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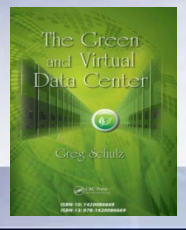
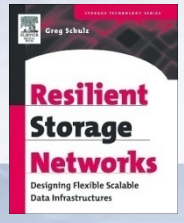
Industry Trends and Perspectives:
The Green and Virtual Data Center

Greg Schulz, Founder & Sr. Analyst -The StorageIO Group
Author “The Green and Virtual Data Center” (Auerbach)
And “Resilient Storage Networks” (Elsevier)





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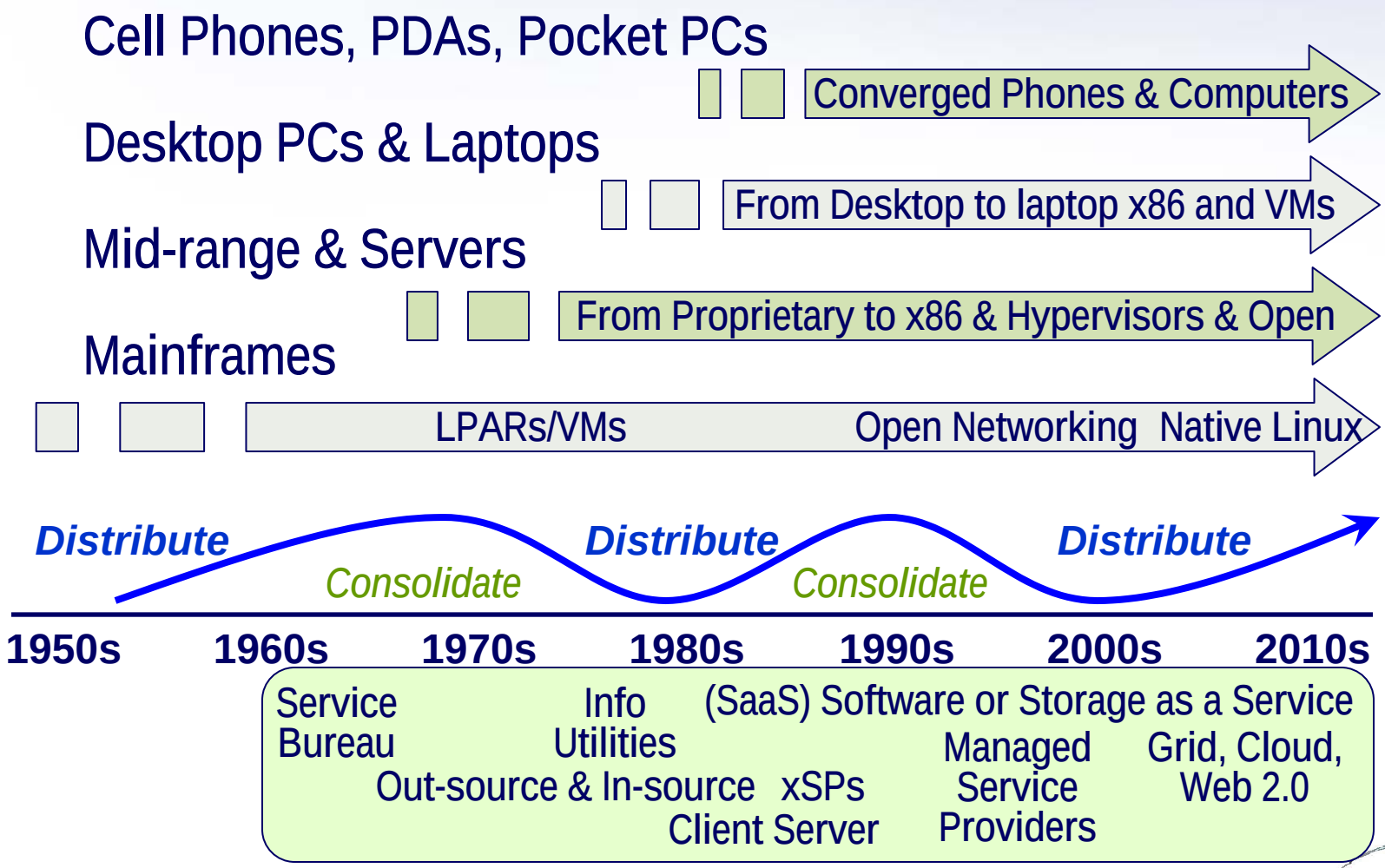
Industry Trends: Compute Continuum

We are in a consolidation phase (***Again!***)



Source: "The Green and Virtual Data Center" (Auerbach)

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Industry Trends: Expanding Data Footprint

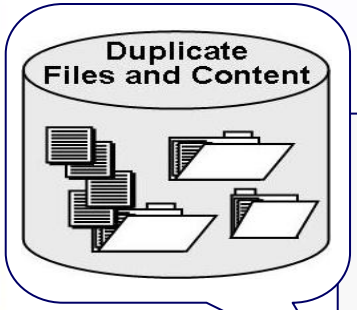
Management: Counter impact of expanding data footprint

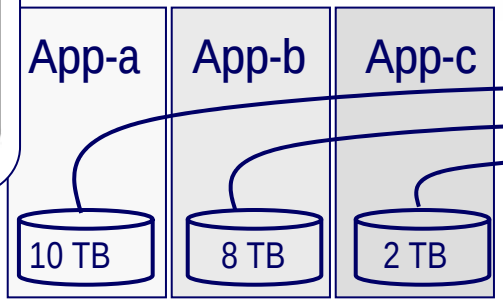
Sparse, Duplicate Files and Content

Original Data
Primary Database, Email, File serving

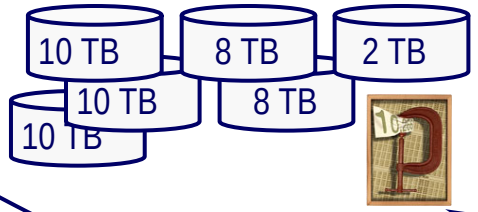
Copies – Data Proliferation and expanding data footprint
DSS, Training, Test, Dev QA, Operational, Needs
Backup, BC, DR, HA, Archive, Compliance

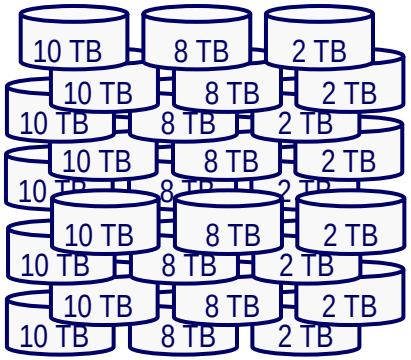
In addition to storage space capacity IOPS and MBPS to move data also needs to be considered.

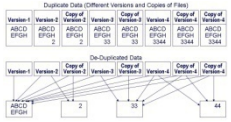




RAID 1+0 RAID 1 RAID 5







Archive Compress De-dupe

Challenge: More data to backup, protect and manage
Action: Reduce footprint impact: Archive, Compress, De-dupe, Tiered Storage

See "Business Benefits of Data Footprint Reduction" www.storageio.com

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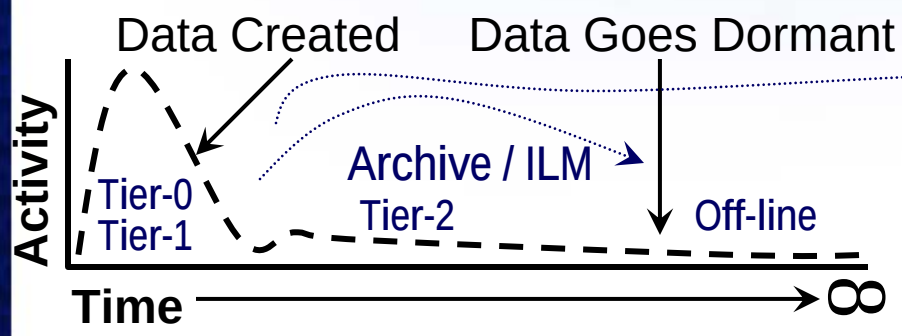
Industry Trends: Shifting Landscapes

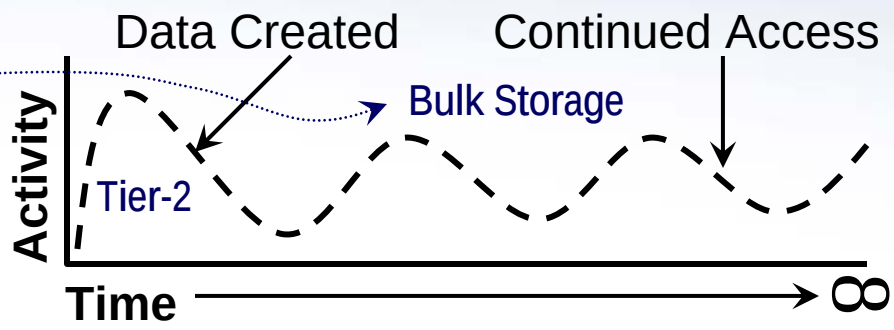
Changing data lifecycle and access patterns

Legacy and Transactional Data



Profile = Data is created, worked with and then goes dormant after some period of time with probability of little to no future access or use
Examples = Database, Email, Transactional, general file serving, project oriented data
Action = Ideal candidate for archiving off of primary or on-line storage too off-line and removable media or MAID 2.0 & IPM based storage combined with purging or deletion of data no longer needed to meet compliance or other commitments

Web 2.0 and On-line Data



Profile = Data is created, worked with and then may go idle briefly, then accessed, then idle, then active, then idle, then active…
Examples = Web, Reference and lookup, fixed content, Web 2.0 and social networking, media and entertainment, some email, search, seasonal or event and research based data
Action = On-line storage with variable performance to meet changing workload demands, bulk and clustered storage, IPM enabled storage and storage caching

Source: "The Green and Virtual Data Center" (Auerbach)

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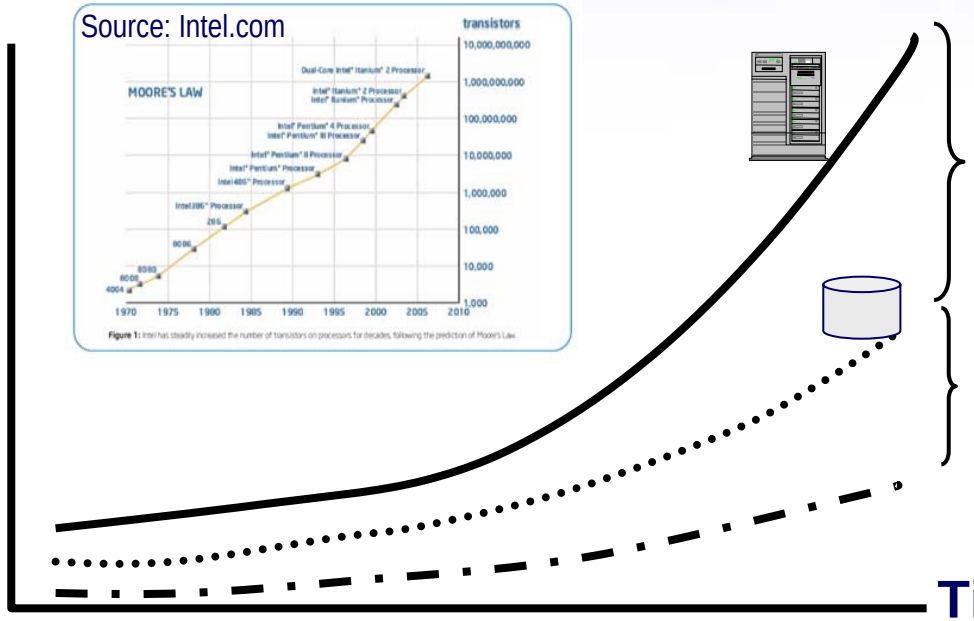
Industry Trends: I/O Performance Gap

Disk I/O lags server performance and storage capacity

Sustaining IT and Business Growth, Maintaining QoS



Server processor performance curve

Disk storage capacity curve

Disk storage performance curve (IOPS)

See "Data Center Performance Bottlenecks" www.storageio.com

Action Items

- ✓Address I/O issues/problems
- ✓Storage & I/O optimization
- ✓User fewer, yet fast devices
- ✓Balance SSD (RAM & FLASH)
- ✓Fast 15.5K SAS & FC disks
- ✓Data footprint reduction

Source: "The Green and Virtual Data Center" (Auerbach)

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Next Generation Data Centers

What the "Information Factory" of the future will look like

New and Emerging

Time Tested and Field Proven

Balance of new and old technologies

SSD (RAM & FLASH)
Clusters & Grids
Clouds, policy based automation and Virtualization, tiered access (FCoE, Object Access), DLP

Magnetic disks and tape, clusters and tiered storage, RAID, tiered data protection, encryption, tiered access (FC, iSCSI, SAS, NAS)

- Highly optimized, secure, resilient and flexible, dense resources, (beyond just consolidation), automated, efficient enabling more work and productivity to be done
- Clouds are complimentary to traditional IT resources as another tier of resource for IT service delivery
- Keep in mind that virtual, cloud, grid and SOA solutions require physical resources, software, tools, facilities and people!

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Green Computing: Shifting Focus

From green-wash to action, from energy avoidance to energy efficiency

"A little less conversation, a little more action please…" - Elvis

RIP: Green-wash and Green hype!

- Green-hype
  - On endangered species list
  - Less on perception
  - More on substance
- Closing the green gap
  - Economics vs. CO_2 only focus
  - Sustain growth and service
  - From energy avoidance to energy efficiency

Energy Avoidance Power Down, Over Consolidate Decrease Amount of Useful Work Decrease Energy Used	Use/Activity Useful Work Power Used Time Poor Efficiency Gap
Some Energy Efficiency Faster Components, Same Power Increase Amount of Useful Work Same Amount Energy Used	Use/Activity Improved (Better) Efficiency & Economic Gap
Some Energy Efficiency Lower Power Draw Components Same Useful Work Done Decrease Energy Used	Use/Activity
More Energy Efficiency Faster Components/Less Power Increase Amount Useful Work Decrease Energy Used	Use/Activity Very Good Efficiency Gap

Source: "The Green and Virtual Data Center" (Auerbach)

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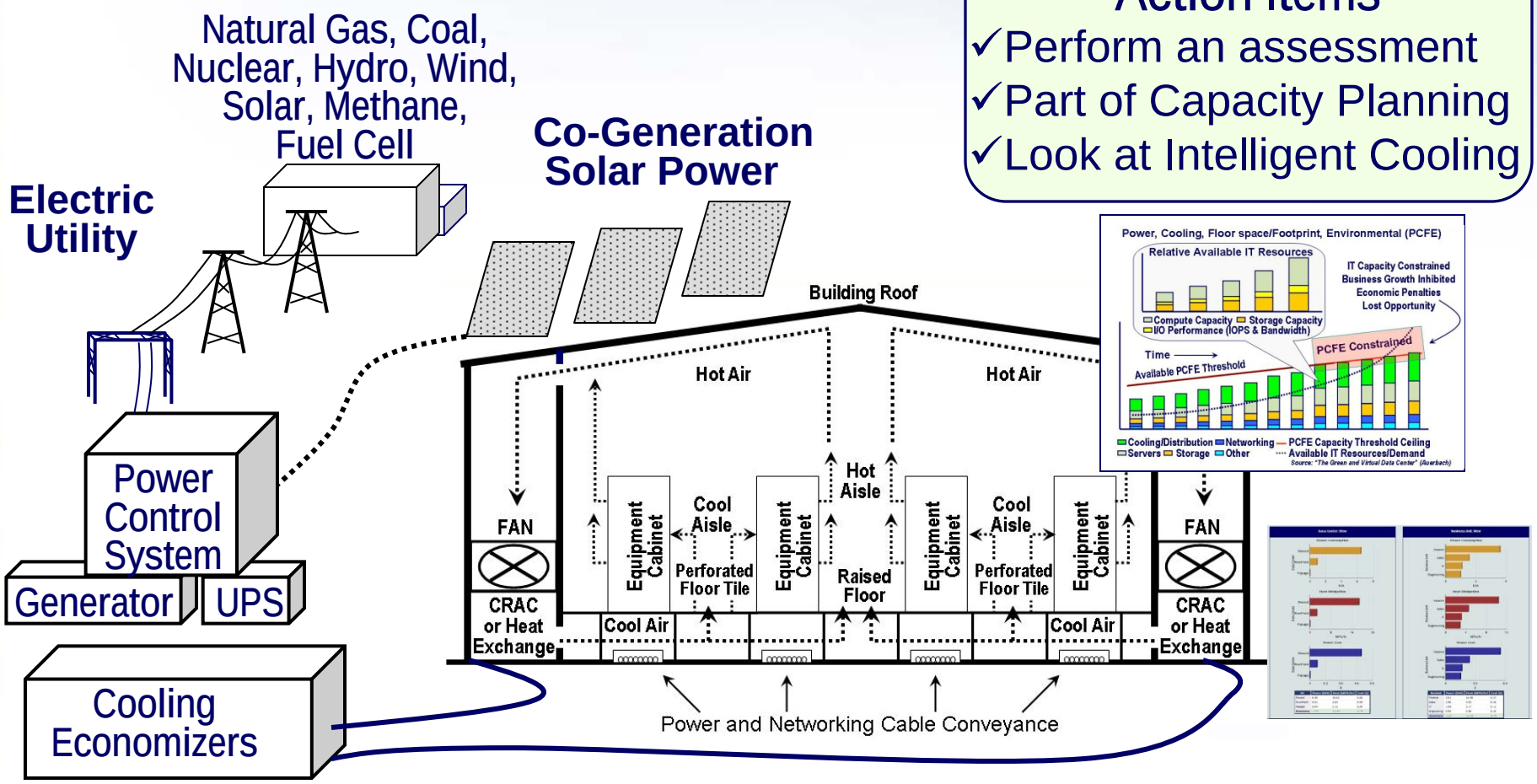
Physical Facilities – Habitats for Technology

HVAC, Alternative Energy and Cooling, Co-Generation

Action Items

- ✓Perform an assessment
- ✓Part of Capacity Planning
- ✓Look at Intelligent Cooling



Source: "The Green and Virtual Data Center" (Auerbach)

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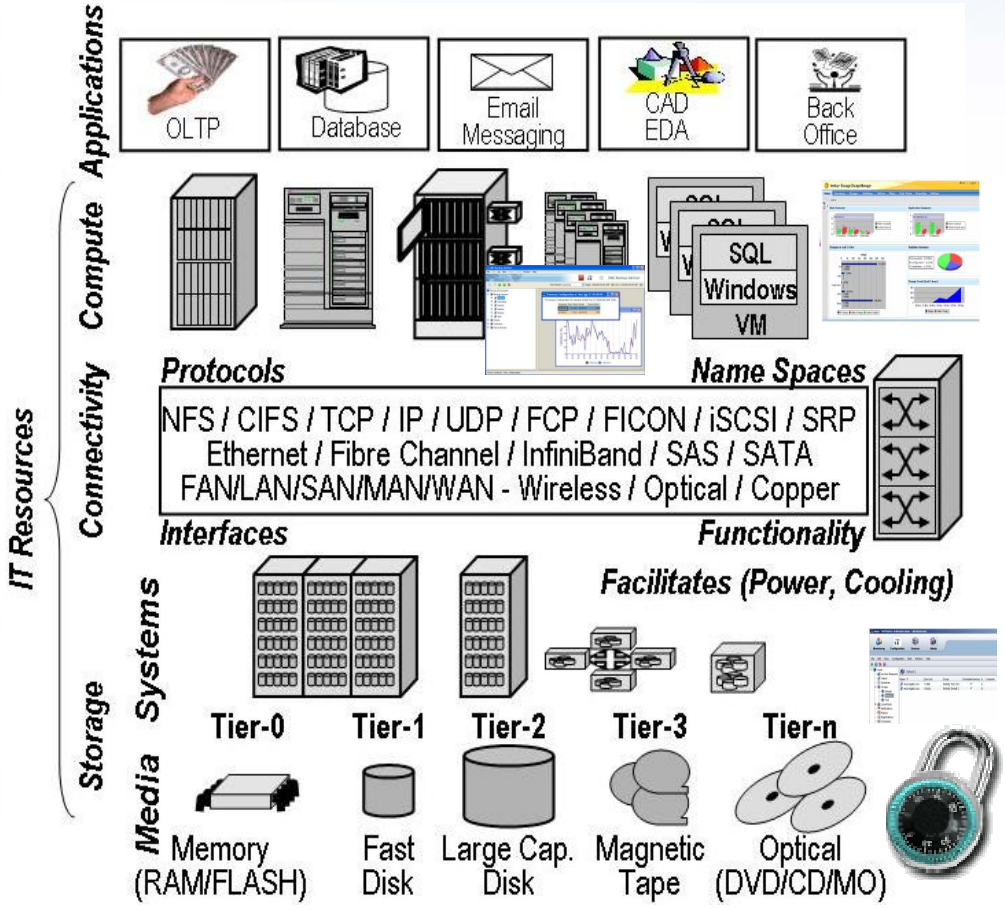
Cross Technology Domain Management

Server, storage, networking and software convergence

IRM = Software, tools, procedures, policies, best practices



Source: "The Green and Virtual Data Center" (Auerbach)

Infrastructure Resource Management (*IRM*) functions and activities

Processes and Tools

- Namespace and virtualization
- Measurements and metrics
- Monitoring and reporting
- Modeling, analysis, planning
- Resource usage and allocation
- Performance and capacity plan
- Thin provisioning and purposing
- Diagnostic and resolution
- Change & configuration validation
- Data protection and footprint reduction
- Policy management and service levels
- Facilities and asset management
- Logical and physical security
- Procurement and disposition

See "Data Protection Options for Virtualized Servers" www.storageio.com

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IT Resource Tiering: Technology Alignment

Balance Performance, Availability, Capacity, Energy (PACE)

- Align technology balancing PACE with cost, QoS and SLA
  - Active (Cost per IOP) vs. In-active / Idle (Cost per Capacity)
  - Transactions and IOPS vs. Bandwidth vs. Latency
  - Availability vs. Performance vs. Cost vs. Footprint (Physical & Energy)
- Applies across different IT resources to:
  - Applications and services
  - Data protection (BC/DR, Backup, HA)
  - Security (Logical and Physical)
  - Servers and Storage (Virtual and Physical)
  - Access, I/O and networking

- Cloud and SaaS based solutions and services are another tier!
  - Supplement and compliment existing tiers of IT resources (BC/DR)
  - Shift processing, storage/data to other venue/provider

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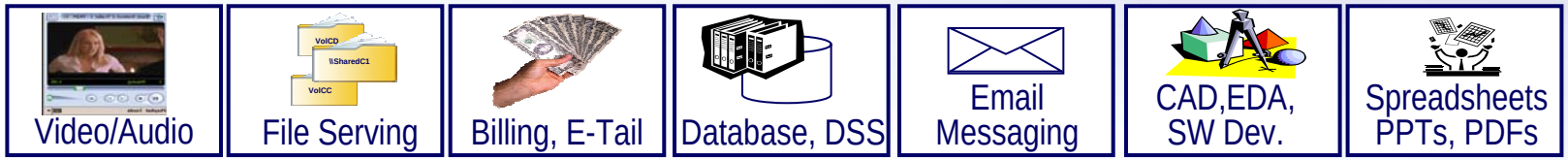
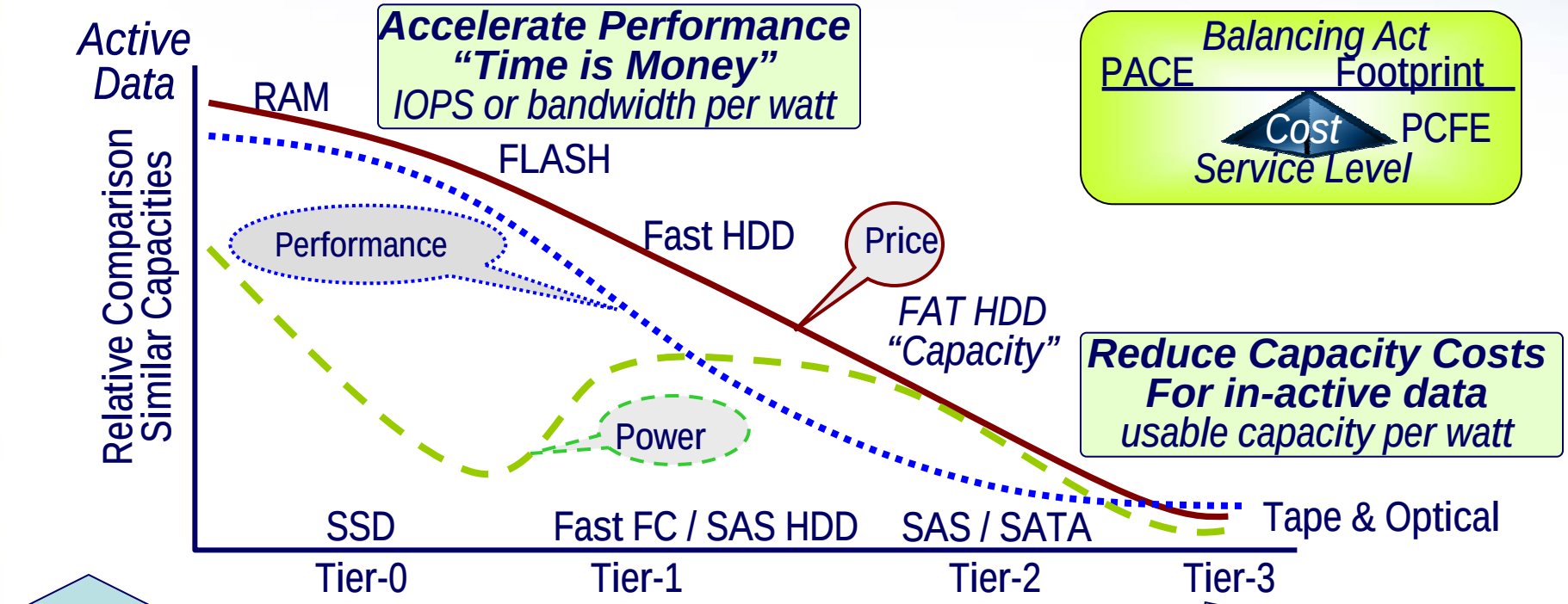
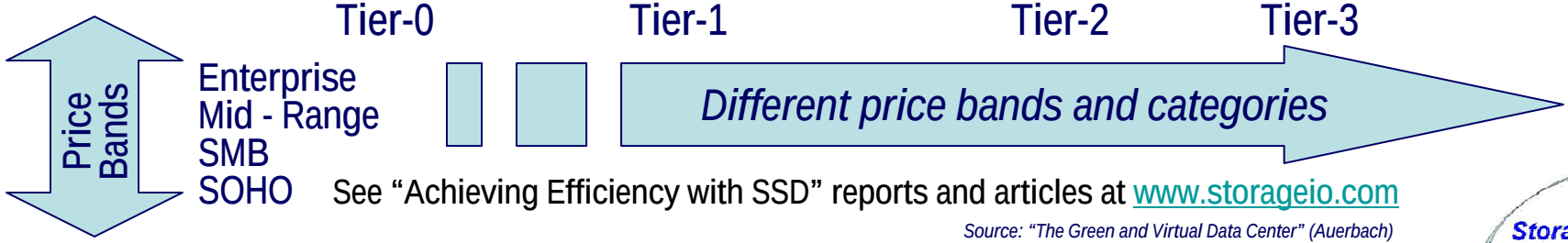
Industry Trend: Tiered Resources

Balance Performance, Availability, Capacity, Energy (PACE)







See "Achieving Efficiency with SSD" reports and articles at www.storageio.com

Source: "The Green and Virtual Data Center" (Auerbach)

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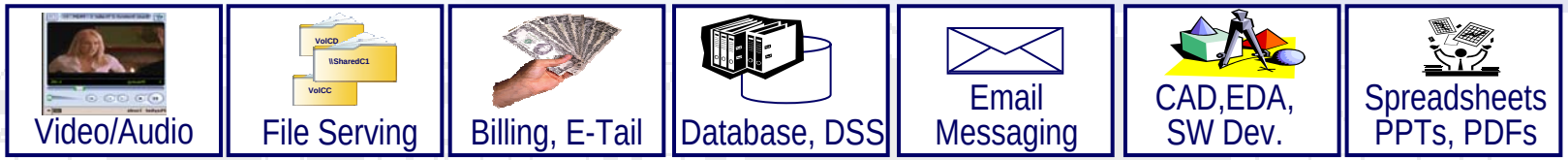
Tiered Data Protection

Balance Cost, Data Loss, Availability and Applicable Threats



Relative Protection Cost

RTO = Recovery Time Objective = When data can be usable or available

RPO = Recovery Point Objective = What point data is recovered to, how much data can you afford to potential lose

Synchronous Data mirroring, replication, Continuous availability, non-stop processing. RTO and RPO near or at zero

Asynchronous remote data mirroring, replication, snapshot and copy. HA failover cluster. Longer RTO and/or RPO.

Remote tape or disk to disk to tape backup, copies and vaulting. Remote archiving. Extended RTO & RPO.

Continuous Minutes Hours Days Weeks Months

Source: "The Green and Virtual Data Center" (Auerbach)

RTO and RPO timeline and data lifecycle

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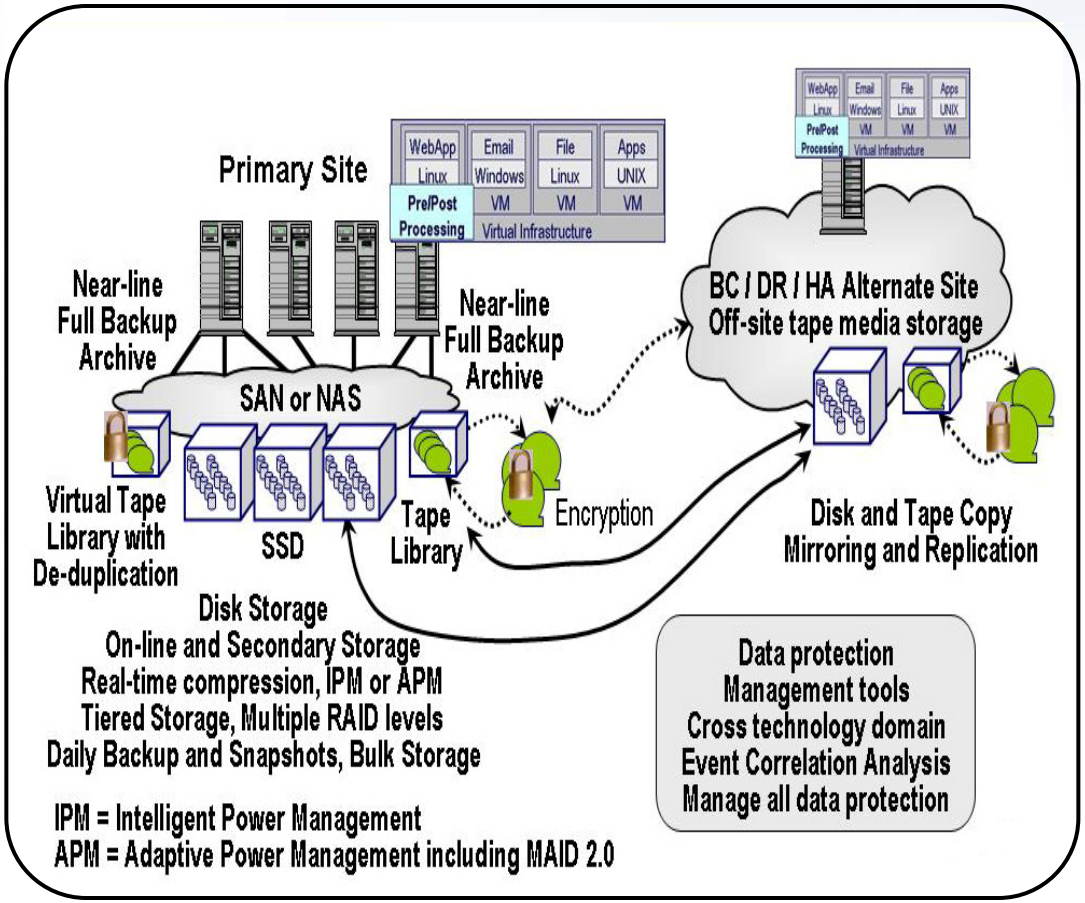
Tiered Data Protection and Storage

Balance Performance, Availability, Capacity, Energy (PACE)



VTLs Complimenting Tape

- D2D2T – De-stage to tape
- Protect disk based backups
- Data Archiving
  - Data preservation
  - Compliance
  - Non-compliance
  - Data footprint reduction
- Support green initiatives
- Part of tiered storage model
- Bulk and removable media

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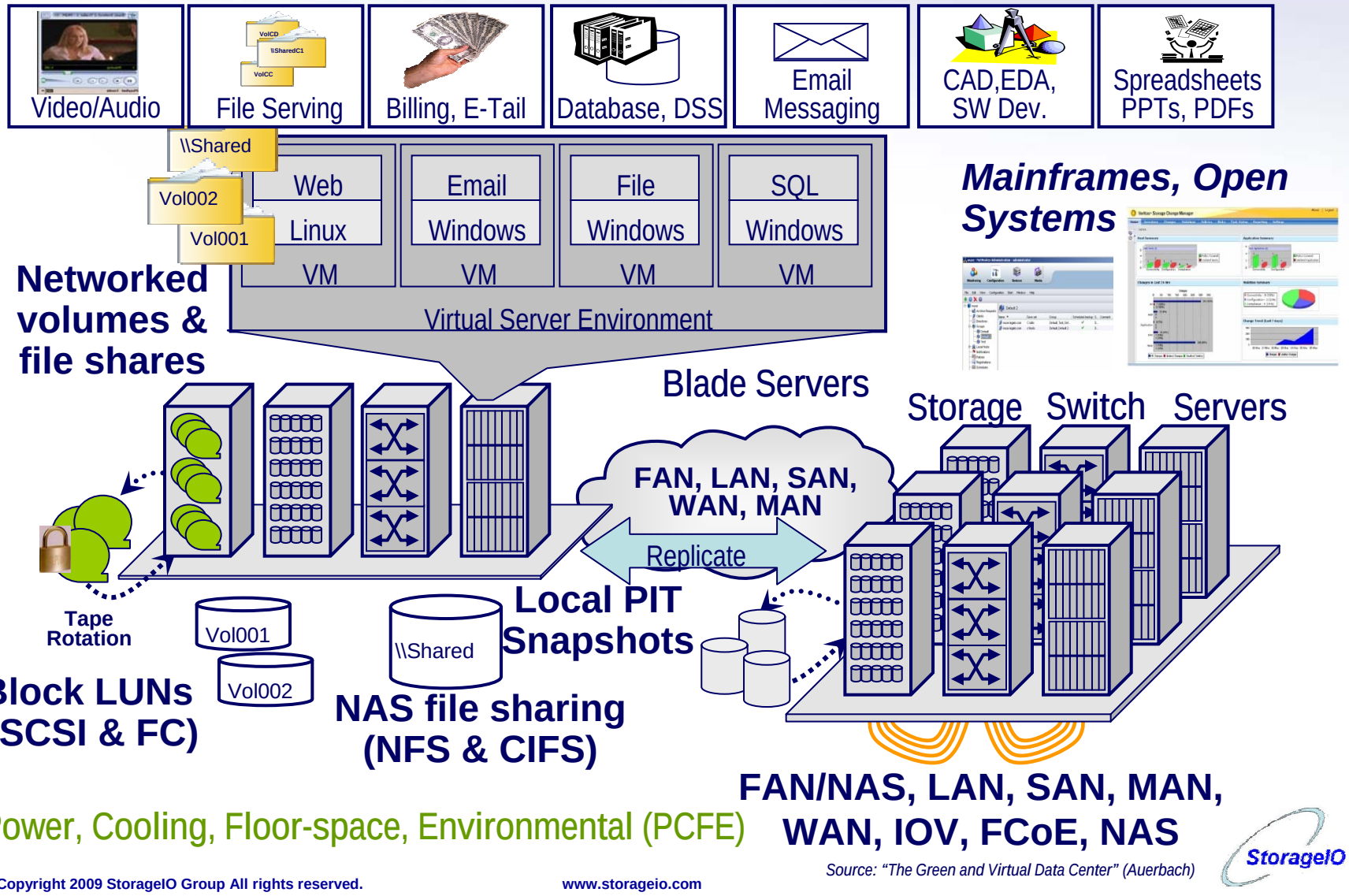
Industry Trends: Virtualization

Current focus is consolidation of physical resources



Power, Cooling, Floor-space, Environmental (PCFE)

Source: "The Green and Virtual Data Center" (Auerbach)

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Industry Trends: Virtualization (Next Phase)

Life beyond consolidation: Abstract, Emulate and Management

Issues That Inhibit Consolidation:
- QoS and performance barriers
- Politics and financial constraints
- Competitive or legal purposes
- Security and compliance

Tomorrow

Non-consolidated servers or storage

A huge market and IT virtualization opportunity!

Total server and storage market size

Action
- **Emulation**
- **Abstraction**
- **Aggregation**
- **Migration**

Consolidation applies only to a fraction of all servers or storage

Consolidated servers and storage using virtualization

Today

Market and IT opportunity = Life beyond consolidation
Using server or storage virtualization for IT resource management enabling abstraction and transparency for massive scaling, BC, DR & routine infrastructure resource management (IRM) operational functions

Source: "The Green and Virtual Data Center" (Auerbach)

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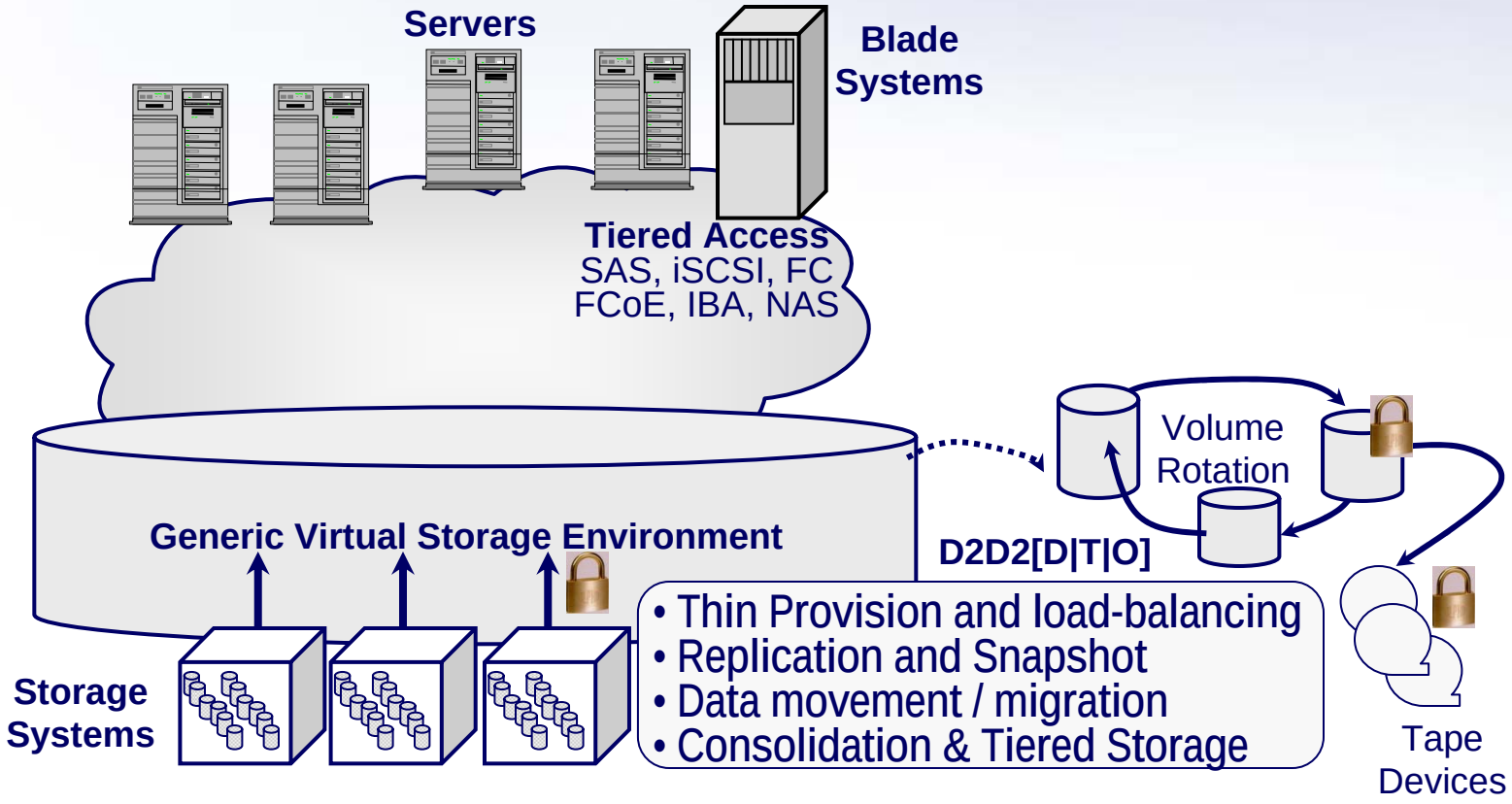
The Many Facets of Storage Virtualization

Consolidation, Emulation, Abstraction, Data Migration, BC/DR



Source: "The Green and Virtual Data Center" (Auerbach)

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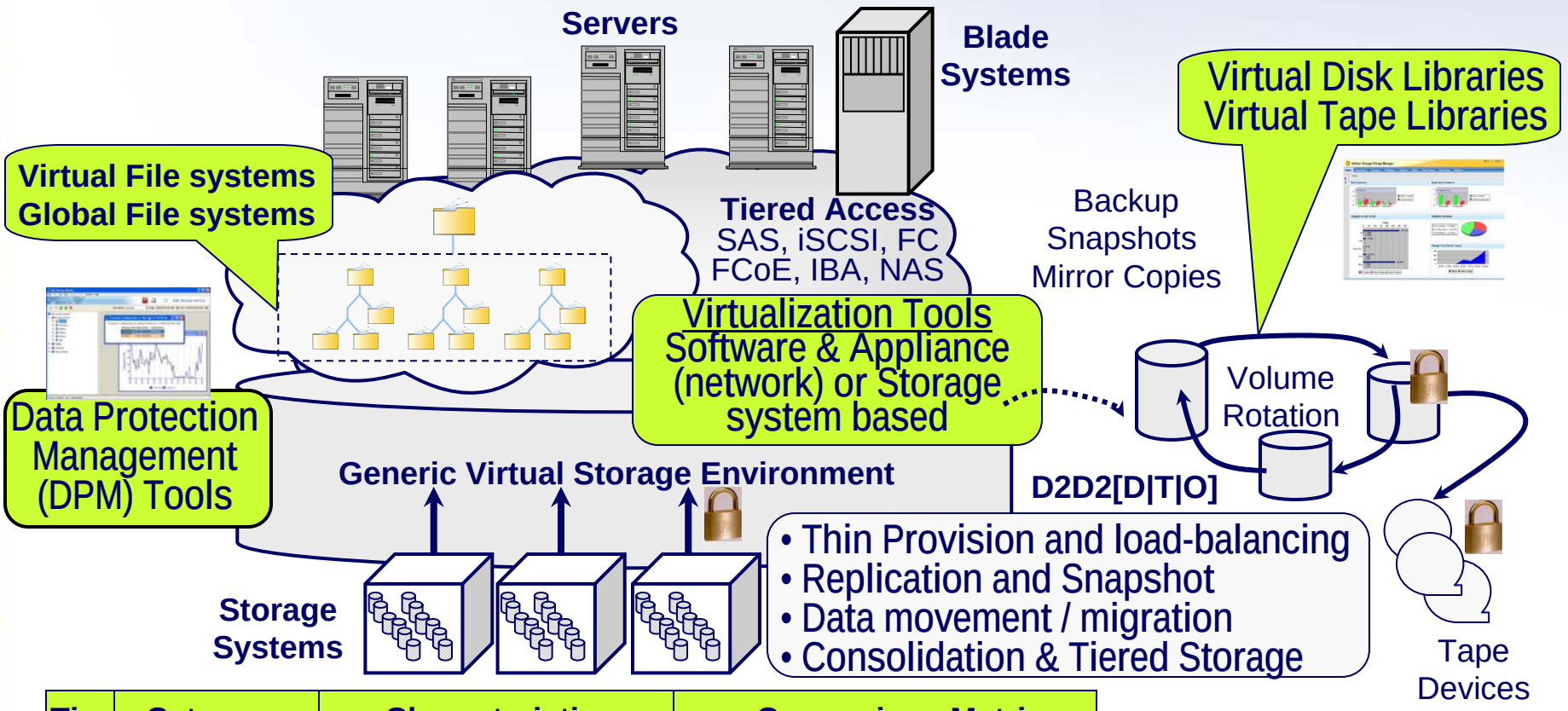
The Many Facets of Storage Virtualization

Different Approaches And Locations For Virtualization



Tier	Category	Characteristics	Comparison Metrics
T0	Ultra Fast	SSD (FLASH/RAM)	$ per IOP or transaction
T1	Primary	10K/15K FC/SAS	IOP per watt per footprint
T2	Secondary	Large Capacity SATA	Capacity per watt
Tx	Tertiary	Tape, Optical, Etc.	$ per capacity per watt

= Encryption and Key Management

Source: "The Green and Virtual Data Center" (Auerbach)

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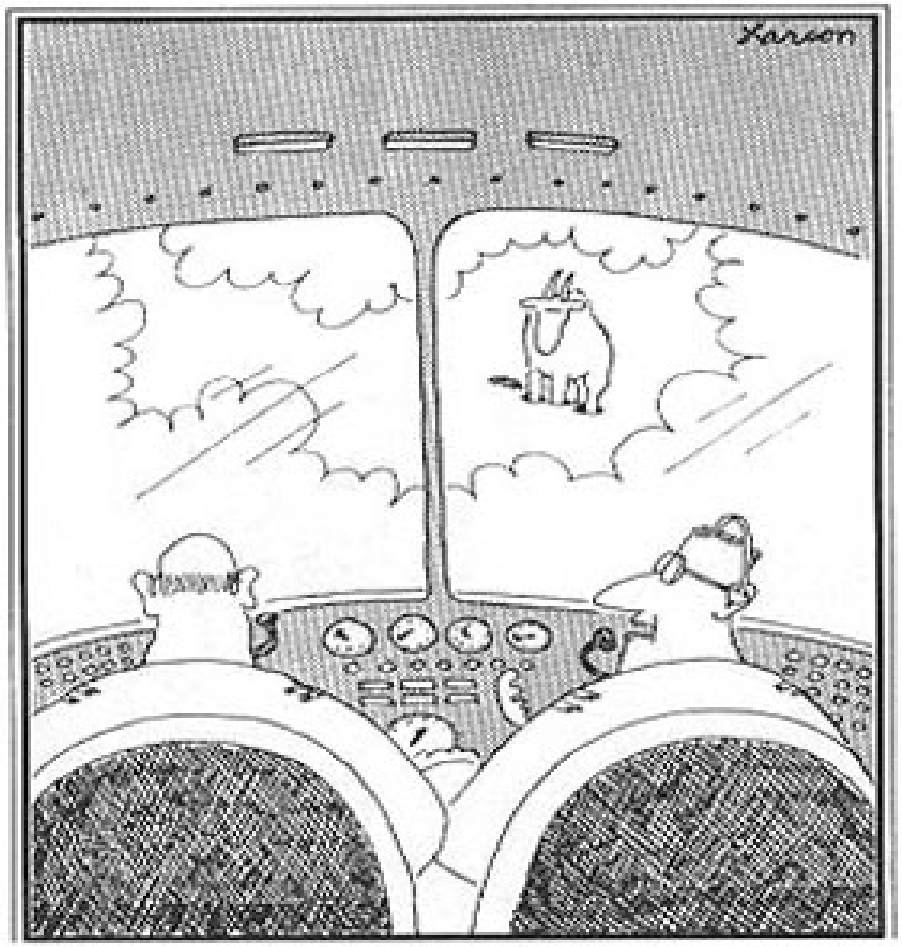
Industry Trends: Cloud Computing

Cloudy weather & confusion vs. clear skies & opportunity



"Say . . . What's a mountain goat doing way up here in a cloud bank?"

- Many types of clouds
  - Scientific vs. commercial
  - Services vs. solutions
  - Architecture vs. products
  - Public vs. private
  - Protocols and personalities
- Confusion and skepticism
  - Lingering reminder of SSPs
  - Replacement vs. complimentary
  - BC/DR and availability
- Opportunities & call to action
  - Clarify - Avoid flying blind
  - Position as a IT tiered resource
  - Complimentary vs. competitive
  - Protect & preserve, part of BC/DR

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Industry Trends: Converged Networking

I/O Virtualization (IOV) and Converged I/O Networking

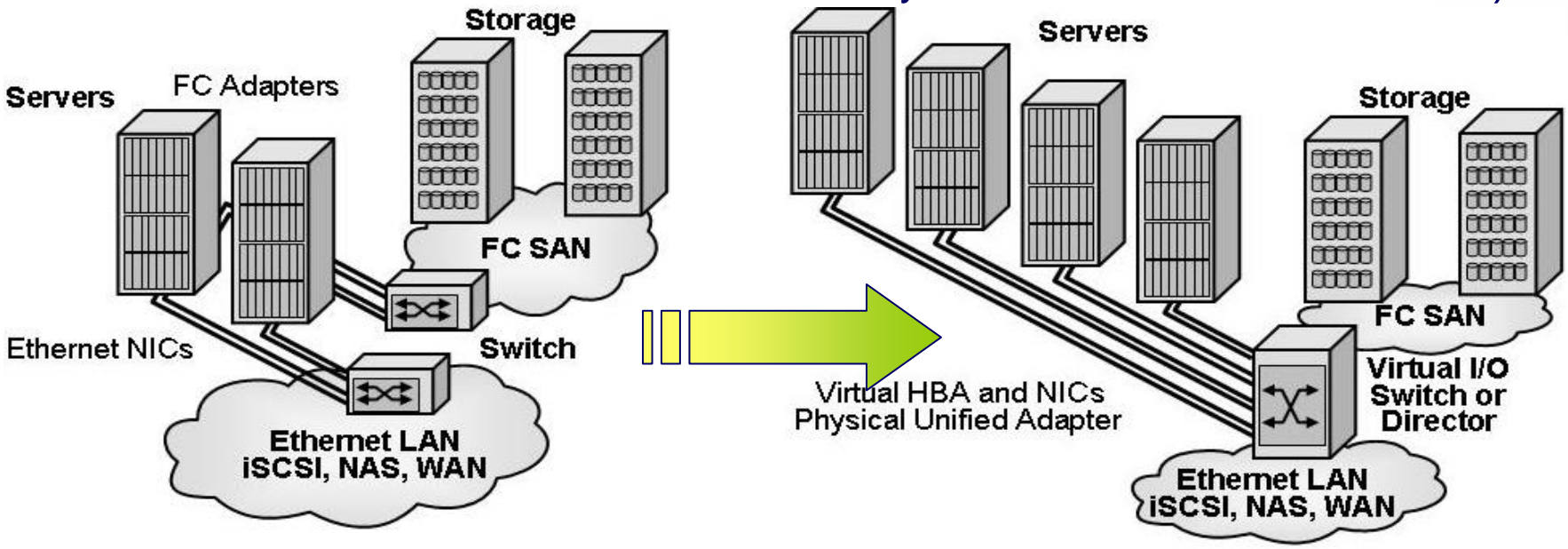
I/O, I/O, Its Off To Virtual Work We Go…

Traditional Approaches

Separate networks & interconnects
(Fibre Channel, GbE, IBA, Etc.)

Evolving Approaches

Unified & converged interconnects
(Virtualized FC, GbE, FCoE, Etc.
Physical Data Center Ethernet or IBA)



Need for speed: Consolidation, Reduce Response Time (Productivity), Support Growth

See "FCoE Overview" and "I/O, I/O, its Off To Virtual Work we Go" www.storageio.com

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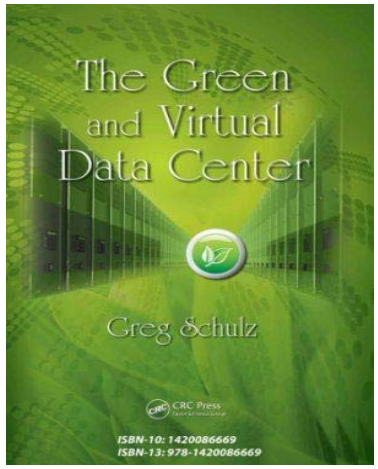
Green Computing: Shifting Focus - Continued

Boosting IT efficiency & productivity, addressing PCFE and other IT issues

Wheel of opportunity: PCFE optimization and IT productivity

Policies, metrics, monitoring and best practices efficiency rebates



Also see SNIA and other venues for various tips

PCFE: Power, Cooling, Footprint, EH&S

Source: "The Green and Virtual Data Center" (Auerbach)

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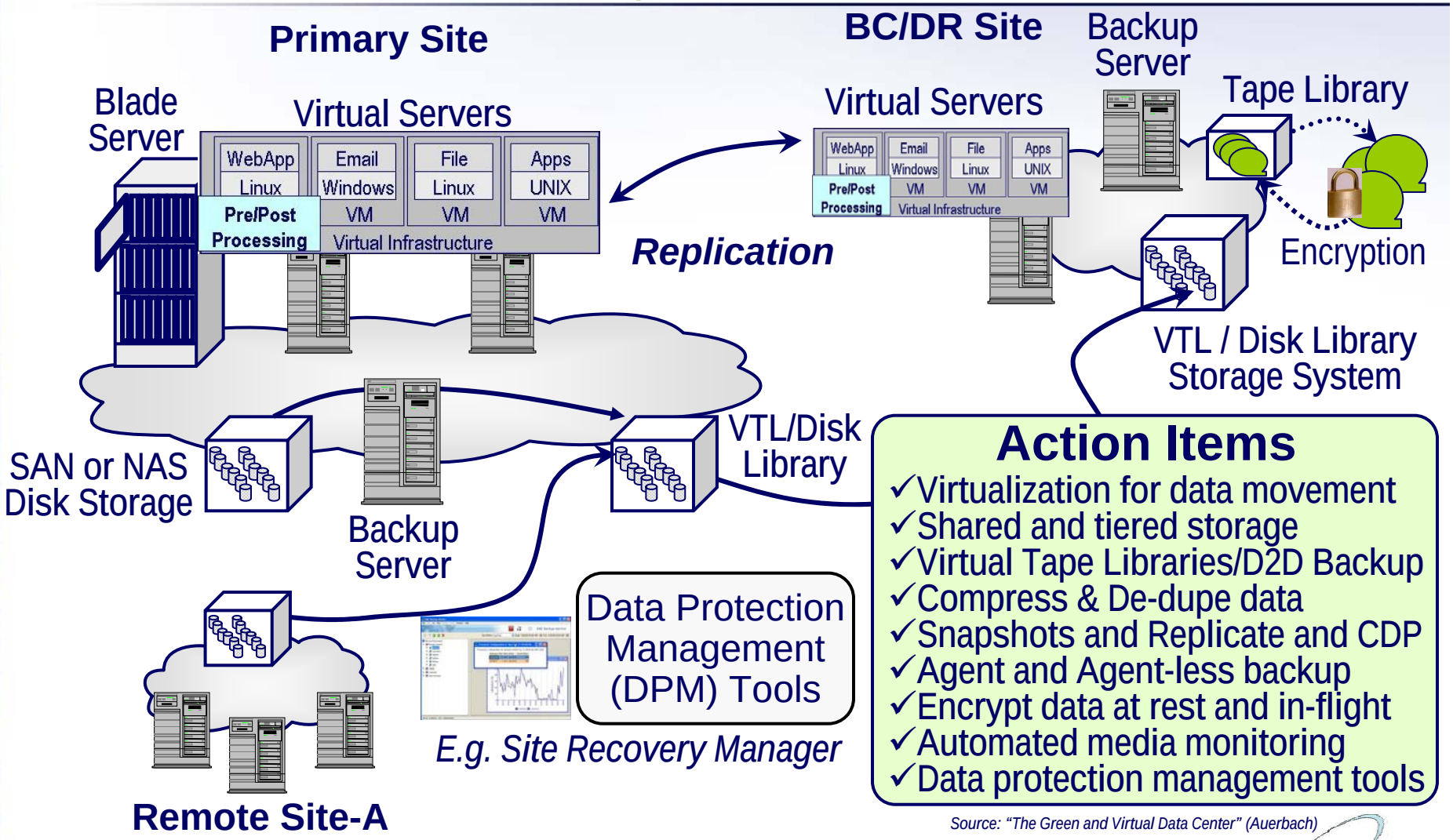
What You Can Do Today!

Combine Different Techniques to Address Data Protection



Action Items

- ✓Virtualization for data movement
- ✓Shared and tiered storage
- ✓Virtual Tape Libraries/D2D Backup
- ✓Compress & De-dupe data
- ✓Snapshots and Replicate and CDP
- ✓Agent and Agent-less backup
- ✓Encrypt data at rest and in-flight
- ✓Automated media monitoring
- ✓Data protection management tools

Source: "The Green and Virtual Data Center" (Auerbach)

See "Data Protection Options for Virtualized Servers" www.storageio.com

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Closing Comments

Basic Premises – Gain management insight and control

- IT data centers are information factories
  - Efficient equipment, management tools and resources needed
- Many approaches depending upon your customers issues
  - Do more with less: Shift from energy avoidance to efficiency
    - Small improvements on large scale have big benefits!
    - More IOPS or Transactions or Files processed per watt of energy
    - More usable capacity in given footprint per watt of energy
- Avoid simply moving IT problems around
  - Solve problems and issues to enable IT and business growth
    - Instead of race to replace tape, revamp data protection architecture
- Balance between futures and what works today
  - Leverage virtualization to bridge from the past to the future
  - Virtualization and cloud computing require real resources & people

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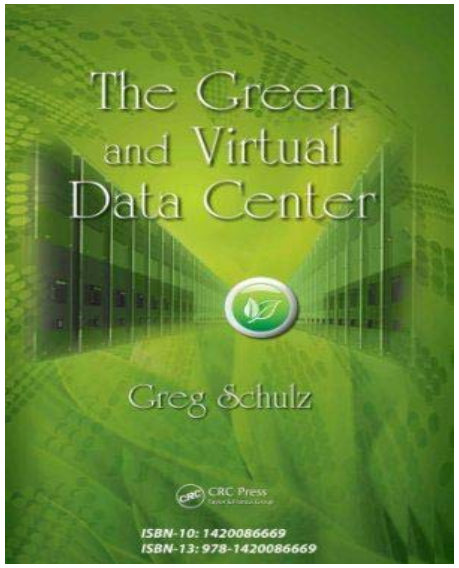
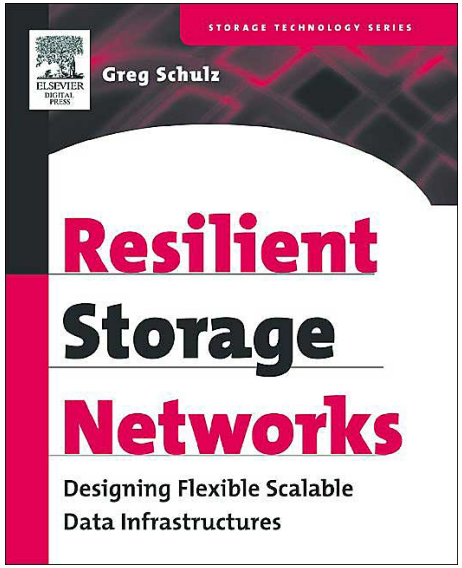
Closing Comments

Look at 2009 as a challenging opportunity

- Where you can learn more: RSS
  - www.storageio.com (Book info, white papers, articles, tips, videos)
  - www.storageioblog.com & www.twitter.com/storageio
  - www.thegreenandvirtualdatacenter.com





Order your copy of "The Green and Virtual Data Center" (Auerbach)
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Thank You

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