The Advanced Technology QA Consortium has worked to develop several mechanisms for the exchange and review of digital images and treatment planning data used to document treatment delivered on advanced-technology clinical trials in radiation therapy. These mechanisms can be described in terms of the three methods outlined below. For each of these methods, the supported data objects, exchange formats, transport protocols/media, data submission software, and review tools are described.

ATC Method 1

ATC Method 1 encompasses mechanisms for submission and review of data developed and maintained by the Image-guided Therapy QA Center (ITC).

Supported Data Objects

ATC Method 1 supports the submission and review of the following objects:

- CT/MR Images (axial planes)
- Organ-at-risk/Target-volume contours
- 3D Dose distributions
- Treatment plan specifications (beams, brachytherapy sources)
- Dose-volume histograms
- Treatment verification images (scanned films, EPID images)
- Diagnostic images (CT/MR/US/PET)
- Screen-capture images (JPEG) for data QA

Exchange Formats

ATC Method 1 supports the submission of digital treatment planning data as either DICOM RT objects or as RTOG Data Exchange Format files. (Please refer to the ATC web site, http://atc.wustl.edu/resources for RTOG Format specifications and DICOM conformance statements.) Diagnostic radiological and treatment verification (film scans or EPID) images can be submitted as DICOM objects or JPEG files. Treatment planning system iso-dose images and DVH plots can be submitted as JPEG files. Files may be combined as "tar" or "zip" archives and may be compressed or encrypted (ZIP) prior to submission.

Transport Protocols/Media

ATC Method 1 supports the submission of data over the Internet using FTP or by the shipment of storage media. The ITC maintains an FTP server (castor.wustl.edu) with individual accounts for institutions participating in advanced-technology protocols and treatment planning manufacturers testing data export capabilities. Users may submit data files, but may not access other users' data. The ITC also accepts data submitted on storage media including CD-ROMs (DICOM and RTOG files) and 4mm or 8mm tape cartridges (RTOG files only).

Data Submission Software

The ITC maintains a list of commercial ATC Compliant Treatment Planning Systems (see http://atc.wustl.edu/credentialing/atc_compliant_tps.html), which can produce data in a format suitable for submission on ATC-supported protocols. Windows/PC-based application software

(ITC DICOMpiler), available from the ATC web site, can be used for receiving DICOM data over a local area network, selecting objects to be submitted, anonymizing the data, and creating a DICOM fileset that can be written to CD-ROM or sent via FTP. A wide range of commercial and free-ware FTP client and CD-burning software is available for use in submitting data in Method 1.

Review Tools

Data submitted using ATC Method 1 are imported into a proprietary (CMS) treatment planning file system format. These data may be reviewed from any Internet-connected web browser using the ITC Remote Review Tool (RRT). The RRT provides a display of DVHs and axial patient images with overlaid organ-at-risk/target-volume contours, as well as user-defined iso-dose curves. RRT users can also edit contours on axial images, re-calculate DVHs for these user-defined structures, and display point doses on axial images. In addition, these data may be accessed at the ITC using FOCUS/FOCAL software for data quality assurance.

Status

As of 3/2005, this method is actively in production at the ITC to support the submission and review of digital data for RTOG (four closed, nine active), NSABP (one active), JCOG (one active) protocols. In addition, this method is being actively implemented at the Quality Assurance Review Center (QARC) for review of volumetric treatment planning data for several COG protocols.

ATC Method 2

ATC Method 2 employs mechanisms for submission and review of data being developed by the Resource Center for Emerging Technologies (RCET) in cooperation with the Image-guided Therapy QA Center (ITC). Data submission is accomplished using RCET WebSys client and server software. A phased development of this method is planned:

- Phase 1 ("Method 2a") – uses the existing ITC Remote Review Tool (requires import of data into RRT filesystem) for web-based review of volumetric treatment planning data and the RCET Rapid Image Viewer applet for review of diagnostic image series. As of 3/2005, software to support this method is in development and testing at the ITC.
- Phase 2 ("Method 2b") – uses a modified ITC Remote Review Tool (direct access of data from WebSys database) for web-based review of volumetric treatment planning data and the RCET Rapid Image Viewer applet for review of diagnostic image series. Extension to Phase 2 is planned following the implementation of Phase 1.

Supported Data Objects

ATC Method 2 supports the submission and review of the following objects:

- CT Images (axial planes)
- MR Images (Only to be used as diagnostics images)
- Organ-at-risk/Target-volume contours
- 3D Dose distributions
- Treatment plan specifications (beams, brachytherapy sources)
- Dose-volume histograms
- Treatment verification images (SC/CR)

- Diagnostic images (CT/MR/US/CR)

Exchange Formats

ATC Method 2 supports the submission of digital treatment planning data as either DICOM RT objects or as RTOG Data Exchange Format files. (Please refer to the ATC web site, http://atc.wustl.edu/resources for RTOG Format specifications and DICOM conformance statements.) Diagnostic radiological and treatment verification (film scans or EPID) images can be submitted as DICOM objects. Treatment planning system iso-dose images and DVH plots can be submitted as JPEG files.

Transport Protocols/Media

ATC Method 2 supports the submission of data over the Internet using HTTP. A WebSys server is in development and testing at ITC. Prior to uploading data to the WebSys server, the WebSys client software anonymizes and encrypts data files selected by the user. Individual accounts are maintained on the WebSys server for institutions participating in advanced-technology protocols. Users may submit data files, and access their own data. Study chairs and their designates can be given access to all data within a study protocol.

Data Submission Software

The WebSys client (Windows/PC-based software, downloaded from the ATC web site) can be used for selecting DICOM/RTOG files to be submitted, anonymizing the data, encrypting data files, uploading data to the WebSys server, and registering submissions in the WebSys database. (The ITC DICOMpiler, available from the ATC web site, can be used for receiving DICOM data over a local area network.) The ITC is currently testing the functionality of the WebSys system for the submission of DICOM and RTOG format data and its compatibility with protocol data sets exported from ATC-compliant commercial Treatment Planning Systems (see http://atc.wustl.edu/credentialing/atc_compliant_tps.html). For acquisition and submission of screen captured images a utility is available (for Windows OS).

Review Tools

For Phase 1 implementation of ATC Method 2, submitted data are to be downloaded at the ITC and imported into the Remote Review Tool file system. These data may then be reviewed from any Internet-connected web browser using the ITC Remote Review Tool (RRT). In addition, these data may be accessed using FOCUS/FOCAL software for data quality assurance at the ITC. Diagnostic image series can be reviewed immediately after submission using the RCET Rapid Image View applet (linked from the ATC web site.) Phase 2 implementation of this method will use a (yet-to-be developed) modified ITC Remote Review Tool, which will access data directly from WebSys database.

ATC Method 2 employs mechanisms for submission and review of data being developed by the Resource Center for Emerging Technologies (RCET) in cooperation with the Image-guided Therapy QA Center (ITC). Data submission is accomplished using RCET WebSys client and server software.

Status

As of May 2005, ATC Method 2 remains a "works in progress" that is undergoing testing at ITC with fixes and changes in WebSys/NetSys software made by RCET. It is not yet in production use for ATC supported protocols.

ATC Method 3

ATC Method 3 employs mechanisms for submission and rapid review of image files generated by scanning text documents or screen capturing images. These images are submitted to a server using the NetSys software developed by the Resource Center for Emerging Technologies (RCET). Images are reviewed using a standard internet browser (Internet Explorer, Firefox, Netscape) in conjunction with the Rapid View Image applet developed by RCET. This method is currently being implemented by the National Cancer Institute of Canada Clinical Trials Group (NCIC CTG) to support submission and rapid review of patients accrued to its MA.20 clinical trial.

Supported Data Objects

ATC Method 3 supports the submission and review of the following objects:

- Screen captured images
- Scanned documents

Exchange Formats

ATC Method 3 supports the submission of screen captured images and scanned documents in a variety of formats (GIF, JPG, SGI, XWD, PNG, TIFF, BMP). These images are converted to DICOM 3 objects and JPEG images for uploading to the NCIC CTG production server.

Transport Protocols/Media

ATC Method 3 supports the submission of data over the Internet using HTTP and a Secure Object Archiving Protocol (SOAP) to a NetSys production server at NCIC CTG (Kingston, Ontario, Canada). Prior to uploading data to the server, the user must ensure that any patient information contained in the scanned or screen captured images is removed. Individual accounts are maintained on the NetSys server for institutions participating in NCIC protocols. Users may submit data files, and access their own data. Study chairs and their designates can be given access to all data within a study protocol.

Data Submission Software

Public domain software (IrfanView) is used to annotate image files and remove any patient identification. The NetSys client (Windows/PC-based software, distributed by NCIC) can be used for selecting files to be submitted encrypting data files, uploading data to the NCIC NetSys server, and registering submissions in the NetSys database

Review Tools

Images files uploaded to the NetSys server can be reviewed immediately after submission using a standard browser and the RCET Rapid Image View applet.

Status

The following timeline was presented by Dr. Colin Field at the January 2005 ATC meeting for NCIC's efforts in implementing ATC Method 3 to support the MA.20 protocol:

- 1/31/05: Complete MA.20 testing on test server
- 2/04/05: Based on feedback from testing, fine tune FAQ, submission and review manuals.
- 2/1105: Move test system to production system
- 3/04/05: Test admin tools: Adding users, changing privileges, deleting cases, creating protocols
- 3/04/05: MA.20 user testing of production system
- 3/11/05: Based on feedback of MA.20 user testing, make final corrections to web pages, FAQ, and documentation
- 3/15/05: Activate MA.20 dry runs and electronic rapid review on production server

While good progress has been made to accomplish this timeline, as of April 2005, ATC Method 3 had not yet been placed in Production mode.