Enabling Siemens medical imaging applications on IBM Storwize V7000 and Storwize V7000 Unified systems

Maximizing clinical and healthcare benefits

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August 2015

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Abstract

Clinical practices, worldwide are using high-resolution mobile devices, advanced digital-imaging technologies, and intelligent software-engineering solutions to deliver better quality healthcare on smaller financial budgets with improved collaborative workflow efficiencies and reduced time to diagnosis. IBM has now partnered with Siemens Healthcare to bring validated medical archive solutions to combine Siemens medical imaging applications with smart IBM storage. This joint solution maximizes the clinical benefits with faster medical decisions facilitated with advanced visualization capabilities. Clinicians and medical specialties can now look beyond a typical picture archiving and communication system (PACS), magnetic resonance imaging (MRI), and computed tomography (CT) images to achieve fast and accurate diagnosis to dispense advisory and interventional remedies with vascular, tissue, molecular, differentiation contrasts, and alternative treatment options.

This paper describes how IBM Storwize V7000 and IBM Storwize V7000 Unified systems (independently) work with the Siemens medical imaging applications to deliver a robust, scalable, easy-to-use solution. As tested, this solution is well suited for any medical environment that processes 200,000 annual studies per year to over 4 million annual studies per year. The performance, virtualization, availability, and scalability capabilities for all Siemens imaging applications are easily supported on these IBM storage systems for a small radiologist office, a radiology department, or a large hospital network.

Introduction: Siemens medical imaging applications

Siemens Healthcare offers the following three PACS software for diagnostic and radiologic applications in a clinical and medical environment. These three applications are outlined and described in this section.

- **syngo.via**
- **syngo Imaging**
- **syngo.plaza**

### Siemens syngo.via application, version VA11A (or later)

In modern healthcare, clinical images play an essential role in diagnosing diseases and to justify, apply, and monitor the appropriate treatment protocol. The new version VA11A (at the time of this publication) of Siemens syngo.via addresses these needs, allowing a clinician to diagnose cases and share results easily. syngo.via now supports even more imaging modalities with the recent increase in the number of specialized clinical applications.

Cancer is a threat to the entire human body. Interdisciplinary imaging studies [such as CT, magnetic resonance (MR), and positron emission tomography (PET) scans] are now routinely used in oncology diagnostic evaluations. With increasing patient numbers and data volumes, a clinician cannot afford to waste time searching for the right patient, prior studies, or the right tools. Typical radiology information system (RIS) and PACS workplaces are often limited to basic 2D or 3D image display and are not designed for quantitative hybrid follow-up reading. syngo.via helps a clinician to master these challenges. It supports a multimodality approach, offers comprehensive advanced tools for the entire workflow, reflects and creates the necessary data flows, enables efficient follow-up comparisons, and provides interfaces that allow the clinician to focus on the right diagnosis and rapid treatment for their patients.
syngo.via can be used as a stand-alone application or together with a variety of software options (syngo.via engines). The syngo.via engines are fine-tuned software application bundles that consist of a set of syngo.via software applications dedicated to a specific clinical field or diagnostic procedure. Optional engines are available for cardiology, oncology, and neurology. Additionally, other engines for CT and MR scans offer a multi-disciplinary platform to deliver hybrid, multi-modality diagnostic capabilities, such as molecular imaging, detailed filtered tissue characterization, automated bone removal information, integration of precise PET and CT or MR quantified and volumetric metrics for precision surgery and interventional procedures, automated Response Evaluation Criteria in Solid Tumors (RECIST) calculations, dynamic review of native or subtracted scenes with contrast differentiation, vessel analysis everywhere, digital subtraction angiography (DSA) post-processing, remasking, pixel shifting, and many additional benefits for cardiology, oncology, neurology, and other specialties.

**Siemens syngo.via solution benefits at a glance:**

- Decreases report turnaround time and reduces costs because of increased reading efficiency
- Facilitates fast and easy collaborative sharing of images with colleagues and patients anywhere
- Expands business cases with a significantly increased number of clinical applications and broader multimodality support
- Finds older images of patients automatically and combines and displays data from a variety of sources rapidly
- Integrates PACS seamlessly from any major vendor
- Integrates advanced visualization software efficiently with pre-existing PACS in a single workstation
- Incorporates advanced visualization into radiology workflow to increase diagnostic confidence and improve surgical planning
- Enables easy access to syngo.via from any computer located on a hospital network, through its client/server architecture.
- Facilitates automated and managed updates in real time due to centralized image processing on the syngo.via server.

**Siemens syngo Imaging application, version VB36C (or later)**

Siemens syngo Imaging application provides advanced PACS functionality with benefits, such as accelerated workflow, powerful archiving, and centralized and secured data access to current and previous exams.

**Greater speed**

Siemens syngo Imaging and its fast Siemens proprietary transfer protocol help to save significant time in accessing images from almost any reading or viewing workplace, provided, the Internet connection to the clinical network is active, Digital Imaging and Communications in Medicine (DICOM) compliance is followed, and the minimum hardware and software requirements are met, and local data security regulations are adhered to. Besides addressing common Integrating the Healthcare Enterprise (IHE) and...
common hierarchical query requests, syngo Imaging also provides relational query, even for complex searches.

**Data security even when working outside the hospital network**

Images and data can be safely transferred inside or outside the virtual private network (VPN) through the Internet or the intranet, and by complying with security rules and protocols. The Siemens syngo Imaging WebAccess feature addresses complex administration of firewalls for workplaces outside the hospital domain, and makes an easy choice for cloud deployments.

**Efficient administration**

Siemens syngo Imaging user-management functions allow an administrator to automatically align with the existing user management of the hospitals. Time and administration efforts can be saved as user accounts and security rules are managed only once. Siemens syngo Imaging system-monitoring functions continuously monitor the entire system, and automatically reacts to the occurrence of any errors in the system.

**Easy installation and integration**

Siemens syngo Imaging ensures a fast and easy installation without an administrator or super-user rights. It complies with the global medical standards (such as DICOM, HL7, HIPAA, and others) that are commonly accepted.

Key benefits include:

- Personalized tools and display layouts to match individual preferences
- Navigation across studies and series
- Computer-aided design (CAD) support
- Role-based access to quality assurance (QA) functions
- Encapsulated PDF viewer

**Siemens syngo.plaza application, version VA20D (or later)**

Siemens syngo.plaza is the new agile PACS solution for the clinical routine. It is the first PACS from Siemens that supports 2D, 3D, and 4D image reading. It includes features to display, process, read, report, communicate, distribute, store, and archive digital medical images. It supports the physician in diagnosis and treatment planning. It also supports DICOM structured reports. In a comprehensive imaging suite, syngo.plaza integrates with hospital information system (HIS) and RIS to enable customer-specific workflows. syngo.plaza can be scaled in an extendable and modular way from a stand-alone workstation to an enterprise scenario. syngo.plaza offers multiple solutions ranging from dedicated to shared image storage, from a single to multiple archives, from a small radiologist office to an enterprise imaging solution. The functionality of syngo.plaza can be extended by several advanced post-processing features and applications. syngo.plaza is ideally adapted for integration with syngo.via to address:
• **Case-specific reading**: *syngo.plaza* features a single-application feeling for the cases that can be routine or complex in 2D, 3D, or 4D. Patient launching requires only a single click, no matter which application is needed. *syngo.plaza* automatically loads the patient into a preconfigured and individually defined mode, according to case complexity.

• **Intuitive user interface**: Through the consistent and intuitive user interface, the look and feel is the same for 2D, 3D, and 4D reading, at any reading and modality workplace. *syngo.plaza* is ideal for integration with *syngo.via*. The exchange of data and information between *syngo.plaza* and *syngo.via* is performed using DICOM protocols. The clinician can apply *syngo.via* on the *syngo.plaza* workplace if additional steps are further required to facilitate advanced post-processing on certain images. The images are automatically prepared in advance in *syngo.via* and shown in the appropriate application and in the appropriate layout. The relevant post-processing steps can be performed immediately. Figure 1 provides a simplistic overview of the interaction of different healthcare information systems with *syngo.plaza*.

![Diagram of healthcare information systems interaction](image)

*Figure 1: Interaction of different healthcare information systems with *syngo.via* and *syngo.plaza**

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Enumeration from Figure 1:

- **1 – Modality:** Various modalities, other DICOM nodes, and syngo.via communicate with syngo.plaza through the DICOM interface.
- **2 – HL7 interface:** The HL7 interface of syngo.plaza permits a two-way exchange of HL7 messages between syngo.plaza and the HIS or RIS. syngo.plaza can be called directly from a HIS or RIS. syngo.plaza provides an interface for image call-up for this front-end integration.
- **3 – Automatic launch with syngo.via:** With the selection of an examination, syngo.plaza can trigger the workflow-supported image processing in syngo.via, through DICOM protocols.
- **4 – Other clinical systems:** If syngo.plaza is installed together with syngo.via, both applications communicate using the DICOM interface with other systems, such as electronic medical record (EMR), computerized physician order entry (CPOE) and so on, (for image transfer) and the file interface (for example, to exchange study instance IDs).
- **5 – DICOM archive:** syngo.plaza uses the DICOM archive to facilitate short-term storage, and for syngo.via and its own long-term storage requirements. This archive is the repository of all images, in support of the radiology environment.

In summary, syngo.plaza receives symptom-specific, DICOM-structured reports back from RIS / PACS / syngo.via workplaces. The modified images from the new clinical consultations are stored temporarily in syngo.via (short-term storage images). They are then, sent to syngo.plaza (long-term storage) for archiving. syngo.plaza reports the acknowledgment of the completion of successful archiving of the images back to syngo.via, as a DICOM storage commitment.
Introduction: IBM Storwize V7000 and Storwize V7000 Unified systems

This section provides introduction and highlights the IBM® Storwize® V7000 and Storwize V7000 Unified systems.

IBM Storwize V7000 Unified and IBM Storwize V7000 are virtualized, enterprise-class storage systems that provide the foundation for implementing an effective storage infrastructure and transforming the economics of data storage. These systems are highly scalable virtualized, flash optimized storage systems designed to consolidate workloads into a single system for ease of management, easy installation, reduced costs, superior performance and high availability.

Designed for software-defined environments, the IBM Storwize family includes the latest technologies that both complement and enhance virtual environments, as well as built-in functions such as industry-first hardware accelerated IBM Real-time Compression™, they can reduce the cost of storage by up to half while maintaining application performance. They are designed to deliver outstanding efficiency, ease of use and dependability for organizations of all sizes. Illustrated benefits, as follows:

- **Hardware-accelerated Real-time Compression** reduces storage acquisition costs up to half by using up to 80% less disk and flash capacity.
- **High-performance thin provisioning** simplifies and automates storage deployment for all workloads.
- **Clustered systems** provides the ability for block systems to both scale up and out for performance and capacity.
- **IBM Active Cloud Engine®** enables highly efficient policy-based management of files to reduce costs through the use of tiered storage (Storwize V7000 Unified only). IBM Active Cloud Engine creates a common namespace access to globally distributed files, quickly and cost-effectively. The scalability is not limited to a single data center. As a cloud feature, it allows multiple sites to participate in fast information exchange, while still owning their own data. The files can reside in any data center, and can be accessible from anywhere.
- **Remote mirroring** protects data while optimizing network bandwidth to help reduce costs.
- **IP replication** reduces remote mirroring costs with innovative network optimization.
IBM Storwize V7000: SAN configurations, tests, and results

An IBM Storwize V7000 system was tested with Siemens syngo Imaging, (version VB36). The connectivity between the Storwize V7000 system, and the Siemens syngo Imaging application server was configured as a storage area network (SAN)-attached configuration (as shown in Figure 2).

Figure 2: SAN-attached Storwize V7000 configuration with syngo Imaging application

Test results

Various tests with the SAN-attached configuration were successfully completed, and validated that:

- Siemens syngo Imaging and the IBM Storwize V7000 system can co-exist easily without any extra coding or specialty application programming interfaces (APIs).
- As tested, the joint solution specified conservatively handles 100,000 to 500,000 annual radiological studies per year, and the solution is easily scalable to sustain even larger annual image volumes.
- The application performance, virtualization, availability, and scalability capabilities are easily supported for a small radiologist office, a radiology department, or a large hospital network.
Planning information and best practice recommendations

This section provides specific instructions, planning information, and useful documentation that can help in proper planning, systems assurance, and successful installation of Siemens Imaging Applications with the Storwize V7000 or the Storwize V7000 Unified system.

The following information can help in successful planning and implementation of an IBM Storwize V7000 Unified system in your environment.

IBM Storwize V7000 Unified Knowledge Center:
ibm.com/support/knowledgecenter/ST5Q4U/landing/v7000_unified_welcome.htm

- This IBM Storwize V7000 Unified Knowledge Center is a useful link, and it contains all of the documented information that is required to set up the Storwize V7000 hardware and manage the system using its web-based management GUI and its command-line interface (CLI).
- At the time of this publication, the latest version of IBM Storwize V7000 Unified Version is marked 1.5.2 Knowledge Center and dated May 25, 2015
- When you begin your planning, make sure that you are using the most recent documentation, and the latest version of the software.

IBM Storwize V7000 Unified library and related publications:
ibm.com/support/knowledgecenter/ST5Q4U_1.5.2/com.ibm.storwize.v7000.unified.152.doc/mlt_relatedinf o_224agr.html?cp=ST5Q4U%2F0-11

- Make sure to review the applicable publications and documents identified in Table 2: Storwize V7000 Unified Library, (at: ibm.com/support/knowledgecenter/ST5Q4U_1.5.2/com.ibm.storwize.v7000.unified.152.doc/mlt_relatedinfo_224agr.html?cp=ST5Q4U%2F0-11)
- Download Implementing the IBM Storwize V7000 Unified Disk System from IBM Redbooks® at: ibm.com/redbooks/redpieces/abstracts/sg248010.html
- Pay attention to understand the product. There are a number of learning modules and tutorials.

Best practice guides

You can refer to the following best practices guides for more details.

- Asynchronous Replication for IBM Storwize V7000 Unified - ibm.com/support/docview.wss?uid=ssg1S7004539
- Performance for IBM Storwize V7000 Unified - ibm.com/support/docview.wss?uid=ssg1S7004532

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- Performance Recommendations for Disk Alignment using Microsoft® Windows® - ibm.com/support/docview.wss?uid=ssg1S1003291
- Compressed filesystem configuration on Storwize V7000 Unified - ibm.com/support/docview.wss?uid=ssg1S1004566
- Managing authentication and ID mapping - ibm.com/support/knowledgecenter/ST5Q4U_1.5.0/com.ibm.storwize.v7000.unified.150.doc/mng_auth_srv_topic_welcome.html (Found in Knowledge Center and supersedes earlier Authentication Best Practice document)

Planning requirements

This system requires good planning to ensure that it delivers maximum performance for many years to come. The following recommendations are offered:

1. Ensure that the required worksheets and checklists (hardware, software, network, configurations, planning, and so on to add the file modules) are completed before starting the installation steps.
2. Use the Capacity Magic and Disk Magic tools to plan out the storage capacity logical unit numbers (LUNs) and validate performance requirements of specific volumes, and so on.
   - The Capacity Magic tool determines the configuration for the required storage capacity based on input data, adding buffer for metadata, snapshots, and so on. Refer to: ibm.com/partnerworld/wps/servlet/ContentHandler/SSPQ048068H83479I86
   - The Disk Magic tool helps verify that performance requirements can be met with the system configuration determined with the Capacity Magic tool by adjusting drive types, Redundant Array of Independent Disks (RAID) levels, and the number of drives required accordingly. Refer to: ibm.com/partnerworld/wps/servlet/ContentHandler/SSPQ048068H83479I86
3. When adding Storwize V7000 Unified file modules to an existing Storwize V7000 system, it is essential that you review and complete the tables in the guide entitled: Adding Storwize V7000 Unified File modules to an Existing Storwize V7000 System (book number: SC27-4223-03) in IBM Pubs at: ibm.com/support/knowledgecenter/api/content/nl/en-us/ST5Q4U_1.4.2/com.ibm.storwize.v7000.unified.142.doc/ifsv7k_bkmap_installing.pdf
4. When using these tools, be sure to have the latest versions.
5. Validate that you have all required planning information and perform a Technical Delivery Assessment (TDA). Complete the checklists as these can help in validating the planned setup and environment. You can find the documentation and checklists at the following URLs: IBMers can refer to ibm.com/support/assure/assur30i.nsf/WebIndex/SA986 Business Partners can refer to ibm.com/partnerworld/wps/servlet/ContentHandler/salib_SA986
6. Have this information validated by IBM SMEs and architects before starting the installation.
7. Perform hardware installation planning: Validate required cables, connectors, network cards, location, layout, floor space, rack layout, power, and cooling and so on.
8. Define and validate the environment and services: IP addresses, existing Network Time Protocol (NTP) servers and IP addresses, existing DNS servers and IP addresses, domains, authentication
servers, net group ID and mapping support, backup servers, method chosen, IBM Tivoli® Storage Manager – hierarchical storage management (HSM) servers, and storage, if required, AntiVirus scan engines, and so on. These servers should be available and pre-exist in the common network.

9. Plan for system implementation:
   - Define the local and remote storage area network (SAN) zoning requirements (if needed).
   - Define the network requirements for management and data access
   - Define the network interfaces of Storwize V7000 and file modules, including subnets and virtual LANs (VLANs)
   - Define the logical configuration of the system (both file and block access)
   - Define the pools and LUN layout for block access
   - Define the pools, exports / shares, file systems, file sets, and directory structures.

10. Define the users required for the management and monitoring roles of the Storwize V7000 Unified itself and for file-based access requiring authentication. Configure them within the authentication service/directory server.

11. Plan for the user ID mapping method (external/mixed).

12. Define the authorizations required for every file access user within the file system, file set, and directory structures.

Additional references to aid planning efforts
   - Interoperability support pages for Storwize V7000 Unified: [ibm.com/support/docview.wss?uid=ssg1S1004679#_AV](http://ibm.com/support/docview.wss?uid=ssg1S1004679#_AV)
   - Configuration limits and restrictions: [ibm.com/support/docview.wss?uid=ssg1S1004680](http://ibm.com/support/docview.wss?uid=ssg1S1004680)
   - The general ‘Limitations’ section in IBM Knowledge Center is very useful as preparation for the planning and implementation decisions: [ibm.com/support/knowledgecenter/search/limitations?scope=ST5Q4U_1.5.0&lang=en](http://ibm.com/support/knowledgecenter/search/limitations?scope=ST5Q4U_1.5.0&lang=en)

Checkpoints for security authentication
   - Decide which implementation of security authentication service will be used.
   - The Storwize V7000 Unified supports only one authentication method at a time and changing it later is not recommended. Therefore, it is important to carefully decide and select the method up-front.

Implementation

The installation, implementation, and configuration tasks are grouped into major steps of the installation processes. Each step is performed sequentially and in most cases, must be completed before the next step can begin.

- Follow the implementation task checklist.
- Unpack, rack, and cable hardware.
- Conduct power-on self-test (POST) and self-checks
- Validate license keys, licenses, and install the latest software.
- Initialize the system.
- Perform base configuration.
- Perform manual set up and configuration changes.
- Plan and configure networking.

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- Set up alerting and call-home capabilities.
- Set up directory services and security authentication services
- Run health check of system.
- Define user security functions and access privileges.
- Configure storage controller and logical disks
- Configure antivirus capabilities.
- File services configuration and use.

**Lessons learned:** Some may not apply to your system or environment, but it is not a bad idea to have them validated with IBM teams in case of any questions:

- Make sure to download and use the correct version of the Storwize V7000 Unified software configuration guide before you start your Storwize V7000 Unified planning and installation efforts.
- Save all your TDA documents and the completed software configuration guide for easy reference at a later date.
- Save a physical copy of these completed documents in the rack / cabinet of the Storwize V7000 installed system.
- It is absolutely necessary to have a completed, verified, and validated TDA worksheet before starting any Storwize V7000 Unified installation. More eyes during the TDA and planning processes are definitely helpful, and this effort catches more errors in the planning stage before the actual installation. This diligence prevents wrong assumptions, incorrect planning, configuration errors, and other issues.
- Storwize V7000 Unified is a complicated system with its built-in intelligence. It does not tolerate any inefficiency that pre-exists in a client network. It requires a certain level of network preparedness before use.

**Training services:** In-house instructors from IBM authorized partners such as Arrow, Avnet, Ingram Micro, LearnQuest, and Global Knowledge companies, periodically deliver relevant education workshops worldwide for understanding, recommending, sizing, and implementing IBM Storwize V7000 and Storwize V7000 Unified systems. These workshops are typically four-days long. Specific information on workshop details, timings, locations and more is available at the following URL:


The following workshops for the IBM Storwize V7000 systems are recommended.

- SSG0G: IBM Storwize V7000 Unified implementation workshop
- SSE1G: IBM Storwize V7000 implementation workshop

**Storwize V7000 Unified shipments**

Make sure that all required cables, cards, disks, and components are available and have been validated, cross checked, and inventoried with the packing lists enclosed with the shipment.
Siemens and IBM solution delivery recommendations

To ensure a smooth installation of the complete clinical imaging application solution using Siemens syngo.via or the complete Radiology Image Management Application using syngo.plaza or syngo Imaging applications, this section offers the following recommendations and best practices:

- Recommended minimum system requirements
- Recommended file systems layout best practices
- Recommended storage sizing matrix for Siemens imaging applications

Recommended minimum system requirements for Siemens medical imaging applications

Siemens syngo.via, syngo.plaza, or syngo Imaging applications run on specific server configurations to meet customer requirements of scalability. All these applications are reliable, stable, and easy to manage. They can be integrated into popular Microsoft and Citrix environments. Server sizing and server load are also dependent on the footprint of these applications in client environments. Additionally, the annual growth of numbers of examinations and resulting data volume should be considered for mid- and long-term planning. You can consult with your Siemens sales representative for detailed server and client configurations.

File systems layout: Best practice recommendations

In strict terms of storage, a distinction is made between short-term online storage and long-term archive storage as follows:

- Short-term storage: New images sent from the modality to syngo.plaza are registered in the database and stored in the short-term storage. The short-term storage has a limited storage capacity, but allows direct access to the images, for example, during image post processing and reporting. Images can be archived there for 3 to 12 months.
- Long-term storage: Images are copied from the short-term storage to the long-term storage based on specific rules. This step is the actual archiving. The long-term storage provides a very large storage capacity. Images can be archived there for many years.

IBM Storwize V7000 and Storwize V7000 Unified systems fulfill the following requirements of electronic archiving systems, as outlined by syngo Imaging, syngo.via and syngo.plaza:

- Long-term storage of the images
- Access to short-term storage with SAN and Common Internet File System (CIFS) protocols
- Access to long-term storage with CIFS protocols
- Quick access to all archived images (independent of the time of archiving)
- Database-supported image management, based on metadata
- Long-term readability of the images by compliance with the DICOM standard
- Support of DICOM migration procedures

Enabling Siemens medical imaging applications on IBM Storwize V7000 and Storwize V7000 Unified systems
Message exchange with other information systems

For improved performance in a normal and a typical production environment, lay out the file systems for syngo Imaging, syngo.via, and syngo.plaza as per the following guidelines and best practice recommendations.

- Short-term storage supports the use of SAN storage or NAS storage with CIFS mount point.
- Long-term storage supports the use of SAN storage, NAS storage with CIFS mount point, and externally virtualized storage systems.
- The IBM Storwize V7000 system easily supports short-term storage and long-term storage through SAN capabilities, and also offers tiered storage capabilities such as multiple types and sizes of drives, enhanced performance with solid-state drives (SSDs), improved efficiencies with its built-in virtualization capabilities, and real time data compression.
- The IBM Storwize V7000 Unified system can simultaneously support short-term storage and long-term storage through the simultaneous use of SAN and NAS capabilities.
- Siemens syngo Imaging, syngo.via, and syngo.plaza PACS applications support multiple mount points for NAS archiving to:
  - Increase the archive capacity
  - Enable two copies of image data on different NAS locations (for every NAS location, a backup location can be configured)
  - Support rule-based archiving to several NAS locations (for example, all CT and MR images are archived at location A and all other images are archived at location B).
- Create the file system on the Storwize V7000 Unified system by using the cluster method of creating block-allocation maps to achieve a uniform disk performance across all storage capacities.
- Create the file system on the Storwize V7000 Unified system by using the logfileplacement value as striped to stripe the log file of the file system across all metadata disks.
- Recommend using the block size of 256 KB for both, short-term storage and long-term storage.
- As a best practice, run all Windows servers with dual 10 GbE bonded network channel connections, with MTU=9000. This best practice applies to any Windows server running Siemens syngo Imaging, syngo.via, or syngo.plaza applications.

**Networking Connectivity Guidelines**

As a best practice, run all Siemens imaging servers with dual 10 GbE bonded network channel connections, with MTU=9000. If networking with virtual machines (VMs), the physical hosts must be set up with MTU=9000. Also be sure to configure the virtual switch ports to MTU=9000, if configuring with VMware. The default values of the virtual switch come with MTU=1500, and leaving it at MTU=1500, can cause implementation issues, such as repeated retransmissions of patient studies, longer job durations, increased network packet drops, and other issues.
The Siemens Imaging Application Services are unconstrained to the physical medium over which TCP/IP message traffic is carried. An equipment list and configuration information for the physical media supported is available upon request.

### Siemens medical imaging modalities and storage sizing guidelines

<table>
<thead>
<tr>
<th>No.</th>
<th>Modality (Refer to the Glossary for definitions)</th>
<th>Images per study</th>
<th>MB per image</th>
<th>MB per study</th>
<th>Annual Studies (est)</th>
<th>Estimated storage (1 year) (TB)</th>
<th>Estimated storage (3 years) (TB)</th>
<th>Estimated storage (5 years) (TB)</th>
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</thead>
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<td>1</td>
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<td>4</td>
<td>8.39</td>
<td>34</td>
<td>200,000</td>
<td>7</td>
<td>20</td>
<td>34</td>
</tr>
<tr>
<td>2</td>
<td>CR (Mammo)</td>
<td>6</td>
<td>56</td>
<td>336</td>
<td>200,000</td>
<td>67</td>
<td>202</td>
<td>336</td>
</tr>
<tr>
<td>3</td>
<td>CT-Conventional</td>
<td>100</td>
<td>0.52</td>
<td>52</td>
<td>200,000</td>
<td>10</td>
<td>31</td>
<td>52</td>
</tr>
<tr>
<td>4</td>
<td>CT-64 slice</td>
<td>5800</td>
<td>0.14</td>
<td>812</td>
<td>200,000</td>
<td>162</td>
<td>487</td>
<td>812</td>
</tr>
<tr>
<td>5</td>
<td>MR-Conventional</td>
<td>200</td>
<td>0.52</td>
<td>104</td>
<td>200,000</td>
<td>21</td>
<td>62</td>
<td>104</td>
</tr>
<tr>
<td>6</td>
<td>MR (advanced)</td>
<td>3000</td>
<td>0.52</td>
<td>1560</td>
<td>200,000</td>
<td>312</td>
<td>936</td>
<td>1560</td>
</tr>
<tr>
<td>7</td>
<td>US-multiframe</td>
<td>50</td>
<td>1.44</td>
<td>72</td>
<td>200,000</td>
<td>14</td>
<td>43</td>
<td>72</td>
</tr>
<tr>
<td>8</td>
<td>XA-cardio</td>
<td>24</td>
<td>14.67</td>
<td>352</td>
<td>200,000</td>
<td>70</td>
<td>211</td>
<td>352</td>
</tr>
<tr>
<td>9</td>
<td>FD-thorax</td>
<td>2</td>
<td>19.48</td>
<td>39</td>
<td>200,000</td>
<td>8</td>
<td>23</td>
<td>39</td>
</tr>
</tbody>
</table>

Table 1: Siemens imaging modalities and storage sizing guidelines

Assumptions:

- Decimal values have been rounded to the nearest integer value.
- Storage values are computed using marketing terabytes, and not engineering terabytes
  - 1 marketing terabyte = 1000 marketing gigabytes (not 1024 GB)
  - 1 marketing gigabyte = 1000 marketing megabytes (not 1024 MB)
- Storage numbers based on raw storage computations.
- Compression capabilities are not assumed in the computations.
- RAID protection is not assumed in these computations. Depending on the specific RAID protection required, these estimates need to be increased appropriately. (Some clients prefer RAID-5, and some clients might prefer RAID-6).
- IBM Storwize V7000 system specifications are available at: ibm.com/systems/storage/disk/storwize_v7000/specifications.html

### IBM solution sizing recommendations for a range of annual studies

The earlier section highlighted the typical storage requirements based on a combination of specific imaging modalities considered for any clinical environment.

Considering the total number of annual studies of a healthcare institution with all its different modalities, an additional level of estimation that ties the entire Siemens and IBM solution together in a most practical and a cost-effective way is required. Refer to Table 2.
Table 2: IBM solution sizing recommendations for a range of annual studies

<table>
<thead>
<tr>
<th>No.</th>
<th>Estimated MB per study</th>
<th>Annual studies</th>
<th>Estimated storage (1 year) (TB)</th>
<th>Estimated storage (3 years) (TB)</th>
<th>Estimated storage (5 years) (TB)</th>
<th>Recommended storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>300</td>
<td>200,000</td>
<td>60</td>
<td>180</td>
<td>300</td>
<td>IBM Storwize V7000</td>
</tr>
<tr>
<td>2</td>
<td>300</td>
<td>500,000</td>
<td>150</td>
<td>450</td>
<td>750</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>300</td>
<td>1,000,000</td>
<td>300</td>
<td>900</td>
<td>1500</td>
<td>Storwize V7000 Unified</td>
</tr>
<tr>
<td>4</td>
<td>300</td>
<td>1,500,000</td>
<td>450</td>
<td>1350</td>
<td>2250</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>300</td>
<td>2,000,000</td>
<td>600</td>
<td>1800</td>
<td>3000</td>
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</tr>
<tr>
<td>6</td>
<td>300</td>
<td>2,500,000</td>
<td>750</td>
<td>2250</td>
<td>3750</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>300</td>
<td>3,000,000</td>
<td>900</td>
<td>2700</td>
<td>4500</td>
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<td>3,500,000</td>
<td>1050</td>
<td>3150</td>
<td>5250</td>
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</tr>
<tr>
<td>9</td>
<td>300</td>
<td>4,000,000</td>
<td>1200</td>
<td>3600</td>
<td>6000</td>
<td></td>
</tr>
</tbody>
</table>

Assumptions:

- Decimal values have been rounded to the nearest integer value.
- Storage values are computed using marketing terabytes, and not engineering terabytes.
- 1 marketing terabyte = 1000 marketing gigabytes (not 1024 GB)
- 1 marketing gigabyte = 1000 marketing megabytes (not 1024 MB)
- Storage numbers based on raw storage computations.
- All numbers are estimated numbers.
- Servers can be clustered to meet more stringent client requirements. Siemens syngo Imaging, syngo.via, and syngo.plaza imaging applications support single or clustered server configurations.
- Paired or clustered servers are always recommended for high availability.
- A pair of two Siemens syngo Imaging, syngo.via, and syngo.plaza servers is recommended for high availability up to 2 million annual studies.
- While this typical sizing table offers a range from 200,000 annual studies to 4 million annual studies, the authors believe that it is easy to compute the estimated storage requirement for a new clinical office with entirely different modalities.
- For example, if a radiology group only does CR studies, but processes 100,000 annual estimated studies, then, extrapolate from Table 1 by using the following computations and round out the decimals to the nearest integer:
  - Storage for 1 year = 100,000 x (MB per study) = 3 TB
  - Storage for 3 years = 100,000 x (MB per study) = 10 TB
  - Storage for 5 years = 100,000 x (MB per study) = 17 TB
- As another example, if a certain clinical practice uses a different modality, this is generally, how the computational estimates are calculated:
  - Annual studies processed by the clinical practice = X studies
  - Approximate number of images per study = Y images/study
  - Approximate size of each image = Z MB/image.
- Computed total storage required/study = \( Y \times Z \)
- Estimated 1 year storage requirement = \( X \times Y \times Z / (1000 \times 1000) \) terabytes
- Estimated 3 year storage requirement = \( 3 \times X \times Y \times Z / (1000 \times 1000) \) terabytes
- Estimated 5 year storage requirement = \( 5 \times X \times Y \times Z / (1000 \times 1000) \) terabytes

- While Table 2 provides approximate estimates, it offers a good starting point for further discussions on fine tuning the estimated requirements of a specific clinical situation or a potential opportunity.

**Solution benefits: With IBM Storwize V7000 and Storwize V7000 Unified systems**

IBM Storwize V7000 and Storwize V7000 Unified storage systems offer the following significant benefits for healthcare clients running Siemens syngo Imaging, syngo.via, and syngo.plaza PACS imaging applications in CIFS environments.

- Simplifies administration by consolidating short-term storage and long-term storage into a single system.
- Delivers improved performance by delivering multithreaded I/O through different interface node IP addresses, simultaneously.
- Both systems easily support data migration, data archiving, and data prefetching capabilities with built-in features that are already included in Siemens syngo Imaging, syngo.via, and syngo.plaza software applications.

Based on these benefits, the IBM Storwize V7000 and IBM Storwize V7000 Unified systems offer flexible and scalable choices to easily support different use cases for a healthcare environment. These use cases can easily range, from a single small radiology office to a radiology department in a single hospital or a collection of different radiology and nuclear medicine modalities under a large hospital system network.

**Summary**

This paper documents that IBM Storwize V7000 and IBM Storwize V7000 Unified systems work (independently) with the Siemens Imaging Applications to deliver a robust, scalable, easy-to-use and deploy solution. As tested, this solution is well suited for any medical environment that processes 200,000 annual studies per year to over 4 million annual studies per year. The performance, virtualization, availability and scalability capabilities for all Siemens imaging applications are easily supported, for a small radiologist office, a radiology department, or a large hospital network.
Acknowledgments

Special thanks to the Siemens teams in Germany and US for loaning the environment in their data centers that enabled the IBM test team to create an operational test environment and run tests to document real life results.

Many thanks to the IBM client executives, IBM Systems and Technology Group members, and other team members who contributed with their recommendations during the test run and review process and enabled successful completion and validation so that Siemens syngo.via and syngo.plaza software applications can run successfully over SAN and NAS environments facilitated by IBM Storwize V7000 and Storwize V7000 Unified systems.

Appendixes: Use-case scenarios

These appendixes outline various use cases using different solutions built with IBM Storwize V7000 and IBM Storwize V7000 Unified systems.

These different use cases outline different imaging capabilities as evidenced typically by a small radiologist office, a large radiology department in a single hospital, or a large RIS system that consists of multiple radiology departments situated in a hospital network.

These validated solutions have been successfully tested to work optimally with Siemens syngo.via, syngo.plaza, or syngo Imaging applications in all healthcare client environments.
Appendix 1: Use case: Single radiology practice

Use-case scenario
There are two modalities (CR and CT) generating about 5 GB of image data per day. Approximately 20,000 examinations are performed annually. Refer to Figure 3.

System configuration
This is a central system configuration with one shared database. Three reporting workplaces (clients) and a number of client workstations or image viewing are set up. Some of these client workstations are local to the network. Some of the additional client workstations are set up as web clients. The central server maintains the database, and also acts as a web server for remote clients.

Enabling Siemens medical imaging applications on IBM Storwize V7000 and Storwize V7000 Unified systems
Additionally, the following solution details are outlined:

- The server is designed in such a way that the images can be stored in the short-term storage for six to twelve months, and in the long-term storage for storing images longer than twelve months.
- The archive is SAN storage.
- Access to image data is controlled by user rights also for web viewing.
- The storage recommended is IBM Storwize V7000 that acts as a short-term storage and as a long-time archive.
- IBM Storwize V7000 is either direct-attached to the server or SAN-attached to the server.
- For short-term storage requirements, a RAID 10 configuration is recommended with 10000 rpm drives.
- For long-term storage requirements, a RAID 5 disk configuration is recommended with 7200 rpm drives.

Workflow:

- New images of all modalities are sent to one server.
- The clients are not assigned to a certain modality.
Appendix 2: Use case: Radiology services with clustered failover

Use-case scenario

There are five modalities generating about 20 GB of image data per day. Approximately 100,000 examinations are performed annually.

To address this workload, and for this use case, an IBM Storwize V7000 Unified system can be configured and set up with Microsoft Windows servers running Siemens syngo.via (version VA11A), and syngo.plaza (version VA20D) applications. The required file systems and medical imaging data resides on the IBM Storwize V7000 Unified system. It is easily made available to the syngo.via (version VA11A), and syngo.plaza (version VA20D) applications as CIFS shares over the network, as shown in Error! Reference source not found..

![Diagram of NAS (CIFS) attached IBM Storwize V7000 Unified configuration with syngo.plaza and syngo.via servers]

Figure 4: NAS (CIFS) attached IBM Storwize V7000 Unified configuration with syngo.plaza and syngo.via servers
A full-fledged deployment, including modalities, is represented in Figure 3. Note that the Storwize V7000 Unified system is connected to the server cluster as a NAS device, being accessed with the CIFS protocol, and through 10 GbE ports. The following list provides the additional highlights of this solution deployment model.

- The shares are exported from the Storwize V7000 Unified system using CIFS protocols.
- In terms of network security, Active Directory (AD) security services is configured on the network. The Storwize V7000 Unified system is configured to be a member of the AD services, and the same Domain Name Services (DNS) as the client Microsoft Windows 2008 virtual machines on their network.

Figure 3: Radiology solutions with a clustered failover and with external public Internet access through the firewall
System configuration

- In order to achieve increased system availability, two *syngo*.plaza servers are clustered in a centralized data center location.
- Each server is configured with the Microsoft Cluster Service (MSCS) to monitor the processes on both servers and initiate switch over to the fully functional server in the event of failure. One common database is configured for both servers.
- Several client workplaces are set up.
- Each separate web server allows for up to 100 concurrent viewing users over LAN and WAN.
- With a firewall, referring physicians or specialists outside the medical institution can be connected.

Additionally, the following solution details are outlined:

- The servers are designed in such a way that images can be stored in the short-term storage for three to six months, and long-term storage for storing images longer than six months.
- The archive is NAS storage.
- Access to image data is controlled by user rights also for web viewing.
- The storage is recommended as IBM Storwize V7000 that acts as a short-term storage, and a long-term storage archive.
- For short-term storage requirements, a RAID 10 configuration is recommended with 10 k drives.
- For long-term storage requirements, a RAID 5 disk configuration is recommended with 7.2 k drives.

Workflow

- New images of all modalities are sent to the server cluster.
- IBM Storwize V7000 Unified serves as NAS storage and is used as the archive.
- The archive is connected to *syngo*.plaza through a CIFS mount point.
- All reporting and viewing users access the central database.
Appendix 3: Use case: Large radiology department in a hospital

Use-case scenario

There are several state-of-the-art modalities generating about 50 GB of image data per day. As many as 250,000 or more examinations are performed every year. Refer to Figure 4.

Figure 4: An illustration of a large radiology department supporting many state-of-art modalities for exploratory, diagnostic, and interventional imaging options
System configuration

- To process a very large number of examinations quickly, a server farm is installed with four application servers.
- Five modalities are connected to each application server.
- If an application server fails, the modalities connected to this server can send their image data to another intact application server. In this way, no image data is lost and image processing can be continued without interruption.
- The central server is connected to all four application servers and two web servers. It controls the access of the clients and web clients to the stored image data.
- Fifteen concurrent reporting workplaces (clients) are connected to the server farm. Two web servers allow for up to 200 concurrent viewing users over the Ethernet network.

Additionally, the following solution details are outlined:

- The servers are designed in such a way that images can be stored in the short-term storage for about three months, and long-term storage for storing images longer than three months.
- The archive is NAS storage, configured as two separate IBM Storwize V7000 Unified systems.
- The first Storwize V7000 Unified system acts as the short-term storage. The second IBM Storwize V7000 Unified system acts as the long-term storage.
- Access to image data is controlled by user rights also for web viewing.

Workflow

- Each modality transmits its images to one connected application server. There, the images are stored locally. At the same time, the metadata that is required for access to these images is stored on the central server.
- Each connected client and web client can load all images that are stored centrally in the server farm. The central server controls access to all the images.
- Two IBM Storwize V7000 Unified systems connected through CIFS mount points are used as the archive.
- For a failover solution, two central servers can be clustered together.
Appendix 4: Use case: Multiple radiology departments in a hospital network

Use-case scenario

Multiple syngo.plaza systems in different radiology departments can form a shared multi-PACS system. As many as 1,000,000 or more examinations are performed every year. Combined with an institution-wide RIS, this configuration provides a solution that can cover the entire radiology workflow in large hospitals with different radiology departments, as shown in Figure 5.

Figure 5: Multiple radiology departments in a hospital network
System configuration

- In this example, the multi-PACS system consists of two *syngo*.plaza systems in two different radiology departments A and B.
- Each PACS system consists of one server farm.
- The RIS is connected to both PACS systems and controls the patient data for both PACS systems.

Additionally, the following solution details are outlined:

- The servers are designed so that images can be stored in the short-term storage for less than three months, and long-term storage for storing images longer than six months.
- The short-term storage archive is recommended as IBM Storwize V7000 Unified.
- The long-term storage archive is recommended as a second IBM Storwize V7000 Unified.
- Access to image data is controlled by user rights also for web viewing.
- For short-term storage requirements, a RAID 10 configuration is recommended with 10 k drives.
- For long-term storage requirements, a RAID 5 disk configuration is recommended with 7.2 k drives.

Workflow

- Orders for new radiological examinations and appointments for these examinations are registered in the RIS.
- This information is transmitted to the modalities as DICOM worklist.
- After the examination, the images are transmitted to the *syngo*.plaza server and reported at the integrated reporting workplaces.
- At these workplaces, physicians concurrently use the RIS application and the PACS application.
- The images are archived in the appropriate departmental PACS and the reports are stored in a central RIS.
- Physicians can access the images of the other department over the DICOM Query Spanning. The *Query Spanning* functionality means that patient images can be queried and retrieved from several DICOM nodes in one step, using DICOM Query / Retrieve. In this way, a local query can be extended to a global query. The prefetching of patient images can be combined with the *Query Spanning* functionality. In the configuration tool, the administrator sets up a PC as a *query gateway* and defines the data sources to be simultaneously queried by this PC. In this way, prior patient images can be prefetched from multiple archives and automatically forwarded to a destination node.
- By means of suitable rules, the images are fetched during low-load periods and stored in the PACS of the local department. Subsequently, the data can be quickly accessed.
Glossary

**Active Directory (AD)** – Is the Microsoft implementation of an X.500 directory service that stores information about a network’s resources.

**Computer-aided design (CAD)** – Working in the background and acting as a DICOM node, syngo CAD manager supports multiple CAD applications, automatically recognizes the study type, applies the algorithm, and automatically routes the results to the correct destination.

**Common Internet File System (CIFS)** – An Internet file system protocol, based on Microsoft Server Message Block. CIFS is intended to complement existing protocols such as HTTP, FTP, and NFS.

**CR** – Computed radiography system for imaging. Also used for mammography.

**CT** – Computed tomography system for imaging. CT was earlier called computerized axial tomography. It is a radiographic technique that produces an image of a detailed cross section of tissue. CT uses a narrowly collimated beam of X-rays that rotates in a full arc around the patient to image the body in cross-sectional slices. An array of detectors, positioned at several angles, records those X-rays that pass through the body. The image is created by a computer that uses multiple attenuation readings taken around the periphery of the body part. The computer calculates tissue absorption and produces a representation of the tissues that demonstrates the densities of the various structures. Tumor masses, infarctions, bone displacement, and accumulations of fluid can be detected. For cardiological examination, ultrafast CT is electrocardiogram-triggered and this allows visualization of cardiac function and blood flow.

**Digital Imaging and Communication in Medicine (DICOM)** – Is a worldwide standard for exchanging patient images and data. It enables the exchange of images and data between heterogeneous information systems and various imaging and image producing and processing devices (modalities).

**Electronic medical record (EMR)** – Is the digital form of the patient record containing all clinical and part of the administrative information of a patient (such as name, stay in hospital, diagnosis, treatments, and so).

**Fibre Channel (FC)** – A standard protocol from the area of storage networking. Copper cables and fiber-optic cables are used as the transmission media. Access to the hard disks is block-based.

**Flat-panel detector (FD) technology** – Instead of X-ray films, these are amorphous silicon-based digital plates that capture the images, as beamed from the X-ray machine. The system also enables technologists to review exposures instantly to make sure that they are acceptable. It is a process that can take several minutes with a conventional X-ray unit. After a procedure has been completed, the study can be sent to a PACS through DICOM storage class connections.

**Gigabit per second (Gbps)** – A dimension for data transfer rate.

**Health Level 7 (HL7)** – A standard for the exchange, management, and integration of electronic healthcare information.

**Integrating the Healthcare Enterprise (IHE)** – An initiative by users and companies to achieve maximum interoperability of the digital information systems used in health services. The basis for this is the integration of the profiles that are based on the working procedures actually followed in radiology. You can find further information about IHE at: www.ihe.net.
Hospital information system (HIS) – A central data processing system for processing medical and administrative data in a hospital.

Long-term storage – A storage medium for long-term storage or archiving images. Tape archives and jukeboxes are frequently used for this.

Mount point – A mount point (/mnt) is the point within a directory structure at which a data medium or a file system from the network is mounted.

Multiframe – A multiframe consists of a series of frames. The individual frames are stored as sandwich stacks in a single multiframe image file. A multiframe uses only a single DICOM header for all frames. The processing and evaluation of multiframe images is possible in syngo.plaza without any restrictions.

Network-attached storage (NAS) – A mass storage unit attached to the local network for expanding the memory capacity. A NAS can have its own hard disk storage or can be attached to a storage area network (SAN). Data communication is performed at file level.

Picture archiving and communication system (PACS) – A system consisting of several components for digital storage, distribution, and display of images.

Redundant Array of Independent Disks (RAID) – A system that stores data redundantly on more than one hard disk. RAID systems always consist of several hard disks. They can be configured to enhance both system performance and data security. There are various RAID levels (0, 1, 2, 3, 4, 5, and so on), which differ in the manner of interaction of the hard disks.

Radiology information system (RIS) – A system for the radiology department that takes care of patient administration, documentation, acknowledgment of services, and the writing of reports (for example, syngo workflow).

Storage area network (SAN) – In a SAN, several servers can be connected to several storage systems. FC cables are used for transmission. The SAN provides storage capacity at block level.

Small Computer Systems Interface (SCSI) – A standardized parallel interface for data transmission between devices on a PC bus.

Solid-state drive (SSD) – In systems and applications, refers to an electronic memory storage.

Short-term storage – Is based on storage technologies and connections that allow fast access to image data. Typically, a RAID system that is connected directly to the server is used as short-term storage.

Transmission Control Protocol/Internet Protocol (TCP/IP) – TCP/IP is the communication protocol for the Internet. TCP/IP defines the rule that computers must follow to communicate with each other over the Internet.

TWAIN – A standard for data exchange between image input devices (scanners, digital cameras) and programs for Microsoft Windows. An image processing program equipped with a TWAIN interface can receive data from any image input device that provides adequate support of this procedure.

Virtual private network (VPN) – A network that uses a public telecommunication infrastructure, such as the Internet, to provide remote offices or individual users with secure access to their organization’s network.
Resources

The following websites provide useful references to supplement the information contained in this paper:

- Siemens Medical Portal
  http://www.medical.siemens.com

- Siemens Healthcare Portal
  http://www.siemens.com/healthcare

- Siemens syngo.plaza : Software Version 20A and higher system description guide
  Contact Siemens Medical Portal (http://www.medical.siemens.com) for a recent copy of this guide.

- Siemens syngo.imaging XS: Simple, smart, affordable – the compact PACS solution document
  Contact Siemens Medical Portal (http://www.medical.siemens.com) for a recent copy of this guide.

- Siemens syngo.via. Images, my way. Efficiency and Ease-of-Use, Anywhere
  www.usa.siemens.com/syngo.via

- syngo.via Server and Client Technical Configuration Details

- TWAIN
  http://en.wikipedia.org/wiki/TWAIN

- IBM Redbooks
  ibm.com/redbooks

- IBM Publications Center

- IBM Storwize V7000 Introduction and Implementation Guide [SG247938]
  ibm.com/redbooks/redpieces/abstracts/sg247938.html?Open
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