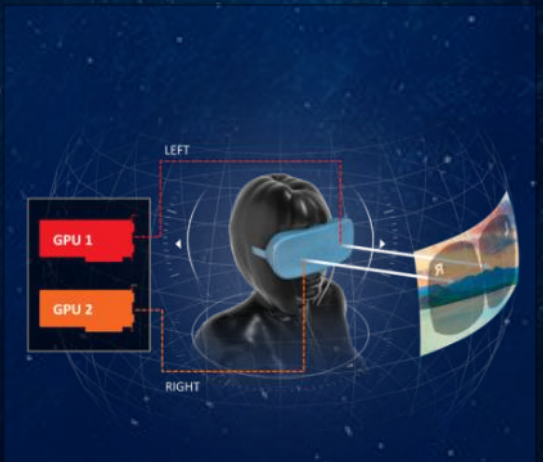
AMD LIQUIDVR FEATURES

Latest data latch

Efficient low-latency GPU head tracking

Affinity multi-GPU



Lower latency and increases quality with multiple GPUs

Asynchronous shaders

Minimizes latency and stuttering

Direct-to-display

Delivers a seamless plug & play VR experience

Content developers

HMD developers

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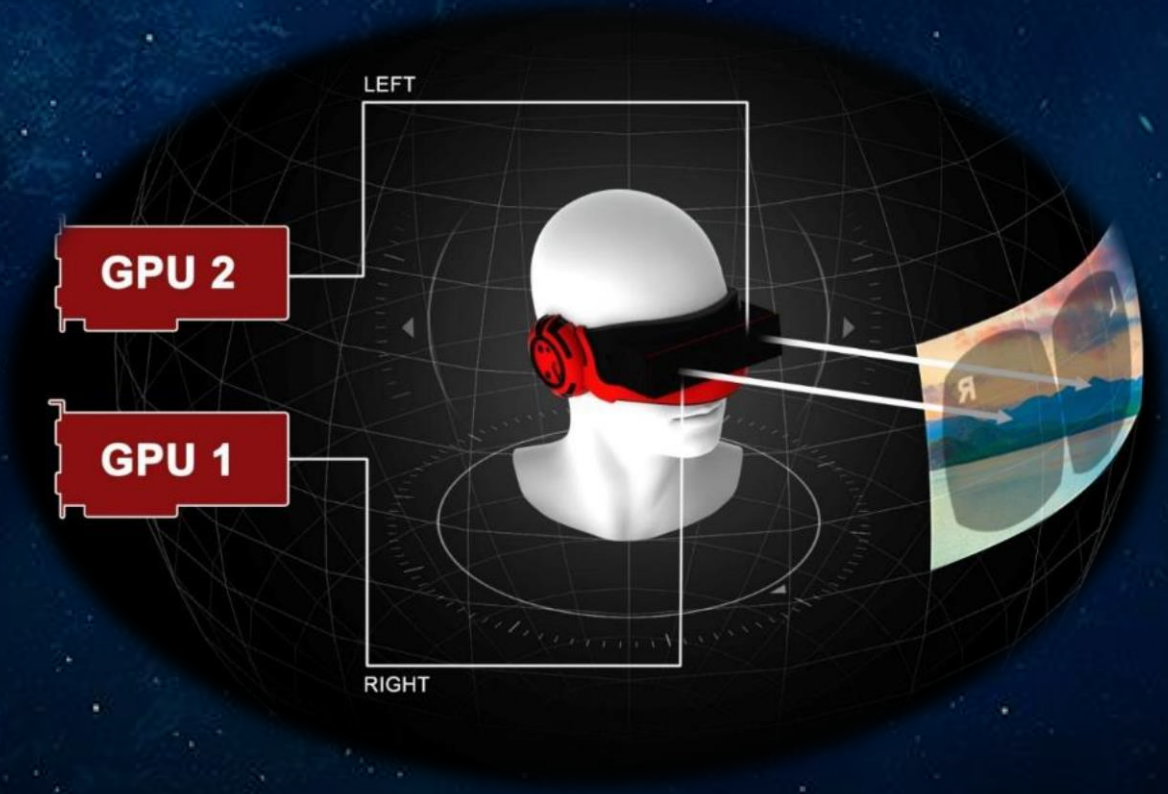
Latest Data Latch

- Using up-to-date head tracking inputs for VR rendering and image/time warp
- Workaround for API buffer update semantics
  - Post-submission data update/latching
- Trade-offs
  - Could be less important with time-warp
  - Might require engine refactoring

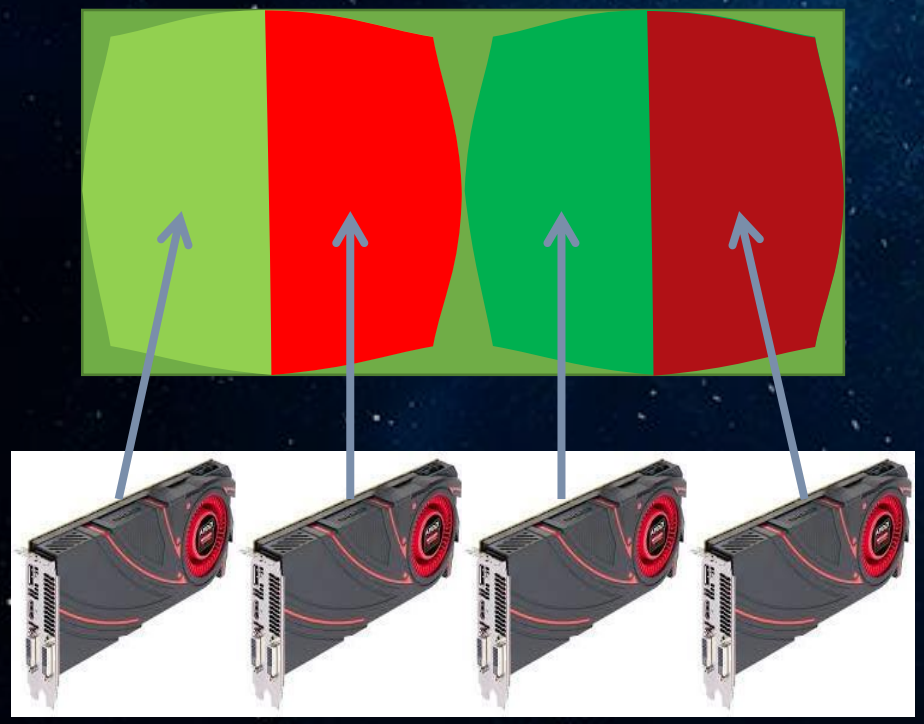
Affinity Multi-GPU

- Explicit control of GPUs
  - Broadcast API commands to GPUs
  - Application controls GPU affinity
  - Explicit transfers and synchronization
  - Control of resource instancing
- Assign GPU per eye in case of 2 GPUs
  - No AFR latency increase
- Could support more than 2 GPUs

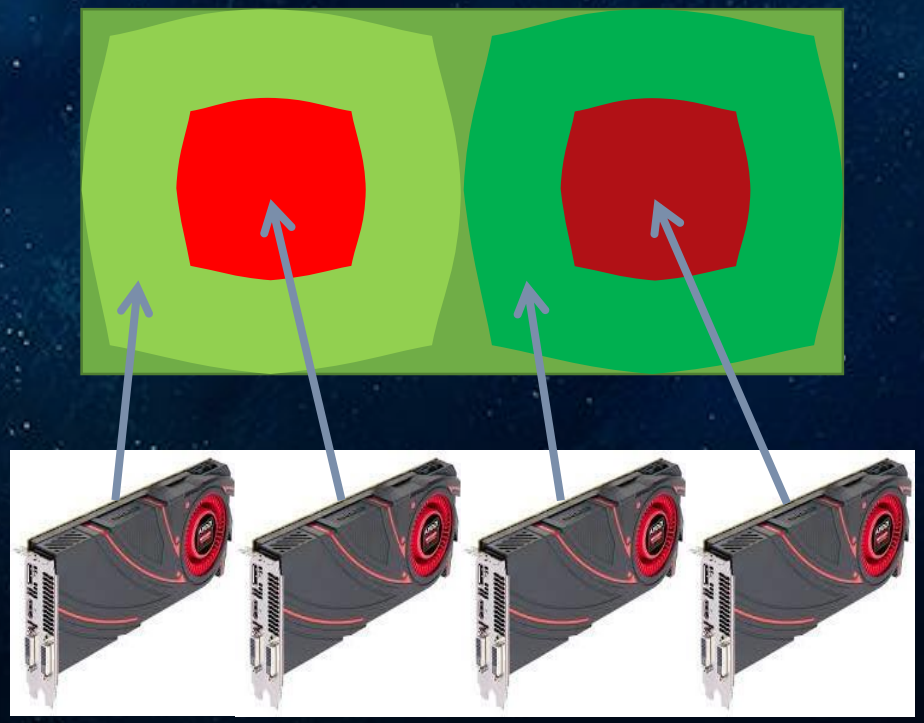


MGPU and Foveated Rendering

Split eye rendering



- Foveated rendering



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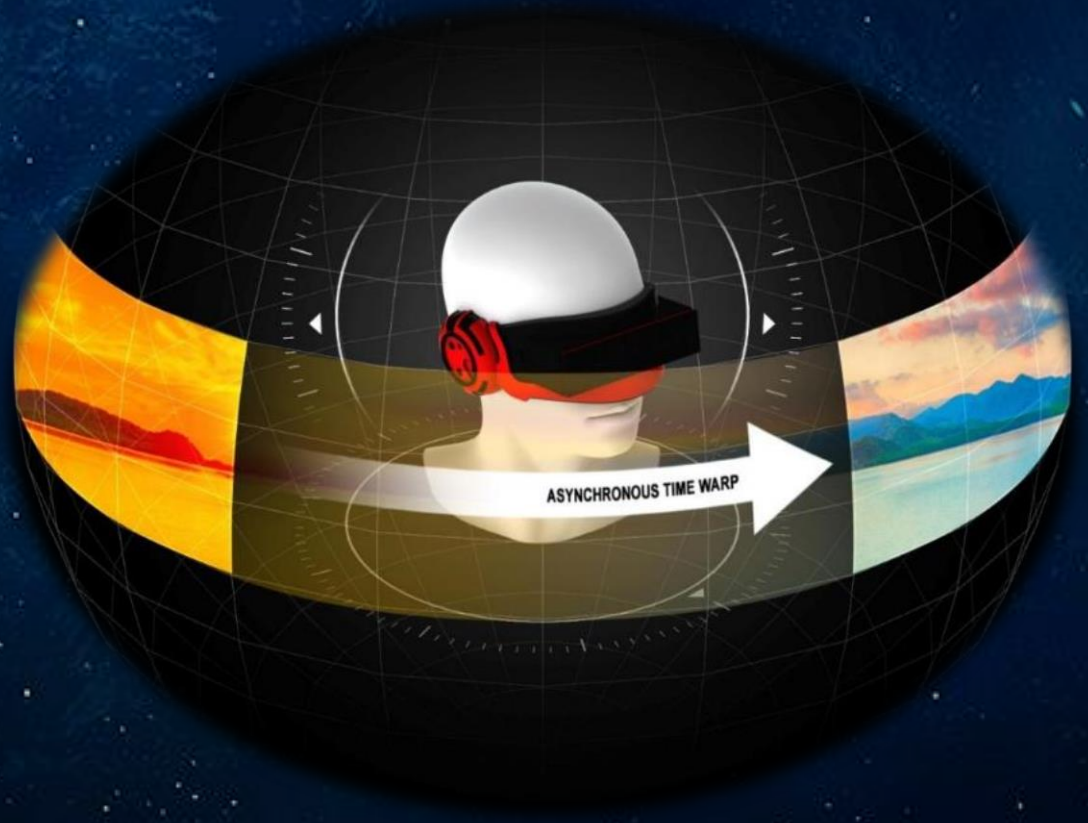
Asynchronous Compute for VR

- Execute VR image processing in parallel with rendering
- Creates superb VR experience
  - Minimizes latency
  - Eliminates judder
- Execution priority controls



Direct-to-Display

- Simplifies user experience
- Doesn’t mess up desktop
- Brings native HMD support to OS
- Optimizes system stability
- Seamless HMD support from multiple vendors

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Foveated rendering with eye tracking

Leverage Multi Eye/Resolution rendering and eye tracking to allow for more precise control of areas to be rendered in higher or lower resolution

Benefits:

- Can improve range of product support for applications
- Optimize Performance
- Minimizes on perceived image quality

Objects directly in focus of the eye are rendered at the highest resolution while areas not being directly looked at are rendered at lower resolutions

Vulkan® Support

- Vulkan <-> DirectX 11 /12 inter-op
  - Open DX11 resources
  - GPU synchronization with DX11

- Add support of Vulkan VR apps

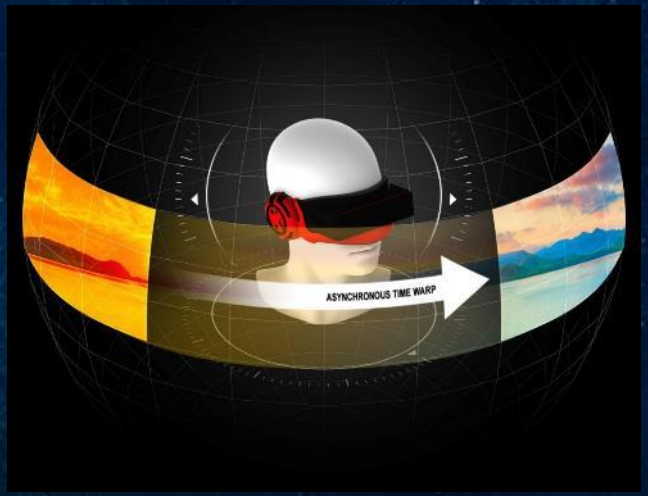
Asynchronous space warp support

Extended support for new products

Enhancements to the LiquidVR Asynchronous Time Warp feature

Benefits:

- Can improve range of product support for applications
- Optimizes VR Performance
- Minimizes impact on VR image quality



Asynchronous Space Warp improves on the ATW feature that allows engines to render at lower frame rates and fill in dropped frames without impacting quality

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True Audio Next (TAN)

- Real-time GPU audio physics processing
- Optimized for superior VR experience
- Leverages Asynchronous Compute
  - Not “another DSP”

Immersive audio in real time

Radeon™ Loom

- GPU optimized multi-camera photo/video stitching
  - 4 – 24 camera rig
  - High resolution sensors
  - Real-time stitching
  - Image processing (color, wb, csc …)
  - 8k/16k output

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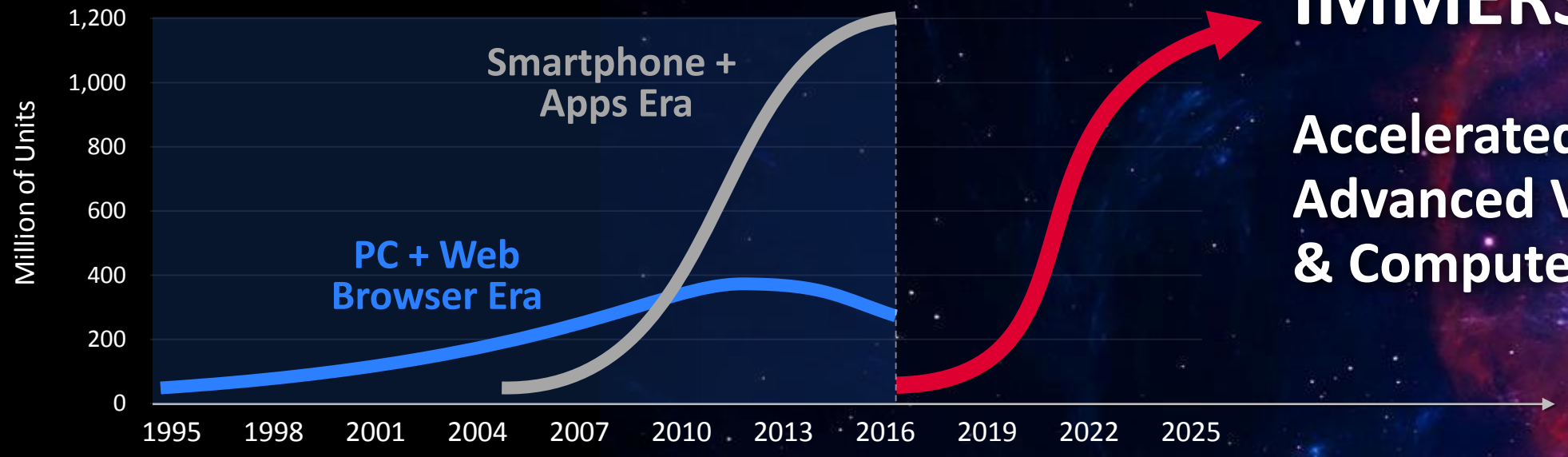
Never a Better Time for Innovation...

- AMD leadership in VR
- AMD LiquidVR environment
- Location base VR … technology enablement



IMMERSIVE ERA

Accelerated by Advanced Visualization & Compute

Source: AMD

Thank You

David Naegle
AMD Fellow, VR, Display & GPU Roadmap Team

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