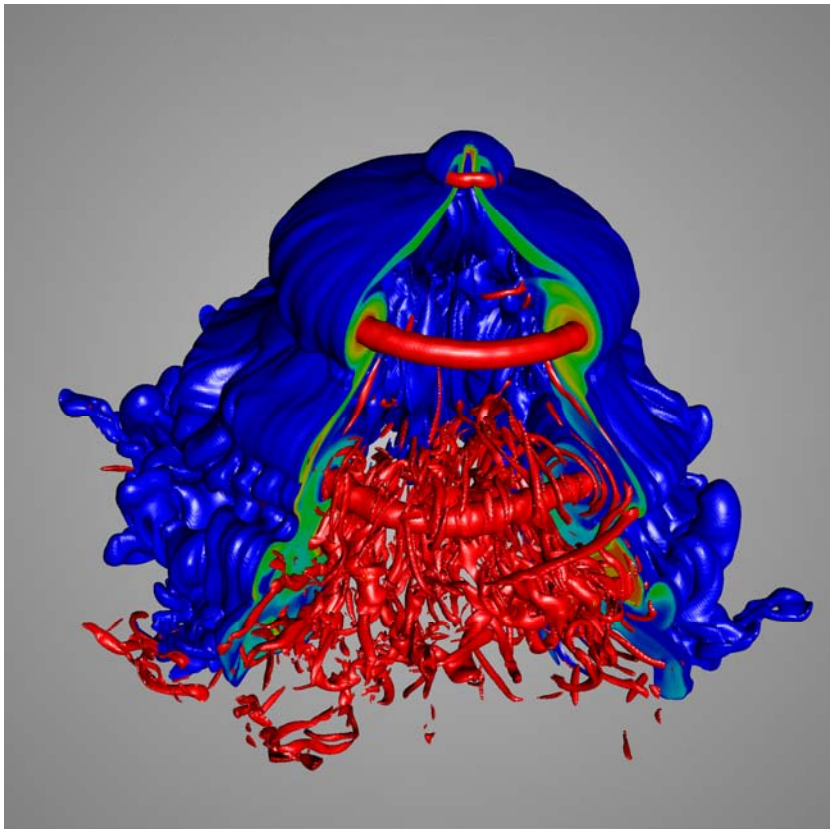
VisIt

IEEE Visualization Tutorial

Hank Childs

October 10, 2004

The VisIt Team:
Eric Brugger (project leader), Kathleen Bonnell, Hank Childs, Jeremy Meredith, Mark Miller, and Brad Whitlock
Alum: Sean Ahern



Gas bubble subjected to shock (Raptor)

UCRL-PRES -207039

Work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract W-7405-Eng-48.

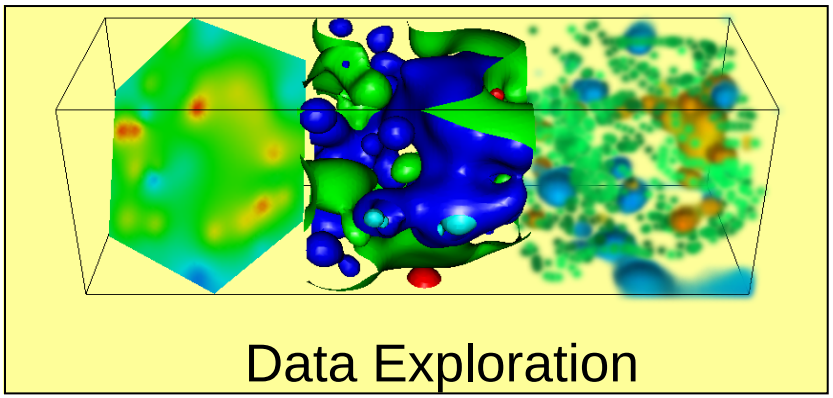
VisIt: Background

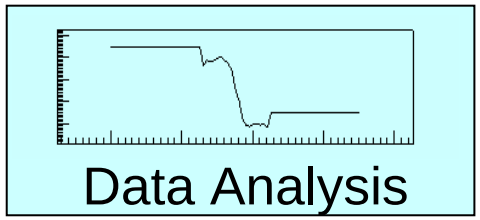
- Background
- Design
- Big data handling
- Extensibility & Future Directions

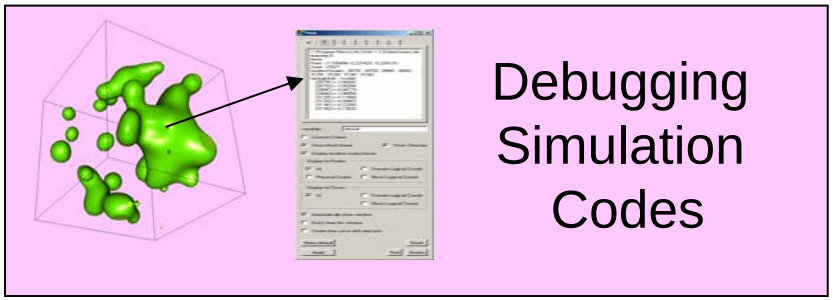
- What space is VisIt filling?
- What types of data?
- What types of operations does VisIt support?
- What is the target environment?
- What is the availability of VisIt?

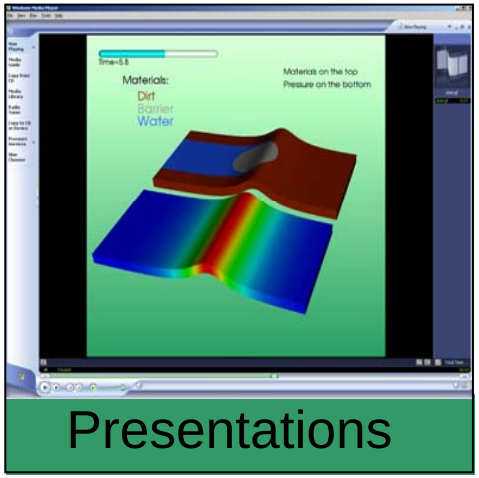
What space is VisIt filling?

- VisIt is an end user tool.
  - Used by: physicists, engineers, code developers, vis experts.
  - Goals: robustness, usability, performance
- Emphasis on large data and unusual data models
- VisIt is used for:



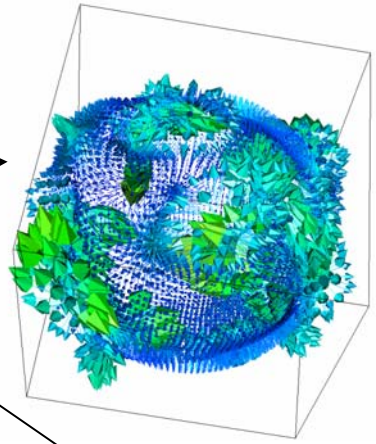


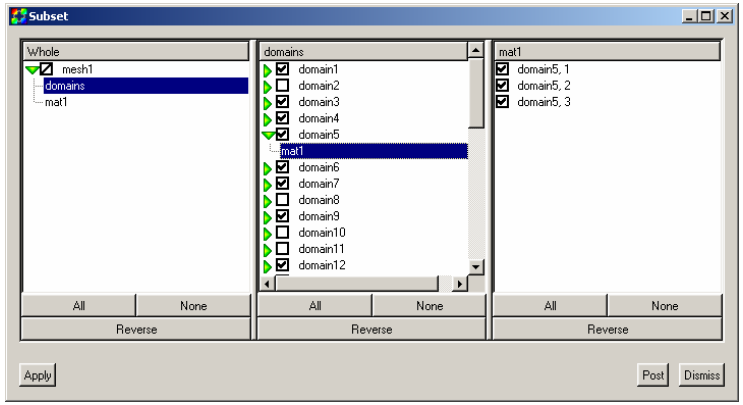


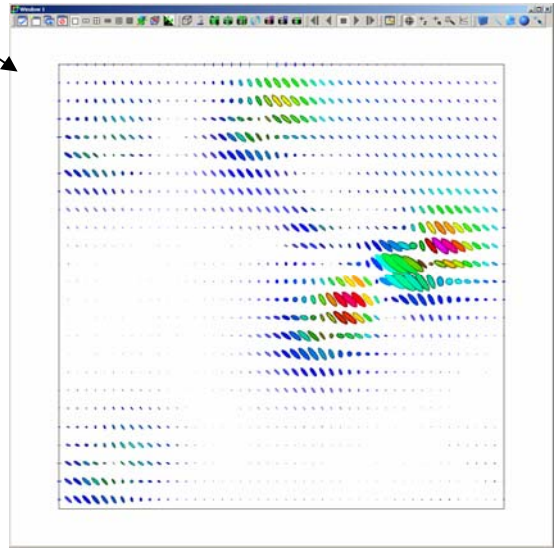


What types of data can VisIt handle?

- Meshes:
  - 2D and 3D unstructured meshes, curvilinear, rectilinear, point meshes, and AMR meshes.
- Variables:
  - Scalar, vector, material, species, tensor
- Selection:
  - Domain, group, arbitrary



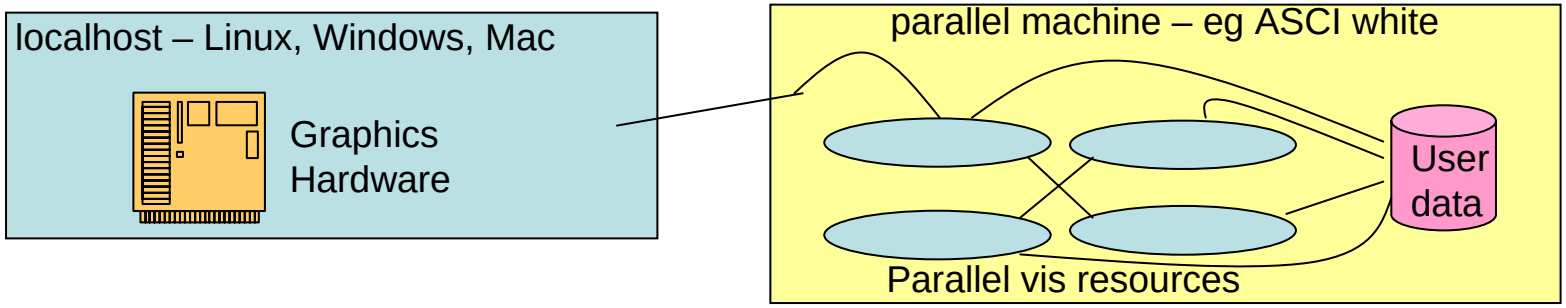




What types of operations does VisIt support?

Data Exploration	Data Analysis
• Slicing by plane, sphere, cone… • Contouring • Volume rendering • Alter zones displayed (clip, …) • Expressions to create new variables (a+b, gradient(a), etc) • Much more…	• Produce 1D curve along line based on scalar value (“lineout”) • Ops on 1D curves (L2Norm, …) • Surface area, volume, etc. • All queries can be taken over all timesteps to produce 1D curve. • Much more…
Debug Simulation Codes	**Presentations**
• Query per-zone values by picking on screen • Show only zones that meet some criteria (ie high temperature zones/ hot spots) • Much more…	• Controls over much of the final pictures look and feel – annotations, colors, etc. • Complete movie creation, including final MPEG generation. • Much more…

What is the target environment for VisIt?



- Parallel vis machine w/ access to data
  - Could be resource rich or poor
- Desktop machines with good graphics cards
- Gigabit interconnect

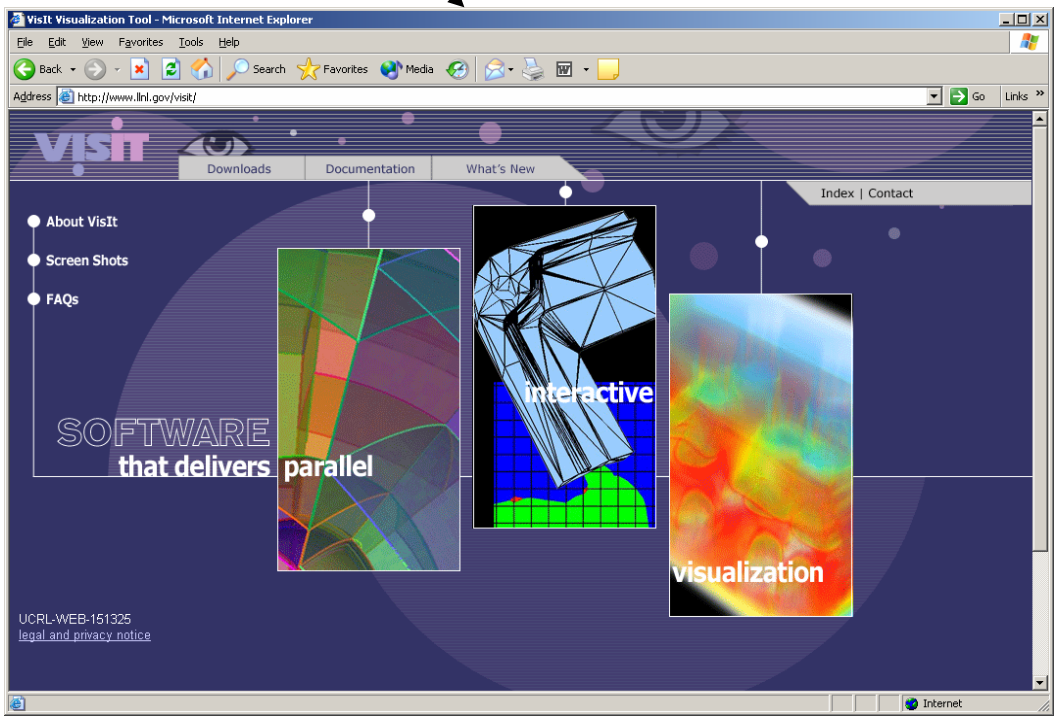
Blue Gene/L, 65536 procs., # vis procs to be determined (<512).

ASC white, 8192 procs., 512 vis procs.

➢ This is the target environment for VisIt. This environment is not necessary for the tool to run successfully.

What is the availability of VisIt?

- Publicly available (http://www.llnl.gov/visit).
- Supported by 6 LLNL developers.
- Support for Linux, AIX, Tru64, Solaris, IRIX, Windows, and Mac.

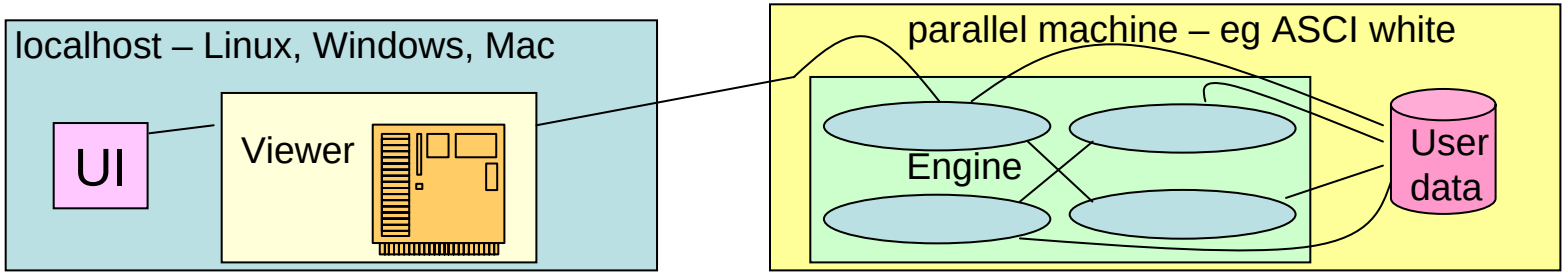


VisIt: Design

- Background
- Design
- Big data handling
- Extensibility & Future Directions

- Basic architecture
- Data flow network design

Basic Architecture



- Distributed design to leverage parallel compute resources and graphics hardware.
- Three major components – “UI”, “Viewer”, “Engine”

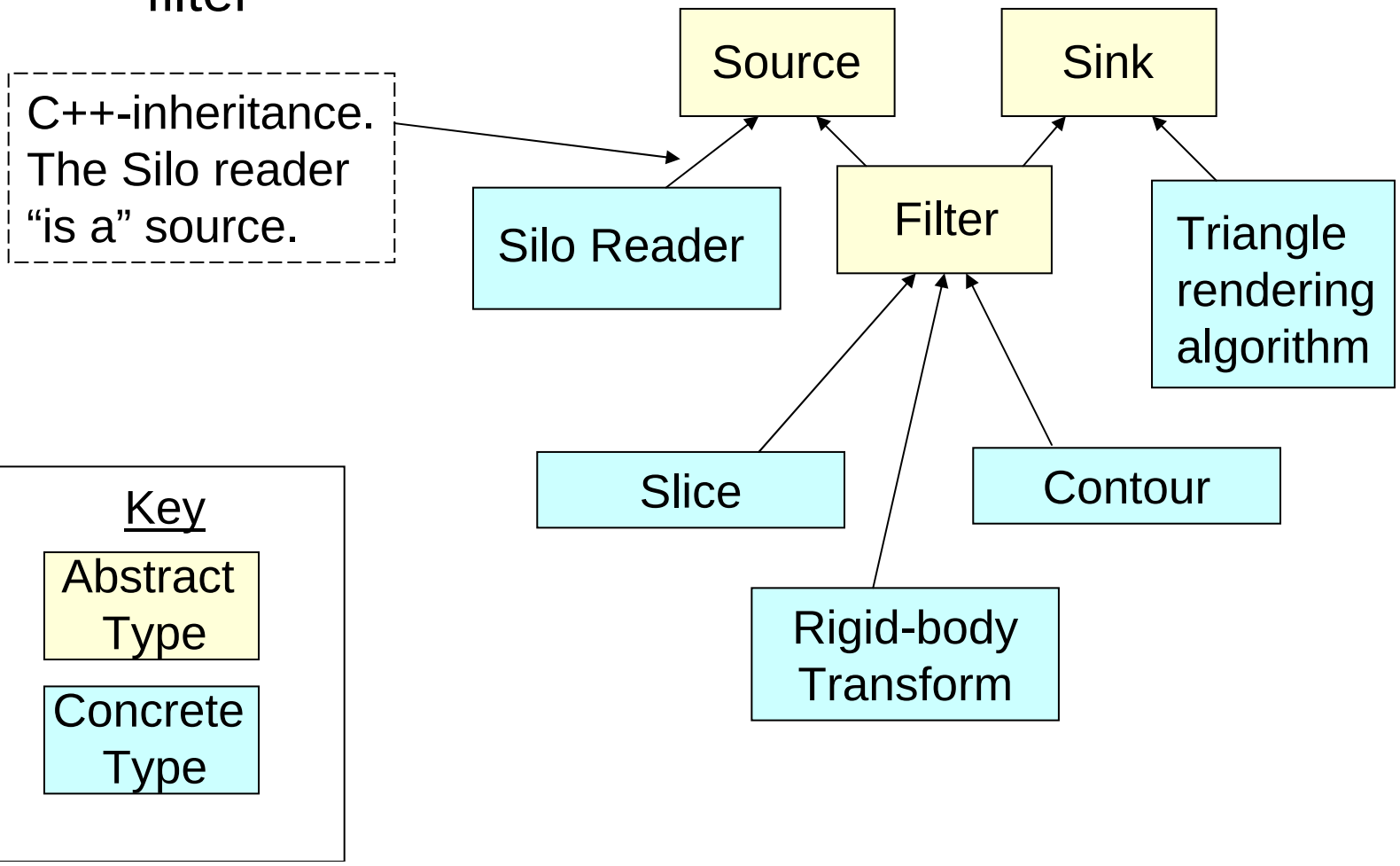
UI responsible for user interface
- Designed to easily add new UI components
- Currently
  - Qt-based graphical
  - Python-based CLI

Viewer responsible for:
- Windowing and rendering
- Managing centralized state
  - Enables fault tolerance

Engine responsible for all data management
- Parallelized
- Based on data flow networks

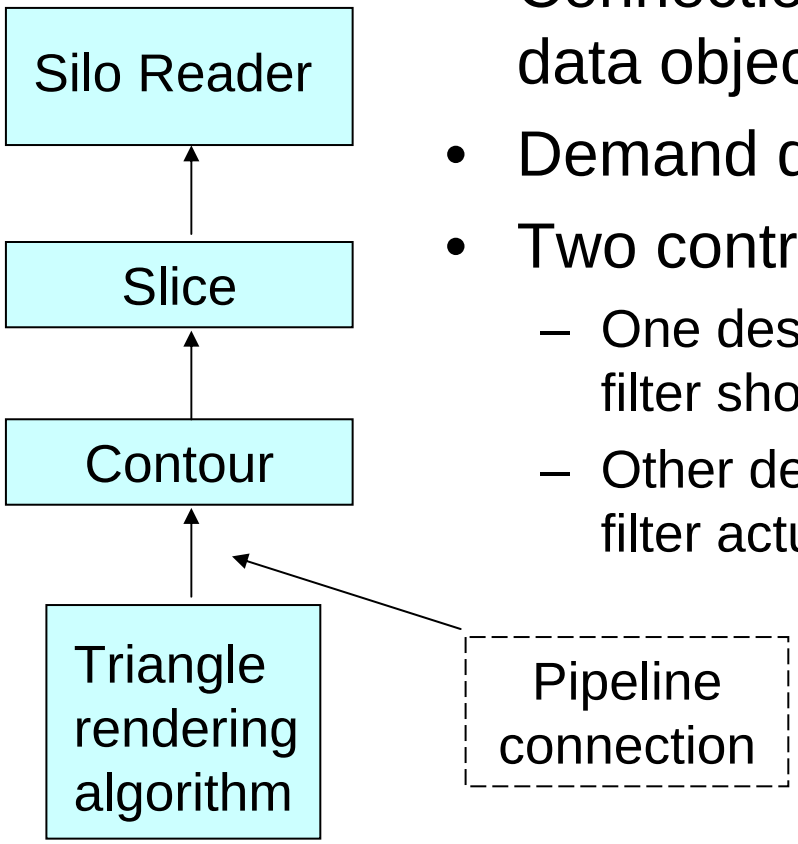
Data Flow Networks

- Two primary types: data objects and process objects
- Three basic types of process objects: source, sink, filter



Pipelines

- A pipeline is created with a source, sink, and many filters.



- Connections are made through data objects (output to input).
- Demand driven
- Two contracts for pipeline:
  - One describes what the input to a filter should look like
  - Other describes what the output of a filter actually has.

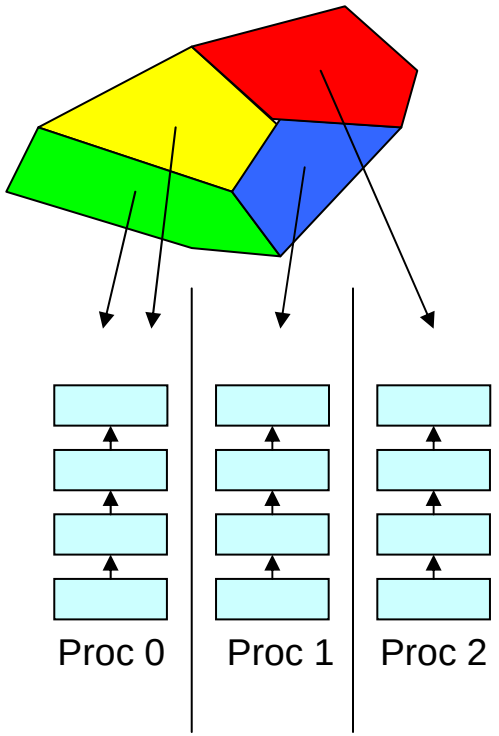
VisIt: Big data handling

- Background
- Design
- Big data handling
- Extensibility & Future Directions

- How does VisIt parallelize work?
- Rendering large surfaces
- Ghost data
- Removing unneeded data

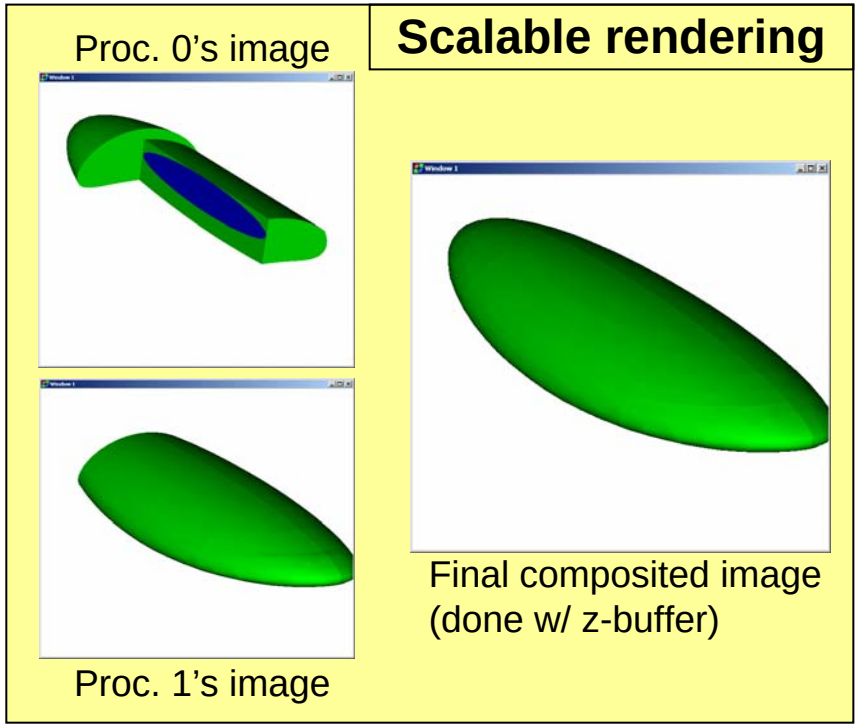
How does VisIt parallelize work?

- Identical pipelines on each processor.
- Domain overloading
- All domains executed by Filter A before moving on to Filter B
  - Enables collective communication.
  - Streaming still possible, but not implemented.



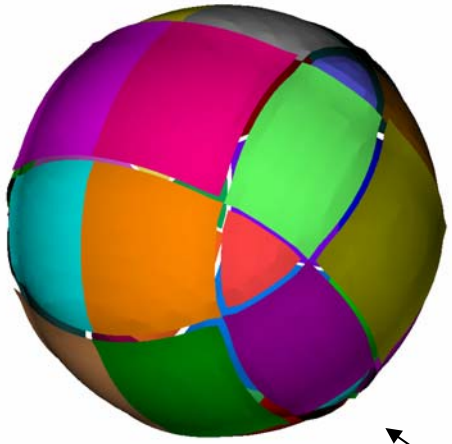
Rendering large surfaces

- VisIt has two rendering modes:
  - Hardware accelerated
  - Scalable rendering mode
- Hardware accelerated
  - Brings triangles to Viewer and uses graphics card
- Scalable rendering
  - Leave triangles on Engine.
  - Do parallel rendering to get image.
  - Transfer image to local desktop
  - Must get new image for each view frustum.

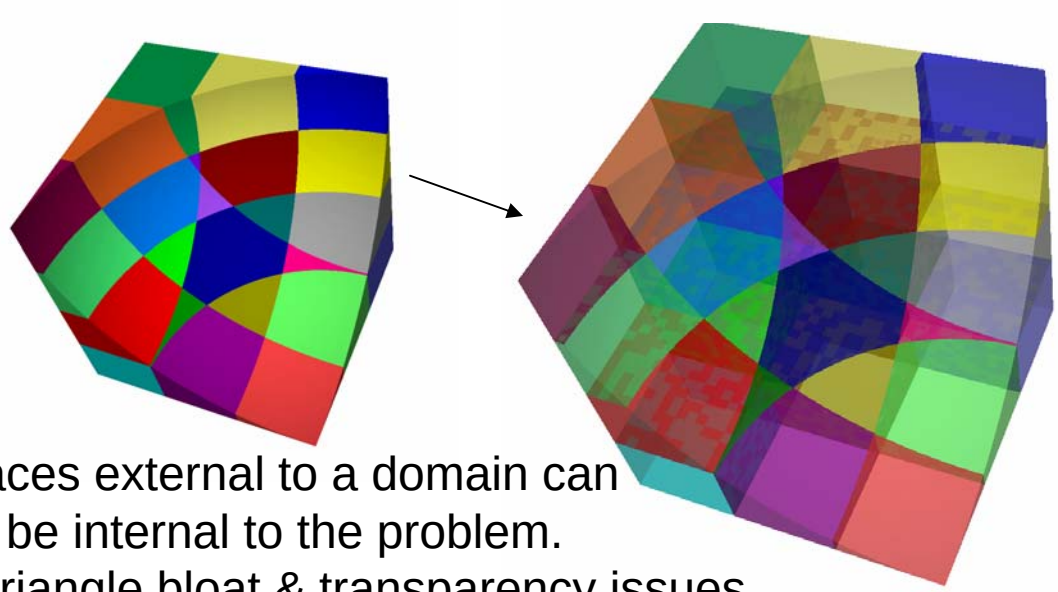


Ghost data

- Using domain decomposition leads to artifacts along the domain boundaries.
- Solved by ghost data
  - Ghost zone and ghost nodes
  - Filters request what type of ghost data they need.



Poor interpolation along domain boundaries leads to discontinuous isosurfaces.

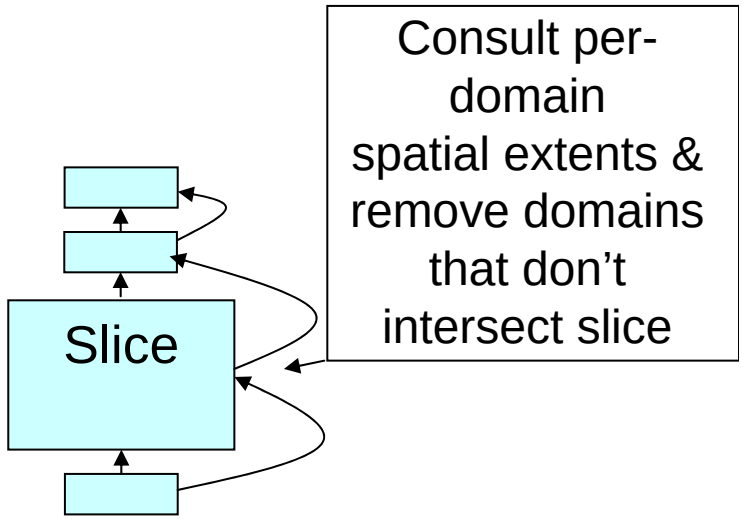


Faces external to a domain can be internal to the problem.
Causes triangle bloat & transparency issues.

Ghost data solves these problems!

Removing Unneeded Data

- Not all data is necessary to make the “final picture”
  - Ex: Slice only affects some domains.
- Meta-data can be used to prevent data from ever being operated on.
  - Each filter can reduce set of domains considered.

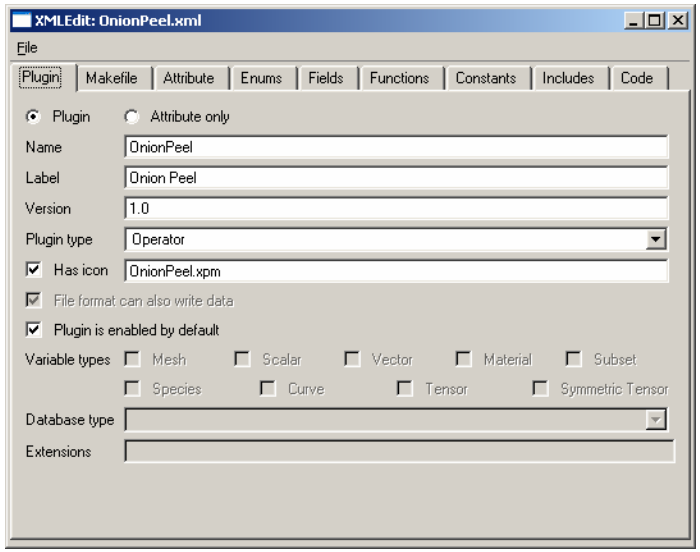


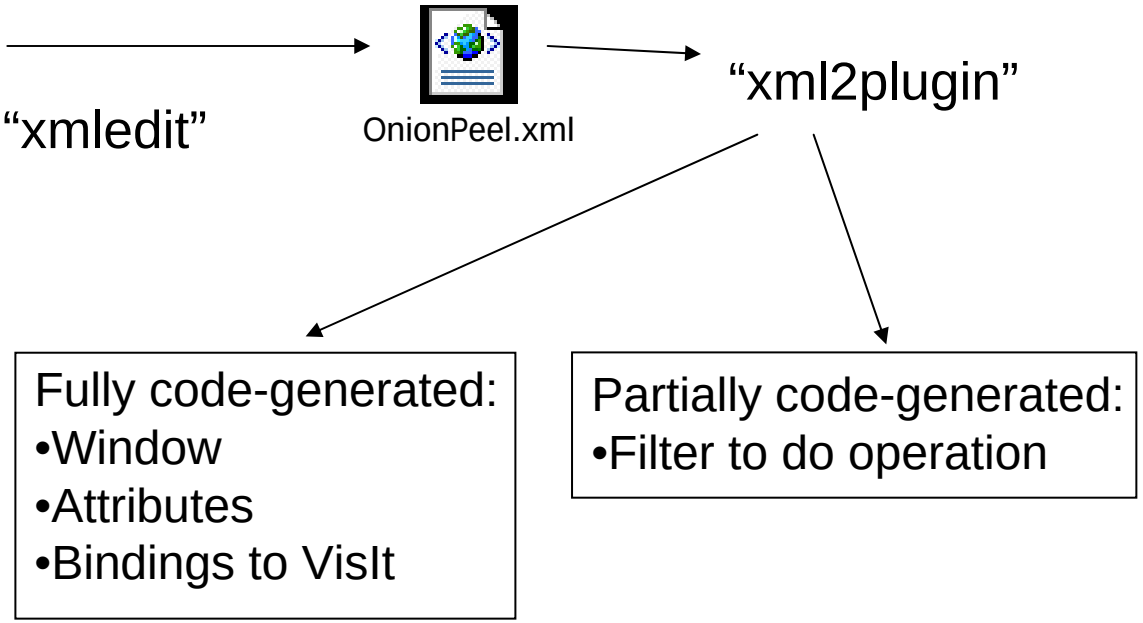
VisIt

- Background
- Design
- Big data handling
- Extensibility & Future Directions

Extensibility: Plugins

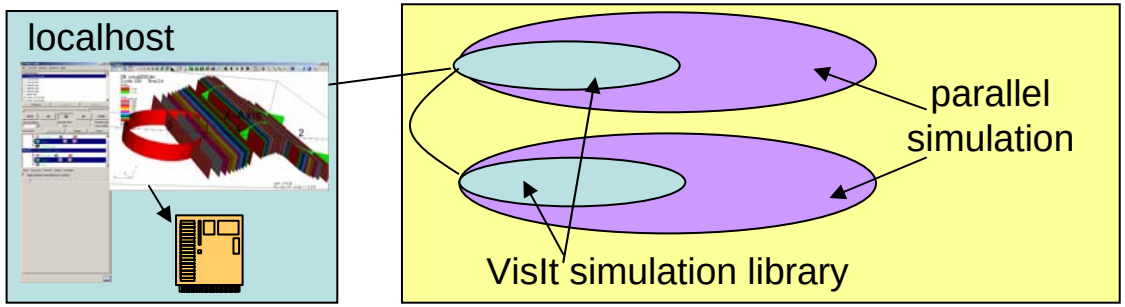
- VisIt has a plugin architecture.
  - Databases, operators, and plots
- May be more plugins in the future
  - Expressions? Queries?



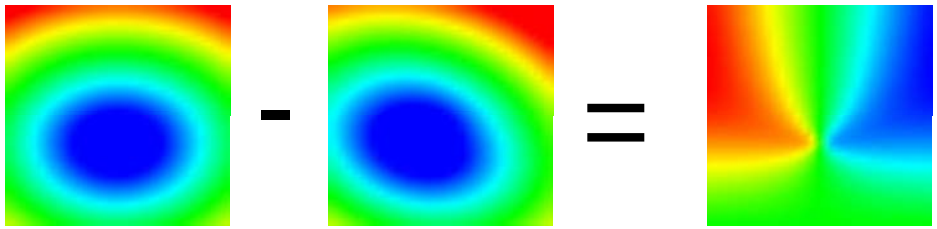


Future Directions

- Connecting to a running simulation.
  - Alpha version up and going.



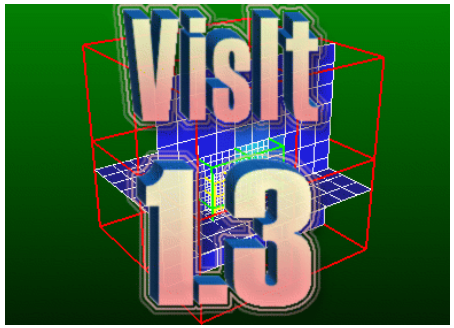
- Comparing databases.
  - Recent code to lock/correlate multiple databases in time.



- Allowing queries to be used anywhere in the code.
  - Threshold by Query(90th percentile, “pressure”), …

Future Directions: Continuing to make a usable tool for our user base.

- VisIt's usage is high (~1000 startups per month).
- 13 releases in last 12 months



  - 800 enhancements/bugs resolved.
  - Majority of work is on robustness, usability, and performance.
  - Regression suite has grown to over 700 tests.
  - Extensive on-line and off-line documentation.

- 3 classes on VisIt were given.
  - 302 slides + >60 exercises.

Slides from the VisIt class