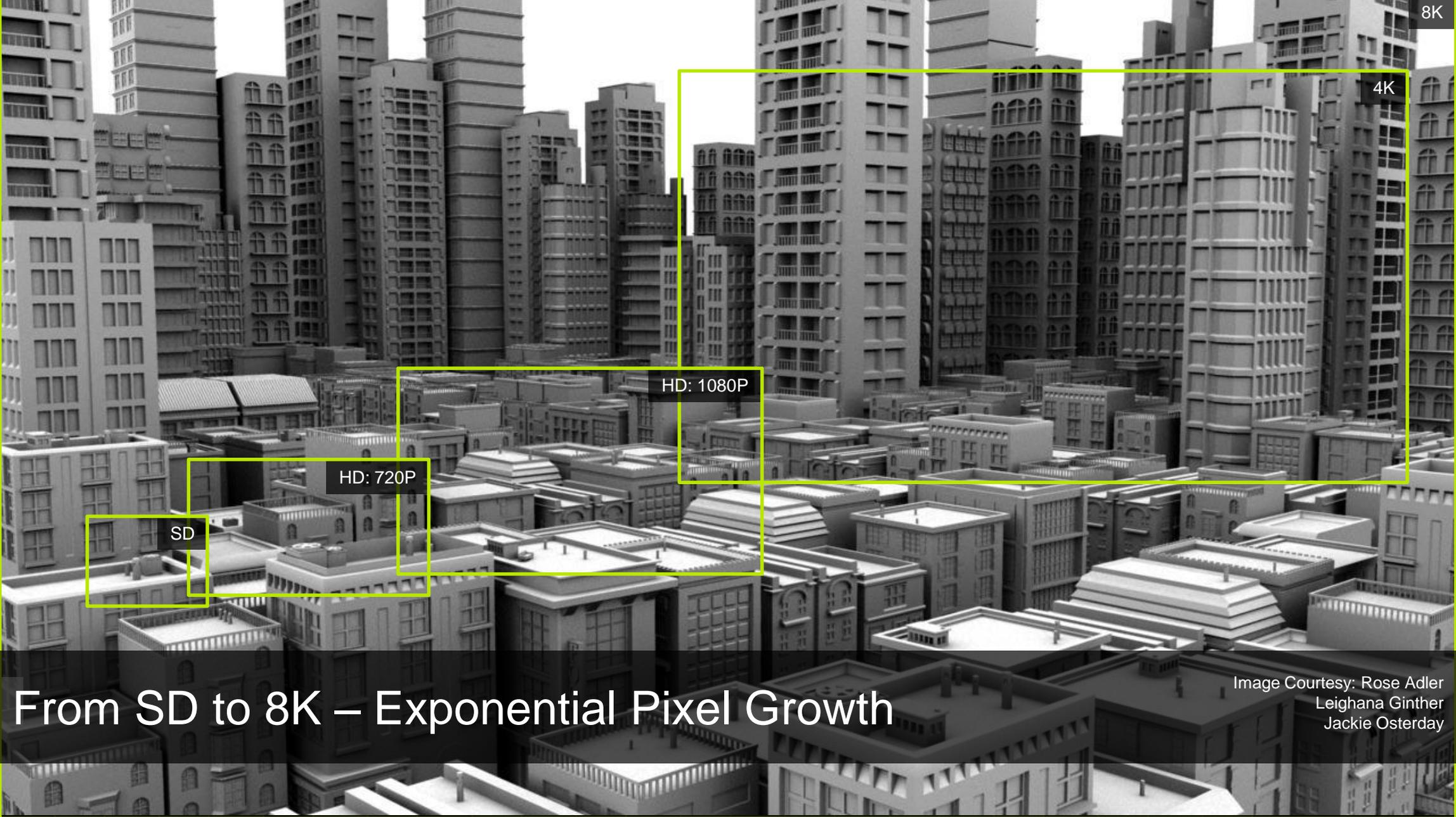


GPU TECHNOLOGY
CONFERENCE

S5142 - SEE THE BIG PICTURE: SCALABLE VISUALIZATION SOLUTIONS FOR HIGH RESOLUTION DISPLAYS

DOUG TRAILL, SENIOR SOLUTIONS ARCHITECT, NVIDIA
QUADROSVS@NVIDIA.COM



8K

4K

HD: 1080P

HD: 720P

SD

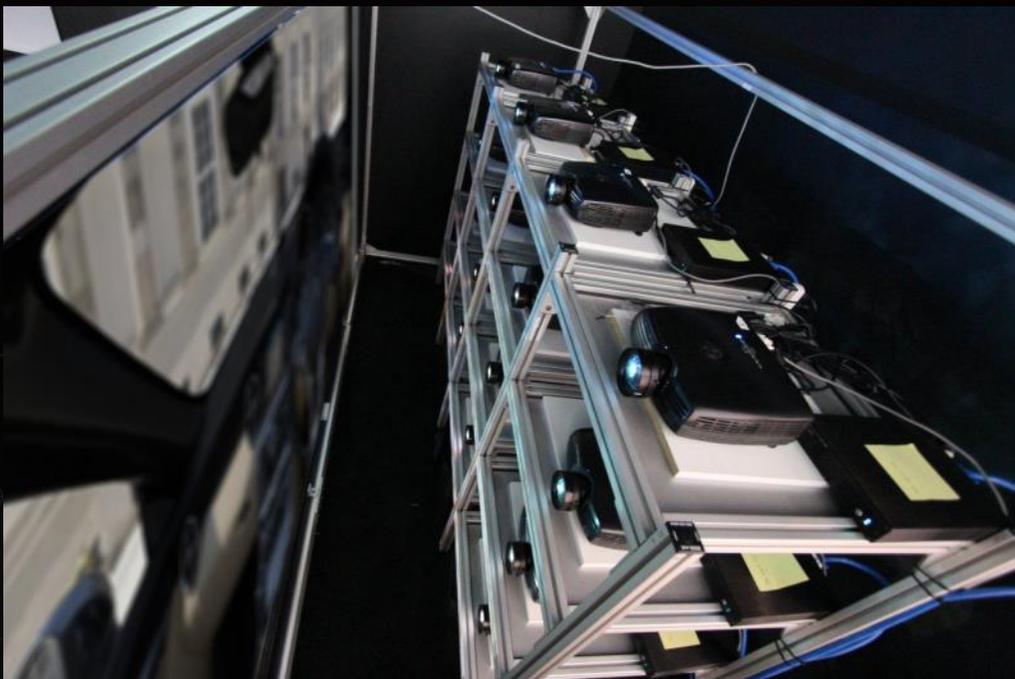
From SD to 8K – Exponential Pixel Growth

Image Courtesy: Rose Adler
Leighana Ginther
Jackie Osterday

Scaling Detail

Realism requires resolution - scale any application across up to 16 displays from just one system using 4 independent display outputs of Quadro M6000 and Quadro Sync

Scale even further with a visualization cluster of systems built upon Quadro Sync



20MPixel - 16 Projector

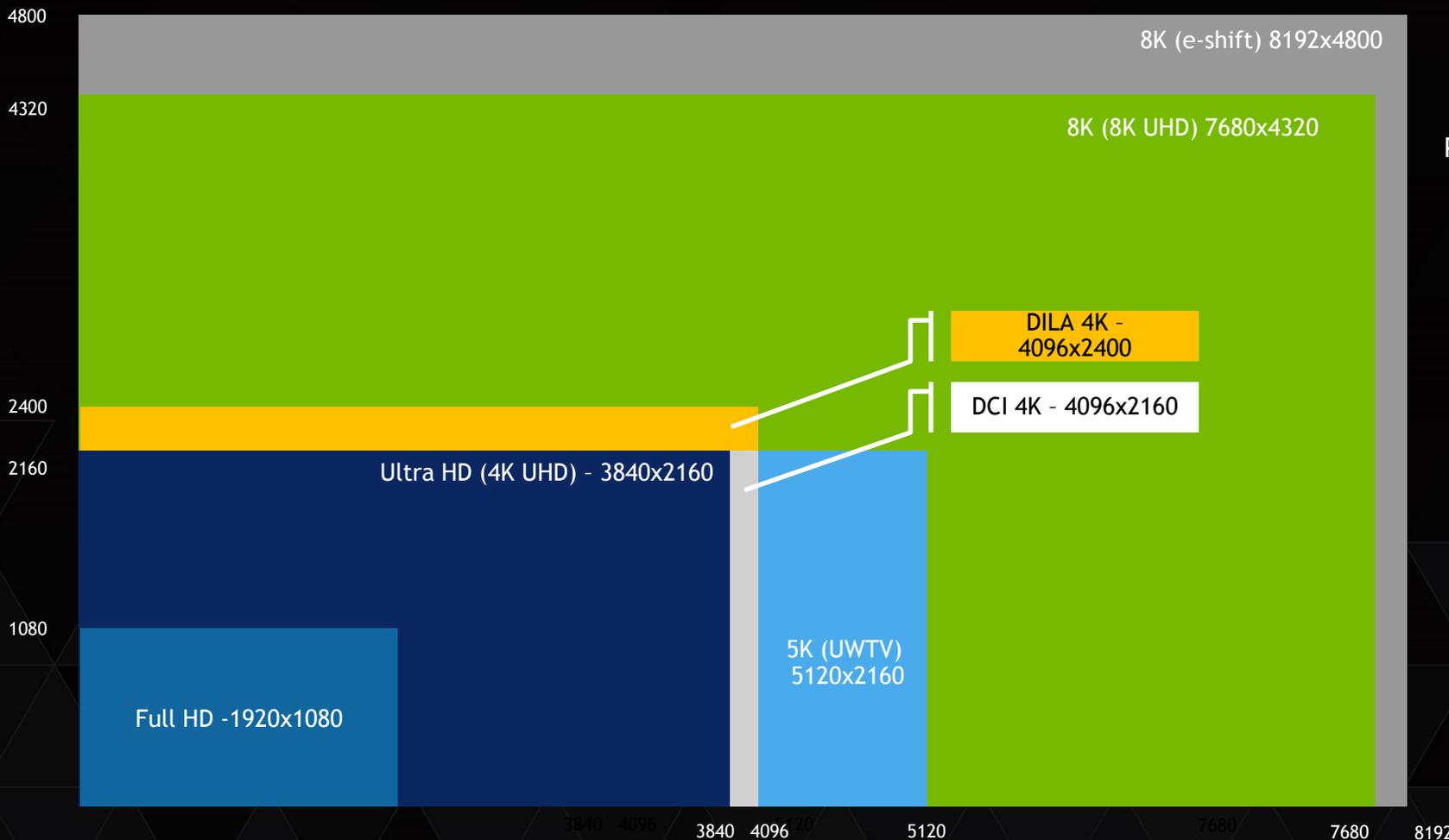
10MPixel - 8 Projector

4MPixel - 1 Projector

- 16 HD projector, 20MPixel, wall display
- One system with 4 Quadro K5200's & Quadro Sync

FROM HD TO 4K & BEYOND

INCREASING DISPLAY RESOLUTIONS



4K UHD - 4 times HD res
8K UHD - 16 times HD res

Professional 4K projectors
4096x2160
4096x2400

8k Projectors
JVC - 8192x4800 (e-shift)
(4 * 4K)

SCALE FROM 4K UP...



Image courtesy of Prysm Inc



Image courtesy of Visbox



Image Courtesy of Elbit Systems

MOSAIC

Single workstation
Single Desktop
Up to 4 GPUs - 16 display heads
Application independent

~142 Mpixels
(16 * 4K)



GPU Affinity

Single workstation
Multiple - desktops/GRIDs
Up to 8 GPUs - 32 display heads
Application dependent

~284 Mpixels
(32*4k)



Cluster solution

Multiple workstations
Multiple - desktops/GRIDs
Up to ~200 GPUs - 800 display heads
Application dependent

~7,078 Mpixels
(800x4K)

PROJECT ON TO ANY SURFACE...



Image Courtesy of IMMERSIVE DESIGN STUDIOS
S5642 - Canvas: GPU Image Processing on Giant Surface – Thomas Soetens – Wed 3/18

WARP + INTENSITY API (WINDOWS + LINUX)



Image courtesy of Joachim Tesch
- Max Planck Institute for Biological Cybernetics



Image courtesy of Christie Digital

Projection Blending & Mapping
software available from:



S5143 - Architectural Display Walls Using NVAPI - 5.00 pm today

QUADRO M6000

World's Most Powerful Pro Graphics Card

- World's most powerful Graphics Solution
- Beyond 4K support
 - Drive single 8K or multiple 4K/5K displays
 - Flight Simulation, Video Walls
- Enable 4K @ 60 Hz video decode and encode including HEVC (H.265)
- Designed to tackle most challenging workflows
 - Turbocharged Persona - 250W with maximum performance



QUADRO DRIVER FEATURES

<p>Custom Resolutions</p> <p>GTF, DMT, CVT, CVT-RB, Manual timing</p>	<p>MOSAIC</p> <p>Seamless Desktop across multiple GPUs</p>	<p>Tiled Displays</p> <p>Automatic MOSAIC setup on tile displays using Display ID</p>	<p>10/12 bit Color</p> <p>Support High Dynamic Range Displays</p>
<p>EDID Management</p> <p>Capture and Read EDID from file</p>	<p>MOSAIC + Sync</p> <p>Framelock, Overlap support, 3D stereo</p>	<p>Ultra high resolution Desktop</p> <p>Up to 16k by 16k</p>	<p>3D Stereo</p> <p>OpenGL/DirectX, active, passive, pixel packed</p>
<p>4K resolution</p> <p>DP1.2 per connector or HDMI1.4b</p>	<p>GPU Direct 4 Video</p> <p>Picture-in-Picture support</p>	<p>External or Internal Sync</p> <p>Genlock/TTL Sync. Internal Sync</p>	<p>Display Port MST</p> <p>Support multi-streaming devices</p>
<p>Warp + Intensity API</p> <p>Edge-blending, projection mapping. Windows + Linux</p>	<p>NVAPI</p> <p>Programmatically control driver</p>	<p>Display Clone Modes</p> <p>Display Port Clone, Pan & Scan clone, 4K cloning</p>	<p>GPU Affinity</p> <p>Multi-GPU support and Swap Groups</p>
<p>8K e-shift support</p> <p>Native support for 8k e-shift projector</p>	<p>MOSAIC CONFIDENCE MONITOR</p> <p>Smart clone features</p>	<p>NVWMI</p> <p>Scripting/Event monitor/remote setup</p>	

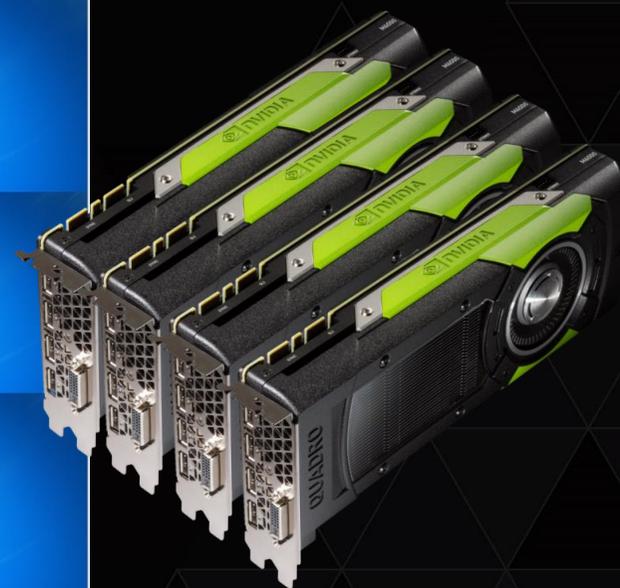
MOSAIC - WHY IS IT NEEDED?

- WINDOWS ON ITS OWN
- INDEPENDENT DESKTOPS

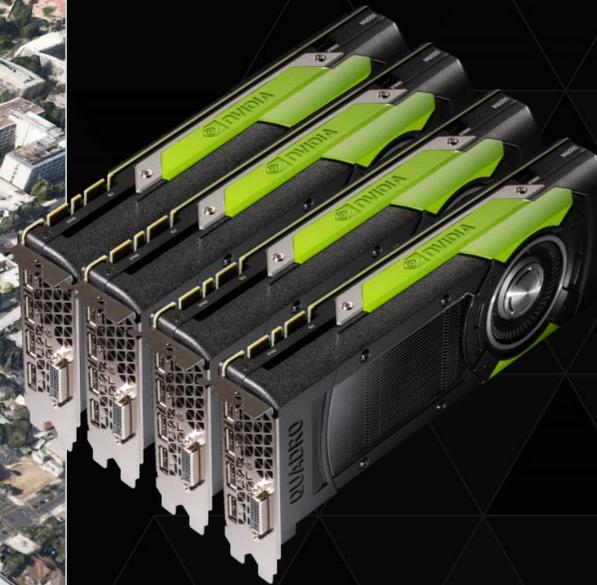
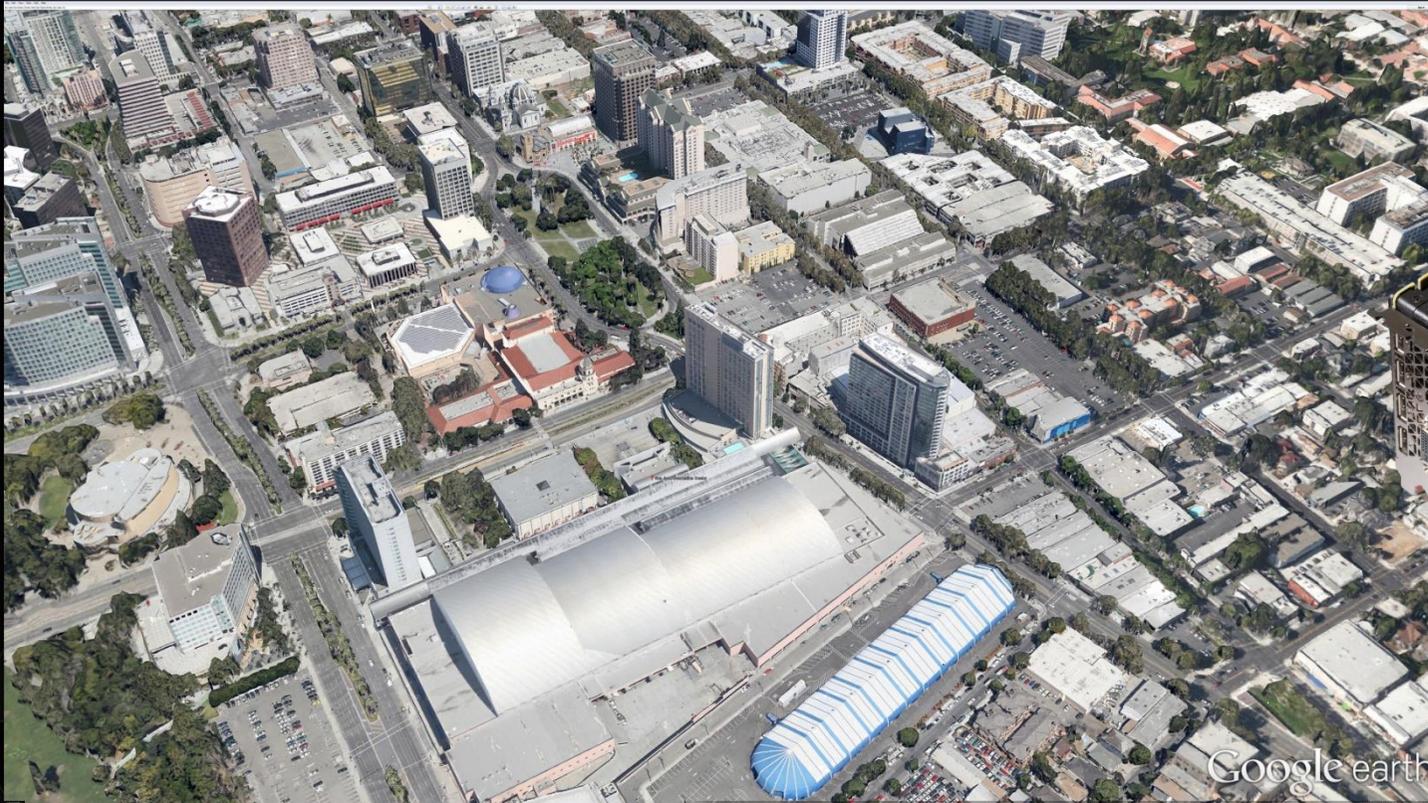


WINDOWS ON ITS OWN

- INDEPENDENT DESKTOPS



WITH MOSAIC - ONE LARGE DESKTOP



Max Number displays

Ultra - hi resolution

BEST

BETTER

GOOD

		<u>1 GPU</u>	<u>2 GPUs</u>	<u>3 GPUs</u>	<u>4 GPUS</u>
QUADRO M6000 ^{New}		4 <i>Overlap + bezel correction</i>	8 <i>Overlap + bezel correction SLI (2) or Quadro Sync</i>	12 <i>Overlap + bezel correction Quadro Sync</i>	16 <i>Overlap + bezel correction Quadro Sync</i>
QUADRO K5200		4 <i>Overlap + bezel correction</i>	8 <i>Overlap + bezel correction SLI (2) or Quadro Sync</i>	12 <i>Overlap + bezel correction Quadro Sync</i>	16 <i>Overlap + bezel correction Quadro Sync</i>
QUADRO K4200 (3)		3 <i>Overlap + bezel correction</i>	6 <i>Overlap + bezel correction SLI (2) or Quadro Sync</i>	9 <i>Overlap + bezel correction Quadro Sync</i>	12 <i>Overlap + bezel correction Quadro Sync</i>
QUADRO K1200 ^{New} NVS510		4 <i>Overlap^{New (1)} bezel correction</i>	8 <i>bezel correction</i>	12 <i>bezel correction</i>	16 <i>bezel correction</i>

(1) Overlap support on **single GPU** - NVS510, K1200, K2200 - Supported in new driver release - coming very soon.

(2) SLI must be certified platform - http://www.nvidia.com/object/quadro_sli_compatible_systems.html

(3) K4200 can support 4 display heads per card using DP MST hub

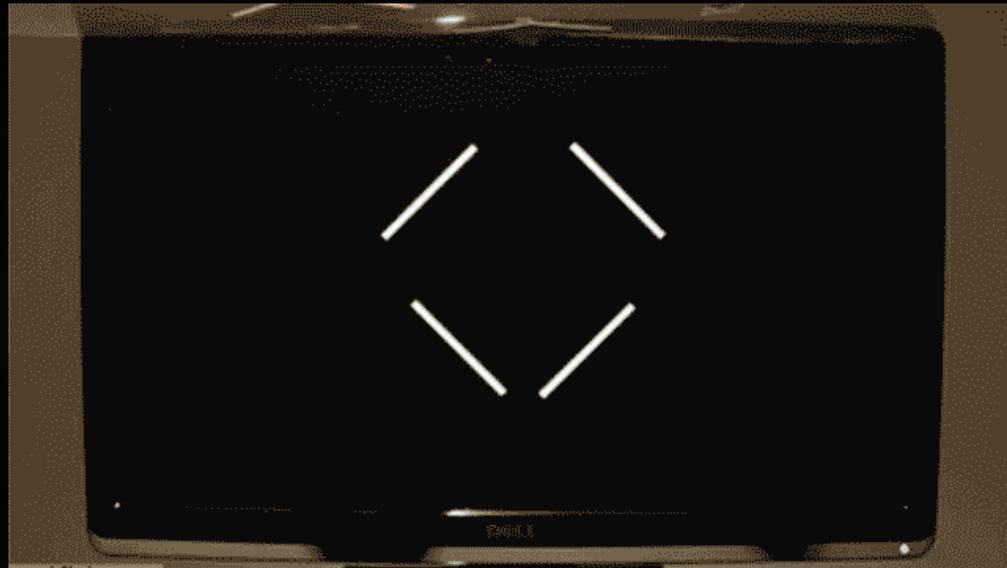
Multi-GPU Overlap requires SLI or Quadro Sync card.

MOSAIC is supported on Windows 7, 8.1, 10 + Linux

Quadro Sync

Focus on the image and not the artifacts

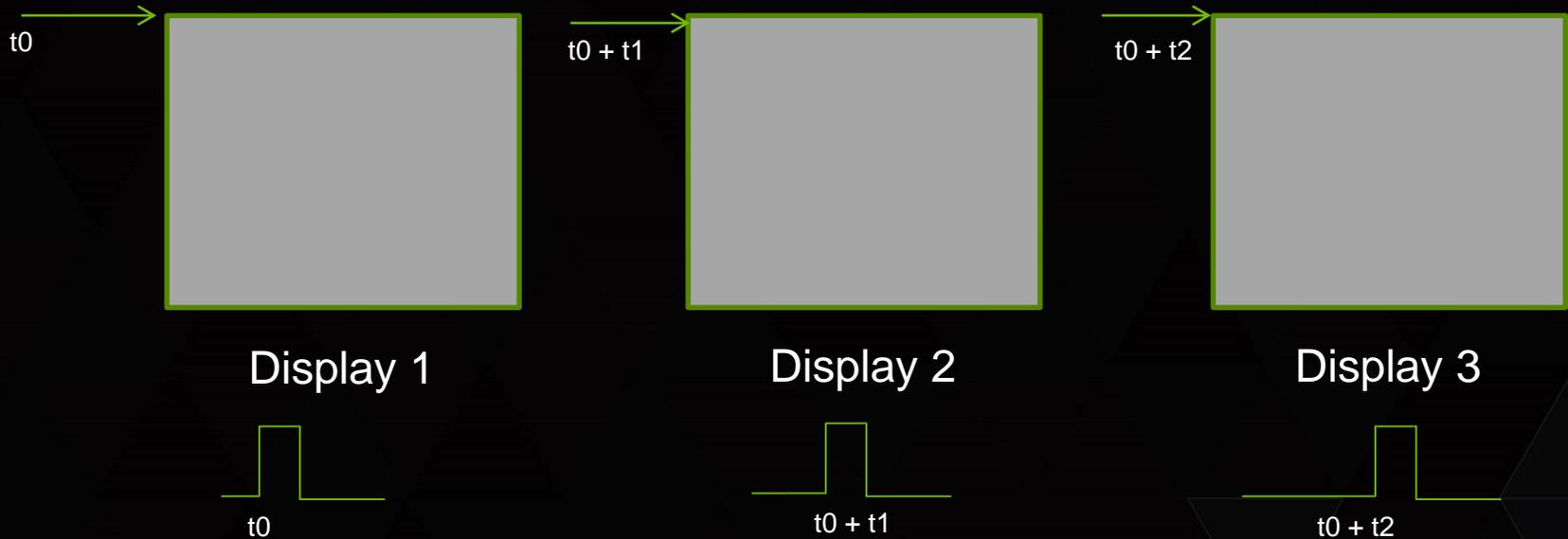
WHY IS SYNC IS IMPORTANT?



Bezel's hide sync issues !!!

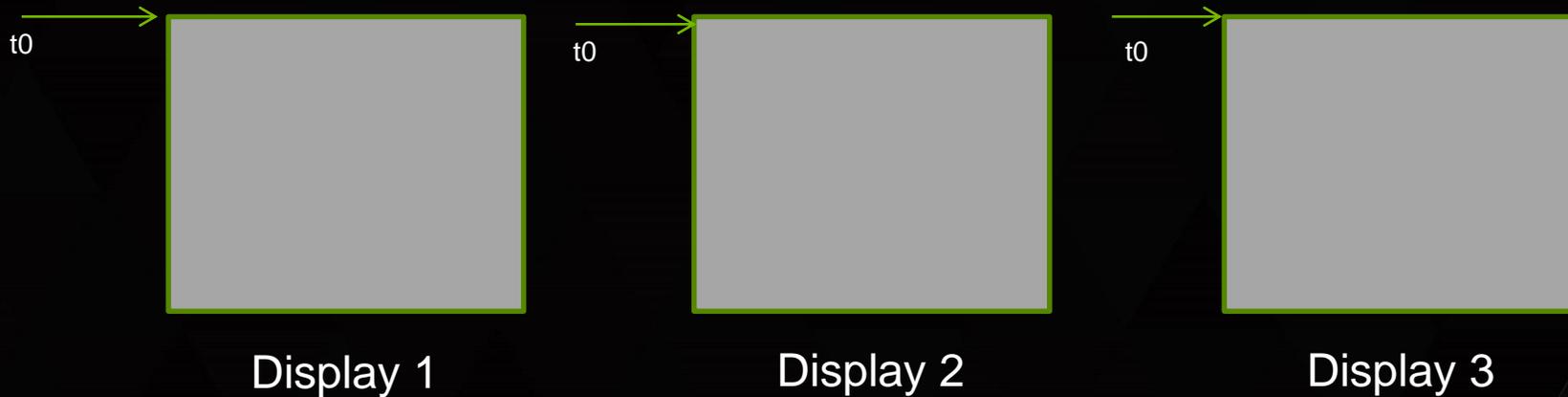
Image from gizmodo.com

VERTICAL SYNC



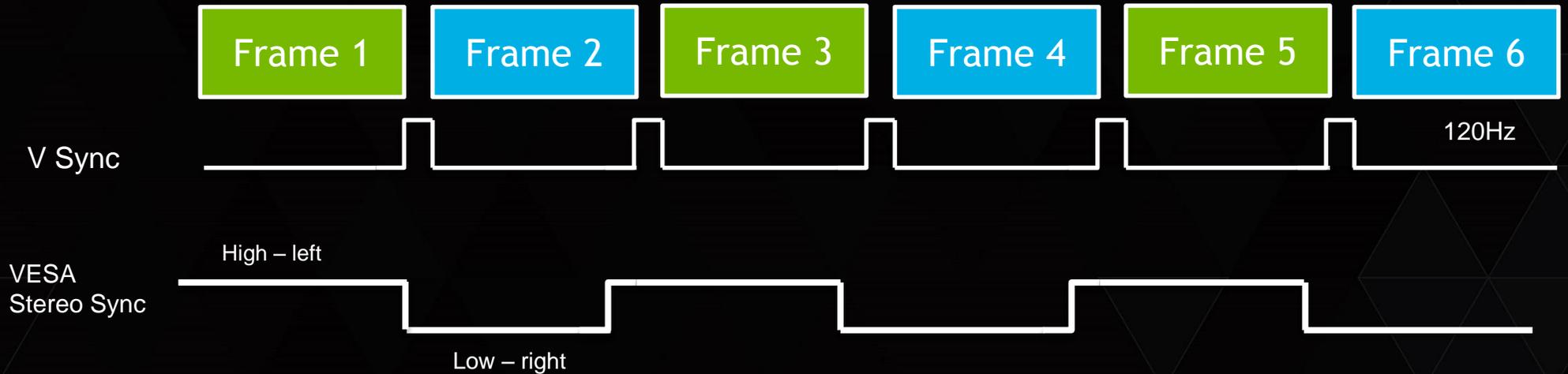
- *Vertical Sync* is the pulse that indicates the start of the display refresh.
- To avoid *tearing* on a single screen the application swap buffers are synced to *vertical sync*.
- Although all three displays may have the same refresh rate - *vertical sync* start may be different.
- This can result in *tearing* between displays.

FRAMELOCK/GENLOCK



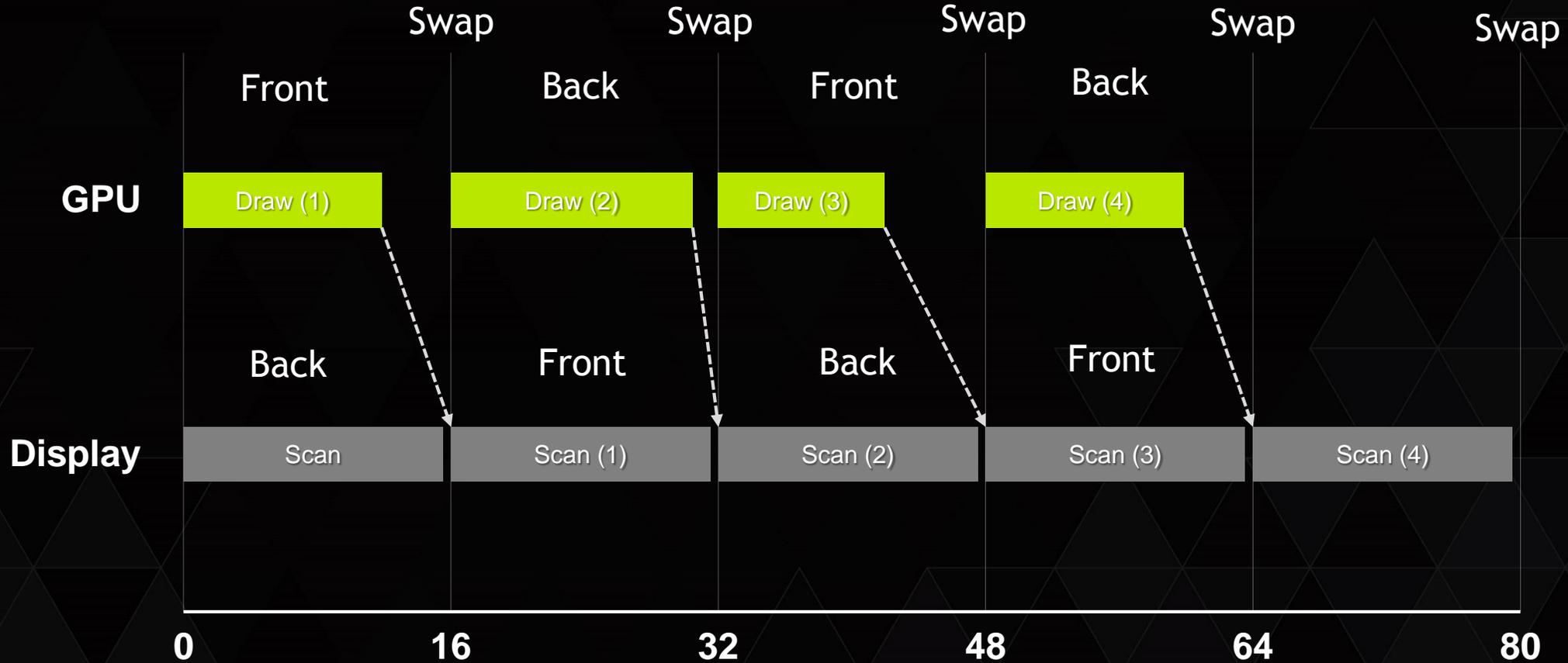
- *Frame Lock/Genlock* provides a common sync signal between graphics cards to insure the vertical sync pulse starts at a common start.
- This is commonly referred to as *Frame Synchronization*
- *Frame Lock* - Synchronization is generated from a master node. All other nodes would be sync to this.
- *Genlock* - synchronization is from an external sync generator (house sync). Each node attached to the genlock signal is synced from that signal.
- *Frame Lock & Genlock* can be mixed in the cluster. With the master node being synchronized from the genlock pulse

STEREO LOCK

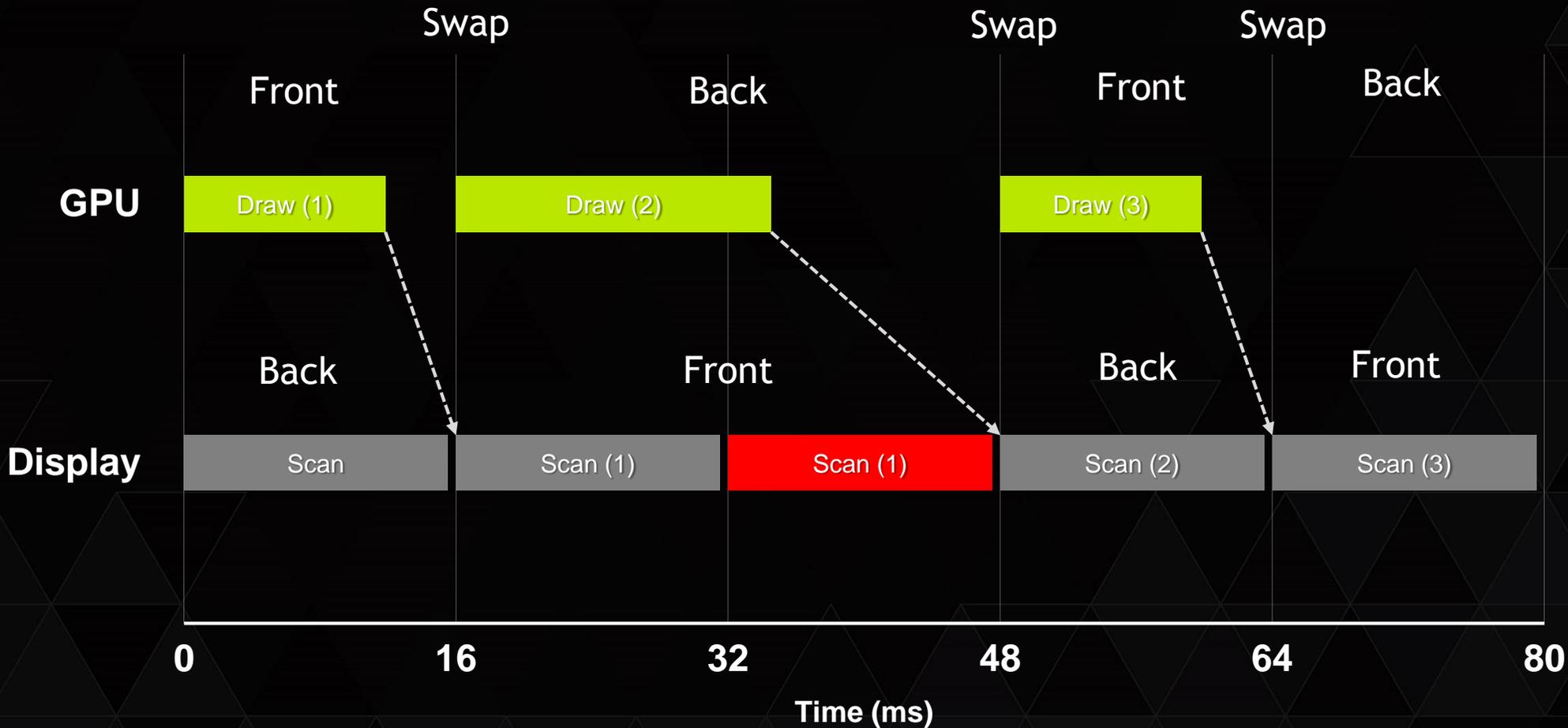


No information that tells a display or stereo glasses which eye is left or right

SWAPBUFFERS



SWAPBUFFERS



SWAPBUFFERS IN A CLUSTER



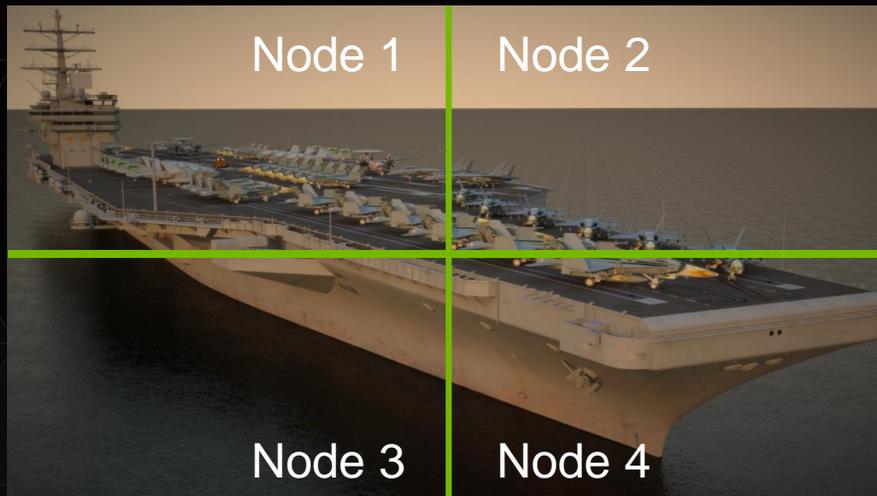
Each node is now rendering a scene with different complexity i.e from least to highest we get:

1. node 3 ~ 16ms = 60fps
2. node 4 ~ 36ms = 30fps
3. node 2 ~ 53ms = 15fps
4. node 1 ~ 99ms = 10fps

- With each node running at a different rate the user would perceive tearing on the screen.
- We need a mechanism to ensure that each node will *swap* at the same time.

SWAP GROUP AND SWAP BARRIER

- NVIDIA Extensions to OpenGL /DirectX (via NVAPI)
 - Swap Group - provides synchronization multiple GPUs in a single host
 - Swap Barrier - provides synchronization of GPUs across multiple nodes.
 - Use RJ45 (framelock) connection on Quadro Sync - so faster than sync over a network



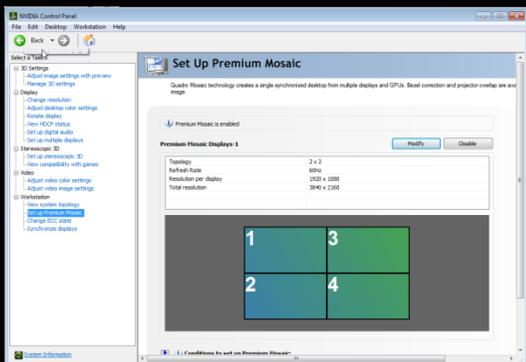
With *Swap Barrier* each node will wait until all nodes have completed their render

1. node 3 ~ 16ms = 10fps
2. node 4 ~ 36ms = 10fps
3. node 2 ~ 53ms = 10fps
4. node 1 ~ 99ms = 10fps

MOSAIC

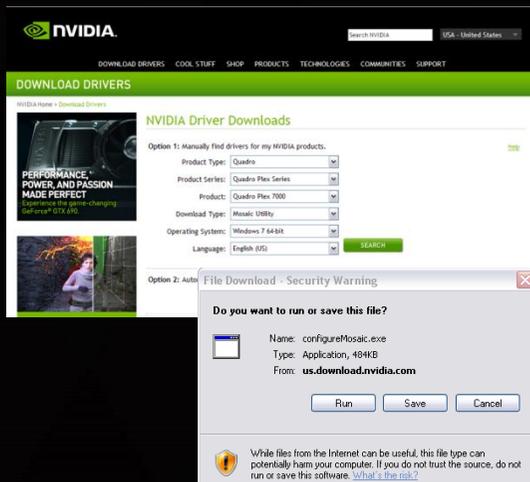
Setup and configuration

SETTING UP MOSAIC



Control Panel

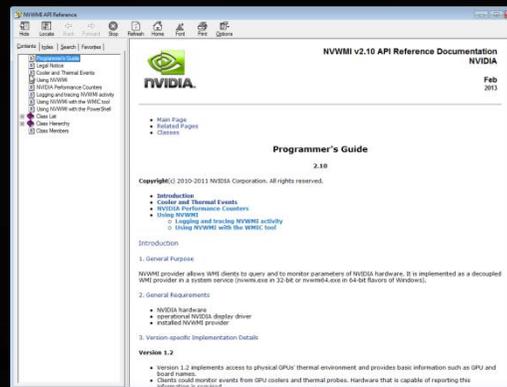
Driver Install



Configuremosaic

Large display walls

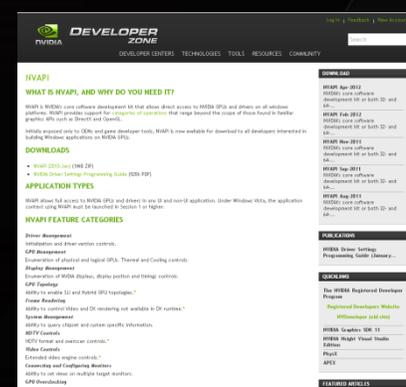
Download from NVIDIA driver section



NVNMI

Setup from a remote machine
Powershell scripts
Program directly

Install with Driver - under advanced options

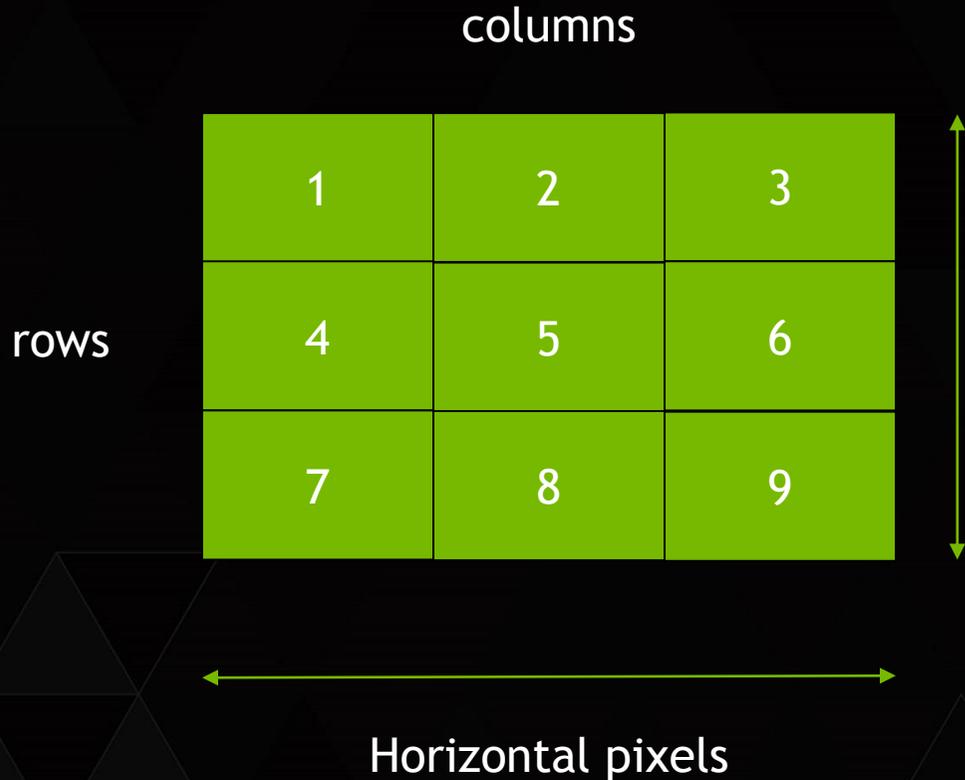


NVAPI

Incorporate MOSAIC setup into your own application

Registered Developer for NDA access NVAPI

MOSAIC GRIDS



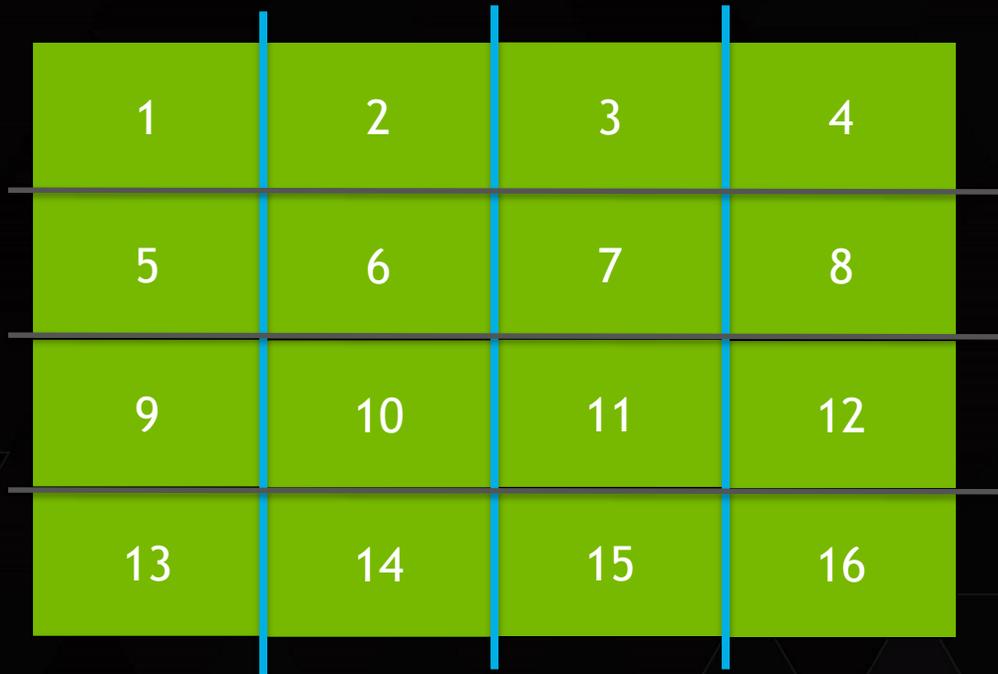
Rows x columns ≤ 16
Max Horizontal or vertical Pixels ≤ 16384

Enumeration of the Grid always starts top left and goes left to right

UNDERSTANDING TOPOLOGIES

Column overlap or bezel correction

Row
Overlap or
Bezel correction



Bezel correction will increase overall pixel size

i.e each display is 1920x1080
Bezel per column is 100

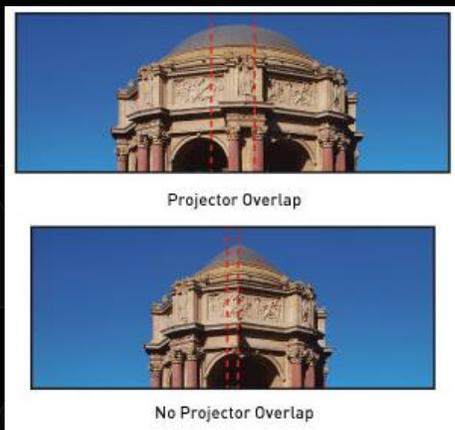
Total horizontal width
 $= 1920 * 4 + 100 * 3 = 7980$

Overlap correction will decrease overall pixel size

BEZEL AND OVERLAP CORRECTION

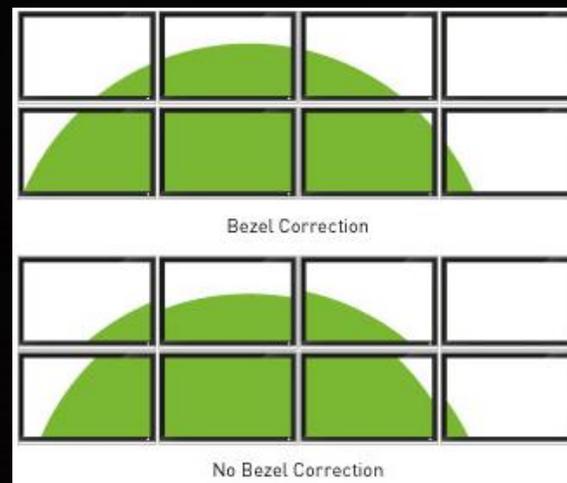
▶ Bezel Correction

- ▶ Will make the image look continuous as we render under the bezel

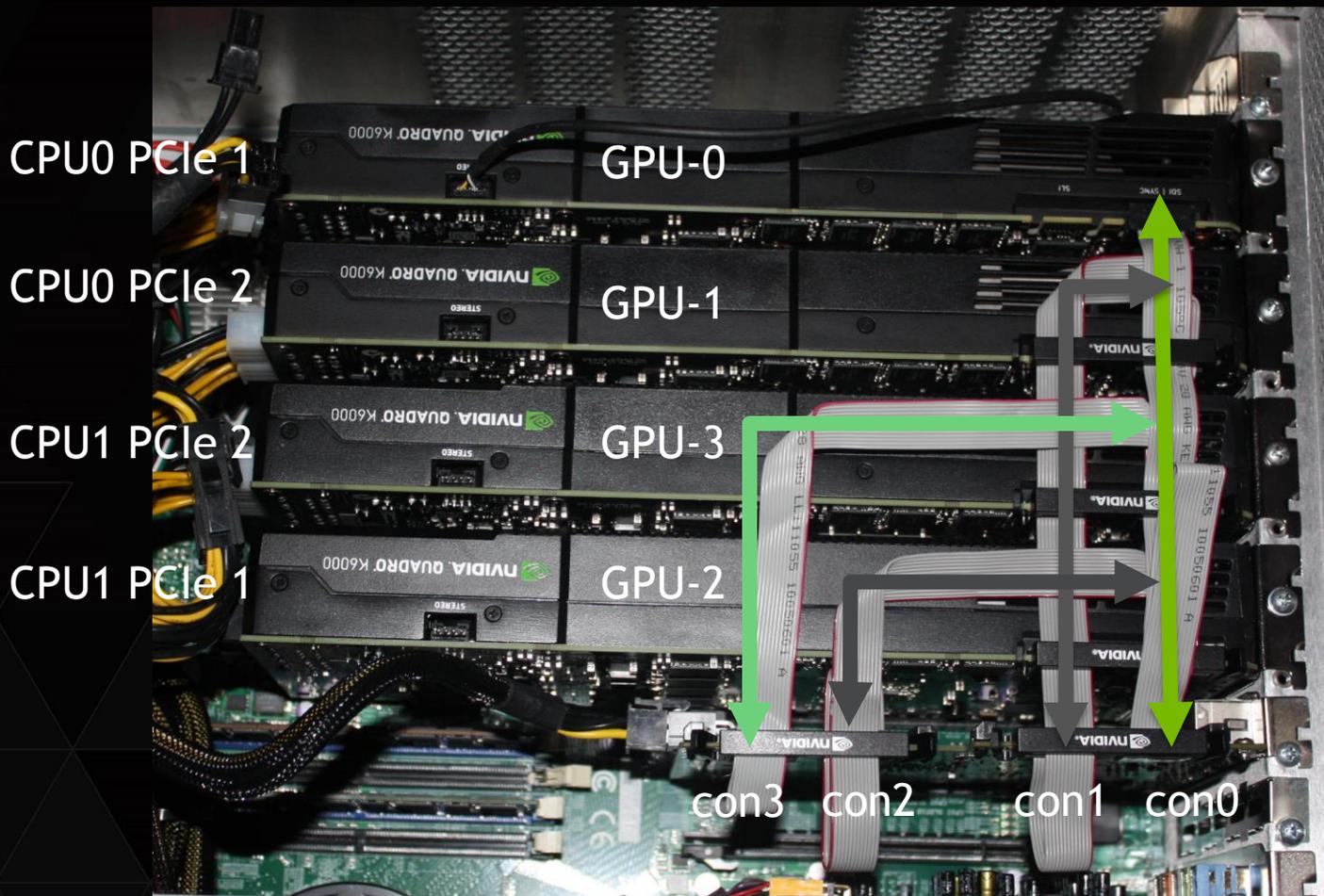


▶ Overlap Correction

- ▶ For projectors it maintains the aspect ratio of the display.

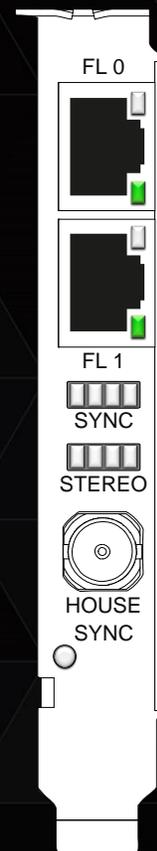


ANATOMY OF A SYSTEM



stereo sync bracket

Quadro Sync card



REAR PANEL - BOXX 8950 - 4 K6000S

VESA Stereo Bracket

GPU 0

GPU 1

GPU 3

GPU 2

Quadro Sync



Slot 2

VESA stereo - only one per system required
Doesn't require PCIe slot - just a blank

Slot 4

K6000 - Master GPU will have a green LED
after POST

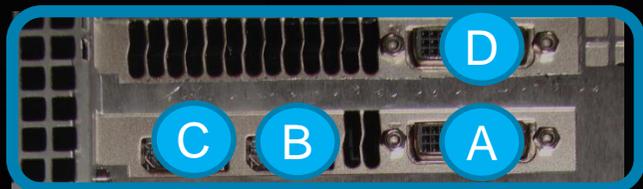
Slot 6

Slot 8

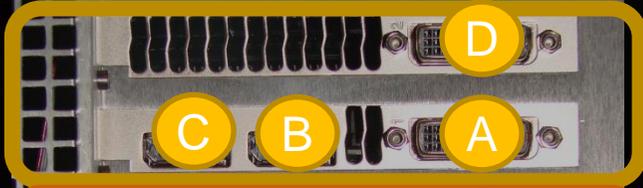
Connect to all 4 GPUs.
At boot-up LEDs will be amber showing GPU connected

PORT NUMBERING

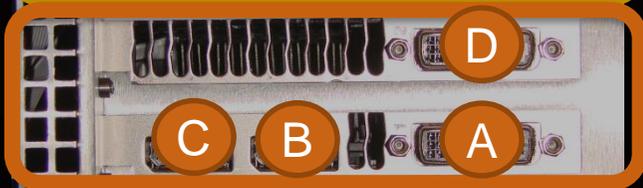
GPU 0



GPU 1



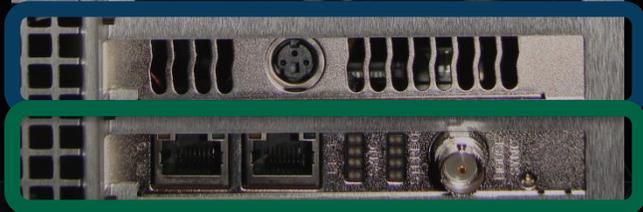
GPU 2



VESA Stereo Bracket



Quadro Sync



Ports auto enumerate depending what is attached –

i.e. A + D are attached

A = 0,0

D = 0,1

A + B + D are attached

A = 1,0

B = 1,1

D = 1,2

A + B + C + D are attached

A = 2,0

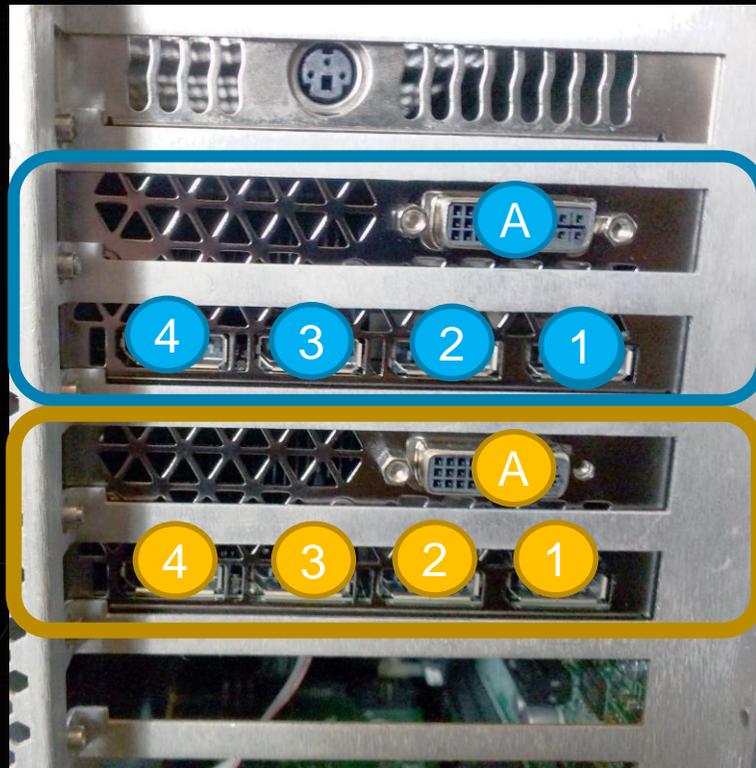
B = 2,1

C = 2,2

D = 2,3

PORT NUMBERING - QUADRO M6000

GPU 0



GPU 1

Ports auto enumerate depending what is attached –

i.e. A + 1 are attached

A = 0,0

1 = 0,1

1, 2, 3, & 4 attached

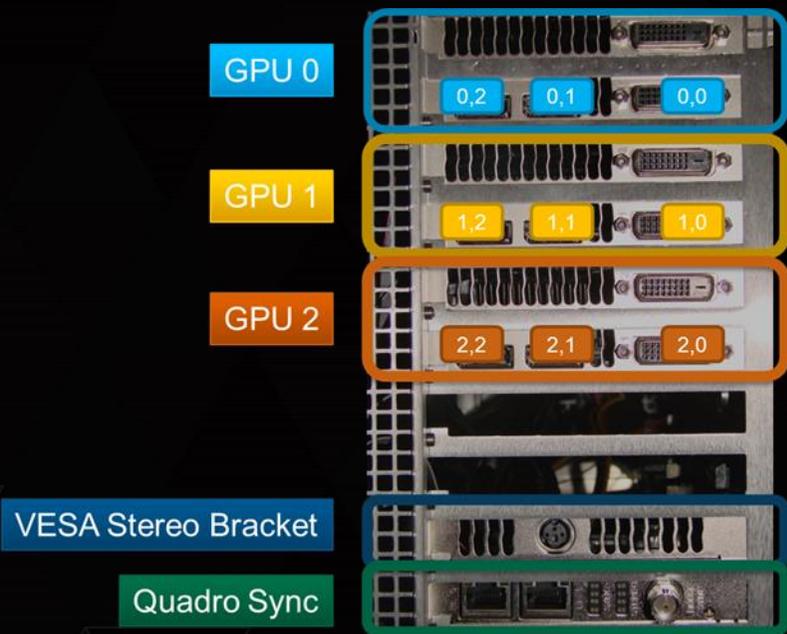
1 = 1,0

2 = 1,1

3 = 1,2

4 = 1,3

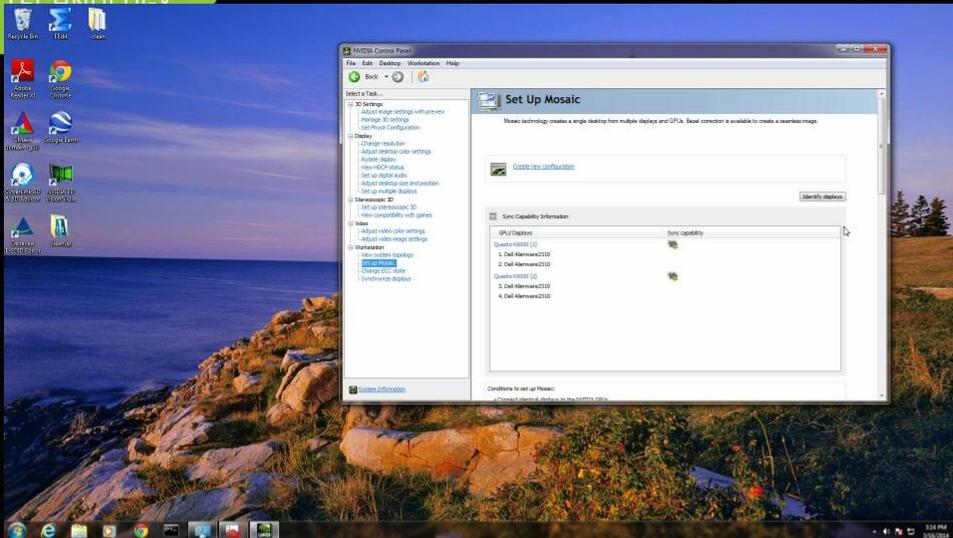
RELATING PORTS TO GRID



`configureMosaic.exe set rows=3 cols=3`

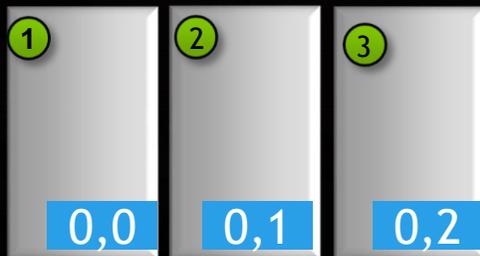
`configureMosaic.exe set rows=3 cols=3 out=0,0 out=0,1 out=0,2 out=1,0 out=1,1 out=1,2 out=2,0 out=2,1 out=2,2`





PORTRAIT MODE

- ▶ Some operations are best done by Command line
 - ▶ i.e. Portrait mode requires that GUI starts in **Landscape mode** - it's a feature ;-)



```
configureMosaic set rows=1 cols=3 rotate=90
```

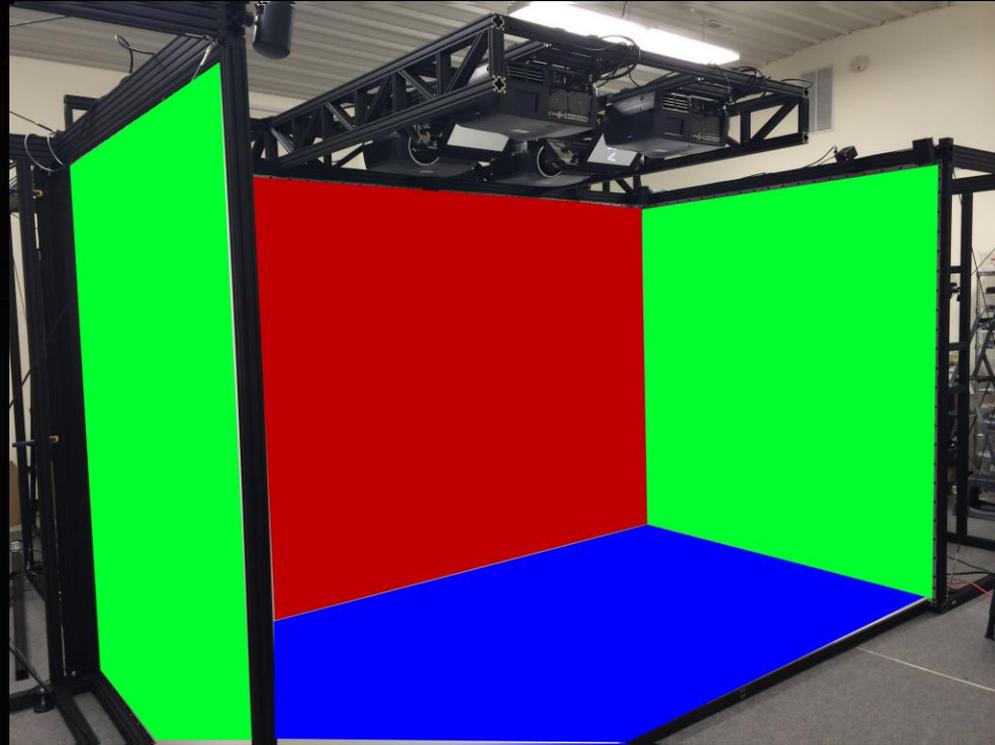
Valid Rotate values

90
180
270

MOSAIC GRIDS

- 12 Projectors, driven by 3 K5000s
- Floor and Front wall - 4 projectors
- Side walls are 2 projectors
- 4th GPU used a console output
- After configuring MOSAIC set Sync.
- Dual boot - works with Linux.

Image courtesy of VisBox



```
configureMosaic.exe set rows=1 cols=1 out=0,0 nextgrid rows=2 cols=2 overlap=384,240 out=1,0 out=1,1 out=1,2 out=1,3 nextgrid  
rows=2 cols=2 overlap=0,240 out=3,0 out=3,1 out=3,3 out=3,2 nextgrid rows=2 cols=2 overlap=384,480 out=2,0 out=2,1 out=2,2  
out=2,3
```

MOSAIC VERSUS EQUALIZER

MOSAIC with Clip

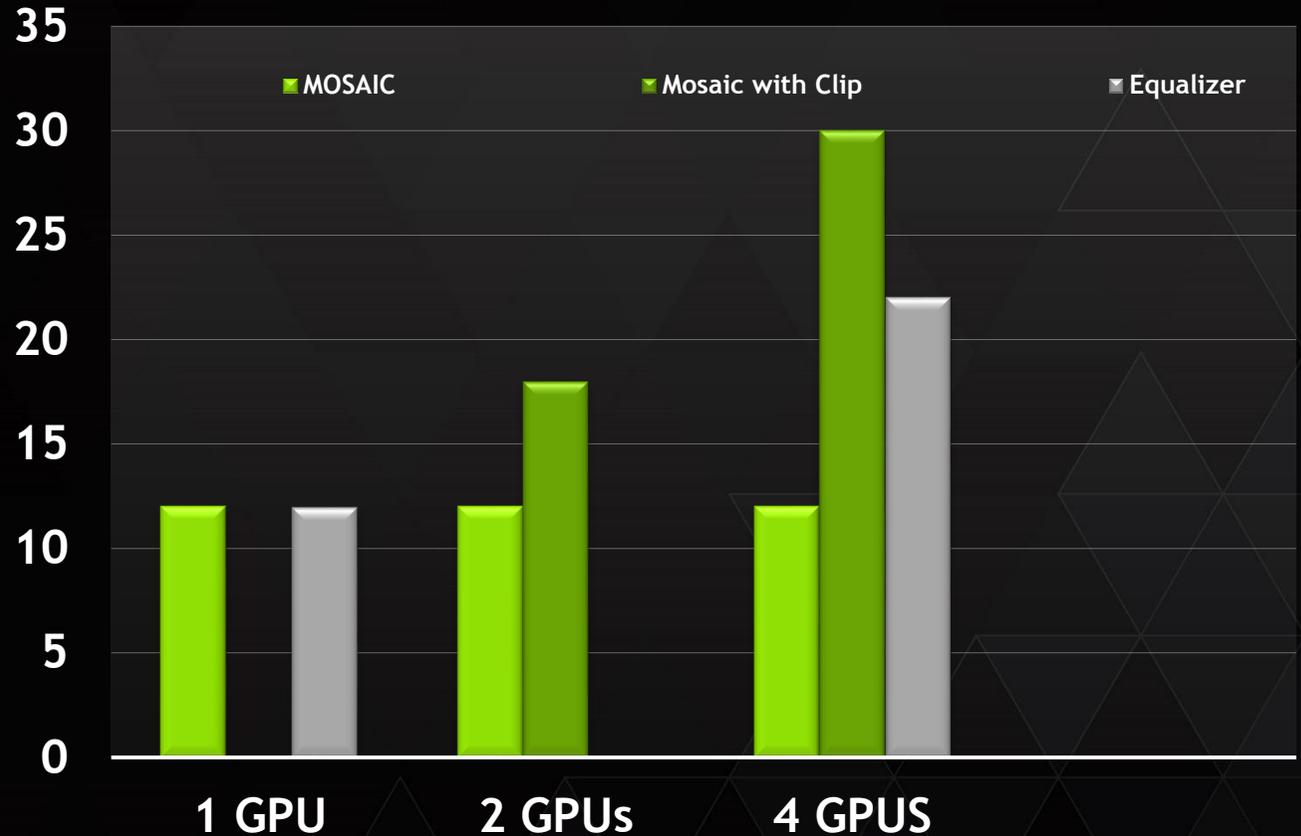
- Improves fill performance

Flat Wall

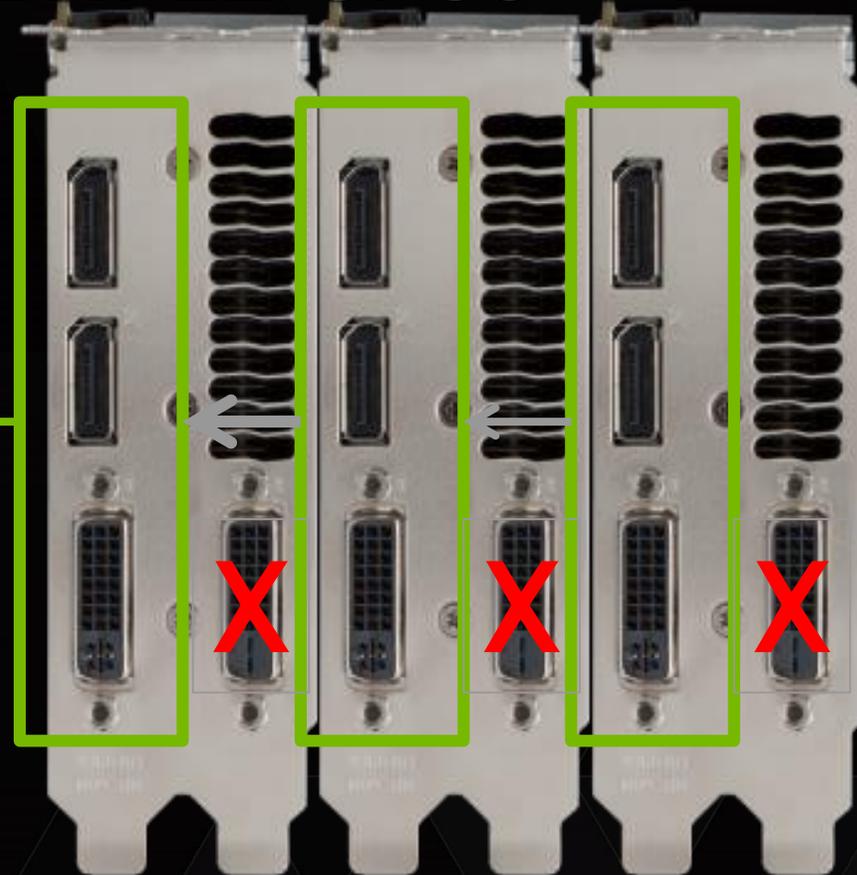
- 4 1920x1200 monitors
- 2x2 MOSAIC layout

Equalizer

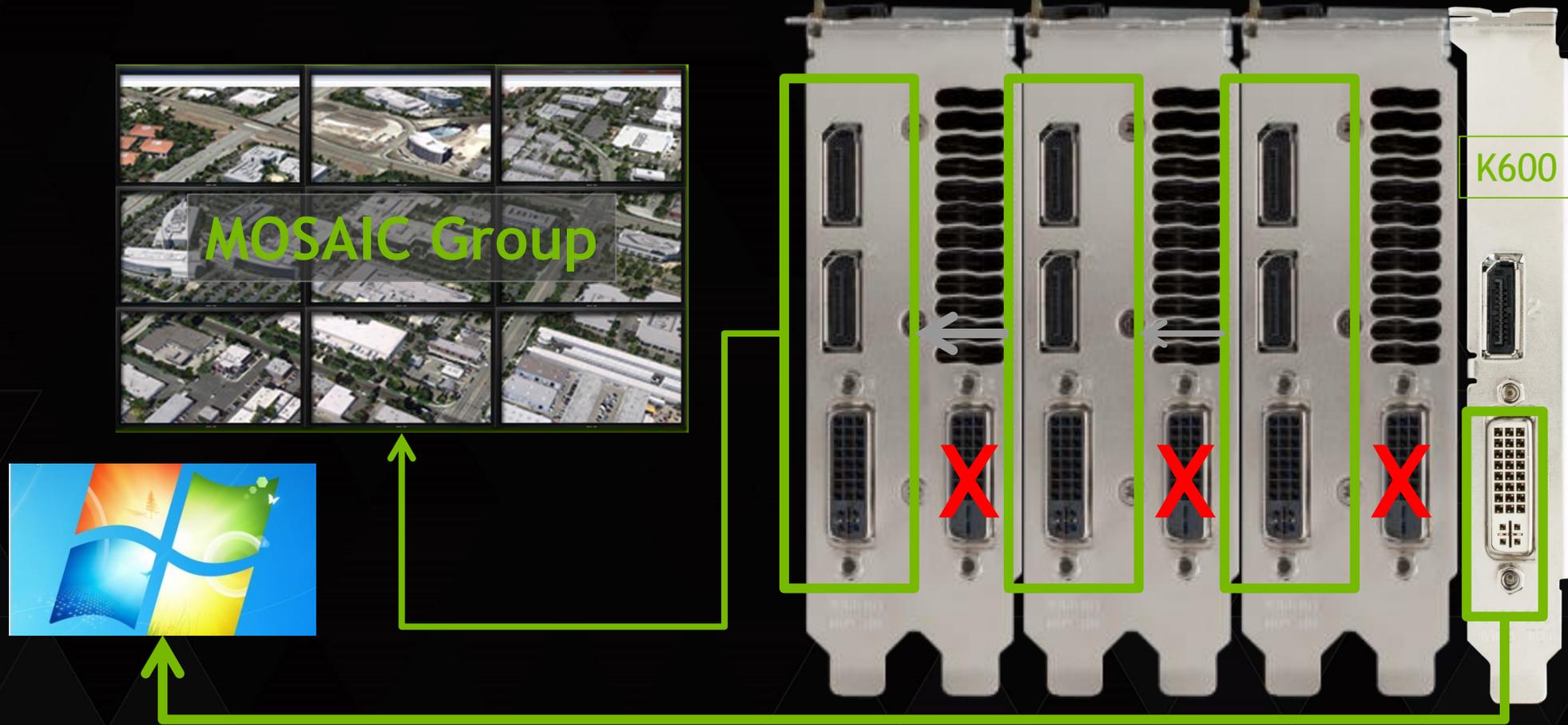
- Open source
- API intercept to convert applications to run on multi-GPUS



MOSAIC ACROSS MULTIPLE GPUS + 1



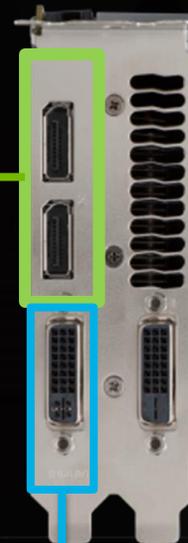
MOSAIC ACROSS MULTIPLE GPUS + 1



MOSAIC CONFIDENCE MONITOR R352

Aimed at 4K projectors with dual inputs.

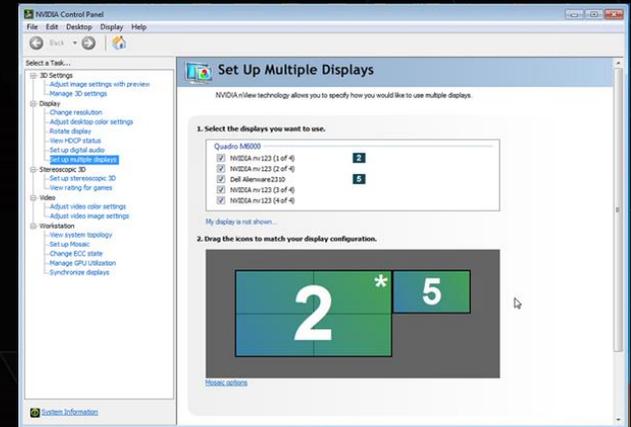
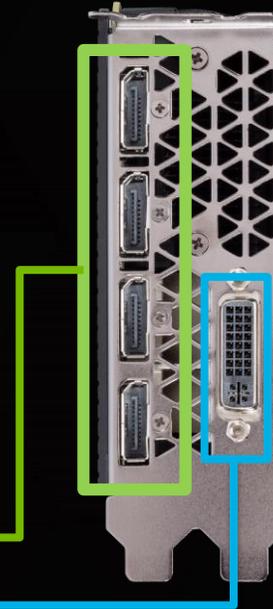
- Scale
- Area of interest
- Pan + Scan mode



- ▶ All displays on **single GPU**.
- ▶ Clone to a single monitor.

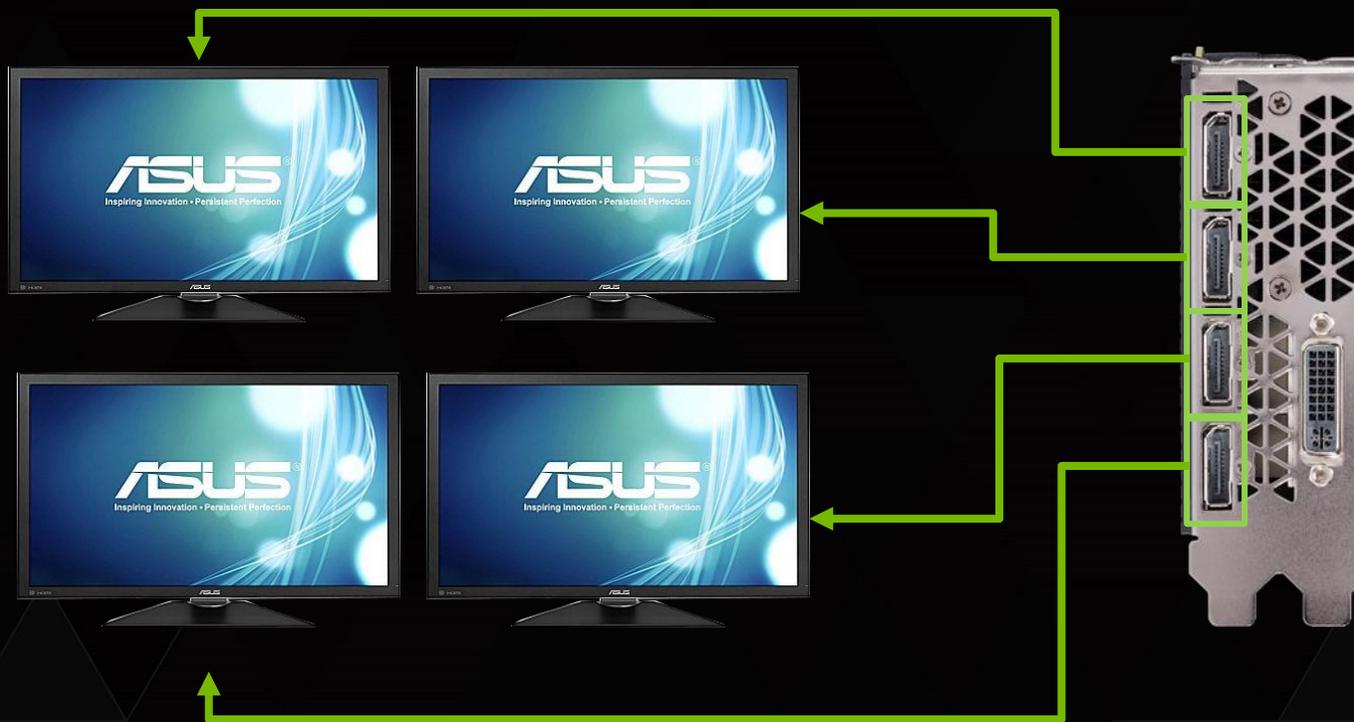
MOSAIC +1 ON QUADRO M6000

- Scale
- Area or interest
- Pan + Scan mode



5 active displays on single M6000
MUST be 4 native DP connections
Working in the lab - coming soon.....

M6000 - 4 X "4K" @60HZ



Supports 4 "4K" DP monitors - **both** MST + SST monitors are supported
Support 2 "5K" monitors.

SVS FEATURES

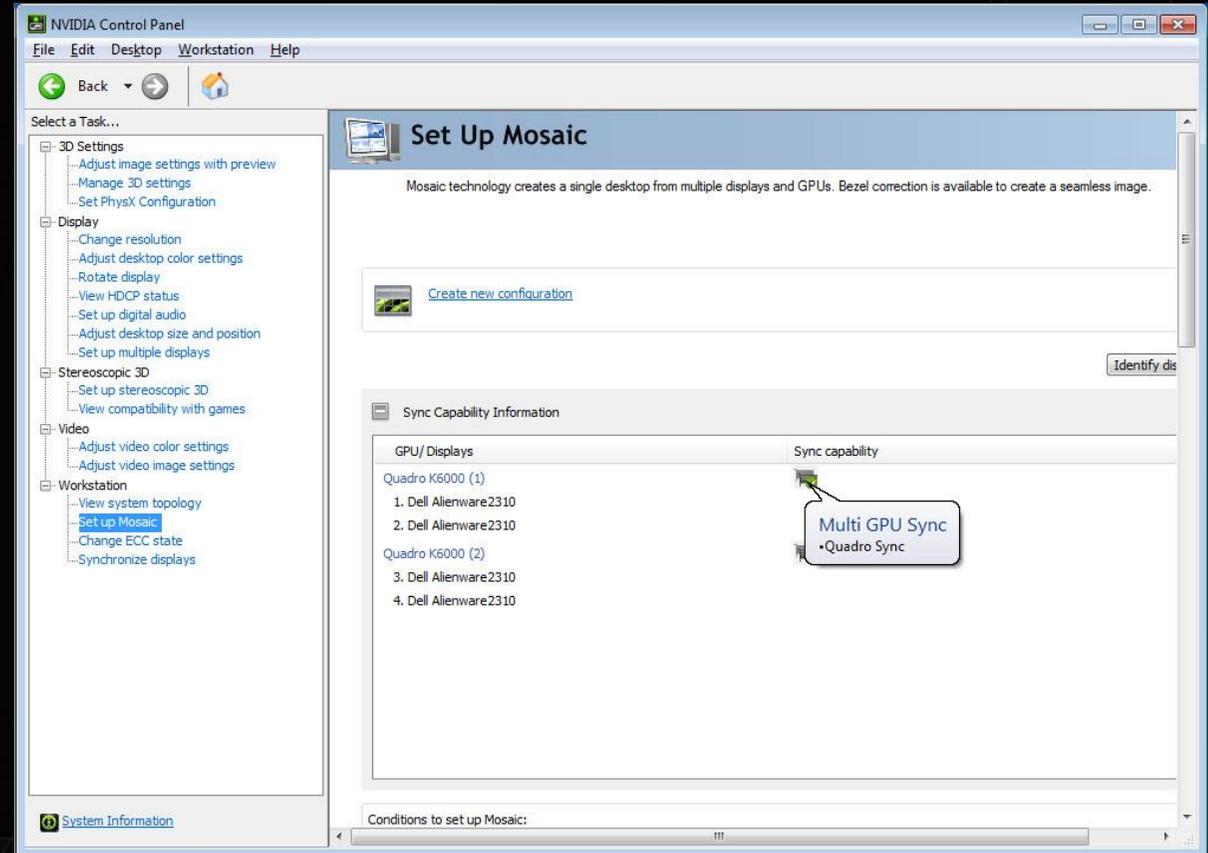
Premium MOSAIC= MOSAIC
with Sync

Sync Capability Information

Indicates whether or not card or
system can be sync'd.

R331 driver and above

- GPU and port number OSD



NEW SVS FEATURES - R346

Force Stereo Shuttering

- ▶ **Memory Allocation Policy**

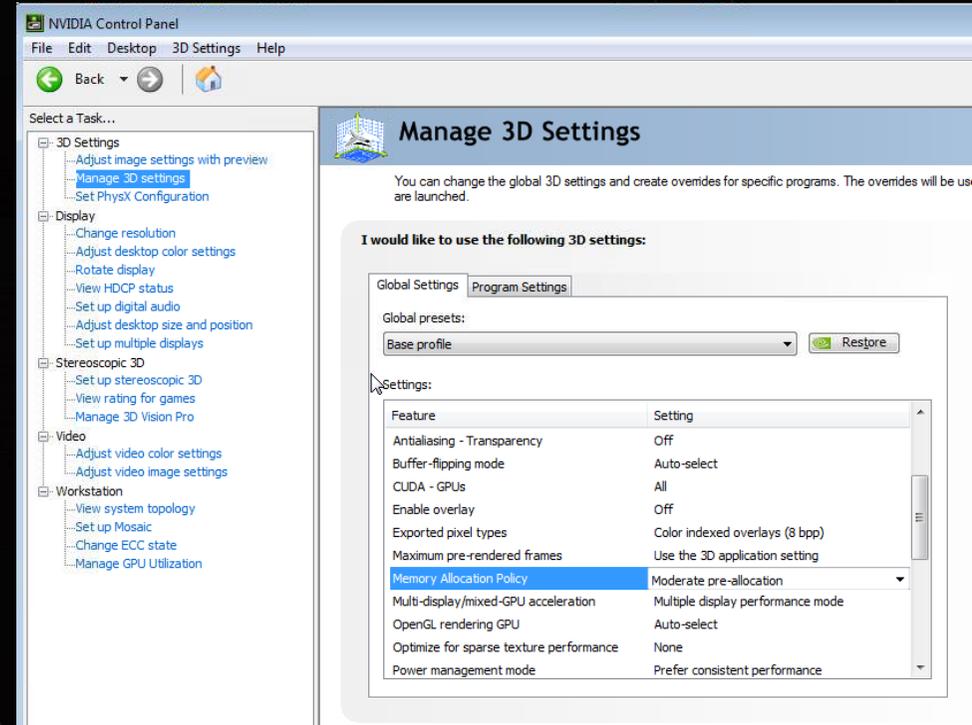
- ▶ Moderate Pre-allocation

- ▶ **Set Stereo to enable**

VESA stereo (3-pin) port will now be **active**
- even if no stereo app is running.

Notes:

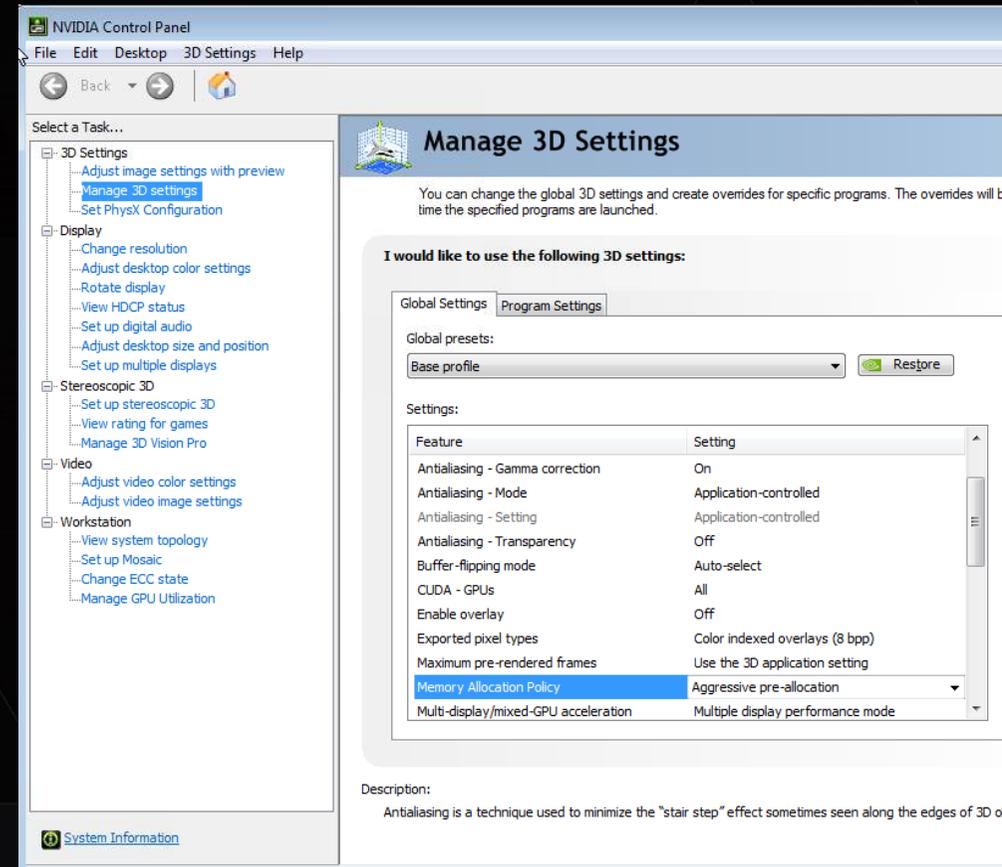
- 1) AERO desktop will always be disabled
- 2) 3D Vision Pro hub will be always enabled.



NEW SVS FEATURES - R346

Mode set Reduction

- ▶ “mode-sets” (SCREEN FLASH) reduction during setup for:
 - ▶ “Swap Groups”
 - ▶ “tear free” mode - i.e. Video Edit Profile
- ▶ Memory Allocation Policy
 - ▶ Aggressive Pre-allocation
- ▶ Note:
 - ▶ force stereo will also be enabled
 - ▶ AERO is disabled
 - ▶ Doesn't affect MOSAIC setup - ie. Still screen flash



NVIDIA Control Panel

File Edit Desktop 3D Settings Help

Back Home

Select a Task...

- 3D Settings
 - Adjust image settings with preview
 - Manage 3D settings
 - Set PhysX Configuration
- Display
 - Change resolution
 - Adjust desktop color settings
 - Rotate display
 - View HDCP status
 - Set up digital audio
 - Adjust desktop size and position
 - Set up multiple displays
- Stereoscopic 3D
 - Set up stereoscopic 3D
 - View rating for games
 - Manage 3D Vision Pro
- Video
 - Adjust video color settings
 - Adjust video image settings
- Workstation
 - View system topology
 - Set up Mosaic
 - Change ECC state
 - Manage GPU Utilization

Manage 3D Settings

You can change the global 3D settings and create overrides for specific programs. The overrides will be used the next time the specified programs are launched.

I would like to use the following 3D settings:

Global Settings Program Settings

Global presets:
Base profile Restore

Settings:

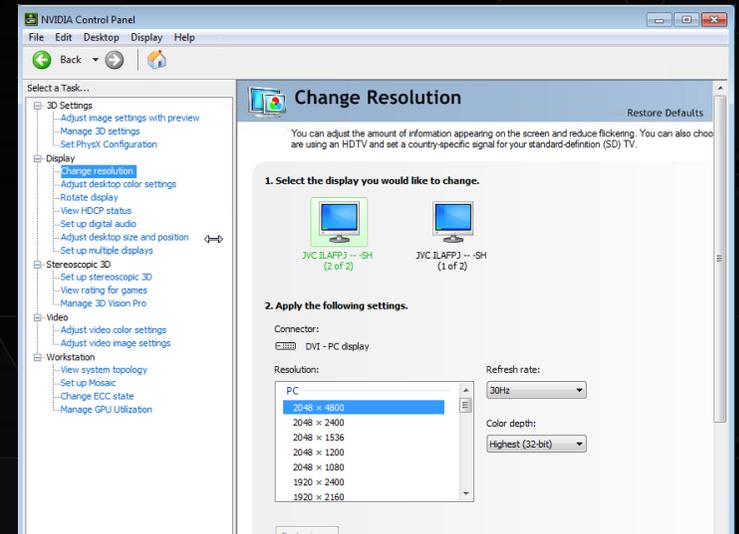
Feature	Setting
Antialiasing - Gamma correction	On
Antialiasing - Mode	Application-controlled
Antialiasing - Setting	Application-controlled
Antialiasing - Transparency	Off
Buffer-flipping mode	Auto-select
CUDA - GPUs	All
Enable overlay	Off
Exported pixel types	Color indexed overlays (8 bpp)
Maximum pre-rendered frames	Use the 3D application setting
Memory Allocation Policy	Aggressive pre-allocation
Multi-display/mixed-GPU acceleration	Multiple display performance mode

Description:
Antialiasing is a technique used to minimize the "stair step" effect sometimes seen along the edges of 3D objects.

System Information

JVC 8K E-SHIFT PROJECTOR SUPPORT

- ▶ NVIDIA drivers detects projector via EDID
- ▶ Exposes a **2400x4800** display timing per input (**projector has 4 inputs**).
- ▶ We scan out - alternate **1200x2400** odd/even frames
- ▶ VESA stereo (3pin) port is used to identify odd/even frame.



TILED DISPLAYS - AUTO MOSIAC

- **Each Tile (Display)**
 - Unique EDID
 - VESA Display ID extension - provides position information
 - NVIDIA driver automatically enables MOSAIC
- **Example Displays**
 - 4K MST Monitors
 - 5K MST Monitors
 - 4K “research” projector



GPU TECHNOLOGY
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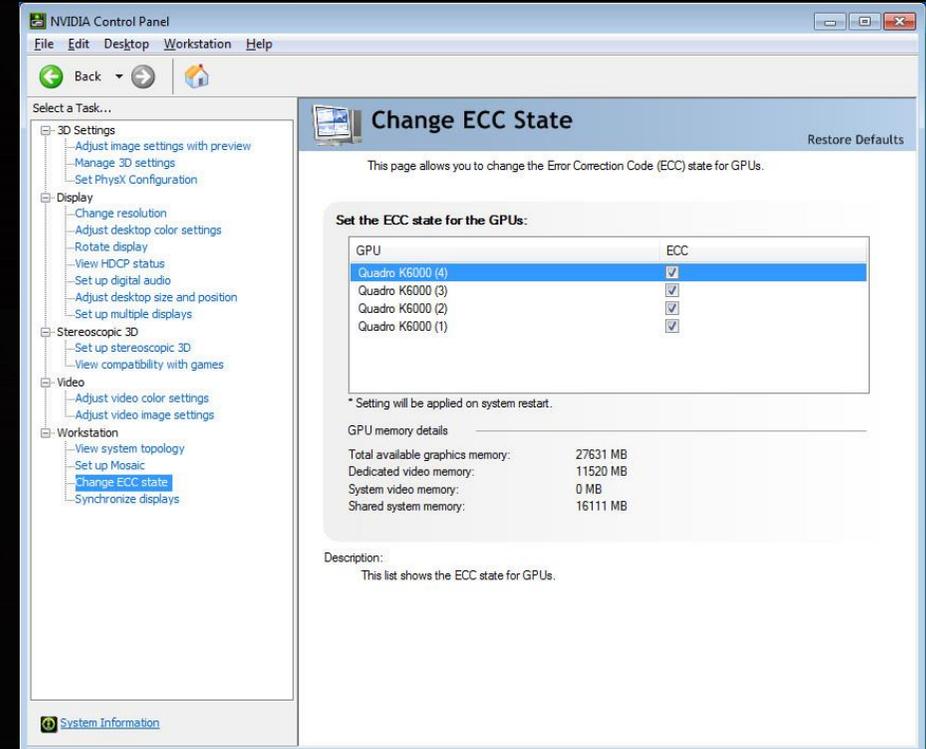
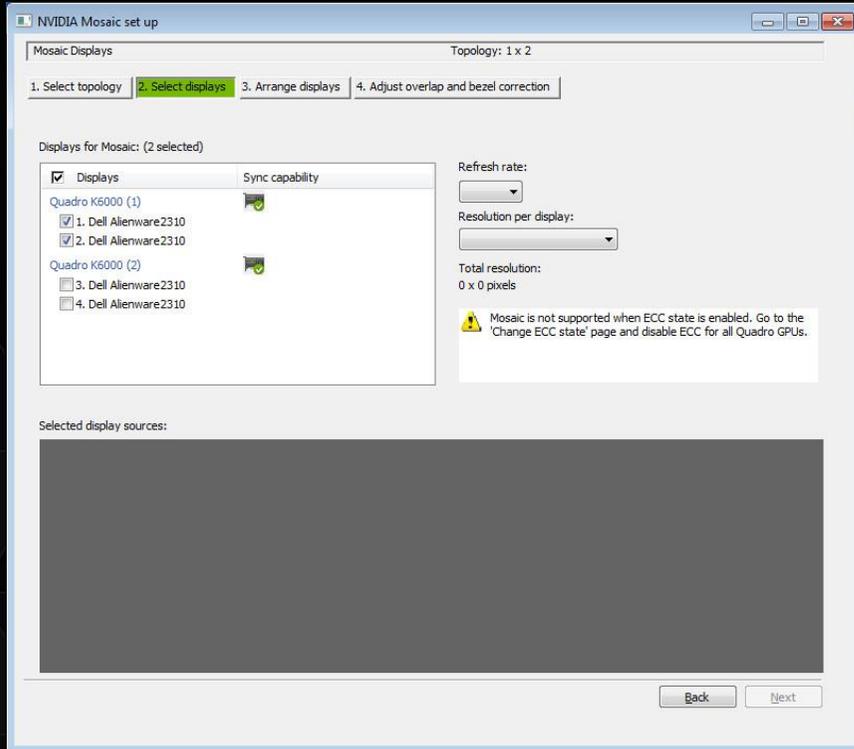
COMMON MOSAIC SETUP ISSUES

JOIN THE CONVERSATION

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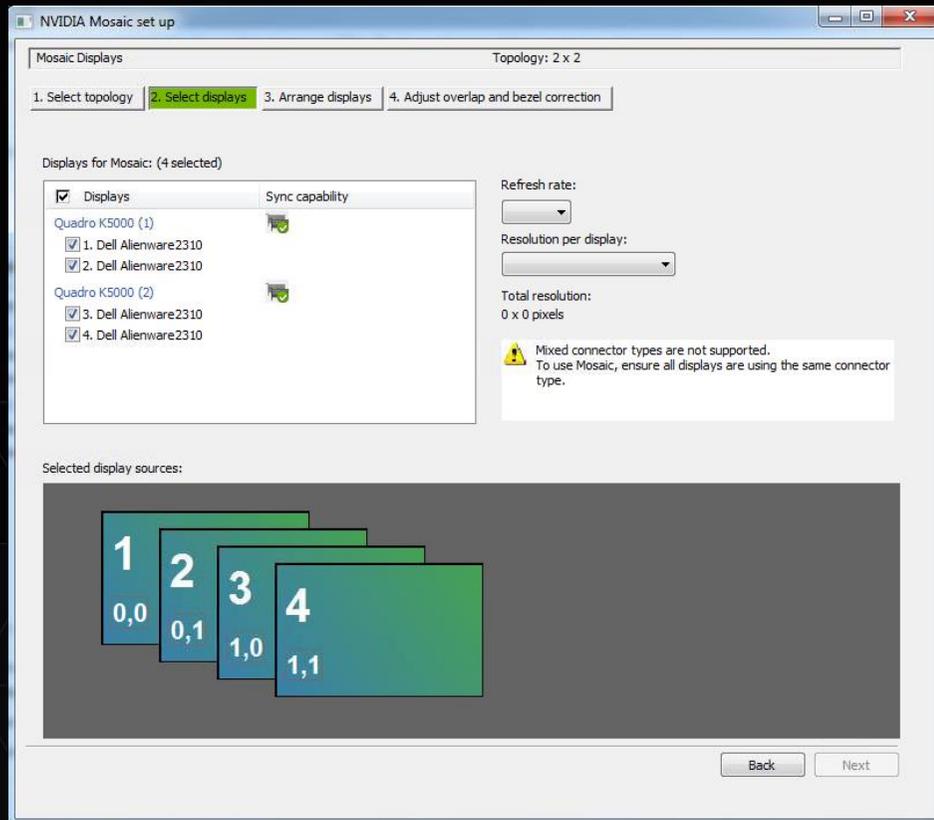
MOSAIC DOESN'T ENABLE ON MULTI-GPUS



MOSAIC **does not work** with ECC on - Make sure it is off

MOSAIC ERROR - MIXED CONNECTORS

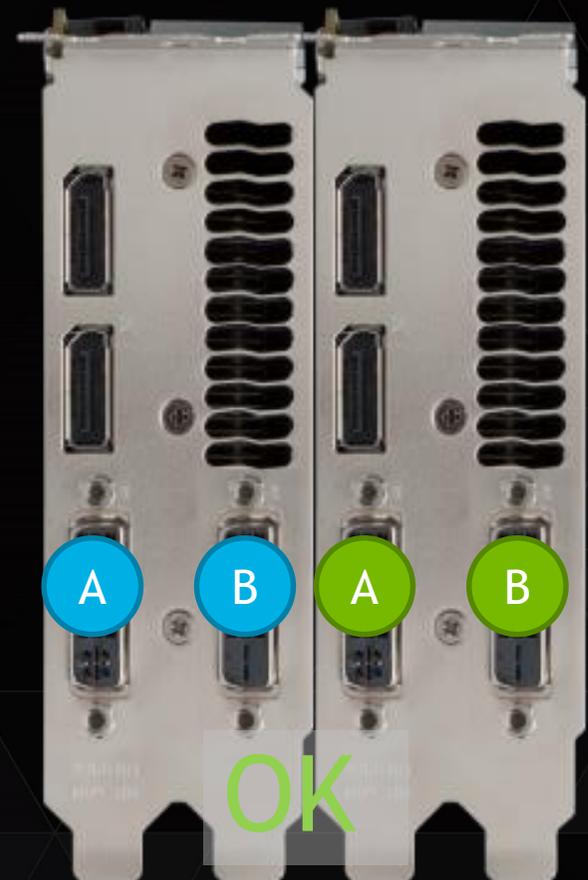
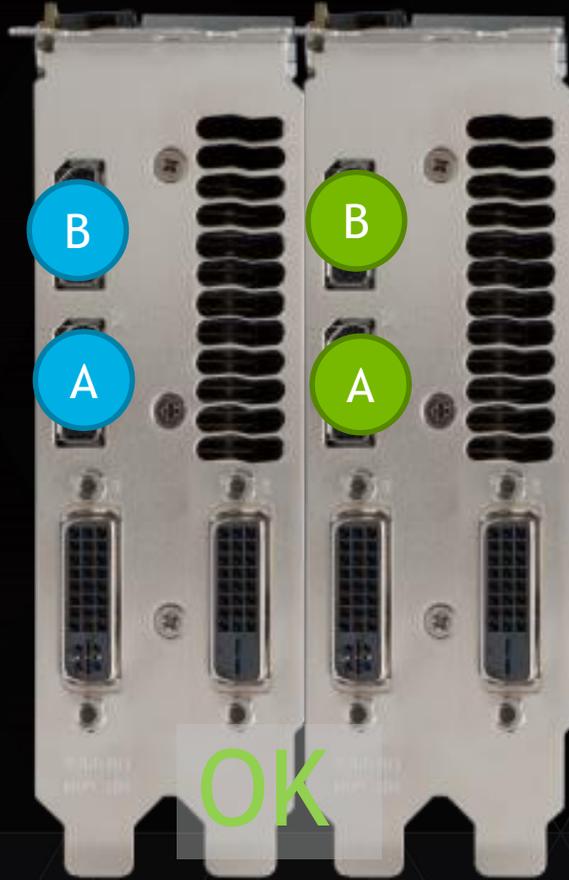
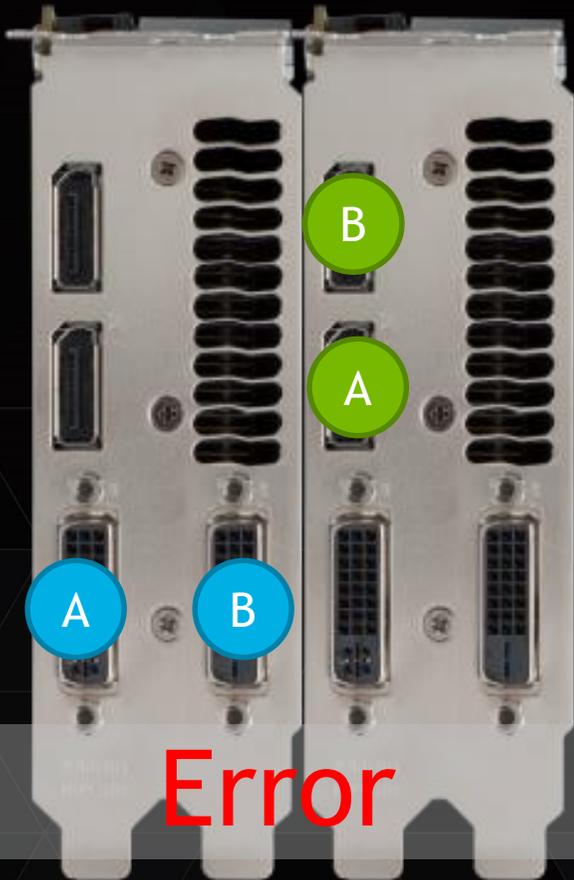
Error - “Mixed Connectors are not Supported”



- ▶ Occurs if you have two DVI connectors on one GPU and use DP on the other.
- ▶ Complex rule
 - ▶ Basically need to use connectors of all one type first before using opposite
 - ▶ True even if you use dongles

MOSAIC ERROR - MIXED CONNECTORS

Error - "Mixed Connectors are not Supported"



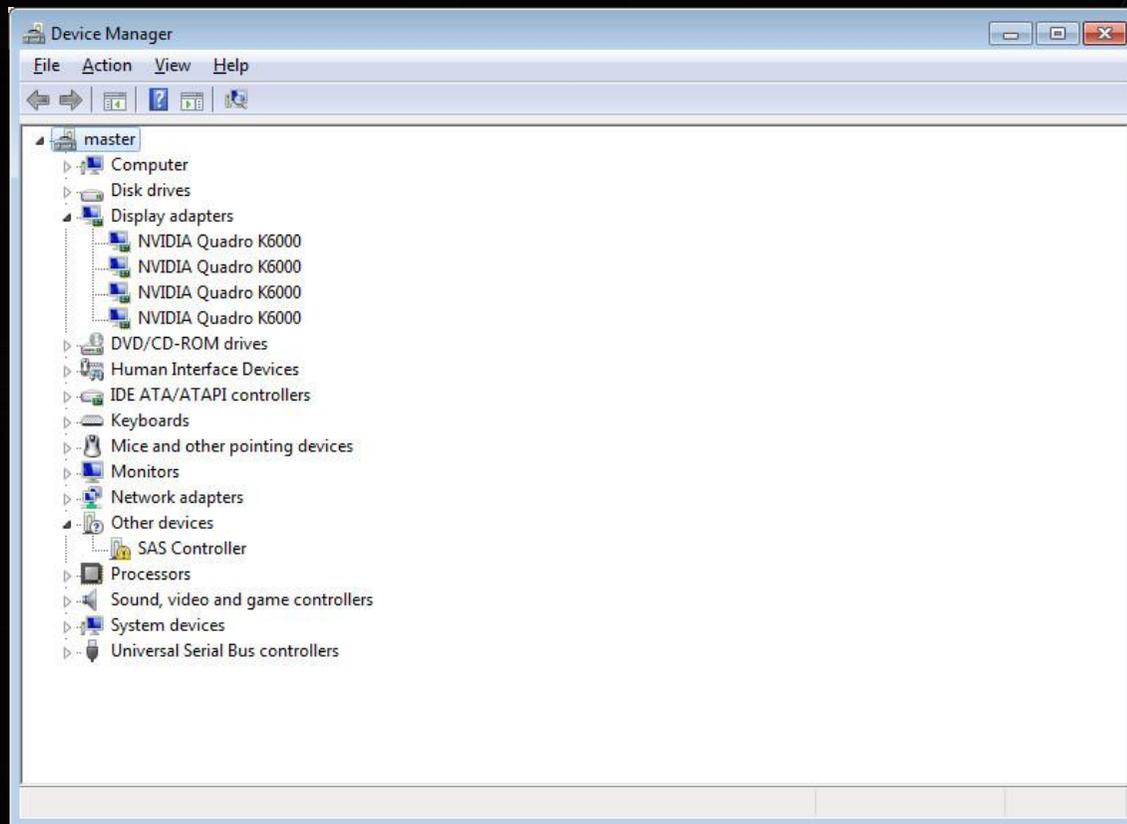
MOSAIC TIPS

Make sure there is no Mirror Driver installed

Mirror Driver is installed by remote admin software. It will sit between the OS and graphics driver.

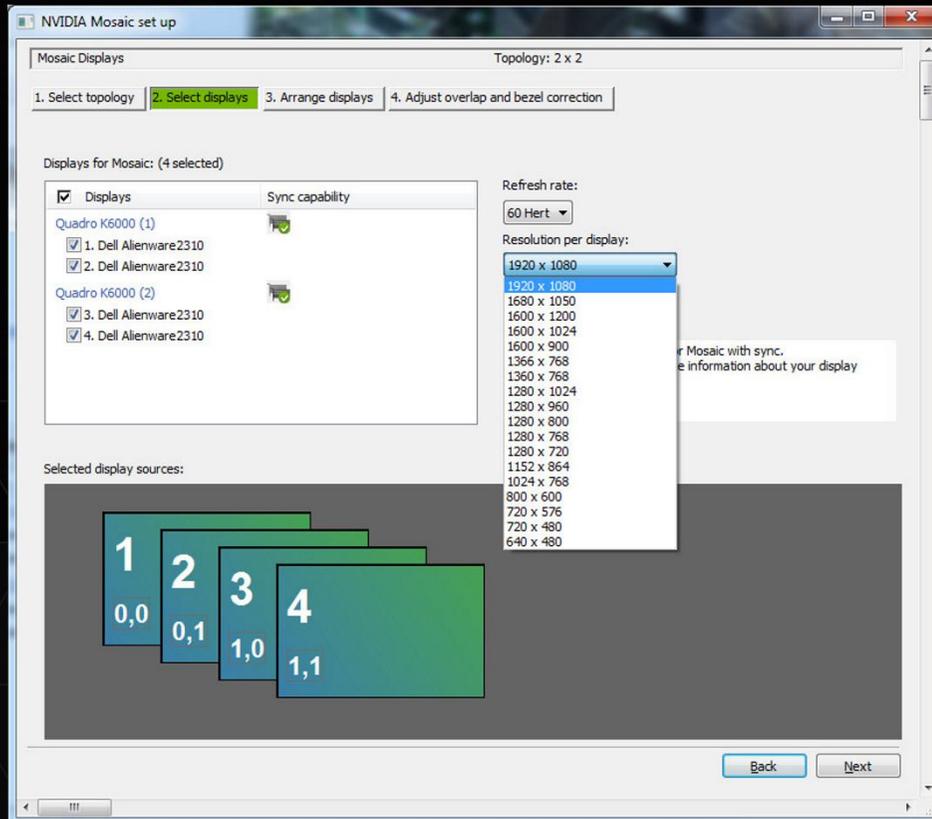
Will often break

- 3D stereo
- accelerated video playback
- MOSAIC + Sync
- Cause DWM to crash



MOSAIC DISPLAY RESOLUTION NOT LISTED

Resolution missing from MOSAIC setup menu



- ▶ Display Resolution is missing in drop down
- ▶ Three probably causes:
 1. Expected Resolution is not **common** across all displays
 2. The requested topology **exceeds** the **16K** max width or height in pixels.
 3. Bug related to **rotated** displays where max resolution is OK but NVIDIA CPL calculates based on landscape display

MOSAIC RESOLUTION NOT LISTED

No Common timings

- ▶ 1920x1080 @60 - just an identifier

Resolution, refresh rate		3840 × 2160 pixels, 60.000 Hz	
		Horizontal (2200)	Vertical (1125)
Active		1920	1080
Border		0	0
Front porch		88	4
Sync width		44	5
Back porch		148	36
Polarity		Positive (+)	Positive (+)

1. Displays have different **EDIDs**
2. **Mixing EDID and Custom resolutions** - custom resolution may not match EDID.
3. Wrong **cabling**
 - DP to HDMI dongle blocks resolutions
 - Single link DVI cables versus dual link

System topology will report backend timings

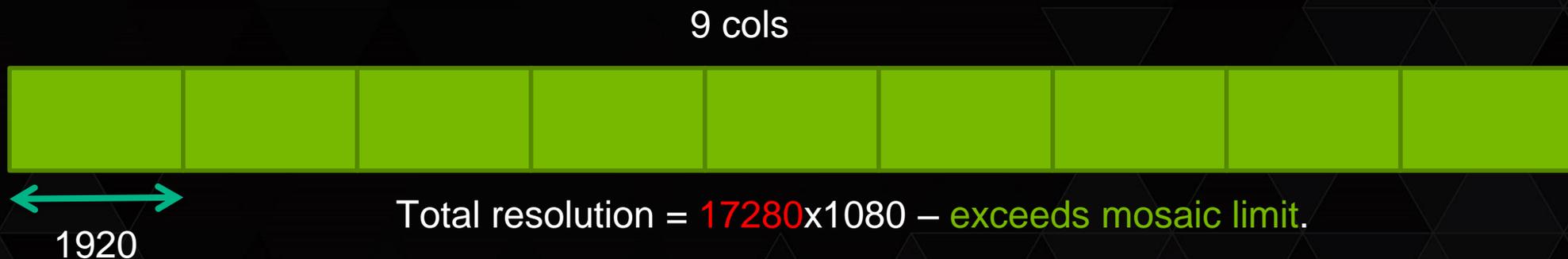
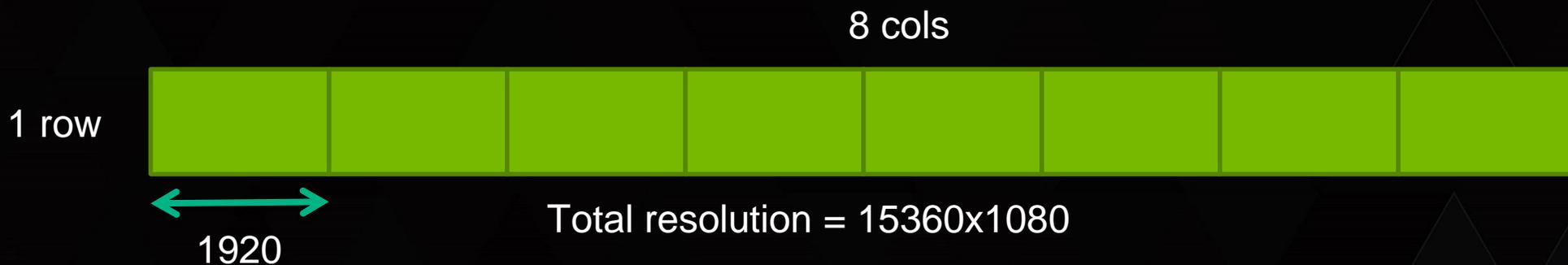
MOSAIC RESOLUTION NOT LISTED

No Common timings - Solutions

- ▶ Use **System Topology**
 - ▶ To check timing - will catch most differences
- ▶ Use **nvtimingdiag.exe**
 - ▶ Prints detailed timing to help identify miss-matched displays
 - ▶ Contact - QuadroSVS@nvidia.com for a copy.
- ▶ Use **ManageEDID**
 - ▶ Apply one good EDID to all sources
- ▶ **Avoid** mixing Custom Resolutions and EDIDs
 - ▶ Apply custom resolution to all displays.

MOSAIC RESOLUTION NOT LISTED

Make sure **max resolution does** not exceed (16384)



Note Bezel Correction will add to the total resolution.

MOSAIC RESOLUTION NOT LISTED

Portrait mode

- ▶ Bug with calculating total pixel width. Value is based on Landscape mode not Portrait.
- ▶ Can result in total resolutions that are within max spec being excluded
- ▶ Solution
 - ▶ Use configuremosaic command tool i.e.
 - ▶ Configuremosaic set rows =1 col=8 rotate=90

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DISPLAY CONNECTORS

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DRIVING ULTRA HIGH RES DISPLAYS

Connector	Version	Max pixel clock	Color depth	Max resolution for single cable
Display Port	1.3**	~	6bpc (YUV 4:2:0)	Up to 8k (UHD) @60Hz
	1.3**	~	12bpc	Up to 5K @ 60Hz
	1.2	~592 MHz	12bpc	Up to 4K @ 60Hz
	1.1a	~330 MHz	10bpc	Up to 4k @ 30Hz
HDMI	2.0*	~600 MHz	12bpc	Up to 4K @ 60Hz
	2.0	~330 MHz	6bpc (YUV 4:2:0)	Up to 4K @ 60Hz
	1.4b	~330 MHz	10bpc	Up to 4k @ 30Hz
	1.0 to 1.3			Does not support 4K
DVI	Dual Link	330 MHz	8bpc	Up to 4K @ 30Hz
	Single link	165 MHz		Does not support 4K

Resolution per cable is a function of the connection bandwidth and color depth.

Color - Windows Desktop 8bit, OpenGL Apps - 10/12bit, DirectX??

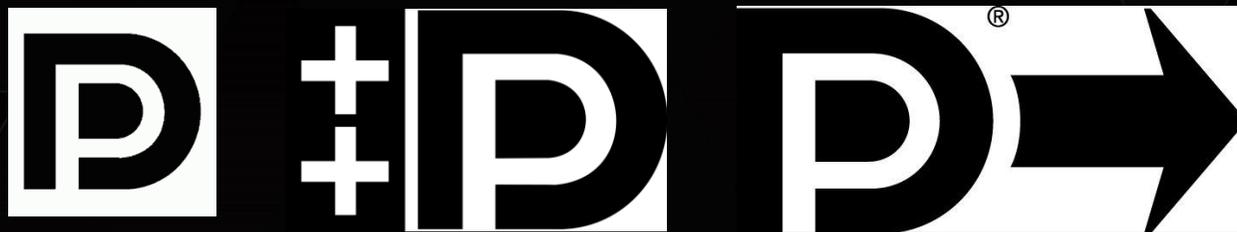
NOTE: Displays, extenders, switches may not implement full speed connections

*High bandwidth HDMI2.0 supported on M6000 using DVI to HDMI adaptor

** DP1.3 support has not been announced

DISPLAY PORT

- ▶ Always use **certified** “Logo’d” Display Port equipment
 - ▶ Displays
 - ▶ Dongle
 - ▶ MST Hubs
 - ▶ Cables
 - ▶ Extenders



NVIDIA only tests equipment that is DP Certified

HDMI CABLES DONGLES

▶ DVI to HDMI

- ▶ DVI to HDMI is **pin compatible**
- ▶ HDMI signaling over single-link DVI cables (3840x2160@60Hz)
- ▶ HDMI 2.0 / HDMI1.4b support



“good” quality cables



Adaptors tend to have more leakage
- don't support high resolution

▶ DP to HDMI

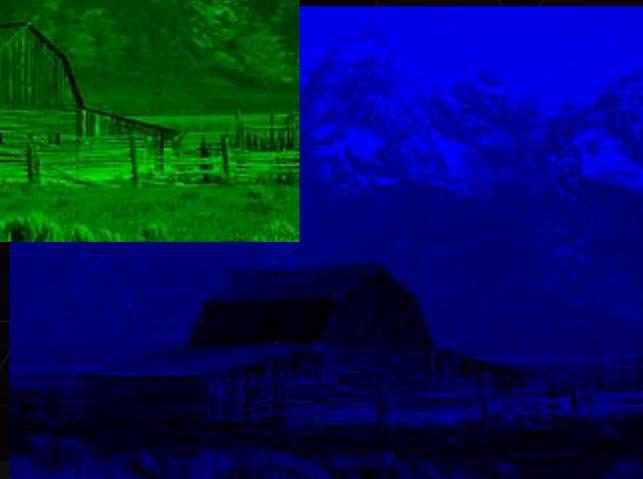
- ▶ DP (Type 2) to HDMI passive dongle
- ▶ HDMI 2.0 / HDMI1.4b support
- ▶ Marketed as supporting 4K HD, stereoscopic



HDMI 2.0 (4:2:0) support added in R340 - Kepler cards + above

HDMI 2.0 (4:4:4) supported on Quadro M6000 (Note - probably only through DVI port - not sure the DP to HDMI dongles support it)

RGB COLOR



YCBCR - BRINGING COLOR TO A BLACK AND WHITE TV



Y = Luminosity

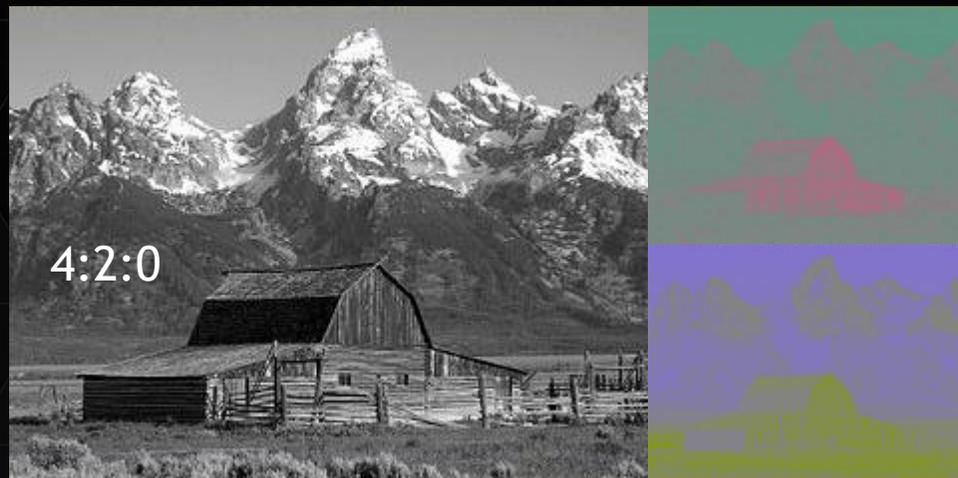
Cb = "Blue-ness"



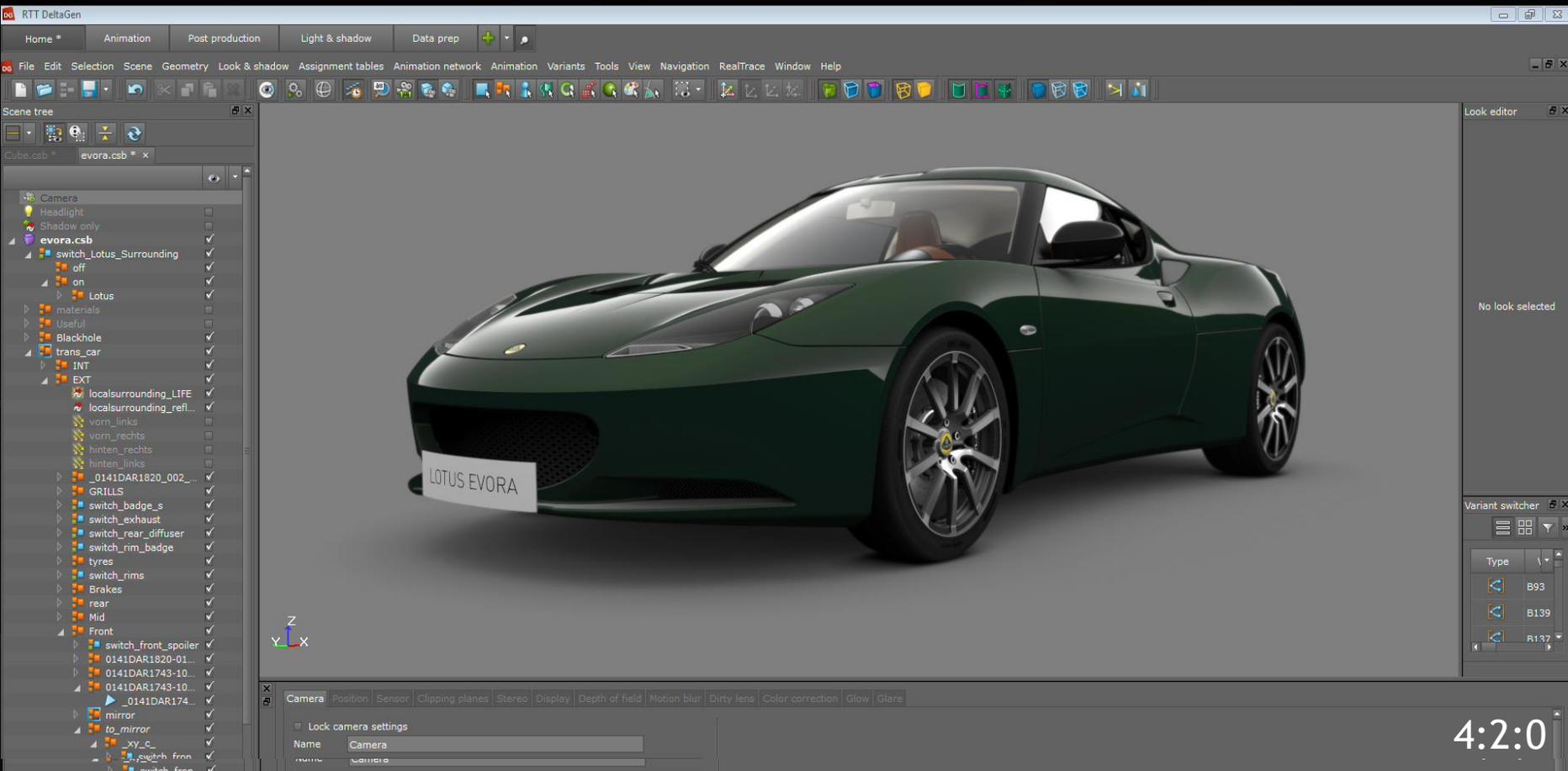
Cr = "Red-ness"



1/2 THE DATA SIZE



WHAT'S THE IMPACT?



evora.csb	✓
switch_Lotus_Surrounding	✓
off	✓
on	✓
Lotus	✓
materials	□
Useful	□
Blackhole	✓
trans_car	✓
INT	✓
EXT	✓
localsurrounding_LIFE	✓
localsurrounding_refl...	✓
vorn_links	□
vorn_rechts	□
hinten_rechts	□
hinten_links	□
_0141DAR1820_002_...	✓
GRILLS	✓
switch_badge_s	✓

4:4:4

evora.csb	✓
switch_Lotus_Surrounding	✓
off	✓
on	✓
Lotus	✓
materials	□
Useful	□
Blackhole	✓
trans_car	✓
INT	✓
EXT	✓
localsurrounding_LIFE	✓
localsurrounding_refl...	✓
vorn_links	□
vorn_rechts	□
hinten_rechts	□
hinten_links	□
_0141DAR1820_002_...	✓
GRILLS	✓
switch_badge_s	✓

4:2:0

DISPLAY PORT + HDMI ARE SMART CONNECTIONS

- ▶ **Link training at power-up**
 - ▶ Sink - Source devices.
 - ▶ Exchange details about capabilities
 - ▶ Will test the cable bandwidth
 - ▶ Maintains signal quality by lowering bandwidth.
- ▶ **This means:**
 - ▶ Short cables may support high resolution (bandwidth) signals
 - ▶ Longer cables may block high resolution (bandwidth) signals)
 - ▶ When troubleshooting try to use as short as possible cables.

DISPLAY PORT MST HUBS

All hubs have the same bandwidth (HBR 2) - 5.4 Gbps



Max Res 2 ports ~2560x1600@60Hz



Max Res 3 ports ~ 2048x1536@60Hz

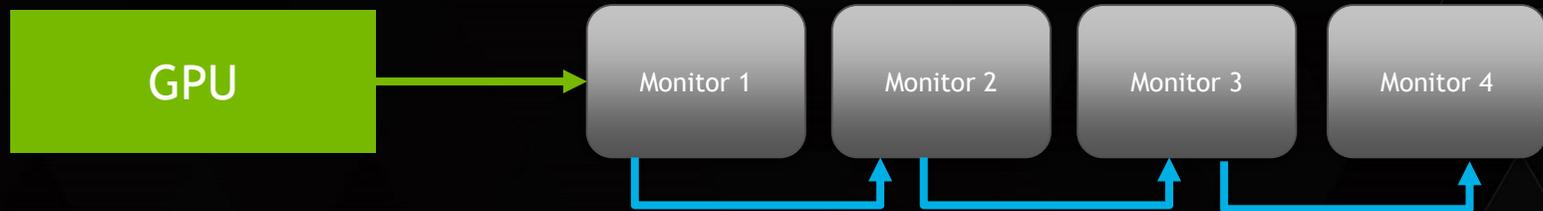


Max Res 4 port ~ 1920x1080@60Hz

Max active displays per card = 4. MST Hubs **do not** let you exceed that
MOSAIC + MST Hubs is **supported**. Use a DP certified hub.

DP MULTI-STREAMING DISPLAYS

- ▶ Daisy chain from one display to the next

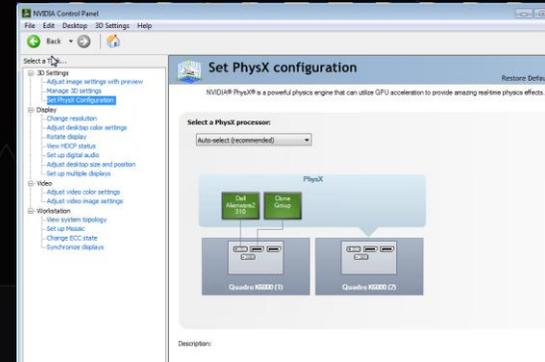
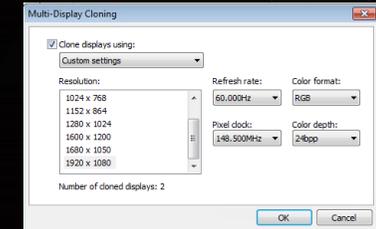
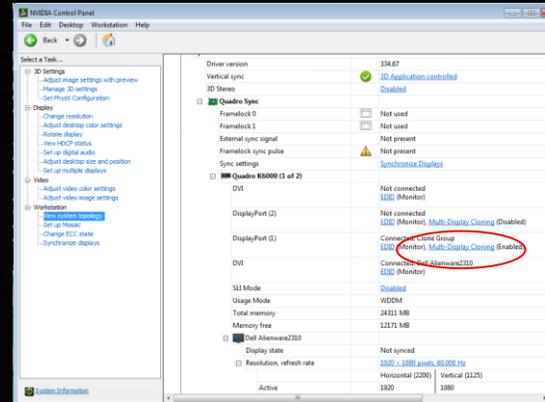
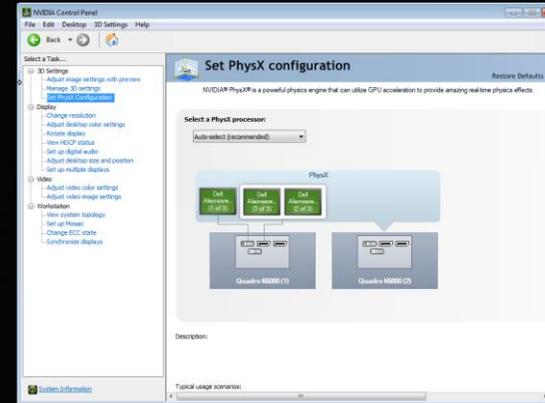


Max bandwidth is 5.4 Gbps to share between monitors

- We currently **do not** “support” MOSAIC with daisy chaining.
- We support DP Clone mode & Extended desktop.
- Max of 4 Displays per GPU.

DP MST CLONING

- Showing 3 displays
 - Two are using MST Hub
- Two displays on MST hub are “branching device”
- Select “Multi-Display Cloning”
- After enabled - identified as a Clone Group



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BUILDING A CLUSTER

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QUADRO SYNC - HARDWARE + SOFTWARE

▶ Hardware

- ▶ RJ45 - Framelock for synchronization of multiple displays to a common internal sync
- ▶ BNC/Genlock - Framelock for synchronization of multiple displays to a common external house sync

▶ Software

- ▶ *Requires application to be written with extensions*
- ▶ Swap Group and Swap Barrier are OpenGL & DirectX Extensions that provide enhanced synchronization of the graphics swap buffer.

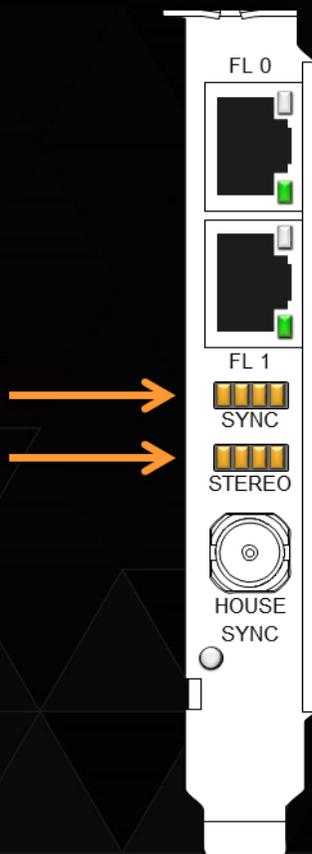


Quadro Sync

QUADRO SYNC FEATURES

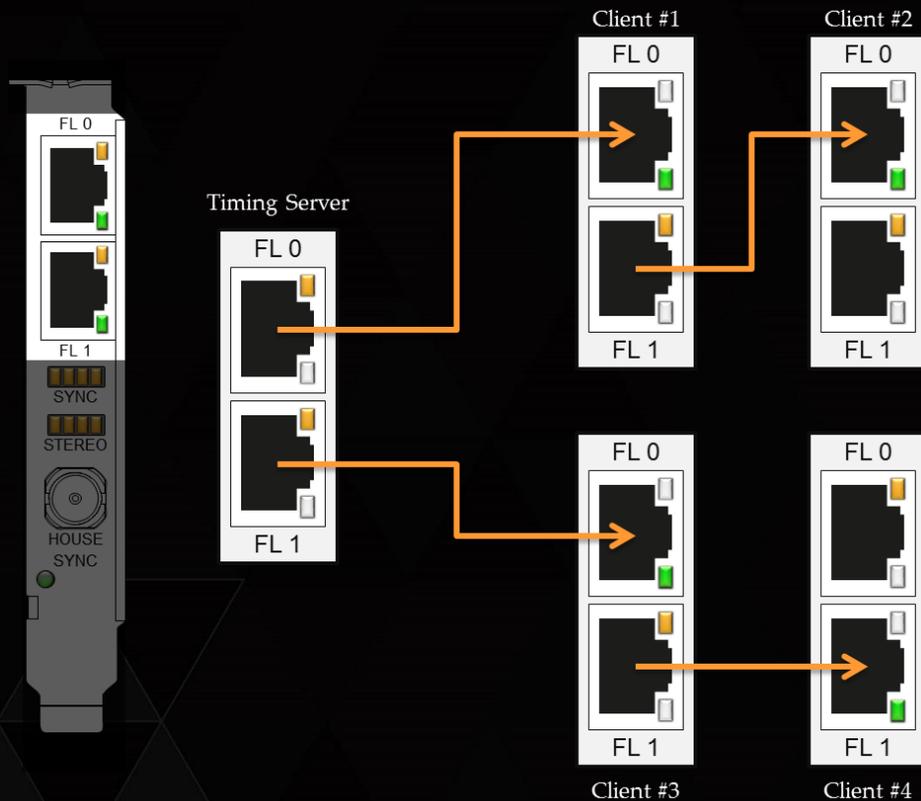
- ▶ Increased Swap Barrier Support
 - ▶ Up to **25 Quadro Sync** cards in single chain.
 - ▶ **50 Quadro Sync** cards in a cluster
 - ▶ 4 GPUs per Quadro Sync - 200 GPUs with Swap Barrier Support
- ▶ **Sync Delay** and Skew settings
 - ▶ Ability to adjust sync delay per Quadro card.
- ▶ Control via NVAPI
 - ▶ public developer version - developer.nvidia.com/nvapi
 - ▶ Example code on how to control Quadro Sync
- ▶ Control via NVSMI
 - ▶ Allows **remote** control across a cluster

BOOTING



- ▶ When the board boots after shutdown ALL the Sync and Stereo lights turn **Solid Amber**, like at the left
 - ▶ A reboot will not change the LEDs from the previous state, only a power cycle does
 - ▶ The LEDs change to the correct status after the driver loads
- ▶ If there are no LEDs illuminated on system boot, check the power cable

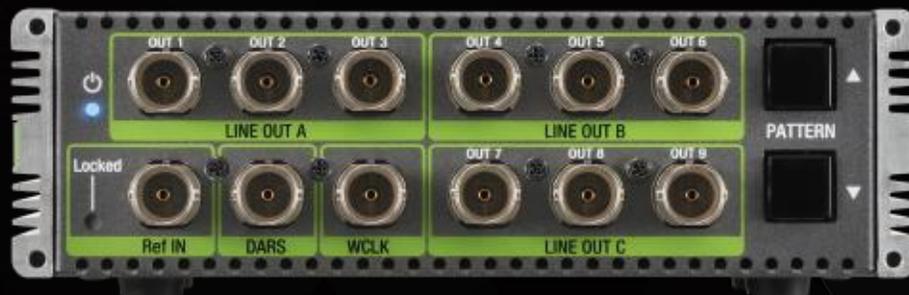
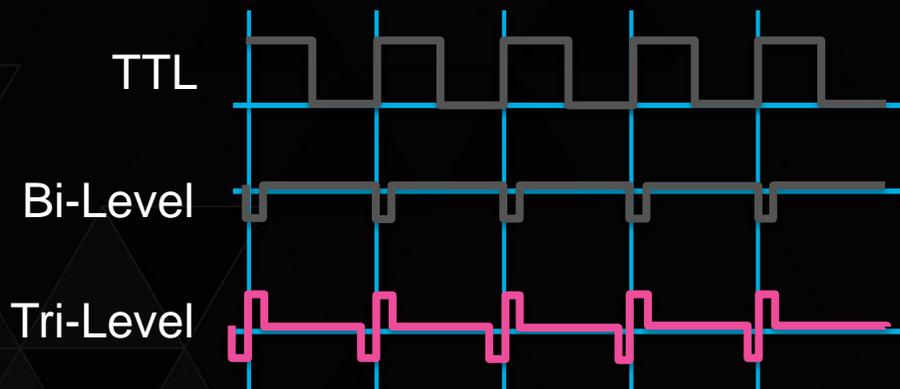
WIRING A CLUSTER



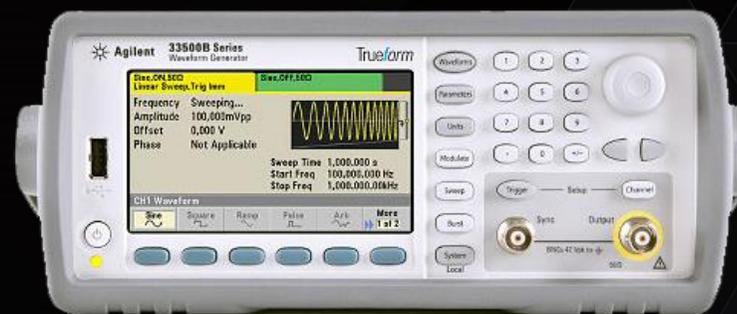
- ▶ Connect the nodes with quality CAT 5 cables, no longer than they need to be
- ▶ Put the timing server in the **middle**
 - ▶ This system should have the stereo connector for active stereo if needed

EXTERNAL SYNC

- ▶ 3 Formats of Sync Sources
 - ▶ TTL: 3.3V, 50% duty cycle, high impedance
 - ▶ Bi-Level Composite (NTSC/PAL): 75Ω, ±300mV
 - ▶ Tri-Level Composite (HDTV): 75Ω, ±300mV



Grass Valley ADVC G4 (bi/tri level) <= 60Hz



Agilent 3350B (TTL, bi/tri level) variable

CHECKING SYNC STATUS

LEDs on the board

- ▶ Frame Lock Sync & Stereo Phase per GPU (not display)

- ▶ House/External Sync

- ▶ Solid **Green** - Present

- ▶ Frame Lock connectors

- ▶ **Amber** Output

- ▶ **Green** Input



Control Panel

- ▶ System Topology Viewer provides per display sync information

The screenshot shows the Windows System Topology Viewer window. The 'Timing' section is expanded, showing the following information:

Property	Value
Display state	Server
Resolution, refresh rate	1920 x 2160 pixels, 49.996 Hz
Active	1920
Border	0
Front porch	13
Sync width	140
Back porch	127
Polarity	Negative (-)
Timing	The display is locked to an internal timing signal
EDID source	Monitor...
OS Screen Identifier	1

A green arrow points to the 'Timing' row, which indicates that the display is locked to an internal timing signal.

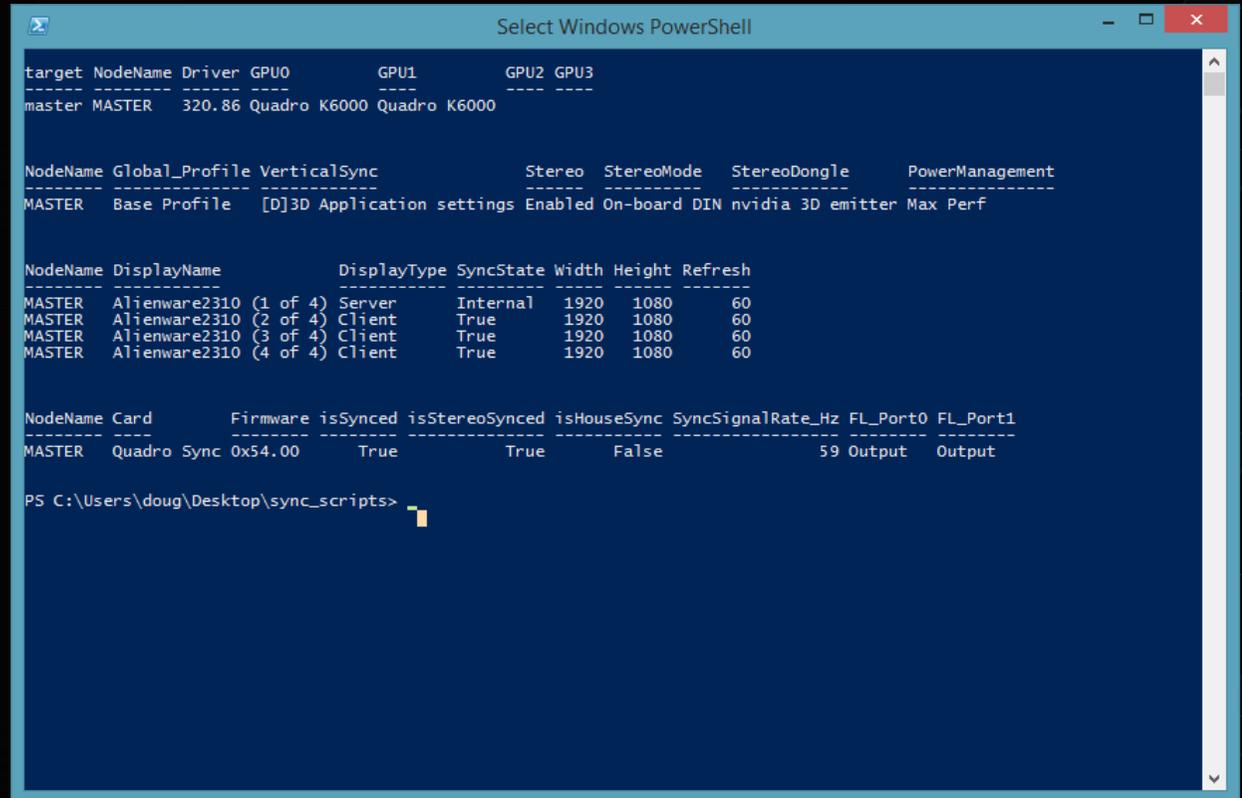
SYNC + POWERSHELL

query_sync.ps1

```
.\query_sync [-auth] node1 node  
2 node 3 ...
```

-auth - prompt for
username/password

node1.. is the list of machines to
query.



```
Select Windows PowerShell

target  nodeName  Driver  GPU0      GPU1      GPU2  GPU3
-----  -
master  MASTER    320.86  Quadro K6000  Quadro K6000

nodeName  Global_Profile  VerticalSync          Stereo  StereoMode  StereoDongle  PowerManagement
-----  -
MASTER    Base Profile    [D]3D Application settings  Enabled  On-board DIN  nvidia 3D emitter  Max Perf

nodeName  DisplayName          DisplayType  SyncState  Width  Height  Refresh
-----  -
MASTER    Alienware2310 (1 of 4)  Server      Internal   1920   1080   60
MASTER    Alienware2310 (2 of 4)  Client      True       1920   1080   60
MASTER    Alienware2310 (3 of 4)  Client      True       1920   1080   60
MASTER    Alienware2310 (4 of 4)  Client      True       1920   1080   60

nodeName  Card          Firmware  isSynced  isStereoSynced  isHouseSync  SyncSignalRate_Hz  FL_Port0  FL_Port1
-----  -
MASTER    Quadro Sync  0x54.00   True      True           False        59 Output      Output

PS C:\Users\doug\Desktop\sync_scripts>
```

Contact us at QuadroSVS@nvidia.com if you want a copy of the script

SYNC + POWERSHELL + NVWMI

- ▶ Query Sync
- ▶ Set Sync on remote machines
- ▶ Monitor Sync events
 - ▶ Report to log if framelock status changes.

```
Windows PowerShell

target  nodeName  driver  GPU0      GPU1 GPU2 GPU3
-----  -
sync1   SYNC1      320.78  Quadro K5000
sync2   SYNC2      320.78  Quadro K5000
sync3   SYNC3      320.78  Quadro K5000

nodeName  Global_Profile  VerticalSync      Stereo      StereoMode      StereoDongle  PowerManagement
-----  -
SYNC1    Base Profile    [D]3D Application settings [D]Disabled [D]On-board DIN [D] NVIDIA DRIVER Contro...
SYNC2    Base Profile    [D]3D Application settings [D]Disabled [D]On-board DIN [D] NVIDIA DRIVER Contro...
SYNC3    Base Profile    [D]3D Application settings [D]Disabled [D]On-board DIN [D] NVIDIA DRIVER Contro...

nodeName  DisplayName      DisplayType  SyncState  Width  Height  Refresh
-----  -
SYNC1    DELL 2408WFP      Internal    Internal    1280   720    60
SYNC2    DELL 2408WFP      Internal    Internal    1280   768    60
SYNC2    DELL 2408WFP      Internal    Internal    1280   720    60

nodeName  Card      Firmware  isSynced  isStereoSynced  isHouseSync  SyncSignalRate_Hz  FL_Port0  FL_Port1
-----  -
SYNC1    Quadro Sync 0x52.00  False     False           False         60           Input   Output
SYNC2    Quadro Sync 0x54.00  False     False           False         60           Input   Output
SYNC3    Quadro Sync 0x54.00  False     False           False         60           Input   Output

PS C:\Users\doug\Desktop>
```

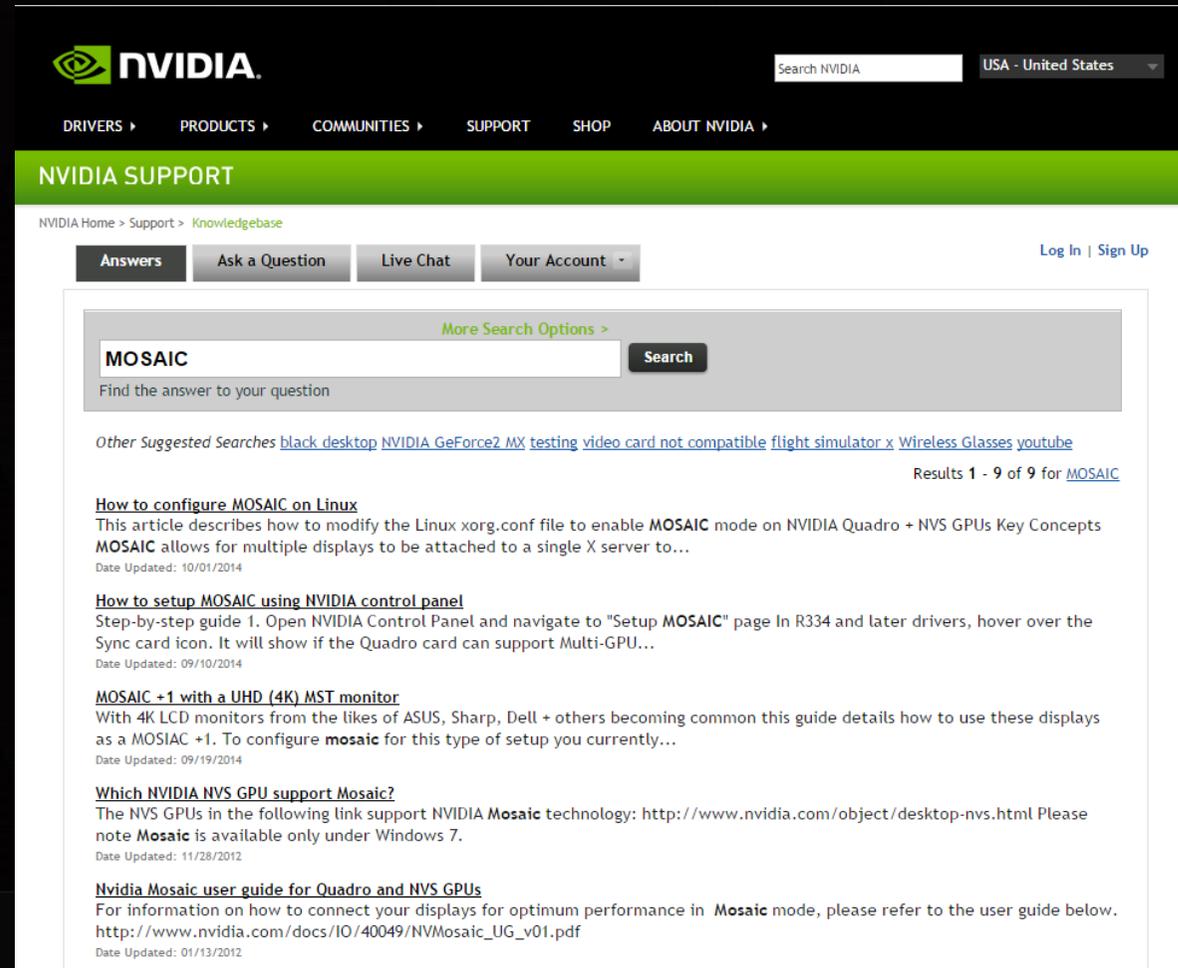
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GETTING HELP

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HTTP://NVIDIA.CUSTHELP.COM/



The screenshot displays the NVIDIA Customer Help website interface. At the top, the NVIDIA logo is on the left, and a search bar with the text "Search NVIDIA" and a dropdown menu for "USA - United States" is on the right. Below the logo is a navigation menu with links for DRIVERS, PRODUCTS, COMMUNITIES, SUPPORT, SHOP, and ABOUT NVIDIA. A green banner below the navigation menu reads "NVIDIA SUPPORT".

The main content area shows the breadcrumb "NVIDIA Home > Support > Knowledgebase" and a navigation bar with buttons for "Answers", "Ask a Question", "Live Chat", and "Your Account". On the right side of this bar are links for "Log In" and "Sign Up".

A search bar contains the text "MOSAIC" and a "Search" button. Below the search bar, there are "More Search Options" and a prompt "Find the answer to your question".

Underneath, there are "Other Suggested Searches" with links: [black desktop](#), [NVIDIA GeForce2 MX testing](#), [video card not compatible](#), [flight simulator x](#), [Wireless Glasses](#), and [youtube](#). Below this, it says "Results 1 - 9 of 9 for MOSAIC".

The first search result is titled "[How to configure MOSAIC on Linux](#)". The description states: "This article describes how to modify the Linux xorg.conf file to enable MOSAIC mode on NVIDIA Quadro + NVS GPUs Key Concepts MOSAIC allows for multiple displays to be attached to a single X server to...". The date updated is "10/01/2014".

The second result is titled "[How to setup MOSAIC using NVIDIA control panel](#)". The description states: "Step-by-step guide 1. Open NVIDIA Control Panel and navigate to 'Setup MOSAIC' page In R334 and later drivers, hover over the Sync card icon. It will show if the Quadro card can support Multi-GPU...". The date updated is "09/10/2014".

The third result is titled "[MOSAIC +1 with a UHD \(4K\) MST monitor](#)". The description states: "With 4K LCD monitors from the likes of ASUS, Sharp, Dell + others becoming common this guide details how to use these displays as a MOSIAC +1. To configure mosaic for this type of setup you currently...". The date updated is "09/19/2014".

The fourth result is titled "[Which NVIDIA NVS GPU support Mosaic?](#)". The description states: "The NVS GPUs in the following link support NVIDIA Mosaic technology: <http://www.nvidia.com/object/desktop-nvs.html> Please note Mosaic is available only under Windows 7.". The date updated is "11/28/2012".

The fifth result is titled "[Nvidia Mosaic user guide for Quadro and NVS GPUs](#)". The description states: "For information on how to connect your displays for optimum performance in Mosaic mode, please refer to the user guide below. http://www.nvidia.com/docs/IO/40049/NVMosaic_UG_v01.pdf". The date updated is "01/13/2012".

SDKS + UTILITIES

- ▶ **OpenGL/DirectX** Swap Group examples
 - ▶ QuadroSVS@nvidia.com
- ▶ **GPU Affinity**
 - ▶ QuadroSVS@nvidia.com
- ▶ **Warp + Blend API SDK**
 - ▶ QuadroSVS@nvidia.com
- ▶ **NVAPI Sync samples**
 - ▶ Developer.nvidia.com
- ▶ **NVAPI MOSAIC samples**
 - ▶ QuadroSVS@nvidia.com
- ▶ **NVWMI examples**
 - ▶ Developer.nvidia.com
 - ▶ QuadroSVS@nvidia.com
 - ▶ Sync, event monitors, EDID examples
- ▶ **Configuremosaic**
 - ▶ Nvidia.com - driver downloads
- ▶ **Nvtimingdiag.exe**
 - ▶ QuadroSVS@nvidia.com
- ▶ **Clip MOSAIC - perf enhancement**
 - ▶ QuadroSVS@nvidia.com
- ▶ **ManageEDID**
 - ▶ Command line EDID management
 - ▶ QuadroSVS@nvidia.com

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SUMMARY

Quadro M6000

MOSAIC

Quadro Sync

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THANK YOU

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