Implementing Quality of Service for the Software Defined Networking Enabled Future Internet

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Agenda of our talk

• Motivations
• Our QoS Framework for SDN
• Objective of our experiments
• Experimental Setup and Results
• Conclusions
Motivation

• Achieving high QoS is a major concern in the current Internet
  – Service Level Agreement between business customers and a Service Provider

• Current QoS mechanisms (IntServ & DiffServ) are practically not possible to implement globally over the Internet
Three tasks are needed to be performed in the current Internet for establishing QoS

- Determining availability of network resources
  - Difficult to determine because each device runs its own control software
- Configure network resources if they are available
  - No standard protocol available to configure resources
- Reconfigure network resources on a failure condition
  - Resilience protocols need to depend on vendor specific protocol for reconfiguration

With SDN, all the above tasks are practically possible to implement

- Centralized control
- Standard OpenFlow, OF-CONFIG or OVSDB protocol for configuration and reconfiguration.
Our proposed Framework

Assumptions:
1. A single AS is controlled by a single controller.
2. The controller is able to communicate with the bandwidth broker through the northbound API.

Bandwidth broker
Northbound API
OpenFlow and OVSDB protocol

RouteFlow
Controller

Autonomous system enabled with SDN Technologies

OpenFlow switch/router
Controller connections with OpenFlow switches
Client/Server or other AS connecting with this AS
By default, three queues are implemented for each port:

- The first queue is for **control traffic**
- The second queue is for **high priority traffic**
- The third queue is for **best effort traffic**
- Q is a **rate limiter queue for high priority traffic** at the edge router (Router A)
Objective of Experiments

• To evaluate three QoS failure recovery scenarios for SDN networks using our implemented Framework
  – When enough bandwidth in the working and the failure recovery path, neither high-priority nor best-effort traffic should get affected
  – When limited bandwidth, best-effort traffic get affected to fulfill the requirements of high-priority traffic
  – When very low bandwidth, high-priority traffic also gets affected, but there should be no interference from best-effort traffic.
Evaluation topologies

Client or Server

OpenFlow Switch/Router

LAN

Controller

Bandwidth Broker

Evaluation topologies

Amsterdam

London

Brussels

Frankfurt

Paris

Strasbourg

Munich

Vienna

Zagreb

Rome

Hamburg

Berlin

Zurich

Milan

Nancy

Lyons

OpenFlow Switch/Router

LAN

Controller

Bandwidth Broker

Evaluation topologies

AS 1

AS 2

AS 3

AS 4

AS 5
OFELIA island @ iMinds
Creating a CityFlow experiment

OpenFlow Experiment idea

GUI

Use Cityflow OF images

Emulab runs the additional scripts from ns file

Hardware Mapping and swap in

Add script lines for automated datapath configuration

- Specify links to script
- Auto -> available NICs

#generated by Netbuild 1.03
set ns [new Simulator]
sourcetb_world.tcl
#set ocfloctl1 [new node]
#set ocfloctl2 [new node]
#set ofconn1 [new ocfConn] ofconn1 ofConn
#set ofconn2 [new ocfConn] ofconn2 ofConn
set sock [new sock]
#set of-node-ofsock2 [new ofSock] ofSock 2

#set datachannel1 [new duplex-link Sofoicli0 Sofoicli0 1000Mbps One DropTail]
#set controlchannel1 [new simplex-link Sofoicli0 Sofoicli0 [1000Mbps One DropTail]
#set controlchannel2 [new duplex-link Sofoicli0 Sofoicli0 1000Mbps One DropTail]
#set controlchannel3 [new simplex-link Sofoicli0 Sofoicli0 1000Mbps One DropTail]
#set set-ip-link Sofoicli0 controlchannel1 172.16.0.1
#set set-ip-link Sofoicli0 controlchannel1 172.16.0.2
#set set-ip-link Sofoicli0 controlchannel1 172.16.1.1
#set set-ip-link Sofoicli0 controlchannel2 172.16.2.1
#set set-ip-link Sofoicli0 controlchannel2 172.16.2.100

#set nsproxy Static
set run
#netBuild-generated ns file ends.
Emulation environment

Traffic between the controller and switches

- Link DOWN Event
- Link UP Event
- ARP, OSPF, Flow-mod and queue configuration messages
- OSPF, Flow-Mod and queue reconfiguration messages
- ECHO, OSPF, and ARP messages

Number of packets per second vs. Experiment Time in seconds
Traffic for the client connecting Zagreb

Best-Effort Traffic 0.560 Mb/s and High priority Traffic 0.240 Mb/s from each server

- Received Best-Effort Traffic
- Sent Best-Effort Traffic
- Received High-Priority Traffic
- Sent High-Priority Traffic

An average of 0.560 Mb/s Best-Effort traffic sent from each server

An average of 0.240 Mb/s High-Priority traffic sent from each server

Link DOWN

Link UP
Traffic for the client connecting Zagreb

Best-Effort Traffic 2.28 Mb/s and High priority Traffic 0.760 Mb/s from each server

An average of 2.28 Mb/s Best-Effort traffic sent from each server

An average of 0.760 Mb/s High-Priority traffic sent from each server

Link DOWN

Link UP
Traffic for the client connecting Zagreb

Best-Effort Traffic 4.8 Mb/s and High priority Traffic 1.8 Mb/s from each server

An average of 4.8 Mb/s Best-Effort traffic sent from each server
An average of 1.8 Mb/s High-priority traffic sent from each server
Traffic on link Milan-Munich (no interference link)
Total traffic received by all clients

Data rate of each server to each client (Mb/s)
(30% high-priority traffic and 70% best-effort traffic)
Multiple AS experiment

Total traffic received by all clients in access networks

- Best-Effort Traffic before link down
- Best-Effort Traffic after link down
- Best-Effort Traffic after link up
- High-Priority Traffic before link down
- High-Priority Traffic after link down
- High-Priority Traffic after link up

Data rate of the CDN server to each client (Mb/s)
(30% High-Priority Traffic and 70% Best-Effort Traffic)
Conclusions

• Designed a framework for Diffserv-like operation in OpenFlow

• Implemented QoS-aware failure recovery using VPS technology

• Experimentally validated the approach in single and multi-AS scenario’s
Questions?

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- [www.cityflow.eu](http://www.cityflow.eu) (Project website for more detail)