DICOM Support in 3D Slicer and CTK

Steve Pieper, PhD
Isomics, Inc.

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Topics

- Some History
- Current Slicer DICOM Architecture
- Current Use Cases / Related Projects
- Wishlist

DICOM in Research

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- In QIICR we hope to help researchers use DICOM correctly for certain well-defined use cases (three QIN trials)

DICOM for Image Analysis

- Insight Toolkit
  - ITKv3: GDCMImageIO (Malaterre, GDCM)
  - ITKv4: GDCMImageIO + DCMTKImageIO (Williams, Iowa)
- Visualization Toolkit
  - vtkDICOMImageReader (Turek, Miller, GE)
  - vtkDICOM* (Gobbi, Promising new work in progress)
- Difficult for GUI-less Libraries to Handle Generality of DICOM
  - Very CT/MR-centric
  - Many hard-coded assumptions about mapping of slices to volumes
  - No networking support
  - Sometimes the user just has to tell you how she wants to use the data

DICOM in Slicer2

- Custom VTK Classes and Tcl GUI, Reader Only
- Written by Attila Tanacs, then at JHU now at University of Szeged
- Early 2000s

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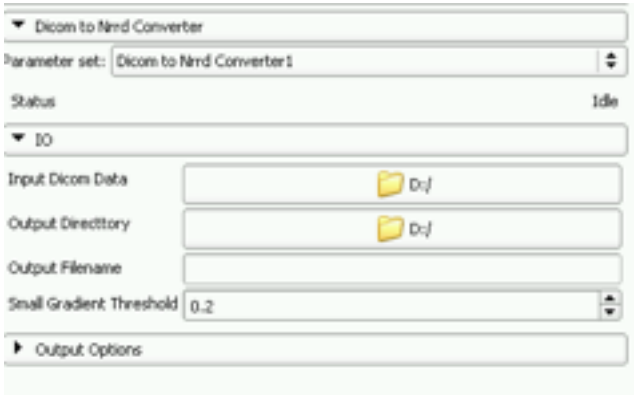
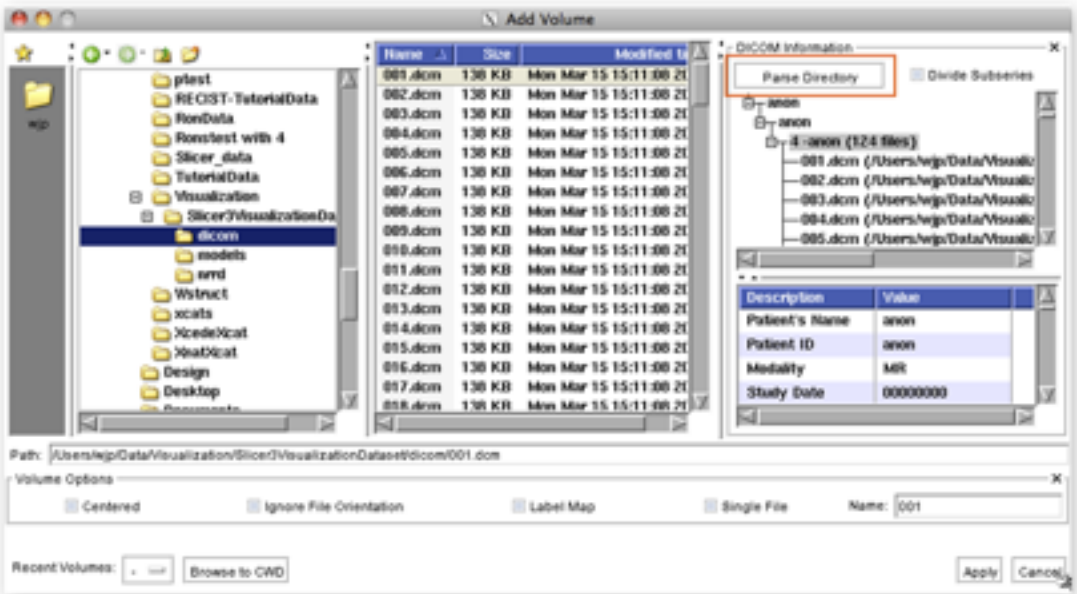
http://slicer.org/archives/slicer2.html

DICOM Readers in Slicer3

- vtkITK based parser
- ITK GDCM ImageIO to load volumes
- GDCM-based Diffusion Tool (DicomToNrrd)





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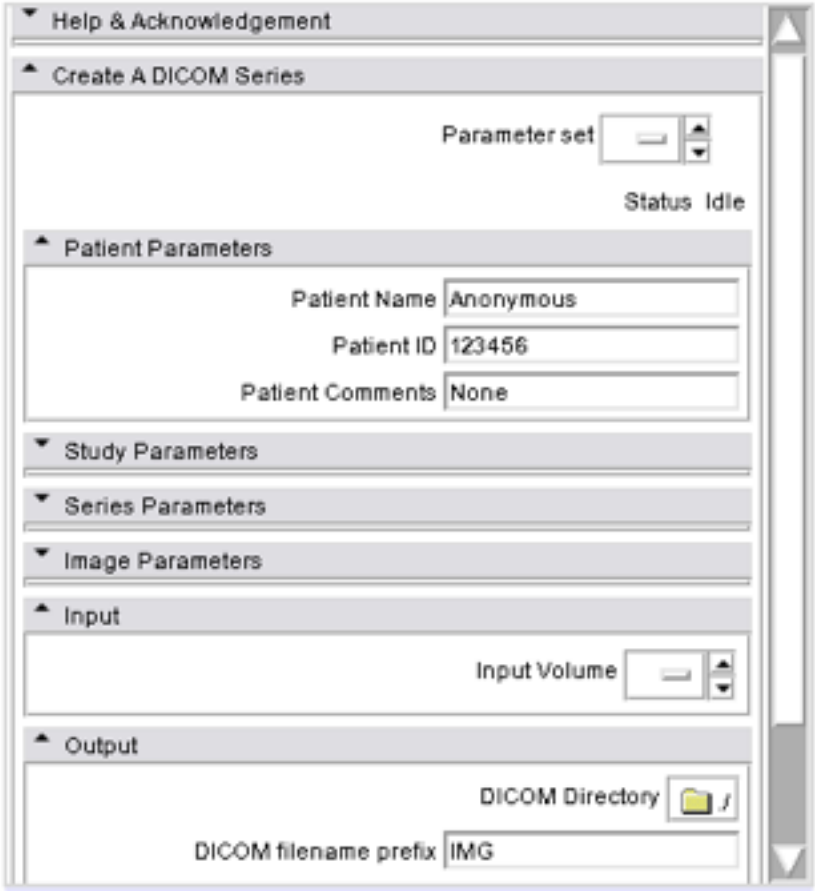
http://www.slicer.org/slicerWiki/index.php/Modules:Loading-Data-3.6

DICOM Writer in Slicer3

- ITK/GDCM Based Command Line Module
- Manual Parameters
- Everything is a CT
  - Designed as the minimal set of DICOM tags to successfully push ITK results to the GE PACS



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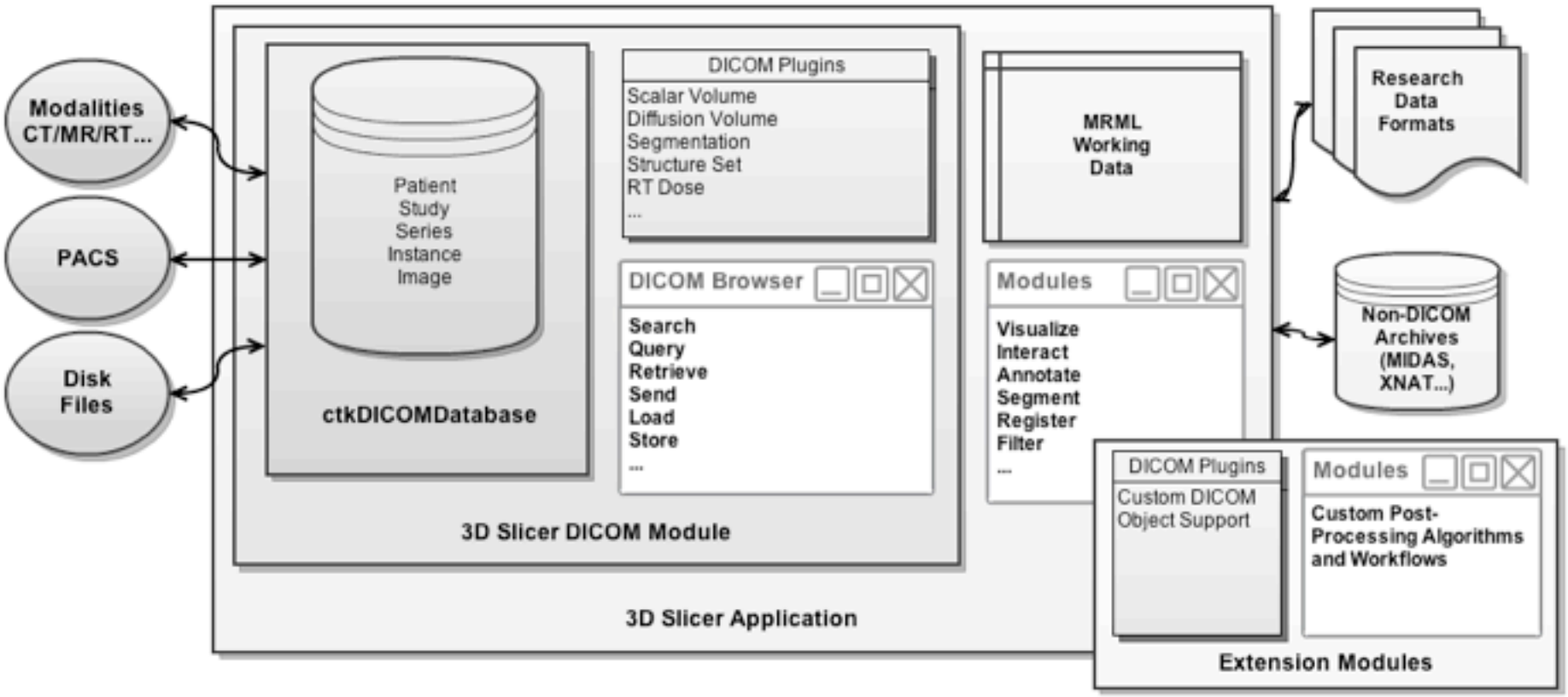
Slicer4 DICOM Goals

- Interoperability with Clinical Systems
  - PACS
  - Scanners
  - Workstations (Navigation, Dosimetry, CAD…)
- Networking: Query/Retrieve/Listen (FIND, MOVE, STORE)
- DICOM Describes Acquisitions, not What the Data IS
  - Interpret Acquisition Context
  - Route to Analysis Modules
  - Display
- Encapsulate Results as DICOM Objects

DICOM Implementation



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DCMTK

- Widely Used BSD-licensed C++ DICOM ToolKit from OFFIS at University of Oldenberg
- CMake-ified in the Past Few Years
  - First Passes by David Gobbi and Julien Jomier, Catalyzed by NA-MIC
- Supports
  - Data Objects
  - Networking, File I/O
- DCMTK-build Shared with ITKv4

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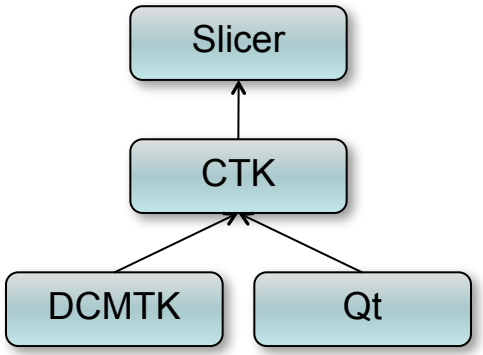
Common ToolKit: CTK

- Over a Dozen US and European Collaborators
  - Avoid Duplication of Effort in Medical Image Software Development
- High Level DICOM Classes
  - DCMTK for Implementation
  - Qt for OS Abstractions, Object Structures, GUI, Database
  - Application Hosting
  - Python Wrapped



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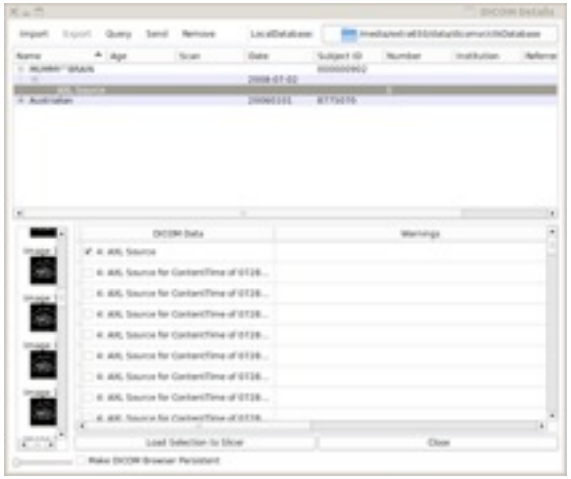
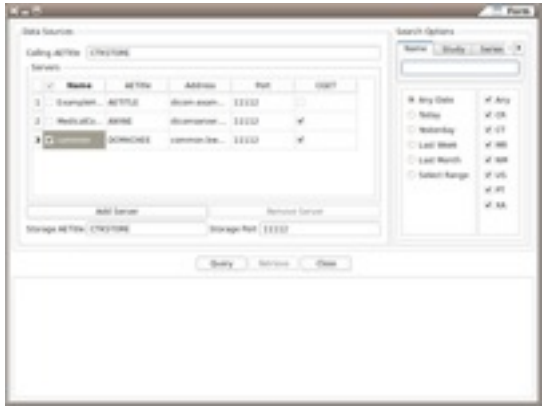
Slicer DICOM Module

- Glue Between DICOM and Slicer
  - Core DICOM Parsing in DCMTK/CTK
  - Data Pre-Cached in Database
  - MRML Manipulation in Slicer Module Logic
  - Python Classes to Connect the Pieces
- Patient/Study/Series Browser
  - Offers Slicer Interpretation of Selected Data
  - Multiple Interpretations where DICOM Data is Ambiguous
  - Loaded Data Retains UID Link





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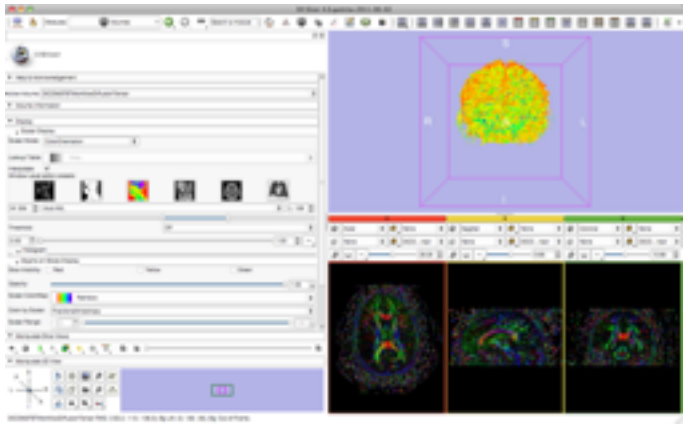
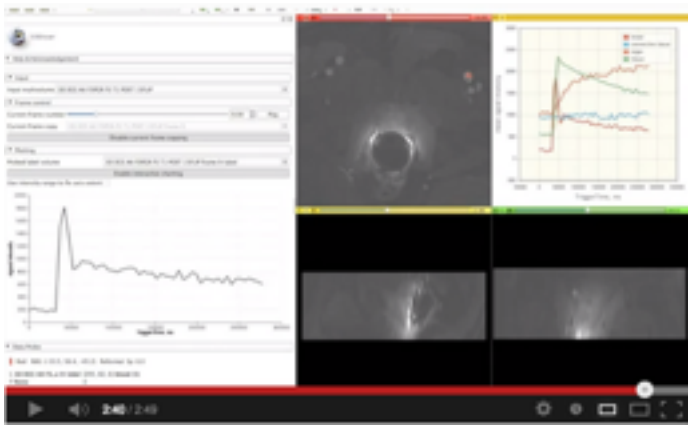
Anatomy of DICOM Plugins

- Provided by Extensions for Custom DICOM Acquisitions
- DICOMPlugin Methods
  - examine
  - load
  - exportOptions
- DICOMPlugin Properties
  - tags
- DICOMLoadable Properties
  - name
  - fileList
  - warnings
  - confidence

Bundled DICOM Plugins

- Scalar Volume Plugin
  - Most Common: maps DICOM Series to Scalar Volume
  - Warns for inconsistent slice spacing, sheared directions, …
- Diffusion Volume Plugin
  - Routes a Diffusion Scan to DicomToNrrd (DWIConvert)
- Multivolume Plugin
  - Routes Image Sequences to Load as Multivolumes
- Slicer Data Bundle Plugin (Work in Progress)
  - Zipped MRML Directories in DICOM Private Tags
  - Screenshot Image as Secondary Capture





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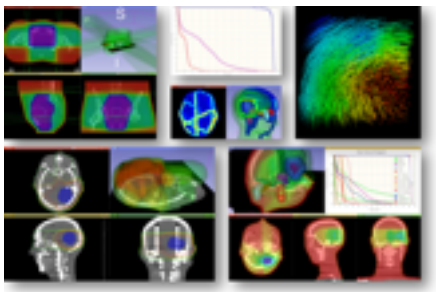
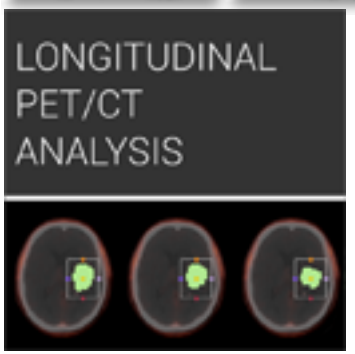
Extension DICOM Plugins

- SlicerRT
  - DICOM RT Import/Export
  - Dose, Beam, Contour...
- Longitudinal PET/CT
  - Access All Studies for a Patient
  - PET SUV Calculations, etc
- Reporting
  - QIN Workflows
  - SR, SEG





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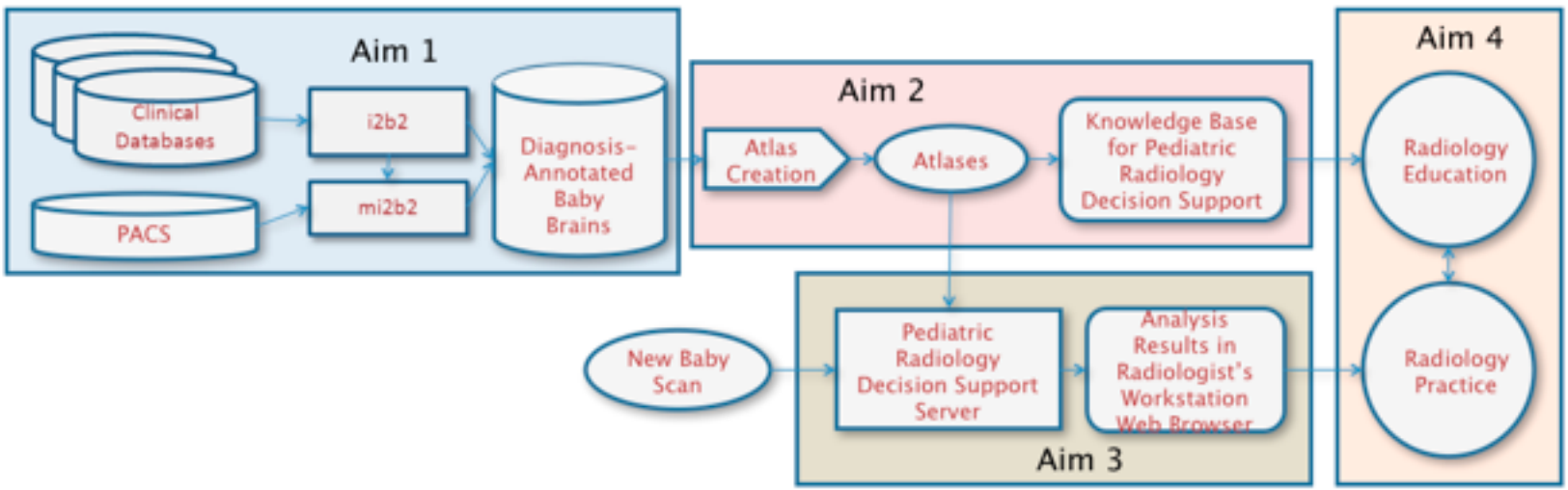
Related Projects: mi2b2 (babybrains)

- Combines Harvard Hospital Databases with PACS for Research
- IRB Controlled Process, Audit Trail
- Delivers DICOM Transfer and Database/CSV
  - Prescriptions, Lab Results, Procedures, Reports...



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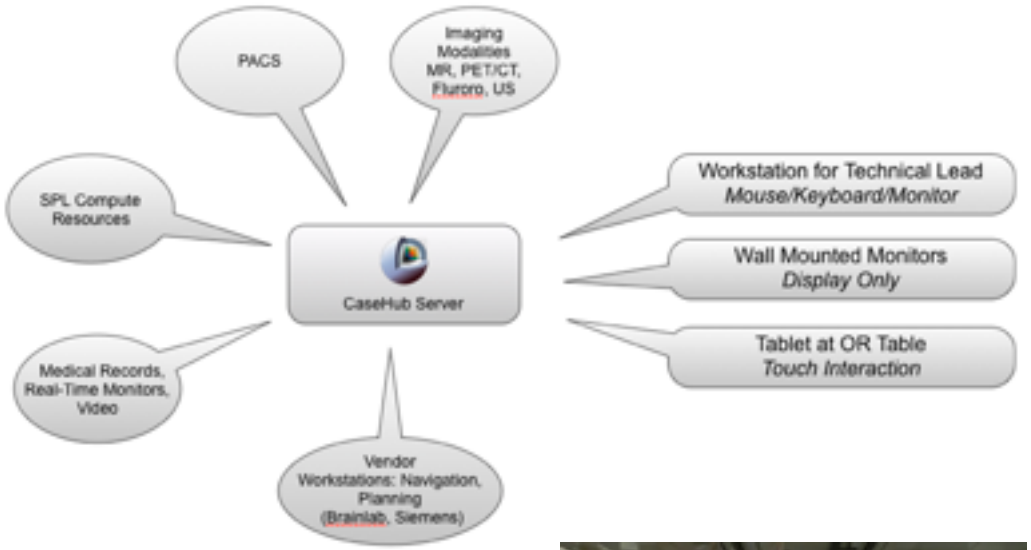
https://mi2b2.org

Related Projects: NCIGT, NAC, Siemens

- NAC: Funded effort for next 5 years to improve data handling in image guided neurosurgery
  - AMIGO
  - CaseHub
  - Steered Segmentation
  - Steered Registration
- Siemens collaboration to improve syngo.via for interventional procedures
  - Interoperability
  - Point of Care Interfaces



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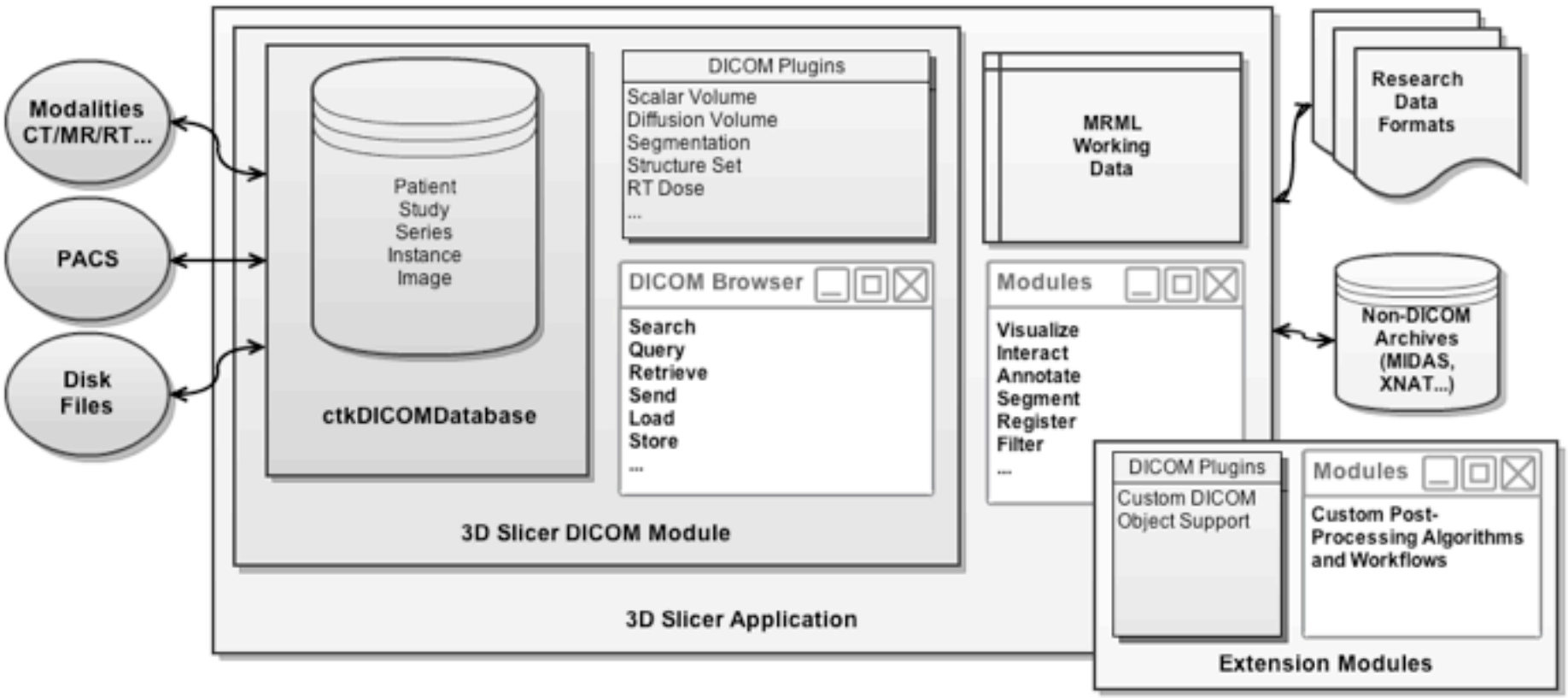
Architecture: Review



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Wishlist

- Improved documentation
  - Hyperlinked and Annotated Specification (with Examples)
- Fix missing pieces (Float volumes?)
- Better testing infrastructure: Server
  - Public, Query-able, Broad Range of Sample DICOM
- Enhanced functionality at appropriate levels of generality
  - DCMTK, CTK, ITK, Slicer, Extensions
- Incorporate newer DICOM standards
  - Registration Transforms, Hanging Protocols, Structured Reports…
- Improved DICOM database
- Faster DICOM parsing
  - Adding to database, caching tags, loading images
- Ultimately make DICOM the default save option for Slicer
  - Track provenance

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