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V2X communication overview and V2I traffic light demonstrator

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Embedded Computing Hauptseminar, Prof. Dr-Ing. Hobelsberger

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V2I traffic light demonstrator
V2X communication overview

Outline

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Standards

5G C-V2X

IEEE 802.11p

Discussion

V2I Demonstrator

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V2X

V2I

Standards and associations

5G Cellular-V2X

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V2X communication overview

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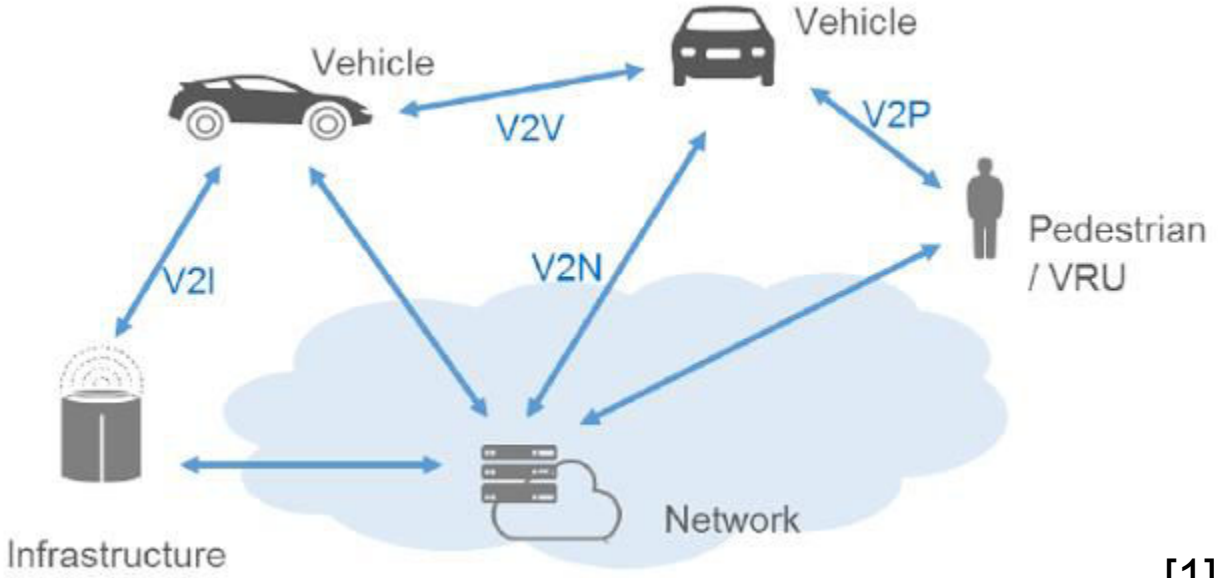

[1]

- V2X vehicle-to-everything

- V2V vehicle-to-vehicle
- V2I vehicle-to-infrastructure
- V2P vehicle-to-pedestrian
- V2N vehicle-to-network

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V2X use cases

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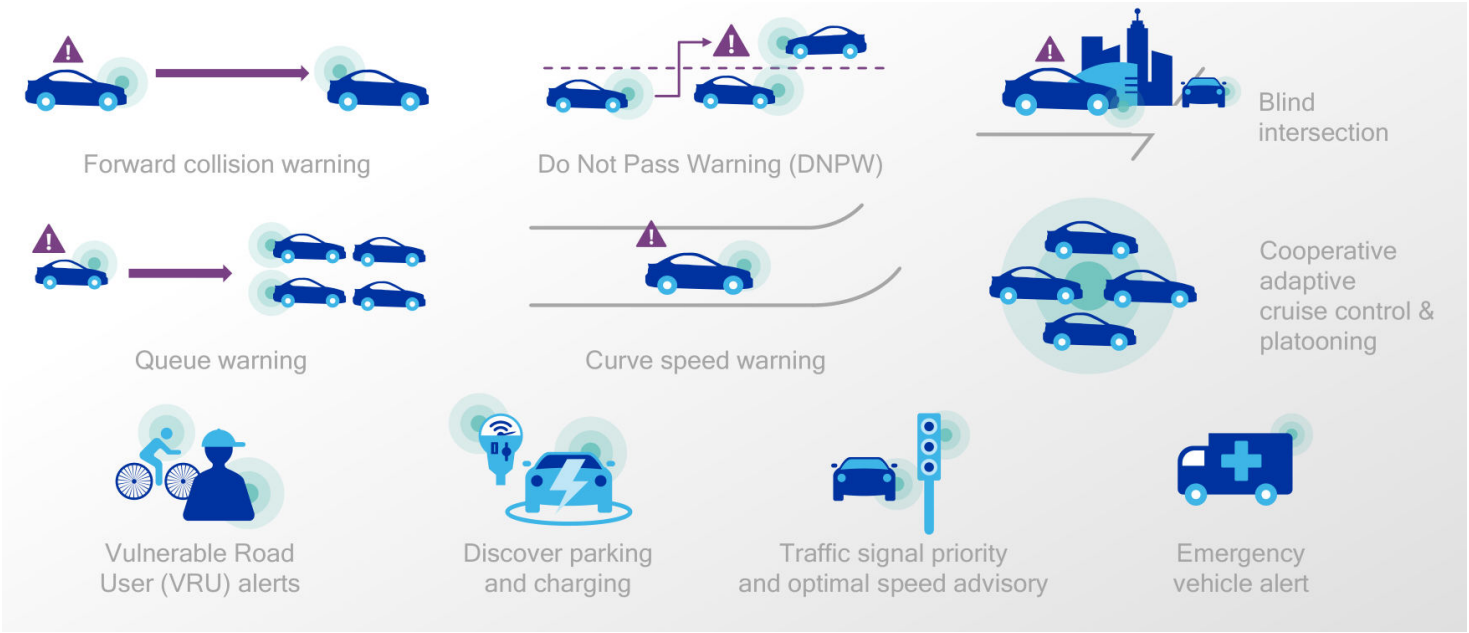

[2]

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Sensor-fusion and V2X

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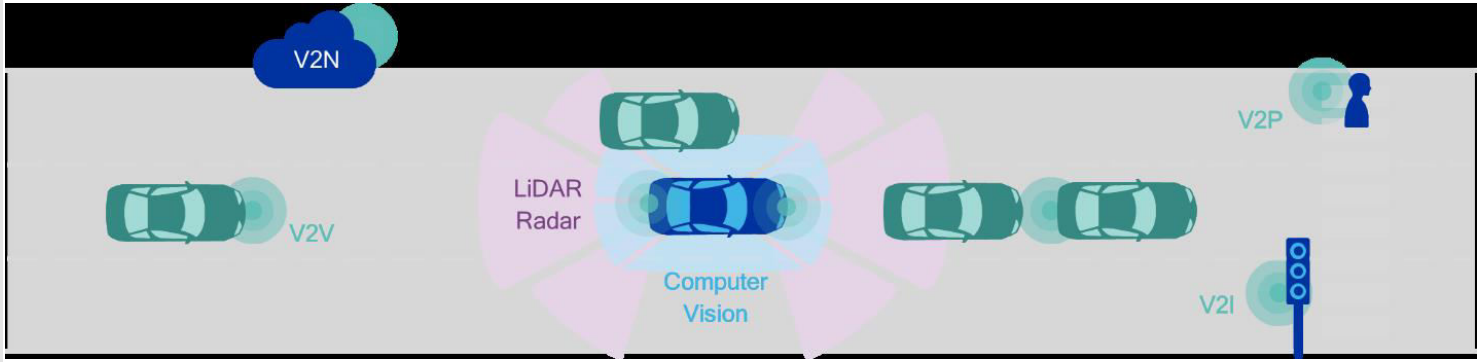

[3]

- World view: each car has global view over itself
- Combing on-board sensor data with V2V and V2I data
- Belief-Desire-Intention algorithm

V2V extends safety

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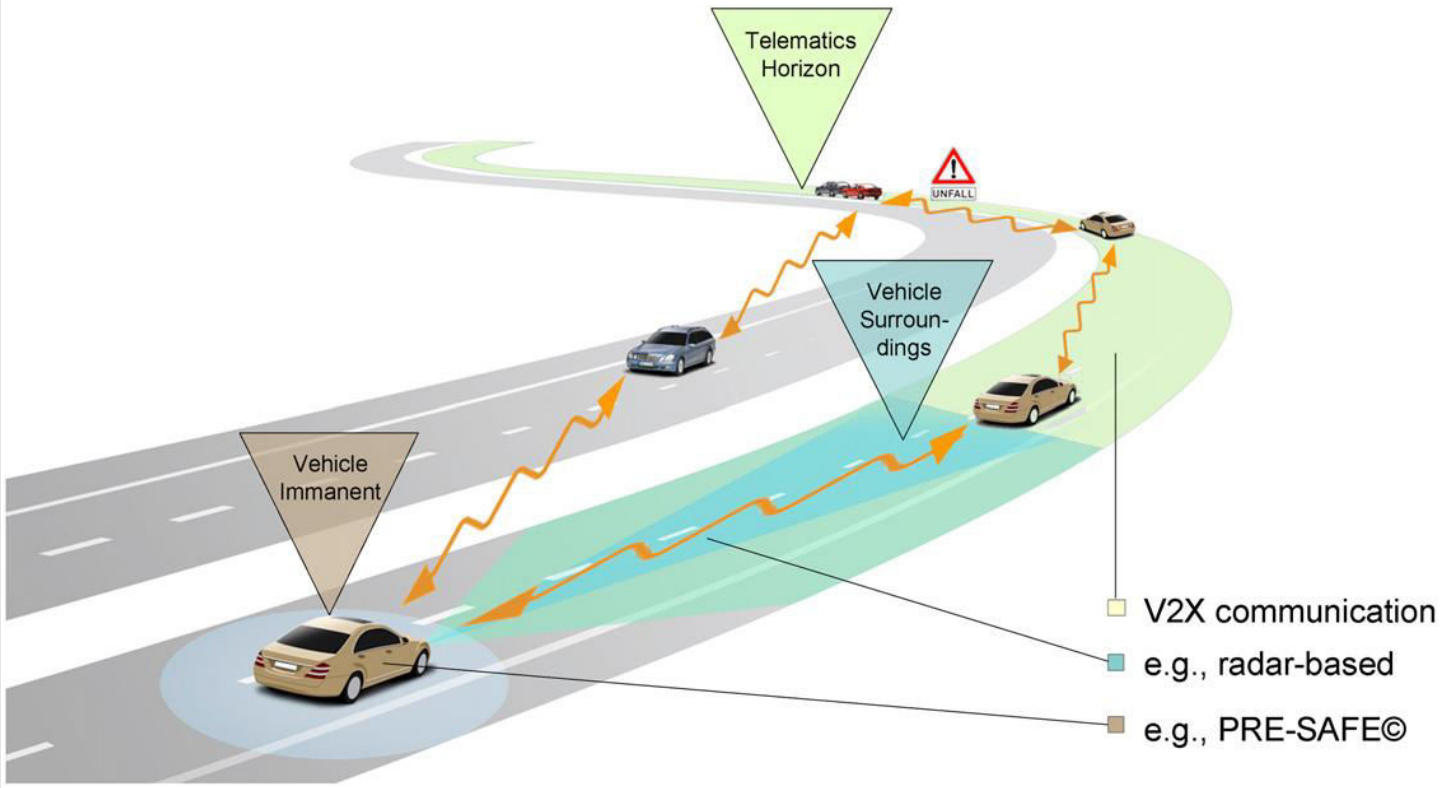

[4]

- Extensive view of surrounding
  - Telematics Horizon

V2I / V2X security issues

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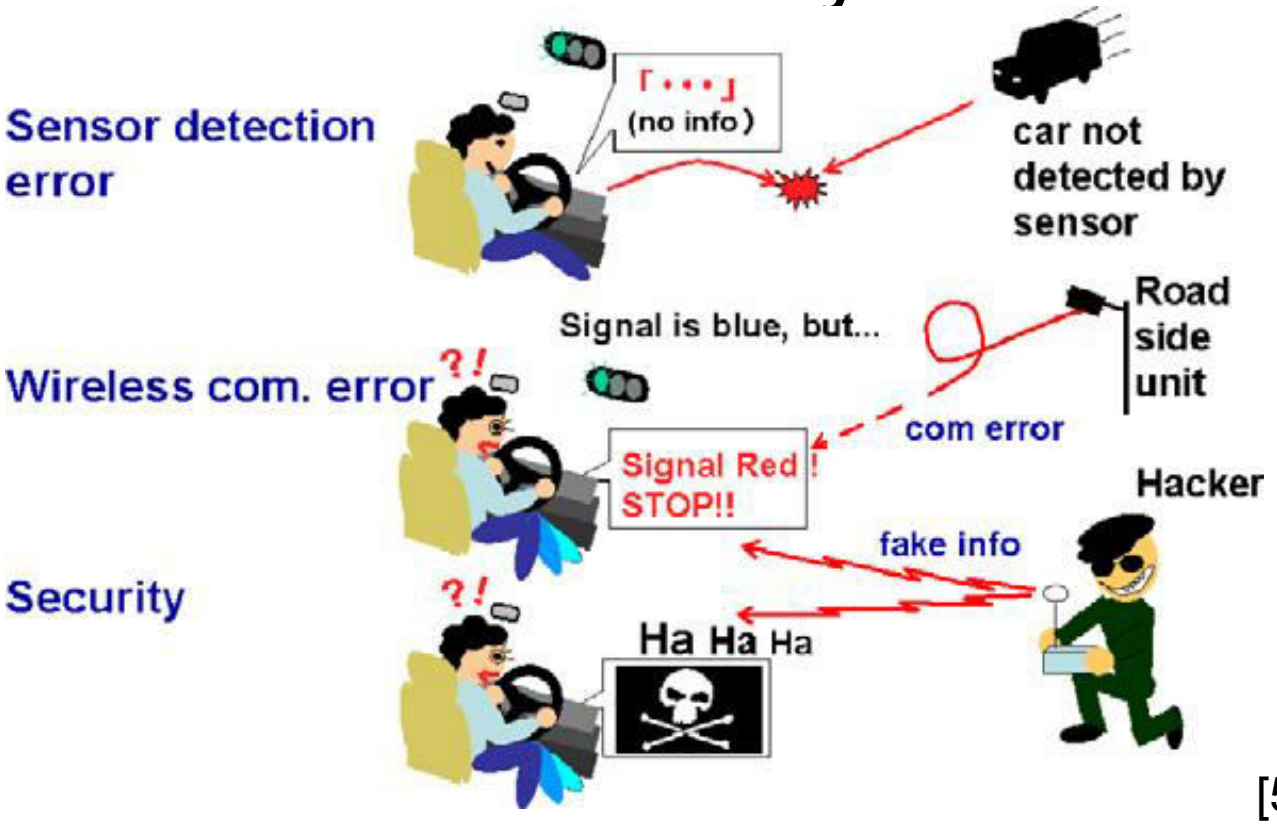

[5]

- Countermeasures
  - treat V2X information as suggestion only
  - Verify, authenticate emergency vehicle by RSU
  - Peer-to-Peer verification of emergency vehicle (V2V)

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V2I approaching emergency vehicle

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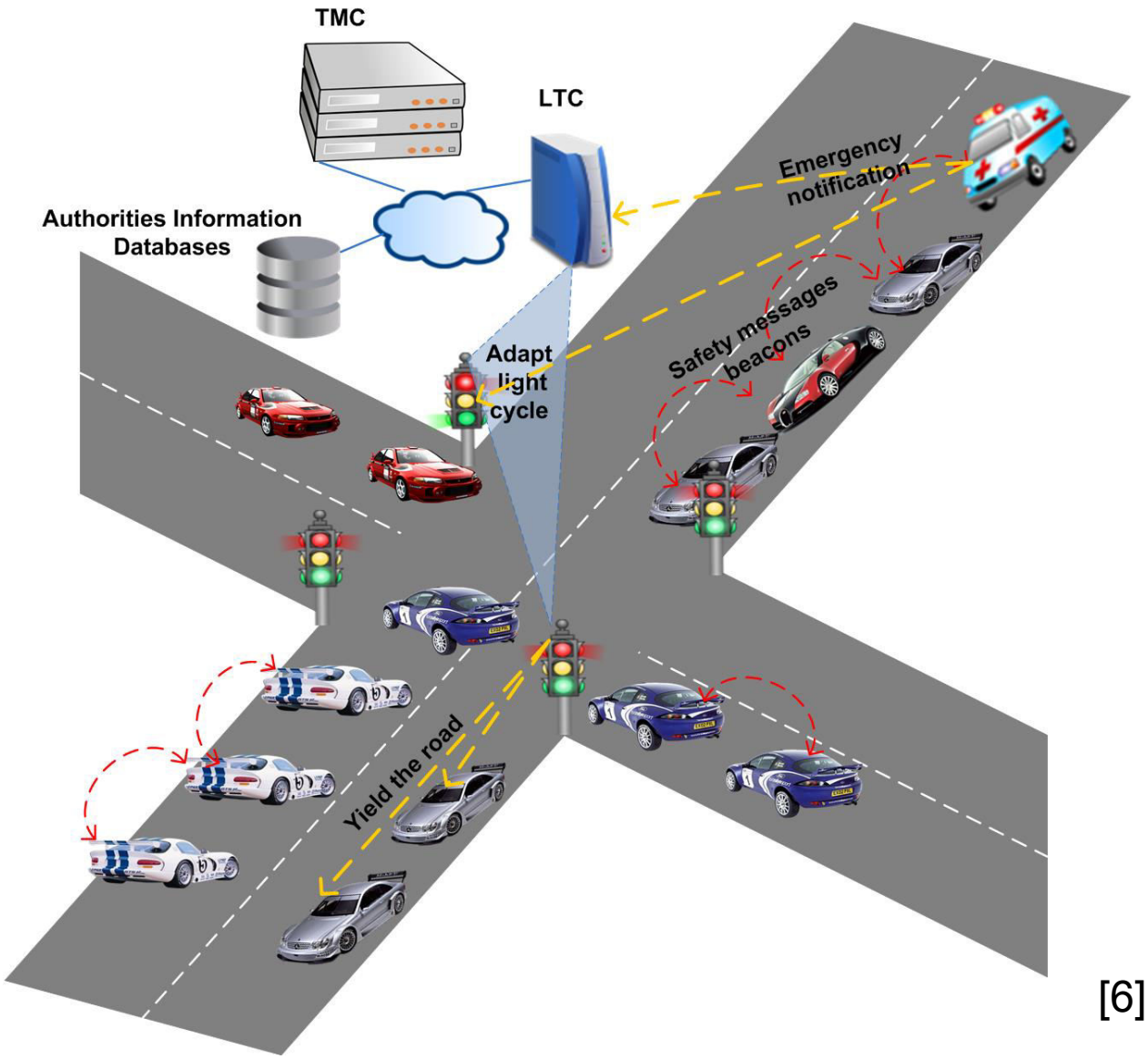

[6]

V2I dynamic intersection management

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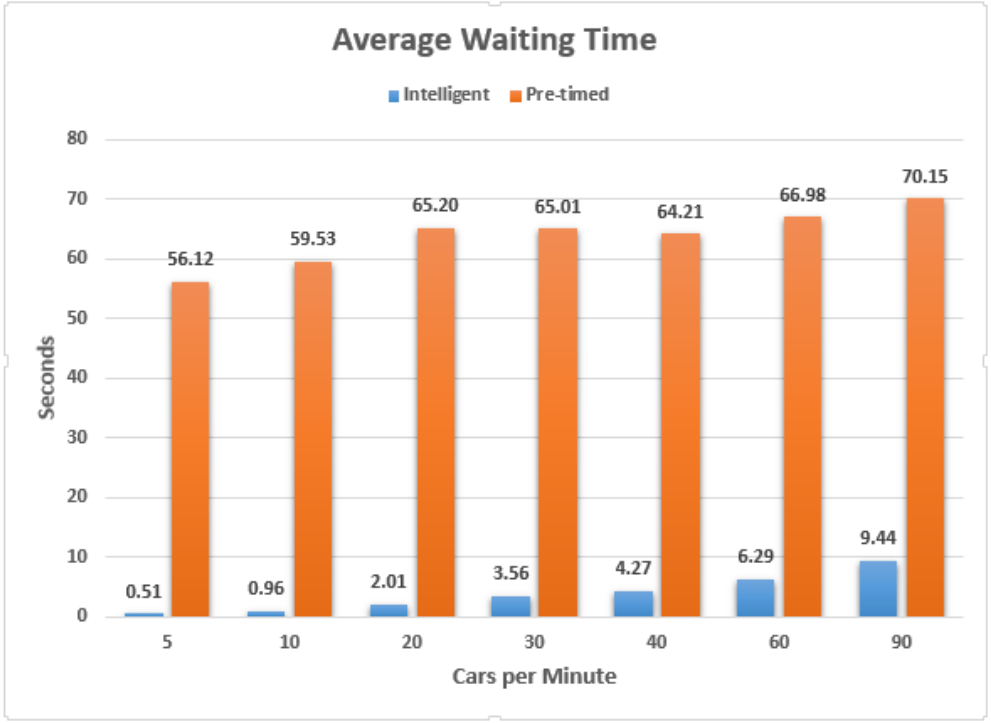

[7]

- For each vehicle individually:
  - dynamically assign time slot to pass intersection
  - vehicle notifies RSU, if it left intersection
  - Pedestrians ?

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Standards and associations

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- **C2C-Consortium**:
  - Car manufacturers, component suppliers, technology companies and research institutions
  - Goal: Standard for a Cooperative Intelligent Transportation System (C-ITS) in Europe
  - Focus on a validation process for V2V and contribute to European standardization authorities
- **5GAA**:
  - Telecommunication providers, car manufacturers, component suppliers and technology companies.
  - Pushing 5G LTE services for V2X

Standards and associations

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- **3GPP**:
  - Standardization body for specifying mobile communication standards
  - Important for V2X: Releases 14/15 (5G LTE)
- **IEEE**:
  - Standardization committees of a wide range of technologies
  - IEEE 802.11p Wireless standard

5G Cellular V2X

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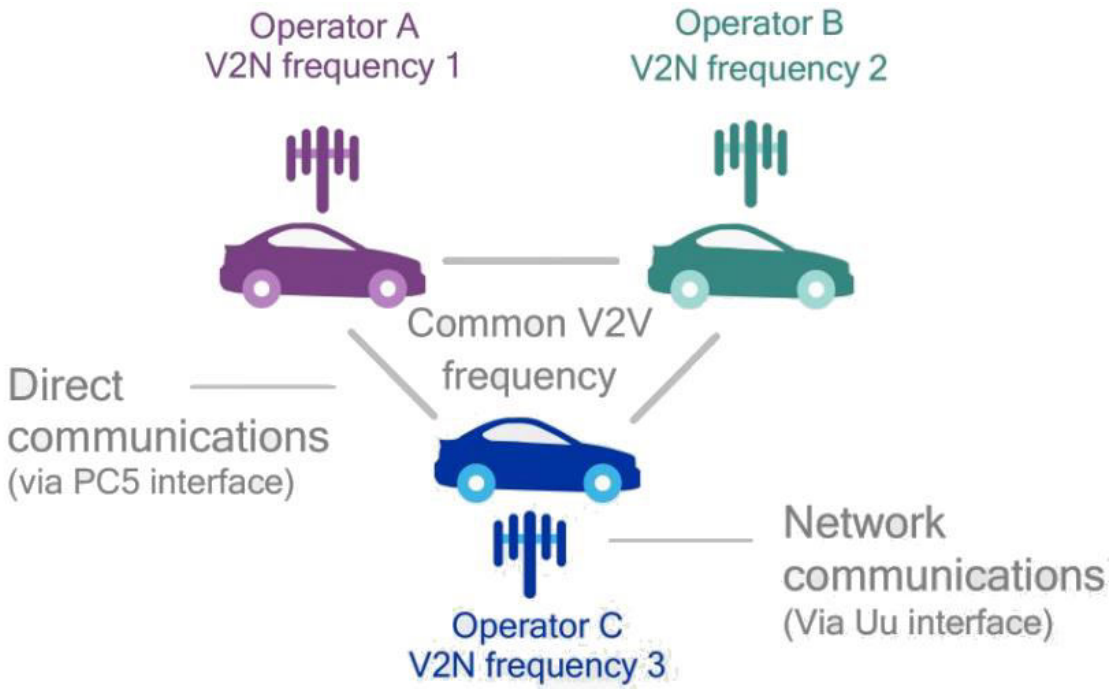
- C-V2X / LTE-V2X based on LTE-Direct
- 70 MHz of bandwidth
- Direct communication over PC5-Interface
- Network communication over Uu-Interface
- 3GPP Release 14 and 15
- Ready for market 2018



[8]

IEEE 802.11p WAVE

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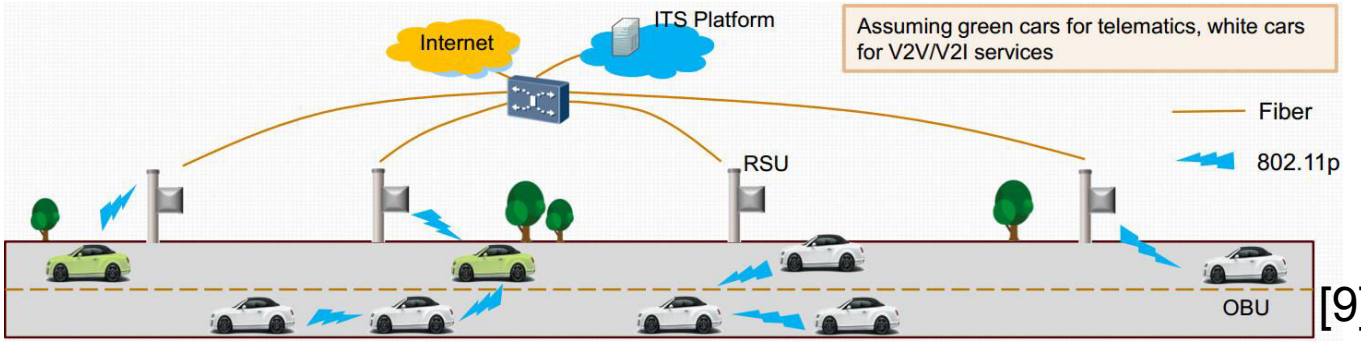
- Continuation of the IEEE 802.11 radio standard
- Low latency V2X use cases

- Challenge:
  - interferences between channels
- Network infrastructure:
  - RSUs needed
  - Radio equipment needed
- Frequency:
  - 5,9 GHz band
  - restricted
- Communication setup:
  - Solution for slow communication setups
  - Wave BSS



[9]

C-V2X versus IEEE 802.11p

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- Different approaches: cellular / WiFi
- Performance issues, if IEEE 802.11p has low market share, rural regions
  - Cellular 4G 5G can provide support
- High infrastructure deployment costs
  - Evolved Packet Core -> 5G (see Europe / Asia)
  - RSU with IEEE 802.11p Access points
- Frequencies must be released for 5G / IEEE 802.11p
- IEEE 802.11p is already deployed for V2V
- C-V2X is ready for market in 2018
- Business model is clear for 5G services, but not for IEEE 802.11p

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V2I traffic light system

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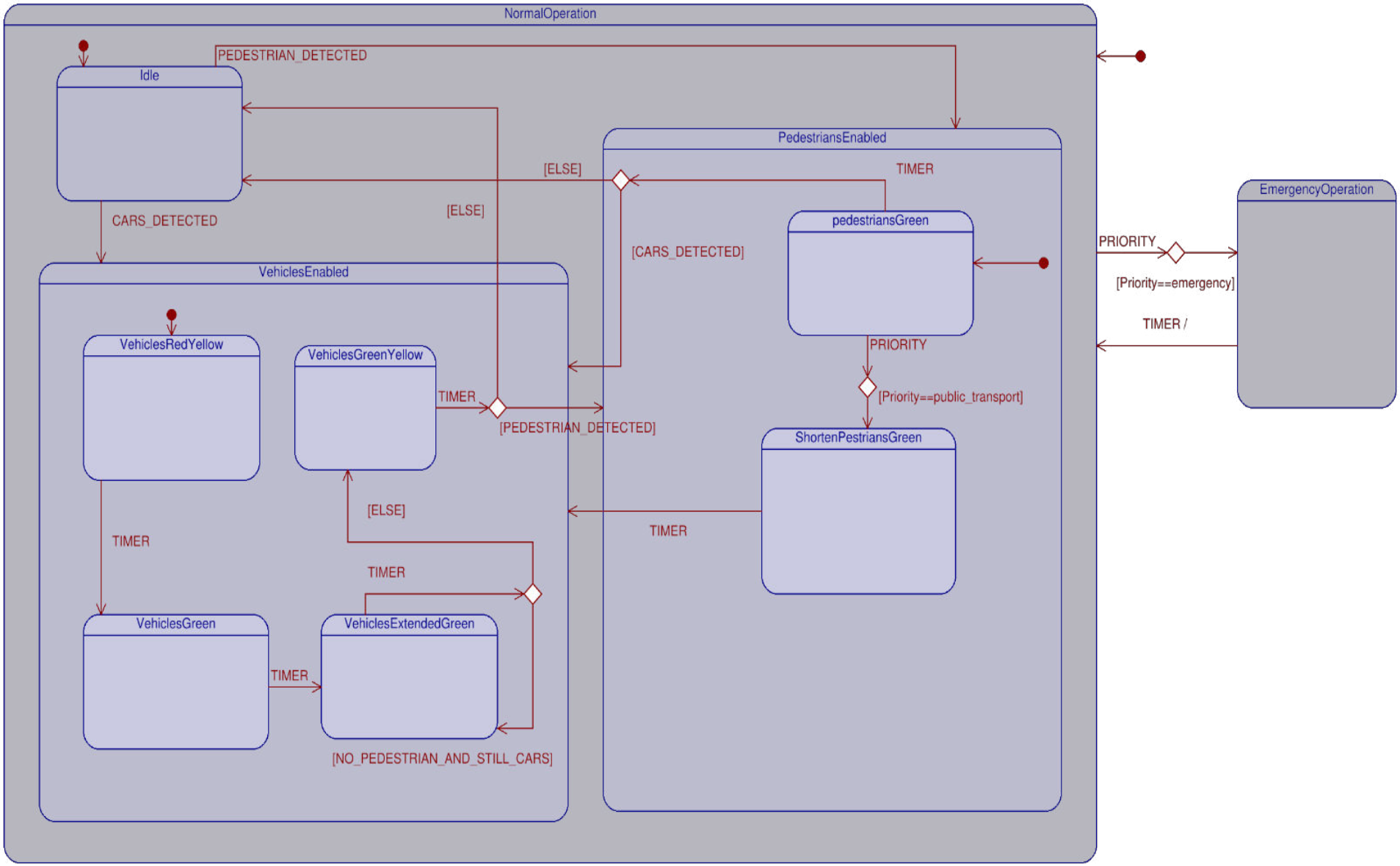
V2I traffic light system UML



Use cases

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1. Green wave
2. Dynamic traffic light signal cycles ☺
3. Traffic light status request ☺
4. Crossing priority for emergency vehicles ☺
5. Numeric signal cycle indicator for pedestrians

Use cases

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6. Communication interface for pedestrians ☺
7. Simplified crossing for handicapped ☺ pedestrians
8. Road toll collection ☺
9. Traffic education
10. Augmented reality advertisement

Conclusion

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- V2X key technology for autonomous driving
- Paper gives an overview over V2X, V2I
- V2X will be deployed in several phases
- We are at the beginning of the first phase
- Our provided use case contribute to this (V2I, I2P)
- Demonstrator underpins use cases

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