

ATC Informatics Committee Report

Walter R. Bosch, D.Sc.

ATC Steering Committee Meeting

October 2, 2008

Philadelphia, PA

ATC Informatics Committee

• Mission

- Share pertinent information and provide input regarding the latest informatics technology available and/or used at the QA Centers/Cooperative Groups
- Periodically review and assess the ATC's informatics infrastructure and developmental schedule.

• Membership

- Walter Bosch (Chair)
- Joe Deasy (Co-Chair)
- John Matthews
- Richard Hanusik
- Huy Duong
- Brenda Young (liaison ACRIN/RTOG)
- Joel Saltz (liaison caBIG)

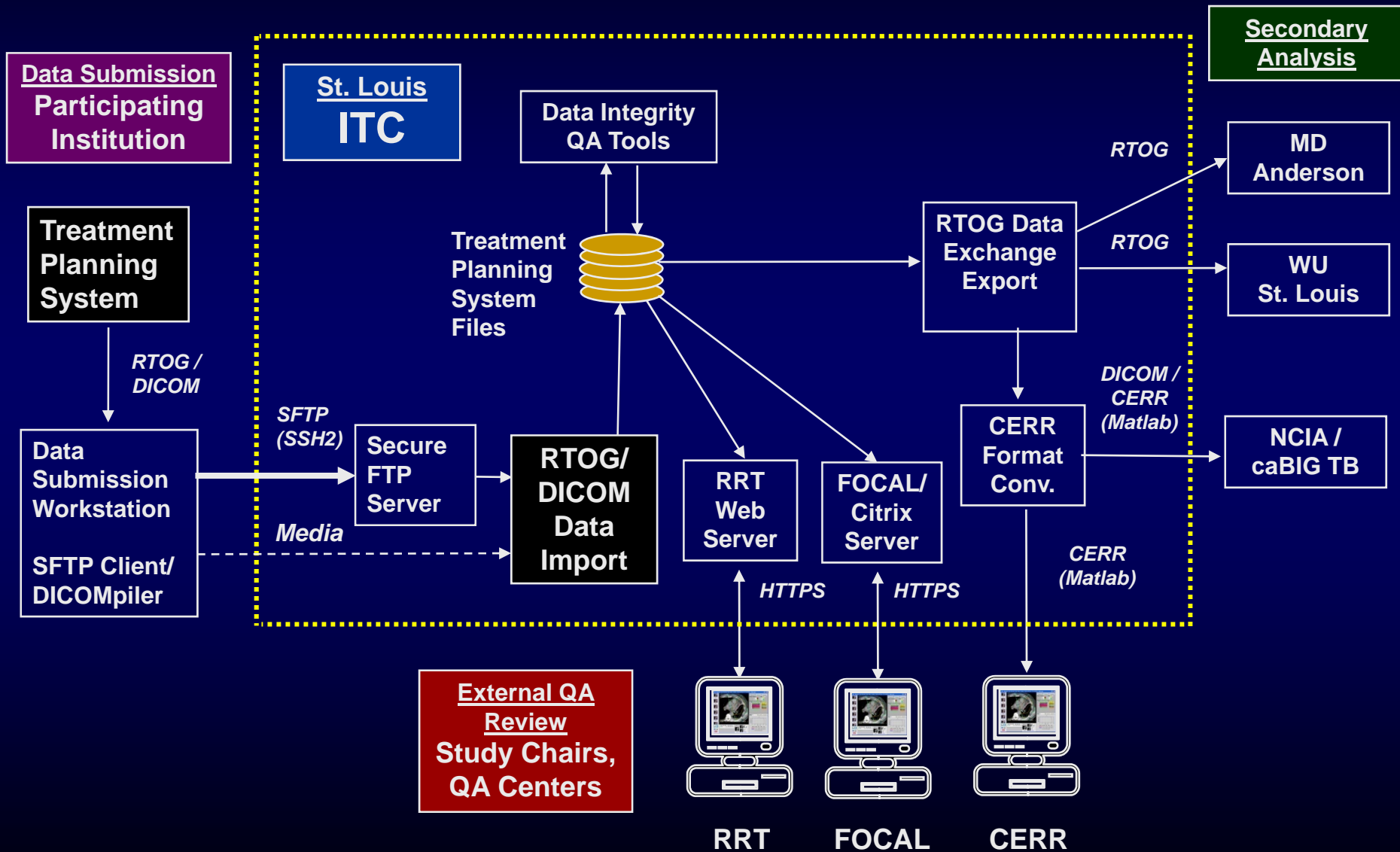
ATC Informatics Committee Report

- QuASA²R Update & Development Timeline
- CERR Integration
- Uniform Structure Names
- Consensus Contouring
- ITC Data Exchange Support Efforts
- Related Informatics Efforts: View, OPEN, ...

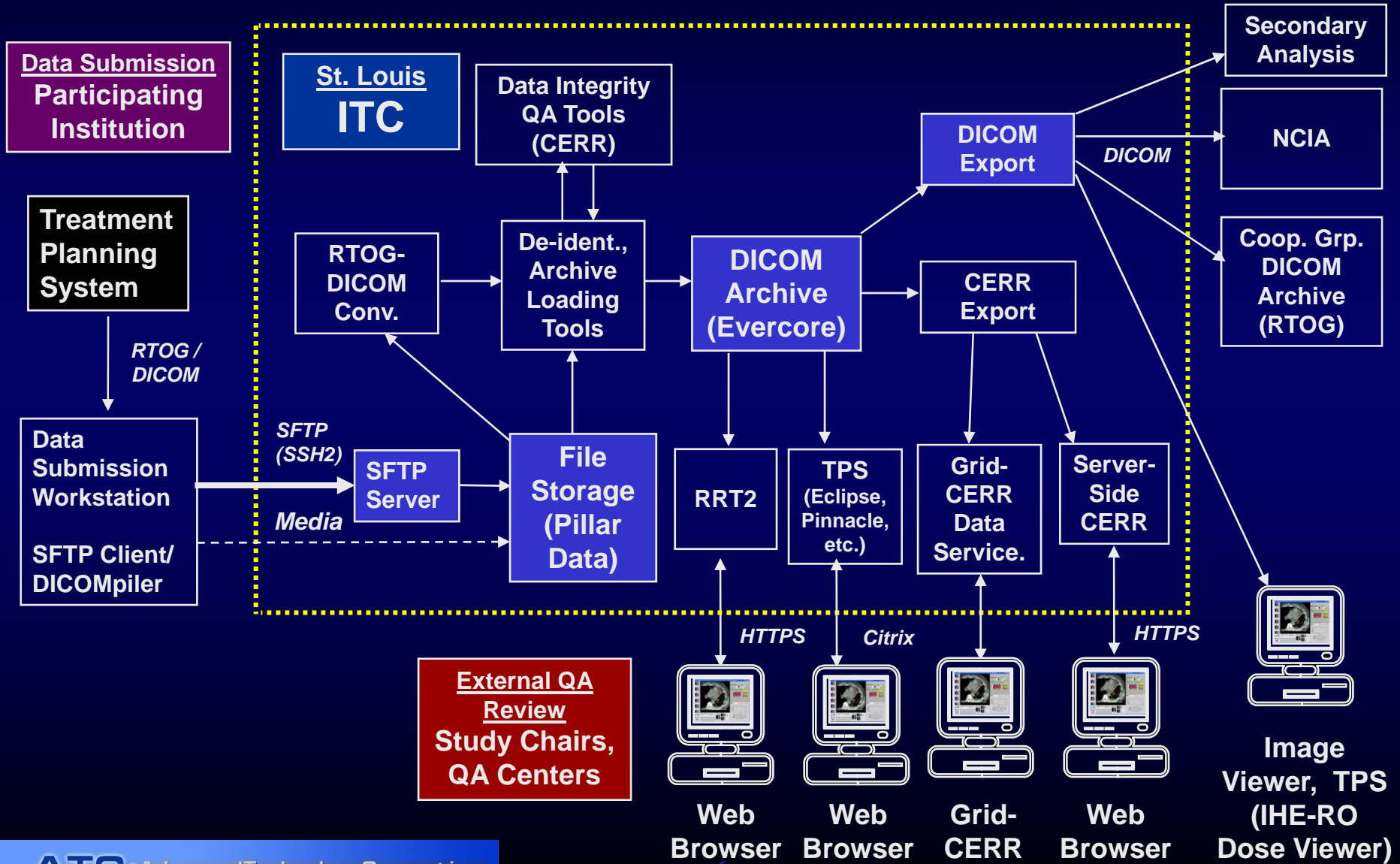
ATC QuASA²R (Quality Assurance Submission, Archive, Analysis, and Review) System

- Constraints
 - Tools must support DDIQA as well as PCQA workflow
 - New imaging and treatment technologies, e.g., IGRT, ART, require new QA workflows, new tools.
 - System must maintain continuous support for ongoing protocols
 - Development budget is limited
- Approach
 - Use modular approach to enable stepwise implementation, testing, and upgrades, while maintaining service to ongoing studies
 - Invest in the interfaces, i.e., data standards (DICOM, IHE-RO) and support for TP vendor data export
 - Use commercial “off-the-shelf” and open-source software wherever possible and focus custom software development efforts only on features not otherwise available.

QuASA²R – Current Components and Data Flow



QuASA²R – Development Plan



Pillar Data Systems

Network Attached Storage

- System installed at ITC – Jan 2008
 - Setup, training, filesystem creation
- SFTP server integration/testing – Feb 2008
 - Used for exchange of vendor DICOM Spatial Registration data for IHE-RO Domain Pre-testing
- ITC data backup system integration – Feb 2008
 - Nightly updates of compressed backup datasets
- RRT secure HTTP server integration – Feb 2008
 - RTOG closed protocol cases accessible on RRT
- System Upgrade/Update – May 2008
 - Software update (improved NFS performance, stability)
 - +10 TB additional capacity
 - + CIFS (Windows file sharing) for TeraMedica Evercore

ITC TeraMedica Evercore Archive

- Installation at ITC, June 9-12, 2008
 - TeraMedica Evercore Archive v. 4.5.1
 - OS: Windows 2003 Server Enterprise x64
 - Database: MS SQL Server 2005 x64
 - Servers: (2) DELL PowerEdge 2950 Servers with quad-core 3GHz Xeon processor, 16 GB RAM, GB ethernet
 - Primary database server, secondary archive server
 - Primary archive server, secondary database server
 - Storage: Pillar Data Systems NAS (20 TB)



ITC Evercore® Progress to Date

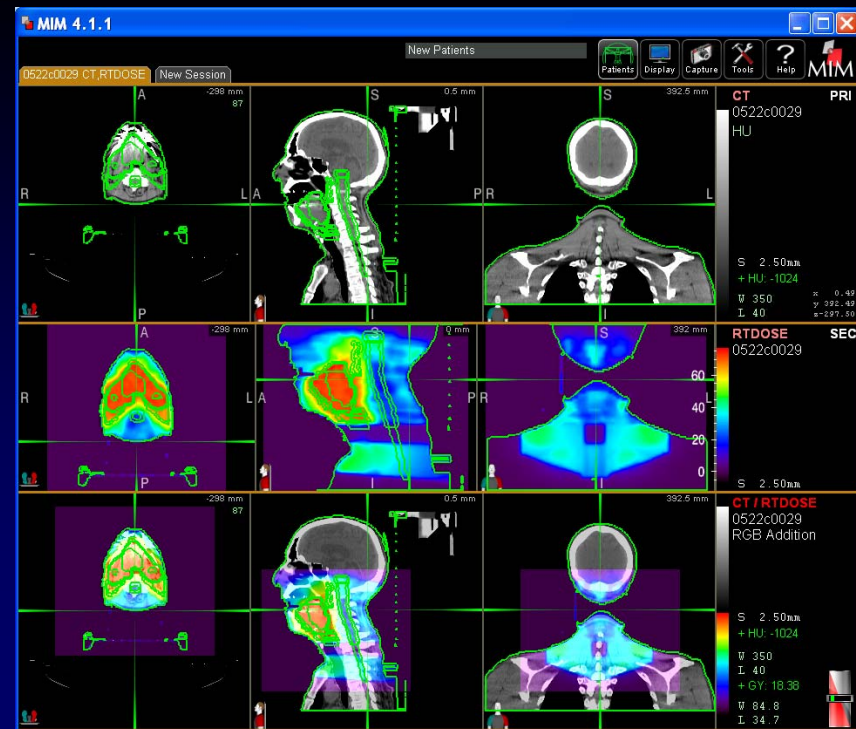
- Preliminary configuration of Evercore™ Organizations (PMO, STMO, FMO) for Clinical Trials data management
- Operational Testing
 - Loading of DICOM, non-DICOM (CERR) data
 - Q/R from MIMvista, K-Pacs
- Requirements definition for tools to load DICOM, CERR data into archive
 - Re-identification
 - Create new DICOM instances
 - Referential integrity check

The screenshot shows the Evercore Patient Search interface in a Microsoft Internet Explorer browser. The page title is "Evercore - Patient Search - Microsoft Internet Explorer". The user is logged in as "walter Enterprise Super Users". The interface includes a search form with the following fields: Patient Organization (Enterprise), Patient ID, Last Name (RTOG), First Name (0522), MPI ID (0522c0029), Accession Number, Performed Date Range (All), Begin, and End. Below the search form are "Search" and "Reset" buttons, and an "Export Selected Items..." button. The search results are displayed in a table with columns: Patient ID, Last Name, First Name, Birth Date, Gender, MPI ID, PMO, and Links. The table contains several rows of patient data, including studies and series. At the bottom of the interface, there are "Export Selected Items..." and "Create Patient" buttons, and a copyright notice for TeraMedica.

Patient ID	Last Name	First Name	Birth Date	Gender	MPI ID	PMO	Links
RTOG^0522^29^DEMO^	RTOG	0522			0522c0029	ITC	
Study ID/Acsn#: 8994623/8994623 - Abdomen^1WBPETCT			Perf: 09/16/2005 8:58AM		Ref. Phys:	Arch: N	
Series#: 606 - PET WB			Images: 355 Mod: PT		Part:	Equip: ITCbosch	
Study ID/Acsn#: 9328091/9328091 - Abdomen^1WBPETCT			Perf: 02/07/2006 9:41AM		Ref. Phys:	Arch: N	
Series#: 606 - PET WB			Images: 404 Mod: PT		Part:	Equip: ITCbosch	
Study ID: RT Data			Perf: {0}		Ref. Phys:	Arch: N	
Series#: CT			Images: 173 Mod: CT		Part:	Equip: ITCbosch	
Series#: RTDOSE			Images: 1 Mod: RTDOSE		Part:	Equip: ITCbosch	
Series#: RTSTRUCT			Images: 1 Mod: RTSTRUCT		Part:	Equip: ITCbosch	
CERR (1)							
0522c0029.mat.bz2	Author:	Description:	Size: 25273 KB			Stored: 06/13/2008	

Diagnostic Image / RT Review Tools

- Tools currently being evaluated for review of PET, MR, CT images and RT data:
 - MIMvista
 - Velocity AI
- Features
 - CT, MR, PET registration (rigid, deformable)
 - RT Structure Set, RT Dose display



Timeline for QuASA²R Upgrades (1)

	Project	Date
1	Pillar Data Storage System <ul style="list-style-type: none"> • Stable support for existing QuASA²R components • Flexible foundation for DICOM Archive 	Installed Jan 2008, Upgraded May 2008 <ul style="list-style-type: none"> • Data backup, SFTP, RRT, Evercore operational
2	ITC DDIQA Server/Tape Backup Upgrade	Begin Summer 2008 <ul style="list-style-type: none"> • Phase 1 is operational • Phase 2 is in progress
3	DICOM-based RT Archive (TeraMedica) <ul style="list-style-type: none"> • Support for wide range of imaging and RT datasets 	Installed June 2008 <ul style="list-style-type: none"> • Prelim. Configuration • Testing in progress
4	Data format conversion tools <ul style="list-style-type: none"> • DICOM conv. for legacy (RTOG) data • CERR conv. for phantom dosimetry • CERR conv. for distributed case review 	Work in progress <ul style="list-style-type: none"> • Starting Jan 2007 • Batch conv. Apr 2008 • Data service is work in progress

Timeline for QuASA²R Upgrades (2)

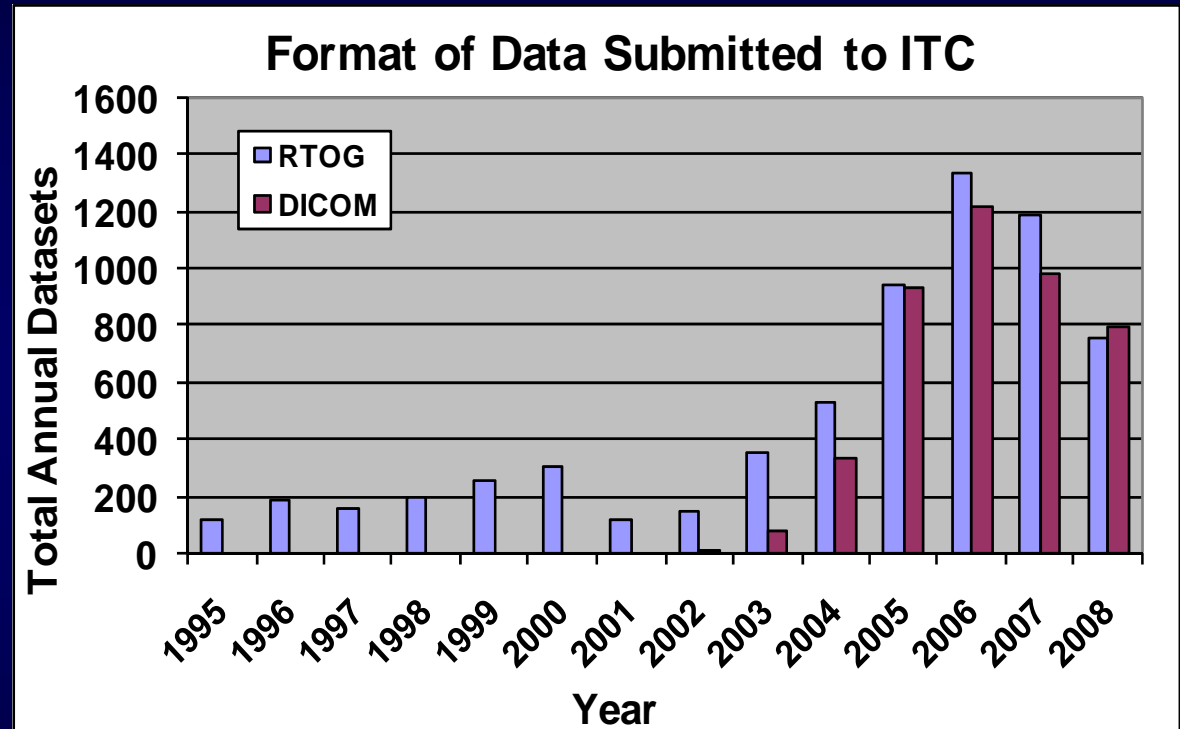
	Project	Date
5	Digital Data Integrity QA workflow tools (CERR) <ul style="list-style-type: none"> • DDIQA Server • Data anonymization / ID reconciliation • Archive loading • Case data management (inventory, revision) • DICOM consistency checks (DVTk) • Structure naming / Structure editing / Dose summation 	Begin Summer 2008 <ul style="list-style-type: none"> • DDIQA server, CERR installed May 2008 • Migration of existing tools to new platform in progress
6	Diagnostic Image/RT Review Tools <ul style="list-style-type: none"> • MIMvista • Velocity AI 	Evaluation in progress <ul style="list-style-type: none"> • Q/R tests with Evercore June 2008
7	QuASA ² R / Commercial TPS Integration <ul style="list-style-type: none"> • Eclipse • Pinnacle • CMS 	Begin Fall 2008

Timeline for QuASA²R Upgrades (3)

	Project	Date
8	Grid-enabled CERR for production case review at ITC <ul style="list-style-type: none">• Secure download, seamless review• Anticipatory data push	Begin Fall 2008 <ul style="list-style-type: none">• Collaborative work in progress with J. Deasy (WU), J. Saltz (Emory)
9	Server-side review tools <ul style="list-style-type: none">• Image Digest / QA Report Generator (CERR)• Multi-planar (T/S/C) tool for contour and dose review	Begin Spring 2009 <ul style="list-style-type: none">• Collaborative work with J. Deasy (WU), J. Saltz (Emory)

RTOG/DICOM TP Data Formats

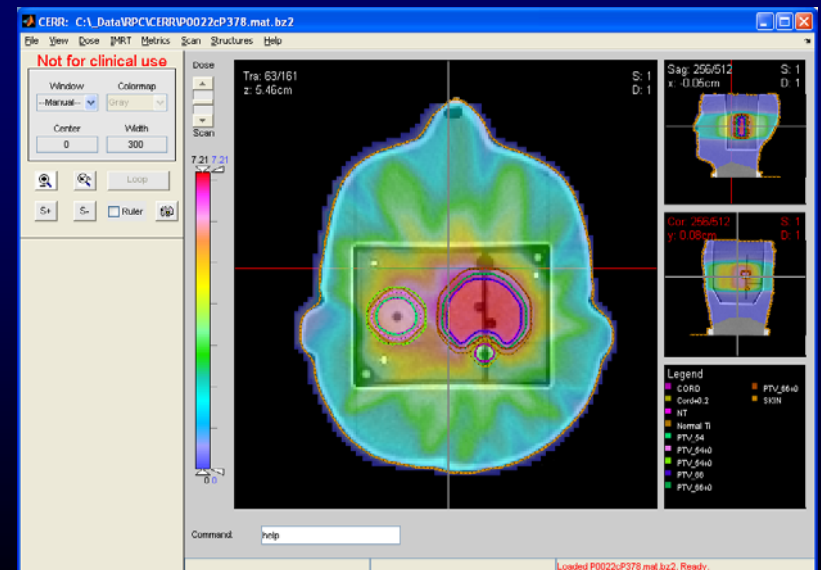
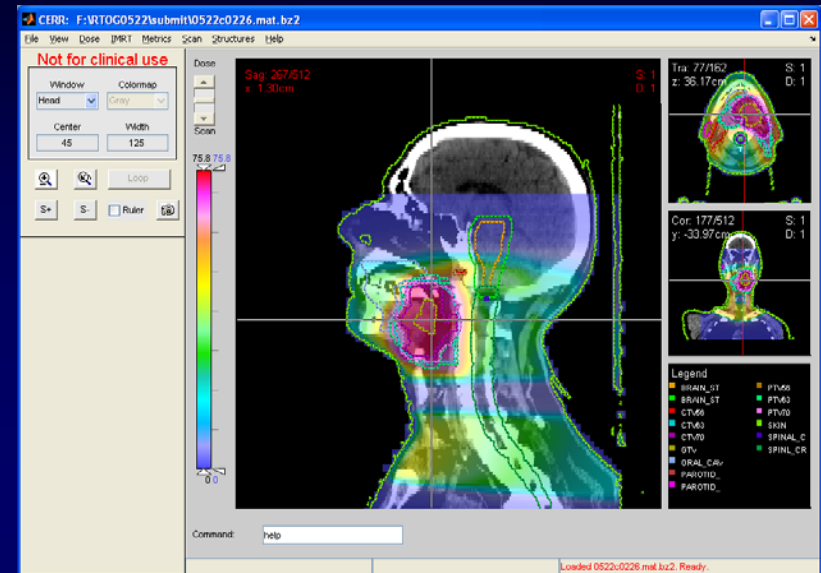
- 2008 is the first year in which the majority of datasets submitted to ITC were DICOM.
- The proportion of DICOM datasets is expected to grow as updated TP systems with DICOM export are installed and older versions are no longer supported.
 - Pinnacle³ (7.6, 8.0)
 - XiO (4.3.x)



Datasets processed as of Sept. 15, 2008

Data Format Conversion using CERR

- Data format conversion
 - RTOG 0522 treatment planning data export to NCIA as CERR, DICOM
- Transfer of RPC Phantom Data for evaluation of Film Dosimetry
 - Since April 2008, 256 RPC Phantom Datasets have been converted to CERR for comparison with film/TLD dosimetry using FilmQA tool



NCIA RTOG 0522 Project

- **ACRIN 4500: Quantitative PET (PET/CT) pre- and post-treatment images submitted to ACRIN, forwarded to NCI Archive**
- **RTOG 0522: CT, Structures, Doses, Plans submitted to ITC (DICOM or RTOG Data Exchange), forwarded to NCI Archive (DICOM)**
 - **Digital data integrity, protocol compliance QA**
 - **RT data (CT, Structures, Doses) format conversion**
 - **Data (DICOM and CERR) upload to NCIA**

RTOG 0522/NCIA Project

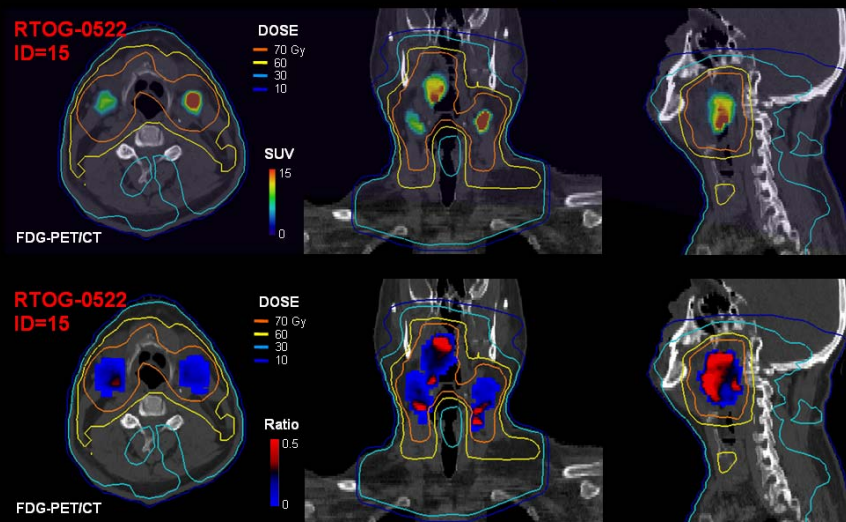
- Assess feasibility of accessing/using the RTOG 0522 dataset (DICOM RT data objects as well as advanced imaging, FDG-PET/CT in treatment assessment manner) components as a reference data set.



RTOG-0522 TRIAL

Robert Jeraj, Chihwa Song, **University of Wisconsin**
John Freymann, Justin Kirby, Carl Jaffe,
Vikram Bhadrasin, Jim Deye, **NIH/NCI**
Walter Bosch, Joe Deasy, Yu Wu, Divya Khullar,
Jim Purdy, **ATC/ITC, Washington University**
Anthony Levering, **ACRIN**
Betty O'Meara, Mike Gillin, **RTOG**
Kian Ang, **MD Anderson**

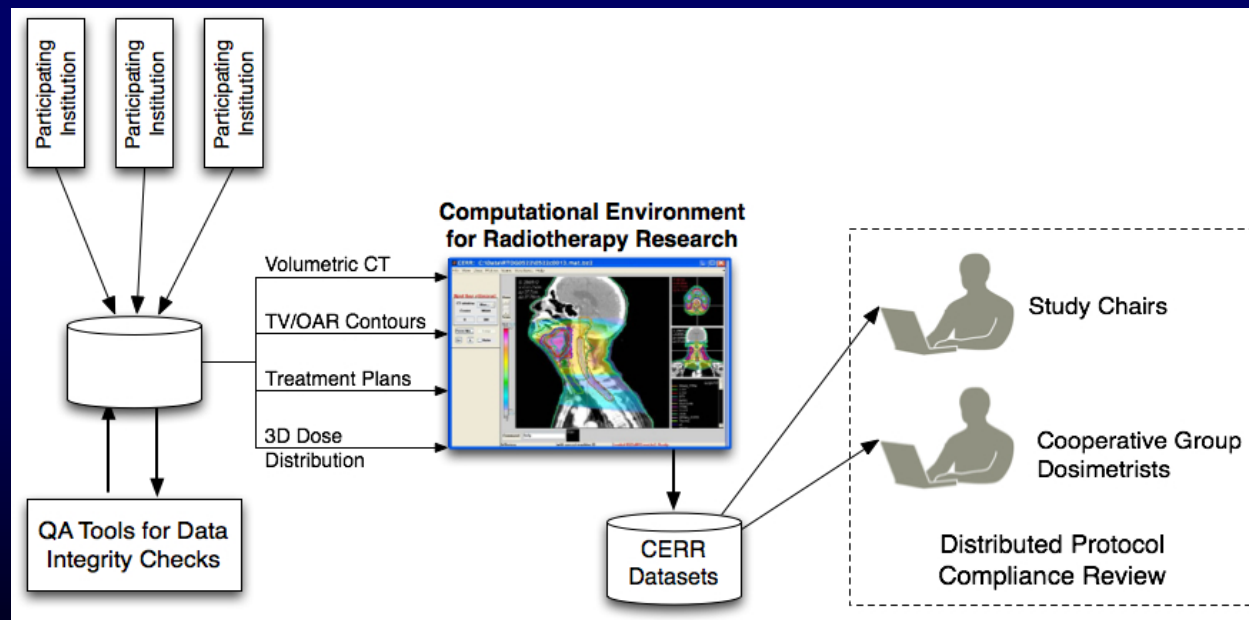
Treatment response



Grid Computing and RT Clinical Trials

The caBIG In Vivo Imaging middleware is used to deploy existing CERR software as an integrated communication and review tool for Radiation Therapy clinical trials, institutional credentialing, and case quality assurance.

- Simplified and secure distribution of data to reviewers
- Capture reviewer scoring, modifications for subsequent analysis



Application of caGrid[®] Middleware to Facilitate Quality Assurance for Advanced Technology Radiation Therapy Clinical Trials

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² Image-Guided Therapy QI Center, Washington University, St. Louis, MO

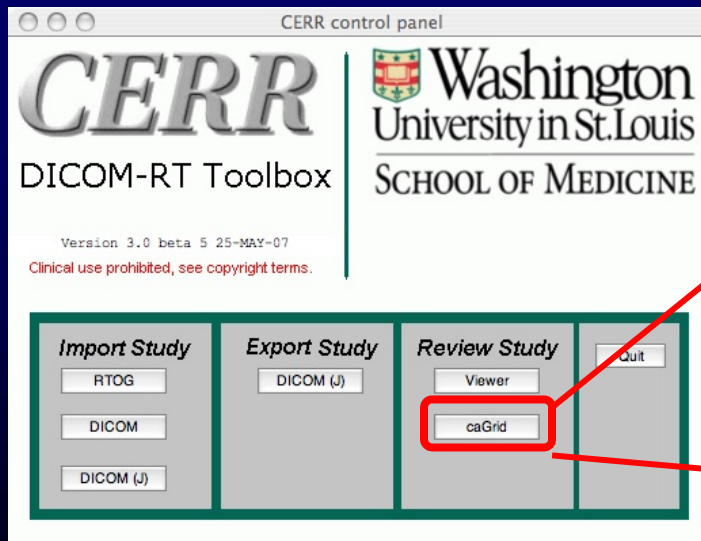
³ Department of Radiation Oncology, Washington University, St. Louis, MO

⁴ Department of Radiation Oncology, UC Davis Cancer Center, Davis, CA

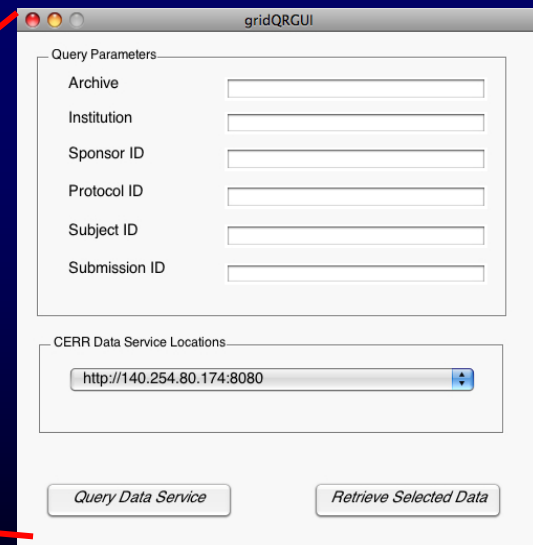


Components of Grid Enabled CERR

- A caGrid data service for storing CERR objects
 - Stores the metadata of the CERR MATLAB objects in a XML database
 - Provides Query and high performance data transfer from/to the client
- CERR client is modified to support grid interactions
 - Grid based Query/Retrieve interface
 - Grid security interface



Grid Q/R GUI



Data Review using CERR

- **RTOG 0418**

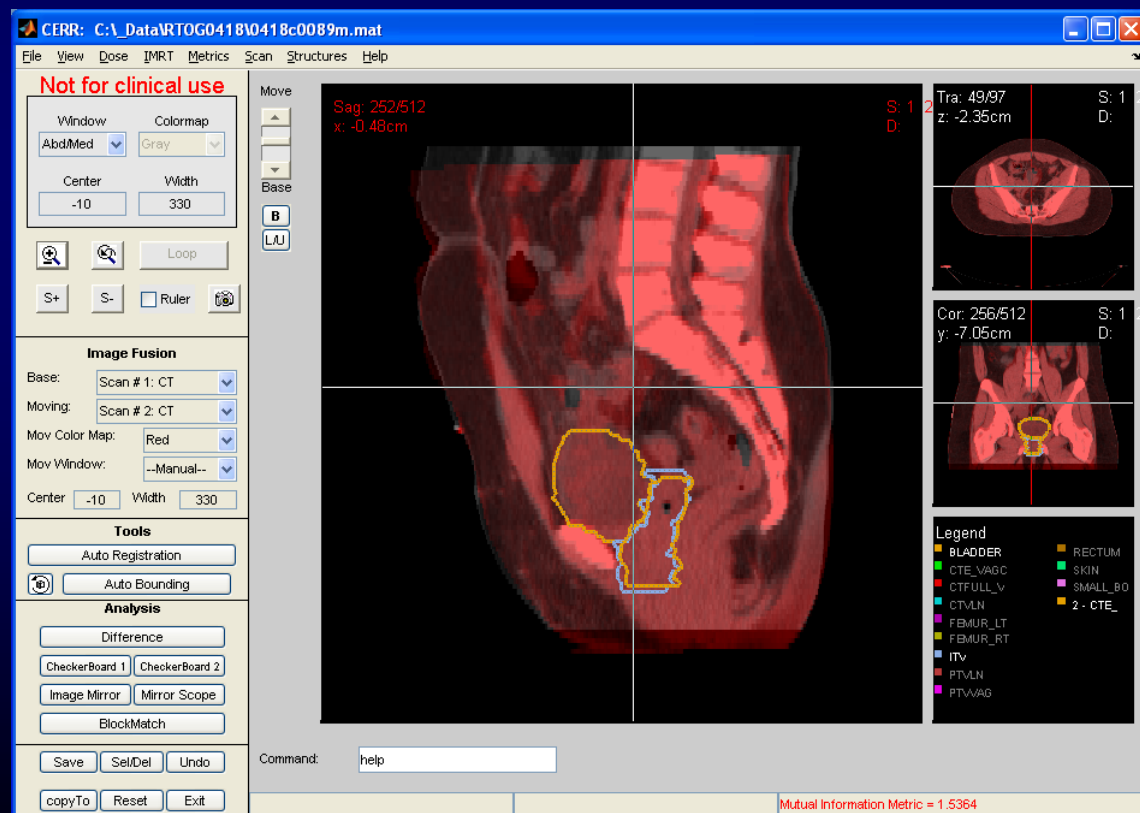
- Evaluation of ITV using registration of full-bladder (planning) CT and empty-bladder CT scans.

- **Multi-planar display**

- Images
- Structures
- Dose

- **Protocol Case QA using**

- CERR
- WebEx



Uniform Structure Names

- Work in progress with RTOG Informatics Committee and Advanced Technology Integration Committee
- Draft proposal (9/5/08)
 - OAR names derived from list used for RTOG AT trials
 - Indicate laterality for paired organs
 - TV names include prescription dose (Gy)
 - PRV names include margin (mm)
- Parallel effort to define codes for ROI types in DICOM segmentation objects.

Uniform Structure Names for RT Clinical Trials

DRAFT

A Uniform Tissue Naming Proposal for Use in RT Clinical Trials

Walter R. Bosch, D.Sc.

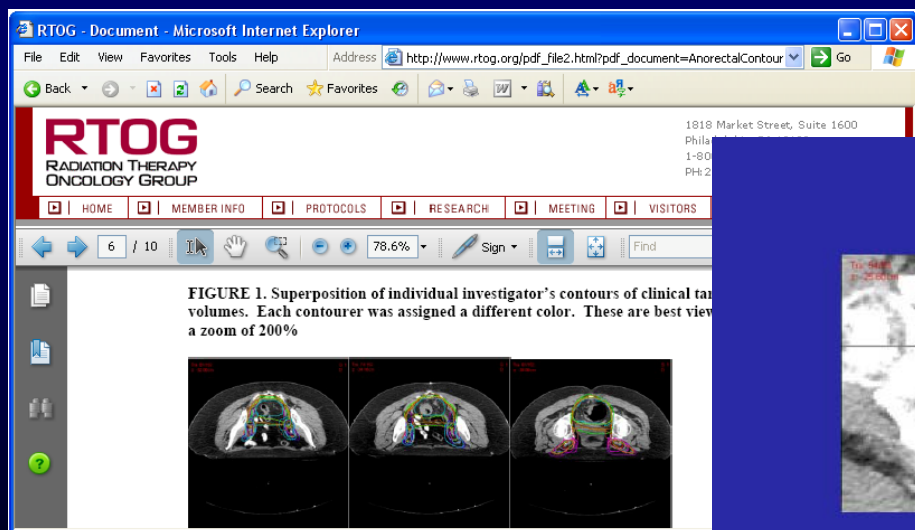
Background

Consistent naming of contoured structures used in radiotherapy treatment planning is essential to facilitate the comparison of dose-volume statistics across patients for quality assurance and outcomes analysis. Maintaining consistency in structure names is particularly important (and challenging) in multi-institutional clinical trials, in which treatment planning data are collected from many participating institutions. Differences in treatment planning techniques and local languages are among the factors that contribute to variations in the names used to identify structures.

The Image Guided Therapy QA Center (ITC) has developed a Digital Data Integrity QA process to examine submitted RT treatment planning data for completeness and consistency. This process involves resolving discrepancies between submitted and protocol-specified structure names. For some data sets, the mapping between submitted and protocol-specified structure names is obvious, and the process of assigning standard names using ITC tools is straightforward. Other cases, however, require visual inspection of images and contours to identify structures. For trials involving disease sites with many organs at risk, e.g., H/N IMRT, the effort required to correctly identify all structures can be substantial.

ATC Support for RTOG Consensus Image Segmentation Atlases

- Pelvic Lymph Node Volumes for Prostate Cancer
- Post-op Prostate Contours Atlas
- Anorectal Atlas
- GYN Atlas for CTV Delineation in Post-op Cervical and Endometrial Cancer



ATC Efforts in Support of RT Data Exchange Standards

- DICOM Working Group – 7
 - Maintenance of current DICOM RT information object definitions
 - Development of next-generation RT objects
- IHE-RO
 - Define profiles for interoperable use of existing standards (e.g., DICOM)
- Direct Support for TP Vendor Data Export Efforts

DICOM: 2nd Generation RT Objects

- Some limitations of current DICOM RT objects
 - Complex referential structure means changes in one object may necessitate changes in others objects just to maintain referential integrity.
 - Difficulty in retrieving a collection of RT objects for a given phase of a patient's treatment
 - New DICOM objects offer better representation for image segmentation
 - Multiple uses of RT Plan for prescription, plan development, approval, delivery.
 - Complex conditions of a common RT Plan object used in multiple contexts, many optional attributes

DICOM WG-7 Activities

- New RT objects (larger number of smaller objects)
 - Workflow instructions
 - Physician Intent, RT Planning Prescription objects
 - RT Course (“container”) object – support for unmanaged workflow, clinical trials submissions
 - Use new DICOM segmentation (surface, volume) and registration (rigid, deformable) objects
 - Radiation Set (fraction group)
 - Separate radiation delivery objects per treatment modality: C-arm Photon Beam, C-arm Electron Beam, C-arm Ion Beam, Tomotherapeutic Photon beam, Non-isocentric Photon Beam

DICOM WG-7 Meeting Schedule

- WG-7 meetings addressing the design of 2nd -generation DICOM RT objects:
 - Oct 30 – Nov 2, 2007 – Los Angeles, CA
 - Dec 10-14, 2007 – Las Vegas, NM
 - Apr 22-25, 2008 – NEMA HQ
 - June 16-19, 2008 – Santa Fe, NM
 - Oct 21-24, 2008 – Charleston, SC
 - Mar 17-20, 2009 – Washington, DC

IHE-RO Update



- **ATC is an Organizational Member of the International Integrating the Healthcare Enterprise (IHE) as of March, 2008, and remains fully committed to supporting the mission and vision of IHE in Radiation Oncology.**
 - Active participation in IHE Radiation Oncology Technical Committee
 - Distribution of IHE-RO Test Data and Test Tools via ITC Secure FTP server
 - Participation in 2008 IHE-RO Connectathon Test Committee (Jul 31 – Aug 5, 2008, Houston)

IHE-RO Profiles

- 2007 IHE-RO Profile
 - Basic Treatment Planning Inter-operability Profile was tested at Aug 2007 Connectathon
- 2008 IHE-RO Profiles
 - Multimodality Registration Profile to be tested at Aug 2008 Connectathon in Houston and demonstrated at ASTRO 2008
 - Treatment Delivery Workflow Profile is not yet ready for Connectathon
- 2009 IHE-RO Profiles
 - Treatment Delivery Workflow
 - Advanced Plan Integration – Electrons, Dynamic plans, Compensators, Bolus, Dose compositing

IHE-RO TC Meeting Schedule

- Technical Committee Meetings
 - Sept 25-27, 2008 – Boston, MA
 - Dec 15-19, 2008 – Mountain View, CA
 - Mar 23-25, 2009 – Washington, DC
 - June 3-9, 2009 – Domain Pre-testing, Erlangen, Germany
 - Sept 14-21, 2009 – Connectathon, Washington, DC
 - Nov 5-7, 2009 – Post-ASTRO, Chicago, IL
 - Jan 25-29, 2010 – location TBD

ITC Support of TP Vendor Data Export Development and Testing – 2008

- **BrainLAB**
 - Received DICOM data 5/29/2008 (CTs, RTstruct, RTplan, RTdose, Rtimages)
 - RTdose was not multi-frame; Beams missing ITC required iso-center position
- **CMS**
 - Received incorrectly registered RTdose for HFP patient
 - CMS agrees and is investigating
- **Nucletron**
 - SPOT-Pro (brachy seed) is ATC compliant as of 4/7/2008
 - Received US images from Wm Beaumont (3/26/2008) and Nucletron (pre-release software) – deemed too far from DICOM standard
- **SonoTECH** (European HDR planning system)
 - Vendor Complete as of 4/11/2008
- **Tomotherapy**
 - Clarification re availability of Hi-ART 3.x with DICOM export capability (6/6/2008)
- **Varian Eclipse**
 - Have received non-compliant data from multiple sites (frequently from Japan)
 - Data processed at ITC with non-production import code

Related Informatics Efforts

- MAX – QARC
- TRIAD – ACR
- VIEW – QARC, ACR
- OPEN – CTSU
- CDMS – caBIG
- Docu-MART – CTEP, CALGB, ECOG, SWOG

ATC IT Infrastructure

- IT infrastructure at ATC member centers has grown to support local QA workflow:
 - QuASA²R focuses on ITC workflow
 - TPS-based DDIQA tools and repository
 - RRT – web-based segmentation and dose review
 - CERR – multiplanar, multimodality segmentation and dose review
 - Portable RT viewer
 - Server-side
 - DICOM archive (TeraMedica Evercore®)
 - MAX focuses on QARC workflow
 - DICOMmunicator image submission and review
 - RRT – web-based segmentation and dose review
 - CERR – MAX integration, added QARC functionality

Related Informatics Efforts: QARC MAX

- Meeting at QARC (5/6/08)
 - Bosch, Sharma, FitzGerald, Urie, Ulin, Laurie, Hanusik
 - Review features (data management, QA workflow support, audit trail) of the MAX IT infrastructure
 - Plan caGrid integration for distributed reviews using MAX.
 - Assess the effort needed to produce a non-QARC-specific instance (4-6 mo x 1 FTE).

Related Informatics Efforts: VIEW

VIEW Consortium

- ◆ First trial identified
 - NCCTG Second Line Therapy for NSCLC
 - CALGB, SWOG, ECOG, NCIC, CTSU
 - 1,000 patients / 5,000 CT scans
- ◆ QARC recipient of images, logging, site liaison, tracking, and reporting
- ◆ ACRIN will then receive images from QARC for quality control and archiving
- ◆ June 2008 activation planned

Related Informatics Efforts: ACR TRIAD

ACR TRIAD

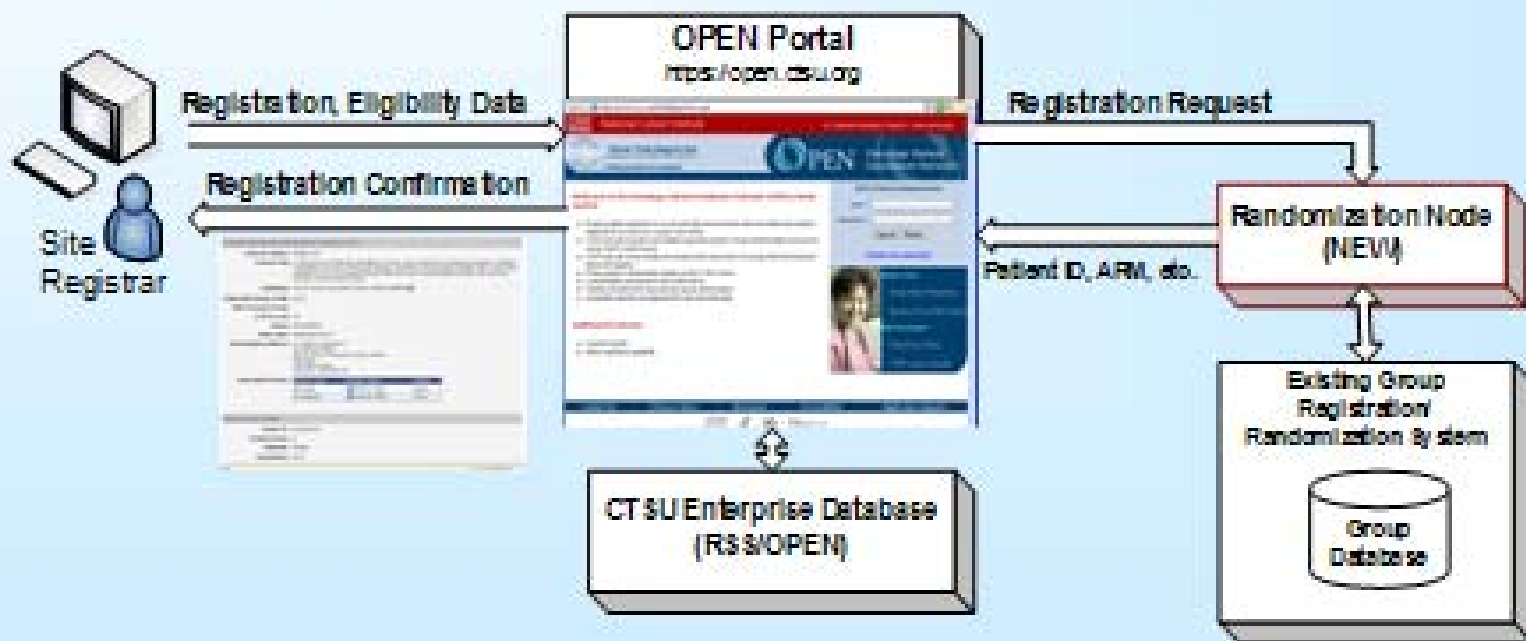
- ◆ Software in final beta testing
- ◆ CT, MRI, PET/CT, and Ultrasound from various vendors tested
- ◆ Formal validation plans for the application in process
- ◆ Suitability as a DICOM RT application not yet determined

The OPEN System...

- Is a standardized web-based environment for enrollment of all patients in clinical trials across the NCI-sponsored Cooperative Group Clinical Trials Program.
 - Supports all treatment and associated ancillary studies for the Cooperative Groups.
 - Is a partner system to the Regulatory Support System and will support the same set of trials.
 - Available for all authorized users, regardless of Group affiliations.
- Collects the information needed to credential and enroll patients.
- Is integrated with the CTSU Enterprise System
 - Utilizes existing protocol data, regulatory data, and roster data for validation rules.
- Integrates the existing Group registration/randomization systems
 - Performs the randomization and any custom validation checks.
 - Provides real-time treatment assignment back to OPEN to present to the site Registrar.

Example Registration Flow

- A site user enters information through an on-line enrollment screen;
- OPEN exchanges messages with the lead Group systems;
- The Group system responds with patient id, treatment arm, etc.



Clinical Data Management System – Remote Data Capture

CDMS Procurement Background



- The National Cancer Institute (NCI) is purchasing licensing rights for a commercial clinical data management system (CDMS) software product and related installation, support and maintenance services to support the conduct of cancer clinical research in the NCI Clinical Research Enterprise.
- The system will be made available free of charge to all NCI-supported organizations conducting cancer clinical trials.
- It is an unlimited-user, perpetual license
- Can be used for all cancer trials, including industry
- Cannot be used for non-cancer trials under this license

Purpose of the CDMS Procurement

- Will deliver full-function clinical data management capability to the entire NCI-supported clinical research community, irrespective of a given organization's ability to pay for such a system.
- The new system will allow researchers to share information with other caBIG compatible systems and tools, within the given research organization, with other research organizations and with NCI itself.



Related Informatics Efforts: Docu-MART

- Document Management, Authoring, Review, and Tracking System
- Authoring tool
 - Predefined structured protocol templates (XML)
 - Selection Wizard – auto generation of draft document
 - Pre-populate 80-90% of Protocol Document based on template and approved Concept or Letter of Intent
 - Auto generation of Protocol Submission Worksheet and Change memo
 - Protocol completeness check
- Online review, commenting, tracking

The following information was excerpted from a presentation given at the September 18, 2007 Group Chairs Meeting:

Docu-MART Features to Aid Cooperative Group Protocol Development

- Standardized protocol format and structure . . . pre-populated sections:
 - Concept submission form
 - Pharmaceutical Information Record
 - CAEPR information
 - Informed Consent
 - AE Reporting Guidelines
 - CRADA/CTA
- Identifies required sections for GOG to complete during authoring stage
- Tracks reviewer participation . . . system generated email reminders with deadlines
- Performs completeness check prior to submission to NCI
- Auto-generation of change memo
- Reconciliation report allows site to submit revised “clean” version only
- Highlights changes made in addition to NCI requested changes
- Allows for real-time independent access to document status without the need to query NCI