VNA and XDS
An appraisal of two approaches to providing multiple points of access to patient data within and across institutions
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Background

Building on the vast experience of PACS, RIS and HIS enabled by the now almost universal adoption of DICOM and HL7 in medical institutions over the last quarter century, the march toward the widespread establishment of the full-blown Electronic Medical Record (EMR), in its turn facilitated by adherence to the growing number of Integrating the Healthcare Enterprise (IHE) profiles, is continuing at a pace.

As the synergies of the full range of the technologies working together yield improved clinical outcomes in new ways and the benefits are seen to be real, the medical profession is beginning to accept that major change is both inevitable and desirable. At the same time the unprecedented speed and scale of the big data revolution of which EMR is a part challenge even the most convinced and IT-capable clinician.

Clearly, the medical profession is realizing that the paradigm is shifting away from the traditional model of clinical systems designed primarily to serve the departmental requirements to a new model of systems that provide a more rounded view of the patient to all clinicians involved. This would be alarming to the specialist if the patient-centred model did not also provide more comprehensive clinical information about the patient which, when accessed meaningfully and in a timely and integrated fashion, can lead to holistic diagnoses, more effective treatment and improved outcomes in ways that that were practically impossible with multiple discrete systems. Indeed, for this reason a unified patient record has long been one of the driving objectives in health IT for clinicians.

Key among the innovations bringing about these changes since the turn of the millennium, and increasingly over the last few years, have been the Vendor Neutral Archive (VNA) and Cross-Enterprise Document Sharing (XDS) and XDS for images (XDS-i). While the acronyms are already familiar it is easy to see how clinical professionals often find the discussion of these new, sophisticated and similar technologies bewildering, especially when it is set against the backdrop of a shifting paradigm.

This article seeks to allay some of the confusion by explaining what VNA and XDS are, identifying if and how they can work together to produce comprehensive patient information and achieve an optimized medical record and image management solution within the patient-centred EMR.
Definitions

**VNA** – an information technology that archives digital medical images with documents and files in a standards-compliant way in a central storage infrastructure that meets patient-centred clinical needs both within and across multiple medical specialties regardless of the health IT systems provider.

**XDS/XDS-i** – IHE-defined components that enable the standards-compliant sharing of digital medical documents with images and files across multiple healthcare enterprises. Operation is through federated document repositories and a document registry to create a record of information about a patient from different healthcare facilities within a given clinical affinity.

An important distinction to make at the outset is that a VNA is a technology based upon standards that provide healthcare enterprises system interoperability and data ownership through system and data format neutrality. Despite its commonly being referred to as a product, XDS is a defined set of IHE standards (actors and transactions). The XDS roles can be fulfilled by a number of applications such as PACS, VNA and e-MPI systems, or by dedicated XDS component providers.

Both VNA and XDS seek to enable access to patients’ medical records and images at multiple distributed points of access within and between enterprises.

While the differences between VNA and XDS become clear on examination, superficially these definitions sound quite similar. It would appear that VNA and XDS are two comparable solutions to a single problem.

VNA and XDS Architectures and Philosophies

Reducing the systems schematically to their fundamental elements reveals the first differences between VNA and XDS, in their topology and transactional relationships.

![Simplified topological schematic of VNA](image1)

![Simplified topological schematic of XDS](image2)

Essentially a VNA is a “middle-ware” that enables interoperability between (“front end”) clinical systems while separating the underlying hardware including the (“back end”) storage. The VNA accumulates all the images and reports into a central archive in the form of a database between the clinical workflow layer,
where the studies are produced, and the data storage layer, where they are stored on a variety of media. It is important to understand that, somewhat counter-intuitively, the VNA itself is not where the files are stored, but it is essentially a software layer of data management intelligence between the clinical and storage layers. Prior to implementation of the VNA the digital files themselves may be stored on a single platform but they are more likely to be found on different media in a variety of locations. After the VNA is installed all studies go back and forth between the clinical and storage layers directed by the VNA, indeed a VNA’s topology and its transactional relationships are virtually the same.

The primary aim of XDS/XDS-i is the sharing of medical documents and diagnostic studies between and across enterprises from where, so to speak, they lie in their dispersed locations. The organizational structure of XDS in schematic form is inherently more like a net although the embedded logical footprint of a hub-and-spoke architecture is discernible around the twin engines of the system, the XDS Registry and the XDS Repository. The registry identifies the (single or) multiple repository locations and nature of the documents therein while the XDS repositories store the documents in a transparent and consistent manner to respond to retrieval requests.

For the sake of simplicity, the XDS transactional schematic, 2b, shows only one source, one repository and one consumer. The key benefit of XDS, however, is its distributed nature, i.e. multiple sources, repositories and consumers linked through a (logically) single registry, and the reality is more like 2a. Conceptually, the XDS repository stores the documents that are made available for sharing. In reality, however, the XDS source and repository actors may be combined in a single system, again like in 2a.

Although the philosophies of VNA and XDS are quite distinct, much of the user’s experience of their functionality in accessing medical documents and image studies, at any one of a number of points, can feel similar. Indeed, both technologies work, as it were, in the background and many of the differences are not readily discernible; their powerful and sophisticated engines are hidden from view.
Case Studies

Small-scale and large-scale VNA-only and XDS-only projects have been implemented worldwide. The following examples illustrate in outline the features and functions of each.

**New South Wales (NSW), Australia – VNA-only**

Designed and implemented by the TeraMedica Division of FUJIFILM Medical Systems U.S.A., Inc. and completed December 2013, HealthShare NSW is one of the largest VNA deployments in the world. It consists of more than 150 clinical facilities and numerous disparate imaging systems organized into 15 Local Health Districts. This deployment spans across a state of over 300,000 square miles, an area comparable to the combined areas of England and France. In all, 10 different RIS/PACS systems are connected to Synapse VNA, enabling image exchange between multiple vendor PACS including GE, Siemens, Carestream as well as others. The VNA also image enables various EMRs.

Synapse VNA not only provides imaging exchange but also normalizes and translates the data through integration with a state-wide Patient Identity Registry to resolve local patient records from each district’s RIS/PACS to a single patient record.

In addition, Synapse VNA dynamically translates clinical data within the studies to match each district’s description of the data enabling local RIS/PACS to process it according to previously defined rules. For example, Synapse VNA translates procedure codes and descriptions, modality codes and body-part descriptions from the originating system’s definitions to the appropriate definition for the retrieving systems allowing each system to utilize its local hanging protocols.

Synapse VNA also creates and stores DICOM Structured Reports (SR) from an HL7 results-message received from the various EMRs and PACS systems to allow report distribution across the districts. If required, these stored DICOM SR can be used to reconstruct HL7 results messages with relevant metadata morphed for consumption by the requesting RIS/PACS. As each district uses its own RIS and EMR, this allows the reports to be easily distributed with the images without the need for providers to access other systems to view the report.

**Frysian Cardiology Network – XDS-only**

The Medical Center Leeuwarden (MCL), one of the leading cardiology centres in northern Netherlands selected XDS-based products from Forcare to implement a cardiology information exchange with four
referring hospitals in its vicinity. The XDS-based cardiology network exchanges cardiac image and related information from a variety of cardiology systems. Since each hospital maintains its own cardiac system environment XDS was chosen due to its support for distributed repositories. A central XDS Registry is used to index cardiology information that is made available by the community hospitals for review by a cardiologist in MCL. XDS has demonstrated its flexibility due to the possibility of making changes to the local cardiology (IT) infrastructure inside the hospitals without affecting the exchange of cardiac information between them.

Question – VNA or XDS or Both?

As seen above, large-scale stand-alone VNA solutions have been successfully implemented and major solo-XDS projects have been delivered to the great utility and satisfaction of the users. While these live projects prove robustly that both systems are fit for purpose, frankly speaking their existence as discrete solutions does not actually enlighten us as to whether VNA in the one case or XDS in the other is the better technology for the situation.

Given the youth of both technologies, it is not likely that the buyers of the one system were (fully) aware of the benefits of the other, or that their combination might provide an even better solution. Indeed, it is not even widely known that VNA and XDS can combine, and much less how.

This raises key questions for healthcare IT strategists: Does the full-blown deployment of the one technology make the other superfluous, or might the optimum solution be a combination of both?

The answers emerge in three steps. The evaluator must identify:

- the key features and functions of each technology
- the same or broadly similar functions
- any different functions

Paradoxically, as a starting point, a listing of the major similarities between VNA and XDS helps clarify their differences.
VNA and XDS Similarities

Both VNA and XDS:

- seek to provide the user maximum access to and utility of the medical studies and,
- hence are drivers in the move toward the EMR and Clinical Enterprise Content Management (ECM).
- provide a single point of access to all files within or across the enterprise and,
- the possibility to see and share data about a single patient from different sources.
- provide exchange of data (between departments in single institutions or across multiple institutions)
- provide support for DICOM and non-DICOM files
- allow data access controls
- can enable clinical data interoperability within a healthcare enterprise, or between multiple enterprises
- contain a high level of business intelligence
- enable centralized auditing

VNA and XDS Differences

Only VNA:

- incorporates a centralized archive for all diagnostic image studies and related reports
- provides Hierarchical Storage and Clinical Information Life-Cycle Management (ILM) in line with user-defined rules
- incorporates inherent multi-vendor PACS integration
- enables DICOM Routing and DICOM Tag Morphing
- allows data transformations based on established business rules

The primary emphases of VNA are: intelligent archiving of medical image studies, accessibility and archive neutrality with a capability to archive and view all associated patient records.

Only XDS:

- offers support for multiple federated clinical document repositories
- facilitates advanced access control, patient privacy protection and consent functions
- provides a content-agnostic infrastructure to share clinical documents
- provides medical-standards-based architecture for linking multiple XDS domains together to enable sharing across very broad areas

The primary emphases of XDS are cross-enterprise medical document sharing, content + context understanding and enabling patient access consent.
Although the systems that support them are quite different in philosophy and infrastructure, at the end-user interface some of the functions of VNA and XDS – most prominently, for example, a single point of access to all files within or across the enterprise – do in some respects overlap. At the same time there are also significant differences and some of their unique features, like Clinical Information Lifecycle Management (ILM) in VNA and patient privacy protection and consent (PPC) in XDS, are complementary.

Clearly, trans-departmental and trans-enterprise accessibility to clinical data are integral to the operation of patient-centred healthcare provided by both VNA and XDS, but the two unique functions cited above, ILM and PPC, for example, would also be highly desirable. It would be tempting, in this context, to ascertain if, for example, ILM, one of the inherently VNA functions could be grafted onto the XDS infrastructure or conversely could PPC from XDS be implemented in a VNA? It transpires, however, that the only way to have all of the different functions of both technologies is to establish a combination of VNA and XDS that we might refer to as a unified system or hybrid.

In this context users can look at their individual needs and begin to determine if one of the two technologies better meets their requirements, or if they would be better served by the hybrid.

An Optimized VNA-XDS Hybrid Solution (theoretical example)

Although some of the design criteria that form and inform VNA and XDS are the same, their logical IT infrastructures are different and inherently discrete. As illustrated above, however, it is possible to embed a VNA within an XDS framework. For this to happen, both infrastructures must co-exist and when they do each technology augments the functionality of the other.

The superimposition of XDS upon a VNA foundation creates a 2-tiered infrastructure that enables comprehensive clinical document management. This structure, which provides universal access to all clinical content, we shall call, for the purposes of the present paper, Clinical Enterprise Content Management (CECM). It is built on the dual concepts of:

- providing a standardized interface to ingest clinical document content (ie image and non-image)
- operating the standardized interfaces to index and retrieve documents

The benefit of creating a dual-tier infrastructure is built upon the concept of layering an XDS infrastructure upon a VNA architecture.
As the VNA is by definition an archive, or in other terms, a data repository (NB small "r"), it is easy to convert the VNA into an XDS Repository provided that the VNA has the inherent technology requirements. The primary difference between a VNA archive and an XDS Repository is additional metadata defined by the XDS standards and required communication transactions. As the IHE-defined XDS transactions are built upon existing IHE standards such as DICOM, WADO, HL7 and web services there is not a large gap between a full featured enterprise VNA and an XDS Repository.

In a hybrid VNA-XDS environment the VNA takes on the dual roles of XDS Document Source and XDS Repository in most instances. The data flows into the VNA which applies the necessary XDS data fields to allow it to act as the XDS repository. From there, the VNA (XDS Repository) will publish information about the data it is managing to the XDS Registry. Once the data is registered, any authorized XDS Document Consumer can retrieve it from the XDS Repository/Document Source which in this case is the VNA.

The beauty of a combined solution is that it allows the benefits provided only by a VNA such as a single centralized archive, intelligent clinical life cycle management, and data routing and translation to be combined with the standards based ingestion and distribution layers inherent to XDS. Additionally, the flexibility of the XDS standard allows the components to be mixed and matched regardless of the source of vendor of the data. All the components may be sourced from a single vendor or the VNA/XDS Image Source & Repository can be used with an existing XDS Registry and Document Consumer from a different vendor. This provides freedom from vendor-lock and allows efficient usage of IT resources to provide savings to healthcare providers.

An alternative path to creating a hybrid solution is to insert a VNA into an existing XDS infrastructure. Since an XDS infrastructure supports multiple XDS repositories the VNA can become an additional XDS Repository in the domain with multiple inputs (PACS, departmental non-DICOM sources, etc) or it can replace an existing XDS Repository or Repositories. In this case, it would typically entail migrating data from the current Repository, such as a PACS system, into the VNA allowing all the VNA benefits to be realized in addition to the XDS benefits.

**Warnings**

Numerous vendors make CECM-like claims of functionality but scrutiny almost invariably exposes inadequacies, especially in the area of universal access.

The handling of non-DICOM objects, for one, is a general and growing issue, indeed it is likely to become critical as the number of non-DICOM objects is set to increase exponentially over the next few years through the burgeoning output of specialties like endoscopy, dermatology, pathology and genomics.

Currently many PACS and VNA vendors routinely archive non-DICOM (and even some DICOM) objects using proprietary protocols. The irony here is that a VNA operating according to this logic may provide the end-user with neutrality/flexibility at the level of the clinical “front end”, i.e., what is viewed and “inserted” into the VNA, and it may allow end-users relatively conveniently to switch visualisation and workflow providers, but only to create a new technological trap in the form of objects stored in proprietary format at the “back end” or “extracted” from the storage/archive. The most insidious aspect of this trap is that it may only be discovered years later when the end-user wants to change VNA provider.

Another technique used by some PACS and VNA vendors when confronted with non-DICOM objects
is simply to apply a DICOM header to them to create a new DICOM object. This procedure, known as “DICOM-wrapping”, effectively migrates the non-DICOM object into the designated PACS archive and in so doing deprives it of its original characteristics; this practice inconveniently restricts the possibility of viewing the former non-DICOM object to a DICOM viewer or PACS workstation.

In some quarters of the profession, there is already a growing recognition of the nature-changing effect of DICOM-wrapping upon non-DICOM objects. Technologies that employ this technique are increasingly referred to, especially in Europe, as Super-PACS or PACS 2 solutions rather than VNA. It must be stated, however, that the terminology is still young and not all vendors use the terms uniformly.

All of the foregoing incongruities inevitably obfuscate the meaning of VNA and, more importantly undermine the neutrality and integrity of the technologies implemented, impacting negatively upon their utility. It is incumbent upon end-users considering VNA to ensure that clinical objects (like JPEG) and general objects (like PDF) can be stored in original format and viewed universally as well, of course, as viewing and archiving native-DICOM-objects in DICOM.

Using XDS as the standards-based interface to access all clinical content can overcome the anomaly inherent in some VNAs regarding the handling of non-DICOM content. This may be expedient in the small number of situations where the VNA exists and the end-user is seeking subsequently to introduce IHE and XDS, but if the institution is embarking on a new enterprise-wide project, it stands to reason that it would be practical. On the other hand, since XDS has its own cost, it is economical to specify a VNA solution that handles all objects in native format ex-novo.

Enter the Universal Viewer and XDS Viewer

Thus far we have considered the archiving and sharing of clinical objects and what is emerging to be the complementary nature of VNA and XDS.

In both cases, whether the technologies are implemented independently or combined into a unified solution, the clinician will need to access and view the stored and/or shared objects from multiple departments and modalities within or across institutions.

VNAs provide access through DICOM services to (DICOM) content on any system stored inside the VNA. One way to access non-DICOM content is through industry-standard web (services) interfaces or customised viewers. In many cases, all of the managed data is made accessible through the EMR via the VNA.

A preferred – many would now say indispensable – tool in both technologies is a viewer. The viewer serves as a single platform to support the access and visualisation of medical images from multiple modalities in any format – DICOM and non-DICOM – as well as reports on any computer or, increasingly, on a mobile device. In XDS this tool is the XDS viewer and it is designated, that is it functions, in XDS terminology, as a Document Consumer. In VNA the tool is called the universal viewer, and in solo-VNA implementations it is not an XDS Document Consumer but operates independently of any XDS infrastructure.

In early implementations viewers in both VNA and XDS have been used for post-diagnostic review only; it was never their purpose to substitute for the diagnostic workstations which were part of the specialty PACS. Indeed some applications embedded a link to launch the installed specialist or advanced PACS viewers when diagnostic work was to be undertaken, but the procedure never became widely adopted.
The viewer is an area where current implementations of VNA and XDS also diverge somewhat. How the clinician prefers to access, view and use studies obliged him/her to understand the differences between the XDS Viewer and the Universal Viewer and the consequences of implementing the one rather than the other solution. The user is required to make a choice, not only simply between products, but also of utility and philosophy.

In XDS, in enabling the diagnostic viewing stations to act as Document Consumers they effectively become part of the XDS infrastructure, clearly defining standards-based query and retrieve transactions to allow external XDS-enabled applications to query and retrieve documents within an XDS-based system.

While some VNA vendors offer a universal viewer, a number of them have connectivity that is proprietary to their own VNA system. Furthermore few can support non-DICOM objects natively. Fortunately, universal viewers are now available that are:

(i) completely medical standards-based, hence devoid of any proprietary connectivity, and,
(ii) they can handle DICOM as well as non-DICOM studies in original format.

These two characteristics would seem to define a truly neutral universal viewer.

The nascent acknowledgement of true neutrality in the universal viewer appears to be leading to the emergence of a de facto definitive standard while recognition of the market potential has seen the introduction of a number of powerful but truly neutral, zero-footprint, web-based universal viewers by leading third-party developers of advanced visualisation tools. Such are their augmented capabilities that end-users are now being offered universal viewers as an alternative to the existing specialty or PACS viewer.

As the awareness of VNA rises and the technology’s capability expands to manage more clinical content, one can observe a synchronous increase in the functionality of these universal viewers with the inclusion of native non-DICOM display and support for emerging standards such as WADO-RS (Web Access to DICOM Persistent Objects by RESTful Services) and QIDO-RS (Query-based on ID for DICOM Objects by RESTful Services). Another trend is the inclusion of diagnostic capabilities including multi-monitor support, hanging protocols and advanced toolsets setting the stage to build a “deconstructed model”, which allows the consumer to combine best-of-breed VNA capabilities and workflow engine with diagnostic-capable universal viewers across the enterprise.

As a general rule standard XDS viewers are used for post-diagnostic review only. However, if the diagnostic viewing stations are enabled to act as Document Consumers they will inevitably be used for diagnostic work within an XDS-based system. If the diagnostic stations are not enabled to act as XDS Document Consumers, the XDS viewer will be an additional component operating within the XDS infrastructure.

With the move to VNA-XDS hybrid-based CECM in the offing, soon it will be possible for institutions to use a third-party universal viewer to access all the clinical data from the VNA, XDS or hybrid, regardless of the format of the stored data. In adopting a third-party universal viewer users may benefit from some enhanced clinical functionality but at the same time they may lose some guaranteed VNA-XDS-PACS integration and the benefit of single-vendor support. On the credit side, however, the move will surely include XDS Document Consumer functionality in the third-party universal viewer, remove the integration obstacles and tend to “future proof” the legacy infrastructure.
Criteria for the Selection of VNA or XDS or a Combination – Some Guidelines

✓ SIZE OF PROJECT
While both VNA and XDS can successfully handle multiple-enterprise projects implemented on a giant scale, VNA architecture is more scalable downwards and better adaptable to smaller installations, and especially for solutions for multiple departments within a single institution. Even in these conditions, however, the economic viability of the project will also depend on the number of studies to be archived and the minimum critical volume above which economic benefits will accrue. XDS, on the other hand, is less impacted than VNA by the number of studies.

✓ NUMBER OF INSTITUTIONS VS NUMBER OF STUDIES
While both VNA and XDS can successfully handle projects implemented across wide-area geographies, the sharing philosophy of XDS is logically more naturally suited to multiple enterprises, and especially in situations where clinical information must be readily shared and specialist expertise and centres of excellence are widely dispersed or remote from each other. Because the philosophy of XDS is primarily based on sharing clinical data and interactive transactions rather than archiving, its utility is more related to the infrastructure (i.e. the number of entities, departments, system distribution and document types) than, for example, to the number of studies archived, which is more of a VNA parameter.

✓ ORGANISATIONAL COMPATIBILITY
Implicit within the above two criteria is a more subtle consideration. Due to the capacity of a VNA to archive centrally contrasted with the typically distributed infrastructure of XDS, a VNA tends to be designated for single enterprise projects and an XDS tends to be conceived more for multiple enterprise projects. As any senior hospital administrator can attest, practically speaking it is much easier to organise and run a project in a single enterprise than to reach consensus and co-ordinate a project of a similar scale across multiple entities. It has been known for projects to be delayed or even founder before implementation because of absence of agreement across enterprise boundaries.

✓ DIRECT BUDGET/COST-BENEFIT ANALYSIS
Although the cost of a VNA-XDS combination is higher than that of either solo option, the final figure will not be the simple sum of the two components, but considerably mitigated. For example:

• a single viewer with XDS capabilities can serve both systems, resulting in direct savings and enhanced utility

• the installation, training and maintenance costs will be rationalised; two solutions will be installed and supported, so to speak, for the price of one.

• because the contract value will be greater, the buyer will have stronger grounds for negotiation of discounts in the price of the overall supply.

• because the hybrid system can manage and distribute (share) any data types while providing data benefits such as normalization, clinical information life-cycle management and consolidated infra-structure, the purchaser will realise immediate benefits while ensuring additional systems will not need to be purchased in the future to implement with new systems or facilities.
**INDIRECT BUDGET/COST-BENEFITS**

While the financial benefits from a VNA-XDS hybrid may be found in lower total cost of ownership, its consequential savings to the end-user may be even greater. The combination of VNA and XDS is much more powerful than the simple sum of the two parts for, apart from providing more features and functions which should result in better and faster clinical outcomes, the hospital will also be able to use it as the engine for internal clinical document management. Instead of building many proprietary connections between clinical source systems and the internal EMR or HIS, the VNA+XDS layer can:

- serve as a document management infrastructure that reduces the integration complexity
- “image-enable” and “document-enable” the EMR and,
- when required, allow external access to documents.

This is a latent capability of Clinical Enterprise Content Management. By embedding CECM into the hospital’s IT infrastructure its dependency on EMR vendors (EPIC, Cerner, etc) is reduced in a way that is somehow similar to how a VNA makes a hospital less dependent on the PACS vendor. Furthermore, the burden of sophistication of the EMR can be lessened.

**NATURE OF THE SPECIALTIES WITHIN THE ENTERPRISE(S)**

DICOM is now almost universally established in radiology, but this is not the case in other specialties and many clinical documents are produced in a non-DICOM format. The greater the number of specialties to be incorporated into the combined archive of the institutions or the multiple institutions, the more likely it is that it will include many non-DICOM formats. If, as is probable, the hospital wishes to archive all its clinical content, DICOM and non-DICOM, in a standards-compliant manner, it has a choice. It can:

- select a VNA that archives and retrieves in a standards-compliant manner in native format according to IHE profiles, or,
- use an XDS Repository/Registry (with accompanying capture and conversion mechanisms), or,
- opt for a VNA-XDS hybrid and clinical Enterprise Content Management

In any implementation, the specifier must carefully consider workflows for clinical object storage. This factor is most critical in Option 2 as XDS support by source system is still rare and using an XDS Repository/Registry necessitates the capture and conversion of the objects to the XDS format. As technologies develop and mature generally this may change but with presently available versions of XDS components, at least as regards archiving in native file-format, it may be simpler for the purchaser to select option 1 or 3.

**LEVEL OF EXISTING STANDARDS ADOPTION AND UNDERSTANDING**

As evidenced in various government initiatives in the USA (ONC, CONNECT, HITSP, Meaningful Use etc), in Canada (Infoway) and Europe (epSOS) IHE is becoming widely adopted at an incredible pace because of the focus on interoperability. VNA and XDS drive the adoption of standards-based interoperability.

**EXISTING INSTITUTIONAL CULTURE**

Healthcare institutions vary in their receptivity to new technologies. In the fields of VNA and XDS there are even regional cultural differences. In Europe, where healthcare is broadly state owned and run and competition is less relevant, sharing is much more palatable. In the USA where much of healthcare is provided by private
institutions, institutional ownership of the clinical data in the shape of a VNA may be more appealing. In any case, both VNA and XDS can provide benefits whether working independently or in combination.

**AVAILABILITY / SIGNIFICANCE OF E-MPI**
Both VNA and XDS need e-MPI to function in the cross-enterprise scenario and potential adopters must be sure to specify a technology that is or can be integrated with the e-MPI operated by the enterprises. By contrast, within the intra-enterprise situation the presence or absence of an e-MPI is not a real issue as both the technologies will interface with the patient index system of the single enterprise.

**ANY OTHER CONSIDERATIONS?**
Information Governance policies such as HIPAA, XDS, ATNA, XUA, BPPC etc are all pieces in this puzzle.

**Conclusions**
As advances in technology create new possibilities, healthcare enterprises, whether privately held or state supported, will be perennially driven by the dual obligations to provide improved patient-centred care together with greater administrative efficiency. VNA and XDS are relatively recent developments in healthcare IT that can help achieve these two seemingly divergent objectives; in other words produce better clinical outcomes for less.

Is one of these two technologies superior to the other? Apparently not, simply because VNA and XDS do similar but not the same jobs. There is inherently no basis to favour one technology over the other, but individual situations may determine which one is the more suitable.

The first responsibility of the decision maker is to know the hospital's current and anticipated needs and so to specify economically the most appropriate solution. Clearly, only an informed assessment of the respective functions of the alternatives can determine the greater suitability of the one solution or the other or their combination in a given context.

The writer's aim here has been merely to flag some of the relative merits of VNA and XDS and their combination and to equip interested parties with some of the right questions to put to their would-be suppliers.

While the list may not be exhaustive, some of the key knowledge to acquire before making a decision may be evinced by the guidelines given above.

The potential buyer should also tread warily along any technological path the leads to a point of no return, or, at least, toward a trap from which it is difficult to escape. Now, more than ever, technologies need to be future-proof, as far as that is technically possible.

In the emerging world of exponentially increasing, multiple format clinical objects and images, the healthcare IT strategist must choose a solution that is infinitely scalable, facilitates interoperability, that is not beholden or limited to a single format – even the venerable DICOM – and puts the power of clinical data ownership back in the hands of the institution in the service of the patient at the centre of enterprise.
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