CineGrid @ IEEE MSST 2008

Building a New User Community for Very High Quality Media Applications On Very High Speed Networks

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Laurin Herr
President
Pacific Interface Inc.

Laurin@pacific-interface.com

Shaofeng Liu
Graduate Student Researcher
UCSD/Calit2

S8liu@ucsd.edu

What is CineGrid?

- CineGrid is a non-profit international membership organization.
- CineGrid's mission is to build an interdisciplinary community focused on the research, development, and demonstration of networked collaborative tools to enable the production, use and exchange of very high-quality digital media over high-speed photonic networks.
- Members of CineGrid are a mix of media arts schools, research universities, scientific laboratories, post-production facilities and hardware/software developers around the world connected by 1 Gigabit Ethernet and 10 Gigabit Ethernet networks used for research and education.

CineGrid Founding Members

- Cisco Systems
- Keio University DMC
- Lucasfilm Ltd.
- NTT Network Innovation Laboratories
- Pacific Interface Inc.
- Ryerson University/Rogers Communications Centre
- San Francisco State University/INGI
- Sony Electronics America
- University of Amsterdam
- University of California San Diego/Calit2/CRCA
- University of Illinois at Urbana-Champaign/NCSA
- University of Illinois Chicago/EVL
- University of Southern California, School of Cinematic Arts
- University of Washington/Research Channel

CineGrid Institutional Members

- California Academy of Sciences
- Cinepost, ACE Prague
- Dark Strand
- i2CAT
- JVC America
- Korea Advanced Institute of Science and Technology (KAIST)
- Louisiana State University, Center for Com and Tech
- Mechdyne
- Meyer Sound Laboratories
- Nortel Networks
- Renaissance Computing Initiative (RENCI)
- SARA
- Sharp Corporation Japan
- Sharp Labs USA
- Swedish Royal Institute of Technology
- Tohoku University/Kawamata Lab
- Waag Society

CineGrid Network/Exchange Members

- CANARIE
- CENIC
- CESNET
- CzechLight
- Internet 2
- JANET
- Japan Gigabit Network 2
- National LambdaRail
- NetherLight
- Pacific Wave
- Pacific North West GigaPOP
- StarLight
- SURFnet
- WIDE

Cinema combines art and science, culture and commerce. Increasingly digital.

- In California alone, movie industry employed 245,000 with $17 billion payroll in 2005.
- Movie-making is going global. Local talent is key!
- Regional and international networks become “infrastructure incentives” for digital media companies to attract jobs and deliver results worldwide.

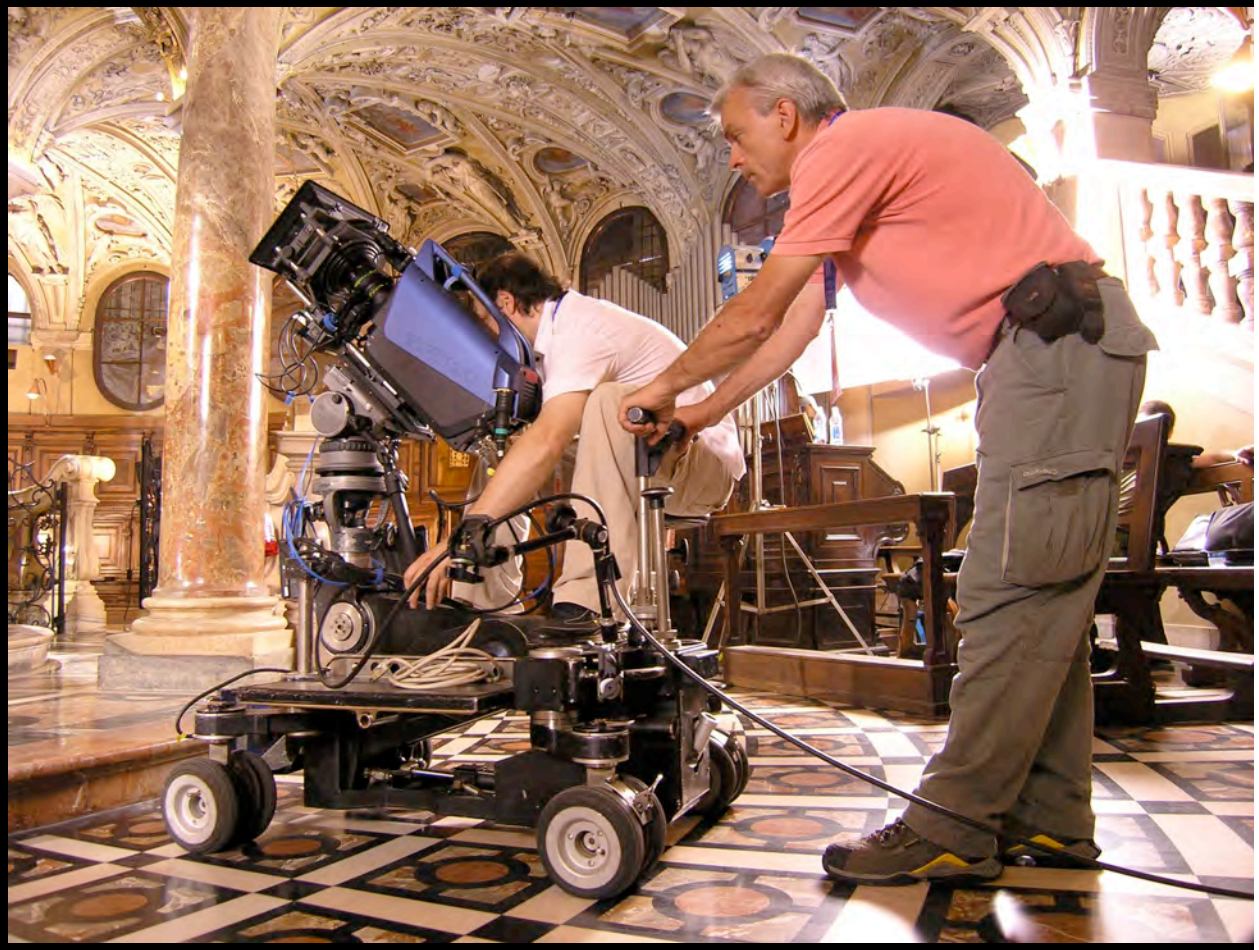
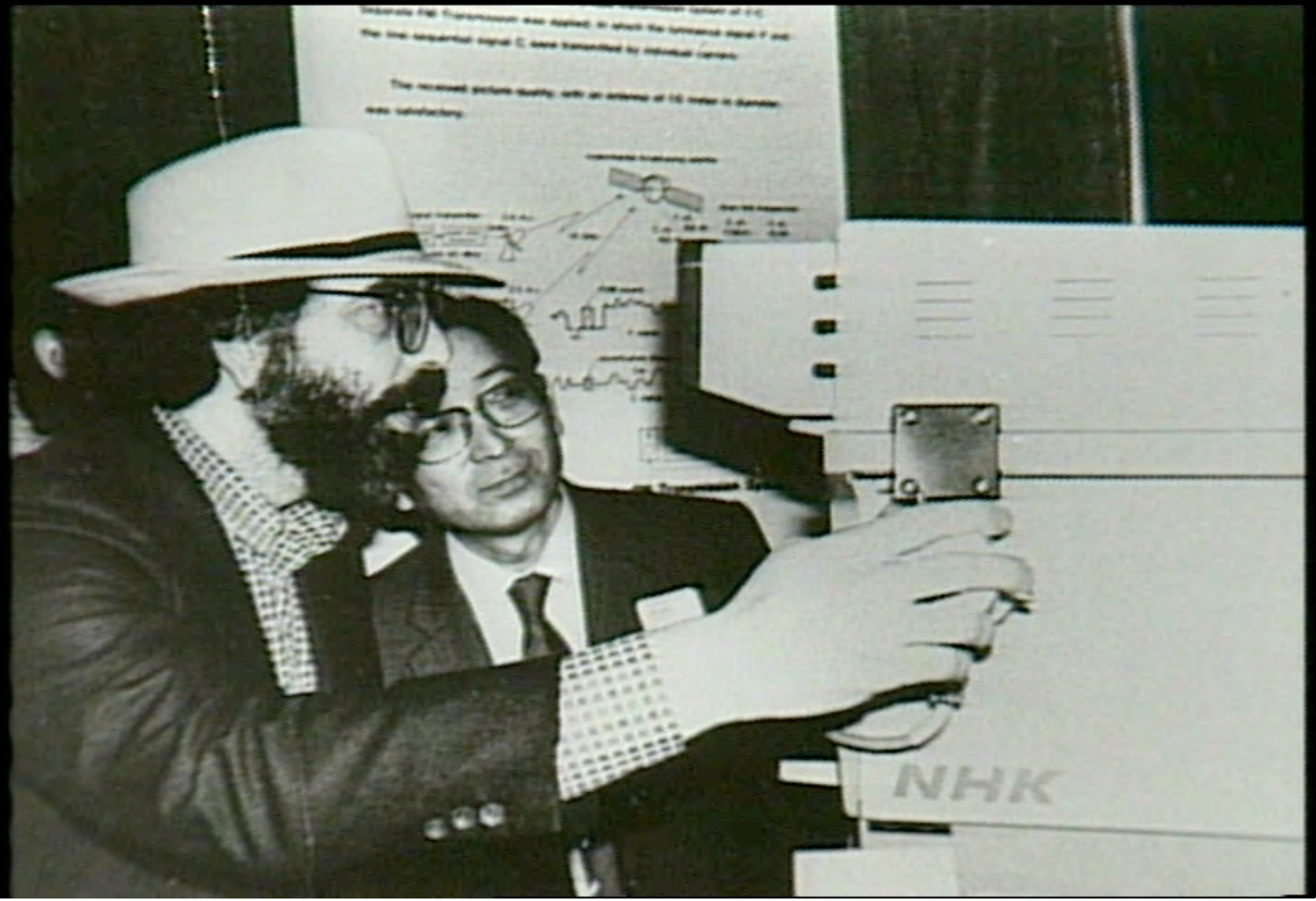


Photo: Naohisa Ohta

1981

Francis Ford Coppola with Dr. Takashi Fujio

“First Look” at HDTV Electronic Cinema



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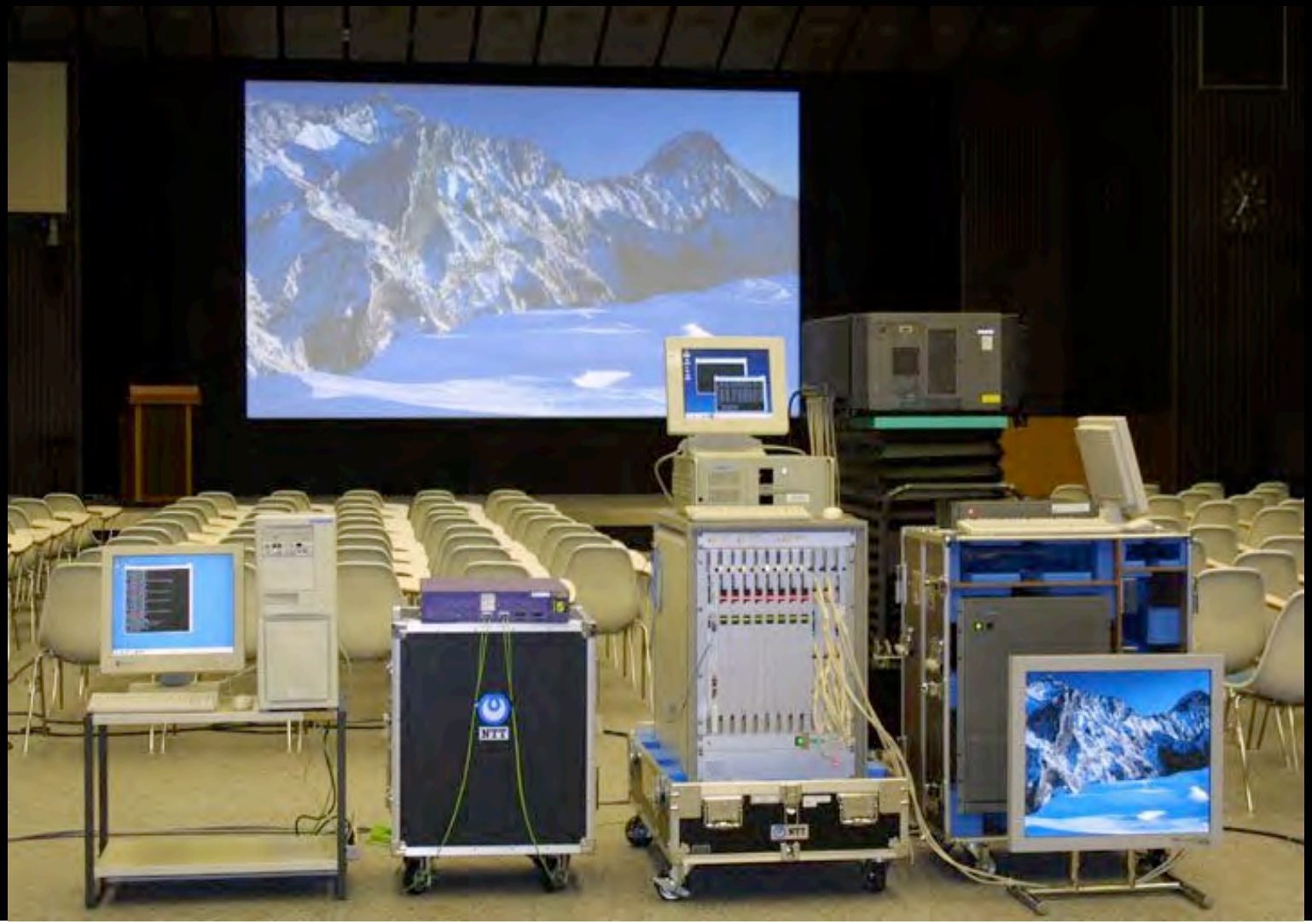
2001

NTT Network Innovations Laboratory

“First Look” at 4K Digital Cinema



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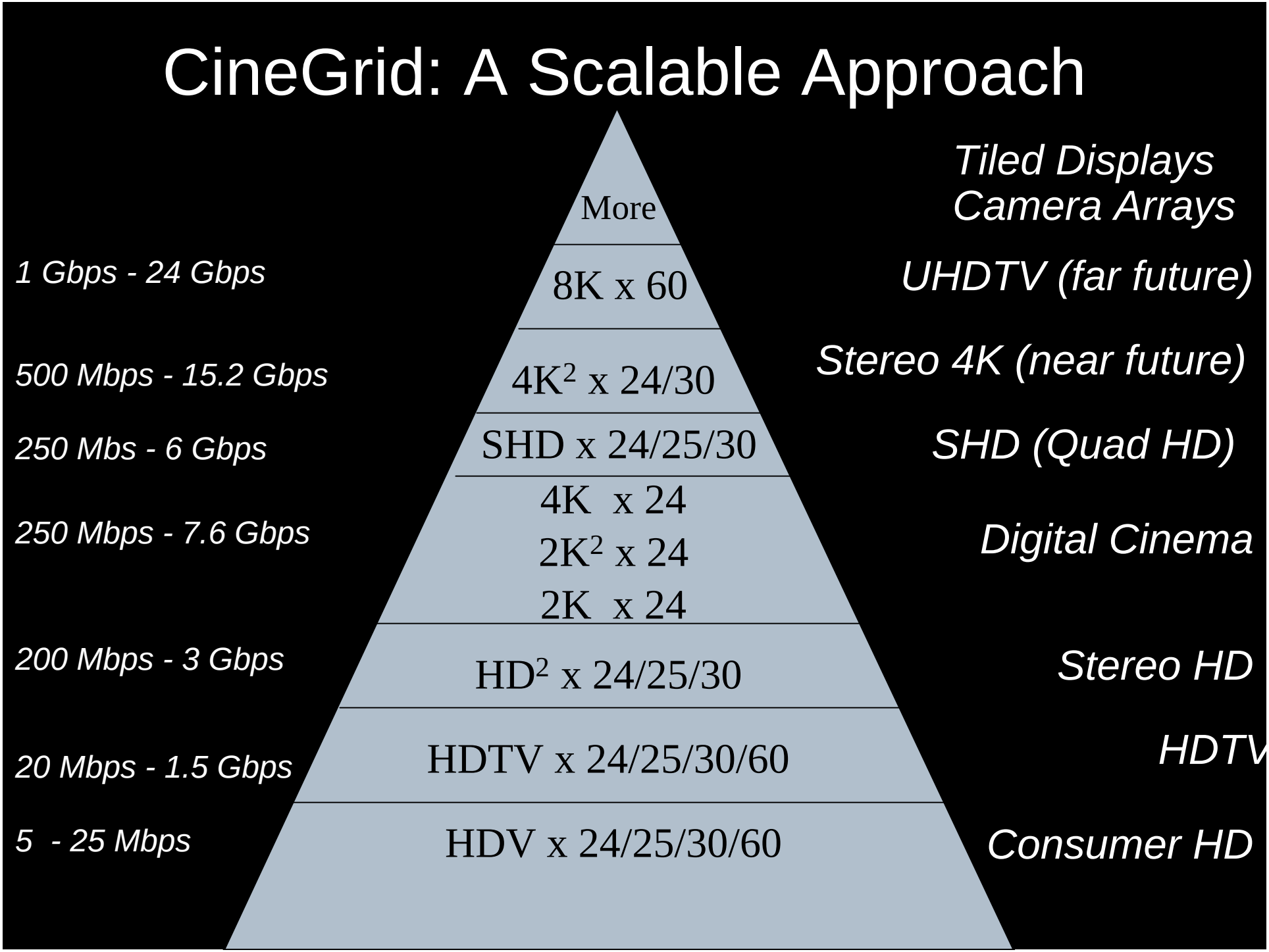
2004 “First Look” at 100 Mpixel OptIPortal for Scientific Visualization and Remote Collaboration

CineGrid: A Scalable Approach



Need to Big Data Objects Globally

- **Digital Motion Picture for Audio Post-Production**
  - 1 TV Episode Dubbing Reference ~ 1 GB
  - 1 Theatrical 5.1 Final Mix ~ 8 GB
  - 1 Theatrical Feature Dubbing reference ~ 30 GB
- **Digital Motion Picture Acquisition**
  - 4K RGB x 24 FPS x 10bit/color: ~ 48MB/Frame uncompressed *(ideal)*
  - 6:1 ~ 20:1 shooting ratios => 48TB ~ 160TB digital camera originals
- **Digital Dailies**
  - HD compressed MPEG-2 @ 25 ~ 50 Mb/s
- **Digital Post-production and Visual Effects**
  - Gigabytes - Terabytes to Select Sites Depending on Project
- **Digital Motion Picture Distribution**
  - Film Printing in Regions
    - Features ~ 8TB
    - Trailers ~ 200GB
  - Digital Cinema Package to Theatres
    - Features ~ 100 - 300GB per DCP
    - Trailers ~ 2 - 4GB per DCP
  - Web Download to Consumers
    - Features ~ 1.3GB
    - TV Shows ~ 600MB

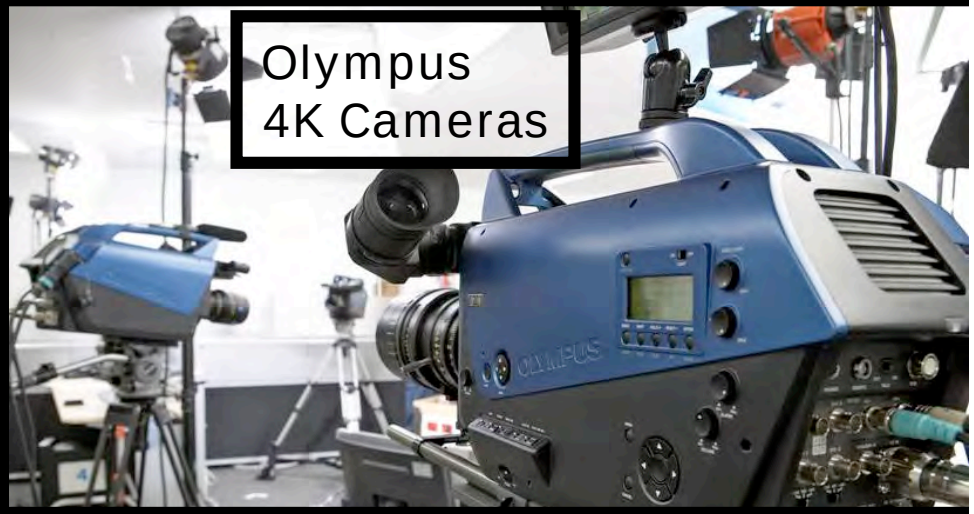
CineGrid Testbed for Networked Media

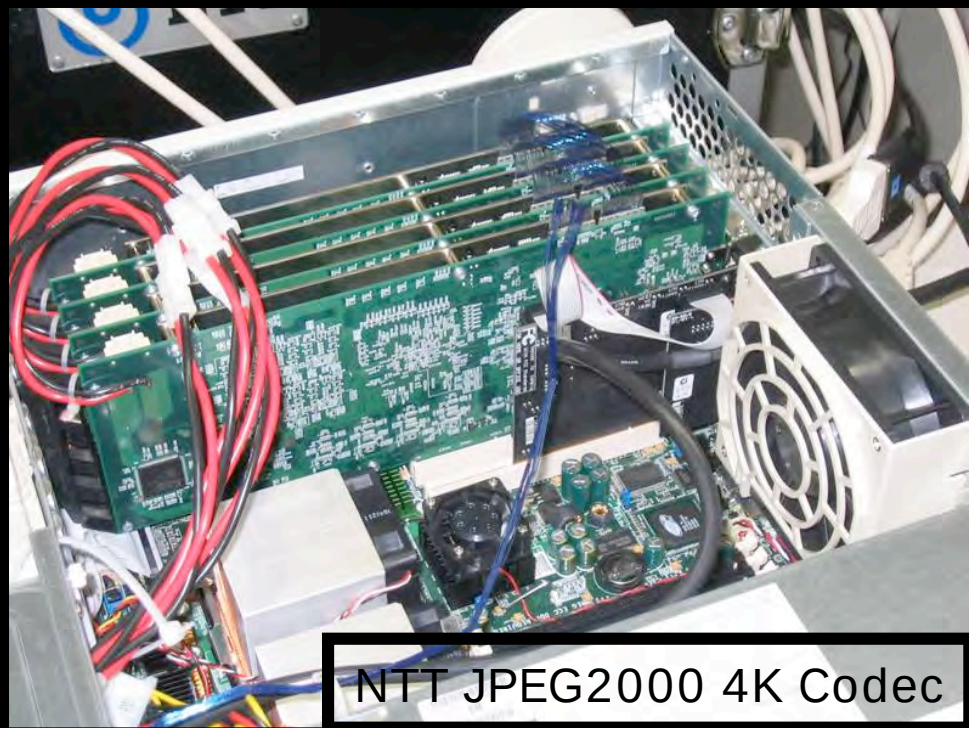
- CineGrid community is creating a virtual cyber-infrastructure comprised of “nodes” and “networks” capable of being used as a global-scale, non-profit testbed for new digital media workflows
- CineGrid testbed is fast enough to carry high-quality media formats - digital cinema or scientific visualization - in real-time or “fast enough” to explore new types of workflows and collaboration systems that assume the use of persistent 1 Gbps or 10 Gbps network access
- CineGrid members can prototype new networked media applications using next generation wide-area networking technology before it is widely available commercially, without requiring them individually to make long-term upfront cyber-infrastructure investments during pre-commercial phase of high risk innovation.

CineGrid “Node” at UCSD/Calit2

200 Person Stadium Seating
Sony SXRD 4K/HDTV projector
2 x Christie Powerpoint projector
30’ x 15’ Stewart screen
Meyer Sound speakers for 8.2 audio
SGI Prism w/21TB fast disk
NTT JPEG 2000 4K streaming codec
Zaxel 4K uncompressed recorder/player
10 GE connectivity

CineGrid “Node” at Keio University/DMC





CENIC is CineGrid's Backbone in California

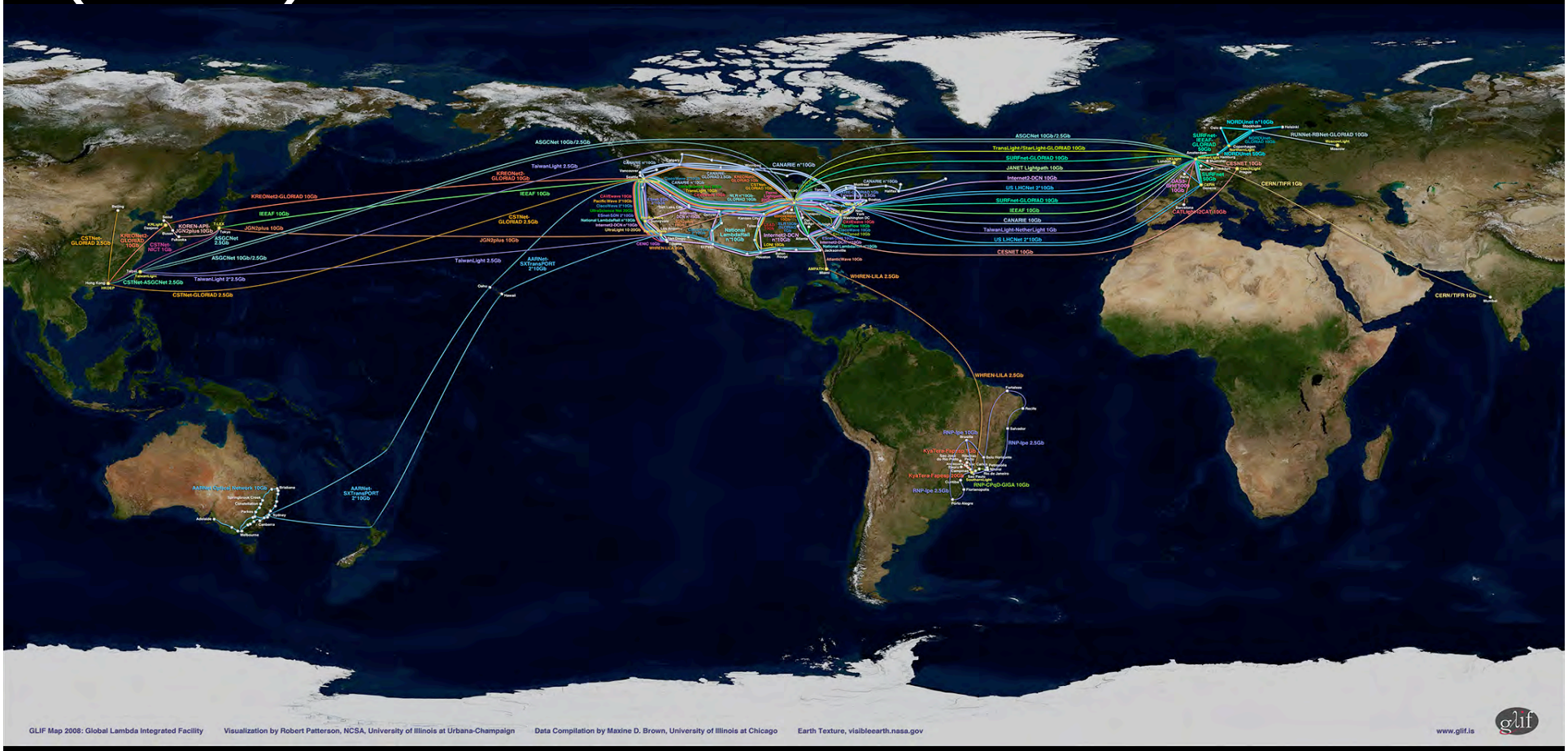
To date, CineGrid has primarily utilized:

- Los Angeles to San Diego
- Los Angeles to San Francisco
- San Diego to San Francisco

NLR is CineGrid's Backbone in USA

Cisco has built 3 x 10 GigE waves on NLR and installed 6506 switches for access points in San Diego, Los Angeles, Sunnyvale, Seattle, Chicago and McLean that can be used by CineGrid projects.

Global Lambda Integrated Facility (GLIF) is CineGrid's Global Backbone



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2008 GLF Visualization by Bob Patterson, NCSA/UIUC

CineGrid Projects: “Learning by Doing”

CineGrid @ iGrid 2005

CineGrid @ AES 2006

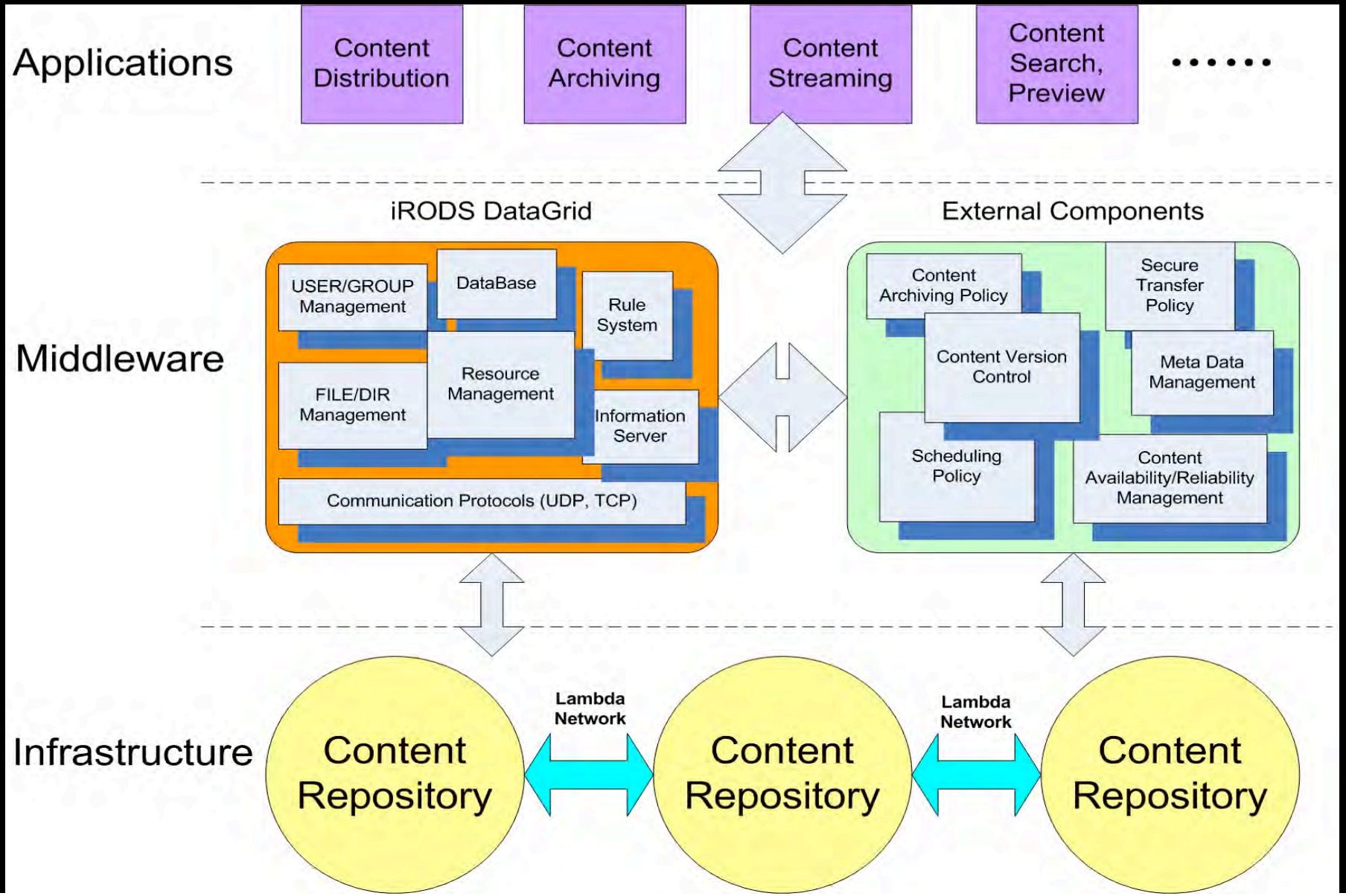
CineGrid @ Holland Festival 2007

CineGrid @ GLIF 2007

CineGrid Exchange

- CineGrid Exchange collects high quality digital media assets, including (but not limited to) 4K, 2K, HD, mono & stereo, still & motion pictures; plus audio with various channel counts. Future addition of 8K, gigapixel, high FPS.
- CineGrid Exchange first three digital repositories already established: more to be added as offered by members
  - UCSD/Calit2 in San Diego
  - UvA in Amsterdam
  - Keio/DMC in Tokyo
- CineGrid has written permissions to make Exchange media accessible to CineGrid members via fast network access.
- CineGrid Exchange will support member-driven testbeds for networked digital media asset management, transcoding, distribution and preservation experiments.

CineGrid Exchange Architecture



CineGrid Exchange Repositories Linked by Networks

San Diego @ UCSD/Calit2 *(56 TB with 10Gbps connectivity)*
Amsterdam @ UvA *(20 TB with 10Gbps connectivity)*
Tokyo @ Keio/DMC *(8 TB with 10 Gbps connectivity)*
Total length = 21,000 km

Integrating File Transfer for CineGrid Exchange

- FTP: most common protocol
- UDT: UDP-based Data Transfer
- RBUDP: Reliable Blast UDP appears fastest for CineGrid Exchange
- Integrated RBUDP into iRODS to support more efficient workflows
  - Convert RBUDP protocol from C++ to C
  - Integrate RBUDP into iRODS communication library
  - Adapt RBUDP functions to iRODS's communication model
  - Test RBUDP + iRODS performance (ongoing)
- Future developments for fast(er) file transfer capabilities
  - Make RBUDP multi-threading capable
  - Reduce RBUDP per file ACK to increase throughput for small files
  - Accelerate disk-to-disk media file transfer via 10 Gbps network

CineGrid Exchange Data Transfer Experiments "4K Digital Camera Originals"

- Live performance of "Magic Lanterns" at AMPAS shot using Dalsa 4K digital cinema cameras connected to purpose-built CODEX field recorder, then copied to external Ciprico disk slower than real-time
- Camera data transferred via network from Los Angeles to CineGrid Exchange in San Diego ~ 100 miles
  - RAW frame size: 16MB
  - RAW data rate: 3.2 Gbps
  - Data volume: 11 TB
  - Network: 1Gbps VLAN over CENIC
- Transfer Speeds Measured: Disk to Disk via network
  - Parallel FTP (MTU 1500) = 160 Mbps
  - Parallel FTP (MTU 9000) = 216 Mbps
  - Parallel FTP + FastSoft (MTU 1500) = 272 Mbps
  - RBUDP (MTU 9000) = 336 Mbps *[RAM to RAM = 930 Mbps]*

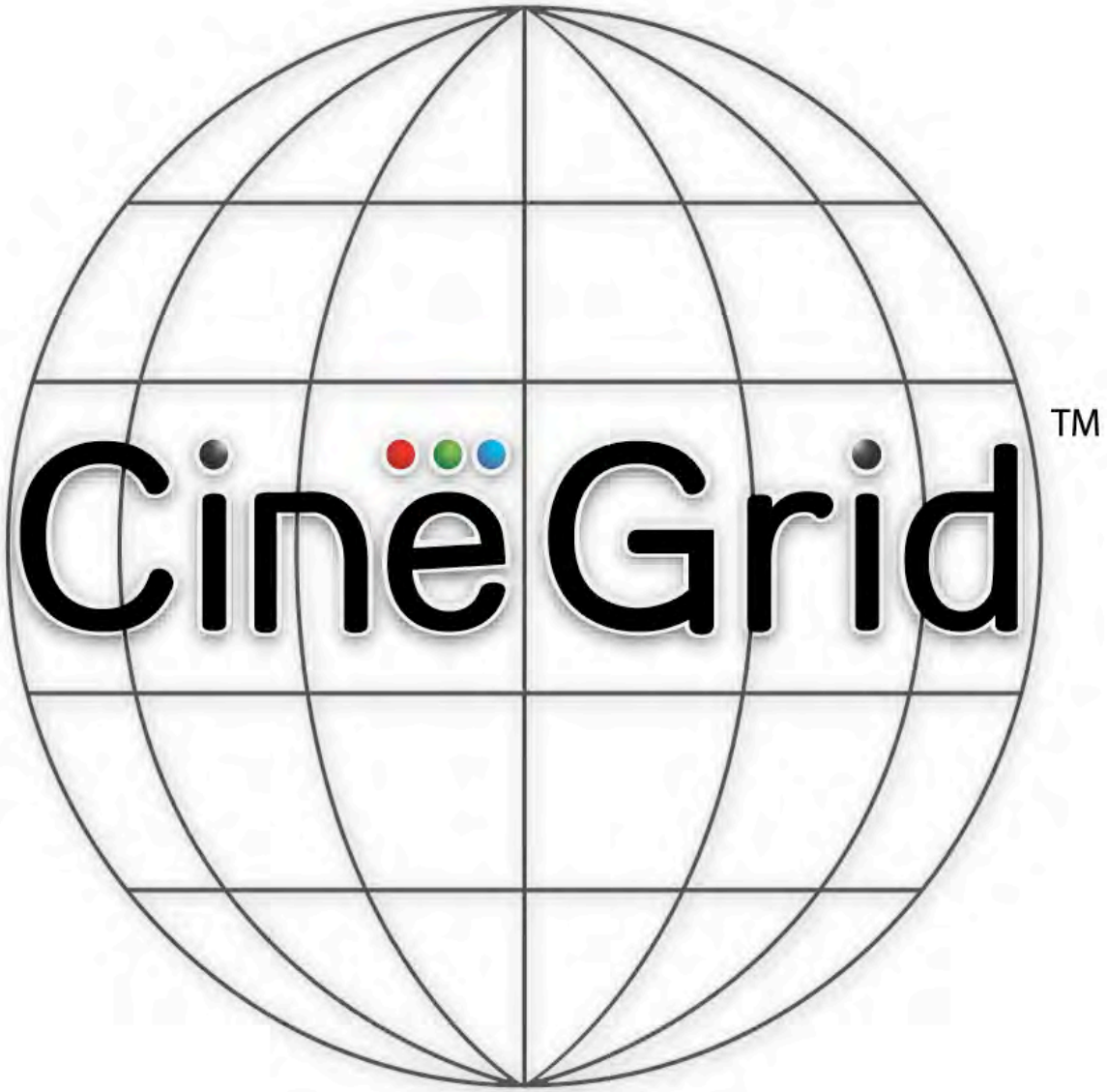
CineGrid Exchange Data Transfer Experiments

Network Capacity	1Gbps	10Gbps	10Gbps	10Gbps
Average Media File Size	2.2 GB	1 GB	1 GB	1 GB
Media Data Volume	2.2 TB	1 TB	1 TB	1 TB
Media Source	Tokyo	San Diego	Amsterdam	Amsterdam
Media Destination	San Diego	Tokyo	San Diego	Tokyo
Disk read speed	4.9Gbps	5.4Gbps	5.3Gbps	5.3Gbps
Disk write speed	3.8Gbps	3.6Gbps	3.5Gbps	3.6Gbps
Network speed (iperf)	750Mbps	6.4Gbps	6Gbps	6Gbps
Disk-2-Disk XFR speed (iRODS+RBUDP)	650Mbps	1.2Gbps	1.2Gbps	1.05Gbps

CineGrid Projects: 2008-2009

- CineGrid Exchange (UCSD/Calit2, Keio/DMC, UvA)
- GreenLight Project (UCSD/Calit2)
- Magic Lanterns (AMPAS/STC, UCSD/Calit2, USC/SCA)
- Alternate Endings (USC/SCA, UCSD/Calit2)
- CineGrid Audio Studio (UCSD/Calit2, Lucasfilm)
- VizCasting (UIC/EVL, Sharp Labs, others)
- Two-Way 4K (NTT, Keio/DMC, UCSD/Calit2, UIC/EVL)
- Photonic Multicasting (CESNET, StarLight, UW)
- Future of the Story (USC/SCA, Keio/DMC)
- And many more…. *Your Project Here !*

CineGrid International Workshop 2007
@ UCSD/Calit2 in San Diego
Save the Date: December 7-10, 2008



www.cinegrid.org