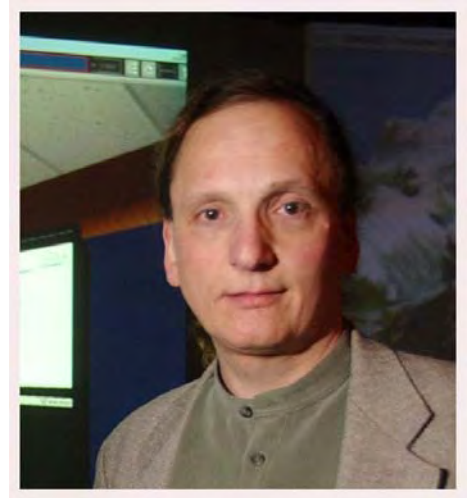




Dalhousie Distributed Research Institute and Virtual Environment

Advanced Collaboration and the Access Grid

Jonathan M. Borwein, FRSC
Research Chair in IT
Faculty of Computer Science
Dalhousie University Halifax
Nova Scotia Canada



URL: www.cs.dal.ca/ddrive





Advanced Collaboration and the AccessGrid

1. Introduction

2. CEIC—what it is and what it does

- Best Practice Statements
- The WDML
- The FWDM

3. The Access Grid, WestGrid and the Future

- What they are
- A slide show

4. Advanced Collaboration Environments

- What they are
- A slide show

**This presentation is largely pictorial
and starts with:**


Greetings from Canada

and



**Thanks to Alf van der Poorten for
agreeing to speechify for me**

**We first advertise 3 CEIC initiatives
briefly and then turn to the main
show.**



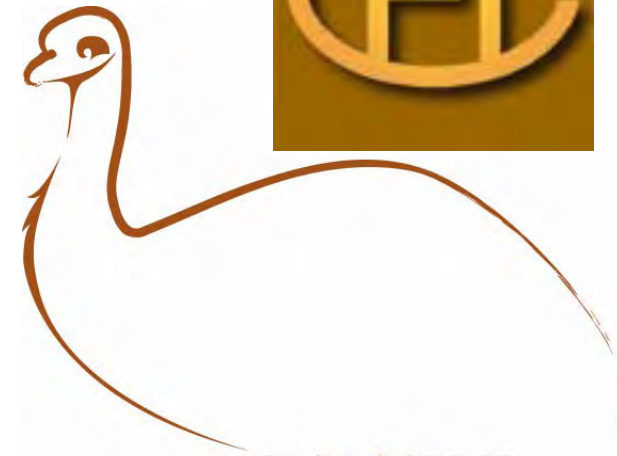
Mathematical Society xyz

Local Contact Homepage

| General | Publications |
|---|--|
| <ul style="list-style-type: none"> ▶ About the Society ▶ Office ▶ News ▶ History ▶ Awards ▶ Grants | <ul style="list-style-type: none"> ▶ Newsletters ▶ Journals ▶ Proceedings ▶ Bulletins ▶ Further Publications |
| Members | Activities |
| <ul style="list-style-type: none"> ▶ Membership ▶ Dues ▶ Reciprocal Societies ▶ Register of Members ▶ Honorary Members | <ul style="list-style-type: none"> ▶ Meetings ▶ Joint Initiatives ▶ Recommendations / Reports ▶ Mathematics Competitions ▶ Discussion Forums |
| Organization | Further Information |
| <ul style="list-style-type: none"> ▶ Board ▶ Committees / Deputies ▶ Interest Groups ▶ Statutes | <ul style="list-style-type: none"> ▶ Mathematical Societies ▶ Mathematical Departments ▶ Mathematics and School ▶ University Studies ▶ Professional Perspectives ▶ Job Offers ▶ Further Links |

Standard Math-Net Page

© Mathematical Society xyz; last update: 2003-06-03



IMU

We mention the **CEIC**'s work on
 Best Practice Statements
 MathNet Pages
 and
 IMU on the Web



IMU on the Web

► [IMU](#)

► [Contact](#)

Communications and Information from the CEIC

Prior postings: #1, #2

Also known as **imu on the web**, these columns will appear in each IMU-Net newsletter and will be accompanied by additional commentary and links. Some will be invited signed opinions and some will come from the CEIC itself. They intend to stimulate interest in and debate about electronic matters. Our first piece, written by the CEIC, is on the vexing problem of Journal pricing.

[IMU ON THE WEB #1: WHAT CAN YOU DO ABOUT JOURNAL PRICES?](#)

The IMU Committee on Electronic Information and Communication

► [Home](#)

► [General](#)

► [People](#)

► [News](#)

► [Publications](#)

► [IMU on the Web](#)

► [Activities](#)

► [Further Info](#)

About the
Math-Net Page

WDML

world digital mathematics library

International Mathematical Union | Committee on Electronic Information Communication | Math-Net

[Home](#)

[About WDML](#)

[Digital Math Library](#)

[Digitization Projects](#)

[Registry](#)

[Publications](#)

[Contact Us](#)

WDML News

Update on Metadata Standards

In order to create links from the two major reviewing databases to digitized articles, Mathematical Reviews and Zentralblatt have recommended some standards that would allow projects to transfer information simply. An explanation of these standards and their purpose can be found in a new release of the standards called **Simple Metadata**.

Upcoming Event

New Developments in Electronic Publishing of Mathematics, a workshop integrating mathematicians, libraries, editors and publishers will be held in conjunction with the 5th EMANI workshop and the 3rd WDML workshop on June 25 to 27, 2004 in Stockholm, Sweden.

Communications and Information from the CEIC



Dalhousie Distributed Research Institute and Virtual Environment

CECM | SFU CoLab | WestGrid | Faculty of Computer Science | DCRI | Experimental Mathematics | DocServer | IRMACS

[D-Drive Home](#) > [FWDM](#)

[Home](#)

[News](#)

[Seminars](#)

[Research Team](#)

[Technologies](#)

[Partners](#)

[FWDM](#)

[Contact Us](#)

Federated World Directory of Mathematicians

Federated searching is a system that provides a common user interface for searching and retrieving information across heterogeneous datasets over the Internet.

Preamble

In 1998 the CEIC was asked to explore the feasibility of an electronic World Directory of Mathematicians to replace the traditional hard copy. The CEIC concluded that intellectual property and privacy issues in different countries made this, while desirable, impossible for the 2002 edition of the WDM. With the emergence of better Internet search tools, we now believe it is realistic to build a federated directory, as defined above. What this provides is a rapid and simple search over existing online databases with no additional work for the user.

Current Directory

- [Electronic World Directory of Mathematicians](#)

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Grid Computing



WestGrid

WestGrid Resources

(MOUSE OVER LOCATIONS TO SEE RESOURCES)



C3.ca

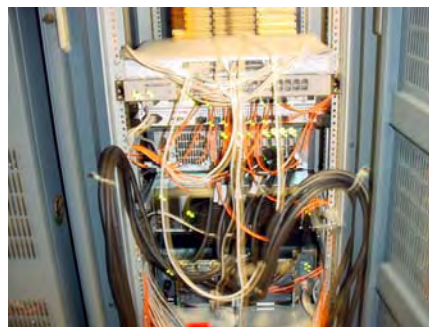


www.westgrid.ca



ENIAC (1948)

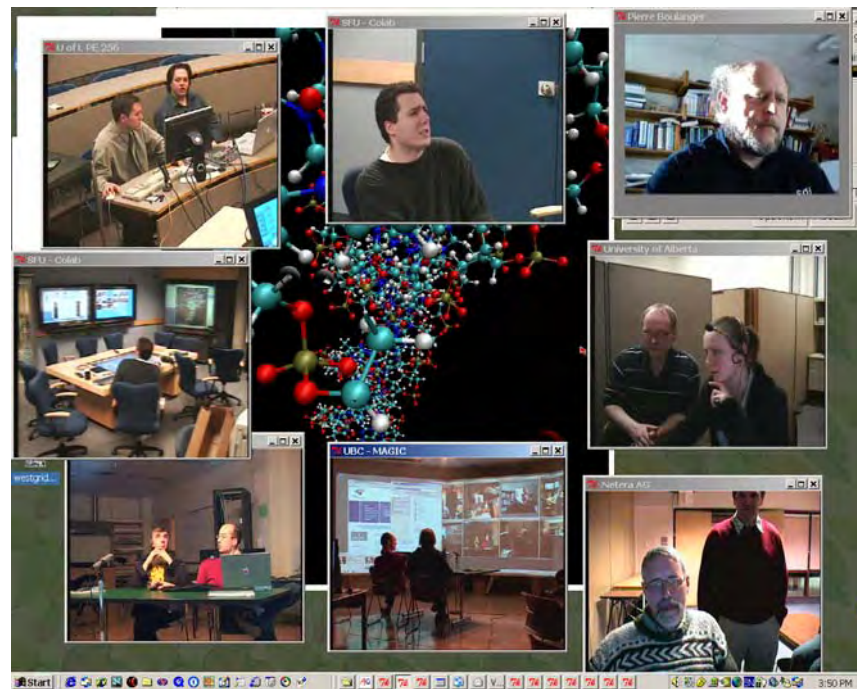
32 SGI cpu's



SFU fast interconnect

The Access Grid

SFU 'Top500' cluster

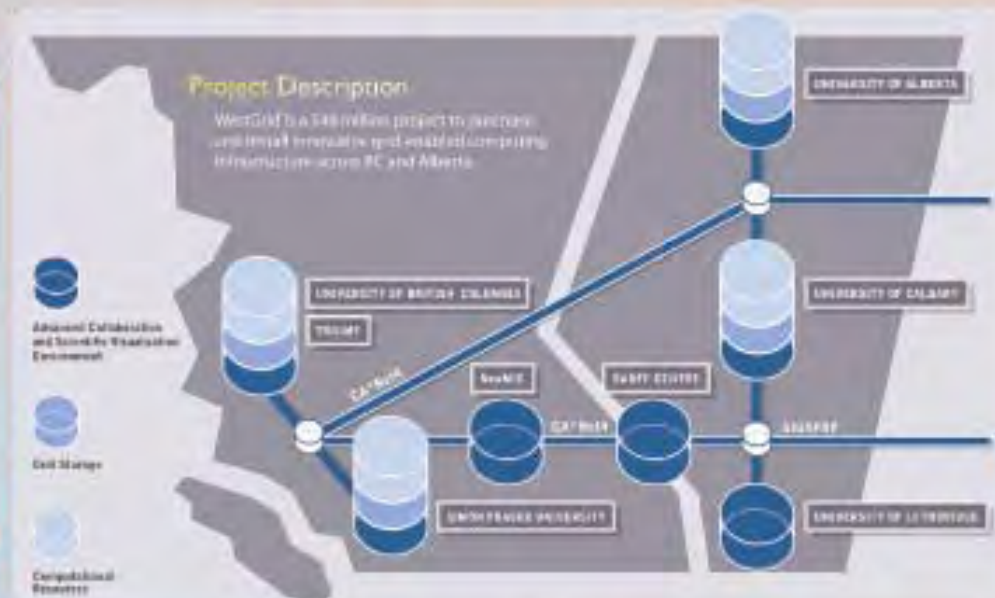


What is WestGrid?

PROJECT SUMMARY

WestGrid is a \$48 million project to acquire and install grid-enabled computational, data storage and collaboration facilities at 8 institutions, including:

- New MIC
- Simon Fraser University
- The Banff Centre
- TRIUMF
- University of Alberta
- University of British Columbia
- University of Calgary
- University of Lethbridge



Five co-principal investigators lead the project (Jonathan Borwein, Grenfell Patey, Jonathan Schaeffer, Brian Unger, Michel Vetterli) with the involvement of over 250 researchers and users, a chief technology officer, distributed systems architect, technical support staff at partner institutions, Netera Alliance, BCNET and CANARIE.



Components

1. UofA: Large shared memory computer:

SGI Origin 256 processor system for shared-memory parallel computing, plus a 5 Terabyte disk storage system and 10 Terabytes of tape storage.

2. UofC: Cluster of Multi-Processors (CluMP):

HP SC45 144 processors for message passing parallel computing, plus a 5 Terabyte disk storage system. “Genematcher2” genome sequence analyzer.

3. UBC/TRIUMF: Large commodity Linux farm:

1008 processor IBM blade cluster for naturally parallel computing jobs, plus a 10 Terabyte disk and 70 Terabyte tape storage facility.

4. SFU: Network storage:

A scalable network storage facility consisting initially of 24 Terabytes of disk and 135 Terabytes of tape silo capacity.

5. Collaboration and Visualization facilities:

Video conferencing and document sharing capabilities, built on the Access Grid technology, enhanced with visualization, virtual reality and other enhanced collaborative facilities.

6. Grid services:

Grid computing tools will form an integral part of WestGrid.



Funding

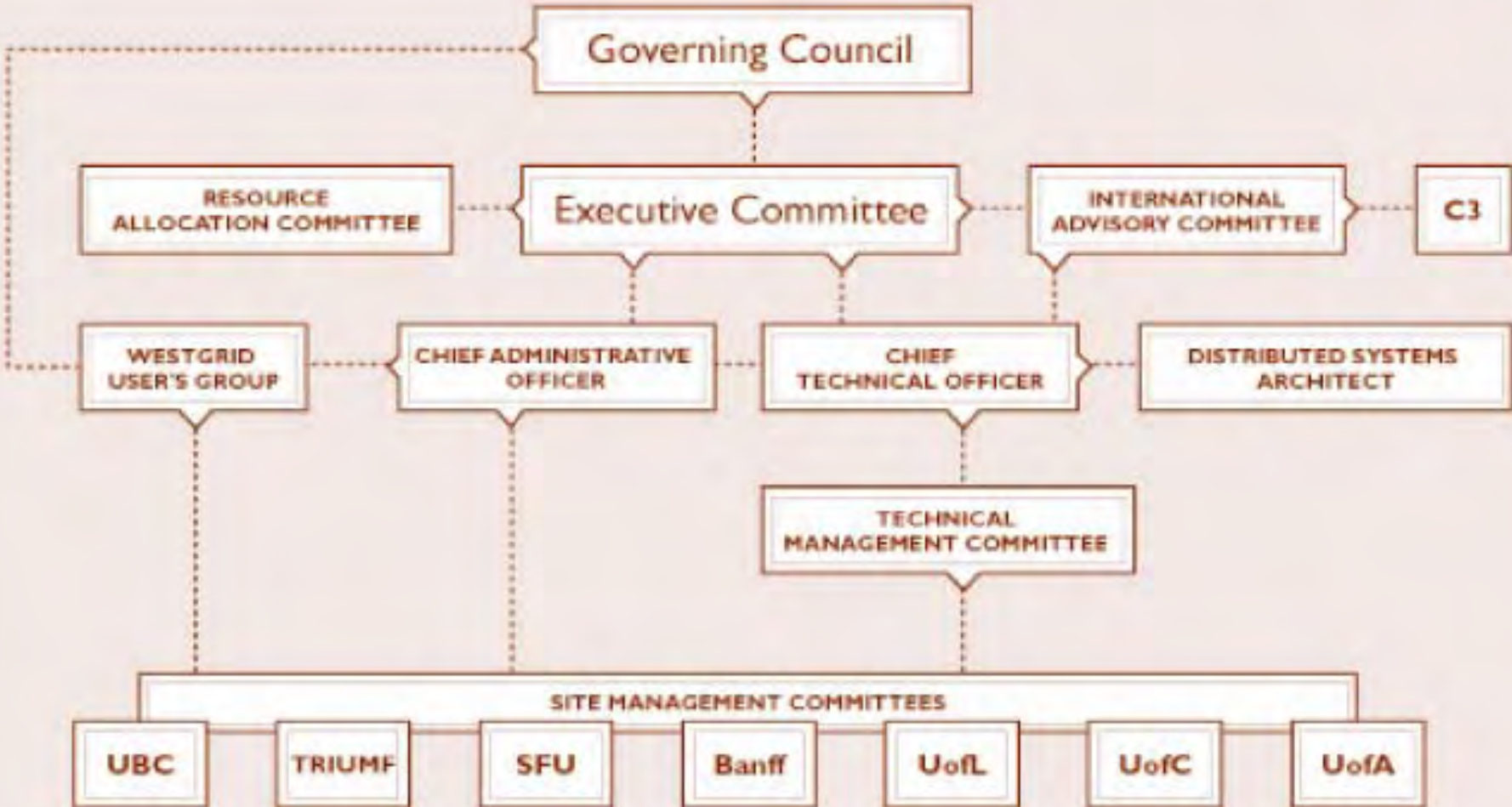
Funding and other support has been provided by:

- Alberta Innovation and Science
- BC Knowledge Development Fund
- Canada Foundation for Innovation
 - Hewlett Packard
 - IBM
 - SGI

- BCNET
- CANARIE
- Netera Alliance

- NewMIC
- Simon Fraser University
 - The Banff Centre
 - TRIUMF
- University of Alberta
- University of British Columbia
 - University of Calgary
 - University of Lethbridge

WestGrid Governance and Management



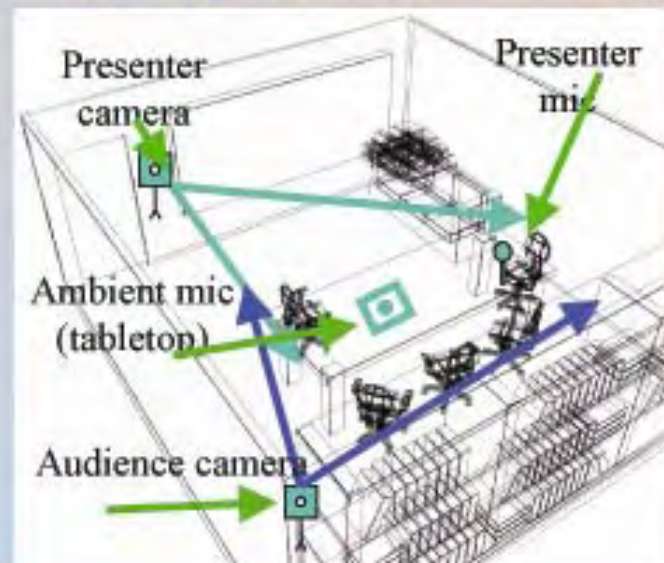
WestGrid Capital Budget: 2003-2005

Revenues

| | |
|------------------------------|-------------------|
| CFI (Federal) | 11,990,839 |
| ASRIP (Alberta Gov't) | 5,795,420 |
| BCKDF (BC Gov't) | 5,711,591 |
| HP (in-kind) | 7,167,218 |
| IBM (in-kind) | 5,524,174 |
| SGI (in-kind) | 7,224,457 |
| Other private sector | 1,030,517 |
| Institutions | 384,453 |
| TOTAL: | 44,828,669 |

Access Grid Collaboration

- 180 AG nodes worldwide
- State-of-the-art SGI visualization server (SFU)
- WestGrid will add scientific visualization and virtual reality
- SFU GridRoom in Collaboratory
- 2nd Gridroom coming



Annual User Requirements

- **Annually** - users are expected to complete a CFI “Impact Report” via an on-line web form.
- **Ongoing** - users are expected to acknowledge WestGrid in publications facilitated by use of WestGrid resources.
- **Publications** - when updating project descriptions, users are requested to provide references for the above publications that acknowledge the support of WestGrid resources.



Initial Network

- HPC/storage sites connected by layer-2, gigabit-per-second network
 - Network appears as a local subnet at SFU, UBC, UofC and UofA
- Uses components provided by BCNet, CANARIE, Netera and the local sites
- Lethbridge and Banff connected via NeteraNet

Initial HPC Resources

- 1008 processor IBM (Xeon) blade cluster
- 256 processor SGI Origin 3900
- 144 processor HP AlphaServer-SC45
- 28000 processor Parasol Genematcher-II

Also access to:

- 160 processor HP Alpha Cluster
- 192 processor AMD Athlon Cluster
- 236 processors in SGI Origin servers



Initial storage resources

- Central storage site (IBM)
 - 24TB of disk, 135TB of tape
 - Will be expanded as needed
- Local storage
 - Total of over 30TB disk, 30TB tape distributed between 4 campuses

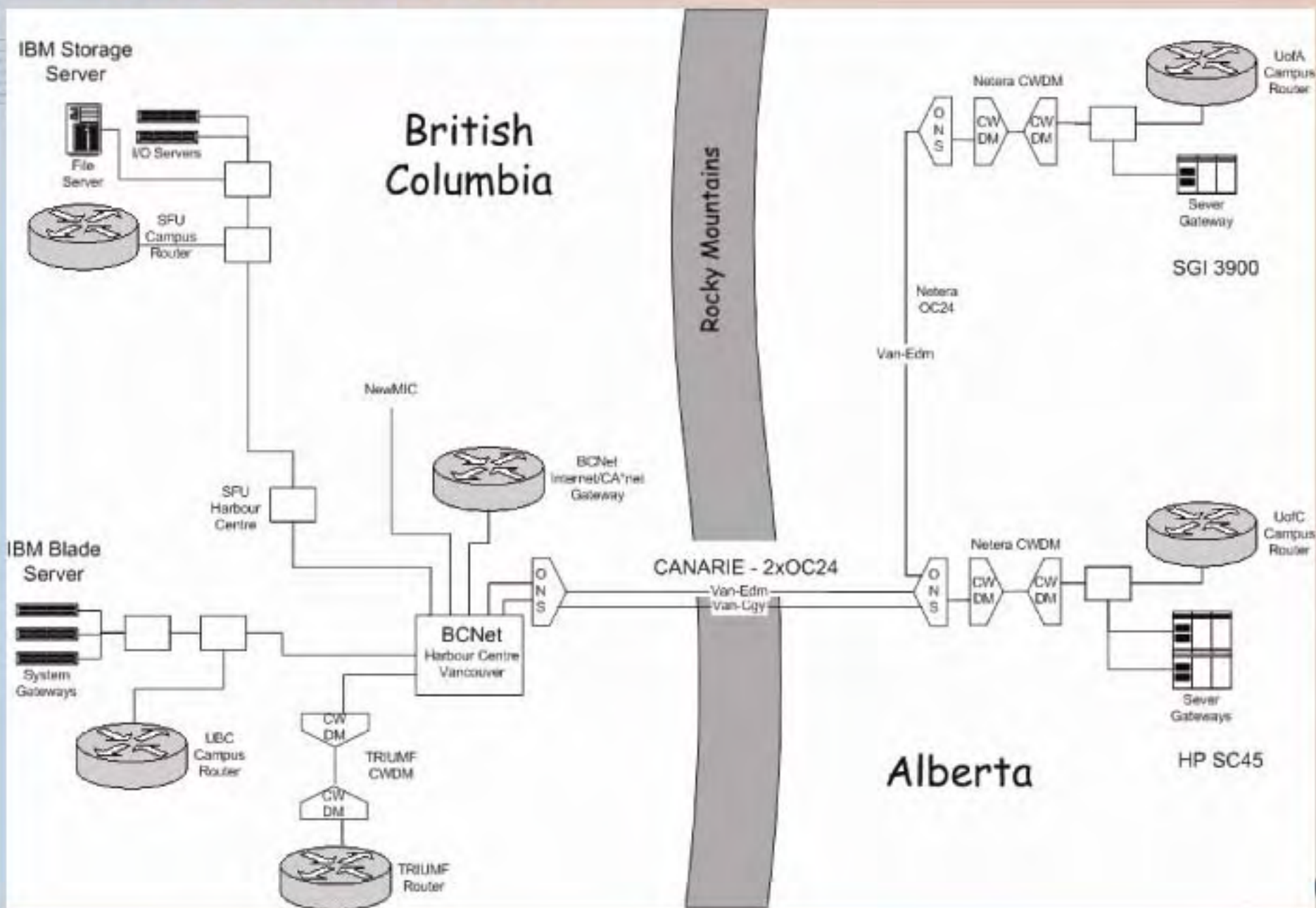


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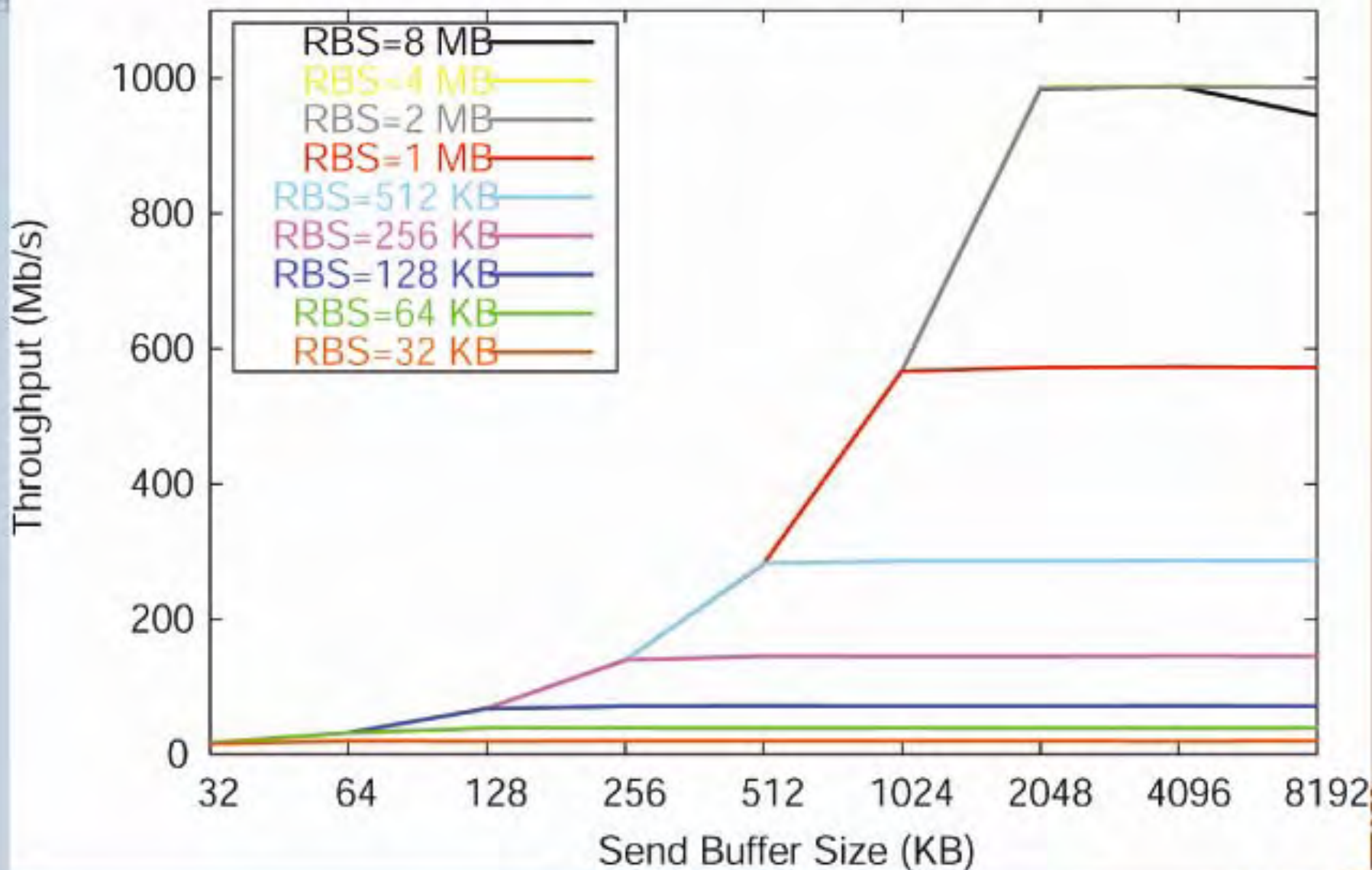


WestGrid-Core network



Network performance – UofC to SFU

UofC (HP SC45) to SFU (IBM p650)



Grid Computing

- Grid services provide interoperability between resources in different management domains
- Global user namespace using Certificate Authority (CA) model
 - each CA is unique (signing key is unique)
 - each CA issues unique DNs to users
- Grid user is mapped to local user on “Grid enabled” resource
- Grid use is all about trust - and developing technologies to ensure trusting environments
- Many Grid tools are still rudimentary. Much more research still remains to be done.



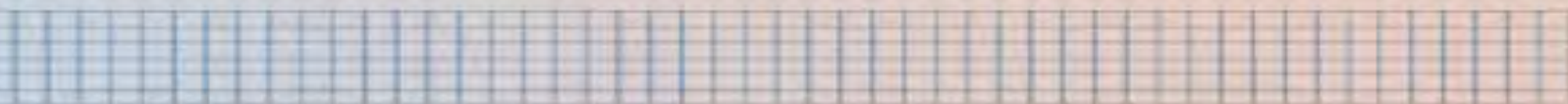
WestGrid “Grid philosophy”

- Promote use of Grid technologies to users/projects that can benefit from them
- Encourage use of “robust” Grid tools in place of traditional alternatives
- Don’t impose the use of Grid technologies on users that don’t need them, or that already have good solutions that are not Grid enabled

WestGrid needs world class scientific discovery; we don’t want to get in the way of this



Grid Components



Basic services:

- Security/authentication service
- Remote job starting service
- Information discovery service
- Data movement service

High level systems/services:

- Meta-scheduling
- Repository management tools

AG and Advanced Collaborative Environments

- The Access Grid (AG) is a “**voice, image etc over IP**” collaboration technology which offers a uniquely cost effective and high-quality experience for users and participants of collaborations---**each site being different.**
- It is described on the Argonne access grid website as “**an ensemble of resources including multimedia large-format displays, presentation and interactive environments, and interfaces to Grid middleware and to visualization environments.**”

- AG technology is used at over 180 sites worldwide for activities such as very large distributed meetings, lectures, seminars, and other interactive collaborative tasks.
- **WestGrid** is utilizing the Access Grid as an enabling technology to provide collaborative resources to **all 7 (soon 12) WestGrid sites**.
- Leveraging AG's capabilities and integrating visualization tools and other services, AG is a base for scientific visualization and for research into new collaborative technologies.

SGI Delivers the Most Powerful Collaborative Visualization Available with Visual Area Networking

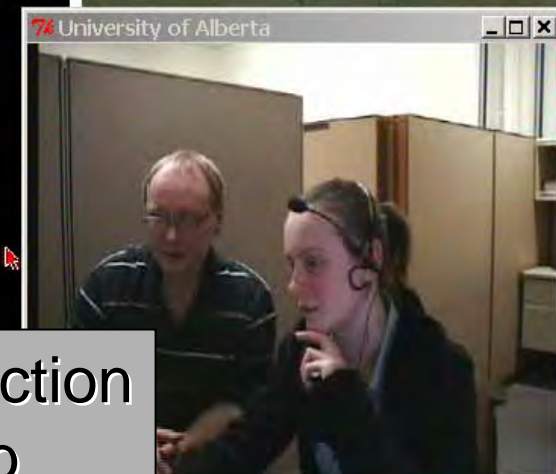
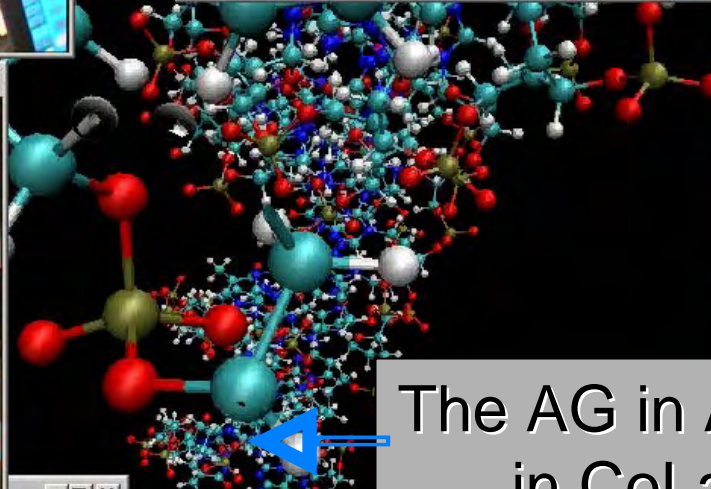
Raising the bar again, SGI has increased the performance and interactivity available to remote users and multi-user collaborative teams, enabling them to visually analyze complex data sets and reach decisions faster than ever before.

The combination of OpenGL Vizserver 3.3 with Onyx4 and the new Scalable Graphics Capture card can now deliver full screen visual results to remote clients at up to 30 frames per second, with some scientific visualization and engineering analysis applications able to achieve as high as 60 frames per second for full screen results.

SGI Delivers the Most Powerful Collaborative Visualization Available with Visual Area Networking

Illustrating the benefits of OpenGL Vizserver 3.3 with Onyx4, is **WestGrid**, a \$48 million grid computing infrastructure project that provides high performance computing, networking, and collaboration tools to seven institutions in western Canada. WestGrid is dramatically advancing the visualization capability delivered to the researcher's desktop using an 8-pipe Silicon Graphics Onyx4 as a VAN server at Simon Fraser University, in Vancouver, B.C.

"We are excited by the level of visualization capability this allows us to deliver to the desktop of our computational community," explains Brian Corrie, collaboration and visualization coordinator for WestGrid. "We are able to deliver very data-intensive interactive, collaborative visualizations between researchers in Vancouver, Edmonton, Calgary, Lethbridge, and Banff—a distance of more than 800 km." (May 20, Press Release)



The AG in Action
in CoLab



Netera in Calgary



Lethbridge Alberta







University
of Calgary

Simon Fraser Colab







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One of six or so such "smart" **i-rooms** or **ACE's**; with focus on

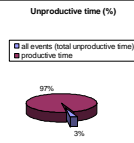
- mathematical science and computational science
- science education and advanced publishing

Built to facilitate **and study** face-face and distant collaboration

- heterogeneous, synchronous and asynchronous

Cost of about 750K but a **Grid Station** or **Grid Room**

- with commodity components can be built for 5K, 50K etc.



- Four 50" plasma screens and one 72" back projected screen
- two conventional smart white boards
 - one plasma in table, one "portable" – can be tiled variously
 - all touch sensitive (soon optically)
 - can be written on and captured

- Connects to a 192 cpu Beowulf and 32 cpu COMPAQ alpha
- "top 500" machine in June 2002 (for \$250K)
 - run directly out of **Maple** or **Matlab**

- All sorts of (research) **HCI** issues – some anticipated
- prototype for **IRMACS** and for **WestGrid**



ERDER AIS 3141592653589

SFU CoLab



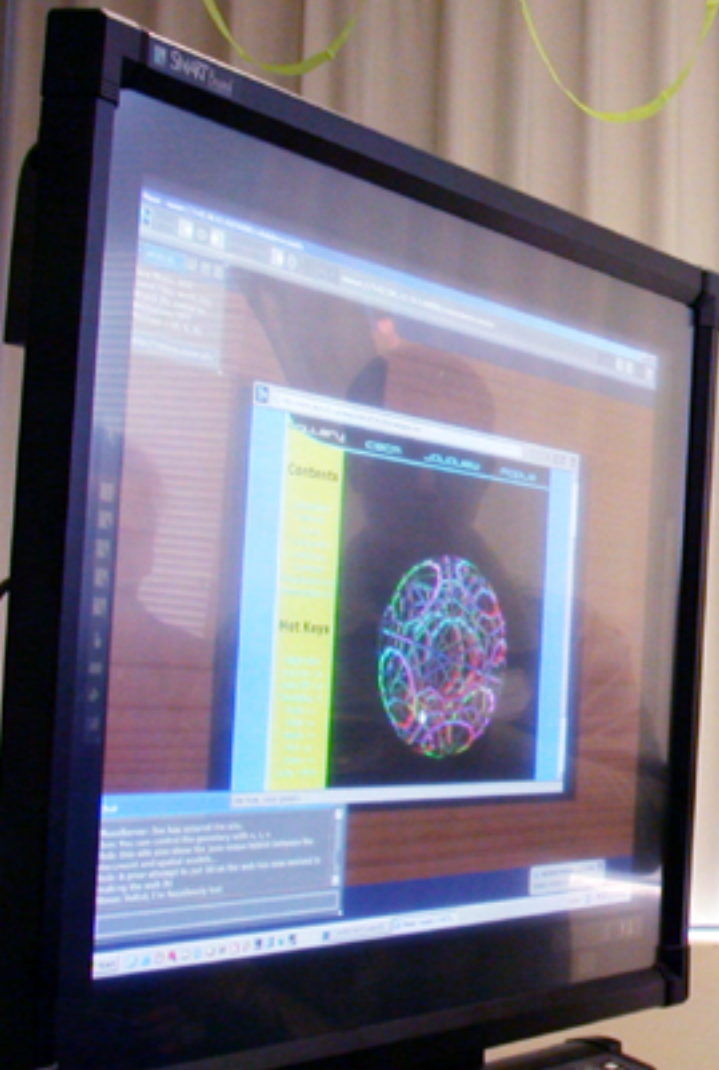
A Grade 4 math class

SFU CoLab



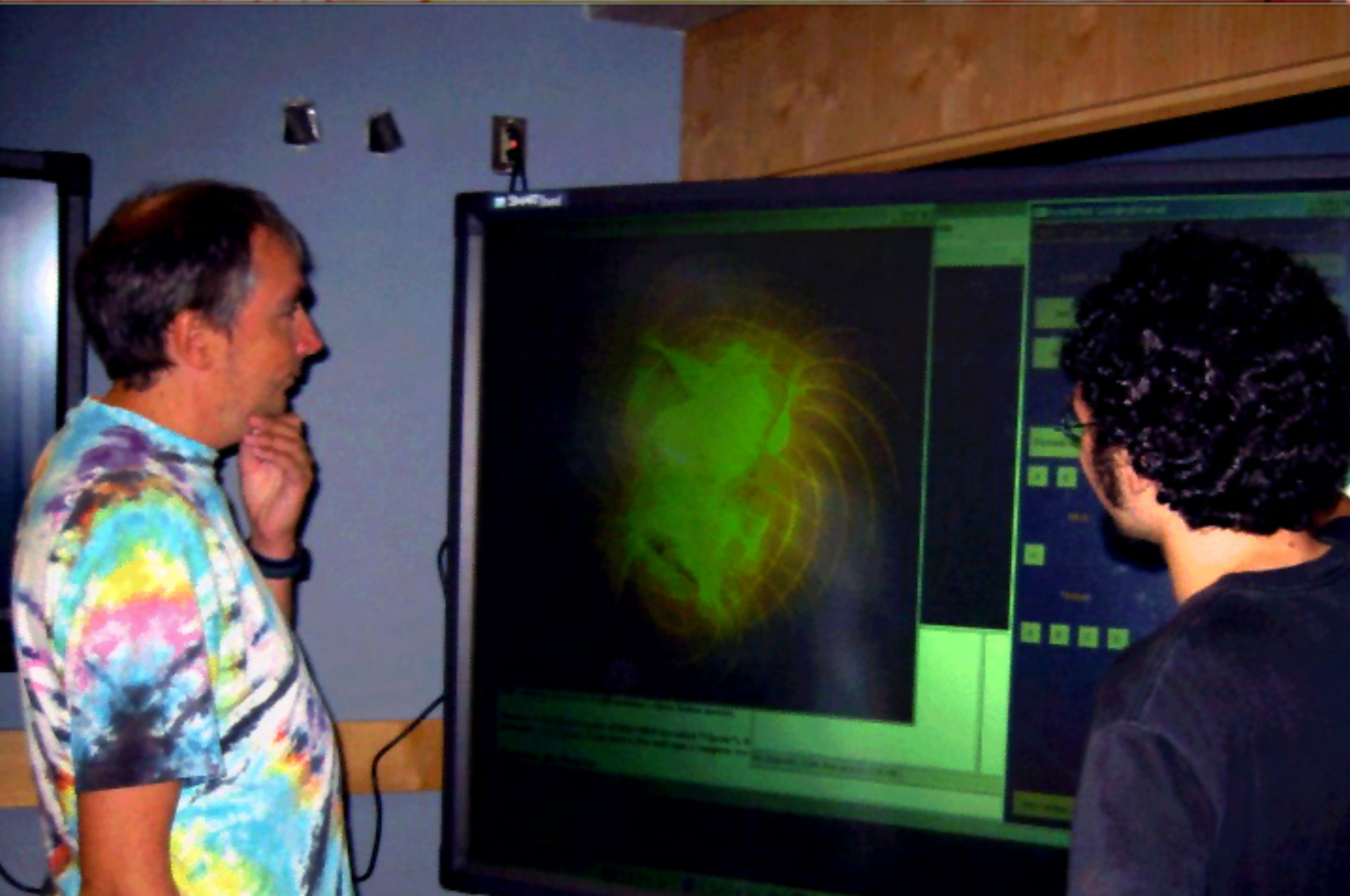
ORDER AT 3141592653589

SFU CoLab



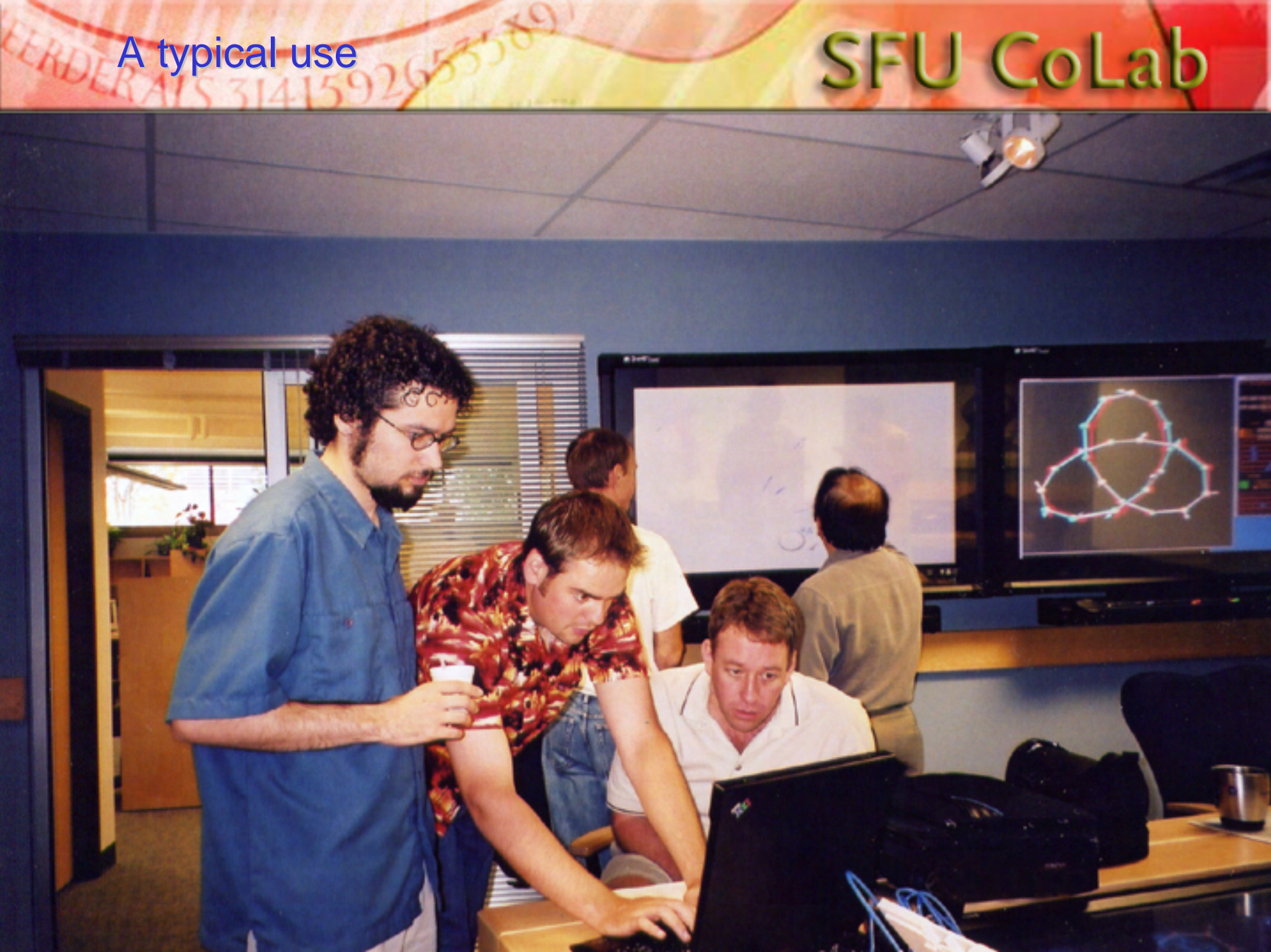
Examining a climate model

SFU CoLab



A typical use

SFU CoLab





◀ Steve Wolfram in a new kind of lab

SFU CoLab

CoLab_Tour.mov

00:01:03

⏪ ⏩ ⏸ ⏴ ⏵

📺

🍏

The video player displays a scene from a meeting room. Five people are gathered around a large, light-colored conference table. In the background, there are several large monitors displaying data and charts. The room is dimly lit, with overhead lights providing illumination. The video player interface includes a progress bar at 00:01:03, a volume control, and standard playback controls (play/pause, stop, previous, next) and a TV icon.



← JMB

Users of CoLab

All levels and many disciplines (can squeeze in 30 users)

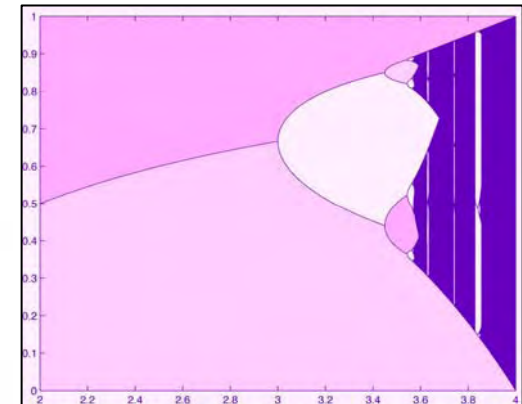
- Grade four through "infinity"
- Naïve and sophisticated
- Peer-to-peer and one-many

Many uses

- Research "proofs and refutations"
 - proof reading, brainstorming
 - grant writing, business meetings
- Teaching
- Outreach

Many partners

- Vendors, private sector, government, academic





← The Life of Pi

Users of CoLab



π Day

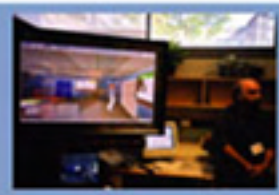
Open House



Friday · 14 March 2003 · Simon Fraser University · CoLab · www.colab.sfu.ca/PiDay/ · 604.291.5615

Lectures by World Experts

The Life of Pi – Jonathan Borwein
Knots in Action – Rob Scharein



Reception for All

All kinds of Pies
Donuts and Pretzels
T-shirts

Demos for Budding Scientists and their Teachers

Come check out a new state-of-the-art research lab for collaborations at SFU.

CoLab Technologies: Smart Boards and Access Grids
Mathematical Software · Virtual CoLab · Mathematical Learning Objects · Hands-on Sessions



ERDER AIS 3141592653589

Users of CoLab



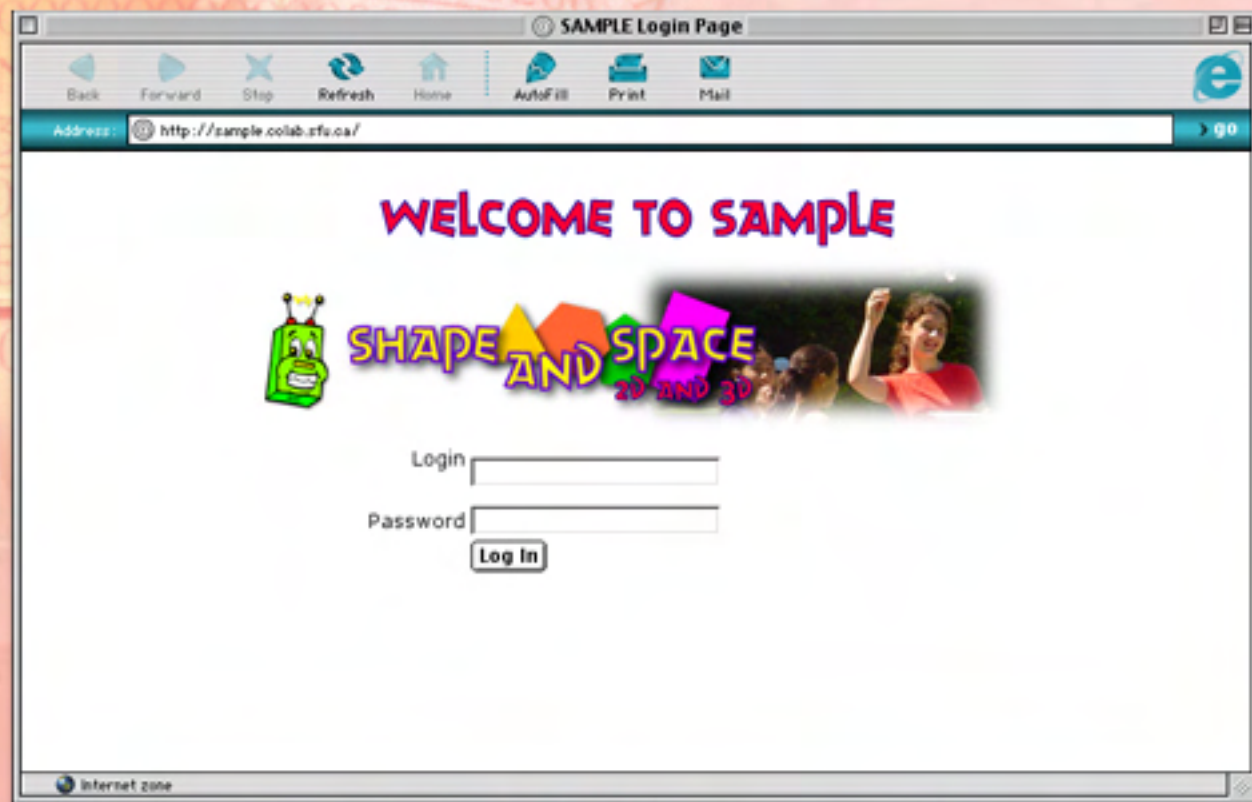


ESSEO - CASSMC
Math Camp Mathcamp
2001
National
University of the Pacific June 21-28
Regional Highways

| | |
|---------------------------|------------|
| University of the Pacific | Month 29 |
| University of the Pacific | May 21-23 |
| University of the Pacific | May 23-25 |
| University of the Pacific | May 25-27 |
| University of the Pacific | May 27-29 |
| University of the Pacific | June 21-23 |
| University of the Pacific | June 23-25 |
| University of the Pacific | June 25-27 |
| University of the Pacific | June 27-29 |
| University of the Pacific | July 1-3 |
| University of the Pacific | July 3-5 |
| University of the Pacific | July 5-7 |
| University of the Pacific | July 7-9 |
| University of the Pacific | July 9-11 |
| University of the Pacific | July 11-13 |
| University of the Pacific | July 13-15 |
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University of the Pacific - Office of the Student Government Services
University of the Pacific - Office of the Student Organizations Services
University of the Pacific - Office of the Student Clubs Services
University of the Pacific - Office of the Student Groups Services
University of the Pacific - Office of the Student Societies Services
University of the Pacific - Office of the Student Fraternities Services
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University of the Pacific - Office of the Student Societies Services
University of the Pacific - Office of the Student Fraternities Services
University of the Pacific - Office of the Student Sororities Services

SAMPLE Education Project



The screenshot shows a web browser window titled "SAMPLE Login Page". The address bar contains the URL "http://sample.colab.sfu.ca/". The page content includes the text "WELCOME TO SAMPLE" in red, a logo for "SHAPE AND SPACE 2D AND 3D" featuring a green character and colorful geometric shapes, and a login form with fields for "Login" and "Password", and a "Log In" button. The browser's status bar at the bottom indicates "Internet zone".

SAMPLE Login Page

Address: <http://sample.colab.sfu.ca/>

WELCOME TO SAMPLE

SHAPE AND SPACE
2D AND 3D

Login

Password

Internet zone

sample.colab.sfu.ca

- Funded by Canada's Initiative on New Economy: (Sample) Advanced Mathematically Productive Learning Environment
- built from ground up – content for a digital age
 - based on Learning Object Repository principles
 - paper and scissors, spaghetti, chat-rooms and applets
 - "Contemporary look and feel"

Software & hardware exploration – cognitive styles

- e.g., MathPads



Partnered by CECM spin-off MathResources

- is building commercial counterpart (3 year project with "regional development money")



Three Sample lessons

SAMPLE

Unit 1 - Shape and Space


Back Forward Stop Refresh Home Autofill Print Mail

Address: <http://sample.eolab.sfu.ca/teacher/>

Live Home Page Apple Apple Support Apple Store Tools Mac OS X Microsoft MacTopic Office for Macintosh FISH


Choose Your Lesson

| Basic | Enrichment | Extra |
|----------|------------|----------|
| D-Series | E-Series | F-Series |
| D1 | E1 | F1 |
| D2 | E2 | |
| D3 | E3 | |



Lesson E3

Approximation of the Circumference of a Circle



- Play
- Learn
- Talk Through
- Self Check
- Parents' Notes
- Teachers' Den
- Share Ideas
- Help

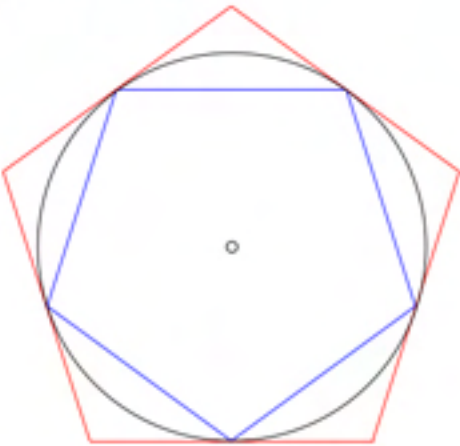
PLAY

[Explore](#) | [Challenge](#)

Number of sides:

Diameter: 4.04
Number of sides: 5

Perimeter of red = $5 \times 2.94 = 14.69$
Perimeter of blue = $5 \times 2.38 = 11.89$



EXPLORE

2. What can you say about the perimeter of the circle - called the circumference? Will this always be true?

[Go Back](#) | [Answer](#) | [Next](#)

ANSWER

2. The circumference must be somewhere in between the perimeters of the inscribed and circumscribed polygons. This will always be true.

Internet zone

Unit 1 - Shape and Space


Back Forward Stop Refresh Home Autofill Print Mail

Address: <http://sample.colab.sfo.ca/teacher/>

Live Home Page Apple Apple Support! Apple Store iTools Mac OS X Microsoft MacTopic Office for Macintosh HGN


Choose Your Lesson

| Basic | Enrichment | Extra |
|----------|------------|----------|
| D-Series | E-Series | F-Series |
| D1 | E1 | F1 |
| D2 | E2 | |
| D3 | E3 | |



Lesson D5

Precise Description of Shapes



Play Learn

- Talk Through
- Self Check
- Parents' Notes
- Teachers' Den
- Share Ideas
- Help

Number of sides:

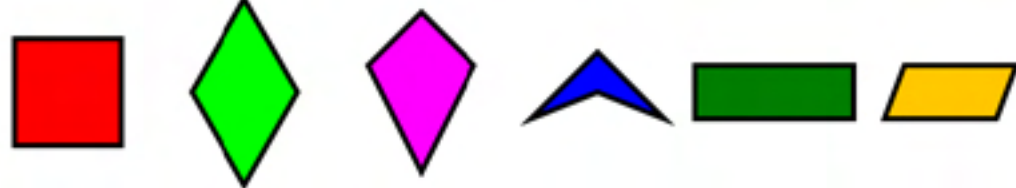
Parallel sides:

Right angles:

Length of sides:

Interior angles:

Polygon type:



EXPLORE

4. On grid paper, draw two of the polyhedra that you made in the Play Window

[Go Back](#) | [Answer](#)

ANSWER

4. We can draw these polyhedra by following the steps below.

For prisms:

1. Draw a base.
2. Draw the other base.
3. Connect the vertices.
4. Dot the hidden edges, or

Unit 1 - Shape and Space


Back Forward Stop Refresh Home AutoFill Print Mail

Address: <http://sample.colab.sfu.ca/teacher/>


Live Home Page Apple Apple Support! Apple Store iTools Mac OS X Microsoft MacTopic Office for Macintosh MSN

Choose Your Lesson

| Basic | Enrichment | Extra |
|----------|------------|----------|
| D-Series | E-Series | F-Series |
| D1 | E1 | F1 |
| D2 | E2 | |
| D3 | E3 | |



Lesson E6




Play
Learn
Talk Through
Self Check
Parents' Notes
Teachers' Notes

PLAY

[Explore](#)

cube - cross pattern

pause



click and drag to rotate the object

EXPLORE

1. The polyhedra you've been looking at in the Play window are called regular polyhedra (also known as the Platonic Solids). Why do you think that is?

[Answer](#) | [Next](#)

ANSWER

1. They are called regular polyhedra because all of their faces are congruent regular polygons. For example, the faces of the octahedron are congruent equilateral triangles.

Internet zone

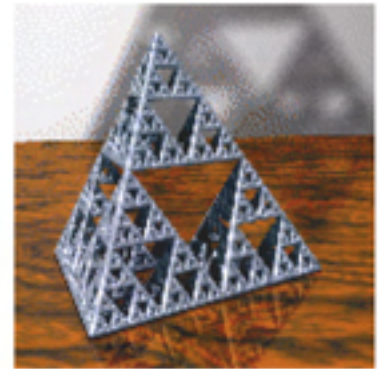
Virtual CoLab





Built on **Muse**, an avatar-based “chat room” software

- Provides “plug and play” design
- Affords good architectural metaphors
- Yields 3D navigation with live interfaces
- Client needs only free plugin on a PC



“The most prominent requisite to a lecturer, though perhaps not really the most important, is a good delivery; for though to all true philosophers science and nature will have charms innumerable in every dress, yet I am sorry to say that the generality of mankind cannot accompany us one short hour unless the path is strewn with flowers.”

— **Michael Faraday**

Virtual CoLab



Portable CoLab





← colab.msite

Virtual CoLab

Muse - muse://142.58.12.161:6888/colab.msite

muse://142.58.12.161:6888/colab.msite

vCoLab

Axis Mode: Z
Geom File: archi_3ds
Attach Pt: camera
Animation: OFF
Position : [0, 0, 0]
<http://www.cecm.sfu>

Chat

MuseServer: You have entered 'Virtual CoLab © SFU'
MuseServer: There is 1 other visitor at this site.
MuseServer: Jen has entered the site.
digs: Hi Jen, nice to see you here!
Jen: Hey Steve, How is the Vcolab Development going?
digs: Its really coming along now!! hey try this....

digs

EXIT

7

menu

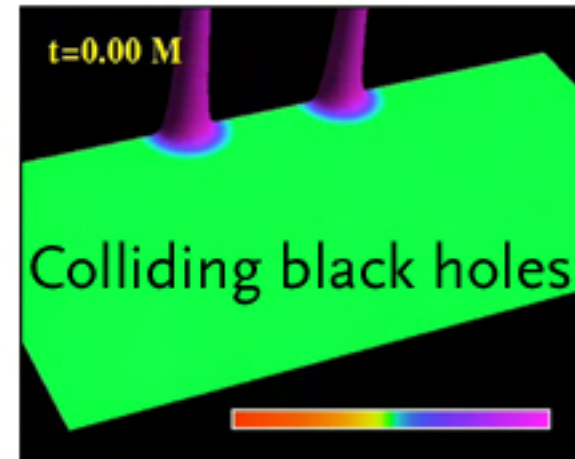
Visualization





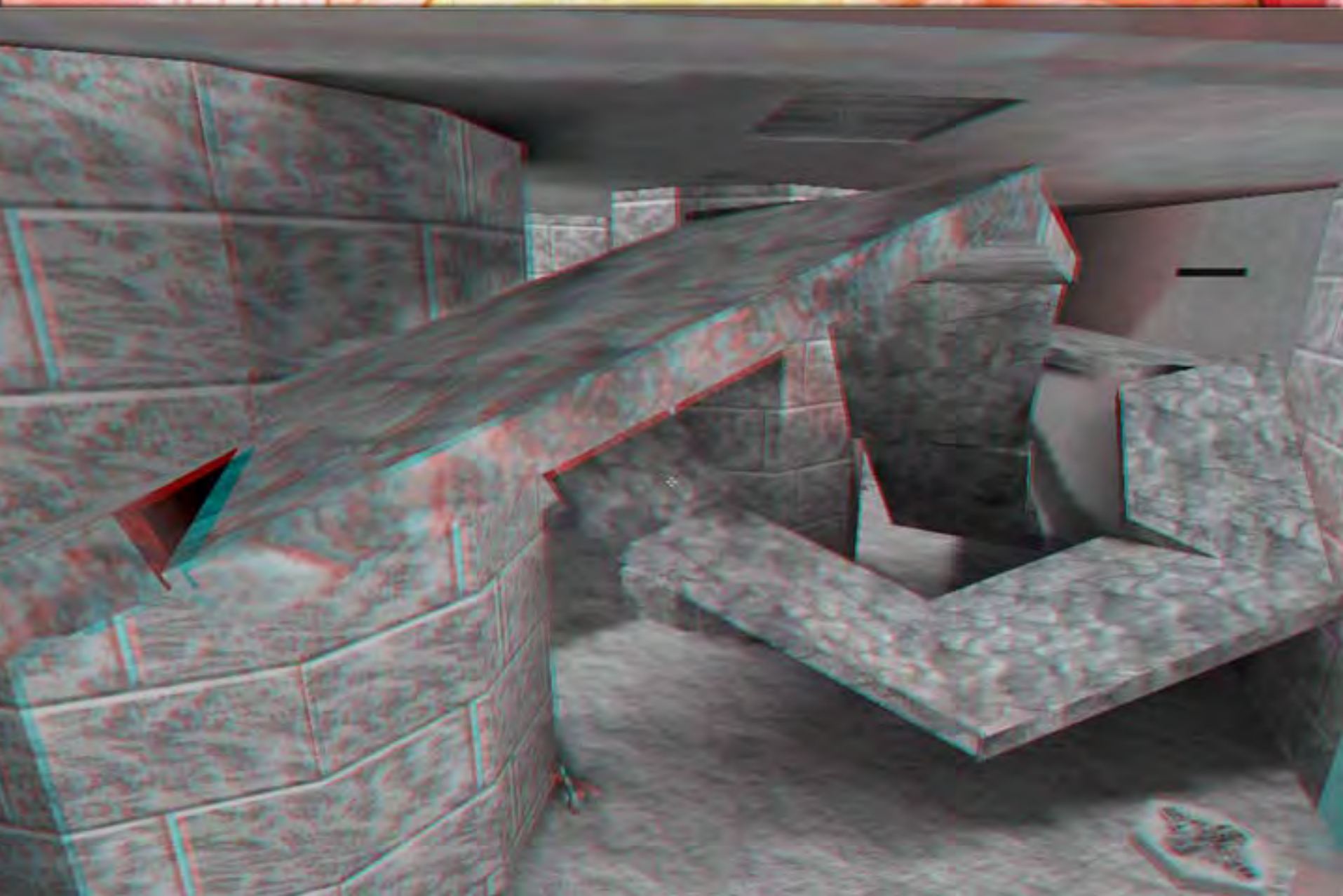
Obvious issues include cost and when to use

- 3D or 2D?
- Passive or active?
- Local or distant delivery?
- Precomputed or real-time?
- “Shock and awe” or shared?
- **Sound quality** is often more of an issue for collaboration.
- Have used Rob Scharein’s **KnotPlot** and Konrad Polthier’s **JavaView** as prototypes for mathematical visualization tools.



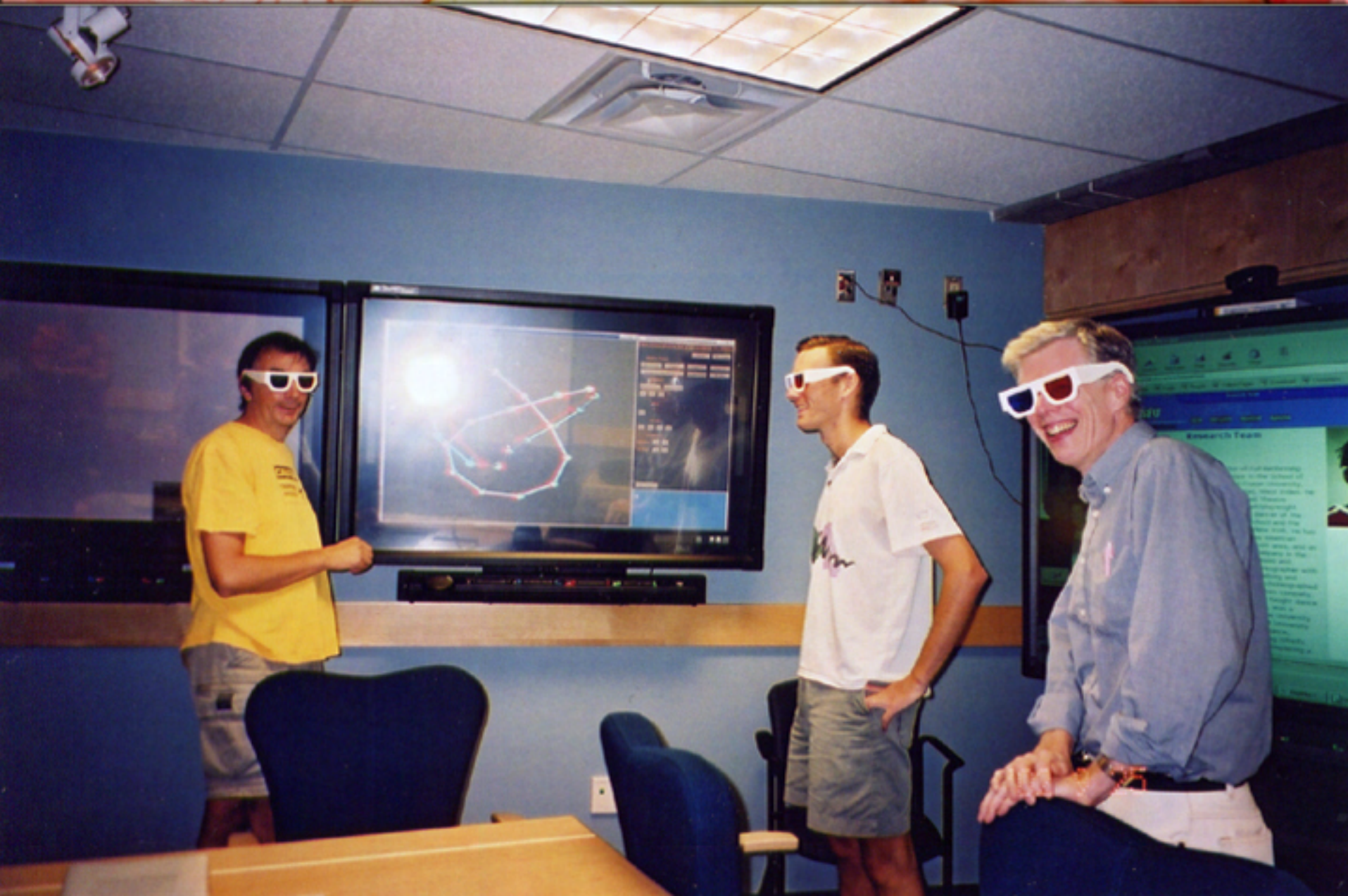
Rob's anaglyph
world

Visualization



Passive to Active

Visualization



The cave opened out

Visualization



Passive to Active

Visualization



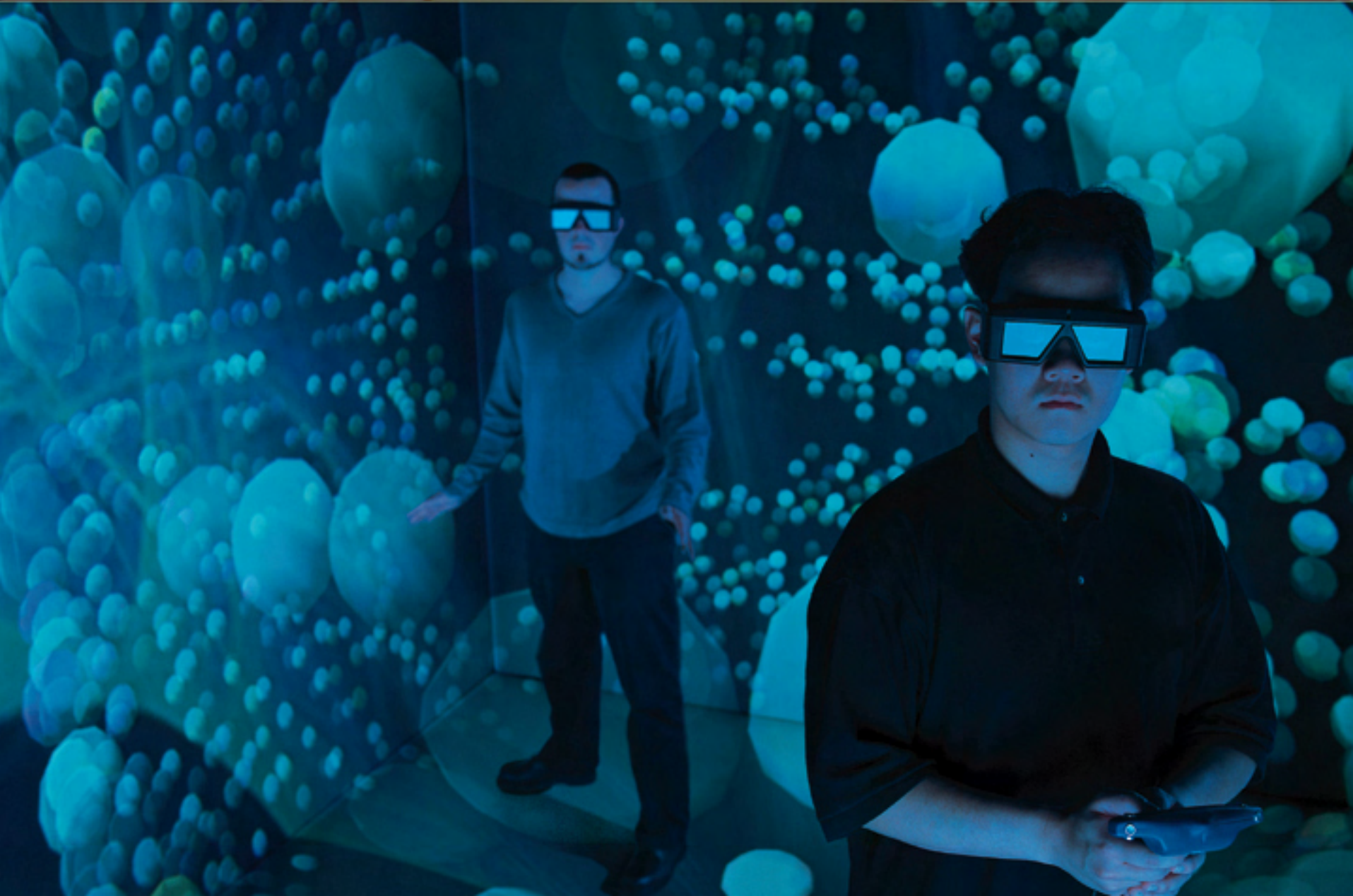
Heart Muscle

Visualization



Polyhedra

Visualization





c0004.AVI

00:00:11

c0005.AVI

00:00:12



c0006.AVI

00:00:18

caveKnotPlotMovieB.avi

00:00:46





KnotPlot freeware

Visualization



LEIBERATS 3141592688389

Visualization



Visuelle Mathematik: Aesthetische Forschung, sinnlich wie Kino aus Hollywood

Glänzende Ideen, brillant ins Bild gesetzt

Mathematik kann brillant sein. Die Computergrafik stellt das in Form von Bildern, die Beweise klarer machen können.

Mathematik ist nicht nur eine Wissenschaft, sondern auch eine Kunst. Die Computergrafik stellt das in Form von Bildern, die Beweise klarer machen können. Ein Beispiel dafür ist die Visualisierung von Fraktalen, die in der Natur und in der Kunst vorkommen. Ein weiteres Beispiel ist die Visualisierung von Graphen, die in der Informatik und in der Physik vorkommen.



Das Bild zeigt ein Fraktal, das aus vielen kleinen Dreiecken besteht. Es ist ein Beispiel für die Visualisierung von Fraktalen, die in der Natur und in der Kunst vorkommen.

65 seltsame Stellen

Das Diagramm zeigt die Verteilung von 65 seltsamen Stellen. Die x-Achse zeigt die Anzahl der Stellen, die y-Achse die Häufigkeit. Die Kurve zeigt eine deutliche Abnahme der Häufigkeit mit zunehmender Anzahl von Stellen.



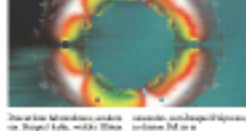
Viele kleine Einheiten. Ein Diagramm, das die Verteilung von 65 seltsamen Stellen zeigt.

Gibt es diese Figur?

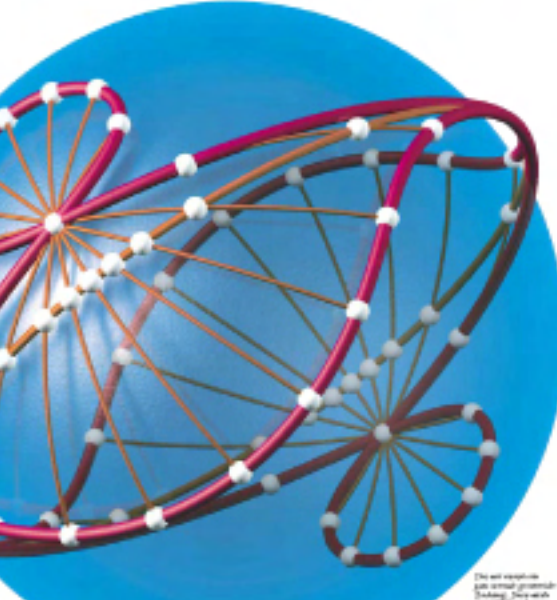
Die Frage lautet: Gibt es diese Figur? Die Abbildung zeigt eine komplexe geometrische Figur, die aus vielen kleinen Dreiecken besteht. Die Frage ist, ob es eine solche Figur gibt, die alle Bedingungen erfüllt.

Nullstellen eines Polynoms

Die Abbildung zeigt die Nullstellen eines Polynoms. Die x-Achse zeigt die reelle Achse, die y-Achse die imaginäre Achse. Die Nullstellen sind als Punkte in der Ebene dargestellt.



Die Abbildung zeigt die Nullstellen eines Polynoms. Die x-Achse zeigt die reelle Achse, die y-Achse die imaginäre Achse. Die Nullstellen sind als Punkte in der Ebene dargestellt.



Glitzerndes Erbomolekül

Das Bild zeigt ein glitzerndes Erbomolekül. Die Abbildung zeigt die Struktur des Moleküls, das aus vielen Atomen besteht. Die Atome sind als Punkte dargestellt, die durch Linien verbunden sind.



Das Bild zeigt ein glitzerndes Erbomolekül. Die Abbildung zeigt die Struktur des Moleküls, das aus vielen Atomen besteht.

Chaos mit Struktur

Das Bild zeigt Chaos mit Struktur. Die Abbildung zeigt eine komplexe, chaotische Struktur, die jedoch eine gewisse Ordnung aufweist. Die Struktur ist als ein Netzwerk von Linien dargestellt.



Das Bild zeigt Chaos mit Struktur. Die Abbildung zeigt eine komplexe, chaotische Struktur, die jedoch eine gewisse Ordnung aufweist.

Ein Punkt geht wandern

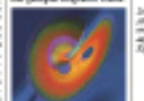
Das Bild zeigt einen Punkt, der wandert. Die Abbildung zeigt die Bewegung des Punktes über die Zeit. Die Bewegung ist als eine Linie dargestellt, die sich über die Zeit erstreckt.



Das Bild zeigt einen Punkt, der wandert. Die Abbildung zeigt die Bewegung des Punktes über die Zeit.

Schocks machen Wirbel

Das Bild zeigt Schocks, die Wirbel machen. Die Abbildung zeigt die Entstehung von Wirbeln aus Schocks. Die Wirbel sind als Kreise dargestellt, die sich um einen zentralen Punkt drehen.



Das Bild zeigt Schocks, die Wirbel machen. Die Abbildung zeigt die Entstehung von Wirbeln aus Schocks.

Wie man eine Kugel unkrepelt

Das Bild zeigt, wie man eine Kugel unkrepelt. Die Abbildung zeigt die Struktur einer Kugel, die aus vielen kleinen Kugeln besteht. Die Kugeln sind als Punkte dargestellt, die durch Linien verbunden sind.

Molekulares Ballett

Das Bild zeigt ein molekulares Ballett. Die Abbildung zeigt die Bewegung von Molekülen über die Zeit. Die Bewegung ist als eine Linie dargestellt, die sich über die Zeit erstreckt.



Das Bild zeigt ein molekulares Ballett. Die Abbildung zeigt die Bewegung von Molekülen über die Zeit.

Bilder aus Schall

Das Bild zeigt Bilder aus Schall. Die Abbildung zeigt die Umwandlung von Schall in Bilder. Die Bilder sind als Punkte dargestellt, die durch Linien verbunden sind.



Das Bild zeigt Bilder aus Schall. Die Abbildung zeigt die Umwandlung von Schall in Bilder.

Virtuelles Atzen

Das Bild zeigt virtuelles Atzen. Die Abbildung zeigt die Struktur eines virtuellen Atzens. Die Atzen sind als Punkte dargestellt, die durch Linien verbunden sind.



Das Bild zeigt virtuelles Atzen. Die Abbildung zeigt die Struktur eines virtuellen Atzens.

35 Millionen Bälle

Das Bild zeigt 35 Millionen Bälle. Die Abbildung zeigt die Anordnung von 35 Millionen Bällen. Die Bälle sind als Punkte dargestellt, die durch Linien verbunden sind.

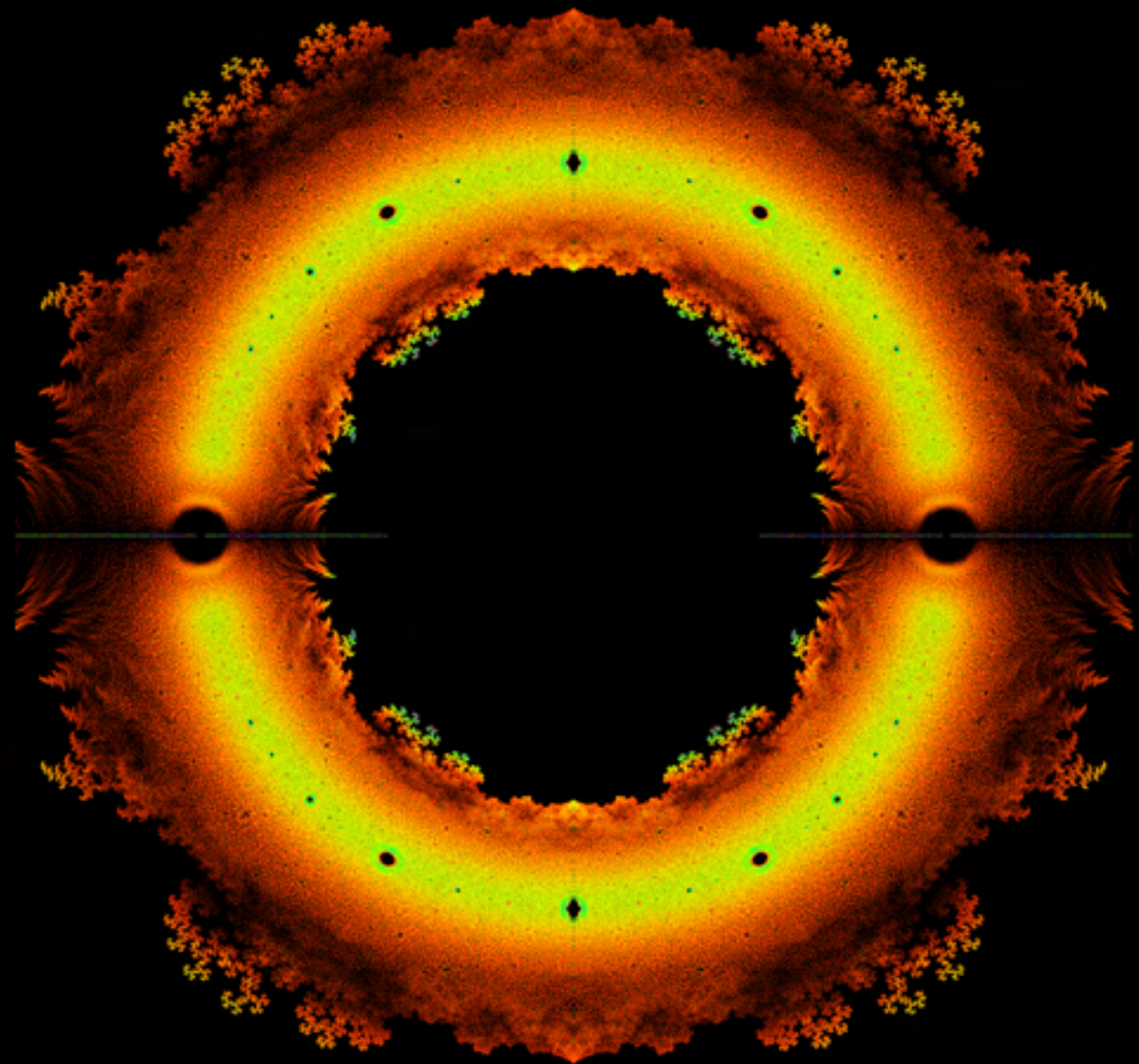


Das Bild zeigt 35 Millionen Bälle. Die Abbildung zeigt die Anordnung von 35 Millionen Bällen.



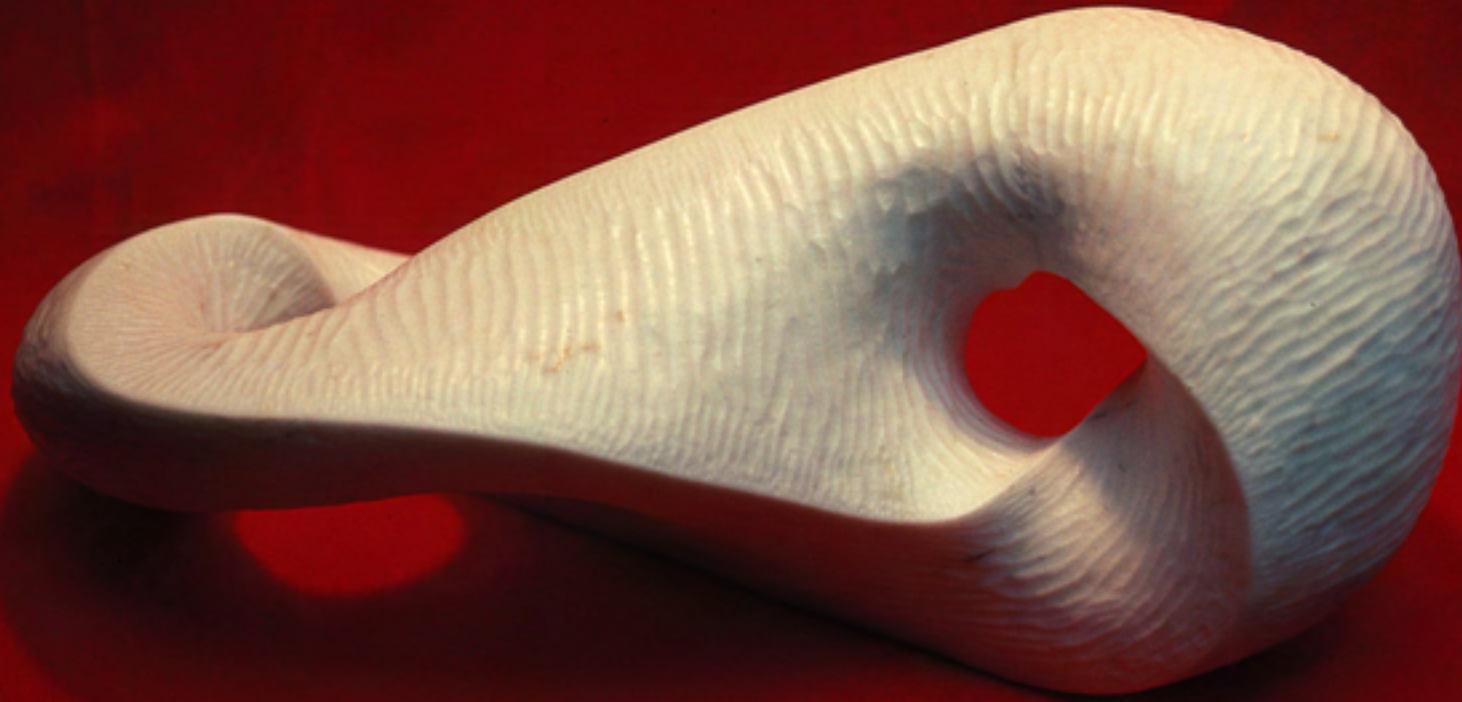
▶ Math by Experiment

Visualization



Helaman Ferguson

Visualization





Mathematics
by Experiment

Plausible Reasoning in the 21st Century

Jonathan Borwein
David Bailey

Experimentation in Mathematics

Computational Paths to Discovery



Jonathan Borwein
David Bailey
Roland Girgensohn

A man and his art

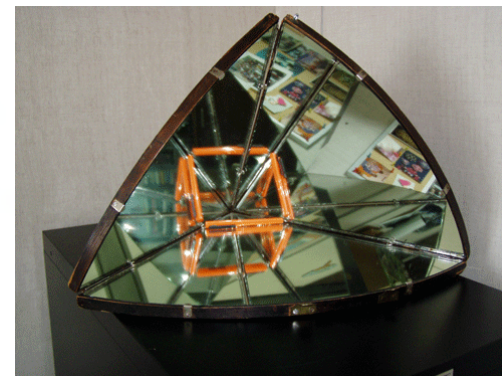


Three (small) SFU prototypes for WestGrid

- 192 cpu (home built Athlon) **Beowulf cluster** being cloned
- 32 cpu **COMPAQ alpha clump**
- 8 (+48) cpu **SGI Origin SMP**
 - Single image login, file management, etc.



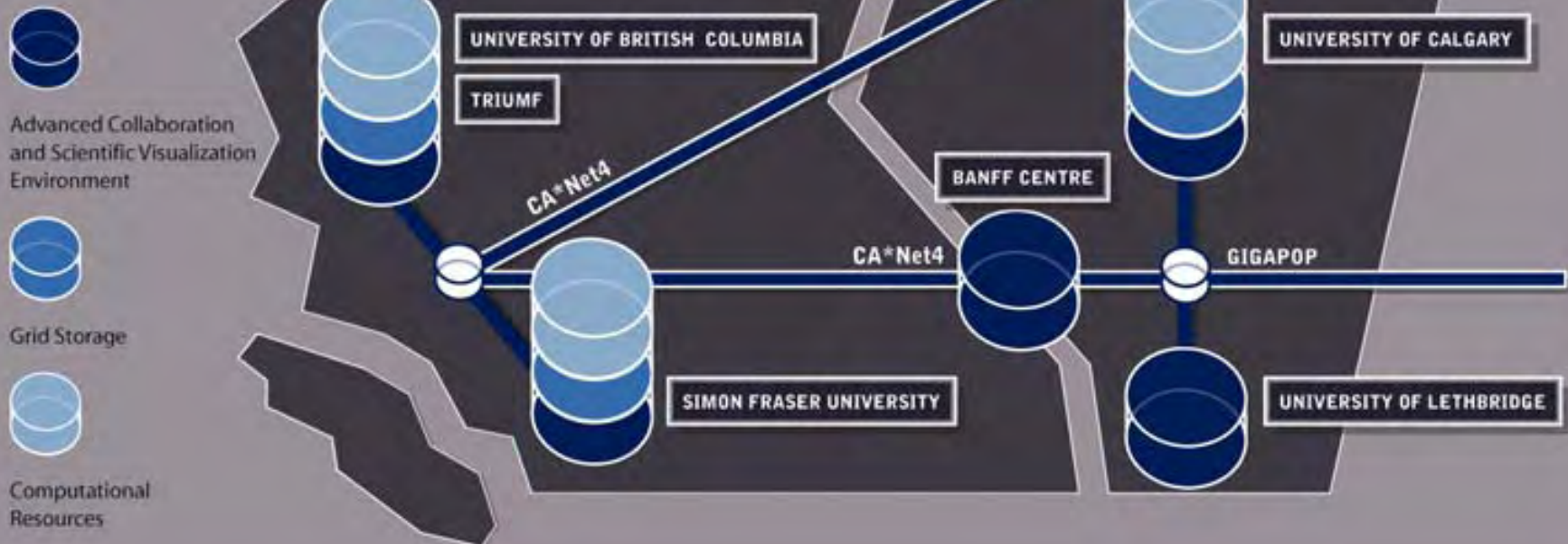
- SFU has 3 geographically separated locations
 - All with high tech programs
 - Immersive resources
(making for a fine test-bed)



Grid Computing

Project Description

WestGrid is a \$48 million project to purchase and install innovative grid-enabled computing infrastructure across BC and Alberta.



- **Resources** 48 million dollar installation (cost effective)
 - 256 Cpu Origin **Edmonton**
 - 1008 Cpu IBM Blade server **UBC**
 - 156 CPU Compac Alpha **Calgary**
 - Archival storage and Visualization server **SFU**
- Single sign on and Grid enabled
- 1500km **GigE** private network
- Going National

Access Grid again

Grid Computing



142.231.1.58/50258

--Ryerson University-- AUDIENCE1
AUDIENCE1
4.8 f/s 130 kb/s [4.0%]
 mute color info...

CoLab Audience
root@142.28.12.160h261
0 f/s 0 bps [0%]
 mute color info...

NewMIC MAIN
MAIN
25 f/s 60 kb/s [0%]
 mute color info...

UALR VRC/AG AUDIENCE
AUDIENCE
25 f/s 24 kb/s [0%]
 mute color info...

UALR VRC/AG MAIN
MAIN
25 f/s 25 kb/s [0%]
 mute color info...

WInerdon
eye15816@132.243.96.190h261
25 f/s 95 kb/s [0%]

--Ryerson University-- AUDIENCE2
AUDIENCE2
9.7 f/s 60 kb/s [2.8%]
 mute color

CoLab Speaker
root@142.58.12.160h261
0 f/s 0 bps [0%]
 mute color

NewMIC PRESENTER
PRESENTER
25 f/s 27 kb/s [0%]
 mute color

UALR VRC/AG AUDIENCE
AUDIENCE
25 f/s 25 kb/s [0%]
 mute color

UALR VRC/AG PRESENTER
PRESENTER
25 f/s 25 kb/s [0%]
 mute color

CoLab Audience
root@142.58.12.160h261
8.2 f/s 269 kb/s

Grid Computing



Four city opening

Based on these experiences we are now
building the

**Dalhousie Distributed
Research Institute
and
Virtual Environment**



Come and visit www.cs.dal.ca/ddrive



Western Canada Research Grid



Users

- CURRENT NOTICES
- HPC TECHNICAL SUPPORT
- HPC TRAINING & MATERIALS
- ACCESS TO HPC RESOURCES
- USER REQUIREMENTS
- ACCESS GRID



Management

- PROJECT LEADERS
- GOVERNANCE STRUCTURE
- WESTGRID CONTACTS
- WORKING GROUPS



Media & Public

- ABOUT WESTGRID
- RESEARCH ACTIVITY
- NEWS & IMAGES

*FLASH PLUGIN REQUIRED TO VIEW THIS SECTION.

WESTGRID HOME

SITE MAP

WestGrid is a \$48 million project to purchase and install innovative grid-enabled computing infrastructure across BC and Alberta.

WESTGRID PARTNERS

MAP OF RESOURCES

MAILING LISTS:

Please click below to be added to the list.

INFO

General enquires, information.

HPC

Researchers interested in high performance and grid computing.

VIZ

Researchers working on collaborative and visualization tools.

Grid Computing News and Updates

First year Report

[Download PDF here](#)

BCNET - Netera - WestGrid Advanced Networks Conference 2004

Web casts of presentations at the BCNET-WestGrid-Netera Advanced Networks Conference are available until end of June at www.bc.net

ACCESS GRID RETREAT 2004

June 9-11, 2004
Toronto, Canada
Hosted by Ryerson University