

**How to Work with Scientists**  
***Building Scientific Communities***

**Maxine Brown and Tom DeFanti**  
**STAR TAP/StarLight**  
**Electronic Visualization Laboratory**  
**University of Illinois at Chicago**



# Electronic Visualization Laboratory

## ~30 Years of Art/Science Research/Education

- **Develop virtual-reality hardware**
  - CAVE, ImmersaDesk, tiled displays
- **Develop virtual-reality software**
  - CAVERNsoft, Quanta
- **Develop infrastructure**
  - STAR TAP, StarLight
- **Develop applications with e-scientists, using our technologies and infrastructure**
  - Bioinformatics, Geoscience
- **Create conference events to create “teams” of early adopters**



# SIGGRAPH 92

## Showcase: Science in the 21<sup>st</sup> Century



“From the atom to the Universe...it’s all here. Three dozen projects can now come through the network and appear to be in McCormick Place...Simulations on remote supercomputers or created from data gathered from far away instruments, these visualizations demonstrate the power of distributed computing, doing computing where the resources are and not necessarily on a single machine.”

— Larry Smarr, Director, National Center for Supercomputing Applications, UIUC



UCSD NCMIR  
in San Diego



UCSD NCMIR  
in Chicago



“We have to develop the technology and techniques—and the sociology—to go along with group activities.”

— Sid Karin, Director, San Diego Supercomputer Center, UCSD

[www-ncmir.ucsd.edu](http://www-ncmir.ucsd.edu)

# SIGGRAPH 92

## Showcase: Science in the 21<sup>st</sup> Century

“VR is a mode of scientific visualization. It’s something that lets you get inside of the data. Now, with most computer screens you’re outside looking in. In this, you’re inside looking out.”

— Tom DeFanti, Director, Electronic Visualization Laboratory, UIC



“In a few years, the network is the computer...It doesn’t matter where your supercomputer is, your data resources, your sensors, scanners or satellite data. It can come from anywhere, be stored anywhere, but you can access it, at your fingertips, on your desktop.”

— Maxine Brown, Associate Director, Electronic Visualization Laboratory, UIC

Electronic Visualization Laboratory

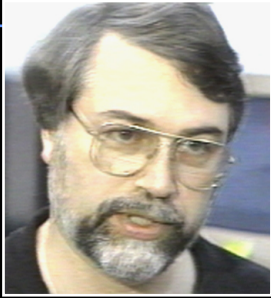
[www.evl.uic.edu](http://www.evl.uic.edu) [www.cavernus.org](http://www.cavernus.org)

STARLIGHT<sup>SM</sup>



# SIGGRAPH 94

## VROOM: Virtual Reality Room



**“It’s the real start of humans being able to immerse themselves inside the brains of computers—seeing what the computers are seeing.”**

— Larry Smarr, Director, NCSA, UIUC

**“See things you’ve never seen before.”**

— Tom DeFanti, Director, Electronic Visualization Laboratory, UIC



General Motors  
Research

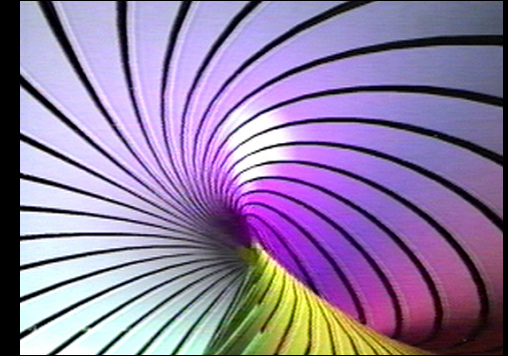
**“Virtual prototyping of new products, from small to large.”**

— Rick Stevens, Director, Math and Computer Science Division, Argonne National Lab



**“Next year—Get rid of the Machine Farm and put gigabit networks in place to talk to computers at remote sites—a whole new level of interaction and communication.”**

— Maxine Brown, Associate Director, Electronic Visualization Laboratory, UIC  
[www.evl.uic.edu/EVL/VROOM/HTML](http://www.evl.uic.edu/EVL/VROOM/HTML)



Post-Euclidean Walkabout  
George Francis, NCSA, UIUC  
[www.math.uiuc.edu/~gfrancis/](http://www.math.uiuc.edu/~gfrancis/)



# Supercomputing 95

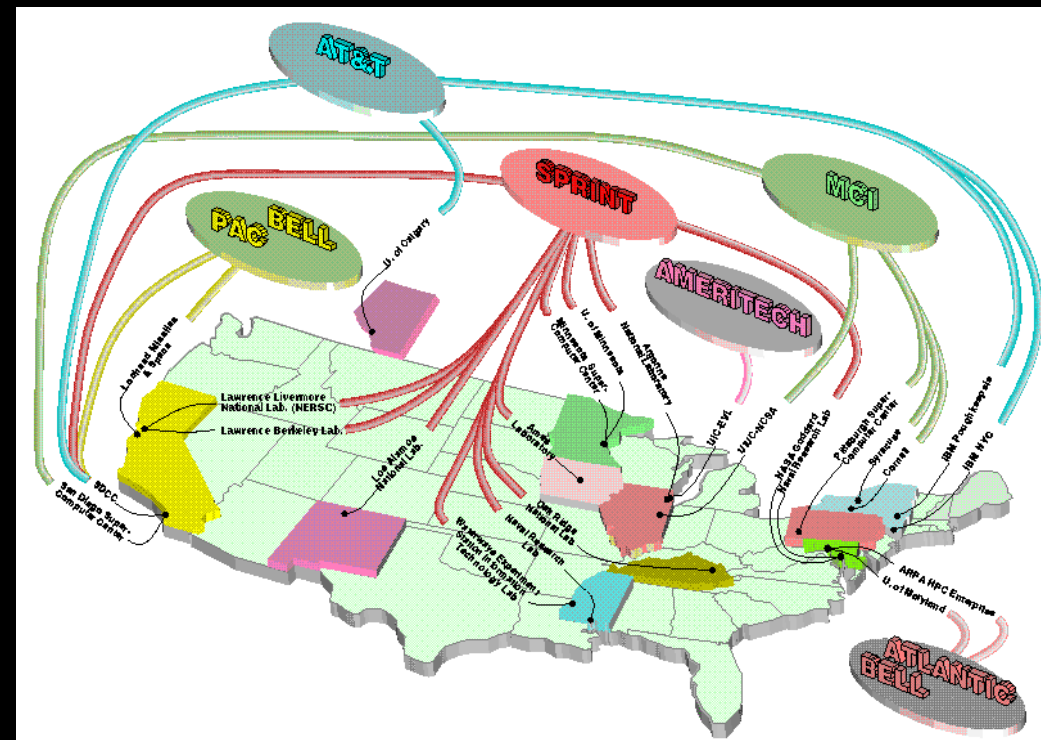
## *I-WAY: Information Wide Area Year*

The Internet evolved from ARPAnet, a research network built in 1969 that primarily was a communications tool of the research community until the invention of the World Wide Web-and later Mosaic-that opened it up to the wider community.

I-WAY leaders Ian Foster, Larry Smarr, Rick Stevens and Tom DeFanti, believe the next great wave of evolution on the Internet will be unleashed by I-WAY.

### I-WAY featured:

- Application demonstrations
- OC-3 backbone
- Large-scale immersive displays
- I-Soft programming environment



<http://archive.ncsa.uiuc.edu/General/Training/SC95/GII.HPCC.html>

# Supercomputing 95

## *I-WAY: Information Wide Area Year*



**“We definitely pushed the envelope. There’s a whole community of people now who have a different way of thinking about how to do science and how to do visualization, and have been a part of an experience that will guide or influence how they think about science over the next few years.”**

— Rick Stevens, Director, Math and Computer Science Division, Argonne National Lab



**“I-PoP machines uniformly configure gateways to supercomputers. I-Soft software creates a necessary standard operating environment.”**

— Ian Foster, Associate Director, Math and Computer Science Division, Argonne National Laboratory



**“One of the reasons we’ve been working on virtual-reality is because it’s an excellent test for networking. We need the supercomputers to give us the realism, and we need the high-speed networks to give us telepresence—being somewhere else.”**

— Tom DeFanti, Director, Electronic Visualization Lab, UIC



**“VR is an intelligent user interface into the whole electronic superhighway. How are people going to talk to computers in the future?”**

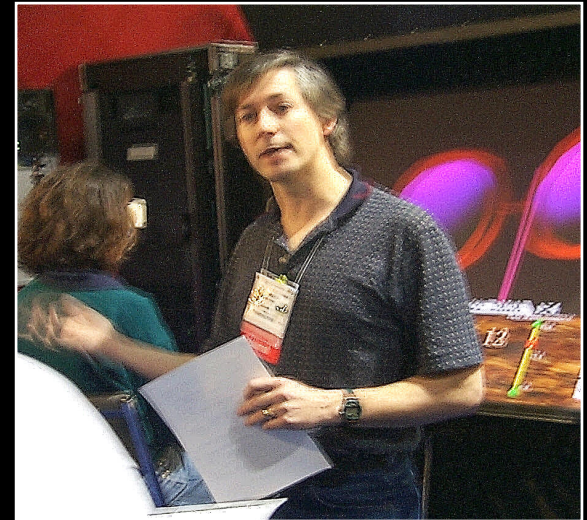
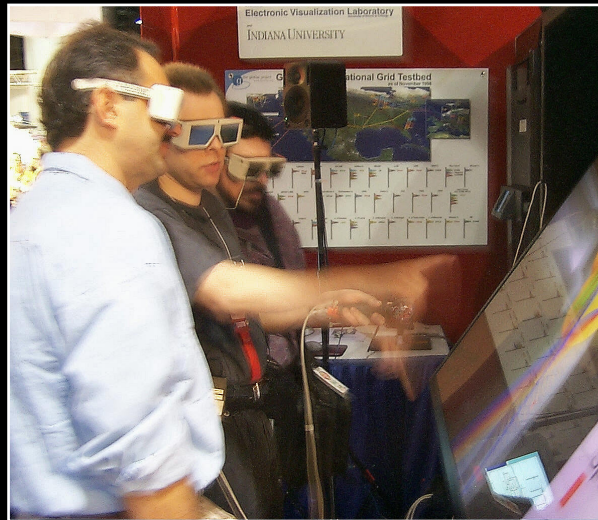
— Maxine Brown, Associate Director, Electronic Visualization Lab, UIC



# iGrid 1998 at SC'98

## November 7-13, 1998, Orlando, Florida, USA

- 10 countries: Australia, Canada, Germany, Japan, Netherlands, Russia, Singapore, Switzerland, Taiwan, USA
- 22 demonstrations featured technical innovations and application advancements requiring high-speed networks, with emphasis on remote instrumentation control, tele-immersion, real-time client server systems, multimedia, tele-teaching, digital video, distributed computing, and high-throughput, high-priority data transfers



[www.startup.net/igrd98](http://www.startup.net/igrd98)

Electronic Visualization Laboratory

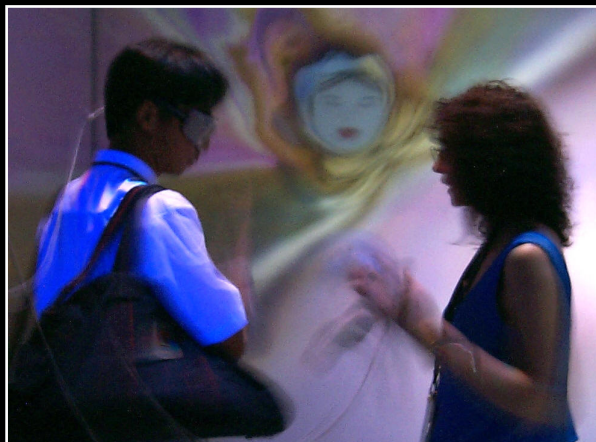
STARLIGHT<sup>SM</sup>



# iGrid 2000 at INET 2000

## July 18-21, 2000, Yokohama, Japan

- 14 countries: Canada, CERN, Germany, Greece, Japan, Korea, Mexico, Netherlands, Singapore, Spain, Sweden, Taiwan, United Kingdom, USA
- 24 demonstrations featuring technical innovations in tele-immersion, large datasets, distributed computing, remote instrumentation, collaboration, streaming media, human/computer interfaces, digital video and high-definition television, and grid architecture development, and application advancements in science, engineering, cultural heritage, distance education, media communications, and art and architecture
- **100Mb transpacific bandwidth carefully managed**



[www.startap.net/igrig2000](http://www.startap.net/igrig2000)

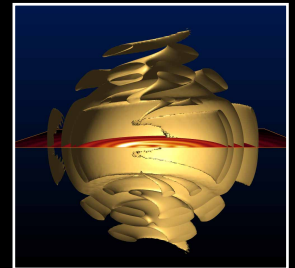
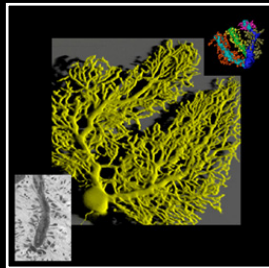
Electronic Visualization Laboratory

STARLIGHT<sup>SM</sup>

# iGrid 2002

September 24-26, 2002, Amsterdam, The Netherlands

- **28 demonstrations from 16 countries:** Australia, Canada, CERN, France, Finland, Germany, Greece, Italy, Japan, The Netherlands, Singapore, Spain, Sweden, Taiwan, United Kingdom, United States
- Applications demonstrated: art, bioinformatics, chemistry, cosmology, cultural heritage, education, high-definition media streaming, manufacturing medicine, neuroscience, physics, tele-science



- Grid technologies demonstrated: Major emphasis on grid middleware, data management grids, data replication grids, visualization grids, data/visualization grids, computational grids, access grids, grid portals
- **25Gb transatlantic bandwidth (100Mb/attendee, 250x iGrid2000!)**

[www.startap.net/igrid2002](http://www.startap.net/igrid2002)

Electronic Visualization Laboratory

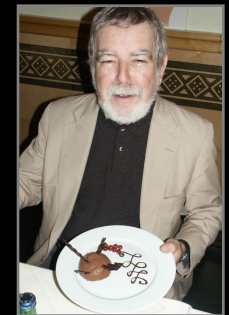
STARLIGHT<sup>SM</sup>



# iGrid 2002

September 24-26, 2002, Amsterdam, The Netherlands 2002

A worldwide community of e-scientists, application programmers, networking engineers, electrical/computer engineers, artists and computer scientists working together



Electronic Visualization Laboratory

STARLIGHT<sup>SM</sup>

# iGrid 2002 Lessons Learned?

- No bottleneck whatsoever in the network
- “Virtual” bottlenecks in uncongested networks – applications couldn’t cope (software, OSs, NICs, routers,...?)
- Many got 50-100Mb single stream TCP
- Multicast issues; TCP was slow...
- ~12 applications did  $\geq 2\text{Gb}$  using UDP and other protocols
- IPv6 UDP got 400+Mb to Japan
- 22 papers to be published in *Future Generation Computer Systems* by Elsevier!!

**“This is the first time I didn’t have to replicate my data”**

**– Arthurine Breckenridge, SNL**

**“We streamed in 14 different formats to the rest of the world in multicast”**

**– Egon Verharen, SURnet**



# iGrid 2002 Outcomes?

## Setting new world data transfer records...

- **SC2002 High Performance Bandwidth Challenge**
  - **Network Intensive Grid Computing** won the “Highest Performing Application” award ... peak data transfer rate of 16.8 Gbps
  - **High Performance Data Webs** won “Best Use of Emerging Network Infrastructure” ... peak transfer rate of 2.4 Gbps
- **Internet2 Land Speed Record**
  - **Bandwidth Challenge to the Low-Lands** won by transferring 6.7 GB of data across 10,978 kilometers (~6,800 miles) in less than one minute during SC2002
- **Other Challenges**
  - **Video IBPster** participated in a high-speed data transfer project across Canada and the United States ... transferring at ~11 Gbps

<http://scinet.supercomp.org/bwc>

[www.internet2.edu](http://www.internet2.edu)

[www.startup.net/starlight/PUBLICATIONS](http://www.startup.net/starlight/PUBLICATIONS)

Electronic Visualization Laboratory

STARLIGHT<sup>SM</sup>

**For More Information**

***i*Grid 2004 ?**

[www.startap.net/starlight](http://www.startap.net/starlight)  
[maxine@uic.edu](mailto:maxine@uic.edu)



Electronic Visualization Laboratory

**STARLIGHT<sup>SM</sup>**