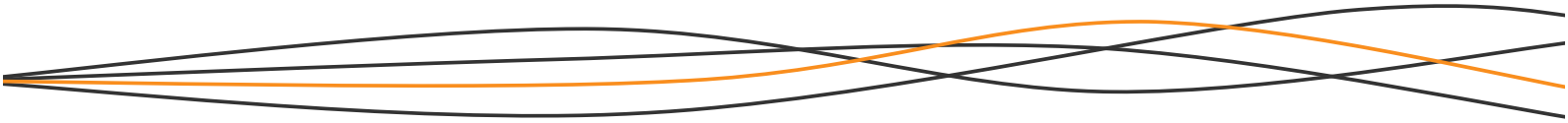
Turbo Charging WAN Optimization with WAN Virtualization



A Talari White Paper

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Introduction

WAN Virtualization is revolutionizing Enterprise Wide Area Network (WAN) economics, simultaneously enabling significant reductions in monthly operating WAN spending, much higher bandwidth and greater reliability and application performance predictability than what's available from a single MPLS WAN provider.

Talari's Adaptive Private Networking (APN) WAN Virtualization technology in particular does for Enterprise WANs what RAID did for storage – delivering a network with 30x – 100x bandwidth/$, monthly WAN costs reduced by 40% - 90%, and with greater reliability than existing private WANs using Frame Relay or MPLS.

In a carrier-pricing environment where a price/performance factor of 2x (50%) is enormous, WAN Virtualization brings Moore's Law and Internet economics to Enterprise WAN buyers for the first time in 15+ years. And a properly designed WAN Virtualization solution does this incrementally and seamlessly on top of existing networks – no forklift upgrades required.

WAN Virtualization is complementary to existing WAN Optimization solutions. While WAN Optimization can enable enterprise customers a one-time ability to avoid a bandwidth upgrade to their private MPLS network, where WAN Optimization really shines is as a means to do application acceleration.

This paper will show how, in addition to its other benefits, Talari's Adaptive Private Networking (APN) technology for WAN Virtualization also delivers application acceleration performance benefits, both on its own *and* in conjunction with WAN Optimization. We use file transfers – the most common network application, and certainly the one most commonly utilized and cross-comparable for measured benchmarking results – to demonstrate the benefits WAN Virtualization brings to application performance and performance predictability. All test results cited were created using Talari APN technology and technology from WAN Optimization market leader Riverbed Technology.

WAN Optimization delivers application acceleration for file transfers via three key mechanisms:

- CIFS termination
- Memory-based compression (for the first time a given file is transferred)
- Disk-based de-duplication

There are other WAN Opt techniques that have some effect, but these three are by far the most important.

WAN Virtualization delivers application acceleration for file transfers via two key mechanisms:

- Bandwidth aggregation
- Loss mitigation

WAN Virtualization also has other techniques that have some effect. For example, just as WAN Optimization does, WAN Virtualization uses TCP termination to accelerate TCP-based file transfers such as FTP. Talari's APN WAN Virtualization technology also does bottleneck bandwidth management and inbound congestion avoidance to ensure fewer packet drops and congestion at critical last mile links in the face of multiple simultaneous TCP flows, especially when those flows are coming from different locations on the WAN. But bandwidth aggregation and loss mitigation are the most important techniques for file transfers.

For this paper, Talari performed a number of tests, using its Mercury appliances and Riverbed Steelhead appliances. All tests were done with one of two 40 MB files, one compressible via memory-based compression at roughly a 2-to-1-compression ratio, and one not compressible.

The testing was for the most part done using Microsoft's CIFS protocol, while a few tests were done via FTP. The other key variables in the testing:

- Tests using Windows XP and Windows 7 client, server Operating Systems
- Tests with and without Talari and Riverbed appliances
- Riverbed testing done for both "cold" (first-time) transfers and "warm" (2nd and successive, de-duplicated) transfers

The results of the testing demonstrate that Talari's bandwidth aggregation and loss mitigation benefits each work in conjunction with Riverbed's WAN Optimization technology to provide multiplicative benefit in application acceleration.

Warm Transfers are Best

The first result of the testing [Figure 1] confirms what is intuitively obvious to most people, and borne out by customers' experience with WAN Optimization products. Namely, "warm transfers" – transfers where the data is already on the disk of the destination Steelhead appliance and can be de-duplicated – are the fastest transfers across the WAN possible. The bandwidth aggregation capabilities of APN are of little to no value in this case, which makes sense given that for a warm transfer, with the data available in a local appliance, bandwidth across the WAN is not the limiting factor.

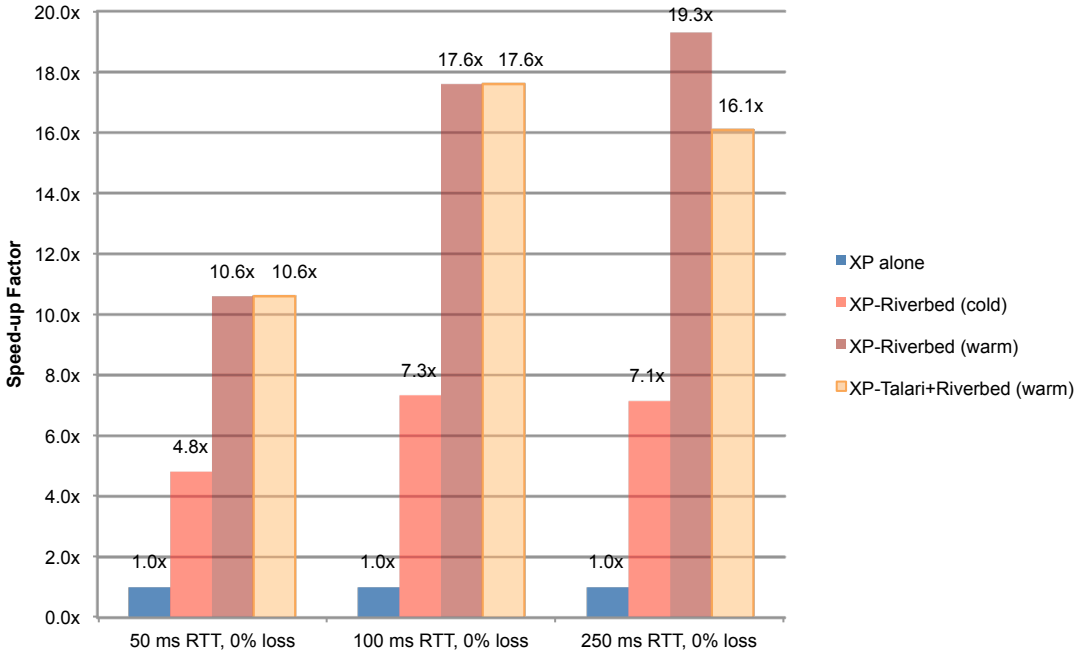

Figure 1 – Windows XP speed-up factors for a 40 Mbyte compressible file transfer when using Riverbed and Talari appliances

In the face of packet loss, Talari's APN WAN Virtualization solution provides some benefit for this "warm transfer" access. For XP, or under low loss, the benefit is not substantial. For Win 7 under high packet loss, especially when coupled with high latency (and in real life loss and latency usually do go together), the benefit can be substantial [Figures 2 through 5] – **4x** to **5x** *additional* speed-up in transfer time for warm transfers, as the Riverbed solution deals with packets going round trip across the WAN to verify that de-duplication can take place. For example, the transfer time is reduced from 97 seconds to 20 seconds for a 20 Mbps link at 250 milliseconds RTT and 5% loss.

While it's true that network conditions with loss as high as 5% are rare, it can and does happen occasionally, and delivering predictable application performance no matter the network conditions is a desirable thing, and a worthy goal for any WAN manager.

We'll talk much more about the benefits of loss mitigation for WAN application performance in the rest of the paper.

The key takeaway, of course, is that the only thing faster than "warm" file transfers would be truly local file access.

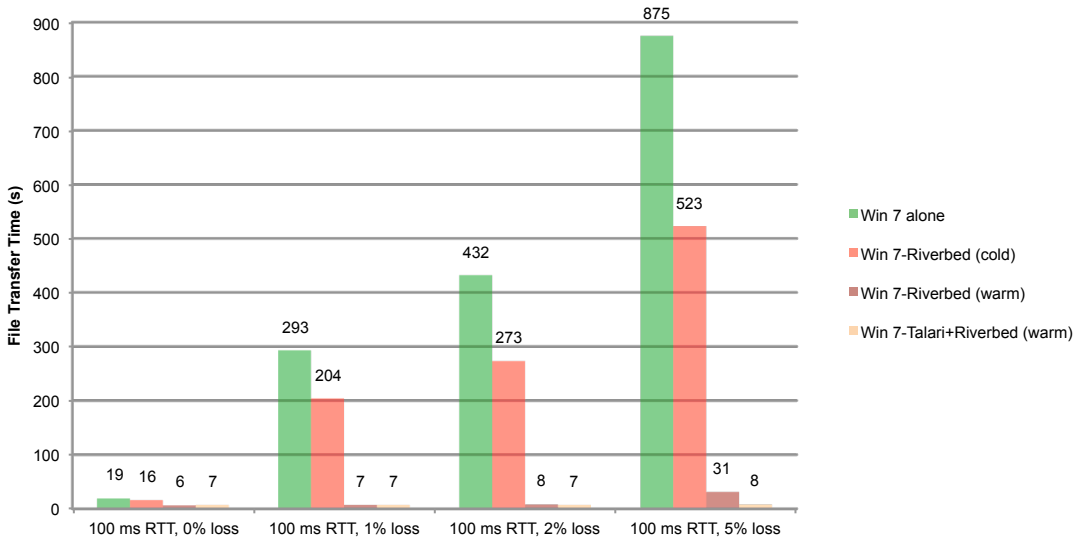

Figure 2 – Windows 7 file transfer times for a compressible 40 Mbyte file on a 20 Mbps link for different loss rates with 100 ms RTT when using Riverbed and Talari appliances

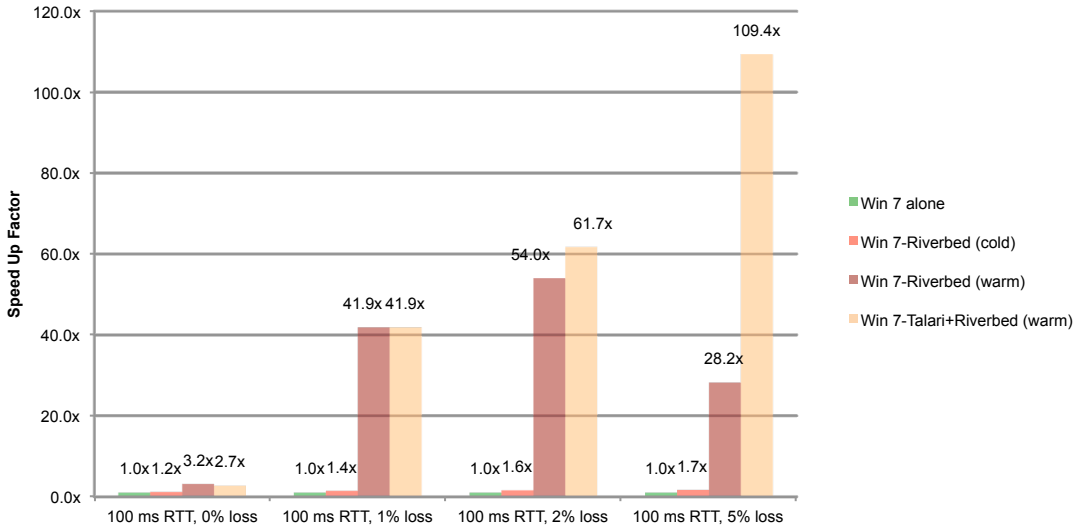

Figure 3 – Windows 7 file speed-up factors relative to Windows 7 alone for a compressible 40 Mbyte file on a 20 Mbps link for different loss rates with 100 ms RTT when using Riverbed and Talari appliances

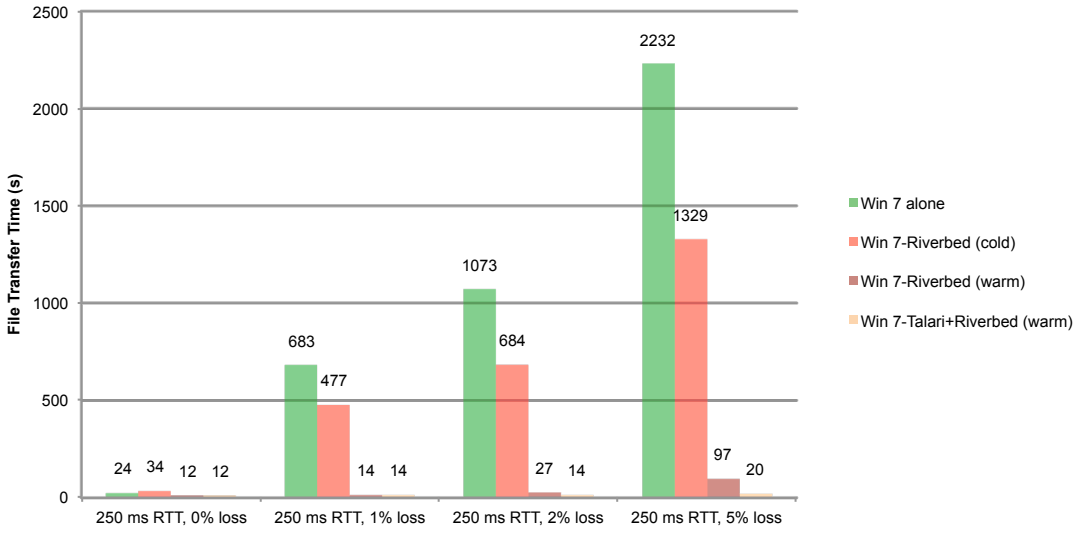

Figure 4 – Windows 7 file transfer times for a compressible 40 Mbyte file on a 20 Mbps link for different loss rates with 250 ms RTT when using Riverbed and Talari appliances

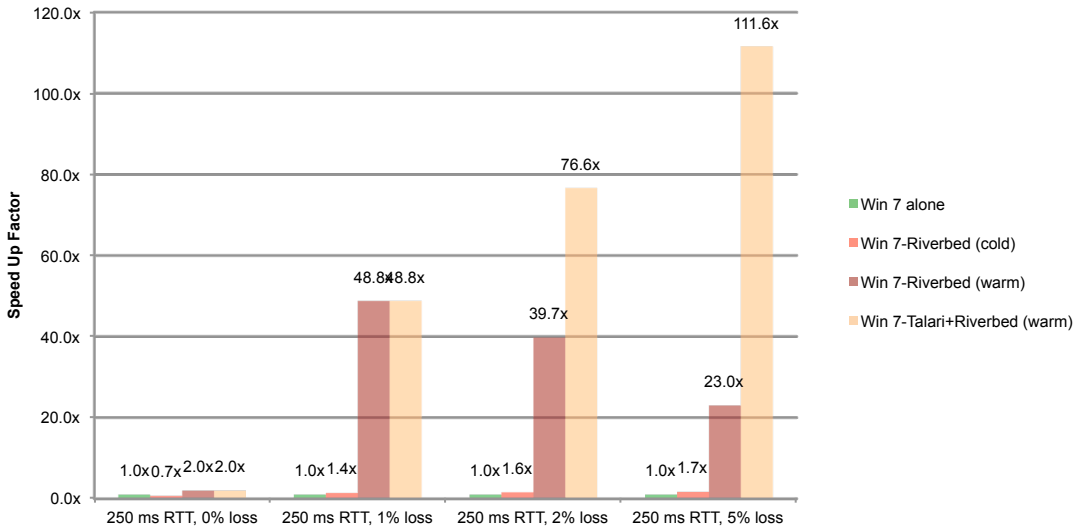

Figure 5 – Windows 7 file speed-up factors relative to Windows 7 alone for a compressible 40 Mbyte file on a 20 Mbps link for different loss rates with 250 ms RTT when using Riverbed and Talari appliances

One interesting comparison is to look at the transfer time at 50 and 100 ms RTT under 5% loss conditions across permutations of XP and Win 7, with and without Steelhead (warm and cold), and with and without Talari [Figures 6 and 7]. The combination of Win 7, Steelhead (warm transfer) and Talari delivers file transfer speed-up of over **175x** and **190x** respectively – 5 seconds versus 885 seconds and 8 seconds versus 1543 seconds (over 25 minutes) for our 40 MB file! In other words, more than two orders of magnitude improvement even under what is considered very poor network conditions.

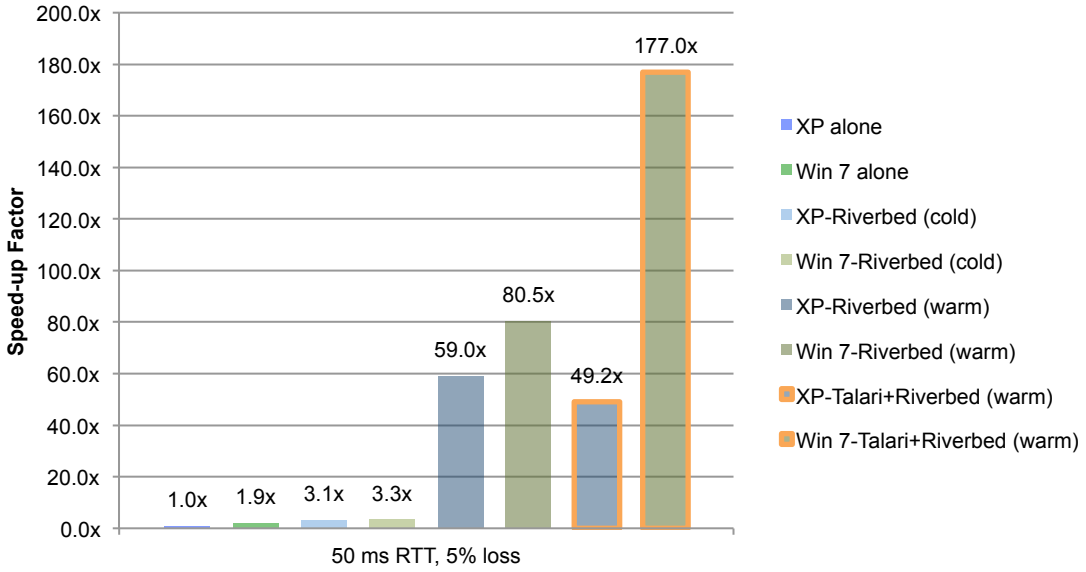

Figure 6 – Windows XP and Windows 7 speed-up factors relative to Windows XP alone for a 40 Mbyte compressible file transfer for variety of combinations of Riverbed and Talari appliances with 50ms RTT and 5% loss

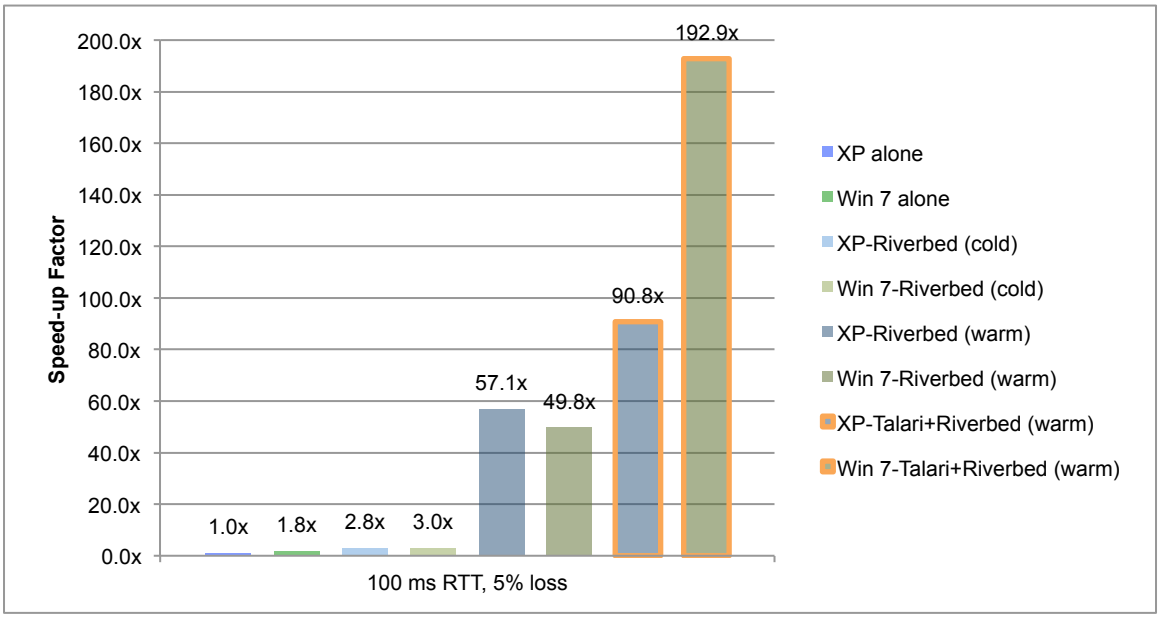

Figure 7 – Windows XP and Windows 7 speed-up factors relative to Windows XP alone for a 40 Mbyte compressible file transfer for variety of combinations of Riverbed and Talari appliances with 100 ms RTT and 5% loss

Adding bandwidth for first-time transfers

While it's true that the best performance is for "warm transfers" - files accessed a second or successive time at a given WAN location with little or no change to the file in question – the reality of application use on networks is that very frequently the file never has been accessed at that location. And so the rest of this paper looks at performance for these so-called "cold", first-time transfers, and the benefits that WAN Virtualization's bandwidth aggregation and loss mitigation capabilities bring. We look first at the benefits of bandwidth aggregation.

Windows 7 vs. Windows XP on the WAN

While this paper is about how WAN Virtualization complements WAN Optimization in delivering application acceleration, it's worth noting that Win 7 provides substantial benefits over XP for WAN access in general, and file transfers using the CIFS protocol in particular. Microsoft has improved CIFS performance on the WAN across the board. In the face of packet loss, Win 7 CIFS is substantially better than XP, but performance under zero packet loss conditions is spectacularly better. See the Talari white paper ***'Does Windows 7 Hold the Key to Building a Faster WAN?'*** for more details here.

As these charts [Figures 8 and 9] show, adding bandwidth improves performance when there is no WAN packet loss almost proportional to the additional bandwidth available.

For each latency figure, the first 2 measurements are using only a T1 WAN connection – i.e. what a typical branch will have with an MPLS WAN. For this compressible file, you can see that Riverbed improves performances by a little more than **2x** for 50 ms RTT, **~2.5x** for 100 ms RTT, and a little more than **3x** for 250 ms RTT. Riverbed's performance speed-up for XP is somewhat greater than for Win 7.

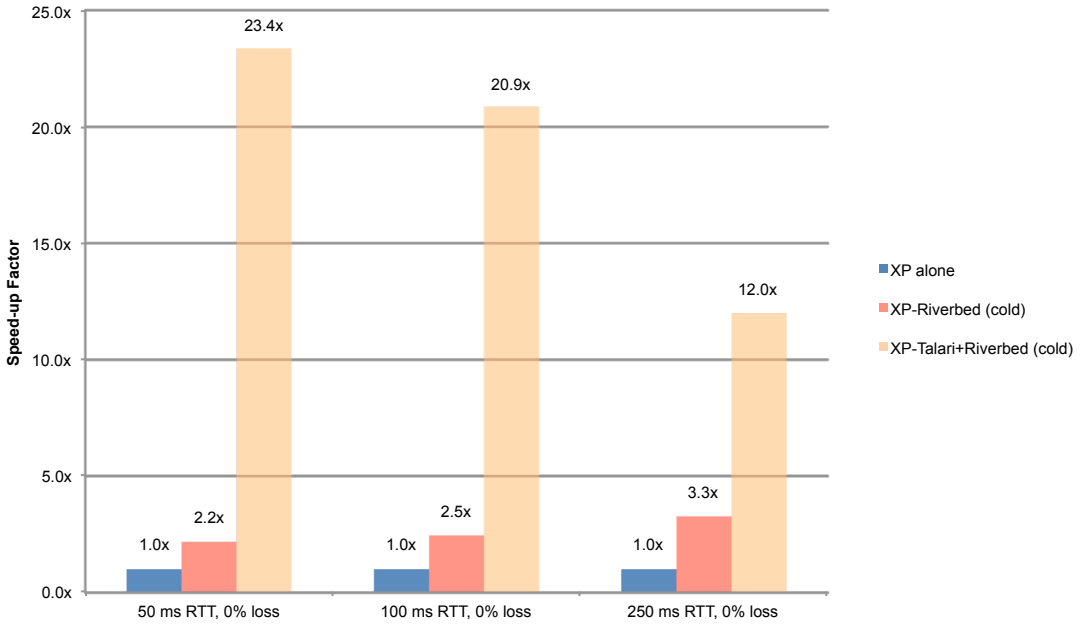

Figure 8 – Windows XP speed-up factor relative to Windows XP alone for a 40 Mbyte compressible file transfer when comparing a 1.5 Mbps link versus a 1.5 Mbps combined with a 20 Mbps link using Talari APN appliances

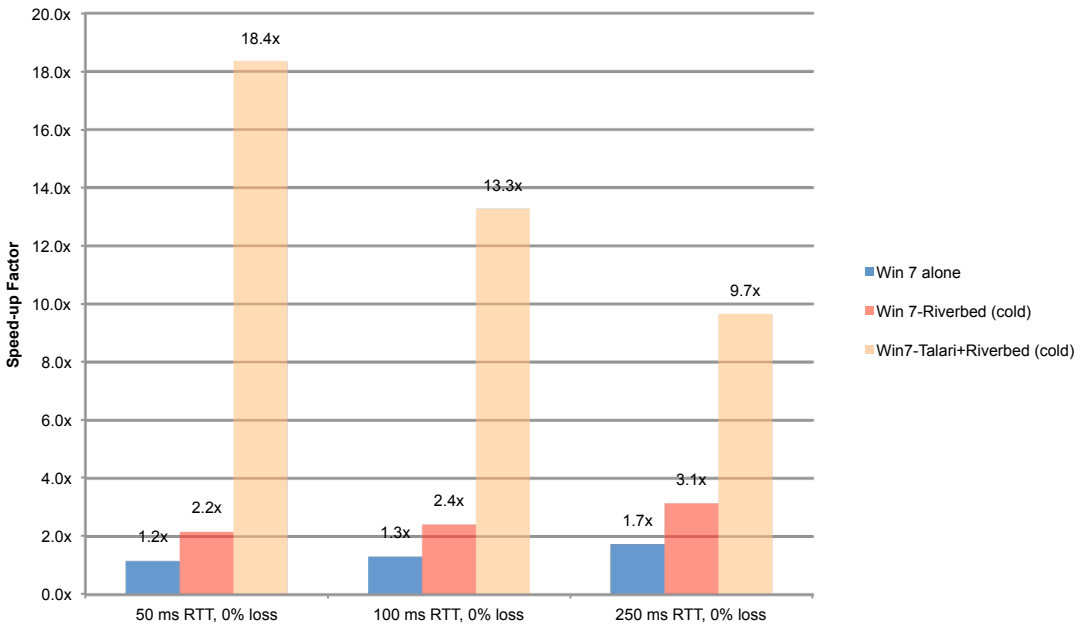

Figure 9 – Windows 7 speed-up factor relative to Windows XP alone for a 40 Mbyte compressible file transfer when comparing a 1.5 Mbps link versus a 1.5 Mbps combined with a 20 Mbps link using Talari APN appliances

For the measurements where the Talari WAN Virtualization appliances are added, there is also a 20 Mbps broadband link available for the branch site, as well as a high-speed Internet pipe at the data center site. Leveraging this additional Internet bandwidth, we see overall performance speed-ups of anywhere from **9.7x** to **23.4x**

versus XP alone on a 1.5 Mbps link from this addition of approximately **13x** additional bandwidth. The speed-up factor is greater for lower latencies, and is greater for XP than for Win 7 – again, as Riverbed does a somewhat better job speeding up XP CIFS performance than it does Win 7 performance. In comparing the performance of Riverbed acceleration without Talari and Riverbed acceleration augmented by APN's bandwidth aggregation capability, we see that WAN Virtualization here delivers additional speed-ups of **3x** to **4x** at 250 ms all the way up to speed-ups of **8.5x** to almost **11x** at lower latencies.

We see similar results using a non-compressible file [Figures 10 and 11].

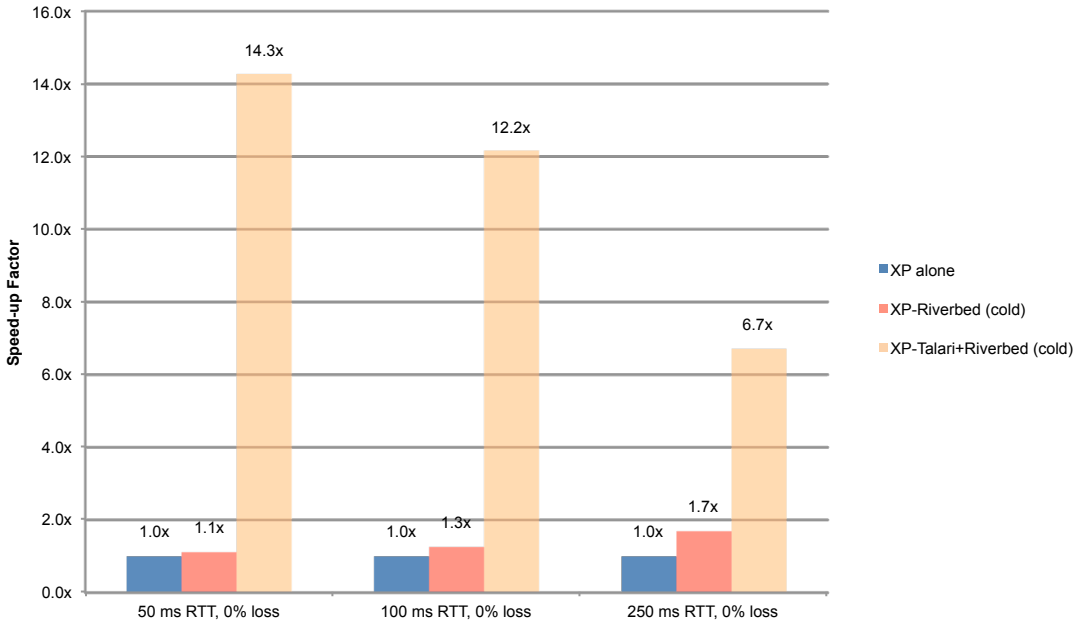

Figure 10 – Windows XP speed-up factor relative to Windows XP alone for a 40 Mbyte non-compressible file transfer when comparing a 1.5 Mbps link versus a 1.5 Mbps combined with a 20 Mbps link using Talari APN appliances

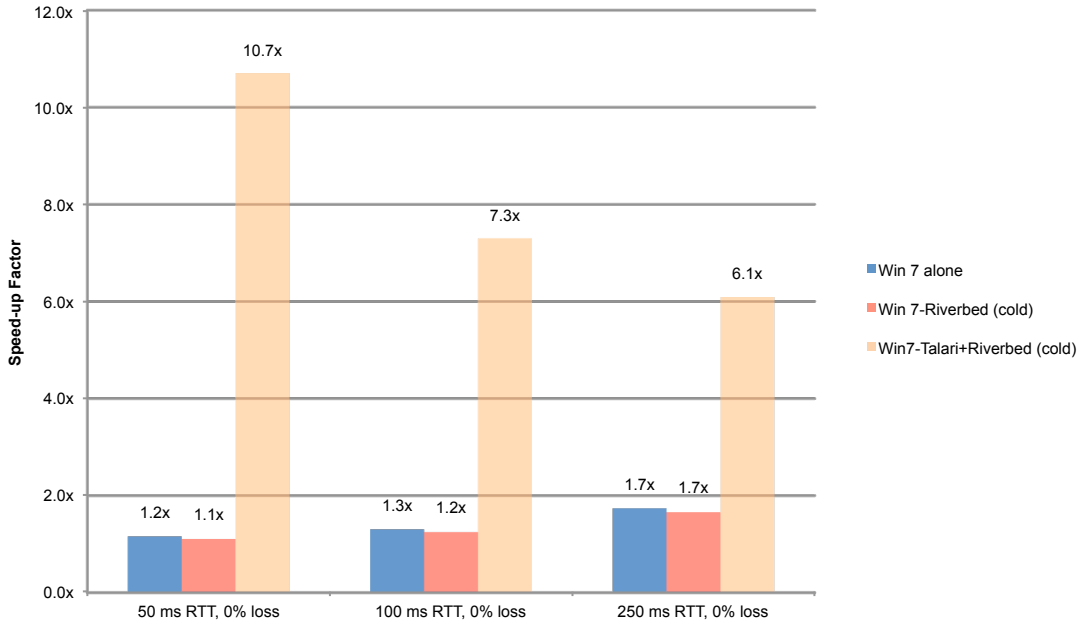

Figure 11 – Windows 7 speed-up factor relative to Windows XP alone for a 40 Mbyte non-compressible file transfer when comparing a 1.5 Mbps link versus a 1.5 Mbps combined with a 20 Mbps link using Talari APN appliances

For the non-compressible file, you can see that Riverbed alone improves performance of this first time transfer very little at the lower latencies, and **~1.7x** at 250 ms latency. When adding Talari to the mix, while the combined overall performance speed-ups are lower than for the compressible file, the relative benefit that addition of the Talari bandwidth aggregation delivers compared to the performance of Riverbed acceleration alone is even greater, as we see the speed-ups due to the bandwidth aggregation at 50 ms of **9.7x** and almost **13x**.

Mitigating the effects of loss

As you would intuitively expect, adding bandwidth improves the performance of large file transfers. But most corporate WANs today don't use Internet connections for intranet traffic for anything other than backup connectivity, due to the unpredictable performance resulting from the not infrequent episodes of congestion (loss and jitter/high latency) that occur on the public Internet. Talari's WAN Virtualization technology enables you to safely take advantage of inexpensive Internet bandwidth to augment (or even replace) MPLS bandwidth. One of the primary techniques to do this safely is loss mitigation.

By hiding loss from the application, while simultaneously ensuring that WAN links are used efficiently (more efficiently than TCP itself will, in fact), WAN Virtualization can deliver greater performance under loss, even with only a single active link.

The following charts [Figures 12 through 15] show this advantage under varying loss conditions for XP and Win 7, respectively. As you can see from the charts, Talari's WAN Virtualization technology working together with WAN Optimization – again, all of these are "cold" transfers – delivers very predictable performance in the face of loss, with huge speed-up factors versus what XP or Win 7 alone, or WAN Optimization without Talari's WAN Virtualization, can do.

Figures 12 and 14 show file transfer times in seconds; lower numbers are better. The near flat orange lines for the combination of Riverbed and Talari in each case shows how WAN Virtualization delivers excellent, predictable performance even in the face of loss which slows performance in non-WAN Virtualization environments to a crawl.

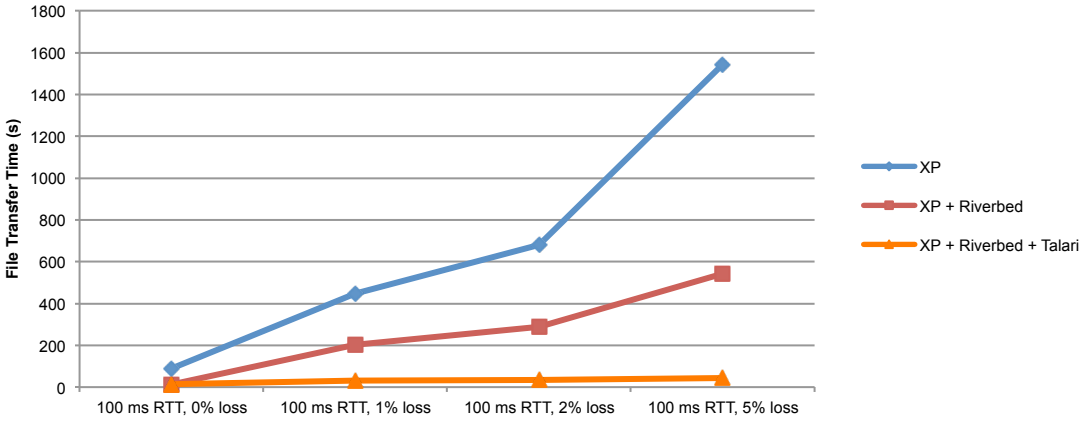

Figure 12 – Windows XP file transfer time for a 40 Mbyte compressible file on a single 20 Mbps link for different loss rates with 100 ms RTT when using Riverbed (cold) and Talari appliances

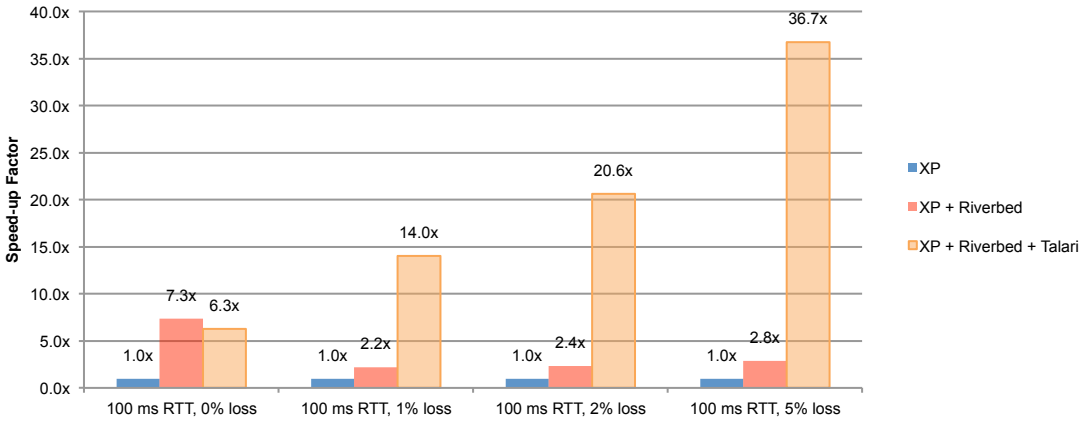

Figure 13 – Windows XP file speed-up factor relative to Windows XP alone for a 40 Mbyte compressible file on a single 20 Mbps link for different loss rates with 100 ms RTT when using Riverbed (cold) and Talari appliances

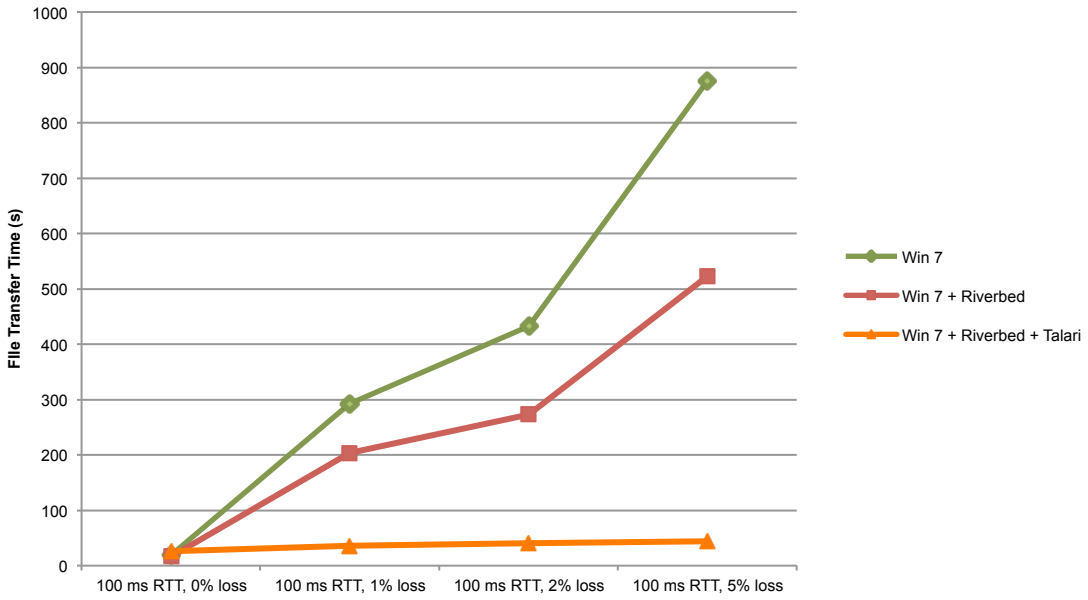

Figure 14 – Windows 7 file transfer time for a 40 Mbyte compressible file on a single 20 Mbps link for different loss rates with 100 ms RTT when using Riverbed (cold) and Talari appliances

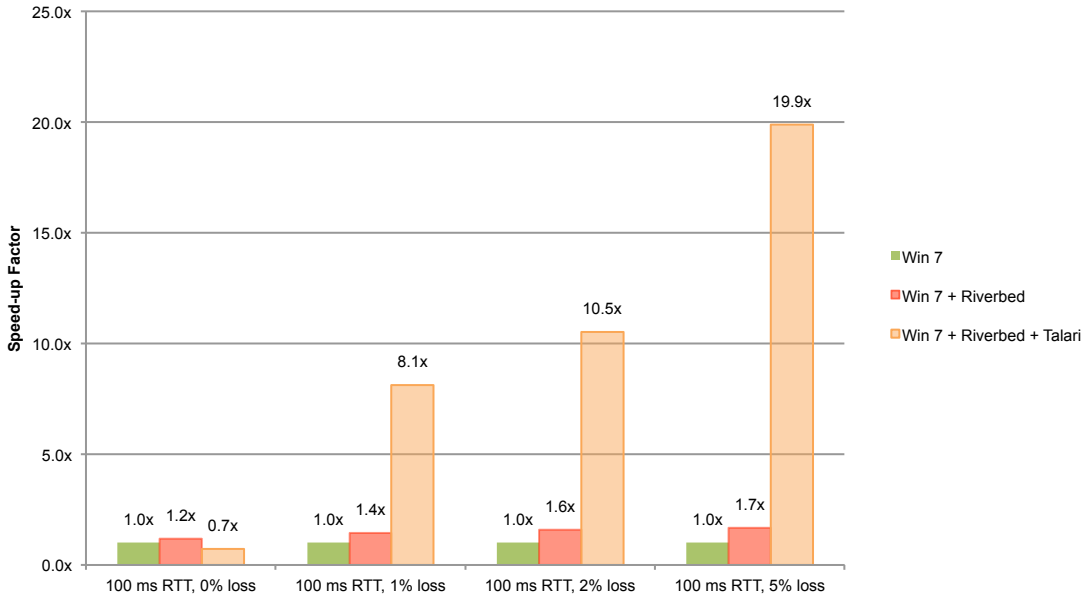

Figure 15 – Windows 7 file speed-up factor relative to Windows 7 alone for a 40 Mbyte compressible file on a single 20 Mbps link for different loss rates with 100 ms RTT when using Riverbed (cold) and Talari appliances

As can be seen from the charts, Riverbed's CIFS termination capability improves performance somewhat under loss – **2.2x** to **2.8x** for XP, and **1.4x** to **1.7x** for Win 7 – but adding Talari's loss mitigation capability to the mix delivers **14x** to **37x** speed-up for XP, and **8x** to **20x** improvements for Win 7. This means that WAN Virtualization is accelerating the performance of WAN Optimization under loss by **6x** to **13x** for XP, and **~6x** to **12x** for Win 7.

As noted earlier, while high loss is not a common occurrence, it does happen some small percentage of the time depending on your WAN and your network locations, and the ability to deliver predictable application performance no matter the network conditions not only enables the ability to take advantage of the diversity, scalability and lower cost which leveraging Internet bandwidth brings, but also means that end users experience fewer performance problems with WAN applications than they would with a non-WAN Virtualization solution using only expensive MPLS connections.

Loss mitigation and bandwidth aggregation together

APN's loss mitigation and bandwidth aggregation capabilities do work together. While they generally do not work multiplicatively in conjunction with traffic being accelerated by WAN Optimization, you will in all cases see a large benefit over having no WAN Virtualization, or WAN Optimization at all. Comparing the results shown in Figure 16 to the corresponding equivalent in Figure 15 shows that for this particular case, the speed-up benefits, while large, are somewhat less under loss than if there were only a single 20 Mbps link – **6.4x** vs **8.1x**, **10.2x** vs. **10.5x** and **17.5x** vs. **19.9x** for 1%, 2% and 5% loss, respectively.

This is because when adding a relatively small 1.5 Mbps link to the bandwidth of a 20 Mbps link (which is what comparing the results in Figures 15 and 16 is essentially doing) it's difficult to take advantage of the extra bandwidth when ***all*** network connections are experiencing meaningful packet loss. Such a situation - with high loss simultaneously across all links - will almost never occur in real life. And if comparing the results, say, for two 10 Mbps links versus one under loss, then the two link case *would* show higher performance than the single link case – even if the bandwidth aggregation benefit and loss mitigation benefit of WAN Virtualization used in conjunction with WAN Optimization might not be *fully* multiplicative.

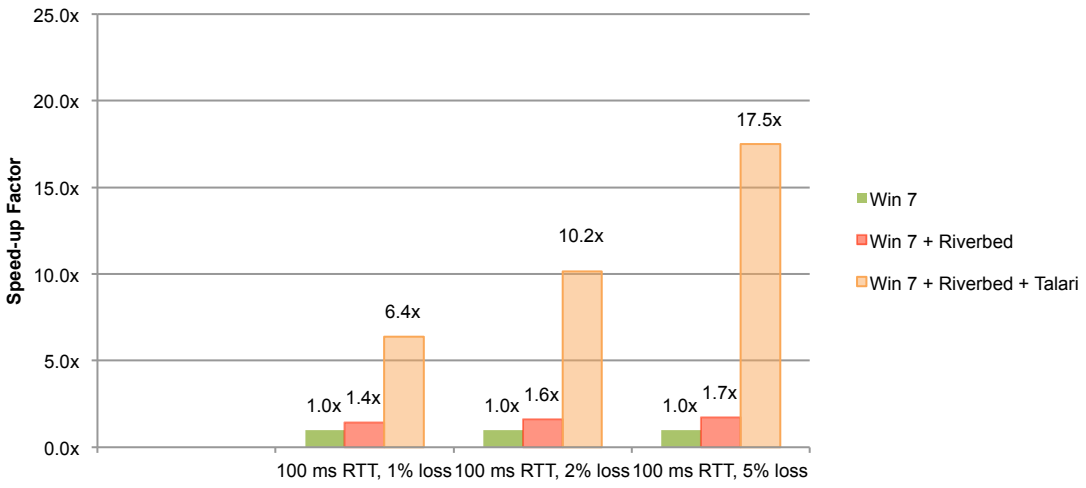

Figure 16 – Windows 7 file speed-up factor relative to Windows 7 alone for a 40 Mbyte compressible file on a 1.5 Mbps plus a 20 Mbps links for different loss rates with 100 ms RTT when using Riverbed (cold) and Talari appliances

WAN Virtualization's loss mitigation and bandwidth aggregation capabilities when used with Win 7 alone generally ***are*** multiplicative; see ***'Does Windows 7 Hold the Key to Building a Faster WAN?'*** white paper for more details.

In real life, the benefits of the combination of WAN Optimization and WAN Virtualization techniques under network loss are actually ***greater*** than suggested by the tests shown in this white paper, since WAN Virtualization will quickly switch traffic away from a path observing sustained loss, putting it on one that is not currently experiencing high loss. Loss mitigation is good, but loss avoidance is even better. While avoiding the affects of loss (and jitter) is often less of an issue for large file transfers, it is an especially important issue for interactive applications like VDI or web application access with complex pages. Talari's WAN Virtualization solution does that optimization, including across the set of bulk and interactive flows, automatically.

Conclusion

The results of the testing demonstrate that the bandwidth aggregation and loss mitigation benefits of WAN virtualization using APN each work in conjunction with Riverbed's WAN Optimization technology to provide multiplicative benefit in application acceleration.

While "warm" transfers are almost always the fastest possible transfer across the WAN, since only some of the time will any given file or chunk of data have already been seen at a given location on a WAN when a user requests it, for maximum performance and especially performance predictability it is critical to be able to speed up "cold" transfers as well.

APN's bandwidth aggregation capability improves first time transfers by almost as much as the additional bandwidth enabled, whether in conjunction with Riverbed WAN Optimization or on its own.

APN's loss mitigation helps first time transfers quite a bit for Windows XP users, and helps **hugely** for Windows 7 users or for TCP-based transfers like FTP using any operating system.

If you're interested in the application acceleration benefits that Talari's WAN Virtualization solution can bring to your network, visit http://www.talari.com for more information and contact information. For access to the raw test data used in this paper please send your request via email to info(at)talari.com.