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5G Communications and beyond: The case of 5G CARMEN

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EIGHTBELLS
Independent Research & Consultancy

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Our Company

Eight Bells (8BELLS) is a 4-years old **SME** based in Nicosia, Cyprus. In 2020 8BELLS established **a new branch** in Athens, Greece.

Delivers customizable solutions that enhance existing communication technologies relevant to **5G, Cloud Computing, Internet of Things, Cybersecurity.** Specializes **also** in modelling and analysis for businesses.

Has participated in more than 20 EU and national projects that have attracted more than €4 million**.**

Preparation, Execution, Management of R&D projects (mainly H2020), analysis, and quantification of results. Business and Technical Consulting.

EIGHT BELLS at a glance 2/3

Research Expertise & Consulting Services

5G communications	NVF Cloud service	Cybersecurity solutions	Advisory services	Consulting
Customizable solutions that enhance modern communications relevant to the area of 5G Mobile Technology	Knowledge on Network Function Virtualization (NFV) and management solutions for Cloud infrastructures.	Portfolio of cybersecurity solutions that can be used for risk assessment, cyber-hygiene, anomaly detection, and threat remediation.	Delivers special advisory services in ICT that help clients understand the market dynamics and profit from the ever-changing landscape. Advise and support other companies and organizations in every step of the process.	Business consulting includes also innovation management, technology transfer and exploitation (including market analysis, patenting, licensing, etc.).

EIGHT BELLS at a glance 3/3

Technical Capabilities

Systems & Networks engineering: including design, implementation and integration.

Cloud Computing and Everything-as-a-Service: design, deployment and maintenance of cloud computing infrastructure, etc.

Privacy, Security & Data Protection: Cybersecurity Gap Analysis, Virtualized Cybersecurity, Privacy Impact Assessment, Privacy-by-design architectures.

Software development: for 5G security, wireless network security, software quality assurance, machine learning applications, data analysis and visualization, cloud computing, etc.

Dissemination, Communication and Exploitation Activities.

Ethical and legal compliance activities for various projects, including compliance to the GDPR.

Our Projects

RUNNING

SANCUS

TERMINET

5G CARMEN

5G-INDUCE

GUARD

TrustedFog

AFFORDABLE 5G

AI@EDGE

5GMed

CUREX
SECURE AND PRIVATE HEALTH DATA EXCHANGE

RESPOND-A

CPSoSWARM

SDN-µSense

THISEAS
Cyprus National Defense Project

SPIDER
5G CYBER RANGE

CARAMEL

SmArt5Grid

FINISHED

SOFTFIRE

Orca
Orchestration and Reconfiguration Control Architecture

FLAME

5G ESSENCE

WiSHFUL

FED4FIRE
FEDERATION FOR FIRE PLUS

Outline

Funded 5G for CCAM projects in Europe

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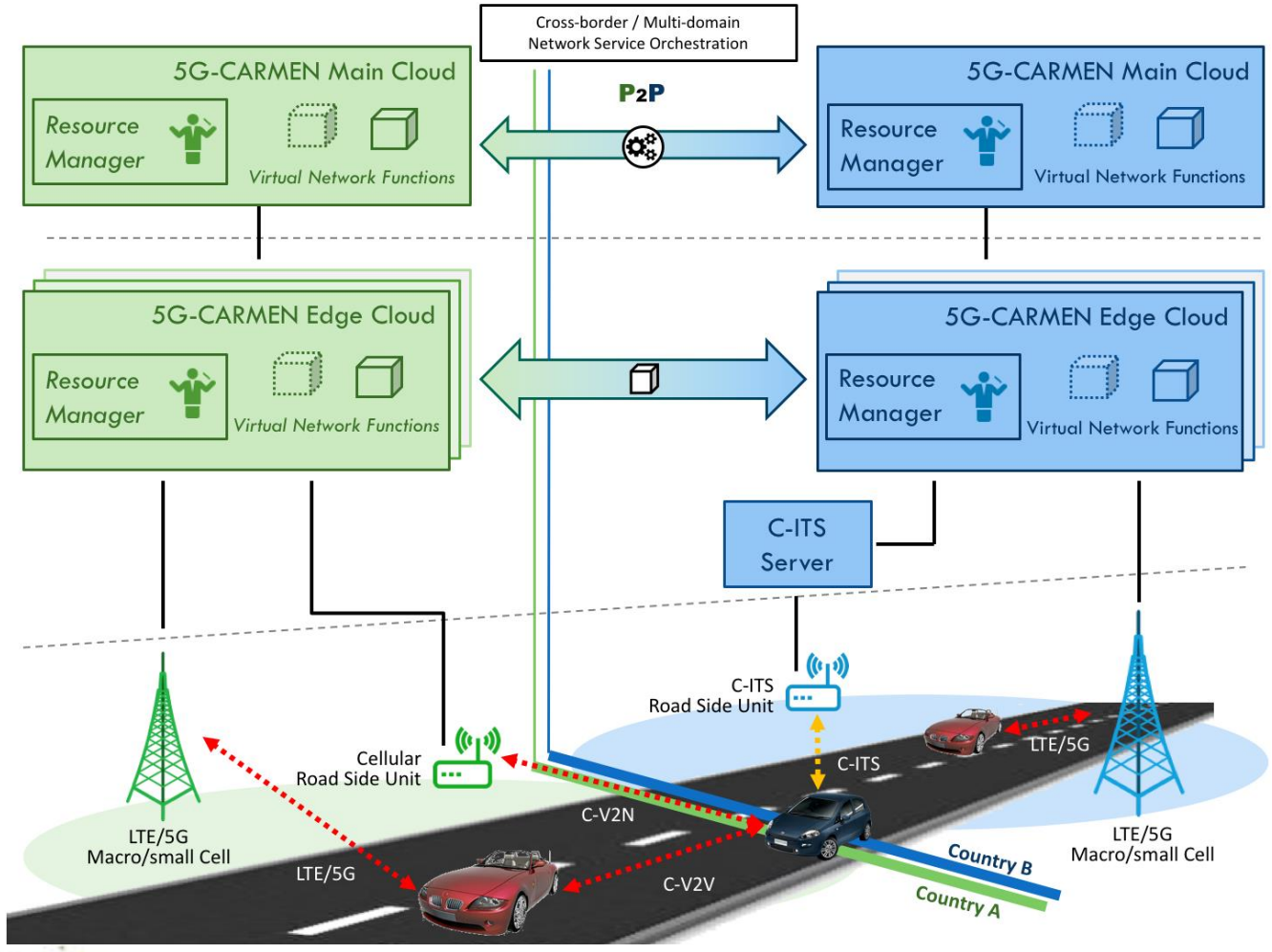
Funded 5G for CCAM projects in Europe

CCAM: **C**ooperative, **C**onnected and **A**utomated **M**obility

- 5G-CARMEN: 600 km of roads across an important north-south corridor from **Bologna to Munich** via the Brenner Pass
- 5GCROCO: over highways between Metz, Merzig and Luxembourg, crossing the **borders of France, Germany and Luxembourg**
- 5G-Mobix: along two cross-border corridors between **Spain and Portugal**, a short corridor between **Greece and Turkey**, and **six national urban sites** in Versailles (France), Berlin and Stuttgart (Germany), Eindhoven-Helmond (Netherlands) and Espoo (Finland).

Introduction to 5G CARMEN concept



5G-CARMEN builds on a distributed, multi-layer cloud architecture consisting of two tiers.

Tier 1: Along the corridor with multiple MEC servers deployed at the network for low latency and computational power.

Tier 2: A traditional large-scale cloud, responsible for providing high processing capabilities, but also higher latency due to propagation delay and congestion

Main objectives

- ✓ 5G CARMEN builds a 5G-enabled corridor to conduct cross-border trials and deploys a mixture of 5G micro- and macro-cells for ubiquitous C-V2X connectivity.
- ✓ The 5G New Radio supports latency sensitive and/or bandwidth hungry services and applications.
- ✓ The project leverages on a distributed mobile edge cloud spanning from the vehicle itself to the centralized cloud. Multi-tenancy and neutral host concepts are leveraged upon to deliver a final platform capable of enabling new business models.
- ✓ 5G-CARMEN complements C-V2X with LTE and C-ITS technologies, targeting interoperability and harnessing a hybrid network.

Challenges and advances in 5G CARMEN

- ✓ Deployment of a **Hybrid radio access network for connected vehicles**
- ✓ Development of **a new air interface (5G New Radio)** in new portions of the spectrum
- ✓ Deployment and testing of a **Distributed and multi-layer network-embedded edge cloud**
- ✓ Proposal of a **MEC-assisted range extension and interworking between C-V2X and C-ITS**
- ✓ **Service-oriented predictive QoS** through end-to-end network slicing
- ✓ New **business models and market potential**

Role of 8BELLS (1/2)

Leader of WP6: Connected mobility, data management and Business modeling

- Setting up a process to elaborate the cooperation models and cooperative future business models for connected mobility in 5G-CARMEN
- Defining and validating these cooperation models during the piloting phase of 5G-CARMEN, based on the defined use cases
- Building business models for connected mobility, including the multiple contributions from partners

Role of 8BELLS (2/2)

Main contribution to WP4: 5G CARMEN service oriented, federated, and secure platforms for CAAM

- Developing mechanisms to multi domain network resource management framework
- Developing mobile identity management solutions
- Delivering and implementing service orchestration solutions

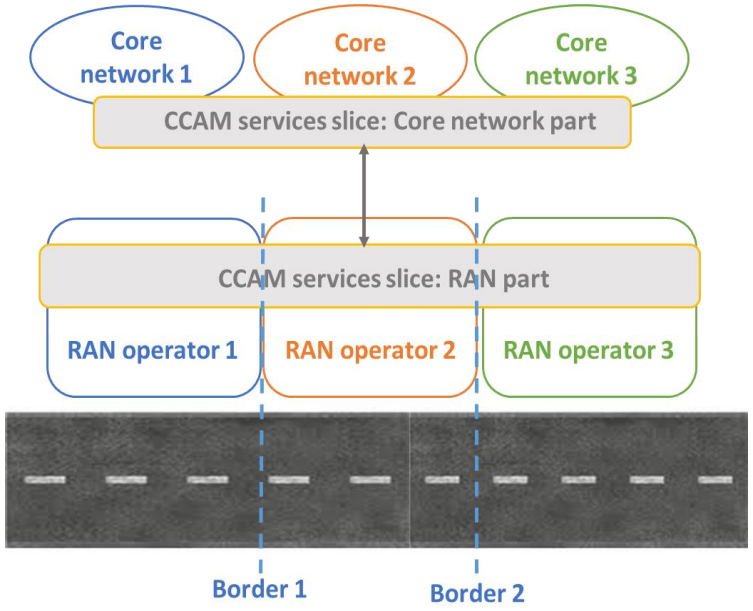
Main results so far (1/2)

Type of road	Maximum inter-RSU distance (m)		
	Green Driving	Situation Awareness	Cooperative Manoeuvring, Video Streaming
Motorway	4010	3374	1422
Urban A	4010	3374	1422
Urban minor	2560	1733	246
Rural A	2178	1833	773
Rural minor	1066	897	378

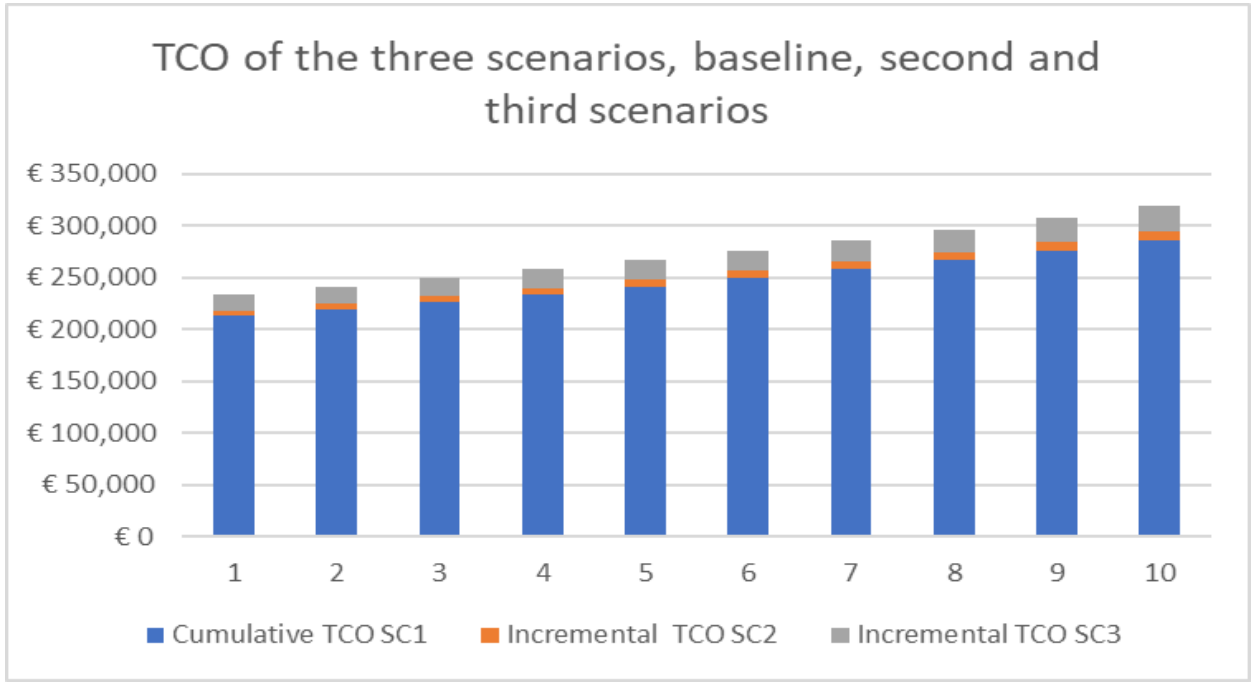
Maximum Inter Road Station Unit for different types of road and different driving types/applications

- ✓ RSU units are directly related with infrastructure costs

Main results so far (2/2)



Business Collaborative Model



Total Cost of Ownerships for three scenarios

Conclusions and next steps (1/2)

- Simulations based on software tools, scenarios and joint platforms have predicted the maximum RSU for different cases. This is taken into account for estimating the **total cost of ownership** in these cases
- First RSU contribute to the main TCO
- Adding new RSUs does not contribute significantly to capital expenditure
- In the next months, new analysis will be done considering experimental data from use cases (WP5)

Conclusions and next steps (2/2)

- A new CCAM project (5G MED, for the corridor Barcelona – Perpignan) will start in January 2021
- It will demonstrate how a (multi-stakeholder 5G infrastructure featuring a variety of technologies, (Rel.16 5GNR at 3.5 GHz, Rel.16 NR-V2X at 5.9 GHz, unlicensed mm-wave, network slicing and service orchestration), can be used to jointly deliver **CCAM and FRMCS services.**
- 8BELLS will collaborate with partners to **collect the required data** from the pilots and **validate it** using statistical analysis
- In addition, the role of 8BELLS will be to **enable the cross-border 5G business**, prioritizing contributions that can pave the way for adoption of the 5GMed technological components

Thank you!

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