Survey of DICOM Conformance Statements

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I. INTRODUCTION

Essential to selecting and purchasing DICOM equipment is the Conformance Statement, whose role and structure is strictly defined in ACR/NEMA DICOM PS3.2 [1]. The statement specifies which services are available in which roles to operate on what kinds of object in response to what real world activities, as well as choices of encoding and hardware connections. Feasibility of interconnectivity between devices is determined by matching Conformance Statements. Equipment cannot be considered to conform to the DICOM standard unless such a statement is made available.

This study aims to evaluate the availability of these statements, including their availability in electronic form, their compliance with the standard format, and the extent of services defined within them.

II. METHODS

Conformance Statements were solicited from various known equipment vendors by approaching local sales representatives, field engineers, key individuals in the DICOM field, variously by telephone, letter, electronic mail, as well as publically on the Usenet news service, over a period of six months.

When multiple statements for the same equipment were obtained, only the most recent version was evaluated. Where multiple statements or sections of statements pertained to different application entities operative simultaneously on the same device, these were considered as one statement and device.

Each statement was evaluated against the standard requirements specified in PS 3.2 [1]. Each statement was examined in detail to determine what Service Object Pair (SOP) Classes were specified and in what role as Service Class User (SCU) or Provider(SCP) or both, which Transfer Syntaxes were supported, and what limitations on Associations were present.

III. RESULTS

Thirty-nine (39) statements were obtained, 17 in paper form only and 22 in electronic form or both. Currently 15 of these are available publically on the World Wide Web or by anonymous FTP.

Table 1. Vendors and Organizations.

3M	Icon Medical	Philips
Agfa	Infimed	Picker
Algotec	Intech	Polaroid
ALI	ISG	Sectra-Imtec
Cemax	Mallinckrodt Institute	Siemens
Duke University	Merge	SMS
EMED	Mitra	UCDMC
GE	PBT	

Statements were obtained from 23 vendors and organizations listed in Table 1.

Table 2. Types of devices.

6	Gateways and convertors
13	Primary acquisition devices
4	Image archives
11	Workstations
3	Printing devices
2	Test software suites

The types of devices represented are displayed in Table 2.

All statements complied with the layout specified in PS 3.2 [1]. All statements contained sufficient information to determine the parameters being evaluated.

Only one statement indicate support for offline media as defined in PS 3.10,11 and 12 [2,3,4].

Table 3. Composite Image Storage SOP Class support.

SOP Class	SCU	SCP	Both	Total
CR	2	6	14	22
CT	9	6	17	32
MR	7	6	17	30
US (old)	2	5	12	19
US MF (old)	0	2	9	11
US (new)	0	0	0	0
US MF (new)	0	0	0	0
NM (old)	1	4	11	16
NM (new)	0	1	3	4
SC	7	5	16	28
XA Single	0	1	3	4
XA Biplane	0	0	2	2
RF	1	1	3	5
Overlay	2	0	7	9
Curve	0	0	7	7
Modality LUT	0	0	6	6
VOI LUT	0	0	6	6
Any	14	6	17	37

Support of various Composite Image Storage SOP Classes is displayed in Table 3.

Table 4. Query/Retrieve SOP Class support.

SOP Class	SCU	SCP	Both	Total
Patient Root	4	7	2	13
Get	0	4	1	5
Move	4	6	2	12
Both Get & Move	0	3	1	4
Study Root	5	10	3	18
Get	0	4	1	5
Move	5	9	3	17
Both Get & Move	0	3	1	4
Patient/Study Root	3	6	2	11
Get	0	4	0	4
Move	3	6	2	11
Both Get & Move	0	4	0	4
Any	5	10	4	19

Support of various Query/Retrieve SOP Classes is displayed in Table 4.

Table 5. Print Management Meta SOP Class support.

Meta-SOP Class	SCU	SCP	Both	Total
Gray				
Basic	4	3	2	9
Referenced	0	1	0	1
Color				
Basic	1	1	0	2
Referenced	1	1	0	2
Any	4	3	2	9

Support of various Print Management Meta SOP Classes is displayed in Table 5.

All statements indicated support for the default little endian byte order implicit value representation transfer syntax, for all presentation contexts, as is mandated by the standard. Fifteen (15) other devices variously supported either the little endian or big endian byte order explicit value representation or both. Three (3) devices supported some form of compression transfer syntax, one image server indicating support for all JPEG transfer syntaxes, another image server supporting JPEG lossless 8 bit non-hierarchical transfer syntax with any predictor, and one workstation supporting JPEG lossless 8 bit non-hierarchical with a predictor selection value of 1.

Two (2) devices supported negotiation of asynchronous windows on association establishment, 15 devices did not limit the number of associations accepted, for 8 devices this parameter was configurable, and for 6 this parameter was fixed at ranges from 4 to 20 in order to limit downgrading of performance with multiple simultaneous associations.

All network support utilized TCP/IP. No statement indicated support for OSI protocols.

IV. DISCUSSION

Though some vendors eagerly supplied Conformance Statements upon request, in other cases they were not as readily forthcoming. In some instances, statements were provided by competitors, customers in other marketing regions, or other interested parties. Several major vendors totally ignored repeated requests

at trade shows and by electronic mail and failed to provide statements directly at all.

Despite these difficulties, reasonable coverage of a large number of both major and minor vendors was obtained. European and North American vendors are well represented. Not one statement was forthcoming from a Japanese vendor.

During the survey period a request for proposals for an acquisition device indicating that bids must be accompanied by a DICOM Conformance Statement satisfying the DICOM requirements in the proposal, resulted in not one of the 5 bidders presenting such a statement, though 4 of the 5 were known to comply with the specifications.

Towards the end of the survey there was a noticeable improvement in the availability of statements, particularly in electronic form. Despite this, the awareness of the critical importance of the Conformance Statement amongst those responsible for purchasing on the consumers side, and sales on the vendors side seems remarkably low. Continuation and expansion of the major educational effort in this regard is necessary.

All the statements that were available were complete, well presented, and compliant with the requirements of the standard, though some were more informative than others particularly with regard to which type 3 attributes were supported and in what manner.

Of those statements made available, the majority were for either acquisition devices acting as composite image Storage SOP Class Users, or workstations acting as composite image Storage SOP Class Providers or both Users and Providers.

Few acquisition devices provided Query/Retrieve SCP services, nor did all workstations act as Query/Retrieve SCUs. Of those that did, the preferred service is the C-Move rather than the C-Get. Only one workstation claimed to provide C-Get as an SCU, which leaves the one image archive server that only offers C-get as an SCP with few connection options. This presumably reflects the simplicity of implementing the C-Move service on a separate association as opposed to sharing and turning around the existing association for C-Get requested C-Store sub-operations.

Only a small number statements covering Print devices was available, and not surprisingly most of these covered devices offering the Basic Grayscale Meta SOP Class as an SCP. Notably, few workstations and primary aquisition devices supported this class as an SCU, indicating that printing from these devices is for now obtained outside the context of DICOM.

No statements indicated support for the new part PS 3.13 [5] covering point-to-point communications support for printing. Whether this reflects lack of implementation or merely the immense difficulty of obtaining recently approved parts from NEMA is uncertain.

Of the statements surveyed, very few indicated support for other than the mandatory default transfer syntax. The use of alternative transfer syntaxes that don't offer compression and hence any significant performance advantage may seem pointless to most implementors. This state of affairs may change as wider support for offline file formats as described in PS 3.10 [2] is offered, since the little endian byte order explicit value representation is mandated for the File Meta-Information Header and the DICOM Directory File.

Support for JPEG transfer syntaxes seems sporadic, and in most cases confined to the lossless form of compression also utilized in the cardiac angiographic media storage application profile[4]. The author of the one server claiming to offer all defined JPEG transfer syntaxes may not have been aware that a composite image Storage SOP Class SCU and SCP storing an image offered in a compressed syntax is required to be able to translate it to the default transfer syntax to transfer it to another SCP that does not support the compressed transfer syntax, rather than merely regurgitating the stored byte stream.

In conclusion, despite the high quality of the surveyed statements, the difficulty with which they were obtained is dismaying, and indicates a need for continued education of vendors and consumers. The DICOM conformance described in the statements is largely confined to simple TCP/IP network transfer and retrieval and printing of images with minimal support of the more advanced elements of DICOM. OSI support is non-existent. Offline media seem largely ignored by all but the cardiologists.

V. ADDENDUM

More detailed and recently updated summary information outlining the services described in each Conformance Statement is always available electronically from "http://www.rahul.net/dclunie/dicom-conformance/survey.html".

VI. REFERENCES

1. ACR/NEMA DICOM PS 3.2 - Conformance.
2. ACR/NEMA DICOM PS 3.10 - Media Storage & File Format.
3. ACR/NEMA DICOM PS 3.11 - Media Storage Application Profiles.
4. ACR/NEMA DICOM PS 3.12 - Media Formats & Physical Media.
5. ACR/NEMA DICOM PS 3.13 - Print Management Point-To-Point Communication Support.