# LTE V2X Communication – Scenario and OAI Roadmap

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# Acknowledgements

- **Orange Labs and EURECOM** - 3 years active collaboration on V2X
  - EURECOM subcontractor to Orange Labs in the 5GPP 5GCAR for Simulation/Emulation evaluations of future 5G architecture for Automotive

- **EURECOM**
  - Raymond Knopp
  - Panagiotis Matzakos
  - Tien-Thinh Nguyen

**OPEN AiR**
**INTERFACE**

**OpenAirInterface**
5G software alliance for democratising wireless innovation

- **OrangeLabs**
  - Bernadette Villeforceix
  - Christian Bouissou

http://www.openairinterface.org/

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# Problem Space & Stakeholders
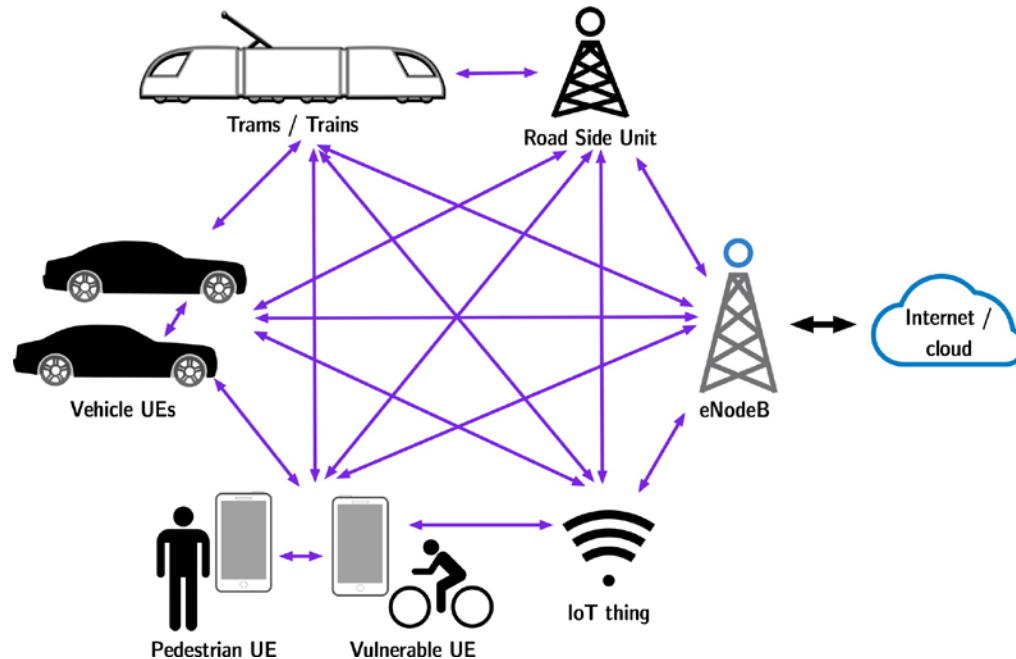


Source: Dr. Gallo, EURECOM

- **Key Stakeholders**
  - Automotive industry
  - V2X techno providers
  - Cellular industry
  - Vulnerable road users

- **Key CONOPs for V2X**
  - Dedicated V2V/V2I/V2P communication, without network support (no SIM)
  - Mixed Uu – PC5 communication (V2N)

- **Key Services**
  - V2X critical safety communication
  - Safety of vulnerable road users
  - Mission-critical communication
  - Collective Perception
  - Automated driving/Platooning
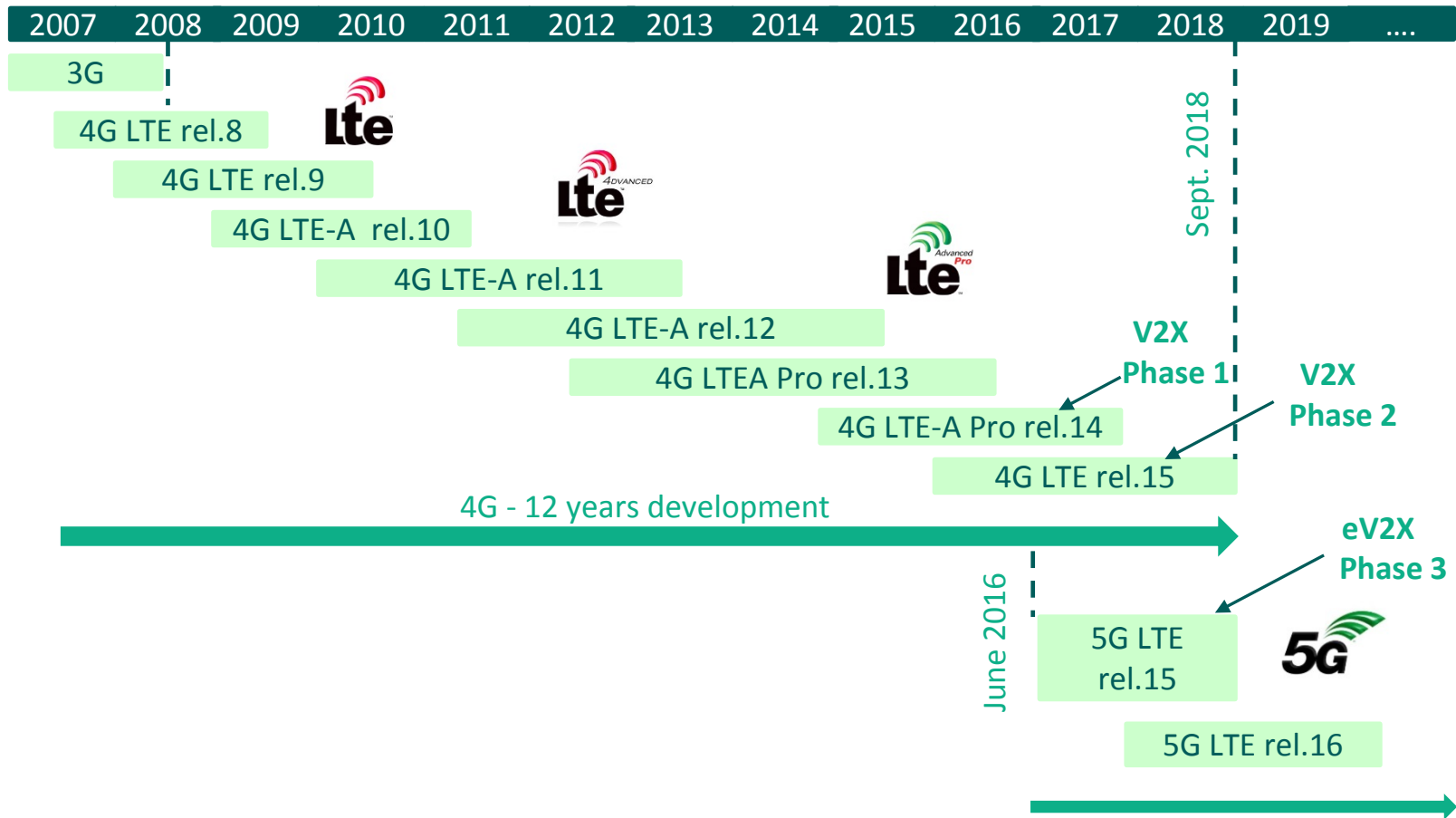  - Remote sensing and control

# LTE V2X Scenarios

- **Scenario 1: Off-Network V2X-PC5**
  - ➢ UEs are off-network but
    communicate directly via a Sidelink channel

- **Scenario 2: On-Network V2X-PC5**
  - ➢ UEs are located closed to their eNodeB
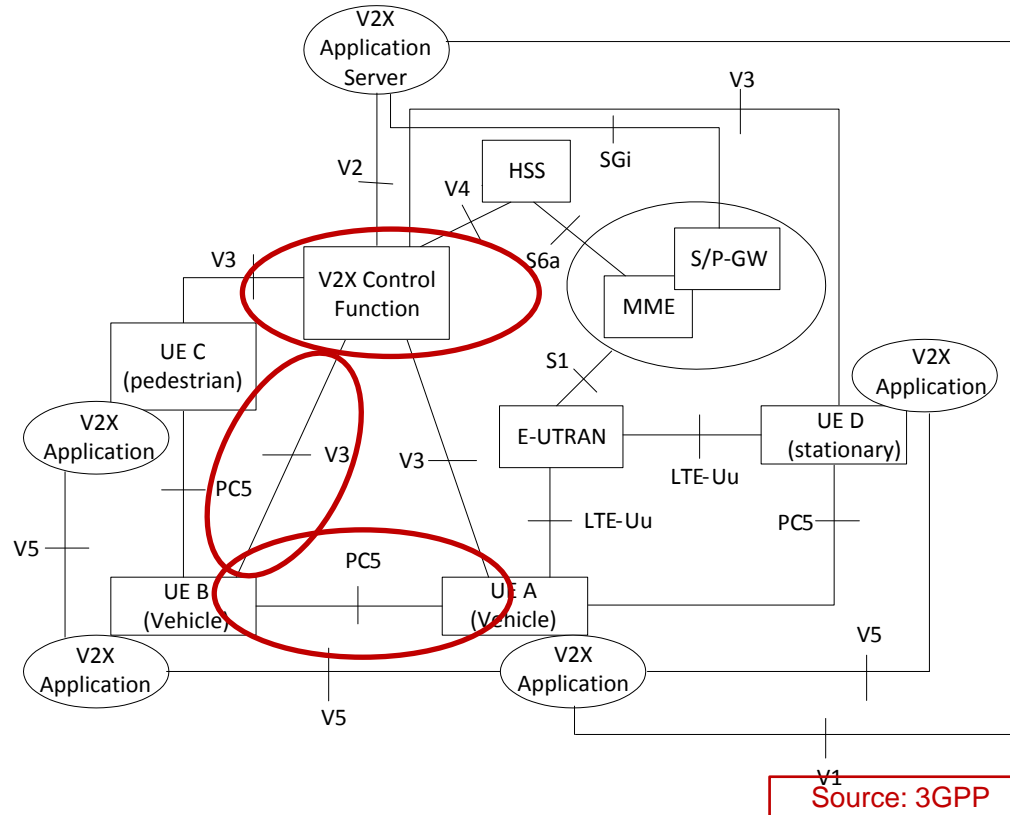    but communicate directly via a Sidelink channel

- **Communication Patterns**
  - ➢ 'Selective' One-to-Many (group multicast)
    - – No Signaling - V2X is connection-less
  - ➢ Pure IPv6

- **Spectrum**
  - ➢ V2V PC5 – 5.9GHz (current implementations)
  - ➢ V2I-V2N Uu – 3.4 GHz  (require Research spectrum)

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# LTE Proximity Services (ProSe)



| 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | .... |

3G

4G LTE rel.8

4G LTE rel.9

4G LTE-A rel.10

4G LTE-A rel.11

4G LTE-A rel.12

4G LTEA Pro rel.13

4G LTE-A Pro rel.14

4G LTE rel.15

Sept. 2018

V2X Phase 1

V2X Phase 2

4G - 12 years development

eV2X Phase 3

June 2016

5G LTE rel.15

5G LTE rel.16

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# LTE V2X Extended Architecture



Source: 3GPP

- **New Architecture Elements:**
  - ➤ V2X Control Function – similar to Prose Function
  - ➤ PC5 interface – as D2D Prose
  - ➤ V3 interface – as PC3, but with V2X-related messages
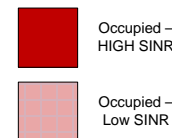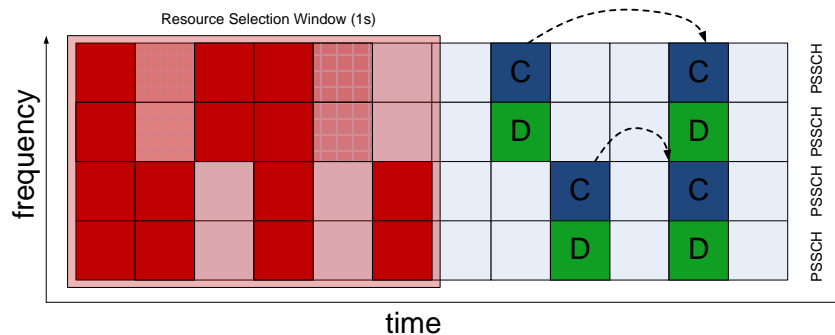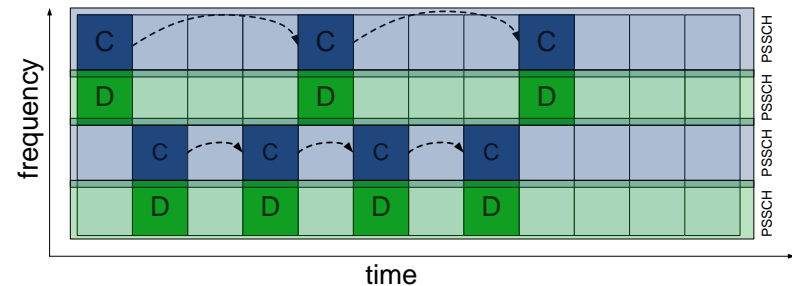
# LTE-V2X – Distributed Scheduler

**LTE V2X mode 3 (eNB)**
- multiple SPS configurations can be active
- can be different period/MCS for flexibility
- UE does not have to transmit if no data
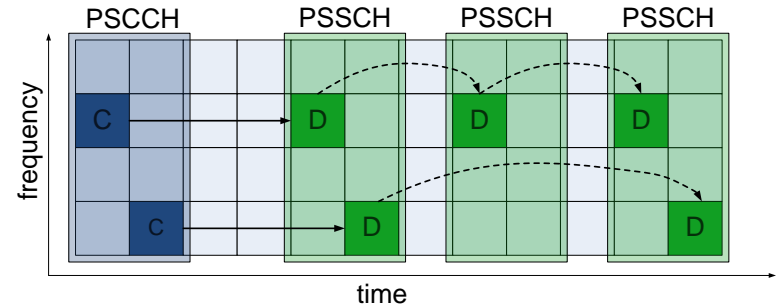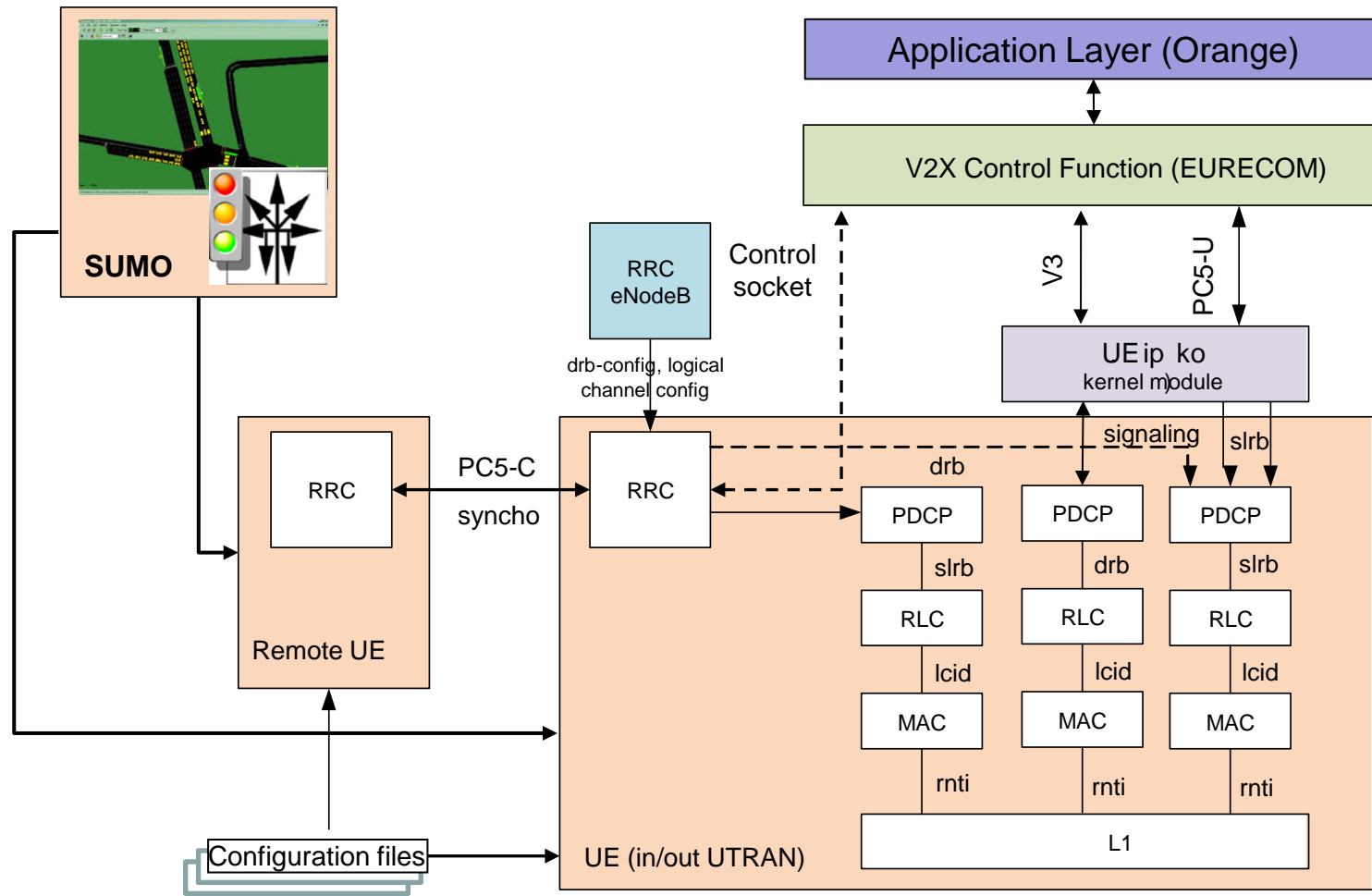
**LTE V2X mode 4 (Ad-Hoc)**
- resource location and MCS selected autonomously
- resources are reserved in advance ("SPS")
- control-data in the same subframe (Reduced latency)



**LTE V2X mode 4 Resource Allocation**
- 1s monitoring windows
- Selection of the 20% RB with lowest RSSI

# OAI Architecture - V2X Interfaces & SUMO for Vehicular mobility

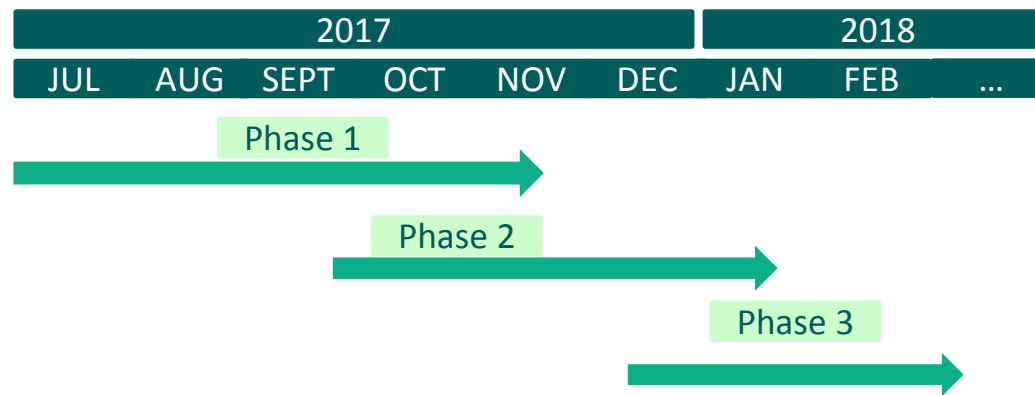# LTE V2X for Public Safety on OAI - RoadMap

- **Phase 1 - Emulation**
  - ➢ Redesign of emulation mode – new PHY STUB

- **Phase 2 – V2X Implementation**
  - ➢ Part A – Implementation of the V2X/RRC/PDCP/RLC/MAC
  - ➢ Part B – Implementation of the PHY
  - ➢ Part C – Integration of SUMO for vehicular mobility

- **Phase 3: Performance Evaluation**
  - ➢ Mode 3 and Mode 4
  - ➢ Small scale (1 eNB, 2 UE), large scale (>50 UEs)

| 2017 | | | | | | 2018 | | |
|------|------|------|------|------|------|------|------|------|
| JUL | AUG | SEPT | OCT | NOV | DEC | JAN | FEB | ... |

Phase 1

Phase 2

Phase 3

- **OAI Code**
  - ➢ https://gitlab.eurecom.fr/matzakos/LTE-D2D

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