Features of Oracle StorageTek's VSM/VLE virtual storage products –or- How to get the most feature/function with your tape storage

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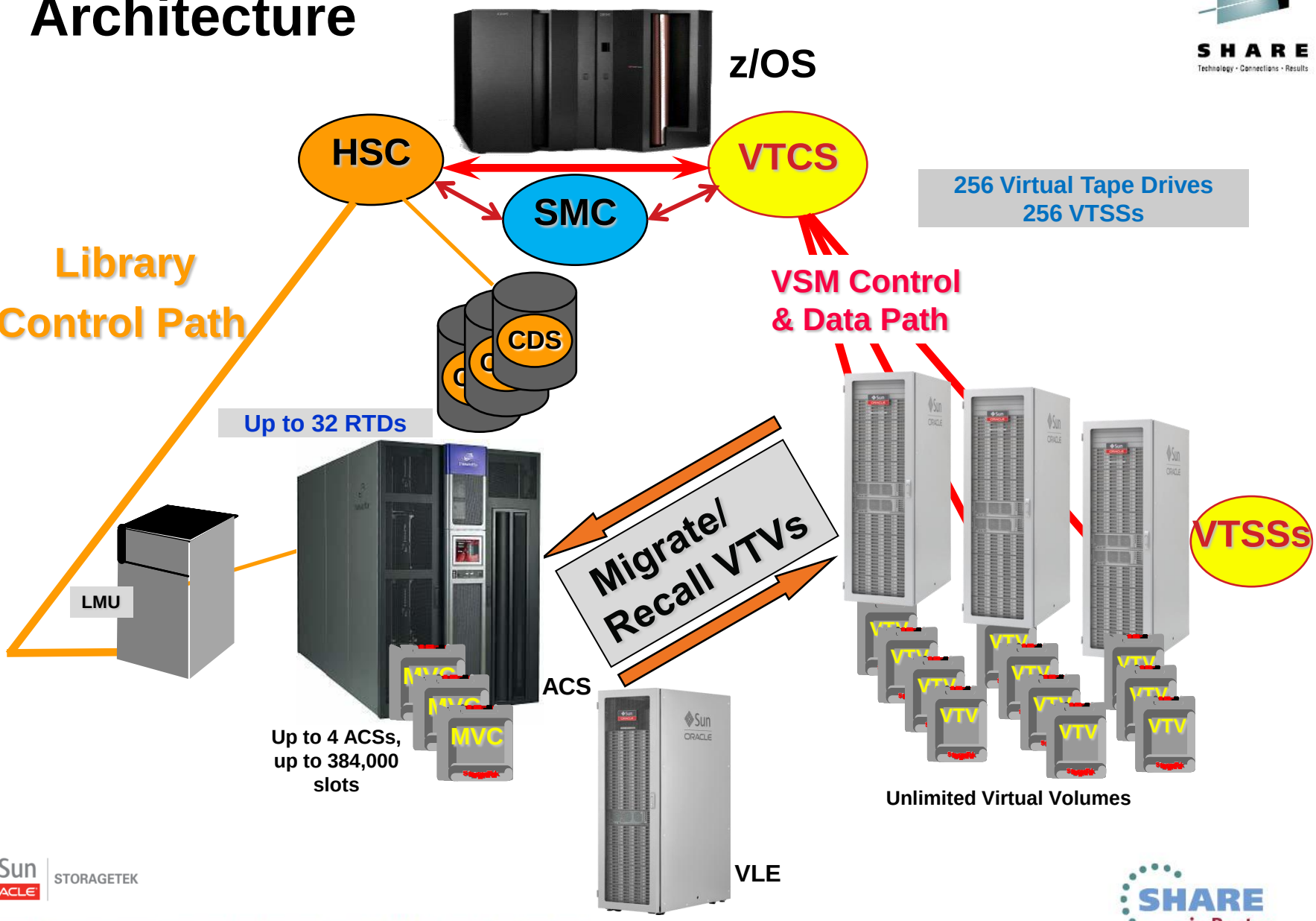
Session 14134

VSM Legacy

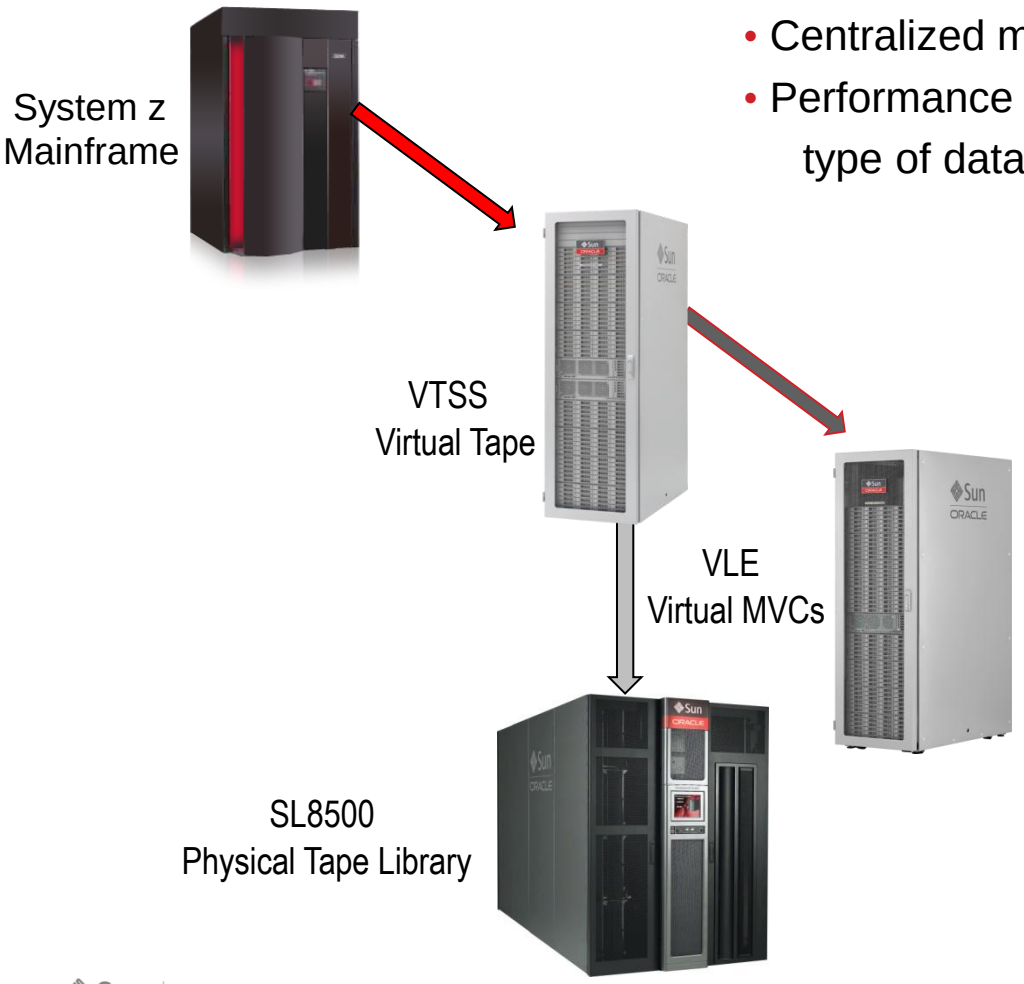
- A commitment to innovation, leadership, and investment protection
  - Full read/write interchange across generations

Architecture



Oracle's StorageTek Virtual Storage Manager (VSM) Tiered Storage

- Provides seamless integration of hardware and software
- Centralized management for all parts of storage system
- Performance and cost of storage closely matched to type of data



- **Tier 1 – High Performance**
  VTSS Disk 10TB – 1.2PB
  (300PB effective capacity)
- **Tier 2 – Economical VLE**
  Disk 330TB – 338PB
  VLE-to-VLE Dedup'd copy
- **Tier 3 – Tape**
  Up to 1000PB
  lowest cost, high capacity
  long-term archiving

Agenda

- VSM Architecture
- Clustered VTSS
  - Uni-directional
  - Bi-directional
- VTCS Dynamic Reclaim
- Concurrent Tape Recall/Mount
- VTCS DR Synchronization
- Cross-TapePlex Replication
- VLE Overview
- VLE Features
  - Encryption
  - Deduplication

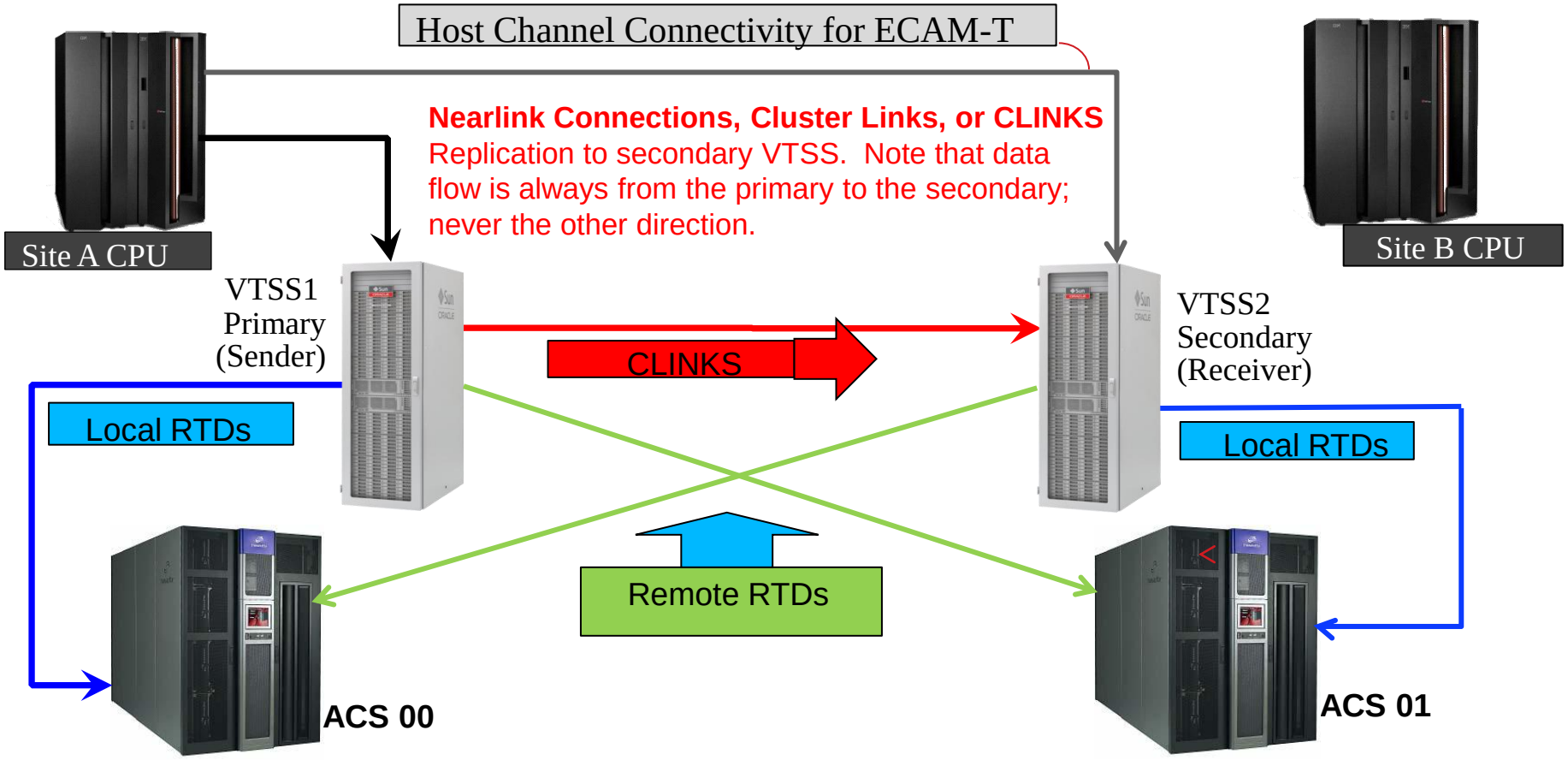
VSM Architecture

- VSM creates VTVs (virtual tape volumes) in VTSS buffer
- VTVs are migrated to VLEs (Virtual Library Extensions) and/or MVCs (Multi-Volume Cartridges) based on customer policies
- Migration to MVCs can be:
  - 1 to 4 VTV copies
  - On different MVCs
  - On MVCs in up to 4 different ACS Library locations
  - On different media
    - for maximum performance or high capacity for archive
  - This allows customers to have VTV copies at their production site, DR site, and other site(s) automatically
- In the event that a VTV cannot be read on one MVC, VSM's host software, VTCS (Virtual Tape Control Software), will automatically select the VTV from an another MVC

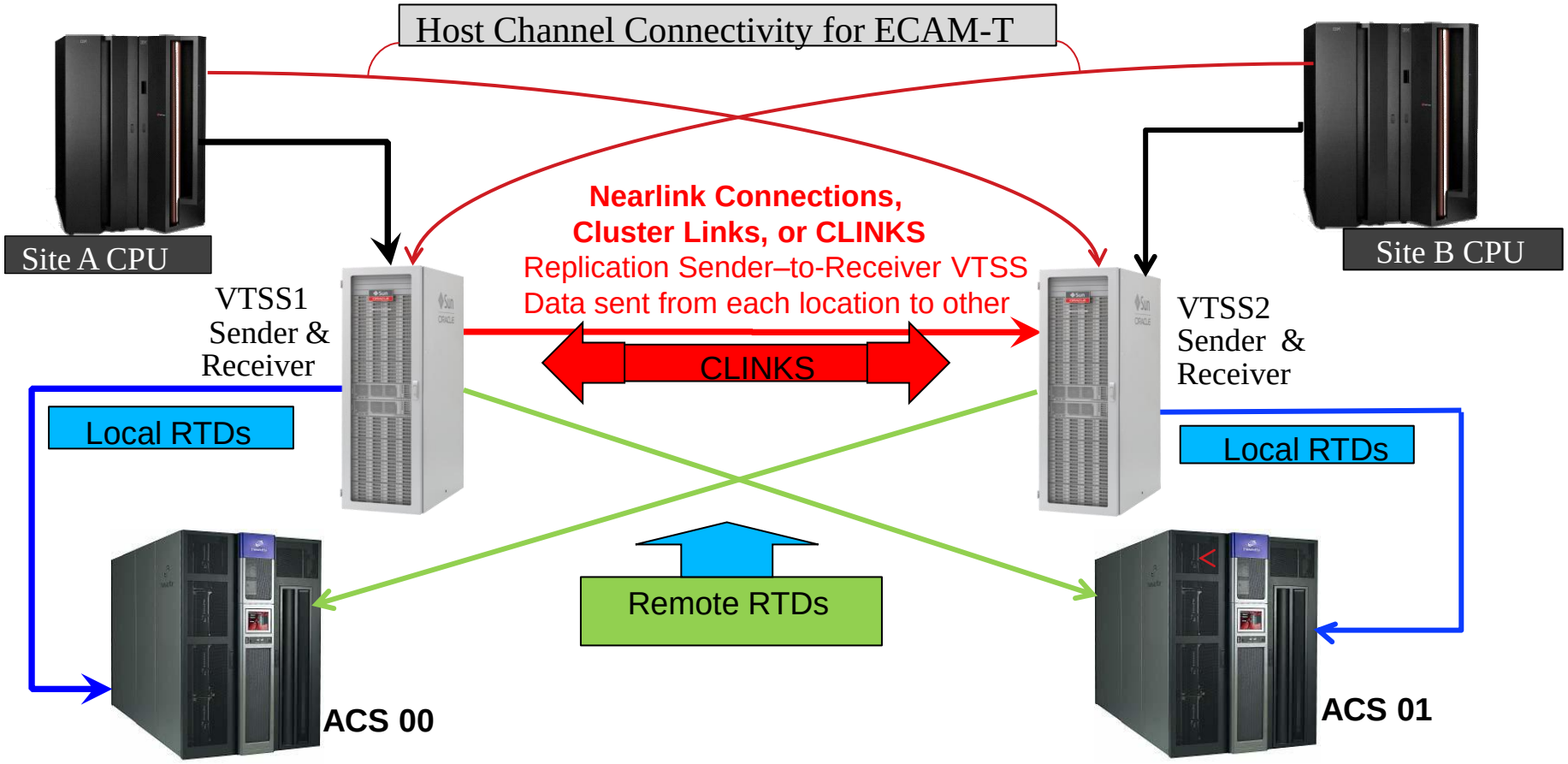
VSM Feature: Clustered VTSS

- Clustered VTSS offers the highest level of availability
  - Virtual volumes are written to a Primary VTSS and then upon dismount are replicated to a Secondary VTSS – either in the same location or at a remote site
  - Configured in a singleTapePlex with one set of CDSs
- Clustered VTSS is defined as a pair of VTSSs
  - Uni-directional – one site replicating to a second site
  - Bi-directional – each site replicating to the other
  - Replication queued at VTV dismount based on customer-defined policies
  - Replication can be:
    - via FICON or IP for VSM5; IP for VSM6
    - Synchronous or non-synchronous
    - requires no host involvement
    - runs in background

Uni-Directional Clustered VTSS



Bi-Directional Clustered VTSS



Clustered VTSS (cont'd)

- Clustered VTSS allows you to:
  - Have VTV copy (or copies) offsite electronically via:
    - remote vRTDs in remote VLEs and/or
    - remote RTDs in remote ACSs
    - in same city; preferably in different city or state
- Secondary VTSS acts as a warm standby
- Used for High Availability and Disaster Recovery
- Provides immediate Business Continuance
- Eliminates single point of failure

VSM Feature: VTCS Dynamic Reclaim

- With the introduction of higher-capacity tape drives, MVCs (Multi-Volume Cartridges) now hold thousands of gigabytes of data, which are individual datasets, or VTVs (Virtual Tape Volumes) stacked on the tape, often with different expiration dates
- Capacity of Oracle's StorageTek T10000x Tape Drives
  - T10000B has a native capacity of 1 terabyte
  - T10000C has a native capacity of 5 terabytes
  - T10000D has a native capacity of 8.5 terabytes
- Over time, tapes becomes fragmented with non-current data caused by expiring VTVs interspersed throughout the tape
- How can unused space be reclaimed fast and efficiently?
- Traditional reclaim is done when a fragmented MVC reaches a customer-defined threshold, it requires the user to run a Reclaim job, which recalls VTVs back into the VTCS buffer, and re-migrates them back out to a different MVC

VTCS Dynamic Reclaim (cont'd)

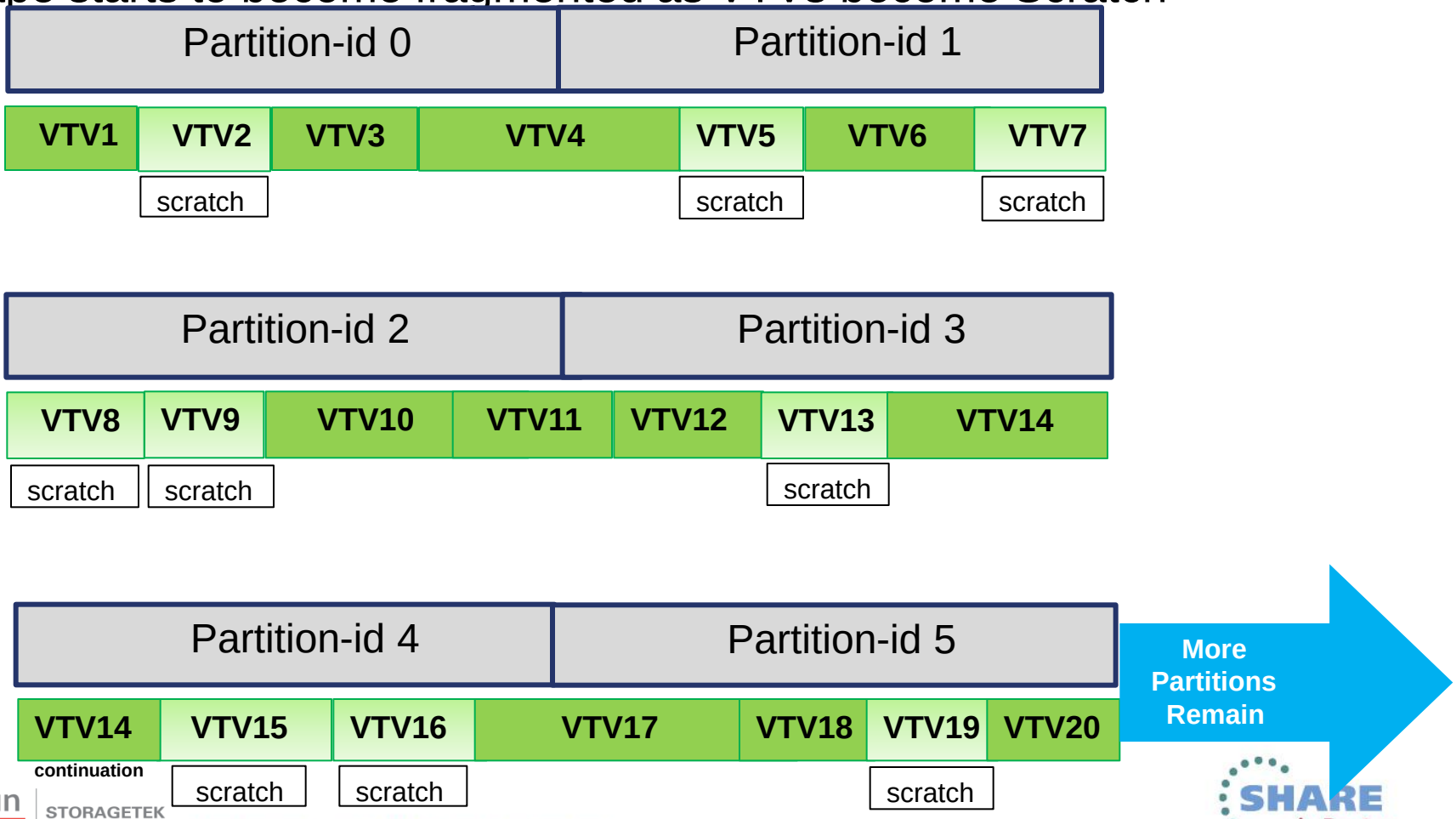
- Oracle's StorageTek T10000B and T10000C tape drives introduced a new tape technology called tape partitioning
- This provided an opportunity to *dynamically* reclaim unused space on tapes
- VTCS Dynamic Reclaim is VSM's implementation of reclamation for partitioned MVCs

VTCS Dynamic Reclaim (cont'd)

- Dynamic Reclaim requires no RTD mounts, no VTSS buffer resources and no data movement
- Dynamic Reclaim works by creating automatically linked partitions on the tape whereby VTVs can span across partitions and be non-contiguous on the tape
- Dynamic Reclaim keeps the partition-id and block-id in the CDS (Control Data Set) Partition Map Record

How Dynamic Reclaim Works

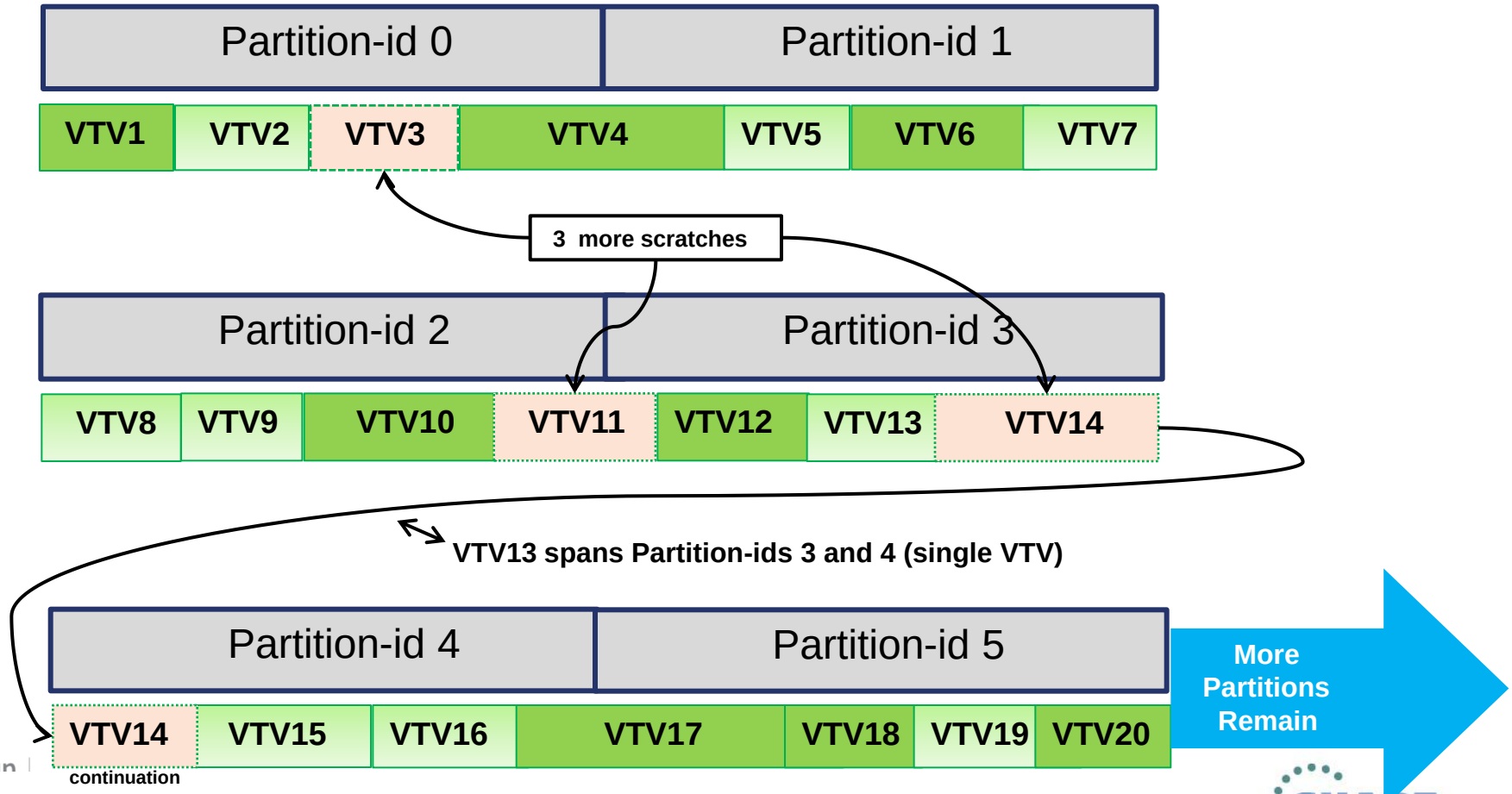
- The first time a partition-format MVC is mounted for migration, VTVs are migrated in consecutive block-ids into partitions
- Tape starts to become fragmented as VTVs become Scratch



How Dynamic Reclaim Works (cont'd)

- Tape continues to fragment – 3 more VTVs Scratched

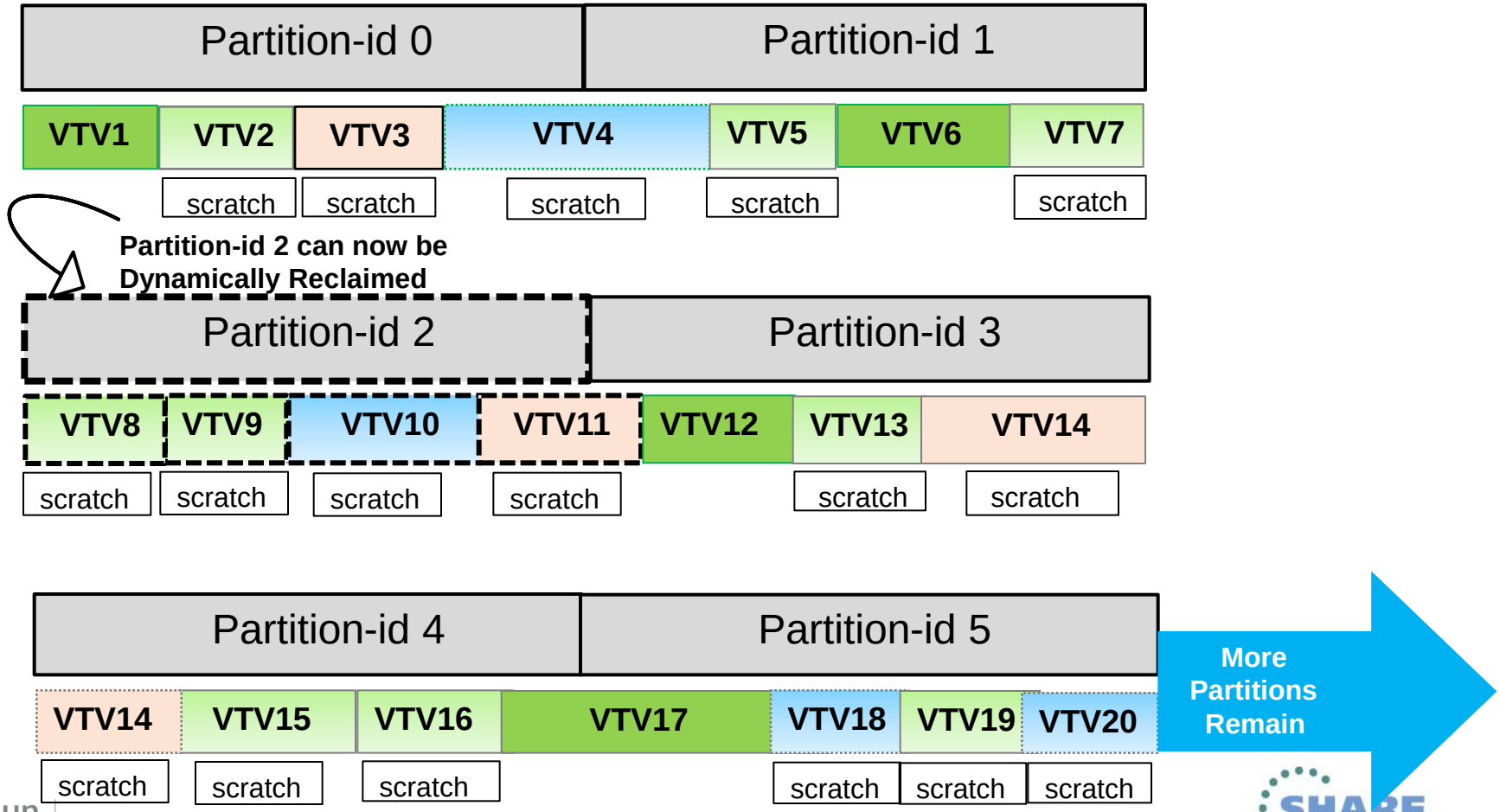
Note: <u>All</u> Partitions <u>still</u> have active VTVs and are not eligible to be Dynamically Reclaimed



How Dynamic Reclaim Works (cont'd)

- Tape fragmentation continues - four more VTVs Scratched

Note: Partition-id 2 has no more active VTVs and becomes eligible for Dynamic Reclaim

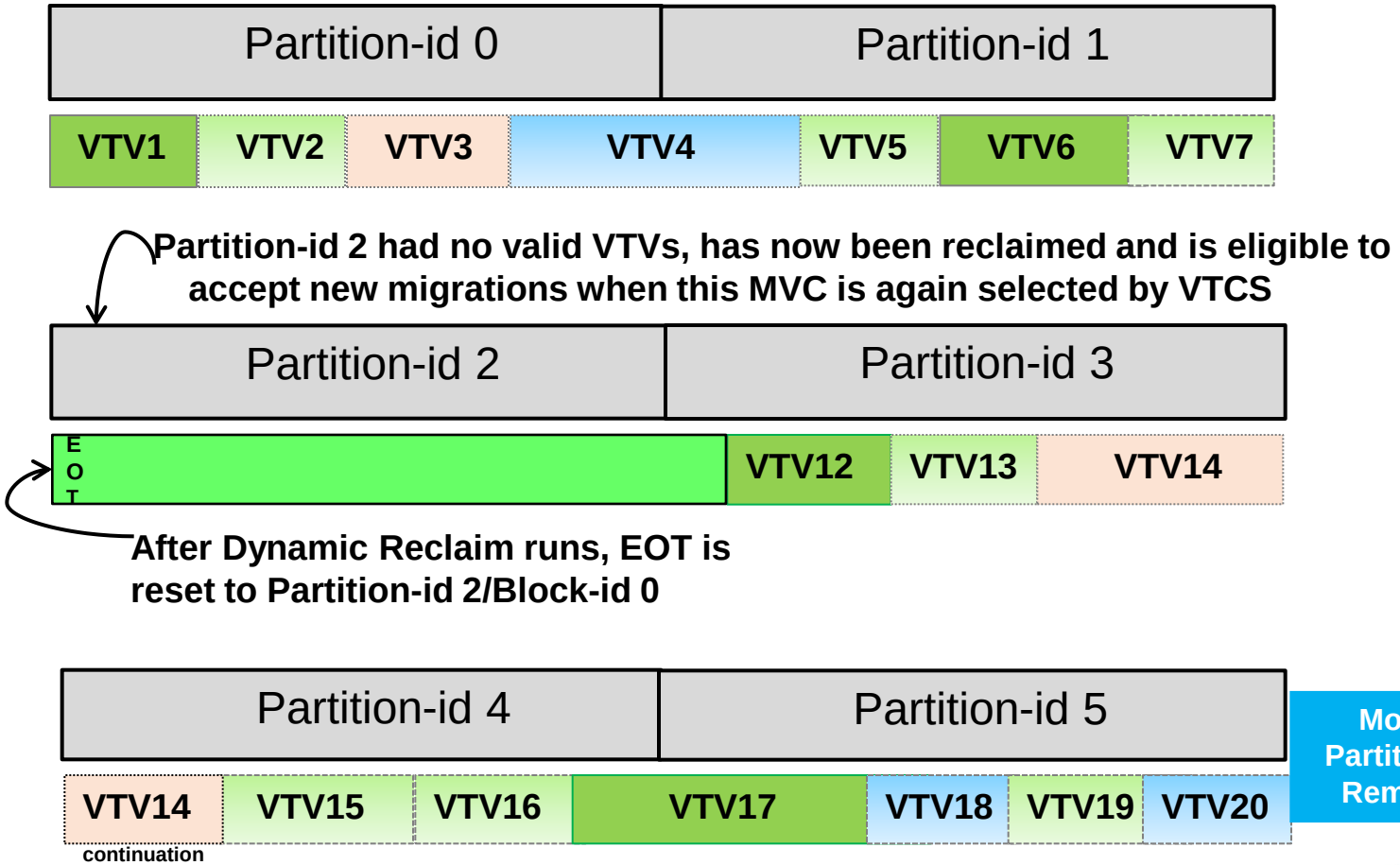


Dynamic Reclaim Executes

- So now we have an MVC that has been filled with VTVs
- The tape has become fragmented
- Once the tape becomes fragmented over and above the customer-defined threshold for Dynamic Reclaim, VTCS Dynamic Reclaim runs automatically
- During dynamic reclamation, each partition is examined to see if there are any active VTVs
- Only partitions with no active VTVs will be reclaimed during this execution process

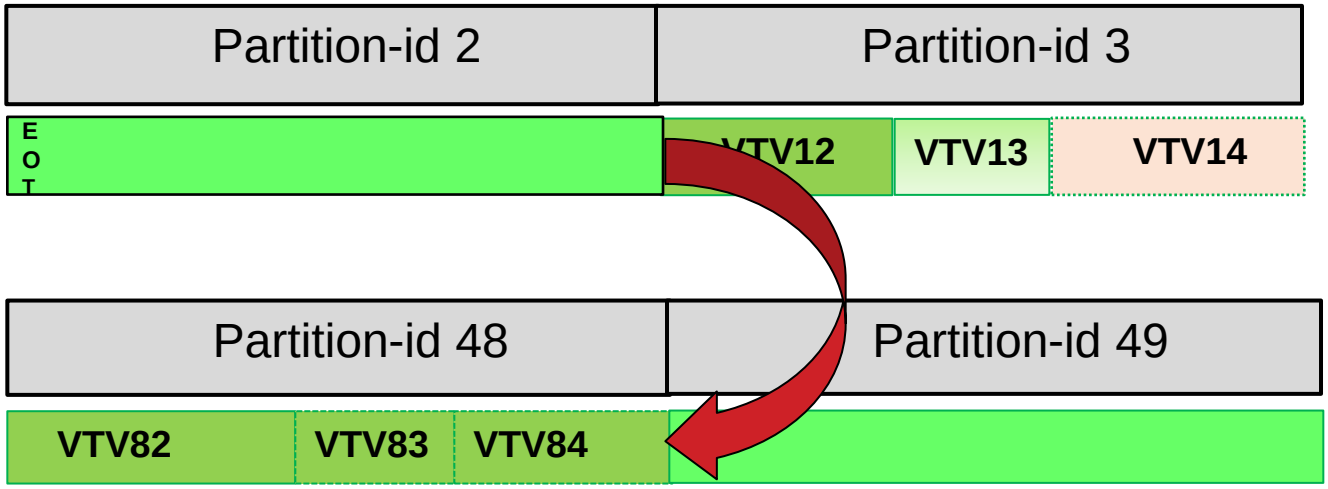
Dynamic Reclaim Executes (cont'd)

- When VTCS Dynamic Reclaim runs, Partition-id 2 is reclaimed
  Each Partition is examined during the reclamation process to check for valid VTVs



After Dynamic Reclaim Runs

- When VTCS again selects this MVC for migration, VTVs will start being written to the partition-id/block-id marked EOT
- When migrations start occurring to partition-id 2, the first block-id on that partition is changed to block-id 0 and then the block-ids are numbered consecutively from that point on and automatically linked to the next empty partition



Dynamic Reclaim Enablement

- The first time an MVC cartridge is used, the format, standard or partitioned, is determined by whether Dynamic Reclaim is enabled
- Dynamic Reclaim is enabled by defining the VTCS CONFIG INPLACE parameter, which is a new parameter on the VTCS CONFIg RECLAIM Statement The settings for this parameter are:
  - INPLACE(YES) – this specifies that Dynamic Reclaim is enabled at the global level for all Storage Classes and that the fragmentation percentage to start Dynamic Reclaim (INPTHRSH) will also be specified globally
  - INPLACE(NO) – this specifies that Dynamic Reclaim is enabled, but the parameter will be specified for certain Storage Classes on each STORclas statement

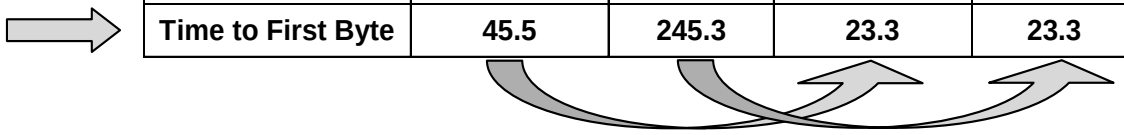
VSM Feature: Concurrent Tape Recall/Mount

- The problem:
- Recalls of VTVs from tape has always meant that the entire VTV had to be recalled back into the buffer from the tape before the application could begin to access the data.
- The time to recall the VTV is determined by:
  - the time to mount the MVC on the drive
  - the time to locate the VTV on the tape
  - the recall data transfer rate *times* the size of the VTV
- Depending on the size of the VTV, the VTSS FICON recall data transfer rate can be the dominant portion of the overall recall time. Because of this, many customers will intentionally use smaller VTV sizes, 400 MB vs. 4GB. This reduces the recall time, but significantly increases the number of VTVs that the customer, MVS, and VTCS have to manage.

Concurrent Tape Recall/Mount (cont'd)

- The solution:
- VSM Concurrent Tape Recall/Mount is a feature in VSM which will drastically improve the mount time for a VTV that is not resident on the (VTSS) Virtual Tape Subsystem buffer
- This VSM feature is also referred to as "Early Time To First Byte" or by the acronym ETTFB. The following is an approximate time comparison:

All Times in Seconds	Time Without ETTFB		With ETTFB	
	SL3000/T9840D		SL3000/T9840D	
	400MB VTV	4GB VTV	400MB VTV	4GB VTV
Mount Time	12.3	12.3	12.3	12.3
Locate Time	11	11	11	11
Recall Time	22.2	222	22.2	222
VTV Mount Time	0	0	0	0
Time to First Byte	45.5	245.3	23.3	23.3



How Does ETTFB Work?

- The concept of the ETTFB feature is to reduce the time to first byte as seen by the application job.
- This is achieved by overlapping the VTV recall and mount.
- Instead of waiting for the entire recall to complete, after the recall has been initiated, the VTV is concurrently mounted on the VTD as well.
- This allows the application to access the VTV while it is still being recalled.
- VTSS is responsible for pacing the VTD during the recall process. If the application attempts to read part of the VTV that has not yet been recalled, the application's I/O request will be blocked until the required VTV data has been recalled.

How to Enable ETTFB

- Two new VTCS CONFIG parameters are being provided:
  - A new VTCS CONFIG GLOBAL statement parameter FASTRECL=YES/NO will enable or disable the ETTFB feature for all VTSSs in the configuration.
    - Note: This feature is Disabled by default.
  - A new VTCS CONFIG VTSS statement parameter NOERLYMT will allow the customer to disable the ETTFB feature for an individual VTSS. This parameter is only relevant if the FASTRECL=YES is globally specified.

VSM Feature: VTCS DR Synchronization

- How to ensure critical VTV data is synchronized with CDS metadata:
  - Ensure all Disaster Recovery critical data has been migrated and is secured at the customer's recovery location
  - Establish system checkpoints in order to establish a recovery point
  - Ensure that DR data remains consistent with metadata until the next checkpoint
  - The metadata copy must be valid and complete when a disaster is declared, either real or test
  - Allow the VSM customer to create CDS backups that reflect checkpoints of the VSM environment with a consistent set of DR data at a given point in time
  - The CDS backup, plus other backups (e.g. Tape Management Catalog, System Catalogs) then form a checkpoint of the entire system
  - VTCS DR Synchronization is a feature that can provide all of these

VTCS DR Synchronization (cont'd)

- Once the customer has determined which data is DR critical:
  - The DRMONitr Utility is run against the data. This will stall a job stream until the VTV copies have reached their MVC target destination(s).
  - Then the DRCHKPT Utility is run, which establishes a checkpoint time. This serves to protect MVC content until some point in the future (i.e. the next DRCHKPT run).
  - After DRMONitr and DRCHKPT have completed, then the CDS backup should be taken, along with other DR critical datasets, such as the TMC and MVS Catalogs.
  - Meanwhile, don't allow overwrites on MVCs until the next DR baseline is established – this is protected by the utility software
- In the event a disaster is declared (real or test), the CDS is restored from the current backup. Because the backup's MVC contents are protected, they can be used without the need for audits because they will be ***synchronized*** with the CDS.

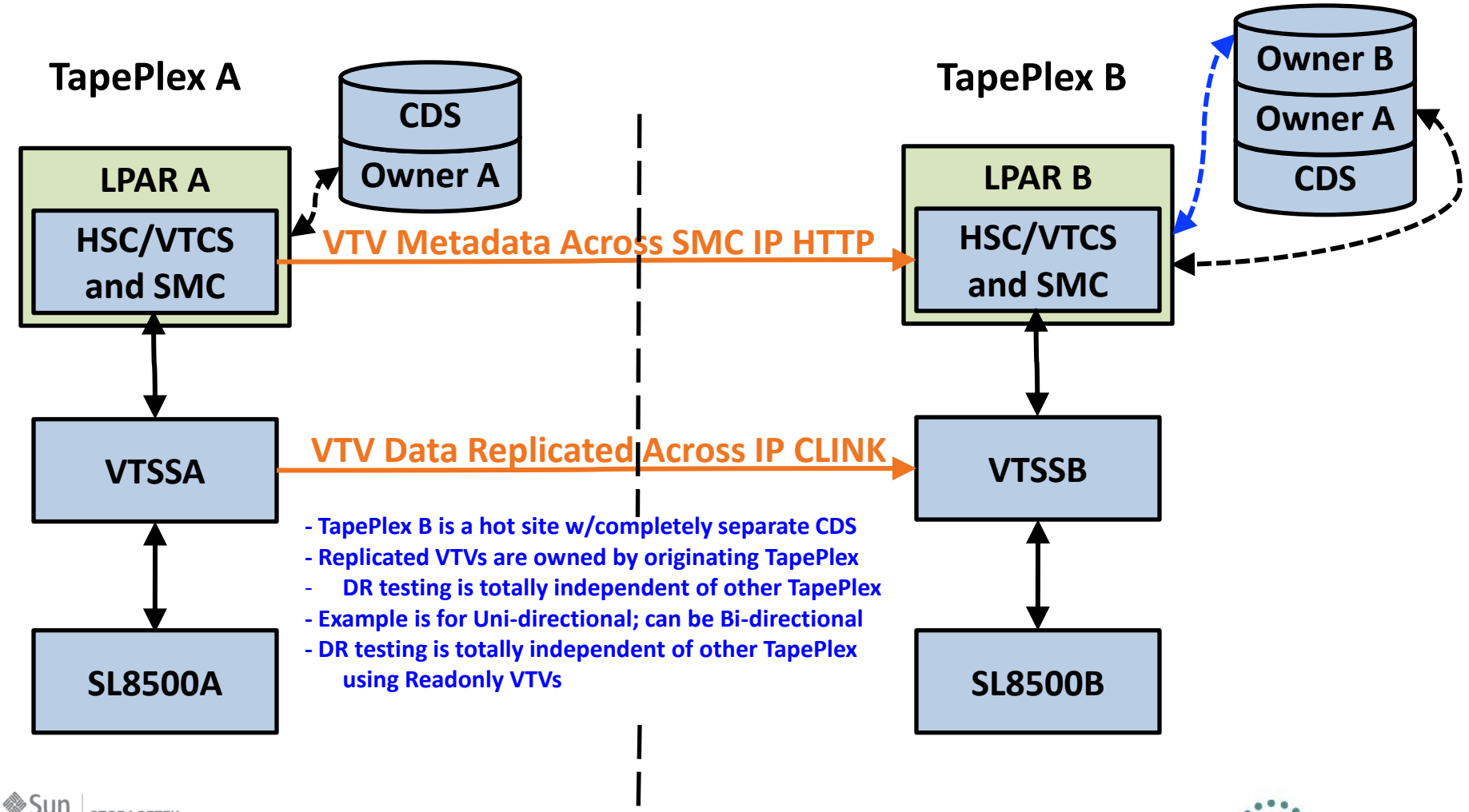
VSM Feature: Cross-TapePlex Replication (CTR)

- Cross-TapePlex Replication operates as an electronic Export and electronic Import of VTV data into a separate TapePlex, with its own CDS configuration, via FICON or IP CLINKs for VSM5, or IP CLINKs for VSM6
- Metadata is transmitted from sending to receiving TapePlex over IP using SMC HTTP
- Originating TapePlex retains ownership of the VTV
- Receiving TapePlex cannot update or scratch VTV
- When VTV is scratched at originating TapePlex, all copies will be scratched
- Provides additional data copies for cascading unlimited number of data copies within TapePlexes and across TapePlexes by the receiving TapePlex's migration policies

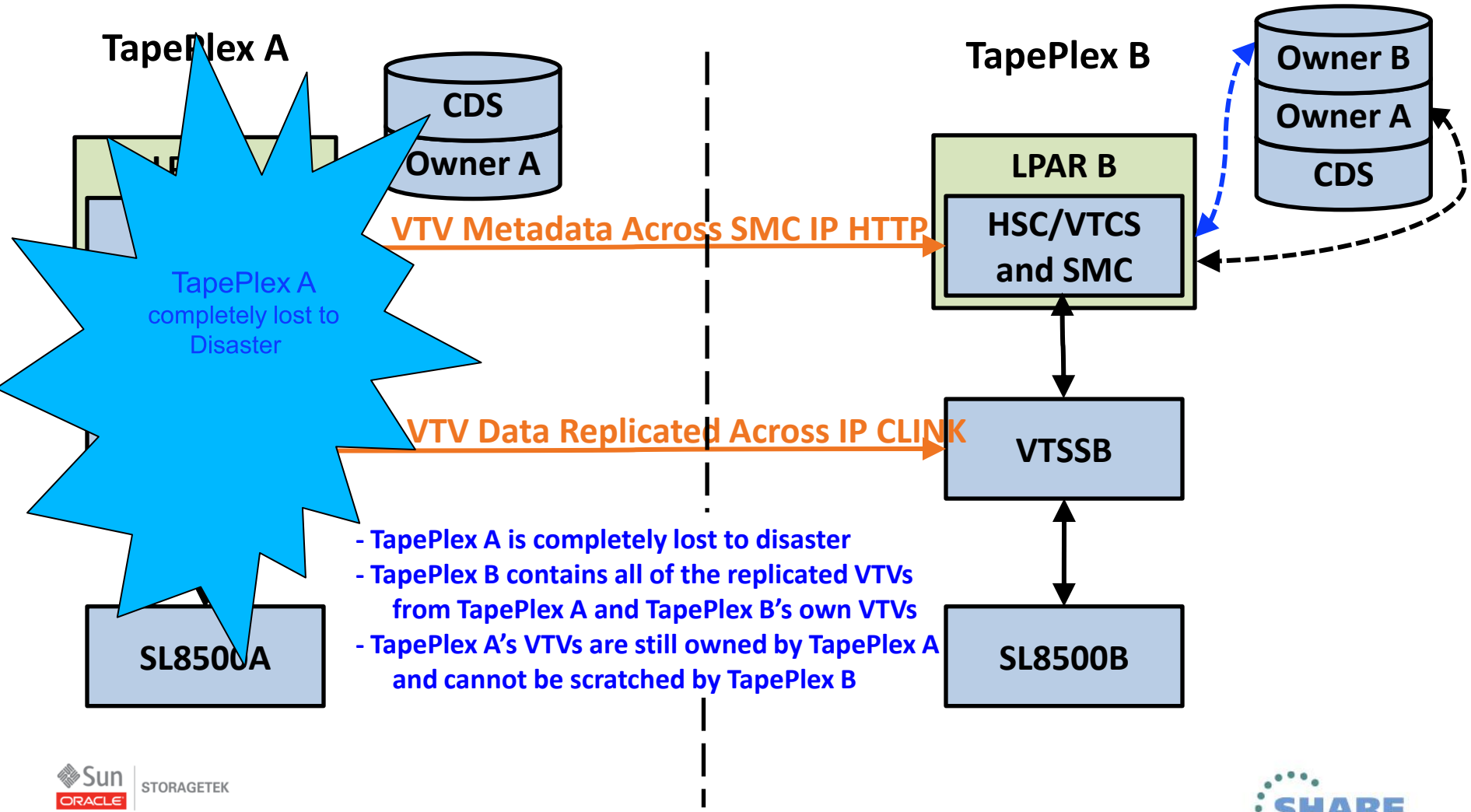
Cross-TapePlex Replication (CTR) (cont'd)

- DR tests can be run without impacting or disrupting the production environment
- If a VTV is needed to be sent back to the owning TapePlex, the electronic export *automatically* recalls the VTV back to the originating TapePlex
- The EEXPORT Utility can also be used to bring the VTV back to the originating TapePlex manually
- CTR Requirements:
  - VTV ranges for the replicated VTVs in both TapePlexes must be the same
  - No overlapping volsers allowed
  - Management Class names for the replicated VTVs must be identical in both TapePlexes

CTR Uni-directional Configuration
Normal Operations

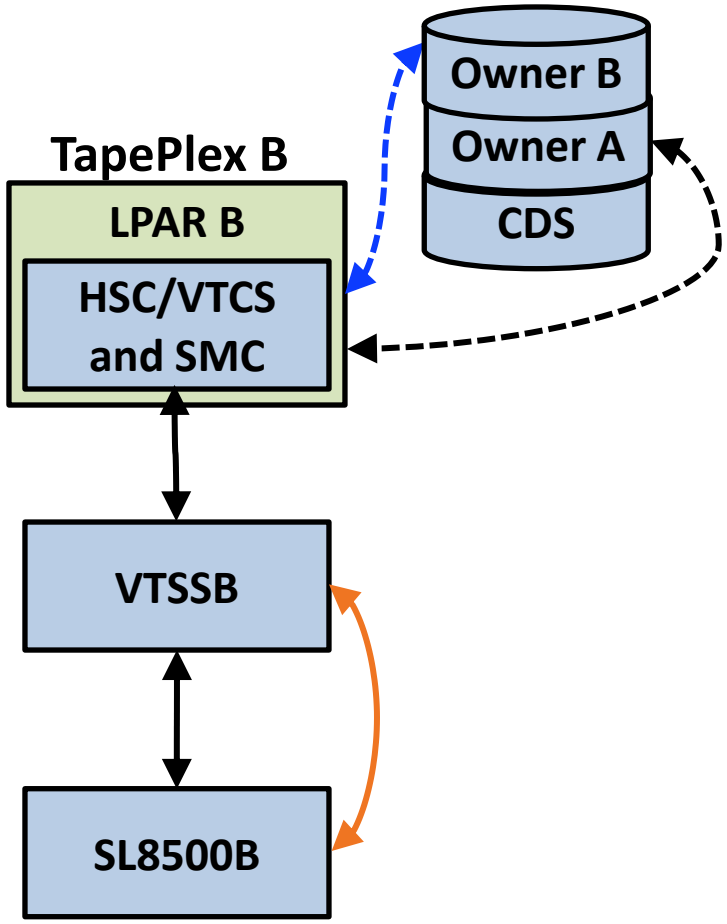


CTR Uni-directional Configuration
Complete Loss of TapePlex A



CTR Uni-directional Configuration
Business Resumption after Loss of TapePlex A

1. Initially, VTVs owned by LPAR A are protected against being scratched
   - This is because they are still owned by TapePlex A
2. During an extended outage, VTVs owned by LPAR A can be changed to be owned by TapePlex B



Virtual Library Extension (VLE) Overview

- VLE is **“more virtual tape” –**
  - VLE looks like a tape library to the VTSS and VTCS
  - The VTVs are stored in Virtual MVCs (VMVCs) on disk
- At the VLE, reads and writes are at disk speed...more virtual tape means no real tape mounts/dismounts
- VLE is a collection of nodes, which together comprise a VLE system, and are interconnected with a private internal network – any node can access any other node in the complex
- The VLE solution consists of VTSS, VLE appliance (hardware and software), VTCS and SMC
- VLE, therefore, provides an additional storage tier in the VSM solution. VTVs can now migrate from VTSS to VLE to provide fast access to recent data. Additionally, VTVs can transition from VLE storage to real tape media (MVCs) for long term archive

VLE Features

- **Multi-Node VLE** – This feature enables massive scaling of the VLE storage system
  - You can construct multi-node systems that can consist of one to 64 nodes, with multiple nodes interconnected by a private network
  - A multi-node VLE appears to SMC/VTCS as a single VLE
- **VLE-to-VLE Copy** - The VLE storage system can now manage data transfers independent of the VTSS
  - If you want to migrate two VTV copies to separate, interconnected VLEs, for example, you can use Management and Storage Classes to migrate one copy using VTSS-to-VLE connections and the second copy using VLE-to-VLE connections. The second migration , therefore, uses no VTSS resources
  - This frees VTSS resources for other work while the additional VTV copies are being made, which improves the overall VTSS throughput

VLE Features (cont'd)

- **Encryption** – This enables encryption of VMVCs written to the VLE
  - Feature is enabled via an encryption key stored on the node, on a per node basis, backed up on a USB device
  - Technology which protects information by converting it into unreadable code
  - No additional charge for Encryption
  - Encryption takes place in the VLE
  - Enabled via VLE GUI

- **Data Deduplication** - This eliminates redundant data in a VLE system
  - Replaces redundant pieces of data with a reference to the original instance
  - Is controlled by a STORCLAS statement parameter
  - Increases the effective capacity of the VLE
  - Is performed by the VLE before the VTV is written to a VMVC

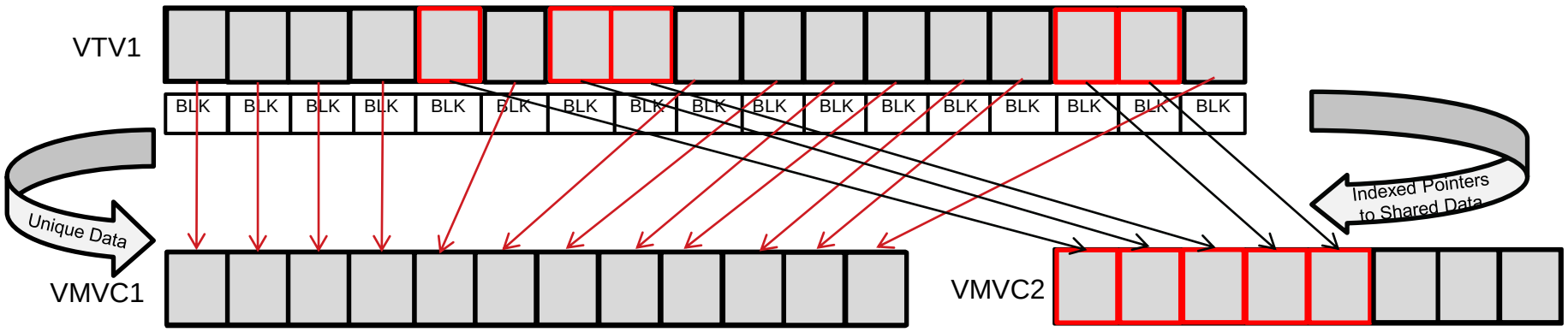
VLE Features (cont'd)

More on Data Deduplication:

- If Dedup is enabled, as data is migrated into the VLE from the VTSS, each 4K block is analyzed, using hashing algorithms and table lookups, to determine if it is unique or if another copy already exists within the VLE
- When a block of data already exists on another VMVC, then the VTV data will point to shared data on the other VMVC
- When VTVs are migrated with Deduplication enabled to a VMVC in the VLE, they are broken up into VTV data and shared data
- Dedup requires a reconstruction process to rehydrate the data for a recall back to VTSS
- Included with base VLE code at no charge.

VLE Features (cont'd)

How Dedup Works . . .



- As VTV1 is being migrated into the VLE, each block is analyzed to determine if that block of data already exists. If it does, an index is created pointing to where in the VLE that particular shared block of data is stored. If the block of data is unique, then it is written to a VMVC.
- If VMVC2 is Drained, shared blocks of data will remain on the VMVC.
- VMVC1 could also contain shared blocks of data, but it is not shown in this diagram.

Thank you . . .

Questions ?