TECHNICAL WHITE PAPER

The Vendor Neutral Archive

Principles, benefits and the G4PACS implementation

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Document control

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Executive summary

A hospital's imaging archive outlives every viewer, every workstation and usually every PACS vendor it will ever buy. A Vendor Neutral Archive (VNA) separates the long-term storage of images and documents from the applications that create and display them, so that the archive can stay in place while everything around it changes.

This paper explains what makes an archive genuinely vendor neutral, why hospitals move to one, what to look for when evaluating a VNA, and how the G4PACS Archive & VNA implements these principles on-premise, in the cloud, or in a hybrid deployment. It closes with a migration approach and a capacity planning example.

- **Neutrality is about formats and interfaces, not marketing.** Data stored in standard DICOM objects, reachable through DICOM, DICOMweb, HL7 and FHIR, and exportable in bulk without the vendor's help.
- **The archive is the system of record.** Viewers, workstations and AI tools read from it and write to it, but none of them own the data.
- **Lifecycle management lives in the archive.** Retention, tiering, legal holds and purging are policies of the archive, not features of a viewer.
- **Migration happens once.** A VNA absorbs the archives of departmental systems in the background, then makes future replacements a matter of pointing a new application at the same data.

1. What a Vendor Neutral Archive is

1.1 Definition

A Vendor Neutral Archive is a medical image and document repository that stores objects in standard formats, exposes them through standard interfaces, and is designed to be used by clinical applications from any vendor. The term contrasts with the archive component of a traditional PACS, which is typically usable only through that PACS vendor's own viewer and tooling.

1.2 Archive of a PACS versus VNA

Aspect	Archive inside a traditional PACS	Vendor Neutral Archive
Storage format	Often proprietary or vendor-modified DICOM; private compression	Standard DICOM objects; standard transfer syntaxes only
Access	The vendor's viewer and tools	DICOM, DICOMweb, HL7, FHIR from any application
Scope	Radiology (sometimes cardiology)	Enterprise: radiology, cardiology, pathology, dermatology, endoscopy, documents
Patient identity	Tied to one RIS	Reconciled across departments and facilities
Lifecycle	Manual, per study	Policy based: retention, tiering, legal hold, purge
Replacing the viewer	Requires migrating the archive	Point the new viewer at the same archive
Exit	Vendor-assisted export, months, extra cost	Bulk export in standard formats at any time

1.3 The standards that make neutrality possible

Standard	Role in a VNA
DICOM (PS3)	Object format, Storage, Query/Retrieve, Modality Worklist, Storage Commitment
DICOMweb (QIDO-RS, WADO-RS, STOW-RS)	RESTful query, retrieve and store for web viewers, portals and AI services
HL7 v2 (ADT, ORM, ORU)	Patient demographics, orders and reports from RIS and HIS
HL7 FHIR (ImagingStudy, Patient, DiagnosticReport)	Modern resource-based integration with EHRs and applications
IHE profiles (XDS-I.b, PIX/PDQ, IOCM, SWF)	Cross-enterprise sharing, patient identity reconciliation, image object change management
Encapsulated PDF/CDA, VL, WSI SOP classes	Non-radiology content stored as DICOM objects

2. Why hospitals adopt a VNA

2.1 Freedom to change applications

The average life of a PACS viewer is five to seven years; the retention obligation for images is often ten years, and for paediatric or oncology cases much longer. With the archive decoupled, a hospital can replace or add viewers, reporting tools and AI applications without touching the data or negotiating a migration with the outgoing vendor.

2.2 One archive for the enterprise

Cardiology, pathology, dermatology, ophthalmology, endoscopy and wound care all produce images. A VNA gives them a single, governed store with common retention rules and one patient index, instead of departmental silos with their own backups, contracts and security reviews.

2.3 Consolidation across sites

Hospital groups inherit several PACS through mergers. A VNA lets each site keep its modalities and workflows while the images converge into one archive with reconciled patient identities, so a radiologist at any site sees the full history.

2.4 Lifecycle and cost control

Most of an archive is rarely opened: in a typical hospital more than 80% of studies are older than two years and are accessed a few times a year at most. A VNA applies policies that keep recent studies on fast storage and move older ones to cheaper tiers, purges what may legally be purged, and preserves what must be kept.

2.5 Resilience and disaster recovery

Because the archive is independent of the applications, it can be replicated to a second site or a cloud region on its own schedule, and any standards-based viewer can be used to read from the replica if the primary is lost.

What a VNA does not do. A VNA is not a viewer, a worklist or a reporting system. It also does not make a hospital independent of standards work: patient identity reconciliation and consistent DICOM tagging still need to be designed. A good VNA provides the tools for that; it does not remove the need for it.

3. Evaluating a VNA: what to look for

Criterion	Question to ask	Why it matters
Format neutrality	Are objects stored exactly as received, in standard DICOM with standard transfer syntaxes?	Proprietary changes make export and migration lossy or impossible.
Interface neutrality	Are DICOM, DICOMweb, HL7 and FHIR all first-class, documented and unlicensed?	Every application, present and future, connects through these.
Bulk export	Can the hospital export the whole archive itself, in standard formats, without the vendor?	The exit clause is only real if the export is real.
Identity management	How are patient identities reconciled across RIS, HIS and sites?	One archive is only useful if one patient is one patient.
Lifecycle policies	Can retention, tiering, legal hold and purge be defined per site, modality, age and body part?	Cost control and regulatory compliance depend on it.
Deployment choice	On-premise, cloud and hybrid, with the same software and the same data model?	Requirements change; the archive should not have to.
Non-DICOM content	How are PDFs, videos, photographs and pathology slides handled?	Enterprise imaging is more than radiology.
Security	Encryption at rest and in transit, single sign-on, complete audit trail?	Patient data protection and HIPAA/GDPR obligations.
Migration tooling	Is background migration with validation part of the product?	Migration is the largest risk in any archive project.

4. The G4PACS Archive & VNA

4.1 Architecture

The G4PACS Archive & VNA is the system of record of every G4PACS installation and can equally serve third-party viewers, workstations and AI services. It is organised in four layers:

Layer	Function	Implementation
Ingestion	Receives objects from modalities, PACS, workstations and applications	DICOM C-STORE, DICOMweb STOW-RS, HL7 and FHIR feeds; validation and normalisation of tags without altering pixel data
Index	Patient, study, series and instance metadata; identity reconciliation; audit	Relational index with full DICOM tag coverage; PIX-style patient linking across sites
Storage tiers	Where the objects live	Tier 1: local NVMe cache for recent studies. Tier 2: S3-compatible object storage, on-premise or in the cloud, for long-term retention and disaster recovery
Services	How applications reach the data	DICOM SCP/SCU, DICOMweb (QIDO-RS, WADO-RS, STOW-RS), HL7 v2, FHIR; routing to remote readers and AI

4.2 Format neutrality

Objects are stored as received. The archive never re-encodes pixel data and never adds private attributes. Any transcoding needed for display is performed by the viewing component at retrieval time and is not written back. The full list of accepted SOP classes and transfer syntaxes is published in the *DICOM Conformance Statement* (G4-DCS-040), which is regenerated with every release.

4.3 Interface neutrality

- **DICOM:** Verification, Storage, Query/Retrieve (Patient Root and Study Root), Modality Worklist, as SCP and SCU.
- **DICOMweb:** QIDO-RS, WADO-RS and STOW-RS, so browser-based viewers and cloud applications need no DICOM stack.

- **HL7 v2:** ADT, ORM and ORU messages from RIS and HIS; **FHIR:** ImagingStudy, Patient and DiagnosticReport resources.
- **Bulk export:** an administrator can export any selection of studies, or the whole archive, as standard DICOM files with a manifest, to local storage or to an S3 bucket, without assistance from G4 Medical Systems.

4.4 Information lifecycle management

Policies are defined by the administrator and applied continuously by the archive:

Policy	Example
Tiering	Keep studies on the NVMe tier for 24 months after the last access, then hold them only on object storage
Retention	Adults: 10 years after the study date. Paediatric: until the patient's 25th birthday. Mammography: 15 years
Legal hold	Studies referenced in a litigation request are frozen regardless of retention rules
Purge	Studies past retention are listed for review and deleted only after approval, with an audit record
Replication	Every object is replicated to the cloud region within 15 minutes of ingestion; verified by checksum

4.5 Deployment options

Deployment	Tier 1 (recent studies)	Tier 2 (long-term)	Best for
On-premise	Hospital data centre	Hospital object storage	Strict data residency, limited bandwidth
Cloud	G4PACS cloud region	G4PACS cloud region	Imaging centres and clinics without IT staff
Hybrid	Hospital data centre	Cloud region chosen by the hospital	Most hospitals: local speed, cloud economics, built-in disaster recovery

The same software and the same data model are used in all three, so a hospital can start on-premise and add the cloud tier later, or the reverse, without a migration.

4.6 Security and compliance

- AES-256 encryption at rest on both tiers; TLS 1.3 for every interface; DICOM TLS available per node.
- Single sign-on with SAML 2.0 and OpenID Connect; role-based access with break-glass access logged.
- A complete audit trail of every access, export, policy action and configuration change, exportable for HIPAA and GDPR reviews.
- Data stays in the region selected at installation; no cross-region copies are made without configuration by the hospital.

5. Migrating to the VNA

5.1 Approach

Migration runs in the background while the existing systems stay in use. The archive pulls studies from the legacy system with DICOM Query/Retrieve (or ingests an export), validates each object by checksum and tag comparison, reconciles patient identities against the master patient index, and records every decision. Clinical users notice nothing until the cut-over, when viewers are pointed at the new archive.

Phase	Activities	Typical duration
1. Assessment	Inventory of studies, modalities and SOP classes; identity quality analysis; retention rules	2 to 4 weeks
2. Pilot	Migrate one modality or one year; validate with radiologists; tune tag normalisation	2 to 3 weeks
3. Bulk migration	Newest studies first, then older years; runs at night and off-peak; continuous validation	Weeks to months depending on volume and legacy system speed
4. Cut-over	Modalities and viewers repointed; legacy system read-only	1 day per site

Phase	Activities	Typical duration
5. Decommission	Final delta migration; certificate of completeness; legacy storage released	2 weeks

5.2 Validation

Every migrated instance is compared with its source by SOP Instance UID, size and checksum; study and series counts are reconciled per patient; a sample of studies from each modality and year is opened by a radiologist. Discrepancies are listed with their cause (missing in source, corrupt object, identity conflict) for resolution before the legacy system is decommissioned.

6. Capacity planning example

A 400-bed hospital with radiology, cardiology and a small pathology service. Volumes are typical values and should be replaced with the hospital's own statistics.

Source	Studies per year	Average size	Volume per year
CT	28 000	250 MB	7.0 TB
MR	12 000	150 MB	1.8 TB
DR / CR	60 000	30 MB	1.8 TB
Mammography incl. tomosynthesis	8 000	1.2 GB	9.6 TB
Ultrasound	25 000	60 MB	1.5 TB
Cardiology (cath, echo)	6 000	600 MB	3.6 TB
Pathology whole-slide (pilot)	2 000	1.5 GB	3.0 TB
Documents, video, photographs	-	-	0.5 TB
Total			**28.8 TB per year**

Tier	Sizing rule	Result
Tier 1, NVMe	Last 24 months plus 20% headroom	70 TB usable
Tier 2, object storage	Full retention (10 years) with replication	290 TB, growing 29 TB per year
Legacy migration	Existing archive to be absorbed	Add current archive size to tier 2

Object storage is priced per terabyte-month; keeping only the recent two years on fast local disks is what makes the hybrid model cost less than either a full on-premise or a full cloud archive.

7. Conclusion

A Vendor Neutral Archive turns the imaging archive from a component of a vendor's product into an asset of the hospital. The test of neutrality is practical: standard formats, standard interfaces, self-service export, and lifecycle policies that belong to the archive. The G4PACS Archive & VNA is built on these principles and runs the same way on-premise, in the cloud and in the hybrid deployment most hospitals choose.

To discuss an assessment of your archive, contact sales@g4pacs.com or request a demonstration at www.g4pacs.com.

Appendix A. Glossary

Term	Meaning
DICOM	Digital Imaging and Communications in Medicine; the standard format and protocol for medical images
DICOMweb	The RESTful web services of DICOM: QIDO-RS (query), WADO-RS (retrieve), STOW-RS (store)
FHIR	Fast Healthcare Interoperability Resources; HL7's resource-based standard for health data exchange
IHE	Integrating the Healthcare Enterprise; profiles that specify how standards are used together
ILM	Information Lifecycle Management: tiering, retention, legal hold and purge policies
MPI	Master Patient Index; the reference list of patient identities across systems
PACS	Picture Archiving and Communication System
S3-compatible	Object storage that uses the Amazon S3 API, available from many vendors and clouds
SOP class	A DICOM object type, for example CT Image Storage
Transfer syntax	The encoding of a DICOM object, including its compression
VNA	Vendor Neutral Archive