CommAgility

ARTICLE

# CommAgility research: pathways to the future

*By Dimitri Marandin, LTE Systems Architect, CommAgility*
*www.commagility.com*

## Overview

Research participation is at the heart of CommAgility's innovation strategy. Our modular hardware solutions, LTE PHY and protocol stack software, test vectors and configurations give us a unique ability to modify any aspect of a wireless solution. This has allowed us to be at the forefront of driving LTE into new markets such as ground-to-air and satellite communications, and will also enable us to develop new wireless solutions in and around 5G.

Coupled with our in-depth knowledge of 3GPP specifications, we are proud to be able to support 5G and LTE research projects which are exploring novel applications, improved architectures, and protocol enhancements. With our ongoing involvement in key deployment projects for private networks, including satellite comms and ground to air solutions, this allows us to bring innovation to marketplace.

In this article we discuss our involvement in current and planned research activities, and what they mean for CommAgility's future product roadmap. We believe these activities will position us at the forefront of 5G infrastructure solutions and also the new vertical markets that they promise to create.

## COHERENT

COHERENT is an H2020 5G-PPP project funded by the European Commission, to help research and develop 5G radio access networks.

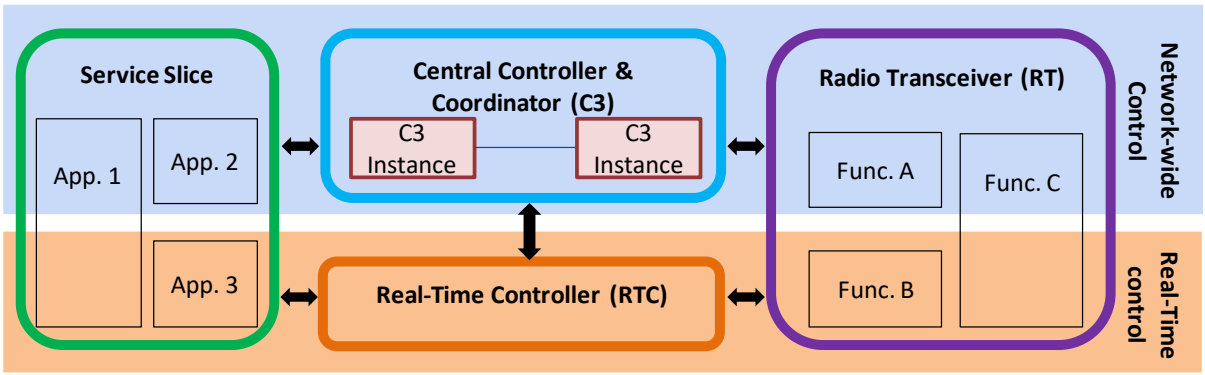
Mobile traffic is growing rapidly and networks are getting ever more complex. Together with the need for inter-network coordination of wireless network resources, this means that it can't be 'business as usual' for 5G heterogeneous radio access networks – we need dramatic improvements in control, coordination and flexible spectrum management.

To solve these issues, the COHERENT project is researching, developing and validating an innovative unified control and coordination framework for 5G heterogeneous radio access networks (RANs). The emphasis is on software defined networking (SDN) for RANs, efficient radio resource modelling and management in programmable RANs, and flexible spectrum management.

The COHERENT system architecture [1] has been designed based on three key concepts:

### i) Control Separation

Control separation is achieved by introducing two control entities, namely the Central Controller and Coordinator (C3) and the Real-Time Controller (RTC). The C3 is a logically centralised entity, which provides network-wide control/coordination for the network and maintains the logically centralised network view, therefore achieving logical centralised control and coordination. By separating control functionalities between the C3 and the RTC, the C3 makes decisions that affect the logically centralised network states, while the RTCs handle control decisions for latency-sensitive network functionalities in radio transceivers (RT) without coordinating with other RTCs.




*Control separation in COHERENT architecture[1]*

### ii) Network Abstractions

The COHERENT network abstractions are two-fold:

1) to expose the network state and user conditions for network control applications via effective aggregation principles

2) to provide a means to express performance goals and configurations in a unified manner that can be automatically translated down to radio access technology (RAT)-specific control actions.

The project team has developed theories and methods to abstract the low layer network states and behaviours of different underlying mobile networks (Wi-Fi and LTE). This approach provides a simplified abstracted network view for control and resource coordination, which significantly reduces the signalling overhead – and thus makes it feasible to create scalable network-wide control solutions.

### iii) Network Slicing

Software-Defined Networking (SDN) and Network Function Virtualisation (NFV) promise to reduce the cost to deploy and operate large networks by migrating Network Functions (NFs) from dedicated hardware appliances to software instances running on general purpose virtualised network and compute infrastructures.

Operators can abstract the physical network into service-specific slices, possibly operated by different mobile virtual network operators (MVNOs). The network slices envisioned in COHERENT span the whole protocol stack from the underlying (virtualised) hardware resources. up to network services and applications running on top of them.

## Proof of concept

COHERENT has built a true proof-of-concept prototype based on CommAgility's LTE software products, SmallCellPHY and SmallCellSTACK protocol stack, integrated with the company's AMC-K2L-RF2 eNodeB platform to provide a customized small cell solution. Having the deep domain knowledge and expertise to make adaptations in software allowed us to support COHERENT and to contribute to 5G development. CommAgility attended the recent European Conference on Networks and Communications (EuCNC 2017) in Finland, where COHERENT demonstrated the applicability and benefits of its approach.

CommAgility's LTE base station has been integrated with the 5G-EmPOWER RAN Coordinator acting as the C3 and the load balancing control function with handover decision functionality delegated to the C3. Thus, the standard LTE software was customized to provide the possibility to trigger handover not only from eNodeBs (as specified in the LTE specification), but also from the coordinator.

Dr. Tao Chen, COHERENT coordinator and Senior Researcher at VTT Technical Research Centre of Finland Ltd (one of the COHERENT partner organizations), said: "Verifying the COHERENT concept in the commercial LTE platform is an important milestone of the project. CommAgility's software and hardware made it possible. It becomes an invaluable part of COHERENT's research contribution to 5G networks."

Roberto Riggio, Chief Scientist at FBK CREATE-NET (one of the COHERENT partner organizations), said: "This project allowed us to integrate and pilot our 5G-EmPOWER RAN Coordinator with CommAgility's base stations and to extend the 5G-EmPOWER SDK with the primitives and APIs that are relevant for CommAgility's customer base. I have been impressed by CommAgility's goal-driven attitude which proved that academia and businesses can successfully innovate in the competitive 5G market."

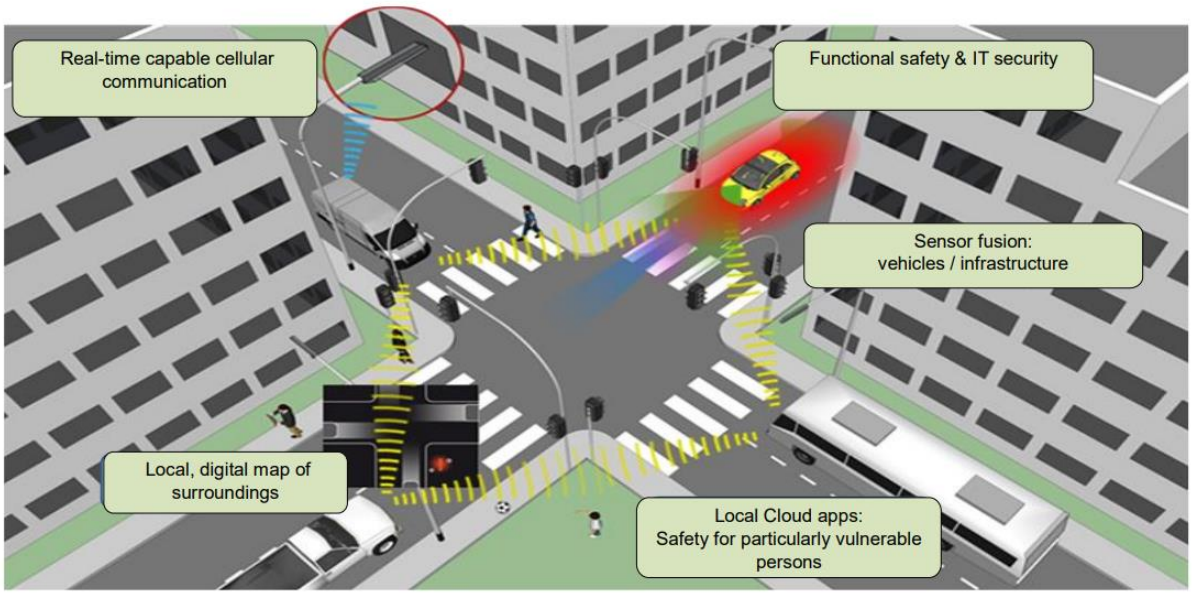
## InVerSiV

As we accept the inevitability of automated driving, recent technical progress has created vehicles which can already drive fully automated, and no longer need the driver to cope with many situations. However, traffic in the city poses an enormous challenge for these systems. The number of variables in cities is huge compared to, for example, the motorway, and this remains a major challenge.

InVerSiV (Intelligent Traffic Infrastructure for Safe Connected Driving in the Megacity) is a project, supported by European Regional Development Funding, which attempts to address this challenge.

If the sensors in vehicles are networked with roadside environmental sensors and traffic management controllers, a more comprehensive assessment of the environment can be made by autonomous vehicles, allowing the technology to better assess the situation. By building an intelligent transport infrastructure within the city, InVerSiV attempts to bring the relatively safe autonomous driving environment of the motorway to urban traffic.

By adding extra data, fully automated driving will be safer than relying on car-borne sensors alone. For example, vehicles can use additional non-real-time information, such as Google Maps, can exchange data with other vehicles, and can use as much existing data as possible. The more detailed the information, the safer the driving; all of which should help to make driverless driving in the city a practical reality as soon as possible.




Designated test beds for creating environment maps are being set up to model inner-city scenarios with mixed traffic to validate the research and explore its commercialisation. In November 2017 an early demonstration of the project was given to the sponsor on a specially equipped test track near the university in Dortmund, Germany. It was able to successfully show the first interaction of infrastructure sensors with vehicles.

CommAgility's eNodeB has provided robust and high-speed delivery of sensor data to the edge-cloud server and distributing the environment map to the mobile devices. By customising the LTE eNodeB scheduler for delay-sensitive applications and locating the eNodeB close to the Evolved Packet Core (EPC) at the edge cloud, CommAgility addressed the low-latency requirements of automotive applications.

InVerSiV was named 'project of the month' in December 2017 by the Ministry of Economy, Innovation, Digitization and Energy of the State of North Rhine-Westphalia.

## Conclusions

As CommAgility moves forward with its own 5G New Radio developments, we can build upon our existing research experience to address the full promise of 5G in the context of its target application markets. For example, COHERENT supports the commercial challenges of enhanced mobile broadband (eMBB) gigabit-per-second bandwidths and the exponential growth in wireless traffic, while InVerSiV investigates ultra-reliable and low-latency communications (uRLLC) in the context of Vehicle-to-Infrastructure and Vehicle-to-Vehicle applications.

During 2018 we are actively engaging with the research community to use our COHERENT and InVerSiV experience to drive innovation in new directions by responding to further calls for participation. For example, one proposal puts forward an evolution of LTE-V2X to embrace the core technological innovations of 5G, such as New Radio, new frequency bands, C-RAN, Mobile Edge Computing, and network virtualisation. We look forward to reporting on these exciting developments when the projects develop further with a research update.

Involvement in diverse research projects strengthens CommAgility's value proposition in multiple ways. Firstly, it allows us to keep ahead of market thinking, by being part of larger more disruptive projects which lead the way for more mainstream implementations. Secondly, it helps us develop IP in these new application spaces, which we can then use to differentiate our product offerings. Lastly, collaboration within the project teams allows us to build an ecosystem of partners to address commercial opportunities, for which the interoperability and integration work has already been achieved.

Overall, the knowledge, skills and innovation that we develop through research projects will help our customers. They will be able to benefit from our experience, to get access to new 5G solutions more quickly, and to take full advantage of the capabilities of tomorrow's new networks.

**Further information**

For more on COHERENT, see https://5g-ppp.eu/coherent/

For more on InverSiV, see https://www.efre.nrw.de/daten-fakten/gute-praxisbeispiele/inversiv-autonomes-fahren-in-der-stadt/

[1] D2.2, System architecture and abstractions for mobile networks, COHERENT project deliverable, 2016.

## About CommAgility

CommAgility, a Wireless Telecom Group company, is an award-winning developer of embedded signal processing and RF modules, and LTE PHY/stack software, for 4G and 5G mobile network and related applications. CommAgility designs the latest DSP, FPGA and RF technologies into compact, powerful, and reliable products based on industry standard architectures. CommAgility's LTE software for mobile devices and wireless infrastructure includes physical layer and protocol stack for small cells, physical layer and protocol stack for terminals, an advanced scheduler for small cells, and IP development in the areas of advanced PHY algorithms in multi-core SDR platforms. See www.commagility.com