



Illuminating the Shadow Mesh: Red Storm Visualization

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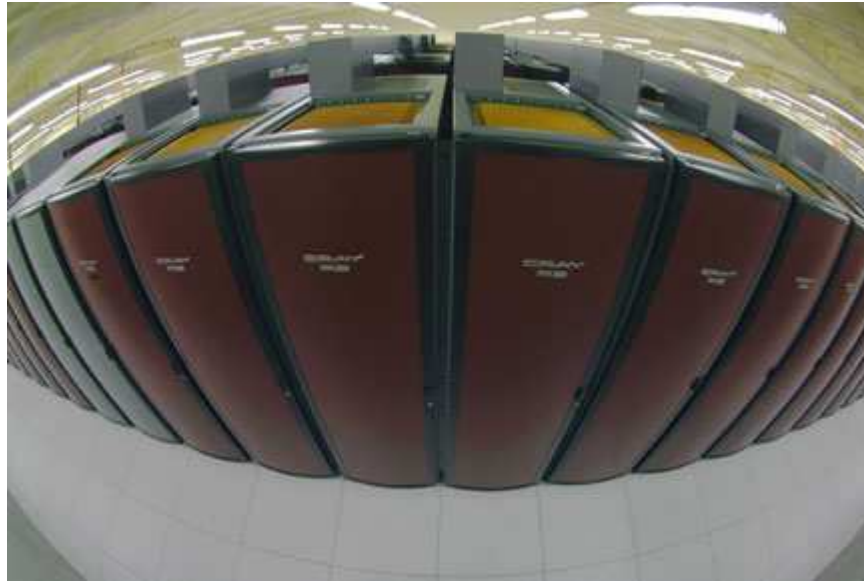
Albuquerque, New Mexico

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Illuminating the Shadow Mesh

Red Storm Overview



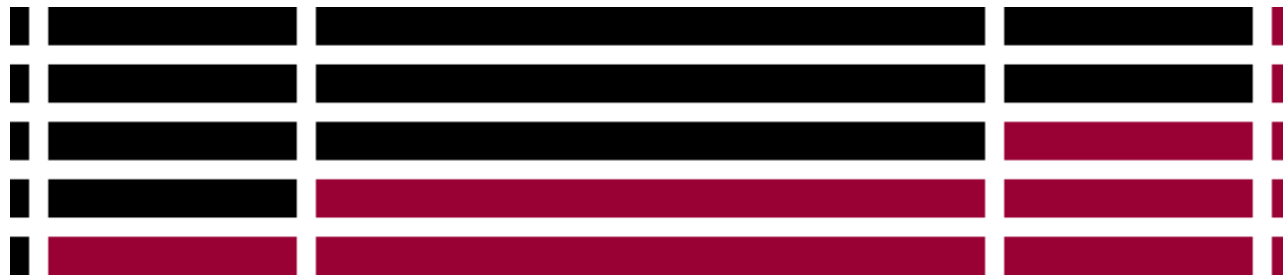
- 5 cabinet rows, 175 total cabinets
- 12,960 dual-core compute nodes: 25,920 total cores
- 640 dual-core service nodes
- 101.4 TFlops performance, #2 on Nov. '06 Top500



Illuminating the Shadow Mesh

Red Storm Overview

- 320 TB of disk storage
- Lustre file system
- Partial Torus
- Lightweight Catamount kernel
- Physically re-partitionable



Illuminating the Shadow Mesh Luz Design Considerations

- Represent the logical or virtual system
- Represent the physical system

- Mapping Information, Wish to overlay:
 - ◆ Physical onto logical
 - ◆ Logical onto physical
 - ◆ System meta-data onto visualization
- Employ 3D visualization to explore & understand routing



Illuminating the Shadow Mesh Luz Design, User Profiles

- System Administrators & Managers
 - ◆ Need status & statistics
 - ◆ Need real-time decision support
- System Engineers
 - ◆ Need detailed, low-level information
 - ◆ Need physical-to-logical system translation
- XT3 Developers
 - ◆ Need statistics and historical information
- HPC Research & Analysis
- General HPC Management



Illuminating the Shadow Mesh

Luz, Goals for base functionality

- Must present multiple views of system
 - ◆ Physical View
 - ◆ Logical View
- Tight coupling with system logs and data bases
- Provide interface for direct MySQL querying
- Luz user interface (GUI) must be intuitive & powerful
- Leverage information visualization techniques
 - ◆ Present mesh as a volume
 - ◆ Transparency for context without clutter
 - ◆ Interactive object selection



Illuminating the Shadow Mesh Luz, Base Functionality Support

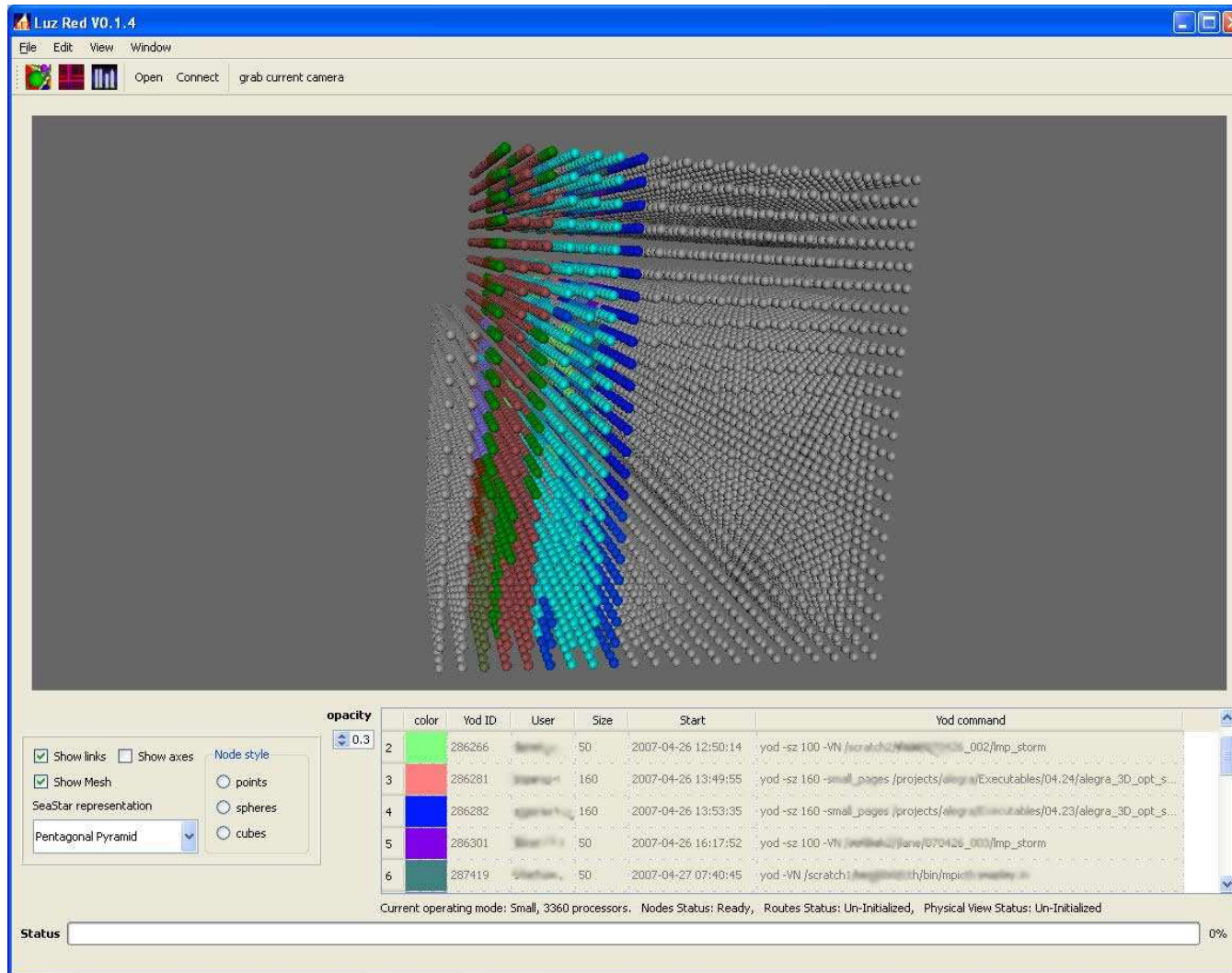
- Many layers below the hood
 - ◆ C++ Implementation
 - ◆ Visualization Tool Kit for visualization library
 - ◆ Qt for cross-platform GUI

- Luz is a suite of tools wrapped as one application
 - ◆ Scripts and daemons interacting with system data base
 - ◆ Network and firewall negotiation
 - ◆ Daemons monitoring system log
 - ◆ Job status and allocation updating
 - ◆ Scripts interacting with Luz database for ShadowMesh
 - ◆ Other Luz support services, address translation etc...



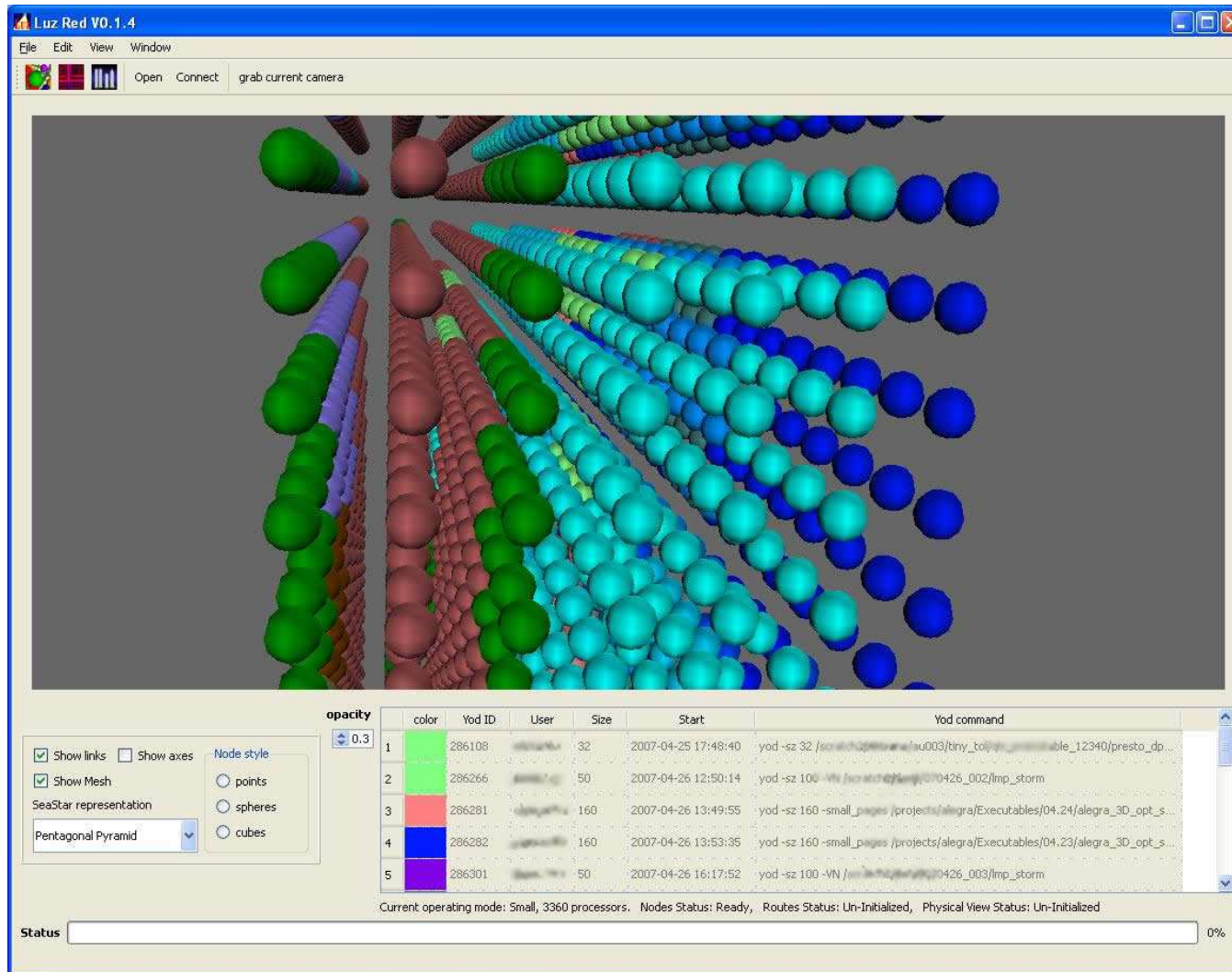
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Luz Preview

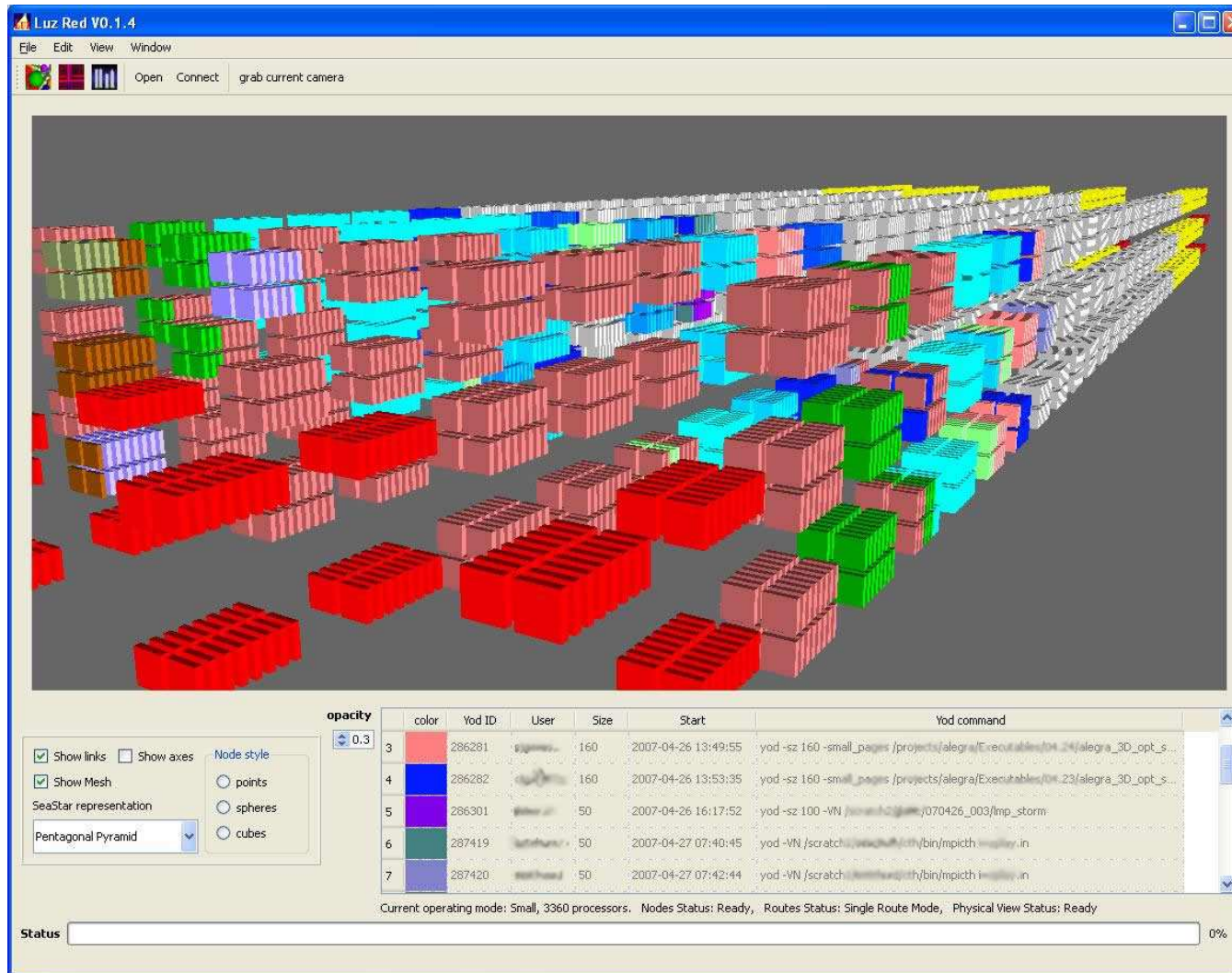


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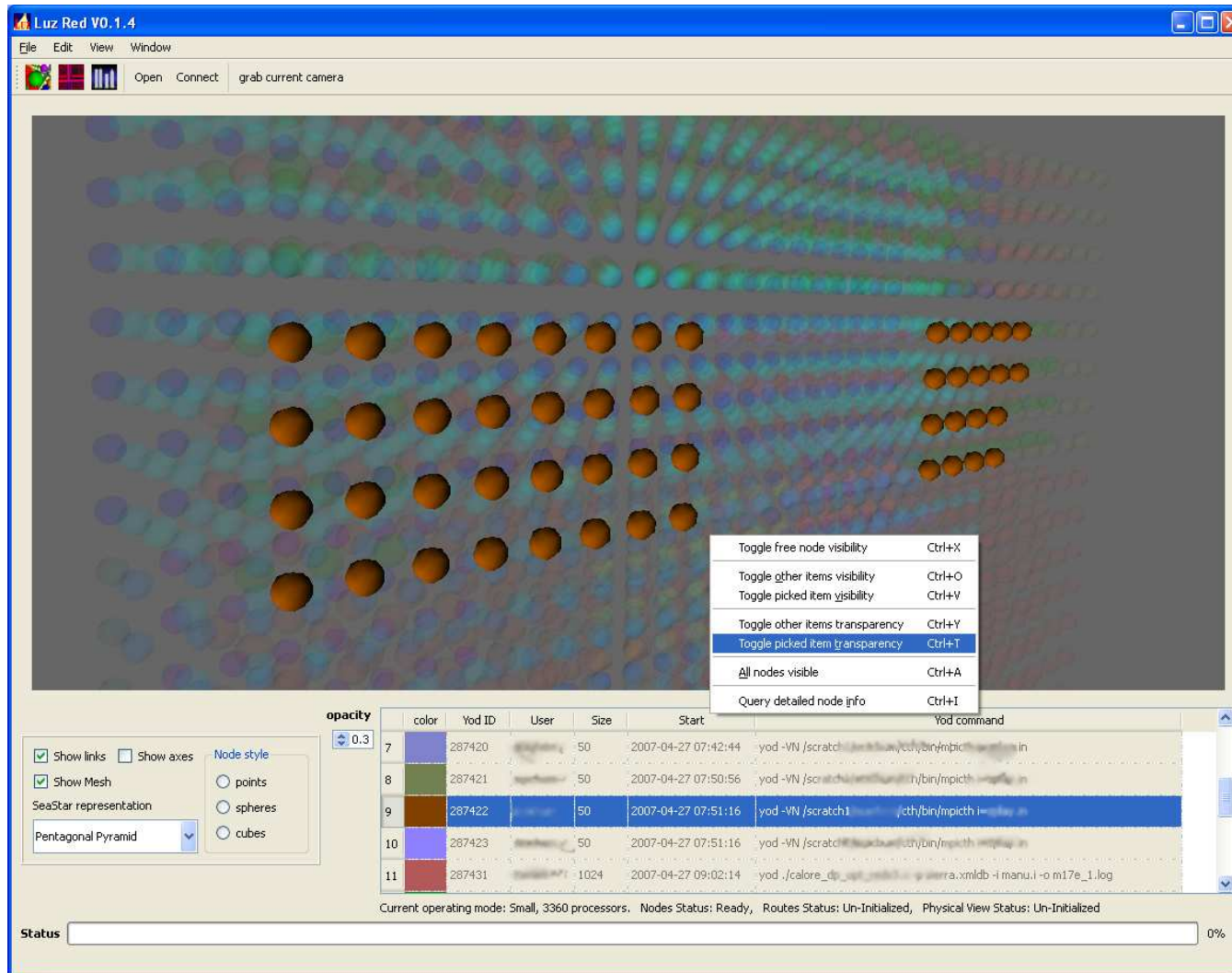
Luz Preview



Illuminating the Shadow Mesh Luz Preview

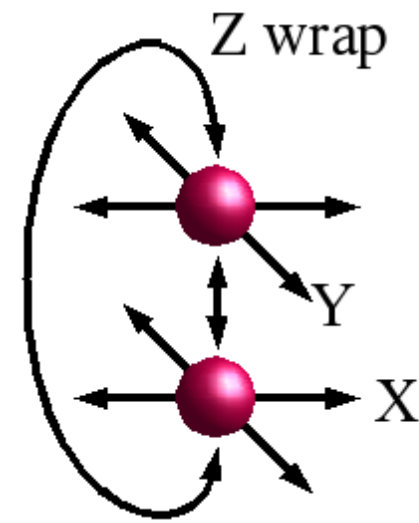


Illuminating the Shadow Mesh Luz Preview



Illuminating the Shadow Mesh Red Storm Routing

- Logical space is 3D partial torus
- Cray SeaStar Networking
 - ◆ Bi-directional in (X, Y, Z)
 - ◆ Provides link to L0 control system
 - ◆ Also DMA engine
- Only logical Z dimension wraps
- Routing is static, calculated at boot
- Route dimension preference: X, Y, Z
- Big source of job failures,
job hangs, maintenance concerns,
unknown system state



Illuminating the Shadow Mesh

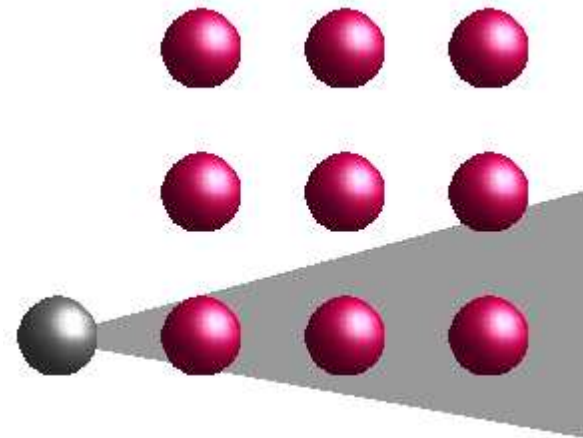
Luz, Looking into the Mesh

- Opteron failure
 - ◆ Current job needs re-start
 - ◆ Removed from node queue
- SeaStar failure
 - ◆ Current job needs re-start
 - ◆ What else? Good question!
- The failed job is explicit
- What are the implicit and indirect consequences?



Illuminating the Shadow Mesh Luz, Shadow Mesh

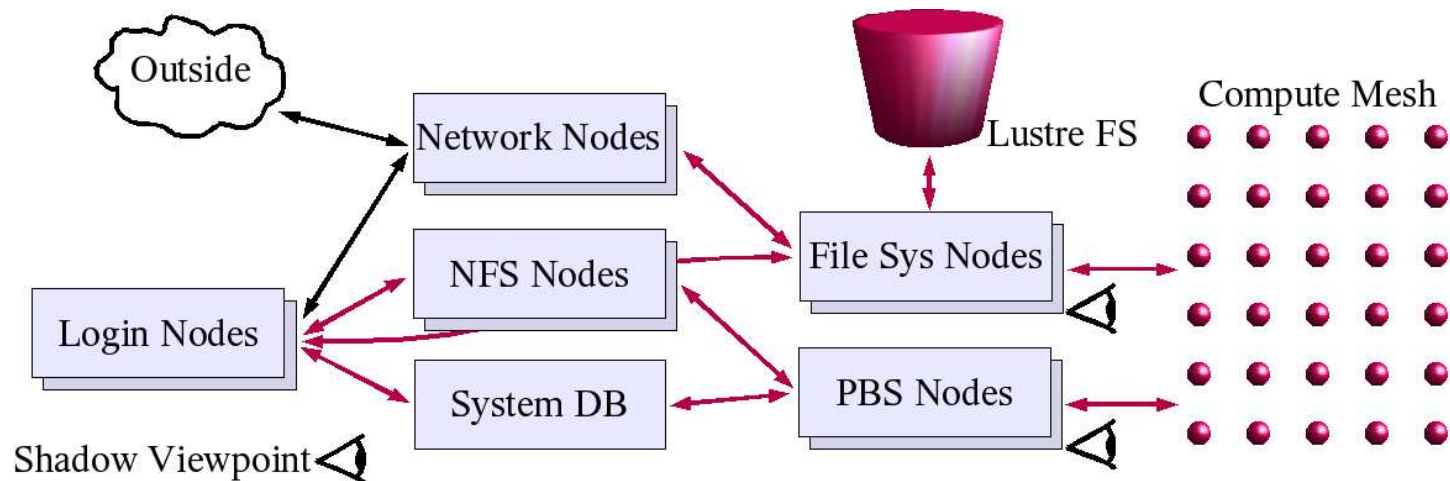
- A dead SeaStar casts a ‘quiet’ shadow
 - ◆ No communication to PBS nodes
 - ◆ No communication to Lustre
 - ◆ No nuthin’
- Not able to dynamically re-route around the dead link
- All nodes downstream are now isolated and “in shadow”
- Question: downstream with respect to which nodes?
- What to do? Just re-boot 25K nodes?



Illuminating the Shadow Mesh

Luz, Defining a Shadow

- Many shadows cast in Red Storm by a dead link
- Potentially compute a “shadow set” from
 - ◆ Login nodes
 - ◆ PBS nodes
 - ◆ Lustre nodes
 - ◆ Compute nodes



Illuminating the Shadow Mesh

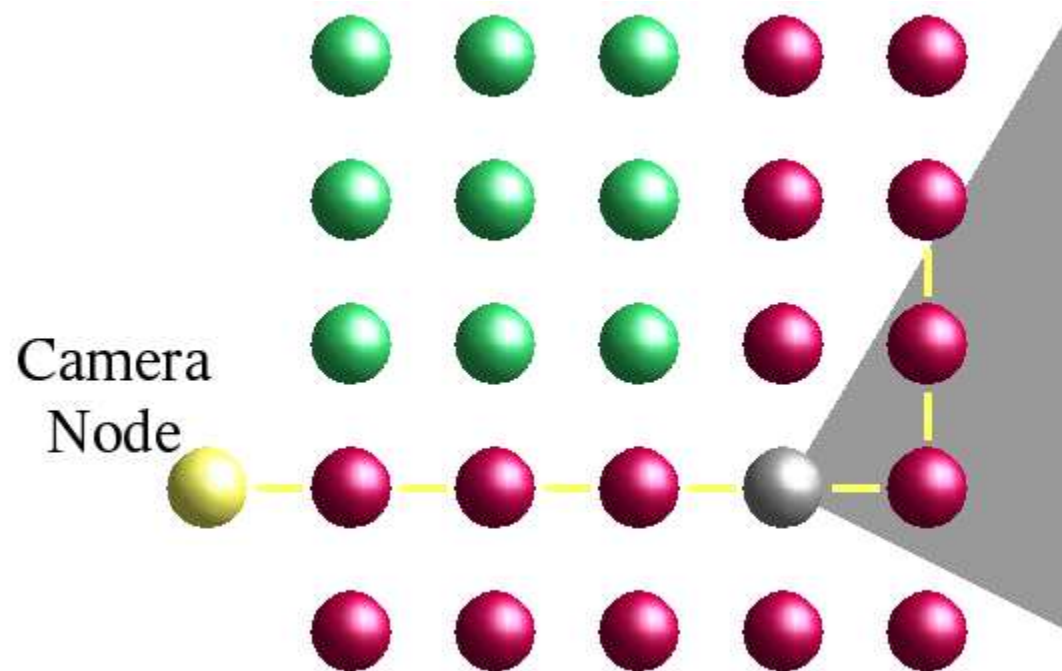
Luz, Defining a Shadow

- Could define shadow as set of nodes suffering any reduced connectivity as result of dead link
- Motivation:
 - ◆ Enable decision making
 - ◆ Optimize Red Storm utilization and performance
- Shadow Mesh gives a cost
- System administrators use cost-benefit analysis to determine response to SeaStar failure
- Q: What is the shadow? A: That depends.
- Allow selection of “camera viewpoints” to define shadow



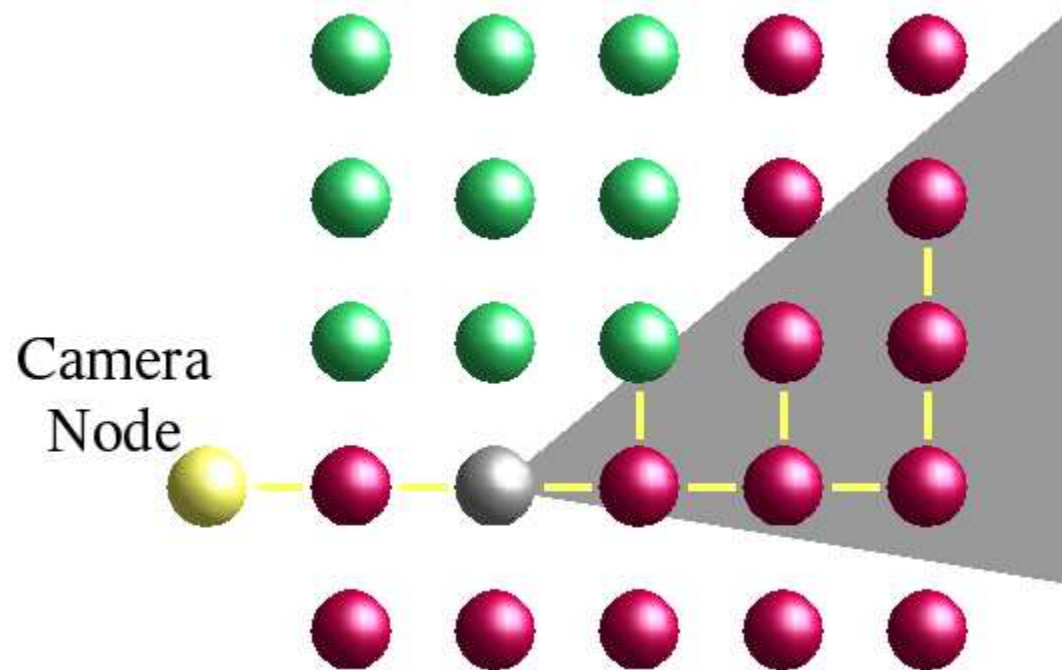
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Luz, Defining a Shadow



Illuminating the Shadow Mesh

Luz, Defining a Shadow



Illuminating the Shadow Mesh

Luz, Computing the Shadow Set

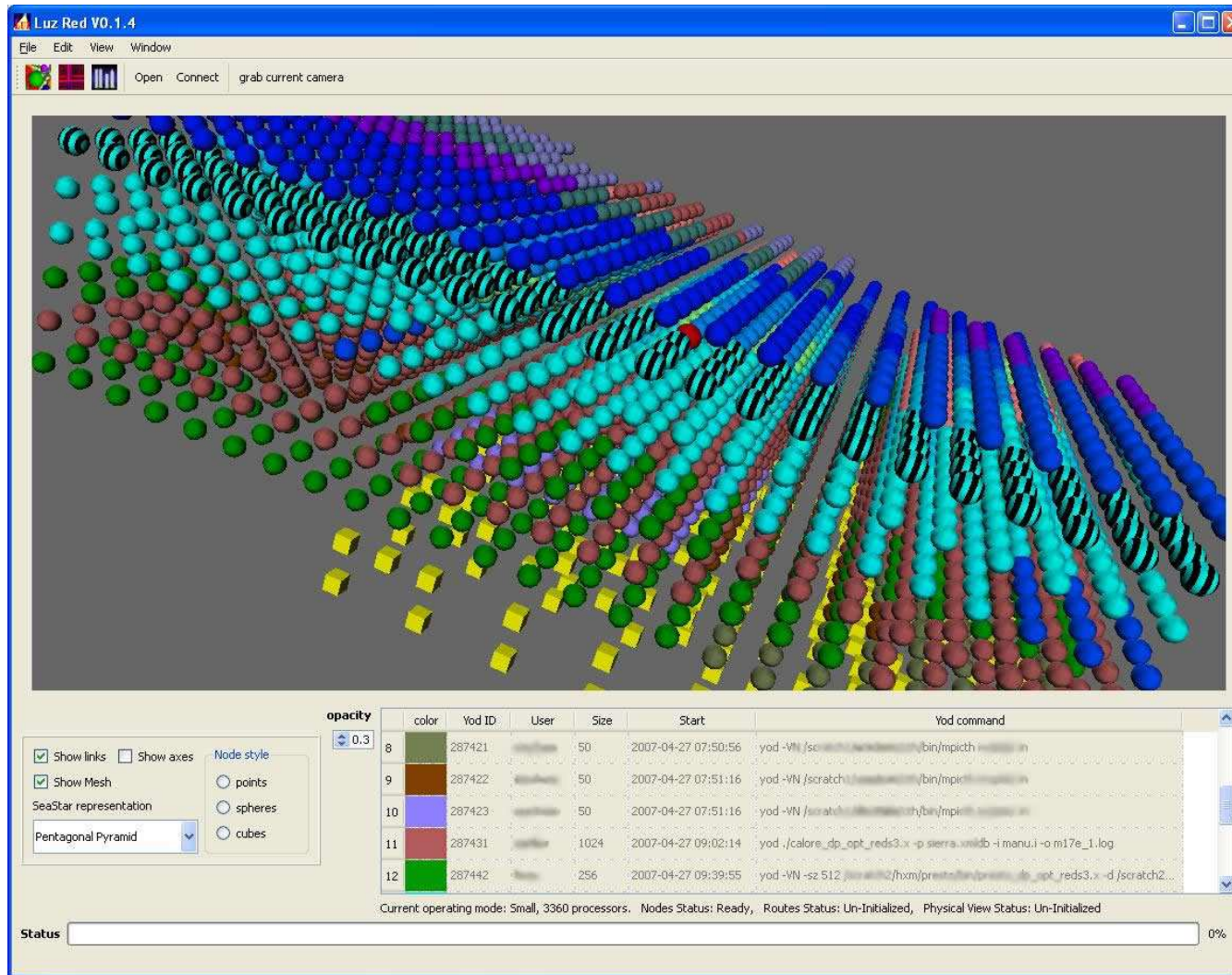
- Need custom MySQL schema to allow real-time shadow computation
- Routing is not symmetric
- Route table re-computed upon boot

Field	Type	Null	Key
beg	smallint(6)	YES	MUL
end	smallint(6)	YES	
hop_src	smallint(6)	YES	MUL
hop_dst	smallint(6)	YES	MUL
hop_src_output_port	tinyint(4)	YES	
hop_dst_input_port	tinyint(4)	YES	



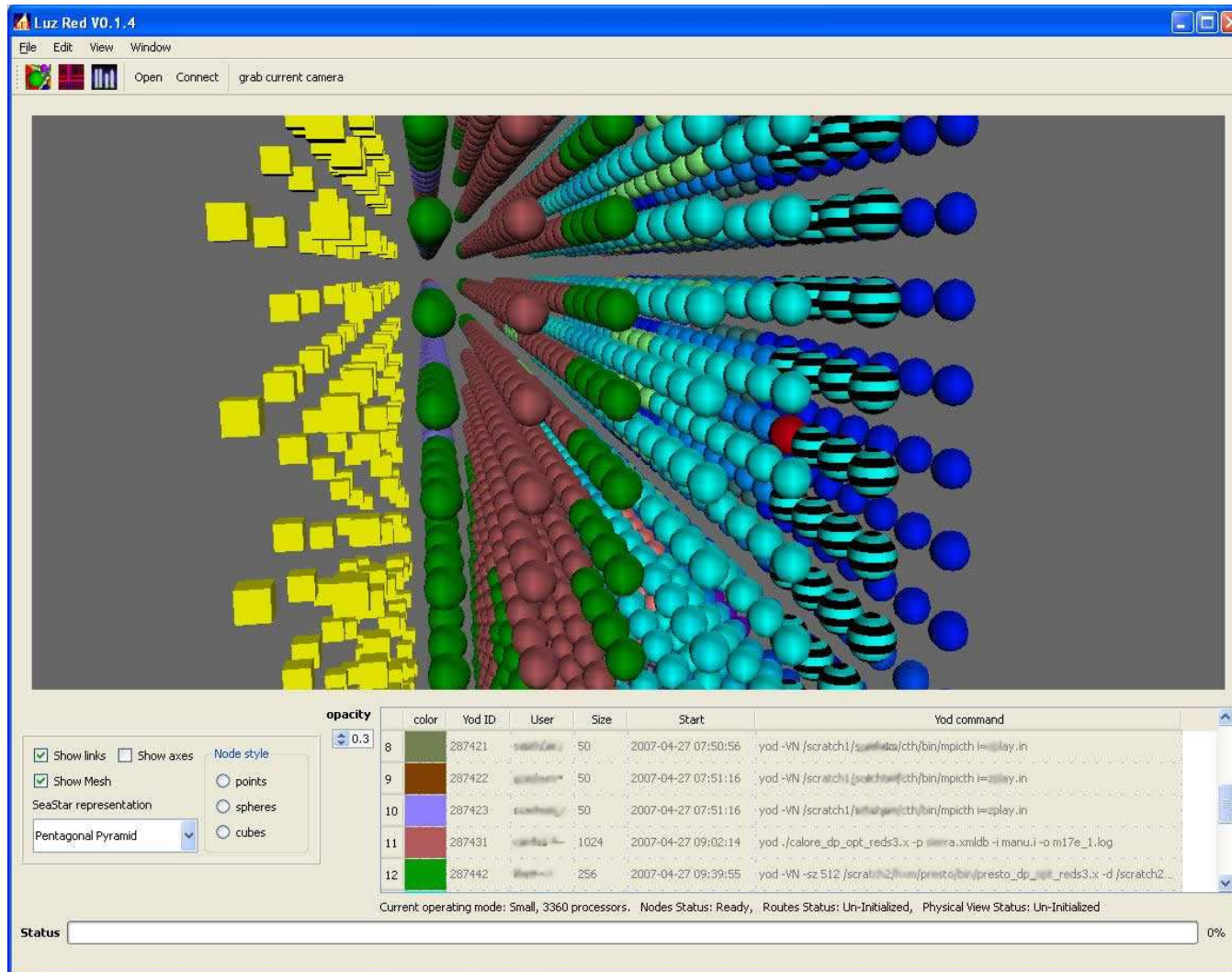
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Luz, Shadow Sample



Illuminating the Shadow Mesh

Luz, Shadow Sample



Illuminating the Shadow Mesh

Luz, Shadow Sample

The screenshot shows the Luz Red V0.1.4 software interface. The main window displays a 3D visualization of a shadow mesh, consisting of numerous colored spheres and cubes arranged in a grid-like pattern. The interface includes a menu bar (File, Edit, View, Window) and a toolbar with icons for Open, Connect, and grab current camera. Below the main window is a control panel with checkboxes for 'Show links', 'Show axes', 'Show Mesh', and 'SeaStar representation'. The 'Node style' section has radio buttons for 'points', 'spheres', and 'cubes', with 'cubes' selected. A dropdown menu shows 'Pentagonal Pyramid'. Below the control panel is a table with columns for 'opacity', 'color', 'Yod ID', 'User', 'Size', 'Start', and 'Yod command'. The table contains 5 rows of data. At the bottom, a status bar shows 'Current operating mode: Small, 3360 processors. Nodes Status: Ready, Routes Status: Un-Initialized, Physical View Status: Un-Initialized' and a progress bar at 0%.

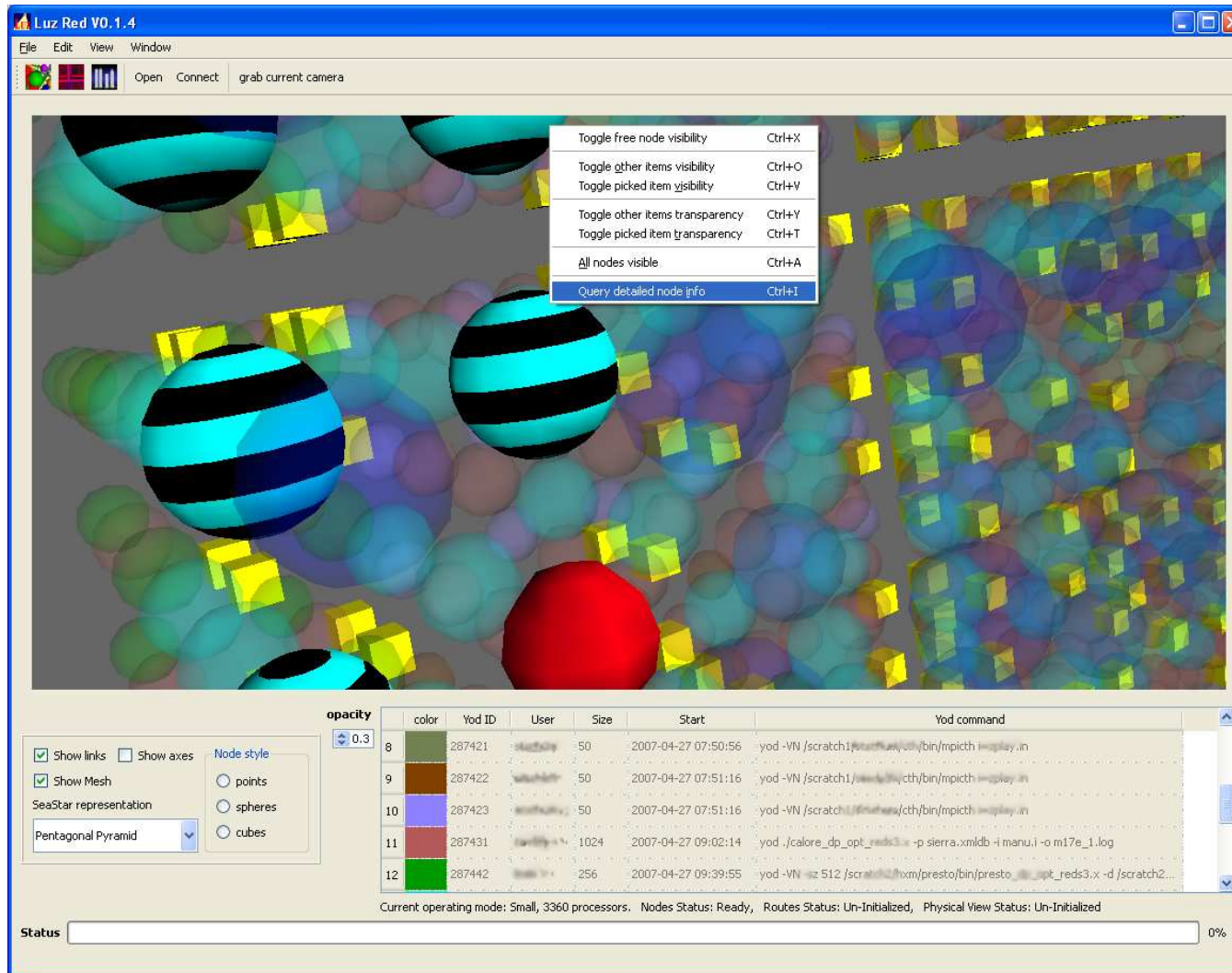
opacity	color	Yod ID	User	Size	Start	Yod command
0.3	8	287421	scathiku	50	2007-04-27 07:50:56	yod -vN /scratch1/walshw/cth/bin/mpictch i=qalay.in
	9	287422	gabhuon	50	2007-04-27 07:51:16	yod -vN /scratch1/walshw/cth/bin/mpictch i=qalay.in
	10	287423	scathiku	50	2007-04-27 07:51:16	yod -vN /scratch1/walshw/cth/bin/mpictch i=qalay.in
	11	287431	scathiku	1024	2007-04-27 09:02:14	yod ./calore_dp_opt_reds3.x -p sierra.xmldb -i manu.i -o m17e_1_log
	12	287442	scathiku	256	2007-04-27 09:39:55	yod -vN -sz 512 /scratch2/hom/presto/bin/presto_dp_opt_reds3.x -d /scratch2...

Status: 0%



Illuminating the Shadow Mesh

Luz, Shadow Sample



Illuminating the Shadow Mesh

Luz Conclusion

- Future
 - ◆ Shadow Islands & Shadow Refinement
 - ◆ Better torroidal representation
 - ◆ Improved annotation and 'pop-up' meta-data
- Thank you

