OptIPlanet - connecting users, backplanes and networks

Bernard Pailthorpe, UQ and QCIF Ltd.
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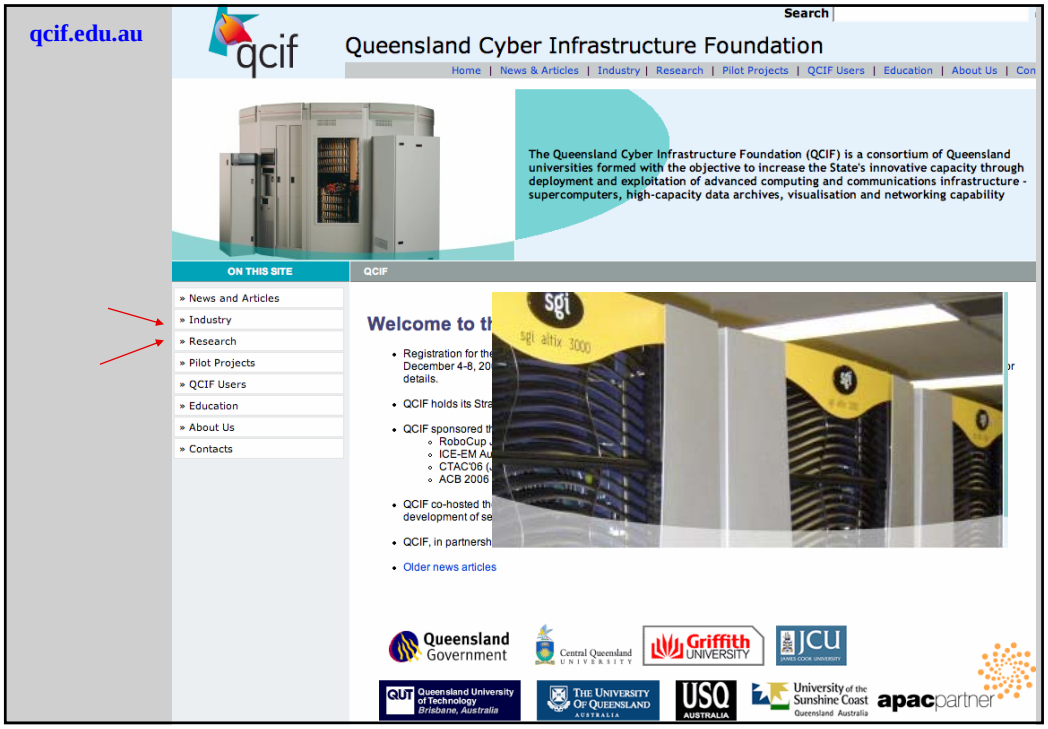
Queensland Cyber-infrastructure

qcif.edu.au
vislab.uq.edu.au

Outline

- **QCIF - HPC infrastructure; Projects**
  - **Supercomputers & HPC; Data; Visualisation; Networking**
    -> Computational Science & Engineering
- **Networks: real-time computing**
  Access Grid: Collaborative working; Data Grids; SensorNets; Displays -> scalable
- **OptIPortals**
  … wall-sized desktops
- **Network performance tuning**



QCIF's Activities, Impacts

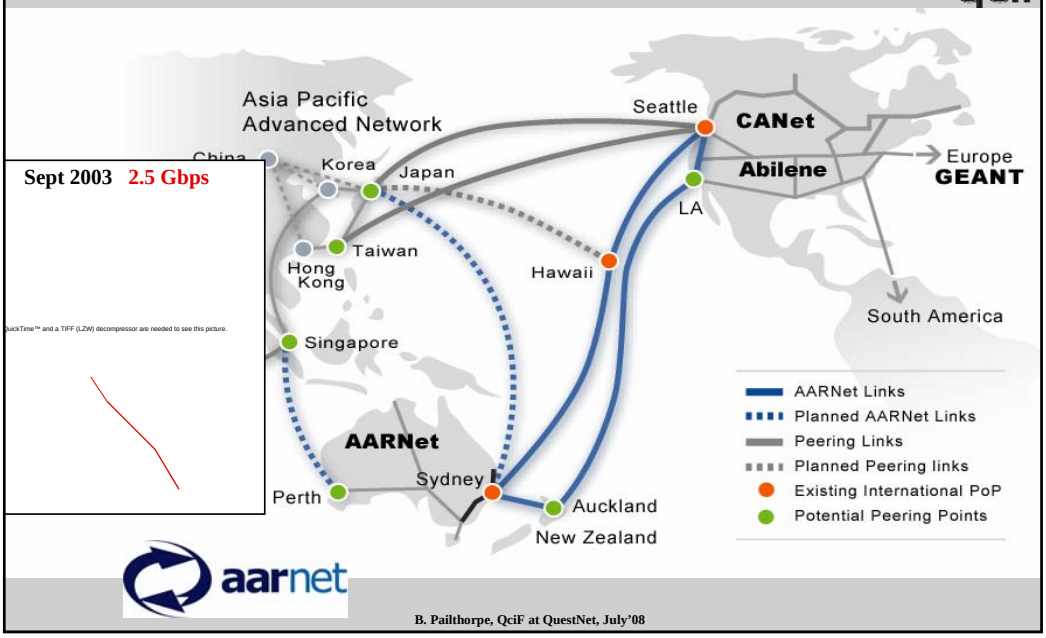
Connected to the world @ 1 , 2.5, (10) Gbps

Scientists using world class
computing and data resources
+ collaborating together

Industry uptake of HPC - supercomputers, ..

Public decision making based on data

Connected to the world



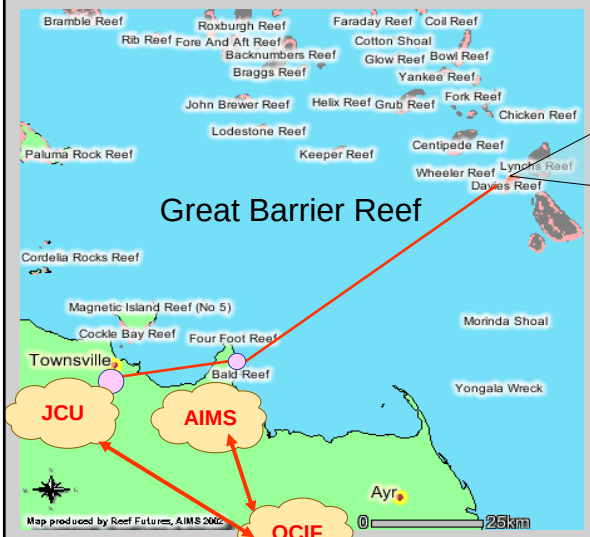
B. Pailthorpe, QciF at QuestNet, July'08

Collaborating with CalIT2

CREON meeting, at AIMS, March 30, 2006
- network upgrade to 1 Gbps a few days prior

B. Pailthorpe, QciF at QuestNet, July'08

Tourism & Tropical Futures



The challenges
- **tropics**
- **distance; power**

Source: Stuart Kininmonth, AIMS Australia.

B. Pailthorpe, QciF at QuestNet, July'08

SensorNet on GBR + AIMS

The first internet POP on the GBR, at Davies reef.

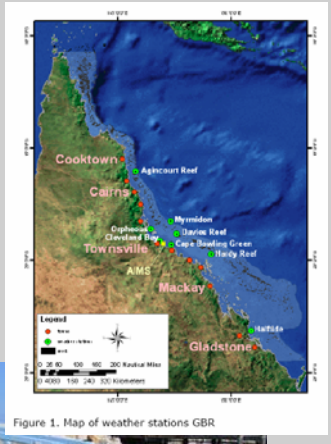
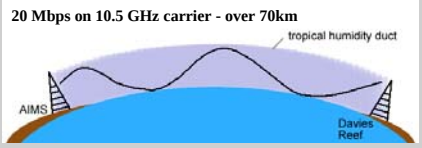


Figure 1. Map of weather stations GBR



Graham Woods, Elec Eng, JCU

Stuart Kinninmonth, AIMS

B. Pailthorpe, QciF at QuestNet, July'08 **Sensor buoys**

Industry competitiveness - Coal Loader

Dalrymple Bay - coal jams in chute (~10m)

6000 tonne/hr throughput; ~ US$50/t; 4-5 t dump from wagon

Payback time ~ 69 sec. of operations

Figure 1: A critical transfer station at DBCT which was modelled using discrete element analysis and HPC.

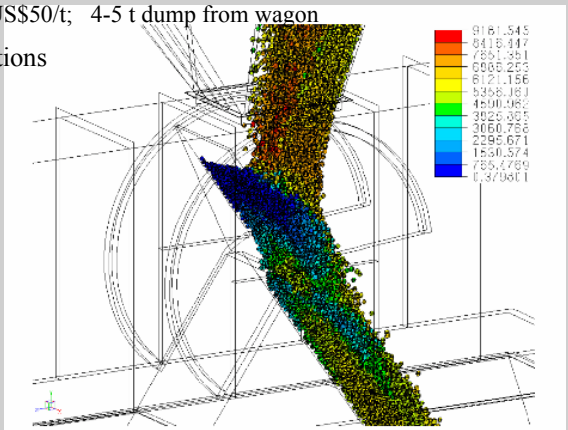


Figure 3: Diagram showing velocities (in mm/s) of particles in transfer chute.

Prof. Jeff Logheran, JCU
Peter Wotherspoon, BBI DBCT

Local industry - smarter manufacturing

Boat building - manufacturing composites; USQ and Creative Advanced Build (Toowoomba).

- Controlled Vacuum Infusion of resin into fibre reinforced polymer structures
  - allow more even spread of resin throughout laminate
  - reduces risks trial-&-error exp't
- Design & build 13-metre houseboat

CAD models of boat ->

Polyworx - flow simulations

+ Finite Element Modeling

(*ABAQUS)*

- analyse structural behaviour of boat under operational static & dynamic loading.

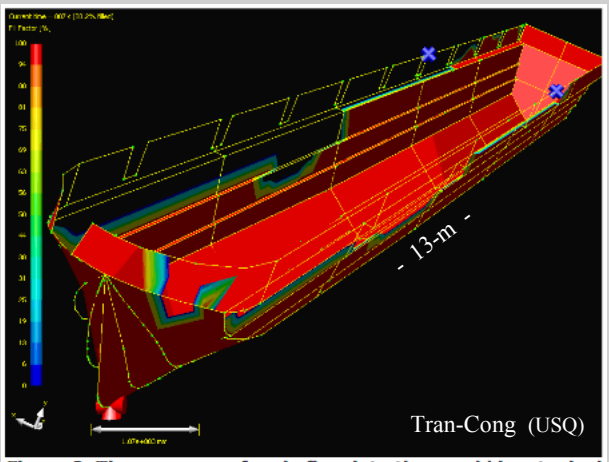


Figure 2: The progress of resin flow into the mould in a typical CIV simulation

Improving health care

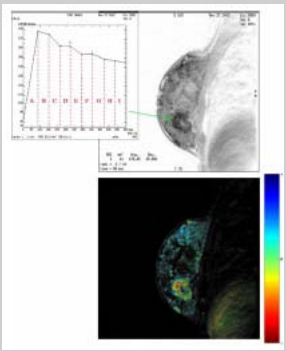
3D MRI imaging: breast cancer

QUEENSLAND X-RAY

Public health benefits

(11,000 new cases pa)

vs. Proj. cost



2D slice visualisation

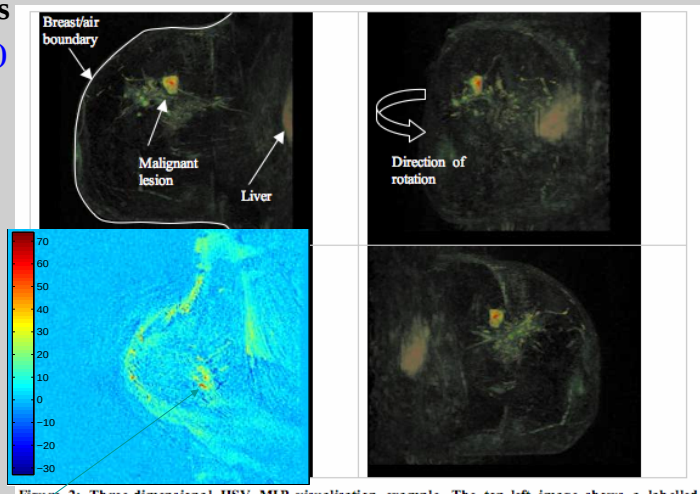


Figure 2: Three-dimensional HSV MIP visualisation example. The top-left image shows a labelled sagittal view through the colour-coded breast volume. The remaining images represent views from different angles (the direction of rotation is shown in the top-right image).

Resolve 15 pixel suspicious ROI (~ 2mm)

EMI, School of ITEE, UQ

Prof. Stuart Crozier &
Dr. Andrew Maenart &, ITEE, UQ
+ Dr Kerry McMahon, Qld. X-Ray

B. Pailthorpe, QciF at QuestNet, July'08

New industries:

Medical Imaging MRI scanners

superconducting magnets

qcif

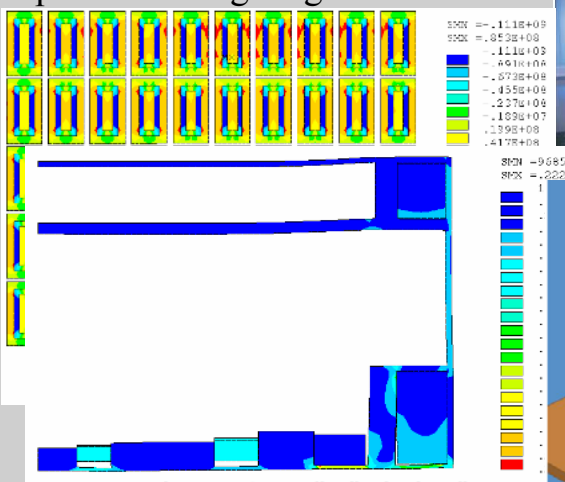
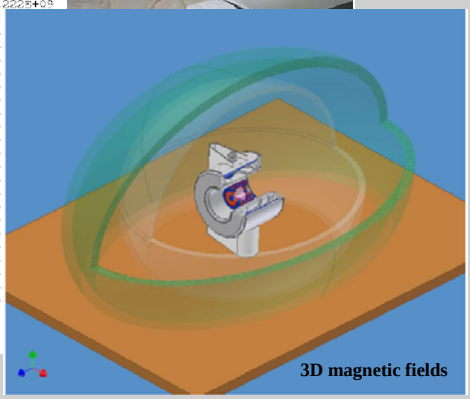


Figure 4a: Stress distribution in coils and formers of the magnet.

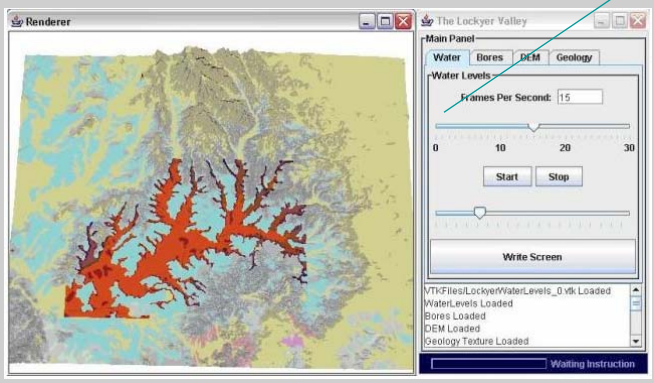


Dr. Riyu Wei (UQ & Magnetica),
Nicky Milson (**Magnetica Pty. Ltd.**).

B. Pailthorpe, QciF at QuestNet, July'08

Issues for Qld - Water quality

- **Water management & salinity monitoring in Lockyer Valley, Qld.**
  - **– data sets for groundwater management & salinity monitoring**
  - **– bore locations, surface strata, groundwater table levels , …**
- **Java J2ME enabled mobile phone or PDA**
  - **– remote access to data/HPC: VTK off-screen rendering**



Java viualisations framework

On-site mobile phone vis for community engagement, consultation & decision making

Prof. Ian Turner, QUT
Andrew Durick, **DNRM**

Basic Research: Biodiversity on Coral Reefs

Ecological models: Sean Connolly, JCU

model thousands of species + highly complex interactions

<u>understand</u>:

• impacts of human activity targeted to particular species,
- eg. fishing & re-zoning

• biodiversity, productivity, stability of ecosystems
- respond to habitat loss, increased stresses

eg. more frequent mass coral die-offs due to global warming

∞ fisheries and tourism generate $100's m pa

Science, Nature

Chem Eng: Suresh Batia (UQ)

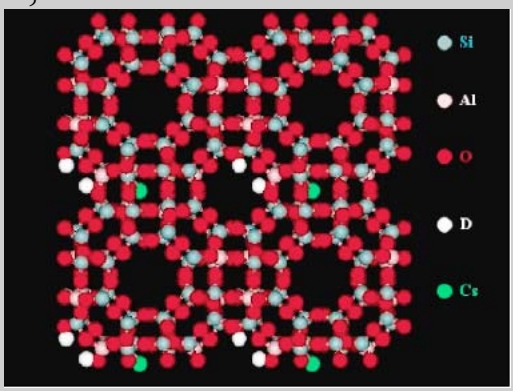
Transport and Adsorption in Nanomaterials

Pores diam ~ 5 - 50 ångström, molec ~3-5 å

Monte Carlo & molecular dynamics (MD) simulations

Molecular sieving in microporous materials

- method of separation
  many industrial applications:
  separations, catalytic processing.



Zeolite rho structure

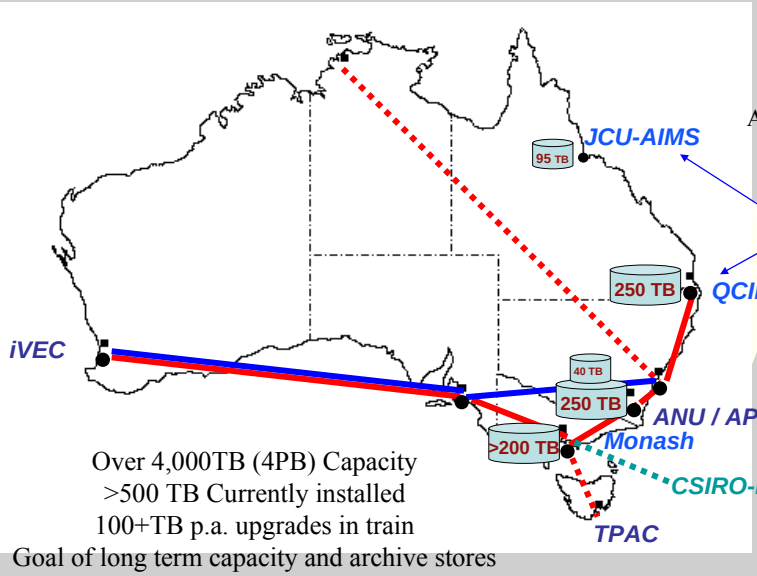
Phys. Rev. Lett., 91, 0126102 (2003); 95, 245901 (2005).

Collaborative working: AG

- **Networks**
  - **Synchronous usage**
  - **Real-time performance**
  - **also Data movement** **(~ TB archives)**

Beyond VTC: Room - to -room interactions

Australian Data Gid



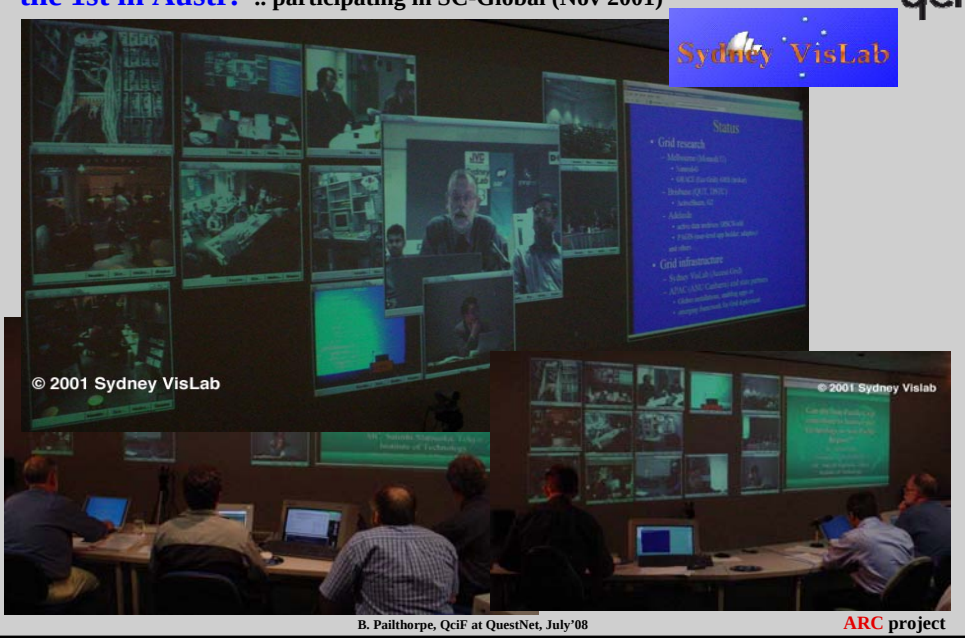
Recent Activity
ARC, DART, ARCHER
SRB Support
....

Over 4,000TB (4PB) Capacity
>500 TB Currently installed
100+TB p.a. upgrades in train
Goal of long term capacity and archive stores

B. Pailthorpe, QciF at QuestNet, July'08

Access Grid - ATP, Sydney

the 1st in Austr. .. participating in SC-Global (Nov 2001)

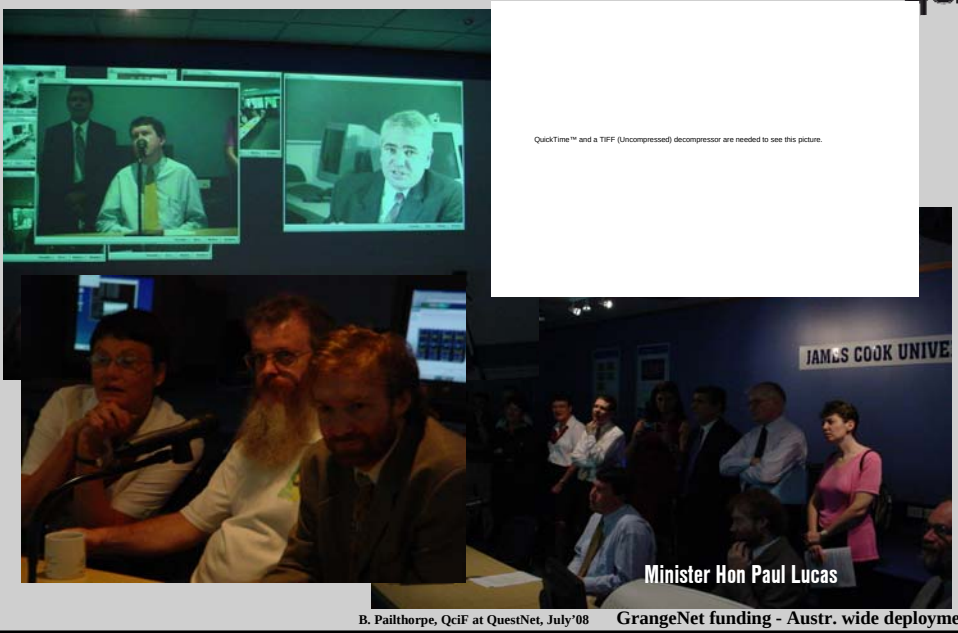


B. Pailthorpe, QciF at QuestNet, July'08

ARC project

Australia's 2nd A/G node:

JCU, Townsville, Apr 30, 2002



 GrangeNet funding - Austr. wide deployment

AG - impact

".. in 2006 AG saved Qld. Universities $2.2m in avoided travel costs …

.. and increased research productivity by 40,000 hours.. " (time saved)

Est'm CO_2 savings = 1,300 tonnes in 2006, for Qld.

& guesstimate ~ 5,000 t. nationally

Ref. //flights.carbonplanet.com/
-> 0.3 kg CO_2/ passegneg-km

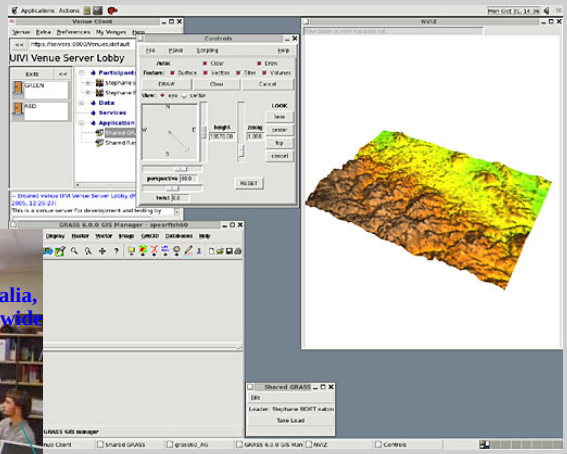
Collaborative working: Access Grid

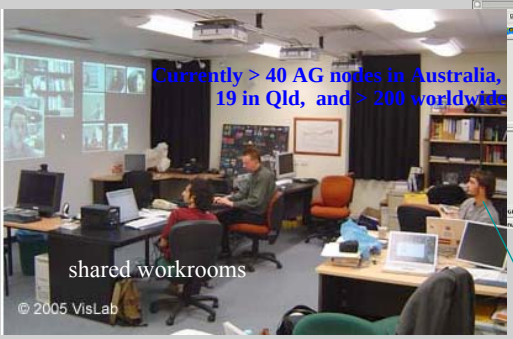
B Pailthorpe, Chris Willing, N Bordes (UQ)

Beyond sharing ppt for meetings …

- Geographic Information Systems

(GIS) for urban planning, logistics, mapping, resources, response, ….





Shared Grass (GIS software app), within AG environment
Stéphane Bidet, + **Downloads** at:
http://www.vislab.uq.edu.au/research/accessgrid/software/

High Definition Video for the AccessGrid

Relative video image sizes (Original vs. DV vs. HDV)

Leon rewrote vic: native HDV & HD

Applications

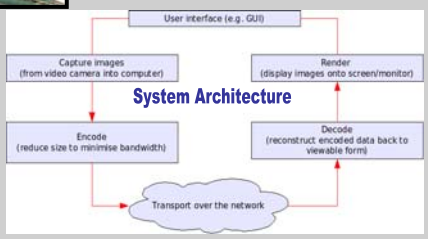
- Emergency response environments
- Remote education and accreditation
  - Agric, Vet.
- Tele-Medicine
- Virtual Meeting Rooms

Participants

UQ: Leon Zadorin, Chris Willing
ANU: Rhys Hawkins, Andrew Howard
JCU: Andrew Sharpe
AARNet: Greg Wickham

Project Status

- High-fidelity video capture capabilities
- High-definition video encoding and decoding
- Hardware accelerated video rendering
- Streamlined network transmission



http://www.vislab.uq.edu.au/research/accessgrid/hd_video/index.html

We're talking about displays:

- User interface to computers, ….
  - Desktop monitors, PowerWall, Visionarium, VR, ImmersaDesk …..
  - and now the OptiPortal (

Historical progress: ~ 1975 - 2000

Computers

(Cray 1 -> teraflops) **x 10^6**

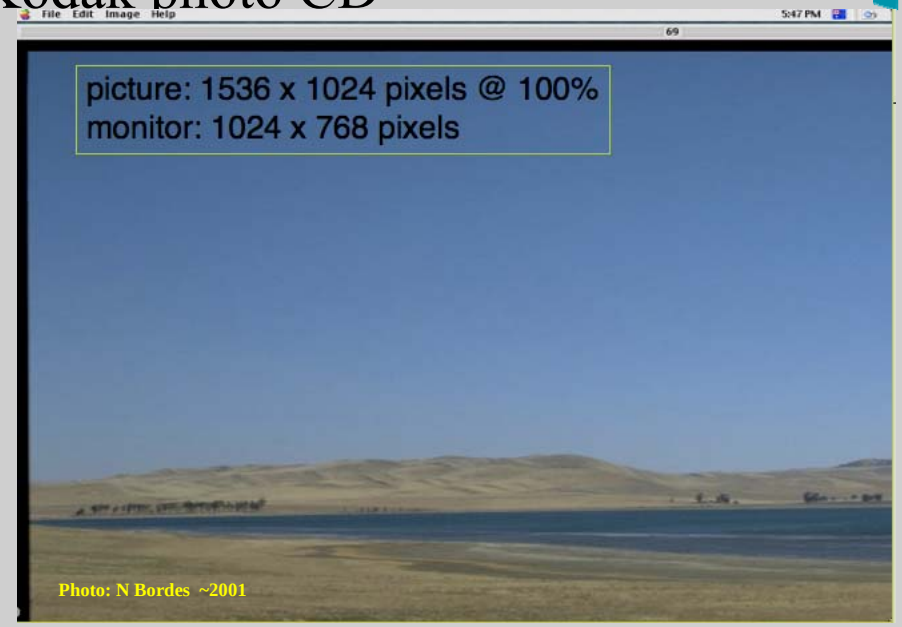
.. and data and networks …

Desktop monitors

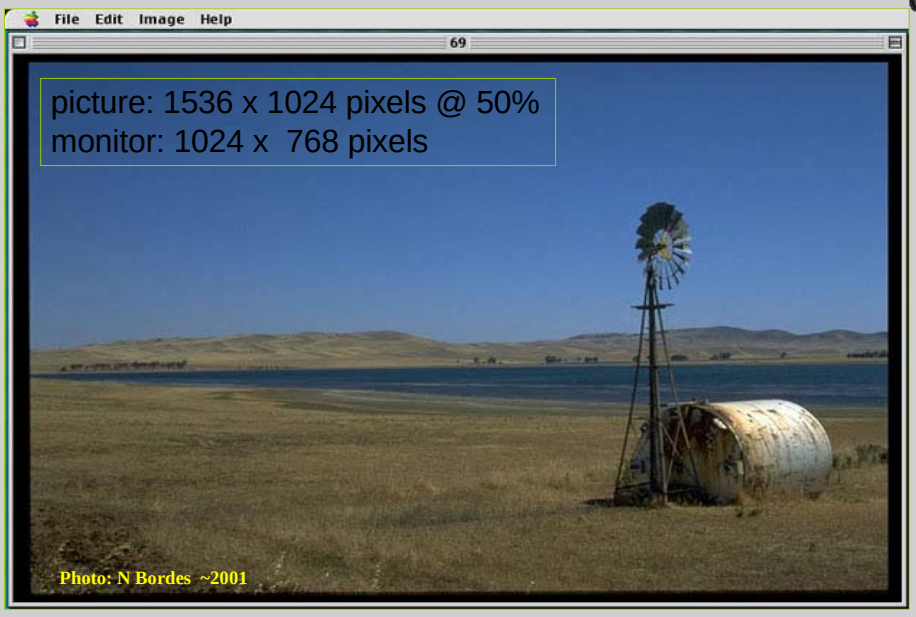
(~ 1 Mega-pixel) **x $10^{0.2}$**

… and then it took off

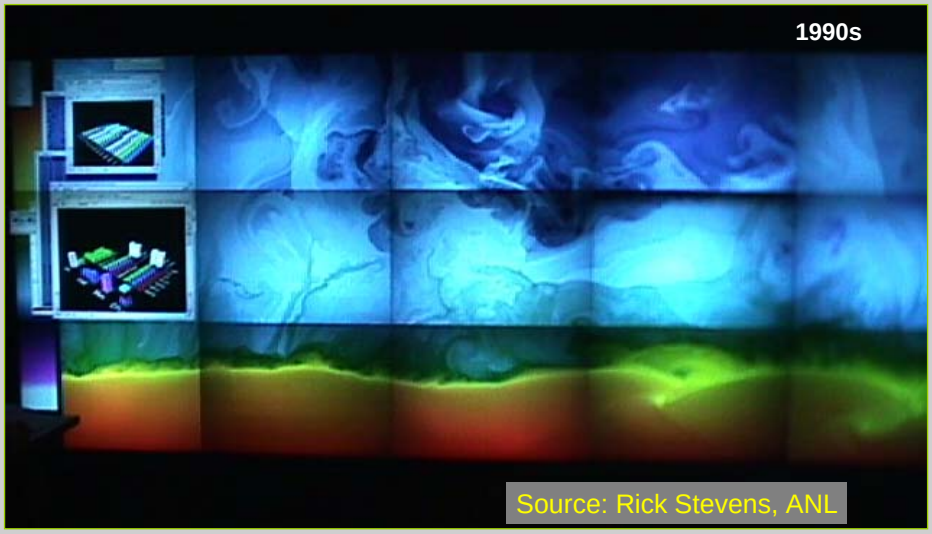
Kodak photo CD



… only see the whole picture at reduced resolution



PowerWalls: FuturesLab @ ANL



PowerWall @ Princeton

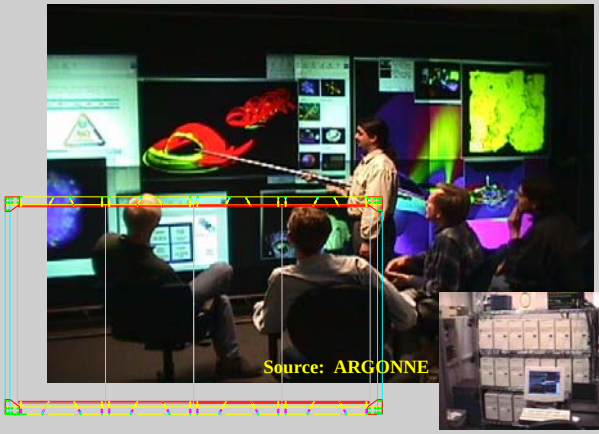
8 commodity projectors, flexible screen, NT-based cluster

*Active*Mural, a Tiled, projection display wall

Argonne, Princeton and UIUC Collaboration ~ NCSA

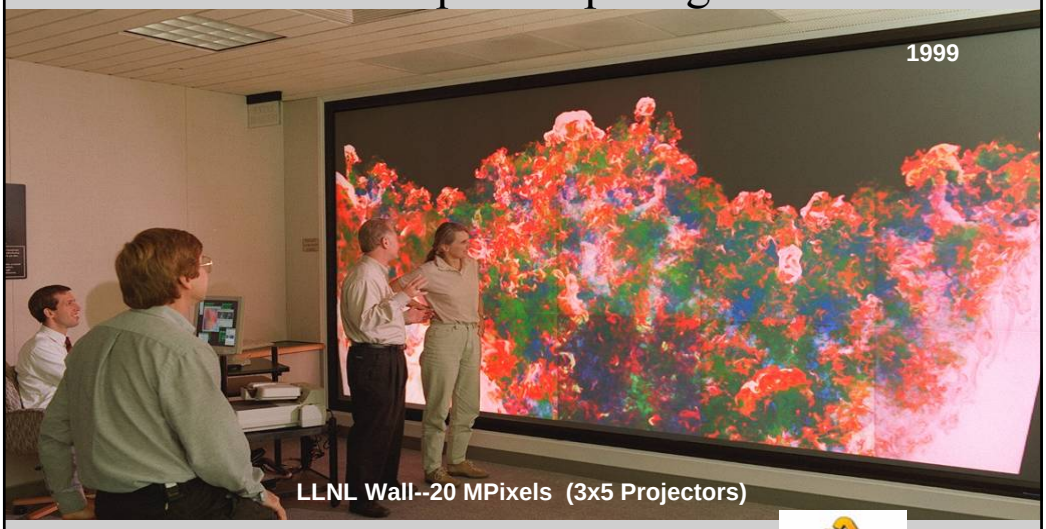
8' x 16' display wall (R. Stevens, et al, ANL)

- **Jenmar BlackScreen**
- **8 LCD → 15 DLP → 24 DLP projectors** * lots of tuning, alignment, balancing
- **8-20 MegaPixels**
- **SGI and Linux drivers**
- **VR and ActiveSpace UI**



B. Pailthorpe, QciF at QuestNet, July'08

DoE *ASCI* Brought Power Walls to the Frontier of Supercomputing



An Early sPPM Simulation Run. Source: LLNL

L. Smarr, at *TeraGrid* June'08

B. Pailthorpe, QciF at QuestNet, July'08

The UCSD & U. Sydney HiRes desktop display

Medical Imaging: liver CAT scan

OpenDX, WireGL/Chromium, user interfaces

B. Pailthorpe, QciF at QuestNet, July'08

CalIT2 New Laboratories for "Living in the Future"

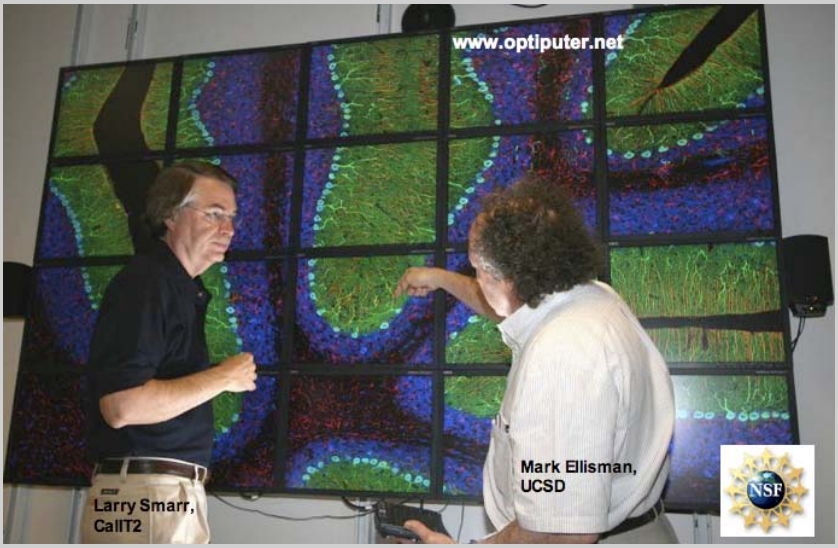
- "Convergence" Laboratory Facilities
  - Nanotech, BioMEMS, Chips, Radio, Photonics
  - VR, Digital Cinema, HDTV, Gaming
- Over 1000 Researchers in Two Buildings
  - Linked via Dedicated Optical Networks

www.calit2.net

"Preparing for a World in Which Distance is Eliminated…" Larry Smarr

B. Pailthorpe, QciF at QuestNet, July'08

OptiPortal displays



B. Pailthorpe, QciF at QuestNet, July'08

OptiPuter: NSF, 2003-08

Nearly One Half Billion Pixels in Calit2 Extreme Visualization Project!

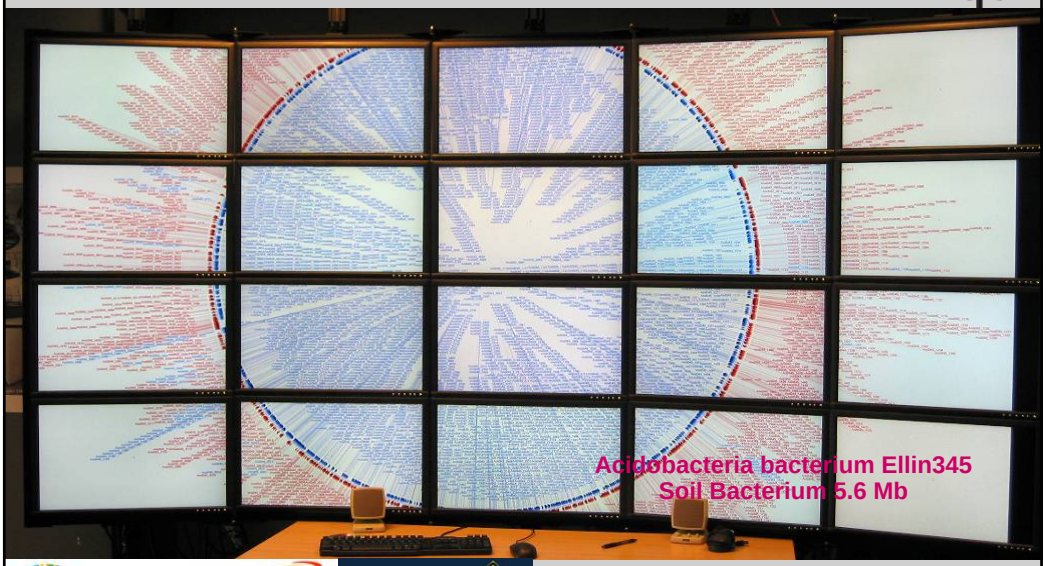
Connected at 2,000 Megabits/s!

Falko Kuester, UCSD; Steven Jenks, UCI

UCI HIPerWall Analyzing Pre- and Post- Katrina

B. Pailthorpe, QciF at QuestNet, July'08

OptIPortal: Interactively View Microbial Genome



Source: Raj Singh, L Smarr, UCSD

t QuestNet, July'08

… zoom in on the Microbial Genome

Source: Raj Singh, UCSD

t QuestNet, July'08

… zoom in on the Microbial Genome

camera OptIPuter Powered by Rocks ROCKS

Source: Raj Singh, UCSD

OptiPortal Display at UQ VisLab (50 Mpx)

Tiled 4 x 5 24" LCD display
7680 x 6000 pixels
Cluster, Cent-OS ROCKS
1 x PC, 2 x Nvidia : 4 LCD panels
+ head node / network node
SAGE, C-GLX ~ A$50k for 50 Mpx

Constructed by Chris Willing, Jonathon White, Imran Saed .. as a summer project (Dec'07)

+ OptiPortable
- joint with AARNet -
.. now at the QuestNet-08 show

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

www.vislab.uq.edu.au/research/optiputer/

Software environments

www.evl.uic.edu/cavern/**sage**

Scalable Adaptive Graphics Engine

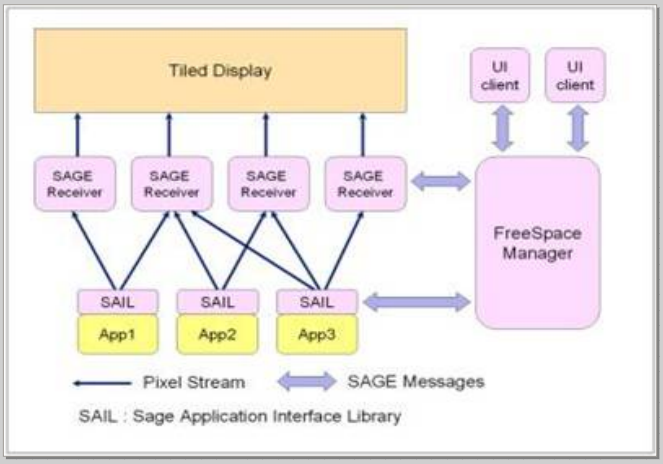
vis.ucsd.edu/~**cglx**/

Cross-Platform Cluster Graphics Library (v1.2.1)

www.rocksclusters.org

ROCKS: / CentOS - cluster management

SAGE System

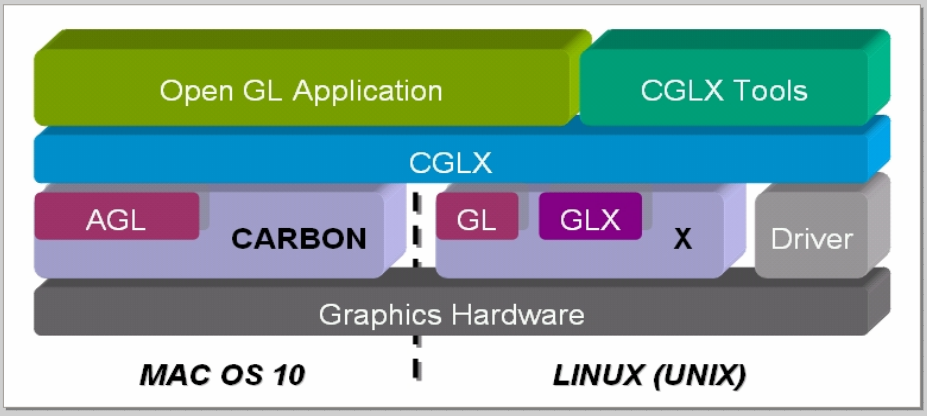


evl.uic.edu/cavern/sage

SAGE Example

EVL

CGLX Architecture



Distributed real-time rendering
Reimplements openGL and many Glut libraries
- convert any openGL app
Scalable resolution and performance

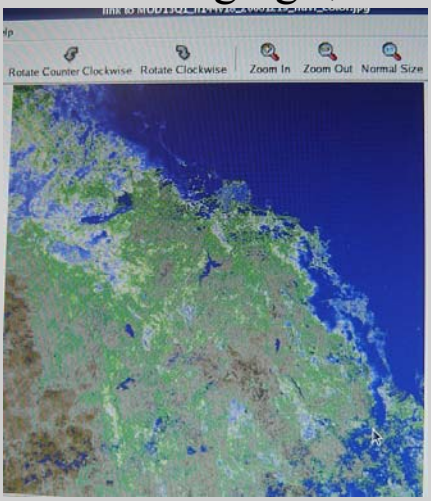
vis.ucsd & calit2

+ 3rd party apps in CGLX
- native on OprtlPortal

CGLX Example: brain circuits .. in CGLX

M. Ellisman, NICMR & calit2

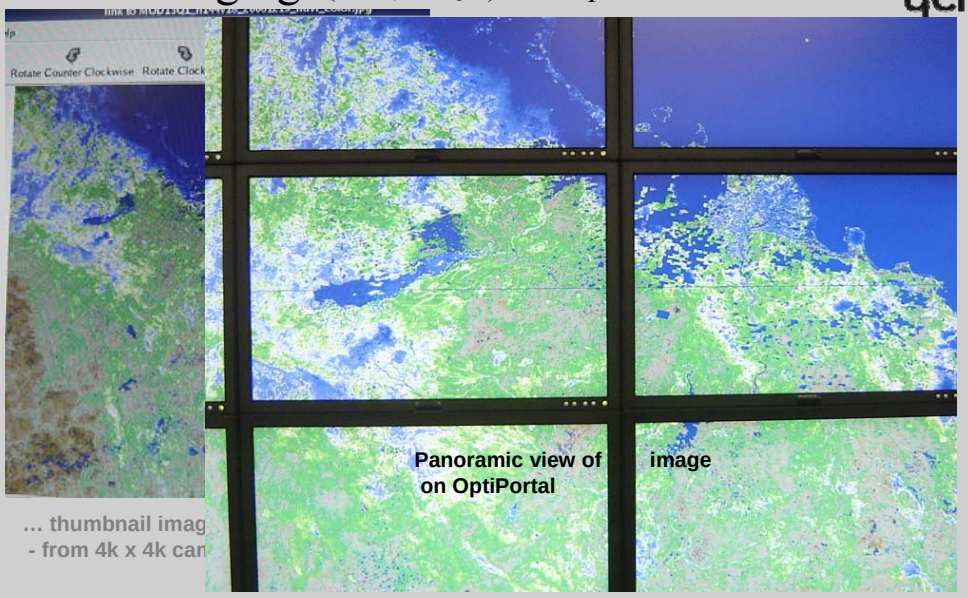
Satellite imaging (ndvi, N Qld) - on a regular monitor



T. Gill, B. Pailthorpe & S. Phinn, UQ
- study of land cover

We've become used to looking at thumbnail images - from 4k x 4k cameras (EM, ..)

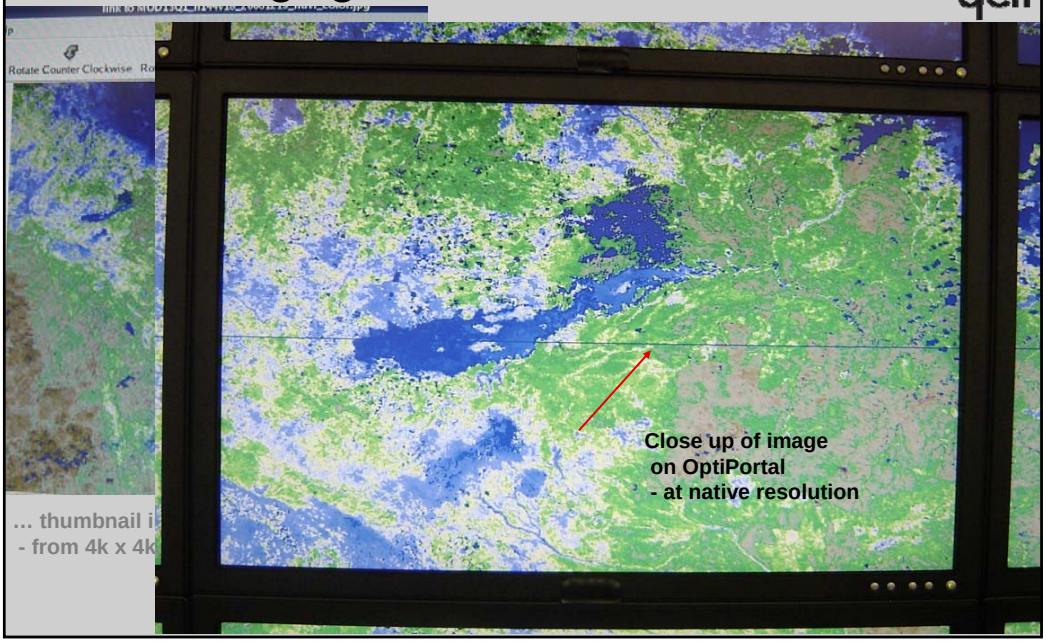
Satellite imaging (ndvi, N Qld) - on OptiPortal



... thumbnail imag
- from 4k x 4k can

B. Pailthorpe, QciF at QuestNet, July'08

Satellite imaging (ndvi, N Qld) - on OptiPortal



... thumbnail i
- from 4k x 4k

OptIPuterizing Australian Universities in 2008:
CENIC Coupling to AARNet

Phil Scanlan, Founder:
Australian American
Leadership Dialogue
www.aald.org

U. Melb. 100 MegaPixel OptiPortal launched Jan 15, 2008, using Compressed HD on 1 Gbps, over AARNet
www.calit2.net/newsroom/release.php?id=1219

UMelbourne/Calit2 Telepresence Session May 21, 2008

B. Pailthorpe, QciF at QuestNet, July'08

Network tuning

- **Synchronous, collaborative systems**
  - **Real-time performance**

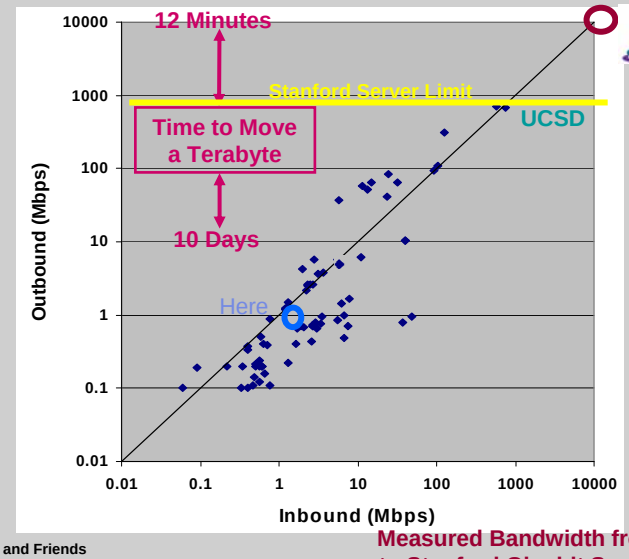
0.5%

B. Pailthorpe, QciF at QuestNet, July'08

Shared Internet Bandwidth: Unpredictable, Widely Varying, Jitter, Asymmetric

Computers In:

Australia
Canada
Czech Rep.
India
Japan
Korea
Mexico
Moorea
Netherlands
Poland
Taiwan
United States



OptIPuter

1000x Normal Internet!

Data Intensive Sciences Require Fast Predictable Bandwidth

Source: Larry Smarr and Friends

Measured Bandwidth from User Computer to Stanford Gigabit Server in Megabits/sec
http://netspeed.stanford.edu/

B. Pailthorpe, QciF at QuestNet, July'08

Measured Internet Bandwidth: Australian sites

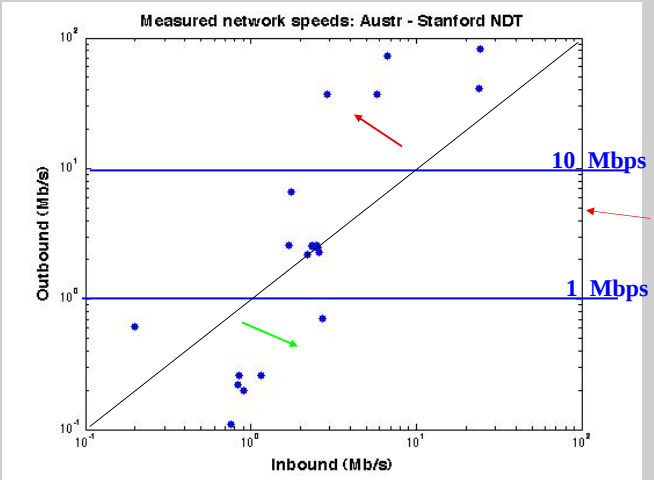
Computers at:

UQ
QUT
Monash
U Tas.
U Adel.
Curtin/CSIRO
- Perth

[all on 1 Gbps]

home:
- Melb. Syd, Brisb (ADSL, 3G...)

QuestNet
- Royal Pines



ITS techs

" 0.5 km/h "

Dept / Lab users

3G
= "broad"band ?
ADSL

Source: Larry, Bernard and Friends

Measured Bandwidth from User Computer to Stanford Gigabit NDT Server (Mbps)
//netspeed.stanford.edu/

B. Pailthorpe, QciF at QuestNet, July'08

APAC NF (ANU) - GridFTP transfers, major HPC sites

Mbps

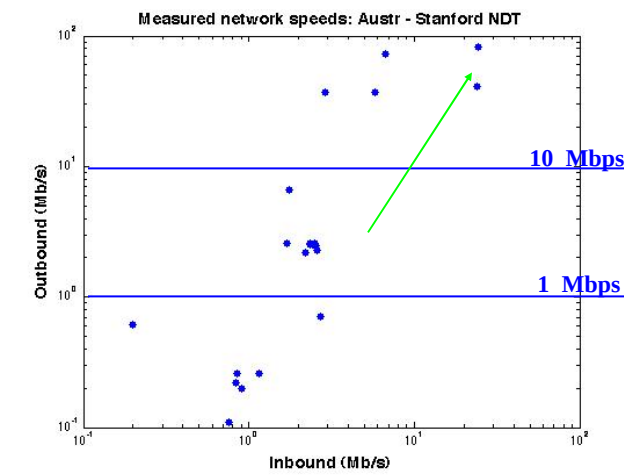
	receive / send	ac3	ANU			iVEC	Mor
		gridftp-barossa.ac3.edu.au	gridftp-ac.apac.edu.au	gridftp-dc.apac.edu.au	store.apac.edu.au	gridftp-cognac.ivec.org	gridftp.its.mo
ac3	gridftp-barossa.ac3.edu.au		9.5	10.0	10.1	9.5	n
ANU	gridftp-ac.apac.edu.au	9.5		28.9	22.1	3.3	12
	gridftp-dc.apac.edu.au	9.9	42.7		23.1	4.8	42
	store.apac.edu.au	9.8	36.6	19.6		16.3	43
iVEC	gridftp-cognac.ivec.org	5.8	2.5	21.6	19.0		14
Monash	gridftp.its.monash.edu.au	n/a	11.3	34.8	22.2	15.6	
QUT	ng2.qut.edu.au	3.0	2.6	3.1	3.0	1.2	n
SAPAC	ngdata.sapac.edu.au	1.7	3.4	16.9	16.3	2.1	13
UQ	gust.hpcu.uq.edu.au	3.1	3.0	2.8	2.6	1.1	2
	ngdata.hpcu.uq.edu.au	10.0	5.1	20.3	11.2	7.4	18
VPAC	gridftp-brecca.vpac.org	10.0	8.6	10.1	10.1	9.4	10
CSIRO	ngdata.hpsc.csiro.au	10.1	11.7	36.4	22.6	12.7	38

ARC DGAL project (Monash, ANU, UQ 2007)
5 -> 20-40 Mbps

http://info.apac.edu.au/data_transfer/stats/GridFTP/

.. with a little bit of tuning

.. and on to 500 Mbps



Tune buffer sizes:
sysctl
net.local.stream.recvspace
net.local.stream.sendspace:
8 kB default -> 64+

net.inet.tcp.sendspace
net.inet.tcp.recvspace:
32 kB default -> 8+ M

kern.ipc.maxsockbuf:
262 K -> 16+ M

etc.

.. and then lots of things would work better…

Summary

- **Users at the network endpoints**
  - **High performance displays**
  - **Share large data, images, HD streams, shared apps**
- **need to tune the networks for real-time performance**

-> good displays + good networks + good science
= global collaboratory

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