A Survey on Adaptive Traffic Engineering System based on Virtual Routing Topologies

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***Abstract*- In order to avoid network congestion and service disruptions to handle traffic dynamics in network environment introducing an efficient traffic engineering and management system called AMPLE that executes adaptive traffic control by utilizing multiple virtualized routing topologies. The proposed system comprises of two complemental parts: offline link weight optimization where it takes as input of physical network topology and create maximum routing path diversity across multiple virtual routing topologies for long term operation via optimized setting of link weights. Based on these diverse paths, adaptive traffic control performs intelligent traffic splitting throughout individual routing topologies in response to the monitored network dynamics at short duration. According to the evaluation with real network topologies and traffic traces, the proposed system is able to deal nearly optimally with unpredicted traffic dynamics and, as such, it forms a new proposal for reaching improved quality of service and overall network performance in IP networks.**

INTRODUCTION

Traffic engineering is a essential to controlling the performance of a Contemporary network by analyzing, predicting and regulating the nature of data transmission in network. Hence it is an essential aspect of contemporary network management. In recent years, the of virtual networks has got enhancing aid of the research community, on the general spirit being to enable virtualized network resources on top of the same physical network infrastructure. Such resources not only include physical elements such as routers or links, but also soft resources such as logical network topologies through configurations that allow them to coexist gracefully. The motivation differs from the existing proposals focus on virtual network provisioning to support service differentiation, resource sharing or co-existing heterogeneous platforms. Instead of considering how multiple “equivalent” virtual network topologies, each having its own routing configuration In a static manner, Offline TE techniques aim to optimize network resources but needs exact idea of traffic matrices in order to make optimized network configurations for long-term operation.

However, these approaches frequently shows operational inefficiencies due to frequent and significant traffic dynamics in operational networks. Traffic engineering for plain IP-based networks (It will be referring to these as IGP based networks, as is common in the literature since they route traffic based on the Interior Gateway Protocol, OSPF or IS-IS) has received a lot of attention in the research community.

EXISTING SYSTEM

IGP-based TE mechanisms are limited to offline operation and thus cannot deal efficiently with substantial traffic dynamics. IGP-based TE permits for stable traffic delivery through native IGP paths, without flexible traffic splitting for dynamic load balancing. In addition, changing IGP link weights in reaction to emerging network congestion may cause routing re-convergence problems that potentially disrupt ongoing traffic sessions. In effect, it has been recently argued that dynamic/online route re-computation is to be considered harmful even in the case of network failures, let alone for dealing with traffic dynamics.

PROPOSED SYSTEM

In proposed system AMPLE (Adaptive Multi-topology traffic Engineering), a wholistic system based on virtualized IGP routing topologies for dynamic traffic engineering. The idea behind this strategy follows the offline purveying of multiple diverse paths in the routing plane and online spreading of the traffic load for dynamic load balancing in the forwarding plane.The approach can be briefly described as follows. MT-IGPs are utilized as the fundamental routing protocol for allowing traffic-agnostical intra-domain path diversity among all source-destination pairs.With MT-IGP routing, customer traffic allotted to different virtual routing topologies (VRTs) follows distinct IGP paths according to the dedicated IGP link weight configurations within each VRT.

Figure 1 describes how path diversity can be reached for S-D pairs in the Point-of-Presence (PoP) level Abilene network topology with three VRTs, by considering as an example from Sunny Vale to ashington. The *i*th number in the bracket related with each data link is the IGP weight.For example, if the link between Kansas City and Houston is highly loaded, some traffic originally carried through the green path (in VRT 1) can be shifted to the other two (i.e. the blue and pink paths in VRTs 2 and 3 respectively) by adjusting the traffic splitting ratio across the three VRTs at Sunny Vale.

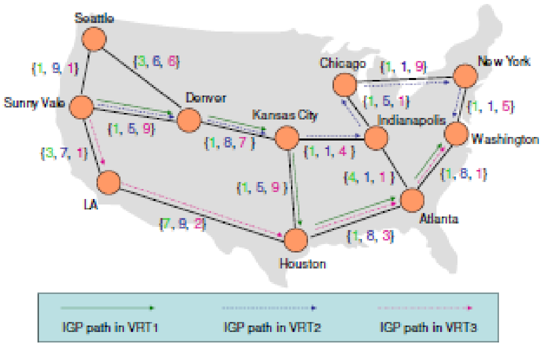

Fig 1:providing path diversity Abliene network topology

The ultimate goal is to intelligently adjust traffic assignment through splitting across multiple routing topologies at individual source PoP nodes in reaction to the monitored traffic conditions. In order to achieve this, the underlying MT-IGP link weights need to be carefully computed offline and set for maximizing path diversity, based on which the adaptive traffic control is performed.

SYSTEM OVERVIEW

Figure 2 shows AMPLE TE system, on Offline MT-IGP Link Weight Optimization (OLWO) and Adaptive Traffic Control (ATC) forming the fundamental parts. The ultimate objective of OLWO is to provision offline maximum intra-domain path diversity in the routing plane, allowing the ATC component to adjust at short timescale the traffic assignment across individual VRTs in the forwarding plane. A salient novelty is that the optimization of the MT-IGP link weights does not rely on the availability of the traffic matrix a priori, which plagues existing offline TE solutions due to the typical inaccuracy of traffic matrix estimations. Instead, our offline link weight optimization is only based on the characteristics of the network itself, i.e. the physical topology. The computed MT-IGP link weights are configured in individual routers and the corresponding IGP paths within each VRT are populated in their local routing information bases (MT-RIBs). While OLWO focuses on static routing configuration in a long timescale (e.g. weekly or monthly), the ATC component provides complementary functionality response to the behavior of traffic that cannot be usually anticipated. to enable short timescale (e.g. hourly) control in response to the behavior of traffic that cannot be usually anticipated.

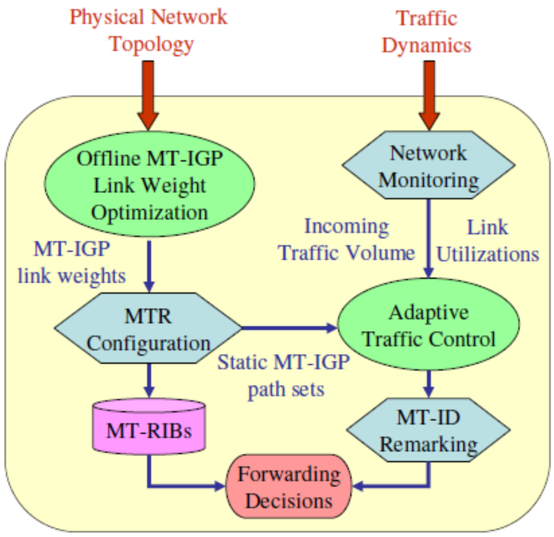

Fig 2:AMPLE overview

As shown in the figure, the input for ATC includes: (1) the diverse MT-IGP paths according to the link weights computed by OLWO, and (2) monitored network and traffic data such as incoming traffic volume and link utilizations. At each short-time interval, ATC computes new traffic splitting ratio across individual VRTs for re-assigning traffic in an optimal way to the diverse IGP 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 (MT-IDs) of their locally originated traffic accordingly. The TE manager function can be realized as a dedicated server, but for robustness and resilience it can be implemented in a distributed replicated manner for avoiding the existence of a single point of failure. In the next section we present the detailed design of individual components in the AMPLE system.

COMPONENT SPECIFICATION

Virtual Traffic Allocation

In this Module, the diverse MT-IGP paths based on the link weights calculated by OLWO. Monitored network and traffic data such as incoming traffic volume and link utilizations. At each short-time period, ATC calculates a new traffic splitting ratio over individual VRTs for transferring traffic in an optimum way to the diverse IGP paths within each S-D pair. This functionality is managed by a centralized TE manager which has complete knowledge of the network topology and periodically assembles 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, which use this configuration for remarking the multi-topology identifiers (MTIDs) of their locally originated traffic accordingly.

Offline Link Weight Optimization

In this module, to decide the definition of "path diversity" within PoPs as traffic engineering. Let us consider the two assumptions of MT-IGP link weight configuration. In the first assumption, extremely diverse paths are available for some Pop-level S-D pairs, although for some other pairs individual paths are totally overlapping on one another over all VRTs. In the second assumption, none of the S-D pairs have disjoint paths, but none of them are totally overlapping either. Obviously, in the first assumption if any "critical" link that is shared through all paths goes congested, its load cannot be relieved via adjustment of traffic splitting ratios at the associated sources, as their traffic will necessarily travel throughout this link regardless of VRT is used. Therefore, scheme targets the second assumption by reaching "equilibrized" path diversity throughout all S-D pairs.

Network Monitoring

In this Module, Network monitoring is responsible for assembling up-to-date traffic conditions in real-time and brings an significant function for the ATC operations. AMPLE acquires a hop-by-hop based monitoring mechanism that is similar to the proposal. The basic idea is that a dedicated monitoring factor deployed at all PoP node is responsible for monitoring:

1. The volume of the traffic developed by the local customers towards other PoPs.

2. The usage of the directly attached inter-PoP links

Adaptive Traffic Control

In this Module, evaluate the incoming traffic volume and the network load for the current interval as compute new traffic splitting ratios at individual PoP source nodes based on the splitting ratio configuration in the previous interval, according to the newly measured traffic demand and the network load for dynamic load balancing.ATC algorithm description by defining the following parameters:

• $t(u,v)$ — traffic from the source PoP node u to the destination PoP node v.

• $\varphi u,v(r)$ — traffic splitting ratio of $t(u,v)$ at u on routing topology r, $0.0 \leq \varphi u,v(r) \leq 1.0$.

We define an iteration counter y which is set initially to zero.

Step 1: Identify the most utilized link $l$max in the network, which can be simply achieved by visiting the updated LL in the TIB.

Step 2: For the set of S-D pairs whose traffic flows are routed through $l$max in *at least one but not all* the routing topologies (i.e. $FDoI = 0$).

consider each one at a time and compute its newtraffic splitting ratio among the VRTs until the first feasible one is identified (see details in the follow-up description). A feasible traffic flow means that, with the new splitting ratios, the utilization of $l$max can be reduced without introducing new hot spots with utilization higher than the original value. To support this operation, all feasible S-D pairs that meet the above requirement are identified from the entry of $l$max in the LL.

Step 3: If such a feasible traffic flow is found, accept the corresponding new splitting ratio adjustment. Increment the counter y by one and go to Step 1 if the maximum K iterations have not been reached (i.e. $y \leq K$). If no feasible traffic flow exists or $y = K$, the algorithm stops and the latest resulting values for the traffic splitting ratio are configured in the corresponding entry in the SPDL in order to be executed by individual source PoP nodes.The parameter K controls the algorithm to repeat at most K iterations in order to avoid long running time. The value of K can be carefully determined by taking into account the trade-off between the TE performance and system complexity. In Step 2, the task is to examine the feasibility of reducing the load of the most utilized link by decreasing the splitting ratios of a traffic flow assigned to the routing topologies that use this link, and shift a proportion of the relevant traffic to alternative paths with lower utilization in other topologies. More specifically, the adjustment works as follows. First, a deviation of the traffic splitting ratio, denoted by δ where $0.0 < \delta \leq 1.0$, is taken out for trial. For the traffic flow $t(u,v)$ under consideration, let $R+$ be the set of routing topologies in which the IGP paths from u to v traverse $l$max. The main idea is to decrease the sum of traffic splitting ratios on all the routing topologies in $R+$ by δ and at the same time to increase the sum of the ratios on other topologies that do not use $l$max by δ. (We denote this set of topologies by $R–$ where $R– = R\backslash R+$.) Specifically, for all the topologies in $R+$, which share a common link with the same (maximum) utilization, their traffic splitting ratios are evenly decreased. Hence, the new traffic splitting ratio for each routing topology in $R+$ becomes:

$$\phi_{u,v}(r)' = \phi_{u,v}(r) - \delta/|R^{+}| \qquad \forall r \in R^{+}$$

On the other hand, let μr be the bottleneck link utilization of the IGP path in routing topology $r \in R–$. To obtain μr, the TE manager should first identify the ID of the bottleneck link along the IGP path between the associated S-D pair from the SDPL, and then refer to the LL to obtain its utilization. The traffic splitting ratio of each routing topology in $R–$ increases in an inverse proportion to its current bottleneck link utilization, i.e.

$$\phi_{u,v}(r)' = \phi_{u,v}(r) + \left(\frac{1-\mu_r}{\sum_{r\in R^-} 1-\mu_r} \times \delta \right) \quad \forall r \in R^-$$

The lower (higher) the bottleneck link utilization, the higher (lower) the traffic splitting ratio will be increased.

EXPERIMENTAL RESULTS

By using AMPLE first we insert the router path between two nodes in the experiment for connection between the router path diversity across network management system.

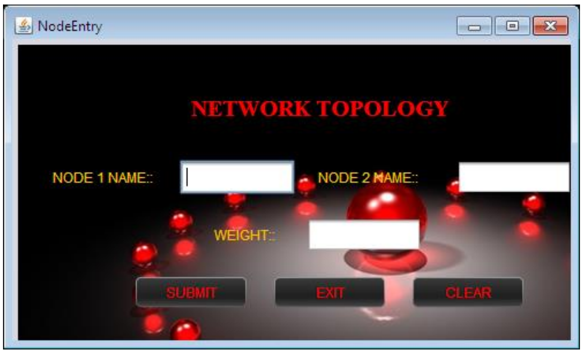

Fig 3:Network topology

In the Network Topology this figure 3 describes about node connection between the two routers across virtual path topologies by assigning optimized weight between two routers in complementory network management system.
Fig 4 depicts the AMPLE TE where it shows the link weights which had been assigned in network topologies.

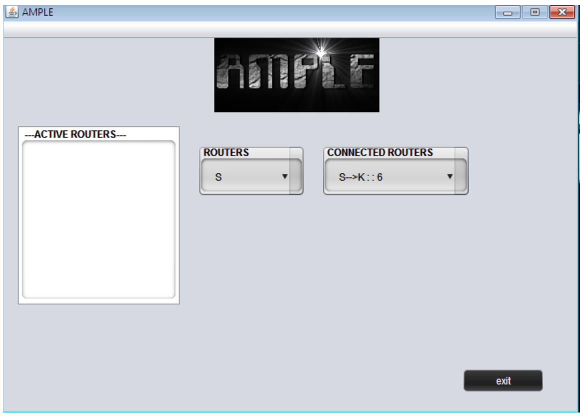

Fig 4:AMPLE TE

The figure describes the node entry which had inserted in routers between the two nodes,where to handle traffic dynamics which weight is properly assigned and transmission of data with short time interval.

CONCLUSION

AMPLE, a novel TE system based on virtualized IGP routing that enables short timescale traffic control against unexpected traffic dynamics using multi topology IGP-based networks. The framework encompasses two major components, namely, Offline Link Weight Optimization (OLWO) and Adaptive Traffic Control (ATC). The OLWO component takes the physical network topology as the input and aims to produce maximum IGP path diversity across multiple routing topologies through the optimized setting of MT-IGP link weights. Based on these diverse paths, the ATC component performs intelligent traffic splitting adjustments across individual routing topologies in reaction to the monitored network dynamics at short timescale. In future work is to consider a holistic TE paradigm based on AMPLE, which is able to simultaneously tackle both traffic and network dynamics, for instance network failures.

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