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On Bandwidth on Demand Problem

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In recent years there is a trend in a backbone traffic growth between Data Centers (DC). According to TeleGeography on the most demanded route across the Atlantic ocean, by the end of 2017 the share of such traffic had reached 75%, and in 2023 it will exceed 93%. It can be explained by the development of the global cloud service market, which is currently concentrated in North America and Europe. Therefore the traffic growth between DC is provided mainly by the DCs of cloud providers, as well as enterprise DC that use hybrid clouds.

But cloud DC impose special requirements on channel bandwidth allocation and charging policy. The most promising approach to satisfy these requirements is to provide the channel bandwidth on the model "pay and go"- only when there is a need in it, i.e. the bandwidth on demand. Having a high penetration of SDN and NFV technologies within DC, cloud providers and their enterprise customers impose requirements on the SDN and NFV technologies implementation for backbone networks allowing bandwidth on demand (BoD service) to balance the computational load and to carry out the data migration between DCs.

In this paper we consider the possible protocols and technologies on different OSI Reference model levels that can help with the implementation of bandwidth on demand. On the transport and network level we can engage multipath protocols that allow the data transmission through several routes simultaneously (we will call data flows on different routes as subflows). There are two schemes of such route generation: static and dynamic. In static route generation scheme there is always the same number of used routes. We will note the drawbacks of such approach that show favour to dynamic scheme when the routes are allocated dynamically in dependence of current network load and bandwidth requirements.

Also we discuss the balancing techniques (Equal Cost Multi-Path (ECMP), Ethernet VPN (EVPN), Link Aggregation Group (LAG)), that allow to route different transport flows through different disjoint channels. It can give an advantage when used together with multipath protocols.

We also present the mathematical problem statement for the bandwidth on demand problem and considering this problem in relation to the optical transport network (OTN). The main issue here is that optical network is a channel switching network whereas OSI Reference model was developed for packet switching network. We assume that optical network contains Reconfigurable Optical Add-Drop Multiplexors (ROADM) to offer the flexibility to add wavelengths or easily change their destination. In addition, they can be managed remotely, providing full control and monitoring over the entire high capacity infrastructure. To implement bandwidth on demand, the network providers should maintain the certain level of bandwidth reservation. In this paper we wouldn't consider the problem of reservation size selection and would assume that required bandwidth is always available for clients. With such assumption and Menger's theorem we can deduce the number of wavelength that is needed to the data transfer with a given bandwidth requirement.

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