

Toward a New Route Control Model for Multidomain Optical Networks

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ABSTRACT

Numerous questions remain unanswered as designers work to perfect the control plane model for multidomain optical networks. Optical Border Gateway Protocol (OBGP) is an extension of BGP that has been suggested by certain projects to facilitate the advertising and signaling of optical information across routing domains. We contend, however, that optical networks of the future provide a chance to circumvent BGP's restrictions, particularly in the areas of routing and traffic engineering. Here, we provide an alternative to BGP/OBGP for route control. Extensive simulations validate our route control model's ability to significantly lessen blocking compared to OBGP, without increasing the volume or frequency of inter-domain routing updates.

INTRODUCTION

In the future, clients won't have to commit to a whole year or even a single month of capacity allotment in advance. Instead, providers will have to provide real-time, short-term (hours or minutes) ad hoc optical connections between nodes (for redundancy purposes, for example). It is difficult to meet these needs within the context of a multidomain optical network. The Optical Border Gateway Protocol (OBGP) is being considered by certain academics as a potential interdomain routing protocol for optical networks of the future [1-3]. The proposed changes are made to BGP [4] with the intention of enabling it to carry and communicate optical information between OBGP neighbours. The power of this method lies in the fact that optical networks will reap the benefits of the BGP-based route control architecture (such as its tried-and-true scalability). However, the routing model will share the same shortcomings as BGP, such as:

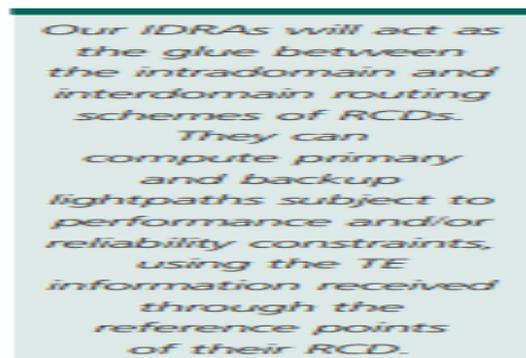
- The inability to effectively communicate and exploit traffic engineering (TE) information
- Inability to use multipath routing
- Convergence and chattiness that are too slow, preventing network problems from being identified and fixed quickly.

In a nutshell, we contend that the present BGP and OBGP multidomain routing models, which are primarily focused on the sharing of network reachability information (NRI), will not be enough. In addition to NRI, it is now generally acknowledged that next-generation optical networks would also need the ability for nearby domains to share PSI. We argue in favour of a shift, with a focus on taking inspiration from BGP while

avoiding its flaws. Particularly, research into the design of a distributed control plane that can aggregate PSI computation, communication, and efficient use is required in a multidomain environment. Here we provide a novel paradigm for multidomain optical networks that integrates inter-domain routing with TE management. We outline its structure and the inter-domain NRI and PSI communications that make it possible. Our concept does not aim to enhance BGP or OBGP but rather to replace them with a new method. In addition, we provide a routing and wave length assignment (RWA) technique that efficiently computes interdomain light pathways by using the NRI and PSI.

MODEL FOR REVISING ROUTING CONTROLS

Our control plane is completely decoupled and distributed to support our multidomain approach of route control. Separating the control and data planes involves using separate circuits to physically link the control plane nodes together. In the past, separation of this sort has been used by other highly scalable and successful networks as Sig-



Our IDRAs will act as the glue between the intradomain and interdomain routing schemes of RCDs. They can compute primary and backup lightpaths subject to performance and/or reliability constraints, using the TE information received through the reference points of their RCD.

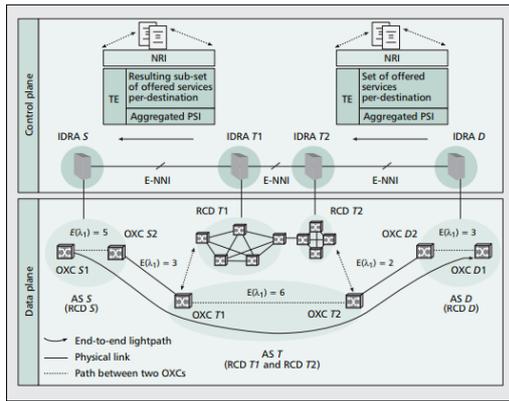


Figure 1. Architecture of the IDRA-based routing and TE control model.

Communication System 7 (NS7) nailing. It will be useful in the future to have separate fibers and nodes for transmitting routing and signalling data between RCDs. This method takes use of the trend toward increasingly complicated and trustworthy routing and TE control models, where the key is relieving traffic forwarders of the responsibility of transmitting control information and executing complex calculations based on it.

THE STRUCTURE FOR MANAGING TRAVEL PATHS

Interdomain Routing Agents (IDRAs) [6] are the components of our route control concept. For example, Fig. 1 depicts a source domain S, a destination domain D, and a transit provider T that is divided into two RCDs, T1 and T2, respectively. IDRAs have a dual function in the system. They are responsible, on the one hand, for relaying routing and signalling data between RCDs. But they also have a distributed responsibility for calculating and deploying interdomain light paths, much like the path computation element (PCE) model [7]. However, BGP/OBGP is absent in the case of IDRAs, which is a major difference between the IDRA-based and PCE-based route control models. Our IDRAs will connect RCDs' internal and external routing protocols. Using the TE data acquired via the RCD's reference points, they can calculate primary and backup light paths that adhere to performance and/or reliability constraints. The user-network interface (UNI), the internal network-network interface (I-NNI), and the external network-network interface (E-NNI) are the three standardized interfaces used to link optical networks, and each is represented by a reference point. In particular, the E-NNI facilitates communication and signalling between RCDs, either inside the same AS or beyond AS boundaries. Policies governing information sharing through E-NNIs govern the degree to which resources inside each RCD are publicly visible.

A MODEL FOR THE EXCHANGE OF DATA BETWEEN ROUTING AND TE

There are three steps required to set up an interdomain light path: routing, signalling, and initialization. To identify a route between the local optical node making the request and the destination node, the IDRA in the source domain leverages the information advertised by nearby IDRAs during the routing phase. In step two, the IDRA at the source communicates with the IDRAs of the RCDs along the route selected. In the third stage, the light path is set up; specifically, the IDRA at each RCD along the route is responsible for laying out the section of the route that passes through its RCD. The IDRAs' advertising includes the standard NRI as well as TE information, which includes PSI and the suite of services provided by the RCDs along a route (Fig. 1). When composing ads, IDRAs factor in the status of both the intradomain and interdomain portions of the path when aggregating PSI. The services' purpose is to allow RCDs in the route control model to communicate using more sophisticated TE data formats. For certain destinations, an RCD may promote wavelength conversion, while for others it may promote multichip traffic grooming. The optimum route to a location may be determined in our model by an IDRA based on a number of service needs, the PSI along candidate routes, or a combination of the two.

REACHABILITY DATA FOR NETWORKS

For the sake of clarity, we assume that the optical cross-connects (OXCs) do not conduct wavelength conversion, which means that the wavelength continuity requirement applies to every light path calculated by the IDRAs. Each domain may choose which wavelengths can be utilized to connect to its local networks based on its own TE and routing regulations. Within this architecture, the data an IDRA includes in its NRI messages consists of: • The last resting place(s). • The NH to go to those locations (the address of the ingress OXC in the RCD where the advertising was broadcast). Since an OXC destination could be connected via multiple fibers, we need to store the following: • A set of pairs (I, Mi) for each destination, where I denotes a specific wavelength, I denotes the wavelength's identifier, and Mi denotes the maximum multiplicity adverb tied for I. The NRI messages are instantly triggered by an IDRA if a new destination becomes available or an existing one becomes unavailable. In contrast to BGP, IDRAs do not include the AS-path to a destination in the NRI they share with one another. In our paradigm, the IDRAs utilize the TE information in the routing advertising to compare routes rather

than comparing routes based on the length of the AS-path. Light path length is a major factor in how well the RWA technique used by the IDRA performs, hence it is included in the PSI messages that are sent between the IDRA. Another key distinction between BGP and the IDRA-based approach is that IDRA may advertise numerous routes per destination, even with the same NH address, but BGP can only advertise the "best" route.

CONDITIONS OF THE PATH

Each intradomain sub path is abstracted as a single hop, and the routes advertised by the IDRA are made up of this collection of loose hops; this is done to maintain anonymity across RCD borders and to enable loop-free pathways. IDRA T1 in Fig. 1 informs IDRA S about the route P(T1, D1), complete with a list of hops that are not required: OXC

$$T1 \rightarrow OXC T2 \rightarrow OXC D2 \rightarrow OXC D1.$$

The PSI is made up of aggregated wavelength availability and aggregated load information, and it is associated with each route promoted by the IDRA. Here, we provide a straightforward method in which both totals are whole numbers. In order to promote PSI messages, IDRA collect and organize the following three types of data: Downstream domains' PSI and PSI associated with interdomain linkages • The aggregated PSI seen in downstream domains' interdomain ads We then go on to detail how this operation is carried out. Availability of Pooled Wavelengths Knowledge — As can be seen in Fig. 2a, the effective number of available wavelengths (ENAW) of type I between any two OXCs inside an RCD is calculated by the local IDRA. There are two possible routes between OXC 1 and OXC 4 in this case. The total number of type I wavelengths on each connection is also shown in Figure 2a. Between OXC 1 and OXC 4, the maximum number of wavelengths I that may be utilized along the route that passes via OXC 2 is 3. This is because there are only three possible light pathways from OXC 1 to OXC 4 through OXC 2. Similarly, there is a maximum of one wavelength I that may be utilized to go from OXC 1 to OXC 4 through the route that passes via OXC 5. An IDRA determines the ENAW I between OXC 1 and OXC 4 as the greater of the two values (i.e., $E_{1,4}(I) = 3$). Keeping the minimal number of accessible wavelengths on the links of a candidate route and then computing the maximum across all candidates is all that's required to compute the ENAW. Between two border OXCs in a transit domain, the ENAW is crucial because it "conservatively" captures the practical availability of wavelength I inside the domain. As an integer, it also provides highly aggregated state information, making it the

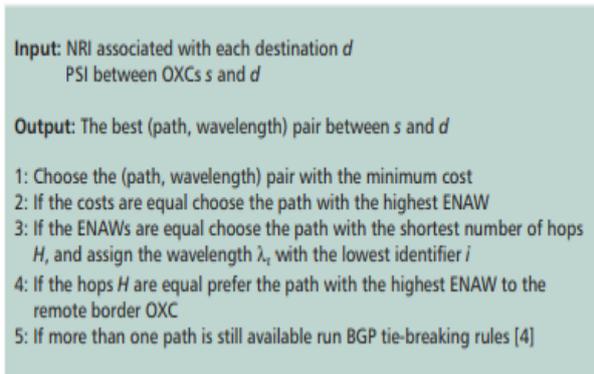
most integral part of a PSI aggregate's wavelength availability component. For the interdomain part, each IDRA knows which wavelengths are in use on its interdomain connections and, through PSI advertising from neighbouring IDRA, which wavelengths are available downstream.

THE RWA APPROACH

OBGP makes use of multiprotocol BGP extensions and expanded communities to encode and broadcast optical data. On the other hand, because OBGP's routing algorithm is similar to BGP's, it will often choose the light path that passes via the fewest ASs. OBGP, like BGP, may be used to exchange NRI, but it cannot process PSI. Although it is now simple to recognize this gap in the routing models provided by BGP/OBGP, filling it without increasing the volume or frequency of routing messages exchanged between domains is a formidable challenge that requires novel solutions. In this piece, we provide a straightforward solution to the issue at hand. IDRA, like BGP routers, use Keepalive messages to confirm that their nearby IDRA's processing modules (i.e., electrical and software modules) are still functional. It's important to remember that nearby IDRA are hardwired together, making it possible to discover and fix optical layer faults much more quickly than via the transmission of Keepalive signals. Keepalive messages in BGP always consist just of the 19-byte BGP header and no further data. To ensure that PSI is only updated, when necessary, our methodology expands on the Keepalive notion. Light path selection is shown in a simplified form in Fig. 3 (for clarity, we simply depict the selection of a single route). As can be seen in Figure 3, the IDRA select minimum-cost paths (step 1). If multiple paths exhibit the same (minimal) cost, the IDRA break the tie by determining which path has the highest ENAW along the candidate paths, then by determining which path has the fewest hops (H), and finally by taking the same steps as BGP.

EVALUATION OF PERFORMANCE

The purpose of this subsection is to evaluate IDRA versus OBGP in terms of route control model performance. Our focus will be on analysing the



■ Figure 3. IDRA RWA decision process.

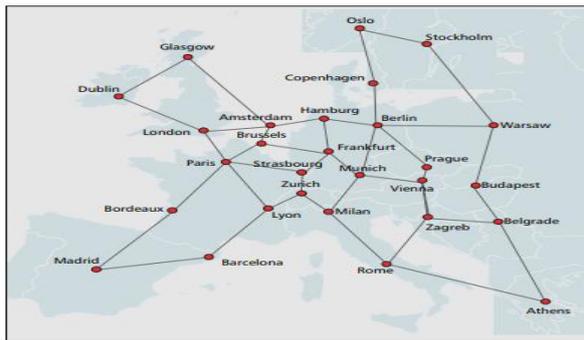


Figure 4. Pan-European reference network topology

percentage of routing messages issued to prevent light path requests made over domain boundaries (BR). To this goal, we have used OPNET to run several simulations. Fig. 4 depicts the trial setup that was decided upon. Reference topology for a pan-European fibre optic network, proposed in [9]. The nodes were selected in [9] to represent some of the most important Internet exchange locations in Europe, and the network consists of 28 domains and 41 interdomain linkages. There has been a rise in the usage of this sample topology during the last several years as a benchmark for computer-based simulations. We have constructed 10 alternative possible topologies within each area. We've selected 10 distinct configurations for each of the 10 hypothetical situations by randomly putting 18 sources and 10 destinations throughout the whole European network, one in each domain. This gives us a total of one hundred permutations to use in our experiments. The shown findings are the mean values for the BR and the total number of routing messages exchanged throughout the simulation's execution period across all 100 parameters. In our pan-European network, we deployed a total of 5,300 fibers at a rate of 12 wavelengths per fiber. We have utilized varying Keepalive update intervals (KT) to evaluate how often the PSI is updated. By default, BGP nodes have a Keepalive value of 60 seconds, and if a node loses three consecutive Keepalive signals, it will terminate the BGP connection. Throughout the duration of the simulation, we have tried out three different scaled

and normalized values: $KT = 1$, $KT = 3$, and $KT = 5$ units. Obviously, the IDRA needs more time to detect and react when the electrical or software modules of a neighboring IDRA become inoperative the higher the values of KT . Therefore, low values of KT are desired both to increase the responsiveness between neighbouring IDRA and to support updating PSI more frequently; this is a significant benefit of transmitting PSI via Keepalive messages.

CONCLUSIONS

In this article, we've argued in favour of the chance to make a change afforded by future optical networking, and we've taken the first step toward this goal by proposing and testing a route control model that is distinct from BGP/OBGP. Our model's simplicity is one of its main benefits. It makes advantage of some of BGP/OBGP's features and easily integrates highly aggregated PSI as two integer values, and it is constructed using standard networking procedures. The suggested route control paradigm is simple, but it significantly reduces the blocking seen with OBGP. This is accomplished without increasing the number of routing messages sent beyond what is already required. In reality, by decreasing the blockage, it is feasible to decrease the exchange of network reachability messages and path explorations when blocking occurs, resulting in less routing messages being shared between domains thanks to our technique. These results show promise, but additional investigation in this area is required. First, our findings and interpretations only apply to a very constrained multidomain optical situation (the pan-European reference network shown in Fig. 4), therefore more research is required to evaluate the efficacy of the suggestions presented here in a more general setting. Second, we must investigate the possible influence of wavelength conversion, especially when the conversion is conducted at domain borders, since our findings were obtained under the wavelength continuity restriction. Finally, the incorporation of NRI and PSI exchange at the I-NNI and E-NNI interfaces will necessitate efforts toward standardization.

REFERENCES

- [1] M. Blanchet, F. Parent, and B. St-Arnaud, "Optical BGP (OBGP): Inters Lightpath Provisioning," IETF draft, ietfdraft-parent-obgp-01, Mar. 2001.
- [2] M. J. Francisco et al., "End-To-End Signaling and Routing for Optical IP Networks," Proc. IEEE ICC, New York, NY, Apr. 2002.
- [3] L. Wang, H. Zhang, and L. Zheng, "Reducing the OBGP Protection Switching Time in WDM Mesh Networks," Proc. OFC, Anaheim, CA, Mar. 2006.
- [4] Y. Rekhter, T. Li, and S. Hares, "A Border Gateway Protocol 4 (BGP-4)," IETF RFC 4271, Jan. 2006.

[5] G. Liu, C. Ji, and V. Chan, "On the Scalability of Network Management Information for Inter-Domain LightPath Assessment," *IEEE/ACM Trans. Networking*, vol. 13, no. 1, Feb. 2005.

[6] M. Yannuzzi et al., "Interdomain RWA based on Stochastic Estimation Methods and Adaptive Filtering for Optical Networks," *Proc. GLOBECOM '06, San Francisco, CA, Nov./Dec. 2006*.

[7] A. Farrel, J. P. Vasseur, and J. Ash, "A Path Computation Element (PCE)-Based Architecture," *IETF RFC 4655*, Aug. 2006.

[8] M. Yannuzzi, *Strategies for Internet Route Control: Past, Present, and Future*, Doctoral thesis, Tech. Univ. of Catalonia, Spain, 2007.

[9] S. De Maesschalck et al., "Pan-European Optical Transport Networks: An Availability-Based Comparison," *Photonic Network Commun.*, Springer, vol. 5, no. 3, May 2003, pp. 203–25.

[10] NOBEL: Next Generation Optical Networks for Broadband European Leadership, IST Integrated Project (FP6- 506760), <http://www.ist-nobel.org/>