Estimation of available bandwidth

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Definition of available bandwidth

The *bandwidth on an end-to-end path* is the maximum amount of data that can be transmitted simultaneously.

The available bandwidth is an important metric for several applications, such as

- grid,
- video and voice streaming,
- overlay routing,
- p2p file transfers,
- server selection, and
- interdomain path monitoring.

Tools previously developed for available bandwidth monitoring and diagnosis often have high overhead and are difficult to use.

Unfortunately, RIPE Test Box doesn’t measure the available bandwidth but it collects the numerical values characterized the network heals like delay, jitter, routing path, etc.

This data allows us to investigate the basic interdependences of available bandwidth from significant network parameters. Our aim is to estimate the available bandwidth from the delay value received from one point of path.

Bandwidth modeling

- Padhye J., Firoiu V., Towsley D., Kurose J., *Modeling TCP Throughput: A Simple Model and its Empirical Validation* // Proc. SIGCOMM Symp. Communications Architectures and Protocols - Aug. 1998 - pp. 304-314

$$B_{av} = \frac{W}{D}$$

Here ***W*** is the size of transmitted packet and ***D*** is the packet delay.

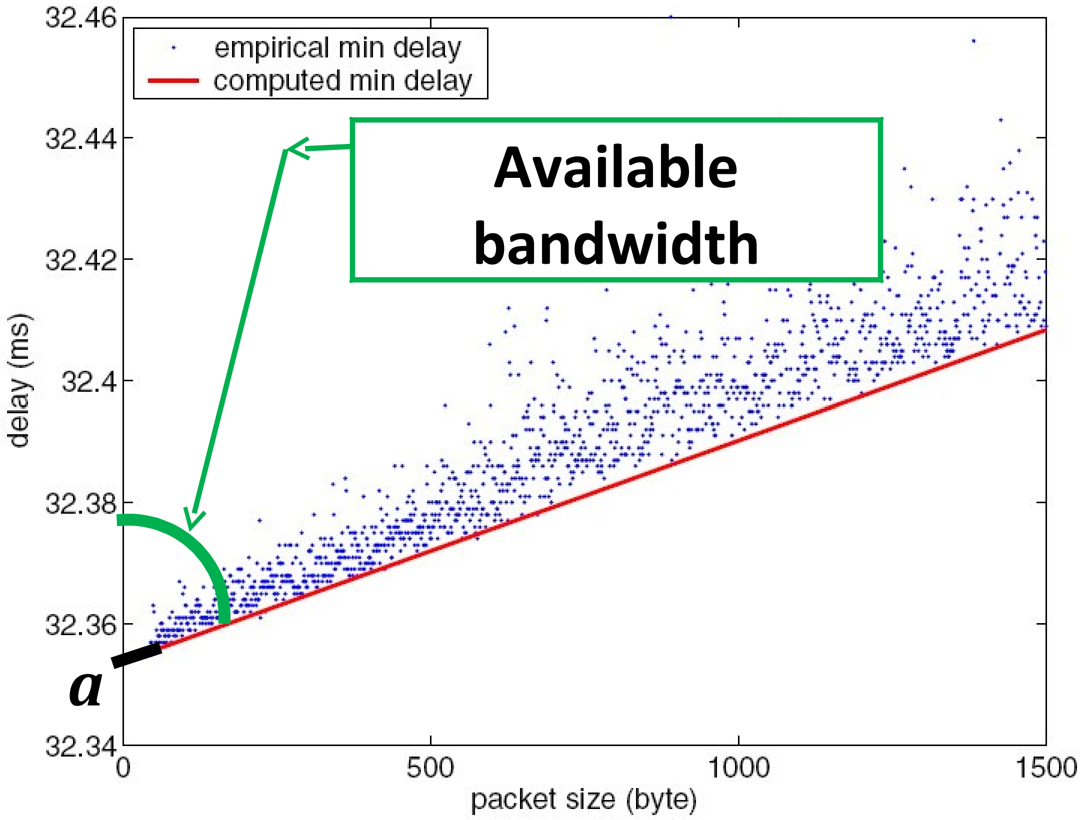
The delay value is caused by such constant network factors as propagation delay, transmission delay, per-packet router processing time, etc.

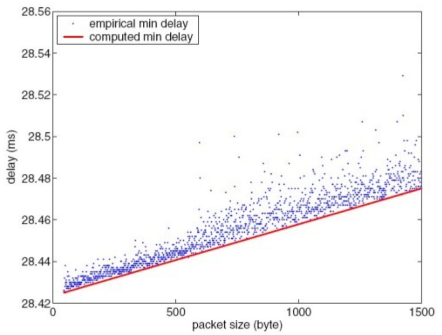
- Choi, B.-Y., Moon, S., Zhang, Z.-L., Papagiannaki, K. and Diot, C., *Analysis of Point-To-Point Packet Delay In an Operational Network*, Infocom *2004*, Hong Kong, 2004, pp. 1797-1807

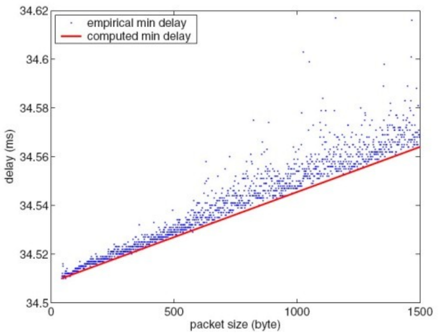
Choi et al proved that the fixed delay component (i.e., the total propagation and transmission delay) for a packet of size *p* is a *linear* (or precisely, an *affine*) function of its size.

Minimum packet delay vs. packet size

To validate this assumption, Choi et al check the minimum delay of packets of the same size for each path, and plot the minimum delay against the packet size. But the parameters of their linear equation will not be a simple function of the link capacities and the propagation delays.







Our model

Graphic of linear dependence between network delay and packet size constructed on the previous slide introduced intercept value ***a*** for delay function. Then the equation for the available bandwidth which path consists of two or more hops should be modernized to the following view:

$$B_{av} = \frac{W}{D - a}$$

The value ***D*** is related to the distance between the sites plus the propagation delay and per-packet router processing time at each hop along the path between the sites

Key equation

Our model supposes the variation of packet size on the same path for calculation of available bandwidth. If the testing process between two fixed points is organized by packets with different sizes W_1 and W_2 and then the delay D gets also two different values. Our model must give the identical value of available bandwidth independently from packet size of testing packets. The received system from two equations is easy solved concerning D:

$$B_{av} = \frac{W_1 - W_2}{D_1 - D_2}$$

It is easy to use the linear approach for calculation of ***a***:

$$a = f(n,l) \approx \alpha n + \beta l$$

Here ***n*** is the number of hops (routers) that gives the *traceroute* command and ***l*** is the sum of single length of routing path.

Measurement process

There are several ways to measure network delay between two remote points in global network.

Field of application of our method is the area from *tens Kbps* to *several Mbps.*

The basic problem is the precise measurements of delay ***D***. The high precision of measurement ($\leq 10^{-5}$ second) is necessary for accurate result.

Results for delay could be received from RIPE Test Box database.

The sizes of testing packets should different in several times, it is reasonable to choose 100 and 1124 *bytes* correspondingly

Unfortunately, current version of RIPE measurement system did not provide not a simple interface for measuring

D_1 (W_1 = 100 bytes)

D_2 (W_2 =1124 bytes)

Testing results

Routinely the special utilities could be used for delay measurements; we tried to test traditional *ping,* the new *UDPping* and other utility.

In result of test the simplest utility *ping* was found to be a best choice for delay measurements.

Two commands (windows syntacx)

$ping –s 100 tt143.ripe.net -> D_1

$ping –s 1124 tt143.ripe.net -> D_2

For example, ADSL connection at my home gives

D_1 = 18 *ms*

D_2 = 42 *ms*

that corresponds to 350 *Kbps* of available bandwidth

During FTP session the delay grows to

D_1 = 300 *ms*

D_2 = 425 *ms*

that corresponds to 60 *Kbps* of available bandwidth

This is very rough computation, but it could be made quickly and independently.

Future work

The additional experiments on the different direction are necessary for verifying our model. During experiment the received data should be compared with results of iperf utility from NLANR.org. We have contacted with Baek-Young Choi from University of Missouri, Kansas City. It will be interesting to test remote direction like Australia and New Zeland.

Unfortunately, there is not a simple way to receive data with delays for different packet sizes in current configuration of RIPE Test Box.

After finishing research our mechanisms could be incorporated in RIPE Test Box mechanism and an additional graphics could be added to database.