Software-Defined Network (SDN) Use Case for Bandwidth on Demand Applications

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Abstract

Service providers and enterprises are increasingly offering services
and applications from data centers. Subsequently, data centers
originate significant amount of network traffic. Without proper
network provisioning, user applications and services are subject to
congestion and delay.

In this document, we argue the necessity in providing network
information to the applications, and thereby enabling the
applications to directly provision network edge devices and relevant
applications.

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1. Introduction

Bandwidth on Demand services are offered by network operators in industry and research sectors to support the needs of selected customers needing high point-to-point bandwidth connections. Such services take advantage of dynamic control of the underlying network to set up forwarding and resource allocation as requested by the customer. Some control is given directly to the customer via a portal so that there is no need to go through an intermediate stage of service order provisioning on the part of the network operator.

Currently such services are often based on management interfaces to vendor equipment that are vendor-specific, and as a result the operator must redesign its supporting control application for each vendor domain, or limit their offering to a single vendor domain.

In this document, we propose that providing a common interface to networks of different vendors and technologies would enable the network provider to offer Bandwidth on Demand services that are more widely deployable, less complex to develop and capable of offering more sophisticated features, using additional network information.

Here are some of the conventions used in this document. The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC-2119 [RFC2119].

3. Related Work

There has been much work in this area in recent years.
OpenFlow has defined an architecture for offering virtualized network control through a centralized controller and proxies called FlowVisors. These allow users to configure forwarding of packets within slices of the network partitioned off for their use. The controller is designed to control each network element directly through a dedicated control interface. It is not designed to work with existing control plane protocols.

More generally, TMF has developed models and interfaces for operations and administration of networks through the north-bound interface provided by the element management system. These interfaces are not intended for real-time control of the network element and need to take into account variations in the design and features of different types of equipment.

PCE is a client-server protocol that operates in MPLS networks that enables the network operators to compute and potentially provision optimal point-to-point and point-to-multipoint connections. However, PCE does not interface with applications to optimize traffic from user applications.

4. Problem Definition

Figure 1 illustrates the relationship between application and network today, where customer control of bandwidth on demand is provided through applications created by the network operator supporting the user interface, features and backend accounting for the service. Such applications are used in single domain deployments and have limited visibility of underlying networks and resource availability.

```
+-------------+                  +-------------+
| Application |                  | Application |
| #1          |                  | #2          |
+-------------+                  +-------------+

|                                |
|                                |
+------------------+            +------------------+
|  Network         |            | Network          |
|  Domain #1       |            |   Domain #2      |
+------------------+            +------------------+
```

Figure 1: Application to network relationship today
This presents a number of challenges and problems. Without a standard interface to the network domain and its control plane, each bandwidth on demand supporting application must be built for a specific set of vendor equipment and is not easily generalizable to different vendors or even different equipment offered by a single vendor. While signaling interfaces such as the UNI could offer standardized access to network control, such interfaces have not been adopted because they provide minimal security and functionality and are designed for more of a peer relationship between network elements.

Similarly, bandwidth on demand applications must be designed for a single technology, which restricts the range of use and potential users. If Domain #1 uses SDH, for example, and Domain #2 uses OTN it may be necessary to design supporting Application #2 from scratch even though Application #1 has been successfully offering service. Ideally the interface should allow some level of technology independence, as well as potentially integration of control of multiple layers (esp. packet and circuit).

Third, the application is generally limited to simple services connecting a source to destination, because interfaces hide network topology and do not allow visualization of the topology for different customer views. For some services users may wish to exercise control over path routing aspects such as shared risk, or inclusion or exclusion of areas for policy reasons.
5. The Role of an SDN Layer

To solve the above problem, the proposal is to introduce a software-driven network (SDN) layer (as shown in Figure 2), that is responsible for network virtualization, programmability and monitoring, between supporting applications and the network.

![Diagram of Application to network relationship for SDN](image)

The purpose of the SDN Layer is to enable the applications supporting bandwidth on demand services to access information about and control traffic flows at the network layer through a standard, secure and customizable interface. Applications can visualize the traffic flows at the network layer, and manage the mapping or binding between user traffic flows to the network connections from the edge of the networks.

The implementation of an SDN Layer involves interfacing among different types of applications and different types of network domains, based on technology or vendor, administrative or policy control. Standardized interfaces must be defined to support this.
For the architecture to be useful for existing technologies as well as new, it should be capable of interworking with existing forms of network control plane as well as potential new control structures for networks, such as OpenFlow. The focus should be on providing richer access to network resources as opposed to redesigning network control itself.

5. Use Cases

5.1. Scheduled/ Dynamic Bandwidth On-Demand Service

Figure 3 illustrates flow in a scheduled or dynamic bandwidth service. In the simplest case, connectivity may already be provided between user-specified endpoints, however the bandwidth allocated between endpoints can be varied within some overall limit based on predefined schedule or on spontaneous customer request.

In more sophisticated services, the customer may be allowed to create new connections within a specified set of endpoints and delete such connections when the connectivity is no longer required.

User

Req’s +------------+
-------| Controller |
+--------+

\|/

+------ PE1 +------ PE2 +------

==== Provisioned Connection ===>

Figure 3: Scheduled/Dynamic BoD Service
5.2. Multi-Layer BoD Support

Figure 4 illustrates a BoD service that supports multi-layer network control. This extends allows the network operator’s supporting applications to control mapping of end user packet flows onto an underlying circuit-based transport network to support high speed bandwidth on demand service. Different transport network technologies may be used to provide the server layer transport functions so that the application can evolve easily with new transport technologies.

5.3. Virtualized Network Service

Figure 5 illustrates flow in a virtualized network service that offers some degree of topology visibility and control in addition to the features of scheduled or dynamic BoD. For some customers it may be desirable to provide tailored visibility into the topology of the resources they control, in order for the customer to put into effect their own routing of traffic within their dedicated domain.
At this time such visibility is not possible to provide, as protocols provide either no visibility into topology or full visibility into topology. For security reasons it is likely that a supporting network operator will want to limit visibility and control to some virtualized topology.
6. Security Considerations

7. IANA Considerations

This document has no actions for IANA.

8. Normative References


10. Acknowledgments

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