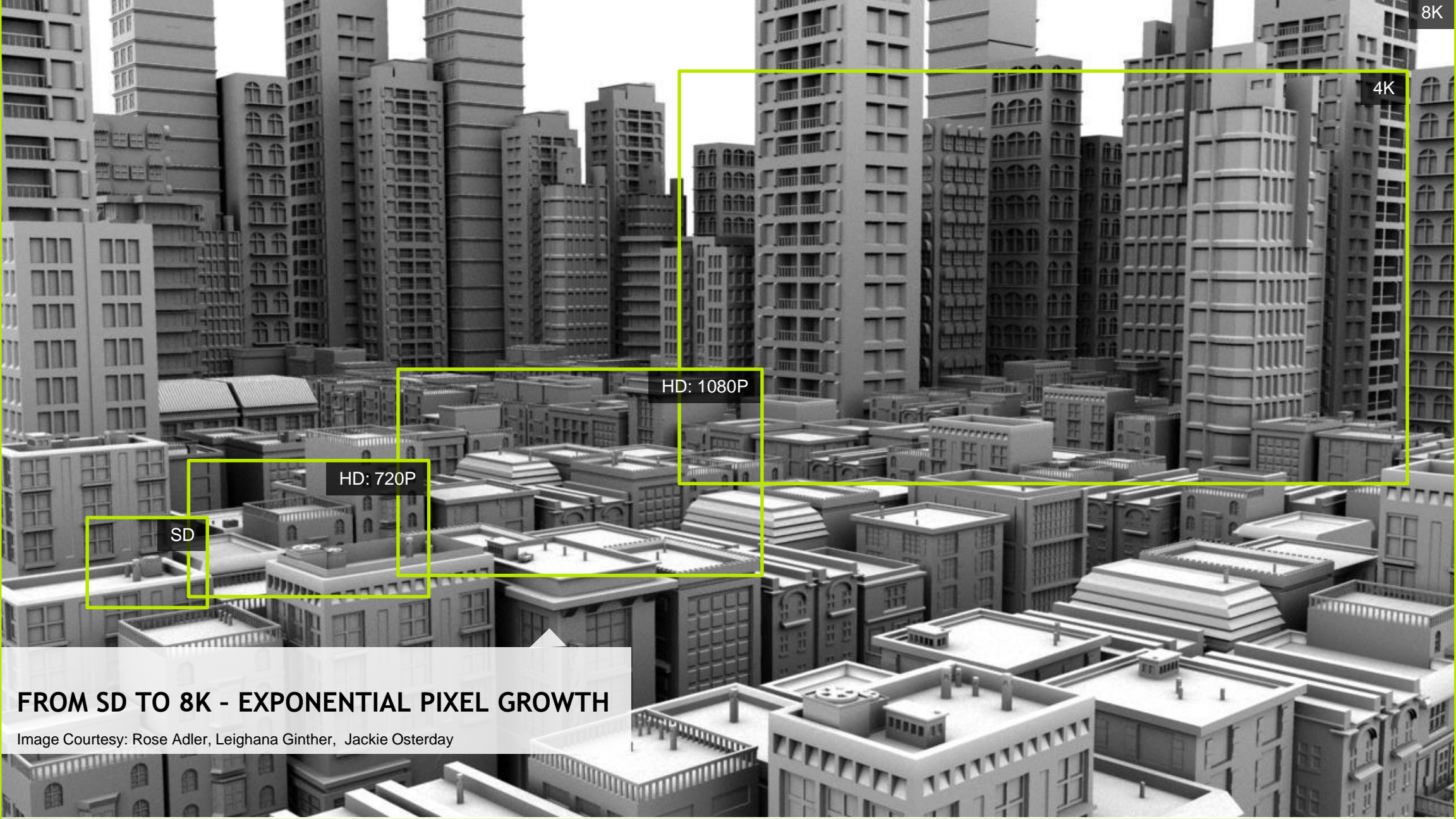# SEE THE BIG PICTURE: HOW TO BUILD LARGE DISPLAY WALLS USING NVIDIA DESIGNWORKS™ APIS/TOOLS

Doug Traill (QuadroSVS@nvidia.com)

FROM SD TO 8K – EXPONENTIAL PIXEL GROWTH

Image Courtesy: Rose Adler, Leighana Ginther, Jackie Osterday
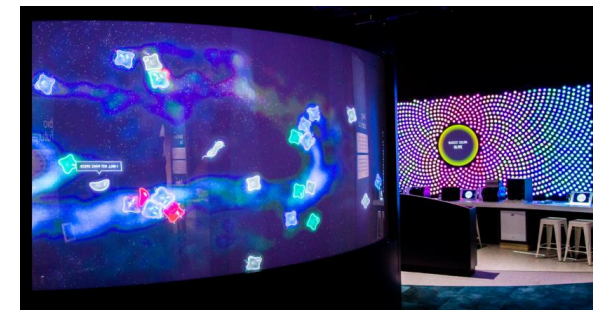
LARGE SCALE VISUALIZATION
See the big Picture

Clockwise from upper left images courtesy of Vislogix, Prysm, Inc., Visbox, Christie Digital, IMMERSIVE DESIGN STUDIOS, Elbit Systems.

Monday	
3.45pm Hangout Pod C	**MOASIC – Video wall**

Tuesday	
1.00pm Room 210E	**S6452 – Run-Time Scene-Graph Construction from Geographic Source Data**
1.30 pm Room 212B	**Canvas: The Enterprise Media Server Solution for Game Engines**

Wednesday	
10.00 am Room 212B	**S6770 - GPU Image Processing on Giant Surfaces**
10.00 am Room LL21A	**CAVE2.0: The Worlds Largest Virtual Reality Cluster @PSA**
10.30 am Room LL21C	**S6350: State of the art Real-time Graphics for Events, Broadcast & interactive content**
4.30 pm Room LL20C	**S6752 – Sports Training and VR: Challenges in Making the Physical, Virtual**
Wednesday Evening – GTC Party	
The Tech	**BioDesign Studio - Wrap around display using 11 projectors – running MOSAIC**

Thursday	
9.30 am Room 210E	**S6649 – One Size Doesn't Fit all: The Importance of Aligning VR Environments to Workflows - MechDyne**
10.00 am Room 210E	**S6567 – Large Scale and Multi-Display Visualization - JVC**
10.30am Room 210E	**S6766 – VR in the Brown University YUART**

Ultimate performance & Interactivity
Dual slot FF with Sync support

Demanding 3D content & Interactivity
Dual slot FF with Sync support

Quadro M6000-12GB

Quadro M6000-24GB

Quadro M5000

Performance 3D content
Single slot FF with Sync support

Video and basic 3D content
Low profile for SFF systems

Quadro M4000

Quadro K1200

Video and basic 3D content
Single slot FF with 8 display outputs

2-way SLI support

Quadro Sync Support – 4 GPUs

NVS 810

Digital Signage	Interactive Displays, Conference Rooms
	Product Design Reviews
	Specialty Applications

Digital Signage	Interactive Displays	Conference Rooms	Project Design Review	Specialist
▪ Retail	▪ Retail	▪ Projection or tiled walls	▪ 4K + stereo display walls	▪ Event marketing
▪ Corporate signage	▪ Corporate briefings	▪ Conference rooms	▪ Product design	▪ Broadcast display walls
▪ Hotel lobbies	▪ Museums and education	▪ Briefing centers	▪ Architectural design	▪ Projection mapping
▪ Tradeshows and events				▪ Large display systems
Ideal NVIDIA GPUs	**Ideal NVIDIA GPUs**	**Ideal NVIDIA GPUs**	**Ideal NVIDIA GPUs**	**Ideal NVIDIA GPUs**
▪ NVS 810	▪ Quadro K1200	▪ Quadro K1200	▪ Quadro M5000	▪ Quadro M5000 + Sync
▪ Quadro K1200	▪ Quadro M4000	▪ Quadro M4000	▪ Quadro M6000	▪ Quadro M6000 + Sync
	▪ Quadro M5000	▪ Quadro M5000		
Features	**Features**	**Features**	**Features**	**Features**
▪ Low power	▪ Single desktop	▪ Projection overlap	▪ Projection overlap	▪ Projection overlap
▪ Small Form Factor (SFF)	▪ Touch interaction	▪ Warp engine	▪ Warp engine	▪ External sync support
▪ Reliability	▪ Seamless 4K playback	▪ App scaling, mixed 2D/3D	▪ Specialist 3D stereo	▪ Warp engine
			▪ Specialist 4K projection	

MULTI-GPU MOSAIC WITH SYNC

Sync requires a physical connection between GPUs

Two-way SLI (requires bridge)

- **2** Quadro cards (8 displays)

- Certified OEM workstations

  - Dell/HP/Lenovo

- SLI Motherboards

  - New – R361/R364 driver

  - Quadro now supported in GTX cert motherboards.

Quadro Sync

- **2 to 4** Quadro cards (16 displays)

- Any motherboard or expansion chassis

- Support for external Sync sources.

  - House Sync

  - Sync from another Quadro Sync card.

NVS 810
8 displays – 1 card !!

- 8 mini-DP1.2 connectors

- Dual GPUs – single card

- MOSAIC with Sync (single card)

- 8 - 4096x2160@30Hz

- 8 - 1920x1080@60Hz

- No additional power connector – 68 W

M6000-24GB
Do more

Same performance – more memory

Note

- Can't mix 12GB and 24GB cards in SLI

- Can't mix 12-GB & 24GB cards in a cluster.
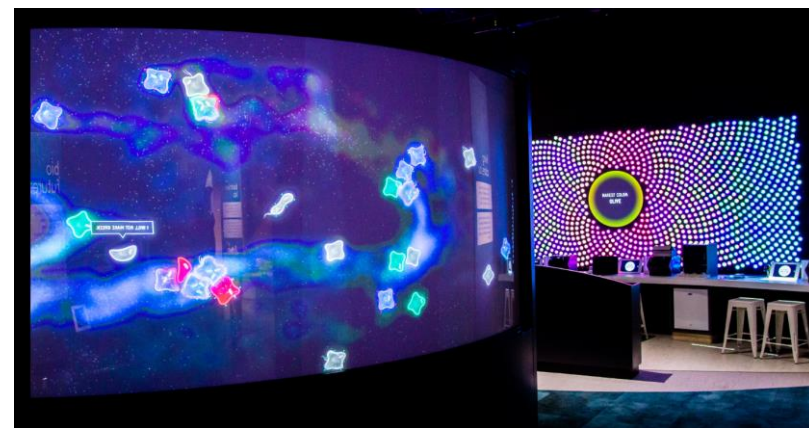
NVIDIA. DESIGNWORKS™

Display Management Technologies

MOSAIC

WARP & BLEND

DISPLAY MANAGEMENT APIS

Monitoring + Setup tools

NVAPI

NVWMI

SYNC

developer.nvidia.com/designworks

MOSAIC – SETUP & CONFIGURATION

MOSAIC GRIDS

columns

1	2	3
4	5	6
7	8	9

rows

Vertical Pixels
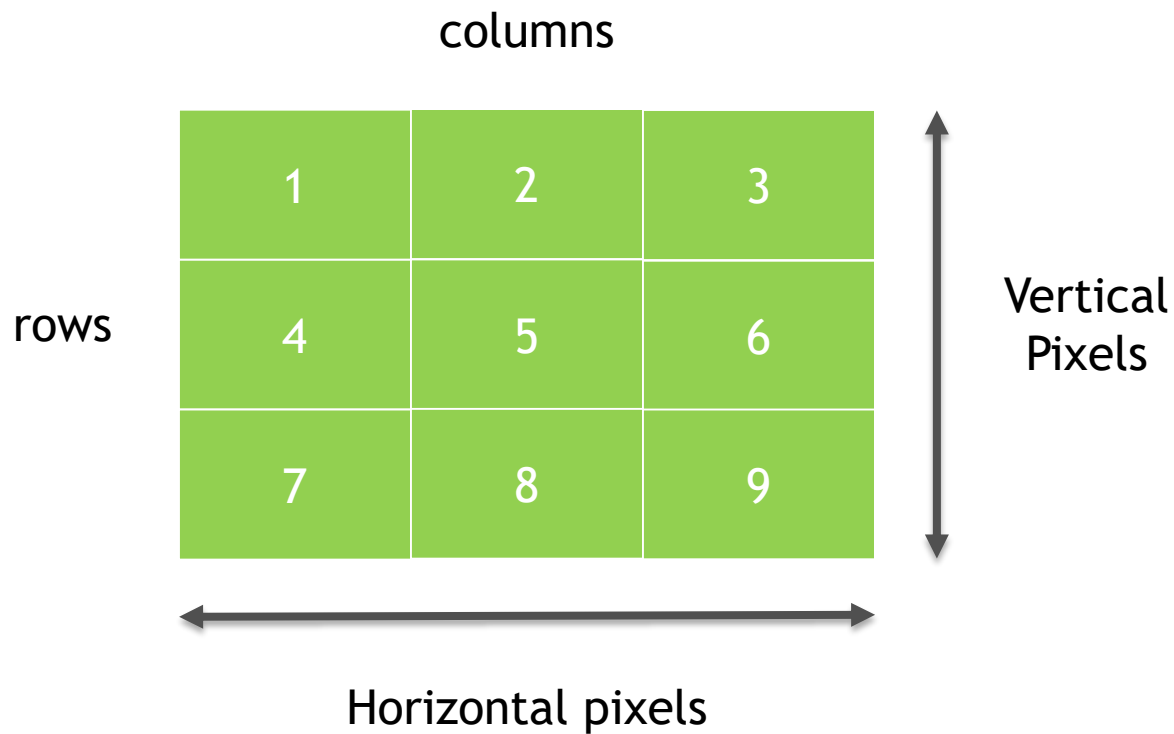
Horizontal pixels

Rows x columns <= 16
Max Horizontal or vertical Pixels <= 16384

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

BEZEL AND OVERLAP CORRECTION

Bezel Correction

Will make the image look continuous as we render under the bezel
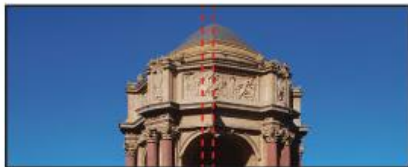
Bezel Correction

No Bezel Correction

Projector Overlap

No Projector Overlap

Overlap Correction

For projectors it maintains the aspect ratio of the display.

NVIDIA.

UNDERSTANDING TOPOLOGIES

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

Row Overlap/Bezel correction

Column Overlap/Bezel correction
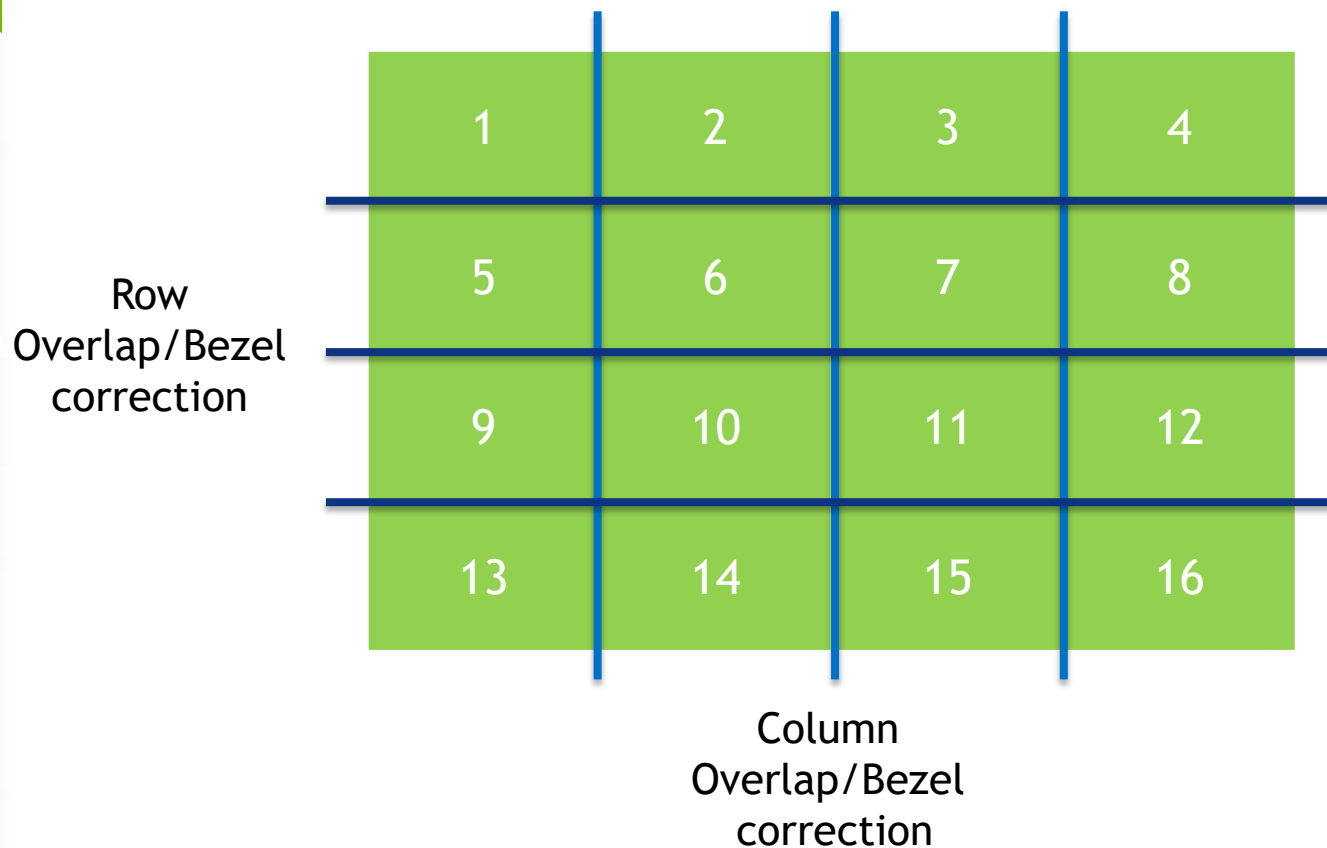
Bezel correction will increase overall pixel size

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

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

Total horizontal width
= 1920*4 - 100*3 = 7380

ANATOMY OF A SYSTEM

stereo sync bracket

CPU0 PCIe 1 — GPU-0

CPU0 PCIe 2 — GPU-1

CPU1 PCIe 2 — GPU-3

CPU1 PCIe 1 — GPU-2

con3 con2 con1 con0

Quadro Sync card

FL 0

FL 1

SYNC

STEREO

HOUSE SYNC
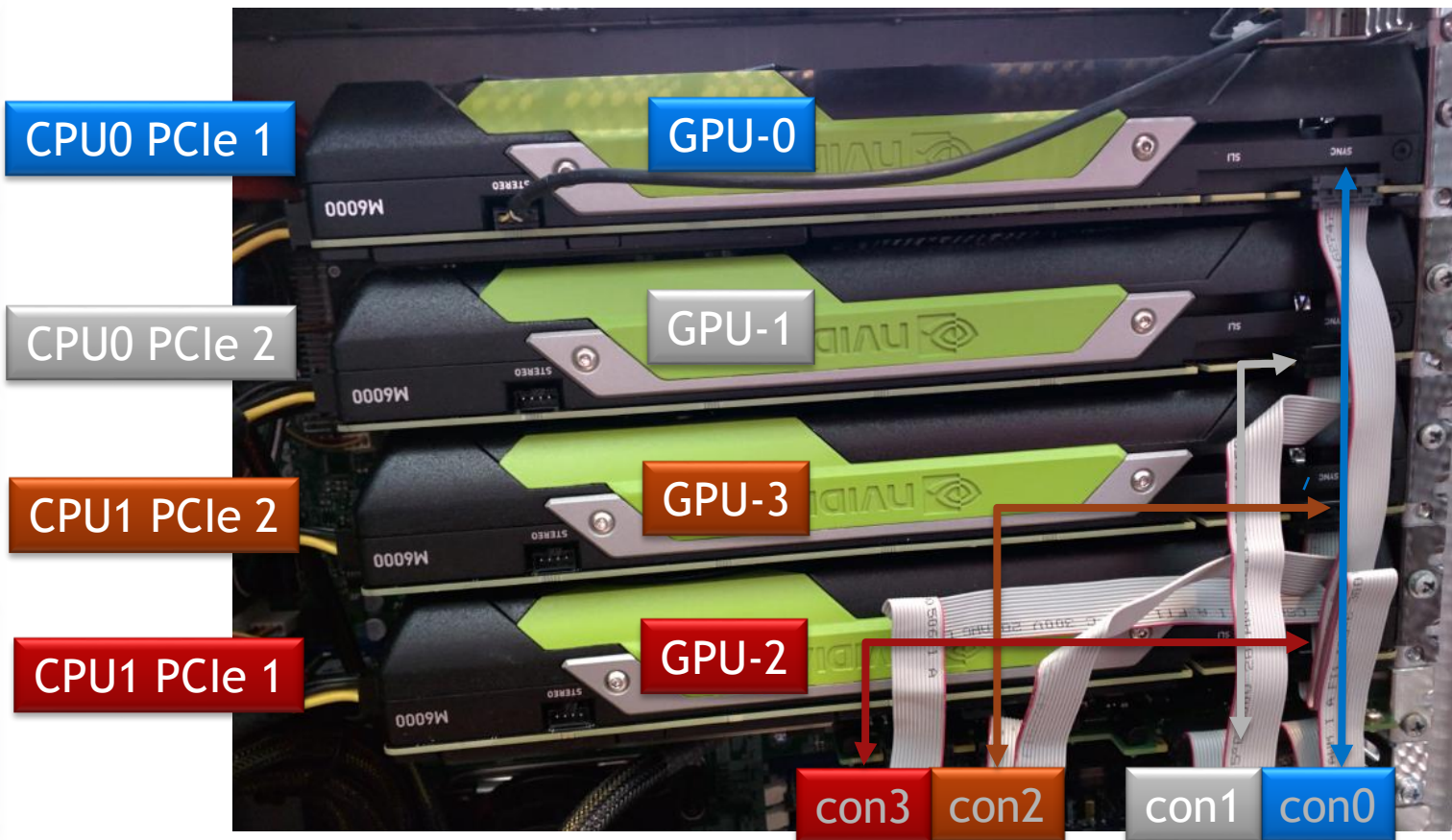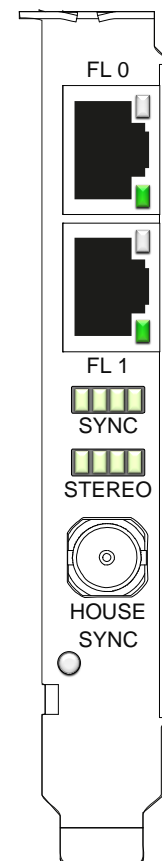
REAR PANEL - 4 M6000S

VESA Stereo Bracket

GPU 0

GPU 1

GPU 3

GPU 2

Quadro Sync

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

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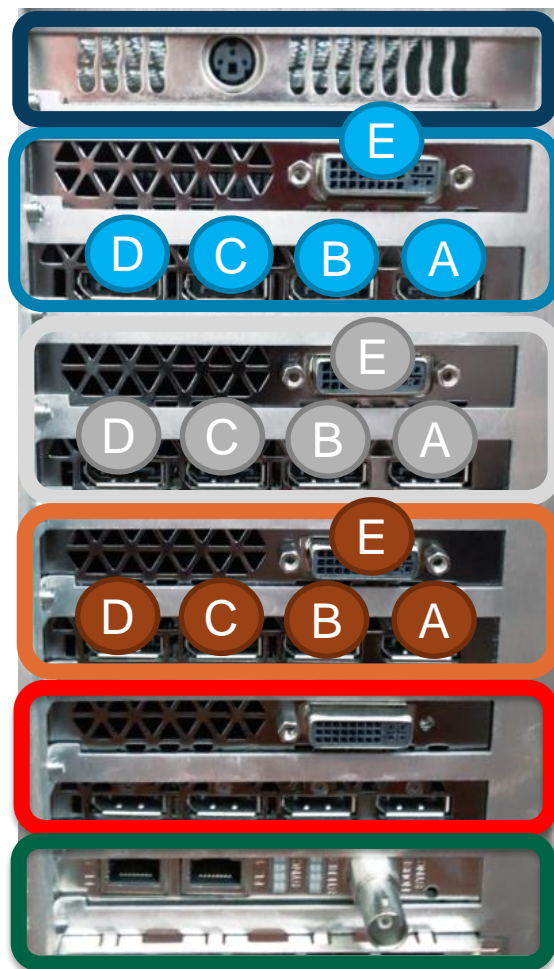At boot-up LEDs will be amber showing GPU connected

PORT NUMBERING

VESA Stereo Bracket

GPU 0

E

D C B A

GPU 1

E

D C B A

GPU 3

E

D C B A

GPU 2

Quadro Sync

i.e. only E is attached
E = 0,0

A + E are attached
A = 1,0
E = 1,1

A + B + C + D are attached
A = 3,0
B = 3,1
C = 3,2
D = 3,3

RELATING PORTS TO GRID
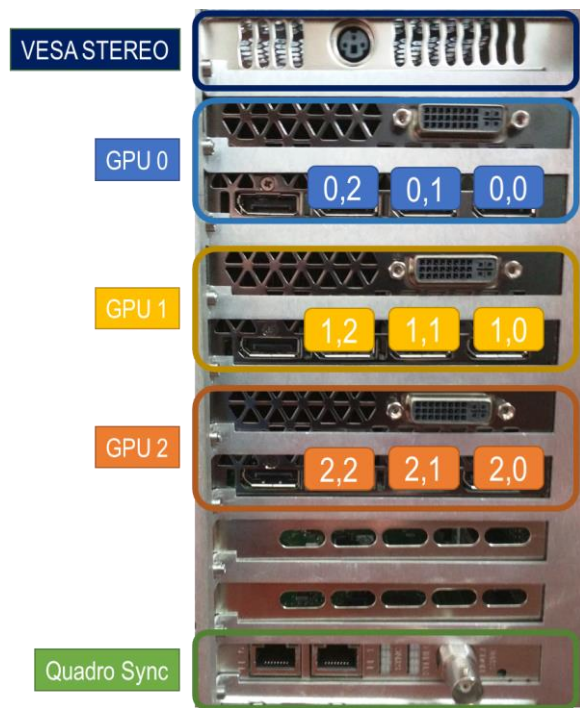
configureMosaic-x64.exe set rows=3 cols=3
configureMosaic-x64.exe set rows=3 cols=3 out=0,0 out=0,1 out=0,2 out=1,0 out=1,1 out=1,2 out=2,0 out=2,1 out=2,2
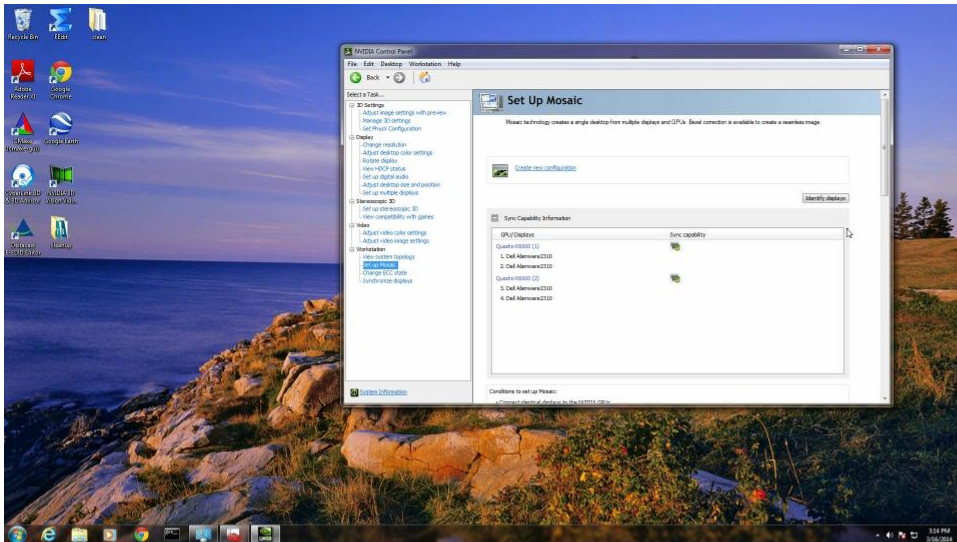
MOSAIC WITH SYNC
MOSAIC with Sync = Premium MOSAIC = SLI MOSAIC

Setup MOSAIC Menu

- Roll over icon under "Sync capability"

- Indicates whether card can be sync'd

  - Multi-GPU Sync "Quadro Sync" –multi-GPU sync via Quadro Sync card

  - Mutli-GPU Sync "SLI Bridge" – 2-way GPU sync via SLI bridge

  - Single GPU Sync - outputs on single card can be framelocked.
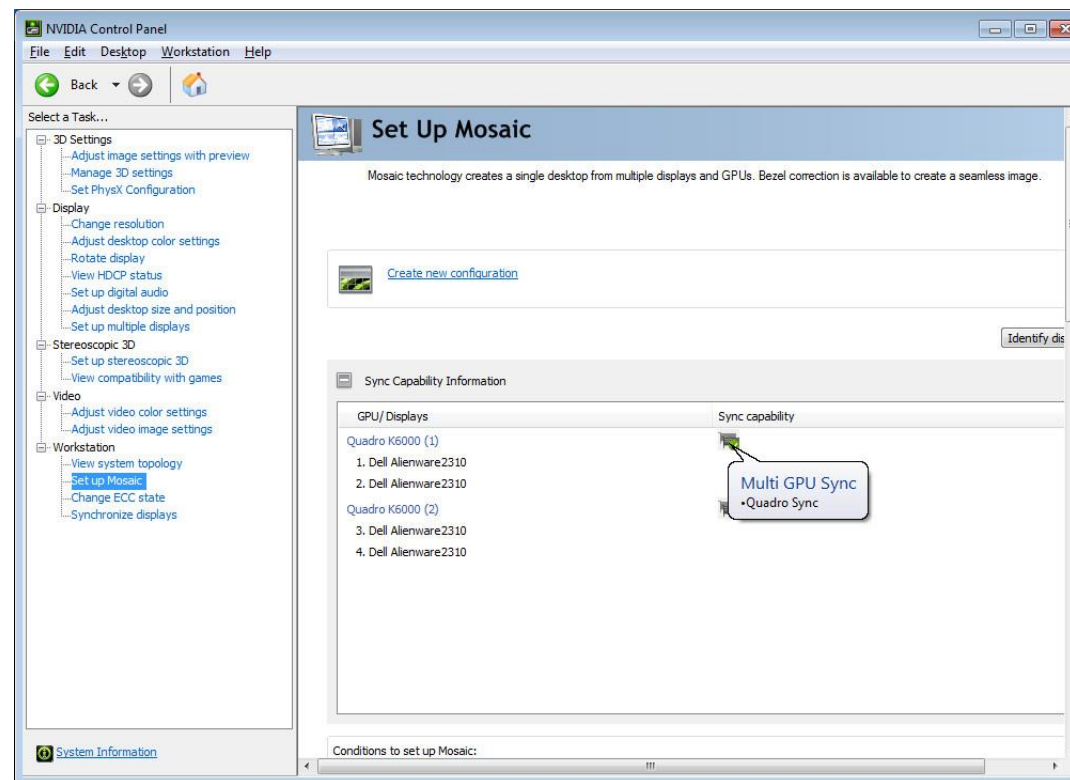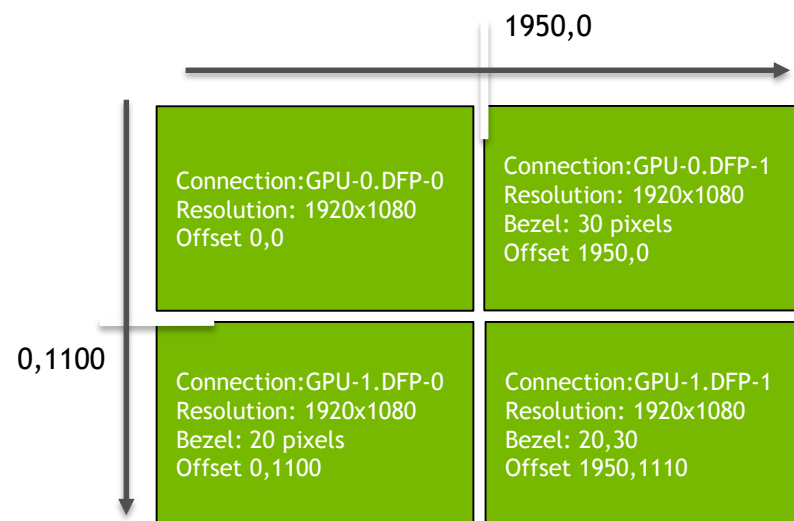
LINUX
Single GPU (4 outputs) – MetaModes only

```
Section "Screen"
    Identifier      "Screen0"
    Device          "Device0"
    Monitor         "Monitor0"
    DefaultDepth    24
    Option          "MetaModes" "1920x1080 +0+0,
1920x1080 +1920+0, 1920x1080 +0+1080, 1920x1080
+1920+1080"
    Option          "nvidiaXineramaInfo" "FALSE"
    SubSection      "Display"
        Depth       24
    EndSubSection
EndSection
```

1920,0

0,1080

Connection:GPU-0.DFP-0
Resolution: 1920x1080
Offset 0,0

Connection:GPU-0.DFP-1
Resolution: 1920x1080
Offset 1920,0

Connection:GPU-0.DFP-2
Resolution: 1920x1080
Offset 0,1080

Connection:GPU-0.DFP-3
Resolution: 1920x1080
Offset 1920,1080
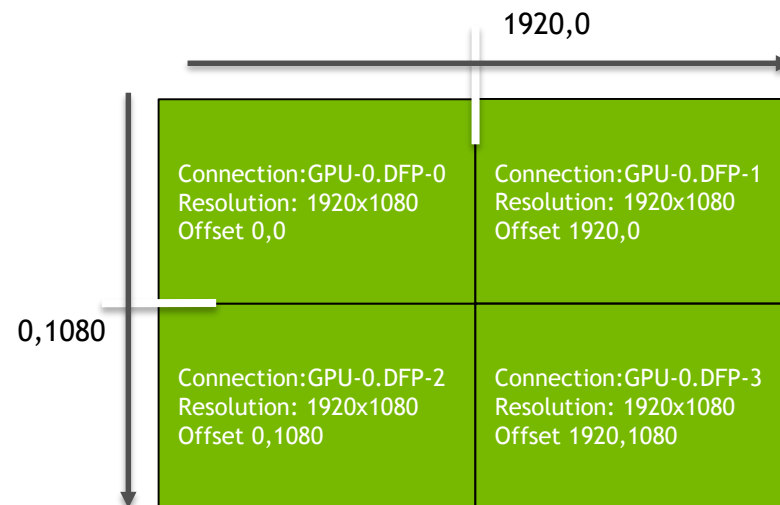
LINUX

2 GPUs example – Use BaseMOSAIC (No SLI or QUADRO SYNC)
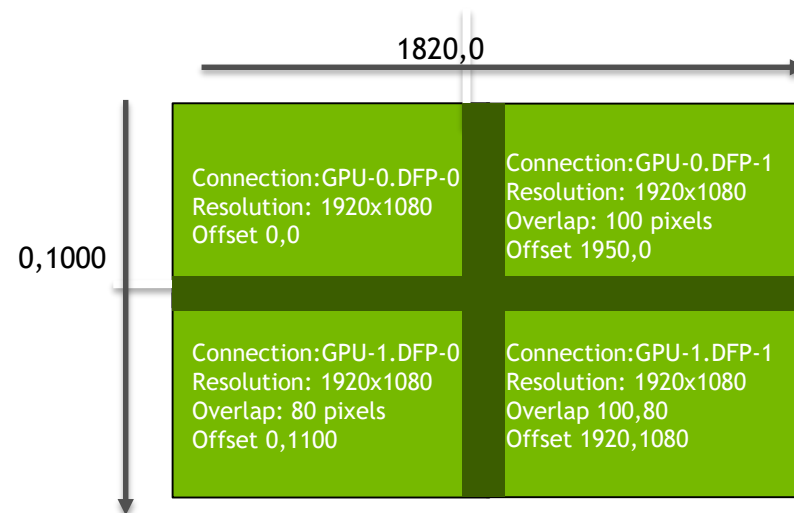
```
Section "Screen"
    Identifier      "Screen0"
    Device          "Device0"
    Monitor         "Monitor0"
    DefaultDepth    24
    Option          "BaseMosaic"    "TRUE"
    Option          "MetaModes" "GPU-0.DFP-0:
1920x1080 +0+0, GPU-0.DFP-1:  1920x1080 +1950+0,
GPU-1.DFP-0: 1920x1080 +0+1100, GPU-1.DFP-1:
1920x1080 +1950+1100"
    Option          "nvidiaXineramaInfo" "FALSE"
    SubSection      "Display"
        Depth       24
    EndSubSection
EndSection
```


1950,0

Connection:GPU-0.DFP-0
Resolution: 1920x1080
Offset 0,0

Connection:GPU-0.DFP-1
Resolution: 1920x1080
Bezel: 30 pixels
Offset 1950,0

0,1100

Connection:GPU-1.DFP-0
Resolution: 1920x1080
Bezel: 20 pixels
Offset 0,1100

Connection:GPU-1.DFP-1
Resolution: 1920x1080
Bezel: 20,30
Offset 1950,1110

LINUX

2 GPUS with Quadro Sync or SLI connector – Use "SLI" "MOSIAC"

```
Section "Screen"
    Identifier      "Screen0"
    Device          "Device0"
    Monitor         "Monitor0"
    DefaultDepth    24
    Option          "SLI"    "MOSAIC"
    Option          "MetaModes" "GPU-0.DFP-0:
1920x1080 +0+0, GPU-0.DFP-1:  1920x1080
+1820+0, GPU-1.DFP-0: 1920x1080 +0+1000, GPU-
1.DFP-1: 1920x1080 +1820+1000"
    Option          "nvidiaXineramaInfo"
"FALSE"
    SubSection      "Display"
        Depth       24
    EndSubSection
EndSection
```


NVS810 – Use this mode

LINUX TIPS
Window Manager (GNOME, Unity, KDE etc) may over-ride MOSAIC settings.

```
Section "Screen"
    Identifier      "Screen0"
    Device          "Device0"
    Monitor         "Monitor0"
    DefaultDepth     24
    Option          "MetaModes" "1920x1080 +0+0, 1920x1080 +1920+0, 1920x1080 +3840+0"
    Option          "nvidiaXineramaInfo" "False"
    SubSection      "Display"
        Depth        24
    EndSubSection
EndSection

Section "Extensions"
    Option          "Composite" "Disable"
    Option           "RANDR" "Disable"
EndSection
```
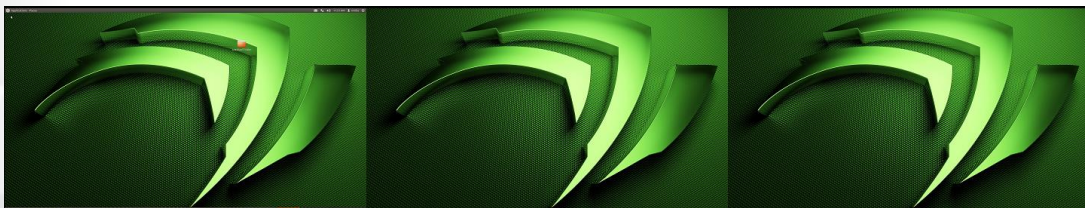

1x3 MOSAIC – but three separate Desktops
MOSAIC is running – i.e. Windows should open full screen
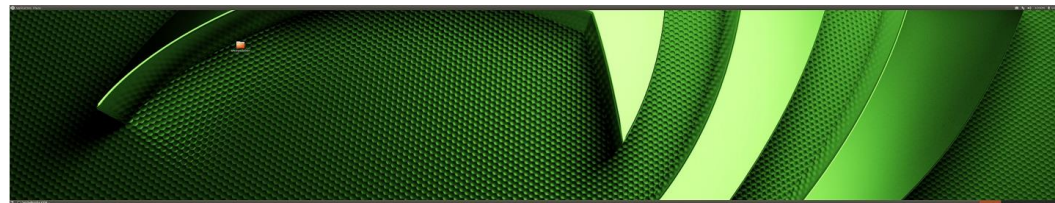
1x3 MOSAIC – Single Desktop

LINUX TIPS
MOSAIC with Quadro Sync

Set SLI MOSAIC in xorg.conf

After restarting X - Enable Framelock (Not automatic)
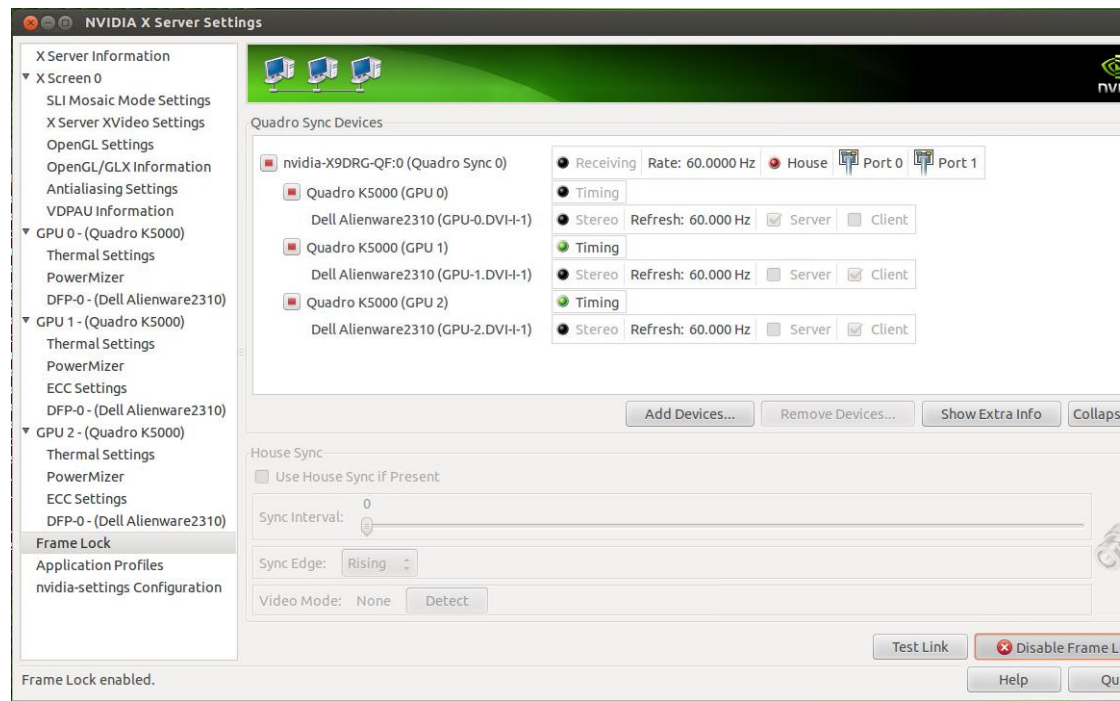
PORTRAIT MODE
Command line or Control panel

Windows
  configureMosaic set rows=2 cols=4 rotate=90

- Applies to all displays in array
- Valid values for rotate:
  - 90
  - 180
  - 270

Control Panel - Portrait mode requires that GUI starts in Landscape mode – it's a feature ;-)

Image Courtesy of Ars Electronica

MULTIPLE MOSAIC GRIDS

Driving CAVE from single workstation

Windows

- Use configuremosaic tool

- "nextgrid" option

- Only one GRID can cross multiple GPUs

Linux

- Use Metamodes for each GRID

- Define xscreen per wall

- GRID cannot cross multiple GPUs.
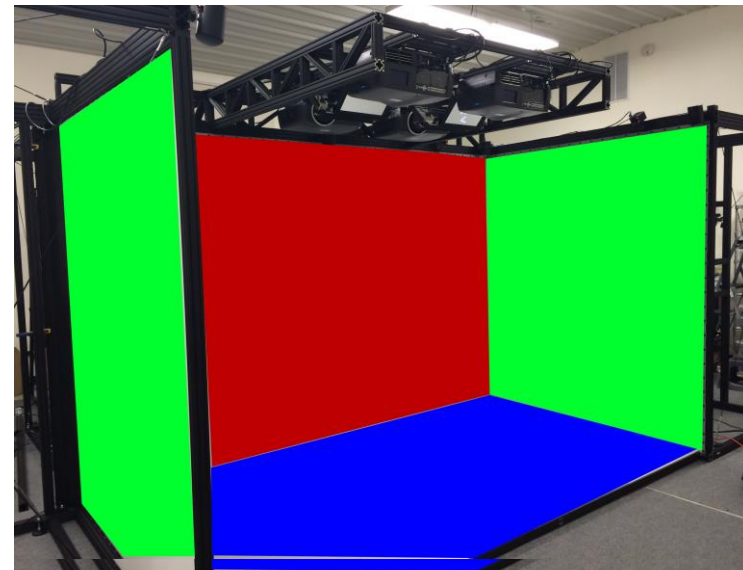
Image courtesy of VisBox

```
configureMosaic-x64.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
```

CLIP MOSAIC
Load balance Pixel fill rate on multi-GPU MOSAIC

Benefits

- Divides pixel fill between GPUs – improves perf on large res displays

Requirements

- Full screen OGL or DirectX app

- Supported on Windows + Linux

  - Windows – command-line utility - send email to QuadroSVS@nvidia.com

  - Linux – environment variable.   __GL_MOSAIC_CLIP_TO_SUBDEV=1

SMART CLONE
Single GPU MOSAIC only

- Pan and Scan

    - Clones the area around mouse

- Select area to clone

    - Yellow box shows clone are

- Scaled clone
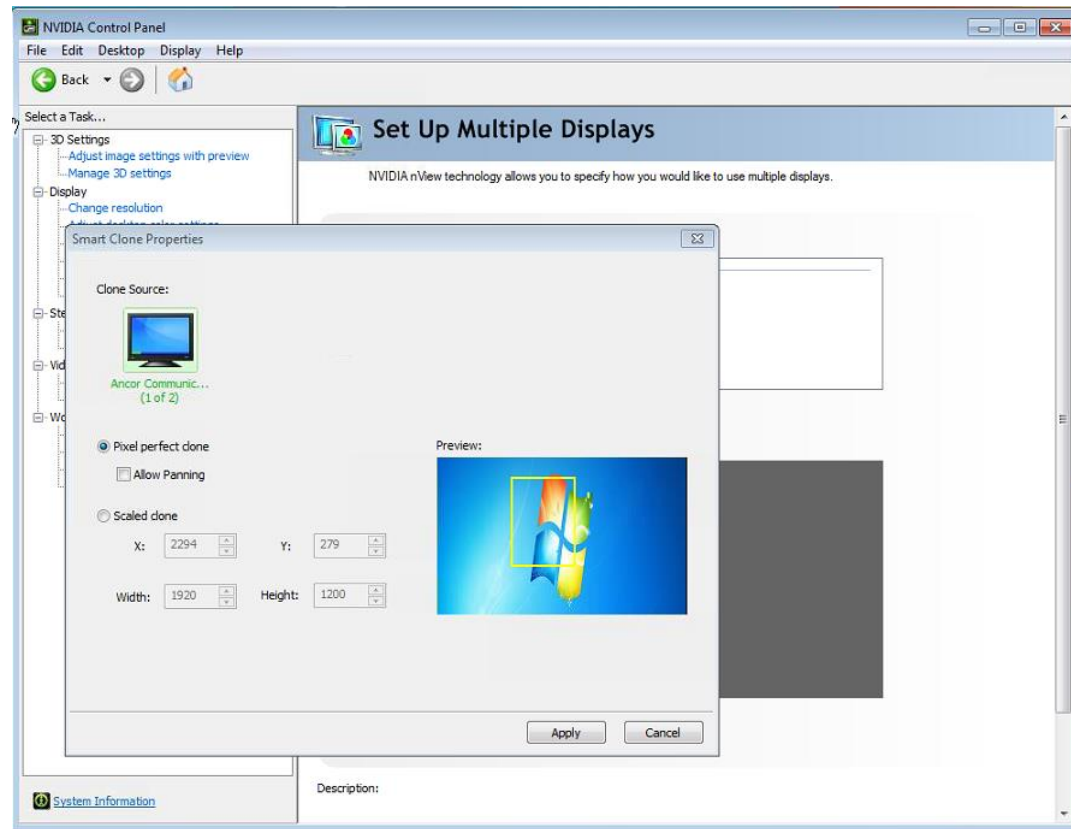
MOSAIC +1
Across multiple GPUs

- Windows

  - GRID spans multiple GPUs

    - Spare ports on GPU cannot be used for additional displays

    - Add a Quadro K620

    - New display is like a new grid

- Linux

  - Not officially supported

    - Use Option "MOSAICplusOne"
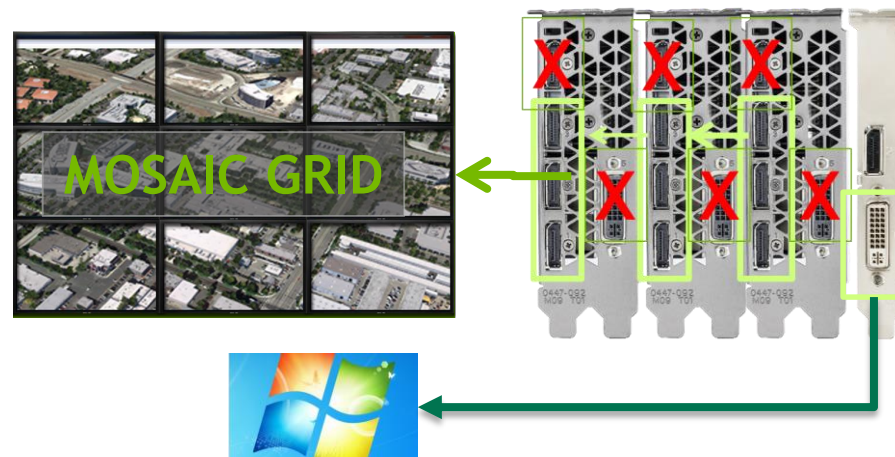
MEMORY PRE-ALLOCATION

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.

- AERO desktop will always be disabled

- 3D Vision Pro hub will be always enabled.
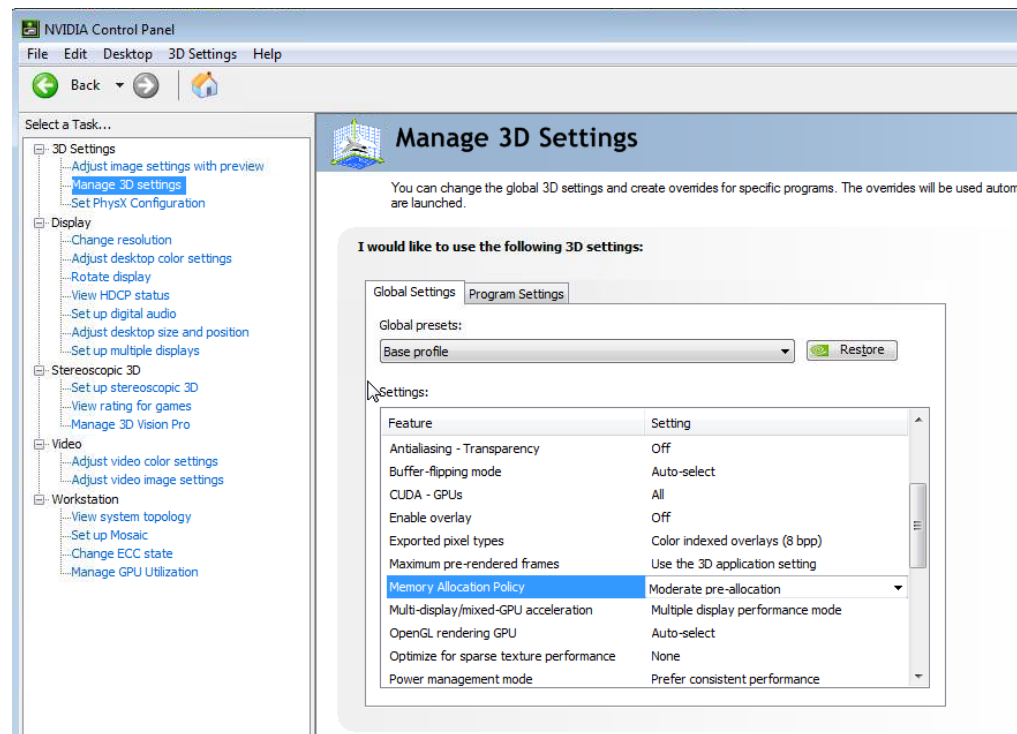
Windows 7 only – not supported on Win8.1/Win10

MEMORY PRE-ALLOCATION

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
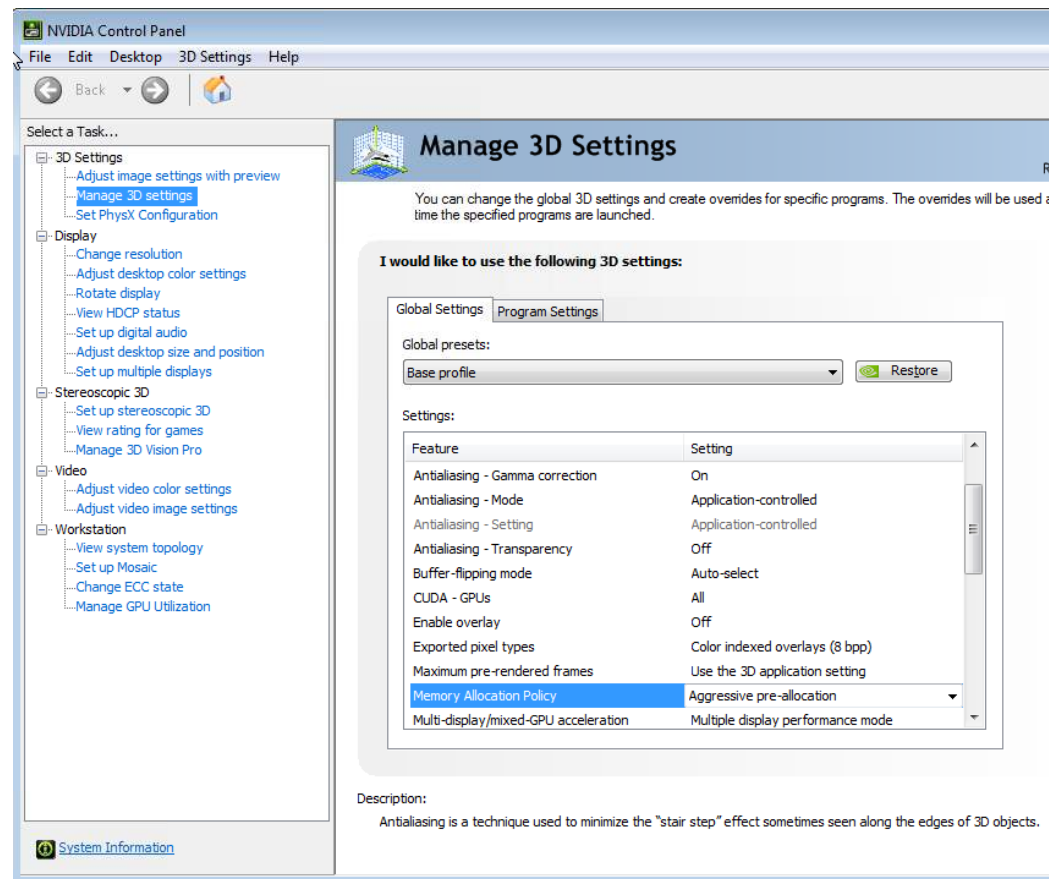
Windows 7 only – not supported on Win8.1/Win10

JVC 4K/8K E-SHIFT PROJECTOR

Native support in NVIDIA Windows driver (Linux support planned)

8k Projector

- Similar to active stereo – scans alternate odd/even frames (1200x2400)

- Automatically detected by driver

  - EDID is seen at 2400x4800 resolution per input (project has 4 inputs)

  - VESA stereo (3pin) port is used to identify odd/even frame.
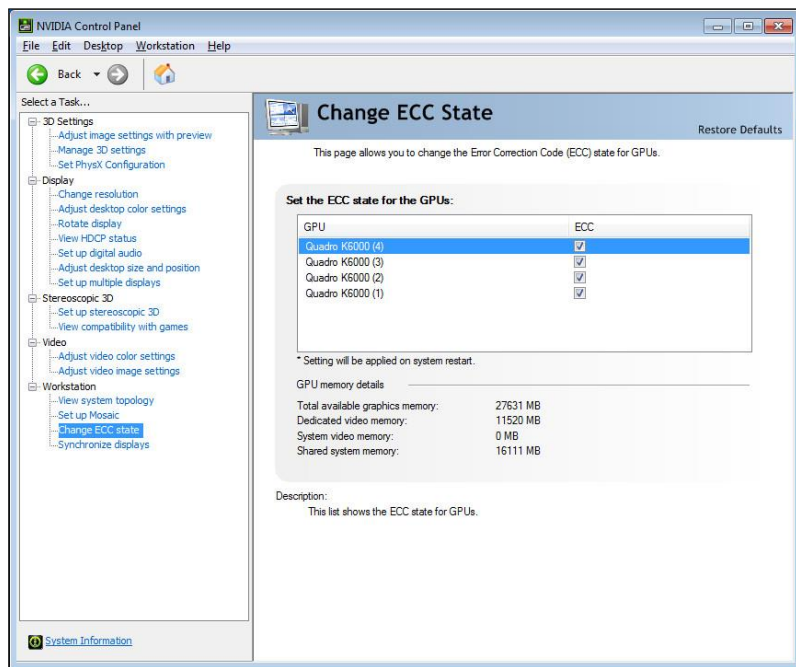
4k Projector

- Similar to passive stereo – separate odd/even frames

- Enabled using configuremosaic tool.

```
configuremosaic set rows=1 cols=1 pixelshift
out=0,0,tl out=0,1,br res=1920,1080,60
```

COMMON MOSAIC SETUP ISSUES

MOSAIC DOESN'T ENABLE ON MULTI-GPUS
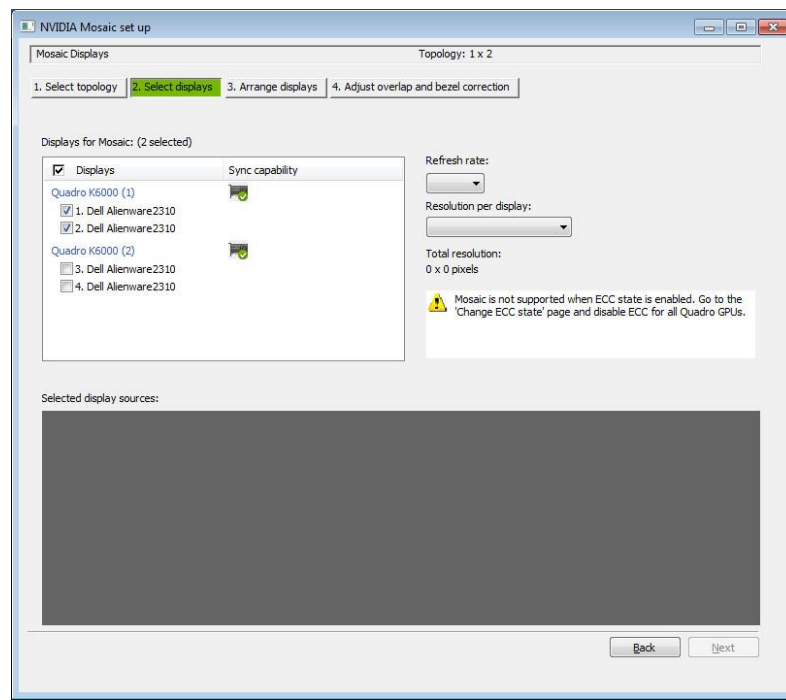
MOSAIC does not work with ECC ON - Make sure it is disabled

MOSAIC ERROR – MIXED CONNECTORS

Error – "Mixed Connectors are not Supported"
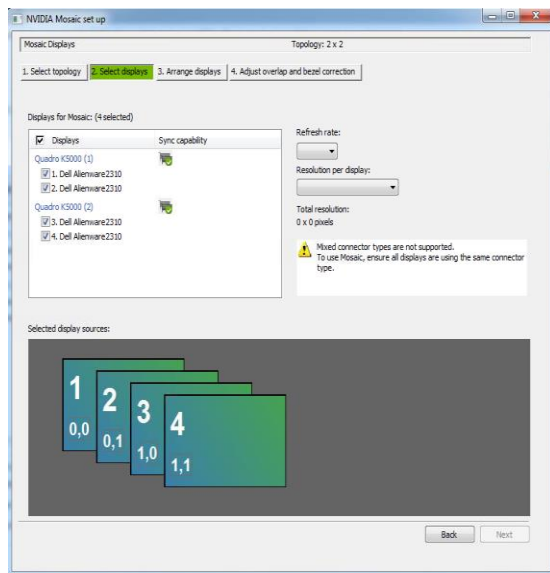
Affects Multi-GPU MOSAIC

- Match connector position on each GPU

- For "odd" number setups make sure primary GPU has all connectors used

    - i.e 7 displays – use 4 connectors on GPU0 and 3 connectors on GPU1.

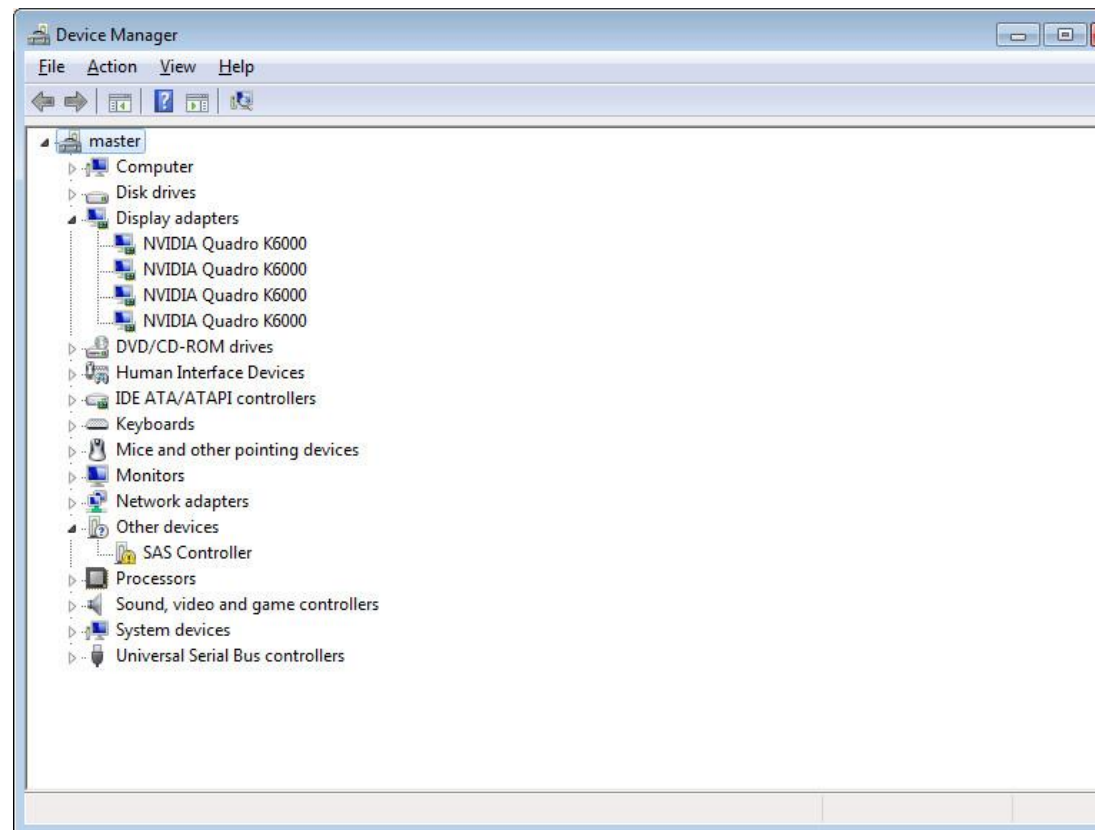- Make sure you are using dongles of all of one type – i.e. passive dongles.

Error   OK
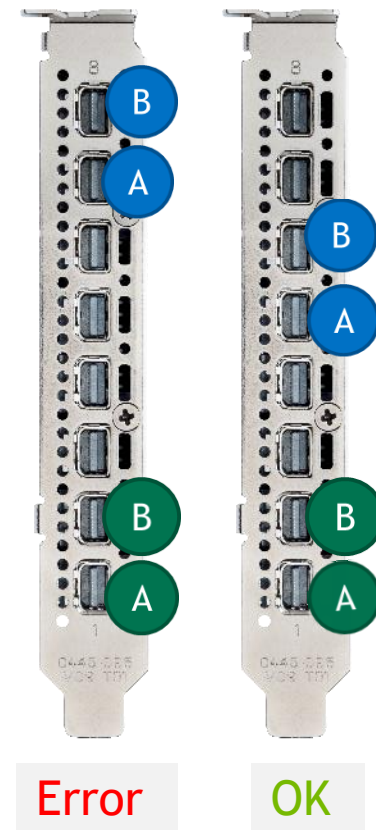
MOSAIC TIPS
Check for mirror display drivers

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. For displays with large number of display modes in EDID, NVIDIA driver will limit the number of modes exposed. (Use ManageEDID tool with a fake EDID with just the required display timing).
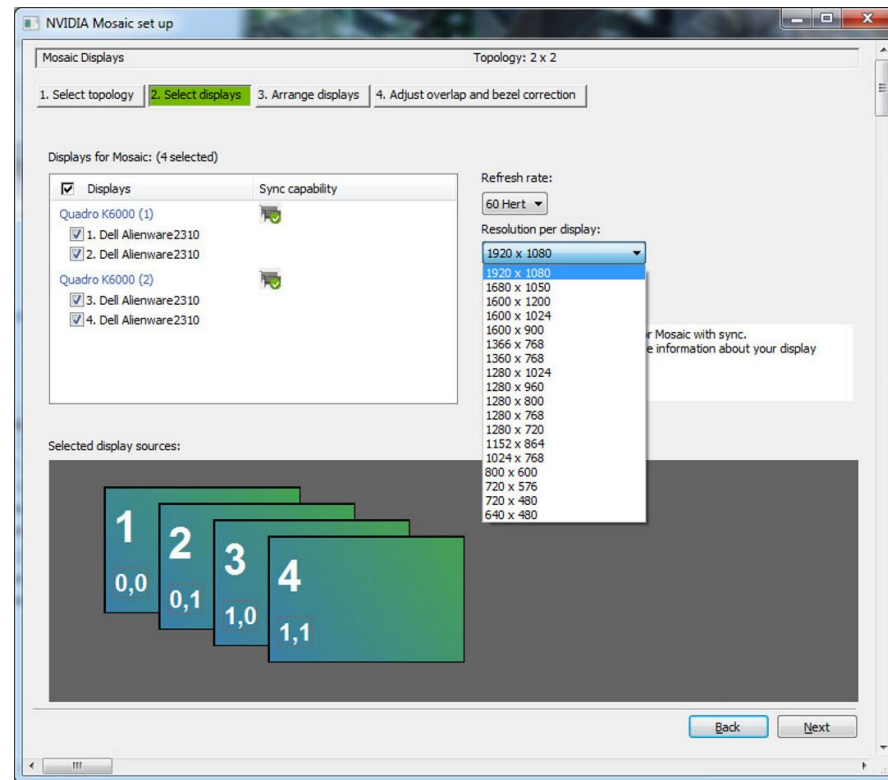
MOSAIC RESOLUTION NOT LISTED

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

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

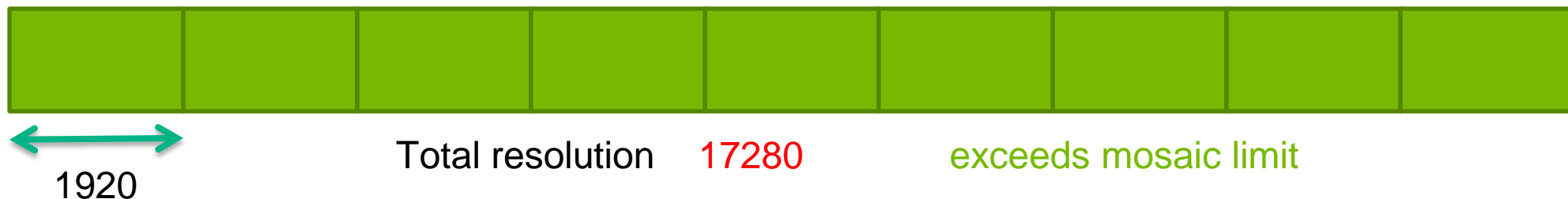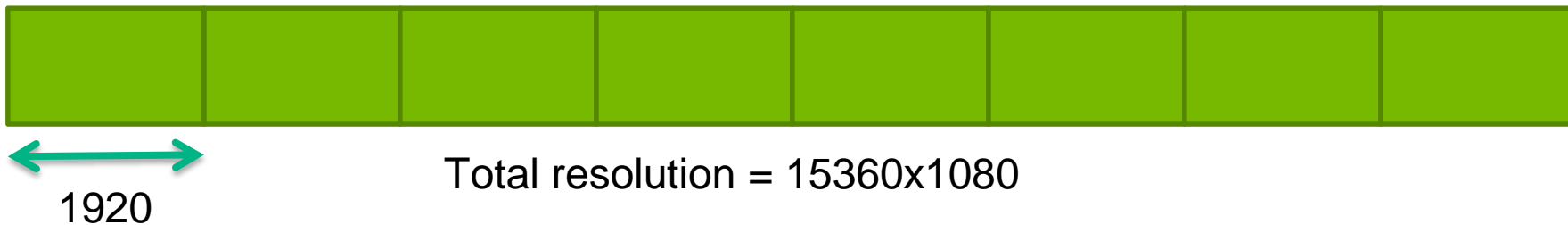 Contact – QuadroSVS@nvidia.com for a copy.

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)

Total resolution = 15360x1080

1920

Total resolution   17280   exceeds mosaic limit

1920

Note Bezel Correction will add to the total resolution.

WARP + INTENSITY ADJUSTMENTS

PROJECTION BLENDING

Warp + Blend Engine

3rd party software available from

scalable
DISPLAY TECHNOLOGIES

VIOSO®

play-out.com™

Fraunhofer
FOKUS

CHRISTIE®

Pixelwix
Inovative Media Solutions

coolux®
A CHRISTIE COMPANY

IMMERSAVIEW

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

WARP AND BLEND

API for geometry and intensity adjustments for seamless projection environments

WARP NOT JUST FOR PROJECTORS
Arbitrary display layouts
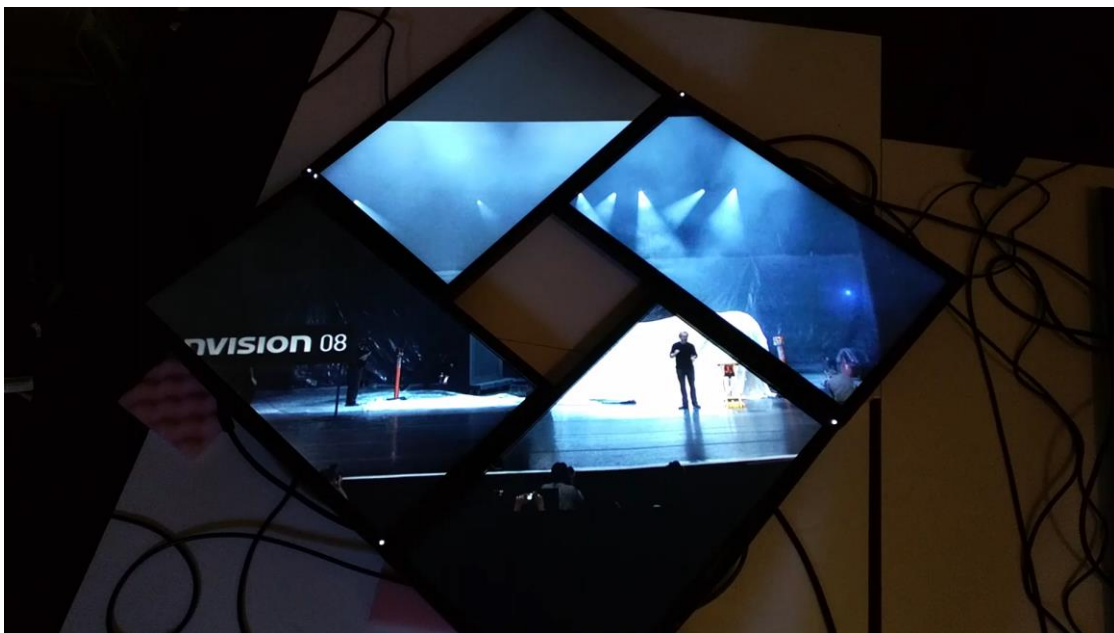
GTC – S5143 **Architectural Display Walls Using NVAPI**
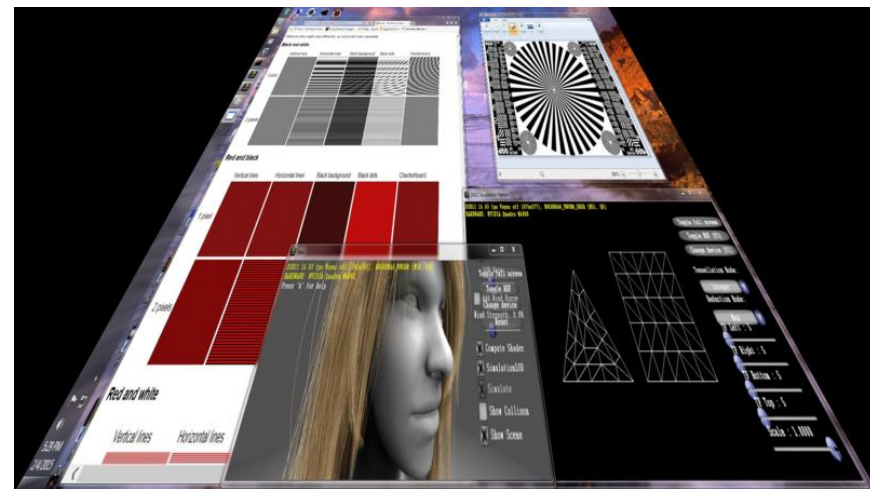
WARP 2.0
New filtering methods

NvAPI_GPU_SetScanoutCompositionParameter

Selectable via NVAPI

- Bilinear

- BI-CUBIC Triangular

- BI-CUBIC Bell Shaped

- BI-CUBIC Bspline

- BI-CUBIC – Adaptive Triangular

- BI-CUBIC – Adaptive Bell Shaped

- BI-CUBIC Adaptive Bspline
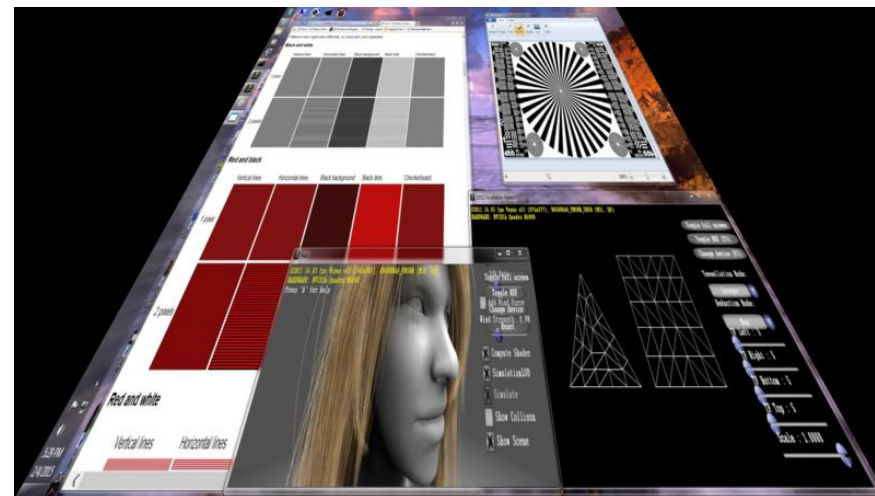
Bi-cubic triangular filtering

IMPLEMENTING WARP
Links to past talks/info

Windows

- S5143 - Architectural Display Walls Using NVAPI – Doug Traill, GTC 2015

- S2322 - Warping & Blending for Multi-Display Systems – Shalini Venkataraman GTC 2012

- Sample code - DesignWorks developer pages

Linux

- Sample code - nv-control-warpblend. Shipped with driver. Tar ball can be downloaded here: ftp://download.nvidia.com/XFree86/nvidia-settings/

- Go to samples directory.

LCD TILE WALLS

MOSAIC + WARP
## Solves issues with sync on LCD panels

Tearing between each row

- Appears with fast moving video or interactive content

- Display wall is framelocked – but response time of LCD panels results in this optical effect
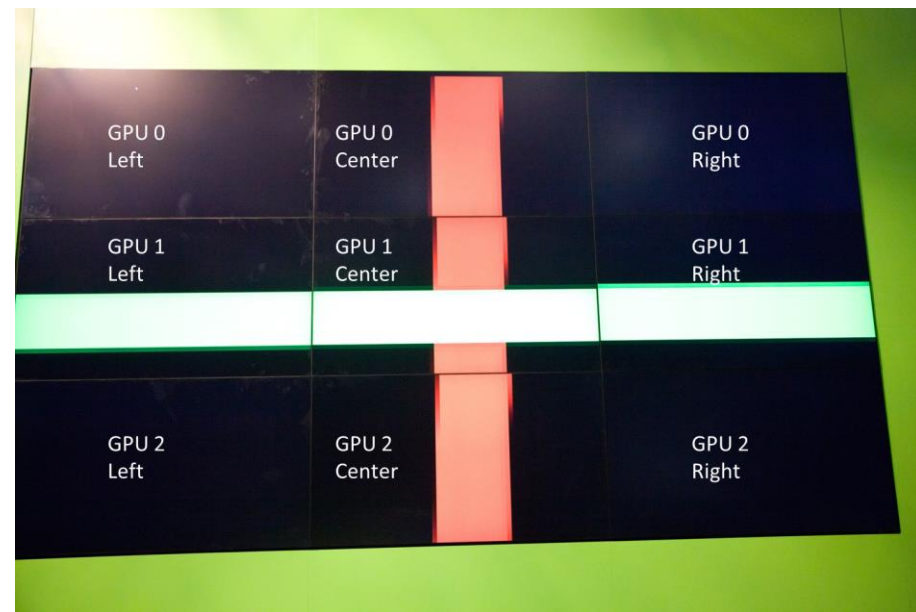
LET'S TAKE A CLOSER LOOK

What's happening

- Progressive scan-out from line 0 to line 1080

- Each lower row appears to be rendering ahead

- Columns within a row appear to be sync'd

Line 0

Line 1080

Line 0

Line 1080
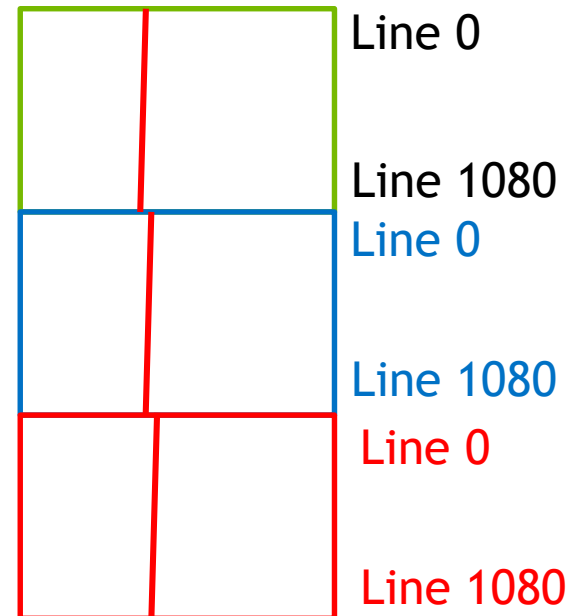
Line 0

Line 1080

SOLVING THIS PROBLEM

Use WARP API + rotated row

- Progressive scan-out from line 0 to line 1080

- Rotate every other row

  - Line 1080 -> Line 1080

  - Line 0 -> Line 0

- WARP API

 - Rotate Desktop image so looks correct to the viewer

Line 0

Line 1080

Line 1080

Physically rotate display

Line 0

Line 0

Line 1080
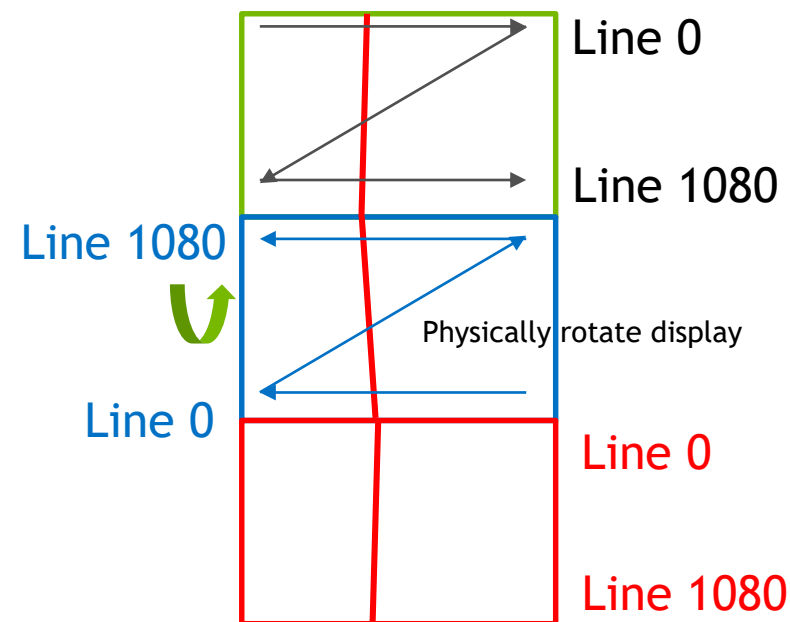
DISPLAY MANAGEMENT APIS

NVWMI TOOLKIT & NVAPI

Remote management and NVIDIA control panel APIs manage complexity

NVWMI remote management API
▪   **Monitor and manage NVIDIA graphics from anywhere**
▪   **Do everything the control panel can do and more**
▪   **Plugs into Microsoft's WMI**
▪   **Perfmon support**
▪ **Scriptable	wmic	powershell	C# support**

NVAPI for the NVIDIA control panel
▪   **Custom resolutions**
▪   **EDID management**
▪   **Warp + Blend API (Quadro only)**
▪   **MOSAIC API**
▪   **Reskinning the NVIDIA control panel (build your own)**
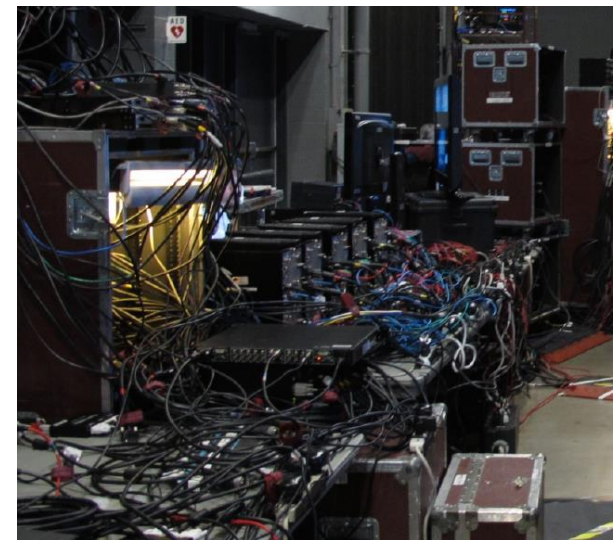
Without NVIDIA Technology

With NVIDIA Technology

Image courtesy of Immersive Design Studio

NVAPI FUNCTIONS
Selection of different features

Custom Resolutions	MOSAIC	Sync Management	EDID Management
GFT, DMT, CVT, CVT-RB, Manual timing	Seamless desktop across multiple GPUs	Genlock/TTL sync, framelock (internal sync)	Capture and read EDID from file
EDID Management	**WARP + Intensity API**	**Driver Profiles**	**Driver Settings**
Capture and read EDID from file	Edge-blending, projection mapping on Windows or Linux	Global and nView profile management	Manage 3D settings selection
Display Setup	**GPU Direct for Video**	**Color Management**	**GPU Utilization**
Clone mode, display position	Picture-in-picture support	Color space conversion via NVAPI SDK	GPU utilization, memory etc.

 NVIDIA

NVAPI BASICS

Public & NDA Version

Public – developer.nvidia.com

Most functions available – MOSAIC, WARP etc NO Custom Resolution.

NDA – registered developer with NDA. NVIDIA provides access to partner network for download

All functions available – including custom resolution

More SDK examples

Structure versions

Each structure in NVAPI contains a version field that must be set.

NV_XXX.version = NV_XXX_VER;

displayIds – unique identifier for each display attached. Includes GPU info.

NVWMI
Plug into Windows Management Infrastructure

Accessible using:

- WMIC – command line

- Powershell

- C#

developer.nvidia.com/nvwmi

- SDK samples

- White paper

Installed with the driver - C:\Program Files\NVIDIA Corporation\NVIDIA WMI Provider

MOSAIC SETUP
NVWMI – adds remote setup support

- Class – DisplayManager

- Function – createDisplayGrids

- Input parameters – string containing grid information i.e.

  "rows=2;cols=2;stereo=0;layout=1.1 1.2 1.3 1.4;mode=1920 1200 32 60"

- Layout – numbering starts at "1".
  Different than control panel

```csharp
ObjectGetOptions Options = new ObjectGetOptions();
ManagementPath Path = new ManagementPath("DisplayManager");
ManagementClass ClassInstance = new ManagementClass(Scope,
Path, Options);
ManagementBaseObject inParams =
ClassInstance.GetMethodParameters("createDisplayGrids");

string[] grid_input_params = { "rows=1;cols=2" };
inParams["grids"] = grid_input_params;

ManagementBaseObject outParams =
ClassInstance.InvokeMethod("createDisplayGrids", inParams,
null);
```
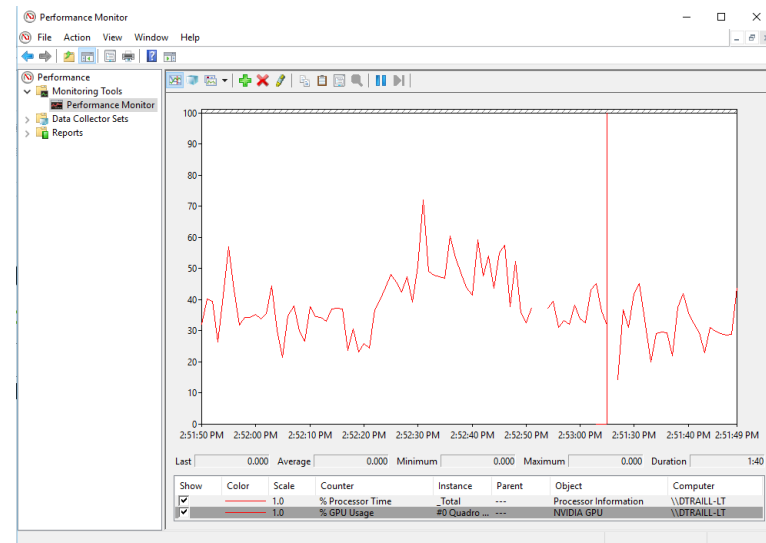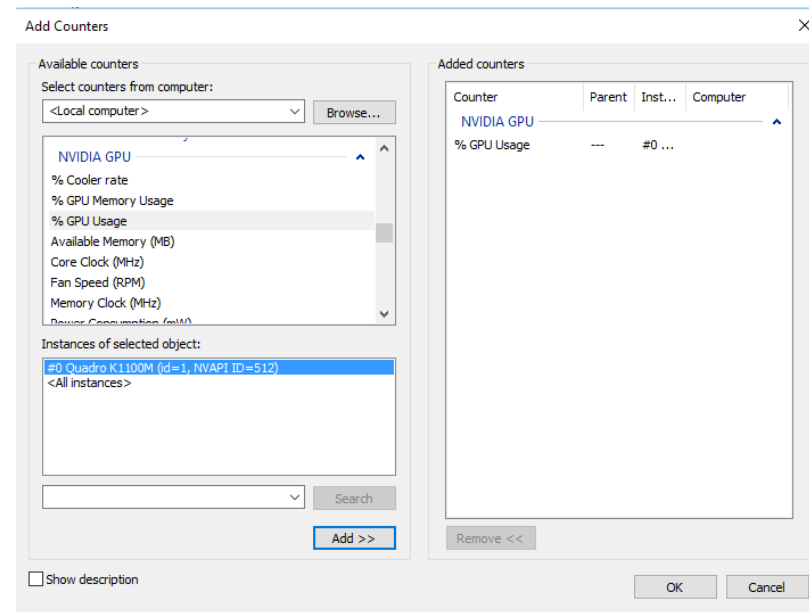
C# code snippet

PERFORMANCE MONITOR

Performance Counters

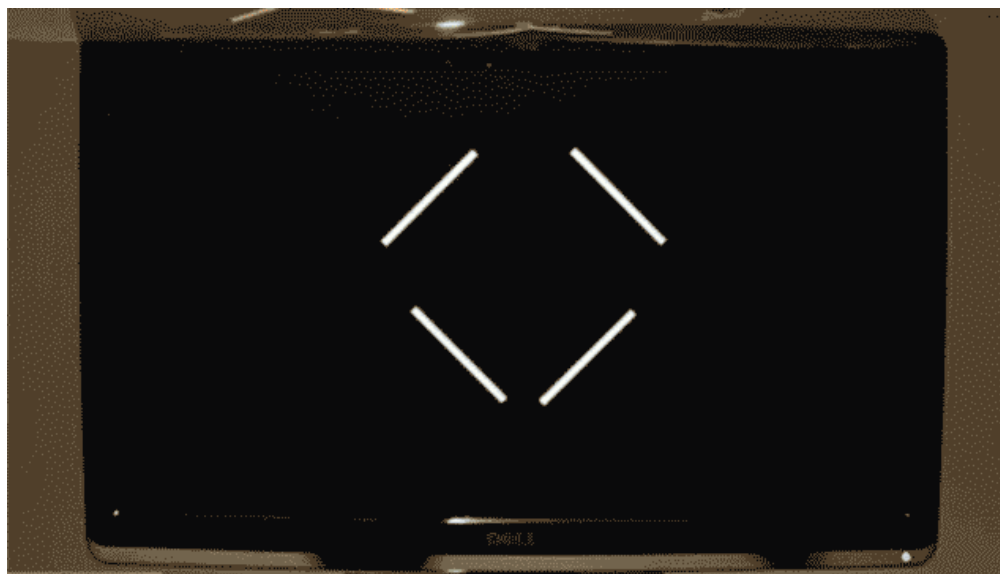- monitor utilization

- Temperature/power

Event monitor

- Quadro Sync events

  - Changes in sync status reported without polling.
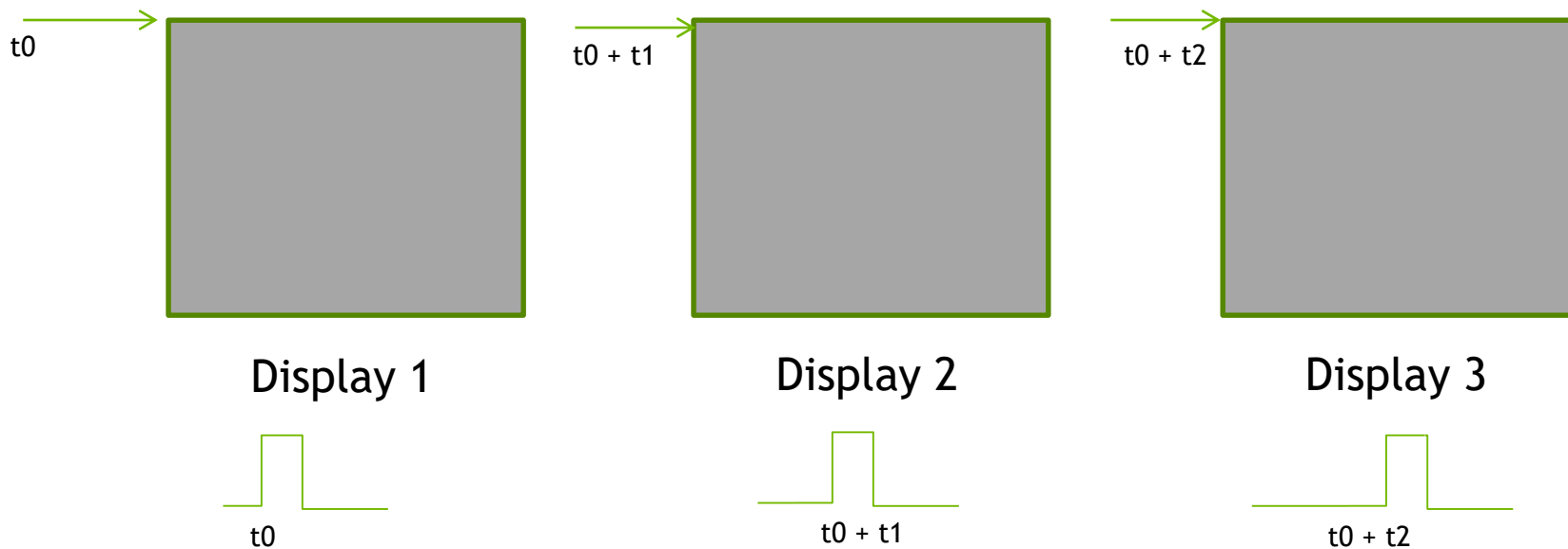
QUADRO SYNC

WHY IS SYNC IS IMPORTANT?


Bezel's hide sync issues !!!

Image from gizmodo.com

VERTICAL SYNC

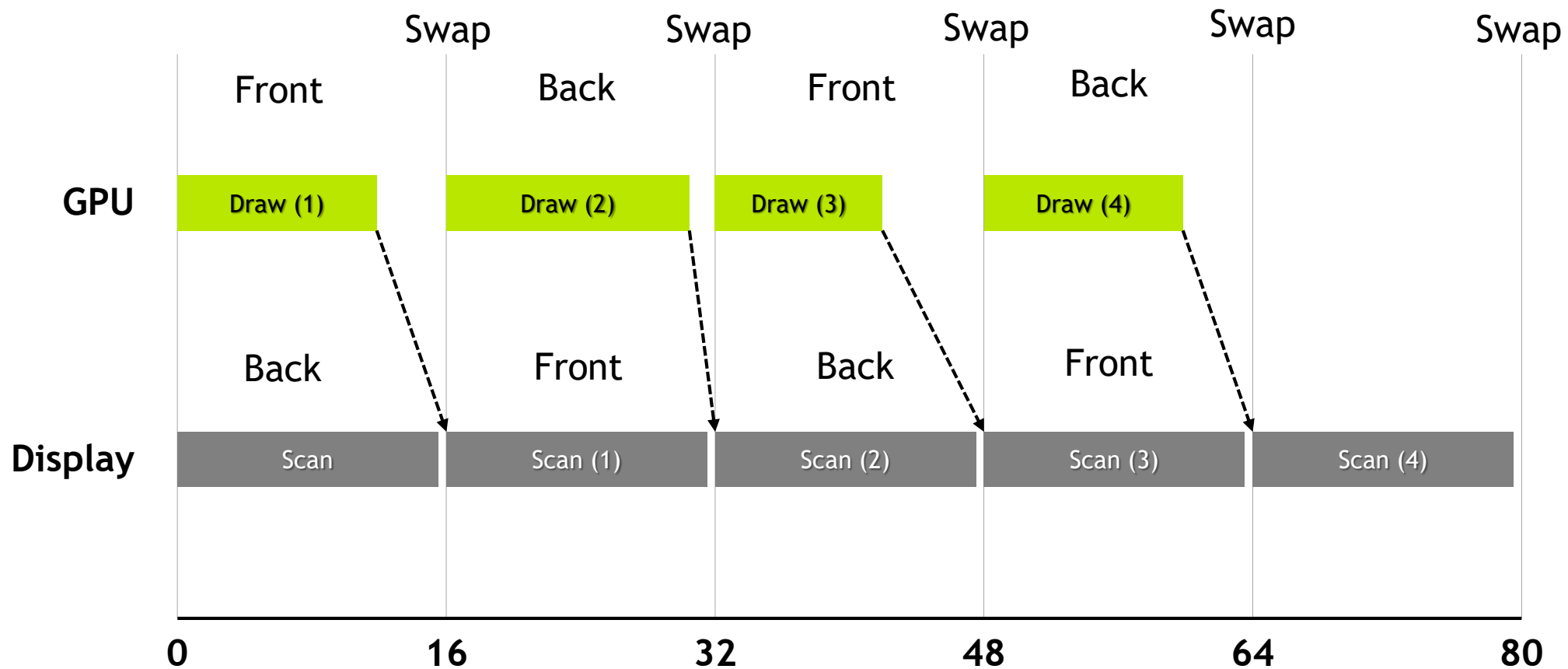Display 1   Display 2   Display 3

- *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.

NVIDIA.

FRAMELOCK/GENLOCK
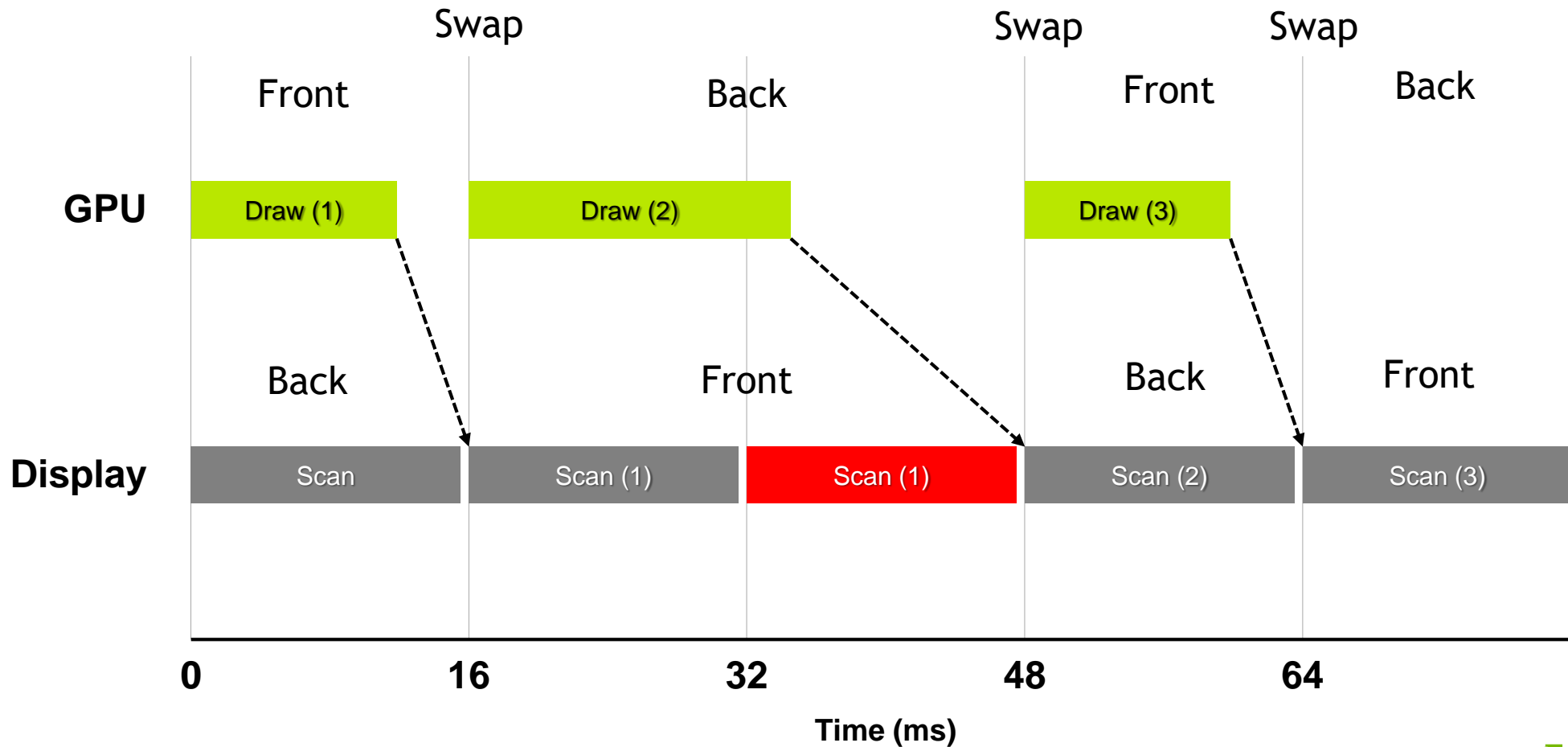

Display 1   Display 2   Display 3
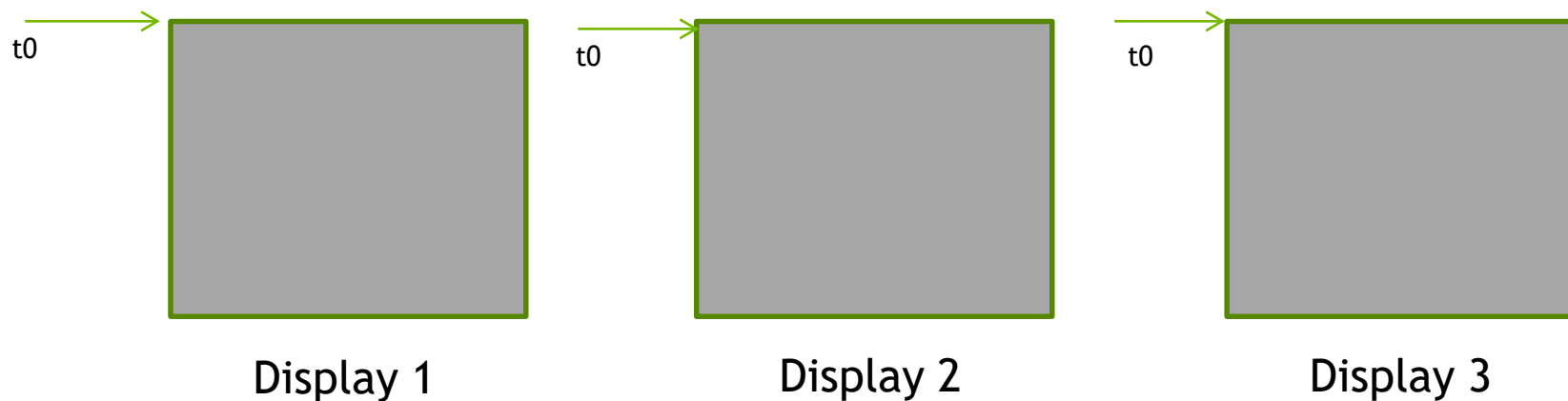
- *Framelock/Genlock provides a* common sync signal between graphics cards to insure the vertical sync pulse starts at a common start.
- This is commonly referred to as *Frame Synchronization*
- *Framelock* – Synchronization is generated from a master node. All other nodes would be sync to this.
- *Genlock* – synchronization is from an external sync generator (house sync). Each node attached to the genlock signal is synced from that signal.
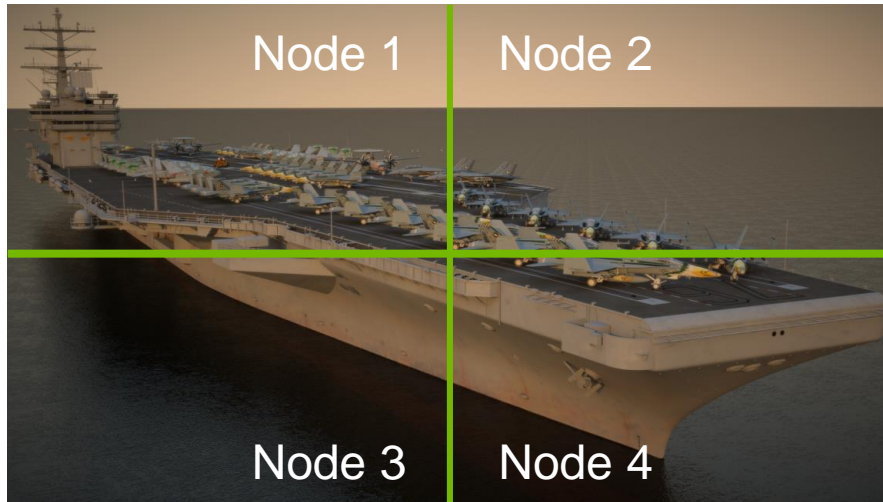- *Framelock & Genlock* can be mixed in the cluster. With the master node being synchronized from the genlock pulse.

SWAPBUFFERS

Swap   Swap   Swap   Swap   Swap

GPU

Front   Back   Front   Back

Draw (1)   Draw (2)   Draw (3)   Draw (4)

Back   Front   Back   Front

Display

Scan   Scan (1)   Scan (2)   Scan (3)   Scan (4)

0   16   32   48   64   80

69

SWAPBUFFERS

Swap   Swap   Swap

GPU

Front   Back   Front   Back

Draw (1)   Draw (2)   Draw (3)

Back   Front   Back   Front

Display Scan   Scan (1)   Scan (1)   Scan (2)   Scan (3)

0   16   32   48   64

Time (ms)

SWAPBUFFERS IN A CLUSTER

Node 1 | Node 2
Node 3 | Node 4

Each node is now rendering a scene with different complexity i.e from least to highest we get:
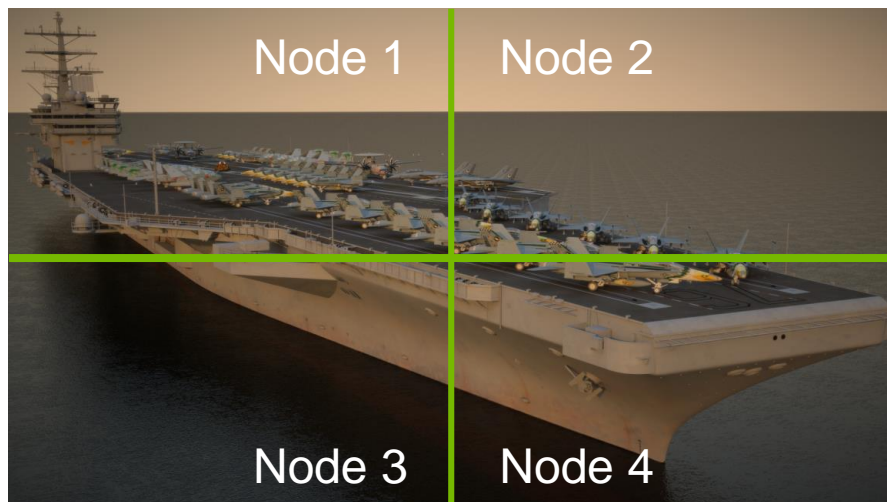1. node 3 ~ 16ms = 60fps
2. node 4 ~ 36ms = 30fps
3. node 2 ~ 53ms = 15fps
4. node 1 ~ 99ms = 10fps

- 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
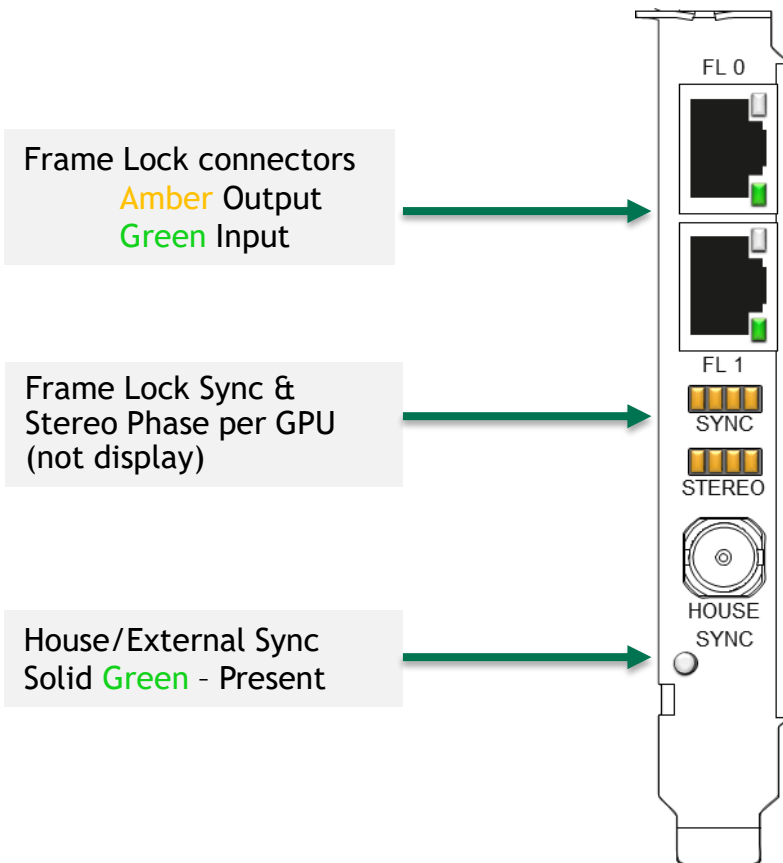4. node 1 ~ 99ms = 10fps

WIRING A CLUSTER
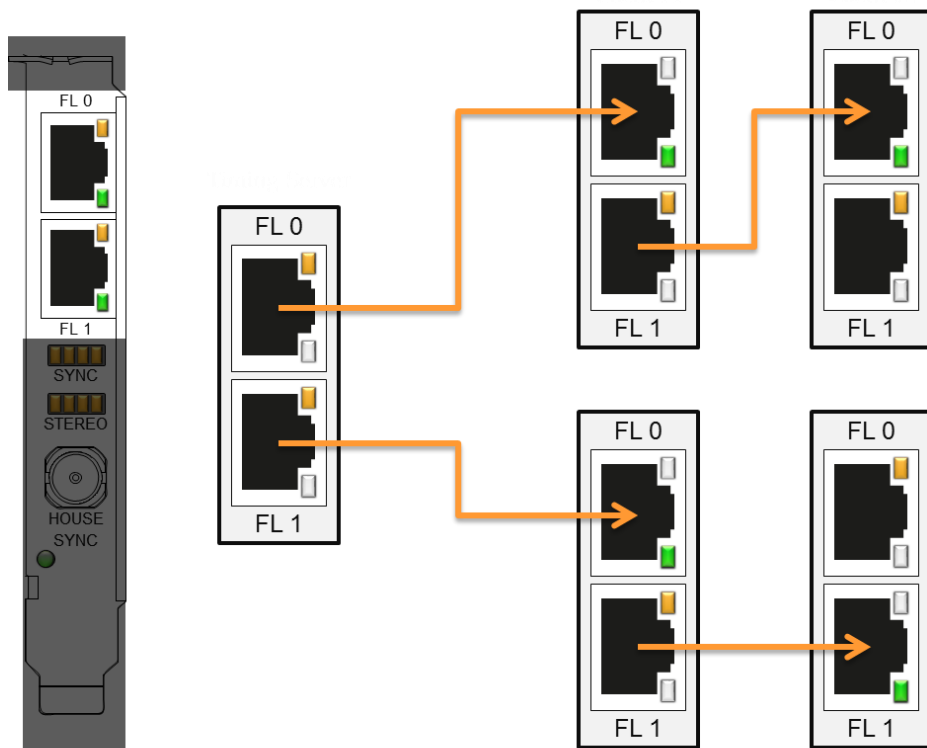
Connect the nodes with quality CAT 5 cables, no longer than they need to be

Put the timing server in the middle

This system should have the stereo connector for active stereo if needed

CHECKING SYNC STATUS

Frame Lock connectors
Amber Output
Green Input

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

House/External Sync
Solid Green – Present

Control Panel

System Topology Viewer provides per
display sync information

	automated computer con... (1 of 2)		
	Display state	Server	
	Resolution, refresh rate	1920 × 2160 pixels, 49.996 Hz	
		Horizontal (2200)	Vertical (2300)
	Active	1920	2160
	Border	0	0
	Front porch	13	8
	Sync width	140	10
	Back porch	127	122
	Polarity	Negative (-)	Negative (-)
	Timing	The display is locked to an internal timing signal	
	EDID source	Monitor...	
	OS Screen Identifier	1	

FL 0

FL 1

SYNC

STEREO

HOUSE
SYNC

QUADRO SYNC FIRMWARE
Version 0x57

Fixes

- Issues with 50Hz house sync signals

- Start delay and Sync offset functions

- Mosaic as part of cluster – each node is running MOSAIC locally.

- General stability related to Maxwell generation of GPUs.

If your system isn't broken – don't fix it.
i.e. please only upgrade if one of the issues above applies to you

BUILDING CLUSTER AWARE SOFTWARE

CLUSTER SOFTWARE
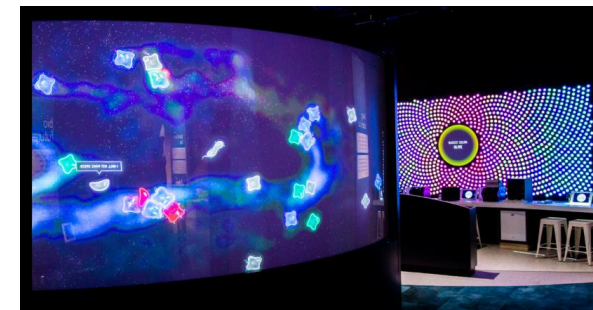
3rd party/Open Source

MORE INFO - OTHER TALKS

Monday	
2.00pm room LL20A pm	See the Big Picture
3.45pm Hangout Pod C	MOASIC – Video wall

Tuesday	
1.00pm Room 210E	**S6452 – Run-Time Scene-Graph Construction from Geographic Source Data**
1.30 pm Room 212B	**Canvas: The Enterprise Media Server Solution for Game Engines**

Wednesday	
10.00 am Room 212B	**S6770 - GPU Image Processing on Giant Surfaces**
10.00 am Room LL21A	**CAVE2.0: The Worlds Largest Virtual Reality Cluster @PSA**
10.30 am Room LL21C	**S6350: State of the art Real-time Graphics for Events, Broadcast & interactive content**
4.30 pm Room LL20C	**S6752 – Sports Training and VR: Challenges in Making the Physical, Virtual**
Wednesday Evening – GTC Party	
The Tech	**BioDesign Studio - Wrap around display using 11 projectors – running MOSAIC**

Thursday	
9.30 am Room 210E	**S6649 – One Size Doesn't Fit all: The Importance of Aligning VR Environments to Workflows - MechDyne**
10.00 am Room 210E	**S6567 – Large Scale and Multi-Display Visualization - JVC**
10.30am Room 210E	**S6766 – VR in the Brown University YUART**

THANK YOU

JOIN THE CONVERSATION
#GTC16

Questions - QuadroSVS@nvidia.com

Follow us on twitter - @dougtraill