Backup Software Data Deduplication: What you need to know

Presented by W. Curtis Preston
Executive Editor & Independent Backup Expert
When I was in the IT Department

- When I started as “backup guy” at $35B company in 1993:
  - Tape Drive: QIC 80 (80 MB capacity)
  - Tape Drive: Exabyte 8200 (2.5 GB & 256KB/s)
  - Biggest Server: 4 GB (’93), 100 GB (’96)
  - Entire Data Center: 200 GB (’93), 400 GB (’96)
  - My TIVO now has 5 times the storage my data center did!
- Consulting in backup & recovery since ‘96
- Author of O’Reilly’s Backup & Recovery & Using SANs and NAS
- Webmaster of BackupCentral.com
- Founder/CEO of Truth in IT
- Follow me on Twitter @wcpreston
Agenda

- Understanding deduplication
- Advantages and disadvantages of software dedupe
- Dedupe isn’t the answer to everything
Understanding deduplication

BUT FIRST I HAVE TO TAKE YOU BACK IN TIME...
A 1993 Commercial

- This commercial ran the year I entered the industry. (1993)
History of My World Part I

- When I joined the industry (1993)
  - Disks were 4 MB/s, tapes were 256 KB/s
  - Networks were 10 Mb shared

- Seventeen years later (2010)
  - Disks are 70 MB/s, tapes are 160 MB/s
  - Networks are 10 Gb switched

- Changes in 17 years
  - 17x increase in disk speed (luckily, RAID has created virtual disks that are way faster)
  - 625x increase in tape speed!
  - 1000x+ increase in network speed
More History

• Plan A: Stage to disk, spool to tape
  • Pioneered by IBM in 90s, widely adopted in late 00s
  • Large, very fast virtual disk as caching mechanism to tape
  • Only need enough disk to hold one night’s backups
  • Helps backups; does not help restores

• Plan B: Backup to disk, leave on disk
  • AKA the early VTL craze
  • Helps backups and restores
  • Disk was still way too expensive to make this feasible for most people
Plan C: Dedupe

• **It’s perfect for “traditional” backup**
  - Fulls backup the same data every day/week/month
  - Incrementals backup entire file when only one byte changes
  - Both backup file 100 times if it’s in 100 locations
  - Databases are often backed up full every day
  - Tons of duplicate blocks!
  - Average actual reduction of 10:1 and higher

• **It’s not perfect for everything**
  - Pre-compressed or encrypted data
  - File types that don’t have versions (multimedia)
Naysayers

- Eliminate all but one copy?
  - No, just eliminate duplicates per location

- What about hash collisions?
  - More on this later, but this is nothing but FUD

- Doesn’t this have immutability concerns?
  - Everything that changes the format of the data has immutability concerns (e.g. sector-based storage, tar, etc)
  - Job of backup/archive applications is to verify same in/out

- What about the “dedupe tax”?  
  - Let’s talk more about this one a bit
Is There a Plan D?

- Some pundits/analysts think target dedupe is a band-aid, and will eventually be done away with via software dedupe, delta-backups, etc.
- Maybe this will happen in a 3-5 year time span, maybe it won’t
- For some environments, it’s already happened
- One of the main purposes of this session is to examine software dedupe and see where it is appropriate
Plan D?
Appliance & software deduplication

**Appliance Dedupe**
- Standalone appliance that sits behind backup server and dedupes native backups
- Still appliance
  - Appliances that run backup sw in appliance
  - Appliances that support OST & dedupe before appliance

**Software Dedupe**
- Software running on backup server or client that dedupes data to generic storage
- At least three different flavors
- Generally seen as competitor to hardware dedupe
Death of Disk Drives & Dedupe Tax

- Two sure things in backups
- If doing D2D2T or large restores, single stream restore speed is very important
- The dedupe tax can significantly impair your ability to create a fast, single stream of data
- It is caused by reality that deduping data fragments each data set over time
- Each vendor must be doing something to address this issue, or their restore speeds will be very, very slow
Some post-process target dedupe vendors circumvent the dedupe tax for recent restores (caching recent data in native format, forward referencing)

Software dedupe vendors, being inline vendors, are not able to apply these techniques
Where Is the Data Deduped?

- **Target Dedupe**
  - Data is sent unmodified across LAN & deduped at target
  - No LAN/WAN benefits until you replicate target to target
  - Usually cannot compress or encrypt before sending to target

- **Source Dedupe**
  - Redundant data is identified at backup client
  - Only new, unique data sent across LAN/WAN
  - LAN/WAN benefits, can back up remote/mobile data
  - Allows for compression, encryption at source
Source dedupe vs Delta backups

- Delta backups store only new, unique segments between backups of a given client
- They do not compare Elvis’ backups to Apollo’s backups
- Source dedupe compares all segments to each other, regardless of source
- Delta comparison is considered dedupe in appliance world, but not in software world
Hash-based Dedupe

- All software dedupe is hash-based
- Slice all data into segments or chunks
- Run chunk through hashing algorithm (SHA-1)
- Check hash value against all other hash values
- Chunk with identical hash value is discarded
Hash Collision FUD

- There is a finite number of hashes ($2^{160}$)
- It is possible that two chunks with different contents could have the same hash
- It is also possible that Catherine Zeta Jones will dump Michael Douglas and ask me out
- The odds of these two events are roughly the same
## Real Odds of a Hash Collision

In order to reach $1:10^{15}$ odds (UBER on single drive) or $1:10^5$ odds (Double drive failure), the following amounts of hashes and Yottabytes are needed:

<table>
<thead>
<tr>
<th>Hash</th>
<th>Hash Size</th>
<th>Hashes Needed</th>
<th>Zettabytes Needed</th>
<th>Hashes Needed</th>
<th>Yottabytes Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHA1</td>
<td>160</td>
<td>5.4E+16</td>
<td>432</td>
<td>5.4E+21</td>
<td>43</td>
</tr>
<tr>
<td>Tigger</td>
<td>192</td>
<td>3.5E+21</td>
<td>28,345,529</td>
<td>3.5E+26</td>
<td>2,834,560</td>
</tr>
<tr>
<td>SHA256</td>
<td>256</td>
<td>1.5E+31</td>
<td>121,743,120,636,759,000</td>
<td>1.5E+36</td>
<td>12,174,342,499,597,800</td>
</tr>
</tbody>
</table>

- **$10^{-15}$**: Odds of single disk writing incorrect data and not knowing it (AKA Undetectable Bit Error Rate or UBER)
- With SHA-1, we have to write 432 YB to get those odds
- **$10^{-5}$**: Best odds of a double-disk RAID5 failure
- With SHA-1, we have to write 43 ZB to reach those odds

- Modified by Joseph Chapa, PhD using MacLaurin series expansion to mitigate Excel’s lack of precision and is here: [backupcentral.com/hash-odds.xls](http://backupcentral.com/hash-odds.xls)
- YB/ZB needed assumes an 8K chunk size. Larger chunk increases YB/ZB needed
ADVANTAGES AND DISADVANTAGES
Advantages of Source Dedupe

- Reduces bandwidth usage from very beginning
- Allows backup of relatively large datasets over relatively small WAN connections
- Easy backup of mobile data
- All dedupe is global
- Allows for database/application agents
- Can be used to backup virtual servers
Advantages of Software Target Dedupe

- Can use any storage as target, including repurposed storage
- Always global (to capacity)
- Integrated with backup software (including replication)
- Hybrid dedupe allows compression & encryption at client
Disadvantages of Software Dedupe

- Generally not a scalable as appliance dedupe, either in capacity or performance
- Largest capacity source dedupe system is 52 TB (native)
- Appliance systems offer PBs
- Fastest restore is 360 MB/s, vs 1000s of MB/s w/appliance dedupe
- Some of the other stats are not impressive either
- May need to upgrade or replace your backup software to get dedupe functionality
Name That Dedupe

• Integrated Target Dedupe
  • Symantec NetBackup, TSM, ARCServe, CommVault Simpana

• Integrated Source Dedupe
  • Asigra, Symantec NetBackup & Backup Exec, TSM

• Standalone Source Dedupe
  • EMC Avamar, i365 eVault, Symantec NetBackup
Dedupe isn’t the answer to everything

- It’s still a bulk copy of the data for backup and restore
- Creates backup window issues
- Creates RTO/RPO challenges
- At some point, many companies requirements will drive them to CDP and near-CDP
Continuous Data Protection

- Replication with a back button
- Continuously copy block changes to backup system
- Replicated copy always ready for instant restore
- System can roll back in time to recover from logical corruption
Near-CDP

- Snapshots & replication
- Also allows for continuous zero-impact backups
- Can recover to latest snapshot
- Some object to the term “near-CDP” but there is no replacement term
THANK YOU!