AMPLE: Adaptive Multi-Topology BGP for Scalable and Flexible Traffic Engineering

Ravi Kumar
Department of Physics, Panjab University, Chandigarh, India

ABSTRACT

The Internet is a collection of networks, each controlled by different administrations. Traffic engineering is an important mechanism for Internet network providers seeking to optimize network performance and traffic delivery. Routing optimization plays a key role in traffic engineering, finding efficient routes so as to achieve the desired network performance. In this proposed method presents an intelligent multi-topology BGP (MT-BGP) based inter-domain traffic engineering (TE) scheme that is able to handle unexpected traffic fluctuations with near-optimal network performance. The proposed method provides the AMPLE: An Adaptive MT-BGP traffic engineering based on virtual routing topologies is mainly focused to create own path in traffic congestion. TE system based on virtualized BGP routing that enables short timescale traffic control against unexpected traffic dynamics using multi-topology BGP-based networks. The framework contains three major components, namely Offline Link Weight Optimization (OLWO), Adaptive Traffic Control (ATC) and Admission Control (ADC) algorithm. Admission control algorithm achieved low delay and high throughput Instead of frequently changing BGP link weights then create the own path based on virtual routing topologies, we use multi-topology BGP routing protocols that allow adaptively splitting traffic across multiple routing topologies.

Keywords: *Admission control algorithm, AMPLE, Transmission Control Protocol, Traffic Engineering*.

I. INTRODUCTION

Traffic engineering is a method of optimizing the performance of a telecommunications network by dynamically analyzing, predicting and regulating the behavior of data transmitted over that network. It is an important mechanism for Internet network providers seeking to optimize network performance and traffic delivery. Traffic engineering involves adapting the routing of traffic to the network conditions, with the joint goals of good user performance and efficient use of network resources. Most work on traffic engineering has focused on techniques for controlling the flow of traffic within a single Autonomous System (AS), such as a company, university campus, or Internet Service Provider (ISP). TE has been considered as one of the vital components of an autonomous system required to achieve both high resource utilization and high quality of service for both real time and non real-time applications [9].

Intra domain IGRP- Interior Gateway Routing Protocol

The Interior Gateway Routing Protocol (IGRP) is an advanced distance vector routing protocol. The Interior Gateway Routing Protocol (IGRP) is a routing protocol that was developed in the mid-1980s by Cisco Systems, Inc. Cisco's principal goal in creating IGRP was to provide a robust protocol for routing within an autonomous system (AS). Such protocols are known as Interior Gateway Routing Protocols [3]. An interior gateway protocol (IGP) is a routing protocol that is used to exchange routing information within an autonomous system (AS).

Link State indicates that a router executing OSPF will be concerned with tracking the operational state of each of its network interfaces. A change in the operational state of an interface is what triggers the router to send a routing update [4]. This is in stark contrast to RIP, which is a timer-based protocol that sends routing updates every 30 seconds, whether or not changes in the network have occurred.

Inter domain BGRP- Border Gateway Routing Protocol

The Internet consists of tens of thousands of Autonomous Systems (AS) that use the Border Gateway Protocol (BGP) to exchange information about how to reach blocks of destination IP addresses (called IP prefixes). BGP is an incremental protocol -a BGP-speaking router sends an announcement message when a new route is available and a withdrawal message when a route no longer exists. Inter-domain Traffic Engineering (TE) based on BGP (Border Gateway Protocol). The BGP is an inter-autonomous system (AS) routing protocol. An autonomous system is an administrative domain. That is, it is a network or group of networks under a common administration and with common routing policies [1]. BGP is used to exchange routing information in the Internet and is the protocol used by default to communicate between Internet service providers (ISP). Customer networks, such as universities and corporations, usually employ protocols known as Interior Gateway Protocol (IGP) to exchange routing information within their networks. Examples of IGPs are Routing Information Protocol (RIP) and Open shortest Path Protocol (OSPF). Customers connect to ISPs, and ISPs use BGP to exchange customer and ISP routes. A network under the administrative control of a single organization is called an autonomous system (AS). There are two types of routing, intra-domain routing which is the process of routing within an AS, and inter-domain routing which is the process of routing among different ASs. BGP is the dominant inter-domain routing protocol on the Internet (BGP). BGP has been deployed since the commercialization of the Internet, and version 4 of the protocol has been in wide use for over a decade [3].

II. RELATED WORK

The following papers are motivated to propose the virtual routing protocols based on traffic engineering concepts, Multi-topology BGP (MT-BGP) based intra-domain traffic engineering (TE) scheme [5]. It is able to handle traffic problems, unexpected traffic fluctuations one autonomous system to another autonomous system. These are most useful for avoiding network congestion in effective manner. Internet routing is handled by two distinct protocols with different objectives. Inside a single domain, link-state intradomain routing protocols distribute the entire network topology to all routers and select the shortest path according to a metric chosen by the network administrator. For scalability reasons, the interdomain routing protocol is only aware of the interconnections between distinct domains, it does not know any information about the content of each domain.

The Border Gateway Protocol (BGP) [9] is the current de facto standard interdomain routing protocol. In BGP terminology, a domain is called an Autonomous System (AS). BGP is a path-vector protocol that works by sending route advertisements. A route advertisement indicates the reachability of a network (i.e. a network address and a netmask representing a block of contiguous IP addresses - for instance, 192.168.0.0/24 represents a block of 256 addresses between 192.168.0.0 and 192.168.0.255) because this network belongs to the same AS as the advertising router or because a route advertisement for this network was received from another AS. The length of the AS-path can be considered as the route metric. A route advertisement may also contain several optional attributes such as the local-pref, Multi-Exit Discriminator (MED) or communities attributes [9].

III. PROPOSED METHOD

3.1 Ample

AMPLE includes two distinct tasks, first one offline network dimensioning through link weight optimization for achieving maximum intra-domain path diversity across multiple MT-IGP routing topologies; second one adaptive traffic splitting ratio adjustment across these routing topologies for achieving dynamic load balancing in case of unexpected traffic dynamics [6]. In AMPLE, the MT-IGP configuration produced in the offline phase provides an opportunity to use multiple diverse IGP paths for carrying traffic with arbitrary splitting across multiple routing topologies. More specifically, each source node can adjust the splitting ratio of its local traffic (through remarking the Multi-Topology ID field of the IP packets) according to the monitored traffic and network conditions in order to achieve sustainable optimized network performance (e.g. minimize the Maximum Link Utilization, MLU). It is worth mentioning that the computing of new traffic splitting ratios at each source PoP node is performed by a central traffic engineering manager. This TE manager has the knowledge about the entire network topology and periodically gathers the overall network status such as the current utilization of each link and traffic matrices based on which the new traffic splitting ratio is computed and thereafter enforced at individual source nodes [9].

3.2 Border Gateway Protocol

The Border Gateway Protocol (BGP) is the de facto interdomain routing protocol used to exchange reachability information between Autonomous Systems in the global Internet. BGP is a path-vector protocol that allows each Autonomous System to override distance-based metrics with policy-based metrics when choosing best routes. A group of Autonomous Systems to independently define BGP policies that together lead to BGP protocol oscillations that never converge on a stable routing [7]. One approach to addressing this problem is based on static analysis of routing policies to determine if they are safe. We explore the worst-case complexity for convergence oriented static analysis of BGP routing policies. We present an abstract model of BGP and use it to define several global sanity conditions on routing policies that are related to BGP convergence/divergence.

ASs want to choose own non-local routing policy

- Interdomain routing must accommodate this
- BGP is the current interdomain routing protocol
- BGP: Border Gateway ProtocolASs want to choose own non-local routing policy
- Interdomain routing must accommodate this
- BGP is the current interdomain routing protocol
- BGP: Border Gateway Protocol

In proposed system using BGP protocol the system consists of three complementary components: **offline link weight optimization** that takes as input the physical network topology and tries to produce maximum routing path diversity across multiple virtual routing topologies for long term operation through the optimized setting of link weights [8]. Based on these diverse paths, **adaptive traffic control** performs intelligent traffic splitting across individual routing topologies in reaction to the monitored network dynamics at short timescale. **Admission control algorithm** using dynamically creates a new path with help of virtual routing topologies. According to our evaluation with real network topologies and traffic traces, the proposed system is able to cope almost optimally with unpredicted traffic dynamics and, as such, it constitutes a new proposal for achieving better quality of service and overall network performance in IP networks using BGP. In proposed system, AMPLE has a high chance of achieving inter network performance with large number of routing topologies, although this is yet to be further verified with traffic traces data from other operational networks when available. Offline network dimensioning through link weight optimization for achieving maximum inter-domain path diversity across multiple MT-BGP routing topologies; and adaptive traffic splits ratio adjustment across these routing topologies for achieving dynamic load balancing in case of unexpected traffic dynamics.

3.2.1 Virtual Traffic Allocation

In this Module, the diverse MT-BGP paths according to the link weights computed by OLWO. Monitored network and traffic data such as incoming traffic volume and link utilizations. At each short-time interval, ATC computes a new traffic splitting ratio across individual VRTs for re-assigning traffic in an optimal way to the diverse BGP paths between each S-D pair. This functionality is handled by a centralized TE manager who has complete knowledge of the network topology and periodically gathers the up-to-date monitored traffic conditions of the operating network. These new splitting ratios are then configured by the TE manager to individual source PoP nodes, who use this configuration for remarking the multi-topology identifiers (MTIDs) of their locally originated traffic accordingly.

3.2.2 Offline Link Weight Optimization (OLWO)

In this module, to determine the definition of “path diversity” between PoPs for traffic engineering. Let’s consider the following two scenarios of MT-BGP link weight configuration. In the first case, highly diverse paths are available for some Pop-level S-D pairs, while for some other pairs individual paths are completely overlapping with each other across all VRTs. In the second case, none of the S-D pairs have disjoint paths, but none of them are completely overlapping either. Obviously, in the first case if any “critical” link that is shared by all paths becomes congested, its load cannot be alleviated through adjusting traffic splitting ratios at the associated sources, as their traffic will inevitably travel through this link no matter which VRT is used. Hence, our strategy targets the second scenario by achieving “balanced” path diversity across all S-D pairs.

3.3 Proposed Admission Control Algorithm

In order for the Bandwidth Broker to decide whether an incoming resource reservation request will be accepted or not it has to perform some sort of admission control. This function can be performed using straightforward algorithms or using more sophisticated architectures [14]. Our admission control algorithm is the set of criteria controlling whether to admit a new flow; these are based on an approximate model of traffic flows and use measured quantities as inputs [15]. In proposed system using admission control algorithm at border gateway protocol. Here admission control algorithm mainly used for to seek the less traffic path. After found the less traffic flow, but if there is no path, then ADC immediately inform to virtual routing topologies. Suddenly if possible means it’s creates own path.

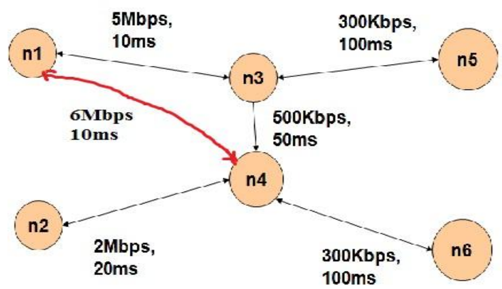

Fig.4. Creates new path with help of ADC

In this above figure, packets send from node 1 to node 2 (system). It's have various path between node 1 and node 2. But the paths all are high traffic may be packets will send delay or packets will loss rather than virtual routing topologies creates new path between 1 and 2 (mentioned in red color line) because high bandwidth with low traffic, its identified with help of admission control algorithm.

IV. RESULT & DISCUSSION

In this research, AMPLE: An adaptive MT-BGP Traffic Engineering based on Virtual Routing Topologies mainly focus to creates the own path in traffic congestion with help of admission control algorithm.

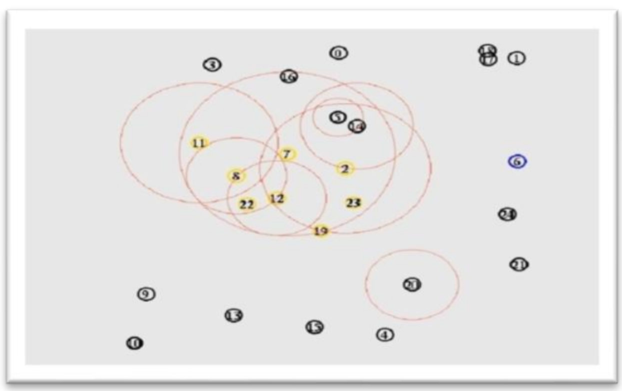

Fig. 4.1. Searching low traffic flow

AMPLE includes three distinct tasks, namely
(1) offline network dimensioning through link weight optimization for achieving maximum inter-domain path diversity across multiple MT-BGP routing topologies; and
(2) adaptive traffic splitting ratio adjustment across these routing topologies for achieving dynamic load balancing in case of unexpected traffic dynamics.

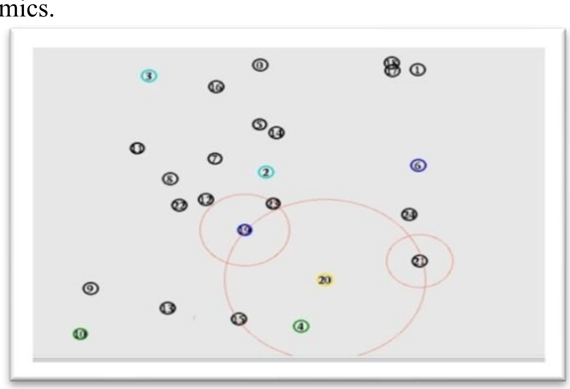

Fig.4.2. Creates new path with help of ADC algorithm

(3) Admission control algorithm used in proposed system. Virtual routing topologies creates new path with help of ADC algorithm. These objectives are low delay, no packet loss and high throughput. AMPLE (Adaptive Multi-toPoLogy traffic Engineering a current BGP), TE approach that is capable of adaptively handling traffic dynamics in operational IP networks. Instead of re-assigning BGP link weights in response to traffic fluctuations, we adopt multi-topology BGPs (MT-BGPs) AMPLE system based on virtualized BGP routing topologies for dynamic traffic engineering.

V. CONCLUSION

In this research paper a novel method, AMPLE: An adaptive MT-BGP traffic engineering based on virtual routing topologies is mainly focus to create own path in traffic congestion is proposed. TE system based on virtualized BGP routing that enables short timescale traffic control against unexpected traffic dynamics using multi-topology BGP based networks. The framework contains three major components, namely Offline Link Weight Optimization (OLWO), Adaptive Traffic Control (ATC) and admission control Algorithm. Admission control algorithm achieved low delay and high throughput Instead of frequently changing BGP link weights then create own path based on virtual routing topologies, we use multi-topology BGP routing protocols that allow adaptively splitting traffic across multiple routing topologies.

REFERENCE

1. *N. Feamster, J. Winick, and J. Rexford, ”A model of BGP routing for network engineering”,. In Proc. ACM SIGMETRICS, June 2004.*
2. *Ning wang, Kin hon ho, George pavlou, and Michael howarth, university of surrey “An overview of routing optimization for internet traffic engineering”.*
3. *Cisco Systems, BGP Multipath Load Sharing for Both eBGP and iBGP in an MPLS-VPN”, 2005.*
4. *Ning Wang, Kin Hon Ho, George Pavlou, AMPLE: “An Adaptive Traffic Engineering System Based on Virtual Routing Topologies”. IEEE communications Magazine March 2012.*
5. *N. Wang, K-H. Ho and G. Pavlou, “Adaptive Multi-topology IGP Based Traffic Engineering with Near-Optimal Performance “, Proc. IFIP Networking 2008.*
6. *sugih Jamin, Scott Shenker, Lixia zhang, and David D. Clark “ An admission control algorithm for predictive real-time service”.*
7. *T.D. Lagkas, G.I. Papadimitriou, A.S. Pomportsis “QAP: A QoS supportive adaptive polling protocol for wireless LANs” Computer Communications 29 (2006), pp.618–633*
8. *Yuxia Lin, Vincent W.S. Wong, “An admission control algorithm for multi-hop 802.11e-based WLANs”. Computer Communications 31 (2008), pp.3510–3520*
9. *Sugih Jamin, Peter B. Danzig, Scott J. Shenker, and Lixia Zhang “A Measurement-based Admission Control Algorithm for Integrated Services Packet Networks.*