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2013 OFA Developer Workshop

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Richer content = more storage

- Frame rates for movie content are increasing from the historical 24 frames per second (fsp) to 48 fps (e.g. in The Hobbit by Peter Jackson) and 60 fps and may eventually be as high as 300 fps.
- Regular Cameras are now available that can support 120 fps
- Special cameras can support up to 3,000 fps at high resolution
- 4K production is commonplace but 6K and even 8K movie production is starting to appear in professional video projects. Video resolutions of 16K and even higher are contemplated in the future.

Ultra-HD Content Coming Soon

BBC Image of HNK
Super Hi-Vision Camera

Sharp 8K X 4K LCD Display

- NHK from Japan has been making steady progress on their Super Hi-Vision TV that could display 33 megapixel video with 22:1 multichannel sound.
- Sharp has been demonstrating an 8K X 4K LCD Display
- The BBC shot some 8K Summer Olympic Content

Professional video production is moving to multiple petabyte requirements!

- As video resolution and frame rate increase and stereoscopic projects multiply, the storage capacity and bandwidth performance of these devices and systems becomes staggering.
- A calculation shows that 16,000 X 8,000 pixel resolution, 64 color bits/pixel, 300 fps raw video content could require **307 GB/s data rates and 1.1 PB/hour**. If this was full stereoscopic capture then these requirements would double.
- Truly the bandwidth and capacity requirements to work with future rich media formats are staggering!

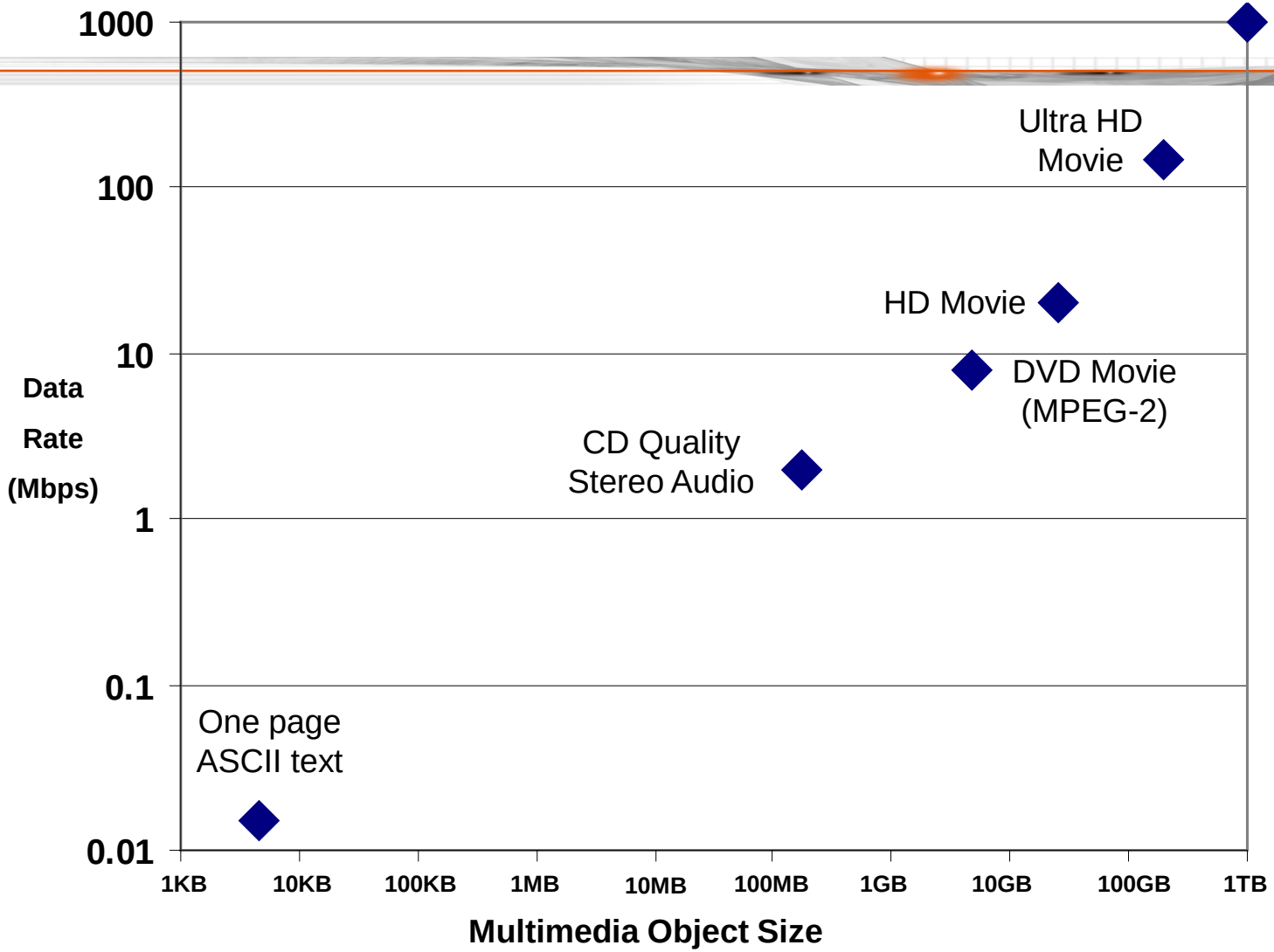
Example resolution, data rates and storage capacity requirements for professional media standards

Format	Resolution (width X height)	Frame Rate (fps)	Data Rates (MBps)	Storage Capacity/Hour (GB)
SDTV (NTSC, 4:2:2, 8-bit)	720 X 480	~30	6.25	22
HDTV (1080p, 4:2:2, 8-bit)	1920 X 1080	24	49.8	179
Digital Cinema 2k (4:2:4, 10-bit) YUV	2048 X 1080	24	199	716
Digital Cinema 4K (4:4:4, 12-bit) YUV	4096 X 2160	48	1,910	6,880
Digital Cinema 8K (4:4:4, 16 bit)	7680 X 4320	120	23,890	86,000

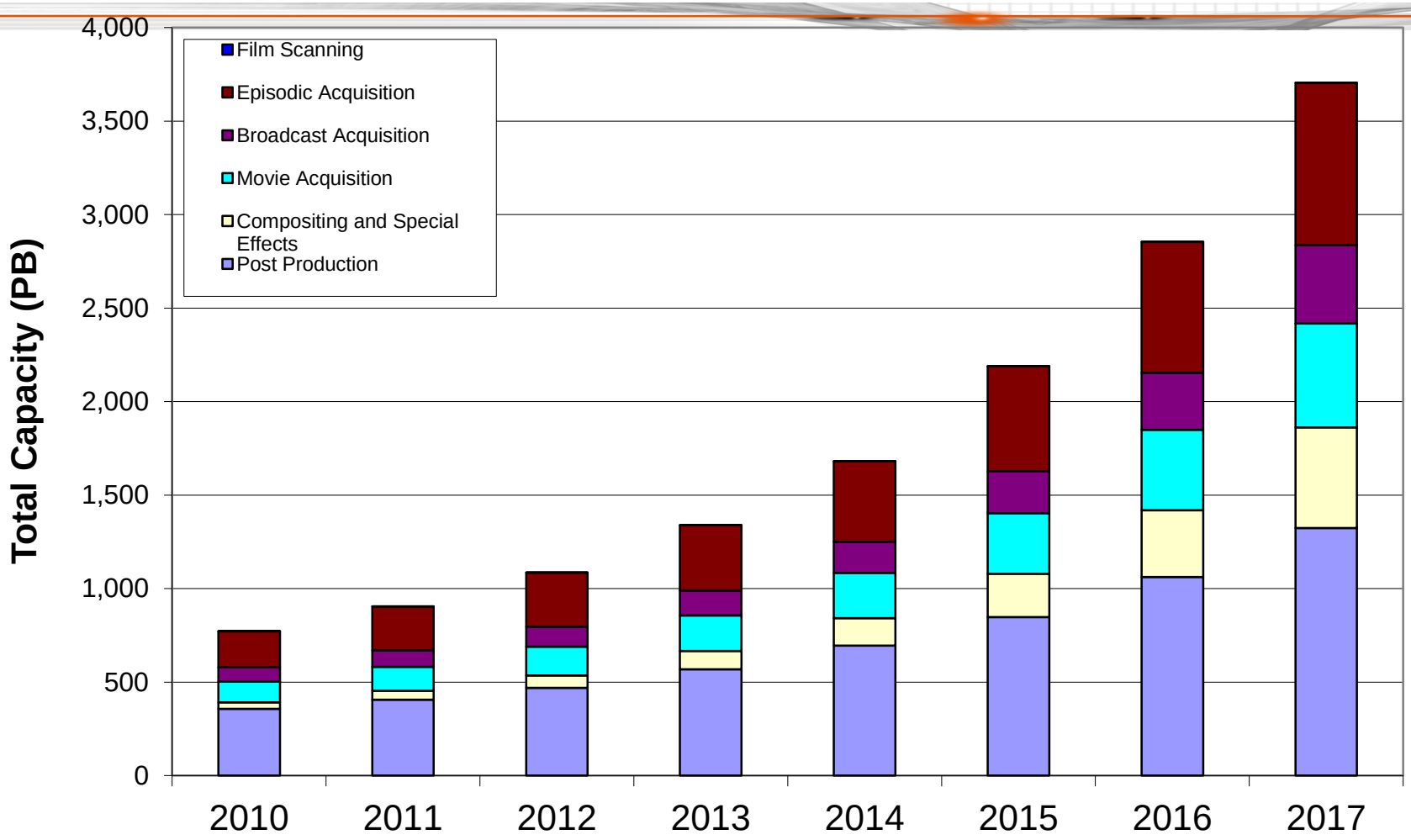
8K Ultra-HD may use more than 100X capacity of HD!

"Super Hi-Vision" Video Parameters for Next Generation Television, SMPTE Motion Imaging Journal, May/June 2012, P. 63-68

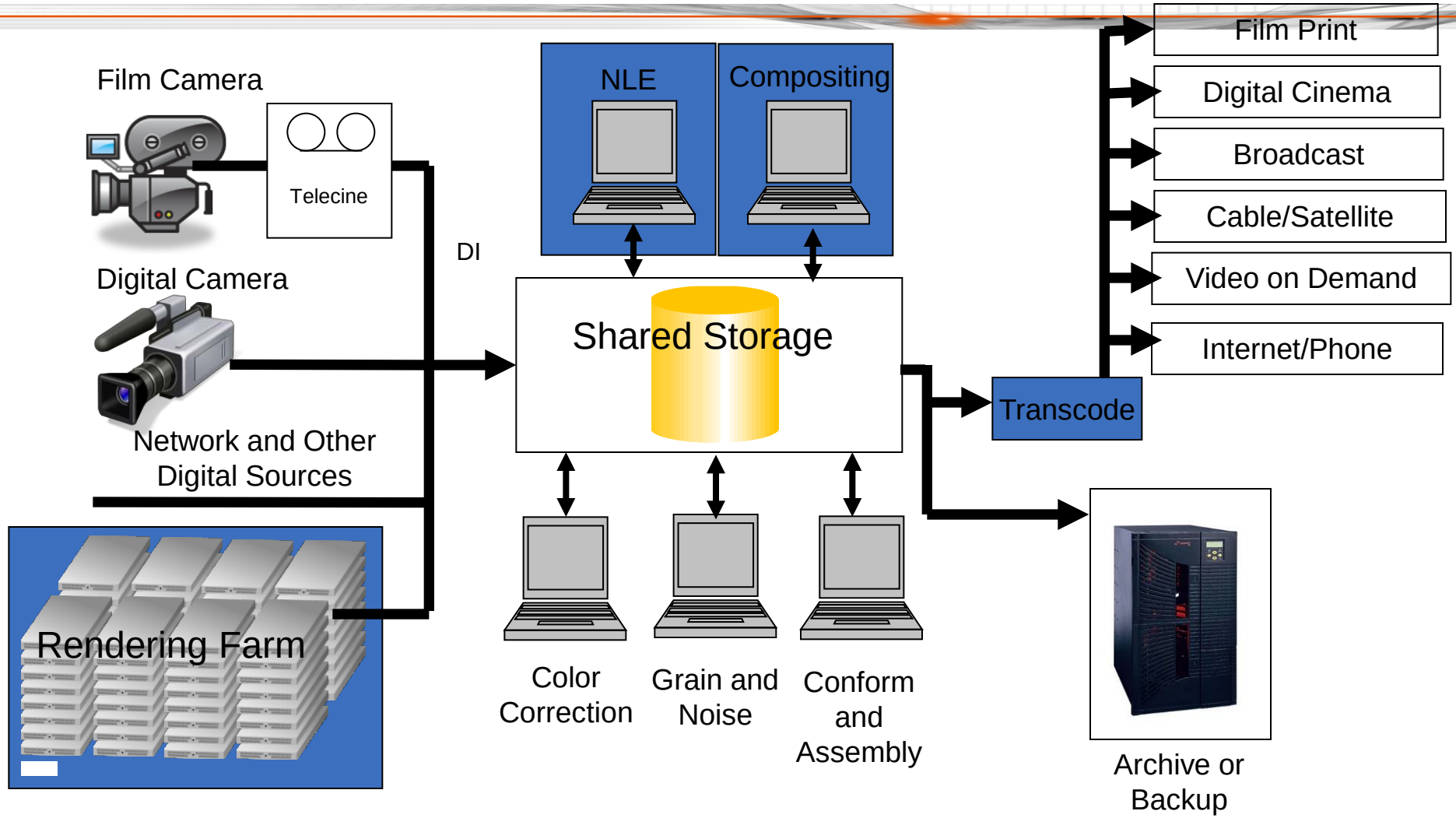
Media Content Size Trends



Annual Capacity Projections for creation of video content



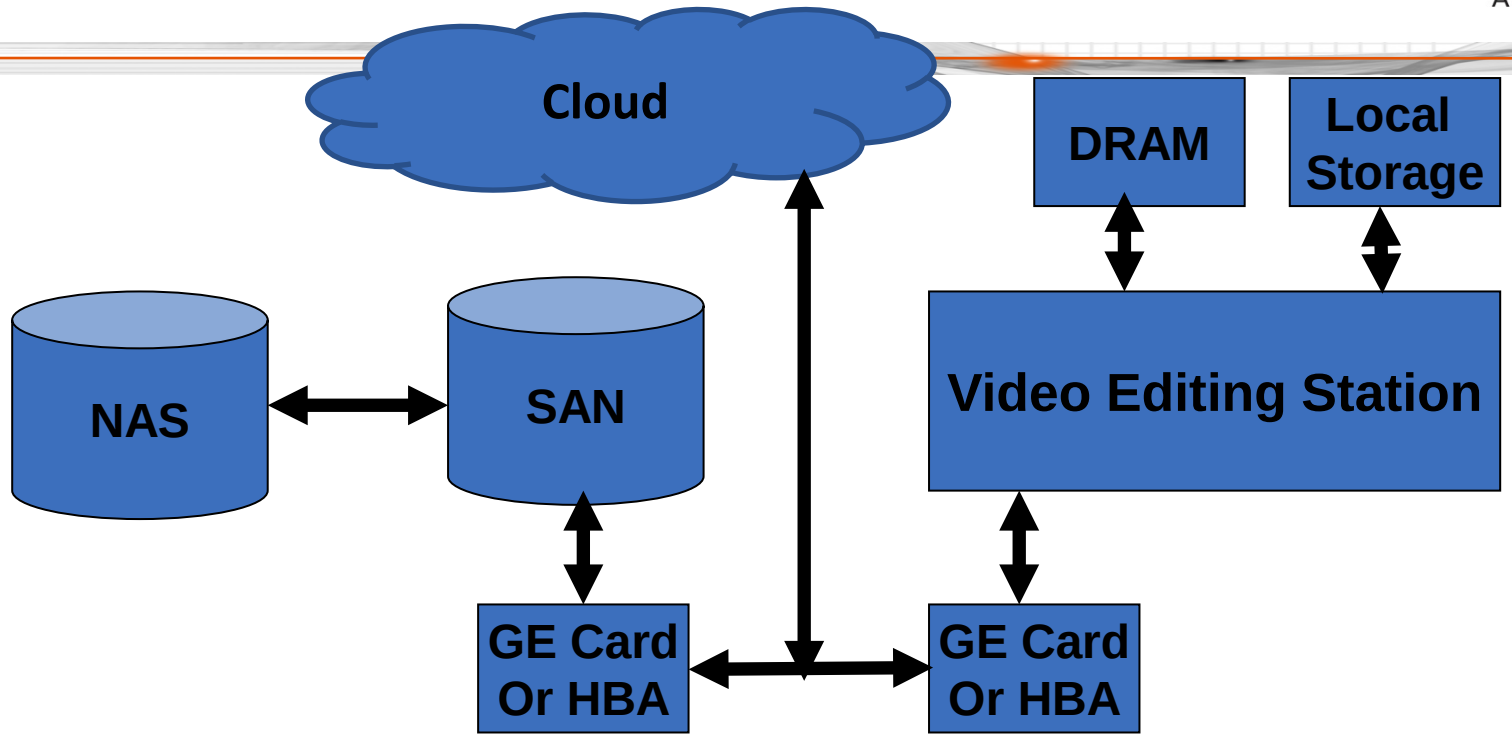
Digital Movie Workflow



Unique features of professional media and entertainment work flows

- There can be no pauses in real-time streaming and no dropped frames
- Increasing resolution demands, particularly for the original content, drive very high data rates
- Latency requirements for data access varies in workflow and is lowest (lowest latency) where the creative process takes place
  - Capture
  - Editing
  - Other post production work

Professional non-linear editing model



- In addition to traditional local storage and network storage, content in cloud storage is starting to play a role in modern workflows
- In late 2010 M&E professionals involved in post production showed the following statistics: 83.8% had DAS
  - Over 69% of these had more than 1 TB of DAS
- 81.2% had NAS or SAN—use of network storage is increasing
  - Over 58% had more than 16 TB of NAS or SAN

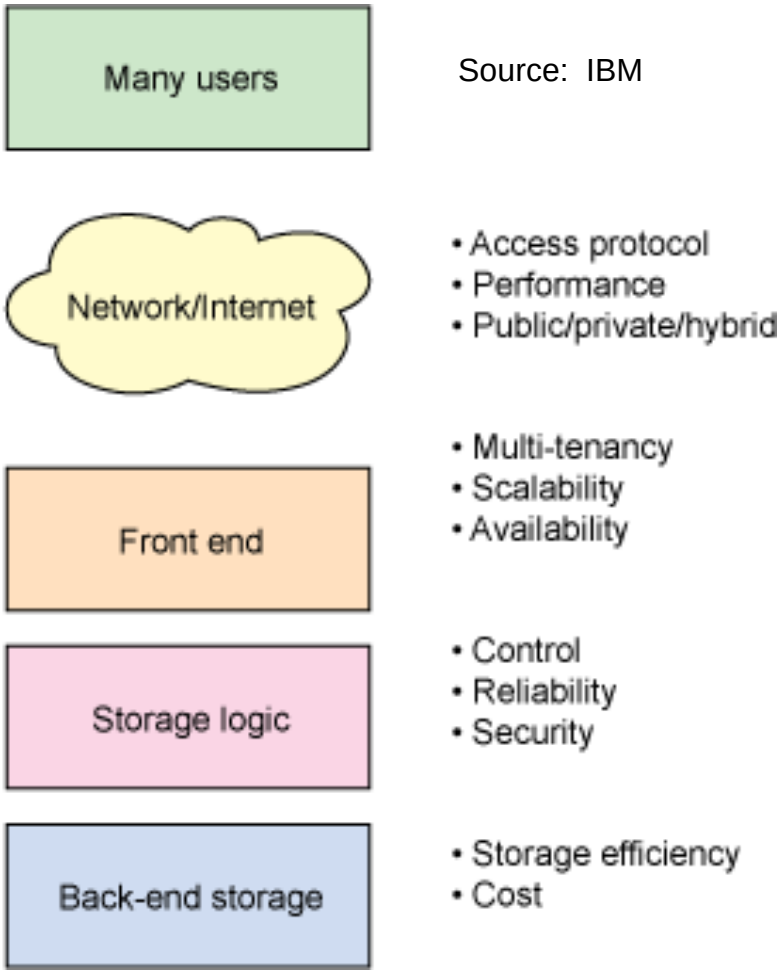
Coughlin Associates Professional M&E Survey, 2009 & 2010

Post Production and the Cloud?

- Non-linear editing (NLE) is generally done from uncompressed or at most slightly compressed source content since heavy compression can lead to loss of resolution and can cause timing problems.
- However the actual editing may use lower resolution proxies with the editing changes incorporated into the uncompressed content after editing is done.
- There is an increasing trend, particularly for movie production, to create collaborative workflows where the post-production activities may be done anywhere in the world.
- While the latency of remote access through the Internet may limit the use of cloud storage for direct creative editing, cloud storage can be used effectively for compute intensive operations such as rendering transcoding, content distribution and archiving.

Cloud storage services

- Technology enablers of Cloud Storage
  - Object storage
  - Virtualization
  - Storage Tiering
  - Deduplication (where appropriate)
- Cloud Storage Implementations
  - *Hybrid (local* and cloud)
  - Gateway/Appliance allowing use of cloud as a storage tier
  - Full private or public cloud storage (remote storage accessible through the Internet)



The cloud for M&E content

- In many regards cloud offerings are an out-sourcing approach
- But there are new M&E capabilities enabled by the rise of remote services
- Growth in cloud storage use by professional video
  - enables collaborative workflow
  - Internet enabled content distribution with technologies such as those of Aspera or BitSpeed
  - new cost effective services through the cloud enable greater sophistication for smaller shops
  - Some vendors offering cloud “archiving” services
- Cloud storage drives growth in tiered storage including flash memory, tape, HDDs

Storage System Trends

- Virtualization
- Deduplication
- Software Defined Storage (higher level of abstraction and Separation of the Control Plane from the data plane)
- Open Compute Project
- Hadoop Replication and Erasure Codes
- Consumer Storage Trends

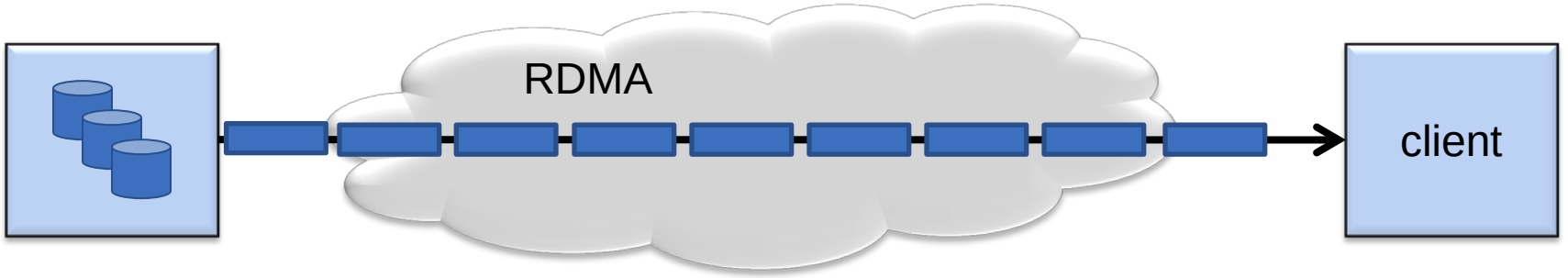
Media Storage in the Cloud

- Fujifilm announced a cloud storage archiving service using LTO tape (Permivault) in 2011.
- The LTFS file system on LTO 5 or 6 tape is seen as a means of creating object-based archives using this low cost storage media according to LTO experts at IBM. Front Porch Digital also indicated that their DIVA archive using the AXF video file formats will enable cloud archive applications. (tied into the FPD's media asset management system).
- Other companies providing cloud based archives include Content Bridge which does encoding, provides a content library for content distribution and also provides an optional on-line archiving service for the master distribution content and Canto (using the Archiware PreSTORE service).
- Nirvanix, one of the most out-spoken champions for video content in the clouds is used by NBC Universal for their digital master content storage

The Cloud as the Central Storage for Post Production?

- What would it take to provide low latency, on-line storage at a distance?
- One possible answer: Remote Direct Memory Access (RDMA)
  - A modern communications paradigm focused on ultra-low latency and very high bandwidth
  - E.g. InfiniBand, iWARP and RoCE
  - It has achieved currency in high performance computing and in other performance- or cost-sensitive environments

RDMA has two interesting characteristics (Source Paul Grun of Cray Presentation)



Achieving full wire speed requires keeping the pipe full with data

IB's transport protocol is fundamentally different from TCP

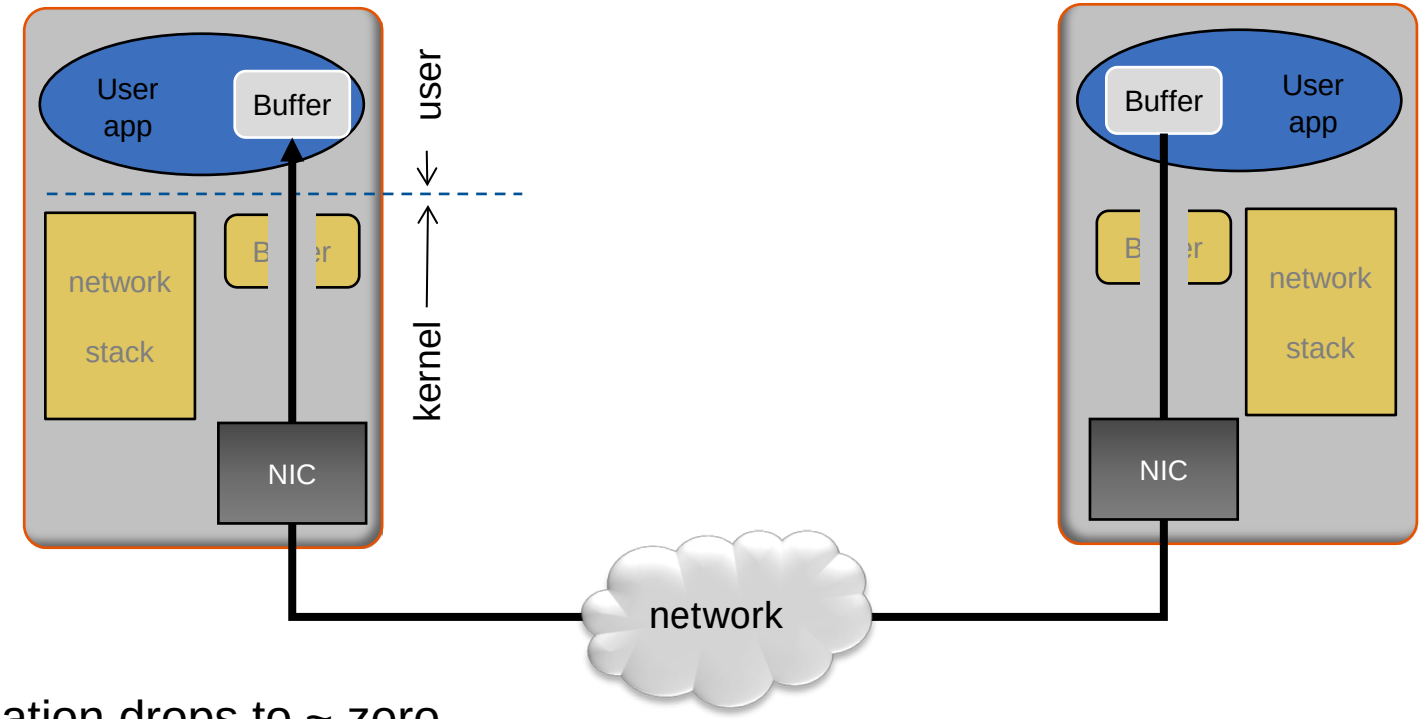
Its sliding window measures packets, not bytes, in flight (there can be up to eight million 2kbyte packets in flight)

This means we can keep the wire continuously full

→ First result: Much easier to get full wire bandwidth

…and the 2nd interesting characteristic

(Source Paul Grun of Cray Presentation)

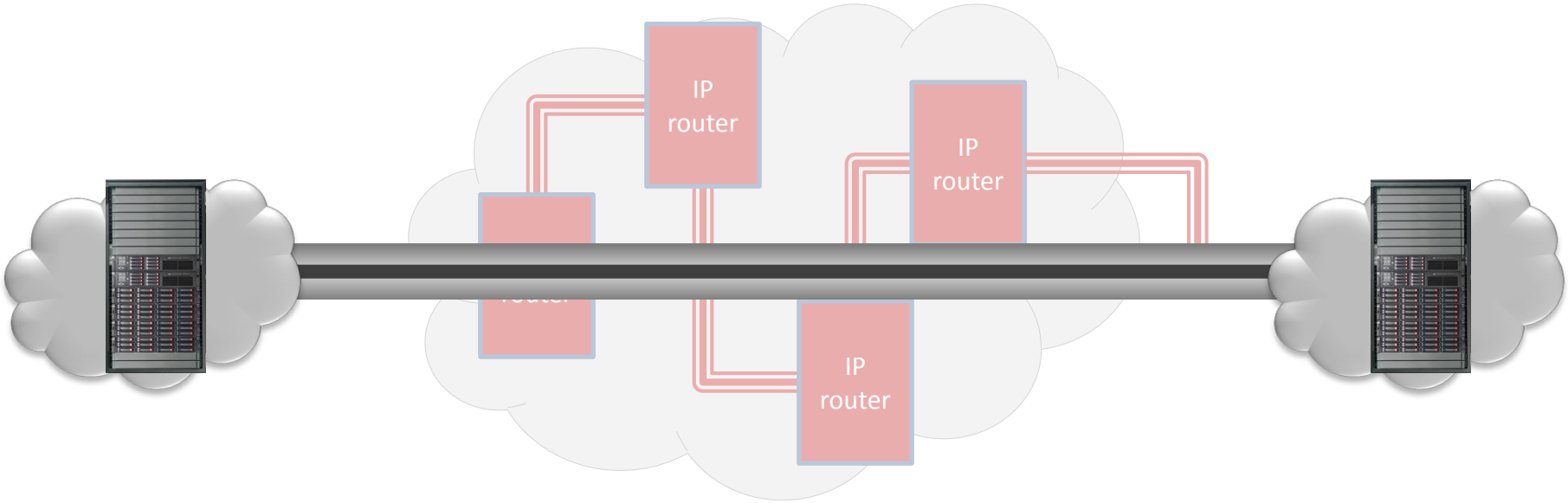


1. CPU utilization drops to ~ zero
2. Memory bandwidth demand drops to ~ zero
3. Network bandwidth is not gated by processor speed

→ 2nd result: Efficient use of resources, high bandwidth and low latencies

Extending the layer 2 fabric

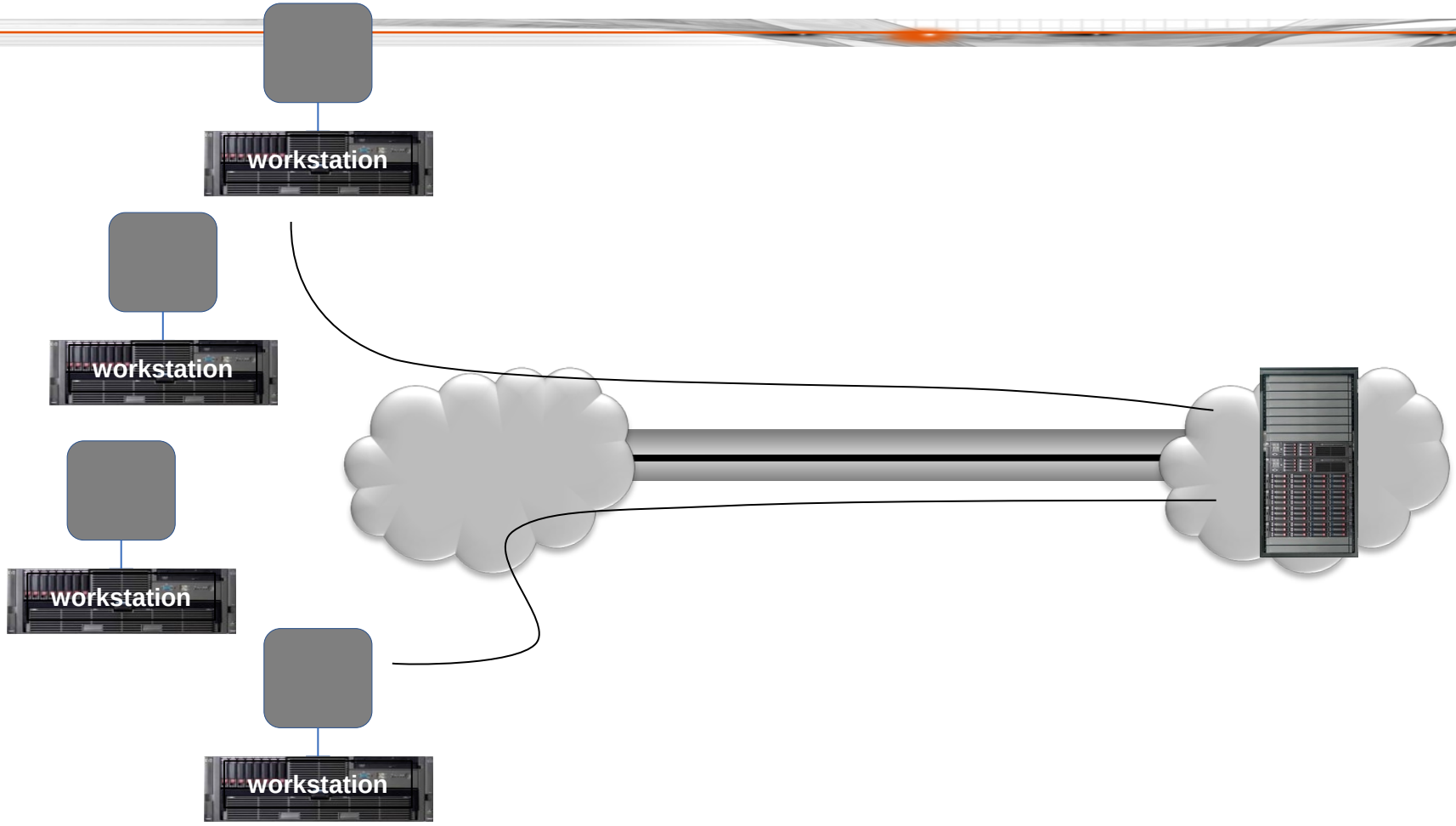
(Source Paul Grun of Cray Presentation)



What we really want is to connect two subnets.
A Layer 2 fabric maybe a better choice for non-ubiquitous connectivity.

RDMA over the WAN → Collaboration

(Source Paul Grun of Cray Presentation)



Mount the remote filesystem “as though it were local” →real time collaboration

RDMA over the WAN → Efficient File Transfer

(Source Paul Grun of Cray Presentation)

RDMA = efficient transport for long, fast networks → efficient b/w utilization
Direct data placement = low impact to local and remote subnets
Direct data placement = very low CPU utilization at either end

Summary and Conclusions

• Demand for higher resolution and higher frame rate content for media and entertainment applications is driving multiple-PB storage needs—these needs will only increase in the future

•This also increases bandwidth demand for real time and download use of content

•Cloud-based services are playing an increasing role by enabling collaborative workflows

•Can Remote Direct Memory Access through the Internet provide a way to enhance collaborative video workflows?

•Can real-time video post production be possible using RDMA?

Thanks!

Thank You

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