

Distance Challenges of Native Array IP Replication Solutions

Brocade extension overcomes distance challenges.

Is your array-based IP replication solution meeting your availability and recovery objectives? This tech brief highlights the challenges inherent to native array IP replication solutions when replicating over long distances and discusses the advanced technologies available with Brocade Extension solutions that overcome these challenges.

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Introduction

Enterprise Data Centers continue to be challenged with effectively managing the growing amount of data that has to be replicated between data centers for Disaster Recovery/Business Continuity (DR/BC). Not only is the amount of data doubling every two years, the type of workloads and application data that needs to be protected is expanding beyond Fibre Channel (FC)/FICON block storage to include more business-critical Internet Protocol (IP)-based storage—for both block-based and file-based data. Whereas a wide variety of IP replication solutions are available in the market, including a growing number of disk arrays and tape devices with native IP replication ports, these solutions are not optimized for replication over long distance. In a local or metropolitan environment, these replication solutions may deliver the needed performance and throughput to meet service levels and recovery objectives. However, when replicating over longer distance, these solutions have several inherent challenges that make it almost impossible to meet growing service level and recovery expectations. Such challenges include widespread replication throughput issues, network availability problems, and data security exposure.

For most enterprise organizations, replicating over distance is a key requirement to ensure adequate data protection for DR/BC. Replication throughput, however, must be at a level that enables the required recovery objectives to be met, regardless of the distance between data centers. Whereas meeting performance requirements at a local, campus, or even metro data center level can be achieved using array native IP replication solutions, these solutions are challenged to deliver the needed throughput over longer distances. With distance, these applications suffer major performance “droop,” a result of the effects of latency. In fact, testing shows that array native IP replication throughput dropped 44 percent compared to local replication application performance, with just 25 milliseconds (ms) latency (replicating between New York and Chicago, for instance). This is due to latency alone. Beyond 25-millisecond latency, throughput dropped quite dramatically, making replication over longer distances using native array IP replication ports a nonviable solution for most enterprise organizations.

Another challenge for array native IP replication solutions is that IP Wide-Area Network (WAN) connections are notorious for being problematic. In addition to network latency, WAN connections experience frequent disruptions and events that have enormous implications for replication traffic. Issues such as dropped packets, jitter, degraded or complete loss of network connectivity, and competing demands for bandwidth from the user community all negatively impact replication applications, making it difficult to achieve availability and recovery objectives. As an example, when inserting just 0.1 percent packet loss (a rate that is common) into the New York to Chicago replication over distance test scenario described above, native array IP replication throughput dropped by a huge 98 percent compared to local replication performance. These types of replication solutions were simply not designed to handle network interruptions. Keep in mind that each time a WAN link goes down, data in transit on the failed WAN link is lost, the replication application can time out and stop (including the main Input/Output [I/O] if performing synchronous replication), and the application goes into its restart/resync recovery mode.

And with each restart/resync, replication falls further and further behind. With the large (and growing) amount of data that needs to be replicated and the very high replication speeds, even a small unplanned outage can take days to recover from and can result in unrecoverable data.

To make matters worse, IP WAN connections typically involve multiple hops and often involve multiple service providers, making it complex and time-consuming to troubleshoot IP WAN problems. Native array IP replication solutions provide troubleshooting tools for issues related to the storage device itself, but they offer no visibility into the storage network or the state of the IP WAN connections. All that is known is that the replication time is exceeding target levels. There is no proactive warning or insight that allows administrators to quickly identify and resolve potential issues. As a result, network issues require reactive management that can impact operations and lead to downtime. Even ownership of storage network issues can be a challenge, often resulting in the assignment of blame within the IT organization and increased time to resolution.

Data security is another significant challenge for native array IP replication solutions. Some arrays encrypt data to provide protection for data-at-rest but often do not provide encryption for data in-flight. This means that after the data leaves the confines of the secure data center, critical data is unprotected, making it vulnerable to security breaches, data theft, and “man-in-the-middle” attacks. With the growing threats of hacking, snooping, and other high-profile cybercrimes, protecting data in-flight across the IP WAN is essential to meeting data security objectives. However, security cannot be performed at the expense of throughput. Some IP replication solutions do provide encryption of data in-flight as an option, but the performance penalty is unacceptable—often reducing throughput by 30 to 70 percent.

Brocade® Extension solutions leverage 20 years of distance connectivity innovation and thought leadership to augment native IP replication solutions to overcome these critical challenges, helping Enterprise IT meet its recovery and security objectives.

Overcoming Distance Challenges

The Brocade 7840 Extension Switch is a purpose-built, multiprotocol storage connectivity solution that brings enterprise-class extension benefits—previously available only to FC/FICON storage—to IP storage replication, enabling new IP storage applications and new DR/BC architectures. Key IP storage features include:

- Local data center application throughput over unlimited distances
- Enhanced security with strong encryption for data in-flight, without a performance penalty
- Continuous availability with protection against WAN disruptions
- Simplified network management with greater control and insight

The Brocade 7840 supports simultaneous FC, FICON, and IP storage applications, consolidating and extending replication I/O from heterogeneous arrays and multiple protocols across the same managed tunnel, offering a comprehensive storage extension solution that integrates seamlessly into any IP network.

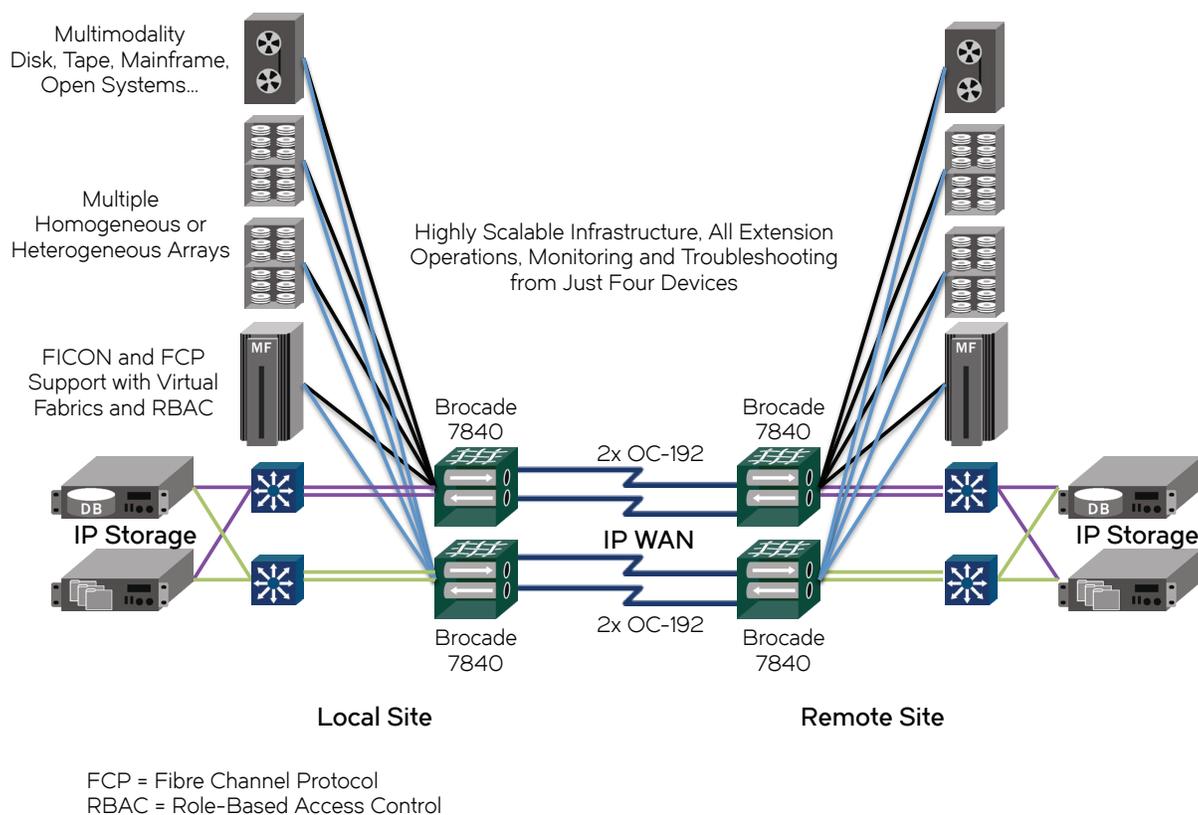


Figure 1: Multimodality large-scale Brocade Extension deployment.

Accelerated Performance over Distance

The Brocade 7840 delivers industry-leading scalability and throughput over distance, moving up to 50 times more data compared to native IP replication solutions. This new level of performance over distance for IP storage applications enables use cases that were not previously feasible. In addition, with up to 80 gigabits per second (Gbps) of replication throughput per platform—far greater than any other IP replication solution—the Brocade 7840 also meets the requirements of large-scale deployments, providing concurrent support for multimodality environments (disk, tape, file, block, open systems, mainframe, and so on), as well as capacity for growth. Because it allows the consolidation of replication I/O across a single managed tunnel, the Brocade 7840 negates the need for multiple extension technologies to support various applications within the data center and makes efficient use of shared network bandwidth. No other solution on the market provides this level of performance, scale, flexibility, or cost-effectiveness.

To illustrate the point, consider the New York to Chicago replication example discussed above. Instead of a 98 percent drop in throughput using the native IP replication solution with 25 millisecond latency and 0.1 percent packet loss, the Brocade 7840, with the same WAN connection, delivers throughput equivalent to that achieved locally within the

data center. In fact, the Brocade 7840 is able to maintain local data center replication throughput even across intercontinental distances. And Brocade maintains local data center throughput even when 0.5 percent packet loss is added.

The exceptional performance and scalability delivered by the Brocade 7840 enables new ways to think about IP storage replication. With local data center performance over any distance, new IP storage capabilities are now available for your DR/BC infrastructure. Significant new distance applications can be deployed to meet availability and recovery objectives. New opportunities are available for consolidation and greater efficiencies, which share the WAN Infrastructure between storage and nonstorage applications.

To achieve this new level of performance for IP storage, the Brocade 7840 incorporates several advanced technologies that are essential to ensuring maximum throughput and bandwidth utilization over distance, including these:

- An aggressive Transmission Control Protocol (TCP) stack that is optimized for storage, called WAN-Optimized TCP (WO-TCP), a capability that is not available with solutions that use standard TCP stacks alone
- An advanced line-rate data compression architecture with three compression algorithms that are the most aggressive in the industry
- An encapsulation methodology that enables the industry's most efficient data transport across the WAN
- Protocol acceleration technology for open systems data replication, tape, and mainframe applications, which selectively apply optimization to all applications that can benefit in a consolidated, heterogeneous environment

These unique technologies from Brocade combine to deliver industry-leading performance over distance. They are discussed in more detail in the Advanced Technologies section of this paper.

Enhanced Security

Protecting data-at-rest within the data center—as is done with native IP replication solutions—is only a part of the challenge. After application data leaves the security of the data center and is replicated across an IP network (regardless of whether it uses the public Internet or private WAN connections), it becomes vulnerable to hackers and theft, exposing the organization to data breaches and unwanted publicity.

The Brocade 7840 leverages dedicated hardware to provide strong 256-bit Advance Encryption Standard (AES) encryption of data flows to protect data in-flight between data centers. By performing encryption at full line rate, data can be protected without impacting replication performance, ensuring that both security and throughput over distance requirements are met.

Brocade encryption technology is discussed in more detail in the Advanced Technologies section of this paper.

Continuous Availability

Network disruptions and outages severely impact replication performance, making it difficult to achieve availability and recovery objectives. Brocade offers a variety of unique technologies and capabilities that help overcome network interruptions and ensure continuous availability.

One unique technology is Brocade Extension Trunking. Typically, when a WAN link goes down, packets in transit on the failed link are lost, and the replication application stops and goes into error recovery mode. With Brocade Extension Trunking, availability is maintained by automatically retransmitting lost packets over a nonaffected WAN link, allowing the replication application to continue without disruption. Brocade Extension Trunking is a key technology for enabling continuous availability.

Another critical and unique Brocade technology is Adaptive Rate Limiting (ARL). When one extension switch becomes unavailable in a redundant pair, the bandwidth allocated to that device typically goes unused, resulting in only 50 percent of the bandwidth being available while the device is down. With ARL, the operating extension device automatically detects the idle/down device and dynamically adjusts to utilize 100 percent of the available WAN bandwidth, providing full throughput even during a failure. Without the ability to automatically adjust to WAN bandwidth changes—as is the case with array-based native IP ports—either too much or too little bandwidth causes nonoptimal performance. ARL can also be used alongside nonstorage applications to ensure that high-priority applications maintain their bandwidth during an outage, while lower priority applications sacrifice theirs. Also, if an IP path goes down, ARL works with Extension Trunking to optimally adjust the bandwidth usage based on the remaining path or paths.

The Brocade 7840 is one component of an overall system that works together to help ensure continuous availability of the replication solution and to guard against disruption. Brocade Fabric Vision™ technology works with the Brocade 7840, providing threshold-based monitoring between data centers to automatically detect WAN issues and avoid unplanned downtime. With powerful built-in proactive monitoring, management, and diagnostic tools, organizations can get early warning of potential problems and minimize downtime with faster troubleshooting.

In addition, Brocade Fabric Vision technology and the Brocade 7840 built-in traffic generator and WAN test tool allows organizations to pretest, validate, and troubleshoot the physical infrastructure, eliminating potential delays and downstream reliability issues for new deployments.

No other solution in the market offers this level of resiliency, availability, and control across the storage network. These key capabilities are discussed in more detail in the Advanced Technologies section of this paper.

Simplified Management

Monitoring a storage network is complex and requires advanced network expertise. It often involves manually collecting and compiling data from a variety of sources—a tedious and time-consuming task—and interpreting that data based on personal

experience. Such is the case with native IP replication solutions. Without in-depth visibility and tools that take the “manual” effort out of network management, administrators spend too much time troubleshooting and not enough time planning for new initiatives.

Brocade Fabric Vision technology delivers unprecedented, real-time visibility and actionable insights into the storage network, helping organizations dramatically simplify management and reduce management costs. It does this by means of a variety of technologies, including the Monitoring and Alerting Policy Suite (MAPS), Flow Vision, and Brocade Network Advisor.

MAPS is a powerful, threshold-based proactive monitoring and alerting capability that allows organizations to deploy 15 years of Brocade best practices with a single click of a cursor. With predefined groups, policies, rules and actions, and intuitive reporting capabilities, MAPS simplifies proactive, threshold-based monitoring and alerting of storage networks. Organizations that choose to customize their policies can do so quickly and easily, saving valuable time. In addition to streamlining deployment of proactive monitoring and alerting, MAPS delivers new levels of instrumentation and granularity, to fine-tune storage resources and accelerate troubleshooting and problem resolution.

Flow Vision works with MAPS to identify, nondisruptively monitor, and analyze the performance of specific data flows or frame types. Being able to visualize flows of interest through tunnels allows administrators to visualize specific applications, ensure that service levels are met, and simplify troubleshooting flow performance issues.

Brocade Fabric Vision technology is integrated into Brocade Network Advisor, providing “out of the box” or customizable dashboard views that display the most critical storage network metrics on one screen—with drill-down capabilities to instantly view these and more:

- Real-time health and performance data and historical trends
- Out-of-compliance conditions, congestion, and latency concerns on flows
- The status of Small Form-Factor Pluggables (SFPs) and a variety of port-level error statistics

Together, Brocade Fabric Vision technology delivers real-time information that organizations can act on to meet availability and recovery objectives, and it integrates with third-party orchestration tools to provide holistic, end-to-end management of the storage network.

No other solution in the market offers this level of visibility, efficiency, and simplicity—driving down operational and capital costs.

Brocade Advanced Technologies

Brocade Extension solutions leverage 20 years of distance connectivity innovation and thought leadership to deliver purpose-built, data center hardened extension platforms with a highly differentiated feature set.

All of the Brocade advanced technologies described below apply to FC, FICON, and IP storage replication solutions, enabling a consolidated, comprehensive storage extension solution that accelerates performance of all applications over distance, enhances security, reduces downtime, and simplifies management of the end-to-end storage network.

WAN-Optimized TCP

Transmission Control Protocol (TCP) is essential to the high-speed transport of large data sets that are common in storage extension. Through years of experience, Brocade has developed an aggressive TCP stack called WAN-Optimized TCP (WO-TCP). Brocade WO-TCP optimizes TCP window size and flow control, accelerating TCP transport specifically for storage applications with heavy throughput. It also helps ensure full utilization of available bandwidth and maximum sustained throughput over the WAN. Regular TCP has exponential backoff and responds badly to situations like packet loss over a WAN. (In other words, it might interpret it as congestion, in which case the standard response is exponential backoff. However, that is exactly the wrong response when you are using a WAN connection and you have a high throughput workload that needs to get through.)

Often array-based native IP replication solutions require WAN optimization products to deliver adequate application throughput over distance. Brocade WO-TCP is a transport that cannot be outperformed by competing WAN optimization products. In other words, you receive negligible benefits from additional WAN optimization when using the Brocade 7840 Extension Switch. Overall, Brocade technology is comparable from the perspective of the data transport bottom line. The total bytes transferred within the same period of time, over the same bandwidth, are virtually the same compared to competing WAN optimization products, but a Brocade Extension solution costs considerably less than WAN optimization products of comparable speed.

Brocade Extension technology makes WAN optimization totally unnecessary for extension of Fibre Channel over IP (FCIP) and IP storage. In fact, adding WAN optimization to a Brocade Extension network introduces complexity, another point of failure, and another asset to configure, manage, monitor, and troubleshoot. If WAN optimization already exists, Brocade Extension technology unnecessarily consumes that resource, which other nonstorage applications should use instead.

Brocade WO-TCP integrates with ARL, and the synergy of these two technologies creates an industry-dominating transport for storage. No similar transport exists on any other IP extension or native array IP replication solution.

Line-Rate Data Compression

Brocade has developed specialized compression algorithms for the Brocade 7840. These algorithms vary in processing rate and compression ratio and are the most aggressive compression algorithms available in the industry. They cannot be found on any array-based native IP ports or competing products.

Table 1: Brocade IP Extension Compression

Platform Configuration	Max. FC Application Throughput	Max. IP Application Throughput	Max. IP + FC Application Throughput	Max. WAN Throughput
7840 Base	20 Gbps – Aggressive Deflate	20 Gbps – Aggressive Deflate	20 Gbps – Aggressive Deflate	5 Gbps
7840 Base + Upgrade #1	30 Gbps – Deflate	30 Gbps – Deflate	30 Gbps – Deflate	10 Gbps
7840 Base + Upgrades #1 and #2	80 Gbps – Fast Deflate	32 Gbps – Deflate 40 Gbps – Uncompressed	40 Gbps FC – Fast Deflate + 20 Gbps IP – Aggressive Deflate	25 Gbps (or 40 Gbps for FC only with Fast Deflate or IP-only uncompressed)

Brocade IP Extension offers two compression algorithms; Deflate and Aggressive Deflate, and provides up to 32 Gbps of ingress throughput per platform using Deflate compression. Depending upon the compressibility of the data, the WAN bandwidth required is reduced accordingly.

Line-Rate Data Encryption

Brocade has developed hardware-based Internet Protocol security (IPsec) for secure data in-flight across Brocade Extension Inter-Switch Links (ISLs). Brocade IPsec operates at line-rate and introduces only a couple of microseconds (μ s) of added latency, making it useful for synchronous applications. Brocade IPsec uses AES-GCM-256, Diffie-Hellman 2048-bit Modular Exponential (MODP), Internet Key Exchange version 2 (IKEv2), Hashed Message Authentication Mode Secure Hash Algorithm 512 (HMAC-SHA2-512), and Transport Mode, and it is rekeyed every few hours without disruption. A Preshared Key (PSK) is configured per tunnel and trunk on each side.

Best practice is to use Brocade IPsec for Extension, both FCIP and IP Extension. Brocade IPsec is part of circuit formation and protects data from virtually every type of attack, including sniffers, data modification, identity spoofing, man-in-the-middle, and denial of service attacks.

Brocade IPsec requires no additional licenses or costs and is very simple to configure. IPsec plus Extension Trunking gives you the ability to granularly load balance encrypted storage flows across all the trunk's member circuits. Up to 20 Gbps is supported for a single trunk, and two such trunks are supported per Brocade 7840. This is a large amount of encrypted load balanced data bandwidth (up to 40 Gbps) for a single box. IPsec provides prudent security for most organizations and is provided at no additional cost with Brocade Extension solutions.

Efficient Encapsulation Methodology (FC → FCIP, IP Encapsulation) FCIP Encapsulation

To create the maximum payload per unit of overhead, Brocade uses a unique method of forming streams of bytes from storage I/O. There is no concept of individual FC frame discrete encapsulation, which would be far too inefficient (yet is used by many competing products). Brocade forms a stream of bytes, which is transported by WO-TCP. Sixteen data frames form a stream called a "batch." Each batch has a single extension header, which reduces headers by 16:1. The batch is then compressed. By compressing the entire batch, it is possible to gain higher compression ratios. Brocade has developed various

Deflate-based compression algorithms, namely Fast Deflate, Deflate, and Aggressive Deflate. Each algorithm has a different trade-off of speed vs. compression ratio. The stream fills TCP segments to their maximum segment size. The maximum segment size is the IP Maximum Transmission Unit (MTU) minus the IP and TCP headers (IP + TCP headers totals about 40 bytes). The result is full-size IP datagrams and minimal overhead, no matter what the compression is. Relative to other competing replication transports, the Brocade FCIP encapsulation method excels in efficiency.

IP Encapsulation

When Local-Area Network (LAN) TCP/IP traffic is run through Brocade IP Extension, the LAN TCP sessions are proxied (terminated locally), resulting in two TCP connections being created. One TCP connection is created between the local storage array and the local extension device; another is created between the remote extension device and the remote storage array. By doing this, incoming LAN TCP/IP traffic is stripped of all network headers (Ethernet/IP/TCP), leaving only the data behind for transport across the WAN. Brocade then "batches" the data frames together, which are then transported across the WAN using WO-TCP. This very efficient process minimizes the protocol overhead imposed by the Brocade IP Extension solution. It also allows the use of jumbo frames on the WAN, even if the storage application does not support jumbo frames. This is made possible by the fact that the batches are sent across the WAN in jumbo-sized Ethernet frames and then are broken up into standard-sized Ethernet frames by the remote extension device, presenting standard MTU frames to the remote storage array. This process allows the fastest possible communications from the end IP storage devices and the Brocade 7840 by local fiber connections within the data center. WO-TCP is a data transport that has no comparison to IP storage end devices. No competing replication transport is as efficient or performs as well as the Brocade IP encapsulation method with WO-TCP.

Protocol Optimization

Many storage replication applications, whether native FC or native IP, perform unsolicited writes, meaning that writes are sent without first requiring a transfer ready from the remote side. Unsolicited writes indicate the immediate sending of data across the WAN, usually on the heels of the Small Computer System Interface (SCSI) write command. This means that many FC-based Remote Data Replication (RDR) applications have built-in protocol optimization, and the behavior is identical to array-based native IP replication. For those FC-based replication applications that do not have single round-trip functionality, Brocade has innovated the FastWrite feature. FastWrite is a protocol optimization technique that eliminates the command/transfer-ready round-trip needed to start the data-out of an I/O. The effect is the same as unsolicited writes.

When using extension devices external to storage arrays, combining other storage applications such as tape, mainframe, and file-based data over the same tunnel (one VE_Port) or different tunnels (different VE_Ports) is highly efficient and cost-effective. Brocade Extension has protocol optimization for Open Systems Tape Pipelining (OSTP) read/write and FICON Acceleration (XRC, tape read/write, and Teradata), supporting optimization of all of these protocols simultaneously. Brocade Extension can discern these different applications and apply protocol optimization to those that can benefit. These applications can be extended great distances, mitigating the effects of latency while maintaining full bandwidth utilization.

Extension Trunking

With Extension Trunking from Brocade, each storage I/O accesses all the WAN bandwidth that is seen by all the circuits belonging to a tunnel. An extension tunnel is defined by its VE_Port endpoint. The tunnel has a maximum bandwidth of 20 Gbps on the Brocade 7840 Extension Switch.

Having multiple circuits per tunnel enables high availability. Extension Trunking spreads data across all circuits, and those circuits can be dispersed across various paths and service providers; there is no requirement for equal bandwidth or latency among the circuits. This capability, combined with the ability to failover/failback without data loss or out-of-order data, is essential for mainframe environments and makes for more durable open system RDR environments, as well.

If an IP path goes down at any level (service provider, local or remote, switches or routers, optics, cables, and so on)—and circuits are dispersed across different service providers, routers, switches and paths—then no outage occurs, provided at least one path remains up. ARL optimally readjusts the bandwidth usage based on the remaining path or paths.

Extension Trunking is lossless. No data is lost, and all data is received by the Upper Layer Protocols (ULP) in-order. The storage applications do not time out and do not perform error recovery, ensuring continuous operation.

ARL (Adaptive Rate Limiting)

Where rate limiting occurs in the network is important, and that point is after storage flows have been aggregated and before the IP WAN. Brocade Extension technology should be connected as close to the WAN as possible. This way, the aggregate of all data flows is managed holistically with security and Quality of Service (QoS) effectively applied.

Array "auto-adjust" rate limiting pertains to just the array itself. More than one array renders auto-adjust rate limiting ineffective. Moreover, auto-adjust rate limiting cannot take into account changes occurring in the WAN. As an example, consider a degraded situation in which a primary OC-192 (10 Gbps) goes offline and is backed up by two secondary OC-48s (5 Gbps) that are shared with nonstorage applications. There is no way for array auto-adjust rate limiting to compensate for this outage. The overall bandwidth has been reduced in half, forcing the native IP ports to use TCP flow control to manage the inevitable congestion. TCP does not efficiently manage flow control while providing performance, and the result is poor storage throughput, which is worse than the bandwidth outage itself.

This is not the case with Brocade ARL. ARL automatically adjusts the rate limiting on all associated circuits replicating across the IP WAN, regardless of the ingress FC or IP device and the WAN path or paths. ARL automatically adjusts rate limiting when other Brocade Extension circuits go online/offline or the available IP WAN bandwidth experiences changes. ARL works across all Brocade Extension products and uses the same WAN infrastructure.

Shared WAN connections with nonstorage applications are very common. ARL is designed to work on WAN connections that are shared with other IP storage and nonstorage applications. Array auto-adjust rate limiting was not designed for such

instances. In fact, the Brocade 7840 can be configured so that during an outage, high-priority applications maintain their bandwidth while lower-priority devices sacrifice theirs. ARL dynamically adjusts rate limits independent to each circuit, permitting efficient use of WO-TCP across a variety of ever-changing WAN environments. In this example, during the WAN service outage the overall bandwidth is halved, and the Brocade ARL, integrated with WO-TCP, best utilizes the available bandwidth while maintaining nonstop operations.

ARL is a function of primary importance for optimal operation. If auto-adjust rate limiting on array-based native IP ports cannot efficiently adapt to changes in WAN bandwidth, either too much rate or too little rate causes nonoptimal performance. Consider how constantly varying workloads make it impractical to tune individual arrays. Additionally, Logical Unit Number (LUN)/volumes cannot practically be relocated to remedy the array auto-adjust rate limiting problem. Dedicating WAN bandwidth to specific array native IP ports causes imbalanced issues. The only answer is to locate Brocade ARL downstream from the arrays.

Brocade Fabric Vision Technology

Monitoring and Alerting Policy Suite (MAPS)

Brocade customers and Original Equipment Manufacturer (OEM) partners ask, “How can we resolve support issues more quickly and effectively?” “How do we resolve issues before they become critical and before the RDR application goes down?” The situation is further aggravated by the inability to quickly pinpoint whether the problem is a network issue or a storage issue. Both customers and OEM partners are greatly interested in the ability provided by Brocade to proactively monitor and effectively troubleshoot the local storage connections and network device health—as well as the ability of the IP WAN to meet its Service Level Agreement (SLA).

It is important to build intelligence into these networking systems. When a data connection starts to experience errors of any kind, the proper action might not be readily apparent until the situation becomes a major outage. Given the large permutation of possible errors and effects, years of practical experience is required. Brocade provides operational excellence by leveraging 20 years of Extension experience, both in open systems and mainframe. Brocade introduced MAPS—a key element of Brocade Fabric Vision technology—for Brocade Fabric OS® (Brocade FOS) and Brocade Network Advisor, in order to provide a comprehensive suite of monitors, alerts, actions, and reporting of storage networks. MAPS assists operations in achieving higher availability, quicker troubleshooting, and infrastructure planning. It provides a prebuilt, policy-based threshold monitoring and alerting tool that proactively monitors the storage extension network health, based on a comprehensive set of metrics at tunnel, circuit, and QoS layers. Administrators can configure multiple fabrics at one time using predefined or customized rules and policies for specific ports or switch elements.

MAPS monitors utilization, packet loss, Round-Trip Time (RTT), jitter, and state changes for tunnels and trunks, circuits, and PerPriority-TCP-QoS (PTQ). Each PTQ priority (class-F, low, medium, or high) is monitored independently and includes throughput, duplicate Acknowledgments (ACKs), packet count, packet loss, and slow-starts.

MAPS can be used in many situations. One example is the fencing of circuits that exhibit errors. MAPS is simple and easy to deploy, with preset threshold levels and responses (Conservative, Moderate, and Aggressive) based on Brocade best practices. As needed—though not required—virtually every element is customizable in MAPS. This type of configuration, monitoring, reporting, and diagnosis system is not available on any other IP replication or extension solution.

Flow Vision

Visualization of flows through tunnels is another important capability of the Brocade 7840. Not all flows are created equal, and a tunnel managed by Brocade allows administrators to centrally visualize each application. Storage Administrators monitor network and flow behavior to ensure that SLAs are met. This is very difficult to accomplish if managed from each originating device and port.

Troubleshooting network flows is often a difficult and daunting endeavor. Making matters worse, Storage Administrators are not familiar with IP networks, and IP Network Administrators are not familiar with storage. These two groups have very different cultures and operating guidelines. It is difficult for Storage Administrators to depend solely on Network Administrators to maintain their replication environment, which makes flow, TCP, circuit, and tunnel monitoring and visualization considerably more important.

When troubleshooting storage flows, imagine that the flows fall into one of two categories: victims or perpetrators. If something goes wrong in the network, every flow becomes a victim. However, sometimes there is nothing wrong with the network, and flows fall victim to perpetrators. Perpetrator flows are flows that utilize excessive resources to the point that other flows fall victim. This frequently happens downstream from the storage handoff to the IP WAN. Brocade Extension provides features, functionality, and tools to deal with storage SLAs. Flows within the protection of Brocade Extension tunnels meet their SLAs when they come up against perpetrator flows.

Flow Vision, a key element of Brocade Fabric Vision technology, enables administrators to identify, monitor, and analyze specific application flows in order to simplify troubleshooting, maximize performance, avoid congestion, and optimize resources. The Brocade 7840 has the capability to monitor specific LUN flows between F_Ports that are communicating end-to-end across the extension network. It is also possible to monitor flows coming in from an E_Port. At LUN level granularity, I/O Operations Per Second (IOPS) and data rate can be monitored.

Flow Vision includes the following features:

- **Flow Monitor:** This provides comprehensive visibility into flows across storage extension networks, including the ability to automatically learn flows and nondisruptively monitor flow performance. Administrators can monitor all flows from a specific storage device that are writing to or reading from a destination storage device or LUN, or across a storage extension network. Additionally, administrators can perform LUN-level monitoring of specific frame types to identify resource contention or congestion that is affecting application performance.

- Flow Generator: This is a built-in traffic generator for pretesting and validating storage extension infrastructure—including route verification, QoS zone setup, Extension Trunking configuration, WAN access, IPsec policy setting, and integrity of optics, cables, and ports—for robustness, before deploying applications.

For more information on Brocade Fabric Vision technology, please visit:

<http://www.brocade.com/solutions-technology/technology/san-fabric-technology/fabric-vision.page>

WAN Test Tool (Wtool)

Wtool was introduced with the Brocade 7840 and accurately tests multiple IP network paths. Wtool generates traffic at specified rates between a pair of IP addresses. Wtool reports achieved throughputs, jitter, experienced latencies, congestion, packet losses, and network reordering. Wtool supports pertinent circuit characteristics, including Path MTU (PMTU), VLAN tagging, IPv4/IPv6, IPsec, and jumbo frames. The main purpose of Wtool is to validate the IP network before deploying a circuit. It is also useful as a diagnostics tool when you encounter a reliability issue with a circuit.

Wtool simulates Extension traffic in exactly the way that the IP network sees it, such that the test results are truly relevant. Wtool runs in the background and allows multiple simultaneous test sessions to coexist, up to eight sessions (four sessions per DP). Each test session equates to a single circuit. The total concurrent test capacity is eight circuits or two fully loaded tunnels/trunks. These connections are a User Datagram Protocol (UDP)-like simulation to facilitate detection of congestion, out-of-order delivery, and packet loss. However, Wtool runs the same TCP as the circuits do, so that IP network security mechanisms do not prevent testing, and IP network security devices are tested also.

Summary

Brocade Extension solutions leverage 20 years of distance connectivity innovation to deliver purpose-built, data center hardened extension platforms with a unique set of features to overcome the challenges faced by native array IP replication solutions and help Enterprise IT achieve its data availability and recovery objectives:

- Maximum throughput over any distance
- Security for data in-flight, without a performance penalty
- Continuous availability
- Network visibility with consolidated control
- Simplified management

Regardless of protocol (FC, FICON, IP, or any combination), Brocade Extension solutions offer the fastest, most reliable, and most cost-effective network infrastructure for consolidated, highly scalable, multisite data center environments implementing data replication over distance solutions.

Take control of DR/BC with Brocade Extension solutions for IP, FC, and FICON storage.

About Brocade

Brocade networking solutions help organizations transition smoothly to a world where applications and information reside anywhere. Innovative Ethernet and storage networking solutions for data center, campus, and service provider networks help reduce complexity and cost while enabling virtualization and cloud computing to increase business agility. Learn more at www.brocade.com.

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