Leveraging NVIDIA Quadro vDWS to Provide Horsepower to Virtual CAD Workstations

Wesley Struble
Varick Teller
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1. Who is DENSO?
Establishment of Nippondenso Co., Ltd.

(Currently DENSO Corporation)
Global Supplier of Advanced Automotive Technology, Systems and Components with $40.4 Billion in Sales
(For fiscal year ending March 31, 2017)
DENSO in North America with $9.6 Billion in Sales

- 32 COMPANIES & AFFILIATES
- 28 MANUFACTURING LOCATIONS
- 24,000 EMPLOYEES
Automotive Products

**Powertrain Control System**
Engine management system, Gasoline direct injection, Starter, Alternator, etc.

**Electrification Systems**
Hybrid and electric vehicle components, inverter, DC/DC converter, motor generator, relays, etc.

**Thermal Systems**
Heating Ventilation Air Conditioning (HVAC), Compressor, Heat exchangers, Battery thermal management, etc.

**Information & Communications Systems**
Instrument cluster, Head-up display, Human machine interface technologies, Horn, Keyless entry, Wireless phone charger, etc.

**Driving Control & Safety Systems**
Passive safety technologies, Airbag sensing system, Active safety technologies, Traction control system, Antilock braking system, etc.
# Non-Automotive Products

<table>
<thead>
<tr>
<th>Home Appliances</th>
<th>Development and manufacture of products such as CO2 refrigerant heat-pump water heaters, central air conditioners and Home Energy Management Systems (HEMS).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Products</td>
<td>Development and manufacture of factory automation products (industrial robots, programmable logic controllers,) automatic identification products (bar-code readers, QR code readers and IC card-related products.)</td>
</tr>
<tr>
<td>Micro Grid</td>
<td>We are helping to realize a low-carbon society through micro-grid products and technologies including Home Energy Management Systems (HEMS), storage batteries, V2H (vehicle-to-home) power supply systems, and other products that create, store, and conserve energy in the age of connected cars and homes.</td>
</tr>
<tr>
<td>Electric Power Assist</td>
<td>Electric power assist technology derived from our automotive motor/control systems contributes to a safer, more secure and eco-friendly society.</td>
</tr>
<tr>
<td>Security</td>
<td>Our sensing technologies are contributing to safer and more secure living.</td>
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</tbody>
</table>
Major North American Customers
In the Community

Our Main Focus Areas:

**Education**
- FIRST Robotics
- A World in Motion
- SAE student teams and events

**Environmental Conservation**
- Rouge Rescue
- Greening of Detroit

**Health and Welfare**
- Relay for Life
- United Way
- Holiday food drive and gift giving
Journey: Discrete Graphics for CAD Virtual Workstations
DENSO International America, Inc. (DIAM) began deploying CAD applications on VDI in 2013. User testing resulted in rejection of a number of CAD design use cases. Despite only being accepted for a small section of use cases, there was agreement to implement because of benefit gained.
Early testing for GPU-enabled graphics included vSGA and vDGA. Performance and density were insufficient.

In late 2014, DENSO International America, Inc. participated in the GRID-enabled vGPU early access program offered by VMware & NVIDIA.
Journey: Discrete Graphics for CAD Virtual Workstations

- Graphical performance in Beta was significantly improved over that of existing, non-GPU enabled VDI environment for the CAD applications used by DIAM (CATIA/NX).
- NVIDIA announced vGPU GA in March 2015. DIAM re-built test environment with released software.
- Formal testing resulted in acceptance of all CAD design use cases previously rejected in our current (non-GPU enabled) VDI environment.
- DIAM released vGPU solution across our production CAD VDI environments in June 2015.
Landing on a Virtual Hardware Configuration
CAD Workstations at DIAM

- To design for multiple customers, DIAM maintained CAD workstations with several boot partitions. Each partition contained separate customer design environments, as well as one partition for the DIAM environment.
CAD Workstations at DIAM

• It was more efficient to have all customer environments available on one workstation, rather than have separate walk-up workstations for each environment.
• It was also more cost-effective, as fewer workstations were required.
• However, administration was difficult, and users had to discontinue work in the DIAM environment when they needed to boot to a customer environment.
• Time was lost while rebooting workstations into the different environments.
Landing on a Virtual Hardware Configuration

Virtual Desktop Configurations:
Desired Density per Server: >10 VMs

CAD Virtual Desktop:
• 16 GB Memory
• 4 vCPUs
• 1 GB vGPU

CAE Virtual Desktop:
• 16-48 GB Memory
• 8 vCPUs
• 2 GB vGPU
Landing on a Virtual Hardware Configuration

Hardware Configuration:

CAD:
Cisco C240M3 Servers
- 256 GB Memory
- 2 E5-2650 CPU
- Dual 10 Gb NIC
- 2 NVIDIA K2 GRID Cards

CAE:
Cisco C240M4 Servers
- 256 GB Memory
- 2 E5-2670 CPU
- Dual 10 Gb NIC
- 2 NVIDIA M60 GRID Cards

Nimble CS500 Hybrid Storage Array
vGPU for CAD VDI: CAD Anywhere
vGPU for CAD VDI: CAD Anywhere
vGPU for CAD VDI: Results

**Benchmarking Tools**
- ESX: nvidia-smi --query-gpu=utilization.gpu,utilization.memory --format=csv --filename=/tmp/test.csv --loop=15
- CATIA: c: testvisuperfodraw
- NX: SPECapc for SIEMENS NX 8.5 ([https://www.spec.org/](https://www.spec.org/))
- User testing

**NVIDIA GRID**
- GRID K2, K240Q profile
vGPU for CAD VDI: Results

CATIA Performance
- Exported assembly: 529 MB
- Total triangles: 1,593,482

Software (non-GPU) Graphics

vGPU Graphics
vGPU for CAD VDI: Results

SPEC APC NX 8.5 Performance

- Benchmarking: graphics operations
- Displayed: seconds to complete all graphics operations (lower is better)

<table>
<thead>
<tr>
<th>Graphics Operation</th>
<th>VDI</th>
<th>VDI w/vGPU</th>
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</thead>
<tbody>
<tr>
<td>120 rotations</td>
<td>2493</td>
<td>146</td>
</tr>
<tr>
<td>90 zooms</td>
<td>10685</td>
<td>198</td>
</tr>
<tr>
<td>40 clip ops</td>
<td>8622</td>
<td>270</td>
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<tr>
<td>10 fits</td>
<td>23705</td>
<td>455</td>
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<tr>
<td>40 pans</td>
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<tr>
<td>4 regens</td>
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<tr>
<td>30 perspective ops</td>
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</tbody>
</table>

- submarine.prt (87 MB)
- engine.prt (111 MB)
- suvbody.prt (279 MB)
- powertrain.prt (348 MB)
# vGPU for CAD VDI: Use Cases

<table>
<thead>
<tr>
<th>CAD Operation</th>
<th>Part Number</th>
<th>Date &amp; Time</th>
<th>File Size</th>
<th>Model classification (small, medium, large, extra large)</th>
<th>VDI for CAD Multiboot (Accessing from Multi-boot CAD machine) Accept or Reject</th>
<th>MULTIBOOT CAD MACHINE Accept or Reject</th>
<th>Comment about VDI</th>
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<tbody>
<tr>
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<td>3. Open 2D Data</td>
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<td>4. Navigate 3D data</td>
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<td>Use Pan command in wireframe mode</td>
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<td>Use Zoom in command in wireframe mode</td>
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<td>Use Pan command in Shaded mode</td>
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<td>Use Zoom in command in wireframe mode</td>
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<td>Use Pan command in Shaded mode</td>
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<td>Use Zoom in command in shaded mode</td>
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<td>Use Zoom out command in shaded mode</td>
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vGPU for CAD VDI: Results

**User Feedback:**

“VDI has really changed how our department operates. Now everyone is able to access Teamcenter drawings and 3D data without needing a dedicated CAD machine. The drawing review tools are very powerful, as VDI allows for easy access to data, and zoom into the nitty gritty details that even printed drawings can't provide.”

“(When navigating 3D data) much improved from regular VDI environment; Graphic response is outstanding.”

“Compared to VDI, GPU VDI is fast in opening the Assembly data.”
vGPU for CAD VDI: Results

**Lessons Learned/Benefits**
- Graphics performance that satisfies most design and engineering requirements.
- Increased flexibility & availability for users (compared to dedicated CAD workstations and non-GPU enabled VDI solution).
- VMware Optimization Tool sets Windows settings to optimize performance.
- Concurrent user testing to identify best profile for your user’s requirements.
- Data transfer times reduced due to data center network.
Benchmarking and Deployment of Tesla M60
In April of 2016 DIAM set up a proof-of-concept environment with GRID 2.0 (M60) enabled vGPU.
Based on the results of the POC, DIAM deployed its CAE VDI on GRID 2.0 in December 2016.
Benchmarking and Deployment of Tesla M60

SPEC APC NX 8.5 Performance
- Benchmarking: graphics operations
- Displayed: seconds to complete all graphics operations (lower is better)

VM Profile
- 16 GB Memory
- 4 vCPU
- 1GB GPU Memory
vGPU for CAD VDI: Results

**CATIA Performance**

- Exported assembly: 529 MB
- Total triangles: 1,985,597
- c: testvisuperfodraw (lower visualization time is better)

**vGPU K2**

**vGPU M60**
User Feedback:

“I've been using the GRID 2.0 environment for NX modeling and drafting. It has the same performance as when I connect remotely to my CAD machine.”

“I have been working with the new (GRID) 2.0 and I noticed a very good improvement in speed. I would say about 20% to 30% speed increase compare to the current VDI GPU. For modeling of single parts it is almost comparable to our regular system.”

“Better than current VDI on the bigger models and shading.”
6. Looking Forward: NVIDIA Tesla P40
Journey: Discrete Graphics for CAD Virtual Workstations

- NVIDIA Announces P40 GRID Card.
- Due to explosion in VDI usage, IT gets agreement from engineering teams to remove customer environments from physical workstations. Customer environments are now virtual only.
- DIAM migrates test environment to Horizon 7.4 to test VMware’s Blast Extreme protocol.
Journey: Discrete Graphics for CAD Virtual Workstations

- DIAM creates P40 benchmark environment
- Testing of P40 hardware results in additional performance improvements.
- DIAM is evaluating whether to move forward with CAD VDI refresh, using P40 GRID cards.
Looking Forward: NVIDIA Tesla P40

SPEC NX 8.5 Performance

- Benchmarking: graphics operations
- Displayed: seconds to complete all graphics operations (lower is better)

VM Profile

- 16 GB Memory
- 4 vCPU
- 1GB GPU Memory
Looking Forward: NVIDIA Tesla P40

CATIA Performance
- Exported assembly: 529 MB
- Total triangles: 1,985,597
- c: testvisuperfodraw (lower visualization time is better)

vGPU K2
Rotation Axis
  Vertical
  Horizontal
  Sight
Parameters
  Angle (deg): 3
  Repeat: 120
LOD Selection
  Static Mode
  Dynamic Mode
Results
  Visualization Time: 40.94 ms

vGPU M60
Rotation Axis
  Vertical
  Horizontal
  Sight
Parameters
  Angle (deg): 3
  Repeat: 120
LOD Selection
  Static Mode
  Dynamic Mode
Results
  Visualization Time: 307.73 ms

vGPU P40
Rotation Axis
  Vertical
  Horizontal
  Sight
Parameters
  Angle (deg): 3
  Repeat: 120
LOD Selection
  Static Mode
  Dynamic Mode
Results
  Visualization Time: 319.47 ms
Blast Extreme Acceleration with NVIDIA GRID

• Potential to improve user experience by moving from PCoIP to VMware’s Blast Extreme.
• New display protocol can reduce machine latency by offloading encoding to GPU.

Blast Extreme Acceleration with NVIDIA GRID

- Performance tweaking:
  - Enabled lossless compression (registry setting from VMware’s Blast Extreme Tech Paper.)
Blast Extreme Acceleration with NVIDIA GRID

• Further tweaks:
  • VMware-supplied Group Policy templates:
  • Recommended for low-latency, high-bandwidth settings (LAN)

MaxBandwidthKbpsPerMegaPixelSlope = 25000 (default is 6200)
• Specifies the slope of the kbps per megapixel of remote screen’s resolution that may be used by the Blast protocol for a remote session.

Max Frame Rate = 60 (default is 30)
• Specifies the maximum rate of screen updates. Use this setting to manage the average bandwidth that users consume.

H.264maxQP = 28 (default is 36)
H.264minQP = 10 (default is 10)
• Specifies the image quality for the remote display configured to use H.264 encoding. You can specify the minimum and maximum quantization values that determine how much an image is controlled for lossless compression. You can specify a minimum quantization value for the best image quality. You can specify a maximum quantization value for the lowest image quality.

Source: http://blog.rueegg.com/?p=129
vGPU for CAD VDI: Results

**Further Lessons Learned**

- There is no “one-size fits all” when it comes to user requirements. Understand each group's individual needs.
- Spec to application requirements, not a user group.
- Read all documentation thoroughly before deployment.
- Have a good relationship with your NVIDIA team.
- Current VDI solution still does not satisfy 100% of the users. As technology matures, need to find a way to accommodate “power users”, while remaining cost-effective.
5.
Questions?
Questions?

Thank you!

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Crafting the Core