A new design for a DICOM-3 server

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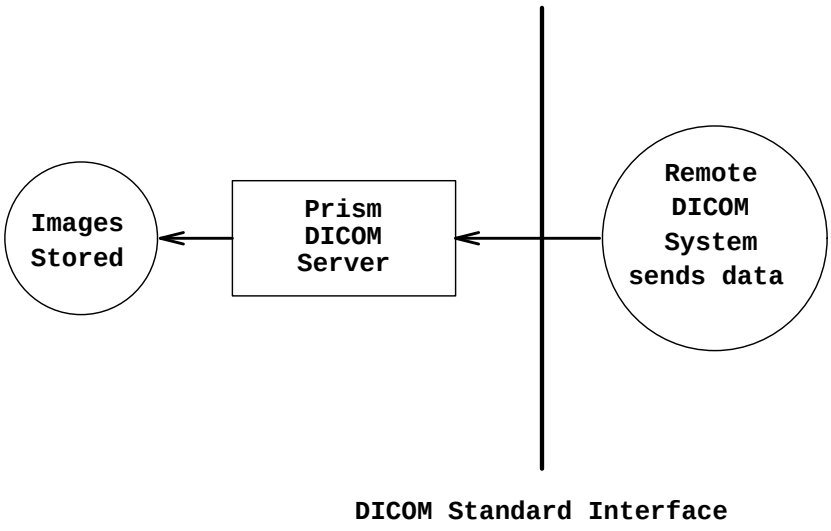
DICOM: server and client data flow



Components of the DICOM protocol

- The *DICOM Upper Layer protocol* (DUL) is the language used to make connections, compose, send, receive and decode messages.

- *DICOM Services* are the things DICOM programs can do, e.g., send, store, look up information.

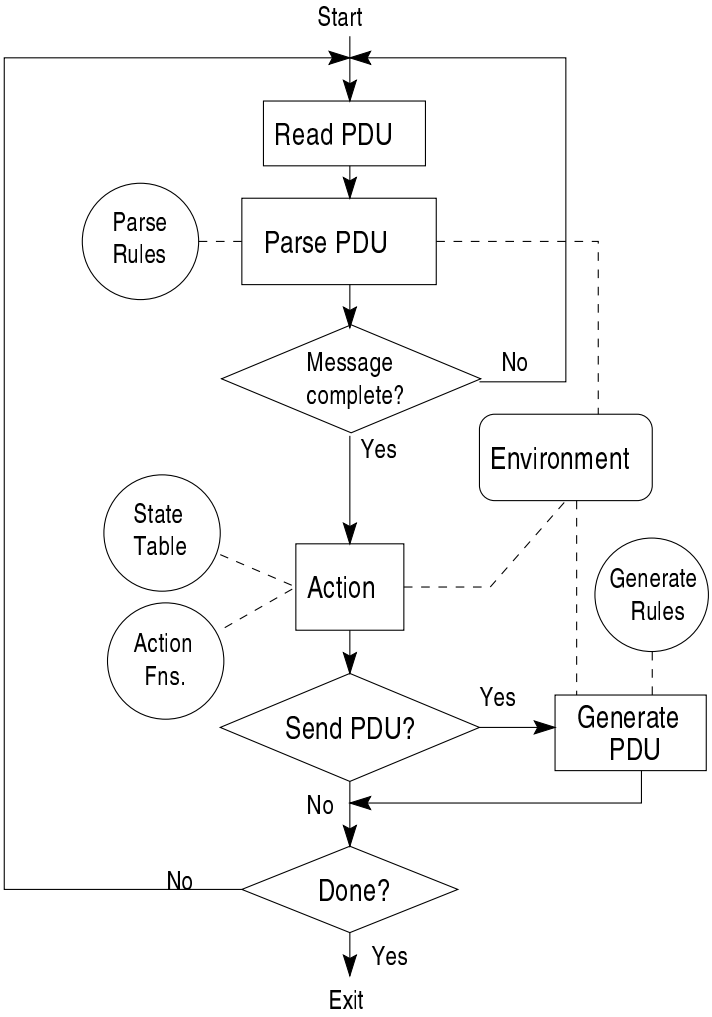
- *DICOM Objects* are the things that programs can send and receive, e.g., patient data, CT images, MR images, radiotherapy beams (DICOM-RT).

DICOM is a language

Sentence	$\Leftrightarrow$	DICOM message
Grammar	$\Leftrightarrow$	PDU structure and state table
Vocabulary	$\Leftrightarrow$	DICOM objects and services

We implemented this language with *rules* and a *generic* recursive descent parser.

DICOM parser and state machine



Parse rule for A-Associate Request PDU

```
(:A-Associate-RQ-PDU
  #x01    ;; A-Associate-RQ PDU Type tag [1 byte]
  *       ;; Reserved field -- not tested [1 byte]
  (* 4)   ;; PDU Length [4 bytes] parsed procedurally
  (>var Protocol-Version fixnum 2 :Big-Endian)
  (* 2)
  (>var Called-AE-Title string 16 :Space-Pad)
  (>var Calling-AE-Title string 16 :Space-Pad)
  (* 32)
  :Application-Context-Item-RQ/AC
  (:Repeat (1 *) :Presentation-Context-Item-RQ)
  :User-Information-Item-RQ/AC)
```

State table entry for Data Transfer state

```
(state-06

  "Association established, ready for data transfer"

  ((event-09) dt-01 state-06)

  ((event-10) dt-02 state-06)

  ((event-20) dt-03 state-06)

  ((event-21) dt-04 state-06)

  ((event-11) ar-01 state-07)

  ((event-12A event-12B) ar-02 state-08)

  ((event-16) aa-03 nil)

  ((event-17) aa-04 nil)

  ((event-15) aa-01 state-13)

  ((event-03 event-04 event-06 event-13 event-19)
       aa-08 state-13))
```

How we did it

- Wrote a specification, the Prism DICOM Server (PDS) Conformance Statement,
- Drafted a design,
- Wrote the code,
- Tested with several kinds of image data sources,
- Put into clinical use.

PDS code (May 2000)

The PDS is coded entirely in Common Lisp

- Code: 5238 lines
- Data dictionary: 1499 lines
- Rules: 1672 lines
- Total: 8409 lines

Initial experience with PDS

- Successfully tested with:
  - CTN test programs
  - Elscint CT at Soroka Medical Center, Beersheva
  - GE CT and MR at the University of Washington
  - Philips CT at Washington State University
  - Picker CT at the Seattle VA Medical Center
- Clinical implementation in December 1999
- Two errors discovered since initial implementation
- Runs as a server daemon on our HP Unix cluster

Ingredients for DICOM-RT

For a client (part of Prism):

- DICOM Upper Layer Protocol support
- DICOM-RT object definitions (add to generation rules)
- C-STORE SOP with RT objects
- Translation from Prism objects to RT objects
- User interface

For a server (e.g., for CNTS):

- DICOM Upper Layer Protocol support
- DICOM-RT object definitions (add to parse rules)
- C-STORE SOP with RT objects
- Translation from RT objects to CNTS input data
- the rest of the server support, as in PDS