FLAMINGO

European Seventh Framework Network of Excellence

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WP2 — Mobility, education and training

Deliverable D2.3 — Third version of course material and tutorials

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Executive Summary

This document presents the achievements along the third year of project in the tasks of WP2, namely Mobility and Exchange, Research Observatory, Tutorials Setup and Dissemination and Course design and Realization.

The task Mobility and Exchange has grown as compared with the previous periods. In fact, in front of the six visits of last year, this year we have had a total of eighteen visits carried out by fourteen different FLAMINGO researchers, out of which nine were executed by co-supervised PhD students. This is a clear proof of the vitality of the network. On the other hand, five senior researchers will participate in joint PhD examination boards. Also is worthy to mention that the project has currently 9 co-supervised PhDs of which three at least will graduate with a degree jointly provided by the University of Twente and the University of Federal Armed Forces of Munich.

By means of the task Research Observatory we have managed to modify or create from scratch a total of twelve Wikipedia pages, ten out of which have been successfully retained. This represents an increase of 37,5% in respect to the number of pages edited in the previous year. The strategy in that case continued making incremental changes or starting with relatively short new documents to deal better with any potential critics or rejections from the Wikipedia community. FLAMINGO editors' contributions are substantial, if not the authors of the whole page, comparing the extension of their additions with the actual size of the page.

By means of the task Tutorials Setup and Dissemination, project participants designed and taught six new tutorials in this third year. This represents an increase of 100% in respect to the last reported period. In all these cases, tutorials were clearly oriented to research hot topics nowadays like a practical experimentation in FIRE contexts, security in wireless tiny devices, practical implementation of the concept of virtual network functions and others. In addition, FLAMINGO researchers have recently submitted two additional tutorials based on topics coined within WP6 to the challenging IEEE/IFIP Network Operations and Management Symposium (NOMS) that will take place in Istanbul, Turkey in Spring of 2016. All in all, these tutorials are being presented to a much broader community than just FLAMINGO community, like industry, standardization organizations, researchers, and academics.

By means of the task Course Design and Realization we have edited and published one Massive Open Online Course (MOOC) on Internet security (still in elaboration), three new modules more oriented to practical exercises rather than presenting concepts and an additional new video on policy-based management. These new training and dissemination material add to the 21 already published videos during the first and second year of the project, and contribute to the current FLAMINGO video material repository, which is made available to the public in general through the project YouTube channel. Interpreting results extracted from Google Analytics we have figured out which are the most attractive videos in terms of topic, duration and format to continue enhancing impact of future releases.

Contents

1 Introduction

The goal of work package 2 is to integrate FLAMINGO partners by fostering their mobility, and to disseminate state of the art network and service management knowledge to students within the NoE, as well as researchers within academia and industry. This goal will be achieved through the design and implementation of four tasks extending the full life cycle of the project. Each of these four tasks is in turn addressing a specific and measurable objective by means of which we can track and determine the level of success of this work package.

The first objective is "to coordinate the mobility and exchange of FLAMINGO Ph.D. students and researchers". This coordination is grounded in a collaboration plan emanating from the activities promoted by the three research work packages of the NoE. The achievement of that objective will be stated in terms of number of visits and the outcomes from visits of project participants in hosting institutions and other collaboration and integration activities.

The second objective is "to coordinate the design and realization of network and services management course material for undergraduate and graduate students". The number, but also the complexity of the material of courses produced and the impact caused by these courses, measured by means of some statistics, are indexes to evaluate the success in this task.

The third objective is "to coordinate the design and realization of network and services management tutorial material for researchers within academia and industry". This objective is highly related to the previous one and its main distinguishing feature is the scope (more oriented to the current needs of researchers), and public addressed (which is also more oriented to people working in state of the art and hot topics in the network and service management area). In that respect, the duty assigned to this work package is to stimulate the project participants to create and give such tutorials from their respective areas of research and interest and to compete with external producers to have the tutorial accepted in public fora.

Finally, the fourth objective is "to establish and maintain a research observatory in the area of network and service management". In the course of this third year of the project we have focused in producing new articles in Wikipedia as well as improving existing ones, maintaining the development of a web crawling tool aimed to analyze research trends as well as maintaining and improving the Simpleweb site.

In addition to the work package related objectives summarized above, the project has a number of S.M.A.R.T. objectives, three of which are highly relevant to the goals and activities foreseen within WP2. These are:

- S.M.A.R.T. "Integration of Ph.D. Students" whose scope is within our first objective
- S.M.A.R.T. "Course and training material" whose scope lays within our second and third work package objectives
- S.M.A.R.T. "Integration of the research community" whose scope lays within our fourth work package objective

This deliverable reports the achievements of work package 2 in the third year of the project and it is structured as follows. In Section 2 we report the results in mobility and exchanges. Section 3 presents course design and realization. Section 4 comments the tutorials created and planned. Section 5 discusses the research observatory activities and in particular the work done in Wikipedia, the activity related to the web crawler and the maintenance actions adopted in the Simpleweb. Finally, Section 6 concludes this document by summarizing the achievement made during this year from the point of view of the S.M.A.R.T. objectives above mentioned.

2 Mobility and Exchange

This activity corresponds to task T2.1 of the DoW, whose goal is to support the mobility of Ph.D. students and researchers, to foster both integration and jointly executed research among the FLAMINGO partners. Table 1 gives an overview of last year project achievements in comparison with the two previous ones. Also the table is offering a classification of these visits in terms of their duration.

Table 1: Indicators of progress in mobility and exchange

Achieved in Y1	Achieved for Y2	Achieved in Y3
1 visit of one day 1 visit of two days 2 visits of one week 1 visit of two weeks	1 visit of 1 day 1 visit of one week 2 visits of two weeks 2 visits of three weeks	• 2 visits of 1 day • 11 visits $>$ 1 day and $<$ 1 week • 4 visits $>$ 1 week and $<$ 1 month • 1 visit of 1 month
	Participation of 4 researchers in 3 examination committees	Participation of 3 FLAMINGO researchers in 3 examination committees. Planned participation of 2 FLAMINGO researchers in 2 examination committees
	Creation of 2 joint PhD degrees	Creation of 2 new joint PhD degrees

2.1 Visits of jointly supervised PhD students

At the start of the third year of the project we continued having above ten PhD students co-supervised by two doctors of different participating institutions. These students and their supervisors and co-supervisors and the days they have spent visiting the later are presented in Table 2.

Table 2: Co-supervised PhD students visits within the third year of project

Student	Supervisor	Co-supervisor	Visit to	Days
Radhika Garg	Burkhard Stiller	Joan Serrat	UPC	1
Gaetan Hurel	Jerome François	Gabi Dreo	UniBwM	3
Guilherme Sperb	Burkhard Stiller	Filip de Turk	iMINDS	3
Rick Hofstede	Aiko Pras	Gabi Dreo	UniBwM	3
Christian Dietz	Gabi Dreo	Aiko Pras	UT	5
Mario Flores	José L. Melús	Burkhard Stiller	iMINDS	10
Anthea Mayzaud	Remi Badonel	Jürgen Schönwälder	Jacobs	10
Bram Naudts	Filip de Turk	Jürgen Schönwälder	UPC	10
Sebastian Seeber	Gabi Dreo	Aiko Pras	UT	26

Each of the visits was planned to produce concrete results. In the following paragraphs we summarize each one.

Radhika Garg (UZH) visited UPC in October 2015 to meet her PhD co-advisor for one day. The purpose of the visit was for her to expose the co-supervisor the status of her PhD and to discuss one by one the main contributions of her thesis, which is almost concluded and facing the defense early next year. Also plans for the examination were discussed.

Gaetan Hurel (INRIA) visited UniBwM in February 2015. He worked on a joint paper regarding network security using software-defined networking. Thanks to this visit both parties reformulated the research challenges and more specifically, they concluded to provide a first step towards the evaluation of different Openflow messages (e.g., PACKET_IN, FLOWMOD) for network security applications. To this end, they built a prototype based on both software and hardware Openflow switches and replayed several network attacks (e.g., Distributed Denial of Service) within this testbed. This joint paper was concluded afterwards and has been submitted to NOMS 2016.

Guilherme Sperb (UZH) visited the iMINDS group in Ghent in January 2015. Once there he jointly elaborated on a possibly plan for the migration of EmanicsLab.org to a new MyPLC version. That plan would be the starting point of the process of configuring the EmanicsLab nodes with IPv6 subnets. The collaborating participants also refined a mini tutorial on how the nodes should be configured through the Web interface. This would allow each Principal Investigator to proceed by themselves, depending on the IPv6 prefixes and subnets of each EmanicsLab site.

Rick Hofstede (UT) visited UniBwM in January 2015. The main purpose of these visits was to make arrangements for his PhD defense. He also had opportunity to discuss with Gabi Dreo, his co-supervisor, technical aspects of the PhD. In addition, the grounds for a paper planned to be published as part of our WP5/WP6 collaboration were setup. Finally, he was also able to participate in a PhD seminar at UniBwM, organized for all the group's PhD students.

Christian Dietz (UniBwM) visited the DACS research group at UT in July 2015 to work on two research papers and about his co-supervised PhD topic. Among the technical topics discussed is worthy to mention the comparison of different Big Data analysis technologies in the area of flow-based network anomaly and intrusion detection. In particular, they decided to compare a Hadoop cluster available at UT and a SAP Hana system available at UniBwM. In this meeting they discussed the criteria that they will use for the comparison as well as the use cases. It turned out that both institutions still have to clarify some data privacy aspects to perform such a comparison on the same data set in both institutions.

Mario Flores (UPC) visited the iMINDS group in Ghent in August 2015. The main purpose of this visit was to continue the development between the two involved parties in the collaboration to establish willingness to pay functions that can determine the mechanism to map virtual resources to physical resources in virtual network environments. This collaboration is framed within WP7. Thanks to that visit it was possible to take data from Geant for elaborating a simulator of demand.

Anthea Mayzaud (INRIA) went to JUB in April 2015 to further elaborate the research collaboration between the research groups at JUB and INRIA on the topics of distributed network monitoring for the Internet of Things (IoT), establish scope of a paper for CNSM 2015 and continue the implementation of the distributed network monitoring approach in Contiki 2.7. Three algorithms were designed to detect Directed Acyclic Graph (DAG) inconsistency attack, version number attack and selective forwarding attacks. However, to implement those algorithms the promiscuous mode needed to be enabled first. The visit stopped while implementing the promiscuous mode and solving bugs.

Bram Naudts (iMINDS) visited UPC in April 2015 as a first step to implement a collaboration between iMINDS and UPC in the context of virtual network embedding taking into account economic factors. In the visit the problem definition was clarified and presented. As a first research topic the reduction of opportunity cost was chosen. Also they set up in Eclipse making use of an existing

code base that implemented virtual network mapping. They also had the opportunity to work on the dynamic pricing algorithm and defining and gathering the required parameters. Another aspect that was tackled was the generation of realistic virtual network request via the definition of different market segments. A first version was created.

Sebastian Seeber (UniBwM) did two visits to UT in Enschede totalizing 26 days. Direct outcomes of these visits have been the opportunity to discuss the research directions of his PhD with his co-supervisor, elaborate on the refinement of the research questions and the topic itself and open new perspectives further collaborations in concrete instruments like papers and joint projects for the H2020 calls.

2.2 Other researchers' visits

In addition, other FLAMINGO researchers have been also traveling abroad to collaborate with other colleagues of the NoE as detailed in Table 3 and described immediately after.

Table 3: Other FLAMINGO researchers' mobility within the NoE

Marinos Charalambides	UCL	iMINDS	2
Joan Serrat	UPC	UZH	4
Corinna Schmitt	UZH	UniBwM	6
Anna Sperotto	UT	UniBwM	10
Daphne Tuncer	UCL	UT	30

Marinos Charalambides (UCL) visited iMinds at Ghent in the beginning of October 2015. During his visit he collaborated with researchers from iMINDS on a joint paper (for WP6), which is currently being prepared for a journal submission, and also made initial steps towards a new research activity on network function virtualization to be developed in a subsequent visit.

Joan Serrat (UPC) visited the group of UZH in Zurich in April 2015. During the visit the main discussion was centered about the organization of the 11th edition of the Conference on Network and Service Management, of which he is the General Chair and one group member is belonging to the Organizing Committee as well. Also they took advantage to discuss the co-supervision of the thesis of one UZH student and about several alternatives of continuing the co-direction of one of the UPC PhD students once the FLAMINGO projects ends.

Corinna Schmitt (UZH) visited Gabi Dreo's team in UniBwM in several occasions along this year. The focus of her visits were on research on security issues and related definitions like data, information, security, and privacy, attack detection and prevention mechanisms in general. She also discussed about how work from FLAMINGO can be used for future project proposals and in particular in the H2020 framework. She also received feedback on the ongoing publication for ICDCS 2015.

Anna Sperotto (UT) had two visits to the group of UniBwM. The first visit took place in May 2015 and was mainly focused on joint research collaborations between the groups of UT and UniBwM. The second visit took place in July 2015 and was focused on H2020 proposals preparation.

Daphne Tuncer (UCL) visited DACS research group in UT, where she spent one month doing joint research in the area of security in network function virtualization

2.3 Participation of FLAMINGO researchers in PhD examination committees

In the course of the reported year several FLAMINGO researchers have traveled abroad to participate as members of the examination board of all the FLAMINGO PhD students that defended their thesis. This is one of several mobility activities that will continue in the future as well.

George Pavlou (UCL) participated in the examination of Ricardo Schmidt (UT) that took place November 26th, 2014 at the UT.

Gabi Dreo (UniBwM) participated in the examination of Rashid Mijumbi (UPC) that took place November 6th, 2014 at the UPC in Barcelona.

Marinos Charalambides (UCL) participated in the examination of Hendrik Moens (iMINDS) that took place in May 5th, 2015 at the University of Ghent.

2.4 Creation of joint PhD degrees

Following the path of the two joint PhD degrees already achieved during last year, this one has been possible to sign the corresponding contracts for an additional one. This is for the UniBwM PhD student Robert Koch, who will receive a joint degree from the UniBwM and the UT.

3 Course Design and Realization

FLAMINGO partners have continued the production of course material, but this time more focused on new instruments, like a complete Massive Online Open Course (MOOC) on Internet security, complementary material for self-testing and laboratory practices already produced videos, instead of producing new videos as we did in the past year. This material continues to be made available in the FLAMINGO YouTube channel [1] and the MOOC will be made available through an open platform. We remind the reader that the reason of selecting YouTube was that videos in high definition are openly accessible to everyone without the need for people to sign up. Also, with only using a descriptive name of the video, keywords and a more detailed video description, video courses offered by FLAMINGO partners can easily be found searching on Google or directly on YouTube. Also, YouTube allows every participant to contribute to the project channel at any time without the need to share credentials.

In Table 4 we give the overview of progress along the three years of the project on that activity and in the following subsections we present a summary of each item created during the third year of the project.

Table 4: Indicators of progress in course design and realization

Achieved in Y1	Achieved for Y2	Achieved in Y3
7 videos	14 new videos	• 1 MOOC (still under development) • 3 complementary course material $>$ 1 new video

3.1 Course title: MOOC on Internet security

- Editor: Aiko Pras (UT)

- Contributors: Network management team at University of Twente
- Course type: self-contained MOOC
- Target audience: Researchers and students that are interested to learn the principles of Internet security

FLAMINGO members at the UT recently started the development of a MOOC on Internet security. Internet security is an important topic, nearly everyday there is news regarding some kind of cyber-attacks. Banks, service providers, critical infrastructures (such as the gas and electricity networks), governments, schools and many other organizations are constantly being attacked via the Internet. Such attacks range from "information stealing to massive "Distributed Denial of Service" (DDoS).

At this moment there is not (yet) a complete MOOC on Internet Security, although there are some existing Coursera courses that briefly touch the subject. This new MOOC targets at thousands of students worldwide. Note that the UT FLAMINGO members already have a position in this area, since they already provide online lectures "Network Security" to several other universities, including the Security Masters Program of the European Institute of Technology (EIT/ICT-Labs).

Creation of the MOOC involves the following steps:

1. Creation of video lectures. We will build upon the existing and novel FLAMINGO YouTube movies, which include "white board animations", "animated slides", and "animated slides with video" as well as "traditional movies". From our previous FLAMINGO experience we have learned that video lectures should be very short, typically 10 minutes each.
2. Creation of online exercises. This is the main and novel challenge, with which FLAMINGO partners have not yet experimented. After several experiments we decided that the exercises will be performed in a Virtual Machine, for which we have selected the Vagrant technology.
3. Creation of online exams, for certifying / grading students.
4. Creation of an online discussion forum (using the facilities like Piazza or the MOOCs platform).
5. Offering the MOOC via an existing MOOC platform, such as (open) edX. Note that MOOC elements, such as video lectures and exercises, will also be hosted on platforms like YouTube.

The MOOC will focus on two topics: technologies to secure the Internet (such as IPSec, ssh, HTTPS, SSL, DNSSec) and Internet attack and mitigation techniques (such as scans, DDoS attacks, SQL injection, XSS, Flow-based measurements, Intrusion Detection Systems, Firewalls).

3.2 Course title: WPA / WPA2 Security

- Editor: Sebastian Seeber (UniBwM)
- Course type: Video slides complemented with practical exercises
- Target audience: Graduated students

This course is an extension of the already existing video on WPA/WPA2, which includes a virtual machine to make use of different tools with which the student can practice on the topic. The virtual machine comes with a short instruction on how to start and use the virtual machine. Once this

is done the additional instructions will be provided as a document within the virtual machine. The course will teach the attendees how to use tools like: aircrack-ng, airmon-ng, coWPAtty and wifite. This part can be seen as an extension to the YouTube course WPA/WPA2 from last year. While the part form last year focused on the theoretical aspects of the WPA technology, this year the virtual machine provides the attendees the possibility to improve their practical skills. In addition, to these tools the virtual machine includes Wifi traces, which should be used during this course.

3.3 Course title: Introduction to Nagios-based Monitoring

- Editor: Remi Badonnel (INRIA)
- Course type: Self comprehension test and practices on Nagios
- Target audience: People who has taken the Introduction to Nagios-based Monitoring and Advanced Nagios Configuration from the same editor

This online exercise relates to the video entitled “Introduction to Nagios-based Monitoring” available on the FLAMINGO YouTube channel. It is composed of 30 questions with growing difficulty about the Nagios monitoring system. It provides a support to MOOC followers for evaluating their knowledge on the key concepts and features offered by the Nagios system such as service checks, notifications, state calculation and functional architecture. It also permits to progressively build small configuration files that can then be experimented by followers on their own infrastructure in 7 detailed steps with an Ubuntu distribution.

3.4 Course title: Policy-based management

- Editor/contributors: Marinos Charalambides (UCL)
- Course type: conventional slide-based course
- Target audience: Researchers and students that are interested to learn how the behavior of networks can be flexibly configured through policies

This course introduces the policy-based management paradigm. It first gives an overview of the most common architecture and describes the functionality of the various components and communication protocols. A notation/language for specifying policies is also presented, which leads to network resource management examples.

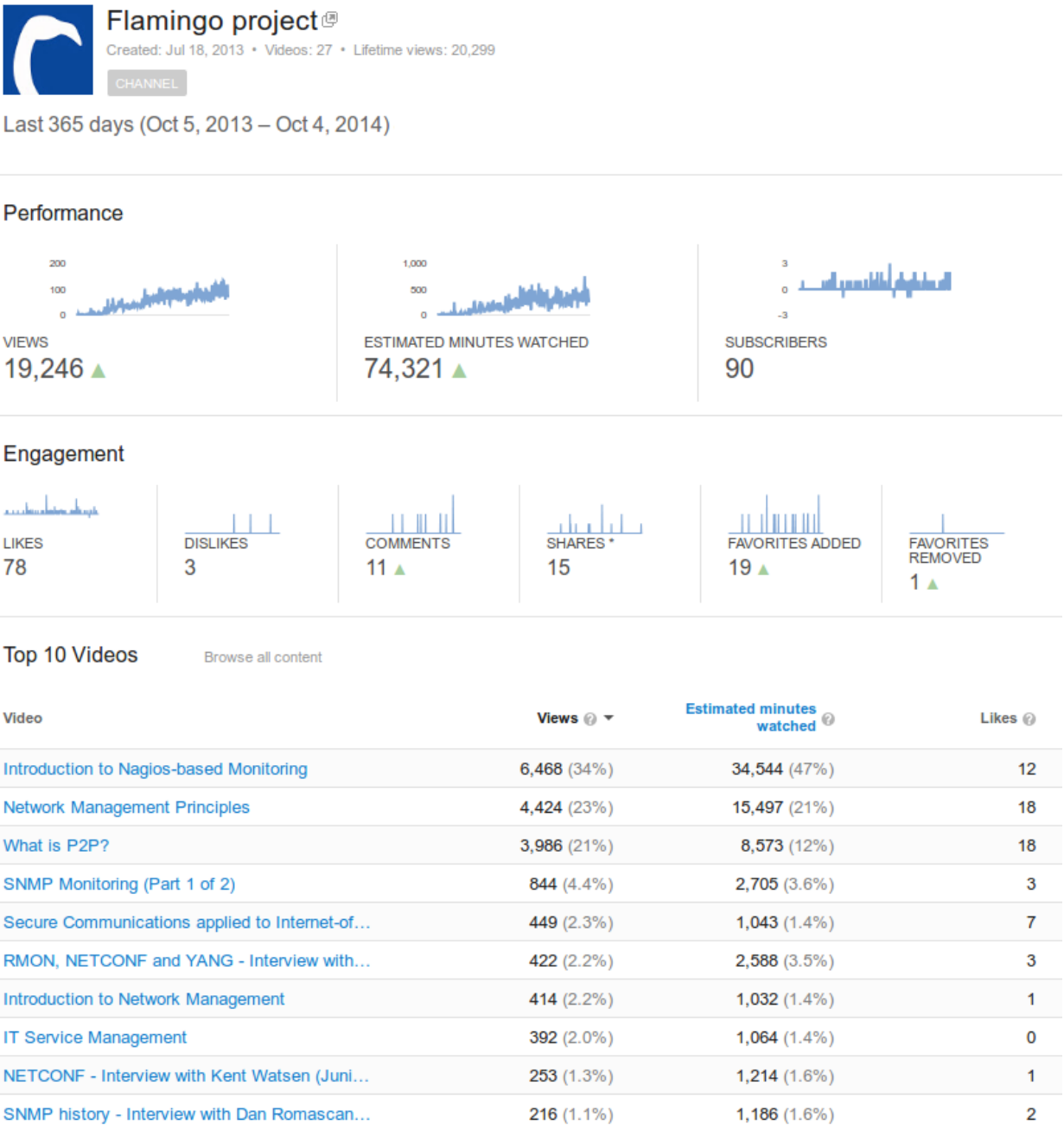
3.5 Course title: Practical exercises on PBNM

- Editor: Joan Serrat (UPC)
- Course type: self-contained practical exercises on policy-based network management
- Target audience: people who has the knowledge provided in the video course Policy-based Network Management

This course is a complement of the video entitled “Policy-based management” presented in Section 5.3. It consist in a virtual machine emulating a mobile network environment that can be controlled by means of policies. Course learners can then program their own policies and observe how the mobile network is reacting as a consequence of the control exercised by the policies.

3.6 Analysis of impact of the videos in the FLAMINGO channel

Like we did last year, we have used Google Analytics to see the most prominent aspects reflected by these statistics with the aim to extract lessons to improve the impact of our courses and complementing materials. The following figures reflect a few of such statistics, which we comment along.



Flamingo project

Created: Jul 18, 2013 • Videos: 27 • Lifetime views: 20,299

CHANNEL

Last 365 days (Oct 5, 2013 – Oct 4, 2014)

Performance

VIEWS 19,246 ▲

ESTIMATED MINUTES WATCHED 74,321 ▲

SUBSCRIBERS 90

Engagement

LIKES 78

DISLIKES 3

COMMENTS 11 ▲

SHARES * 15

FAVORITES ADDED 19 ▲

FAVORITES REMOVED 1 ▲

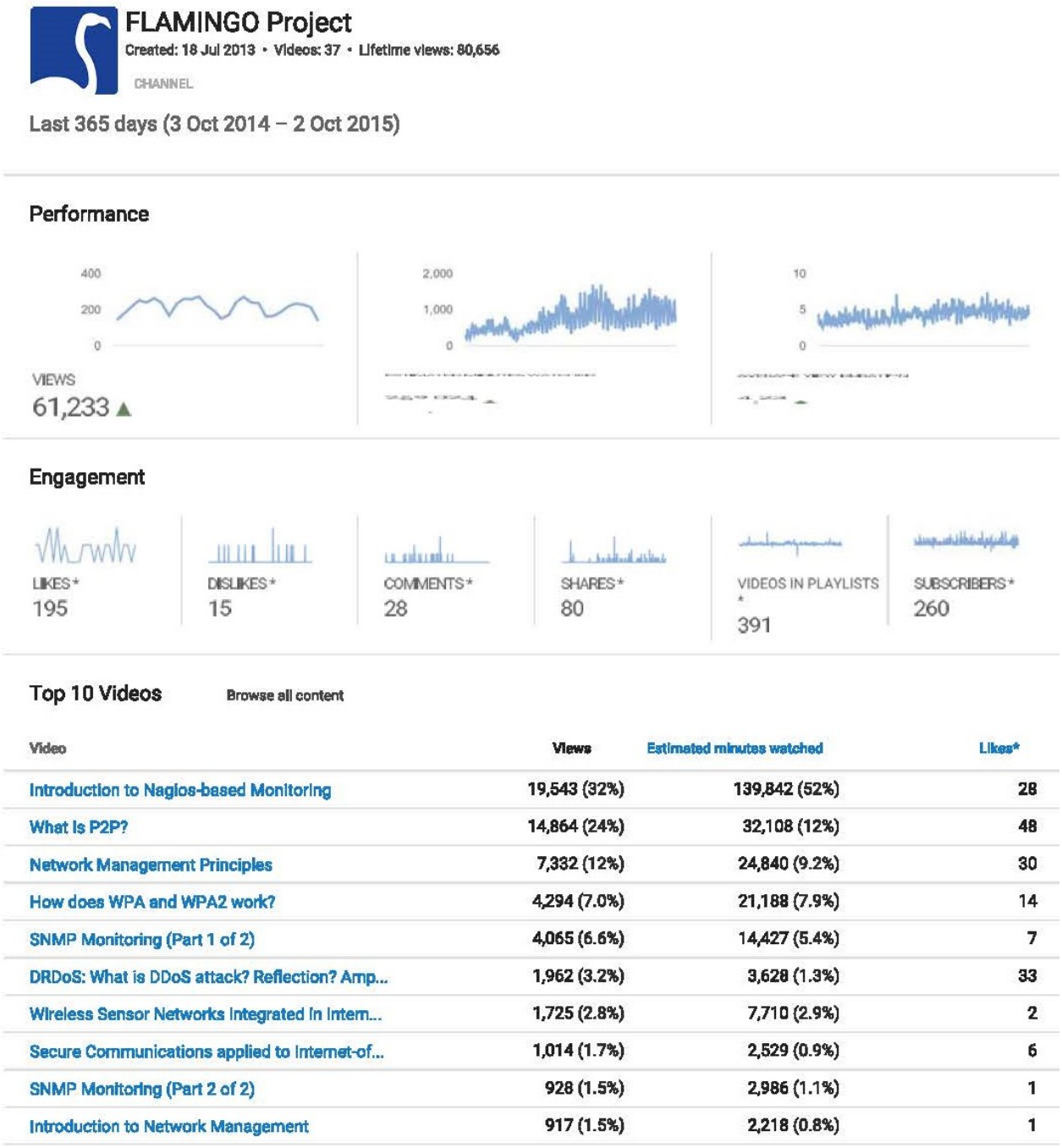
Top 10 Videos Browse all content

Video	Views	Estimated minutes watched	Likes
Introduction to Nagios-based Monitoring	6,468 (34%)	34,544 (47%)	12
Network Management Principles	4,424 (23%)	15,497 (21%)	18
What is P2P?	3,986 (21%)	8,573 (12%)	18
SNMP Monitoring (Part 1 of 2)	844 (4.4%)	2,705 (3.6%)	3
Secure Communications applied to Internet-of…	449 (2.3%)	1,043 (1.4%)	7
RMON, NETCONF and YANG - Interview with…	422 (2.2%)	2,588 (3.5%)	3
Introduction to Network Management	414 (2.2%)	1,032 (1.4%)	1
IT Service Management	392 (2.0%)	1,064 (1.4%)	0
NETCONF - Interview with Kent Watsen (Juni…	253 (1.3%)	1,214 (1.6%)	1
SNMP history - Interview with Dan Romascan…	216 (1.1%)	1,186 (1.6%)	2

Figure 1: The 10 most viewed FLAMINGO videos in 365 days of previous period

Figure 1 presents the 10 most viewed videos in the latest 365 days of the previous period (up to 06/10/2014). As it can be seen, the first three videos advance the others about an order of magnitude. Arguing on the potential reasons, we can say that the former is on a very specific tool

which is still in use in several domains. What is also true is that the fourth is also on a specific tool although much less used than the former. What is surprising is that the second in the list is dealing about the same topic as the seventh, which has a much lower number of visits. Therefore the conclusion would be that title/topic is not the only reason inviting people to open and see the videos.



FLAMINGO Project

Created: 18 Jul 2013 • Videos: 37 • Lifetime views: 80,656

CHANNEL

Last 365 days (3 Oct 2014 – 2 Oct 2015)

Performance

400
200
0

VIEWS
61,233 ▲

2,000
1,000
0

10
5
0

Engagement

LIKES*	DISLIKES*	COMMENTS*	SHARES*	VIDEOS IN PLAYLISTS*	SUBSCRIBERS*
195	15	28	80	391	260

Top 10 Videos Browse all content

Video	Views	Estimated minutes watched	Likes*
Introduction to Nagios-based Monitoring	19,543 (32%)	139,842 (52%)	28
What Is P2P?	14,864 (24%)	32,108 (12%)	48
Network Management Principles	7,332 (12%)	24,840 (9.2%)	30
How does WPA and WPA2 work?	4,294 (7.0%)	21,188 (7.9%)	14
SNMP Monitoring (Part 1 of 2)	4,065 (6.6%)	14,427 (5.4%)	7
DRDoS: What is DDoS attack? Reflection? Amp...	1,962 (3.2%)	3,628 (1.3%)	33
Wireless Sensor Networks Integrated In Intern...	1,725 (2.8%)	7,710 (2.9%)	2
Secure Communications applied to Internet-of...	1,014 (1.7%)	2,529 (0.9%)	6
SNMP Monitoring (Part 2 of 2)	928 (1.5%)	2,986 (1.1%)	1
Introduction to Network Management	917 (1.5%)	2,218 (0.8%)	1

Figure 2: The 10 most viewed FLAMINGO videos in 365 days of current period

Figure 2 shows the same statistics as Figure 1 but for the currently reported period. This is, the latest 365 days up to the moment of editing this section of the deliverable D2.3. Two main finding are apparent. One, the number of total visits is much more than last year, hence the interest for

our videos is improving. Second, the five best positioned videos in terms of number of visits are basically the same, whereas the other five have been replaced by new entrants.

Looking more insight we present Figures 3, 4, 5 and 6, where it can be observed how long logged users stay observing the video.

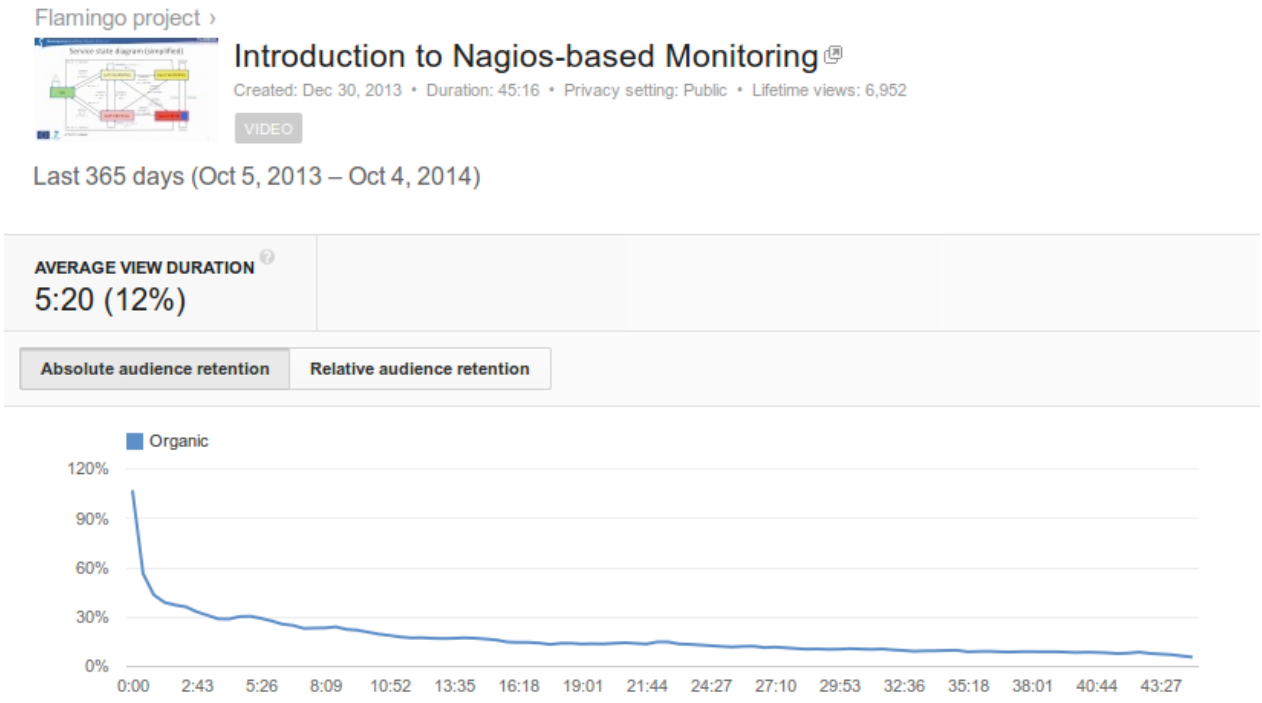


Figure 3: Audience retention of the video Introduction of Nagios-based Monitoring of previous period

According to Figure 3, the interest of people to stay in the video entitled Introduction to Nagios-based Monitoring, which by the way has the highest number of visits, drops quickly to stabilize around a 12% of people staying up to the end (keep in mind that this video lasts for more than 40 minutes).

Figure 4 reveals a very similar behavior as its counterpart in the last reported period. The average view duration has improved a bit, but it is kept low in comparison with the total video duration.

Figure 5 shows the same retention figure but in this case for the P2P video. The trends are similar to the previous case but without the initial fall that is shown in the former. This can be attributed perhaps to the edition style of What is P2P?, which keeps the interest of the viewers much more than a conventional slides-based tutorial. We also continue observing that videos of duration of 5 minutes or less are followed with more people up to the end.

Looking at Figure 6 we can see in fact the same behavior as in Figure 3a. Therefore, the conclusions derived above are still valid.

4 Tutorials Setup and Dissemination

The goal of this task is to develop and present advanced tutorials for PhD students and researchers in general. We already started this activity in year one and have continued in year two. Table 5 gives an overview of global progress

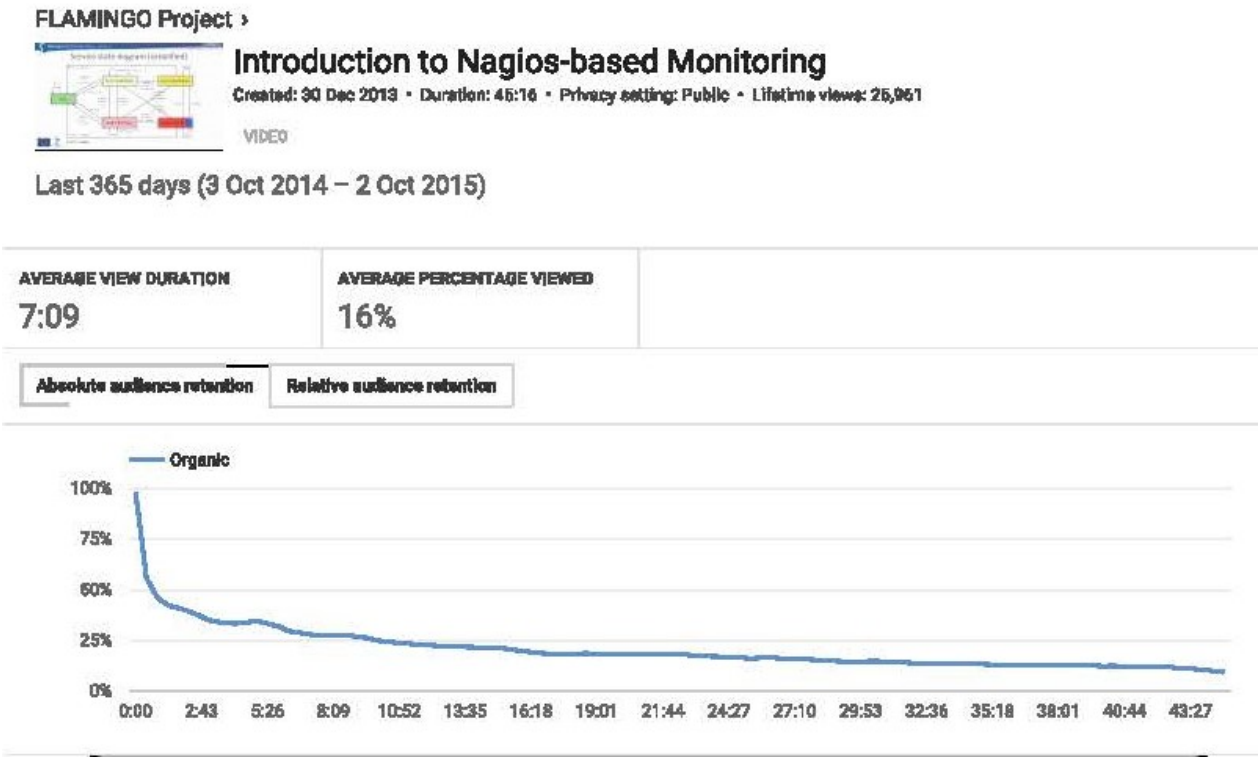


Figure 4: Audience retention of the video Introduction of Nagios-based Monitoring of current period

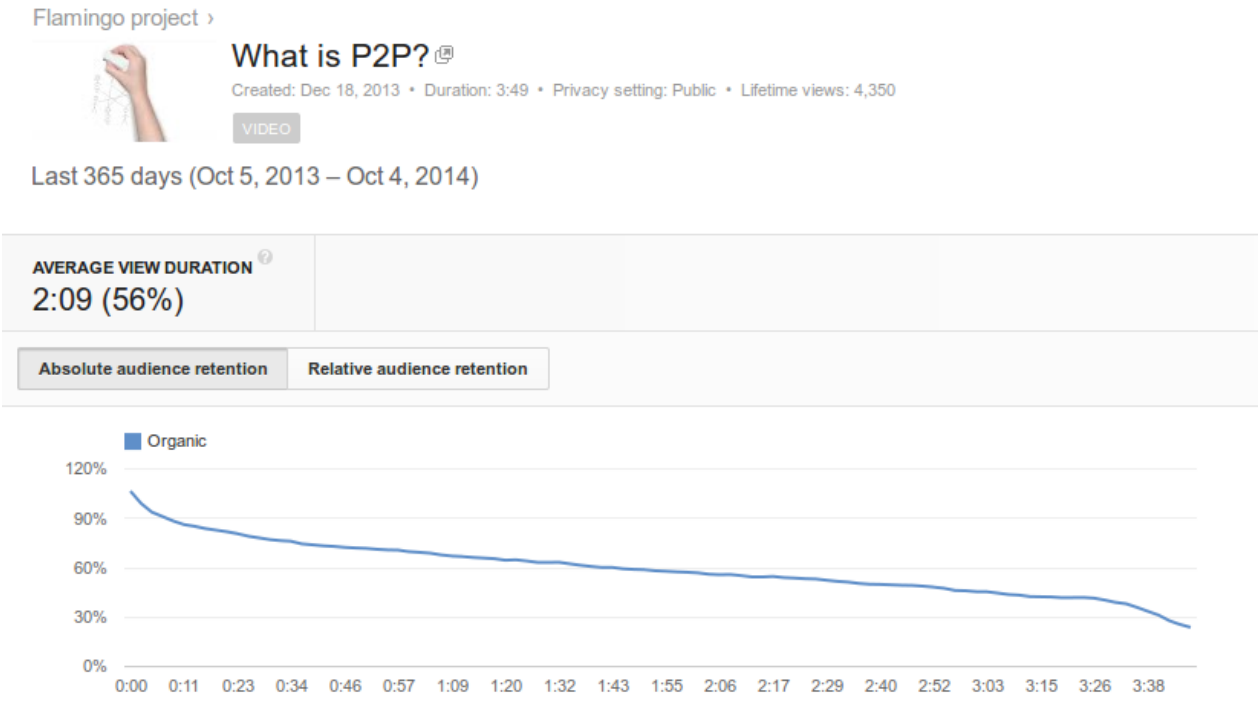


Figure 5: Audience retention of the video What is P2P? of previous period

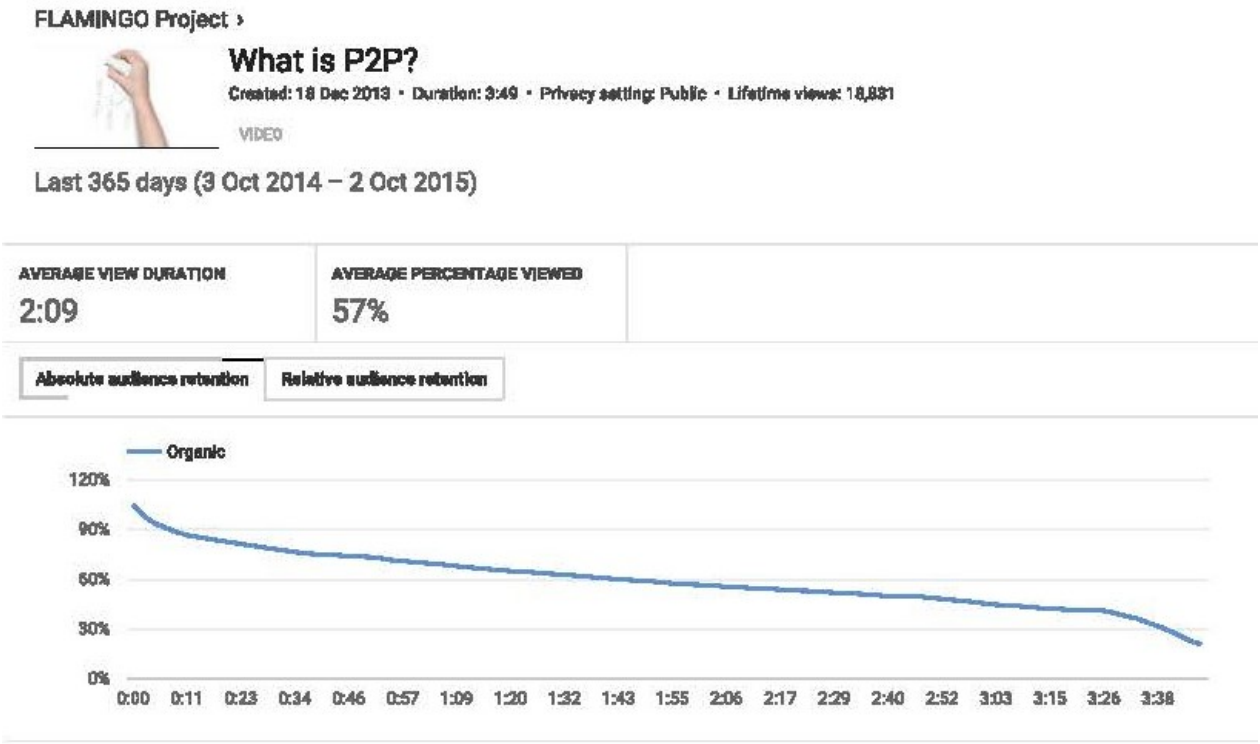


Figure 6: Audience retention of the video What is P2P? of current period

Table 5: Indicators of progress on Tutorials setup and dissemination

Achieved in Y1	Achieved for Y2	Achieved in Y2
3 tutorials organized and given	3 new tutorials organized and given	8 tutorials organized. Up to now 6 were given

The first tutorial reported was given at the ITU-T Meeting SG17: Security [2] in Geneva in April 2015. Three more tutorial were given at the AIMS 2015 [3] that took place in Ghent in June 2015. Finally, two more were given at the Fed4FIRE-GENI Research Experiment Summit [4] that took place in Ghent early July 2015.

In addition, two more tutorials have been created and submitted to the IEEE/IFIP Network Operations and Management Symposium [5] to be held in Istanbul in 2016

4.1 Two-way Authentication for Tiny Devices (tutorial download)

- Organizer: Corinna Schmitt (UZH) and Burkhard Stiller (UZH)
- Event: ITU-T Meeting SG17: Security. ITU-T, Geneva, Switzerland, 15 April, 2015

The tutorial covers a brief overview about the research, the application area, developed solutions TinyDTLS and TinyTO, and lessons learned. The audience acknowledged these standard-based solutions, which allow for the support of a two-way authentication on constraint devices, like sensor

nodes (e.g.,, TelosB or OPAL). The audience was pleased to learn that not only theoretical ideas were presented, but existing solutions and successfully running code. The following discussions raised the question of what can be a common definition for constraint devices. This seems to be a dedicated need for the ITU, since no formal definition is in place. Furthermore, the question on how to perform the key management and its standardization was asked. For external liaisons purposes the meeting was successful in order to continue standardization efforts under ITU in the SG 17 addressing security issues, especially Questions 5 and 11.

4.2 Map-Reduce and Hadoop (tutorial download)

- Organizers: Jérôme François (INRIA)
- Event: 9th International Conference on Autonomous Infrastructure, Management and Security (AIMS 2015), Ghent, Belgium, June 23th

This tutorial introduces Hadoop and how it can be applied to different challenges today's community is facing in network management. Data analytics is, thus, the focus of this tutorial as networks are producing tons of various logs, for example network traffic measures, firewall alerts, or SNMP messages. They form the basis of many management functions, which may necessitate basic processing like accounting or more complex calculations in particular for providing predictions on the future for (a) configuration purposes, (b) detecting security anomalies, or (c) supporting fault management.

4.3 Deploying Network Function Virtualization Experiments on the Virtual Wall Test-bed (tutorial download)

- Organizers: Niels Bouten (iMINDS) and Rashid Mijumbi (UPC)
- Event: 9th International Conference on Autonomous Infrastructure, Management and Security (AIMS 2015), Ghent, Belgium, June 24th

The goal of this hands-on tutorial is to familiarize all participants with the concept of NFV in general and possible benefits of combining it with SDN. This will be accomplished by deploying several network functions on the Virtual Wall and interconnecting them using OpenFlow. This allows for the creation of individual Service Function Chains (SFC) for different users. These experiments will be run in a live network setting, facilitated by the Virtual Wall test-bed. The Virtual Wall is a test-bed facility for setting up large-scale network topologies. Its nodes can be assigned different functionality and organized in arbitrary network topologies on the fly. As such, it is a generic experimental environment for advanced network, distributed software and service evaluation, and supports scalability research. The facility has been made available to the research community through different FP7 FIRE projects.

4.4 Powering Monitoring Analytics with ELK Stack (tutorial download)

- Organizers: Abdelkader Lahmadi (INRIA) and Frederick Beck (INRIA)
- Event: 9th International Conference on Autonomous Infrastructure,ITUTSG Management and Security (AIMS 2015), Ghent, Belgium, June 25th

This hands-on tutorial introduces the open source Elasticsearch, Logstash and Kibana (ELK) stack and its components, including Elasticsearch for deep search and data analytics, Logstash for centralized logging, log enrichment, and parsing, and Kibana for powerful and beautiful data visualizations. ELK enables the analysis and visualization of monitoring data, such as logs and netflows. A first step details these individual components and the second step provides guidelines for their deployment and configuration. In the third step participants performed hands-on practical work for collecting, processing, and enriching logs and netflows, combined with the creation of associated visualization and dashboards aspects.

4.5 Tengu: Big Data Experimentation (tutorial download)

- Organizer: Thomas Vanhove (iMINDS)
- Event: Fed4FIRE-GENI Research Experiment Summit, Ghent, Belgium, July 8th, 2015

Tengu (`http://tengu.intec.ugent.be`) is an experimentation toolkit that allows Fed4FIRE users to easily set up an experiment for big data analysis and cloud applications. During this tutorial different data processing and analysis tools (kafka, cassandra, storm, hadoop) were interconnected with each other. To achieve this Chef is used to manage the configuration of the different components.

4.6 Network Function Virtualization experiments on the Fed4FIRE testbed (tutorial download)

- Organizers: Niels Bouten (iMINDS) and Rashid Mijumbi (UPC)
- Event: Fed4FIRE-GENI Research Experiment Summit, Ghent, Belgium, July 7th, 2015

The goal of this hands-on tutorial is to familiarize the participants with the concepts of Network Function Virtualization (NFV) in general and highlight the possible benefits of combining it with SDN. During the tutorial, OpenFlow is used to interconnect different Virtualized Network Functions (VNFs) to allow the creation of different Service Function Chains (SFCs) in a dynamic way. The VNFs were deployed by using Click modular router implementations. The experiments were deployed using the Fed4FIRE experimentation tools.

4.7 Network Function Virtualization: Conception, Present and Future (tutorial download)

- Organizers: Niels Bouten (iMINDS) and Rashid Mijumbi (UPC)
- Event: IEEE/IFIP Network Operations and Management Symposium. Istanbul, Turkey 25-29 April 2016

This tutorial will include four main parts on NFV: conception, present, future and demonstration. In the conception part, they will present a comprehensive view of NFV. In particular, they will discuss the motivation towards NFV, including its history, system design considerations and anticipated gains. They will also discuss some of the main use cases (such as the customer premises equipment and mobile core network) as well as the NFV architecture as proposed by the ETSI industrial specification group working on NFV. They will introduce the related concepts of software defined networking (SDN) and cloud computing and explore the synergies between these three networking concepts, as well as current research and industrial efforts to implement environments involving all three. In the second (present) part, they will survey the different major projects on NFV.

4.8 Powering Monitoring Analytics with ELK Stack

- Organizer: Abdelkader Lahmadi (INRIA)
- Event: IEEE/IFIP Network Operations and Management Symposium. Istanbul, Turkey 25-29 April 2016

The goal of this hands-on tutorial is to familiarize the participants with the issues related to monitoring data analytics and its usefulness for both network management researchers and scientists when dealing with logs data. It also provides an in-depth study of the open source ELK stack and its components, including Elasticsearch for deep search and data analytics, Logstash for centralized logging, log enrichment, and parsing, and Kibana for powerful and beautiful data visualizations. ELK mainly enables the analysis and visualization of monitoring data, such as logs and netflows.

5 Research Observatory

As stated in the DoW the goal of the research observatory is to educate researchers within industry and academia regarding the state of the art in network and service management. In terms of global progress we have to highlight that in year three we continued the impulse of the activity in Wikipedia having edited or created a total of twelve pages. Also, it is worthy to mention the task of adapting a crawling tool developed in another project to the needs of FLAMINGO researchers and the dissemination activities through Simpleweb have continued.

Table 6: Indicators of progress on the research observatory

	Achieved in Y1	Achieved for Y2	Achieved in Y3
Through Wikipedia	Not yet started	8 pages edited/created	12 pages edited/created
Web crawling	Not yet started	First adaptation steps to FLAMINGO completed	Maintenance of the tool adapted to FLAMINGO community needs
Through Simpleweb	Maintenance of RSS feeds, conference announcement and tools' repository	Maintenance of RSS feeds, conference announcement and tools' repository	Maintenance of RSS feeds, conference announcement and tools' repository

5.1 Wikipedia activity

In the third year we progressed through the same approach adapted since the beginning. Work was initiated from the three research workpackages under the initiative of the researchers and coordinated from this workpackage as a whole. Most of the editors had already experience from the previous editions, therefore this time was easier than before. But as we detail later not all pages were accepted by Wikipedia editors. In particular, two subjects were considered two new and hence unappropriated to appear in the encyclopedia. In the following Subsections we go through all these pages highlighting the work done. Note that on the side of the page title we provide its link and on the side of the name of each editor his Wikipedia user name.

5.1.1 Quality of experience (link to page)

- Editor: Stefano Petrangeli (Stefano flamingo)
- Contributors: Niels Bouten (Nbouten), and Maxim Claeys (Maxclaey)

The page was partially reorganized and made more consistent. More specifically, a figure was removed and the titles of some sections were changed. Content wise, in the "Multimedia Services" section, a paragraph about QoE-centric network management solutions was added, which describes how QoE can be monitored and proactively controlled using network-based solutions. Here, a reference to a FLAMINGO paper was also added.

The page has around 12 KB out of which the editors of FLAMINGO added 3.3 KB and removed 0.2 KB

5.1.2 Adaptive bitrate streaming (link to page)

- Editor: Niels Bouten (Nbouten)
- Contributors: Maxim Claeys (Maxclaey)

In the "Benefits of adaptive bitrate streaming", a paragraph has been inserted to clearly state the benefits of HTTP Adaptive Bitrate (ABR) solutions. In the "Implementations" section, a paragraph has been added about Self-learning clients, which describes how HTTP ABR clients can learn an optimal behavior to maximize the end-users' QoE (here, a reference to a FLAMINGO paper was also added).

This page has currently 29 KB out of which the FLAMINGO editors contributed with 5 KB.

5.1.3 Value network analysis (link to page)

- Editor: Bram Naudts (Bramnaudts)

The contribution to this existing article include three types of complementary analysis and their description: exchange analysis, impact analysis and value creation analysis.

This page is the outcome of 30 different editors since 2006. The page has currently about 7 KB of which 0.5 KB correspond to the contribution of the FLAMINGO editor

5.1.4 Value Delivery Modeling Language

- Editor: Bram Naudts (Bramnaudts)

The contribution is a description of what Value Delivery Modeling Language (VDML) and its goal. The nine requirements that VDML satisfies are described as well as the existing value models to which VDML refers. We also referred to a use case example.

The page was rejected by the Wikipedia editors who argued that the topic is too new to have an encyclopedia article - the only sources the Wikipedia reviewer could find so far are primary sources. A concept has to be well-known and written about in reliable independent secondary sources first.

5.1.5 E3 value analysis

- Editor: Bram Naudts (Bramnaudts)

The contribution consists of a description of this ontology and its goal. It introduces the different concepts of e3 value network analysis (actor, value object, value port, etc.) and it also links to the c3-value modeling scheme.

This page had reached above 5KB when it was rejected for clarity reasons and lack of a mainstream press citation.

5.1.6 Receiving party pays (link to page)

- Editor: Christos Tsiaras (Christostsiaras)

It is a new page consisting of a single paragraph document describing the principle of Receiving Party Pays supported by three references The main editing to that page was

1. Created the new page concerning the Receiving party pays (RPP) principle of the termination rates policies.
2. Linked to the RPP page from the Termination rates page

The page was created by the FLAMINGO editor in 2015 with more than 2.8 KB. At this moment it has the contributions of other three different authors having reached an amount of 2.9 KB.

5.1.7 Schengen Routing (link to page)

- Editor: Sebastian Seeber (SsGer0710)

This is a new page presenting a first overview of Schengen Routing. In addition there is a section on Applicability and another on the Reasons for Schengen Routing. This is an initial step to see the reaction of the responsible editors.

The page was created last August and it is above 6 KB of which the FLAMINGO editors are the absolute authors. Up to the moment of closing this deliverable no feedback has been received from other Wikipedia users or editors.

5.2 Software-defined networking (link to page)

- Editor: Sebastian Seeber (SsGer0710)
- Contributor: Gaetan Hurel

These authors have carried out a total of eight edits. Three out of these edits are for sure the most important ones. The first describes the behavior when flows arrive to a switch and a flow table lookup is performed. The second edit deals with how Software-Defined Networking (SDN)

architecture may enable, facilitate or enhance network-related security applications due to the controller's central view of the network. The last edit is a contribution presenting security applications built upon the SDN controller, with different aims in mind. This edit also includes security applications that leverage the SDN controller by implementing some moving target defense (MTD) algorithms.

This page was created in 2011, not by a FLAMINGO editor, and has reached now about 40 KB thanks to the contributions of about 200 users. In this context, the FLAMINGO editors added above 8 KB and removed 3.5 KB, which gives the magnitude of its relative importance.

5.3 Policy-based management (link to page)

- Editor: Marinos Charalambides (marinoscx)

The page has been updated with information on policy refinement, an important part of the policy management life cycle. Also, the page was improved to include links to 3 article categories (network management, configuration management, computer networking) and also links from other Wikipedia articles.

This page was created by the FLAMINGO editor in 2014 and has reached a size above 11 KB through successive edits almost all from FLAMINGO.

5.4 Content delivery network (link to page)

- Editor: Marinos Charalambides (marinoscx)
- Contributor: Daphne Tuncer

The page has been updated with information concerning telco-CDNs. Pointers to research output from FLAMINGO have also been provided.

This page, created in 2004 and with inputs from 900 different people, is currently around 23 KB of which the FLAMINGO editor contributed with 1400.

5.5 6LoWPAN (link to page)

- Editor: Anthea Mayzaud (Flamingo 666)

The edit consists in the addition a full paragraph under the title Routing considerations and protocols for mesh topologies in 6LoWPAN containing a set of standardized protocols to be used in this context of low power wireless networks

This page was created in 2006 having reached a content of 10.5 KB of which 1 KB are from the FLAMINGO editor.

5.6 Maintenance of the Web Crawling tool

The Web Crawler has been improved as part of its maintenance during that reported period, to improve impact on the different communities of users. As the most relevant changes, we can mention the addition of Scopus among the different databases the tool uses for searching. Also new functions were added as follows. From a functional point of view, two modes are now available, one is the search with disambiguation, which was the default one in the previous version, and the search making use of the FLAMINGO taxonomy that now is optional. In addition, the sources from which the tool is searching can be selected, as well as the subtrees of the taxonomy that can be individually selected as well. Last, the authors list includes the source of the entries and the results can be exported to a pdf file. The crawler continues being available at `https://researchobservatory.fp7-flamingo.eu/`. Figure 7 shows the Web Crawler user interface in a search process.

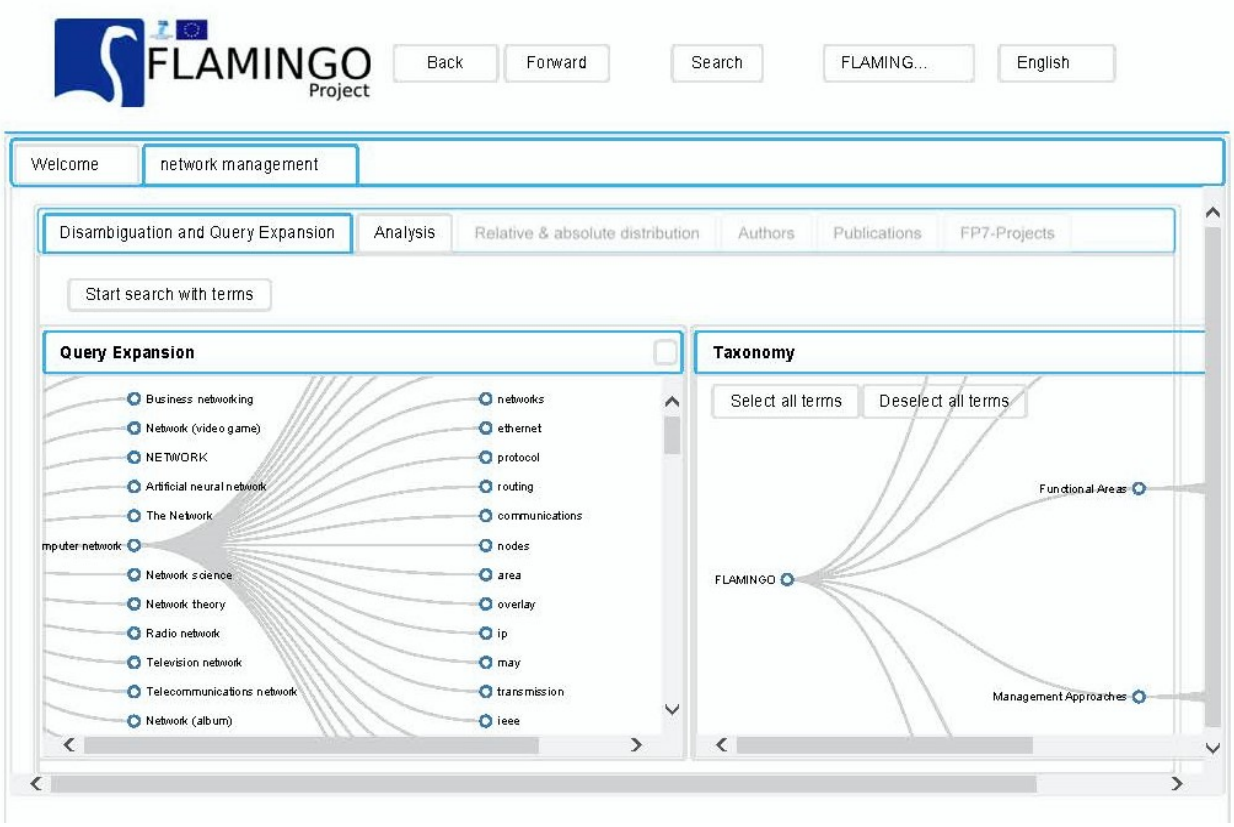


Figure 7: Web Crawler user interface in a search process

5.7 Maintenance of Simpleweb

The repositories in the Simpleweb [6] have been updated removing outdated elements and adding new ones. This concerns for instance to the open source and commercial software in the area of network and service management. Also, the lists of conferences and call for papers were maintained in the Simpleweb wiki. Both of them have been updated on a weekly base and showed upcoming events. In addition, both information are also available via RSS feeds. Figure 8 shows a snapshot of software tools on the Simpleweb website.

Figure 8: Snapshot of software tools on Simpleweb website

6 Conclusions

Work package 2, devoted to mobility, education and training has achieved its intended goals of providing orientation and guidance to project participants to help forming a well-integrated community.

FLAMINGO has been keeping the nine PhD students already identified in year 1 doing their respective research activities under the co-supervision of at least two senior researchers of the NoE. In addition, it has designed a collaboration plan consisting of activities directly emanated from the research work packages. These collaborations triggered visits ranging from a few days to 1 month of fourteen FLAMINGO researchers abroad. This visits strengthened the link between the PhD student and his/her co-supervisor, set the grounds of collaborative work between partners or designed the edition of common papers among others. In that respect the improvement achieved in respect to the previous reported period is remarkable.

The project S.M.A.R.T. objective entitled Integration of Ph.D. Students, states “After 9 months each research WP will have identified at least two fully integrated Ph.D. students, which means that these students will be jointly supervised and financially paid by FLAMINGO. At the end of the FLAMINGO project, we will have at least 9 fully integrated Ph.D. students”. For the reasons explained in the above paragraph we conclude that this objective has been achieved along the third year of project.

The production of courses and training material has been in the focus of this work package during this third year as well. One MOOC, and four additional course modules, out of which three consist of practical exercises have been produced. Hence the differentiating factor of this year in respect to the previous has been to start producing practical exercises and evaluation questionnaires never tried before. Tracking the impact of these videos based on the number of times each has been viewed, we have concluded that videos on specific tools and of shorter duration (a few minutes) have more acceptance. In addition, FLAMINGO partners have developed eight tutorials that have been taught to different communities.

The S.M.A.R.T. objective entitled Course and training material states "FLAMINGO will develop course material for network management, and make such material available to European and other universities. In addition, FLAMINGO will develop training material to facilitate current researchers within industry to keep up with the latest developments in this important field". Therefore, based on what we summarized in the paragraph above we can conclude that this S.M.A.R.T. objective has also been achieved for the reported period.

Finally, FLAMINGO has devoted effort to create or modify articles in Wikipedia. A total of twelve pages were created or edited, with a significant relative contribution of the FLAMINGO editors. The impact and acceptance of these changes in pages as well as the new ones will be continually tracked and appropriate feedback will be extracted to continue this activity in the next year. Also, other activities already initiated in the previous year like the database and RSS channels of the Simpleweb platform, and a Web Crawler have been continued.

The research observatory is related to the S.M.A.R.T. Objective Integration of the research community, which states "To integrate the Network and Service management community, FLAMINGO partners will create a research observatory. An initial version will be operational by the end of year one". Therefore, according to the outcomes summarized in the previous paragraph we conclude that this S.M.A.R.T. objective has been achieved through the second year of the project.

7 Acknowledgement

This deliverable was made possible due to the large and open help of the WP2 Partners of the FLAMINGO NoE. Many thanks to all of them.

8 References

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