



CogNet

7.3 – Dissemination, Communication, Exploitation and Standardisation Report

Year 1

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Acronyms and Definitions

| Acronym | Defined as |
|---------|---|
| SDN | Software Defined Network |
| NFV | Network Function Virtualisation |
| M2M | Machine to Machine |
| IOT | Internet Of Things |
| MANO | Management and Orchestration |
| OSM | Open Source MANO |
| NLP | Natural Language Processing |
| IRTF | Internet Research Task Force |
| NFVRG | Network Function Virtualization Research Group |
| NMRG | Network Management Research Group |
| SDNRG | Software Defined Network Research Group |
| NMLRG | Network Machine Learning Research Group |
| SUPA | Simplified Use of Policy Abstractions |
| ETSI | European Telecommunications Standards Institute |
| ISG | Industry Specification Group |
| EVE WG | Evolution and Ecosystem Working Group |
| H2A | Human Health Analytics |

Executive Summary

This document provides a report on all the activities related to Communication, Dissemination, Exploitation and Standardisation for the first year of the CogNet project.

During the first year of the project the technical activities have been mainly focused on the use-case definition and the architecture design.

The first section of the document describes the communication and dissemination strategy where the web site assumes a pivotal role as it acts as the main access point towards all the social media streams that are being used by the consortium.

The other key aspect for sharing the outcomes of CogNet is entrusted to the published papers and conferences' participation which have involved all the partners, each one within their own expertise area. The results of the exploitation activities are reported in the deliverable 7.8 which is also due in M12.

The last section of this document covers the activities related to standardization. This includes the listing of contributions to the different research groups and standardization bodies related to the different technologies that are being targeted by the CogNet project.

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1. Dissemination and Communication activities

The first year of the CogNet Project has been mainly focused on the architecture design, the definition of the various use-cases and scenarios and on the initial deployment of demonstrators that are currently under development.

The ongoing research carried out by all partners regarding the integration between network management and machine learning technics has produced a number of papers, posters and presentations that, together with the project's online presence and social media communications, constitute the overall dissemination activity detailed in this section.

The primary objective of dissemination is promoting the project's technical achievements and outcomes by identifying the proper targets and audience and selecting the more efficient channel to target any of the specific audience in order to maximize the impact. The main actors that have been targeted during the first year of the project can be summarized as follow:

- Industrial community: including service providers, telecom operators and content providers.
- Public organizations and regulators: public authorities, local/regional and national governments, European institutions and the European Commission.
- The scientific community: academia, research institutions, students.
- General public: technology experts, professionals and anyone who is interested in the 5G, network management and machine learning related topics.

The consortium has set up a number of different channels used for external dissemination as reported in the sections that follow. These include, among others, website, social media accounts, publications, conference participation, workshops and the organization of industrial events.

1.1. Online presence

The online presence is managed through the website and the social media accounts. These are maintained and updated with the latest project news and achievements. All the social media accounts are directly reachable through the website so that the online social footprint of CogNet can be easily identified and navigated.

1.1.1. Website

The CogNet website (<http://www.cognet.5g-ppp.eu/>) is on-line since September 2015, and it acts as the main entry point for the dissemination activity of the Project. A description of all the sections has already been reported in D7.1 [1].

Since the web site was launched it has been continuously updated with the relevant information covering communications and dissemination activities as soon as they became available. In particular the "News" section reports, on a time line basis, all the events attendance information

and a monthly updated regular-blog entitled “From the Inside Out” which illustrates the on-going activities of the Project.

All the public Deliverables are being made available for users to download as soon as they are ready for submission which can be found in the “Public Deliverables” sub-section. The “Publication” sub-section contains a list of all of the papers, posters and presentations that have been published by the Consortium.

1.1.1.1 Website Statistics

The website is provided with an easy-to-use plug-in that is installed within the *Wordpress* tool that generates and keeps track of a wide set of statistics. This is useful to retrieve metric information about the visibility of our activities to the global audience. The following figures provide an overview of these metrics.

| Summary | | |
|-----------------------|--------------|------------------|
| User(s) Online: | 0 | |
| | Visitor | Visit |
| Today: | 13 | 38 |
| Yesterday: | 41 | 6,362 |
| Last 7 Days (Week): | 847 | 7,765 |
| Last 30 Days (Month): | 2,271 | 23,122 |
| Last 365 Days (Year): | 8,960 | 2,513,149 |
| Total: | 8,960 | 2,513,149 |

Figure 1-1: Statistics Summary



Figure 1-2: Visitors in the last 6 months

1.1.2. Twitter

In line with our phased approach to dissemination (starting with *awareness-raising*, then onto *positioning*, and finally *market*) our social media strategy also followed a phased approach. Therefore, in year one, we concentrated on getting the CogNet project name “out there” via Twitter. This was a deliberate approach since most of our key deliverables will not be due for publication until years two and three of the project.

Out of the 19 projects funded as part of 5G-PPP, CogNet ranks fourth on Twitter in terms of the number of Followers. Annex I contains a snapshot of all 5G-PPP projects on Twitter as of 14-June, 2016.

1.1.3. Other Social Media

During the first year CogNet had 4 discussions/announcements on LinkedIn as well as 2 videos on YouTube. As we produce more outputs in year two, we will move to the positioning phase of our dissemination. This will involve the use of additional social media, such as LinkedIn for discussing our outputs and YouTube to broadcast interviews at events where we have presented papers. We will also maintain a strong presence on Twitter but will naturally move towards more nuanced dissemination as our work matures and our deliverables are made available.

1.1.4. Online Links

| | |
|----------|---|
| Website | http://www.cognet.5g-ppp.eu |
| Twitter | @5GPPPCogNet |
| LinkedIn | https://www.linkedin.com/groups/8353951 |
| YouTube | https://www.youtube.com/channel/UCv3BjdE2XedmnSOOYLq6E_w |
| Facebook | https://www.facebook.com/5GPPPCogNet/ |

1.2. Publications in conferences and journals

The main goal of the dissemination and communication activities listed in this section are to present the project research results and share experiences in the area of 5G network management, in particular solutions based on the use of machine learning. As a direct consequence of the project focus on Software Networks, these activities have been concentrated on such network technologies, especially SDN and NFV as its current realizations.

In this section we report two types of activities covering both those oriented towards achieving academic goals (papers, short papers, talks and posters), and those focused on the dissemination and communication of the Cognet results among the industry (as is the case with industrial events, seminars and workshops).

1.2.1. Industry oriented events

There is a growing interest in industry in matters related to 5G, Software Networks and the different mechanisms for enhancing network management that will address the challenges that next-generation network infrastructures will bring. As a result of this interest, and given the leadership position of several of the partners in the innovation activities related to the fields mentioned above, both internally (mostly in the case of multinational companies) and externally (within industrial communities and fora) the team has received several invitations to participate in industrial-oriented events of different nature, where the CogNet goals, architecture principles, challenges and results have been disseminated and discussed. The following list captures the details of such activities that have occurred during this period.

1. **Title: “The Application of Machine Learning and Data Analytics to Network Management for Large Scale Networks”** (invited talk)

Description: this was a brief overview of the concepts of 5G Network Management, what ML is about and how it can be applied to Network Management, and also some of the high level use cases in CogNet.

Speaker: Robert Mullins (TSSG)

Event: Fokus Fuseco Forum

Date: November 5th-6th 2015.

Location: Berlin, Germany.

URL: <https://www.fokus.fraunhofer.de/go/fuseco-forum-2015>

Event topic: Digital Convergence and Seamless Connectivity for everyone and everything – Bringing 5G, SDN/NFV and M2M/IOT together.

2. **Title: “Deep Natural Language Processing for Cognitive Dialog Systems”** (invited talk)

Description: an IBM/UNITN event had been organized targeting one important aspect of the CogNet project: advanced machine learning methods for Cognitive Business. Talks on cognitive computing were presented by three distinguished speakers which was followed with a panel discussion.

Speaker: Alessandro Moschitti (UNITN)

Event: Deep Natural Language Processing for Cognitive Dialog Systems

Date: November 18th, 2015

Location: Trento, Italy.

URL: <http://webmagazine.unitn.it/en/evento/disi/7021/deep-natural-language-processing-for-cognitive-dialog-systems>

Event topic: Deep Natural Language Processing.

3. Title: **“CogNet: An NFV/SDN based architecture for Autonomic 5G Network Management using Machine Learning”** (poster)

Description: Poster presenting the CogNet project with particular focus on the architecture.

Authors: Domenico Gallico (IRT), Matteo Biancani (IRT), Haytham Assem (IBM), Diego Lopez (TID)

Event: 5G: From Myth to Reality (ETSI)

Date: April 21st, 2016

Location: Sophia Antipolis, France

URL: <http://www.etsi.org/news-events/events/1025-2016-04-5g-from-myth-to-reality>

Event topic: in the 5G research context, three specific classes of use cases are emerging as candidates for early prioritization: enhanced mobile broadband, massive machine type communications and ultra-reliable/low latency communications. This event reviewed the potential of these classes of use cases from a socio economic and technological perspective.

4. Title: **“NFV Service Orchestration and Lifecycle Management based on Open Source MANO”** (invited talk)

Description: Current evolution of Open Source MANO stacks, in which we presented the OSM project and the CogNet architecture as a demonstration of the applicability of Open Source principles to MANO, and the evolution trends of NFV advanced management.

Speaker: Diego Lopez (TID)

Event: TMForumLive!

Date: May 9th-12th 2016

Location: Nice, France

URL: <http://www.tmforumlive.org>

Event topic: Managing complex hybrid networks end-to-end

5. Title: **“Deep Natural Language Processing for Fact Verification and User Interaction”** (presentation)

Description: NLP and ML best world researchers for discussing future research directions, especially in an industrial perspective

Speaker: Alessandro Moschitti (UNITN)

Event: Google NLP Workshop 2016

Date: May 17th, 2016

Location: London, England.

Event topic: Natural Language Processing and Machine Learning

6. **Title: "The future of 5G with Cognitive Computing"** (presentation)

Description: propagations of new types of devices such as smart phones and smart tablets, along with the extensive improvement on mobile communication networks, have produced an eruption of new applications that consume resources from mobile networks and led to an explosive increase of network traffic. Meanwhile, it is expected that the machine-to-machine communication will be increased tremendously in the future to complement the dominating human-centric communication of today. This will lead to a huge diversity of communication characteristic. Both trends will raise new requirements on network scalability, data rates and more stringent latency and reliability which opens the door for leveraging cognitive computing technologies for tackling these new emerged challenges.

Speaker: Haytham Assem (IBM)

Event: IBM Technical Leadership Exchange (TLE)

Date: May 18th, 2016

Location: Dublin, Ireland

Event topic: New Emerging Technologies for commercialization.

7. **Title: "CogNet: A new architecture featuring cognitive features"** (poster)

Description: it is expected that the fifth generation mobile networks (5G) will support both human-to-human and machine-to-machine communications, connecting up to trillions of devices and reaching formidable levels of complexity and traffic volume. This brings a new set of challenges for managing the network due to the diversity and the sheer size of the network. It will be necessary for the network to largely manage itself and deal with organisation, configuration, security, and optimisation issues.

Author: Teodora Sandra Buda (IBM)

Event: IBM Technical Leadership Exchange (TLE)

Date: May 18th, 2016

Location: Dublin, Ireland

Event topic: New Emerging Technologies for commercialization.

8. **Title: "Applying Machine Learning to Intent-Based Networking "** (presentation)

Description: the talk highlights how Machine Learning techniques can be used to address different aspects of the operation and control of NFV and propose future OPNFV activities in this area.

Author: Diego R. Lopez (TID)

Event: Open Platform for NFV (OPNFV) Summit

Date: June 20th-23rd, 2016

Location: Berlin, Germany

URL: <http://events.linuxfoundation.org/events/opnfv-summit>

Event topic: NFV (OPNFV)

9. **Title:** “**1st International Workshop on Network Management, Quality of Service and Security for 5G Networks**” (organization of industrial events)

Description: Conference representing the activities of the Network Management, QoS and Security working groups.

Organiser and Chair: Robert Mullins (TSSG)

Event: Conference Workshop hosted at 25th European Conference on Networks and Communications (EuCNC) 2016.

Date: June 27th, 2016

Location: Athens, Greece

URL: <http://www.eucnc.eu/>. More detail available on: http://wiki.netmgmtwg.5g-ppp.eu/mediawiki/index.php/Workshop_agenda

Event topic: Network Management, QoS and Security in 5G

1.2.2. Academic Excellence

The research efforts carried out so far in the CogNet project have been focused mainly on the application of machine learning and modern technologies to problems arising in the management of 5G networks. This work has resulted in a set of publications covering a wide variety of areas.

A considerable effort has focused on spreading our project activities towards the academic community. We have attended cutting-edge conferences and engaged in fruitful discussions with top teams among the machine learning and the 5G networks communities.

In particular, 27 conference papers have been presented in several international conferences with double or, in very few cases, single-blind peer reviewing. Among them, 13 have been published by UNITN, some of which have been presented in the most important academic events in their fields (ACM CIKM-2015, ACM SIGIR 2015, ACL-2015, ACL-2016, NAACL-2016). Two of the papers have also won the best-paper awards at high-profile venues. The research on structural representations for kernel-based machine learning conducted by the University of Trento has been recognized with a best paper award at the 24th ACM International Conference on Information and Knowledge Management (CIKM 2015). At the later stages of the CogNet project, a similar approach, based on tree and graph kernels will be applied to telecom data to model network behavior, as foreseen in Task 3.2.

In addition, UPM team results in machine learning and data analytics have been published in many different domains such as marketing, aviation, health sector, and telecommunications.

Ten articles have been published in journals indexed in the first and second quartiles of the ISI-JCR index spanning some of the theoretical topics covered in WP3 and WP4. Besides, UPM has published some international books on web mining and has presented, together with Nokia, at the EUCNC-16 a seminal work that covers applying machine learning to the prediction of NFVI events (WP4). Other collateral contributions are an IBM academic award to develop technology on cognitive systems related to Watson and the development of the system H2A, for the analysis of Electronic Health Records (EHR). UPM is participating in several European projects related to Big Data technologies and acting as project coordinators in some of those projects that create interesting synergies with CogNet. Currently, UPM is very active on the FP7-ONTIC, EIT-HEALTH and EIT-Digital research projects on Big Data. In addition, several members of the UPM team are key lecturers in the EIT Digital Master Program in Data Science (<http://www.masterschool.eitdigital.eu/>).

There have also been other scientific contributions: two contributions to scientific journal submitted recently, as well as one white paper, one scientific presentation and three invited talks. In particular, Prof. Moschitti of the UNITN has given two invited talks focused on relational models for Machine Learning, more specifically on combining Tree Kernels and Deep Neural Networks, covering an important aspect of Machine Learning, spanning the topics from Tasks 3.1 and 3.2.

In this subsection we list and describe all dissemination and communication activities related to academic goals. The items listed below include conference attendance, articles presented in conferences and subsequently published in proceedings volumes and finally articles submitted to and accepted by scientific journals (sorted by date of publication/realization).

1. Title: “**Distributional Neural Networks for Automatic Crossword Puzzles**” (short paper)

Description: in this paper, we created a labelled dataset of 2 million clues for crossword puzzles on which we apply an innovative Distributional Neural Network (DNN) for re-ranking clue pairs. Our DNN is computationally efficient and can thus take advantage of such large datasets showing a large improvement over the tree kernel (TK) approach, when the latter uses small training data. In contrast, when data is scarce, TKs outperform DNNs.

Authors: Aliaksei Severyn (UNITN), Massimo Nicosia (UNITN), Gianni Barlacchi (UNITN) and Alessandro Moschitti (UNITN).

Event: 53rd annual meeting of the Association for Computational Linguistics (ACL)

Date: July 26th-31st, 2015

Location: Beijing, China.

URL: <http://acl2015.org/index.html>

Event topic: Natural Language Processing, Machine Learning

2. Title: “**SACRY: Syntax-based automatic crossword puzzle resolution system**” (demo+paper)

Description in this paper, we present our Crossword Puzzle Resolution System (SACRY). Our system is based on WebCrow, one of the most advanced systems for automatic crossword puzzle resolution. Our extensive experiments over our two million clue dataset show that our approach highly improves the quality of the answer list, enabling the achievement of unprecedented results on the complete CP resolution tasks, i.e., accuracy of 99.17%.

Authors: Gianni Barlacchi (UNITN), Massimo Nicosia (UNITN), Alessandro Moschitti (UNITN)

Event: 53rd annual meeting of the Association for Computational Linguistics – ACL.

Date: July 26th-31st, 2015

Location: Beijing, China.

URL: <http://acl2015.org/index.html>

Event topic: Natural Language Processing, Machine Learning

3. Title: “**Learning to Rank Short Text Pairs with Convolutional Deep Neural Networks**” (paper)

Description: in this paper, we present a convolutional neural network architecture for re-ranking pairs of short texts, where we learn the optimal representation of text pairs and a similarity function to relate them in a supervised way from the available training data.

Authors: Aliaksei Severyn (UNITN), Alessandro Moschitti (UNITN)

Event: 38th International ACM SIGIR Conference on Research and Development in Information Retrieval

Date: August 9th – 13rd, 2015

Location: Santiago de Chile, Chile

URL: <http://sigir2015.org/>

Event topic: Information retrieval, data mining

4. Title: “**Assessing the Impact of Syntactic and Semantic Structures for Answer Passages Reranking**” (paper)

Description: we have developed structural representations and applied them to the Information Retrieval and Question Answering task. Additionally, we define links between structures and use tree kernels to generate relational features to get more informative representations. Our study provides an extensive empirical evaluation showing that a

structural relational model consistently outperforms the state of the art. At the later stages of the CogNet project, a similar approach, based on tree and graph kernels will be applied to the telecom data to model network behavior, as foreseen in Task 3.2.

Authors: Kateryna Tymoshenko (UNITN), Alessandro Moschitti (UNITN)

Event: 24th ACM International Conference on Information and Knowledge Management - CIKM

Date: October 19th – 23rd, 2015

Location: Melbourne, Australia

URL: <http://www.cikm-2015.org/>

Event topic: Knowledge Management, Information Retrieval and Data Base/Data Mining

Comment: Best paper award

5. Title: “**Deep Neural Networks for Named Entity Recognition in Italian**” (paper)

Description: this paper investigates a Deep Neural Network (DNN) approach for sequence modelling, applying it to the Named Entity Recognition task. Our model relies on a word-level log-likelihood as a cost function and advocates a novel recurrent feedback mechanism to ensure that the dependencies between the output tags are properly modelled. The evaluation of our DNN model on state-of-the-art benchmarking datasets shows that it performs on par with the previous best algorithms, that require a considerable amount of manual domain-specific engineering, and outperforms the state-of-the-art when adding more features. In the telecom context, we are extending this approach for modelling performance degradation.

Authors: Daniele Bonadiman (UNITN), Aliaksei Severyn (UNITN), Alessandro Moschitti (UNITN)

Event: 2nd Italian Conference on Computational Linguistics, Clic-It pages

Date: December 3rd-4th, 2015

Location: Trento, Italy

URL: <https://clic2015.fbk.eu/>

Event topic: Machine learning, NLP

Comment: Best paper award

6. Title: “**5G PPP – 5G Architecture White Paper**” (in progress).

Description: the European Union funded 5G Public Private Partnership (5GPPP) is an important initiative where public and private sectors in Europe work together to develop 5G and secure the European leadership. Several projects have received support to work on areas ranging from physical layer to overall architecture, network management and software networks. This is very important because 5G is not only a new radio but also a framework that integrates new with existing technologies to meet the requirements of 5G

applications. The 5G Architecture Working Group as part of the 5GPPP Initiative is looking at capturing novel trends and key technological enablers for the realization of the 5G architecture. It also targets at presenting in a harmonized way the architectural concepts developed in various projects and initiatives (not limited to 5GPPP projects only) so as to provide a consolidated view on the technical directions for the architecture design in the 5G era.

Authors: Nearly representatives from all 5G-PPP projects including IBM

Event: EUCNC White Paper Architecture Work Group

Date: June 27th-30th, 2016

Location: Athens, Greece.

URL: <http://www.eucnc.eu/>

Event topic: European conference on networks and communications.

7. **Title:** "**Intent-Based Networking - And How Machine Learning Can Bring Convergence**" (presentation)

Description: an introduction to Intent-Based Networking and a discussion of how the application of ML techniques (and in particular a common architecture for ML, as defined by CogNet) can be used to achieve the intent promise.

Author: Pedro A. Aranda (TID)

Event: Joint Expert Group and Vision Group Workshop "Networld 2020 Strategic Research Agenda"

Date: March 16th, 2016

Location: Bologna, Italy

URL: http://www.networld2020.eu/wp-content/uploads/2016/03/Agenda_v8-final-rev1.pdf

Event topic: Virtualised Network and Services

8. **Title:** "**Parallelized unsupervised feature selection for large-scale network traffic analysis**" (paper)

Description: a parallelized unsupervised feature selection new algorithm based on a new formulation of the leverage scores is proposed to be applied into enormous datasets often present in network traffic analysis by improving the amount of time necessary for these operations.

Authors: Bruno Ordozgoiti (UPM), Sandra Gómez Canaval (UPM) and Alberto Mozo (UPM).

Event: 24th European Symposium on Artificial Neural Networks, Computational Intelligence and Machine Learning (ESANN).

Date: April 27th - 29th, 2016

Location: Bruges, Belgium

URL: <https://www.elen.ucl.ac.be/esann/index.php?pg=welcome>

Event topic: Machine Learning

9. Title: **"PSCEG: An unbiased Parallel Subspace Clustering algorithm using Exact Grids"**
(paper)

Description: a new parallel subspace clustering algorithm generating an exact grid without the need to specify its size based on the distribution of each dimension is proposed. In addition, the parallel implementation using Resilient Distributed Datasets of this algorithm achieves a significant speedup in high dimensional scenarios.

Authors: Bo Zhu (UPM), Bruno Ordozgoiti (UPM) and Alberto Mozo (UPM).

Event: 24th European Symposium on Artificial Neural Networks, Computational Intelligence and Machine Learning (ESANN).

Date: April 27th - 29th, 2016

Location: Bruges, Belgium

URL: <https://www.elen.ucl.ac.be/esann/index.php?pg=welcome>

Event topic: Machine Learning

10. Title: **"First IFIP/IEEE International Workshop on Management of 5G Networks - 5GMan 2016"**

Description: The main goal of the workshop was to present state-of-the-art research results and experience reports in the area of management of 5G networks, addressing topics such as management of SDN and NFV-based networks and services, advances in the management of cloud platforms, programmatic languages and abstraction applied to resources and service management, big data and analytics applied to management.

Member of the organizing committee: Imen Grida Ben Yahia (Orange)

Event: Workshop co-located with NOMS Network Operations Management Symposium 2016

Date: April 29th, 2016

Location: Istanbul, Turkey

URL: <http://161.106.2.35/>

Event topic: Management of 5G Networks

11. Title: **"Can Machine Learning aid in delivering new Use cases and Scenarios in 5G?"**
(paper)

Description: 5G represents the next generation of communication networks and services, and will bring a new set of use cases and scenarios. These in turn will address a new set of challenges from the network and service management perspective, such as network traffic and resource management, big data management and energy efficiency. Consequently,

novel techniques and strategies are required to address these challenges in a smarter way. In this paper, we present the limitations of the current network and service management and describe in detail the challenges that 5G is expected to face from a management perspective. The main contribution of this paper is presenting a set of use cases and scenarios of 5G in which machine learning can aid in addressing their management challenges. It is expected that machine learning can provide a higher and more intelligent level of monitoring and management of networks and applications, improve operational efficiencies and facilitate the requirements of the future 5G network.

Authors: Teodora Sandra Buda (IBM), Haytham Assem (IBM), Diego Lopez (TID), Marius-Iulian Corici (Fraunhofer FOKUS), Danny Raz (NOKIA), Olga Uryupina (UNITN), Robert Mullins (TSSG), Imen Grida Ben Yahia (Orange).

Event: 1th International Workshop on Management of 5G Networks (IEEE 5GMan). Co-located with IFIP/IEEE Network Operations and Management Symposium (NOMS).

Date: May 25th-29th, 2016.

Location: Istanbul, Turkey

URL: <http://161.106.2.35/index.html>

Event topic: Management of 5G Networks

12. Title: "**Agile Service Manager for 5G**" (paper)

Description: this paper presents an underlying framework to support and accelerate the production of applications and services in the context of programmable networks (SDN and NFV, clouds). The proposed framework addresses moreover the "5G KPI of reducing the average service creation time from 90 hours to 90 minutes" as declared by 5GPPP association in early 2015 among other KPIs. The proposed framework relies on SDN, NFV and Cloud principles and technologies and proposes extensions towards the end to end abstraction that is required for automation of service production. A Service Manager Architecture fulfilling the agility, acceleration and automation requirements is presented along with its relationships and interfaces with the applications and network levels. An application requiring network services, expressed in a network service descriptor, is used to illustrate the architecture usage and benefits and highlights the remaining future research needs and trails.

Authors: Marouen Mechtri (Orange), Imen Grida Ben Yahia (Orange), Djamel Zeghlache (Orange).

Event: 1th International Workshop on Management of 5G Networks (IEEE 5GMan). Co-located with IFIP/IEEE Network Operations and Management Symposium (NOMS).

Date: May 25th-29th, 2016.

Location: Istanbul, Turkey

URL: <http://161.106.2.35/index.html>

Event topic: Management of 5G Networks

13. **Title: “Emerging Management Challenges for the 5G era: Multi-Service Provision through Optimal End-to-End Resource Slicing in Virtualized Infrastructures”** (short paper)

Description: today there are forceful work streams that aim at realizing the "5th generation of wireless/mobile broadband". This paper intends to analyze the emerging management challenges for the 5G era towards multi-service provision through optimal end-to-end resource slicing in virtualized infrastructures. Also, this paper proposes essential advances in the management intelligence, in order to achieve constantly agile and therefore optimal system behavior in the demanding 5G wireless environment.

Authors: Kostas Tsagkaris (Orange), Imen Grida Ben Yahia (Orange), Andreas Georgakopoulos (Orange), Panagiotis Demestichas (Orange).

Event: 1th International Workshop on Management of 5G Networks (IEEE 5GMan). Co-located with IFIP/IEEE Network Operations and Management Symposium (NOMS).

Date: May 25th-29th, 2016.

Location: Istanbul, Turkey

URL: <http://161.106.2.35/index.html>

Event topic: Management of 5G Networks

14. **Title: “Crossword Puzzle Resolution in Italian using Distributional Models for Clue Similarity”** (short paper)

Description: in this paper, following our recent work on crossword puzzle resolution, we create a labelled dataset, and propose (i) a set of re-ranking baselines and (ii) a neural re-ranking model based on distributed representations of clues and answers. Our neural model improves over our proposed baselines and the state of the art.

Authors: Massimo Nicosia (UNITN) and Alessandro Moschitti (UNITN)

Event: 7th Italian Information Retrieval Workshop - IIR

Date: May 30th – 31st, 2016

Location: Venezia, Italy

URL: <http://www.dais.unive.it/IIR2016/>

Event topic: Information retrieval, question answering

15. **Title: “ARRAU: Linguistically-Motivated Annotation of Anaphoric Description”** (paper)

Description: this paper presents a second release of the ARRAU dataset of anaphoric description. The dataset will be used for the Large-Scale Events scenario to provide data for events fusion.

Authors: Olga Uryupina (UNITN), Ron Artstein, Antonella Bristot, Federica Cavicchio, Kepa J. Rodriguez and Massimo Poesio.

Event: 10th Conference on Language Resources and Evaluation- LREC.

Date: May 23rd-28th, 2016.

Location: Portorož, Slovenia.

URL: <http://lrec2016.lrec-conf.org/en/>

Event topic: Resources and evaluation

16. Title: **“Machine Learning for Autonomic Network Management in a Connected Cars Scenario”** (paper)

Description: this paper presents a preliminary approach towards Autonomic Network Management on a connected cars scenario. The focus is on the machine learning part, which will allow forecasting resource demand requirements, detecting errors, attacks and outlier events, and responding and taking corrective actions.

Authors: Gorka Velez (VIC), Marco Quartulli (VIC), Angel Martin (VIC), Oihana Otaegui (VIC), Haytham Assem (IBM)

Event: 10th International Workshop on Communication Technologies for Vehicles - NETS4CARS NETS4TRAINS NETS4AIRCRAFT.

Date: June 6th-7th, 2016

Location: San Sebastián, Spain.

URL: <http://nets4workshop.ceit.es/>

Event topic: Information management. Mobility management, Network management, traffic modelling and optimization.

17. Title: **“Convolutional Neural Networks vs. Convolution Kernels: Feature Engineering for Question Answering”** (paper)

Description: in this paper, we study, compare and combine two state-of-the-art approaches to automatic feature engineering: Convolution Tree Kernels (CTKs) and Convolutional Neural Networks (CNNs) for learning to rank answer sentences in a Question Answering (QA) setting. For this purpose, we propose novel CNNs using relational information and combine them with relational CTKs. The results show that (i) both approaches achieve the state of the art on a question answering task, where CTKs produce higher accuracy and (ii) combining such methods leads to unprecedented high results.

Authors: Kateryna Tymoshenko (UNITN), Daniele Bonadiman (UNITN) and Alessandro Moschitti (UNITN)

Event: 15th Annual Conference of the North American Chapter of the Association for Computational Linguistics: Human Language Technologies NAACL pages

Date: June 12nd - 17th, 2016

Location: San Diego, USA

URL: <http://naacl.org/naacl-hlt-2016/index.html>

Event topic: Machine learning, NLP

18. **Title: "A Machine Learning Architecture Enabling Intent-Based Network Management"** (invited talk)

Description: invited talk that will highlight how Intent can be applied to network management through a general architecture as the one defined by CogNet.

Invited speaker: Diego R. Lopez (TID)

Event: 12th International Conference on IP + Optical Network (iPOP)

Date: June 15th-17th, 2016

Location: Yokohama, Japan

URL: <http://www.pilab.jp/ipop2016/>

Event topic: Intent Based Network Management (IBNM)

19. **Title: "KeLP at SemEval-2016 Task 3: Learning Semantic Relations between Questions and Answers"** (paper)

Description: this paper describes the KeLP system participating in the SemEval-2016 Community Question Answering (cQA) task. The challenge tasks are modeled as binary kernel-based classifiers.

Authors: Simone Filice, Danilo Croce, Alessandro Moschitti (UNITN) and Roberto Basili.

Event: 10th International Workshop on Semantic Evaluation -SemEval

Date: June 16th – 17th, 2016

Location: San Diego, USA

URL: <http://alt.qcri.org/semeval2016/>

Event topic: Machine learning, Natural Language Processing evaluation

20. **Title: "ConvKN at SemEval-2016 Task 3: Answer and Question Selection for Question Answering on Arabic and English Fora"**

Description: we describe our system, ConvKN, participating to the SemEval-2016 Task 3 "Community Question Answering". The task targeted the reranking of questions and comments in real-life web fora both in English and Arabic. ConvKN combines convolutional tree kernels with convolutional neural networks and additional manually designed features.

Authors: Alberto Barron-Cedeno, Daniele Bonadiman (UNITN), Giovanni Da San Martino, Shafiq Joty, Alessandro Moschitti (UNITN), Fahad A. Al Obaidli, Salvatore Romeo, Kateryna Tymoshenko (UNITN) and Antonio Uva (UNITN).

Event: 10th International Workshop on Semantic Evaluation -SemEval

Date: June 16th – 17th, 2016

Location: San Diego, USA

URL: <http://alt.qcri.org/semEval2016/>

Event topic: Machine learning, Natural Language Processing evaluation

21. Title: **“The Rhythms of Italian Cities: Estimating Presence Patterns from Mobile Phone Data”** (poster)

Description: in this contribution, we investigate the rhythm of Italian cities by studying the dynamics of the geographical distribution of persons over the whole Italian territory. We investigate patterns of mobile consumption over space and time.

Authors: G. Barlacchi (UNITN), P. Bosetti, Q. Zhang, M. Chinazzi, S. Bernaola, A. Vespignani and B. Lepri.

Event: 2nd Annual International Conference on Computational Social Science

Date: June 24th– 26th, 2016.

Location: Chicago, USA.

URL: <http://www.kellogg.northwestern.edu/news-events/conference/ic2s2/2016.aspx>

Event topic: Mobile phone data analysis.

22. Title: **“An Energy Efficient Architecture for 5G Network Management”** (paper)

Description: the paper presents a "systemic" approach to reduce energy consumption in 5G networks leveraging the possibility offered by SDN separating the control and data plane. This view, starting from the knowledge of the state of the network (and its history) gives the possibility to optimize energy consumption at the network level using cognitive approaches and prediction algorithms.

Authors: Kieran Sullivan (VIC), Michael Barros (VIC), Angel Martin (VIC).

Event: 1th International Workshop on Network Management, QoS and Security for 5G networks (EuCNC)

Date: June 27th-30th, 2016

Location: Athens, Greece

Organizer: European Commission

URL: <http://www.eucnc.eu/>

Event topic: Software-Defined Infrastructures (Traffic engineering, QoS, energy-efficiency) and Management Technologies (energy-efficient networks/infrastructures).

23. Title: **“CogNet: A Network Management Architecture Featuring Cognitive Capabilities”** (paper)

Description: it is expected that the fifth generation mobile networks (5G) will support both human-to-human and machine-to-machine communications, connecting up to trillions of devices and reaching formidable levels of complexity and traffic volume. This

brings a new set of challenges for managing the network due to the diversity and the sheer size of the network. It will be necessary for the network to largely manage itself and deal with organisation, configuration, security, and optimisation issues. This paper proposes an architecture of an autonomic self-managing network based on Network Function Virtualization, which is capable of achieving or balancing objectives such as high QoS, low energy usage and operational efficiency. The main novelty of the architecture is the Cognitive Smart Engine introduced to enable Machine Learning, particularly (near) real-time learning, in order to dynamically adapt resources to the immediate requirements of the virtual network functions, while minimizing performance degradations to fulfil SLA requirements. This architecture is built within the CogNet European Horizon 2020 project, which refers to Cognitive Networks.

Authors: Lei Xu (IBM), Haytham Assem (IBM), Teodora Sandra Buda (IBM), Diego R. López (TID), Imen Grida Ben Yahia (Orange), Mikhail Smirnov (Fraunhofer FOKUS), Danny Raz (Nokia), Olga Uryupina (UNITN), Angel Martin (VIC), Alberto Mozo (UPM), Domenico Gallico (IRT) and Robert Mullins (TSSG)

Event: 25th European Conference on Networks and Communications (EUCNC)

Date: June 27th-30th 2016

Location: Athens, Greece

Organizer: European Commission

URL: <http://www.eucnc.eu/>

Event topic: Network Management.

24. **Title: “Cooperative Caching in C-RAN using Bayesian Classification and Greedy Placement”** (paper)

Description: it proposes setting up a simulation-based environment for quantitative evaluation of Machine Learning and statistical forecasting algorithms for the autonomic management of 5G networks. The setup proposed for distributed caching is improved using ML-based popularity estimation and greedy algorithms for a smart content distribution among the different caches.

Authors: Beñat Azpiazu (VIC), Marco Quartulli (VIC), Angel Martín (VIC), Igor Golaizola (VIC), Basilio Sierra.

Event: 25th European Conference on Networks and Communications (EUCNC)

Date: June 27th-30th, 2016

Location: Athens, Greece

Organizer: European Commission

URL: <http://www.eucnc.eu/>

Event topic: Network Management, Quality of Service and Security for 5G Networks

25. Title: "**Using Machine Learning to Detect Noisy Neighbors in 5G Networks**" (paper)

Description: 5G networks are expected to be more dynamic and chaotic in their structure than current networks. With the advent of Network Function Virtualization (NFV), Network Functions (NF) will no longer be tightly coupled with the hardware they are running on, which poses new challenges in network management. Noisy neighbor is a term commonly used to describe situations in NFV infrastructure where an application experiences degradation in performance due to the fact that some of the resources it needs are occupied by other applications in the same cloud node. This situations cannot be easily identified using straightforward approaches, which calls for the use of sophisticated methods for NFV infrastructure management. In this paper we demonstrate how Machine Learning (ML) techniques can be used to identify such events. Through experiments using data collected at real NFV infrastructure, we show that standard models for automated classification can detect the noisy neighbor phenomenon with an accuracy of more than 90% in a simple scenario.

Authors: Udi Margolin (Nokia), Alberto Mozo (UPM), Bruno Ordozgoiti (UPM), Danni Raz (Nokia), Elisha Rosensweig (Nokia) and Itai Segall (Nokia).

Event: Conference Workshop hosted at Conference Workshop hosted at 25th European Conference on Networks and Communications (EuCNC) 2016.

Date: June 27th-30th 2016

Location: Athens, Greece

Organizer: European Commission

URL: <http://www.eucnc.eu/Event> topic: Network Management, QoS and Security in 5G.

26. Title: "**LiMoSINe pipeline: Multilingual UIMA-based NLP platform**" (demo+paper)

Description: we present a robust and efficient parallelizable multilingual UIMA-based platform for automatically annotating textual inputs with different layers of linguistic description. The pipeline will be used for processing social media texts (tweets) for the Large-Scale Events scenario.

Authors: Olga Uryupina (UNITN), Barbara Plank, Gianni Barlacchi (UNITN) and Francisco Valverde Albacete, Manos Tsagkias, Antonio Uva (UNITN) and Alessandro Moschitti (UNITN).

Event: 54th Annual meeting of the Association for Computational Linguistics (ACL)

Date: August 7th-12th, 2016.

Location: Berlin, Germany

URL: http://acl2016.org/index.php?article_id=46

Event topic: Machine learning, NLP

27. **Title:** “**Taking the best from the Crowd: Learning Question Passage Classification from Noisy Data**” (accepted paper)

Description: we propose methods to take into account the disagreement between crowd annotators as well as their skills for weighting instances in learning algorithms. The latter can thus better deal with noise in the annotation and produce higher accuracy.

Authors: Azad Abad (UNITN), Alessandro Moschitti (UNITN)

Event: 5th Joint Conference on Lexical and Computational Semantics – SEM.

Date: August 11st-12th, 2016

Location: Berlin, Germany.

URL: <https://sites.google.com/site/starsem2016/>

Event topic: Lexical and Computational Semantics

28. **Title:** “**Integrated Terahertz Communication with Reflectors for 5G Small Cell Networks**” (submitted paper).

Description: overview paper on smart Terahertz antennae and how they can be applied to improve data transmission to specific locations and for specific 5G use cases that are relevant to CogNet.

Author: Michael Taynnan Barros (TSSG), Sasitharam Balasubramaniam (TSSG), Robert Mullins (TSSG)

Journal: IEEE Transactions on Vehicular Technology

Year: 2016

Topic: Land, airborne, and maritime mobile services, vehicular electrotechnology, equipment, and systems identified with the automotive industry.

29. **Title:** “**Spark2Fires: A new parallel approximate subspace clustering algorithm**” (accepted paper)

Description: subspace clustering allows finding all lower-dimensional clusters hidden in subspaces of high dimensional data. Although the majority of existing subspace clustering algorithms adopt certain heuristic pruning techniques to reduce the search space, the time complexity of such algorithms remain exponential with regard to the highest dimensionality of hidden subspace clusters. Even with help of parallelism, these techniques will require extremely high computational time in practice. In this paper we propose a novel subspace clustering technique that reduces the exponential time complexity to quadratic via approximation.

Authors: Bo Zhu (UPM) and Alberto Mozo (UPM).

Event: 3rd International Workshop on Big Data Applications and Principles (BigDap). Co-located with the 20th East-European Conference on Advances in Databases and Information Systems (ADBIS).

Date: August 28th-31st, 2016

Location: Prague, Czech Republic

URL: <http://dbdmg.polito.it/bigdap2016/>

Event topic: Big data

30. Title: **"Feature Ranking and Selection for Big Data Sets"** (accepted paper)

Description: the availability of big data sets has led to the successful application of machine learning and data mining to problems that were previously unsolved. The use of these techniques, though, is rarely straightforward. High dimensionality is often one of the main obstacles that must be overcome before learning an adequate model or drawing useful conclusions from large amounts of data. In this paper it is proved that data sets comprised of a huge number of rows can be easily transformed into a compact square matrix that preserves the permutation yielded by rank revealing QR factorizations.

Authors: Bruno Ordozgoiti (UPM), Sandra Gómez Canaval (UPM) and Alberto Mozo (UPM).

Event: 3rd International Workshop on Big Data Applications and Principles (BigDap). Co-located with the 20th East-European Conference on Advances in Databases and Information Systems (ADBIS).

Date: August 28th-31st, 2016

Location: Prague, Czech Republic

URL: <http://dbdmg.polito.it/bigdap2016/>

Event topic: Big data

31. Title: **"Machine Learning as a Service for enabling Internet of Things and People"** (submitted paper).

Description: the future internet is expected to connect billions of people, things and services having the potential to deliver a new set of applications by deriving new insights from the data generated from these diverse data sources. This highly interconnected global network brings new types of challenges in analysing and making sense of Data. This is why Machine Learning is expected to be a crucial technology in the future, in making sense of data, in improving business and decision making, and in so doing providing the potential to solve a wide range of problems in healthcare, telecommunications, urban computing, and others. Machine Learning algorithms can learn how to perform certain tasks by generalizing examples from a range of sampling. This is a totally different paradigm than traditional programming language approaches, which are based on writing programs that process data to produce an output. However, choosing a suitable machine learning algorithm for a particular application requires a substantial amount of time and effort that is hard to undertake even with excellent research papers and textbooks. In order to reduce the time and effort, this paper introduces the TCDC (Train, Compare, Decide, and Change) approach, which can be

thought as a 'Machine Learning as a Service' approach, to aid machine learning researchers and practitioners to choose the optimum machine learning model to use for achieving the best tradeoff between Accuracy and Interpretability, Computational Complexity, and Ease of Implementation. The paper includes the results of testing and evaluating the recommenders based on the TCDC approach (in comparison to the traditional default approach) applied to 12 datasets that are available as open-source datasets drawn from diverse domains including healthcare, agriculture, aerodynamics and others. We show based on our results that our proposed approach select the best model in terms of predictive accuracy in 62.5% for all regression tests performed and 75% for all classification tests.

Authors: Haytham Assem (IBM), Lei Xu (IBM) and Sandra Buda (IBM).

Journal: Personal and Ubiquitous Computing (PUC)

Editorial: Springer

Year: 2016

Topic: Internet of People and Ubiquitous Computing.

32. **Title: "Software Defined Network self-management using Machine Learning"**

(submitted paper)Description: this paper studies the feasibility to integrate Machine Learning methods in a SDN controller, in order to instantiate the most efficient network topology in terms of forwarded services Key Performance Indicators. The learning can be done based on the experience gathered in previous measurements aiming smart traffic routing.

Authors: Jon Egaña (VIC), Marco Quartulli (VIC), Angel Martín (VIC), Igor G Olaizola (VIC), Juan José Igarza.

Event: 13th International Symposium on Wireless Communication Systems ISWCS

Date: September 20th-23rd, 2016

Location: Poznan, Poland

Organizers: IEEE and Eurasip

URL: <http://iswcs2016.org/>

Event topic: Networking, protocols, cognitive radio, wireless sensor networks, services and applications. Self-organisation and Software defined networking.

2. Exploitation

As already mentioned in the executive summary of this document, the exploitation activities are reported in detail in Deliverable 7.8 where the business and research values potentially generated by the CogNet use cases and scenarios and will be analysed.

3. Standardisation activities

Since the application of machine learning to network management is still perceived mostly as a research activity by the standards community, and given that the CogNet architecture has just started to solidify around the first demonstrator, the standardisation activities of this period have been mostly focused on contributing to those pre-standardization research groups connected with the CogNet goals. These include building awareness on the CogNet activities and identifying future collaborations in which CogNet can provide feedback to the bodies dealing with some of the technologies on which CogNet is based.

With respect to the standards bodies, the CogNet team has initiated the following:

- First contacts with the IRTF groups related to CogNet goals: NFVRG, NMRG, SDNRG and the proposed group on machine learning NMLRG. A proposal to introduce the CogNet architecture and their applicability of the use cases described in WP4 and WP5 is being submitted to these groups with a special emphasis on the upcoming joint NFVRG/NMRG/SDNRG session on Software Networks Management scheduled for IETF96, July 2016, in Berlin.
- Direct conversations with the main contributors of the SUPA WG of the IETF with the intention of clarifying the applicability of SUPA to represent the policy expressions that constitute the output of the CogNet Smart Engine and the possible contributions of the project as a relevant SUPA application framework. The results are encouraging and we expect to be in the position to make active contributions to SUPA in the coming months.
- The application of the conclusions of the EVE005 Group Specification of the ETSI NFV ISG regarding the interaction among SDN controllers into the NFV framework to the CogNet architecture. The EVE WG of ETSI NFV has been informed and the CogNet team will prepare the appropriate contributions to the EVE005 evolution as the experience with the architecture grows. Given the alignment of EVE005 with the recent ONF report on SDN and NFV, these contributions will likely be connected to the ONF Architecture WG as well. The appropriate body to bring the contribution to, will be selected in a case-by-case basis, as soon as the impact in the respective documents will be analysed.
- The awareness about the applicability of machine learning techniques for telco network management through the TM Forum. The presentation at the recent TMForumLive! event mentioned above served as a first contact and the team has been invited to consider TMF Open-APIs as one of the southbound interfaces of the CogNet Smart Engine and to contribute to a survey on advance orchestration techniques.

With respect to open source projects, the CogNet team began by the identification of a series of open-source projects that will be applied to the development of the CogNet software base and its demonstrators. The team has a strong commitment on contributing back any result produced in the project to the relevant open-source communities and in particular some actions have already been taken with respect to most likely projects to contribute to by means of:

- The planned presentation at the OPNFV Summit in Berlin will allow building awareness about CogNet and seeking for members of the community willing to experiment with the CogNet results as part of a dedicated OPNFV project.
- The conversations on the connections between machine learning techniques and intent-based networking with the leadership of the ODL community, including the discussion of tentative experiments in the coming months.
- The direct participation of project members in the End User Advisory Groups (EUAGs) of the OPNFV and OSM communities. That would allow CogNet not only to facilitate the contribution of results and requirements to the project, but to facilitate as well the identification of new use cases via end-user inputs to these groups.

4. Conclusion

This deliverable has presented the latest updates on all the WP7 related tasks and activities for the first year of the project.

The main purpose of the activities has been creating a wide spread awareness of the project research topics in all the relevant communities and propose contributions to standardization bodies and research groups. All these activities will be monitored and periodically reviewed during the whole project life-cycle, taking into account the latest outcomes in the CogNet research fields, improving the overall impact of the Consortium achievements.

A.1. Twitter figures for 5G-PPP projects

| Project | Twitter Account | Followers | Tweets | Following |
|---------------|------------------|-------------|--------|-----------|
| EURO 5G | @5GPPP | 1451 | 833 | 49 |
| METIS-II | @metis2020 | 502 | 146 | 42 |
| 5G-Ensure | @5GEnsure | 240 | 511 | 89 |
| CogNet | @5GPPPCogNet | 177 | 249 | 240 |
| 5G-NORMA | @5G_NORMA | 138 | 25 | 26 |
| 5G-Crosshaul | @Crosshaul_eu | 106 | 50 | 12 |
| SESAME | @Sesame_H2020 | 100 | 91 | 125 |
| Sonata | @sonataNFV | 96 | 38 | 31 |
| CHARISMA | @charisma5G | 76 | 54 | 68 |
| Speed5G | @SPEED_5G | 72 | 13 | 17 |
| FANTASTIC | @FANTASTIC5G | 61 | 23 | 6 |
| SUPERFLUIDITY | @Superfluidity5g | 61 | 29 | 52 |
| 5G-Xhaul | @5G_Xhaul | 27 | 15 | 17 |
| 5GEX | @5g_ex | 14 | 17 | 20 |
| Selfnet | @5GPPP_SELFNET | 19 | 4 | 114 |
| COHERENT | @H2020_COHERENT | 8 | - | 29 |
| Flex5Gware | - | | | |
| VirtuWind | - | | | |
| mmMAGIC | - | | | |

Table 1: Twitter figures for 5G-PPP Projects as of 4th July, 2016

References

- [1] D7.1 - CogNet Online Presence