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Docket No. **DOT-OST-2018-0210** –Comment by Siemens Mobility on V2X Communications

Siemens Mobility, as an integrated mobility provider, offers a wide range of services and products ranging from road, rail to intermodal solutions and intelligent infrastructure.

We thrive to shape the digital future of mobility and to enable truly multimodal and sustainable transport systems. With digitalization, Siemens enables mobility operators to make cities, vehicles and infrastructure intelligent. Siemens Mobility is a leader in Connected Vehicle and intelligent transportation technologies, and is working with cities including Tampa, FL, New York, NY, Las Vegas, NV, Anaheim, CA, Columbus, OH and Madison, WI to design and deploy these types of intelligent systems.

Our ITS (Intelligent Traffic Systems) business segment provides the necessary roadside infrastructure (Roadside Units) to enable communication between vehicles and the infrastructure in order to enhance safety and efficiency of mobility on roads and in cities. As the world market leader in traffic technology, the company also offers advanced software and systems to modernize and improve urban and interurban traffic.

Summary

As an infrastructure provider our customers are generally public authorities including cities and road operators. We therefore have an elevated interest in building a lasting CV ecosystem in which the investments of our clients maximize public benefit in terms of safer roads through V2X communication. In order to create a future-proof CV ecosystem in which public money is used as effectively as possible, we believe a number of points and principles need to be adhered to:

DSRC for short-range, safety critical communication: DSRC is not only the best-placed but currently also the only validated and available short-range communication technology on the market capable of delivering secure ad-hoc direct vehicle-to-vehicle and/or vehicle-to-infrastructure communication.

In case further short-range communication technologies are introduced to the market, it has to be ensured that these are **interoperable** with the existing infrastructure – otherwise, vehicles and infrastructure will not be able to communicate with one another creating a fragmented CV ecosystem where benefits in terms of road safety are significantly reduced.

Moreover, **backwards compatibility** has to be ensured to safeguard investments made and to guarantee that newer releases are compatible with older ones

Deploying different technologies in the same region will require the installation of additional equipment (vehicles and infrastructure). It will increase the complexity for the road operator and vehicle installation, adds no benefit for the traffic participant, but increases the cost for all parties. From this perspective, a single technology solution is preferable.

Nevertheless, we do also see the potential of other communication technologies when it comes to **long-range communication**.
While l**ong-range communication** cannot guarantee the required latency and availability for safety related application, long-range communication technologies like 4G and in the future 5G can play an important role for non-safety critical applications.

While we believe that DSRC is currently the only available technology for short-range, safety-critical messages, we closely follow the evolution of other technologies including C-V2X. As an infrastructure provider, our objective is to use the best placed technology for a given use case for our customers. We therefore remain open to other technological options.

Overall, we regard a hybrid communication approach combining time critical DSRC communication and long-range technologies such as 4G for less time critical applications as the most practical and beneficial V2V and V2X solution.

1. Please provide information on what existing or future technologies could be used for V2X communications, including, but not limited to, DSRC, LTE C-V2X and 5G New Radio. What are the advantages and disadvantages of each technology? What is the timeframe for deployment of technologies not yet in production? Please provide data supporting your position.

Comment:

DSRC has been explicitly designed for road safety applications and is a well proven, mature technology that provides low latency, interoperable and reliable communication that meets the connected vehicle application requirements. The 802.11p based devices are available today from multiple vendors, supported by several major car manufacturers and used in multiple CV projects not only in the US but also in Europe and Asia. It is based on publicly available standards to create an environment in which manufacturers can develop products. This fosters competition and keeps prices moderate. It has been designed to incur minimal costs to OEMs and road operators and its simplicity makes it a very robust V2X short-range communication technology. For the end users no costs per minute or per Byte are incurred.

3GPP generations lack backwards compatibility. E.g. LTE-V2X(Rel. 14) and 3GPP New Radio (Rel.16) are not technically interoperable. Investment in Rel.14 system are therefore lost. This means that new Rel.14 technologies would need new investment. Safety information would have to be duplicated for a transition period in case there was a change from Release 14 to Release 16.

On the other hand, IEEE NGV is interoperable to IEEE 802.11p (DSRC). Investments in older systems are secured, new applications will be introduced based on evolution on technology.

Therefore, we believe that **DSRC which is based on the wireless standard 802.11p is not only the best-placed but also the only validated and available <u>short-range</u> communication technology** on the market capable of delivering secure ad-hoc direct vehicle-to-vehicle and/or vehicle-to-infrastructure communication.

In order to ensure that vehicles and road infrastructure of different brands can talk to one another, new technologies need to be evaluated based on the interoperability with the existing devices and how significantly they would improve efficiency of the already deployed applications. To ensure and maximize benefits for road safety and build a future-proof system, certain essential principles need to be adhered to for safety-critical, short-range V2X applications:

- **Interoperability**: To achieve meaningful road safety benefits, vehicles and roads have to be able to communicate with each other using a single language. CV market fragmentation is an impediment to road safety.

- **Backward compatibility**: investment in CV is long-term, as vehicles and road-side equipment have long life cycles. Future technologies have to operate with deployed equipment preventing road safety disruption.

We also need to clearly distinguish between short and long-range communication technologies: Safety critical V2X applications require a low-latency, reliable and robust **short-range communication**. **Long-range communication** like 4G cannot guarantee the required latency and availability for safety related application, as the communication heavily depends on the network utilization. For non-safety critical applications, however, long-range communication technologies like 4G and in the future 5G can be used.

We therefore regard a hybrid communication approach combining time critical DSRC communication and long-range technologies such as 4G for less time critical applications as the most practical and beneficial V2V and V2X solution. Such a hybrid approach would allow for the co-existence of different technologies where they serve different purposes in order to maximize the benefits for road safety.

2. Of the V2X communications technologies previously discussed, at present only DSRC is permitted to be used in the 5.9 GHz spectrum band for transportation applications. If that allocation were to be changed to allow any communication technology for transportation applications, could DSRC and other technologies (e.g., C-V2X, 5G or any future technology) operate in the same spectrum band or even the same channel without interference? Why or why not? If there are any technical challenges to achieving this goal, what are they and how can they be overcome?

Comment:

3GPP LTE-V2X(Rel. 14), 3GPP New Radio (Rel.16) were not designed to be technically interoperable with the existing DSRC communication technology. If operated in the same channel, they will interfere with each over, as they are using different channel access technologies.

Therefore, coexistence in the 5.9 GHz spectrum band would require a band split where specific channels have to be exclusively dedicated to specific technologies. Additionally, adjacent channel interference would have to be considered.

A band split would, however, result in the transmission of the same content by two different technologies within the same frequency band and therefore constitute an inefficient use of valuable channel resources. It would also reduce the channel resources available for additional CV applications to be developed in the future – like sensor data sharing (collective perception), platooning and others. Thus, a band split of the 5.9 GHz band should be avoided. Instead, the option of using a different frequency band could be explored.

The problems associated with a band split illustrate the importance of ensuring interoperability: Future technologies need to be designed to be able to co-exist and be interoperable with existing communication technologies. They have to use at least the same access technology as DSRC for being interoperable within the channel. Based on the experience from the USDOT CV pilots deployed DSRC applications use all channels except for Ch 184. Additional future CV applications will require even more bandwidth. If multiple technologies are operating in the 5.9 GHz spectrum neither of them may have sufficient bandwidth for reliable and safe communication and the possibilities for future extension of the system are limited.

3. To what extent is it technically feasible for multiple V2X communications technologies and protocols to be interoperable with one another? Why or why not? Can this be done in a way that meets the performance requirements for safety of life applications, as they were discussed in the V2V NPRM? What additional equipment would be needed to achieve interoperability or changes in standards and specifications? What is the projected cost of any necessary changes? How soon can these changes and equipment prototypes be available for testing?

Comment:

3GPP LTE-V2X(Rel. 14), 3GPP New Radio (Rel.16) and DSRC are not technically interoperable. Due to different channel access technologies, they do not understand each-other and therefore interfere with each-other.

DSRC has been designed to be interoperable and backwards compatible. However, the same does not hold true for the communication technologies 3GPP LTE-V2X (Rel. 14) and 3GPP New Radio (Rel.16) and their successor technologies.

If the spectrum will be split for allowing technology coexistence, messages have to be duplicated over different technologies. Hardware costs would double and the capacity of the spectrum for a single technology will be reduced. Vehicles, infrastructure components have to implement communication devices for all allowed technologies.

If there is only partial implementation potentially not all messages will be received from all sources which will have an implication on safety of life.

The latency introduced by bridging devices, cost of the implementation, single point of failure and unclear liability separation between vendors and road operators needs to be taken into consideration as well.

4. To what extent is it technically feasible for different generations of the same V2X communications technologies and protocols to be interoperable with one another? Why or why not? Can this be done in a way that meets the performance requirements for safety of life applications? What additional equipment or changes in standards and specifications would be needed to achieve interoperability? What is the projected cost of any necessary changes?

Comment:

For saving the investments of installed systems, technology enhancements have to be **backwards compatible**. Thus, older systems need to be able to decode messages from new systems using technology enhancements. E.g.

the future IEEE NGV (Next Generation V2X) is based on IEEE 802.11p (DSRC) and is backwards interoperable with IEEE 802.11p.

3GPP generations lack backwards compatibility. E.g. LTE-V2X(Rel. 14) and 3GPP New Radio (Rel.16) are not technically interoperable. Investment in Rel.14 system are therefore lost. This means that new technologies would need new investment. Safety information would have to be duplicated for a transition period in case there was a change from Release 14 to Release 16.

If backwards compatibility is not ensured and required, investments in CV infrastructure may not be scalable as future technologies may not be able to operate with deployed equipment causing road safety disruption.

> 5. Even if they are interoperable across different technologies and generations of the same technology, would there be advantages if a single communications protocol were to be used for V2V safety communications? What about other V2X safety applications, such as those involving V2I and V2P communications?

Comment:

A single protocol ensures the interoperability and continuity of the service, reduces the cost of implementation, provides consistent test results and clearly defines safety functionality separation between V2V and V2X devices. Therefore, we see strong advantages in using a single communication protocol.

V2X is a system which benefits from overall cooperation of all traffic participants. The communication protocols have to be understood by all traffic participants, regardless of the underlying communication technology used. This includes the data dictionaries and also a common trust center for assuring authorization and message security. V2I, V2P, V2V application protocols therefore have to be harmonized so that all traffic participants are able to communicate with each other for enhancing safety of life, regardless of used communication technology.

> 6. How would the development of alternative communication technologies affect other V2I and V2P communications, such as those supporting mobility or environmental applications? Do these applications have the same or different interoperability issues as V2V safety communications? Do different V2X applications (e.g., platooning) have different communication needs, particularly latency?

Comment:

A **hybrid communication approach combining time critical DSRC communication and long-range technologies like 4G and 5G for less time critical applications** provides options for alternative communication technologies to be used for selected V2P and V2I applications as long as they ensure compatibility and interoperability with already deployed devices.

V2I and V2P applications may use the same application protocols and trust system, regardless which communication technology is used. This is also true for application using hybrid communication (short range, cellular). E.g. Platooning applications cannot be seen separately as they are used by road vehicles, which benefit from cooperative safety message of other traffic participants and may share the same communication device as V2X safety communication.

7. Do different communication technologies present different issues concerning physical security (i.e., how to integrate alternative communication technologies into vehicle systems), message security (i.e., SCMS design or other approaches), or other issues such as cybersecurity or privacy? Would these concerns be affected if multiple but still interoperable communication technologies are used rather than one?

Comment:

The SCMS security concept was successfully implemented using DSRC communication between OBUs and RSUs. CV applications shall use one common trust system (e.g. PKI) to assuring authorization of the source of the messages and to assure that the payload of the messages are not manipulated during communication.

8. How could communications technologies (DSRC, C-V2X, 5G or some other technology) be leveraged to support current and emerging automated vehicle applications? Will different communication technologies be used in different ways? How?

Comments:

V2X is a system which gives most benefit for connected automated vehicles, on a cooperative basis, using a single technology for short range communication. Cellular systems like 4G/5G support V2X application for long range communication. Currently 4G is used as a part of the hybrid communication. In the future 5G can replace 4G communication for less time critical applications, but not for real-time applications.

9. How could deployments, both existing and planned, assess communications needs and determine which technologies are most appropriate and whether and how interoperability could be achieved?

Comments:

In a specific region only a single technology for short range technology will be 100% interoperable and achieve maximum benefit for safety of life and future automated driving.

Deploying different technologies in the same region will require the installation of additional equipment (vehicles and infrastructure), reducing the interoperability. It will increase the complexity for the road operator and vehicle installation, adds no benefit for the traffic participant, but increases the cost for all parties.

Current pilots use real life environment providing results confirming that DSRC based CV implementation meets application requirements. Interoperability between all road users is the primary requirement for safety applications.