Project: IEEE P802.15 Interest Group for Wireless Personal Area Networks (WPANs)

Submission Title: Compatibility between RF and OWC/OCC in V2X System

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Source: Huy Nguyen, Minh Duc Thieu, Thanh Luan Vu, Yeong Min Jang [Kookmin University], Sangsung Choi[Woosong University].

Contact: +82-2-910-5068 E-Mail: yjang@kookmin.ac.kr

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Abstract: A summary considerations of the compatible with RF of optical V2X communication system

Purpose: To consider the compatibility of RF in optical V2X communication system

Introduction

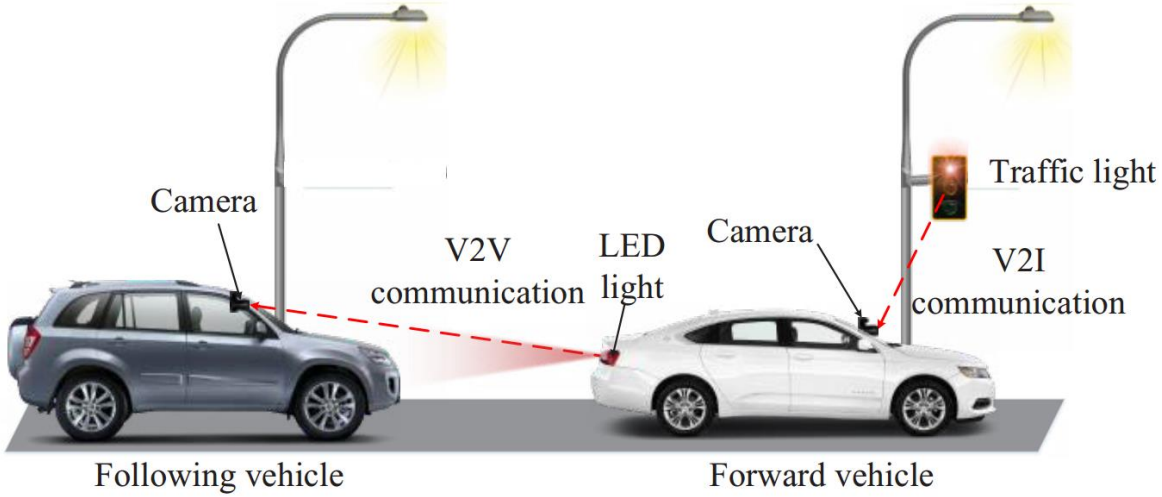
- The usage of OWC/OCC does not exclude RF communication.
- RF can be used for mobile devices such as smartphones, tablets to communicate with vehicles while visible light is used for V2X.
- Therefore, these two technologies should be fully compatible and do not interfere with each other.

Contents

- Intelligent Transportation Systems (ITS) OCC system based V2V communication.
- A considerations of compatibility between RF and OWC/OCC in V2X communication system

1. ITS OCC system-based V2V communication

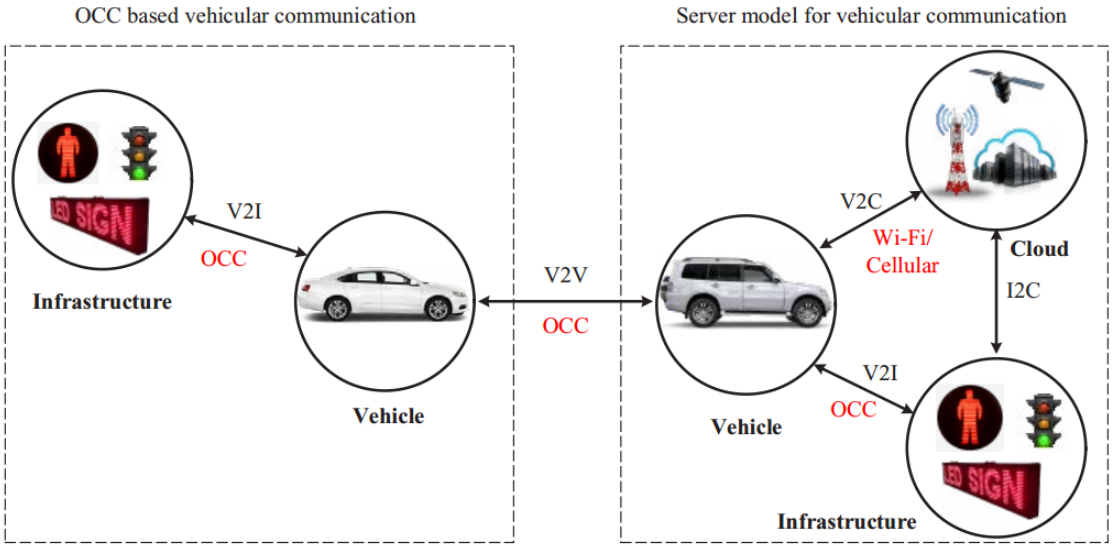
V2I and V2V communication using OCC



Example of V2I and V2V communication using OCC

- OCC uses vehicle backlight LED lights or traffic lights as Tx and camera (webcam or high-speed camera) as Rx. Here, the Tx (traffic light or vehicles rear LEDs) transmit the vehicles status (speed, safety information, emergency message, and etc.) or the traffic condition.
- The receiver can be a single or pair of image sensor which receives the transmitted information from the Tx.

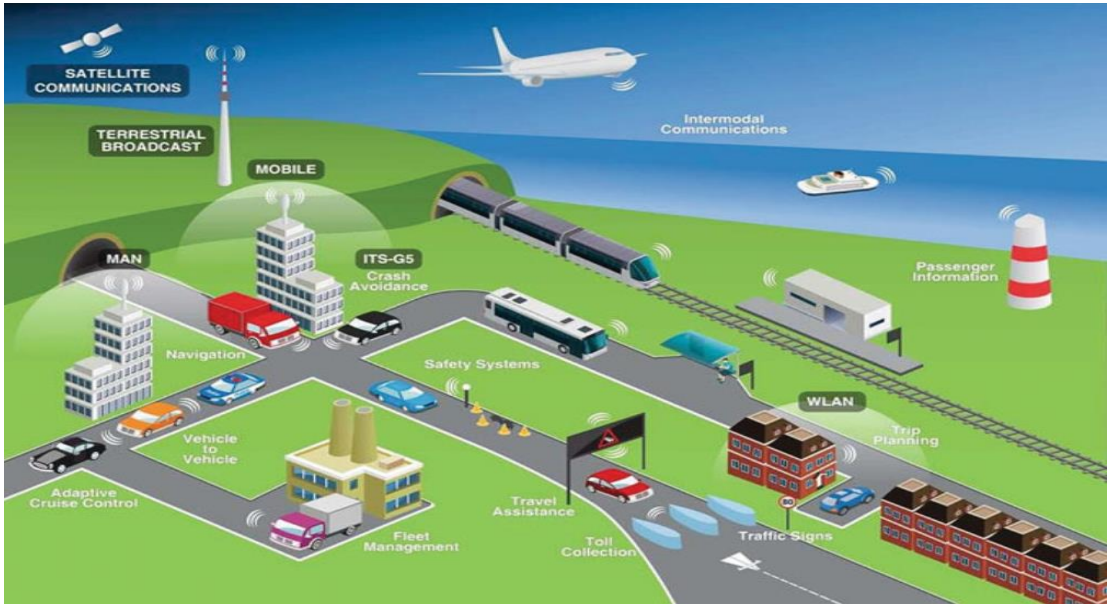
IoV Architecture based on OCC



IoV Architecture based on OCC

- There are four types of communication namely, V2V, V2I, V2C, and infrastructure-to-cloud (I2C) or vice versa. For V2V and V2I communication, we suggested OCC-based communication and for V2C and I2C we recommended Wi-Fi or cellular-based communication.

Intelligent Transportation Systems (ITS) Scenario

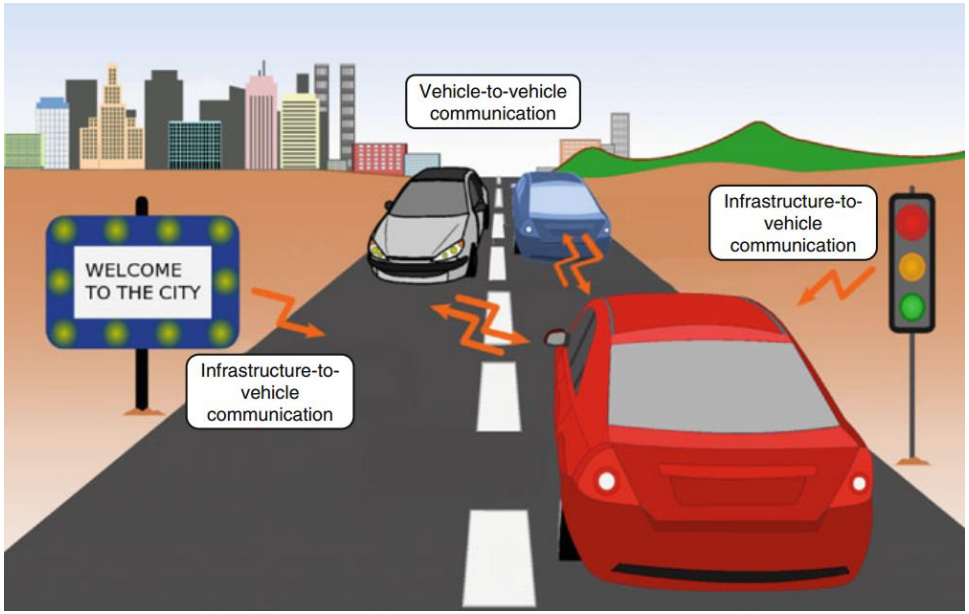


ITS scenario

- Data available from vehicles and road side units can be either consumed locally in the boundary of a geolocalized network or transmitted to a server for central fusion and processing.

- These data can be used to detect events such as road works, traffic jam, approaching emergency vehicle, etc.
- Such data are processed in order to produce driving recommendation dedicated to a single or a specific group of drivers and transmitted wirelessly to vehicles.

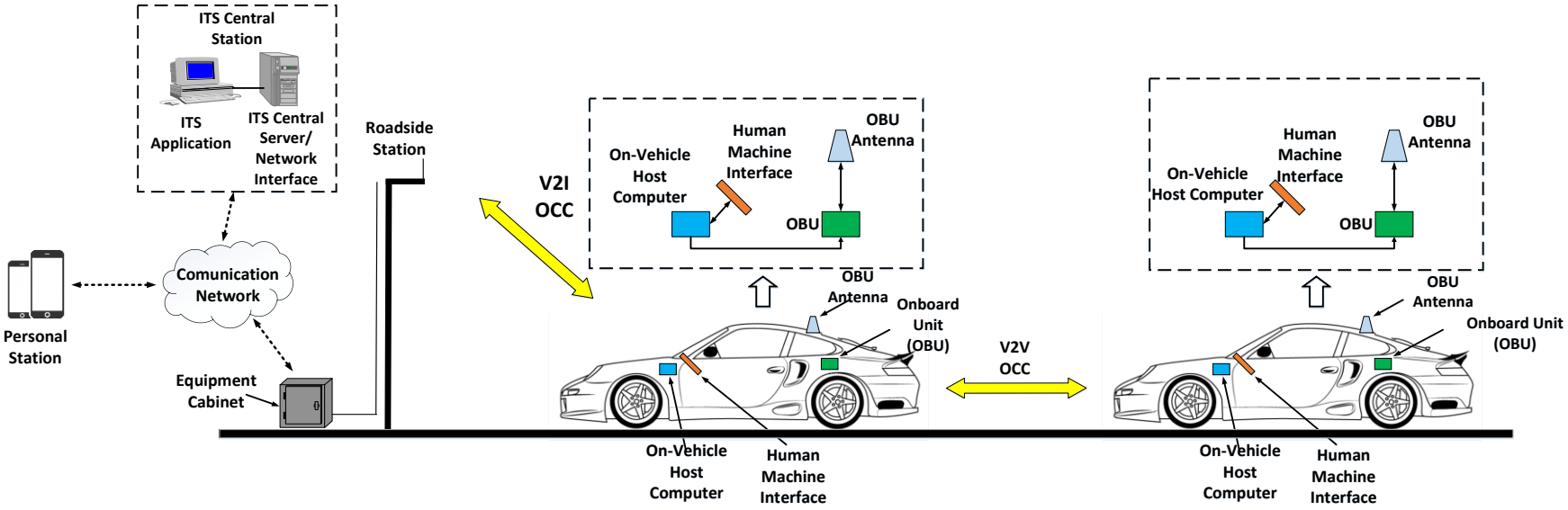
OCC in Intelligent Transportation Systems (ITS)



Example of vehicular communication enabled by OCC

- OCC can be applied into the Infrastructure, Traffic light, Digital Signage, Car back-light, Car front-light, etc.
- OCC Technology can support I2V and V2V

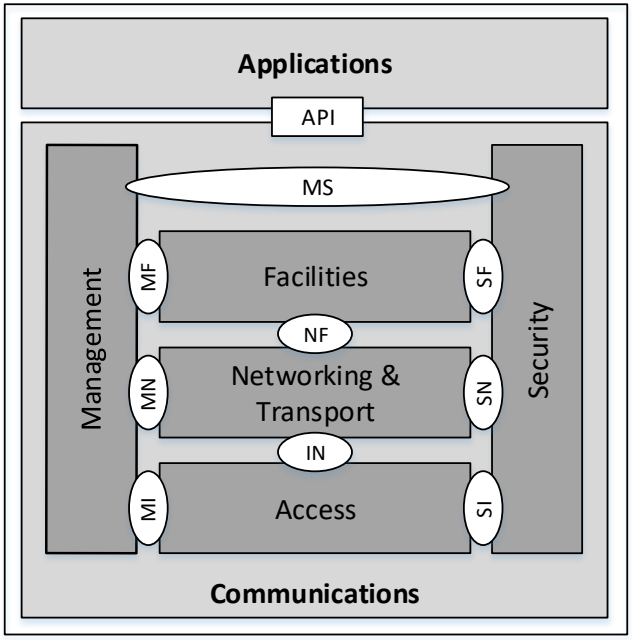
OCC in Intelligent Transportation Systems (ITS)



OCC-based ITS communication overview

- The ITS infrastructure and the ITS ad-hoc network are networks specifically designed to accommodate and implement ITS services and applications. They are interconnected and connected to public access, private access, and local data networks via ITS-SU

ITS based OCC Architecture

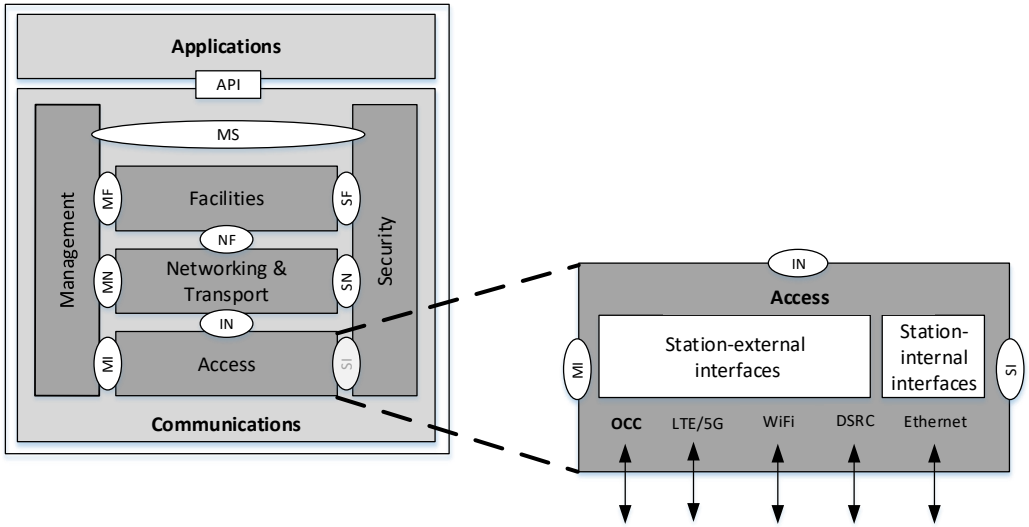


ITS reference architecture

The ITS-S architecture includes six layers:

- Access layer
- Networking & transport layer
- Facilities layer
- Management entity
- Security entity
- Application entity

ITS based OCC Architecture (2)



ITS reference architecture

The ITS-S access layer provides a means of communication between entities inside and outside the station via the interface.

- The following four interface classes are distinguished:
  - Wireless interfaces out of an ITS
  - Wired interfaces out of an ITS
  - Wireless interfaces for station-internal communications.
  - Wired interfaces for station-internal communications.
- OCC will be added into Access layer and it will be considered as wireless interface to communicate out of an ITS

2. A considerations of compatibility between RF and OWC/OCC in V2X system

Dedicated Short Range Communications (DSRC)

- Dedicated Short Range Communications (DSRC) is the technology that is currently predominant in the U.S. connected-vehicle market.
- In Report and Order FCC-03-324, the Federal Communications Commission (FCC) allocated 75 MHz of spectrum in the 5.9 GHz band for use by Intelligent Transport System (ITS) vehicle safety and mobility applications [1].
- DSRC also enjoys strong support from the trade association Global Automakers, in which Honda, Nissan and Toyota participate [1].

Compatibility between RF and OWC/OCC (1)

- DSRC is a mature technology able to provide long distance communication.
- On the other hand, VLC is not able to provide comparable communication distances, but it is considered to have a great potential in high traffic densities [2]
- Therefore, the two technologies, DSRC and VLC might be used together to improve the performances in communication-based vehicle safety applications.

Compatibility between RF and OWC/OCC (2)

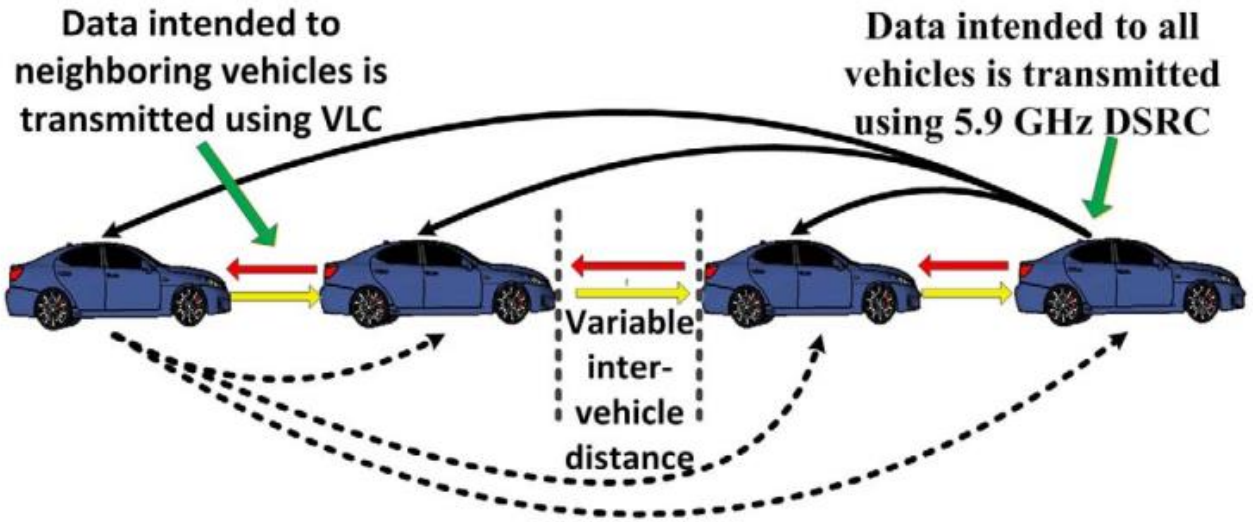


Illustration of DSRC and VLC vehicular heterogeneous network for platooning applications as part of autonomous driving

References

[1] https://www.wardsauto.com/industry-voices/dsrc-vs-5glte-which-will-it-be-connected-vehicles

[2] Alin-Mihai Cailean, Mihai Dimian, "Current Challenges for Visible Light Communications Usage in Vehicle Applications: A Survey," IEEE Communication Surveys & Tutorials, vol. 19, no. 4, pp. 2681-2703, 2017.

[3] EN ISO 22738:2019, *Intelligent transport systems-Localized communications-Optical camera communication*