Network Working Group
Internet Draft
Intended status: Informational
Expires: August2014

Yunbin Xu
CATR

Guoying Zhang
CATR

Weiqiang Cheng
CMCC

Haomian zheng
Huawei

February 13, 2014

Use Cases and Requirements of Dynamic Service Control based on Performance Monitoring in ACTN Architecture
draft-xu-actn-perf-dynamic-service-control-00.txt

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Abstract

This document introduces the dynamic creation, modification and optimization of services based on the performance monitoring in the Abstraction and Control of Transport Networks (ACTN) architecture.

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1. Introduction

The rapid growth of Internet traffic and the emerging applications such as cloud computing, datacenter interconnection, IP and optical integration, LTE backhauling, are driving the transport network to provide dynamic service provisioning based on the customer requirement and high quality services with guaranteed performance.

For datacenter interconnection services, IP network transit links, LTE backhauling services or some business customer services, the traffic vary over time. However, traditional optical network could only provide connection based on the maximum bandwidth needed. Based on flow traffic monitoring, it is possible to adjust the connection bandwidth according to the real bandwidth needed, create new connections or increase bandwidth when network traffic exceeds some certain threshold or reduce connection bandwidth when traffic drops down, thus helping the customers to save cost.

On the other hand, customers have different SLA requirements. Some customers such as financial service companies need ultra-low-latency transmission, some other customers has strict requirements on bit error rate (BER). In order to provide high quality services according to customer SLA, network provider needs to measure the service performance, and dynamically provision and optimize services based on the performance monitoring result.

The optical transport networks support various performance monitoring mechanisms, such as traffic flow statistics, packet delay, delay variation, throughput and packet-loss rate for MPLS-TP and packet OTN networks, BER, FEC error correction counters for OTN and DWDM networks, etc. These mechanisms can be used to support dynamic service control based on performance monitoring.

The Abstraction and Control of Transport Networks (ACTN) described in [ACTN-FWK] provides a centralized control architecture and open interfaces that can transmit the customer requirements and policies to the network, and provide customers with the network status to make a decision. This draft mainly discusses the use cases and requirements of dynamic service control based on performance monitoring in ACTN architecture, the requirements for southbound and northbound interface are also discussed.

2. Use Cases and Requirements for Dynamic Service Control based on Performance Monitoring

2.1. Dynamic Service Control based on Traffic Monitoring

For LTE backhauling based on MPLS-TP packet transport networks(PTN) or packet OTN, it is required that real time or semi-real time traffic monitoring of the network should be conducted so as to resize or optimize traffic and do load balance. In IP and optical network integration scenario, the optical network can bypass IP transit traffic as far as the transit traffic bandwidth is large enough to occupy the granularity of an ODUk. Network traffic monitoring is important to facilitate automatic discovery of the imbalance of network traffic, and initiate the network optimization, thus helping the network operator or the virtual network service provider to use the network more efficiently and save CAPEX/OPEX.

For datacenter interconnection or enterprise leased line services, the traffic may vary over time and the customer want to pay for the bandwidth they really used. Therefore, it is important to provide some mechanism to monitor the network traffic, adjust and optimize the services dynamically to help the customers save expenses.

In order to support these scenarios, the customers or client layer network controllers need to send traffic monitoring and control policies to the network, while the transport network should report the traffic monitoring results and dynamically control and adjust network connections based on the traffic optimization policy. The service adjustment or network optimization operations normally should be initiated with the decision of the customer.

2.2. Dynamic Service Control based on SLA monitoring

Customer services have various SLA requirements, such as service availability, latency, latency jitter, packet loss rate, BER, etc. The transport network can satisfy service availability and BER requirements by providing different protection and restoration mechanisms. However, for other performance parameters, there are no such mechanisms.

In order to provide high quality services according to customer SLA, one possible solution is to measure the service SLA related performance parameters, and dynamically provision and optimize services based on the performance monitoring results.

When the network performance deterioration that violates the SLA is detected, service optimization operations such as service rerouting, creation of new connections could be automatically started.

In order to support this requirement, the customer should be able to send its SLA information to the network, and the transport network should determine which performance parameters need to be monitored and the strategy of service optimization. When the service performance degradation is detected, the transport network can notify the customer and immediately start the service optimization procedure, so as to reduce the impact on the service.

3. Workflows of ACTN Control Modules

In the ACTN architecture [ACTN-FWK], centralized controllers including Physical Network Controller (PNC), Virtual Network Controller (VNC), customer controller, and the interfaces between them have been defined.

For different use cases and scenarios the workflows across the customer controller, VNC and PNC are different.

3.1. Workflows for Traffic Monitoring based Dynamic Service Control

Figure 1 shows the workflows for dynamic service control based on traffic monitoring.

In order to realize dynamic service creation, adjustment and optimization based on traffic monitoring, the customer controller should send traffic monitoring and traffic optimization strategies to Virtual Network Controller (VNC). VNC sends the corresponding path traffic monitoring request to PNC. Traffic monitoring parameters and monitoring cycle need to be carried in this request.

PNC gets the traffic monitoring results from the underlying physical networks, then reports to VNC. According to the traffic optimization strategy obtained from the customer controller, VNC determines whether the service needs to be adjusted, or a new connection should be created. If it needs to, then VNC send the traffic monitoring results to the customer controller, indicating that the service needs adjustment.

Customer controller confirms whether the service can be optimized, then sends a service adjustment request to VNC. VNC will convert it into path modification or creation request, and send it to PNC to complete the service optimization. Then, PNC returns the optimization results to VNC, and VNC passes the results to the customer controller.

```
   +-------------------------------------------------+
   | Customer   +----------------------------+      |
   | Controller | Dynamic Service Control APP |      |
   |            +----------------------------+      |
   +-------------------------------------------------+
   1.Traffic|  /|\4.Traffic           | /|\
   Monitor& |   |  Monitor             |  | 8.Traffic
   Optimize |   |  Result   5.Service |  | modify &
   Policy   |   |             modify& |  | optimize
           \|/  |       optimize Req.\|/ | result
   +-------------------------------------------------+
   | Virtual    +--------------------------------+   |
   | Network    |Dynamic Service Control Agent  |   |
   | Controller +--------------------------------+   |
   |      +---------------+ +-------------------+   |
   |      | Flow Optimize | | vConnection Agent |   |
   |      +---------------+ +-------------------+   |
   +-------------------------------------------------+
   2. Path  |  /|\3.Traffic           |  |
   Monitor  |   | Monitor             |  |7.Path
   Request  |   | Result     6.Path   |  | modify &
            |   |            modify&  |  | optimize
           \|/  |       optimize Req.\|/ | result
   +------------------------------------------------+
   | Physical   +----------------------+            |
   | Network    | Network Provisioning |            |
   | Controller +----------------------+            |
   |            +----------------------+            |
   |            | Network Monitoring   |            |
   |            +----------------------+            |
   +------------------------------------------------+
```

Figure 1 Workflows for dynamic service control based on traffic monitoring

3.2. Workflows for SLA monitoring based Dynamic Service control

Figure 2 shows the workflows for dynamic service control based on SLA related performance monitoring.

Customer controller sends the customer service SLA information and the performance based optimization strategy to VNC.

VNC will convert the SLA information to path performance monitoring request, which carries the performance monitoring parameters such as delay, jitter, packet loss, bit error rate and monitoring cycle, and then send it to the PNC.

PNC starts the performance monitoring in the underlying physical networks, collects the results of related path, and reports to VNC. VNC determines whether the relevant performance parameters can satisfy the SLA agreements. If the performance degradation seriously influences the service, such as service packet delay exceeds the performance threshold, VNC will immediately start the optimization and adjustment. Then the performance monitoring results as well as the optimizing or adjusting results will be send to the customer controller.

```
+------------------------------------------------+
| Customer   +-----------------------------+     |
| Controller | Dynamic Service Control APP |     |
|            +-----------------------------+     |
+------------------------------------------------+
1. SLA&  |  /|\6.SLA                |
Optimize |   |  Monitor, modify &  |
Policy   |   |  Optimize           |
         |   |  Result             | 7.Ack
        \|/  |                    \|/
+------------------------------------------------+
| Virtual    +-------------------------------+   |
| Network    |Dynamic Service Control Agent  |   |
| Controller +-------------------------------+   |
|      +---------------+ +-------------------+   |
|      | Flow Optimize | | vConnection Agent |   |
|      +---------------+ +-------------------+   |
+------------------------------------------------+
2. Path  |  /|\3.SLA                | /|\
Monitor  |   | Monitor             |  |5.Path
Request  |   | Result     4.Path   |  | Modify &
         |   |            Modify&  |  | Optimize
        \|/  |       Optimize Req.\|/ | Result
+------------------------------------------------+
| Physical   +----------------------+            |
| Network    | Network Provisioning |            |
| Controller +----------------------+            |
|            +----------------------+            |
|            | Network Monitoring   |            |
|            +----------------------+            |
+------------------------------------------------+
```

Figure 2 Workflows for dynamic service control based on SLA monitoring

4. Requirement for ACTN Interface

ACTN Interfaces defined [ACTN-FWK] includes the following:

- o Consumer-VNC Interface (CVI): an interface between a customer controller and a virtual network controller.

- o VNC-PNC Interface (VPI): an interface between a virtual network controller and a physical network controller.

4.1. Interface Requirements for Dynamic Service Control Based on Traffic Monitoring

According to the work flow of dynamic service control based on performance monitoring, the information carried in CVI interface mainly relates to the traffic monitoring and control strategy, while the VPI interface mainly relates to transports path related traffic monitoring parameters and results.

1. CVI Interface

The following information is used by the customer controller to send to VNC through the CVI interface.

- o Customer service performance monitoring strategy, including the traffic monitoring object (the service need to be monitored), monitoring parameters (e.g., transmitted and received bytes per unit time), traffic monitoring cycle (e.g., 15 minutes, 24 hours), threshold of traffic monitoring (e.g., high and low threshold), etc.

- o Customer service optimization strategy, such as enabling service creation or modification when traffic exceeds the threshold.

The following information is used for VNC to send to the customer controller through VPI interface.

- o Traffic monitoring results, to indicate if the traffic exceeds the bandwidth threshold.

2. VPI Interface

The following parameters are used for VNC to send to PNC.

o Traffic monitoring parameters, monitoring object, monitoring cycle, performance threshold.

The following information is used for PNC to send to VNC.

o Traffic monitoring results.

4.2. Interface Requirements of Dynamic Service Control based on SLA monitoring

According to the work flow of dynamic service control based on SLA monitoring, the information in VCI interface mainly contains the SLA related information and measurement strategy, while the VPI interface mainly transports path related performance monitoring parameters and results.

1. CVI Interface

The following information is used by the customer controller to send to the VNC through CVI interface.

o SLA related performance requirement information, including the required quality of service parameters (e.g., BER, delay, delay jitter, packet loss rate, throughput, etc.).

o Service optimization strategy, including the service performance degradation thresholds and the consequent operations that are allowed (e.g., rerouting).

The following information is used by the customer controller to send to VNC.

o Monitoring results of service performance, including performance monitoring parameters, and the services that have been influenced.

o Service optimization results based on performance.

2. VPI Interface

The following information is used by VNC to send to PNC.

o The path performance monitoring request parameters, monitoring cycle and threshold.

The following information is used for PNC sending to VNC.

o Path performance monitoring results.

4.3. Discussion

Performance monitoring in a large scale network could generate a huge amount of performance information. Therefore, the appropriate way to deliver the information in CVI and VPI interfaces should be carefully considered.

5. Security Considerations

This document raises no new security issues.

6. IANA Considerations

No new IANA considerations are raised by this document.

7. References

7.1. Informative References

[ACTN-FWK] Daniele C., Luyuan Fang, Yong Lee and Diego Lopez, "Framework for Abstraction and Control of Transport Networks",draft-ceccarelli-actn-framework-00.

Authors' Address

Yunbin Xu
China Academy of Telecom Research
NO.52 Huayuan Beilu, Haidian District, Beijing, China
Email: xuyunbin@catr.cn

Guoying Zhang
China Academy of Telecom Research
NO.52 Huayuan Beilu, Haidian District, Beijing, China
Email: zhangguoying@catr.cn

Weiqiang Cheng
China Mobile
No.32 Xuanwumen West Street, Xicheng District, Beijing, China
Email:chengweiqiang@chinamobile.com

Haomian Zheng
Huawei Technologies
F3-1-B R&D Center, Bantian, Longgang District Shenzhen, China
Email: zhenghaomian@huawei.com