Winter 2018

EURESCOM message

The magazine for telecom insiders

Celtic-Plus
Newsletter 2/2018

Network Slicing

The Kennedy perspective
The truth, the whole truth and nothing but the truth

European issues
5G end-to-end facilities

A bit beyond
Digital shrink

CELTIC-NEXT
Next Generation Telecommunications

New EUREKA Cluster CELTIC-NEXT will start on 1st January 2019

The new EUREKA Cluster CELTIC-NEXT is the successor of Celtic-Plus. The 8-year-programme is dedicated to next generation telecommunications and will start operations in January 2019.

CELTIC-NEXT is a business-driven programme for developing the next generations of telecommunications technologies and services in order to meet the evolving needs of businesses and citizens in Europe. The technological focus of CELTIC-NEXT is on research areas like cybersecurity, Artificial Intelligence, 5G and beyond, FinTech, Big Data, business analytics, and IoT. A special focus of CELTIC-NEXT is on applications and services serving vertical sectors such as content (video, gaming), e-health, smart cities, agriculture, mobility, energy, automotive, e-commerce, and industry/ manufacturing.

Further information is available on the CELTIC-NEXT Website at **www.celticnext.eu**

CELTIC-NEXT
Next Generation Telecommunications

Join the Industry-Driven Research Programme for Next Generation Telecoms

CELTIC-NEXT Call for Project Proposals – Deadline: April 2019

Do not miss the opportunity to participate in CELTIC-NEXT, the industry-driven European ICT and telecommunications research programme under the umbrella of EUREKA. Submission deadline for the first CELTIC-NEXT call for project proposals is in April 2019; the exact date and the submission form will be provided on the CELTIC-NEXT website in January 2019.

CELTIC-NEXT projects are collaborative private-public partnership R&D projects. All EUREKA member countries and associated countries can financially support them. More information on public funding and national contacts per country can be found on the CELTIC-NEXT Website under Public Authorities. Please talk to your national contact early in the process.
Preparing and submitting a CELTIC-NEXT project proposal is easy. Just register on the CELTIC-NEXT online proposal tool, fill in the Web forms, and upload your proposal in pdf. Access to the proposal tool and to a proposal template will be available via the Call Information page on the CELTIC-NEXT website.

Benefits of participating in CELTIC-NEXT include:

- You are free to define your project proposal according to your own research interests and priorities.
- Your proposals are not bound by any call texts, as long as it is within the ICT/telecommunications area.
- CELTIC-NEXT projects are close to the market and have a track record of exploiting their results soon after the end of the project.
- High-quality proposals have an excellent chance of receiving funding, with an average success rate of 60 %.
- The results of the evaluation will already be known in November 2018.

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

Contact:

CELTIC-NEXT Office
office@celticnext.eu

Peter Herrmann
herrmann@celticnext.eu
Website: www.celticnext.eu

Dear readers,

Network slicing has become one of the major concepts in 5G. What has driven the development of the slicing concept is the ambition to better utilise future networks. While some are excited about the opportunities slicing provides, others doubt that slicing is really that new and revolutionary.

In this issue of Eurescom message, we will shed light on network slicing and present insights from leading European researchers in this area.

In the first article of the cover theme, Eurescom message editor Anastasius Gavras presents an overview on network slicing with a focus on the motivation and concepts of slicing. The next article presents the framework for slice control, management and orchestration developed by 5G PPP project SliceNet. In an article from Orange France, the authors present their results on how Artificial Intelligence can serve future sliced networks. In the final cover theme article researchers from Eurecom present their insights on slicing and orchestration in a service-oriented Radio Access Network (RAN) architecture.

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 how the meaning of the term “truth” has changed in the information age in his column "The Kennedy Perspective". See also our “European issues” section, in which Eurescom message editor Uwe Herzog explains the new European 5G end-to-end facilities and how they facilitate 5G trials with vertical sector industries. Finally, in the latest "A bit beyond" article you can learn about how AI-powered chatbots could help you tackle stress and depression.

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.

Milon Gupta
Editor-in-chief

Cover image: © fotolia.de

EVENTS CALENDAR

25 – 28 November 2018
6th Global Wireless Summit
Chiang Rai, Thailand
http://web2.mfu.ac.th/conferences/gws2018/

28 – 30 November 2018
6th Global 5G Event
Rio de Janeiro, Brazil
https://5g-ppp.eu/6th-global-5g-event-5g-technology-changing-pardigms-of-a-new-society/

4 – 6 December 2018
ICT 2018: Imagine Digital – Connect Europe
Vienna, Austria
https://ec.europa.eu/digital-single-market/en/events/ict-2018-imagine-digital-connect-europe

25 – 28 February 2019
Mobile World Congress 2019
Barcelona, Spain
https://www.mobileworldcongress.com/

17 – 18 June 2019
7th Global 5G Event
Valencia, Spain
https://5g-ppp.eu

18 – 21 June 2019
EuCNC 2019
Valencia, Spain
https://www.eucnc.eu

SNAPSHOT

Healthcare assistant on wheels

Moxi (photo) is an AI healthcare robot. The prototype has been designed to serve as a supporting member of healthcare professional teams. Its purpose is to relieve staff of non-patient facing logistical tasks, in order to give nurses more time to focus on patient care. The developers claim that Moxi is socially intelligent, autonomous, mobile, safe, and flexible. Moxi has been developed by Diligent Robotics, a US startup based in Austin, Texas.

For further information see the Diligent Robotics website at http://diligentrobots.com/moxi/

Contents

The truth, the whole truth and nothing but the truth

David Kennedy
Eurescom
kennedy@eurescom.eu

We are now in the information age and, for the first time, we are all beginning to realise that we have been fed a lot of false information as part of the wonderful widespread availability of information today. In fact the business of information management has been going on for as long as people have been trying to manipulate others – probably forever, but the difference today is that the tools of the information age are making the whole concept more dangerous.

© fotolia.de

We are all aware of marketing – where, for the purpose of promoting a product or service, or even a political view, information is spread through advertising and media to promote the ambition of whoever is paying for it.

The concept of propaganda, which has connotations of using parts of the truth for political effect originated somewhere in the middle ages. Again it is something we can deal with, as we know the source and can rationalise against the inherent bias – but it is still a powerful political tool.

Misinformation is more difficult, as here people often share untrue things they have seen and liked because they fit with their views and prejudices. The subtlety is that they do not actually know the information is false because they want to believe it.

Humour can also be an information weapon. But we need to defend humour, as in many cases it is the first weapon for attacking unjust regimes or highlighting the double standards of many of our political representatives.

But our new trend is disinformation, which is where individuals or groups deliberately spread false information to influence the views and opinions of the public in general or, even worse, to obscure the truth. This is often done by spreading false stories and or rumours in order to damage the public perception of people or events.

The social media algorithms have a lot to answer for here. Facebook and similar sites tend to show you more of the type of information you like. Therefore it is actually limiting your information to the sort that reinforces your pre-held views and steers you towards more contact with people who have similar views as you. So it is guilty of preventing you from having a healthy selection of viewpoints to consider.

This has the effect of polarizing communities. If we only speak and interact with people who share our views we will end up with false ideas about the world around us. For example, I often have to deal with the view that all Irishmen drink. This usually comes from people who spend a significant proportion of their time in Ireland in the pubs and, because they only have this view, they assume that is the full truth. They need to get out more!

So what can we do with our biased polarized social information networks today? I, for one, would like to have a truth filter on the content.

My truth filter would tell me, if the source of information was untrustworthy, just as my mail client warns me against potential harmful attachments. Some would argue that truth is a matter of perspective but I don't agree. Truth is usually absolute but, just as history is often the account of what happened by whoever won, people can be economical with the truth and then it becomes propaganda again.

One of the biggest challenges to truth is our current trend for trying to be balanced in everything. There is a recurrence of people choosing to believe there is no global warming. They are a minority, but media representations will put them in debate one to one with respected scientists representing the majority of the scientific community. This concept of "balance", giving an uneducated perspective the same airtime as the informed educated viewpoint is creating a new political concept where my ignorance has the same rights as your educated view.

If we allow this to continue, we will end up in a world where the truth does not really matter and governance done like reality TV where people vote for what they like regardless of the consequences. And worse still the elected representatives will only act to grant the whimsical mass wishes rather than consider what is right and good for society.

Maybe we're already there ...

Overview on network slicing

Motivation and concepts

Anastasius Gavras
Eurescom
gavras@eurescom.eu

The future of society is tightly coupled with the evolution of information and communication technologies. The new 5G network infrastructure is currently in the focus of research, innovation and increasingly receives media attention. 5G is not only about a faster network access, but marks a transition from a rather static network infrastructure to a much more dynamic one. It is just too expensive and inefficient to build a separate infrastructure for each service.

Hence the basic motivations are to increase the utilisation of network infrastructure resources, to enable its shared use for multiple applications posing very diverging requirements on the network and to add the required flexibility and scalability to meet these requirements.

Network slicing is one of the main concepts in 5G. The concept was first formulated by the Next Generation Mobile Networks (NGMN) Alliance in the context of future networks. Slicing was originally defined as a set of run-time network functions, and resources to run these network functions, forming a complete instantiated logical network to meet certain network characteristics required by the service.

Historically the concept of slicing is older. For example PlanetLab – a global research network that supports the development of new network services – was established in 2003 and defines slicing in a similar way.

The definition that is given by 3GPP today is that of a logical representation of the network functions and corresponding resource requirements necessary to provide the required telecommunication services and network capabilities [1].

Requirements and drivers

In the course of identifying the requirements for the 5G network infrastructure a large number of use cases have been described and analysed by standards bodies, such as 3GPP and ITU or industry forums such as NGMN. The different requirements have been consolidated and agreed in three main classes:

- Enhanced Mobile Broadband (eMBB) – also called Extreme Mobile Broadband
- Ultra-Reliable and Low Latency Communications (URLLC), and
- Massive Machine Type Communications (mMTC)

In addition to the main key performance indicators relevant to the service experience, such as user data rate, latency, and density of devices, the following aspects are relevant from the deployment and network operational perspective and should be met by network slicing:

- Service diversity – The ability to deliver different service classes (eMBB, URLLC, mMTC) over the same infrastructure.
- Guaranteed performance – Simultaneously guarantee several performance KPIs, such as user data rate or reliable service.
- Fast deployment and short time-to-market – The ability to deploy and provision network services for customers in hours or even minutes.
- Resource isolation – Guarantee that each network service tailored for a customer is secured and does not suffer performance degradation by other services.
- Automation and autonomic network management – Increase the agility and ease of adaptation of the network performance to unforeseen network conditions.
- Convergence of fixed and mobile access – Treat all access technologies equally and deliver the same user experience regardless of the network access technology type.
- Innovation ecosystem and new business models – Evolve the network into a digital business ecosystem that is attractive for innovators in the vertical industries, for service providers and operators alike.

Business motivation

From a business point of view, a slice includes a combination of all relevant network resources, network functions, service functions and enablers required to fulfil a specific business case or service, including the functions of an Operation Support System (OSS) and Business Support System (BSS).

The behaviour of a network slice is realized via a network slice instance. From the network infrastructure point of view, network slice instances require the partitioning and assignment of a set of resources that can be used in an isolated, disjunctive or non- disjunctive manner for that slice.

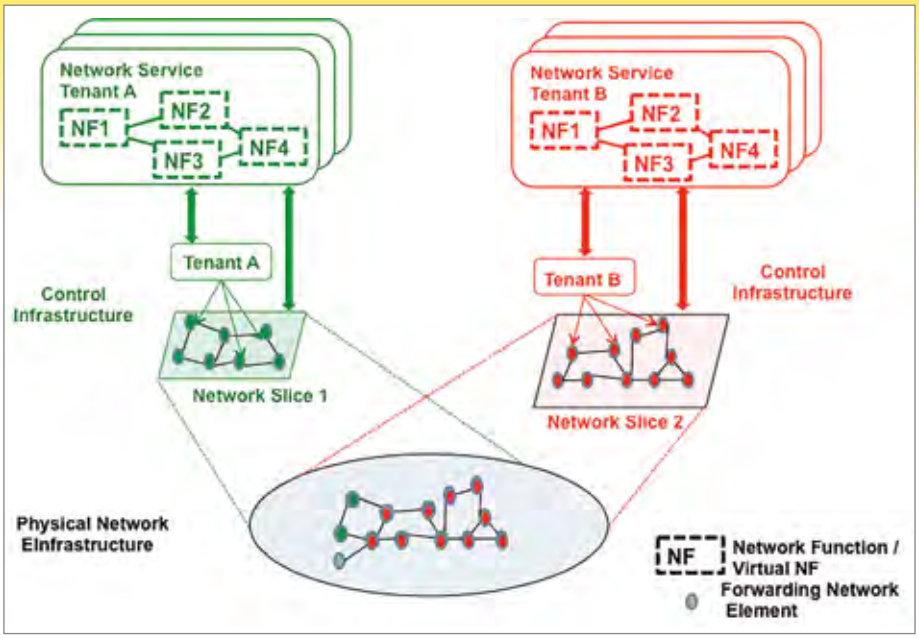
Network slicing transforms the networking perspective by abstracting, isolating, orchestrating, softwarizing, and separating logical network functions from the underlying physical network resources.

To support network slicing, the management plane creates a group of network resources, connects them with the physical and virtual network and service functions as appropriate, and instantiates the network and service functions assigned to the slice. During slice operations, the control plane is governing all network resources, network functions, and service functions assigned to the slice. It controls them as appropriate to support an end-to-end service.

The establishment of slices is both business-driven, because slices are the support for different types and service characteristics and business cases, as well as technology-driven because slices are a grouping of physical or virtual resources (network, computation, storage) which can act as a sub network. A slice can accommodate service components and physical and/or virtual network functions in all network segments: access, core, back-/front-haul, edge and enterprise networks.

Network operators can use network slicing to enable different services to receive different treatment and to allow the allocation and release of network resources according to their context and contention policy. Network softwarization techniques may be used to realize and manage network slicing. Network slicing provides the means by which the network operators can provide programmable network capabilities to over-the-top providers and other market players without changing their physical infrastructure. Slices can dynamically support multiple services, multi-tenancy, and the integration means for vertical industries such as the automotive, energy, healthcare, media/entertainment and other industries.

The figure indicatively illustrates how infrastructure resources are assigned to slices and how network functions are allocated to slices.



The basic concept of network slicing (Source: 5G Architecture white paper, V2.0 [2])

Virtualisation

Network virtualisation is an essential ingredient for network slicing. It is defined by the ability to create logical, virtual networks that are decoupled from the underlying network hardware to ensure the network can better integrate with and support virtual environments. Virtualisation takes advantage of the efficiency and agility of software-based computation and storage, and transpose these properties to the network.

The induced software programmability led to the introduction of Software Defined Networking (SDN) which is a method of using software to create network abstraction layers over the physical infrastructure and separate logically isolated virtual networks. It is this property that inspired ITU to define slicing as the basic concept of network softwarization. According to ITU-T Y.3011 slicing allows logically isolated network partitions with a slice to be considered as the unit of programmable resource, such as network, computation and storage.

SDN is often complemented by Network Function Virtualisation (NFV), which represents an alternative way to design, deploy and manage network services. SDN and NFV are related concepts – SDN is used to separate the control and data planes of the network, while NFV focuses on optimising the network services themselves. NFV aims to speed up the deployment of new networks services by implementing them in software that can be provisioned rapidly in virtualised environments.

Separating hype from reality

What is the difference between a slice and a Virtual Private Network (VPN)? This is the most frequently asked question in heated debates about the value of network slicing. Trying to separate hype from reality, the articles in this cover theme provide insight into new network capabilities and applications that were not possible before.

For example the article on “Slice and Network Intelligence” explains how slicing is combined with Artificial Intelligence and Big Data to ensure effective network operations and network management. The article on “End-to-End Cognitive Network Slicing” provides an overview of the SliceNet project, which delivers a full framework for slice control, management and orchestration. Finally the article on “Slicing and Orchestration in a Service-Oriented RAN Architecture” provides an insight on how slicing is applied to the Radio Access Network (RAN), which is probably one of the most challenging areas for slicing, because the radio spectrum is such a scarce resource.

Conclusion

Network slicing continues to be the subject of heated debates, in particular in the context of demonstrating the capabilities it promises. Advanced 5G validation trials and pilots are being executed worldwide. They aim to showcase the ability to meet diverging vertical industry requirements during concurrent use of the same network infrastructure by multiple applications. Each vertical industry application is seeking independent service guarantees that slicing and virtualisation as well as multi-domain resource management must assure. With the first deployments of 5G planned in 2020, there is little time to trial and experiment with network slicing.

References

[1] 3GPP TR 23.799 V14.0.0 (2016-12)
[2] 5G PPP Architecture White Paper, Version 2.0, https://5g-ppp.eu/wp-content/uploads/2018/01/5G-PPP-5G-Architecture-White-Paper-Jan-2018-v2.0.pdf

End-to-end cognitive network slicing

The SliceNet framework for slice control, management and orchestration

Qi Wang
University of the West of Scotland
Qi.Wang@uws.ac.uk

Jose Alcaraz-Calero
University of the West of Scotland
Jose.Alcaraz-Calero@uws.ac.uk

Maria Barros Weiss
Eurescom
barros@eurescom.eu

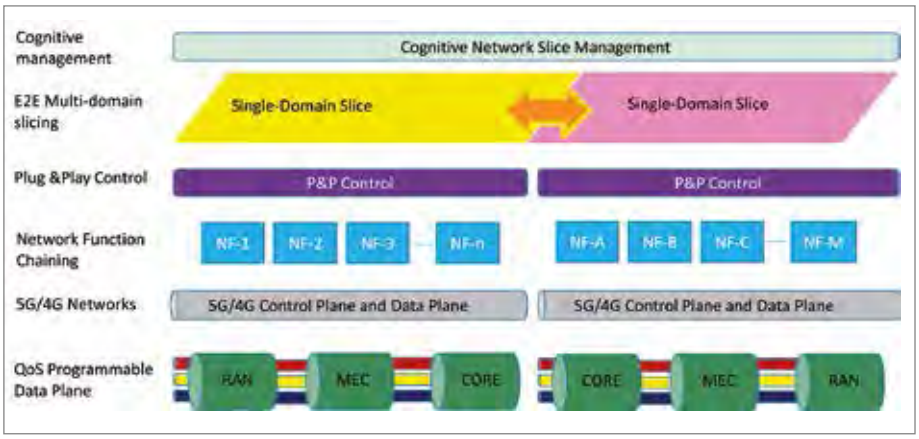


Figure 1: E2E network slicing framework concept in SliceNet

The future generation networks aim to overcome the limitations of current network paradigms. They do so by addressing the challenges of controlling, managing, and orchestrating a fully softwarised network and services running on the infrastructure. The instrument for achieving this vision is network slicing. In this article we explain how the SliceNet project, which is part of the European 5G Infrastructure PPP, is contributing to the realisation of network slicing.

SliceNet is set to implement end-to-end multi-domain network slicing that provides a management plane for slices. Thus, SliceNet facilitates the creation of value-added services by verticals and optimised Quality of Experience (QoE) for end users.

5G motivation and context

Infrastructure providers are concerned with optimising the utilisation of their infrastructure resources. At the same time they are keen to offer richer services to customers who are more and more demanding, not only in regard to service usage but also regarding QoE expectations. On the other hand, vertical customers are demanding a much higher flexibility in controlling the network services they receive.

The 5G PPP is an EU initiative set up to boost Europe's position in the global market for 5G networks. SliceNet is one of the 5G-PPP projects addressing the slicing concept across operator domains and offering a multi-domain multi-tenant plug & play control framework for vertical customisable network slicing. SliceNet will advance slicing-based softwarisation of 5G systems with architectural enhancements and infrastructure integration, as well as novel enablers for the slicing control plane, management plane and cross-plane orchestration.

For 5G network operators, SliceNet will enable a truly end-to-end multi-domain network management paradigm with integrated FCAPS (Fault, Configuration, Accounting, Performance and Security). For 5G service providers and users, SliceNet will achieve significantly higher service quality towards warranted perceived quality through intelligent QoE-driven design. For 5G vertical businesses, SliceNet will help them to employ 5G services in a more rapid and efficient manner through a 'one-stop-shop' approach.

End-to-end network slicing

To date reported prototypes do not implement truly end-to-end (E2E), QoS/QoE-aware network slice control, management and orchestration across multiple administrative domains. SliceNet has identified this gap as a high-priority technical issue to tackle for achieving the E2E application quality required for the adoption of 5G applications. Current solutions have mostly focused on the Radio Access Network (RAN) and Core network in a single 5G operator's domain for network slice prototyping, even if they need an E2E dimension in order to be adopted for large-scale applications. Figure 1 illustrates the E2E network slicing framework concept in SliceNet.

A network slice in SliceNet is an independent, end-to-end logical network running on a shared physical infrastructure, which spans across all the network segments and may include a vertical's enterprise networks and multiple network service providers' domains to provide one or more services.

A network slice comprises specific RAT settings and a set of network functions (virtual and/or physical) over the end-to-end logical network to achieve the expected SLA and all the resources (virtual and/or physical, dedicated and/or shared) required to run these network functions that are purposely selected and chained to deliver the end-to-end service and the associated SLA. The data plane over which network slices operate should be programmable according to the SLA requirements.

Some of the control and monitoring capabilities of the network slice can be exposed to the vertical user by means of a plug & play control framework. The network slice service provider and/or digital service provider can optimise the QoE of the service provided by the network slice to enhance the experienced quality. In this context, we focus on slices for applications by verticals.

A network slice's lifecycle and FCAPS (Fault, Configuration, Accounting, Performance and Security) management and orchestration belong to the network management plane. Cognitive network slice management is envisioned to support dynamic QoE optimisation for the verticals' network slices during their operational lifetime.

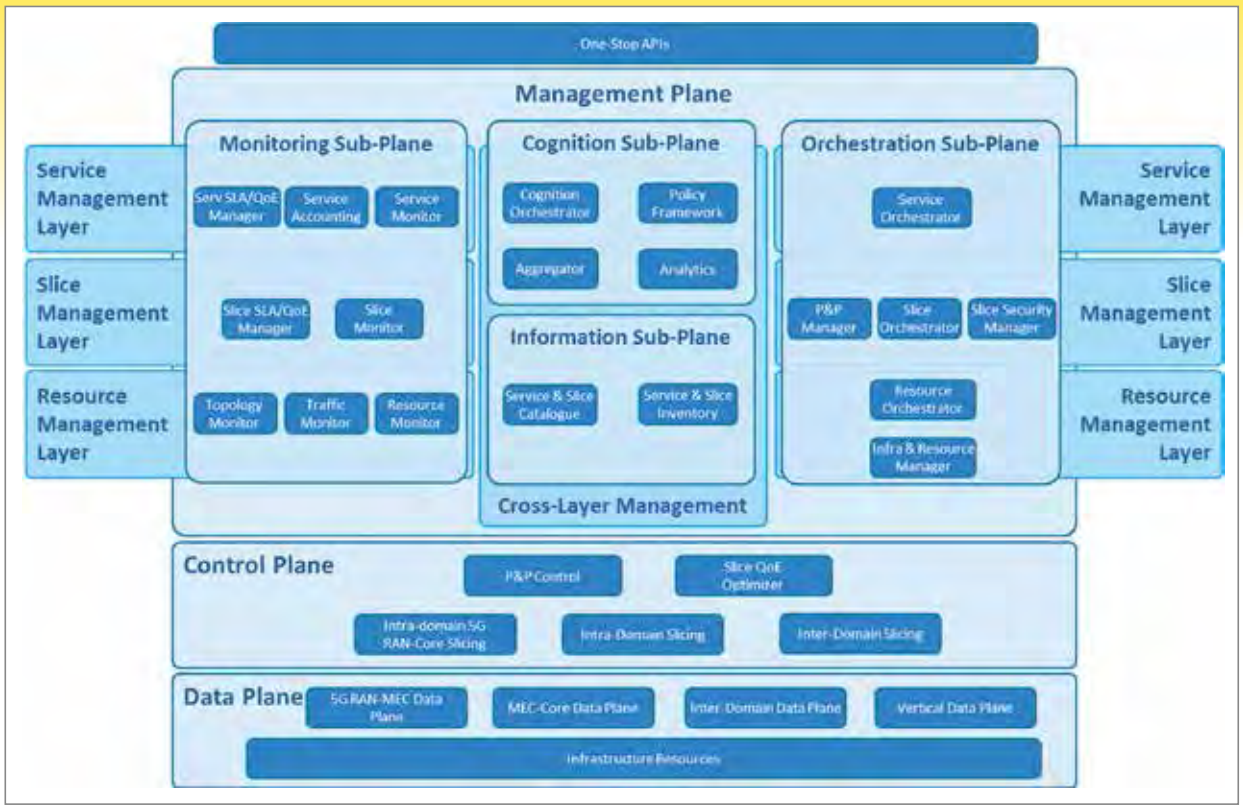


Figure 2: SliceNet logical architecture for network slice control and management

SliceNet network slice control, management and orchestration architecture

To realise the SliceNet network slicing concept, the project has defined an overall logical architecture for slice control, management and orchestration (Figure 2), which is compliant with the 3GPP models for network slicing [2].

As you can see in Figure 2, SliceNet has defined a modular architecture that is structured into three planes. At the bottom, there is a network slice QoS aware, programmable data plane. This data plane spans the different network segments within a single domain, as well as verticals' data plane and cross-domain data paths from the E2E perspective. Over this data plane, an overlay control plane controls the network slices on top of 4G/5G network infrastructures.

It is worth clarifying that this SliceNet control plane operates and interacts with the underlying 4G/5G control plane and data plane for added values of network slice control. In particular, the SliceNet plug & play control enables the verticals to monitor, control and manage their own slices. At the top in this architecture, a cognitive network slice management plane oversees the control plane and the data plane.

The management plane itself is organised into four sub-planes. Firstly, a monitoring sub-plane provides the monitoring capabilities of running slices at multiple layers including resources, slices, and services. Secondly, a cognition sub-plane, together with an information sub-plane, enables a MAPE-K (Monitor-Analyse-Plan-Execute over a shared Knowledge) loop to empower the management plane to achieve cognitive network slice management for the verticals. Finally, an orchestration sub-plane delivers the orchestration capabilities across the planes and at the various layers.

Adoption by vertical industries

SliceNet employs a "verticals in the loop" design and prototyping approach. There is a strong interest of the verticals' industries towards 5G technologies. Vertical stakeholders are forming partnerships with 5G ICT industry stakeholders to achieve the fully connected society vision of 5G. The European Commission (EC) incentivises vertical industry participation in research from the early stage, which includes supporting project trials by verticals. Users are very much in the focus of 5G network solutions, and users' QoE has been the focus of SliceNet.

Use cases

SliceNet will be demonstrated through three representative vertical use cases. They are aligned with the three 5G use case classes defined by 3GPP, namely Ultra-Reliable Low-Latency Communications (URLLC), massive Machine-Type Communication (mMTC), and enhanced Mobile BroadBand (eMBB).

The vertical use cases include the following. Firstly, the Smart Grid Self-Healing use case demonstrates enhanced automation in energy distribution networks with self-healing capabilities. Secondly, the e-Health Smart/Connected Ambulance use case shows how to improve the emergency ambulance services by leveraging mobile/multi-access edge computing. Thirdly, the Smart City use case demonstrates an Intelligent Public Lighting system in the city Alba Iulia in Romania and assesses the various technical and operational KPIs against the initial status quo in the city.

Conclusion and outlook

SliceNet aims to achieve E2E QoS/QoE aware network slicing with cognitive network slice management capabilities beyond the state of the art. Towards this end, the project will advance network slicing-based 5G systems with significant architectural enhancements to 4G/5G networks, and produce novel enablers in terms of multi-domain network slicing, plug & play control, cognitive management, among others. The three selected use cases, aligned with the three main 5G network slice types, will demonstrate the overall benefits in adopting the SliceNet framework for network slice control, management and orchestration in meeting the diverse QoS/QoE requirements from various vertical businesses.

References

[1] https://slicenet.eu/
[2] http://www.3gpp.org/NEWS-EVENTS/3GPP-NEWS/1951-SA5_5G

Slicing and network intelligence

How AI serves future sliced networks

Imen Grida Ben Yahia
Orange Labs Networks
Imen.gridabenyahia@orange.com

Joanna Balcerzak
Orange Labs Networks
joanna.balcerzak@orange.com

Future networks with slicing need to have built-in and embedded intelligence. This will enable better agility, resiliency, faster customization and higher security, which are required by 5G users and a growing number of vertical use cases in areas like eHealth, Smart City, and Smart Grid. In this article, we explain the challenges of using Artificial Intelligence (AI) in sliced networks, recall the network slicing concept, sketch the role of AI for future network operations, and introduce the network data analytics function (NWDAF) as an entry point to AI.

Embedding Artificial Intelligence (AI) into the network will provide a greater level of automation and adaptiveness, enabling efficient orchestration and dynamic provisioning adapted to the type of slice, the offered services and the nature of network functions. It will also result in higher resiliency and better availability of future sliced networks and their associated services.

The network slicing concept

A network slice is a logical network provisioned with a set of isolated virtual resources on the shared physical infrastructure that can be dynamically created to provide specific network capabilities and characteristics. The network slicing concept [1] consists of Service Instance Layer, Network Slice Instance Layer and Resource Layer. The network slice instance selection for User Equipment (UE) is normally triggered as part of the registration procedure by the first Access and Mobility Management Function (AMF) in the core network that receives the registration request from the UE. The AMF retrieves the slices that are allowed by the user subscription and interacts with the Network Slice Selection Function (NSSF) to select the appropriate network slice instance that will serve a particular device.

A given UE may access multiple slices over the same access network. Each slice may serve a particular service type based on a Service-level Agreement (SLA). The identification of a network slice is done via the Single Network Slice Selection Assistance Information (S-NSSAI), which is composed of Slice/Service Type (SST) and Slice Differentiator (SD). UE receives services through a Protocol Data Unit (PDU) session, which is a logical connection between the UE and network. The S-NSSAI is included in any signalling message containing PDU Session information, so Next Generation Radio Access Network (NG-RAN) is enabled to apply policies at PDU session level according to the SLA represented by the network slice. A maximum of eight S-NSSAI items may be sent in signalling messages between the UE and the network. A PDU session belongs to only one specific network slice instance.

Management requirements for slicing

Each slice must be independently managed as a separate network. In the following, a set of requirements are listed to properly operate slices:

- Isolation to prevent from attacks or faults in one slice, becomes necessary to avert bad impact on other slices.
- A large number of Key Performance Indicators (KPIs) require real-time advanced automation to ensure KPI association, correlation, forecasting of indicators evolution and anomaly detection of data.
- Slice congestion and the prevention of impacting other slices.

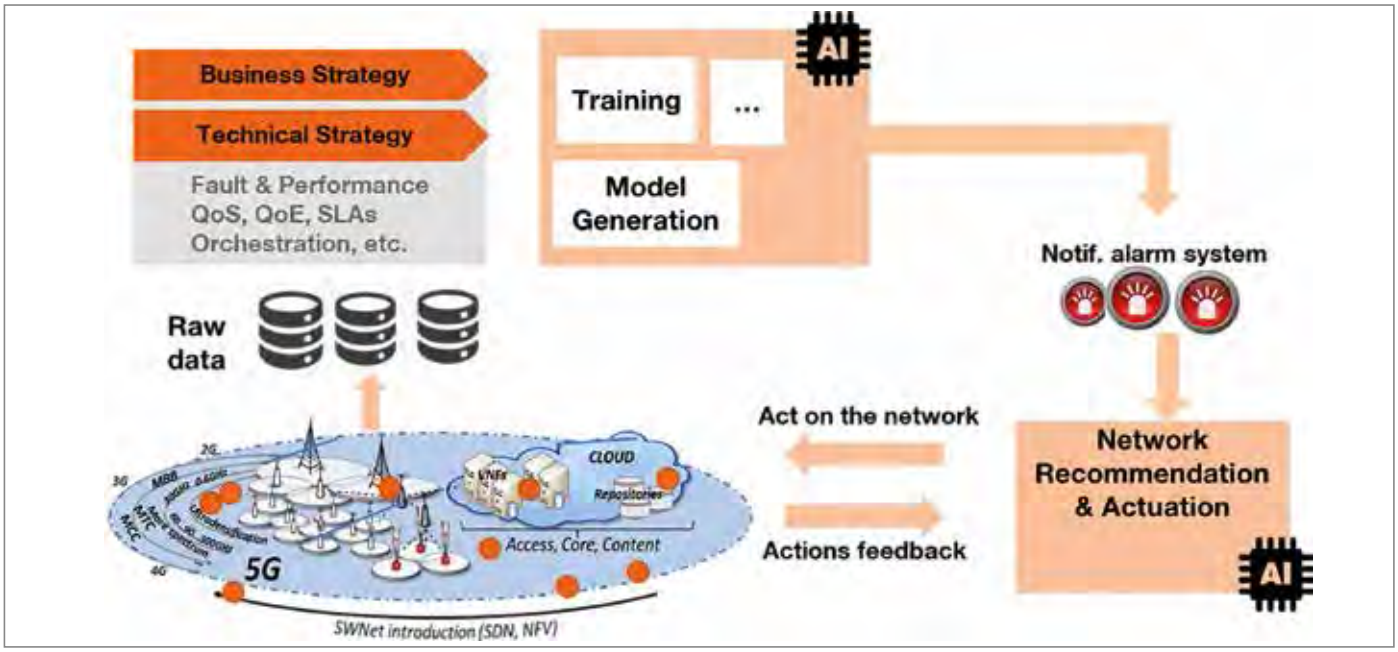


Figure 1: Future Network Intelligence with AI – a simplified view

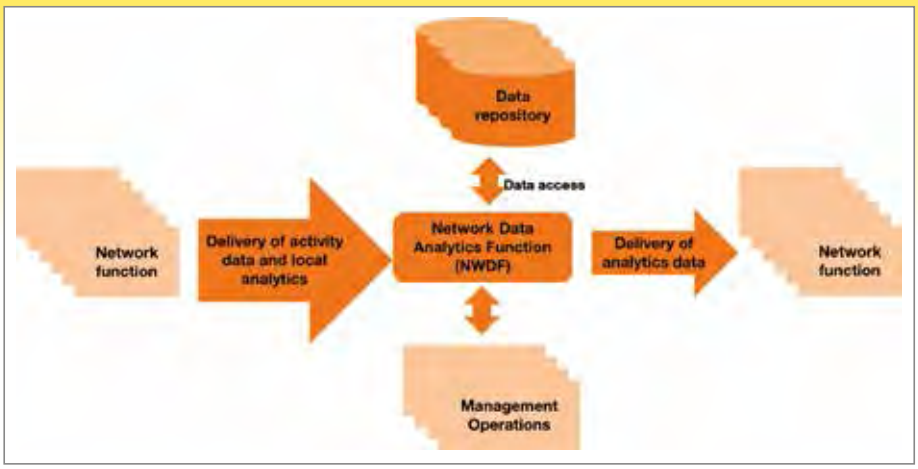


Figure 2: Network Data Analytics Function – Towards Analytics in Network Slicing

- "Smart" monitoring with aggregation and correlation techniques becomes mandatory to take into account the different levels introduced by the Network Slicing concept: service level, slice level and resource level.
- Performance requirements for the different slices are a challenge: it takes into account the number of devices, the types of devices, their mobility and traffic patterns, the delay and the jitter requirements, the device capabilities, but also the slice granularity per service type, the flow or even the distribution of traffic per slice, and so on.

Future network intelligence with AI

Artificial Intelligence and big data are multi-disciplinary domains spanning from statistics, robotic, machine learning to optimization, and more. Hence, future network intelligence is the target to reach with AI and big data. In figure 1, we show a simplified view of Future Network Intelligence with AI. It shows that the future network encompasses the previous network generation as well as 5G sliced networks. From these heterogeneous network generations, different data sources will be available.

The goal of AI will be to extract information, build knowledge and make decisions based on data analysis and the formal modelling of slices, services and resources status. In the following we cite several cases to exemplify AI for future sliced networks [2].

Optimization algorithms are essential to efficiently allocate network elements and devices while reducing the energy consumption. In addition, optimization techniques allow an efficient deployment of the slice and the offered services while combining different constraints and inputs like the customer preferences, slice types, resource status and in the meantime meet the business constraints.

Network recommendation systems that are usually based on learning by interaction techniques like reinforcement learning recommend the network configurations slice templates parameters to meet a given deployment constraints or a vertical request. That kind of system learns from past deployments to better fit the future ones.

Machine learning and deep learning models, algorithms and techniques leverage slice, service and resource management operations, hereafter some examples:

1. Smart prediction and forecasting of networked slice resources enable better anticipation of faults, performance degradation and maintain service availability to verticals. With machine learning, service unavailability and interruption are avoided especially for critical services like remote surgery.
2. Cognitive scaling embeds ML algorithms to adjust network and cloud capacity accordingly to usage analysis and forecasting results.
3. The context of slicing is particularly highlighting the consideration of multi-levels (services, slices and their associated resources) and heterogeneous data sources: In this regards, data fusion techniques, with for example, Convolutional Neural Networks (CNN) and Long Short Term Memory (LSTM) are recommended to ensure data discovery and association, pattern identifications, data dependency and correlation.
4. Preventing attacks and malware which target established services and verticals as well as ensuring the QoS of a given network slice session requires advanced techniques of anomaly detection or learning-by-interaction techniques to prevent attacks and fraud from happening on the networks. The network is then able to "remember" what was tagged as nasty event and to prevent that from happening thanks to deep learning techniques including pattern recognition.

AI's entry point for network slicing

The network data analytics function (NWDAF) could be considered as an entry point to realize AI in the sliced future networks applications cited above. Hence, NWDAF forms a part of the 3GPP's 5G standardization efforts and could become a central point for analytics in the 5G core network. NWDAF provides an identifier for each network slice instance and its associated load level information. Several network functions are using this NWDAF, such as the Policy Control Function (PCF) and the NSSF (Network Slice Selection Function). The PCF may use that data in its decision policies, and the NSSF may use the load level information provided by NWDAF for slice selection.

In figure 2, the general framework for 5G network automation is depicted as follows:
The Mobility Pattern is a concept defined in 3GPP. It may be used by the AMF to characterize and optimize the UE mobility. This concept gives the opportunity to predict the mobility, since NWDAF can learn UE mobility history and discover the rules and patterns of UE mobility. In its turn, the AMF determines and updates the Mobility Pattern of the UE based on subscription of the UE, statistics of the UE mobility, network local policy, and UE-assisted information, or any combination of them.

The statistics of the UE mobility can be historical or according to an expected UE moving trajectory. This information can be used for optimization and seamless transition of the handover process while ensuring better quality of service with direct impact on QoE improvement. Data related to UE behaviour can be also useful in case of analytics to introduce tailored services taking into account the habits and preferences of the client.

Conclusion

Artificial Intelligence for services, slices and their associated resources is becoming a must for managing the network operations. In fact, the future network is a combination of different and heterogeneous technologies, data formats (several levels) and massive customization per slice and per services involving a huge set of KPIs to maintain. Thus AI and big data are essential and require a methodology to meet the active transformation of networks.

References

[1] NGMN 5G P1 Requirements & Architecture Work Stream End-to-End Architecture; Description of Network Slicing Concept by NGMN Alliance; v.1; 2016-01

[2] IEEE-Communication-Society, Network Intelligence Initiative, https://www.comsoc.org/committees/emerging-technologies-initiatives/network-intelligence

Celtic-Plus Newsletter 2/2018

Outlook 2019: CELTIC-NEXT Cluster starts in January 2019

Events: CELTIC Proposers Day in Madrid

Project Highlights: E3 – Successful business development of e-health services

Start-up Success Stories: A new paradigm in digital asset management

Editorial

Table of Contents

Dear reader,

The CELTIC-NEXT Cluster was endorsed by the EUREKA High Level Group at the 3rd and final meeting of the Finnish EUREKA Presidency on 20th June 2018 in Helsinki. CELTIC-NEXT will formally start its operations in January 2019. In this issue you will find the most important facts on what is new and what remains, when CELTIC-NEXT will start next year.

Maybe the shortest information of this Newsletter is at the same time the most exciting: Innovate UK has announced that they will fund CELTIC projects in 2019. So if you have good partners from the United Kingdom, please invite them to join you and to participate in CELTIC project proposals.

Start-ups are of critical importance for our research activities. We have asked Steny Solitude from Perfect Memory, a French SME that exists since 2008. It is an SME that has already overcome a number of difficulties in its first 10 years of existence and that generates now more and more business. Steny explains how his company can help to make any data and document actionable for the business. Perfect Memory was created thank to two CELTIC projects. See this and more information in Steny's Article.

The Project Highlight of this issue is about a very good CELTIC project, the E3 project. You may recall the announcement one year ago on "the first live transmission of awake surgery". E3 has now ended, and the coordinator, Oscar Chabrera from Vilynx, explains the outcome of this project. Vilynx is a start-up company that was created after a successful CELTIC project. I would like to highlight the impressive achievements and feel proud that we at CELTIC have facilitated their success.

In this issue, you can also read about our Proposers Day in Madrid, which was hosted by CDTI the Spanish funding agency. We had 70 registered participants from eight different countries. Highlights of the day were the keynote on Artificial Intelligence and the panel on successful CELTIC projects showing impressing results such as "The world's first 100G quantum safe transport over 2,800 km". The Public Authorities from Spain, Germany and Sweden presented their national funding schemes and 8 project ideas were shown and discussed in the networking session.

In the Celtic-Plus Autumn Call that closed on 15th October, we received four CELTIC project proposals – the evaluation by the Group of Experts, the Public Authorities and the CELTIC Core Group is currently ongoing and the results will be known after the Label Meeting that will take place in Heidelberg in mid-November 2018.

Celtic-Plus is fast evolving towards CELTIC-NEXT and we expect that CELTIC-NEXT will continue to attract our highly innovative community, which is constantly pushing the borders of ICT technology. If you are not yet part of the Celtic-Plus community and would like to join, there are ample opportunities, like, e.g., the online Proposer's Day on 29 of November 2018. Other Proposers Days for early 2019 will be announced shortly and, of course, the next call for proposal, which ends in April 2019. Feel free to talk to me or any other colleagues at the Celtic-Plus Office – I look forward to hearing from you.

Peter Herrmann
Editor-in-chief

IMPRINT
Editor-in-chief:
Peter Herrmann
herrmann@celticplus.eu

Contact:
Celtic Office
c/o Eurescom GmbH
Wieblinger Weg 19
69123 Heidelberg, Germany
Tel: +49 6221 989 381
Fax: +49 6221 989 451
www.celticplus.eu

UK to join funders supporting Celtic-Plus projects

In October 2018, the UK announced that it will be supporting Celtic-Plus cluster projects in 2019. Innovate UK, part of UK Research and Innovation, is the UK public authority for granting national funding of Celtic-Plus labelled international projects. Further information will follow in the coming months.

CELTIC-NEXT Cluster starts in January 2019

CELTIC-NEXT, the successor of Celtic-Plus, will start its operation in January 2019. The EUREKA Cluster dedicated to next-generation telecommunications has a duration of 8 years until December 2026. On 20th June 2018, the CELTIC-NEXT Cluster had received the EUREKA Label in Helsinki, based on a decision by the EUREKA High Level Group.

At the HLR Meeting in Helsinki, CELTIC-NEXT was represented by the two CELTIC Vice Chairs Valery Blavette from Orange and Jari Lehmusvuori from Nokia as well as the CELTIC Office Director, Peter Herrmann.

Foundations of CELTIC-NEXT

The CELTIC-NEXT Core Group is composed of 8 operators, 7 technology providers and 1 research organisation. In 2017 the CELTIC Core Group identified the critical technological and societal issues that need to be addressed in the coming years. These topics are documented in the CELTIC-NEXT White Paper [1] and the CELTIC-NEXT Scope and Research Areas document [2].

CELTIC-NEXT will be based on the core values that have been supporting the Celtic community for 15 years, i.e. a bottom-up industry-driven approach, along with large flagship projects aimed at solving issues of strategic importance through a combined effort and coordinated approach of public authorities and industry.

Peter Herrmann presenting CELTIC-NEXT to the EUREKA High Level Group. On stage (from left) representatives of the Finnish EUREKA Chairmanship team: Kenneth Nyholm, Heikki Uusi Honko (Chairman), and Tom Warras.

Main technological trends

The main technological trends on the critical technological and societal issues that need to be addressed in the coming years are laid down in the CELTIC-NEXT Scope and Research Areas document, which is briefly summarised below.

Networking and Cloud enablers addressing and using technology from such research areas as cyber security, artificial intelligence, 5G and beyond, FinTech, big data, business analytics, and IoT are considered as important orientations to develop. A special focus of CELTIC-NEXT will be on applications and services serving vertical sectors such as content (video, gaming), e-health, smart cities, agriculture, mobility, energy, automotive, e-commerce, and industry/ manufacturing. Those verticals are equally important to advance, along with optimising and improving efficiency and reliability with the best end-to-end connectivity and security. The evolution of ICT services over the next period will be achieved via a partnership model where the vertical sectors collaborate in determining their ICT solutions. This will be a key focus of the CELTIC-NEXT end-to-end perspective.

Another key issue for CELTIC-NEXT will be to develop communications infrastructures and services that can adapt to the requirements of various business sectors. The needs of communications between vehicles are, for example, quite different from the needs for piloting electrical power in buildings and houses. The same applies to the virtual and immersive reality techniques that will become a critical element in the health and media/digital industry in the coming years. There will be many unique challenges behind innovative manufacturing processes that must be supported by one ubiquitous infrastructure. We expect that many of the CELTIC-NEXT projects will define and develop self-adaptable solutions, able to fit the needs of many different sectors and societal challenges. CELTIC-NEXT with its end-to-end approach is key for allowing the development of dedicated applications using the network with all the required features for a given economic sector.

Representatives from vertical sectors will be progressively invited to participate in the CELTIC-NEXT Industry Core Group to ensure the continuous cross-fertilisation of ideas. In parallel, the telecommunications industry shall exploit the full power of cross sectors technologies such as Artificial Intelligence and Big Data, to define and provide customised and smart solutions for the different economic sectors and the whole society.

First CELTIC-NEXT project

The official start date of CELTIC-NEXT will be the 1st of January 2019. The Spring Call will close in April 2019 – the precise date will be decided shortly after the editorial deadline of this newsletter. The label decisions will be known within 6 weeks after submission, and the first project will start in autumn 2019.

References

[1] CELTIC-NEXT White Paper – https://bscw.celticplus.eu/pub/bscw.cgi/d26025/CELTIC-NEXT-WhitePaper.pdf

[2] CELTIC-NEXT Scope and Research Areas document – https://bscw.celticplus.eu/pub/bscw.cgi/d27676/Celtic-Next-Scope-and-Research-Area.pdf

CELTIC Proposers Day in Madrid

On 26th September 2018, CELTIC and CDTI jointly organised a Proposers Day hosted by CDTI in Madrid. The goal was to help boost the participation of Spanish companies in CELTIC Projects. The Proposers Day provided information on funding opportunities and project topics. This time the focus was on Artificial Intelligence.

The Proposers Day was opened by Mrs Ángeles Valbuena, Head of Foreign Technology Action Programmes Department from CDTI, and by Mr Riza Durucasugil, Celtic-Plus Vice-Chair from Netas. They welcomed the 70 participants and explained why progress in the technology field of communications for the digital society is of critical importance for Spain and Europe. The Spanish contribution has an important place in the European activities of CELTIC.

Welcome by Mrs Ángeles Valbuena (right), CDTI, Head of Foreign Technology Action Programmes Department and Riza Durucasugil, Celtic Vice Chair from Netas,Turkey

Audience of the Proposers Day in the meeting room at CDT

Artificial Intelligence at Telefonica

Dr. Richard Benjamins, Telefónica's Data and AI Ambassador presented how Artificial Intelligence is changing the business of telecom operators. He explained that Telefonica is one of the most digitalised telecom operator in Europe. Artificial Intelligence helps the company to optimise the business internally and improves operations of business with the customers. It allows better predictions of communication behaviour and therefore allows to better meet the needs of their customers.

Dr. Richard Benjamins presenting the keynote speech about Artificial Intelligence

CELTIC-NEXT project framework in Spain, Germany and Sweden

Juana Sanchez from CDTI presented the Spanish involvement in CELTIC projects. Spanish companies are among the most active in Celtic during the period from 2012 to 2018. There is no other country that had more participation in CELTIC projects than Spain. The next speaker from CDTI, Emilio Iglesias, explained the funding mechanisms of Innoglobal Calls and the open calls from CDTI. CELTIC projects that will be submitted to the Celtic autumn call will be eligible to apply to the coming Innoglobal Call that will close on 5th December 2018.

Matthias Kuom from DLR explained the main focus of funding in Germany on new mega trends and the challenges for applying these trends in the ICT domain. The current main topics are production systems (Industry 4.0), energy systems for the future and social systems able to cope with demographic changes. Influencing and boosting the digital revolution is one of the top priorities of the German government.

Lars Gustafsson from VINNOVA introduced the current main challenges in Sweden on Artificial Intelligence, digital security and the investment in competences and education. He explained that the EUREKA Clusters are strategically important for the internationalisation of SME and Swedish industry. He also explained how the process for receiving funding in Sweden works.

Juana Sanchez and Emilio Iglesias explaining CELTIC projects at CDTI

Lars Gustafsson from VINNOVA

Matthias Kuom from DLR

José Tomás Romero, head of innovation department at AMETIC opened the panel on business impacts of CELTIC projects

Panellists (from left): Bruno Duval from Citypassenger, Antonio Cuadra Sanchez from INDRA, Jaime Ruiz from Nokia, Oscar Chabrera Villarreal from Vilynx, and Reijo Savola from FTT

Panel on business impacts of CELTIC projects

José Tomás Romero from AMETIC opened and guided through the panel session. Bruno Duval from CityPassenger (a France SME) presented the results of the CELTIC projects ODSI and SENDATE-TANDEM both working in the Security domain. The project allowed developing a new security concept "Network-as-a-dongle" that has already been implemented by a manufacturer. CityPassenger highlighted the commercial and technological advantages thanks to participating in these projects.

Reijo Savola from VTT presented the flagship project SENDATE, which is also working in the Security domain. Reijo reported the impressive result that the world's first safe 100G quantum transport over 2,800 km has been achieved in a trial of this project. In addition, a new world-record capacity of 400 Gb/s with single-photodiode reception has been achieved in this project.

Antonio Cuadra Sanchez from INDRA presented the EUREKA Innovation Award winner, CELTIC project NOTTS – Next generation over-the-top multimedia services. The project was awarded due to its excellence in providing a scalable and robust video streaming solution to deliver adapted media content, with the guaranteed level of quality that customers expect and demand. Antonio explained why he and the projects partners are excited about the Business impacts that the project has generated.

Jaime Ruiz from Nokia presented the CELTIC project MONALIS focussing also on Video delivery technology that is the most bandwidth-hungry application. It is targeting QoE assessment and evaluation techniques for adaptive streaming. Jaime underlined that the optimum experience in terms of perception and delivery guarantee happens when the delivered format is the minimum required for a given display.

Oscar Chabrera Villarreal from Vilynx presented a series of very successful SME-led CELTIC projects commercializing e-health solutions. The last, the E3 project, only finished last summer. Very important in this project is that 4 hospitals are directly taking part in this project. Among many results in the course of the project the first live awake brain surgery retransmission at TELECOM Nancy and Nancy University Hospital has been realized thanks to the E3 project.

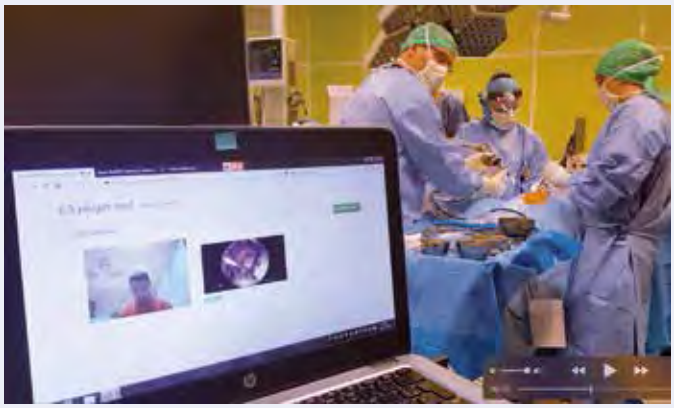
Project proposal pitches

Another core element of the Proposers Day was the pitching of project ideas. 8 proposers presented their ideas on a wide range of ICT topics. They included autonomous vehicles, traffic monitoring in cities 5G-related technologies, Artificial Intelligence, automotive telecoms, future service platforms, data sovereignty, and tourism services. The presentations led to productive discussions with the audience. Since then, two of these pitch presentations have already turned into project proposals in the CELTIC Autumn Call in October. The evaluation by the CELTIC Experts is currently progressing.

■ Further information
All presentations and project pitches are available at https://www.celticplus.eu/event/proposers-day-in-madrid-26-september-2018/

E3 – Successful business development of e-health services

Oscar Chabrera
ViLynx
oscar@vilynx.com



■ Further information
E3 project page – www.celticplus.eu/project-e3/ or please visit our website: https://medvc.eu/

Celtic-Plus project 'E-health services Everywhere and for Everybody' (E3) ended on 30th June 2018. After 42 months of research and development, it will take less than 24 months for the project to reach break-even and pay back the investment made by the partners reaching a ROI of 1.3X. This is due to expected annual recurrent revenue of 2.6 million euro.

E3 designed and implemented an end-to-end platform able to allow everybody access to e-health services everywhere, exploiting and extending the results of Celtic-Plus project HIPERMED and testing the developments in 15 healthcare scenarios (professional to professional, professional to patient and patient to patient) validated by doctors and professors testing the platform results.

The E3 project is a cross-domain SME driven project involving 8 SMEs, 1 Industry firm, and 3 universities. E3 has proved that international cooperation encourage by EUREKA and Celtic-Plus is a must – not only to join the necessary expertise to master the project, but also to ease cross-partner and cross-country exploitation of the project results or even to help other partners exploit the developed solutions.

The international cooperation in E3 has allowed us to get the inputs from the medical system of 5 different countries – Spain, Finland, France, Poland and Turkey. This facilitated tuning the solutions to match the e-health sector needs in a broader scope. In addition, the collaboration with external self-funded potential final users – 6 SMEs and 4 hospitals and medical institutions – has proven to be the right approach for going to market faster, as solutions are tailored to end-user needs.

The E3 project has also fostered the medVC company (see Celtic-Plus Newsletter 1-2018), a Polish spin-off commercializing video assistance systems for both doctors and hospitals, establishing medVC as a transmission platform for the European Surgery Association and deploying the solution in 15 clinics.

UL (Université de Lorraine) adapted the video encoding to the specificity and constraints of the medical world, both in terms of visual quality of the compressed videos and compression ratio thresholds. UL has developed an original method of data hiding to produce smart videos by carrying more information within a compressed video stream without generating any additional payload in terms of bit rate or degradation in visual perception. A patent is in progress and a start-up company is under construction with the support of Lorraine incubator.

VESTEL, a Turkish manufacturer is fostering Android-based STB, HDTV and mobile phones by offering E3 applications by default as they are easy to use and accessible everywhere where the other partners' solutions can be sold.

Finnish SME SENIORSOME SENEScreen NO touch User Interface is allowing elderly to use voice to manage the healthcare platform allowing seniors to interact without having to understand how the system works as people voice commands and controls the system.

Spanish SME IDI EIKON medical WebRTC provides low-cost advanced healthcare services, which are currently on sale at both Spanish and Latin-American hospitals.

Institut Mines Télécom has put forward the living lab methodology and the co-design concept. IMT, thanks to E3, was able to increase the expertise and skills of the living lab PROMETEE, especially with the development of a methodology to measure satisfaction of scenarios' participants.

The face2face solution by Spanish SME CALBOQUER provides health support to over 10 million users.

Turkish SME SoSoft has launched the E3 nurse-patient monitoring system at home, where the patient's vitals are collected via a wearable bracelet and processed to determine his/her health status (normal or emergent). The system also interacts with the patient verbally in case of anomalies such as unconsciousness.

VITEC, a French medical devices provider, plans to integrate E3 solutions in their hardware and software medical products enhancing product competitiveness.

Finnish SME eHOIVA offers an HR planning and management solution for healthcare professionals, which has improved efficiency in healthcare processes, provided digital signing for patients and ensured accurate healthcare data on patient home visits and shortened invoicing processes as well as allowed activity tracking.

The ViLynx ML technology has been adapted to iOS, Android and Roku TV and deployed for media customers in both US and Europe. This helped ViLynx to be included by Gartner as "Cool Vendors in AI for Media and Entertainment". The ViLynx AI-powered platform uses unsupervised learning techniques to provide solutions for the creation of automatic trailers, automatic video editing, content generation, semantic search, recommendations, personalization and insight analytics from day one, without the requirements of specific datasets opening a new world of possibilities for taking advantage of eHealth databases.

Dr. Gallet, ENT surgeon at Nancy University Hospital, said: "The E3 project was used to organise an international course between France and Canada. The E3 solution was stable, user-friendly, with a remarkable audio and video quality, despite low speed networks". He added: "We used the E3 solution to carry out surgical coaching during live surgeries: this tool opens new perspectives in surgical education."

A new paradigm in digital asset management

Innovative DAM solution by Perfect Memory based on Celtic-Plus results

Steny Solitude
Perfect Memory
steny.solitude@perfect-memory.com

The DAM-as-a-Brain concept

Perfect Memory is a French SME which has created an innovative digital asset management (DAM) solution based on results by Celtic-Plus projects MediaMap and MediaMap+. Perfect Memory has designed a semantic micro-services platform called DAM-as-a-Brain to collect and interpret data and make them actionable for business. The platform collects any kind of content from any source, maps it into the organisation's living business vocabulary and provides intuitive and contextualized access to any authorised user.

Organisations need to cope with the increase of internal and external connections between users, data sources and business channels. It increases the volume of data generated by organisations' activities. To be understandable and actionable, this big data must be normalised, refined and exposed to the users through one unique access point. It cannot be done with any DAM that relies on the principle of closed, not IP-compliant, and non-agile database.

Providing the organisation with a DAM that can help to improve the customers' privacy and the business workflow requires building the DAM upon a semantic micro-service architecture where the number of connected services is scalable and the capability of process content in volume is guaranteed.

The DAM-as-a-Brain merges the best of DAM, BPM and semantic processing and machine learning. It provides a business-centric data governance to simplify the user experience and to enable flexible monitoring of business workflows in an open information system.

Google, Apple, Facebook, Amazon and Microsoft (GAFAM) have demonstrated how strategic it can be to let the ecosystem work for one's organisation. The DAM-as-a-Brain implements this paradigm shift; it:

- makes any content and data accessible by the users
- makes the DAM customizable using organisation's business rules
- lets the organisations connect to its ecosystem
- makes the IT as agile as the organisation's data model

As a consequence, it improves the organisation's capability to evolve with the market needs.

Conclusion

Perfect Memory has delivered its DAM-as-a-Brain solution to Broadcasters like RTL, Radio France, and Eurovision Media Services.

Today Perfect Memory is extending its market to retailers and we are at the heart of the project of the French intelligence platform with ATOS as our first integrator.

Perfect Memory's DAM-as-a-Brain is a product to:

- generate new business opportunities
- collaborate seamlessly between business lines and IT
- accelerate workflows matching business needs
- provide dedicated business lines tools to streamline content exploitation
- enrich and offer a more intuitive UX Experience vs. existing systems

DAM-as-a-Brain is the direct result of two ambitious Celtic projects: MediaMap and MediaMap+ Plus which included the following consortium partners: Radio France, RTBF, SGT, Compiègne University of Technology, Limecraft, VRT, Belgavox, Memnon Exalead, and Vitec.

- Further information

Perfect Memory website – www.perfect-memory.com
MediaMap – www.celticplus.eu/project-mediamap-2/
MediaMap+ – www.celticplus.eu/project-mediamap/

Celtic-Plus Smart Connected World

www.celticplus.eu

About Celtic-Plus

Celtic-Plus is an industry-driven European research initiative to define, perform and finance through public and private funding common research projects in the area of telecommunications, new media, future Internet, and applications & services focusing on a new "Smart Connected World" paradigm. Celtic-Plus is a EUREKA ICT cluster and belongs to the inter-governmental EUREKA network. Celtic-Plus is open to any type of company covering the Celtic-Plus research areas, large industry as well as small companies or universities and research organisations. Even companies outside the EUREKA countries may get some possibilities to join a Celtic-Plus project under certain conditions.

Slicing and orchestration in a service-oriented RAN architecture

Navid Nikaein
Communication System
Department, Eurecom
navid.nikaein@eurecom.fr

Chia-Yu Chang
Communication System
Department, Eurecom
chia-yu.chang@eurecom.fr

Radio access network (RAN) slicing is one of the key enablers to realize the service-oriented 5G vision and deliver RAN-as-a-service. Specifically, four foundation pillars are required for the RAN slicing, i.e., network slicing, end-to-end (E2E) service orientation, RAN sharing, and software-defined RAN (SD-RAN).

To dynamically manage and orchestrate diverse slices [1], a multi-service execution environment is required to enable on-the-fly virtualization of RANs on top of the same physical RAN infrastructure, each customized and programmed as per slice requirements. Such an execution environment is necessary to support heterogeneous underlying RAN infrastructures, e.g., monolithic base station (BS) or disaggregated entities such as radio unit (RU), distributed unit (DU) and centralized unit (CU) with flexible functional split in between [2].

Furthermore, to support a number of services in a flexible and customized manner, both softwarization and virtualization techniques shall be applied, in which the former can decouple network functions from the underlying hardware, while the latter can instantiate several customized network functions over a common infrastructure. Via leveraging the aforementioned three key technologies, a slice can be flexibly customized to satisfy the requirements of E2E services with different levels of isolation and sharing.

Most recently, the network slicing concept has been highlighted to enhance service optimization and support multi-tenancy via the means of customization and isolation. 3GPP studies are also conducted to address the challenges of E2E network slice management and orchestration in TR28.801, and highlight the RAN slicing aspect in TR38.801. Regarding the network orchestration, the ETSI MANO architectural framework is realized in several open source implementations to management and orchestration network slices, such as OSM, OPNFV, M-CORD, and JoX.

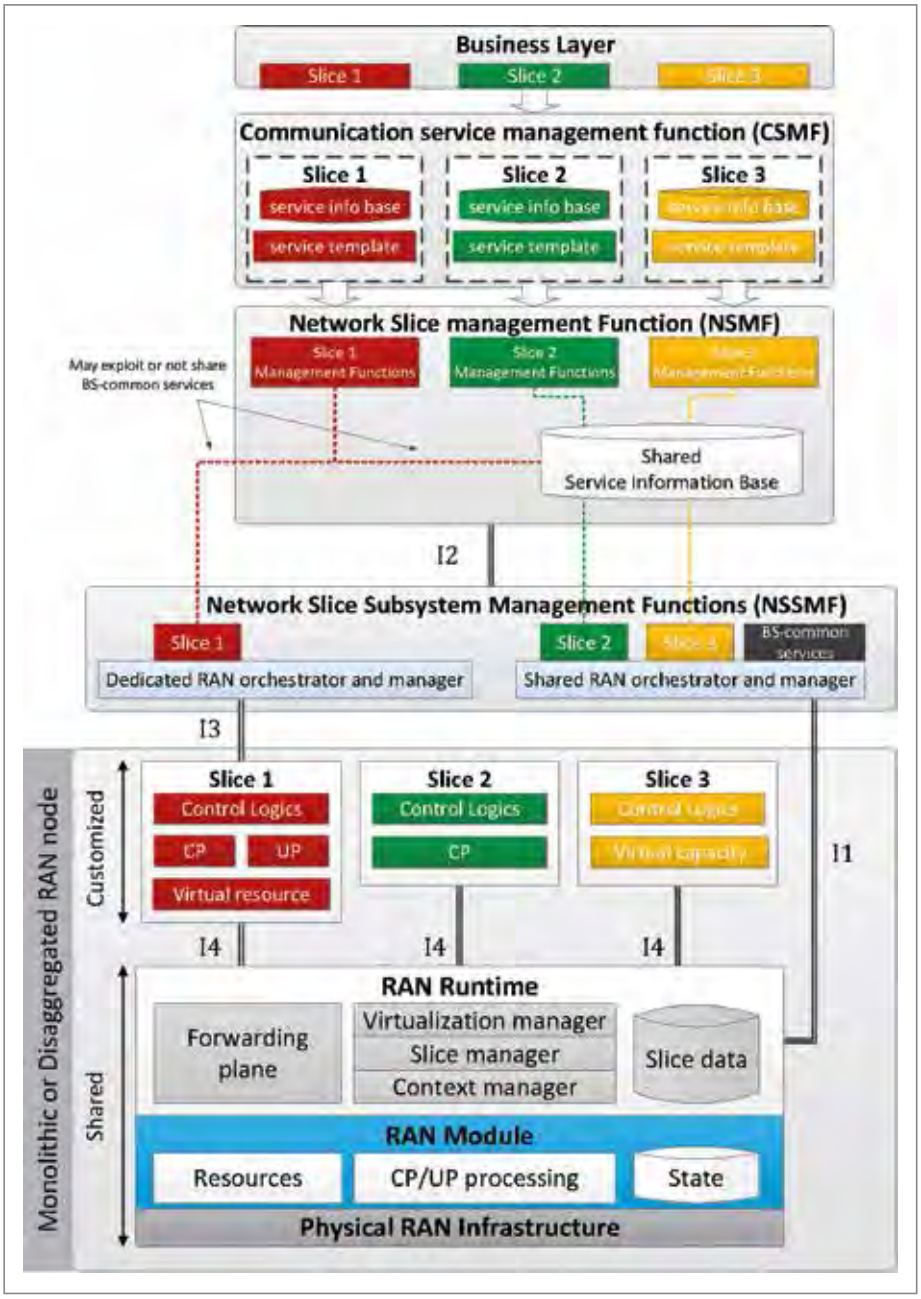


Figure 1: RAN slicing runtime system architecture

Nevertheless, RAN slicing remains challenging in providing different levels of isolation and sharing in terms of resource and state, while enabling slice orchestration for multi-service disaggregated RAN infrastructures. This calls for a unified and flexible execution environment to run multiple virtualized RAN instances with the required levels of customization over the monolithic or disaggregated RAN. To this end, a RAN runtime slicing system is proposed [3].

RAN slicing runtime system

The RAN slicing architecture is shown in Figure 1. The RAN runtime is the core component through

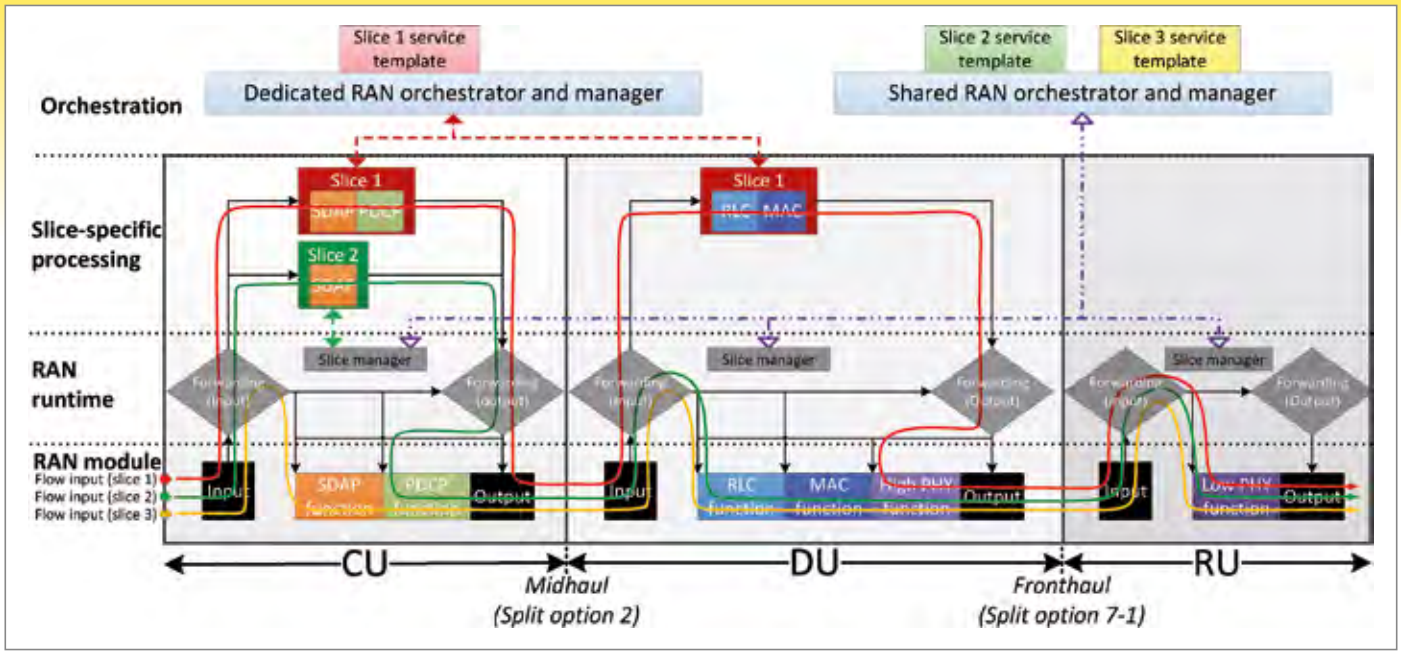


Figure 2: An example of multi-service chaining in disaggregated RAN

which each slice interacts with the underlying RAN module to access resources and states, and controls the underlying RAN behaviors.

RAN runtime

Within the RAN runtime, four services are provided: (a) slice manager, (b) virtualization manager, (c) context manager, and (d) common control applications operating over a shared slice data. Slice data includes both slice context – e.g., basic information to instantiate a slice service like its identity, user context and their slice association – and module context – e.g., control plane [CP] and user plane [UP] state information, module primitives. They are used to customize and manage a slice in terms of the required resources, states, processing, and users. Slice data can be transferred or shared among different runtime instances dynamically due to the user and network dynamics, e.g., user handover and/or RAN service template change when updating the functional splits.

Based on the slice service template and slice context, the slice manager determines the CP/UP processing chain for each slice and each traffic flow, and programs the forwarding plane allowing to direct the input and output streams across multiplexed processing operated by the underlying RAN module and customized processing performed by each slice. An E2E RAN service is operated by the slice manager in support of service continuity when the slice service template is updated. Furthermore, the slice manager is responsible for taking actions based on a set of policy rules when detecting any conflicts among multiple slices.

The virtualization manager provides the required level of isolation and sharing among slices. Specifically, it partitions resources and states, abstracts physical resources and states to/from the virtual ones, and reveals virtual resources and states to a slice, which are decoupled from the physical ones. Regarding resource aspects, it can rely on the two-level scheduler framework that abstracts physical resource blocks (PRBs) into either virtual resource blocks (vRBs) or virtual transport block (vTBs) to be scheduled by each individual slice customized scheduler. Once these virtualized resources are allocated, the virtualization manager will map the vRB/vTB allocation to the PRBs by considering the slice priority, service level agreement (SLA) and resource multiplexing capability.

The context manager performs CRUD operations – i.e., create, read, update, and delete – on both slice and module context. To create a slice context, it performs slice admission control based on the service template that defines the required processing, resources, and states. Upon admission control, module context is used to register (a) slice-specific life-cycle primitives to the slice manager, and (b) requested resources and/or performance to the virtualization manager.

The common control applications provide shared control logic for multiple slices. It can accommodate the customized control logic from different slice-specific control applications, resolve their conflicts, and enforce a feasible policy to the underlying RAN module.

Slice orchestration

To facilitate slice orchestration and management, four interfaces (I1 to I4) are provided between the RAN runtime and the communication service management function (CSMF), network slice management function (NSMF) and network slice subnet management function (NSSMF) defined by 3GPP in TR 28.801.

The I1 interface serves several purposes. Firstly, information about the activated services and capabilities of runtime are exposed through this interface. Secondly, it serves the service registration to RAN runtime during slice creation based on the service template. Thirdly, monitoring and feedback messages are retrieved to facilitate slice coordination and service template update.

The I2 interface is between the NSMF and NSSMF. A need for dedicated service orchestration and management is highlighted to enable applying slice-specific life-cycle primitives, self-maintaining service continuity and isolation, and allowing for control logic being applied for slice-specific applications, e.g., slice-dependent load balancing.

The I3 interface is between the dedicated service management and corresponding slice at the RAN node through which a slice owner can customize service monitoring and management as per slice needs. Furthermore, it is used by the slice manager to indicate any changes in the underlying RAN infrastructure and/or RAN module allowing the dedicated service management for adaptation.

The I4 interface provides communication channels between slices and RAN runtime allowing each slice as a separate process, whether being local or remote. Hence, each slice is executed in isolation, either at host or guest level, leveraging OS and virtualization technologies like container or virtual machine.

Multi-service chaining

A slice service chain can be split between disaggregated RAN entities according to the applied functional split. Such a chain can be composed horizontally based on the multiplexed functions provided by the underlying RAN modules, and/or vertically when customized CP/UP processing is required for tailoring to service requirements. The overall service chain of each slice is composed by the forwarding plane in RAN runtime, which can leverage the SDN-based match-action abstractions to build slice forwarding input and output paths across multiplexed and customized functions. An example of a disaggregated RAN with different levels of customization in the downlink direction is shown in Figure 2. Note that slice-specific function customization is described in the service template, and the customized forwarding path of each slice is managed by the RAN runtime in coordination with the slice orchestrator.

Examples of RAN slicing

We present three different slices, shown in Figure 1, and each slice maintains its service information base (SIB) and service template. Several information items can be retrieved through SIB: SLA, user information, user to slice association, and service inventory. The service template contains tangible per-slice requirements through the CSMF functionality. Using this template, the NSMF prepares network service instances, in which each slice is orchestrated and managed in shared or dedicated NSSMF at RAN-domain.

Take slice 1 as an example, it relies on a dedicated service orchestrator and manager such that the resulting slice is fully controlled by the slice owner with customized CP/UP processing and virtual resources. Slices 2 and 3 do not request such customization, and thus their services are managed through a shared RAN-domain service orchestrator based on the information stored in a shared SIB.

Further information

For more information, please visit www.5g-picture-project.eu and slicenet.eu, respectively. A 3GPP- compatible RAN slicing and service orchestration architecture is provided exploiting RAN runtime to enable a multi-service execution environment in the 5G disaggregated RAN architecture. Under the 5G-PPP research programme, the SLICENET project is exploring further challenges. For more information, please visit www.slicenet.eu.

References

[1] IMT-2020 Deliverables, ITU-T Focus Group, 2017.
[2] C.-Y. Chang, N. Nikaein, O. Arouk, K. Katsalis, A. Ksentini, T. Turletti, and K. Samdanis, "Slice orchestration for multi-service disaggregated ultra-dense RANs," IEEE Communications Magazine, vol. 56, no. 8, pp. 70–77, Aug. 2018.
[3] C.-Y. Chang and N. Nikaein, "RAN runtime slicing system for flexible and dynamic service execution environment," IEEE Access, vol. 6, pp. 34018–34042, 2018.

5G end-to-end facilities

Facilitating 5G trials with vertical sector industries

Uwe Herzog
Eurescom
herzog@eurescom.eu

The first set of 5G standards specifications has been released by 3GPP this year. This provides the basis for starting trials with standards-compliant 5G equipment. Besides verifying compliance with the specifications, it is essential to validate whether 5G end-to-end connectivity meets the requirements of vertical sector industries, both in terms of technological and business aspects. Three EC funded projects have started in July 2018, providing 5G end-to-end facilities that are mainly intended for this purpose.

Unlike in previous generations of mobile communication systems, the usability of 5G systems in vertical sector industries and meeting their specific requirements has been an objective of 5G systems design from the outset. This could give a new push to an otherwise rather saturated market – at least in Europe – and would be thus of benefit for the whole mobile communications industry.

On the other hand, also vertical sector industries could largely benefit from 5G, whether it would be, e.g., for making production or logistics more efficient or enabling new type of products, services or applications. However, each industry has its own specific needs and requirements that 5G systems will have to meet in order to be applicable. 5G systems have been designed and standardised taking such requirements into consideration. It is now time to verify with interested partners from vertical sectors, whether 5G actually does meet their requirements, and also to validate whether the use of 5G is viable from a business perspective of the verticals.

EC call for 5G end-to-end facilities

In order to facilitate trials with vertical industries, the European Commission has called for proposals for consortia providing 5G end-to-end facilities that will be offered for such experimentation. According to the ICT-17-2018 "5G End to End Facility" call text, "the challenges consist in providing an end to end facility that can i) demonstrate that the key 5G PPP network KPIs can be met; ii) be validated and accessed and used by vertical industries to set up research trials of innovative use cases, to further validate core 5G KPIs in the context of concurrent usages by multiple users.

Three project proposals have been awarded and kicked off in July this year: 5G EVE, 5G-VINNI and 5GENESIS. Their goal is to prepare extensive validation platforms for verticals use cases. The main users of their platforms will be the projects that will be awarded in the ICT-19-2019 Call on "Advanced 5G validation trials across multiple vertical industries". These projects are requested to implement their trials preferably over the 5G end-to-end platforms developed under ICT-17-2018. Given the available budget of 90 million euro, about 6 to 9 projects can be expected.

5G EVE

The first of the three ICT-17 projects that will provide 5G end-to-end facilities is 5G EVE. It is coor-

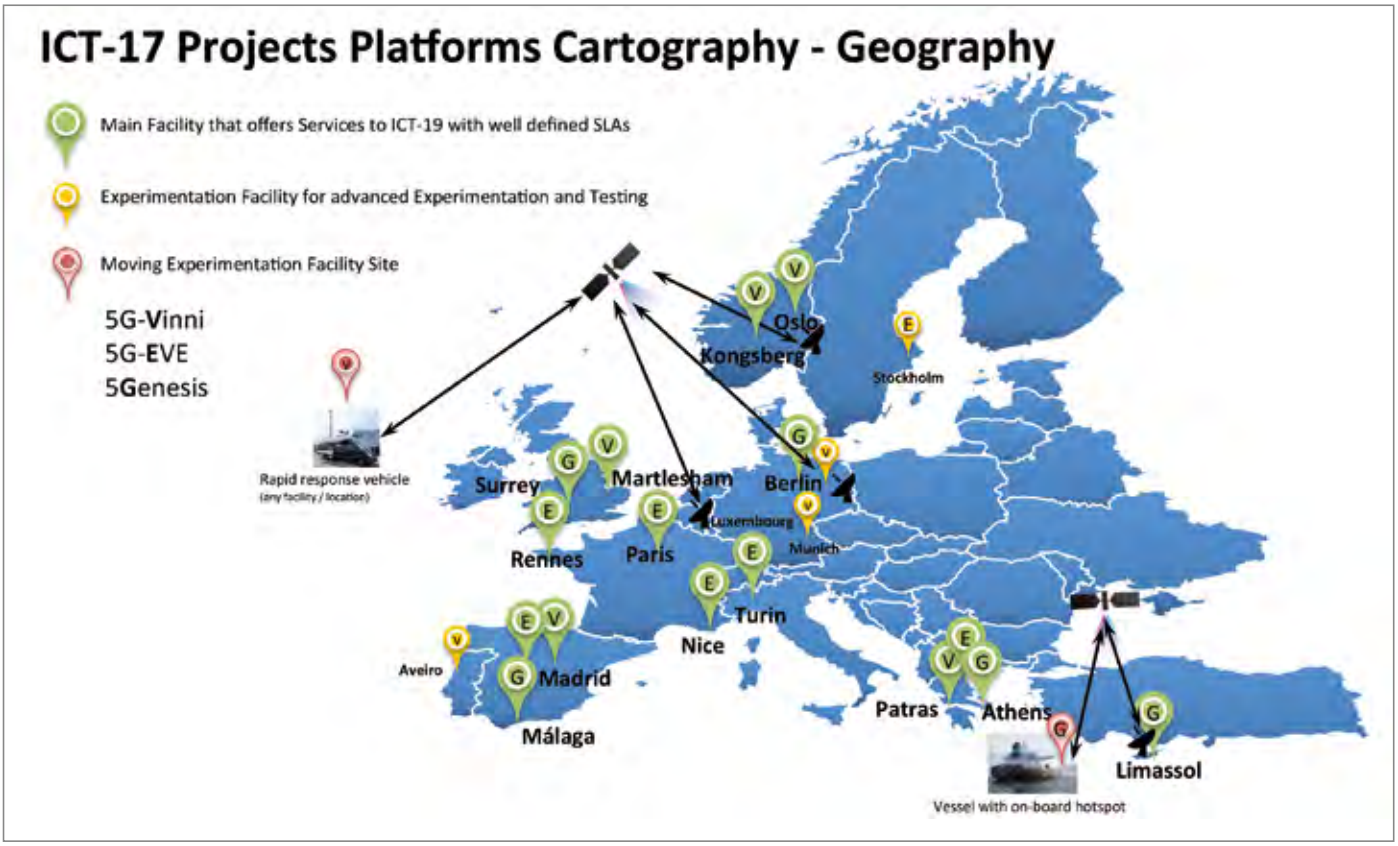


Figure 1: Overview of facility sites offered by the three ICT-17 projects (graphic courtesy of 5G-VINNI)

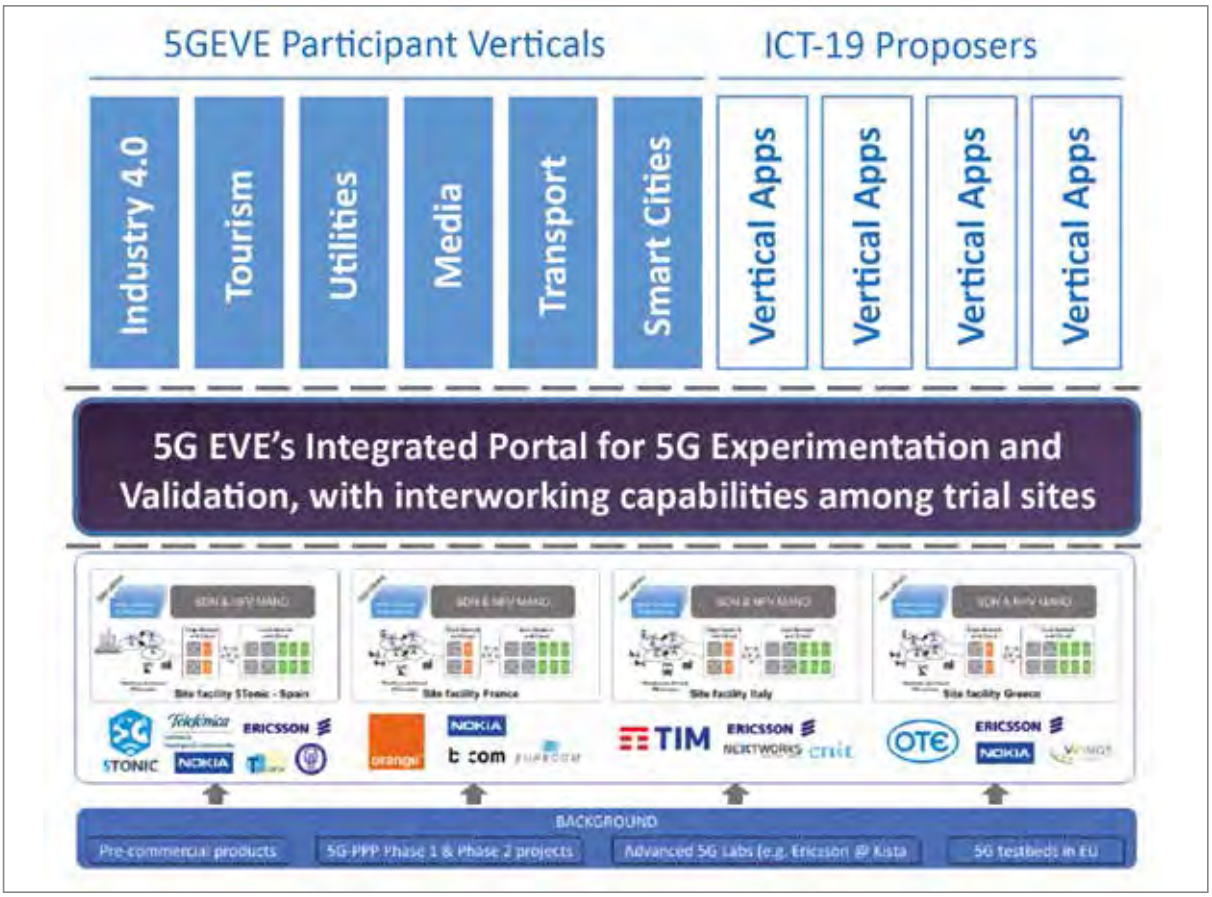


Figure 2: Helicopter view of the 5G EVE concept

dinated by TIM and has 28 partners in total. The project goal is to build an operational abstraction of the facility sites that provide vertical industries with a single operational interface towards the 5G end-to-end facility. 5G EVE will provide the means for experimenting with eMBB, mMTC and URLLC services, with access technologies, backhaul/fronthaul, Mobile Edge Computing, core network, slicing and orchestration.

5G EVE will interconnect its four existing European sites to form a unique 5G end to end facility, which will be offered to the vertical industries for pilots' execution and validation. The four sites are in Greece (Athens, provided by OTE), Spain (Leganés, provided by Telefónica), France (Nice, Paris and Rennes, provided by Orange) and Italy (Turin, provided by TIM).

In terms of standards compliance, initially 3GPP Rel. 15 will be offered, which will be upgraded to Rel. 16 after release of the standard.

The schedule is that by May 2019 the specification and planning will be completed and the deployment as well as a first round of tests will be started. The official testbed release is planned for January 2020. Upgrades to the testbed are planned every 6 months until project end in June 2021.

Further information is available at https://www.5g-eve.eu/.

5G-VINNI

The overall goal of 5G-VINNI is to build an open large-scale 5G end-to-end facility which can demonstrate that key 5G network KPIs can be met, and which can be validated, accessed and used by vertical industries (e.g. in ICT-19 projects) to test use cases and validate 5G KPIs. 5G-VINNI is coordinated by Telenor and there are 23 consortium partners. The duration is 3 years.

In more detail, 5G-VINNI has the following 6 key objectives:

- Design an advanced and accessible 5G end to end facility for verticals and ICT-19.
- Build several interworking sites of the 5G-VINNI end to end facility.
- Provide user friendly zero-touch orchestration, operations and management systems for the 5G-VINNI facility.
- Validate the 5G KPIs and support the execution of E2E trial of vertical use cases for ICT-19 projects.
- Develop a viable business and ecosystem model to support the life of the 5G-VNNI facility during and beyond the span of the project for verticals and ICT-19.
- Demonstrate the value of 5G solutions to the 5G community

5G-VINNI has 4 main facility sites in Norway (Oslo, Kongsberg), UK (Martlesham), Spain (Leganés) and Greece (Patras). There are 3 further Experimentation Facility sites that provide environments for advanced focused experimentation and testing possibilities which are in Portugal (Aveiro), Germany (Berlin) and Germany (Munich). In addition, there is a Moving Experimentation Facility site in the form of a satellite connected vehicle.

Similar to 5G EVE, 5G-VINNI will offer a wide range of 5G capabilities for trials, including 5G New Radio, 5G Core, NFV Infrastructure and Orchestration, Multi-Access Edge Computing, Network Slicing etc. For example, Network Slice as a Service will be offered for eMBB, URLLC and mMTC.

Timewise, a detailed service offer with SLA and an onboarding roadmap will be provided on 1 July 2019, and the facilities will be ready for ICT-19 project experimentation on 1 January 2020, same as for 5G EVE. Finally, the 5G-VINNI facility will be available until 1 July 2022. Terms and conditions for use after the 5G-VINNI project ends are still to be announced.

Further information at http://www.5g-vinni.eu/.

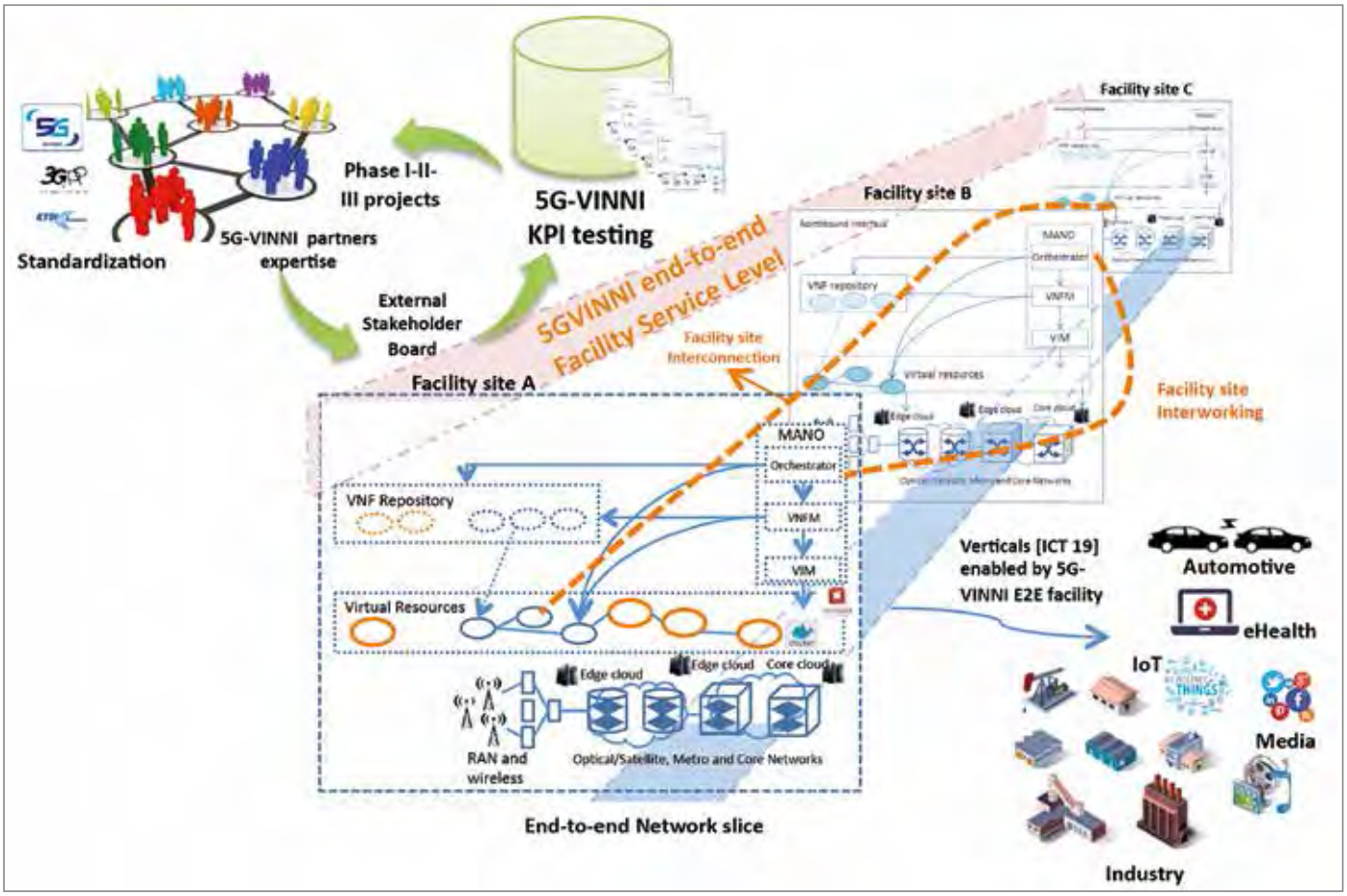


Figure 3: 5G-VINNI architecture

5GENESIS

The third of the three projects is 5GENESIS. It is coordinated by NCSR "Demokritos".

The 5GENESIS platform will emerge as the evolution of existing testbeds, already owned and operated by the 5GENESIS partners, suitable for large-scale field experimentation. It will be composed of the platforms in Athens (Demokritos Campus, COSMOTE testbed, Egaleo Football Stadium), Malaga (Univ. of Malaga, Telefonica Edge Computing, Malaga City), Limassol (combining terrestrial and satellite communications), Surrey (5GIC testbed) and Berlin (testbeds by Fraunhofer FOKUS, IHP, and Humboldt University).

While 5G EVE and 5G-VINNI will provide a single interface for the users of their facilities, each of the five platforms of 5GENESIS seems to act as an individual instance. As 5GENESIS explained at the ICT-19 info day in Brussels in September 2018, each of the five 5GENESIS platform owners acts as a single point of contact for the vertical user or experimenter of the local facility, and negotiates the terms of use as well as the compensation for the human and technical resources which will be employed for the support of the experiment. A management handbook has already been prepared directed towards ICT-19 proposers, i.e. the envisaged users of the facilities, and is publicly available for download from the project website.

Further information is available at www.5genesis.eu.

News in brief

Next EU research and innovation programme "Horizon Europe" is taking shape

In summer 2018, the European Commission presented its proposal for the next EU framework programme for research and innovation, which is called "Horizon Europe". The new programme for the Multiannual Financial Framework period 2021-2027 will succeed the current research and innovation programme Horizon 2020, which has officially still two more years to go, and even more until the last projects are closed. The Commission proposal contains initial information on research topics, funding and instruments, which are now under discussion at the European Parliament and the European Council.

Research topics

The Commission's "Proposal for a DECISION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on establishing the specific programme implementing Horizon Europe – the Framework Programme for Research and Innovation" was published on 7 June 2018. It provides, among others, an overview on what research topics at a high level are currently foreseen. Research on communication networks will be mainly included under Pillar II – 'Global Challenges and Industrial Competiveness', and there under cluster "Digital and Industry", which includes 9 areas of intervention. The most interesting area of intervention for networking research is 'Next Generation Internet' (NGI), where it says: "The Internet has become a key enabler of the digital transformation of all sectors of our economy and society. The EU needs to take the lead in driving the next generation Internet towards a human-centric ecosystem in line with our social and ethical values." The topic is then structured into three parts:

- An infrastructure part – "Technologies and systems for trusted and energy-efficient smart network and service infrastructures (connectivity beyond 5G, software defined infrastructures, Internet of things, cloud infrastructures, cognitive clouds)". The research should likely follow a roadmap-based approach.
- A services part – "Next Generation Internet applications and services for consumers, industry and society building on trust, interoperability, better user control of data ...". These services will use the infrastructure of the above bullet. The research will be rather bottom up and not a roadmap based approach.
- And finally, research on technologies that can apply to both previous bullets – "distributed ledger technologies, working in highly distributed environments, facilitating data mapping and data transfer across hybrid infrastructures with inherent data protection, embedding artificial intelligence, data analytics, security and control".

The **draft rules for participation** reveal details on the implementation of Horizon Europe. For example, in Horizon Europe, the award criteria will be excellence, impact, and quality and efficiency of the implementation. These are the same criteria as for previous research and innovation programmes.

Partnership options

The draft rules also foresee again the option for setting up European Partnerships in Horizon Europe, as the PPPs have been in Horizon 2020. Three forms of partnerships are currently described. One of those is in the form of a contractual arrangement similar to the PPPs in Horizon 2020 but is now called "Co-programmed European Partnerships". Another form would be research and innovation programmes undertaken jointly by the EU and several Member States – called "Institutionalised European Partnerships" – according to articles 185 or 187 of the Treaty on the Functioning of the European Union (TFEU), such as Joint Undertakings.

From experience in previous programmes, Joint Undertakings (JU) seem more complex, e.g. for their setup, which can only be initiated by national governments and Member States (under Article 185 TFEU), and regarding the overall administration and decision making in the JU. Furthermore, the EC funding rate is only at 30 %, because additional funding is expected from other sources. This might bring along another disadvantage which is the potential lack of synchronisation of funding decisions between the EU and involved Member States. It may result in some partners of an approved project not receiving funding from their Member State. In Co-programmed European Partnerships an overall higher funding is expected.

Funding volume

The budget figures in the EU Commission proposal are currently given only on the higher levels of clusters. For Pillar II 'Global Challenges and Industrial Competitiveness', 52.7 billion euro are planned for the period 2021-2027, of which 15 billion euro are planned for the cluster 'Digital and Industry', in which NGI is one of the 9 areas of intervention. On an overall level, however, a budget increase from Horizon 2020 to Horizon Europe is expected, as the proposed Horizon Europe budget of 94.1 billion euro is a significant increase compared to the overall Horizon 2020 budget of 77 billion euro. This expectation is based on the assumption that the negotiations between Commission, European Parliament and Member States do not result in significant overall budget cuts.

Further information at:
https://ec.europa.eu/info/designing-next-research-and-innovation-framework-programme/what-shapes-next-framework-programme_en

Regulation on free flow of non-personal data adopted

On 4 October 2018, the European Parliament adopted a Regulation on the free flow of non-personal data, which was proposed by the European Commission in September 2017. The Regulation aims at removing obstacles to the free movement of non-personal data. The Regulation is expected to enter into force by the end of 2018. Once formally adopted, Member States will have 6 months to apply the new rules.

The Regulation on the free flow of non-personal data has no impact on the application of the General Data Protection Regulation (GDPR), as it does not cover personal data. However, the EC's intention is that the two Regulations will function together to enable the free flow of any data – personal and non-personal – thus creating a single European space for data.

The EC expects that the new rules will amplify the growth of Europe's data economy by enabling European start-ups and SMEs to create new services through cross-border data innovation. The EC estimates that this could lead to an increase of the EU's GDP by 4%, or €739 billion, until 2020.

Further information at:
https://ec.europa.eu/digital-single-market/en/news/proposal-regulation-european-parliament-and-council-framework-free-flow-non-personal-data

Wi-Fi Alliance® introduces new naming system for Wi-Fi generations

In October 2018, Wi-Fi Alliance® presented Wi-Fi 6 as part of a new naming approach. Wi-Fi 6 is the industry designation by Wi-Fi Alliance for products and networks that support the next generation of Wi-Fi®, based on 802.11ax technology.

The intention of the new naming system is to provide users with an easy-to-understand designation for the Wi-Fi technology supported and used by their device. The new names will replace the naming system based on the cryptic names of IEEE standards groups.

The new naming system identifies Wi-Fi generations by a numerical sequence which corresponds to major advancements in Wi-Fi. The generation names can be used by product vendors to identify the latest Wi-Fi technology a device supports, by OS vendors to identify the generation of Wi-Fi connection between a device and network, and by service providers to identify the capabilities of a Wi-Fi network to their customers. The generational terminology may also be used to designate previous Wi-Fi generations, such as 802.11n or 802.11ac.

The numerical sequence is defined as follows: Wi-Fi 6 identifies devices that support 802.11ax technology; Wi-Fi 5 identifies devices that support 802.11ac technology; Wi-Fi 4 identifies devices that support 802.11n technology. According to Wi-Fi Alliance®, industry adoption of the new terminology will help users better understand the experience they can expect.

In addition to describing the capabilities of the device, device manufacturers or OS vendors can incorporate the generational terminology in User Interface (UI) visuals to indicate the current type of Wi-Fi connection. The UI visual will adjust as a device moves between Wi-Fi networks so users have real-time awareness of their device connection. Beginning with Wi-Fi 6, Wi-Fi Alliance certification programmes based on major IEEE 802.11 releases will use a generational Wi-Fi name. Wi-Fi CERTIFIED 6™ certification is coming in 2019.

Further information at:
https://www.wi-fi.org/wi-fi-6

Digital shrink

How Artificial Intelligence is entering psychotherapy

Milon Gupta
Eurescom
gupta@eurescom.eu

Artificial Intelligence is changing the world of work as we knew it. People of all kinds of professions, from lawyers and journalists to financial analysts and telemarketers, are affected by the invasion of Artificial Intelligence in their realms. Until recently, professionals in areas requiring a high degree of human empathy may have felt quite safe from the impact of AI on their jobs. That was yesterday. Now, even psychotherapists are getting competition from clever algorithms.

An increasing number of AI-powered chatbots has entered the grey zone between life coaching and psychotherapy providing support to people with mental issues like stress or depression. The promise of digital counsellors like HelloJoy and Tess is to be available whenever a person in mental distress needs someone to talk to.

Woebot

One of the latest and most ambitious digital shrinks on the market is Woebot. The team who developed the Woebot smartphone app consists of psychologists with clinical experience from Stanford University. Their self-proclaimed mission is "to make mental health radically accessible to everyone", as they say on their website [1]. They claim that Woebot can reduce symptoms associated with anxiety and depression in just two weeks. Unlike the creators of other therapeutic chatbots they support their claims with clinical research.

The dialogue approach used by Woebot is based on cognitive-behavioural therapy (CBT), a psychotherapy method that aims to improve mental health by challenging and changing unhelpful thoughts and behaviours. CBT has been used by trained psychotherapists to treat anxiety and depression by supporting patients in reframing their negative thoughts and beliefs.

Woebot and other chatbots using CBT like Wysa [2] mimic the emotionally intelligent behaviour of a trained coach or therapist through AI-based learning, which aims to constantly improve

the quality of questions and observations offered to the user.

Advantages of chatbots

It could be argued that AI-powered chatbots are a poor surrogate for a trained professional. Depending on the mental condition of the user, relying on a chatbot alone could even be more harmful than helpful. Most developers of such apps are aware of the limitations and risks, which is why many of them have an inbuilt function that directs users to a human counsellor or therapist, if they need more help.

At the same time, the developers of such digital helpers claim also a number of advantages. A chatbot is always available, whenever the user needs it, unlike a human therapist. Furthermore, chatbots are cheap compared to the fees of a professional counsellor, which could be a factor in countries where people are not sufficiently covered by health insurance.

In a number of countries and regions, there is a mismatch between the number of psychotherapists and the growing number of people with mental health issues. There is also a widespread lack of awareness and acceptance of mental health issues. Take India, for example: a study conducted by the Word Health Organization (WHO) in 2015 found out that one in five Indians, equivalent to 200 million people, may suffer from depression in their lifetime. Due to the stigma associated with mental illness, a lack of awareness, and limited access to professional help, only 10-12% of these sufferers will seek help. Widespread access to mobile phones and the availability of therapeutic apps could change this.

The problem of access to professional help is particularly acute in war situations. In the course of the civil war in Syria, for example, over one million Syrian refugees fled to Lebanon. One-fifth of them suffered from mental health disorders, according to the WHO. This was the situation, when in 2016 Karim entered the scene. Karim is an Arabic-speaking chatbot designed by US-based startup X2AI. They partnered with an aid organisation to bring Karim to aid workers and refugees in a refugee camp in Lebanon.

What it means for the future of healthcare

The advent of therapeutic chatbots is an interesting case of what happens, when Artificial Intelligence enters a professional field. It appears that psychotherapists are not yet at risk of having to queue at the local employment centre. The number of people temporarily or permanently affected by mental disorders is rising. The WHO estimates that globally, an estimated 300 million people are affected by depression alone, not to speak of other disorders. According to the WHO's Mental Health Atlas, the median number of mental health workers worldwide is 9 per 100,000 population. However, there is extreme variation, ranging from below 1 per 100,000 population in low-income countries to over 50 in high-income countries.

This means that especially in emerging and developing countries, therapeutic apps might be the best chance for many less affluent people with mental disorders to get access to psychotherapy at all. That is, if they have a disorder, like depression, which is suitable for AI-based therapy at all – for many mental disorders, AI-based conversations would be of not much use. Thus, psychotherapy appears to be a sector, where Artificial Intelligence doesn't kill highly paid jobs. AI rather improves the level of healthcare services while at the same time offering the prospect of reducing the cost per patient.

References

[[1] Woebot website – https://woebot.io
[2] Wysa website – https://www.wysa.io
[3] WHO Mental Health Atlas 2014 – apps.who.int/iris/bitstream/10665/178879/1/9789241565011_eng.pdf

Imprint

Eurescom message, winter issue 2018
ISSN 1618-5196 (print edition)
ISSN 1618-520X (Internet edition)

Editors:
Milon Gupta (editor-in-chief), Anastasius Gavras, Uwe Herzog

Submissions are welcome, including proposals for articles and complete articles, but we reserve the right to edit.
If you would like to contribute, or send any comments, please contact:
Eurescom message
Wieblinger Weg 19/4
69123 Heidelberg, Germany
Phone: +49 6221 989-0
Fax: +49 6221 989-209
E-mail: message@eurescom.eu

Advertising:
Luitgard Hauer
phone: +49 6221 989-405, e-mail: hauer@eurescom.eu
Eurescom message is published twice a year.
Eurescom message on the Web: http://www.eurescom.eu/message

Data Protection Declaration:
https://www.eurescom.eu/data-protection-declaration.html

EuresTools

The Top Choice for Horizon 2020

Effective Tools for Successful Projects

EuresTools is a comprehensive suite of Cloud-based software tools which facilitate controlling and reporting and enable project teams to communicate and manage information effectively. Over 200 successful European research projects and initiatives have already benefited from **EuresTools**.

Contact us at **services@eurescom.eu** to get further information.

http://www.eurescom.eu/EuresTools

EURESCOM

European Institute for Research
and Strategic Studies
in Telecommunications GmbH
Wieblinger Weg 19/4
69123 Heidelberg, Germany
Phone: +49 6221 989-0
Fax: +49 6221 989 209
E-mail: info@eurescom.eu
Website: www.eurescom.eu

Innovation through Collaboration

Eurescom is the leading organisation for managing collaborative R&D in telecommunications. Our mission is to provide efficient management and support of R&D projects, programmes, and initiatives for our customers. We offer more than two decades of experience in managing large-scale, international R&D for major industry players, the European Commission, and EUREKA Cluster Celtic-Plus. What distinguishes Eurescom is the combination of a secure, reliable infrastructure for collaborative work, a large European network of experts, and internationally outstanding project management skills.

QR code to the online edition of Eurescom message