Project Achievements

SENDATE-FICUS

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Project Websites

www.celticnext.eu/project-sendate-ficus

www.sendate.eu

Secure Networking for a Data center cloud in Europe - Flexible infrastructure for data center communication providing unique security

SENDATE-FICUS was one of the five subprojects of the Celtic-Plus flagship project, SENDATE. The objective of SENDATE-FICUS was to evolve existing high-performance networks into robust, even more efficient, flexible, and secure communication networks with simple and fast service provisioning and maintenance.

Main focus

Future communication networks have to be highly flexible, which implies fast automatic control and management. Network reconfiguration will occur so fast that manual supervision and control will become impossible. Therefore, methods have been developed which inherently ensure the stability and security of the network.

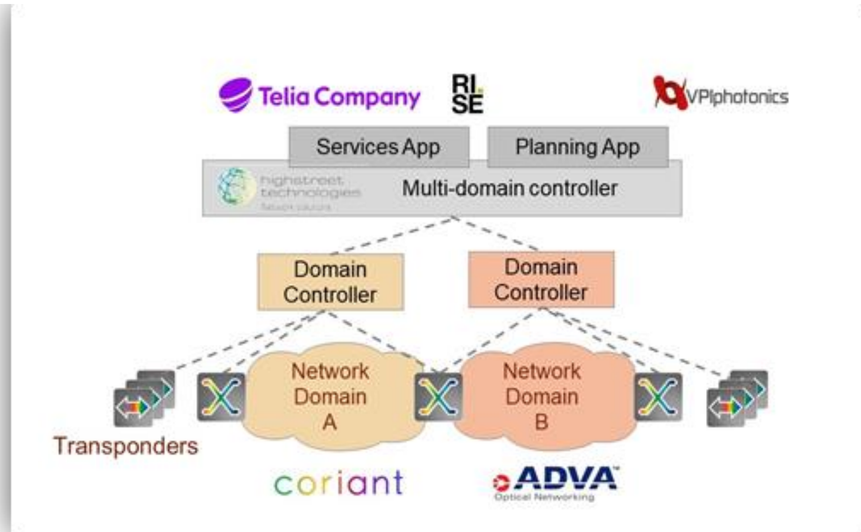
The project focused on the increase of flexibility and scalability of the network infrastructure. Special attention was given to network security and stability despite more stringent requirements and higher complexity.

Transmission paths change dynamically and, accordingly, network connections have to be switched dynamically as well. It is necessary to adapt the capacity of the connections flexibly, and the networks must be able to be reconfigured in the shortest time, without endangering their security and stability. This physical layer flexibility is leveraged in higher network layers by joint balanced optimization. Additionally, approaches have been investigated which ensure data security on the physical layer.

Approach

The general approach of the project was to build on successful communication systems developed in recent years, or even just under development by Coriant, and evolve them into more efficient and secure solutions. This could be achieved by combining Coriant's broad experience in communication networks with the deep knowledge of specialists from research institutions and smaller companies throughout Europe.

Security and reliability in programmable optical networks, which connect data centers and therefore need fast and flexible reconfiguration, were investigated. Appropriate methods for guaranteeing security and reliability have been developed. To ensure secure communication, adaptive coherent receivers for quantum communication with machine learning algorithms were investigated. Concerning secure transmit and receive techniques, SENDATE-FICUS investigated adaptive pre-compensation techniques designed to compensate imperfections of dynamically switched integrated components and to simultaneously encrypt the transmitted signal. Concerning flexible network infrastructure, the research topics were elastic transport networks and multi-layer control. Flexible transmission has been expected to offer high granularity (demonstration in a field trial), flexible and robust reconfiguration on the bit transmission layer, increased reliability of dynamic optical networks by intelligent transient suppression,



direct-detection system design for short reach interconnects, and heterogeneous data-center network orchestration.

Achieved results

The project covered several topics to improve security and flexibility of networks. Following, three examples are presented (for other and for more on these see https://www.sendate.eu/pubs-ficus).

The development of quantum computers threatens the security of today's transmission cryptosystems. Ensuring the security of future optical communication and optical networks can be done with quantum key distribution (QKD) systems. Presently such systems need special hardware and two fiber links, hence they are very expensive. We developed a system using commercially available off-the-shelf components which transmits the QKD channels on the same fiber as the regular DWDM (dense wavelength division multiplex) channels. This feature is very attractive for a practical implementation. Advanced techniques, as machine learning and adaptive filters, were implemented to enable high key rates and reach. Systems with 40 MBaud and 1 GBaud were designed and experimentally tested over lengths of 40 km and 26 km, respectively. Experiments showed that the QKD system can coexist in the same fiber with a commercial DWDM System. 56 channels can be tolerated over 25 km.

In an industry-first production network field trial we demonstrated autonomous intelligent transponder (AIT) technology. The live field trial showed the ability of the developed AIT transponder to autonomously adapt to changing network conditions in real time to support optimal service quality and performance while simplifying operations.

The AIT trial was conducted on a live 1,500-kilometer fibre route, in Telia Carrier's backbone network, connecting Munich, Zurich, Strasbourg and Frankfurt. The trial featured multiple use cases that tested AIT's capabilities under varied channel conditions and quality impairments, including the impact of neighbour channels, aging components, and adding and dropping of channels. In all cases, the AIT autonomously adapted transmission parameters such as modulation schemes to changing channel conditions, minimizing network cost and maximizing performance, measured as total fibre capacity throughput and spectral efficiency.

Service providers face the real-world challenge of provisioning across multi-vendor optical networks, due to the new high-bandwidth end-user applications which drive increased demand for photonic layer connectivity. Today these networks are operated as separate domains involving proprietary and mostly offline planning. An open and integrated approach to multi-domain service planning helps solve this challenge. In combination with SDN (Software Defined Network) -based orchestration of multi-vendor transport elements, including open line systems, integrated and real-time service planning paves the way for a more agile and automated optical infrastructure capable of meeting stringent performance demands of new services, including 5G.

In an industry-first multi-vendor multi-domain SDN field trial we demonstrated real-time planning of transparent high-speed services across a disaggregated, multi-domain optical network. The trial showcased the critical role that standards-based SDN interworking and integrated planning play in simplifying operations and reducing end-to-end provisioning times in multi-domain, disaggregated optical networks. The trial was conducted in the Telia Company R&D lab in Stockholm, with live connectivity to production network fibres, and included participation from optical networking and SDN solution suppliers and research partners.

Based on the SENDATE SDN Control Architecture, the multi-vendor trial configuration was designed to demonstrate end-to-end wavelength service activation between disaggregated transponders, spanning SDN-enabled ADVA and Coriant optical domains. Use cases tested during the trial included dynamic optical reach planning using 100G and 200G alien wavelength provisioning across multi-vendor optical domains. The SDN controller was based on OpenDaylight, with an integrated photonic planning app running as a micro-service.

Impact

The investigation and realization of the new concepts and the resulting highly efficient and secure future networks will lead to a significant advantage for Europe, and will boost development of all implicated industries. This impact is not restricted to the telecommunication and IT sectors, but also covers "verticals", such as Industry 4.0, machinery construction, automotive and pharmaceutical industry, which rely all on a flexible and secure communication architecture. In addition, socio-economic advantages offered to all citizens can be expected, like improvements in the areas of e-commerce, e-health, telecommuting etc. Last but not least, a leading position of European companies is necessary to ensure the public's trust in communication networks in general, and the outcomes of the project position the partners as such.

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.

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