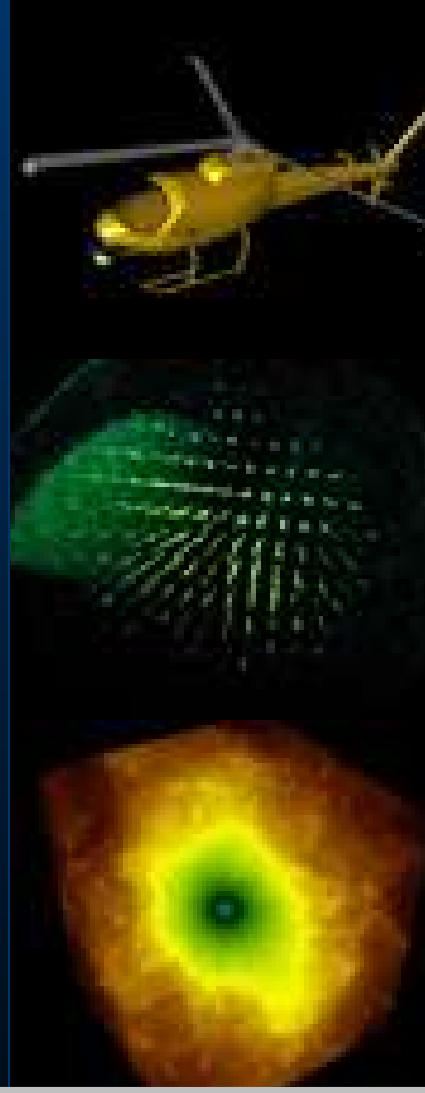
Visualization ToolKit (VTK)
Part I



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Outline

- Overview
- Installation
- Typical structure of a VTK application
- Visualization pipeline
- VTK scene

Overview

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- Higher-level visualization library or API
- Open source – www.vtk.org
- Major contributors
  - Kitware inc
  - GE
  - Sandia National Lab
  - Los Alamos National Lab
- Thousands users from industry and research institutes

Overview

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- Multiple platforms – Unix, MacOs, Windows
- 1130 C++ classes
- Java, Python, Tcl wrappers
  - Performance compared with using VTK's C++ interface
  - Faster development cycle
  - Fast prototyping
- Last release 5.0.2

Overview

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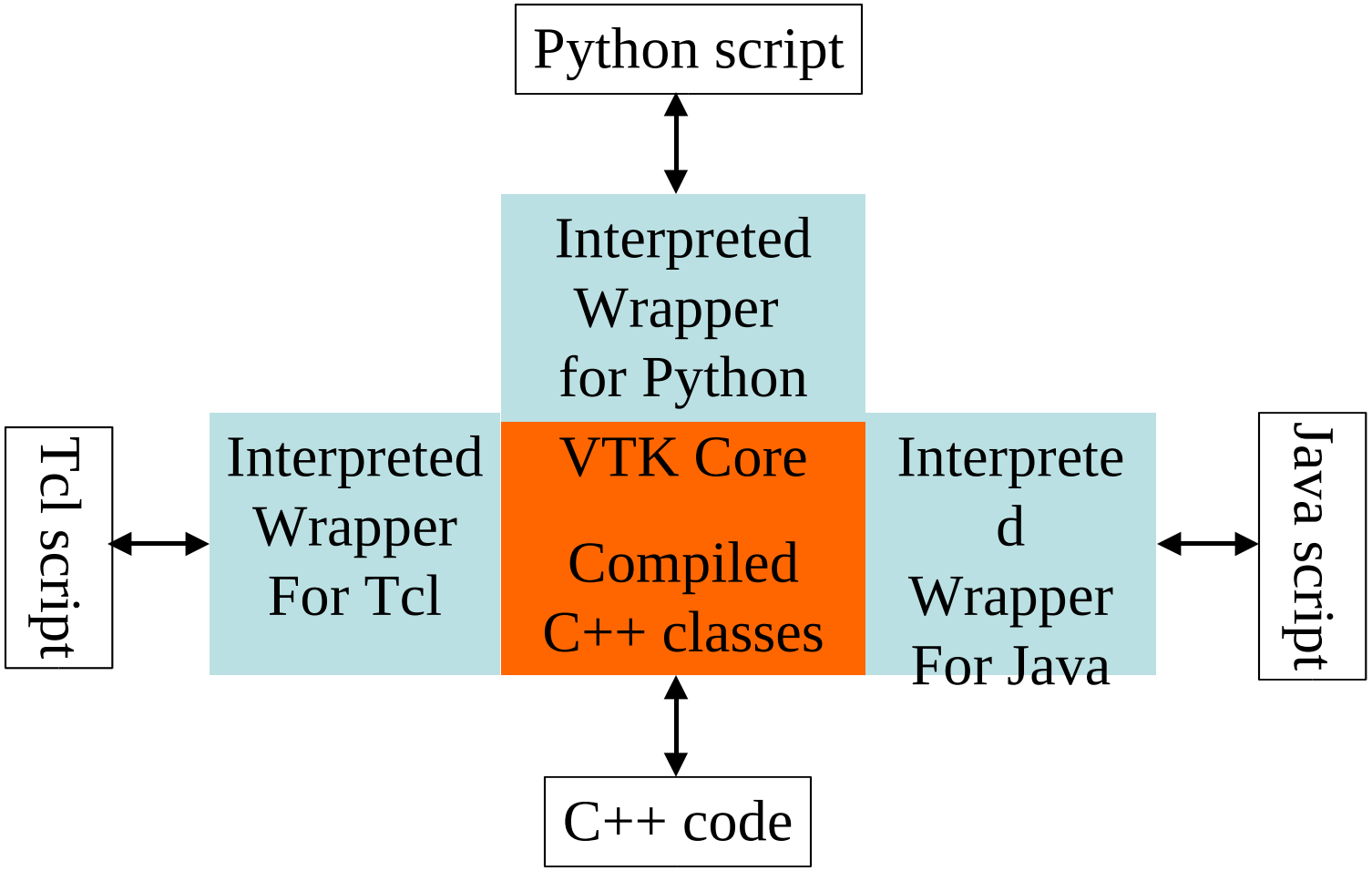
- **Architecture**



Overview

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- Documentation
  - Online manual: www.vtk.org/doc/release/5.0/html/
  - The Visualization Toolkit User's Guide
  - The Visualization Toolkiit, An Object-Oriiented Approach To 3D Graphics
  - Mailing list: vtkusers@vtk.org
  - VTK wiki: www.vtk.org/Wiki/VTK
  - Professional supports from Kitware inc

Overview

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- Related software
  - ITK: www.itk.org
  - CMake: www.cmake.org
  - ParaView: www.paraview.org

Installation

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- VTK Source directory
  - VTK/Common – Core classes
  - VTK/Filtering – Pipeline implementation superclasses
  - VTK/GenericFiltering – Adaptor framework
  - VTK/Graphics – Filter classes that process 3D data
  - VTK/Hybrid – Complex classes depending on graphics & imaging
  - VTK/Imaging – Image processing filters
  - VTK/IO – Reading/Writing data

Installation

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- VTK/Paralell – Paralell processing
- VTK/Rendering – Rendering geometric data
- VTK/Utilities – Utility libraries
- VTK/VolumeRendering – Rendering volume data
- VTK/Widgets – Interactive graphical objects
- VTK/Wrapping – Script language binder

Installation

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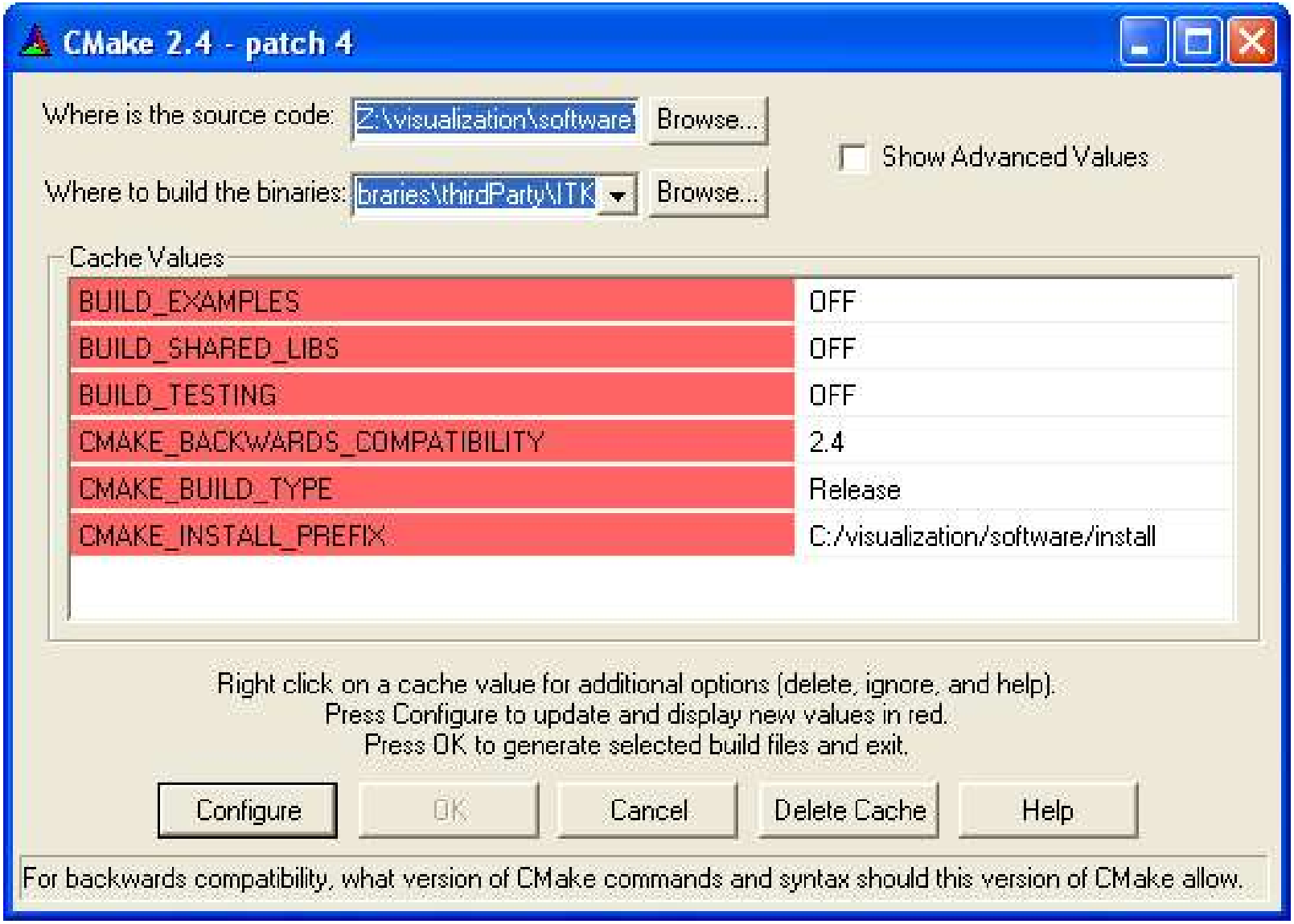
- CMake: www.cmake.org
  - Cross-platform
  - Open Source
  - Out-of-place build
- CMake configure for VTK
  - Wrapper for Java, Python, Tcl
  - Shared or static lib
  - Specify C/C++ compilers
  - Specify path include paths and libs

Installation



Installation

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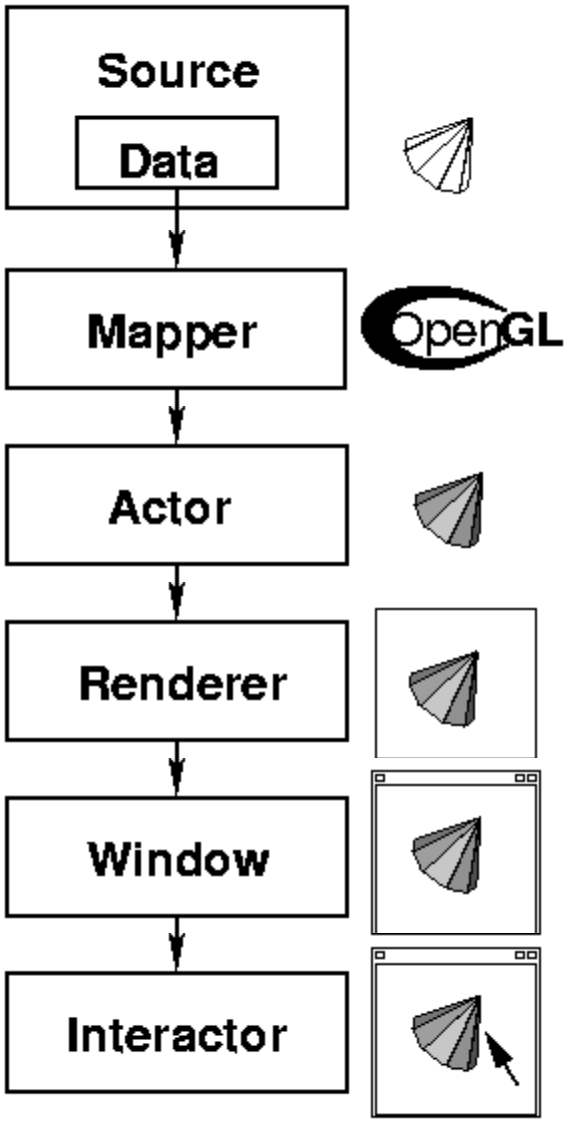
- Usage:
  - cd build_dir
  - ccmake source_dir
  - Configure VTK build with cmake
  - make
  - make install

Typical Structure



package require vtk

vtkConeSource cone

cone SetHeight 3.0

vtkPolyDataMapper coneMapper

coneMapper SetInputConnection [cone GetOutputPort]

vtkActor coneActor

coneActor SetMapper coneMapper

vtkRenderer ren1

ren1 AddActor coneActor

vtkRenderWindow renWin

renWin AddRenderer ren1

renWin SetSize 300 300

vtkRenderWindowInteractor iren

iren SetRenderWindow renWin

iren Initialize

Typical Structure

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Tcl script:

```
package require vtk
vtkConeSource cone
cone SetHeight 3.0

vtkPolyDataMapper coneMapper
coneMapper SetInputConnection
[cone GetOutputPort]

vtkActor coneActor
coneActor SetMapper coneMapper

vtkRenderer ren1
ren1 AddActor coneActor

vtkRenderWindow renWin
renWin AddRenderer ren1
renWin SetSize 300 300

vtkRenderWindowInteractor iren
iren SetRenderWindow renWin
iren Initialize
```

C++ code:

```
#include “vtkConeSource.h”
#include “vtkPolyDataMapper.h”
#include “vtkActor.h”
#include “vtk

vtkConeSource *cone =
      vtkConeSource::New();
Cone->SetHeight(3.0);

vtkPolyDataMapper *coneMapper;
coneMapper = vtkPolyDataMapper::New();
coneMapper->SetInputConnection
(cone->GetOutputPort());

……
……
```

Visualization Pipeline

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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

Visualization Pipeline

- Topology and geometry of sampling data

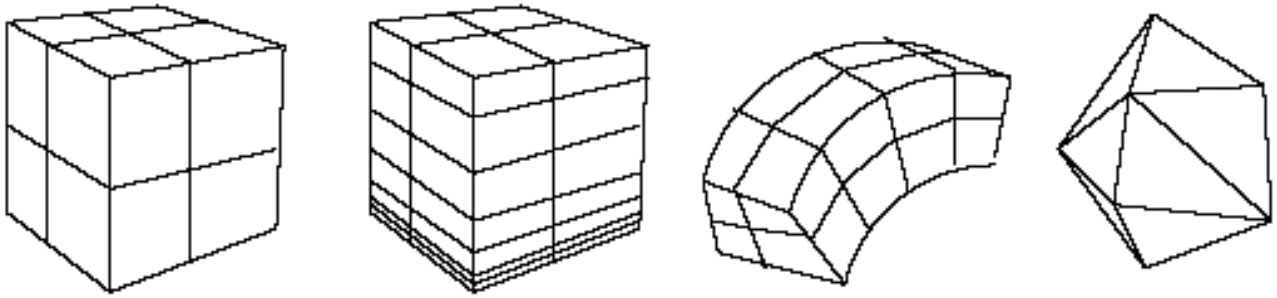

	Image data	Rectilinear	Curvilinear	Unstructured
Topology	regular	regular	regular	irregular
Geometry	regular	partially regular	irregular	irregular

Visualization Pipeline

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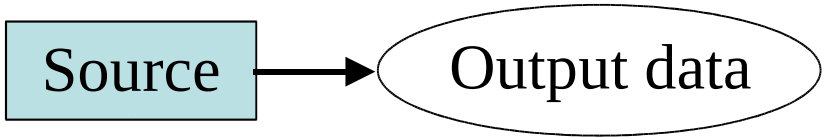
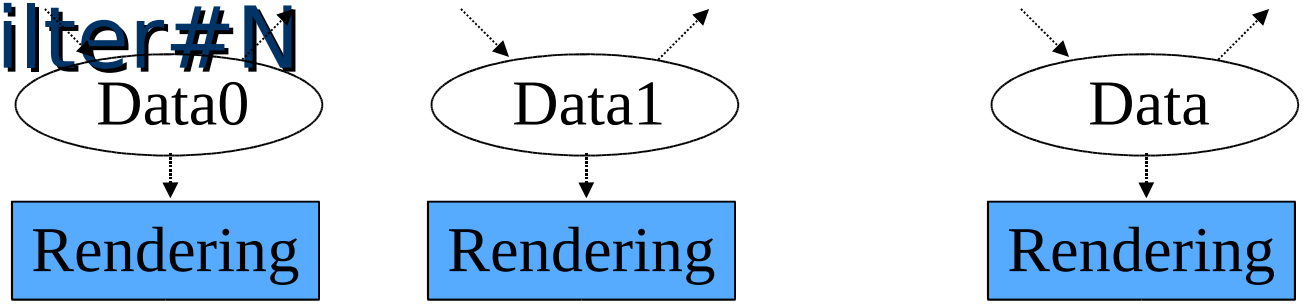
- Dataset is a viewable item
- Processing modules
  - Source – data file reader or graphical primitives



  - Filter – processing module

Visualization Pipeline

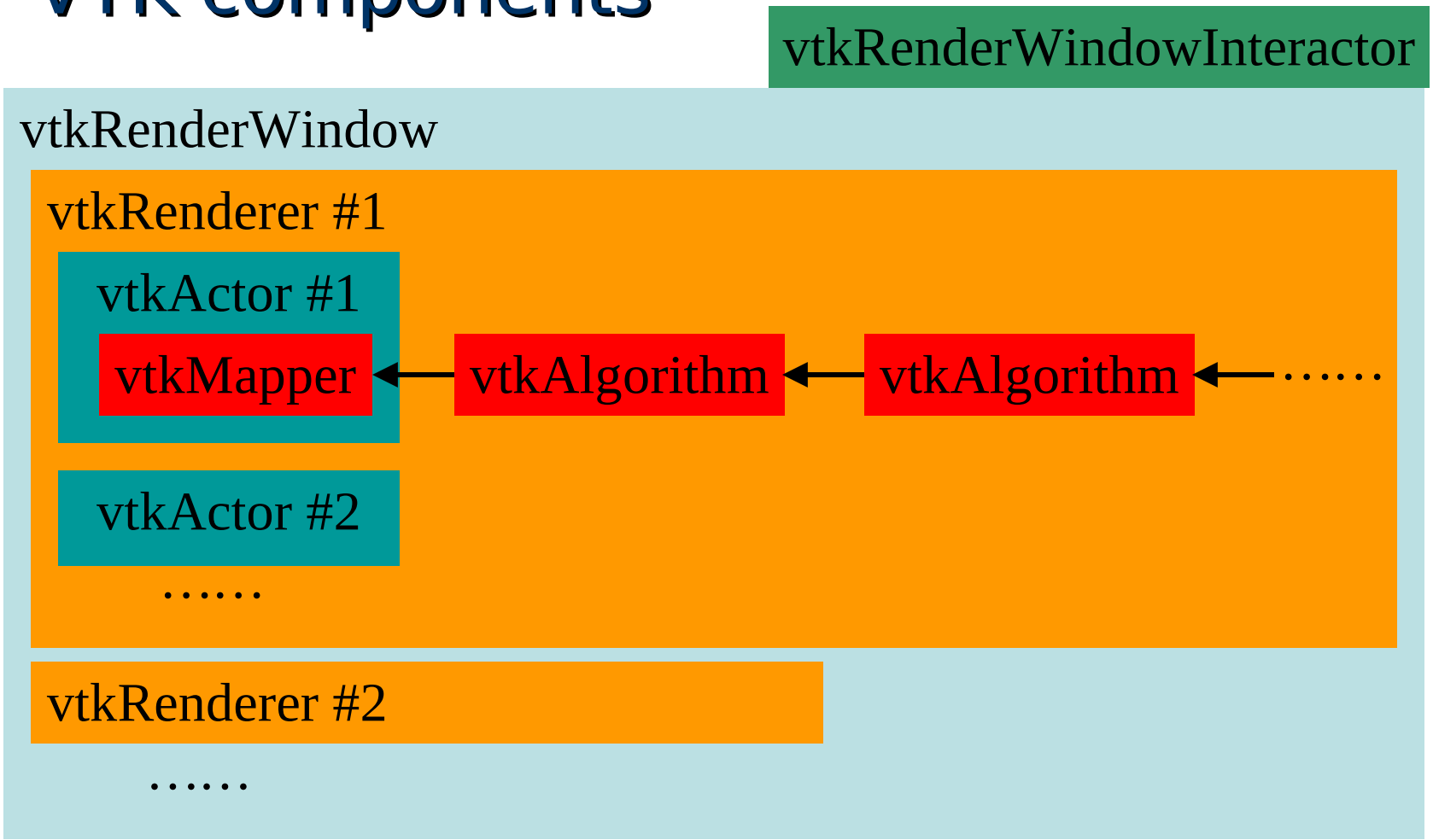
- Visualization pipeline:
  Source Filter#1 Filter#2 ... Filter#N




```
Filter_1->SetInputConnection(Source->GetOutputPort());
Filter_2->SetInputConnection(Filter_1->GetOutputPort());
.....
```

VTK Scene

- **VTK components**



VTK Scene

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- vtkRenderWindowInteractor
  - **Set render window**
  - Set interactor style
  - Set desired still/interactive refresh rates
  - Control cursor

VTK Scene

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- vtkRenderWindow
  - **Add/Remove renderers**
  - Set window size/position
  - Control stereo setting
  - Enable/Disable anti-aliasing
  - Control cursor
  - Set desired still/interactive refresh rates

VTK Scene

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- vtkRenderer
  - **Add/Remove actors**
  - Add/Remove lights
  - Set active camera
  - Enabel/Disable storing rendered image for update

VTK Scene

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- vtkProp (superclass of vtkActor2D and vtkProp3D)
  - **Set mapper**
  - Set visibility
  - Set orientation/location/scaling
  - Set display style
  - Set surface property

VTK Scene

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- vtkAbstractMapper3D
  - Subclasses
    - vtkPolyDataMapper: for polygonal data
    - vtkVolumeMapper: for rectilinear volumetric data
    - vtkUnstructuredGridVolumeMapper: for unstructured data
  - Map input data into graphics primitives

VTK Scene

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- vtkAlgorithm
  - Number of inputs/outputs
    - Source: 0 input, >1 outputs
      - Procedural objects (cube, cone, cylinder…)
      - From data files
    - Filter: >1 inputs, >1 outputs
      - Polygonal Polygonal
      - Polygonal Volumetric
      - Volumetric Polygonal
      - Volumetric Volumetric
    - Writer: >1 inputs, 0 output
      - To data files

VTK Scene

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- Examples
  - Tutorial/Step5/Tcl/Cone5.tcl
  - VolumeRendering/Tcl/SimpleRaycast.tcl