EPIC EHR: BUILDING HIGH AVAILABILITY INFRASTRUCTURES
BEST PRACTICES FOR PROTECTING EPIC EHR ENVIRONMENTS

EMC HEALTHCARE GROUP

ABSTRACT

Epic Electronic Health Records (EHR) is at the core of delivering quality patient care and maintaining efficient health system operations. While ensuring high availability this vital application environment is critical, the Epic EHR environment presents numerous, complex challenges for protecting its many different data streams. This white paper presents specific best practices from EMC for deploying effective backup, disaster recovery, and business continuity strategies that will both maximize high availability and efficiency of Epic EHR environments.

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EXECUTIVE SUMMARY

Numerous healthcare organizations are investing in Epic Electronic Health Record (EHR) solutions to improve quality of patient care and efficiency. With growing reliance on digital records for everything from patient test results and medical records to billing and HIPAA reporting, high availability of Epic EHR environments has never been more important.

Given the complexity of Epic’s database structure and multiple data streams, implementing appropriate high availability strategies is especially challenging. From years of working with Epic and delivering hundreds of backup, disaster recovery, and business continuity solutions to healthcare providers, EMC has gained unparalleled experience and expertise in protecting Epic EHR environments.

This white paper provides design recommendations from EMC that will help healthcare providers mitigate risks of downtime and data loss in their Epic EHR environments. By following these guidelines, healthcare providers will have greater assurance of meeting service-level agreements for application and data availability to enhance productivity of clinicians and administrators, support quality care, and ensure regulatory compliance while increasing their IT infrastructure efficiency.
INTRODUCTION
Deploying an EHR is typically one of the largest investments a healthcare organization can make. Government funding to offset the cost is available through the Health Information Technology for Economic and Clinical Health (HITECH) Act for healthcare providers that can demonstrate "meaningful use" of their EHRs.

Epic EHR solutions help healthcare providers show meaningful use by providing an end-to-end view of each patient, integrating data across the healthcare spectrum into a single, patient-centric database (Figure 1). All Epic applications—from evidence-based decision support to quality management and outcomes reporting—are tightly integrated with this database to optimize care and efficiency.

With clinicians and administrators relying on Epic EHR for streamlined management over all aspects of patient care, high availability is critical. This requires a comprehensive strategy for backup, disaster recovery (DR), and business continuity. Lack of appropriate data protection puts the entire healthcare organization at tremendous risk. Data loss or delays in retrieving patient information can mean fines for non-compliance with HIPAA or, most dire, compromised patient care.
A HOLISTIC APPROACH TO PROTECTING EPIC

As one of the IT industry’s leading providers of high availability solutions, EMC has delivered hundreds of backup, disaster recovery, and business continuity deployments to healthcare providers worldwide.

EMC has worked closely with Epic for years, developing and delivering lab-tested, Epic-approved solutions for healthcare providers. This experience has earned EMC a 60 percent share of the Epic market (Figure 2).

![Epic Market Share by Technology Vendor](image)

*Figure 2 – Epic Market Share by Technology Vendor*

Drawing upon deep IT and Epic-specific expertise and experience, EMC applies a comprehensive, holistic approach to addressing the unique needs of healthcare providers. This ensures that Epic applications are properly protected as part of an enterprise-wide high availability strategy and an "Epic Good Maintenance" status is maintained.

One of the ways EMC assists healthcare providers is through EMC Professional Services. This organization is staffed with Epic-trained personnel who can help streamline solution implementation and apply best practices for protecting Epic and the entire enterprise infrastructure.
EPIC HIGH AVAILABILITY CHALLENGES

There are several challenges associated with protecting Epic EHR. Epic environments often are large, rendering traditional tape backup approaches ineffective. Epic also includes a wide variety of data streams across its InterSystems Caché database and integrated analytics and reporting engine, Cogito, which each require their own data protection strategies.

Achieving high availability in this diverse environment must balance Epic specifications and healthcare provider service-level agreements (SLAs) by using the appropriate mix of backup, disaster recovery, and business continuity solutions. These can be aligned as follows:

- **Backup** – 250 gigabytes per hour recovery time objective (RTO) and 24-hour recovery point objective (RPO) with data retention for at least 30 days
- **Disaster Recovery** – Multi-hour RTO and RPO
- **Business Continuity** – Sub-second RTO and near-zero RPO

The goal is to have a “continuous availability” SLA with zero-level RTO/RPO, completely eliminating downtime and data loss.

EMC High Availability Solutions For EPIC

To address Epic’s high availability requirement, EMC has developed a reference architecture (Figure 3) based on proven backup, DR, and business continuity solutions:

![Figure 3 – Epic Enterprise High Availability Reference Architecture](image_url)
Backup
- **EMC Avamar** deduplication backup software and system enables daily full backups with immediate single-step restore, and integration with VMware’s vStorage API for Data Protection (VADP) for guest and image-level virtual machine backups.

- **Avamar with EMC Data Domain** deduplication storage systems, typically used for larger Epic implementations, integrates Avamar agents and Data Domain Boost software to back up the Caché and Cogito databases to Data Domain deduplication storage, while backing up the remainder of the Epic environment to Avamar Data Stores.

DR/Business Continuity
- **EMC SRDF** and **EMC MirrorView** provides synchronous and asynchronous replication
- **EMC RecoverPoint** remote data protection provides instantaneous DVR-like recovery to a point in time without data loss

These solutions replicate EMC VMAX enterprise storage, EMC VNX unified storage and VCE Vblock Systems across local or remote sites. RecoverPoint offers tight integration with VMware vCenter Site Recovery Manager (SRM) for protection of virtualized infrastructures.

Continuous Availability
- **EMC VPLEX** virtual storage enables transparent mobility and active-active sharing of IT resources across sites, achieving zero RPO and RTO.

Centralized Reporting
- **EMC Data Protection Advisor (DPA)** provides end-to-end monitoring, reporting, and analytics across multiple high availability solutions.
HIGH AVAILABILITY DESIGN RECOMMENDATIONS FOR EPIC

Drawing on its extensive Epic experience, EMC has developed comprehensive design recommendations ensuring high availability in Epic environments. These recommendations consider that each healthcare provider’s deployment will vary based on individual infrastructure environments and SLAs. The Appendix includes key questions to review prior to initiating an Epic high availability project.

Epic EHR workloads are allocated to various disk pools on primary storage in the healthcare provider’s production data center and secondary storage in a remote site. Backup and replication strategies are employed based on the type of workload for each disk pool as described below.

Production Caché Database

Because of the Caché database’s critical function, Epic requires Caché shadowing to ensure an RTO of 20 to 30 minutes and an RPO of less than 30 seconds. With Caché shadowing, log files from the production server are compressed and shipped to the DR shadow server for replay (Figure 4). Epic permits local Caché shadowing although EMC and Epic recommend shadowing to a remote site for maximum protection.

![Figure 4 – Caché Shadowing for Production Epic Database](image)

In some cases, healthcare providers have multi-site DR configurations, which will require three copies of the Caché database. To achieve this, EMC recommends creating two database clones using solutions such as EMC TimeFinder software or EMC MirrorView software. EMC SRDF or EMC RecoverPoint solutions can replicate the clone to a third data center.

This process requires a database freeze to stop data from flowing into the database at which point the first clone is broken off as clone fracture. A database thaw allows data to resume flowing as the two clones are switched, allowing replication to proceed completely independent of the production environment (Figure 5). For this procedure, custom scripts are needed. EMC Professional Services can assist with script customization and implementation of the appropriate technologies.
This cloning and replication strategy allows healthcare providers to build a consistency group and establish a clean, non-corrupt copy of the database at the DR site. Only changes since prior synchronization are transmitted during replication.

For backing up the Caché database, the same cloning technique can be used. In this case, the second clone is backed up with Avamar or Avamar and Data Domain (Figure 6).
**DR Landing Zone for Production Caché Database**
EMC and Epic recommend configuring a dedicated disk pool at the DR site as a target for the shadow copy of the Caché database.

**Production Clones of Caché Database**
A dedicated disk pool is required for clones used in replicating and backing up the production Caché database. EMC recommends sizing this disk pool twice as large as Epic advises to accommodate two clones. This allows one clone to remain offline for added protection while the other clone is synchronized with the production database.

**DR Landing Zone for Database Clones**
EMC recommends configuring a dedicated disk pool at the DR site as a target for replicating production clones of the Caché database. The DR disk pool should be identical to the production disk pool.

**Cogito Analytics and Reporting Engine**
To meet accountability requirements of the Affordable Care Act, real-time reporting and recovery of this data are essential. Epic’s method for protecting its Cogito database running on Microsoft SQL Server or Oracle is log shipping. Alternatively, EMC recommends array-based replication for much faster recovery compared to rebuilding the database as required in log shipping.

Any of EMC’s replication solutions can be used to protect Cogito. A true active-active data center configuration can be achieved with VPLEX and Microsoft SQL Server Always On high availability solution (Figure 7). With VPLEX, data is continuously synchronous so database services can run uninterrupted if a site outage occurs. RecoverPoint provides a comparable method of recovery, including journaling of the Cogito database, but unlike VPLEX, would require restarting database services.

**Figure 7 – VPLEX Replication of Cogito Analytics and Reporting Engine**

**DR Landing Zone for Cogito Analytics and Reporting Engine**
Because Cogito databases handle financial data, this information is just as important to the CFO as the Caché database is to clinicians. EMC recommends creating a dedicated disk pool at the DR site as a target for the Cogito analytics and reporting engine. Because billing occurs nearly simultaneously with delivery of care, fast recovery of Cogito data is especially important. Continuous synchronous mirroring using VPLEX is EMC’s preferred method of data protection for this disk pool.
Production Journals and Report Shadow

Caché is designed with an I/O access pattern of continuous, random database file reads interspersed every 80 seconds by large bursts of writes. Between those bursts, writes are stored in Journal files and logged in the Write Intent Journal (WIJ), both of which are stored in a separate disk pool from the database.

Replicating the Journal and WIJ files adds an important layer of protection. Although WIJ is not often replicated, EMC recommends doing so to help speed recovery. A valid copy of the Journal and WIJ files created every 80 seconds, combined with a Caché database copy, assures healthcare providers of recovering all completed database transactions if outages or data loss occur.

Epic’s Journal Replication Utility (/epic/prd/bin/epic/jrncopy) compresses and copies new Journal files to a landing zone remote from the production data center (Figure 8). By placing the command line in the “crontab” of the file server, administrators can direct the utility to run every 80 seconds or at longer intervals. Copies of Journal and WIJ files at the landing zone can be backed up using any one of the EMC backup solutions to meet SLA requirements.

This same disk pool contains a shadow copy of Cogito reports. Larger healthcare providers may choose to replicate this shadow copy to the DR site using RecoverPoint to ensure continued access if the primary site was unavailable. Executive healthcare management often requires Cogito reports within a few days or even immediately.

DR Landing Zone for Production Journals and Report Shadow

EMC recommends configuring a dedicated disk pool at the DR site as a target for Journal and WIJ files, and the Cogito report shadow. This disk pool should be in the same location as the shadow copy of the Caché database.

Business Objects, BLOB, and VMware

This disk pool contains several important services, including Business Objects, which is the report generator for Cogito and necessary for review and analysis of critical data. In addition, the pool includes binary large object (BLOB) data, typically scanned images, logos, “smart text” that physicians use for note taking, and patient photos for positive identification. VMware and Citrix virtual environments also reside in this pool.
EMC recommends replicating the entire disk pool using RecoverPoint or VPLEX to ensure business continuity. Since most of this disk pool is virtualized, vCenter SRM can be integrated into the replication strategy.

For backup, VMware VADP can be used with EMC Avamar (Figure 9).

**Figure 9 – VMware Image-Level Backup**

**DR Landing Zone for Business Objects, BLOB, and VMware**
EMC recommends configuring a dedicated disk pool at the DR site as a target for all replicated Business Objects enterprise data, BLOB files, and virtual machines. Ideally, if VPLEX is used, healthcare providers will have a continuously available environment without the need for clustering.

**Enterprise-wide Data Streams**
An additional consideration—often overlooked—is protecting other enterprise systems that are integrated with the Epic EHR. EMC recommends that healthcare providers discuss their individual application environments with EMC Professional Services to determine the best strategy for ensuring high availability of integrated applications.
OVERALL HIGH AVAILABILITY BEST PRACTICES FOR EPIC

In addition to protecting individual data streams, EMC recommends several overall best practices for ensuring high availability in Epic environments.

Monitoring of Caché shadowing

Epic advises to carefully monitor the Caché shadowing process to ensure it does not fall behind production workloads. Otherwise, the RPO can increase significantly.

Epic backup sizing

Sizing the Epic backup environment is critical for optimal performance (Figure 10). Because the Caché database structure spans a minimum of eight file systems, EMC recommends separating backups into four to eight data sets.

In addition, the maximum concurrent file count for an Avamar client writing to Data Domain is 1,000 files. It may be necessary to install multiple Avamar clients to allow concurrent backup and restore streams between Avamar and Data Domain.

To ensure strong backup and recovery performance, a minimum of one processor core and two gigabytes of memory are required for each data stream on the Avamar backup proxy server. EMC also recommends 10 Gigabit Ethernet network cards to optimize performance in an integrated Avamar and Data Domain environment.

<table>
<thead>
<tr>
<th>Disk Pool</th>
<th>Drive Count</th>
<th>Data Type</th>
<th>Useable Capacity (GB)</th>
<th>Backup Freq.</th>
<th>Cloned nightly Backup</th>
<th>Storage Use</th>
<th>Retention</th>
<th>Recovery Window</th>
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<tbody>
<tr>
<td>1</td>
<td>22 dedicated drive</td>
<td>Production Database</td>
<td>1,700</td>
<td>Nightly</td>
<td>Required</td>
<td>Cache DB (flat file)</td>
<td>30 days</td>
<td>6 hours</td>
</tr>
<tr>
<td>2</td>
<td>22 dedicated (for Performance)</td>
<td>Production Journal Files</td>
<td>300</td>
<td>Nightly</td>
<td>Required</td>
<td>Cache DB (flat file)</td>
<td>30 days</td>
<td>6 hours</td>
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<tr>
<td></td>
<td></td>
<td>Production Application Files</td>
<td>100</td>
<td>Nightly</td>
<td>Required</td>
<td>Cache DB (flat file)</td>
<td>30 days</td>
<td>6 hours</td>
</tr>
<tr>
<td>3</td>
<td>Min 12 shared drives</td>
<td>Report Shadow Data and Journal Files</td>
<td>2,000</td>
<td>Nightly</td>
<td>Snapshot</td>
<td>Cache DB (flat file)</td>
<td>14 days</td>
<td>12 hours</td>
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<tr>
<td></td>
<td></td>
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<td>14 days</td>
<td>12 hours</td>
</tr>
<tr>
<td>4</td>
<td>Min 31 shared disks for Performance</td>
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<td>Min Weekly</td>
<td>Not Needed</td>
<td>Oracle or SQL DB</td>
<td>30 days</td>
<td>18 hours</td>
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<td></td>
<td></td>
<td>Clarity RDBMS Test Data</td>
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<td>After upgrades</td>
<td>Not Needed</td>
<td>Oracle or SQL DB</td>
<td>30 days</td>
<td>18 hours</td>
</tr>
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<td></td>
<td>Production Restore Area</td>
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<td>Not Needed</td>
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<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>Nightly</td>
<td>Snapshot</td>
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<td>7 days</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Production Support</td>
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<td>Nightly</td>
<td>Snapshot</td>
<td>Cache DB (flat file)</td>
<td>7 days</td>
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<td></td>
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<td>Release Testing</td>
<td>1,700</td>
<td>Nightly</td>
<td>Snapshot</td>
<td>Cache DB (flat file)</td>
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<td>8 hours</td>
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</table>

Figure 10: EMC Recommended Sizing for Epic Backup and Recovery
Testing the DR Shadow Environment
EMC recommends testing the Caché shadow environment at least twice per year. Some organizations opt to run production operations from their DR data center for up to six months annually as another level of testing. Scheduled downtime for database and client updates is required every other month at a minimum, providing an opportunity for organizations to switch back to the production site during these update periods.

Sizing of Production and DR Disk Pools for Business Objects, BLOB, and Virtual Machines
EMC specifies that production and DR disk pools for Business Objects data, BLOB files, and virtual machines are the same size and configured with identical performance characteristics to enable full business continuity should the production site become unavailable.
EPIC HIGH AVAILABILITY ADVANTAGES

With a properly designed and implemented EMC high availability environment for Epic EHR, healthcare providers maintain higher levels of productivity and cost efficiency.

Here are just a few examples:

- One EMC-Epic customer reduced storage requirements for one month’s worth of full daily backups from 37 terabytes to less than one terabyte.
- Another customer shrunk data and network bandwidth utilization by 99 percent, enabling disaster recovery from a remote location.
- A healthcare provider recovered 31,000 Epic patient records three times faster with EMC than its previous disaster recovery solution.

For clinicians at bedside, Epic high availability means complete access to vital patient records at all times to support the highest quality patient care. Administrators access billing services without disruption to ensure the financial health of their organizations.

Healthcare providers can also move aggressively on new electronic medical records initiatives with confidence that data is protected. And by ensuring that all reporting functions are available, providers are in a stronger position to comply with key healthcare regulations.
CONCLUSION

For any healthcare system, rapid access to medical and patient information is the cornerstone of quality patient care. Especially today, with the spotlight on accountability, there is simply no room for gaps in patient information. That makes Epic EHR more critical to healthcare operations than ever before, and ensuring its availability of paramount importance.

With an investment as large and complex as Epic EHR, healthcare providers must implement the right high availability strategies and solutions. Too much is at risk for vital health records to be unavailable or, worse, lost. That is why it is so important to work with a knowledgeable and experienced partner.

Few vendors are as qualified as EMC to help healthcare providers meet their high availability requirements for Epic EHR. With years of experience serving the healthcare industry and collaborating with Epic, EMC is able to mitigate risks, deliver predictable results, and help healthcare providers maximize the value of their Epic EHR investments.
APPENDIX

When embarking on a high availability project for Epic EHR, consider the following key questions:

1. Do you have defined RTOs and RPOs for each of the key Epic data streams?
2. What data requires backup?
3. How fast does data need to be backed up?
4. How long does data need to be retained?
5. Where will you house replication copies for disaster recovery?
6. How many miles from your primary data center will your disaster recovery site be?
7. What is the connectivity between your primary and disaster recovery sites?
8. Will you use a third party to provide disaster recovery or run the site internally?

When planning disaster recovery, what additional systems and applications are needed to consider Epic functional?
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