Accelerating NetApp SnapMirror replication with Citrix CloudBridge

NetApp SnapMirror is used for replication of file systems across datacenters for disaster recovery and business intelligence mining. This white paper covers the additional benefits for replication with SnapMirror provided by Citrix CloudBridge, which compresses the data and significantly improves WAN utilization in the presence of latency and packet loss. This benefit applies to covers full-volume and incremental replications.

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A full-volume replication is usually performed during off hours or weekends, while incremental replication is done throughout the day and requires a full-volume replicate as a starting point.

Key features

- **TCP optimization.**
  Changes standard TCP window size and congestion behavior to improve throughput

- **Data compression.**
  Compresses and de-duplicates blocks of data to reduce the amount transferred

- **Protocol acceleration.**
  Modifies the default behavior of protocols to account for WAN latencies

- **QoS.**
  Uses application- level classification and prioritization of traffic to meet SLAs.

Benefits

- Improves RPO by accelerating data replication and mitigating the effects of latency and packet loss

- Reduces WAN bandwidth required to meet the RPO objective

Two replication metrics are usually spelled out for disaster recovery implementations:

- Recovery point objective (RPO): indicates the time point to which the filer can recover and drives replication frequency
- Recovery time objective (RTO): indicates how long it will take the filer to get back up and running the last snapshot after a failure

To meet the RPO objective, the replication needs to run at the desired frequency and complete within the assigned window. These replication flows are large and could run for extended periods depending upon bandwidth and the condition of the WAN link between the primary and secondary data centers.

Missing the RPO and RTO targets can:

- Lead to significant loss of data
- Impact regulatory compliance with possible penalties
- Adversely impact recovery from a catastrophic failure

Citrix® internal testing of SnapMirror® performance when combined with the CloudBridge™ appliance showed a 10-fold improvement in replication times, along with a corresponding decrease in WAN bandwidth over SnapMirror with optimal configuration. Details of the testing and results are provided in the following paragraphs.

Replication performance

Replication solutions depend upon reliable data transfer and use TCP for transport. An effective TCP data transfer rate depends upon a variety of factors, including receiver buffer size, network round trip time (RTT) and packet loss.

- **Receive buffer size.** This is the amount of data that the receiving device can accept without acknowledging the sending device. If the sender does not receive an acknowledgement back, it will stop and wait, and eventually may even retransmit.
- **RTT.** A TCP sender sends an amount of data up to the size of the receiver buffer and then waits for acknowledgement before sending more. Long RTTs reduce the amount of bandwidth that can be effectively utilized by a sending station, regardless of the available link bandwidth.
- **Packet loss.** Any packet loss on the network further impacts efficient bandwidth utilization since the sender must re-send and get acknowledgement before proceeding. Also, TCP congestion management is conservative in the way it reverts back to the original sending rate. The cumulative effect of this behavior leads to a significant drop in bandwidth utilization.

SnapMirror provides the ability to adjust the size of the TCP receiver buffer to compensate for network latency. In addition, SnapMirror provides the following functionality to reduce the amount of data that needs to be transferred:

• Network compression. SnapMirror can compress the data being transferred.
• De-duplication. SnapMirror has optimizations to remove duplicate data at the source, further minimizing the amount that needs to be transferred.

CloudBridge optimization

CloudBridge brings additional capabilities to complement SnapMirror and further accelerate replication. With advanced QoS enforcement, it can apply appropriate priorities to critical traffic on the link. CloudBridge is a symmetrical solution requiring an appliance at both ends of the WAN link. The following is a snapshot of the key technologies employed and their benefits:

• TCP optimization. CloudBridge manages traffic at the network layer by acting as a TCP proxy to accelerate the data transfers. CloudBridge dynamically adjusts the TCP window size and congestion response behavior to maximize throughput for the available WAN conditions (latency and loss). Figure 1 compares standard TCP behavior and optimized TCP with CloudBridge in the presence of loss in the WAN network.
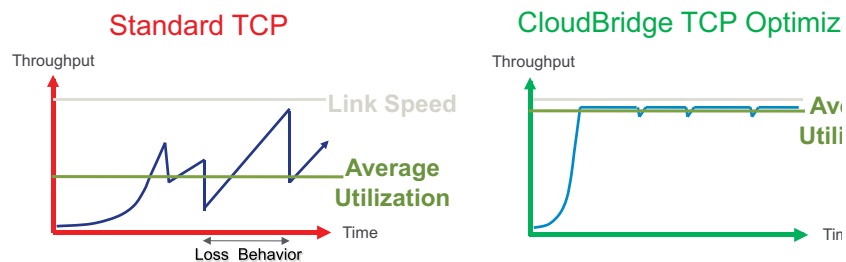
Figure 1: CloudBridge TCP optimization vs. standard TCP behavior

• **Data compression.** CloudBridge implements a high-performance compression engine to reduce the volume of data transferred on the wire.
• **Protocol acceleration.** SnapMirror is designed for data transfers over the WAN and is very efficient. But other protocols on the same link, such as CIFS or MAPI, could benefit significantly from protocol optimization. By acting as a local proxy, CloudBridge speeds up the information exchange and frees additional bandwidth that can be utilized for other critical data.
• **QoS.** CloudBridge implements deep application-level classification and prioritization of the link traffic that help enforce application-level SLAs. This allows SnapMirror replication to run in the background, not affecting business- critical applications. Figure 2 shows how a generic network link is made application aware with CloudBridge.
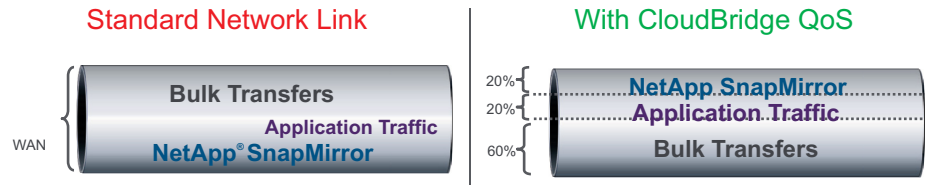
Figure 2: CloudBridge QoS vs. standard network link

Test setup and results

Figure 3 shows a test setup with NetApp FAS3270 filers running in ONTAP 7 mode in two data centers with a pair of CloudBridge 5000 appliances optimizing the replication. The test was conducted with a WAN simulator to model an OC3 link with a 50ms round trip delay, which is typical of coast-coast traffic in the United States. A sample 2GB SnapMirror volume transfer was tested with 0 percent loss and a low 0.01 percent loss on the network.
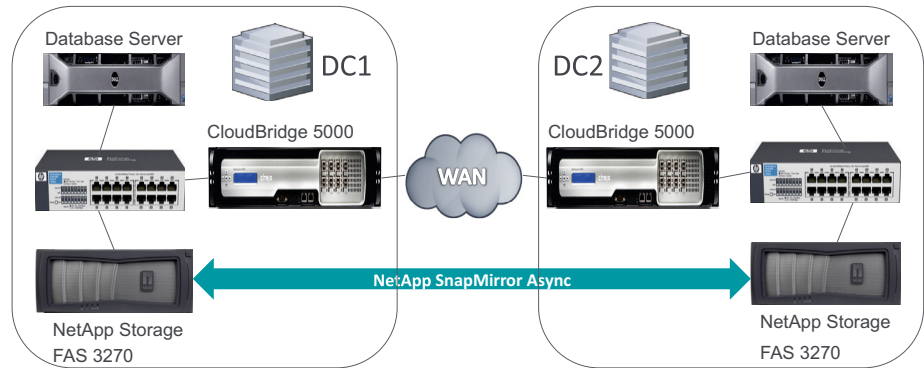

Figure 3: Test setup

The baseline transfer performance was benchmarked with zero loss and used recommended window sizing for SnapMirror, without network compression turned on. The test was repeated with CloudBridge introduced to further optimize the transfer. In this case, CloudBridge utilized network compression and the results showed a two-fold reduction in replication time. Next, the tests were repeated under 0.01 percent loss conditions. In this case, CloudBridge employed aggressive TCP re-transmit behavior and achieved a more dramatic 10-fold reduction in transfer time.
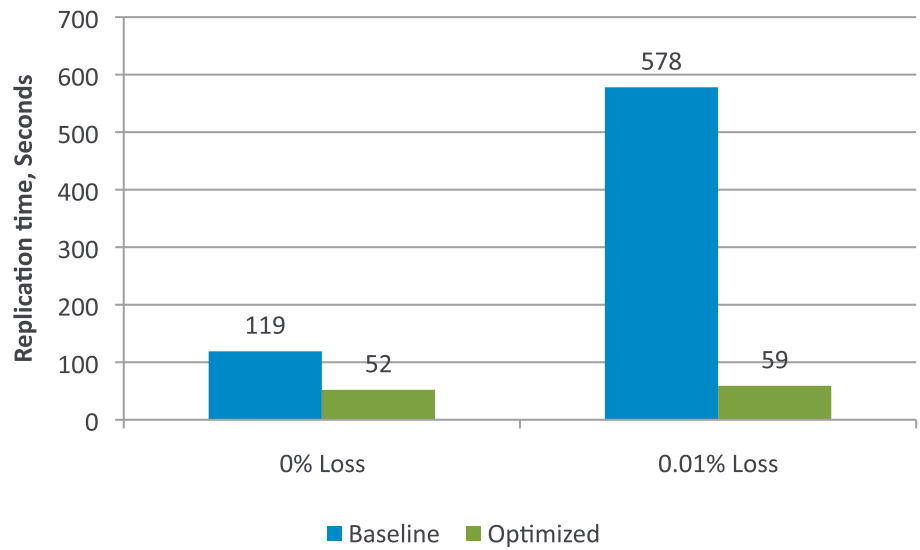
Figure 4: Replication time with and without CloudBridge

To determine the effect of built-in SnapMirror de-duplication, the tests were repeated with a 4GB volume, which was repeated four times to simulate data redundancy. This test setup had a 0.01 percent WAN packet loss. With de- duplication turned on, SnapMirror compressed the transfer to 1254MB and reduced replication time by three times. The addition of CloudBridge to this setup enabled further compression of the data and improved WAN utilization in the presence of packet loss. Combining SnapMirror de-duplication with CloudBridge compression and congestion management reduced replication time by more than 30 times.
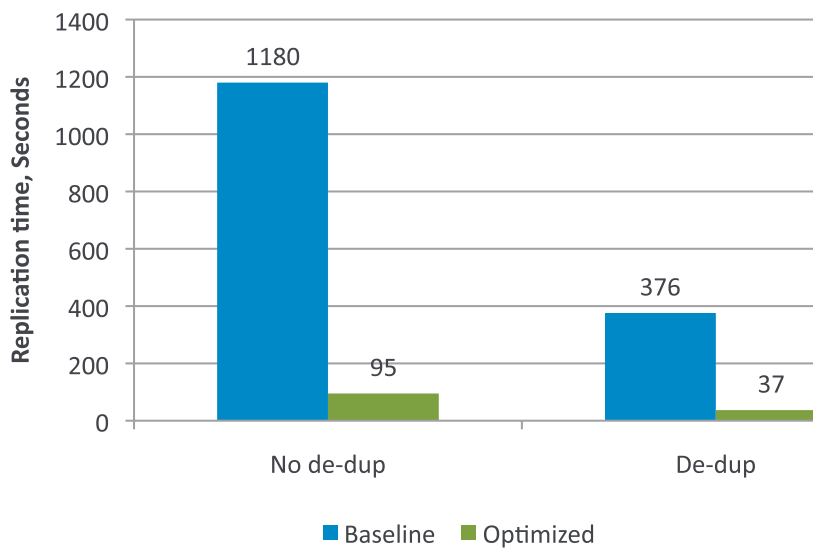

Figure 5: Using CloudBridge with NetApp de-duplication

Summary

SnapMirror provides data de-duplication and tools to adjust TCP window size to mitigate the effect of WAN latency. CloudBridge complements these technologies and further accelerates data replication by:

• Reducing the amount of data transferred
• Maximizing throughput on imperfect WAN links with a combination of loss and high latencies

In addition, by using deep application-level classification, prioritization and traffic shaping, CloudBridge can make the WAN link QoS aware and extend SnapMirror replication for continuous availability. Thanks to these acceleration and QoS benefits, adding CloudBridge to a disaster recovery solution can:

• Improve RPO by accelerating data replication and mitigating the effects of latency and packet loss
• Reduce WAN bandwidth required to meet RPO objectives
• Enable continuous replication by guaranteeing available bandwidth and prioritizing replication traffic

The net is that the CloudBridge appliance can provide a 10-fold improvement in NetApp SnapMirror replication times, along with a corresponding decrease in WAN bandwidth over SnapMirror alone in an optimal configuration. These advantages are on top of improvements from the NetApp internal optimization settings.

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