

# 助力智能网联测试体系的构建

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**ROHDE & SCHWARZ**

Make ideas real



## 01 C-V2X验证框架体系

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## 02 智能网联汽车三级验证体系构建

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## 03 整车外场测试需求及方案

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# 车联网是跨行业融合的最佳实践



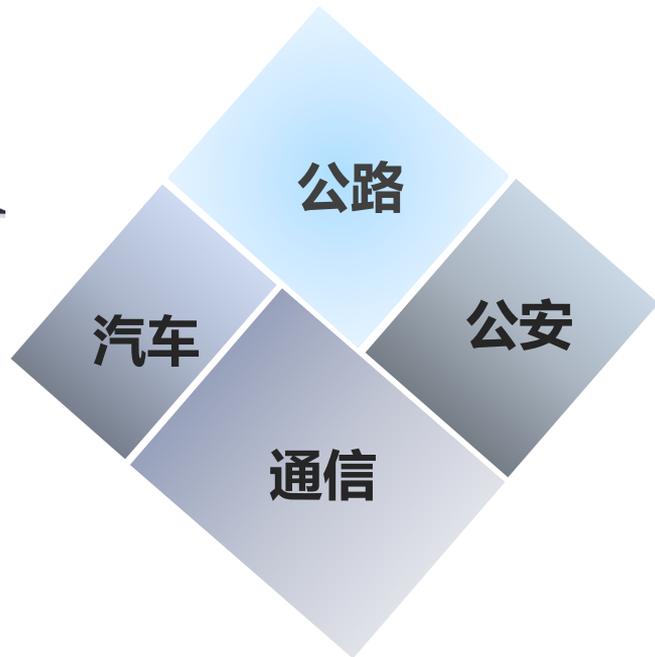
智慧的路

聪明的车

可靠的通信

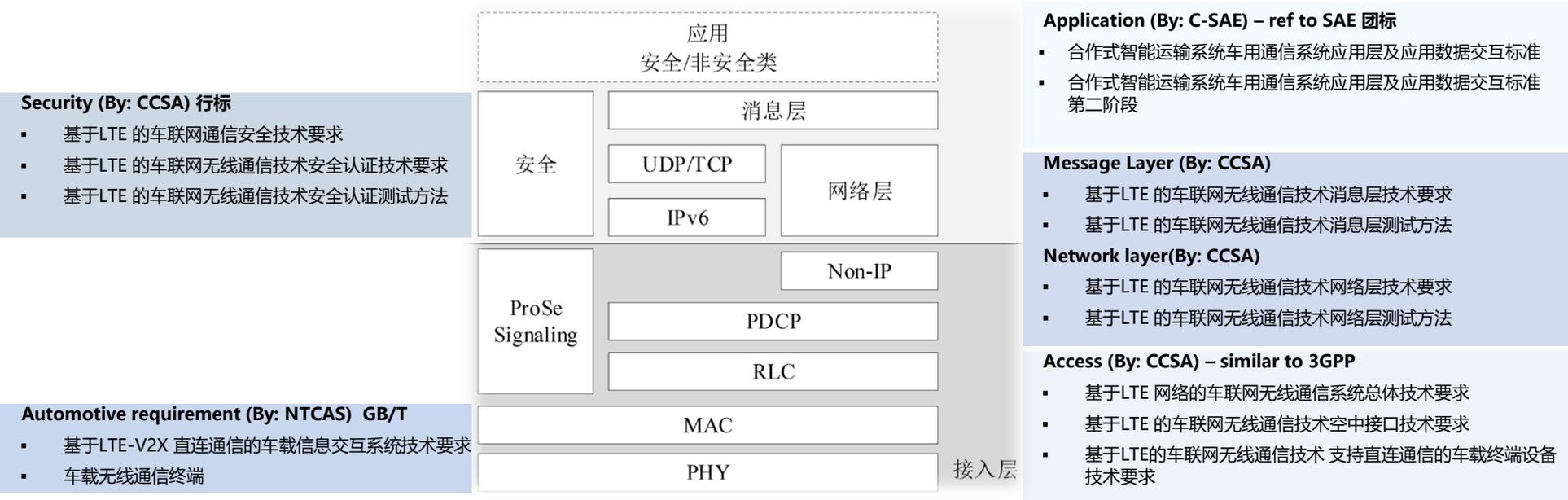
共同构筑指挥交通的目标

- ✓ 安全
- ✓ 舒适
- ✓ 绿色

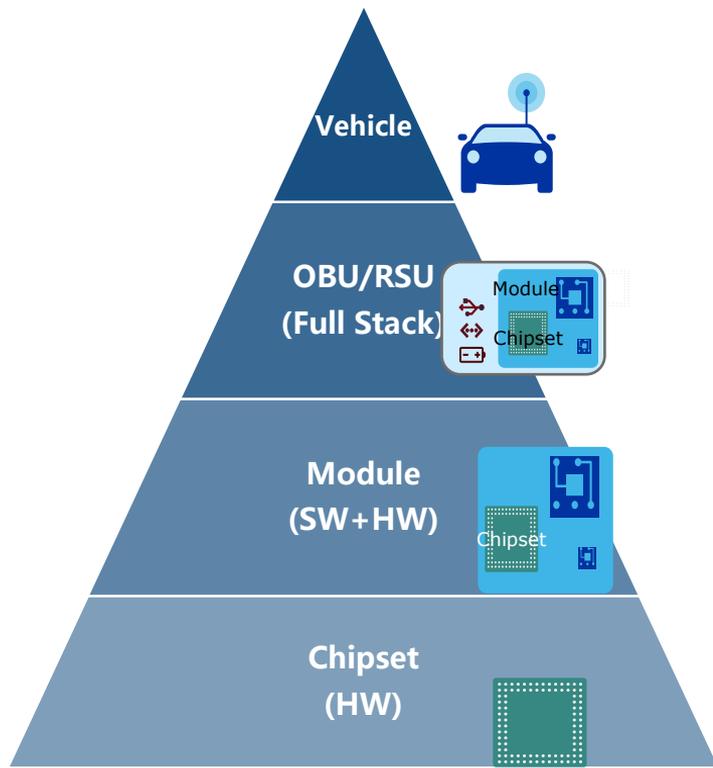


# C-V2X验证框架测试

## 协议栈及相应规范

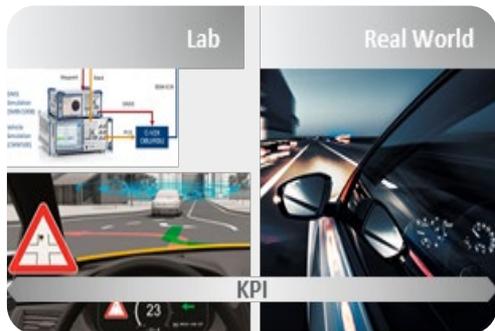


# LTE-V2X 终端产业链



# 构筑三级验证体系

## 仿真测试



- ✓ 零部件功能HIL
- ✓ 整车功能VIL
- ✓ 交通场景仿真

## 封闭道路测试



- ✓ 半真实环境整车验证

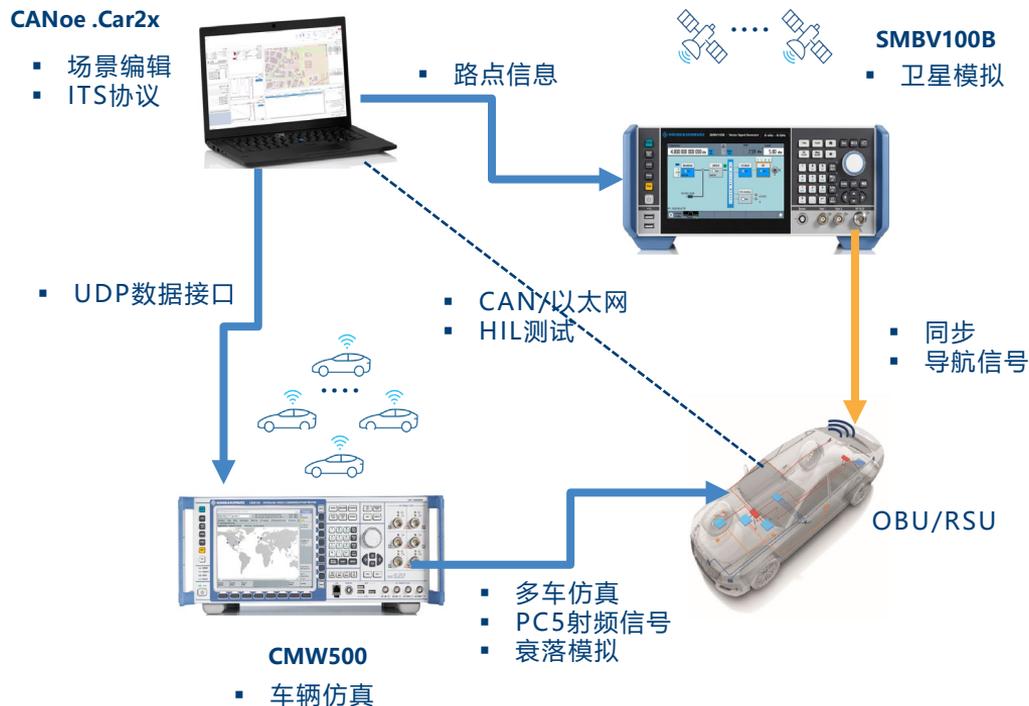
## 开放道路测试



- ✓ 真实环境整车规模验证

# C-V2X大规模测试需求

## 测试系统示意图



# C-V2X大规模测试需求

## 测试平台与结果

### 测试界面

启动底层场景运行

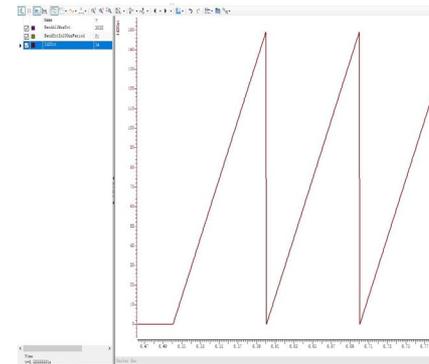
地理化信息配置

仿真车辆 & 车辆地理化显示

ITS消息

车辆位置信息

消息发送统计:  
1. 发送消息总数  
2. 仿真周期统计  
3. 时间 vs 车辆消息发送ID



```

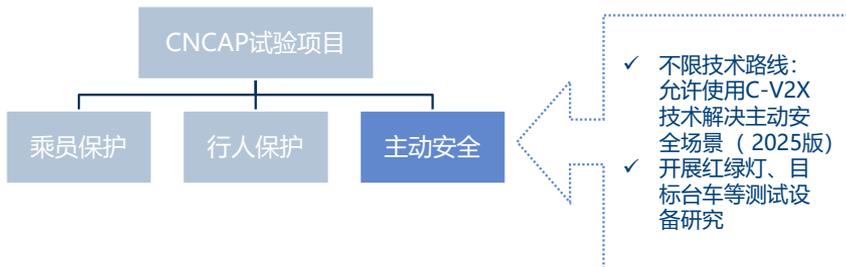
remote 241592211 distance: 727.80 m | speed: 0.0 km/h | orientation: NONE
remote 240380475 distance: 749.90 m | speed: 0.0 km/h | orientation: NONE
remote 240380105 distance: 762.00 m | speed: 0.0 km/h | orientation: NONE

Please input number and press ENTER:
0: safe turn signal on, 1: right turn signal on, 2: all light off,
3: hard braking, 4: disabled vehicle, 5: None
6: turn on new speed, 8: turn off emergency, 9: 50M STOP
10: head light on, 11: 50M head light signal on
12: no data display on/off, 13: no data display on/off
14: no event info on/off, 15: no event info on/off
16: no event info on/off, 17: no event info on/off
18: no event info on/off, 19: no event info on/off
20: system info success

Local | Lat: 40.07280 | Lon: 116.31610 | elevation: 83 | heading: 265.5 deg | speed = 0.0 km/h
The number of remote is 150.
remote 16790223 distance: 142.00 m | speed: 0.0 km/h | orientation: ONCOMING FAR LEFT
remote 30644975 distance: 122.00 m | speed: 0.0 km/h | orientation: ONCOMING FAR LEFT
remote 81007017 distance: 96.50 m | speed: 0.0 km/h | orientation: ONCOMING FAR LEFT
remote 17421818 distance: 70.00 m | speed: 0.0 km/h | orientation: NONE
remote 13562320 distance: 127.50 m | speed: 0.0 km/h | orientation: ONCOMING FAR LEFT
remote 15100023 distance: 200.00 m | speed: 0.0 km/h | orientation: NONE
remote 97121073 distance: 126.80 m | speed: 0.0 km/h | orientation: ONCOMING FAR LEFT
remote 100707803 distance: 81.20 m | speed: 0.0 km/h | orientation: NONE
remote 218110915 distance: 82.20 m | speed: 0.0 km/h | orientation: NONE
remote 124224295 distance: 82.20 m | speed: 0.0 km/h | orientation: NONE
remote 251871347 distance: 74.20 m | speed: 0.0 km/h | orientation: NONE
remote 167902529 distance: 80.00 m | speed: 0.0 km/h | orientation: NONE
remote 285222779 distance: 87.40 m | speed: 0.0 km/h | orientation: NONE
remote 267328928 distance: 82.20 m | speed: 0.0 km/h | orientation: NONE
remote 234894131 distance: 70.00 m | speed: 0.0 km/h | orientation: NONE
remote 262348213 distance: 70.00 m | speed: 0.0 km/h | orientation: NONE
remote 268448363 distance: 70.00 m | speed: 0.0 km/h | orientation: NONE
remote 380380979 distance: 80.00 m | speed: 0.0 km/h | orientation: NONE
remote 302002995 distance: 68.00 m | speed: 0.0 km/h | orientation: NONE
remote 316445107 distance: 80.00 m | speed: 0.0 km/h | orientation: NONE
remote 486552371 distance: 80.00 m | speed: 0.0 km/h | orientation: NONE
remote 326398083 distance: 77.20 m | speed: 0.0 km/h | orientation: NONE
remote 520398083 distance: 77.20 m | speed: 0.0 km/h | orientation: NONE
remote 402569753 distance: 80.00 m | speed: 0.0 km/h | orientation: NONE
remote 553661235 distance: 80.20 m | speed: 0.0 km/h | orientation: NONE
remote 487210102 distance: 82.00 m | speed: 0.0 km/h | orientation: NONE
remote 487751155 distance: 87.20 m | speed: 0.0 km/h | orientation: NONE
    
```

# 封闭道路测试

## CNCAP主动安全路线图草案2022-2028



测评项目		2022	2025 (新增)	
主动安全 ADAS	甲类	车间安全辅助	<ul style="list-style-type: none"> <li>车辆直行与前方直行的车辆冲突场景：要求制动和报警；</li> <li>车辆直行与穿行的车辆冲突场景：合遮挡，要求预警；不合遮挡，要求制动。</li> <li>车辆左转与对向行驶的车辆冲突场景：要求制动。</li> <li>高速超车追尾场景：要求预警。</li> <li>原有场景优化与加严。</li> </ul>	
		行人安全辅助	<ul style="list-style-type: none"> <li>车辆直行与穿行的行人冲突场景，要求制动</li> <li>车辆直行与前方直行的行人冲突场景，要求制动和报警。</li> <li>车辆左转与穿行的行人冲突场景：要求制动。</li> <li>原有场景优化与加严。</li> </ul>	
		两轮车安全辅助	<ul style="list-style-type: none"> <li>车辆直行与穿行的二轮车冲突场景，要求制动。</li> <li>车辆直行与前方直行的二轮车冲突场景，要求制动和报警。</li> <li>车辆左转与穿行的二轮车冲突场景：要求制动。</li> <li>车辆右转与穿行的二轮车冲突场景：要求制动。</li> <li>原有场景优化与加严。</li> </ul>	
	乙类	侧方辅助	<ul style="list-style-type: none"> <li>直线车道内偏侧场景，要求纠偏和报警。</li> <li>车辆直行偏移与盲区内的二轮车冲突场景：要求报警。</li> <li>车辆直行偏移与盲区内的车辆冲突场景：要求报警。</li> </ul>	<ul style="list-style-type: none"> <li>车辆直行偏移与盲区内的二轮车冲突场景：要求纠偏。</li> <li>车辆直行偏移与盲区内的车辆冲突场景：要求纠偏。</li> <li>弯道内车辆偏侧场景，要求报警。</li> <li>ESC作为得分前提。</li> <li>原有场景优化与加严。</li> </ul>
		车道辅助		
	丙类	低速车周安全辅助	无	<ul style="list-style-type: none"> <li>车辆开门与直行的二轮车冲突场景：要求报警。</li> <li>车辆倒车与穿行的行人、二轮车冲突场景：要求报警。</li> </ul>
丁类	交通标识辅助 驾驶员监控	<ul style="list-style-type: none"> <li>限速标识识别：要求报警。</li> </ul>	<ul style="list-style-type: none"> <li>驾驶员监控，包含分神驾驶与疲劳驾驶：要求报警。</li> <li>违反交通信号灯场景：要求报警。</li> </ul>	
研究项目		<ul style="list-style-type: none"> <li>开展符合中国交通特征的软目标研究；</li> <li>开展基于V2X功能测试红绿灯、目标台车等测试设备研究。</li> </ul>		

## 智慧城市基础设施与智能网联汽车协同发展试点城市

各地政府都在依托自身优势，积极发力推动智能网联产业发展



# 从实验室到外场 — 虚实结合的验证方案

## R&S方案概览

### 实验室

**VECTOR**  
CANoe .Car2x



零部件测试



Radio Communication Tester  
**R&S® CMW500**



Simulated Cars



Vector Signal Generator for GNSS  
**R&S® SMVB100B**



GNSS Satellites



TCU/OBU

### 试验场

**VECTOR**  
CANoe .Car2x



GNSS Satellites

整车测试



Radio Communication Tester  
**R&S® CMW500**

Blind Sync  
UE



Amplifier  
**R&S® BBA150-Exxx**



Antenna  
**R&S® HFxxx Family**



C-V2X PCS signal @ 5.9GHz

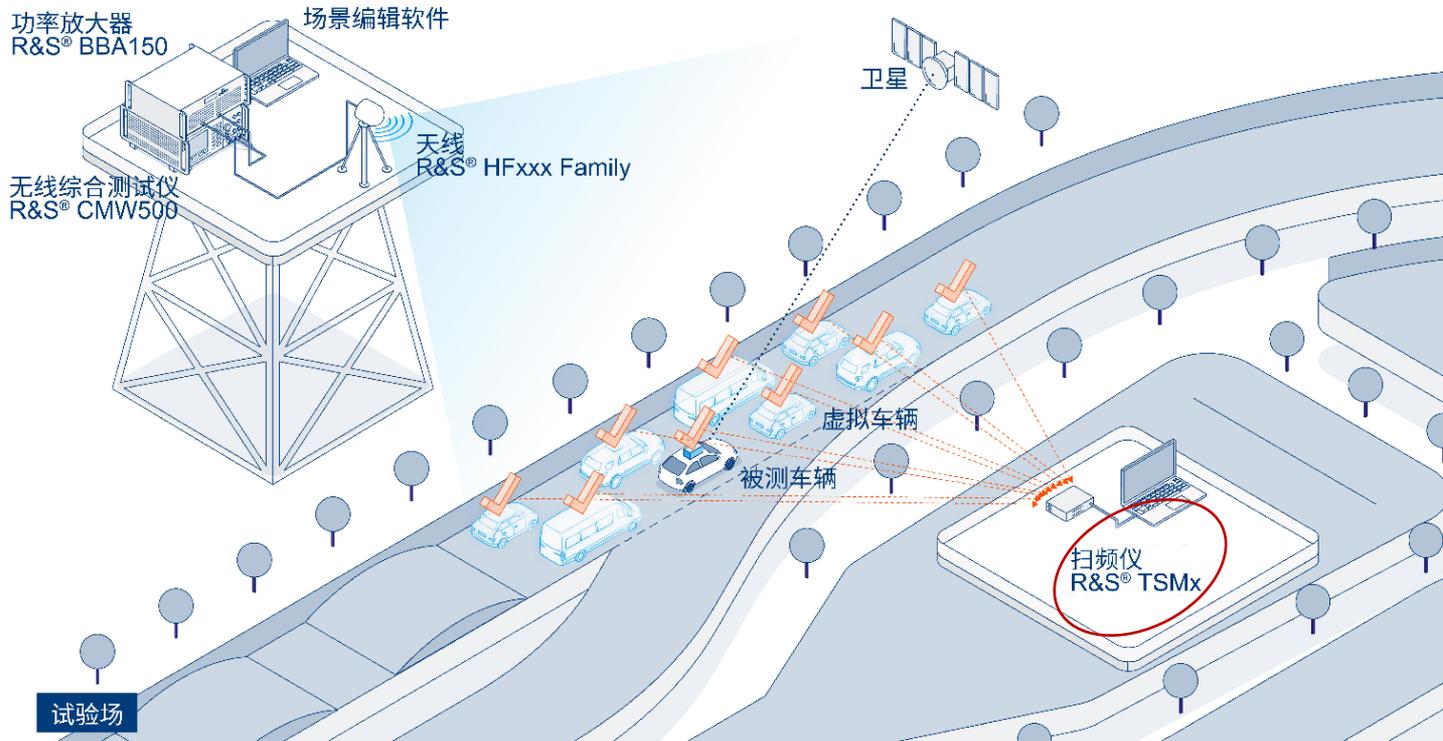


Simulated Cars



# 从实验室到外场 — 自定义场景

## 能解决哪些问题？



### 解决实际外场测试痛点

- ✓ **灵活自定义** — 摆脱封闭场地对各类交通场景的制约
- ✓ **独家专利** — 可使用实际卫星定位

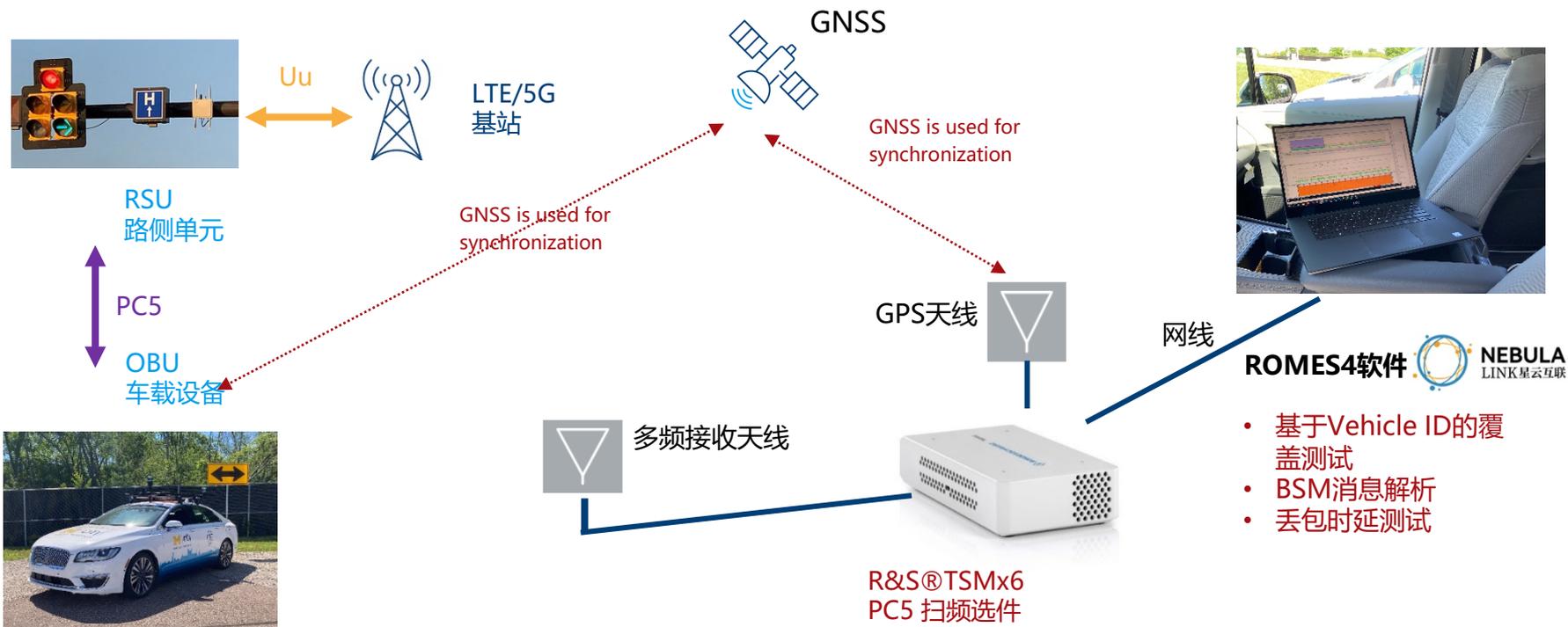
### 可复现大规模复杂场景

- ✓ **一切尽在模拟** — CMW500可搭建200+虚拟背景车辆 / 路测设施 / ...
- ✓ **高效省力** — 仅需1台真实车辆

### 保证验证结果统一有效

- ✓ **一致性保证** — 实验室 (HiL/ViL) 与外场测试使用同一核心设备
- ✓ **成本节约** — 测试资源有效复用

# C-V2X / PC5 扫频仪测试框图



# LIVE DEMO



# 从实验室到外场 — 自定义场景

方案演示搭建

Demo in Munich



Demo in Beijing



欢迎联系R&S中国销售获取完整配置与现场演示支持