Chapter 8
Analysis of the High-Speed Network Performance through a Prediction Feedback Based Model

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ABSTRACT

Performance modeling of a high speed network is challenging, especially when the size of the network is large. The high speed networks span various applications such as the transportation, wireless sensors, et cetera. The present day transportation system makes uses of Internet for efficient command and control transfers. In such a communication system, reliability and in-time data transfer is critical. In addition to the sensor information, the present day wireless networks target to support streaming of multimedia and entertainment data from mobile to infrastructure network and vice versa. In this chapter, a novel modeling method for the network and its traffic shaping is introduced, and simulation model is provided. The performance with this model is analyzed. The case-study with wireless networks is considered. The chapter is essentially about solving the congestion control of packet loss using a differentially fed neural network controller.

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INTRODUCTION

In a wireless network, the reflections and multi path transmission result in increased self similarity for the signal at the receiving end. The self similarity of the network refers to the invariance of the shape of the autocorrelation function when observed over multiple time scales. The self similarity imparts long-range dependency in to the traffic. As a result of long range dependency, the traffic turns bursty resulting in under or over utilization of the resources, increased packet loss etc.

In order to reduce the loss of multimedia data over the wireless medium, it is required to pump-in less data by controlling the degree of compression (and improving the channel coding) when the channel is more noisy. The importance of signal strength over the delays in a wireless channel are provided in (Beatriz Soret, M. Carmen Aguayo Torres, and J. Tomás Entrambasaguas, 2010).

When command and control data is to be exchanged, the data needs additional protection with an appropriate channel coding mechanism. It reduces the further deterioration of the signal to noise ratio (SNR) over the disturbed channel. In order to make it possible, a feedback on the channel status in terms of percentage loss of the data packets over the channel is required to be transferred to the source. Based on this input, a decision on the data transmission rate over the channel may be done.

For a perfect synergy between the forward and the feedback path, the properties of forward path that impart aberrations to the signal have to be annulled by generating appropriate signals in the feedback path. Ideally, the controller generating the feedback signal should have the same characteristics of the network. I.e., it should be a network in its own sense.

A good controller is required to foresee the trends in the network traffic variations and provide inputs to the traffic source well in advance. The source would get sufficient time to adjust the traffic rate or provide sufficient redundancies with appropriate channel coding schemes so that it would not flood the resources when it is disturbed. In this work, a neural network based controller is proposed. When a portion of the output of the neural network is tapped and provided as the additional input, it starts exhibiting the important characteristics of the data network such as self similarity, long range dependency, abstraction and so on and behaves as a miniaturized data network.

BACKGROUND

Independent of its origin, the internet traffic has a few know characteristics in common. It includes

- A few Predictable parameters in statistical sense
- Traffic follows poisson distribution
- Internet traffic is bursty. This is because packets of various size are involved Burstiness of one flow affects the other adaptive flows. This property is useful for the traffic control
- Overlapping of the independent on-off data sources leads to the arrival pattern distribution with heavy-tailed autocorrelation function.The long-range dependancy in the traffic leads to no “flattening” towards a mean when zoomed out. The same structures may be found at different time scales; hence the traffic is self similar
- TCP is known to propagate bottleneck self-similarity to the end system. The work-around is to use a model to predict traffic instead of guessing

The other features of the internet traffic include jitter, packet losses, delay, large buffer requirements, less data for decision, time varying characteristics and congestion.