



# 100Gbps Transatlantic Science Trials Workshop

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# What is SAGE?



- SAGE – Scalable Adaptive Graphics Environment
- Operating System software for organizing visualizations and information on scalable display walls to help researchers deal with problems of scale and complexity in their research.
- Specializes in streaming visualizations from remote rendering servers / supercomputers.

# What is SAGE?

Bitplayer  
Streaming animation of  
tornado simulation using  
UDP.  
516 Mbps

MagicCarpet  
Streaming Blue Marble dataset  
from San Diego to EVL using  
UDP.  
6.7Gbps

About 9 Gbps in total.  
SAGE can simultaneously support these applications  
without decreasing their performance

SVC  
Locally streaming HD  
camera live video using  
UDP.  
538Mbps

JuxtaView  
Locally streaming the aerial  
photography of downtown  
Chicago using TCP.  
850 Mbps

# SAGE User Community

## Over 107 Sites (58 U.S. and 49 Global)

SAGE User Sites 2013			
<b>Australia</b> <ul style="list-style-type: none"> <li>AARNet</li> <li>Australian National University</li> <li>CSIRO Discovery Center</li> <li>CSIRO Information and Communication Technologies, Marsfield</li> <li>Monash University – Caulfield</li> <li>Monash University – Clayton</li> <li>Monash University – Clayton, eResearch Centre, CAVE2</li> <li>University of Melbourne</li> <li>University of Queensland</li> </ul>	<b>Japan</b> <ul style="list-style-type: none"> <li>Cybernet Systems Co., Inc.</li> <li>Knowledge Capital, VisLab Osaka</li> <li>Kyoto University</li> <li>National Institute of Adv. Industrial Science and Technology (AIST)</li> <li>National Institute of Information and Communications Technology (NICT), Koganei, Japan (3)</li> <li>NICT, Keihanna Research Center</li> <li>NTT Advanced Technologies Corp</li> <li>NTT Network Innovation Laboratories, Yokosuka</li> <li>Osaka University, CyberMedia Center</li> </ul>	<b>Saudi Arabia</b> <ul style="list-style-type: none"> <li>King Abdullah University for Science and Technology (KAUST)</li> </ul>	<ul style="list-style-type: none"> <li>Purdue University, Envision Center for Data Perceptualization</li> <li>Rincon Research Corporation</li> <li>Sharp Laboratories of America</li> <li>South Metro Career Center</li> <li>Texas A&amp;M University, Computer Science</li> <li>Earth Resources Obs and Science</li> <li>United States Geological Survey</li> <li>Univ California, Davis, Institute for Ultra-Scale Visualization</li> <li>Univ California, San Diego Nat'l Ctr for Microscopy and Imaging Rsrh</li> <li>Univ California, San Diego, Scripps Institution of Oceanography</li> <li>University of Hawaii, Center for Microbial Oceanography: Research and Education (2)</li> <li>University of Illinois at Chicago (UIC), ACM Student Chapter</li> <li>UIC, Electronic Visualization Lab (EVL), CAVE2</li> <li>UIC, EVL, Cyber-Commons 3D</li> <li>UIC Graham Clinical Performance Center</li> <li>UIC Innovation Center</li> <li>UIC Pathology Department</li> <li>UIUC National Center for Supercomputing Applications</li> <li>University of Michigan, Dept. of Atmospheric, Oceanic &amp; Space Sciences</li> <li>University of Michigan, Digital Media Commons</li> <li>University of Michigan, School of Information</li> <li>University of Texas at Austin, Texas Advanced Computing Center (TACC)</li> <li>University of Washington</li> <li>Zoom Digital Signage</li> </ul>
<b>Belgium</b> <ul style="list-style-type: none"> <li>Katholieke Universiteit Leuven, IBBT</li> </ul>	<b>Korea</b> <ul style="list-style-type: none"> <li>Gwangju Institute of Science and Technology (GIST)</li> <li>Korea Institute of Science and Technology Information (KISTI)</li> </ul>	<b>Taiwan</b> <ul style="list-style-type: none"> <li>National Center for High-performance Computing (NCHC)</li> <li>National Central University, GeoComputing Laboratory</li> </ul>	
<b>Brazil</b> <ul style="list-style-type: none"> <li>RNP (Brazilian R&amp;E Network)</li> <li>University of Sao Paulo, Laboratory of Computer Architecture and Networks</li> </ul>	<b>Mexico</b> <ul style="list-style-type: none"> <li>Ensenada Center for Scientific Research and Higher Education (CICESE)</li> </ul>	<b>United States</b> <ul style="list-style-type: none"> <li>Adler Planetarium &amp; Astronomy Museum</li> <li>Argonne National Laboratory, Center for Nanoscale Materials (2)</li> <li>Argonne National Laboratory, Math and Computer Science</li> <li>Argonne National Laboratory, Transportation Research and Analysis Computing Center</li> <li>Calit2/U California, Irvine</li> <li>Calit2-QI/U California, San Diego (7)</li> <li>Casa Familiar</li> <li>Case Western Reserve University, Kelvin Smith Library</li> <li>Extreme Networks</li> <li>Florida International University, Center for Internet Augmented Research &amp; Assessment (CIARA)</li> <li>Lakota Technical Solutions Inc</li> <li>Louisiana State University, Center for Computation and Technology</li> <li>Lucasfilm, Information Technology</li> <li>Michigan Technological Univ., Computer Science</li> <li>Monsanto (3)</li> <li>NASA Ames Research Center, Lunar Science Institute</li> <li>NASA Goddard Space Flight Center, Space Visualization Studio</li> <li>Naval Postgraduate School (7)</li> <li>Northwestern University, Int'l Center for Advanced Internet Research (ICAIR)</li> </ul>	
<b>Canada</b> <ul style="list-style-type: none"> <li>CANARIE</li> <li>Ciena Networks (2)</li> <li>Communications Research Centre</li> <li>Simon Fraser University</li> </ul>	<b>Netherlands</b> <ul style="list-style-type: none"> <li>SURFsara</li> <li>SURFsara Collaboratorium</li> <li>University of Amsterdam, e-BioScience Laboratory</li> <li>University of Amsterdam, System and Network Engineering Research Group</li> </ul>		
<b>China</b> <ul style="list-style-type: none"> <li>Beihang University, State Key Lab of Software Environment Dev.</li> <li>Chinese Academy of Sciences, Computer Network Information Center</li> </ul>	<b>New Zealand</b> <ul style="list-style-type: none"> <li>Victoria University of Wellington</li> </ul>		
<b>Czech Republic</b> <ul style="list-style-type: none"> <li>Czech Technical Univ in Prague</li> <li>Masaryk Univ, Lab of Advanced Networking Technologies (2)</li> </ul>	<b>Poland</b> <ul style="list-style-type: none"> <li>Poznan Supercomputing and Networking Center</li> </ul>		
<b>Germany</b> <ul style="list-style-type: none"> <li>Braunschweig University of Technology, Institute of Computer and Network Engineering</li> </ul>	<b>Russia</b> <ul style="list-style-type: none"> <li>Russian Academy of Sciences, Science and Innovation Center</li> <li>Russian Academy of Sciences, Space Research Institute</li> </ul>		
<b>India</b> <ul style="list-style-type: none"> <li>Monsanto Research Centre</li> </ul>			



# New SAGE Grant

- Address Community Requests:
  - Greater reliability, Enabling Greater Integration of Visualization Tools, Enhanced collaboration.
- Leverage emerging technologies:
  - Cloud Services, Hybrid Reality Environments, Software Defined Networks.

# SAGE and SDN

- Planning trials at 100Gbps from UIC to StarLight to SURFsara in The Netherlands
- Working with Masaryk University to do transatlantic trials with UltraGrid at 100Gbps
- Working with Osaka University/NICT to incorporate SDN/OpenFlow into SAGE
- Working with Argonne National Lab to stream volumetric visualizations to CAVE2
- Talking with Monash University, Australia, about streaming CAVE2-to-CAVE2

# 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.





# Petr Holub

## UltraGrid

- [www.ultragrid.cz](http://www.ultragrid.cz), part of SAGE distribution
- HD/4K/8K video support, audio support
- Uncompressed video/audio transmission
- Compression support:
  - CUDA-based GPU JPEG
  - low-latency H.264 (GPL, based on X264)
  - SILK for audio
- UltraGrid v1.2 release optimizes SAGE interface
- Talking with EVL to get access to 100Gbps for UltraGrid

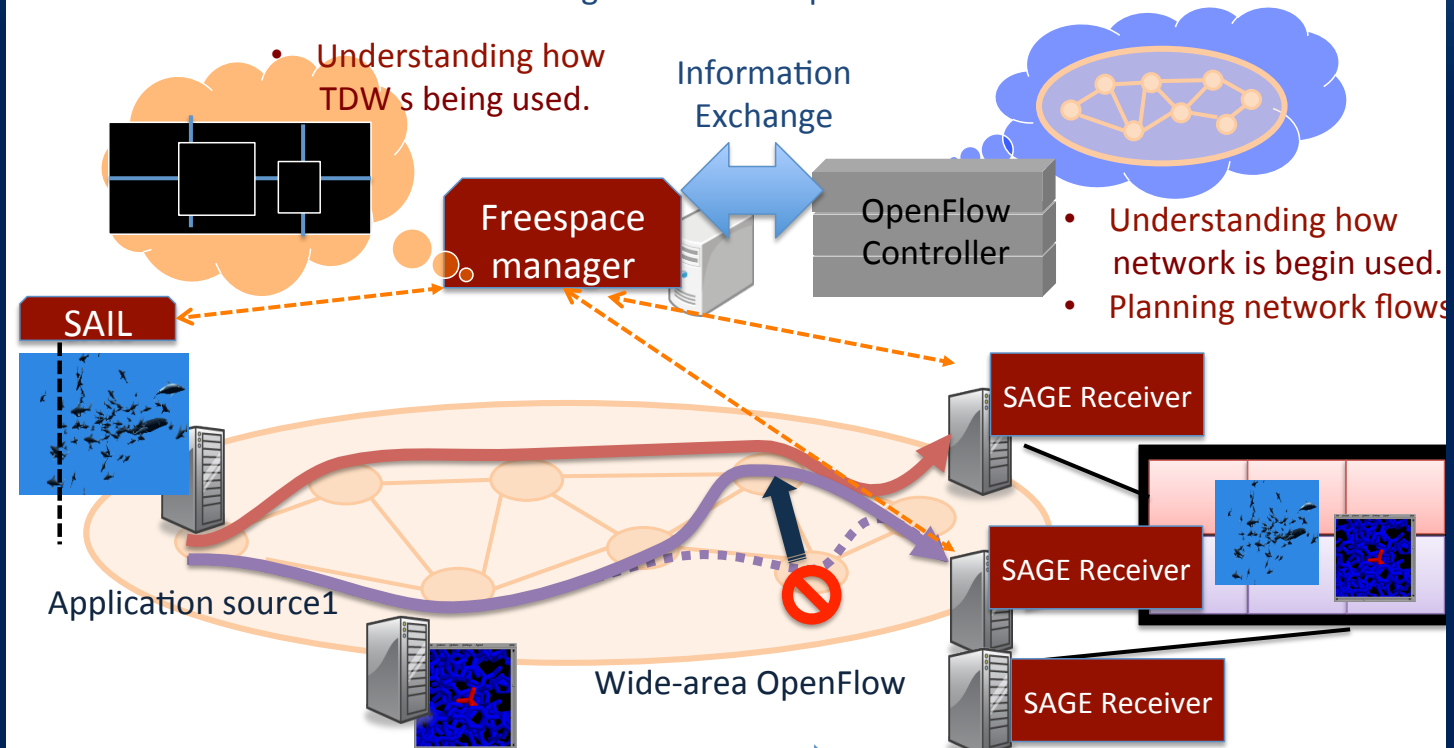


# Shinji Shimojo

## SDN-Enhanced SAGE



- Goal: dynamic flow control of multiple network streams from multiple sites for smooth user-interaction & visualization
- Approach: having SAGE interact with OpenFlow controller as a software program that controls the whole network against network parameters resulted from user interaction.



**How efficiently can we use network?** → Visit OsakaU (#2538) and NICT (#4341)

[http://sc.ime.cmc.osaka-u.ac.jp/wp/wp-content/themes/STARLIGHT/TRANS LIGHT/sc\\_wp/pdf/sc12-demo2-date.pdf](http://sc.ime.cmc.osaka-u.ac.jp/wp/wp-content/themes/STARLIGHT/TRANS LIGHT/sc_wp/pdf/sc12-demo2-date.pdf)

STARLIGHT  
TRANS LIGHT

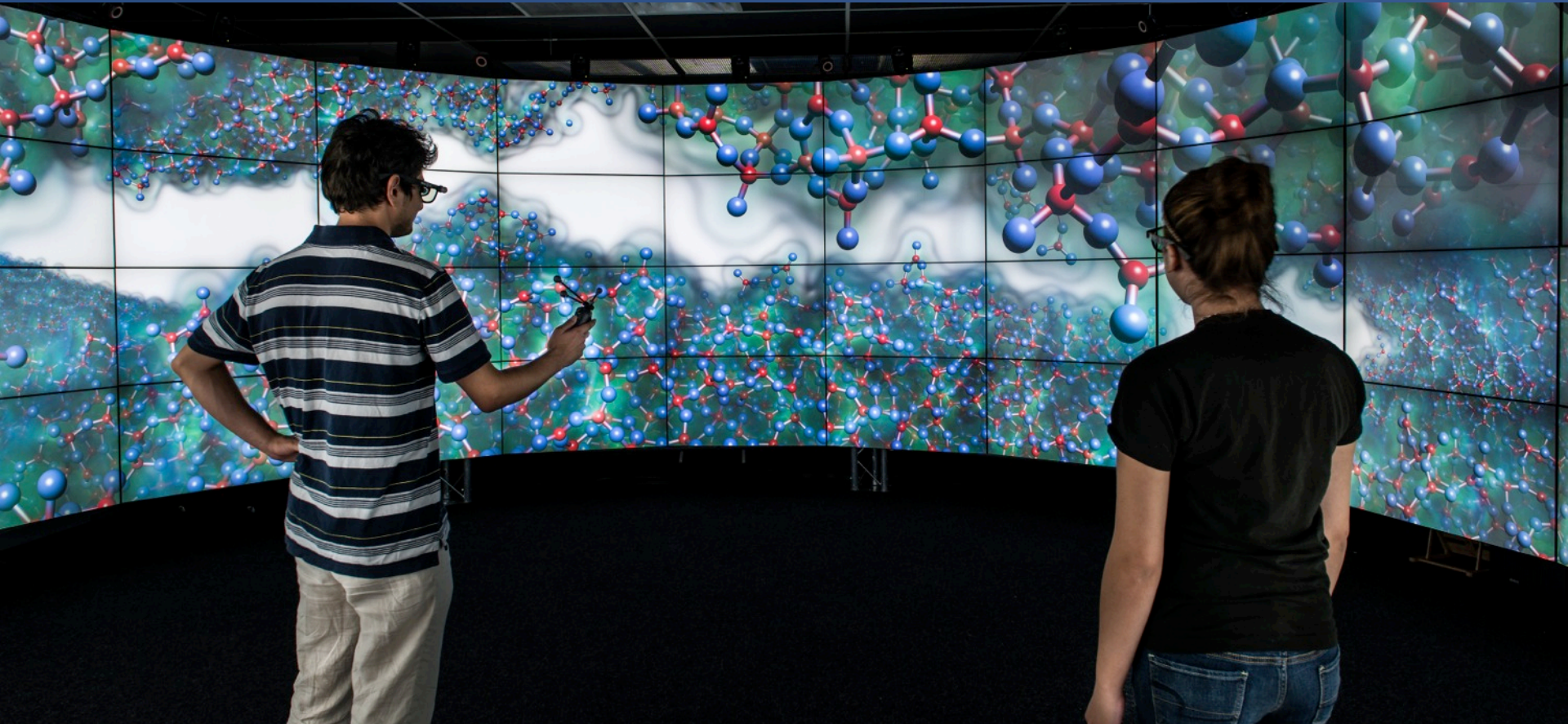
glif





Tomoya Furuichi, Susumu Date, Hiroaki Yamanaka, Kohei Ichikawa, Hirotake Abe, Haruo Takemura, and Eiji Kawai, "A prototype of network failure avoidance functionality for SAGE using OpenFlow", Proceedings of 2012 IEEE 36th International Conference on Computer Software and Applications Workshops (The Sixth Middleware Architecture in the Internet (MidArch 2012)), pp.88-93, Jul. 2012.

# Mike Papka, ALCF Argonne National Laboratory

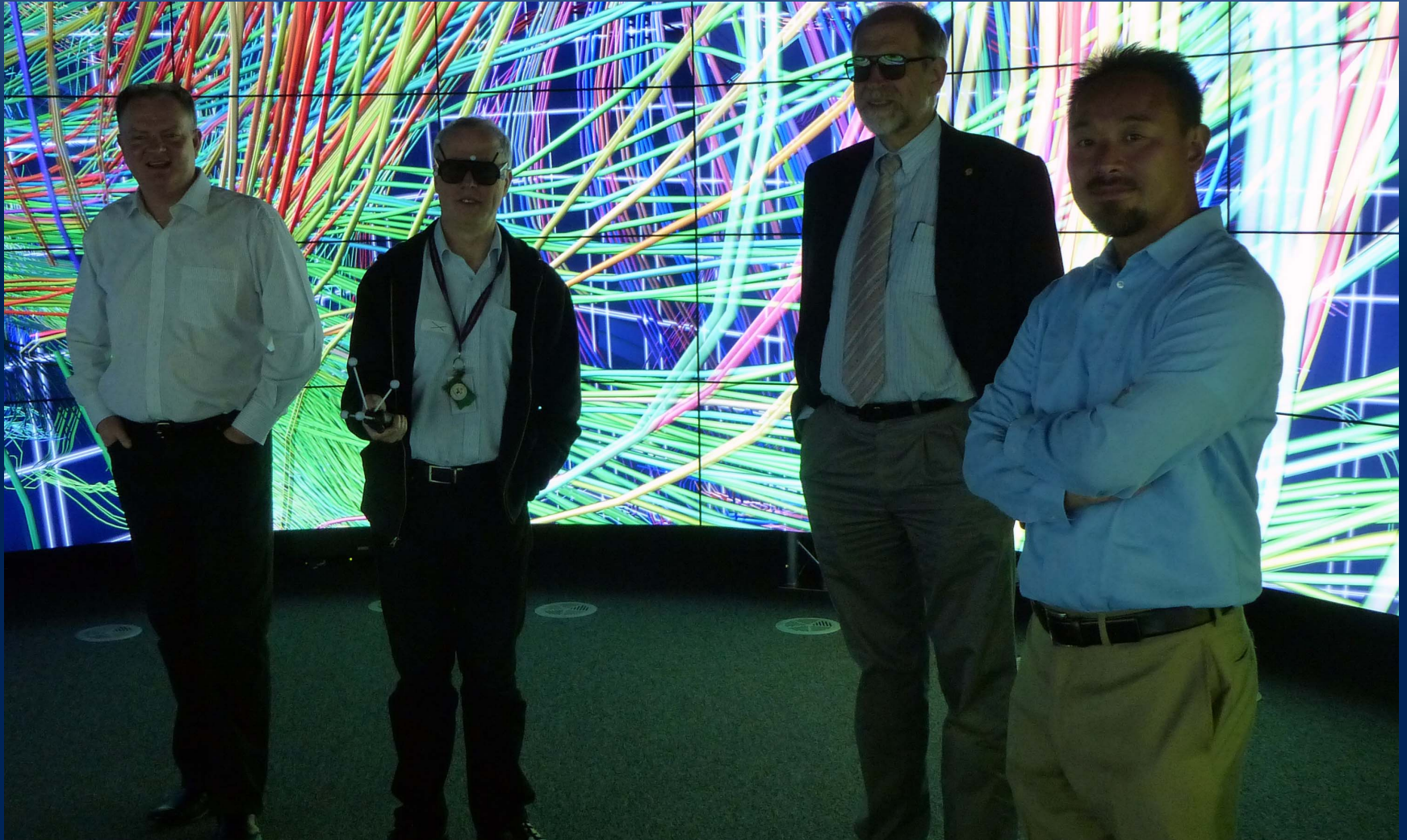


Khairi Reda, an EVL research assistant and computer science PhD candidate, uses the CAVE2 to fly through a close-up of a glass fissure computed in a 5-Million atom molecular dynamics simulation. Visualization by Reda, Aaron Knoll and Michael Papka of the Argonne Leadership Computing Facility (ALCF) at Argonne National Laboratory. Simulation and data provided by Kenichi Nomura and Priya Vashishta of University of Southern California. EVL OmegaLib software is used to display the 3D model in CAVE2



# Paul Bonnington

## Monash University, Australia







SC13 Birds of a Feather Meeting  
Tuesday, November 19 2013  
12:15PM – 01:15PM

Colorado Convention Center Rooms 501/502  
[www.sagecommons.org](http://www.sagecommons.org)

# Thank You

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