



Autonomous  
Car

#812

# V2X Deployment Worldwide

## Lead Markets, Technical Decisions and Future Outlook

Few technologies in the automotive industry have taken as long as Vehicle-To-X (V2X) communications to reach market maturity. Research into V2X began during the 1980s, and aside from Japan, most drivers in the rest of the world have yet to experience the safety and convenience benefits promised by V2X proponents. This is because V2X is, by its very nature, a challenging and ambitious proposition – one that requires OEMs to work alongside governments and road operators in developing complex standards and agreeing roll-out plans.

As the automotive industries in China, Europe and USA shift from researching V2X to planning deployment strategies, OEMs, system suppliers, network providers and local city authorities face different challenges in successfully rolling-out V2X.

The aim of this report is to provide the reader with insight on today's market situation regarding V2X in four main regions – Europe, USA, China and Japan and how the V2X market is likely to transform over the short term future.

### TABLE OF CONTENTS



#### Executive Summary

#### An introduction to V2X

#### Driving factors and use cases

#### Regulations

#### Technology landscape

#### Regional overview and trials

#### OEM offering and deployment

#### Volume forecast by region

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- > Helps you understand the current challenges relating to frequency allocation.
- > Gives a high-level overview on the impact of data implications
- > Provides market sizing data for a 10-year horizon until 2030.
- > Focuses on the industry shift from a single solution to embracing a hybrid approach
- > Provides a summary of trials and deployment activities being supported by OEMs across four key regions
- > Includes an overview of key technologies being considered together with their potential development roadmap

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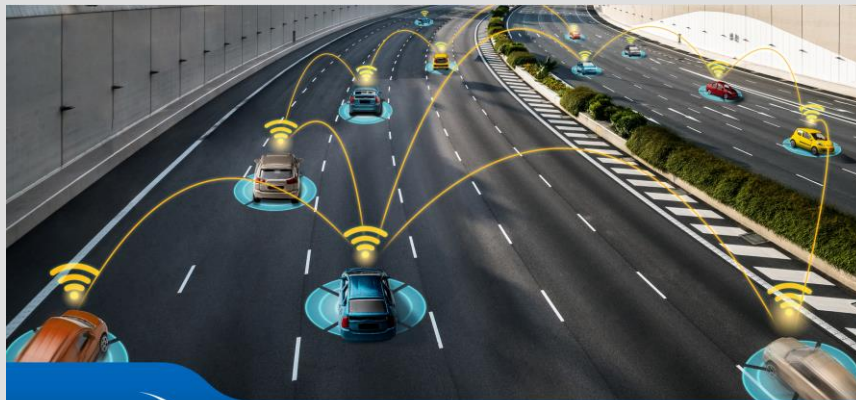
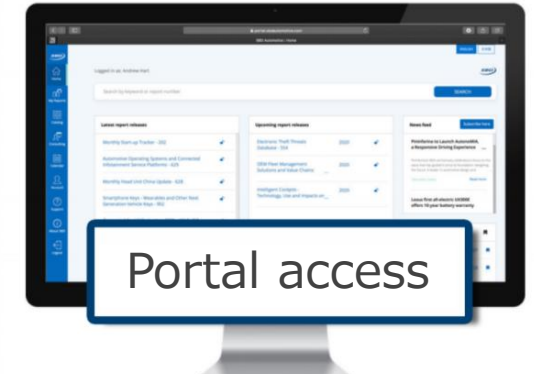
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Lead Markets, Technical Decisions and Future Outlook

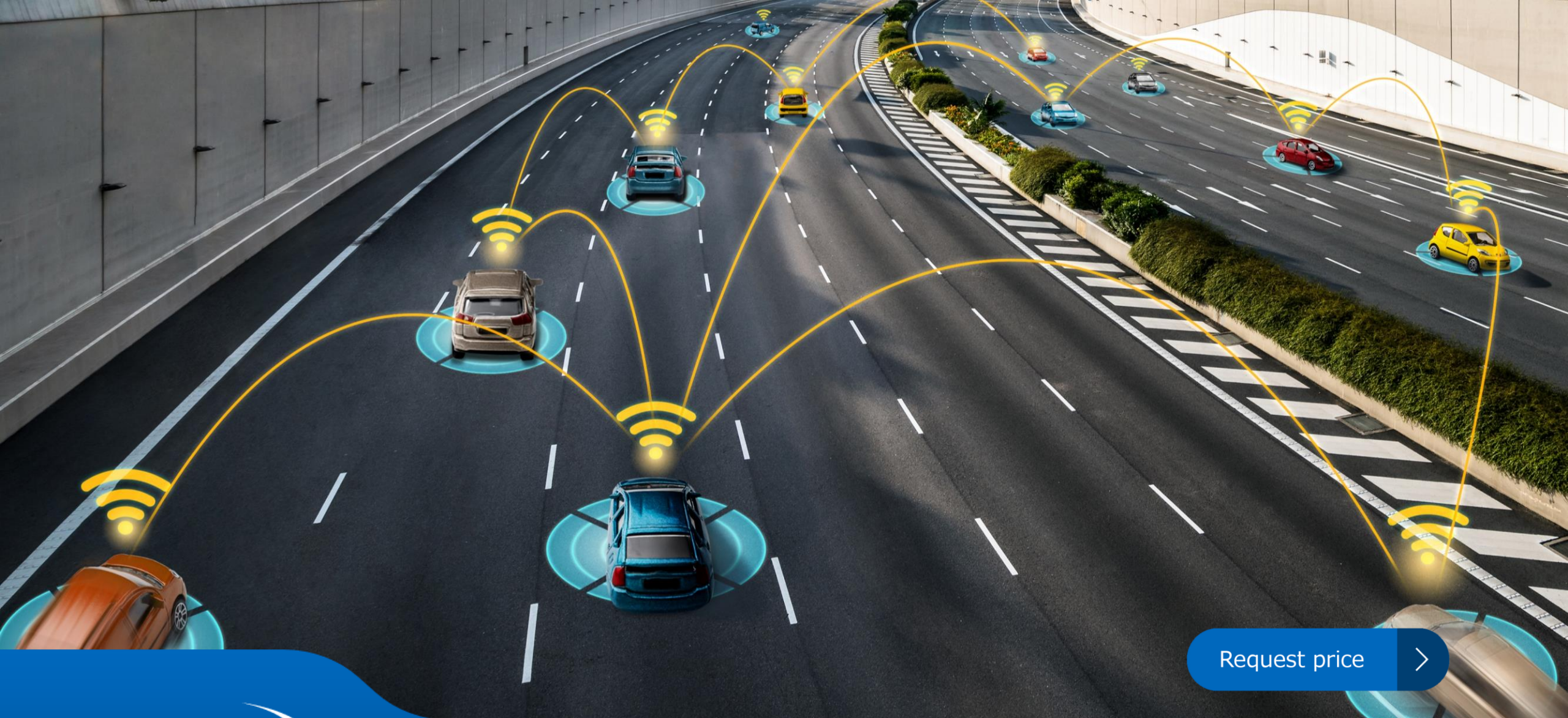
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# V2X DEPLOYMENT WORLDWIDE

Lead Markets, Technical Decisions and Future Outlook



# Contents page

<b>Introduction</b>	3	→ China	52	<b>Appendix</b>	110
→ Purpose of the report	4			→ Use case definition	111
→ Table of content	5			→ Acronyms	114
<b>Executive Summary</b>	6			<b>Contact Us</b>	116
<b>An introduction to V2X</b>	9				
→ What is V2X	10				
→ Unique selling proposition	11				
→ Role of V2X in supporting ADAS & AV	12				
→ Technology solutions	13				
→ Frequency overview across various regions	18				
<b>Driving factors &amp; Use cases</b>	19				
→ Driving factors	20				
→ Use cases	25				
<b>Regulations</b>	30				
→ Europe	32				
→ USA	41				
→ Japan	46				
		<b>Technology landscape</b>	59		
		→ DSRC	60		
		→ C-V2X	61		
		→ Data exchange implications	64		
		→ Deployment challenges & barriers	65		
		→ V2X suppliers	66		
		→ Evolution towards single solution	67		
		<b>Regional overview &amp; trials</b>	68		
		→ Key regional differences	69		
		→ Europe	70		
		→ USA	73		
		→ Japan	75		
		→ China	77		
		<b>OEM offering &amp; deployment</b>	79		
		<b>Volume forecast by region</b>	104		
		→ Forecast methodology	105		
		→ Per region forecast (split by technology)	106		

**Note:** In the report where appropriate V2X predominantly includes V2V and V2I.

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## Introduction

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# Purpose of this report

Few technologies in the automotive industry have taken as long as Vehicle-To-X (V2X) communications to reach market maturity. Research into V2X began during the 1980s, and aside from Japan, most drivers in the rest of the world have yet to experience the safety and convenience benefits promised by V2X proponents. This is because V2X is, by its very nature, a challenging and ambitious proposition – one that requires OEMs to work alongside governments and road operators in developing complex standards and agreeing roll-out plans.

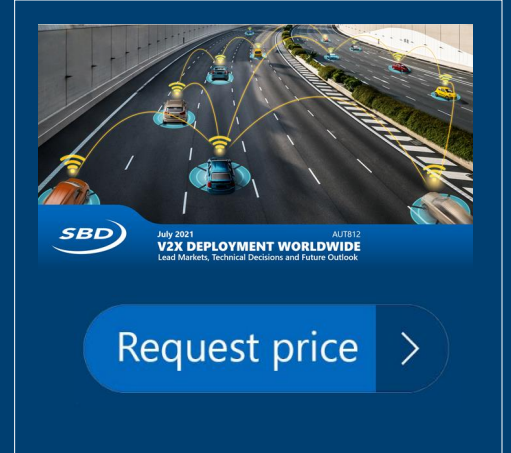
As the automotive industries in China, Europe and USA shift from researching V2X to planning deployment strategies, OEMs, system suppliers, network providers and local city authorities face different challenges in successfully rolling-out V2X.

The aim of this report is to provide the reader with insight on today's market situation regarding V2X in four main regions – Europe, USA, China and Japan and how the V2X market is likely to transform over the short term future.

This report includes:

- An overview of key technologies being considered together with their potential development roadmap
- Helps understand the current challenges relating to frequency allocation
- Focuses on the shift in industry from a single solution to embracing a hybrid approach
- A high level overview on the impact of data implications
- Provides a summary of trials and deployment activities being supported by OEMs across four key regions
- Provides market sizing data for a 10-year horizon of until 2030.

# Example slides from the report





# What is V2X?

V2X (Vehicle to everything) is a wireless communication technology to allow vehicles to communicate with other vehicles and the road infrastructure. There are two competing technology solutions:

- DSRC (Dedicated short-range communication)
- C-V2X (Cellular – V2X)

Within V2X there are multiple categories including V2V (Vehicle to Vehicle), V2P (Vehicle to Pedestrian) and V2I (Vehicle to Infrastructure) to name a few. The main reasons for adopting this technology are increased safety, road congestion management and facilitate the introduction of higher levels of vehicle automation.

## Safety benefits

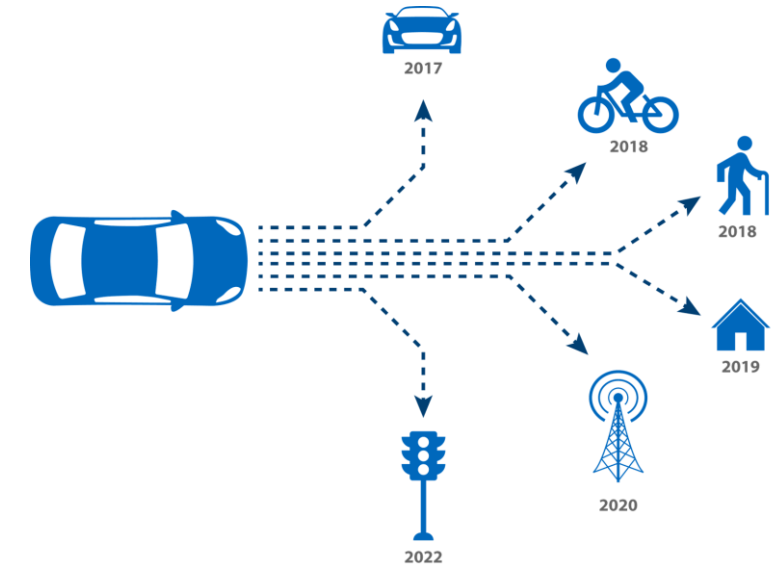
V2X technologies do not need to rely upon on-board vehicle sensors such as radar and cameras to provide their applications. As V2X does not need line of sight in order to detect objects or hazards, it can deliver a unique set of USP use cases, including being able to detect hazards around blind corners and extended ranges far beyond the capability of any current physical vehicle mounted sensor.

## Congestion reduction

V2X has the potential to reduce road congestions and the effect they have on the environment by enabling methods such as platooning and smoothing out traffic flow.

## Enabling higher levels of vehicle autonomy

V2X is viewed as a key solution to support the future traffic model. The main advantage of V2X is that it could help vehicles know “what is ahead” or “behind” for merging scenarios, a key information that on-board sensors would not always be able to provide. Partially autonomous vehicles can potentially be delivered without V2X, however, having V2X capability will allow a fully autonomous vehicle to be controlled in a much more robust way and for a wider range of scenarios.



- **V2V – Vehicle-to-Vehicle**  
Alerts one vehicle to the presence of another. Cars ‘talk’ using DSRC technology.
- **V2D – Vehicle-to-device**  
Vehicles communicate with cyclists’ V2D device and vice versa.
- **V2P – Vehicle-to-pedestrian.**  
Car communication with pedestrian with approaching alerts and vice versa.
- **V2H – Vehicle-to-home**  
Vehicles will act as supplement power supplies to the home.
- **V2G – Vehicle-to-grid**  
Smart grid controls vehicle charging and return electricity to the grid.
- **V2I – Vehicle-to-Infrastructure.**  
Alerts vehicles to traffic lights, traffic congestion, road conditions, etc.





# Drivers - Driver and pedestrian safety

## Overview

A number of governments, safety bodies and international regulators have been actively working to reduce the number of deaths on road around the world for many years. Not only do road collisions, injuries and deaths impose a heavy cost on the individual involved, they also impose a heavy financial hit for economies. V2X has long been pushed as a major contributor to lowering road deaths and increasing overall safety.

## What is behind the drive?

The European Commission has set itself the goal of no deaths on European roads by 2050. In addition, the commission aims for 50% fewer deaths, and 50% fewer serious injuries by 2030. Its targets like these from multiple governments and bodies around the world that is contributing to the rollout of technologies that can contribute to vehicle safety, V2X being among them.

V2X will allow vehicles the perception they need to identify hazards and potentially dangerous situations at a distance far greater than current ADAS can. The advent of higher levels of automation are also seen as one of the main contributors to lowering road deaths. V2X is undoubtedly a key enabler of autonomous vehicles.



Work zone and Vulnerable Road User warning – Audi



– Audi

## Stakeholders to benefit

### Road users

## Type of benefit

The ultimate benefitting stakeholder from greater road safety is road users themselves. Although not in a position to push the rollout of technologies like V2X directly, consumer buying power and public opinion will play a part in the success of V2X deployment.

### Governments

With V2X contributing towards greater road safety and more perceptive vehicles, governments will be keen to see progress in meeting their ambitious targets of reducing road injuries and deaths, the result of which will be a lower economic impact on the state.



# Overview of C-ITS Strategy

## EU C-ITS Strategy

### Purpose and objectives

In 2016, The European Commission formally adopted the European Strategy on Cooperative Intelligent Transport Systems (C-ITS). This strategy was initially intended to facilitate the successful introduction of cooperative and connected vehicles in Europe by 2019. There were a number of key elements that the strategy hoped to address and in so doing create the right environment and necessary conditions for vehicles to talk to each other and infrastructure. These included:

- Avoid a fragmented internal market
- Define and support common priorities
- Use a mix of communication technologies
- Address security and data protection issues
- Develop the right legal framework
- Cooperate at international level

In addition to aiding and ensuring the adoption of sufficient legal framework for such technologies, the strategy also looks after funding for research and development projects relating to intelligent transport, including at a G7 level.

The strategy cooperates and coordinates with the C-Roads platform. Multiple member states have received funding with the help of this strategy to facilitate pilots and other research activities.

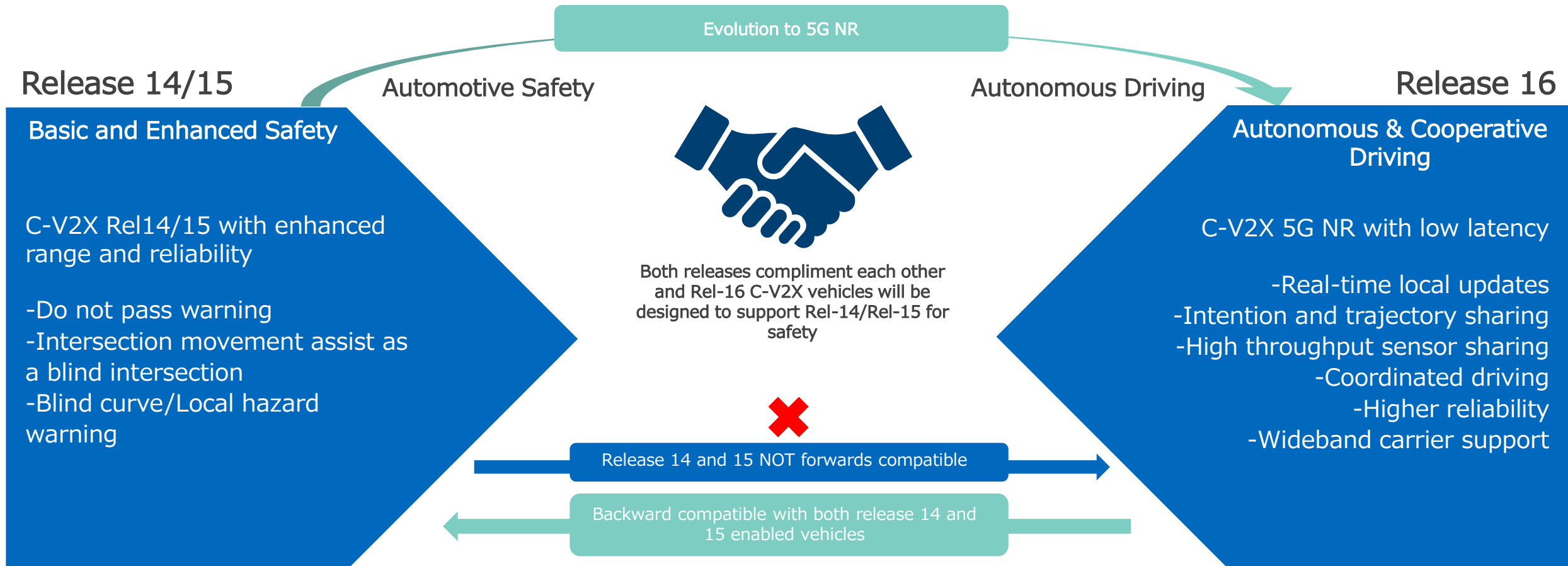




# C-V2X Rel14 & Rel16

5G NR C-V2X is an evolution in connectivity providing lower latency, ultra reliable communication with high data rates. These characteristics make it ideal for supporting use cases related to autonomous driving and safety critical applications. Specifications for 5G NR were accounted for in 3GPP release 16.

Release 16 and release 14 both compliment each other in terms of functionality and properties they can offer in order to support V2X features both basic and safety critical.





# Recent trials - USA

## Audi, Applied Information, Temple school safety

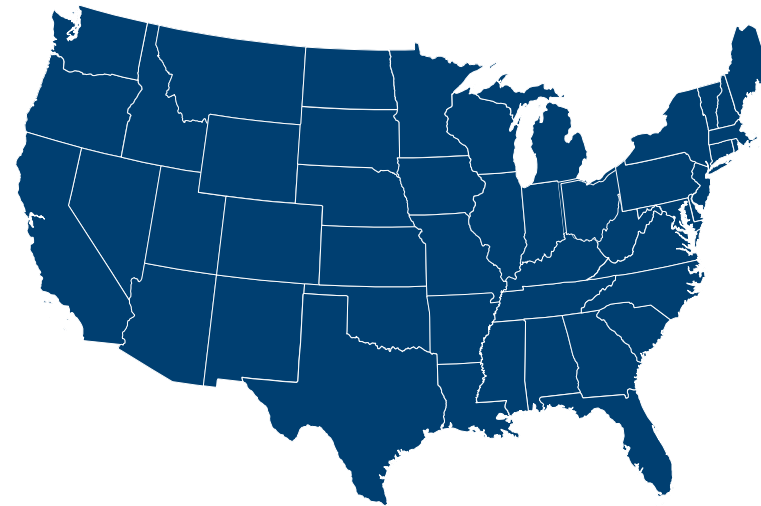
Timeline	2020-2021
Location	Alpharetta, Georgia
Technology	C-V2X
More info	<a href="#">Click Here</a>

## Smart Road Corridor Virginia

Timeline	2020
Location	Virginia
Technology	C-V2X
More info	<a href="#">Click Here</a>

## Connected Vehicle Deployment Program NYC

Timeline	2013 - 2021
Location	New York
Technology	DSRC 5.9GHz band
More info	<a href="#">Click Here</a>



## Connected Vehicle Deployment Program WY

Timeline	2013-2021
Location	Wyoming
Technology	DSRC 5.9GHz
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## Connected Vehicle Deployment Program THEA

Timeline	2013-2021
Location	Tampa
Technology	DSRC 5.9GHz band
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## Cellular-V2X Connected Car Trials (Ford, AT&T, Nokia, Qualcomm etc.)

Timeline	2017
Location	San Diego, CA
Technology	C-V2X
More info	<a href="#">Click Here</a>

## Applied Information - Honolulu

Timeline	2020
Location	Honolulu, Hawaii
Technology	C-V2X
More info	<a href="#">Click Here</a>

## Honda + Verizon M City

Timeline	2021
Location	Michigan
Technology	5G
More info	<a href="#">Click Here</a>

## Applied Information - Arlington, Texas

Timeline	2020
Location	Arlington, Texas
Technology	C-V2X
More info	<a href="#">Click Here</a>





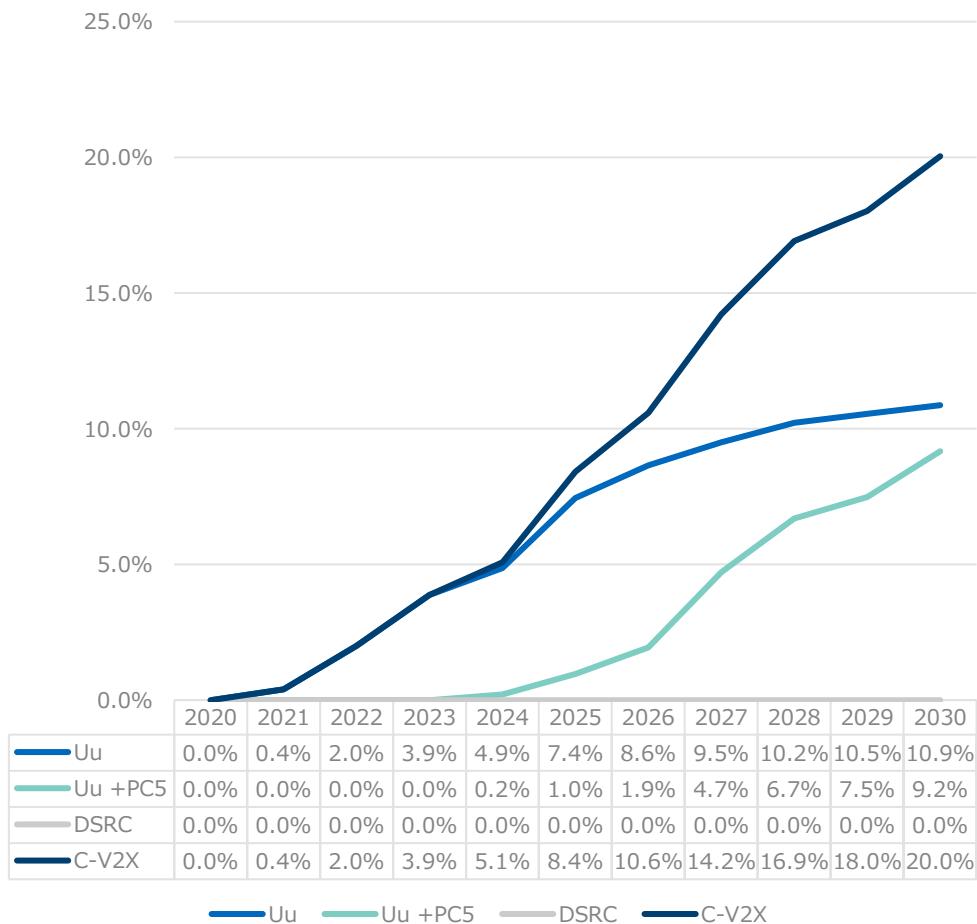
# OEMs - Audi

Technology	Trial or deployment	Models	Fitment strategy	Europe	USA	Japan	China	OEM position and outlook
Cellular (5G)	Trial	Q8	N/A		✓			Audi of America are trialling C-V2X technology in partnership with the Virginia Department of Transportation (VDOT) and Qualcomm Technologies Inc. The trial involves evaluating two specific use cases for V2X, work zones + roadside workers and traffic signal information. Roadside workers will be wearing C-V2X equipped vests so both them and the approaching vehicle can receive alerts about each other. Traffic signal information using C-V2X is intended to supplement Audis existing Traffic Light Information system.
Cellular (5G)	Trial	E-Tron	N/A		✓			Audi of America, Applied Information and Temple are trialling 5G supported use cases in living areas around school buses and school zones. The school zone use case incorporates roadside units (RSU) installed in school zone safety beacons intended to slow down passing vehicles, while the school bus use case will use onboard units (OBU) to broadcast C-V2X safety messages from school buses to C-V2X-equipped vehicles when the bus stop arm is extended to indicate no passing is allowed.
Cellular (4G)	Deployment	A7L (SAIC-Audi)	N/A				✓	Audi has announced that V2X would be launched firstly on A7L (SAIC-Audi) in 2022 with some use cases, including EBW: Emergency Brake Warning, GLOSA: Green Light Optimal Speed Advisory, AVW: Abnormal Vehicle Warning etc.
Cellular (4G)	Deployment	All models excluding R8, TT and Q2	Standard as part of Audi Connect Package on: A1, A3, A4, A5, A6, A7, A8, Q3, Q5, Q7, Q8, e-tron	✓	✓			Audi has chosen to pursue cellular based V2X. Since July 2019, Traffic Light Information and GLOSA have been available in Ingolstadt and Dusseldorf, Germany for selected Audi models. This comes 2 years after the feature was first launched in the USA in 2017. Audi cite that the delay was due to the varying nature of traffic light infrastructure in Europe. Audi have suggested that green wave technology could be used to inform route planning, as well as predictive adaptive cruise control allowing for vehicles to brake automatically at red lights.
Cellular (4G/5G)	Trial	Unknown	N/A	✓				Active between 2017 – 2019, Audi took part in the Connected Vehicle to Everything of Tomorrow (ConVeX). The main focus of the project was on Vehicle-to-Vehicle (V2V), Vehicle-to-Infrastructure (V2I) and Vehicle-to-Pedestrian (V2P) direct communication, as well as Vehicle-to-Network (V2N) wide area communications.
Cellular	Trial	Unknown	N/A				✓	Active between 2018 – 2020, Audi was a key partner in the LTE network based Vehicle to Everything (LTE-V2X) city-wide trial (Wuxi IoV Phase II). The project aimed to trial the world's first city-wide LTE-V2X IoV solution.

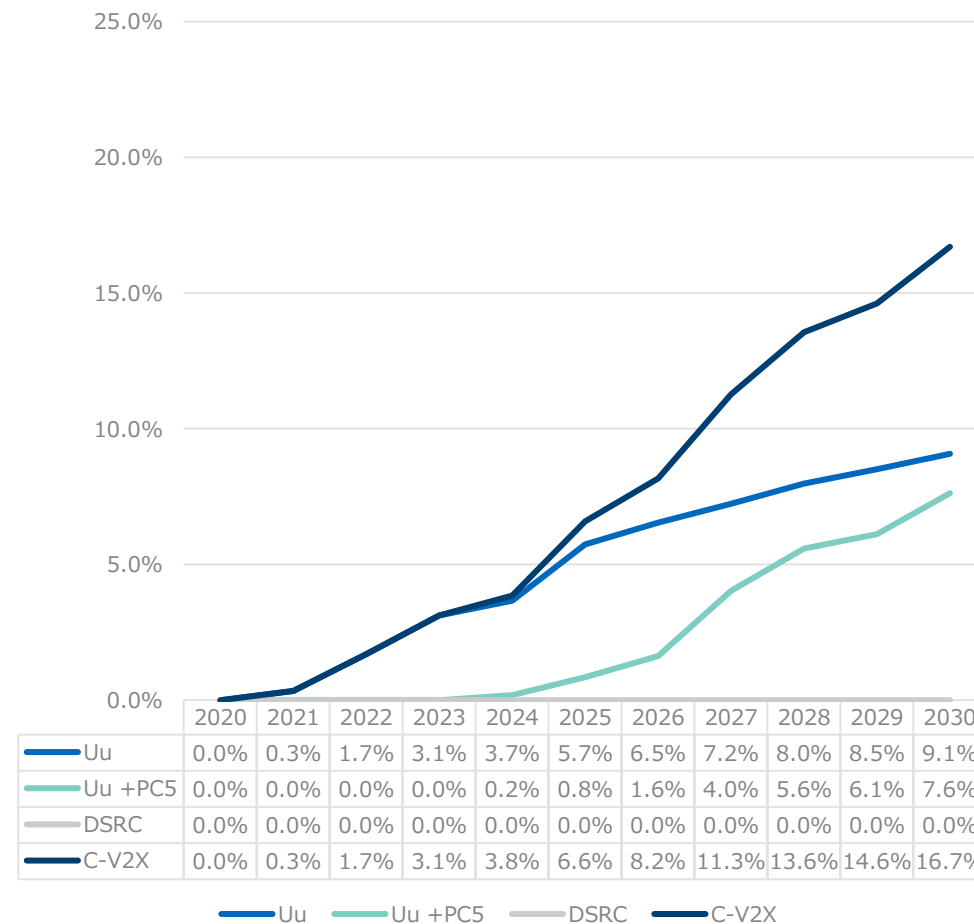


# China - V2X penetration rate for new vehicles

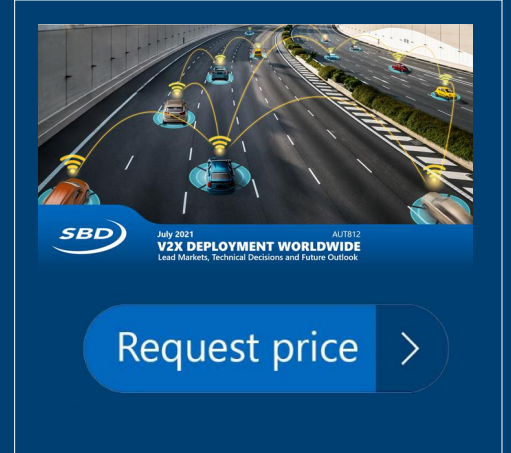
Optimistic growth curve



Pessimistic growth curve



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