Software Defined Network approach Driven by the *mPlane* Measurement Plane

E. Tego[1], A. Rufini[1], A. Valenti[1], F. Matera[1], M. Mellia[2], S. Traverso[2]

1 Fondazione Ugo Bordoni, via del Policlinico 147, 00161, Roma, Italy, mat@fub.it
2 Politecnico di Torino
**mat@fub.it*

Abstract
In this work we experimentally show a Software Defined Network approach based on a central unit (orchestrator) that automatically manages GbE links in a regional network driven by the performance analysis carried out by the *mPlane* measurement plane, that for such an aim takes into account active and passive Quality of Service tests.

1. Introduction
Future network management will require many automatic processes to allocate suitable resources maintaining high levels of Quality of Service (QoS) and fast resilience. All these requirements appear to be satisfied by novel approaches based on the concept of Software Defined Network (SDN) [1]. First of all SDN adopts a separation of the control and data plane and it uses a central entity, called *Orchestrator*, that manages the whole network. We believe that in addition for a correct functioning of a SDN would be preferable the introduction of a *plane* that collects all the information about the state of the network performance in different measuring points, with location ranging from the access to the core. An example of such *monitoring approach* was demonstrated in the FP7 MPLANE (*an Intelligent Measurement Plane for Future Network and Application Management*, http://www.ict-mplane.eu/) project that introduced a *measurement plane* alongside the Internet's data and control planes. It is able to collect the measurements from several probes, both active and passive, located in different points of the network, with an intelligent reasoner that permits to analyze all the corresponding data, summarizing and illustrating output information in terms of network performance, traffic characteristics, Quality of Service (QoS) and user perception [2-3].
In this work we adopt the mPlane reasoner to drive a SDN approach tested in an experimental GMPLS test bed [4], where we demonstrated a QoS control at the user location [5] with a traffic load monitoring in GbE core routers, with a centralized PC (orchestrator) that drove the switch on/off of the optical Gb/s links according to traffic thresholds [6]. We show that by means of the mPlane measurement plane we can have a much wider overview about the network performance, especially in terms of impairments and therefore a SDN based on mPlane can act a much more efficient network management to always maintain high QoS levels.

2. The SDN model based on mPlane
SDN approach is currently considered as a fundamental method to dynamically manage networks according to different requirements that can come both for the inner and to the peripheral of the network [1]. For an instance a network can be managed according to QoS data coming from the users as reported in [4]. In this paper we make a big step forward using the data from the mPlane reasoner that allows us to know both the QoS user characteristics and the network behaviour analyzing the traffic in terms of packet behaviour [3][7-8]. In particular from the analysis of the correlation among QoS measurements and traffic monitoring carried out in a field trial [7] it was demonstrated that the reasoner can generate alarms when congestions are approaching [8]. In this work such alarms are adopted to drive the decisions of the orchestrator about the network reconfiguration to reduce such a congestion. As described in [4] the *orchestrator* is directly connected by means of Fast Ethernet (FE) links to the GbE routers and communications are obtained by means of Simple Network Management Protocol (SNMP) from the routers to the orchestrator [6]. Triggering of calculation of a new network configuration based on the monitored traffic, as well as the calculation of the new network configuration itself, are achieved by using batch scripting. Eventually, network reconfiguration is performed by logging via telnet into the IP routers, and executing commands to perform rerouting and activation/deactivation of GbE interfaces. In particular the on/off switching of the physical paths (i.e. GbE optical links) is obtained by two procedures described in [6] and called Fixed Upper Fixed Lower (FUFL) and Dynamic Upper Fixed Lower (DUFL), where we observed no packet losses during these operations.
In this experiments a capacity bottleneck can be set up in a specific link to emulate network congestion conditions.

2. Experimental test bed and results

Our approach was tested in the laboratory infrastructure described in Fig. 1, consisting of two Alcatel 7713 routers with 1Gbps and 10Gbps interfaces, two juniper M10i routers, with 1Gbps Ethernet interfaces, a CISCO 3800 router, a GPON access and several PCs. Congestion processes are introduced by means of the JAR Network Emulator, that can also elaborate traffic up to 10Gbps. As described in the figure

we distinguish the network with Media Server, routers, OLT and PC2, PC3 and PC4. The SDN part is composed by the orchestrator (PC) and the mPlane PC acting both as supervisor and reasoner [2-3]. mPlane inputs are data coming from active and passive probes; here we use the *mSLAcert* active probe, that was developed just in the framework of the mPlane project and it permits the verification and certification of the Service Level Agreement (SLA) between ISP and client. It operates by measuring UDP and TCP throughput, plus other parameters as delay, jitter and packet losses. On the other hand TSTAT, a passive sniffer that extracts transport-layer information about the TCP flows [3], is used as passive probe. mSLAcert agents are located in the PC2, PC3 and PC4 and TSTAT in one of the two Alcatel routers. mPlane reasoner can generate alarms that feed the orchestrator that, in this set-up, can change the configuration of Alcatel router gates.
In this contribution we only report a test showing the SDN behavior consequent to a congestion.

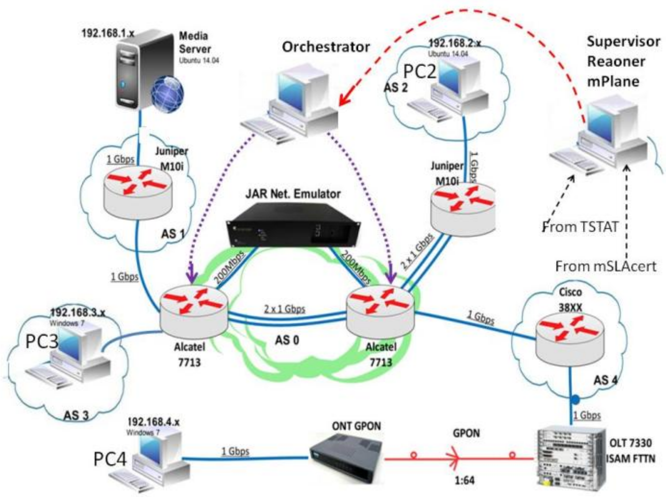

Figure 1: Testbed in FUB, used for the simulation of the congestion.

The test starts with a transmission from PC3 to PC4 with a flux at 77 Mbps, and at the beginning all the traffic between the two Alcatel routers is routed through the link dedicated to the JAR, that is set at the maximum capacity of 200 Mbps. At T1 time another flux is generated by the Media Server at 92 Mbps. However the total traffic crossing the JAR path is below 200 Mbps and therefore no congestion effect is manifested.
In fig. 2 the throughput measured by the mSLAcert probe at PC4 is reported and we can see that up to T2 time no reduction is shown. At T2 a further flux at 77 Mbps is launched by the Media Server and in such a case a strong congestion is shown up by fig.2.
This effect has been analyzed by traffic inside the network by means of TSTAT and in fig. 3 we report the mean bandwidth (Throughput, blu points), the number of retransmitted segments of the flow due to time out (Timeout_retry n., red points) and the ones due to fast retransmit (Fast_retry n, green points) process. In the same figure we also report in the two rows the Pearson correlation values [8] between Throughput and Timeout_retry n and between Throughput and Fast_retry.

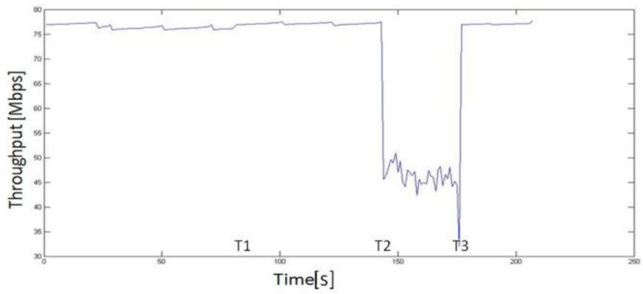

Figure 2: Monitored throughput at PC4.

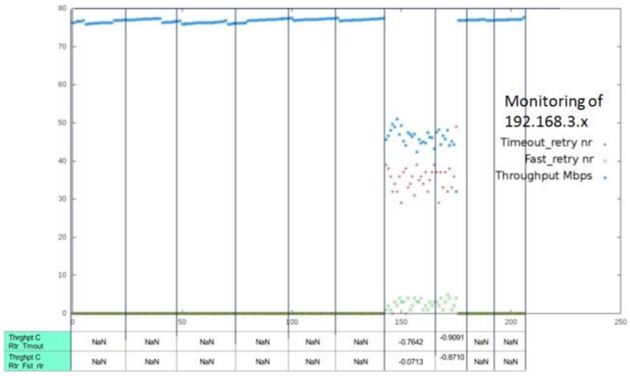

Figure 3:Correlation with the passive data for the simulation

As illustrated by the figure 3, such correlation values, in correspondence of the congestion, are able to directly generates an alarm. At T3 such an alarm is detected by the orchestrator [4] that reroutes the traffic to another GbE link between the two Alcatel, that allows a capacity of 1 Gbps. Therefore the effect of the rerouting is clearly seen in fig. 2 and in fig. 3 with the fast increasing of the throughput.

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References

[1] Sezer, S. et al "Are we ready for SDN? Implementation challenges for software-defined networks, IEEE Communications Magazine, 51, (7) 2013 , pp. 36 – 43
[2] https://www.ict-mplane.eu/public/verification-and-certification-service-level-agreements
[3] P. Casas et al "Unveiling network and service performance degradation in the wild with mplane" IEEE Communication Magazine, 2016, pp. 71-76
[4] E. Tego, F. Matera, D. Del Buono, V. Attanasio, "Quality of Service Management based on Software Defined Networking Approach in wide GbE Networks" EuMed Telco 2014 Napoli, Novembre 2014
[5] A. Rufini, et al, "Multilevel bandwidth measurements and capacity exploitation in gigabit passive optical networks, IET communications, IET Communications Volume 8, issue 18, December 2014, p. 3357 – 3365.
[6] E. Tego, et al "Facing the reality: validation of energy saving mechanisms on a testbed" J. of Elect. and Comp. Engin., Hindawi, March 2014
[7] S. Traverso, et al, "Exploting Hybrid Measurements for Network Troubleshooting" Invited at Networks 2014, Sept, 2014 Madeira (PT)
[8] E. Tego et al "Quality of Service monitoring adopting correlation among active and passive measurements" Submitted to Networks2016