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## **ENDEAVOUR Towards a flexible software-defined network ecosystem D5.8: Final report on exploitation and dissemination plans**

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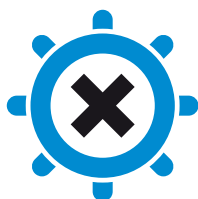
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# ENDEAVOUR: Towards a flexible software-defined network ecosystem



## ENDEAVOUR

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20/12/17	0.6	Change website picture	Owezarski

## Executive Summary

This deliverable presents exploitation plans for the project members as well as dissemination activities during the last year of the project. It also describes the implementation results for the software tools developed during the project. Dissemination includes, e.g., scientific papers, journals and conferences of interest, press releases. Current to-date activities are presented, targeting different scientific communities, students, stakeholders, IXP operators, IXP members, and decision makers. ENDEAVOUR dissemination and exploitation plans aim at ensuring that all relevant stakeholders, decision makers, IXP operators, IXP members, and communities are informed about project activities and outcomes. ENDEAVOUR dissemination consisted of activities of project promotion as a whole, and dissemination of specific and innovative results (e.g., scientific papers).

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## 1 Dissemination Plan


During the three years, ENDEAVOUR has focused on spreading the project ideas and use case scenarios through publishing news on different project / platform websites, forums, etc. Specifically, the main dissemination goal was to create a group of followers (network providers, network operators, IXPs, end-users) eager to use our results for their own network management and operation activities, services and deployment. A secondary goal was to collect requirements expressed by IXP operators and IXP end users, and issue related use cases. To this end, the dissemination plan of the partners of the ENDEAVOUR project consisted of the following activities.

- Publishing premier high-quality papers in major international conferences and journals in the area of networking to promote new ideas and concepts stemming from project activities and outcomes.
- Gaining requirements from IXP operators and members.
- Dissemination of results and prototype implementations to companies for possible industrial exploitation.

### 1.1 Project Website

The ENDEAVOUR public portal (<https://www.h2020-endeavour.eu/>) offers an extensive compilation of relevant information for project members, partners, reviewers (European Commission) and anybody else interested in the ongoing research carried out at the ENDEAVOUR project. A detailed description of this portal can be found in the ENDEAVOUR deliverable D5.2. As a key aspect, the ENDEAVOUR portal contains links to the main communication channels for dissemination and feedback. This website, publicly accessible at <https://www.h2020-endeavour.eu/>, describes the main goals of the ENDEAVOUR project. It also featured a collaborative tool for the consortium members. The portal is based on Drupal, an open source CMS tool.

Reserved access



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**ENDEAVOUR @ KAUST-NSF Conference on Environmental Monitoring**

Marco Canini will present the ENDEAVOUR project at the [KAUST-NSF Conference on Environmental Monitoring](#).

**Towards a Flexible Software-Defined Network Ecosystem**

[Read more](#)

**ENDEAVOUR @ MAKI Scientific Workshop 2016**

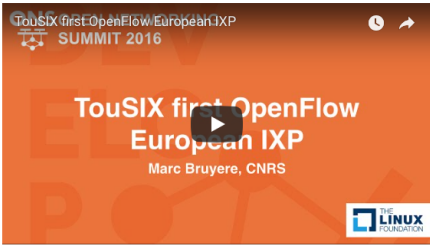
Marco Canini gave an invited talk at the [MAKI – Scientific Workshop 2016](#) titled *Towards a Flexible Software-Defined Network Ecosystem*, where he presented some of the ongoing activities of the project. This is the abstract of the talk:

[Read more](#)

**ENDEAVOUR @ Open Networking Summit**

A small representation of the ENDEAVOUR team was present at the [Open Networking Summit 2016](#), where Marc Bruyere gave a talk about TouSIX, the first European IXP backed by OpenFlow SDN.

Watch below the video recording of the talk.



[Read more](#)


**Twitter Feed**

Tweets by @h2020\_endeavour

endeavour Retweeted

**Marc Bruyere** @bruyere marc

So glad to be presenting at the first @faucetsdn conference at @BerkeleyLab  
Thanks to @TOUJX\_GIX @h2020\_endeavour sekiya-lab.info



Oct 19, 2017

endeavour Retweeted

**Marc Bruyere** @bruyere marc

Ignacio Castro from QMUL is presenting the work done by @h2020\_endeavour at @euimiv

[Embed](#) [View on Twitter](#)

Figure 1: Main menu of ENDEAVOUR website

The project web site is kept up to date so as to provide an accurate view on the work performed and the results achieved in the ENDEAVOUR project, as reflected by Figure 1.

## 1.2 Conferences, workshops, and journals

One of the important dissemination activities dealt with publishing premier high-quality papers in major international conferences and journals, and giving talks in workshops in the area of networking to promote new ideas and concepts stemming from project activities and outcomes. This dissemination activities also include giving talks, making demos, or presenting tutorials.

Currently published papers in 2017 are listed below:

- Antichi, G., Castro, I., Chiesa, M., Fernandes, E. L., Lapeyrade, R., Kopp, D., Han, J. H., Bruyere, M., Dietzel, C., Gusat, M., Moore, A. W., Owezarski, P., Uhlig, S., Canini, M.. (2017). “ENDEAVOUR: A Scalable SDN Architecture for Real-World IXPs ”. In *IEEE Journal on Selected Areas in Communications*, 35(11), November 2017.
- Kathareios, G., Anghel, A., Mat, A., Clauberg, R., Gusat, M., (2017), “Catch it if you can: Real-Time Network Anomaly Detection with Low False Alarm Rates”, *International Conference on Machine Learning Applications (ICMLA2017)*, December 2017.
- Chiesa, M., Demmler, D., Canini, M., Schapira, M., Schneider T. (2017). “SIXPACK: Securing Internet eXchange Points Against Curious onlookers”. In *International Conference on emerging Networking EXperiments and Technologies (CoNEXT 2017)*, December 2017.
- Varga, P., Kathareios, G., Mat, A., Clauberg, R., Anghel, A., Orosz, P., Nagy, B., Tothfalusi, T., Kovacs, L., Gusat, M. (2017). “Real-Time Security Services for SDN-based Datacenters”, *International Conference on Network and System Management, (CNSM)*, November 2017.
- Giotsas, V., Smaragdakis, G., Dietzel C., Richter, P., Feldmann, A., Berger, A. (2017). “Inferring BGP Blackholing Activity in the Internet”. In *ACM Internet Measurements Conference (IMC)*, 2017.
- Giotsas, V., Dietzel C., Smaragdakis, G., Feldmann, A., Berger, A., Aben, E. (2017). “Detecting Peering Infrastructure Outages in the Wild”. In *ACM SIGCOMM 2017*.
- Simo Tegueu, A.F., Abdellatif, S., Villemur, T., Berthou, P., “A dynamic resource defragmentation scheme for virtualized SDN-enabled substrate networks”, *6th IEEE International Conference on Cloud Networking (CloudNet)*, Prague, Czech Republic, September 2017.



- Chen, L., Abdellatif, S., Gayraud, T., Berthou, P. “A Steiner Tree Based Approach For The Efficient Support Of Multipoint Communications In A Multi-Domain Context”, 22nd IEEE Symposium on Computers and Communications ( ISCC 2017 ), July 2017, Heraklion, Greece, 2017.
- Simo Tegueu, A.F., Abdellatif, S., Villemur, T., Berthou, P., “A reactive resource defragmentation method for virtual links mapping in software-defined networks”, 23rd IEEE International Symposium on Local and Metropolitan Area Networks (LANMAN 2017), June 2017, Osaka, Japan.
- Nguyen, T. D., Chiesa, M., Canini, M. (2017). “Decentralized Consistent Updates in SDN”. In Symposium on SDN Research (SOSR '17).

The current list of demos performed is listed below:

- Dethise, A., Chiesa, M., Canini, M. (2017 August). “Privacy-Preserving Detection of Inter-Domain SDN Rules Overlaps”. In Proceedings of SIGCOMM (SIGCOMM'17), Los Angeles, USA, August 2017
- Dietzel, C., Antichi, G., Castro, I., Fernandes, E.L., Chiesa, M., Kopp, D., “SDN-enabled Traffic Engineering and Advanced Blackholing at IXPs”, Proceedings of Symposium on SDN Research (SOSR '17), Santa Clara, CA, USA, April 3 - 4, 2017.
- Canini, M., Chiesa, M. (2017 February). “Towards a Flexible Software-Defined Network Ecosystem”, KAUST Global IT Summit 2017, KAUST, Saudi Arabia, February 8-10, 2017

Talks given are listed below:

- Canini, M., “Towards a Flexible Software-Defined Network Ecosystem”, KAUST- NSF Conference on Environmental Monitoring, KAUST, Saudi Arabia, November 6-8, 2017
- Dietzel, C., ”Inferring BGP Blackholing Activity in the Internet”, RIPE Meeting 75, Dubai, UAE, 24 October, 2017.
- Bruyère, M., “SDN IXP”, 1st FAUCET SDN conference, Berkeley, CA; USA, 19 October, 2017.

- Castro, I., “ENDEAVOUR: Towards a flexible software-defined network ecosystem”, EURO-IX’31, Bratislava, Slovakia, 16 October, 2017.
- Dietzel, C., ”Peering Outages in the Wild”, Eurasia Network Operators Group Meeting 14, Minsk, Belarus, 9 October, 2017.
- Dietzel, C., ”BGP Community Harvesting: Detecting Peering Locations”, European Peering Forum, Lisbon, Portugal, 20 September, 2017.
- Dietzel, C., ”Peering Outages in the Wild”, European Peering Forum, Lisbon, Portugal, 19 September, 2017.
- Bruyère, M., “Umbrella Fabric - OpenFlow SDN - The TouIX to TouSIX experience”, SDN IXP by Internet NZ Workshop, Wellington, New Zealand, 27 June, 2017.
- Dietzel, C., ”ENDEAVOUR: Towards SDN enabled IXP”, NANOG, Washington DC, USA, 7 March, 2017.
- Bruyère, M., “Umbrella Fabric - OpenFlow SDN - The TouIX to TouSIX experience”, APNIC-APRICOT workshop, Ho Chi Minh City, Vietnam, 27 February 2017.
- Bruyère, M., “Umbrella Fabric - OpenFlow SDN - The TouIX to TouSIX experience”, SANOG, Islamabad, Pakistan, 24 January, 2017.

### 1.3 Open source releases

The software developed within ENDEAVOUR is released as open source as much as possible to foster dissemination. A GitHub repository is used for that purpose and is directly accessible from the ENDEAVOUR web site.

### 1.4 ENDEAVOUR Workshops

The External Advisory Board workshop took place on August 24th, 2017, in Los Angeles, in parallel with SIGCOMM conference.

The use case demonstration workshop took place during EURO-IX’31, in Bratislava, Slovakia. D5.7 [1] summarizes the event and the feedback we received.

## 2 Exploitation plans

### 2.1 Academic Partners

Academic partners have common objectives in terms of dissemination and exploitation. As such, for all academic partners involved in the ENDEAVOUR project, dissemination and exploitation plans include:

- Publishing premier high quality papers in major top conferences and journals in the area of networking, security, and QoS to promote our new disruptive ideas and concepts.
- Gaining significant skills in the area of IXP fabrics building and management, and all related applications and services. Such skills and knowledge will lead to new courses to be held to PhD students thanks to summer schools, or to undergraduate students of universities and engineering schools.
- Finding new research directions and prospecting for new academic and industrial partners for future research projects based on skills and results gained in ENDEAVOUR.
- Disseminate our upcoming results and prototype implementation to company for possible industrial exploitation.

Details on this dissemination and exploitation plans for each academic partner are given in the following.

#### 2.1.1 Queen Mary University London

The Queen Mary University of London exploitation plans include:

- The publication of academic papers.
- Talks on topics related to ENDEAVOUR.
- Collaboration with potential industrial partners: the Queen Mary University of London collaborated with the TouIX IXP in Toulouse, CNRS and Cambridge in the design of the UMBRELLA architecture.

#### 2.1.2 Université catholique de Louvain

For its exploitation purposes, the UCL plans included:

- Papers that have been published.

- Talks on topics related to ENDEAVOUR.
- Achieve a positive impact on IXP operations at DE-CIX.
- Collaborations with new partners: the UCL has collaborated with Princeton University and ETH Zurich on the design of iSDX, a scalable SDX design and open source implementation that has already spurred early adoption in a US government agency. The UCL has also started collaborating with Università della Svizzera italiana and attracted the interest of a potential industrial partner, Netronome, for the work on NetPaxos.
- The UCL has collaborated with UFRGS on the design of Dynam-ix, a **Dynamic Interconnection eXchange**. Through user surveys on IXP port utilization, we confirm a continuous significant amount of spare capacity in the IXP ports. We posit that through a dynamic marketplace in the IXPs, we may utilize this spare capacity for dynamic agreements to offer faster port utilization and congestion control. We devised Dynam-ix as an approach and architecture that enables dynamic interconnection agreements.

### 2.1.3 University of Cambridge

University of Cambridge started gaining contributions for its exploitation purpose:

- Papers have been published.
- Talks, Tutorials and Demo have been carried out successfully.
- Dealing new possible industrial partners: University of Cambridge together with CNRS collaborate with the TouIX IXP in Toulouse. In particular, the design of the UMBRELLA architecture, where UCAM has been actively involved, helped to create a strong relationship with the aforementioned IXP. While the ENDEAVOUR consortium took advantage demonstrating its outcomes on a small environment, TouIX benefited demonstrating new technologies thus potentially attract new customers.

### 2.1.4 CNRS

As shown in this deliverable, CNRS gained contributions for its exploitation purpose:

- Papers have been published.
- For academic teaching, even if no specific lecture has been yet included for students at university or engineering schools, the way networking is taught takes into consideration the new requirements that network operators, IXP operators, and end users expressed.
- Dealing with prospection for new industrial partners, CNRS is now involved in a project with the TouIX IXP in Toulouse. The development objectives of TouIX and ENDEAVOUR being very close, and CNRS being involved in both projects, we set-up a win-win strategy between the two projects. Thus, ENDEAVOUR consortium largely benefited from being able to take advantage of a small and open IXP for testing some of the solution that it designed (for instance the UMBRELLA architecture). On the other side, TouIX could demonstrate the benefits of such new technologies to its members, and potentially gain new members.
- CNRS and TouIX applied for organizing the Euro-IX event in 2017. Our application was finally not selected for 2017. This would have been a premier exposure for ENDEAVOUR results.
- CNRS and IBM found common interest in machine learning based traffic characterization and anomaly detection. The requirements of the use case which IBM is working on significantly overpass the scale of the experiments that CNRS did performed in the framework of the ENDEAVOUR project. Big data techniques could then be one solution to study and integrate. CNRS was also a partner of the European FP7 ONTIC project that specifically dealt with issuing new algorithms for traffic classification in big data environments. ONTIC specifically took advantage of the Hadoop facilities. For that purpose, CNRS then developed a new version of its ORUNADA algorithm so as to take advantage of Hadoop STORM. A large scale experiment has been run, expecting that the performance results will match the IBM requirements. It finally failed. New solutions will be studied after the end of the ENDEAVOUR project.

### 2.1.5 King Abdullah University of Science and Technology

For its exploitation purposes, the KAUST plans included:

- Papers that have been published.

- Talks on topics related to ENDEAVOUR.
- Achieve a positive impact on IXP operations at DE-CIX.
- Collaborations with new partners: KAUST has collaborated with Princeton University and ETH Zurich on the design of iSDX, a scalable SDX design and open source implementation that has already spurred early adoption in a US government agency. KAUST has also started collaborating with Università della Svizzera italiana and attracted the interest of a potential industrial partner, Netronome, for the work on NetPaxos.

## 2.2 Industrial Partners

Beside the industrial focus, ENDEAVOUR's industrial partners also had a strong research interests, which is in-line with the academia exploitation plan including:

- Publication of high-quality papers in major top conferences and/or workshops.
- Talks, tutorials and/or demos on topics related to ENDEAVOUR's goals.
- Exploiting new research directions in the area of SDN at IXPs.
- Collaborations with new partners: establish close cooperations with academic partners for ongoing research activities as well as future EU-funded projects, for instance in the field of networking, SDN and monitoring.

### 2.2.1 DE-CIX

The DE-CIX exploitation plans include:

- Extend DE-CIX's peering platform, services, and development activities with the ideas, concepts, and prototypes developed by ENDEAVOUR. DE-CIX focuses on bringing those prototypes to a production-ready state for commercial deployment. DE-CIX operates IXPs at various locations at different scales, thus enabling to deploy SDN at smaller IXPs first, while exploring possibilities to scale the technology to larger IXPs successively.

- Contribute to standardization processes at the IETF to make the outcomes of the ENDEAVOUR project available to a wider audience with a strong practical focus.
- Giving talks at operator centric conferences, such as RIPE, NANOG, or EURO-IX to promote the results of ENDEAVOUR.
- Discuss the ENDEAVOUR outcomes with IXP members to align with their requirements for the future. Furthermore, DE-CIX targets SDN deployments in particular with a direct benefit for its members in mind.
- Closely cooperate with hardware vendors to support them building SDN capable hardware suited for the needs of IXPs, especially in terms of scalability and feature support.

### 2.2.2 IBM Research

The IBM Research exploitation plans include:

- Exploring potential use cases and applicability of ENDEAVOUR to IBMs product portfolio, in the areas of datacenter networking, Cloud and High-Performance Computing (HPC) interconnects. IBM may exploit the ENDEAVOUR results for their developments of IT systems for Cloud, datacenter, virtualization, and Big Data appliances, potentially also including emerging trends in custom HPC.
- Provide input to SoftLayer and IBM labs (Cloud Innovation Lab, Watson) on ENDEAVOUR-related topics such as: 1) off-/on-line monitoring products, 2) improved management tools for multitenant datacenters, 3) the next-next-generation of virtualization extensions to be added to the currently limited SDN/OpenFlow, as well as monitoring and sampling (sFlow, AQM/RED) networking standards and 4) potentially helping IEEE, IETF, ITU and the other standardization bodies with the results acquired in the area of SDN and distributed high speed (beyond 10Gbps) monitoring.

The commercial impact of these plans could be witnessed in:

- Lower IBMs Cloud TCO and power consumption.
- Increased security of the multitenant datacenter, while improving the workload/traffic observability - hence securing better QoE per tenant and lower management costs for Cloud operators.

- Enabling the standardization of IBM's next generation of monitoring for 100/400Gbps/1Tbps Converged Enhanced Ethernet architectures.



### 3 Acronyms

**IXP** Internet eXchange Point  
**CMS** Content mangement System  
**SDN** Software Defined Network  
**QoS** Quality of Service  
**QoE** Quality of Experience  
**SDX** Software Defined eXchange  
**TouIX** Toulouse Internet eXchange  
**RIPE** Réseaux IP Européens  
**NANOG** North American Network Operating Group  
**HPC** High Performance Computing  
**AQM** Active Queue Management  
**RED** Random Early Detection  
**IETF** Internet Engineering Task Force  
**ITU** International Telecommunication Union  
**SANOG** South Asia Network Operator Group  
**APNIC** Asia Pacific Network Information center  
**SIGCOMM** Special Interest Group on COMMunication  
**EURO-IX** EUROpean Internet eXchange congress  
**CNRS** Centre National de la Recherche Scientifique  
**UCL** Universit Catholique de Louvain  
**ETH** Eidgenssische Technische Hochschule  
**iSDX** Industrial-Scale Software-Defined IXP  
**UFRGS** Universidade Federal do Rio Grande do Sul  
**IBM** International Business Machines Corporation  
**FP7 ONTIC** Framework Program 7 - Online Network Traffic Characterization  
**ORUNADA** Online Real-time Unsupervised Network Anomaly Detection  
**KAUST** King Abdullah University of Science and Technology  
**IT** Information Technology  
**IEEE** Institute of Electrical and Electronics Engineers  
**TCO** Total Cost of Ownership

## References

- [1] Dietzel, Castro, and Kopp. D.5.7. Report from Use Case Demonstration Workshop. In *Deliverable of the H2020 ENDEAVOUR project*, Dec 2017.