

Integrating the Healthcare Enterprise: Profile Testing and Connectathon

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Disclosures

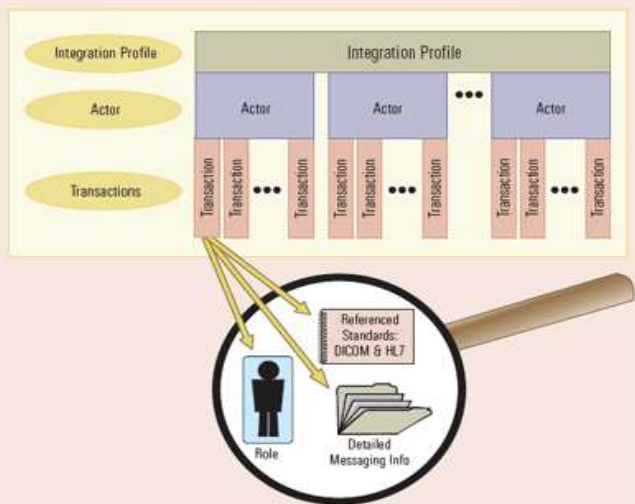
AAPM Service Contract: IHE-RO Test Manager

IHE Process

1. **Define** a clinical use case involving connectivity.
2. **Create** Integration Profiles to specify how existing data standards are to be used to solve clinical problems.
3. **Test** the adherence of clinical systems to Profile specifications.
4. **Publish** results to assist users in selecting interoperable systems.

IHE Testing

Organization of the Technical Framework



IHE Testing is based on specifications laid out in the Technical Framework

Vendors register to test products as one or more **Actor(s)** within an **Integration Profile**.

Adherence is tested by demonstrating

1. Behavior (input, output, display) conforms to requirements for each **Transaction**
2. Successful exchange of clinical information with other vendors' products playing the role of the other Actors in the Profile.

What is a Connectathon?

Structured, cross-vendor, live, supervised test event

- All participating vendors' products tested together in the same place/time.
- Each vendor tests with multiple trading partners (actual product to product).
- Experts from each vendor available for immediate problem resolution... fixes are often done in minutes, not months!!
- Testing of real-world clinical scenarios with IHE Integration Profiles.
- Supervised by test monitors, i.e. "judges".

Connectathons

■ IHE NA Connectathon (annual since 1999)

- 9 IHE Domains
- 180+ IHE Profiles
- >100 vendors, >400 engineers
- Cleveland Convention Center
- January 20-24, 2020



■ IHE-RO Connectathon (since 2007)

- Radiation Oncology Domain
- 5-8 vendors
- RaySearch Labs, Stockholm, Sweden
- October 7-11, 2019





IHE-RO Connectathon

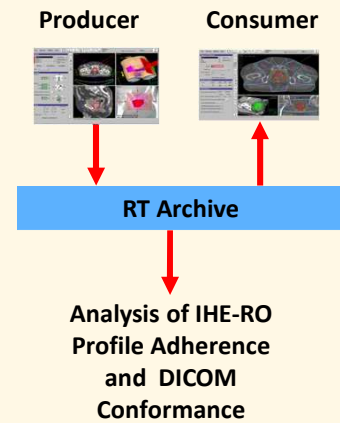
- Annual, week-long event
 - ½ day setup
 - ½ day cleanup
- Hosted at AAPM HQ, vendor facilities, and academic centers
- Supervised, informal test events (“Domain Pre-Testing”) have also been held between Connectathons.

Connectathon Judges

- Volunteers (clinical physicists and physicians) assist in testing adherence of products to IHE-RO Profiles.
- Assist vendors in creating meaningful test data.
 - Want data to be as clinically relevant as practical.
 - Purpose of testing is NOT to see which product is “best”.
- Compare data displayed by “producer” and “consumer” Actors
 - Side-by-side comparison of product displays.
 - Assure consistent interpretation of information in both products.

Test Archive

- A DICOM ARCHIVE is used to store
 - Initial test datasets
 - Output data from “Producer” Actors
 - Input data for “Consumer” Actors
- Initial test dataset
 - Starting data for the first Actor in a Profile
 - Stored in the Archive before testing begins
 - Each vendor starts with their own test dataset instance (Patient ID with vendor code)
- Data produced by Profile Actors can be retrieved for troubleshooting and analysis by judges.



IHE-RO Integration Profiles in Testing (2019)

- Basic RT Objects Profile-II (BRTO-II)
- Multi-Modality Image Registration for Radiation Oncology (MMRO-III)
- Treatment Planning – Plan Content (TPPC)
- Treatment Delivery Workflow-II (TDW-II)

Treatment Planning – Plan Content Profile

- Constraints on DICOM RT Plan content are specified for each of 14 *beam techniques*:

Basic Static Beam	Virtual Wedge Beam
Basic Static MLC Beam	Static Electron Beam
Arc Beam	Step & Shoot Beam
MLC Fixed Aperture Arc Beam	Sliding Window Beam
MLC Variable Aperture Arc Beam	IMAT/VMAT Beam
Hard Wedge Beam	Photon Applicator Beam
Motorized Wedge Beam	Photon Applicator Arc Beam

- For each beam technique there are two Actors
 - Producer** (TPS)
 - Consumer** (TPS/TMS)

DICOM Content Requirements - TPPC Step & Shoot Beam Plan

Presence	Usage
R	Required to be present
O	Optional
D	Must be displayed by consumer
+	Additional requirement (beyond DICOM)
*	Need not be displayed by consumer

Attribute	Tag	Beam Technique	
		Step & Shoot	
		Presence	Specific Rules
> Beam Number	(300A,00C0)	R+*	Shall be >= 1.
> Beam Name	(300A,00C2)	R+	
> Beam Type	(300A,00C4)	R+*	Shall be STATIC.
> Radiation Type	(300A,00C6)	R+*	Shall be PHOTON.
> High-Dose Technique Type	(300A,00C7)	O+*	If present, must be handled safely
> Primary <u>Fluence</u> Mode Sequence	(3002,0050)	R+*	
>> <u>Fluence</u> Mode	(3002,0051)	D	
>> <u>Fluence</u> Mode ID	(3002,0052)	D	
> Treatment Machine Name	(300A,00B2)	R+*	Shall be constant.
> Primary Dosimeter Unit	(300A,00B3)	R+	Shall be MU.
> Source-Axis Distance	(300A,00B4)	R+*	
> Beam Limiting Device Sequence	(300A,00B6)	R+*	
>> RT Beam Limiting Device Type	(300A,00B8)	R+*	At least 1 MLC shall be present
>> Leaf Position Boundaries	(300A,00BE)	R+*	Shall be present for MLCs. May or may not be present for jaws, may be ignored for jaws
> Referenced Patient Setup Number	(300C,006A)	R+*	Shall be >= 1.
> Treatment Delivery Type	(300A,00CE)	R+*	

Connectathon Test Procedure

- **Test datasets** are created for each vendor and stored in an Archive (CT images and RT Structure Set).
- Plan producers retrieve test datasets and **create and store RT Plans** per planning instructions.
- Plan consumers retrieve producers' plans from the archive and display them.
- Judges **compare side-by-side plan displays** on producer and consumer systems to check consistency.
- Goal: **demonstrate successful exchange with 3+ partners**
- **Content is validated** using test tools.

IHE Radiation Oncology - TPPC Profile Testing

Revision 1.2 of the TPPC Profile (Final Implementation, updated 2/13/16) will be tested at the IHE-RO 2016 Connectathon. The Treatment Planning - Plan Content (TPPC) Profile is tested by importing CT image and Structure Set test data in a Producer Actor, creating a treatment plan (and dose) for a supported beam type, and exporting the plan (and dose) to an Archive for retrieval by a test partner Consumer Actor. Side-by-side comparison of plan displays on the Producer and Consumer Actors is essential to verify interoperable exchange of plan information.

General Instructions

- Import and save CT images and RT structure set for both supra and prone patients. Import the multiple beam meta patient if you are testing stereotactic beams.
- For each producer, create two plans, one with all supported options and one without options (if you support multiple options e.g. beam limiting device, table, etc.)
- Place isocenter as follows:
 - Supine patient: HBB: x = 3.2cm, y = 33.2cm, z = 273 mm (Q000)
 - Prone patient: HBB: x = 2.7cm, y = 26.6cm, z = 264 mm (Q000)
- Brain meta patient: CT isocenter 1: x = 42.3cm, y = 194.3cm, z = 65.8cm; isocenter 2: x = 39.2cm, y = 216.9cm, z = 65.8cm (Q000)
- Brain meta patient: MR isocenter 1: x = 36.8cm, y = 17.8cm, z = 32.7cm; isocenter 2: x = 14.7cm, y = 45.7cm, z = 32.7cm (Q000)
- Spine Meta patient: CT isocenter: x: 7cm, y: 285cm, z: 354.0cm (Q000)

Specify dose as follows:

- Supine HBB: a total dose of 54 Gy (27 x 2 Gy fractions) to 60%.
- Prone HBB: total dose of 45 Gy (22.5 x 2 Gy fractions) to 60%.
- Brain Meta: total dose of 20 Gy total in either or both PTVs.
- Spine Meta: total dose of 27 Gy (13.5 Gy fractions) to CTV.

• Label the plan appropriately, e.g. plan_meta, etc.

• If possible, save each plan and dose in its own Q000 beam and use the Series Description to identify the TPPC Actor, i.e. beam type that produced it.

• If possible, do not include table beams in the plan.

• Calculate dose and export 2D, 3D, and 100% isodose (normal to the maximum dose).

• Label the dose to correspond to the plan, e.g. dose_conformal, etc.

• Place the plan patient head at least 20% of your gain (at least one, if more than one beam type is tested).

• Although it is not a Profile requirement, consider making the testing more interesting by creating a plan using a head first treatment section. (The CT images are headfirst scans.)

Test Datasets

Four patient datasets are available for testing TPPC Actors:

- TPPC/IMB00 - Supine (headfirst) patient
- TPPC/IMB01 - Prone (headfirst) patient
- TPPC/IMB02 - Multiple beam meta patient
- TPPC/IMB03 - Spine meta patient



Connectathon Scoring

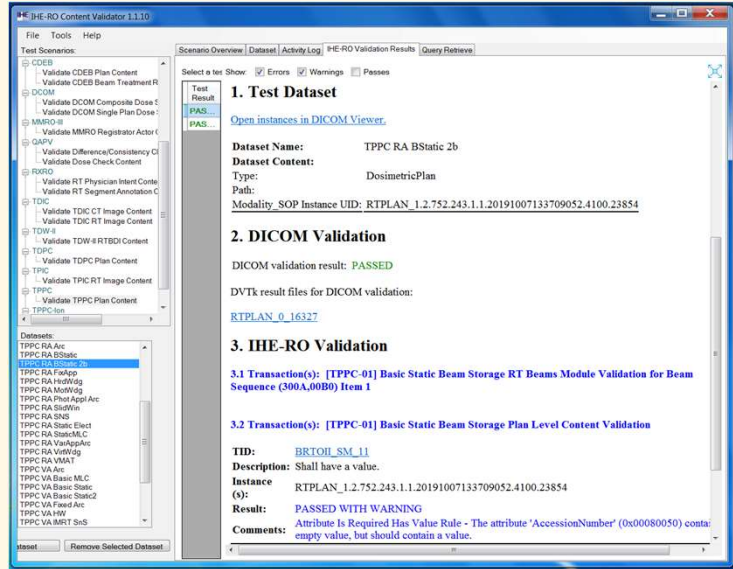
- TPPC checklist of plan parameters used for side-by-side comparison of Producer and Consumer Actors



MLC ARC BEAM	Result:	Pass	Fail
	Producer	Consumer	Discrepancy/Comments
Plan Name			
Gantry Start Angle(s)			
Gantry Stop Angle			
Energy			
Couch			
Collimator			
Field Size			
SSD			
MU			
Wedge ID/ Applicator			
Wedge orientation			
MLC shape review			
# control points			
Control pt meterset			
Orientation			
Isocenter			
Structure display			
Dose display			
Ref point dose			

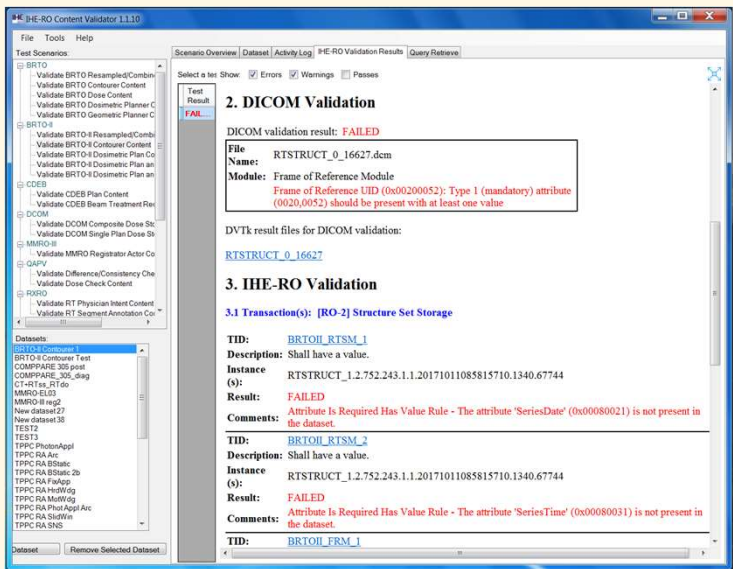
IHE-RO Test Tools

- Test Tool software is used to
 - Prepare products for testing
 - Assess readiness of products for live testing – (participants must submit Test Tool results to qualify for the Connectathon)
 - Assist judges in the formal testing process.



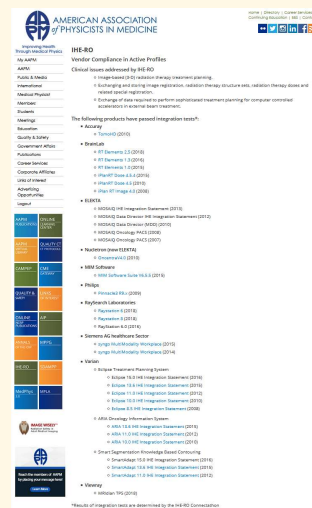
IHE-RO Test Tools

- IHE-RO Test Tools are developed and maintained by ICT Automatisering
 - IHE-RO Content Validator** – evaluates DICOM conformance and IHE-RO Profile adherence for all current Profiles
 - IHE-RO UPS Validator** – tests DICOM Treatment Delivery Workflow Management (Uniform Procedure Step)



Connectathon Test Results

- Only Connectathon *successes* are published.
- Incomplete test(s) or failures are *not* made public.
- Integration Statements are published by vendors to indicate the specific Profile(s) and Actor(s) for which a specific release of a product has been successfully tested.
- Systems tested at a Connectathon must match those referenced in the manufacturer’s Integration Statement. Re-testing is needed if some part of the product that affects interoperability is changed.
- Links to Integration Statements can be found at <https://www.aapm.org/IHERO/VendorCompliance.asp>



Summary

- Testing is essential to assure cross-vendor interoperability with real products.
- The annual IHE-RO Connectathon brings together 30+ vendor engineers and judges.
- Testing involves side-by-side comparisons and test-tool analysis.
- Connectathons offer an opportunity to detect and repair errors in software.
- Successes are published as IHE Integration Statements.