

Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)**Submission Title:** PHY Mode Categorization for IEEE802.15.7a High Data Rate OCC TG**Date Submitted:** November 2020**Source:** Vinayagam Mariappan (SMR Automotive Modules Korea Ltd.), Geonyoung Choi, Jaehong Kim, Jong Chang Ham, Wonsik Hong, Hojin Huh (SMR Automotive Modules Korea Ltd.).**Address:** Contact Information: +82-32-6507-785, FAX: +82-32-6507-871, E-Mail: vinayagam@ieee.org**Re:****Abstract:** This document introduces the required PHY modes to be supported on IEEE802.15.7a High Data Rate OCC (Optical Camera Communication) TG. The proposed PHY modes adapts to varying channel conditions and maintaining connectivity during high mobility (speeds up to 350 km/h), flicker mitigation, Radio Frequency (RF) co-existence, and a communication range of up to 200m for vehicle-to-everything (V2X) and device-to-device (D2D) communication applications.**Purpose:** To provided required PHY mode support of the OCC in IEEE802.15.7a High Data Rate OCC.**Notice:** This document has been prepared to assist the IEEE P802.15. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.**Release:** The contributor acknowledges and accepts that this contribution becomes the property of IEEE and may be made publicly available by P802.15.

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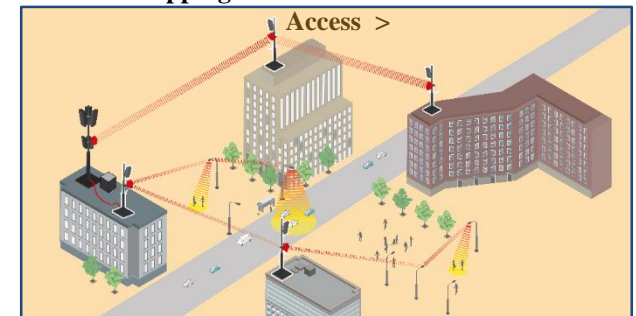
OCC Application Usage Scenarios Categorization (1)

• Low/Non-Mobility OCC Applications

- Static Object and Pedestrian Network Access
- Indoor / Outdoor Environment Monitoring and Internet Access
- Security Monitoring in Home/Industrial / Commercial Buildings
- Small Cell Backhaul
- Patient Monitoring in Hospitals
- Exhibition and Shopping Malls Network Access
- Meeting / Conference Rooms Network Access
- Industrial IoT and Automation etc.



< Shopping Area OCC Link for Network Access >

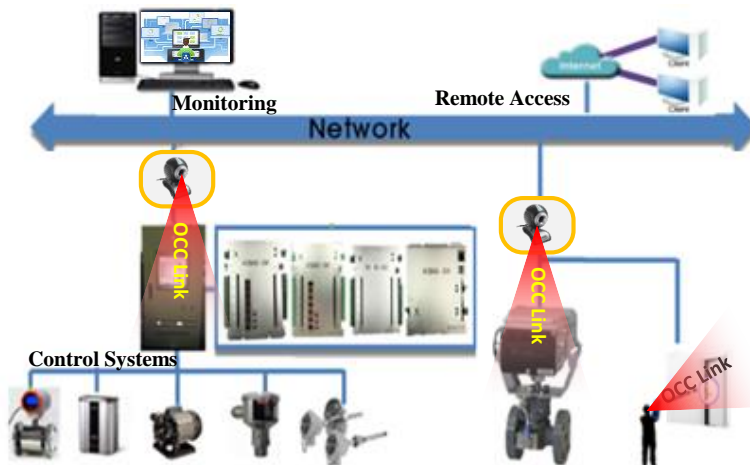


< Small Cell Backhaul >

<https://mentor.ieee.org/802.11/dcn/18/11-18-0909-01-001c-lc-usage-model.pptx>



< Smart Devices OCC Link for Network Access >



< OCC Link for Automatic Control Solution >



< Living Area OCC Link for Network Access >

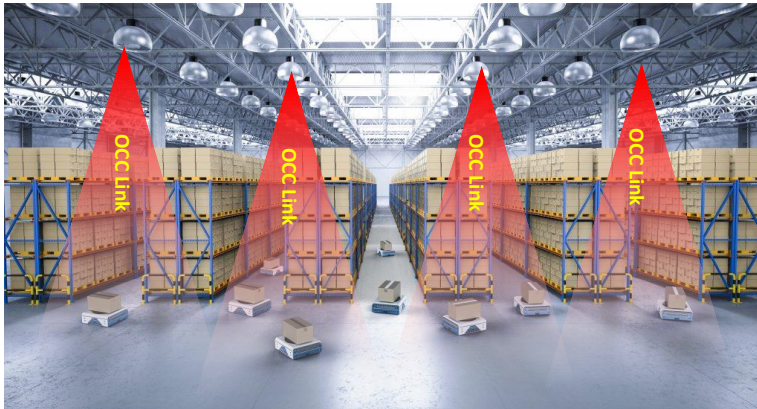
OCC Application Usage Scenarios Categorization (2)

• Restricted Mobility OCC Applications

- Airport Indoor and Ground Vehicles
- Robotics Automation
- Logistics Automation Solution in Warehouse
- Automated Guided Vehicle (AGV) used in Factory, Logistics, etc.
- Mobile robots in a personalized manufacturing cells
- Product Assembly Line Automation
- Electric Kick scooter and Bicycle Riders on-the-way Network Access



< OCC Link for Bicycle Riders Navigation >



< OCC Link for AGV in Logistics Automation >

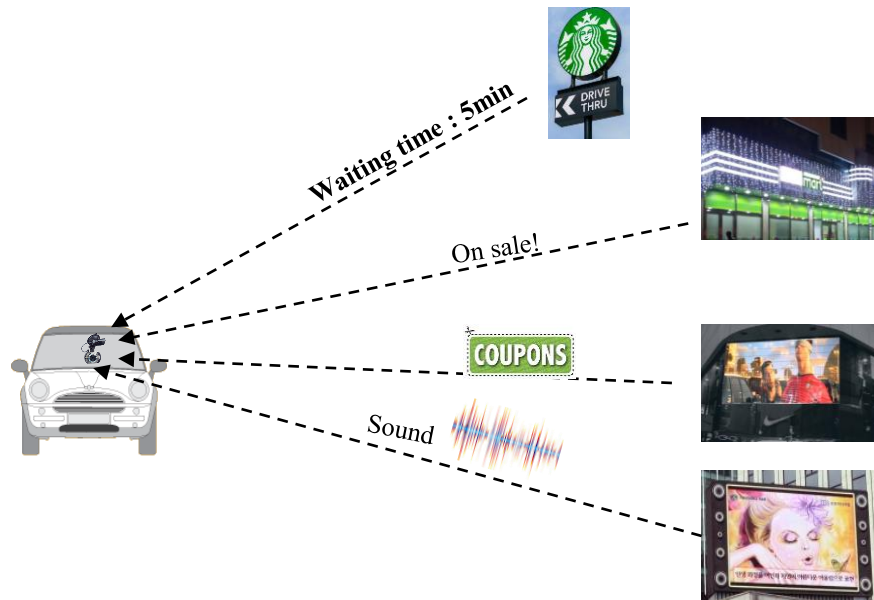


< OCC Link for Airport Indoor Service Vehicle and Robotics Navigation >

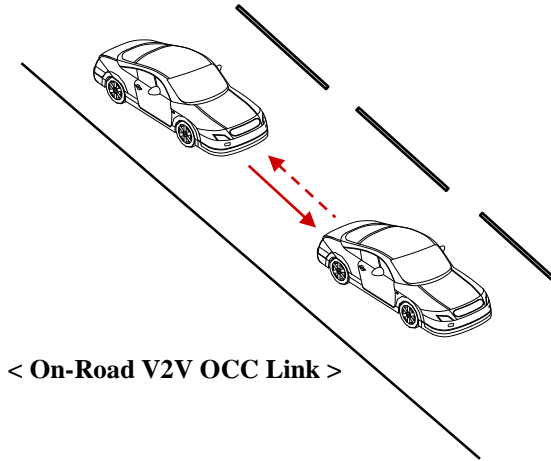
OCC Application Usage Scenarios Categorization (3)

• High Mobility OCC Applications

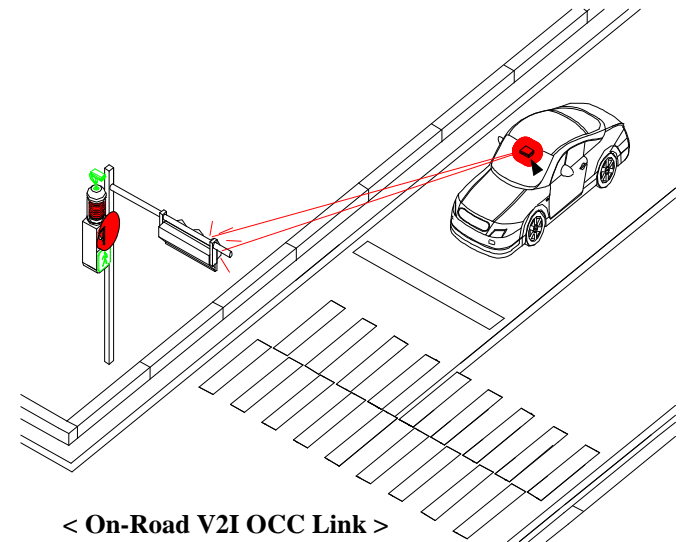
- Advanced driver-assistance systems (ADAS)
- Autonomous Vehicles (AVS)
- Vehicle to Everything (V2X) communication
- Collision avoidance in V2X network or Drone network



< On-Road V2I OCC Links Using Signage >



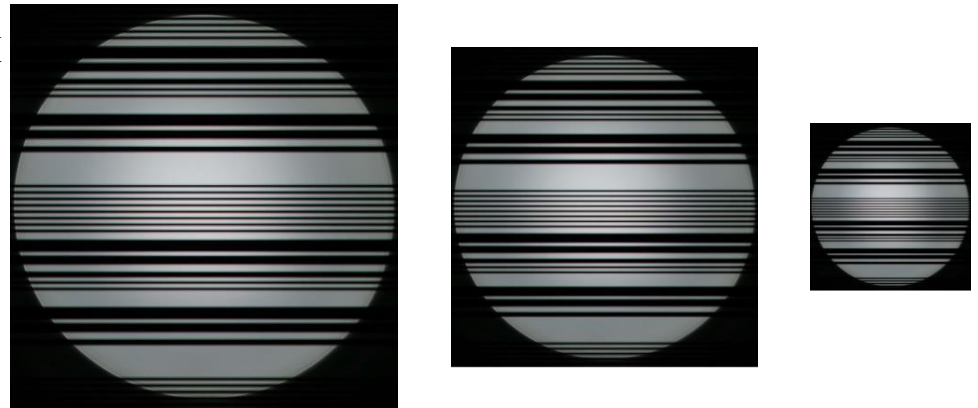
< On-Road V2V OCC Link >



< On-Road V2I OCC Link >

PHY Modes Categorization

- OCC Receiver detects the LED Stripe or Display Coded Color pattern size differs according with distance.
- Need Mobility adaptive data synchronization , handover, and inter-symbol bit sampling method by distance and mobility speed based camera zooming mechanism or sampling mechanism.
- Proposed to categorize the PHY Mode with Mobility Condition
 - PHY Mode I : Low/Non-Mobility TX/RX
 - PHY Mode II: Restricted Mobility TX/RX
 - PHY Mode III : High Mobility TX/RX



< OCC Receiver LED Stripe in Different Distance Level >

PHY Mode I : Low/Non-Mobility TX/RX



< OCC Link based Network Access >

<https://mentor.ieee.org/802.11/dcn/18/11-18-0909-01-00lc-lc-usage-model.pptx>

- **PHY Mode Coverage**

- Used for static object / human network Access and pedestrian mobility environment network access
 - Includes Indoor / Outdoor environment access
- TX : LED and Display / Signage
- To maintain the connectivity during restricted mobility (speeds up to 10 km/h)
- Communication range of up to 200m
- Day-Night Communication Mode
- Data Rate : Up to 100 Mbps
- Need an environmental condition, adaptive data synchronization and handover mechanism
- Need only basic inter-symbol bit sampling method

PHY Mode II: Restricted Mobility TX/RX

- **PHY Mode Coverage**

- Used for Indoor or Outdoor Speed Restricted Mobility Vehicle

- Includes Factory / Warehouse AGV, Airport Indoor / Outdoor Service Vehicles, Electric Kick Scooter / Bicycle Riders, Mobile robots in a home / industry / manufacturing cells, Automated production Assembly Lines

- TX : LED and Display / Signage

- To maintain the connectivity during restricted mobility (speeds up to 20/30 km/h)

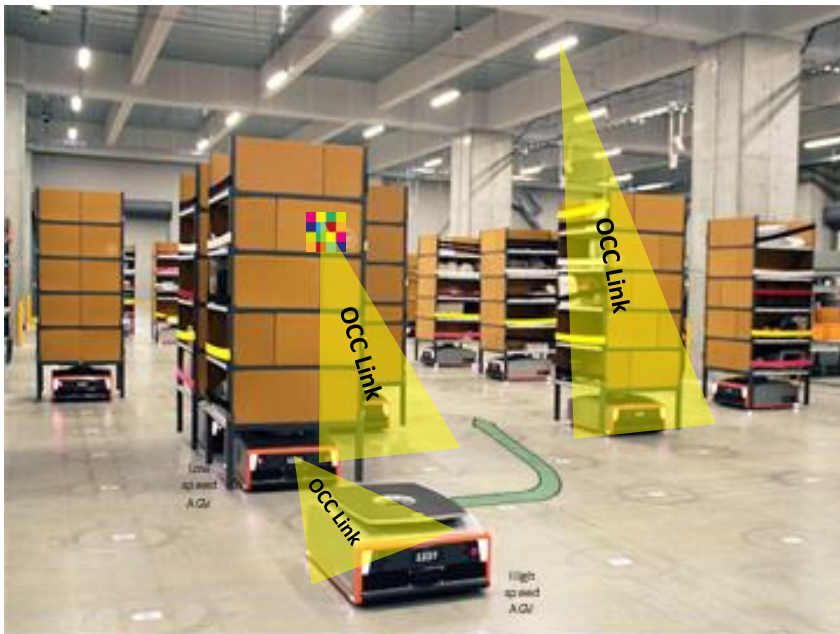
- Communication range of up to 10~20 m

- Day-Night Communication Mode

- Data Rate : Up to 100 Mbps

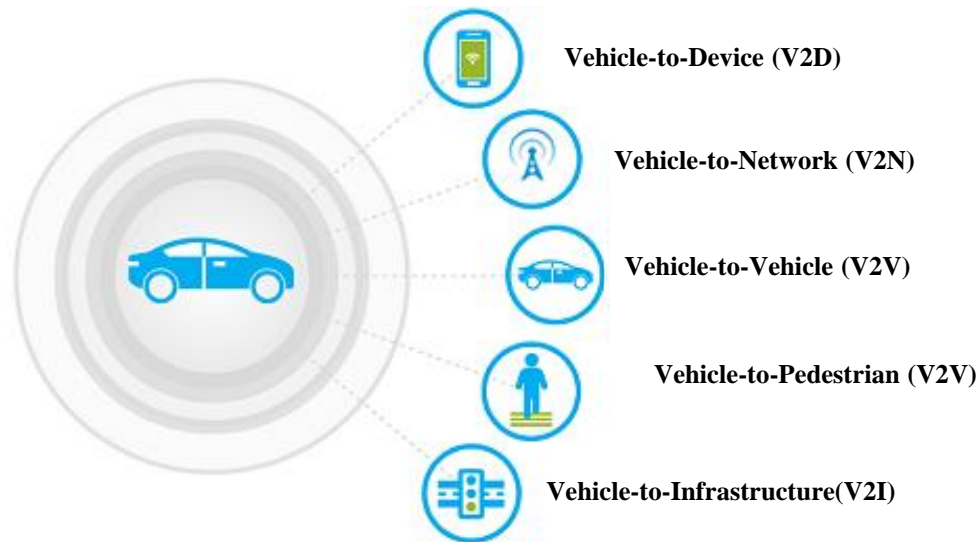
- Need a restricted environment adaptive data synchronization and handover mechanism

- Need to provide environment adaptive inter-symbol bit sampling method



< OCC Link based AGV for Warehouse Automation >

PHY Mode III : High Mobility TX/RX



< OCC Network Access for V2X Connectivity >

- **PHY Mode Coverage**

- Used for On-Road Vehicles
- TX : LED and Display / Signage
- To maintain the connectivity during high mobility (speeds up to 350 km/h)
- Communication range of up to 200m
- Day-Night Communication Mode
- Data Rate : Up to 100 Mbps
- Need a very fast data synchronization and robust handover mechanism
- Need to provide distance adaptive inter-symbol bit sampling method

Conclusion

- Proposed the PHY Mode Categorization for IEEE802.15.7a High Data Rate OCC TG.
- Uses of the High Data Rate OCC can be classified into Low/Non-Mobility, Restricted Mobility, and High Mobility groups according to the application usage.
- This proposed PHY mode categorization will help to describe the PHY technical information in details since the OCC mobility scenario needs more stability in receiver side to have a reliable communication.
- The proposed PHY mode based OCC Link can provide the flexible, secure, and safety user network access link.