XIP: the eXtensible Imaging Platform

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Abstract

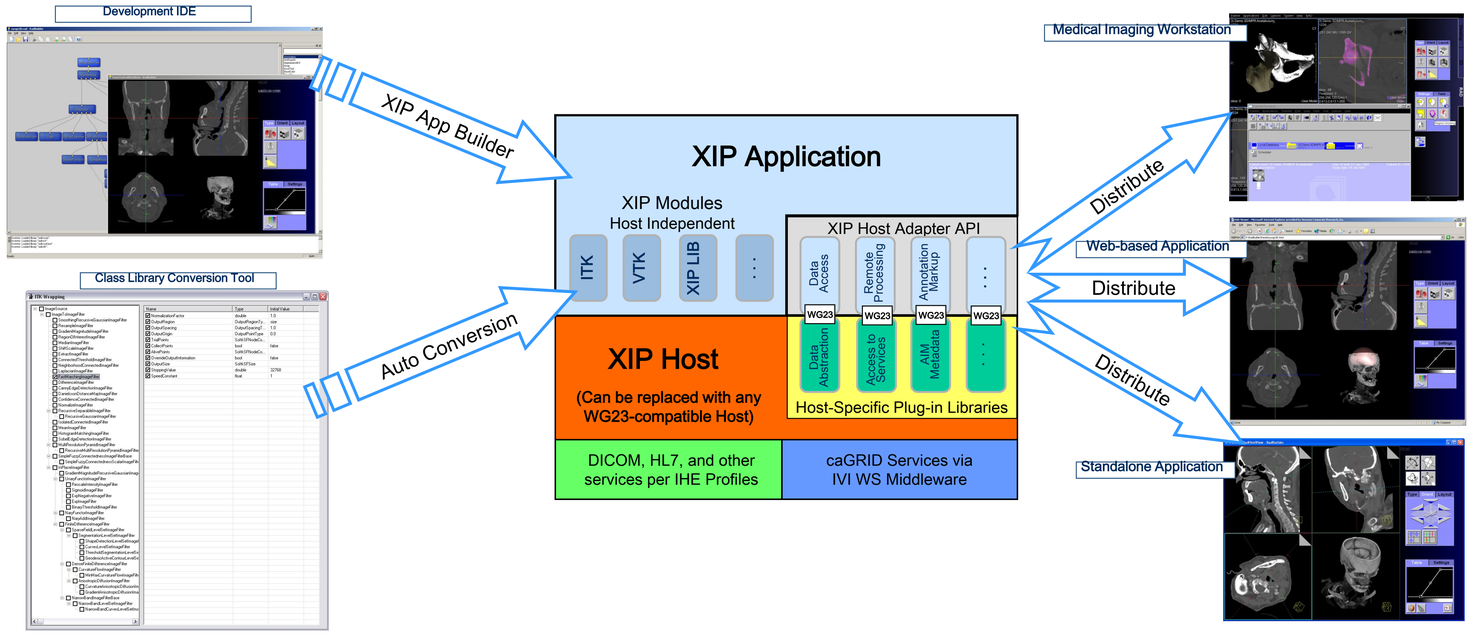
To encourage the increased use of imaging in clinical trials the caBIG In Vivo Imaging Workspace is developing the open-source eXtensible Imaging Platform (XIP) that supports the rapid building of 'plug-in' applications for image analysis and visualization. The applications built by these tools will utilize a host-system-independent interface being standardized by DICOM WG-23, hence could be launched and controlled by any system that supports that interface. Host independence facilitates translational research across multiple centers by allowing the same application to be deployed into a wide variety of settings, both research-oriented and clinically-oriented. The XIP package will include reference workstation implementations that can utilize DICOM services as well as caGRID data and analytic services to support hosted XIP applications. The XIP application builder is based on OpenInventor™, with extensions to support medical imaging applications (e.g. lesion detection, multi-dimensional visualization, registration and fusion). These extensions can include both custom-built objects as well as automatically-generated wrapper objects for commonly used toolkits such as ITK and VTK.

What is XIP ?

- XIP is an open source environment for rapidly developing medical imaging applications from an extensible set of modular elements
- Researchers will be able to easily develop and evaluate new approaches to medical imaging problems, and use them in a translational research setting
- caGrid makes it possible to develop an XIP architecture that allows users to choose between remotely hosted grid-based components and data sources as well as locally available components and sources
  - Components may include analytic services, e.g. CAD algorithms, algorithms for quantifying changes in consecutive imaging studies, algorithms associated with a 3-D visualization pipeline etc.
  - Available data sources include NCIA, caGRID data services, DICOM data repositories, local databases, etc.
- XIP will be a reference implementation of the DICOM WG-23 Interfaces

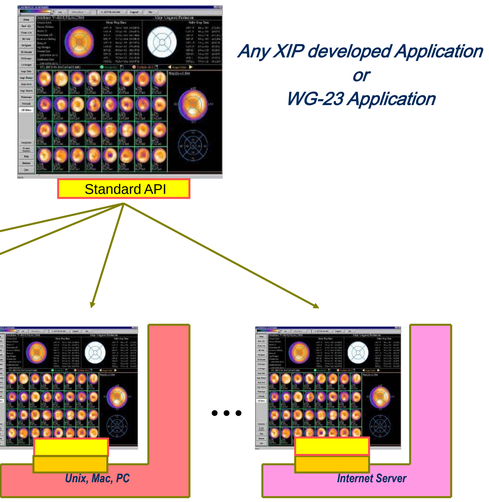
Where did XIP come from?

- XIP is a project funded by NCI's caBIG™ program [caBIG-IMG-99-01-31052006]
- The XIP project is coordinated by the Software Special Interest Group (SW SIG) in the caBIG In-Vivo Imaging Work Space (IVI WS)
- The XIP team is working closely with DICOM WG-23 – Application Hosting
- The XIP Application development framework and builder tools are being derived from the ivRAD and RADBuilder tools created by the Imaging Architectures program at Siemens Corporate Research (SCR)
  - SCR will strip out Siemens-proprietary code, replacing it with open-source code
  - The modified, enhanced package with be released with a free license via NCI
- The Electronic Radiology Lab at Washington University's Mallinckrodt Institute of Radiology will provide open-source reference implementations of XIP hosts and applications targeted toward IVI WS SW SIG needs



WG-23 addresses clinical integration and vendor inter-operability by defining standardized "plugs" and "sockets" (APIs)

caBIG XIP addresses an open-architecture, integrated development environment for rapid prototyping & collaboration based on WG 23 APIs.

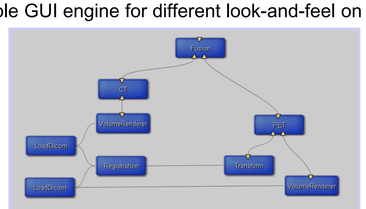


Any XIP developed Application or WG-23 Application

The same application can run on any XIP or WG-23 Host

XIP Applications

- Interconnected Open Inventor™ engines, nodes, and manipulators from XIP Libraries (Model/View/Controller design pattern)
  - Engines enable the creation of processing pipelines and animation
  - Nodes support the concept of scene graphs, which are hierarchical structures of objects describing what needs to be visualized in 2D/3D
  - Manipulators handle input devices, measurements and coordinate transforms in response to user interaction via a simple event model
- Focused on the processing logic, not the infrastructure or data format
- Skinnable GUI engine for different look-and-feel on different platforms



XIP Libraries

- Sets of Open Inventor™ objects that XIP applications may utilize
  - Stock Open Inventor™ object for 3D graphics, modeling, UI, picking, etc.
  - Standard XIP objects for interacting with, retrieving data from, and storing data to XIP or DICOM WG-23 Hosts via the DICOM WG-23 interfaces
  - Standard XIP objects that extend the stock Open Inventor™ objects with functions useful for building medical imaging applications
  - VTK classes wrapped into Open Inventor™ objects to support visualization
  - ITK classes wrapped into Open Inventor™ objects for easy use in XIP applications
  - Custom objects supplied by developers to extend the standard XIP objects
  - Open Inventor™ provides a flexible string-based interface (e.g. for scripting or multiple programming language bindings) and can be serialized (e.g. for saving state)
- Many XIP Libraries are host-independent, but if dependent on host services:
  - XIP libraries have internal dynamic 'adapter' libraries to allow for easy switching between XIP hosts or platforms (i.e. simply swap the dynamic library)
  - The XIP Application always sees the same Open Inventor™ objects regardless of host
- XIP libraries may be auto-generated from existing class libraries (e.g. ITK, VTK), or may be custom-built from new or existing code

XIP Host

- Provides the infrastructure in which XIP or DICOM WG-23 Applications run
  - Authenticates user
  - Manages installation, launching, and termination of XIP Applications
  - Provides data and services to XIP Applications
  - Accepts status information and results back from XIP Applications
  - Deals with auditing and controls access to services and data
- Isolates the XIP application from the nature of databases, archives, networks, and possibly image data formats
  - Manages caGRID interactions and security
  - Manages access to DICOM networks, objects, and services
  - Maps images and associated meta-data from various sources between their native form and a common form useable by the XIP application
- Handles workflow issues
  - General Purpose Worklist support, following IHE profiles
- Supports any application that follows the DICOM WG-23 Application Hosting Interface Standard

Summary

The XIP platform will make it **easier and less expensive to access specific post-processing applications at multiple sites, simplifying clinical trials**, and most importantly, increasing the uniformity of imaging and analysis.

Imaging applications developed by research groups will more easily be accessible within the clinical operating environment, simplifying workflows and speeding data processing and analysis.

Once validated, **the software should be readily transitioned into products** through streamlined Federal Drug Administration (FDA) approval processes due to the re-use of tested libraries and open source development processes that have already been used in approved devices.