LEARNING THE LESSONS OF THE EUROPEAN ISA MANDATE

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James Hodgson
Principal Analyst

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EXECUTIVE SUMMARY

The inclusion of intelligent speed assistance (ISA) in the updated General Safety requirements (GSR 2) in the European Union came as a surprise to many automakers. Initially, many OEMs had not anticipated the key role that digital map layers capturing speed restrictions, working in tandem with active safety cameras to provide highly accurate determination of local speed limits. Once the essential role of maps had been identified, automakers then had to identify partners capable of building, maintaining and delivering the speed restriction map content across the entire impacted region, and over lengthy automotive lifecycles. Furthermore, the universal nature of the mandate required OEMs to deliver ISA functionality in all vehicle segments, including the most mass-market, cost sensitive model. This challenge is made more difficult by the rapid turnaround between the publication of the mandate and its first implementations, requiring automakers to devise ways of delivering ISA on existing platforms designed years before the role of location intelligence in ISA was known. While the difficulties of satisfying the ISA mandate have been significant, it is key that the automotive industry recognizes the long-term

role of map data and location intelligence as a key enabling technology. Many future automotive applications, such as certain NCAP ADAS and autonomous driving functions will also rely on map attribution.

Therefore, finding partners that are not only capable of delivering on the short-term ISA requirement, but which can also scale into new applications, multiple vehicle configurations (hardware, software and services) and into multiple regions, will be essential for automakers in the future.

INTRODUCTION

For decades, digital maps and location intelligence have played an important role in the automotive industry, providing route guidance and other navigation experiences to consumers, and opening up important avenues for automotive brand differentiation in the cabin. Now, automotive grade maps and location-based services are set to play a greater role in the driving experience and personal mobility in general, expanding out of the infotainment domain and into powertrain, active safety and autonomous driving.

An important catalyst in this transformation of the role of automotive digital maps is the ISA system, which is one of a number of active safety systems included in the updated GSR 2, which sets the minimum threshold for safety technologies equipped in new vehicles shipping in the EU. While many of the ADAS required by the updated GSR 2 are already commonplace, such as Autonomous Emergency Braking (AEB), ISA is set to jump from a niche technology to full penetration of new vehicles sold in Europe by mid-2024.

Therefore, automotive OEMs have been on a steep learning curve, learning important lessons about sourcing and scaling the fundamental technologies of a system that can identify local speed restrictions, with a high degree of accuracy, on a variety of road types, in multiple countries, and in a wide range of scenarios. In particular, the automotive industry has come to understand the key role that digital maps and location intelligence play as a quasi-sensor input supporting active sensors to robustly identify local speed restrictions, as well as developing scalable and efficient ways to deploy location intelligence across vehicles in every cost segment.

The rapid turnaround between the finalization of the ISA requirement within GSR 2 and the type-approval deadline of the first vehicles impacted by the mandate has frustrated many automakers. However, it is essential that no automaker view ISA maps as an inconvenient one-off. Rather, the automotive industry must recognize that digital maps and location intelligence will be a core technology for many future applications, ranging from Euro NCAP-assessed ADAS to Electric Vehicle (EV) range extension and highly automated driving. Therefore, automakers must select location intelligence partners with great care, opting for a platform capable of meeting the immediate ISA requirement, while also ensuring that it can scale to meet the wide range of location intelligence needs of future applications.

LESSONS LEARNED FROM THE ISA ROLLOUT

WHAT IS INTELLIGENT SPEED ASSISTANCE?

ISA is an active safety system designed to prevent accidents due to accidental speeding. The system identifies the local speed limit and communicates the speed limit to the driver. In contrast to standard road sign recognition systems, an ISA system also incorporates a mechanism to help the driver avoid accidental speeding. This can take the form of an auditory/visual warning to the driver in the most basic implementations or can include a mechanism to limit the vehicle's speed, only allowing the vehicle to exceed the speed limit when deliberate accelerating behavior is detected by the accelerator pedal. This allows the driver to retain the ability to accelerate away from a hazard.

INTELLIGENT SPEED ASSISTANCE IN GSR 2

ISA systems will be mandated on all passenger and commercial vehicles shipped in the EU, with a two-phase implementation process, impacting all new models shipping from July 2022, and all new vehicles shipping from 2024. The EU GSR 2 not only requires the fitment of ISA, but also sets the standard for how the ISA should perform in the field, mandating a certain level of accuracy, not only at the point of sale, but also throughout the vehicle's lifecycle. ISA systems are subject to a driving test to guarantee a minimum Quality of Service (QoS). The 400 Kilometer (km) to 500 km route must include highway, urban, and non-urban road types, with each road type accounting for at least 25% of the total distance. The system must be able to correctly identify the speed for over 90% of the total route, with an 80% success rate for each of the three road types. An ISA system scoring a passing grade must also be able to detect temporary speed limits (including digital signage), as well as implied speed restrictions that are not expressed in any visible signage. Finally, the system must be able to function properly across all EU member nations, accounting for all of the differing road signage formats and practices adopted by different countries.

WHY ARE DIGITAL MAPS ESSENTIAL?

Road Sign Recognition (RSR) systems have been a mainstay of camera-based active safety systems for many years, identifying the content of physical road signage and displaying this content to the driver via the embedded Human-Machine Interface (HMI). Some automakers expected that their pre-existing RSR systems would be sufficient to fulfill the ISA requirement of GSR 2, and were blindsided when camera-only systems proved effective only 50% to 60% of the time, falling well short of the 90% required pass rate.

Camera-only approaches to ISA fall short for the following reasons:

1. Many speed restrictions are implicit and are not accompanied by any physical signage. As such, there is nothing for the active sensor system to identify and display to the driver

2. Camera-based systems also struggle to identify conditional speed limits, for example speed restrictions with sub signage setting out the hours during which the speed restriction applies

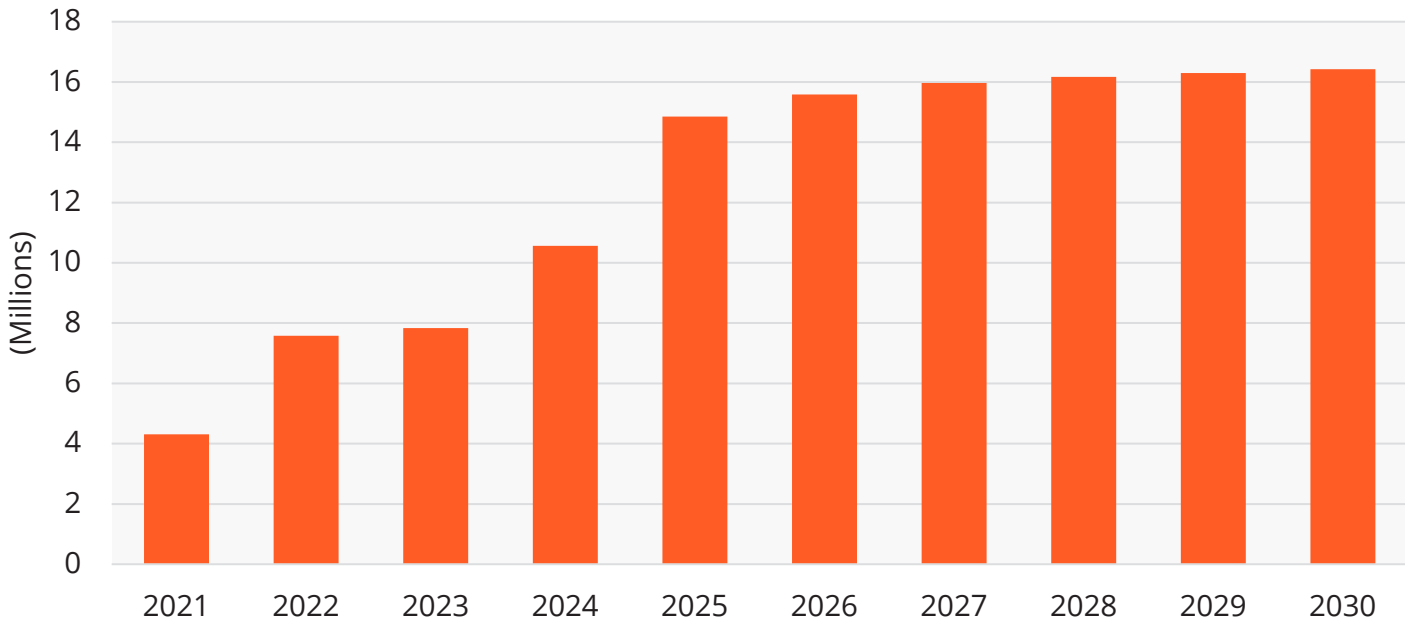
3. Camera sensors struggle to perform in poor lighting or weather scenarios, and are rendered completely ineffective in cases where the physical signage is occluded by hanging foliage, for example

Given the above weaknesses of camera-only RSR systems, a robust ISA requires a sensor fusion approach, supplementing the forward-facing camera with a map layer featuring road signage content, sub-signage content, and the implied speed limits, which constitute around 60% of all speed restrictions in Europe.

In order to operate as an automotive brand in Europe, an automaker must have an effective ISA system and, by extension, a location platform provider capable of delivering map content and location services to all vehicle segments in all impacted countries over a lengthy time horizon.

Chart 1: New Vehicles Shipping in Europe with ISA 2021 to 2030

(Source: ABI Research)



CHALLENGES FOR AUTOMAKERS

Deploying a safety technology with digital maps as an essential enabling technology presents automakers with a number of new challenges.

SCALING INTO ALL VEHICLE SEGMENTS

First, a mandate impacting all models means scaling map content and location services into all vehicle segments, including mass market, cost-sensitive models that have not yet been equipped with connected infotainment or navigation systems. These vehicles, therefore, lack the usual hardware footprint required for local map storage. While some ISA solutions host the application in the cloud or stream map content to a local cache, this approach will likewise require OEMs to deploy new connectivity packages in cost-sensitive models.

SCALING INTO MULTIPLE COUNTRIES

Second, a mandate impacting all EU countries means building a speed restriction map layer covering major and minor road segments in a wide variety of countries, including some countries that have only been partially served by navigation-grade content to date. Therefore, automakers need a location platform with comprehensive coverage today, and the ability to maintain and refresh this comprehensive coverage on an ongoing basis.

ISA LIFECYCLE MANAGEMENT

Thirdly, a mandate impacting the vehicle throughout its lifecycle means delivering updated map content for 14 years. Furthermore, this 14 year horizon for each individual vehicle in reality translates into far longer horizons for the automaker as a whole. This is due to the fact that each vehicle model will require at least 3 years development, and remain on sale for several years, with the last example of the model rolling out of the dealership carrying the 14 year lifecycle maintenance requirement. For most safety mandates in the past, fulfilling the mandate merely required one-off fitment of the enabling hardware at point of sale, with any maintenance burden falling squarely on the shoulders on the end consumer. In contrast, ISA systems are dependent on regularly updated map content, as approximately 10% of speed restrictions in Europe change every year. Therefore, OEMs need a location platform capable of updating map content and delivering this updated map content to maintain the effectiveness of the ISA solution.

Ultimately, the scale of the challenge has meant that some OEMs have not been able to turn around a GSR 2-compliant solution in time, and some models are having their launch delayed due to a failure to achieve type approval.

MORE THAN JUST INTELLIGENT SPEED ASSISTANCE

With the first phase of the ISA mandate now in effect, the automotive industry has learned a number of important lessons about deploying applications based on location intelligence, particularly about scaling these applications across multiple vehicle segments and regions. The factors that drive the need for maps in the ISA application include:

- A high accuracy requirement, demanding support for camera sensors
- Providing semantic insight on the scene in scenarios in which the camera sensors are compromised
- A need to anticipate road rules beyond the range of active sensors, and beyond occlusions (NLOS)

Clearly, these requirements are not unique to the ISA application, but apply equally to a number of other ADAS, highly automated driving, and powertrain optimization. Therefore, it is vital that automakers do not consider ISA maps a one-off inconvenience, but learn from the painful lessons of that last year to better leverage location intelligence in the future.

FUTURE AUTONOMOUS APPLICATIONS BUILT ON LOCATION INTELLIGENCE

EURO NCAP

Perhaps the most important factor that has driven the adoption of active safety/ADAS in recent years is the work of safety ratings agencies, such as Euro NCAP. Mechanisms like the five-star safety rating take complex safety systems and communicate their value to consumers in an efficient and easy to understand way, while standardized testing of active safety systems helps to disentangle variations in OEM branding. Around 70% of new vehicles tested by Euro NCAP are awarded a five-star rating, so any system that is either required or that contributes to a five-star safety rating is likely to be made widely available as a standard feature.

Over time, safety ratings agencies adjust the active safety systems considered. Newer systems are gradually introduced to the roadmap, as their enabling technologies scale and costs come down, and the number of points awarded for different systems is likewise adjusted. From 2023, Euro NCAP will begin awarding points for a number of new safety assist ADAS, including speed assist systems.

In total, a maximum of 40 points will be awarded for speed assist systems, including 20 points for accurately detecting and displaying and speed limits, 10 points for assessing upcoming road features, and a final 10 points for detecting local hazards. As with the EU ISA mandate, a minimum threshold is required in terms of geographic coverage (France, Germany, the United Kingdom, Italy, Luxembourg, Spain, the Netherlands, Sweden, and at least half of the Euro NCAP Application Area) and the number of roads where the functionality is available (>80% of public roads).

SPEED LIMITS

The specific testing protocols devised by EuroNCAP are carefully calibrated to encourage the development of safety systems that deliver real world benefits. This is evident in the testing of speed limits, where points are awarded for detection of conditional and implicit speed limits. Categories of conditional speed limits covered include weather, time, vehicle categories etc., while implicit speed limits are broken down into 3 categories – highway, city entry / exit and residential. As mentioned above in section [3.3], camera-only speed limit detection systems exhibit poor performance for conditional speed sub-signage, and virtually no performance for implicit speed limits.

Camera sensors are much better suited for detecting dynamic and roadwork speed limits, which are likewise covered by the Euro NCAP speed limit assessment and can also be determined by dynamic feeds from connected road signage or aggregated vehicle sensor data. Therefore, as with the ISA mandate, the Euro NCAP assessment criteria for speed limits rewards the use of camera and map data sensor fusion approaches.

ROAD FEATURES

The updated Euro NCAP protocols recognize the value of maps featuring attribution beyond speed restrictions, with 10 points available for the detection of curves, roundabouts, junctions, traffic lights, stop signs, yield signs, and no entry signs. These points are conditional on the pairing of road features insights with a secondary ADAS, such as Adaptive Cruise Control (ACC), to improve the safety of the secondary system.

LOCAL HAZARDS

While road features like road geometry are typically static, as well as most speed restrictions, the updated Euro NCAP also rewards coverage of more dynamic map layers, detailing the occurrence of local hazards, such as traffic jams, accidents, static vehicles2, and other items on the road. Once again, dynamic map layers are capable of detecting and identifying road hazards far beyond the range of a vehicle's active sensors, behind occlusions and around corners, improving the ability of vehicle safety systems to anticipate and respond.

Overall, there is significant cross over between the requirements of the ISA mandate and the 2023 Euro NCAP speed limit assessments, with Euro NCAP elevating and expanding the role of digital maps in active safety. Both Euro NCAP and GSR 2 place value on the role of maps as sensors to supplement active sensors, as well as lifetime maintenance/map updates to prevent accidental speeding in multiple scenarios and for many years. However, layering Euro NCAP assessment criteria on top of the ISA mandate expands the role of map-based ADAS from accurate determination of speed limits to anticipating changes in road geometry and dynamic road hazards.

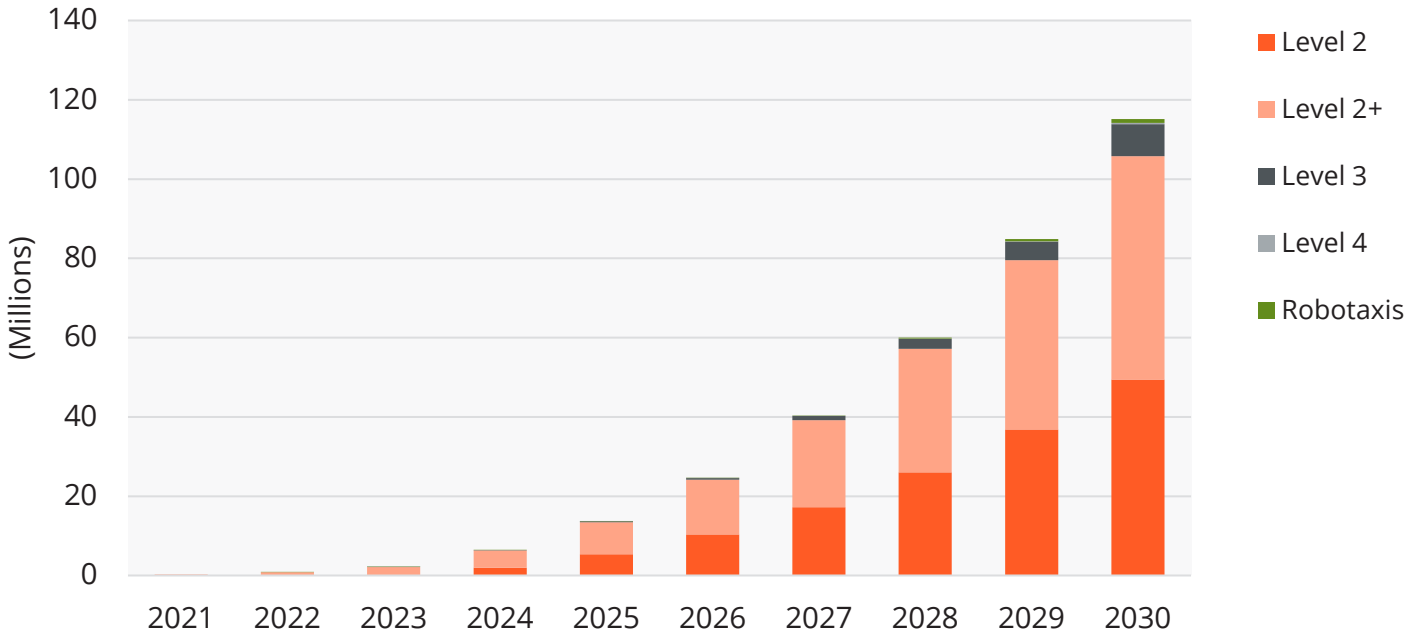
AUTONOMOUS DRIVING

Apart from a minority of small-volume sports vehicle manufacturers, all automotive OEMs are pushing to deploy increasingly automated driving experiences, covering a full spectrum of applications from supervised highway assistance to fully driverless robotaxis. Mapping and location intelligence plays a key role across the full range of semi-autonomous and fully autonomous applications.

As well as being widely employed in many of today's autonomous driving prototypes and fledgling commercialized autonomous vehicle products, the central role of maps and location intelligence in autonomous driving is increasingly being captured in the regulations and standards that will define the future direction of the autonomous vehicle market. For example, UN Regulation 79, which governs automated steering control functions, requires two different sources to define the operational design domain of the ODD, while the upcoming ISO 5083 standard includes definitions for reliable map attributes (RMAs) that can be safety relied upon by an autonomous driving system.

Chart 2: Vehicles in Circulation Using Autonomous Vehicle Maps/HD Maps Forecast, 2021 to 2030

(Source: ABI Research)



LOCALIZATION

The core application for autonomous vehicle maps is localization—positioning the vehicle within the environment model. In practice, this involves positioning the vehicle within the lane of travel, supporting onboard sensors in cases where lane markings are obscured, or providing essential inputs in contexts where the lanes of travel are implied, such as at intersections. The ability to position the vehicle relative to the known location of road features and road-adjacent features captured in the map attribution enables scalable, low-cost positioning of autonomous vehicles in the driving environment.

PATH PLANNING

Information on upcoming road geometry and elevation changes captured in the AV map can enable the autonomous vehicle system to better anticipate and account for bends, junctions, lane merges, and highway exits, delivering a smoother journey experience for the consumer. Capturing semantic details, such as typical driving speeds for different road segments, and typical acceleration / deceleration behavior in autonomous vehicle map layers can also help to make the autonomous driving experience more comfortable and familiar, easing adoption of autonomous features.

PERCEPTION

Sensor fusion has been widely adopted in active safety and autonomous driving, leveraging the mirrored qualities of different sensor types to improve overall perception. An up-to-date map with attribution detailing the location of static features such as street furniture (e.g. road signage, road boundaries and delineators, and traffic lights) can be correlated with the insights from on-board sensors. For camera sensors, this can increase the confidence of obstacle detection in poor lighting and weather contexts, while for low resolution radar sensors, map attribution can be the key to distinguishing between bridges and stationary vehicles on the road.

GEOFENCING

Every autonomous application is designed with a certain operational design domain (ODD) in mind – the environment in which the target features and level of driver disengagement can be safely delivered. Many of the factors that constitute this ODD, including lane geometry and speed restrictions can be captured in the HD map, and leveraged to ensure that the application is only available to the consumer when safe. As a typical journey is likely to move in and out of the semi-autonomous application's ODD, it is important that OEMs make adequate HMI provision for a safe handover back to the driver. In this context, live map data layers can provide valuable insight into the road and traffic situation at the anticipated handover point long before it comes into the range of the vehicle's embedded sensors, ensuring that a successful handover is executed long before the ODD is exited. For OEMs, ensuring safe use of their semi-autonomous vehicle applications through ODD geofencing will be key to maintaining the integrity of their brands, and to successfully building consumer confidence in what is still an emerging technology.

SCALING LOCATION INTELLIGENCE INTO NEW REGIONS, NEW VEHICLE SEGMENTS, AND NEW APPLICATIONS

The active safety and autonomous driving applications considered above are by no means exhaustive, but illustrate the rapidly expanding role of mapping and location intelligence in automotive, not only for long term ambitions like highly automated driving, but also for short term considerations such as EuroNCAP ratings. As maps expand into new vehicle domains, so the requirements of the map evolve, in terms of their attribution and time to reflect reality. Therefore, scalability is a key capability that automakers should look for in location platform suppliers, prioritizing partners capable of delivering on mandates and safety systems in a variety of vehicle segments and regions today, with the ability to enable richer attribution and faster time to reflect reality in future applications.

Table 1: How TomTom's Portfolio Supports Scalable ADAS Solutions

(Source: ABI Research)

		PACKAGES					
		Vehicles with Navigation or without Navigation					
		Connected or Not Connected Vehicles			Connected Vehicles Only		
		ADAS Maps	HD Maps	VH Onboard	VH Online	VH Streamed	Hazard Warning
USE CASES	Eco Routing	●		●	●	●	
	ISA	●		●	●	●	
	Euro NCAP	●		●	●	●	●
	Speed Control	●		●	●	●	●
	Lane Assistance	●	●	●		●	
	Automated Driving	●	●	●		●	●
	Geofencing	●	●	●	●	●	

SCALING INTO NEW REGIONS

The potential for maps and location intelligence to enable highly automated driving has spawned a number of startups and investments by dedicated autonomous vehicle software providers. However, it is important to recognize that location-enriched mobility is not a distant prospect or long term ambition – it is a reality for automakers today. Put simply, in order to sell cars in Europe, an automaker must have an ISA system. Therefore, current coverage of all impacted European markets is the minimum requirement for an effective location platform, as well as the required scale and bandwidth to capture changes in speed restrictions on all road types and in all countries on an ongoing basis for many years to come. Future applications will require the ability to capture deltas not only in speed restrictions, but in a much wider set of map attribution.

As such, the optimal location platform will have sufficient geographic reach today, plus the necessary investments in AI, sensor data aggregation and pipeline automation to enable sustainable expansion of the digital maps into new regions with the required freshness – a key consideration of global OEMs shipping to a variety of markets. TomTom currently has 7 million kilometers of ISA speed limits covered in the European market, covering some 98% of the most driven road classes, and 5 million vehicles in circulation use TomTom's ADAS location services, as of December 2021.

SCALING INTO ALL VEHICLE SEGMENTS

One of the biggest challenges that OEMs have faced when addressing the ISA mandate has been the need to deliver innovative technology in the most cost-sensitive vehicle segments. Historically, ADAS are introduced on premium vehicles and filter through to more mass-market models as the enabling technologies scale and come down in price. The problem of delivering ISA in cost-sensitive models will be further complicated from July 2024, when existing vehicle designs conceived before GSR 2 requirements were finalized will need to feature ISA for type approval.

Every vehicle platform is different, varying according to hardware footprint (memory, local compute resources, infotainment specification) and connected services packages. Typically, global OEMs will have multiple sub brands and models within those brands stretching all the way from low volume, high margin premium vehicles through to mass market, cost-sensitive vehicles. Therefore, automakers operating a variety of vehicle platforms need an equally varied set of GSR 2-qualified ISA solutions, accommodating for differences in vehicle hardware, software and services configurations.

TomTom has developed a package of location intelligence assets combining the map data, location services and virtual horizon software engines required to deliver ISA functionality across a wide range of vehicle configurations, accommodating for a broad spectrum of hardware footprints and connectivity packages.

UNCONNECTED VEHICLES WITHOUT NAVIGATION

The biggest challenge facing automakers when delivering on ISA is the inclusion of highly cost-sensitive models in the mandate, particularly vehicle platforms without navigation or connectivity.

In these contexts, TomTom's static ADAS ISA map data and Virtual Horizon Onboard can be stored locally, likely on a dedicated ECU added to satisfy GSR 2 requirements. Map updates can be addressed via USB.

UNCONNECTED VEHICLES WITH NAVIGATION

For vehicles with navigation system but no connectivity, TomTom supports customers with static map data that can be co-located with the navigation map data storage, Similarly, the navigation system can also host the Virtual Horizon Onboard software to enable the ISA functionality without the need for connectivity. This integration path enables automakers to take advantage of pre-existing hardware resources in the vehicle in order to minimize the additional costs incurred when delivering ISA.

CONNECTED VEHICLES WITHOUT NAVIGATION

Connectivity gives OEMs more avenues to address ISA mandates or additional EuroNCAP goals, both in terms of where the necessary map data is stored, and where the enabling Virtual Horizon application is executed. TomTom ADAS static map data can be stored locally within the vehicle on active safety ECU, with map updates delivered over the air. This ECU can also host the Virtual Horizon Onboard application. Alternatively, if the automaker is looking to deliver ISA functionality on models with a leaner hardware footprint, Virtual Horizon Online enables position matching on maps stored in the TomTom cloud. For vehicles with modest hardware footprints capable of supporting a local cache map data, Virtual Horizon hybrid offers a blend of TomTom's onboard and offboard capabilites

Finally, embedded vehicle connectivity also enabled access to TomTom Dynamic Data, such as dynamic speed limits and hazard warnings, which are key ingredients in securing EuroNCAP points under the new protocols.

CONNECTED VEHICLES WITH NAVIGATION

For vehicles with both connectivity and navigation, OEMs have a wide range of integration paths for ISA functionality. All of the TomTom products above can be leveraged by the automaker according to their strategic preference to leverage either the embedded hardware capabilities of their vehicles or the reach of their connected car services.

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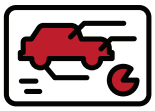
HYUNDAI MOTOR GROUP

CASE STUDY: TOMTOM AND HYUNDAI MOTOR GROUP

In September 2022, TomTom and Hyundai Motor Group announced that TomTom's map and traffic data connected services packages would be featured on whole vehicle lineup – an expansion of a partnership that began with the Genesis brand into Hyundai and Kia models. In addition to the core navigation use case, TomTom's map data will also be leveraged in ADAS applications, including ISA and a Level 2 Highway Driving Assistant (HDA). Specifically, map data on speed restrictions will enable the semi-autonomous application to automatically adjust for upcoming changes in speed limits, and to slow down in preparation for transition ramps and road curves.



SCALING INTO MULTIPLE APPLICATIONS

The future requirements of location-enriched mobility are stretching today's definition of an automotive map almost beyond recognition. There is no one size fits all off the shelf solution capable of addressing every safety, powertrain, navigation, and autonomous driving application. As such, modularity and scalability in map content delivery is essential to ensure cost effective delivery.

For example, TomTom offers separate products for static and dynamic ADAS data, helping OEM customers to incorporate the enabling location technology component at the minimum possible cost.

SUMMARY AND CONCLUSIONS

The ISA mandate is just the beginning of a new era of location-enriched mobility, where map content and location services will improve the efficiency and safety of passenger vehicles. Therefore, it is essential that automakers learn from the mistakes and challenges of the last 18 months to ensure that map data and location intelligence can be scaled into new regions, platforms and applications. One of the key lessons that emerging from the recent ISA mandate is the relationship between flexibility and scalability, with no one size fits all solution capable of accommodating for the variations in hardware and connectivity capabilities of the hundreds of models on sale across the world.

Automakers need location intelligence partners with platforms that have the existing scope to satisfy short terms ISA requirements, the ability to deliver on the map attribution and time to reflect reality associated with future applications, and a flexible set of products spanning the full spectrum of vehicle configurations and capabilities.

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157 Columbus Avenue

New York, NY 10023

+1.516.624.2500

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