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5G-DRIVE

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5G-DRIVE: EU China C-V2X collaboration

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Abstract

This paper is a review of preliminary results and progress of the EU-5G-DRIVE and corresponding twinning project in China. The project is funded under the EU Horizon-2020, from where 5G development and especially enhanced Mobile Broadband and V2X technologies are studied by various organizations around EU. The paper focuses on the first field tests of the project, which has been done in Espoo Finland in May 2019. The field tests are planned so that there are two use case test scenarios, where hybrid communication technologies (ETSI ITS-G5 and LTE/5G) are experimented together with automated car. The tests will produce more information about 5G development and especially focus on interoperability issues between EU and China, where 5G-DRIVE's counter project is executed in parallel. The preliminary results indicate that the current network is not ready for having real collaborative driving and especially, steps towards C-V2X is not straightforward as thought in headlines.

Keywords: automated driving; V2X; C-V2X; hybrid communication; 5G; EU-China collaboration

1. Introduction

5G-DRIVE – 5G HarmoniseD Research and TrIals for serVice Evolution between EU and China – is a Research and Innovation Action, running from 2018 to 2021, funded by the European Commission under the Horizon 2020 programme. 5G-DRIVE consortium consists of European partners from 11 countries and it does collaboration with its Chinese twinning project "5G Large-Scale Trial". 5G-DRIVE together with its twinning project aims to trial and validate the interoperability between EU & China 5G networks, enhanced Mobile Broadband (eMBB) and different V2X scenarios and applications. Below in Figure 1 the research framework is illustrated. (5G-DRIVE 2019)

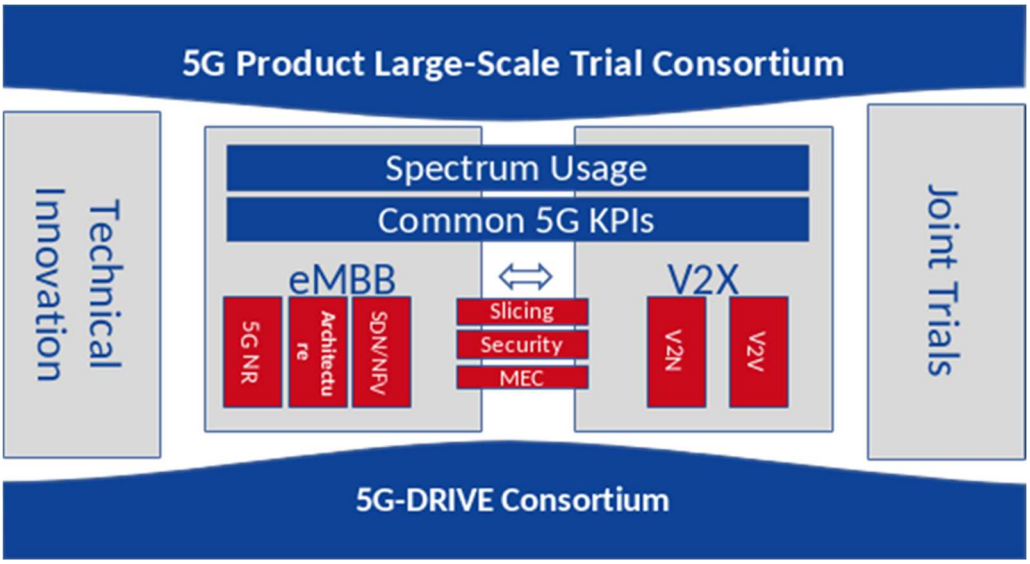

Fig. 1. 5G-DRIVE research framework.

The project activities are divided in three mail pillars: testing and demonstrating, researching key advantages of 5G and to enhance EU-China collaboration and interoperability. Testing and demonstrating actions will focus on the latest 5G key technologies in eMBB and V2X communication. The main research actions focus on key innovation in networking slicing, network virtualization, 5G transport network, edge computing and New Radio features and how to support real use cases with existing 5G development. EU-China collaboration will concentrate on 5G at all levels via knowledge sharing and joint actions. 5G-DRIVE project will use 3.5 GHz band for 5G enhanced Mobile Broadband (eMBB) tests and 3.5 & 5.9 GHz bands for V2X/C-V2X testing.

5G-DRIVE project includes laboratory, testbed and open area testing, which takes place in Surrey (UK), JRC Ispra (IT), Espoo (FI) and also the special 2,6 GHz LTE network in Tampere (FI). In this paper, the focus is on open area done in Espoo Finland in Nokia campus area and in Tampere and project C-V2X tests progress. Below in Figure 2, the test set-up that will be tested in Espoo trials is described. More accurate test plan can be seen from the project deliverables (see Kutila et al. 2019). The preliminary plan was to build up the test set-up, so that it uses V2I communication in the first phase and then V2V communication will be added to trials when 5G equipment are available. This approach turned out to be very good, since there have been major challenges to get C-V2X tests equipment for the consortium. These challenges have caused some delays for the project and also some modifications to test plans. Later on in this paper, the reasons for these availability challenges is analyzed in more details.

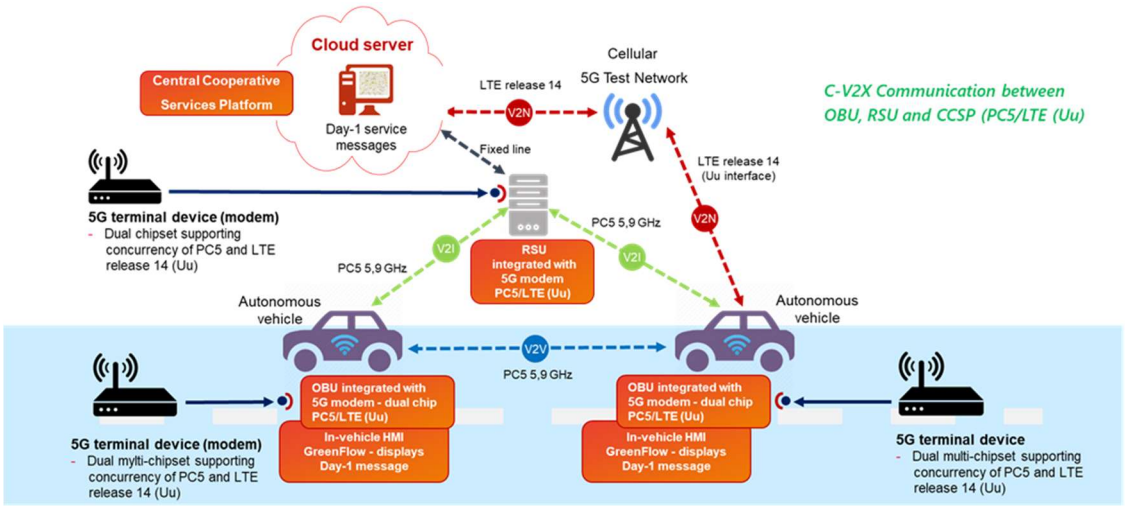

Fig. 2. 5G-DRIVE Finnish trials test set-up.

The tests planned to execute in Espoo test site will focus on C-V2X applications, where safety related applications will be tested in open area environment together with automated vehicle provided by VTT Technical Research Centre of Finland. The two tested use cases will be (see Figure 3):

- Green Light Optimized Speed Advisory (GLOSA)
- Intersection safety V2I

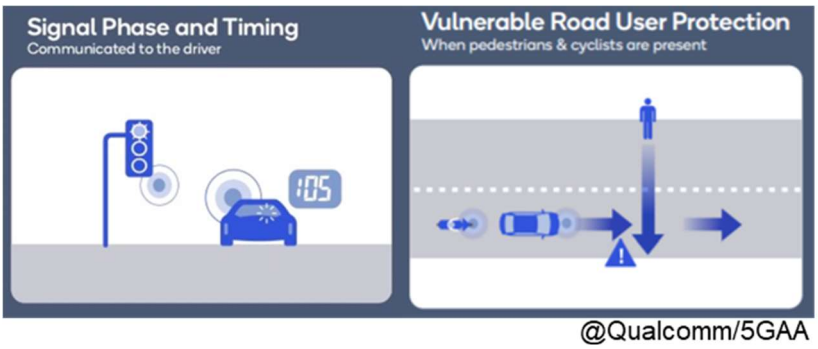

Fig. 3. 5G-DRIVE V2X applications (Qualcomm 2019).

The selected use cases are well experimented in Europe with using DSRC (ITS G5) technologies already for more than 10 years. This was the reason to selected these specific use cases to take lesson what shifting to C-V2X means and what are the implementation challenges between Europe and China.

In the GLOSA V2I application the automated vehicle will be connected to road side units (RSU). Integrated traffic lights will provide status information via hybrid LTE/(5G) and ITS-G5 channels in intersection areas. The messages are C-ITS compatible using the latest version of SAE J2735 (2016). In intersection safety V2I application, connected vehicle will get warning DENM (Decentralized Environmental Notification Message) via hybrid 5G and ITS-G5 channels from the infrastructure. The DENM includes warning about a pedestrian crossing an uncontrolled intersection with a conflicting path to an approaching vehicle. The actual tests will be done with emulate, since the use case is time critical and safety sensitive. The first obvious challenge is that China uses more U.S. style Basic Safety Message (BSM) format. This means implementation of the wrapper between BSM and DENM messages for having sufficient interoperability for testing purposes. The difference is not big one since most of the message fields are same, but the order of fields is different.

2. Field trials

The automated passenger car called “Marilyn” (see Figure 4 and 5) which has been equipped with sensing systems and ECUs needed for automated driving functions. There are also ITS G5 and LTE OBUs (on board unit) for data exchange. LTE will be later on updated to the 5G Release 14 devices.

The Espoo trial site has been equipped with the following equipment (see Figure 6) to support the communication trial scenarios.

- Multi-channel RTK base station
- WiFi, 60 GHz
- Commercial LTE network

In addition, there are virtual traffic lights available which status is communicated to the trial vehicles from the back-office system. 5G-DRIVE also used the own physical traffic light, which is connected to the IoT cloud for exchanging message directly with the trial vehicles.

Fig. 4. “Marilyn” automated passenger car.

Fig. 5. Espoo trial site overview.

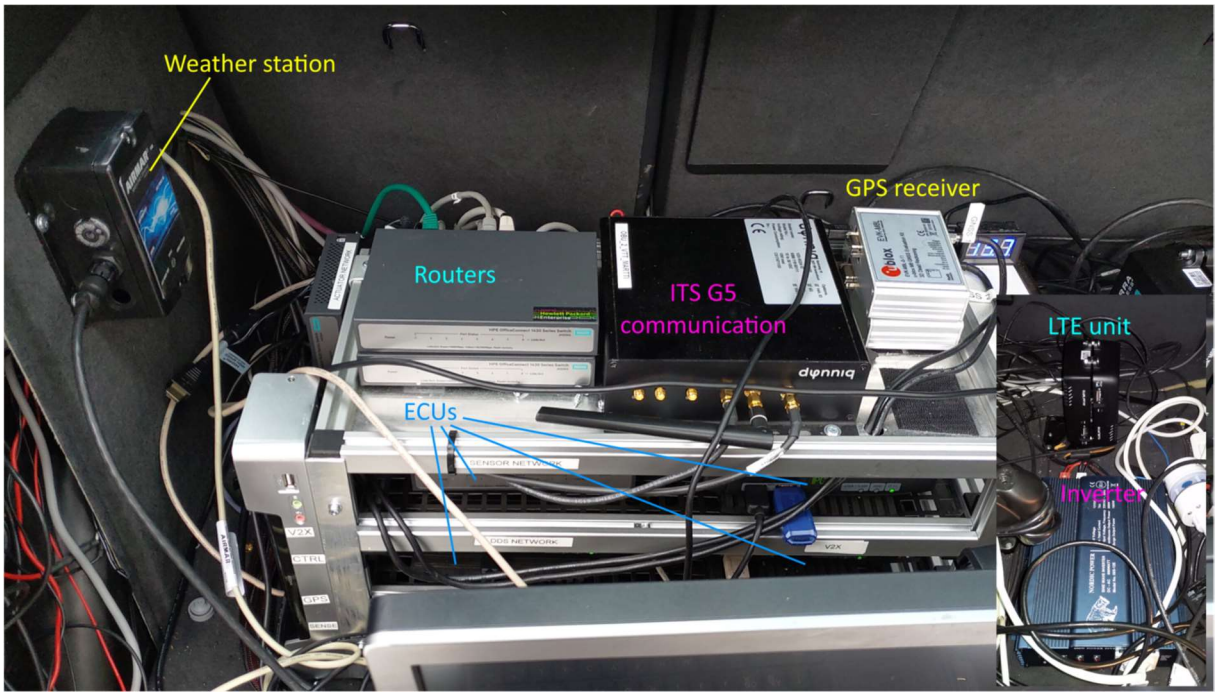

Fig. 6. On-board equipment.

3. Test results

During the first project year V2X field test have been executed in Espoo and Tampere. Both test environments are open environments where tests are done with respect of other traffic. In V2X trials VTT's automated car Marilyn (Figure 7) shows influence of buildings for latencies in the test network, where the number of Ue equipment being active is only one. The light means high latencies and dark blue low.

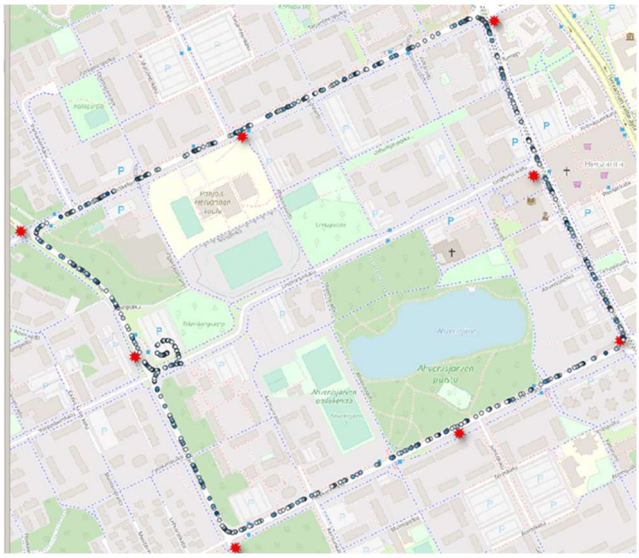

Fig. 7. Latency measurements in the Tampere test network.

According to the results, the median latency in this 2 km long route is about 385 ms. However, the latency includes whole message trip: OBU (LTE) → base-station (LTE) → MEC (optical fiber) → MQTT server (fiber) → MEC (fiber) → basestation (LTE) → OBU. The variation is high (deviation 92 ms) and influence of trees, buildings and

line-of-sight has high impact, especially in these high frequencies (2,6 GHz). This will be reality with the high-frequency networks, which needs to be taken into account when developing robust and safe automated driving functions and planning e.g. right speed or sensor fusion sub-systems.

In addition to V2X tests, Vediafi has done technical 5G network testing on public networks that are available in Finland. According to the measurements in Turku and Espoo the average download speed has variated between 247-317 Mbps, upload speed 27-45 Mbps and the loaded ping 53-108 ms. Measurements were done in tests sites in various locations and by using Huawei 5G router and fast.com online service. The measurements pointed out that the 5G networks are not yet as capable as expected and networks capacity has still significant inequality. If these results are compared with the KPIs (will be published in project deliverables) set in the project for EU and China side the capacity results are in line with GLOSA requirements. However, for automated driving and Day 1 (safety related DEMN messages) type of massages the results are not good enough, when focusing on latencies.

4. Lessons learnt

The aim of the project is to test 5G based C-V2X devices and do EU China collaboration for C-V2x harmonization. However, the first year of the project has shown the challenges that might occur, when emerging technologies and international collaboration is combined. During 2018, when the project plan was written and when the project started, shipment and 5G modules manufactures estimated that their equipment will be available during 2019 at least some releases. However, it has been very difficult for the international consortium to get desired devices for tests. Finally, after various months and several contacting attempts to different manufacturers and vendors consortium has been able to get couple C-V2X OBUs. The field tests have shown that technical capability and reliability of devices and communication networks is still far away from those promises that has been set for the technology.

This giant gap between promises and real-world experiences, might be fulfilled in the next year already, when 5G technology has developed and more testing and research has been done. But especially now in this transition phase, where 5G technology is obtruding for B2B and B2C market, it is good to have experiences from the field tests. Tests will give valuable information and knowledge about technical capability. Benchmarking towards existing technologies and solutions is also very important and must be taken into account, when planning potential business cases and public services. Since, based on current tests results 5G is still more a hype word than significant improvement to LTE technology.

On the international level, the project has also faced unexpected challenges. These challenges are related on joint trial between EU and China. Some of the challenges are typical parallel project problems such as communication between projects and scheduling, but there seem to be also some impact from political atmosphere, which reflects challenges for collaboration in terms of having same equipment which is scientifically necessary. There have been discussions about equipment tests between projects and because of trade wars there is challenges to ship equipment. 5G-Drive consortium engages participants and test site also from UK and uncertainty related on brexit has also caused some challenges to organize joint meeting. These challenges are political problems, which must be considered in future tests and if necessary, some modifications must be made for test plans.

5. Conclusion

This paper presented first preliminary results and progress about the EU-5G-DRIVE project. Project is Horizon 2020 project and it is done in collaboration with its corresponding twinning project in China. Both of these projects is focusing on 5G technology and how it can be used in traffic and especially in vehicle to everything communication. The first year of the project has shown that testing with cutting edge technologies is very challenging and technological capability might be lacking from the market promises.

Although, the project consortium has faced some challenges it is still confiding that planned tests can be executed during the project. The first preliminary results from the tests done in Finland in Espoo and Tampere shows that the network latencies are still quite high and network is unstable, but it might be fixed during upcoming months. Testing has also shown that hybrid approach, where ETSI ITS-G5 and LTE/5G technologies

are combined might be reasonable solution for the future. However this need more testing and experimental information from the field. The 5G-Drive project will do this kind of testing in future and results will be published in project deliverables (see 5G-DRIVE 2019).

Acknowledgements

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