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Paper Authors

***M.NAGALAKSHMI, S.SUNITHA.**

* Dept of CSE, CVRT.

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ADAPTIVE MULTI-PATH ROUTING FOR INTERNET TRAFFIC ENGINEERING

***M.NAGALAKSHMI,**S.SUNITHA**
*PG Scholar, Dept of CSE, CVRT, AP, India
**Assistant Professor, Dept of CSE, CVRT, AP, India

ABSTRACT

Traffic engineering is a method of optimizing the performance of a telecommunication network by dynamically analysing, predicting and regulating the link utilization over the network. It handles the unexpected traffic dynamics for achieving better quality of service and overall network performance in wireless sensor networks. One of the existing AMPLE (Adaptive Multi-topology traffic Engineering) is an efficient traffic engineering and management system that performs effective routing by using multiple virtualized routing topologies using the components: offline link weight optimization that takes the physical network topology as an input and tries to produce maximum routing path diversity across multiple virtual routing topologies for long term operation through the optimized setting of link weights. Based on these diverse paths, adaptive traffic control performs intelligent traffic splitting across individual routing topologies in reaction to the monitored network dynamics at real time. The proposed multipath routing system offers a promising solution for traffic dynamics in today's networks in an efficient manner by considering the effective link utilization factors in addition to this and concentrated in providing proper analysis in case of node failure in the networks. Simulation is done using NS-2

I. INTRODUCTION

Traffic Engineering (TE) is an essential aspect of contemporary network management. Offline TE approaches aim to optimize network resources in a static manner but require accurate estimation of traffic matrices in order to produce optimized network configurations for long-term operation (a resource provisioning period each time, typically in the order of weeks or even longer). However these approaches often exhibit operational inefficiencies due to frequent and significant traffic dynamics in operational networks. Network monitoring is responsible for collecting up-to- date traffic conditions in real-time plays an important role for supporting the ATC operations. AMPLE adopts a hop-by-hop based monitoring mechanism. The basic idea is that a dedicated monitoring agent deployed at every PoP node is responsible for monitoring: The volume of the traffic originated by the local customers toward other PoPs (intra- PoP traffic is ignored). The utilization of directly attached inter-PoP links is efficient.

II. AMPLE SYSTEM

AMPLE (Adaptive Multi-topology traffic Engineering) is a holistic system based on virtualized IGP routing topologies for dynamic traffic engineering. The

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fundamental idea behind this scheme follows the strategy of offline provisioning of multiple diverse paths in the routing plane and online spreading of the traffic load for dynamic load balancing in the forwarding plane, as advocated. The approach can be briefly described as follows. MT-IGPs are used as the underlying routing protocol for providing traffic-agnostic intra domain path diversity between all source-destination pairs. With MT- IGP routing, customer traffic assigned to different virtual routing topologies (VRTs) follows distinct IGP paths according to the dedicated IGP link weight configurations within each VRT.

A. Example for Providing Path Diversity in the Network

Path diversity generally describes that the source node have multiple routes to reach the destination.Number of paths for a packet to transit between two points Inside an autonomous system network (ISP) Fully link and PoP (Point of Presence) disjoint paths Observed at IP level

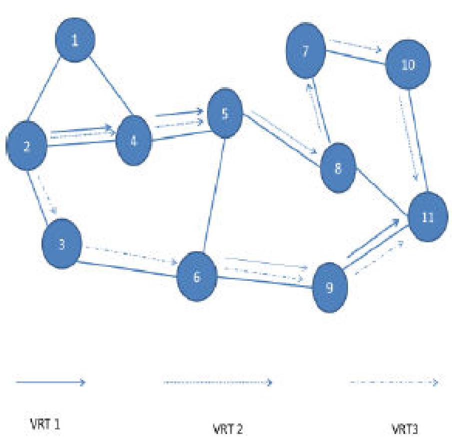

Fig 1 Path diversity in a network

Figure.1 depicts an illustration of how path diversity can be achieved for S-D pairs in the Point-of-Presence (PoP) level in the above network topology with three VRTs, by considering as an example from node1 to node 2. As illustrated in the figure, with each network link assigned distinct IGP link weights in the three VRTs, completely non-overlapping paths can be provisioned between the S-D pair. As such, the key task of the offline configuration is to compute MT-IGP link weights for providing maximum path diversity for every S-D pair.

For example, if the link between node 5 and node 6 is highly loaded, some traffic originally carried through the green path (in VRT 1) can be shifted to the other two (i.e. VRTs 2 and 3, respectively) by adjusting the traffic splitting ratio across the three VRTs at node 2. 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 adaptive traffic control is performed.

III. PROPOSED SYSTEM

B. Construction of network topology

Once the initial topology is constructed, especially when the location of the nodes is random, the administrator has no control over the design of the network. In some dense areas high number of redundant nodes is shown which will increase the number of message collisions and will provide several copies of the same information from similarly located nodes. By modifying these parameters the topology of the network can change.based paradigm works efficiently in a traffic engineering (TE) system with a central manager. The main reason is that new traffic splitting ratios are computed by the TE manager who is able to have the global view of the network to achieve a global optimum in traffic control.

To fulfil the second task, a traffic engineering information base (TIB) is needed by the TE manager to maintain necessary network state based on which new traffic splitting ratios are computed. The structure of our proposed TIB, which consists of two inter-related repositories, namely the Link List (LL) and the S-D Pair List (SDPL). The LL maintains a list of entries for individual network links. Each LL entry records the latest monitored utilization of a link and the involvement of this link in the IGP paths between associated S-D pairs in individual VRTs. More specifically, for each VRT, if the IGP path between an S-D pair includes this link, then the ID of this S-D pair is recorded in the LL entry. It is worth mentioning that this involvement information remains static after the MT-IGP link weights have been configured (static information is presented in black in during each ATC interval, the TIB is updated upon the occurrence of two events.First, upon receiving the link utilization report from the network monitoring component, the TE manager updates the link utilization entry in the LL and the ID of the bottleneck link for each S-D pair under each VRT in SDPL. Second, when the adaptive traffic control phase is completed and the new traffic splitting ratios are computed, the splitting ratio field in SDPL is updated accordingly for each S-D pair under each VRT.ATC is performed based on the up-to-date data maintained in the TIB.

VII. LINK WEIGHT OPTIMIZATION

Intra-domain routing in IP backbone network relies on link state protocols such as OSPF. These protocols associate a weight or cost with each network link and compute traffic routes based on these weights. The proposed method s for selecting link weight largely ignores the issue of failures which arise as part of everyday network operations. Changing link weights during a short- lived failure is impractical.

There are two main goals when setting link weights: keeping end-to-end delay low and ensuring that no link is overloaded. The idea is that this will attract more traffic to high capacity links and less traffic to low capacity links, thereby yielding a good distribution of traffic load. Another common recommendation is to assign a link a weight proportional to its physical length in order to minimize propagation delay.

C. Traffic model

The basic idea of dedicated monitoring agent is deployed at every point of presence (PoP) node which collects up-to- date traffic conditions to support Adaptive Traffic Control (ATC) operations. In a periodic fashion, the central TE manager polls individual monitoring agents within each PoP and collects their locally monitored traffic volume and link utilizations. These statistics are then used by

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the central TE manager for updating its maintained traffic engineering information base (TIB) and computing traffic splitting ratios for the next interval. Such a hop-by-hop ratios are computed by the TE manager who is able to have the global view of the network to achieve a global optimum in traffic control

D. Offline MT-IGP Link Weight Optimization (OLWO) And Adaptive Traffic Control (ATC)

In Offline link weight optimization physical network topology is considered as input and tries to produce maximum routing path diversity across multiple virtual routing topologies for long term operation through the optimized setting of link weights. 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.

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.

While OLWO focuses on static routing configuration in a long timescale, the ATC enable short timescale control in response to the behaviour of traffic. At each short-time interval, ATC computes a new traffic splitting ratio across individual virtual routing technique (VRTs) for reassigning traffic in an optimal way between each source and destination (S-D) pair.

E. Performance evaluation

AMPLE achieve near-optimal network performance with only a small number of routing topologies. Thus dedicated traffic engineering manager is responsible for computing optimized traffic splitting ratios according to its maintained TE information base. The traffic splitting ratio of every node using adaptive traffic control algorithm is calculated.

The link weight optimization is done for estimating the path without traffic and the alternative path is chosen based on adaptive traffic control algorithm. The routing information are maintained in the traffic information base for effective multipath routing Based on the ratio the packets are splitted to its neighbour nodes to control congestion. The QoS parameters like end to end delay, maximum link utilization, packet loss are analysed with the actual and ample system.

IV. FORMATION OF WIRELESS SENSOR NETWORK

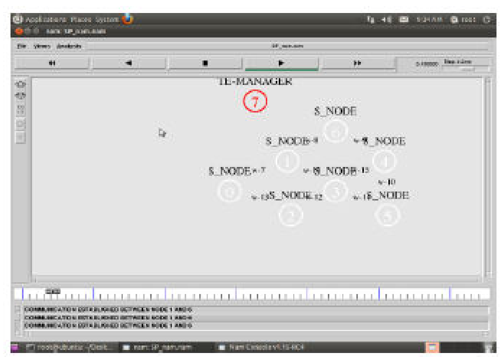

Fig 2 Simulation of sensor network

Fig. 2 wireless sensor nodes are created and all the routing information is sent to the traffic engineering system which maintains the details about all the sensor nodes. After sending all the information about the nodes the path is selected to transfer the packets. If the link is overloaded the loss of packets will occur and then it is denoted as high traffic in the selected path so the alternate path is chosen from the multipath which is already chosen. The link weight optimization is done for

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estimating the path without traffic and the alternative path is chosen based on adaptive traffic control algorithm. The routing information are maintained in the traffic information base for effective multipath routing

V. AMPLE SYSTEM OVERVIEW

The proposed AMPLE TE system, with Offline MT-IGP Link Weight Optimization (OLWO) and Adaptive Traffic Control (ATC) constituting the key components. As previously mentioned, 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. 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). The input for ATC includes:

• The diverse MT-IGP paths according to the link weights computed by OLWO.

• Monitored network and traffic data such as incoming traffic volume and link utilization

VI. COMPONENTS OF PROPOSED SYSTEM

Offline link weight optimization

This 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

Adaptive traffic control

Performs intelligent traffic splitting across individual routing topologies in reaction to the monitored network dynamics at short timescale. The link weight optimization is done

for estimating the path without traffic and the alternative path is chosen based on adaptive traffic control algorithm. The routing information are maintained in the traffic information base for effective multipath routing

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timescale. In the second case, none of the S-

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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. Toward this end, we define the binary metric of Full Degree of Involvement (FDoI) to evaluate the overall path diversity for a given MT-IGP link weight configuration. More specifically, the FDoI value for a link with respect to an S- D pair is set to 1 if this link is shared by the shortest IGP paths across all VRTs for that S-D pair; otherwise it is set to 0. Let's take Fig. 1 as an example again. The FDoI value for the link from node 2 to node 3with regard to the S-D pair (node 1, node 3) is 1,as this link is part of all the shortest IGP paths between node 1 and node 3 across the three VRTs .In comparison, the FDoI value for the same link with regard to the S-D pair (node 2, node 11) is 0, as alternate routes are available via node 4 in other VRTs. The optimization objective of OLWO is to minimize the sum of FDoI values across all network links with regard to all S-D pairs.

If this sum is equal to 0, then no critical link is formed given the underlying MT-IGP link weights, which means that at least one source in the network will always be able to find alternative path(s) to bypass the over-loaded link given any single link congestion scenario. Our solution is based on an offline optimization algorithm for maximizing path diversity across multiple VRTs.

G. Adaptive Traffic Control

Given the optimized MT-IGP link weights produced by OLWO, adaptive traffic control (ATC) can be invoked at short-time intervals during operation in order to re-optimize the utilization of network resources in reaction to traffic dynamics. The optimization objective of ATC is to minimize the maximum link utilization (MLU), which is defined as the highest utilization among all the links in the network. In this section, we present a lightweight but efficient algorithm that can be applied for adaptive adjustment of the traffic splitting ratio at individual PoP source nodes to achieve this goal. In a periodic fashion, the following two operations are performed:

- Measure the incoming traffic volume and the network load for the current interval as described in the previous section.
- 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.

A drawback of most current approaches is that they view the link weight assignment problem as a static problem largely ignoring network dynamics. However in practice, one of the main challenges of a network operator is to deal with link failures that are encountered on a daily basis in large IP backbones. When a link fails, IS-IS/OSPF routing diverts the traffic over that link to alternate paths, increasing the load of or more of the other links. The most obvious way of restoring the network to its original traffic engineering objectives is to perform a network-wide recomputation and reassignment of link weights.

VIII. SIMULATION RESULTS

The wireless sensor network is simulated and the packets are transferred between the nodes are shown below. The information of each

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node is maintained in TE manager. If the traffic or maximum load is there in the estimated path then the packets will choose the alternative path based on maximum link utilization to communicate with in the network

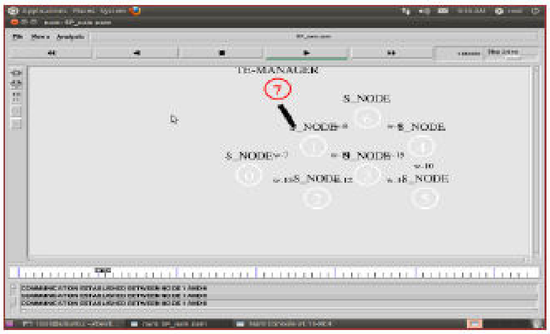

Fig 3 Routing information of each node is maintained by the TE manager

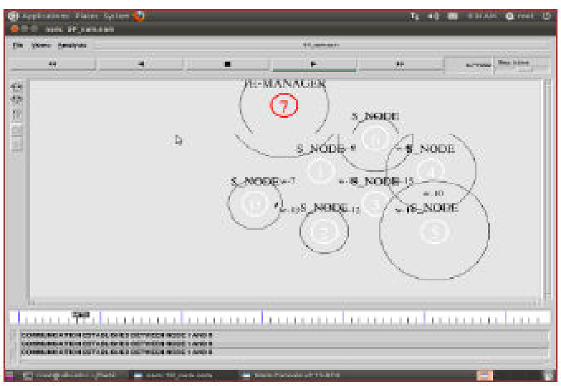

Fig 4 Packet transfer is done between the nodes

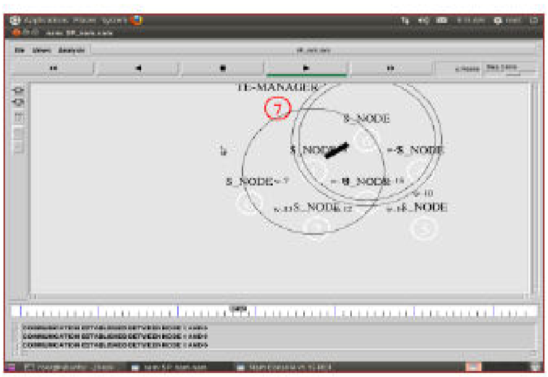

Fig 5 Packet transfer between the source node 1 and the destination node 6

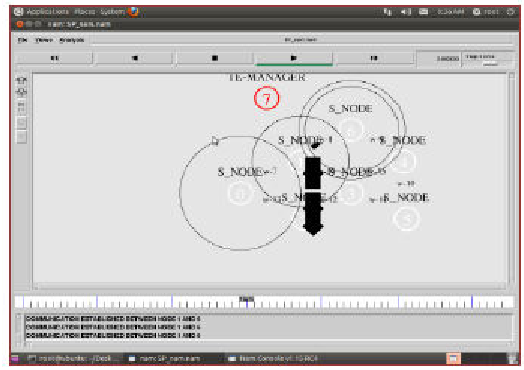

Fig 6 Drop of packets due to maximum traffic flow between source and destination

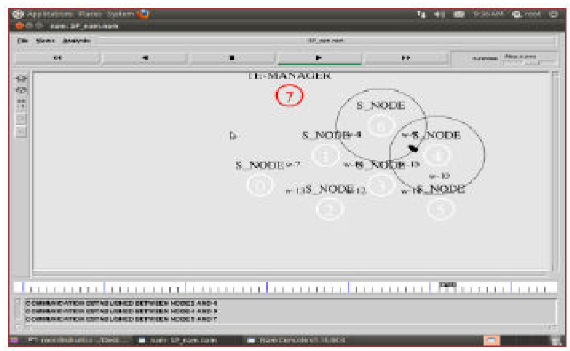

Fig 7 Alternate path is chosen for effective packet transfer

IX. CONCLUSION

After presenting the detailed information on individual components, we now briefly describe how they work in unison as a whole TE system. First, optimized MT-IGP link weights are configured on top of the underlying MT-IGP platform and remain static until the next offline OWLO cycle. During this period, ATC plays the major role for adaptively re-balancing the load according to the traffic dynamics in short-time intervals. As a bootstrap procedure, the initial traffic splitting is evenly distributed across VRTs, but this will be recomputed based on follow-up traffic monitoring results. The TE manager accordingly updates the traffic volume between each S-D pair in the SDPL and link utilization information stored in the LL of the TIB. According to the obtained link utilization information the alternate path is chosen for the packet transfer from the source node to the destination node. In future this AMPLE system is enhanced by analysing the Qos parameters like packet loss, delay, maximum link utilization.

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