



White Paper

# Testing the Data Center Network: Best Practices

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## Executive Summary

Inherent and costly risks are involved in the launch of any Enterprise Data Center Networking (DCN) IT initiative. A major factor of data center mishaps can be attributed to the failure to test data center solutions properly before launch. To illustrate this point, the paper presents a collection of very public and damaging real-world and high-profile data center failures that were witnessed in the press over the last few years. They include the recent NASDAQ/Facebook IPO disruption, as well as Verizon, Visa, malfunction stories, and more. Conversely, there is compelling research that proper testing, before launch, fortifies assurance of IT initiative success. This success, however, cannot be assured unless an understanding and qualified usage of DCN testing best practices is applied.

Through their extensive experience in professional services engagements around the world, Spirent has been able to identify four core best practices in testing for successful DCN IT initiatives. These best practices are: Vendor Performance Testing, Network Failure Threshold Testing, Configuration Defect Testing and using PASS Methodology in Testing

To illustrate the validity of these best practices in DCN testing, Spirent presents six case studies from North America and Europe which demonstrate the application of these best practices in whole or phased use cases. Each of these case studies outlines which DCN testing best practices were applied in the engagements. An overview comparison table provides a reference for how the best practices applied map to the individual case studies.

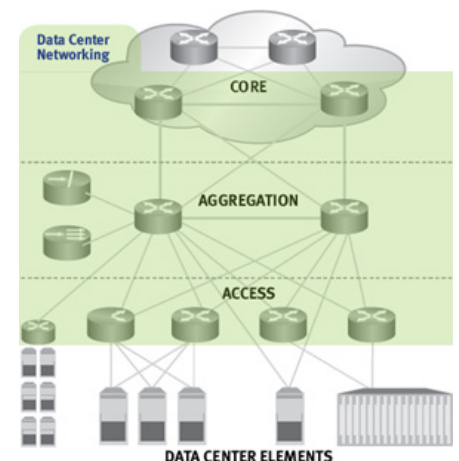
The paper lists the benefits of adopting third-party DCN knowledgeable testing partners for organizations who do not have qualified in-house testing expertise. Guidelines for selecting a suitable testing partner are also included.



## The Inherent Risks in Enterprise Data Center Initiatives

The proliferation of cloud services, rich media, and enterprise applications elevate expectations for data center throughput, reliability, and availability, pushing the limits of what the infrastructure can sustain.

Your network is targeted from the outside by spam, viruses, hackers looking for sensitive data, and other malware. It's vulnerable from the inside with the increase in telecommuting or employees bringing their own gear into the workplace unintentionally creating security threats. Then there's the risk of a power outage, an equipment failure, a planned upgrade, or a configuration error bringing down part or all of your services.



You can proactively address many of these potential sources of failure. An intrusion prevention system can address the external threats, but how can you know if it will actually stop malicious activity or how it will affect network performance and user quality of experience? Redundant systems can address power outages, hardware failures, and congestion, but how can you know if it will failover to the backup system or circuit under the desired conditions? And how can you know ahead of time how a hardware or software upgrade will affect your network?

Then there are the deeper, subtler sources of failure—a network designed with an invalid assumption or implemented with a hidden flaw, an RFP decision made by comparing the specifications on vendor proposals. Do any silver bullets exist to help avoid these potential disasters?

The single answer to all these questions is: testing. Testing is the key to reliability and availability and the assurance of a solution's viability. Inadequate testing, however, causes more problems than not testing by creating a false sense of security. Proper, qualified testing, based on industry best-practices, developed over time through experience and expertise, allow organizations to test and deploy data center networks with confidence.

The alternatives to not testing, on the other hand, are too often sobering.

## Failure to Test DCN Properly and Real-World Mishaps

As enterprises scramble to stay ahead of the curve, upgrades and configuration changes are inevitable, and are also the source of 40 percent of all application downtime, according to Forrester Research. [Forrester Research, *How To Manage Your Information Security Policy Framework*. January 2006.] The news is littered with stories of businesses that have suffered costly downtime and damaging lawsuits as a result of outages or security breaches.

According to Network Computing and the Meta Group, the hourly cost of an hour of downtime ranges from \$90 thousand for media to \$6.48 million for a brokerage service, with telecom hitting in the middle at \$2 million. [Source: Network Computing, the Meta Group and Contingency Planning Research.] You don't have to look far to find dramatic examples of the consequences of inadequate testing, or perhaps no testing at all. Mishaps that occurred where proper testing was not implemented and where damage to the enterprise occurred, include:

- **Bitcoin Service Site**—April, 2013, prominently positioned in the lucrative bleeding edge cryptocurrency market—a digital monetary system outside traditional institutions—the Bitcoin services site **Instawallet**—was hacked and suffered a seismic security breach. **Damage:** The site immediately went down and faced a deluge of claims against it. Bitcoin transactions being irreversible and anonymous make it virtually impossible to reclaim losses after theft. Unable to recover, the enterprise was deemed closed permanently by the following July.
- **Online Social Media Site**—June, 2012, a much anticipated startup debuts—the high profile social media site **Airtime**—was stymied at launch with a host of prominent celebrities on hand to demonstrate the new video-chatting application. The demonstration failed one user interaction after another, with audio problems, video feed freezes and more. **Damage:** Despite the fact the site was developed by prominent players in this space, the high profile fail tainted the offering with the stain of mediocrity from the moment of its debut.

- **National Stock Exchange**—May, 2012, the critically-timed outage **NASDAQ** experienced at the Facebook IPO, right at the opening of trading, prevented brokers and investors from confirming or cancelling their trades, while high-frequency robotrading amplified the outage failure. **Damage:** Law suits against NASDAQ, Facebook, and banks resulted, as well as an FEC investigation. Injury to NASDAQ’s brand was profound, impacting the investment community’s perspective on the fairness of trading practices. NASDAQ set aside \$40 million in damages for investors affected by this failure.
- **Global Financial Institution**—April, 2012, a 45-minute outage of the **Visa** network was due to a system update. **Damage:** Credit card transactions ceased and the risk of fraudulent transactions offline soared. Customer dissatisfaction. Exact financial impact is undisclosed; standard metrics of failure at this scale are in the millions.
- **Major Mobile Service Provider**—December, 2011, **Verizon** had three nationwide LTE data outages due to three separate failures in the IP Multimedia Subsystem: the failure of a back-up communications database; an IMS element not responding properly; and two IMS elements not communicating properly. Additional regional outages occurred in February and March of 2012. **Damage:** In a highly-competitive market, service provider Verizon was seen to fail repeatedly, incurring brand damage.
- **Principal Service Provider**—October, 2011, an outage impacting ‘nearly every continent’, left **BlackBerry** users without services for four days, and described as a ‘critical network failure.’ In July 2012 they suffered another multi-continental outage. **Damage:** Affecting customers on nearly every continent, the original outage severely compromised RIM’s competitive position and resulted in a class action lawsuit with millions of customers.
- **Key Regional Health Care Provider**—October, 2011, **Sutter Health** had a breach that compromised HIPAA data for over 4 million patients and patented data as well. **Damage:** A \$1 to 4 billion class action lawsuit resulted from the security failure.
- **Leading Online Gaming Enterprise**—April, 2011, the **Sony PlayStation** network was compromised by a denial of service (DoS) attack, exposing credit card and personal information of 77 million users, in a 24-day outage. **Damage:** Sony spent \$171 million in the first month on damage control. Sony’s ultimate estimated cost exceeds \$24 billion. Customer satisfaction and trust were severely affected. The cost to credit card companies to issue replacement cards is estimated at \$300 million.
- **Major Airline**—June, 2011, a **United Airlines** check-in system outage caused delays and 100 cancelled flights at O’Hare, was blamed on a “network connectivity issue.” **Damage:** United Airlines was seen to be the cause of widespread impairment to the transportation infrastructure.
- **Online Business Support Tool**—January, 2009, a six-hour outage of **Salesforce.com** that locked over 9,000 subscribers out of applications required to transact business, was caused by changes in database utilization introduced in a new release. In January 2010 they suffered another outage where almost all of their 68,000 customers were affected. In June 2012 they suffered yet another outage. **Damage:** Customer satisfaction directly affected, brand perception of being a reliable enterprise impaired.

The good news is most cases outages are preventable when the right launch strategies and include proper testing, are incorporated.

## Proper Testing, Before Launch, Assures Success

Nemertes Research reports in their issue paper *Strategic IT Initiatives Need Strategic Testing*: “Without proper testing, such strategic initiatives can fail, with serious unforeseen consequences, including significant hard-dollar and opportunity costs.” The Nemertes findings also state that gains from strategic initiatives can be minimized or erased if testing is not implemented before an initiative goes live. The findings add that testing should be performed throughout the lifecycle of a strategic initiative, and that budgeting in advance for testing should be standard practice. Nemertes recommends allocating two to five percent of the overall budget for testing, including capital expenditures and operational costs.

Testing is the key to reliability and availability, but inadequate testing causes possibly more problems than not testing by creating a false sense of security. Industry best-practices, developed over time through experience and expertise, allow organizations to test and deploy data center networks with confidence.

The crucial nature of testing in the success in any data center initiative is widely recognized, but all testing is not created equal. Proper testing is required and is a critical element of ensuring this success. The set of industry best-practices described below were identified and defined after numerous data center testing engagements, across regions and around the globe, by Spirent’s team of Professional Services engineers. Examples of the best practices are exemplified in the case study examples that follow the best practices.

## Data Center Network Testing Best Practices

### DCN Testing Best Practice #1: Vendor Performance Testing

Assure through real-world testing parameters that all network devices perform in conformance with claims represented in vendor collateral or by company representatives. In doing so, recognize that while a device’s capabilities may indeed be able to perform as advertised under ideal conditions established by the vendor, the real-world capabilities of performance delivery in a data center may be entirely different.

### DCN Testing Best Practice #2: Network Failure Threshold Testing

Establish the point at which a network fails within real-world applications and user bandwidth before launch. Having the ability to assure that the failure threshold is well above and beyond the projected use case and application utility profile of a network is critical to assure the success of the initiative. Identifying failure thresholds is also essential to building in headroom for future-proofing a data center network initiative.

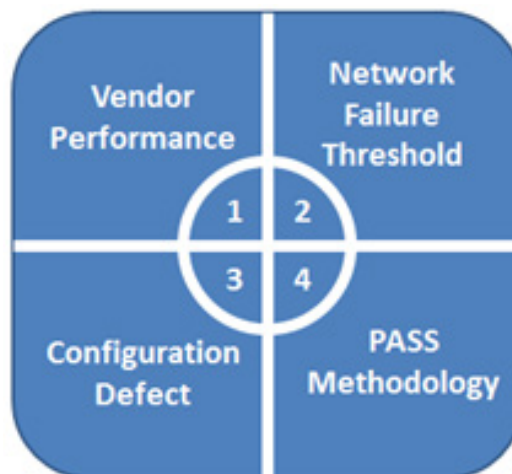
## DCN Testing Best Practice #3: Configuration Defect Testing

Integrating a diverse array of component devices and applications into a unified architecture may cause unforeseen issues that, without testing properly, could result in network failure. Real-world testing for firmware and configuration defects is crucial to ensure the network is performing as planned.

## DCN Testing Best Practice #4: PASS Methodology Testing\*

PASS is the industry's first holistic test methodology to validate the performance, availability, security and scalability (PASS) of data center networks. Developed by Spirent, the PASS methodology includes:

- **Performance**—Optimize data center services and infrastructure to maximize user experience
- **Availability**—Ensure network uptime, high availability in daily operation and under extreme conditions
- **Security**—Eliminate vulnerabilities and exposure to attacks with assurance of segregated traffic, etc.
- **Scalability**—Validate the maximum number of simultaneous users successfully supported, bandwidth scale, etc.



\*To learn more about PASS Methodology go to [www.spirent.com](http://www.spirent.com) and search the keyword 'PASS'

## Case Studies in DCN Testing—North America and Europe

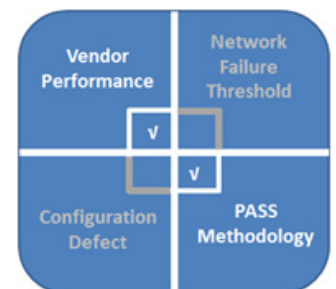
The following six case studies exemplify the application of the best practices. While each organization had unique challenges requiring custom testing solutions, there were marked similarities in a number of the component testing requirements for success. Many test lab managers conduct their testing in phased approaches, so the cases below may represent a specific phase of DCN testing which incorporated a subset of rules and best practices.

### Case 1 Profile: Global Entertainment Corporation – Data Center Consolidation

A global entertainment and media corporation designed a new data center facility to accommodate the capacity of two existing data centers with future growth in mind, which included the possible requirement of managing the traffic of two subsidiary television networks.

- Challenge**—Over 15 devices from more than 7 vendors planned for the data center were to be integrated simultaneously. The project team needed to select the optimum vendors to validate the design before cutting over from legacy data centers to the consolidated data center. A number of vendors were present to attend the testing campaign to assure that pending sales of their solutions were represented properly.
- Solution**—Spirent Professional Services and the project team conducted a competitive assessment for all the network devices, including layer 2-3 switches, layer 4+ firewalls and security appliances, and layer 4+ load balancers. The schedule was tight, less than 30 days. Spirent Professional Services established a set of critical performance metrics. They tested for QoS, throughput, latency, security, and component failure for a compressed testing campaign using Spirent TestCenter and Avalanche for a mix of traffic typical of the company's content to assure the solutions aligned with deployment needs.
- Benefit and Outcome**—Based on the results of the test, the project team built the data center confident that the final vendor choices were an exact fit for the data center needs. A number of vendors whose solutions failed initial testing campaign, made adjustments to their products, and retested, securing their sale to the customer. Because of the success of the engagement, the customer subsequently requested a proposal for pre-deployment data center network testing to verify the end result was ready to go live and accommodation of future growth was assured.

**Case 1: Best Practice Applications**—This engagement is an example of the Vendor Performance Testing best practices, and represented Phase 1 of the customer's DCN testing. However, the volume of vendors and devices in this case was extremely aggressive and exceeded the scope of traditional professional services engagements of this kind. Nonetheless, the findings provided the customer with the confidence, based on sound test result data, to assure that the professional services test team was the right choice for Phase 2: to test for Network Failure Threshold, which would include configuration defects in its test plan.



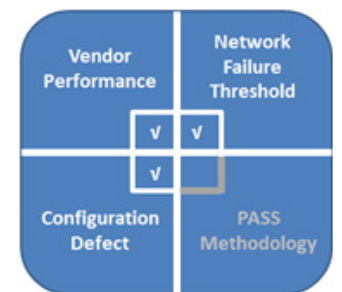


## Case 2 Profile: Financial Institution – Data Center Upgrade

A major bank in the United Kingdom, in conjunction with a key global network equipment manufacturer, planned to implement a new data center network infrastructure. With some pre-existing issues already being observed, and new solutions being added, the initiative's success was in doubt.

- **Challenge**—Before launch, the bank needed to identify how network failure affected live applications running on the network and to assure network performance, service availability, and the functionality of other network features. In addition, issues with ARP performance and traffic distribution under the QoS configuration in the financial institution's live network needed to be addressed.
- **Solution**—Spirent developed a test plan using Spirent best practices and test methodology and employing Spirent TestCenter. A series of core network tests were executed. These included testing the server farm (both stand alone and virtualized), ARP performance, load balancing module performance, and failover tests. Tests were targeted to isolate and troubleshoot existing data center problems and resolve them before testing a new data center network infrastructure for performance, availability, and functionality.
- **Benefit and Outcome**—Testing identified configuration and firmware issues in the pre-production network. It also revealed the strengths and weaknesses of the various configurations tested. This evaluation allowed an objective decision to be made between the virtualized or stand-alone servers. The availability of servers with various hardware and operating systems combinations was successfully evaluated, facilitating successful deployment of the data center and meeting the launch deadline.

**Case 2: Best Practice Applications**—Understanding the site's various configuration weaknesses helped to isolate the failure threshold, which was critical to ensure the success of the new data center. In the course of the testing, new network devices were tested for their successful integration into the network. NOTE: Dedicated security testing campaign was part of a follow-on phase for this company, which would complete the PASS methodology best practice application.

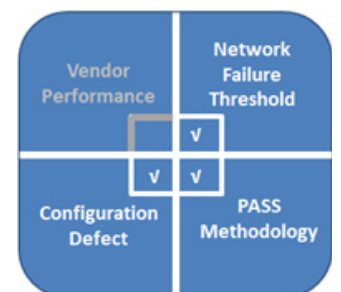


## Case 3 Profile: Business News & Information Resource – Data Center Migration

Management for one of the most trusted information resources for the world’s business leaders and senior executives realized that it had outgrown its existing data center. The influential online enterprise prepared to move to a new center that could better accommodate its growth.

- Challenge**—The project faced serious time pressure, one month to launch before the company’s biggest event, an annual report that was downloaded worldwide. Downtime was not an option. The company needed to identify the limits of a new system as well as optimize the network to assure a seamless cutover from the legacy data center to a new one.
- Solution**—Using Spirent Avalanche to perform the tests on the new data center infrastructure, Spirent Professional Services test results revealed several issues that would have seriously impaired performance. The site was performing at only a fraction of the requirement. Testing identified the new site’s breaking point. Further tests performance, availability, scalability and security testing isolated the core problem. The project team used this information to tune servers and resolve performance issues. After optimizing the web servers, the Spirent team tested the application servers, the performance of hardware devices, such as load balancers, and even the failover site.
- Benefit and Outcome**—When the day came to switch over to the new site, the company felt confident that the new web infrastructure could handle the demands of real-world traffic, and it did. By preventing downtime, testing saved the company time and money, and just as importantly, they preserved their brand image of providing critical information in a reliable manner, through all conditions, including extreme peak conditions. [Note: Based on the success of this engagement, the company engaged Spirent Professional Servers several years later, after upgrading the data center with a new content serving platform, with similar results. The system again stood up to the onslaught of traffic without a hitch.]

**Case 3: Best Practice Applications**—Facing their biggest anticipated peak traffic of the year, the customer needed to assure their new network architecture worked exactly as planned and, employing the comprehensive PASS methodology, conducted testing that targeted configuration defects to identify the failure point and assure future growth for years to come.

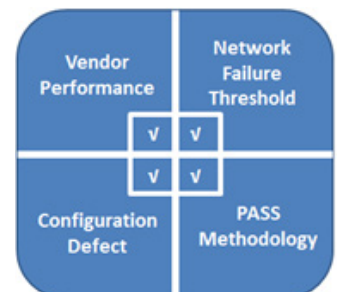


## Case 4 Profile: Pharmaceutical – Data Center Integration and Upgrade

The system integrator (SI) for this large French multi-national enterprise was responsible for building two new data centers and connecting them to the existing data center.

- **Challenge**—The compatibility of the new devices with the original data center needed to be assessed before cut over. The customer needed to select the devices that delivered the right performance and high availability. Solutions from each vendor needed to be verified with the live data center for performance, QoS and failover scenarios.
- **Solution**—Employing Spirent TestCenter, Spirent Professional Services implemented a rigorous test plan for throughput, latency and failover time in various scenarios. In addition, they tested the impact of network congestion on critical traffic, especially voice.
- **Benefit and Outcome**—Testing revealed firmware and configuration defects in all vendor solutions, especially when under high load. Test reports provided both objective and critical comparisons of the different vendor solutions. With this report, the SI was able to recommend the solutions that best fulfilled the requirements for the data center deployment. After selection, the customer requested two phases of re-testing to assure that all defects had been addressed. As a result, the SI was fully confident that the network architecture would work as designed. When the customer went live they had no critical loss of service and are very confident that their data center solution meets their future requirements.

**Case 4: Best Practice Applications**—In this case the SI was implementing their solution for the customer’s two new data centers and required independent verification that every aspect of the data center was ready for launch. In doing so, the SI adopted all four best practices in central testing campaign

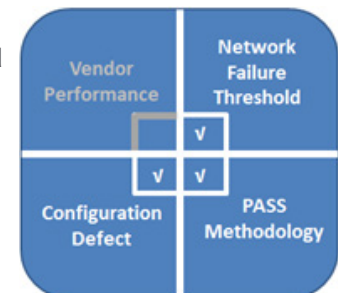


## Case 5 Profile: Construction Group—Data Center Migration

With 70,000 employees, a French multi-national company planned for a new data center with critical business applications.

- **Challenge**—Business applications in the new data center included Microsoft SharePoint, which had to support 32,000 local and remote users. Application performance and availability in the new data center infrastructure needed to be verified for local and remote users in reading and writing modes. Also, the new data center needed to be launched without interruption to workforce productivity or tight construction schedules, which were intensely budget-sensitive.
- **Solution**—Spirent Professional Services simulated remote sites and executed 20 test scenarios to determine application performance, availability, and the maximum load supported by the system before bringing it online. This test plan included integrating existing and new user behavior scenarios with the applications as defined by the customer.
- **Benefit and Outcome**—Testing validated the data center infrastructure design as being in accordance with the exacting customer requirements. As a result, no additional upgrades were required and the customer launched their data center on schedule and on budget, maintaining uninterrupted productivity of their workforce. Based on the success of the first engagement, the customer expanded their testing strategy to encompass web portal and firewall assessments to assure that these IT initiatives were also ready for launch, ensuring that budgets, operations and schedules were not adversely affected.

**Case 5: Best Practice Applications**—In this testing engagement, the customer needed to assure that their vast workforce, which operated in a meshed local and remote work model, experienced robust application performance. Understanding the network failure threshold without interrupting workforce productivity was critical. Applying PASS methodology and testing configuration defects was key to the success of this test plan.



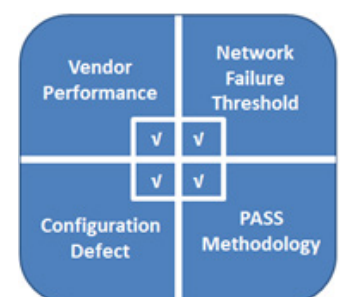
## Case 6 Profile: Online Brokerage – Data Center Migration

Strategic planning at this leading North American independent online investing company highlighted the need to upgrade the existing DCN to support heightened user volume, new functionality, increased security, and headroom for future growth.

- **Challenge**—While the legacy network was inadequate for future needs, it had the virtue of simplicity and low latency. The brokerage required the new DCN with its increased complexity and a remote backup facility to retain the low-latency advantages of the old network. The project team needed to test the new data center design for capacity, headroom, security, and performance under attack before switching over from the legacy data center.
- **Solution**—Using Spirent TestCenter and Avalanche, Spirent Professional Services proposed a multilayer testing strategy: performance testing and security testing per domain. Industry-standard RFC 2544-based performance tests for throughput and latency were divided into network (layer 2-3) and application (layer 4-7) capacity tests with security components in place. Security testing per domain generated network impairments and attacks at extremely high rates, including denial of service (DoS) attacks and a worm outbreak.
- **Benefit and Outcome**—Testing validated the network design as able to support current requirements and scale to support future growth requirements. Multiple issues were discovered pre-launch and corrected, such as an underperforming link that would cause congestion during high-demand, a vendor software error that blocked LACP-bundled traffic, and others.

**NOTE**—Two months after the evaluation, a sudden 200-point drop in the Dow Jones Industrial Average caused a 3-hour window of dramatically spiked trading activity. Response times for most of the online brokerages increased from two to eight times normal, resulting in a 25% drop in the overall number of successful trades and related revenue. The brokerage’s response times and trade volume were unaffected by the spike in traffic and their performance during this event is credited with their taking a more commanding position in the market. Based on the first experience, the brokerage engaged Spirent Professional Services to evaluate the design for the remote backup data center for security, functionality, scalability, and performance under attack. This second phase of testing validated the design while uncovering several configuration issues with performance and revenue implications, such as a backup system that ran at 50 percent of pre-failure performance and a domain with throughput at 90 percent of line rate. The launch of the remote backup facility met performance, security and growth targets while staying on schedule.

Case 6: Best Practice Applications—This forward-thinking company aggressively applied all of the DCN testing best practices in a timely manner well ahead of expected peak usage periods. They also designed the subsequent DCN expansion with the same measured quality of advance planning for the next phase of their robust data center expansion strategy.



## Overview of Best Practices Adopted in Case Studies

The comparison table below provides an overview of how the best practices applied map to the individual case studies

	Vendor Performance	Network Failure Threshold	Configuration Defect	PASS Methodology
Case 1	✓			✓
Case 2	✓	✓	✓	
Case 3		✓	✓	✓
Case 4	✓	✓	✓	✓
Case 5		✓	✓	✓
Case 6	✓	✓	✓	✓

## Advantages of Third-Party DCN Testing

All the examples in the case studies above have one detail in common: an objective third party performing the tests. In two cases, system integrators reached out to a third party to provide independent and neutral verification of their solution with their customer.

As voke's ITO (Infrastructure Test Optimization) whitepaper, and Gartner research notes observe, implementation of IT initiatives such as data center network design, consolidation, and virtualization represent significant infrastructure and budget commitments that carry considerable risk. The value of testing is clear to mitigate these risks relying on in-house engineering resources, who may not have the required testing expertise, may too often bring unreliable testing results. Therefore customers who engage third-party test partners follow an established and prudent strategy of ensuring success in their IT initiative and protect the initial investment cost of the initiative.

In addition to isolating and correcting problems before deployment, third-party testing provides CapEx and OpEx savings by using a third-party test infrastructure, obviating the need to acquire and maintain a test bed year round, and eliminating the time and cost to train test engineers to gain expertise in current best practices. Subsequent engagements by the same third party, whose value was verified by earlier engagements, become even more cost-effective and efficient.



## Selecting a Test Partner

The choice of a qualified test partner is critical. Employing a test partner who has a team of test experts in the field of data center testing is a key factor in making this choice.

Testing should be a core competency of the partner, not an open-source freeware or an ad hoc solution offered on request. This means the partner is an established global name in the test and measurement industry with verifiable experience and expertise. The testing partners capabilities must have the power and sophistication to support all the elements of test realism: real user behavior, real converged traffic, and real network conditions.



Their testing platform must support robust, standards-based test methodologies that stress the performance, availability, security, and scalability of the device or system under test.

The test partner should be a neutral party without a motivation to influence the test results, as may be the case with a system integrator testing their own solution. Some systems integrators who do their testing in house have a vested interest in delivering positive results.

The testing team should have a holistic understanding of networks, be able to articulate testing benefits and ROI vs. risk, and have an established delivery process. A test partner's qualifications are further strengthened if they have extensive expertise in lab and test automation and can provide references of successful engagements. Ideally, the team should support the latest automation tools and built-in GUI-based tools for simplifying and automating standards-based and customizable test cases without extensive scripting knowledge as a requirement.

Since purchase of required test equipment can be prohibitive, selecting a test partner who also manufactures a broad array of networking test equipment and provides options to rent test equipment, offers added advantages and cost benefits. The most advantageous test partners that provide test rental equipment are those who supply devices manufactured by the same company.

## Conclusion

Testing is the key to reliability and availability, but inadequate testing causes more problems than not testing by creating a false sense of security. Industry best-practices, developed over time through experience and expertise, allow organizations to test and deploy data center networks with confidence. These best practices are to: conduct Vendor Performance, Network Failure Threshold and Configuration Defect Testing, as well as, to employ the PASS Methodology in testing. In addition, engaging a third-party test partner is the most reliable and cost-effective means of assuring the success of a data center launch.

## About Spirent

Spirent Communications plc. (LSE: SPT), a global leader in test & measurement, inspires innovation within development labs, networks and IT organizations, enabling its customers to deploy communications networks, services, applications and devices that enrich life. Our extensive portfolio of solutions tests data centers, cloud computing and virtualized environments, high speed Ethernet networks and services, 3G/4G wireless networks and devices, network and application security, and positioning technologies. The world's largest equipment manufacturers, service providers, enterprise and governments rely daily on Spirent to help ensure their success.

For additional information on on Professional Services solutions please visit

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