SAGE and UltraGrid
Applications in Research & Education

Maxine D. Brown, Director
Luc Renambot, Senior Research Scientist
Electronic Visualization Laboratory
University of Illinois at Chicago
What is SAGE?

• SAGE – Scalable Adaptive Graphics Environment
• Operating System software to organize visualizations and information on scalable display walls and help researchers deal with problems of scale and complexity in their data.
• Specializes in streaming visualizations from remote rendering servers / supercomputers.
SAGE Walls Are Great For...

Show Context & Detail in Data at the Same Time

High Density Genomic Data Visualization
SAGE Walls Are Great For...

Supporting Data Rich Collaboration

Integrating Disparate Pieces of Evidence

Comparing Stories About The Data
# SAGE Has Received Widespread Adoption

Over 100 sites in 2014

<table>
<thead>
<tr>
<th>Australia</th>
<th>Germany</th>
<th>India</th>
<th>Japan</th>
<th>Saudi Arabia</th>
<th>Taiwan</th>
<th>United States</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>Korea</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Katholieke Universiteit Leuven, IBBT</td>
<td>Gwangju Institute of Science and Technology (GIST) Korea Institute of Science and Technology Information (KISTI)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td>Mexico</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bahiana Medical School Fluminense Federal University, Computer Science Institute Mackenzie University, Laboratory for Cinematic Arts and Visualization Paraiba Federal University, LAViD RNP (Brazilian R&amp;E Network) Santa Izabel Hospital University of Sao Paulo, LAP</td>
<td>Ensenada Center for Scientific Research and Higher Education (CICESE)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td>Netherlands</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CANARIE, Ciena Networks (2) Communications Research Centre Simon Fraser University</td>
<td>SURFsara SURFsara Collaboratorium University of Amsterdam, e-BioScience Laboratory University of Amsterdam, System and Network Engineering Research Group</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>China</td>
<td>New Zealand</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beihang University, State Key Lab of Software Environment Dev. Chinese Academy of Sciences, Computer Network Information Center</td>
<td>Victoria University of Wellington</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Czech Republic</td>
<td>Poland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CESNET Czech Technical Univ in Prague Masaryk Univ, Lab of Advanced Networking Technologies (2)</td>
<td>Poznan Supercomputing and Networking Center</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Russia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Russian Academy of Sciences, Science and Innovation Center Russian Academy of Sciences, Space Research Institute</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>United States</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NASA Marshall Space Flight Center Naval Postgraduate School (7) Northwestern University, iCAIR Purdue University, Envision Center for Data Perceptualization Raincon Research Corporation Sharp Laboratories of America South Metro Career Center Texas A&amp;M University, Computer Science United States Geological Survey, Earth Resources Obs and Science Univ California, Davis, Institute for Ultra-Scale Visualization Univ California, San Diego Nat’l Ctr for Microscopy and Imaging Rsrh Univ California, San Diego, Scripps Institution of Oceanography University of Hawaii, Center for Microbial Oceanography: Research and Education (2) University of Illinois at Chicago (UIC), ACM Student Chapter UIC, Electronic Visualization Lab (EVL), CAVE2 UIC, EVL, Cyber-Commons 3D UIC Graham Clinical Performance Center UIC Innovation Center UIC Pathology Department UIUC National Center for Supercomputing Applications University of Michigan, Dept. of Atmospheric, Oceanic &amp; Space Sciences University of Michigan, Digital Media Commons University of Michigan, School of Information University of Texas at Austin, Texas Advanced Computing Center (TACC) University of Washington Zoom Digital Signage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SAGE User Sites 2014**

- Australia
  - AARNet
  - Australian National University
  - CSIRO Discovery Center
  - CSIRO Info. and Communication Technologies
  - Marsfield
  - Monash University – Caulfield
  - Monash University – Clayton
  - Monash University – Clayton, eResearch Centre, CAVE2
  - University of Melbourne
  - University of Queensland
- Belgium
  - Katholieke Universiteit Leuven, IBBT
- Brazil
  - Bahiana Medical School
  - Fluminense Federal University, Computer Science Institute
  - Mackenzie University, Laboratory for Cinematic Arts and Visualization
  - Paraiba Federal University, LAViD
  - RNP (Brazilian R&E Network)
  - Santa Izabel Hospital
  - University of Sao Paulo, LAP
- Canada
  - CANARIE
  - Ciena Networks (2)
  - Communications Research Centre
  - Simon Fraser University
- China
  - Beihang University, State Key Lab of Software Environment Dev.
  - Chinese Academy of Sciences, Computer Network Information Center
- Czech Republic
  - CESNET
  - Czech Technical Univ in Prague
  - Masaryk Univ, Lab of Advanced Networking Technologies (2)

**Additional Sites**

- NASA Marshall Space Flight Center
- Naval Postgraduate School (7)
- Northwestern University, iCAIR
- Purdue University, Envision Center for Data Perceptualization
- Raincon Research Corporation
- Sharp Laboratories of America
- South Metro Career Center
- Texas A&M University, Computer Science
- United States Geological Survey, Earth Resources Obs and Science
- Univ California, Davis, Institute for Ultra-Scale Visualization
- Univ California, San Diego Nat’l Ctr for Microscopy and Imaging Rsrh
- Univ California, San Diego, Scripps Institution of Oceanography
- University of Hawaii, Center for Microbial Oceanography: Research and Education (2)
- University of Illinois at Chicago (UIC), ACM Student Chapter
- UIC, Electronic Visualization Lab (EVL), CAVE2
- UIC, EVL, Cyber-Commons 3D
- UIC Graham Clinical Performance Center
- UIC Innovation Center
- UIC Pathology Department
- UIUC National Center for Supercomputing Applications
- University of Michigan, Dept. of Atmospheric, Oceanic & Space Sciences
- University of Michigan, Digital Media Commons
- University of Michigan, School of Information
- University of Texas at Austin, Texas Advanced Computing Center (TACC)
- University of Washington
- Zoom Digital Signage

**Updated February 2, 2014**
SAGE and UltraGrid

- www.ultragrid.cz is part of SAGE distribution
- We use UltraGrid to stream visualizations over “best effort” and high-performance networks, as it does not require any network engineering
- UltraGrid supports HD, 4K and 3D video
  - With and without compression
- UltraGrid supports also webcams
  - H264 hardware encoder at ~ 8Mbps
  - Low CPU load
  - Decompression on client side
  - Under $100
4K 3D Movies Streamed from Poland to Chicago
US Ignite Application Summit in Chicago, June 25, 2013

- Poznan Supercomputing and Networking Center (PSNC) streamed 3D-interleaved 4K movies to EVL over the GLIF infrastructure.
- UltraGrid (CESNET and Masaryk University, Czech Republic) used to do the streaming. Streams averaged 3.4Gbps.
- SAGE used to push the movie frames onto 3D tiled display wall and open additional windows with supporting information.
SAGE Video from EVL CAVE2™ to Calit2-QI VROOM

- Panasonic GH3 and wide-angle lens
- Uncompressed HDMI output to Blackmagic card
- UltraGrid real-time compression (H264 at 10Mbps)
- Displayed using SAGE on VROOM wall

“Perhaps the best [demo] I have ever seen!” – Larry Smarr, Calit2 Director
Distributed Class: Chicago/Honolulu
UIC/EVL and Univ Hawaii Manoa, Spring 2014

- UIC: Andrew Johnson
- UHM: Jason Leigh
- Co-teach “Visualization and Visual Analytics”
- Class meets twice a week: once local, once distributed
- Once a week: SAGE wall to wall collaboration
- Used both LifeSize and Webcam
Distributed Class: Chicago/Honolulu
UIC/EVL and Univ Hawaii Manoa, Spring 2014
SAGE R&D Mtgs: Chicago/Honolulu
UIC/EVL and Univ Hawaii Manoa, Ongoing

- UIC: Luc Renambot, Lance Long and graduate student SAGE developers
- UHM: Jason Leigh
- Webcam H264 + echo-cancelling microphone
- $80 + $120
Thank You!

Electronic Visualization Laboratory
University of Illinois at Chicago

Maxine Brown
Luc Renambot

maxine@uic.edu
www.evl.uic.edu
www.youtube.com/evltube
www.facebook.com/UIC.EVL

www.evl.uic.edu