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IBM Spectrum Protect™: faster WAN replication and backups with PORTrockIT

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Executive summary

IBM Spectrum Protect™, previously known as IBM Tivoli Storage Manager or TSM, is the cornerstone of many large companies' data protection strategies, offering a wide range of backup and recovery options for all kinds of storage environments.

However, as companies increasingly see the value of backing up data from their main data centre to a remote site, IBM Spectrum Protect™ can run into difficulties. Moving large amounts of data across a wide area network (WAN) can be a slow process, especially when the distance between the two sites creates high levels of latency, and packet loss rates increase. And as transfer rates slow, it increases the risk of overrunning backup windows and affecting the performance of other business-critical systems.

This paper shows how PORTrockIT can solve the problem by significantly mitigating the effects of both latency and packet loss on IBM Spectrum Protect™ WAN backup and recovery jobs. Even in the most challenging scenario we tested, with 360ms of latency and 1% packet loss, PORTrockIT was able to complete backup jobs 210 times faster than a traditional network architecture.

PORTrockIT can help your business accelerate WAN backups with IBM Spectrum Protect™ – keeping your data properly protected, reducing the risk of disruption to your business, and helping to ensure that you get the full value from your investment in high-speed network infrastructure.

Why speed matters

Protecting enterprise data is a game that is played for high stakes. In particular, as the demand for real-time information and 24/7 services increases across all industries, the ability to back up and recover systems and data quickly becomes more and more valuable. By shrinking recovery time and recovery point objectives, companies can put themselves in a strong position to maintain seamless continuity even in the most challenging and unexpected disaster recovery situations.

IBM Spectrum Protect™ is a key part of many companies' data protection infrastructure, and offers many options for software-defined storage environments, including file, block and object-level data protection, incremental backups, VM replication, storage tiering, snapshots and data compression. However, the value of these advanced features cannot be fully realized if the network infrastructure fails to provide an adequate level of performance.

For example, IBM Spectrum Protect™'s compression features can help to accelerate backups by reducing the total amount of data that needs to be moved across a WAN, but this only works up to a point. Once the data is fully compressed, transfer rate across the WAN becomes the main limiting factor on backup performance – and if an acceptable transfer rate cannot be achieved, backup jobs will start to overrun the available backup window.

Overrunning backups are more than a technical issue for the IT department: they affect business users too. If overnight backup jobs spill over into working hours, users may find that transactional systems become less responsive and reporting jobs take much longer. This is because the backup job is still hogging network bandwidth, and the congestion reduces performance for all the other systems.

Moreover, if a backup job runs so slowly that it cannot be completed within a reasonable window, the only options are to back the data up less frequently, or to back up a smaller amount of data – both of which reduce the company's ability to protect its systems and data effectively, and create business risk.

So why does network infrastructure have such an impact on backup performance? And what can be done to address the issue?

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The problems: latency and packet loss

In general, there are two main issues that cause the majority of performance problems when backing up data across a wide area network (WAN).

The first is latency – the time delay between a system sending a packet across the WAN, and the target system receiving that packet. The main causes of latency are the physical distance that the packet has to travel, and the time taken to receive, queue and process packets at either end of the connection and at any intermediate gateways. The further the data has to travel, and the more gateways it has to pass through, the greater the latency.

For backup solutions that use the TCP/IP protocol – such as IBM Spectrum Protect™ – high latency can cripple transfer rates, even over a theoretically high-bandwidth WAN infrastructure. TCP/IP works by sending a group of packets, then waiting for an acknowledgement that the packets have been received before it sends the next group. If the latency of the connection is high, then the sender spends most of its time waiting for acknowledgements, rather than actually sending data. During these periods, the network is effectively idle, with no new data being transferred.

The second issue is packet loss – where a packet sent from a system on one side of the WAN never arrives at the system that is intended to receive it, or the acknowledgement from the recipient goes astray before it reaches the sender. When this happens, TCP/IP automatically reduces the number of packets it sends in the next group, to compensate for the unreliability of the connection. As a result, network utilisation is greatly reduced, because the sender is sending fewer packets in the same amount of time.

Organisations often try to solve TCP/IP performance issues by investing in more expensive network infrastructure that offers a larger maximum bandwidth. However, this does not fix the problem. As we have seen, latency and packet loss prevent TCP/IP connections from fully utilising the available bandwidth – so any extra investment in bandwidth will simply be wasted unless the latency and packet loss issues can be addressed.

The solution: PORTrockIT

PORTrockIT offers a solution to network latency issues. Instead of sending a group of packets down a single physical connection and waiting for a response, the solution creates a number of parallel virtual connections that send a constant stream of data across the physical connection.

As soon as a virtual connection has sent its packets and starts waiting for an acknowledgement from the recipient, PORTrockIT immediately opens another virtual connection and sends the next set of packets. Further connections are opened until the first connection receives its acknowledgement; this first connection is then used to send another set of packets, and the whole process repeats.

This parallelisation practically eliminates the effects of latency by ensuring that the physical connection is constantly transferring new packets from the sender to the recipient: there is no longer any idle time, and the network's bandwidth can be fully utilised.

The solution also significantly reduces the impact of packet loss. If one of the virtual connections loses a packet, TCP/IP will only reduce the number of packets in the next group sent by that specific virtual connection. All the other virtual connections continue to operate at full speed.

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Moreover, PORTrockIT is capable of optimizing the flow of data across the WAN in real time, even if network conditions change. The solution incorporates a number of artificial intelligence engines that continuously manage, control and configure multiple aspects of PORTrockIT – enabling the appliance to operate optimally at all times, without any need for input from a network administrator.

In practical terms, PORTrockIT is installed as a pair of appliances, deployed at either end of the WAN. The IBM Spectrum Protect™ client simply passes data to the PORTrockIT appliance on the near side of the WAN, which manages the virtual connections to the second PORTrockIT appliance on the far side of the WAN. Once the second PORTrockIT appliance begins receiving packets, it routes them seamlessly to the IBM Spectrum Protect™ server. The effect is simply much faster network transfer performance, without any need to make any changes to the rest of the network architecture.

Turning theory into practice

To demonstrate the kind of results that PORTrockIT can deliver for IBM Spectrum Protect™ customers, Bridgeworks conducted a set of performance tests at an independent testing facility in the UK. The test infrastructures mimicked a real-world IBM Spectrum Protect™ architecture, using a WANulator to simulate different levels of latency and packet loss between the client (the system that holds the data that needs to be backed up), and the server (the system that will receive the backed-up data).

The first set of tests were performed on an unaccelerated architecture, where the client and server were connected directly to the WANulator (see figure 1 overleaf). The same tests were then repeated on an architecture that was accelerated by introducing two PORTrockIT appliances, which sat either side of the WANulator, between the client and the server (see figure 2 overleaf).

Test equipment

Software:

- IBM Spectrum Protect™ Client 7.1.2.0
- IBM Spectrum Protect™ Server 6.3.5.0

Hardware:

- IBM Spectrum Protect™ Client
  - Windows Server 2012 R2 host
  - IBM System x3250, 4Gb RAM, Intel Xeon E31230 3.2GHz
- IBM Spectrum Protect™ Server
  - Windows Server 2012 R2 host
  - DELL R710, 8Gb RAM, 2x Intel Xeon E5506 2.13GHz, DELL SAS HBA
- 2 x PORTrockIT Nodes
- IBM Ultrium HH LTO5 SAS Tape Drive
- LTO 5 Tape
- WANulator host

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Figure 1: Unaccelerated infrastructure

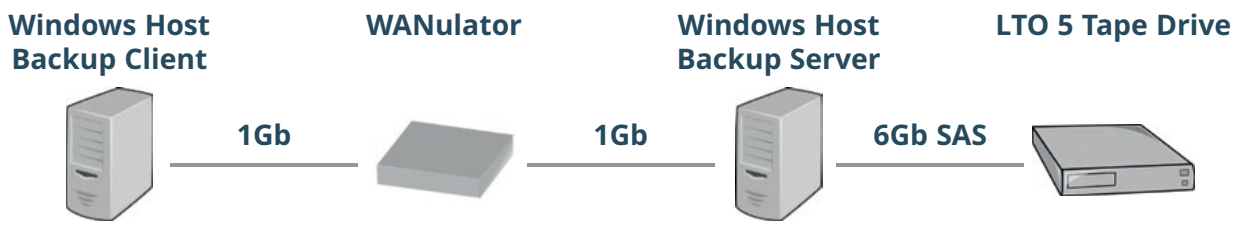

Figure 2: Accelerated infrastructure with PORTrockIT

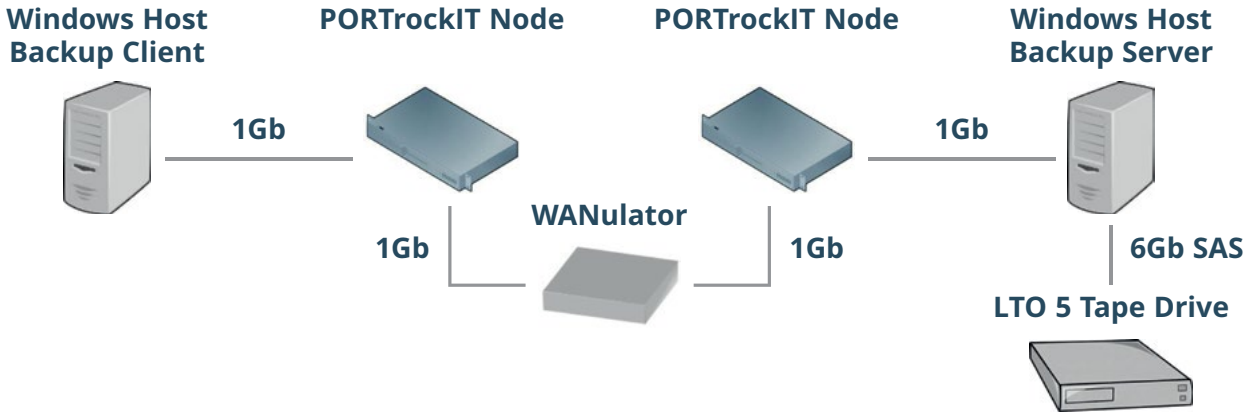

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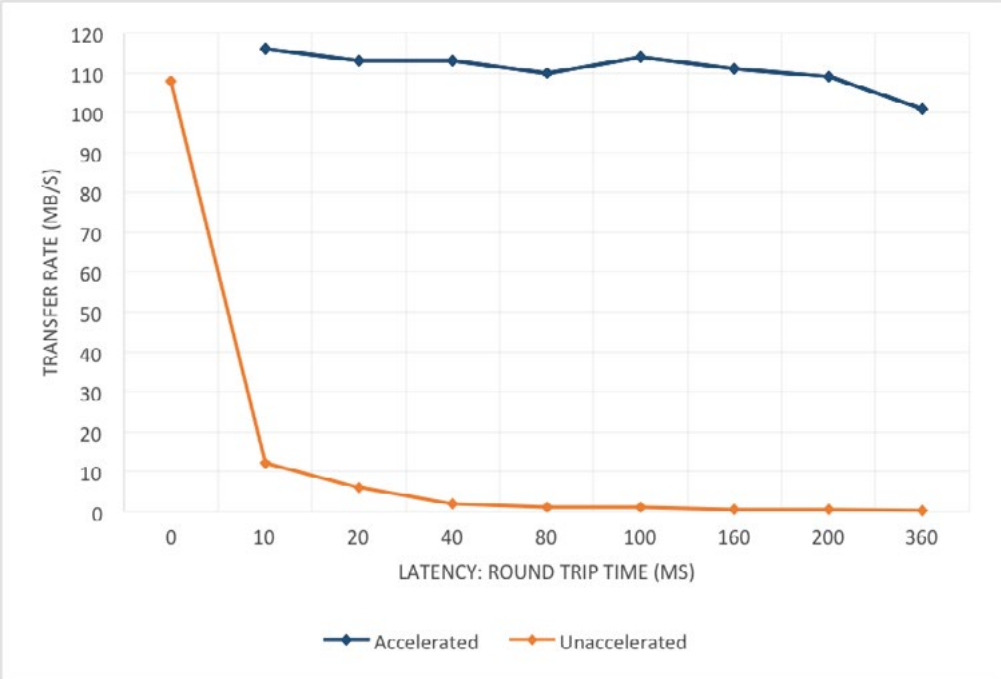
Figure 3: Accelerated and unaccelerated performance at various latencies with 0% packet loss



What the data tells us

Latency

The first test simulated a scenario with no packet loss, at latencies ranging from 0ms to 360ms round trip time (RTT). A 40GB data set was transferred from the backup client to the backup server, first via the unaccelerated architecture, and then again via the accelerated architecture with PORTrockIT. The data set was created using highly compressible data, to ensure that no adverse effects on performance would be introduced by the tape device.

(NOTE: Unlike WAN optimisation products which use compression or deduplication techniques to improve throughput, PORTrockIT transfers data as-is, without making any modifications. This means that PORTrockIT is able to accelerate deduped, compressed or encrypted data transfers to exactly the same extent as it accelerates as any other data type.)

Looking at Figure 3, the results show that performance on the unaccelerated architecture degraded significantly as soon as even small amount of latency were introduced. Even 10ms of latency reduced performance from 108MB/s to just 12MB/s, and when latency rose above 80ms, transfer rates dropped to just 1MB/s or below.

By contrast, the accelerated architecture with PORTrockIT provided a stable transfer rate of more than 100MB/s at all latencies. In the case of a network with 360ms of latency, the performance gain with PORTrockIT was 101MB/s – delivering a transfer rate more than 335 times faster than the unaccelerated architecture.

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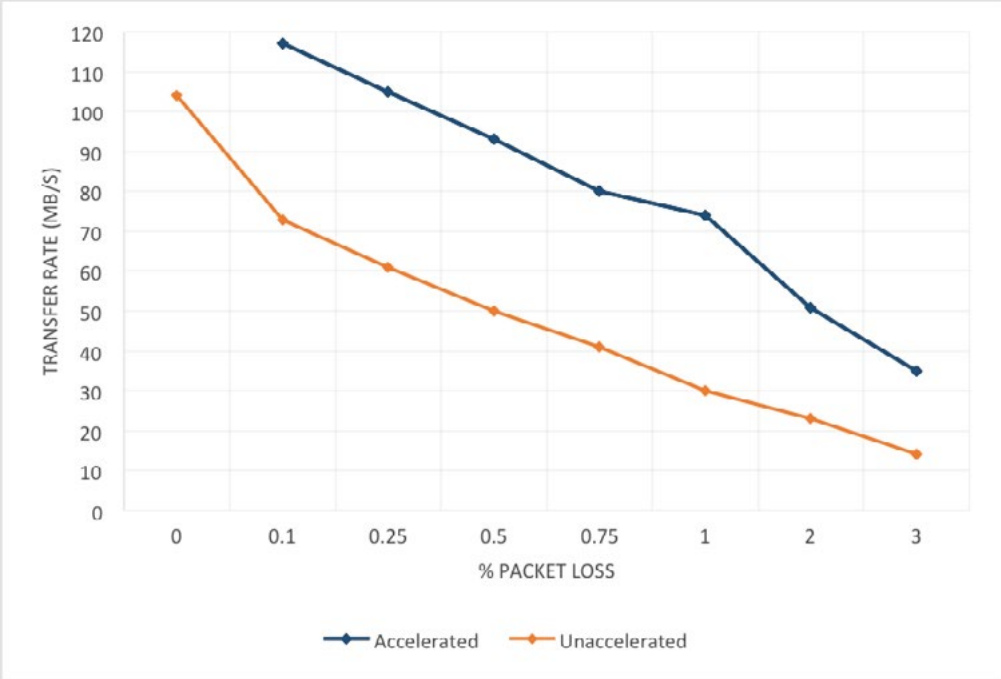
Packet loss

The second test investigated the performance of the two architectures on a network with zero latency, but with various levels of packet loss. Again, a highly compressible 40GB data set was transferred from the backup client to the backup server using both the unaccelerated and accelerated architectures.

From Figure 4, we can see that for both architectures, performance degrades as packet loss increases – but in all cases, performance is considerably higher with the accelerated architecture. Even in the extreme case of a network with 3% packet loss, the accelerated architecture still delivers a transfer rate of 35MB/s – more than twice as fast as the unaccelerated architecture.

Figure 4: Accelerated and unaccelerated performance at various levels of packet loss with zero latency



Combined effects of packet loss and latency

Finally, the team decided to test three different packet loss scenarios (0.1%, 0.5% and 1%) at various levels of latency. However, based on the results of the previous tests, Bridgeworks estimated that if it used a 40GB data set on the unaccelerated architecture, some individual tests would take more than 5 days to complete. This meant that testing all of the scenarios with a 40GB data set would take many months.

The team therefore decided to use two different data sets for the remaining tests: the same 40GB data set for tests on the accelerated architecture, but a smaller 1GB data set for the unaccelerated architecture. As before, both data sets contained highly compressible data, to avoid adverse effects from the tape drive.

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Figures 5, 6 and 7 all show that the unaccelerated architecture saw severe performance degradation from the combination of latency and packet loss. The impact of latency appears to be the main problem: although all three graphs show reasonable performance at 0ms of latency, as soon as it rises above 10ms, transfer rates instantly fall below 10MB/s.

In all three scenarios, the accelerated architecture performed considerably better. Figures 5 and 6 show that at low or moderate levels of packet loss, latency has minimal impact on performance until it reaches very high levels (200ms or above). Up until this point, PORTrockIT delivers transfer rates that are consistently higher than 100MB/s at 0.1% packet loss, and consistently higher than 90MB/s at 0.5% packet loss.

Figure 7 suggests that once the packet loss rate reaches 1%, PORTrockIT's performance does begin to degrade as the level of latency rises. However, even at higher latency levels, it is still many times faster than the unaccelerated infrastructure. Peak performance is at 40ms latency, where the PORTrockIT architecture achieves speeds of 110MB/s – more than 180 times faster than the unaccelerated architecture.

Even in the most challenging scenario (360ms of latency with 1% packet loss), the accelerated architecture achieved a transfer rate of 21MB/s. This is 210 times faster than the unaccelerated transfer rate of 0.1MB/s.

Figure 5: Accelerated and unaccelerated performance with 0.1% packet loss at various levels of latency

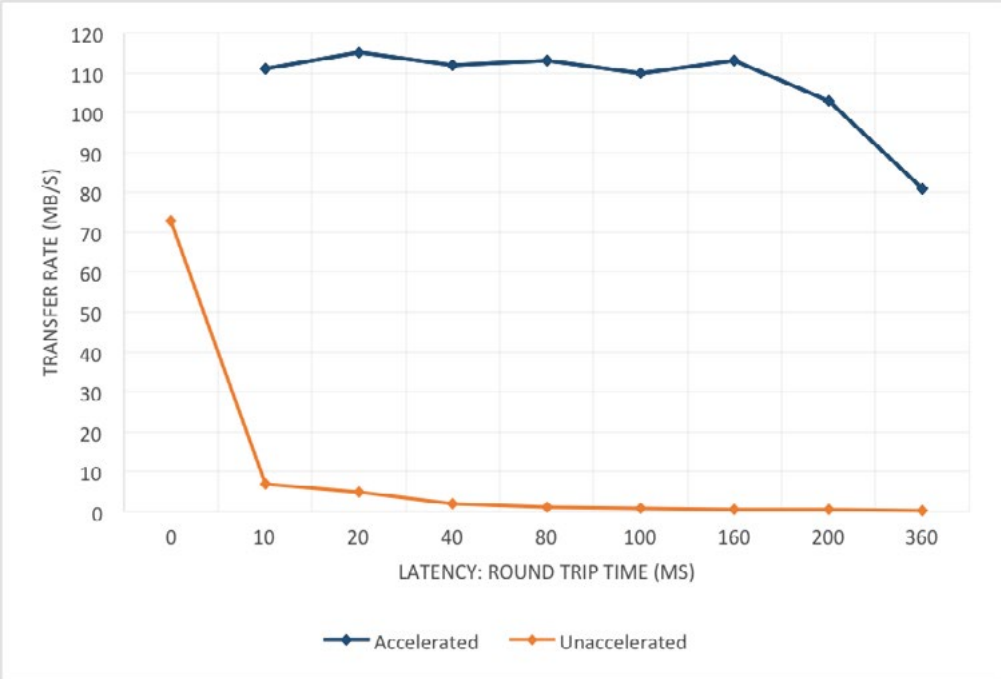

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Figure 6: Accelerated and unaccelerated performance with 0.5% packet loss at various levels of latency

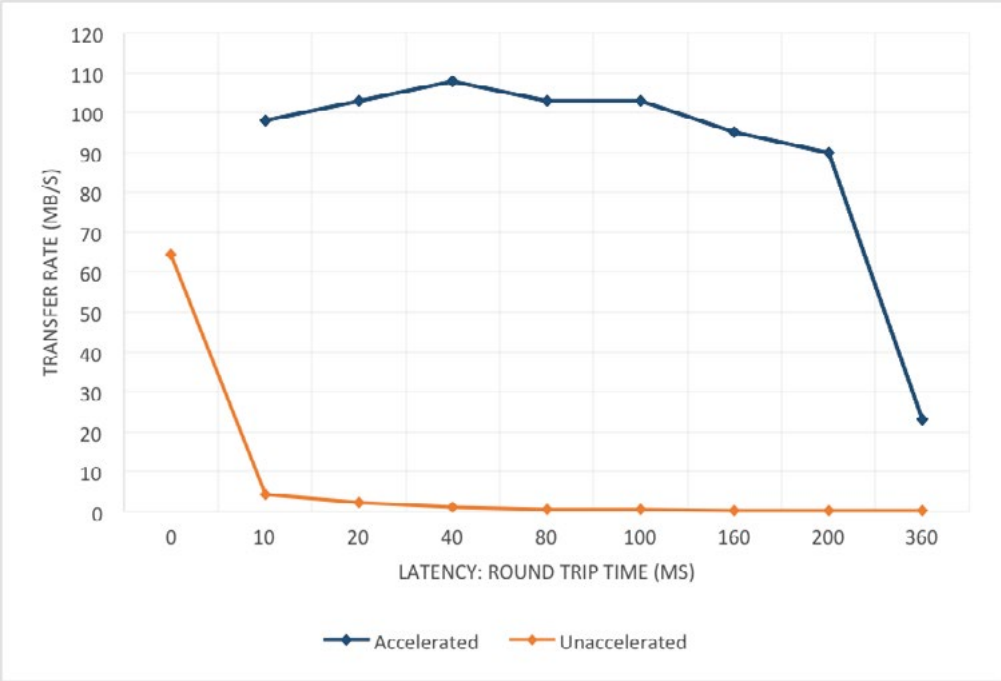
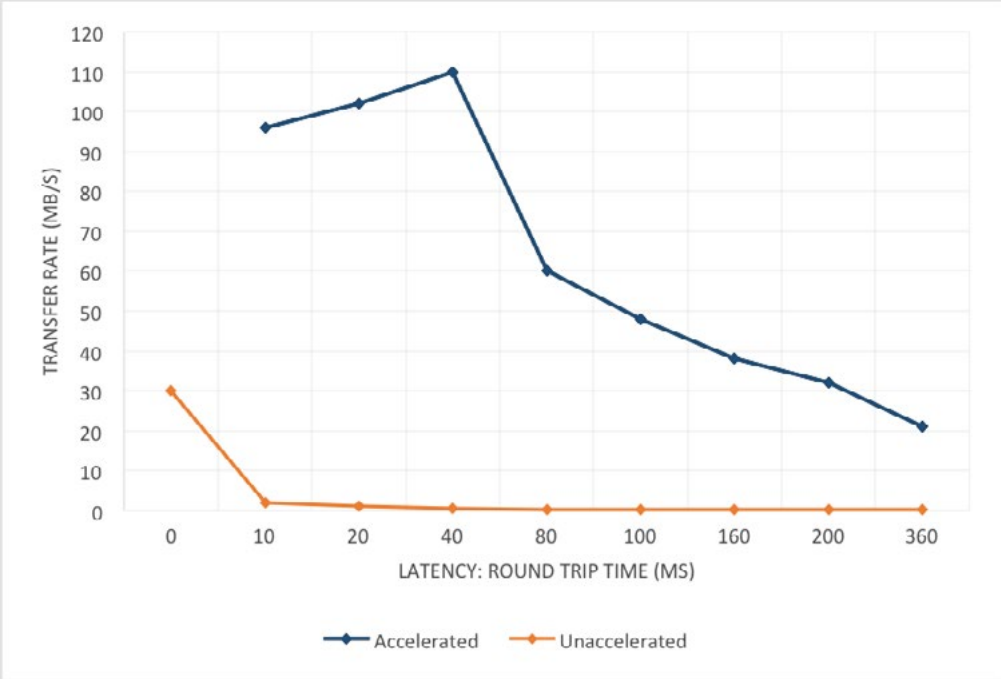


Figure 7: Accelerated and unaccelerated performance with 1% packet loss at various levels of latency



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Realising the business benefits

For companies that use IBM Spectrum Protect™ to manage WAN backup jobs, PORTrockIT can transform performance. If the backup process is threatening to overrun the available window, or if it is desirable to reduce backup times to free up server and network resources for other important jobs, PORTrockIT provides an elegant solution.

PORTrockIT offers plug-in-and-go technology that can be implemented quickly with minimal impact on the rest of your IT infrastructure – keeping deployment cost and risk to a minimum. By maximising the performance of existing infrastructure, PORTrockIT also reduces the need to invest in expensive high-bandwidth connections or more powerful backup servers – enabling significant cost-avoidance.

Most important of all, PORTrockIT removes the risk of relying on a backup infrastructure that is not fast, robust or reliable enough to keep your business-critical data adequately protected. By accelerating WAN data transfers, the solution empowers you to back up and recover data whenever the business needs it – not just when technical constraints allow it.

As a result, you can optimize your recovery time and recovery point objectives, keeping your systems and data protected and available when the business needs it, and delivering higher service levels to business users and customers.

Take the next steps

To learn more about PORTrockIT and other smart networking solutions from Bridgeworks, please visit www.4bridgeworks.com, or call us on +44 (0) 1202 588 588.

About the author

David Trossell has been part of the IT industry for over 30 years, working for infrastructure specialists such as Rediffusion, Norsk Data and Spectra Logic before joining Bridgeworks in 2000 as CEO/CTO. He is a recognised visionary in the storage technology industry, and has been instrumental in setting the company's strategic direction and developing its innovative range of solutions. David is the primary inventor behind Bridgeworks' intellectual property, and has authored or co-authored 16 international patents.

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