V2X activities of 5G-DRIVE

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Dynniq footprint

Dynniq is an engineering company. It is technical systems and service provider in the domain of Transport and Energy.
Dynniq provides services and operates in the following markets: traffic control and management (for traffic safety, efficiency and comfort), ICT infrastructure (services) and energy. Innovation activities: e.g. ITS (including connected, cooperative and automated driving), smart grids, and 5G for V2X applications.
With more than 1,800 professionals Dynniq is working for nearly 1,000 customers in and outside Europe and achieves annual revenues of around EUR 400 mil.

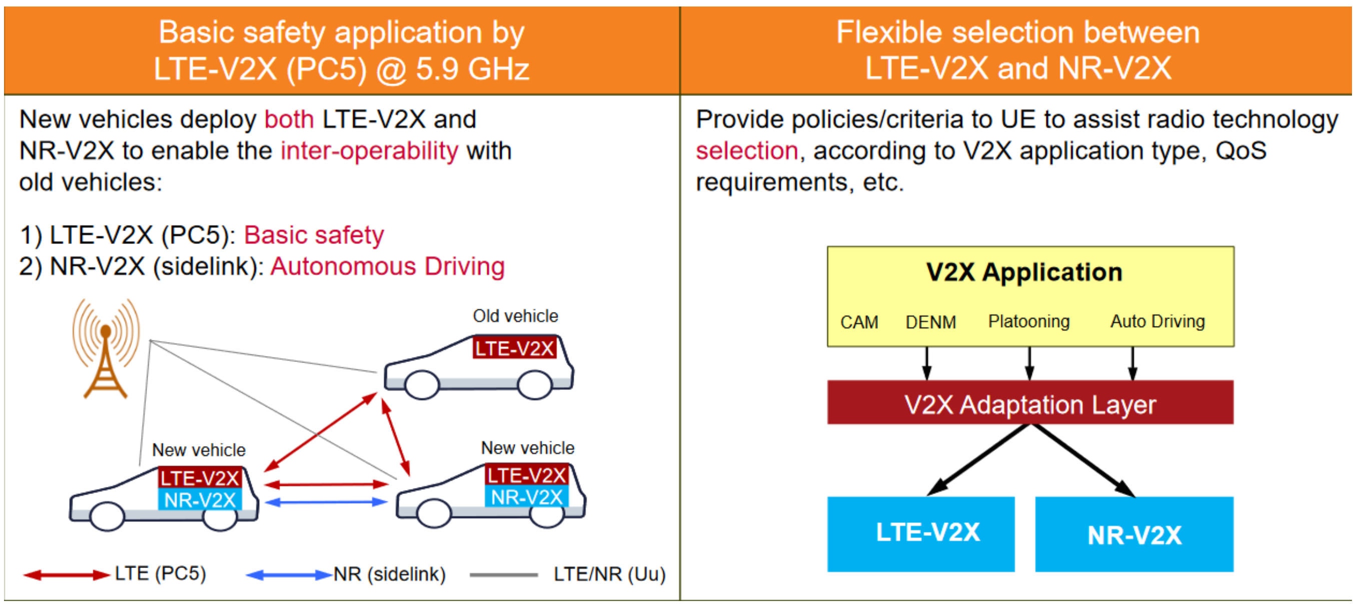
dynniq energising mobility

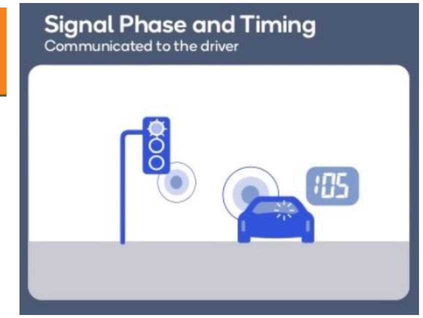
5G-DRIVE V2X Joint Trial Schedule

Main Activities of V2X Development

- Identification and testing technologies in relation to 5G, e.g. MEC, IoT and URLLC (Ultra Reliable Low Latency Communications)
- Validation of the 5G KPIs in terms of bandwidth, latency and communication ranges in different scenarios and pilot sites
- Evaluation of the resilience against cyber/RF attacks and interference
- Cooperation with Chinese partners: joint trial setup, execution and evaluation

V2X Trials in Europe



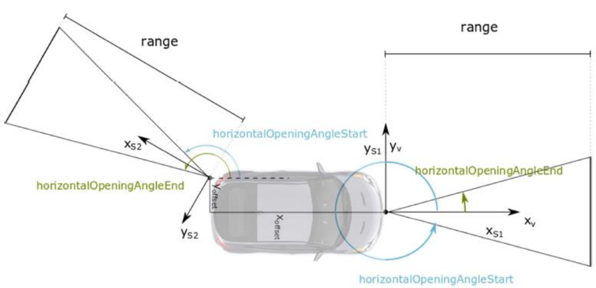


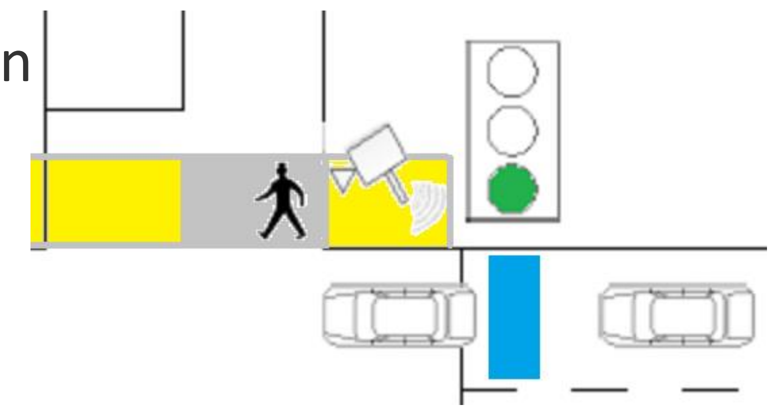
- Test and validate IoV based on *LTE-V2X using 5.9GHz band for V2V; 3.5GHz band for V2N*
- Trial Espoo: demonstration of 5G benefits for automated driving use cases
- Trial Ispra: focusing on evaluating the co-existence of ITS-G5 and LTE-V2X

5G-DRIVE V2X Use Cases

- GLOSA (Green Light Optimal Speed Advisory)

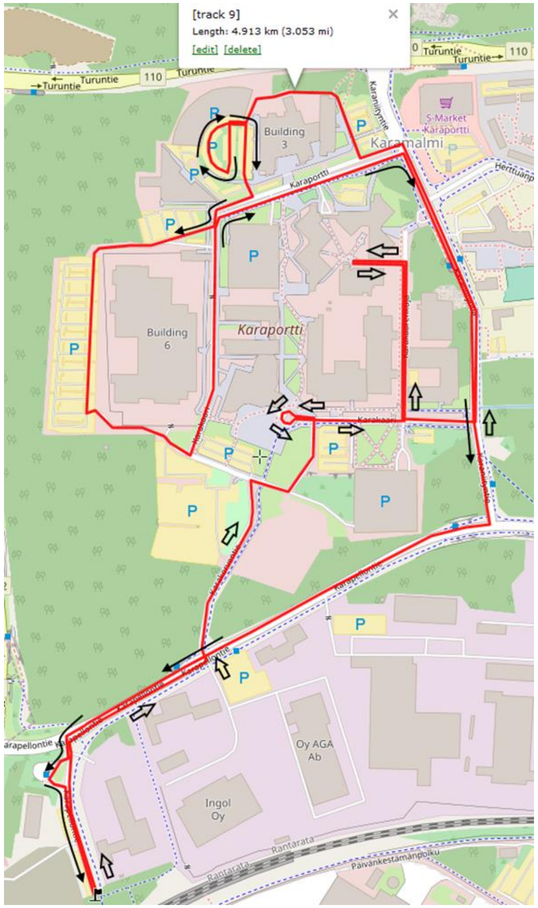
- Intelligent intersection
  - è CPM (Collaborative Perception





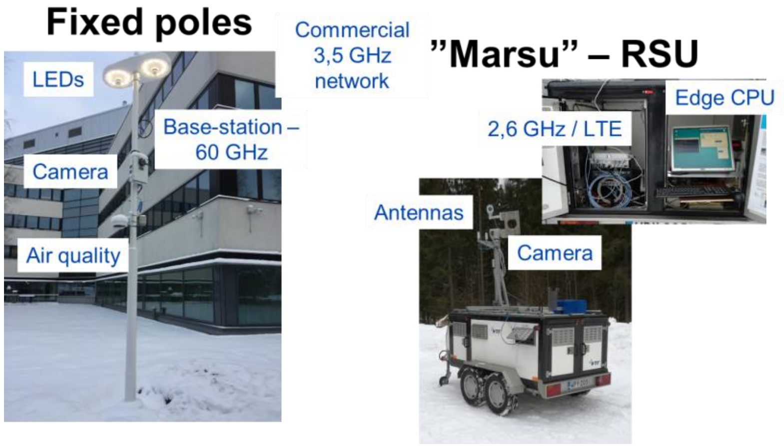
Espoo Trial Definition

- eMMB at 2.6, 3.5 and 60 GHz
- MQTT cloud broker for geocasting
- IEEE 802.11p baseline, future upgrade to LTE-V2X rel. 14
- MEC to optimize channel load
- GLOSA use case MAP and SPaT
- Safety use cases, DENM and future messages



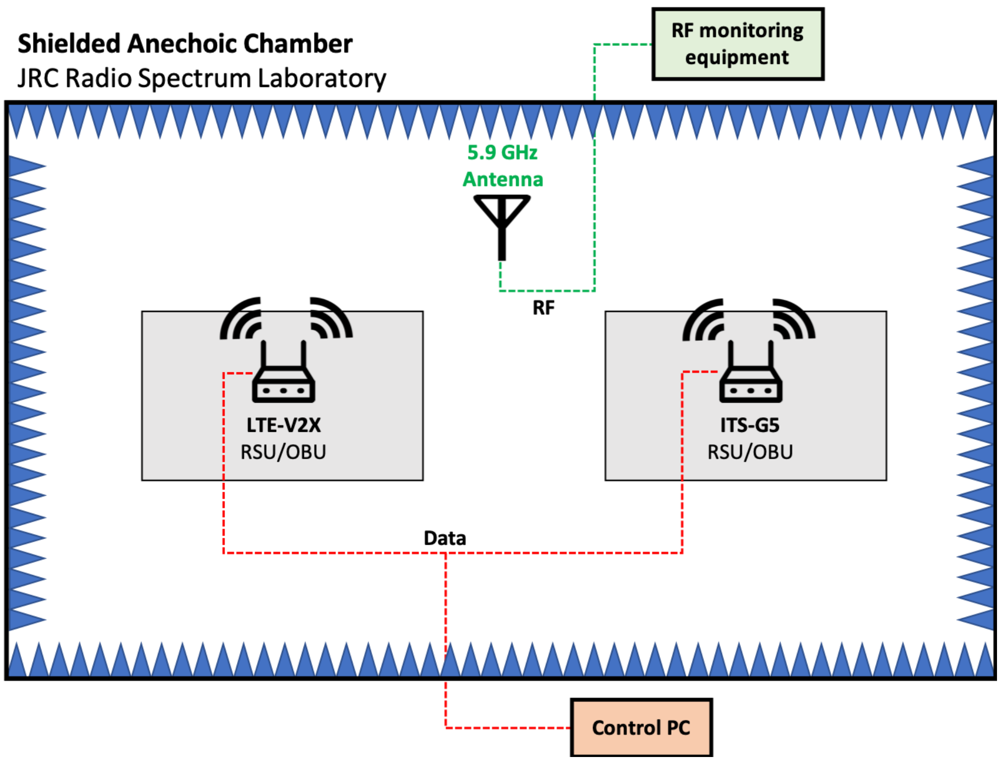
Espoo Trial Equipment

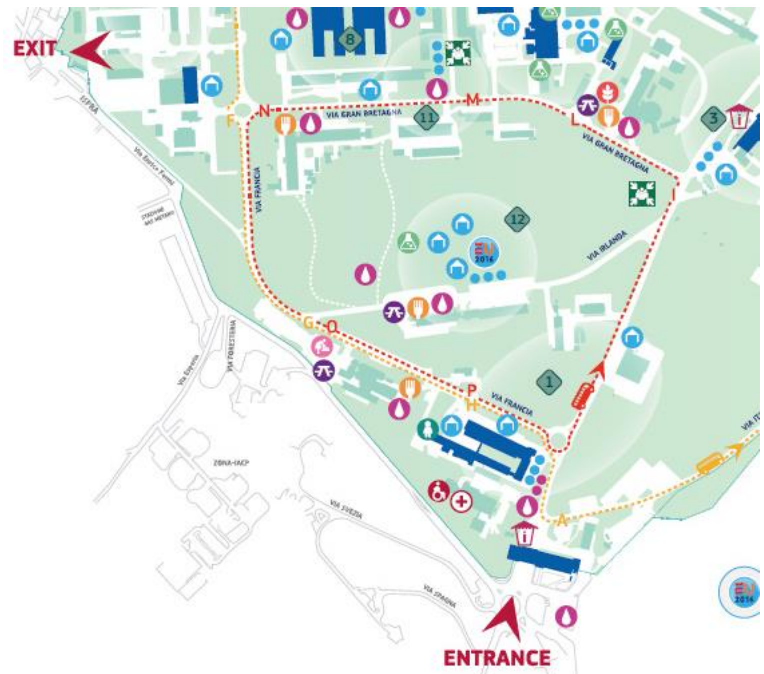
- Many communication technologies
- MEC available on-site
  - Connected to RSU
  - Connected to IoT



Ispra Trial Definition

- Co-existence of ITS-G5 and LTE-V2X
- GLOSA and safety use cases
- Start with lab tests





Ispra Trial Equipment

- LTE FDD/TDD MIMO equipment



- ITS-G5 equipment

Evaluation KPIs

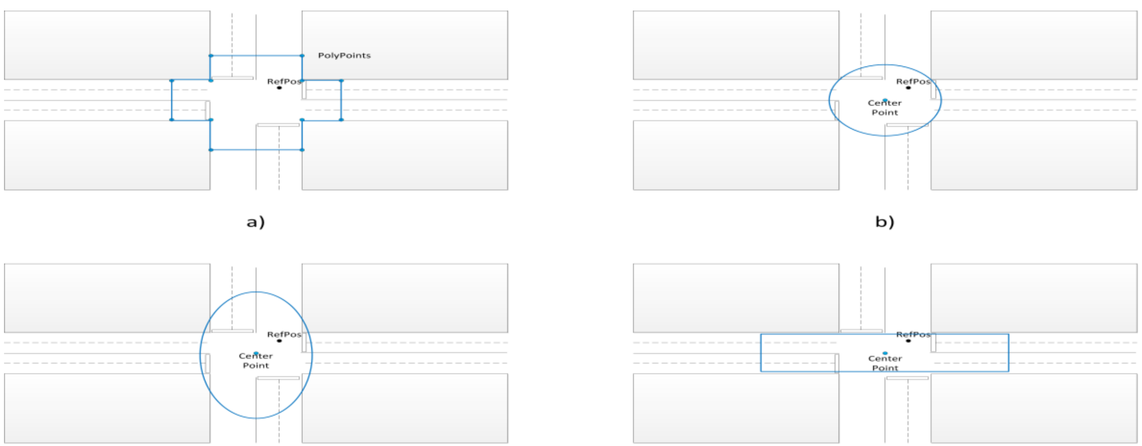
	Trial Scenarios	Objective	Expected outcome
1	Uplink bandwidth capacity / eMMB	Exchange raw sensor data between vehicles and digital local infrastructure (MEC) connected via LTE/5G. Focus especially uplink capacity	Raw sensor data delivery rates (Mbits/sec) vs. the automated driving data sharing requirements
2	Inter-operability between different mobile network band frequencies	Switching between different frequency bands (2,6; 3,5; 60 GHz)	Switching latency between different frequency bands - overhead/latency increase
3	Mobile-edge computing	Data transmission and receiving from local edge-computing sites.	5G-MEC server routed connectivy to the car terminals. C-ITS message exchange between MEC and vehicle
4	Message formats	C-ITS vs. Chinese message formats. Compare service quality levels. Take into account e.g. SENSORIS work group proposals	Feasibility of e.g. the SENSORIS and C2CC compatible message formats
5	Latency times / uRLLC	V2V, V2I latency times with using low payload ping-messages	Latency time comparison in milliseconds.
6	E2E Uu-based V2X service validation and performance evaluation	To experimentally validate the functionality and performance of an E2E V2X service over e.g. the 3.5GHz Uu interface	Two vehicle-embedded UEs send/receive V2X messages over the Uu interface (i.e., via e.g. the 3.5GHz base station).
7	E2E PC5-based V2X service validation and performance evaluation	To experimentally validate the functionality and performance of an E2E V2V service over the 5.9GHz PC5 interface	Two vehicle-embedded UEs send/receive V2V messages over the PC5 interface (i.e., direct link without eNB involvement)

Implementation of CPM

- Encoding according to ASN.1 description
- Usage of Common Data Dictionary

CPM	ItsPduHeader (as in [ETSI EN 102 894-2])		
	CollectivePerception	GenerationDeltaTime (as in [ETSI EN 302 637-2])	
		CPMParameters	OriginatingStationContainer
			SensorInformationContainer
			PerceivedObjectContainer

- Clear profiling and examples required



a) b) c) d)

	Data Field/Element			
SensorI nformation Ccntainer	Sequence of N SensorEntry	SensorEntry	SensorID	
			SensorType	
			SensorDetails choice between:	VehicleSensor
				StationarySensor Radial
				StationarySensor Polygon
				StationarySensor Circular
				StationarySensor Ellipse
				StationarySensor Rectangle

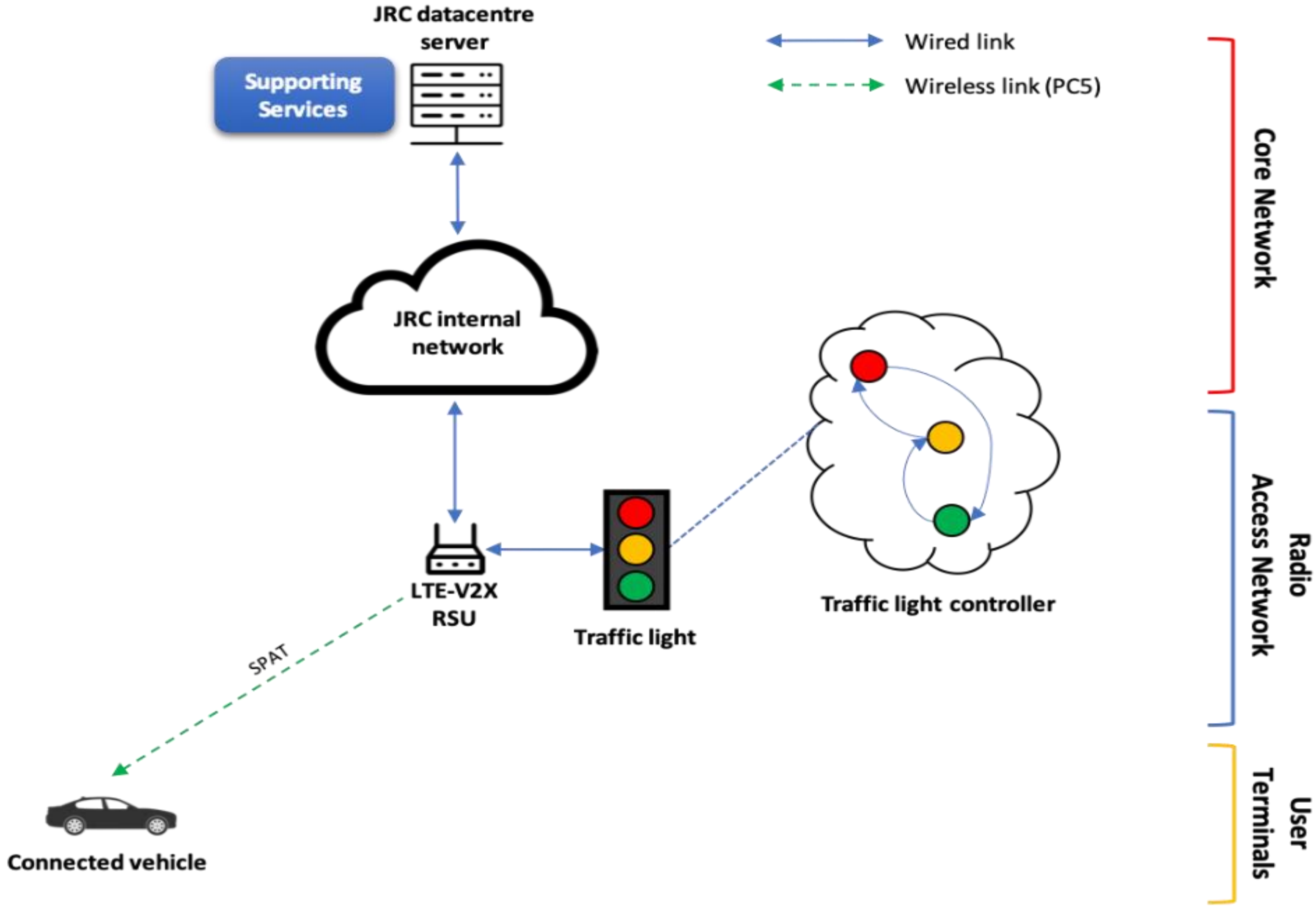
Communication Vulnerabilities

- Assessment of the potential vulnerabilities of V2X comm. from the physical to the service layer
  - è *identification*, *authenticity*, and *integrity*
    fake equipment, false information and fake certificates
  - è *availability*
    flood with fake certificates, message flood, channel jamming
  - è *confidentiality* and *privacy*
    false messages related to privacy control, replay attacks, jamming

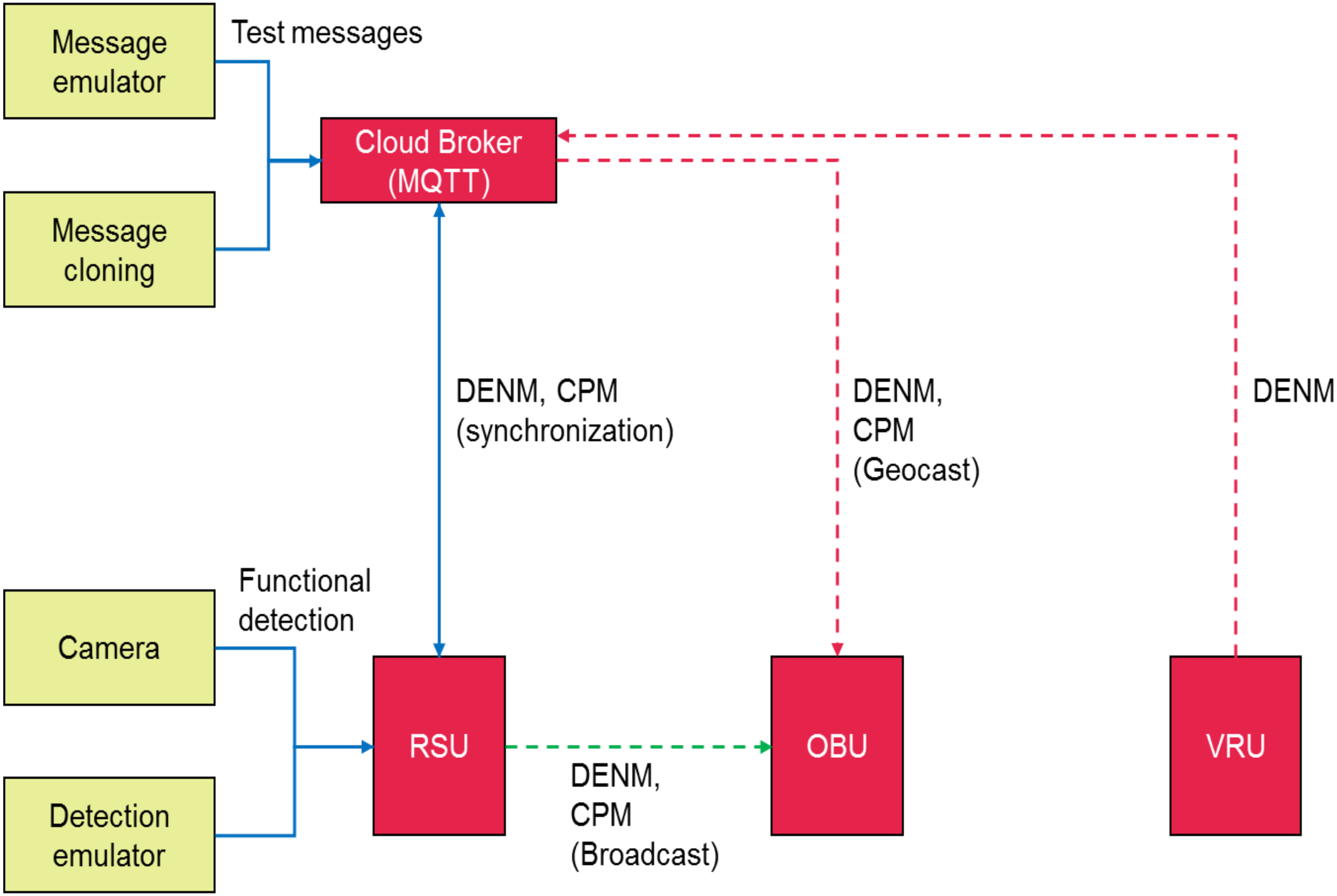
Co-Existence with ITS-G5

- Coexistence study of LTE-V2X and ITS-G5 in 5.9 GHz
  - è testing defined in ETSI Harmonised Standard for5.9 GHz (ETSI EN 302 571) on ITS-G5 devices from Cohda Wireless
  - è procuring LTE-V2X development platforms for coexistence and field tests (JRC & Qualcomm)
  - è JRC attending ETSI ERM TG37 meetings to test coexistence mechanisms between ITS-G5 and LTE-V2X

GLOSA Physical Architecture (JRC, Ispra)



Intelligent Intersection Functional Architecture



EU-China potential joint trial topics

	Joint trial topic	Objective
1	Uplink bandwidth / eMMB	Exchange raw sensor data between vehicles and digital local infrastructure (MEC) connected via 5G
2	Inter-operability between different mobile network band frequencies	Switching between different frequency bands (2,6; 3,5; 28 GHz)
3	Mobile-edge computing	Data transmission and receiving from local edge-computing sites
4	Messages	C-ITS vs. Chinese message formats. Compare service quality levels. Take into account SENSORIS work group proposals
5	Latencies / URRLC	V2V, V2I latency times with using simple ping-messages
6	End-2-End Uu-based V2X service validation and performance evaluation	Validate the functionality and performance of an E2E V2X service over the 3.5GHz Uu interface
7	End-2-End PC5-based V2X service validation and performance evaluation	Validate the functionality and performance of an E2E V2V service over the 5.9GHz PC5 interface

EU vs. China V2X trials

EU trials

Scenario	KPI title	Metrics
GLOSA APPLICATION		
MEC - MAP		
	Latency	< 5 s
	Packet Error rate	< 10 %
MEC - SPaT		
	Latency	< 2 s
	Packet Error rate	< 10 %
IoT MAO		
	Latency	< 10 s
	Packet Error rate	< 1 %
DAY 1 MESSAGES		
Low traffic - DEMN		
	Latency	< 10 ms
	Packet error rate	< 1 %
	Active stations	100
GLOSA		
	Channel load	150 000 b/s
AUTOMATED DRIVING		
bandwidth - CPM		
	Packet error rate	< 10 %
	Latency	< 100 ms
	Active stations	> 100
	Channel load	> 1 620 000 B/s
bandwidth -- MCM		
	Packet error rate	< 1 %
	Latency	< 100 ms
	Active stations	> 300
	Channel load	> 1 120 000 B/s

China trials

Scenario	KPI title	Metrics
LTE based KPIs		
ACCESSIBILITY		
	UE attach success rate (SR)	> 95 %
	RRC connection setup SR	> 95 %
	Paging SR	> 95 %
	Call drop rate	< 5 %
MOBILITY		
	Handover (HO) SR	> 95 %
	HO latency data place (DP)	60 ms
	HO latency control plane (CP)	40 ms
INTEGRITY		
	CP latency	100 ms
	DP latency	30 ms
LTE optimization KPIs in commercial network		
COVERAGE		
	RSRP	> -100 dBm
	SINR	> -3 dB
	City coverage	> 95 %
	Rural coverage	> 92 %
ACCESSABILITY		
	RRC reconnection ratio	< 5 %
	VoLTE success ratio (QCI1)	> 99 %
	SRVCC HO ratio	< 0,2 %
	VolLTE call drop rate	< 1 %
LTE general KPIs in commercial network		
	DL average rate	35 Mbps
	UL average rate	6-7 Mbps
	Outdoor DL rate at edge	5 Mbps
	CDF 5 % RSRP at edge	-105 dBm
	CDF 5 % SINR at edge	0 dB
	CDF 50 % RSRP	-90 dBm
	CDF 50 % SINR at edge	13 dB

Thank you for your attention!

Find us at www.5g-drive.eu

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