CUUG
Calgary Unix Users Group
Dedicated to Unix & Open Systems

SiliconGraphics Pandemic Rescue!

or how I saved my dream retro-computer from Down Under

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(https://otengineering.ca)

But why, Rees?

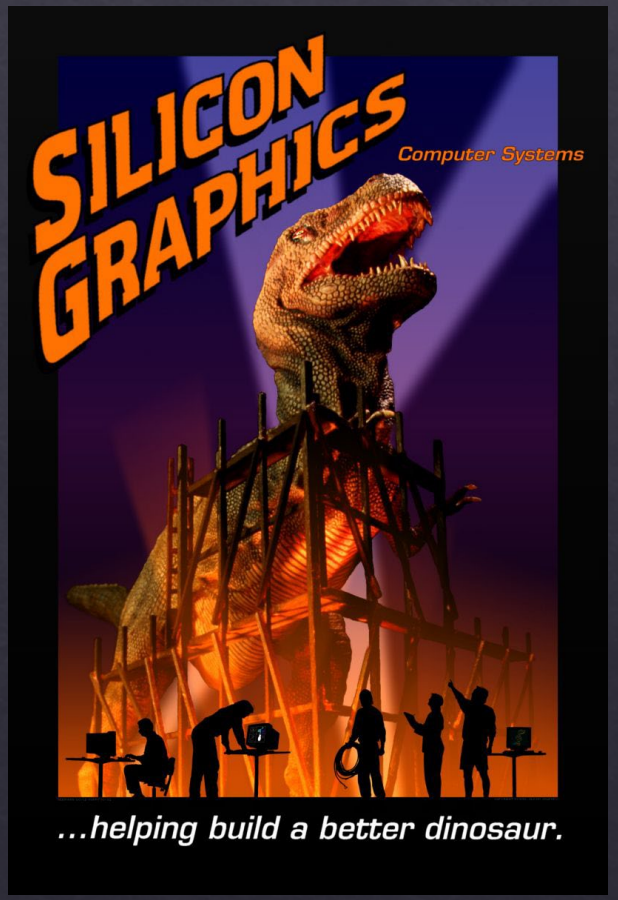
- Retro-computing and games have exploded in popularity
- A true window into computing's past
- Feeds the human need to hoard everything
- Bona-fide collectibles?
- "Cottage industry" of service, support and customization
- SGIs have not been successfully emulated, except in a very limited way through MAME (incomplete, buggy, no graphics)

The Infinicube

Personally: SGI represents the pinnacle of commercial UNIX 3D graphical computer workstations that changed the world.

About sgi

- Company founded in Nov ’81; bankrupt in May 2009
- Most powerful 3D UNIX workstations of their day
  - Mostly MIPS architecture, early models were Motorola 68K-based
- Founder James Clark a pioneer in 3D graphics
  - Invented the “Geometry Engine”: First VLSI chip to put a geometric graphics pipeline into a single chip (was an entire cabinet of parts)
  - Left SGI in January 1994 to found Netscape
- Created OpenGL (derived from IrisGL)
- Dominated design & Hollywood studios until the mid 2000s
- Bought Cray and released lineup of ccNUMA SSI HPC clusters
- Attempting to save themselves, switched to Linux on Itanium
- Many FOSS contributions (ex: XFS file system, Inventor toolkit)



SGI 4GE7MCM
(4x Geometry Engine 7)

- Multi-chip Module:
  - 32 MFLOPS, 80K gates per GE7
  - Total 320K gates & 128 MFLOPS in 1992!
- MIMD design optimized for 3D graphics:
  - Vertex transformation and scaling
  - Pixel processing & FX
  - Lighting, clipping and projection

Pandemic Collecting Fad / Peak Retro?

- Began collecting “dream” machines to keep my mind off COVID pandemic
- Most require minor hardware repair or major restoration work
- Heard about SGI machines decades ago
  - web forums (defunct NekoChan) and vintage computer forums
- If it’s too hard to emulate, you have to get your hands on the real thing!
- Software, tools and cables are getting hard to find
  - Most 50-pin SCSI 1 and 2 disks are dying, requiring SD-card drive emulators
  - Some graphics cards use old timings and analog sync signals (15 KHz, SoG, 13W3)
  - Cabling and I/O standards have gone all digital-serial (SATA, USB, HDMI)

Deskside or rack-sized graphical supercomputers

- Had to have one! The ultimate UNIX and retro challenge!
- Avoid “Commercial reseller” market for medical or professional use
- Nothing in Canada that I could find for sale
- Physical size and shipping poses a huge challenge
- “I know what I have!” mentality for completely obsolete computers?
- Expected to put in time and money for restoration

The search for sgi machines takes months…

- Classifieds on two SGI user groups:
  1. Silicon Graphics User Group (forums at https://sgi.sh + Discord chat server)
  2. IRIXNetwork (forums at https://irixnet.org)
- Vintage Computer Fed. (https://vcfed.org)
- cctalk mailing list (https://classiccmp.org)
- Craigslist, Kijiji.ca & Facebook Marketplace
- Computer recyclers – ex: Drumheller, Rhode Island, Illinois, and more

Winner: eBay! Two Onyx2 desksides found in Melbourne, AUS

Acquisitions (a.k.a. the hoarding) begins

- R10K O2 from a sgi.sh Discord group member in Vancouver
- Two R4K Indy models from an eBay seller in Ontario
  - Later, a box of keyboards and mice from the same seller
- An Octane, minus PSU, from a recycler in Drumheller
  - Found a power supply from a Discord group member in Ottawa
- Repaired cold solder on Indy XZ (24-bit 3D) graphics board from a forum member in Washington
- Dual 360 MHz R10K CPU module and more RAM from a reseller close-out

Much Experience gained: installing, configuring, maintaining IRIX machines. But **I needed to go bigger.**

Here's what I won at auction

- One of two Onyx2 units, supposedly bought in a past government auction
- Never used by the current owner
- Unknown, as-is condition
- Cheap! $395 AUD ($375 CAD)

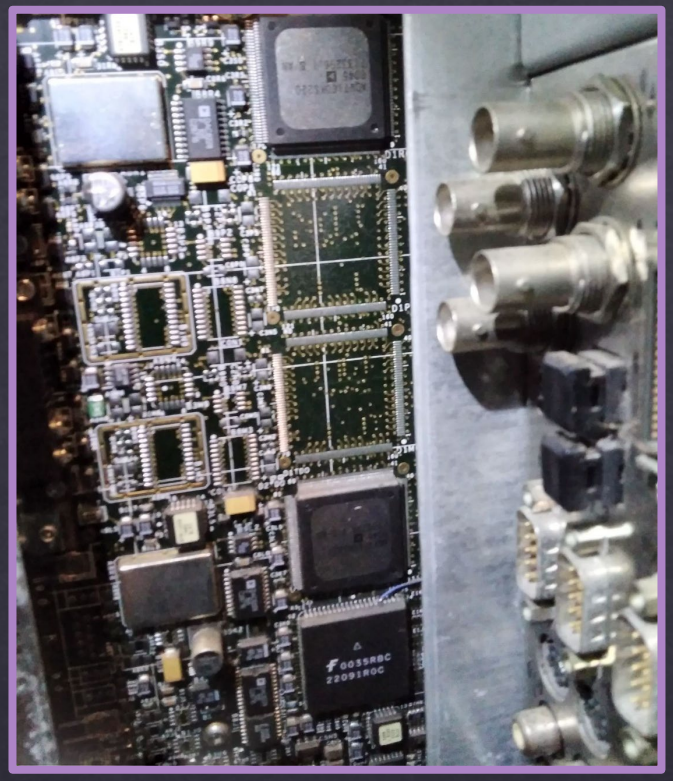
Problem: local pickup only
Solution: buy it anyway and figure it out later!

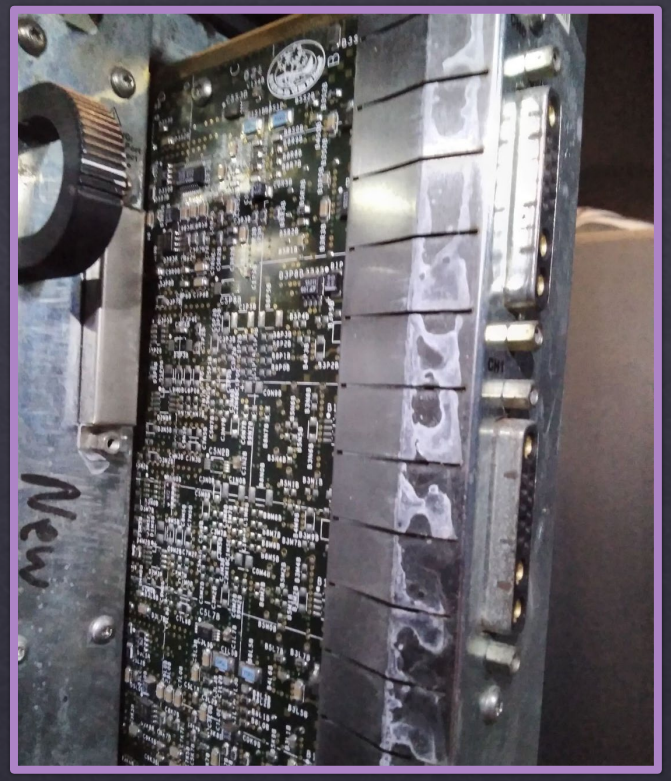
Help from an amazing friend

- Challenge: Melbourne is constantly on lockdown!
- Call a friend? Dean, a fellow engineer, comes through for me!
- Early in the pandemic, narrowly escaped South America with his Aussie GF on a long-way-round trip from Canada to Melbourne
- Shipping big things is hard. Unable to find an economical method.
- **Fast plan!** Shove it in a storage locker in Melbourne close to the docks
- May 7, 2021: Purple “Dinosaur” in a holding pen at *Kennard’s Self Storage*

Unbeknownst to us, the Onyx2 would be sentenced to **bake in a 2x2m storage locker** until the end of the pandemic

Pickup day! Dean pulls a few cards for me

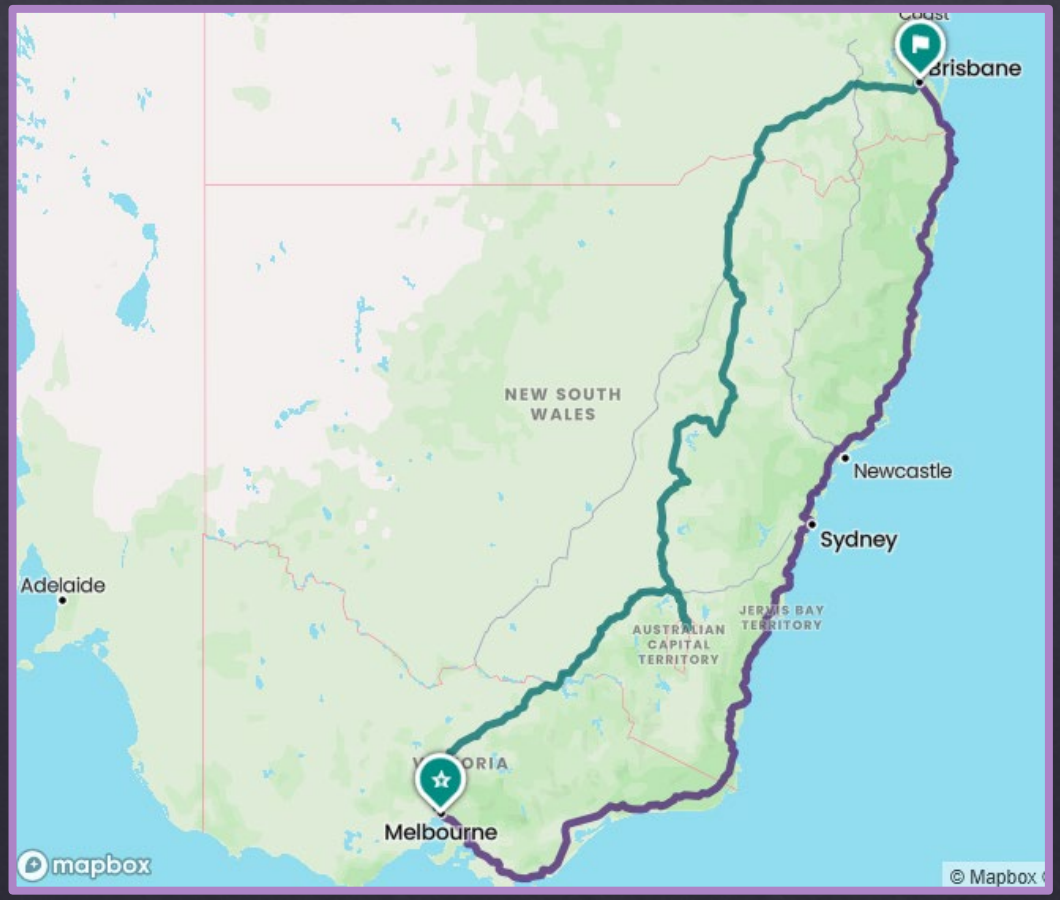




Melbourne is subtropical and machines sat in a shed outside.

Dean goes North, and I start researching

- Dean and his GF head north through the Outback on a trip to Brisbane (Queensland)
- I started researching shipping methods and rates
- **November 20, 2022:** Lockdowns in Australia mean that Dean doesn't return to Melbourne to get the Onyx2 Until 18 and a half months later!



Freight shipping methods

Air

- Expensive but Fast
- Nearly door-to-door
- Excellent for delicate cargo and not exposed to the elements
- Put in an aluminum case for air freight
- Requires less packing and protection
- Normally 10x LCL $/kg, but at historic low approaching LCL rates!

Ocean (LCL)

- Cheap and Slow
- Arrives in Vancouver, then what?
- Subject to more risk (sinking) and exposure to the elements
- In a sea can with other’s cargo
- Pandemic price is off the charts!

Onyx2 Deskside as originally shipped

Onyx2 Deskside System Site Requirements

There are two variations of the Silicon Graphics Onyx2 graphics subsystem: Onyx2 Reality and Onyx2 InfiniteReality. Places where these differ from a site-preparation standpoint are pointed out in the text.

For information about selecting a physical location for a Silicon Graphics Onyx2 deskside system, see "Selecting a Location for an SGI 2000-Series Deskside or Onyx2 Deskside System" on page 57.

Onyx2 Deskside System Specifications

Table 6-6 lists the physical specifications of the Silicon Graphics Onyx2 deskside system.

Table 6-6 Onyx2 Deskside System Physical Specifications

Dimensions		
With skins:	length	24″ (61 cm)
	width	19.8″ (50.3 cm)
	height	26.5″ (67.3 cm)
Without skins:	length	21″ (53.3 cm)
	width	17.7″ (45 cm)
	height	23.9″ (60.7 cm)
Shipping:	length	30.9″ (78.5 cm)
	width	25.8″ (65.5 cm)
	height	42.5″ (108 cm)
Weight:	minimum	120 lbs (54.4 kg)
	maximum	170 lbs (77 kg)
	shipping (max.)	190 lbs (86.2 kg)
Floor Loading:	minimum	36 lb/ft² (175 kg/m²)
	maximum	51 lb/ft² (250 kg/m²)
Air Temperature		
Operating:	0-5,000 ft	41° to 95° F (5° to 35° C)
	5,000-10,000 ft	41° to 86° F (5° to 30° C)

SGI 2000-Series Deskside and Onyx2 Deskside Shipping Crate

Figure 6-1 illustrates and lists the dimensions of the shipping crate used for the SGI 2000-series deskside and Silicon Graphics Onyx2 deskside chassis.

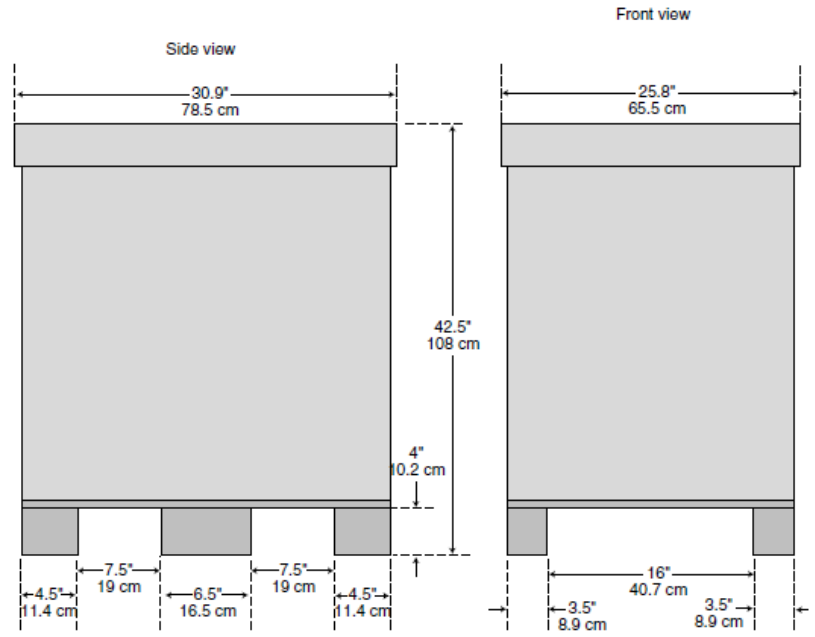


Figure 6-1 SGI 2000-Series Deskside and Onyx2 Deskside Shipping Crate

How to pack it without flying to Oz?

“Traditional” Wood Crate

- Can’t build your own!
- Special certification required (ISPM15)
  - heat-treated
  - fumigated with methyl bromide (against insects, plant diseases, etc)
  - stamped
- For LCL/Ocean: wrappings and special anti-salt and moisture protection available
- Professional packer will do it all for you

Honeycomb board and plastic

- Alternative materials, like paper, plastic or wood panels are exempt from ISMP 15!
- Light-weight and ideal for air
- Sustainable
- less toxic than fumigated wood
- Rebul (rebul.com.au) offers an amazing non-wood alternative
  - Honeycomb board and re-useable
  - 1/3 the cost of traditional crating

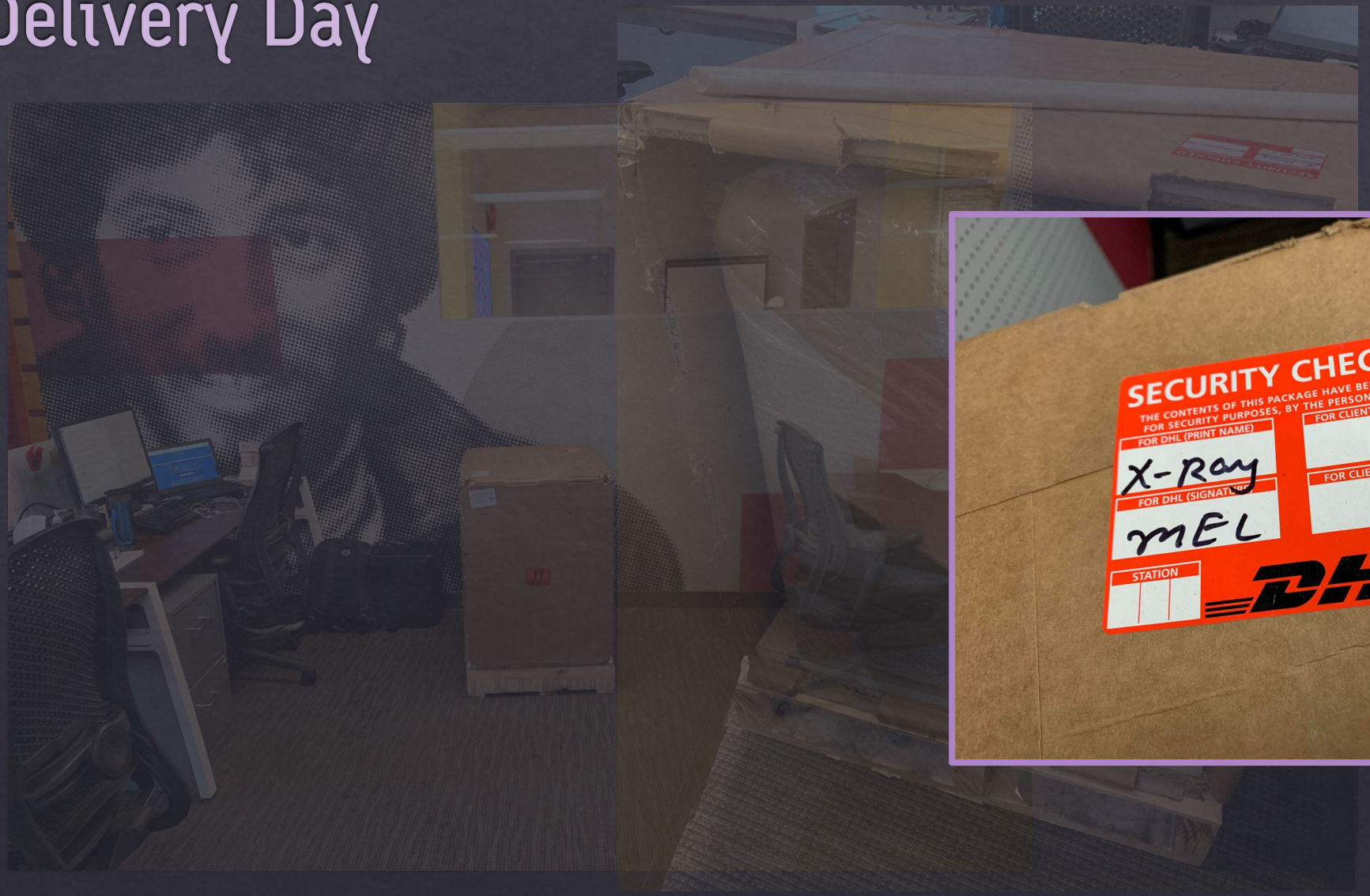
Bringing it all on home

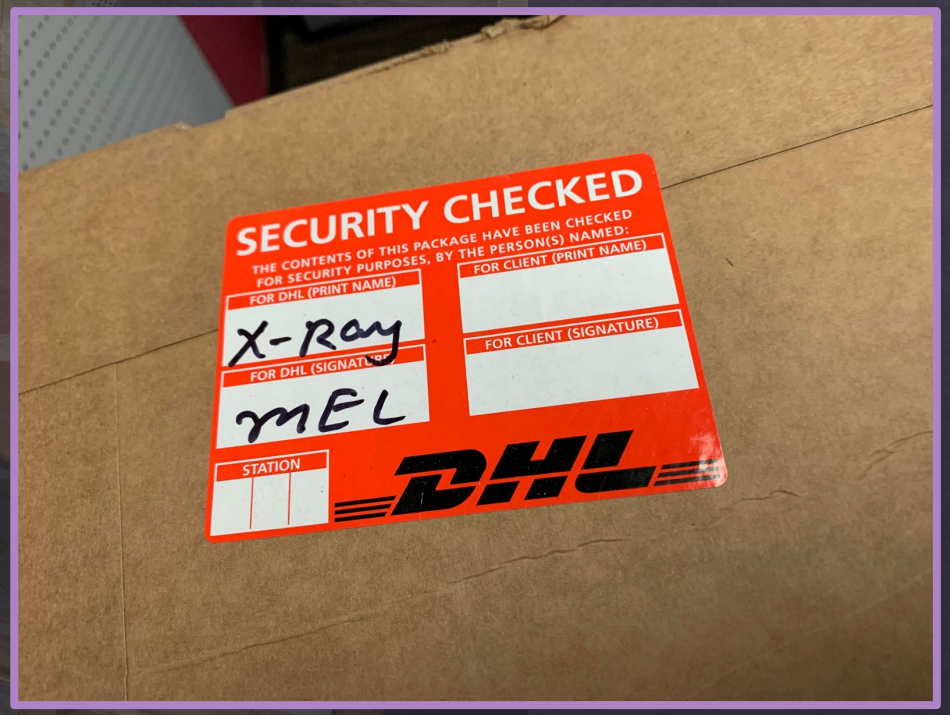
- Late October 2022: I had a reliable quote from ReBul
  - using their innovative honeycomb materials
  - Included air freight door-to-door through DHL
- November 23: Dean got the machine from Kennard's to Rebul
- December 1: Onyx2 Ships from Oz
- December 9: Delivery day!

Delivery Day

Delivery Day

Delivery Day





What did I end up buying?

- Onyx2 with InfiniteReality3 graphics (circa 2000)
  - 4x450MHz MIPS R12000 CPUs (amazing!)
  - 2GB RAM (8GB Max)
  - 2x RM10-256 raster manager memory boards (= 512MB Texture memory)
  - DG5-2 (two-output) display board
  - Two SCSI-3 U160 SCA Hard disks with drive sleds (nice bonus!)
- 3D performance?
  - 13.1 Million polys/s
  - 5.6 Mpixels/s fill rate
  - 6.8 MVoxels/s volume rendering
  - 8xFSAA, z-buffered, textured

Cost Breakdown ($ CAD)

	QTY	Cost ea.	Subtotal
Onyx2 at auction			$375
Kennard's Self Storage	18	$35	$630
ReBul packing and air freight			$2042
DHL fees (GST + brokerage)			$38
		Total:	**$3085**

Disassembly and inspection

- Once I got the system home, I took it apart outside and moved the chassis downstairs
- Cleaned everything
- Dust deposits on top of all cards
- Fan tray was disgusting
- System had clearly been used in a dusty and semi-humid environment

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Proper prep work is essential.
Every board is properly reseated.

Let’s boot it up and test it!

- Connect null-modem cable at 9600,8,N,1 to the MSC
- Turn MSC keyswitch from *Standby* to *Diagnostic* position and play around
- Connect LCD, PS/2 KB and mouse. Turn keyswitch to “ON” – do we get graphics?

Great success: Powers up and runs on the first try!

Feeding the beast in its new home

- Power supply is designed for heavy duty use and supplying large amounts of DC current at 3.3V
- Requires its own 1-phase 20A circuit (minimum) for 1224W output

OR

- Can also be supplied with 2-phase 240VAC for more power (1750W max) at less current draw (auto-switching)

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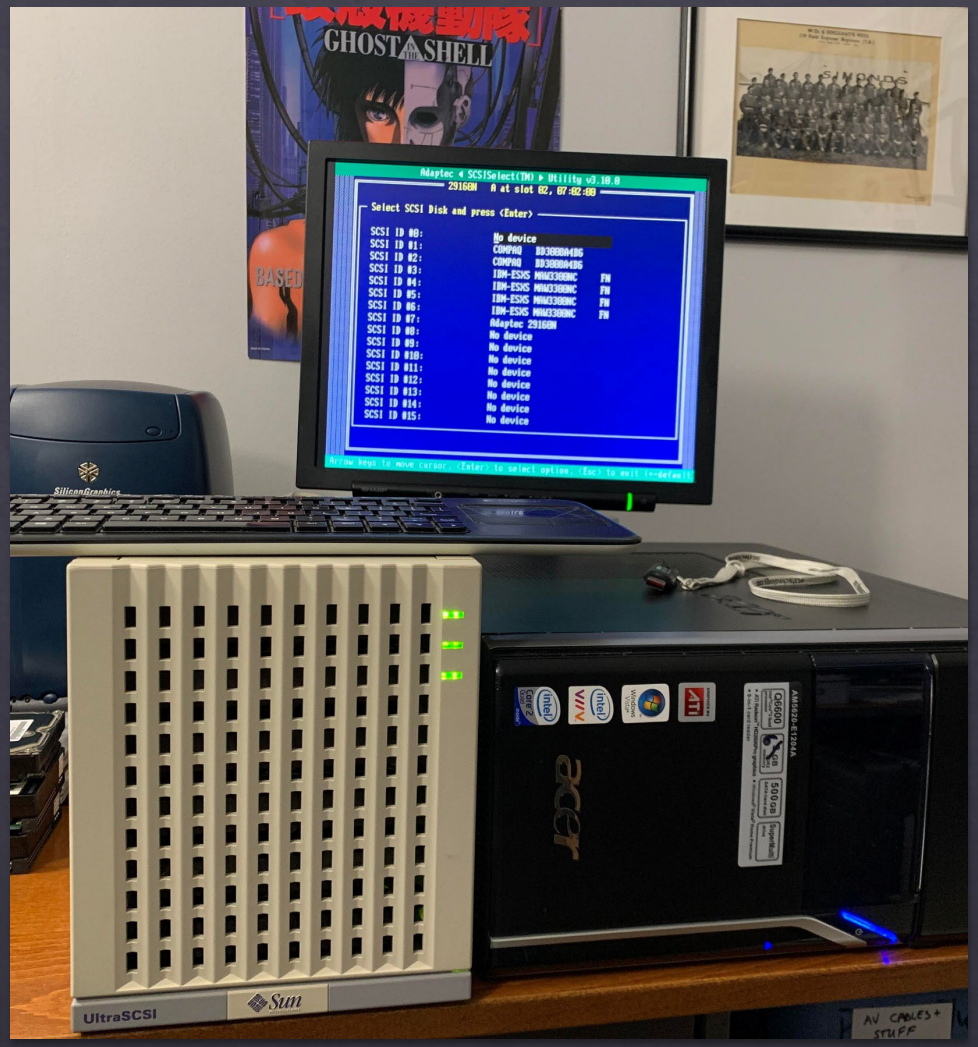
Feeding the beast in its new home

- Actual measured usage is approx. 500W continuous @ 125 VAC / 20A 1-P
- Same power and heat output than a modern desktop with high-end graphics cards?
  - Ex: NVIDIA GeForce RTX 2060 Super are 175W each!
  - RTX 3060 Ti are 200W each

Dedicated 1P-20A circuit and breaker installed with non-conductive (poly) conduit.

Forensic imaging of both original drives

- IRIX EFS and XFS volumes and partitions are mountable on Linux
- Used an Adaptec UltraSCSI card and SUN UltraSCSI enclosure to image both hard disks that came with the Onyx2
- Used ddrescue to be safe, in case each drive was about to fail
- To be safe, use direct disk access and retry bad sectors only 3 times:




```
# ddrescue -d -r3 /dev/sdb disk1.img disk1.log
```

Forensic results: Previous owner and use case?

- Node-locked licenses recovered for various software packages
  - Multigen (Paradigm Simulations) VEGA: Real-time 3D simulation toolkit
    - Build rapid large-scale real-time simulations and worlds
    - Supports objects stored in SQL databases (MySQL, Oracle, etc.)
    - Have License option for Ocean (currents, waves, vessels) and Land-based (trains, cars, etc.) dynamic physics modules
    - Depends on OpenGL Performer API
  - SGI's OpenGL Performer: Commercial Scene-graph API and tools for real-time visualization
    - Support SMP, multiple pipelines, clustering, etc.
- Part of a train simulator for defunct State Rail Authority of New South Wales (1980-2003)?
- Simulator developed by *Sydac Pty. Ltd.* of Adelaide (Now Oktal of France)
- **Passwords:** cracked in minutes by "John the Ripper" (https://openwall.com/john)
  - /etc/passwd file was extracted from the disk images

“DEVELOPMENTS IN VIRTUAL REALITY AND COLLABORATIVE RAIL TRAINING”

- CORE 2004 Railway Engineering Conference in Darwin, Australia (June 2004)
- Paper by Eichinger, Geraghty, Wickham of Sydac
- describes Virtual Reality Facility at SRA NSW

Permalink to paper

Future plans and goals

- Make use of the Multigen VEGA and OpenGL Performer software licenses
- Extremely high quality commercial code and documentation
- C/C++/OpenGL coding & support the hobby SGI retro community
- VR CAVE in my basement: projector and shutter glasses
- 3D modelling in Softimage 3D and Alias|Wavefront Studio and Maya
- Produce an animated short and print it to 35mm cinema-grade film
  - Friend has high end film printers: phosphor raster printing straight to 35mm film, frame by frame
  - Semi-private screening?

Wrap-up

- I offer OT/ICS Cybersecurity Engineering services in Western Canada:

  ☛https://otengineering.ca

- Li: https://www.linkedin.com/in/reeskm
- CUUG: https://cuug.ab.ca
- SGUG: https://sgi.sh

Thanks to CUUG and my friends of the Silicon Graphics User Group