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RESEARCH ARTICLE

TEPG: a traffic engineering based power-aware greedy routing algorithm in backbone networks with bundled links

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Appendix

Intuitions for each step of Algorithm TEPG are elaborated as follows.

We split TEPG into two parts: the Hop-by-hop greedy routing stage (HHR) and the Traffic Assignment stage inside the Bundled links (TAB). The intuition is to achieve a power-aware routing among the BLs at HHR stage and a further power-saving traffic assignment inside each BL at TAB stage.

1 HHR stage

HHR is divided into two stages: (i) an Available Capacity of Neighbor Nodes based hop-by-hop routing stage (ACNN) and (ii) a Greedy Pruning stage (GP). The intuition is that two stage correspond to a green TE-based routing process and a greedy pruning process respectively.

1.1 ACNN stage

In this stage, we try to power off as many network components as possible to obtain the smallest network sub-graph sufficient to route all the traffic demands. The intuition is that an exquisite initial solution can reduce the computational overhead as much as possible at the following stages. For each next hop node, we select the node with the minimum available capacity to route traffic in all the neighbor nodes of the current hop node. The intuition is that similar to the bin-packing problem, traffic aggregated to a minimum available capacity of neighbor node can avoid the waste of energy and unnecessary state switching caused by awakening a cable, a BL or even a node to accommodate the incoming traffic.

1.2 Greedy Pruning (GP)

In the stage, we prune the unnecessary powered-on network elements on the basis of ACNN stage and acquire further energy savings. We sort nodes and links according to four combined node-link sorting criteria, and then try to switch off as many nodes and links as possible in this order. The stage is, once for each combined node-link sorting criterion, run four times. The intuitions are that pruning can acquire a solution with the smallest energy consumption by considering different sorting criteria comprehensively, and nodes are firstly considered to be powered off due to the energy saving achieved by switching off nodes is higher than by switching off links.

2 Traffic Assignment stage inside the BLs (TAB)

In the stage, we try to achieve a further energy saving by investigating how to assign traffic flowing through a

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BL among the cables reasonably in the stage. We aim to seek a traffic assignment solution among the cables to accommodate traffic demands carried on them and make power consumption minimum for each link. The intuition is that a smallest cables set to transmit traffic in each BL can be found by adopting water-filling algorithm.