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ANNUAL REPORT 2022

5GAA - Connected Mobility For People, Vehicles and Transport Infrastructure

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FOREWORD

Christoph Voigt
Chairman of the 5GAA Board

"Collaboration among public and private actors has always been the cornerstone of our association, as we have historically looked to provide a space for dialogue with experts and decision-makers."

The 5G Automotive Association (5GAA) is a global, cross-industry organisation of companies from the automotive, technology, and telecommunications industries (ICT) working together to develop end-to-end solutions for future mobility and transportation services. Created on September 2016, 5GAA has rapidly expanded to include key players with a global footprint in the automotive, technology and telecommunications industries. This includes over 120 automotive manufacturers, Tier-1 suppliers, chipset/communication system providers, mobile operators and infrastructure vendors, 13 of the top 15 global automakers and telecommunications companies and the top five global wireless infrastructure companies.

This report highlights our progress in supporting the establishment of cellular vehicle-to-everything (C-V2X) in the market and cross-industry alignment, and our focus on all aspects of advanced use cases which will benefit from the evolution to 5G-V2X.

More than six years after its creation, 5GAA keeps moving forward to make our roads safer and traffic more efficient, and to reduce emissions. The journey ahead for the association is clearly defined in our 5GAA roadmap: continuing to support LTE-V2X widespread deployment while positioning 5G-V2X as the next step in the C-V2X evolution, and preparing its roll-out to turn the roadmap use cases into reality at scale. This 2030 visionary roadmap – updated at the end of 2022 – is a crucial instrument that allows 5GAA to offer a consolidated view on the future global introduction of advanced use cases for connected and automated driving from

the different actors of the 5G ecosystem, including automakers, network operators, and equipment providers globally.

The continuing need for international dialogue and cooperation within the ecosystem underscores our role as a global collaboration forum. Regular meetings between 5GAA members and various road operators foster exchanges of views and experiences on 5G-related topics and the infrastructure needed to build a truly connected ecosystem. We are now at a crossroad where we already see more than 200 million network-connected vehicles on the roads and a growing number of cars with LTE-V2X direct communications in China. It is thus the right moment to leverage existing LTE-V2X developments and pave the way for 5G-V2X, the future reference technology for automotive direct connectivity and a critical enabler of automated driving.

The innovative track of planned 3GPP releases (of which the 5GAA is a proud Market Representative Partner) looks as promising as ever for automotive applications, and it is now time to look at the non-terrestrial networks complementing globally deployed 4G/5G networks.

Collaboration among public and private actors has always been the cornerstone of our association, as we have historically looked to provide a space for dialogue with experts and decision-makers. At the same time, 5GAA will continue to turn to road operators for best practices and recommendations. As challenging as consensus might be, it is from that exchange that we thrive.

LOOKING BACK AT 2022:
KEY HIGHLIGHTS & MILESTONES

Regular face to face member networking events

3 face-to-face meetings in 2022 with prominent demonstrations

Consistent presence at global events

Flagship events of 5GAA, such as MWC Barcelona

Embracing change

5GAA new strategy adopted

Roadmap 2030

Publication of the updated roadmap & engagement with Road Operators to contribute to the next release

Protecting Vulnerable Road Users

Addressing safety concerns and promoting inclusion for vulnerable road users

C-V2X, a market reality

Continuing lifting barriers to C-V2X rollout

Vision and **Strategy**

5GAA bridges the automotive and telecommunication industries to address society's connected mobility needs bringing inclusive access to smarter, safer and environmentally sustainable services and solutions, integrated into intelligent road transportation and traffic management

SAFER **SMARTER** **ENVIRONMENTALLY FRIENDLY**

Services and Solutions

Digital Roads
Ensure traffic managers and other infrastructure owners are integrated in the V2X ecosystem and share data, information and services.

Digital Vehicles
Ensure vehicles get connected, share relevant data, and deliver safer, smarter and greener services to the drivers.
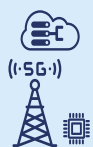
Digital Users
Ensure smart devices are integrated in the V2X ecosystem and contribute to protect Vulnerable Road Users.

Trust
Bring trust between people, vehicles, and infrastructure as well as markets, policy makers, and stakeholders.

Connectivity and flexible Architecture
Ensure V2X fully embraces connectivity and architecture opportunities and help the V2X ecosystem to closely follow the evolution of radio and network technologies and standards.

Strategic Objectives and Priority Areas

With C-V2X technology, 5GAA is revolutionising the mobility ecosystem and the way drivers interact with the world. 5GAA's ambition is to improve the overall transportation industry to make it safer, greener and more efficient for vehicles, road users and the surrounding infrastructure.

Timeline labels:

3GPP Rels. 8-13 March 2016 — LTE-V2X mobile network communications (Uu)

3GPP Rel. 14 March 2017 — LTE-V2X direct communications (PC5)

3GPP Rel. 15 June 2018 — 5G-V2X mobile network communications (Uu)

3GPP Rel. 16 December 2019 — 5G-V2X direct communications (PC5)

3GPP Rel. 17 June 2022 — 5G-V2X power efficiency for Vehicle-to-Pedestrian (V2P) applications

Hazard warning

V2V safety use case

Enhanced Navigation and Infotainment

Cooperative automated driving

Advanced Cooperative automated driving & VRU interaction

C-V2X mobile network communications (Uu)

C-V2X direct communications (PC5)

C-V2X Roadmap 2030: A visionary roadmap for advanced driving use cases, connectivity technologies, and radio spectrum needs

This landmark roadmap synthesised 5GAA's vision of the future, anticipating and analysing many day-1 basic safety and intersection use cases and deployments thanks to stakeholders in the global ITS community.

It focused on advanced driving use cases that pave the way to automated driving, tele-operation, automated valet parking, and sensor sharing – all of which contribute to global safety, mobility, environmental stewardship, and transportation equity goals.

With the release of this updated roadmap, 5GAA celebrated six years of intense activity, global cooperation, partnerships, and demonstrations that have accelerated the commercial availability and global deployment of these revolutionary technologies. Since the publication of the initial 5GAA roadmap in 2020, we have seen a growing deployment of connected safety services targeting traffic efficiency and safety. Vehicles enabled with both C-V2X network and direct communications modes have been released on the Chinese market. The first 5G cars, relying on 3GPP Release 15 standard, are available in China, Europe and the US, leveraging the rapidly growing 5G networks.

Many original equipment makers (OEM) have extended the list of hazard warnings distributed over the network within their products. Many cities provide pre-emptive green lights to emergency responders, and time-to-green information to vehicles over the network. These positive market changes are reflected in the new roadmap.

In the last two years, 5GAA has focused on advanced safety (e.g. sensor sharing, cooperative manoeuvres) and automated driving (e.g. automated valet parking, tele-operation) use cases as well as the state of technology readiness and availability to bring them to market.

5GAA members can now embrace 5G-V2X as a mature solution for automotive-related 3GPP 5G technologies. 5G-V2X will support messages relevant to both advanced driving and previous message types, ensuring service continuity for basic safety services. 5GAA recognises that the evolution of V2X within different regional markets will lead to further deployment options.

In terms of standards, the radio layer is already covered by 3GPP, which is currently working on Release 18 – completion is foreseen by the end of 2023 and will feature new enhancements to V2X. Upper layer standardisation is occurring via regional standards development organisations (e.g. ETSI, SAE International, NTCAS, C-SAE, ARIB, etc.), as additional work on profiles and protocols is needed. for new advanced use cases, such as
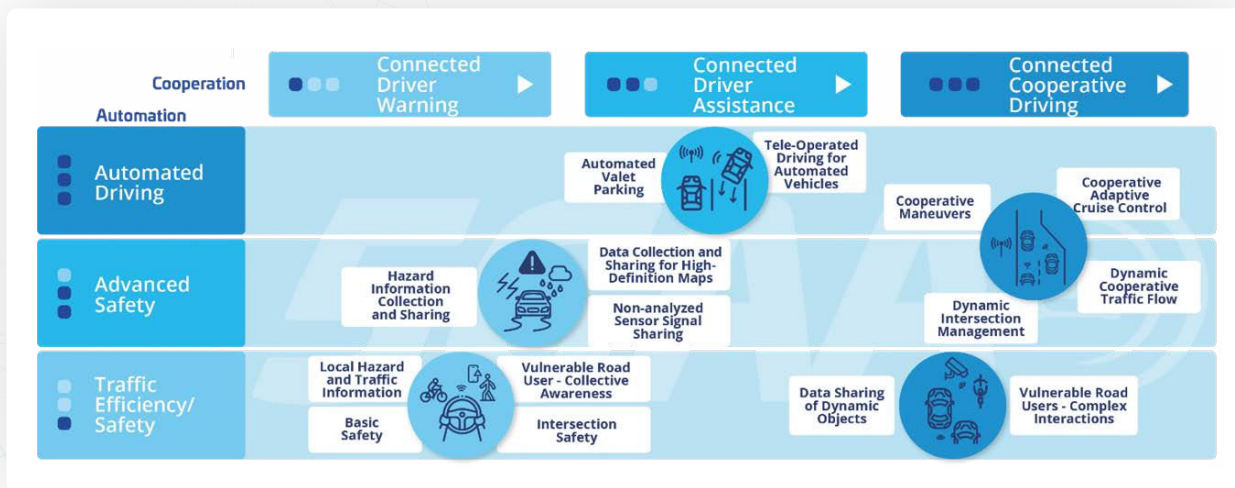
Evolution of C-VX use cases towards connected cooperative driving

group start. Activities on automated valet parking (AVP) standardisation have started in Europe and the US, and internationally under ISO. In short, with ongoing standardisation activities around the world and 3GPP 5G-V2X releases, technology enablers such as positioning, power consumption, and multiaccess edge computing (MEC) have been enhanced and can now support connected assistance and cooperative driving applications.

Improved understanding of the complexity of applications and the needed cooperation in the ecosystem have also had an impact on the new

version of the roadmap. Network-based solutions are also an option for vulnerable road user (VRU) awareness, and some of the safety and advanced automated driving use cases (e.g. group start, cooperative manoeuvres) will require more time before they can be deployed on the roads.

Work on the various use cases also builds on numerous ongoing efforts by standardisation bodies in the area of next-generation radio interfaces to increase the capacity of direct and mobile network-based communications, thus enabling advanced use cases. Automotive and telecommunication

companies are significantly engaged in these standardisation efforts, and this white paper aims to give an overview of the roadmap for introducing these new cases, together with the necessary regulatory and spectrum policy requirements.

The roadmap activities will enable advances toward a more complete digital road system benefiting vehicles, VRUs, and road operators, as well as smart cities looking to expand non-terrestrial network (NTN) connectivity and further explore vehicle automation and cooperative manoeuvres, as shown in the figure above.

The roadmap complements other industry roadmaps (ERTRAC's CCAM roadmap, UK Zenzic, SAE, China ICV, Car-2-Car Communication Consortium) on connected vehicles by factoring in connectivity, automotive aspects, functional safety and use cases that cover the full range of road users/vehicles.

As we move forward , 5GAA is working on defining the path ahead for advanced 5G developments enabling the next set of use cases and a new roadmap release. Alignment with stakeholders, e.g. road operators seeking to digitalise road infrastructure and smart cities, will also be the focus of future 5GAA releases .
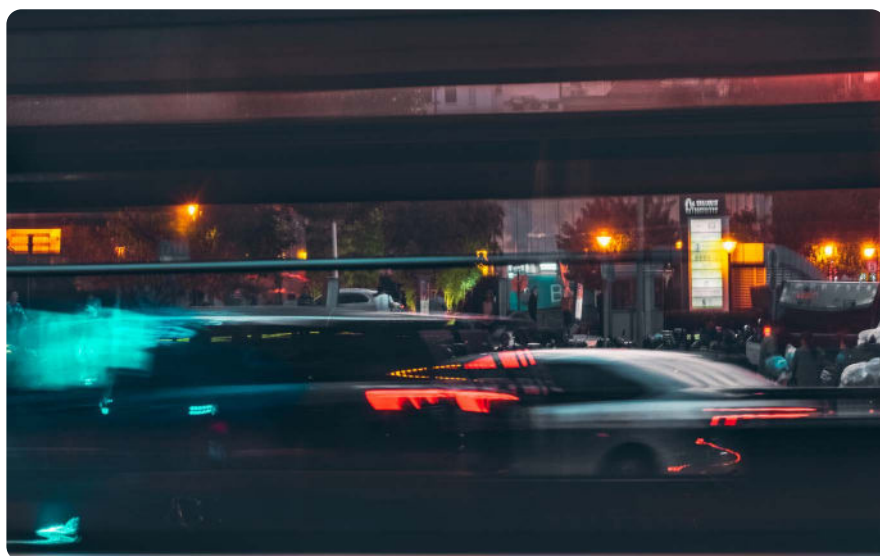
Based on the previous version of the released roadmap, 5GAA members have verified the most promising use cases in China, Europe and North America. Moreover, although the roadmap focuses on these regions, 5GAA is in close contact with other regions (e.g. South Korea, Japan, Australia, and India), which helps it keep on top of global market trends.

The detailed use cases listed in the 5GAA roadmap include the service level requirements (SLR) listed in the 5GAA C-V2X technical reports series. The rollout of use cases and services in the different regions depends heavily on ongoing security, spectrum and privacy regulations, and may change in the future.
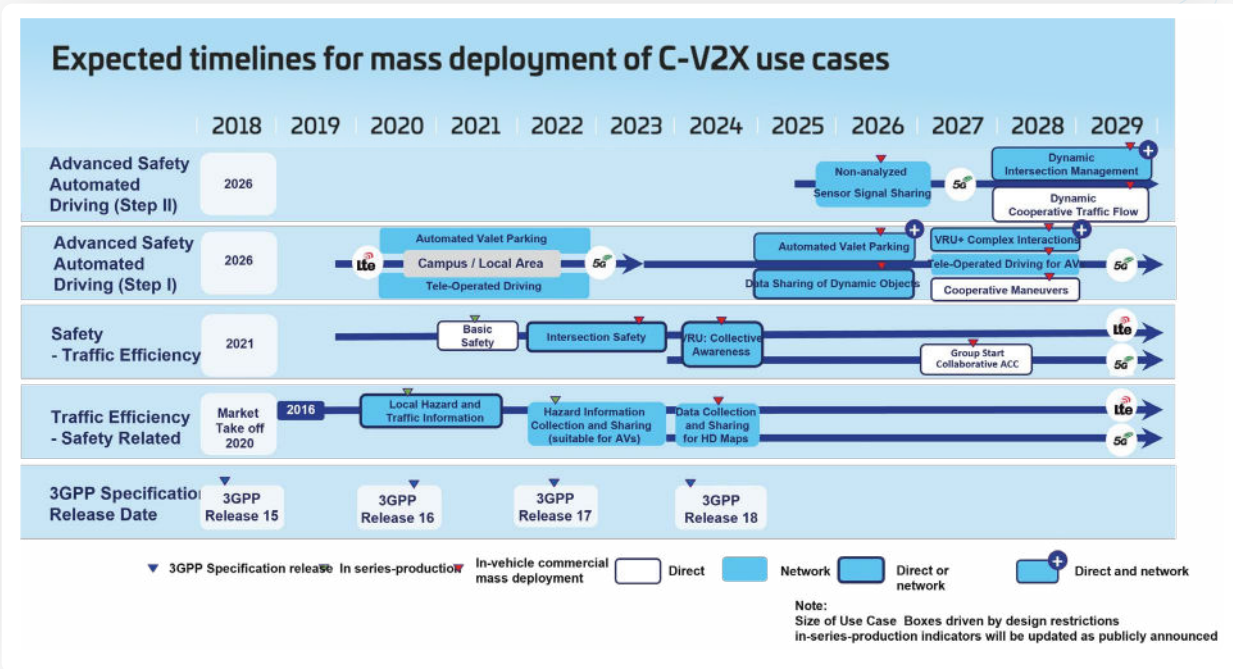
Since 2020, we have experienced a combination of major vehicle mass deployments and 'tip of the iceberg' deployments helping to accelerate several use cases listed in the 5GAA roadmap: Local Hazard and Traffic Information, Hazard Information Collection and Sharing (suitable for AVs),

as well as Basic Safety Applications.

Many of these mass-deployed use cases are motivated by regional safety regulations or incentives, e.g. Europe and China NCAP as well as the EU Commission Delegated Regulation on detected road safety-related events or
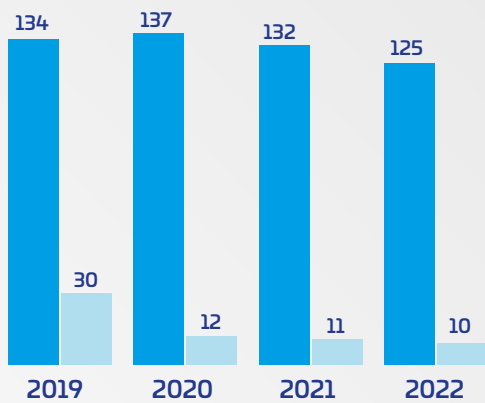
conditions. Due to these actions, we include Intersection Safety as a new use case group reflecting, for example, the prospective China NCAP categories of 'red light violation warning' and 'intersection collision warning' by 2025. While there is no near-term prospect for V2X in the US NCAP, there is a strong focus on intersection safety in this region.
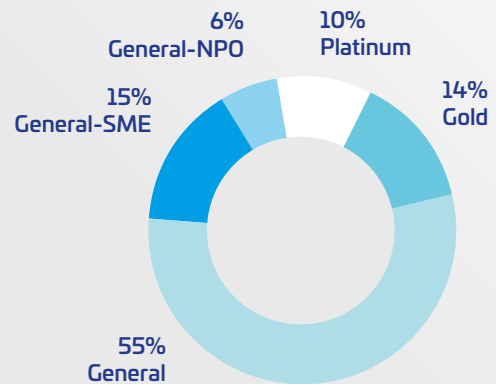

Expected timelines for mass deployment of C-V2X use cases

		2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Advanced Safety Automated Driving (Step II)	2026								Non-analyzed Sensor Signal Sharing	5G		Dynamic Intersection Management / Dynamic Cooperative Traffic Flow	
Advanced Safety Automated Driving (Step I)	2026		lte	Automated Valet Parking / Campus / Local Area / Tele-Operated Driving	5G			Automated Valet Parking / Data Sharing of Dynamic Objects		VRU+ Complex Interactions / Tele-Operated Driving for AV / Cooperative Maneuvers	5G	
Safety - Traffic Efficiency	2021			Basic Safety	Intersection Safety	VRU: Collective Awareness				Group Start Collaborative ACC	lte / 5G	
Traffic Efficiency - Safety Related	Market Take off 2020	2016	Local Hazard and Traffic Information	Hazard Information Collection and Sharing (suitable for AVs)	Data Collection and Sharing for HD Maps					lte / 5G	
3GPP Specification Release Date	3GPP Release 15	3GPP Release 16	3GPP Release 17	3GPP Release 18								

▼ 3GPP Specification release   ▼ In series-production   In-vehicle commercial mass deployment   ☐ Direct   ☐ Network   ☐ Direct or network   ⊕ Direct and network

Note:
Size of Use Case Boxes driven by design restrictions
in-series-production indicators will be updated as publicly announced

5GAA **membership**

Overview membership*

Member Campanies (119 total)

	2019	2020	2021	2022
All members	134	137	132	125
New members total	30	12	11	10

■ All members as of Dec 31, 2022
■ New members total

Membership category

- 6% General-NPO
- 10% Platinum
- 15% General-SME
- 14% Gold
- 55% General

Regional split

Americas
24% — **29** Companies

Europe and Middle East
45% — **53** Companies

Asia-Pacific
31% — **37** Companies
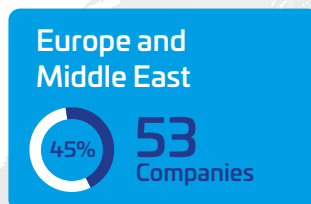
119 MEMBERS IN 2022

Membership survey trends

Overall perception of 5GAA

Legend: ■ 2020 ■ 2021 ■ 2022

Member focus: 4,0 / 3,9 / 3,9
External reputation: 4,2 / 4,1 / 4,1
Technical expertise: 4,4 / 4,2 / 4,3
Driver for ecosystem innovation: 4,0 / 3,8 / 3,8
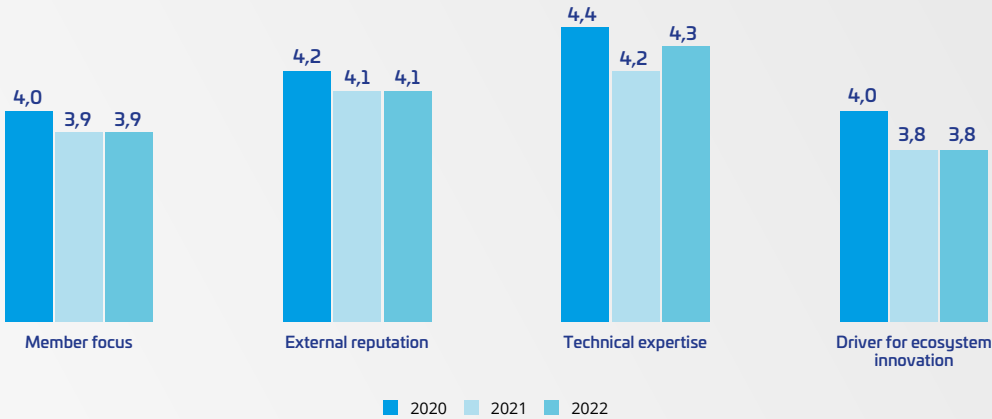
Based on yearly surveys of 5GAA's membership, the overall perception of the association (out of a maximum score of 5) is very good across the categories shown, but particularly high for 'technical expertise', with a slight rebound after COVID19.

A slight drop-off in perceived value is noted coinciding with the COVID-19 period, especially 2021-2022.

Overview MoU and new partners

* Liaison without formal agreement yet

Partnerships with organizations

Throughout 2022, 5GAA committed to enhancing its collaboration with partner organisations across the world. These partnerships are a crucial factor in 5GAA's efforts to promote the C-V2X ecosystem in Europe, the US, and Asia.

Our consistent and transparent communication with standard (e.g. ETSI, 3GPP, SAE, C-SAE) and certification (e.g. OmniAir, GCF) organisations has led to significant exchanges of information, know-how and developments in testing activities on the different continents.

Moreover, 5GAA is further enhancing its collaboration with other industry stakeholders.

5GAA and Arizona's Institute of Automated Mobility (IAM) signed a memorandum of understanding (MoU) in October 2022 to cooperate in areas of common interest, such as digital road infrastructure and connected mobility. In the same month, 5GAA concluded an MoU with the US-based National Electrical Manufacturers Association (NEMA), with whom it works together on connected vehicle infrastructure topics.

5GAA signed a cooperation agreement with another partner of 5GAA in the US, the American Traffic Safety Association (ATSSA), aiming to collaborate on studies related to C-V2X benefits to traffic and work zone safety.

Finally, 5GAA is pleased to work closely with the Crash Avoidance Metrics LLC (CAMP), a partnership providing a framework for pre-competitive crash avoidance research to improve real-world safety by defining elements of automotive crash avoidance countermeasures and accelerating implementation to improve traffic safety.

IAM MoU Signing – Los Angeles, 2022

NEMA MoU Signing – Los Angeles, 2022

ATSSA MoU Signing – Atlanta, 2022

ESA MoU Signing – Bremen, 2022

5GAA The Hague, February 2023

5GAA cooperation with road operators

Road operators and regulatory bodies play a vital role in the mobility ecosystem as they lay the groundwork for strategic public partnerships. 5GAA takes pride in its strategic collaboration with road infrastructure operators, with which it seeks to deepen dialogue to advance an ambitious and purposeful technology deployment vision. In this context, the 5GAA Board decision calling for the next C-V2X roadmap to also reflect road operators' deployment strategies is a key objective in 5GAA's ongoing engagement with public authorities.

To build the next C-V2X deployment roadmap that will reflect both road operator needs and the industry vision, 5GAA is pursuing closer engagement

with road operators globally. In April 2022, 5GAA organised a workshop with local and regional infrastructure owners and operators in Atlanta, Georgia, focused on the safety and mobility benefits of C-V2X, and a demonstration of such applications at the Peachtree Corners Curiosity Lab and Infrastructure Automotive Technology Laboratory (iATL). In October, 5GAA organised meetings with European road operators at the DEKRA centre in Malaga, Spain to align actions towards achieving the technology deployment 2030 Roadmap for demonstrating connected V2X applications.

5GAA supports public authorities in their pursuit of regulatory certainty while

deploying connected infrastructure. Specifically, 5GAA welcomed and supported numerous requests from US infrastructure owners and operators asking to be granted authority to deploy C-V2X in the 5.9GHz band following the private-public Joint Waiver Request at the FCC i n December 2021.

5GAA submitted comments and replies to the FCC highlighting the broad public and private commitment to deploying C-V2X infrastructure and allowing the operation of C-V2X in the 5.9 ITS band for various safety applications. Similarly, in South Korea, 5GAA welcomed the National Radio Agency's new rule to allow LTE-V2X operations in the 5.9GHz band.

Enabling **C-V2X deployment**

Overview of the top key highlights in relation to deployment in each region

Audi joins Spoke Safety, Qualcomm and Commsignia to help protect cyclists through connected technology

© Audi of Americas

BMW is introducing America's first 5G Connected Cars with T-Mobile's Magenta drive

© Forbes

Stellantis deploys connected Jeep for V2X trial in Virginia, USA

© Stellantis

SAE publishes series of C-V2X US application standards

© SAE International

Vodafone la
improve roa

Commsignia OBU and RSU get EU RED certificate

Quectel Announces C-V2X Module AG18 to Enhance Driving Safety and Efficiency

...unches platform to ...d safety in Europe

Ford C-V2X Tech Spreads in China amid connected services push

Green lights for emergency vehicles with Ford's intelligent traffic light system

Hyundai Mobis targets the future mobility market with its integrated 5G V2X solution

Autotalks unveils world's first V2X chipsets which support 5G-V2X for collision avoidance

Two new mass production Chinese models powered by Autotalks' V2X solution as of 2023

Murata Announces Advanced V2X Solution already been selected for integration by a major vehicle manufacturer

Cohda launches dual-mode and 5G-ready MK6 Road-Side Unit (RSU) and On-Board Unit (OBU)

5GAA live demonstrations

C-V2X technology revolutionises the mobility ecosystem and how drivers interact with the world, making smart cars a reality today. These cars communicate with their surrounding infrastructure, be it other cars or vulnerable road users, while providing a better driving experience.

5GAA is at the forefront of redefining transportation, by providing real-time, reliable, and actionable information flows to enable safety, mobility, and environmental applications – innovative tracks reinforced thanks to 5GAA's partnership and collaboration with 3GPP.

Innovations such as 5G-V2X direct communication, edge computing, and non-terrestrial networks prove that the technology is constantly evolving. This is the right moment to leverage existing C-V2X developments and keep expanding functionalities, building up the infrastructure, and improving the reliability of the use cases.

Atlanta Live Demonstrations
May 2022

In May 2022, the 5G Automotive Association (5GAA) came together in Atlanta for a workshop on "C-V2X: Ready to Deploy", followed by a series of live C-V2X demonstrations.

The demos took place in two different locations, the Alpharetta Infrastructure Automotive Technology Laboratory (iATL) and the Peachtree Corners Curiosity Lab, and were open to local authorities and the broader ecosystem stakeholders.

Our members showcased cellular vehicle-to-everything services and devices using cellular networks, for a wide range of applications

Participating members

Malaga Live Demonstrations
October 2022

Smart mobility technology is a reality today, with 'Cellular Vehicle-to-Everything' (C-V2X) allowing connected vehicles to communicate with each other and their surroundings in order to take a step forward in transport safety.

Deployment plans are primarily sustained by the global trend in the automotive industry to adopt 4G LTE cellular technology, followed by the emerging 5G high-speed low latency communications. Beyond infotainment, C-V2X will capitalize on vehicular and smartphone connectivity to contribute to better safety, less congestion and reduced emissions.

During a live demonstrations event in Malaga, the 5G Automotive Association (5GAA) showcased ready-to-deploy use cases and a sneak preview of what the future has in store on the DEKRA test track, with a focus on vulnerable road users (VRUs).

Prominent members and partners of the 5GAA including Dekra, Audi, Huawei, Intel, Vodafone, Nokia, Deutsche Telekom, Continental or Ericsson, demonstrated the current state of C-V2X and the road to the future, and how V2X communication will pave the way to transport safety for vulnerable road users (VRUs). These solutions already deliver immediate, anonymous safety alerts, even outside of the range of visual sight.

Seventeen (17) live demonstrations were shown to the media, with representatives of our members being available for questions.

Participating members

Contributing to standardization enabling technology deployment

Global standards (input to 3GPP)

5GAA continues to act as a respected Market Representative Partner (MRP) of 3GPP.

In November 2022, 5GAA jointly organised and moderated the 5G Vertical User Workshop (online) together with other 3GPP MRPs. 5GAA strategically contributed to specific study items of 3GPP.

For example, 5GAA has submitted proposals for new features and requirements to 3GPP RAN and SA Release 18 workshop, and mapped the relevant study items to 5GAA priorities. The work on Rel-18 is ongoing with several items identified and addressed to 3GPP, while the preparation for the upcoming Release 19 and 5GAA's input is already underway.

One of the first objectives of 5GAA is to provide continuous automotive guidance to telecommunication standards organisations (SDO). 5GAA has developed a standardisation strategy to interact with multiple SDOs, provide its know-how, and meet the standardisation needs of the association's own internal work. This process resulted in tight cooperation with multiple standardisation bodies all over the world.

Regional standards (ETSI, SAE, C-SAE)

5GAA is also contributing to regional standardisation bodies, having secured key partnerships in Europe (ETSI), Asia (C-SAE) and North America (SAE).

5GAA has collaborated extensively with ETSI regarding its new Work Item on Automated Valet Parking (AVP), providing targeted input based on the extensive work already completed within 5GAA on the AVP Use Case. Furthermore, 5GAA contributed to ETSI MEC on potential enhancements to MEC VIS API and on abstracted network information for industries. Lastly, 5GAA is also closely monitoring and engaging on the latest updates on harmonised standard EN 302 571, SRDoc for channels >10MHz, and coexistence between road ITS technologies.

5GAA has been in continuous contact with C-SAE, monitoring and interacting with relevant V2X standards in China. A significant deliverable from 5GAA was completed in 2022 regarding C-V2X standardisation in China. The technical report of the work shed light on the typical C-V2X-related standardisation organisations and industry alliances in China comprising stakeholders from ICT, automobile, transportation and traffic management industries. It analysed their working scope, main role, list of ongoing standards, etc. to help prioritise 5GAA input.

5GAA is closely engaging with SAE in North America as well. With the initial publication of the J3161 family of standards [1-3], the V2X industry received the necessary information to begin deployment of V2X systems based on LTE-V2X. However, the work in SAE began over four years ago, so the ITS industry now has the opportunity to examine the deployment profiles of the J3161 family and provide recommendations to extend, improve, and clarify the documents as needed. 5GAA has produced two technical reports (WI 4WARD I & II) recommending enhancements to the minimum performance and configuration profiles defined in SAE's J3161 family of standards.

Specific bodies and certification

Working Group 3 (WG3) was involved in a Connected Vehicle Work Stream (CVWS) with the Global Certification Forum (GCF), which has developed in conjunction with 5GAA a certification programme aimed at meeting the needs of the automotive industry as it manages the growth of connected vehicles and infrastructure across the world. The CVWS is meant to enable compliance assessment for the connected vehicles industry. Its scope includes 3GPP C-V2X technological standards on which the certification programme is also based. 5GAA's collaboration with GCF is continuing in 2023 by working together on understanding and meeting the needs of the automotive industry when it comes to testing for C-V2X technologies.

Another 5GAA MoU partner with whom WG3 has collaborated is the OmniAir Consortium – a US-based association that promotes the certification for connected vehicles and interoperability across vendors and operating systems. Many of OmniAir's core members are also 5GAA members, something that has significantly facilitated joint efforts on test control interfaces and test specification parameter issues. Moreover, the Joint Task Force established between WG3 and OmniAir has continued its efforts in harmonising testing and certification across the regions.

Leveraging **innovative solutions** to advance connected mobility

Work Programme Overview

From January to December 2022 , there were 22 active Work Items, out of which 16 were completed in 2022. This led to 19 approved deliverables in the form of technical reports, white papers, and position papers. During the same period, 11 new Work Items were launched.

In 2022, the 5GAA Work Programme integrated the new priority areas. This proved very important in giving a comprehensive structure to our overall work on services and solutions helping to define the use cases on which 5GAA operates. In this category, descriptions of the roadmap and use case implementation and maintenance played an essential role, helping to justify the work split between digital roads, digital vehicles, and digital users.

In the 'digital road' category, 5GAA worked on bridging the gap with road operators and looking at the tolling opportunities with V2X. In the 'digital vehicle' category, we investigated how 5G-V2X would change the design of V2X use cases using complex interactions. There was also substantial work on AVP, one of the automated driving use cases appearing closest on our roadmap. In the 'digital user' category, we

demonstrated how to protect VRUs with six independent demonstrations. In the underlying category of 'trust', we looked at misbehaviour detection, predictive quality of service (QoS), privacy, market pull, and user demands, as well as the design of a conformity assessment programme.

Finally, as a primary basis of our work, we investigated the use of satellite communication, edge computing across mobile network operators, and the communication profiles for the US LTE-V2X sidelink stack in the connectivity area. Further, we elaborated on how 5G should evolve to answer some of the automotive needs.

Key figures

22
active Work Items throughout 2022

16
completed Work Items

19
appoved deliverables

11
new Work Items launched

5GAA top achievements in 2022

The essential work on the roadmap heavily influenced the last two years of work programming and planning, in particular:

• The work done on AVP and other complex interaction use cases building the way towards a fruitful 5G-V2X deployment
• The work on VRU protection services as an essential part of the safety offering

• The reach out to the road operator community – trying to understand their needs and what we can realistically offer them
• The lengthy but essential work to understand how MEC will serve automotive needs
• The efforts to add non-terrestrial networks to the scope of 3GPP technologies

Work Items Results 2022

Distributed vehicular antenna systems

Distributed vehicular antenna systems are wireless communication systems that utilise multiple, strategically placed antennas on vehicles and infrastructure to enable reliable communication. The system mitigates the effects of signal attenuation and fading caused by obstacles in high-density environments. The antennas are connected to a centralised controller, which manages communication, selects the best antenna for a specific task, and adapts to changing environmental conditions. These systems are used in various vehicular communication networks to enhance safety, reliability, and efficiency.

USE CASE

Distributed vehicular antenna systems enable robust communication in dense urban environment s typically characterised by tall buildings and other obstacles that can cause attenuation and multipath fading, resulting in reduced signal quality and range between the vehicles and the infrastructure.

A distributed antenna system can address this challenge by strategically placing multiple antennas throughout the environment.

Consider an autonomous vehicle fleet operating in a dense urban area, which requires efficient and reliable communication with the surrounding infrastructure. In this case, a distributed vehicular antenna system could be deployed to facilitate high-quality communication by utilising multiple antennas installed on vehicles and other infrastructure elements.

These antennas would be linked to a centralised controller responsible for managing vehicle and infrastructure communication.

By using multiple communication paths, a distributed antenna system would extend the range and reliability of the communication. Additionally, the system would dynamically adjust the communication parameters based on the changing environmental conditions, such as obstacles or the number of vehicles in the area.

A distributed vehicular antenna system can provide a robust infrastructure for autonomous vehicles and other vehicular communication networks in high-density urban environments.

The Predictive QoS and V2X Service Adaptation

The Predictive QoS and V2X Service Adaptation (PRESA) is a technical framework developed by 5GAA to facilitate efficient and reliable communication between vehicles and the surrounding infrastructure. The framework is designed to adapt vehicular communication services in real time, based on the changing environmental conditions, to maintain the quality of service.

PRESA uses advanced technologies such as machine learning, artificial intelligence, and big data analytics to predict the communication network's performance and adapt vehicular QoS parameters in real time. The framework can optimise communication between vehicles and the infrastructure by providing efficient QoS adaptation, improving communication performance, and reducing latency.

It comprises several components, including a predictive analytics engine, a QoS adaptation engine, and a communication controller. The analytics engine predicts communication performance in real time. In contrast, the QoS adaptation engine adjusts the QoS parameters of vehicular services based on the expected performance to maintain efficient and reliable communication infrastructure. The communication controller coordinates the communication between the vehicles and the infrastructure, providing efficient and reliable communication based on the predicted performance.

The PRESA framework can be used in various vehicular communication networks, such as intelligent transportation systems, cooperative driving, and autonomous vehicles. The framework can significantly improve the efficiency, reliability, and safety of vehicle communication services by adapting the QoS parameters according to ever-changing environmental conditions.

USE CASE

One clear and illustrative use case for PRESA can be seen in the context of cooperative driving, which involves vehicles exchanging information with each other and with the infrastructure to improve safety, traffic flow, and fuel efficiency. The framework can enhance the reliability and efficiency of vehicle by predicting and adapting the QoS parameters of vehicle's communication services in real-time conditions.

For example, imagine a scenario where two vehicles are simultaneously approaching an intersection, and both want to make a left turn. The cars must communicate with each other and the traffic infrastructure to coordinate their movements and avoid collisions. The PRESA framework can predict the performance of the communication network based on traffic density, weather conditions, and other environmental factors, and immediately adapt the QoS parameters of the communication services to ensure that the communication between the vehicles and the infrastructure is efficient and reliable. The framework can also be used to adapt the QoS parameters of vehicular services based on the changing conditions.

For instance, if a vehicle is driving through an area with poor network coverage, PRESA can predict the network's performance and adapt the communication services' QoS parameters to ensure reliable communication is maintained.

In summary, the PRESA framework can improve the efficiency and reliability of vehicular communication services in the context of cooperative driving by predicting and adapting the QoS parameters of vehicular services in real time, based on changing environmental conditions.
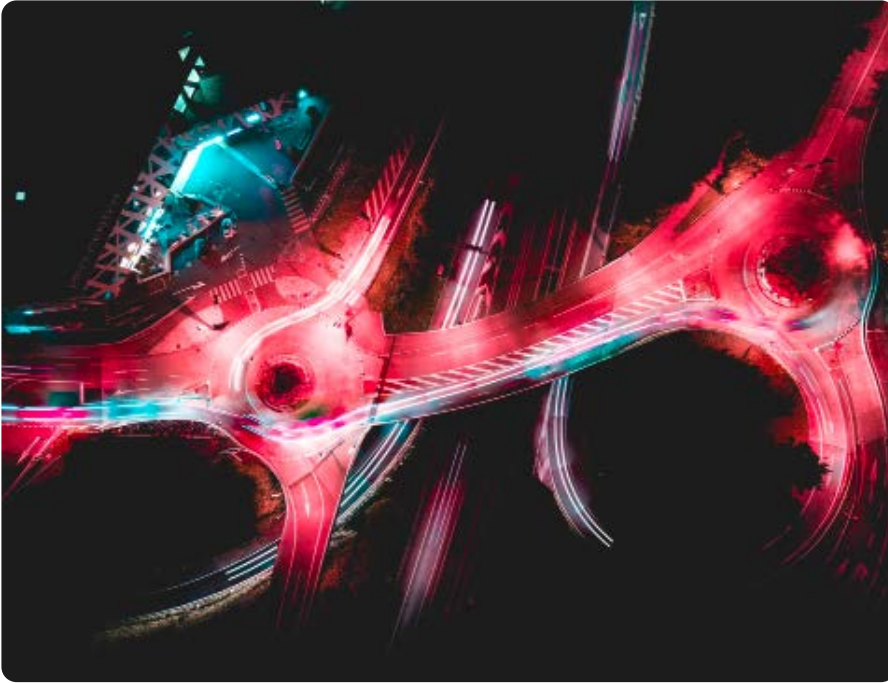
Misbehaviour detection

Misbehaviour detection is a framework developed by 5GAA to detect and mitigate malicious or unintentional misbehaviours in vehicular communication networks. The framework is designed to enhance the security and reliability of vehicular communication by detecting and isolating misbehaving nodes or vehicles in the network.

The 5GAA Misbehaviour Detection framework includes several components: a behaviour model, a detection module, and a response module. The first model identifies the expected behaviour of the nodes in the network and the characteristics of misbehaving nodes. Then, the detection module analyses the network traffic and identifies misbehaving nodes based on deviations from the expected behaviour. The response module takes appropriate action to mitigate the effects of misbehaviours, such as blocking malicious nodes or isolating malfunctioning ones.

USE CASE
The Misbehaviour Detection framework can be used to detect and isolate malicious nodes that attempt to interfere with the communication between vehicles or between vehicles and the infrastructure. For example, suppose a vehicle sends false data to the other cars in the network. In that case, the framework can detect this misbehaviour and block the malicious vehicle from the network, ensuring the safety and reliability of the communication.

Another use case for Misbehaviour Detection is in autonomous driving. In this case, the framework can be used to detect and mitigate the effects of malfunctioning vehicles or infrastructure elements that can impact the safety and performance of autonomous driving. For example, suppose a roadside unit is malfunctioning and sending erroneous data to autonomous vehicles. In that case, the framework can detect this behaviour and isolate the malfunctioning unit from the network, ensuring the safety of the autonomous driving system.

Conformity Assessment Strategy Evaluation (CASE)

Conformity Assessment Strategy Evaluation (CASE) is a framework developed by 5GAA to ensure the conformity of vehicular communication devices and services with established technical standards and specifications. The CASE framework provides guidelines for evaluating the performance and compatibility of vehicular communication devices and services with established standards and specifications.

The CASE framework includes several components, such as a test strategy, a test framework, and a test execution plan. The test strategy defines the objectives, scope, and requirements for the conformity assessment. The test framework provides a set of test cases and procedures to evaluate the performance and compatibility of vehicular communication devices and services with established standards and specifications. The test execution plan defines the schedule, resources, and procedures for executing the tests.

The framework also guides the evaluation of the conformity assessment results and the reporting of the test findings. Evaluating the results involves comparing the performance and compatibility of vehicular communication devices and services with established standards and specifications, and identifying any deviations or non-conformities. The reporting of the test findings includes:

▶ Documenting the test results.
▶ Identifying any deviations or non-conformities.
▶ Making recommendations for addressing any issues.

In summary, the CASE framework is a set of guidelines and procedures for evaluating the performance and compatibility of vehicular communication devices and services with established technical standards and specifications. The framework ensures the conformity of vehicular communication devices and services, enhances vehicular communication networks' interoperability, and improves vehicular communication services' reliability and safety.

USE CASE

An illustrative use case for the CASE framework is in the context of testing and evaluating the performance and compatibility of vehicular communication devices and services for autonomous driving.

As autonomous driving technology becomes more prevalent, ensuring that the communication devices and services used in autonomous vehicles conform to established technical standards and specifications is essential. The CASE framework can be used to evaluate the performance and compatibility of these communication devices and services with the established standards and specifications, ensuring that they function reliably and safely in a range of scenarios and environments.

For example, imagine an autonomous vehicle driving on a highway that needs to communicate with other vehicles and infrastructure to ensure safe and efficient driving. The CASE framework can be used to test and evaluate the performance and compatibility of the communication devices and services used in the autonomous vehicle, ensuring that they meet established standards and specifications for reliable and safe communication. Further, it can enhance the interoperability and reliability of vehicular communication networks and improve the efficiency of vehicular communication services.

Another use case for the framework when testing and evaluating the performance and compatibility of vehicular communication devices and services for smart transportation systems.

Intelligent transportation systems rely on seamless and reliable communication between vehicles, infrastructure, and other connected devices to improve traffic flow, reduce congestion, and enhance safety. The CASE framework can be used to evaluate the performance and compatibility of the communication devices and services used in smart transportation systems, ensuring that they meet established technical standards and specifications.

For example, imagine a smart traffic management system that uses vehicle-to-infrastructure (V2I) communication to monitor traffic flow and adjust traffic signals in real time. CASE can be used to test and evaluate the performance and compatibility of the V2I communication devices and services used in the intelligent traffic management system, ensuring that they meet established technical standards and specifications for reliable and efficient communication.

Thus, the CASE framework ensures that vehicular communication devices and services meet the needs of smart transportation systems, enhance the interoperability and reliability of vehicular communication networks, and improve the efficiency and safety of transportation systems.
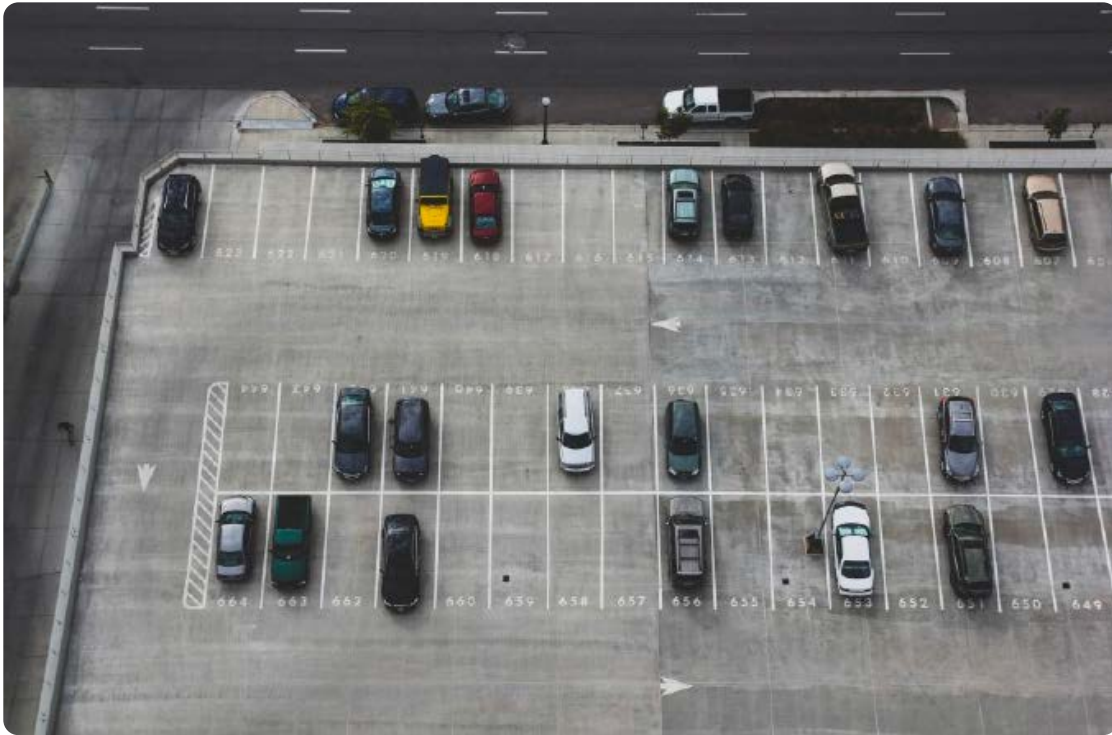
Automated Valet Parking

Automated valet parking (AVP) technology is a system that allows vehicles to park themselves in a designated parking area without the need for human intervention. AVP systems typically use sensor technologies, communication protocols, and control algorithms to enable vehicles to navigate to a parking spot, park themselves, and retrieve the vehicle when the user requests it. This technology can potentially increase efficiency, improve safety, reduce emissions, and enhance user experience in parking facilities. However, the successful implementation of AVP systems requires close collaboration between industry stakeholders, regulators, and policymakers, but also ongoing research and development efforts to address the remaining technical and regulatory challenges.

USE CASE
One potential use case worth mentioning for AVP technology is in public parking facilities. AVP systems can increase the efficiency of parking facilities by reducing the time required for drivers to find available parking spots and park their vehicles. AVP systems can also reduce the risk of accidents and collisions, as they are designed to avoid obstacles and other vehicles in the parking facility.

In addition, AVP technology can enhance the user experience by providing a more convenient and seamless parking process. Users can leave their vehicles at a designated drop-off point, and the AVP system will take care of parking the vehicle. When the user returns, they can request their vehicle through a mobile app or other interface, and the AVP system will retrieve the vehicle and deliver it to a designated pick-up point.

Another use case for AVP is in the context of mobility services such as ride-sharing or car-sharing. AVP technology can enable self-driving vehicles to park themselves in designated areas after dropping off passengers, freeing up the vehicle to pick up new passengers or return to a central location for maintenance. This can increase the efficiency of mobility services by reducing the time required for vehicles to find parking and enabling them to serve more passengers.

AVP technology can also reduce the need for human intervention in parking and retrieval processes, further streamlining the operations of mobility services. In addition, AVP technology can enhance the user experience by providing a seamless and convenient parking process for passengers, who can exit the vehicle and let the AVP system take care of parking.

Engaging policymakers
to design future-proof regulatory framework

In order to utilise the regional expertise available, 5GAA coordinates with the relevant authorities via the Working Group 6 regional sub-groups, namely: EU, US, China, Japan, and Korea, to ensure a regulatory landscape that is conducive to C-ITS deployment.

In this context, our association aims to support policymaking with expert technical knowledge and ensure a future-proof regulatory framework for the rollout of intelligent transport systems that support the needs of industry, and enable ongoing technological development and innovation, within each region and country.

EU

In Europe, 5GAA works closely with the European institutions, national governments, ministries and regional authorities to safeguard key principles, such as technology neutrality and the interoperability of different systems. We also raise awareness of the necessary infrastructural developments required to make connected and automated mobility a reality, such as well-functioning National Access Points (NAPs), the utilisation of non-terrestrial networks, and safe sharing of relevant data.

These efforts are best exemplified in the ongoing work surrounding the ITS Directive Revision, as well as on other key topics, e.g. ITS spectrum-related aspects or the EU connectivity satellite constellation (IRIS²). As a cross-industry, cross-national association , we are proud to be a trusted stakeholder among regional, national, and European public authorities, as well as a reliable ally among other stakeholders that share a common vision.

USA

In the United States and the Americas, 5GAA is supporting local and state departments of transportation with industry expertise on the benefits of C-V2X within their road safety policies and priorities.

Recognising that connected infrastructure is a pre-requisite for widespread ITS deployment, our association works together with our members to achieve regulatory certainty for both industry and road infrastructure deployers. As such, 5GAA is pleased to work together with transportation safety stakeholders and support road safety champions.

Asia

Finally, within China, Japan, and Korea, 5GAA provides advice on spectrum management for intelligent and connected transport services, with national policymakers and regulatory agencies. The membership driven regional groups have established their priorities for each of the regional Work Programmes for the next 12 months.

The WG6 China has published three technical reports providing status updates on relevant policies, standards, tests and verifications, and in the coming year will be looking at the large-scale deployment from pilot to (pre-)commercial LTE-V2X technology and increasing the number of organised collaborations that 5GAA has with relevant China-based organisations. WG6 Japan has been largely focused on spectrum management and the 5.9GHz assignment for ITS, work that continues as the top priority in 2023 while WG6 Korea has been instrumental in preparing 5GAA visit to Seoul in Q2 2023.

Internal and external
communications

Communication and positioning of 5GAA

Over the past four years, 5GAA has effectively raised awareness of the industry's need for C-V2X technology as the optimal solution to address the challenges of mobility and connectivity worldwide.

Authoritative voice in ITS

As the authoritative industry voice in ITS ecosystems, 5GAA has effectively raised awareness of the industry's need for C-V2X technology as the optimal solution to address the challenges of mobility and connectivity worldwide.

Profile-raising at events

5GAA Flagship events @ Mobile World Congress Barcelona and ITS Los Angeles

5GAA organised high-level panel discussions as part of larger tradeshows such as the Mobile World Congress Barcelona and ITS Los Angeles. Among the panellists, the association welcomed 5GAA members, representative of local authorities and road operators.

Recognition of 5GAA as an association
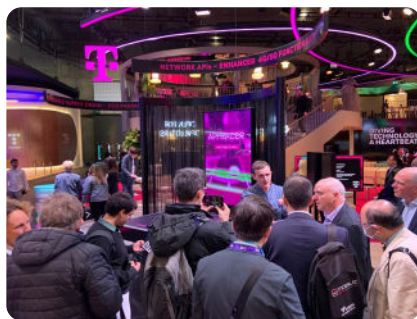
Successful PR events in Malaga, with over 400 media mentions
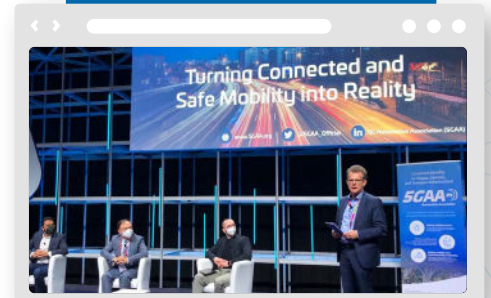
Close relationship with 150 preferred journalists across trade, mainstream and policy outlets: 11 interviews in 2022 with 5GAA representatives

5GAA positively mentioned in top general and specialized media

5GAA footprint in **worldwide media**

Press Tours

5GAA organised high-level panel discussions as part of larger tradeshows such as the Mobile World Congress Barcelona and ITS Los Angeles. Among the panellists, the association welcomed 5GAA members, representative of local authorities and road operators.

Increased member focus & enhanced internal communications to keep a growing community engaged and informed

> Equipped members to be ambassadors of 5GAA by creating marketing and communications tools including nearly 20 videos advocating for C-V2X technology across demos, use cases
> Communications, explainers and

meetings showcasing 5GAA in action
> Internal newsletter (every 6 weeks) to all member representatives
> Monthly 5GAA webinar campaign since Q4 2019 (both internal/ leadership and technical webinars)

KEY COMMUNICATIONS FIGURES 2022

21,344
followers on Twitter and LinkedIn combined
(journalists, industry experts, broader ecosystem and policymakers)

48,688
visits on 5GAA website

18
news items

13
publications

Growing 5GAA online presence

In 2022, 5GAA has registered a steady growth on social media platforms with over 21,000 followers on Twitter and LinkedIn combined. Our audience is composed of journalists, business analysts, policymakers, industry experts and the broader transportation and telecommunications ecosystem.

The 5GAA has been a reference for various stakeholders in 2022 and has leveraged in 9 studies, 3 white papers and 20 news items . At the same time, 5GAA issued 8 newsletters dedicated to its members or the road operators community.

The end of 2022 also reflected the finalisation of the new IT platform both concerning the members' area as well as the external website.

together we will pioneer the digital transformation
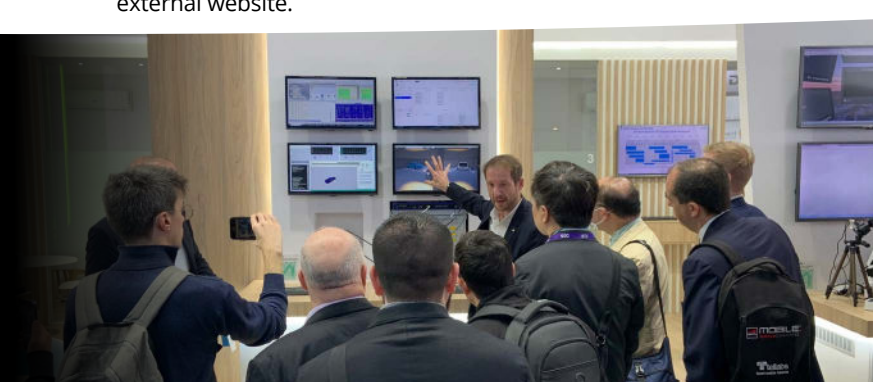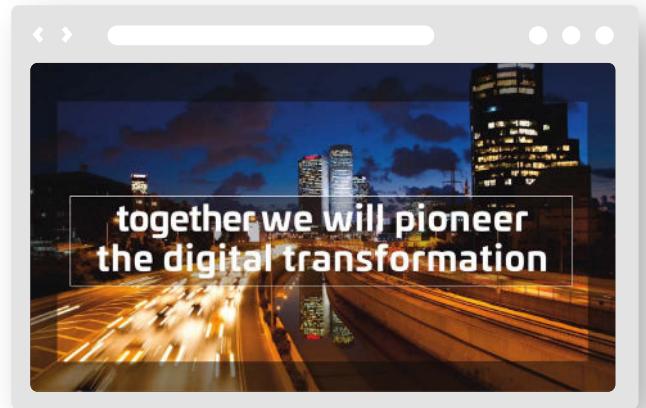
NOTES

The 5G Automotive Association (5GAA) is a global cross-industry organisation of companies from the automotive, technology and telecommunications industries, working together to develop end-to-end connectivity solutions for intelligent transportation, future mobility systems and smart cities. Since its creation in 2016, the Association grew to over 130 members whose mission is to develop, test and promote communication solutions, initiate their standardization and accelerate their commercial availability and global market penetration, to address society's connected mobility and road safety needs with applications such as automated driving, ubiquitous access to services and integration into smart city and intelligent transportation. For more information, visit 5GAA's website, LinkedIn and Twitter pages.