

A Method For Allocating Bandwidth To Network User

Technical Field

5 The present disclosure generally relates to a technique or method for controlling network user bandwidth in an IT network, where there are many network users sharing the same Internet Service Provider (ISP) link to access external Internet services.

10 Background

Many existing Internet gateways or network controllers can control network bandwidth (or speed) of each network user, but the control setting is usually a static fixed configuration. For example, if the configuration sets 2Mbps per user, each user will be capped at 2Mbps at all time, regardless of the overall usage of the link to the Internet provided by the Internet Service Provider (ISP). For a typical public WiFi, each user is limited to maximum speed of 2Mbps, and 5Mbps for a typical premium access.

The reason for having user bandwidth control is generally for security and fair bandwidth sharing across the network, so that each user is capped or limited to a certain speed they can consume, and no single user can potentially abuse or consume the entire capacity of the link to the Internet. This helps to reduce potential network congestion and ensures reasonable level of user experience for all users.

However, by statically setting network bandwidth (or speed) of each network user, the capacity or total bandwidth of the link to the Internet is not efficiently utilized. As a result, the user experience is not maximized. For example, when the total number of network users sharing the same link to the Internet is low, each user is still capped at the preconfigured speed (e.g. 2Mbps), and they are unable to burst to use the spare capacity. Particularly in countries like Singapore, where the fiber broadband is widely deployed with huge capacity at each location, it's very common for a hotspot network to have 100Mbps (or even 1Gbps) link to the Internet. When there are only 10 active users and if each user is capped at 2Mbps, they can only use total of 20Mbps,

wasting all other available capacity. This causes a lot of wastage on the available resource capacity, while the user experience is not maximized.

The Infocomm Development Authority of Singapore (IDA) suggests to use dynamic bandwidth allocation method for Wireless@SG hotspots, which correlates the active no. of users with the available ISP link capacity, and dynamically reallocates per user bandwidth. For example, if a network has a ISP link of 100Mbps, when there're 10 active users, the gateway will reallocate per user bandwidth to be 10Mbps. But this method assumes each user will fully use their allocated 10Mbps, which is not always the case, therefore the total link usage will still be far below the available 100Mbps, while some users who may need more than 10Mbps are unable to burst to use the spare capacity.

Summary

An embodiment of the invention is a method of allocating bandwidth to a network user. The network comprises a link to the Internet and the link to the Internet has a total bandwidth provided by an Internet service provider. The method comprises: (a) giving the network user a first bandwidth to use, (b) determining a percentage of utilization of the total bandwidth, and (c) adjusting the first bandwidth of the network user to a second bandwidth based on the percentage of utilization of the total bandwidth. The percentage of utilization of the total bandwidth is a ratio of an actual utilization to the total bandwidth. The actual utilization is an amount of data transmitted through the link to the Internet over a time period.

The first bandwidth given to the network user can be a maximum bandwidth allowable in the network. The maximum bandwidth allowable in the network is preferably insufficient for the network user to launch a denial of service attack to another network with a smaller bandwidth.

If the percentage of utilization of the total bandwidth is 90% or more, the first bandwidth allocated to the network user can be reduced by 10% to arrive at the second bandwidth. The second bandwidth can be further reduced until the percentage of utilization of the total bandwidth is less than 90% or until the second bandwidth is at a minimum bandwidth.

If the percentage of utilization of the total bandwidth is between 80% and 90%, the first bandwidth can be kept unchanged.

If the percentage of utilization of the total bandwidth is between 50% and 80%, the first bandwidth can be increased by 10% to arrive at the second bandwidth.

- 5 If the percentage of utilization of the total bandwidth is less than 50%, the first bandwidth can be increased by 20% to arrive at the second bandwidth.

Brief Description of the Drawings

- 10 Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 illustrates a typical network with a local area network having a link to the Internet.

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Figure 2 illustrates the changes of network bandwidth allocated to the network user based on the utilization of the total bandwidth of the link to the Internet.

Figure 3 illustrates a method of changing the network bandwidth of a network user.

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Detailed Description

In the present disclosure, depiction of a given element or consideration or use of a particular element number in a particular figure or a reference thereto in
25 corresponding descriptive material can encompass the same, an equivalent, or an analogous element or element number identified in another figure or descriptive material associated therewith. While aspects of the present disclosure will be described in conjunction with the embodiments provided herein, it will be understood that they are not intended to limit the present disclosure to these embodiments. On
30 the contrary, the present disclosure is intended to cover alternatives, modifications and equivalents to the embodiments described herein, which are included within the scope of the present disclosure as defined by the appended claims. Furthermore, in

the following detailed description, specific details are set forth in order to provide a thorough understanding of the present disclosure. However, it will be recognized by an individual having ordinary skill in the art, i.e. a skilled person, that the present disclosure may be practiced without specific details, and/or with multiple details arising from combinations of aspects of particular embodiments. In a number of instances, well-known systems, methods, procedures, and components have not been described in detail as not to unnecessarily obscure aspects of the embodiments of the present disclosure.

The technique or method in the present disclosure addresses the limitations described in the background section by correlating the actual usage of the link to the Internet with its subscribed capacity or total capacity, and adaptively adjusting network bandwidth or speed of each user, so that each user can burst to an maximum bandwidth or speed allowable when the network usage is low, and slow down when the network usage is high. This technique will fully utilize the capacity of the link to the Internet and maximize the experience of the users.

The technique or method in the present disclosure can be used at public hotspot networks or visitor based networks, such as public WiFi network, eg. shopping malls, cafes, retail outlets, and hospitalities network.

Figure 1 illustrates a typical network with a local area network having a link to the Internet. There are multiple network users using different types of network enabled devices, such as desktop computer, laptop computer, mobile phone and tablet to access the network. The users are connected to the local area network through wired connection (e.g. Ethernet) or wireless connection (e.g. WiFi). The users transmit and receive data with users in the same local area network or with users in another network through the Internet gateway.

Figure 2 illustrates the adjustment of the network bandwidth allocated to the network user based on on the utilization of the total bandwidth of the link to the Internet.

Figure 3 illustrates a method of changing the network bandwidth of a network user.

The process which a typical user goes through in accessing the network 10 is as follows:

1. Network user connects his device to the network 10 through wireless connection or network port via UTP cable.
- 5 2. Network user tries to browse Internet using a standard browser. The browsing request comes into a Internet gateway.
3. The Internet gateway redirects network user's browser to a captive portal login page. From login page, network user enters his username & password and accepts Terms and Conditions for access.
- 10 4. Once authenticated, the Internet gateway automatically permits network user with full Internet access, and at the same time allocates a network bandwidth or speed to the network user.

There are two steps in the technique or method of the present disclosure:

- 15 1. Real-time monitoring of the utilization of the link to the Internet.
2. Adjust the network bandwidth or speed of each network user.

An embodiment of the invention is a method of allocating bandwidth to a network user. The network comprises a link to the Internet and the link to the Internet has a total bandwidth provided by an Internet service provider. The method comprises: (a) giving the network user a first bandwidth to use, (b) determining a percentage of utilization of the total bandwidth, and (c) adjusting the first bandwidth of the network user to a second bandwidth based on the percentage of utilization of the total bandwidth. The percentage of utilization of the total bandwidth is a ratio of an actual utilization to the total bandwidth. The actual utilization is an amount of data transmitted through the link to the Internet over a time period.

The amount of data transmitted through the link to the Internet over the time period (that is, the actual utilization) can be calculated by:

- (a) recording the cumulative data transmitted (in bytes) at a Time 1;
- (b) recording the cumulative data transmitted (in bytes) at a later Time 2; and
- 30 (c) calculating the actual utilization (in bits per second) between Time 2 and Time 1 using the formula:

$$[(\text{Data at Time 2} - \text{Data at Time 1}) \times 8] / [(\text{Time 2} - \text{Time 1}) \times 60]$$

The percentage of utilization of the total bandwidth provided by the Internet service provider can be calculated using the formula:

$$(\text{Actual Utilization} / \text{Total Bandwidth}) \times 100$$

- 5 The first bandwidth given to the network user can be a maximum bandwidth allowable in the network. The maximum bandwidth allowable in the network is preferably insufficient for the network user to launch a denial of service attack to another network with a smaller bandwidth.

10 When a network user first logs in to the network, he can be given a maximum bandwidth allowable to start with. The maximum bandwidth allowable for a network user is a high bandwidth given to the user when the network is not congested. This maximum bandwidth is usually less than the total bandwidth of the link to the Internet. For example, if the total bandwidth of the link to the Internet is 1Gbps, the maximum bandwidth allowable can be set at 20Mbps. The network users should not
15 be given too high a maximum bandwidth so that their expectation is moderated. A network user also should not be given so high a maximum bandwidth that the user can launch a denial of service attack to another network with a smaller bandwidth. For example, with a total bandwidth of 1Gbps and there is only one user using the network, the user can potentially be given 100Mbps of bandwidth to use. However,
20 giving a network user 100Mbps to use may be undesirable.

After starting with a maximum bandwidth allowable, the bandwidth of the network user can be adjusted depending on the utilization of the total bandwidth.

If the percentage of utilization of the total bandwidth is 90% or more, the first bandwidth allocated to the network user can be reduced by 10% to arrive at the
25 second bandwidth. The second bandwidth (that is, the bandwidth currently enjoyed by the network user) can be further reduced by 10% until the percentage of utilization of the total bandwidth is less than 90% or until the second bandwidth is at a minimum bandwidth.

The minimum bandwidth is the lowest bandwidth that a network user will be given
30 when the network is very congested. For example, the minimum bandwidth can be

1Mbps. At the minimum bandwidth, the network's fair queuing mechanism will take place to schedule user traffic out through the link to the Internet.

If the percentage of utilization of the total bandwidth is between 80% and 90%, the first bandwidth can be kept unchanged.

- 5 If the percentage of utilization of the total bandwidth is between 50% and 80%, the first bandwidth can be increased by 10% to arrive at the second bandwidth.

If the percentage of utilization of the total bandwidth is less than 50%, the first bandwidth can be increased by 20% to arrive at the second bandwidth.

- 10 The percentage of utilization of 80% to 90% is probably the optimal level of utilization of the total bandwidth. When the percentage of utilization is 50% to 80%, the network users can be given greater bandwidth by increasing the bandwidth of the network users by 10%. The increase will enable the network users to experience higher upload and download speed. When the percentage of utilization is below 50%, increasing the user bandwidth by 20% will speed up the increase and enable the
- 15 network users to experience higher network speed more quickly. Increasing the bandwidth of the network users continues at 10% or 20% at a time until the percentage of utilization of the total bandwidth is between 80% to 90%.

Table below summarizes the actions on user bandwidth or speed, depending on the utilization of the total bandwidth.

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S/N	Percentage of utilization of the total bandwidth	Bandwidth or speed change for all network users
1	Greater than 90%	Reduce current bandwidth or speed by 10% until bandwidth or speed is at a minimum bandwidth.
2	80% to 90%	Keep current bandwidth or speed unchanged.
3	50% to 80%	Increase current bandwidth or speed by 10% until bandwidth or speed is at a maximum bandwidth.
4	Less than 50%	Increase current bandwidth or speed by 20% until bandwidth or speed is at a maximum bandwidth.

In the foregoing detailed description, embodiments of the present disclosure in relation to a method for allocating bandwidth to network user are described with reference to the provided figures. The description of the various embodiments herein is not intended to call out or be limited only to specific or particular representations of the present disclosure, but merely to illustrate non-limiting examples of the present disclosure.

The present disclosure serves to address at least some of the mentioned problems and issues associated with the prior art. Although only some embodiments of the present disclosure are disclosed herein, it will be apparent to a person having ordinary skill in the art in view of the present disclosure that a variety of changes and/or modifications can be made to the disclosed embodiments without departing from the scope of the present disclosure. The scope of the present disclosure as well as the scope of the following claims is not limited to embodiments described herein.

Claims

1. A method of allocating bandwidth to a network user, the network comprising a link to the Internet, the link to the Internet having a total bandwidth provided by an Internet service provider, the method comprising:
- 5 giving the network user a first bandwidth to use;
determining a percentage of utilization of the total bandwidth; and
adjusting the first bandwidth of the network user to a second bandwidth based on the percentage of utilization of the total bandwidth,
- 10 wherein the percentage of utilization of the total bandwidth is a ratio of an actual utilization to the total bandwidth; and
the actual utilization is an amount of data transmitted through the link to the Internet over a time period.
- 15 2. The method of claim 1 wherein the first bandwidth given to the network user is a maximum bandwidth allowable in the network and the maximum bandwidth allowable in the network is insufficient for the network user to launch a denial of service attack to another network with a smaller bandwidth.
- 20 3. The method of claim 1 wherein if the percentage of utilization of the total bandwidth is 90% or more, reducing the first bandwidth by 10% to arrive at the second bandwidth.
4. The method of claim 3 wherein further reducing the second bandwidth until
- 25 the percentage of utilization of the total bandwidth is less than 90% or until the second bandwidth is at a minimum bandwidth.
5. The method of claim 1, wherein if the percentage of utilization of the total bandwidth is between 80% and 90%, keeping the first bandwidth unchanged.
- 30 6. The method of claim 1, wherein if the percentage of utilization of the total bandwidth is between 50% and 80%, increasing the first bandwidth by 10% to arrive at the second bandwidth.

7. The method of claim 1, wherein if the percentage of utilization of the total bandwidth is less than 50%, increasing the first bandwidth by 20% to arrive at the second bandwidth.