ICT-257422

CHANGE

CHANGE: Enabling Innovation in the Internet Architecture through Flexible Flow-Processing Extensions

Specific Targeted Research Project

FP7 ICT Objective 1.1 – The Network of the Future

D6.1 – Dissemination and Exploitation Plan and Record

Due date of deliverable: January 15th, 2012

Actual submission date: January 31, 2012

Start date of project	October 1, 2010
Duration	36 months
Lead contractor for this deliverable	NEC Europe Ltd.
Version	1.0, January 31, 2012
Confidentiality status	Public

Abstract

This document lays out the dissemination and exploitation plan of the CHANGE project partners and presents a record of early dissemination activities.

Target Audience

The general public.

Impressum

Full project title	CHANGE: Enabling Innovation in the Internet Architecture through Flexible Flow-Processing Extensions
Title of the workpackage	WP6 – Dissemination, Exploitation and Standardization
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This project is co-funded by the European Union through the ICT programme under FP7.

Executive Summary

This document lays out the dissemination and exploitation plan of the CHANGE project partners and presents a record of early dissemination activities. The project has taken the approach of targeting prestigious dissemination venues, choosing quality over quantity. It has already managed to achieve publications in top-tier conferences such as ACM IMC, USENIX NSDI and IEEE INFOCOM, given a series of world-wide academic and industrial talks, and released some of its code as open source, some of which have been already included as part of FreeBSD. In this deliverable we describe these and a number of other CHANGE dissemination activities carried out so far.

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Work-package	WP6 – Dissemination, Exploitation and Standardization
Security	PUBLIC (PU)
Nature	R
Version	3.0
Total number of pages	15

Contents

1 Introduction and Overall Strategy

Since the beginning of the project, the dissemination and exploitation plan of CHANGE has focused on quality rather than quantity, targeting a limited number of prestigious outlets for its results. This is coupled with a focus on a number of diverse dissemination activities including publications, workshops and international talks, to name a few.

Concentrating on high quality venues begins with publications. CHANGE partners always target top-tier conferences and journals. Even though this results in a lower number of publications, this ensures that they reach the widest and most qualified audience. With this goal in mind, CHANGE partners have already gotten several papers accepted: an ACM IMC paper, two ACM SIGCOMM posters (one given the best poster award), a CoNEXT 2010 PRESTO paper, an IEEE INFOCOM paper, and a USENIX NSDI paper, among others (please refer to the next section in this deliverable for a full list of publications).

Another important dissemination outlet is open source software: high-quality, free open source software is an excellent means to disseminate project results, as it can potentially lead to large numbers of developers in the field to adopt it. To this end, the CHANGE project has already produced Netmap, a novel framework for fast packet I/O that can, for example, allow a single core running at 900 MHz to generate the 14.8 Mp/s that saturate a 10Gb interface. The source for netmap is freely available, and efforts have been made to use it to enhance the performance of the popular Click modular router system; active development currently targets porting Netmap to Linux for even wider adoption and dissemination.

Yet another important means of disseminating the project's results is participation in EC-organized events, where CHANGE has given talks for IECT 2010, the Future Internet Cluster, and has two members in the European Future Internet Assembly (FIA). Further, CHANGE has been collaborating with other EU FP7 projects in the area. In particular, it has contributed requirements to the OFELIA testbed, and has organized a summer school jointly with that project.

To further disseminate project concepts and results, CHANGE partners have been involved in a series of world-wide lectures and talks, including seminars at the Chinese Academy of Science in Beijing, at the 3rd Future Internet Testbed and Research (FIT&R) Workshop in Korea, and a keynote at the Social Networks and Future Internet Workshop in Annecy, France, and many others. Further, CHANGE partners have given industry talks at world-class companies such as Apple, HP Huawei and Technicolor, including an hour-long Google Tech Talk.

A further venue for dissemination are the CHANGE-sponsored workshops. Out of three planned ones, the first one, called the summer school, has already taken place. Organized in collaboration with the EU FP7 OFELIA project, the school was a great success, hosting more than 54 PhD students and researchers. The program contained presentations by well-known international experts. The topics of the tutorials covered Future Internet, (optical) network virtualization, NetFPGAs with the focus on OpenFlow as seen by researchers, hardware vendors, and network operators (much more detailed information on the summer school will be

given in deliverable 6.2 of the project).

One final dissemination activity consists of standardization activities. Here, two CHANGE partners, NEC and DT, have been actively involved in the Open Networking Foundation (ONF) since its inception (the ONF is the standardization body for OpenFlow), with DT being on the ONF board that gives strategic directives and one member of NEC receiving the Outstanding Technical Contributors award. Further, CHANGE is also co-chair of the IRTF's Virtual Networks Research Group, and will seek to contribute, as the project matures, to various IRTF working groups related to topics of virtual and software defined networks.

Regarding exploitation, the four industry partners in CHANGE (NEC, DT, Nextworks and Dreamlab) will seek to exploit the project's results for existing and future products. For instance, NEC will aim to enhance its network infrastructure solutions and network control platform portfolio by carrying out technology transfers to NEC Business Units, thus taking advantage of open innovation in the European environment; enhancing the interoperability of its solutions by influencing standards related to the development of new products in the area of flow processing; and continuing the high level of scientific excellence of NEC's European R&D through high-level publications and membership at top conferences.

Nextworks participation in CHANGE has the objective of advancing the company expertise on programmable networking platforms based on commodity/legacy hardware. Nextworks is interested in CHANGE's Flow Processing architecture and, in particular, the definition of enhanced Control Plane tools for these platforms have the potential to open new market opportunities in the Future Internet. By participating in the architectural and prototype development activities in CHANGE, Nextworks will start pursuing this new business activity, by taking advantage of the outstanding and renowned R&D consortium assembled by the project, with views towards developing novel Flow Processing products.

DT expects that the results of CHANGE contribute significantly to the introduction of innovative services based on virtualized and open network architectures. More flexibility and the ability to provide individually tailored network/service environments to customers are seen as the key for commercial success in the future. During the runtime of the project T-Labs will permanently have a tight synchronization with the relevant business units of DT, especially with the Group's strategic business units.

Finally, Dreamlab will aim to greatly profit from CHANGE results in terms of strengthened collaboration with top researchers in Europe and with the final goal of using the project's results as input to the company's existing network solutions portfolio.

As shown, the multi-pronged, high-quality approach of the CHANGE project is already producing important dissemination and exploitation results. This trend is likely to only improve as the output of the project matures.

2 Early Dissemination Activities

This section covers, in great detail, all of the dissemination activities of the CHANGE project to date. A further deliverable due at the end of the project, D6.5, will cover all of the project's activities.

2.1 Standardization

The CHANGE project has been active in, or is seeking to target, a number of standardization bodies. Here's a summary of the activities to date.

IETF/IRTF The CHANGE project is currently participating in two areas. The first consists of the IRTF's Virtual Networks Research Group, where NEC is the initiator and co-chair. This RG aims at a venue for discussing ideas with respect to network virtualization as a new means for today's Internet, as a transition path to new technologies, or as an integral part of the future Internet. Researchers from the US, Europe, and Asia discuss what exactly network virtualization could bring as benefit, how it is impacting the Internet, and what might be the impact to the Internet architecture. Key players at this point in time are University of Southern California/ISI, the EU 4WARD project, Alcatel-Lucent, NSN, and NEC.

A second area currently being monitored by CHANGE partners is the Software Driven Networks (SDNP) Birds-Of-a-Feather (BOF). Software Driven Networks (SDN) is an approach to networks that enables applications to converse with and manipulate the control of software network devices and resources. SDNs are comprised of applications, control software, and interfaces to services that are hosted in an overlay or logical/virtual network, as well as the devices making up the physical network. Modern applications require the ability to easily interact and manipulate these resources. Applications can benefit from knowing the available resources and from requesting that the network make the resources available in specific ways. The key players at this point are CA Technologies and Infinera with participation from the ONF, Cisco, Juniper, and Verizon.

ONF: Founded in 2011 by Deutsche Telekom, Facebook, Google, Microsoft, Verizon, and Yahoo!, the Open Networking Foundation (ONF) is a nonprofit organization whose goal is to rethink networking and quickly and collaboratively bring to market standards and solutions. ONF will accelerate the delivery and use of Software-Defined Networking (SDN) standards and foster a vibrant market of products, services, applications, customers, and users.

ONF is led by a Board of Directors consisting of major network operators. It charters the working groups, appoints working-group chairs, and approves the standards. DT is a member of this board and is involved in strategic decisions. The Executive Director and Technical Advisory Group report to the Board, and the Executive Director oversees all market education and regional activities and chairs the Council of Chairs, which is made up of the chairs of the technical working groups.

Both DT and NEC have been very active in the ONF and have been members of the Open Networking Foundation (ONF) since the body was founded. NEC is participating in all ONF events, including member

meetings, trade shows, business education events, and others. Initially, the ONF established two working groups: the Extensibility WG for core OpenFlow protocol design and the Config-mgmt WG in charge of switch configuration and management. NEC has and is currently raising issues in the extensibility WG and is a major driver for the config-mgmt WG together with Microsoft (WG chair) and Infoblox. Further, Juergen Quittek, from NEC, recently received the Outstanding Technical Contributors award for his contributions [3]. Please note that we are not able to provide more information than this about the activities since the ONF has a policy of keeping such work private.

2.2 Publications

Despite it being only over a year old, the CHANGE project already has a number of publications, several of them in top-tier conferences. Here's a list of them:

- Norbert Egi, Adam Greenhalg, Mark Handley, Mickael Hoerdt, Felipe Huici, Laurent Mathy, Panagiotis Papadimitriou. Forwarding Path Architectures for Multicore Software Routers CoNEXT 2010 PRESTO Workshop Philadelphia, USA Nov 30th 2010.

- Luigi Rizzo, Matteo Landi. Netmap: memory mapped access to network devices. ACM Sigcomm 2011 Poster, Toronto (CA), Aug.17, 2011 (Best Poster Award). Proceedings of the ACM SIGCOMM 2011 conference, pg. 422-423

- Simon van der Linden, Gregory Detal, Olivier Bonaventure. Revisiting Next-hop Selection in Multipath Networks. Proceedings of the ACM SIGCOMM 2011 conference, Poster session.

- N. Sarrar, S. Uhlig, A. Feldmann, R. Sherwood, and X. Huang. Leveraging Zipf's Law for Traffic Offloading. To appear in ACM SIGCOMM Computer Communications Review, Vol. 42, No. 1, January 2012.

- C. Rotsos, N. Sarrar, S. Uhlig, R. Sherwood, and A. W. Moore. OFLOPS: An Open Framework for OpenFlow Switch Evaluation. To appear in proc. of PAM, Vienna, Austria, March 2012.

- M. Honda, Y. Nishida, C. Raiciu, A. Greenhalgh, M. Handley, H. Tokuda - Is It Possible to Extend TCP? - in proceedings of ACM Internet Measurement Conference (IMC) 2011, Berlin, Germany

- Luigi Rizzo, Marta Carbone, Gaetano Catalli. Transparent acceleration of software packet forwarding using netmap. IEEE Infocom 2012, Orlando, FL 25-30 March 2012 (to appear)

- Costin Raiciu, Christoph Paasch, Sebastien Barre, Alan Ford, Michio Honda, Fabien Duchene, Olivier Bonaventure, Mark Handley. How Hard Can It Be? Designing and Implementing a Deployable Multipath TCP. Proceedings of the 9th USENIX conference on Networked systems design and implementation, San Jose, CA, 2012.

Also note that UCLouvain filed in July 2011 a patent that covers the work on CFLB load balancing that is included in one of the deliverables.

2.3 Talks

As further dissemination, CHANGE partners have given a series of world-wide talks for both academic and industrial audiences. Here's a full list of these talks:

- Felipe Huici. Enabling Innovation in the Internet Architecture through Flexible Flow-Processing Extensions ICT 2010 Brussels, BE 27-29 Sept. 2010
- Felipe Huici. Enabling Innovation in the Internet Architecture through Flexible Flow-Processing Extensions EC Future Internet Cluster Brussels, BE 18-20 Oct. 2010
- Adam Kapovitz. Programmability of the infrastructure Smart Infrastructures session, FIA Ghent Ghent, Belgium 16/12/2010.
- Laurent Mathy. Virtualization and Software Networking CFIP2011, Sainte-Maxime, France 12/05/2011
- Laurent Mathy. Virtualization and Software Networking Seminar@UCLouvain Louvain-la-Neuve, Belgium 19/05/2011
- Laurent Mathy. Software Networking and Flow Processing Seminar Series, The Institute of Computing Technology, The Chinese Academy of Sciences Beijing, China 08/06/2011
- Laurent Mathy. Flow Processing for Internet Innovation 3rd Future Internet Testbed & Research (FIT&R) Workshop Seoul, Korea 13/06/2011
- Laurent Mathy. Virtualization and Software Networking 6th International Conference on Future Internet Technologies (CFI 2011) Seoul, Korea 14/06/2011
- Laurent Mathy. Virtualization and Software Networking Keynote at Social Networks and Future Internet Workshop Annecy, France 27/06/2011
- Vladimir Olteanu. Efficiently Migrating Stateful Middleboxes. Presentation during the Work in Progress Session - 23rd ACM Symposium on Operating Systems Principles Cascais, Portugal 23-26 Oct. 2011.
- Luigi Rizzo, Netmap: a Novel Framework for High Speed Packet I/O GoogleTechTalks, Google, Mt.View (CA), Aug.2011 http://www.youtube.com/watch?v=SPtoXNW9yEQ
- Luigi Rizzo, The netmap framework for fast packet I/O: status and future developments SOSP 2011 WIP session, Cascais (PT), Oct.25, 2011

- Luigi Rizzo, Marta Carbone, Gaetano Catalli, Improving the performance of Open vSwitch, EuroBSDCon 2011, Marseeen, NL, 8-9 oct. 2011 http://2011.eurobsdcon.org/talks.html
- Luigi Rizzo, Netmap: a Novel Framework for High Speed Packet I/O. HP Labs, Palo Alto (CA), Aug.9, 2011
- Luigi Rizzo, Netmap: a Novel Framework for High Speed Packet I/O. Apple, Cupertino (CA), Aug. 11, 2011
- Luigi Rizzo, Netmap: a Novel Framework for High Speed Packet I/O. Technicolor Labs Palo Alto (CA), Aug.12, 2011
- Luigi Rizzo, Netmap: a Novel Framework for High Speed Packet I/O. University College London (UK), Oct.11, 2011
- Luigi Rizzo, Netmap: a Novel Framework for High Speed Packet I/O. Imperial College, London (UK), Oct.12, 2011
- Luigi Rizzo, Netmap: a Novel Framework for High Speed Packet I/O. Cambridge University (UK), Oct.13.
- Luigi Rizzo, Netmap: a Novel Framework for High Speed Packet I/O. CHANGE-Ophelia summer school, Berkin (GER), Nov.11, 2011
- Mark Handley. Not your father's Internet, or where did the Internet architecture go? And what can we do about it? CHANGE/OFELIA Summer School Berlin, Germany 7-11 Nov. 2011
- Srini Seetharaman, Paul Weissmann (DT). OpenFlow Tutorial CHANGE/OFELIA Summer School Berlin, Germany 7-11 Nov. 2011
- Srini Seetharaman, Paul Weissmann (DT). OpenFlow in Production Networks CHANGE/OFELIA Summer School Berlin, Germany 7-11 Nov. 2011
- Mark Handley. Flow processing and the rise of the middle MSN 2011 Abingdon, UK 11/07/2011.

2.4 Open Source Releases

Providing open source code and systems to the community is another of the ways that the CHANGE project is disseminating its results. The primary example of this so far is Netmap, which is now part part of FreeBSD HEAD, acknowledging the CHANGE contribution. In addition, CHANGE has ported OpenvSwitch [4] and Click [2], two popular packages in the community, to netmap, resulting in huge speeds-ups. To reach an even wider audience, netmap is currently being ported to Linux.

In addition, Click has contributed the publication of "Click under the Hood", a document describing the internals of the Click system. The document is now available on the official Click page [1]. In addition, CHANGE is planning to release part of the ClickOS software as open source, and likely include it in the Click distribution tree.

2.5 Workshops

A further venue for dissemination are CHANGE-sponsored workshops. Out of of the three described in the description of work document, the first one, called the summer school, has already taken place. In this section we give a brief description of it (deliverable D6.2 will give a much more detailed account of the event). In addition, CHANGE co-organized the KIVS 2011 workshop; in this section we also describe this event.

2.5.1 Summer School

The objective of the OFELIA/CHANGE Summer School was to bring together PhD students and researchers who are currently working on future Internet topics such as:

- Principles of evolving future architectures
- New networking paradigms
- OpenFlow-related topics
- Programmable networks, NetFPGAs
- Network virtualization
- Measurements and analysis that characterize and quantify architectural limitations
- Discussions on interworking with the existing Internet and deployability

The summer school was jointly organized by the EU FP7 projects OFELIA and CHANGE. The organization committee consists of participants from both the OFELIA and the CHANGE project. The event took place in Berlin between November 7 and November 11, directly after the Internet Measurement Conference 2011 (November 2-4, also in Berlin). Overall, we hosted more than 54 PhD students, and researchers for this event. The program contained presentations by well-known international experts on various topics. Moreover, we organized a poster session where students presented their research ideas and received constructive feedback. For registration, students had to submit a 2-page extended abstracts and to mutually review their abstracts. Finally, to foster interaction between PhD students, we also organized social events in addition to the scientific program. A much more detailed report on the summer school will be provided in the upcoming deliverable 6.2.

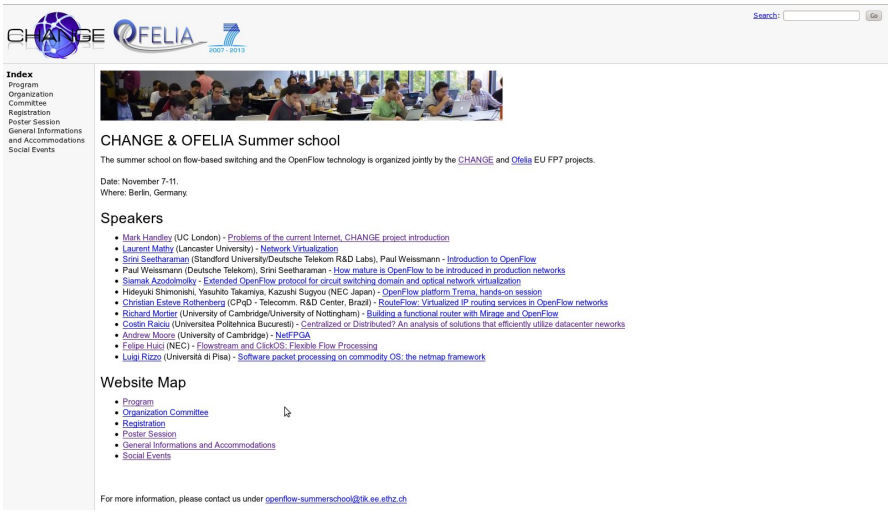

Figure 2.1: The summer school home page.

2.5.2 KIVS WS NV 2011

CHANGE was part of the Organizing Committee and member of the Technical Program Committee for the KIVS 2011 Workshop on Challenges and Solutions for Network Virtualization held no March 10th 2011 in Kiel, Germany.

Figure 2.2: The KIVS home page displaying the CHANGE logo.

The general topic of the workshop was network virtualization, which is closely related to many of the topics in the CHANGE project. More specifically, the topics of interested included:

- Solutions and drivers
- Virtualization technologies, platforms, and architectures
- Use cases, applications and services enabled by NV
- Business considerations and economic aspects
- Network virtualization in data centers
- Mobile virtual network operators
- Control plane and management plane mechanisms for virtual networks
- Resource allocation for co-existing networks
- Radio access network sharing
- Monitoring in virtualized environments, e.g. QoE or energy consumption
- Network virtualization for energy efficiency
- Isolation, performance and security

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[2] Eddie Kohler, Robert Morris, Benjie Chen, John Jannotti, and M. Frans Kaashoek. The click modular router. *ACM Trans. Comput. Syst.*, 18:263–297, August 2000.

[3] ONF Blog. ONF Recognizes Standards Stars. https://www.opennetworking.org/, January 2012.

[4] Open vSwitch. Open vSwitch, an Open Virtual Switch. https://openvswitch.org/, January 2012.