Summer 2016

EURESCOM message

The magazine for telecom insiders

Celtic-Plus
Newsletter 1/2016

Terrestrial-Satellite Convergence

The Kennedy perspective
How 5G will change the nature of democracy

Events
European Conference on Networks and Communications in Athens

A bit beyond
Alex for president

Celtic-Plus Proposers Day in Istanbul

22 September 2016

Discuss your project ideas with potential partners and find out about funding opportunities in your countries at our next Celtic-Plus Proposers Day in Istanbul on 22 September 2016.

Celtic-Plus Proposers Days are discussion fora for organisations related to telecommunications that are interested to participate in a Celtic-Plus project and want to benefit from performing collaborative research through the EUREKA Cluster Celtic-Plus.

Please have a look at the preliminary programme and register for this event at www.celticplus.eu/event/celtic-plus-proposers-day-on-22-september-in-istanbul/

If you have any questions or need help, do not hesitate to contact the Celtic-Plus Office – we would be pleased to help you.

Contact:
Celtic-Plus Office, office@celticplus.eu or
Peter Herrmann, herrmann@celticplus.eu

This event is kindly hosted by:

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TÜBİTAK

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

Celtic-Plus Call for Project Proposals – Deadline: 14 October 2016

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 14 October 2016.

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 at 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 60-70 %.
- The results of the evaluation will already be known in November/ December 2016.
- If you have any questions or need help, do not hesitate to contact us; we are pleased to help you.

Contact:

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office@celticplus.eu

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Celtic-Plus
Smart Connected World

www.celticplus.eu

Dear readers,

Satellite communications and terrestrial communications co-existed for decades without a high degree of integration. This has been changing recently. Efforts towards satellite-terrestrial integration are increasing, and particularly machine-to-machine communication and the 5th generation of communication networks (5G) are adding to the dynamics of innovation in terrestrial-satellite integration.

In this issue of Eurescom message, we will present insights on the latest developments of terrestrial- satellite integration. Our cover theme presents selected views by experts from academia, industry and the European Space Agency (ESA) on what is happening in Europe.

In the first article of the cover theme, Adam Kapovits, project manager at Eurescom, presents an overview on satellite communications and 5G. The next article presents results from ESA-funded research on satellite communication in the 5G ecosystem. Continuing with ESA, we feature an exclusive interview with Maria Guta from ESA, who shares her insights on terrestrial-satellite integration. This is followed by an article highlighting opportunities for integrated solutions of satellite networks and machine-to-machine communication. Concluding the cover theme, we present an article from Thales which explains the opportunities of satellite on-board processing for terrestrial network integration.

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 5G and the nature of democracy in his column "The Kennedy Perspective". See also our events section, which contains a report on the European Conference on Networks and Communications in Athens. Finally, in the latest "A bit beyond" article you can learn about how to become a US presidential candidate.

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

EVENTS CALENDAR

4 – 7 September 2016
PIMRC '16 – 27th IEEE International Symposium on Personal, Indoor and Mobile Radio Communications
Valencia, Spain
http://www.ieee-pimrc.org

20 – 23 September 2016
ISWCS '16 – 13th International Symposium on Wireless Communication Systems
Poznan, Poland
http://iswcs2016.org

22 September 2016
Celtic-Plus Proposers Day
Istanbul, Turkey
https://www.celticplus.eu/event/celtic-plus-proposers-day-on-22-september-in-istanbul/

8 November 2016
FIWARE Open Day
Brussels, Belgium
https://www.fiware.org

9 – 10 November 2016
5G Global Event
Rome, Italy
https://5g-ppp.eu

4 – 8 December 2016
IEEE GLOBECOM 2016
Washington DC, USA
http://globecom2016.ieee-globecom.org

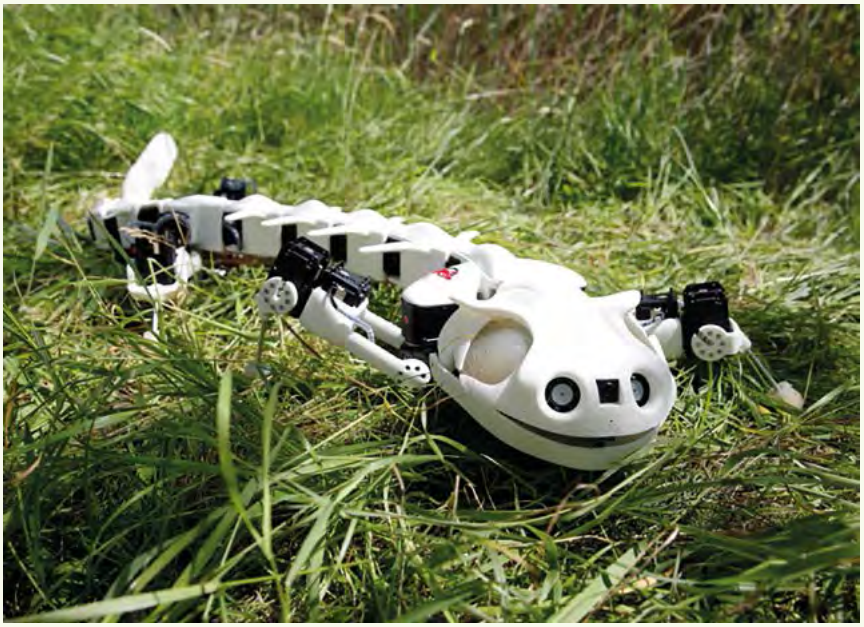
SNAPSHOT

Robot Salamander

Researchers at the Swiss Federal Institute of Technology in Lausanne have developed a robot salamander called Pleurobot. It mimics a real salamander in the way it walks, crawls and swims.

The Swiss researchers aimed to demonstrate how Pleurobot's design methodology and production methods may lead to cost-effective platforms with physical interfaces for neuroscientists, biomechanists, functional morphologists, paleontologists, and roboticists.

For further information see the Pleurobot website at http://biorob.epfl.ch/pleurobot



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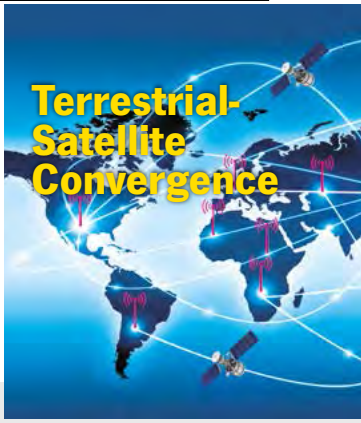

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How 5G will change the nature of democracy

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I have been involved in many discussions over the last period about the real requirements for 5G, and one aspect that no one has mentioned so far is the impact 5G could have on democracy. Our ideas of civilisation are generally based on individual freedoms and rights. We look at countries that don't support the same levels of freedom and wonder how they have not been challenged.

The answers are complex and involve many parameters, ranging from the level of education and wealth distribution to the access to information and justice. In all cases injustice will stimulate revolution when the ones deprived decide they have nothing left to lose or, as we have seen in recent history, when the rest of the global community decides to act.

What has this to do with 5G? Well, one thing that comes with advanced communications is information. Information is power. Information is power in ways that are obvious when you see it in action. When the first telephone got to the Eskimos they were able to find out at what price their fish were selling for the big city markets. The next time their trader tried to buy their fish for a cheap price, he got a lesson on the power of communications.

So what has this to do with 5G and elections?

There have been two major votes going on in 2016 – the UK referendum on leaving the European Union and the US presidential election. Both of these votes are wonderful examples of misinformation and downright lies. What is impressive is the speed of propagation of the false claims and the inability of anyone to stop them.

The continuously connected world we are envisaging for 5G will mean that the dissemination of stories will get ever faster and harder to evaluate. If people then use the secure identity 5G will give them to vote and decide on these issues, we run the risk that votes will be influenced more by the latest social network rant than any rational discussion on issues.

Picture a society where the fully connected individual can vote on each and every policy issue at a local, regional and national level as easily as he can vote for a Eurovision song today. What will this do for democracy? It will create a situation where no long-term policies can be followed as the crowd are fickle. Politicians, as we know them today, may disappear in favour of "soundbite" specialists who exploit the short attention span of the community.

I don't want this future! I want the benefits of a connected society. So the real issue is that we need a truth and honesty filter in our future systems. Now here is a research topic that we can get our teeth into. Let us take a percentage of the EU research funds and put them into a focussed programme that can identify false information, scams, lies and malicious communications and stop them at source.

If we take the controlling system that ensures the truth to the extreme, we could find ourselves back in "1984". Maybe George Orwell, the author of this visionary fiction had a point: "Progress is not an illusion, it happens, but it is slow and invariably disappointing."

Satellite communications and 5G – An overview

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Traditionally satellite technology has been associated with proprietary solutions and being expensive, addressing primarily niche markets and applications, in addition to direct broadcasting. In the past few years satellite technology has come a long way improving both on its technical performance and capabilities as well as becoming much more competitive to match terrestrial offers.

The emerging 5G vision opens a new chapter in communications and offers the possibility to consider satellite communication alongside and in combination with terrestrial solutions. Let us have a look at some of the key aspects to be considered for such an integration.

The market perspective

The satellite industry should be regarded as a subset of the telecommunications industry and the space industry. Revenues in the satellite sector accounted for about 4% of global telecommunications revenues, according to the Satellite Industry Association report from 2015. The satellite industry revenue falls into four major segments: 1. satellite services, which is the largest segment, representing 60% of the total of 203 billion dollar in 2014; 2. satellite manufacturing; 3. the launch industry, and 4. ground equipment. The satellite services segment includes broadcast, radio, broadband amongst the consumer communication services, but also revenues from mobile services, enterprise services and backhaul, as well as remote sensing and earth observation.

Strengths of satellite communication

There are a couple of features and capabilities of satellite communication that distinguishes it from terrestrial solutions. One of them is the capability to address whole geographic regions and country groups, even continents, using a minimum amount of infrastructure on the ground. The other notable advantage of satellite communication is its intrinsic broadcast nature and capability. This intrinsic broadcast capability enables satellite communication to deliver the same content to a very large number of network nodes and user devices – potentially scattered around a very broad geographic area – with unparalleled efficiency.

Both of these capabilities position satellite communication as an interesting technology that can complement and support terrestrial solutions in delivering on the 5G promises, some of which are very challenging.

Constraints of satellite solutions

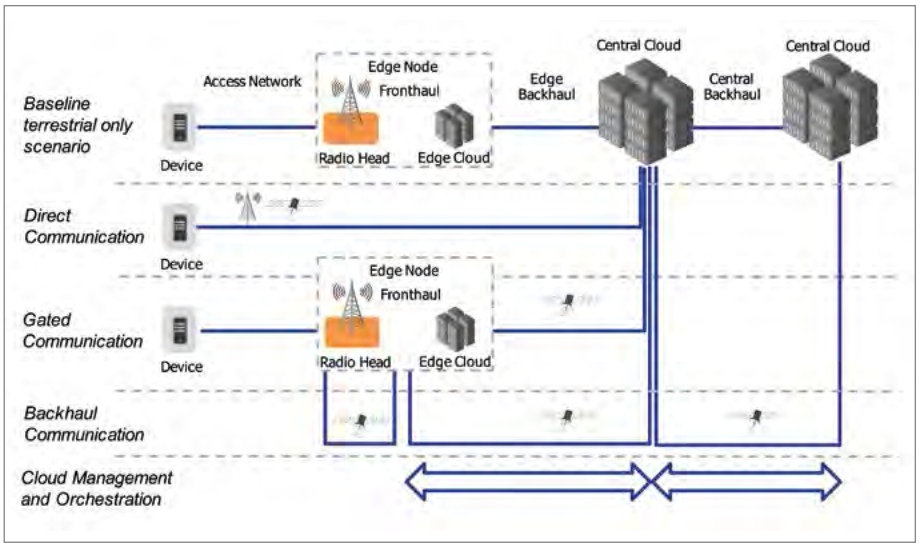
There are also some characteristic constraints of satellite solutions that need to be considered. The single most important of them is the comparatively large propagation delay. This is down to physics, and the positioning of satellites. In case of the so-called geosynchronous equatorial orbiting (GEO) satellites the satellites are positioned 35,786 kilometres above the Earth's equator and consequently any communication suffers from the propagation delay over the distance from Earth to orbit and from orbit to ground. This propagation delay amounts to about 500 ms round-trip delay. Apart from well-known mitigation techniques to deal with this stable delay, lately Low Earth Orbit (LEO) satellites – orbiting below an altitude of 2,000 km – and their constellations are proposed and explored in an increasing manner, as they suffer from much less propagation delay.

Difference in development cycles

Satellites in general are planned for and have a lifetime of tens of years. This is true for GEO satellites in particular. Concerning LEO satellite constellations, these need to be managed and continuously replenished. This can be a rather complex task, as some of the recently proposed LEO satellite constellations consist of several hundred satellites.

One characteristic difference of satellite solutions from terrestrial ones is that fixing a system once in orbit is practically impossible. Therefore critical systems on board of satellites are implemented with redundancy to ensure that satellites deliver on their mission over their expected lifetime considering the rather harsh environment they operate. This also means that satellite solutions tend to rely on proven and very robust technology, and historically on-board capabilities of satellites tend to be rather modest in comparison to their terrestrial counterparts. Although hardware updates of satellite on-board systems are not possible, they can be reconfigured. Finally, in general satellite solutions are characterised by relatively long development, implementation and testing phase before deployment. This is different from terrestrial solutions where technologies and solutions are easier to be tested in situ.

In summary, until recently satellite technology evolution followed different, slower development cycles, resulting also in a considerably different business model to recap the development costs



Potential roles of satellite in a Mobile Edge Computing based 5G implementation. Through virtualisation and slicing satellite supports heterogeneous use cases and deployments. Please note that all of the depicted communication models can be deployed and can co-exist in parallel. (ESA Artes 1 study INSTINCT, https://artes.esa.int/projects/instinct)

and investment in deployment over the long operational lifetime.

We would like to note here however another characteristic feature and advantage that a satellite infrastructure offers. Once in orbit, a satellite infrastructure offers a quick and flexible roll-out of services and provisioning connectivity.

Possible use-case scenarios for satellite communication in 5G

The various 5G activities [FP7 METIS, NGMN white paper, ITU-R M.2083-0: IMT Vision - "Framework and overall objectives of the future development of IMT for 2020 and beyond", ETSI 3GPP TR 38.913 v0.3.0] over the years have identified a broad range of use cases for 5G. Eurescom, together with some key players have conducted some studies funded by the European Space Agency over the last couple of years that concluded that satellite communication can be a useful contributor in many cases. Potential use cases that could benefit from the incorporation of satellite communication to a varying degree include the NGMN use case families broadcast-like services, broadband access everywhere, higher user mobility, massive Internet of Things, lifeline communications and ultra-reliable communications, but also broadband access in dense areas.

Possible role of satellite in a 5G delivery architecture

The most obvious application of satellite communication in a 5G delivery architecture is in the backhaul segment of the network (see figure). Deploying satellite in this segment could support the terrestrial 5G solution with an offload, to start with. However, satellite in the backhaul can assist with populating content caches close to the edge, deliver over the air configuration updates and software patches for M2M solutions, and support the instantiation of network functions at the edge in mobile edge computing solutions through replication of virtual machines via broadcast.

A more futuristic usage scenario of satellite is when it is deployed in the access network communicating directly to the user terminal, possibly LEO satellites with some embedded facilities. This usage of satellites can help with signalling offload or creating an emergency 5G slice.

Until now satellite communication had to be understood as a transparent communication channel via satellite, sometimes referred to as a "bent pipe". However, with the advancement of technology on-board processing – including storage – in satellites can open up opportunities to place networking functionalities in space. Ultimately, such a vision includes complete mobile base stations in space flying on a low Earth orbit.

Outlook

There is still a lot of work to be done in order to address the main issues concerning satellite communication and its potential use within a 5G environment. An essential element that needs to be in place to support the implementation of integrated 5G solutions are standards. The standards for 5G are currently being shaped, and it is critical that they leave room and include the provisions for an integration of satellite communication with terrestrial 5G implementations.

Satellite communications in the 5G ecosystem

Results from ESA-funded research

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Satellite communications is becoming an important element in the 5G ecosystem, complementing fixed and wireless terrestrial communication. This article presents results from two studies which were partially supported by the European Space Agency under ESA ARTES 1 (Service delivery over integrated satellite terrestrial networks) and INSTINCT (Scenarios for integration of satellite components in future networks).

The "software defined" implementation model

In order to increase utilisation of ICT resources and attain flexibility of provisioning, the IT community developed new technology based on virtualisation. This technology enabled the cloud computing delivery model, which executes on standard general purpose ICT equipment and facilitates the "software defined" implementation model.

This new delivery model enables the introduction of new business roles and prompts the redefinition of existing business roles in the service-delivery value chains based on the NIST definition of cloud computing and its service models. Beyond IaaS, PaaS and SaaS, managed virtual service providers thereof as well as facilitator service providers such as brokers, interoperability exchanges and federation managers are introduced.

In the "software defined" model the role of software developers has become central and open source has become an established model for development processes. These developments have challenged the regulatory frameworks that ensure economic investments and fair competition.

Virtualisation in the telecoms industry

The telecommunications industry is actively adopting these changes and re-positioning its offers to compete with the Over-The-Top (OTT) service providers for market shares. At the infrastructure level, telcos are in a good position concerning the network-connectivity resources and are committed to further invest in acquisition and deployment of terrestrial and satellite resources. In addition, the telcos are working on the deployment of computing resources as close to the customer as possible as the basis for the provisioning and management of their service offerings. Services are assembled and managed on-demand from a pool of virtual network functions through the concept of Service Function Chaining (SFC). Last but not least, Big Data and Machine Learning contribute to high automation of the service delivery and execution as well as the operation and business support processes.

The 5G initiative covers all above aspects in an effort to deliver the technology that meets the ambitious KPIs of the 5G-PPP programme. However, the 5G initiative is predominantly driven by

the terrestrial operators and as such does not sufficiently consider requirements derived from use cases specific to the satellite operators.

Opportunities of satellite communication in 5G

Users want one network that meets their requirements. At the same time, application developers will not design their solutions to accommodate different network characteristics such as propagation delay. This implies that seamless compatibility of satellite and terrestrial 5G networks is an important market requirement.

Cost-effective global service delivery is only possible via satellite communications. Service and data delivery to remote areas will continue to be a clear market opportunity for satellite network operators.

Management of fleets, hotels, peering services with all parties, virtual private networks, telehealth, tele-learning, e-government, and video services for island nations are just a few examples of human-centric use cases. In addition, the emerging market for massive IoT/M2M solutions will open new opportunities for delivering connectivity at very reasonable cost (see Figure 1).

Compared to terrestrial mobile service value chains, satellite communication operators can provide a single global network at reduced operations and business support costs. This advantage will increase in the future considering the deployment of mega constellations of Low Earth Orbiting (LEO) satellites offering services such as fine-grained geo-location ubiquitous access or effective global transit. Furthermore, in the future cloud computing resources may be deployed in space. As a result virtual operator business models based on satellite resources will be more effective and efficient in space than on the ground.

Satellite networks are less vulnerable to physical attacks and natural disasters than their terrestrial counterparts – an intrinsic property that makes them the preferred delivery method for highly secure and mission-critical services. Due to the physical properties of optical free space communication, combined with the intrinsic point-to-multipoint and broadcast capability, satellite links can deliver more performant and reliable services than terrestrial links.

Capacity increases have progressed significantly due to new concepts such as spatial reuse of frequencies and spectral efficiency gains through new modulation codes. This will continue by exploiting the predictive position of the satellite and the geo-location capability of ground equipment to devise adaptive and more efficient schemes.

Further envisaged performance improvements relate to routing and traffic engineering algorithms that leverage the full predictability of the infrastructure, potentially delivering assured-quality connectivity services via a fully meshed routed network.

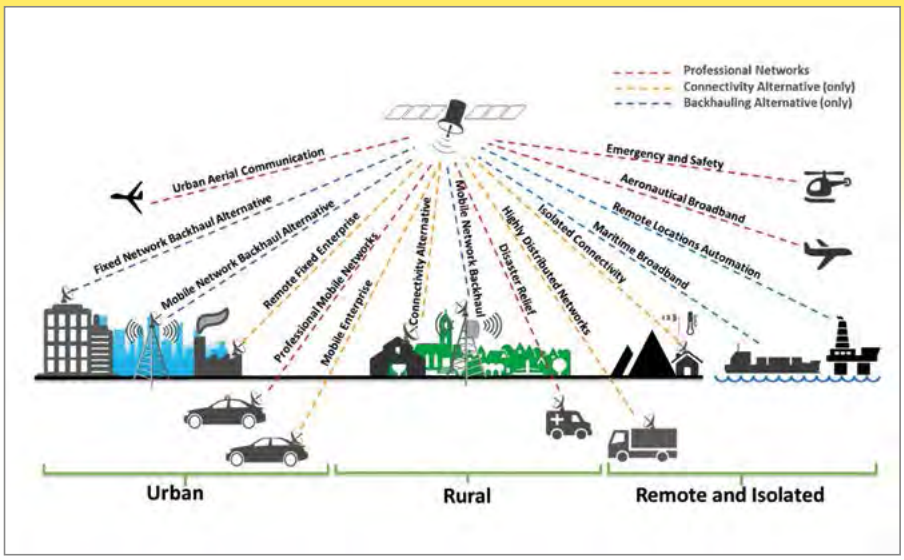

Figure 1: Selected use cases for satellite communication in 5G

Advances in propulsion and positioning technology enable satellite re-positioning on-demand. Such "mission topologies" can be instantiated for an ephemeral time period in user and operator scenarios, opening up great innovation potential in this area.

New manufacturing processes and technologies will dramatically bring down the traditionally high cost of space-platform manufacturing allowing new market entrants to "disrupt" the market with specialised skills such as virtual factory services. The same applies to launching and retreatment costs, as technology advancements are taking place in smaller commercial entities. Costs of operations and maintenance of Data Centres (DCs) in orbit are potentially lower than on earth, due to favourable environmental conditions.

Challenges of satellite communication in 5G

Propagation latency is perceived as the main limitation of services based on satellite technology. Ultimately, the propagation latency of the connectivity services will be managed by an adequate size and topology of the constellations, the dynamic configuration of the client beams as well as Delay Tolerant Networking (DTN) and caching capabilities.

The processing latency will be managed by an adequate distribution of the virtual functions' execution across space- and ground-based DCs. New architectures and topologies of space-based DCs will emerge, responding to business-driven use cases. Selected areas for research and innovation related to network functions are:

- Channel model
- Modulation and error correction codes
- Antenna design
- MAC protocols
- L2 Virtual Private Networks based on MPLS across any links with concurrent support for packet and circuit switched links
- Routing algorithms considering properties such as link and energy costs, latency or regional restrictions

The most important challenge is the interoperability with terrestrial networks supporting both B2B and B2C scenarios. In particular interoperability is necessary to enable overlay, backhaul and transit for terrestrial systems.

The interoperability at the level or IaaS, PaaS and SaaS related business roles; including the facilitator business roles will be essential for achieving agile value chains in two-sided markets. Several challenges related to data interoperability are expected to be addressed via emerging international space operations standards.

The overall architectural framework introduced by the 5G-PPP architecture work group is presented in its published white paper. Therein the impact of software technologies, new business roles and value chains is described in the context of the future software network architecture. The challenge ahead is related to the full softwarization and programmability of the infrastructure composed of physical and virtual resources including the life-cycle management.

An accurate time service is critical for the synchronisation of ground-based nodes and for the fine-grained determination of satellite position, and thus is a primary input parameter for the management of topologies, routes and data flows. An exemplary deployment for a LEO constellation including interworking capabilities with Geostationary Earth Orbit (GEO) satellites and other terrestrial networks is shown in Figure 2.

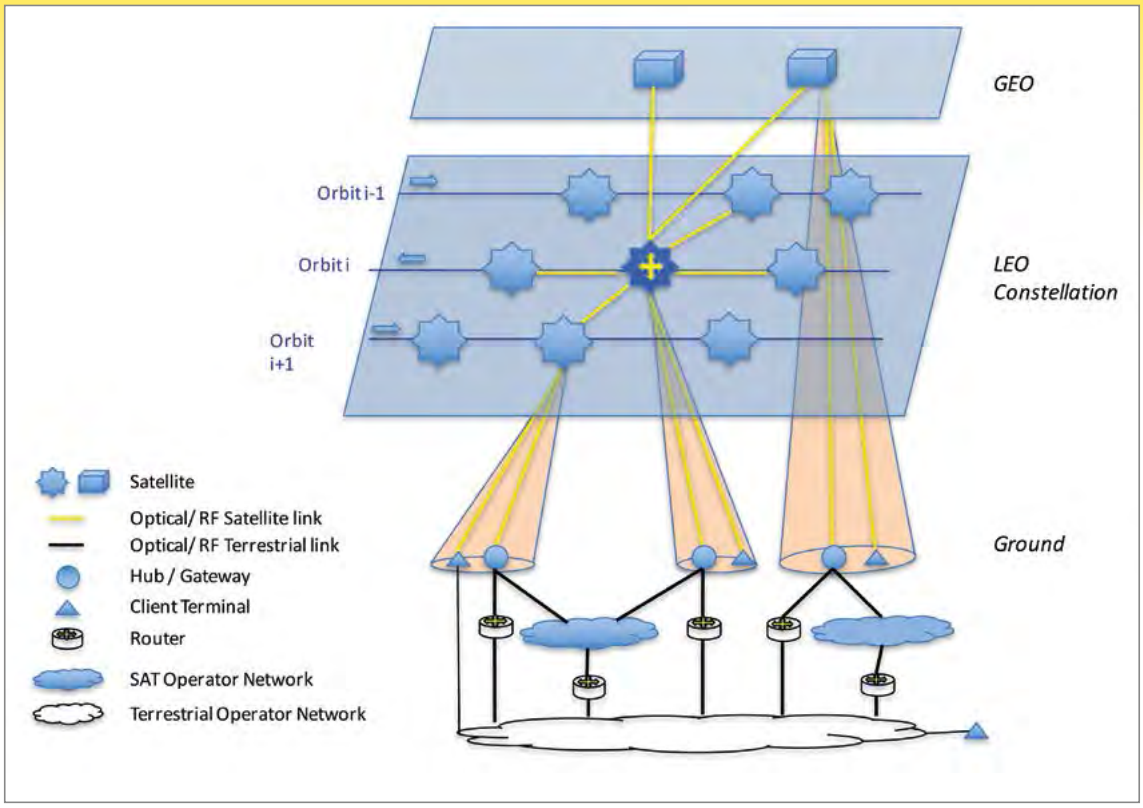

Figure 2: Converged physical architecture

Conclusions and further steps

Satellite communication has the potential to guarantee bandwidth, performance and security anywhere at competitive prices. To achieve and exploit this potential and stimulate investments, a number of steps are needed, including:

- Closer involvement and cooperation with terrestrial players in the 5G activities, including technology, standardisation and regulatory issues. A suggested roadmap of required activities is illustrated in Figure 3.
- Enablement of APIs to programmable resources and their inclusion in the value chains, for example via developer platforms and marketplaces.
- Cross-disciplinary research and innovation in space platform manufacturing, launching, positioning, space-generated data and telecommunications.
- Accelerated introduction of public-private partnership projects supporting proof of concept initiatives through large pilot projects for selected B2C and B2B services in various vertical sectors, intellectual property rights transfer from the public to the private sector, and targeted investments.

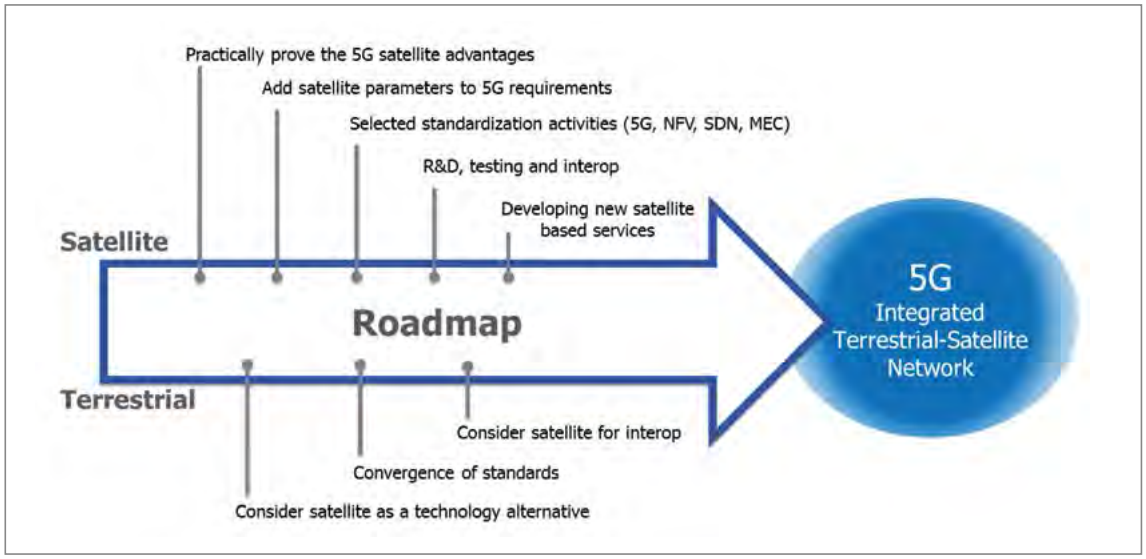

Figure 3: 5G Roadmap for satellite integration

Celtic-Plus Newsletter 1/2016

HFCC/G.fast – Hybrid Fibre-Copper Connectivity using G.fast

Business impact and networking – Celtic-Plus Event in Stockholm

SASER – Safe and Secure European Routing

Editorial

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Dear readers,

Some people ask critical questions about what the value of collaborative international R&D project work really is. Are programmes like EUREKA, Celtic-Plus and other collaborative initiatives truly worth the tremendous effort we put into them? The answer from a Celtic-Plus perspective is a clear 'yes'. In November 2015, we received additional proof for that when we had the final reviews and the closing session of our large Flagship Project, SASER – Safe and Secure European Routing. At this session, which was hosted by the project leader Alcatel-Lucent in Stuttgart, the SASER project participants proudly presented their ground-breaking achievements. More than 80 participants attended the event, among them high-level representatives of the funding bodies in Germany, France and Finland.

The European business impact that SASER already achieved during the lifetime of the project is huge. Dozens of new products and product improvements, many standards contributions, and numerous published papers are proof that SASER has been a huge step towards better and more secure communications in Europe and a push for European industry in related ICT sectors. This demonstrates very well that such collaborative R&D projects are crucial for Europe's companies, because they ensure that technology invented and made in Europe stays at the competitive edge necessary to be successful in the global market of cutting-edge technical products.

A new Celtic-Plus Flagship Project has started in April 2016. The project is called SENDATE, Secure Networking for a Data Center Cloud in Europe, which is applying innovative approaches such as Network Functions Virtualization (NFV) in combination with Software Defined Networking (SDN) for a secure, flexible, low latency, and locality-aware distributed data centre approach to support the upcoming application scenarios.

Due to the high number of labelled projects in 2015, we still have about 10 new projects in the starting phase. The next chance to submit project proposals to Celtic-Plus is our Autumn Call, closing on 14 October 2016.

To better help you find your way into the Celtic-Plus world, we have changed and updated the information that was previously presented in the Celtic-Plus Purple Book in a completely new document: "Celtic-Plus – Scope and Research Areas 2016/2017". I hope that this document will make it easier for you to work on your Celtic-Plus project idea and get familiar with the Celtic-Plus programme philosophy.

In this issue of our newsletter, we present to you project results and information on our activities. In spring 2016, we had a Proposers Day in Madrid and our Celtic-Plus Event in Stockholm, which was collocated with the EUREKA Innovation Week and other EUREKA Cluster meetings that were hosted under the Swedish EUREKA Chairmanship. At Celtic-Plus we are very proud that another Celtic-Plus project won the prestigious EUREKA Innovation Award. Our project HFCC/G.fast (Hybrid Fibre-Copper connectivity using G.fast) has been selected as winner in the category 'Competitiveness'. Please read their success story in this issue.

You might have noticed that I took over the responsibility for the newsletter from Peter Stollenmayer who returned to his parent company, Deutsche Telekom. I would like to thank him for the excellent work that he contributed during the last two years in the Celtic Office.

I hope you enjoy reading this issue of the Celtic-Plus Newsletter, and would welcome your comments.

Peter Herrmann
Editor-in-chief

HFCC/G.fast – Hybrid Fibre-Copper Connectivity using G.fast

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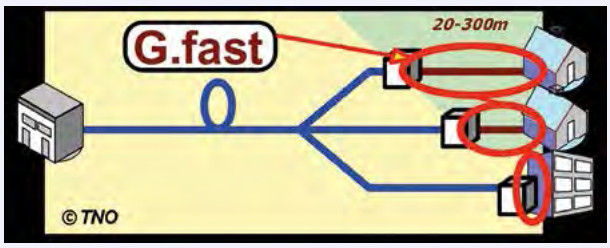


Figure 1: The deployment of G.fast in the access network

The Celtic-Plus project HFCC/G.fast, which stands for Hybrid Fibre-Copper connectivity using G.fast, had the goal of completing the standardization of G.fast, and it achieved its goal. This article tells you how, and why this is important.

The development of European economy, lifestyle and society is increasingly dependent on ICT. We are experiencing an ICT-driven industrial revolution where new values are created at unprecedented rates. One cornerstone of this development of competitiveness, lifestyle, and society is broadband access systems. Without affordable and capable broadband connections to our homes, our lives would be quite different. Our goal is to bring users ten times more bandwidth at much lower cost than any alternative.

A central development is that optical fibre gradually replaces copper growing from the central offices outwards so that new generations of broadband systems can operate over shorter and shorter copper loops and deliver higher bandwidths. This progression has been achieved through first voiceband modems and ISDN, over the ADSL family and then the VDSL systems, delivering about a factor of ten more bandwidth every ten years or so. The next step is G.fast, a hybrid fibre-copper system that delivers gigabit speeds over telephony wires.

With the first project in a series of three, the CELTIC project 4GBB, we developed the G.fast concept and initiated standardization of G.fast family of standards. The first version of the standard was completed in record time by the CELTIC project HFCC/G.fast. Previous broadband generations took about ten years from concept to market, but through effective collaboration and coordination using the CELTIC projects as a platform, it was possible to cut five years of the process. The project's vertical structure, where each segment of the chain was represented by at least one enthusiastic partner, together with the project's strong industrial orientation, were key elements of success.

The G.fast technology

G.fast surly is the ideal technology for pumping up the capacity of the access network yet a factor of ten. Fibre roll-out all the way to the homes is still prohibitively expensive and therefore not happening on a sufficient scale. G.fast needs new fibre but bridges the final, most expensive, gap of about 200 m to the homes by providing high-speed broadband over the existing copper cables (see Figure 1).

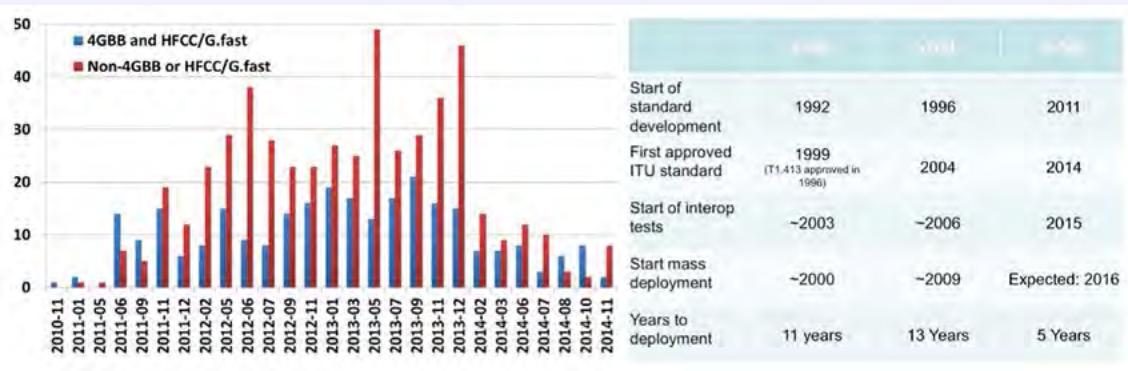
G.fast standardisation – main goal of HFCC/G.fast

The main goal of the HFCC/G.fast project was to complete the G.fast standardisation which was reached on 4th December 2014. Members of the consortium submitted over 300 standardization contributions during the brief period of five years from the start of G.fast standardisation until deployment (see Figure 2).

Conclusion

Most people in the industrialized world can relate to broadband communications. We all use the Internet and all the content and services made available by this incredible platform. It has not only changed our lives and lifestyle, it is also profoundly transforming business and industry. The DSL family, operating over telephony copper cables and backhauled by optical fibre, has been the most common broadband access type throughout this societal metamorphosis. As such, it has had a tremendous impact on our society, our economy and us. With 4GBB, we initiated the standardization of G.fast, the newest member of this family of broadband systems. With HFCC, we completed the standard and produced G.fast hardware and support systems.

■ Further information about the HFCC/G.fast project is available at www.celticplus.eu/project-hfcc_g_fast/



Start of standard development	1992	1996	2011
First approved ITU standard	1999 (T1.413 approved in 1996)	2004	2014
Start of interop tests	~2003	~2006	2015
Start mass deployment	~2000	~2009	Expected: 2016
Years to deployment	11 years	13 Years	5 Years

Figure 2: Standardisation contributions from 4GBB and HFCC/G.fast partners (note on the right side that interoperability testing for ADSL came after large-scale deployment)

Ideas for New Projects

Celtic-Plus Proposers Day in Madrid

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On 16 March 2016, Celtic-Plus held a Proposers Day in Madrid, kindly hosted by CDTI, one of the two Spanish funding authorities. Celtic-Plus Proposers Days follow mainly three purposes: informing about public funding opportunities, discussing potential ideas for Celtic-Plus project proposals, and networking with potential project partners. Spain is in charge of the EUREKA Chairmanship in 2016/2017, and we expect a strong increase of attention regarding EUREKA- and EUREKA-Cluster projects.

The Celtic Office organises three Proposers Days per year in different EUREKA countries. In 2016, Proposers Days are organized in Madrid, Istanbul, and Belgium.

For this first Proposers Day of the year in Madrid, nearly 90 people had registered. The host, CDTI (Centro para el Desarrollo Tecnológico Industrial), provided a perfect local organisation for open and constructive discussions. The audience was welcomed by José Maria Perez, head of energy communications at CDTI, Antonio Alcolea, Deputy General Director of SETSI, MINETUR (Ministry of Industry, Energy and Tourism), and by the Celtic-Plus Chairman, Jacques Magen, who invited all Spanish ICT-related companies to actively participate in Celtic-Plus.

Oscar Chabrera, who has led the award-winning HIPERMED (High Performance Telemedicine platform) project, reported in his keynote about the large societal and commercial impacts of his successful Celtic-Plus project. He stressed that working within the Celtic-Plus environment provides the freedom for projects aiming at exploitable results to add real value.

Spanish Celtic-Plus framework and public funding

Oscar Fernández Moyana and Javier Echávarri from CDTI, together with Jesus Cañadas and José Ángel Alonso from MINETUR, informed the audience about the Spanish Celtic-Plus framework and the improvements in public funding of MINETUR. The public funding mechanisms of CDTI and MINETUR are different. CDTI's funding is based on loans, of which 30% are not to be re-imbursed; they can go up to 75% of the eligible budget. In addition CDTI issues tax relief certificates. Organisations can apply for the funds at any time. MINETUR's funding is based on grants and loans; grants can go up to 60% for SMEs. There is one call per year; the 2016 deadline is planned for the end of July. The Celtic-Plus Label is a pre-requisite for being funded.

José Tomás Romero introduced "es.Internet", an industry-led technology platform with about 400 members. One of the premises is "market-pull", i.e. the different application sectors raise the needs. Although it is a Spanish initiative, it has an international scope and collaborates with FI-PPP, 5G-PPP, and EUREKA Clusters like Celtic-Plus.

Celtic-Plus project idea pitches

One of the core elements of the Proposers Day was the presentation of nine interesting project idea pitches, which were well received and thoroughly discussed.

Among the presented research ideas are 5G-related networks, applications, and testbeds, and RFID technologies. For the detailed presentations see https://www.celticplus.eu/event/celtic-plus-proposers-day-on-16-march-2016-in-madrid/

Participating in Celtic-Plus is easy

In a best-practices session the participants learned how easy it is to submit a project proposal to Celtic-Plus. By the different Call deadlines proposals get submitted to the Celtic-Plus online proposal portal. A template for the proposal is available on the Celtic-Plus Website at www.celticplus.eu. Usually within a month, the proposals are evaluated by independent experts and labelled in a special Celtic-Plus Labelling meeting with the Public Funding Authorities. Typically within less than six weeks, proposers get a reply whether their projects received the Celtic-Plus Label, and what comments were made by the experts and Funding Authorities. As soon as the public funding is ensured, labelled projects can start. The typical success rate is 60-70%. The Celtic Office is happy to provide any required support through all phases.

Conclusion

The Celtic-Plus Proposers Days are crucial means for incubating novel ideas for new Celtic-Plus projects, to discuss these ideas with interested experts and to network with other organisations to build strong consortia for successful projects. If the ideas are turning into project proposals, consortia with at least two EUREKA countries participating are very welcome to submit their proposals at the upcoming Call on 14 October 2016.

Further information

- Presentation slides and photos of the Proposers Day – www.celticplus.eu/event/celtic-plus-proposers-day-on-16-march-2016-in-madrid/
- Summaries and contacts of project ideas presented at earlier Proposers Days – www.celticplus.eu/project-ideas-from-proposers-days
- Information on upcoming Proposers Days – www.celticplus.eu/?post_type=tribe_events

Business impact and networking

Celtic-Plus Event in Stockholm

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This year's Celtic-Plus Event took place under the Swedish EUREKA chairmanship in Stockholm, Sweden, on 28 – 29 April 2016. It was held in conjunction with the EUREKA Innovation Week, which attracted more than 900 participants and 50 exhibitors from 33 countries.

The Celtic-Plus Event was opened by Cecilia Sjöberg, Director and Head of Services and ICT Division at VINNOVA, and Celtic-Plus Chairman Jacques Magen. The event presented achievements of Celtic-Plus projects and provided a glimpse on the future of information and communications technologies. The major annual event of EUREKA Cluster Celtic-Plus also offered ample matchmaking opportunities for developing new project ideas and partnerships in the area of ICT.

The participants had the opportunity to get first-hand insights on a number of successful Celtic-Plus projects, including some which had finished a few years ago and which have already achieved significant business impact.

Rollout of G.fast technology in the UK

A special highlight of the event was the announcement that BT is now rolling out the new gigabit broadband access technology in the UK to 10 million customers. The G.fast technology that was developed by the HFCC/G.fast project is the next step for bringing optical fibre closer to homes. In many aspects it is the successor of the well-known DSL technology but with Gbps class bandwidth. For this outstanding achievement the HFCC/G.fast project has won the prestigious EUREKA award in the category "Competitiveness".

In a roundtable the representatives from six outstanding projects discussed together about their achievements and the usefulness of the EUREKA/Celtic-Plus context. In addition, five Celtic-Plus projects received a Celtic-Plus Award (see next article).

Common session of Celtic-Plus and ITEA 3

For the first time Celtic-Plus and ITEA 3 had a joint session. It was animated by the two chair persons, Zeynep Sarılar from ITEA 3 and Jacques Magen from Celtic-Plus. The keynote presentation by Lena Carlsson from the Swedish Agency for Economic and Regional Growth gave new insights on how digitalisation transforms society. The second keynote speaker, Daniele Quercia from Bell Labs in Cambridge, presented completely new aspects for future city planning, taking into account noises and also odours, for example in "Smelly Maps" of the city of London.

15 Celtic-Plus projects in the exhibition

The exhibition included 15 Celtic-Plus projects that presented their results, which attracted many participants who engaged in intensive discussions and networking. The project booths showed real prototypes that were either hardware or software implementations.

Sessions on the second day

The second day started with a keynote speech by Anna Piperal from eEstonia. She presented news from one of the most digitalized countries in the world, Estonia, where 97% of all administrative

Anna Piperal from eEstonia presented the advanced state of digitization in her country

Roundtable session of public authorities, from left: Jacques Magen (Moderator), Hannu Nurmi (Finland), Mark Burbidge (Canada), Juana Sanchez (Spain, CDTI), Mete Karaca (Turkey), Andreas Aurelius (Sweden), Jesus Canadas (Spain, MINETUR), Serge Bodjrenou (France), and Gitae Shim (South-Korea)

acts are done electronically, without paper. This was intensively discussed by the audience.

In a roundtable session, public authorities form Finland, France, Spain, Sweden, Turkey and for the firat time also from Canada and from South-Korea explained the processes and recent development in their countries that allow to fund Celtic-Plus projects.

The next session was dedicated to 25 new project ideas that were presented in five-minute pitches to the audience. This session was the starting point for ample networking among emerging project consortia and talks between future proposer and the representatives from public authorities. In the project pitch session not only project ideas from Europe, but for the first time also ideas from Canada and South Korea were presented. A large number of transnational research projects are expected to be launched as a result of the many personal encounters at the event.

- Further information on the Celtic-Plus Event 2016 is available at https://www.celticplus.eu/event/celtic-plus-event-2016/

Five Winners at Celtic-Plus Awards 2016 in Stockholm

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At the Celtic-Plus Event in Stockholm on 28 April 2016, five projects were awarded for their outstanding work. Three projects received the Celtic-Plus Excellence Award and two projects the Celtic-Plus Innovation Award. The awards were presented to the winners by Celtic-Plus chairman Jacques Magen und Andreas Aurelius, head of ICT at Vinnova, the Swedish innovation agency, which hosted the Celtic-Plus Event as part of the EUREKA Innovation Week.

Excellence Award in the category Network Technologies: SASER – Safe and Secure European Routing

SASER has contributed to making communications networks in Europe faster, more cost-effective, safer and more secure. The goal of Celtic-Plus flagship project SASER was to provide concepts and solutions for secure transport networks in the 2020 time frame.
The quantity and quality of SASER results is truly impressive, and the business importance of SASER for Europe is extremely high. With the results of the SASER project, Europe has significantly increased its competitiveness in the areas of optical networking and network security.

- Project leader: Alcatel-Lucent Deutschland AG, Germany
- Duration: August 2012 – December 2015
- Website: http://projects.celticplus.eu/saser/

Excellence Award in the category Services and Applications: QuEEN – Quality of Experience Estimators in Networks

QuEEN developed a new quality-of-experience (QoE) agent, which can flexibly aggregate QoE components. The project created a powerful quality assessment tool that adapts to various communications technologies.
The project has been the source for a new paradigm in the QoE technology. It has realized a new modular and layered QoE agent that can flexibly aggregate different QoE components. The QuEEN Agent has the potential to become "an enabler for a complete new way of using QoE in many different communication related fields.

- Project leader: Orange S.A., France
- Duration: September 2011 – December 2014
- Website: https://www.celticplus.eu/project-queen/

Excellence Award in the category Smart Cities: TILAS – Technology improvements for large scale smart cities deployments

TILAS enhanced the already deployed infrastructure in Santander's Smart City with its over 1,200 sensors. It provided solutions ranging from node testing, node packaging, latency reduction to over the air programming.
The project is an important step in the Internet of Things (IoT) development for Smart Cities. It is very positive that components developed in the project have been tested on real Smart City platforms in Santander, Seoul, Paris and Grenoble.

- Project leader: TST Sistemas, Spain
- Duration: Mach 2013 – December 2015
- Website: https://www.celticplus.eu/project-tilas/

Celtic-Plus Innovation Award: HIPERMED – High Performance Telemedicine platform

Hipermed implemented a High Performance Telemedicine Platform based on a unified Service Oriented Architecture, which provides media over IP.

Five healthcare scenarios (professional-to-professional and professional-to-patient) have been implemented on the platform and were validated by medical doctors.

Hipermed was the first true Multi-domain Celtic project where 3 hospitals have been actively involved and where the expertise from the medical side became equally important as the communication aspects.

As a result of the project, one new company, VIDEOCAFE, was founded, and 20 new jobs created.

- Project leader: Merkum Energética 2010, Spain
- Duration: July 2010 – June 2013
- Website: http://www.hipermed.org

Celtic-Plus Innovation Award: IPNQSIS – IP Network monitoring for Quality of Service Intelligent Support

IPNQSIS developed mechanisms that allow monitoring and managing service quality of IPTV, Mobile TV, VoIP and videoconferencing. These mechanisms enable optimising the customers' Quality of Experience.

IPNQSIS has demonstrated a high level of innovation and business relevance. A particularly strong point is the exchange and benchmarking of components, which resulted in a common vision between four national demonstrators. Furthermore, the project addressed the links between QoS and QoE through different technical approaches and for different scenarios.

- Project leader: Indra Sistemas, Spain
- Duration: October 2010 – April 2013
- Website: https://www.celticplus.eu/project-ipnqsis/

SASER – Safe and Secure European Routing

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In the SASER project a European consortium of 69 leading industry and academic partners from Germany, France, Finland, Denmark, and the United Kingdom joined forces to develop safe and secure European routing. The goal of SASER was to provide the scientific, technical, and technological concepts and solutions for secure telecommunication networks in the 2020 timeframe. These European solutions are based on the strengths and expertise in security, software-defined networking, and high-speed optical transport networks to overcome the bottlenecks and vulnerabilities of today's electronic all-IP based infrastructure.

Key topics

The collaborative work of the partners in SASER addressed three key topics: security, networking, and physical layer transmission.

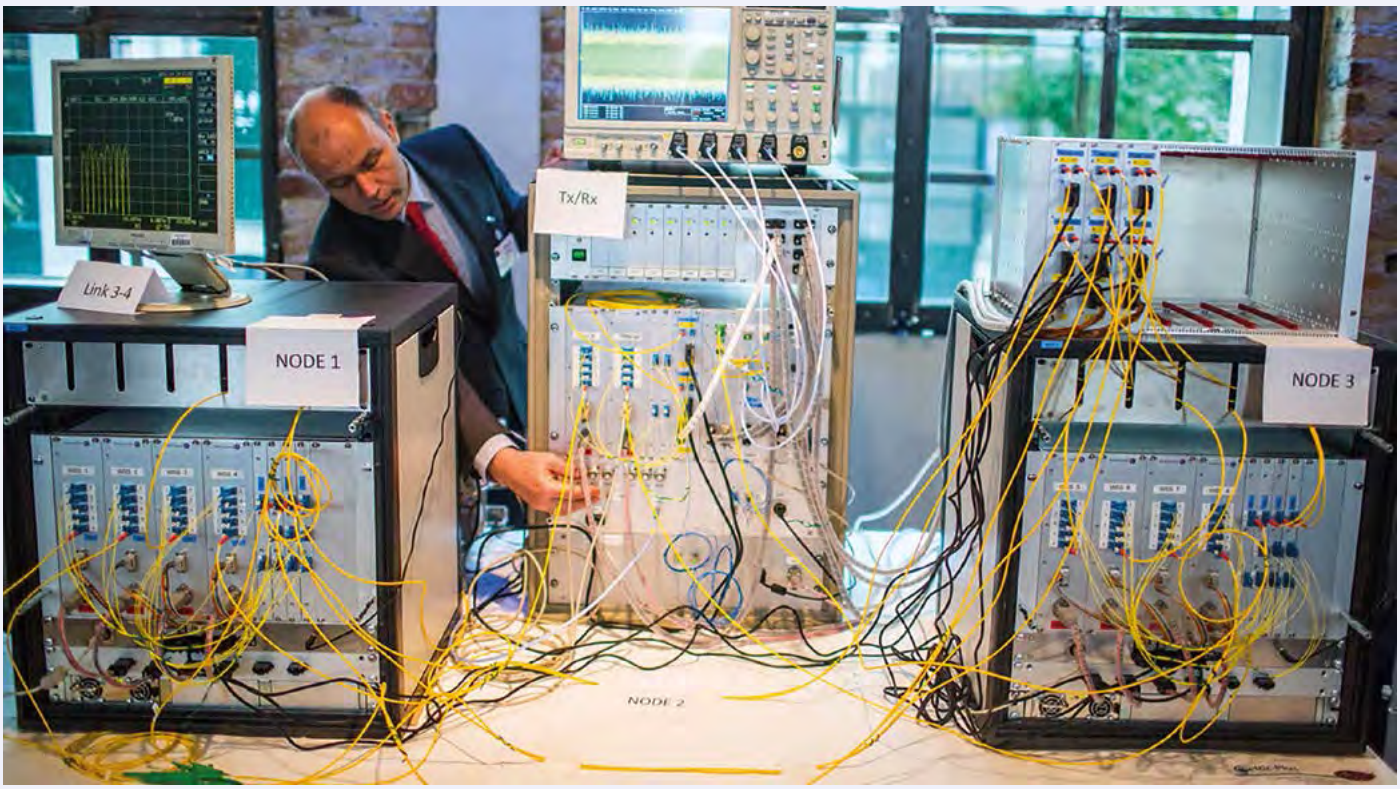
Security

The first topic focused on security, safety, and reliability. A new architecture and operational concepts of highly secure and reliable transport networks were developed and evaluated. This included the analysis of system requirements, system constraints, and new technologies like network virtualization and software defined networking. In addition, the protection of networks against external and internal attacks was investigated, e.g. backdoor and anomaly detection, and appropriate methods to secure networks were developed. The focus was on the analysis of threats and security requirements of the newly defined network architecture. Finally, safe and reliable transmission was ensured using innovative coding mechanisms.

Networking

The focus of the second key topic was on scalable, reliable, and energy-efficient network and node architectures taking benefit from low energy optical transport networking techniques. Therefore, centralized vs. decentralized node architectures and their related layer depended functionalities were evaluated. The replacement and reduction of core routers by integrated optical/electrical nodes with different switching granularities and transparent bypassing of IP routers were analyzed, leading to a reduced dependency on IP router solutions.

Furthermore, extensive use of optical switching approaches to bypass complex, energy-hungry electronic packet-processing entities were evaluated, which greatly improve the scalability and feasibility of the 2020 telecoms infrastructure. Another topic in this area was the development of



SASER demonstration

Examining the SASER results (from left): Dr. Andreas Leven, Alcatel-Lucent; Cornelia Rogall-Grothe, State Secretary at BMI – German ministry of the interior; and Dr. Georg Schütte, state secretary at BMBF – German Federal Ministry for Education and Research; Berlin 2014

novel photonic switching technologies for efficient large-scale nodes to overcome scalability and energy limitations of electronic solutions. In addition, a tool for multi-layer optimization of network resources, like e.g. spectral efficiency, with respect to cost, energy, availability, robustness, and switching times was developed.

Physical layer transmission

The goal in regard to physical layer transmission was to achieve a high spectral efficiency and energy efficient transport of optical signals. Therefore, an adaptive transmission format was developed employing flexible bandwidth channels and using software-defined optics to make optimal use of system spectral resources. Furthermore, the researchers have evaluated and implemented data conversion and digital signal processing schemes for high throughput transmission at low energy consumption. Finally, digital signal processing mechanisms for mitigation of optical components' limitations were developed.

Results

The SASER partners performed 9 field trials including 4 transmission world records, filed 76 IPRs, and contributed to more than 561 scientific presentations, journals, and conferences. The implementation of 46 demonstrators and 32 prototypes influenced the development / improvement of 20 / 28 products. The successful result transfer into product innovations of the industry partners created high business impact.

On the research side, 118 supervised master and PhD theses contributed to the great research results. In addition, 3 new companies were founded and the partners made 36 standardization contributions including 4 open source software contributions.

Conclusion

Overall, the SASER project was a very successful Celtic-Plus project. This was confirmed recently at the EUREKA Week in Stockholm 2016, when the SASER project received the Celtic-Plus Excellence Award for Network Technologies.

Already in 2015, during a high-level project closing event, the representatives of the national funding authorities, i.e. the German BMBF, the French DGE and the Finnish Tekes, expressed their high satisfaction with the project outcome concerning its technological and economic impact, and additionally expressed their support for a new funded project, SENDATE, which will investigate new research questions raised by SASER.

- Further information about SASER is available at www.celticplus.eu/project-saser/

IPNQSIS – Service-aware architecture for better Quality of Experience of multimedia services

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The Celtic-Plus project IPNQSIS, IP Network Monitoring for Quality of Service (QoE) Intelligent Support, has been a short-term, product-oriented R&D project. It aimed at improving the customers' perception of multimedia services.

The IPNQSIS project included 18 companies and institutions from Spain, France, Sweden and Finland (see figure 1). The consortium has developed a next-generation management architecture for improving QoE-driven network management.

The main goal for improving telecommunications services was to get a clear picture about how customers perceive the quality of their multimedia services. The project has designed a multimedia services management platform to assure the QoE delivered to end users. The work was performed from a customer perspective, optimizing the QoE. In this way, we have developed mechanisms to monitor and manage services offered on Next Generation IP Networks (IPTV, Mobile TV, VoIP) and to assure the optimal levels of Quality of Experience (QoE) in terms of customer experience management.

Business impact

The market focus of this project has been on telecommunication operators, and the main business lines in which our technology has been applied are traffic analysis for improving customer experience and reducing network cost, Correlation between QoE-QoS in multimedia applications, and IPTV QoE monitoring and QoE network management. Our technology is making product developments possible that enable greater correlation between the quality of the service and the actual user experience, thereby ensuring greater customer satisfaction.

The results that came out of the project comprise 26 commercial products related to three main business lines that were directly implemented in the market with a mean expected return on investment over the next 3 years of about 10 times the initial investment. Those products

Figure 1: IPNQSIS partners

allow to evaluate the Quality of Experience of multimedia services, such as IPTV, in order to enhance customer satisfaction and, therefore, to improve the quality of life of the citizens.

On the one hand, an essential goal was to get a clear picture about how customers perceive the quality of the multimedia services, and as a result we have developed a suite of products to monitor the customers' experience when using the services of an operator. On the other hand, the project has developed methods to analyse detailed content demand patterns from social media and other services that lead to a better evaluation and understanding of customers' behaviour. Moreover, IPNQSIS has implemented Quality of Experience (QoE) network management capabilities to improve the productivity of the applications, and, consequently, increase customer satisfaction.

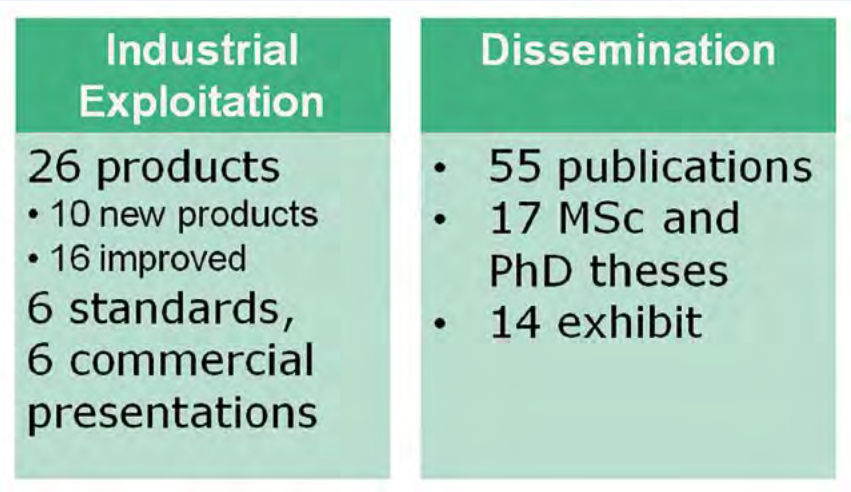


Figure 2: Impact of the IPNQSIS project

Business and dissemination outcomes

The partners of IPNQSIS have significantly improved their business position in comparison with their direct competitors. In addition, 100 dissemination activities to influence the existing solutions globally have been carried out: 55 papers have been accepted in journals, conferences, workshops and book chapters; 14 exhibitions, booths and poster sessions, 6 contribution to standards (IEEE, ITU-T, ETSI, etc.), 6 commercial presentations, 19 PhD and master theses, and over 20 press and social media releases. Figure 2 shows a summary of the industrial exploitation and dissemination activities.

Finally, we received very good feedback and ideas from customers and end users at our exhibitions booths at the Celtic Event, the Future Network and Mobile Summit, the NEM summit, and other events as well as at commercial presentations for major European telecommunication operators. Besides, IPNQSIS has demonstrated a high level of innovation and business relevance by winning the Celtic-Plus Innovation Award 2016.

Outlook

The IPNQSIS consortium led by Indra, Spain's number one IT multinational, consisted of 18 members belonging to major companies, universities and research centres.

This work has been partially funded by the CDTI in Spain under PRINCE project, DGCIS in France, VINNOVA in Sweden and TEKES in Finland.

The successful joint business impact achieved by the consortium has led to new research projects, such as EIT Digital NFMD (Networks for Future Media Distribution) and EUREKA Celtic-Plus project NOTTS (Next generation Over-The-Top multimedia Services). NOTTS extends the scope to OTT (Over The Top) services and offers a promising future in terms of business outcomes.

■ You can find more information on IPNQSIS at https://www.celticplus.eu/project-ipnqsis/

IPNQSIS

Celtic-Plus
Smart Connected World

www.celticplus.eu

About Celtic-Plus

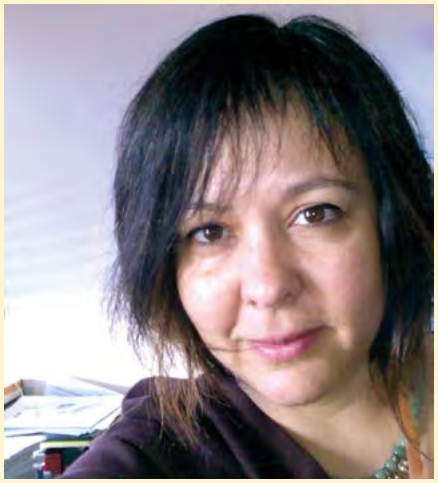
Celtic-Plus is an industry-driven European research initiative to define, perform and finance through public and private funding common research projects in the area of telecommunications, new media, future Internet, and applications & services focusing on a new "Smart Connected World" paradigm. Celtic-Plus 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.

EUREKA

Ubiquitous access

Interview on terrestrial-satellite convergence with Maria Guta from ESA

The convergence of terrestrial and satellite networks offers a number of benefits. At the same time there are still a few challenges to be tackled. Eurescom message editor-in-chief Milon Gupta asked Maria Guta, Senior Telecommunications System Engineer at the European Space Agency, ESA, about her insights on the status and future development of terrestrial-satellite convergence in Europe and worldwide. The views expressed by Ms Guta are her own and do not reflect the official opinion of the European Space Agency.



Maria Guta, ESA

What are the benefits of terrestrial-satellite convergence?

Future telecommunications networks will change everything about how we live, work, and interact. We examine the benefits of terrestrial-satellite convergence in the 5G environment, as it aims to provide a 'living network' experience to users. This is being reflected through requirements of ultra-high speed connectivity anywhere, anytime; emerging IoT applications addressing the needs of various user communities and of several vertical industries. To deliver on all these, the 5G environment has to be open towards a very broad set of requirements expressing a high variety, ensure high flexibility and embrace and integrate a broad range of technologies including satellite. Actually, satellite networks provide the means to support the spanning of the 5G environment towards other domains, especially global and highly reliable and secure networks.

Nowadays, ultra-high-speed satellite technologies permit a drastic decrease in deployment costs and make sharing of the environment a reality. Additionally, non-geostationary satellite constellations provide delays comparable to terrestrial networks by which they can now address efficiently a number of delay-sensitive use cases.

Satellite networks provide communication characteristics that cannot be supplied by other technologies. Thus, they are not competing with, but complementing existing and new 5G terrestrial technologies. The convergence of terrestrial and satellite networks needs to explore such complementarity and enable collaboration in hybrid services provisioning. Thus, a large number of the 5G 'living network' expectations can be fulfilled in a cost-effective, technically efficient and timely manner. Cost efficiency relates to the viability of several connectivity use cases; technical efficiency relates to the optimized use of resources i.e. spectrum, capacity, energy; time to deploy relates to how fast some services can be deployed vs costs. Timely delivery of services is indeed crucial, as this enables new revenues for all stakeholders.

From this perspective the largest advantage of convergence that satellite networks can offer is the uniform ubiquitous access especially for the new highly distributed network infrastructures where different users of the same service are distributed across the world. Beneficial synergies can also be obtained when the native broadcast/multicast capability of satellite networks is used for several fundamental 5G use cases, for example video services, simultaneous software updates of distributed edge network nodes, and global sensor networks.

Terrestrial-satellite convergence will also be beneficial for a number of specific use cases such as overspill, hot standby networks, and even coverage, where terrestrial-only deployments become highly expensive.

In which phase of technology development do you see terrestrial-satellite convergence today?

Although convergence of terrestrial satellite technology has always been a key element of services provisioning, the expectations of a future 5G 'living network' press for faster convergence.

Business-wise, the need to guarantee new revenues is equally pressing the terrestrial and satellite sector, while the costs of new infrastructure deployment are increasing.

Integration of Terrestrial-satellite networks is already a reality. However, a number of features, such as guarantee of end-to-end QoS, secure delivery, mobility and multicast support, are not always obtained in a technically and cost-efficient way. These are the areas where I see an urgent need to explore new technical solutions enabling true convergence.

Emerging networking techniques such as SDN/NVF and ICN should enable faster convergence. All these techniques lead to the softwarisation of telecommunication networks, permitting flexible and faster deployment of networks and of enabling features such as security, mobility, multicast, when and where these are needed, almost instantaneously, supporting also unified services orchestration and guaranteed service delivery.

Satellite networks can benefit the most from the use of such emerging technologies to further reduce their CAPEX and OPEX. It is obvious that satellite ground and user segment, meaning terminals, are the components where new technology is introduced first. Virtualization, SDN/NVF and ICN techniques are by now mainstream in R&D activities related to satellite ground/user segment. Talking in terms of Technology Readiness Levels, such developments should approach very soon TRL level 6, equivalent to 'System/subsystem model or prototype demonstration in a relevant environment'. Cloudification of satellite modem radio access and the orchestration of unified services remain still areas of lower Technology Readiness Levels. There is a need for large-scale live experimentations of integrated terrestrial satellite SDN/NVF-enabled networks to push TRL higher and test pre-operational end-to-end service performance.

To complete the picture, SDN/NVF and in-network caching are excellent examples of spin in technologies towards software-defined payloads and the development of advanced satellite constellation networks, which are able to adjust to changing needs over time. These are considered already in development roadmaps. However, several technical issues still need to be addressed due to the constrained environments these new technologies need to apply to.

How has research funded by ESA helped in the development of integrated solutions?

ESA's purpose provides for cooperation among European States in space research and technology including within operational space applica-

tions systems. The latter includes technology developments in support of commercial satellite operations. This support aims at maintaining and improving the capability and competitiveness of Europe's satellite industry in the global communications market, including 5G.

ESA R&D activities aim to mitigate the risks linked to the introduction of new technologies or of innovative system concepts in the market. Our research programme ARTES, which stands for Advanced Research in Telecommunications Systems, is already supporting some 5G-related projects involving our traditional satcom partners, and I am happy to also count terrestrial actors amongst the project participants.

These projects include, as a pre-requisite, the necessary studies on integrated SDN/NVF enabled system architectures to enable efficient delivery of machine-to-machine, Internet of Things and future 5G services, for example in media and entertainment. Additionally, a number of test-bed development activities are to be initiated to support the validation and live experimentation of these new technologies. Furthermore, we have taken steps to assess the impact of some of the ongoing satellite developments, like the mega-constellations in a 5G context.

Which technological, regulatory and business-related challenges still need to be addressed?

5G will operate as a shared environment comprised of several heterogeneous network components, and satellite will be part of this evolution. Convergence is key to a future which will see new players emerging, such as virtual network operators pooling terrestrial and satellite services in different domains and use cases. Eventually this could lead to the need for technically solid solutions for spectrum optimization to respond to a regulatory framework always under pressure.

Innovation and new service development, benefiting from integrated satellite and terrestrial services, will be required in the different services domains. This should not be limited to the more traditional satellite domains, such as video, remote connectivity, aeronautics, or backhaul. Services in support of emergency and safety and disaster relief may need special attention.

European initiatives, such as the Digital Single Market, and policies on cross-border content rights management are also crucial in establishing a solid environment enabling the creation of new services and new revenue streams.

All these factors should facilitate the evolution of the traditional static value chains and the positioning of conventional and new players. Network softwarisation should also facilitate the permutation of different value chain configurations where new actors could easily play a role or multiple roles. This would enable several instantiations of open technical and business trustful interfaces that could make the promised 'living network' a reality.

By when do you expect terrestrial-satellite integration to be mature for the market?

Network softwarisation as an emerging and disruptive technological evolution should be considered an accelerator of the terrestrial-satellite integration. However, this integration will not occur all at once, and it will neither cover all network components nor all market segments simultaneously. The evolution of value chains is also crucial in determining the rapidity of convergence and integration.

Several variants shall be ready for the market at different time scales. For example virtualization and SDN/NVF implementation at the satellite ground segment should be ready in less than two years, enabling unified service orchestration of integrated terrestrial networks.

Differences will occur in the various service domains. Innovation is usually introduced first in the media and entertainment sector, as it is there that new actors and value chain mutations are already occurring. However, big data and the emergence of connected objects economies should accelerate the integration speed in domains such as energy, automotive, and healthcare.

Differences will also occur in geographical areas. Well-served geographical areas such as Western Europe and North America would probably experience an evolutionary path. Green field deployments in uncovered and under-served areas as well as emerging countries could benefit straight away from new technological developments.

Although well-developed economies are those where new services are traditionally deployed first, the new technologies should also permit affordable service offerings to emerging and underdeveloped economies. It is there where satellite services can be deployed faster and in a cost-efficient manner.

Satellite networks and machine-to-machine communication

Opportunities for integrated solutions

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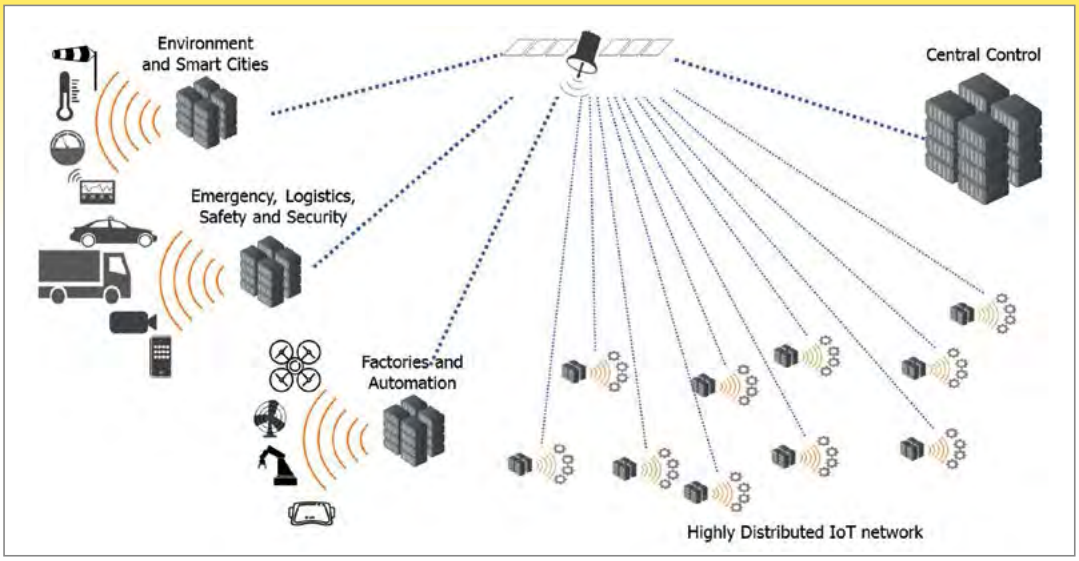
The expansion of the telecommunication systems towards digital convergence means to connect exponentially more devices to the network, which cannot come from the already saturated human devices market, only from the growth of connected devices, sensors and actuators, which use M2M communication. With its minimal terrestrial infrastructure needs, satellite provides a suitable technology alternative to terrestrial-only deployments for fast and reliable M2M services at reduced costs.

With their wide coverage and inherent broadcast capability, satellite networks are able to reach a very large number of geographically dispersed devices in a secure and reliable manner using only a very modest bandwidth. In addition, they are able to aggregate information and to broadcast data very efficiently. This makes satellite networks a prominent candidate for complementing existing and newly developed terrestrial technologies that mainly concentrate on low delay and high capacity communication (essential for human communication), but does not sufficiently address the need for coverage and wide area mobility, both being very important from an M2M perspective.

M2M trends

To achieve the expected success of M2M, network deployments have to surpass the current communication limits in terms of network and connection availability, efficiency and costs, especially in the initial phases of deployment when massive infrastructure deployments are not possible.

Satellite networks will alleviate some of these limitations and provide a better service than the current terrestrial systems through a single and secure connectivity network, which can be immediately made available without requiring complex installations usually on third party premises.



Main M2M use cases with efficient satellite backhaul

Due to their virtually infrastructure-less service, satellite networks can increase the coverage of terrestrial systems in remote, difficult-to-access areas as well as beyond country borders, making them ideal for single highly distributed system deployments such as static or mobile outdoor sensor and actuator networks like naval, asset management, weather or smart cities, for example.

Due to the large coverage and the reduced number of handovers, satellite networks can provide efficient connectivity to cars, trains, airplanes or unmanned aerial vehicles, as well as reach areas where the terrestrial infrastructure is missing and would require high infrastructure deployment costs.

Using their intrinsic broadcasting capabilities, satellite networks are able to reach a very high number of devices while consuming only a limited amount of resources. Satellites can provide control and management information to distributed network areas with reasonably low delay and very low number of messages, making them the most prominent candidate for maintenance and upgrade of M2M network infrastructures.

The adoption of edge networks as functional entities for M2M data aggregation and analytics are constraining the communication related delay and latency limitations to the access segment of the network, considerably relaxing any such latency requirement in the backhaul part of the network. Because of this satellite with the associated security and limited deployment costs becomes technically attractive to support the backhaul for low delay services too.

How satellite responds to M2M challenges

The exponential increase of the number of connected devices requires new technologies to be considered beyond terrestrial radio towards massive data aggregation and data broadcasting.

Satellite networks offer already the means for massive data aggregation through their geo-observation environment as well as the means to share the uplink connectivity in a very efficient manner from a very large number of connected network areas.

The deployment of a large number of devices poses a clear operational challenge, as the devices have to be maintained (security patches, etc.), configured and upgraded from time to time. Satellite can eminently support this through the efficient distribution of data on a massive scale and with a global reach, complementing terrestrial deployments.

Furthermore, satellite can provide on-demand backhaul capacity without the need of deploying additional terrestrial infrastructures. This can be used in the initial phase of the deployment of new services when the income does not yet motivate the roll-out of a terrestrial infrastructure or as intermittent backhaul as needed by a majority of M2M services, where the environment is shared on a time base between a very large number of services.

Devices can be constrained by limited computation and storage resources, and power capacity operating on battery. To enable the efficient communication of devices, M2M networks often rely on local communication aggregators and gateways, which use cheap, efficient short-distance communication technologies to the devices and are able to control the usage of the backhaul efficiently. The specific capability of satellite to address a very wide geographic area at the same time reduces the need to build out a backhaul to the gateways in the specific locations through providing a single hop uniform connection. This way, edge networks are inter-connected with a simple and straightforward infrastructure, i.e. offering little possibility for failures or degradation due to human error.

Ultimately, satellite networks can provide a very efficient connectivity alternative for M2M communication. In addition, satellite networks can also provide an alternative for remote and isolated areas as well as for congested environments where the radio capacity is not anymore available for communication and in dense inter-domain networks where data packets have to be passed through multiple autonomous systems to reach their destination. This represents the current market of the satellite networks, where M2M is now becoming one of the important connectivity services.

Additional M2M opportunities with satellite networks

Beyond the immediate benefits described above, using satellite networks as the main means to connect and transmit M2M data, satellite networks open a set of additional opportunities for developing new markets beyond the ones currently considered within the 5G environment.

Satellite networks can reach a very wide area, crossing any type of borders and through this ensuring the availability of connectivity through a single network provider. Based on this property, new opportunities arise in the connectivity of the M2M devices including roaming using the single satellite operator. Other business opportunities come from device activation and configuration via satellite for using the local network infrastructure and the backup for continuous connectivity availability of the communication to the satellite network in case when no terrestrial network is available.

Satellite networks have a very long tradition of supporting geo-observation use cases. Using satellite imagery the terrestrial-located analytics can derive results with global economic impact. Through the integration of satellite communication with UAV, especially via new transmission

technologies over-the-air, satellite networks can enable a comprehensive sensor and image analytics that can further progress the digital translation of the real world environment.

Finally, the current evolution towards mobile wireless networks introduced a new type of gateway specifically for M2M, which moves through the environment and collects the sensor data from devices with no long-range communication capabilities. Satellite backhaul for such a mobile M2M gateway could provide the means to combine and aggregate the data from multiple sources and use the uplink in an aggregated form. Such a solution would offer a very secure connection between the mobile data collector and the network specifically suitable for this type of delay-tolerant services.

Conclusion

To reach and deliver on the ambition of having a massive number of devices connected, the M2M ecosystem and environment has to consider and incorporate a broad and heterogeneous range of access and backhaul technologies appropriate for the different types of devices and usage scenarios. One of these technologies with a very large potential in backhauling is satellite communication, due to its capability to slice in a time-base the uplink connectivity as well as its efficiency to broadcast on a massive scale.

For this to become a reality, an integrated satellite-terrestrial network architecture is needed that considers the necessary advancements in efficient short-distance M2M communication between devices and edge networks as well as the efficient backhauling, appropriate for the application needs.

Satellite on-board processing for terrestrial network integration

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Satellite communications enjoys a renewed market interest. The capability to place processing on-board of satellites would dramatically change the daily experience and benefits in our private and professional life accessing the Internet. Such solutions are close to becoming a reality, thanks to European research efforts including contributions by Thales Alenia Space.

The primary objective of the technological evolution to place processing on-board of satellites is the full convergence and integration with terrestrial networks. The first step to reach this objective is to improve in space payload systems the Digital Sub-Microelectronics (DSM) based components and technologies. The next generation satellite communications systems and payloads need flexibility and reconfigurability that only on-board processing can deliver. We witness a specific interest from satellite operators in this subject, and the National and European Agencies (ESA and EC) are clearly supporting this evolution and development.

The vision and its implementation

Thales Alenia Space is acting on this technological vision and taking the necessary steps to deliver innovative SatCom systems and solutions that constitute the basis of an end-to-end system integrated in a seamless way with the terrestrial network infrastructures capable to support with high performance in terms of traffic throughput (terabit) and repeater flexibility/re-configurability of new challenging services and applications such as: (i) the LAN-to-LAN/Business-to-Business connectivity services, (ii) Machine-to-Machine (M2M), (iii) Internet-of-Things (IoT) applications in a high-security communication environment for the future Internet architectures, based on Software Defined Networking (SDN) and Cloud Computing paradigms.

The proposed technology will provide satellite access to end users in Ku, Ka or higher frequency bands while operating on the Feeder Link/Access Network in classical and new frequency ranges, such as the Q/V band, or also using optical links, thus guaranteeing a high throughput, terabit data traffic exchange.

Major critical requirements for the SatCom processing evolution need to be well defined taking into account the current status of the technology in the terrestrial networks and applications: this will enlarge the space mission capabilities vision giving to the space technology the possibility to enter in new and more integrated markets.

A key element in this technology evolution is Deep Sub-Micron (DSM) technology improvement, extending the integration scale of the components from the current standard (typically more than 96 nm) towards the new and challenging one (i.e. 65 nm, 45 nm, 28 nm and better) that are comparable to the components already used in common Internet equipment, like smartphones, notebooks and computers in general.

The targeted improvement of the DSM integration scale can support the modularity and flexibility as well as general capability needed in digital signal processing in satellite payloads. It includes the integration of several different key electronic components such as ASICs, FPGA, memories, high-speed low-power analogue-to-digital and digital-to-analogue converters.

Space missions driven by on-board processing architectures

Future space missions need better performance and extended capabilities to be comparable with those already experienced in the terrestrial networks. These missions will be based on an on-board processing (OBP) architecture equipped with suitable capabilities to cover a set of mandatory requirements for the future systems as shown in Figure 1.

These future systems will be stimulated by:

- the increased operational satellite life (> 10 years), during which the objectives of the mission can change or new access characteristics can be required (new waveforms, new protocols, and other) or a

new user or service connectivity topology can be supported.
- the increased satellite payload flexibility need, in terms of bandwidth management, agility in the frequency configuration at payload level or more complex channelization capability.
- an increased satellite payload configurability and re-configurability is needed that can support cross-band inter-transponders and/or inter-beam configuration or beam resource clustering in a high spot-beams antenna coverage.
- the adoption of a modular approach in designing the satellite payloads where, starting from common modules/components (FPGAs, ASICs, processors, etc.), several processing payload architectures can be implemented, or in a dual-use context to improve the integration and sub-system sharing between commercial and military SatCom payload sections.

From the technological point of view for the Next Generation OBP new potential technical solutions have to consider the following aspects:
- reduction in the size, weight and power (SW&P) consumption (dissipation) at the payload level, and consequently reduction of the component integration scale (from current 96 nm to 65 nm and beyond);
- Improvement of the up and down link performances;
- Improvement of the payload flexibility and configurability;
- Adoption of a modular approach in a first phase in terms of design and in a future phase in terms of possibility to aggregate on the sky entire satellite functionality's by versatile modules.

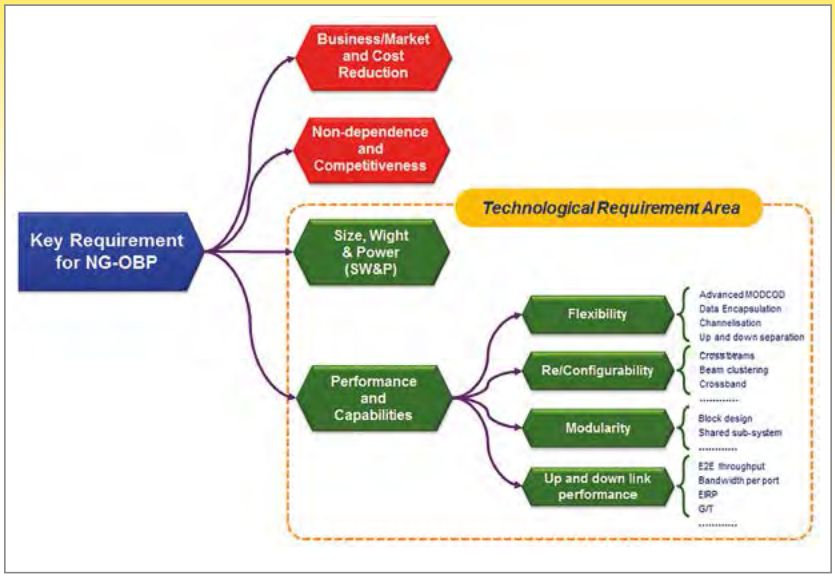

Figure 1: Next Generation OBP Key Requirement Summary

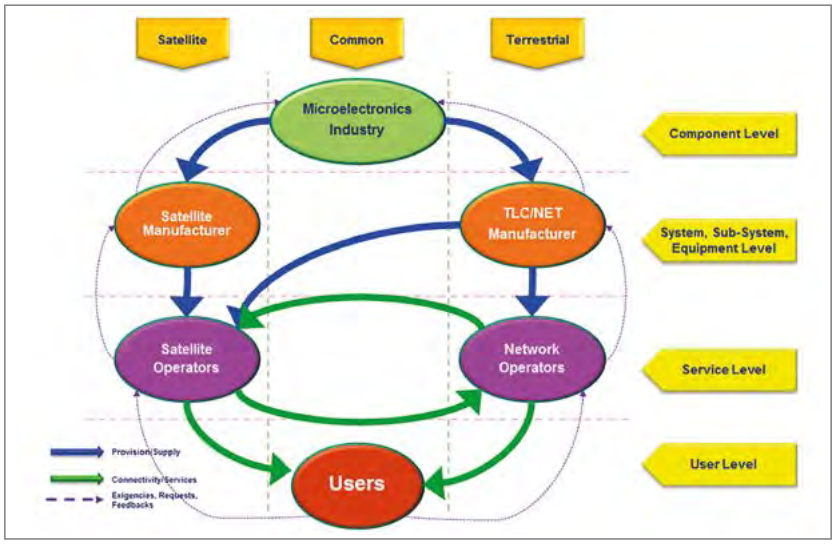

Figure 2: Beneficiary Value Chain

Conclusions and outlook

Coverage of the high performance terrestrial network technology is not extended worldwide due to the implementation costs. Instead it concentrates mainly on the Western World and principally in the large urban areas, increasing the global Digital Divide. In parallel satellite access for data traffic is becoming attractive in terms of costs (see the experience of the Eutelsat KaSAT service, provided by Tooway [1]), and quality of service and performance, especially with the arrival of new satcom constellations that are moving to be competitive with those provided by the current terrestrial technology (UMTS and related new protocols like HSPA, Wi-Fi, WiMAX, and 4G/LTE.

Next generation OBP in space can give us the possibility to really expand and make Internet access pervasive, complementing the terrestrial network infrastructures in a peer way and contributing to the reduction of the Digital Divide. Satellite manufacturers and operators, agencies and R&D institutions/universities are working on to improve the technology, mainly in terms of increasing satellite data throughput capacity, but also in-orbit flexibility and configurability. This progress supports the Next Generation Networking (NGN) initiative promoted by ITU-T ([2] and [3]).

We contend that in order to reach the above objective the involved market actors have to cooperate establishing a profitable value chain for the potential beneficiaries [4], as outlined in Figure 2.

The value chain should start from the component manufacturer and go all the way to the end user as depicted on the vertical axis in the figure passing through the space and terrestrial actors (positioned along the horizontal axis in the figure). As such Figure 2 depicts the basic idea of the relationships between space and terrestrial actors in view of the technological evolution towards a seamless integration between the network domains.

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European Conference on Networks and Communications in Athens

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5G architecture panel in Athens

The 25th edition of EuCNC, the European Conference on Networks and Communications in Athens, Greece, took place from 27 to 30 June 2016. It attracted more than 500 participants from Europe and beyond. The event showed the status of research in advanced networks and associated topics. Keynotes, parallel sessions, workshops, and demonstrations in the exhibition covered a wide range of topics around the next generation of communication systems.

Scope of topics

This year's conference provided in my view a rich choice of sessions of various types and content, in the format of workshops on the first day, and keynotes, technical sessions, special sessions and panel discussions on the main conference days. In addition, the large exhibition area with booths from various projects and companies was a good complement of the programme and a good opportunity for detailed discussions at the booths and networking with the other participants.

The conference sessions presented in six to eight parallel tracks the wide scope of European research in advanced networks. Topics included 5G architecture, standardisation, the physical layer, fronthaul and backhaul for 5G, optical-wireless integration, network management, network functions virtualization (NFV), and programmable networks. The dominant theme across all sessions was 5G, the next generation of communication networks.

Keynotes

The keynotes on the second day highlighted the opportunities, which 5G and other advanced network technologies offer to Europe's society and economy.

Mario Campolargo, Director for "Net Futures" at the EC's DG CONNECT, gave a motivating talk which encouraged the audience to grasp the opportunities presented via the research, development and innovation opportunities of the Horizon 2020 programme.

Georgios A. Onopas, Director of the fixed & mobile Access Networks Department of Greek network operator OTE Group, made the point that Greece 5G and IoT are accelerating the digital transformation of economy and society.

Dr. Edward G. Tiedemann Jr., Senior Vice-President for Engineering at US semiconductor and telecoms equipment manufacturer Qualcomm Technologies, put his large experience in the sector into his presentation with a focus on his company's vision on 5G, covering the progress of technology in this area.

The global dimension of the conference's presentation of 5G was further underlined on day three by the keynote of Dr. Chih-Lin I, Chief Scientist on Wireless Technologies at China Mobile Research Institute, who presented China's progress towards 5G, claiming that China had reached the mid-point of its 5G journey.

In a more technical keynote, Alain Servel, Expert in ADAS and ITS at French PSA Group, presented the status and progress on 5G radio access for multiservice integration.

Special sessions

In addition to keynotes and regular workshop sessions, there were also ten special sessions, which partly went beyond the topical scope of the main conference or added a special focus, like, for example, the session on 5G-satellite integration or the session on inclusive radio communications for 5G and beyond.

Exhibition

More than 30 exhibitors, which included Horizon 2020 projects and companies, showed their solutions to an interested audience in the exhibition. Like in the conference programme, there was a focus on 5G, while other topics, like the Internet of Things (IoT), were also present.

I look forward to EuCNC 2017, which will be organised in the Finnish city of Oulu.

5G PPP stand in the exhibition

Plenary session at EuCNC

News in brief

Public-private partnership on cybersecurity

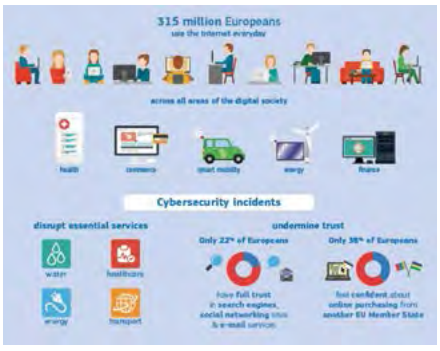
On 5 July 2016, the European Commission and the European Cyber Security Organisation (ECSO) signed a contractual Public-Private Partnership (cPPP) on cybersecurity as part of the EU's cybersecurity strategy.

The aim of the partnership is to foster cooperation between public and private actors at early stages of the research and innovation process. Through this, citizens and businesses in Europe should get better access to innovative and trustworthy European ICT products, services and software which comply with EU data and privacy protection laws.

The partnership also aims to stimulate the European cybersecurity industry by helping align demand and supply. The European Commission expects the cPPP to be instrumental in structuring and coordinating resources of the European digital security industry. The cPPP will include a wide range of actors, from innovative SMEs to producers of components and equipment, critical infrastructure operators and research institutes, brought together under the umbrella of ECSO.

The EU will invest up to 450 million euro in this partnership under its Horizon 2020 research and innovation programme. The European Commission expects cybersecurity market players to invest three times more. The first calls for proposal will be launched in the first quarter of 2017.

Further information: https://ec.europa.eu/digital-single-market/en/cybersecurity-industry



Nation-wide Internet of Things network launched in South Korea

In June 2016, SK Telecom completed South Korea's nation-wide commercial Internet of Things network. The network, which covers 99 percent of the country's population, will allow smart devices to talk to each other.

SK Telecom, South Korea's largest wireless carrier, announced the nationwide deployment of its Low Power Wide Area Network (LPWAN) based on LoRa technology at a press conference on 4 July 2016.

The company finished building LoRaWAN across the country by end of June 2016. By securing both nationwide LTE-M and LoRaWAN, which are two main pillars of the IoT network, SK Telecom said that it is now fully ready to create valuable business opportunities in the IoT era. The company had completed nationwide LTE-M rollout in March 2016.

To promote the growth of the IoT market, SK Telecom plans to offer attractive price plans and develop innovative IoT services, while offering strong support for SMEs. To this end, the company will invest a total of 100 billion won (78 million euro) by the end of 2017. It expects these efforts to lead to a rapid expansion of the IoT industry by connecting over four million things to its IoT-dedicated networks.

Further information: http://www.sktelecom.com/en/press/detail.do?idx=1172

BMW, Intel and Mobileye join forces to develop self-driving vehicles

Joining forces (from left): Brian Krzanich, CEO of Intel; Harald Krüger, Chairman of BMW; Professor Amnon Shashua, Chairman and CTO of Mobileye

German carmaker BMW, US chip producer Intel and computer vision firm Mobileye from Israel agreed in July 2016 to jointly develop self-driving vehicles. The three firms will collaborate on the systems needed to make cars that can safely navigate without any help from a human driver. The vehicles are envisioned to be capable of driving safely along major roads as well as in suburban and inner city areas.

The goal of the collaboration is to develop solutions that enable the drivers to not only take their hands off the steering wheel, but reach the so called "eyes off" (level 3) and ultimately the "mind off" (level 4) level transforming the driver's in-car time into leisure or work time. This level of autonomy would enable the vehicle to achieve the final stage of traveling "driver off" (level 5) without a human driver inside.

The companies have agreed to a set of deliverables and milestones to deliver fully autonomous cars based on a common reference architecture. Near term, the companies will demonstrate an autonomous test drive with a highly automated driving (HAD) prototype. In 2017 the platform will extend to fleets with extended autonomous test drives.

The common autonomous driving platform will be made available to multiple car vendors and other industries which could benefit from autonomous machines and deep machine learning. The collaboration partners aim to bring their autonomous driving technologies into series production by 2021.

Further information: https://www.press.bmwgroup.com/global/article/detail/T0261586EN/bmw-group-intel-and-mobileye-team-up-to-bring-fully-autonomous-driving-to-streets-by-2021?language=en

Alex for president

Lessons on going viral

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Alex Anderson (left) with his supporters (source: www.alexanderson2016.com)

The presidential race in the United States is not just a political event, but also one of the world's biggest media events. Barack Obama is said to have been the first US president who owed a large share of his success to his Internet campaign. While that may have been new in 2007, massive campaigning via the Net has become today's standard.

Alex Anderson's presidential campaign

One of the hopeful candidates, who in 2015 launched his campaign for selection as presidential frontrunner of the Republican Party, has been Alex Anderson, a congressman from California. His campaign under the slogan "America is Now" attracted more than 200,000 unique visitors to his campaign website at www.alexanderson2016.com and more than 26,000 people follow his Twitter account @Americaisnow. His announcement to have former NSA contractor and whistleblower Edward Snowden as his running mate and candidate for vice president caught significant public attention in the US and boosted his followership.

The truth about Alex Anderson

You may wonder why such a popular candidate has not progressed further in the race for the Republican nomination. The main reason is that Alex Anderson is an Italian author living in Campione d'Italia, on the Italian-Swiss border, and his real name is Alessandro Nardone. For eight months, the 39-year-old marketing consultant was able to fool thousands of Americans into believing that he was real. And even now that it is known his candidacy has been faked, he still has loyal supporters on Social Media, like "Doug Stamper" (a character from the popular US series "House of Cards"), Twitter handle: @stampercroff, who tweeted on 4 May 2016: "@tedcruz, now the best choice is to become an @Americaisnow's supporter. Believe me."

Fake presidential candidates like Alex Anderson are nothing extraordinary in the US. According to Time magazine, over 1,200 people – and animals – have submitted the required forms to the Federal Election Commission to run for president in 2016, about three times as many as in 2012. Take for example Limberbutt McCubbins (https://limberbutt.com/), who has been seeking the Democratic presidential nomination with the slogan "Meow Is The Time" – yes, you guessed it, Limberbutt is a cat, and not the first animal to run for US presidential nomination; that was Pigasus, a boar hog nominated as a candidate in the US presidential election 1968.

How to create a viral campaign

Unlike 1968, creating and sustaining a convincing fake campaign is much easier today, thanks to the Internet. Alessandro Nardone and his campaign team never set foot on American soil. Their popular YouTube video – more than 26,000 views to date – was filmed in front of a bar in Campione d'Italia, and not in Los Angeles, as claimed. Mr Nardone has a distinct Italian accent. Thus, he hired a voice-over artist from the US to do his talking.

Not everyone fell for it: two Washington journalists called Mr Nardone to interview him on his fake campaign but then decided to follow him. They even offered advice on how to appear more credible.

Alex Anderson's campaign worked so well, because he pushed the right buttons and exploited the anti-establishment sentiment among many voters. Every time he bashed Hillary Clinton on Social Media, he gained more supporters. He even managed to be connected to the top four US political topics on Twitter in September 2015.

Why he did it

Originally, Mr Nardone created the fake presidential campaign as a marketing ploy for his self-published thriller, in which Alex Anderson is the protagonist. To his surprise, people started taking the character seriously, and Mr Nardone succumbed to the temptation of continuing the charade, to the utter dismay of his wife. When his wife and daughter went to bed, he went to the PC and turned into Alex Anderson, having conversations with unsuspecting American citizens via Twitter.

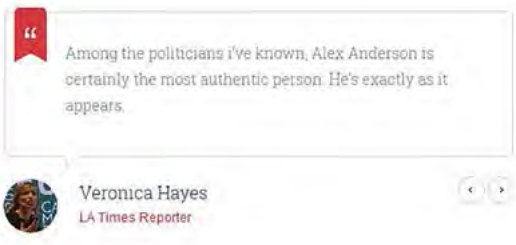
What started as a marketing gag turned into a socio-political experiment. As Mr Nardone explained on BBC News, he continued his months-long game of deception to illustrate the superficiality of the web, where media-savvy posers can easily manipulate others.

He said: "If I can run a fake campaign from here in Italy and convince thousands of Americans to consider voting for someone who doesn't exist, then so can anyone. How do we know that Donald Trump isn't just pretending for a new television series to compete with House of Cards?"

Lessons to be learned

If you think charades like the Alex Anderson campaign cannot happen in Europe, think again. Already in 2001, a Dachshund called Saucisse, French for sausage, was a candidate for municipal elections in the southern French city of Marseille. Saucisse won 4 percent of the votes.

Today's information and communication technologies make it relatively easy to blur the boundaries between reality and fiction. Beyond the fun factor of fake political campaigns, they signal that the risk of manipulation has become more serious than ever. The next Alex may not be a harmless writer.



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