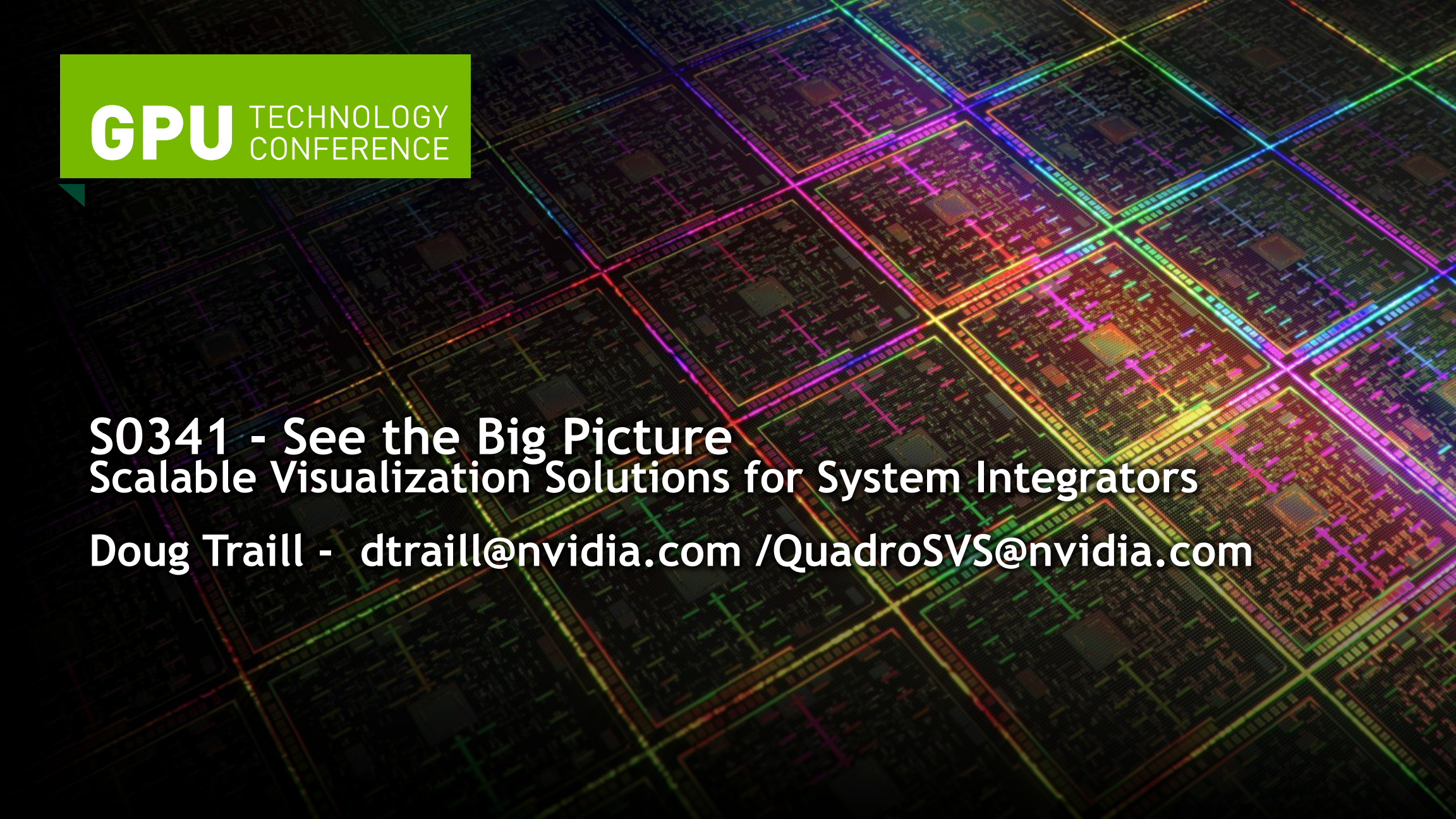


S0341 - See the Big Picture
Scalable Visualization Solutions for System Integrators

Doug Traill - dtraill@nvidia.com /QuadroSVS@nvidia.com

SVS Solutions

MOSAIC

4K Desktop

Conference Room

4K Cinema

Visualization Room

GSync

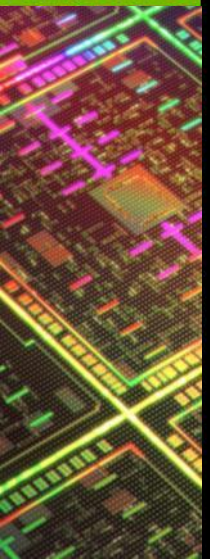
Operations Center

Visual Simulation

Immersive VR Room

Planetarium

GPU TECHNOLOGY CONFERENCE



** Schedule subject to change. Please check the online schedule and digital signage outside of session rooms for updates.*

Monday, 05/14/2012

Time	Location	Session
10:30am	Room A2	S0341, See the Big Picture Scalable Visualization Solutions for System Integrators
1:00pm	Room A2	S0530, Multi-Display Roundtable
2:30pm	Room A2	S0601, GPU-Based Video Processing Round Table

Tuesday, 05/15/2012

Time	Location	Session
2:00pm	Hall 1	S0515, Multi-GPU Programming
4:00pm	Room J2	S0356, Optimized Texture Transfers
5:00pm	Room J2	S0267A, Mixing Graphics and Compute with Multiple GPUs

Wednesday, 05/16/2012

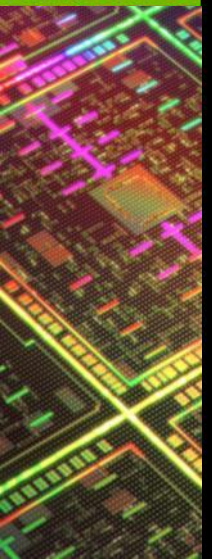
Time	Location	Session
9:00am	Room A1	S0353, Programming Multi-GPUs for Scalable Rendering
10:00am	Room A1	S0322, Warping & Blending for Multi-Display Systems
10:30am	Room A1	S0355, Seamless Scalable Displays - Using NVDIA Warp + Intensity API

Thursday, 05/17/2012

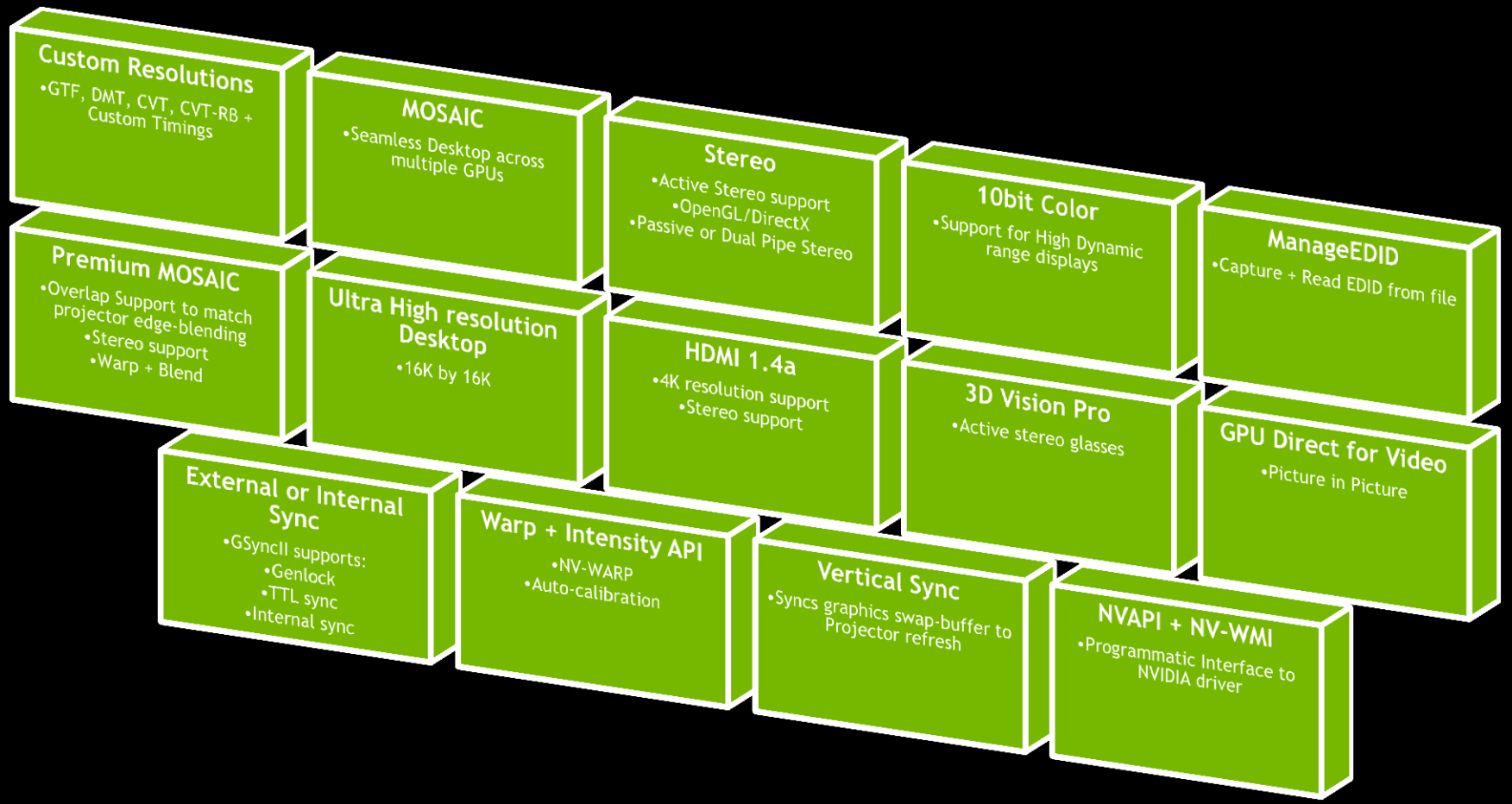
Time	Location	Session
9:00am	Room A1	S0326, Next Generation InfoWall

Three (3) things that I want you learn

- MOSAIC – Application Scalability
- Synchronization – Focus to on the image and not the artifacts
- Visual Acuity – ultra high resolution “retina” displays.



Quadro Features for System Integrators



MOSAIC Technologies

✘ **Without Mosaic:**

✓ **With Mosaic:**

Mosaic Features
Scale with Quadro and NVS Solutions

Key Features

- Unified Desktop (up to 8 display devices*)
- Application Spanning
- Taskbar Spanning
- Bezel Correction
- Windows 7 + Linux Support

* All displays require matching timings and resolution

Premium Mosaic Features

Additional Premium Features

- Seamless Display
- Projector Overlap
- Stereo Support
- Quadro G-Sync Support
- Linux and Windows Vista, XP and 7 Support
- NEW API Support for Warp + Intensity Correction

Single or Dual Quadro Plex

Single or SLI:
Quadro 5000, 6000

NV-WARP – Warp + Intensity API

Wednesday Room A1 – 10.00am Warping + Blending for Seamless Displays

SDK – Available to Registered Developers

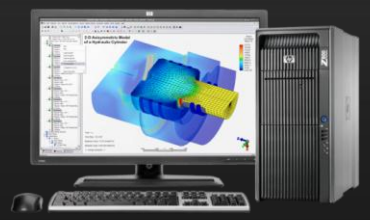
- ✓ Sample SDK
- ✓ Three function calls
- ✓ NVAPI
- ✓ Win7 only

scalable DISPLAY TECHNOLOGIES

3rd party applications

- ✓ Full Auto-calibration system
- ✓ Premium MOSAIC support
- ✓ Win 7 only

Certified Platforms for Dual QUADRO 5000/6000
Premium MOSAIC



HP Z800/Z820
Dual Quadro5000/6000

Dell T7500
Dual Quadro5000/6000

Lenovo D20/C20
Dual Quadro5000/6000

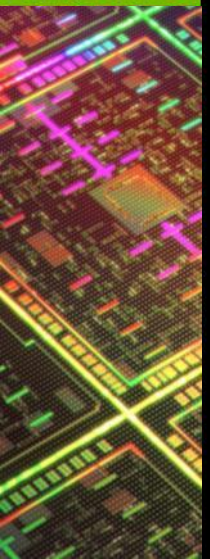
Fujitsu R670/R570
Dual Quadro5000/6000

http://www.nvidia.com/object/quadro_sli_compatible_systems.html

Certified Quadro Plex Platforms

- Most workstation/server class platforms support single Quadro Plex
- Most can support Dual Quadro Plex
- Test suite for system builders to certify Quadro Plex.

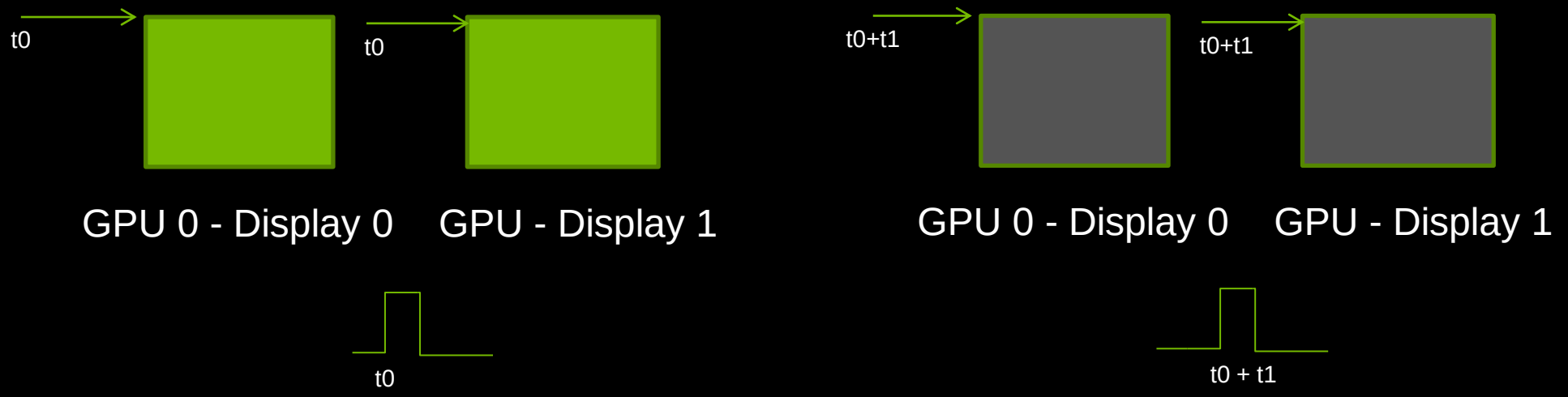
http://www.nvidia.com/page/quadroplex_certified_platforms.html



Differences between Premium Mosaic + Mosaic

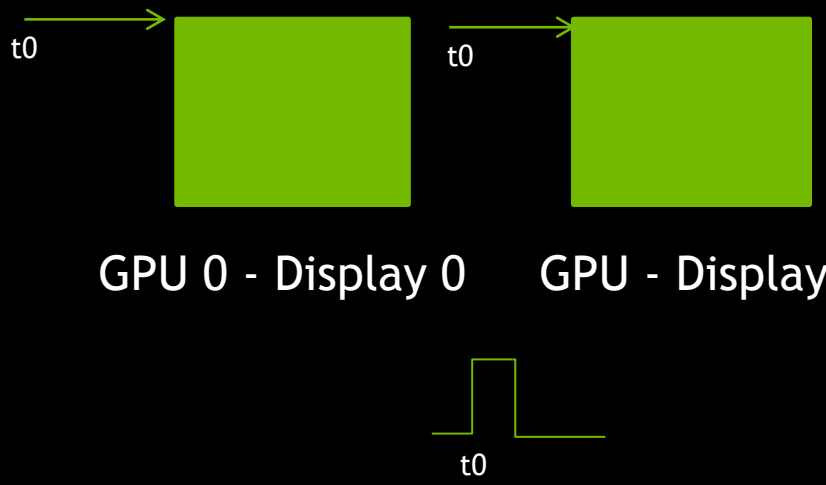
- Frame Synchronization
  - **Vertical Sync** – to a common timing - without a physical connection between cards there is no method for having a common sync
    - Effect is tearing
  - Stereo
    - Without frame sync don't have method for sync left/right eye between GPUS
  - Overlap
    - Without frame sync tearing would be most noticeable in a blend region.
    - We disable this feature so tearing is not shown.

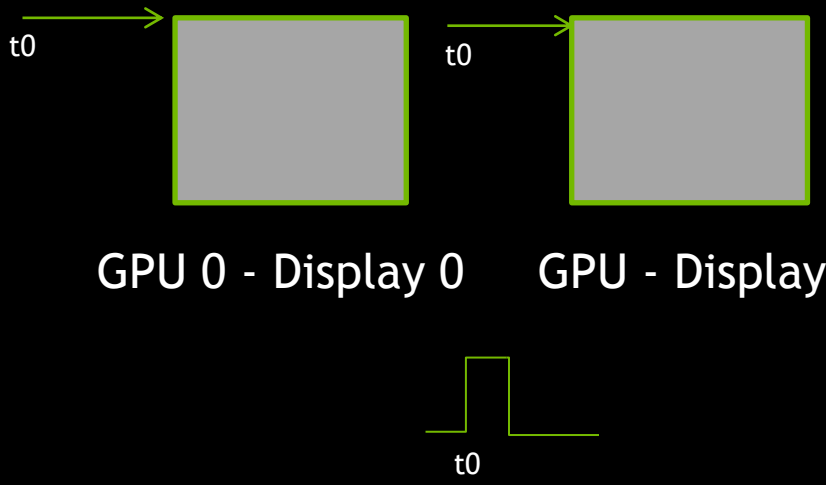
No Frame Sync



- *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 four displays may have the same refresh rate – *vertical sync* start between 2 GPUs will be different.
- This can result in *tearing* between displays.

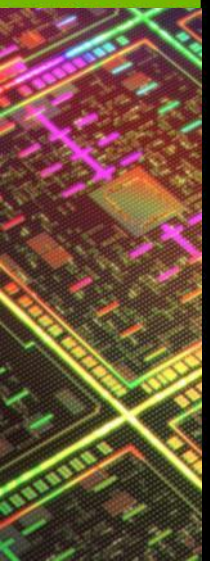
Frame Sync – on SLI Mosaic

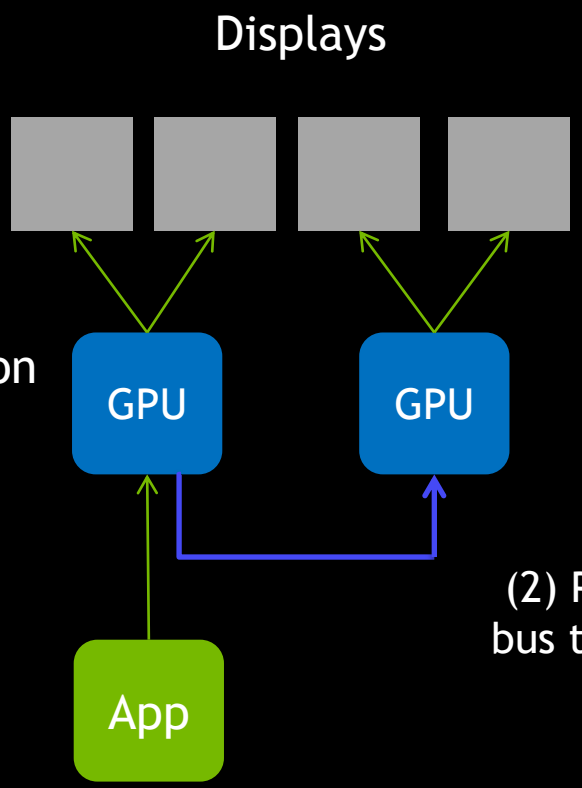




- *Framelock provides a* common sync signal between graphics cards to insure the vertical sync pulse starts at a common start.
- This is commonly referred to as *Frame Synchronization*
- On SLI Mosaic in a workstation – Framelock signal is provided across the SLI Bridge.
- Between Dual Quadro Plex's framelock signal is provided between the CAT5 cable

Let the OS manage multiple displays

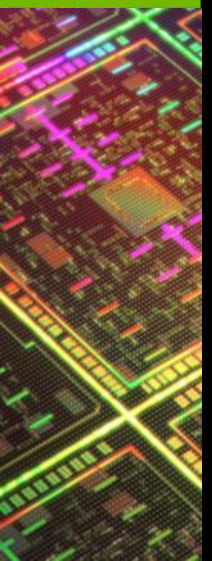


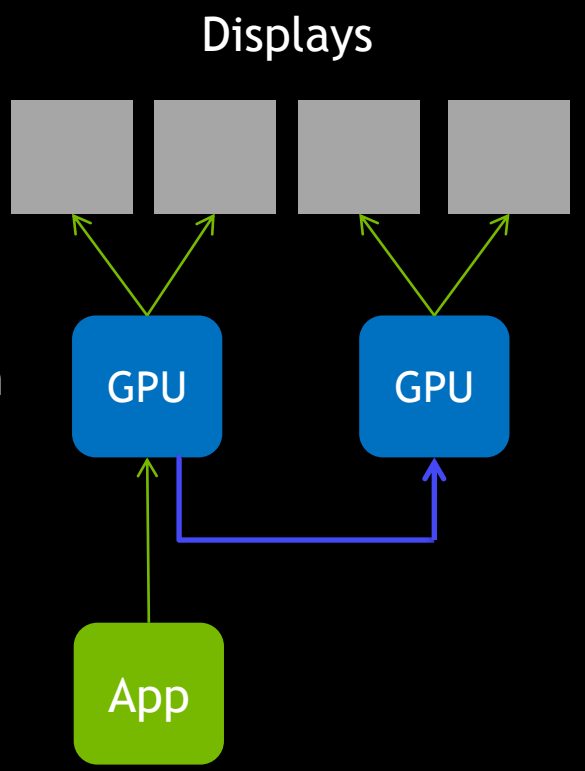


(1) Rendering occurs on one GPU

(2) Pixels are copied across PCIe bus to the other GPU for display

Let the Application manage multiple displays



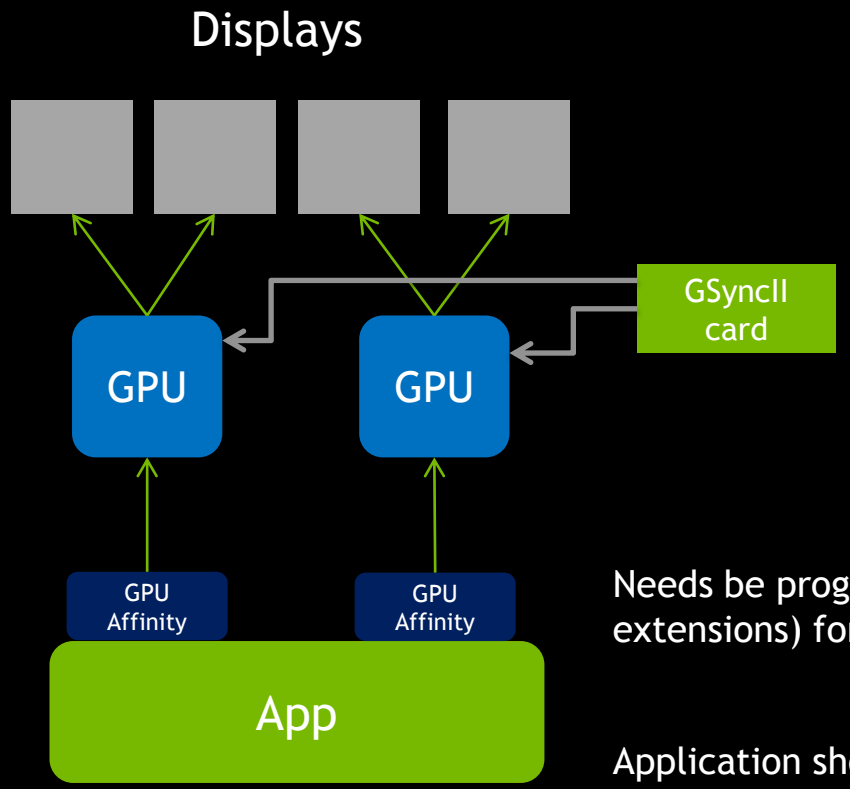


(1) Rendering occurs on one GPU

(2) Pixels are copied across PCIe

Application with GPU Affinity

Wednesday 9.00am Programming Multi-GPUs for Scalable Rendering



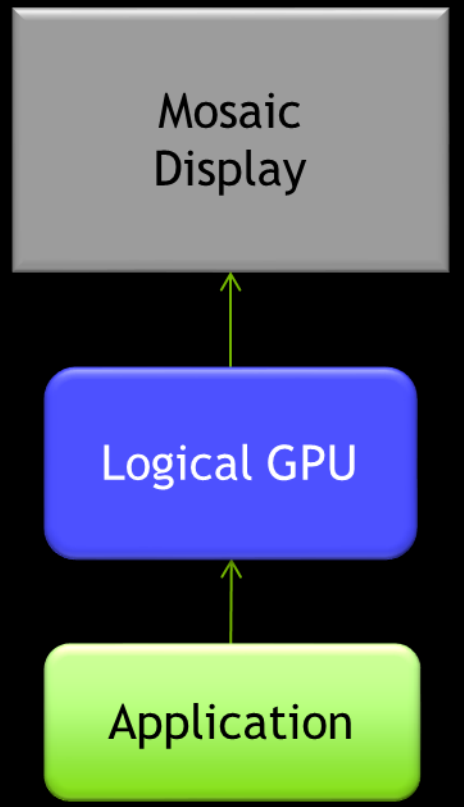
GsyncII Card needed for framelock

Needs be programmed using GPU Affinity (nvidia extensions) for Max performance

Application should use NV swap groups to sync swap buffer between GPUs

Application needs to be multi-threaded (4 Draw threads)

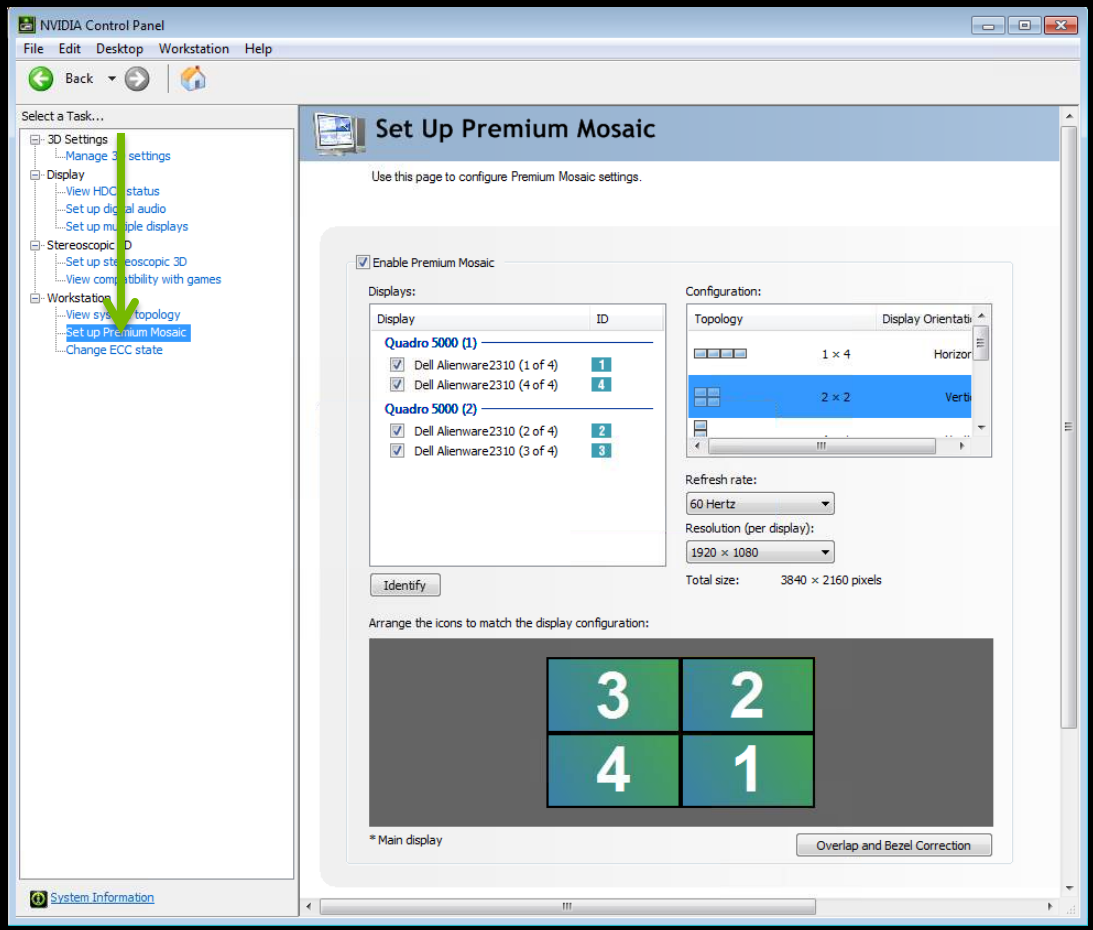
MOSAIC – hides the complexity from the application



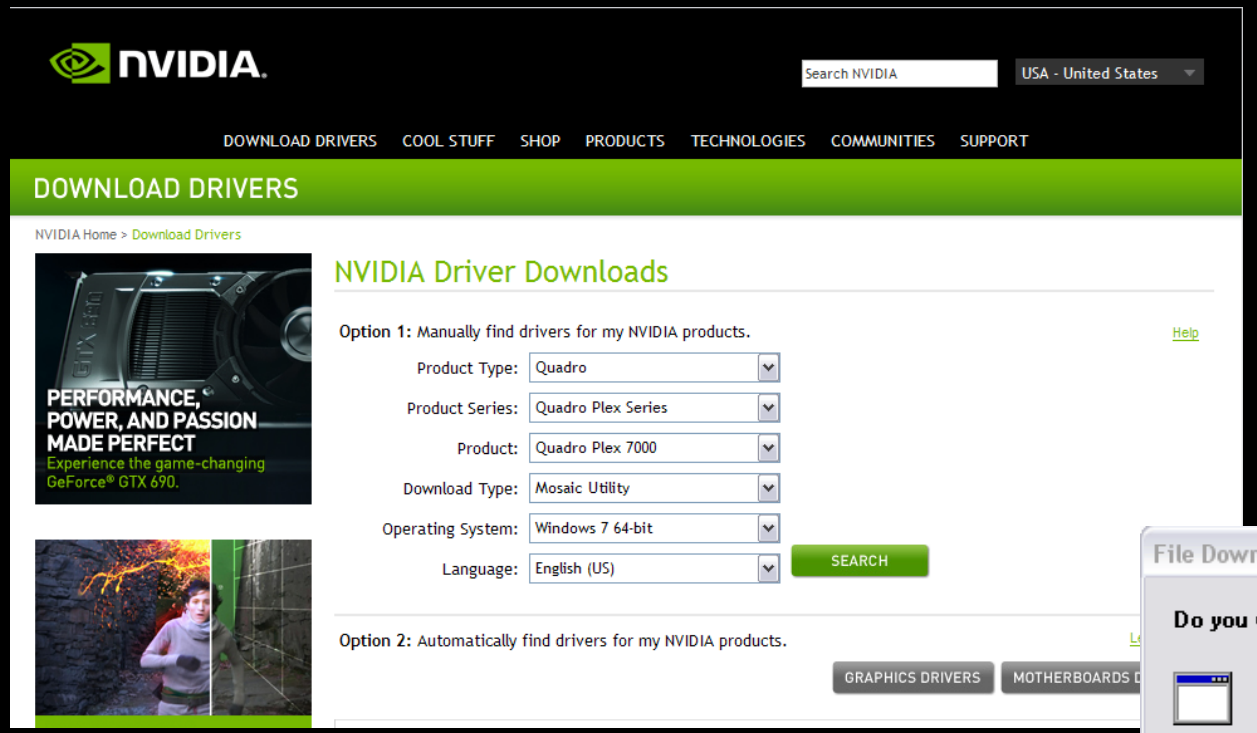
In MOSAIC mode driver works in Broadcast mode to GPUs

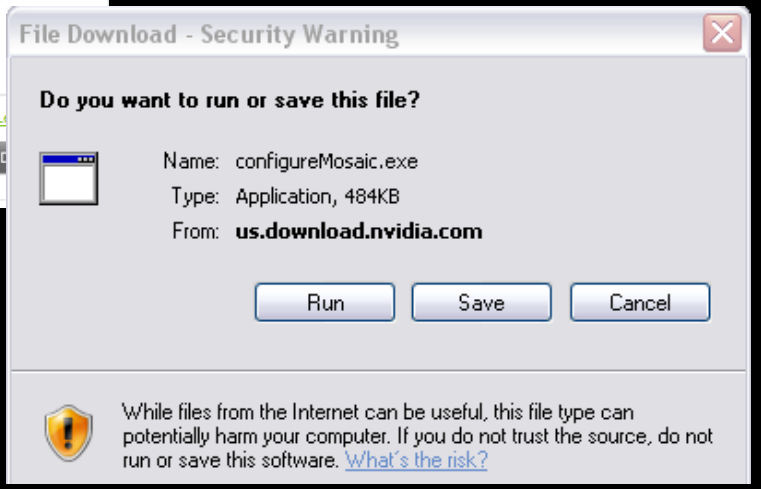
NVIDIA Control Panel

- Order in which commands are applied can matter
  - (1) Manage 3D Settings
    - Profile
    - Stereo
    - Vsync etc
  - (2) Set Resolution
  - (3) Set MOSAIC and/or Synchronization



Configure Mosaic

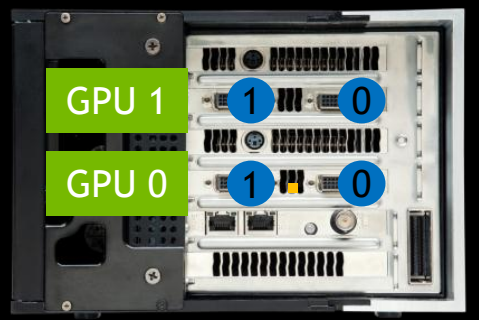


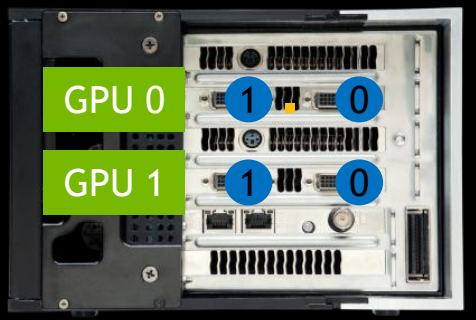


Understanding Topologies

- MOSAIC uses Grids to Topology
- Grid is numbered by TOP ROW – left to right

Port numbers - QuadroPlex 7000

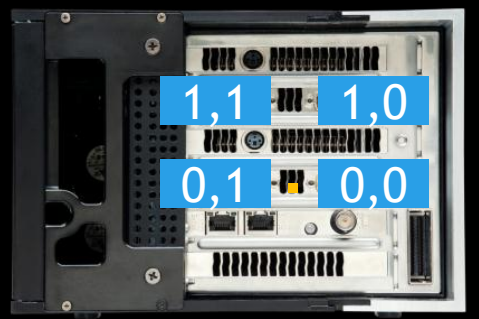


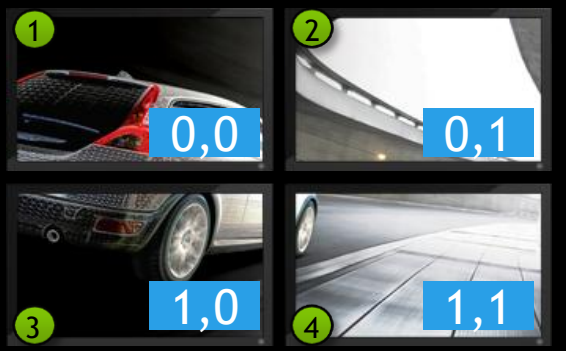


Amber LED appears at POST

Amber LED indicates the primary GPU (0)
Right hand port = is the primary port (0)
We can describe each port by (GPU,Port) number

Relating Ports to Grid

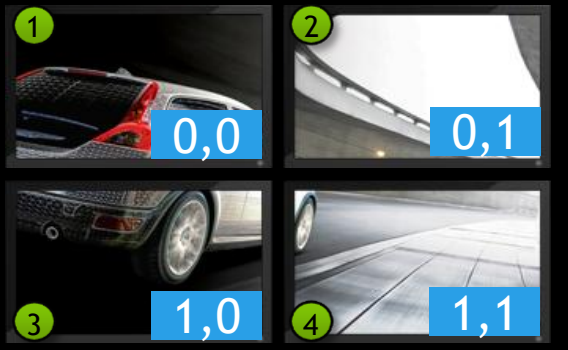




configureMosaic.exe set rows=2 cols=2
configureMosaic.exe set rows=2 cols=2 out=0,0 out=0,1 out=1,0 out=1,1
(1) (2) (3) (4)

1x4 Grid

configureMosaic.exe set rows=1 cols=4



2x2 Grid

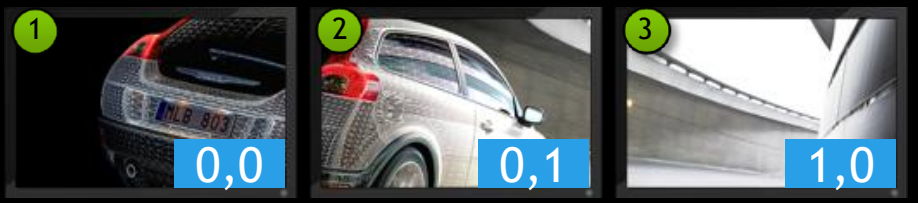
configureMosaic.exe set rows=2 cols=2

1x2 Grid

configureMosaic.exe set rows=1 cols=2

2x1 Grid

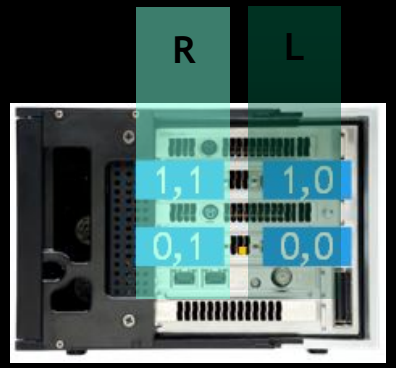
configureMosaic.exe set rows=2 cols=1



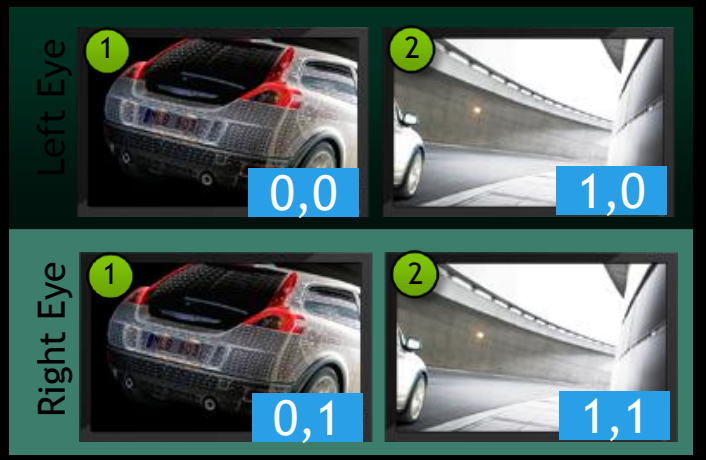
1x3 Grid

configureMosaic.exe set rows=1 cols=3

Passive Stereo

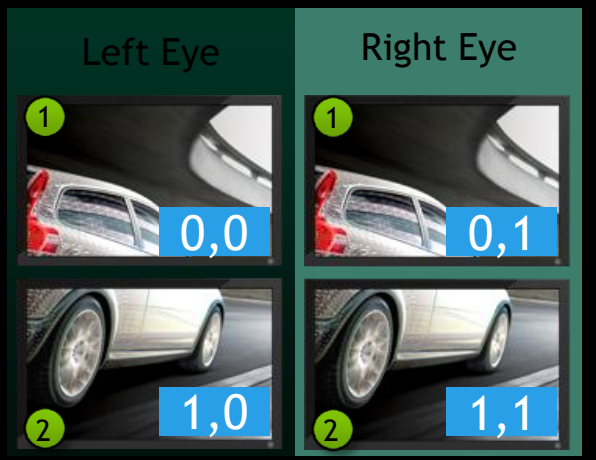


Stereo - Display mode	nView Clone mode
Stereo - Enable	On
Stereo - Swap eyes	Off



1x2 Grid

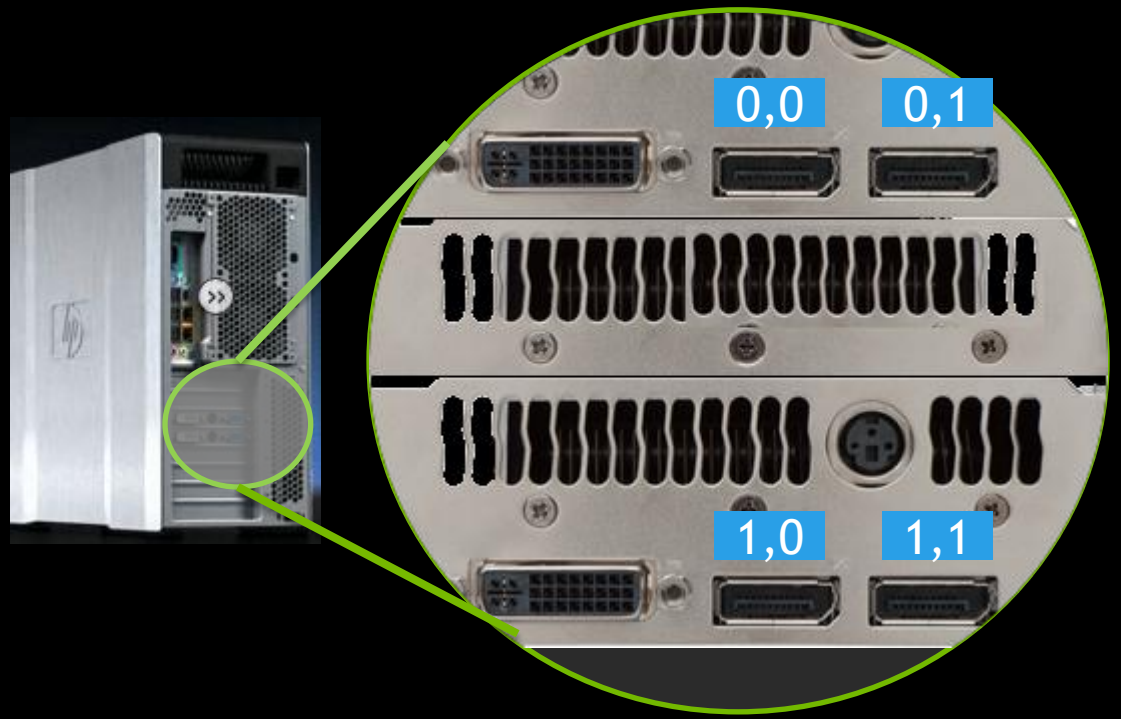
configureMosaic.exe set rows=1 cols=2 passivestereo



2x1 Grid

configureMosaic.exe set rows=2 cols=1 passivestereo

Port layout for SLI workstation

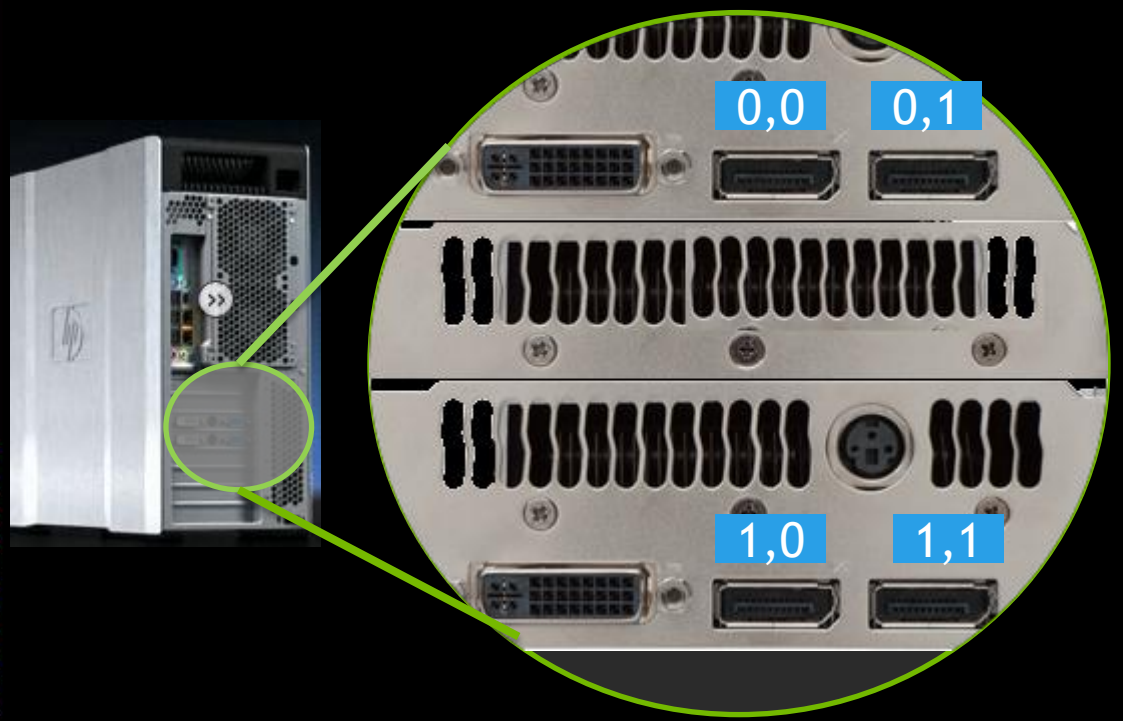


Master - PCI Slot 2

Blank

PCI Slot 4

Port layout for SLI workstation



Only two connections per GPU !

Layout for HP Z800 – other workstations may vary

Verifying outputs

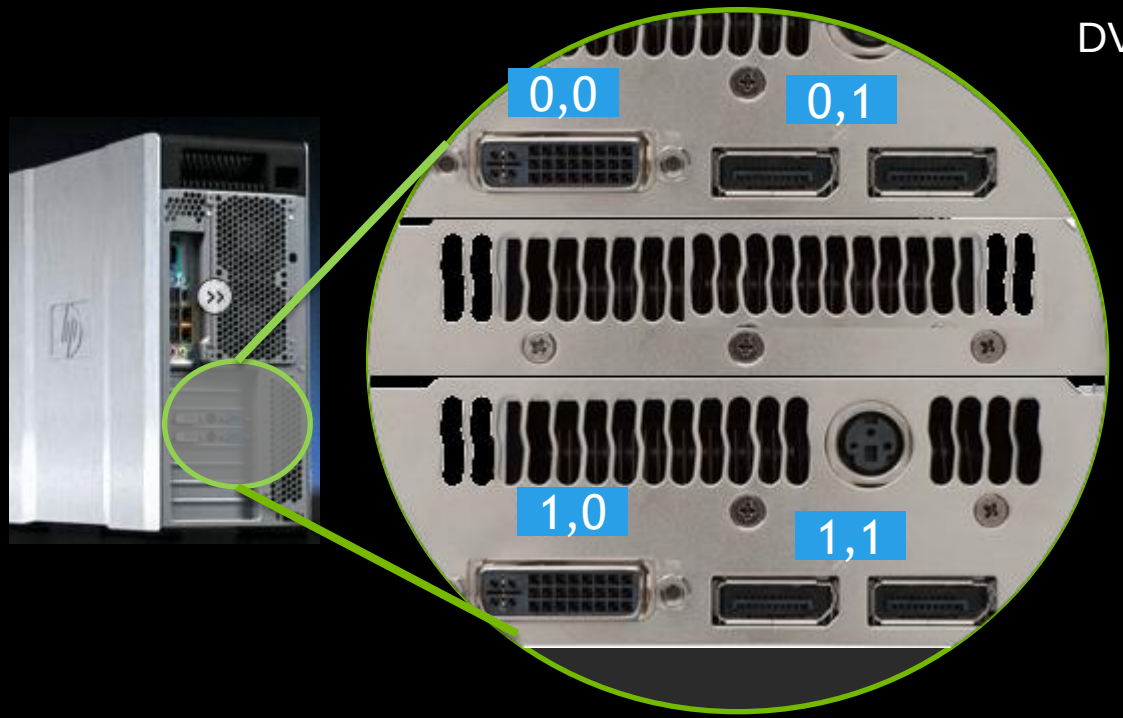
only 0,0 on
configuremosaic set rows=1, cols=1 out=0,0

only 0,1 on
configuremosaic set rows=1, cols=1 out=0,1

only 1,0 on
configuremosaic set rows=1, cols=1 out=1,0

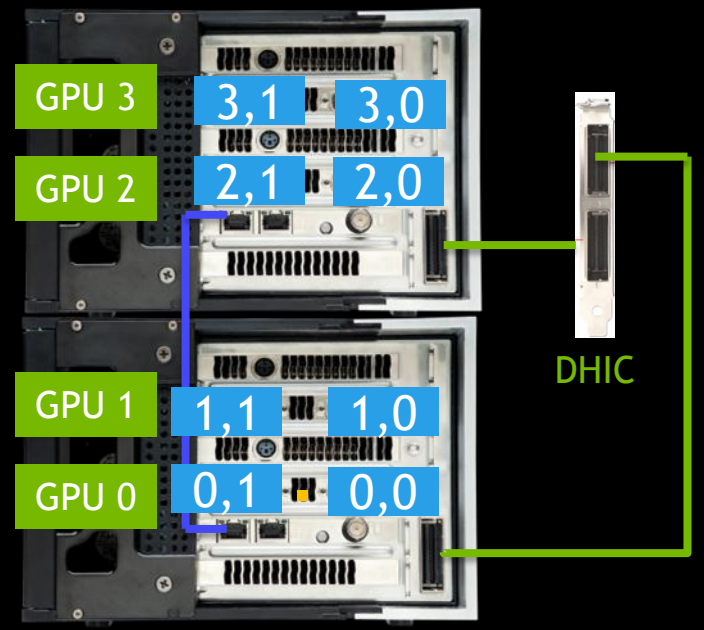
only 1,1 on
configuremosaic set rows=1, cols=1 out=1,1

Port layout for SLI workstation



DVI port is always primary on card – if used !

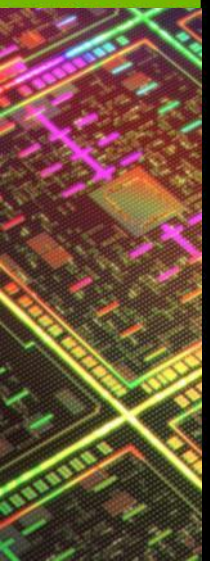
Dual Quadro Plex



Secondary

Primary

- DHIC required for SLI Mosaic > 4 displays
- Amber LED – indicates master
- Framelock
  - RJ45 between GsyncII cards

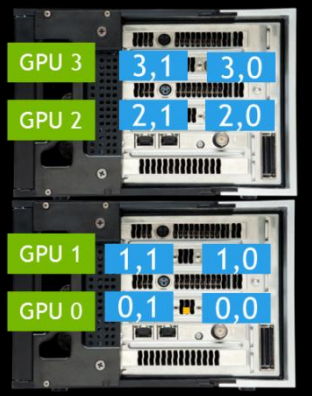


2x4 Grid

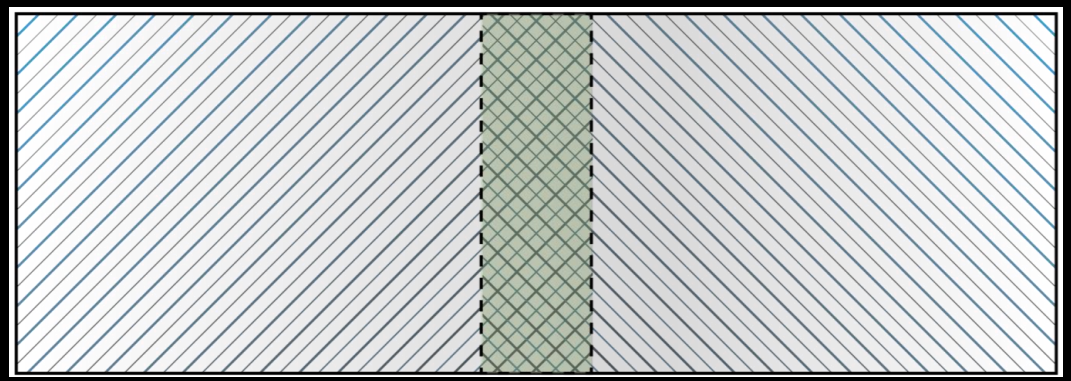
configureMosaic set rows=2 cols=4 out=0,0 out=0,1 out=2,0 out=2,1 out=1,0 out=1,1 out=3,0 out=3,1

2x4 Grid

configureMosaic set rows=2 cols=4



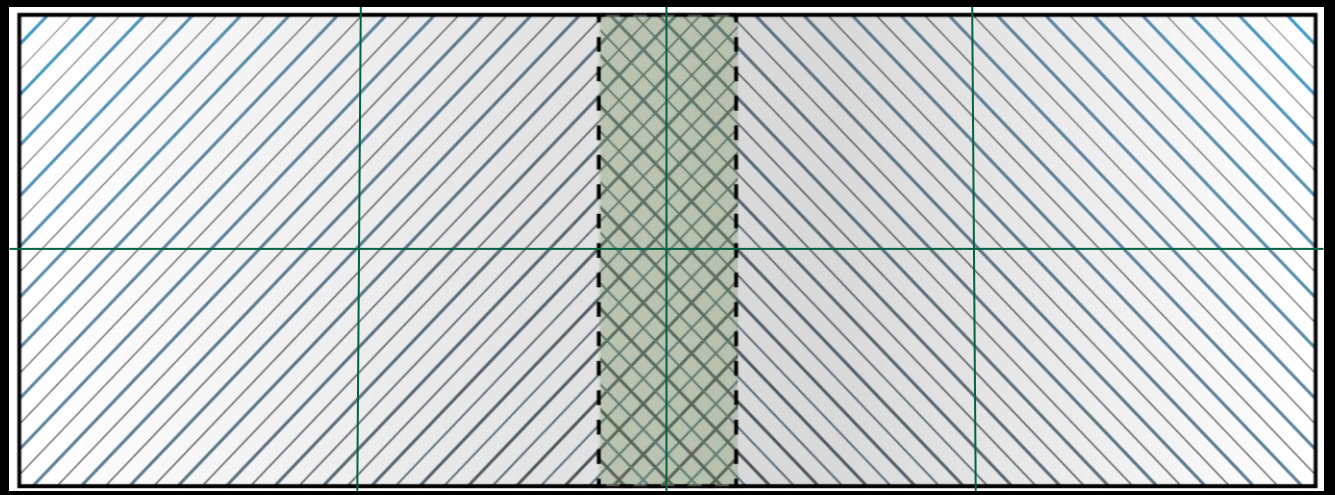
2 Channel Overlap



180 pixel overlap

configureMosaic.exe set rows=1 cols=2 overlap=180,0

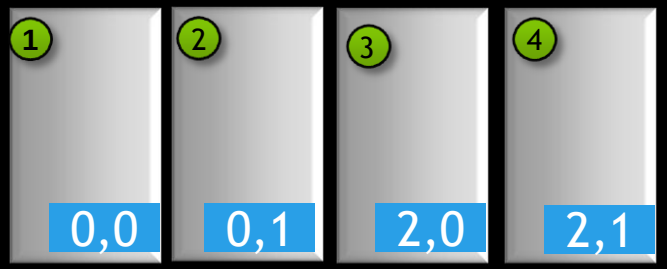
Blending 4K Projectors



0 pixel overlap | 180 pixel overlap | 0 pixel overlap

configureMosaic.exe set rows=2 cols=4 overlapcol=0,180,0

Portrait Mode - Win 7 only

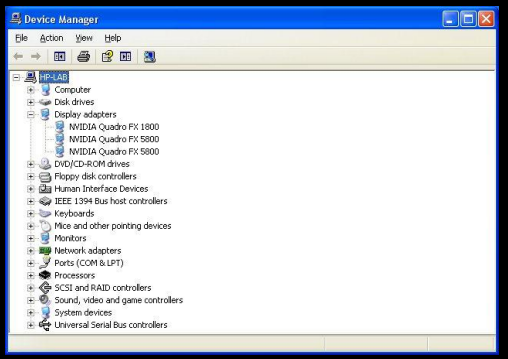


Rotate values
90
180
270

configureMosaic set rows=1 cols=4 rotate=90

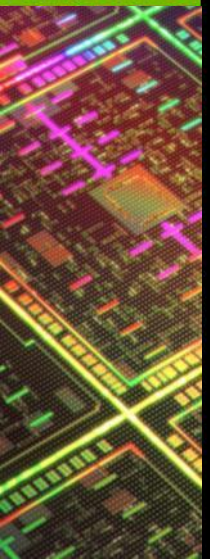
MOSAIC + 1 - setting up multiple GRIDS

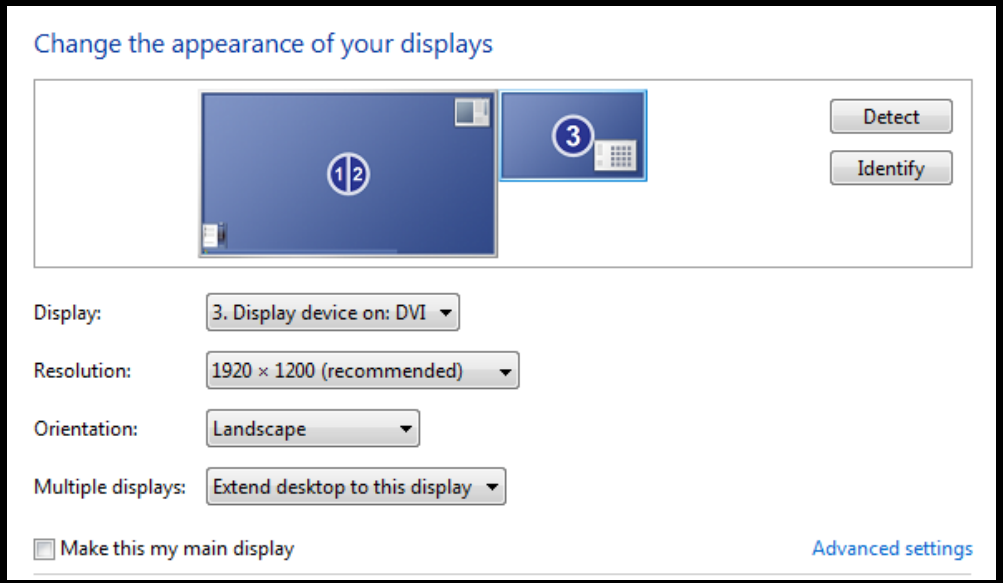
FX1800 Display



configureMosaic set rows=2 cols=2 nextgrid rows=1 cols=1

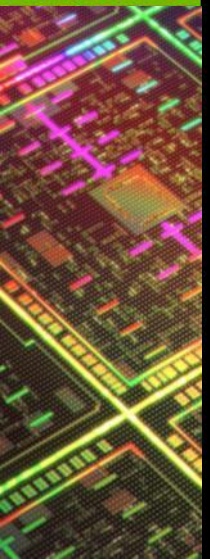
Note: only 1 grid can be across multiple GPUs

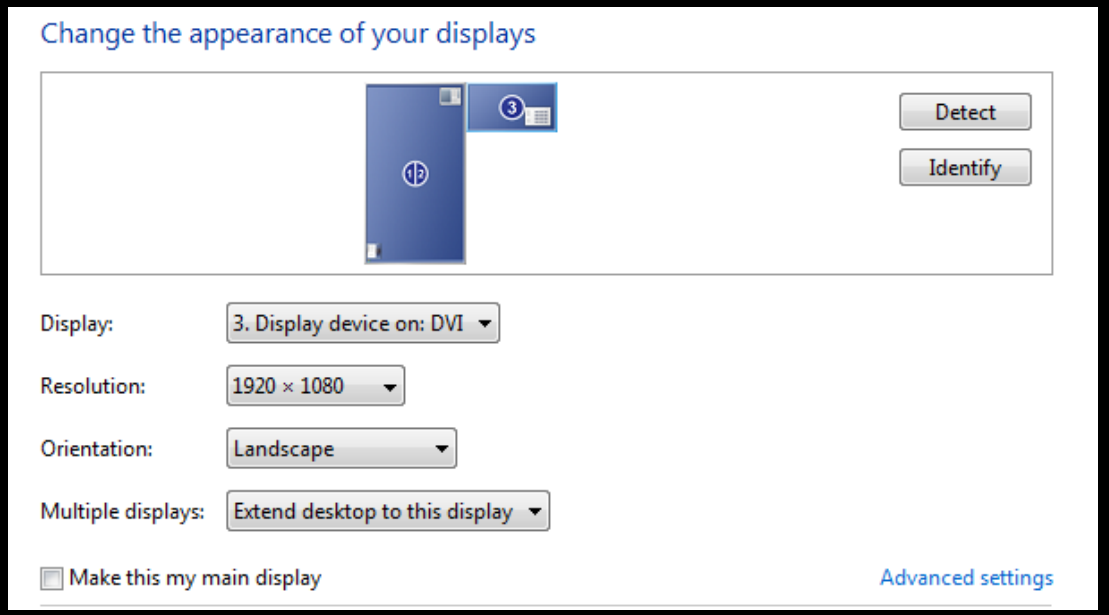




configureMosaic set rows=2 cols=2 nextgrid rows=1 cols=1

The first grid set is the primary

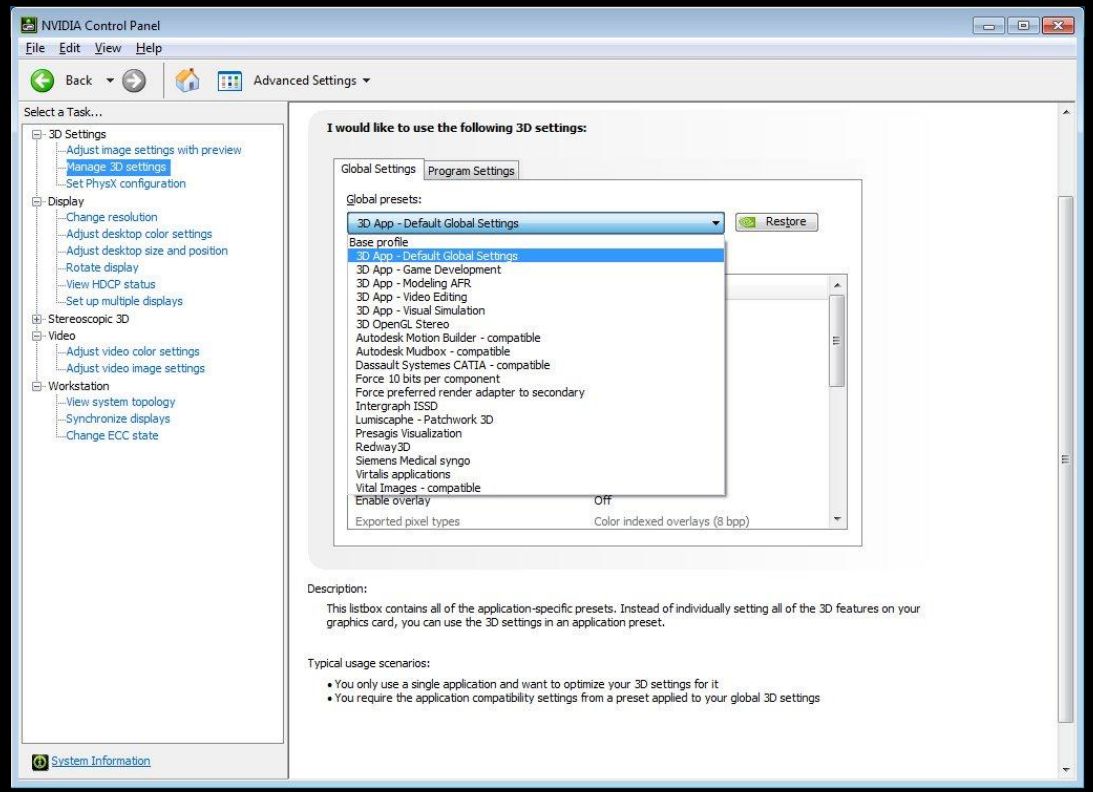


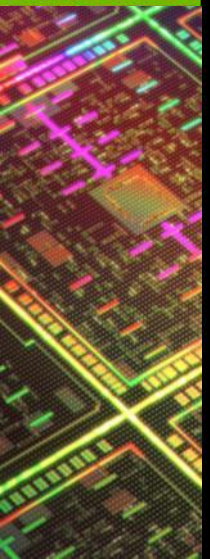


configureMosaic set rows=2 cols=2 rotate=90 nextgrid rows=1 cols=1

Win 7 - Driver Profiles

- Set **Default** 3D settings for profile
- Sets **Driver Optimization**
- Generic + ISV Types
  - 3D App – Visual Simulation
  - 3D App – Video Editing
  - Autodesk Motion Builder
  - Dassault System CATIA
  - etc.

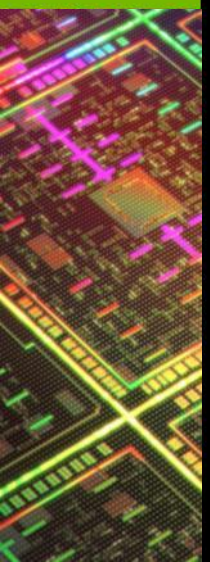


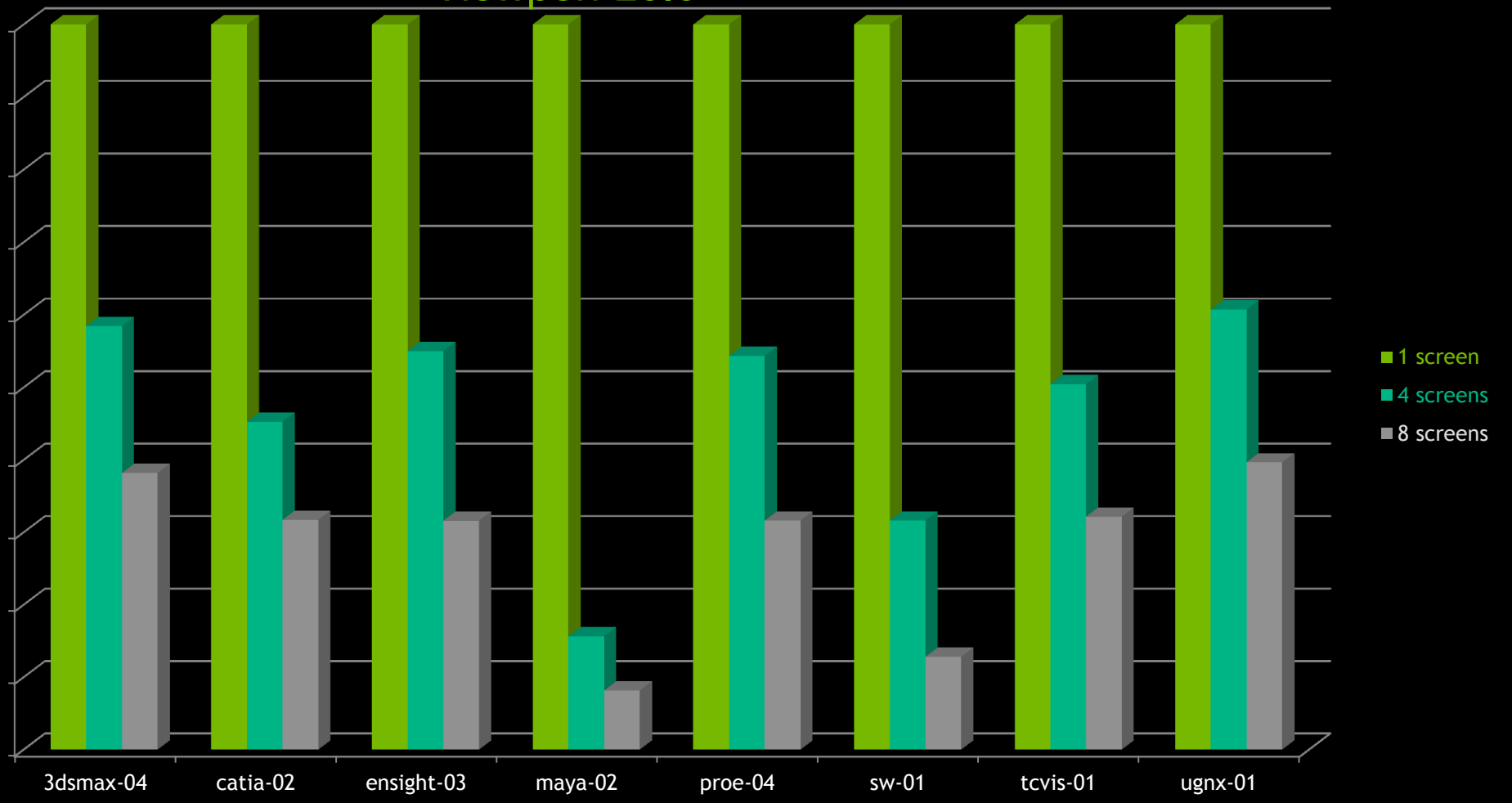


Common Profiles

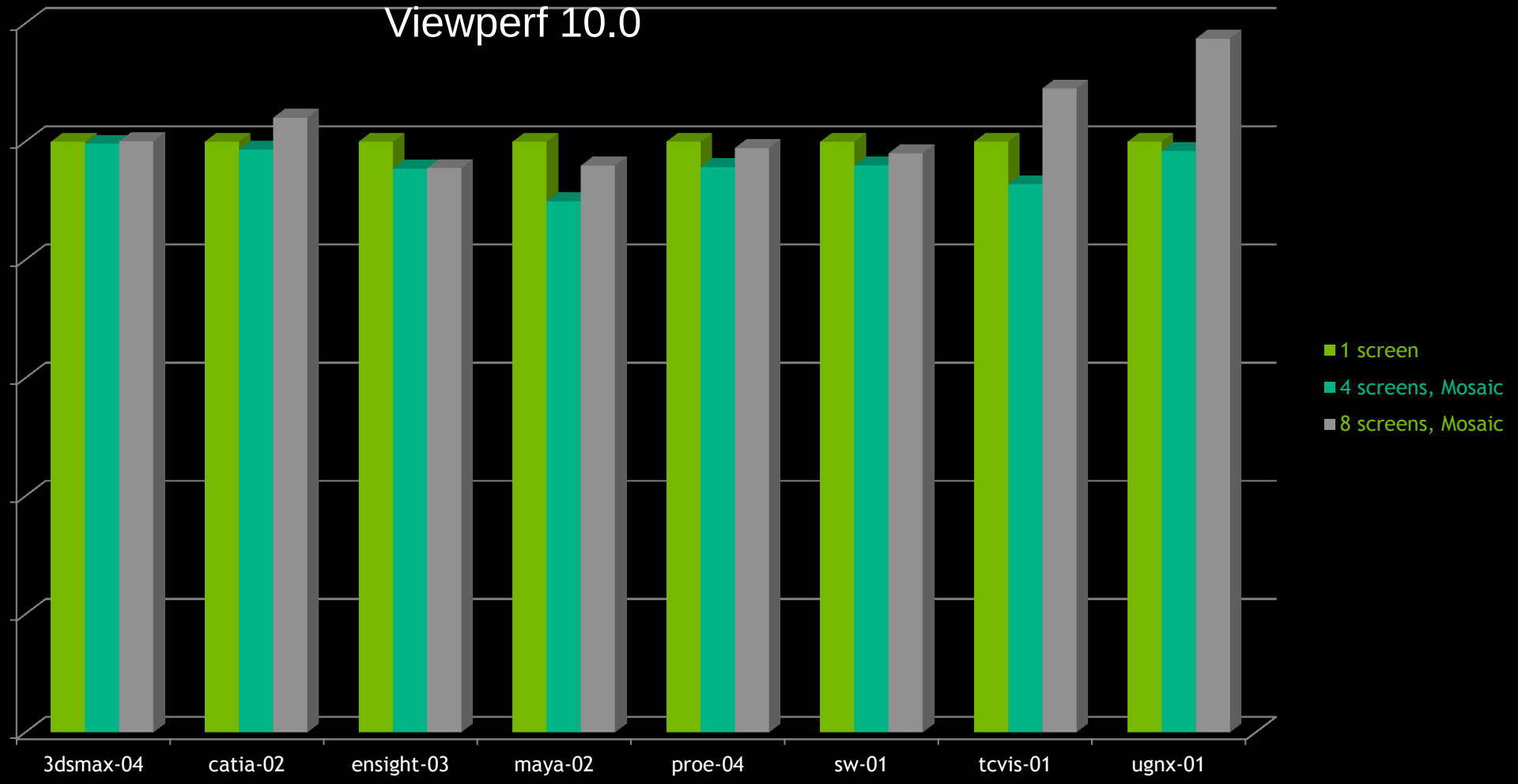
- 3D App – Game Development
  - Turns card into Geforce card
  - Good for DirectX Games
- 3D App – Modeling AFR
  - CAD/3D modeling type applications
  - Support for SLI Alternate frame rendering
- 3D App – Video Editing
  - Optimization for video playback & editing
  - Eliminates video tearing
- 3D App - Visual Simulation
  - **Optimizes OpenGL pipeline for Viz Sim Applications**
  - **Good for applications wanting fixed fps - i.e. 60fps**
  - **No Quad-buffered stereo support**
- Workstation Dynamic Streaming
  - **Applications using GSync**
  - **Applications wanting fixed fps.**
  - **Quad-buffered stereo suport.**

Performance Hit for Multiple Displays



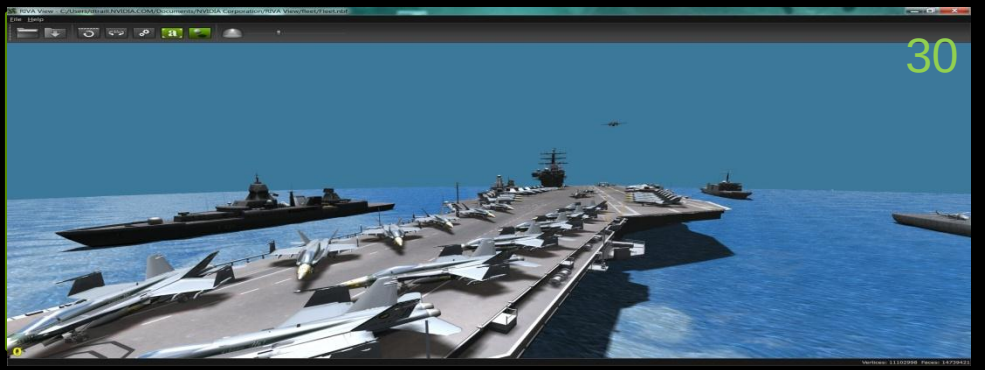


SLI Mosaic Performance Advantage

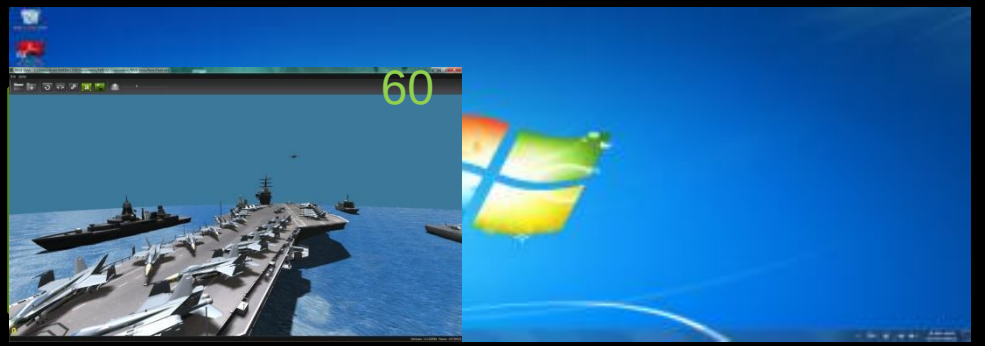


MOSAIC Performance Enhancements

- Multi-GPUs (does not work on single GPU)
- Pixel Fill limited apps
- MOSAIC uses a lot of fill



Pixel Fill = Screen size – larger screen more fill



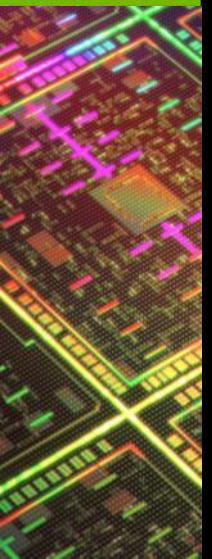
If you shrink the window and performance improves the app is fill limited

MOSAIC Performance Enhancements

- Scissor clip function
- Best for full screen apps
- If you drag windows around you will see distortion.

- To enable
  - **enable_Mosaic_Clip_To_Subdev.exe**
- To disable
  - **disable_Mosaic_Clip_To_Subdev.exe**

Improves fill performance on MOSAIC – Performance Gain will vary by Application

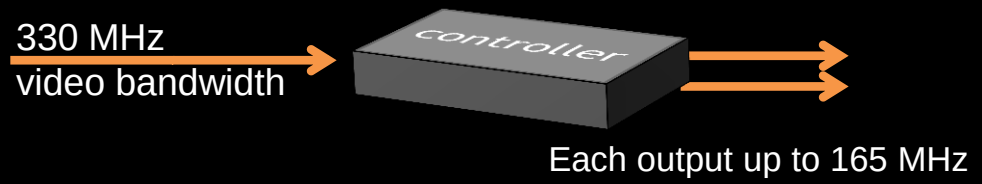


email: QuadroSVS@nvidia.com

Video Display Controllers

Features

- Dual link DVI or DP input
- 2 or more DVI outputs



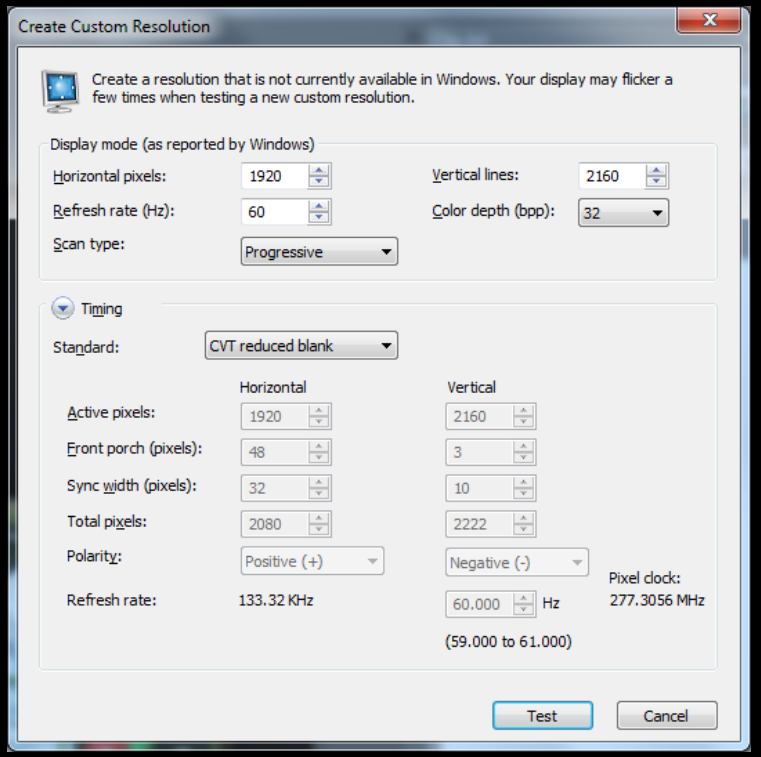
Examples

- CYVIZ XPO.3
- DataPath X4
- Pixell VP-4xx
- Planar Quad Controller
- Black Diamond Video – DVI splitter
- Matrox Triple head to Go
- Etc

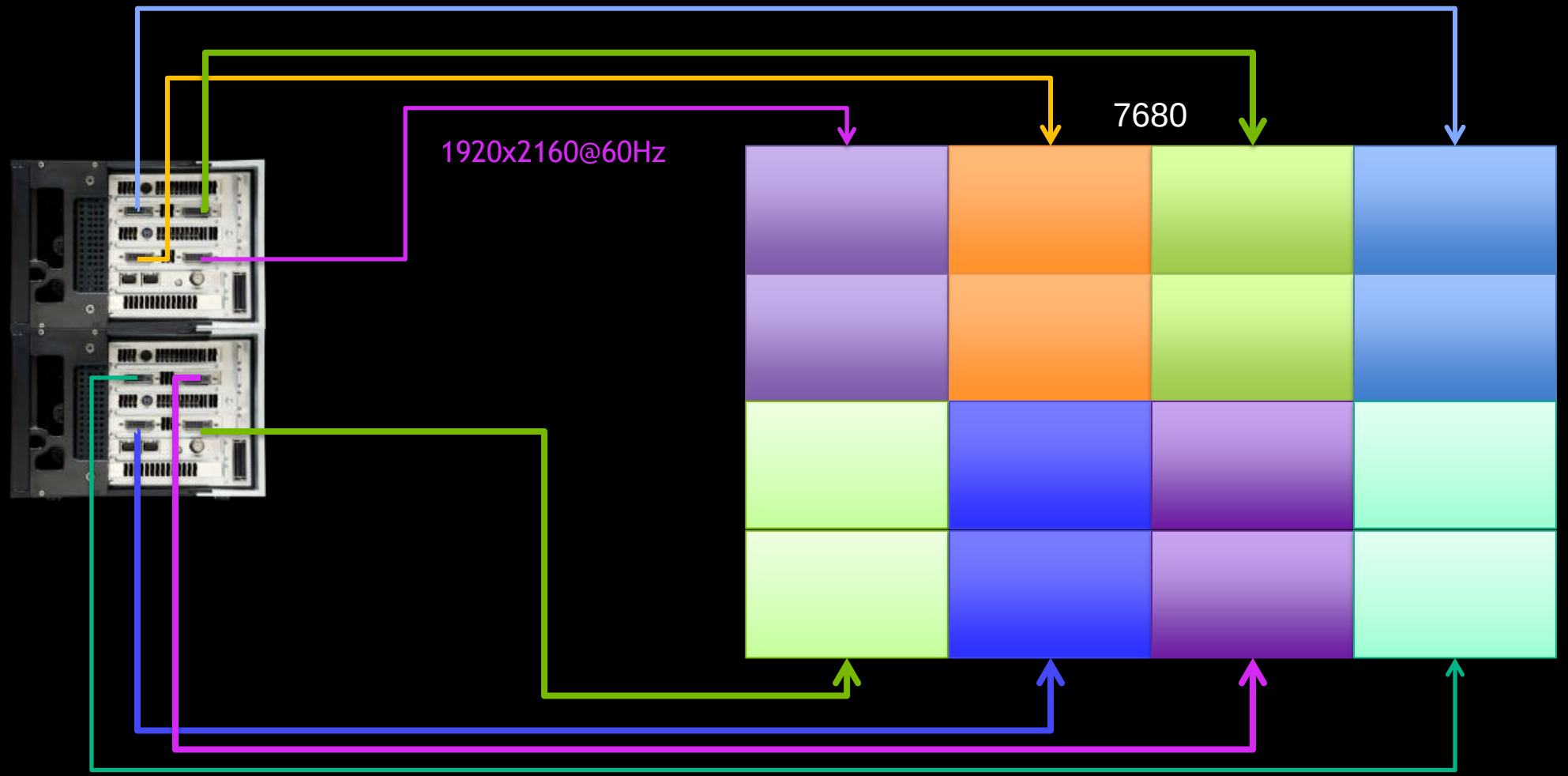
1:1 pixel mapping of input to output

16 BARCO Projection cubes

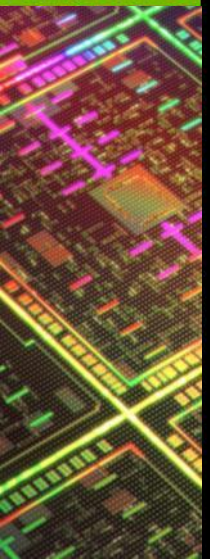
- 4x4 BARCO Projection cubes
  - Dual Quadro Plex 7000
  - Linux running Premium MOASIC
  - Each output runs two cubes – 1920x2160@60Hz
  - CUBE splits signal across two displays at 1920x1080
  - For Stereo 3D input is frame doubled to 120Hz



4x4 1920x1080@60Hz



configureMosaic set rows=2 cols=4 res=1920,2160,60



Using Linux

```
#Configure MOSAIC layout
nvidia-xconfig --sli=Mosaic --metamodes=
"GPU-0.DFP-0: 1920x2160+0+0, GPU-0.DFP-1: 1920x2160+1920+0,
 GPU-1.DFP-0: 1920x2160+3840+0, GPU-1.DFP-1: 1920x2160+5760+0,
 GPU-2.DFP-0: 1920x2160+0+2160, GPU-2.DFP-1: 1920x2160+1920+2160,
 GPU-3.DFP-0: 1920x2160+3840+2160, GPU-3.DFP-1: 1920x2160+5760+2160"

#Turn off composite Desktop - this affects stereo + gsync.
nvidia-xconfig --no-composite

#Set stereo mode.  On board DIN =3;
nvidia-xconfig --stereo=3

#Turn off twinview xinerman info - this creates a large desktop.
nvidia-xconfig --no-twinview-xinerama-info
```

USF - Tampa

- 16 thin bezel – LCD panels
  - 720p resolution
  - Passive stereo – horizontal line interlace.
  - 4 x4 array
- Dual Quadro Plex 7000
  - One output per card
  - Video processor splits across 4 cubes
  - 1:1 pixel mapping

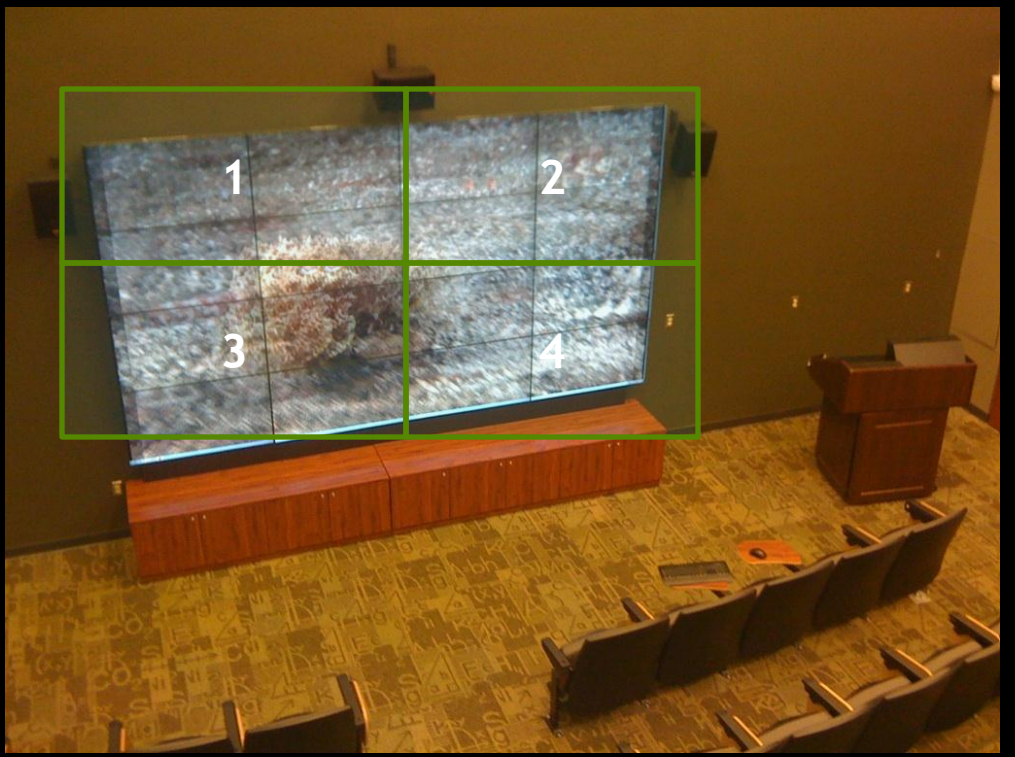
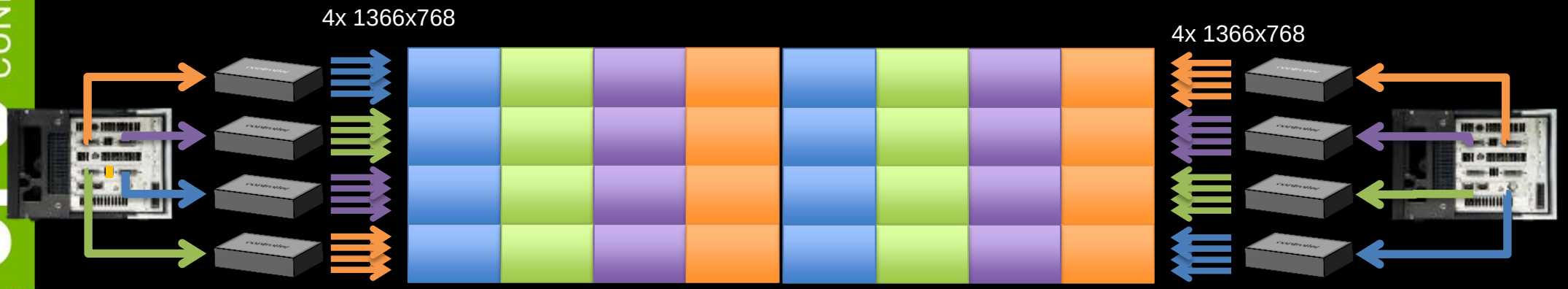


Image courtesy of University of South Florida - Tampa

4x8 1366x768@60Hz



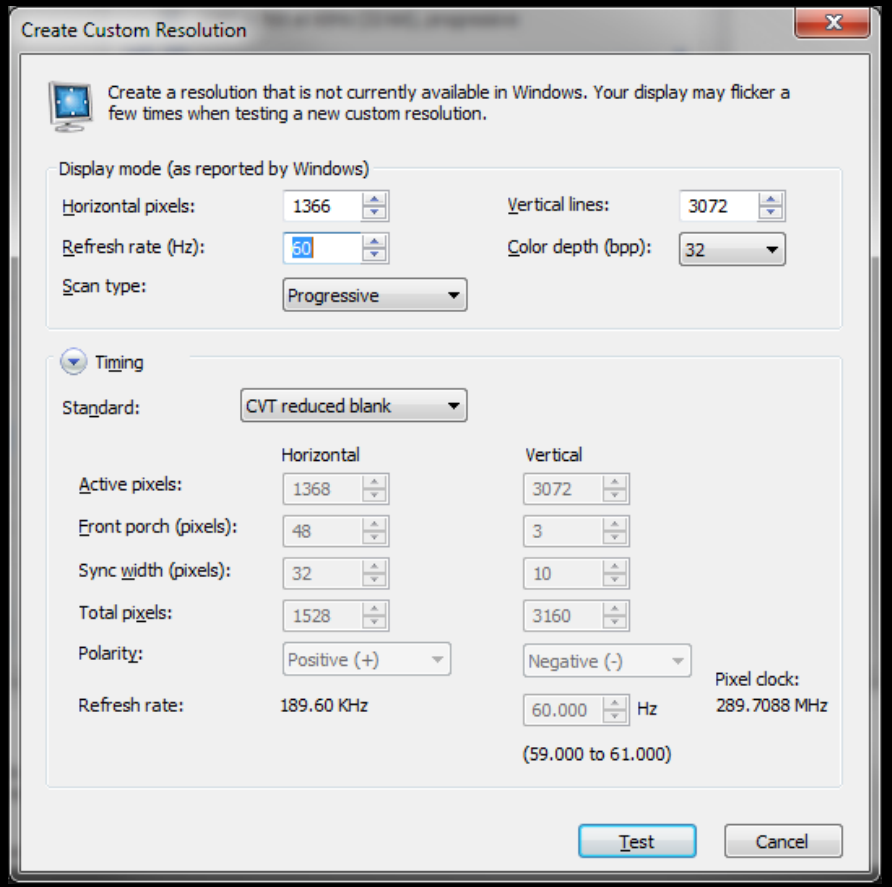
32 1366x768@60 Displays

configureMosaic set rows=1 cols=8 res=1366,3072,60

NOTE: follow the display ordering diagrams from earlier, this image is wired for visual clarity

Total Resolution – 10,944 x 3072

Create the Custom Resolution



- If the controller does not provide the resolution, create one
  - **Make sure to select a timing other than Automatic for the Standard**
  - **Make sure the Pixel clock on the lower right is <= 330MHz**
- Set the same resolution on all attached controllers

NVIDIA Scalable Visualization Solutions

Display Channels

> 8 DVI

Beyond 8 DVI Dual Link Requires Clustered PCs with Quadro G-Sync to synchronize displays and Multi GPU aware software.

Quadro Plex Scalable Visualization Solutions (Single Host)

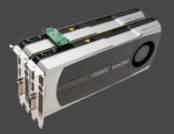
4-8 DVI

Runs Any Standard Application

Quadro SLI Workstation
(Dual Quadro 5000/6000)

2-4 DVI

or



2-4 DP

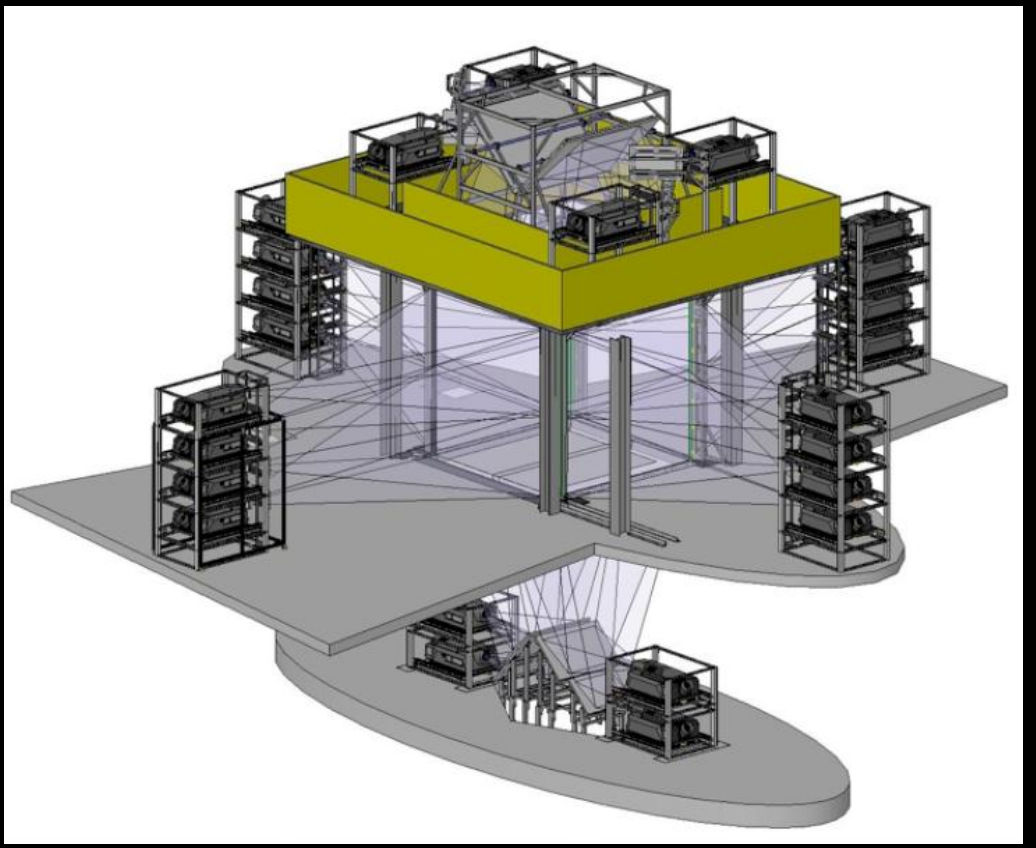
Runs Any Standard Application

Single Workstation
(with Add-in Card)

1-2 DP

Runs Any Standard Application

Largest CAVE in the World

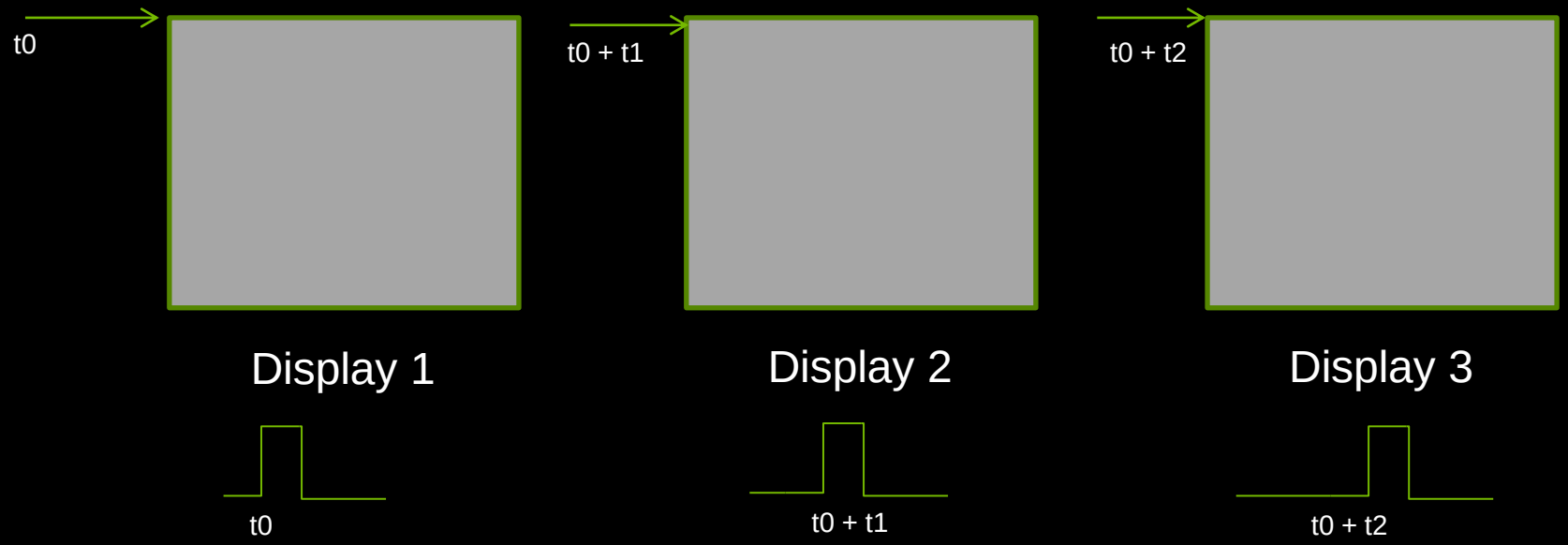


- C6 at Iowa State
  - 4 x 4K projectors per wall
  - 6 sides
  - 96 NVIDIA GPUs in a cluster driving the display
- Kaust University
  - Similar in Design to C6
  - Uses Quadro Plex's to reduce node count.

GSync II - Hardware + Software Sync

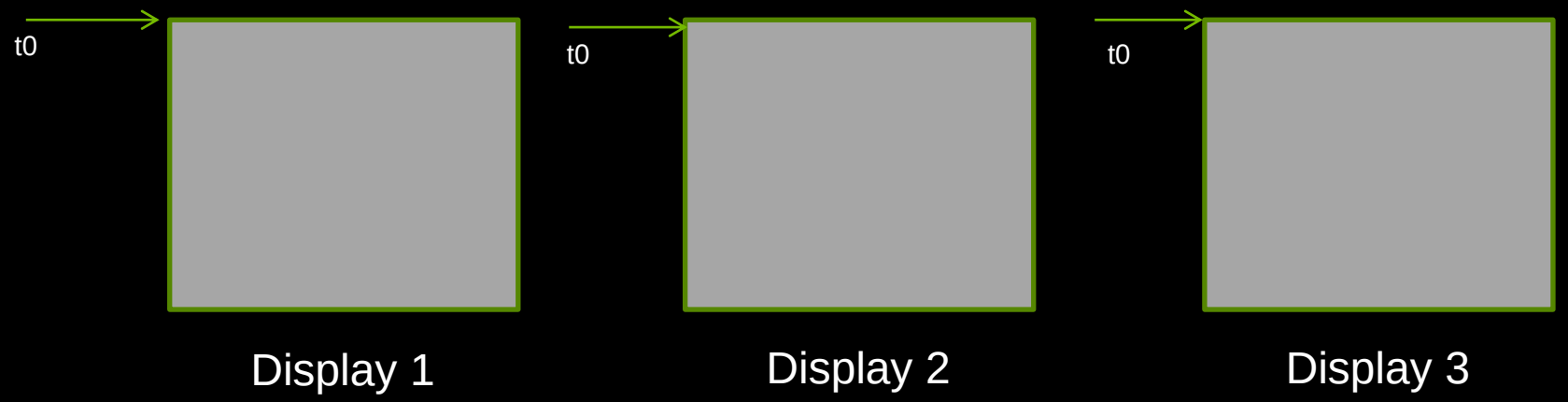
- Hardware
  - RJ45 - Framelock for synchronization of multiple displays to a common internal sync
  - BNC/Genlock - Framelock for synchronization of multiple displays to a common external house sync
- Software
  - *Requires application to be written with extensions*
  - Swap Group and Swap Barrier are openGL /DirectX Extensions that provide enhanced synchronization of the graphics swap buffer.

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.

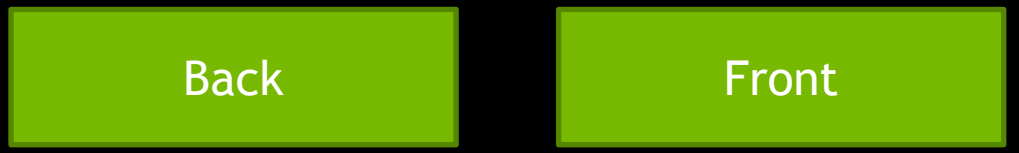
Framelock/Genlock



- *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

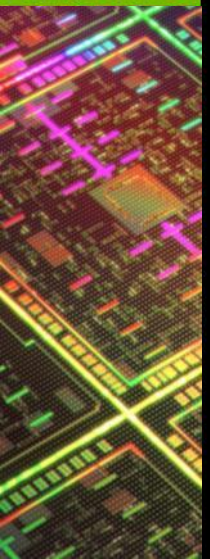
Swapbuffers

- Mono OpenGL applications have two buffers



The application will render into one buffer while the pixels are read to the screen from the other buffer. Once the render process is complete the *buffers swap*. i.e

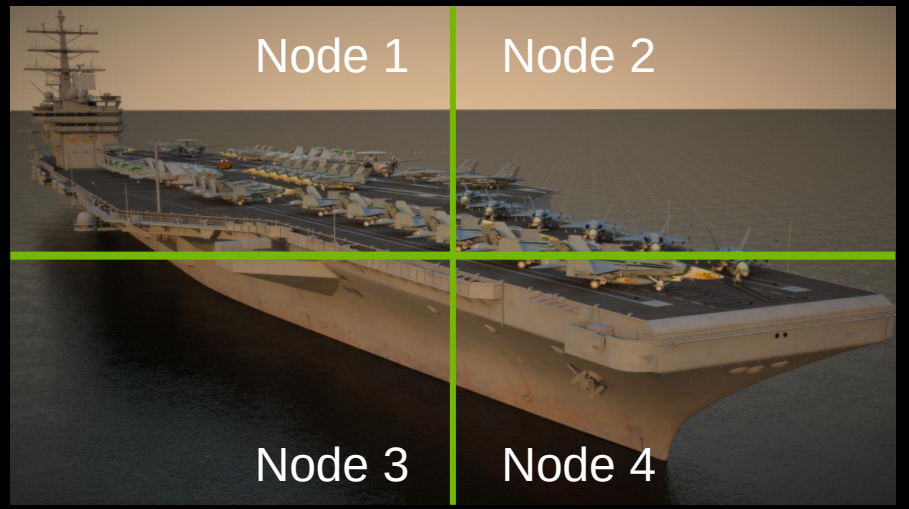
- Front – render
- Back – read to screen
- swap
- Back – render
- Front - read to screen.



Swapbuffers

- Swap between the two buffers will occur:
  - On the first *vertical sync* after the Render process completes
- For example at 60Hz refresh rate we have 16.67 ms to complete the render of a frame
  - If render time = 10ms frame rate will be 60 fps (we swap on vertical sync)
  - If render time = 17 ms frame rate will be 30 fps (we swap on the next vertical sync).

Swapbuffers in a cluster



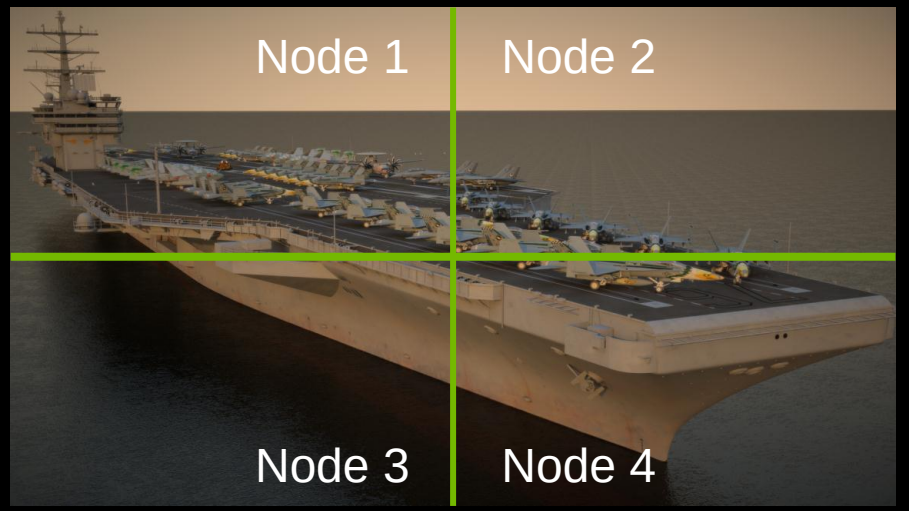
Each node is now rendering a scene with different complexity i.e from least to highest we get:

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

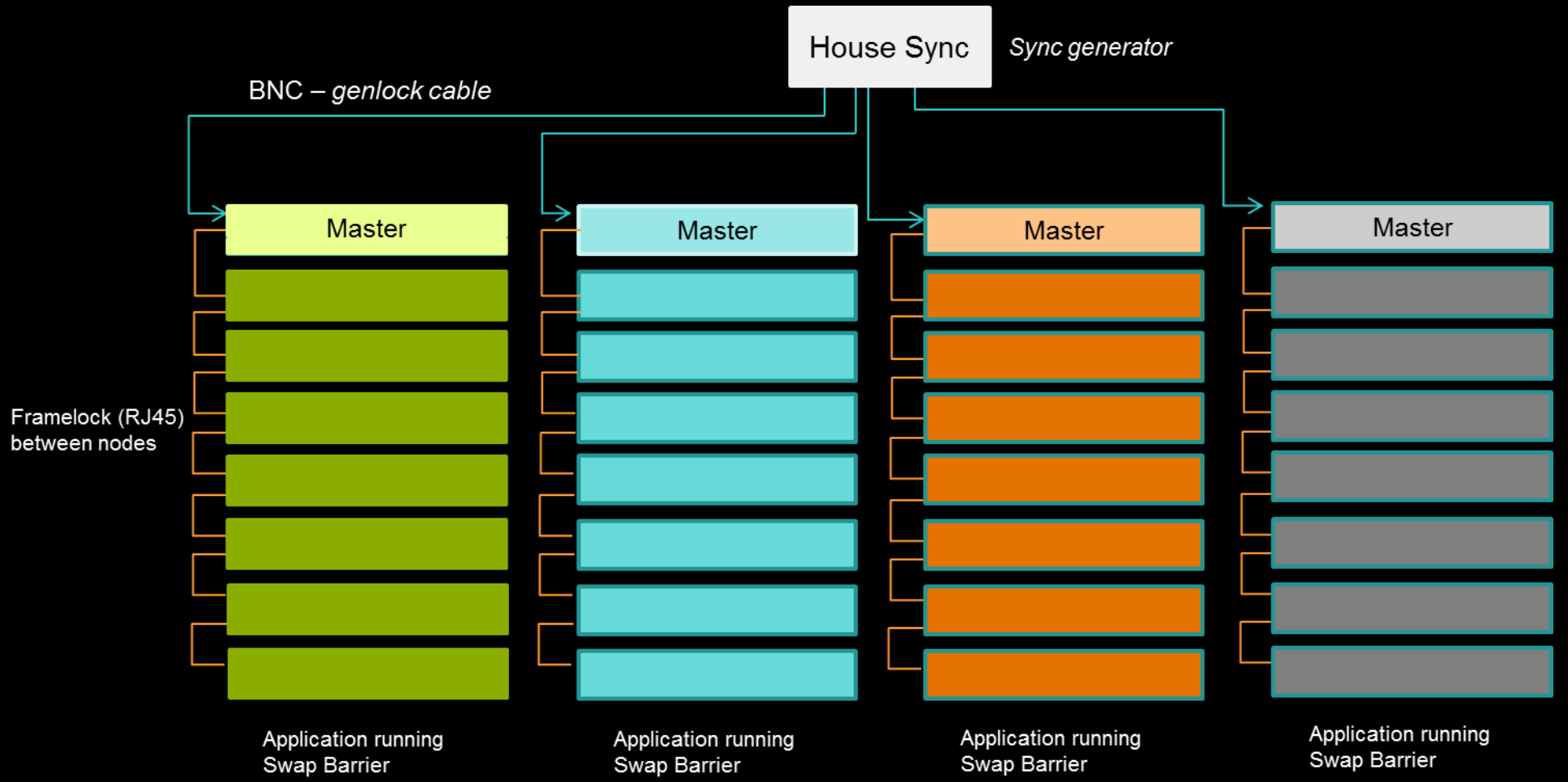
- Nvidia Extensions to OpenGL /DirectX (via NVAPI)
  - Swap Group – provides synchronization multiple GPUs in a single host
  - Swap Barrier – provides synchronization of GPUs across multiple nodes.
  - Use RJ45 (framelock) connection on Gsync – so faster than sync over a network

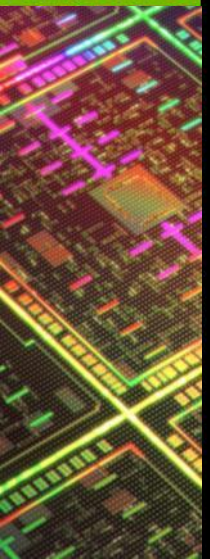


With *Swap Barrier* each node will wait until all nodes have completed their render

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

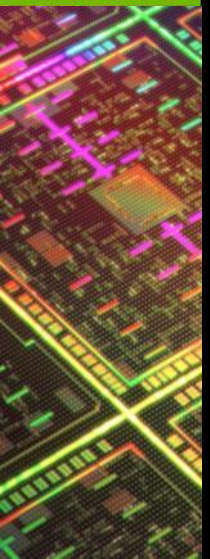
32 Node cluster





GSyncII Signaling

- CAT 5 – not ethernet
  - Framelock (sync pulse – will be same as House Sync)
  - Swap Ready
    - Physical connection to GPU for swap group.
    - High when blocked, low when ready to swap.
  - Stereo Sync
    - VESA stereo port
    - Not used for passive stereo
    - Make sure stereo is enabled in Manage 3D settings on timing server + client prior to enabling synchronization.



Driver Profiles for GSync

- Most Common (can be exceptions)
  - Workstation Dynamic streaming
    - Stereo
    - Swap Groups
    - Constant frame rate
  - 3D App Visual Simulation
    - Constant frame rate

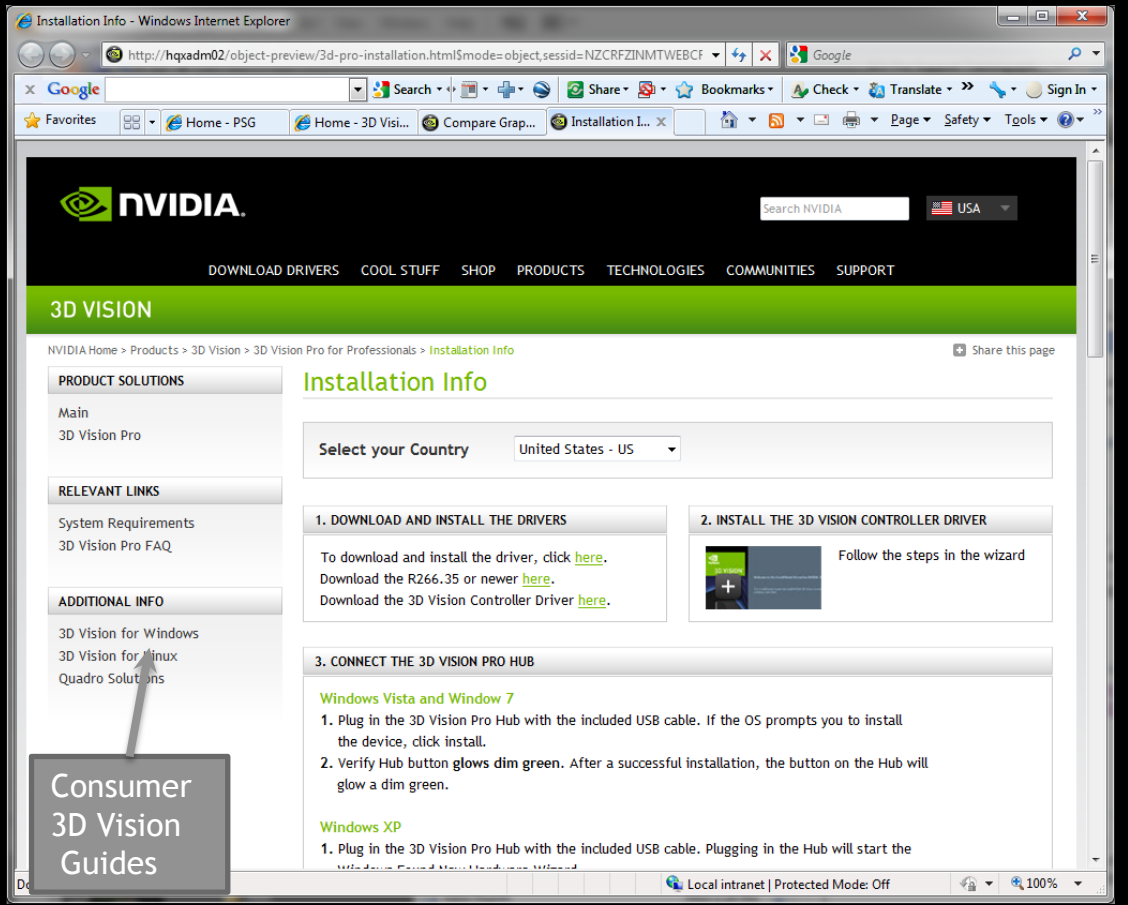
3D Vision Pro with Projection systems

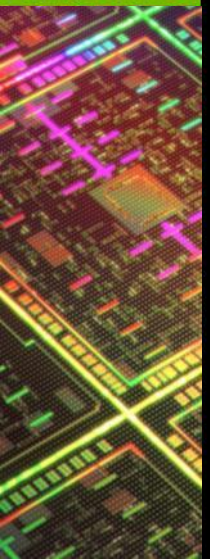
NVIDIA 3D Vision Pro

- 3D Vision Pro Glasses
  - 120 Hz Active Shutter
  - 2.4Ghz RF control
  - 24 hours battery life
  - Support for 3D Vision Ready LCDs, Projectors, CRT's and DLP TVs
- 3D Vision Pro Hub
  - Up to 100 ft (30m) range
  - Provides UI and NVAPI information
  - Supports Quadro boards with stereo DIN and those without including mobile workstation
  - Supports same GeForce boards and features as 3D Vision
  - Wide Pro application support on Quadro

Installation - Windows

- Drivers and Guide are at www.nvidia.com/3dvpro
- Drivers need to be installed before the hub is connected
- Need
  - 266.35 or newer display driver
  - 266.21 or newer USB driver
  - Support display with refresh rate set correctly



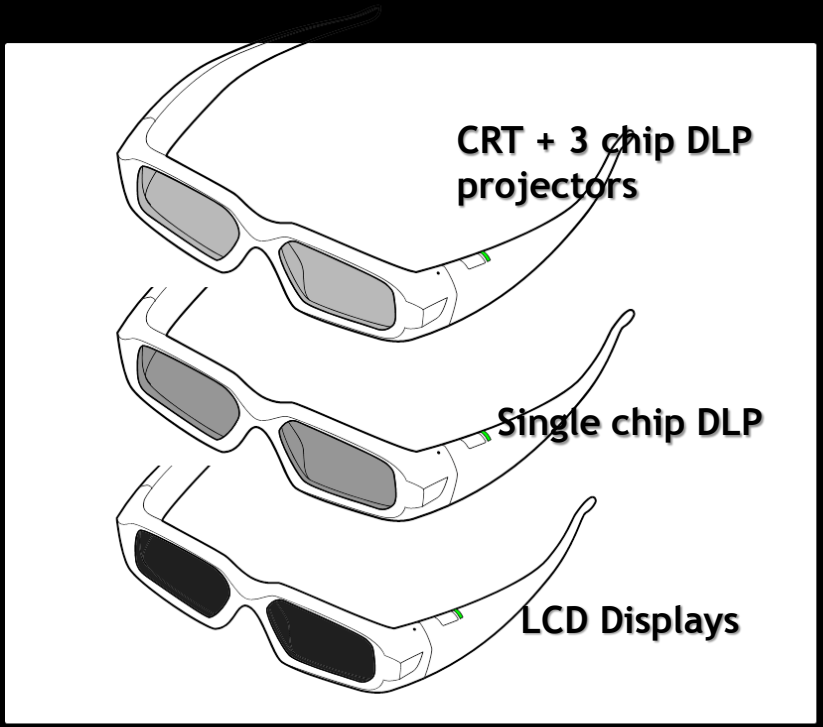


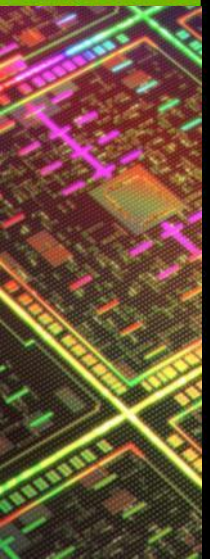
More Complex 3D Vision Pro installs

- Projectors that require active stereo sync
- Double or Triple flash Projectors
  - 60Hz input to 120Hz
  - 48Hz input to 144Hz

3D Vision Pro Glasses Syncing to different timings

- 3DV Pro Glasses adjust to the display or projector they are working with
  - Dark interval and timings
- When using the glasses you'll see the lens "darkness" change with different devices
- Timings selected from display EDID
  - If EDID is known uses programmed values
  - If not recognized, uses CRT (or DLP if connected to a DLP TV)



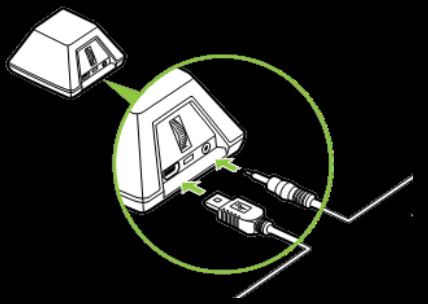


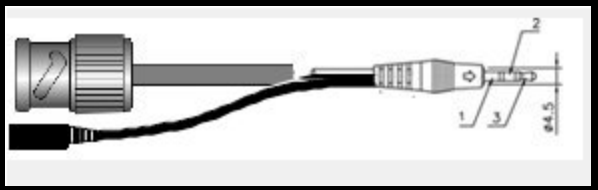
Projectors that require active stereo sync

- Most Pro projectors require VESA stereo sync e.g.
  - BARCO Galaxy
  - Christie Mirage
  - DPi Titan
  - Projection Design F35
- Sync is used by the projector to identify left or right eye.
- Sync is looped through the projector to the hub (emitter).
  - Projector has a one frame buffer.
  - Projectors will delay the sync signal by one frame – reversing left/right eye.

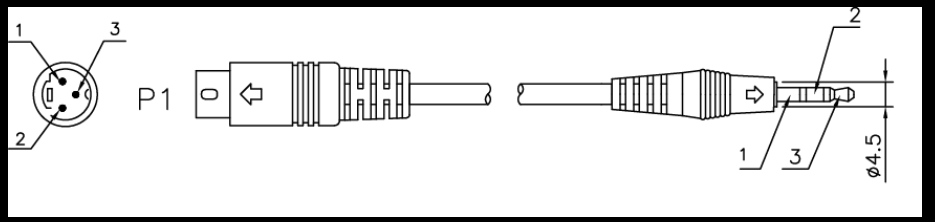
Projectors that require active stereo sync

- Problem
  - Sync from the projector is typically BNC
  - Current Hub require 5V DC on VESA input.
- Solution
  - System integrators needs to make special cable to provide 5V





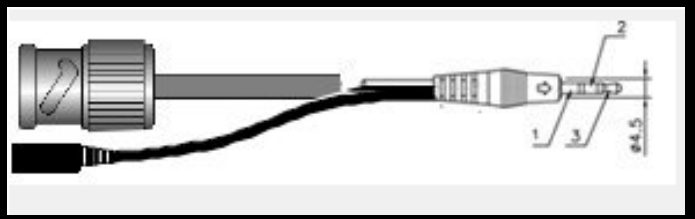
Standard Pin outs for 3D Vision Pro Hub



Pin 1: Ground
Pin 2: +5V
Pin 3: Stereo Sync signal (High = Left Eye image being displayed, Low = Right Eye)

Custom Cable BNC to min-jack pinout

From Projector



3D Vision Pro Hub

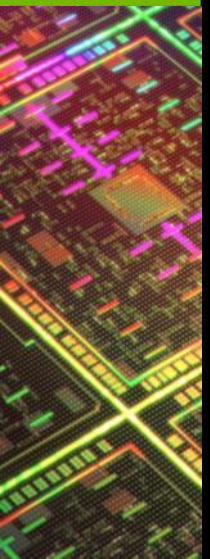
Signal Name	Cable	BNC	3D Vision Pro - mini Jack
5Volts	ext source	N/A	2
GROUND	COAX Braid	Shell	1
Stereo L/R	COAX Center	Center	3

Double or triple flash projectors

- Take 60Hz input and double to 120Hz
- Take 48Hz input and triple to 144Hz
- Reduces overall infrastructure cost – single-link DLP.

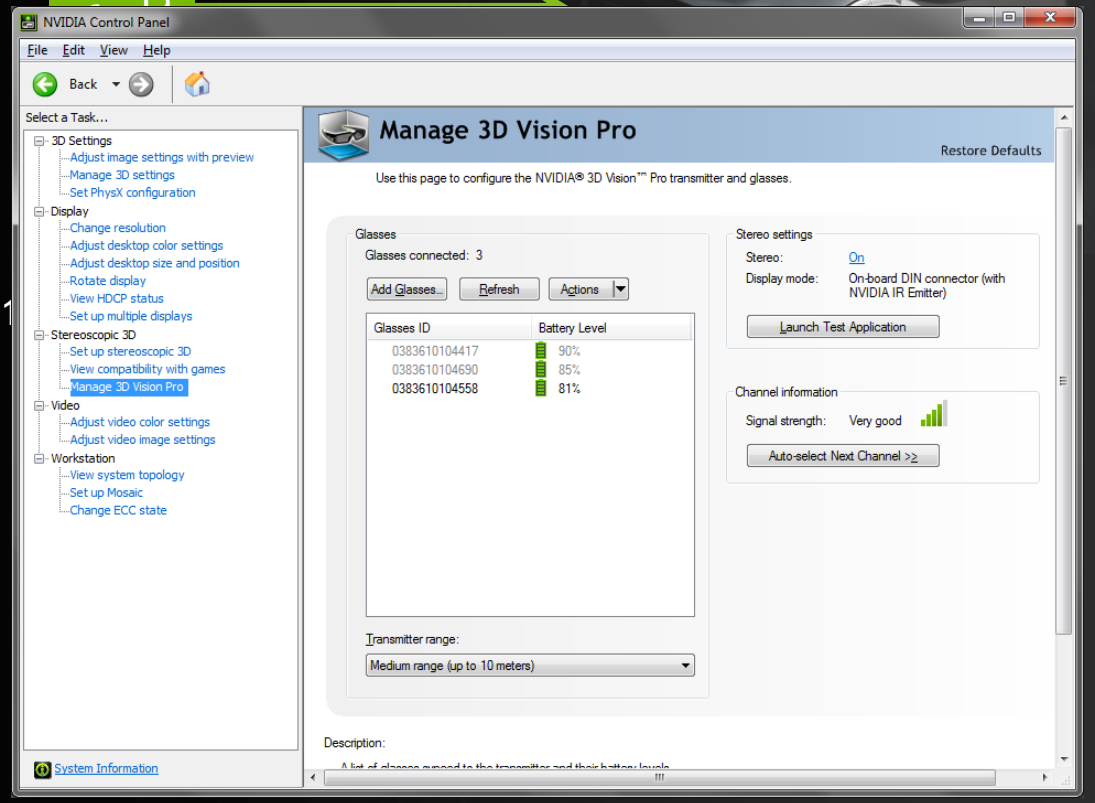
- Problem
  - Stereo sync is generated by the projector at 120 Hz
  - Hub is set to 60 Hz –this is what the workstation generates

- Solution
  - Command line tool that set hub to 120 Hz – runs on a proxy PC.



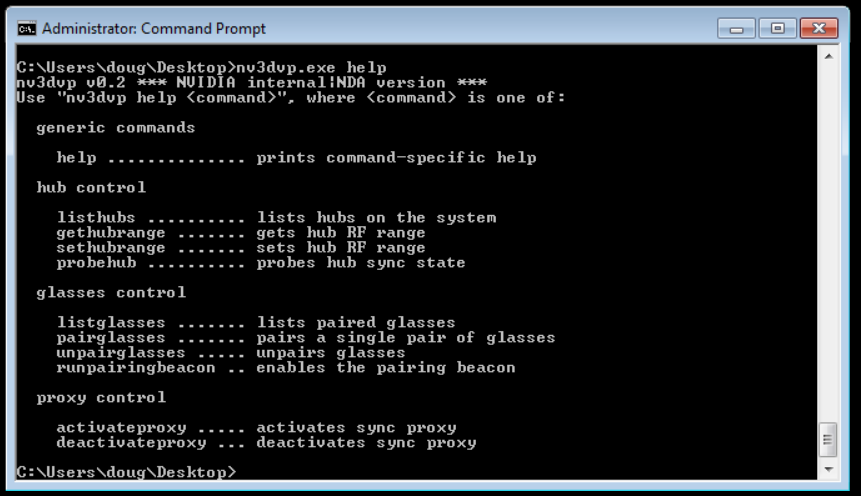
Proxy System

- Management of Glasses
  - Management is separate of on-screen rendering
- Multiple Stereo Sources
  - Single PC manages pairing for all devices
- Double or triple flash projectors
  - Command line tool
  - Sets hub to correct refresh rate



Command line for setting 3DVision Pro

- nv3dvp.exe



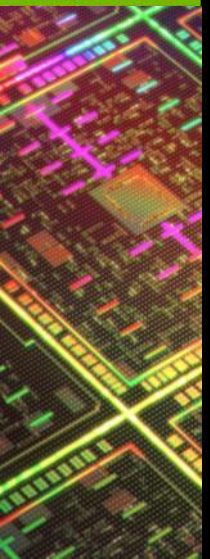
`nv3dvp.exe activateproxy` **`display-refresh-rate`**

display-refresh-rate is the refresh of the stereo display

Examples:

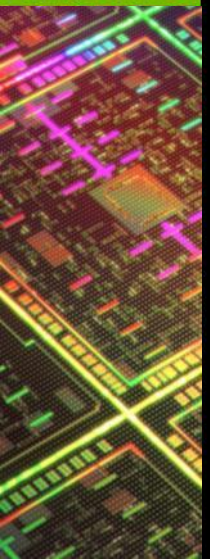
- `nv3dvp.exe activateproxy` **`120`** (120Hz stereo display)
- `nv3dvp.exe activateproxy` **`96`** (96Hz stereo display)
- `nv3dvp.exe activateproxy` **`144`** (144Hz stereo display)

Email: QuadroSVS@nvidia.com



Summary

- Synchronization
  - Focus on the image and not the artifacts
- Reliability
  - 24/7 Operation
  - Fortune 500 companies put their trust in Quadro
- Visual Acuity
  - Ultra high resolution ‘retnia’ displays
  - Reality based Design
- Application Scalability
  - The applications I use on my desktop just work



Questions & a Reminder

** Schedule subject to change. Please check the online schedule and digital signage outside of session rooms for updates.*

Monday, 05/14/2012

Time	Location	Session
10:30am	Room A2	S0341, See the Big Picture Scalable Visualization Solutions for System Integrators
1:00pm	Room A2	S0530, Multi-Display Roundtable
2:30pm	Room A2	S0601, GPU-Based Video Processing Round Table

Tuesday, 05/15/2012

Time	Location	Session
2:00pm	Hall 1	S0515, Multi-GPU Programming
4:00pm	Room J2	S0356, Optimized Texture Transfers
5:00pm	Room J2	S0267A, Mixing Graphics and Compute with Multiple GPUs

Wednesday, 05/16/2012

Time	Location	Session
9:00am	Room A1	S0353, Programming Multi-GPUs for Scalable Rendering
10:00am	Room A1	S0322, Warping & Blending for Multi-Display Systems
10:30am	Room A1	S0355, Seamless Scalable Displays - Using NVDIA Warp + Intensity API

Thursday, 05/17/2012

Time	Location	Session
9:00am	Room A1	S0326, Next Generation InfoWall

To learn more or if have more questions – contact us at QuadroSVS@nvidia.com