

Intelligent Space Reclamation in Thin-Provisioned Environments

Increasing Productivity and Maximizing ROI with Centralized Storage Management

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Executive Overview

The use of thin provisioning continues to grow in organizations of all sizes as they look to maximize the return on their investments in storage hardware. The benefits provided by thin provisioning and over-allocation of storage allow businesses to optimize storage allocation at potentially reduced costs, while preserving performance.

At the same time, thin provisioning can result in misallocation of storage, which results in wasted storage, excess capacity and unnecessary expenditures if not managed properly. This potential for misallocation has led to an increase in technologies that reclaim wasted storage: SCSI UNMAP and Zero Detect. Both of these technologies require accompanying tasks and utilities which, to date, have proved inefficient, labor-intensive, under-utilized and lacking of any central management or reporting capabilities.

As thin provisioning evolves and increases in use, a new solution is required to address the current shortcomings and help complement the increased exposure of the technology. Key attributes required include:

- significant ease-of-use improvements
- support for unattended operations
- and central management and reporting.

These attributes will lead to more proactive and intelligent storage management, and allow storage managers to contribute to their organizations in a more strategic manner.

The Benefits of Thin Provisioning

In traditional (thick provisioned) storage environments, users may leave anywhere from 30% to 50% of their allocated space unused. For every 10 TB purchased, 3 to 5 TB are left unused because of inefficient provisioning. This not only wastes space, it also means additional expenditures for disks and/or storage arrays. Thin provisioning improves storage utilization, which reduces storage costs.

More organizations continue to implement thin provisioning as part of their overall corporate storage strategy due to its efficiencies and cost savings. However, like most paths to improved operations and reduced costs, care is required as to how this technology is implemented to ensure the maximum benefits are achieved and potential pitfalls are avoided.

At the highest level, the goal of thin provisioning is to maximize and optimize the storage available in storage area networks (SANs). Rather than utilizing a pre-determined and set amount of storage, as in thick provisioning, thin provisioning allows for changing the allocation of disk storage across multiple systems.

Thin Provisioning: These systems have a pre-determined minimum amount of storage allocated, but can pull from the available pool of storage to increase what is available to a system or user at any particular time.

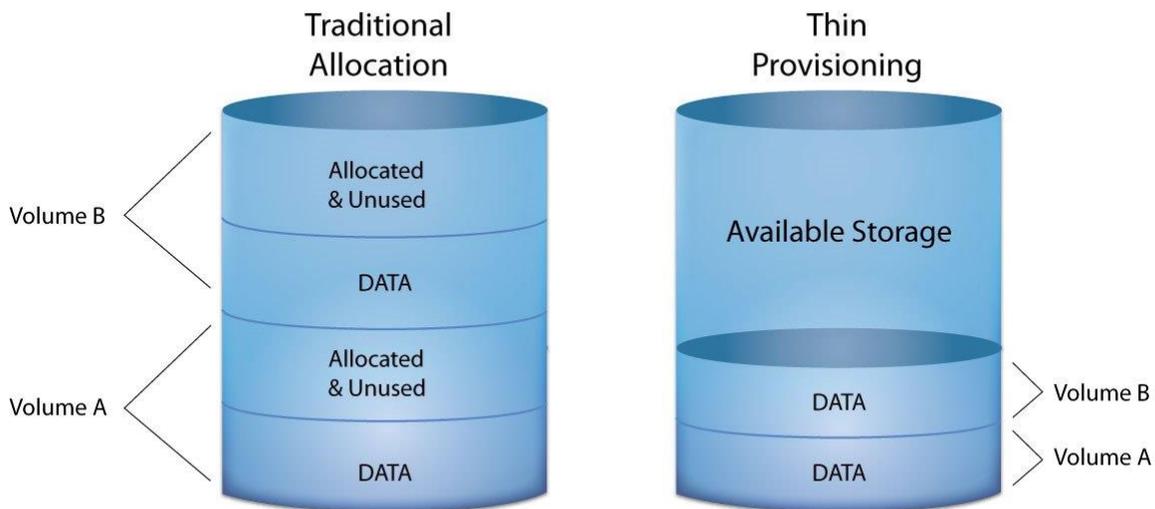
In essence, the storage environment has the appearance of having more physical storage available than actually is available. This results in increased efficiency and a reduced amount of storage capacity that needs to be purchased. The smaller the amount of resources used than what is allocated, the more efficient the thin provisioning environment will be.

Thick Provisioning: Alternatively, if a system always has enough resources to simultaneously support all of the virtualized resources, then it is NOT thin-provisioned. Rather, it is thick provisioned.

At a lower level, thin provisioning relies on on-demand allocation of blocks of data rather than allocating all the data blocks up front. This helps eliminate most wasted space, which in turn improves utilization rates.

In traditional (i.e. "fat" or "thick") storage environments, it is not uncommon to have large pools of storage capacity on various servers that do not get used. The excess cost can be substantial.

In thin-provisioned environments, storage capacity utilization rates are usually very high, often close to 100%. This is very efficient, and comes without incurring the costs of a storage or system administrator modifying the system to accomplish it. Thin provisioning allows organizations to purchase less storage capacity initially, defer storage capacity upgrades and save on overall hardware and associated costs (e.g. electricity, floor space) of keeping traditional storage functional.



The Benefits of Over-Allocation

Thin provisioning enables organizations to achieve over-allocation of storage.

Over-allocation is a mechanism that allows a server to view more storage capacity than has been physically reserved on the storage array itself.

What's the benefit? It gives flexibility in the growth of storage volumes and eliminates the need to attempt to accurately predict how much a volume will grow. Instead, block growth becomes sequential. Physical storage capacity on the array is only dedicated when data is actually written, not when the storage volume is initially allocated. The servers, and by extension the applications that reside on them, view a full size volume from the storage but the storage itself only allocates the blocks of data when they are written.

As a practical consideration, a storage manager needs to monitor actual storage used, adding additional storage capacity such as disks, solid-state drives, etc., as necessary to satisfy current and future data requirements. With over-allocation, much of this administrative time and overhead is eliminated.

Where is Thin Provisioning Used?

Thin-provisioned storage can be used in 2 places:

- At the storage controller/LUN level
- At a virtual guest drive level.

In virtual environments, there can even be a mix or both thin- and thick-provisioned storage.

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Wasted Storage: An Unnecessary Expense

Despite the real benefits provided by thin provisioning and over-allocation, organizations run the risk of not realizing the upside of the technology if it is not managed properly.

In a Windows environment, the problem materializes because of the disconnect between the NTFS file system and the hypervisor and/or storage controller. Despite the fact that a file has been deleted and NTFS now sees that space as free and no longer in use, the hypervisor and/or storage controller does not see that the space is no longer in use and available to be reclaimed.

This results in wasted storage, excess capacity and unnecessary expenditures.

Technologies to Reclaim Wasted Storage Space

There are essentially 2 technologies used to reclaim wasted storage space: SCSI UNMAP and Zero Detect.

- SCSI UNMAP is a relatively new addition to the SCSI command set.
- Zero Detect detects when zeros are written to blocks/clusters.

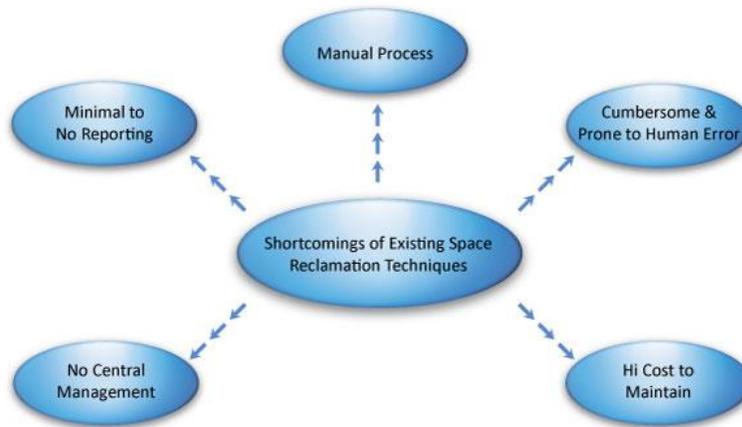
Both technologies signal a storage controller or hypervisor that storage is no longer in use and can be reclaimed. Some environments may even support a mixture of both technologies. Depending on the storage controller and/or hypervisor in use, blocks/clusters are then reclaimed - either shrinking a thin-provisioned guest drive or returning space to the storage pool.

Shortcomings of Existing Space Reclamation Techniques

Space reclamation in a thin-provisioned environment is typically a very challenging process for storage administrators. Often, it is simply ignored, because avoidance is sometimes seen as the lesser of two evils. However, this avoidance can be very expensive in terms of hardware expenditures.

When space reclamation is attempted, it is often a laborious undertaking as it may involve running a special tool in a virtual guest or on a physical server along with performing specific tasks at the hypervisor or storage controller. Because the existing tools available to the administrator are so limited, the process has many shortcomings:

- It is a manual process and not easily automated
- It is cumbersome and prone to human error
- There is minimal or no reporting
- There is no central management
- There is a high cost to maintain the solution.



Existing solutions are usually built around command-line utilities, such as SDelete, that run inside of a Windows guest. Using SDelete or a similar command-line utility involves numerous tasks in order to accomplish the goal of actually reclaiming space.

First, command-line tools address one drive on a single machine at a time, so the command needs to be initiated separately to account for each thin-provisioned drive in your environment. The chances for something going wrong in this scenario are not low. To help address this shortcoming, a script could be written to help. However, any script file needs to be maintained and updated regularly to ensure any changes in the environment are accounted for. Again, the potential for missing an update or not accounting for all changes is not insignificant.

This lack of central management is a major shortcoming for a storage administrator attempting to provide a robust storage management solution for his or her organization. None of the command-line utilities available today, including SDelete, have any reporting capabilities. This is really a component of central management, and the fact that it is not available to a storage manager makes the job much more difficult. It relegates the chore of reclaiming storage to guesswork, never a good concept when dealing with expensive storage solutions.

The High Cost of Unused Storage

Besides the labor inefficiencies of manual space reclamation, there is the potential for a huge waste of the actual storage itself, as well as unnecessary investment in expensive storage.

A common scenario that many overburdened storage administrators find themselves in is the case of having to purchase additional storage when it is not necessary. And if the actual need can be accurately determined, it comes at the expense of much time and resources.

The lack of adequate reporting combined with the antiquated tools of recovering space results in insufficient knowledge of how much space is actually not being used, and therefore available for reclamation. Rather than get caught without enough storage, expensive storage acquisitions are often made, because it is the safe course of action. But it can be a costly and unnecessary one.

Space Reclamation for the Future

A solution is needed that addresses the myriad of shortcomings outlined above. This would encompass:

- An easier (more automated) process of reclaiming space
- Unattended operations
- Central management and reporting
- Proactive and intelligent storage management
- Delay or elimination of unnecessary storage procurements.

Automation of the space reclamation task can help ensure regular and ongoing recovery of valuable storage. This can include performing the job at intervals such as daily, monthly or in accordance with an organization's other storage maintenance tasks.

Central management provides a systematic and controlled method to deploy, manage and report on the entire space reclamation process. Without central management and control, the typical manual processes that have previously been used to accomplish the goals of your space reclamation projects have necessarily been implemented in piecemeal, one machine and one drive at a time.

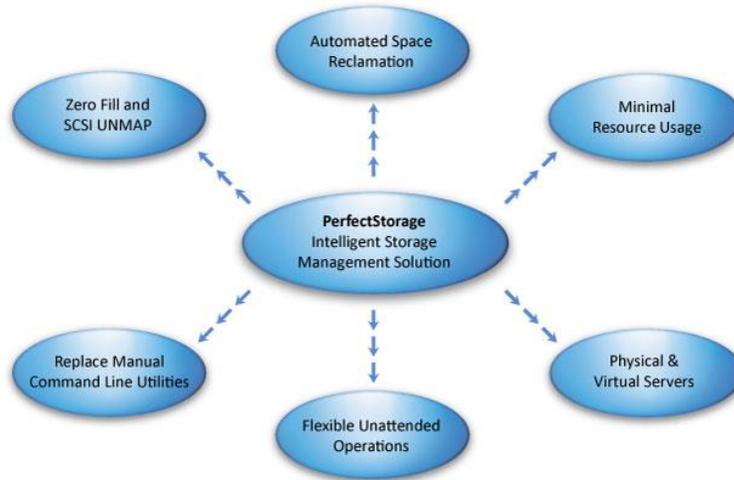
The reporting piece of the space reclamation puzzle can help elevate your entire storage management process. It can move from an ad hoc and random set of tools and tasks to a more strategic, proactive and intelligent part of the IT organization. Before resources are devoted to recovering space, reports can be created and studied to ensure there is adequate storage to be reclaimed to justify devoting any resources to the reclamation.

All this reporting and improved management of the entire process can lead to much more sophisticated analysis of an organization's real storage use and needs. Where the simple yet expensive solution is often to purchase more storage, the more informed and intelligent answer to a storage problem may be to do a better job at reclaiming space and delaying or even foregoing additional storage purchases. This can have a significant positive effect on the bottom line, with much less hardware required.

PerfectStorage -- An Intelligent Storage Management Solution for Thin-Provisioned Drives

[PerfectStorage](#) addresses the shortcomings of today's thin-provisioned space reclamation problems with a robust solution that saves time, resources and capital expenditures:

- Automating SCSI UNMAP or Zero Fill processes in thin-provisioned Windows systems
- Minimal resource usage
- Replacement for manual, cumbersome command-line utilities
- Support for physical and virtual servers
- Flexible unattended operations.



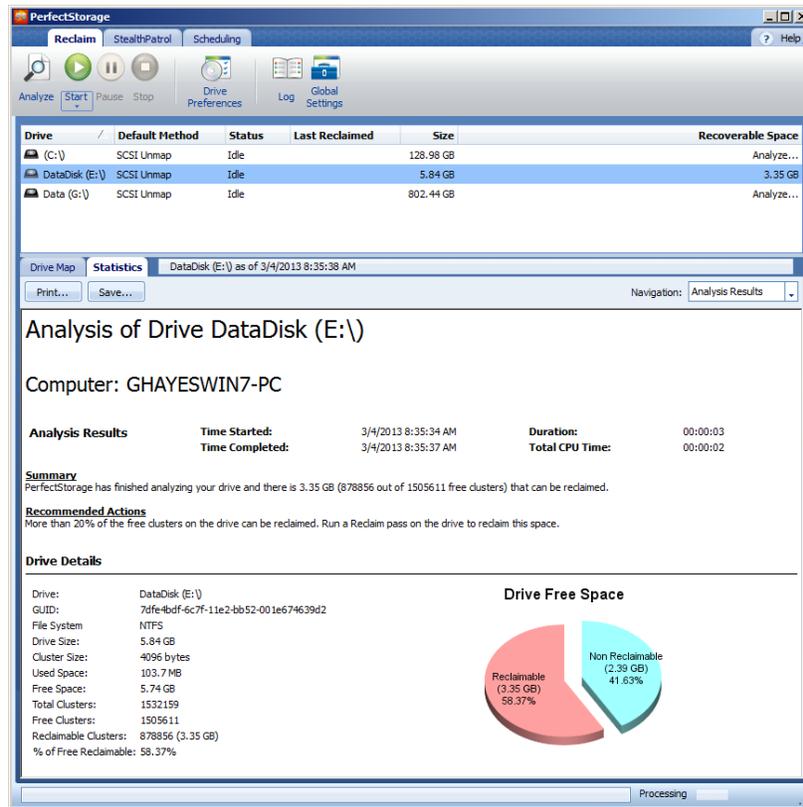
By focusing specifically on thin-provisioned drives, PerfectStorage can provide the most intelligent solution to the specific problems and issues of this environment. By working with various hardware vendors, PerfectStorage supports a wide range of hardware that utilizes either Zero Fill or SCSI UNMAP. Couple this with increasing support in hypervisors for SCSI UNMAP, and it allows storage managers to take better control of their storage management. It allows them to be proactive rather than reactive.

In either a SAN or on virtual systems, PerfectStorage helps to more easily reclaim free space that is no longer being used. This allows storage managers to make better use of their thin-provisioned storage and eliminate wasted space.

PerfectStorage performs its duties without requiring Windows systems to be taken offline, which means it can even be used in a production environment. So the additional benefit of improved productivity across the entire user community can also be achieved. With accurate and full reporting across all thin-provisioned drives, the guesswork and impulse to purchase additional storage is eliminated.

For Zero Fill environments, PerfectStorage utilizes its exclusive **Smart Zero Fill™** to only zero fill clusters not already zeroed, resulting in minimal storage activity and minimal resource usage. Smart Zero Fill also reports on how much space was reclaimed, so benefits can be easily quantified.

With the high cost of labor, storage and opportunity, automated thin-provisioned space reclamation should be an important part of any sophisticated storage management solutions. With PerfectStorage, storage administrators can take control of the space reclamation process and include it as part of their proactive storage management.



Conclusion

The potential of thin provisioning is being realized today by thousands of organizations worldwide. Thin provisioning allows organizations to do more with less and become more efficient and cost-effective with their storage.

However, if not implemented properly or not managed properly, the opportunity for increased savings and efficiencies may not only be lost, but may also come at the expense of unnecessary increased costs, lost time, decreased productivity and improper storage management.

PerfectStorage helps maximize the potential of thin provisioning and reduces the risks associated with the technology by providing:

- Automated SCSI UNMAP or Zero Fill processes in thin-provisioned Windows systems
- Minimal resource usage
- Replacement for manual, cumbersome command-line utilities
- Support for physical and virtual servers
- Flexible unattended operations.

By implementing [PerfectStorage](#), storage managers can be more proactive and in better control of overall organizational storage management. This will lead to more automation and unattended operations, which significantly improves storage management productivity, central management for better control and the delay or elimination of unnecessary storage procurements.

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About Raxco Software

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