Argonne NATIONAL LABORATORY

... for a brighter future

Virtual Environments for Visualization of Large Scale Scientific Data

65-tile Varrier autostereo display

Located at Calit^2 laboratory, UCSD

Image courtesy Robert Kooima

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Mathematics and Computer Science Division

UltraVis
SciDAC Institute for Ultrascale Visualization
www.ultravis.org

U.S. Department of Energy

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Virtual Environments

Definition, application to scientific visualization

What is virtual reality, or a virtual environment?

Virtual world, immersion, sensory feedback, and interactivity

In a word,

PRESENCE

Application to Large Scale Science

Why we need better devices for exascale science

How do we get there

Definition by example: You know it when you see it

Be the data

Stereo

HMD

CAVE

GeoWall

Mono

Power Wall

Tiled Display

Autostereo

Varrier

Personal Varrier

Dynallax

Future Visualization Requirements

Current devices are inadequate but not human capability.

Property	Future	Current
Data size	10 K ^3 (1 trillion points / time step)	2K ^3 (4 billion elements / time step)
Image size	10 K ^2 (100 megapixels)	2K ^2 (4 megapixels)
Information bandwidth	400 MB x 60 Hz = 24 GB/s	16 MB x 60 Hz = 1 GB/s

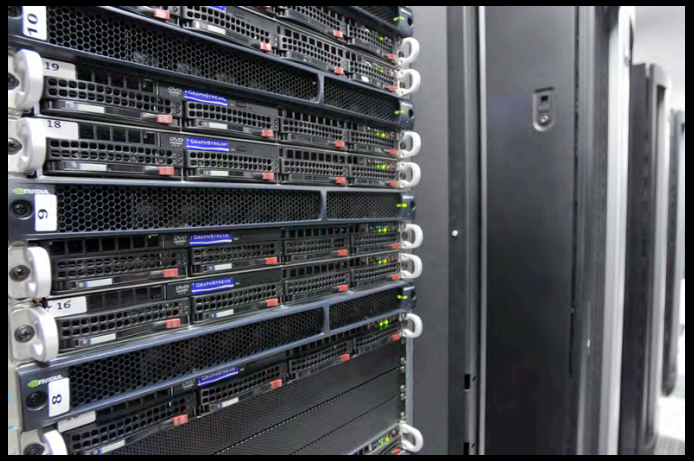
Resource	Human Capability	Current Device Capability
Spatial resolution	126 M receptors (equiv. 50 color Mpixel)	4 Mpixel
Field of view	180 degrees	60 degrees
Temporal resolution	80 Hz	60 Hz
Dynamic range	trillions of colors (16 bit color)	8 bit color
Stereo depth resolution	.12mm at 40 cm away	2D usually

"Overload is a failure of design, not an attribute of information."

Edward Tufte

How to Engage Science at the Exascale

Start with leadership-class HPC machines

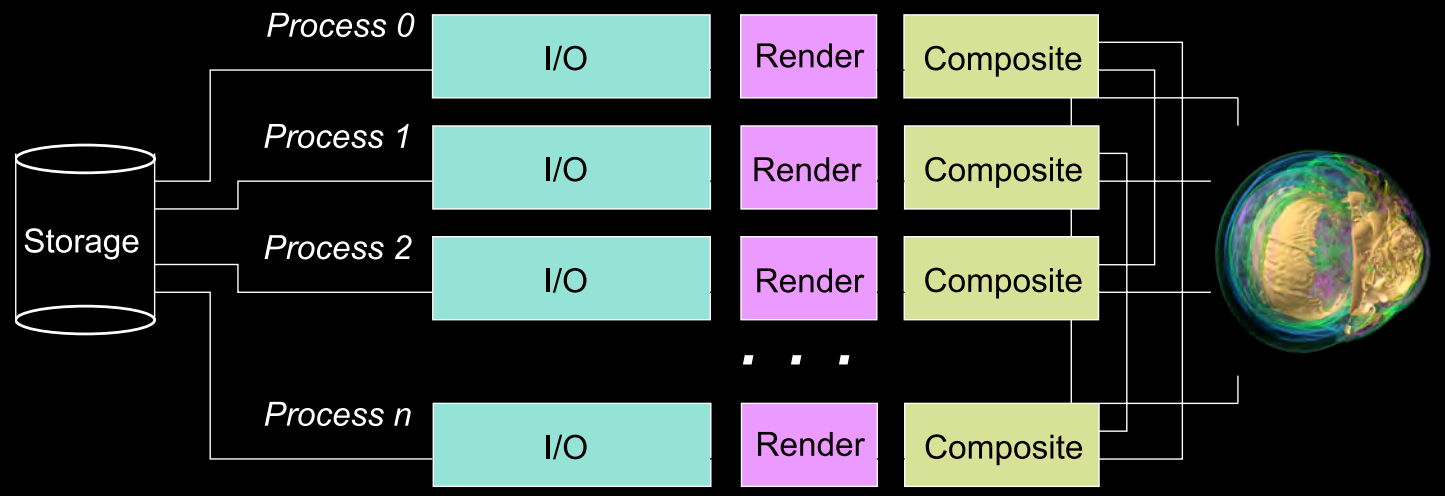


Intrepid is a 557 teraflop IBM Blue Gene/P supercomputer with 160,000 cores. Eureka is a 111 teraflop NVIDIA QuadroPlex cluster with 100 CPUs and 200 GPUs.

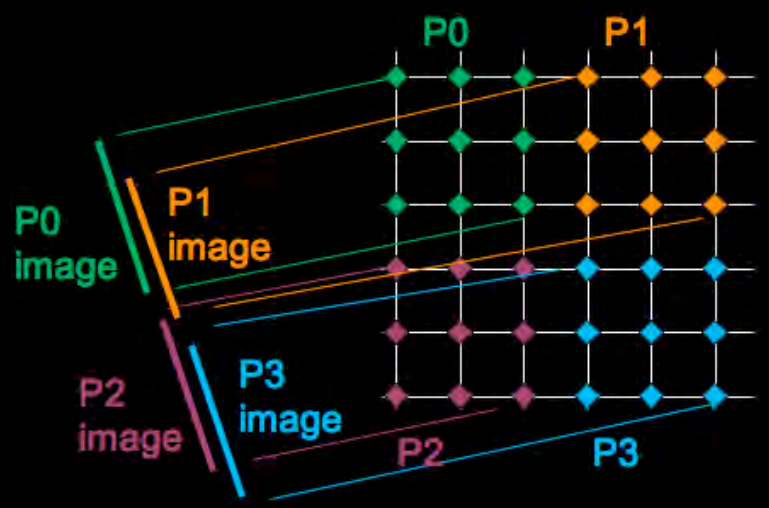
Images courtesy Argonne Leadership Computing Facility

Develop Scalable, Parallel Algorithms for Visualization

Parallel volume rendering



Parallel structure



Sort last rendering

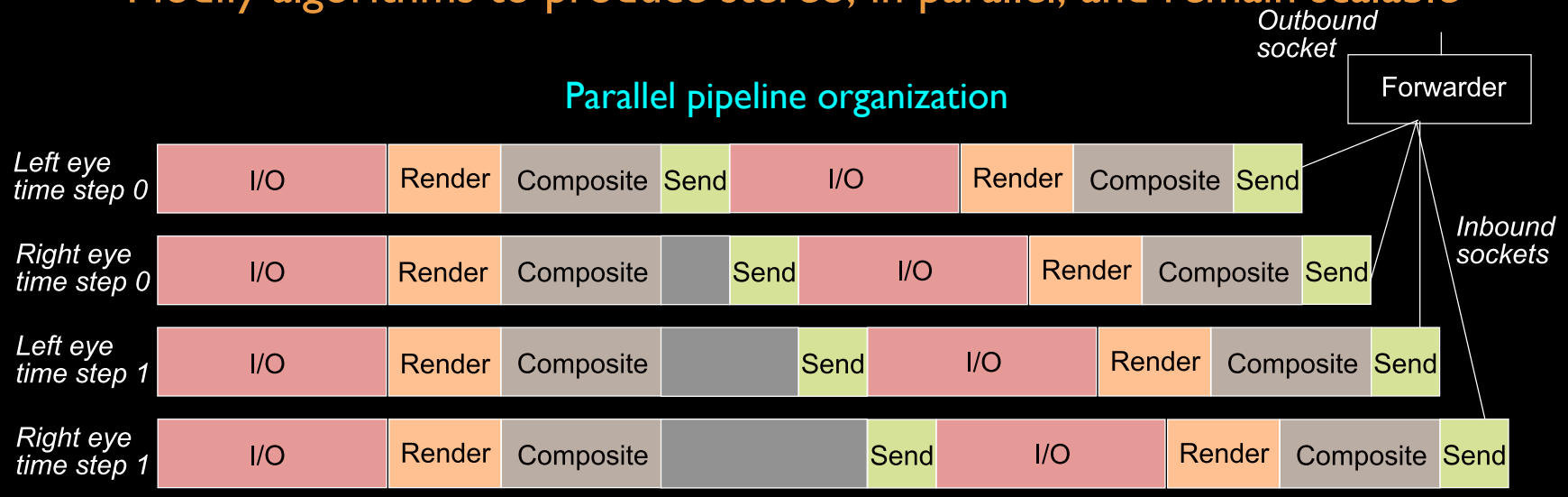
Core collapse supernova shock wave simulation, on a structured grid of 864^3 data elements.

Data courtesy of John Blondin (NCSU) and Tony Mezzacappa (ORNL)

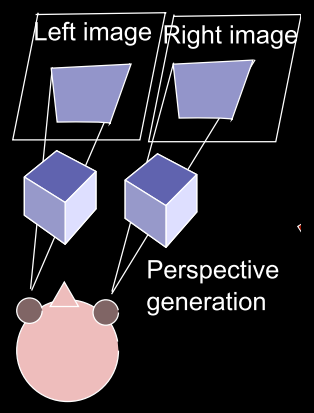
Add Stereo

Modify algorithms to produce stereo, in parallel, and remain scalable

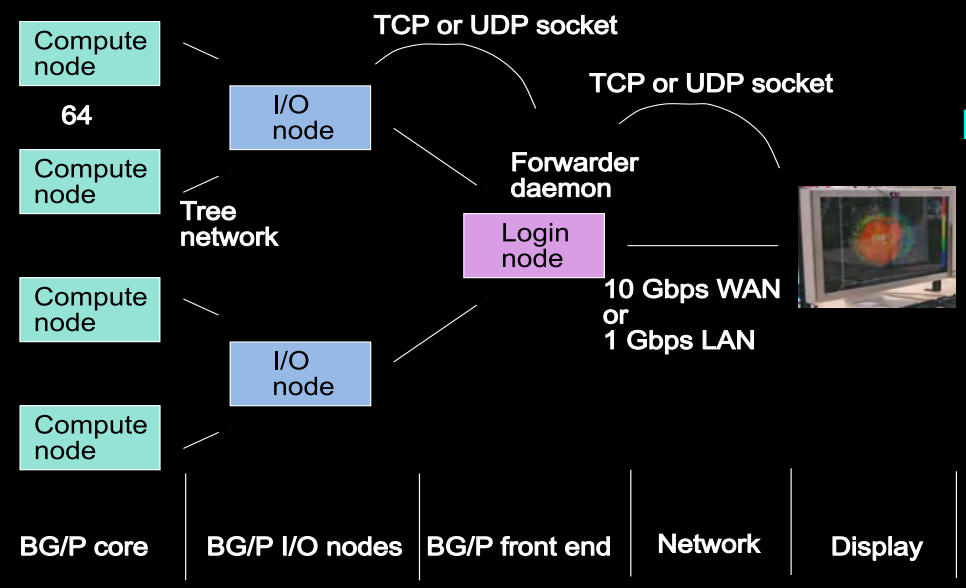
Parallel pipeline organization



Perspective ray casting



Data path



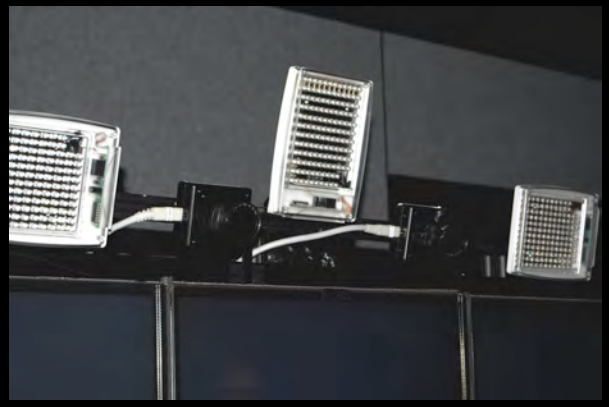
Build Novel Devices

Head tracking, navigation, work environments

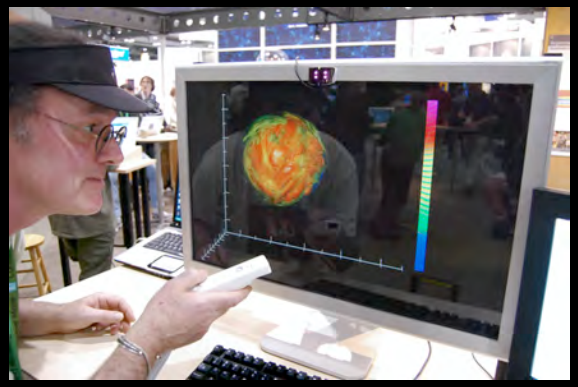
Scientist workstation

Direct interaction

Common / demo space



Tetherless face tracking



SC08 show floor

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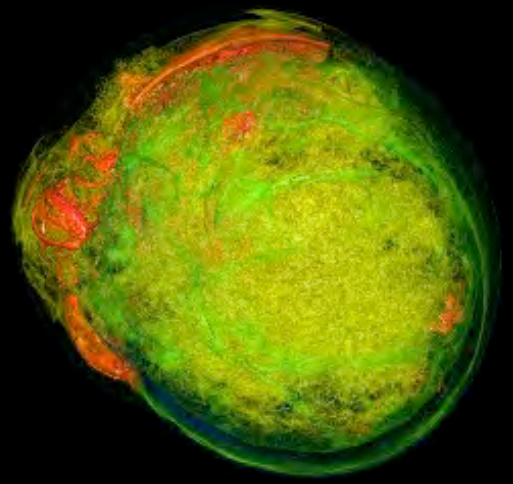

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