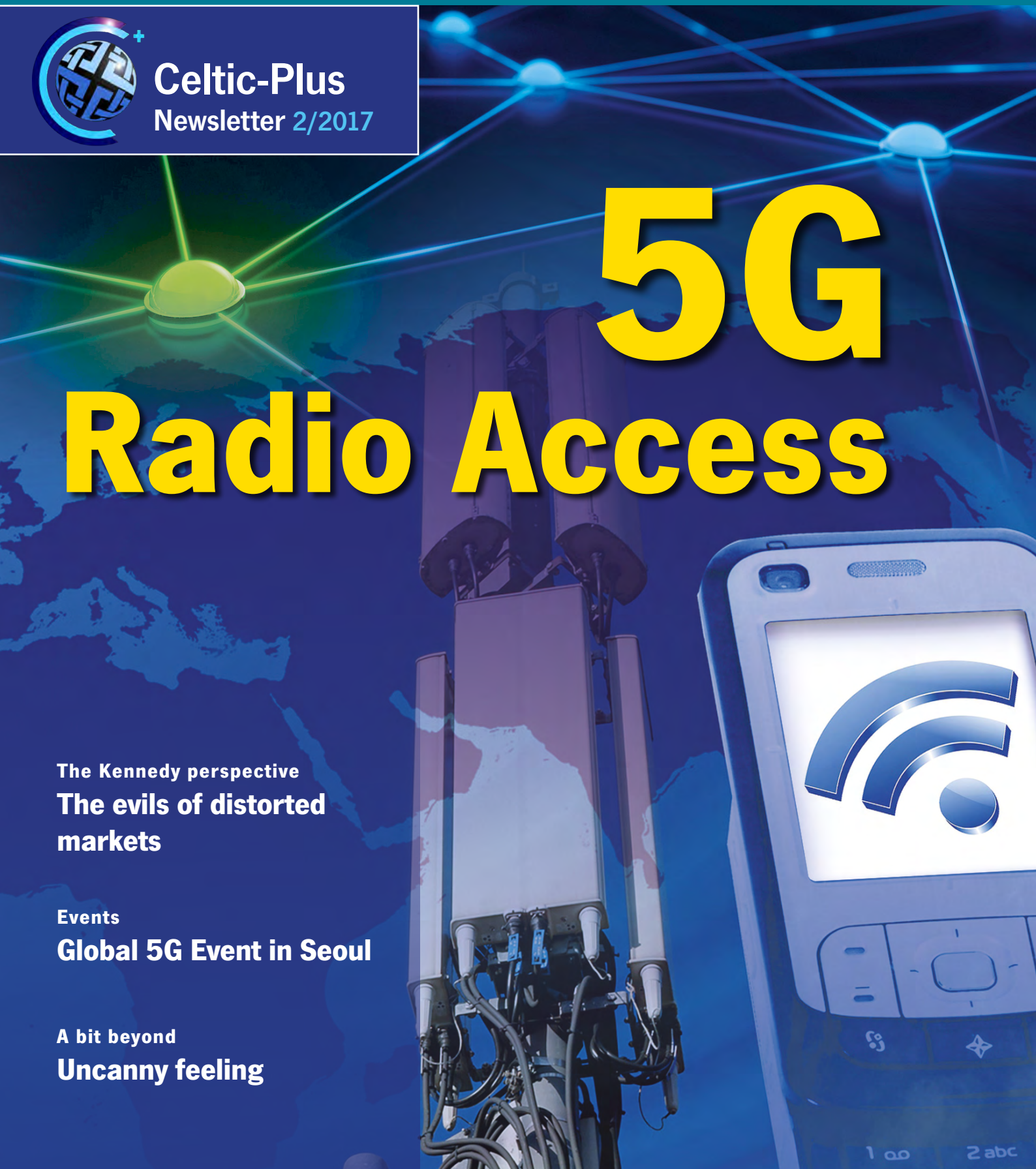
Winter 2017

EURESCOM message

The magazine for telecom insiders



Celtic-Plus
Newsletter 2/2017

5G Radio Access

The Kennedy perspective
The evils of distorted markets

Events
Global 5G Event in Seoul

A bit beyond
Uncanny feeling

Effective Network Management in 5G

SELFNET Industry Workshop | Heidelberg, Germany | 24 May 2018

Why network operators cannot afford to miss this workshop

If you are involved in network management either on the operator side or the vendor side, this workshop is for you. There are three main reasons why you cannot afford to miss this workshop:

- You will get **first-hand information on the innovative network** management framework developed by 5G-PPP project SELFNET.
- You will have a **chance to influence the offerings of SELFNET-based network management solutions.**
- You will have a unique opportunity to discuss with the developers of the network management framework and your peers the **challenges and solutions for effectively managing your network.**

Who will attend – Meet your peers from the telecoms industry

Our industry workshop is an invitation-only event. We would like to ensure that we have mainly business-oriented representatives from the telecoms industry in the room. This includes:

- Senior managers from innovation and operations departments at **network operators and service provider**s
- Senior managers from innovation and product development at **telecoms vendors**
- Representatives of the **relevant bodies** like the 5G Infrastructure Association and standards organisations like ETSI.

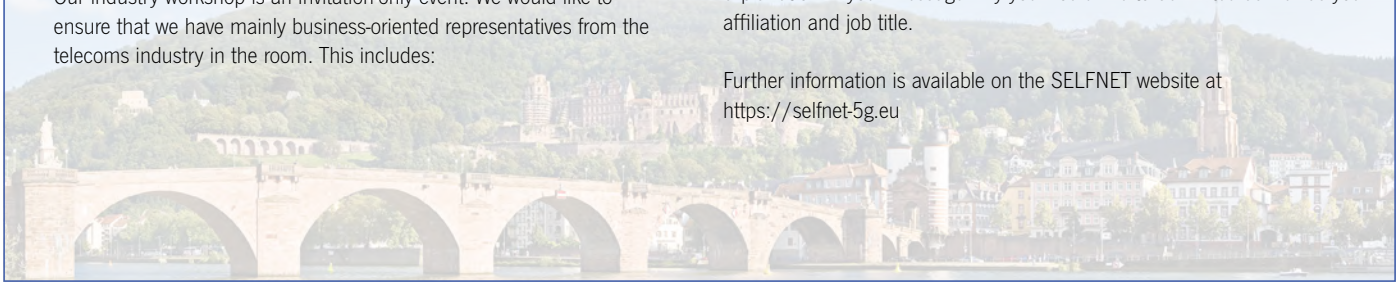
In order to make the interaction at the workshop effective, the audience size is limited to **60 participants.**

How to get an invitation, if you have not been invited yet

In order to register, you need an e-mail registration with the invitation link. Do you fit the profile of the telecoms industry audience we seek to gather? Haven't you been invited yet?

Then please contact us at **contact@selfnet-5g.eu** and provide a brief explanation in your message why you would like to be invited as well as your affiliation and job title.

Further information is available on the SELFNET website at https://selfnet-5g.eu



Join the Industry-Driven Research Programme for a Smart Connected World

Celtic-Plus Call for Project Proposals – Deadline: 23 April 2018

Do not miss the opportunity to participate in Celtic-Plus, the industry-driven European ICT and telecommunications research programme under the umbrella of EUREKA. Submission deadline for the next call for project proposals is 23 April 2018.

Celtic-Plus 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-Plus Public Authorities Website. Please talk to your national contact early in the process.

Easy proposal process

Preparing and submitting a Celtic-Plus project proposal is easy. Just register on the Celtic-Plus online proposal tool, fill in the Web forms, and upload your proposal in pdf. Access to the proposal tool and to a proposal template is available via our Call Information page (https://www.celticplus.eu/call-information).

Benefits of participating in Celtic-Plus

- 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-Plus 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 June 2018.

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

Contact:

Celtic-Plus Office
office@celticplus.eu

Peter Herrmann
herrmann@celticplus.eu

Celtic-Plus
Smart Connected World
www.celticplus.eu

Dear readers,

In the previous edition of Eurescom message, we featured 'Network Management in 5G' as our cover theme. And now we focus again on 5G: this time our cover theme is 5G Radio Access. The Eurescom message editorial team decided to select this topic, because there are significant advances happening in 5G Radio Access Network (RAN) technologies. In addition, we are close to the first larger-scale implementations of 5G which are announced for 2018, most prominently the 5G showcase at the upcoming Olympic Winter Games in Korea.

In this issue, we will present selected innovations in the area of 5G Radio Access that have been developed in Europe. In the first article of the cover theme, Eurescom message editor Uwe Herzog, who is also involved in two 5G-PPP projects, presents an overview on the status and challenges of 5G Radio Access. The next article presents results from 5G-PPP project 5G-NORMA on multi-service RAN customization. Another 5G-PPP project, SPEED-5G, and its approach to enhanced Dynamic Spectrum Access is featured in the following article.

Complementing these two project reports, we feature an exclusive interview with Terje Tjelta, former senior research scientist at Telenor, about the status and trends of 5G radio access from a European perspective. Concluding the cover theme, we present an article by Samsung on the results of 5G-PPP project mmMAGIC, which explored millimetre-wave based next generation mobile systems.

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 market distortions in his column "The Kennedy Perspective". See also our events section, which contains a report on the 4th Global 5G Event in Seoul, Korea. Finally, in the latest "A bit beyond" article you can learn about how computers recognise and respond to human emotions.

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, composing

EVENTS CALENDAR

26 February – 1 March 2018
Mobile World Congress 2018
Barcelona, Spain
https://www.mobileworldcongress.com

7 March 2018
Speed 5G Workshop
London, UK
https://speed-5g.eu

12 – 16 March 2018
CeBIT 2018
Hanover, Germany
http://www.cebit.de/en/

16 – 19 April 2018
Transport Research Arena (TRA 2018) – A Digital Era for Transport
Vienna, Austria
http://www.traconference.eu

16 – 17 May 2018
5th Global 5G Event (in conjunction with 5G North America)
Austin, TX, USA
https://tmt.knect365.com/5g-north-america/

24 May 2018
SELFNET Industry Workshop
Heidelberg, Germany
https://selfnet-5g.eu

24 – 25 May 2018
Celtic-Plus Event 2018 (to be co-located with Finnish EUREKA Event)
Finland
https://www.celticplus.eu

SNAPSHOT

Digital Human

Soul Machines, a start-up from New Zealand, has developed what they call Digital Humans. These AI-powered avatars, like the one on the photo, very much look like humans and are able of human-like facial expressions.

For further information see the website of Soul Machines at https://www.soulmachines.com and the 'A bit beyond' article in this issue of Eurescom message.

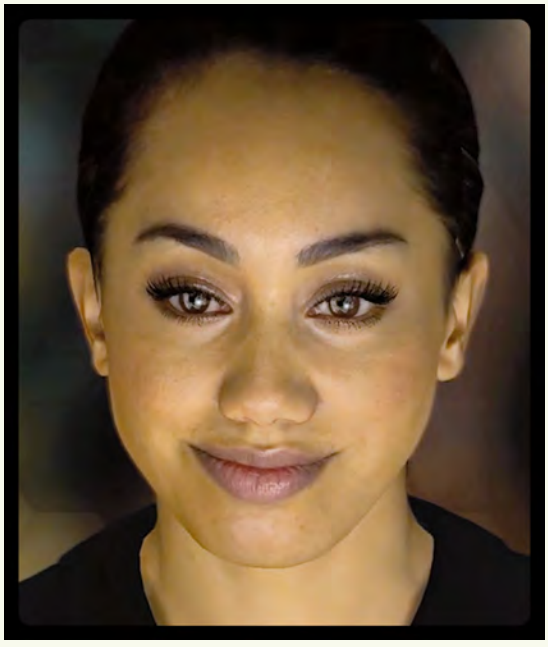


Photo source: Soul Machines - www.soulmachines.com

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The evils of distorted markets

David Kennedy
Eurescom
kennedy@eurescom.eu

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All our well-known marketing theory books are based on the principle that you create a need and then sell a solution to that need. The consumers pay for whatever gratification they get. This has worked from the simple cup of coffee to complex services for hundreds of years.

But times are changing. There are models emerging where the producer pays for the product to be on the market and the consumer can consume it for free. There is a recent trend in Horizon 2020 projects where the projects are encouraged to publish their papers under one or another open publishing model and this can cost a significant amount of money. This means that the publishers have the production costs of a book paid for before a single copy is sold. You can download the "book" or you can buy it. But if you buy it I don't think the authors benefit, unless they have a special contract with the publishers.

My concern with this is: who then pays the authors? This works as long as they are paid by research programmes where there is sufficient funding but it is only sustainable as long as there are research programmes. When the funding programme ends, then there is no business model and the system collapses.

Another example of this is the Horizon 2020 FIRE programme. FIRE (Future Internet Research and Experimentation) is an initiative launched and financed by the European Commission that has been growing since its inception in 2010 with the ambition of being Europe's Open Lab for Future Internet research, development and innovation. It has been successful in offering cutting edge test facilities, but the business model has been that other projects are paid to use the facility. The end result of this has been to distort the real marketplace where nobody will pay to use test facilities in the open market, if they are paid to use them in the FIRE initiative.

I fully accept that some projects need support to access test facilities. But then that should be in their budget, and they should "purchase" the facilities in a similar way to a real-world marketplace. The end effect of being paid to use facilities is that projects have used it to boost their budget rather than based on their absolute need of the facilities.

We are now facing the same scenario in the upcoming call for phase 3 of the 5G-PPP. We have a first call for infrastructure projects and a later call for application projects. The logic is that the application projects should employ the infrastructure provided by the first set of projects to demonstrate the advanced applications. What is not specified in the call is how this should work.

My opinion is that we should avoid repeating the distorting effect of the FIRE model and have a clear pseudo business relationship between the infrastructure projects and the application projects. The infrastructure projects should have an office where the application projects can request services and facilities, and a pro-forma agreement of the contractual arrangement should be prepared. This should also cover what happens when the infrastructure project ends and the application project wants to continue. The logic of this approach is to prepare for a sustainable model where an "Infrastructure as a Service" (IaaS) business would have a possibility to grow from the research programme and allow the eco systems developed within the programme to migrate to the real world.

But as the rock band Queen once sung: "Is this the real life or is this just fantasy?"

5G radio access innovation

An overview

Uwe Herzog
Eurescom
herzog@eurescom.eu

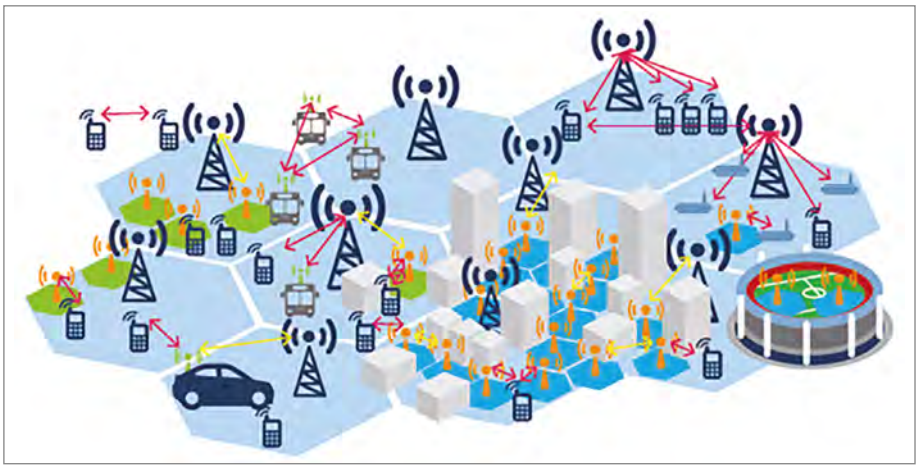


Illustration of the 5G RAN [1]

5G is the next generation mobile network. Thousands of researchers and engineers world-wide are currently busy with designing its concepts, specifying details and standardising them. One area of the mobile system where significant advances are expected is the 5G Radio Access Network (RAN).

The key innovations that 5G systems will bring about include, for example, very high data rates that are needed for enhanced mobile broadband services. Current discussions show that this feature seems to be of high interest in particular to operators in Asia, specifically in Korea and Japan, and they plan to exploit that during the Olympic Games in 2018 and 2020 in their countries.

Other innovations of 5G include very low latency for devices and enabling connectivity for a massive amount of devices in a certain area with target figures of one million devices per km^2. These are often discussed as the key 5G innovations. And indeed, they match well with the use cases agreed in 5G standardisation – enhanced mobile broadband, massive machine-type communications, and ultra-reliable low latency services. However, there are further characteristics that 5G systems will have to provide. Looking from the operators' perspective, there are requirements like, for example, low power consumption, support of ultra-low cost networks, cost efficiency with variable cost models, and flexibility for future evolutions, as I have seen in a presentation by Orange.

More than just higher bit rates

In the light of all these targets and ambitions, it becomes clear that 5G Radio will need to have more innovations than "just" enabling higher bitrates. Maybe it is the flexibility that will be the most important feature of 5G RAN. It will need to be able to integrate various radio technologies, from the novel radio technologies developed for 5G over previous generation LTE-Advanced and WiFi advanced solutions. 5G radio will be provided with spectrum from as low as 700 MHz up to mm-wave band and will have to manage with the varying propagation conditions and available channel bandwidths available. Power consumption is an important aspect if one considers that an IoT type sensor should manage to survive with limited energy over many years. There are voices in the 5G discussions which consider that there will be no need for a system beyond 5G, as 5G will be modular and flexible enough so that all future innovations can be done within 5G – which might be an interesting aspect for telecom operators as this could help to reduce future capital expenditure.

The question is: what could a flexible architecture for 5G RAN look like? 5G PPP Phase 1 project 5G-NORMA has developed the concept of a flexible architecture which fosters the support of diverse services with different requirements within a common network infrastructure (see article in this magazine).

5G trials

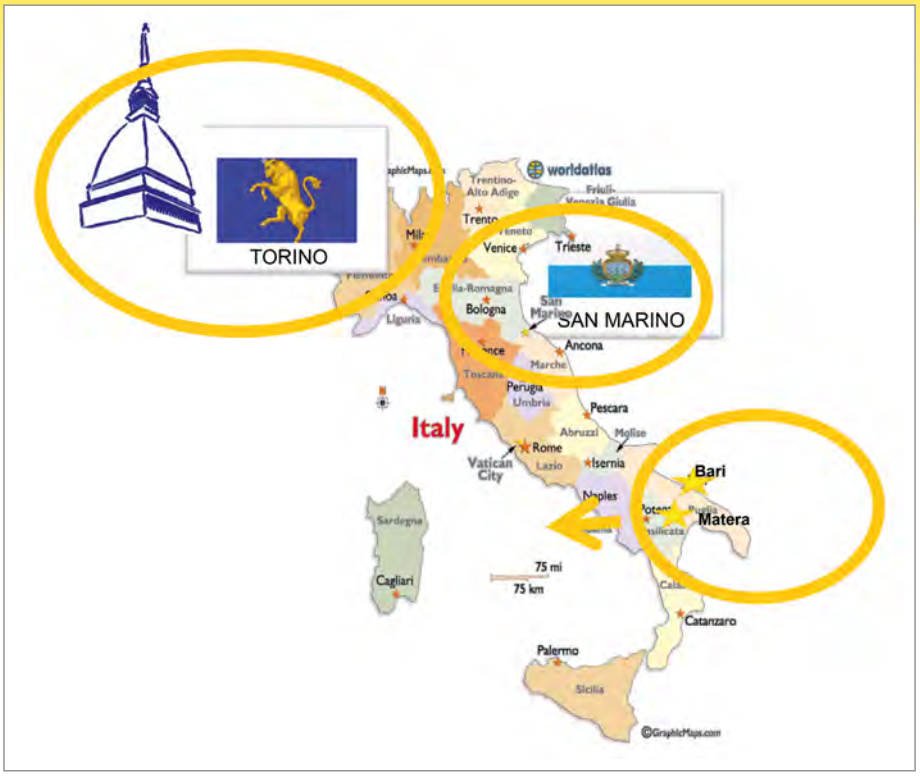
As the full 5G standard is planned to be released only at the end of 2019, the availability of 5G standard-compliant equipment and the large scale rollout is expected only from year 2020 onwards. However, a huge number of trials are planned to be performed before that and have actually already started. The European Commission has published a 5G Action Plan [2] to facilitate a coordinated approach for 5G deployments in order to keep Europe ahead in the 5G race. Every Member State should identify at least one major city to be "5G-enabled" by the end of 2020. Quite a number of announcements for deploying 5G in cities have already been made.

Plans for early 5G deployments in a few places in Italy and San Marino were already announced by Telecom Italia Mobile. More details have been released recently that show that these plans have well progressed. The deployments are planned for Torino, San Marino, Bari and Matera. Torino will be the first 5G city and the first live demos will already happen at the end of 2017 in Torino. The services tested will include e.g. public safety (use of wearable cams, sensors, drones), environment monitoring, Virtual Reality city tours with guides and remote monitoring and assistance to patients. San Marino will join in Q1/2018 and will then be the first European country having 5G! Bari will be one of the first 4.0 ports in Italy, allowing better management of logistics and transport, and for Matera, the 2019 European capital of culture, a 3D virtualisation and reconstruction of archaeological sites and museums trial will be deployed.

Advancing Europe in the 5G race

As mentioned above, the EC has published a 5G Action Plan in order to coordinate 5G activities in Europe. Europe has been leading 2G, which was a huge success, but other regions have caught up since then, and Europe was even lagging behind in LTE. The EC has therefore prepared the 5G Action Plan, following a number of events, surveys and industry consultations involving Commissioner Günther Oettinger and high-level industry representatives. The Plan calls all member states for a joint action to align roadmaps, make spectrum available, promote early deployment, and more.

A lesson learnt from LTE seems to be that early availability of spectrum directly correlates



Trials in Italy / San Marino (Source: TIM)

with fast market uptake. In 2015, the proportion of 4G/LTE subscriptions measured against the total population was 75% in the US, 82% in the Republic of Korea, 65% in Japan, and 28 % in the EU [3]. There is the view that this late uptake of LTE in Europe was due to a lack of coordinated approach, among others regarding the availability of spectrum for operators. For example, while auctions of the 700 MHz band have been held in US already in 2008, in Europe auctions of suitable bands were held only between 2010 and 2013. The EC's Action Plan is therefore an important activity to foster 5G and to try to regain European leadership.

Still work ahead

Even though first trials of 5G technologies are already commencing there is still quite an effort required to further advance, test and standardise 5G. To pick a few specific items from the author's personal view, more research seems to be needed in the areas of mm-wave, efficient use of spectrum, and slicing, which is a concept for increasing the use of infrastructure resources based on virtualisation. While some good work on exploring use of mm-waves has been done already in this exciting new area, there are less specific activities in collaborative research in Europe taking place on this topic at the moment.

While network virtualisation and slicing are very hot topics, there seems to be not enough progress, and the debate has not yet led to a clear definition and what a suitable granularity of a slice could be. Finally, given the target of 1000-fold increase of capacity, it will be difficult to achieve this with the available spectrum below 6 GHz, unless an extreme use of the small-cell concept or other technologies is employed. What seems needed are innovative models for efficient use of available spectrum, whether licensed, lightly-licensed, or unlicensed. 5G PPP Phase 1 project SPEED-5G has proposed an approach for increasing the available spectrum by a "demand-driven" and "situation-aware" spectrum access, breaking the technology and regulatory silos that are traditionally in place. Some more details of this concept are presented in another article in this magazine.

References

[1] Source: 5G PPP White Paper:"5G innovations for new business opportunities", https://5g-ppp.eu/wp-content/uploads/2017/03/5GPPP-brochure-final-web-MWC.pdf
[2] https://ec.europa.eu/digital-single-market/en/news/communication-5g-europe-action-plan-and-accompanying-staff-working-document
[3] Source: IDATE, figures for 2015

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Multi-service RAN customization

The 5G-NORMA approach

Diomidis S. Michalopoulos
Nokia Bell Labs, Germany
diomidis.michalopoulos@nokia-bell-labs.com

Mark Doll
Nokia Bell Labs, Germany
mark.doll@nokia-bell-labs.com

Peter Rost
Nokia Bell Labs, Germany
peter.m.rost@nokia-bell-labs.com

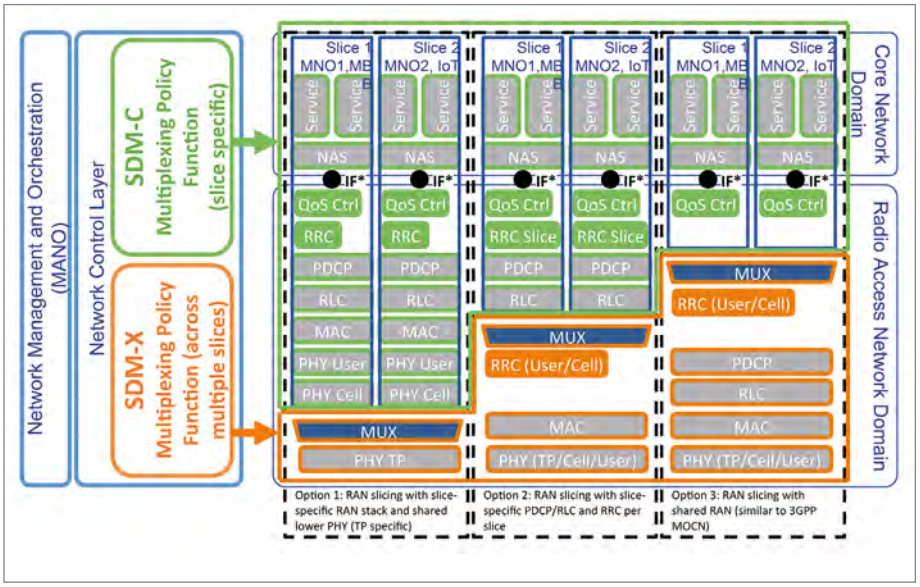


Figure 1: The three RAN slicing options considered

5G-NORMA is a 5G PPP Phase 1 project, which has developed the concept of a flexible 5G architecture. This architecture fosters the support of diverse services with different requirements within a common network infrastructure.

The principal concept behind this approach is the transition from a network of physical, hardware-based entities to a network of functions. This essentially means that the fundamental network operations are decoupled from the hardware elements: In conjunction with the network function virtualization concept, any network function is not bound to a given physical device as it traditionally was, but can rather be executed in any network element with processing availability.

The first step towards this envisioned flexible architecture is the decomposition of network functions. With reference to the RAN protocol stack, this implies that some network functionalities carried out in the RAN (radio access network) are detached from the protocol layers, as they traditionally are, and can thus be executed in cloud entities such as the edge cloud. This provides an increased level of flexibility of deployment that adapts to diverse services, because instead of introducing diverse parametrizations of a common virtual network function (VNF), different VNFs can be allocated to different services.

RAN slicing

Network function decomposition is conceptually in line with the notion of RAN slicing, i.e., the virtual partitioning of the RAN into logical networks. In fact, RAN slicing represents an attractive architectural approach particularly for implementing scenarios where services with diverse requirements co-exist in a limited geographical space, such as an industrial campus.

Depending on the extent of the shared infrastructure across different RAN slices, we distinguish three major slicing options, as depicted in figure 1. Specifically, the upper part of figure 1, included in the green frame, corresponds to the RAN part which is not shared between slices, whereas the lower part, included in the orange frame, illustrates the shared RAN part. Following the approach developed in the 5G-NORMA project, the slice-specific RAN part is controlled by a dedicated Software Defined Mobile Network Controller (SDM-C), whereas the shared part is controlled by the SDMC coordinator (SDM-X), which spans multiple slices. In all three slicing options, the co-existence of two slices is considered, corresponding to Mobile Network Operator (MNO) 1 and 2, respectively. Such MNOs carry out different services, corresponding for example to Mobile Broadband (MBB) and Internet-of-things (IoT), respectively.

The RAN slicing option 1 corresponds to a slice-specific RAN. That is, the protocol layer functionalities are separate for the slices involved, with the only exception of the lower part of the Physical layer (i.e., the physical transponder) which is shared. The main advantage of this option is its flexibility, since each slice can be customized across the entire protocol stack. However, this increases the complexity of implementation. The typical example of this slicing option is the common deployment of legacy technologies (such as 4G) and future technologies (such as 5G).

In RAN slicing option 2, the common RAN part, includes the entire PHY and MAC layers at the data plane as well as the RRC layer at the control plane. This allows for some level of flexibility, as slice-specific QoS prioritization is utilized, while reducing the overall complexity due to the multiplexing of the common part, providing a less complex alternative to option 1. Finally, RAN slicing option 3 corresponds to a slice-aware shared RAN, where the entire RAN deployment is shared by the involved MNOs.

RAN adaptation to slices

A major aspect of the flexible architecture developed in 5G-NORMA is the ability of network functions to be dynamically configured both in terms of functional operation and physical location. In fact, 5G-NORMA reveals a new dimension in network architecture where functions are extracted from a pool of resources and are used exactly

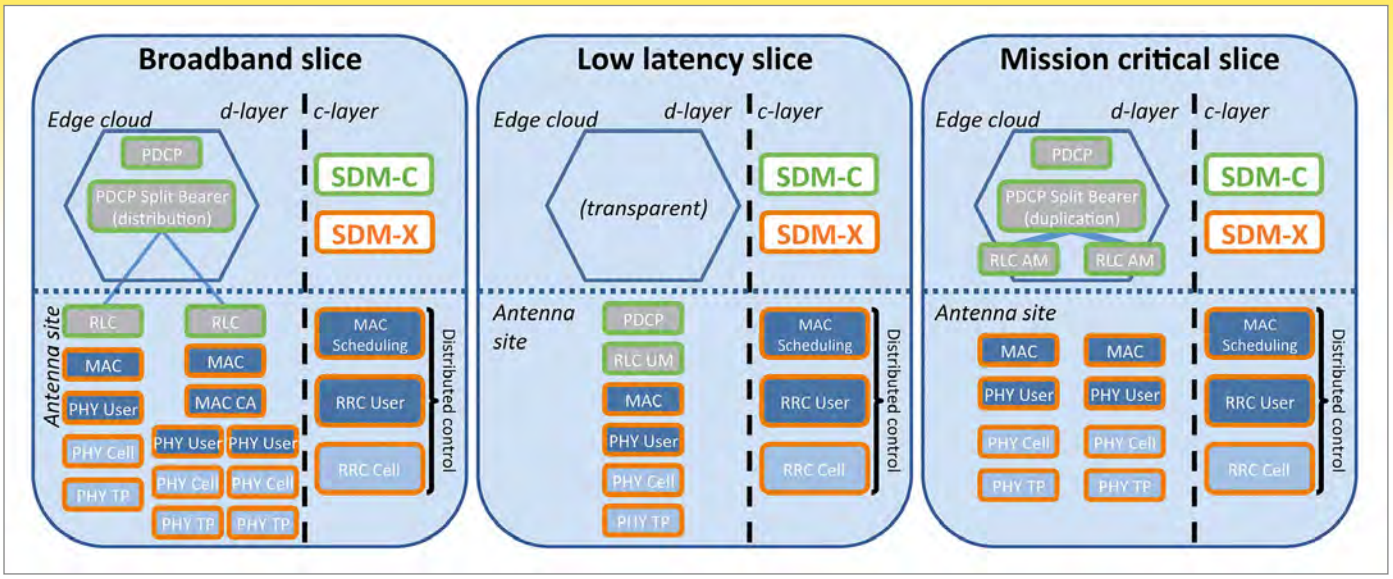


Figure 2: RAN slice adaptation – Function selection and placement

when and where they are needed. This implies that different slices are allocated different functions or function blocks. Two fundamental levels of flexible function allocation are distinguished: function selection and function placement, as illustrated in figure 2.

Depending on the slice requirements on throughput, latency, and reliability, a different set of network functions is used. For instance, for meeting the high demand of the broadband slice in terms of throughput, special network functionalities are deployed which are associated with the concept of multi-connectivity. As shown in the left part of figure 2, the PDCP layer is enhanced with an additional functionality (PDCP Split Bearer) which splits the information flow into two logical channels that are then combined at the UE. Similarly, the MAC layer can also be partially enhanced with the carrier aggregation functionality, depicted with MAC CA in figure 2, for further increase of the downlink throughput. Moreover, for facilitating multi-connectivity, the PDCP Split Bearer functionality is chosen to be placed in the edge cloud, whereas lower RAN functionalities are carried out at the antenna site in order to satisfy their real-time operation requirements.

Contrary to the broadband slice, the low latency and the mission critical slice are associated with requirements relevant to machine-type communications. Specifically, the low latency slice (c.f. figure 2, middle column) is usually associated with applications with small, bursty packets, where fast delivery is important, contrary to the achieved data rate. To this end, functions such as the PDCP Split Bearer and MAC CA are not included here, while the RLC layer is simplified to support only the unacknowledged mode of operation (RLC AM), accounting for a faster packet transmission. For the same reason, all network functionalities are placed at the antenna site, leaving the edge in a "transparent" mode of operation. As far as the mission-critical slice is concerned (c.f. figure 2, right column), the reliability level is of paramount importance. Consequently, an additional functionality is included in the PDCP layer, which is used for duplicating data across different antenna sites, exploiting macro diversity and thereby increasing the reliability. Similar to the broadband slice, such functionality is placed at the edge cloud, allowing for a centralized coordination of duplicated packets.

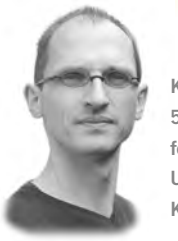
Conclusion

Flexible architecture designs facilitate the support of diverse services under a common infrastructure. The 5G-NORMA project develops an architecture framework that allows the RAN to be customized to the supported network slices. This is achieved by flexibly adapting the operation of network functions as well as the location where such functions are carried out.

Further information 5G-NORMA website – https://5g-ppp.eu/5g-norma

Enhanced Dynamic Spectrum Access

The Speed-5G approach to delivering data capacity



Klaus Moessner
5G Innovation Centre, Institute for Communication Systems, University of Surrey
K.Moessner@surrey.ac.uk

One of the major promises of 5G networks is to provide 1,000-fold capacity compared to current wireless and mobile broadband technologies. To be able to provide this huge capacity, we would need a significant increase in the available spectrum, if we were using traditional approaches. In particular, when looking at the sub 6 GHz spectrum bands, it is rather impossible to identify and allocate so much additional spectrum. SPEED-5G, a 5G PPP Phase 1 project, has been working to provide a solution for this challenge. The main concept is described below.

The options for increasing the available spectrum in these bands for mobile operators are rather limited. However, to meet the 1,000-fold increase target, a combination of additional spectrum, a more efficient air interface, as well as a more dynamic and flexible approach to share and access spectrum and radio resources will contribute to meeting this target. The SPEED-5G project concentrates on such new approaches to share, aggregate and dynamically allocate and access radio and spectrum resources, across the boundaries of individual air interface technologies, spectrum licensing regimes and individual spectrum ownership. To achieve higher capacity, the SPEED-5G approach facilitates and encourages "demand driven" and "situation aware" resource access, thus breaking the traditional technology and regulatory silos that are traditionally in place.

Breaking the technology silos

Looking at our radio environment, at least in urban and sub-urban areas there are constantly several different air interfaces active. However, considering the actual use, the duty cycles show typically heavy underuse of most of these systems. This goes back to the way radio systems and spectrum access are regulated but also to the technology differences between the various radio access systems used. The available air interfaces range from different generations of cellular technologies, to the whole range of general purpose wireless local area access, to specialised IoT air interfaces optimised for energy efficiency and typically supporting rather small bandwidths, as indicated in figure 1.

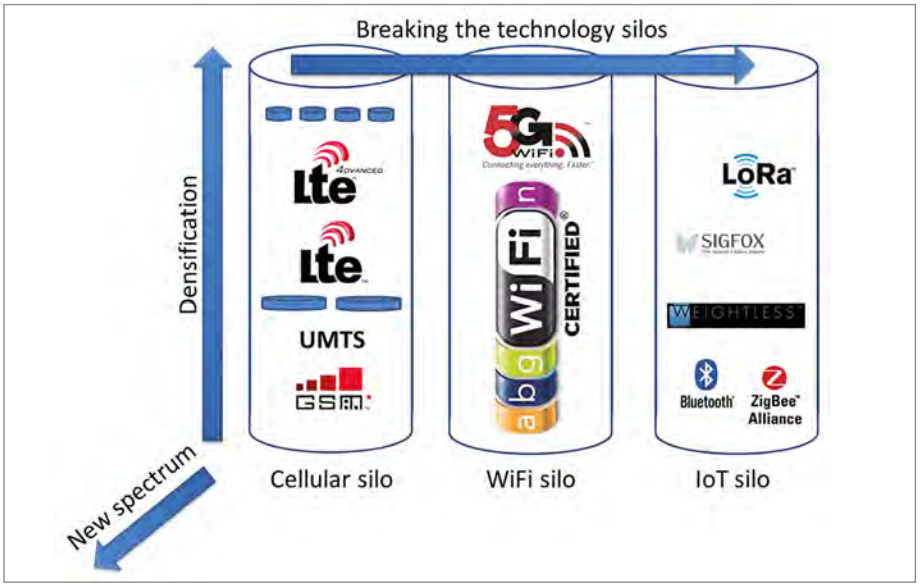


Figure 1: SPEED-5G concept for overcoming technology silos in 5G

These technologies and the rules under which they operate were defined using a rather rigid approach in terms of regulation, but also in the ways the radio resources were divided and shared between the different technologies, different operators and in the end different users.

Spectrum regulation started out following a command and control approach and has very much changed over the last decade to allow, with LSA (Licence Shared Access), LAA (Licence Assisted Access) and alike, a much more flexible and dynamic way to access spectrum. However the approach to run networks had not been changed to a similar extent, sharing and dynamic access are still the exception rather than the rule.

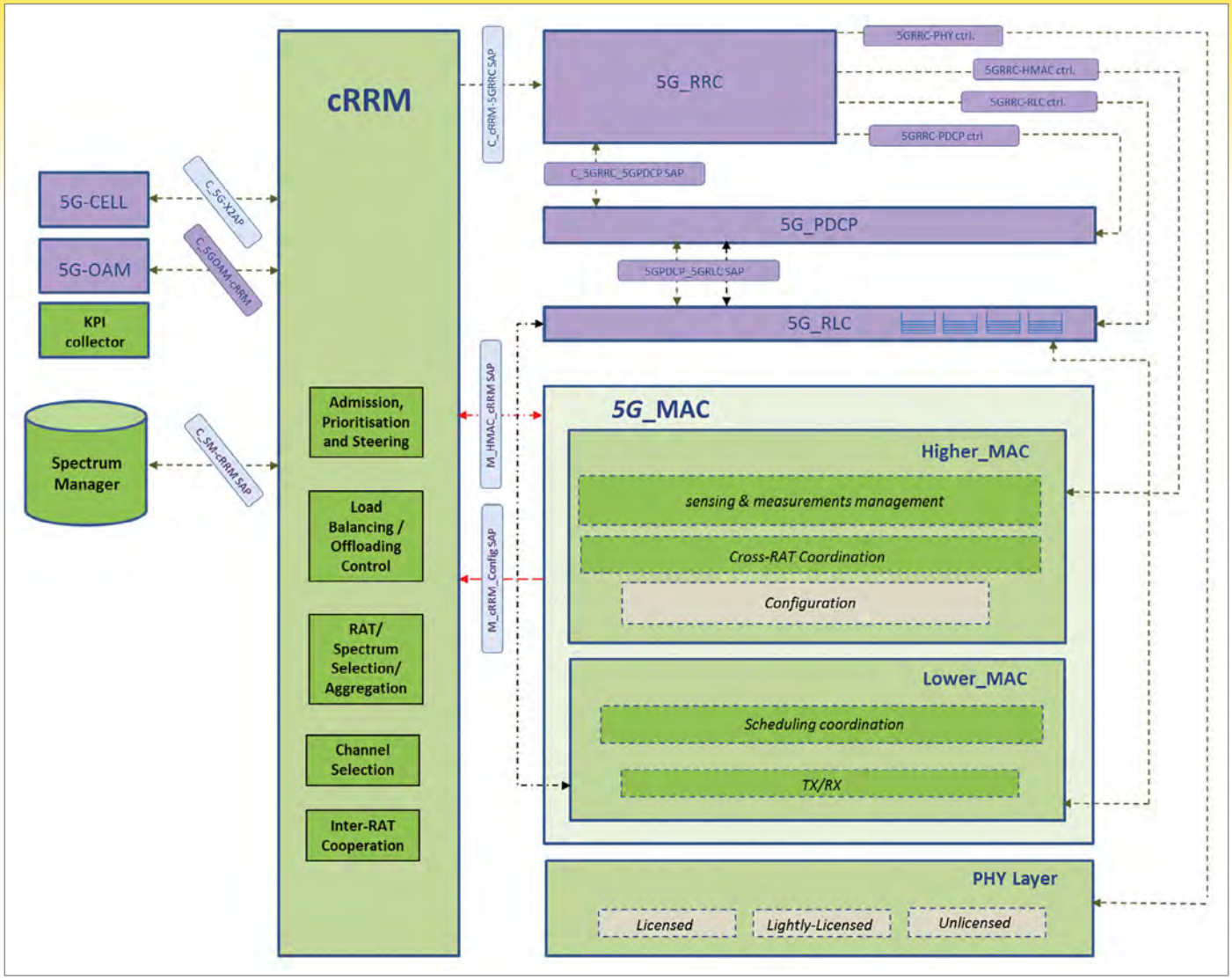
SPEED-5G started out asking the question of how new resource management techniques can operate across these existing application, technology and license regime silos.

A framework for enhanced Dynamic Spectrum Access

SPEED-5G focused on small cell deployments, their characteristics and the challenges this form of access network poses. The main issues are related to the very high numbers of (small) cells and how they can be managed using SON (Self-Organising Networking) mechanisms as well as the issue of how efficient spectrum use can be achieved in such deployments. To be able to satisfy the capacity requirements, we defined a framework that facilitates dynamic access of licensed, lightly licensed and licence exempt bands. At the same time, we investigated, as part of our algorithms, enhanced interference coordination that enables fair co-existence between the different users.

The overall design of our approach, the eDSA (enhanced Dynamic Spectrum Access) shown in Figure 2, is lean and scalable and provides a set of interfaces required to easily manage a high number of small cells, avoid signalling congestion, and improve the system efficiency. The main aspects of the architecture are different levels of hierarchy that address and introduce different levels of agility and flexibility. The Radio Resource Management (RRM) having one centralised and several distributed components deals with the longer term, slower changing conditions that need dynamic resource allocation. The MAC has been split into an upper MAC that also incorporates some of the more RRM related features such as measurements and sensing, and a lower MAC that is more access technology specific and implements the very short term access aspects.

The SPEED-5G eDSA can manage several RATs (radio access technologies) and offers an efficient means for offloading part of the traffic, considering various shared license regimes. The Radio Resource Management (RRM) part of eDSA has been defined comprising centralised and distributed functions as well as an adaptation layer that interfaces (southbound) with the upper



SPEED-5G's framework for enhanced Dynamic Spectrum Access (eDSA)

MAC layer, and (northbound) with OAM (Operations, administration and management), spectrum manager and KPI (Key Performance Indicator) collector. The eDSA approach has been defined and simulated. Features such as load balancing, dynamic resource access, and aggregation are being implemented in a series of proof of concept (POC) implementations.

Capacity gains

The framework has been tested against a range of scenarios using various algorithms; we have seen improvements that eDSA brings in all scenarios investigated. This includes scenarios ranging from efficient license-assisted access, load balancing across different systems and license regimes, context-aware resources, and co-primary sharing. In all these scenarios we have proven that the algorithms will significantly contribute to the increase in the overall capacity that can be provided.

Conclusion

Spectrum and radio resources will need to be dynamically managed to reach the goal of a 1,000-fold capacity increase that 5G systems promise. The SPEED-5G eDSA approach contributes to achieving this goal by providing a framework that includes an architecture but also a library of algorithms that facilitate efficiency gains through a more dynamic way of handling radio resources.

Further information eDSA and detailed performance results are available at http://www.speed-5g.eu

Europe at the forefront of 5G

Interview with Terje Tjelta about 5G radio access

Radio access is a key area for the successful implementation of 5G. Equal to its importance are the technical and regulatory challenges for implementing 5G radio access. Eurescom message editor-in-chief Milon Gupta asked Terje Tjelta, Associate Professor at the University of Oslo, Department of Technology Systems and former senior research scientist at Telenor, what progress has been made in tackling the challenges of 5G radio.

What are the main innovations of 5G radio access compared to 4G?

Tjelta: The promises of 5G are superior to 4G in many respects. They include significantly higher data rates, much larger gross capacity, and an ability to handle a large number of various types of terminals and things. This suggests that 5G-based innovation requires large capacity, for example to enable virtual reality or augmented reality capabilities, and new types of services for applications including machine type communication. With the ability to serve quite different use cases and types of terminals over the same radio interface, 5G will become a very interesting and cost-efficient technology for the future information society. One of the most important 5G features is being very well adapted to dynamically programmable software using the concept of network slicing. Finally, 5G will be much more effective with respect to power consumption.

What is the current status of 5G radio access technology, and what progress has been made?

Tjelta: With respect to radio access the main international standardisation organisation is the 3GPP. The standardisation work is heading towards a fully complete 5G standard by end of 2019. Currently two paths are followed: evolved LTE and new radio. There are also two phases defined, Phase 1 by June 2018 (Release 15), and Phase 2 by December 2019 (Release 16). In addition, there will be an early result of Phase 1 available in December 2017, including some features to the benefit of developing markets, which will not be a stand-alone solution, as it depends on 4G.

Professor Terje Tjelta

Which challenges remain to be addressed, before 5G radio access can be fully implemented in Europe?

Tjelta: 5G radio access must first become an internationally accepted standard before it will be rolled out on a larger scale. For the full 5G standard the timeline suggests from 2020 and beyond. However, the 5G labelling, may well happen before. It is not only a question of technology and agreements by international standardisation bodies, but also a question of business aspects. All business players will look for market share and the right time for investments in 5G. Some of the suggested use-case requirements will require a regulatory acceptance to deliver guaranteed link availabilities, rates, and latencies. The regulatory regimes must accept this type of specialised solutions.

What are the chances of achieving a global regulation on harmonised spectrum allocation for 5G in time for market rollout?

Tjelta: Clearly, spectrum will be made available suitable for 5G everywhere in world. With global harmonisation it is possible to provide services easier, as interference problems between countries can be reduced, and also the market for the actual 5G radio technology will become larger. If spectrum is made available in different bands, the equipment must be able to handle more radio frequency options, perhaps with poorer performance and cost efficiency. The frequency range 3.4 to 3.8 GHz suggested in Europe may be used for enhanced mobile broadband. Within this frequency range it seems that most countries in the world have the possibility to authorise use for 5G. There is a high interest in the millimetre range. Several bands in the range 24 to 86 GHz, under study for ITU-R/WRC-19, will provide the most extreme rates. Perhaps the lowest range 26 to 28 GHz can be considered as a harmonised band, where 5G developments are taking place today, Europe at 26 GHz band and Americas and Asia at 28 GHz. But there are several other options of harmonisation, for example at 32 GHz.

How much spectrum needs to be widely available by which date, in Europe and globally, to progress testing new radio for 5G without delay?

Tjelta: Spectrum is one of the most important keys to 5G success. For test purposes and early commercial launch in Europe, it has been suggested to make three radio frequency ranges available: high band at 24.25 to 27.5 GHz, middle band at 3.4 to 3.8 GHz, and low band at 700 MHz. The test period has basically started and will increase in 2018. For enhanced broadband, spectrum with sufficient wide channels should be provided such as about 100 MHz below 6 GHz and several hundred MHz up to 1 GHz at the millimetre wave range.

How will European telcos deal with the transition from 4G to 5G?

Tjelta: Operators will gradually take 5G into use. The earlier generations will continue to exist side by side, and then be gradually phased out. For example, 2G and 3G are being phased out now, but 4G will co-exist with 5G beyond 2025, most likely. The transition will start after early tests have taken place, but it will not get up to speed before the standard is approved and equipment is available. This indicates a time frame from 2020 onwards. By then, operators will take a decision on the availability of mature technology and their commercial judgement.

By when do you expect 5G radio access to be rolled out on a large scale in Europe?

Tjelta: The major roll-out activity of 5G will take place in the first half of the 2020s. By around 2025, 5G will have become the main radio access technology. With a core network that is agnostic to the actual radio access technology, the picture will most likely be more one of heterogeneous access. But 5G will have many advantages being able to serve many use case applications with the same air interface technology.

How do you see Europe's global position in 5G, from the current R&D phase to commercial rollout?

Tjelta: The new 5G radio access is developed as a global technology and with a lot of globally coordinated activities. Europe has a very impressive collaborative research programme for supporting innovation in 5G. Companies that are active in the European research collaboration have every chance to be at the forefront when it comes to delivering new solutions based on 5G. There will clearly be competition from other global business players on the 5G market, as we already observe preparing for trials. However, at the same time 5G opens up opportunities to all players for much better and faster service innovation. This will lead to more shared business solutions and collaboration involving existing and new players.

Millimetre-wave based next generation mobile systems

Results of 5G-PPP project mmMAGIC

Yue Wang
Samsung Electronics
Research Institute UK
Coordinator of mmMAGIC
yue2.wang@samsung.com

The millimetre-wave spectrum of 6–100 GHz is considered a key-enabling feature of 5G. Despite its potential, there are many challenges when exploiting the mm-wave bands in 5G communications. Horizon 2020 5G-PPP project mmMAGIC, which ended in June 2017, made considerable advances in addressing these challenges.

mmMAGIC was dedicated to researching and developing the novel radio access technologies (RAT) at the mm-wave frequency bands. The work, which was carried out by a consortium of 19 partners, covered a wide range of technologies as the key enabling solutions for mm-wave based next generation mobile systems.

Techno-economic assessment of mm-wave RAN

Business considerations and techno-economic assessments have an enormous impact on deployments, because of the significant network expenses that may incur, particularly in a coming new cellular generation. mmMAGIC generated methodology and results in techno-economic evaluations of mm-wave radio access networks (RANs). Quantitative comparisons of capital expenses (CAPEX), operational expenses (OPEX), and total cost of ownership (TCO), were made between early 5G and 5G+ scenarios, and between 4G small cells and early 5G scenarios. Transport network costs, representing one of the most significant contributions to the overall cost, were analysed for both backhaul and fronthaul, and for the cases of owned lines and leased lines. Centralized and distributed network deployments, including their RAN components, were considered, with the degree of centralization characterized by a pre-defined functional split. Results led to insightful conclusions on the more beneficial split options from an economic viewpoint and the configuration parameters that contributed most to the final CAPEX, OPEX, and TCO.

Chanel measurement and modelling

The availability of reliable and accurate channel models is crucial for the design, deployment, standardization, and evaluation of a 5G RAT. mmMAGIC conducted extensive measurements for outdoor and indoor propagation scenarios. Calibrated with the measurement results, supplementary ray tracing simulations were performed to generate large data sets for deriving additional parameters for stochastic modelling.

The mmMAGIC geometric stochastic channel model was released in May 2017, including major features, such as ground reflection and blockage effects, the support of large bandwidths and large antenna arrays, the provision of spatial consistency, and the enhanced outdoor-to-indoor penetration loss modelling. Several mmMAGIC channel modelling approaches were adopted and reflected in the latest respective channel models in 3GPP and ITU-R. An open-source QuaDRiGa channel model platform was developed and further enhanced through the implementation of a subset of the mmMAGIC features in the new release. The software supports link- and system-level simulations with arbitrary antenna configurations.

RAN functions and architecture integration

One of the key challenges in mm-wave networks is the integration of the mm-wave system into the overall 5G environment, especially considering the variety of use cases and deployment scenarios. The project identified and specified key 5G enablers and RAN functions, namely multi-connectivity, tight-interworking with LTE, cell clustering, a new mobility state "RRC_INACTIVE", self-backhauling, network slicing, and interference coordination. The listed key enablers were identified since March 2016 and are now part of 3GPP technical documents.

Specific RAN functionalities are power-efficiency oriented KPIs, transport layer optimization, low frequency band assisted initial access and other PHY layer specific features helping to further increase performance. Furthermore, a multi-RAT multi-layer management framework was introduced, which can be tailored to integrate various RATs into one system and therefore can be seen as a generic method for system integration, performance and power efficiency optimization across all available links.

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Editorial

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Dear readers,

Amidst the fast-changing ICT environment, also Celtic-Plus and this newsletter are constantly changing. The first modest change concerns this newsletter. From this issue on, we will have a new section called the 'Chairman's Corner', which is inaugurated by, you guessed it, our chairman Jacques Magen. In future editions, this section may sometimes change its name to 'Vice-chairman's Corner' or 'Vice-chairwoman's Corner', as the three vice-chairpersons of Celtic-Plus – Valérie Blavette, Jari Lehmusvuori, and Riza Durucasugil – will also get the opportunity to share their views and insights in this section. The new section is opened with a bang: Jacques Magen will outline the first time in public what the plans for the future of Celtic-Plus beyond 2018 are.

From the future of Celtic-Plus back to our current activities: In the Celtic-Plus Autumn Call, which closed on 16 October, we received 9 Celtic-Plus project proposals. 8 of them were labelled at the label meeting in Paris on 20 November. The technical evaluators as well as the Celtic-Plus Core Group and the Public authorities indicated that the quality of the proposals was high, and we expect that most of these projects will start in 2018.

Enough organisational matters for now – let us have a look at the exciting Celtic-Plus projects. Shortly before the publication of this newsletter, our flagship project SENDATE had its mid-term event in Paris, which included a high-level event on the first day. Read all about it in this issue. Smaller, but nonetheless important for the technological development of the ICT sector in Europe, are the three projects presented in our popular section 'Project Highlights'. The selection of projects and results is evidence for the rich diversity of topics and concepts covered by Celtic-Plus. The article on UPSC explains how to unleash the power of the SIM; in the ACEMIND article, readers learn about network management tools for the future smart home; and the MITSU article explains a novel concept for seamless wireless video streaming.

As you can see in this issue of our newsletter, Celtic-Plus is a vibrant programme with a 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 proposers day on 13 December 2017 in Luxembourg and, of course, the next call for proposal, which ends on 23 April 2018. 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

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.

The future of Celtic-Plus

As Chairman of the Celtic-Plus EUREKA Cluster, I have the honour and privilege to be the first to write a contribution for this new section. And appropriate to this occasion, I have great news: the Celtic Industry Core Group, supported by the public authorities constituting the "Celtac", the Celtic Authorities Committee, have decided that Celtic-Plus needs to continue beyond 2018, the current date for completing Celtic-Plus. Therefore, it is my pleasure and duty as Chairman to lead this effort towards a renewed EUREKA label.

Before providing further details on what is to come next, a little bit of history. Celtic was formally kicked off in 2003 after two years of effort to prepare a new EUREKA Cluster that would differentiate from the existing ones, ITEA and MEDEA at the time, which were dedicated respectively to software and embedded systems and to microelectronics. The objective of Celtic was to run innovative research & innovation projects dedicated to "end-to-end communication systems", involving both telecommunications manufacturers and operators, to keep and strengthen European leadership in telecommunications.

The EUREKA High-Level Representatives agreed with that approach and decided to grant Celtic with the EUREKA label for 5 years, and then to renew it for another 3 years until 2011.

In 2010, the Celtic Industry Core Group expanded to welcome IT manufacturers and specialised industry players, e.g. in security. The focus broadened to the "Smart Connected World" to cope with the evolution of the telecommunications landscape, including not only network infrastructure but also new media, Future Internet, green Internet, and related applications and services. The label for Celtic-Plus was granted for 8 years.

Throughout those 15 years, Celtic and Celtic-Plus projects have been widely successful and have brought many innovations to the marketplace. I would not dare to cite here only a few examples, as they are so numerous. Suffice it to say that in addition to being recognized in the Celtic awards, some of those projects also received awards from EUREKA and other organisations, recognizing their added value for economy and society.

So here we are, almost at the end of Celtic-Plus. I am really proud to look at all the achievements that are behind us – "us" representing the Celtic community as a whole. This community by the way is one of the things I am most proud of. So now, should we consider that our work is done, and that there is nothing more to do? This is certainly not the feedback we get from the Core Group, from the Public Authorities, and moreover from all of you. Therefore, it is now the right time to roll up the sleeves and prepare for a new Celtic.

We have started to think about what kind of programme would be required to cope on the one hand with the continuous development of the telecoms-related landscape, and on the other hand with the changing context of ICT research & innovation in Europe and beyond. A first presentation, highlighting some preliminary ideas, was given at the EUREKA High-Level Group meeting that was held mid-October in Tampere, Finland, thanks to the support of the Finnish EUREKA Chair and of the Inter-Cluster Committee, which includes all EUREKA Clusters in a dedicated group.

We see this new Celtic based on the core values that have been supporting our R&D community for 15 years now, i.e. the bottom-up industry-driven approach, combined with large strategic flagship projects. There are critical issues that need to be addressed in the coming years, which are not addressed by other EUREKA instruments, and only partially by other instruments in Europe. From a technological standpoint, Networking and Cloud Enablers addressing and using technology from such areas as cyber security, artificial intelligence, 5G and beyond, FinTech, big data, business analytics, IoT and cloud, are considered as important orientations to develop. Applications and services, more and more serving vertical sectors such as content (video, gaming), e-Health, smart cities, agriculture, mobility, energy, automotive, and manufacturing, are equally important to advance, while end-to-end connectivity and security will still be significant domains to address.

We believe that strengthening ties with the national public authorities, improving again and again our processes and tools, and refining periodically the scope and implementation of the renewed Celtic-Plus, will strengthen the programme. Furthermore, we will increase the impact of the projects and of the programme on economy and society by increasing the involvement of SMEs, strengthening support to newly created start-ups and to growing SMEs, improving our partnering tool, shall help broaden our community. Finally, increasing the flexibility of the programme to reflect more quickly technological and market trends, and allow projects that are closer to the market, up to high technology readiness levels.

These are only preliminary ideas. We have just started to prepare for this renewed programme, and the formal application for the EUREKA label is scheduled for June 2018. Until then, we welcome your support towards this important milestone in the life of the European telecommunications industry – and beyond.

Jacques Magen
Chairman of Celtic-Plus

P.S.: I am looking forward to meeting you at the next Celtic-Plus Proposers' Days and Event. The next Celtic-Plus Event Annual Event will be co-located with the EUREKA Innovation Week in Helsinki, Finland, on 22–25 May 2018. I hope to see you there!

SENDATE Mid-Term Event in Paris

Peter Herrmann
Celtic-Plus
herrmann@celticplus.eu

On 21 – 23 November 2017, SENDATE, the Celtic-Plus flagship project for secure networking of data centers in Europe, held its mid-term event in Paris. More than 170 high-level representatives from industry and public funding organisations participated in the main event on 21 November, which was held at Orange Gardens, the research and innovation campus of French network operator and service provider Orange.

The participants discussed SENDATE's progress in creating a secure, distributed data center environment, which meets the requirements of industrial communication, autonomous driving, and more.

The event started with presentations by representatives of ministries and funding agencies from the countries financing SENDATE. After that industry leaders from the consortium presented the achievements of the five SENDATE subprojects. These presentations were complemented by demonstrations of technical results. The event concluded with a panel discussion on "Changes in Cybersecurity in Europe until 2020".

Opening session

The event was opened by Nicolas Demassieux, Senior Vice President at Orange Labs Research. In his opening remarks he welcomed the researchers from industry and from academia working in the SENDATE project. Explaining Orange's engagement in SENDATE, he pointed out that Orange is one of the telcos most committed to pushing the boundaries of technology.

His presentation was followed by representatives of the public authorities funding SENDATE, starting with Mathieu Weill, Director of the Digital Economy Department at the French Directorate-General for Enterprise (DGE). He reaffirmed the

Nicolas Demassieux, Senior Vice President, Orange Labs Research

strong support of France for this project, where colleagues from Finland, Germany, and Sweden work together to address key technology challenges in the ICT domain. He particularly highlighted SENDATE's contribution to making broadband networks across Europe more secure, which he considers critical for our economy.

Heikki Uusi-Honko, Finnish EUREKA chair at Tekes, said that SENDATE is a very important project and that in the future it would be good to see more effective market driven innovation. He outlined the vision for EUREKA Clusters according to which interaction between industry leads to agile and fast innovation. He argued to go beyond adapting to global disruptions and trends and instead be active contributors to these developments. In this respect, he considers SENDATE a good example of countries coming together to initiate something that can lead global changes.

Heike Prasse, Head of Unit for Communication Systems at the German Federal Ministry of Education and Research (BMBF) said that Europe must be at the forefront and set its own priorities. She pointed out that two thirds of the growth in Europe is due to investment in R&D. In this context she considers it important to link industry production with modern information and communication technology.

Andreas Aurelius, Head of the ICT department at Sweden's innovation agency VINNOVA, said that Cybersecurity is one of the main priorities of the Swedish government. He pointed out that Cybersecurity is a very big challenge that is not easy to address. Thus, he considers initiatives like SENDATE to be very important, in order to go beyond just talking about cybersecurity, but take real action with real impact. Underlining this statement, he announced that Sweden will increase its financial support to EUREKA clusters even more.

After the opening presentations, the high level representatives of funding agencies and companies got a first-hand impression of the SENDATE results at a demo tour.

Presentations of SENDATE project partners

The event continued with presentations by high level representatives of the SENDATE project partners, including Nokia, Ericsson, Coriant, and

Mathieu Weill, Director of the Digital Economy Department at the French Directorate-General for Enterprise (DGE)

Demonstration of SENDATE results for high-level representatives of funding agencies and companies

ADVA. Jean-Luc Beylat, President of Nokia Bell Labs France, highlighted the strategic relevance of the SENDATE project for Nokia. Jörg-Peter Elbers, Senior Vice President at ADVA, Advanced Technology, pointed out that SENDATE will be solving enterprise challenges related to the increase of costs due to increased data traffic.

Harald Bock, Vice President Network & Technology Strategy at Coriant, said that his company particularly sees the value of the project in autonomous intelligent transponder networks. And Elena Fersman, Global Research Area Director for Machine Intelligence at Ericsson Research, said that data centre security is key for 5G.

Panel discussion

At the end of the event, five high-level industry representatives explored in a panel discussion, which was moderated by David Kennedy from Eurescom, the changes in cybersecurity in Europe until 2020.

Marcus Braendle, Senior Vice President and CEO of Airbus Cyber Security, said that cybersecurity is a must as an enabler for industry in view of future and current markets. He reminded the audience that mobile banking only became a reality when the security issue was solved". Detlef Houdeau, Senior Director Business Development at Infineon, highlighted the growing importance of consumer guidance, as consumers also have some level of responsibility. He added that providers need to train consumers so that they can select devices with the proper security level.
The panel discussion highlighted that there are still tremendous challenges ahead on the way to creating a secure cyber world.

Panelists at the SENDATE event (from left): Eric Dubois, Sales & Marketing Manager for Industrial Automation division, ABB France; Markus Braendle, Senior Vice President and CEO of Airbus Cyber Security; Tauno Vähä-Heikkilä, VP Connectivity, VTT Technical Research Centre of Finland; Emmanuel Dotaro, Director, ICT & Cybersecurity Labs, Thales Secure Communications and Information Systems; Detlef Houdeau, Senior Director Business Development, Infineon AG, Germany

Conclusion

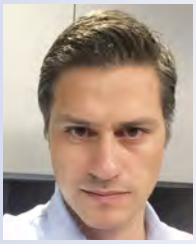
The high-level event on day one was followed by two days of mid-term reviews of the five subprojects. At the end of the three-day event, the main insight was that the SENDATE flagship project is on track and that its solutions are more urgently needed in Europe than ever.

About SENDATE

SENDATE, Secure Networking for a Data Centre Cloud in Europe, is a 70 million euro public-private partnership project comprising 83 companies, research organizations, and universities from Germany, France, Finland, and Sweden. The strategic goal of the three-year project is to address the current performance and security issues of data centers and pave the way to a more effective and secure network topology for data centers based on de-localization and secure connectivity. SENDATE aims to create a secure, flexible and efficient control of data flows on the Internet in Europe. The project runs from April 2016 to May 2019 under Celtic-Plus, the EURE-KA Cluster for a Smart Connected World, and is partly publicly funded by the research ministries/agencies BMBF (Germany), DGE (France), TEKES (Finland), and VINNOVA (Sweden).

- Further information:
  SENDATE website – http://www.sendate.eu/

UPSC – Unleash the Power of SIM Card



Rahmi Cem Cevikbas
Turkcell Technology
Cem.cevikbas @turkcell.com.tr

The threats of phishing, viruses and sniffer attacks are a serious barrier to the adoption of banking and transactional services on mobile devices. The SIM card within connected mobile devices has not yet unleashed its full potential. Instead, user-unfriendly security mechanisms around single-factor authentication methods, like passwords and log-ins, are used. The UPSC project facilitated and sped up the development process for mobile applications that are using SIM cards as the secure element.

In February 2017, Celtic-Plus project UPSC – Unleash The Power of SIM Card – was finalized with great success, demonstrating how SIM cards can be exploited in secure digital services.

The project started in the last quarter of 2014 with partners from the Netherlands, Korea, and Turkey, who had diversified experiences in security, SIM cards, mobile application development, and financial services.

The consortium's goal was to provide a full-fledged framework where SIM cards are used as the security service provider for mobile applications and to demonstrate the capabilities of this framework in different real-world scenarios.

Approach

Today, the utilization of SIM cards in secure digital services is very limited. Services use the security of SIM cards through OTA (Over The Air) platforms, which cause delays and unfriendly user interfaces. There is also SIM Alliance's "Open Mobile API" standard, which describes how to reach the SIM card, however the interface is hard to use and provides a more generic approach rather than being practical.

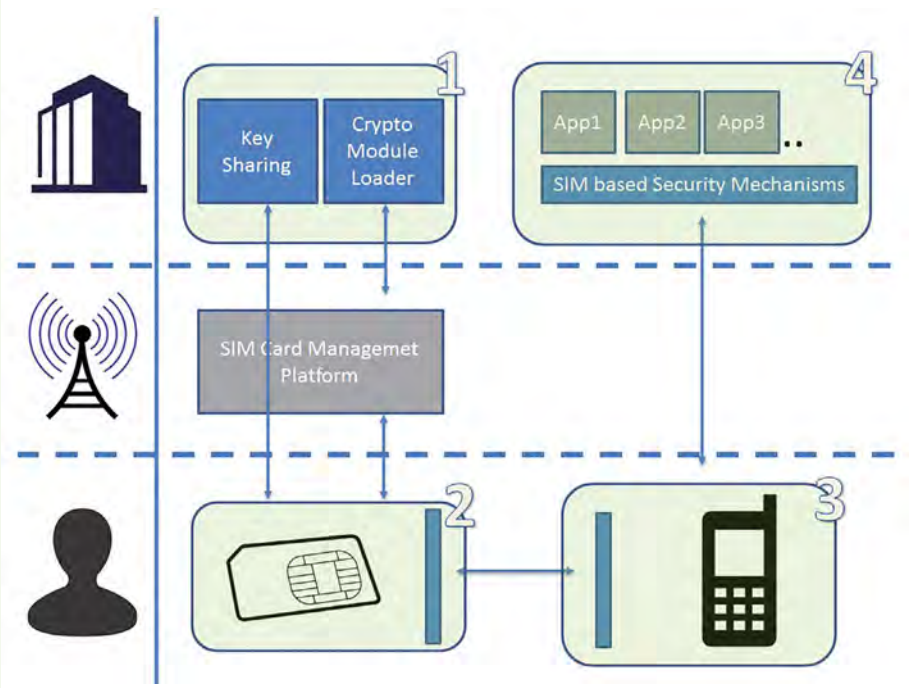


Figure: Components delivered by the UPSC project

The UPSC project has provided easy-to-use frameworks to application and service providers by isolating the complexities of SIM card usage. Developers who use the UPSC framework need to call the high-level APIs of the framework to seamlessly initiate a connection to the SIM card, prepare APDU (Application Protocol Data Unit) commands and utilize security functions of the SIM card, like encryption and signing.

Achieved results

The figure shows the main deliverables of the UPSC framework and their relations to each other:

- A server side architecture which includes downloading of crypto algorithms and secure keys to the SIM card in a secure way.
- A SIM card framework architecture where crypto algorithms can be called from terminal applications.
- An intelligent terminal framework which provides high level APIs to mobile applications.
- Demonstration of UPSC framework in mobile applications, mostly in finance and authentication services. These demo applications include: multiple document-signing in a mobile signature service, authentication of mobile banking applications, NFC based mobile payment scenarios, and remote payment.

Conclusion

The UPSC project not only achieved its goal of providing a full-fledged framework for mobile application developers, but also completed its mission of exploiting how the framework can be used in real-world scenarios.

Thanks to UPSC's high-level APIs to access the SIM card, telcos now have an alternative method of monetizing their SIM cards. On the other hand, service providers can also benefit from UPSC by enhancing the security and usability of their mobile applications.

The next step of the UPSC consortium partners will be to implement the algorithms and mechanisms developed in this project for IoT environments, where security and data integrity are also very crucial.

- Further information:
UPSC pages on the Celtic-Plus website – https://www.celticplus.eu/project-upsc/
UPSC source codes and executable files – https://github.com/paromix/upsc

ACEMIND – Delivering your future home network management tool

Olivier Bouchet – ACEMIND Project leader
Orange
olivier.bouchet@orange.com

Figure: Several devices and one dashboard

Finalized in November 2016, the Celtic-Plus project ACEMIND provides a set of simple solutions for enhancing home network management. The ACEMIND home network is constituted by Information and Communication Technology (ICT) devices, home appliances or white products, and home automation sensors delivering Internet of Things (IoT) services. The ACEMIND dashboard manages a large range of services such as energy, hybrid network supervision or senior care. ACEMIND also proposes a new wireless technology using optical wireless communications: Light Fidelity (LiFi).

The main achievements are a unique interface and four prototypes:

- Dashboard: the ACEMIND dashboard shows a complete view of customers' devices at home, like ICT devices, white products and home automation sensors. The dashboard comprises as well an interface to services, e. g. Security, Senior Care for elderly people or Green Home.
- Wired/wireless hybrid network: a hardware and software prototype optimizes the IEEE 1905.1 standard for hybrid networks (Ethernet, WiFi, PLC, ...) with innovative capabilities, such as automatic switching or home network anomaly detection.
- Green prototype: we focused as a first step on optimisation of home power consumption with a solution to flatten the energy consumption peak. Simplicity and transparency for customers were key factors for the design of the service.
- LiFi prototype: The optical wireless communication demonstrator proposes a bilateral communication with two devices. The first one is connected to the Orange Livebox, and the second one is plugged to a laptop.

Background

The scope of the project was very ambitious with the target to run research activities driven by the customer expectations. During the project lifetime with seven project partners (Arçelik – Turkey, Devolo and IHP – Germany, Flowmon – Czech Republic, University of Athens – Greece, Oledcomm and Orange – France), we polled users about their expectations regarding their home networks and collected more than 3,000 customer feedbacks. These results gave inputs to the specification of a Proof of Concept (PoC) in line with home users' expectations, such as simplicity, transparency, network security, a unique dashboard and a unique box, with a visualization of the room topology instead of the network topology.

Conclusion

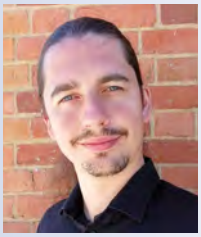
Key figures: one open source software user, one PhD thesis, and seven conference papers. In addition, two new products, commercially available from Oledcomm and Devolo, have been developed based on the project results. One Orange patent has also originated from ACEMIND.

Moreover, presentations of the ACEMIND results in various entities of the Orange group have either inspired or reinforced the roadmap of three internal projects devoted to new smart-home interfaces and services.

In September 2017, a huge LiFi challenge (Terabit per second – Tbps) was launched through a new European project named WORTECS.:

- Further information:
  ACEMIND pages on the Celtic-Plus website – www.celticplus.eu/project-acemind/

MITSU – Seamless wireless video streaming



Piotr Pawałowski
Poznań Supercomputing and Networking Center
astagor@man.poznan.pl

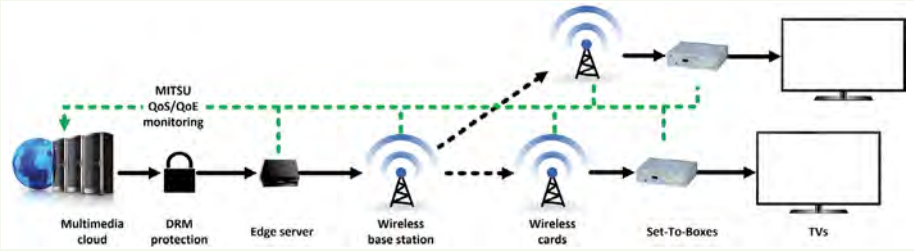


Figure 1: MITSU end-to-end video distribution cloud over wireless networks

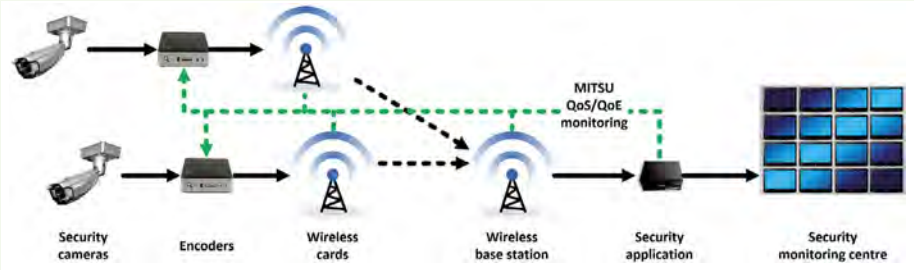


Figure 2: MITSU end-to-end security monitoring over wireless networks

Seamless and continuous video delivery to users wherever they are and whatever network connection they are using is one of the major challenges for telecom operators and content providers. Market demands are pushing toward a very fast deployment of video solutions that are often not interoperable and imply an increasing processing complexity. This often causes a decreased quality of delivered video, especially over wireless networks. The MITSU project has developed a set of technologies that optimize video transmission over heterogeneous wireless networks. Thanks to MITSU end users can get better video quality.

MITSU focused on end-to-end video delivery, from video sources through encoders, transmission channels, wireless networks and up to end-user devices. It developed algorithms and methods to optimize encoding and transmission processes that can dynamically react to changing network parameters. The project has taken into account video delivery over WiFi, LTE and WIMAX networks. Two main video delivery scenarios were studied: the multimedia scenario, where multiple users watch the same video content, and the security monitoring scenario, where multiple video sources are delivered in the uplink direction and presented in the monitoring centre.

Innovation for Quality of Experience

The main innovation of MITSU is the constant monitoring of Quality of Experience (QoE) at the end user's premises and the introduction of content- and QoE-awareness to the system. This steps beyond the state-of-the-art, where only QoS information is gathered and used. It enables a novel approach to various decision processes which can benefit from a more complete set of information.

Based on the project's developments, a novel solution for monitoring and scaling a video distribution cloud has been created that enables dynamic allocation of resources (Figure 1).

The solution focused on the full chain of video-content delivery to end users. It was tested with real users in Spain, where the last mile connection was done over wireless networks. The solution includes video encoders and a DRM media storage deployed in a cloud environment. The end users receive set-top-box devices allowing them to watch videos on their TVs. A monitoring system monitors the cloud, wireless links and end user devices, providing information that can be used to adapt the streaming parameters to optimize the quality.

The MITSU technology is also used for security video monitoring and was tested in a real-world environment in Poland, where security cameras have been placed in different locations in the city of Poznan. The solution enables to send a high number of video streams from the cameras to a monitoring centre (Figure 2).

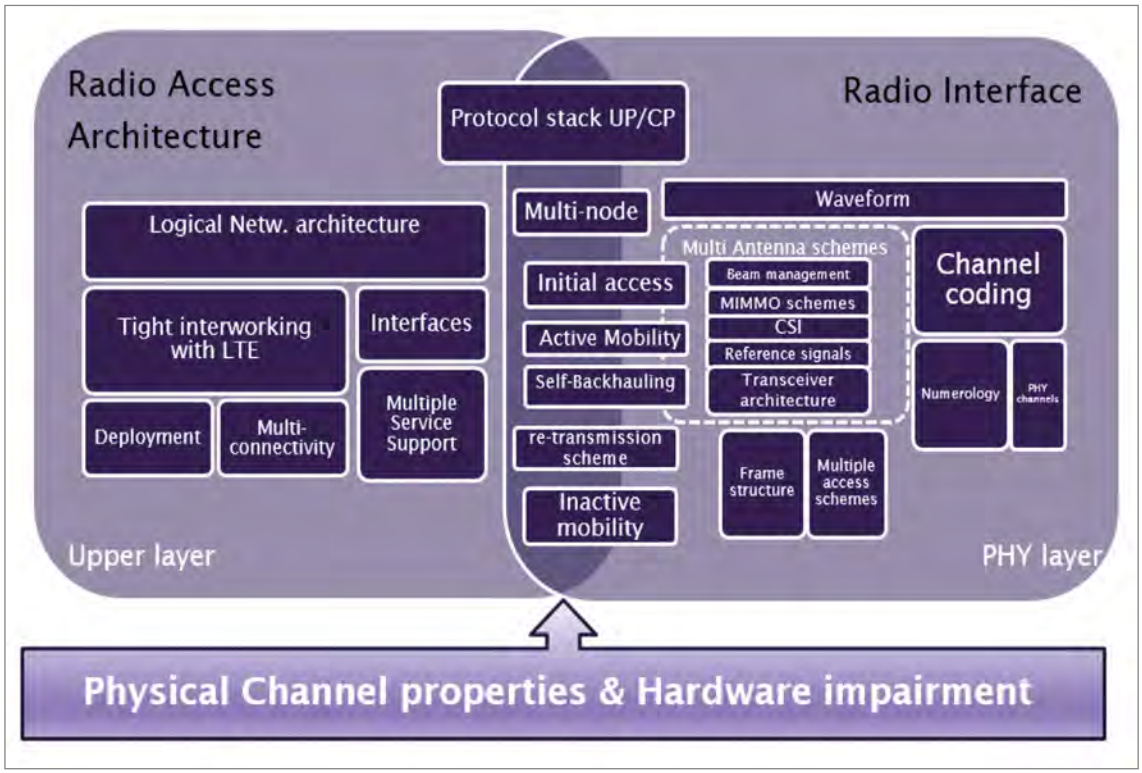
The system monitors the link state as well as the quality of the streams' content and can take the viewer's preferences into account in order to assign more bandwidth to a specific stream in order to increase its quality. It is designed to provide surveillance from buses, trams, trains, robots and places where connection using a wired network is not possible.

The above-mentioned deployments are not the only possibilities of the created technology, as various MITSU components can be used separately to introduce evolutionary improvements in various video streaming systems. The outcomes have allowed the companies taking part in the project to introduce new products and improve some of their existing solutions.

Conclusion

MITSU has introduced new technology allowing significant improvement of the Quality of Experience when transmitting video over wireless networks. The value of this technology has been proven in two test scenarios with end-users. The partners continue working on the technology to cope with the fast-changing video streaming landscape. New video coding and transmission standards will be incorporated into the MITSU solution. Attention will also be given to the creation of software modules for mobile devices, which will allow seamless high quality-streaming from smartphones over heterogeneous wireless networks. The approaching introduction of 5G technologies will give new possibilities to increase video streaming quality, but it will require new research in a follow-up project.

- Further information: MITSU project pages on the Celtic-Plus website – https://www.celticplus.eu/project-mitsu/



System concept of mmMAGIC

Radio interface concept

A radio interface concept was studied and developed in mmMAGIC, considering the specific features and requirements in the mm-wave bands. The radio interface components included waveform, numerology, subframe structure, channel coding, initial access, and spectrum sharing. mmMAGIC evaluated a number of waveform candidates, including multi-carrier and signal carrier variants, and recommended OFDM with enhanced techniques, including PAPR reduction, phase noise mitigation and windowing/pulse shaping for frequency localization.

Furthermore, advanced prefixes such as Unique Word (UW) were exploited to enhance performance without adding training overhead, and a new waveform BF-OFDM was developed and evaluated. A scalable numerology was proposed, which can be used for different carrier frequencies and bandwidths. Five subframe structures were defined, with extensions to support Integrated Access and Backhaul (IAB) operations. Some subframes allow fully dynamic TDD operation for better match of DL/UL traffic and for latency reduction. Advanced decoders were developed for LDPC and Polar codes, allowing very high throughput with tolerance to hardware impairments. An overall concept for initial- and multiple-access was studied, covering cell discovery, random access, beam search/tracking, flexible multiplexing, and resource allocation.

Under this overall concept, a number of techniques were developed, including efficient beam sweeping schemes, coordinated random access scheme with suitable preamble design, and advanced beam tracking schemes. A new spectrum-sharing concept was proposed, including spectrum pooling architectures, functions and beam coordination techniques. The listed solutions were developed in parallel with 3GPP activities, serving the purpose of pre-standards industry alignment. Some of the studied air interface solutions, like, e.g., waveform, numerology, channel coding, and asynchronous HARQ, were adopted in 3GPP.

Multi-antenna multi-node design

The project team carried out an extensive study of new concepts and proposed solutions on multi-antenna and multi-node transceiver schemes in mm-wave spectrum. A key contribution of the project was the modelling of the hardware impairments in mm-wave transceivers (with contributions to 3GPP) and the analysis of their impact on system performance, paving the way towards the implementation of practical mm-wave systems. mmMAGIC also extensively studied the Transmitarray configurations for radio access and backhaul applications. Hybrid Beamforming was recommended as the preferable architecture for most of the radio access needs in mm-wave communications, due to its flexibility and robustness against main hardware impairments. Finally, mmMAGIC validated the need for multi-node configurations to enhance the link reliability of mm-wave systems.

The mmMAGIC system concept

The overall system concept integrated the technical components enhanced or developed in the project, focusing on 24 different functionalities and more than forty different implementations of them. The project made a number of recommendations in terms of the system design and integration for mm-wave based 5G mobile systems, all incorporated into the final system concept.

Conclusion

mmMAGIC delivered a comprehensive portfolio of technologies and dissemination outputs across the two-year project duration. The project created profound impact on the current and future know-how of 5G mm-wave technologies. It laid a solid foundation for global standardization and alignment of the new mm-wave 5G technologies, which in turn boosted the technology readiness in this crucial 5G area.

Further information mmMAGIC website – https://5g-mmmagic.eu

The author would like to thank Miurel Tercero, Miltiadis Filippou, Michael Peter, Hardy Halbauer, Jian Luo, Mythri Hunukumbure, and Mehrdad Shariat for their contribution to this article.

Visions for Future Communications Summit

Rui L. Aguiar
IT Aveiro, Chairman of the NetWorld2020 Steering Board
ruilaa@ua.pt

Panel of speakers at the event in Lisbon (from left): Adam Drobot (OpenTechWorks Inc.), Keren Bergman (University of Columbia), Augusto Albuquerque (ISCTE-IUL), Marcello Caleffi (University of Naples / CNIT LNCM), Lajos Hanzo (University of Southampton), and Tomaso De Cola (DLR – German Aerospace Center)

Within the European NetWorld 2020 platform a discussion has started on what the relevant communications research issues around 2025 and after will be. This discussion led to the organization of Visions for Future Communications Summit hosted by Instituto de Telecomunicações and ISCTE-IUL, Lisbon, on 23-24 October 2017, jointly organized by Networld2020, IEEE and NSF. About 60 participants attended.

The event was a very good forum to discuss and understand where research is going and what focus is required in the short, middle and longer term. Despite the fact that the call for contributions focused on longer-term issues, the community reacted with three different sets of contributions, which can be structured in i) evolutions for the upcoming 5G networks; ii) technology gaps already felt today, which will be gaining increasing importance; and iii) disruptive technologies to overcome the fundamental limitations of current technologies and solutions to address different domains currently neglected.

Evolutions beyond 5G

In terms of 5G evolutions with products to enter the market between 2018 and 2022, it is expected to have evolutions in terms of new radio bands (such as mm or cm bands), new spectrum sharing and coexistence schemes, and large (practical) antenna arrays (MIMO). The integration of visible light, optical wireless and satellite networks will support specific services and scenarios. A different aspect of those evolutions is the need to improve network softwarization, especially from the point of view of network management, operation and associated costs. Two other trends that will be unavoidable to be improved are network security at all levels, and energy efficiency at all layers.

Contributing to the discussion: Henning Schulzrinne, former CTO of the US Federal Communications Commission and co-designer of the Session Initiation Protocol (SIP), now professor for computer science at Columbia University

Four trends that may change network architecture

Regarding technology gaps, four areas were identified which may eventually change network architecture radically. All four of them relate to so far unsolved challenges on trends already perceived, and that may evolve with minimal disruption (or not), as identified above. The first one is related to the network virtualization and softwarization trend and on its final limits and consequences: what to virtualize and to what gains is not an aspect that is clear in industry or academia, and will require strong expertise to be clarified. The second one is related to the fundamental network protocols, including their addressing and routing mechanisms. Although discussions are ongoing on concepts as named data networking (NDN) or information centric networking (ICN), it is clear that introducing a new network layer and protocol would take several decades. A third point is the social impact of our networks, and how this needs to be integrated in a proper governance model – and how such a governance aspect may be supported implicitly by the network protocols. Finally, aspects of security and robustness remain as an area that may potentially see large changes, with upcoming technologies like blockchain.

Disruptive technologies

The issue of disruptive technologies appears due to the new materials and technologies that are coming into the network. Photonic communications present extreme challenges regarding silicon-based interconnect technologies, with silicon-based circuits supporting ultra-high-speed, low-latency and energy-efficient photonic interconnect structures. Nano-scale technologies are also a major disruptive trend, with the use of new materials, like two-dimensional (1 atom thick) layers or carbon (or other) atoms called gra-

phene, which can be compounded with mechanisms derived from biological cells. As we move into the nano-world, quantum effects start to influence communication technology more and more, and the design of quantum computers and quantum communications systems will present a whole new set of challenges to reach reliable and secure systems.

Conclusion

Overall, the event allowed to gather a good number of European and North American experts and identified a large number of relevant topics for future research. The insights will be used to provide useful input to European R&D programmes. It seems apparent that activities are needed specifically in softwarization management, security, nano-scale and quantum communications.

Further information at https://futurecomresearch.eu

5G: Accelerating the 4th Industrial Revolution

Global 5G Event in Seoul

Uwe Herzog
Eurescom
herzog@eurescom.eu

The fourth Global 5G Event attracted 300 participants from five continents, who met on 22 – 24 November 2017 in Seoul, Korea. Their purpose was to cooperate on building global consensus on 5G among the world's 5G promotion organizations. The theme of the event was "5G, Accelerating the 4th Industrial Revolution".

The event consisted of a two-day workshop at the JW Marriott Hotel Seoul (22 – 23 November) and a PyeongChang 5G Tour on 24 November at which foreign participants were invited by 5G Forum to visit the 5G field trial site at the PyeongChang Winter Olympic Venue.

The Host: 5G Forum

The Global 5G Event was organised by 5G Forum, the leading organisation promoting the vision of 5G in Korea.

The 5G promotion organisations from the other parts of the world contributed to the event: the Fifth Generation Mobile Communications Promotion Forum (5GMF) from Japan, 5G Americas, the IMT-2020 (5G) Promotion Group from China, and the 5G Industry Association from Europe. The event was already the fourth in a series of events, which started in 2016 with the 1st Global 5G Event in Beijing, the 2nd event in Rome and the 3rd event in Tokyo.

5G Forum (https://www.5gforum.org/) was founded in 2013 and aims to become the leading force in the development of next-generation communications technology and contribute to the momentum of economic growth through the development of ICT industry in efforts to actualize the new administration's agenda of the creative economy

5G pilot at the Winter Olympics 2018

The event was opened with a welcome by Mr. YoungMin You, Minster of Science and ICT (MSIT) of the Republic of Korea, pointing out the importance of modern mobile communications for the country. Following that, Seong-Mok Oh, chairman of the host of the event, 5G-FORUM, gave a keynote in which he highlighted the efforts of Korea Telecom (KT) to deploy a 5G pilot which consists of a number of interesting services to be trialled during the Winter Olympics in Korea in February 2018. The preparations and details of the pilot were part of a number of further presentations, and it thus became clear that this pilot must be high on the agenda of KT - South Korea's largest telecom operator, who put it in their presentation as the "first 5G deployment in the world". This is probably not fully correct, as e.g. TIM will launch its 5G pilot in Torino already in December 2017, followed by a pilot in San Marino in Q1/2018 covering the whole country, but the message stated by KT indicates their pride in the probably enormous effort that was required.

European perspective

The European 5G delegation consisted of Bernard Barani, Deputy Head of Unit Future Connectivity Systems at the EC's DG CONNECT, Dr. Colin Willcock, Chairman of the Board of the 5G Infrastructure Association, Jean-Pierre Bienaimé, Secretary General of the 5G Industry Association, Dr. Didier Bourse, Senior Director for European R&I Programs at Nokia, Uwe Herzog, Programme Manager at Eurescom, and Dr. Emilio Calvanese Strinati from CEA LETI.

Colin Willcock, chairman of the 5G Industry Association gave an update on European 5G activities. He gave an overview of the main achievements of 5G PPP Phase 1 projects, an overview of the set of Phase 2 projects that have started in June 2017 and informed of the upcoming calls for proposals in 5G PPP Phase 3.

Uwe Herzog from Eurescom gave an overview of 5G deployment plans in Europe. Many operators will start pre-standard trials already in 2018, e.g. TIM, Telia and Telenor, and launch 5G services commercially from 2020. Having 5G ready with a number of services at Euro 2020 as a popular event with matches in 13 different cities is a clear target and will serve as a catalyst.

Didier Bourse from Nokia, who is chair of the 5G PPP Trials Working Group, presented details of the Trials Roadmap Version 2.0 which was released at the occasion of this event. The document addresses the latest updates of the Roadmap strategy, the 5G Private Trials, the 5G Platforms, the 5G Vertical Pilots, the 5G Pan-EU Flagship event 5G for UEFA EURO 2020 and the 5G Trials Cities. Didier Bourse pointed out that "the Roadmap Version 2.0 is a great "reference" document for Industry, Research Centers and Academics, EC and Member States for developing the 5G Pan-EU Trials and Pilots strategy". He continued saying that the core part of the 5G trials and pilots will be achieved through private trials, both commercial and pre-commercial. These will be between network operators and manufacturers/vendors and will step by step also involve vertical stakeholders. The 5G trial at UEFA EURO 2020 will be a major 5G Pan-EU Flagship event.

5G for verticals

One session was dedicated to 5G for vertical sectors, addressing the event motto of 4th industrial revolution. Jean-Pierre Bienaime, Secretary General of 5G-IA, presented on requirements and expectations of vertical sectors on 5G in Europe.

A number of vertical companies are involved in 5G PPP Phase 2 projects, e.g. Volvo for automotive, the BBC for media and entertainment and Hamburg port for transport and logistics. Requirements from verticals on 5G networks are quite distinctive and ensuring they are met is key for a successful application of 5G in these sectors. Jean-Pierre stated that Automotive may drive 5G adoption in Europe thanks to the heavy engagement of big players, e.g. Peugeot, BMW and Volvo who are participating in Phase 2 projects. He concluded with the view that 5G is vertical driven, as a true differentiator to previous "G" which were more human user driven.

Opening panel at the Global 5G Event in Seoul (from right): Dr. Chung G. Kang (Moderator), Executive VP, The Korea Institute of Communication and Information Sciences (KICS); Mr. Bernard Barani, Deputy Head of Unit, European Commission, DG CONNECT; Ms. Nese Guendelsberger, Senior Deputy Bureau Chief, Wireless Telecommunications Bureau, FCC; Mr. Lidong Chen, Deputy Director, Department of Information and Communications Development, MIIT; Mr. Gaku Nakazato, Director of New-Generation Mobile Communication Office, Ministry of Internal Affairs and Communications; Mr. Choi Woo Hyuk, Director of ICT and Broadcasting Technology Policy Division at the Korean Ministry of Science and ICT; and Mr. José Gontijo, Director of the Department of Science, Technology and Digital Innovation – MSTIC

Dr. Colin Willcock, Chairman of the 5G Industry Association Board

The strong interest of the automotive sector was also expressed by other presenters, e.g. by Japanese operator SoftBank at the example of autonomous driving. It addresses an issue in an "ultra-ageing society" as speaker Hitoshi Yoshino said, with the average age of 58 of taxi-drivers in Japan coupled with a shortage of drivers. Ultra-low latency will be important for vehicular control he said. But also other application sectors were addressed in the session, e.g. remote surgery in e-health or various applications of Virtual Reality.

Tour to Winter Olympics 5G Trial site

On the day after the two-day conference, the foreign participants of the event were invited by 5G Forum to the PyeongChang 5G Tour where they could visit the 5G field trial site at the PyeongChang Winter Olympic Venue, 180 km east of Seoul. There, winter had already arrived with lots of snow and chilly temperatures.

KT is currently very busy with preparing this 5G pilot as the start of the Olympics in February 2018 is approaching fast. Five pre-5G services are planned to be ready to demonstrate the potential of 5G, and they can be seen as innovation in winter sports broadcasting: For the Omni View service, athletes will be equipped with a GPS module. This, combined with wireless 5G cameras, will allow spectators at the stadium or elsewhere to watch and monitor the athletes at the stadium in real time.

The 360° VR live service allows remote spectators to feel as if they were actually at the stadium. With the Time slice service 100 cameras installed in the stadium capture the movements of athletes and transmit the videos to screens. SyncView transmits videos from the perspective of the athletes captured by miniature cameras in real time. Finally, there will also be a 5G-enabled self-driving bus.

The network coverage will include the Olympic venues and parts of the Seoul area. KT has specified and developed this pilot in cooperation with a number of well-known chipset manufacturers, mobile network vendor and other partners. KT together with Samsung have also developed special user terminals in the form of a tablet to experience the various services. It will remain interesting to see whether KT will succeed in getting everything ready and finally running in time for the event, and also what the user experience will be.

Outlook

In conclusion it can be said that the fourth Global 5G Event continued the thread of discussion be-

5G Center at the Alpensia Ski Jumping Stadium in PyeongChang, location of the 2018 Winter Olympics

tween the main players shaping the 5G networks. In the run-up towards the goal of implementing 5G networks in the 2020 timeframe, there is still global coordination work to do. The discussion will continue at the next, the 5th Global 5G Event, which will be held in Austin, TX, USA, on 16-17 May 2018, hosted by the 5G Americas (http://www.5gamericas.org/en/), which will be organised in conjunction with the 5G World North America event.

Further information

- Global 5G Event pages on the 5G Forum website – https://www.5gforum.org/english
- Event website of the 4th Global 5G Event in Seoul – https://www.4th-g5ge.org/

News in brief

Advisory group calls for doubling of EU investment in research and innovation

In summer 2017, an independent high-level group of senior experts chaired by Pascal Lamy, former Director-General of the World Trade Organization, presented a report with recommendations for EU research and innovation to the European Commission.

The recommendations include that Europe must capitalise better on the knowledge it produces, and turn its innovation potential into economic growth. Research and innovation should be prioritised in EU and national budgets, with a doubling of the budget of the successor to Horizon 2020, the current EU research and innovation programme. And it should involve citizens in addressing global challenges through broadly mobilising innovation missions.

The report, entitled "LAB – FAB – APP: Investing in the European future we want" highlights that in the last twenty years, two thirds of economic growth in industrialised countries is attributed to research and innovation. Its recommendations focus on maximising the impact of EU investments in research and innovation in order to increase prosperity and solve our biggest societal challenges.

The Group altogether made eleven recommendations for more effective R&I investments by the EU:

- Prioritise research and innovation in EU and national budgets, including a doubling of the budget of the post-2020 EU research and innovation programme
- Build a true EU innovation policy that creates future markets
- Educate for the future and invest in people who will make the change
- Design the EU R&I programme for greater impact
- Adopt a mission-oriented, impact-focused approach to address global challenges
- Rationalise the EU funding landscape and achieve synergy with structural funds
- Simplify further, privilege impact over process
- Mobilise and involve citizens
- Better align EU and national R&I investment
- Make international R&I cooperation a trademark of EU research and innovation
- Capture and better communicate impact

The High Level Group on maximising the impact of EU Research and Innovation Programmes brings together 12 members who hold top-level positions in public and private organisations. The Group was tasked in December 2016 to advise the Commission on how to maximise the impact of the EU's investment in research and innovation.

The Commission will respond to the recommendations of the High Level Group in a Communication to be published later in 2017. The recommendations and results of the conference will feed into the preparation of the successor research and innovation programme to Horizon 2020, due to be proposed by the Commission in 2018.

Further information at: http://ec.europa.eu/research/evaluations/pdf/archive/other_reports_studies_and_documents/hlg_2017_report.pdf

OECD report – More government efforts for digital transformation needed

An OECD report published in October 2017 claims that unequal access and usage could hold back the potential of the digital economy. Digital progress is uneven across countries, businesses, and within societies. Broadening access to digital opportunities and helping those lagging behind to catch up would increase the benefits of the digital transformation and help ensure they are widely shared across economies and people, according to the report.

The OECD Digital Economy Outlook 2017 says government policy has not kept pace with the digital innovation and transformation of economies and societies led by big technology firms. It calls on countries to step up their efforts, invest more in education and skills, and encourage greater use of advanced technologies like big data analysis and cloud computing, in particular by small businesses, to make the digital shift more productive and inclusive.

Trends identified by the report include that access to the Internet is growing, average speeds are faster, and prices are falling. However, mobile

data usage – a key driver of the digital economy – is growing much faster in some countries than others, with Finland and Latvia being particularly advanced.

In terms of overall Internet usage, 97% or more of the population used the Internet in 2016 in Denmark, Iceland, Japan, Luxembourg and Norway while 60% or less did so in Mexico and Turkey. Over 95% of 16-24 year-olds went online versus less than 63% of 55-74 year-olds.

In 2016, 95% of OECD country firms had high-speed Internet, up from 86% in 2010, with the biggest increases in Mexico, Latvia and Poland. However, there are big gaps between large and small firms, particularly in Mexico, Greece, Poland and Turkey. Small firms also lag behind in their use of advanced tools such as big data analysis and cloud computing.

Beyond revealing digital inequalities, the report recommends that governments review labour laws, trade agreements and other legislation to take account of job displacement, the emergence of new forms of work, and the evolving trade landscape. It calls on governments to also work together to tackle digital security and privacy risks amid increasing concerns about data breaches and security incidents that risk weighing on uptake of digital services.

Further information at:
http://www.oecd-ilibrary.org/science-and-technology/oecd-digital-economy-outlook-2017_9789264276284-en

ENISA report on IoT security

On 20 November 2017, the EU Cybersecurity Agency ENISA published a report on the security of IoT (Internet of Things). The study titled 'Baseline Security Recommendations for Internet of Things in the context of critical information infrastructures' was developed in cooperation with the ENISA IoT Security Experts Group and additional key stakeholders.

The authors define IoT as "a cyber-physical ecosystem of interconnected sensors and actuators, which enables intelligent decision making". According to ENISA, the threats and risks related to IoT devices, systems and services are growing.

The ENISA report provides IoT experts, developers, manufacturers, decision makers and security personnel with a guide to good practices and recommendations on preventing and mitigating cyber-attacks against IoT. The recommendations of the report are meant to be of use to all actors involved, from the European Commission and governments to the IoT industry, providers, operators, manufacturers and consumers' associations.

The report builds on the expertise and insight previously gained by ENISA through its sectorial studies on smart infrastructures such as smart homes, smart cities, intelligent public transport, smart cars, smart airports and eHealth.

ENISA plans to focus its future work in the field on enhancing the security and resilience of IoT in Europe, engaging all relevant key stakeholders and providing studies and knowledge to face the upcoming challenges. According to ENISA, the baseline security requirements presented in this report can serve as a foundation for further efforts towards a harmonised EU approach to IoT security.

Further information at:
https://www.enisa.europa.eu/publications/baseline-security-recommendations-for-iot

New president of European Patent Office elected

On 11 October 2017, the Administrative Council of the European Patent Organisation has elected António Campinos to succeed Benoît Battistelli as President of the European Patent Office (EPO). His five-year term will start on 1 July 2018.

A Portuguese national, Mr Campinos is currently Executive Director of the European Union Intellectual Property Office (EUIPO). He is also a former President of the Portuguese Institute of Industrial Property (INPI). In that function, he served as the Portuguese representative on the Administrative Council of the European Patent Organisation for several years.

António Campinos, new president of the European Patent Office

The Administrative Council, consisting of the delegations from all member states, is the organisation's legislative body. It is responsible for supervising the activities of the Office, approving the budget and appointing the president of the EPO.

Further information at: http://www.epo.org/news-issues/news/2017/20171011.html

Uncanny feeling

Computers get emotional

Milon Gupta
Eurescom
gupta@eurescom.eu

The relationship between humans and computers is ambiguous. On the one hand humans increasingly depend on computers at work and at home. Some even love their devices and become addicted. On the other hand, many people fear that artificially-intelligent computers will make their jobs redundant. And how do computers feel about it? They don't feel anything at all – yet. That could soon change: in the shadow of advances in artificial intelligence, computers are also learning to recognise and express emotions.

Pepper, the emotional robot

Research on affective computing has been going on for the last two decades, pioneered by MIT professor Rosalind Picard in the mid-1990s. However, only recently have somewhat emotionally intelligent computers crawled out of the labs. In June 2014, as reported in Eurescom message [1], the SoftBank Group unveiled a robot called Pepper, which the Japanese company said could read human emotions by analysing gestures, expressions and voice tones.

SoftBank's Pepper robot reads human emotions (photo: Softbank)

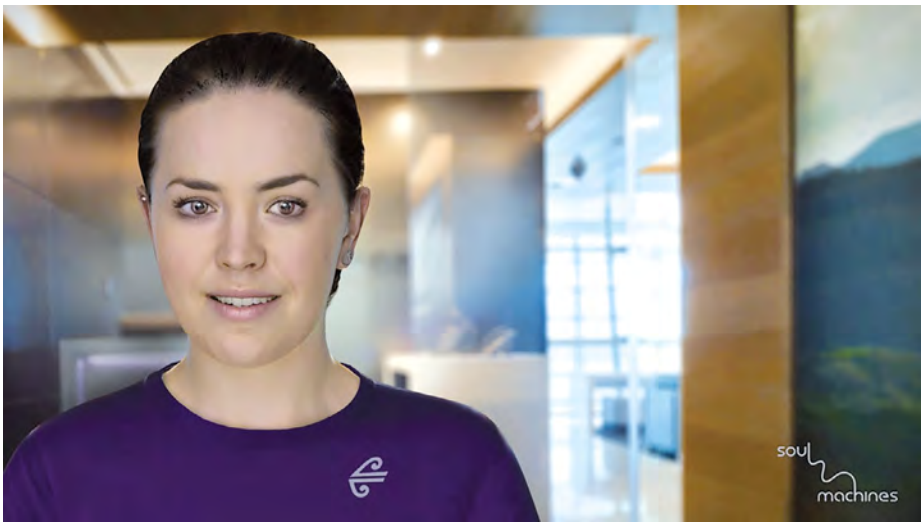
Pepper's "emotional engine" is based on research by Paul Ekman, professor emeritus at the University of California, who had found out that facial expressions of emotions are not culturally determined, but universal. His list of basic emotions encoded in facial muscles include amusement, contempt, contentment, embarrassment, excitement, guilt, pride in achievement, relief, satisfaction, sensory pleasure, and shame.

While reading emotions is already a huge challenge, it is even more challenging for robots to respond to human emotions in an emphatic way that makes humans feel comfortable. In 2015, a fully automated hotel with robotic concierges instead of human personnel opened in Japan, as reported in Eurescom message. These robot concierges looked almost human. However, their stiff artificial smiles and robotic speech leave humans with an uncanny feeling.

According to the "uncanny valley" hypothesis, we find robots weird when they almost look and behave like human beings. The term "valley" in this context refers to the dip in a graph of experienced comfort level when people are confronted with different levels of naturalness and human-likeness in other beings.

Meet Sophie, the service agent

In the past two years the focus has shifted from robots to avatars, in order to bridge the "uncanny valley". Soul Machines, a start-up from New Zealand, has developed what they call "digital humans", avatars which are capable of responding through human-like facial expressions. Their latest digital human is Sophie, whose task is to



Sophie, the "digital human" created by Soul Machines for Air New Zealand (photo: Soul Machines – www.soulmachines.com)

enhance the customer service of Air New Zealand. As part of her temporary duties, she answers questions about New Zealand as a tourist destination and the airline's services.

The digital humans created by Soul Machines are already coming close to bridging the uncanny valley through near-human-like verbal and facial responses. This is made possible through simplified models of the human brain. At the core of the start-up's technology are virtual neurotransmitters that can simulate human hormones like dopamine, serotonin and oxytocin.

On the road to Westworld?

Dr. Mark Sagar, CEO of Soul Machines, claims that within a decade humans will be interacting with life-like emotionally-responsive robots. In order to turn this scenario into reality, robotics will have to catch up with Artificial Intelligence (AI) technology.

When this advance in robotics is achieved, scenarios like in the science-fiction thriller Westworld could become technologically realistic. The thriller shows a Western-themed amusement park populated by androids that malfunction and begin killing the human visitors.

Although such nightmares could be technologically possible one day, other scenarios of interaction between humans and emotional computers appear more likely. Think of digital tutors in learning scenarios or of companion devices like digital pets. In other scenarios, affective computing may rather be invisible, like in social monitoring. A car could, for example, monitor the emotions of a driver and alert other drivers around him, if he gets angry. Similarly, the mail client of the future could alert us, if we are about to sends an angry e-mail.

While this may sound useful, we should not forgot the unlimited possibilities it opens for the advertising of the future. If Google and Facebook know what we feel and make us interact with an emotionally manipulative avatar, I would consider this a good reason to be afraid – and in the future they will know, if you are.

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European Institute for Research
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in Telecommunications GmbH
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69123 Heidelberg, Germany
Phone: +49 6221 989-0
Fax: +49 6221 989 209
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