



White Paper Series

## Context Management and Tag Morphing in the Real World

Wayne T. DeJarnette, Ph.D.  
President, DeJarnette Research Systems, Inc.  
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A debate is currently raging in the medical imaging and DICOM connectivity worlds. This debate has been brought about by the recent interest in Vendor Neutral Archive products. The debate is over the need for what is referred to as “tag morphing” functionality when specifying an image archive. “Tag morphing” is the ability to retrieve an image or study from the archive in a fashion such that one or more of the DICOM elements (metadata fields) are created, deleted or manipulated to provide new value(s) for the DICOM element(s) so as to make the retrieving DICOM equipment function properly.

### ***The History of “Tag Morphing”***

The concept of “tag morphing” is more than 25 years old. It predates the existence of the DICOM standard. In the early days of digital medical imaging, it was not uncommon to want to acquire image data from modalities of different manufacturers and provide some useful processing capability for that data. Common early external applications included multi-planar reconstruction, radiation therapy planning, dental implant planning, etc.

In each application case, it was required that the image and demographic data be acquired in the modality’s native image format and converted to some “common format” for input to the processing application. Each vendor of add-on-equipment had their own “common format” for use by their application.

The ACR-NEMA<sup>1</sup> V1 and V2 standards were an attempt by the ACR to standardize on an “image transfer format” and electronic transfer protocol so that interface development for these third-party applications would be lessened. While this standardization attempt improved the situation, it did not completely eliminate the need to understand each vendor’s modality “image transfer format”. Modality vendors made use of the ACR-NEMA standard, but, due to limitations and inconsistencies of the standard, programmer error and the desire for competitive advantage among the modality manufacturers, the “ACR-NEMA format” only succeeded in decreasing the magnitude of the problem. It was still necessary that users of these modality data sets account for variances in the implementation of the standard by the various modality manufacturers. The numbers and types of variances were large. **This accounting for variances, converting from one vendor’s ACR-NEMA implementation to another vendor’s ACR-NEMA implementation was the beginning of what we today call “tag morphing”.**

The release of the DICOM<sup>2</sup> standard in September 1993 greatly improved the situation. Many of the limitations, inconsistencies and overly general specifications in the ACR-NEMA V2 standard were eliminated. There was wider vendor acceptance and commitment to the DICOM standard than there had been to the ACR-NEMA standard. All of this helped to further limit the amount of “tag morphing” required to effectively communicate between two equipment manufacturers’ equipment<sup>3</sup>. With the passage of 17 years since the standard’s release, DICOM implementations have become more consistent across manufacturers. The fact that there are now many more manufacturers making implementations has however compounded the communication problem.

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<sup>1</sup> The ACR-NEMA standard is the forerunner of today’s DICOM standard. The DICOM data transfer format is an extension of the ACR-NEMA data transfer format. The ACR-NEMA V3 standard was renamed DICOM so as to gain support for the standard outside of the U.S.

<sup>2</sup> A historical perspective of the making of the DICOM standard appeared in the article, [DICOM – The Making of a Standard](#), published in *Advance for Administrators in Radiology and Radiation Oncology* in November, 1998. A copy of this article can be found at [www.vendorneutralarchive.com](http://www.vendorneutralarchive.com) in the White Papers section of the web site.

<sup>3</sup> In the 7 year period immediately after the publication of the 1993 DICOM standard, “tag-morphing” to facilitate the interconnection of various pieces of DICOM conformant equipment was still very common. The strangest example, a major modality / PACS manufacturer as late as 2000 required a third party protocol converting gateway (another name for a DICOM “tag-morphing” engine) in order to connect DICOM conformant MR systems they manufactured to the DICOM conformant PACS they also manufactured.

The fact that more is being asked of the standard and its usage in ways never envisioned<sup>4</sup> has redoubled the communication problem.

In a perfect world where there are only perfect DICOM implementations and vendors do not have a need to innovate and improve their products<sup>5</sup>, and where customers do not have new requirements, “tag morphing” would never be necessary for the effective communication of image data sets between systems of different manufacture. We, however, don’t live in such a world and as a result, “tag morphing” is still required in many cases.

### **21<sup>st</sup> Century Real World “Tag Morphing” Examples**

The end user customer desire to share reading workload and/or patient image data between institutions and facilities with PACS products of different manufacture creates a requirement for “tag morphing”. A few easily understood examples appear below<sup>6</sup>:

- The *Patient ID* DICOM element needs to be changed when using one facility’s data at another facility. Without the facility’s correct *Patient ID* for an **existing patient**, the ingested image set will not be properly associated to the patient record. In some PACS, it is possible the ingested study will be held in QC until a manual “match” is done.
- The *Study Description* DICOM element may need to be changed so that the study hangs correctly on the PACS workstation of the ingesting institution.
- The *Accession Number* DICOM element may need to be changed to match the format of the ingesting institution’s standard format. Many institutions have coding built into the accession number, so an accession number must be formed to match the institution’s coding and then placed into the DICOM object so correct routing can take place.
- Private DICOM elements must be either removed or inserted for those PACS systems that can not handle the private elements or need specific private elements to be able to manage the data set correctly.
- The *Institution Name* DICOM element and the *Department Name* DICOM element may need to be manipulated when multiple facilities are using a single PACS/VNA<sup>7</sup>. When pre-fetching studies from the VNA, the PACS will not know which facility to send the study to unless the VNA indicates which destination the pre-fetched study is to be sent.

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<sup>4</sup> Today DICOM communication between PACS of different manufacture has replaced modality – PACS communication as the most challenging usage of the standard.

<sup>5</sup> Innovative new equipment usage frequently results in vendors defining and making use of proprietary, private DICOM elements.

<sup>6</sup> The described “tag-morphing” requirements have been found while deploying Vendor Neutral Archive and inter-PACS image data routing applications.

<sup>7</sup> VNA – Vendor Neutral Archive

Even after 17 years of DICOM experience throughout the industry, programmers still make mistakes resulting in an incorrect implementation of the standard<sup>8</sup>. A few examples follow:

- Image level DICOM elements such as *Image Laterality*, *Photometric Interpretation*, etc. may need to be manipulated to be properly displayed on a new third-party workstation or PACS. This is a frequently observed problem when migrating legacy PACS data.
- Some PACS workstations misinterpret graphic overlay data generated by other systems, making the proper display of the graphic overlay impossible without the manipulation of the data prior to being displayed.
- At least one PACS vendor requires that the DICOM element *Requested Procedure Description* be populated by the modalities with known enumerated values, consistent with a list configured into the PACS, in order to accept the study and display it. Most modalities today have the ability to include this optional DICOM element in their DICOM data sets. A problem occurs when ingesting studies from outside the institution where the *Requested Procedure Description* element may not be provided or is provided but does not correspond to one of the values in the PACS enumerated list. This DICOM element was never intended to be used in this fashion. “Tag morphing” is the tried and true solution to this problem.
- CT images archived by at least one PACS vendor cannot be displayed properly by any other PACS or workstation vendor without changing the *Pixel Representation* DICOM element in all CT images coming from the PACS.

Modality and PACS vendors continue to innovate with their products. This will sometimes result in the need to make use of private DICOM elements as no standard element has been defined for the innovated application. If the modality and PACS vendor are the same, there is generally no problem. When the PACS is replaced, frequently it will be observed that functionality pertaining to the modality is lost. Often, DICOM data manipulation can correct the problem.

Similarly, innovation sometimes leads a manufacturer to make use of a standard DICOM element in an improper fashion<sup>8</sup>. An example:

- A particular modality / PACS vendor in an older revision of software assumed that the DICOM elements, *Partial View* and *Partial View Description* in the Digital Mammography IOD could be used as enumerated fields to provide for use in display station hanging protocols. The standard clearly defined these fields as free form text, not enumerated text. As a result, the PACS could properly display mammography studies produced by their Digital Mammography product, but would improperly display the mammography images produced by other Digital Mammography modality manufacturers. A software “tag morphing” solution solved this problem until the DICOM standard caught up<sup>9</sup>.

As can be seen, there are a number of ways to get into a situation where image data sets which are sufficient for usage by a particular product (PACS or workstation) are much less useful, or in some cases useless, to another DICOM conformant system without some type of “tag morphing” or DICOM header manipulation taking place between the two systems. **The more complex the system under consideration, the more likely it is that this data manipulation capability will be required.**

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<sup>8</sup> The author’s company, DeJarnette Research Systems, Inc. is the market and technology leader in legacy PACS data migration. The company has performed more than 250 migrations between more than 40 different vendor’s PACS products. The described problems are frequently observed in legacy PACS data migrations.

<sup>9</sup> This situation ultimately led to additional DICOM elements being added to the DICOM Digital Mammography IOD, some years later.

## ***“Tag Morphing” is Insufficient – The Need for Context Management***

In common usage, “tag morphing” refers only to the manipulation of DICOM elements in a DICOM object. This manipulation can include changing an element’s value, deleting the element altogether or inserting an element which had not previously been included in the DICOM object.

For modality to workstation or modality to PACS communication, “tag morphing” is sufficient to address issues of clinical utility. This is not the case when the communicating systems are larger, such as PACS to disparate PACS for data sharing, or shared archive to multiple disparate PACS, etc. To effectively correct for differences in the clinical utility of a particular data set, you must be able to manage the entire workflow context. This includes having the ability to manipulate DICOM data sets and the ability to manipulate and communicate data passing between the various information systems, such as RIS, PACS, digital dictation, HIS, etc. This requires HL7 communication and HL7 “tag morphing” capability.

A simple example will illustrate this point. Most PACS deployed today will either not accept or will provide highly limited workflow for an image study received for which there is not a pre-existing RIS order (generally provided by means of HL7 communication). Assume that a Vendor Neutral Archive is used to share image data between a number of disparate PACS at a number of different institutions. Assume that an image data set stored by PACS A is to be reviewed by PACS B at a different institution. In order for PACS B to make maximal use of the image data set stored by PACS A, PACS B should receive a RIS order associated with the data set stored by PACS A prior to receipt of the image data set. This can be accomplished by the Vendor Neutral Archive “preparing” PACS B for receipt of the image data set by sending it the appropriate order and report (if PACS B is not doing the primary read). This, of course, requires that the Vendor Neutral Archive sees all of the communication between each PACS and RIS so that it is synchronized and can act as a synchronizing agent.

In the above example, the Vendor Neutral Archive must appropriately manipulate the stored DICOM image data set and provide the appropriate order and patient information to PACS (and perhaps local RIS as well). This is an example of required **Context Management** capability for a Vendor Neutral Archive. DICOM element manipulation is only a piece of this broader solution.

### ***Conclusion***

Whether one needs “tag morphing” or Context Management capability depends on the problem you are trying to solve. If the problem is simply to store DICOM image data from a PACS or modality, and you don’t care about the ability in the future to have these data sets be usable, without migration, by a PACS of a different manufacturer, then you have no need of either “tag morphing” or Context Management in your DICOM archive.

If, however, you want to minimize the need for archive data migration and maximize the usability of the data you are storing in the DICOM archive, then “tag morphing” is required. If you intend to share data between disparate PACS then Context Management (which includes “tag morphing”) is required of the archive. **These features are the primary distinction between a DICOM archive and a true Vendor Neutral Archive<sup>10</sup>.**

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<sup>10</sup> A Vendor Neutral Archive is more fully defined in the White Paper, *What is a Vendor Neutral Archive?* A copy of this paper can be found in the White Papers section at [www.vendoneutralarchive.com](http://www.vendoneutralarchive.com).