

# Bandwidth Ruler

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## Abstract

With widespread rapid growth in both internet multimedia content and numbers of subscribers, ensuring quality of service (QoS) has become a major concern. This work demonstrates a set of accurate bandwidth provisioning tools for both Voice over IP (VoIP) and data traffic services offered by Internet Service Providers (ISPs). These tools are able to predict the demand for access network bandwidth based on network traffic characteristics and the number of subscribers after taking into account subscriber growth and other relevant factors. The tools are also capable of planning Cable television network capacity when converting analog channels into digital channels.

## 1. Introduction

Facing vigorous competition and rapid growth of multimedia traffic, including such real time services as VoIP, video on demand (VoD) and videoconferencing, ISPs must provide satisfactory service levels. The traditional "best effort" Internet delivery is not sufficient for the new multimedia applications. As a result, bandwidth provisioning to ensure QoS has become a critical issue for ISPs. Moreover, difficulties in financing projects in the current environment mean provisioning must be economical and well timed. An ISP can face several scenarios where more bandwidth is needed, including growth in subscribers and increased user demands for more Internet applications. In practice, due to the lack of appropriate planning tools, ISPs often simply double their network bandwidth and, therefore, their associated costs. Amplified by overly optimistic bandwidth growth projections, this practice resulted in an enormous waste of resources several years ago, followed by a sharp and extended downturn for telecom equipment manufacturers. In other scenarios, ISPs want to increase profits from their existing communication networks by adding subscribers or other services but they may be unsure about how to maintain QoS. QoS is related to user satisfaction, and can have an economic impact when dissatisfied users switch to another ISP for better service.

Some other scenarios also exist; for example, an ISP may need to establish pricing based on various QoS levels. To accommodate the rapid growth of high speed services with guaranteed QoS, it is imperative to have tools to help ISPs, whether cable or telco companies, to better manage their networks and optimize their network resources. Some existing VoIP tools [1] and video streaming calculators [2] offer partial or incomplete solutions to bandwidth provisioning but cannot handle general multimedia Internet traffic. To meet this pressing demand, the Groupe de Recherche en Technologies Avancees d'Internet at Universite de Moncton has developed a tool package, called Bandwith Ruler, which is the outcome of an Atlantic Innovation Fund (AIF) project, Data Traffic Analysis and Tool Development [3], supported by ACOA and Nortel Networks. Bandwidth Ruler consists of 8 calculators that are light-weight and easy to use. These calculators enable cable companies, ISPs, and business enterprises to plan, convert and expand the capacity of their access networks. The objective of this work is to demonstrate the 8 calculators.

## 2. Functionalities of the tools

Bandwidth Ruler handles heterogeneous traffic of integrated VoIP, data and video streaming services. Based on traffic data analysis and modeling, we have developed traffic models for VoIP, high speed data traffic and video streaming traffic, and established the relationships between network bandwidth, numbers of subscribers, and quality of service for a variety of networks. Bandwidth Ruler has been developed based on these relationships. The tools predict the demand for network resources based on the network traffic characteristics and the number of subscribers after taking into account subscriber growth and other relevant factors. The technical details of the tools can be found in [4, 5, 6].

2.1 The Voice over IP calculator can perform capacity planning for VoIP networks with a single codec or multiple codecs. For a given single codec and traffic characteristics including Average Busy Season busy hour load per VoIP subscriber (ABS), and the ratio of the High Day load to the Average Busy Season load (HD/ABS),

the Voice over Internet Protocol Bandwidth Calculator computes any one of the three quantities: access link bandwidth, the number of subscribers, or the quality of service, when the other two quantities are known. In the case of multiple codecs, for given subscriber groups with each group having different traffic characteristics, the Voice over IP Calculator computes either of the two quantities: access link bandwidth or the quality of service, when the other quantity is known.

2.2 The Voice and Data Calculator uses the ABS and HD/ABS of VoIP traffic and the access rate and demand of data traffic to compute required bandwidth or numbers of subscribers for both VoIP and High Speed Data Traffic (HSDT) subscribers for given profiles of VoIP and HSDT subscribers. The access rate is defined as the speed in Mbps that the ISP provides to a customer and the demand is defined as the percentage of the access rate that a subscriber actually consumes.

2.3 The Voice and Traffic Based Data Calculator computes one of the two quantities, either access link bandwidth, or the maximum numbers of high speed data traffic subscribers and VoIP subscribers, when the available bandwidths for VoIP and for data are known. The calculator allows its user to choose built-in traffic models fitted to typical traffic traces or to build a model from a real data traffic trace provided by the tool user.

2.4 The High Speed Data Traffic (HSDT) dimensioning calculator uses real traffic statistics including access rate and demand rate to compute the relationship between the amount of bandwidth, quality of service (QoS), and the number of subscribers. The HSDT calculator computes any one of the three quantities: bandwidth, quality of service and number of subscribers, when the other two are given.

2.5 The Multi-Group High Speed Data Traffic calculator performs capacity planning for networks with heterogeneous data traffic characteristics. For given groups of subscribers with different service requirements, this calculator computes either the quality of service or required bandwidth, if the other one is given.

2.6 The Multi-Group Voice and Data calculator performs capacity planning for networks supporting multiple groups of VoIP subscribers and multiple groups of data services subscribers, with each group having its own traffic characteristics. For given groups of subscribers

with different service requirements, this calculator computes the required bandwidth expressed in Mbps. The calculator first creates profiles for VoIP subscriber groups and data subscriber groups, and then applies dimensioning formulas to compute the required bandwidth.

2.7 The Traffic Based High Speed Data Traffic calculator performs traffic-specific capacity planning for high speed data networks. The user of the calculator can choose built-in traffic models fitted from typical traffic traces or build a model from user-provided statistics or a data file containing a traffic trace. The calculator computes any one of the following three quantities: access link bandwidth, the maximum number of subscribers, or quality of service, when the other two quantities are given.

2.8 The Cable TV Calculator allows cable TV companies to compute their planned network capacities after converting some analog channels to digital. The calculator can handle both constant bit rate and variable bit rate. For a given constant bit rate, the calculator can determine the number of analog channels or the number of digital channels, given the other quantity. For a variable bit rate, the calculator can determine one of the total number of analog channels, the total number of digital channels or the quality of service when the other two are given.

## References

- [1] Voice over IP Calculator team, "Voice over IP bandwidth calculators", <http://www.voip-calculator.com/contact.html>, 23/07/2004
- [2] VSS, "Video Streaming Hosting Calculator", [http://www.videostreamingservices.com/Hosting\\_prices\\_calculator.htm](http://www.videostreamingservices.com/Hosting_prices_calculator.htm), 2003
- [3] CNSR, <http://www.cnsr.info/research/componenth.php>
- [4] J. Almhana, R. McGorman, and Z. Liu, "IP network traffic modeling and capacity planning," Internal Report, 2008.
- [5] R. McGorman, J. Almhana, V. Choulakian, Z. Liu, W. Jedidi, "Similarities between Voice and High Speed Internet Traffic Provisioning", Proceedings of CNSR, 2004.
- [6] R. McGorman, J. Almhana, V. Choulakian, and Z. Liu, "Empirical bandwidth provisioning models for high speed internet traffic," in Proc. CNSR'06, Moncton, pp.188-195, May 24-25, 2006.