

Health Sciences Overview



●●● Health Sciences Practice

BSI's strong team of domain and technology experts cater to the changing needs of the Medical Diagnostics and Analytical equipment companies

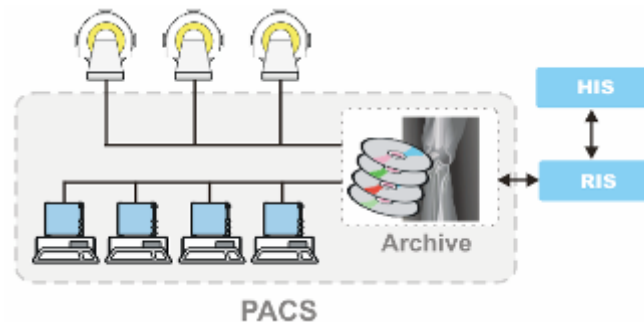
Diagnostics Imaging

- Diagnostic Imaging Application -
Ultrasound, MRI, PET, SPECT
- Core Image processing Algorithm development
- Integration of third party algorithms



Health IT

- PACS/RIS Solutions
- PMS / EMR
- Communication standards
 - DICOM
 - HL7

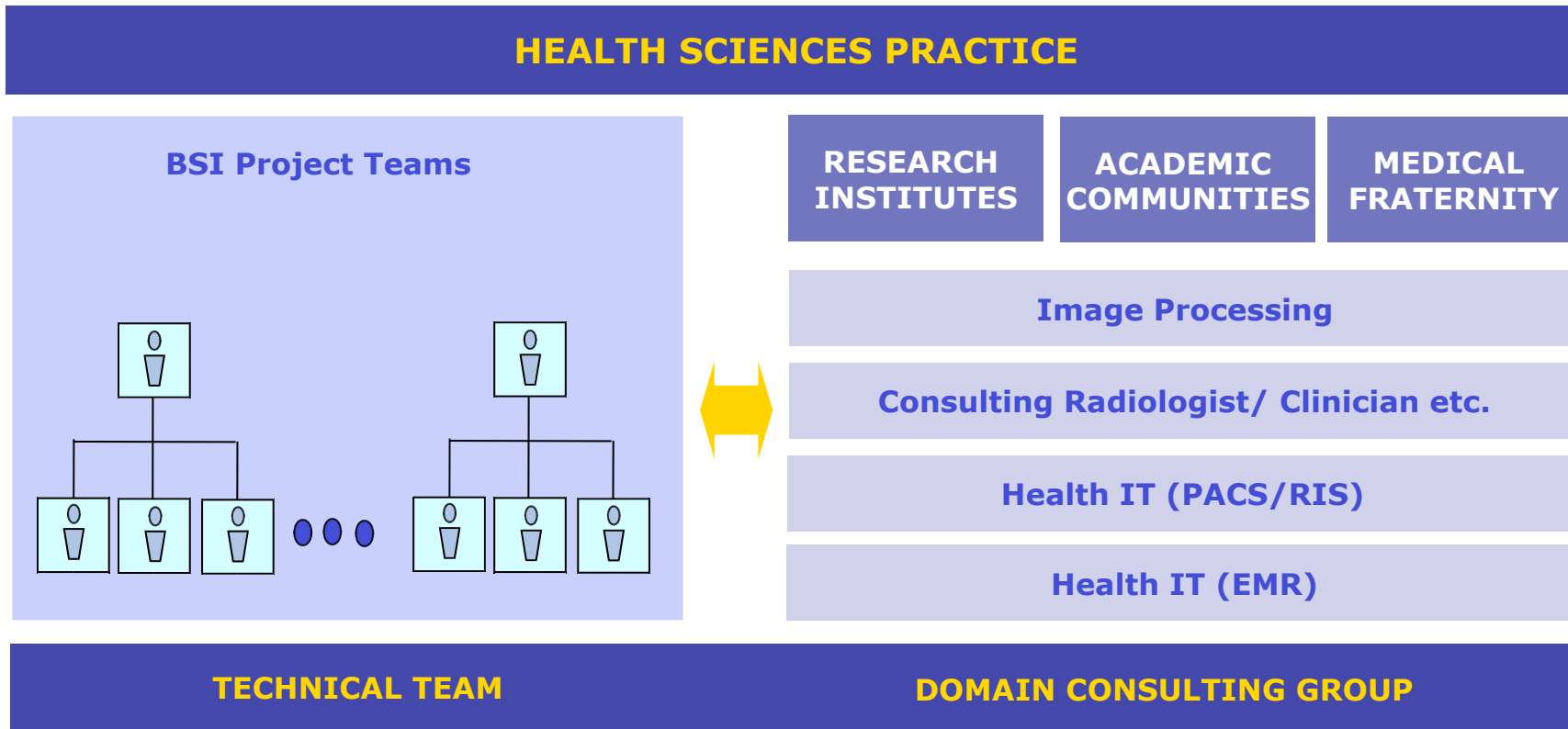


Analytical Instrumentation

- Lab Instruments
- Soft Control Panels
- Data Acquisition
- Data Analysis, Graphs etc
- Compliance
 - 21 CFR Part 11



●●● Health Sciences - Team Structure



●●● Representative Profile (Image Processing Consultant)

- Ph. D (Biomedical Engineering)
Indian Institute of Technology Bombay (2008)
- Ph. D Thesis
Function Diffused optical tomography for Neonatal brain functional monitoring.
- Imaging expertise
 - Medical image processing algorithms
 - Image Analysis
 - Tomographic image reconstruction algorithms
 - Signal processing (Especially medical signals)
- Projects Experience
 - Research and Development of Segmentation algorithm for Features from CTA Data
 - Development of Diffuse Optical Tomography (DOT) image reconstruction algorithm
 - Development of ultrasound hyperthermia system
 - Development of PC controlled Braille from manual braille
 - EEG Analysis and Recording System

●●● Representative Profile (Radiologist)

- M.D. (Radiology)
- Consultant radiologist with well known diagnostic centers in Mumbai
- Experience in consulting and Ground Truth (GT) generation for Imaging R&D projects.
- Modalities experience include
 - Multidetector Spiral CT scan
 - MRI
 - Ultrasonography and Color Doppler
 - Mammography
- Publications
 - Imaging in Mesenteric ischemia on multi-detector CT scan
 - Bone Mineral Densitometry: Comparison of various techniques

●●● Representative Profile (Health IT Consultant)

- **Master of Science (Biomedical Engineering)**
 - University Of Michigan, USA
- Providing adequate subject matter expertise/domain knowledge in areas such as PACS, EMR and Endoscopy
- **Project Experience**

Thorough knowledge of PACS (Picture Archiving and Communication Systems), DICOM (Digital Imaging and Comm. in Medicine), HL7 (Health Level 7) and IHE (Integrated Health Enterprise).

ENTERPRISE WIDE PACS

- Experience in working with a top PACS provider for building their enterprise wide PACS platform.

SPECIALTY PACS

- Experience in specialty PACS system, targeted towards a very specific audience of the medical fraternity

Diagnostic Imaging

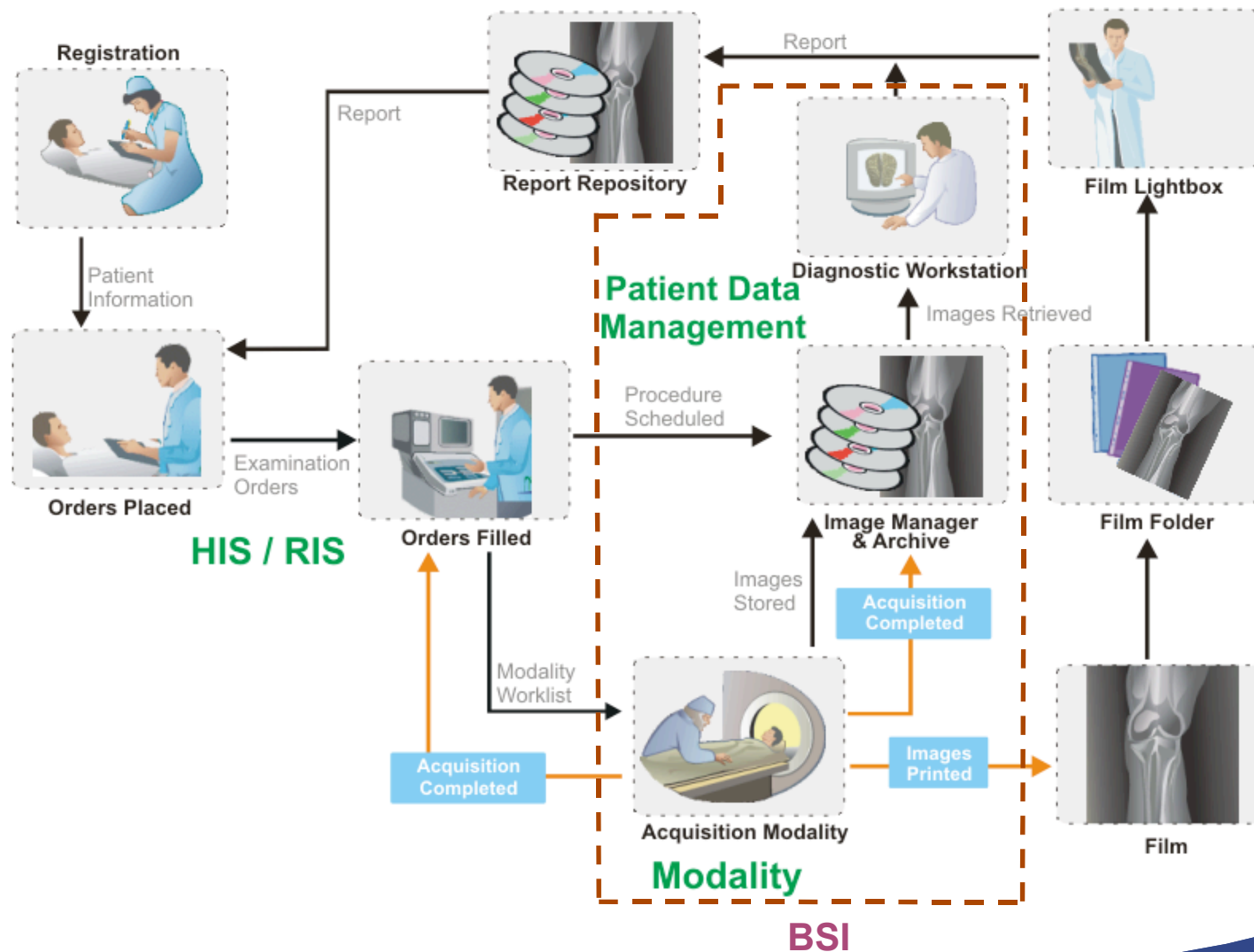
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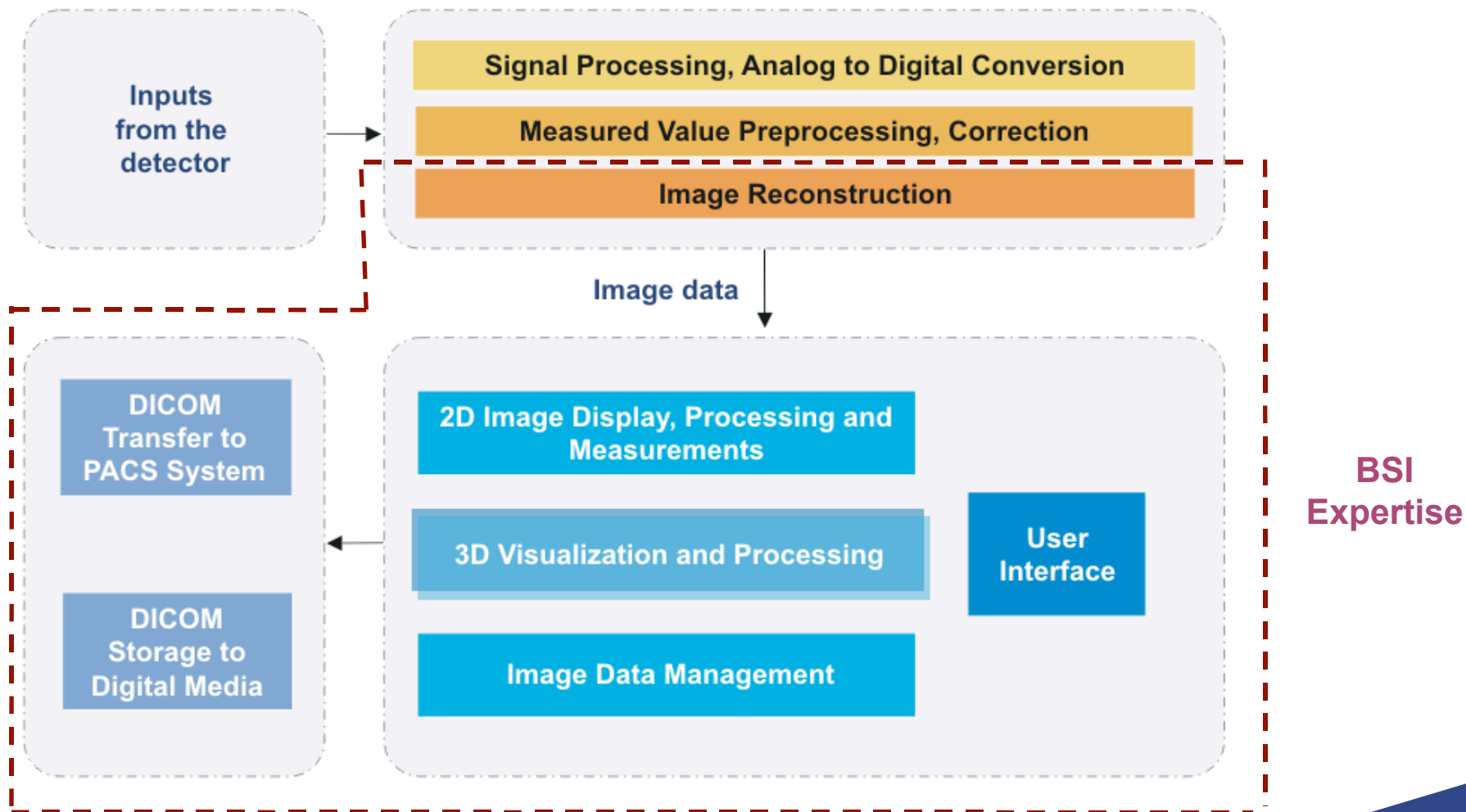
●●● BSI Diagnostic Imaging expertise - Snapshot

- About 10 years domain experience
- 350 Man years experience on a variety of projects
- A dedicated team of more than 60 engineers
- Dedicated Imaging group comprising of
 - Technical team specialized in imaging software development
 - Consulting Image processing experts from research institutes and academic community
- Imaging algorithm development / implementation for different modalities such as MRI, Ultrasound, PET and SPECT
- Experience in evaluation and Integration of third party algorithms and libraries in a vendor neutral manner for quick time to market
- Wide experience in implementing Enterprise wide and Specialty PACS
- Worked with leading companies such as Hitachi Medical Corporation, Gamma Medica, Stratagene, Medicsight

Diagnostic Imaging Workflow



BSI Positioning



●●● BSI Services

- **Collaborative Product Development**

- Console application development for medical imaging modalities – MRI, PET and Ultrasound
- Image acquisition application - SPECT
- Development of 2D & 3D Image processing algorithms and imaging libraries.
- Developing smart and user-friendly User Interfaces for imaging modalities. Building Ease of operation with the use of operator guidance modules
- Patient Information Management System applications
- PACS solutions – Enterprise and Specialty
- Networking solutions in the area of image management (PACS solutions)

- **Enhancement**

- **Performance optimization for special purpose processors**

- **Re-engineering**

- Re-engineering legacy systems using Commercial-Off-The-Shelf Hardware and Software technologies

- **Migration of Software across platforms, operating systems**

- **Sustenance**

- **Compliance**

- Incorporating IHE compliance in modality consoles
- Implementation and testing for DICOM compliance
- 21CFR Part 11 compliance for medical equipment

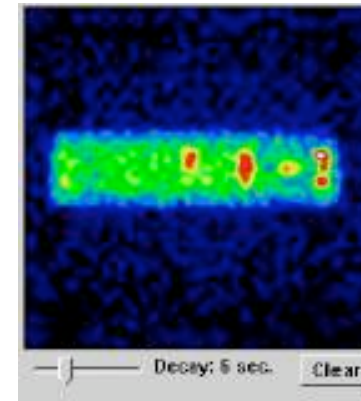
BSI Diagnostic Imaging capabilities

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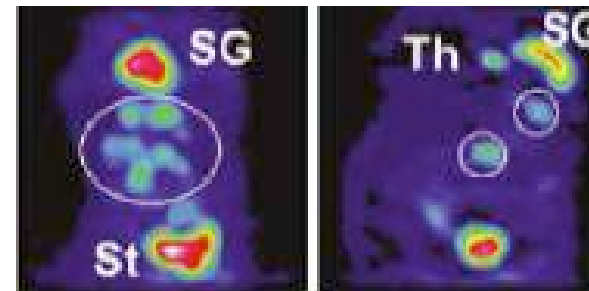
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●●● Image Acquisition - SPECT

- Imaging technique based on detection of gamma rays
- Radionuclide injected to the patient.
- Multiple projections (2D images) acquired from multiple angles using gamma cameras.
- Possible to reconstruct 3D data using tomographic reconstruction algorithm.
- Cardiac and Respiratory gated acquisitions possible.
- Use of multiple gamma cameras (2, 4 etc) provide accelerated acquisition.



SPECT Projection



SPECT Reconstructed data

●●● Post Processing – MRI, Ultrasound

● Post Processing of Images

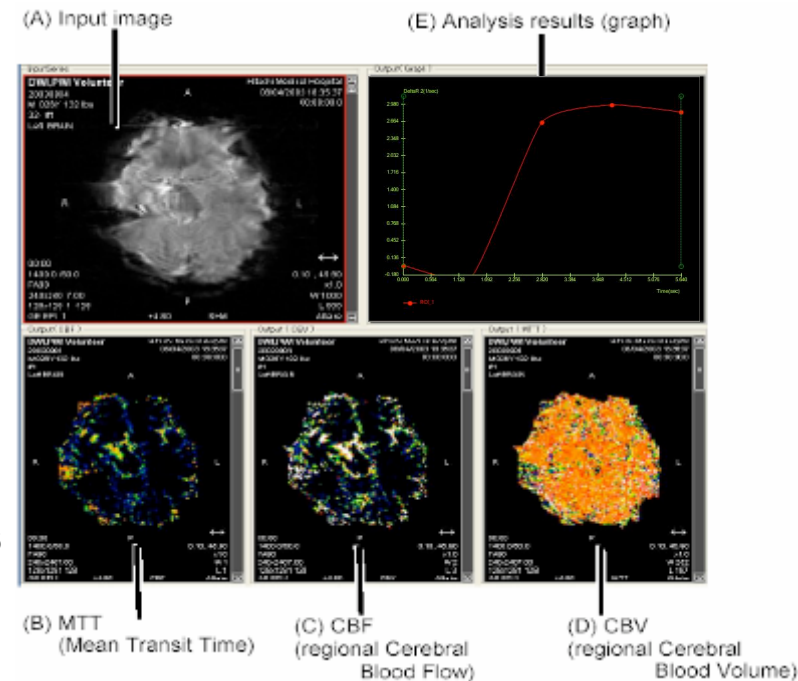
● Image 2D Tasks

- Diffusion, Perfusion
- Add/Sub – Addition, Subtraction of Images
- Dynamic Analysis- Analysis over time
- Velocity Analysis – Analysis of Velocity changes
- Filter – Application of various 2D Filters
- Tissue Tracking – Motion tracking of tissues
- Contour Processing

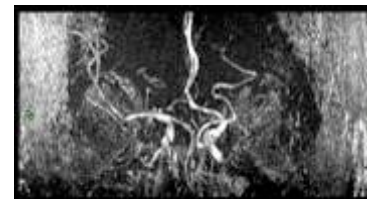
● Image 3D Tasks

- MIP – Maximum Intensity Projection
- MPR – Multi-Planar reformatting
- VR – Volume Rendering

Perfusion



MIP

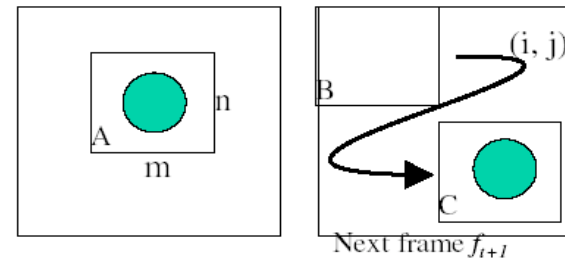
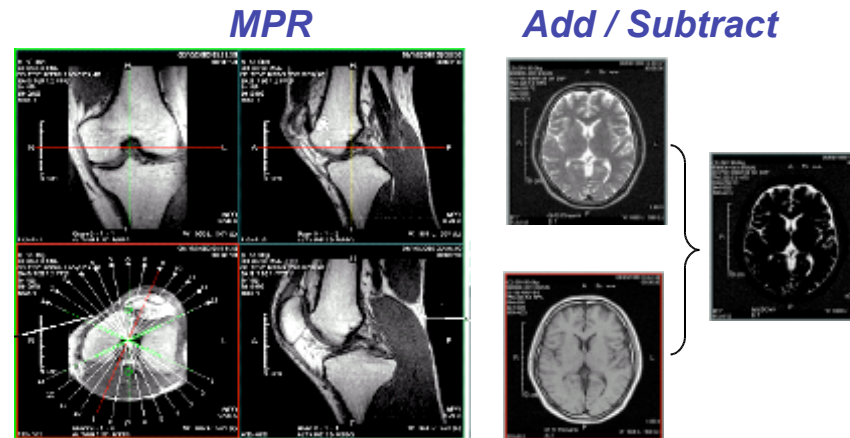


●●● Image Processing Algorithms

● Algorithms for Image Processing

BSI has worked on several Medical Imaging Algorithms (2D/3D)

- Maximum Intensity Projection (MIP)
- Multi Planer Reformat (MPR)
- Volume Rendering
- Addition and Subtraction
- Automatic Contour / Edge detection
- Automatic Motion Tracking
- Region Growing
- Image Filtering
- Statistical Analysis



Motion tracking using block matching

●●● Third Party Software

● Algorithms for Image Processing

- Used third party software called as **Cedara IAP library** for implementing 3D image processing algorithms
- Thorough understanding of the IAP system architecture and various objects the library exposes
- Design of complex IAP pipelines (using IAP objects) and implementation of **3D functionalities** such as Maximum Intensity Projection, Multi Planar Reformat, Volume Rendering (both parallel and perspective), Virtual Endoscopy and 3D filtering.
- Used LCModel for **spectroscopy analysis**

●●● Visualization & Analysis

● Image Visualization and Analysis

BSI has worked on

- 2D and 3D Image Rendering
- Framework for interactive drawing of 2D ROIs
- Interactive image manipulation (Zoom, pan, rotate etc)
- ROI based image processing
- Statistical measurements (e.g Volume)

ROIs, Image Analysis on MRI
Images

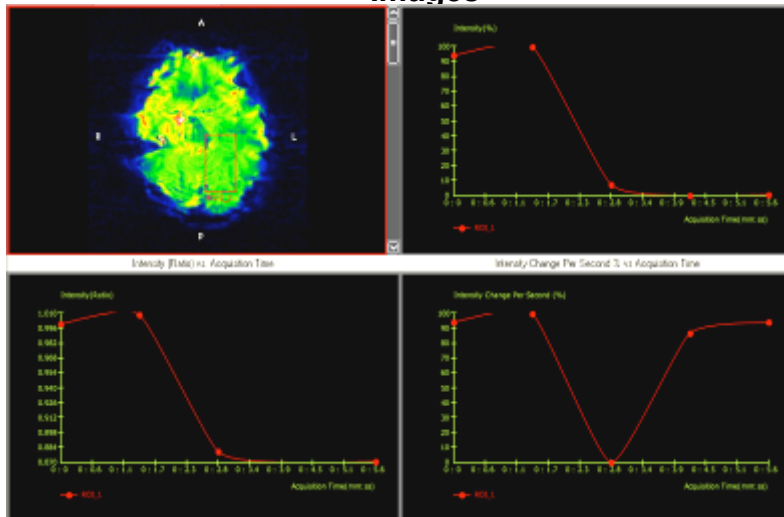
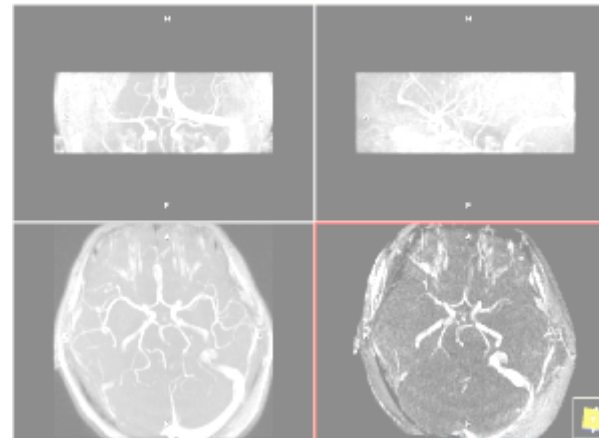
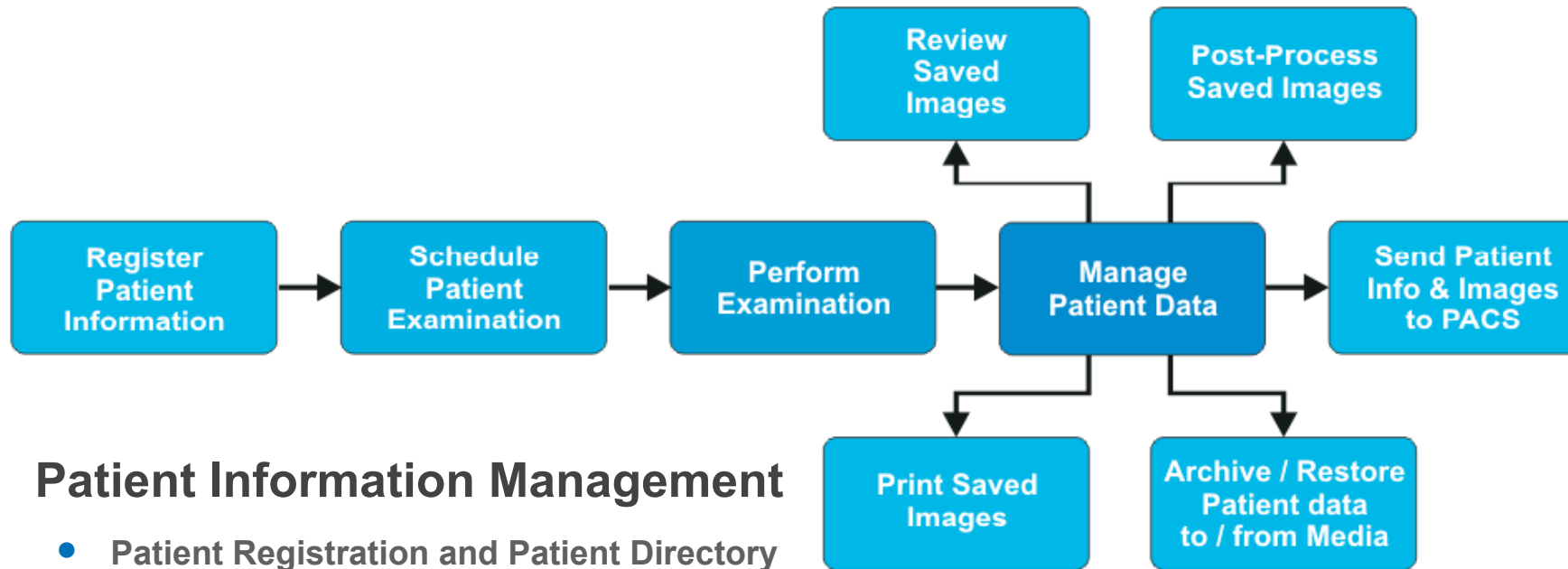


Image Rendering



●●● Patient Information Management



● Patient Information Management

- Patient Registration and Patient Directory
- Common Framework for Patient data management within the medical application
- Examination Window and Process Management Framework
- Database specific functionalities for Patient data storage
- Archive and Restore of Image data (DICOM Standard Support)
- Image Transfer from one modality to other (DICOM Standard Support)

BSI PACS capabilities

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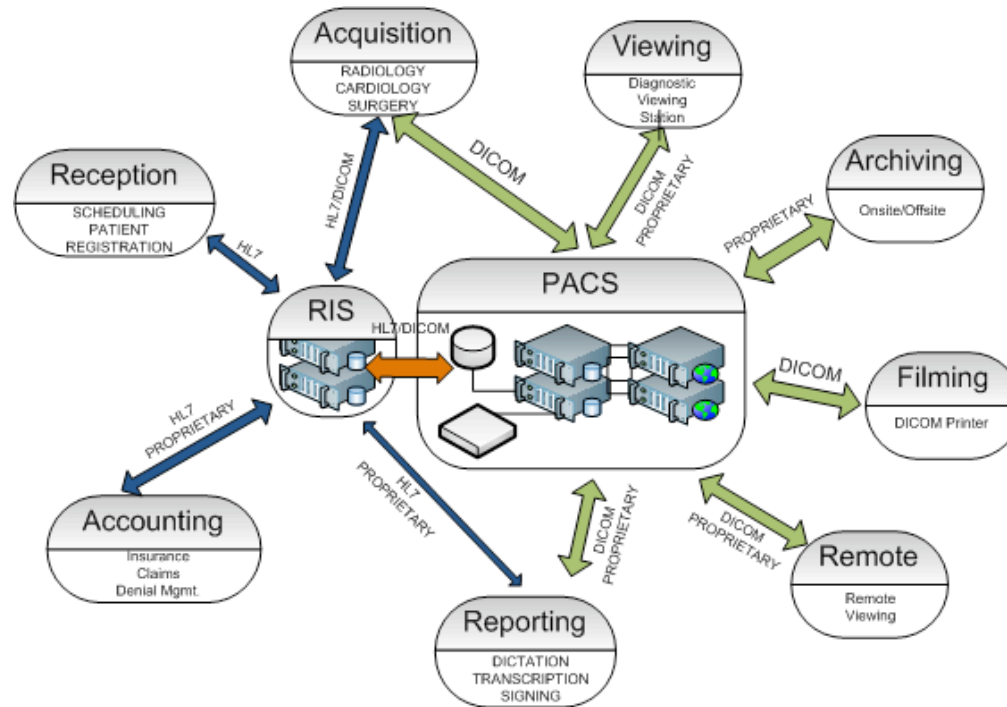
PACS

ENTERPRISE WIDE PACS

- Experience in working with a top PACS provider for building their enterprise wide PACS platform.

SPECIALTY PACS

- Experience in specialty PACS system, targeted towards a very specific audience of the medical fraternity



●●● PACS

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● Our Experience

- Web based architecture to support multiple medical facilities and mobile physicians
- Imaging viewers for multi departments/modalities within the enterprise
- Lossy & Lossless image compression techniques for smart storage of data as per customer requirements.
- Smart image streaming techniques for faster image display on low bandwidth connections
- Synchronization of images and information across multiple servers across multiple facilities for real time data access
- Integrated 3D tools, including Comparative MPR/MIP/Oblique Slice
- License managements tools
- Integrated SAN support
- Available off-site archive/disaster recovery service
- Support for multiple file types (DCM, JPEG, MPEG, AVI, PDF, TIFF, DOC and WAV voice files)

●●● PACS

...contd

● Our Experience

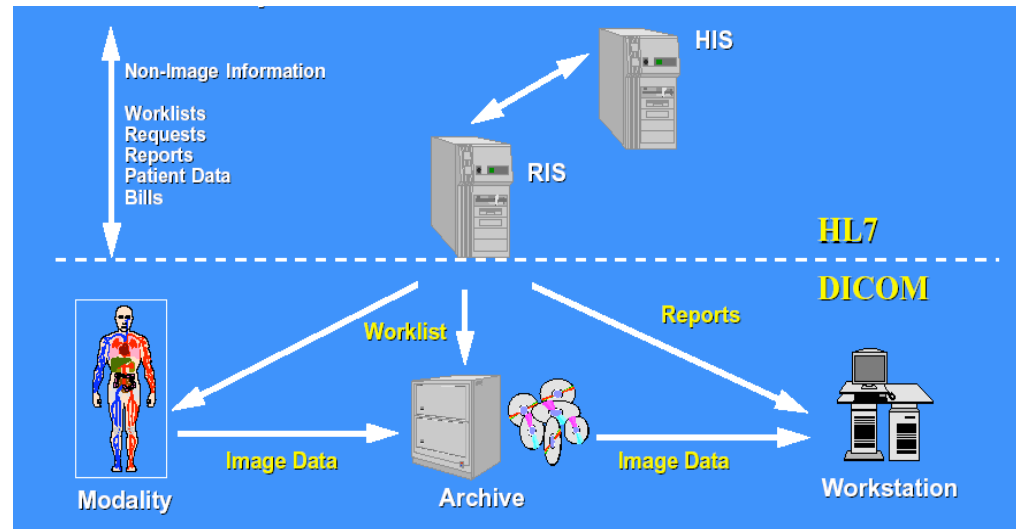
- Speciality orthopaedic planning tools and their integration with PACS
- Excellent understanding of the orthopaedic workflow
- Developed API's for integrating third party products and web portals
- Automatic propagation of viewer/tools updates to PC viewing/reading stations
- EMR integration
- Excellent GUI design and usability
- Integration with OR devices (endoscopy)
- Excellent understanding of the radiology workflow (Worklist, Dictation, Transcription and Reporting)
- Data migration projects from one PACS vendor to another
- Mobile services for the physician including image review and preliminary diagnostics
- Localization of applications

●●● Communication Standards

COMMUNICATION STANDARDS

HL7 is focused at "textual" structured (Non Image) information exchange within the hospital.

DICOM is focused at 'Imaging' i.e. communication of Image data and the relevant information within the hospital.



HL 7 and DICOM are not competing standards but they co-exist to achieve complete Enterprise Integration

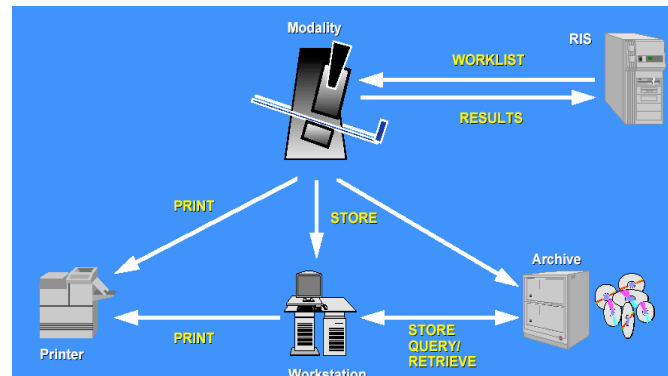
●●● DICOM Expertise

- **Verification Service Class**
 - C-Echo service for SCU (Service Class User)
 - C-Echo service for SCP (Service Class Provider)
- **Storage Service Class**
 - C-Store service for SCU
 - C-Store service for SCP
- **Query / Retrieve Service Class**
 - C-Find service for SCU
 - C-Find service for SCP
 - C-Move service for SCU
 - C-Move Service for SCP
- **DICOM Print Services**
- **Comprehensive Structured Report**

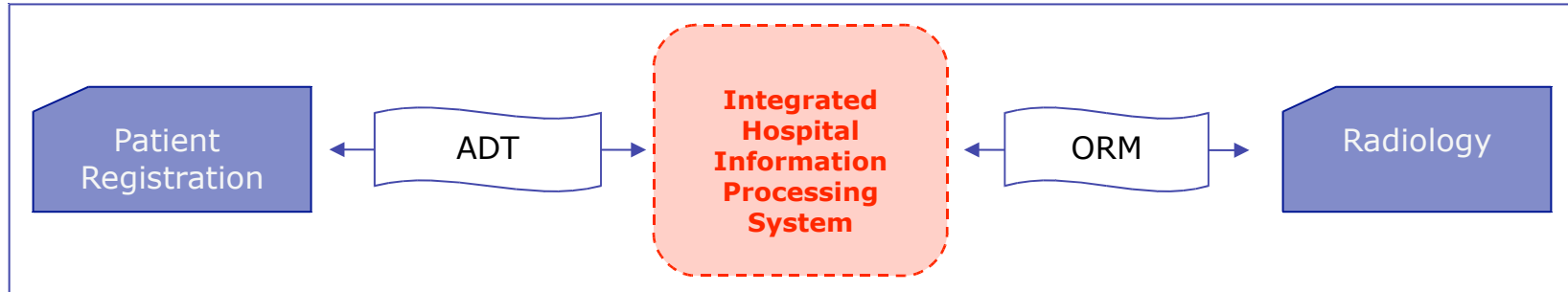
- **Modality Worklist Management (MWM)**
- **Modality Performed Procedure Step (MPPS)**
- **Media Storage – Part10 file, Archive etc.**

IHE – Integrating Healthcare Enterprise

- **Integration Profiles for Acquisition Modality**
 - Scheduled Workflow (SWF)
 - Patient Information Reconciliation (PIR)
 - Consistent Presentation of Images (CPI)
- **DICOM compliance testing prescribed by IHE technical framework**



●●● HL7 Support



Message	Purpose
ADT/ACK_A01	Patient Admit Message
ADT/ACK_A02	Patient Transfer Message
ADT/ACK_A03	Patient Discharge Msg.
ADT/ACK_A06	Transfer Out-patient to In-patient
ADT/ACK_A07	Transfer In-patient to Out-patient
ADT/ACK_A08	Update Patient information
ADT/ACK_A11	Cancel Patient admission
ADT/ACK_A12	Cancel Patient transfer
ADT/ACK_A13	Cancel Patient discharge
ORM/ACK_O01	General Order Message (Creation of Radiology request)
ORU/ACK_O01	Unsolicited Transmission of Observation Message

- **Communication between HIS & RIS applications**
- **Data exchanged by sending/ receiving the HL7 messages**
- **Messages used:**
 - **Admission, Discharge & Transfer messages**
 - **General Order messages**
 - **Unsolicited transmission of an observation message**

●●● Technology Expertise

Processor Architectures	Intel x86, Intel i960, Motorola 68K, Motorola PPC, ARM7, ARM9, MIPS R3000
Platforms	Windows, Unix, Solaris, HP-UX, Linux
File Formats (Imaging)	DCM, JPEG, BMP, etc.
Embedded Operating Systems	VxWorks, pSOS+, Embedded Linux, eCOS, MQX, CMX, OSE, Windows CE, mC/OS
Languages	C/C++, Java, C#, VB.Net, eVC++, Managed C++
Software development tools	Visual Studio .Net, Eclipse, Java, Sun Studio, J2SE, J2ME, GNU, Compact .NET
Other Tools	Rational Rose, UML, Rational XDE (for design documentation), NUnit (for unit testing), .NET Memory Profiler, Ants Profiler (For Performance), Visual Source Safe (for version control), ClearQuest (for defect tracking)
3rd Party Software	Cedara IAP Server (for image processing) MergeCOM (DICOM library) , DicomObjects (DICOM library) HAPI (HL7 API)

Case Studies

●●● Development of operator console for Multiple Modalities

Client

The client is one of the world's largest manufacturers & sellers of medical electronics equipment

The Need

- Development of a single user-friendly operator console for multiple modalities (**MRI, CT, PET**).
- Additional features to increase customer satisfaction levels

BSI's Role

- Applications of the Operator console included *Patient Registration, Patient Directory, Examination Window, Scan Management, Image Processing, Image Review, Filming / Printing*

Technology

- .NET(VB .Net, C#, Managed C++), Cedara IAP Server, Merge (DICOM library)
- Rational XDE, Visual source safe/clear case, Bugzilla/clearquest
- Testing
 - Unit Testing - Automated test drivers using Nunit
 - System Test Case - Automation using QTP
 - Performance Testing - Ants
 - Memory Leakage - .Net Memory Profiler

Benefits to the Client

- The generic framework enabled the support for different imaging modalities. This significantly reduced the development time required for developing console application for other modalities.
- Various innovative features not supported by the competition were added to the product, giving the client a competitive edge
- BSI's collaborative development model ensured seamless functioning with the client and its partner vendors resulting in timely completion of the project.
- The product is DICOM compliant



●●● 2D and 3D Image Processing

Client

The client is one of the world's largest manufacturers & sellers of medical electronics equipment

The Need

- Development of a Modality console application consisting of various post-processing tasks such as Maximum Intensity Projection (MIP), Multi Planar Reformat (MPR), Volume Rendering (VR) and many others.
- All these tasks involved implementing various image processing algorithms operating on a plain (single) image (2D processing) / (3D processing).

BSI's Role

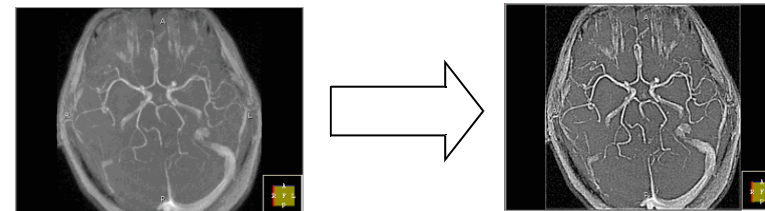
- 3D image processing algorithms implementation using Third Party Libraries
- Design of complex IAP pipelines (using IAP objects) and implementation of 3D functionalities such as MIP, MPR, VR (both parallel and perspective), Virtual Endoscopy and 3D filtering.
- Also involved in various 2D image processing tasks such as Addition/Subtraction of images, Perfusion, 2D Filtering tasks.

Technology

- .Net (VB .Net, C#, Managed C++)

Benefits to the Client

- Plug-in architecture allowed easy replacement of third party software components



**Edge
Enhancement
Filter**

●●● SPECT Image Acquisition

Client

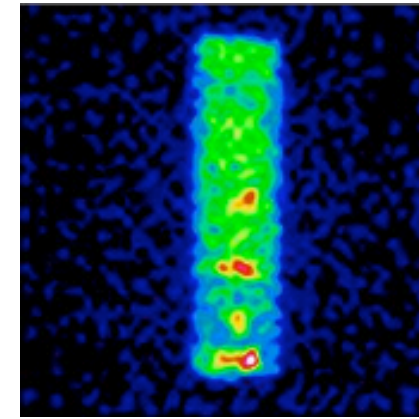
The client is one of the world's innovative manufacturers of next-generation imaging systems for both clinical and pre-clinical applications

The Need

- Development of a standalone image acquisition application (for SPECT Modality) that would display real time projection images.
- This also required implementation of various image acquisition protocols such as Static, Dynamic and Tomographic etc including the gating signal support.

BSI's Role

- A team of domain specialists and architects from BSI worked very closely with the client in the initial phases to gain complete understanding of the SPECT imaging concepts to formulate the software requirement specification in a very short time
- BSI used the SPECT image generation algorithm for acquisition and creation of the projection image. Also implemented the SPECT imaging protocols.
- Offered an effective solution for patient and study data storage and retrieval.



SPECT Projection Image

Technology

VC++, .NET

Benefits to the Client

- Implementation of a scalable & re-usable architecture with efficient Object Oriented design enabled the client to enhance the application with new features for patient data management and image reconstruction in a short timeframe.

●●● Colour Tissue Tracking

Client

The client is one of the world's largest manufacturers & sellers of medical electronics equipment

The Need

- An application for creating a user-friendly display of strain and the torsion data using the latest and easily available display forms.
- Enhance the tracking techniques and fasten the data processing.

BSI's Role

- BSI designed a user-friendly MDI application with the following features:
 - 4 different types of views
 - Saving the color view as motion files
 - ROIs comprising of two equidistant co-axial & similar shapes.
 - Manipulations of ROIs
 - Tracking of a large number of point-pairs on the frames of motion file and displaying the data analyzed in the color view.

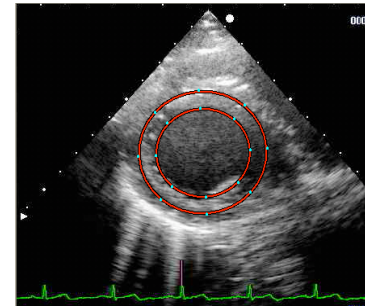


Fig (1) Marked ROI

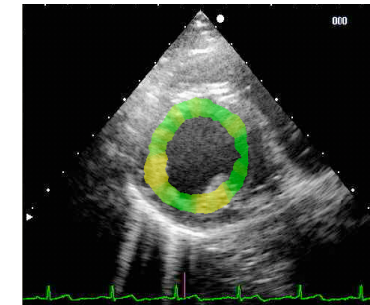


Fig (2) Color view

Technology

- VC++ 5.0/MFC

Benefits to the Client

- The re-usable components resulted in saving time and cost

●●● DICOM compliance in Modality Console Application

Client

The client is one of the world's largest manufacturers & sellers of medical electronics equipment

The Need

- The application required compliance with IHE framework and DICOM standard support. It involved the following
 - Implementation of IHE profiles, DICOM and Non-DICOM storage and retrieval, DICOM Format Conversion, Private tags etc.
 - Testing using MESA Server

BSI's Role

- Understanding of existing application features, its merits and shortcomings, requirements of the new application and the end user perspective.
- Design of a robust and flexible architecture for the application and implementation using .NET technology.

Technology

- .Net (VB .Net, C#, Managed C++)

Benefits to the Client

- Addition of new features
- Faster development of the application
- Faster regression testing due to automated test cases

●●● Patient Information Management

Client

The client is one of the world's largest manufacturers & sellers of medical electronics equipment.

The Need

Patient Information management solution for easy information access

BSI's Role

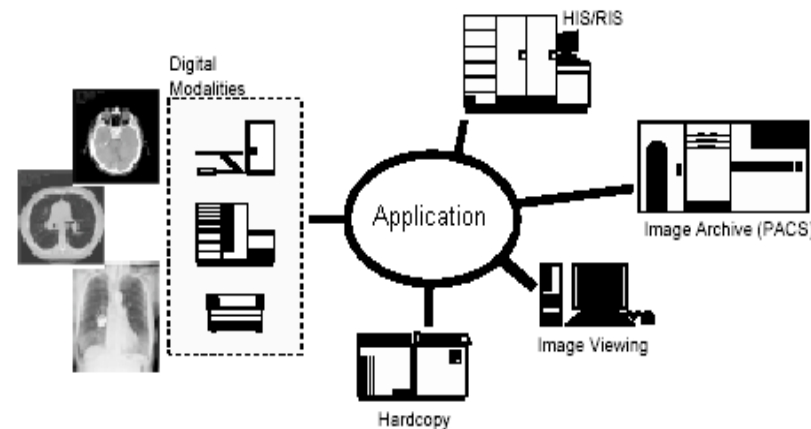
- The features supported by the BSI solution included the following:
 - Patient Registration
 - Emergency Patient Registration and reconciliation
 - Accessing Patient Information from Hospital Information System
 - Examination scheduling
 - Patient data including Examination reports storage, archival and retrieval.
 - Advanced search facilities to Search Patient information

Technology

- .Net (VB .Net, C#, Managed C++)

Benefits to the Client

- Seamless integration with other systems in Health Care Enterprise.



●●● Why BSI?

- **Relevant Competencies enabling quick transition (Domain, Technical)**
 - Well networked with Image processing consultants, Radiologist/Clinicians, Health IT(PACS,EMR) experts from research institutes, academic community and medical fraternity.
 - Imaging algorithm development / implementation for different modalities such as MRI, Ultrasound, PET and SPECT
 - Have clinical experts who work on ground truth generation using patient data for algorithm validations.
- **Cost-effective, process-based engagement models**
 - Reduce Time-To-Market
 - Lower TCO
 - Stringent security policies and measures to prevent IP leakage
- **Global Product support**
- **Value Added Benefits**
 - Improve Quality by usage of industry's best practices
 - Scalable work force
 - Draw upon best practices built through the years and by working with similar companies
 - Leverage multi-platform skills



Thank You