

Tips For Implementing Storage Solutions For Content Creation To Digital Intermediate

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HDD Technology	Application	Highlights
SCSI	Desktop, Workstation, Enterprise-Class Server	Fast – up to 320 MB/s (Ultra320). 1 – 15 devices per channel. Proven Reliability. Widespread adoption. Economical.
Fibre Channel	Enterprise-Class Server Storage Area Network	Very Fast – up to 4 Gb/s interface, with 10 Gb/s roadmap. Extremely reliable. Expensive.
SAS	Enterprise-Class Server DAS, SAN	Very Fast – up to 300 MB/s (Serial SCSI Interface). Up to 540 MB/s using SAS x 2 link. Support up to 128 devices over long distances. Can be expanded to 16,000 devices on a channel. Future 6 and 12 Gb/s. Expensive.
SATA	DAS, Near-line Storage Desktop, Workstation Disk Backup, Archiving	Up to 300 MB/s. 600 MB/s on roadmap. Extremely large capacity – shipping 1TB drives. Not as reliable as others. Can mix with SAS. Economical.

- ▶ Throughput Requirements: Calculate based on highest bandwidth format recorded to hard drive, not by camera acquisition format. i.e. tape, optical, card.
- ▶ Required Throughput Rate = Highest Data Rate per Session x 4
 - ▶ (x 4) = Support reading and writing of 2 video streams, 2 channels of audio (actualities, VO, music), plus a graphics stream and overhead.
- ▶ Add bandwidth overhead when editing on MPEG-based formats like HDV and XDCAM. Throughput demand varies with the mix of I, B and P frames.

Video Data and Storage Rates

Video Format	MB/s	(MB/s) x 4	GB/hr	Hours/Terabyte
Speed and Capacity Rates = (highest-bandwidth format you edit) x number of streams you want to move at the same time, and estimating the amount of material you will have on the system at any one time.				
DV (DV25, DVCAM) 60i	3.7	14.8	13	75
DVCPRO50 60i	7.4	30	27	37
Uncompressed 10-bit SD 60i	27	108	97	10
HDV (25 Mbps) 60i	3.7	14.8	13	75
XDCAM (35 Mbps) 60i	5.2	21	19	53
DVCPRO HD 720/60i	14.8	60	60	17
DVCPRO HD 729/24pn	6.7	27	24	41
Avid DNxHD 220	27.5	110	100	10
CineForm 1080p24 or 720p60	19.2	77	70	14
Uncompressed HD 720p 8-bit	110	440	396	2.5
Uncompressed HD 720p 10-bit	138	552	497	2
Uncompressed HD 1080i 8-bit	120	480	432	2.25
Uncompressed HD 1080i 10-bit	155	620	558	1.8
Uncompressed HD 1080p 10-bit (4:4:4 RGB 24fps)	190	760	667	1.5

Storage Capacity Needed depends on:

- ▶ Editing format's data rate
- ▶ Amount of material required for a typical project
- ▶ Number of projects that will simultaneously be on the device

Typical Source-to-Final ratios:

- ▶ Fiction/Corporate work: 5:1
 - ▶ (including rough footage, graphics, render files, etc.)
- ▶ Documentary - 10:1 to 20:1
- ▶ Motion graphics: 10:1 to 20:1

Examples:

- ▶ 5 min. corporate project shot & edited in DV ~ 5 GB
- ▶ 1 hr. documentary edited in DVCPRO HD ~ 1 TB plus

RAID-0. Striping: This technique has striping but no redundancy of data. It offers the best performance but no fault tolerance.

RAID-1. Mirroring: Disk mirroring and consists of at least two drives that duplicate the storage of data. There is no striping. Read performance is improved since either disk can be read at the same time. Write performance is the same as for single disk storage. Provides the best performance and the best fault tolerance in a multi-user system.

RAID-3. Virtual Disk Blocks: This type uses striping and dedicates one drive to storing parity information. The embedded error checking information is used to detect errors. Since an I/O operation addresses all drives at the same time, RAID-3 cannot overlap I/O. RAID-3 is best for single-user systems with long record applications.

RAID-5. Striped Parity: This type includes a rotating parity array - all read and write operations can be overlapped. RAID-5 stores parity information but not redundant data (although parity information can be used to reconstruct data). RAID-5 requires at least three and usually five disks for the array. Best for multi-user systems where performance is not critical or that do few write operations.

RAID-6. Dual Parity: This type is similar to RAID-5 but includes a second parity scheme that is distributed across different drives. It offers extremely high fault- and drive-failure tolerance. Newer high-performance solutions are now coming onto the market.

RAID-10. Combining RAID-0 and RAID-1 is often referred to as RAID-10, which offers higher performance than RAID-1 but at a much higher cost. There are two subtypes: In RAID-0+1, data is organized as stripes across multiple disks, and then the striped disk sets are mirrored. In RAID-1+0, the data is mirrored and the mirrors are striped.

RAID-50 (or RAID-5+0). This type consists of a series of RAID-5 groups and striped in RAID-0 fashion to improve RAID-5 performance without reducing data protection.

Storage Requirements For Post Production and Digital Intermediate

Digital Media Workflow Example

Acquisition

Telecine

Film Camera



HIPPI/GSN



VTR/DDR
HDTV, SDTV



SMPTE 292M

Network Feed

GigE, HIPPI, GSN, IB

HDTV/24P



SMPTE 292M

Digital Camera

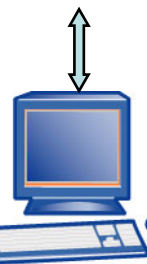
Color Correction

Post Production

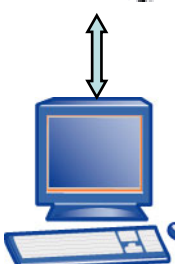
Editing & Compositing



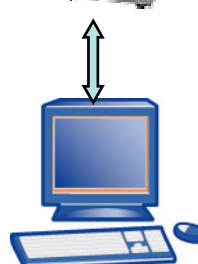
Storage SAN/NAS



Grain & Noise



Grain & Noise



Preview

Distribution

Modeling



DVD Mastering



Broadcast DTV,
SDTV, HDTV



VTR/DDR
DTV, SDTV, HDTV



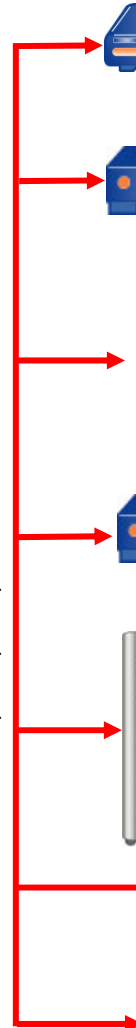
Theatre



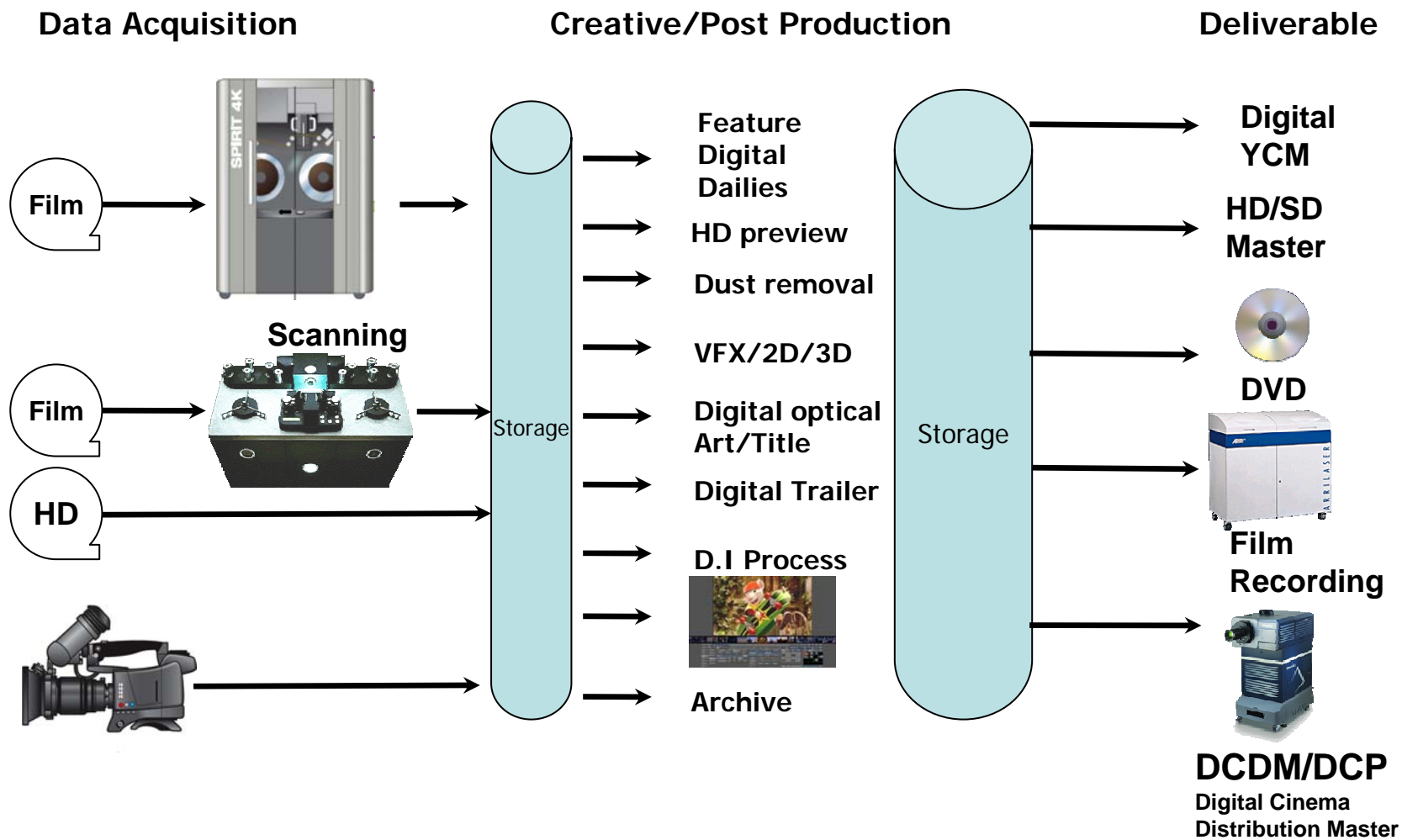
Digital Cinema



Archival Storage



Digital Media Workflow Example



Storage Decisions for Post Production:

- ▶ Determine your company's present and future direction.
- ▶ Balance the appropriate technology offerings with the business vision.

Example:

- ▶ Storage for VFX (2D, 3D, Art) is different than for Digital Intermediate.
- ▶ VFX requires large number of workstation or render nodes with small IO performance over NFS for VFX.
- ▶ Digital Intermediate applications require large IO performance that's capable of sustaining 2K (288 MB/s) or 4K (1.2Gbyte/s) throughput per workstation.

- ▶ **VFX only Facility can use NAS (Network Attached Storage).**
 - ▶ Small IO will require a large NAS gateway to support a large number of render nodes.
 - ▶ Choose vendors that offer high IOPS performance.
- **Hybrid Facility (Digital Intermediate Facility) should use SAN (Storage Area Network) that can support a very large NAS infrastructure.**
 - Large IO necessitating a few workstations connected directly to a SAN to support high throughput read/write operations.
 - ▶ Need to support small and large IO bandwidth in the same facility to accommodate both VFX, Editing and Digital Intermediate workflows. Need shared file system support.

Backup and Data Migration:

- ▶ It's nearly impossible to move 50 – 200 TB from disk to tape or any other archive medium for long term storage when the storage system is being utilized to generate income.
- ▶ Most NAS solutions must move data via a Gigabit Ethernet network.
- ▶ Problem: Moving 10 TB via a Gigabit network will take more than 24 hours and that assumes that there's no activity on the NAS server.
- ▶ Solution: Implement SAN solution where multiple servers can act as a NAS gateway and other servers can be connected to a tape library for backup operations.

Final Recommendations for storage planning:

- Not all storage vendors can support small IO and large IO metrics at the same time – choose wisely.
- Focus on a scalable architecture, scalable infrastructure, scalable servers and scalable storage.
- Plan for growth. Storage in post industry grows at 50 - 100% per year.



About Cutting Edge

Founded in 1992

Leading developer of customized high performance network storage solutions:

- ▶ Integrated DAS & NAS Solutions
- ▶ Modular NAS & iSCSI-SAN Solutions
- ▶ Rugged Field Application Solutions
- ▶ Custom Storage Solutions
- ▶ EdgeWare 64-bit NAS/iSCSI OS



Executive Team

Michael Ehman, CEO

Deborah Inman, President

Dr. Scott Smyth, CTO

New Integrated and Modular Storage Offerings





EdgeWare™ Storage Operating System

Cutting Edge Storage Solutions based on field proven EdgeWare OS. EdgeWare is a Linux-based 64-bit network storage operating system, purpose built to manage high terabyte volumes while providing robust security, high availability and sustained data throughput.

Enterprise Features

- **IP Failover**
- **Multiple Snapshots**
- **Remote Mirroring**
- **Monitoring Alerts & SNMP**
- **Disk Quotas & Encryption**
- **Remote Mirroring**
- **Block Level Storage**
- **Web-Based Interface**
- **NAS & iSCSI SAN Functionality**
- **Error Recovery Levels 1 & 2**

Cutting Edge DAS Product Line



RAIDSTOR

Enterprise Class High Reliability Solution

- **Dual controller active/active support for increased data protection**
- **Dynamic provisioning: support for array and LUN expansion**
- **Built-in performance analysis & management for RAID array tuning**
- **Automatic and transparent drive rebuild with global hot spares**
- **High availability RAID protection for critical data**
- **2 year 24/7 365 day support**

DAS Product Line Continuation



Specifications

- **Dual active/active controllers:**
guaranteeing no single point of failure
- **Mix SAS/SATA drives in the same system**
- **Expand up to 60 drives (will increase to 96)**
- **Dual 4x (12Gb/s) high speed SAS host connection with dual controller failover redundancy**
- **RAID 6 and snapshot support**
- **Online capacity growth through dynamic array and LUN expansion**

EdgeWare iSCSI/NAS Storage Server

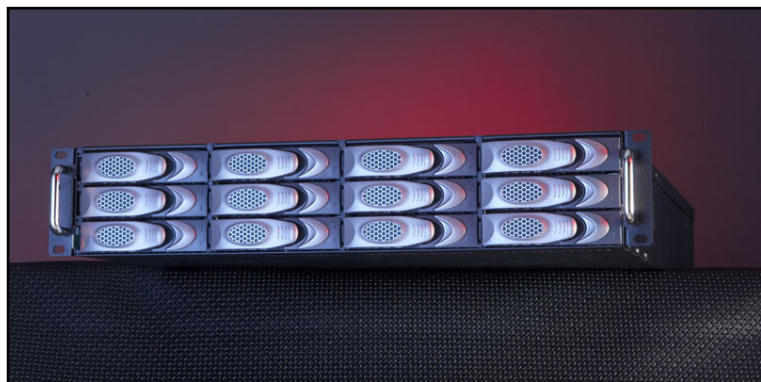


Cutting Edge ISS
(Integrated Storage Solution)



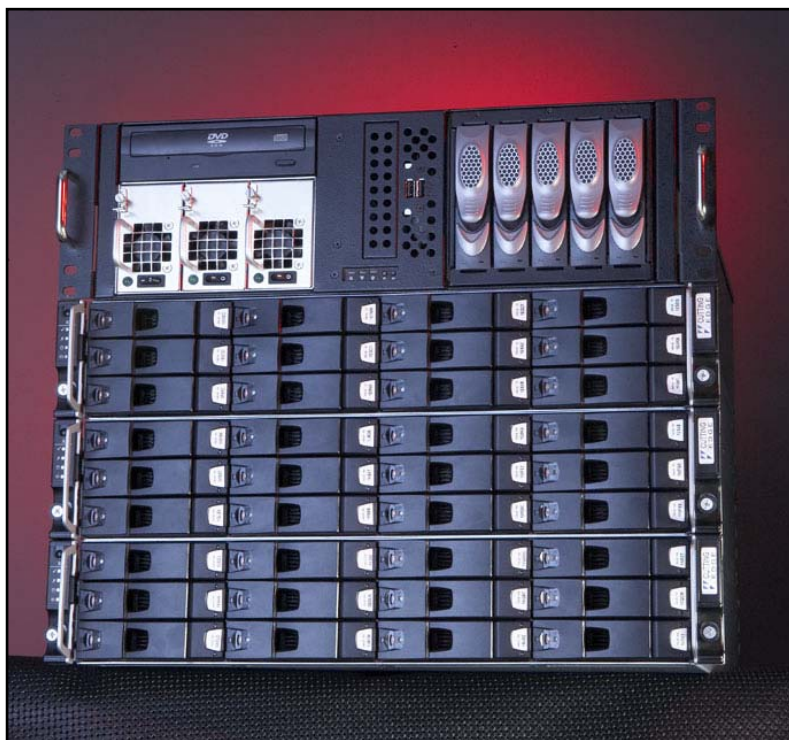
Cutting Edge MSS
(Modular Storage Solution)

Near Line ISS with EdgeWare



- **Form Factor: 1U, 2U, 3U, 4U, 5U, and 8U 19" Rackmount**
- **Capacities: Up to 36TB of storage using SATA II Drives**
- **Network Conductivity from 2 to 20 GbE ports**
- **Speed up to 2000 MB/s over IP Network**
- **Enterprise level performance with EdgeWare OS (64-bit)**
- **Hardware RAID with battery backup**
- **Remote mirroring and remote replication**
- **Block level storage for increased security and transfer rate**
- **Multiple snapshots**

Enterprise MSS with EdgeWare



- Available with high density 4U 48 bay chassis
- 384TB per 42U cabinet (using 1TB drives)
- No Single Point of Failure
- Active/Passive Failover (Active/Active coming soon)
- Fibre Channel back end connections for storage expansion - Scalable to 1000TB w/ network connection
- 2000MB/s data transfer rate
- Up to eight 4Gb Fibre Channel ports to storage switch – for TBs of storage capacity expansion
- High Performance using dual 10GbE or 20GbE equivalent network conductivity
- 16 CPU cores, soon to be 32 CPU cores per server. Future Quad CPU sockets for more power

Thank You

The End