High Performance Remote Graphics

Shawn Hall
BP has a single High Performance Computing center in Houston (AKA “the HPC”)
Researchers globally use the HPC
Impractical to replicate compute, storage, and networking resources at every major site
What is easier to move across the network – terabytes of compressed seismic data or compressed pixels?
— We use Expedat from Data Expedition to move data quickly
Answer: compressed pixels
Questions from management

• Most researchers already have a nice workstation at their desk, so why don’t we just shove all their workstations in the server room close to the data?
  — Cost inefficient
  — Space inefficient
  — Hard to administer

• Can we just use servers and virtualize them? What do we do with the workstations?
Cost comparison

**Dell Precision 7820 Workstation**
- 1 x Intel Xeon Gold 6140 18C @ 2.3 GHz
- Nvidia Quadro P4000 8 GB
  - Subtract $598 for P400 2 GB
- 96 GB RAM 2666 MHz DDR4
- 2 x 3.5” 1 TB 7200 RPM HDD
- $9,875 (Dell website)
- $945 (remote graphics software)
- **Grand total: $10,820**

**Dell R740 Rack Server**
- 2 x Intel Xeon Gold 6140 18C @ 2.3 GHz
- Nvidia Tesla P40 24 GB
- 768 GB RAM 2666 MHz DDR4
- 8 x 3.5” 1 TB 7200 RPM HDD
  - Just use NAS w/ dedup in reality
- $51,936 (Dell website)
- $16,380 (8 VMs - software licensing)
- $43,453 (24 VMs – software licensing)
- Sliced into 8 VMs = **$8,540 per user**
  - Oversubscribed 2:1 = **$4,270 per user**
- Sliced into 24 VMs = **$3,975 per user**
  - Oversubscribed 2:1 = **$1,987 per user**
Oversubscription benefits of virtualization

• Oversubscribe CPU cores
  — E.g. Give each VM 18 cores on a 36 core host
• Oversubscribe memory*
  — Memory ballooning add/removes memory from VMs based on pressure
• Oversubscribe GPU
  — vGPU memory is fixed, but vGPU can use all host GPU cores
  — Requires vGPU scheduling policy change**
• Oversubscribe network
  — 40/100 GbE host network shared by VMs

* In theory – has not been successfully tested w/ vGPU
Components used at BP

• Server with Nvidia Tesla series GPU
  — Tesla GPU required for GPU virtualization
• Nvidia vGPU capable hypervisor
• Nvidia vGPU host and guest drivers
• Mechdyne TGX remote graphics software
  — Captures video of remote system and sends to local system
• Leostream Connection Broker software
  — Acts as traffic officer directing users to available systems
Gives greater flexibility for choosing slices of GPU allocated to VMs

Fewer GPU cards with multiple GPU chips per card makes vGPU a necessity
• Offloads computation through Nvidia Capture SDK to GPU to minimize latency
• High color accuracy
• Multi user collaboration
• Data is SSL encrypted
• Compatible with Windows, Mac, and Linux
• Performance improvements come “automatically” with GPU improvements
Leostream

• Very flexible, vendor agnostic connection broker
• Directs users to available systems based on policies
• Uses 3 components
  — Leostream Connection Broker – routes users to a desktop, manages TGX connection settings, defines policies around desktop usage
  — Leostream Connect – runs on user’s computer, establishes and configures TGX session based on Connection Broker response
    — Windows, Mac, Linux clients
  — Leostream Agent – runs on remote computer and helps the Connection Broker to manage connections


Architecture detail

Leostream

Connection

Broker

Which system?

Use this one.

Leostream Connect

TGX Receiver

System and configuration info

Please start / resume a session for me

X / Gnome session

startx

Keyboard and mouse inputs

NVFBC

Capture GPU frame buffer

VM w/ vGPU

NVENC

CUDA

H.264 video w/ AAC audio

NVDEC

Client
System management

- Systems are provisioned with a minimal kickstart file
- System configuration is managed with Ansible
  - CentOS and RHEL VM images
  - Hypervisor hosts
  - Virtualization manager (provisioning VMs)
  - (To-do) health checks and/or cleanup tasks on VMs
Demo/video
Use in BP
Previously, I've been very limited in bandwidth here in the UK (often < 200 Kb), as I connect over SSH the StarCCM+ graphics front end to the CFD simulations running on the HPC. X Windows never worked and the connection has been painfully slow, with several minutes lag for several types of operation. TGX has overcome all these problems and is making the process of interacting with HPC more easy and efficient. – London, UK based CFD engineer

Thanks for installing TGX on my laptop. I am glad that I did so as I am presently on vacation in India. And TGX has outperformed any other remote work option for me by a margin (Hydra and EOD). The screen update is almost real time. – Houston, TX based geophysicist

I love TGX, it has been a life saver for me and it is very stable. I have been on the same session and I just logout and back in and my work area is still there. – Houston, TX based geophysicist
Questions?