Performance Basics

Leah Schoeb, Member of SNIA Technical Council

SNIA Emerald™ Training

SNIA Emerald Power Efficiency Measurement Specification, for use in EPA ENERGY STAR®

July 14-17, 2014

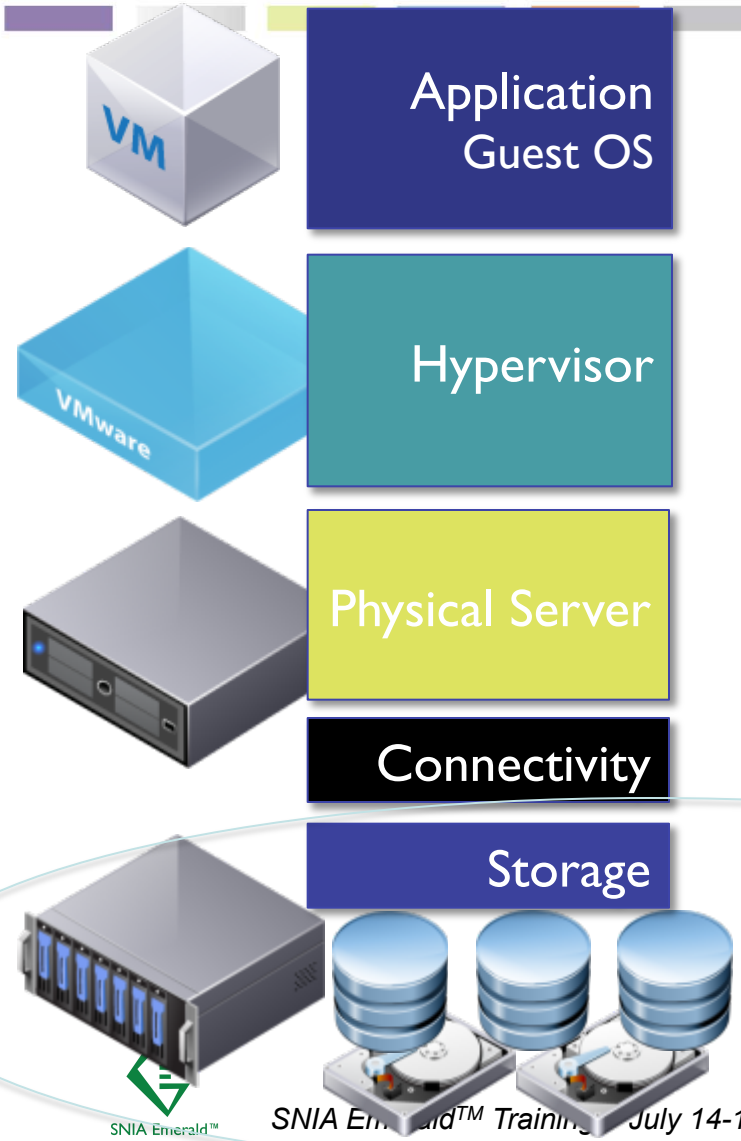
SNIA™ Green Storage Initiative

SNIA Emerald™

Agenda

- Today's Impact on Storage Performance
- Storage Performance Planning
- Troubleshooting Methodology and basic metrics

IO Performance Needs Monitoring at Every Level



Application Level
App Specific Perf tools/stats

Guest OS
CPU Utilization, Memory Utilization, I/O Latency

Virtualization Level
Performance Metrics /Charts
Limits, Shares, Virtualization Contention

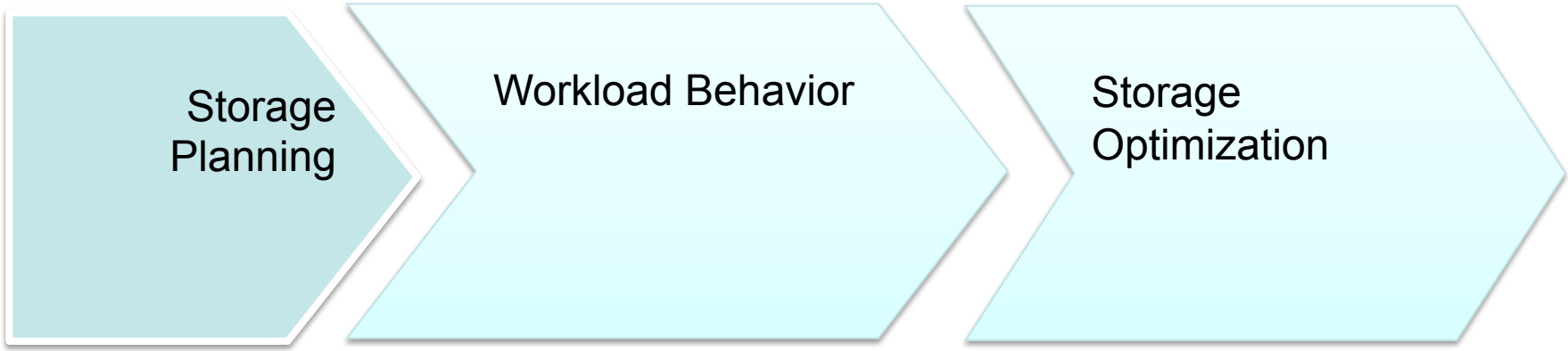
Physical Server Level
CPU and Memory Saturation, Power Saving

Connectivity Level
Network/FC Switches and data paths
Packet loss, Bandwidth Utilization

Storage Level
SAN or NAS Devices
Utilization, Latency, Throughput

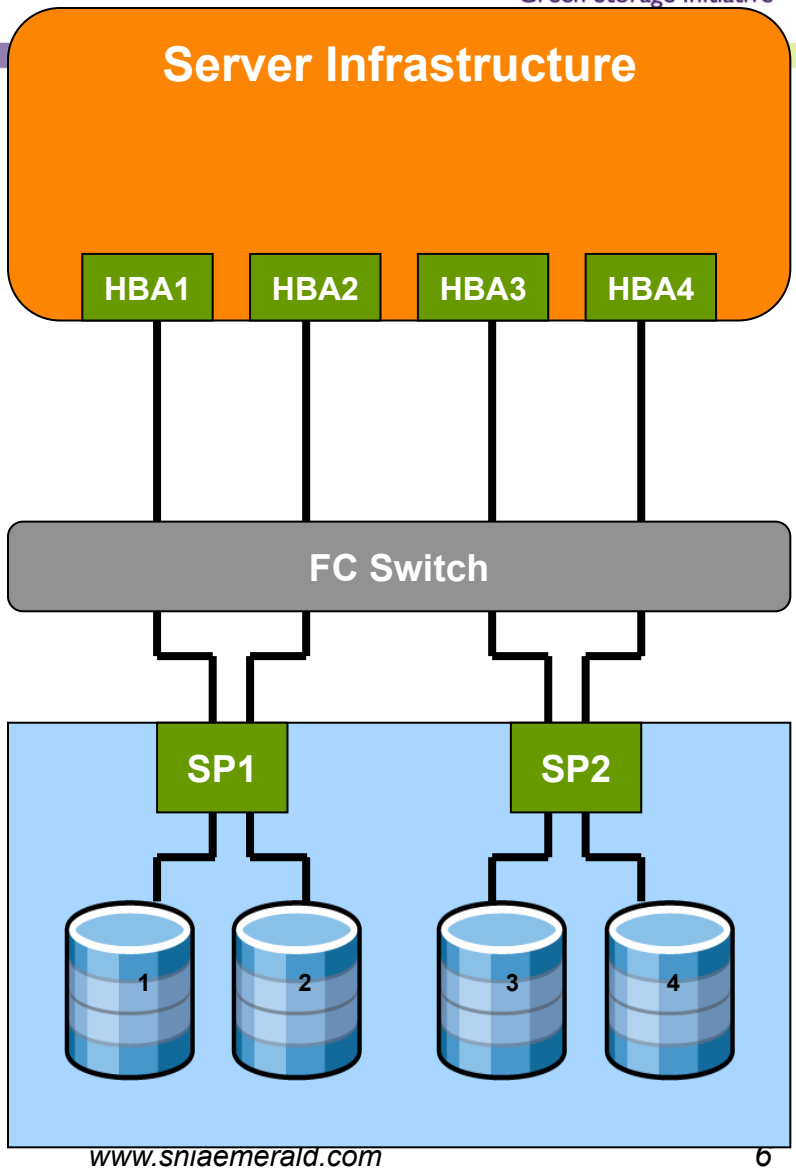
Storage Performance Planning

Planning for Performance

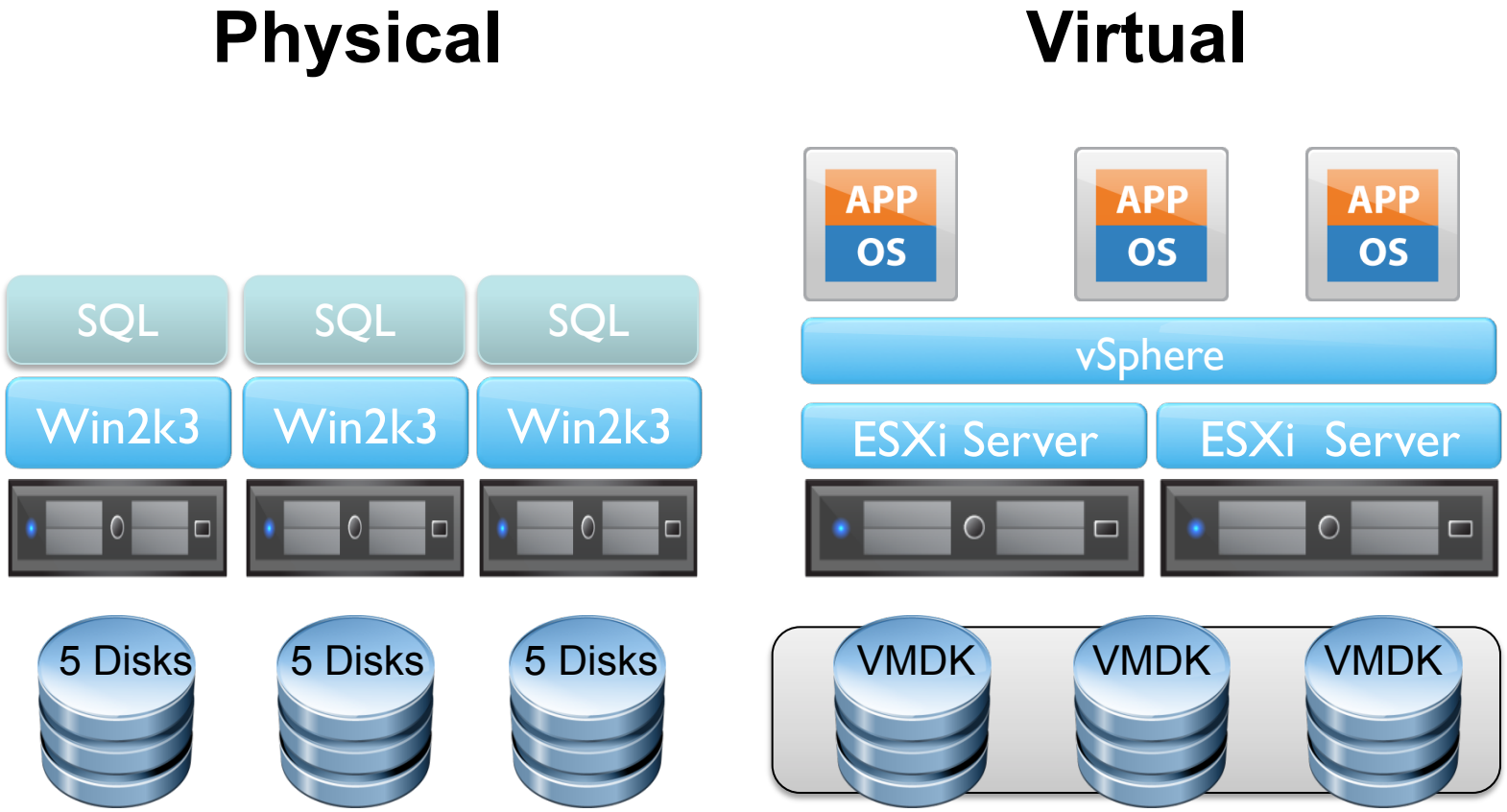


Storage Planning

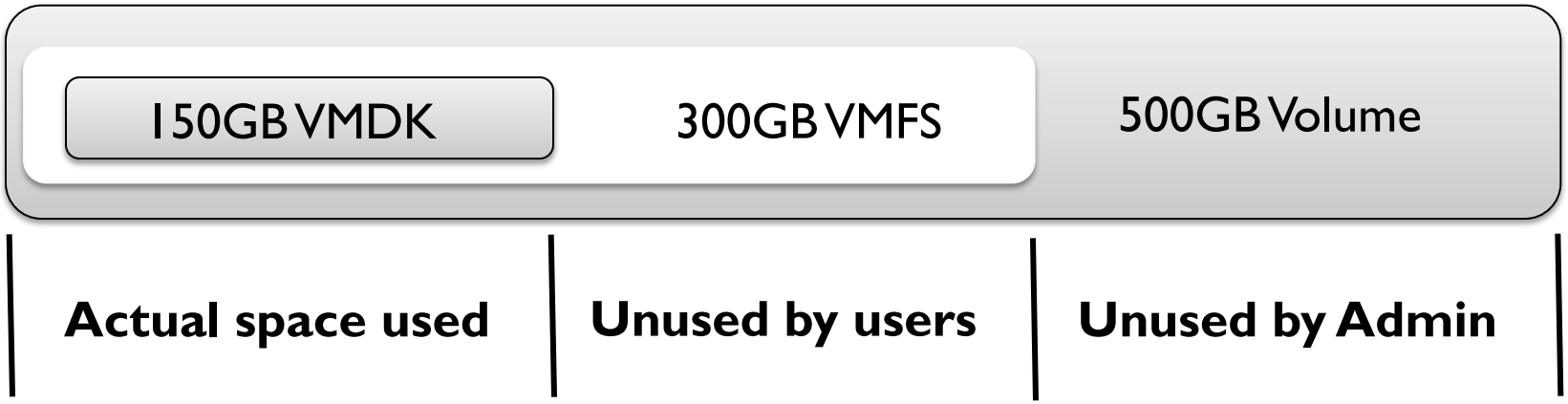
- Understand the workload
- Sharing or Consolidation
- Storage Protocol Options
  - File, block, or object
- Data Reduction Options
  - Thin provisioning
- Data Protection
- Other Storage Technology trade offs



Virtualize to consolidate

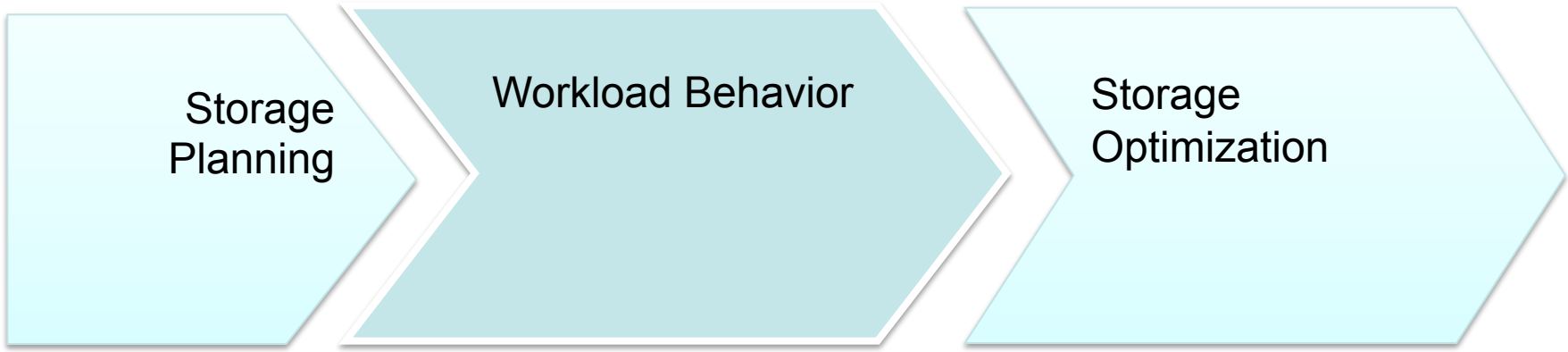


Over Provisioning

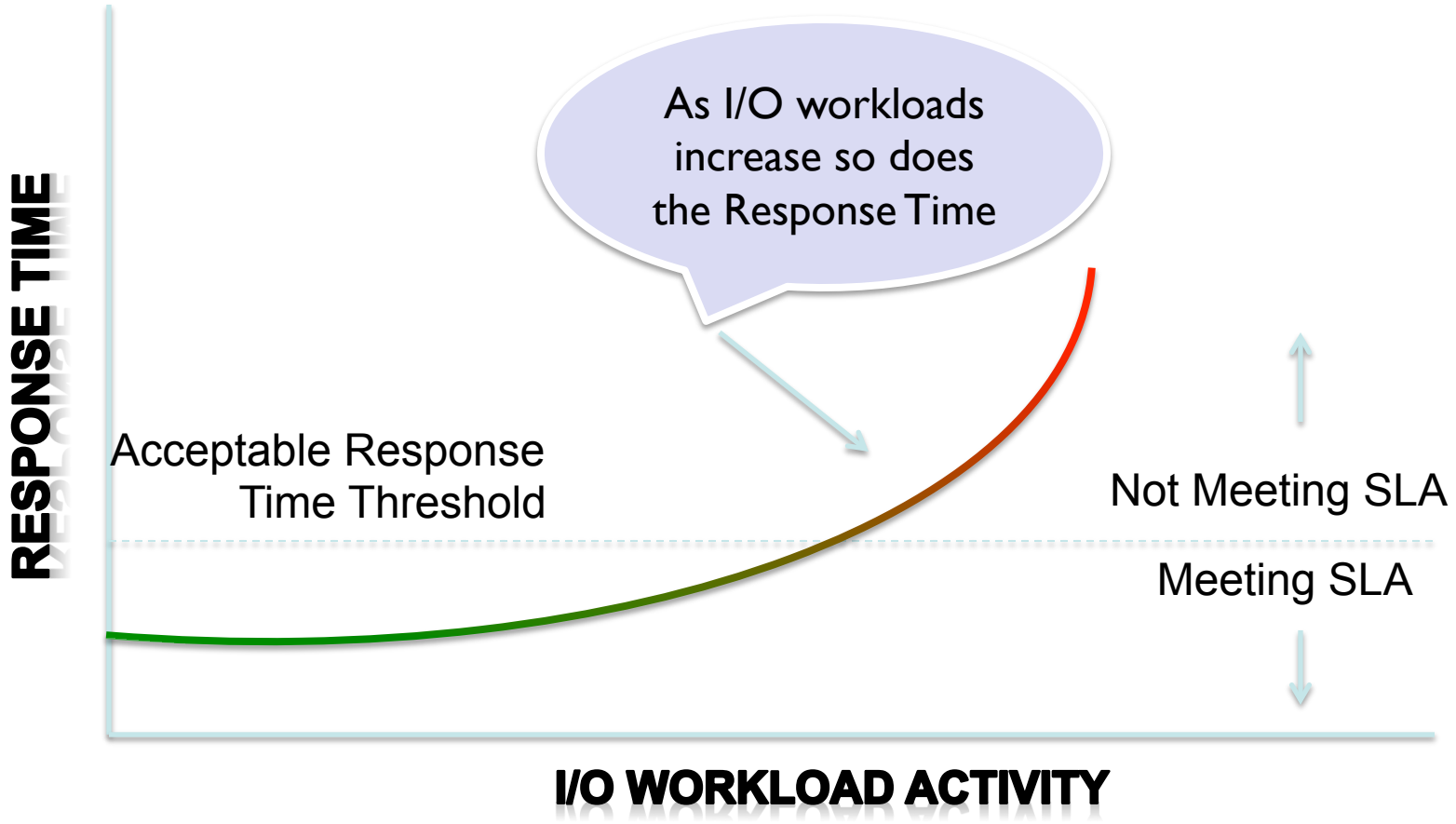


- Using Thick provisioning it is easy to over provision.
- You may want to **consider Thin Provisioning**.
- Most vendors offer Thin Provisioning

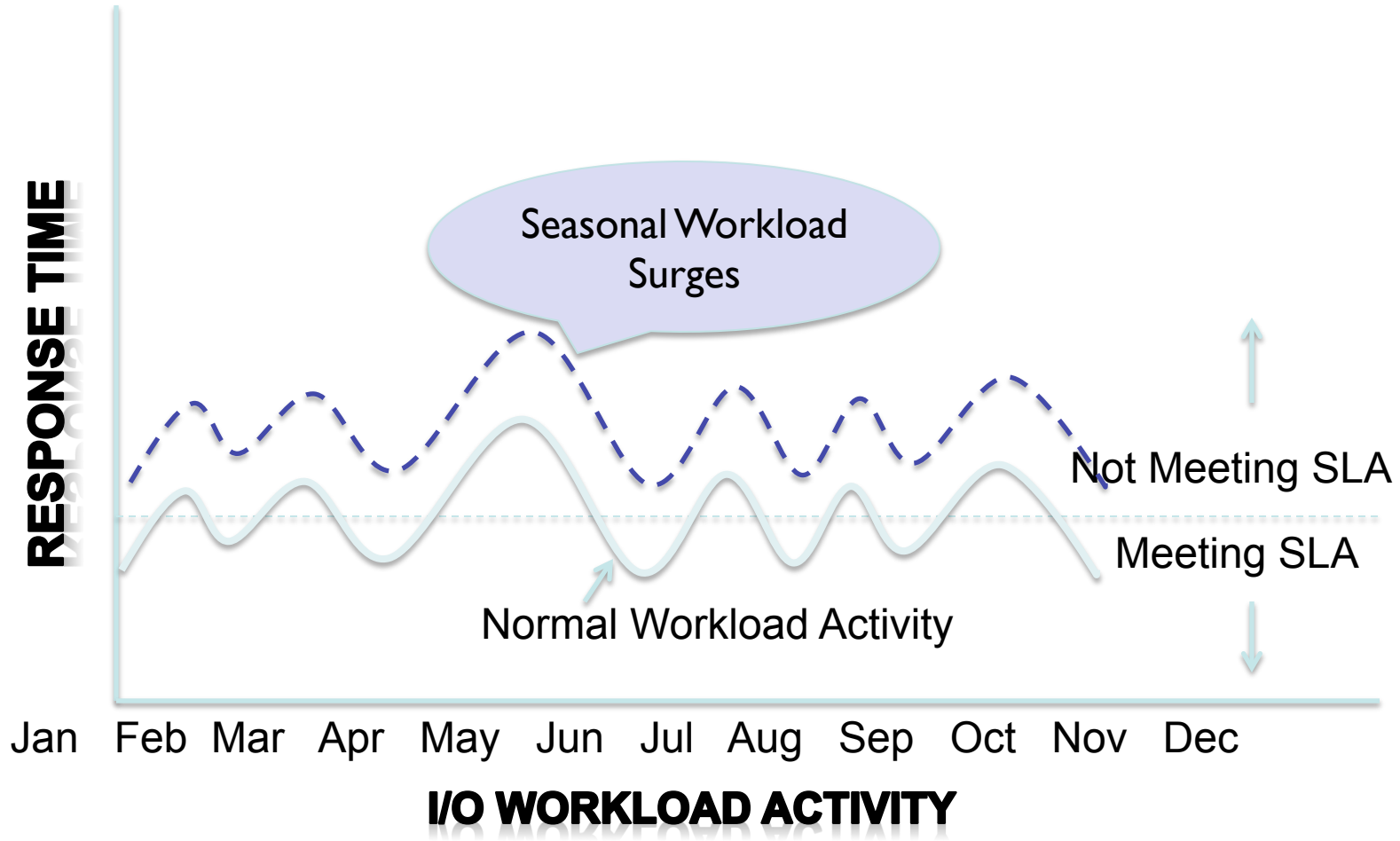
Planning for Performance



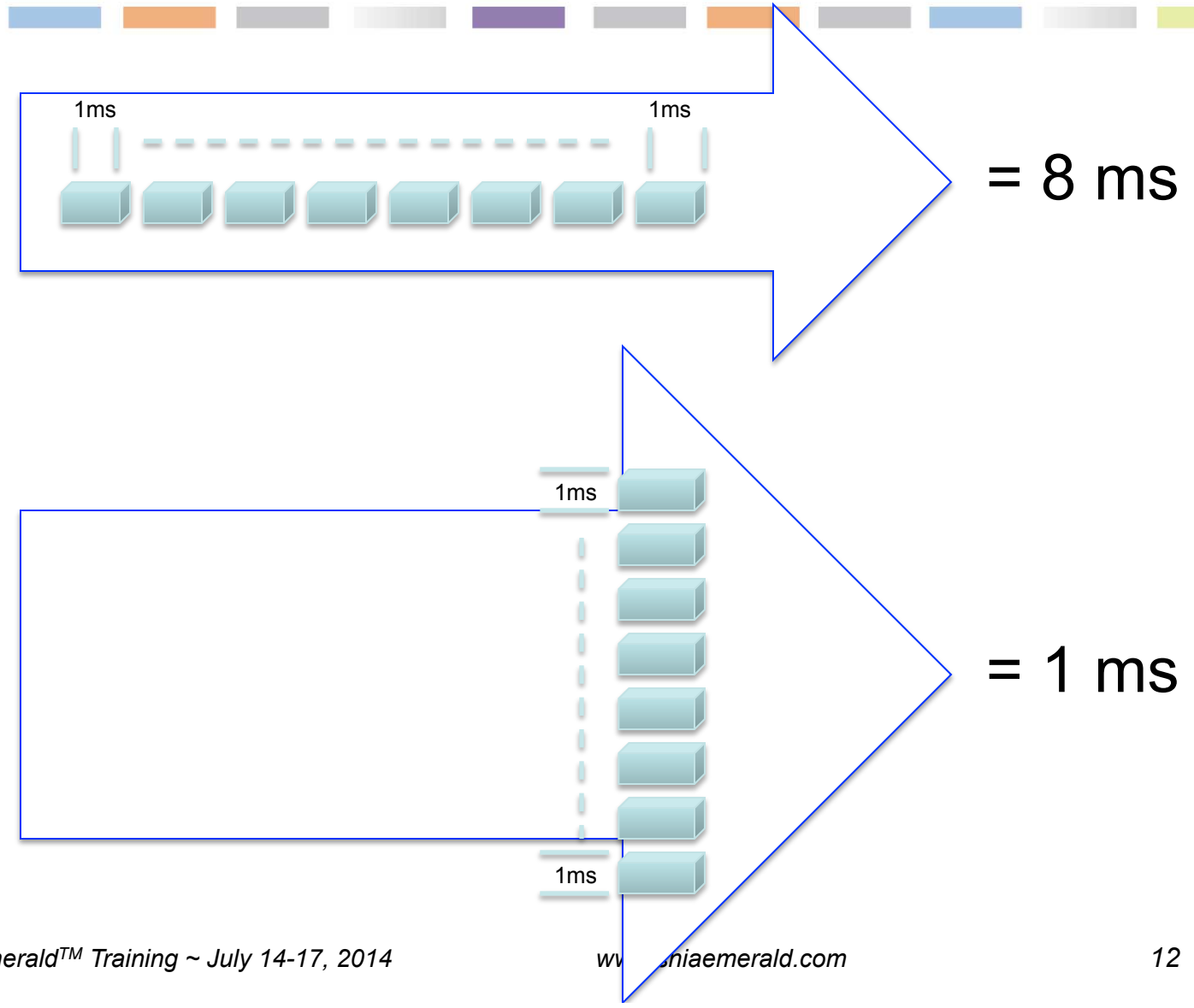
I/O Workload Activity vs. Response Time Supply and Demand



Seasonal/Periodic Performance Surges



Single vs. Multi-threaded Applications



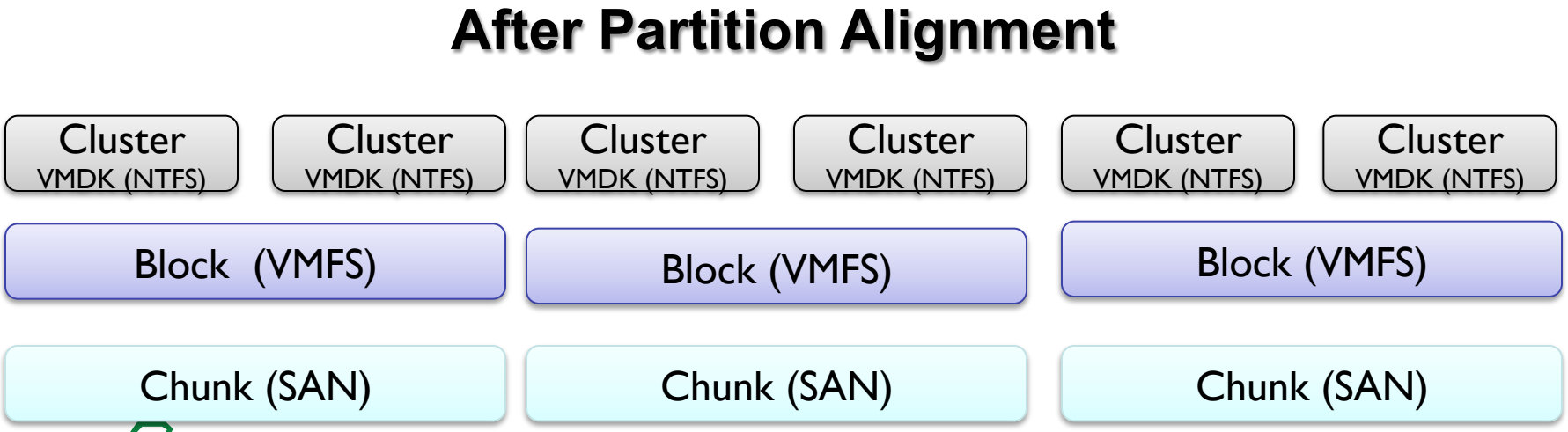
I/O Queue Depth

- The number of I/O request waiting to be completed
  - Also known as outstanding I/Os
- Limiting host I/O demands
- Certain applications, under extreme load, can gain performance by increasing the I/O Queue Depth
- Accepting requests from the Application

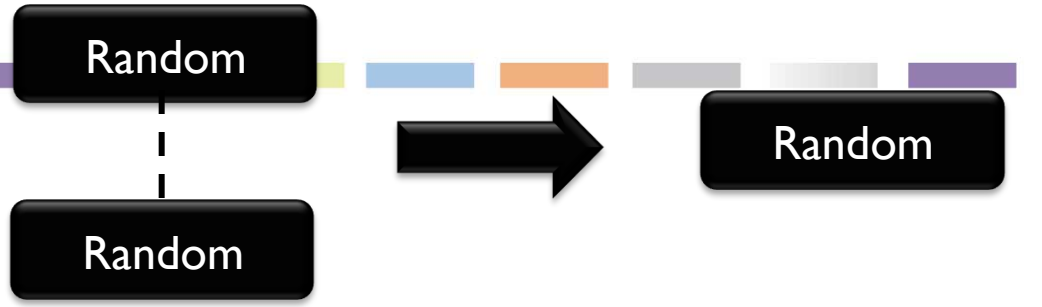
Skew

- Asymmetry of a distribution about its mean or the non-uniform distribution of data or I/O activity across storage devices.
- New storage technologies are handling this automatically
- Disk skew
  - An area of the disk has higher amounts of activity
  - Referred to as a ‘hot spot’
  - Data is accessed more frequently
- Controller skew
  - A controller has a higher amount of activity compared to rest of the controllers in a storage system.

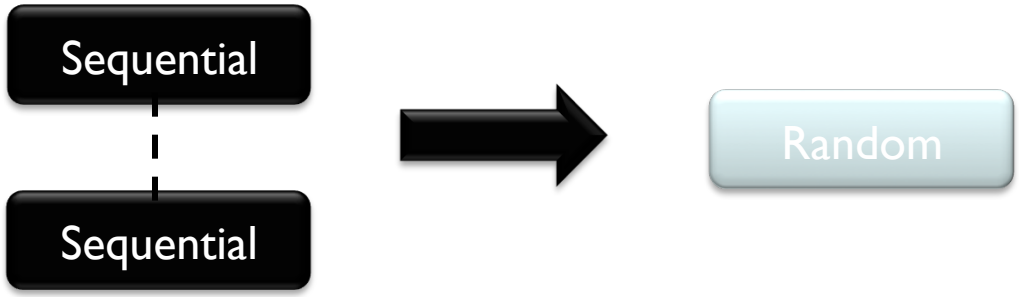
Misalignment



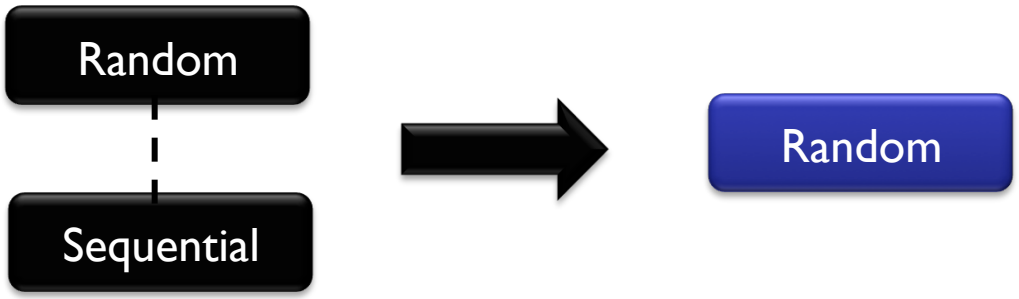
Workload Consolidation



Group similar workloads together (Random w/ Random and Sequential /w Sequential)

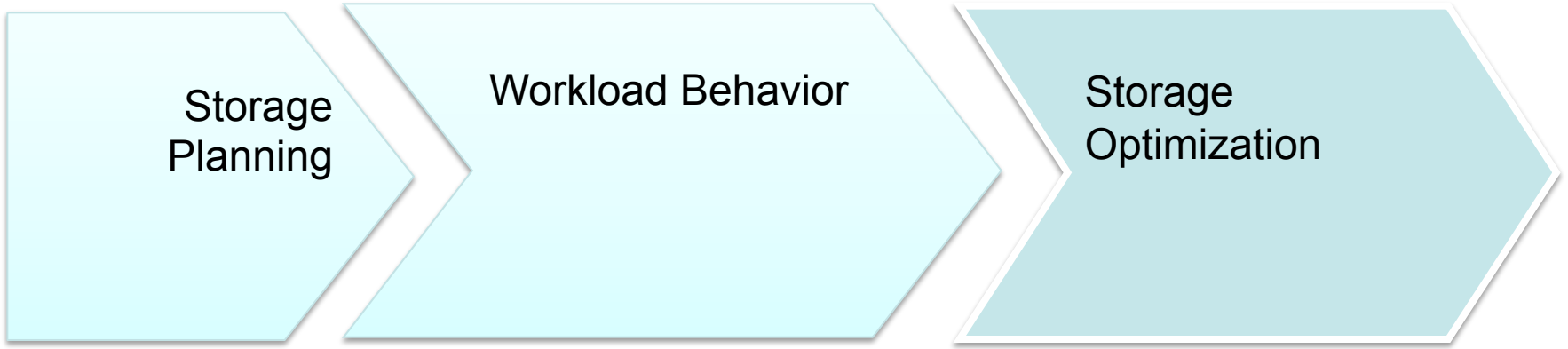


Too many sequential threads on a lun will appear as a random workload to the storage ***Negative Impact on Sequential Perf***.



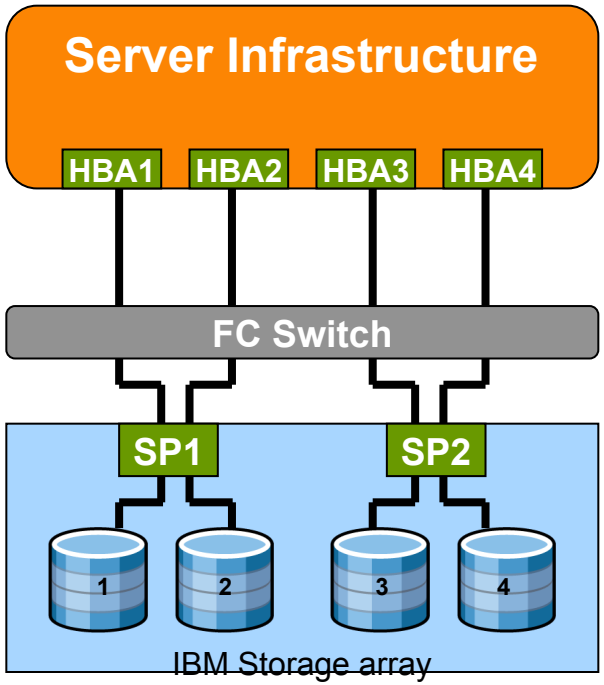
Mixing Sequential with Random can hurt Sequential workload Throughput. ***Negative Impact on Sequential Perf***.

Planning and Best Practices



Optimizing Storage

- Over 80% of storage related performance problems stem from misconfigured storage hardware
  - Consult SAN Configuration Best Practice Guides
  - Ensure disks are correctly distributed
  - Ensure the appropriate controller cache is enabled
  - Count the cost in choosing a level of protection



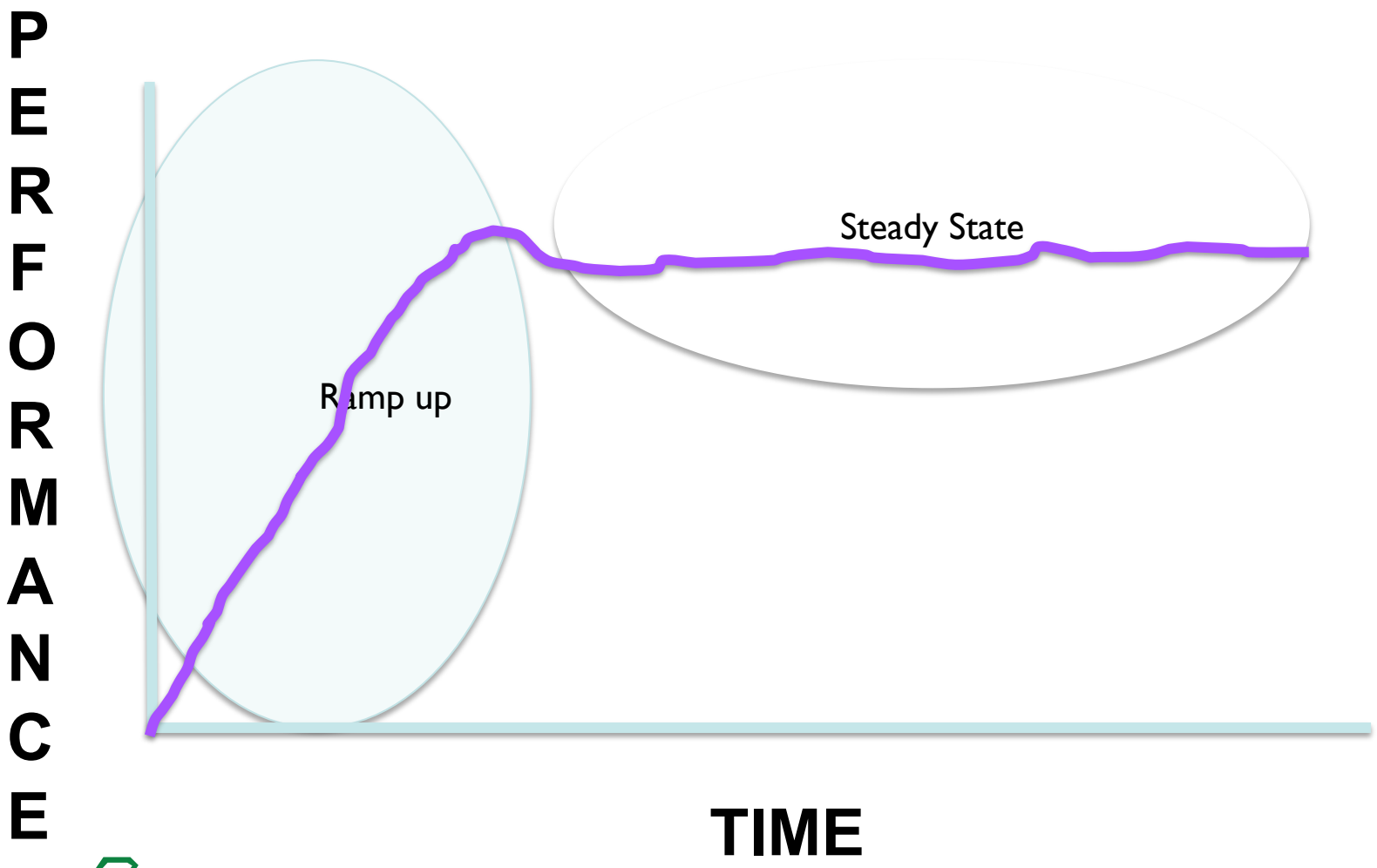
Optimizing Storage

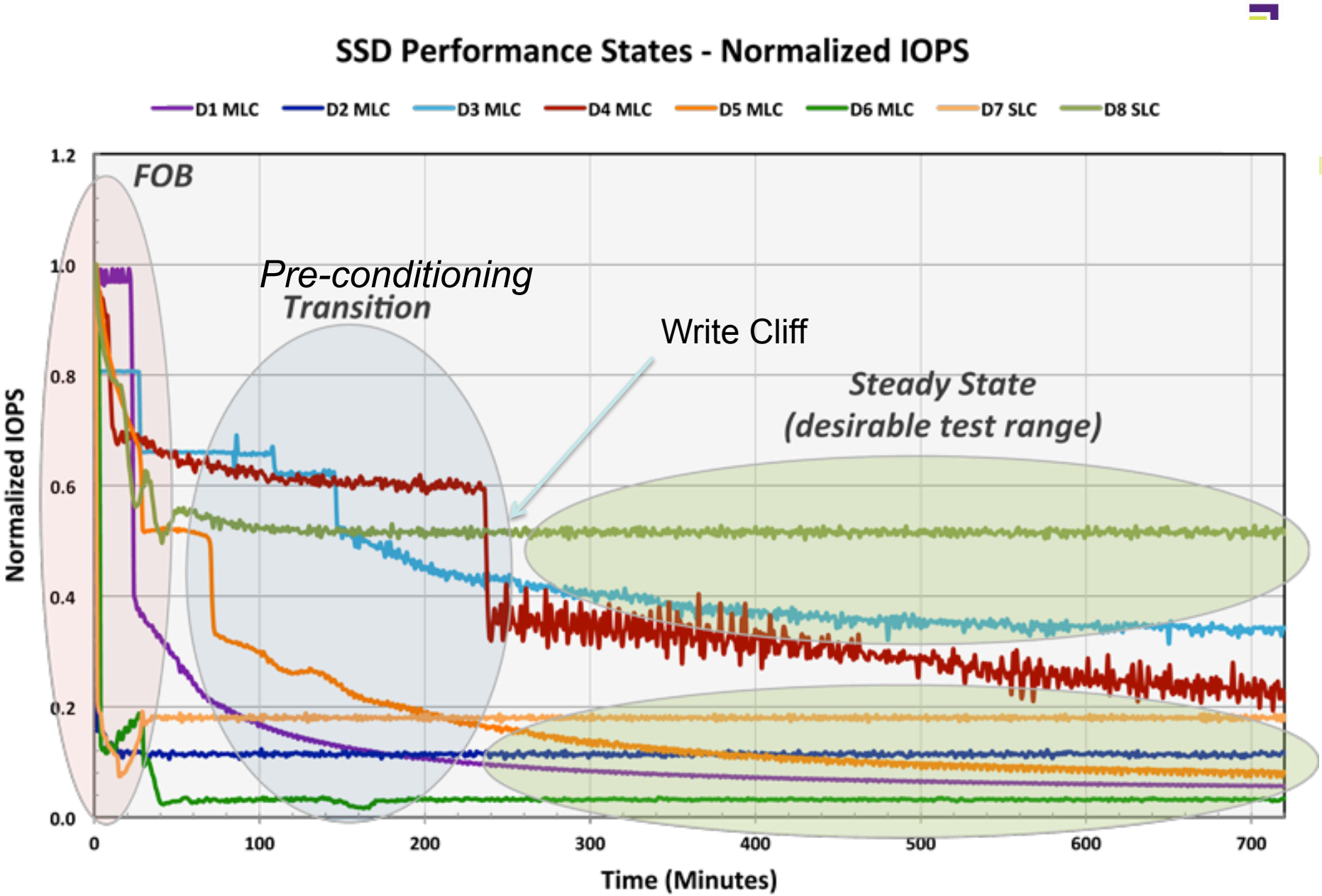
- Avoid negatively impacting high volume sequential performance
- Choose a storage protocol best fitting requirements and needs
- Use the Hypervisor filesystem (VMFS, ZFS, SMB3, etc…)
  - No overhead compared to RDM (physical or virtual)
- Thick provisioning
  - Use when possible to help prevent over provisioning
  - No performance impact compared to Thick
- Are other departments sharing a RAID set

Performance Curve Basics

101 BASICS

Traditional Disk Performance Curve





(SNIA SSSI Specification)

Measuring Accurate Performance w/ All Flash Arrays

- **Problem**
  - Traditional IO generation tools don't work
- **Flash as a unique behavior**
  - Not a hard disk drive
- **Built-in data services**
  - Inline data reduction technologies
- **Different Performance curve**
  - Flash arrays measure differently than traditional systems

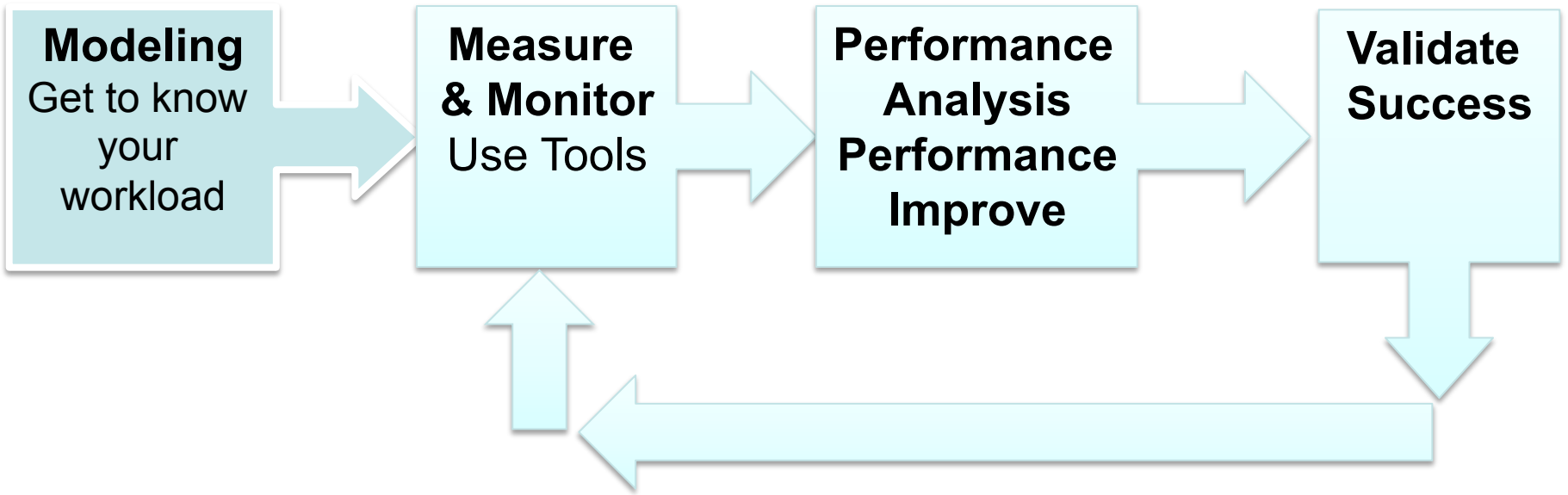
Inadequate Tool Sets

- Measuring new technology based on old assumptions
  - Don't Do It!
- Result – **Inflated performance results**, inaccurate measurements
- **Negatively Impacts Everyone**
- Setting accurate expectations

Troubleshooting Methodology Storage Performance

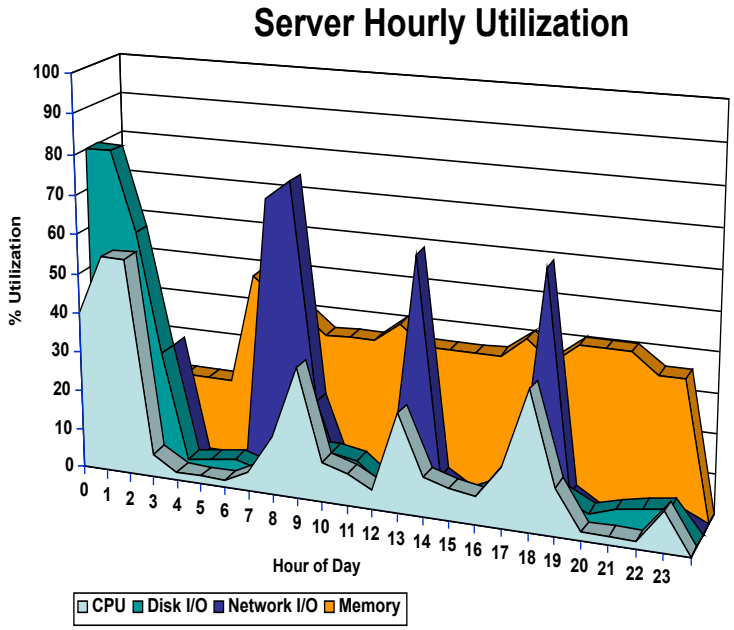
101 BASICS

Performance Methodology

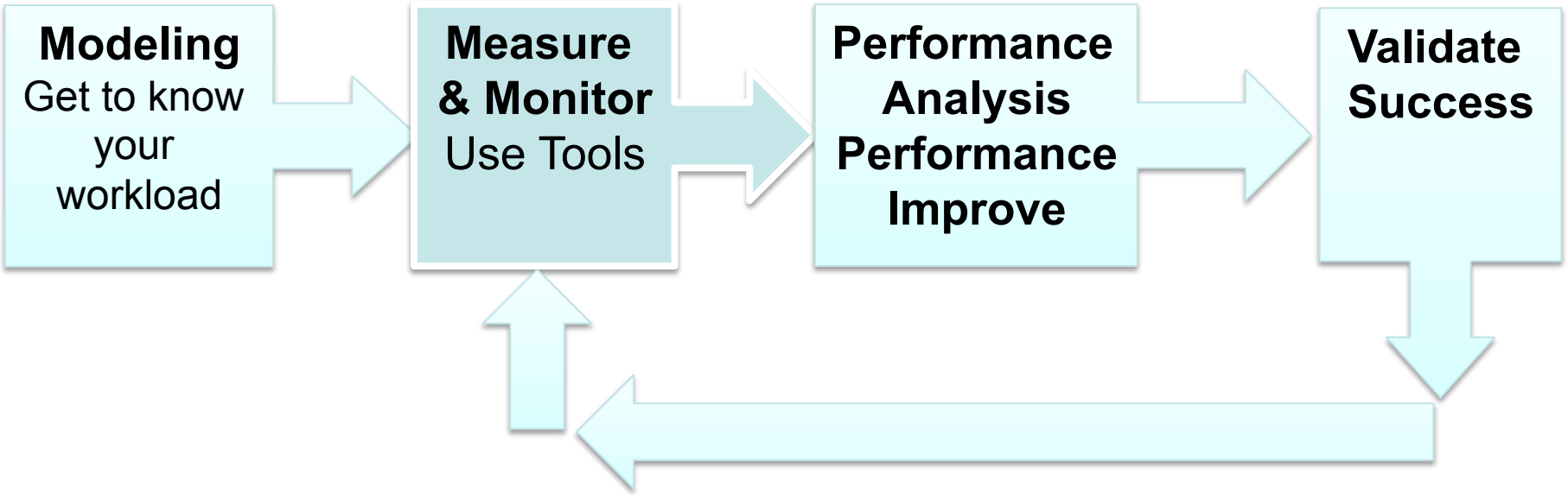


Understanding Your Workload

- Workload Indicators
  - Demand for resources vs. Resources currently used
  - Result is a percentage of Workload
    - Low latency number is Good – Object has the resources it needs
    - Can go above 100% - Object is "Starving"
- Workload summarized across critical resources
- Workload Details View
  - Detailed understanding of the lacking resource and associated metrics
  - View the state of the Peer and Parent Objects and troubleshoot
    - A Configuration issue?
    - Lack of resources?



Performance Methodology



Approach to Real-Time Performance Management

SNIA Green Storage Initiative

3rd Generation – Holistic, Real Time Analytics

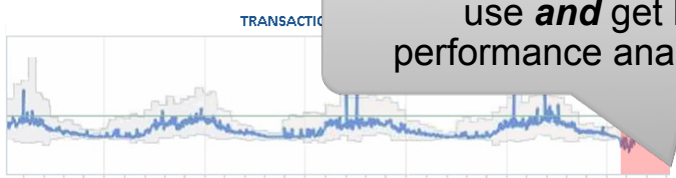
Flexible INTEGRATION to many data sources

gomez · Microsoft System Center Operations Manager · keynote · Tivoli software · EMC smarts · HYPERIC · vmware · ...

Enterprise SCALABILITY

Patented performance ANALYTICS

$$\sigma^2_{w,k-1} = \frac{1}{k-2}\sum_{i=1}^{k-1} w_i^2 - \frac{k-1}{k-2}\bar{w}^2_{k-1}$$



I can put all my monitoring tools to good use ***and*** get better performance analytics.

Powerful information DASHBOARDS




Infrastructure vs. Operations Impacts on the storage performance & efficiency

OPERATIONS

Performance
App = host
Limited movement

Capacity
Dedicated resources
Pre-committed

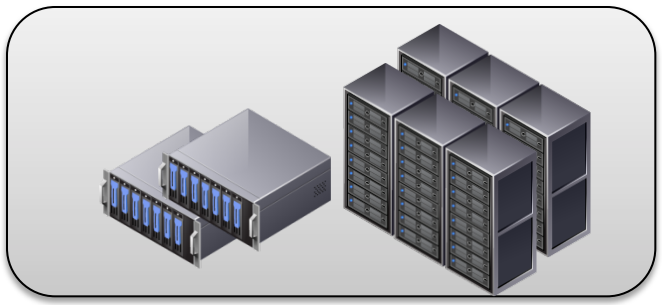
Configuration
Static , pre-configured
1-1 mapping

Performance
Resource abstraction
Mobility
+

Capacity
Resource pooling
Minimize waste, Prevent Stress
+

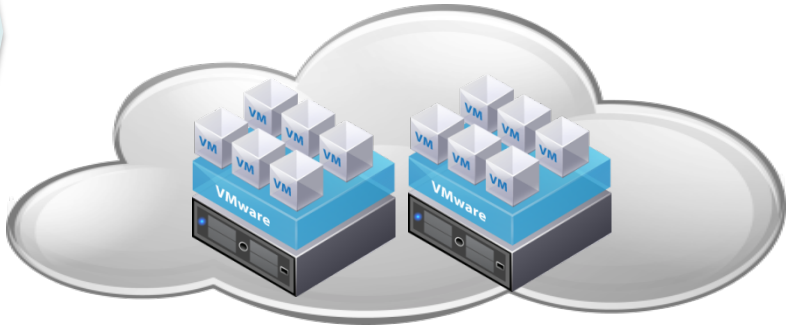
Configuration
On-demand, self-service
Dependencies

INFRASTRUCTURE



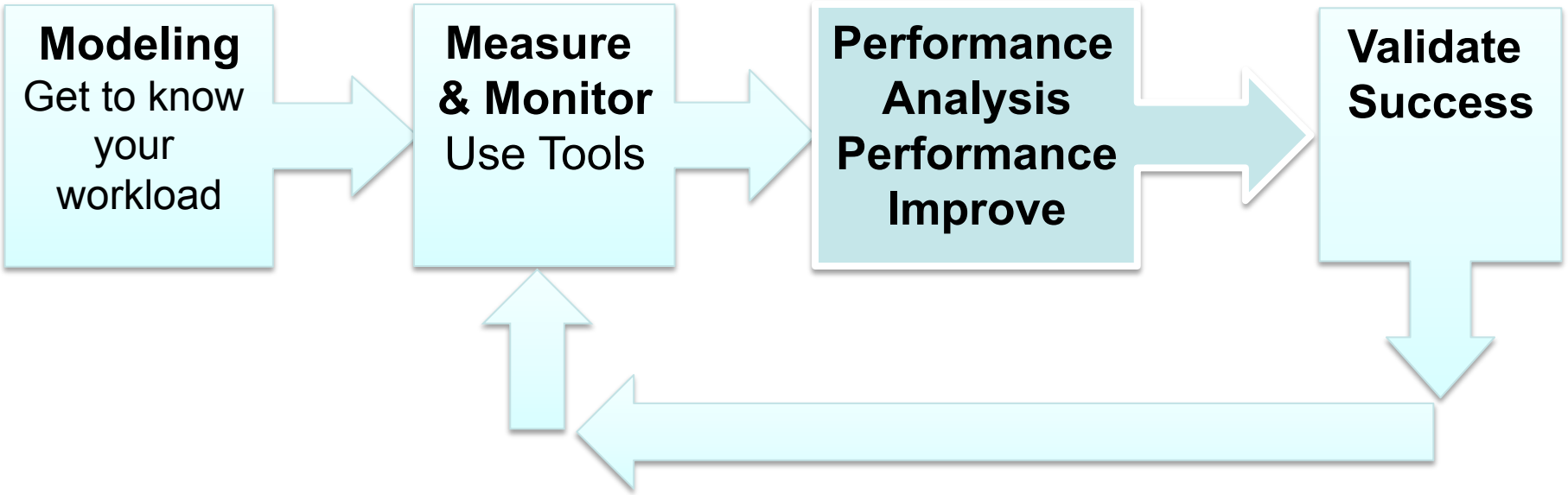
Physical Datacenters

Setup | Update | Inventory | HA
vMotion | DRS | Distr. S/W | I/O Control
Cloud OS



Virtual Datacenters

Performance Methodology



Basic Metrics

- Performance (Data at work) – I/O per second (IOPS)
- Throughput (Data on the move) - Mega- or Giga- bytes per second (MB/sec, GB/sec)
  - Network throughput Mega- or Giga- bits per second (Mbps, Gbps)
- Idle (Data at rest)
- Response time
  - HHDs – milliseconds (ms)
  - SSS – microseconds
  - Overall response times – milliseconds (ms)
- Retries
- Queue Depth

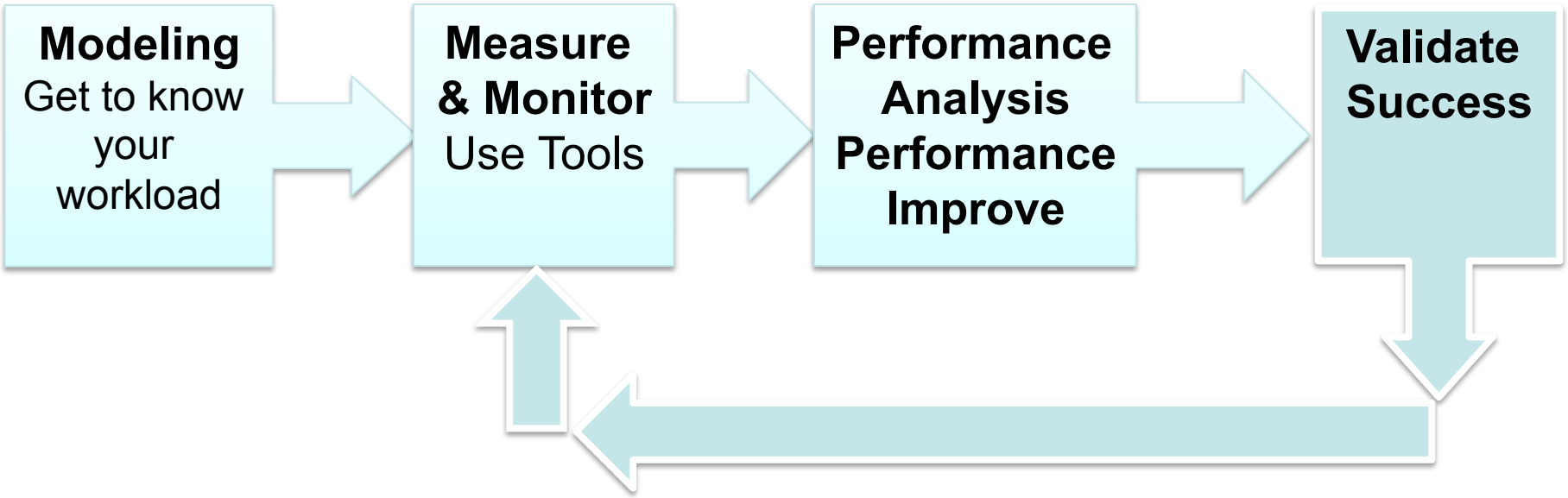
Basic Metrics

- Power performance - I/Os per watt
- Write coalescing
  - Combining several or many small blocks into one large block then writing that single large block to disk
- Hard Disk Drive Service Time:
  - **Seek** - The initial operation a disk performs to place the read/ write head on the right track of a disk drive.
  - **Latency (Rotational Latency)** - The secondary operation that occurs after the “seek”, which is the time it takes for the data to reach the read/write head of a disk drive.
  - **Transfer Time** – The time it takes for data to be read from or written to the host after seek and latency.
  - **Service Time** = seek + latency + transfer Time

Identifying Unhealthy Storage

Metric	Described	Threshold
Average Device latency	latencies from the storage system	10-15 ms
Average Kernel latency	Latencies from the kernel's I/O subsystem	1-2 ms
Aborts and retries	Can't keep up with demand and times out or something broke	1
Response Time	Overall application or OS response time	Many IOs above 10 ms

Performance Methodology



Monitor and Validate Success

- Does your application continue meet its SLA?
- Do known activities perform the same or better?
- Check and monitor key performance counters
- Are business and application owners satisfied?

Thank You

Leah Schoeb
leah@evaluatorgroup.com
Twitter:@vLeahSchoeb

I/O Generator Tools

101 BASICS

I/O Generators - IOmeter

- An access pattern contains mainly the following parameters:
  - **Transfer Request Size** - a minimal data unit to which the test can apply.
  - **Percent Random/Sequential Distribution** - percentage of random requests (read/write ratio)
  - **Percent Read/Write Distribution** - percentage of requests for reading.
  - **# of Outstanding I/Os** - defines a number of simultaneous I/O requests for the given worker and, correspondingly, disc load.

I/O Generators - Vdbench

- I/O workload generator
  - Both uniform and non-uniform distributions
  - Built to measure storage systems
- Generates and measure storage performance (block or file)
- Collect and replay real world enterprise application workloads with the addition of SWAT
- Swiss army knife of I/O generators
- Java based is ported to most major operating systems
  - Unix, Linux, windows, etc…

I/O Generators - Summary

- Many IO Generators
- Uniform vs. non-uniform distributions
- Skew
- Replay real world workloads
- Measuring a disk vs. a storage system
- Measuring block vs file