



# SPC Benchmark-1™ (SPC-1)

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# Presentations and Speakers

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- ✍ **The Storage Performance Council (SPC)**  
Leah Schoeb (*Sun Microsystems, Inc.*)
  
- ✍ **SPC Benchmark-1™ (SPC-1)**  
Roger Reich (*VERITAS Software Corporation*)
  
- ✍ **SPC-1 Benchmark Design**  
Bruce McNutt (*IBM Corporation*)
  
- ✍ **Producing SPC-1 Benchmark Results**  
Peter Dreisbach (*Adaptec, Inc.*)
  
- ✍ **Validating SPC-1 Benchmark Results**  
Walter E. Baker (*Gradient Systems, Inc.*)
  
- ✍ **SPC and SPC-1 – Next Steps**  
Mel Boksenbaum (*Hitachi Data Systems Corporation*)



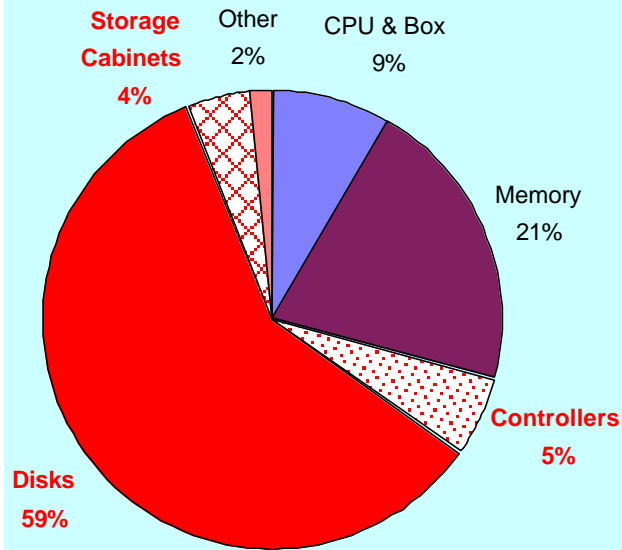
# Storage Performance Is Important

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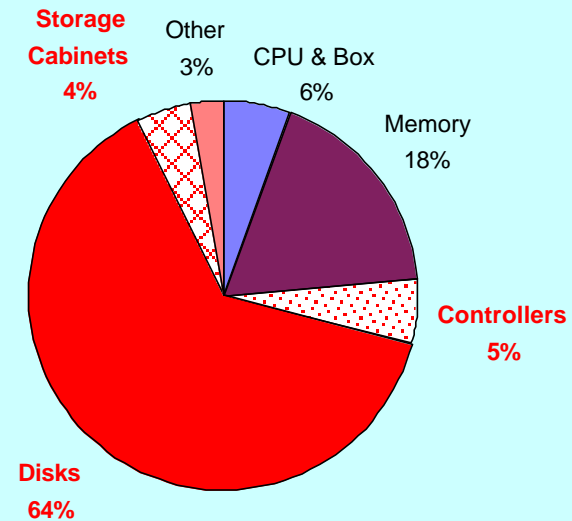
- ✍ Storage cost is 40-80% of system cost
- ✍ The storage bottleneck will limit system performance
- ✍ Customers embrace “multi-vendor” storage solutions
- ✍ SANs allow heterogeneous shared storage subsystems

# System Cost

TPC-C Server Hardware Costs - 4 CPU



TPC-C Server Hardware Costs - 1 CPU



**Storage is between 68% (59+5+4) and 73% (59+5+4) of the system hardware cost in these two TPC-C examples.**



# The Storage Industry Problem

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- ✍ Many benchmarks: Ipeak, Iometer, Winbench, logen, Qbench, Norton, Coretest, many proprietary...
- ✍ De-facto standards: PC Desktop = Ziff Davis
- ✍ No widely supported cross-vendor organization focused on **STORAGE** benchmarks
- ✍ Customers are unable to accurately make performance or price/performance tradeoffs
- ✍ Developers lack clear standards on which to tune and evolve implementations



# Example Solutions in Other Markets

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## ✎ Transaction Processing Performance Council (TPC)

- Standardizes and disseminates verifiable performance data on OLTP and DS systems

## ✎ SPEC

- Standardized benchmarks for CPU architectures



# SPC Mission

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**✍ The SPC is a non-profit corporation founded in 1998 to:**

- define, standardize, and promote the first industry standard STORAGE benchmarks
- to disseminate objective, verifiable performance data

**to developers, product managers, and customers of computer systems.**



# Another Industry Council?

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## ✍ Why will the SPC succeed?

- Only group of storage performance experts
- Focused mission of storage benchmarks
- Leverages TPC experience
- Efficient infrastructure
- New workload analysis techniques
- Attitude that Quality = Success
- Unique in the industry



# SPC Objectives

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- ✍ **Drive performance improvement in the computer systems industry for storage**
- ✍ **Insure that customers can accurately compare products in a multi-vendor world**
- ✍ **Establish a level “playing field” for all manufacturers**
- ✍ **Publicize benchmark results**
- ✍ **Ensure accuracy and authenticity of published results**



# SPC Membership

- ✍ Founded in late 1997
- ✍ Non-profit status: 1998
- ✍ 12 member companies

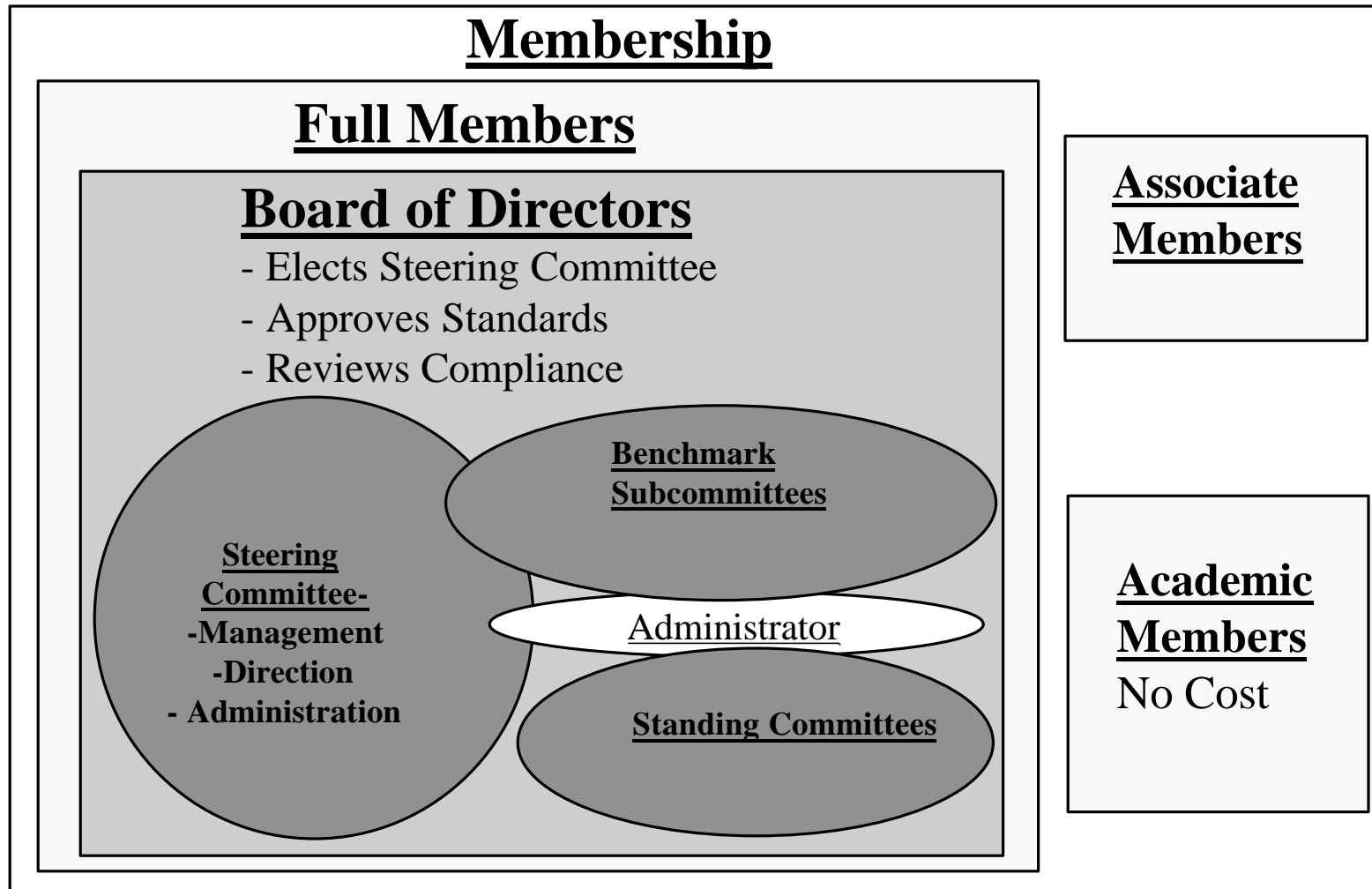


Better answers





# SPC Organizational Structure

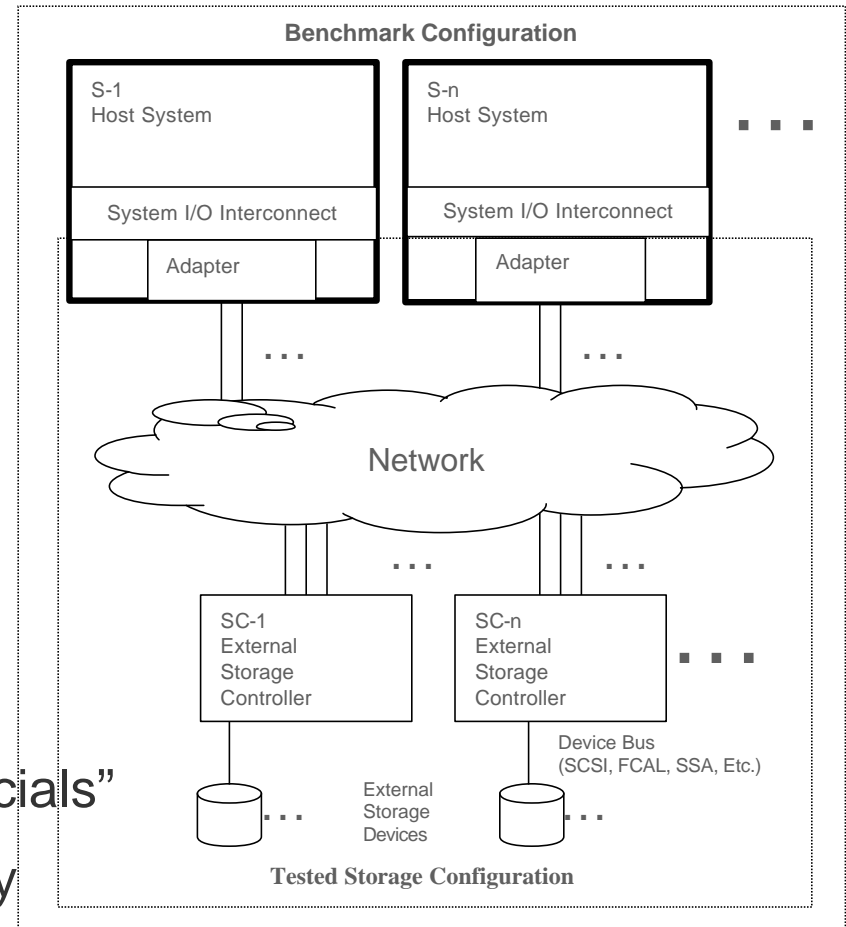




# SPC Benchmark-1™ Vision

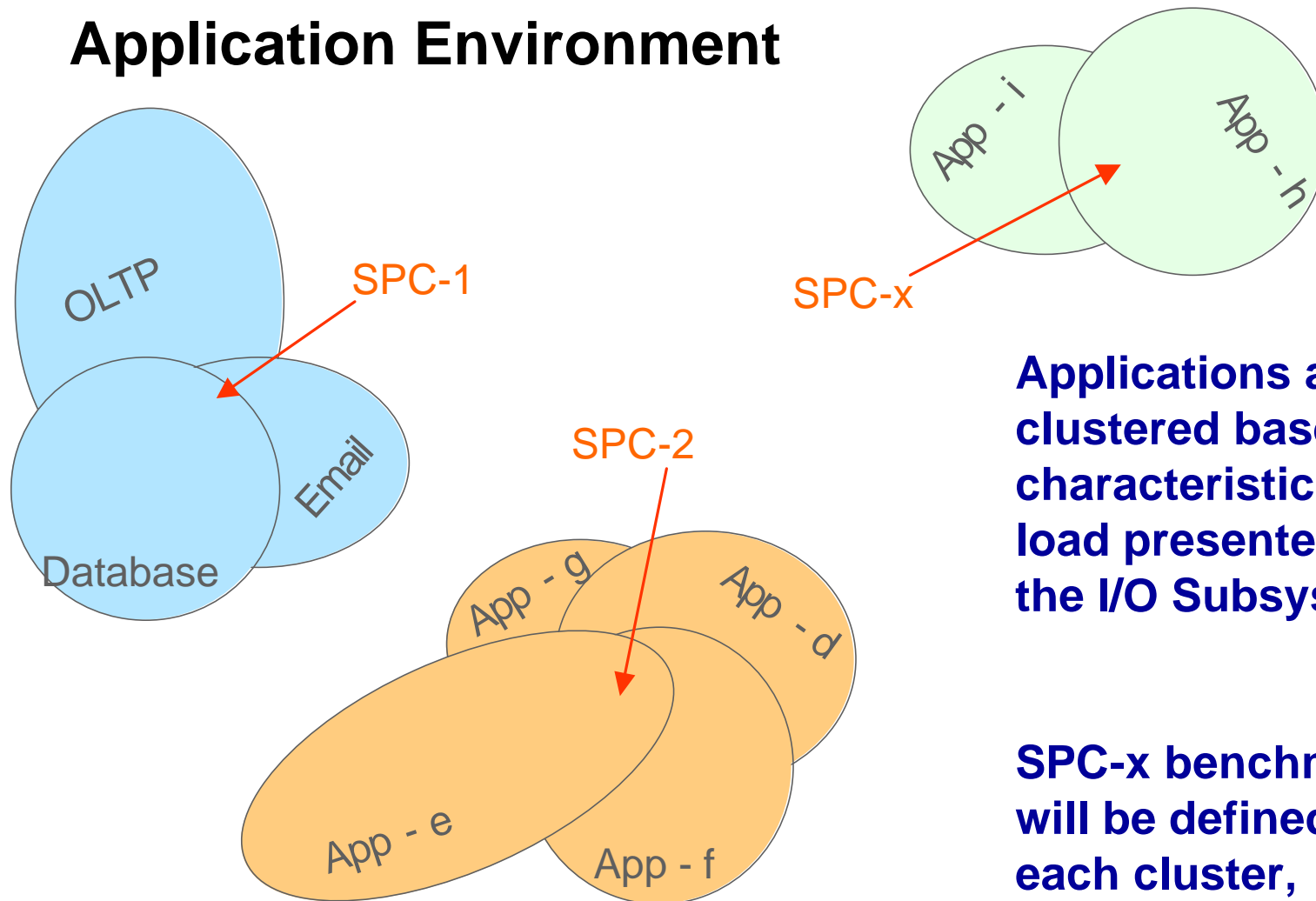
## Overarching Objectives

- ✎ Value for:
  - End-Users/Integrators
  - Industry Analysts/Press
  - Engineers
- ✎ Relevance
  - Real world
  - Sophisticated
- ✎ Prohibit cheating & “benchmark specials”
- ✎ Enforce a standard of product quality
- ✎ Support a richness of configurations



# SPC Benchmark-1™ Vision

## Application Environment



**Applications are clustered based on characteristics of load presented to the I/O Subsystem**

**SPC-x benchmark will be defined for each cluster, starting with SPC-1**



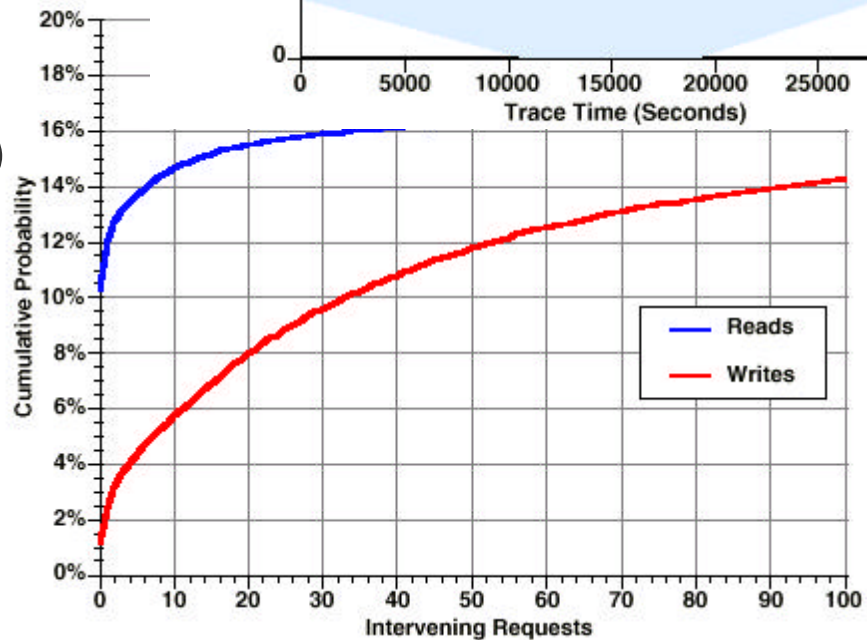
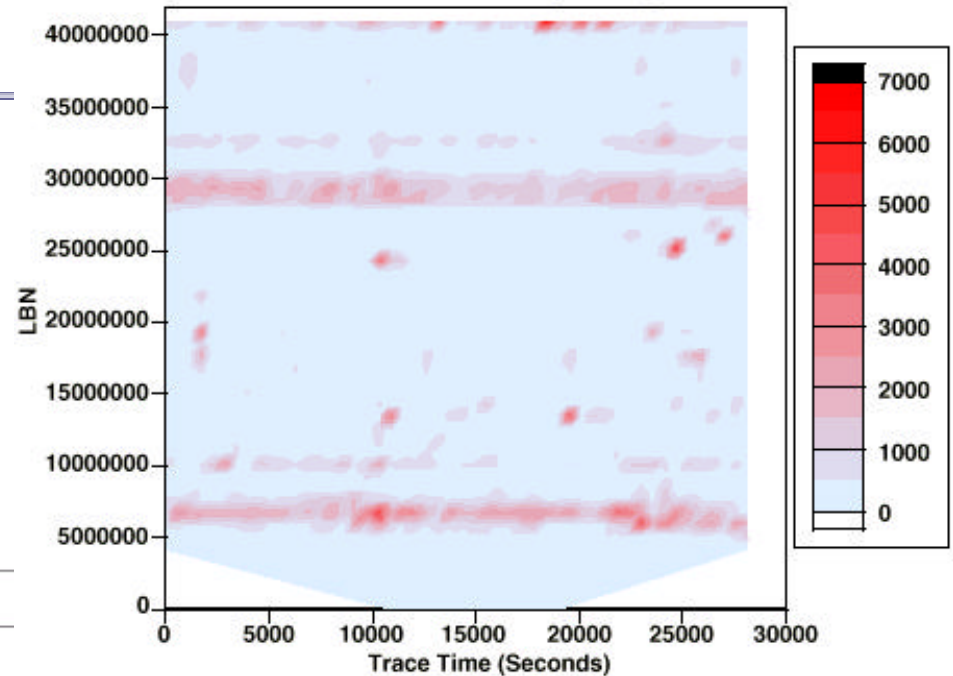
# SPC-1 Vision

## Workload

### Usage Parameters

- I/O size distribution
- R/W distribution
- Inter-arrival
- Locality (temporal, spatial)
- Seek Distance
- Sequentiality
- Re-Reference
- Fractal Relationships

LBN Access Frequency

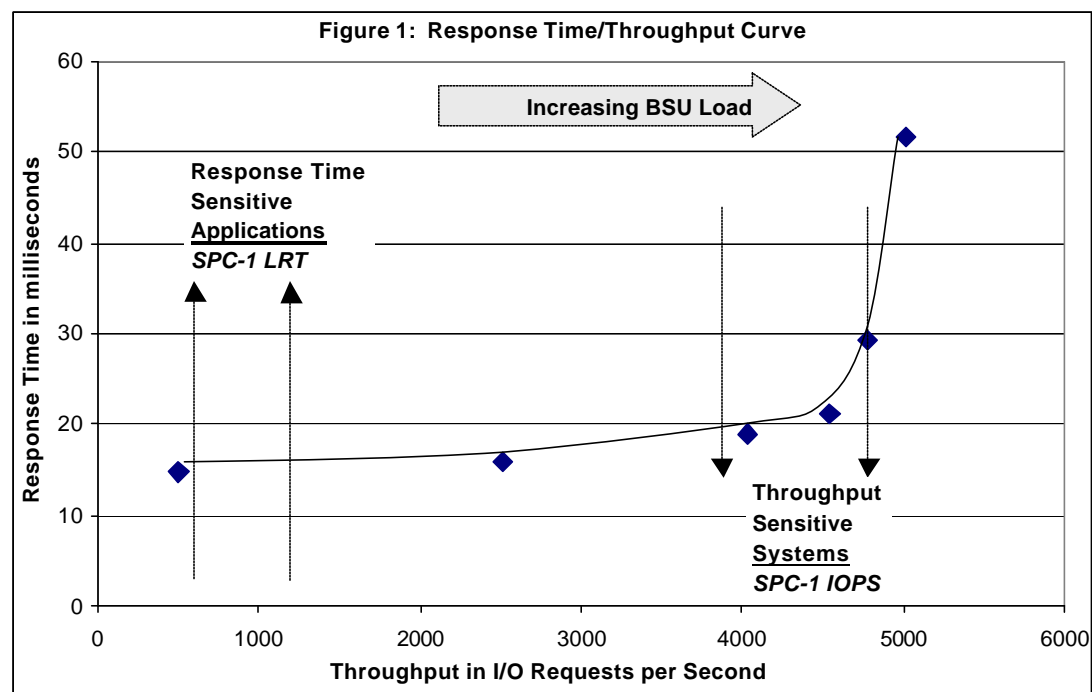




# SPC Benchmark-1™ Vision

## Primary Metrics

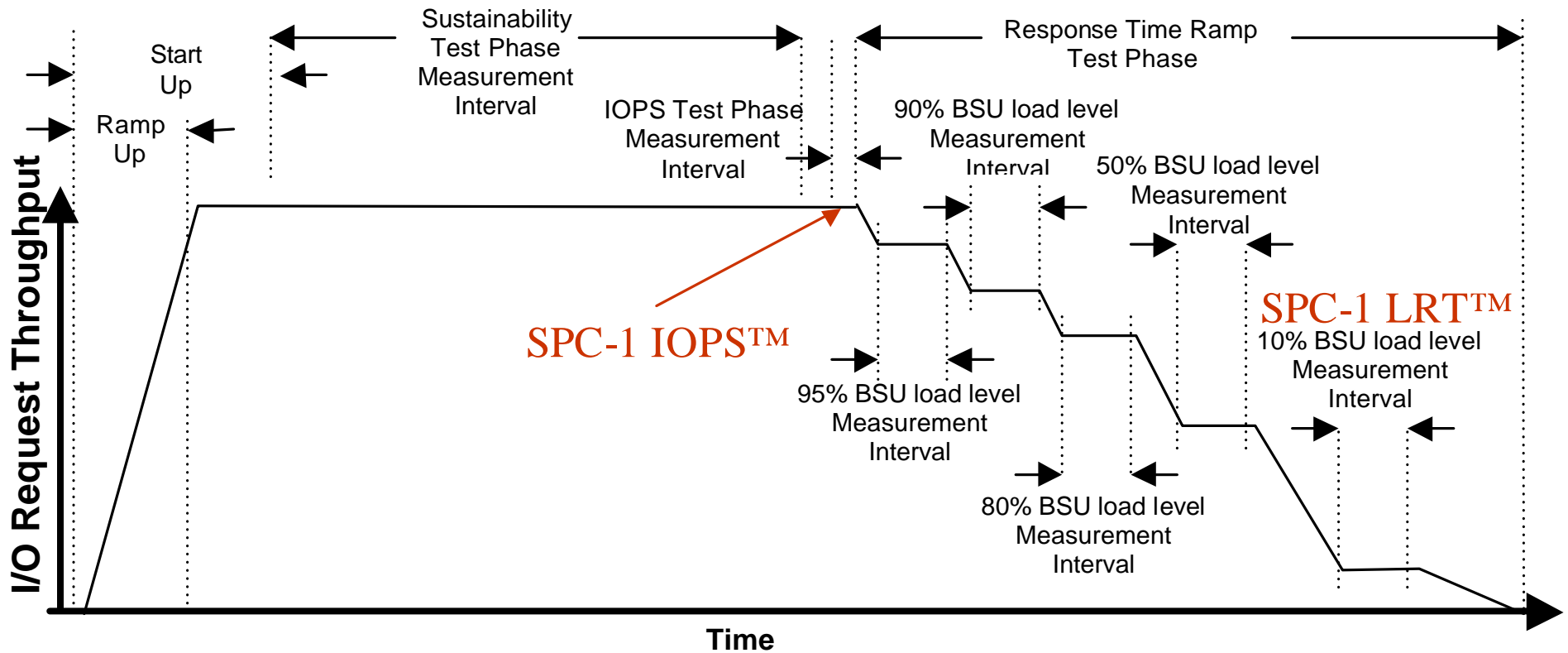
- ✎ SPC-1 IOPS (Maximum Throughput)
- ✎ SPC-1 LRT (Best Response Time @ light load)
- ✎ Price
- ✎ Capacity
- ✎ Data Protection Level





# SPC Benchmark-1™ Vision

## Test Components



## & Repeatability & Data Persistence



# The SPC-1 Design Goal: Realism

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- ✍ **Realistic I/O mix.**
- ✍ **Realistic contention and queuing.**
- ✍ **Realistic cache hit ratios and memory requirements.**



# Structure of SPC-1 I/O

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- ✍ **The benchmark is built using a set of 8 application-like I/O streams.**
- ✍ **8 running streams = 1 Business Scaling Unit (BSU).**
- ✍ **A running stream is called...**
  - formally, an *execution instance*.
  - informally, a *daemon*.
- ✍ **To get more load, more daemons are deployed in sets of 8.**
- ✍ **Heaviest load tested so far: 400 BSU's (3,200 daemons).**



# The Mix of Daemons (1 BSU)

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	Performing Reads	Performing Writes
Random Daemons	<b>5</b>	
Sequential Daemons	<b>2</b>	<b>1</b>

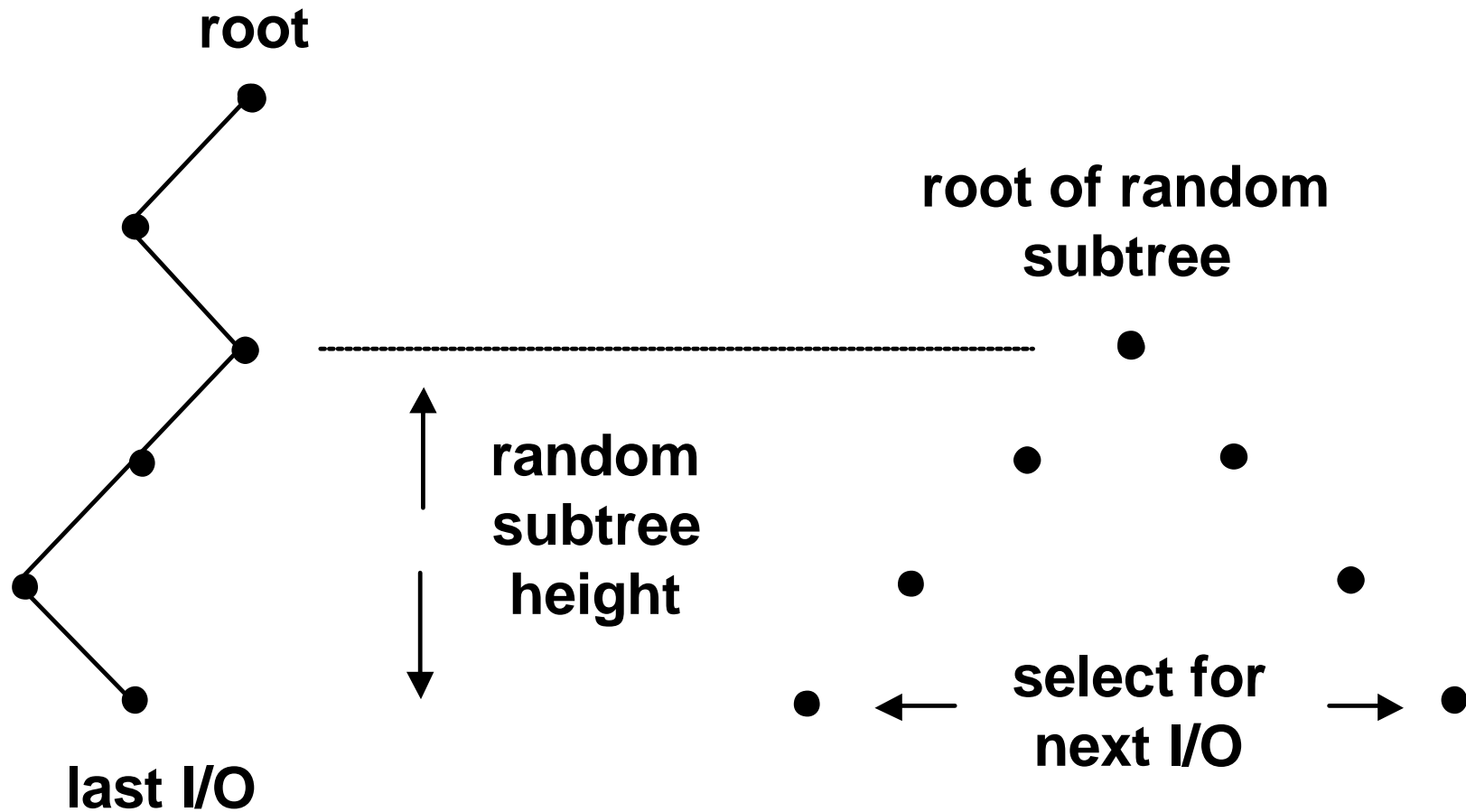


# SPC-1 Daemon Behavior

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- ✍ **Sequential Read/Write: daemon reads/writes one record at a time in sequence**
  - starting point is random within a defined area.
  - starts a new sequence after writing a specified amount of data.
  
- ✍ **Random Read+Write: daemon selects addresses based upon a specified random walk.**

# Random Walk Addresses





## The Mix of I/O (1 BSU)

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	<b>Read (per s)</b>	<b>Write (per s)</b>	<b>All (per s)</b>
<b>Random</b>	<b>14.5</b>	<b>16.2</b>	<b>30.7</b>
<b>Sequential</b>	<b>5.3</b>	<b>14.0</b>	<b>19.3</b>
<b>All</b>	<b>19.8</b>	<b>30.2</b>	<b>50</b>



# Bottom Line

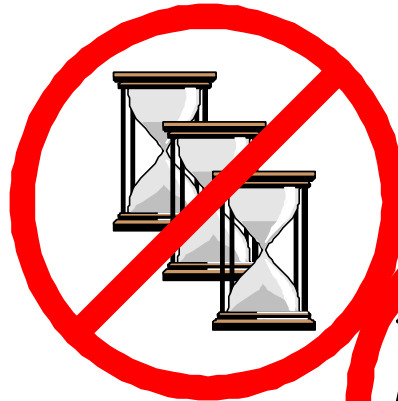
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- ✍ **Not only is the SPC-1 benchmark the first industry standard test of storage performance...**
- ✍ **It also brings together, for the first time, a mix of benchmark I/O suitable for *realistic* tests of modern storage.**

# Running The SPC-1 Benchmark

Running SPC-1 does not require “excessive”:

✍ Time



✍ Effort



✍ Expense





# About The Benchmark Kit

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## SPC-1 benchmark kit includes:

- ✍ Benchmark executables & scripts
  - Solaris
  - AIX
  - Windows NT / Windows 2000
  - Linux (planned for subsequent release)
  - HP/UX (planned for subsequent release)
- ✍ Results summary & FDR Production tools
- ✍ Documentation



# Running The SPC-1 Benchmark

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## Understand the Specification

- ✍ Useful when measuring or comparing systems
  - Current vs. proposed systems
  - Configuration changes
- ✍ Critical when obtaining results for publication
  - Full FDR

## Use the Benchmark Kit

- ✍ Implements the workload defined by the Specification
- ✍ The only implementation allowed for audited / published results



# About The Benchmark Kit

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## Member companies have developed and contributed components:

- ✍ Sun: Core benchmark driver technology
- ✍ IBM: Random Walk algorithm
- ✍ IBM: Digital signature
- ✍ Compaq, Gradient: Results summary & FDR Production tools
- ✍ Adaptec, LSI: Kit verification efforts



# Running The SPC-1 Benchmark

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## First, obtain the Specification & the Benchmark Kit

- ✍ Both will be available from [www.StoragePerformance.org](http://www.StoragePerformance.org)

## Second, prepare the Benchmark Configuration (BC)

- ✍ Must have Java development environment
  - » See documentation for recommendations
- ✍ Must provide sufficient memory and cycles
  - » May require multiple hosts and/or JVMs
- ✍ Similar to a system which would be deployed for the storage being tested

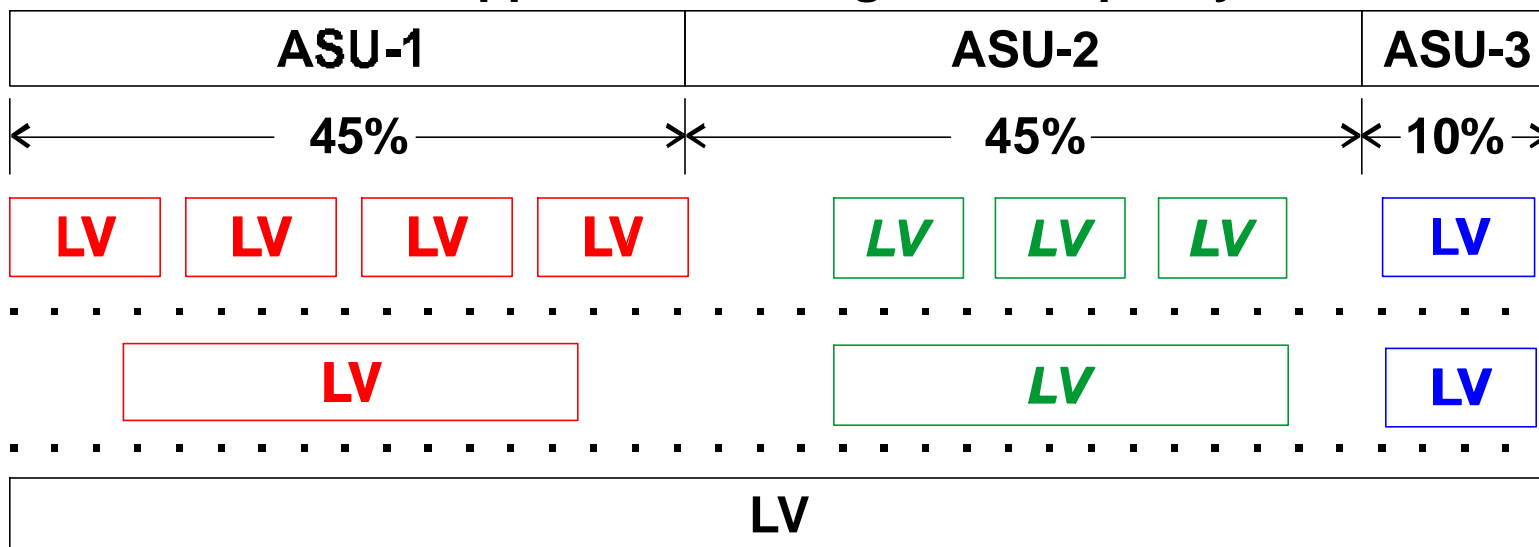


# Running The SPC-1 Benchmark

## Tested Storage Configuration (TSC)

✍ Must conform to the Specification

### Total Application Storage Unit Capacity





# Running The SPC-1 Benchmark

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## Third, tune the Benchmark Configuration

- ✍ Maximum IOPs
- ✍ Average Response Time < 30ms
- ✍ Best use of hardware

## Fourth, Run the Benchmark

Data Persistence Test Phase 1	25 min.
Restart / power cycle	5 min.
Data Persistence Test Phase 2	15 min.
Restart / power cycle	5 min.
Sustainability Test	190 min.
Response Time Ramp	50 min.
Restart / power cycle	5 min.
Repeatability Test Phase 1	30 min.
Restart / power cycle	5 min.
Repeatability Test Phase 2	30 min.
<b>Total</b>	<b>About 6 hours</b>



# Running The SPC-1 Benchmark

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## Fifth step is to prepare the FDR

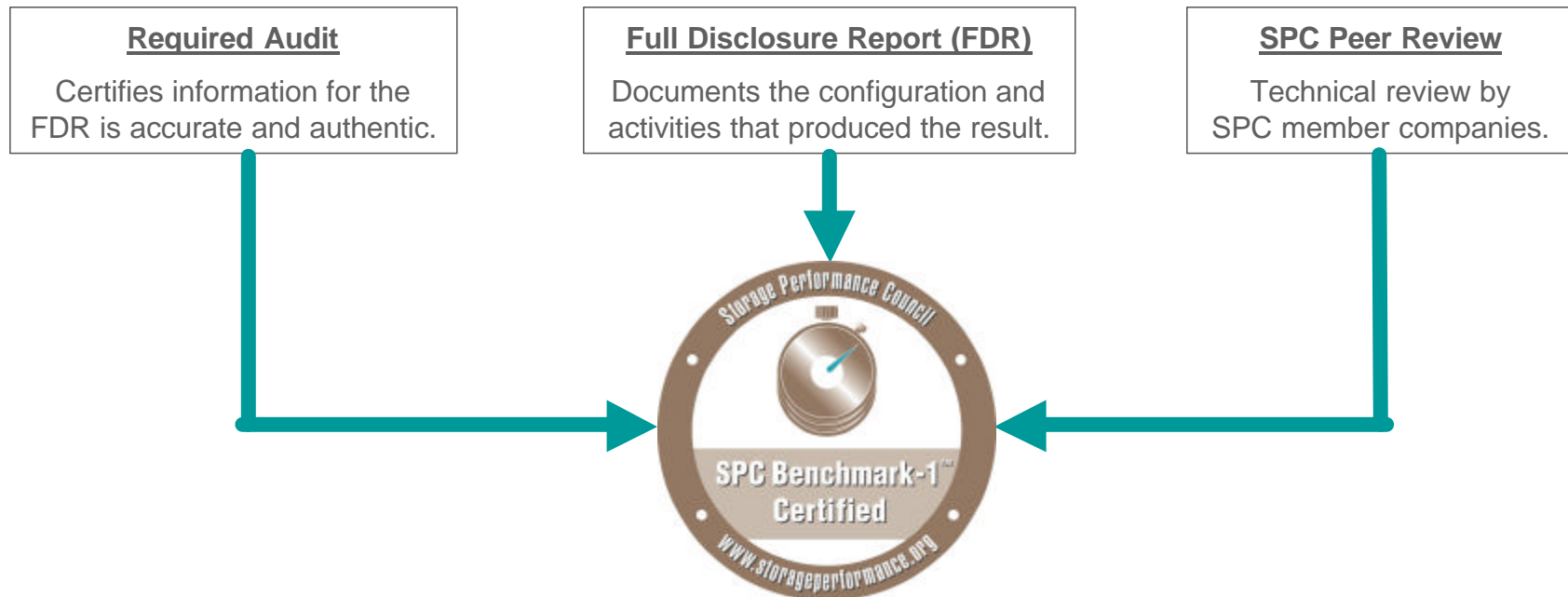
- ✍ if desired
- ✍ Benchmark Kit includes tool to extract data and “draft” the FDR



# SPC-1 Results Validation

## The SPC-1 Results Validation Process

- Successful completion of the three components listed below produces an official, approved SPC-1 Benchmark Result.





# SPC-1 Results Validation

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## ✍ Required Audit

- **Certifies the information produced for the FDR is accurate and authentic based on the specification.**
  - Benchmark Configuration (BC)
  - Benchmark measurements and results production
  - Pricing and availability
- **Audits are provided by the SPC Auditing Services.**
  - The SPC Administrator – Gradient Systems, Inc.
- **Two type of audits:**
  - On-site
  - Remote



# SPC-1 Results Validation

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## ✍ Required Audit

- **On-Site Audit: The Auditor is physically present during benchmark execution and information collection.**
  - Required for the first execution of the Workload Generator on a specific Host System platform.
  - Required when a Test Sponsor has failed a Remote Audit or submitted a non-compliant result.
- **Remote Audit: The Auditor is not physically present.**
  - Results files (encrypted) and other required materials are submitted to the SPC Auditing Service.
  - The SPC Auditing Service ensures completeness, authenticity, and accurateness.



# SPC-1 Results Validation

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## ✍ Full Disclosure Report (FDR)

- Documents the results, procedures, configuration and equipment used to produce the benchmark result.
- The FDR will allow replication of the benchmark result given appropriate documentation and products.
- **Also includes:**
  - An audit certification letter issued by the SPC Audit Service
  - A Letter of Good Faith issued by the Test Sponsor
    - » An assurance of fidelity and candor even if not explicitly required by the current benchmark specification.



# SPC-1 Results Validation

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## SPC Peer Review

- A 60-day period after the result has been submitted to the SPC.
- SPC member companies may raise issues of compliance during this review.
  - An exchange of information may resolve an issue.
  - In that case, no formal action is taken or recorded.
- Unresolved issues are forwarded to the Compliance Review Committee (CRC).



# SPC-1 Results Validation

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## ✍ SPC Peer Review

- **The Compliance Review Committee (CRC) will provide one of the following recommendations:**
  - Compliant, Insignificant Deviation, or Non-Compliant
- **The SPC will vote on the CRC recommendation.**
  - **Insignificant Deviation:** The result remains an official SPC-1 result but must include a update with the finding.
  - **Non-Compliant:** The result is removed from the SPC-1 results directory and cannot be used or referenced by the Test Sponsor.



# SPC-1 Results Validation

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# SPC Next Steps

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## ✍ SPC-2 Benchmark and Beyond

- **Web server (or exchange server) Benchmark**
- **Sequential workload**
  - Back-up/Restore applications, data streaming applications
  - Research needed to determine representative, meaningful workload
- **Network Attached Storage (NAS) Benchmark**



# SPC Next Steps

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## ✍️ **“Customizable” version of SPC Kit**

- **Allows customer to tune the driver to specific workload or application**
- **Ask “what-if” questions to evaluate various performance or configuration options**
- **Adjust data transfer length, read/write ratios, locality of reference, random/sequential ratio**



# SPC Next Steps

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- ✍ **Establish SPC as The Industry Standard**
  - **Published results for all storage solutions**
  - **SPC Benchmark Test results required for all RFPs for new equipment purchases**



# SPC Next Steps

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✍ **How to Join SPC**

✍ **How to view SPC Benchmark Results**

[www.storageperformance.org](http://www.storageperformance.org)