ENDEAVOUR: Towards a flexible software-defined network ecosystem

ENDEAVOUR

Project name	ENDEAVOUR
Project ID	H2020-ICT-2014-1 Project No. 644960
Working Package Number	5
Deliverable Number	5.5
Document title	Report from the Demonstrators for Implementation Feedback Workshop
Document version	0.6
Editor in Chief	Dietzel, DE-CIX
Authors	Dietzel, Bleidner, Abt, Canini, Chiesa
Date	28/07/2016
Reviewer	Castro, Uhlig, QMUL
Date of Review	19/07/2016
Status	*Public*

Revision History

Date	Version	Description	Author
04/07/16	0.1	Initial Structure	Dietzel
11/07/16	0.2	Initial Draft	Dietzel, Bleidner
15/07/16	0.3	First Complete Draft	Dietzel, Bleidner, Abt
17/07/16	0.4	Additional Contents and Revision	Canini, Chiesa
19/07/16	0.5	Full Review	Castro, Uhlig
21/07/16	0.6	Final Changes	Dietzel, Bleidner, Abt

Contents

1 Introduction **5**

2 Demonstrators for Implementation Feedback Workshop **6**
2.1 Audience 6
2.2 Demonstrator Development 7
2.3 Feedback 9
2.4 TouSIX Visit 11

3 Summary **11**

4 Acronyms **12**

Executive Summary

By introducing Software Defined Networking (SDN) technologies at the core of the inter-domain ecosystem, ENDEAVOUR seeks to address fundamental limitations of today's Internet. To date, the potential of SDN for Internet eXchange Point (IXP) members and operators lacks a proof of feasibility. Over the course of the project ENDEAVOUR collected a multitude of appealing use cases. A subset of those was selected and demonstrated to the extended External Advisory Board. Thus, ENDEAVOUR seeks to obtain as much feedback of experts in a very early stage of the implementation.

ENDEAVOUR organized the second feedback workshop in Toulouse, hosted by CNRS-LAAS. The workshop participants are experts from academia as well as from industry. After a brief update on the status of the ENDEAVOUR platform, the core of this presentation focused on the integration of the iSDX and the Umbrella components, followed by a detailed overview of the use cases.

The strong interest of the audience on ENDEAVOUR was shown by the multitude of high quality and deeply technical comments. In general, the feedback has been largely positive. As a result, we will proceed with the implementation, address the feedback, and prioritize according to the input of the workshop while accounting for the resources of the consortium.

1 Introduction

ENDEAVOUR aims to change the current connectivity model in one of the core interconnection elements of the Internet, namely IXPs, with state-of-the-art (and beyond) SDN technologies. We believe SDN bears the potential to overcome inherent limitations of today's interconnection paradigm and can help in coping with the ever increasing bandwidth demands. Moreover, ENDEAVOUR envisions fundamental advances in terms of network management and applications, directly within the network interconnection fabric. Indeed, SDN can help both network and IXP operators to simplify their management while enabling a whole new set of features and services.

In order to tackle those challenges ENDEAVOUR made already substantial progress in putting forward new use cases, documented in the deliverables D4.2 [1] and D4.3 [5]. While D4.2 is a collection of use cases that seek to improve the operations of IXPs and thus generate benefits for the IXPs themselves, D4.3 sketches scenarios that add features for IXP members. To come up with those various use cases of SDN at IXPs we collected feedback at a workshop with IXP members, evaluated related work, and utilized the valuable knowledge of the DE-CIX operations.

One of the goals for the ENDEAVOUR project is to demonstrate the technical feasibility of the selected use cases trough a prototype implementation. To exploit potential synergies, ENDEAVOUR builds upon software of similar efforts by other research projects integrating the iSDX [9] and Umbrella [2] contributions while also adding other envisioned use cases on top.

To maximize the impact of the contributions of this research project, ENDEAVOUR seeks to gain as much informed feedback as possible. Therefore, we took advantage of the ENDEAVOUR EAB (Extended Advisory Board) and other well-know experts which were invited for the second ENDEAVOUR workshop. During this workshop the consortium met with the experts at CNRS-LAAS Toulouse on July 1st, 2016. Experts who could not travel to Toulouse participated via video-conference. This workshop gathered feedback on the current developments within the project, e.g., use cases, implementation, and next steps.

The workshop participants are experts from the academia as well as from the industry. The academic experts who attended are highly distinguished for their expertise in inter-domain routing, programmable networks, Internet architectures, measurements, network security and IXPs. Our representatives from industry are well established experts across multiple sectors, including carrier networks and service providers optimization, networking

hardware vendors and large Internet content providers.

At the beginning of the workshop, we briefly introduced the project and outlined the accomplished milestones. Then, we presented the progress on the work being done for the integration of two core components of the ENDEAVOUR platform, i.e., iSDX and Umbrella, and highlighted the technical challenges. The integration of these components realizes the ENDEAVOUR architecture upon which the ENDEAVOUR demonstrator is built. Beyond the demonstrator's architecture, we explained and discussed the project use cases in detail. The attendees of the workshop contributed a wide range of feedback at different levels ranging from high-level ideas, suggestions, and directions, to technical advise and comments.

Overall, the feedback we obtained supports the ultimate goal of ENDEAVOUR to impact the Internet at large by bringing SDN to IXPs. Thus, it will be considered for further developments of the demonstrator and all related activities within the project.

2 Demonstrators for Implementation Feedback Workshop

The workshop aimed at presenting the recent developments of the ENDEAVOUR platform, illustrating the use cases of ENDEAVOUR, and collecting valuable feedback from the audience.

Updating on the status of the ENDEAVOUR platform, the core of this presentation focused on the integration of the iSDX and the Umbrella components, highlighting the key benefits of the resulting architecture. After collecting the feedback on the main architecture, an overview of the use cases also was presented. The goal was to better identify which use cases would have the most operationally impact, and therefore should be developed on top of the ENDEAVOUR architecture.

In the following, we report on the audience of the workshop, give background information about the demonstrator and the use cases, and give an account of the feedback received by the audience.

2.1 Audience

We invited an heterogeneous group of internationally recognized networking experts belonging to both the academia and industry. Below is the list of the participants.

Expert	Affiliation	Fields of Expertise
Jennifer Rexford	Princeton University	Software Defined Networking; Enterprise and data-center networks; Network virtualization; Internet architecture; TE; Interdomain routing; Internet measurement
Xenofontas Dimitropoulos	FORTH / University of Crete	Internet measurements; Interdomain routing
Josh Bailey	Google	Software Defined Networking; Network management; Internet measurements
Yatish Kumar	Corsa Technology	Networking and communication industry experience
Carolyn Raab	Corsa Technology	Networking and communication industry experience
Ben Mack-Crane	Corsa Technology	Networking and communication industry experience
Bernhard Plattner	ETH Zürich	Network security; Internet measurements; Internet architecture
Ingmar Poese	BENOCS	Internet routing; TE
Ilya Baldin	RENCI	High-speed optical network architectures; Cross-layer interactions; Signaling schemes; Network security

2.2 Demonstrator Development

An integral part of ENDEAVOUR is the development of a demonstrator to showcase the initial work documented in previous deliverables [2, 4, 1, 5]. DE-CIX, UCL, QMUL, and CRNS closely collaborate in the ongoing development process to implement the demonstrator, including a selection of use cases presented in [1, 5].

Figure 1 depicts an overview of the ENDEAVOUR platform as envisioned in [2]. The ENDEAVOUR platform builds upon an ongoing research project, namely iSDX [8], which is led by Princeton and where UCL has contributed. The team behind iSDX has developed a promising architecture designed for enabling policies and more flexibility within an IXP using the SDN technology.

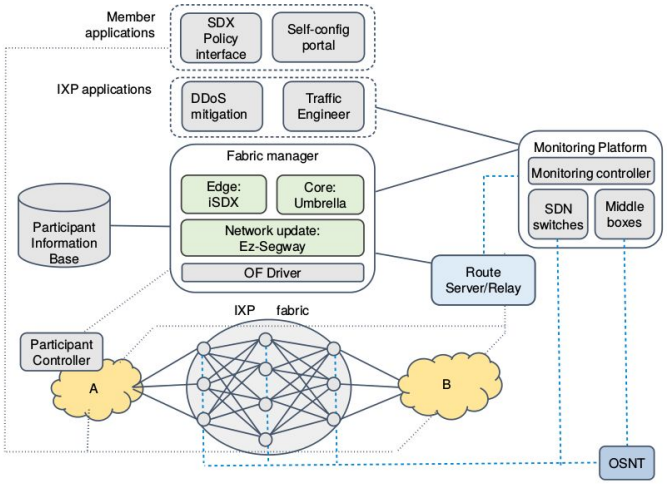

Figure 1: ENDEAVOUR architecture [2].

Since the iSDX code [9] is available under the Apache License Version 2.0, the ENDEAVOUR partners decided to use the already available development of iSDX and further extend and adapt it to the objectives and requirements of the ENDEAVOUR project. The current development state of the ENDEAVOUR platform is available on GitHub [6]. While iSDX already includes some building blocks required for the ENDEAVOUR architecture, as depicted in Figure 1, we made fundamental changes to the original code. We integrated the designs of iSDX and Umbrella [2] into the ENDEAVOUR fabric manager. By integrating the Umbrella design, we contributed new features in multiple areas, including:

- Support of multi-switch IXP topologies;
- Address Resolution Protocol (ARP) broadcast prevention;
- Path encoding based on layer 2 destination address encoding.

The presentation also reported on the ongoing development process, whose effort is distributed across the project partners, and also presented an available testbed which was set up at DE-CIX.

In addition to the ENDEAVOUR platform, the consortium is also making progress towards implementing various use cases. During the workshop, the presentation described an up-to-date list of the use cases and their development status, which is also available in [7]. We are continuously working

towards a functional demonstrator which we want to showcase to a broader audience later this year.

2.3 Feedback

The strong interest of the audience on ENDEAVOUR was shown by the multitude of high quality and deeply technical comments. This section summarizes the feedback obtained during the workshop. First, we list the feedback received regarding the ENDEAVOUR platform. Then, we report the comments raised during the discussion. In addition to those questions, there were a number of minor technical questions to clarify the understanding of the ENDEAVOUR demonstrator. We do not report these minor questions.

Below is the main feedback we received.

- Umbrella broadcast control/layer 2 hygiene features and scaling features are really important (especially as non-SDN exchanges struggle with these things - AMS-IX has the ARP sponge, but still exchanges just tell everyone one MAC address per port and hope for the best).
- iSDX TE features the operator world is perhaps not quite mentally ready for. But those features can be used to implement Distributed Denial of Service (DDoS) protection combined with fine grained OpenFlow rule type matching as discussed.
- iSDX is not industrial scale given the single switch limitation and peer can override the provided next hop. However the TE features will be as useful as above.
- Switches have improved. Broadcom-based switches are relatively inexpensive and have OpenFlow Abstractions that do OpenFlow 1.3 multi-table (rather than relatively primitive OpenFlow Data Plane Abstractions). Today's hardware does 10^6 flows, potentially more in special cases (and that is just what is shipping today). It might be good to revisit the fabric design to take advantage of multi-table/more flows (even multi-table by itself improves scaling). Or, what is enabled by a network with switches of differing capabilities (we don't have to use the same switch everywhere in the fabric).
- Regulators may be interested in what happens in exchanges. Might be good to understand what regulators think.

- Requiring interoperability with non-SDN devices is still key (data to this point shows that SDN adoption for one reason or another is very slow, so to have an impact, interoperability is critical).
- Being able to make use of higher resolution timeseries of counters would be great.
- Of all possible use cases, DDoS and other security related ones may be best to concentrate on first as is likely to be of most interest to the operators.

The most relevant questions during the discussion are listed below.

- "Can you use Multi-Exit Discriminator (MED) as of today and will it be possible with the ENDEAVOUR SDX?": Indeed, the current IXP implementation is capable of MED and redistributes it to other members as defined by the policies. However, some networks may not take it into account and others may ignore it purposively. In contrast, the SDN enabled implementation will be able to enforce such policies.
- "Do you consider TE across several IXPs?": At the present moment it is not a feature, however due to recent developments in the IXP space we may consider it in the future.
- "What are the implication for Quality of Service (QoS) policies at the exchange when the customer wants to put in place end-to-end quality of service?": We have considered this for a use case in D4.3 [5]. However, since the challenge here is rather the coordination of members (i.e., standardization) and the IXP only has to deliver a frame without altering information, we did not select this use case for implementation in the demonstrator yet. For the future we envision the IXP, as neutral entity, to help to negotiate QoS policy metrics as a broker.
- "How is the situation regarding the monitoring capabilities of the platform going to change? Will there be more detailed monitoring capabilities on flow/subflow-level?": This strongly depends on the implementation in hardware. The OpenFlow interface supports monitoring on such detailed levels. For instance, the Corsa switches have special statistics in the hardware. The hardware has the capabilities for high speed fine grained counting without packet loss. These counters are connected to serial links with high bandwidth. However, getting the statistics out of the hardware boxes might prove challenging.

- "Considering the ENDEAVOUR architecture, are the routing policies expressed by an SDX member treated confidentially or are they shared amongst all members?": To address this issue, Chiesa presented some ongoing work in SIXPACK [3], which helps to maintain privacy of routing policies.

2.4 TouSIX Visit

TouSIX, an IXP based in Toulouse that has expressed great interest in the project, generously offered to the ENDEAVOUR consortium a guided tour through their data center. This rare opportunity to verify the theoretical insights from virtualized testbeds with real-world implementations was embraced by the consortium, which visited the data center.

3 Summary

The second ENDEAVOUR workshop has been largely positive. It reported on the advancements of the demonstrator development and use cases being considered for implementation. The consortium obtained important feedback by an audience of invited experts from academia and industry. As a result, we will proceed with the implementation, address the feedback, and prioritize according to the input of the workshop while accounting for the resources of the consortium.

4 Acronyms

SDN Software Defined Networking

IXP Internet eXchange Point

QoS Quality of Service

DDoS Distributed Denial of Service

TE Traffic Engineering

ARP Address Resolution Protocol

MED Multi-Exit Discriminator

References

[1] S. Bleidner, C. Dietzel, and M. Bruyere. ENDEAVOUR Deliverable 4.2: Design of Use Cases for Operators of IXPs, 2016.

[2] M. Bruyere, M. Canini, M. Chiesa, and T. Nguyen. ENDEAVOUR Deliverable 2.2: Design and Final Requirements of the SDN Architecture, 2016.

[3] M. Chiesa, D. Demmler, M. Canini, M. Schapira, and T. Schneider. Towards Securing Internet eXchange Points Against Curious onlooKers. In *Proceedings of ANRW'16)*, Jul 2016.

[4] I. de Castro, T. Boettger, E. Leao, and C. Dietzel. ENDEAVOUR Deliverable 3.2: Design and Final Requirements of the Monitoring Platform, 2016.

[5] C. Dietzel, S. Bleidner, G. Kathareios, P. Owezarski, S. Abdellatif, M. Chiesa, M. Canini, and Antichi. ENDEAVOUR Deliverable 4.3: Design of Use Cases for Members of IXPs, 2016.

[6] ENDEAVOUR. ENDEAVOUR platform. `https://github.com/h2020-endeavour`.

[7] ENDEAVOUR. ENDEAVOUR Use Case Overview. `https://github.com/h2020-endeavour/endeavour/blob/master/usecases.md`.

[8] A. Gupta, R. MacDavid, R. Birkner, M. Canini, N. Feamster, J. Rexford, and L. Vanbever. An Industrial-Scale Software Defined Internet Exchange Point. In *12th USENIX Symposium on Networked Systems Design and Implementation (NSDI 15)*, 2016.

[9] iSDX. Industry Scale SDX Controller (iSDX). `https://github.com/sdn-ixp/iSDX`.