Jitterworks™
Network Performance Assessment

This document is a comprehensive network performance assessment for ABC Corp. It contains detailed data, analysis, conclusions and considerations regarding key network performance indicators for the monitoring period 3/10/2020 – 4/5/2020.

Performance assessment delivered 12 May, 2020

Table of Contents

1. Scope of Assessment

This assessment is designed to determine the performance of the Internet service provider (ISP) as well as key network equipment relative to industry best practices and client requirements.

This assessment was performed for ABC Corp.

ABC Corp. operates in a small office environment with 2-4 employees and 1-4 patients on site at a given time. A private WiFi for corporate use and guest WiFi for clients is provided.

Cloud services are used for client information and appointments.

Voice calls are received over the Internet using VoIP technology.

Internet video conferencing (e.g. Skype, FaceTime) technology is used occasionally.

Inbound and outbound FAX services are utilized.

ABC Corp. has had problems with intermittent Internet outages resulting in voice calls being interrupted.

Network latency, outages, utilization and throughput will be the primary performance metrics gathered during the monitoring period.

2. Network Overview

Internet service is provided over coax cable by ISP Business. The agreement includes business entry level service with expected bandwidth of 35 Mbps download and 5 Mbps upload.

The acronym ISP is used in place of the name of the Internet service provider contracted by the client in this assessment.

The service enters the building in the basement where the ISP cable modem (Netgear CG3000DCR) is located. From this location, a Cat 5e network cable connects to a TP-Link wireless router (TL-WR841N). The router provides WiFi for the employees on the "ABC WiFi" network and connects to a Zyxel 16 port 10/100 Mbps switch (ES1100). The switch has Power over Ethernet (PoE) capable ports which provide power and network connectivity to 4 Yealink (SIP-T22P) phones.

Other office equipment connected to the Zyxel switch ordered by IP address:

- Ingenico Terminal (for POS processing)
- Apple Mac
- AMPAK Technology (device to monitor refrigerator temperature)
- iMac
- Bose SoundTouch
- Sonos Audio
- Apple Time Capsule
- Apple Airport (provides WiFi for clients on the "ABC Corp" network)
- Netgear Arlo Wireless (for connectivity to security camera)
- Epson XP-820 printer

Knowing what equipment is being used to run the company's network is an important component of any assessment as it has a direct impact on network performance. Also, by documenting the equipment used, the network overview section serves as a valuable reference when diagnosing and fixing network problems.

3. Assessment Summary

This network assessment is a detailed analysis of ABC Corp's existing IT infrastructure and network performance. The purpose of the assessment is to identify opportunities for improvement by obtaining a comprehensive view into the health of your existing network.

A JitterHub network performance monitor was connected to the Zyxel switch to collect and graph key network performance metrics and monitor for network outages.

On March 11, several outages were detected lasting from 30 seconds to as long as 4 minutes. Outages of this duration will have a dramatic impact on all Internet related services. March 11 was not a typical day, but is indicative of what can occur over coax cable networks that are old, prone to interference, or are pushed to carry more bandwidth from multiple clients sharing the same wiring infrastructure. Coax cable can be impacted by temperature fluctuations, moisture or interference from electronic and radio signals.

Network latency measures the round trip time it takes data to go to a specific site on the Internet and back. The variation of the average latency is called jitter. Applications such as voice calls made over the Internet (VoIP) and live video calls are impacted by latency and jitter. These applications rely on low latency and low jitter in order to prevent calls from breaking up or being dropped. Overall, the latency and jitter measurements gathered by the JitterHub was typical for a coax cable ISP. Our experience has been that a coax cable ISP will provide a marginal experience for VoIP and live video calls as latency and jitter are generally insufficient for what is required to provide reliable service.

Our utilization measurement averages the amount of data downloaded from and uploaded to the Internet. During business hours these averages were approximately 1 Mbps of download, with occasional spikes to 4 MBps, and less than 1 Mbps for upload. The 35 Mbps download and 5 Mbps upload bandwidth provided by the ISP's entry level package is more than enough to handle your needs.

The JitterHub performs eight throughput tests per day to ensure the ISP is providing the network bandwidth they have agreed to provide. Our tests revealed 28 Mbps of download and 6 Mbps of upload bandwidth consistently. Though we would like to have

seen a download speed closer to 35 Mbps, this is consistent with what we have measured at other ISP Business customers in this area. These numbers are not negatively impacting your network performance.

Some improvements could be made to the existing equipment that would improve network performance. However, intermittent outages and high latency will most likely continue to occur because of the inherent problems associated with coax ISPs. Those improvements would include replacing the TP-Link wireless router with a dedicated firewall and dedicated WiFi access point. Though not impacting performance, the Zyxel 16 port 10/100 Mbps switch could be replaced by a switch with a quieter or fanless switch. *(This last observation was added to this assessment due to specific concerns expressed by this client. It is our responsibility in any assessment we conduct to address specific issues when possible.)*

Based on ABC Corp's network concerns and the information provided by this assessment, it is clear that you may want to look into other ISPs in the area for services that better suit your needs. You may want to inquire about the following services when considering another provider.

- Hosted VoIP Service
- ATA Device for IP Fax
- Wi-Fi Access Point(s)
- 4G LTE Failover Device
- 20 Mbps fiber optic Internet connection. Most ISPs will offer, or at least recommend more - probably starting at 50 Mbps. The throughput tests and utilization graphs below will show that no more than 20 Mbps is necessary.

Based on this client's needs, we are suggesting they look for a provider that offers the kind of fiber optic options they may want to consider in order to improve their latency and jitter issues.

JitterWorks is not affiliated with or endorse any Internet service provider. We provide information about key network performance metrics that will give the client a better understanding of their current system and the information required to make an educated decision when choosing an ISP that suits their needs and their budget.
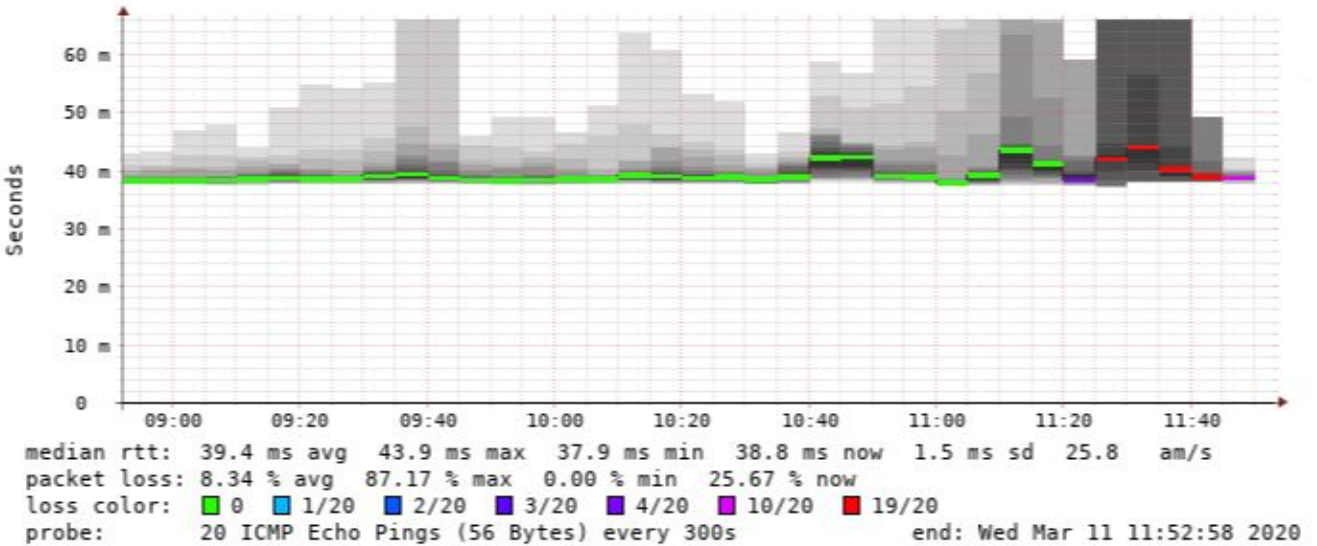
4. LOTUs Overview

As summarized above, the key network performance monitoring metrics the JitterHub collected are Latency, Outages, Throughput and Utilization (LOTUs). This section will get into more detail with the use of graphs generated by the JitterHub network performance monitor.

4.1 Latency and Jitter

Latency is the fundamental network metric used to analyze response time. While bandwidth is important when discussing how long it takes to move a certain amount of data from one place to another, the speed at which data gets to and from that location is directly impacted by latency.

The graph below represents latency on the morning of March 11 when several intermittent outages were experienced in the office. The green line represents average round trip time, 40 milliseconds, for data to go to a Google server and back.The shaded areas, which can be above or below, indicate the variation, or jitter, from the average. Darker shading indicates that more data is experiencing jitter which will impact VoIP calls and live video conferences. When the line color changes from green it shows data did not make the round trip and indicates "packet loss." The "loss color" legend indicates how much data is not making it to the destination and back. Red indicates19 to 20 out of 20 data packets (95 - 100%) are not making it to the destination and back. In this case, the packet loss is critical and impacted all Internet traffic.

```
              60 m
              50 m
    Seconds   40 m
              30 m
              20 m
              10 m
               0
                   09:00   09:20   09:40   10:00   10:20   10:40   11:00   11:20   11:40

median rtt:    39.4 ms avg   43.9 ms max   37.9 ms min   38.8 ms now   1.5 ms sd   25.8    am/s
packet loss:   8.34 % avg    87.17 % max   0.00 % min    25.67 % now
loss color:    ■ 0   ■ 1/20   ■ 2/20   ■ 3/20   ■ 4/20   ■ 10/20   ■ 19/20
probe:         20 ICMP Echo Pings (56 Bytes) every 300s        end: Wed Mar 11 11:52:58 2020
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The graph above charts latency during about a 3 hour period in order to visually demonstrate the effects of packet loss. The JitterHub is designed to track, trend, graph and archive latency over the entire duration of the assessment, in this client's case, one month. Some clients have been gathering performance information for over a year.

Below is a graph from a client that moved from a cable coax ISP (at week 52), to a shared fiber (weeks 1 - 3), and finally to a dedicated fiber (after week 3). Note the round trip latency to the Google server goes from 20 milliseconds, with 12 milliseconds of variation (jitter), to 5 milliseconds with 2-3 milliseconds of jitter, to less than 2 milliseconds with no jitter (green line with no shading above or below). There is generally little or no cost difference between the coax and shared fiber Internet connection, but a dramatic improvement in network performance. Unfortunately, the shared fiber connection is not available at ABC Corp.'s current location. There is a substantial increase in cost between a shared fiber connection and a dedicated connection (DIA), but the performance is as good as it gets.

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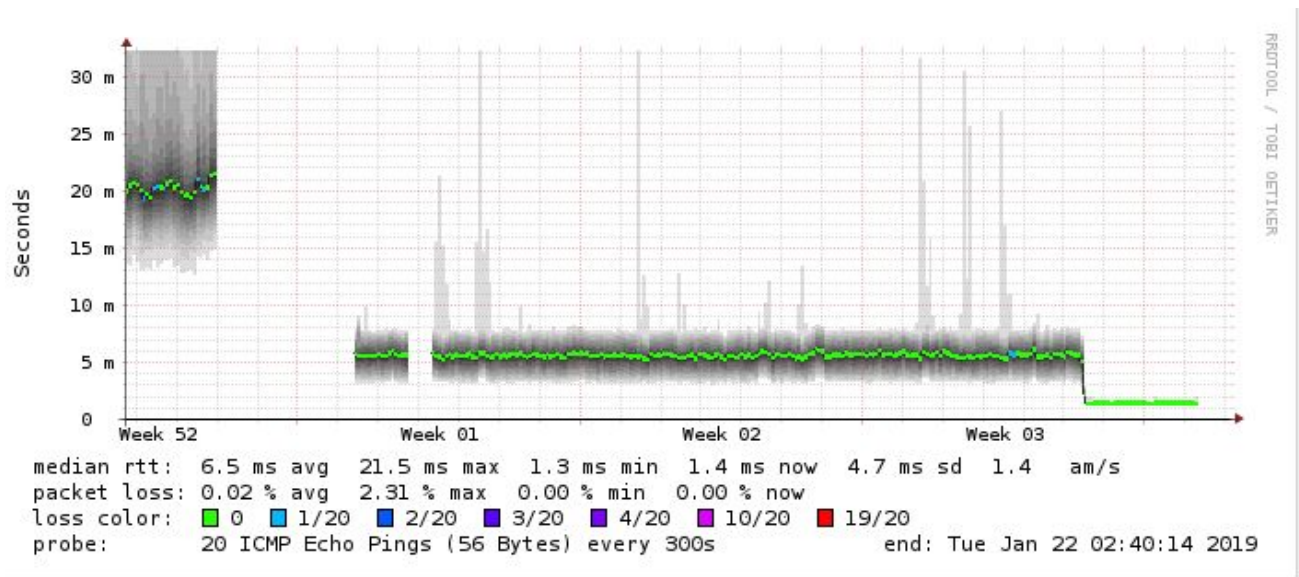
Graphs can be displayed in any time dimension. Hourly, daily, weekly, monthly and yearly depending on the needs of the client, the intended goals of the analysis and the scope of the assessment.

4.2 Outages

Early notification can often lead to proactive diagnosis of failing equipment. We had a client who was experiencing a two minute outage "once a month." The JitterHub tracks the exact time and duration of every outage. Quickly a trend emerged where the frequency of outages was considerably more than once a month since it often occurred outside of business hours. Providing this information to the ISP enabled them to verify that their equipment was failing and required replacement.

On several occasions the JitterHub has been able to notify clients of Internet outages during off hours enabling them to have the problem corrected before employees arrive to find there is no Internet service. Tracking and troubleshooting Internet outages and sending timely notifications has led to the detection of bigger problems such as a tripped electrical breaker and larger scale power outages.

JitterHub power outage reports have been used to guarantee Service Level Agreements (SLA) as well as provide proof that a provider was not meeting their obligations. In one

case, this enabled the termination of a contract without having to pay early termination fees.

The actual alerts for the March 11, 2019 outage are below (March 14, 27 and 31 had similar outages).

2020-03-11 10:18:35 DOWN: jw_npm
2020-03-11 10:19:05 UP: jw_npm

2020-03-11 10:26:10 DOWN: jw_npm
2020-03-11 10:26:25 UP: jw_npm

2020-03-11 11:06:31 DOWN: jw_npm
2020-03-11 11:06:39 UP: jw_npm

2020-03-11 11:31:41 DOWN: jw_npm
2020-03-11 11:31:43 UP: jw_npm

2020-03-11 11:36:09 DOWN: jw_npm
2020-03-11 11:36:13 UP: jw_npm

2020-03-11 13:02:10 DOWN: jw_npm
2020-03-11 13:06:17 UP: jw_npm

Outage alerts are broadcast to a client at the exact time their network goes down and again when it goes back up. Alerts are sent via text, email or both to as many people the client deems necessary.
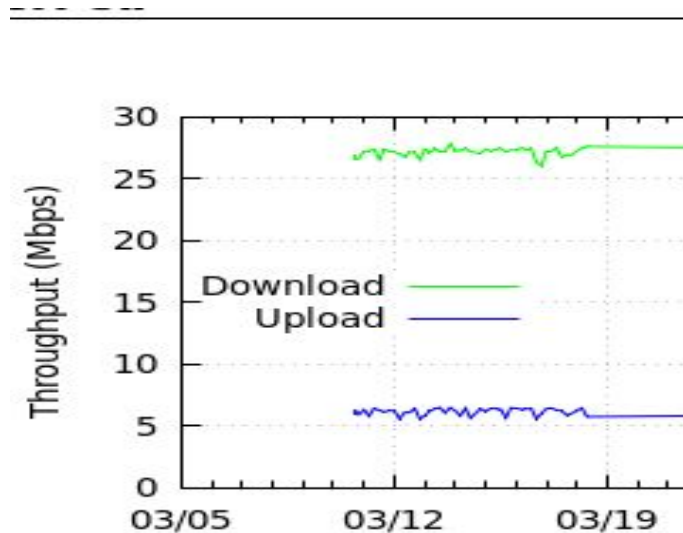
4.3 Throughput

Throughput tests confirm ABC Corp.'s ISP is providing bandwidth as stated in the service agreement. We generally run 8 tests over a 24 hour period to two different locations. Along with confirming the contracted bandwidth, the tests can indicate problems with on-premise routers which are often corrected by a simple restart of the device.

Fluctuations in throughput can indicate high Internet utilization. A drop in throughput due to high utilization is confirmed by cross referencing the utilization graphs. During the network performance assessment period, utilization did not negatively impact throughput.

Though the contracted bandwidth is 35 Mbps download, the ISP is only able to provide 28 Mbps.

ISP Business Services Customer Terms and Conditions states: "ISP makes no representation regarding the speed of the Internet Service. Actual speeds may vary and are not guaranteed. Many factors affect speed including, without limitation, the number of workstations using a single connection."

The best way to describe the difference between throughput and bandwidth is to think of bandwidth as the maximum amount of data that can be transmitted in a second and throughput as the actual amount of data that is being transmitted in a second. The graph above demonstrates the exact amount of data their network is transmitting.
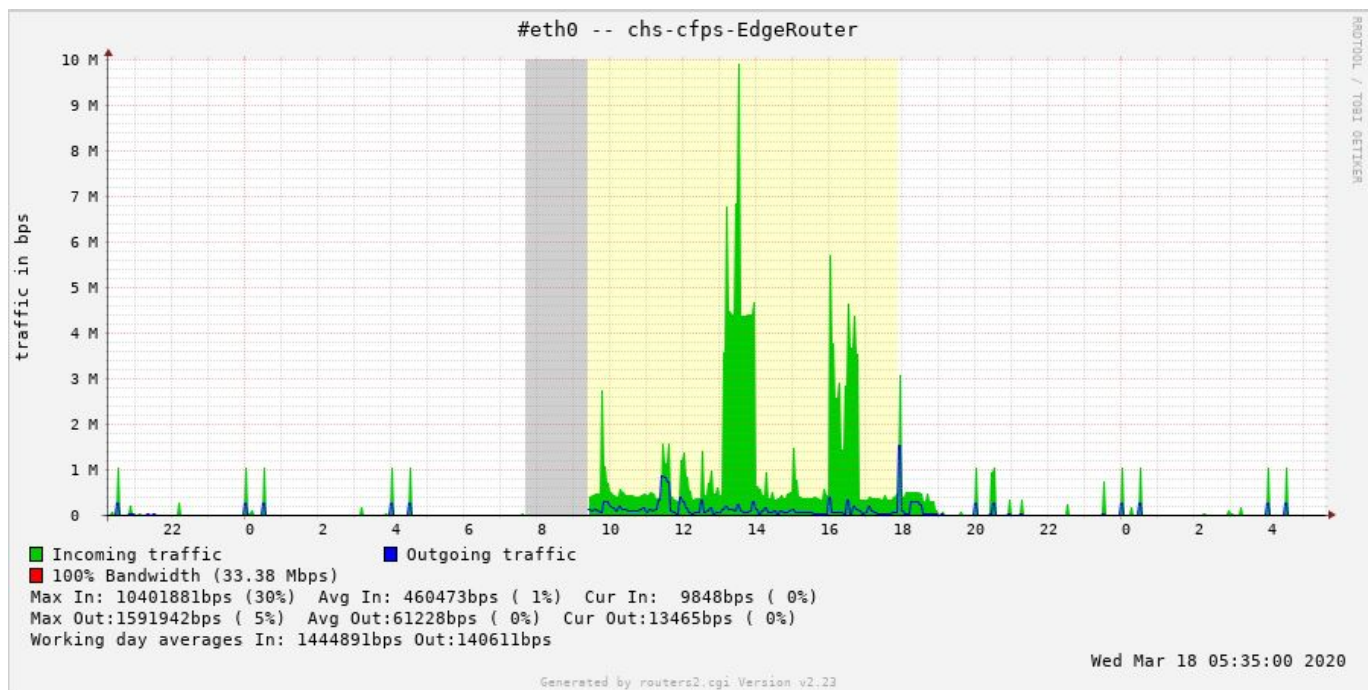
4.4 (Bandwidth) Utilization

Generally, most Internet service providers price their service offerings based on bandwidth. That is, the amount of data that can be moved from one location to another in a second. Determining how much bandwidth you need is key to not overpaying for unnecessary bandwidth.

Most ISPs offer suggestions or even calculators to help determine how much bandwidth is required based on the type of services used and number of users. In our experience, these calculations are normally an overestimation of what is required. It is difficult for businesses to determine exactly how much bandwidth they actually require. As a result, monthly recurring charges for Internet services are higher than they need to be. Monitoring bandwidth utilization is an early indicator if more or less bandwidth is required resulting from a change in technology (e.g. an increase in video conferencing or cloud services) or a change in the number of network users.

The graph below is network utilization for Wednesday, March 18, 2020. Green indicates download bandwidth and blue is upload. Spikes occur at every 4 hours on the hour and 30 minutes after the hour. These represent throughput tests. Utilization in this chart is averaged over a 2 minute period to even out spikes that can skew utilization. As a result the throughput tests, which generally run in under 10 seconds, use 1 Mb of bandwidth over the 2 minute period when actually they have a burst of 28 Mbps for 10 seconds and then the network is idle. During business hours, the download averages under 1 Mbps and upload is well under 1 Mbps. From approximately 1 PM - 2 PM download utilization increases to 4-5 Mbps and again from 4 - 5 PM. Noticing this we contacted the office and were told that the office was streaming live coverage of Covid-19 news conferences.

Even when streaming high definition video, ABC Corp. has sufficient bandwidth with their current ISP package (35 Mbps download and 5 Mbps upload). This information is helpful when selecting a proper bandwidth package if a change in Internet service providers is necessary.

Notice in the graph above that the most bandwidth utilization occurs during business hours, which makes sense. In the Section 3 Assessment Summary, based on the specific needs of this client, we were able to suggest the kind of service this client needs to pursue when considering the ISPs that service their geographic area. By looking at the utilization graph above, we determined that this client's needs do not exceed more than a 20 Mbps fiber connection and they can solve their latency and jitter issues without overpaying for bandwidth.