Introduction to Data Protection: Backup to Tape, Disk and Beyond

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  - Online DPCO Knowledge Base: www.snia.org/forums/dpco/knowledge
  - Online Product Selection Guide: http://www.snia.org/forums/dpco/psg
- 2016 goals include educating the vendor and user communities, market outreach, and advocacy and support of any technical work associated with data protection and capacity optimization

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- **Trends in Data Protection**
- **Protecting Data in the Big Data World**
- **Advanced Data Reduction Concepts**
- **Privacy vs Data Protection – The impact of EU Legislation**
- **Encryption: What, Where & Why**

Abstract

- Introduction to Data Protection: Backup to Tape, Disk and Beyond
- Extending the enterprise backup paradigm with disk-based technologies allow users to significantly shrink or eliminate the backup time window. This tutorial focuses on various methodologies that can deliver efficient and cost effective solutions. This includes approaches to storage pooling inside of modern backup applications, using disk and file systems within these pools, as well as how and when to utilize Continuous Data Protection, deduplication and virtual tape libraries (VTL), as well as the cloud.
- Learning Objectives:
  - Get a basic grounding in backup and restore technology including tape, disk, snapshots, deduplication, virtual tape, replication technologies and cloud
  - Compare and contrast backup and restore alternatives to achieve data protection and data recovery
  - Identify and define backup and restore operations and terms

Agenda

- Fundamental concepts in Data Protection
- Overview of Backup Mechanisms
- Backup Technologies

Data Protection: Defined

- SNIA definition of Data Protection: Assurance that data is not corrupted, is accessible for authorized purposes only, and is in compliance with applicable requirements
- There are a wide variety of tools available to us to achieve data protection, including backup, restoration, replication and disaster recovery
- It is critical to stay focused on the actual goal -- availability of the data -- using the right set of tools for the specific job -- within time and budgets
- Held in the balance are concepts like the value of the data (data importance or business criticality), budget, speed, and cost of downtime

Data Protection Design Trade-offs

Assessing your priorities

- Backup window
  - Shorten or eliminate
- Recovery Time Objective (RTO)
  - Speed of recovery
  - What is the cost of application downtime?
- Recovery Point Objective (RPO)
  - Amount of data loss
  - How far back in time to recover data?
- Move data offsite for Disaster Recovery (DR)

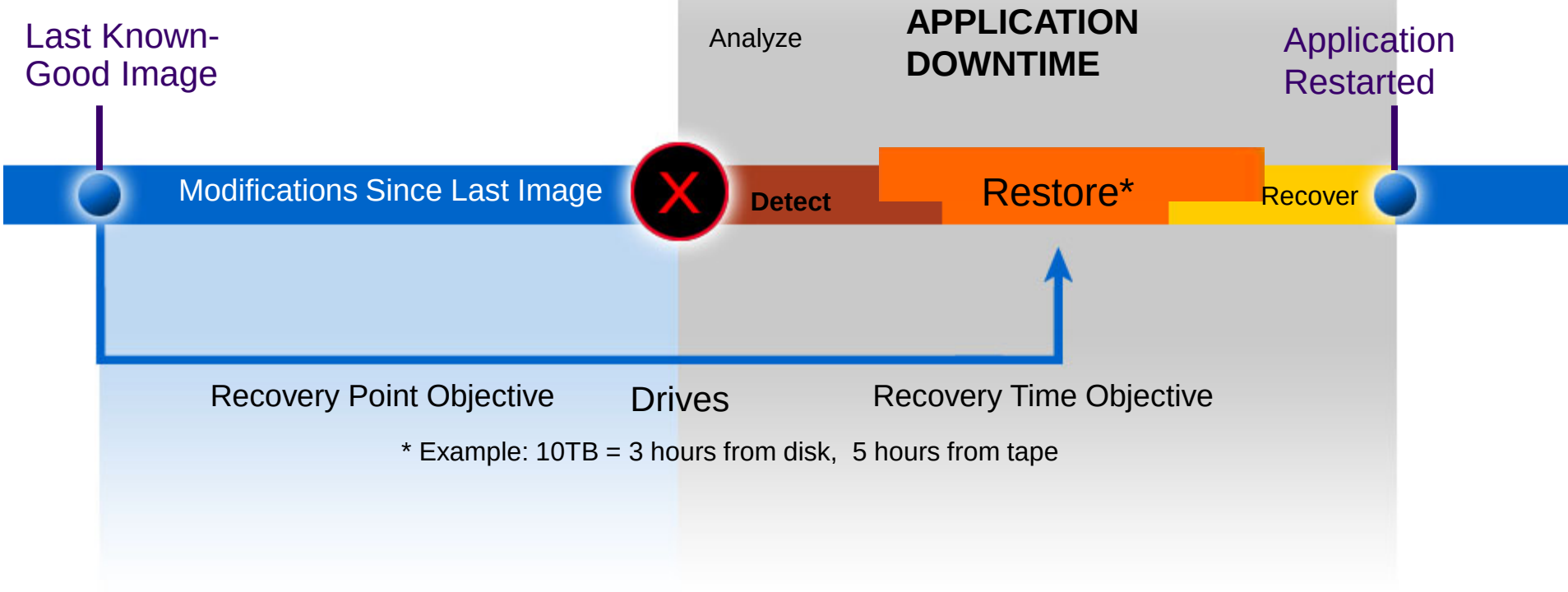
There are trade-offs everywhere

- Newer technology improves but may not eliminate trade-offs
  - Cost, downtime, business impact
- Need to identify the priority order, and establish SLA (Service Level Agreement) targets for each data type
  - What is the cost of a lost application?

The Process of Recovery

- Detection
  - Corruption or failure reported
- Diagnosis / Decision
  - What went wrong?
  - What recovery point should be used?
  - What method of recovery should be used -- overall strategy for the recovery?
- Restoration
  - Moving the data from backup to primary location
  - From tape to disk, or disk to disk, or cloud to disk; Restore the lost or corrupted information from the backup or archive (source), to the primary or production disks
- Recovery – Almost done!
  - Application environment – perform standard recovery & startup operations
  - Any additional steps
    - Replay log may be applied to a database
    - Journals may be replayed or a file system
- Test and Verify

Traditional Recovery



Protection Based on Recovery

Years Days Hrs Mins Secs

Recovery Point

Secs Mins Hrs Days ????

Recovery Time

Protection Methods

Tape Backups	Capture on Write	Synthetic Backup
Vaults	Disk Backups	Data Replication
Archival	Snapshots	Cloud Backup

Recovery Methods

Instant Recovery Restore from Tape, Disk, Cloud

Point-in-Time Recovery

Roll Back Search & Retrieve

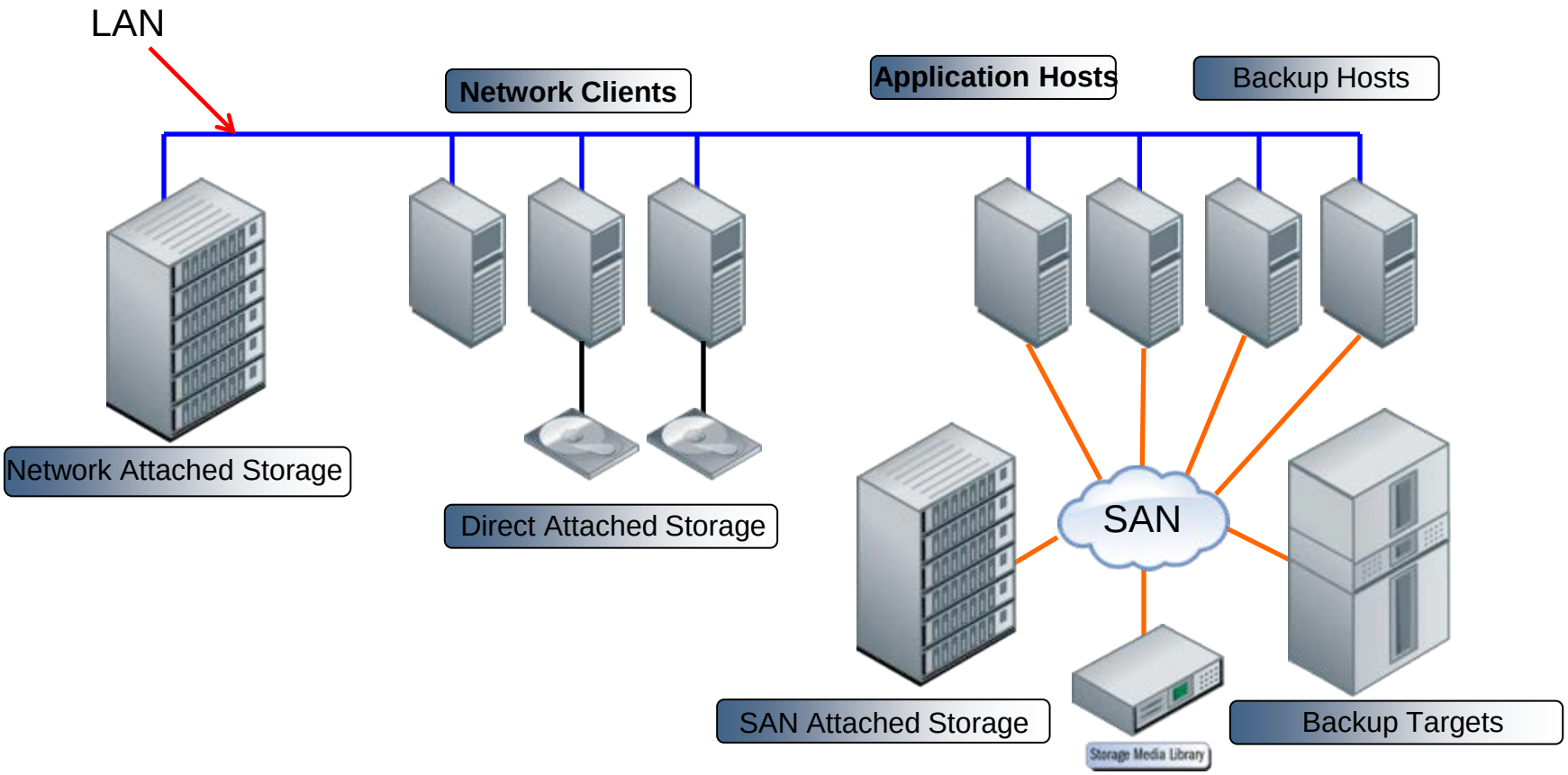
Backup Methodologies

- Cold
  - Offline image of all data
  - As backup window shrinks & data size expands, cold backup becomes untenable
  - Cheapest and simplest way to backup data
- Application Consistent
  - Application supports ability to take parts of data set offline during backup
  - Application knows how to recover from a collection of consistent pieces
  - Avoids downtime due to backup window
- Crash Consistent or Atomic
  - Data copied or frozen at the exact same moment across entire dataset
  - Application recovery from an atomic backup similar to an application failover
    - Rebuilding may be needed
  - No backup window

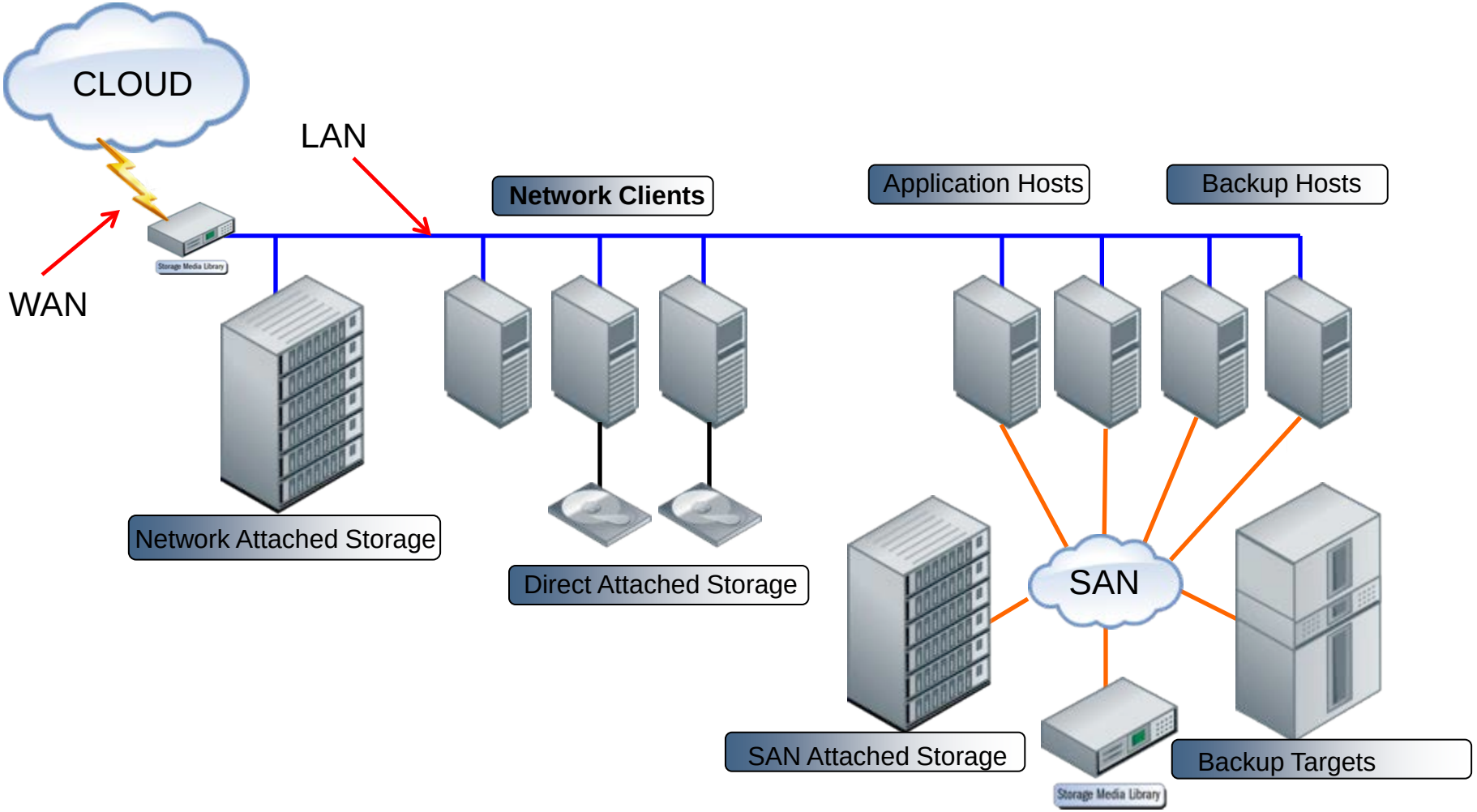
Backup to Tape, Disk and Beyond

- Fundamental concepts in Data Protection
- Overview of Backup Mechanisms
- Backup Technologies

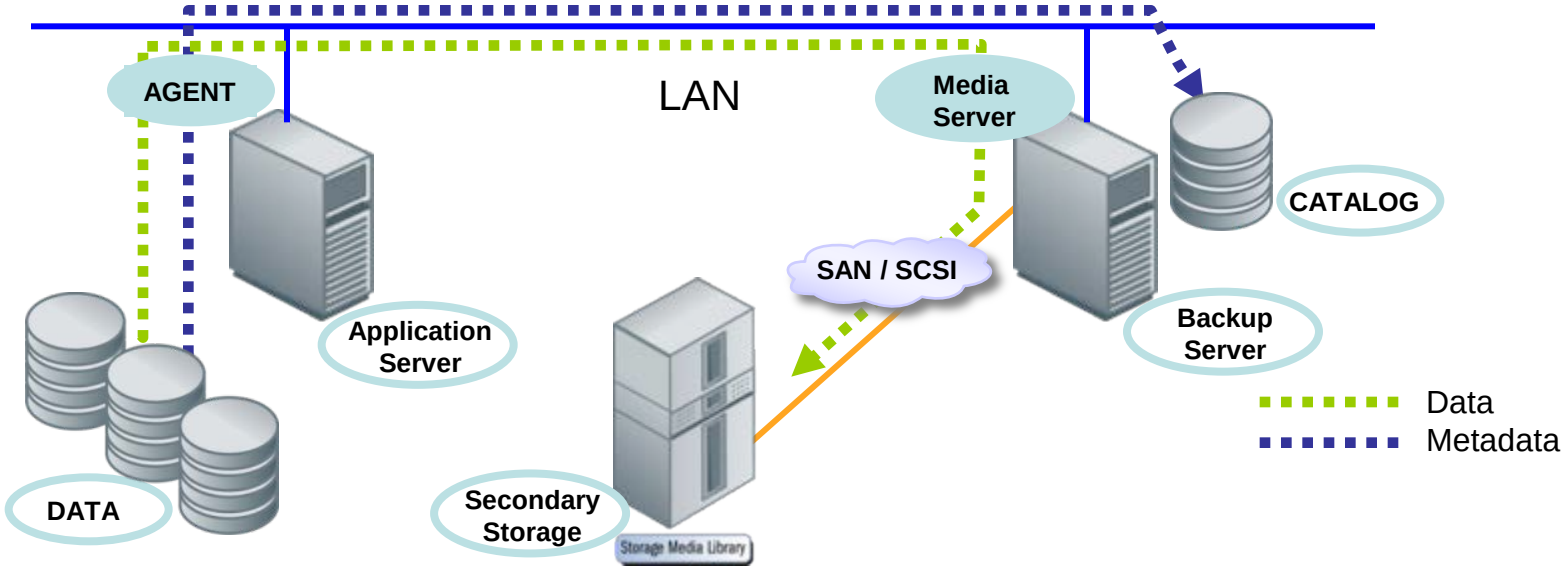
Backup Networking 101



“Cloud” Backup

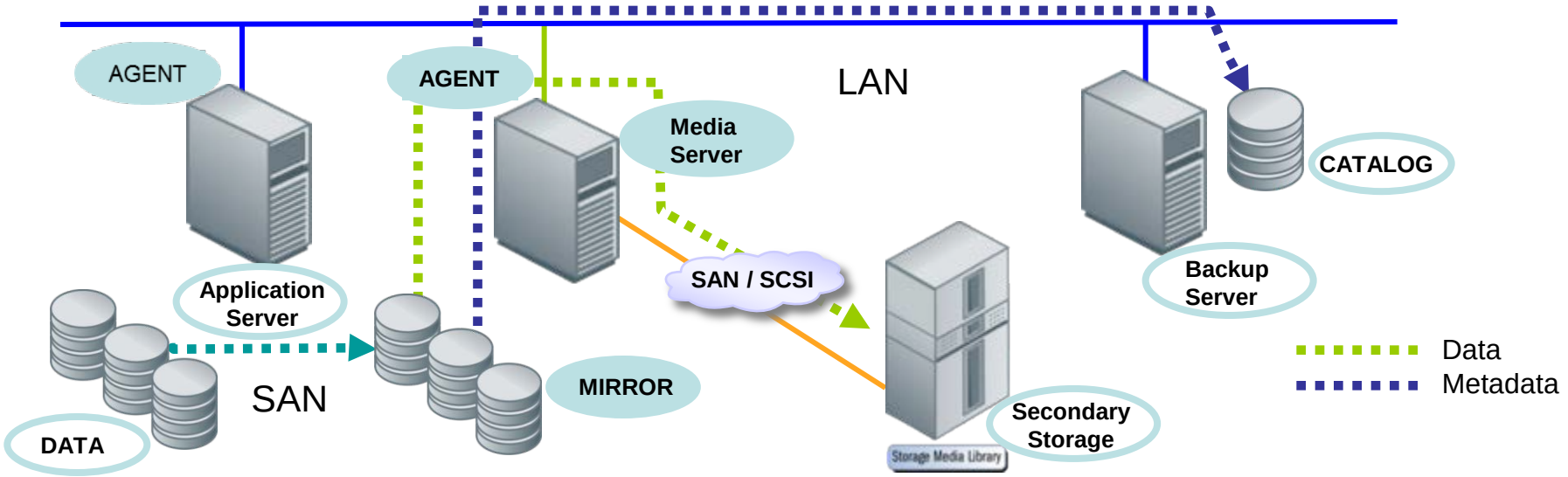


LAN Backup



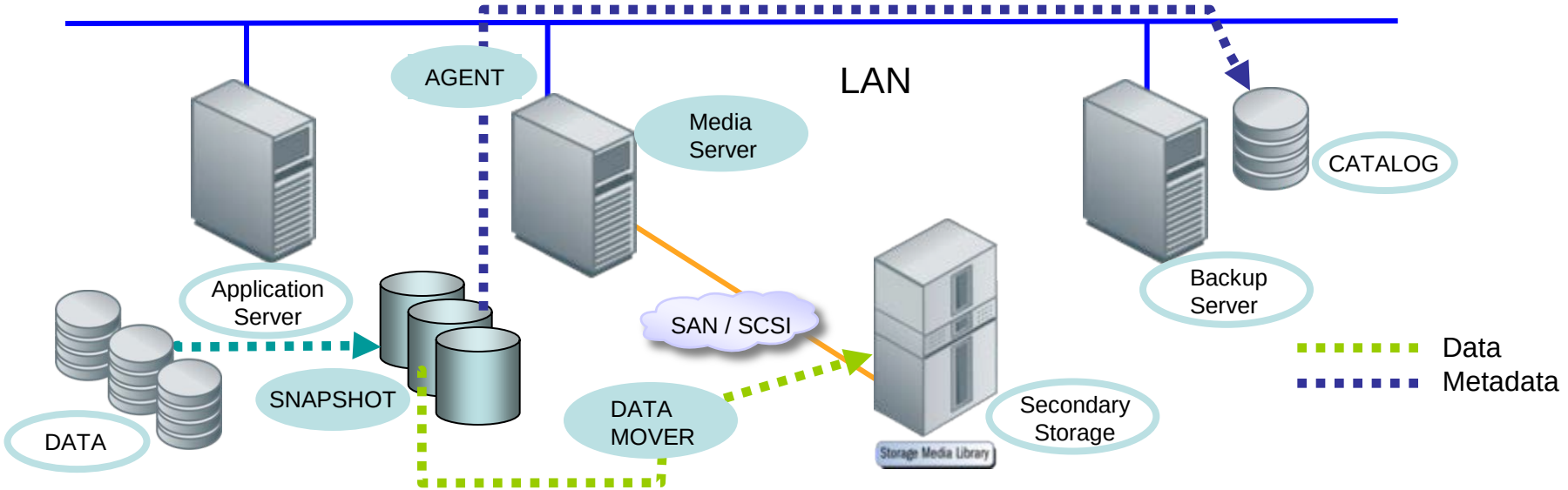
- Backup server receives data and Metadata from application server across the LAN
  - LAN is impacted by both backup and restore requests
  - Application server may be impacted by storage I/O
  - CIFS, NFS, iSCSI, NDMP, or vendor specific

Server-free Backup (Application)



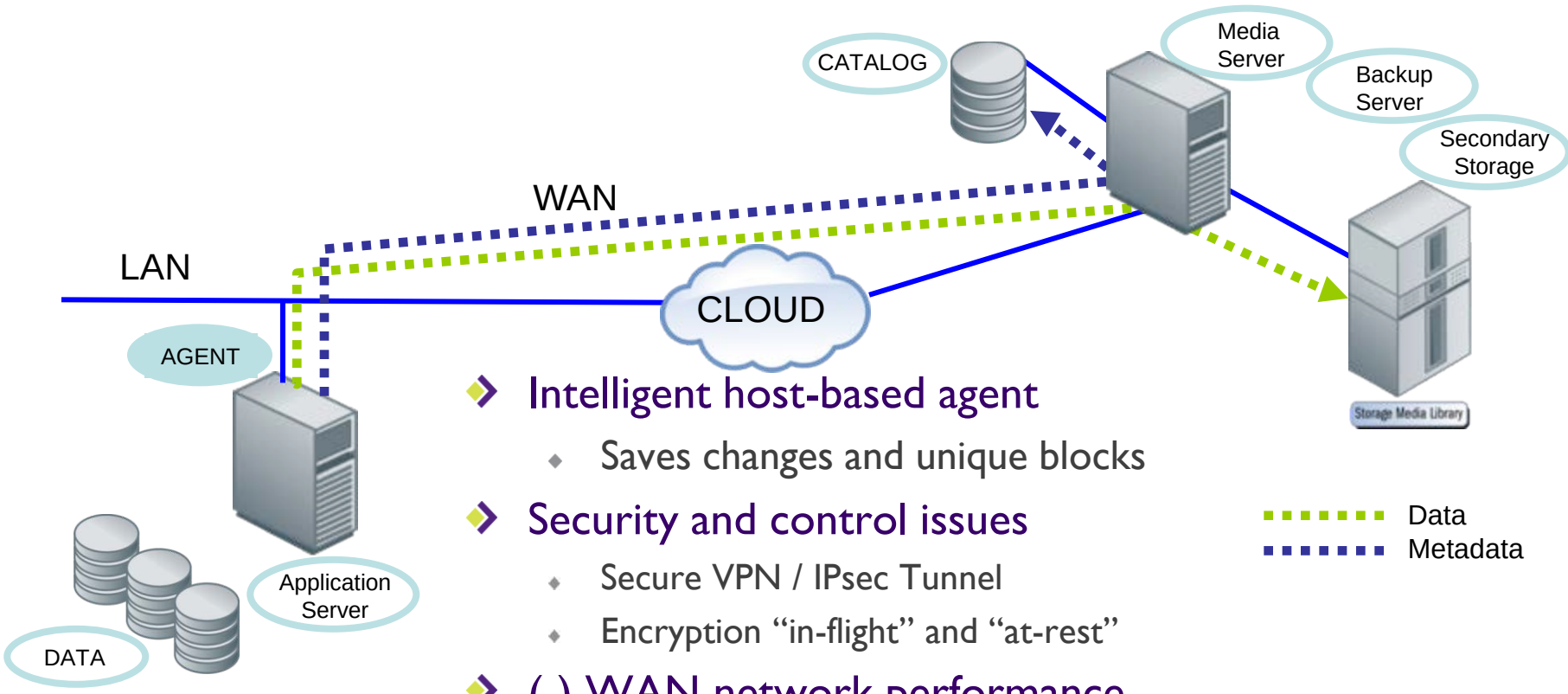
- The application server allocates a snapshot/mirror of the primary storage volume to a media server that delivers the data over the LAN or SAN
  - Media server must understand the volume structure
    - Mirror: Application server impacted when creating the mirror
    - Snapshot: Application server impacted by volume access
  - Metadata over the LAN to the backup server

Server-free Backup (Server-less)



- Backup server delegates the data movement and I/O processing to a "Data-mover" enabled on a device within the environment
  - Network Data Management Protocol (NDMP)
    - NDMP is a general open network protocol for controlling the exchange of data between two parties

Cloud Backup



- Intelligent host-based agent
  - Saves changes and unique blocks
- Security and control issues
  - Secure VPN / IPsec Tunnel
  - Encryption "in-flight" and "at-rest"
- (-) WAN network performance
  - Can use local cache to mitigate ("hybrid cloud")
- (+) Lower CAPEX
- (+) Off-site protection

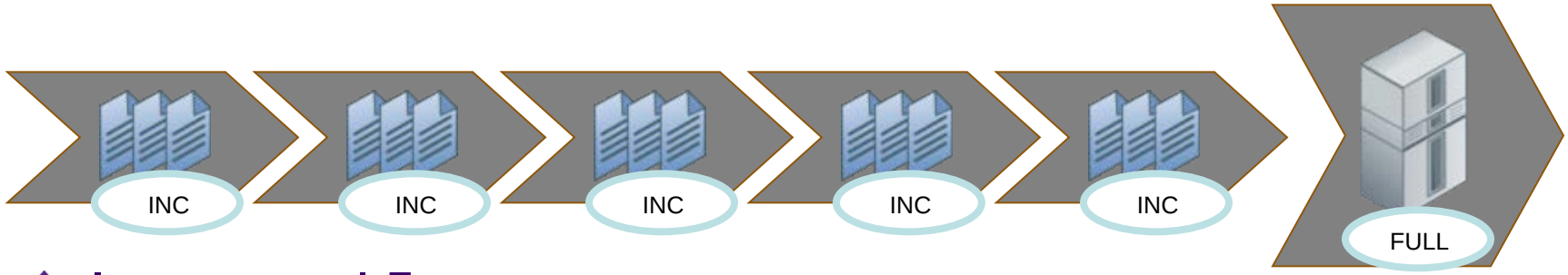
Traditional Backup Schedules

- Full Backup
  - Everything copied to backup (cold or hot backup)
    - Full view of the volume at that point in time
  - Restoration straight-forward as all data is available in one backup image
  - Huge resource consumption (server, network, tapes)
- Incremental Backup
  - Only the data that changed since last full or incremental
    - Change in the archive bit
  - Usually requires multiple increments and previous full backup to do full restore
  - Much less data is transferred
- Differential backup
  - All of the data that changed from the last full backup
  - Usually less data is transferred than a full
  - Usually less time to restore full dataset than incremental

Synthetic Backup & Incremental Forever

Synthetic Full Backups

- Incremental backups are performed each day
  - Full backups are constructed from incrementals typically weekly or monthly
  - Less application server and network overhead



Incremental Forever

- Incremental backups are performed every day
- Primary backups are often sent to disk-based targets
- Collections of combined incrementals used for offsite copies
  - Usually consolidate images from clients or application and create tapes
  - May construct synthetic full in the cloud

What gets Backed Up and How

File-level backups

- Any change to a file will cause entire file to be backed up
- Open files often require special handling SW
  - Open files may get passed over – measure the risks
- PRO: Ease of BU and restore
- CON: Moves tons of data

Client-side backups

- Intelligent agent monitors changes and protects only new files or blocks
- Agent enables advanced technology, granular backups and user policies
- Deduplication can enable network efficiency, reduce BU data volume
- PRO: Efficiently distributes work
- CON: Complex client/server

What gets Backed Up and How (Cont.)

- Block-level backups
  - Only the blocks that change in a file are saved
  - Requires client-side processing to discover changed blocks
  - PROs: Smaller backups, less network impact, faster
  - CONs: Client-side impact, increased complexity

Backup to Tape, Disk and Beyond

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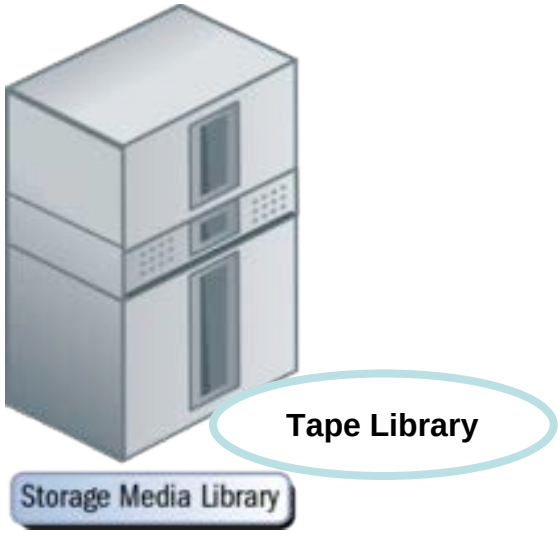
Introduction to Tape

- Sequential access technology
  - Versus random access
- Can be removed and stored on a shelf or offsite
  - Disaster recovery
  - Encrypted, archived for compliance
  - Reduced power consumption
- Media replacement costs
  - Tape life, reusability
- Performance and Utilization
  - Can accept data at very high speeds, if you can push it
  - Streaming and multiplexing
- Typically Managed by backup and recovery software
  - Controls robotics (Inventory)
  - Media management



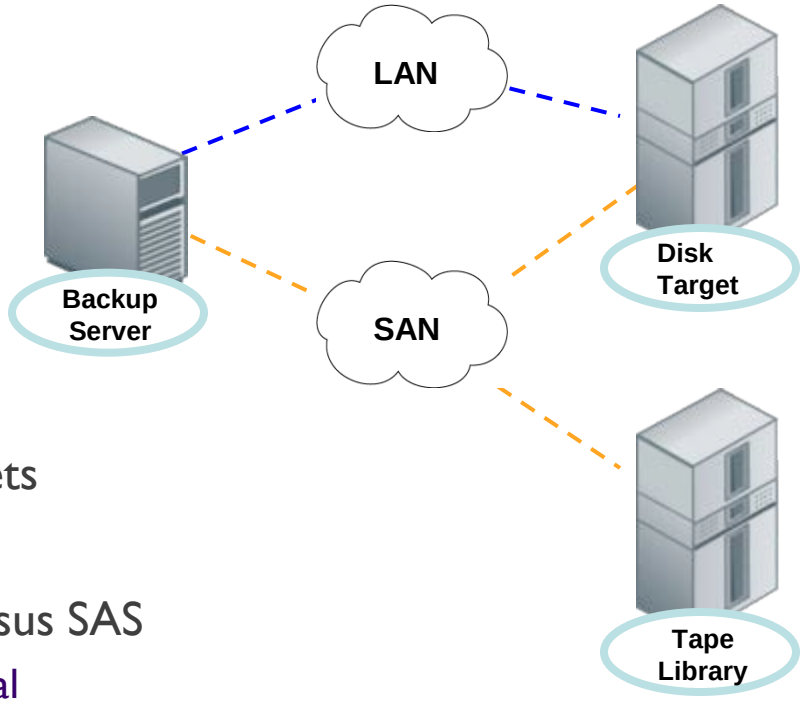
Tape is not Dead!

Tape Based Backup: Considerations

- Tape drives run faster than most backup jobs – Is this good?
  - Matching backup speed is more important than exceeding it
  - Avoid shoe-shining
- Slower hosts can tie up an expensive drive
  - It's a shame to waste a drive on these hosts
- Slower tapes can tie up expensive (important) servers
  - It is a shame to let the tape drive throttle backup servers
  - Slow backup can impact production servers as well
- Replacing your tapes infrastructure may not solve your backup challenges
  - A well designed backup architecture is the best answer
- If backup target speed is your issue:
  - Consider alternates such as virtual tape (VTL) or D2D2T
- Security, security, security…

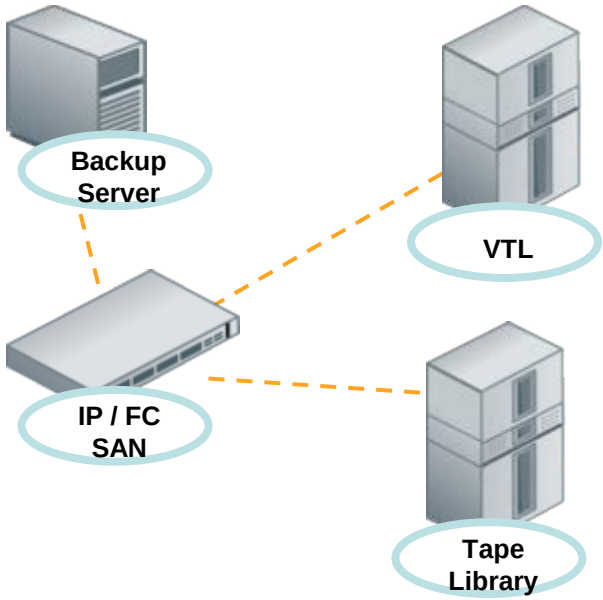
Introduction to B2D / D2D

- What?
  - Backup to Disk / Disk to Disk Backup
  - Disk as a primary backup target
- Why?
  - Performance and reliability
    - Reduced backup window
    - Greatly improved restores
    - RAID protection
    - Eliminate mechanical interfaces
  - More effective sharing of backup targets
- Considerations
  - Fibre Channel Disks versus SATA versus SAS
    - I/O random access vs. MB/s sequential
  - SAN, NAS or DAS
  - VTL or mirroring
  - Consider a mix of Disk and Tape (D2D2T)
  - Consider a capacity-optimized appliance



Introduction to VTL

- What:
  - Virtual Tape Libraries emulate traditional tape
  - Fits within existing backup environment
  - Easy to deploy and integrate
  - Reduce / eliminate tape handling

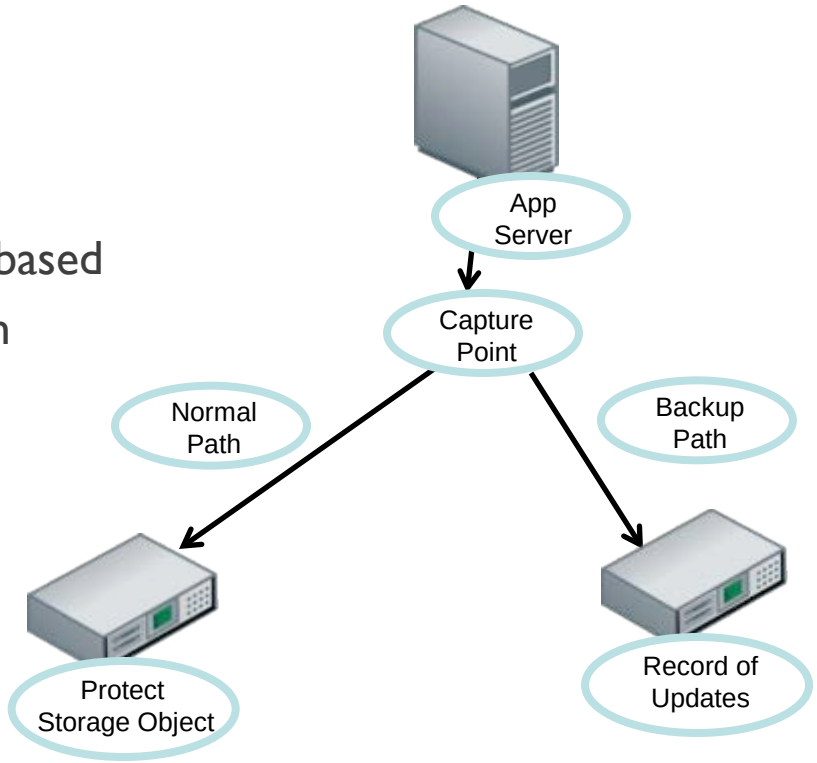


- Why:
  - Improved performance and reliability (see B2D)
  - Reduced complexity versus straight B2D or tape
  - Unlimited tape drives reduce device sharing, improve backup times
  - Enables technologies such as remote replication, deduplication

- Considerations:
  - Easy to manage in traditional backup software environment
  - Can extend the life of current physical tape investment

Introduction to CDP

- What:
  - Continuous Data Protection
  - Capture every change as it occurs
  - May be host-based, SAN-based, array-based
  - Protected copy in a secondary location
  - "Roll back" to any point in time
- How:
  - Block-based
  - File-based
  - Application-based



- Why:
  - Implementations of true CDP today are delivering zero data loss, zero backup window and simple recovery; CDP customers can protect all data at all times and recover directly to any point in time
  - "Near CDP" (Snapshots, checkpoints) may also help but will not catch every change

Contrasting CDP and Replication

- Replication is not CDP (Synchronous)
  - Replica or mirror is a single Point-in-Time copy of the data
  - Multiple replicas plus logs can create multiple points in time
- Snapshots are not CDP (Asynchronous)
  - Data loss possible if crash or corruption happens between snaps
  - Snapshots frequently to same system as primary
  - Lack continuous index with embedded knowledge of relationship of data to files, folders, application and server
- Backups (even multiple backups) are not CDP:
  - Schedule frequency
  - Database logging can provide additional granularity but still not CDP

Introduction to Snapshots

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What?

- A disk based "instant copy" that captures original data at a point in time
  - Snapshots can be read-only or read-write
- Also known as Checkpoint, Point-in-Time, Stable Image, Clone
- Often handled at the storage level
  - May be done at application server, hypervisor, and/or in cloud

Why?

- Allows for complete backup or restore
  - With application downtime measured in minutes (or less)
- May be able to be combined with replication
- Most vendors: Image only = (entire Volume)
- Backup/Restore of individual files is possible
  - If conventional backup is done from snapshot
  - Or, if file-map is stored with Image backup

Snapshot Considerations

	Full Copy Snapshots	Differential (or "Delta") Copy Snapshots
Upsides	◆ Minimal performance impact ◆ Independent copy available for DR	◆ Less storage consumption ◆ Often takes advantage of cheaper disk
Downsides	◆ High disk utilization ◆ No GEO-redundant protection	◆ Performance may be impacted ◆ Dependent on primary copy
Applications	◆ Disaster Recovery ◆ Near zero backup window ◆ Fastest restore ◆ Valuable for data repurposing	◆ Backup source ◆ Near zero backup window ◆ Fast restore ◆ Can help with data repurposing ◆ Beware performance impact

Introduction to Data Deduplication

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- What?
  - The process of examining a data-set or I/O stream at the sub-file level and storing and/or sending only unique data
  - Client-side SW, Target-side HW or SW, can be both client and target
- Why?
  - Reduction in cost per terabyte stored
  - Significant reduction in storage footprint
  - Less network bandwidth required

Check out SNIA Tutorial:

Advanced Deduplication Concepts

- Considerations
  - Greater amount of data stored in less physical space
  - Suitable for backup, archive and now more often primary storage
  - Enables lower cost replication for offsite copies
  - Beware of 1000:1 dedupe claims – Know your data and use case
  - Multiple performance trade-offs

Factors Impacting Space Savings

More Effective Deduplication	Less Effective Deduplication
Data created by users	Data captured from mother nature
Low change rates	High change rates
Reference data and inactive data	Active data, encrypted data, compressed data
Applications with lower data transfer rates	Applications with higher data transfer rates
Use of full backups	Use of incremental backups
Longer retention of deduplicated data	Shorter retention of deduplicated data
Continuous business process improvement	Business as usual operational procedures
Format awareness	No format awareness
Temporal data deduplication	Spatial data deduplication

Don’t forget about compression!

Next Steps in Data Protection

- Choose the appropriate level of protection
  - Assess risk versus cost versus complexity
  - Include your "customers" in your decisions
- Match RPO and RTO goals with technology
  - Consider resources required to support your decisions
  - Consider centralized versus distributed solutions
- Performance is ALWAYS a consideration
  - Assess your system today for strengths and weaknesses
  - A new box or new software may NOT be the answer
- Use archive to reduce the volume of data to be backed up
- When in doubt, call in the experts

Where to Get More Information

- Related tutorials
  - Advanced Data Reduction Concepts
  - Trends in Data Protection and Restoration Technologies
  - Managing Backup and Recovery in Today's Agile, Complex and Heterogeneous Data Centers
  - The Changing Role of Data Protection in a Virtualized World
  - Protecting Data in the Big Data World
  - Retaining Information for 100 Years
- Visit the Data Protection and Capacity Optimization Committee (DPCO) website http://www.snia.org/forums/dpco/
- DPCO – Data Protection Best Practices White Paper

  http://www.snia.org/forums/dpco/
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