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DICOM

Digital Imaging and Communications in Medicine

The Next Generation of the DICOM Standard for Radiation Therapy

Ulrich Busch

Varian Medical Systems

Systems Analyst
Baden, Switzerland

Chairman DICOM WG-07 Radiotherapy

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The Next Generation of the DICOM Standard for RT

WG-07 Radiotherapy (RT)

History

What is 2nd Generation RT

Workflow and Data

Key Principles

Design Approches

Conclusions

WG-07 Scope

Radiotherapy

Dealing with Cancer Treatment through Radiation

DICOM WG-07

Covering Radiotherapy in DICOM
In continous Operation since 1995
6 Supplements, 130 CPs

Next Generation DICOM in Radiotherapy

Aka: 'DICOM RT 2nd Generation'
Complete new set of DICOM IODs for RT

Supplement 147

DICOM RT Milestones

Phase 1: 1st Generation

1992	IEC SC 62C, proprietary format
1994/5	Ad-hoc Working Group @ Nema: WG-07
1997	Supp 11: RT Plan, RT Image, RT Dose, RT Stucture Set
1999	Supp 29: RT Treatment Record

Phase 2: 1st Generation Extensions

2004	IHE-RO: Started
	WG-07: Vision for: Use of DICOM WL in RT / 2nd Generation RT Objects
2006	Supp 102: RT Ion

Phase 3: 2nd Generation

2007	Supp 147: Workitem for 2nd Generation RT Objects
2007	IHE-RO: First Formal Connectathon
2008	DICOM Worklist enters RT: Supp 96 (WG-06) and Supp 74, IHE-RO
2009	Supp 147: Formal Specification started
2013	Supp 160: Workitem Workflow and Positioning
2013/4	Supp 147 Public Comment (expected)

Why 2nd Generation ?

Clinical

- Advances in Radiotherapy:
  - Modern Clinical Flow:
    - Dynamics requires Flexibility
    - Constant Adaptation to Disease Response
- More Efficiency Required: Workflow
- More Safety Required: Tighter Definitions

Applications

- Stakeholders in RT (WG-07):
  - More in depth-understanding of Standard
  - Elevated Experience
  - IHE-RO

  -> Ready to go forward

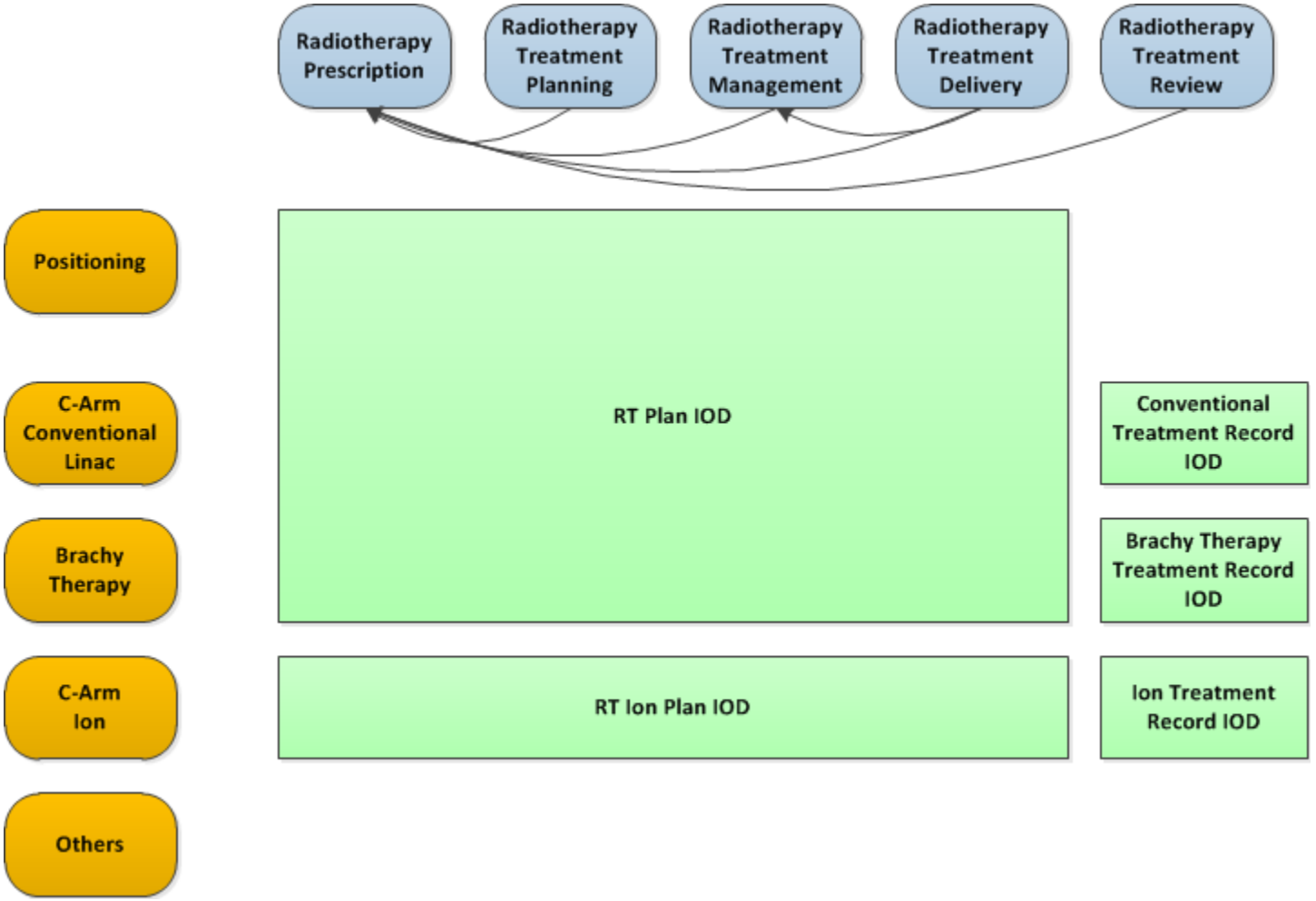
Why 2nd Generation ?

1st Gen Specification Issues

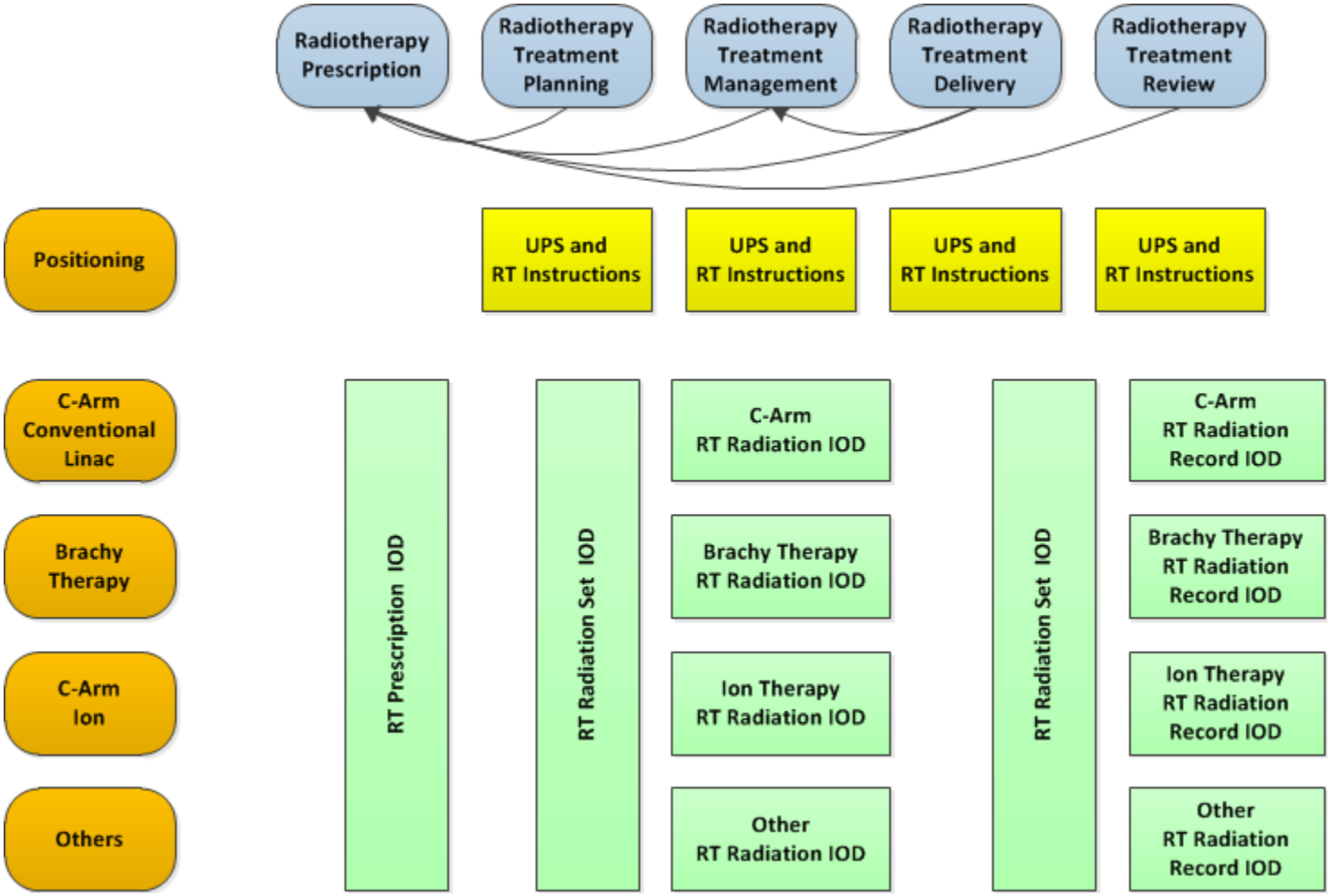
- new Treatment Technologies can't be added easily
- Too much of a static model clinical process
- Integration of new DICOM objects outside RT
  (e.g. volume and surface segmentation, multi-frame images)

- Large and Complex RT Plan IOD
  - No differentiation between prescription and treatment device parameters
  - Big versioning problem, esp. with adaptive therapy

1st Generation Approach



2nd Generation Approach



Key Principles

1. **Granularity: Finer-Granularity of Objects**
2. **Dynamics: IOD Lifetime**
3. **Workflow Support: Worklist and ‘electronic dogtag’**

4. **Modalities: Separation: Modality-Independent versus Modality-Specific**
5. **Modalities: Extensibility to new Modalities**
6. **Conceptual Volumes: Cross-IOD Anatomy Instance References**
7. **Segmentation: Geometric Information versus RT Payload**

8. **Optionality: Less optional Attributes**
9. **Building Blocks: Macros**

Granularity and Dynamics

Finer-grained object model

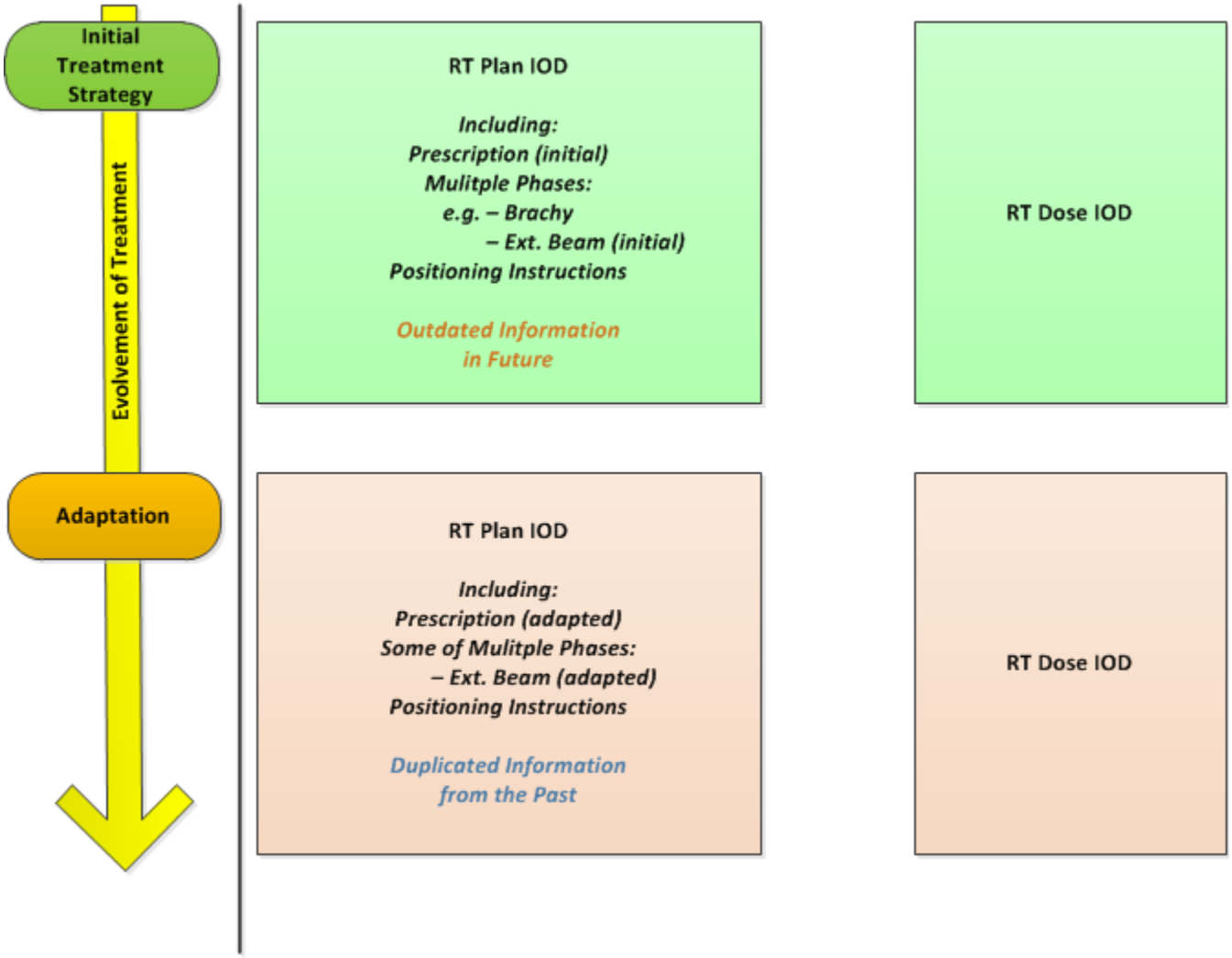
- **No complex ‘monster’ objects**
- **Objects with dedicated purpose**

- **Objects design along:**
  - **Frequency of Change (how often)**
  - **Content of Change (what is changed)**

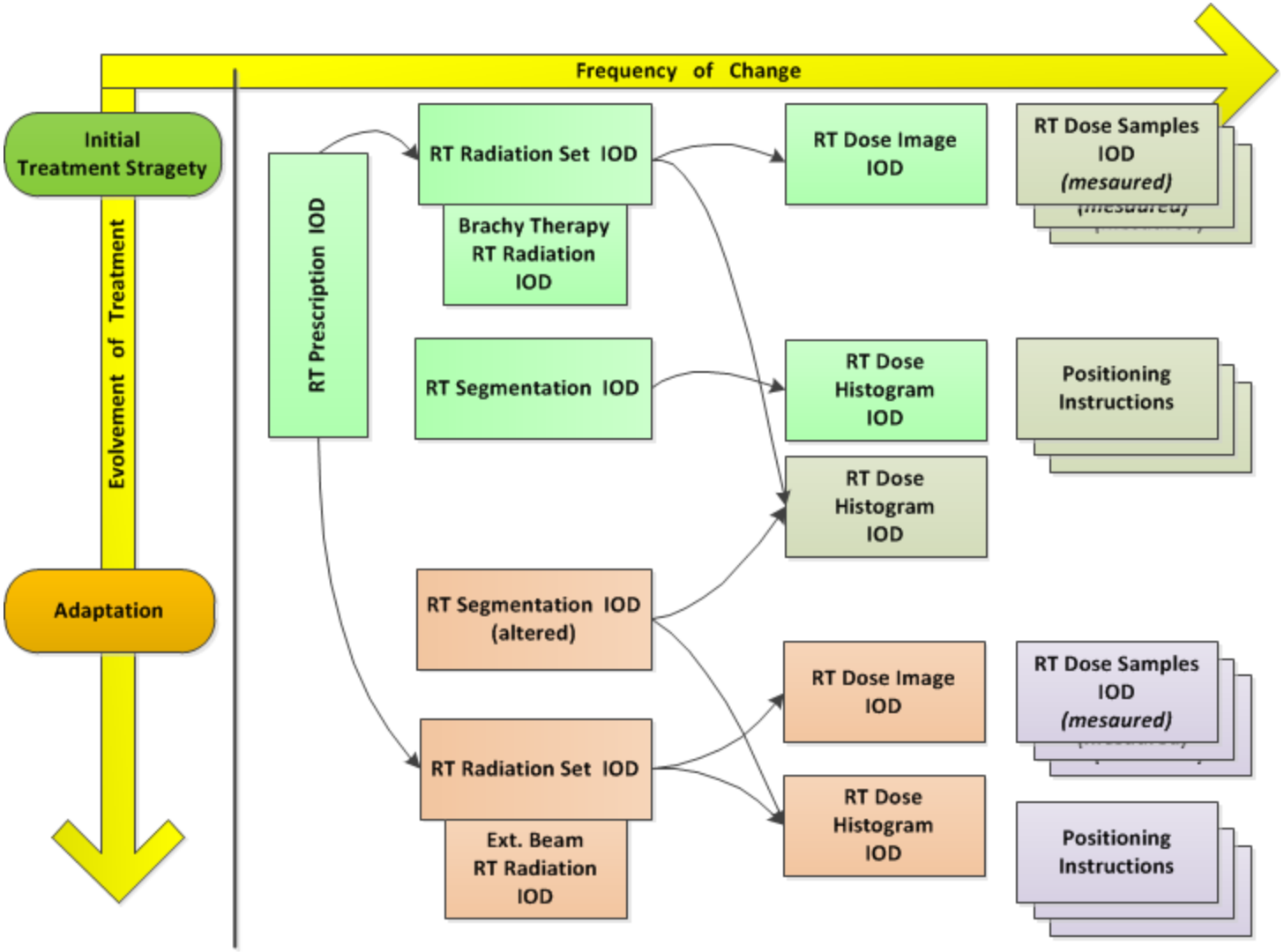
Comprehensive RT Process Perspective

- **1st Generation: Treatment Planning System Focus**
- **2nd Generation: Incorporateing complete Treatment Workflow**

1st Gen Large Objects



2nd Gen Dedicated Objects



Granularity and Dynamics

Workflow Enabled

- **Because we have better dedicated objects**
- **Still possible to work with and without DICOM Worklist**

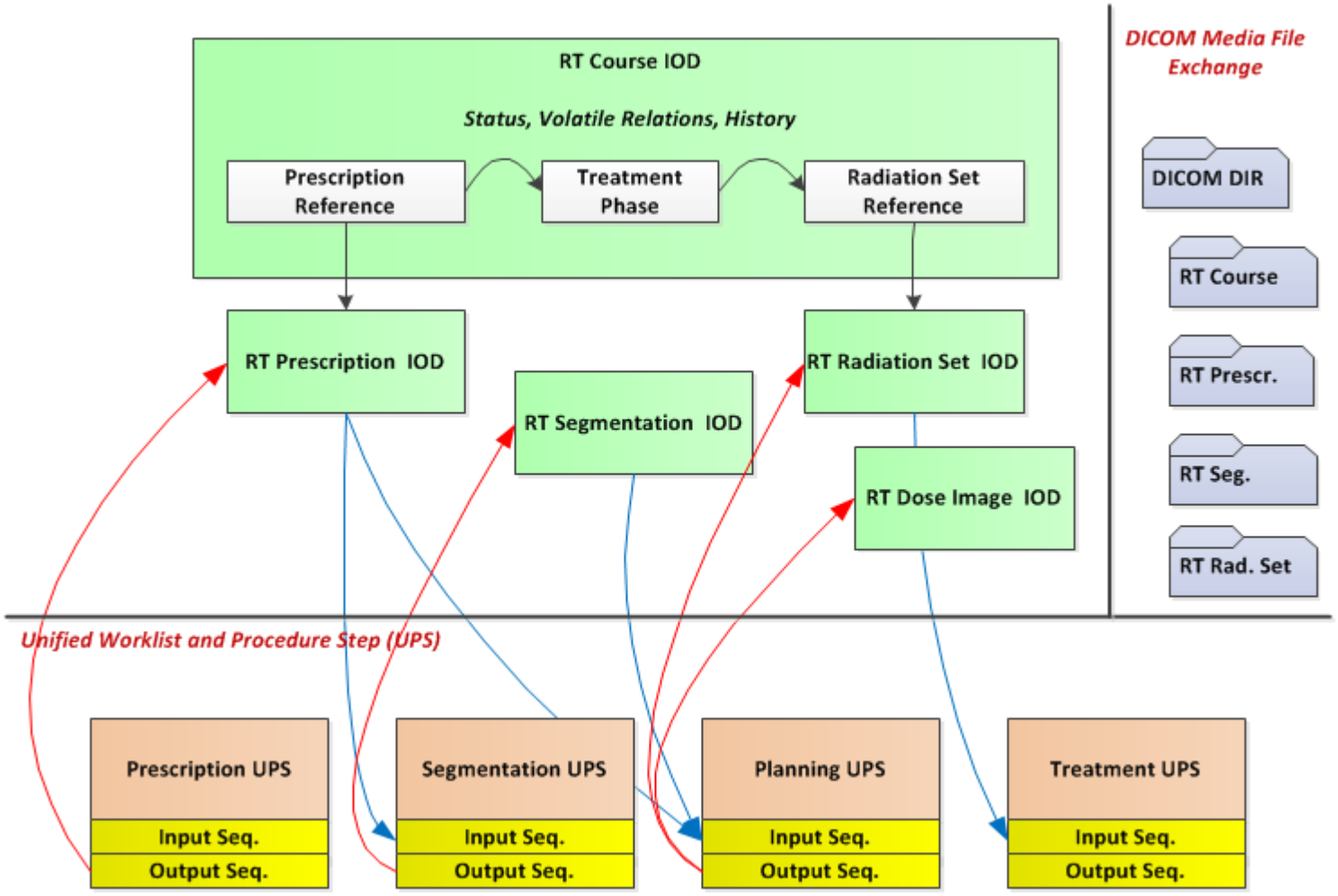
Volatile Information outside IODs

- **Status information**
- **Dynamic Relations**

Addressed By

- **Either: UPS**
- **Or: RT Course IOD**

RT Course and UPS



Modalities

Modality-Independent Information

- **Abstraction**
- **IODs seperate from specifics of modalities / Use of Shared Modules**
- **Handle RT Process Dependencies in this category:**
  - Dose / Treatment Fraction Tracking
  - Relation to Prescription

Modality-Dependent Information

- **Specialization well-defined**

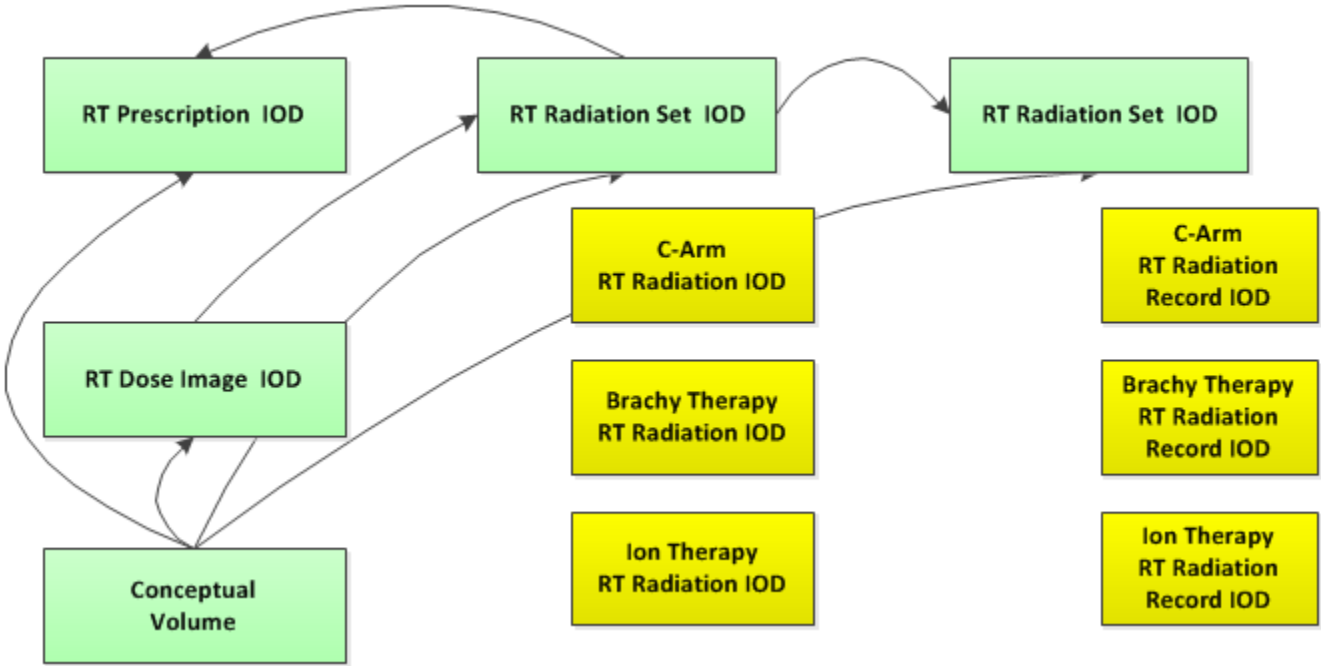
Advantage: Extensibility

- **Add new Tx Modalities IODs without Redesign / Side affects to existing IODS**

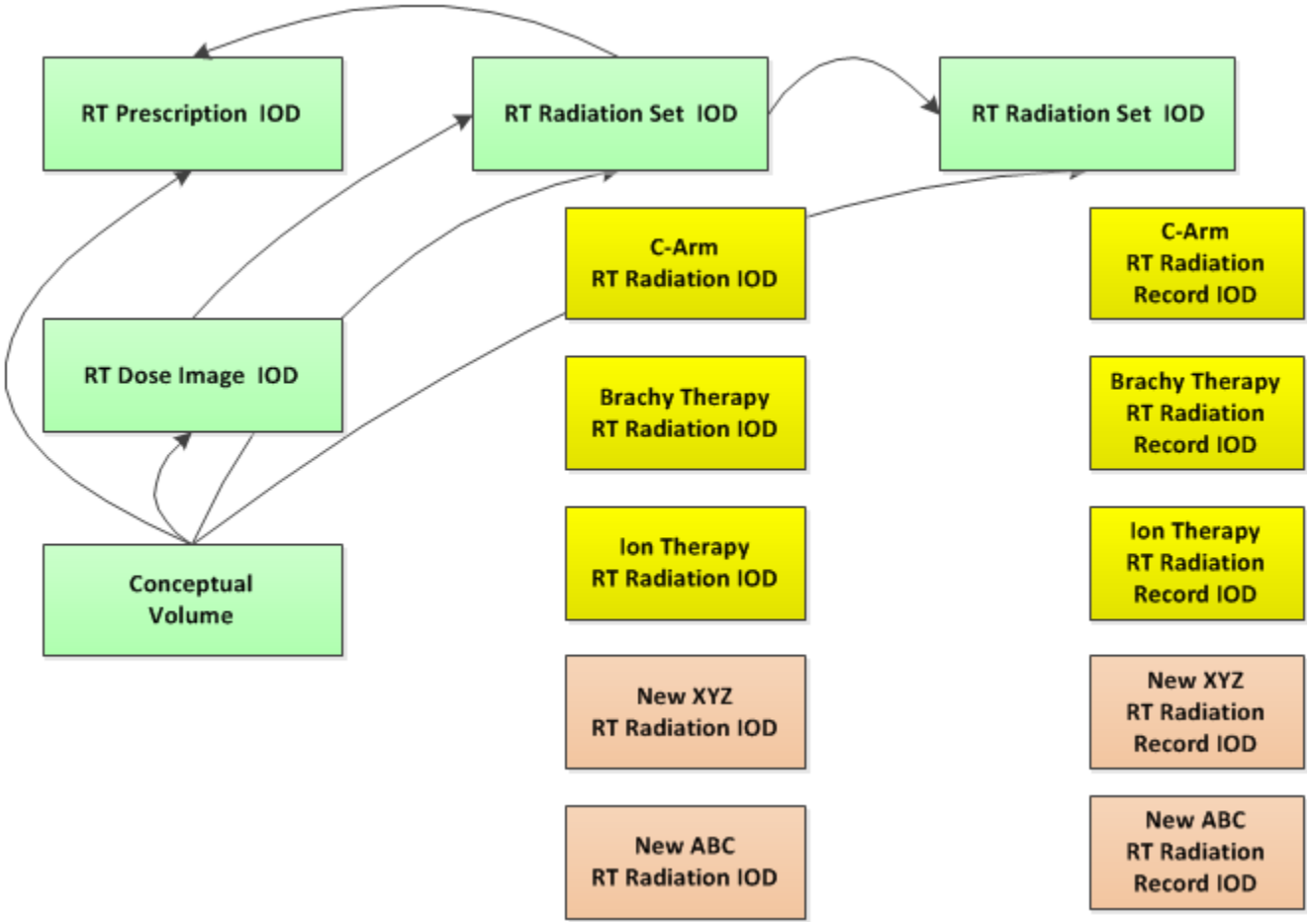
Cost:

- **Future Modalities must comply with generic Structure**

Modalities Today



Modalities Tomorrow



Specific Designs

Dose Object

- **Use of Multi-frame approach**
- **Comprehensive dose scope model**

RT Segmentation

- **Adds Radiotherapy Annotation by a Facade IOD**
- **Uses existing IODs for Geometry:**
  - Segmentation IOD
  - Surface IOD
  - Structure Set DIO

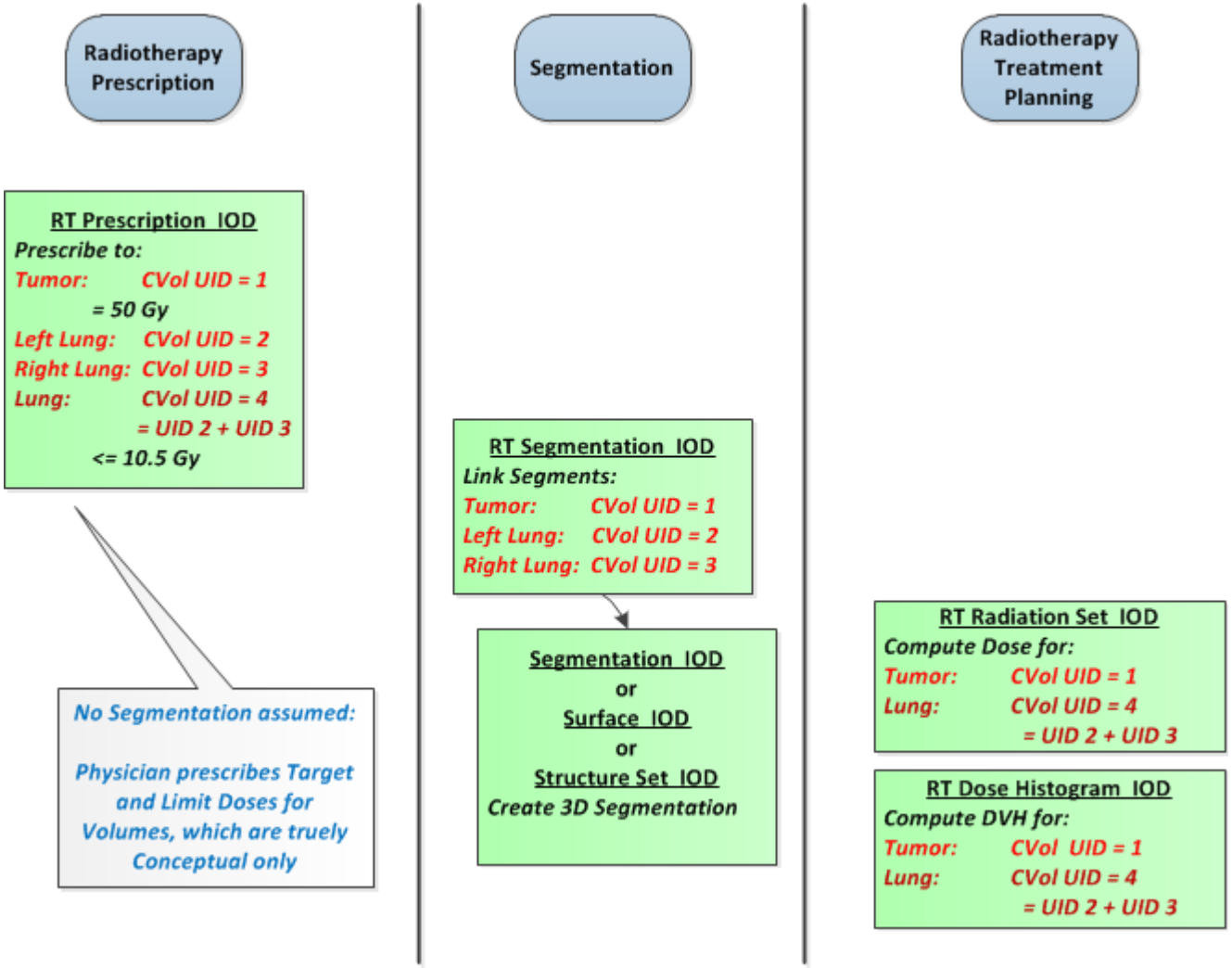
Conceptual Volumes

- **Re-identification of Anatomic Entities**
  - Across different SOP instances of different SOP Classes
  - At different points in time
- **Capability of Combinations of such Entities**

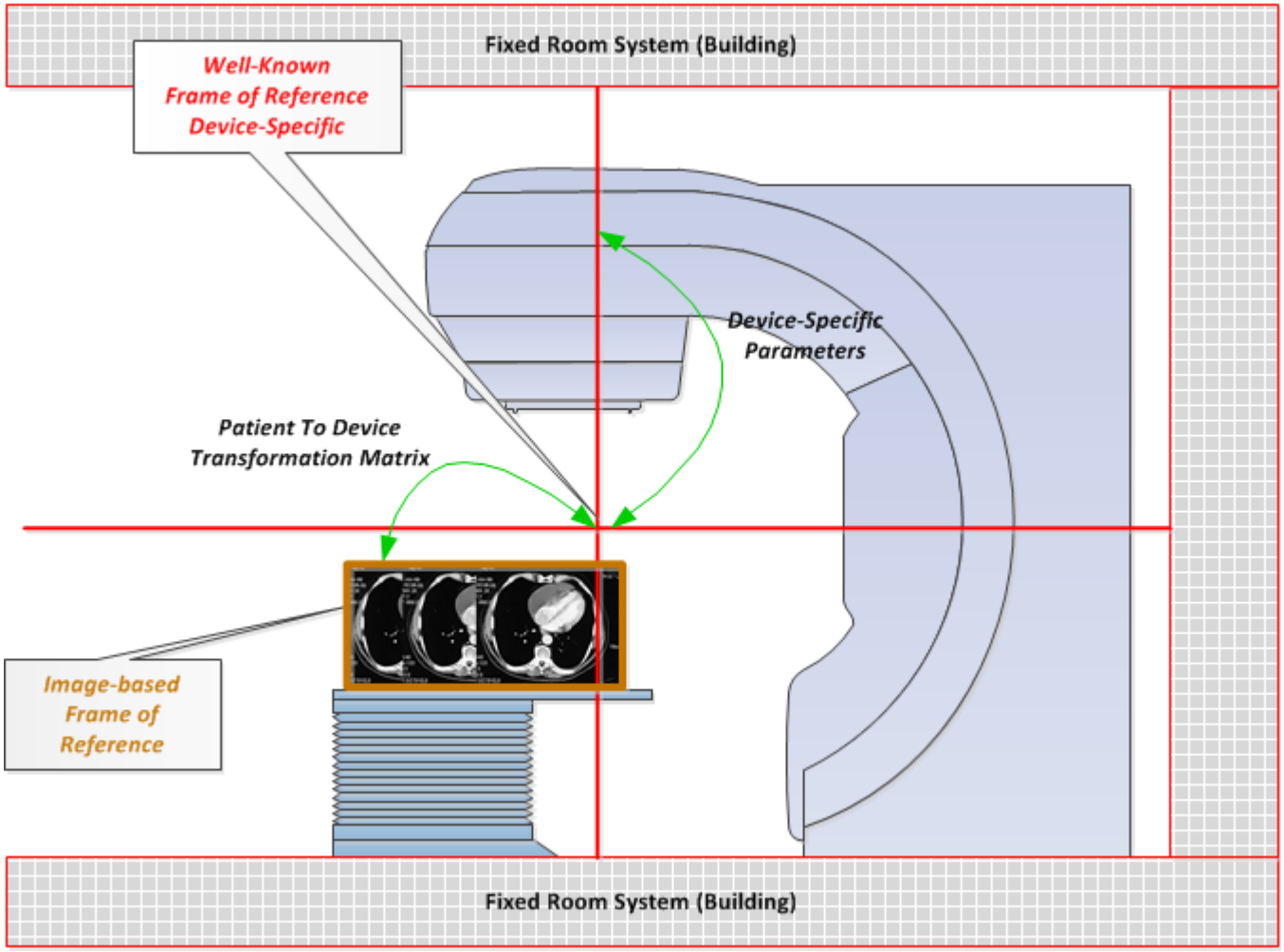
Image Frame of Reference to RT Device Transformation

- **Formalism to related the Patient of the Therapeutic Device Geometry**

Conceptual Volumes / Seg.



FOR to Device System



Specification Guidelines

Extensive Use of Macros

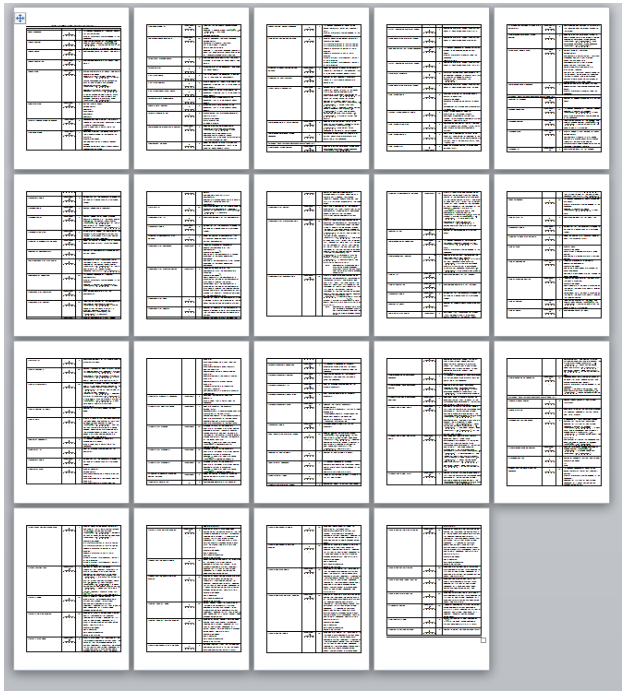
- **Supplement has 250 pages – otherwise x3**
- **Stimulate**
  - **Systematic Implementation**
  - **Consistent Implementation**
- **Better Readability**
  - **Some Learning Curve)**
  - **Fast identification of same content**

Approaches for 2-level parameters

- **(sorted out together with WG-06)**
- **Like Segmented Property Category Code / Segmented Property Type Code**
- **Coded Parameter:**
  - **1st level: Use of one CID**
  - **2nd level: Use of CIDs depending on 1st-level Code**

Macros

External Beam:
1st Gen: 11 Pages



2nd Gen: 1 Page

Table C.8.A.G2-1
C-ARM PHOTON-ELECTRON BEAM MODULE ATTRIBUTES

Attribute Name	Tag	Type	Description
Radiation Particle	(30xx,5110)	1	Particle Type of Radiation. See C.8.A.G2.1.1. Enumerated Values: PHOTON ELECTRON
Treatment Machine Mode Sequence	(30xx,0C97)	1	Annotates the mode of operation for treatment machine. Only a single Item shall be included in this sequence. See C.8.A.G2.1.3.
>Include 'Code Sequence Macro' Table 8.8-1.			*Defined CID SUP147017.*
Include 'Beam Mode Macro' Table' C.8.A.1.18-1			
C-Arm Photon-Electron Control Point Sequence	(30xx,0C00)	1	Control points used to model the beam delivery. Two or more Items shall be included in this sequence.
>Include 'External Beam Control Point General Attributes Macro' Table C.8.A.1.16-1			
>Include 'RT Beam Limiting Device Positions Macro' Table C.8.A.1.20-1			
>Include 'Wedge Positions Macro' Table C.8.A.1.22-1			
>Gantry Roll Continuous Angle	(30xx,51B5)	1C	Treatment machine gantry angle, i.e. orientation of IEC GANTRY coordinate system with respect to IEC FIXED REFERENCE coordinate system (degrees). Required if the Control Point Item Index (30xx,0111) equals 1 or attribute value changes at any Control Point. See C.8.A.1.16.1.1 and C.8.A.G2.1.2.
>Surface Entry Point	(300A,012E)	2C	Patient surface entry point coordinates (x,y,z), along the central axis of the beam, in the patient based coordinate system described in C.7.6.2.1.1 (mm). Required if the Control Point Item Index (30xx,0111) equals 1 or attribute value changes at any Control Point. See C.8.A.1.16.1.1.
>Source to Surface Distance	(300A,0130)	2C	Source to Patient Surface distance (mm). Required if the Control Point Item Index (30xx,0111) equals 1 or attribute value changes at any Control Point. See C.8.A.1.16.1.1.

Specification Guidelines

Enforcement of Contents

- **Less Optionality**
- **Emphasis on Type 1, 1C**

Extensive Use of DICOM Codes

- **Well-defined semantics**
- **Localization Ready**
- **Extensible in controlled manner**
  - **Use of Defined CIDs**
  - **Partly ‚Non-Extensible‘ CIDs -> Extension only by WG-07**

Some Recommendations (for DICOM Reformers)

Avoid Large Supplements

- **Split it in pieces where possible (Was not possible in RT)**

Maintain elaborate Document History

- **Trace of Discussions, Decisions, Reviews**

Hold Face-to-Face Workshops

- **Homework is a challenge for many participants**

-> Work in small Groups during Face-to-Face Meetings

Don’t start with Backwards Compatibility

- **Homework is a challenge for many participants**

Consider the whole Standard

- **New Constructs where needed, but don’t re-invent**
- **Check for possibility of general use of your constructs**
- **Use existing Codes, Language**

Design for 20 Years

- **Later Incremental Changes compromise Quality**
- **Add Hooks for Future Development**

References

http://dicom.nema.org/

http://www.HL7.org/

http://www.IHE.net/

Author Contacts

Ulrich Busch

- **Ulrich.Busch@varian.com**
- **Varian Medical Systems**
  Imaging Laboratory GmbH
  Täfernstrasse 7
  CH-5404 Baden-Dättwil
  Switzerland

Thank you for your attention !