Coordinated Operations between IP and Transport Network Management Systems in Multi-vendor Settings

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Abstract: This paper outlines some promising results recently obtained in a field trial led by Telefónica and ADVA Optical Networking. The technology tested enables coordinated orchestrations among IP and transport management systems in multi-vendor settings.
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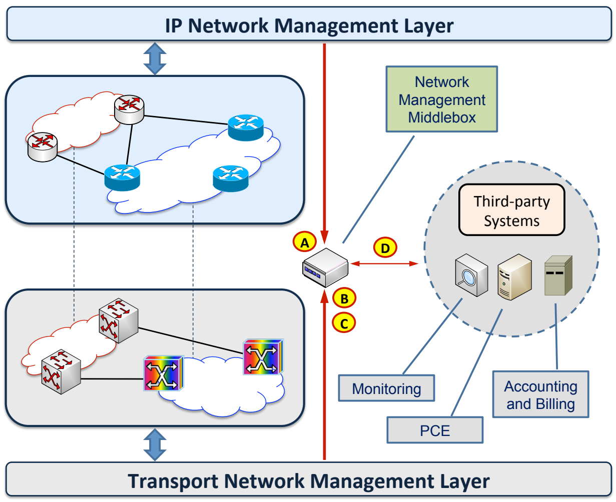
1. Introduction

Although IP and transport networks are typically deployed in tandem, their intrinsic differences have profoundly segmented the way in which operators manage these infrastructures. Most operators choose to have at least two vendors for the IP layer (e.g., Cisco and Juniper), and typically the same strategy applies to the optical transport layer (e.g., Ciena and Huawei). This decision is not only to avoid having critical dependencies on a single supplier but also to negotiate better deals on their purchases. In practice, the purchase of equipment is typically conditioned by a set of requirements, including specific interoperability features that need to be available both at the data and control planes. The reason for this is to avoid deploying network infrastructures that might end up containing islands that will be limited to run in isolation. However, when it comes to "managing" these multi-layer and multi-vendor settings, the isolation is unavoidable in practice. While there have been significant advances in the interoperability areas of both the control and data planes, the isolation of operational functions and management systems between layers and across vendors remains as large as ever. Indeed, the lack of commercial solutions capable of providing automated coordination of management procedures, or the orchestration of business practices between layers and vendors, poses considerable challenges and overheads to operators, both in terms of CAPEX and OPEX.

To face these challenges, we outline a pragmatic solution that is being developed in Europe, and which has been recently tested in a field trial in O2 premises in Germany in an effort driven by Telefónica and ADVA Optical Networking [1–3]. As we shall show, this new solution is being implemented in the form of a middlebox [4,5] (cf. Fig. 1), with special focus on multi-vendor settings—both at the IP and the optical layer. The results shown in this paper correspond to the demonstration of how our middlebox is able to coordinate IP traffic offloading actions to the photonic network, using state-of-the-art equipment from different vendors.

2. "ONE": A Middlebox Enabling Seamless Interoperation between IP and Transport Management Systems

To overcome the existing isolation between the IP and Transport Management Systems, we have followed a straightforward approach. This consists in the development of a sort of "adapter" (i.e., a "middlebox"), that can provide a simple and reliable communication channel between the different management ecosystems. We call this middlebox "ONE". The fundamental goal is to enable their interoperation, with the aim of supporting a set of operations, such as coordinated provisioning and post-failure management. The strengths of this approach can be summarized as follows. First, it inherently avoids the complexity of dealing with large-scale integration efforts toward a unified Network Management System (NMS) capable of offering the functionality required by the different technologies in each layer. More specifically, our middlebox does not seek the integration of systems but rather to enable communication and interoperation of the already deployed NMSs, in a simple, cost-effective, and "standardized" way. Second, the role of our middlebox



Use cases in the figure	
(A)	Human initiated actions, typically triggered by administrators in the IP layer. This is to allow the IP management layer to request the provisioning of resources to the Transport management system.
(B)	Proactive actions initiated based on policies defined in the IP NMSs (e.g., to help handling traffic bursts, etc.).
(C)	Coordinated self-healing actions, such as post-recovery actions supported through smart analytics.
(D)	Seamless integration of third-party subsystems such as Path Computation Elements (PCEs), etc. Indeed, the middlebox embeds a Path Computation Client (PCC).

Fig. 1. ONE: A middlebox enabling coordinated operations and procedures among IP and Transport management systems. ONE is being prototyped basically as a proof-of-concept for use cases (A) – (D), and with special focus on multi-vendor settings.

is to significantly facilitate the telecom business processes as they are today, rather than modifying them. And third, even though our approach enables certain autonomic functionality, it also natively supports the possibility of having the desired level of human supervision and manual control whenever required during the automation of management procedures and/or tasks.

Figure 1 succinctly illustrates our solution and the use cases for which it was initially devised. Observe that nowadays, even very basic operations, such as the provisioning of a new IP link, require multiple communications between human operators from different departments, and therefore, lead to long service provisioning time scales (typically in the range of several hours up to days). Our solution not only promises to dramatically reduce these timescales but also to add functionality that it is not currently available in the market, such as IP offloading and post-recovery actions in multi-vendor scenarios.

For an in-depth description of the ONE middlebox and its internals the reader is referred to [4]; in particular, to the multimedia content therein.

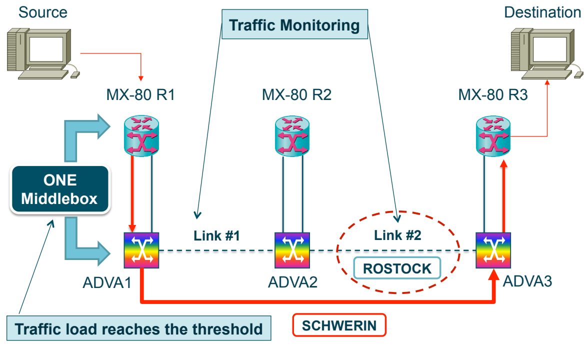
3. Field Trials

We now proceed to describe the field trials led by Telefónica in O2 premises in Germany during the second quarter of 2012. The focus of the trials is on core network operations, in response to Telefónica's interest in getting increased coordination and automation in IP/MPLS over DWDM networks; and particularly, in settings composed of network elements provided by different vendors. These trials served for testing an initial prototype implementation of the ONE middlebox, and the success of the event captured the attention of the international press [1–3].

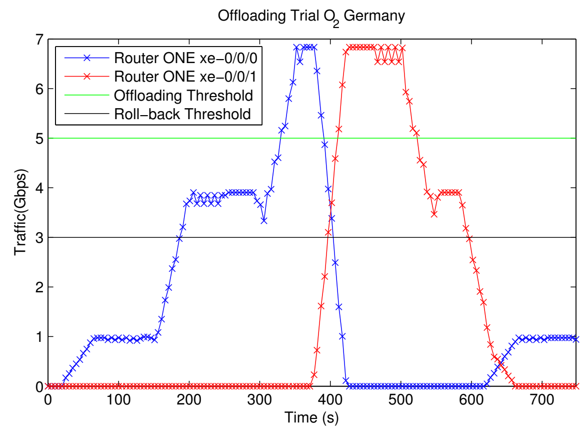
The scenario for the trial is shown in Fig. 2a. The multi-layer and multi-vendor network used during the trials was set as follows. Three JUNIPER routers from the MX series were connected to three optical transport nodes provided by ADVA Optical Networking. All devices were located in the same place (at premises of O2 in Germany). The physical connectivity between ADVA optical nodes 2 and 3 was through Rostock, while the one between the ADVA nodes 1 and 3 was through Schwerin. In this setting, the configuration of the routers orchestrated by the ONE middlebox was automated through the CLI, while the configurations on the transport layer were made through IETF's UNI standard.

The main goals of this trial were to assess the effectiveness of the ONE middlebox in supporting automated coordination of two basic operations: (1) IP offloading in order to dynamically cope with sudden fluctuations of traffic in the IP network; and (2) Multi-layer recovery actions. Due to space limitation, in this paper we can only present some of the results obtained for the IP offloading tests.

To this end, we used two additional nodes (cf. Fig. 2a). The traffic was sourced from the node on the left hand-side, which was sent to the destination on the right hand-side of Fig. 2a, traversing the links shown in the figure. A traffic monitoring tool was used for assessing the load on the different links. The traffic used for the assessment was the mean over 40 seconds, and the thresholds defined in the ONE middlebox for triggering the IP offloading operations were set



(a)



(b)

Fig. 2a) Scenario for the trials; 2b) Results obtained during the IP offloading tests.

to: (a) 5 Gbps for the offloading actions; and (b) 3 Gbps for the uploading and rollback actions. For the tests shown in this paper, all the links were set to 10 Gbps.

As shown in Fig. 2a, when the traffic on the monitored links reached the specified thresholds, the event notifications received by the ONE middlebox triggered the corresponding IP offloading and uploading actions. Figure 2b shows the results obtained. The plots illustrate the traffic evolution on two different interfaces of the first router (R1). The one with the peak on the left represents the traffic on the initial configuration, i.e., before offloading traffic to the photonic mesh. In this configuration, the traffic was delivered using interface xe-0/0/0 on router R1, and it was sent over the Rostock link, so in this case the three routers were traversed at the IP layer. The plot with the peak on the right represents the evolution of traffic after the offloading. To this end, a new IP link was set up directly between routers R1 and R3 using the existing connectivity (and spare capacity) through Schwerin. In order to shift the traffic smoothly, a new interface was configured on router R1, namely, xe-0/0/1, which was used to handle the transition of the traffic load. The advantage of this approach is that both the IP offloading and uploading actions were possible without the occurrence of packet losses at destination. As shown in Fig. 2b, the traffic offloading action occurred around after 380 seconds of test, while the uploading operation occurred around after 620 seconds—recall that certain time was required for assessing the traffic mean before comparing with the preconfigured thresholds. In our tests, the offloading operation took an overall time of around 60 seconds to set up. Overall, these trials demonstrated how the ONE middlebox could be used for coordinating the dynamic bypass of routers in multi-vendor settings (R2 in the results shown here).

4. Conclusion

This paper has outlined a pragmatic solution that is being developed and prototyped for enabling coordinated operations among different management systems, with special focus on multi-vendor settings. The preliminary results shown here only describe the coordination of actions directly with the network elements, but the work that is being carried out will enable interoperation among NMSs in a standardized way, supported though standard Web Services and the MTOSI interface. We are also planning to enable interoperation and functionality with OpenFlow.

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