DICOM℠
Digital Imaging and Communications in Medicine

Review of WG17 Work Item 1 Output:

DICOM Encapsulated STL

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Agenda

- **WG17 Mandate & Work Item**
- **Specifics of Proposal**
  - **New IOD / SOP**
  - **Other related changes**
- **Expected use by community**
- **Strategy for adoption by vendors**
- **Larger WG17 context & future**

WG17 & Work Item

Our mandate is to facilitate a way to store/query/retrieve 3D models, intended for 3D manufacturing, as DICOM objects (Work Item 1).

The approved Work Item is focused on (a) leveraging the existing and growing ecosystem of DICOM-capable systems in use in healthcare institutions and (b) leveraging standards already in use in the 3D printing industry.

Specifics of Proposal

New Information Object Definition (IOD):

- **Encapsulated native 3D file for Creation, Review, Update, and Printing (manufacturing)**

New Service Object Pair (SOP) Class:

- **Encapsulated STL Storage**
  - » Only STL in this proposal
  - » Other file types will have distinct SOP Classes

Specifics of Proposal (cont'd)

Other extensions to DICOM standard

- Contain references to existing IODs from which the model is derived (which may be from multiple studies)
- Allow users to review 3D printing models for accuracy/relevance prior to printing
- Include a 2D preview representation
- Indicate whether the 3D printed model contains protected health information

Expected Use

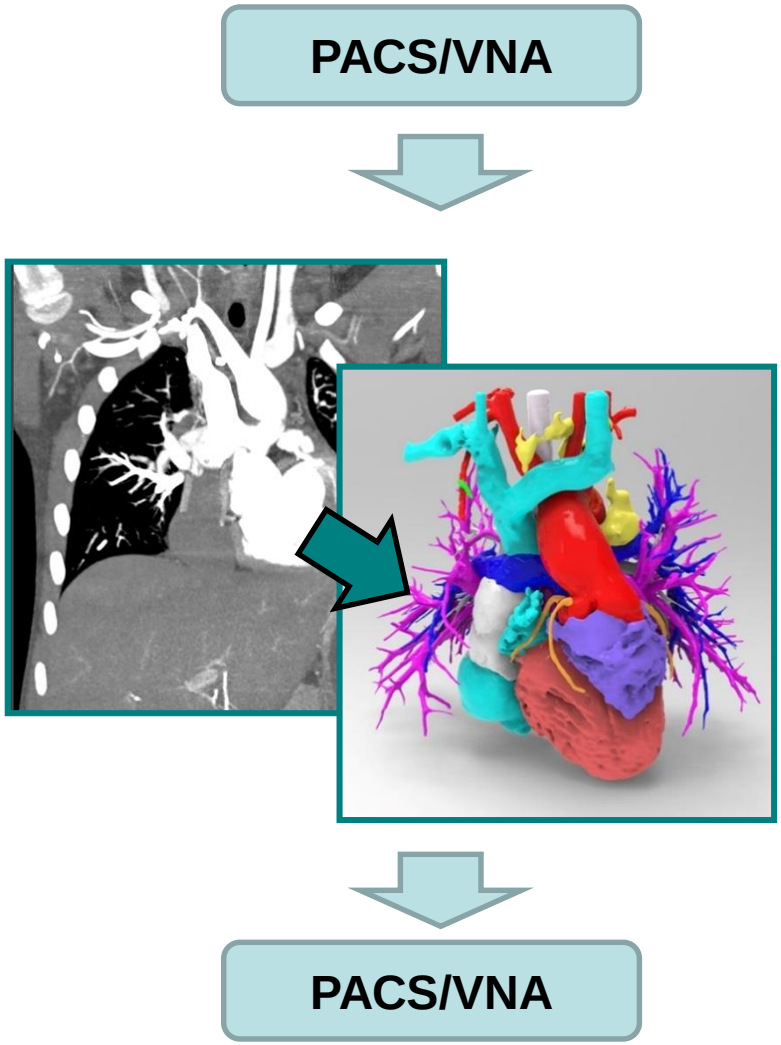
The new IOD/SOP is expected to address these real world use cases:

- **Creation**
- **Review**
- **Update**
- **Print**

Expected Use (continued)

Use Case 1: Creation

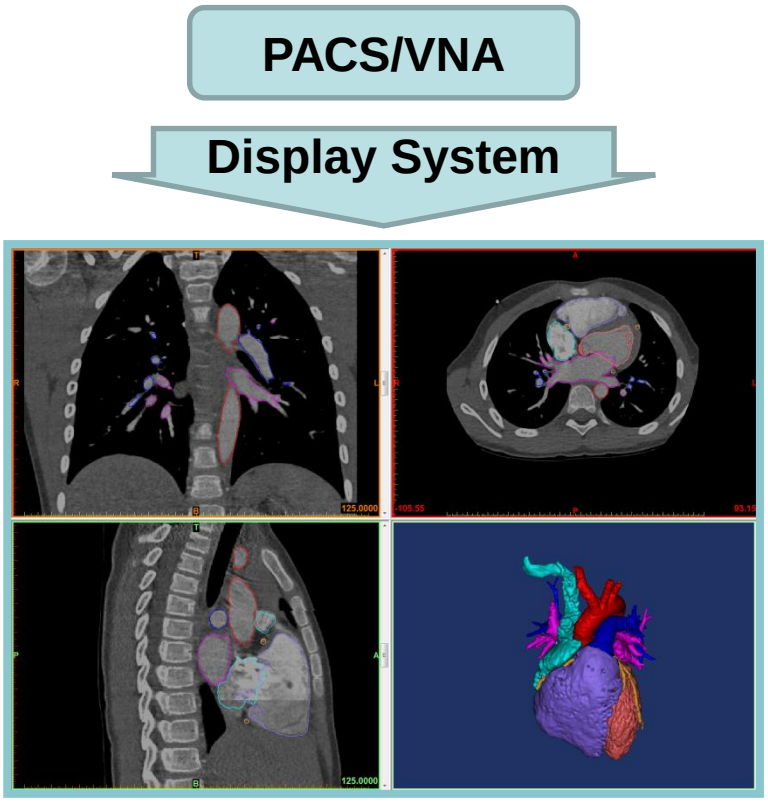
- Medical reconstruction software queries Image manger system
- **User creates patient-specific 3D model** (reconstruction and modeling)
- Modeler system creates the new type DICOM object containing the 3D model, populating all required metadata
- **User saves 3D model back to the patient's record in DICOM** format as either (a) an addition to an existing study or (b) a new study
- The **Modeler system stores the new DICOM** object in the Image Manager system



Expected Use (continued)

Use Case 2: Review

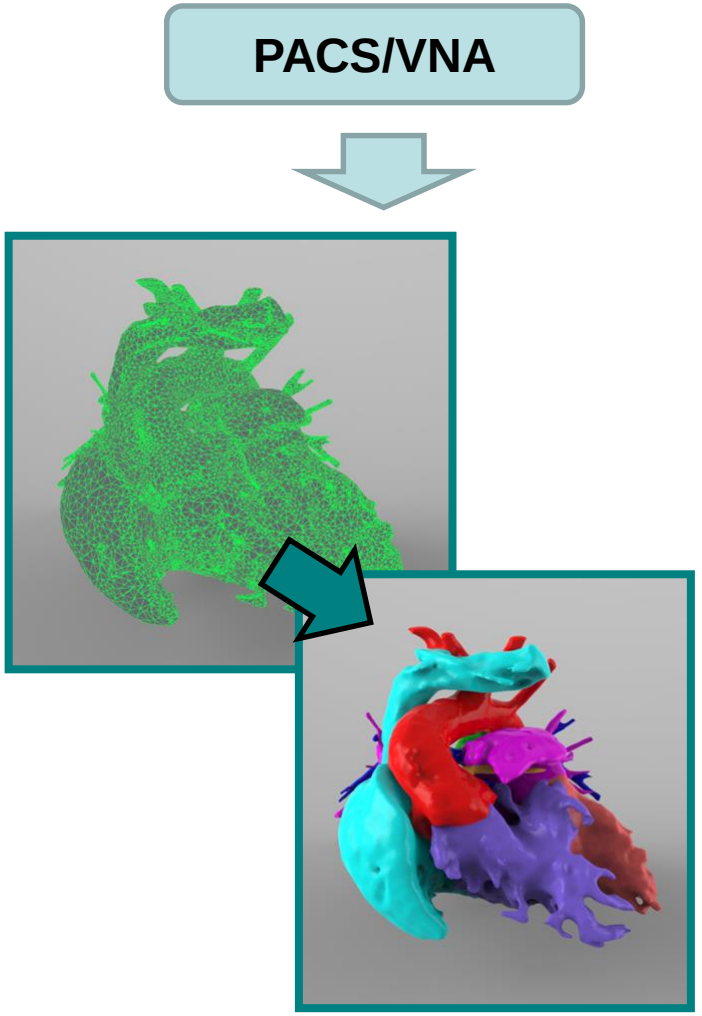
- At a later time to Use Case 1, a user indicates desire to **visually review a 3D model , prior to 3D printing**
- The Display system queries the Image Manager for the DICOM objects of new type
- The Display system retrieves the indicated object
- The **Display system extracts the 3D model** from the object and displays it to the user, potentially registered for simultaneous display with source images



Expected Use (continued)

Use Case 3: Update

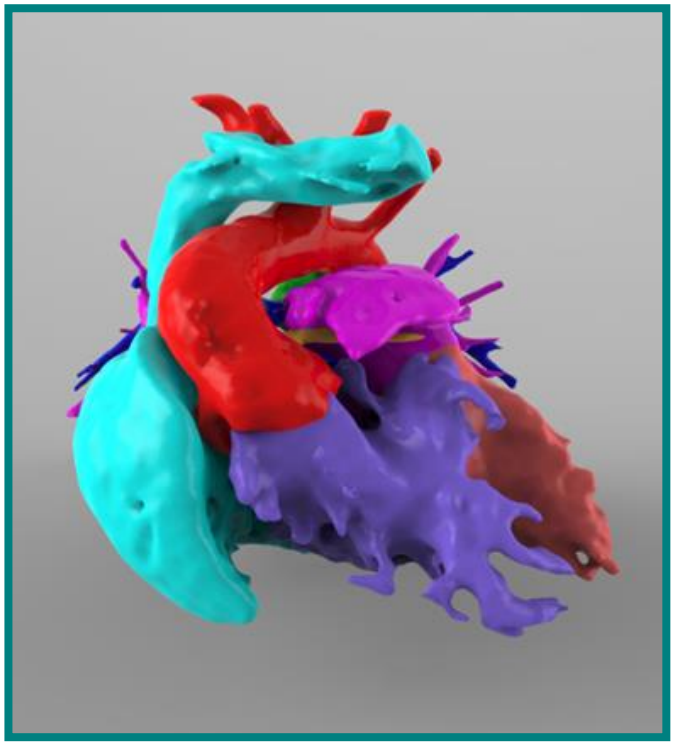
- At a later time to Use Case 1, a **user indicates desire to modify a 3D model** for a particular patient
- The Modeler system queries the Image Manager for the DICOM objects of new type
- If necessary, **the Modeler system retrieves any source images** (s1 to sN) required for this modification to occur
- User interacts with the Modeler system to adjust the 3D printable model as desired



Expected Use (continued)

Use Case 3: Update (cont'd)

- **User saves back to the patient's record in DICOM format** as either (a) an addition to an existing study, or (b) a new study
- The Modeler system creates the new type DICOM object containing the new version 3D model, populating all required metadata and including a unique identifier reference to the supplanted earlier 3D print model object
- The Modeler system stores the new DICOM object in the Image Manager system

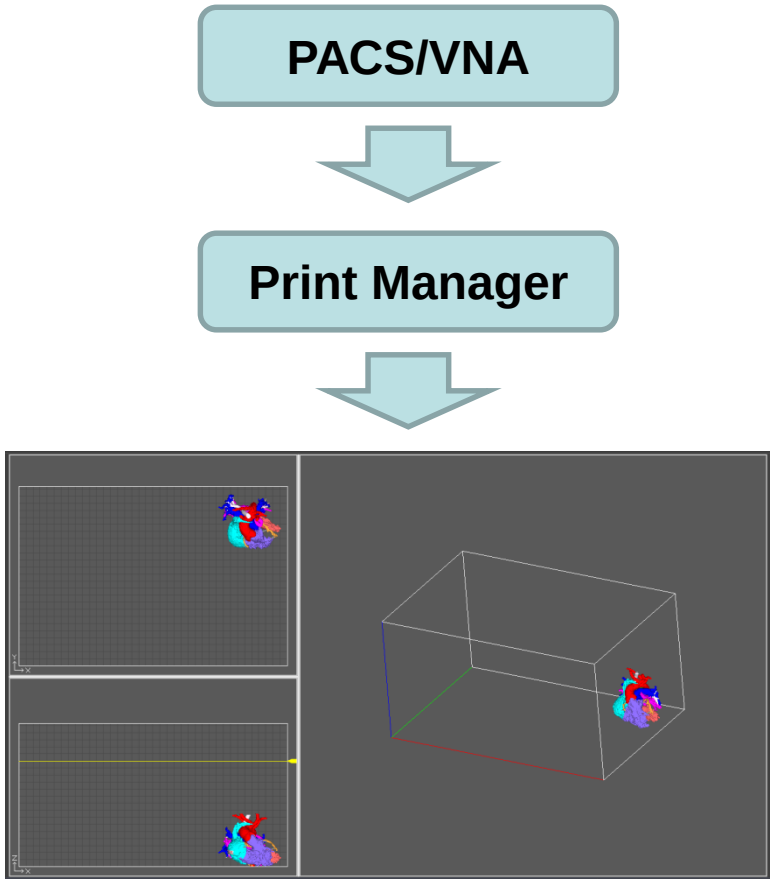


PACS/VNA

Expected Use (continued)

Use Case 4: Print

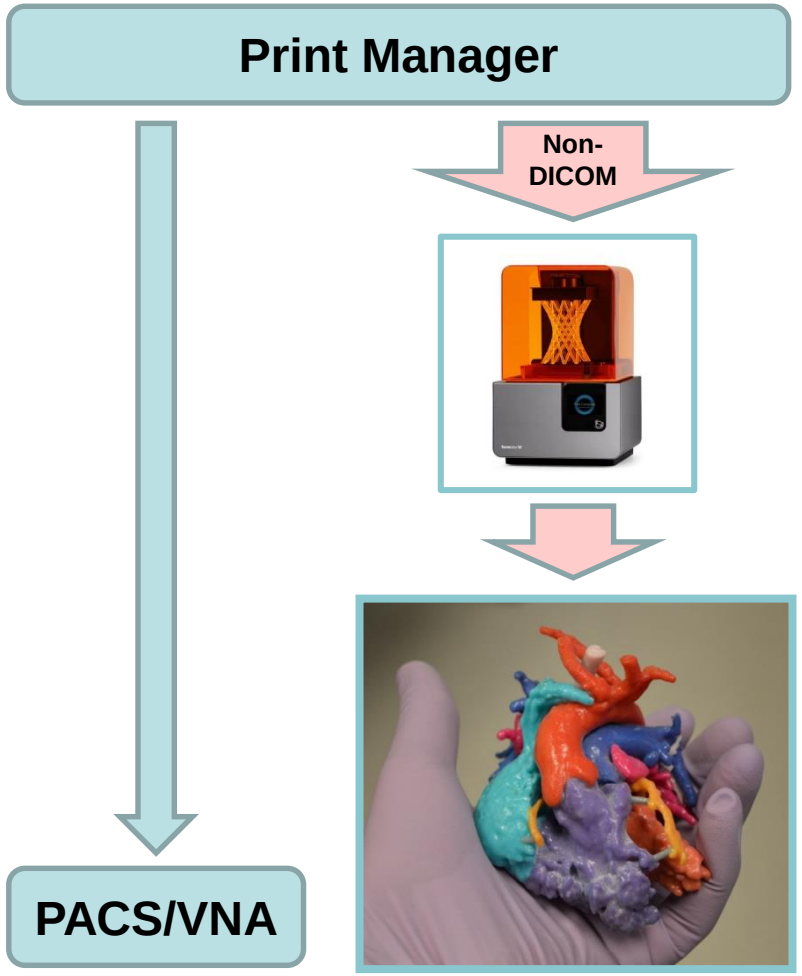
- At a later time to Use Case 1, a user indicates desire to print a 3D model for a particular patient
- The Print Manager system queries the Image Manager for the DICOM objects of new type belonging to the patient
- The Print Manager system retrieves the indicated 3D print model object
- The Print Manager access the 3D model information within the object, using this to create non-DICOM print instructions for a specific 3d printer (e.g. .stl)



Expected Use (continued)

Use Case 4: Print (cont'd)

- The Print Manager prompts the user for any necessary additional print parameters (e.g. support, bed placement, material parameters, etc.)
- The Print Manager submits the print job to the printer
- Optionally, the Print Manager may save an updated 3d print object back to the Image Manager in order to preserve exact print parameters used (per Use Case 3, steps 7+).



Other Aspects Addressed

- **Laterality Mirroring**
  - **Clinically important to know if 3D model was created by mirroring a structure from left to right or vice versa**
  - **Introduce new attribute to record the technique**
- **Patient Confidentiality**
  - **Clarified use of existing *Burned in Annotation* and *Recognizable Visual Features* attributes as they apply to 3D models**
- **Preview Image**
  - **Extend existing capability for JPEG MIME-type inclusion to allow for a preview image**

Strategy for Adoption

- **Success depends on both:**
  - **Traditional PACS/VNA vendors, and**
  - **3D print model software vendors**
- **Both must adopt the new standard simultaneously**
- **Open source reference implementation may be helpful**

Strategy for Adoption (cont'd)

- **Groundwork for success is as follows**
  - **Enable traditional PACS/VNA vendors and new 3D print model software vendors to participate in new IOD development**
  - **Enable user community to push their vendors to adopt the new IOD via:**
    - User group meetings
    - Conferences
    - Societies (RSNA, SME, WAM3DP, etc.)

Larger WG17 Context

Work Item requires us to support more than just STL:

- **STL captures geometry as a triangular mesh, but contains no metadata (e.g. units) or color**

G-CODE, X3D, VRML, AMF, 3MF, PLY, OBJ/MTL, and U3D/PDF

- **May contain additional, print-appropriate metadata, material properties, color information**
- **Will focus on a small, select number of formats**

Open Question

Should some transformation between DICOM Surface Mesh Module (C.27.1) and encapsulated 3D print models be explored?

- **Similar, but not identical data structures (lossy conversion) when dealing with more advanced print formats (material properties, texture mapping)**
- **Limited adoption of Surface Mesh Module (no current 3D print community adoption)**

End of Presentation

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Questions?