ITKv4 DICOM Status

Mathieu Malaterre, Mark Roden
Alexandre Gouaillard, William Ryan, Daniel Blezek

Summary

1. DICOM Query/Retrieve (network protocol) abstraction
   - GDCM/DCMTK
2. Streaming
3. RTSTRUCT
4. MOSAIC
5. DICOM DataSet abstraction
   - GDCM/DCMTK

DICOM Query/Retrieve

- C-ECHO
- C-STORE
- C-FIND (Patient & Study)
  - Patient/Study Only will *not* be available
- C-GET: will *not* be available
- C-MOVE
  - No external application required
  - C-STORE SCP association using different port

C-ECHO

- An implementation for Service Class User (SCU) for the Verification SOP Class. Sends a DICOM C-ECHO message to a Service Class Provided (SCP) and waits for an answer.
- Used to verify basic DICOM connectivity
- PING !

itk::DICOMSCU (C-ECHO)

```
itk::DICOMSCU scu;
scu.SetPeer( "mi2b2.slicer.org" );
scu.SetCalledAETitle( "MI2B2" );
scu.SetPort( 11112 );
try {
  scu.SendEcho();
} catch ( itk::DICOMException & e ){
  std::cerr << e.what() << std::endl;
}
```

C-STORE

- This is used to send DataSet using the DICOM protocol (over TCP/IP).
- Equivalent to HTTP PUT

itk::DICOMSCU (C-STORE)

```
vector<string> filenames = …;
itk::DICOMSCU scu;
scu.SetPeer( “mi2b2.slicer.org” );
scu.SetCalledAETitle( “MI2B2” );
scu.SetPort( 11112 );
try {
  scu.SendStore( filenames );
} catch ( itk::DICOMException & e ){
  std::cerr << e.what() << std::endl;
}
```

C-FIND

- This is used to query an SCP using the C-FIND message.
- In SQL

```
select PATIENT.PatientID,
  STUDY.StudyDate,
  STUDY.ModalitiesInStudy,
  STUDY.StudyDescription

from   PATIENT, STUDY

where  PATIENT.PatientID = "99999"

and    STUDY.Patient_fk = PATIENT.pk
```

itk::DICOMSCU (C-FIND)

```
itk::DICOMSCU scu;
scu.Set...
itk::SeriesQuery::Pointer query = SeriesQuery::New();
query->SetPatientName( “X*” );
vector<itk::DICOMDataSet> cfind_results;
try {
  cfind_results = scu.SendFind( query );
} catch ( itk::DICOMException & e ){
  std::cerr << e.what() << std::endl;
}
```

itk::DICOMSCU (C-FIND) Open Questions

```
itk::SeriesQuery::Pointer query = SeriesQuery::New();
query->SetPatientName( "* 王 ^ 小東 *" );

itk::SeriesQuery::Pointer query = SeriesQuery::New();
query->SetPatientName( "*Jérôme*" );

itk::SeriesQuery::Pointer query = SeriesQuery::New();
query->SetPatientName( "*Rüdiger*" );
```

C-GET

- This is essentially just a C-MOVE, except it does not require an extra step (anotehr Association).
- This is not implemented in some private implementation.

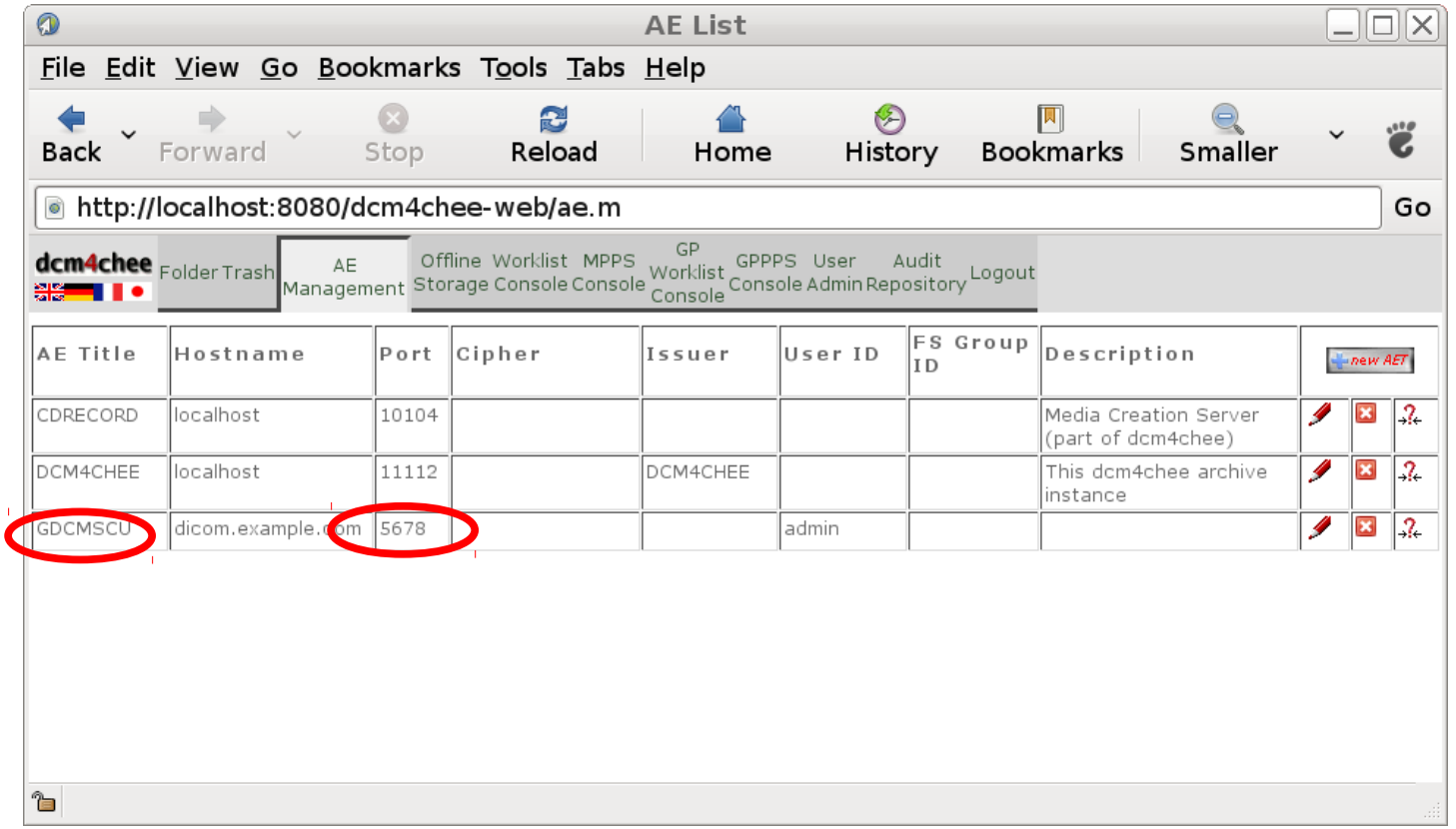
C-MOVE

- This is used to retrieved DataSet using the DICOM protocol (over TCP/IP)
- Somewhat equivalent to HTTP GET

itk::DICOMSCU (C-MOVE)

```
itk::DICOMSCU scu;
scu.SetPeer( “mi2b2.slicer.org” );
scu.SetCalledAETitle( “MI2B2” );
scu.SetPort( 11112 );
scu.SetAETitle( “GDCMSCU” );
scu.SetIncomingPort( 5678 );
scu.SetOutputDirectory( “/tmp” );
try {
  scu.SendMove( cfind_results );
} catch ( itk::DICOMException & e ){
  std::cerr << e.what() << std::endl;
}
```

Server side configuration (dcm4chee)



Streaming

- Read/Write:
  - RAW
  - JPEG 2000
- User demand:
  - JPEG
  - JPEG-LS
  - RLE

JPEG 2000 Streaming

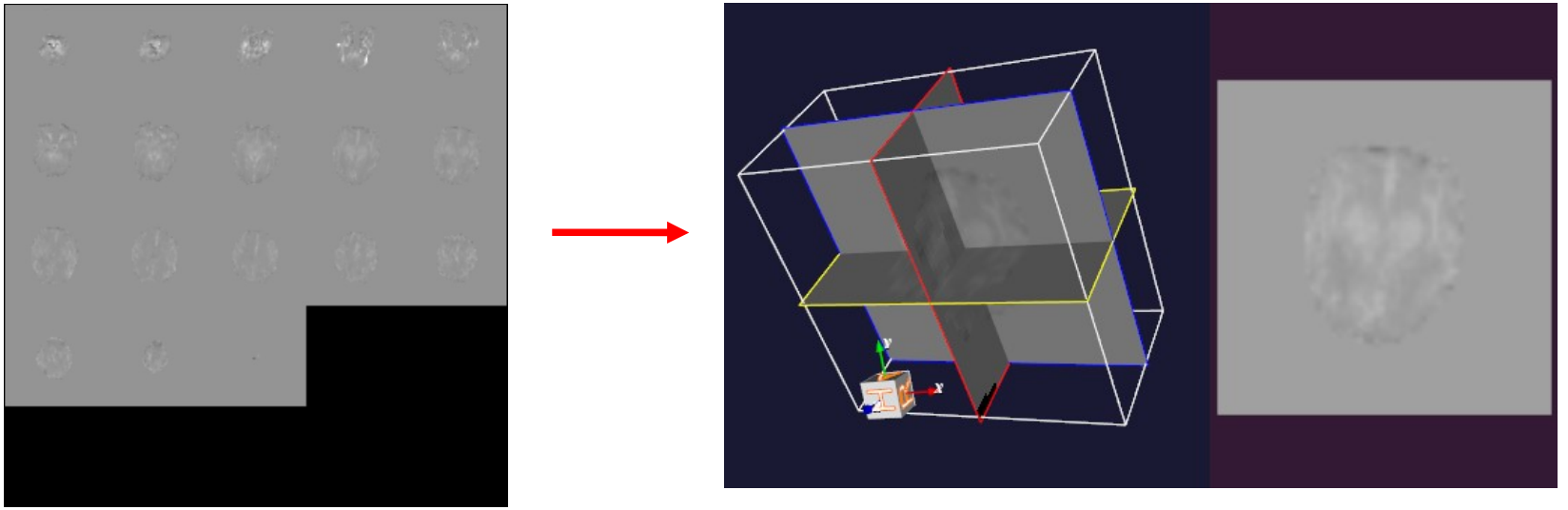
- Reading:
  - Support in OpenJPEG v2, using opj_set_decode_area API
- Writing:
  - Support in OpenJPEG v2 using opj_write_tile
  - Open Question: when user extent do not match tile requirement

JPEG/JPEG-LS/RLE

- No direct support for streaming.
  - Need to decompress the whole image, to access the last scanline
  - 16 bits based standard, worse case scenario is 4Gb dataset.

itk::MOSAICImageIO

- Subclass of itk::GDCMImageIO
- Identical to itk::GDCMImageIO, except image is *untiled*.



itk::RTSTRUCT

- 2D contours will be loaded as itk::QuadEdgeMesh
- Provide a itk::RTSTRUCTProperties to attach properties to each individual itk::QuadEdgeMesh

itk::DICOMDataSet

- itk::DICOMDataSet should replace the itk::MetaDataDictionary implementation for storing DICOM Attributes.
- Will allow re-use of third party lib (eg. DCMTK or GDCM), it will hold a pointer to the internal implementation.
- Interface will implements Supp 118 for querying of attributes
- One itk::DICOMDataSet per file (3D multiframes is not a Series of 2D frames)

Supp 118 queries

```
(0008,1090) LO [RHAPSODE]                                  #   8, 1 ManufacturersModelName
(0008,2111) ST [JPEG 2000 irreversible (lossy) 69:1]       #  36, 1 DerivationDescription
...
(0008,9215) SQ (Sequence with undefined length #=1)        # u/l, 1 DerivationCodeSequence
  (fffe,e000) na (Item with undefined length #=3)            # u/l, 1 Item
    (0008,0100) SH [113040]                                    #   6, 1 CodeValue
    (0008,0102) SH [DCM]                                       #   4, 1 CodingSchemeDesignator
    (0008,0104) LO [Lossy Compression]                         #  18, 1 CodeMeaning
  (fffe,e00d) na (ItemDelimitationItem)                      #   0, 0 ItemDelimitationItem
(fffe,e0dd) na (SequenceDelimitationItem)                  #   0, 0 SequenceDelimitationItem
```

```
const itk::DICOMDataSet &ds = dicomio->GetDICOMDataSet();
string value;
string query = "/DicomNativeModel/DicomAttribute[@keyword='DerivationCodeSequence']"
  "/Item[@number=1]/DicomAttribute[@keyword='CodeMeaning']/Value[@number=1]";
ds.GetValueFromQuery( query, value );
std::cout << "Code Meaning=" << value << std::endl;
```

Filter DICOM DataSet(s)

```
ImageIOType::Pointer dicomio = ImageIOType::New();
ReaderType::Pointer reader = ReaderType::New();
reader->SetFileNames( filenames );
reader->SetImageIO( dicomio );
reader->Update();
FilterType::Pointer filter = FilterType::New();
filter->SetInput( reader->GetOutput() );
ImageIOType::Pointer dicomio2 = ImageIOType::New();
DICOMFilterType::Pointer anonymize = DICOMFilterType::New();
anonymize->SetInput( dicomio->GetDICOMDataSetArray() );
WriterType::Pointer writer = WriterType::New();
writer->SetInput( filter->GetOutput() );
dicomio2->SetDICOMDataSetArray( anonymize-
  >GetDICOMDataSetArray() );
writer->SetImageIO( dicomio2 );
writer->SetFileNames( outputfilenames );
writer->Update();
```

Implementation Specific (GDCM)

```
itk::DICOMDataSet &dicomds = io->GetDICOMDataSet();

itk::GDCMDataSet &gdcmds =
  dynamic_cast<itk::DICOMDataSet&>(dicomds);

gdcm::DataSet &ds = gdcmds->GetGDCMDataSet();

const gdcm::PrivateTag
  tstringdata(0x33,0x1f,"GEMS_GENIE_1");

if( !ds.FindDataElement( tstringdata ) ) return 1;

const gdcm::DataElement& stringdata =
  ds.GetDataElement( tstringdata );

ProcessSDOHeader( stringdata );
```