



Technical Case Study:
**Beaumont Hospitals Enhance Business
Productivity Using NetApp Data ONTAP® 7G**

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TECHNICAL CASE
STUDY

Network Appliance, a pioneer and industry leader in data storage technology, helps organizations understand and meet complex technical challenges with advanced storage solutions and global data management strategies.

Executive Summary

Like many organizations, Beaumont must cost-effectively scale its storage infrastructure to accommodate business growth and continually evolving application requirements. Key IT storage objectives are to support rapid data growth and maximize the full power and capacity of each disk for high performance, while simultaneously reducing backup windows to ensure around-the-clock database availability. With these objectives in mind, the Beaumont team worked with NetApp Global Services to initiate a consolidation and technology-refresh project that would take advantage of NetApp Data ONTAP 7G with FlexVol™ technology to improve capacity turn-on and provisioning, application and database performance, disk efficiency, backup processes, and recoverability.

The Customer

Beaumont Hospitals employ a staff of 15,000, including more than 2,400 private-practice physicians representing some 91 medical and surgical specialties. Beaumont facilities include two hospitals with seven medical office buildings, a rehabilitation/health center, primary and specialty-care clinics, four extended-care centers, a research institute, home care, and a hospice. Beaumont's 1,061-bed hospital in Royal Oak is a major teaching and referral center with Level I trauma designation. William Beaumont Hospital in Royal Oak is ranked in 11 of 17 categories in the prestigious 2005 *U.S. News & World Report* "Best Hospitals" lists and has had an 11-year presence on the annual listings. The hospital was honored again this year as the top heart and heart-surgery center in Michigan.

The Existing Environment

Beaumont utilizes NetApp storage across its facilities in Royal Oak and Troy. Nine systems (four NetApp F820 systems, two NetApp F840 systems, a NetApp F740 system, and a clustered NetApp FAS270 system) with 26TB of total capacity supported mission-critical applications serving data for patient care systems, surgical databases, imaging systems, pharmacy data, inventory systems, ERP systems that integrated with other vendors, and a Web portal used by patients for accessing medical records and billing. NetApp systems hosted 22 production databases (Oracle® over NFS and Microsoft® SQL Server). For data protection, the hospital utilizes NetApp SnapVault® software to back up data to a NetApp NearStore® R200 system. In addition, the IT team utilizes SyncSort BackupExpress for tape backup to StorageTek tape libraries.

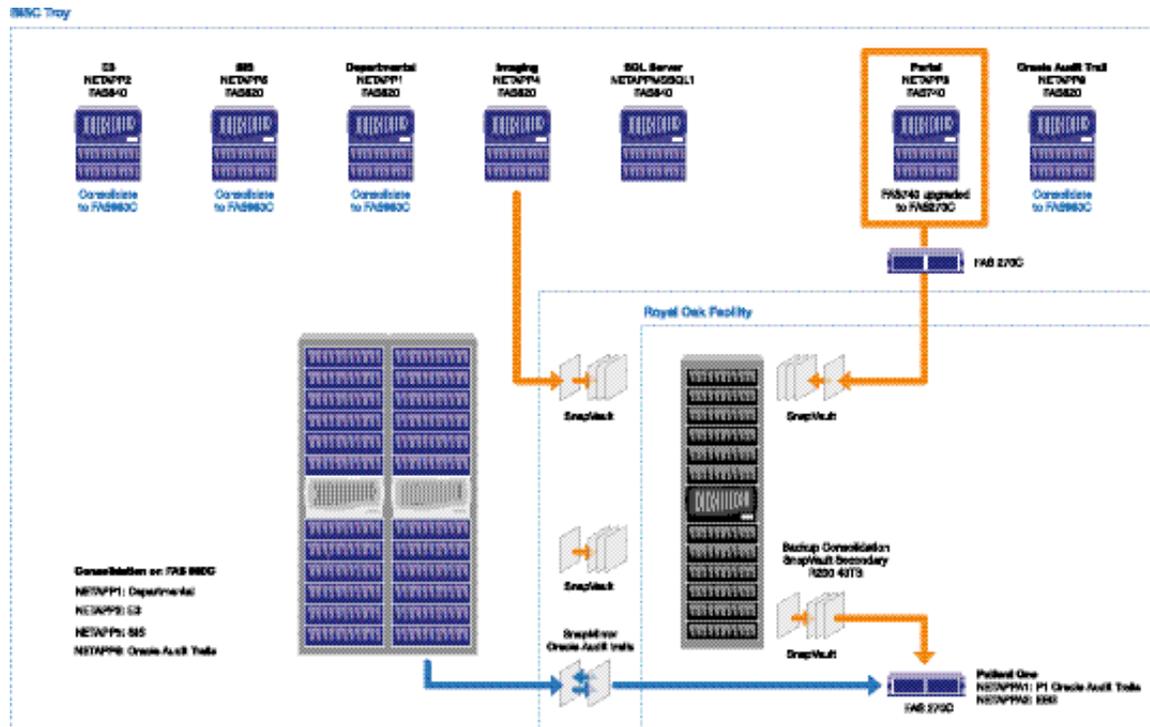
Supported applications and systems include:

- Oracle8i™, Oracle9i™, and Oracle10g™ with various applications for patient tracking and billing applications
- Oracle E-Business Suite Financials
- Unisys AR system
- ERP
- EEG and medical-imaging radiology applications (via CIFS)
- ProVation Medical software
- Windows® data center servers
- Microsoft Office applications (spreadsheets and departmental data)
- Web servers
- Approximately 10,000 PCs
- Caching systems

Consolidation and Technology-Refresh Objectives

Like many organizations, Beaumont must cost-effectively scale its storage infrastructure to accommodate business growth and continually evolving application requirements. Key IT storage objectives are to support rapid data growth and maximize the full power and capacity of each disk for high performance, while simultaneously reducing backup windows to ensure around-the-clock database availability. With these objectives in mind, the Beaumont team worked with NetApp Global Services to initiate a consolidation and technology-refresh project that would take advantage of NetApp Data ONTAP 7G with FlexVol technology to improve:

- *Capacity turn-on and reprovisioning.* The hospital was constantly running out of storage space. Backing up volumes and recreating them with additional capacity were resource-consuming manual processes, and the IT team frequently had to ask users to clean up files and data so that capacity could be reprovisioned for mission-critical applications.
- *Application performance.* When applications ran out of space, the IT team typically added more storage in units of one or two disks. In most cases, all new writes to the application would then go to the newly added drives. The result? Disk bottlenecks. The degraded performance that followed these volume expansions was not acceptable for applications requiring very high-speed I/O.
- *Database performance.* Since many databases were typically hosted on a single volume, any performance hit compromised all applications.
- *Disk efficiency.* In the hospital's high-transaction environment (surgery scheduling, staff scheduling, medicine distribution, test results, and so on), the rate of data change resulted in fragmentation inefficiencies.
- *Backup processes.* The existing process of putting databases in hot-backup mode for backup to tape simply took too long. Already at four to six hours, the backup process increasingly threatened to impact operations.
- *Recoverability.* Patching or recovering a database took significant, production-impacting time. In the existing structure, databases were on qtrees on the same volume. Although independent Snapshot™ schedules were possible, restores were done using a single-file restore, a more lengthy process that negatively impacted multiple functions, departments, and user bases.



The Solution: Migrate to Network Appliance Data ONTAP 7G with FlexVol Technology

A five-year history of working with NetApp storage solutions plus a detailed evaluation of NetApp Data ONTAP 7G and FlexVol technology convinced the Beaumont team that migrating to this environment would provide the dynamic provisioning, flexibility, and data-management granularity required for the hospital’s expanding storage requirements.

Beaumont initially tested Data ONTAP 7G beta software and then worked with NetApp Global Services to develop the implementation and data migration plan. The project included consolidating the existing 26TB of capacity for efficiency and adding primary-application redundancy, as well as setting up data-replication relationships (via NetApp SnapVault software) between the Troy and Royal Oak facilities. The configuration today leverages NetApp Data ONTAP 7G and FlexVol technology across an infrastructure that includes clustered NetApp FAS960 and FAS270 systems. The existing NetApp R200 was leveraged as secondary storage. Table 1 highlights the current deployment.

<p>Clustered NetApp FAS960 Systems</p> <ul style="list-style-type: none"> • Configured with 21.5TB (raw) • (189) 72GB 15kB RPM FC drives • (56) 144GB 10kB RPM FC drives • Field-upgradeable to 48TB (raw) • NetApp WAFL® (high-performance, optimized, self-tuning file system) • NetApp Data ONTAP 7G • NetApp Snapshot technology and SnapRestore® software for instantaneous data restoration • Max 255 Snapshot copies per volume • (2) remote management console cards • (2) dual-port FC HBAs (Tape SAN) • (8) dual-port Gigabit NICs (optical) • (2) onboard 10/100 NICs 	<p>NetApp R200 System</p> <ul style="list-style-type: none"> • Configured with 40TB of ATA drives (raw) • Field-upgradeable to 96TB of ATA (raw) • NetApp WAFL • NetApp Data ONTAP 7G • Snapshot technology and SnapRestore software for instantaneous data restoration • Max 255 Snapshot copies per volume • (2) dual-port FC HBAs (Tape SAN) • (3) dual-port Gigabit NICs (optical) • (1) onboard 10/100 NIC 	<p>SyncSort Virtual Tape Library</p> <ul style="list-style-type: none"> • RAID-protected tape backups • Self-healing tape backups • Tape backups protected by Snapshot technology • Daily incremental and differential tape backups; can live and die on R200 and push full backups to tape weekly
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Table 1) NetApp Data ONTAP 7G with FlexVol technology deployment at Beaumont.

Beaumont reports that the NetApp iSCSI SAN took very little time to install and has provided a simple and cost-effective storage infrastructure solution. Because iSCSI is based on standard Ethernet technology, installation consisted primarily of the addition of a new license key and installation of a hardware adapter card. Additionally, the iSCSI solution enabled SQL Server databases based on Windows to communicate over the existing IP infrastructure and using standard SCSI storage commands.

The Operational Impact and Benefits of the NetApp Solution

The Data ONTAP 7G environment supports a broad-functionality production environment that now includes more than 25 Oracle and SQL Server databases servicing patient tracking systems, surgical databases, internal payroll and human resource information, medical imaging, and test-results applications.

NetApp Data ONTAP 7G provides multiprotocol (iSCSI, NFS, and CIFS) connectivity to a common pool of storage, enabling Beaumont to deliver both file- and block-based access in support of a myriad of mission-critical software applications and management functions: Oracle Databases accessed using NFS, SQL Server databases accessed using iSCSI, CIFS-based imaging systems, Web-accessible patient services, and transaction and audit trail logs.

Operational Efficiency

NetApp FlexVol technology provides a uniquely flexible infrastructure that allows Beaumont to improve operational efficiencies. Taking advantage of hardware-independent flexible

volumes, Beaumont can seamlessly grow and shrink volumes—on-the-fly and without any downtime or disruption to clients. FlexVol technology also allows applications to take advantage of all the spindles in an aggregate so that I/O-bound applications run faster than with traditional volumes that have a smaller number of spindles available to them.

Application Performance

Placing each database in its own FlexVol volume allows fine-tuned management to meet performance, availability, and recovery goals. In the past, for example, adding one or two disk drives at a time—instead of multiple drives—frequently resulted in a disk bottleneck. To resolve this issue when expanding capacity with traditional volumes, the company had adopted the practice of adding full RAID groups to a single volume. With the Data ONTAP 7G WAFL reallocate capability, Beaumont is able to ensure that write operations are now automatically distributed across all of the drives—not just the recently added—in the aggregate.

Fast Capacity Turn-On and Reprovisioning

NetApp Data ONTAP 7G allows Beaumont on-the-fly provisioning of new storage to different functional groups within the hospital. This capability ensures Beaumont can quickly react to changing needs, while still maintaining high utilization of the infrastructure. Prior to the migration, storage utilization averaged 43% to 50%. After migration to NetApp Data ONTAP 7G, the hospital's storage utilization increased by more than 50% to an impressive 76%.¹

Automated Backups and Restores

Utilizing NetApp Snapshot technology and NetApp SnapManager® for Microsoft SQL Server software allows SQL Server databases to be backed up within seconds instead of hours. Today, Beaumont benefits from automated backups and restores of SQL Server systems, reduced backup times, and significantly faster restores to help prevent and minimize outages.

Enhanced Recoverability

As part of an overall disaster recovery strategy, Beaumont utilizes NetApp SnapVault software to back up data to a NetApp NearStore system in Troy, Michigan. This process simplifies backup and saves the time and expense of tape backups (although the company does use still utilize SyncSort for secondary protection). NetApp SnapVault software conserves space on the NearStore system by performing infinite incremental backups after an initial full backup. This functionality eliminated the need to place databases in hot-backup mode for long periods of time. Additionally, NetApp RAID-DP™ protects against double-disk failures. Overall, the NetApp solution streamlines backup procedures and helps Beaumont achieve higher levels of data protection.

Another significant benefit that Beaumont derives with Data ONTAP 7G software is the ability to have independent data management schedules for various databases, based on the criticality of the data. Flexible volumes enable more granular Snapshot schedules, further reducing database time-to-restore. In addition to streamlined backup processes, data recovery is notably improved. If an end-user file is deleted or corrupted, it takes less than five minutes to recover from a recent Snapshot copy. Beaumont has shown that entire Oracle and SQL Server databases can be recovered in five to 15 minutes. Overall, the organization has been able to significantly streamline administrative processes.

¹ Based upon customer-managed testing conducted by NetApp technical engineering. Outputs of the df command captured in the NetApp Autosupport feature from pre-migration systems were compared to post-migration df outputs. (The df “disk free” command is commonly utilized to determine free disk space, including blocks and inodes.)

Ecosystem Interoperability

One of the other advantages that Beaumont derives with the NetApp solution is interoperability with the ecosystem. Beaumont can still utilize its StorageTek tape library and SyncSort Backup Express for backing up select OSSV data to the NearStore system.

The Migration Process

Beaumont was one of first customers to take advantage of NetApp Data ONTAP 7G with FlexVol technology, beginning tests of beta code (including extensive tests of FlexVol features) four months prior to product release. The migration process was initiated after various planning exercises were carried out with a team of NetApp Professional Services engineers (PSEs). Of primary importance to the group was maintaining the quality of storage services, as well as ensuring minimal disruption of storage services to Beaumont's internal and external customers. To avoid impacting production services, the planning and execution process took place over several weeks. And the actual disruption to storage services? Less than 30 minutes for each application server.

NetApp PSEs assisted in architecting the environment and also scripted for autolock removal, installation, upgrading of heads, initial SnapVault relationships, and setup of NetApp DataFabric[®] Manager software for monitoring and management. Since Beaumont used qtrees extensively to provision, manage, and monitor NetApp storage, qtree SnapMirror[®] was the migration tool of choice. Once the new equipment was installed in the Troy and Royal Oak, Michigan areas, each qtree hosted on the traditional volumes on the original systems was replicated via qtree SnapMirror to a new host. Qtree SnapMirror was used to replicate all of the company's 22 Oracle Database instances and other data sets. The Web services system did not utilize qtrees extensively, so NDMP copy was used to migrate that data to the new system (utilizing the existing IP infrastructure).

Beaumont took advantage of the data migration to organize its data on multiple aggregates, setting up the structure according to application type and access patterns. The process of migration involved identifying each data set on the existing systems; identifying the responsible data managers/application administrators within Beaumont; communicating the migration process, timeline, and benefits of a postmigration environment; and coordinating the actual transition.

IT infrastructure changes included:

- Name services (DNS, Netbios aliases)
- NFS mountpoints and CIFS share mappings
- Host access and authentication mechanisms (NTLM/Kerberos, /etc/exports, configuring igroups, and so on)
- Appliance-based quotas

With agreement on the postmigration architecture, the team replicated qtrees via qtree SnapMirror to the new equipment. Each new NetApp system was configured appropriately to provide storage services to all of the host clients, in advance of the actual point where the clients were reconfigured to access the new storage. Once all of the data was copied over to the new systems (a process that took several weeks to move multiple terabytes of data), each application was temporarily stopped, reconfigured to access the new storage, and restarted. Because of thorough planning, the process of configuring each application server to access the newly migrated data was scripted and completed quickly. For systems accessed via FCP and iSCSI, rebooting the application servers took longer than the actual reconfiguration.

The entire architecting and planning process was completed over a three-day period and executed over several weeks. Typically the initial mirroring took hours to run. Once Beaumont got the data mirrored over, the database was brought down, a final mirroring update done, and the database brought back up.

Summary

The NetApp Data ONTAP 7G and FlexVol technology solution has enabled Beaumont to consolidate and simplify its internal infrastructure. Because the NetApp systems are extremely easy to manage, Beaumont has significantly reduced support costs, particularly in terms of the time spent on backups. This simplicity aids system administration and delivers positive financial benefits. The decision to support databases and Web servers with NetApp storage has significantly improved site uptime and performance. The combined Oracle on NetApp solution has directly impacted revenues by increasing site availability, improving database performance, enhancing the user experience, and ensuring virtually limitless site scalability.

The NetApp storage infrastructure is helping Beaumont ensure application and data availability to support the organization's ambitious strategy for delivering world-class patient care. IT support of the strategic plan is focused on business continuity, ensuring that Beaumont's data is available to everyone who needs it, whenever it's needed—critical patient treatments and essential business operations such as scheduling and billing depend on the ability to access data. The NetApp Data ONTAP 7G with FlexVol technology solution is helping Beaumont Hospitals continue to lead the industry in delivery of patient care and services.



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