A Study of VPN Growth Trends for Network Planning

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1. Introduction

IP based Virtual Private Networks (VPNs) are being deployed as the solution of choice for site-to-site communication for a large number of enterprises. The provider networks that support these services are faced with unique challenges in terms of network planning. There is a lot of value in understanding the characteristics of VPNs from the perspective of planning, provisioning and maintenance of the service provider network. Recent studies have provided architectural and design guidelines to build efficient VPN services [2, 3, 4]. In essence, the customer's requirements can be characterized in terms of a hose that delivers a contracted service [1]. Further, the nature of customer traffic can be better understood using specialized methods to derive approximate traffic matrices for such IP VPNs [5].

In the following paragraphs we propose to complement these ideas by adding information about how VPNs change over time. We use the term "VPN Growth" to describe changes in a VPN in terms of the number customer endpoints (the size), the Committed Information Rate (CIR, the contracted bandwidth) and the Peak Information Rate (PIR).

We find that understanding VPN Growth trends in combination with customer traffic matrices and network topology allows the provider to better anticipate network planning requirements.

2. Gathering VPN Growth Information

We begin with a discussion of the data and the metrics we examine in order to obtain growth trends.

2..1 Overview of dataset

The data we are analyzing spans several years for a current VPN service from a large IP VPN service provider. It is comprises administrative information recorded for each VPN customer to track such things as a unique identifier for the VPN, the port details at the provider edge routers, the capacity contracted for each customer endpoint etc. This data is available as daily snapshots of the administrative database. Changes in customer information, if any, can be inferred by comparing two snapshots. Also available is SNMP data that may be used to relate each customer's information from the administrative database with the actual traffic that is being generated by that customer, to a reasonable approximation based on the derived traffic matrices [5].

2..2 Metrics to Capture Growth

In the current study we consider two dimensions to describe the changes to a VPN. One dimension consists of the nature of changes to the VPN, while the other features the quantum and frequency of changes. The three main properties of a VPN to consider are the following:

1. **Size:** Size is measured in terms of the number of customer endpoints that constitute the VPN.

2. **CIR:** The contracted bandwidth for the each customer endpoint is indicated by the CIR.
3. **PIR:** The peak rate to which each customer endpoint can burst is the PIR

We look at these metrics with to infer the following:

1. **Quantum of Change:** The amount by which size or CIR/PIR change over a given time interval.
2. **Frequency of Change:** When the changes occured and how often to do they happen.

3. Impact of Growth Trends on Network Planning

Optimal operation of a VPN service requires a good understanding of customer requirements. In the following paragraphs we discuss the significance of VPN growth trends in making efficient network operations possible. We examine the value in combining traffic matrices with VPN growth trends to expect traffic change. The extent of change in VPN characteristics can have important implications for planning for growth in the network. Finally, we can examine the feasibility of certain design techniques for provisioning, considering the frequency and nature of changes to customer requirements.

1. **Traffic changes:** With continual addition and removal of customer endpoints and changes in contracted bandwidth, it is important to understand the change in traffic load offered to the network. Often customers upgrade contracted bandwidth in anticipation of future demand and in some instances may over-provision their contracted capacity. By correlating traffic matrix information with VPN size and CIR/PIR changes, we can get a better idea of the typical impact of changes in customer networks or requirements. This can yield important multiplexing gains to the provider and potentially reduce over-provisioning at the network level as well as on an individual customer basis.
2. **Provisioning for growth:** Building a network with a good understanding of future requirements leads to a more durable and scalable service. The quantum and frequency of changes in VPNs is important from this perspective. A good estimate of the expected increase in number of customer endpoints or bandwidth requirements can lead to less frequent operational changes.
3. **Feasible provisioning techniques:** Recent advances in optimization-based provisioning techniques have yielded a rich set of options in the way a provider can design a network. But the trade-off with more efficient algorithms is their complexity. A better understanding of how often such provisioning operations need to be invoked can help us identify the techniques that are feasible.

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