Aggregation for Measurement Efficiency in the ENABLE Service

By

Karthik Balasubramanian

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Professor in Charge

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Committee Members

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To my parents

Without whose love and encouragement this would not have been possible

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Abstract

The speed of the Internet backbone has increased considerably in the recent years due to the ever-growing demands of emerging Next Generation Internet applications. Unfortunately, distributed applications are not able to take advantage of these high-speed networks. The ENABLE (Enhancing of Network-Aware Applications and Bottleneck Elimination) service has been developed with the objective of enabling applications to optimize their use of the network and achieve the highest possible throughput. In other words, it provides clients with the correct tuning parameters for a given network path. It accomplishes this task by conducting network measurements with heavyweight tools such as pipechar, which occupy a significant amount of bandwidth. In order to minimize the bandwidth occupancy by such measurement tools, we need to aggregate the measurements to avoid redundant testing.

In this thesis, three aggregation schemes have been proposed to reduce redundant measurements. The aggregation schemes have been implemented, tested and evaluated.

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Chapter 1

Introduction

Emerging Next Generation Internet (NGI) applications are pushing the limits of available network bandwidth. There are two critical services required to guarantee maximum efficient use of the network resources. The first is a system for monitoring the performance of each component in the system, enabling detailed performance analysis of the complete end-to-end system. The second is a system for monitoring current network characteristics, and providing this information to network-aware applications, which can effectively adapt to the current network conditions. These capabilities require a very similar set of services. Both require an adaptive monitoring infrastructure, a monitor data publishing mechanism, and monitor data analysis tools. The ultimate goal is to address these issues in order to provide manageability, reliability, and adaptability for high performance applications running over wide-area networks.

The next generation of high-speed networks will allow DOE (Department of Energy) scientists, unprecedented levels of collaboration. Large data archives will be easily accessed from anywhere on the network. However, diagnosing performance problems in high-speed wide-area distributed systems is difficult because the components are geographically and administratively dispersed, and problems in one element of the system may manifest itself elsewhere in the network. Problems may be transient, and may be due to activity in the infrastructure. Also, a large volume of monitoring data may be needed for diagnosis and the type of monitoring data and its analysis depends on the

nature of the problem, and the necessary monitoring data may not be available when it is needed.

In addition to the ability to locate performance problems, in order to efficiently use NGI networks this new class of applications will need to be *"network-aware"*. Network-aware applications attempt to adjust their resource demands in response to changes in resource availability. Emerging QoS services will allow the application to participate in resource management, so that network resources are applied in a way that is most effective for the application. Network-aware applications will require a general-purpose service that provides information about the past, current, and future state of all the network links that it wishes to use. This service is called *ENABLE* (Enhancing of Network-aware applications and Bottleneck Elimination). This service will include monitoring tools, visualization tools, archival tools, problem detection tools, and monitoring data summary and retrieval tools. The monitoring tools will be capable of monitoring the entire end-to-end system, and will include tools for monitoring network components (switches, routers, and links), system components (hosts, disks, etc.), and applications. The results of the monitoring will then be published in directory services via the Lightweight Directory Access Protocol (LDAP) [7], allowing network-aware applications to obtain the information needed to adapt to current conditions.

1.1 ENABLE Overview

The Enable service works as follows: An Enable server is co-located on a system that serves large data files to the wide-area network (e.g.: an FTP or HTTP server). The Enable service is then configured to monitor the network links to a set of client hosts from the perspective of that data server. The list of client hosts may be obtained in 2 ways: The log files are monitored for connection from clients and then network tests are run based on this list of clients. The other way is by reading the list of hosts at start-up from a configuration file. Several measurement tools such as Ping, Pipechar, Iperf and Nettest are used. The current version of the Enable service supports only Ping and Pipechar [2] by default. The network monitoring results are stored in a database, and can be queried by network-aware distributed components at any time. The Enable service runs the network tests on a time interval basis (e.g.: every 6 hours, or whenever a new client connects). The applications use statically defined maximum link throughput information, along with dynamically determined delay information, to compute the optimal buffer sizes. The Enable service makes this much simpler by providing the client and server with the optimal buffer size to use for a given link.

1.1.1 Scalability Issues

As mentioned before, one of the network tools that the Enable service runs is the Pipechar tool. A single Pipechar test runs for about 15-20 minutes and occupies approx. 100 Kbits/sec [16]. Hence, there is a need to minimize the number of Pipechar measurements performed by the Enable service. This thesis work involves proposing and implementing aggregation schemes that will reduce redundant testing between the server

and the client hosts. This is done in order to scale the Enable service to networks with many clients. Aggregation involves the abstraction of a set of individual pair-wise performance behaviors by a single performance characteristic. This is a widely used method to improve the scalability of routing and quality of service schemes. Unfortunately, there is a fundamental trade-off between precision and scalability in any such aggregation technique [16].

1.2 Thesis Organization

Chapter 2 discusses about the ENABLE service architecture. Chapter 3 discusses about the Scalability issues that are involved with the Enable service. This is followed by Chapter 4, which discusses in detail, the three aggregation schemes that have been proposed and implemented. In Chapter 5, the tests conducted have been discussed along with an analysis of results and a performance evaluation of the three aggregation schemes. Finally in Chapter 6, conclusions have been drawn based on test results and some possible future work has been suggested.

Chapter 2

ENABLE Architecture

The Enable service has three distinct components. The first component constitutes the Enable network advice server, whose functionality is to run a set of network measurement tools between the server and clients that connect to the server. The second component is a protocol for clients to communicate with the servers. Finally, the third component is nothing but a simple API that makes queries with the Enable Server. The Enable service has been designed in such a way that it can be easy to install, configure and use.

The architecture of Enable is shown in Figure 1. “The simplicity of the design is its strength. An Enable Server is installed on every data server host, such as an FTP server, and that Enable server is responsible only for determining the optimal network parameters between clients and itself” [16]. The Enable service is easy to deploy and configure, since it does not require the software to be installed on every client host. There is no centralized coordination problem, since the Enable service is always co-located with the data server. The following sections describe the functionality and the implementation details of the Enable Service.

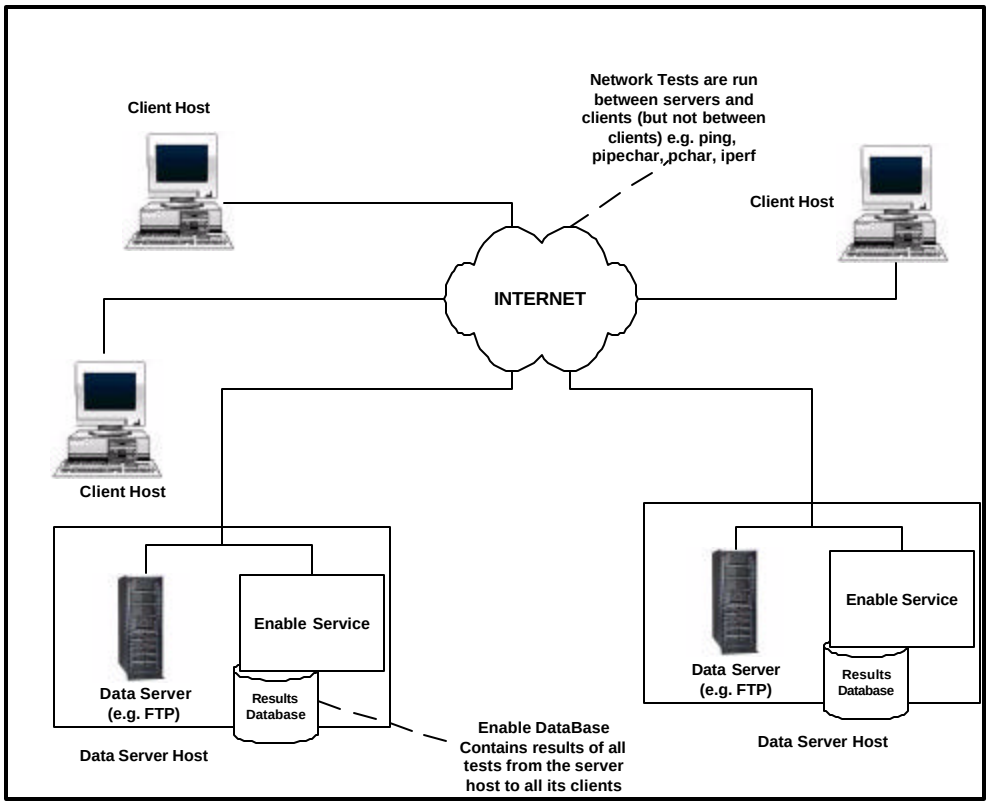

Figure 1: Enable Service Architecture

2.1 Functionality

The Enable service is so named, because it enables clients to achieve much higher throughput from the server. The Enable Server periodically runs tests between itself and a number of client hosts. In other words, when Enable detects a new client, it runs pipechar and ping and stores the results in a database. These client hosts are generally read at start-up from a configuration file, manually added using an API or command-line utility, or automatically added by monitoring log files from the data server, such as HTTP or FTP logs. The results of the network tests are stored in a database. The scheduling of tests for each client is dynamically configurable ie, the user can specify how periodically the tests need to be run. Clients then query the Enable server, which listens on a well-known port, for network parameters, also called "network advice". The protocol for doing this is

XML-RPC [19], a standard XML-based protocol that performs remote procedure calls over HTTP. A standard protocol is used so that third party software can easily interface with the Enable service without using the Enable API or libraries. Currently a Python [13] based API has been developed that allows the user to interact and query network information from the Enable server. An example of a simple API that clients use to query the Enable Server is as follows:

```
tcp_buffer_size = EnableGetBufferSize(ftp_hostname)
```

returns the optimal buffer size between the client and the FTP server host, and:

```
net_info = EnableGetNetInfo(ftp_hostname)
```

returns the result of all network tests for that network path.

Currently the Enable server supports network tests such as ping, pipechar, pchar [14], and iperf, but only ping and pipechar are run by default. Note that the network tests are run between servers and clients (but not between clients).

2.2 Implementation

The Enable framework has been implemented by the LBL group at University of California, Berkeley. It is implemented using the Python language, and uses XML-RPC for client-server communication. The use of Python with XML-RPC greatly simplified the development of the server, as Python includes very powerful built in modules for threads, queues, databases, regular expressions, configuration file parsing; almost everything required by this service. The server uses a thread pool of worker threads for running the network tests, and a scheduler thread to feed jobs to the workers. There is also a thread for scanning log files (e.g. FTP logs) for new hosts to monitor. It has been

designed for the easy addition of new tests, and each test is realized by a class instance in Enable. Enable requires only 3 specific methods in the new class be implemented: "init", "can_I_run" (is it safe to start this test), and "run". There is a configuration file that specifies the list of log files to monitor and how often to re-run the tests.

2.3 Related Work

A number of network monitoring systems have been developed for gathering performance measurements on large networks. For example, the National Internet Measurement Infrastructure (NIMI) [12] uses active measurements for fault diagnosis in large networks such as the Internet. The focus of the NIMI project is to develop techniques for performing Internet measurement that are capable of scaling to full-Internet size. NIMI uses multiple synchronized NIMI daemons as end-points for a set of measurement tools. An IP packet generator collects data along an Internet path between the two NIMI daemons.

The Surveyor [5] system is an infrastructure that measures end-to-end unidirectional delay, packet loss and route information along Internet paths. It is globally deployed at about 50 higher education and research sites. It makes use of dedicated computers and hardware to perform continuous network measurements. These computers have GPS hardware for time synchronization. The unidirectional delay is measured as follows. A test packet containing 12 bytes of user data including a sequence number and a timestamp is generated every two seconds. The packet is sent using UDP (User Data Protocol). Since the Surveyor machines have GPS hardware, the machines that receive

the test packets are capable of determining the delay by subtracting “time in received packet” from “current time”.

The Web100 [15] project is aimed at making end-hosts on the Internet to automatically achieve high bandwidth data rates over the high performance research networks. The goal of the Web100 project is to enable ordinary network users to attain full network data rates without help from network experts. It also frees the end user from the need to have detailed knowledge of the network in order to use it effectively. The details of the implementation of the Web100 software suite are as follows. Tools are designed to locate bottlenecks within the following subsystems: the sending application, the sending operating system, the Internet path, the receiving operating system, and the receiving application. As part of the applications work, a suite of host-based network diagnostic and performance measurement tools are developed to give the user and network administrator a dynamic view of the behavior of individual TCP sessions. TCP autotuning is performed in process-level code. Autotuning is the ability to automatically tune TCP to simultaneously achieve maximum throughput across all connections for all applications within the resource limits of the host.

Chapter 3

Scalability Issues with ENABLE

This chapter discusses the scalability issues involved in running the Enable service and the possible aggregation solutions. It also describes the pipechar tool in detail.

As already mentioned before, there are a number of scalability issues that arise when running network testing tools in the Enable service. One issue is, whether to time out clients from the database if the server does not get a connection from a client for a particular period of time. This is to ensure that the size of the database does not keep increasing. Another issue is, controlling how frequent the tests should be run. The third issue, the most important one and that which is being addressed in this thesis work is, to reduce the amount of redundant testing between the server and client hosts. This is done due to the fact that pipechar occupies a significant amount of bandwidth.

3.1 Various techniques for Aggregation

Any aggregation technique will have a certain amount of trade-off between precision and scalability. Several techniques for aggregation will be discussed below. The choice of aggregation schemes will be determined once the Enable service is fully configured and deployed.

An approach for aggregating measurements is to run periodic measurements between the server and clients and keep track of how many queries there were for various clients, and only automatically re-run the tests for only those that go over a particular threshold. For example, if the threshold value is 20, then tests are re-run for all clients that make more than 20 queries. Another approach is to run tests to all clients at least once and develop a database of bottlenecks for all clients. Then additional redundant testing can be avoided for clients with the same bottleneck link. An example is shown below in Table 1.

Client	Bottleneck Router
129.237.116.6	164.113.232.202
129.237.127.152	164.113.232.202
131.243.2.12	131.243.128.100
131.243.2.91	131.243.128.100
192.195.6.68	144.232.0.171

Table 1: Bottlenecks to Clients [16]

From the above table, it can be seen that the bottleneck for clients, 129.237.116.6 and 129.237.127.152 is 164.113.232.202. Hence a pipechar test would be performed to only one of the clients, but not both. Similarly, we can see that 131.243.2.12 and 131.243.2.91 have the same bottleneck and hence a pipechar test is suppressed to one of the clients. From the above table, there is something interesting to note. Hosts belonging to the same Subnet have the same bottleneck. When clients connect to the Enable server,

if they can report both their IP address and subnet information, then it would prove useful for aggregating measurements.

Another method of aggregation can be based on finding the AS number [8] and traceroute information. The AS number can be found out by looking up into a BGP table. Pipechar takes the same route as that of traceroute. Hence, if traceroute to a host indicates that a host is behind an already known existing bottleneck, then measurements can be avoided to that host. Another scheme of aggregation can be based on the AS number and the Ping statistics. These two methods of aggregation will be discussed in detail in a subsequent chapter. The following section discusses about the pipechar tool in detail.

3.2 Pipechar

3.2.1 Overview

In order to utilize the network effectively, distributed applications require information about the state of the network. More commonly, they require information such as the available and maximum bandwidth, current and minimum latency, bottleneck links, burst frequency, and congestion extent. This type of information allows applications to determine parameters like optimal TCP buffer size. However, the TCP buffer size is not the only parameter that affects network performance. A number of other factors also affect network performance. For example, incorrectly configured network components such as routers and switches can degrade network performance drastically. Congested network condition on a router is another factor that affects network performance. System limitation is a very common cause for bottlenecks. In order to

identify the real cause for inefficient utilization of network throughput, a network analysis tool is required. There are several network measurement tools, but all of these tools are limited in one or more of the following ways:

- They target a specific problem.
- They measure neither static nor dynamic bandwidth.
- They cannot locate and distinguish bottleneck links.
- They cannot measure the high-speed link bandwidth accurately beyond a bottleneck link.

Some of the common issues that relate to network measurement tools are:

- What bandwidth needs to be measured? Static or Dynamic?
- Does the measurement tool need to use information from network elements such as routers and switches?
- Does the measurement need to be done hop-by-hop or end-to-end?
- Does the tool need to be installed at both ends of a path? If not, is it send-only or receiver-only?

Pipechar is a user-level tool that solves the above issues and provides user required network information. It is a part of the NCS (Network Characterization Service) package [4]. It runs in user space, hence it is able to run on any platform without router access privileges. Its protocol is designed for scalable and distributed deployment, similar to DNS. Its algorithms provide efficient, speedy and accurate detection of bottlenecks,

especially dynamic bottlenecks. On current and future networks, dynamic bottlenecks do and will affect network performance dramatically.

3.2.2 Functionality of Pipechar

Pipechar probes the network to find out a bottleneck link across a network. It can also supply information regarding RTT and jitter times. It does, however, require super-user privileges in order to run. When pipechar runs, it measures network parameters hop-by-hop rather than end-to-end. Hence, it can be a very intrusive application to use. It is a 'Sender only' network probing program that is used to diagnose potential problems in a network link. Information about the bandwidth at each hop of an internet connection is displayed along with information regarding the ping times. However, in order to do this pipechar has to send a large burst of data through the link, which may cause further problems on the network if already problematic. Pipechar only accurately reports up to the slowest hop in the link. Hence measurements past this slowest hop should not be assumed accurate. The benefit of this is that pipechar runs a lot faster than similar tools like pathchar.

Pipechar reports two kinds of bandwidth metrics: the capacity of the link and the available bandwidth. The capacity is the maximum throughput that the path can provide to an application when there is no competing traffic load (cross traffic). The available bandwidth, on the other hand, is the maximum throughput that the path can provide to an application, given the path's current cross traffic load. Measuring the capacity is crucial for debugging and managing a path. Measuring the available bandwidth, on the other

hand, is of great importance for predicting the end-to-end performance of applications, for dynamic path selection and traffic engineering and for selecting between a number of differentiated classes of service.

3.2.3 Use of Pipechar

This section describes the pipechar tool. We shall also look at the syntax and a sample output of a pipechar test. The syntax for pipechar is as follows: pipechar [-l] xxx.yyy.zz.hhh. In the above command, xxx.yyy.zz.hhh represents the IP address of a host. The "-l" option is used for bypassing non-responsive routers. If a warning message like this: “pipechar [Mar25-2K1]: can't reach the host6[xxx.yyy.zz.hhh] with max_ttl(9) try to analyze partial path instead” appears, then the "-l" option is used to eliminate the problem. If the destination is not reachable, then pipechar displays the following message: “Warning: Host [xxx.yyy.zz.hhh] is not alive”.

Figure 2 shows a sample of a pipechar result.

```
raphael [12] % pipechar -l www-didc.lbl.gov
0: localhost [10 hops]
 1: NoNameNode                          (10.10.127.254)   1.11  -0.09   3.67ms
 2: ks-2-a10-52.r.greatplains.net       (164.113.234.206) 1.21   1.70   8.66ms
 3: ks-2-abilene-ks.r.greatplains.net   (164.113.238.193) 1.15   1.31   9.02ms
 4: dnvr-kscy.abilene.ucaid.edu         (198.32.8.13)     1.06   0.99  21.25ms
 5: snva-dnvr.abilene.ucaid.edu         (198.32.8.1)      1.04   1.04  43.51ms
 6: esnet-snva.abilene.ucaid.edu        (198.32.11.94)    9.30 -10.92  85.29ms
 7: lbl-snv-oc48.es.net                 (134.55.209.6)    1.01   3.83  87.17ms
 8: lbnl-ge-lbl2.es.net                 (198.129.224.1)   1.05  -9.47  85.10ms
 9: ir1000gw.lbl.gov                    (131.243.128.210) 1.42  -3.53  54.75ms
10: george.lbl.gov                      (131.243.2.12)    1.23  -0.78  50.24ms

PipeCharacter statistics: 91.36% reliable
From localhost:
|       64.865 Mbps  100BT (97.0672 Mbps)

1: NoNameNode                       (10.10.127.254)
|
|       58.451 Mbps    !!! ??? congested bottleneck <40.3480% BW used>
2: ks-2-a10-52.r.greatplains.net   (164.113.234.206)
|
|       61.276 Mbps    !!! ??? congested bottleneck <59.7124% BW used>
3: ks-2-abilene-ks.r.greatplains.net(164.113.238.193)
|
|       66.632 Mbps    !!! ??? congested bottleneck <56.2190% BW used>
4: dnvr-kscy.abilene.ucaid.edu     (198.32.8.13 )
|
|       147.294 Mbps             <2.0733% BW used>
*************************************************************************
5: snva-dnvr.abilene.ucaid.edu     (198.32.8.1  )
|
|       6.377 Mbps    !!! ??? congested bottleneck <95.8395% BW used>
6: esnet-snva.abilene.ucaid.edu    (198.32.11.94)
*************************************************************************
|
|       151.314 Mbps    !!!      <90.9448% BW used>
7: lbl-snv-oc48.es.net               (134.55.209.6)
|
|       153.667 Mbps             <4.0800% BW used>
8: lbnl-ge-lbl2.es.net               (198.129.224.1)
|
|       49.778 Mbps    !!! ??? congested bottleneck <67.2414% BW used>
9: ir1000gw.lbl.gov                  (131.243.128.210)
|       58.727 Mbps  100BT (96.4499 Mbps)

10: george.lbl.gov                    (131.243.2.12)
```

Figure 2: Sample Pipechar output

From the above pipechar sample, it can be seen that pipechar has two report sections. In the first section, pipechar prints out some timing for each hop. In this section, three times are reported -- minimum packet forwarding time, average packet differential time, and minimum round trip time (RTT). The 1st and 3rd timings represent how fast

packets can travel through this hop; and the second timing gives some error information (it can be a negative value frequently). In the second section, pipechar does hop-by-hop statistic analysis. It reports a “reliable” percentage parameter. This parameter is a measure of the quality of information it has collected. Obviously, a higher reliable percentage is good. In the above example, it is 91.36%. A low “reliable” percentage implies that more error was encountered during the probing, and the network utilization is high at this time. In the statistic section, the bandwidth utilization is reported. It is analyzed except for the two ends of the path. If the hop analyzed is not in congested bottleneck, the left number is the maximum bandwidth that can be used for this link, and the currently used bandwidth percentage is reported on the right side. If the hop analyzed is a congested hop, then the left number represents the available bandwidth for this hop now. The statistic reports for the two ends of the path are maximum interface speed (left side) and the link bandwidth (right side). If pipechar reports more than a single congested bottleneck, then the narrowest hop is considered for debugging and testing purposes.

Chapter 4

Implementation of Aggregation Schemes

This chapter takes a detailed look at the implementation of the aggregation schemes. All the aggregation schemes have been coded in Perl [17]. The code has been included in Appendix B. The following aggregation schemes have been implemented in this thesis work.

- Aggregation based on Subnet Information.
- Aggregation based on AS Number and Ping Statistics.
- Aggregation based on AS Number and Traceroute Information.

Before we look at the implementation details of the aggregation schemes, let us describe a Looking Glass Server [10]. In this thesis work, a Looking Glass Server is used to determine routing information such as Subnet and AS number.

4.1 Looking Glass Server

A Looking Glass Server basically gives routing information with regard to network prefixes in question. It is useful for resolving Internet operational problems, especially those involved in connectivity and routing. It is generally deployed by a network-provider. A Looking Glass Server allows a provider to conduct a more complete diagnosis of a problem without contacting another provider's operations center, thereby promoting more rapid and efficient resolution of inter-provider routing problems. It

typically provides a subset of common router commands, carefully chosen by the provider as a compromise between debugging capability and reasonable security. An example of a Looking Glass that provides a command-line interface is the server “route-server.cerf.net”. The interface is similar to that of Cisco IOS (Internetwork Operating System) command line interface. Cisco IOS is the software that runs on the vendor’s routers. There are also Looking Glass Servers that provide a graphical web interface. When displayed in a browser, this interface allows commands like traceroute, ping, BGP route query, and other options. Routing commands such as “show ip route " and "show ip bgp” are often used to access the routing views. Looking Glass Servers are located all over the world and the usage of this tool is open to anybody interested.

4.2 Aggregation based on Subnet Information

This is the simplest of the three schemes proposed. Every host that connects to the Enable server is identified based on the Subnet to which it belongs. Hence hosts may need to report their IP addresses when they connect to the Enable server. Hosts sharing an IP address prefix with another host already in the table get similar treatment. In other words, the bottleneck hop for hosts on the same subnet is the same. This obviously does not take into consideration the internal details of the client networks. The Subnet information may be determined by querying a Looking Glass Server.

4.2.1 Implementation of Subnet scheme

In order to retrieve and parse the Subnet information from a Looking Glass Server web page, a few Perl modules from CPAN (Comprehensive Perl Archive Network) [2] were used. These are: HTTP::Request::Common, LWP::UserAgent and LWP::Simple. All these modules form a part of the libwww-perl-5.65 package [2]. The libwww-perl collection is a set of Perl modules, which provides a simple application programming interface to the World-Wide Web.

The HTTP::Request::Common module provide functions that return newly created HTTP::Request objects. These functions are usually more convenient to use than the standard HTTP::Request constructor for these common requests. Some of the functions provided are:

(1) GET $url, Header => Value,...

(2) PUT $url, [Header => Value,...]

(3) POST $url, [$form_ref], [Header => Value,...]

The LWP::UserAgent is a class implementing a World-Wide Web user agent in Perl. It brings together the HTTP::Request, HTTP::Response and the LWP::Protocol classes that form the rest of the core of libwww-perl library. In normal use the application creates a LWP::UserAgent object, and then configures it with values for timeouts, proxies, name, etc. It then creates an instance of HTTP::Request for the request that needs to be performed. This request is then passed to one of the UserAgent's request() methods, which dispatches it using the relevant protocol, and returns a HTTP::Response object.

Figure 3 shows a flowchart representation of the implementation of the Subnet scheme algorithm.

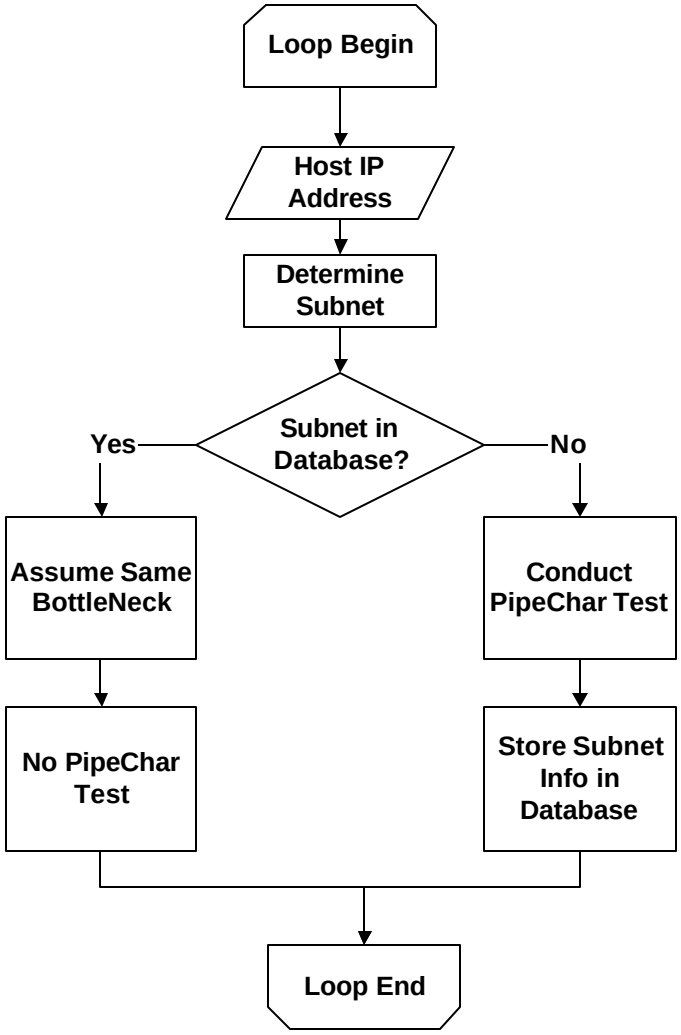

Figure 3: Flowchart representing Subnet Scheme Algorithm

The IP addresses that connect to the Enable server are stored in a configuration file. When the 1st IP address connects, the subnet to which it belongs is found and the subnet information is stored in a hash table. The subnet information is found from a Looking Glass Server website. The subnet information is alone parsed and returned to the

`ipsubnetarray` hashtable. A pipechar test is performed for this address, since it's the first IP address that connects. The bottleneck hop obtained as a result of the pipechar test is stored in another hash table corresponding to the IP address of its host. Note that pipechar sometimes reports several bottlenecks along the path. In such a case, the narrowest hop is taken into consideration. For subsequent IP addresses that connect to the Enable server, the subnet to which they belong are found and if, the subnet already exists in the hash table, then pipechar test is NOT performed for the corresponding host. This way pipechar tests are performed for only hosts that exist on different subnets.

4.3 Aggregation based on AS Number and Ping Statistics

This scheme is based on finding the AS Number and the Ping Statistics of a particular host. Here again hosts need to report their IP addresses when they connect to the Enable server. It is assumed that hosts belonging to different AS numbers have differing bottleneck hops and hence we do not attempt to aggregate pipechar measurements for such hosts. This is based on the simple reasoning that hosts belonging to different AS numbers are geographically located far way from each other. Hence, only hosts belonging to the same AS number are considered for aggregation. But again, not all hosts within the same Autonomous system are aggregated. The Ping time of the hosts is the second parameter that is taken into consideration. Ping times of hosts belonging to the same AS are measured. Based on hypothesis testing procedures, we conclude that 2 hosts belong to the same distribution and hence we avoid redundant pipechar tests for one of the hosts. The hypothesis tested here is phrased in terms of a difference $?_1 - ?_2$ between the means of two different population distributions.

4.3.1 Hypothesis Testing Procedure (Z Test)

The Z test is used to find out if the mean of two different population distributions is equal. In this thesis work, the Z test is used to find out if the mean ping times of two hosts are the same. The ping times are assumed to follow normal distribution. This is based on the fact that when the number of samples is very large, the distribution will tend to a normal distribution. The following are some basic assumptions made in this testing procedure.

- Ping times for host 1: $X_1, X_2, X_3 \ldots X_{100}$ is a random sample from a population with mean μ_1 and variance σ_1^2
- Ping times for host 2: $Y_1, Y_2, Y_3 \ldots Y_{100}$ is a random sample from a population with mean μ_2 and variance σ_2^2
- X and Y samples are independent of one another

The null hypothesis is H_0: $\mu_1 - \mu_2 = \mu_0$ where, μ_0 is the null value of the difference in population means. The value of $\mu_0 = 0$. Hence the null hypothesis becomes H_0: $\mu_1 = \mu_2$. The two hypotheses being tested are H_0: $\mu_1 - \mu_2 = 0$ versus H_a: μ_1 not equal to μ_2. If H_0 is true, then both host 1 and host 2 belong to the same population distribution and hence we can say that both the hosts will have the same bottleneck hop. Hence, pipechar tests will be conducted to only one of the hosts. The Test statistic Z, which is used to decide between H_0 and H_a is defined as

$$Z = \frac{\mu_1 - \mu_2}{\sqrt{\frac{\sigma_1^2}{m} + \frac{\sigma_2^2}{n}}}$$

where,

m : Number of samples for host 1

n : Number of samples for host 2

The set of Z values for which H_0 is to be rejected are specified. A ? (Type I error probability) value is defined. A Type I error probability is defined as the probability of H_0 being rejected when H_0 is actually true. A Type II error probability is defined as the probability of H_0 NOT being rejected when H_0 is false. An interesting analogy: "In the judicial system, H_0 states that the defendant is innocent, so a Type I error results when an innocent person is convicted and a Type II error results when a guilty person is set free" [1]. Assuming a ? value of 0.01, $Z_{?/2} = 2.57$. If, $Z < Z_{?/2}$, then H_0 is accepted. If $Z >= Z_{?/2}$, then H_0 is rejected.

4.3.2 Implementation of Ping Statistics scheme

In this scheme too, HTTP::Request::Common, LWP::UserAgent and LWP::Simple modules from CPAN are used. Here, instead of retrieving the Subnet information, the AS number is parsed and retrieved. There are two more modules used in this program, Math::Cephes [6] and Statistics::Descriptive. This Math::Cephes module provides a perl interface to the cephes math library. It is used in order to calculate the erfc function for calculating the $Z_{?/2}$ value. The Statistics::Descriptive module is used for calculating the variance for ping times for all the hosts. Figure 4 shows the flowchart representation of the implementation of the Ping Statistics Scheme.

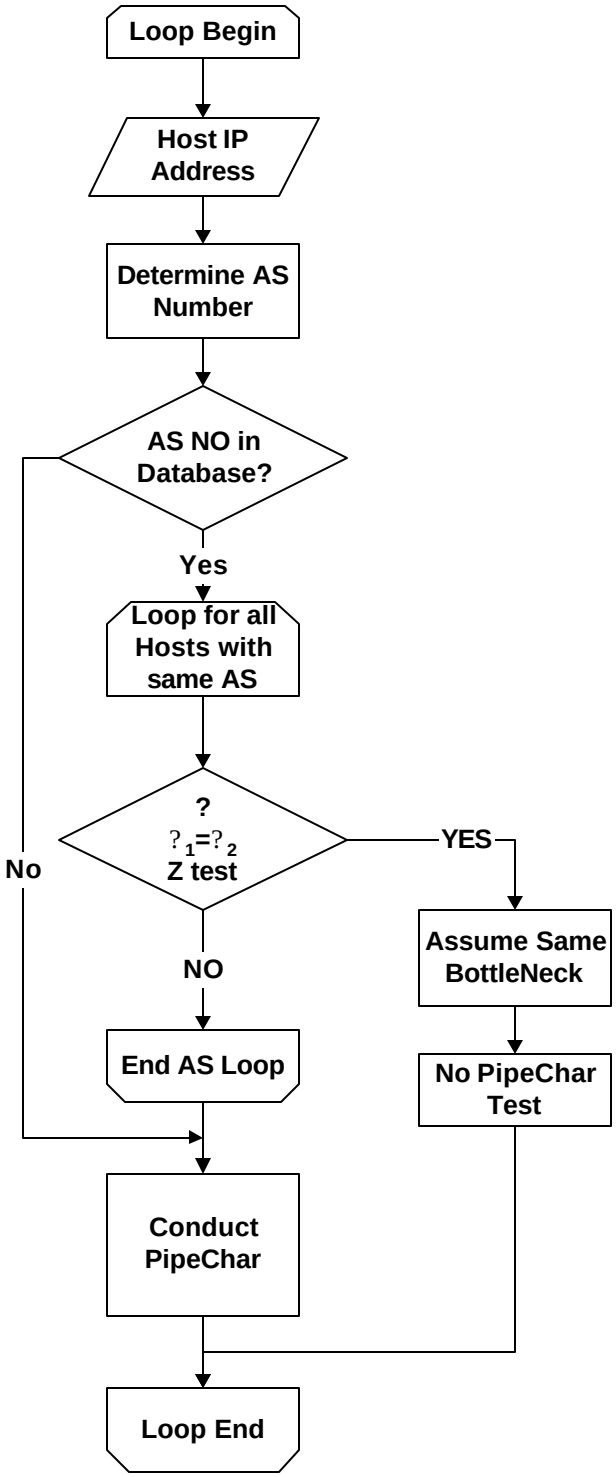

Figure 4: Flowchart representing Ping Statistics Scheme Algorithm

The list of hosts is read from a configuration file. Using a Looking Glass, the AS number is parsed and retrieved and stored in the `ipasarray` hash table. Then the ping test is conducted for all the hosts and the mean ping time is found. Since the ping program itself gives the average round trip time, it is parsed and the mean ping time value is returned. The variance is also computed as part of the script. The number of pings done for each host is 100. For hosts belonging to the same AS, the hypothesis testing procedure is applied for 2 hosts at a time and based on the $Z_{?/2}$ value, it is concluded whether the 2 hosts have the same ping times or not, ie, in other words to say if they will have the same bottleneck hop or not.

4.4. Aggregation based on AS Number and Traceroute Information

4.4.1 Implementation of Traceroute Information scheme

This aggregation scheme is different from the previous one in a way that pipechar tests for hosts belonging to different AS numbers are aggregated. Hosts are read from a configuration file. Figure 5 shows a flowchart representation of the implementation of the Traceroute scheme.

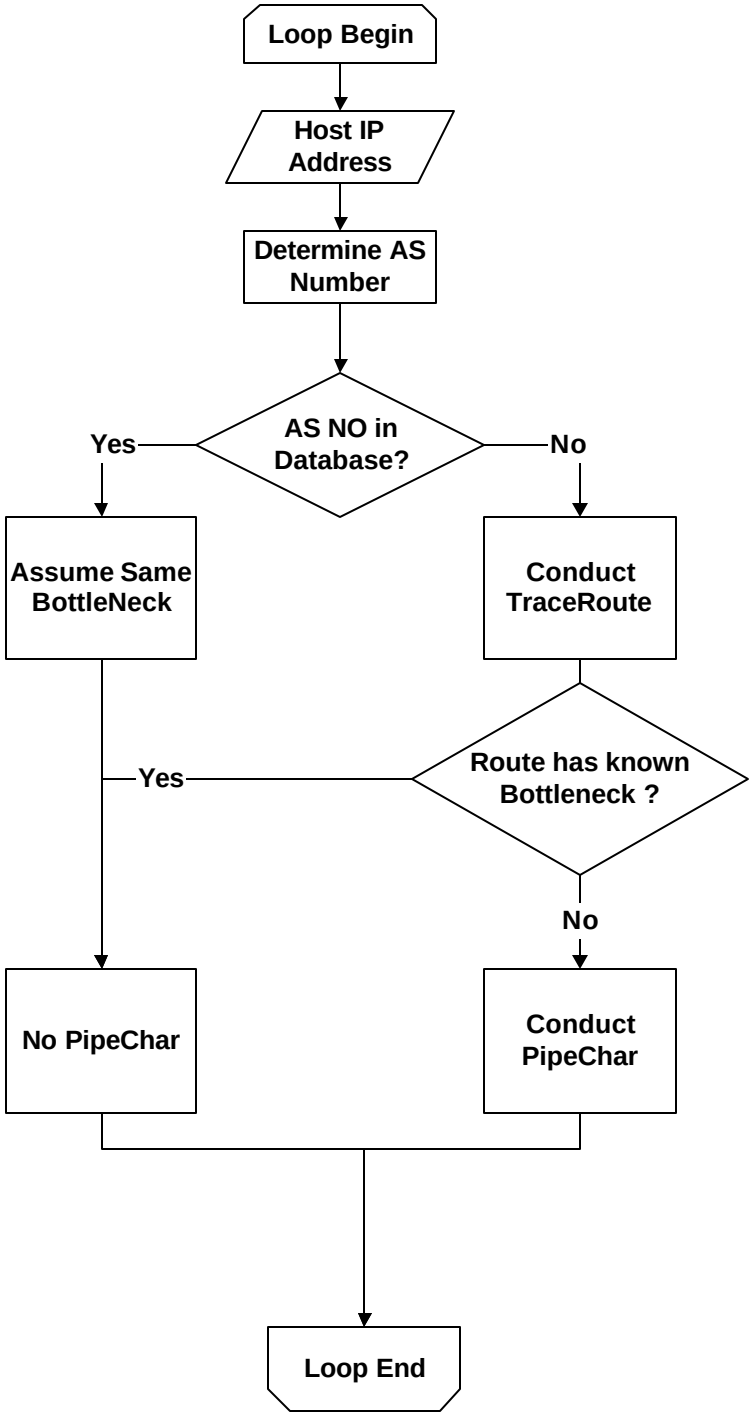

Figure 5: Flowchart representing Traceroute Scheme Algorithm

As always, a pipechar test is performed for the 1st host that connects to the Enable server. For subsequent hosts that connect, a traceroute is conducted for hosts for which the AS number is not already in the hash table. The traceroute result is parsed and compared with the bottleneck file. If there happens to be an already existing bottleneck in the traceroute path, then a pipechar test is avoided for that particular host. If the traceroute path does not contain any existing bottlenecks, then a pipechar test is conducted for that host and the new bottleneck hop is concatenated to the list of bottlenecks in the bottleneck file. This way, as the bottleneck file grows bigger in size, more number of pipechar tests are avoided for future hosts that connect to the Enable server.

Chapter 5

Evaluation of Aggregation Schemes

This chapter discusses the tests that were conducted to evaluate the implementation of the three aggregation schemes and results gathered. A performance comparison has been made between the three schemes. Tests were conducted for the following.

(i) Aggregation based on Subnet Information

(ii) Aggregation based on AS Number and Ping Statistics

(iii) Aggregation based on AS Number and Traceroute information

5.1 Aggregation based on Subnet Information

The Aggregation scheme based on Subnet Information was run for 2 different hosts, one host being the host at EDC (EROS Data Center in Sioux Falls, SD) whose IP address is 192.41.204.5 and the other host being the host at ITTC, University of Kansas, Lawrence, KS whose IP address is 129.237.126.172. The set of clients IP addresses were stored in a configuration file. In this scenario, the host at EDC and the host at ITTC are assumed to be the Enable servers and the set of IP addresses are assumed to be the clients that connect to the Enable service. This testing scenario is similar to the Enable service environment.

5.1.1 Subnet Scheme Tested from EDC host

This test was run from the EDC host (192.41.204.5). The configuration file consists of a set of 14 IP addresses. Note that the IP addresses have been chosen in such a way that they demonstrate the usefulness of the proposed Subnet scheme. Five different subnets have been chosen and 2 or more IP addresses are from one particular subnet. Table 2 below shows the list of IP addresses of the client hosts that were used for the experiment, their respective subnets and the decision taken by the Subnet scheme algorithm.

IP Address	Subnet	Pipechar Test Required?
198.133.219.125	198.133.219.0/24	Yes
66.218.71.83	66.218.64.0/20	Yes
66.218.71.77	66.218.64.0/20	No
198.133.219.25	198.133.219.0/24	No
192.150.14.120	192.150.14.0/24	Yes
66.218.71.81	66.218.64.0/20	No
194.183.224.106	194.183.224.0/19	Yes
192.150.14.110	192.150.14.0/24	No
204.202.132.15	204.202.128.0/19	Yes
194.183.224.114	194.183.224.0/19	No
66.218.71.87	66.218.64.0/20	No
192.150.14.104	192.150.14.0/24	No
204.202.132.25	204.202.128.0/19	No
194.183.224.110	194.183.224.0/19	No

Table 2: Results of Subnet Scheme Tested from EDC host

From the above results, it can be seen that a pipechar test is always performed to the 1st host that connects to the Enable server. This is because there are no already known existing bottlenecks in the database. It can also be seen that, only one pipechar test is performed for hosts that belong to the same subnet. The above results were then, validated by performing individual pipechar tests to each of these IP addresses (hosts) and identifying the bottlenecks. The pipechar results for all hosts are included in Appendix A. Table 3 below shows the results validation for Subnet scheme Tested from EDC host.

Client IP Address	Congested Bottleneck
198.133.219.125	Hops 3 through 15 equally congested
198.133.219.25	
66.218.71.79	Hops 3 through 16 equally congested
66.218.71.81	
66.218.71.83	
66.218.71.87	
192.150.14.104	gbr5-p51.cgcil.ip.att.net (12.123.4.234)
	gbr3-p100.cgcil.ip.att.net (12.122.5.2)
192.150.14.110	gbr5-p51.cgcil.ip.att.net (12.123.4.234)
	gbr3-p100.cgcil.ip.att.net (12.122.5.2)
192.150.14.120	gbr5-p51.cgcil.ip.att.net (12.123.4.234)
	tbr1-p013801.cgcil.ip.att.net (12.122.10.50)
204.202.132.15	Hops 3 through 15 equally congested
204.202.132.25	
194.183.224.106	Hops 3 through 15 equally congested
194.183.224.110	
194.183.224.114	

Table 3: Results Validation for Subnet Scheme Tested from EDC host

From the above table, it is seen that there is no distinct narrow bottleneck for some hosts. For example, for hosts, 198.133.219.125 and 198.133.219.25, there is not a distinct narrow bottleneck. Hops 3 through 15 are equally congested. The results were similar for the following hosts:

- 204.202.132.15 and 204.202.132.25
- 194.183.224.106, 194.183.224.110 and 194.183.224.114
- 66.218.71.79, 66.218.71.81, 66.218.71.83 and 66.218.71.87

For 192.150.14.104 and 192.150.14.110, there was a distinct bottleneck identified.

Bottleneck identified: gbr5-p51.cgcil.ip.att.net (12.123.4.234)

gbr3-p100.cgcil.ip.att.net (12.122.5.2)

The available bandwidth for this hop was approx. 7 Mbps.

For 192.150.14.120, the bottleneck identified was:

gbr5-p51.cgcil.ip.att.net (12.123.4.234)

tbr1-p013801.cgcil.ip.att.net (12.122.10.50)

From the IP addresses of the above bottlenecks, we can say that tbr1-p013801.cgcil.ip.att.net (12.122.10.50) is probably another router that lies on the same subnet as gbr3-p100.cgcil.ip.att.net (12.122.5.2).

5.1.2 Subnet Scheme Tested from ITTC host

This test was run from the ITTC host (129.237.126.172). The configuration file consists of a set of 8 IP addresses. Table 4 below shows the list of IP addresses of the client hosts that were used for this test, their respective subnets and the decision taken by the Subnet scheme algorithm.

IP Address	Subnet	Pipechar Test Required?
216.136.131.71	216.136.128.0/22	Yes
64.58.76.224	64.58.76.0/22	Yes
216.136.131.83	216.136.128.0/22	No
204.202.132.15	204.202.128.0/19	Yes
204.202.132.25	204.202.128.0/19	No
216.136.130.54	216.136.128.0/22	No
64.58.77.41	64.58.76.0/22	No
204.202.132.19	204.202.128.0/19	No

Table 4: Results of Subnet Scheme Tested from ITTC host

From the above results, it can be seen that a pipechar test is always performed to the 1st host that connects to the Enable server. This is because there are no already known existing bottlenecks in the database. The above results were then, validated by performing individual pipechar tests to each of these IP addresses (hosts) and identifying the bottlenecks. The pipechar results for all hosts are included in Appendix A. Table 5 below shows the results validation for Subnet scheme Tested from ITTC host.

Client IP Address	Congested Bottleneck
216.136.131.71	cust-int.level3.net (64.152.81.62)
	ge-1-2-.msr2.sc5.yahoo.com (216.115.101.230)
	Bandwidth = 31.162 Mbps
216.136.131.83	cust-int.level3.net (64.152.69.18)
	ge-0-2-0.msr2.sc5.yahoo.com (216.115.100.237)
	Bandwidth = 33.628 Mbps
216.136.130.54	cust-int.level3.net (64.152.69.18)
	ge-0-2-0.msr2.sc5.yahoo.com (216.115.100.237)
	Bandwidth = 35.112 Mbps
64.58.77.41	bbr01-p6-0.stng01.exodus.net (209.1.169.197)
	dcr03-g9-0.stng01.exodus.net (216.33.96.145)
	Bandwidth = 33.441 Mbps
64.58.76.224	bbr01-p6-0.stng01.exodus.net (209.1.169.197)
	dcr03-g9-0.stng01.exodus.net (216.33.96.145)
	Bandwidth = 35.579 Mbps
204.202.132.15	ks-1-a400-51.r.greatplains.net (164.113.232.202)
	ksca01-edge12.mo.inet.qwest.net (65.120.164.237)
	Bandwidth = 36.724 Mbps
204.202.132.25	ks-1-a400-51.r.greatplains.net (164.113.232.202)
	ksca01-edge12.mo.inet.qwest.net (65.120.164.237)
	Bandwidth = 39.856 Mbps
204.202.132.19	ks-1-a400-51.r.greatplains.net (164.113.232.202)
	ksca01-edge12.mo.inet.qwest.net (65.120.164.237)
	Bandwidth = 35.222 Mbps

Table 5: Results Validation for Subnet Scheme Tested from ITTC host

From the above table, it can be seen that

? 204.202.132.15, 204.202.132.25 and 204.202.132.19 all have exactly the same bottlenecks.

? 64.58.77.41 and 64.58.76.224 also have exactly the same bottlenecks.

? 216.136.131.83 and 216.136.130.54 have exactly the same bottlenecks.

216.136.131.71 also had the same bottleneck hop, but slightly differing IP addresses, ie, the bottleneck routers are the same, but a different port on the router.

From the above Subnet scheme tests, it is seen that the bottlenecks for hosts on the same subnet seem to be the same. This is understandable because, the traceroute path is the same until the last hop. Hence, for hosts belonging to the same subnet it would be very useful to conduct a pipechar test for only one of the hosts and suppress redundant testing for the other hosts. The advantage of this subnet scheme is that it is a very simple method of aggregation. The disadvantage of this scheme is that the extent of aggregation is limited.

5.2 Aggregation based on AS Number and Ping Statistics

This scheme was tested by again running the Perl script from 2 different hosts, one host being the host at EDC and the other host being the host at ITTC. Note that only hosts belonging to the same AS are being aggregated. The sections that follow discuss the various results obtained.

5.2.1 Ping Statistics Scheme Tested from ITTC host (for hosts located in CERN-NSS Domain)

This test was run from the ITTC host (129.237.126.172). The CERN-NSS domain belongs to the European Laboratory for Particle Physics. The purpose of running this test is to determine if the mean ping times for 2 hosts are equal or not using the Z-test. Table

6 below shows the Z-Factor values that were obtained by running the test at different times of the day and on different days.

Date	Time	Host pairs	Z Factor
28th June 2002	2.30 pm	192.65.185.145 & 192.65.185.2	0.79
		192.65.185.33 & 192.65.185.2	1.48
		194.25.7.252 & 192.65.185.2	4.14
		192.65.185.40 & 192.65.185.2	1.65
28th June 2002	7.10 pm	192.65.185.145 & 192.65.185.2	0.99
		192.65.185.33 & 192.65.185.2	1.91
		194.25.7.252 & 192.65.185.2	8.76
		192.65.185.40 & 192.65.185.2	1.97
29th June 2002	12.40 am	192.65.185.145 & 192.65.185.2	0.74
		192.65.185.33 & 192.65.185.2	1.77
		194.25.7.252 & 192.65.185.2	10.97
		192.65.185.40 & 192.65.185.2	1.43
1st July 2002	9.30 am	192.65.185.145 & 192.65.185.2	0.02
		192.65.185.33 & 192.65.185.2	1.66
		194.25.7.252 & 192.65.185.2	5.3
		192.65.185.40 & 192.65.185.2	1.09
3rd July 2002	2.15 pm	192.65.185.145 & 192.65.185.2	0.57
		192.65.185.33 & 192.65.185.2	0.84
		194.25.7.252 & 192.65.185.2	5.29
		192.65.185.40 & 192.65.185.2	1.04

Table 6: Z–Factor values of Ping Statistics Scheme Tested from ITTC host (for hosts located in CERN-NSS Domain)

Table 7 below shows the results of Ping Statistics Scheme Tested from ITTC host (for hosts located in CERN-NSS Domain). The table contains the list of client hosts that were used for the test, their respective AS numbers, the decision made by the Ping scheme algorithm and whether the decisions made are valid or not.

IP Address	AS Number	Pipechar Test Required?	Decision Validated? (Yes - ?, No - ?)
192.65.185.2	3320	Yes	? ?
192.65.185.145	3320	No	? ?
192.65.185.33	3320	No	? ?
194.25.7.252	3320	Yes	? ?
192.65.185.40	3320	No	? ?

Table 7: Results of Ping Statistics Scheme Tested from ITTC host (for hosts located in CERN-NSS Domain)

From Table 6 and Table 7, it is seen that the decision made by the Ping scheme algorithm was consistent. From Table 6, we can see that, for host 194.25.7.252, the decision made by the algorithm was to conduct a pipechar test, since the Z-Factor value was consistently greater than 2.57. In order to validate these results, pipechar tests for the individual hosts were performed and the bottleneck links verified. The pipechar results for all hosts are included in Appendix A. Table 8 below shows the results validation for Ping Statistics Scheme Tested from ITTC host (for hosts located in CERN-NSS Domain).

Client (IP address)	AS number	Bottleneck Link
192.65.185.2	3320	ks-2-abilene-ks.r.greatplains.net(164.113.238.193) ipls-kscy.abilene.ucaid.edu (198.32.8.6) Bandwidth = 71.6 Mbps
192.65.185.145	3320	ks-2-abilene-ks.r.greatplains.net(164.113.238.193) ipls-kscy.abilene.ucaid.edu (198.32.8.6) Bandwidth = 71.8 Mbps
192.65.185.33	3320	ks-2-abilene-ks.r.greatplains.net(164.113.238.193) ipls-kscy.abilene.ucaid.edu (198.32.8.6) Bandwidth = 58 Mbps
194.25.7.252	3320	Traceroute path differs altogether
192.65.185.40	3320	ks-2-abilene-ks.r.greatplains.net(164.113.238.193) ipls-kscy.abilene.ucaid.edu (198.32.8.6) Bandwidth = 78.8 Mbps

Table 8: Results Validation for Ping Statistics Scheme Tested from ITTC host (for hosts located in CERN-NSS Domain)

From the above table, it can be seen that the bottleneck for 192.65.185.2, 192.65.185.145, 192.65.185.33 and 192.65.185.40 is the same.

Bottleneck identified: ks-2-abilene-ks.r.greatplains.net (164.113.238.193)

ipls-kscy.abilene.ucaid.edu (198.32.8.6)

The available bandwidth for this hop was approx. 70 Mbps.

However, the traceroute path for 194.25.7.252 was different and hence the bottleneck was different. This is consistent with the decision made by the algorithm, since the algorithm decides that a pipechar test is required for this host based on the ping measurements and the hypotheses testing procedure.

5.2.2 Ping Statistics Scheme Tested from ITTC host (for hosts located in Yahoo Domain)

This test was also run from the ITTC host (129.237.126.172). This time, a different set of hosts was chosen for this experiment. Table 9 shows the Z-Factor values that were obtained by running the test at different times of the day and on different days.

Date	Time	Host pairs	Z Factor
28th June 2002	11.35 am	216.136.226.6 & 216.136.131.71	5.69
		216.136.129.1 & 216.136.131.71	3.43
		216.136.129.1 & 216.136.226.6	1.01
		216.136.130.54 & 216.136.131.71	2.49
28th June 2002	7.20 pm	216.136.226.6 & 216.136.131.71	6.24
		216.136.129.1 & 216.136.131.71	2.41
		216.136.130.54 & 216.136.131.71	0.14
29th June 2002	12.55 am	216.136.226.6 & 216.136.131.71	6.89
		216.136.129.1 & 216.136.131.71	2.53
		216.136.130.54 & 216.136.131.71	0.47
1st July 2002	10.15 am	216.136.226.6 & 216.136.131.71	6.38
		216.136.129.1 & 216.136.131.71	0.7
		216.136.130.54 & 216.136.131.71	1.03
3rd July 2002	2.30 pm	216.136.226.6 & 216.136.131.71	7.69
		216.136.129.1 & 216.136.131.71	1.48
		216.136.130.54 & 216.136.131.71	2.2

Table 9: Z–Factor values of Ping Statistics Scheme Tested from ITTC host (for hosts located in Yahoo Domain)

Table 10 and 11 show the results of Ping Statistics Scheme Tested from ITTC host (for hosts located in Yahoo Domain) and the results validation respectively. Table 10 contains the list of client hosts that were used for the test, their respective AS numbers, the decision made by the Ping scheme algorithm and whether the decisions made are

valid or not. Table 11 shows the corresponding bottleneck hops for the client hosts that were used in this experiment.

IP Address	AS Number	Pipechar Test Required?	Decision Validated? (Yes - ?, No - ?)
216.136.131.71	10310	Yes	? ?
216.136.226.6	10310	Yes	? ?
216.136.129.1	10310	No	? ?
64.58.77.41	17110	Yes	? ?
216.136.130.54	10310	No	? ?

Table 10: Results of Ping Statistics Scheme Tested from ITTC host (for hosts located in Yahoo Domain)

Client (IP address)	AS number	Bottleneck Link	
216.136.131.71	10310	cust-int.level3.net	(64.152.81.62)
		ge-1-2-0.msr2.sc5.yahoo.com	(216.115.101.230)
		Bandwidth = 31.2 Mbps	
216.136.226.6	10310	cust-int.level3.net	(64.152.69.18)
		ge-1-2-0.msr1.sc5.yahoo.com	(216.115.101.234)
		Bandwidth = 36.5 Mbps	
216.136.129.1	10310	cust-int.level3.net	(64.152.69.18)
		ge-0-2-0.msr2.sc5.yahoo.com	(216.115.101.234)
		Bandwidth = 34.3 Mbps	
64.58.77.41	17110	bbr01-p6-0.stng01.exodus.net	(209.1.169.197)
		dcr03-g9-0.stng01.exodus.net	(216.33.96.145)
		Bandwidth = 33.4 Mbps	
216.136.130.54	10310	cust-int.level3.net	(64.152.69.18)
		ge-0-2-0.msr2.sc5.yahoo.com	(216.115.100.237)
		Bandwidth = 35.1 Mbps	

Table 11: Results Validation for Ping Statistics Scheme Tested from ITTC host (for hosts located in Yahoo Domain)

From the above table, it can be seen that the bottleneck for 216.136.131.71, 216.136.226.6, 216.136.129.1 and 216.136.130.54 is the same. However, 64.58.77.41 residing on a different AS number has a differing bottleneck. But from the results of the Ping algorithm, it states that a pipechar test should be conducted for 216.136.226.6. This is inconsistent with the actual pipechar results.

5.2.3 Ping Statistics Sche me Tested from EDC host

This time the test was run from the EDC host. For this test, yet a different set of hosts was chosen for the experiment. Table 12 below shows the Z-Factor values that were obtained by running the test at different times of the day and on a different day.

Date	Time	Host pairs	Z Factor
29th June 2002	4.05 pm	64.14.118.212 & 209.1.169.197	0.22
		216.34.183.197 & 209.1.169.197	80.99
		216.35.210.126 & 209.1.169.197	1.45
29th June 2002	11.00 pm	64.14.118.212 & 209.1.169.197	2.37
		216.34.183.197 & 209.1.169.197	147.19
		216.35.210.126 & 209.1.169.197	1.35
1st July 2002	10.40 am	64.14.118.212 & 209.1.169.197	0.02
		216.34.183.197 & 209.1.169.197	135.56
		216.35.210.126 & 209.1.169.197	1.38

Table 12: Z–Factor values of Ping Statistics Scheme Tested from EDC host

From Table 12, we can see that the Z-Factor value for 216.34.183.197 is consistently very high. This is because the ping times for host 216.34.183.197 varies by a huge margin from the ping times of the other hosts used in this test. Hence, the algorithm decides that a pipechar test should be conducted for 216.34.183.197. Table 13 shows the results of Ping Statistics Scheme Tested from EDC host. The table contains the list of client hosts that were used for the test, their respective AS numbers, the decision made by the Ping scheme algorithm and whether the decisions made are valid or not.

IP Address	AS Number	Pipechar Test Required?	Decision Validated? (Yes - ?, No - ?)
209.1.169.197	3967	Yes	? ?
64.14.118.212	3967	No	? ?
216.34.183.97	3967	Yes	? ?
216.35.210.126	3967	No	? ?

Table 13: Results of Ping Statistics Scheme Tested from EDC host

In order to validate the above results, pipechar tests were performed for the above hosts and the bottleneck links verified. The pipechar results are included in Appendix A. From the pipechar results, it is seen that there is no distinct bottleneck, but a series of similar bottlenecks for all the 4 hosts. For example, the series of bottlenecks is as shown in Figure 6:

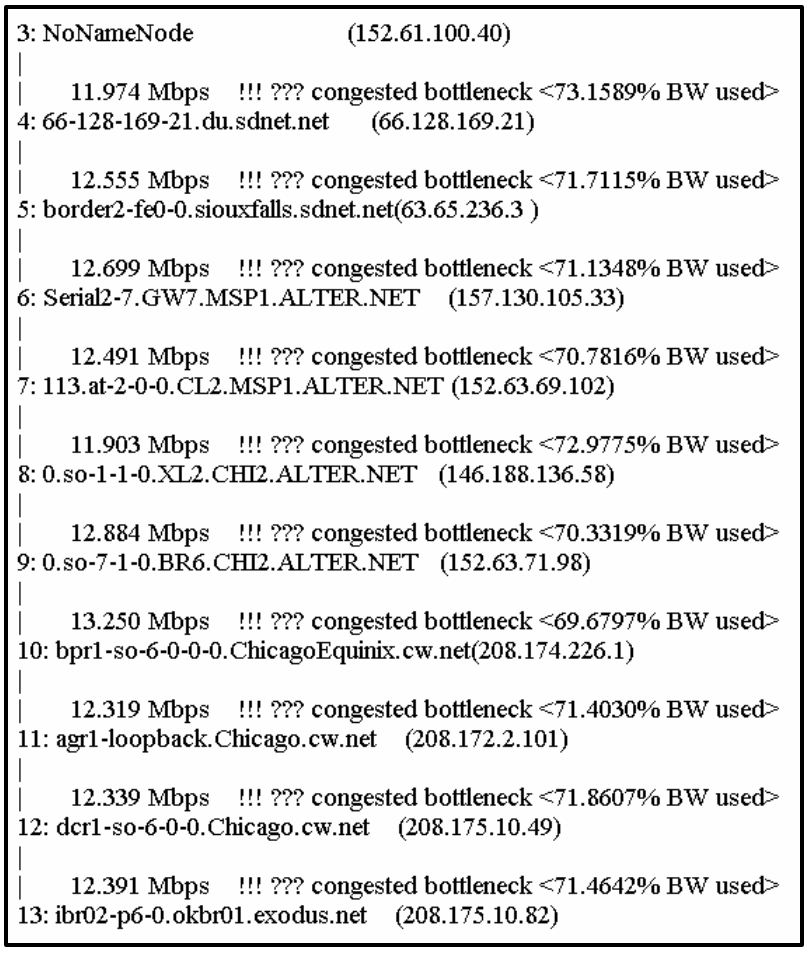

Figure 6: Congested Bottlenecks for hosts used in Ping Statistics Scheme Tested from EDC host

From Figure 6, we can see that hops 3 through 13 are equally congested. The available bandwidth at all hops is approx. 12 Mbps. From the Ping scheme results, we can infer the fact that hosts belonging to the same AS number can be aggregated by this scheme. However, there is a loss of precision involved when this scheme is deployed. From the results above, out of 14 hosts, which were tested in the Ping Statistics scheme, the scheme failed for 2 hosts. The advantage of this scheme is that it is highly scalable.

5.3 Aggregation based on AS Number and Traceroute information

5.3.1 Traceroute Scheme Test

The Aggregation scheme based on AS Number and Traceroute Information was run from the ITTC host and the test results obtained. Note that, in this scheme, hosts belonging to different AS numbers are being aggregated. In this scheme, a database with a list of bottlenecks is created even before starting the test. This is done so that, when the test is run, we can check to see if a traceroute path for any host contains an already existing bottleneck. Figure 7 below shows the results of the Traceroute Scheme test.

```
raphael [20] % perl Traceroute_scheme2.pl

IP address is 131.243.2.20
AS number is 16

IP address is 64.58.76.224
AS number is 17110

IP address is 140.173.170.11
AS number is 4

IP address is 131.243.2.14
AS number is 16

IP address is 131.243.2.28
AS number is 16

IP address is 64.124.237.130
AS number is 6461

IP address is 208.185.204.181
AS number is 14673

traceroute to 131.243.2.20 (131.243.2.20), 30 hops max, 38 byte packets
Known Bottleneck Found in Traceroute Path of 131.243.2.20

129.237.127.254
164.113.234.218
164.113.238.193
198.32.8.13
*198.32.8.1* Known Bottleneck
*198.32.11.94* Known Bottleneck
134.55.209.6
198.129.224.1
198.129.224.6
131.243.128.210

traceroute to 64.58.76.224 (64.58.76.224), 30 hops max, 38 byte packets

traceroute to 140.173.170.11 (140.173.170.11), 30 hops max, 38 byte packets
Known Bottleneck Found in Traceroute Path of 140.173.170.11

129.237.127.254
164.113.234.218
164.113.238.193
198.32.8.13
198.32.8.1
198.32.8.18
*198.32.248.85* Known Bottleneck
*198.32.16.33* Known Bottleneck
198.32.16.82
140.173.155.5
140.173.1.86

traceroute to 64.124.237.130 (64.124.237.130), 30 hops max, 38 byte packets

traceroute to 208.185.204.181 (208.185.204.181), 30 hops max, 38 byte packets

Results Based on AS Number and Traceroute Scheme

IP Address        AS Number    Pipechar Test Required ?

131.243.2.20      16           No
64.58.76.224      17110        Yes
140.173.170.11    4            No
131.243.2.14      16           No
131.243.2.28      16           No
64.124.237.130    6461         Yes
208.185.204.181   14673        Yes
```

Figure 7: Results of Traceroute Scheme Test

From Figure 7, it can be seen that a traceroute is performed to a host for which the AS number has not been seen earlier. The list of bottlenecks is created from a database consisting of results of pipechar tests to different hosts. The pipechar files are named with a .ppc extension. It is also seen that, the traceroute paths for 131.243.2.20 and 140.173.170.11 contain already existing bottlenecks and hence, pipechar tests are suppressed for these hosts. The following table shows the list of bottlenecks that existed at the time when the script was run.

Bottleneck Links
209.1.169.197 - 216.33.96.145
202.54.6.69 - 203.197.148.237
144.232.11.126 - 144.232.194.14
205.171.29.121 - 205.171.5.209
198.32.248.85 - 198.32.16.33
195.74.130.230 - 195.74.128.240
208.172.66.104 - 208.172.75.29
198.32.8.1 - 198.32.11.94
205.171.8.126 - 205.171.31.1
205.171.8.141 - 205.171.25.50

Table 14: List of Already Known Bottlenecks

The above table contains the bottleneck links 198.32.248.85 – 198.32.16.33 and 198.32.8.1 – 198.32.11.94. These two bottlenecks occur in the traceroute result of 140.173.170.11 and 131.243.2.20 respectively. Hence, no pipechar tests are conducted to these hosts. No traceroute tests are conducted to 131.243.2.14 and 131.243.2.28, because they reside in the same AS number as the previous host 131.243.2.20. In order to validate

the results in Figure 7, pipechar tests were performed for the individual hosts and the bottleneck links verified. The pipechar results are included in Appendix A. Note that, as the database of bottlenecks grows in size, more number of pipechar tests are suppressed, because the number of already known bottlenecks increases. Table 15 below shows the results validation for the Traceroute Scheme Test.

IP Addresses	Bottleneck Links
131.243.2.20	snva-dnvr.abilene.ucaid.edu (198.32.8.1) esnet-snva.abilene.ucaid.edu (198.32.11.94) Bandwidth = 20.5 Mbps
64.58.76.224	bbr01-p6-0.stng01.exodus.net (209.1.169.197) dcr03-g9-0.stng01.exodus.net (216.33.96.145) Bandwidth = 35.6 Mbps
140.173.170.11	USC--abilene.ATM.calren2.net (198.32.248.85) guest-b4.isi.edu (198.32.16.33) Bandwidth = 51.7 Mbps
131.243.2.14	snva-dnvr.abilene.ucaid.edu (198.32.8.1) esnet-snva.abilene.ucaid.edu (198.32.11.94) Bandwidth = 38 Mbps
131.243.2.28	snva-dnvr.abilene.ucaid.edu (198.32.8.1) esnet-snva.abilene.ucaid.edu (198.32.11.94) Bandwidth = 34.5 Mbps
64.124.237.130	iah-core-02.inet.qwest.net (205.171.8.126) iah-core-01.inet.qwest.net (205.171.31.1) Bandwidth = 29.5 Mbps
208.185.204.181	svl-brdr-01.inet.qwest.net (205.171.14.106) pos4-1.cr7.sjc2.us.mfnx.net (208.185.175.73) Bandwidth = 33.4 Mbps

Table 15: Results Validation for Traceroute Scheme Test

From the above table, it is seen that the bottleneck for 131.243.2.20, 131.243.2.14 and 131.243.2.28 is the same and the bottlenecks for the other IP addresses are different from each other. The results in Table 15 validate the decisions made by the Traceroute scheme algorithm. The advantage of this scheme is that it is precise, since pipechar takes the same path as that of traceroute.

5.4 Performance Comparison of the Aggregation Schemes

In this thesis, three aggregation schemes have been proposed, implemented and evaluated. These aggregation schemes will be deployed in the actual Enable service once it is fully developed. Also the choice of aggregation schemes will be determined once the Enable service is developed and configured. Each of the three aggregation schemes has their own advantages and disadvantages.

The choice of aggregation schemes can be chosen based on the type of hosts that are being monitored by the Enable service. For example, if the hosts belong to internal networks (within DOE, for example), then it would be most appropriate to use the Subnet scheme. The other two schemes would not work for hosts from internal networks because it requires the AS number information. The AS number will be the same for all hosts within the internal networks. If the hosts being monitored were from the wide area network, then the Ping or the Traceroute scheme would be useful. This is because these two schemes scale very well, even though there is loss of precision in the Ping scheme.

Chapter 6

Conclusions and Future work

6.1 Conclusions

In order to minimize the amount of bandwidth occupied by the pipechar measurement tool, three aggregation schemes were proposed, implemented and evaluated. From the results, it was inferred that the Subnet aggregation scheme is precise and useful for internal networks. The Traceroute and Ping schemes are useful for hosts that are located in the wide-area. Both the Traceroute and the Ping schemes are scalable. From this thesis work, it is seen that the Ping Statistics scheme did not produce good results and hence it is not very useful. Note that, the aggregation techniques that have been implemented attempt to minimize the amount of redundant testing between the server and the clients, but do not completely eliminate redundant testing. The limitation of this thesis work is that, the actual pipechar tests cannot be conducted at run-time. This is because a single pipechar test takes approx. 15-20 minutes to run. The aggregation schemes in this thesis have been implemented in a way so as to only make decisions as to whether a pipechar test is required or not. It can be extended, so that the pipechar test is actually conducted at run-time. For this to happen, the pipechar tool needs to be developed and polished in a better way. Another possible extension to this implementation is to develop an API, so that these aggregation schemes can be interfaced with the Enable service. Another possible extension to this thesis work is to estimate the efficiency of each aggregation scheme.

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Appendix A

```
[bkarthik@ittc-edc ~]$ pipechar -l 198.133.219.125
0: localhost [16 hops]
 1: sd.r.cr.usgs.gov                (192.41.204.1)    0.75  -0.03   1.88ms
 2: NoNameNode                      (152.61.1.26)     0.69   0.94   3.33ms
 3: edcgeonet.cr.usgs.gov           (152.61.212.40)   0.79  -3.12  41.86ms
 4: 66-128-169-21.du.sdnet.net      (66.128.169.21)   5.65   5.97  29.86ms
 5: border2-fe0-0.siouxfalls.sdnet.net  (63.65.236.3)    5.32   6.32  32.27ms
 6: Serial2-7.GW7.MSP1.ALTER.NET    (157.130.105.33)  5.31   5.48  29.76ms
 7: 113.at-1-0-0.CL1.MSP1.ALTER.NET     (152.63.69.90)    5.35   6.12  29.00ms
 8: 0.so-1-0-0.TL1.CHI2.ALTER.NET   (152.63.67.105)   5.15   5.29  40.31ms
 9: 0.so-2-0-0.TL1.SAC1.ALTER.NET   (152.63.8.1)      5.77   8.97  93.23ms
10: 0.so-7-0-0.XL1.SJC2.ALTER.NET   (152.63.55.105)   5.70   6.67  96.64ms
11: POS1-0.XR1.SJC2.ALTER.NET       (152.63.56.138)   4.96   5.95  89.47ms
12: 191.ATM6-0.GW5.SJC2.ALTER.NET   (146.188.144.49)  5.88   7.14  99.32ms
13: ciscosys-gw1.customer.alter.net     (65.208.80.242)   5.35   5.80  91.07ms
14: sjck-dirty-gw1.cisco.com        (128.107.239.5)   5.76   6.33  90.22ms
15: sjck-sdf-ciod-gw1.cisco.com     (128.107.239.106)     5.23   5.80  94.52ms
16: midway.cisco.com                (198.133.219.125)     5.21   1.69 103.32ms

PipeCharacter statistics: 95.11% reliable
From localhost:
|      96.257 Mbps  100BT (102.9328 Mbps)

1: sd.r.cr.usgs.gov             (192.41.204.1)
|
|      158.757 Mbps          <7.2193% BW used>
2: NoNameNode                   (152.61.1.26 )
|
|      99.270 Mbps           <12.4844% BW used>
*********************************************************************************
3: edcgeonet.cr.usgs.gov        (152.61.212.40)
|
|      12.635 Mbps    !!! ??? congested bottleneck <71.7014% BW used>
4: 66-128-169-21.du.sdnet.net      (66.128.169.21)
|
|      13.370 Mbps    !!! ??? congested bottleneck <69.9248% BW used>
5: border2-fe0-0.siouxfalls.sdnet.net(63.65.236.3 )
|
|      13.273 Mbps    !!! ??? congested bottleneck <69.8852% BW used>
6: Serial2-7.GW7.MSP1.ALTER.NET    (157.130.105.33)
|
|      12.821 Mbps    !!! ??? congested bottleneck <70.0823% BW used>
7: 113.at-1-0-0.CL1.MSP1.ALTER.NET (152.63.69.90)
|
|      13.752 Mbps    !!! ??? congested bottleneck <68.9441% BW used>
8: 0.so-1-0-0.TL1.CHI2.ALTER.NET   (152.63.67.105)
|
|      11.972 Mbps    !!! ??? congested bottleneck <72.2848% BW used>
9: 0.so-2-0-0.TL1.SAC1.ALTER.NET   (152.63.8.1  )
|
|      12.211 Mbps    !!! ??? congested bottleneck <71.9200% BW used>
10: 0.so-7-0-0.XL1.SJC2.ALTER.NET   (152.63.55.105)
|
|      14.017 Mbps    !!! ??? congested bottleneck <67.7679% BW used>
11: POS1-0.XR1.SJC2.ALTER.NET       (152.63.56.138)
|
|      11.912 Mbps    !!! ??? congested bottleneck <72.7845% BW used>
12: 191.ATM6-0.GW5.SJC2.ALTER.NET   (146.188.144.49)
|
|      13.021 Mbps    !!! ??? congested bottleneck <70.1102% BW used>
13: ciscosys-gw1.customer.alter.net (65.208.80.242)
|
|      12.392 Mbps    !!! ??? congested bottleneck <72.2271% BW used>
14: sjck-dirty-gw1.cisco.com        (128.107.239.5)
|
|      13.683 Mbps    !!! ??? congested bottleneck <69.3897% BW used>
15: sjck-sdf-ciod-gw1.cisco.com     (128.107.239.106)
*********************************************************************************
**
|      13.830 Mbps possible 100BT (104.7274 Mbps)

16: midway.cisco.com                (198.133.219.125)



[bkarthik@ittc-edc ~]$ pipechar -l 198.133.219.25
0: localhost [16 hops]
 1: sd.r.cr.usgs.gov                (192.41.204.1)    0.76   0.79   1.72ms
 2: NoNameNode                      (152.61.1.26)     1.04   1.09   3.41ms
 3: edcgeonet.cr.usgs.gov           (152.61.212.40)   1.12   1.18  30.70ms
 4: 66-128-169-21.du.sdnet.net      (66.128.169.21)   5.90  -1.63  30.64ms
 5: border2-fe0-0.siouxfalls.sdnet.net  (63.65.236.3)    5.53   8.02  50.88ms
 6: Serial2-7.GW7.MSP1.ALTER.NET    (157.130.105.33)  5.48   6.88  30.44ms
 7: 113.at-1-1-0.CL1.MSP1.ALTER.NET     (152.63.69.98)    5.16   6.18  30.44ms
 8: 0.so-1-0-0.TL1.CHI2.ALTER.NET   (152.63.67.105)   5.51   9.10  41.35ms
 9: 0.so-5-0-0.TL1.SCL2.ALTER.NET   (152.63.1.33)     5.10   6.82  92.50ms
```

```
10: 0.so-1-1-0.XL1.SJC2.ALTER.NET       (152.63.50.153)   6.03   7.38 100.43ms
11: POS1-0.XR1.SJC2.ALTER.NET           (152.63.56.138)   5.71   5.92  98.74ms
12: 191.ATM6-0.GW5.SJC2.ALTER.NET       (146.188.144.49)          5.34   5.56  95.04ms
13: ciscosys-gw1.customer.alter.net     (65.208.80.242)   5.33   5.85  94.56ms
14: sjck-dirty-gw1.cisco.com            (128.107.239.5)   5.43  10.73 101.73ms
15: sjck-sdf-ciod-gw1.cisco.com         (128.107.239.106)         5.54   5.26  96.73ms
16: www.cisco.com                       (198.133.219.25)          5.81  13.83 101.34ms

PipeCharacter statistics: 97.85% reliable
From localhost:
|      94.364 Mbps  100BT (97.0672 Mbps)

1: sd.r.cr.usgs.gov               (192.41.204.1)
|
|      151.243 Mbps    !!!      <55.3779% BW used> May get 26.71% congested
2: NoNameNode                     (152.61.1.26 )
|
|      99.270 Mbps              <6.8873% BW used>
*****************************************************************************
3: edcgeonet.cr.usgs.gov          (152.61.212.40)
|
|      12.100 Mbps    !!! ??? congested bottleneck <72.8814% BW used>
4: 66-128-169-21.du.sdnet.net      (66.128.169.21)
|
|      12.842 Mbps    !!! ??? congested bottleneck <71.0826% BW used>
5: border2-fe0-0.siouxfalls.sdnet.net(63.65.236.3 )
|
|      12.854 Mbps    !!! ??? congested bottleneck <70.7976% BW used>
6: Serial2-7.GW7.MSP1.ALTER.NET    (157.130.105.33)
|
|      13.328 Mbps    !!! ??? congested bottleneck <69.0043% BW used>
7: 113.at-1-1-0.CL1.MSP1.ALTER.NET (152.63.69.98)
|
|      12.830 Mbps    !!! ??? congested bottleneck <70.9566% BW used>
8: 0.so-1-0-0.TL1.CHI2.ALTER.NET   (152.63.67.105)
|
|      13.670 Mbps    !!! ??? congested bottleneck <68.6397% BW used>
9: 0.so-5-0-0.TL1.SCL2.ALTER.NET   (152.63.1.33 )
|
|      11.493 Mbps    !!! ??? congested bottleneck <73.4616% BW used>
10: 0.so-1-1-0.XL1.SJC2.ALTER.NET   (152.63.50.153)
|
|      12.053 Mbps    !!! ??? congested bottleneck <71.9692% BW used>
11: POS1-0.XR1.SJC2.ALTER.NET       (152.63.56.138)
|
|      13.171 Mbps    !!! ??? congested bottleneck <70.0542% BW used>
12: 191.ATM6-0.GW5.SJC2.ALTER.NET   (146.188.144.49)
|
|      13.073 Mbps    !!! ??? congested bottleneck <69.9981% BW used>
13: ciscosys-gw1.customer.alter.net (65.208.80.242)
|
|      13.170 Mbps    !!! ??? congested bottleneck <70.5124% BW used>
14: sjck-dirty-gw1.cisco.com        (128.107.239.5)
|
|      12.642 Mbps    !!! ??? congested bottleneck <70.7652% BW used>
15: sjck-sdf-ciod-gw1.cisco.com     (128.107.239.106)
*****************************************************************************
*
|      10.329 Mbps  10BT (10.0880 Mbps)

16: www.cisco.com                   (198.133.219.25)



[bkarthik@ittc-edc ~]$ pipechar -l 66.218.71.83
0: localhost [17 hops]
 1: sd.r.cr.usgs.gov                (192.41.204.1)    0.69   0.81   1.83ms
 2: NoNameNode                      (152.61.1.26)     0.73   1.07   3.04ms
 3: edcgeonet.cr.usgs.gov           (152.61.212.40)   0.90   8.03  46.96ms
 4: 66-128-169-21.du.sdnet.net      (66.128.169.21)   5.88   6.28  32.34ms
 5: border2-fe0-0.siouxfalls.sdnet.net  (63.65.236.3)    5.69   6.98  31.92ms
 6: Serial2-7.GW7.MSP1.ALTER.NET    (157.130.105.33)          6.19   6.41  30.78ms
 7: 113.at-1-1-0.CL1.MSP1.ALTER.NET     (152.63.69.98)    5.48   6.81  33.35ms
 8: 0.so-0-0-2.XL1.CHI2.ALTER.NET       (152.63.64.45)    5.63   6.81  44.45ms
 9: 0.so-6-0-0.XR1.CHI13.ALTER.NET      (152.63.70.101)   5.14   6.03  48.54ms
10: POS6-0.BR1.CHI13.ALTER.NET          (152.63.73.18)    5.51   6.04  44.47ms
11: so-0-0-0.edge1.Chicago1.Level3.net  (209.0.225.41)    5.22   6.15  41.35ms
12: so-7-0-0.mp2.Chicago1.Level3.net    (209.244.8.13)    5.80   7.09  47.81ms
13: so-2-0-0.mp2.SanJose1.Level3.net    (64.159.0.218)    5.57   6.77 104.41ms
14: gige10-0.ipcolo4.SanJose1.Level3.net(64.159.2.42)     5.78   6.69 113.00ms
15: cust-int.level3.net                 (64.152.69.18)    5.48  -1.29 168.55ms
16: vl11.bas2.scd.yahoo.com             (66.218.64.138)   5.48   4.48 107.74ms
17: w4.scd.yahoo.com                    (66.218.71.83)    5.34   8.90 117.04ms

PipeCharacter statistics: 97.97% reliable
From localhost:
|      103.746 Mbps  100BT (97.0672 Mbps)

1: sd.r.cr.usgs.gov               (192.41.204.1)
|
|      151.243 Mbps             <4.6703% BW used>
2: NoNameNode                     (152.61.1.26 )
```

```
|
|     99.270 Mbps             <19.1111% BW used>
*************************************************************************
3: edcgeonet.cr.usgs.gov          (152.61.212.40)
|
|     12.146 Mbps    !!! ??? congested bottleneck <72.7799% BW used>
4: 66-128-169-21.du.sdnet.net      (66.128.169.21)
|
|     12.471 Mbps    !!! ??? congested bottleneck <71.8953% BW used>
5: border2-fe0-0.siouxfalls.sdnet.net(63.65.236.3 )
|
|     11.305 Mbps    !!! ??? congested bottleneck <74.1560% BW used>
6: Serial2-7.GW7.MSP1.ALTER.NET    (157.130.105.33)
|
|     13.060 Mbps    !!! ??? congested bottleneck <70.7976% BW used>
7: 113.at-1-1-0.CL1.MSP1.ALTER.NET (152.63.69.98)
|
|     12.533 Mbps    !!! ??? congested bottleneck <71.6060% BW used>
8: 0.so-0-0-2.XL1.CHI2.ALTER.NET   (152.63.64.45)
|
|     13.552 Mbps    !!! ??? congested bottleneck <68.8958% BW used>
9: 0.so-6-0-0.XR1.CHI13.ALTER.NET  (152.63.70.101)
|
|     12.649 Mbps    !!! ??? congested bottleneck <70.9777% BW used>
10: POS6-0.BR1.CHI13.ALTER.NET      (152.63.73.18)
|
|     13.277 Mbps    !!! ??? congested bottleneck <69.3545% BW used>
11: so-0-0-0.edge1.Chicago1.Level3.net(209.0.225.41)
|
|     12.090 Mbps    !!! ??? congested bottleneck <72.3995% BW used>
12: so-7-0-0.mp2.Chicago1.Level3.net(209.244.8.13)
|
|     12.477 Mbps    !!! ??? congested bottleneck <71.2798% BW used>
13: so-2-0-0.mp2.SanJose1.Level3.net(64.159.0.218)
|
|     12.340 Mbps    !!! ??? congested bottleneck <72.3422% BW used>
14: gige10-0.ipcolo4.SanJose1.Level3.net(64.159.2.42 )
|
|     13.040 Mbps    !!! ??? congested bottleneck <70.8083% BW used>
15: cust-int.level3.net            (64.152.69.18)
|
|     12.604 Mbps    !!! ??? congested bottleneck <70.7816% BW used>
16: vl11.bas2.scd.yahoo.com        (66.218.64.138)
*************************************************************************
*
|     13.486 Mbps possible 100BT (99.3439 Mbps)
17: w4.scd.yahoo.com               (66.218.71.83)



[bkarthik@ittc-edc ~]$ pipechar -l 66.218.71.79
0: localhost [17 hops]
 1: sd.r.cr.usgs.gov                (192.41.204.1)    0.79   0.85   1.75ms
 2: NoNameNode                      (152.61.1.26)     0.69   9.93  36.06ms
 3: edcgeonet.cr.usgs.gov           (152.61.212.40)   0.85   1.28  29.41ms
 4: 66-128-169-21.du.sdnet.net      (66.128.169.21)   5.72   6.66  31.95ms
 5: border2-fe0-0.siouxfalls.sdnet.net (63.65.236.3)    5.66   5.78  32.10ms
 6: Serial2-7.GW7.MSP1.ALTER.NET    (157.130.105.33)          5.93   5.69  31.36ms
 7: 113.at-1-0-0.CL2.MSP1.ALTER.NET (152.63.69.94)    5.72   6.75  32.53ms
 8: 0.so-1-1-0.XL2.CHI2.ALTER.NET   (146.188.136.58)          5.14   6.29  47.98ms
 9: 0.so-6-0-0.XR2.CHI13.ALTER.NET  (152.63.70.105)   5.72   5.99  44.53ms
10: POS7-0.BR1.CHI13.ALTER.NET      (152.63.73.22)    5.23   6.79  44.21ms
11: so-0-0-0.edge1.Chicago1.Level3.net (209.0.225.41)    5.55   6.38  44.51ms
12: so-7-0-0.mp2.Chicago1.Level3.net   (209.244.8.13)    5.39   5.08  43.65ms
13: so-2-0-0.mp2.SanJose1.Level3.net   (64.159.0.218)    5.99   7.15 104.69ms
14: gige10-0.ipcolo4.SanJose1.Level3.net(64.159.2.42)    5.31  -19.15 120.49ms
15: cust-int.level3.net            (64.152.69.18)    5.91  15.35 108.23ms
16: vl16.bas1.scd.yahoo.com        (66.218.64.146)   5.40   5.61 103.26ms
17: fxptest1.scd.yahoo.com         (66.218.71.79)    5.21   6.41 107.61ms

PipeCharacter statistics: 95.56% reliable
From localhost:
|     91.371 Mbps  100BT (102.9328 Mbps)

1: sd.r.cr.usgs.gov            (192.41.204.1)
|
|     151.243 Mbps            <12.9442% BW used>
2: NoNameNode                  (152.61.1.26 )
|
|     99.270 Mbps             <19.3889% BW used>
*************************************************************************
3: edcgeonet.cr.usgs.gov          (152.61.212.40)
|
|     12.492 Mbps    !!! ??? congested bottleneck <72.0182% BW used>
4: 66-128-169-21.du.sdnet.net      (66.128.169.21)
|
|     12.537 Mbps    !!! ??? congested bottleneck <71.7514% BW used>
5: border2-fe0-0.siouxfalls.sdnet.net(63.65.236.3 )
|
|     11.839 Mbps    !!! ??? congested bottleneck <73.0003% BW used>
6: Serial2-7.GW7.MSP1.ALTER.NET    (157.130.105.33)
```

```
|
|      12.494 Mbps    !!! ??? congested bottleneck <72.0475% BW used>
7: 113.at -1-0-0.CL2.MSP1.ALTER.NET (152.63.69.94)
|
|      13.779 Mbps    !!! ??? congested bottleneck <68.8837% BW used>
8: 0.so -1-1-0.XL2.CHI2.ALTER.NET   (146.188.136.58)
|
|      12.099 Mbps    !!! ??? congested bottleneck <72.0133% BW used>
9: 0.so -6-0-0.XR2.CHI13.ALTER.NET  (152.63.70.105)
|
|      13.385 Mbps    !!! ??? congested bottleneck <69.3897% BW used>
10: POS7 -0.BR1.CHI13.ALTER.NET      (152.63.73.22)
|
|      12.420 Mbps    !!! ??? congested bottleneck <71.1868% BW used>
11: so-0-0-0.edge1.Chicago1.Level3.net(209.0.225.41)
|
|      13.051 Mbps    !!! ??? congested bottleneck <70.3154% BW used>
12: so-7-0-0.mp2.Chicago1.Level3.net(209.244.8.13)
|
|      11.546 Mbps    !!! ??? congested bottleneck <73.2754% BW used>
13: so-2-0-0.mp2.SanJose1.Level3.net(64.159.0.218)
|
|      13.462 Mbps    !!! ??? congested bottleneck <69.8682% BW used>
14: gige10-0.ipcolo4.SanJose1.Level3.net(64.159.2.42 )
|
|      12.083 Mbps    !!! ??? congested bottleneck <72.9181% BW used>
15: cust-int.level3.net             (64.152.69.18)
|
|      12.792 Mbps    !!! ??? congested bottleneck <70.3813% BW used>
16: vl16.bas1.scd.yahoo.com         (66.218.64.146)
*******************************************************************************
|      13.817 Mbps possible 100BT (100.6561 Mbps)

17: fxptest1.scd.yahoo.com          (66.218.71.79)



[bkarthik@ittc-edc ~]$ pipechar -l 66.218.71.87
0: localhost [17 hops]
 1: sd.r.cr.usgs.gov                  (192.41.204.1)    0.66   0.67   1.78ms
 2: NoNameNode                        (152.61.1.26)     0.66   3.39   5.41ms
 3: edcgeonet.cr.usgs.gov             (152.61.212.40)   0.86   0.51  28.91ms
 4: 66-128-169-21.du.sdnet.net        (66.128.169.21)   5.85  -9.20  31.72ms
 5: border2-fe0-0.siouxfalls.sdnet.net  (63.65.236.3)    5.72   7.13  33.73ms
 6: Serial2-7.GW7.MSP1.ALTER.NET      (157.130.105.33)    5.53   7.38  31.94ms
 7: 113.at -1-0-0.CL2.MSP1.ALTER.NET     (152.63.69.94)    5.21   6.74  31.95ms
 8: 0.so -1-1-0.XL2.CHI2.ALTER.NET       (146.188.136.58)      5.51   7.00  44.43ms
 9: 0.so -6-0-0.XR2.CHI13.ALTER.NET      (152.63.70.105)   6.00   7.45  47.63ms
10: POS7 -0.BR1.CHI13.ALTER.NET          (152.63.73.22)    5.74   6.65  45.08ms
11: so-0-0-0.edge1.Chicago1.Level3.net  (209.0.225.41)    5.14   6.60  44.51ms
12: so-7-0-0.mp2.Chicago1.Level3.net    (209.244.8.13)    5.38   6.30  45.57ms
13: so-2-0-0.mp2.SanJose1.Level3.net    (64.159.0.218)    5.92   6.64 108.49ms
14: gige10-0.ipcolo4.SanJose1.Level3.net(64.159.2.42)     6.16   7.07 101.80ms
15: cust-int.level3.net                 (64.152.69.18)    5.31   3.41 282.37ms
16: vl11.bas2.scd.yahoo.com             (66.218.64.138)   5.73   6.22 101.06ms
17: w8.scd.yahoo.com                    (66.218.71.87)    5.91 -55.32 297.10ms

PipeCharacter statistics: 97.97% reliable
From localhost:
|      108.926 Mbps  OC3 (156.8921 Mbps)

1: sd.r.cr.usgs.gov              (192.41.204.1)
|
|      158.757 Mbps            <0.3026% BW used>
2: NoNameNode                    (152.61.1.26 )
|
|      99.270 Mbps             <16.3763% BW used> May get 23.46% congested
*******************************************************************************
3: edcgeonet.cr.usgs.gov         (152.61.212.40)
|
|      12.201 Mbps    !!! ??? congested bottleneck <72.6589% BW used>
4: 66-128-169-21.du.sdnet.net    (66.128.169.21)
|
|      12.422 Mbps    !!! ??? congested bottleneck <72.0035% BW used>
5: border2-fe0-0.siouxfalls.sdnet.net(63.65.236.3 )
|
|      12.737 Mbps    !!! ??? congested bottleneck <71.0512% BW used>
6: Serial2-7.GW7.MSP1.ALTER.NET    (157.130.105.33)
|
|      13.189 Mbps    !!! ??? congested bottleneck <69.3016% BW used>
7: 113.at -1-0-0.CL2.MSP1.ALTER.NET (152.63.69.94)
|
|      12.830 Mbps    !!! ??? congested bottleneck <70.9566% BW used>
8: 0.so -1-1-0.XL2.CHI2.ALTER.NET   (146.188.136.58)
|
|      11.476 Mbps    !!! ??? congested bottleneck <73.3422% BW used>
9: 0.so -6-0-0.XR2.CHI13.ALTER.NET  (152.63.70.105)
|
|      12.115 Mbps    !!! ??? congested bottleneck <72.1254% BW used>
10: POS7 -0.BR1.CHI13.ALTER.NET      (152.63.73.22)
|
```

```
|      13.491 Mbps    !!! ??? congested bottleneck <68.8958% BW used>
11: so-0-0-0.edge1.Chicago1.Level3.net(209.0.225.41)
|
|      13.064 Mbps    !!! ??? congested bottleneck <70.2878% BW used>
12: so-7-0-0.mp2.Chicago1.Level3.net(209.244.8.13)
|
|      11.692 Mbps    !!! ??? congested bottleneck <72.9638% BW used>
13: so-2-0-0.mp2.SanJose1.Level3.net(64.159.0.218)
|
|      11.570 Mbps    !!! ??? congested bottleneck <74.0386% BW used>
14: gige10-0.ipcolo4.SanJose1.Level3.net(64.159.2.42 )
|
|      13.461 Mbps    !!! ??? congested bottleneck <69.8795% BW used>
15: cust-int.level3.net             (64.152.69.18)
|
|      11.999 Mbps    !!! ??? congested bottleneck <72.0719% BW used>
16: vl11.bas2.scd.yahoo.com         (66.218.64.138)
*******************************************************************************
**
|      12.187 Mbps possible 100BT (100.6561 Mbps)

17: w8.scd.yahoo.com                (66.218.71.87)



[bkarthik@ittc-edc ~]$ pipechar -l 66.218.71.81
0: localhost [17 hops]
 1: sd.r.cr.usgs.gov                (192.41.204.1)    0.72   0.61   1.80ms
 2: NoNameNode                      (152.61.1.26)     0.75   2.61  11.04ms
 3: edcgeonet.cr.usgs.gov           (152.61.212.40)   0.94  -2.96  33.04ms
 4: 66-128-169-21.du.sdnet.net      (66.128.169.21)   6.53   8.64  38.12ms
 5: border2-fe0-0.siouxfalls.sdnet.net (63.65.236.3)     5.60   6.15  30.41ms
 6: Serial2-7.GW7.MSP1.ALTER.NET    (157.130.105.33)          5.16   6.04  28.74ms
 7: 113.at-1-1-0.CL1.MSP1.ALTER.NET     (152.63.69.98)    5.60   7.22  32.24ms
 8: 0.so-0-0-2.XL1.CHI2.ALTER.NET   (152.63.64.45)    5.76   6.21  43.33ms
 9: 0.so-6-0-0.XR1.CHI13.ALTER.NET      (152.63.70.101)   5.70   6.20  45.66ms
10: POS6-0.BR1.CHI13.ALTER.NET      (152.63.73.18)    5.80   7.51  50.51ms
11: so-0-0-0.edge1.Chicago1.Level3.net  (209.0.225.41)    5.14   7.48  43.98ms
12: so-7-0-0.mp2.Chicago1.Level3.net    (209.244.8.13)    5.47   6.32  42.90ms
13: so-2-0-0.mp2.SanJose1.Level3.net    (64.159.0.218)    5.33   5.60 100.18ms
14: gige10-0.ipcolo4.SanJose1.Level3.net(64.159.2.42)     6.52   7.60 109.69ms
15: cust-int.level3.net             (64.152.81.62)    5.78 -19.37 230.35ms
16: vl10.bas1.scd.yahoo.com         (66.218.64.134)   5.09   5.74 109.78ms
17: w2.scd.yahoo.com                (66.218.71.81)    5.36   4.34 105.95ms

PipeCharacter statistics: 97.97% reliable
```

```
From localhost:
|      99.448 Mbps  100BT (102.9328 Mbps)

1: sd.r.cr.usgs.gov             (192.41.204.1)
|
|      158.757 Mbps           <4.1060% BW used>
2: NoNameNode                   (152.61.1.26 )
|
|      99.270 Mbps            <20.0212% BW used>
*******************************************************************************
3: edcgeonet.cr.usgs.gov        (152.61.212.40)
|
|      10.905 Mbps    !!! ??? congested bottleneck <75.5127% BW used>
4: 66-128-169-21.du.sdnet.net   (66.128.169.21)
|
|      12.675 Mbps    !!! ??? congested bottleneck <71.4490% BW used>
5: border2-fe0-0.siouxfalls.sdnet.net(63.65.236.3 )
|
|      13.672 Mbps    !!! ??? congested bottleneck <69.0163% BW used>
6: Serial2-7.GW7.MSP1.ALTER.NET    (157.130.105.33)
|
|      12.772 Mbps    !!! ??? congested bottleneck <71.4337% BW used>
7: 113.at-1-1-0.CL1.MSP1.ALTER.NET (152.63.69.98)
|
|      12.241 Mbps    !!! ??? congested bottleneck <72.2415% BW used>
8: 0.so-0-0-2.XL1.CHI2.ALTER.NET   (152.63.64.45)
|
|      12.134 Mbps    !!! ??? congested bottleneck <71.9397% BW used>
9: 0.so-6-0-0.XR1.CHI13.ALTER.NET  (152.63.70.101)
|
|      11.983 Mbps    !!! ??? congested bottleneck <72.4091% BW used>
10: POS6-0.BR1.CHI13.ALTER.NET      (152.63.73.18)
|
|      13.491 Mbps    !!! ??? congested bottleneck <68.8958% BW used>
11: so-0-0-0.edge1.Chicago1.Level3.net(209.0.225.41)
|
|      12.841 Mbps    !!! ??? congested bottleneck <70.7709% BW used>
12: so-7-0-0.mp2.Chicago1.Level3.net(209.244.8.13)
|
|      13.081 Mbps    !!! ??? congested bottleneck <69.9812% BW used>
13: so-2-0-0.mp2.SanJose1.Level3.net(64.159.0.218)
|
|      10.920 Mbps    !!! ??? congested bottleneck <75.4677% BW used>
14: gige10-0.ipcolo4.SanJose1.Level3.net(64.159.2.42 )
|
|      12.346 Mbps    !!! ??? congested bottleneck <72.3375% BW used>
```

```
15: cust-int.level3.net            (64.152.81.62)
|
|      13.648 Mbps    !!! ??? congested bottleneck <68.5473% BW used>
16: vl10.bas1.scd.yahoo.com        (66.218.64.134)
**************************************************************************
|      13.435 Mbps possible 100BT (100.6561 Mbps)

17: w2.scd.yahoo.com               (66.218.71.81)
```

```
[bkarthik@ittc-edc ~]$ pipechar -l 192.150.14.120
0: localhost [15 hops]
 1: sd.r.cr.usgs.gov                (192.41.204.1)    0.75   0.79   1.71ms
 2: NoNameNode                      (152.61.1.26)     1.00   1.36   4.00ms
 3: edcgeonet.cr.usgs.gov           (152.61.212.40)   1.05   0.97  31.42ms
 4: 66-128-169-21.du.sdnet.net      (66.128.169.21)   5.36   5.99  32.11ms
 5: border2-fe0-0.siouxfalls.sdnet.net (63.65.236.3)    5.21   5.86  30.43ms
 6: NoNameNode                      (12.124.116.25)   3.27  -2.25  62.70ms
 7: gbr5-p51.cgcil.ip.att.net       (12.123.4.234)    4.60  14.73  71.72ms
 8: tbr1-p013801.cgcil.ip.att.net   (12.122.10.50)    9.90  14.81  98.01ms
 9: tbr1-cl2.sffca.ip.att.net       (12.122.10.42)    5.33   9.19 137.95ms
10: gbr5-p100.sffca.ip.att.net      (12.122.11.74)    1.62  80.00 177.25ms
11: gar2-p360.sffca.ip.att.net      (12.123.13.149)   5.35  40.36 137.06ms
12: NoNameNode                      (12.124.35.50)    6.33  25.33 123.33ms
13: border10.ge3-0-bbnet2.sfj.pnap.net (216.52.0.78)     6.39   7.10 116.11ms
14: adobe-sjcorp-5.border10.sfj.pnap.net(216.52.2.78)     5.89   0.04 120.05ms
15: www-vip-14.adobe.com           (192.150.14.120)      7.63 -22.63 105.03ms

PipeCharacter statistics: 91.87% reliable
From localhost:
|      95.745 Mbps  100BT (102.9328 Mbps)

1: sd.r.cr.usgs.gov                (192.41.204.1)
|
|      151.243 Mbps    !!!      <53.4553% BW used> May get 24.65% congested
2: NoNameNode                      (152.61.1.26 )
|
|      100.730 Mbps             <4.6799% BW used>
3: edcgeonet.cr.usgs.gov           (152.61.212.40)
|
|      13.326 Mbps    !!! ??? congested bottleneck <70.1771% BW used>
4: 66-128-169-21.du.sdnet.net      (66.128.169.21)
|
|      13.669 Mbps    !!! ??? congested bottleneck <69.2662% BW used>
5: border2-fe0-0.siouxfalls.sdnet.net(63.65.236.3 )
|
|      44.319 Mbps    !!!       <37.2263% BW used>
6: NoNameNode                      (12.124.116.25)
|
|      43.438 Mbps    !!!       <65.2098% BW used> May get 28.94% congested
**************************************************************************
7: gbr5-p51.cgcil.ip.att.net       (12.123.4.234)
|
|      7.219 Mbps    !!! ??? congested bottleneck <83.8400% BW used>
8: tbr1-p013801.cgcil.ip.att.net   (12.122.10.50)
**************************************************************************
|
|      13.047 Mbps    !!! ??? congested bottleneck <35.0844% BW used>
9: tbr1-cl2.sffca.ip.att.net       (12.122.10.42)
| hop analyzed: 0.90 : 22.92
|
|      44.030 Mbps    !!!       <41.0693% BW used>
10: gbr5-p100.sffca.ip.att.net     (12.122.11.74)
|
|      12.940 Mbps    !!! ??? congested bottleneck <70.0767% BW used>
11: gar2-p360.sffca.ip.att.net     (12.123.13.149)
|
|      11.017 Mbps    !!! ??? congested bottleneck <74.7156% BW used>
12: NoNameNode                     (12.124.35.50)
|
|      10.749 Mbps    !!! ??? congested bottleneck <74.9726% BW used>
13: border10.ge3-0-bbnet2.sfj.pnap.net(216.52.0.78 )
|
|      46.936 Mbps             <7.9149% BW used>
14: adobe-sjcorp-5.border10.sfj.pnap.net(216.52.2.78 )
|      9.431 Mbps  10BT (10.1268 Mbps)

15: www-vip-14.adobe.com           (192.150.14.120)
```

```
[bkarthik@ittc-edc ~]$ pipechar -l 192.150.14.104
0: localhost [15 hops]
 1: sd.r.cr.usgs.gov                (192.41.204.1)    0.72   0.81   1.69ms
 2: NoNameNode                      (152.61.1.26)     1.35   1.22   3.39ms
 3: edcgeonet.cr.usgs.gov           (152.61.212.40)   0.98   1.55  29.28ms
 4: 66-128-169-21.du.sdnet.net      (66.128.169.21)   5.67   7.06  30.66ms
 5: border2-fe0-0.siouxfalls.sdnet.net (63.65.236.3)    5.16   5.97  29.33ms
 6: NoNameNode                      (12.124.116.21)   6.49  19.40  76.99ms
```

```
 7: gbr5-p51.cgcil.ip.att.net          (12.123.4.234)    4.14  26.55  82.50ms
 8: gbr3-p100.cgcil.ip.att.net         (12.122.5.2)      6.74   3.52  65.22ms
 9: gbr3-p10.sffca.ip.att.net          (12.122.2.153)    4.19  10.69 105.60ms
10: gbr5-p60.sffca.ip.att.net          (12.122.5.141)    1.06  -2.18 100.58ms
11: gar2-p360.sffca.ip.att.net         (12.123.13.149)   4.87   4.49  98.76ms
12: NoNameNode                         (12.124.35.50)    5.44   3.31  94.29ms
13: border10.ge3-0-bbnet2.sfj.pnap.net (216.52.0.78)     2.39   1.22 103.42ms
14: adobe-sjcorp-5.border10.sfj.pnap.net(216.52.2.78)    10.12  15.11 103.98ms
15: help.studio.adobe.com              (192.150.14.104)          4.23  20.10 118.01ms

PipeCharacter statistics: 80.21% reliable
From localhost:
|       100.139 Mbps  100BT (102.9328 Mbps)

1: sd.r.cr.usgs.gov               (192.41.204.1)
|
|       51.950 Mbps    !!! ??? congested bottleneck <46.7061% BW used>
2: NoNameNode                     (152.61.1.26 )
| hop analyzed: 46.37 : 68.05
|
|       99.270 Mbps              <21.6877% BW used>
3: edcgeonet.cr.usgs.gov          (152.61.212.40)
|
|       12.606 Mbps    !!! ??? congested bottleneck <71.7664% BW used>
4: 66-128-169-21.du.sdnet.net     (66.128.169.21)
|
|       13.783 Mbps    !!! ??? congested bottleneck <69.0163% BW used>
5: border2-fe0-0.siouxfalls.sdnet.net(63.65.236.3 )
|
|       10.756 Mbps    !!! ??? congested bottleneck <75.3429% BW used>
6: NoNameNode                     (12.124.116.21)
|
|       43.438 Mbps    ! !!       <36.2305% BW used>
*********************************************************************
7: gbr5-p51.cgcil.ip.att.net      (12.123.4.234)
|
|       6.926 Mbps    !!! ??? congested bottleneck <82.8889% BW used>
8: gbr3-p100.cgcil.ip.att.net     (12.122.5.2  )
*********************************************************************
|
|       16.834 Mbps    !!! ??? congested bottleneck <71.9607% BW used>
9: gbr3-p10.sffca.ip.att.net      (12.122.2.153)
| hop analyzed: 0.00 : 12.75
|
|       12.334 Mbps    !!! ??? congested bottleneck <71.6563% BW used>
10: gbr5-p60.sffca.ip.att.net     (12.122.5.141)
|
|       14.303 Mbps    !!! ??? congested bottleneck <67.1525% BW used>
11: gar2-p360.sffca.ip.att.net    (12.123.13.149)
|
|       12.925 Mbps    !!! ???  congested bottleneck <70.5882% BW used>
12: NoNameNode                    (12.124.35.50)
| hop analyzed: 58.82 : 24.89
|
|       152.537 Mbps    !!!      <77.4997% BW used>
13: border10.ge3-0-bbnet2.sfj.pnap.net(216.52.0.78 )
|
|       16.375 Mbps    !!! ??? congested bottleneck <62.4534% BW used>
14: adobe-sjcorp-5.border10.sfj.pnap.net(216.52.2.78 )
|       17.033 Mbps possible 100BT (100.8380 Mbps)

15: help.studio.adobe.com         (192.150.14.104)




[bkarthik@ittc-edc ~/Subnet]$ pipechar -l 192.150.14.110
0: localhost [15 hops]
 1: sd.r.cr.usgs.gov                  (192.41.204.1)    0.78  16.71  17.56ms
 2: NoNameNode                        (152.61.1.26)     0.76   0.90   2.81ms
 3: NoNameNode                        (152.61.100.40)   0.83   2.15  46.16ms
 4: 66-128-169-21.du.sdnet.net        (66.128.169.21)   5.48   5.83  30.96ms
 5: border2-fe0-0.siouxfalls.sdnet.net (63.65.236.3)    5.38   6.40  31.74ms
 6: NoNameNode                        (12.124.116.17)   5.73   1.77  60.68ms
 7: gbr5-p51.cgcil.ip.att.net         (12.123.4.234)    5.10   5.40  63.36ms
 8: gbr3-p100.cgcil.ip.att.net        (12.122.5.2)     10.86   4.12  62.80ms
 9: gbr3-p30.sffca.ip.att.net         (12.122.2.150)    5.27   4.02  99.95ms
10: gbr5-p60.sffca.ip.att.net         (12.122.5.141)    4.77   3.85 102.57ms
11: gar2-p360.sffca.ip.att.net        (12.123.13.149)   3.91   5.57 100.68ms
12: NoNameNode                        (12.124.35.50)    5.30   7.26 101.04ms
13: border10.ge2-0-bbnet1.sfj.pnap.net (216.52.0.14)   11.69   6.04  94.99ms
14: adobe-sjcorp-5.border10.sfj.pnap.net(216.52.2.78)    4.03   5.65  96.28ms
15: eportfolio.studio.adobe.com       (192.150.14.110)         7.96   5.44  94.85ms

PipeCharacter statistics: 80.21% reliable
From localhost:
|       92.189 Mbps  100BT (102.9328 Mbps)

1: sd.r.cr.usgs.gov               (192.41.204.1)
|
|       158.757 Mbps             <2.3047% BW used>
2: NoNameNode                     (152.61.1.26 )
```

```
|
|      158.831 Mbps            <8.1828% BW used>
3: NoNameNode                   (152.61.100.40)
|
|      13.040 Mbps    !!! ??? congested bottleneck <70.8082% BW used>
4: 66-128-169-21.du.sdnet.net      (66.128.169.21)
|
|      13.207 Mbps    !!! ??? congested bottleneck <70.2823% BW used>
5: border2-fe0-0.siouxfalls.sdnet.net(63.65.236.3 )
|
|      12.256 Mbps    !!! ??? congested bottleneck <72.0963% BW used>
6: NoNameNode                   (12.124.116.17)
|
|      46.562 Mbps            <11.0045% BW used>
*************************************************************************
7: gbr5-p51.cgcil.ip.att.net       (12.123.4.234)
|
|      6.571 Mbps    !!! ??? congested bottleneck <85.2697% BW used>
8: gbr3-p100.cgcil.ip.att.net      (12.122.5.2  )
*************************************************************************
|
|      13.203 Mbps    !!! ??? congested bottleneck <36.5964% BW used>
9: gbr3-p30.sffca.ip.att.net       (12.122.2.150)
|
|      14.742 Mbps    !!! ??? congested bottleneck <66.4500% BW used>
10: gbr5-p60.sffca.ip.att.net      (12.122.5.141)
|
|      43.722 Mbps            <17.9492% BW used>
11: gar2-p360.sffca.ip.att.net     (12.123.13.149)
|
|      44.259 Mbps    !!!       <69.8227% BW used> May get 26.20% congested
12: NoNameNode                  (12.124.35.50)
|
|      12.429 Mbps    !!! ??? congested bottleneck <28.7785% BW used
13: border10.ge2-0-bbnet1.sfj.pnap.net(216.52.0.14 )
| hop analyzed: 12.74 : 37.46
|
|      43.064 Mbps    !!!       <83.5614% BW used>
14: adobe-sjcorp-5.border10.sfj.pnap.net(216.52.2.78 )
|      9.040 Mbps *** static bottle-neck  10BT (10.1268 Mbps)

15: eportfolio.studio.adobe.com    (192.150.14.110)
```

```
[bkarthik@ittc-edc ~]$ pipechar -l 194.183.224.106
0: localhost [16 hops]
 1: sd.r.cr.usgs.gov                (192.41.204.1)    0.76   0.96   1.88ms
 2: NoNameNode                      (152.61.1.26)     1.27  17.54  28.22ms
 3: edcgeonet.cr.usgs.gov           (152.61.212.40)   1.27   0.95  32.69ms
 4: 66-128-169-21.du.sdnet.net      (66.128.169.21)   5.36   7.72  32.27ms
 5: border2-fe0-0.siouxfalls.sdnet.net  (63.65.236.3)    3.91   4.11  28.83ms
 6: Serial2-7.GW7.MSP1.ALTER.NET    (157.130.105.33)          5.50   5.25  30.35ms
 7: 113.at-1-0-0.CL2.MSP1.ALTER.NET     (152.63.69.94)    5.16   6.04  32.26ms
 8: 0.so-2-0-0.TL2.CHI2.ALTER.NET   (152.63.67.109)   5.68   6.60  42.24ms
 9: 0.so-3-0-0.IL2.NYC9.ALTER.NET   (152.63.9.174)    5.86   5.53  68.00ms
10: 0.so-0-0-0.IR2.NYC12.ALTER.NET      (152.63.23.66)    5.94   5.52  63.03ms
11: so-7-0-0.TR1.BRU2.Alter.Net     (146.188.9.137)   5.53   7.92 159.06ms
12: so-5-0-0.XR2.BRU2.Alter.Net     (146.188.9.146)   5.50   6.21 160.12ms
13: 194.ATM8-0-0.GW2.BRU2.Alter.Net     (146.188.11.81)   5.84 -16.36 165.90ms
14: Perceval-gw.customer.ALTER.NET      (146.188.32.198)          6.07   5.09 166.18ms
15: bebru1201-p0-0.perceval.net     (194.183.225.11)          5.67   6.60 174.67ms
16: www.agfa.com                    (194.183.224.106)         5.71   8.09 148.94ms

PipeCharacter statistics: 97.85% reliable
From localhost:
|      94.241 Mbps  100BT (97.0672 Mbps)

1: sd.r.cr.usgs.gov             (192.41.204.1)
|
|      151.243 Mbps            <0.0789% BW used>
2: NoNameNode                   (152.61.1.26 )
|
|      99.270 Mbps             <0.0789% BW used>
*************************************************************************
3: edcgeonet.cr.usgs.gov           (152.61.212.40)
|
|      13.344 Mbps    !!! ??? congested bottleneck <70.1381% BW used>
4: 66-128-169-21.du.sdnet.net      (66.128.169.21)
|
|      13.642 Mbps    !!! ??? congested bottleneck <69.5398% BW used>
5: border2-fe0-0.siouxfalls.sdnet.net(63.65.236.3 )
|
|      12.796 Mbps    !!! ??? congested bottleneck <70.9249% BW used>
6: Serial2-7.GW7.MSP1.ALTER.NET    (157.130.105.33)
|
|      13.343 Mbps    !!! ??? congested bottleneck <68.9742% BW used>
7: 113.at-1-0-0.CL2.MSP1.ALTER.NET (152.63.69.94)
|
|      12.425 Mbps    !!! ??? congested bottleneck <71.8409% BW used>
8: 0.so-2-0-0.TL2.CHI2.ALTER.NET   (152.63.67.109)
```

```
|
|      11.773 Mbps    !!! ??? congested bottleneck <72.7102% BW used>
9: 0.so -3-0-0.IL2.NYC9.ALTER.NET   (152.63.9.174)
|
|      11.682 Mbps    !!! ??? congested bottleneck <73.0549% BW used>
10: 0.so-0-0-0.IR2.NYC12.ALTER.NET  (152.63.23.66)
|
|      12.464 Mbps    !!! ??? congested bottleneck <71.0930% BW used>
11: so-7-0-0.TR1.BRU2.Alter.Net     (146.188.9.137)
|
|      12.782 Mbps    !!! ??? congested bottleneck <70.8985% BW used>
12: so-5-0-0.XR2.BRU2.Alter.Net     (146.188.9.146)
|
|      11.867 Mbps    !!! ??? congested bottleneck <72.5887% BW used>
13: 194.ATM8-0-0.GW2.BRU2.Alter.Net (146.188.11.81)
|
|      11.749 Mbps    !!! ??? congested bottleneck <73.6452% BW used>
14: Perceval-gw.customer.ALTER.NET  (146.188.32.198)
|
|      12.596 Mbps    !!! ??? congested bottleneck <71.7863% BW used>
15: bebru1201-p0-0.perceval.net     (194.183.225.11)
*******************************************************************************
*
|      12.598 Mbps possible 100BT (104.7274 Mbps)

16: www.agfa.com                    (194.183.224.106)
```

```
[bkarthik@ittc-edc ~]$ pipechar -l 194.183.224.110
0: localhost [16 hops]
 1: sd.r.cr.usgs.gov                (192.41.204.1)    0.77   0.84   1.83ms
 2: NoNameNode                      (152.61.1.26)     1.02  26.42  62.60ms
 3: edcgeonet.cr.usgs.gov           (152.61.212.40)   1.11   4.45  34.19ms
 4: 66-128-169-21.du.sdnet.net      (66.128.169.21)   5.55  16.83  48.93ms
 5: border2-fe0-0.siouxfalls.sdnet.net  (63.65.236.3)    5.04   0.79  36.52ms
 6: Serial2-7.GW7.MSP1.ALTER.NET    (157.130.105.33)          5.86   7.06  31.54ms
 7: 113.at-1-1-0.CL1.MSP1.ALTER.NET     (152.63.69.98)    6.03   6.08  34.00ms
 8: 0.so-1-0-0.TL1.CHI2.ALTER.NET   (152.63.67.105)   5.46   5.97  41.53ms
 9: 0.so-7-0-0.IL1.NYC9.ALTER.NET   (152.63.9.245)    5.30   5.48  65.83ms
10: 0.so-0-0-0.IR1.NYC12.ALTER.NET      (152.63.23.58)    5.46   6.09  63.93ms
11: so-6-0-0.TR2.BRU2.Alter.Net     (146.188.9.46)    5.84   6.15 161.57ms
12: so-6-0-0.XR1.BRU2.Alter.Net     (146.188.9.150)   5.46   6.64 152.71ms
13: 195.ATM8-0-0.GW2.BRU2.Alter.Net     (146.188.11.77)   5.06   1.57 149.08ms
14: Perceval-gw.customer.ALTER.NET      (146.188.32.198)          5.50   5.14 154.34ms
15: bebru1201-p0-0.perceval.net     (194.183.225.11)          6.12   7.64 158.35ms
16: news.agfa.com                   (194.183.224.110)         6.01   7.73 156.58ms

PipeCharacter statistics: 95.59% reliable
From localhost:
|      93.144 Mbps  100BT (102.9328 Mbps)

1: sd.r.cr.usgs.gov                 (192.41.204.1)
|
|      151.243 Mbps    !!!      <54.5927% BW used> May get 24.44% congested
2: NoNameNode                       (152.61.1.26 )
|
|      100.730 Mbps             <8.1688% BW used>
*******************************************************************************
3: edcgeonet.cr.usgs.gov            (152.61.212.40)
|
|      12.878 Mbps    !!! ??? congested bottleneck <71.1660% BW used>
4: 66-128-169-21.du.sdnet.net       (66.128.169.21)
|
|      14.130 Mbps    !!! ??? congested bottleneck <68.2540% BW used>
5: border2-fe0-0.siouxfalls.sdnet.net(63.65.236.3 )
|
|      11.984 Mbps    !!! ??? congested bottleneck <72.6869% BW used>
6: Serial2-7.GW7.MSP1.ALTER.NET     (157.130.105.33)
|
|      11.859 Mbps    !!! ??? congested bottleneck <73.4484% BW used>
7: 113.at-1-1-0.CL1.MSP1.ALTER.NET (152.63.69.98)
|
|      12.945 Mbps    !!! ??? congested bottleneck <70.7067% BW used>
8: 0.so-1-0-0.TL1.CHI2.ALTER.NET    (152.63.67.105)
|
|      13.116 Mbps    !!! ??? congested bottleneck <69.8341% BW used>
9: 0.so-7-0-0.IL1.NYC9.ALTER.NET    (152.63.9.245)
|
|      12.777 Mbps    !!! ??? congested bottleneck <70.7013% BW used>
10: 0.so-0-0-0.IR1.NYC12.ALTER.NET  (152.63.23.58)
|
|      11.746 Mbps    !!! ??? congested bottleneck <72.6215% BW used>
11: so-6-0-0.TR2.BRU2.Alter.Net     (146.188.9.46)
|
|      12.878 Mbps    !!! ??? congested bottleneck <70.6906% BW used>
12: so-6-0-0.XR1.BRU2.Alter.Net     (146.188.9.150)
|
```

```
|      13.820 Mbps    !!! ??? congested bottleneck <68.3857% BW used>
13: 195.ATM8-0-0.GW2.BRU2.Alter.Net (146.188.11.77)
|
|      12.985 Mbps    !!! ??? congested bottleneck <70.9197% BW used>
14: Perceval-gw.customer.ALTER.NET  (146.188.32.198)
|
|      11.665 Mbps    !!! ??? congested bottleneck <73.8391% BW used>
15: bebru1201-p0-0.perceval.net     (194.183.225.11)
********************************************************************************
|      11.974 Mbps possible 100BT (104.7274 Mbps)

16: news.agfa.com                   (194.183.224.110)




[bkarthik@ittc-edc ~]$ pipechar -l 194.183.224.114
0: localhost [16 hops]
 1: sd.r.cr.usgs.gov                  (192.41.204.1)    0.77   0.89   1.77ms
 2: NoNameNode                        (152.61.1.26)     0.84 -25.92  26.84ms
 3: edcgeonet.cr.usgs.gov             (152.61.212.40)   1.09   1.70  31.48ms
 4: 66-128-169-21.du.sdnet.net        (66.128.169.21)   5.46   5.59  30.64ms
 5: border2-fe0-0.siouxfalls.sdnet.net  (63.65.236.3)    6.07   5.97  33.19ms
 6: Serial2-7.GW7.MSP1.ALTER.NET      (157.130.105.33)          5.25   6.12  28.95ms
 7: 113.at-1-0-0.CL1.MSP1.ALTER.NET    (152.63.69.90)    5.11   6.09  30.73ms
 8: 0.so-1-0-0.TL1.CHI2.ALTER.NET     (152.63.67.105)   5.84   6.59  42.02ms
 9: 0.so-7-0-0.IL1.NYC9.ALTER.NET     (152.63.9.245)    5.24   2.58  62.67ms
10: 0.so-0-0-0.IR1.NYC12.ALTER.NET    (152.63.23.58)    5.73   7.08  69.28ms
11: so-6-0-0.TR2.BRU2.Alter.Net       (146.188.9.46)    5.39   6.14 153.61ms
12: so-6-0-0.XR1.BRU2.Alter.Net       (146.188.9.150)   6.11   6.23 163.84ms
13: 195.ATM8-0-0.GW2.BRU2.Alter.Net   (146.188.11.77)   6.23   5.84 152.48ms
14: Perceval-gw.customer.ALTER.NET    (146.188.32.198)          5.54   8.68 159.06ms
15: bebru1201-p0-0.perceval.net       (194.183.225.11)          5.61   6.03 153.40ms
16: ge.medical.agfa.com               (194.183.224.114)         5.25   7.51 149.87ms

PipeCharacter statistics: 97.85% reliable
From localhost:
|      93.872 Mbps  100BT (102.9328 Mbps)

1: sd.r.cr.usgs.gov              (192.41.204.1)
|
|      158.757 Mbps            <8.7991% BW used>
2: NoNameNode                    (152.61.1.26 )
|
|      99.270 Mbps    !!!      <34.1865% BW used> May get 23.13% congested
********************************************************************************
3: edcgeonet.cr.usgs.gov         (152.61.212.40)
|
|      13.084 Mbps    !!! ??? congested bottleneck <70.7121% BW used>
4: 66-128-169-21.du.sdnet.net      (66.128.169.21)
|
|      11.682 Mbps    !!! ??? congested bottleneck <73.6235% BW used>
5: border2-fe0-0.siouxfalls.sdnet.net(63.65.236.3 )
|
|      13.434 Mbps    !!! ??? congested bottleneck <69.5354% BW used>
6: Serial2-7.GW7.MSP1.ALTER.NET    (157.130.105.33)
|
|      13.488 Mbps    !!! ??? congested bottleneck <68.6643% BW used>
7: 113.at-1-0-0.CL1.MSP1.ALTER.NET (152.63.69.90)
|
|      12.071 Mbps    !!! ??? congested bottleneck <72.6121% BW used>
8: 0.so-1-0-0.TL1.CHI2.ALTER.NET   (152.63.67.105)
|
|      13.276 Mbps    !!! ??? congested bottleneck <69.4890% BW used>
9: 0.so-7-0-0.IL1.NYC9.ALTER.NET   (152.63.9.245)
|
|      12.140 Mbps    !!! ??? congested bottleneck <72.0719% BW used>
10: 0.so-0-0-0.IR1.NYC12.ALTER.NET  (152.63.23.58)
|
|      12.823 Mbps    !!! ??? congested bottleneck <70.3264% BW used>
11: so-6-0-0.TR2.BRU2.Alter.Net     (146.188.9.46)
|
|      11.434 Mbps    !!! ??? congested bottleneck <73.8177% BW used>
12: so-6-0-0.XR1.BRU2.Alter.Net     (146.188.9.150)
|
|      11.057 Mbps    !!! ??? congested bottleneck <74.3178% BW used>
13: 195.ATM8-0-0.GW2.BRU2.Alter.Net (146.188.11.77)
|
|      12.902 Mbps    !!! ??? congested bottleneck <71.1035% BW used>
14: Perceval-gw.customer.ALTER.NET  (146.188.32.198)
|
|      12.742 Mbps    !!! ??? congested bottleneck <71.4643% BW used>
15: bebru1201-p0-0.perceval.net     (194.183.225.11)
********************************************************************************
|      13.704 Mbps possible 100BT (95.2726 Mbps)

16: ge.medical.agfa.com          (194.183.224.114)
```

```
[bkarthik@ittc-edc ~/Subnet]$ pipechar -l 204.202.132.15
pipechar [Mar25-2K1] : can't reach the host16[204.202.138.75] with max_ttl(18)
try to analyze partial path instead

0: localhost [16 hops]
 1: sd.r.cr.usgs.gov                (192.41.204.1)    0.71   1.49   2.44ms
 2: NoNameNode                      (152.61.1.26)     0.68   0.77   2.50ms
 3: NoNameNode                      (152.61.100.40)   0.69  37.91  67.17ms
 4: 66-128-169-21.du.sdnet.net      (66.128.169.21)   5.10  -8.45  34.05ms
 5: border2-fe0-0.siouxfalls.sdnet.net  (63.65.236.3)    5.72   7.24  31.70ms
 6: Serial2-7.GW7.MSP1.ALTER.NET    (157.130.105.33)      5.61   6.40  31.76ms
 7: 113.at-2-0-0.CL2.MSP1.ALTER.NET     (152.63.69.102)   5.45   5.63  29.83ms
 8: 0.so-1-1-0.XL2.CHI2.ALTER.NET   (146.188.136.58)      5.76   6.45  42.96ms
 9: 0.so-7-1-0.BR6.CHI2.ALTER.NET   (152.63.71.98)    6.16   5.98  43.80ms
10: bpr1-so-6-0-0-0.ChicagoEquinix.cw.net(208.174.226.1)      5.39   5.15  43.48ms
11: agr1-loopback.Chicago.cw.net    (208.172.2.101)   5.13   6.71  44.94ms
12: dcr2-so-6-0-0.Chicago.cw.net    (208.175.10.177)      5.38   6.30  42.48ms
13: agr3-so-6-0-0.Chicago.cw.net    (208.175.10.138)      5.68   6.36  43.66ms
14: acr1-loopback.Seattle.cw.net    (208.172.82.61)   5.58   4.52  89.87ms
15: bpr1.SeattleSwitchDesign.cw.net     (208.172.82.7)    5.41  -1.57 144.26ms
16: NoNameNode                      (208.173.49.22)   5.85   4.93  93.12ms

PipeCharacter statistics: 95.59% reliable
From localhost:
|      100.699 Mbps  100BT (102.9328 Mbps)

1: sd.r.cr.usgs.gov             (192.41.204.1)
|
|      158.757 Mbps           <4.1958% BW used>
2: NoNameNode                   (152.61.1.26 )
|
|      158.831 Mbps           <0.1456% BW used>
*********************************************************************************
3: NoNameNode                   (152.61.100.40)
|
|      14.039 Mbps    !!! ??? congested bottleneck <68.6028% BW used>
4: 66-128-169-21.du.sdnet.net      (66.128.169.21)
|
|      12.422 Mbps    !!! ??? congested bottleneck <72.0035% BW used>
5: border2-fe0-0.siouxfalls.sdnet.net(63.65.236.3 )
|
|      12.543 Mbps    !!! ??? congested bottleneck <71.4744% BW used>
6: Serial2-7.GW7.MSP1.ALTER.NET    (157.130.105.33)
|
|      12.549 Mbps    !!! ??? congested bottleneck <70.6584% BW used>
7: 113.at-2-0-0.CL2.MSP1.ALTER.NET (152.63.69.102)
|
|      12.261 Mbps    !!! ??? congested bottleneck <72.1981% BW used>
8: 0.so-1-1-0.XL2.CHI2.ALTER.NET   (146.188.136.58)
|
|      11.151 Mbps    !!! ??? congested bottleneck <74.0344% BW used>
9: 0.so-7-1-0.BR6.CHI2.ALTER.NET   (152.63.71.98)
|
|      12.961 Mbps    !!! ??? congested bottleneck <70.3044% BW used>
10: bpr1-so-6-0-0-0.ChicagoEquinix.cw.net(208.174.226.1)
|
|      13.517 Mbps    !!! ??? congested bottleneck <68.8413% BW used>
11: agr1-loopback.Chicago.cw.net    (208.172.2.101)
|
|      13.089 Mbps    !!! ??? congested bottleneck <70.2326% BW used>
12: dcr2-so-6-0-0.Chicago.cw.net    (208.175.10.177)
|
|      12.230 Mbps    !!! ??? congested bottleneck <71.8111% BW used>
13: agr3-so-6-0-0.Chicago.cw.net    (208.175.10.138)
|
|      12.813 Mbps    !!! ??? congested bottleneck <71.3005% BW used>
14: acr1-loopback.Seattle.cw.net    (208.172.82.61)
|
|      13.206 Mbps    !!! ??? congested bottleneck <70.4415% BW used>
15: bpr1.SeattleSwitchDesign.cw.net (208.172.82.7)
*********************************************************************************
|      12.316 Mbps possible 100BT (104.7274 Mbps)

16: NoNameNode                  (208.173.49.22)



[bkarthik@ittc-edc ppc]$ pipechar -l 204.202.132.25
pipechar [Mar25-2K1] : can't reach the host16[204.202.138.75] with max_ttl(18)
try to analyze partial path instead

0: localhost [16 hops]
 1: sd.r.cr.usgs.gov                (192.41.204.1)    0.77   0.82   1.74ms
 2: NoNameNode                      (152.61.1.26)     0.75  -6.49   2.65ms
 3: NoNameNode                      (152.61.100.40)   0.83   0.99  31.99ms
 4: 66-128-169-21.du.sdnet.net      (66.128.169.21)   5.36 -10.01  57.10ms
```

```
 5: border2-fe0-0.siouxfalls.sdnet.net  (63.65.236.3)     5.97   7.59  35.33ms
 6: Serial2-7.GW7.MSP1.ALTER.NET        (157.130.105.33)          5.56   6.47  30.67ms
 7: 113.at-1-0-0.CL1.MSP1.ALTER.NET     (152.63.69.90)    5.15   5.82  29.25ms
 8: 0.so-0-0-2.XL1.CHI2.ALTER.NET       (152.63.64.45)    5.83   7.01  45.12ms
 9: 0.so-7-0-0.BR6.CHI2.ALTER.NET       (152.63.71.94)    5.81   6.23  41.89ms
10: bpr1-so-6-0-0-0.ChicagoEquinix.cw.net(208.174.226.1)          5.64   6.73  42.78ms
11: agr1-loopback.Chicago.cw.net        (208.172.2.101)   6.04   6.76  45.59ms
12: dcr2-so-6-0-0.Chicago.cw.net        (208.175.10.177)          5.78   6.76  44.21ms
13: agr4-so-6-0-0.Chicago.cw.net        (208.175.10.158)          5.31   6.51  44.28ms
14: acr2-loopback.Seattle.cw.net        (208.172.82.62)   5.37   6.35  92.93ms
15: bpr1.SeattleSwitchDesign.cw.net     (208.172.82.7)    5.58   6.59  95.85ms
16: NoNameNode                          (208.173.49.22)   5.95   6.21  94.57ms

PipeCharacter statistics: 95.59% reliable
From localhost:
|      93.872 Mbps  100BT (97.0672 Mbps)

1: sd.r.cr.usgs.gov               (192.41.204.1)
|
|      151.243 Mbps            <2.2164% BW used>
2: NoNameNode                     (152.61.1.26 )
|
|      151.169 Mbps            <9.8556% BW used>
********************************************************************************
3: NoNameNode                     (152.61.100.40)
|
|      13.334 Mbps    !!! ??? congested bottleneck <70.1604% BW used>
4: 66-128-169-21.du.sdnet.net     (66.128.169.21)
|
|      11.882 Mbps    !!! ??? congested bottleneck <73.1858% BW used>
5: border2-fe0-0.siouxfalls.sdnet.net(63.65.236.3 )
|
|      12.661 Mbps    !!! ??? congested bottleneck <71.2178% BW used>
6: Serial2-7.GW7.MSP1.ALTER.NET    (157.130.105.33)
|
|      13.374 Mbps    !!! ??? congested bottleneck <68.9079% BW used>
7: 113.at-1-0-0.CL1.MSP1.ALTER.NET (152.63.69.90)
|
|      12.097 Mbps    !!! ??? congested bottleneck <72.5557% BW used>
8: 0.so-0-0-2.XL1.CHI2.ALTER.NET   (152.63.64.45)
|
|      11.881 Mbps    !!! ??? congested bottleneck <72.4802% BW used>
9: 0.so-7-0-0.BR6.CHI2.ALTER.NET   (152.63.71.94)
|
|      12.345 Mbps    !!! ??? congested bottleneck <71.6312% BW used>
10: bpr1-so-6-0-0-0.ChicagoEquinix.cw.net(208.174.226.1)
|
|      11.333 Mbps    !!! ??? congested bottleneck <73.4968% BW used>
11: agr1-loopback.Chicago.cw.net    (208.172.2.101)
|
|      12.121 Mbps    !!! ??? congested bottleneck <72.3327% BW used>
12: dcr2-so-6-0-0.Chicago.cw.net    (208.175.10.177)
|
|      13.139 Mbps    !!! ??? congested bottleneck <69.8568% BW used>
13: agr4-so-6-0-0.Chicago.cw.net    (208.175.10.158)
|
|      13.315 Mbps    !!! ??? congested bottleneck <70.1938% BW used>
14: acr2-loopback.Seattle.cw.net    (208.172.82.62)
|
|      12.814 Mbps    !!! ??? congested bottleneck <71.3056% BW used>
15: bpr1.SeattleSwitchDesign.cw.net (208.172.82.7)
********************************************************************************
|      12.101 Mbps possible 100BT (95.2726 Mbps)

16: NoNameNode                    (208.173.49.22)



raphael [45] % pipechar -irtc -l 216.136.131.71
0: localhost [16 hops]
 1: NoNameNode                    (10.10.127.254)   0.86   0.77   3.02ms
 2: NoNameNode                    (129.237.2.21)    0.91   0.85   3.13ms
 3: kr-ku-a0-4.kanren.net         (164.113.201.249)         0.93   1.12   4.89ms
 4: ks-1-a400-51.r.greatplains.net      (164.113.232.202)         1.19   1.83  11.01ms
 5: ksca01-edge12.mo.inet.qwest.net     (65.120.164.237)          1.59   1.72  11.57ms
 6: ksca01-core02.mo.inet.qwest.net     (205.171.29.137)          1.39   1.09  11.25ms
 7: dlls01-core02.tx.inet.qwest.net     (205.171.8.141)   1.48   2.63  46.76ms
 8: dlls01-brdr02.tx.inet.qwest.net     (205.171.25.50)   1.37   1.36  29.31ms
 9: pos2-2.core1.Dallas1.Level3.net     (209.245.240.129)         1.20   5.34  62.00ms
10: so-4-0-0.mp2.Dallas1.Level3.net     (209.247.10.105)          1.12   1.49  22.78ms
11: so-3-0-0.mp2.SanJose1.Level3.net    (64.159.1.130)    1.56   3.49  56.51ms
12: gige10-1.ipcolo4.SanJose1.Level3.net(64.159.2.106)    1.41   2.11  55.01ms
13: cust-int.level3.net                 (64.152.81.62)    1.39   2.43  64.63ms
14: ge-1-2-0.msr2.sc5.yahoo.com         (216.115.101.230)         0.23 -27.62  60.17ms
15: vl46.bas2-m.sc5.yahoo.com           (216.115.100.142)         1.24   0.07  73.11ms
16: search1.games.yahoo.com             (216.136.131.71)          0.97   0.32  60.12ms

PipeCharacter statistics: 84.18% reliable
From localhost:
|      83.818 Mbps  100BT (102.9328 Mbps)
```

```
1: NoNameNode                    (10.10.127.254)
|
|      158.757 Mbps             <5.6044% BW used>
2: NoNameNode                    (129.237.2.21)
|
|      158.831 Mbps             <2.2556% BW used>
3: kr-ku-a0-4.kanren.net         (164.113.201.249)
|
|      150.626 Mbps    !!!      <61.0305% BW used> May get 21.90% congested
4: ks-1-a400-51.r.greatplains.net  (164.113.232.202)
|
|      45.028 Mbps    !!! ??? congested bottleneck <70.6930% BW used>
5: ksca01-edge12.mo.inet.qwest.net (65.120.164.237)
|
|      51.056 Mbps        ??? congested bottleneck <14.7777% BW used>
6: ksca01-core02.mo.inet.qwest.net (205.171.29.137)
|
|      47.340 Mbps    !!! ??? congested bottleneck <68.5287% BW used>
7: dlls01-core02.tx.inet.qwest.net (205.171.8.141)
|
|      52.227 Mbps    !!! ??? congested bottleneck <65.9945% BW used>
8: dlls01-brdr02.tx.inet.qwest.net (205.171.25.50)
|
|      48.775 Mbps    !!! ??? congested bottleneck <67.8758% BW used>
9: pos2-2.core1.Dallas1.Level3.net (209.245.240.129)
|
|      152.710 Mbps    !!!      <22.6140% BW used>
10: so-4-0-0.mp2.Dallas1.Level3.net (209.247.10.105)
|
|      44.847 Mbps    !!! ??? congested bottleneck <70.2615% BW used>
11: so-3-0-0.mp2.SanJose1.Level3.net(64.159.1.130)
|
|      50.374 Mbps        ??? congested bottleneck <13.3948% BW used>
12: gige10-1.ipcolo4.SanJose1.Level3.net(64.159.2.106)
|
|      51.044 Mbps    !!! ??? congested bottleneck <66.4852% BW used>
*********************************************************************************
*
13: cust-int.level3.net          (64.152.81.62)
|
|      31.162 Mbps    !!! ??? congested bottleneck <81.4802% BW used>
14: ge-1-2-0.msr2.sc5.yahoo.com     (216.115.101.230)
*********************************************************************************
*
|
|      56.766 Mbps    !!! ??? congested bottleneck <29.3452% BW used>
15: vl46.bas2-m.sc5.yahoo.com       (216.115.100.142)
|      74.304 Mbps  100BT (104.7274 Mbps)

16: search1.games.yahoo.com         (216.136.131.71)
```

```
raphael [94] % pipechar -irtc -l 216.136.131.83
0: localhost [16 hops]
 1: NoNameNode                    (10.10.127.254)   0.91   1.33   3.20ms
 2: NoNameNode                    (129.237.2.21)    0.89   1.27   3.29ms
 3: kr-ku-a0-4.kanren.net         (164.113.201.249)         0.79   2.46   6.01ms
 4: ks-1-a400-51.r.greatplains.net      (164.113.232.202)         1.54   6.44  23.38ms
 5: ksca01-edge12.mo.inet.qwest.net     (65.120.164.237)          1.40   2.25  11.12ms
 6: ksca01-core02.mo.inet.qwest.net     (205.171.29.137)          1.44   1.77  11.84ms
 7: dlls01-core02.tx.inet.qwest.net     (205.171.8.141)   1.35   3.02  22.49ms
 8: dlls01-brdr02.tx.inet.qwest.net     (205.171.25.50)   1.21   1.93  21.71ms
 9: pos1-2.core1.Dallas1.Level3.net     (209.245.240.145)         1.33   6.29  68.33ms
10: so-4-0-0.mp2.Dallas1.Level3.net     (209.247.10.105)          1.25   1.77  36.93ms
11: so-3-0-0.mp2.SanJose1.Level3.net    (64.159.1.130)    1.31   2.36  90.45ms
12: gige10-1.ipcolo4.SanJose1.Level3.net(64.159.2.106)    1.31   2.01  83.42ms
13: cust-int.level3.net                 (64.152.69.18)    1.35   5.21 145.05ms
14: ge-0-2-0.msr2.sc5.yahoo.com         (216.115.100.237)         1.58   3.31 118.74ms
15: vl46.bas2-m.sc5.yahoo.com           (216.115.100.142)         1.41  -0.39  60.02ms
16: search2.games.yahoo.com             (216.136.131.83)          1.66   2.06  60.51ms

PipeCharacter statistics: 86.91% reliable
From localhost:
|      79.208 Mbps  100BT (102.9328 Mbps)

1: NoNameNode                    (10.10.127.254)
|
|      158.757 Mbps             <1.7602% BW used>
2: NoNameNode                    (129.237.2.21)
|
|      158.831 Mbps             <11.9821% BW used>
3: kr-ku-a0-4.kanren.net         (164.113.201.249)
|
|      44.938 Mbps    !!! ??? congested bottleneck <69.8562% BW used>
4: ks-1-a400-51.r.greatplains.net  (164.113.232.202)
|
|      51.226 Mbps        ??? congested bottleneck <14.6132% BW used>
5: ksca01-edge12.mo.inet.qwest.net (65.120.164.237)
```

```
|
|      49.282 Mbps    !!! ??? congested bottleneck <67.8090% BW used>
6: ksca01-core02.mo.inet.qwest.net (205.171.29.137)
|
|      51.895 Mbps    !!! ??? congested bottleneck <65.6677% BW used>
7: dlls01-core02.tx.inet.qwest.net (205.171.8.141)
|
|      156.333 Mbps            <10.7910% BW used>
8: dlls01-brdr02.tx.inet.qwest.net (205.171.25.50)
|
|      43.990 Mbps    !!! ??? congested bottleneck <70.8950% BW used>
9: pos1-2.core1.Dallas1.Level3.net (209.245.240.145)
|
|      56.749 Mbps    !!! ??? congested bottleneck <27.7954% BW used>
10: so-4-0-0.mp2.Dallas1.Level3.net (209.247.10.105)
|
|      53.702 Mbps    !!! ??? congested bottleneck <64.6755% BW used>
11: so-3-0-0.mp2.SanJose1.Level3.net(64.159.1.130)
|
|      54.312 Mbps    !!! ??? congested bottleneck <64.5678% BW used>
12: gige10-1.ipcolo4.SanJose1.Level3.net(64.159.2.106)
|
|      157.463 Mbps            <2.6003% BW used>
*******************************************************************************
13: cust-int.level3.net            (64.152.69.18)
|
|      33.628 Mbps    !!! ??? congested bottleneck <79.6189% BW used>
14: ge-0-2-0.msr2.sc5.yahoo.com     (216.115.100.237)
*******************************************************************************
|
|      159.396 Mbps            <11.0691% BW used>
15: vl46.bas2-m.sc5.yahoo.com       (216.115.100.142)
|      43.452 Mbps  100BT (104.7274 Mbps)

16: search2.games.yahoo.com         (216.136.131.83)




raphael [49] % pipechar -irtc -l 216.136.130.54
0: localhost [16 hops]
 1: NoNameNode                    (10.10.127.254)   0.81   1.35   3.59ms
 2: NoNameNode                    (129.237.2.21)    1.27   1.03   3.20ms
 3: kr-ku-a0-4.kanren.net          (164.113.201.249)        0.80   0.68   4.93ms
 4: ks-1-a400-51.r.greatplains.net      (164.113.232.202)         1.22   5.27  32.75ms
 5: ksca01-edge12.mo.inet.qwest.net      (65.120.164.237)          1.45   3.66  19.32ms
 6: ksca01-core02.mo.inet.qwest.net      (205.171.29.137)          1.66   2.38  11.78ms
 7: dlls01-core02.tx.inet.qwest.net     (205.171.8.141)   1.31   1.53  37.99ms
 8: dlls01-brdr02.tx.inet.qwest.net     (205.171.25.50)   1.45   5.46  36.06ms
 9: pos1-2.core1.Dallas1.Level3.net      (209.245.240.145)         1.65   1.48  23.76ms
10: so-4-0-0.mp2.Dallas1.Level3.net     (209.247.10.105)          1.22   3.14  23.35ms
11: so-3-0-0.mp2.SanJose1.Level3.net    (64.159.1.130)    1.41   3.34  54.73ms
12: gige10-1.ipcolo4.SanJose1.Level3.net(64.159.2.106)    1.02   1.52  54.56ms
13: cust-int.level3.net                 (64.152.69.18)    1.38   7.62 150.59ms
14: ge-0-2-0.msr2.sc5.yahoo.com         (216.115.100.237)         1.53   2.58  63.56ms
15: vl46.bas2-m.sc5.yahoo.com           (216.115.100.142)         1.16  -0.31  59.98ms
16: web10104.mail.yahoo.com             (216.136.130.54)          1.54   4.83  94.17ms

PipeCharacter statistics: 84.18% reliable
From localhost:
|      88.670 Mbps  100BT (97.0672 Mbps)

1: NoNameNode                    (10.10.127.254)
|
|      55.567 Mbps    !!! ??? congested bottleneck <43.1728% BW used>
2: NoNameNode                    (129.237.2.21)
|
|      151.169 Mbps    !!!      <37.1744% BW used>
3: kr-ku-a0-4.kanren.net          (164.113.201.249)
|
|      57.455 Mbps    !!! ??? congested bottleneck <62.0183% BW used>
4: ks-1-a400-51.r.greatplains.net  (164.113.232.202)
|
|      147.294 Mbps            <15.7133% BW used>
5: ksca01-edge12.mo.inet.qwest.net (65.120.164.237)
|
|      42.746 Mbps    !!! ??? congested bottleneck <71.9664% BW used>
6: ksca01-core02.mo.inet.qwest.net (205.171.29.137)
|
|      53.470 Mbps        ??? congested bottleneck <21.6731% BW used>
7: dlls01-core02.tx.inet.qwest.net (205.171.8.141)
|
|      153.667 Mbps            <9.3730% BW used>
8: dlls01-brdr02.tx.inet.qwest.net (205.171.25.50)
|
|      42.530 Mbps    !!! ??? congested bottleneck <71.8134% BW used>
9: pos1-2.core1.Dallas1.Level3.net (209.245.240.145)
|
|      58.522 Mbps    !!! ??? congested bottleneck <31.6872% BW used>
10: so-4-0-0.mp2.Dallas1.Level3.net (209.247.10.105)
```

```
|
|      50.012 Mbps    !!! ??? congested bottleneck <67.0087% BW used>
11: so-3-0-0.mp2.SanJose1.Level3.net(64.159.1.130)
|
|      153.250 Mbps    !!!      <27.8408% BW used>
12: gige10-1.ipcolo4.SanJose1.Level3.net(64.159.2.106)
|
|      51.159 Mbps    !!! ??? congested bottleneck <66.4124% BW used>
*******************************************************************************
13: cust-int.level3.net            (64.152.69.18)
|
|      35.112 Mbps    !!! ??? congested bottleneck <69.6989% BW used>
14: ge-0-2-0.msr2.sc5.yahoo.com      (216.115.100.237)
*******************************************************************************
|
|      150.604 Mbps    !!!      <24.0707% BW used>
15: vl46.bas2-m.sc5.yahoo.com       (216.115.100.142)
|      46.814 Mbps  100BT (95.2726 Mbps)

16: web10104.mail.yahoo.com         (216.136.130.54)
```

```
raphael [10] % pipechar -l 64.58.76.224
0: localhost [20 hops]
 1: NoNameNode                     (10.10.127.254)   0.96   0.99   3.35ms
 2: kr-ku-a0-4.kanren.net          (164.113.201.249)        1.22   0.86   4.46ms
 3: ks-1-a400-51.r.greatplains.net      (164.113.232.202)        1.63  -0.01  28.81ms
 4: kcm-edge-12.inet.qwest.net          (65.120.164.237)         1.17   1.56  11.77ms
 5: kcm-core-03.inet.qwest.net          (205.171.29.141)         1.54   1.52  16.26ms
 6: chi-core-02.inet.qwest.net          (205.171.8.169)   1.12   2.60  42.46ms
 7: chi-brdr-03.inet.qwest.net          (205.171.20.138)         1.48   0.81  34.09ms
 8: acr2-sonet2-2-3-0.Chicago.cw.net    (208.172.1.217)   1.37   1.59  37.88ms
 9: agr3-loopback.Chicago.cw.net        (208.172.2.103)   1.41   2.20  44.99ms
10: dcr1-so-0-2-0.Chicago.cw.net        (208.175.10.9)    1.81   1.71  37.06ms
11: cable-and-wireless-internal-isp.Chicago.cw.net(208.175.10.82)        1.00   1.47  24.90ms
12: bbr01-g4-0.okbr01.exodus.net        (216.34.183.97)   1.66   2.10  27.27ms
13: bbr01-p8-0.whkn01.exodus.net        (216.32.132.54)   1.37   2.37  60.74ms
14: NoNameNode                     (216.74.171.2)    1.59   2.16  78.28ms
15: bbr01-p1-0.stng02.exodus.net        (216.32.132.193)         1.27   3.90  76.99ms
16: bbr01-p6-0.stng01.exodus.net        (209.1.169.197)   1.33   1.37  52.10ms
17: dcr04-g7-0.stng01.exodus.net        (216.33.99.100)   1.61   1.77 131.80ms
18: csr22-ve241.stng01.exodus.net       (216.33.98.19)    1.22  -4.10 111.98ms
19: NoNameNode                     (216.35.210.126)         1.19   2.86  5
2.42ms
20: w3.dcx.yahoo.com                (64.58.76.224)    1.39   4.14  82.37ms

PipeCharacter statistics: 78.59% reliable
From localhost:
|      75.078 Mbps  100BT (97.0672 Mbps)

1: NoNameNode                     (10.10.127.254)
|
|      151.243 Mbps            <21.2644% BW used>
2: kr-ku-a0-4.kanren.net          (164.113.201.249)
|
|      42.378 Mbps    !!! ??? congested bottleneck <71.5892% BW used>
3: ks-1-a400-51.r.greatplains.net  (164.113.232.202)
|
|      150.626 Mbps    !!!      <28.2568% BW used>
4: kcm-edge-12.inet.qwest.net      (65.120.164.237)
|
|      46.397 Mbps    !!! ??? congested bottleneck <69.8170% BW used>
5: kcm-core-03.inet.qwest.net      (205.171.29.141)
|
|      153.392 Mbps    !!!      <27.4855% BW used>
6: chi-core-02.inet.qwest.net      (205.171.8.169)
|
|      47.238 Mbps    !!! ??? congested bottleneck <68.5926% BW used>
7: chi-brdr-03.inet.qwest.net      (205.171.20.138)
|
|      52.149 Mbps    !!! ??? congested bottleneck <66.0441% BW used>
8: acr2-sonet2-2-3-0.Chicago.cw.net(208.172.1.217)
|
|      152.342 Mbps            <2.6335% BW used>
9: agr3-loopback.Chicago.cw.net    (208.172.2.103)
|
|      38.772 Mbps    !!! ??? congested bottleneck <74.2793% BW used>
10: dcr1-so-0-2-0.Chicago.cw.net    (208.175.10.9)
|
|      151.983 Mbps    !!!      <44.4629% BW used>
11: cable-and-wireless-internal-isp.Chicago.cw.net(208.175.10.82)
|
|      42.711 Mbps    !!! ??? congested bottleneck <71.9495% BW used>
12: bbr01-g4-0.okbr01.exodus.net    (216.34.183.97)
|
```

```
|      152.537 Mbps            <17.2102% BW used>
13: bbr01-p8-0.whkn01.exodus.net    (216.32.132.54)
|
|      43.212 Mbps    !!! ??? congested bottleneck <70.8767% BW used>
14: NoNameNode                      (216.74.171.2)
|
|      55.215 Mbps    !!! ??? congested bottleneck <25.9842% BW used>
15: bbr01-p1-0.stng02.exodus.net    (216.32.132.193)
|
|      151.950 Mbps            <4.4396% BW used>
*****************************************************************************
16: bbr01-p6-0.stng01.exodus.net    (209.1.169.197)
|
|      35.579 Mbps    !!! ??? congested bottleneck <75.9119% BW used>
17: dcr03-g9-0.stng01.exodus.net    (216.33.96.145)
*****************************************************************************
|
|      57.182 Mbps    !!! ??? congested bottleneck <31.0401% BW used>
18: csr22-ve241.stng01.exodus.net   (216.33.98.19)
|
|      59.638 Mbps    !!! ??? congested bottleneck <60.9322% BW used>
19: NoNameNode                      (216.35.210.126)
|      51.724 Mbps  100BT (99.0145 Mbps)

20: w3.dcx.yahoo.com                (64.58.76.224)
```

```
raphael [29] % pipechar -l 64.58.77.41
0: localhost [20 hops]
 1: NoNameNode                      (10.10.127.254)   1.00   2.36   6.77ms
 2: kr-ku-a0-4.kanren.net           (164.113.201.249)        0.99   5.56  14.70ms
 3: ks-1-a400-51.r.greatplains.net      (164.113.232.202)        1.33   1.64  11.05ms
 4: kcm-edge-12.inet.qwest.net          (65.120.164.237)         1.29   3.84  21.94ms
 5: kcm-core-03.inet.qwest.net          (205.171.29.141)         1.48   1.49  10.75ms
 6: chi-core-02.inet.qwest.net          (205.171.8.169)   1.28   1.48  24.51ms
 7: chi-brdr-03.inet.qwest.net          (205.171.20.138)         1.30   1.47  25.31ms
 8: acr2-sonet2-2-3-0.Chicago.cw.net    (208.172.1.217)   1.32   3.02  46.21ms
 9: agr3-loopback.Chicago.cw.net        (208.172.2.103)   1.39   3.20  25.82ms
10: dcr1-so-0-2-0.Chicago.cw.net        (208.175.10.9)    1.53   3.61  45.23ms
11: cable-and-wireless-internal-isp.Chicago.cw.net(208.175.10.82)        1.41   1.31  25.59ms
12: bbr01-g4-0.okbr01.exodus.net        (216.34.183.97)   1.21   5.02  48.16ms
13: bbr01-p8-0.whkn01.exodus.net        (216.32.132.54)   1.19   1.63  47.77ms
14: NoNameNode                          (216.74.171.2)    1.26   2.88  46.14ms
15: bbr01-p1-0.stng02.exodus.net        (216.32.132.193)          1.50  14.10 134.25ms
16: bbr01-p6-0.stng01.exodus.net        (209.1.169.197)   1.20   1.75  52.37ms
17: dcr03-g9-0.stng01.exodus.net        (216.33.96.145)   1.28   3.35  52.67ms
18: csr22-ve241.stng01.exodus.net       (216.33.98.19)    1.62  17.81 162.29ms
19: NoNameNode                          (216.35.210.126)          1.64   3.45  5
2.59ms
20: alteon1.dcx.yahoo.com               (64.58.77.41)     1.99   3.92  87.07ms

PipeCharacter statistics: 91.71% reliable
From localhost:
|      71.856 Mbps  100BT (102.9328 Mbps)

1: NoNameNode                       (10.10.127.254)
|
|      158.757 Mbps            <1.0978% BW used>
2: kr-ku-a0-4.kanren.net            (164.113.201.249)
|
|      52.661 Mbps    !!! ??? congested bottleneck <65.1526% BW used>
3: ks-1-a400-51.r.greatplains.net  (164.113.232.202)
|
|      54.276 Mbps    !!! ??? congested bottleneck <64.0189% BW used>
4: kcm-edge-12.inet.qwest.net       (65.120.164.237)
|
|      48.211 Mbps    !!! ??? congested bottleneck <68.6561% BW used>
5: kcm-core-03.inet.qwest.net       (205.171.29.141)
|
|      55.572 Mbps    !!! ??? congested bottleneck <63.7945% BW used>
6: chi-core-02.inet.qwest.net       (205.171.8.169)
|
|      54.203 Mbps    !!! ??? congested bottleneck <64.2129% BW used>
7: chi-brdr-03.inet.qwest.net       (205.171.20.138)
|
|      53.996 Mbps    !!! ??? congested bottleneck <64.8626% BW used>
8: acr2-sonet2-2-3-0.Chicago.cw.net(208.172.1.217)
|
|      50.669 Mbps    !!! ??? congested bottleneck <66.6775% BW used>
9: agr3-loopback.Chicago.cw.net    (208.172.2.103)
|
|      46.225 Mbps    !!! ??? congested bottleneck <69.5798% BW used>
10: dcr1-so-0-2-0.Chicago.cw.net    (208.175.10.9)
|
|      50.049 Mbps    !!! ??? congested bottleneck <66.9854% BW used>
11: cable-and-wireless-internal-isp.Chicago.cw.net(208.175.10.82)
|
```

```
|      59.143 Mbps    !!! ??? congested bottleneck <61.4829% BW used>
12: bbr01-g4-0.okbr01.exodus.net    (216.34.183.97)
|
|      59.625 Mbps    !!! ??? congested bottleneck <61.0306% BW used>
13: bbr01-p8-0.whkn01.exodus.net    (216.32.132.54)
|
|      159.568 Mbps            <5.7706% BW used>
14: NoNameNode                  (216.74.171.2)
|
|      39.823 Mbps    !!! ??? congested bottleneck <74.1418% BW used>
15: bbr01-p1-0.stng02.exodus.net    (216.32.132.193)
|
|      59.031 Mbps    !!! ??? congested bottleneck <33.3332% BW used>
*****************************************************************************
16: bbr01-p6-0.stng01.exodus.net    (209.1.169.197)
|
|      33.441 Mbps    !!! ??? congested bottleneck <78.1418% BW used>
17: dcr03-g9-0.stng01.exodus.net    (216.33.96.145)
*****************************************************************************
|
|      44.712 Mbps            <21.0234% BW used>
18: csr22-ve241.stng01.exodus.net   (216.33.98.19)
|
|      46.234 Mbps            <1.1577% BW used>
19: NoNameNode                  (216.35.210.126)
|      36.217 Mbps  100BT (99.0145 Mbps)

20: alteon1.dcx.yahoo.com          (64.58.77.41 )
```

```
raphael [3] % pipechar -l 204.202.132.15
0: localhost [17 hops]
 1: NoNameNode                    (10.10.127.254)   0.76   8.97  18.97ms
 2: NoNameNode                    (129.237.2.21)    0.81  10.84  13.21ms
 3: kr-ku-a0-4.kanren.net          (164.113.201.249)        0.86  -4.52   4.79ms
 4: ks-1-a400-51.r.greatplains.net     (164.113.232.202)        1.36  13.85  30.61ms
 5: ksca01-edge12.mo.inet.qwest.net     (65.120.164.237)         1.93   2.87  12.83ms
 6: ksca01-core02.mo.inet.qwest.net     (205.171.29.137)         1.46   2.17  11.75ms
 7: dlls01-core02.tx.inet.qwest.net     (205.171.8.141)   1.63   3.24  50.93ms
 8: dlls01-brdr02.tx.inet.qwest.net     (205.171.25.50)   1.28   3.24  31.37ms
 9: p4-4-0-0.r02.dllstx01.us.bb.verio.net(129.250.9.81)   2.51   3.01  27.52ms
10: p16-1-1-0.r20.dllstx01.us.bb.verio.net(129.250.3.22)         2.10   2.57  23.98ms
11: p16-1-1-1.r20.plalca01.us.bb.verio.net(129.250.4.105)        1.66  -0.98  66.54ms
12: p64-0-0-0.r21.plalca01.us.bb.verio.net(129.250.3.77)         1.26   3.91  64.75ms
13: p16-0-1-1.r20.sttlwa01.us.bb.verio.net(129.250.5.82)         1.22   0.19  87.20ms
14: p16-2-0-0.r04.sttlwa01.us.bb.verio.net(129.250.2.169)        1.34   1.36  85.36ms
15: p4-0.infoseek.sttlwa01.us.bb.verio.net(129.250.16.10)        1.30   1.41  82.58ms
16: NoNameNode                   (204.202.138.75)         1.70   3.62  97.30ms
17: ns0.starwave.com             (204.202.132.15)         1.66   7.51 108.39ms

PipeCharacter statistics: 92.83% reliable
From localhost:
|      94.612 Mbps  100BT (102.9328 Mbps)

1: NoNameNode                    (10.10.127.254)
|
|      158.757 Mbps            <5.4658% BW used>
2: NoNameNode                    (129.237.2.21)
|
|      158.831 Mbps            <6.8287% BW used>
3: kr-ku-a0-4.kanren.net          (164.113.201.249)
|
|      150.626 Mbps    !!!      <29.9225% BW used>
*****************************************************************************
*
4: ks-1-a400-51.r.greatplains.net   (164.113.232.202)
|
|      36.724 Mbps    !!! ??? congested bottleneck <75.9940% BW used>
5: ksca01-edge12.mo.inet.qwest.net (65.120.164.237)
*****************************************************************************
*
|
|      153.392 Mbps    !!!      <24.4444% BW used>
6: ksca01-core02.mo.inet.qwest.net (205.171.29.137)
|
|      42.525 Mbps    !!! ??? congested bottleneck <71.5370% BW used>
7: dlls01-core02.tx.inet.qwest.net (205.171.8.141)
|
|      153.667 Mbps            <21.3849% BW used>
8: dlls01-brdr02.tx.inet.qwest.net (205.171.25.50)
|
|      43.874 Mbps             <16.2744% BW used>
9: p4-4-0-0.r02.dllstx01.us.bb.verio.net(129.250.9.81)
|
|      44.030 Mbps             <16.2744% BW used>
10: p16-1-1-0.r20.dllstx01.us.bb.verio.net(129.250.3.22)
|
|      44.750 Mbps        ??? congested bottleneck <3.4982% BW used>
```

```
11: p16-1-1-1.r20.plalca01.us.bb.verio.net(129.250.4.105)
|
|      56.605 Mbps    !!! ??? congested bottleneck <27.0847% BW used>
12: p64-0-0-0.r21.plalca01.us.bb.verio.net(129.250.3.77)
|
|      58.319 Mbps    !!! ??? congested bottleneck <61.8622% BW used>
13: p16-0-1-1.r20.sttlwa01.us.bb.verio.net(129.250.5.82)
|
|      52.152 Mbps    !!! ??? congested bottleneck <65.3086% BW used>
14: p16-2-0-0.r04.sttlwa01.us.bb.verio.net(129.250.2.169)
|
|      159.396 Mbps             <3.1361% BW used>
15: p4-0.infoseek.sttlwa01.us.bb.verio.net(129.250.16.10)
|
|      46.292 Mbps              <5.9931% BW used> May get 23.80% congested
16: NoNameNode                   (204.202.138.75)
|      43.478 Mbps  100BT (100.6561 Mbps)

17: ns0.starwave.com             (204.202.132.15)
```

```
raphael [5] % pipechar -l 204.202.132.25
0: localhost [17 hops]
 1: NoNameNode                    (10.10.127.254)   0.91   1.09   3.19ms
 2: NoNameNode                    (129.237.2.21)    0.83   0.90   3.18ms
 3: kr-ku-a0-4.kanren.net         (164.113.201.249)        0.93   2.35   9.74ms
 4: ks-1-a400-51.r.greatplains.net      (164.113.232.202)        1.24   2.94  11.97ms
 5: ksca01-edge12.mo.inet.qwest.net     (65.120.164.237)         1.41   1.88  11.42ms
 6: ksca01-core02.mo.inet.qwest.net     (205.171.29.137)         1.37   2.74  12.40ms
 7: dlls01-core02.tx.inet.qwest.net     (205.171.8.141)   1.73   1.94  24.56ms
 8: dlls01-brdr02.tx.inet.qwest.net     (205.171.25.50)   1.15   2.02  23.37ms
 9: p4-4-0-0.r02.dllstx01.us.bb.verio.net(129.250.9.81)   1.28   0.88  22.74ms
10: p16-1-1-0.r20.dllstx01.us.bb.verio.net(129.250.3.22)          1.31   1.19  22.76ms
11: p16-1-1-1.r20.plalca01.us.bb.verio.net(129.250.4.105)         1.40   2.32  64.90ms
12: p64-0-0-0.r21.plalca01.us.bb.verio.net(129.250.3.77)          1.31   2.39  64.23ms
13: p16-0-1-1.r20.sttlwa01.us.bb.verio.net(129.250.5.82)          1.49   1.56  87.36ms
14: p16-2-0-0.r04.sttlwa01.us.bb.verio.net(129.250.2.169)         1.53  -0.74 142.18ms
15: p4-0.infoseek.sttlwa01.us.bb.verio.net(129.250.16.10)         1.15   2.68  88.17ms
16: NoNameNode                    (204.202.138.75)          1.65   1.86  83.05ms
17: redirweb01.dig.com            (204.202.132.25)          1.48  -0.90  93.45ms

PipeCharacter statistics: 85.11% reliable
From localhost:
|      79.121 Mbps  100BT (97.0672 Mbps)
```

```
1: NoNameNode                    (10.10.127.254)
|
|      151.243 Mbps             <9.1209% BW used>
2: NoNameNode                    (129.237.2.21)
|
|      151.169 Mbps             <11.0752% BW used>
3: kr-ku-a0-4.kanren.net         (164.113.201.249)
|
|      56.580 Mbps    !!! ??? congested bottleneck <62.5692% BW used>
*****************************************************************************
4: ks-1-a400-51.r.greatplains.net  (164.113.232.202)
|
|      39.856 Mbps    !!! ??? congested bottleneck <76.9619% BW used>
5: ksca01-edge12.mo.inet.qwest.net (65.120.164.237)
*****************************************************************************
|
|      153.392 Mbps             <2.8449% BW used>
6: ksca01-core02.mo.inet.qwest.net (205.171.29.137)
|
|      40.030 Mbps    !!! ??? congested bottleneck <73.0871% BW used>
7: dlls01-core02.tx.inet.qwest.net (205.171.8.141)
|
|      62.423 Mbps    !!! ??? congested bottleneck <39.6161% BW used>
8: dlls01-brdr02.tx.inet.qwest.net (205.171.25.50)
|
|      55.260 Mbps    !!! ??? congested bottleneck <63.7663% BW used>
9: p4-4-0-0.r02.dllstx01.us.bb.verio.net(129.250.9.81)
|
|      54.082 Mbps    !!! ??? congested bottleneck <64.5948% BW used>
10: p16-1-1-0.r20.dllstx01.us.bb.verio.net(129.250.3.22)
|
|      50.348 Mbps    !!! ??? congested bottleneck <66.7965% BW used>
11: p16-1-1-1.r20.plalca01.us.bb.verio.net(129.250.4.105)
|
|      54.568 Mbps    !!! ??? congested bottleneck <64.4049% BW used>
12: p64-0-0-0.r21.plalca01.us.bb.verio.net(129.250.3.77)
|
|      47.350 Mbps    !!! ??? congested bottleneck <68.8245% BW used>
13: p16-0-1-1.r20.sttlwa01.us.bb.verio.net(129.250.5.82)
|
|      45.336 Mbps    !!! ??? congested bottleneck <69.5599% BW used>
14: p16-2-0-0.r04.sttlwa01.us.bb.verio.net(129.250.2.169)
|
|      150.604 Mbps    !!!      <24.5085% BW used>
15: p4-0.infoseek.sttlwa01.us.bb.verio.net(129.250.16.10)
```

```
|
|      42.386 Mbps    !!! ??? congested bottleneck <71.7963% BW used>
16: NoNameNode                  (204.202.138.75)
|      48.550 Mbps  100BT (99.3439 Mbps)

17: redirweb01.dig.com          (204.202.132.25)




raphael [7] % pipechar -l 204.202.132.19
0: localhost [17 hops]
 1: NoNameNode                  (10.10.127.254)   0.72   0.99   3.32ms
 2: NoNameNode                  (129.237.2.21)    0.98   1.44   3.44ms
 3: kr-ku-a0-4.kanren.net       (164.113.201.249)        0.84   1.11   4.70ms
 4: ks-1-a400-51.r.greatplains.net      (164.113.232.202)        1.42   6.20  29.24ms
 5: ksca01-edge12.mo.inet.qwest.net     (65.120.164.237)         1.65   2.59  12.39ms
 6: ksca01-core02.mo.inet.qwest.net     (205.171.29.137)         1.50   1.50  12.52ms
 7: dlls01-core02.tx.inet.qwest.net     (205.171.8.141)   1.26   1.25  22.40ms
 8: dlls01-brdr02.tx.inet.qwest.net     (205.171.25.50)   1.86   1.21  29.50ms
 9: p4-4-0-0.r02.dllstx01.us.bb.verio.net(129.250.9.81)   1.55   1.44  23.07ms
10: p16-1-1-0.r20.dllstx01.us.bb.verio.net(129.250.3.22)          1.45   2.01  23.57ms
11: p16-1-1-1.r20.plalca01.us.bb.verio.net(129.250.4.105)         1.09   2.01  64.60ms
12: p64-0-0-0.r21.plalca01.us.bb.verio.net(129.250.3.77)          1.19  -0.05  63.46ms
13: p16-0-1-1.r20.sttlwa01.us.bb.verio.net(129.250.5.82)          1.57   3.28  90.86ms
14: p16-2-0-0.r04.sttlwa01.us.bb.verio.net(129.250.2.169)         1.67   2.19  85.79ms
15: p4-0.infoseek.sttlwa01.us.bb.verio.net(129.250.16.10)         1.38   1.81  82.15ms
16: NoNameNode                  (204.202.138.75)         1.12   4.46  82.36ms
17: 204.202.132.19              (204.202.132.19)         1.63   1.32  82.01ms

PipeCharacter statistics: 87.68% reliable
From localhost:
|      100.699 Mbps  100BT (102.9328 Mbps)

1: NoNameNode                   (10.10.127.254)
|
|      72.494 Mbps    !!! ??? congested bottleneck <26.5306% BW used>
2: NoNameNode                   (129.237.2.21)
|
|      151.169 Mbps           <14.0816% BW used>
3: kr-ku-a0-4.kanren.net        (164.113.201.249)
|
|      150.626 Mbps           <13.7576% BW used>
*******************************************************************************
4: ks-1-a400-51.r.greatplains.net  (164.113.232.202)
|
|      35.222 Mbps    !!! ??? congested bottleneck <77.8475% BW used>
5: ksca01-edge12.mo.inet.qwest.net (65.120.164.237)
*******************************************************************************
|
|      48.702 Mbps        ??? congested bottleneck <6.8091% BW used>
6: ksca01-core02.mo.inet.qwest.net (205.171.29.137)
|
|      151.314 Mbps           <15.6208% BW used>
7: dlls01-core02.tx.inet.qwest.net (205.171.8.141)
|
|      44.435 Mbps            <16.5232% BW used>
8: dlls01-brdr02.tx.inet.qwest.net (205.171.25.50)
|
|      47.513 Mbps        ??? congested bottleneck <3.1593% BW used>
9: p4-4-0-0.r02.dllstx01.us.bb.verio.net(129.250.9.81)
|
|      50.703 Mbps        ??? congested bottleneck <10.7265% BW used>
10: p16-1-1-0.r20.dllstx01.us.bb.verio.net(129.250.3.22)
|
|      65.184 Mbps    !!! ??? congested bottleneck <57.3838% BW used>
11: p16-1-1-1.r20.plalca01.us.bb.verio.net(129.250.4.105)
|
|      156.750 Mbps           <8.0942% BW used>
12: p64-0-0-0.r21.plalca01.us.bb.verio.net(129.250.3.77)
|
|      46.044 Mbps            <1.6876% BW used> May get 24.60% congested
13: p16-0-1-1.r20.sttlwa01.us.bb.verio.net(129.250.5.82)
|
|      45.208 Mbps        ??? congested bottleneck <4.0192% BW used>
14: p16-2-0-0.r04.sttlwa01.us.bb.verio.net(129.250.2.169)
|
|      50.412 Mbps        ??? congested bottleneck <15.6074% BW used>
15: p4-0.infoseek.sttlwa01.us.bb.verio.net(129.250.16.10)
|
|      151.950 Mbps           <19.0030% BW used>
16: NoNameNode                  (204.202.138.75)
|      44.226 Mbps  100BT (100.6561 Mbps)

17: 204.202.132.19              (204.202.132.19)
```

```
raphael [22] % pipechar -l 192.65.185.2
0: localhost [12 hops]
 1: NoNameNode                    (10.10.127.254)   0.85   0.67   3.20ms
 2: NoNameNode                    (129.237.2.21)    0.80   0.66   4.65ms
 3: ks-2-a10-52.r.greatplains.net      (164.113.234.206)       0.85   1.05   9.09ms
 4: ks-2-abilene-ks.r.greatplains.net  (164.113.238.193)       0.81   1.90  16.68ms
 5: ipls-kscy.abilene.ucaid.edu        (198.32.8.6)      0.84   0.60  18.02ms
 6: clev-ipls.abilene.ucaid.edu        (198.32.8.26)     0.96   1.21  24.23ms
 7: nycm-clev.abilene.ucaid.edu        (198.32.8.30)     0.81   2.07  36.14ms
 8: NoNameNode                    (62.40.103.229)   0.93   1.25 154.03ms
 9: de.it1.it.geant.net           (62.40.96.62)     0.94   1.00 135.71ms
10: it.ch1.ch.geant.net           (62.40.96.33)     0.93   1.04 140.96ms
11: swiCE2-P6-1.switch.ch         (62.40.103.18)    0.88  -0.87 143.26ms
14: 192.65.185.2                  (192.65.185.2)    1.68  -6.04 149.96ms

PipeCharacter statistics: 95.10% reliable
From localhost:
|      84.507 Mbps  100BT (102.9328 Mbps)

1: NoNameNode                  (10.10.127.254)
|
|      158.757 Mbps          <6.4554% BW used>
2: NoNameNode                  (129.237.2.21)
|
|      158.831 Mbps          <6.5650% BW used>
3: ks-2-a10-52.r.greatplains.net   (164.113.234.206)
|
|      159.374 Mbps          <4.6893% BW used>
*******************************************************************************
4: ks-2-abilene-ks.r.greatplains.net(164.113.238.193)
|
|      71.595 Mbps    !!! ??? congested bottleneck <51.6633% BW used>
5: ipls-kscy.abilene.ucaid.edu     (198.32.8.6 )
*******************************************************************************
|
|      162.706 Mbps          <3.3294% BW used>
6: clev-ipls.abilene.ucaid.edu     (198.32.8.26 )
|
|      151.314 Mbps          <16.0247% BW used>
7: nycm-clev.abilene.ucaid.edu     (198.32.8.30 )
|
|      153.667 Mbps          <13.3187% BW used>
8: NoNameNode                  (62.40.103.229)
|
|      157.658 Mbps          <1.3772% BW used>
9: de.it1.it.geant.net         (62.40.96.62 )
|
|      157.290 Mbps          <1.9074% BW used>
10: it.ch1.ch.geant.net          (62.40.96.33 )
|
|      158.017 Mbps          <5.0753% BW used>
11: swiCE2-P6-1.switch.ch        (62.40.103.18)
|      42.730 Mbps *** static bottle-neck  100BT (102.7127 Mbps)

14: 192.65.185.2                 (192.65.185.2)



raphael [24] % pipechar -l 192.65.185.145
0: localhost [12 hops]
 1: NoNameNode                    (10.10.127.254)   0.90   0.99   3.01ms
 2: NoNameNode                    (129.237.2.21)    0.90   0.89   3.39ms
 3: ks-2-a10-52.r.greatplains.net      (164.113.234.206)       0.99   1.27   9.13ms
 4: ks-2-abilene-ks.r.greatplains.net  (164.113.238.193)       0.83   0.91   8.53ms
 5: ipls-kscy.abilene.ucaid.edu        (198.32.8.6)      0.93   1.11  18.02ms
 6: clev-ipls.abilene.ucaid.edu        (198.32.8.26)     0.90   0.75  23.98ms
 7: nycm-clev.abilene.ucaid.edu        (198.32.8.30)     0.93   0.14  40.12ms
 8: NoNameNode                    (62.40.103.229)   0.83   4.43 118.66ms
 9: de.it1.it.geant.net           (62.40.96.62)     0.93   0.93 127.66ms
10: it.ch1.ch.geant.net           (62.40.96.33)     0.90  -4.18 215.48ms
11: swiCE2-P6-1.switch.ch         (62.40.103.18)    0.78   3.97 144.15ms
12: cisco0-cern.who.ch            (192.65.185.145)        1.32  11.18 247.25ms

PipeCharacter statistics: 96.44% reliable
From localhost:
|      79.823 Mbps  100BT (97.0672 Mbps)

1: NoNameNode                  (10.10.127.254)
|
|      151.243 Mbps          <0.3326% BW used>
2: NoNameNode                  (129.237.2.21)
|
|      147.294 Mbps          <10.5149% BW used>
3: ks-2-a10-52.r.greatplains.net   (164.113.234.206)
|
|      150.626 Mbps          <15.6724% BW used>
*******************************************************************************
***
4: ks-2-abilene-ks.r.greatplains.net(164.113.238.193)
```

```
|
|      71.798 Mbps    !!! ??? congested bottleneck <53.0317% BW used>
5: ipls-kscy.abilene.ucaid.edu     (198.32.8.6  )
********************************************************************************
***
|
|      153.392 Mbps            <3.7553% BW used>
6: clev-ipls.abilene.ucaid.edu     (198.32.8.26 )
|
|      151.314 Mbps            <3.1317% BW used>
7: nycm-clev.abilene.ucaid.edu     (198.32.8.30 )
|
|      153.667 Mbps            <10.7986% BW used>
8: NoNameNode                    (62.40.103.229)
|
|      152.342 Mbps            <10.7982% BW used>
9: de.it1.it.geant.net           (62.40.96.62 )
|
|      152.710 Mbps            <2.5904% BW used>
10: it.ch1.ch.geant.net          (62.40.96.33 )
|
|      151.983 Mbps            <13.4164% BW used>
11: swiCE2-P6-1.switch.ch          (62.40.103.18)
|      54.340 Mbps *** static bottle-neck  100BT (97.2873 Mbps)

12: cisco0-cern.who.ch             (192.65.185.145)



raphael [26] % pipechar -l 192.65.185.33
0: localhost [12 hops]
 1: NoNameNode                     (10.10.127.254)   0.97   1.24   3.47ms
 2: NoNameNode                     (129.237.2.21)    0.79   0.82   3.13ms
 3: ks-2-a10-52.r.greatplains.net       (164.113.234.206)        0.88   0.85   8.41ms
 4: ks-2-abilene-ks.r.greatplains.net   (164.113.238.193)        0.88  -1.15  12.32ms
 5: ipls-kscy.abilene.ucaid.edu         (198.32.8.6)      1.20  -0.84  17.70ms
 6: clev-ipls.abilene.ucaid.edu         (198.32.8.26)     0.89   2.33  25.19ms
 7: nycm-clev.abilene.ucaid.edu         (198.32.8.30)     0.91   1.73  39.17ms
 8: NoNameNode                     (62.40.103.229)   0.91   0.48 118.53ms
 9: de.it1.it.geant.net                (62.40.96.62)     0.62   0.93 127.66ms
10: it.ch1.ch.geant.net                (62.40.96.33)     0.93   1.52 141.50ms
11: swiCE2-P6-1.switch.ch              (62.40.103.18)    1.17  -0.63 143.00ms
12: cern1.in2p3.fr                (192.65.185.33)   2.12  -88.47 300.91ms

PipeCharacter statistics: 96.44% reliable
```

```
From localhost:
|      74.457 Mbps  100BT (97.0672 Mbps)

1: NoNameNode                     (10.10.127.254)
|
|      151.243 Mbps            <18.4074% BW used>
2: NoNameNode                     (129.237.2.21)
|
|      151.169 Mbps            <10.8474% BW used>
3: ks-2-a10-52.r.greatplains.net   (164.113.234.206)
|
|      150.626 Mbps            <0.7909% BW used>
********************************************************************************
**
4: ks-2-abilene-ks.r.greatplains.net(164.113.238.193)
|
|      57.500 Mbps    !!! ??? congested bottleneck <61.3226% BW used>
5: ipls-kscy.abilene.ucaid.edu     (198.32.8.6  )
********************************************************************************
**
|
|      153.392 Mbps    !!!      <26.0616% BW used>
6: clev-ipls.abilene.ucaid.edu     (198.32.8.26 )
|
|      151.314 Mbps            <2.6314% BW used>
7: nycm-clev.abilene.ucaid.edu     (198.32.8.30 )
|
|      152.452 Mbps            <28.2184% BW used>
8: NoNameNode                     (62.40.103.229)
|
|      152.342 Mbps    !!!      <31.5677% BW used>
9: de.it1.it.geant.net           (62.40.96.62 )
|
|      152.710 Mbps            <20.3760% BW used>
10: it.ch1.ch.geant.net          (62.40.96.33 )
|
|      151.983 Mbps            <20.3760% BW used>
11: swiCE2-P6-1.switch.ch          (62.40.103.18)
|      33.930 Mbps *** static bottle-neck  100BT (97.2873 Mbps)

12: cern1.in2p3.fr                (192.65.185.33)
```

```
raphael [20] % pipechar -l 194.25.7.252
0: localhost [13 hops]
 1: NoNameNode                    (10.10.127.254)   0.83   1.30   3.57ms
 2: NoNameNode                    (129.237.2.21)    0.98   1.27   5.44ms
 3: kr-ku-a0-4.kanren.net         (164.113.201.249)        1.05  11.31  21.35ms
 4: ks-1-a400-51.r.greatplains.net      (164.113.232.202)        1.55   1.16  11.27ms
 5: ksca01-edge12.mo.inet.qwest.net     (65.120.164.237)         1.25   1.43  10.86ms
 6: ksca01-core03.mo.inet.qwest.net     (205.171.29.141)         1.44   1.33  11.62ms
 7: nwrk01-core01.nj.inet.qwest.net     (205.171.8.186)   1.32   1.85  44.91ms
 8: nwrk01-core03.nj.inet.qwest.net     (205.171.17.6)    1.40   2.32  47.67ms
 9: nycm01-core03.ny.inet.qwest.net     (205.171.5.90)    1.41   3.43  49.41ms
10: nycm01-core02.ny.inet.qwest.net     (205.171.230.9)   1.32   1.58  44.45ms
11: nycm01-brdr02.ny.inet.qwest.net     (205.171.230.21)         1.51   1.60  44.53ms
12: NoNameNode                   (205.171.1.50)    1.31  -0.45  46.53ms
13: CIXP-gw20.CH.net.DTAG.DE           (194.25.7.252)    1.55   7.24 189.93ms

PipeCharacter statistics: 96.71% reliable
From localhost:
|      86.435 Mbps  100BT (102.9328 Mbps)

1: NoNameNode                    (10.10.127.254)
|
|      151.243 Mbps           <14.8262% BW used>
2: NoNameNode                    (129.237.2.21)
|
|      158.831 Mbps           <7.2106% BW used>
3: kr-ku-a0-4.kanren.net         (164.113.201.249)
|
|      44.625 Mbps    !!! ??? congested bottleneck <70.0505% BW used>
4: ks-1-a400-51.r.greatplains.net  (164.113.232.202)
|
|      54.953 Mbps    !!! ??? congested bottleneck <27.7955% BW used>
5: ksca01-edge12.mo.inet.qwest.net (65.120.164.237)
|
|      49.457 Mbps    !!! ??? congested bottleneck <67.6971% BW used>
6: ksca01-core03.mo.inet.qwest.net (205.171.29.141)
|
|      53.173 Mbps    !!! ??? congested bottleneck <64.8627% BW used>
7: nwrk01-core01.nj.inet.qwest.net (205.171.8.186)
|
|      50.824 Mbps    !!! ??? congested bottleneck <66.8912% BW used>
8: nwrk01-core03.nj.inet.qwest.net (205.171.17.6)
|
|      49.961 Mbps    !!! ??? congested bottleneck <67.1255% BW used>
9: nycm01-core03.ny.inet.qwest.net (205.171.5.90)
|
|      53.829 Mbps    !!! ??? congested bottleneck <64.7560% BW used>
**********************************************************************
10: nycm01-core02.ny.inet.qwest.net (205.171.230.9)
|
|      36.638 Mbps    !!! ??? congested bottleneck <75.1352% BW used>
11: nycm01-brdr02.ny.inet.qwest.net (205.171.230.21)
**********************************************************************
|
|      153.250 Mbps           <12.8240% BW used>
12: NoNameNode                   (205.171.1.50)
|      46.332 Mbps  100BT (96.1822 Mbps)

13: CIXP-gw20.CH.net.DTAG.DE           (194.25.7.252)
```

```
raphael [28] % pipechar -l 192.65.185.40
0: localhost [12 hops]
 1: NoNameNode                    (10.10.127.254)   0.90   1.16   3.19ms
 2: NoNameNode                    (129.237.2.21)    0.87   1.03   3.50ms
 3: ks-2-a10-52.r.greatplains.net       (164.113.234.206)        0.93  -0.39  14.61ms
 4: ks-2-abilene-ks.r.greatplains.net   (164.113.238.193)        0.90   0.91  14.71ms
 5: ipls-kscy.abilene.ucaid.edu         (198.32.8.6)      0.71  -0.06  18.93ms
 6: clev-ipls.abilene.ucaid.edu         (198.32.8.26)     0.88   0.73  47.79ms
 7: nycm-clev.abilene.ucaid.edu         (198.32.8.30)     0.98   1.82  38.65ms
 8: NoNameNode                    (62.40.103.229)   0.91   1.16 125.63ms
 9: de.it1.it.geant.net                 (62.40.96.62)     0.95   1.22 134.09ms
10: it.ch1.ch.geant.net                 (62.40.96.33)     0.89   0.88 158.40ms
11: swiCE2-P6-1.switch.ch               (62.40.103.18)    0.92  -6.60 141.20ms
12: rrc04.ripe.net               (192.65.185.40)   1.04   1.16 149.57ms

PipeCharacter statistics: 96.44% reliable
From localhost:
|      80.000 Mbps  100BT (102.9328 Mbps)

1: NoNameNode                    (10.10.127.254)
|
|      158.757 Mbps           <3.7778% BW used>
2: NoNameNode                    (129.237.2.21)
|
|      158.831 Mbps           <6.6810% BW used>
3: ks-2-a10-52.r.greatplains.net   (164.113.234.206)
|
|      147.294 Mbps           <21.3094% BW used>
```

```
*********************************************************************************
4: ks-2-abilene-ks.r.greatplains.net(164.113.238.193)
|
|      78.868 Mbps    !!! ??? congested bottleneck <48.4444% BW used>
5: ipls-kscy.abilene.ucaid.edu     (198.32.8.6  )
*********************************************************************************
|
|      153.392 Mbps            <19.4316% BW used>
6: clev-ipls.abilene.ucaid.edu     (198.32.8.26 )
|
|      158.686 Mbps            <10.0202% BW used>
7: nycm-clev.abilene.ucaid.edu     (198.32.8.30 )
|
|      156.333 Mbps            <6.5443% BW used>
8: NoNameNode                  (62.40.103.229)
|
|      157.658 Mbps            <3.3832% BW used>
9: de.it1.it.geant.net           (62.40.96.62 )
|
|      157.290 Mbps            <5.7083% BW used>
10: it.ch1.ch.geant.net            (62.40.96.33 )
|
|      158.017 Mbps            <2.9388% BW used>
11: swiCE2-P6-1.switch.ch          (62.40.103.18)
|      69.365 Mbps  100BT (102.7127 Mbps)

12: rrc04.ripe.net                 (192.65.185.40)



raphael [13] % pipechar -irtc -l 216.136.226.6
0: localhost [16 hops]
 1: NoNameNode                     (10.10.127.254)   0.93   1.54   3.22ms
 2: NoNameNode                     (129.237.2.21)    0.87   0.76   3.32ms
 3: kr-ku-a0-4.kanren.net          (164.113.201.249)        0.87   1.92   8.66ms
 4: ks-1-a400-51.r.greatplains.net      (164.113.232.202)        1.41   6.20  42.77ms
 5: ksca01-edge12.mo.inet.qwest.net     (65.120.164.237)         1.36   5.23  29.82ms
 6: ksca01-core02.mo.inet.qwest.net     (205.171.29.137)         1.15   1.83  10.90ms
 7: dlls01-core02.tx.inet.qwest.net     (205.171.8.141)   1.36   1.64  30.03ms
 8: dlls01-brdr02.tx.inet.qwest.net     (216.136.129.1)   1.53   2.24  21.81ms
 9: pos2-2.core1.Dallas1.Level3.net     (209.245.240.129)        1.09   4.91  51.86ms
10: so-4-0-0.mp2.Dallas1.Level3.net     (209.247.10.105)         1.47   1.37  54.50ms
11: so-3-0-0.mp2.SanJose1.Level3.net    (64.159.1.130)    1.37   2.65  95.36ms
12: gige10-2.ipcolo4.SanJose1.Level3.net(64.159.2.170)    1.67   2.18  70.98ms
13: cust-int.level3.net                 (64.152.69.18)    1.58   4.24  93.93ms
14: ge-1-2-0.msr1.sc5.yahoo.com         (216.115.101.234)        0.99   4.67 100.34ms
15: vl45.bas1-m.sc5.yahoo.com           (216.115.100.106)        1.30   5.09 110.81ms
16: alteon9.224.sc5.yahoo.com           (216.136.226.6)   1.55  -1.19  62.78ms

PipeCharacter statistics: 86.91% reliable
From localhost:
|      77.253 Mbps  100BT (102.9328 Mbps)

1: NoNameNode                     (10.10.127.254)
|
|      158.757 Mbps            <7.1888% BW used>
2: NoNameNode                     (129.237.2.21)
|
|      158.831 Mbps            <0.8028% BW used>
3: kr-ku-a0-4.kanren.net          (164.113.201.249)
|
|      40.562 Mbps    !!! ??? congested bottleneck <72.5658% BW used>
4: ks-1-a400-51.r.greatplains.net  (164.113.232.202)
|
|      52.796 Mbps        ??? congested bottleneck <68.0811% BW used>
5: ksca01-edge12.mo.inet.qwest.net (65.120.164.237)
|
|      61.955 Mbps    !!! ??? congested bottleneck <59.7124% BW used>
6: ksca01-core02.mo.inet.qwest.net (205.171.29.137)
|
|      151.314 Mbps            <15.2206% BW used>
7: dlls01-core02.tx.inet.qwest.net (205.171.8.141)
|
|      46.395 Mbps    !!! ??? congested bottleneck <69.7186% BW used>
8: dlls01-brdr02.tx.inet.qwest.net (216.136.129.1)
|
|      152.342 Mbps    !!!      <28.7484% BW used>
9: pos2-2.core1.Dallas1.Level3.net (209.245.240.129)
|
|      48.020 Mbps    !!! ??? congested bottleneck <68.4432% BW used>
10: so-4-0-0.mp2.Dallas1.Level3.net (209.247.10.105)
|
|      158.017 Mbps            <6.7255% BW used>
11: so-3-0-0.mp2.SanJose1.Level3.net(64.159.1.130)
|
|      44.259 Mbps             <17.6859% BW used>
12: gige10-2.ipcolo4.SanJose1.Level3.net(64.159.2.170)
|
|      150.432 Mbps    !!!      <37.7762% BW used>
*********************************************************************************
*
```

```
13: cust-int.level3.net            (64.152.69.18)
|
|      36.516 Mbps        ??? congested bottleneck <74.0741% BW  used>
14: ge-1-2-0.msr1.sc5.yahoo.com     (216.115.101.234)
*******************************************************************************
*
|
|      150.604 Mbps    !!!      <64.3229% BW used> May get 24.35% congested
15: vl45.bas1-m.sc5.yahoo.com       (216.115.100.106)
|      46.452 Mbps  100BT (104.7274 Mbps)

16: alteon9.224.sc5.yahoo.com       (216.136.226.6)



raphael [16] % pipechar -irtc -l 216.136.129.1
0: localhost [16 hops]
 1: NoNameNode                     (10.10.127.254)   0.96   0.97   3.07ms
 2: NoNameNode                     (129.237.2.21)    0.83   1.04   3.12ms
 3: kr-ku-a0-4.kanren.net          (164.113.201.249)        0.85   4.69   8.32ms
 4: ks-1-a400-51.r.greatplains.net      (164.113.232.202)        1.45   0.41  30.42ms
 5: ksca01-edge12.mo.inet.qwest.net     (65.120.164.237)         1.38   4.52  20.65ms
 6: ksca01-core02.mo.inet.qwest.net     (205.171.29.137)         1.47   3.13  12.17ms
 7: dlls01-core02.tx.inet.qwest.net     (205.171.8.141)   1.29   6.36  43.60ms
 8: dlls01-brdr02.tx.inet.qwest.net     (205.171.25.50)   1.72   9.43  75.94ms
 9: pos2-2.core1.Dallas1.Level3.net     (209.245.240.129)        1.50   2.70  23.06ms
10: so-4-0-0.mp2.Dallas1.Level3.net     (209.247.10.105)         2.17  11.52  92.84ms
11: so-3-0-0.mp2.SanJose1.Level3.net    (64.159.1.130)    1.95   4.67 125.03ms
12: gige10-1.ipcolo4.SanJose1.Level3.net(64.159.2.106)    1.30   1.90  74.53ms
13: cust-int.level3.net                 (64.152.69.18)    1.36   1.74  70.19ms
14: ge-0-2-0.msr2.sc5.yahoo.com         (216.115.101.234)        1.64   7.04  66.07ms
15: vl45.bas1-m.sc5.yahoo.com           (216.115.100.106)        1.41   1.61  59.93ms
16: alteon5.128.sc5.yahoo.com           (216.136.129.1)   1.68   1.73  63.40ms

PipeCharacter statistics: 84.18% reliable
From localhost:
|      75.314 Mbps  100BT (102.9328 Mbps)

1: NoNameNode                    (10.10.127.254)
|
|      151.243 Mbps            <13.7029% BW used>
2: NoNameNode                    (129.237.2.21)
|
|      158.831 Mbps            <2.3669% BW used>
3: kr-ku-a0-4.kanren.net         (164.113.201.249)
|
|      47.976 Mbps    !!! ??? congested bottleneck <67.9644% BW used>
4: ks-1-a400-51.r.greatplains.net  (164.113.232.202)
|
|      51.828 Mbps    !!! ??? congested bottleneck <66.3394% BW used>
5: ksca01-edge12.mo.inet.qwest.net (65.120.164.237)
|
|      48.421 Mbps    !!! ??? congested bottleneck <68.3572% BW used>
6: ksca01-core02.mo.inet.qwest.net (205.171.29.137)
|
|      158.686 Mbps            <11.8528% BW used>
7: dlls01-core02.tx.inet.qwest.net (205.171.8.141)
|
|      42.059 Mbps    !!! ??? congested bottleneck <71.5893% BW used>
8: dlls01-brdr02.tx.inet.qwest.net (205.171.25.50)
|
|      152.342 Mbps    !!!      <27.1137% BW used>
9: pos2-2.core1.Dallas1.Level3.net (209.245.240.129)
|
|      44.030 Mbps    !!!      <25.2266% BW used>
10: so-4-0-0.mp2.Dallas1.Level3.net (209.247.10.105)
|
|      45.405 Mbps        ??? congested bottleneck <67.8644% BW used>
11: so-3-0-0.mp2.SanJose1.Level3.net(64.159.1.130)
|
|      54.998 Mbps    !!! ??? congested bottleneck <23.5519% BW used>
12: gige10-1.ipcolo4.SanJose1.Level3.net(64.159.2.106)
|
|      157.463 Mbps            <4.9888% BW used>
*******************************************************************************
***
13: cust-int.level3.net            (64.152.69.18)
|
|      34.259 Mbps    !!! ??? congested bottleneck <77.4288% BW used>
14: ge-0-2-0.msr2.sc5.yahoo.com     (216.115.101.234)
*******************************************************************************
***
|
|      150.604 Mbps            <13.5780% BW used>
15: vl45.bas1-m.sc5.yahoo.com       (216.115.100.106)
|      42.883 Mbps  100BT (104.7274 Mbps)

16: alteon5.128.sc5.yahoo.com       (216.136.129.1)
```

```
[bkarthik@ittc-edc ~/Ping]$ pip echar -l 209.1.169.197
pipechar [Mar25-2K1] : can't reach the host15[216.35.65.68] with max_ttl(17)
try to analyze partial path instead

0: localhost [15 hops]
 1: sd.r.cr.usgs.gov                (192.41.204.1)    0.74   0.93   1.79ms
 2: NoNameNode                      (152.61.1.26)     0.71   8.98  10.84ms
 3: NoNameNode                      (152.61.100.40)   0.77   0.69  30.80ms
 4: 66-128-169-21.du.sdnet.net      (66.128.169.21)   5.38   6.79  33.87ms
 5: border2-fe0-0.siouxfalls.sdnet.net  (63.65.236.3)    5.98 -11.54  32.34ms
 6: Serial2-7.GW7.MSP1.ALTER.NET    (157.130.105.33)          5.63   7.26  31.19ms
 7: 113.at-1-0-0.CL1.MSP1.ALTER.NET     (152.63.69.90)    5.38   5.85  32.03ms
 8: 0.so-0-0-2.XL1.CHI2.ALTER.NET       (152.63.64.45)    5.55   6.24  40.32ms
 9: 0.so-7-0-0.BR6.CHI2.ALTER.NET       (152.63.71.94)    5.44   6.77  45.07ms
10: bpr1-so-6-0-0-0.ChicagoEquinix.cw.net(208.174.226.1)          5.59   6.05  45.51ms
11: agr1-loopback.Chicago.cw.net        (208.172.2.101)   5.23   6.72  41.82ms
12: dcr1-so-6-0-0.Chicago.cw.net        (208.175.10.49)   5.52   8.12  43.53ms
13: ibr02-p6-0.okbr01.exodus.net        (208.175.10.82)   5.46   6.13  43.37ms
14: bbr01-g4-0.okbr01.exodus.net        (216.34.183.97)   5.21   6.92  54.81ms
15: bbr01-p8-0.whkn01.exodus.net        (216.32.132.54)   5.67   7.16  74.65ms

PipeCharacter statistics: 95.63% reliable
From localhost:
|      97.826 Mbps  100BT (97.0672 Mbps)

1: sd.r.cr.usgs.gov                (192.41.204.1)
|
|      151.243 Mbps            <4.0761% BW used>
2: NoNameNode                      (152.61.1.26 )
|
|      151.169 Mbps            <8.4306% BW used>
**************************************************************************
3: NoNameNode                      (152.61.100.40)
|
|      13.289 Mbps    !!! ??? congested bottleneck <70.2602% BW used>
4: 66-128-169-21.du.sdnet.net      (66.128.169.21)
|
|      11.851 Mbps    !!! ??? congested bottleneck <73.2531% BW used>
5: border2-fe0-0.siouxfalls.sdnet.net(63.65.236.3 )
|
|      12.489 Mbps    !!! ??? congested bottleneck <71.5909% BW used>
6: Serial2-7.GW7.MSP1.ALTER.NET    (157.130.105.33)
|
|      12.742 Mbps    !!! ??? congested bottleneck <70.2492% BW used>
7: 113.at-1-0-0.CL1.MSP1.ALTER.NET (152.63.69.90)
|
|      12.723 Mbps    !!! ??? congested bottleneck <71.1919% BW used>
8: 0.so-0-0-2.XL1.CHI2.ALTER.NET   (152.63.64.45)
|
|      12.752 Mbps    !!! ??? congested bottleneck <70.6152% BW used>
9: 0.so-7-0-0.BR6.CHI2.ALTER.NET   (152.63.71.94)
|
|      12.451 Mbps    !!! ??? congested bottleneck <71.4030% BW used>
10: bpr1-so-6-0-0-0.ChicagoEquinix.cw.net(208.174.226.1)
|
|      13.261 Mbps    !!! ??? congested bottleneck <69.3897% BW used>
11: agr1-loopback.Chicago.cw.net    (208.172.2.101)
|
|      12.722 Mbps    !!! ??? congested bottleneck <71.0302% BW used>
12: dcr1-so-6-0-0.Chicago.cw.net    (208.175.10.49)
|
|      12.751 Mbps    !!! ??? congested bottleneck <70.6906% BW used>
13: ibr02-p6-0.okbr01.exodus.net    (208.175.10.82)
|
|      13.727 Mbps    !!! ??? congested bottleneck <69.2839% BW used>
14: bbr01-g4-0.okbr01.exodus.net    (216.34.183.97)
**************************************************************************
|      12.692 Mbps possible 100BT (99.1620 Mbps)

15: bbr01-p8-0.whkn01.exodus.net    (216.32.132.54)



[bkarthik@ittc-edc ~/Ping]$ pipechar -l 216.34.183.97
0: localhost [14 hops]
 1: sd.r.cr.usgs.gov                (192.41.204.1)    0.75   0.83   1.75ms
 2: NoNameNode                      (152.61.1.26)     0.77   0.97   3.00ms
 3: NoNameNode                      (152.61.100.40)   0.87   0.76  31.87ms
 4: 66-128-169-21.du.sdnet.net      (66.128.169.21)   5.96   7.47  35.33ms
 5: border2-fe0-0.siouxfalls.sdnet.net  (63.65.236.3)    5.66   7.00  31.58ms
 6: Serial2-7.GW7.MSP1.ALTER.NET    (157.130.105.33)          5.54   5.38  31.81ms
 7: 113.at-2-0-0.CL2.MSP1.ALTER.NET     (152.63.69.102)   5.48   5.95  30.35ms
 8: 0.so-1-1-0.XL2.CHI2.ALTER.NET       (146.188.136.58)          5.92   6.22  43.58ms
 9: 0.so-7-1-0.BR6.CHI2.ALTER.NET       (152.63.71.98)    5.39   5.45  41.03ms
10: bpr1-so-6-0-0-0.ChicagoEquinix.cw.net(208.174.226.1)          5.28   5.76  40.48ms
11: agr1-loopback.Chicago.cw.net        (208.172.2.101)   5.60   6.32  43.34ms
12: dcr1-so-6-0-0.Chicago.cw.net        (208.175.10.49)   5.69   6.04  44.14ms
13: ibr02-p6-0.okbr01.exodus.net        (208.175.10.82)   5.61   6.57  44.23ms
14: bbr01-g4-0.okbr01.exodus.net        (216.34.183.97)   5.44  -2.91  53.55ms

PipeCharacter statistics: 95.68% reliable
```

```
From localhost:
|      96.644 Mbps  100BT (97.0672 Mbps)

1: sd.r.cr.usgs.gov               (192.41.204.1)
|
|      151.243 Mbps            <3.4974% BW used>
2: NoNameNode                     (152.61.1.26 )
|
|      151.169 Mbps            <10.9574% BW used>
*****************************************************************************
3: NoNameNode                     (152.61.100.40)
|
|      11.974 Mbps    !!! ??? congested bottleneck <73.1589% BW used>
4: 66-128-169-21.du.sdnet.net      (66.128.169.21)
|
|      12.555 Mbps    !!! ??? congested bottleneck <71.7115% BW used>
5: border2-fe0-0.siouxfalls.sdnet.net(63.65.236.3 )
|
|      12.699 Mbps    !!! ??? congested bottleneck <71.1348% BW used>
6: Serial2-7.GW7.MSP1.ALTER.NET    (157.130.105.33)
|
|      12.491 Mbps    !!! ??? congested bottleneck <70.7816% BW used>
7: 113.at-2-0-0.CL2.MSP1.ALTER.NET (152.63.69.102)
|
|      11.903 Mbps    !!! ??? congested bottleneck <72.9775% BW used>
8: 0.so-1-1-0.XL2.CHI2.ALTER.NET   (146.188.136.58)
|
|      12.884 Mbps    !!! ??? congested bottleneck <70.3319% BW used>
9: 0.so-7-1-0.BR6.CHI2.ALTER.NET   (152.63.71.98)
|
|      13.250 Mbps    !!! ??? congested bottleneck <69.6797% BW used>
10: bpr1-so-6-0-0-0.ChicagoEquinix.cw.net(208.174.226.1)
|
|      12.319 Mbps    !!! ??? congested bottleneck <71.4030% BW used>
11: agr1-loopback.Chicago.cw.net    (208.172.2.101)
|
|      12.339 Mbps    !!! ??? congested bottleneck <71.8607% BW used>
12: dcr1-so-6-0-0.Chicago.cw.net    (208.175.10.49)
|
|      12.391 Mbps    !!! ??? congested bottleneck <71.4642% BW used>
13: ibr02-p6-0.okbr01.exodus.net    (208.175.10.82)
*****************************************************************************
|      13.245 Mbps possible 100BT (99.1290 Mbps)

14: bbr01-g4-0.okbr01.exodus.net    (216.34.183.97)
```

```
[bkarthik@ittc-edc ~/Ping]$ pipechar -l 216.35.210.126
pipechar [Mar25-2K1] : can't reach the host17[216.109.66.132] with max_ttl(19)
try to analyze partial path instead

0: localhost [17 hops]
 1: sd.r.cr.usgs.gov                (192.41.204.1)    0.71   0.53   1.62ms
 2: NoNameNode                      (152.61.1.26)     0.73   0.61   2.76ms
 3: NoNameNode                      (152.61.100.40)   0.69  -1.63  44.00ms
 4: 66-128-169-21.du.sdnet.net      (66.128.169.21)   5.39   6.58  30.38ms
 5: border2-fe0-0.siouxfalls.sdnet.net  (63.65.236.3)    5.99   6.35  32.52ms
 6: Serial2-7.GW7.MSP1.ALTER.NET    (157.130.105.33)          5.54   6.10  31.18ms
 7: 113.at-1-1-0.CL1.MSP1.ALTER.NET     (152.63.69.98)    5.55   7.09  33.11ms
 8: 0.so-0-0-2.XL1.CHI2.ALTER.NET   (152.63.64.45)    5.53   6.77  40.74ms
 9: 0.so-7-0-0.BR6.CHI2.ALTER.NET   (152.63.71.94)    5.51   6.51  41.33ms
10: bpr1-so-6-0-0-0.ChicagoEquinix.cw.net(208.174.226.1)          5.48   8.29  41.83ms
11: agr1-loopback.Chicago.cw.net    (208.172.2.101)   5.15   6.52  45.81ms
12: dcr1-so-6-0-0.Chicago.cw.net    (208.175.10.49)   5.51   6.14  44.77ms
13: ibr02-p6-0.okbr01.exodus.net    (208.175.10.82)   5.62   6.61  44.78ms
14: bbr01-g3-0.okbr01.exodus.net    (216.34.183.65)   5.39   6.31  46.18ms
15: bbr01-p8-0.whkn01.exodus.net    (216.32.132.54)   5.73   6.12  68.52ms
16: bbr02-g5-0.whkn01.exodus.net    (216.35.65.84)    6.34   7.45  72.17ms
17: bbr01-p0-0.stng01.exodus.net    (216.32.132.193)          5.86   5.37  74.90ms

PipeCharacter statistics: 95.56% reliable
From localhost:
|      100.840 Mbps  100BT (102.9328 Mbps)

1: sd.r.cr.usgs.gov               (192.41.204.1)
|
|      158.757 Mbps            <1.9231% BW used>
2: NoNameNode                     (152.61.1.26 )
|
|      158.831 Mbps            <5.0824% BW used>
*****************************************************************************
3: NoNameNode                     (152.61.100.40)
|
|      13.276 Mbps    !!! ??? congested bottleneck <70.2878% BW used>
4: 66-128-169-21.du.sdnet.net      (66.128.169.21)
|
|      11.835 Mbps    !!! ??? congested bottleneck <73.2888% BW used>
5: border2-fe0-0.siouxfalls.sdnet.net(63.65.236.3 )
|
```

```
|      12.697 Mbps    !!! ??? congested bottleneck <71.1400% BW used>
6: Serial2-7.GW7.MSP1.ALTER.NET    (157.130.105.33)
|
|      12.891 Mbps    !!! ??? congested bottleneck <71.1712% BW used>
7: 113.at-1-1-0.CL1.MSP1.ALTER.NET (152.63.69.98)
|
|      12.787 Mbps    !!! ??? congested bottleneck <71.0512% BW used>
8: 0.so-0-0-2.XL1.CHI2.ALTER.NET   (152.63.64.45)
|
|      12.602 Mbps    !!! ??? congested bottleneck <70.9355% BW used>
9: 0.so-7-0-0.BR6.CHI2.ALTER.NET   (152.63.71.94)
|
|      12.730 Mbps    !!! ??? congested bottleneck <70.8029% BW used>
10: bpr1-so-6-0-0-0.ChicagoEquinix.cw.net(208.174.226.1)
|
|      13.463 Mbps    !!! ??? congested bottleneck <68.9562% BW used>
11: agr1-loopback.Chicago.cw.net    (208.172.2.101)
|
|      12.760 Mbps    !!! ??? congested bottleneck <70.9461% BW used>
12: dcr1-so-6-0-0.Chicago.cw.net    (208.175.10.49)
|
|      12.349 Mbps    !!! ??? congested bottleneck <71.5556% BW used>
13: ibr02-p6-0.okbr01.exodus.net    (208.175.10.82)
|
|      13.254 Mbps    !!! ??? congested bottleneck <70.3264% BW used>
14: bbr01-g3-0.okbr01.exodus.net    (216.34.183.65)
|
|      12.473 Mbps    !!! ??? congested bottleneck <72.0573% BW used>
15: bbr01-p8-0.whkn01.exodus.net    (216.32.132.54)
|
|      11.275 Mbps    !!! ??? congested bottleneck <74.7714% BW used>
16: bbr02-g5-0.whkn01.exodus.net    (216.35.65.84)
*************************************************************************
|      12.278 Mbps possible 100BT (100.6561 Mbps)

17: bbr01-p0-0.stng01.exodus.net    (216.32.132.193)



[bkarthik@ittc-edc ~/Ping]$ pipechar -l 64.14.118.212
pipechar [Mar25-2K1] : can't reach the host18[216.33.98.147] with max_ttl(20)
try to analyze partial path instead

0: localhost [18 hops]
 1: sd.r.cr.usgs.gov                (192.41.204.1)    0.73   0.80   1.67ms
 2: NoNameNode                      (152.61.1.26)     0.79   0.85   2.69ms
 3: NoNameNode                      (152.61.100.40)   0.81  -2.36  41.68ms
 4: 66-128-169-21.du.sdnet.net      (66.128.169.21)   5.53  -3.09  33.34ms
 5: border2-fe0-0.siouxfalls.sdnet.net (63.65.236.3)    6.37   7.50  32.82ms
 6: Serial2-7.GW7.MSP1.ALTER.NET    (157.130.105.33)          5.28   6.61  30.13ms
 7: 113.at-1-0-0.CL2.MSP1.ALTER.NET     (152.63.69.94)    5.40   7.09  33.13ms
 8: 0.so-1-1-0.XL2.CHI2.ALTER.NET   (146.188.136.58)          5.43  13.69  88.83ms
 9: 0.so-7-1-0.BR6.CHI2.ALTER.NET   (152.63.71.98)    5.84   5.52  45.53ms
10: bpr1-so-6-0-0-0.ChicagoEquinix.cw.net(208.174.226.1)          5.06   7.56  57.49ms
11: agr1-loopback.Chicago.cw.net    (208.172.2.101)   6.11   8.67  49.90ms
12: dcr1-so-6-0-0.Chicago.cw.net    (208.175.10.49)   6.17   7.73  49.08ms
13: ibr02-p6-0.okbr01.exodus.net    (208.175.10.82)   5.39   6.26  43.94ms
14: bbr01-g3-0.okbr01.exodus.net    (216.34.183.65)   5.88   6.74  47.49ms
15: bbr01-p8-0.whkn01.exodus.net    (216.32.132.54)   5.23   5.49  65.50ms
16: bbr02-g3-0.whkn01.exodus.net    (216.35.65.68)    6.10   7.59  68.25ms
17: bbr01-p0-0.stng01.exodus.net    (216.32.132.193)          5.76   6.85  76.42ms
18: dcr01-g12-0.stng02.exodus.net   (216.109.66.133)          6.03   6.64  74.04ms

PipeCharacter statistics: 95.53% reliable
From localhost:
|      98.361 Mbps  100BT (97.0672 Mbps)

1: sd.r.cr.usgs.gov                (192.41.204.1)
|
|      151.243 Mbps            <6.9885% BW used>
2: NoNameNode                      (152.61.1.26 )
|
|      151.169 Mbps            <2.2361% BW used>
*************************************************************************
3: NoNameNode                      (152.61.100.40)
|
|      12.923 Mbps    !!! ??? congested bottleneck <71.0669% BW used>
4: 66-128-169-21.du.sdnet.net      (66.128.169.21)
|
|      11.108 Mbps    !!! ??? congested bottleneck <74.8783% BW used>
5: border2-fe0-0.siouxfalls.sdnet.net(63.65.236.3 )
|
|      13.352 Mbps    !!! ??? congested bottleneck <69.7142% BW used>
6: Serial2-7.GW7.MSP1.ALTER.NET    (157.130.105.33)
|
|      12.688 Mbps    !!! ??? congested bottleneck <70.3649% BW used>
7: 113.at-1-0-0.CL2.MSP1.ALTER.NET (152.63.69.94)
|
|      13.019 Mbps    !!! ??? congested bottleneck <70.5449% BW used>
8: 0.so-1-1-0.XL2.CHI2.ALTER.NET   (146.188.136.58)
```

```
|
|      11.823 Mbps    !!! ??? congested bottleneck <72.6027% BW used>
9: 0.so-7-1-0.BR6.CHI2.ALTER.NET   (152.63.71.98)
|
|      13.846 Mbps    !!! ??? congested bottleneck <68.3919% BW used>
10: bpr1-so-6-0-0-0.ChicagoEquinix.cw.net(208.174.226.1)
|
|      11.706 Mbps    !!! ??? congested bottleneck <73.8220% BW used>
11: agr1-loopback.Chicago.cw.net    (208.172.2.101)
|
|      11.322 Mbps    !!! ??? congested bottleneck <74.0597% BW used>
12: dcr1-so-6-0-0.Chicago.cw.net    (208.175.10.49)
|
|      12.923 Mbps    !!! ??? congested bottleneck <70.3209% BW used>
13: ibr02-p6-0.okbr01.exodus.net    (208.175.10.82)
|
|      12.139 Mbps    !!! ??? congested bottleneck <72.7845% BW used>
14: bbr01-g3-0.okbr01.exodus.net    (216.34.183.65)
|
|      13.664 Mbps    !!! ??? congested bottleneck <69.4306% BW used>
15: bbr01-p8-0.whkn01.exodus.net    (216.32.132.54)
|
|      11.733 Mbps    !!! ??? congested bottleneck <73.7619% BW used>
16: bbr02-g3-0.whkn01.exodus.net    (216.35.65.68)
|
|      12.429 Mbps    !!! ??? congested bottleneck <72.2029% BW used>
17: bbr01-p0-0.stng01.exodus.net    (216.32.132.193)
*************************************************************************
|      11.936 Mbps possible 100BT (98.9470 Mbps)

18: dcr01-g12-0.stng02.exodus.net   (216.109.66.133)



raphael [21] % pipechar -l 131.243.2.20
0: localhost [10 hops]
 1: NoNameNode                    (10.10.127.254)   0.94   1.14   3.52ms
 2: ks-2-a10-52.r.greatplains.net       (164.113.234.206)        1.03   1.36
9.36ms
 3: ks-2-abilene-ks.r.greatplains.net   (164.113.238.193)        1.08   5.05  2
4.65ms
 4: dnvr-kscy.abilene.ucaid.edu         (198.32.8.13)     1.11   3.15  31.75ms
 5: snva-dnvr.abilene.ucaid.edu         (198.32.8.1)      0.98   1.66  82.13ms
 6: esnet-snva.abilene.ucaid.edu        (198.32.11.94)    2.89 -36.51  83.58ms
 7: lbl-snv-oc48.es.net                (134.55.209.6)    0.93   7.40 131.19ms
 8: lbnl-ge-lbl2.es.net                (198.129.224.1)   1.03  16.00 133.96ms
 9: ir1000gw.lbl.gov                   (131.243.128.210)         1.13   4.87  9
0.46ms
10: rita.lbl.gov                      (131.243.2.20)    1.18  -0.81  48.43ms

PipeCharacter statistics: 82.61% reliable
From localhost:
|      76.677 Mbps  100BT (97.0672 Mbps)

1: NoNameNode                    (10.10.127.254)
|
|      151.243 Mbps             <8.6576% BW used>
2: ks-2-a10-52.r.greatplains.net   (164.113.234.206)
|
|      65.823 Mbps    !!! ??? congested bottleneck <56.8294% BW used>
3: ks-2-abilene-ks.r.greatplains.net(164.113.238.193)
|
|      63.401 Mbps    !!! ??? congested bottleneck <58.2645% BW used>
4: dnvr-kscy.abilene.ucaid.edu     (198.32.8.13 )
|
|      147.294 Mbps             <5.4536% BW used>
*************************************************************************
****
5: snva-dnvr.abilene.ucaid.edu     (198.32.8.1  )
|
|      20.572 Mbps    !!! ??? congested bottleneck <86.6103% BW used>
6: esnet-snva.abilene.ucaid.edu    (198.32.11.94)
*************************************************************************
****
|
|      63.568 Mbps    !!! ??? congested bottleneck <43.6779% BW used>
7: lbl-snv-oc48.es.net             (134.55.209.6)
|
|      57.533 Mbps    !!! ??? congested bottleneck <62.5993% BW used>
8: lbnl-ge-lbl2.es.net             (198.129.224.1)
|
|      62.637 Mbps    !!! ??? congested bottleneck <59.0734% BW used>
9: ir1000gw.lbl.gov                (131.243.128.210)
|      60.914 Mbps  100BT (96.4499 Mbps)

10: rita.lbl.gov                   (131.243.2.20)



raphael [9] % pipechar -l 140.173.170.11
```

```
0: localhost [13 hops]
 1: NoNameNode                    (10.10.127.254)   0.90   1.08   3.04ms
 2: NoNameNode                    (129.237.2.21)    0.85   0.90   3.15ms
 3: ks-2-a10-52.r.greatplains.net       (164.113.234.206)        0.98   2.28  12.86ms
 4: ks-2-abilene-ks.r.greatplains.net   (164.113.238.193)        0.84   1.31   8.92ms
 5: dnvr-kscy.abilene.ucaid.edu         (198.32.8.13)     0.98   1.15  19.42ms
 6: snva-dnvr.abilene.ucaid.edu         (198.32.8.1)      0.95   2.40  43.83ms
 7: losa-snva.abilene.ucaid.edu         (198.32.8.18)     0.79   4.46  72.11ms
 8: USC--abilene.ATM.calren2.net        (198.32.248.85)   0.92   4.67  71.15ms
 9: guest-b4.isi.edu              (198.32.16.33)    1.36   3.73  58.56ms
10: NoNameNode                    (198.32.16.82)    0.79   3.53  53.35ms
11: snet_la.cairn.net             (140.173.155.5)   0.90   2.97  78.89ms
12: m40-m20.cairn.net             (140.173.1.86)    1.17   0.95 120.06ms
13: omega.cairn.net               (140.173.170.11)         0.86   9.62 257.27ms

PipeCharacter statistics: 89.98% reliable
From localhost:
|      80.357 Mbps  100BT(102.9328 Mbps)

1: NoNameNode                    (10.10.127.254)
|
|      158.757 Mbps            <5.6920% BW used>
2: NoNameNode                    (129.237.2.21)
|
|      72.628 Mbps    !!! ??? congested bottleneck <52.5035% BW used>
3: ks-2-a10-52.r.greatplains.net   (164.113.234.206)
|
|      150.626 Mbps            <13.5992% BW used>
4: ks-2-abilene-ks.r.greatplains.net(164.113.238.193)
|
|      147.294 Mbps            <13.5991% BW used>
5: dnvr-kscy.abilene.ucaid.edu     (198.32.8.13 )
|
|      72.667 Mbps    !!! ??? congested bottleneck <51.0005% BW used>
6: snva-dnvr.abilene.ucaid.edu     (198.32.8.1  )
|
|      151.314 Mbps            <16.3504% BW used>
7: losa-snva.abilene.ucaid.edu     (198.32.8.18 )
|
|      153.667 Mbps            <13.5224% BW used>
********************************************************************************
*******
8: USC--abilene.ATM.calren2.net    (198.32.248.85)
|
|      51.787 Mbps    !!! ??? congested bottleneck <65.9695% BW used>
9: guest-b4.isi.edu              (198.32.16.33)
********************************************************************************
*******
|
|      152.710 Mbps    !!!      <41.9779% BW used>
10: NoNameNode                    (198.32.16.82)
|
|      151.983 Mbps            <12.0974% BW used>
11: snet_la.cairn.net             (140.173.155.5)
|
|      60.996 Mbps    !!! ??? congested bottleneck <60.2980% BW used>
12: m40-m20.cairn.net             (140.173.1.86)
|      83.527 Mbps  100BT (103.8178 Mbps)

13: omega.cairn.net               (140.173.170.11)

raphael [9] % pipechar -l 131.243.2.14
0: localhost [12 hops]
 1: NoNameNode                    (10.10.127.254)          0.89   0.98   2.93ms
 2: NoNameNode                    (129.237.2.21)           0.90   0.97   3.52ms
 3: ks-2-a10-52.r.greatplains.net       (164.113.234.206)    0.87   1.55  15.09ms
 4: ks-2-abilene-ks.r.greatplains.net   (164.113.238.193)  0.92   0.71  10.20ms
 5: dnvr-kscy.abilene.ucaid.edu         (198.32.8.13)          0.93   3.16  26.46ms
 6: snva-dnvr.abilene.ucaid.edu         (198.32.8.1)           0.90   1.43  75.08ms
 7: esnet-snva.abilene.ucaid.edu        (198.32.11.94)         0.79   4.07  70.82ms
 8: lbl-snv-oc48.es.net           (134.55.209.6)           0.80   3.57  47.07ms
 9: lbnl-ge-lbl2.es.net           (198.129.224.1)          0.91   0.41  81.54ms
10: NoNameNode                    (198.129.224.6)          0.66  14.52 115.24ms
11: ir1000gw.lbl.gov              (131.243.128.210)        0.67  -0.67  47.50ms
12: slappy.lbl.gov                (131.243.2.14)           0.73   0.36 104.91ms

PipeCharacter statistics: 85.51% reliable
From localhost:
|      80.447 Mbps  100BT (97.0672 Mbps)

1: NoNameNode                    (10.10.127.254)
|
|      151.243 Mbps            <0.7760% BW used>
2: NoNameNode                    (129.237.2.21)
|
|      151.169 Mbps            <3.5477% BW used>
3: ks-2-a10-52.r.greatplains.net   (164.113.234.206)
|
```

```
|          150.626 Mbps          <5.0219% BW used>
4: ks-2-abilene-ks.r.greatplains.net(164.113.238.193)
|
|          147.294 Mbps          <1.2930% BW used>
5: dnvr-kscy.abilene.ucaid.edu     (198.32.8.13 )
|
|          153.392 Mbps          <2.9093% BW used>
*************************************************************************
6: snva-dnvr.abilene.ucaid.edu     (198.32.8.1  )
|
|          38.092 Mbps    !!! ??? congested bottleneck <77.5086% BW used>
7: esnet-snva.abilene.ucaid.edu    (198.32.11.94)
*************************************************************************
|
|          153.667 Mbps          <1.9924% BW used>
8: lbl-snv-oc48.es.net           (134.55.209.6)
|
|          151.314 Mbps          <12.6524% BW used>
9: lbnl-ge-lbl2.es.net           (198.129.224.1)
|
|          152.710 Mbps    !!!     <39.6268% BW used>
10: NoNameNode                   (198.129.224.6)
|
|          151.983 Mbps          <1.7859% BW used>
11: ir1000gw.lbl.gov             (131.243.128.210)
|          82.645 Mbps  100BT (97.2873 Mbps)

12: slappy.lbl.gov               (131.243.2.14)
```

```
raphael [7] % pipechar -l 131.243.2.28
0: localhost [12 hops]
 1: NoNameNode                    (10.10.127.254)          0.97   1.13   3.62ms
 2: NoNameNode                    (129.237.2.21)           1.01   1.38   3.58ms
 3: ks-2-a10-52.r.greatplains.net       (164.113.234.206)   0.92   1.11  14.06ms
 4: ks-2-abilene-ks.r.greatplains.net  (164.113.238.193)  1.08   1.12   8.56ms
 5: dnvr-kscy.abilene.ucaid.edu         (198.32.8.13)          0.92   2.68  68.76ms
 6: snva-dnvr.abilene.ucaid.edu         (198.32.8.1)           1.04   2.35  43.81ms
 7: esnet-snva.abilene.ucaid.edu        (198.32.11.94)         0.83   5.38  83.85ms
 8: lbl-snv-oc48.es.net                (134.55.209.6)          0.96  11.03 140.04ms
 9: lbnl-ge-lbl2.es.net                (198.129.224.1)         1.30   0.93  47.43ms
10: NoNameNode                         (198.129.224.6)         0.72   2.51  46.37ms
11: ir1000gw.lbl.gov                   (131.243.128.210)       0.92   2.48  46.28ms
12: ag-ds.itg.lbl.gov                 (131.243.2.28)           1.06   4.28  58.62ms

PipeCharacter statistics: 85.51% reliable
From localhost:
|          74.534 Mbps  100BT (97.0672 Mbps)

1: NoNameNode                    (10.10.127.254)
|
|          70.282 Mbps    !!! ??? congested bottleneck <28.7129% BW used>
2: NoNameNode                    (129.237.2.21)
|
|          151.169 Mbps          <8.8119% BW used>
3: ks-2-a10-52.r.greatplains.net   (164.113.234.206)
|
|          65.290 Mbps    !!! ??? congested bottleneck <57.0687% BW  used>
4: ks-2-abilene-ks.r.greatplains.net(164.113.238.193)
|
|          63.333 Mbps    !!! ??? congested bottleneck <57.6944% BW used>
5: dnvr-kscy.abilene.ucaid.edu     (198.32.8.13 )
|
|          68.922 Mbps    !!! ??? congested bottleneck <55.2489% BW used>
*************************************************************************
6: snva-dnvr.abilene.ucaid.edu     (198.32.8.1  )
|
|          34.540 Mbps    !!! ??? congested bottleneck <74.3503% BW used>
7: esnet-snva.abilene.ucaid.edu    (198.32.11.94)
*************************************************************************
|
|          62.357 Mbps    !!! ??? congested bottleneck <59.5088% BW used>
8: lbl-snv-oc48.es.net           (134.55.209.6)
|
|          151.314 Mbps          <20.4241% BW used>
9: lbnl-ge-lbl2.es.net           (198.129.224.1)
|
|          152.710 Mbps    !!!     <44.3594% BW used>
10: NoNameNode                   (198.129.224.6)
|
|          151.983 Mbps          <21.3665% BW used>
11: ir1000gw.lbl.gov             (131.243.128.210)
|          68.117 Mbps  100BT (97.2873 Mbps)

12: ag-ds.itg.lbl.gov            (131.243.2.28)
```

```
raphael [96] % pipechar -irtc -l 64.124.237.130
0: localhost [20 hops]
 1: NoNameNode                    (10.10.127.254)   0.96   1.27   3.40ms
 2: NoNameNode                    (129.237.2.21)    0.77   5.11   7.55ms
 3: kr-ku-a0-4.kanren.net         (164.113.201.249)        0.94   1.54   4.74ms
 4: ks-1-a400-51.r.greatplains.net     (164.113.232.202)        1.36   4.72  25.49ms
 5: kcm-edge-12.inet.qwest.net         (65.120.164.237)         2.06   1.86  12.36ms
 6: kcm-core-03.inet.qwest.net         (205.171.29.141)         1.45   2.83  14.68ms
 7: kcm-core-02.inet.qwest.net         (205.171.29.129)         1.85   2.27  22.39ms
 8: dal-core-02.inet.qwest.net         (205.171.8.141)  1.53   2.54  24.02ms
 9: dal-core-01.inet.qwest.net         (205.171.25.129)         1.80  -1.28  23.43ms
10: iah-core-02.inet.qwest.net         (205.171.8.126)   1.64   6.13  34.16ms
11: iah-core-01.inet.qwest.net         (205.171.31.1)    1.77   3.37  30.53ms
12: svl-core-01.inet.qwest.net         (205.171.8.129)   1.20   5.06 164.43ms
13: svl-core-02.inet.qwest.net         (205.171.14.118)         1.96   2.75  82.10ms
14: svl-brdr-01.inet.qwest.net         (205.171.14.106)         1.52   2.24  68.68ms
15: pos4-1.cr7.sjc2.us.mfnx.net        (208.185.175.73)         1.52   2.17 146.64ms
16: so-6-2-0.mpr3.sjc2.us.mfnx.net     (64.125.30.6)     1.41   3.15 132.96ms
17: so-5-0-0.cr1.sfo1.us.mfnx.net      (208.184.232.54)         1.62   2.40  7
0.55ms
18: so-2-0-0.er1a.sfo1.us.mfnx.net     (208.184.228.2)   2.15   3.13  74.69ms
19: 209.133.66.5.cnet.com              (209.133.66.5)    1.58  -1.16 177.07ms
20: abv-sfo1-nw3.cnet.com              (64.124.237.130)         1.86  -0.00  7
0.99ms

PipeCharacter statistics: 78.59% reliable
From localhost:
|      75.078 Mbps  100BT (97.0672 Mbps)

1: NoNameNode                    (10.10.127.254)
|
|      151.243 Mbps            <19.7080% BW used>
2: NoNameNode                    (129.237.2.21)
|
|      151.169 Mbps            <17.8228% BW used>
3: kr-ku-a0-4.kanren.net         (164.113.201.249)
|
|      150.626 Mbps    !!!     <34.0777% BW used>
4: ks-1-a400-51.r.greatplains.net  (164.113.232.202)
|
|      34.434 Mbps    !!! ??? congested bottleneck <77.4507% BW used>
5: kcm-edge-12.inet.qwest.net      (65.120.164.237)
|
|      153.392 Mbps    !!!     <29.4660% BW used>
6: kcm-core-03.inet.qwest.net      (205.171.29.141)
|
|      37.047 Mbps    !!! ??? congested bottleneck <74.9317% BW used>
7: kcm-core-02.inet.qwest.net      (205.171.29.129)
|
|      153.667 Mbps            <17.6471% BW used>
8: dal-core-02.inet.qwest.net      (205.171.8.141)
|
|      43.874 Mbps             <15.0808% BW used>
9: dal-core-01.inet.qwest.net      (205.171.25.129)
|
|      44.030 Mbps             <9.0151% BW used>
*********************************************************************************
********
10: iah-core-02.inet.qwest.net     (205.171.8.126)
|
|      29.335 Mbps       ??? congested bottleneck <9.4511% BW used>
11: iah-core-01.inet.qwest.net     (205.171.31.1)
*********************************************************************************
********
|
|      153.250 Mbps    !!!     <31.9188% BW used>
12: svl-core-01.inet.qwest.net     (205.171.8.129)
|
|      35.360 Mbps    !!! ??? congested bottleneck <76.3605% BW used>
13: svl-core-02.inet.qwest.net     (205.171.14.118)
|
|      45.369 Mbps       ??? congested bottleneck <4.9185% BW used>
14: svl-brdr-01.inet.qwest.net     (205.171.14.106)
|
|      45.470 Mbps    !!! ??? congested bottleneck <69.5200% BW used>
15: pos4-1.cr7.sjc2.us.mfnx.net    (208.185.175.73)
|
|      151.950 Mbps            <7.6114% BW used>
16: so-6-2-0.mpr3.sjc2.us.mfnx.net  (64.125.30.6 )
|
|      43.542 Mbps             <13.0326% BW used>
17: so-5-0-0.cr1.sfo1.us.mfnx.net  (208.184.232.54)
|
|      44.712 Mbps    !!!     <25.5119% BW used> May get 24.63% congested
18: so-2-0-0.er1a.sfo1.us.mfnx.net  (208.184.228.2)
|
|      43.766 Mbps    !!!     <26.4433% BW used>
19: 209.133.66.5.cnet.com          (209.133.66.5)
|      38.710 Mbps  100BT (99.0145 Mbps)
```

```
20: abv-sfo1-nw3.cnet.com          (64.124.237.130)



raphael [78] % pipechar -irtc -l 208.185.204.181
0: localhost [19 hops]
 1: NoNameNode                    (10.10.127.254)   0.84   0.89   2.92ms
 2: NoNameNode                    (129.237.2.21)    0.90 -10.27   3.20ms
 3: kr-ku-a0-4.kanren.net         (164.113.201.249)        0.92   1.29   4.94ms
 4: ks-1-a400-51.r.greatplains.net      (164.113.232.202)        1.25   1.81  11.21ms
 5: kcm-edge-12.inet.qwest.net         (65.120.164.237)         1.57   1.78  11.13ms
 6: kcm-core-03.inet.qwest.net         (205.171.29.141)         1.32   1.00  11.27ms
 7: kcm-core-02.inet.qwest.net         (205.171.29.129)         1.56   3.08  12.96ms
 8: dal-core-02.inet.qwest.net         (205.171.8.141)   1.57   2.95  23.71ms
 9: dal-core-01.inet.qwest.net         (205.171.25.129)         1.80   2.33  25.19ms
10: iah-core-02.inet.qwest.net         (205.171.8.126)   1.40   1.86  27.77ms
11: iah-core-01.inet.qwest.net         (205.171.31.1)    1.41   4.75  53.97ms
12: svl-core-01.inet.qwest.net         (205.171.8.129)   1.72   6.06 166.60ms
13: svl-core-02.inet.qwest.net         (205.171.14.118)         2.07   1.94  72.39ms
14: svl-brdr-01.inet.qwest.net         (205.171.14.106)         1.35   3.03 100.24ms
15: pos4-1.cr7.sjc2.us.mfnx.net        (208.185.175.73)         1.37   9.56 12
4.32ms
16: so-6-2-0.mpr4.sjc2.us.mfnx.net     (64.125.30.14)    1.13   3.95  68.33ms
17: pos5-0.er2a.sjc2.us.mfnx.net       (208.184.102.238)        1.67   4.31  6
8.71ms
18: vlan2.cs2.sjc2.abov.sitesmith.com  (208.184.169.71)         1.62   4.58  7
1.24ms
21: 208.185.204.181                    (208.185.204.181)        1.55   1.79  7
2.09ms

PipeCharacter statistics: 86.67% reliable
From localhost:
|      85.409 Mbps  100BT (97.0672 Mbps)

1: NoNameNode                  (10.10.127.254)
|
|      151.243 Mbps           <6.5410% BW used>
2: NoNameNode                  (129.237.2.21)
|
|      151.169 Mbps           <1.7429% BW used>
3: kr-ku-a0-4.kanren.net       (164.113.201.249)
|
|      150.626 Mbps    !!!     <62.9277% BW used> May get 26.74% congested
4: ks-1-a400-51.r.greatplains.net  (164.113.232.202)
|
|      45.348 Mbps    !!! ??? congested bottleneck <70.4882% BW used>
5: kcm-edge-12.inet.qwest.net      (65.120.164.237)
|
|      153.392 Mbps            <16.0737% BW used>
6: kcm-core-03.inet.qwest.net      (205.171.29.141)
|
|      43.438 Mbps             <15.4289% BW used>
7: kcm-core-02.inet.qwest.net      (205.171.29.129)
|
|      44.435 Mbps             <0.5728% BW used>
8: dal-core-02.inet.qwest.net      (205.171.8.141)
|
|      38.779 Mbps       ??? congested bottleneck <11.0123% BW used>
9: dal-core-01.inet.qwest.net      (205.171.25.129)
|
|      50.431 Mbps       ??? congested bottleneck <13.9600% BW used>
10: iah-core-02.inet.qwest.net     (205.171.8.126)
|
|      151.983 Mbps            <0.1422% BW used>
11: iah-core-01.inet.qwest.net     (205.171.31.1)
|
|      44.259 Mbps             <18.2559% BW used>
12: svl-core-01.inet.qwest.net     (205.171.8.129)
|
|      50.842 Mbps    !!! ??? congested bottleneck <66.1678% BW used>
13: svl-core-02.inet.qwest.net     (205.171.14.118)
|
|      51.741 Mbps       ??? congested bottleneck <18.6065% BW used>
*******************************************************************************
*******************
14: svl-brdr-01.inet.qwest.net     (205.171.14.106)
|
|      33.380 Mbps    !!! ??? congested bottleneck <72.8174% BW used>
15: pos4-1.cr7.sjc2.us.mfnx.net    (208.185.175.73)
*******************************************************************************
*******************
|
|      151.950 Mbps            <17.4070% BW used>
16: so-6-2-0.mpr4.sjc2.us.mfnx.net  (64.125.30.14)
|
|      43.542 Mbps             <2.7610% BW used>
17: pos5-0.er2a.sjc2.us.mfnx.net   (208.184.102.238)
|
|      44.712 Mbps             <2.7610% BW used>
```

18: vlan2.cs2.sjc2.abov.sitesmith.com(208.184.169.71)
| 46.452 Mbps 100BT (95.4864 Mbps)

21: 208.185.204.181 (208.185.204.181)