EURESCOM message

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CELTIC News 1/2020

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If you have any questions or need help, do not hesitate to contact us; we are pleased to help you.

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Dear readers,

Artificial Intelligence is already used in 4G and the currently deployed 5G networks. That said there is still a huge potential for Artificial Intelligence (AI) to improve management and performance of Beyond 5G networks, which are expected to be developed in the next ten years. AI technologies offer the potential to efficiently address the challenges of complex 5G and Beyond 5G networks, which transport ever-increasing amounts of data.

A number of European research projects are addressing these challenges. Eurescom is involved in some of these projects, which have brought about considerable technological advances. Thus, we considered the time right to dedicate the cover theme of this issue of Eurescom message to Artificial Intelligence for 5G and Beyond and have a look at some of the achievements as well as the remaining challenges.

In the first article of the cover theme, Eurescom message editor Anastasius Gavras and Eurescom project manager and AI expert Dr. Maria Barros Weiss present an overview on Artificial Intelligence for 5G and Beyond. The next article presents Horizon 2020 research project ARIADNE, which investigates the application of AI, and especially Machine Learning (ML), in Beyond 5G scenarios within the novel D-band frequency range.

In an exclusive interview for Eurescom message, Prof. Dr. Hans Dieter Schotten from the German Research Centre for Artificial Intelligence, DFKI, talks about his vision on the future use of AI in networks and the challenges ahead.

In the final article of the cover theme, Salvatore Spadaro from the Technical University of Catalonia and Kenneth Nagin from IBM Israel explain the innovative approach of Horizon 2020 research project SliceNet for cognitive network slice management.

This edition of Eurescom message also includes a variety of further articles on different, ICT-related topics. See, for example, the new opinion article by Eurescom director David Kennedy on the great expectations towards living and working online in his column ''The Kennedy Perspective''. See also our "News in brief" section, which this time features a 5G deal between BT and Ericsson as well as the latest trends in European patent applications. Finally, in the latest ''A bit beyond'' article you can read about the tribulations of online meetings from the home office.

You may notice that the "Events" section in this magazine issue is a bit different compared to previous editions. We would have liked to report about MWC 2020 in Barcelona, which was cancelled due to COVID-19, and a few other major ICT events, which have been turned into virtual

events for the same reason. Instead of reporting about events happening in locations like Barcelona and Dublin, we decided for the first time in the history of our magazine to feature online events.

So far we have abstained from doing it, as we consider photos of people talking on site to an audience and discussing with each other in person a crucial element for attractive event reports that readers may care about weeks after the event has happened. However, due to the fact that practically all events taking place now are virtual, we reconsidered our editorial policy. Thus, we decided to feature 5G-related webinars organised by two of our projects, SliceNet and 5G EVE. The advantage compared to most traditional in-person events is that these webinars have been recorded, and you can watch the video recordings online any time you wish.

My editorial colleagues and I hope you will find value in this edition of Eurescom message, and we would appreciate your comments on the current issue as well as suggestions for future issues. Enjoy reading this magazine issue and stay safe!

Milon Gupta
Editor-in-chief

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EVENTS CALENDAR

07 – 11 June 2020
IEEE ICC 2020
Virtual Event
https://icc2020.ieee-icc.org/

15 – 18 June 2020
EuCNC 2020
Virtual Event
https://www.eucnc.eu

10 – 12 September 2020
IEEE 5G World Forum
Virtual Event
https://ieee-wf-5g.org

6 – 8 October 2020
South Summit
Virtual Event
https://www.southsummit.co

1 – 3 December 2020
ICT 2020
Cologne, Germany
https://ec.europa.eu/eip/ageing/events/ict-2020-leading-digital-age-cologne_en

SNAPSHOT

World's first graduation ceremony with avatars

On 28 March 2020, the world's first graduation ceremony with avatars took place in Tokyo, Japan. Kenichi Ohmae, president of the Graduate School at BBT University, handed over diplomas to two "newme" communication avatars, who represented the graduates. The avatars provided by ANA Holdings were remotely operated by the graduates. Due to the coronavirus lockdown, they were not able to attend the ceremony in person.

Further information is available on the BBT website at *https://bbt.ac/news/news/010344.html*

Contents

CELTIC News

Great Expectations
The growing internet dependency

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In the early days of the internet our expectations were limited – even Tim Berners-Lee considered his invention of the World Wide Web as just something "to allow information sharing within internationally dispersed teams, and the dissemination of information by support groups". Since the international fear of COVID-19 has taken effect, we expect the internet to be the saving grace for humanity. In fact our dependency on our online connectivity is such that in 2016 the UN declared, in a non-binding resolution, that "the same rights people have offline must also be protected online". But now that we really need it, are we ready to move our lives online?

Many companies considered themselves suitable for "remote" working or ready supporters of "home office" scenarios so that when the lockdown rules were inflicted on many European states, they felt capable of continuing their work in a seamless way. However, as we are quickly learning, remote working has its disadvantages as well as its advantages, and I am really not sure which will win out in the long term.

The great debate

We have all heard that the advantages of home working are the flexibility, the lack of office distractions, no commuting and a better life-work balance. However, each of those points can rapidly become a negative, as the lack of a routine affects our will power to keep pushing out completed tasks, questions to our office colleagues can take days to answer rather than the two minutes "head-around-the door" approach we know and love. Home distractions can quickly replace office distractions, and the isolation can even prompt boredom. The point is that it is not easy to replace a good working environment with an equally good virtual one.

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Despite the case for remote working not being proven (yet?), we should be more aware of the bigger impacts of the COVID-19 changes. We have dramatically reduced the amount of travel we do, and this is showing us now how many of the meetings and travels we did were actually necessary. I fully expect that, in many fields, there will be a permanent reduction in travels, and the internet-based meeting services will continue to play a greater role in our collaborative commercial lives. It is not a surprise that the stock value of Zoom Video Communications has jumped to be greater than the value of many airlines in the last couple of weeks.

We are also getting a much clearer picture of the services that we really need to keep life going: supermarkets, shops selling "essential" goods and health services can stay open (and takeaways too). But pubs, cafes, restaurants, cinemas, theatres, libraries, community centres, beauty salons and all shops selling "non-essential" goods have to close – I can't even get my hair cut anymore.

But people are resilient – it is now "normal" that your local fitness club is organising online fitness sessions where the same instructor and class get together over a video conferencing application to have their planned Yoga class. Movies and entertainment streaming has been growing dramatically over the past years and is now

an established "norm". The speed with which grandma and grandpa have learned to Skype or Facetime is incredible – last week they could not operate the iPad.

From the work front, I have now the experience that we have a drop in understanding in the team because of the remote working – and there is an overhead of having to explain to people that they are making work for others, as they have not read the last mail and are not repeating the discussion. But, if we can get people to think more about the team sharing of knowledge and actions, while in isolation, it might actually work.

Conclusion

Right now, I feel that the changes in working lifestyle forced by COVID-19 have helped us to identify more clearly the difficulty of getting a distributed organisation to work effectively. We have not achieved the great expectations where the omnipotent communications infrastructure has allowed virtual presence to replace actual presence.

However, the interesting thing is that rather than disappointment about the internet, the expectations are growing, as we can see that many of the necessary communications are possible. It is just that, despite our technology, virtual hugs just are not the same as a real person-to-person hug.

Artificial Intelligence for 5G and Beyond
An overview

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The advent of powerful ICT and the availability of large amounts of data have triggered an increased interest in the discipline of Artificial Intelligence (AI). The digital transformation of economy and society has brought data ecosystems to the core of many vertical industries. This has catapulted AI from niche discipline to the front of recent ICT research trends, including network research.

In networks, usage and status monitoring data are being collected since the start of modern communications. The main reasons were to be able to better serve and charge the costumer and to identify malfunctions of the network. Over the years, many other motivations for network data collection were added, for example resource usage optimisation, prevention of fraud and misuse, and compliance with legal requirements, just to name a few. The requirements behind these motivations can be met by following proper analysis of network data and by taking corresponding actions. However, the complexity of networks increased dramatically, originally due to the introduction of different types of technologies, lately due to the introduction of virtualisation. On the other side, the digital transformation increased demands on the network, side by side with its increased capacity and complexity. This rendered manual management impossible, as it became essentially impossible for humans to assess and intervene in the network manually, and control actions to keep the networks operational.

Introduction of AI in networks

To cope with the increased traffic, automation processes have been introduced, which take actions based on pre-defined rules. Such actions have been structured according to the affected areas of concern, being Fault, Configuration, Accounting, Performance and Security, which form the FCAPS framework for network management defined by ISO and ITU-T.

The increased network complexity, though, made it difficult for humans to define appropriate rules and to understand the effects of these rules. Furthermore, the observation that certain trends in network behaviour can be predicted and actions taken in anticipation, led to the introduction of AI techniques, and especially Machine Learning (ML) as a subset of AI, in networks. The introduction of AI was facilitated by the large amount of data available to train AI models. The more data is available, the better the resulting models. The introduction of AI has to be justified economically, as there is a cost for transmission, processing, storage and for protecting confidential and privacy-related information embedded in the data.

Data ecosystems at the core of AI systems

Many market reports induce speculation about increased productivity and additional value added services that increase revenues stimulated by AI, without being able to provide concrete figures. Speculation will be reduced, when some uncertainties about AI and certain concerns with a strong link to data are answered.

The fuel of AI is data. The quantity and diversity of data as well as the type of data matter. Furthermore, a whole set of processing is needed to make the data useful and meaningful – the data ecosystem. Nowadays data ecosystems are an essential part of businesses using AI. The quantity of data, type, and diversity needs to be meaningful and trusted to be useful. Data ecosystems include a wide range of tasks: capturing filtering, cleaning, and translating data to machine language; analysing it, giving it a meaning, inferring from that meaning; modelling, learning patterns and estimating behaviours; as well as applying data in processes, and storing and protecting data. Trust in the data is essential, because companies will rely on the data to understand their customers and to make decisions. From the user perspective, there is another dimension where trust is also imperative, that is the trust in the security of the systems. A number of areas still needs further development for AI to be implemented and deployed efficiently in networks, and in particular to handle data. Among others the main concerns are:

- standardized interfaces for data and knowledge exchange
- quality of data that is used for the algorithms training and modelling
- sheer volume of data
- business and personal trust in the data meaning, and data handling

Such concerns make data ecosystem areas grow in importance, side by side with artificial intelligence. They are not telecom industry specific but related with digitalization, and they affect other

sectors as well. This is the anchor point to illustrate that networks can also serve AI applications. Beyond that AI has been more and more serving networks, as the following example suggests.

AI in networks today

Many telecom operators are already applying AI across their operations, while others are still formulating their AI strategies. An Ericsson report published in 2019 indicates that more than 50% of the telecom operators anticipate the introduction of AI techniques in 2020, while another 20 % have a time horizon of three to five years [1].

Yet, many telecom operators have started with trials and AI-based operations some time ago. Early adopters include Telefonica, AT&T, Deutsche Telekom and SK Telecom. The latter, the major Korean operator, is applying AI-based predictive analytics to improve network management and network optimization. This is being accomplished with the evolution of its advanced next generation operation support system in order to cover management automation within the fixed and mobile network domains. According to Park Jin-hyo, Head of the Network Technology R&D Center at SK Telecom, "The AI-assisted network operation technology based on big data analytics will be essential in the 5G era" [2]. Telefonica was in the news with the use of AI predictive analytics in the context of service operations centres, to deliver more insight into how its mobile networks are being used, to anticipate problems such as the "silent churners", and to identify new ways for improving user experience through a customer-interaction platform based on cognitive intelligence. AT&T has been investing in AI for a while now, namely in the service assurance area, in order to continuously predict failures and solve network degradation via automation tools, or the application of ML techniques to help prevent, detect and mitigate cyber-attacks. Deutsche Telekom reported the use of AI for cyber-defence already in 2018 [3].

AI in future networks

Recent Horizon 2020 research projects in the 5G PPP programme, such as SELFNET, CogNet, and SliceNet have demonstrated numerous use cases in which AI/ML can help network optimisation, mitigate network performance problems, or protect the network against attacks. Newer projects in 5G PPP phase III are currently expanding the scope of application of AI/ML in networks. The next example illustrates a very promising application of AI in future networks. Today spectrum is allocated statically and devices are pre-configured to use a certain spectrum range. The goal is to dynamically find available frequencies for transmission that are optimised for specific use cases and to dynamically use frequencies on demand. Beyond reactive allocation, prediction al-

gorithms could anticipate available frequencies in the future. More sophisticated possibilities are to collaboratively maximize wireless communication capacity within a specific area among a large number of communicating entities, or minimise the collective energy expense for a given transmission capacity envelope.

Standardisation of AI in 5G

Things in standardisation are moving as well. In the last years most major telecom standardisation organisations like 3GPP, ETSI or ITU-T have initiated work that studies the introduction of such techniques in the telecoms networks.

Notably 3GPP formalized the use of AI in 5G networks by introducing the Network Data Analytics Function (NWDAF) in the core network. Beyond functions like network slice selection or policy-based charging, the scope of NWDAF extends to inter-domain interaction of data analytics in the 5G system, such as the interaction of Operation Administration and Management (OAM) and the Radio Access Network (RAN).

ETSI ENI (Experiential Networked Intelligence) aims to design a reference architecture to enable the use of AI in network operation and management. The ENI engine interfaces with the existing network to enhance the AI capability of the network. Up to now, ENI has developed use cases, requirements, and a preliminary architecture and interfaces. The work of ENI has been planned to continue until 2021.

ETSI ZSM (Zero touch network and Service Management) focuses on service automation and management that leverages the principles of software networks. The goal of ZSM is to define a new, future-proof, end-to-end interoperable framework enabling agile, efficient and qualitative management and automation of emerging and future networks and services.

ITU-T FG-ML5G (Focus Group on Machine Learning for Future Networks including 5G), focuses on specifications for ML for future networks, including interfaces, network architectures, protocols, algorithms and data formats. The group collected a set of use cases, identified high-level requirements derived from these use cases and proposed a high-level unified ML architecture for future networks that satisfy these requirements.

Trustworthiness is the main challenge

In 2019 the European high-level expert group on AI, appointed by the European Commission, published a set of recommendations for Trustworthy Artificial Intelligence. The recommendations include:

- Transparency, which means that decisions should be comprehensibly explained to humans, who should be informed when interacting with an AI system.

- Accountability, which means that responsibilities of the AI system outcomes are clearly assigned. Ultimately this is important for liabilities in case something goes wrong.
- Technical robustness and safety, which means that the AI systems must be accurate, reliable and reproducible. A fail-safe fallback plan must be in place, if something goes wrong.

Because of certain real-world examples where AI/ML applications did not live up to the expectations, we became suspicious about how much we can trust AI/ML. The web is full of stories in which AI/ML algorithms were fooled by very simple tricks and reached totally wrong conclusions. In network operators' imagination, this can mean network shutdown and total loss of revenue. So, how can we increase the trust in AI/ML, and how can we prevent worst-case scenarios? In some cases this translates into concepts like Human-in-the-Loop. Originally described as a model for human-machine interaction, the human is introduced as an emergency break for an AI/ML algorithm that went amok. Even if this is counterintuitive in view of the goal of full automation, the fact that the networks are a critical infrastructure of society seems to justify this approach, at least as long as the confidence level over the conclusions of an AI/ML algorithm, which is perceived today as a "black box", is not significantly increased.

Conclusion and outlook

A general consensus exists that Artificial Intelligence is the technique to enhance returns on future network investments. In order to reap the anticipated benefits and to justify the investments in AI systems in the first place, the following actions must be accelerated: (i) define standard interfaces to access relevant data, (ii) study the use of AI to enhance customer experience, (iii) trial and experiment with new customer segments and characterize opportunities, (iv) expand the use of AI for network operations, (v) facilitate early adoption of AI-enabled solutions by new use cases. Most importantly we must increase trust in AI system outcomes by introducing transparency, accountability and technical robustness.

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AI for Beyond 5G
Leveraging AI for novel D-band based services

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Systems beyond 5G are set to shift the network communication paradigm, which will heavily affect the information and communication sector. 5G is expected to deliver increased connectivity, highly fault-tolerant communication, and maximum spectral efficiency while keeping latencies at negligible limits. The aspiration is to transform the current 5G wireless thinking from focusing on "local" improvements (e.g. isolating the radio access level or the resource management level) to realizing a vision of pervasive mobile virtual services through network-managing computing and connectivity functions in an integrated way. This beyond 5G transformation envisions bringing together novel radio architectures and an Artificial Intelligence (AI) network approach across various tiers of the technology stack and deployment scenarios.

To address this challenge, multi-disciplinary research teams from industry and academia have joined forces in the Horizon 2020 research project ARIADNE [1], to investigate this link by applying the state of the art in AI and especially Machine Learning (ML) to futuristic beyond 5G scenarios within the D-band frequency range.

ARIADNE's goal is to bring to fruition the notion of AI-aided D-band wireless beyond 5G networks. This entails the challenges of devising a flexible and powerful ML-based wireless network optimisation framework, introducing novel propagation and channel modelling principles, a revolutionary communication theory approach, and developing cutting-edge technology components (see figure). These include beamforming antenna arrays, reconfigurable metasurfaces based on sophisticated materials, Radio Frequency (RF) frontends, baseband processing, medium access control protocols, ML-based resources and network management, as well as devising a suitable performance evaluation framework defined by the appropriate critical use cases and relevant performance metrics.

Work in ARIADNE includes design of prototypes and simulations to collect data for different scenarios and apply AI to discover complex patterns in data. Up to now, use of AI to optimize key performance indicators (KPIs) and automate decision making has been studied under simplified conditions, whereas ARIADNE aims at reducing this gap while addressing the foundations for an AI-optimized D-band wireless network architecture, which is tested under realistic and sophisticated conditions. In this article, we briefly present some D-band beyond 5G scenarios and justify the need of AI based network management approaches.

D-band beyond 5G scenarios

In ARIADNE, the envisioned beyond 5G applications and attributes focus on three carefully selected representative usage scenarios.
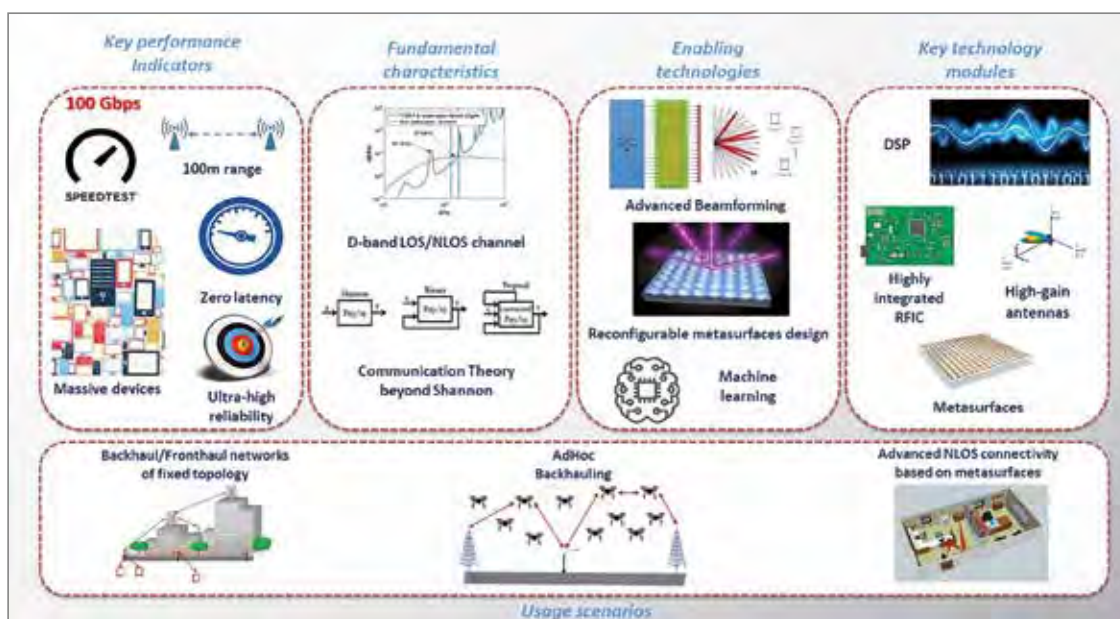
ARIADNE system concept for AI-based networks beyond 5G

Scenario 1 – Backhaul/Fronthaul networks of fixed topology, where small-cell traffic may be carried over D-band links. In particular, the connectivity between small cells and the network aggregation point could be based on point-to-point, or mesh topologies. In such a scenario, apart from the high targeted aggregate data-rates, the critical system parameters are the transmission range, the capability to establish reliable line-of-sight (LOS) and non-LOS (NLOS) links, the energy efficiency, and the installation cost.

Scenario 2 – Ad-Hoc Backhauling, where moving nodes can serve as gateways (access points) offering backhauling for very high data rate connectivity, in the case of irregular traffic increase (special events), ultra-dense connectivity demands (data 'shower') and mobility environment (vehicle traffic management, etc.). Dynamic (ad-hoc) backhaul nodes topology, LOS and multiple hops connectivity (mesh architectures) are the main features of this scenario.

Scenario 3 – Advanced NLOS connectivity based on metasurfaces, where the environment itself is made reconfigurable and can assist the communication between two end-points. For example, randomly distributed environmental objects are coated with reconfigurable intelligent surfaces, e.g., tuneable reflectors, which sense the system's response to the radio waves and feedback the relevant information. Based on the sensed data, the input and the operation of the object coated with intelligent electromagnetic material are jointly optimized and configured through a software controller.

Application of AI and Machine Learning to beyond 5G system challenges

A recent report by Deloitte [5] showed that telecommunications is one of the few industries that is making the highest investment in AI and also reaping the highest Return on Investment (ROI).

In ARIADNE, AI and ML applications are defined within the disciplines of predictive analytics (classification, regression and reinforcement learning methods) and prescriptive analytics (ML-based simulations), which help derive smart and actionable insights. In order to create ML models, the guidance-driven and enterprise-ready approach of RapidMiner [2] is being evaluated in ARIADNE to enable a variety of personas such as analysts, scientists or engineers to efficiently adopt ML.

The list of concrete examples, where ML applications present solutions to ARIADNE scenarios is vast. Examples include:

- Demand forecasting at fronthaul and backhaul during different periods, such as different times of day (considering trend, cycles, seasonality, noise, etc.).
- Resource management in peak and off-peak times: determining smart traffic routes in LOS or NLOS scenarios considering power efficiency, capacity, reliability and other constraints using (ML) model assisted optimization.
- Predicting network congestion or bottlenecks to take pre-emptive corrective measures.
- Predicting various properties of a channel (reliability, latency, signal strength/loss, maximum achievable data rate, degrees of attenuation due to fog, rain and gasses) and environment (direction of user's movement).
- Predicting a metasurface's behaviour (angle of reflection, refraction, transmission, signal strength) to decide on optimal unit-cell to be used, reducing initial setup latency by avoiding time-consuming combinatorial optimization.
- Predicting obstruction of the LOS path between mobile receivers and fixed transceivers in a mobile fronthauling scenario.
- Predictive maintenance: predict decline in performance of infrastructure devices (nodes) in backhaul or fronthaul topology, to repair them before they fail.
- Detecting anomalies in traffic patterns to ensure security against malware, fraud, sabotage or other denial of service attacks.
- Business level models: user experience testing of scenarios or service offerings by evaluating KPIs in terms of cost/benefit with and without the use of ML models.

ARIADNE's approach to Machine Learning

In order to correctly develop and successfully operationalize ML models, the roadmap for ARIADNE carefully considers best practices to avoid common pitfalls in approaching the different disciplines of Machine Learning. In the following we address these in a nutshell.

At the coarse-grained level, business or scientific problems are to be shaped or formulated as Machine Learning problems, for which ARIADNE follows the CRISP-DM analytics methodology [3]. CRISP-DM provides an industry-standard method to identify, define and solve analytics problems. It advocates joint collaboration among subject matter experts and data scientists in various iterative stages, which eventually result in high-quality analytics solutions, which are progressively refined.

Predictive and prescriptive analytics

Predictive Analytics lies at the heart of ML. It involves methods that discover or learn patterns from historical data, which are then applied on new unseen data. Owing to the No Free Lunch theorems [4], modelling is performed using test and trial approaches, using a variety of methods, as no assumptions on a method's performance can be presumed. In the absence of existing models, firstly, baseline models are developed and subsequently enhanced. Each of the Machine Learning application areas high-quality requires predictive or prescriptive problem solving that is treated on its own merits. But when it comes to ML pipeline creation, ARIADNE follows a design patterns based approach.

These ML design patterns address feature engineering, dimensionality reduction, preventing data contamination, cross-validation, optimizing model parameters, comparison of different models using standard performance metrics (e.g., accuracy, precision or recall for classification problems or various error measures for regression problems, e.g. absolute or relative errors, etc.) or custom performance criteria, such as a reward/loss function or a fitness function to optimize. The objective here is to estimate the performance of a predictive model (robustness) as well as the stability of its performance (deviation) in light of the various use case-specific KPIs.

Some of ARIADNE's scenarios are broadly classified under Prescriptive Analytics. Engineers often use predictive (or calculation-based) models of physical systems (such as a metasurface) and run simulations to find the optimal input data that produces a desired outcome. Prescriptive Analytics thus helps to understand the decision boundaries of input data, and their impact on the outcome variable. One of its popular uses is the what-if analysis, whose real-time application is foreseen in ARIADNE.

Conclusion

ARIADNE's holistic approach towards an integrated network managed architecture, where computing and connectivity functions make use of AI and ML, is aiming to improve the future 5G based radio networks at large and meet the highly challenging KPIs defined for beyond 5G scenarios. ARIADNE is committed to disseminating its research results in the broader industrial and academic communities so that ARIADNE's transformative vision of pervasive mobile virtual services can enlarge its outreach and impact.

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"AI-enabled services and applications will significantly benefit from 5G"

Interview with Hans Dieter Schotten from DFKI

Artificial Intelligence has become fashionable in all areas of technological development, including communication networks. How realistic are expectations that AI will significantly improve 5G and beyond networks? When will it happen? And what are the obstacles? Eurescom message editor-in-chief Milon Gupta asked someone about it who has been at the forefront of network development for a long time – professor Hans Dieter Schotten, head of the research department Intelligent Networks at the German Research Center for Artificial Intelligence, DFKI.

How will AI improve 5G and beyond networks?

H. D. Schotten: AI is already used in networks today: network management and SON solutions use symbolic AI solutions; anomaly detection and self-learning event classification are part of many network security systems. With the progress in machine learning, algorithms and computing power, many additional application areas in communications become realistic targets. Anomalies of almost any network property can be detected, events can be classified with high reliability, and systems can learn how to best handle these events based on monitoring the success of implementing measures. All these AI concepts can be applied on network management, network optimisation, and even physical layer routines. As a result, complexity and cost of network management can be reduced, energy efficiency can be improved, networks can be used more efficiently by better adapting them to specific scenarios, and physical layers can learn how to best handle challenging scenarios.

What are currently the major challenges for using AI in future networks?

H. D. Schotten: We need data to train AI, and, additionally, we need to improve the learning efficiency. Federated and distributed learning, transfer learning, data synthesis by generative adversarial networks, and other concepts can help to address this challenge. Hybrid model and data-driven AI will improve the learning efficiency.

Hans Dieter Schotten from DFKI

AI solutions need to be compatible with the telecoms ecosystem. Data is often too valuable to be shared with other parties. Trained-model marketplaces, federated learning, or even AI on homomorphic data could solve this problem.
Security is a big problem, as AI functions can be attacked.

Due to the size of our networks, scalability and overall cost in terms of energy consumption and additional network load need to justify the achievable gains. Dynamically deployable AI functions can help to address this issue.
And, finally, there is always a trust issue when talking about AI.

To what extent can we trust AI functions to run our future networks?

H. D. Schotten: We are using AI already today in many products and even in networks. So, there is some trust in their integrity and performance. The black-box approach is often used to mitigate risks. However, the use of AI functions also allows new, partly AI-enabled attack vectors against the integrity of networks. Some techniques to address this challenge are known, but they need to be adapted and improved continuously.

Certification of AI functionality and implementation will also help to avoid misuse and to create trust.

How critical do you consider data privacy issues for the use of data for training AI?

H. D. Schotten: Data privacy is always a top priority. Some tools to address this issue are known: federated and distributed learning or model-based learning allow to share and use learning results without exposing private data. I assume that efforts to develop and certify these privacy-preserving AI concepts will increase with the growing adoption of AI in public services and infrastructures.

How can 5G networks optimise AI-enabled services and applications?

H. D. Schotten: Whenever we have AI-in-the-loop applications, whenever we consider AI-enabled products that depend on guaranteed and real-time data availability, AI-enabled services and applications will significantly benefit from 5G. Network slicing is a key enabler for many data-driven products and services. And URLLC is a key enabler for applications where AI is processing sensor data collected in real-time for controlling actuators, for example in AI-in-the-loop applications.

What is your vision for the uses and benefits of AI in beyond 5G networks?

H. D. Schotten: We will see synergies of 5G and AI that go far beyond what the technologies can achieve separately. Autonomous machines in public infrastructures and new concepts for humans to interact with and control their cyber-physical environment are just two examples. In general, 5G will provide the high-performance networking infrastructure for AI-enabled solutions where the advantages in standardisation and convergence will be additional benefits provided by 5G. 5G networks will allow AI functions to be deployed where and when needed, saving cost and making the use of AI more agile. On the other hand, AI will help to create Smart Networks, providing a holistic connectivity and computing infrastructure that automatically adapts, end-to-end, to the changing needs of services and varying resources.

Cognitive network slice management
The SliceNet approach

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One of the enablers of 5G and beyond networks is the provisioning of network slices with proper Quality of Experience (QoE) guarantees to meet the requirements of vertical use cases. It poses several challenges to the proper management of the network slices. This is particularly challenging when provisioning multi-domain 5G slices in which several network service providers are required to provision their end-to-end slices.

Traditional manual network management techniques are not adequate for handling the demands of these more complex and time-sensitive scenarios. It is thus mandatory for network slice providers to adopt cognitive network slice management that leverages machine-learning techniques to proactively maintain the network infrastructures and assure the end-to-end QoE of slice users.

Architecture for machine learning-aided slice management

5G networks have undergone a major paradigm shift by adopting softwarization, virtualization and cloud computing technologies. While this new paradigm leads to important benefits, such as reduced capital expenditure, reduced operating expense and improved flexibility, the management of such networks involves huge technical challenges due to the significant complexity introduced. Among others, the challenges include estimating QoE Key Performance Indicators (KPIs) from monitored metrics and reconfiguration operations (remedial actuations) required to support and maintain the desired quality levels. Consequently, conventional network management models dominated by human interventions have be-

come prohibitively expensive and even unviable in many cases. The new trend in managing 5G networks, and in general softwarized/virtualized networks, is to leverage the promising capabilities empowered by Artificial Intelligence (AI) and Machine Learning (ML) techniques in achieving network automation and autonomous network management.

In this context, the 5G PPP project SliceNet [1], has focused on the research and development of AI/ML-based network management for 5G networks, to meet the challenges presented by 5G use cases like Smart Grid, eHealth, Smart City, and others [2].

SliceNet is devoted to the provisioning and management of network slices with Quality of Experience (QoE) guarantees on top of a shared 5G network infrastructure, contemplating a multi-role scenario, in which multiple Network Service Providers (NSPs) offer their infrastructure capabilities to the upper layer Digital Service Provider (DSP), who interfaces with the verticals and brokers among the multiple NSPs, in order to materialize end-to-end (E2E) network services requested by vertical services. To this end, SliceNet has defined a Cognition Plane, a framework which enables 5G control and management systems with the capacity of QoE awareness of slice provisioning and life-cycle management. In particular, it covers the functions needed to monitor, estimate and predict relevant metrics that affect the QoE of the provisioned network services as well as the functions and modules that govern runtime (re-) configurations of the underlying physical and virtual infrastructure to maintain the required QoE levels.

Cognition Plane

In general, the Cognition Plane embraces the monitor-analyse-plan-execute process governed by a knowledge-base (MAPE-K, [3]) approach for automated and autonomic network management. In particular, it has been designed to support machine learning for the monitoring and analysis steps, as well as for creating new knowledge (see figure). QoE monitoring separates the acquisition of monitoring data from the processing of the data and transforms it into slice QoE metrics. The analysis step uses the acquired knowledge to assess the slice QoE and possible impact on corrective actions. The planning and execution steps (called Actuation Framework in the figure) are governed through a Policy Framework, which states declarative rather than imperative rules that need to be applied to maintain the

expected QoE levels. All in all, this Cognition Plane defines a holistic solution that leverages machine learning for the optimised management of slices that support 5G vertical services.

The figure depicts a schematic of the Cognition Plane along the main relationships with other SliceNet sub-systems.

The central piece of the Cognition Plane is the data acquisition system. In this regard, a Data Lake approach is followed [3], which acts as the Knowledge-base (KB) of the MAPE-K loop. All data sources are logically merged into one data store, and analysis outcomes are shared through it. Monitoring functions extract data from the underlying 5G infrastructure through the capabilities of the SliceNet Control Plane (NSP level), which is then normalized and aggregated for its storage at the shared Data Lake (DSP level). This paradigm is used at the NSP level to manage slices deployed at its underlying infrastructures to offer a Network Slice as a Service (NSaaS) towards the DSP level. The DSP constructs and manages E2E slices and offers an NSaaS to its vertical customers. Infrastructure metrics outputs are collected and persisted to support traditional monitoring as well as for ML model training and for extracting QoS metrics.

External feedback from verticals

Moreover, a vertical's feedback mechanism that allows for the vertical customers of the deployed slices to express their experience with the provisioned infrastructure is also supported. The mechanism to support inclusion of external feedback from the vertical is among the innovations of the SliceNet project, and it allows to progress towards the inclusion of the Verticals in the whole management and control of deployed slices. In fact, this vertical feedback approach is under discussion with the ITU-T Focus Group on Machine Learning for Future Networks including 5G.

The feedback from the verticals is combined with internal QoS metrics to allow the data processing applications to assume the role of QoE sensors, learning and estimating the verticals' perception. Data-operations applications may be deployed for each slice to filter relevant data, aggregate slice metrics, etc. As such, flexible QoE sensors may be employed, ranging from simple aggregation and transformation tasks to inference of elaborate ML models.

The Data Lake enables the loose coupling of the analysis and reaction functions. The Analyzer component holds all the trained ML models used to gain insights about the underlying physical/
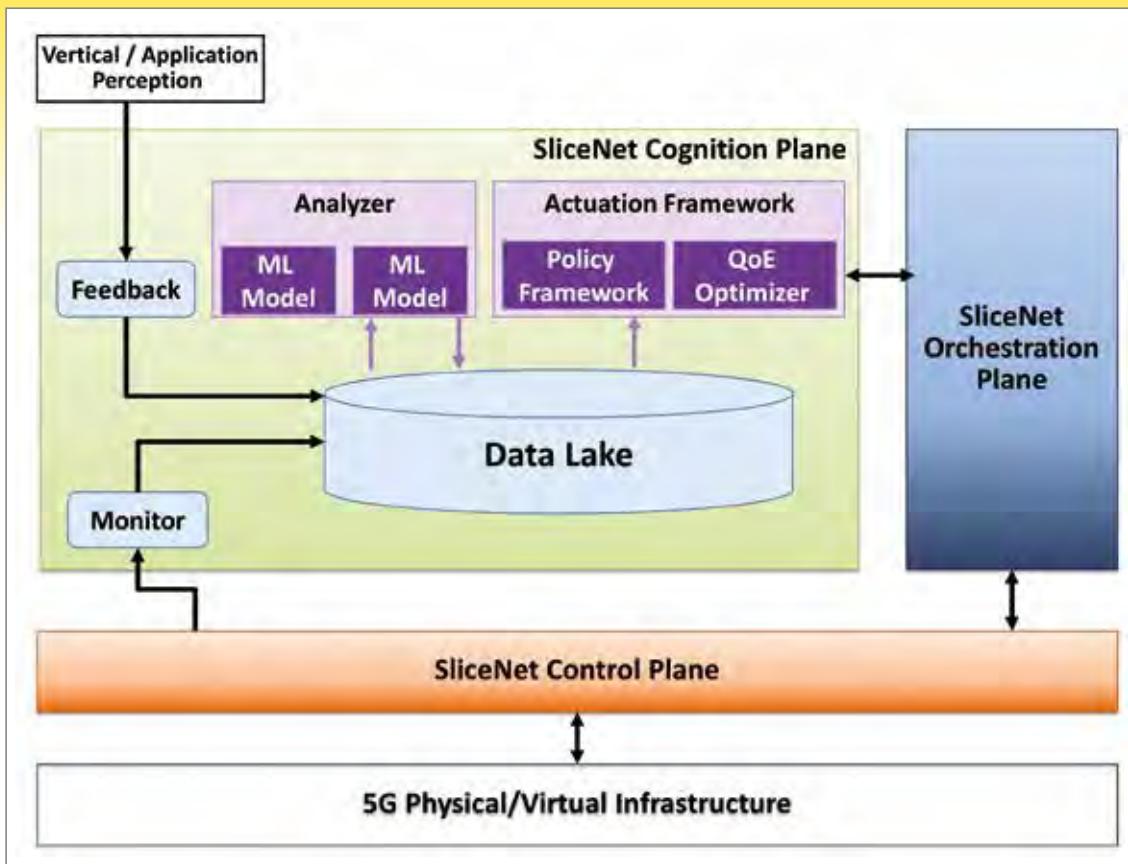
SliceNet cognition plane architecture and framework

virtual infrastructure and the provisioned slices. The multiple ML models implement analytical functions that serve as advanced monitoring functions for the Actuation Framework. As such, the ML models poll the data stored at the centralized Data Lake and, after their analysis and learning, insert their insights and predictions as elaborated data back to the Data Lake.

Actuation Framework

This elaborated data is then employed as stimulus for the Actuation Framework. The Actuation Framework is the part of the Cognition Plane responsible for planning required (re-)configurations of the network infrastructure as well as deployment of new elements and functions on the configured services to remedy undesired situations, like faults or underperformance. To this goal, the Actuation Framework focuses on determining the required changes to E2E slices to support the verticals' QoE, communicating the required (re)configurations with the SliceNet Orchestration Plane, which in turn will enforce all desired actions onto the SliceNet Control Plane.

The Actuation Framework is implemented through two main components: i) a Policy Framework which implements rules that define what actions are executed in response to system and network slice events. Policies follow the Event-Condition-Action (ECA) approach (e.g. [5]) which indicates, for which events and conditions what

actions must be enforced. These policies are then disseminated to multiple decision points across the layered infrastructure; 2) A QoE Optimizer component, one per deployed end-to-end slice, that is responsible for all (re-)configurations necessary to maintain the QoE of a specific E2E slice. Thus, given the rules specified by the Policy Framework, and monitoring data gathered from the Data Lake (raw monitoring, ML model outputs or verticals' feedback), the QoE Optimizer triggers the necessary actions to carry out the desired remedial actuations by engaging with the Orchestration Plane. Such an approach allows for a clean separation of responsibilities, in which the Analyzer defines the "when" that triggers the QoE Optimizer which determines "what" must be done, which in turn interacts with the Orchestration Plane which determines the "how" to reconfigure.

The Cognition Plane is a flexible framework for QoE-aware management of network services that may suit the requirements of multiple roles and administrative entities. Indeed, the components of the Cognition Plane may be instantiated at both NSP and DSP levels independently, potentially articulating MAPE-K loops per administrative role. This is possible thanks to its modularity and replicability that allows to instantiate selected components within the plane per administrative role.

Conclusions

This article describes the Cognition Plane within SliceNet's management layer as an architecture that allows for the QoE/QoS ML-aided management of 5G networks and vertical services. To this end, we described the several elements that constitute the phases of the full cognition MAPE-K-based loop. The main goal of the Cognition Plane is to enable the automated and QoE-aware management and control of end-to-end network slices as offered by DSPs to their vertical customers. In this regard, it is essential to provide the means for analysis of the underlying network slice and its components to determine its quality levels as well as for applying (re-)configurations when needed to maintain the desired quality levels.

References

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[3] J. O. Kephart and D. M. Chess, ''The vision of autonomic computing', Computer, vol. 36, pp. 41–50, January 2003
[4] N. Miloslavskaya, A. Tolstoy, "Big Data, Fast Data and Data Lake Concepts", Elsevier Procedia Computer Science, vol. 88, pp. 300-305, October 2016
[5] IETF Network Modeling Working Group, A YANG Data model for ECA Policy Management, Internet Draft, November 2019

Public premiere of 5G EVE Portal
Live demo at webinar

In a webinar on 27 February 2020, the 5G EVE Portal was for the first time demonstrated live to the interested public. 47 participants, mostly from vertical use-case (ICT-19) projects of the 5G Infrastructure Public Private Partnership (5G PPP), attended the live demo of the 5G EVE portal and validation framework.

The webinar was moderated by Mauro Boldi from TIM, the coordinator of 5G EVE. Originally, the 5G EVE Portal was planned to be presented at MWC 2020 in Barcelona. Due to the cancellation of the event, the 5G EVE team had decided to present the demo online instead.

Manuel Lorenzo from Ericsson Spain

After the welcome and overview by Mauro Boldi, Manuel Lorenzo from Ericsson Spain, technical manager of 5G EVE, briefly explained the roadmap of the 5G EVE validation platform for 2020 and 2021. The roadmap involves three major activity areas: (i) platform validation, (ii) cooperation with ICT-19 projects, and (iii) continued platform development.

Giada Landi from Nextworks

The demo was presented by Giada Landi from Nextworks, who is deputy technical manager of 5G EVE. Before going into the actual live demo, she gave an introduction to the 5G EVE experimentation workflow, which consists of four phases: (i) test design, (ii) test preparation, (iii) test execution and monitoring, and (iv) test performance evaluation and analysis. She went on to


Overview on how to use the 5G EVE portal

Demonstration on how to change the status of an experiment

explain the key roles in the experimentation workflow:
- Vertical: actor with the knowledge of the service to be tested, including SLAs and service components.
- Verticals' VNF (Virtualized Network Function) provider: actor who provides the VNF packages for the vertical applications.
- Experiment developer: actor responsible for specifying the blueprints associated to an experiment, as well as the associated NFV network services descriptors. This user has the knowledge about the 5G EVE infrastructure and expertise about NFV network service modelling.
- Experimenter: actor responsible for the request of an experiment and the assessment of its results; defines the characteristics of an experiment starting from its blueprint, requests the deployment of related virtual environment and experiment execution and analyses results and KPIs.
- Site manager: system and infrastructure administrator for a 5G EVE site.

In addition, Giada Landi explained the basic concepts and terminology, including Experiment Blueprint, Network Service Descriptor, and Experiment Descriptor. After the introduction to the 5G EVE experimentation workflow, she logged
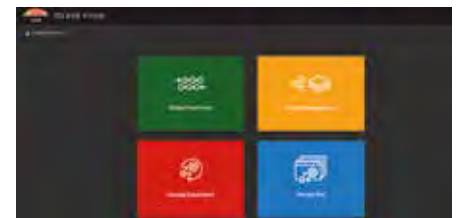
Graphical user interface of the 5G EVE portal

into the portal and went live through the steps of setting up an experiment on the 5G EVE Portal.

About 5G EVE

5G EVE, the '5G European Validation platform for Extensive trials', is a European infrastructure research project within phase 3 of the 5G Infrastructure Public-Private Partnership (5G PPP). The project ambition is to be instrumental towards the pervasive roll-out of 5G end-to-end networks in Europe. 5G EVE started on 1st July 2018 and runs for 36 months. The 15.7 million euro project is coordinated by TIM and is co-funded by the European Commission under the EU's Horizon 2020 programme.

✈ Further information
Video recording of the 5G EVE Portal demo – *https://youtu.be/sv0CJHX12vA*
5G EVE website – *https://www.5g-eve.eu*

Everything you always wanted to know about 5G network slicing

The SliceNet project outcomes webinar series

Over a period of four months, from February to May 2020, Horizon 2020 project Slice-Net organised a series of seven webinars to present its outcomes and achievements in the area of 5G network slicing. The webinars proved to be quite popular, given their technical nature – they constantly attracted between 30 and 60 participants. Moreover, the questions asked in the Q&A part of each webinar showed the substantial interest of participants in 5G network slicing and the results of SliceNet. The good news for those who missed the webinars is that they were all recorded.

Webinar 1:
5G Multi-Domain Slice Control Plane

In the first webinar, Ciriaco Angelo from Ericsson R&D presented requirements and challenges of the 5G multi-domain slice control plane, the SliceNet Approach to design and prototyping, technical achievements and innovations in the area of slicing, and applications in vertical use cases.
*Video recording –*
https://youtu.be/plyopOq437Y

Webinar 2:
Cognitive, Service-Level QoE Management

In this webinar, Kenneth Nagin from IBM Israel explained how SliceNet's Cognition Sub-Plane enables 5G network slice management using machine learning to identify problems and policy driven remedial actuations to fix problems. He described the role played by the sub-plane addressing slice management within the three SliceNet use cases, namely Smart Grid, eHealth, and Smart City. The webinar presented the objectives, requirements and challenges for the cognitive sub-plane, the technical approaches for design and prototyping as well as technical achievements in QoE management. A summary of SliceNet innovations in the area of cognitive QoE management concluded the presentation.
Video recording –
https://youtu.be/mMTzCxLL0-c

Webinar 3:
5G Multi-domain Slice Management

This webinar was particularly aimed at developers in vertical industries and those interested in the design of 5G applications enabled by 5G
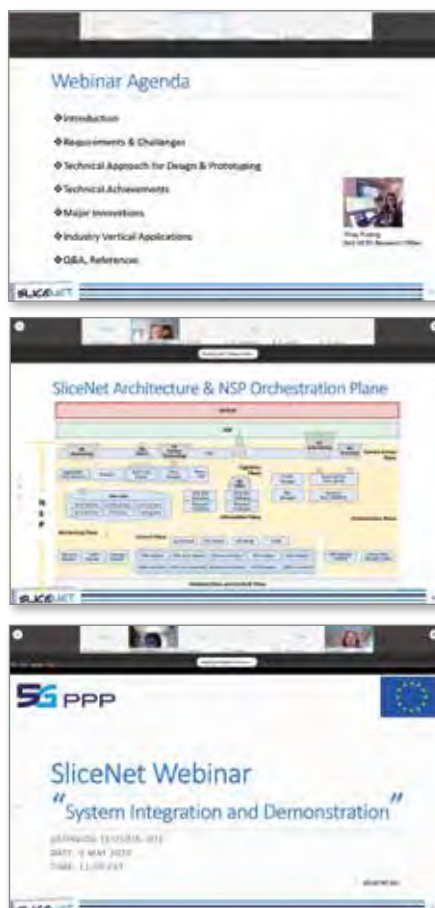
multi-domain slice management. Thuy Truong from DellEMC started by giving an introduction to 5G multi-domain slice management, and then continued to discuss the requirements and challenges of 5G multi-domain slice management. She went on to explain the technical approach for design and prototyping and then discussed vertical applications and QoE management innovations.
Video recording –
https://youtu.be/skyQds_QXAM

Webinar 4:
SliceNet System Architecture

This webinar was aimed at developers and designers both in vertical industries and research interested in SliceNet's 5G system architecture for multi-domain slicing. Marius Iordache from Orange Romania started by giving an introduction to the SliceNet System Architecture, and then discussed the requirements and challenges, particularly the vertical requirements that had to be identified and considered in the architecture. He went on to explain architecture design and

functional decomposition as well as SliceNet's end-to-end slicing friendly reference architecture. He concluded by presenting selected vertical use cases.
Video recording –
https://youtu.be/CmDVhT73tSo

Webinar 5:
Cross-Plane Orchestration and Use Cases Prototyping

This webinar was aimed at developers and designers both in vertical industries and research, interested in 5G system architecture and orchestration. Jose Cabaca from Altice Labs discussed, how the SliceNet definition of Business Roles relates to the definition of Business Roles by ITU-T. He went on to explain the SliceNet Architecture and Orchestration Plane, including particular challenges and requirements. He then focused on the DSP end-to-end service and slice orchestration as well as on the NSP network orchestration. In the last part of the webinar he explained orchestration journeys and provided a summary of innovations.
Video recording –
https://youtu.be/deKSGoHMxJ0

Webinar 6:
System Integration and Demonstration

This webinar was aimed at developers and designers both in vertical industries and research, interested in 5G system integration and frameworks. Georgios Tsiouris from OTE presented the system integration and demonstration achievements of SliceNet. After discussing requirements and challenges, he explained SliceNet's technical approach to system integration and the SliceNet framework validation. He concluded by presenting selected use-case demonstrations.
Video recording –
https://youtu.be/bgJWevMbYKQ

Webinar 7: 5G Integrated Multi Domain Slicing Friendly Infrastructure

This webinar was aimed at developers and designers both in vertical industries and research, interested in 5G slicing infrastructure. Navid Nikaein from EURECOM explained SliceNet's technical approach for design and prototyping of a 5G integrated multi-domain slicing-friendly infrastructure, highlighting the technical achievements and major innovations. He concluded by showing selected vertical applications.
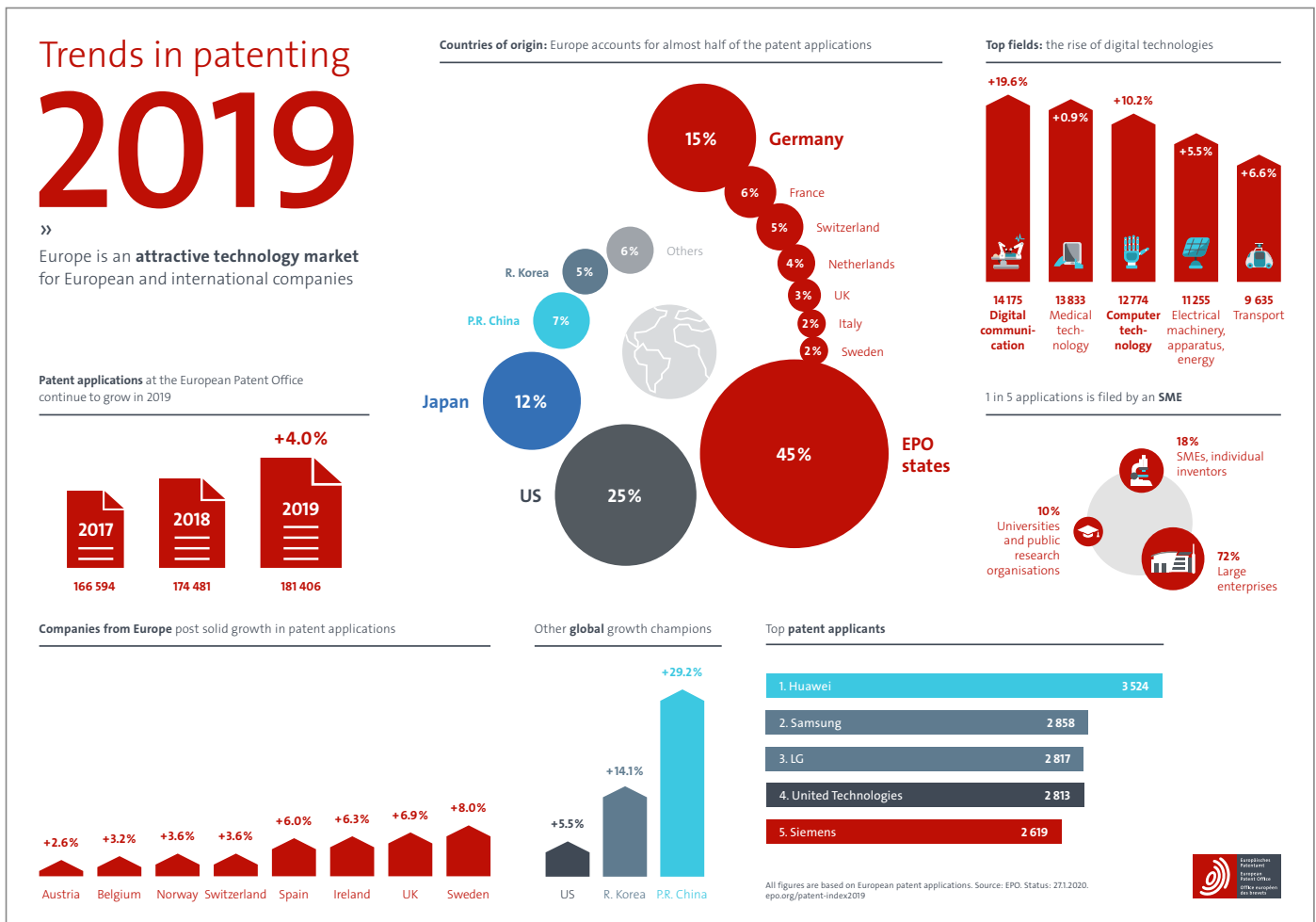*Video recording – https://youtu.be/IMTMX-my3Lk*

✈ Further information
SliceNet project website – *https://slicenet.eu*

News in brief

Digital technologies take top spot in European patent applications

Trends in patenting

2019

» Europe is an **attractive technology market** for European and international companies

Patent applications at the European Patent Office continue to grow in 2019

+4.0%

2017: 166 594
2018: 174 481
2019: 181 406

Countries of origin: Europe accounts for almost half of the patent applications

Germany 15%
France 6%
Switzerland 5%
Netherlands 4%
UK 3%
Italy 2%
Sweden 2%
Others 6%
R. Korea 5%
P.R. China 7%
Japan 12%
US 25%
EPO states 45%

Top fields: the rise of digital technologies

+19.6% — 14 175 **Digital communi-cation**
+0.9% — 13 833 Medical tech-nology
+10.2% — 12 774 **Computer tech-nology**
+5.5% — 11 255 Electrical machinery, apparatus, energy
+6.6% — 9 635 Transport

1 in 5 applications is filed by an **SME**

18% SMEs, individual inventors
10% Universities and public research organisations
72% Large enterprises

Companies from Europe post solid growth in patent applications

Austria +2.6%
Belgium +3.2%
Norway +3.6%
Switzerland +3.6%
Spain +6.0%
Ireland +6.3%
UK +6.9%
Sweden +8.0%

Other **global** growth champions

US +5.5%
R. Korea +14.1%
P.R. China +29.2%

Top **patent applicants**

1. Huawei 3 524
2. Samsung 2 858
3. LG 2 817
4. United Technologies 2 813
5. Siemens 2 619

All figures are based on European patent applications. Source: EPO. Status: 27.1.2020.
epo.org/patent-index2019

Patent statistics published by the European Patent Office (EPO) in March 2020 show that for the first time in more than a decade digital technologies have taken the lead in patent applications filed. According to the EPO Patent Index 2019, the surge in the fields of digital communication and computer technology is fuelling the sustained growth in patent filings: In 2019, the EPO received well over 181,000 applications in total, 4% more than in 2018 and a new all-time high. Patent applications in digital communication grew by 9.6%, driven by technologies crucial to 5G wireless networks. Digital communication overtook medical technology (+0.9%), which had been the most patent-active technology since 2006.

With an increase of 64.6%, Chinese companies contributed most to the growth in digital communication patent applications, with US (+14.6%) and South Korean firms (+36.1%, albeit from a smaller base) following suit. By com-

parison, filings from Europe grew moderately (+3.1%). In terms of share, China, the US and Europe are now the joint leaders, each accounting for roughly a quarter of all patent applications filed with the EPO in this field. The top three applicants in 2019 were Huawei, Ericsson and Qualcomm.

The second fastest-growing field at the EPO in 2019 was computer technology (+10.2%). Here the driving factor for growth was the increase in patent applications related to artificial intelligence, especially in the areas of machine learning and pattern recognition, image data processing and generation, and data retrieval.

US companies (+13.6% compared to 2018) accounted for nearly 40% of all patent applications in computer technology, followed by EPO member states (+9.3%) with almost 30% of the total. Applications from China (+18.7%) made up just over 10%. The leading applicants in 2019 were Alphabet (Google), Microsoft, Samsung,

Huawei, Intel and Siemens. A significant proportion of the growth in 2019 also came from smaller applicants, and from new players.

Other technical fields with solid growth at the EPO in 2019 were: transport (+6.6% compared to 2018), which includes the automotive sector; electrical machinery, apparatus and energy (+5.5%), where many inventions for clean energy technologies are filed; and pharmaceuticals (+4.4%). European companies held the largest share of patent applications in transport, measurement, organic fine chemistry and ''other special machines'' - an area covering a range of technologies including machine tools for various industries and 3D printing.

The technology trends were also reflected in the country data. The top five countries of origin for applications in 2019 were the US, accounting for 25% of total filings, followed by Germany (15%), Japan (12%), China (7%) and France (6%). The increase in applications at the EPO in

2019 was mainly fuelled by the strong increase in filing volumes from China (+29.2%), the US (+5.5%) and South Korea (+14.1%). In the past decade, patent filings from China with the EPO have increased nearly sixfold (12,247 applications in 2019 versus 2,061 in 2010). In 2019, the general upward trend in filings continued from nearly every major industrial region. Patent applications from the 38 EPO countries grew modestly (+1.1%) in 2019, the third year of increase. In relative terms, the share of patent applications from Europe continued to slide, however, falling from 51% in 2009 to 45% in 2019, as more players from outside Europe, and especially Asia, seek to protect their inventions in the European market.

Patent applications coming from the EPO member states developed stably overall, with most firms filing more patent applications than in 2018. Sweden (+8.0%) was the growth champion, boosted by increases in applications related to digital communication and computer technology. Patent filings from the UK (+6.9%) and Switzerland (+3.6%) continued to increase significantly, too, while filings from Italy advanced by +1.2%. After two consecutive years of growth the number of patent applications coming from Europe's top filing country, Germany, remained stable (+0.5%), while France (-2.9%) and the Netherlands (-2.6%) saw decreases last year. The drop in patent filings from France was due to fewer applications in fields such as digital communication and automotive, while in the Netherlands, lower numbers of applications were filed in a number of sectors, including medical technology and biotechnology.

Among the European economies with mid-range patenting volumes, applications from Spain (+6.0%) grew solidly. Belgium (+3.2%), Austria (+2.6%), and Denmark (+0.8%) achieved similar filing levels to 2018, while patent applications from Finland fell further (-1.4%). There were also significant increases from countries with smaller patenting volumes, such as Ireland (+6.3%) and Norway (+3.6%). Portugal (+23.1%) and Greece (+15.8%) also both saw their third year of consecutive growth, albeit from a smaller base.

The company ranking also reflects the rapidly growing importance of digital technologies. Huawei topped the table of patent applicants at the EPO in 2019 with 3 524 applications. Samsung moved up to second place and LG gained a position to take third. The two South Korean firms were followed by US company United Technologies and the top applicant of 2018, Siemens at No.5. Sony is Japan's highest ranking applicant (jumping from 11th to 9th), while Ericsson (moving up to 7th), Philips and Bosch ensure that European companies account for the majority of the applicants in the ranking: The top 10 includes four companies from Europe, two from South Korea, two from the US, and one from each of China and Japan.

A breakdown of applications originating from European countries shows that 72% of them were filed by large companies, 18% by small and medium-sized enterprises and individual inventors, and 10% by universities and public research organisations. This confirms that a significant proportion of EPO applicants are smaller entities.

Further information
EPO Patent Index 2019 – *www.epo.org/patent-index2019*
EPO press release – *https://www.epo.org/news-issues/news/2020/20200312.html*

BT and Ericsson agree deal to deploy cloud native dual-mode 5G Core

In April 2020, British Telecommunication PLC (BT) and Ericsson signed a deal to deploy Ericsson's dual-mode 5G Core, a fully container-based cloud native Mobile Packet Core for 4G, 5G Non-standalone and 5G Standalone services as a single fully integrated core.

The solution, delivered on BT's Network Cloud, will form a key component in BT's move to a single converged IP network. It will incorporate network orchestration and automation, including continuous delivery and integration processes, and it will be integrated into BT's existing customer experience management platforms.

BT decided on Ericsson to replace Huawei's equipment from the core of its 5G network after evaluating different 5G core network vendors. In January 2020, the UK government had decided to ban Huawei from the country's core network. Huawei is allowed to supply gear for the UK's 5G radio access networks (RANs), but it will be restricted to a 35% cap per operator in this part of the 5G network.

Further information
Ericsson press release – *https://www.ericsson.com/en/press-releases/2020/4/bt-and-ericsson-join-up-to-deliver-cloud-native-dual-mode-5g-core*

Clueless users and tricky surroundings

Online meetings from the home office

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The COVID-19 pandemic has changed the way office workers work. One of the major changes for many of them has been that they are no longer office workers but home office workers. Instead of having daily in-person meetings, they were forced to have online meetings. Apart from, at least temporarily, changing the communication culture in a number of organisations, the sudden move from physical to virtual meeting brought about a number of unwanted side effects.

There are two factors contributing to the unwanted side effects of online meetings from the home office: user experience, or rather inexperience, and the different environment. In most cases, these two factors reinforce each other. If this sounds too abstract, let us have a look at a few examples for each factor.

Clueless users

Let me start with some personal experiences from recent online meetings of European research projects in the ICT domain. You would expect technology-savvy researchers from the ICT field, who have had hundreds of online meetings already before the coronavirus lockdown, to be proficient in the use of web-conferencing systems. While this may be true for the majority of them, there is at least one ignorant participant in every call who creates minor or major disruptions.

My experience in ICT project calls is that most participants switch off their webcams, unlike users in most other domains. While this certainly reduces already one channel for unwanted side effects, it still leaves audio. And that can be really disruptive. Like the participant in one of my online project meetings who received a call on his mobile phone. The reason I know this is that his microphone was not muted, and I heard every word he was saying – unfortunately I could not hear the official speaker in the meeting anymore, as his audio volume was a bit low. Appeals

© AdobeStock

to the ignorant talker to close his mic were of no avail – he was fully absorbed in his other conversation, which seemed to be much more interesting than our online meeting. Remember that this is an example from a group of experienced users. It is getting more interesting, if you add inexperience. The following examples are second-hand, but I believe they are true.

Let us stick to the audio channel for this one. BBC News quotes Neil Henderson from Zurich Insurance, who had a call with a client, who was obviously in the bath, as he could hear splashing and the tap running. When the client realised that the microphone was on, the phone slipped into the bath. Then he (the client, not Mr Henderson) jumped out of the bath to get another phone, slid and fell.

If you think this little audio drama was exciting, remember that video offers many more creative opportunities for clueless users to entertain their less creative peers. One example I remember from a recent online project meeting was a participant, who seemed to be oblivious that the webcam was on. He stood up and came back with a sandwich, which he slowly ate in a disgusting manner. It does not sound so bad when you read it, but it was quite disturbing to watch.

Even more unsettling was a woman from the US, who did something really embarrassing in a video conference call – she accidentally left her camera on while going to the toilet, watched in disbelief by her stunned colleagues. How do I know about this? The video went viral on Twitter.

Let us now have a look at the other factor, the environment in the home office.

Tricky surroundings

Already at the office you can have numerous audio-visual distractions that could affect your online meeting. However, even a noisy office environment is like the cave of a reclusive Zen monk in comparison to the audio-visual horrors that many home office environments generate. The worst I personally experienced was an inconsolably crying baby at the home office of a female participant who had not muted her mic.

On the visual side there are reports about life partners visibly passing by at the back of the room – completely naked! Even for those who enjoy the occasional diversion within the hours of looking at boring slides and faces, it may affect focus and productivity – not to speak of the embarrassment of the person in whose home the diversion happens. And while most humans in a household can be educated to display socially responsible behaviour when the webcam is on, there are also cats and dogs that have been reported to interfere with online meetings by making noises or jumping in front of the camera.

In conclusion, I see two paths for the evolution of online meetings at the home office. Scenario one: home office workers update their skills and design their surroundings and technical setup to get closer to an office environment. Scenario two: neither user behaviour nor home office surroundings significantly improve. Instead, the tolerance of online meeting participants will increase the more predictable disruptions like naked spouses and farting dogs become. Time will tell which scenario will dominate.

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