Introduction

Gigabit broadband is in the midst of making the transition from science experiment to broadly available service. In recent years, 1 Gbit/s service has been limited to a few service providers targeting a few lucky houses in a few trial communities, but now we are hearing with increasing frequency from an array of different broadband service providers that either have already launched Gigabit access, are getting ready to launch in new markets, or are planning expansion strategies for existing markets.

The move to 1 Gbit/s, or even faster (a few service providers are already testing residential offerings up to 10 Gbit/s) represents a major leap for customers, and resets the broadband market stage for a new era of competition between service providers. After many years of battling over who could get to the home or business first with hundreds of kbit/s, and then dozens of Mbit/s, and more recently 100 Mbit/s or more, service providers in many cases are set to offer exponential increases in the broadband speeds they currently offer their customers.

According to the Speedtest.net by Ookla website, at the end of 2015 the fastest average downstream speed provided by a broadband service provider was 104.56 Mbit/s from Comcast’s Xfinity Internet offering. Also in December 2015, Akamai’s “State of the Internet” report showed that the average peak broadband speed in the U.S. was 57.3 Mbit/s.

While those averages may seem unimpressive, and still have a long way to grow, it is clear that service providers are trying their best to raise the bar much higher – the number from the Akamai report, for example, was 18% higher than a year earlier. In some cases, providers have taken incremental steps to higher speeds (Comcast, for example, stepped up from its 250 Mbit/s plan to offer a 505 Mbit/s service in some markets), while a growing portion of the market is starting to make a much bigger jump – from 100 Mbit/s or less up toward 1 Gbit/s.

No single service provider has done more to help speed up broadband speeds than Google, whose Google Fiber 1 Gbit/s offering has caused other service providers to rethink their broadband access strategies. In the roughly three years since Google Fiber began connecting its first customers in Kansas City, Kan., with access capable of 1 Gbit/s, numerous other service providers and individual communities acting on their own have thrown their hats into the Gigabit broadband ring (see Figure 1, next page).

The “Google effect” has made an impact on markets all around the U.S., and has driven service providers of all shapes and sizes – not only the biggest ones, such as AT&T and Comcast, but also smaller independents, such as Grande Communications in Texas and Comporium in North Carolina – to join the Gigabit broadband race.

There are even a handful of markets that already feature competition between two or more service providers offering broadband access up to 1 Gbit/s, including Atlanta; Austin, Tex.; Omaha, Neb., and others. Though Gigabit broadband rollouts remain in their very earliest phases, it is already becoming clear that no single service provider will have one market’s Gigabit broadband claims all to itself for very long. Just as service providers went head to head at previous broadband speed thresholds such as 25 Mbit/s and 50 Mbit/s, so they will vie for customers’ attentions at 1 Gbit/s.
The fast-developing market isn’t just limited to 1 Gbit/s offerings either; many service providers have offered Gigabit-plus service to businesses for many years. More recently, a few service providers have begun rollout of Gigabit-plus broadband access up to 10 Gbit/s for residential users. During the second half of 2015 alone, municipally-owned service providers in Salisbury, N.C., and Chattanooga, Tenn., both staked claims to having the first 10 Gbit/s communities in service, and in Detroit, Rocket Fiber appeared set to roll out 10 Gbit/s to a portion of its market that includes both business and residential users.

Though market development of 10 Gbit/s broadband is obviously at an even earlier stage than that of 1 Gbit/s, the list of service providers and communities conducting trials and plotting strategies to help them upgrade toward 10 Gbit/s is expected to grow quickly. It won’t be long before services capable of 1 Gbit/s to 10 Gbit/s become common offerings.
Do You Know How Fast You're Going?

As we move to ever-faster broadband access speeds, the next competitive battleground is coming into view. Being the first service provider in a given market to offer service up to or beyond 1 Gbit/s offers a brief window of time during which the speed itself is all the competitive differentiation necessary.

That window closes quickly, however, and Gigabit-plus broadband service providers need to start competing on other points, such as seeking to provide overall better performance and higher reliability than their competitors.

It is also important to note that services offering up to 1 Gbit/s broadband are not going to be cheap (with 10 Gbit/s even less so). Both the increasing competition Gigabit-plus service providers are facing and the premium prices their customers are paying for higher speeds make it abundantly clear that testing and ongoing management of service quality will be critically important.

The ability to do that is perhaps never more important than at the time when a new service is installed. That is the point when customers expect to see some proof that they will be getting the access speeds that the providers advertise and that they, the users, will be paying for. It is the point when service providers must prove their ability to deliver on the terms of their service-level agreements (SLAs) with customers.

Broadband service providers currently have a variety of tests at their disposal, based on different standards and technologies that they can use to provide proof of performance, and verify their customers’ broadband speeds for service turn-up and SLA purposes.

Lower-layer network tests for verifying Ethernet/IP transport include RFC 2544 and ITU-T Y.1564. With increasing frequency, service providers also are testing stateful TCP (Transmission Control Protocol) throughput via RFC 6349 standard testing during initial service installation. However, as service providers have begun to recognize the importance of overall quality of customer experience as an overarching goal of their customer care efforts, it has become clear that these network-centric tests, while valuable, are not enough.

For this reason, many service providers have added HTTP (Hypertext Transfer Protocol) and FTP (File Transfer Protocol) application-layer throughput verification to their service installation testing regimen. These tests verify connection speed from the customer device to servers in the service provider’s own network, where they can guarantee the promised speed – showing, quite literally, how the service performs from the customer point of view. These tests have become increasingly common in a market environment in which savvy broadband consumers expect their service installers to show them how services will perform before they walk out the door.

The Simplicity of Speedtest.net

There are different hardware-based and software-based tools for conducting tests to verify throughput to the end user. Some handheld test tools typically used in the field by installers to test physical network connections have been adapted with additional functions to allow these test sets to conduct stateful TCP tests and HTTP and FTP throughput tests. On the software side, the modern broadband era has also seen the rise of Web-based test solutions that an individual user can administer to check their broadband speeds.
The best known of these is Speedtest.net by Ookla, which any broadband user can use at any time to measure the speed on whatever broadband connection they happen to be using. Speedtest.net has become such a widely accepted tool for measuring broadband speed that it is not uncommon for broadband providers’ installation technicians to use it during service turn-up at a customer’s home or business. They carry a basic laptop PC along with their other installation and testing gear, and after completing the installation, use the laptop over the new connection to link with an Ookla server in the service provider’s network. In less than a minute, they can get a full reading of downstream and upstream bandwidth being realized by that customer (though Ookla always recommends performing multiple tests to gauge the stability and performance consistency of a connection.)

While use of Speedtest.net by consumers on their own time has probably led to many agitated phone calls to providers from users claiming they aren’t getting broadband speeds as advertised, this is an example of how service providers can use this common Web tool to their own advantage, showing customers what they can expect, at least approximately, in terms of speed and user experience.

Laptops With Limitations

While this method has proven effective for helping technicians test new broadband connections, the ability to obtain accurate results using a cheap laptop and Speedtest.net is fraught with complications as broadband connectivity advances into the Gigabit era. One very obvious reason why service providers like this simple method is that outfitting their technicians with laptops for these tests is not terribly expensive, so capex and opex budgets don’t take a huge hit.

However, when used to test ultra high-speed connections such as 1 Gbit/s, these laptops show their limitations in a couple of significant ways:

- Many laptop models don’t possess interfaces capable of handling 1 Gbit/s, let alone 10 Gbit/s.
- Many laptop models don’t have enough CPU processing, RAM resources and operating system (OS) capabilities to accurately test high-performance lines. Some higher-performance laptops do have better resources, but are of course more expensive, and still may not be able to test 1 Gbit/s or above.

For service providers, the effect of using an overmatched laptop to conduct HTTP and FTP tests at service turn-up can be embarrassing and disastrous. If an inadequate port, or overtaxed CPU, RAM and OS lead to a reading that is far lower than the provider’s advertised speed – say, 200 Mbit/s, compared to an advertised speed of near 1 Gbit/s – the relationship with that customer is bound to get off on the wrong foot. The customer will very likely begin to question the provider’s ability to deliver high quality of experience before the installation technician has even departed.

Heavy Reading has heard anecdotal evidence that suggests some service providers, facing the risk of inconsistent HTTP tests at service turn-up for their Gigabit offerings, have invested in much more expensive, higher-end laptops to improve their ability to get accurate speed readings. In many cases, instead of using a basic model $300 laptop, they have spent 10 times that amount for a high-performance, tricked-out laptop (and of course, that $3,000 multiplied by the number of technicians that need to carry them on calls at a given time). Having to make that much of an investment goes against the whole reason for carrying the laptop in the first place – it’s supposed to be a cheap and easy way of showcasing its broadband speeds.
Putting Test Tools to the Test

VeEX Inc. is a maker of hardware-based, handheld test tools that service providers often use in the field to conduct a variety of connectivity tests. The VeEX VePAL TX300s is a handheld unit capable of OTN, Sonet, Ethernet and Fibre Channel testing applications that can be used in different parts of the network to carry out tests related to voice, data or video services. The TX300s tests 1 Gbit/s and 10 Gbit/s Ethernet, and is 100 Gbit/s-ready, while the company’s MX100e model also tests 1 Gbit/s Ethernet.

VeEX has also added capability for stateful TCP, HTTP and FTP throughput tests to its test sets. Though the company says it does not see a competitive threat from the common practice of using laptops and Speedtest.net to test user bandwidth, it heard from enough service providers confronting problems using laptops to test Gigabit speeds that it saw the opportunity to conduct a comparison test of its own.

The comparison test involved the FPGA-based VeEX VePAL TX300 with dedicated hardware/CPU/RAM resources for TCP, FTP and HTTP performance testing, an Apple laptop (referred to as Laptop 1), and another model of laptop PC (Laptop 2). Both laptops had the same CPU and RAM, but different OSs, while all three devices were equipped with 1 Gbit/s interfaces.

In the test, conducted both in a controlled lab environment and in the field, each device was connected via a 1 Gbit/s line to network servers running TCP and HTTP server applications. For the TCP test, the VeEX TX300 was connected to TCP servers, and also, in a separate instance, to a second TX300. Figure 2 shows the performance levels achieved on the TCP test.

![Figure 2: TCP Test Performance](source: VeEX Inc.)
Results of the HTTP Test
VeEX said Laptop 1 showed maximum throughput achieved 555 Mbit/s. Laptop 2 achieved maximum throughput of 210 Mbit/s. Meanwhile, the VeEX VePAL TX300 achieved a maximum throughput of 945 Mbit/s over the 1 Gbit/s connection.

Results of the TCP Test
The TX300s-to-Server connection showed maximum throughput of 771 Mbit/s. The TX300s-to-TX300s connection achieved maximum throughput of 954 Mbit/s.

Test Summary & Further Investigation
These results suggest that a test tool using its own dedicated FPGA hardware resources produces accurate and reliable results when compared to a mass-market laptop depending on its own CPU speed, RAM, and OS performance. VeEX also went a step further with its comparison test in the lab by using network impairment equipment in line with the device under test and the server. The intent was to introduce impairments such as packet delay, jitter and packet loss — issues that can affect overall TCP test results. According to VeEX, when a 1 millisecond delay was introduced, the TX300’s TCP and HTTP throughput dropped by less than 10%, but throughput performance of the laptops dropped by more than 50%.

Conclusion
The anecdotally reported limitations service providers have experienced using basic laptops to test Gigabit broadband speeds, along with the test results reported by VeEX, both suggest that using a laptop and a Web-based test client produces inaccurate and unreliable results. Given this input, it would be difficult to trust this testing method when needing to prove performance on an SLA, or even to simply show an individual end user evidence of true performance.

The performance and accuracy of broadband access speed testing are vitally important to create a solid foundation on which to build a strong customer relationship. While software-based tests on cheap laptops have become more popular, and do offer cost and simplicity benefits, the overall performance and accuracy of these methods is questionable. VeEX’s comparison tests suggest that test equipment with dedicated hardware (FPGA)/CPU/RAM resources for TCP/HTTP/FTP performance can be more reliable. If speed tests can’t be trusted, broadband access customers will have a hard time trusting their service providers to deliver a high-quality experience on an ongoing basis. In the Gigabit-plus broadband era, that will make the difference between winners and losers.

About VeEX
VeEX® develops innovative test and measurement solutions for next generation communication equipment and networks. Founded in April 2006 by test and measurement industry veterans, VeEX products blend advanced technology and vast technical expertise with the discerning measurement needs of customers. For more information, visit www.veexinc.com.

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