WHAT IS THE ROLE OF TELETRAFFIC ENGINEERING IN BROADBAND NETWORKS?

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Teletraffic Engineering is a well-understood discipline in the traditional voice network, where traffic patterns are established, growth rates can be predicted, and vast amounts of detailed historical data are available for analysis. However, in modern broadband networks, the teletraffic engineering methodologies used for voice networks have become obsolete [1]. Various aspects relating to teletraffic engineering in broadband networks are discussed in this article.

Yestertday’s telephone networks and isolated mainframe computing environments are fitfully transforming themselves into information superhighways. In fact, the next era is frequently dubbed the “Information Age.” The allure, hope, and promise of these visions is caused by, and in turn influences, the fundamental shifts in technology, services, and business paradigms. we are currently witnessing. All three of these changes are essential to creating the envisioned “anytime, anywhere, anyhow, anyone” communication paradigm. We outline some of the most salient features of th new emerging paradigm and the challenges it presents to teletraffic engineers working in broadband networks.

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One of the drivers of the 21st century network paradigm will be the applications and services that evolve and potentially create “killer applications.” Such applications could dramatically alter the ability of the new network to deliver on its promised performance, reliability, availability, and overall Quality of Service (QoS). It will be the job of teletraffic engineers to understand the potential implications of these new services, characterize the important ones to predict their impact on QoS, and develop rules and algorithms (preferably flexible and adaptable) to make the best trade-offs among the competing demands.
1 Why is teletraffic engineering different in broadband networks?

Firstly, the nature of broadband traffic is different to that of traditional voice networks. Many of the methodologies developed for traditional networks were based on the nature of voice calls, and are therefore not applicable to broadband networks. The nature of broadband traffic (broadband traffic characteristics) is discussed in the following sub-section.

The inherent nature of broadband networks is also different to that of traditional voice networks. Broadband networks have:

- high speeds,
- small cell sizes (in ATM networks), and
- limited information in the header.

These factors make teletraffic engineering in broadband networks more difficult than in traditional voice networks. A few more factors that further complicate teletraffic engineering in broadband networks [2] are:

- A wide range of applications with diverse Quality of Service (QoS) requirements must be catered for.
- Much of the traffic (e.g., voice, video) is not amendable to flow control.
- The feedback within the network is “slow”.
- There are a large variety of traffic patterns.

2 Broadband traffic characteristics

In the traditional voice network, the study of traffic characteristics has matured over many years following the seminal work of Erlang in 1909. However, the teletraffic theory that has evolved relied heavily on the facts that
• Only one type of connection is offered, a circuit-switched connection, and
• the order of magnitude of the call holding time is relatively stable and well-known, namely the few minutes of a telephone conversation.

The diversity of broadband service connections and the variety of holding times make the application of teletraffic theory in voice networks to broadband networks very difficult [3]. Figure 3 and Figure 4 show some applications and the variation in holding time and burstiness that may be expected for each one.

![Diagram showing peak bit rate vs burstiness](http://cnx.org/content/m13376/1.4/)

**Figure 3:** Position of applications with respect to holding time and burstiness (sampled and resized from Wikipedia).
To manage the traffic implications of all these types of connections, we must return to the basic principles of traffic statistics. This has been extensively studied in recent years, and there is a large volume of published work on the subject. A Poisson process with one parameter does accurately model telephony traffic. However, to account for the changes with broadband traffic, alternatives to the Erlang formula have been considered [4]. Two methods of modelling the traffic are considered, namely the Bernoulli-Poisson-Pascal approximation and the Maximum Entropy method. These methods use two parameters for describing the traffic, one for the mean demand and another to characterize the variability of the traffic.

3 Mechanisms used for teletraffic engineering in broadband networks

There are two primary mechanisms that are used for teletraffic engineering in broadband networks, namely:

- Traffic Control and Management, and
- Congestion Control

These two mechanisms are described in the following two sub-sections.
3.1 Traffic control and Management

**Definition 4: Traffic control and management**

Traffic control and management is defined as the set of actions performed by the network to:

- avoid congestion
- ensure that users get their required Quality of Service (QoS) guarantees.

The basic control problem is related to the efficient allocation of network resources so as to:

- satisfy different QoS requirements; and
- provide fair access to the network resources for all users

Traffic control and management provides the means by which:

- a user is ensured that the offered cell flows meet the rate specified in the traffic contract; and
- the network is ensured that the traffic contract rates are enforced such that the Quality of Service guarantees are provided for all users.

3.2 Congestion Control

Congestion control is defined as [2] the set of actions performed by the network to prevent or reduce congestion. Congestion control is the most important part of the traffic management issue. A network that controls congestion must:

- be responsive to the different utility functions of the users
- be able to manage the resources so that there is no loss of utility as the load increases

4 A simple example

The process of how a broadband network provides different levels of service to different types of traffic while avoiding congestion will be described briefly by means of a simple example. Links are provided for the reader interested in a more detailed description of the various concepts involved. The concept of traffic control in broadband networks (particularly in ATM networks) is very simple: an application that requires the network to transport traffic from one location to another with a specific Quality of Service (QoS) follows the following procedure [5]:

- The application declares the traffic’s characteristics and the Quality of Service required by the traffic in a traffic contract (in order to make a connection request).
- The network judges whether it has enough resources available to accept the connection, and then either accepts or rejects the connection request. This is known as admission control.
- If there are insufficient resources available in the network at the time, the connection request is rejected.
- If there are sufficient resources available in the network at the time, the connection request is accepted and the network assigns the resources necessary to the connection.
- During communication, the network monitors the conformity between the declared traffic characteristics (in the traffic contract) and the characteristics of the actual traffic entering the network. This is known as traffic policing.
- The network has the capability to discard the non-conformant traffic in the network (using Priority Control).
- The overall rate at which all the traffic is admitted into the network is governed by the network’s traffic shaping policy.

http://cnx.org/content/m13376/1.4/
5 The ATM Traffic Management Framework

The ITU-T has defined a collection of ATM control mechanisms that operate across a spectrum of timing intervals [6]. These control mechanisms are summarised in table 1.

Table 1: Summary of control mechanisms defined in ATM [2]

<table>
<thead>
<tr>
<th>Response Time</th>
<th>Traffic Control Functions</th>
<th>Congestion Control Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long term</td>
<td>Network Resource Management</td>
<td></td>
</tr>
<tr>
<td>Connection Duration</td>
<td>Connection Admission Control (CAC)</td>
<td></td>
</tr>
<tr>
<td>Round-trip propagation time</td>
<td>Fast Resource Management</td>
<td>Explicit forward congestion indication (EFCl), ABR Flow Control</td>
</tr>
<tr>
<td>Cell insertion time</td>
<td>UPC and NPC, Priority Control, Traffic Shaping</td>
<td>Selective Cell Discard, Frame discard</td>
</tr>
</tbody>
</table>

Table 1

Exercise 1  
(Solution on p. 8.)

Give two methods of modelling traffic that have been considered in broadband networks?
Solutions to Exercises in this Module

Solution to Exercise (p. 7)
The two methods are the Bernoulli-Poisson-Pascal approximation and the Maximum Entropy method. These methods use two parameters for describing the traffic, one for the mean demand and another to characterize the variability of the traffic.

References


