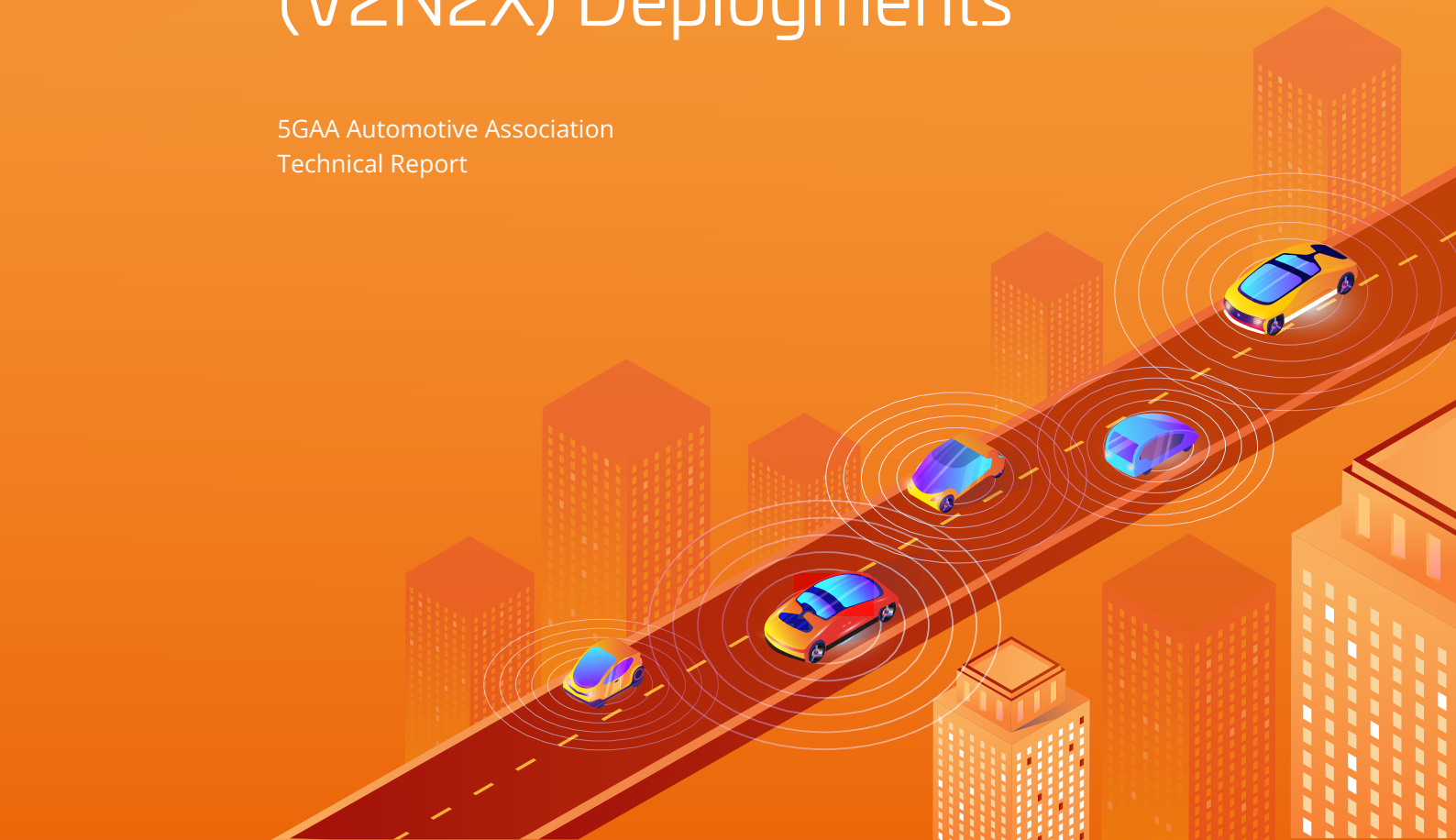
5GAA Automotive Association

Business Perspectives on Vehicle-to-Network-to-Everything (V2N2X) Deployments

5GAA Automotive Association
Technical Report



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Contents

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Foreword

This Technical Report has been produced by 5GAA.

The contents of the present document are subject to continuing work within the Working Groups (WG) and may change following formal WG approval. Should the WG modify the contents of the present document, it will be re-released by the WG with an identifying change of the consistent numbering that all WG meeting documents and files should follow (according to 5GAA Rules of Procedure):

x-nnzzzz

(1) This numbering system has six logical elements:

(a) x: a single letter corresponding to the working group:
where x =
T (Use cases and Technical Requirements)
A (System Architecture and Solution Development)
P (Evaluation, Testbed and Pilots)
S (Standards and Spectrum)
B (Business Models and Go-To-Market Strategies)

(b) nn: two digits to indicate the year. i.e. ,17,18 19, etc

(c) zzzz: unique number of the document

(2) No provision is made for the use of revision numbers. Documents which are a revision of a previous version should indicate the document number of that previous version

(3) The file name of documents shall be the document number. For example, document S-160357 will be contained in file S-160357.doc

1 Scope

Cellular networks facilitate an ever-growing set of capabilities to exchange data in the transport ecosystem. The present document describes the Vehicle-to-Network-to-Everything (V2N2X) market from a business perspective. It contains a brief description of market value, stakeholder needs, factors driving market growth as well as an analysis of business models that exist in a number of exemplary deployments. This document is additional to the high-level description of a V2N2X architecture that can be found in the 5GAA white paper "Road-traffic-operation-in-a-digital-age-a-holistic-cross-stakeholder-approach"[1].

This document is also a complement to the technical report "Vehicle-to-Network-to-Everything (V2N2X) Communications; Architecture, Solution Blueprint, and Use Case Implementation Examples" [2] that provides details about V2N2X architecture and how to realise UCs utilizing cellular networks. It is important to point out that these examples are recently past and current implementations of V2N2X, the full set of features in the architecture and foundational technologies are not yet completely realised. A host of future applications will undoubtedly take advantage of the V2N2X architecture and underlying improvements we see in deployments (e.g., implementation of multi-access edge computing or MEC, network slicing and generally improved coverage of 5G networks). Nevertheless, the essential message that the architecture can be instantiated here and now with existing networks is aptly illustrated by these descriptions. Additionally, the annexes contain detailed descriptions of relevant legislation and deployment examples.

The content of the Task Report (TR) is based on the analysis of existing V2N2X deployments, a Vehicle OEM (Original Equipment Manufacturer) and IOO (Infrastructure Operator and Owner) survey, and the experience of 5GAA members actively involved in the V2N2X market.

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3 Definitions and abbreviations

3.1 Definitions

Service: A business concept describing the process of generating certain value for the service user via applications. Service process usually involves multiple service execution entities based on predefined relations.

Service user: Entity that consumes the service.

Stakeholder: Person, business or other legal entity who is involved in a service or process of a use case. Example stakeholders in V2X services include the driver or traveller, automotive OEM, service provider, road authority, mobile operator, etc.

Stakeholder domain: Part of an entity (a network, an address space, etc.) that is managed by a particular commercial or administrative entity from a stakeholder.

V2X service: A service using vehicle-to-everything communications to realise the values for service users related to road transportation and mobility activities.

3.2 Abbreviations

For the purposes of the present document, the following symbols apply:

FHWA	Federal Highway Administration
TR	Task Report
V2N2X	Vehicle-to-Network-to-Everything
V2X	Vehicle-to-Everything

4 Market

4.1 Market size

Studies indicate a global market size for V2X in 2023 between USD 1.1 billion and 3 billion, with a forecasted growth to well over 20 billion in 2030 [3],[4]. These numbers represent the overall value of V2X including cellular and direct communication technologies for the different traffic participants (vehicles, pedestrians, infrastructure).

The V2N2X market value is a subset of the overall market value. Though there are no detailed figures available of the forecasted share of V2N2X market size, the following underlines that the V2N2X market will have a significant value in the future:

- According to ABIresearch [5] indirect communication via the cellular network (e.g., V2N2X, I2N2V) still constitutes the most significant yet untapped V2X opportunity;
- Cellular connectivity will be available in 346 million vehicles by 2025, and smart city cellular connections will exceed 165 million (ABIresearch [5]).

4.2 Overall factors driving market growth

The trajectory of the market is influenced by multifaceted determinants. Imperatives such as enhanced road safety and efficient traffic management as well as the development of connected and autonomous vehicles are primary drivers.

Concomitantly, the proliferation of smart cities significantly contributes to the growth of the market. Municipal investments in intelligent transportation systems position V2N2X technologies as essential components for optimising traffic flow, reducing congestion, and mitigating environmental impact. Additionally, regulatory initiatives mandating the deployment of overall V2X technologies further underscore their pivotal role in enhancing road safety.

The constant buildout of cellular coverage [6],[7] is also a factor supporting V2N2X market growth, especially as some countries demand road coverage as part of the licence conditions.

4.2.1 Societal challenges

Authorities and communities all around the world struggle with mobility related challenges such as road safety, traffic flow, equity of transport, and sustainability. As a result, authorities have launched programmes to realise these goals.

Broad examples include:

- Zero Deaths Vision (US) [8];
- Mobility Strategy (EU) [9];

- Sustainable Urban Mobility Planning and Monitoring (EU) [10];
- Application Pilot Programme of "Vehicle-Road-Cloud Integration" for Intelligent Connected Vehicles [11] (China).

Besides these examples many, if not all, state, regional and local authorities have programmes aimed at the aforementioned societal challenges.

4.2.2 Digitalisation

In recent years, public authorities have embraced the digitalisation of the transport system, driven by the imperative to enhance overall transportation efficiency. This shift is underpinned by the promise of manifold benefits that can be realised from the integration of digital technologies into transportation infrastructure.

Firstly, digitalisation offers an opportunity to improve traffic management and optimise the utilisation of existing transport networks. Secondly, digitalisation fosters the evolution of smart and interconnected vehicles. The integration of sensors, communication technologies, and autonomous systems enable the vision of a seamless and synchronised flow of traffic.

Furthermore, the digitisation of transportation facilitates an intelligent transport system that is responsive to user needs. Public authorities can harness big data analytics to optimise public transportation schedules, enhance accessibility, and tailor services to individual preferences. This fosters a more inclusive and user-centric transportation ecosystem.

Examples of digitalisation programmes are the FHWA Digital Infrastructure Strategy (work in progress) and the EU programme "Key technologies to boost the digitalisation of transport" [12].

4.2.3 Euro NCAP

Another factor that will be driving market penetration of V2N2X services is the Euro NCAP Vision 2030 [13] expressing the intent to accommodate all forms of connectivity and the various technical communication standards in the rating by evaluating each safety function in a technology neutral way. In the short term, Euro NCAP will capitalise on existing industry investments in connected services and promote systems that improve driver information, raise situational awareness, and warn of imminent hazards.

4.2.4 Legislation

The following paragraphs summarise the state of affairs on legislation in the EU, US, Australia, and China. Annex A contains more details on the mentioned legislation.

European Union

In terms of legislation, the European Union is the most forward leaning region. Within the EU, intelligent transport systems are regulated by Directive 2010/40/EU and the subsequently adopted Commission Delegated Regulations.

In the framework of Directive 2010/40/EU, EU specifications have been adopted in order to ensure compatibility, interoperability and continuity for the deployment and operational use of Intelligent Transport Systems (ITS) for the provision of EU-wide Safety-Related Traffic Information (SRTI), and Real-Time Traffic Information (RTTI) services.

For the purpose of facilitating the provision of compatible, interoperable and continuous real-time traffic information services across the Union, road authorities, road operators, tolling operators, and recharging and refuelling-related stakeholders shall provide the data on infrastructure in a standardised format.

In-vehicle generated data is a potential data source for a number of the formally defined data elements in the Delegated Regulation. This source can be used, for example, to determine speeds, travel times, poor road conditions, and accidents and incidents taking place on the road network. To harness this data source for specific public road operation tasks, such as traffic management and asset management, under the Delegated Regulation, public authorities may request holders of in-vehicle generated data and service providers to share relevant data types under Fair, Reasonable and Non-discriminatory (FRAND) conditions.

Australia

There is presently no legislation in place in Australia mandating ITS data collection and/or sharing.

Australia does have several key policies related to government access to Cooperative Intelligent Transport Systems (C-ITS) and Autonomous Vehicle (AV) data. These policies aim to ensure data privacy, security, and responsible use.

United States

There is presently no legislation in place in the US mandating ITS data collection and/or sharing. However, on 9 March 2023, the "Intelligent Transportation Integration Act" [17] was introduced in the US House of Representatives to establish a programme to use anonymised data from third parties to inform planning and improve transportation management on Federal-aid highways, and for other purposes. This HR1500 Bill is currently in the House Transportation and Infrastructure Committee.

China

The legislation on ITS in China is progressively being refined, with government departments having issued a series of plans and guidelines to promote the development of smart transportation.

The Ministry of Transport and the Ministry of Science and Technology have jointly released the "14th Five-Year Plan for Scientific and Technological Innovation in the Field of Transportation", which sets forth goals for promoting the coordinated development of smart transportation and smart cities.

Departments such as the Ministry of Industry and Information Technology have successively released documents like the "National V2X Industry Standard System

Construction Guide", "V2X Industry Development Action Plan", and "Medium- and Long-term Development Plan of the Automobile Industry" – all of which have significantly promoted the development and application of autonomous driving technology in China.

In addition to policies and plans at the central level, some local governments such as Wuxi City are also actively exploring local legislation for intelligent transportation to meet the specific needs of local ITS development. Indeed, legislation on ITS in China is actively underway, with the government recognising the importance of smart transportation for modern transport systems and beginning to formulate related policies and plans.

5 Stakeholder analysis

5.1 Customer profile model

This chapter provides an analysis of the direct stakeholders in the V2N2X ecosystem, applying the Osterwalder Customer profile model [14]. In this model "customers" are described on the basis of three elements:

1. **Jobs-to-be-done:** The specific goals, or "jobs" in other words, that would lead an organisation or person to use/deploy certain services or products. Jobs can be Functional, Social or Emotional. An example of a Functional job: travellers can use a car or public transport to travel. The job to be done is to get from A to B, the means of transport is the product/solution.
2. **Pains:** The negative experiences, emotions, and risks that an organisation or person experiences in the process of getting the job done. An example: travellers use an ebike instead of a traditional bike to travel from A to B because they dislike arriving sweaty (the pain) at their destination.
3. **Gains:** The benefits which an organisation expects and needs, what would delight the organisation and the things which may increase likelihood of adopting services or products. An example: travellers can use a train instead of a car to travel from A to B so they can watch a movie and relax (the gain) during the ride.

In this analysis the descriptions of jobs-to-be-done are kept to a generic level. The pains and gains are described in the context of V2N2X services, instead of relating them directly to the jobs-to-be-done.

5.2 Stakeholders

The following direct stakeholders can be distinguished:

- Road Users, such as car drivers, truck drivers, cyclists, and pedestrians;
- Infrastructure Operators and Owners, such as road operators, and cities;
- Vehicle OEMs, such as car, motorbike and truck manufacturers.

These stakeholders benefit directly from the implementation of V2N2X services other than, but not excluding, generating revenue. These benefits are as described in the previous chapter: societal benefits (e.g., safety, traffic flow), meeting legislation and/or adding value to existing services. The customer profiles of the Vehicle Infrastructure Operators and Owners, and Vehicle OEMs are described in 5.3, as these are the key stakeholders in the V2N2X ecosystem.

The following indirect stakeholders can be distinguished:

- Service Providers, providing services to road users and/or Vehicle OEMs such as navigation, information services, and fleet management;

- Mobile Network Operators, providing communication networks;
- Field Equipment Manufacturers, providing Traffic Light Controllers, Road Side Units, sensors, etc.;
- Technology Providers, providing services/components to the other stakeholders.

These stakeholders benefit indirectly from the implementation of V2N2X services by selling services to direct stakeholders.

5.3 Infrastructure Operators and Owners

Jobs-to-be-done

Based on the deployment examples and responses to the V2N2X survey, IOOs are of the opinion that V2N2X deployments will support them in the following jobs-to-be-done:

- Provide safer transport;
- Contribute to a more efficient transport system.

IOOs are neutral towards the benefits in terms of more sustainable and equitable transport though overall they expect a positive effect.

Pains

IOOs expect V2N2X deployments can relieve them of the pain of investing in the technology that does not result in instant impact.

IOOs don't expect V2N2X deployments can support them in their challenge of replacing/supplementing fuel tax.

Gains

IOOs expect the following gains from V2N2X deployments:

- Influence the behaviour of road users;
- Reduce investments in field equipment such as detection loops, signage, traffic counters, etc.;
- Obtain (near real time) insights on the behaviour of road users;
- Receive information about road condition.

Furthermore IOOs are mildly positive or neutral about realising the following gains:

- Obtaining/maintaining an innovative image;
- Possibility of deploying dynamic traffic management policies.

Obstacles

IOOs indicate the following obstacles relating to V2N2X deployments:

- Lack of adoption by OEMs;
- Risk of privacy breaches;
- Lack of standardisation;
- Lack of data harmonisation/quality;
- Uncertainty about the costs.

The following items are not experienced as significant obstacles:

- Mobile coverage gaps;
- Limitations on national roaming.

Willingness to fund an Information Sharing Instance

IOOs are mildly positive or neutral about their willingness to fund the operation of a central Information Sharing Instance.

5.4 Vehicle OEMs

Jobs-to-be-done

The participation of Vehicle OEMs in deployments is, today, still limited. Based on the Vehicle OEM survey, the following jobs-to-be-done are expected to be supported by V2N2X deployments:

- Meeting legislation;
- Improving the delivery of safety-relevant applications.

Vehicle OEMs don't expect a strong contribution on the improvement of customer comfort and the generation of additional service revenues.

Pains

Based on the Vehicle OEM survey V2N2X deployments are expected to relieve the following pains:

- Lack of scalable solutions;
- Access to infrastructure data.

Vehicle OEMs are mildly positive or neutral on the effect of V2N2X on the following pains:

- Reduce the need for investments in technology without short/medium-term results;
- Reduce future physical "legacy" in-car equipment.

Vehicle OEMs don't expect V2N2X deployments will reduce the need to support multiple in-car communication technologies.

Gains

Vehicle OEMs expect the following gains from V2N2X deployments:

- Opportunity to offer enhanced services based on data that is only available through the cellular network;
- Obtaining/maintaining an innovative corporate image.

Furthermore Vehicle OEMs are neutral or negative about realising the following gains:

- Gather additional insights into customer behaviour;
- Opportunity to experiment with a “service menu”.

Obstacles

Vehicle OEMs indicate the following obstacles relating to V2N2X deployments:

- Lack of data harmonisation/quality;
- Lack of network coverage;
- Clarity on business case/model to sustainably exploit the potential benefits.

The following items are perceived as minor concerns/obstacles:

- Privacy breaches;
- Uncertainty about the costs.
- Lack of interoperability between V2N2X service providers;
- Lack of standardisation.

Willingness on data sharing

Vehicle OEMs indicate it is likely they would be willing to share data on a “quid pro quo” basis, meaning they expect to receive data in return for their own data or some other kind of compensation (monetarily or non-monetarily). This includes data sharing with competitors. With respect to data according to road safety (e.g., Local Hazard Warning), vehicle manufacturers are prepared to make this available in an anonymised manner to public authorities (or private operators entrusted with a public task such as Road Operators) on a reciprocal basis [15].

6 Business models in exemplary deployments

V2N2X deployments already exist at fairly large scale. Deployments that have been studied as a basis for input for this TR are:

- Talking Traffic (The Netherlands);
- Safety Priority Services (The Netherlands);
- Mobilidata (Flanders, Belgium);
- Cloud Safety Alert Service (US);
- ICV Zones (China).

These deployments use the cellular network to exchange data with road users, cover a significant geographical area (at minimum more than one city or region), have a deployment focus and serve (or expect to within 12 months) at minimum 100,000 unique road users.

The following paragraphs provide a summary of these deployments from a perspective of stakeholders and provided services. More information can be found in Annex B including a detailed description of roles and business models.

6.1 Talking Traffic and Safety Priority Services (The Netherlands)

The Netherlands have an active ecosystem of more than 40 cities and industry partners connecting over 28% of all TLCs and over 25% of the Dutch cars through apps and onboard units. Live use cases include Priority/Pre-emption, Time To Green, Optimisation of Traffic Flow, Emergency Vehicle Warnings, and In-vehicle Signage. The programme is continuously expanding through greater connections to road users, use cases, and connected roadside equipment.

Authorities provide data for free to service providers (and some Vehicle OEMs) so they can realise commercial services with that data. In return, service providers provide status data from road users to the authorities for specific use cases. A group of technology providers offer paid services to both the authorities and the service providers.

Actor type / role	Investing in	Commercial services offered	Revenue source(s)
Policymaker/IOOs	Information sharing entity/Connected roadside equipment/ Data producing systems (road works, speed limits, signs etc.)/ Anonymised consumer data	n.a.	n.a.
V2N Service Providers	Connections with information sharing entity	Information services (mostly apps)	Consumer subscriptions/ Monetisation of consumer data
Technology Providers	n.a.	Connected roadside equipment/ Information sharing entity/Intersection control apps/Tooling	Providing services to direct stakeholders
Mobile Network Operator	n.a.	Cellular data transfer	Subscriptions connected field equipment

6.2 Mobilidata (Flanders, Belgium)

The Mobilidata programme started in 2022 and is gradually launching use cases with the goal to have over 30 live C-ITS cases in 2026, including Priority/Pre-emption, Time To Green, and Traffic Flow Optimisation. Within the Mobilidata programme, governments, companies, and researchers work together to bring innovative technological traffic solutions to all road users. Flanders road usage is to be safer, smoother and more sustainable by adding cooperative digital mobility solutions. Road users benefit from better quality traffic alerts tailored to the route, intelligent traffic lights, and better travel directions in general.

Authorities provide data for free to service providers so they can realise commercial services with that data. In return, service providers provide status data from road users to the authorities for specific uses. A group of technology providers offer paid services to both the authorities and the service providers.

The business models are similar to the setup in The Netherlands.

Actor type/role	Investing in	Commercial services offered	Revenue source(s)
Policymaker/IOOs	Information sharing entity/Connected roadside equipment/ Data producing systems (road works, speed limits, signs etc.)	n.a.	n.a.

V2N Service Providers	Connections with information sharing entity/ Status data road users	Information services + Harvest consumer data + Consumer subscriptions	Consumer subscriptions/ Monetisation of consumer data
Technology Providers	n.a.	Connected roadside equipment/ Information sharing entity/Intersection control apps/Tooling	Providing services to direct stakeholders
Mobile Network Operator	n.a.	Mobile data subscriptions	Subscriptions connected field equipment

6.3 Cloud Safety Alert Service (US)

The Cloud Safety Alert Service is a private-sector initiative to alert drivers (audible warnings, via integrated systems, or in-car signage) of a safety hazard. Called the Safety Cloud platform, this system is sold/licensed by HAAS Alert to Vehicle OEMs and others to augment safety for drivers and roadside personnel such as road workers and first responders. Integrated information from fire and emergency services, towing companies, utilities, work zone contractors, etc. is pushed out via HAAS to nearby vehicles, thereby improving the safety of their workers.

Public safety first responders pay HAAS Alert to send real-time notification alerts to surrounding traffic. HAAS Alert provides these alerts to Vehicle OEMs and mobility apps.

Actor type/role	Investing in	Commercial services offered	Revenue source(s)
Public Safety First Responder	Subscribe to V2N service to make personnel visible to drivers	n.a.	n.a.
IOO	Subscribe to V2N service to make personnel visible to drivers	n.a.	n.a.
V2N Service Provider	n.a.	Information services for OEMs	Services to OEMs

6.4 ICV Pilot Zones China (Wuxi)

To promote large-scale Intelligent Connected Vehicle (ICV) test verifications and deployment, seven national-level ICV pilot zones have been established. During the construction of National Pilot Areas of Connected Vehicles, a strong collaborative ecosystem was formed which brought together actors from the ITS and ICV fields with the local industrial chain.

Up to now, the deployment scale of the "Internet of Vehicles" in Wuxi has reached about 700 kilometres, including the deployment of over 400 intelligent roadside equipment systems. Based on the public security traffic management data, Wuxi has developed several information warning applications such as "Abnormal Vehicle Warning", information notification applications such as "Green Wave Traffic", and other applications such as "High Priority Vehicle Passing".

Actor type/role	Investing in	Commercial services	Revenue source(s)
Policymaker/IOOs	Information sharing entity/ Connected roadside equipment/ Data producing systems (road works, speed limits, signs etc.)	n.a.	n.a.
OEMs	Vehicle connectivity technology services	Vehicle purchase Vehicle subscriptions	Vehicle owners
Technology Providers		Connected roadside equipment/ Information sharing entity/Intersection control apps/Tooling	IOOs
Technology Providers	n.a.	Services such as autonomous driving, assisted driving, HD map and high-precision positioning	Services to OEMs
Mobile Network Operator	n.a.	Mobile data subscriptions	OEMs, road users

7 Conclusions

This report shows not only that the V2N2X setup is viable from a technical perspective, but also that value is created for the different stakeholders:

- Road users are willing to share data to benefit from up-to-date information and warnings, leading to safer and more efficient transport;
- IOOs are digitalising their operations, investing in technology and sharing an increasing amount of data to influence the behaviour of road users, obtain detailed and (near real-time) insights on traffic flow, and expect to reduce investments in field equipment;
- OEMs, though not very active in large-scale deployments yet, are triggered to increase their efforts because of upcoming or new Euro NCAP criteria and legislation.

As a result, the V2N2X ecosystem offers revenue opportunities for businesses supporting these deployments such as mobile network providers, service providers, and technology providers.

However, a number of obstacles are also observed, as shown in the table below.

	IOOs	Vehicle OEMs
Obstacles	**-Lack of adoption by OEMs** **-Uncertainty about the costs** -Risk of privacy breaches -Lack of standardisation -Lack of data harmonisation/ quality	**-Lack of data** **-Clarity on business case/ model to sustainably exploit the potential benefits** -Harmonisation/quality -Lack of network coverage (depending on the region)

Most striking is the “chicken and egg” problem where IOOs wait for OEMs to adopt V2N2X and OEMs wait for IOOs to provide more and better data. Fortunately, existing large-scale deployments show that IOOs have access to early, but significant, benefits leveraging connections with apps and connected fleets so they should not hold back for this reason.

Furthermore, as this study confirms, Vehicle OEMs will become more active in the V2N2X ecosystem in the future, something that can already be witnessed in their increased efforts to share data through V2N2X “within their brand” (e.g., by Audi, Ford, Volvo, and Mercedes).

All of this should offer both sides of the ecosystem a fair level of trust that their efforts are not wasted.

Other observed obstacles are more technical (quality, harmonisation). It seems neither IOOs nor Vehicle OEMs realise that the V2N2X ecosystem has excellent capabilities to standardise and harmonise data, and to manage privacy and security, as intermediate service providers take care of this as part of their offer. More details on the role of service providers can be found in the previously mentioned 5GAA V2N2X Architecture white paper [1]. However, this shows the need for continuous communication about

the features that the V2N2X architecture offers, as well as on the growing cellular coverage.

Annex A: Legislation

A.1 EU

Within the EU, Intelligent Transport Systems are regulated by Directive 2010/40/EU and the subsequently adopted Commission Delegated Regulations. This Directive establishes a framework in support of the coordinated and coherent deployment and use of ITS within the Union, in particular across the borders between the Member States, and sets out the general conditions necessary for that purpose. To facilitate the provision of compatible, interoperable and continuous real-time traffic information services across the Union, road authorities, road operators, tolling operators, and recharging and refuelling-related stakeholders shall provide the data on infrastructure in a standardised format, such as the INSPIRE data specification on transport networks, TN-ITS (CEN/TS17268 and subsequently upgraded versions) or DATEX II (EN 16157, CEN/TS 16157 and subsequently upgraded versions).

The Directive 2010/40/EU defined the following priority areas:

A. Optimal use of road, traffic and travel data;

B. Continuity of traffic and freight management ITS services;

C. ITS road safety and security applications;

D. Linking vehicles with transport infrastructure.

Specific data types considered crucial for the further development of reliable traffic information services and to improve traffic safety, such as traffic regulations, restrictions, and road or lane closures, should be made available. Due to their importance, those data types need to be made accessible as an earlier milestone compared to other data types.

The geographical scope of the Delegated Regulation has been extended to cover the entire road network, excluding private roads identified by Member States. This extension of the geographical scope will apply from 1 January 2028 to all data types listed in the Annex of the Delegated Regulation. All the data types listed in the Delegated Regulation on the TEN-T network, other motorways and primary roads must be accessible via the National Access Points (NAP) by 1 January 2025. When a Member State makes traffic regulations, traffic circulation plans or temporary traffic management measures accessible via a NAP, it is proposed that service providers be obliged to re-use this data in their services to road users, so the information provided via these services is coherent with the data that has been made accessible.

In-vehicle generated data is a potential source for a number of data types in the Delegated Regulation. This source can be used, for example, to determine speeds, travel times, poor road conditions, and accidents and incidents taking place on the road network. To harness this data source for specific public road operation tasks, such as traffic management and asset management, under the new Delegated Regulation, public authorities may request holders of in-vehicle generated data and service

providers to share relevant data types under Fair, Reasonable and Non-discriminatory conditions.

Based on the mentioned EU regulation the following data types shall be ready for the accessibility, exchange, re-use, and update by data holders and data users for the provision of EU-wide, real-time traffic information services. By the 1 January 2025, the following data and services shall be accurate and available across borders to end-users:

1. Infrastructure data (road network including classifications, gas stations, etc.);
2. Crucial types of data on regulations and restrictions (static and dynamic traffic regulations like access conditions for bridges/tunnels, speed limits, etc.);
3. Other data on regulations and restrictions (location and identification of traffic signs reflecting traffic regulations and identifying dangers but also tolled roads, etc.);
4. Crucial types of data on the state of the network:
   - Road and lane closures;
   - Roadworks;
   - Temporary traffic management measures;
5. Other types of data on the state of the network:
   - Bridge closures;
   - Accidents and incidents;
   - Poor road conditions;
   - Weather conditions affecting road surface and visibility;
6. Data on the real-time use of the network:
   - Traffic volume and speed;
   - Location length of traffic queues;
   - Travel times;
   - Waiting time at border crossings;
   - Availability of delivery areas, recharging and refuelling points and their prices.

For a transitional period ending on 31 December 2027, obligations related to data types under points 1, 3, 5 and 6 shall not apply with respect to roads other than the following: (a) comprehensive trans-European road network; (b) other motorways not included in comprehensive trans-European road network; and (c) primary roads.

A.2 Australia

Several policies related to government access to Cooperative Intelligent Transport Systems (C-ITS) and Autonomous Vehicle (AV) data. These policies, outlined in the "Regulating government access to C-ITS and automated vehicle data: Policy paper August 2019" [16], aim to ensure data privacy, security, and responsible use. Key policies mentioned include:

- Privacy and Security: The policy emphasises the importance of protecting individual privacy and maintaining data security throughout the collection, use, and storage of C-ITS and AV data. It calls for robust security measures to prevent unauthorised access and misuse of data.
- Informed Consent and Transparency: The policy advocates for informed consent and transparency in data collection and use. It suggests that individuals should have control over their data and be informed about how it will be used, ensuring transparency in the processes.
- Purpose Limitation: Government agencies are encouraged to have clear and specific purposes for accessing C-ITS and AV data. The policy highlights the importance of collecting only the necessary data to achieve those purposes. It aims to prevent the use of data beyond what is explicitly stated, minimising the risk of mission creep or abuse of data.
- Data Retention and Destruction: The policy recommends that government agencies establish guidelines for data retention periods. It emphasises that data should not be stored longer than necessary. Additionally, secure methods for data destruction should be employed to minimise the risk of unauthorised access.
- Data Sharing and Collaboration: The policy acknowledges the benefits of data sharing and collaboration among stakeholders. It recognises the need for appropriate safeguards and legal frameworks to protect privacy and security during data sharing processes. The policy encourages the establishment of mechanisms to facilitate safe and responsible data sharing.
- Regulatory Framework: The policy proposes the development of a regulatory framework that sets out clear guidelines and obligations for government agencies regarding data access, use, and protection. It suggests the establishment of independent oversight bodies to ensure compliance with the regulations and to promote accountability.

These policies collectively aim to strike a balance between utilising the potential benefits of C-ITS and AV data and safeguarding privacy, security, and public trust. The document highlights the importance of collaboration between government, industry, and the public to effectively implement and comply with these policies in the field of Intelligent Transport Systems and Autonomous Vehicles.

A.3 US

There is presently no legislation in place in the US mandating ITS data collection and/or sharing.

On 9 March 2023, the HR 1500 Bill, described as the "Intelligent Transportation Integration Act"[17], was introduced in the US House of Representatives by representative Graves [R-LA-6] to establish a programme to use anonymised data from third parties to inform planning and improve transportation management on Federal-aid highways, and for other purposes. This bill is currently in the House Transportation and Infrastructure Committee.

If passed, this Bill will direct the Secretary of Transportation to establish and implement a programme within 180 days, focused on: reducing congestion; decreasing vehicle miles travelled; increasing safety; improving freight efficiency; and enhancing environmental conditions, all using digital data. Implementation is foreseen to address the following purposes: adjusting traffic light cycle times; expand/contract lane capacity; provide traveller notifications; prioritise vehicles such as emergency response; and any other purposes deemed necessary.

Outside of this potential legislation, C-ITS adoption is fostered via government funding designed to expand experience with technology. This includes Infrastructure Investment and Jobs Act (IIJA) funds, reauthorisation programmes, or grant programmes, which include SMART (Strengthening Mobility and Revolutionising Transportation); ATTAIN (Advanced Transportation Technology and Innovation); RAISE (Rebuilding American Infrastructure with Sustainability and Equity); and PROTECT (Promoting Resilient Operations for Transformative, Efficient, and Cost-saving Transportation).

A.4 China

The province of Jiangsu and the city of Wuxi in China have issued local regulations concerning Vehicle-to-Everything technology. These regulations mark the establishment of legal support and management frameworks for the development of V2X technology. Specific details include:

Jiangsu Province: Enacted the nation's first provincial-level local regulation on V2X, aimed at promoting the construction of V2X infrastructure and the development of intelligent connected vehicles. This regulation is a pioneering legislative effort addressing new business models and issues, providing a legal foundation to keep the related industries in Jiangsu at the forefront nationally.

Wuxi City: The Standing Committee of the Wuxi Municipal People's Congress has officially issued the "Wuxi City V2X Development Promotion Regulation", which is the country's first local regulation to promote the development of V2X. As the nation's first V2X pilot zone and one of the first cities in the "smart city and intelligent transportation" pilot programme, Wuxi is at the forefront in terms of V2X infrastructure, applications, and industry development.

In summary, Jiangsu Province and Wuxi City have made significant progress in local regulations for V2X technology, which will help drive the application and development of V2X technology and lay the groundwork for future intelligent transportation systems.

Annex B: V2N2X deployment examples

B.1 Selection criteria for deployments

V2N2X deployments already exist at fairly large scale which makes it possibles to use existing deployments as study material for this Task Report. This annex contains a business-focused description of some deployments that have the following characteristics:

- The cellular network is used to exchange data with road users;
- A significant geographical area is covered (at minimum more than one city or region);
- There is a clear deployment focus;
- A minimum of 100,000 unique road users are served, or expected to be served, within the next 12 months.

These examples have been studied as a basis for input for this technical report are:

- The Netherlands (Talking Traffic, Safety Priority Services);
- Flanders, Belgium (Mobilidata);
- The US (Cloud Safety Alert Service);
- China (Wuxi).

B.2 The Netherlands

The Netherlands have multiple initiatives that have reached operational deployment status. The initiatives focus on different use cases but leverage the same operational setup (connections, data sharing facilities, governance etc.).

In July 2023, the following number of connections was reported:

- Approximately 2.5 million passenger cars (out of 8.6m) consuming data from all connected objects and sharing real-time status data (CAM messages) through aftermarket solutions (OBUs and smartphone).
- Approximately 800 ambulances (out of approx. 800) sharing emergency warning messages (DENM) through OBU's as well as requesting pre-emption at connected intersections (SRM/SSM messages).
- Approximately 400 fire trucks (out of approx.. 2,500) sharing emergency warning messages (DENM) through OBU's as well as requesting pre-emption at connected intersections (SRM/SSM messages).
- An unknown number of logistical vehicles consuming data from all connected objects and sharing real time status data (CAM messages) through

aftermarket solutions (OBUs and smartphone).

- An unknown number of bikes sharing real time status data (CAM messages).
- Approximately 1,400 Intersection controllers sharing topology (MAP messages), status and planning (SPAT messages) in real-time as well as processing priority requests (SRM/SSM messages) designated fleets (emergency vehicles, public transport, logistical fleets).
- Approximately 16,000 variable message signs sharing displayed information in DATEX II format.
- Approximately 186 moveable bridges on the main road network (out of 211) sharing open or closed status.

The numbers of connections are growing continuously.

Talking Traffic

The Talking Traffic Partnership is a collaboration between the Dutch Ministry of Infrastructure and Water Management, 60 regional and local authorities and national and international private companies.

These partners are working together to accelerate development and deployment with regard to retrieving and organising traffic light data, to process, enrich and distribution of a wide variety of data and convert this into real-time and made-to-measure data sets and information, and to provide this information to a wide variety of road users though their smart phones, personal navigation devices (PNDs) and in-car systems. Talking Traffic started with a joint co-investment programme to enhance the availability of intelligent data for a wide group of road users (cars, trucks, public transport, emergency services, cyclists). After the initial four-year programme the most relevant use cases were continued through to deployment. Data is exchanged within strict quality parameters including latency budgets (average 200 ms, maximum 1 second).

Use cases

- In-car display of actual dynamic and static speed limits;
- Dynamic pre-emption/priority for designated road users such as emergency vehicles or public transport at intersections equipped with smart traffic lights;
- Optimisation of traffic flow at intersections by using traffic data transmitted by connected vehicles.

Actors and revenue flow

Only the actors that are part of the deployment phase are listed.

Public actors	Role(s)	Investing in/Paying for
Ministry of IenW	Policymaker	Information sharing entity
Rijkswaterstaat/NDW (national highways authority)	IOO	Connected roadside equipment/Data producing systems (road works, speed limits, signs etc.)
All regional road authorities (provinces)	IOOs	Connected roadside equipment

Over 40 cities	IOOs	Connected roadside equipment

Private actors	Role(s)	Revenue stream	Paying customers
Be-Mobile/Flitsmeister	V2N SP AS V2N SP App	Information services + Harvest consumer data + Consumer subscriptions	Private and public fleet owners (e.g. logistics, emergency vehicles)
Locatienet	V2N SP App	Information services	Private and public fleet owners (e.g. logistics, emergency vehicles)
Yunex	Technology provider	Diagnostic tooling	Ministry of IenW
Monotch	Technology provider	Provide services (Information sharing entity)	Ministry of IenW
Royal HaskoningDHV	Technology provider	Provide services (Intersection control apps)	National highway authority Regional road authorities Cities
KoHartog	Technology provider	Roadside equipment	National highway authority Regional road authorities Cities
Swarco	Technology provider	Roadside equipment	National highway authority Regional road authorities Cities
Vialis	Technology provider	Roadside equipment	National highway authority Regional road authorities Cities
KPN (indirect)	Mobile Network Operator	Provide services (connectivity)	Road users (Mobile data subscriptions)
T-Mobile (indirect)	Mobile Network Operator	Provide services (connectivity)	Road users (Mobile data subscriptions)
Vodafone (indirect)	Mobile Network Operator	Provide services (connectivity)	Road users (Mobile data subscriptions)

Safety Priority Services

Safety Priority Services in the Netherlands inform and warn road users on all roads, including unsafe provincial and local roads. The collaboration improves insight into the

impact of traffic warnings and the quality of available data, with room for necessary improvements. Future plans involve exploring "smart routing" to avoid e.g. school zones and accidents. Agreements for delivering Safety Priority Services are in place until 2024, with the intention of long-term collaboration. The goal is to establish Safety Priority Services as the central platform for strategic consultations between governments and information service providers.

With Safety Priority Services, the Netherlands is preparing for EU legislation and rules that will enter into force in 2025. In the Netherlands, the companies involved can gain knowledge and experience in prioritising, designing and offering road safety warnings. This European upscaling is also an express part of their road map for a number of the companies involved.

Use cases

- Traffic jam tail warnings;
- Emergency services warnings;
- Warnings based on Safety Related Traffic Information (temporary slippery roads, wrong-way drivers, extreme weather conditions etc.);
- Traffic rules (dynamic maximum speeds, VMS messages).

Actors and revenue flow

Public actors	Role(s)	Investing in/Paying for
Ministry of IenW	Policymaker	Information sharing entity
Rijkswaterstaat/NDW (national highways authority)	IOO	Data producing systems (road works, speed limits, signs etc.)
AZN (Joint ambulance services) and local Fire services		Data producing systems (status messages)

Private actors	Role(s)	Revenue stream	Paying customers
ANWB	V2N SP AS V2N SP App	Not specified	Not specified
Be-Mobile/Flitsmeister	V2N SP AS V2N SP App	Information services + Harvest consumer data + Consumer subscriptions + Feedback loop to IOO	Private and public fleet owners Ministry of IenW
Hyundai	V2N OEM App	n.a.	n.a.
KIA	V2N OEM App	n.a.	n.a.
TomTom	V2N SP AS V2N SP App	Information services + Feedback loop to IOO	OEMs Ministry of IenW
Monotch	Technology provider	Provide services (Information sharing entity)	Ministry of IenW

KPN (indirect)	Mobile Network Operator	Provide services (connectivity)	Road users (Mobile data subscriptions)
T-Mobile (indirect)	Mobile Network Operator	Provide services (connectivity)	Road users (Mobile data subscriptions)
Vodafone (indirect)	Mobile Network Operator	Provide services (connectivity)	Road users (Mobile data subscriptions)

B.3 Belgium (Flanders)

Mobilidata

Mobilidata is a programme of the Flemish government, supported by imec and with financial support from VLAIO (Flanders Entrepreneurship and Innovation) and CEF (Connecting Europe Facility). Within the Mobilidata programme, governments, companies, and research work together to bring innovative technological traffic solutions to all road users. The plan is for Flanders road usage to be safer, smoother and more sustainable by adding cooperative digital mobility solutions. Road users benefit from better quality traffic alerts tailored to the route, lights turning green quicker at intelligent traffic lights, and better travel directions in general.

Use cases

In total there are 29 operational and two monitoring use cases planned to be deployed. These use cases can be grouped as follow:

- Traffic legislation and advice (static and dynamic speed limits, road signs, etc.);
- Personal support – risk reductions/warnings (Road Works Warnings, Priority Vehicle Warnings, Wrong Way Driving Warnings, Traffic Jam Ahead Warnings, etc.);
- Intelligent traffic light controller (Time-2-Green & Speed Advice, Priority for emergency vehicles and public transport, Traffic Signal Optimisation, etc.);
- Navigation and parking management (Recommended Routing, Truck Parking Information, etc.);
- Policy support (Road Safety Monitor, Smart Mobility and Environment Indicator).

Connections

Mobilidata covers all public Flemish roads, cycle paths and sidewalks (AWV and local authorities combined).

Roadside equipment – cooperative information items

- All moving-traffic relevant static traffic signs (speed and other selected);

- 900 Gantries with lane signalling, dynamic speeds or text VMS;
- 100 moveable bridges and managed tunnels;
- 300 dynamic zone 30 VMS near schools;
- AWV weather station information;
- Integrated information of yearly 12.000 traffic hindrance events managed by the Flanders Traffic Centre
- 1,759 intersections with traffic lights being gradually converted to connected ITLCs;
- Track&trace of all AWV Winter service vehicles;
- Track&trace of all AWV authorised crash absorber vehicles and slow moving vehicles at mobile roadworks;
- Gradual integration of all track&trace of active firefighting vehicles and ambulances;
- Gradual integration of track and trace near ITLC for more than 2250 busses of the Flemish public transport operator De Lijn to enable bus priority use cases.

The most cooperative roadside equipment is the connected intelligent traffic light that react smoothly and adaptively to road users at an intersection, turning green faster or longer based on the actual traffic ahead. Connected to the cloud, data from road users, road authorities, weather stations, traffic databases, among others, are mapped and used. By the end of 2024 a total of 250 such controllers will be connected to their C-ITS platform in Flanders.

Mobilidata fused commercial information and SRTI

- Be-Mobile Traffic traffic jam engine;
- Bosch Wrong Way Driving detection service;
- SRTI when sustainably available.

Current Road User generated cooperative information

- Flitsmeister app users: 2,9 Mio MAU[1] – mainly Benelux;
- KartaGPS app by Ndrive.

Road user road map

- Current Apps Flitsmeister and KartaGPS ambition: double digit growth of MAU and intensity of usage in Belgium by end-2024;
- Mobilidata supported information push for non-cooperative use cases towards GAFAM and mayor traffic information service providers end 2023: mainly aiming for Waze (Google) and Tomtom (OEM) ecosystems. Waze currently reports up to 75,000 5-minute interval concurrent active users in Flanders during peak usage moments;

- Mobilidata supports new active road user (R&D) app development and cyclist IOS and Android SDK by 2024;
- Full/free cooperative collaboration exploration including free support: ongoing minimum until end-2024.

[1] MAU: monthly active users

Actors and revenue flow

Public actors	Role(s)	Investing in/Paying for
AWV (Flemish Agency of Roads and Traffic)	IOO	Data producing systems (road works, speed limits, signs etc.) PIP – Public Information Provider- Data fusion engine MI – Mobilidata Interchange -Information sharing entity Connected Road side equipment Launching Apps (Flitsmeister/ KartaGPS): full app integration of all Mobilidata use cases

Private actors	Role(s)	Revenue stream	Paying customers
Be-Mobile/Flitsmeister	V2N SP AS V2N SP App	Information services + Harvest consumer data + Consumer subscriptions + Mobility services like parking payment	Road users (Mobile data subscriptions)
Be-Mobile / NDrive	V2N SP AS V2N SP App	Information services + Harvest consumer data + Consumer subscriptions	Road users (Mobile data subscriptions)
Bosch	SP2SP AS	Information services based on 3P position information in Geofences	Ultimately Vehicle OEMs
Monotch	Technology provider	Provide services (Information sharing entity)	AWV
KoHARTOG	Technology provider	Roadside equipment ITLC	AWV
Yunex	Technology provider	Roadside equipment ITLC	AWV
Swarco/Dynniq	Technology provider	Roadside equipment ITLC	AWV

imec	Research/Project Management	Programme Management and R&D Use Cases	VLAIO / AWV
Transport & Mobility Leuven	Research	Monitoring and evalution tasks	VLAIO / AWV
Movias	Engineering	Monitoring and evalution tasks	VLAIO / AWV
Tractebel	Engineering	Monitoring and evalution tasks	VLAIO / AWV
Sirus	IT/Software	Linked data transformations	VLAIO / AWV
Be-Mobile	Mobilidata "core" consortium lead – IT Software – and traffic information provider	Provide CORE Mobilidata services	VLAIO / AWV

B.4 US

Digital Alerting for Road Worker and First Responder Safety

The Cloud Safety Alert Service is a private-sector initiative to alert drivers (audible warnings, via integrated systems, or in-car signage) of a safety hazard. Called the Safety Cloud platform, this system is sold/licensed by HAAS Alert to Vehicle OEMs and others to augment safety for drivers and roadside personnel such as road workers and first responders. Integrated information from fire and emergency services, towing companies, utilities, work zone contractors, etc. is pushed out via HAAS to nearby vehicles, thereby improving the safety of their workers.

A first instance of this service involves Stellantis, the manufacturer of Jeep, Dodge, Ram, and Chrysler vehicles. Called EVAS (Emergency Vehicle Alerting System), the feature is enabled and powered by Stellantis' integration with HAAS Alert's Safety Cloud platform, receiving data from emergency vehicles, tow trucks, work zones, and other hazards on the road. EVAS notifies drivers when they are approaching active assets and vehicles on the road equipped with Safety Cloud on the road by displaying a message in the vehicle head unit with a message customised to the hazard type (such as "Emergency Vehicle Ahead," "Tow Truck Ahead," "Work Zone Ahead," etc.), giving drivers more time to slow down and avoid collisions. Additionally, leading manufacturers of fire trucks and construction fleets offer optional in-vehicle instances of this system to alert operators who are otherwise focused on their mission.

Use cases

- In-vehicle alerts of nearby emergency vehicles (EMS, fire);
- In-vehicle alerts of nearby road workers (construction, tow, utility).

Connections

Service penetration is growing rapidly because EVAS is enabled through Stellantis' vehicle connectivity platform – which operates over the public mobile network, and is able to retrofit to vehicles dating back to 2018 via an over-the-air (OTA) update. To

date, more than 1.8 million vehicles in the United States and Canada have the EVAS feature activated and enabled, making it the largest-ever US activation of a V2X or a V2N2X service. EVAS is included as a standard safety feature provided for ten years at no cost to the owner. The service is also integrated with the Waze app and its more than 100 million active users.

Accelerated growth for this use case is expected; HAAS company press materials (June 2023) announced that AT&T Wireless and HAAS Alert have signed a letter of intent to bundle digital alerts from HAAS Alert's service with AT&T connected vehicle solutions for automakers. This means that the estimated 60 million connected vehicles on AT&T's network (Fierce Wireless 27 January 2023) will receive safety alerts as part of their connected solution, delivering life-saving hazard and roadway alerts to drivers behind the wheel.

This system is live nationally in the US and Canada.

Actors and revenue flow

The following actors are part of this deployment

Public actors	Role(s)	Investing in/Paying for
EMS, Fire Departments	Public Safety First Responder	Information Sharing Entity; Subscribe to service to make personnel visible to drivers
Public Works	IOO	Information Sharing Entity; Subscribe to service to make personnel visible to drivers

Private actors	Role(s)	Revenue stream	Paying customers
HAAS Alert	V2N SP AS	Information Services	OEMs to provide in car service, Public & Private Actors to make personnel visible to drivers
Construction Co	Infrastructure Supplier	No revenue, Cost: they pay to have personnel visible in traffic	none
Private Utilities	Infrastructure Supplier	"	none
Private EMS	Private First Responder	"	none
Tow Operator	Private Responder	"	none
App Providers	V2N App	Information, consumer data, consumer subscriptions	Drivers, digital marketing companies
Vehicle OEMs	V2N OEM App	Vehicle purchase Vehicle subscriptions	Vehicle owners
Ambulance, Fire, Construction Truck OEMs	V2N OEM App	No revenue, Cost: they pay to have personnel visible in traffic	none

AT&T Wireless	MNO	Vehicle Subscription	OEMs

B.5 China

Intelligent Connected Vehicles (ICV) pilot zones

To promote large-scale ICV test verifications and deployment, seven national-level ICV pilot zones have been established, including Jiangsu (Wuxi), Tianjin (Xiqing), Hunan (Changsha) etc.. A further 16 pilot cities have also been designated for coordinated development of ICVs and smart city infrastructures, including Beijing, Shanghai, Guangzhou, etc.

During the construction of National Pilot Areas of Connected Vehicles, a strong collaborative ecosystem was formed which brought together actors from the ITS and ICV fields with the local industrial chain. For example, the Wuxi National ITS is a comprehensive test base jointly built by Ministry of Industry and Information Technology (MIIT), Ministry of Public Security and Jiangsu Province, which is today recognised as the world's first urban LTE-V2X application project.

As early as 2021, the Wuxi government, mobile network operators, communication equipment manufacturers, OEMs etc, relying on the advantages of the Internet of Things (IoT) industry in Wuxi had built the first LTE-V2X demonstration model covering 3.7km of open roads and six open intersections near the Taihu Expo Centre. In 2018, Wuxi completed the deployment of small-scale pilot area, including the infrastructure transformation of 39 intersections and a central V2X platform, and realised V2I and V2N applications such as "Traffic Light Information Display" and "Emergency Vehicle Passing Warning". In May 2019, MIIT officially approved and supported Wuxi to create China's first national-level CV pilot area. In 2021 and 2022, as the core area of the MIIT pilot city and also the "dual-intelligence" city by MIIT and MOHURD, Wuxi further upgraded 255 points (e.g., intersections, hazard areas etc.), covering 295.4km of roads in the whole Xidong New City area of 45km^2. It supports 15 functional scenarios, such as unmanned sanitation vehicles, automated shuttle bus, unmanned logistic vehicles, traffic management, traffic light timing optimisation, etc. [18]

Connections

Up to now, the deployment scale of the Internet of Vehicles in Wuxi has reached about 700km, including the deployment of over 400 pieces of intelligent roadside equipment. Based on the public security traffic management data, Wuxi has realised the information warning applications such as "Abnormal Vehicle Warning", real-time information notification applications such as "Green Wave Traffic", and other applications such as "High Priority Vehicle Passing".

At present, the Wuxi Internet of Vehicles platform has shared data from 1,512 intersection signal lights in the city. Based on this data, Wuxi has formed a stable online light status information service for 702 intersections on Baidu Maps, and buses on three priority roads and 28 important intersections have achieved priority traffic services.

Use-cases

- Reporting of Illegal Driving Actions;
- Reporting of Vehicle Dynamic Information;
- Traffic Light Information Display;
- Traffic Light Optimal Speed Advisory;
- Traffic Accident Warning;
- Variable Lane Warning;
- Traffic Jam Warning;
- Intersection Video On Demand;
- Speed Limit Warning;
- Emergency Vehicle Passing Warning;
- Green Wave Traffic

Actors and revenue flow

The following are only some of the Internet of Vehicles participants.

Public actors	Role(s)	Investing in/paying for
Government agencies at all levels	Policymaker	Information sharing entity

Private actors	Role(s)	Revenue stream	Paying customers
OEMs	V2N OEM App	Vehicle purchase Vehicle subscriptions	Vehicle owners
Mobile Network Operator	Connectivity service provider	Mobile data subscriptions	OEMs, road users
Road-side Equipment Manufacturer	Infrastructure Supplier	Road-side equipment	Government agencies
Service Provider	Application and V2X server provider	Services such as autonomous driving, assisted driving, HD map and high-precision positioning	OEMs

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