bigleaf
networks

THE DEFINITIVE GUIDE TO

Optimizing Home Internet for Businesses with Teleworkers

Contents

Overview

This definitive guide is a comprehensive resource full of tips, advice, and examples to help companies optimize the use of home networks for remote workers doing business outside the walls of a normal office. Organizations that consider and understand the constraints of home internet connections can take actions to increase employee productivity and decrease downtime for critical employees working from home. These organizations have better visibility into network issues that impact their WFH teams and mitigating efforts have minimal costs that payoff in results.

SECTION 1

Why Optimizing Home Internet for Remote Workers is Important

In the spring of 2020, millions of workers in America were suddenly asked to work from home if possible. Of those who were employed and didn't work from home already, **57.7%** reported that they had recently begun working from home in April 2020.

Almost overnight, the number of remote workers went from **4.7 million** to an estimated **92 million**. This is stressing networks, application providers, and IT teams like yours who need to optimize these workers' productivity.

Home internet connections that were once a desert from 8 am to 5 pm are now flooded with Zoom, Microsoft Teams, Slack, BlueJeans, Office365, email, and VoIP traffic. In truth, the trend was already toward working from home. The number of remote workers grew 44% over the last five years with no sign of slowing.

In fact, many large tech companies, such as Google, Facebook, and Microsoft have committed to employees working from home until the end of the year. Some companies have stated that employees never have to return to the office.

Right now everybody is a remote worker

The stay-at-home mandates in the spring of 2020 created an explosive growth in the number of people working at home. In just a few months, the number of employees working from home climbed from 15 million to over 92 million! [1]
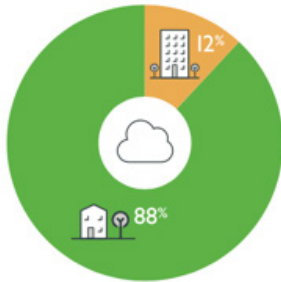
People (millions)

88% of organizations have encouraged people to work from home. [2]

In the first few months of 2020, the number of people working from home climbed to

92.5 million
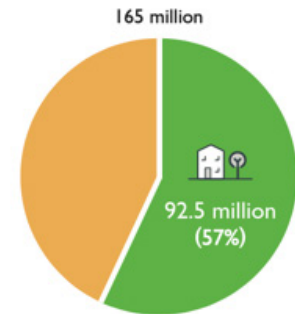
57% of the workforce has been working from home since April 2020.

1. Based on BLS labor force data and polling from CNBC and Waveform.
2. "Gartner HR Survey Reveals 88% of Organizations Have Encouraged or Required Employees to Work From Home Due to Coronavirus" (March 2020 survey)

The number of at-home workers has increased
sixfold since stay-at-home mandates!

Feeling the pain of internet congestion

Business applications are now competing with a lot of different types of internet traffic as more people are working from home. Compared to internet-reliant business communications and applications, typical residential internet use consists of a lot of "bulk data." Bulk data includes streaming media, video games, casual web browsing, and other entertainment-based consumption. When sharing an internet connection with multiple residential users who are on platforms using bulk data, business users' data gets squeezed and they feel the pain of choppy VoIP calls and video conferences.

Rural users face even more challenges. Internet connections in rural communities are frequently slower, have higher latency, and are less reliable.

To keep bulk data from disrupting at-home work, we need tools and technology to prioritize business

applications and make sure they are running optimally on the internet connections available to each household.

Pushing residential ISPs to their limits

IT departments asked to support remote workers are challenged by residential ISP networks. The business network was wholly under control. Now, users are connecting from a mix of ISPs through cable, DSL, and fiber – perhaps even satellite and microwave. However home office workers connect, network administrators no longer have visibility into usage patterns, performance issues, and sources of problems.

People working from home suddenly need more than a reliable connection to their network. They need reliability AND performance, as both significantly impact their ability to get work done. Even the "fastest" home network connection available will often leave users with laggy and choppy video conferences. However, there are ways to identify problems and improve the home office experience.

Typically passing through more distance and equipment, home internet connections are subject to lower reliability than business connections.

SECTION 2

How the Internet at Home is Different than Internet at the Office

When workers open up their laptops in their home workspaces, the applications look the same as they do at the office, but those apps are taking a very different route to the internet.
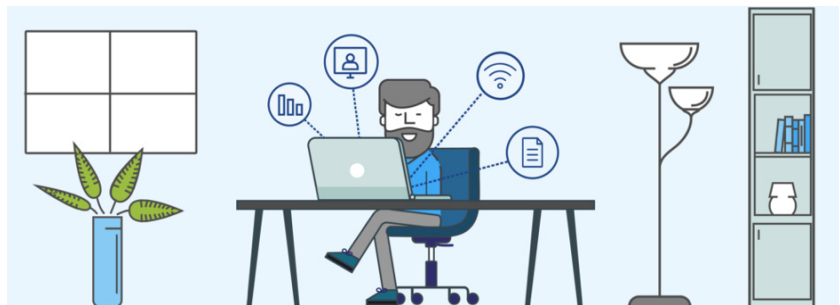
Farther from the internet: Your data has to do your commute

Due to geography, logistics, and economics, residential areas are connected to the internet differently than business areas. To route down residential streets and across neighborhoods, networks require more transitional elements and more cable. It is like each packet has to do the daily commute now.

All the devices between the home office and the ISP's connection to the internet backbone are more points for things to go wrong; more cables to get damaged, more amplifiers, and nodes that get flaky. Whether copper, broadband, or fiber optic, more cable and connections degrade signal in ways that can delay and scramble traffic. For your internet traffic's commute, that translates to more backed up intersections and potholes.

Common failure points for residential ISP connections

Residential networks come in many flavors, but they all have points of failure

Broadband cable modem
Temperature changes cause connectors to retract, weakening connections.

DSL
Cross talk between circuits slow and disrupt traffic.

Fiber to the home
Tight bends in the cable and dirty connectors weaken signal, dropping link and packets.

By comparison, ISPs' network points of presence are closer to business districts and hubs. Their business clients use more robust fiber connections and trusted digital protocols like frame relay, MPLS, and metro Ethernet. The ISPs provide service level agreements (SLAs) that reassure businesses of uptime, speed, and quality of service. A business connection doesn't involve as many changes in media, shared resources, and weather-beaten equipment.

Oversubscription: Sharing with your neighbor keeps costs down
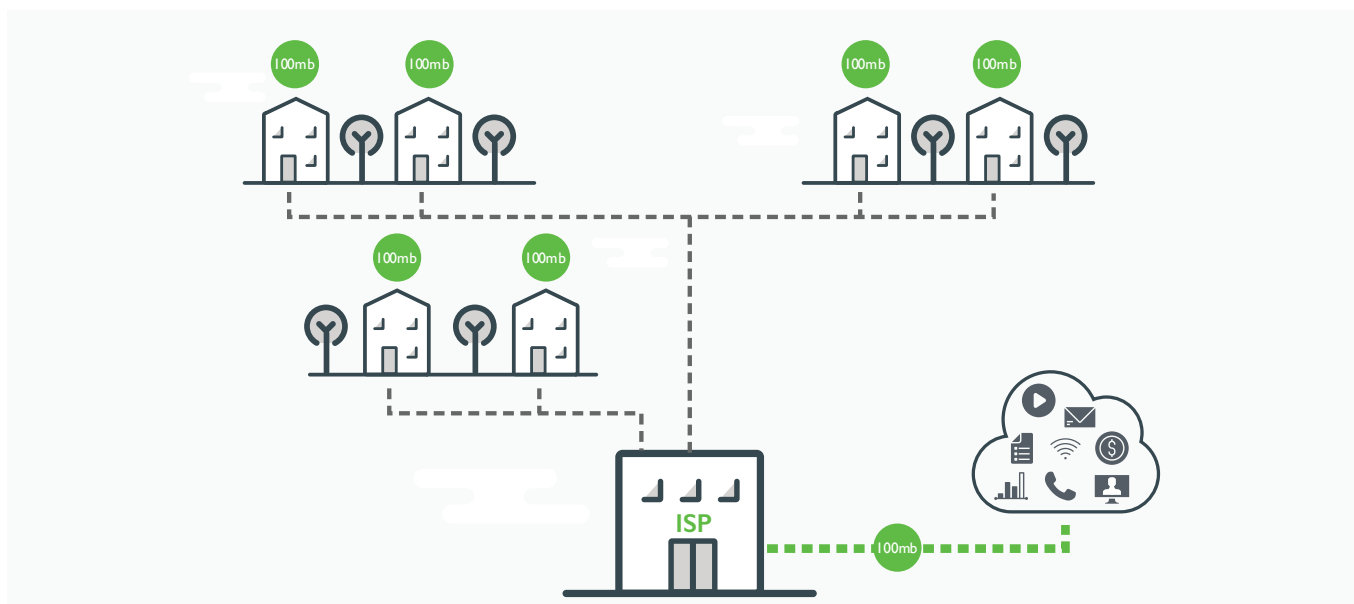
600mb Subscribed, 100mb Capacity

The vast majority of residential users' demand is well below the capacity of their subscribed connections, so ISPs can sell more than their capacity. Of course, when the whole neighborhood starts to work from home, it's a different story.

Like so many internet issues, this can be explained with roads and cars: It would not make any sense to build a freeway to your driveway. We build smaller, residential streets where the demand is not that high. These feed into freeways that have much higher capacity. ISPs provide access to the internet for all their subscribers in much the same way.

When you sign up for a 100mbps ISP modem service, you are not buying a dedicated 100mbps pathway all the way through your ISP's network for every minute of the day. That would mean it would be underutilized whenever you are sleeping or — gasp — doing something offline like reading a book. Instead, the ISPs oversubscribe their network, using historic data to understand what the actual usage is across their subscribers so they can support that usage, without over purchasing their own connection to the internet. This allows them to provide cost effective, while still sufficient, plans for their clients.

Latency versus Bandwidth

Latency is the amount of time it takes for data to travel from one point to another. It is dependent on the physical distance that data must travel through cords, networks and the like to reach its destination. Latency issues can result in jittery video or long download times.

Bandwidth is the rate of data transfer for a fixed period of time. It measures the amount of data that can flow through the network simultaneously. Most home networks have different upload versus download bandwidth capabilities.

There is not a straightforward formula for oversubscription, but it can be up to 100 to 1 (that is, the ISP sells 100 connections of 300mbps for every 300 megabits of their own connection to the internet). Normally, this keeps costs down and does not affect anyone's experience; however, it is not likely that the ISP budgeted for every house on your street to hold two home offices and a remote learning classroom.

Best effort networks

The internet is a "best effort" network. It does not guarantee that a packet of data will get to its destination in a particular time frame – or even in the right order. When the oversubscribed lines get maxed out, its best effort might not be good enough for your business applications. The result will be slowing or loss of packets at the bottlenecks. Best effort is usually fine for file downloads where a momentary bottleneck won't even be noticed. If it is more extensive, the

Do asymmetrical connections affect performance?

Since home internet use tends to be more about receiving data (such as watching videos and downloading applications) home internet is usually asymmetrical — that is, the download capacity is higher than the upload capacity. Fortunately, most business users will not bump into problems with asymmetrical connections unless they are regularly uploading large files or otherwise pushing a lot of data out.

internet may seem a little slower than normal or, if it is really bad, you may have to restart the download.

For a time-based application like a video conference, these traffic jams can create poor performance which is noticeable. When this happens with regularity, it is frustrating, difficult, and can disrupt key business operations.

SECTION 3

Diagnosing Networking Issues in the Home Office

Some parts of the network are beyond our control, such as when oversubscription goes awry. Still there are a lot of things you can do to isolate and treat problems within these networks before calling the ISP.

Is it on the LAN or the WAN?

To start, determine whether the problem is in the local area network or actually with the internet service. This will help you narrow down whether you focus on issues within the home network or if you have to call the ISP.

One way to do this is by testing the network connectivity with the classic network diagnostic tool, ping, which can simultaneously ping the default gateway address (router) and a location on the internet. By looking at the traffic flow at two points, you can see whether the issues start inside or outside of the home.

Use the ping tool

To use ping, have the user **open a terminal** (AKA Command Prompt) on the computer.
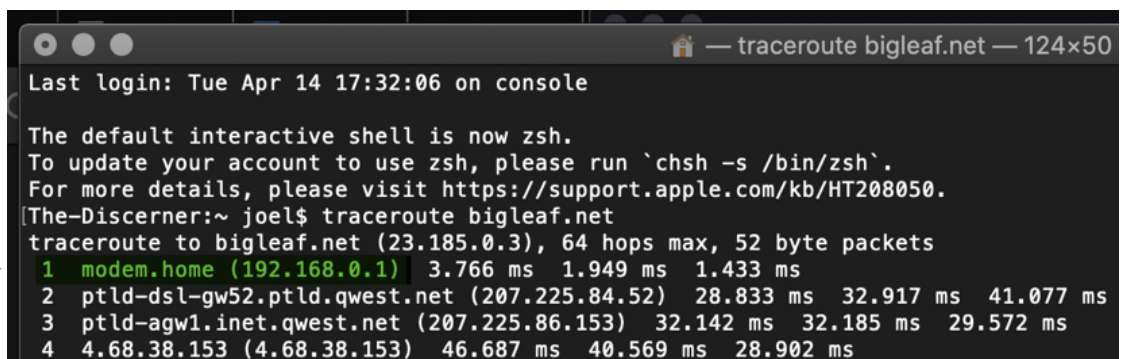
How to open terminal

Mac
- Click the **magnifying glass** in the top right of the screen or press the **Command button + Spacebar.**
- The **Spotlight Search** bar appears. Type `terminal` and then press the **return** button.

Windows
- Click the **Windows** button and then type `CMD`.
- In the results, click **Command Prompt**.

Determine the gateway or router. The quickest way is to type `tracert bigleaf.net` (or on a Mac `traceroute bigleaf.net`) and **press return**. The first address that appears is the LAN gateway.

The **first IP mentioned** in a traceroute is most likely the home router that will be pinged in the next step.

Now, with two different terminal windows, start two pings:

(1)

WAN: *A location on the Internet, for instance, Bigleaf's internet presence*

To ping the WAN, type
`ping bigleaf.net`

(2)

LAN: *The gateway IP*

To ping the LAN, type
`ping 192.168.0.1` or whatever the results from the tracert above

Look at three things:

1) **Is latency over 100 milliseconds on a regular basis?**

   If you are seeing regular results over 100 ms, you have found a problem that will affect video and other apps. Most networks should have a much lower average ping than that.

2) **Are the two pings in sync?**
   - If there are problems on the LAN, the two pings will change in tandem. This shows that problems on the LAN are creating delays in the internet ping. Focus your troubleshooting on local problems.
   - If the WAN ping is fluctuating, slow, or having timeouts but the LAN results are consistent and fast, the problem is on the WAN.

3) **Is there a lot of variation from the mean (jitter)?**

   If the time varies a lot, with pings varying by 50ms from the mean, you are seeing jitter. Jitter creates a lot of challenges for real-time services like video because packets get lost or arrive out of order.

For more detailed information on your network routes and health, we recommend using PingPlotter.

SECTION 4

Improving Business Application Performance on Home Networks

There are a number of things that can be done to improve your business application performance on your home networks.

Turn off all non-business-related applications

Stop all traffic on your network except those that are associated with your business applications. Get the kids to close their tablets and make sure there's no streaming video running on your TV or in the background of your computer while you run just your key business apps.

If this resolves the technical problem but creates problems among the people in the house, configuring the LAN quality of service (QoS) might allow all the uses to operate at the same time but prioritize the business applications.

Upgrade speed and capacity through the ISP

ISPs have chosen to sell speed, so it is natural that consumers believe this is the only solution they have to solve their problems. However, many business applications don't actually require that much bandwidth to use. For example, Zoom only requires 2-3 mbps, so a typical broadband connection should have more than enough capacity for a Zoom call.

Yes, getting a faster subscription might handle the different sources of your internet traffic better, but the additional capacity won't help if the internet connection is experiencing jitter, latency, or packet loss. The "bigger pipe" will cost more money but won't resolve the problem of making sure your business applications are prioritized.

SECTION 5

Improving Home Internet Performance: Is Prioritization the Answer?

Sometimes the network problem is on the LAN, and sometimes it is between the residential router and the ISP. Connection and throughput issues can also spring up between the ISP and its upstream providers.

To check if prioritization can help on the LAN, the first and easiest test is to load up a business application, such as video conferencing, and turn off all of the other internet devices in the house. Turn off the TV with streaming video,

What is Quality of Service?

Quality of service (QoS) measures the overall performance of a computer network. QoS controls the flow of data used by different types of network traffic to ensure that high priority traffic gets a smooth, uninterrupted experience.

switch phones to mobile data only, and take the tablets away from the kids. If this eliminates all of the lag, jitter, and delay problems with the business app, then QoS prioritization can definitely help by making sure that business-critical applications receive a higher priority over that bulk data.

Unfortunately, connection issues beyond the home can't be solved by typical QoS and will need a more intelligent, adaptable QoS solution.

View from the home office

QoS approach #1: Set up QoS on a residential router

Some residential routers have a QoS feature. For network routing on the LAN, QoS allows the home user to manually adjust settings to prioritize traffic by port or other signifier. Configured properly, it can identify and prioritize particular traffic, such as the Zoom meeting with the boss, over others, such as downloading the latest video game. It might be worthwhile to enable QoS.

However, residential hardware is not typically adept at identifying a variety of traffic types, which means that while it's possible to turn QoS support on, it might not actually be addressing the problem. If the router does have greater QoS configuration options, a certain level of technical know-how will likely be needed to make those policy changes. Whether the options are basic or more complex, it's likely that each of your remote workers is using a different model of router and different hardware to connect to the internet. This means the tech team will be supporting an array of devices with different capabilities.

Be aware the *QoS features on the residential router only control LAN traffic in the house*, so they can't do anything about oversubscription or bottlenecks beyond the house. If the latency or jitter is beyond the gateway, this QoS will not resolve the problem.

QoS approach #2: Traditional enterprise solution

Traditional approaches to QoS will work to some extent. In order for a QoS solution to be able to prioritize business traffic over residential traffic, it needs to be able to do these three things:

1. Identify the source and type of network traffic.
2. Synchronize information across devices.
3. Be aware of the total amount of bandwidth available.

Most traditional enterprise QoS solutions can handle the first two requirements just fine, but many don't have the ability to be aware of throughput or network capacity.

QoS approach #3: Traffic prioritization across the WAN

An automated QoS solution that works from the LAN into the WAN is the best of both worlds. By optimizing the available bandwidth for important traffic not just in the LAN but to peered networks on the WAN, a residential software-defined WAN (SD-WAN) solution can proactively make the best of what residential internet connectivity has to offer.

SECTION 6

The Best Technology for Home Office Performance

QoS solutions have been around for a long time, but almost everything available has been built for enterprise situations and larger office networks. Unfortunately, most options for residential use have been limited, as discussed earlier.

Optimizing performance with SD-WAN

While optimizing the LAN and understanding the ISP can help, sometimes a more robust solution is needed. Home networks with even a single internet connection can benefit from SD-WAN technology. Routing around LAN issues with a direct gateway network can minimize performance issues. Adding a second network connection, such as LTE, satellite, or WiFi, provides additional routing options.

SECTION 7

What to Look for in an SD-WAN Provider

Dedicated servers

You should look for your SD-WAN provider to use dedicated servers with diverse private backbone paths. Redundancy and multiple Points of Presence, or "POPs" ensure the best performance.

Bigleaf's owned-and-operated Cloud-Access Gateway Network is fully redundant, with multiple core routers, servers, internet transit circuits, and core backbone circuits. All of our Points of Presence, or "POPs" connect across our dedicated backbone, so traffic between the home office and the core of the internet is always protected. Beyond the core network, each home office with a Bigleaf router connects to multiple Bigleaf POPs at all times, for automatic geographic redundancy — delivering the best possible connectivity.

Owned gateway network

A purpose-built IP network that is owned and operated by your SD-WAN vendor provides the best possible connectivity. Non-owned networks can suffer from compromises in network architecture and management. For example, telecom networks also run MPLS, which adds complexity and more risk of bugs and outages; and content based networks are optimized for serving high-volume data in one direction rather than business-critical applications like VoIP.

Bi-directional versus uni-directional QoS

SD-WAN networks can provide bi-directional QoS or uni-directional QoS. QoS that is bi-directional controls both packets sent and packets received. This maximizes performance in both directions. Uni-directional QoS only controls the packets sent out from the network and does not optimize the packets received in.

For example, Bigleaf software automatically identifies your traffic types, determines which traffic flows require prioritization (such as VoIP), and applies QoS bi-directionally, all without any manual configuration.
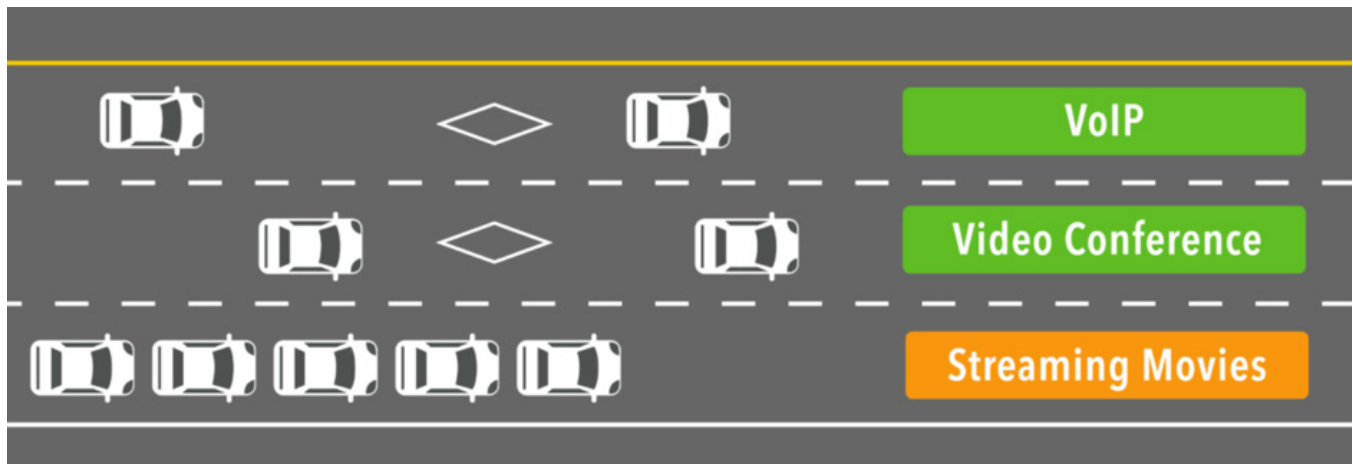
Multiple versus single connections

On a single internet connection, even though traffic can't be moved between circuits, QoS prioritization can help optimize business applications and provide proactive alerts to network issues.

With multiple internet connections, the best QoS systems continually monitor each of your internet connections and adjust in real time based on changing circuit conditions to give your traffic the best possible experience.

Ease of use & set up

Most SD-WAN networks require some degree of technical proficiency to set up and manage. They require hardware and network understanding, and programming skills to set up or change the system. Bigleaf Home Office comes preconfigured and can be set up by a non-technical person. Custom rules can also be created to meet individual company needs by our support team. The technology is invisible and agnostic to other tools such as VPNs or firewalls, so no manual updates need to be made to the device when systems are changed or updated.

Intelligent software automatically identifies and categorizes 100% of your traffic in and out of your home office, determining which applications require prioritization — such as internet-based phone calls and video conferences over streaming home entertainment. Bigleaf's intelligent SD-WAN auto-detects your application needs and adapts in real-time to internet performance and connectivity issues before they impact your business. That means your most important business applications get the VIP treatment when your teams are working remotely with no set up required.

Visibility & reporting

SD-WAN technology can help IT by providing insight into a home network that is not typically available. Connection speeds, packet loss, and ISP reliability can be illuminated through reporting channels. Real-time and historical data from Bigleaf software monitors internet connections 10 times per second. Web dashboards, performance reports and email alerts are all available to deliver insights needed to support remote workers.

This multi-tenant web dashboard provides IT teams the visibility needed to troubleshoot WAN or internet issues, evaluate bandwidth/speed adjustments, and understand the impact of network performance on application experience.

Bigleaf Dashboard Performance Report
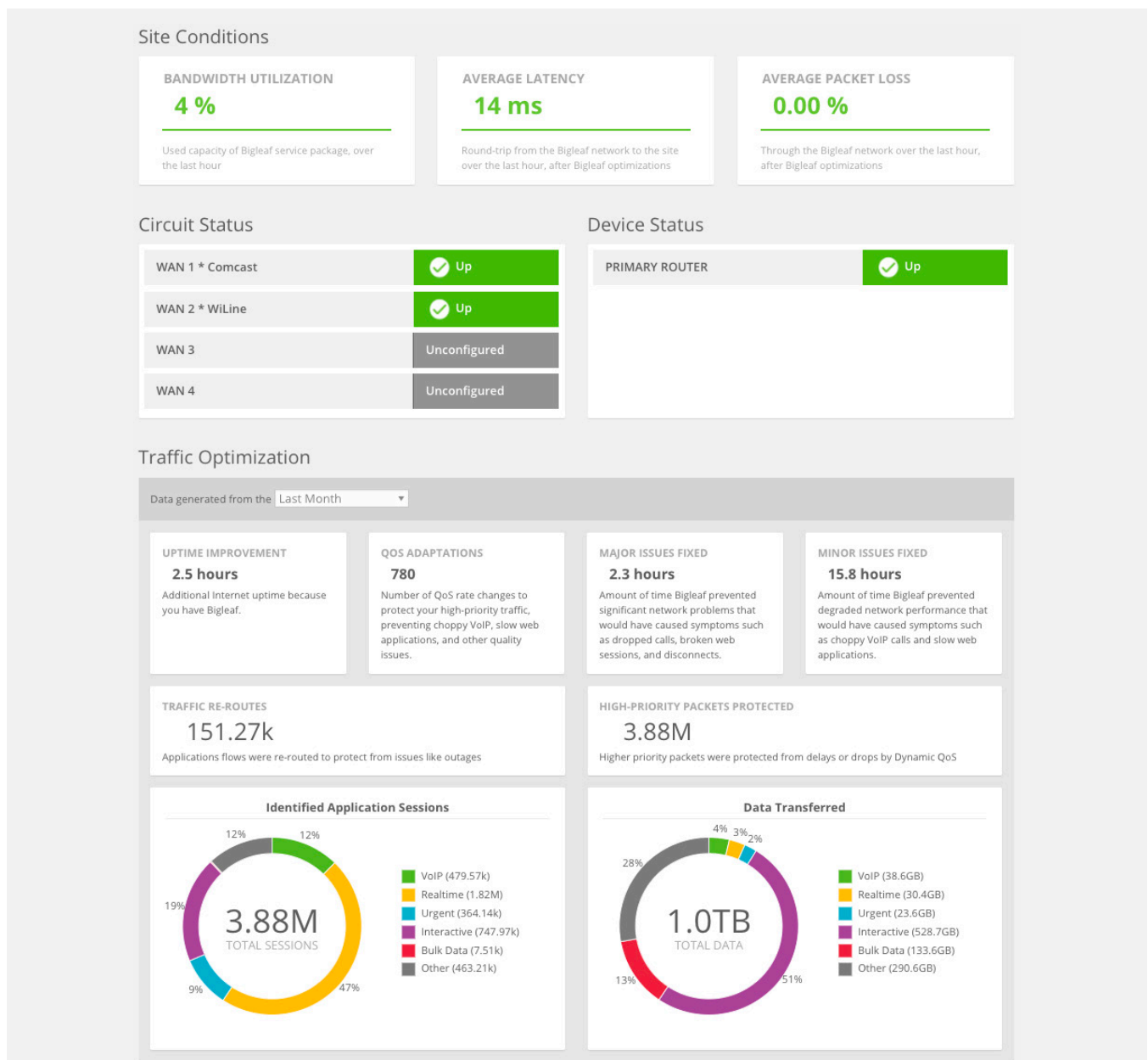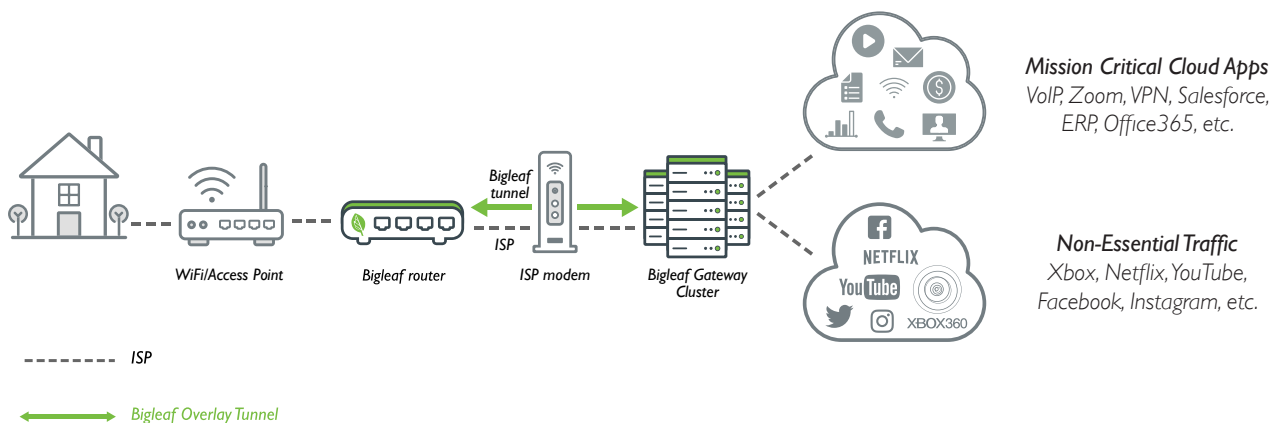
SECTION 8

Conclusion

ROI

The ROI of improving home network connections is clear. Imagine an employee experiences even 15 minutes of network lag or downtime per day. This adds up to hundreds, perhaps even thousands of dollars of lost productivity from the employee and the IT staff called upon to fix the problem. Factor in the cost savings of having a productive worker at home versus at the office where you pay for rent, lights, heat, snacks, etc. and an SD-WAN solution becomes a bargain.

SD-WAN in action

Joe in Utah is a sales executive at a software company. He has a home connection consisting of a Verizon internet connection. Joe was experiencing issues on sales calls over Zoom where he couldn't share his video without it being very choppy. Joe complained to his IT department, and they recommended he install a Bigleaf Home Office device, which he was able to set up without assistance in about 10 minutes. The Bigleaf Home Office device monitors Joe's application use and prioritizes his Zoom call over his kids' Netflix streaming. Joe's IT department can see in real-time his network performance. Because his Verizon network is not providing the level of service he needs, they had Joe add an additional satellite connection. When Verizon goes down, his traffic automatically switches to his satellite connection. Bigleaf has clusters for redundancy, so even routing to a gateway network in another state, latency might go from 14ms to 23ms, which is not enough difference for Joe to even notice. Since installing Bigleaf, Joe has regular video sales calls without issues.

OVERVIEW OF BIGLEAF HOME OFFICE

WiFi/Access Point   *Bigleaf router*   *Bigleaf tunnel*   *ISP modem*   *Bigleaf Gateway Cluster*   *ISP*

Mission Critical Cloud Apps
VoIP, Zoom, VPN, Salesforce, ERP, Office365, etc.

Non-Essential Traffic
Xbox, Netflix, YouTube, Facebook, Instagram, etc.

- - - - - - - - *ISP*

⟵⟶ *Bigleaf Overlay Tunnel*

Additional Resources

Video: Bigleaf Home Office in Action
https://www.bigleaf.net/2020/07/07/video-see-bigleaf-home-office-prioritize-business-app-traffic/

Bigleaf Home Office: Getting Started
https://www.bigleaf.net/getting-started/

About Bigleaf Networks

Bigleaf Networks is committed to helping organizations provide their employees with reliable communications, internet access, and application performance in their home offices. Bigleaf Home Office can keep the chaos and unpredictability of residential internet connections from impacting business communications and applications.

QoS solutions have been around for a long time, but almost everything available has been built for enterprise situations and larger office networks. Unfortunately, most options for residential use have been limited, as discussed earlier.

Bigleaf understands the frustration of home office users and believes its Dynamic QoS prioritization technology can minimize that frustration. Bigleaf Home office uses proprietary algorithms, instead of policies that have to be manually built, to automatically identify and prioritize the traffic for your business communications and applications over other household traffic — while monitoring and adjusting to varying broadband capacity in real time — to make sure your key applications don't drop or lag.

Bigleaf Home Office can also be easily deployed across your team's home offices. The simple set up works seamlessly with existing ISP and broadband connections, supporting both single and multiple circuits.

Alongside QoS, Bigleaf Home Office offers software-defined networking (SD-WAN) with support for redundant network connections and outage detection outside the home network. Bigleaf utilizes its nationwide Cloud Access Network to ensure a high-performance connection to the Cloud. It continually monitors the connection quality of your internet connection. Based on changing circuit conditions, QoS settings and rate limits are adjusted in real time to give your traffic the best possible experience.

LEARN MORE

To get more information on Bigleaf Home Office,
visit **www.bigleaf.net/bigleaf-home-office**

#networkingfromhome