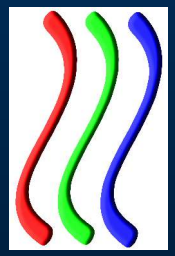
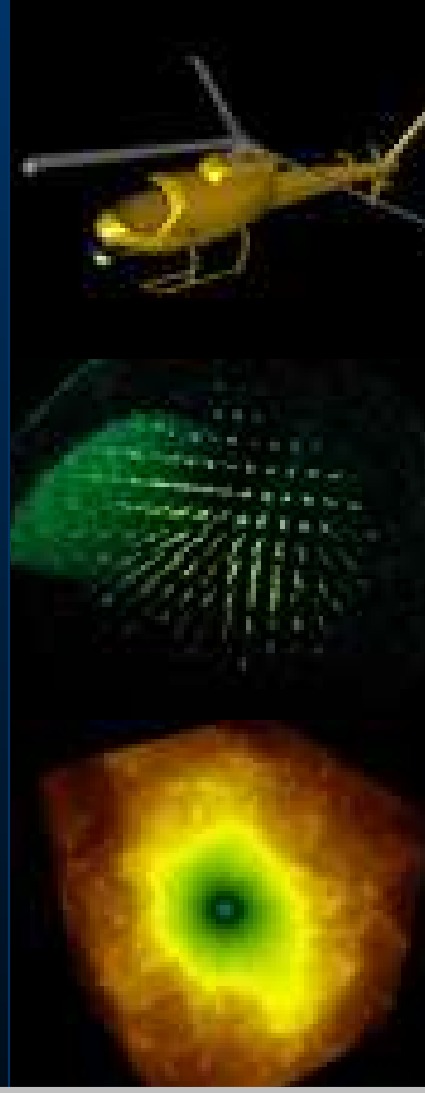
Parallel Visualization with ParaView





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Outline

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- What is ParaView
- Launch modes
- Data flow
- Scalable architecture
- LOD (Level Of Detail)
- Run ParaView on Sharcnet's computing clusters

What is ParaView

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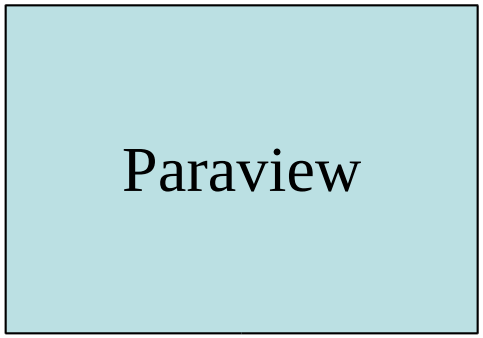
- Scientific Visualization of large dataset
- Open source
- Scalable parallel distributed rendering
- Scripting
- Multi-platforms (Unix, MacOS, Windows)
- Extensible
- Latest release 2.6.0, V3.0 is coming soon

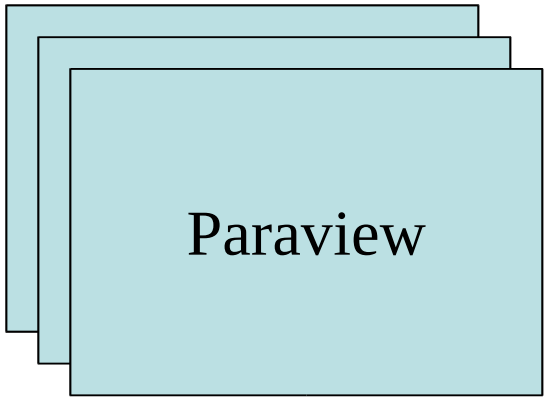
Lauch modes

- Single processor (local, serial)
  - ./paraview
  - GUI on single computer
  - Computing and rendering on single processor
  - Small dataset



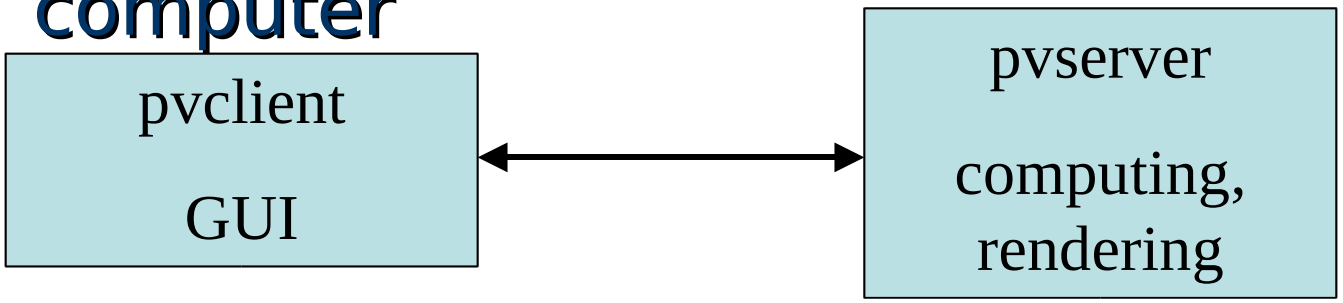
Lauch modes

- Multiple processors (local, parallel)
  - mpirun –np 8 ./paraview
  - GUI on single computer
  - Computing and rendering on multiple processors



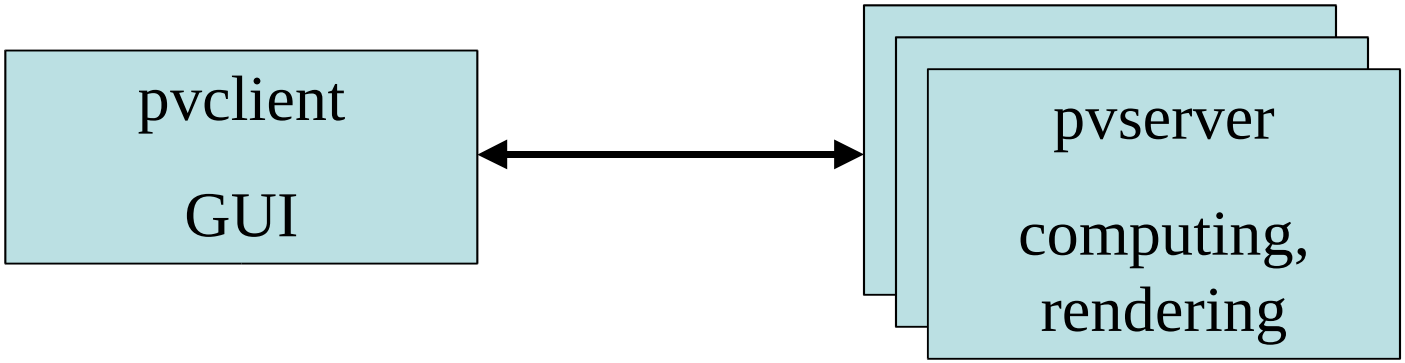
Lauch modes

- Basic client/server mode (remote, serial)
  - ./pvclient -rc on local computer; ./pvserver -rc -ch=client_host
  - GUI on local computer
  - Computing and rendering on remote computer



Lauch modes

- Parallel client/server mode (remote, parallel)
  - ./pvclient -rc on local computer; sqsub –q parallel –n 8 ./pvserver -rc -ch=client_host
  - GUI on local computer
  - Computing and rendering on remote cluster



Lauch modes

- Tiled display mode
- CAVE display mode
- Data-and-rendering distributed mode

Data Flow

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- Data
  - Dimensions: 2D, 3D, 4D …
  - Type:
    - Geometric data (points, lines, polygons)
    - Discrete data (samplings of properties in n-D space)
  - Data properties:
    - Scalar (density, temperature, etc)
    - Vector (velocity, momentum, etc)
    - Tensor

Data Flow

- Topology and geometry of sampling data

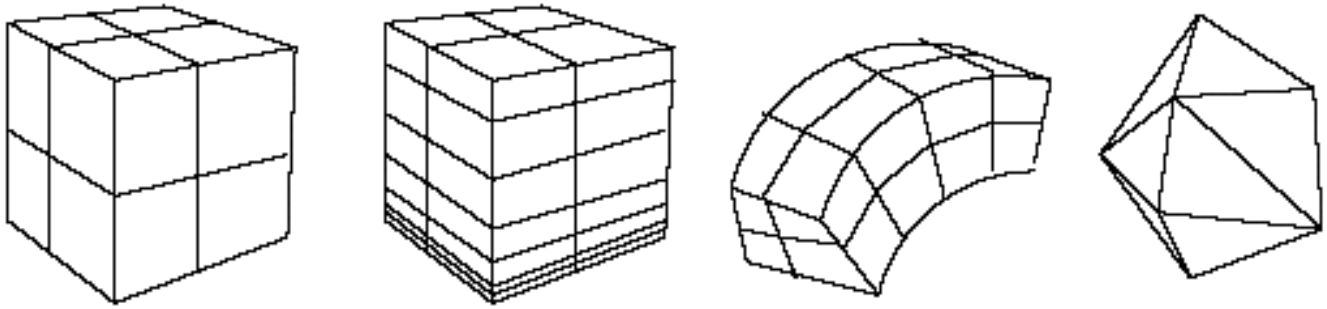

	Image data	Rectilinear	Curvilinear	Unstructured
Topology	regular	regular	regular	irregular
Geometry	regular	partially regular	irregular	irregular

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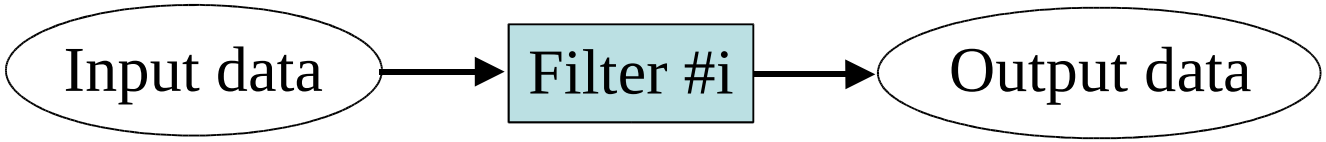
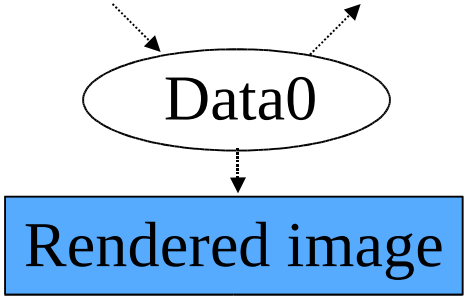
Data Flow

- Processing modules
  - Source – data file reader or graphical primitives
  - Filter – processing module



- Visualization pipeline:

Source ->Filter#1->Filter#2->…->Filter#N



Data Flow

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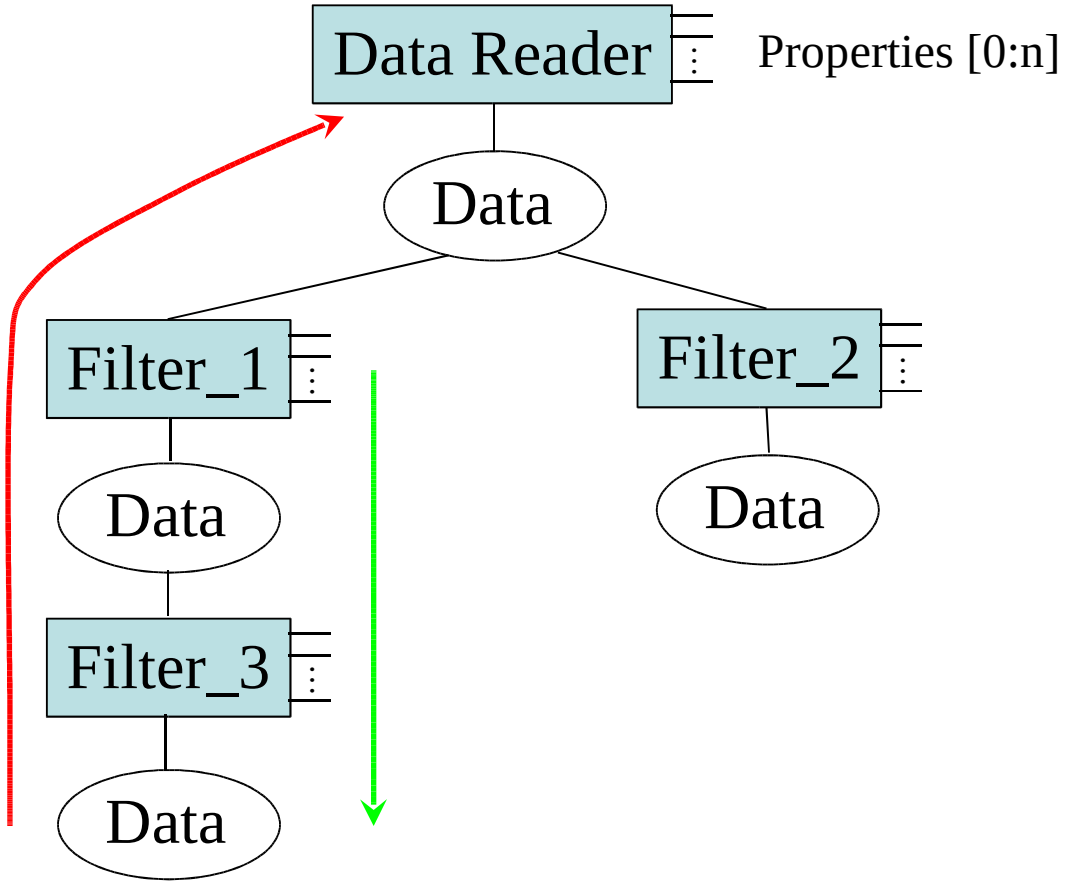
- Data Rendering
  - Outline
  - Shaded surface
  - Wireframe of surface
  - Point cloud of surface
  - Volume rendering

Data Flow

- Pipeline execution – “Lazy update strategy”



Data Flow

- Paraview data file format:

  http://www.paraview.org/Wiki/ParaView:FAQ#What_file_formats_does_ParaView_support.3F

Scalable architecture

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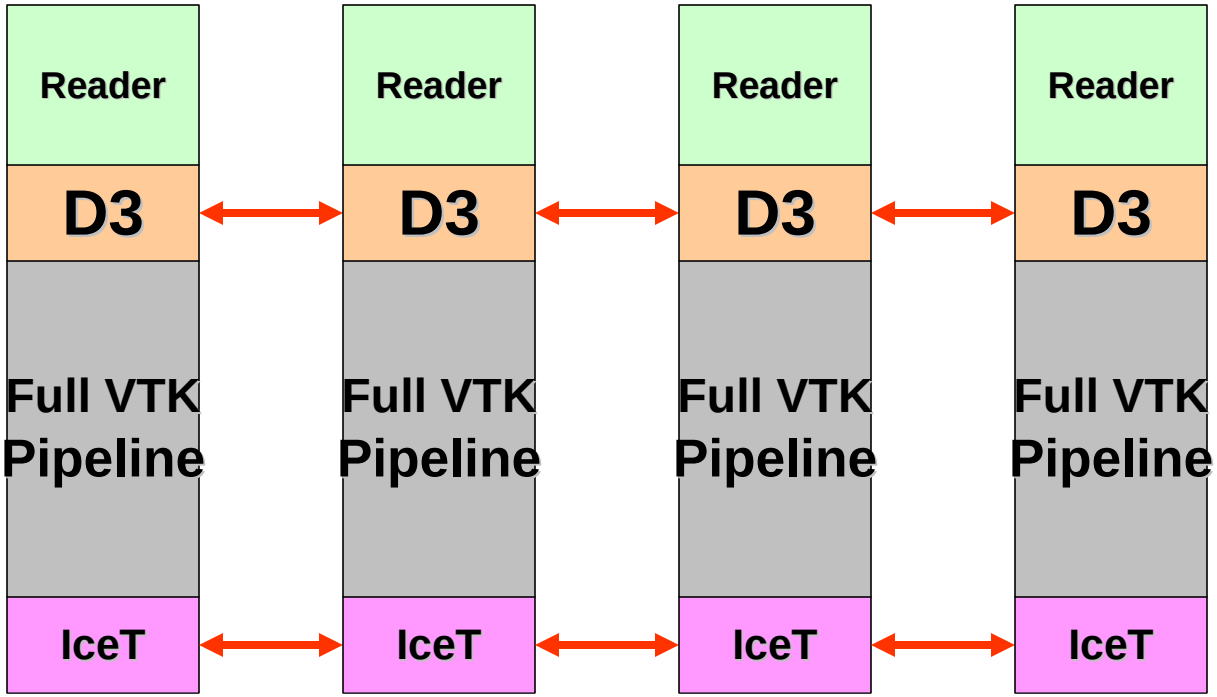
- Distributed execution, no serial bottleneck
- Limited communications



D3 – load balancer

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- D3: Distributed Data Decomposition
- Filter D3
- Spatial decomposition based on k-d tree
- Approximately equal number of mesh elements

D3 – load balancer

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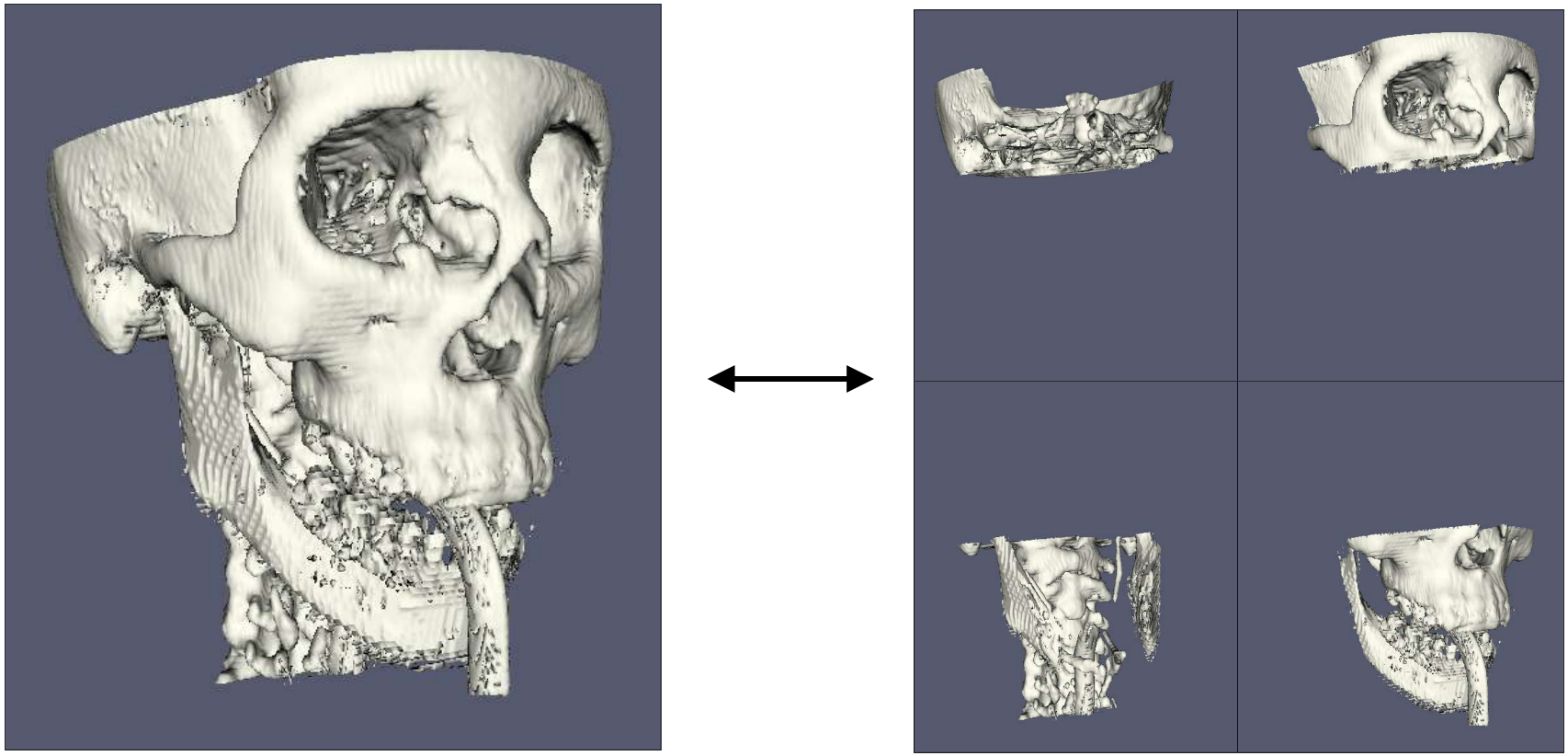

VTK

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- Higher-level visualization library
- Open source rendering engine
- Backbone of ParaView

IceT

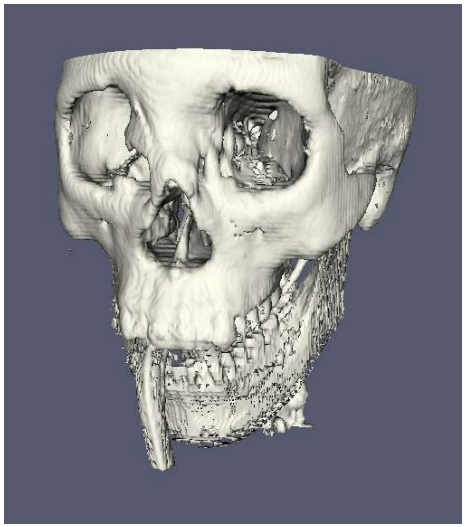
- IceT: Image Compositing Engine for Tiles
- Sort-last
- Can composite images larger than the framebuffer in graphics card

LOD

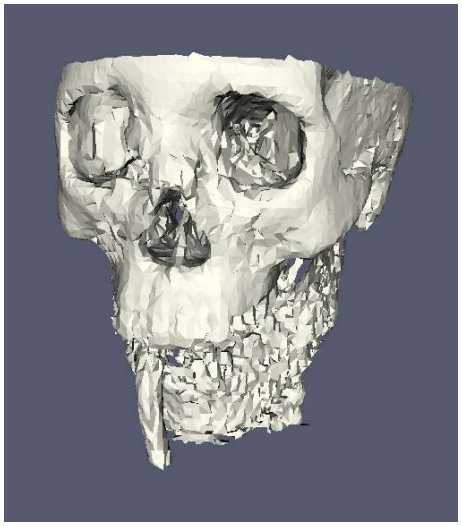
- LOD: Level Of Detail
- Trade-off: rendered image quality and rendering speed
- Two rendering modes
  - Interactive rendering – using low LOD
  - Still rendering – using high LOD

LOD

- Three ways of LOD
  - Geometrical LOD – Decimation of volumetric and/or polygonal data



Original Data

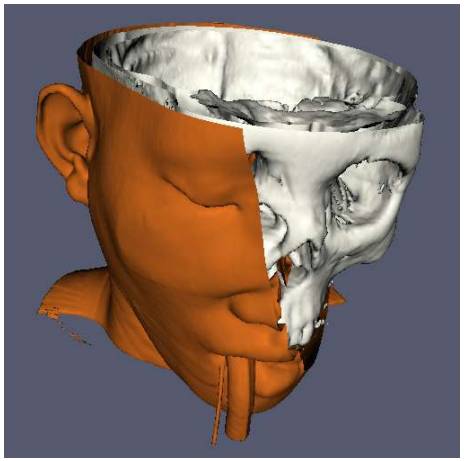


Divisions: 50x50x50

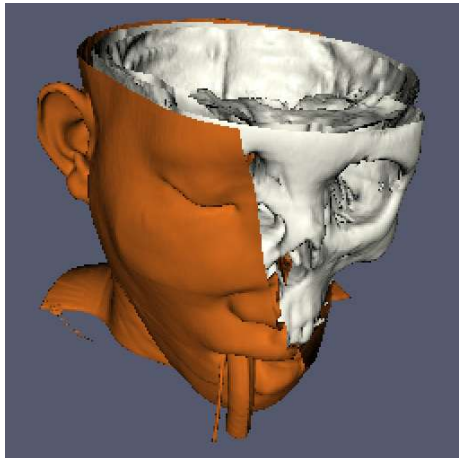
Divisions: 10x10x10

LOD

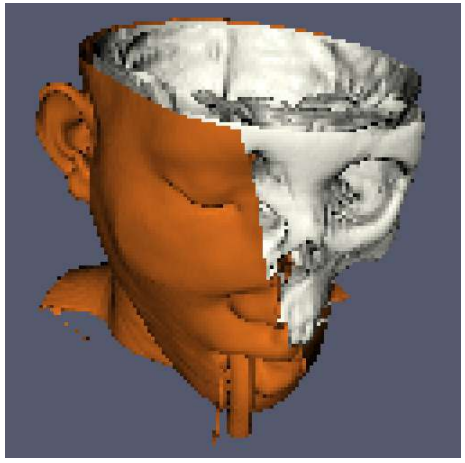
- Image size LOD



Original data



Subsample rate: 2 pixels

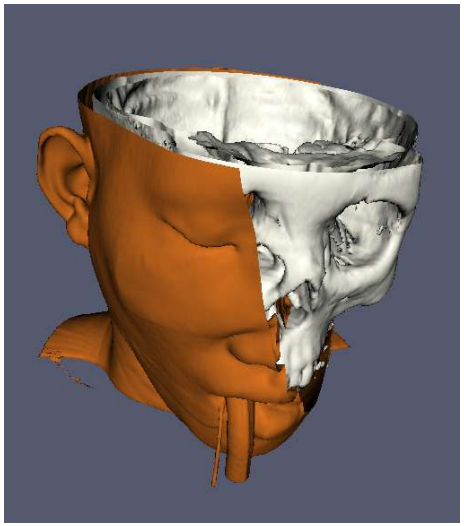


Subsample rate: 4 pixels

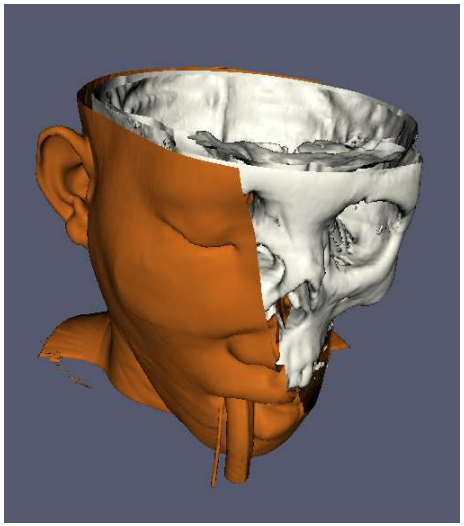
Subsample rate: 8 pixels

LOD

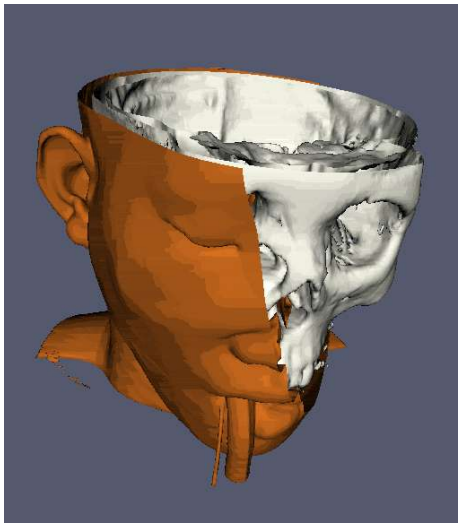
- Color depth LOD
  - Reduce image data transferred from server to client.



24-bit mask



19-bit mask



10-bit mask

Run ParaView on Sharcnet's Computing Clusters

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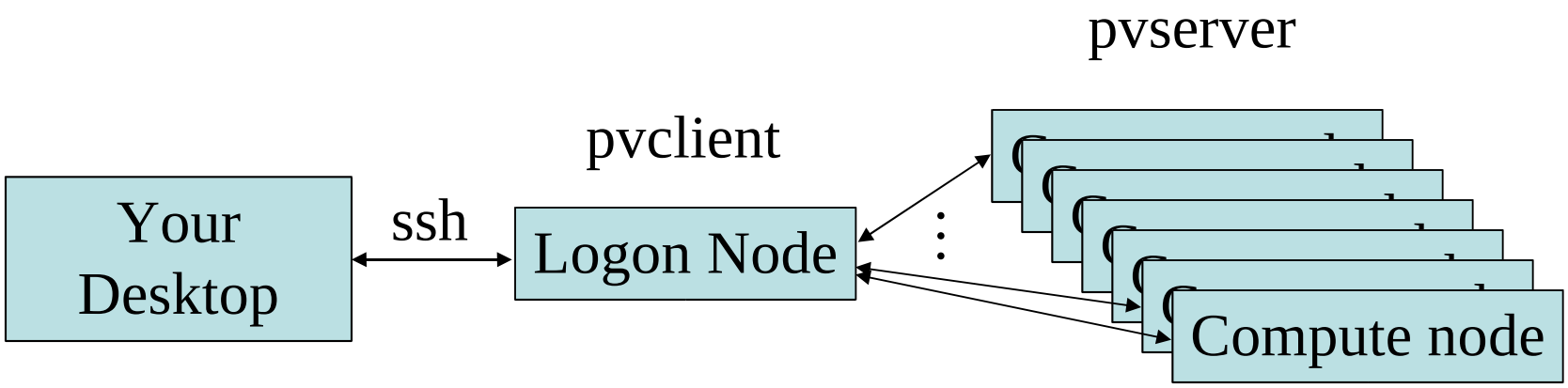
- Computing cluster without graphics hardware
  - Build Paraview with OSMesa
  - Lauch Paraview with --use-offscreen-rendering option



Run ParaView on Sharcnet's Computing Clusters

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- Rendering using CPU is about 10 times slower than using GPU
- High band-width network

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Next:

Demo of ParaView 2.6.0