

Professional VR - As real as it gets

Bob Pette

General Manager - Pro Visualization

January 26, 2017

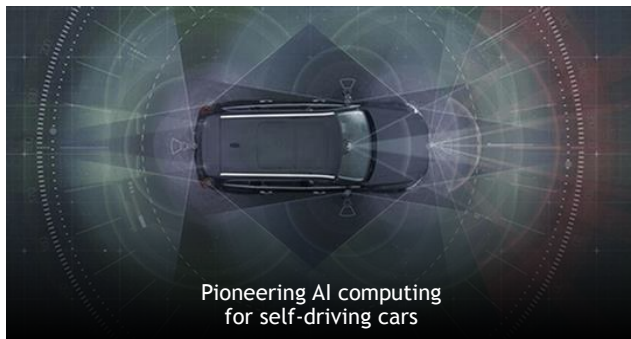


NVIDIA

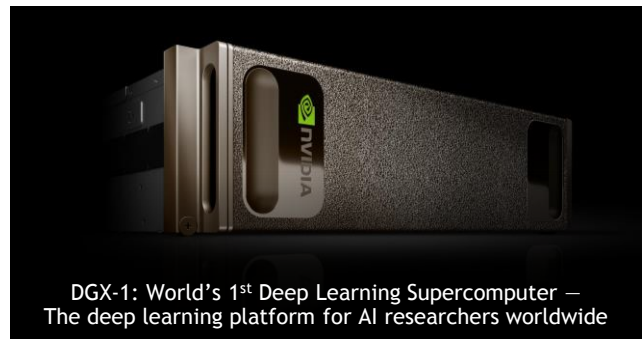
Pioneered GPU Computing | Founded 1993 | \$5B+ | 9,500 Employees



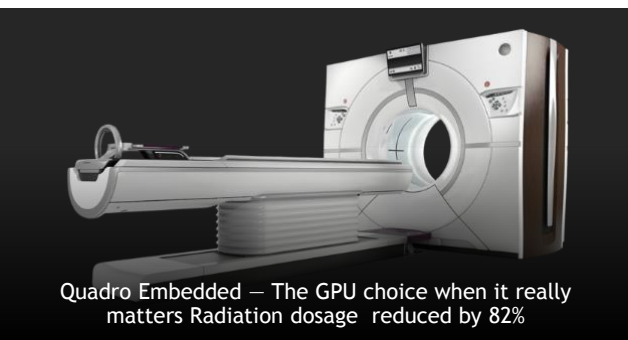
100M NVIDIA GeForce Gamers —
The world's largest gaming platform



Pioneering AI computing
for self-driving cars



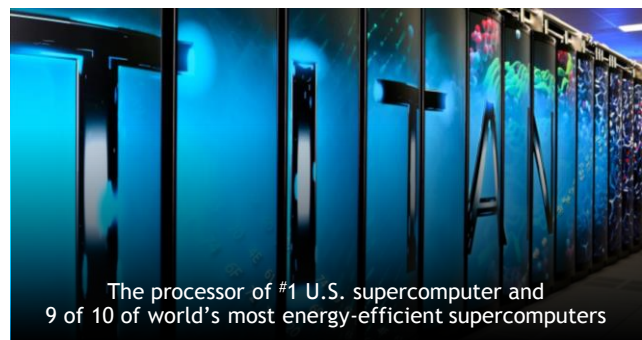
DGX-1: World's 1st Deep Learning Supercomputer —
The deep learning platform for AI researchers worldwide



Quadro Embedded — The GPU choice when it really
matters Radiation dosage reduced by 82%



The visualization platform of
every car company and movie studio



The processor of #1 U.S. supercomputer and
9 of 10 of world's most energy-efficient supercomputers

CUSTOMER AND INDUSTRY TRENDS

LARGER DATA SETS

Viewing whole models at once

“With enough graphics memory, we can make better decisions faster, streamlining everything we do and making our design process more cost-effective.”

— Dennis Malone, Human Engineering
Nissan Technical Center at Nissan NA



ARTIFICIAL INTELLIGENCE

Utilize the power of deep learning

“... when you start to add in AI/machine learning, it’s like you have 1,000 engineers working for you solving problems in a fraction of the time that used to take.”

— Mouse McCoy, HackRod founder

VIRTUAL REALITY

Being in your design

“Providing customers with a high-fidelity VR experience during design review... can prevent costly design changes after construction has started.”

— Alex Cunningham, VDC Engineer
McCarthy Building Companies, Inc.



PHOTOREALISM

Look and feel like the real thing

“A client recently gave us a photograph of a light shining through a door and asked us to replicate the results. Thirty minutes of work, and the results were indistinguishable from the original.”

— Andre Masmeier, Lead 3D Artist [zerone]

VIRTUAL REALITY & AUGMENTED REALITY



Image Courtesy of Magic Leap



Image Courtesy of Microsoft

“The future is already here — it’s just not very evenly distributed.”
- William Gibson, 2003

PERSONAL ENTERTAINMENT VR



Gaming



Sports



Movies



Concerts



Travel



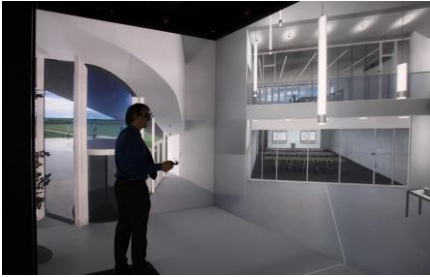
Retail

ENTERPRISE VR/AR



VALUE OF VR EXPERIENCE

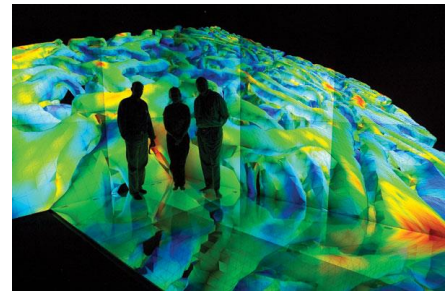
SCALE



NATURAL INTERACTION



EFFICIENT COLLABORATION



INFLECTION POINT IN VR



Viewing a glass fissure computed in a 5-Million atom molecular dynamics nanoscale simulation. Data from University of Southern California. Visualization by the Argonne Leadership Computing Facility and the UIC Electronic Visualization Laboratory (EVL), and viewed in EVL's CAVE2™ Hybrid Reality Environment.

COMPUTING CHALLENGES IN REPRODUCING REALITY

GRAPHICS /
DISPLAY

AUDIO

TOUCH /
PHYSICS

CAPTURE

COMPUTING CHALLENGES IN REPRODUCING REALITY

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CAPTURE

DISPLAY

CHALLENGES

- High-resolution: 60 PPD (20/20)
- Large Field Of View: 110 degrees
- Fast refresh: 90 Hz
- Light: 1 pound
- Cheap: Hundreds of dollars

SOLUTIONS

Tethered

- Oculus Rift
- HTC Vive

Untethered

- GearVR
- Google Daydream & Cardboard



VR PERFORMANCE DEMANDS

Ultra-High Resolution and Frame Rate

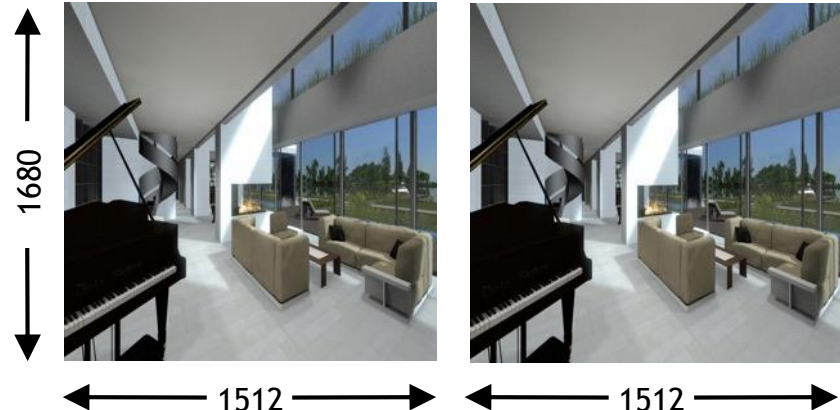
TRADITIONAL = 60 MP/S

(1920 X 1080 @ 30 FPS)



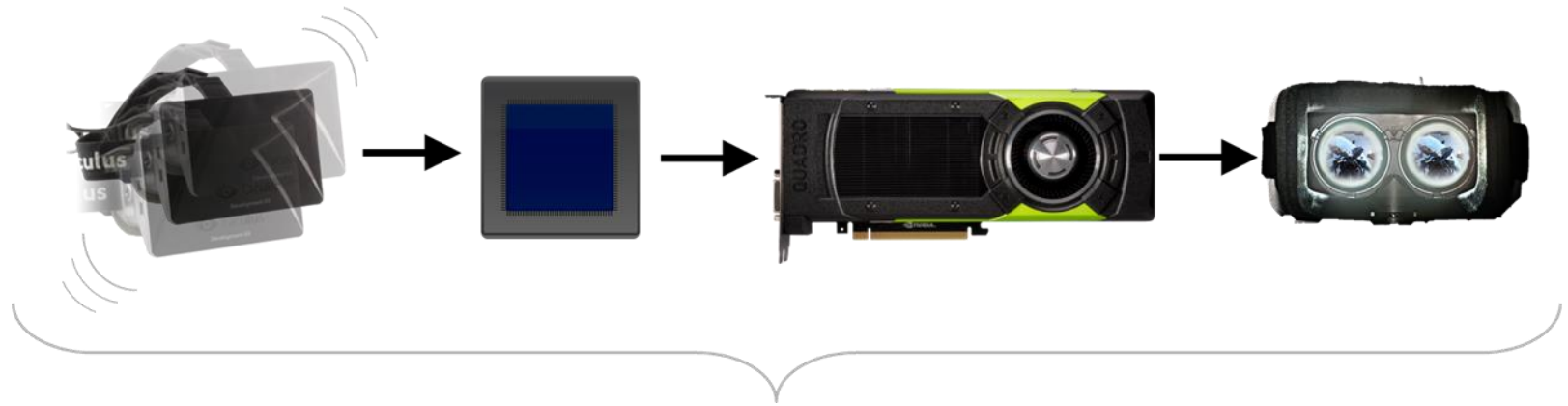
VIRTUAL REALITY = 450 MP/S

(3024 X 1680* @ 90 FPS)



VR PERFORMANCE DEMANDS

Ultra-Low Latency



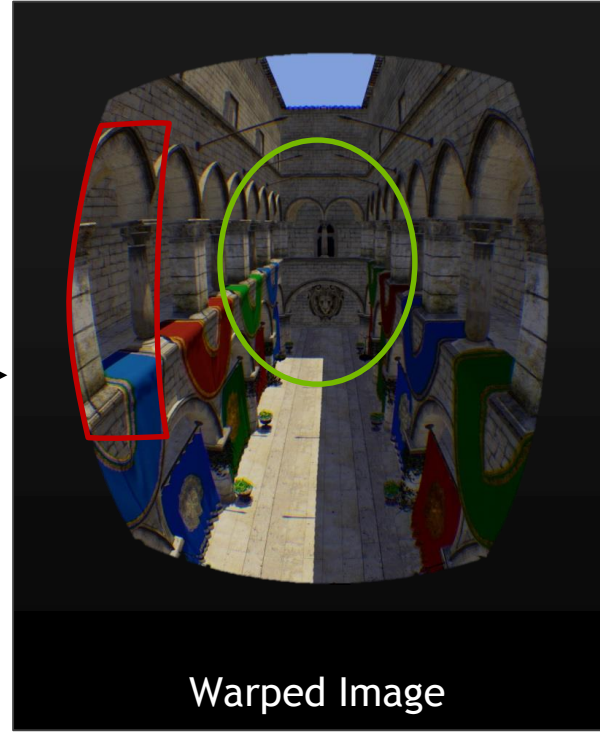
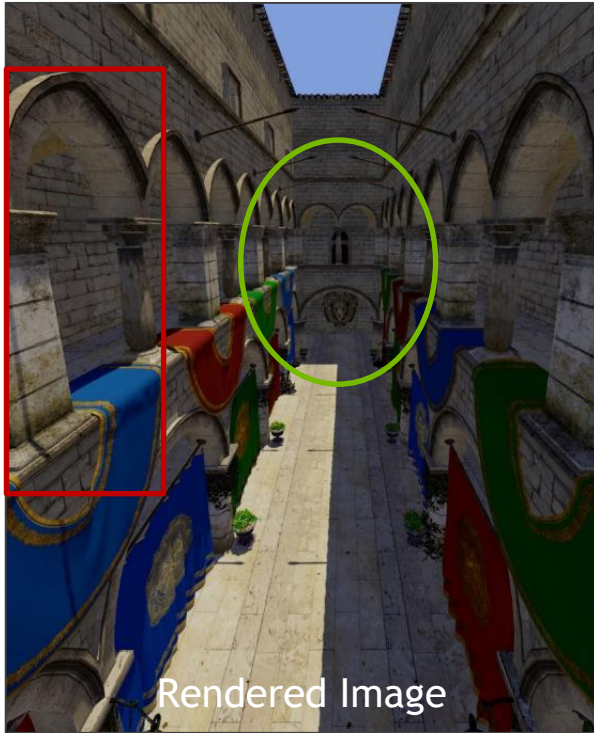
Motion to Photon: ≤ 20 ms

VR RENDERING



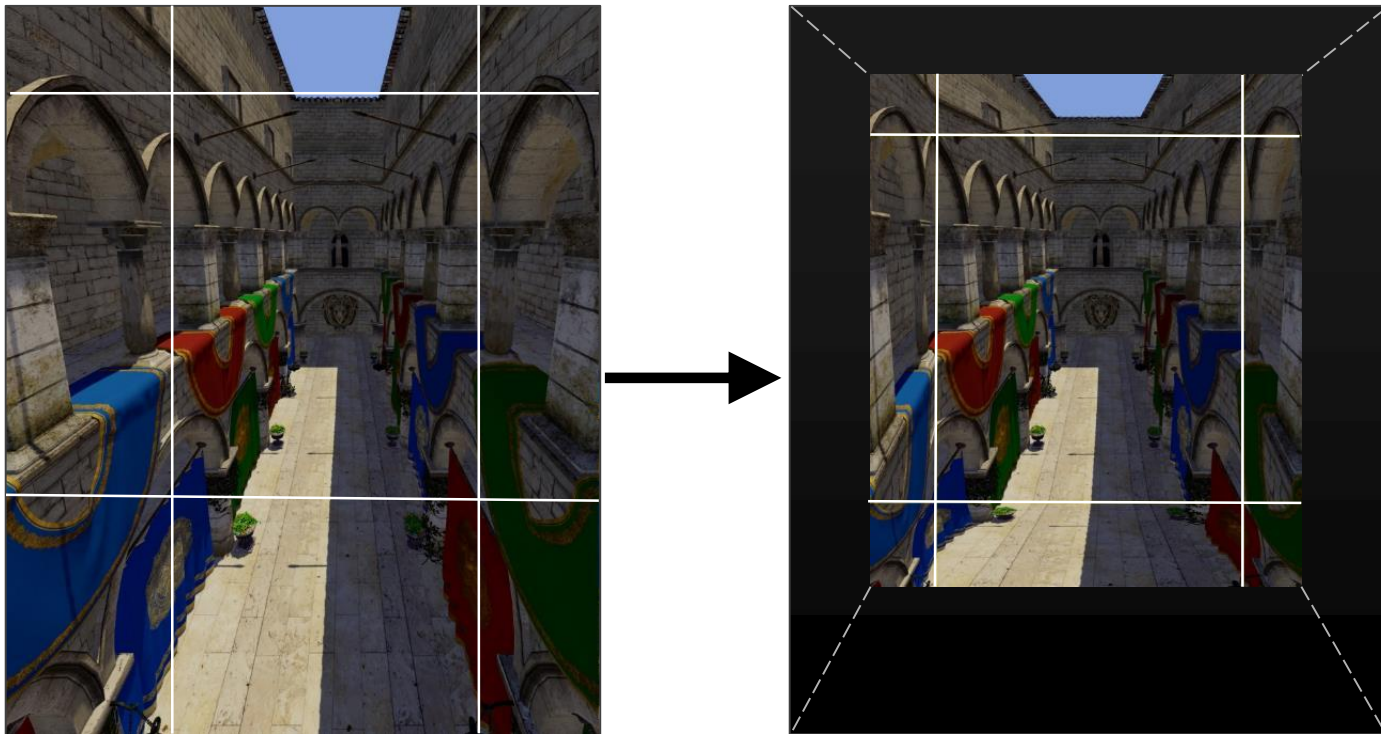
VR RENDERING

GPU renders many pixels that never make it to the screen



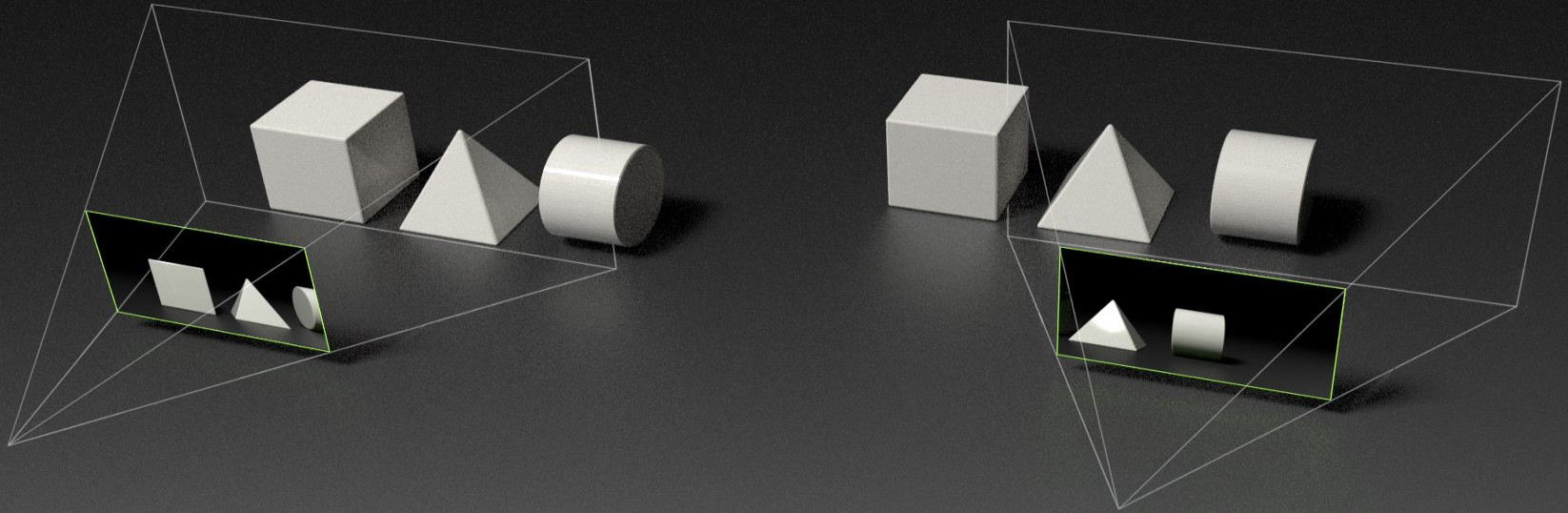
NVIDIA MULTI-RES SHADING

Introduced in Maxwell



TRADITIONAL STEREO RENDERING

Requires 2 geometry passes

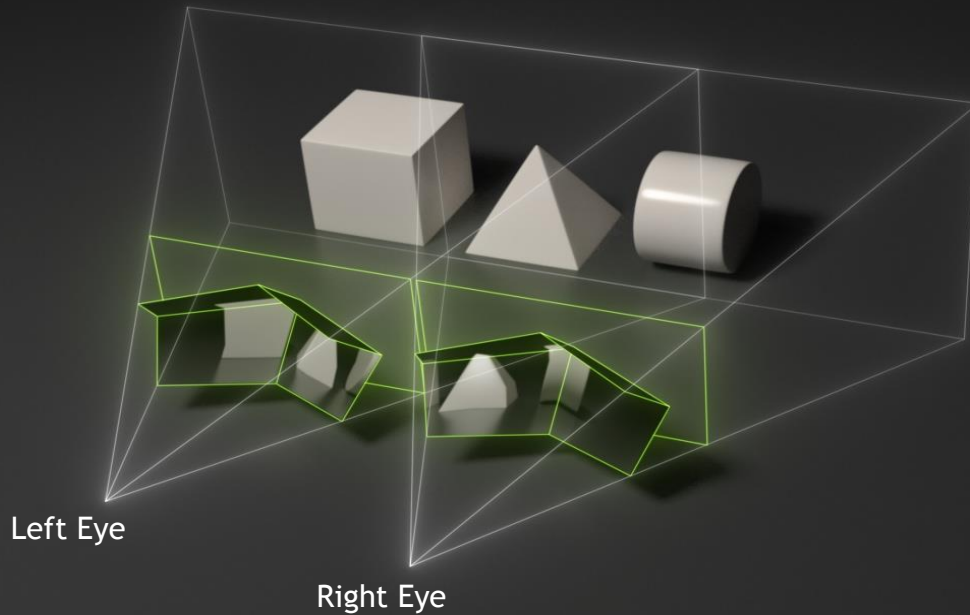


Left Eye (Pass 1)

Right Eye (Pass 2)

SINGLE PASS STEREO

Renders left & right eye in one geometry pass



COMPUTING CHALLENGES IN REPRODUCING REALITY

GRAPHICS /
DISPLAY

AUDIO

TOUCH /
PHYSICS

CAPTURE

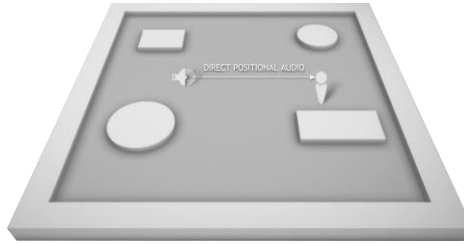
SIMULATING AUDIO IN VR

SYNTHESIS



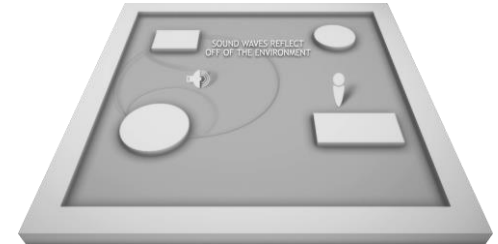
Creation of Source Sounds

DIRECTION



Location of Incoming Sound

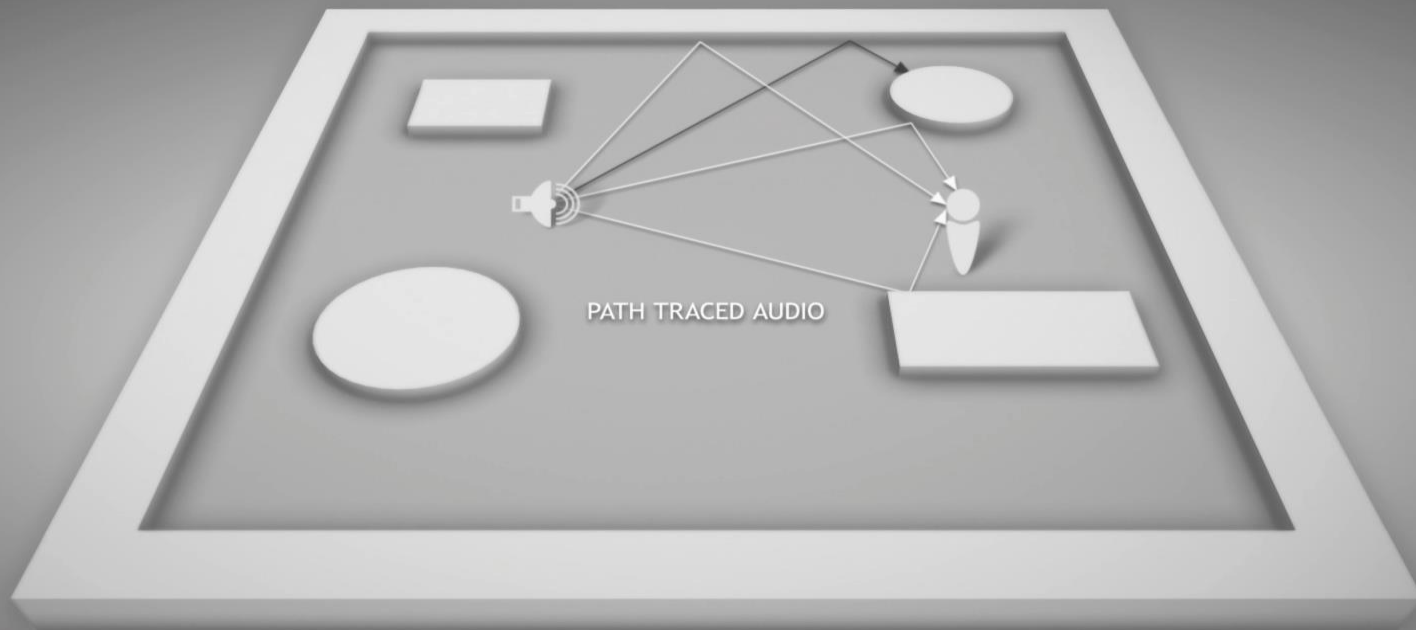
PROPAGATION



How Sound Moves in Space

NVIDIA VRWORKS AUDIO

Models direction and propagation using Ray tracing



COMPUTING CHALLENGES IN REPRODUCING REALITY

GRAPHICS /
DISPLAY

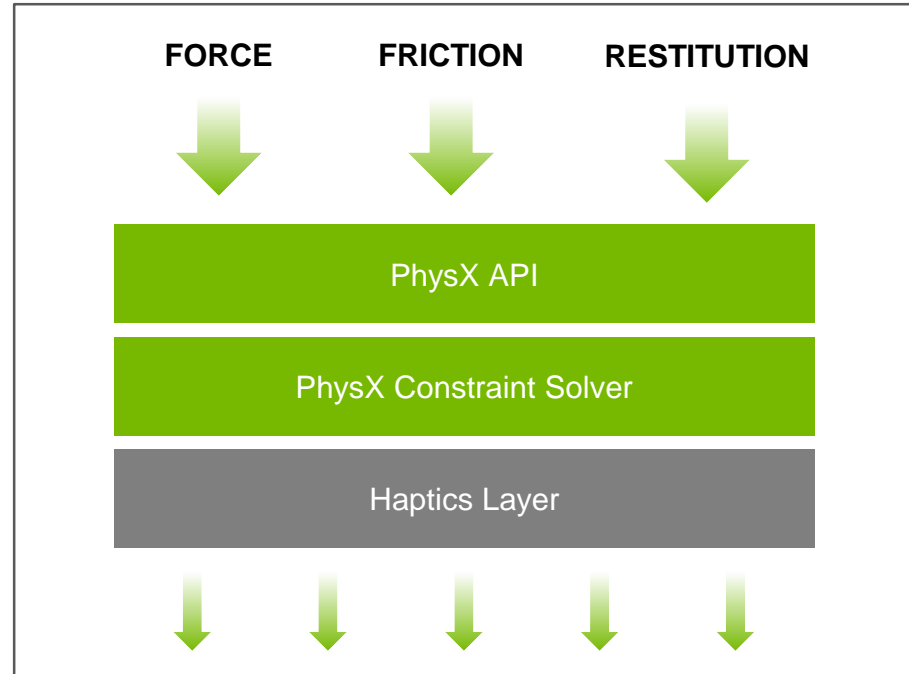
AUDIO

TOUCH /
PHYSICS

CAPTURE

HAPTICS

Collision detection & deformation modeling

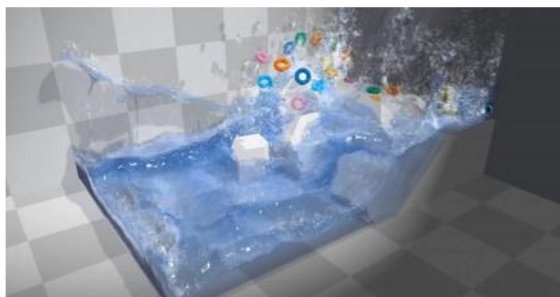


REALISTIC PHYSICS

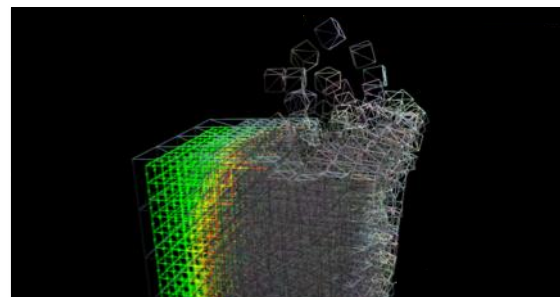
Simulating behavior in VR



PHYSX



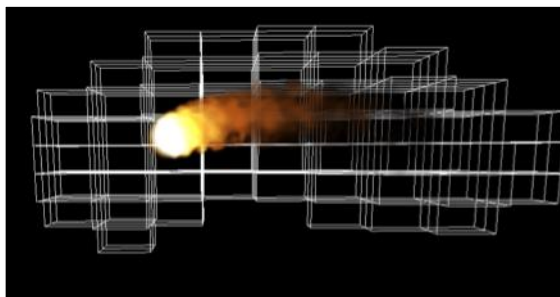
FLEX



DESTRUCTION



HAIRWORKS



FLOW



CLOTH

COMPUTING CHALLENGES IN REPRODUCING REALITY

GRAPHICS /
DISPLAY

AUDIO

TOUCH /
PHYSICS

CAPTURE

SIGNIFICANT COMPUTATION REQUIRED TO DELIVER 360 VIDEO



Capture

4k cameras



Stitch

Decode → Calibrate → Equalize → Stitch → Encode



Display

Single 360 video

INTRODUCING VRWORKS 360 VIDEO

Capture, stitch, and stream
360° videos in real-time

- Real-time and offline stitching from 4k camera rigs
- GPU-accelerated video decode, calibration, equalization, stitching, and encode
- 360 projection onto cube-map and equi-rectangular panorama
- Works with GPUDirect for Video for low latency video ingest



“Capturing and stitching 360 video is time consuming and computationally demanding. NVIDIA’s VRWorks 360 Video SDK will help accelerate STRIVR’s workflows, delivering real-time, high quality 360 video.”

– Masaki Miyanojara, CTO, STRIVR

NVIDIA VRWORKS

Comprehensive SDK for VR Developers: developer.nvidia.com/vrworks/

GRAPHICS



**LENS MATCHED
SHADING**



**SINGLE PASS
STEREO**



**MULTIRES
SHADING**



VR SLI

HEADSET



**CONTEXT
PRIORITY**



**DIRECT
MODE**



**FRONT BUFFER
RENDERING**

TOUCH & PHYSICS



PHYSX

PROFESSIONAL



**WARP &
BLEND**



SYNCHRONIZATION



**GPU
AFFINITY**

AUDIO



**VRWORKS
AUDIO**

VIDEO



**VRWORKS
360 VIDEO**



**GPUDIRECT
FOR VIDEO**

NVIDIA VR PLATFORM



NVIDIA GPUS & SOCS

Industry leading performance
Best-in-class perf per watt
Maxwell multi-projection



NVIDIA SOFTWARE

Game-Ready drivers
GeForce Experience
Enterprise class drivers



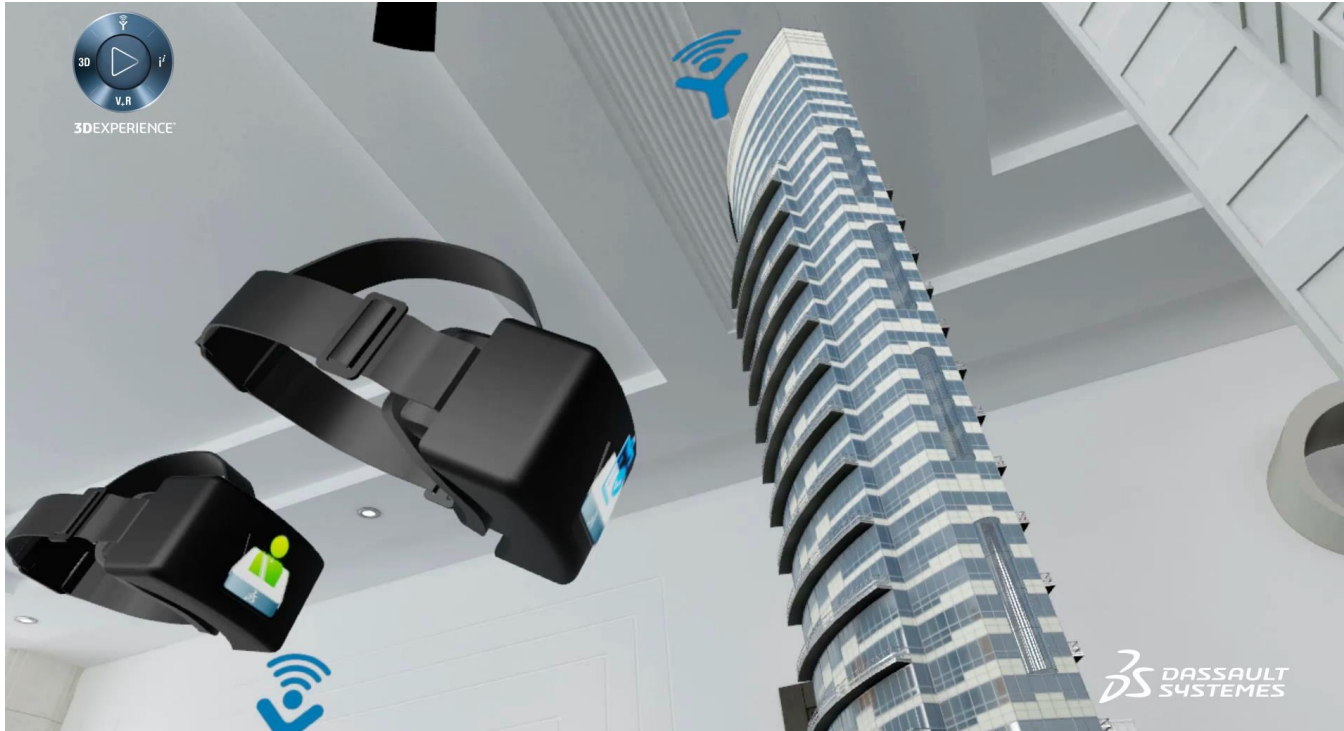
VRWORKS

Faster performance
Lower latency
Better compatibility

ENTERPRISE VR

VIRTUAL REALITY FOR ENTERPRISE WORKFLOWS

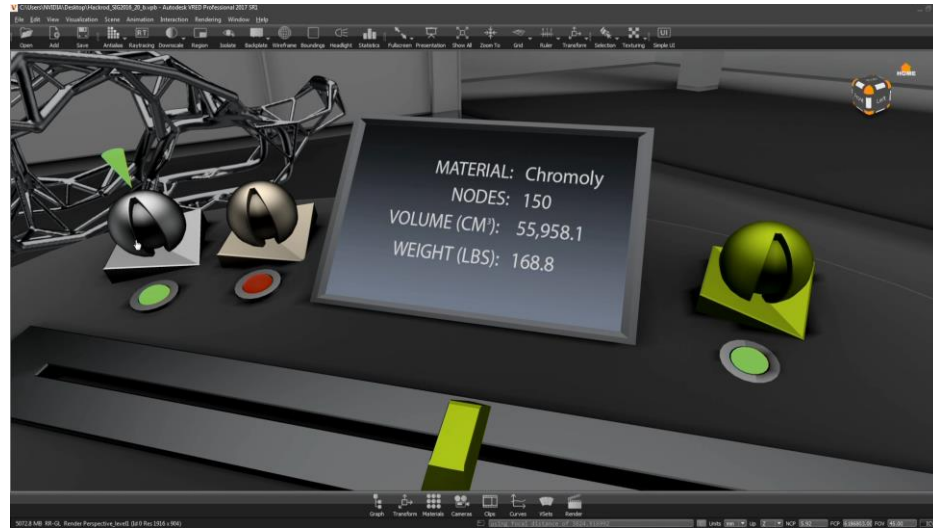
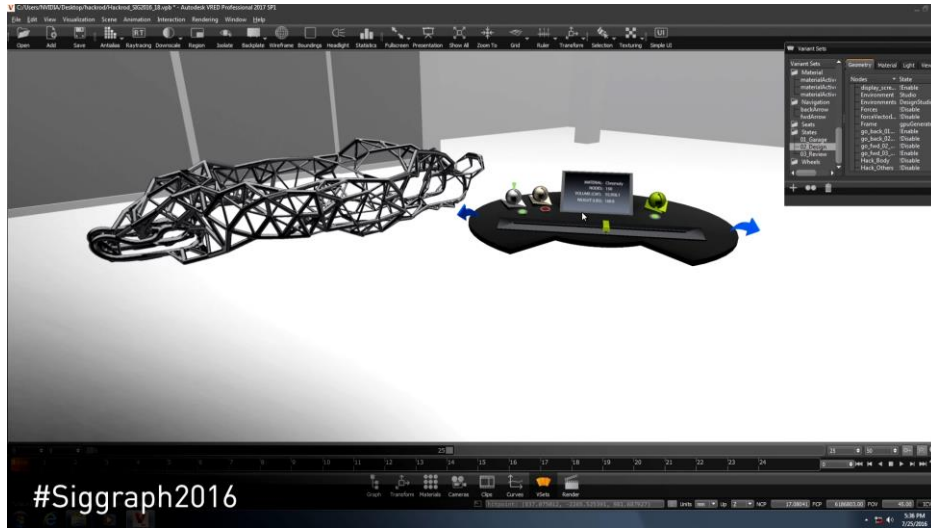
Collaborative Stakeholders Review in Virtual Reality



Collaborative Virtual Reality

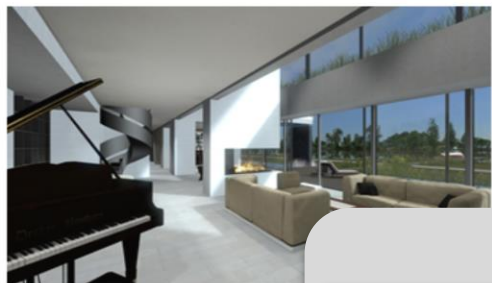
ENTERPRISE WORKFLOWS DESIGNING IN VR

Manufacturing Production Technologies Enabled Generative Design



3D Printing Manufacturing Process Enabled Generative Design

QUADRO VR: AS REAL AS IT GETS



NVIDIA Iray®



NVIDIA Iray VR



VR



The ultimate in presence with Iray VR. Photorealistic experience with Light Fields rendered on DGX-1 or Quadro VCA and viewed with NVIDIA Quadro Pro VR Viewer

NVIDIA IRAY VR

Breakthrough Photoreal VR



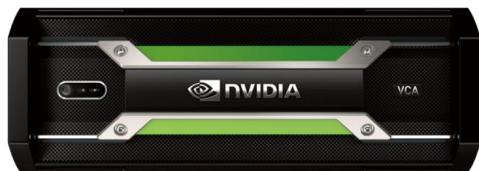
Pre-render light probes
surrounding region of interest



Rasterize depth buffer at
headset eye positions



Reconstruct image for new
viewpoint from depth and
multiple probes



VIRTUAL REALITY FOR ENTERPRISE WORKFLOWS

Realistic Design Environment Experience



Architectural Predictive Design in Virtual Reality

VIRTUAL REALITY FOR ENTERPRISE WORKFLOWS

Opportunities Across VR / AR / MR



ENABLING NEXT-GEN PRO VR/AR



NVIDIA VR READY
For System Builders



NVIDIA VRWORKS
For Developers

LARGER DATA SETS
AI/DL



PHOTOREALISTIC VR
COLLABORATION



VR READY DESKTOP PLATFORMS

Recommended Configurations



HP Z840,
Z640, Z240



DELL Precision
7910, 7810,
5810



LENOVO
P910, P710,
P500



Plus BOXX, PNY
and more

+



Quadro P/M6000 24GB - SLI



Quadro P/M6000 24GB



Quadro P/M6000



Quadro P/M5000

+



HTC VIVE

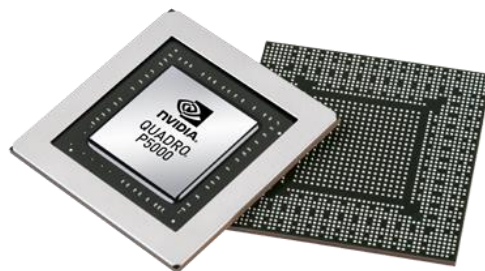
VR READY PASCAL PLATFORM

New Pascal VR Ready Mobile Workstations



Dell Precision 7720

+



NVIDIA Quadro P4000
NVIDIA Quadro P5000

+



HTC Vive HMD

Quadro P6000 & P5000

QUADRO P6000 / P5000 FEATURES & BENEFITS

PERFORMANCE

Pascal GPU technology boosts performance

- Faster graphics performance
- More efficient compute / graphics with pre-emption
- Up to 2x graphics throughput for VR

MEMORY

GDDR5X provides better memory performance

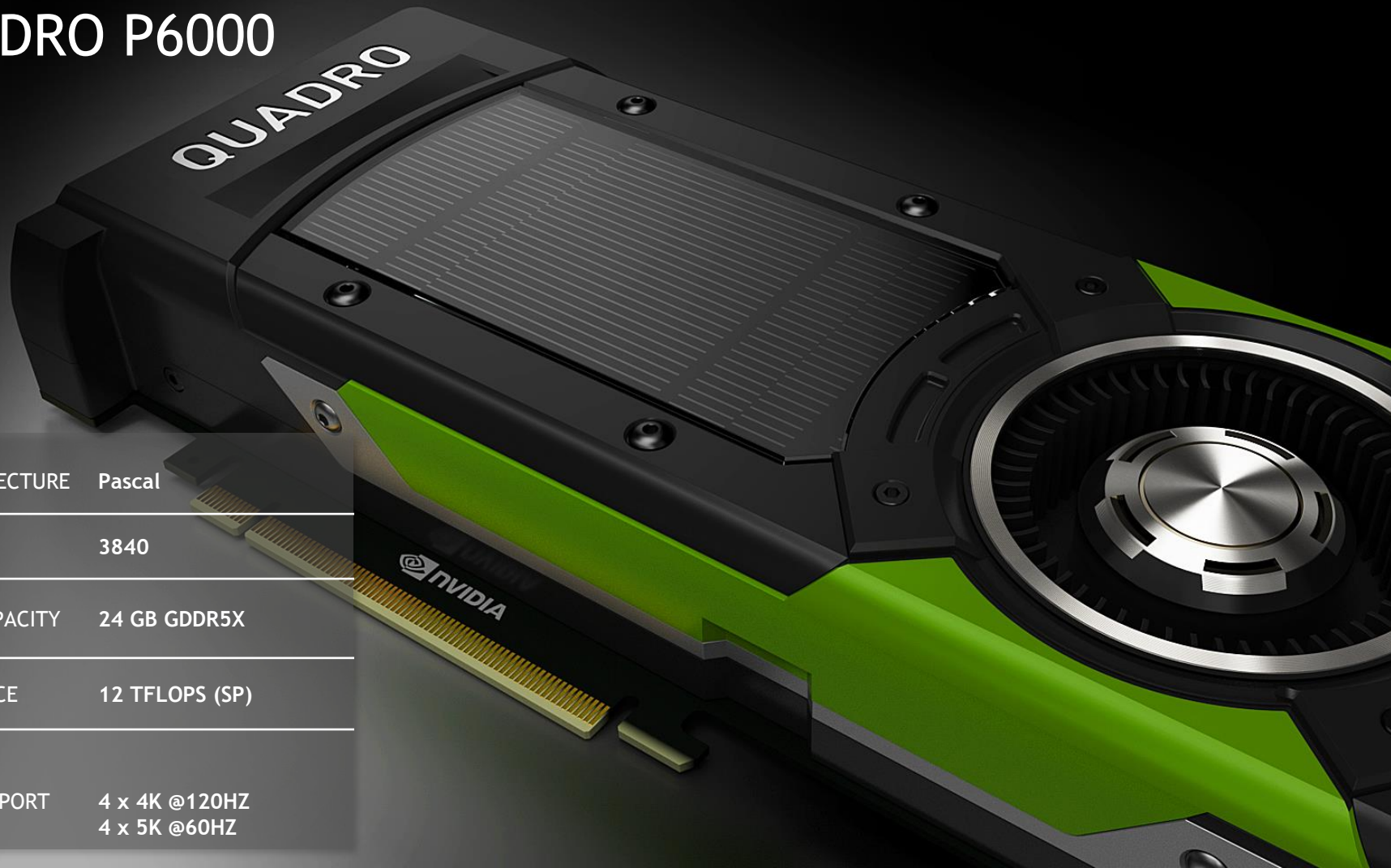
- GDDR5x memory provides fast memory performance
- 16 & 24GB of memory allows largest models, datasets, most immersive VR experiences

DISPLAY

DP 1.4 provides twice the bandwidth of the previous generation

- Drive up to 4 5K displays simultaneously.
- HDR support displays 2x the visible colors resulting in brighter, more saturated images.

QUADRO P6000



GPU ARCHITECTURE Pascal

CUDA CORES 3840

MEMORY CAPACITY 24 GB GDDR5X

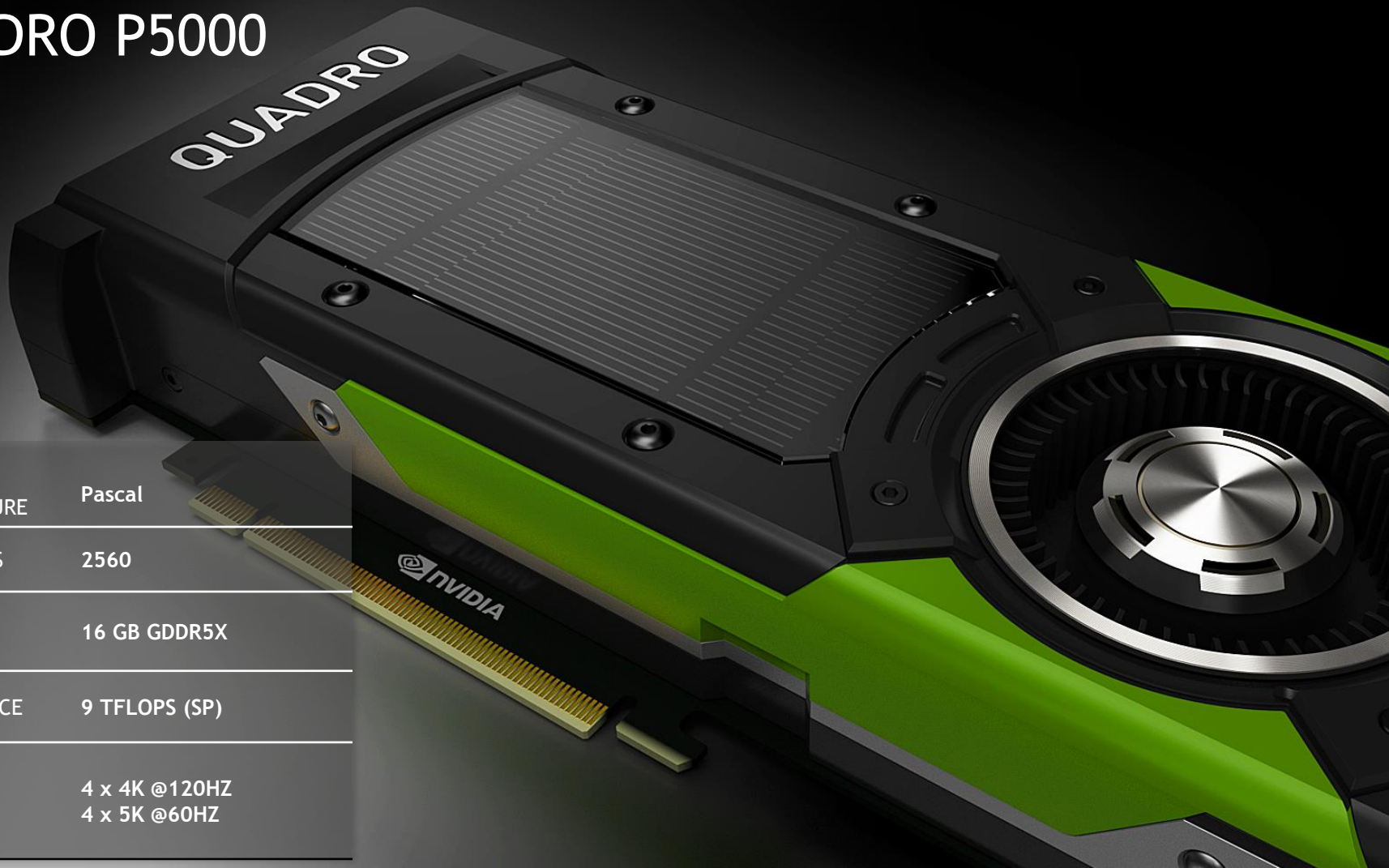
PERFORMANCE 12 TFLOPS (SP)

DISPLAY SUPPORT 4 x 4K @120HZ
4 x 5K @60HZ

QUADRO P6000 VS M6000 24GB

	M6000 24GB	P6000	Benefits
GPU Architecture	Maxwell	Pascal	Most Powerful and Efficient GPU
# CUDA Cores	3,072	3,840	Faster compute & rendering performance
Memory Size	24 GB GDDR5	24 GB GDDR5X	Fast memory performance - Real-Time Interactivity with Large Complex Assemblies, visually detailed VR environments
Memory BW	Up to 317 GB/s	Up to 432 GB/s	Move data to and from GPU faster
Display Support	4x DP + 1x DVI	4x DP 1.4 + 1x DVI	Enabling 4 5K displays
Advanced Display	SYNC	SYNC 2	Synchronize up to 8 GPUs per system
Board Power	225 W or 250 W	250W	
Power Connector	1x 8-pin PCIe	1x 8-pin PCIe	Simplified Connectivity

QUADRO P5000



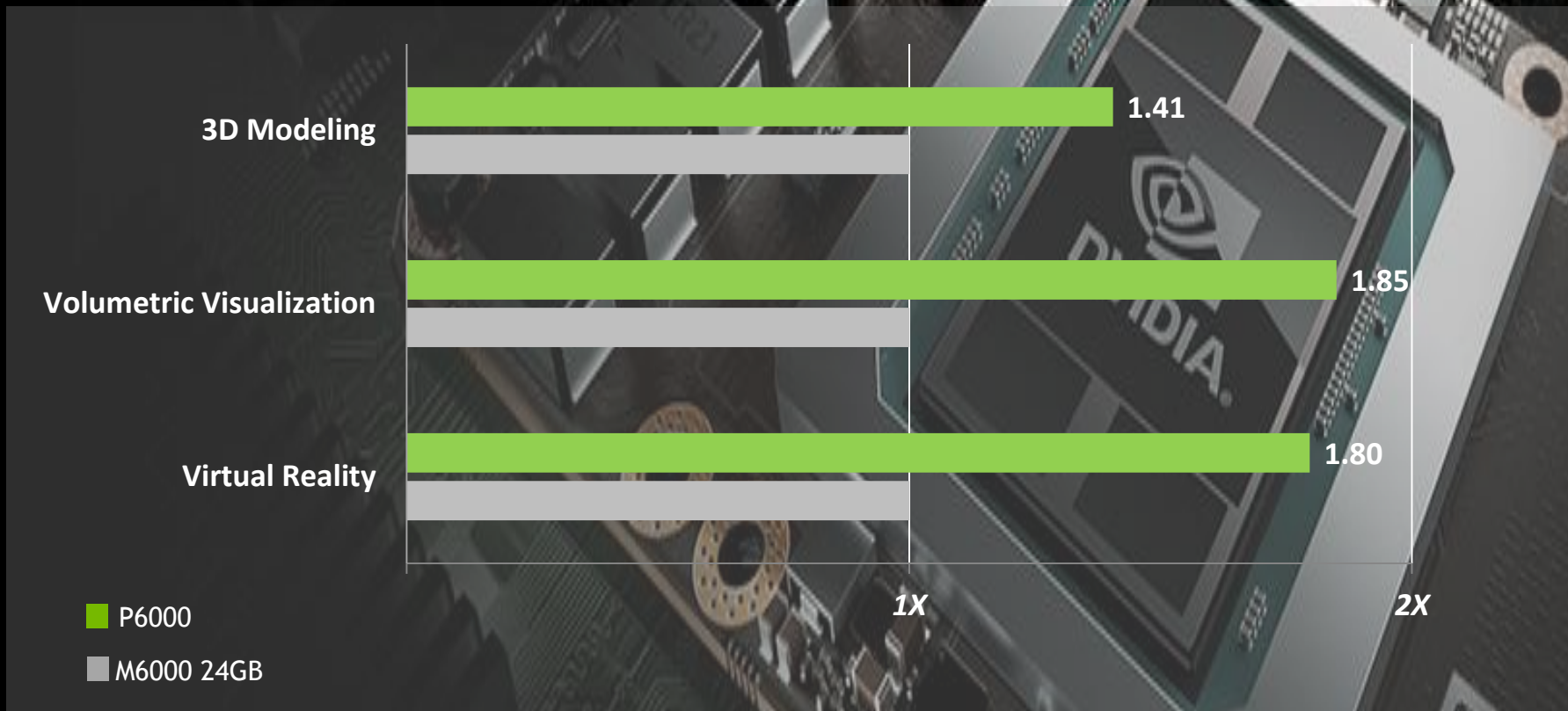
GPU ARCHITECTURE	Pascal
CUDA CORES	2560
MEMORY CAPACITY	16 GB GDDR5X
PERFORMANCE	9 TFLOPS (SP)
DISPLAY SUPPORT	4 x 4K @120HZ 4 x 5K @60HZ

QUADRO P5000 VS M5000

	M5000	P5000	Benefits
GPU Architecture	Maxwell	Pascal	Most Powerful and Efficient GPU
# CUDA Cores	2,048	2,560	Faster compute & rendering performance
Memory Size	8 GB GDDR5	16 GB GDDR5X	Fast memory performance - Real-Time Interactivity with Large Complex Assemblies, visually detailed VR environments
Memory BW	Up to 211 GB/s	Up to 288 GB/s	Move data to and from GPU faster
Display Connectors	4x DP + 1x DVI	4x DP 1.4 + 1x DVI	Enabling 4 5K Displays
Advanced Display	SYNC	SYNC 2	Synchronize up to 8 GPUs per system
Board Power	150 W	180 W	
Power Connector	1x 6-pin PCIe	1x 6-pin PCIe	Simplified Connectivity

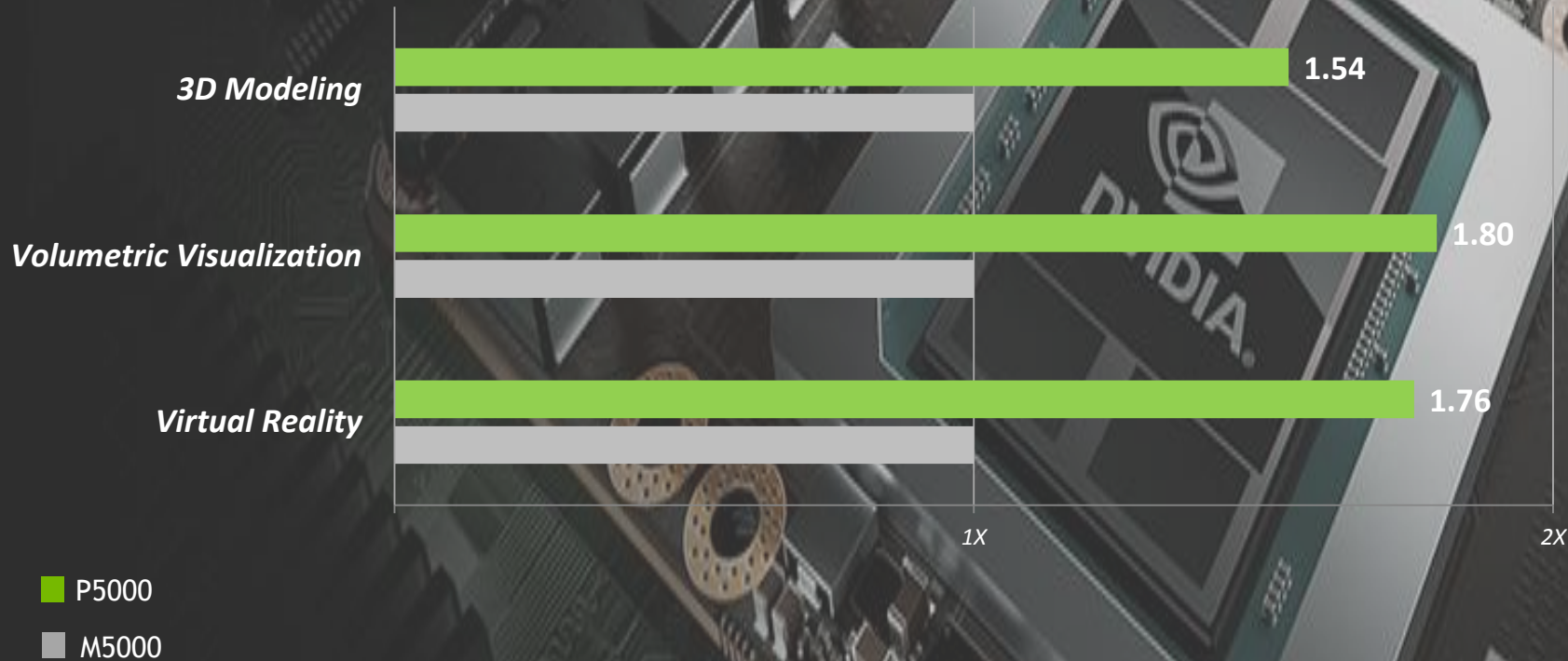
*SPEC VP12 Geomean Score, NVIDIA driver 368.37, Intel E5 2697 V3, 32GB RAM, Win7 SP1-64

P6000 PERFORMANCE



Test system: Intel E5 2697 V3 2.6GHz (3.6GHz Turbo), 32GB RAM, Windows 7 SP1 64-bit, P5000/P6000 NVIDIA graphics driver 368.37, M5000/M6000 24GB NVIDIA graphics driver 367.74. 3D Graphics performance based on publicly available SPECviewperf 12 SNX-02 viewset, Volumetric Viewing performance based on SPECviewperf 12 Energy-01 viewset, Virtual Reality performance based on VRScore beta benchmark.

P5000 PERFORMANCE



Test system: Intel E5 2697 V3 2.6GHz (3.6GHz Turbo), 32GB RAM, Windows 7 SP1 64-bit, P5000/P6000 NVIDIA graphics driver 368.37, M5000/M6000 24GB NVIDIA graphics driver 367.74. 3D Graphics performance based on publicly available SPECviewperf 12 SNX-02 viewset, Volumetric Viewing performance based on SPECviewperf 12 Energy-01 viewset, Virtual Reality performance based on VRScore beta benchmark.

PRO VR

It's more than just 90fps rendering

