As enterprise storage requirements continue to grow, storage administrators often struggle with the challenge of meeting application capacity, performance, and availability requirements while controlling costs. Traditionally, administrators have met performance and availability requirements by allocating enough physical storage capacity to handle anticipated growth. However, this pre-allocation approach generally leads to overprovisioning storage capacity, which can in turn incur unnecessary capital costs and increased energy, space, and management costs—not to mention significant underutilization of that capacity.

Even when organizations overprovision storage capacity as a preventive measure, they still sometimes need to add capacity, leading to increased management and capital expenditures. On the other hand, allocating space on an as-needed basis can be complex, time-consuming, and difficult to manage, and can result in significant application disruption and downtime.

To help increase storage utilization, simplify management, and avoid the excess costs associated with overprovisioning storage capacity, Dell/EMC CX4 Series storage area network (SAN) arrays offer virtual provisioning, a thin provisioning-based storage virtualization technology that enables storage capacity to be allocated simply and automatically on an as-needed basis. One of several features available in Dell/EMC CX4 Series arrays (see the “Flexible, scalable Dell/EMC CX4 Series storage arrays” sidebar in this article), virtual provisioning provides applications access to a virtualized pool of storage capacity that is physically allocated on demand based on application usage, with no application disruption or downtime and no manual intervention required. By helping avoid the need to pre-allocate unused storage and automating key storage provisioning and management tasks, virtual provisioning can dramatically enhance utilization rates and simplify storage management—helping organizations to reduce the total cost of ownership of their storage infrastructures and enhance the energy efficiency of their data centers.

Enhancing Utilization with Thin LUNs

Traditional storage deployments are often overprovisioned, which in addition to cost inefficiency can lead to increased energy and space requirements in the data center. In this approach, storage is partitioned into logical units (LUNs) such that the amount of physical space allocated is the same as the capacity seen by the host servers (see Figure 1).
FLEXIBLE, SCALABLE DELL/EMC CX4 SERIES STORAGE ARRAYS

Dell/EMC CX4 Series storage arrays incorporate a variety of features designed to combine outstanding scalability and performance with flexibility, efficiency, and ease of use to enable organizations to cost-effectively meet data center storage needs:

- **Dell/EMC UltraFlex™ architecture**: The UltraFlex architecture enables administrators to customize the network interconnects and number of ports on each array.
- **Enterprise flash drives (EFDs)**: Hard drives with solid-state flash memory are designed to deliver extremely high performance for latency-sensitive applications.
- **Data-in-place migration**: Support for data-in-place migrations helps simplify upgrades to Dell/EMC CX4 Series models with additional capacity and upgrades from previous-generation Dell/EMC CX Series arrays.
- **Virtual provisioning**: Storage virtualization technology enables storage capacity to be allocated simply and automatically on an as-needed basis as opposed to all at once.
- **Replication**: Dell/EMC CX4 Series arrays support applications that enhance data protection and migration using snapshots, clones, and remote mirroring.
- **Energy efficiency**: Available low-power Serial ATA (SATA) drives consume up to 32 percent less energy than standard 7,200 rpm drives.*

Dell/EMC CX4 Series models provide a range of capacities to help meet different needs—including supporting from 5 to 960 drives for a total storage capacity of up to 954 TB as well as connections to up to 4,096 highly available storage area network (SAN)–attached host servers (see Figure A). For optimal performance, Dell/EMC CX4 Series arrays support 4 Gbps or 8 Gbps Fibre Channel as well as Internet SCSI (iSCSI) using Gigabit Ethernet or 10 Gigabit Ethernet network technologies. Designed to reduce operational and energy costs, simplify management, and enhance utilization while delivering outstanding storage performance and scalability, Dell/EMC CX4 Series arrays can help organizations create scalable, energy-efficient, and cost-effective data centers.

<table>
<thead>
<tr>
<th></th>
<th>Dell/EMC CX4-120</th>
<th>Dell/EMC CX4-240</th>
<th>Dell/EMC CX4-480</th>
<th>Dell/EMC CX4-960</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum cache size</td>
<td>6 GB</td>
<td>8 GB</td>
<td>16 GB</td>
<td>32 GB</td>
</tr>
<tr>
<td>Maximum number of drives per array</td>
<td>120</td>
<td>240</td>
<td>480</td>
<td>960</td>
</tr>
<tr>
<td>Maximum capacity per array</td>
<td>120 TB (with SATA drives) or 72 TB (with Fibre Channel drives)</td>
<td>234 TB (with SATA drives) or 144 TB (with Fibre Channel drives)</td>
<td>474 TB (with SATA drives) or 288 TB (with Fibre Channel drives)</td>
<td>954 TB (with SATA drives) or 576 TB (with Fibre Channel drives)</td>
</tr>
<tr>
<td>Maximum number of highly available SAN-attached host servers</td>
<td>256</td>
<td>512</td>
<td>1,024</td>
<td>4,096</td>
</tr>
<tr>
<td>Thin pools per system</td>
<td>20</td>
<td>40</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>Disks per thin pool</td>
<td>40</td>
<td>80</td>
<td>120</td>
<td>240</td>
</tr>
<tr>
<td>Disks in all thin pools</td>
<td>80</td>
<td>160</td>
<td>240</td>
<td>360</td>
</tr>
<tr>
<td>Thin LUNs per pool</td>
<td>512</td>
<td>1,024</td>
<td>2,048</td>
<td>2,048</td>
</tr>
<tr>
<td>Thin LUNs per system</td>
<td>512</td>
<td>1,024</td>
<td>2,048</td>
<td>2,048</td>
</tr>
</tbody>
</table>

*Based on drive specifications; actual power consumption will vary based on configuration, usage, and manufacturing variability.

Although this type of provisioning can often meet application capacity, performance, and availability requirements, it can also lead to significant underutilization of storage resources.

Virtual provisioning partitions storage into thin LUNs, in which the physical space allocated for storage may be less than the capacity seen by the host server (see Figure 2). Thin LUNs are aggregated into shared storage pools called thin pools. Physical storage is assigned to applications in a capacity-on-demand fashion from shared thin pools. When additional capacity is needed, it is first added to the shared pool and then allocated to individual thin LUNs as required. Capacity can be added to or deleted from thin pools without application disruption or downtime.

Thin pools can consist of any supported drive type—Serial ATA (SATA) drive, Fibre Channel drive, or enterprise flash drive (EFD)—and can support up to 240 drives per pool and a total of 360 drives overall. The number of thin pools and the number of disks per pool vary by array (see Figure A in the sidebar in this article).

Because it avoids the need to pre-allocate storage in anticipation of future needs, the Virtual Provisioning feature helps optimize the utilization and cost of storage resources.
capacity demand, virtual provisioning can dramatically enhance utilization rates while still helping ensure that application capacity, performance, and availability requirements are met. Because capacity can be allocated automatically and with no application downtime or disruption, administrators do not have to overprovision storage in an attempt to avoid the management headache and application disruption often associated with expanding capacity.

The enhanced storage utilization made possible by virtual provisioning provides several key benefits compared with traditional provisioning, including enhanced energy and efficiency for data centers. For example, by avoiding the need to purchase large amounts of excess capacity, this approach can help significantly reduce capital costs, data center footprints, and power and cooling requirements.

**SIMPLIFYING STORAGE ADMINISTRATION**

Because the tasks associated with provisioning capacity and optimizing utilization can be complex and disruptive, traditionally provisioned storage environments can be complicated to manage—which contributes to storage overprovisioning as administrators try to avoid the need to add capacity in the future. Virtual provisioning offers a range of features designed to simplify provisioning and streamline storage management, helping increase utilization rates and reduce administrative costs.

For example, virtual provisioning adds capacity automatically on an as-needed basis, without the need for manual intervention and without application disruption or downtime. Mapping-service software can automatically configure thin LUNs and manage the placement and usage of storage within thin pools, helping avoid the need for storage administrators to configure and manage storage. And management utilities such as EMC® Navisphere® Management Suite and Navisphere Command-Line Interface (CLI) software enable real-time status monitoring and report generation for thin pools.

Dell/EMC CX4 Series storage arrays also offer organizations the flexibility of deploying different types of provisioning to meet different application and business needs. For example, Dell/EMC CX4 Series storage arrays offer support for both virtualized and non-virtualized LUNs, easy migration between virtualized and non-virtualized LUNs without application disruption or downtime, and management and replication tools such as EMC SnapView™, MirrorView™, SAN Copy™, and Navisphere Management Suite.

**CHOOSING BETWEEN THIN LUNs AND TRADITIONAL LUNs**

Although deploying thin LUNs in a virtually provisioned environment helps simplify management and increase energy and cost efficiency, virtual provisioning is not well suited for every application environment. Identifying application requirements and then choosing traditional deployment or virtual provisioning based on those needs can be critical when considering allocation of storage capacity.

For example, virtual provisioning is particularly well suited to environments in which data center space is at a premium; easy deployment and management are required; cost considerations, including capital costs and energy costs, are paramount; and space consumption is difficult to forecast. Traditional provisioning is well suited to environments in which performance requirements down to the level of microseconds must be met, performance must be predictable, data placement must be precise, and concern for space is minimal.

Because Dell/EMC CX4 Series storage arrays support both virtualized and non-virtualized environments and include tools to migrate easily between the two, organizations can easily deploy both virtualized and non-virtualized pools of storage within a single storage array and migrate from one to the other as application and business requirements change.

---

**Figure 1. Traditional provisioning allocates physical storage to match the capacity seen by host servers**

**Figure 2. Virtual provisioning automatically allocates physical storage on demand to help increase utilization while still meeting application requirements**
REDUCING COSTS AND ENHANCING ENERGY EFFICIENCY

Combined with the flexibility to deploy both virtualized and non-virtualized storage pools, virtual provisioning in Dell/EMC CX4 Series arrays can help organizations meet application capacity, performance, and availability requirements while controlling costs. In particular, virtual provisioning of storage can enhance utilization, simplify management, and reduce power and space requirements, allowing organizations to reduce the total cost of ownership of their storage infrastructures and enhance data center energy efficiency.

Greg White is a storage marketing manager in the Dell Global Commercial Marketing organization. He has worked for and with small and medium businesses for 14 years, and for the last several years has focused on helping businesses find solutions for their data growth, data management, and data protection problems.

Annette Cormier is a solutions marketing manager for Dell/EMC storage solutions. She has 20 years of experience in developing and bringing to market enterprise storage, network management, and security products for Dell, Hewlett-Packard, and SGI, and has previously been an IT SAS/Oracle® database programmer at the Natural Resource Ecology Lab (NREL) at Colorado State University and at Pacific Power and Light. Annette has a B.S. in Computer Science, Artificial Intelligence, from Colorado State University.

Eric Cannell is a product marketing manager for Dell/EMC storage systems. He has 17 years of experience developing enterprise technology products, before which he spent 6 years as a software engineer at the NASA Jet Propulsion Laboratory. Eric has B.S. degrees in Astronomy and Computer Science from the University of Illinois, an M.S. in Computer Science from the University of Southern California, and an M.B.A. from the Tuck School of Business at Dartmouth College.