



3Gen Dynamic Thin Provisioning Discussion – White Paper

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Introductions

Thin provisioning has the potential to deliver on three long elusive goals of data center architects and administrators:

1. Eliminate storage waste and ensure that the amount of physical storage allocated to a host closely matches the actual amount of data generated by the applications it supports
2. Simplify storage provisioning by provisioning large volumes up front and relying on the thin provisioning functionality in the storage systems to allocate physical storage on an as needed basis; this dramatically reduces the time typically spent adding storage to hosts in a data center
3. Automate the difficult tasks of storage performance optimization, including disk or spindle layouts and system load balancing

3Gen's Dynamic thin provisioning is the first solution in the industry to deliver this continuous, fully automated, nondisruptive optimization of thin storage environments on the server side. This paper examines how 3Gen's enables smart migration and management of thin provisioning storage environment to achieve initial and ongoing higher storage utilization levels.

Storage Provisioning Methods Comparison

There are three major storage provisioning methods:

1. Traditional method of allocating all the blocks up front. This fully populated physical volumes is often called "fat" or "thick" provisioning. Since all the storage spaces are allocated and available immediately, performance and capacity availability is 100% predictable. The downside is that IT administrator will need to have a good crystal ball to predict the future capacity requirements in order to avoid unnecessary waste of storage capacity.
2. Thin Provisioning with pre-allocated and predicted capacity expansion. This is the method implemented by most computer vendor due to easy software implementation. All applications will be allocated with an upfront pre-determined capacity. When the allocated capacity reaches 85% full, it will automatically expand the volume by a pre-



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determined calculated formula. This method is preferred by most storage providers because it is easy to implement and can be released into the marketplace in a few months of development time. Here are three major disadvantages of this method:

- a. Unpredictable storage performance – substantial slow down during the volume expansion period.
 - b. Multiple concurrent storage expansions can negatively impact client/host data access.
 - c. Potential data loss and corruption when the incoming I/O rate is faster than the volume expansion completion rate.
3. 3Gen's dynamic thin provisioning - employs on-demand allocation of blocks of data when needed by application clients. Thin provisioned volumes are virtual, with the actual storage being drawn from a larger pool and mapped in blocks only when and where writes come in for the volume. 3Gen calls this group of blocks a "Header." From an application's standpoint, a virtual thin provisioning volume looks no different from any other storage volume. As applications write data to it, 3Gen thin provisioning software assigns actual capacity from the pool to that virtual volume. With 3Gen's thin provisioning, storage capacity utilization efficiency can be automatically driven upwards with very little administrative overhead. Organizations can purchase less storage capacity up front, defer storage capacity upgrades in line with actual business usage and save the operating costs (electricity and floor space) associated with keeping unused disk capacity spinning.

3Gen's Dynamic Thin Provisioning Features

Advanced Virtualization with a common pool of storage

3Gen Dynamic Thin Provisioning utilizes advanced virtualization technology to make all physical disk space available to all volumes from a single shared storage pool. Storage Center allows the creation of volumes without the need to pre-allocate disk space.

- a. Virtualization spreads read/write operations across all of the disk drives rather than limiting availability to a single drive or group of drives dedicated to a volume
- b. Create volumes from a common pool of storage space without the typical restrictions of RAID grouping or space pre-allocation
- c. Any volume can simultaneously utilize all of the disk drives in the shared storage pool for improved data access rates
- d. Expired snapshots are automatically coalesced into the free pool of storage

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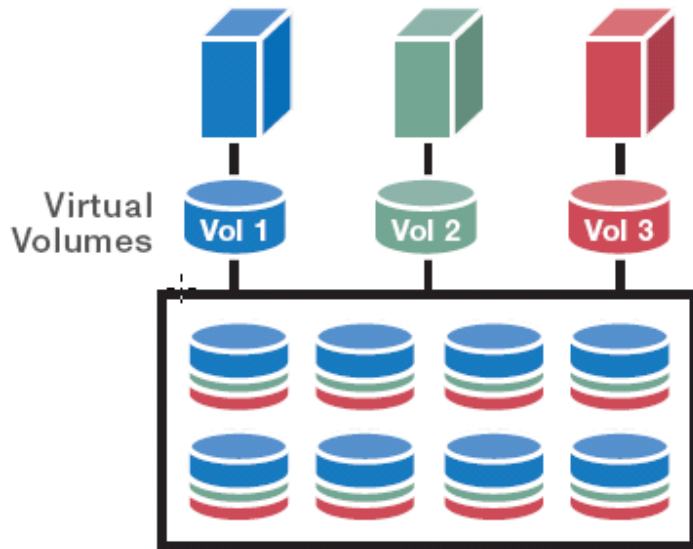


Fig.A 3Gen's virtualization manages all the disks as a single pool of storage, allowing any volume to utilize all the disk drives simultaneously to access data.

Unlimited capacity creation for maximum utilization

With Dynamic Capacity, you can allocate significantly more capacity than the physical disk you have available, enabling maximum utilization of storage resources. User-defined thresholds and automated alerts ensure the appropriate physical storage space will be available.

- Capacity does not have to be fixed on a per-volume basis; volumes can easily be expanded over time
- Volumes can be set to any size within the limits of the operating system
- Administrators receive notification when free space remaining reaches customizable thresholds
- Having a flexible pool of storage allows you to create more volumes for different applications, enables more servers to share a single storage system
- Continual monitoring of allocated, used, and physical storage allows optimum thresholds to be determined

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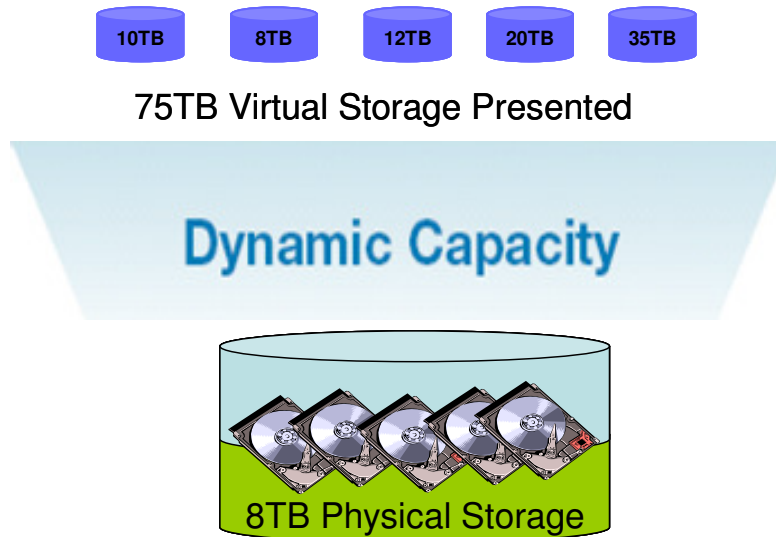


Fig.B *Easily allocate multi-terabyte volumes where the capacity presented to servers is significantly larger than the physically available storage*

Increase performance

Dynamic Provisioning pages mapped to virtual volumes are drawn from and balanced across a large number of physical disk spindles. In contrast, a traditional LUN would normally only use the few spindles in a single RAID group. The virtual volume I/Os are actively load balanced since the shared pool effectively combines many application I/O patterns and spreads the I/O activity evenly across a wide amount of physical resources. This optimization eliminates the challenges of predicting I/O patterns that may result in contention and performance bottlenecks (hot spots), which often, subsequently, must be addressed manually. 3Gen Dynamic Thin Provisioning optimizes the aggregate throughput and delivers the best performance automatically. Traditional thick volumes cannot easily permit the storage administrator to achieve a balanced I/O workload across physical storage resources while thin provisioned volumes, even in a "thick" state, automatically achieve a balanced workload. Overall, there is less data to write and the system can easily manage where the data is placed on the disk, reducing seek time and improving the performance of repetitive disk operations.

- Incremental allocation places data on outer edges of disk platters minimizing seek times
- Dynamic Capacity volumes only contain actual data enabling faster rebuild, copy, replication and backup operations
- Smaller, more efficient volumes enhance application performance
- Replicating smaller volumes takes less time, reduces the amount of bandwidth required and increases replication performance



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Automating Capacity Planning

Dynamic Provisioning is integrated with 3Gen Management software and is managed through 3Gen Control Center Platform. Providing long-term capacity usage trend reports and thresholds monitoring, 3Gen Control Center assists efficient management operations for Dynamic Provisioning virtualized volumes. Automated monitoring of configurable thresholds eliminates the need for time-consuming manual tracking of volume utilization.

- a. Allocate large virtual volumes upfront that don't need constant checking and resizing
- b. Create new multi-terabyte volumes in minutes, not hours
- c. Eliminate downtime associated with volume expansion and resizing
- d. Eliminate the manual tracking of physical disks to volumes (i.e. Excel spreadsheets)
- e. Automated monitoring and notification when configurable thresholds are reached simplifies capacity planning

Summary

More companies are realizing the benefits of using thin provisioning and the ability for a storage team to provision capacity on a pay-as-needed basis. 3Gen Dynamic thin provisioning improves capacity utilization and performance, simplifies storage administration costs and lowers costs of ownership while cutting the up front costs of the storage system. Its flexibility dramatically reduces capacity planning complexity, maximizes availability and allows storage administrators to focus on a few storage pools.

Together, 3Gen's Dynamic Thin Provisioning, 3Gen's Data De-Duplication and Global Clustering offer a comprehensive suite of cloud storage capabilities to enable you to fully optimize your storage utilization for today and tomorrow.

For more information about 3Gen Cloud Storage solutions, please contact our regional sales offices and visit 3Gen website, www.3gendata.com