

StorTrends iTX: Application-aware Scheduled Snapshots

Introduction

In any storage system, the feature that is of paramount importance to the user is data protection. While the user takes for granted that data will not be lost due to a system crash or a design bug, the user also expects that a storage system will protect him or her from inadvertent deletions, unwanted modifications, malicious agents, etc. Snapshots are an industry-wide standard for protecting data at a very fine granularity. Either according to a schedule or under the direction of an administrator, the storage system takes point-in-time snapshots of the contents of a volume in a storage system. Each snapshot is similar to an incremental backup of the data within the system; what distinguishes snapshots is the way that the data is backed up, improving both space utilization as well as performance. AMI's StorTrends iTX storage offerings have industry-leading support for snapshots, offering an exhaustive array of innovative features, with an implementation that optimizes performance and storage capacity utilization.

While snapshots present a consistent state of the volume to the user in terms of the outstanding I/Os to the storage server, this may not be consistent with respect to the application using this volume in terms of its recoverability. Further the application might be using multiple volumes on the storage server for various purposes. For e.g. Microsoft Exchange server uses a log volume and a data volume to maintain, manage and protect its data. Thus a snapshot on both the volumes must be synchronized in order to achieve application recoverability. Also, most often the I/Os may be getting cached on the initiator, which might be doing delayed-writes to the volume, thus the snapshot taken from within the storage server does not always assure application-consistent data recoverability on a disaster.

Thus there needs to be some application and host aware agent on the application server which communicates with the storage server in order to create application-aware consistent snapshots. This host agent must be able to quiesce the application and trigger the snapshots on all the application-specific volumes (**consistency group**). AMI Storage Server and Host Attach Kit (HAK), with its Microsoft VSS

Hardware Provider and Application-specific agents such as MS Exchange and Oracle snapshot agents, comes to the rescue.

1. Microsoft Volume Shadow Copy Service (VSS)

The Volume Shadow Copy Service (VSS), introduced in Microsoft Windows Server 2003 and Windows Storage Server, is the infrastructure that provides built-in high-fidelity snapshotting (shadow-copy) capabilities. VSS is designed to support both host-based and hardware based storage solutions. Host based solutions, as the name exemplifies, are host-resident and either need special software providers or can use the default system software provider of VSS. AMI StorTrends iTX is a hardware based storage solution external

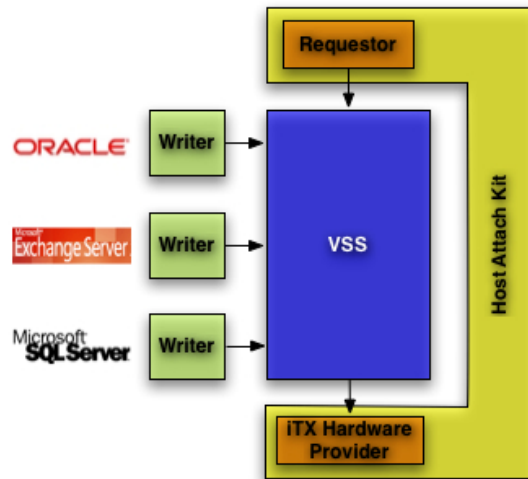


Figure 1: VSS-based Snapshot Architecture

to the host machine. In order to leverage the features of VSS a Host Attach Kit (HAK) is provided by AMI which contains as one of its components a StorTrends iTX VSS Hardware Provider.

For any VSS-based shadow copy infrastructure there are 3 main components that need to interact with the VSS Framework in a manner specified by VSS. These components are

- **Requestor** – This is the component that invokes the Shadow Copy (snapshot) operation. This could either be a backup application creating a VSS-enabled backup or a management application such as the StorTrends iTX Scheduler service, a part of the StorTrends iTX HAK that creates scheduled snapshots.
- **Writer** – As mentioned earlier during the snapshot process, all the outstanding application writes have to be quiesced and further new writes queued, till the snapshot operation is completed in order to create application

consistent snapshots. Writers are application-specific modules which do precisely this.

- **Provider** – Providers are interfaces to snapshotting capabilities, as described earlier. StorTrends iTX Hardware Provider interacts with the snapshot monitor in the StorTrends iTX boxes to create a snapshot. Snapshot operations such as creation, deletion, and rollback in StorTrends are very fast operations with very little overhead. We will discuss briefly the powerful and feature-rich StorTrends snapshots in a subsequent section.

Snapshot Creation Sequence - the VSS way

In order to take the snapshots using the VSS the Requestor, the Writer and the Provider interact with the VSS coordinator in a specific way. The sequence of operations involved in this process¹ is listed below.

- The requestor, in this case the StorTrends iTX Scheduler Service, notifies the VSS coordinator service to prepare for shadow copy creation.
- The VSS coordinator notifies the application-specific writer, say, Exchange or Oracle, to prepare its data for making a shadow copy.
- The writer prepares the data in whatever way is appropriate for that application, such as completing all open transactions, rolling transaction logs, and flushing caches.
- When the data is prepared for shadow copy creation, the writer notifies the VSS coordinator.
- The VSS coordinator relays the message to the requestor (iTX Scheduler), and the requestor initiates the “commit” snapshot phase.
- The VSS coordinator temporarily halts (quiesces) application I/O write requests (I/O read requests are still possible) for the several seconds required to create the shadow copy of the volume or volumes.

¹ See the whitepaper “Storage Management Using Windows Server™ 2003 and Windows® Storage Server 2003 Virtual Disk Service and Volume Shadow Copy Service”, Microsoft Corporation, August 2003

- Now the StorTrends iTX hardware provider informs the Snapshot Monitoring Agent in the StorTrends iTX box to create the snapshots. Note that there could be multiple volumes in the consistency group and the snapshots of all the volumes need to be taken. According to VSS Specification a maximum of 10 seconds is allowed for this entire operation. StorTrends iTX Snapshots are extremely fast and multiple volume snapshots can be created simultaneously with a single call. The StorTrends snapshots are discussed in greater detail in the following section. Note that the scheduler can specify the number of snapshots to retain per volume, and in case the number of snapshots has exceeded this amount the oldest snapshot has to be deleted before creating the new snapshot. But with StorTrends Advanced Snapshots all these operations are finished within the 10 seconds cut-off time for VSS.
- After the shadow copy is created, the VSS coordinator releases the writer from its temporary quiescent phase.
- All queued write I/Os are completed.
- VSS queries the writers to confirm that write I/Os were successfully held during shadow copy creation.
- If the writes were not successfully held (meaning the shadow copy data is potentially inconsistent), the shadow copy is deleted and the requestor is notified.
 - The requestor can retry the process (loop back to 1) or notify the administrator to retry at a later time.

As a direct result of steps 6 and 11-12, the VSS coordinator service ensures that the shadow copy is a highly consistent copy of the original data. Moreover, because all the preparation for making the shadow copy is completed prior to halting the application write I/Os, production performance is not impacted.

Transportable Snapshots

Transportable snapshot is a feature of VSS which can work only with Hardware Providers. This feature enables transport of data between servers accessing the same storage array. By design, storage allocated to one server cannot be

simultaneously used by a second server, which otherwise might result in the two servers managing and writing the same data, the result could spell a disaster. However, the ability to use the snapshot of the data in the other server could enable data protection while at the same time providing an ease of data management. Snapshots taken using AMI StorTrends iTX Hardware provider on one server can be exposed as targets to a different server and used. With StorTrends support for writable snapshots these snapshots can also be used in writable mode thereby enabling a number of advanced storage management solutions.

2. StorTrends iTX Snapshots

StorTrends iTX snapshots are Redirect-on-Write Snapshots i.e. all new writes to the volume to already written portions prior to the snapshot, are redirected to new space on disk, and managed using mapped tables. This means that compared to conventional Copy-on-Write Snapshots, which read the old data, write them to a different area and then perform the new writes, the number of I/Os saved by snapshots is considerable. Further, any portions which were unwritten during the previous snapshot life time can be tracked (provision tracking) and reused. Thus StorTrends snapshots deliver better performance both in terms of I/O and space savings. In fact, upon comparison of StorTrends I/O performance with other contemporary storage stacks, it has been found that contemporary storage stacks typically fall to about 10% of the original performance after a snapshot, whereas StorTrends storage stack performance drop negligibly (by about 5 – 10 %) even after multiple snapshots. StorTrends iTX supports up to 254 Read Only and 254 Writable snapshots². The ability to create snapshots in both Read-only and writable mode is a powerful feature of StorTrends snapshots. Writable snapshots are typically used in testing disaster recovery points using snapshots or CDP, boot server consolidation etc. Further, it has been observed that typically creation, deletion and rollback operations on StorTrends snapshots take less than 100 ms³. A combination

² With the new StorTrends iTX 2.7 coming out later this year these limits have been extended to 1022 Read-only and 1022 Writable snapshots.

³ For an in-depth coverage of StorTrends snapshots, see the whitepaper "AMI Snapshot Technology: Overview" available from www.ami.com.

of all these features make StorTrends snapshot technology the best available in the market.

3. Scheduling Snapshots

Administrators of storage systems in enterprises periodically backup the data of their production servers to other disk-based and tape-based storage servers periodically, say every night, or every week or a month depending on the nature of data. In order to do this job they typically use custom scripts and daemons to schedule such tasks. StorTrends iTX Software makes the job easier for the administrators by allowing them to create schedules for creation of snapshots using its Web-based Management Station – ManageTrends, or its CLI. When a schedule is created the administrator has the option to choose the number of snapshots he wishes to retain - when this count overflows, the StorTrends scheduler will automatically delete the oldest snapshot and create a new snapshot. Additionally, a backup target can be created and the backup utility will use this target to backup the snapshot.

Snapshot Schedule For SecRepsan1

Description

Enter maximum copies and frequency of the schedule:

Maximum copies **Frequency** Every

Maximum Copies	Frequency
<input type="checkbox"/> 200	1 minute
<input type="checkbox"/> 30	5 hour
<input type="checkbox"/> 1	1 week
<input type="checkbox"/> 20	1 month

Backup Target Name

Choose an existing target iqn.1991-10.com.ami:itx:00c09f2164ffd13e:

Create a new target iqn.1991-10.com.ami:itx:00c09f2164ffd13e:

Target User Name (optional)

Target Secret (optional) (min. 12 characters)

Enable Disable

Allow multiple initiators to logon concurrently

NOTE: As a best practice measure, it is recommended that 20% of Storage Pool capacity be reserved (left free) for snapshots

Figure 2: Scheduling Snapshot using ManageTrends

There might be a need to create multiple schedules and snap-retentivity criteria – the StorTrends iTX allows up to 8 levels of schedules of snapshots for each volume or consistency group.

4. Host Attach Kit (HAK) and Agents for non-VSS environments

Volume Shadow Copy service (VSS) was introduced by Microsoft in Windows 2003 server. However, for Windows 2000 and Windows XP, released prior to that there is no support for VSS. StorTrends iTX Software have a solution for such scenarios also called Snapshot Agent Framework Environment (SAFE). SAFE is a part of the StorTrends iTX Host Attach Kit, which also includes StorTrends iTX Scheduler service and StorTrends iTX Hardware Provider for VSS environments. SAFE implicitly checks if the environment is VSS or non-VSS and acts accordingly.

StorTrends iTX HAK also contains agents for Microsoft Exchange and Oracle which help in suspending the respective applications for the process of creating snapshots in non-VSS environments. This typically performs the task similar to that of writers in VSS environment.

SAFE loads the application agents dynamically depending on the configuration found in its safe.ini file in HAK installed path (drive\Program Files\Ami\iTXHardwareProvider). By default, all the agents are configured in safe.ini as disabled state. To enable particular agent, needs to change in the corresponding agent section 'enable' field needs to be modified from 'no' to 'yes' in the safe.ini configuration file. All the enabled application agents configured in the safe.ini are involved by SAFE before taking snapshots.

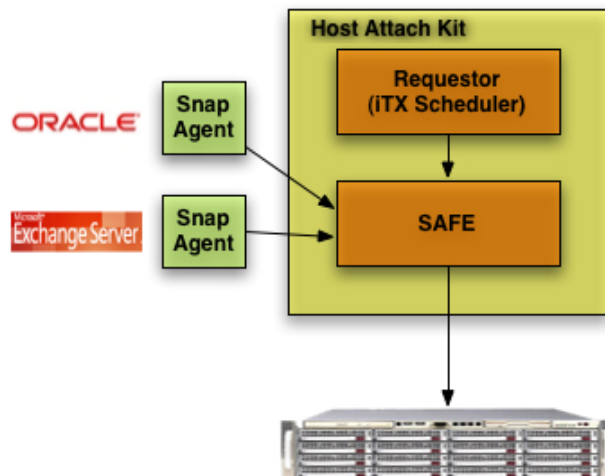


Figure 3: Non-VSS Based Snapshots

SAFE uses the StorTrends iTX Scheduler Service to poll the StorTrends iTX boxes every minute to obtain the snap schedule for the volume defined using either ManageTrends or CLI, as discussed in the earlier section.

If it finds any particular volume needs to take snapshot, using the calls defined by SAFE, it identifies whether the system is VSS-based or non-VSS based and if VSS based initiates the VSS snapshot sequence explained earlier. If, however, the system is non-VSS based, it finds if any of the loaded agents are using the StorTrends iTX volume. If SAFE finds that any of the supported applications are using that particular volume for their storage, then it will communicate with the corresponding application agent to suspend the application and close all the file handles before performing snapshot. The communication between the SAFE and the agents are standardized calls and new application agents can be created as plug-ins to work with SAFE. Currently application agents are available to work with Oracle and MS Exchange Server.

5. Summary

StorTrends snapshots are undoubtedly the best in the industry. With a host of powerful and attractive features, and top performance benefits they truly stand out in comparison to its contemporaries. Combined with this, the benefits of scheduling snapshots using an intuitive GUI, and the ability to create application-specific, consistency-group honoring snapshots means that StorTrends iTX and its tools are truly pioneering and an indispensable tool to the storage administrators.