ACTN BOF
Internet-Draft
Intended status: Informational
Expires: August 18, 2014

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February 14, 2014

Packet Optical Integration (POI) Use Cases for Abstraction and Control of Transport Networks (ACTN)
draft-dhody-actn-poi-use-case-01

Abstract

This document describes the Abstraction and Control of Transport Networks (ACTN) use cases related to Packet and Optical Integration (POI), that may be potentially deployed in various transport networks and apply to different applications.

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1. Introduction

The transport networks are in an unique position to embrace the concepts of software defined networking (SDN) because of the existing separation in control and forwarding plane via GMPLS/ASON. The path computation element (PCE) [RFC4655] and its stateful extension [STATEFUL-PCE] can further provide a central control over the resources. Abstraction and Control of Transport Network (ACTN) is focused on building over the existing blocks by adding programmability, access and control over abstract virtual topologies. [ACTN-PROBLEM] and [ACTN-FWK] provides detailed information regarding this work. Further [ACTN-USECASE] describe the overall use-cases for ACTN. This document focuses on the Packet and Optical Integration (POI) use cases of ACTN.

It is preferable to coordinate network resource control and utilization rather than controlling and optimizing resources at each network layer (packet and optical transport network) independently. This facilitates network efficiency and network automation.

In a multi-layer network via client and server networking roles, Label Switched Paths (LSPs) in a server (lower) layer are used to carry client (higher) layer LSPs across the server (lower) layer

network. Basic Packet and Optical Integration (POI) may be achieved by some of the existing mechanism as specified in [RFC4208] and [RFC5623]. This document explores the POI use cases of ACTN to help provide programmable network services like orchestration, access to abstract topology and control over the resources.

Increasingly there is a need for packet and optical transport networks to work together to provide accelerated services. Transport networks can provide useful information to the packet network allowing it to make intelligent decisions and control its allocated resources. In this POI use-case, we regard packet networks as a customer to transport networks. It is interesting to note that the Packet networks themselves may have their ultimate clients to support. The use case described in this document are primarily concerned with 'packet network as a customer' in a single trusted domain.

1.1. Requirements Language

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 [RFC2119].

2. Terminology

The following terminology is used in this document.

ACTN: Abstraction and Control of Transport Networks.

PCE: Path Computation Element. An entity (component, application, or network node) that is capable of computing a network path or route based on a network graph and applying computational constraints.

POI: Packet and Optical Integration

VNTM: Virtual Network Topology Manager

3. Packet Optical Integration

Connections (or tunnels) formed across the optical transport network, can be used as virtual TE links in the packet network. The relationship is reduced to determining which tunnels to set up, how to trigger them, how to route them, and what capacity to assign them. As the demands in the packet network vary, these tunnels may need to be modified.

An entity in packet network - (maybe a Path Computation Element (PCE), Virtual Network Topology Manager (VNTM) [RFC5623], Controller etc..) should be aware of the abstract topology of the transport network. This entity is the customer controller as per [ACTN-FWK] which interacts with Virtual Network Controller (VNC). The abstract topology may consist of established tunnels in optical transport network or ones that can be created on demand. The level of abstraction is dependent on various management, security and policy considerations. This abstract topology information in the packet network can be utilized in various cases, as detailed in the following sections.

3.1. Traffic Planning, Monitoring and Automatic Network Adjustments

Currently there is a schism between network planning for packet and optical transport networks. Sometimes these networks are administered, operated and planned independently even when they are a part of a single trusted domain. Any change in traffic requirements requires long business process to make changes in the network. In dynamic networks this is no longer acceptable.

A unified Packet+Optical traffic planning tool can be developed which uses the traffic demand matrix to plan the optical transport network. Further based on traffic demand changes, historical data, traffic prediction and monitoring, changes should be made to the optical transport network. An access to abstract topology of the optical transport network based on established and potential (on-demand) tunnels in transport network can provide mechanism to handle this.

Further optical bypass may be established automatically to offload the continuous changing traffic to transport network allowing streamlined business process between packet and optical transport networks.

3.1.1. Automated Congestion Management

Congestion management and synergized network optimization for packet and transport networks can eliminate the need for overbooking of transport networks as dumb pipes. Application could be written that provide automated congestion management and network optimization. Automated congestion management recognizes prolonged congestion in the network and works with the controllers to add bandwidth at a transport layer, to alleviate the congestion, or make changes in the packet layer to reroute traffic around the congestion.

For such applications there is a clear need for an abstract network topology of optical transport layer, further there is also a need for a synergy of cost and SLA across optical and packet networks.

3.2. Protection and Restoration Synergy

The protection and restoration are usually handled individually in Packet and optical layer. There is a need for synergy and optimized handling of protection of resources across layers. A lot more resources in the optical transport network are booked for backup then actually required since there is a lack of coordination between packet and optical layers. The access to abstract graph of transport network with information pertaining to backup path information can help the packet network to handle protection, shared risk, fault restoration in an optimized way. Informing the packet network about both working and protection path which are either already established, or potential path can be useful.

A significant improvements in overall network availability that can be achieved by using optical transport shared-risk link group (SRLG) information to guide packet network decisions; for example, to avoid or minimize common SRLGs for the main (working) path and the loop free alternative or traffic engineered fast reroute (LFA/TE FRR) back-up path. Shared risk information need to be synergized between the packet and optical. A mechanism to provide abstracted SRLG information can help the packet network consider this information while handling protection and restoration.

3.3. Service Awareness

In certain networks like financial information network (stock/ commodity trading) and enterprises using cloud based applications, Latency (delay), Latency-Variation (jitter), Packet Loss and Bandwidth Utilization are associated with the SLA. These SLAs must be synergized across packet and optical transport networks. Network optimization evaluates network resource usage at all layers and recommends or executes service path changes while ensuring SLA compliance. It thus makes more effective use of the network, and relieves current or potential congestion.

The main economic benefits of ACTN arise from its ability to maintain the SLA of the services at reduced overall network cost considering both packet and optical transport network. Operational benefits of the ACTN also stem from greater flexibility in handling dynamic traffic such as demand uncertainty or variations over time, or optimization based on cost or latency, or improved handling of catastrophic failures.

3.4. Coordination between Multiple Network Domains

In some deployments, optical transport network may further be divided into multiple domains, an abstracted topology comprising of multiple optical domains MAY be provided to the packet network. A Seamless aggregation and orchestration across multiple optical transport domains is achieved via the VNC, a great help in such deployments.

Another interesting deployment involves multiple packet network domains. There exist scenarios where the topology provided to the packet network domains may be different based on the initial demand matrix as well as, management, security and policy considerations.

The ACTN framework as described in [ACTN-FWK] should support the aggregation and orchestration across network domains and layers.

4. Security Considerations

TBD.

5. IANA Considerations

None, this is an informational document.

6. Acknowledgments

TBD.

7. References

7.1. Normative References

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Appendix A. Contributor Addresses

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