F5 White Paper

Accelerating Data Replication with F5 WANJet and EMC MirrorView/Asynchronous

This paper addresses disaster recovery plans, common barriers to success, and performance gains that can be achieved by combining the F5 WANJet® application acceleration solution with CLARiiON MirrorView/A replication solutions from EMC®.

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Introduction

In today's business world, disaster recovery (DR) plans are key parts of a company's overall IT planning process. A major component of these plans involves protecting business-critical data through backups and data replication. Such replication and backup processes may occur between data centers, branch and home offices, or primary and backup sites.

When combined with EMC's CLARiiON MirrorView/Asynchronous replication solution, F5's WANJet has demonstrated 5-10 times greater replication performance. This paper is designed to achieve two main goals: to explain the performance requirements for an effective disaster recovery plan and to demonstrate the performance gains that can be achieved by combining WANJet acceleration with CLARiiON MirrorView/A replication solutions from EMC.

Factors That Affect Disaster Recovery Success

Any successful business continuity or DR solution has the same key components at its core. First, there needs to be a solid product to manage the replication processes; second, there needs to be an effective and efficient public or private Wide Area Network (WAN) or Metropolitan Area Network (MAN) network connection between data centers that enables those processes to be accomplished successfully.

Two critical requirements for measuring the success of a business continuity plan are the recovery point objective (RPO) and recovery time objective (RTO). RPO measures the amount of data lost when a disaster occurs and RTO measures the time of lost productivity. IT managers must counterbalance the lowest RTO and RPO possible by considering factors such as:

- Data storage requirements from increased usage and regulatory archival requirements
- Bandwidth between primary and backup locations
- Cost of adding bandwidth
- Importance of some network traffic vs. other traffic
- Network Variability factors (for example, latency and packet loss) that affect WAN performance

Data Replication Across the WAN

One of the most common barriers to the effective deployment of any high-performance data replication solution is the performance of the solution over the WAN links that connect the main and DR sites. Storage management teams, when sizing bandwidth requirements, often find that initial sizing estimates do not meet the DR solution's performance requirements. In practice, true WAN performance is rarely given much thought until the organization ramps up their production replication system and realizes that the available WAN throughput is inadequate. Suddenly, the RPOs and RTOs they expected to meet are no longer realistic.

WANs have several inherent characteristics that are the source of missed expectations within replication scenarios:

- Latency caused by limits to the speed of light over distance and the number of hops between the primary site and DR site
- Packet loss caused by signal degradation over the network medium, oversaturated network links, corrupted packets rejected in-transit, or faulty networking hardware
- Network congestion caused by traffic that exceeds available link bandwidth or device bandwidth, causing added latency and packet loss, which slows overall throughput. Known traffic likely grows over time. Unexpected traffic may also be a factor, such as routing updates or network logging and management traffic that was not considered during initial planning.
- Available bandwidth that does not match expected bandwidth (often due to a combination of the factors listed above).

Unfortunately, these factors often cripple an otherwise good backup/DR plan. Moreover, when the DR application shares WAN links with other application traffic, file transfers, and even possibly other migration or recovery activities that increase over time, previously met RPOs and RTOs can be completely unobtainable. This could be due to congestion caused by the added throughput from other applications, or latency due to the distance between geographically dispersed DR sites. Added latency can cause TCP delays that can prevent the storage team from achieving their RPOs and RTOs regardless of how much bandwidth is provisioned.

The most common solution is to replicate only the most critical data and hence reduce the amount of data replicated. The other option frequently chosen is to lease more bandwidth. Neither option is optimal. They are not the least expensive or most effective solutions because they do not solve the core issue, which is the performance of the application over the WAN.

EMC CLARiiON MirrorView

EMC CLARiiON MirrorView is a storage replication software solution for CLARiiON storage systems. It works by mirroring storage data to a secondary local or remote data store in either a synchronous or asynchronous mode. MirrorView/Synchronous (MirrorView/S) offers real-time synchronization between data stores, ensuring zero data loss. Every data modification is guaranteed to be replicated on both primary and secondary systems before any additional modification is accepted.

MirrorView/Asynchronous (MirrorView/A) works by using a queue (or log) that contains each primary data change over a specified period like 30 seconds, and then updating the changes to the secondary data store. This periodic update model can be used when the local and remote sites are geographically distant, and is a common alternative when some data loss is tolerable. Data loss happens when a failure occurs at a primary site before data in the local queue has been replicated to the remote site.

Figure 1 shows an example of the MirrorView/A replication process.

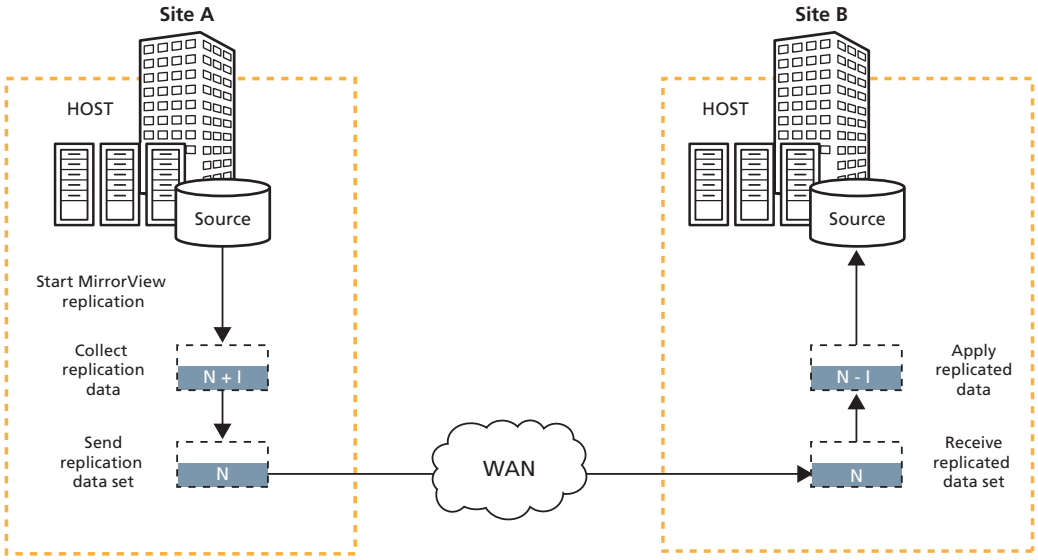

Figure 1: *MirrorView/A Replication Process*

MirrorView/A and Fibre Channel Over IP

While MirrorView supports direct connections between CLARiiON primary and secondary systems or through Fibre switches in a SAN environment, the primary and secondary systems in most DR environments are geographically distributed between two physical sites. Fibre Channel over IP (FCIP) is most commonly used to link these primary and remote data centers across the WAN. FCIP encapsulates Fibre Channel frames within TCP/IP packets, providing an IP transport tunnel for Fibre Channel frames across any standard TCP/IP backbone (such as the Internet).

Other alternatives to FCIP are iSCSI and Internet Fibre Channel Protocol (iFCP). Each offers SAN connectivity between data stores over geographically distributed areas such as a WAN. This paper focuses on leveraging FCIP to accelerate MirrorView/A replication.

Several vendors, including Brocade and Cisco, offer FCIP tunneling solutions. Each vendor has its own unique features but the primary considerations in any FCIP application solution for the purposes of this paper are the effect of latency and packet loss on network and application performance.

WANJet and MirrorView/A

F5 WANJet uses compression, caching, and other acceleration technologies to dramatically improve the speed of application delivery over WAN links. WANJet accelerates a wide variety of application traffic types including data replication, file transfer, email, client-server applications, and many others. WANJet also has some unique features that enable bandwidth to be efficiently allocated across different applications, thereby ensuring that the most critical traffic receives priority access to valuable WAN bandwidth.

There are many advantages to using WANJet to accelerate the MirrorView/A replication process. Combining these two tools helps meet RPOs and RTOs without increasing bandwidth or adding to the replication infrastructure. These benefits are achieved by:

- Accelerating the replication processes regardless of WAN conditions
- Enabling the replication process to adapt dynamically to network congestion
- Guaranteeing bandwidth for important and critical replication traffic
- Providing more control over WAN resources allocated to storage or DR needs

The combination also reduces the cost of meeting RPOs and RTOs by:

- Requiring less bandwidth to replicate the same or more amounts of data
- Reducing the tangible and intangible costs associated with troubleshooting

Finally, the combination secures replication traffic by optionally encrypting the traffic using SSL.

Why WANJet?

WANJet technology improves WAN replication performance by:

- **Avoiding uncompressed data transmission:** WANJet/Transparent Data Reduction Level 1 (TDR1) performs adaptive compression on packet payloads. TDR1 chooses among multiple, scenario-optimized compression algorithms to compress data. TDR1 can be used alone to compress data when transactions are short and the added overhead from manipulating data dictionaries and sending dictionary entries negates the benefits of using WANJet advanced compression. Secondly, TDR1 can be used to compress TDR2-optimized data between WANJet devices. TDR1 can be used for many IP protocols and is implemented automatically by WANJet.
- **Avoiding redundant data transmission:** WANJet advanced compression, or TDR2, performs both data de-duplication (byte-level caching) and compression. TDR2 enables WANJet to avoid sending previously transmitted data. Each WANJet maintains a session-level, byte-based dictionary. When a local WANJet observes duplicate data in the packet stream, it sends a dictionary pointer rather than the original data stream. Being block-based, it is able to compress the exact length of compressible data. TDR2 is most useful when transmitting longer files.
- **Avoiding critical replication traffic degradation when sharing bandwidth with less important traffic:** Bandwidth guarantees and prioritization are critical to ensuring that replication traffic is transferred properly. Application-level QoS ensures that the replication protocol gets the bandwidth it needs and is protected from other data traversing the WAN link.
- **Ensuring that the replication protocol is accelerated regardless of WAN conditions:** TCP Optimization reduces delays in many ways, including terminating connections at each end of the WAN link and rate-shaping traffic. WANJet Optimization Policy enables you to specify the ports (applications) to be accelerated, and prioritize traffic on all ports according to its importance.

- **Ensuring that important information gets encrypted for protection during transmission:** SSL encryption is available for sensitive data to ensure it is protected during transmission.

Further information about WANJet compression and caching is contained in the white paper "WANJet Transparent Data Reduction," available on the F5 website: http://www.f5.com/pdf/white-papers/wanjet-tdr-wp.pdf

Factors That Affect WANJet Acceleration

WANJet acceleration performance may be affected by the:

- Amount of redundant data traversing the WAN.
- "Compress-ability" of the data (for example, text is easily compressible; images are typically not).
- Traffic mix over the WAN links. (This requires WANJet to begin enforcing bandwidth guarantees, which can significantly improve performance of the important traffic at the expense of the less important traffic.)
- Traffic volume and link utilization. (Congestion on the WAN links are also affected by the change in traffic volume over the course of a day. Peak load times during which a replication process is ground to a halt can now be prevented using bandwidth allocation.)

Typical WANJet Configurations

When deployed with MirrorView, WANJet can operate in various configurations, as shown in Figures 2, 3, and 4: in-line, one-armed, multiple WANJet load balanced by F5 BIG-IP devices.

Figure 2 shows a simple in-line data center-to-data center example.

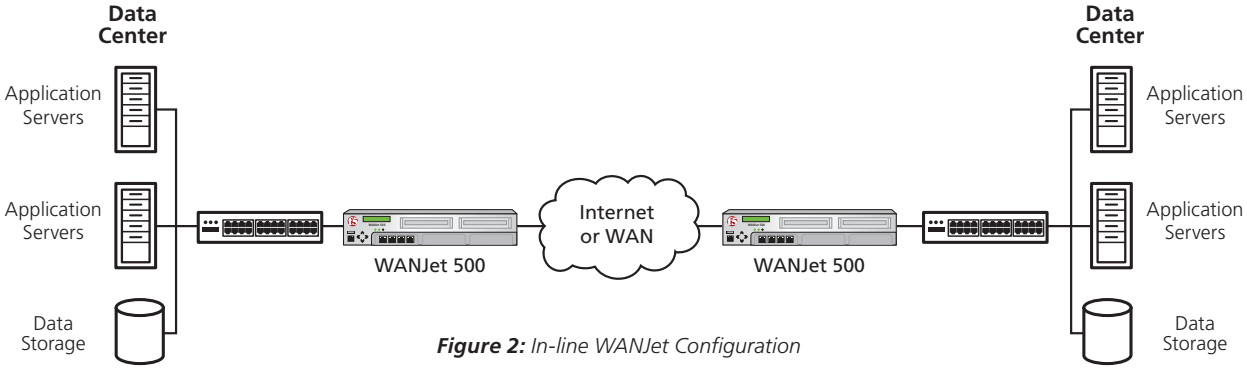

Figure 2: *In-line WANJet Configuration*

Figure 3 shows a simple WANJet one-armed example.

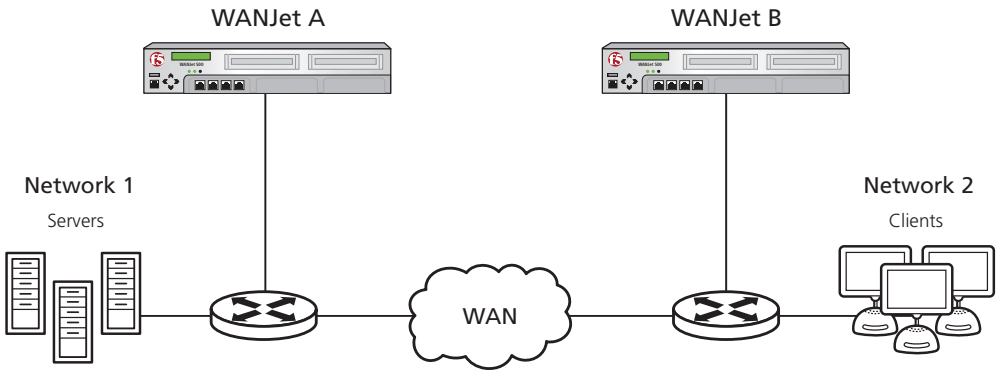

Figure 3: *One-armed WANJet Configuration*

Figure 4 shows a more complex example combining WANJet and BIG-IP® Local Traffic Manager™ (LTM).

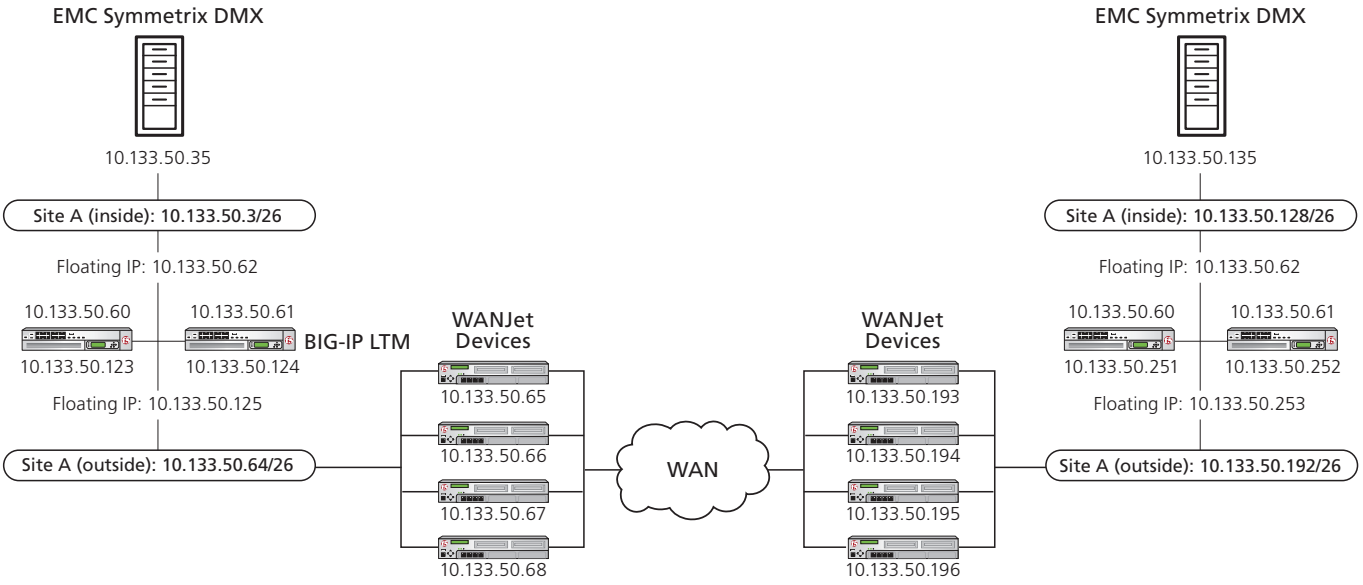

Figure 4: *Complex WANJet Configuration Using BIG-IP LTM*

WANJet–MirrorView/A Compatibility

F5 has successfully performed interoperability and performance testing between WANJet and EMC MirrorView/A using a test bed consisting of two Cisco MDS routers and a FCIP-tunneled WAN link. Similar results can reasonably be expected with other FCIP converters or solutions.

WANJet network installation is transparent to EMC CLARiiON/A devices, so no special configuration is required. Full test bed deployment was accomplished in a half day. The only modification required for the Cisco MDS 9216i routers was to turn off router compression and increase throttling over the WAN links to enable the throughput delivered by WANJet.

In each test case, CLARiiONs were linked over an FCIP tunnel accelerated by a pair of WANJet 500 devices. A LANForge WAN simulator was used to emulate WAN latency and packet loss. Although fiber converters were used in the test environment, they are not necessary; any switch that features copper Gigabit Ethernet ports can be used. A standard, open source load generation tool was used to generate data load for replication by MirrorView/A. Randomness, percent writes, and percent reads of the tool were set to reflect realistic results and match what is commonly seen in real world customer deployments.

Figure 5 shows a drawing of the replication test bed.

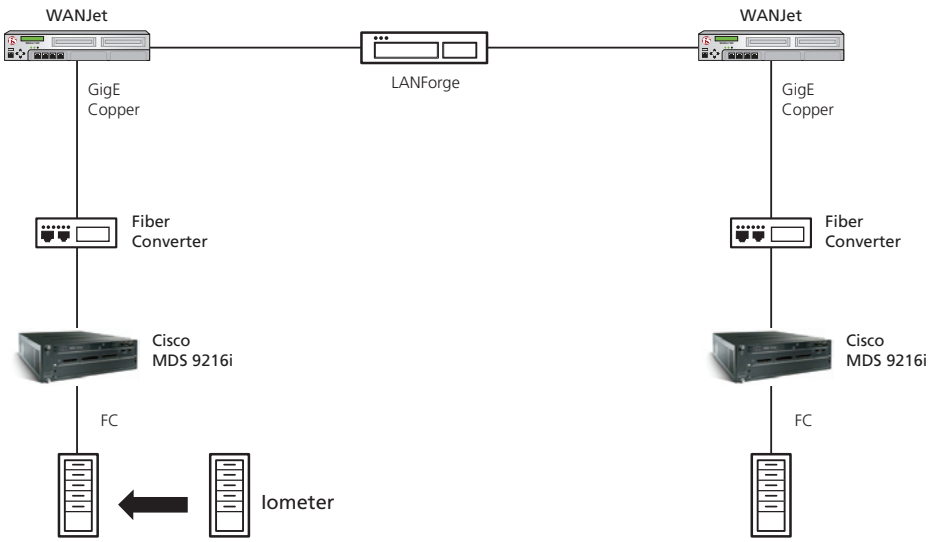

Figure 5: *WANJet–MirrorView/A Replication Scenario Test Bed*

Test Bed Configuration

Table 1 identifies the hardware and software used in the test bed.

Equipment	Configuration	Notes
One EMC CLARiiON CX3-40, One EMC CLARiiON CX3-80	16 LUNs, RAID-5 striped, merged as single consistency group.	It was necessary to use multiple striped LUNs to generate enough load across the WAN for testing.
Two F5 WANJet 500 appliances running v4.2.16	F5 WANJet 500s were deployed in-line.	
Cisco MDS 9216i	Switch ports were configured for throttled bandwidth and RTT settings equal to a multiple of the available WAN bandwidth.	Provided the FCIP tunnel. Bandwidth and RTT throttling configuration reflects the actual WAN link speed multiplied by the acceleration provided by WANJet.
Two Fiber to copper converters	Used to convert 1 Gb/s Ethernet fiber ports to copper.	Converters are not necessary when copper ports are available.
Iometer	Provided 85 percent randomness in transmitted data.	Provided the data load on the MirrorView LUNs to be replicated.

Table 1: *WANJet–MirrorView/A Test Bed Configuration*

Test Results

While each deployment is unique, the test plan outlined above emulated common deployments reflecting typical performance gains. It is important to remember that variations in your particular replication environment affect the possible WANJet performance gains. If your data is more repetitive or more compressible, or if your network reflects higher latency or packet loss than this test network, then you may see performance gains up to 2,000 percent. Speaking to an F5 acceleration solution architect will help you estimate the range of performance gains to expect, and a simple proof-of-concept test can yield very specific results.

Table 2 identifies the recovery performance gains seen during testing.

WAN Link Speed	Induced Latency	Induced Packet Loss	WANJet Performance Increase
10 Mbs	20ms	.01%	700% (7x)
12 Mbs	70ms	1%	680% (6.8x)

Table 2: *WANJet Performance Increase Observed During Testing*

Conclusion

The combination of F5's WANJet acceleration appliances with EMC's MirrorView/A data replication solutions offer performance gains exceeding 680 percent (6.8x acceleration). WANJet's simple, transparent operation minimizes data center disruption during installation.

For larger deployments requiring fault tolerance, WANJet can be combined with F5's BIG-IP Local Traffic Manager. You can learn more in the white paper *"Deploying the BIG-IP LTM and WANJet with EMC Symmetrix SRDF,"* available on the F5 website: http://www.f5.com/pdf/deployment-guides/wanjet-ltm-srdf-dg.pdf

WANJet TCP Optimization, TDR1 compression and TDR2 compression, and de-duplication offer unparalleled, high-speed performance between data centers with anywhere from 6x to 7x performance gains. WANJet delivers:

- **Increased bandwidth utilization:** WANJet TCP optimization, combined with TDR1 and TDR2 acceleration, enables more efficient use of lower-speed WAN links, saving WAN equipment and operating costs
- **Prioritized replication:** Configuring QoS priority for MirrorView/A traffic ensures that replication meets RPO and RTO objectives
- **Replication data security:** SSL encryption protects valuable data in transit to prevent unauthorized access

A further benefit is the partnership agreement between EMC and F5, which enables customers to purchase WANJet hardware and support directly from EMC.

In short, the combination of WANJet and EMC CLARiiON MirrorView/A delivers cost savings and improved RPOs and RTOs. This powerful solution can result in reduced risk and lower costs for enterprise deployments.

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