

Location Benchmarking Report 2023

Report Snapshot

In TechInsights' annual benchmark of global location companies HERE continues to lead across most domains, followed closely by TomTom and Google.

This annual benchmark report compares Google, HERE, Mapbox and TomTom across capabilities like map-making and freshness, meeting automotive and non-automotive industry needs, visualization, the ability to appeal to developers, and sustainability.

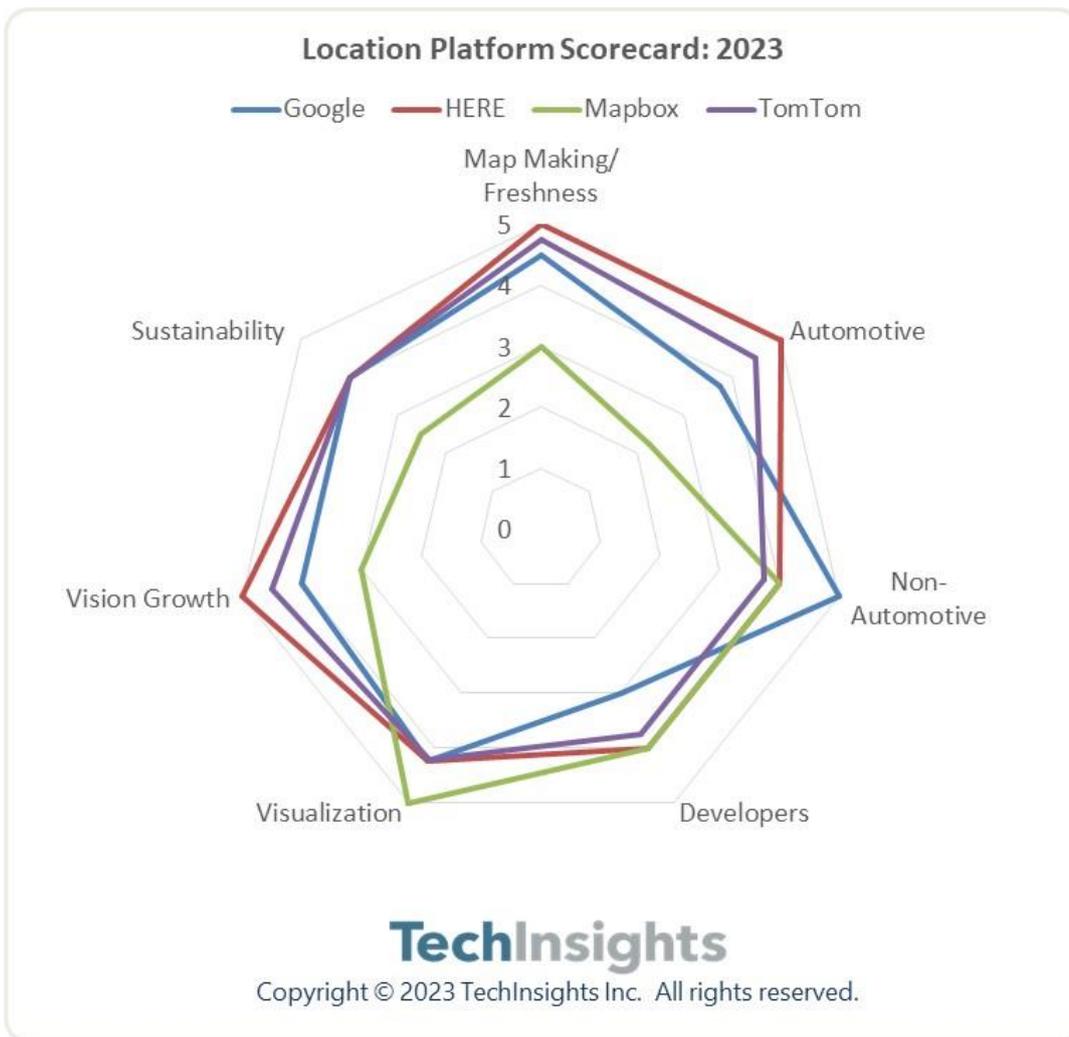
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1. Executive Summary

Enhancements to map-making and map-maintenance processes of global location vendors took center stage during the last 12 months, as Google, HERE and TomTom each launched new maps and platforms that will form the foundation for their future growth.

- Google announced the availability of a HD Map to support ADAS requirements like intelligent speed assist (ISA), HERE introduced UniMap, and TomTom an open standard collaboration with Amazon Web Services, Meta, and Microsoft.



In the 2023 TechInsights' location-platform benchmarking report HERE ranks as a leader and co-leader across many of our seven categories and is followed closely by Google and TomTom, and then Mapbox.

- TechInsights annual benchmarking ranks the location platforms, Google, HERE, Mapbox and TomTom across the following seven categories: Map-making and freshness, automotive, non-automotive, developer community, openness and flexibility, industry vision/ growth and environmental sustainability.
- HERE is a leader in map-making, automotive and industry growth vision. It also scores highly in non-automotive, developer community and visualization. HERE is a leading location content provider to the automotive sector, including ADAS and HD content. HERE has maintained momentum in non-automotive growth across target sectors, e.g. transport and logistics, and mobility, among others. The key pillars of HERE's growth strategy remain partnerships, an open, multi-platform approach, and innovation.
- Google is a joint leader in supporting non-automotive use-cases and sustainability, and scores strongly in map-making/ map maintenance, visualization, and industry vision. Google has made strong progress in automotive. It has a HD Map and has unbundled Google Automotive Services from its Android Automotive OS. Limited flexibility and independence continue to weigh on Google's mapping and developer scores. Google has significant resources, tech leadership, and a strong consumer and developer brand in location services as key strengths.
- TomTom remains ahead of Google in map making. Its ability to leverage Overture Maps positions it well in future. It is a joint leader in sustainability and has strong industry vision. It continues to improve in visualization, and developer community. TomTom remains a strong player in both automotive and map making. TomTom maintains leadership in traffic.
- Mapbox remains a leader in visualization and a co-leader in developer community and non-automotive use-cases. Mapbox's reliance on OpenStreetMap (OSM) and probe data enables it to provide map coverage at scale with low cost. However, community mapping lacks scale, consistency, quality assurance and provenance to satisfy all needs. Mapbox has made some progress in automotive, with GM, Toyota, and Rivian as highlights. Mapbox also has broad range of customers across other sectors, including Snapchat, Strava, dpd, and Grubhub and Tableau.

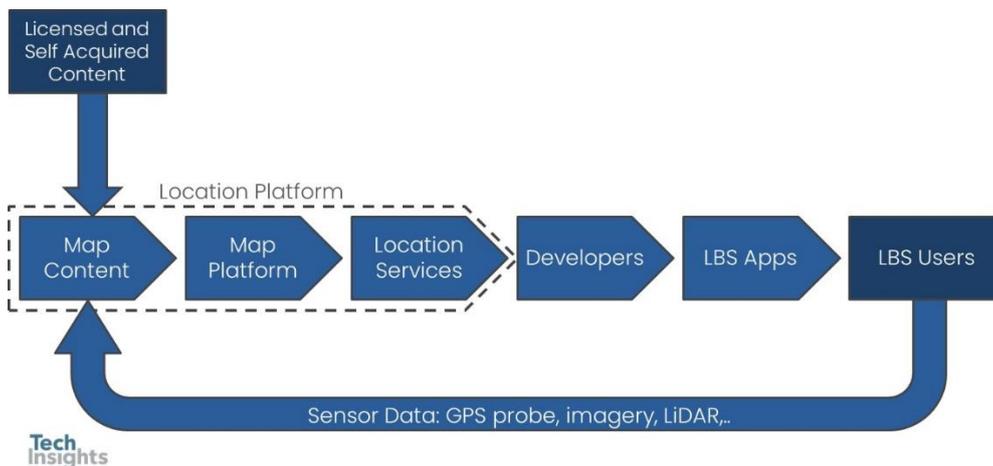
2.Introduction

Location Platform Definition

TechInsights defines a location platform as a company which provides customers with map data and access to a range of location services including digital map tiles, geocoding (converting street names into coordinates and vice-versa), traffic-optimized routing, local businesses, or points of interest (POIs) search, traffic flow and traffic incident information, and more.

Location platforms enable enterprises and long-tail developers to integrate these horizontal location services into their own apps and services, so developers need not invest their own resources in building and maintaining their own maps and common location service capabilities, Exhibit 1.

Exhibit 1 Location Based Services Value-Chain



Location-based applications and location services are usually underpinned by a map and supported by geolocation information provided either automatically via positioning technology like GPS, cell tower/ Wi-Fi signal triangulation, or manually (e.g. postcode input). Location platforms also provide tools for businesses, organizations, and developers to customize these location services to meet their needs. For example, from modifying the style of the map tiles or emphasizing specific details such as railway lines or public transport routes through to fully customized integration of location services into their own apps.

With the proliferation of sensors and live camera feeds (from vehicles and smartphones), location platforms enable enterprises and developers to integrate first-party data and third-party data with map content and location services to create their own custom maps, data visualizations, or unique location insights. For example, a real-estate agent comparing average property prices across a town or city, or retailers mapping cell tower or GPS data traces to identify high-footfall locations within towns. Location platforms can deliver solutions off-the-shelf or on a custom basis depending on customer needs.

Map Making & Maintenance Evolution

Map making continues to evolve towards the near real time capture and publication of reality in sub-meter detail and context with increasing automation and reliability.

The proliferation of sensors, connectivity, [computer vision](#) and both edge and cloud (ML/AI) processing are all playing an important role in the collection and interpretation of data at scale. This data is used to create highly accurate maps with sub-meter precision which can be refreshed on an on-going cadence. So too is the falling cost of acquiring high-definition imagery, lidar, GPS probed data and other map data inputs. These highly detailed and attributed maps support a variety of increasingly sophisticated use cases, delivering precision, freshness, and accuracy to drive competitive advantage for companies which use them.

Map making and map maintenance is complex and requires significant investment and expertise in acquiring, extracting, and orchestrating flows of different datasets and content at scale. Only a handful of companies, including Google, HERE, TomTom and Mapbox, have the capabilities and resources to make and maintain maps at a global level. Over time, map making techniques have become increasingly sophisticated, automated, scalable, and cost effective. Machine Learning (ML) and Artificial Intelligence (AI) assists greater levels of automation in mapping. Modern map-making and maintenance require normalizing, combining and conflating data from many different sources, each with pros and cons. Sources include imagery and data captured by mapping vehicles, satellite, planes and drones, crowdsourced data (including manual edits and photographs), GPS probe data, and in future inputs from a broad range of IoT sensors. Imagery from low earth orbit satellites will also assist. Some of the pros and cons of each approach (though not

exhaustive) have been outlined in our [previous report](#).

Since our previous report TechInsights notes that location platforms HERE and TomTom continue to report a significant increase in the volume of real time imagery captured by cameras installed on fleets. Additionally, in December 2022, AWS, Meta, Microsoft, and TomTom announced the creation of the Overture Maps Foundation, an open map data standard which enables its members to contribute and pool map data to create an interoperable base map that is open for developers to license.

3. Location Demand Drivers

The growth outlook for location services and location intelligence remains bright. Location services, such as those outlined in section 2.1, can support use cases relevant across many industries, including automotive, transport and logistics, mobility, asset tracking, business intelligence, and many other domains. Many of these sectors have established needs for location services. For example, navigation systems are increasingly available as a standard feature on passenger cars. Fleet management solutions enable managers to create delivery schedules for drivers and to monitor the position of their fleet in real-time on digital maps. Increasingly, business intelligence tools enable enterprises to visualize and perform geospatial analysis on geotagged data to assess performance and generate critical business insights.

However, across most industries the nature of demand for location services continues to evolve and therefore creates growth opportunities for suppliers capable of addressing these expanding needs and uses. For example, the automotive industry is moving to increase the penetration of advanced driver assistance systems in vehicles, working toward greater autonomous driving, and is raising production of electrical vehicles (EV) to meet growing demand. The remainder of this chapter addresses how demand for location services is evolving across the sectors listed below, and provides examples of the growth opportunities for providers of location services and geospatial solutions:

- The automotive industry
- The on-demand and mobility market

- Enterprise
- Consumer mobile applications

4. The Automotive Industry

The automotive industry includes light-duty vehicles e.g., passenger cars and vans, and heavy-duty vehicles, such as trucks, buses, and coaches. The automotive sector is a significant source of revenue for providers of location content and location services and will continue to be as the automotive market evolves towards electrification, digitalization, and autonomous driving.

TechInsights expects that the increasing penetration of embedded navigation in mass market vehicles, growth in the ownership of electrified vehicles, mandates for ADAS features like Intelligent Speed Assist (ISA), and vehicles with autonomous capabilities to result in continued expansion of demand for automotive-grade location services. Furthermore, with vehicles becoming more software defined [displays are replacing traditional instrument clusters](#), redefining infotainment and navigation visualization.

Location services are not just needed for driver navigation but increasingly underpins various vehicle performance and vehicle safety capabilities, including (among others) predictive powertrain control, intelligent speed assistance (ISA) and lane departure warnings. Location services are also evolving to support the needs of electric vehicle (EV) drivers, e.g., providing information including the location and likely availability of compatible charging points, and supporting EV specific routing that calculates the optimal route for long journeys that require charging to be taken into consideration due to range limitations. TechInsights expects providers of mapping and location services that can meet these shifting vehicle OEMs requirements across various markets and segments will be best positioned to succeed.

The Continued Rise of In-Vehicle Navigation

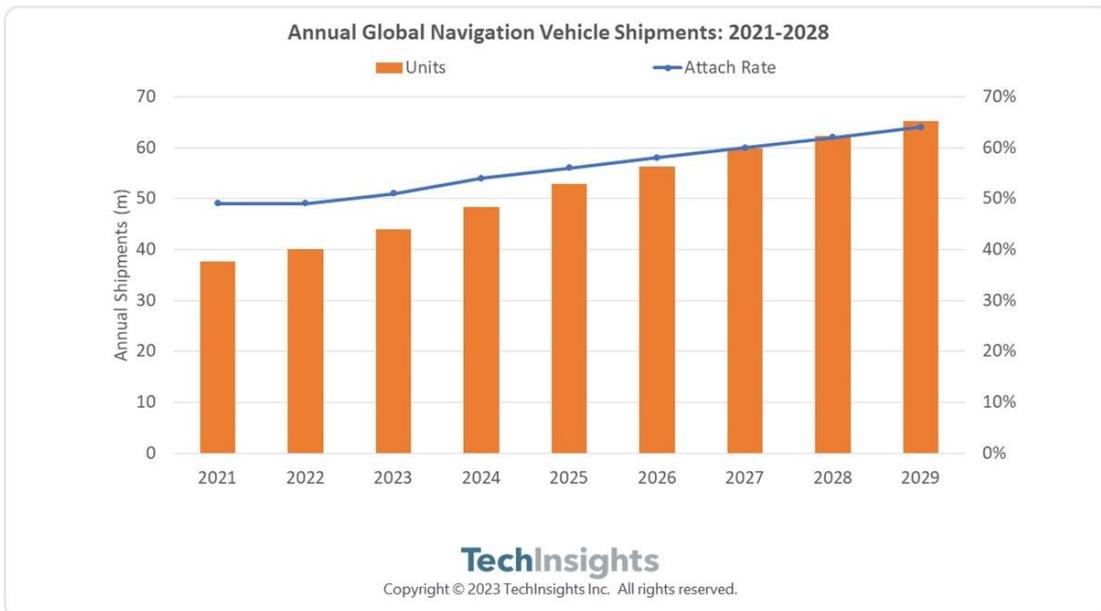
Navigation remains the primary use case for location services and software within the automotive sector, whether this is directly through embedded, or hybrid navigation software integrated with the in-vehicle infotainment (IVI) system, or indirectly through Portable

Navigation Devices (PNDs), smartphone mirroring, or smartphone navigation apps.

Embedded and hybrid navigation solutions were once available on luxury models or as an optional extra. However, they have now become table stakes in the volume car segment. TechInsights forecasts volumes of embedded and hybrid IVI navigation systems will rise globally from just above [37 million at the end of 2021 to just over 62 million by 2028](#), Exhibit 1. This equates to navigation penetration of shipped cars rising from just below 50% to nearly 60% across the period. This growth in demand for navigation systems will provide continued growth opportunities for suppliers of location content and locations services.

Globally, in-vehicle navigation sales will rise from just above 37 m at the end of 2021 to over 62 m by 2028

Exhibit 2 Annual Global Navigation Shipments: 2021-2028



Rising Electric Vehicle Production

An increasing proportion of the 62 million navigation enabled vehicles sold in 2028 (noted above) will be electric vehicles with EV-specific navigation features.

EV navigation services continue to evolve to address some of the early challenges facing EV drivers, including the limited range which EVs can travel before a recharge, and the relatively limited numbers of EV charging stations. Fragmentation of EV charging connectors across vehicle brands and models introduces further complexity for drivers,

as does their availability at charging stations. Consequently, EV OEMs are introducing location-powered services that can ease 'range anxiety' for EV drivers and improve the EV driving experience, particularly for long trips which are more likely to exceed battery capacity without recharge. These EV navigation services include information, such as:

- estimates of the driving distance based on current vehicle charge and analysis of route alternatives.
- the location and likely availability of compatible EV charging stations.
- EV specific routing, designed to factor in charging requirements along the proposed route.

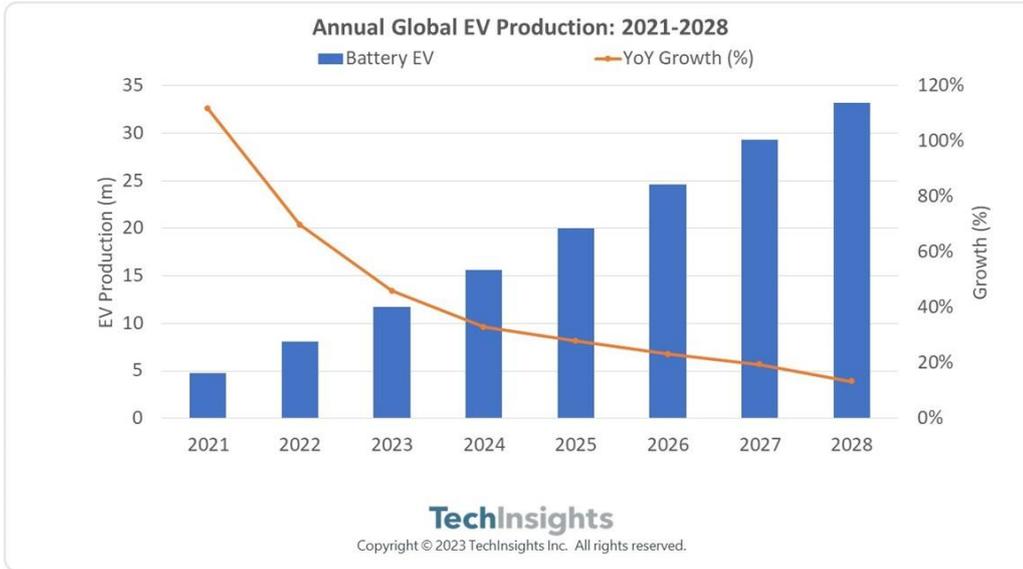
Providers of location services are actively addressing OEM EV requirements by making available EV charging point information from relevant data providers across multiple countries, enabling EV range visualizations, and building EV-optimized routing algorithms.

EV production growth over the next 5 years is being driven by a combination of government mandated bans of the production of vehicles powered by fossil fuels, and increased incentives for consumers to switch to EV. For example, the EU has set 2035 as a deadline banning the sale of new petrol- and diesel-powered vehicles. Furthermore, a rising number of cities and local authorities are introducing low emission (or environmental) zones, where charges are levied on vehicles entering these zones which do not meet emission standards. Therefore, residents living in low emission zones and drivers regularly pass-through these areas have an additional incentive to switch to EVs. Companies which lease vehicles to employees are also making EV options available.

TechInsights estimates global electric vehicle (EV) production will expand 183% and exceed [33 million EV vehicles between 2023 and 2028](#), Exhibit 3. Across this period TechInsights forecasts double digit growth year-on-year.

Annual production of EV cars will expand 183% to exceed 33 million units between 2023 and 2028

Exhibit 3 Annual Global EV Car Production Growth: 2021-2028



Advanced Driver Assistance Systems

TechInsights expects continued and growing automaker demand for advanced driver assistance systems (ADAS) features, like predictive powertrain control, intelligent speed assist (ISA), lane departure warnings, and others, to meet vehicle regulations and to increase driver safety. In Europe, awareness of the New Car Assessment Program (NCAP) among car buyers is growing and naturally OEMs are evaluating what safety features to add to their vehicles to enhance the NCAP rating of their products.

Increasing car safety and reducing road traffic deaths remains an ongoing objective for the automotive sector and governments. Vehicle makers are introducing map-enhanced performance and safety capabilities like predictive powertrain control, lane departure warnings, distance warnings and intelligent speed assistance (ISA) to enhance driver safety and to meet regulatory requirements. These features rely on map data that is processed by software in the vehicle to perform actions, such as limiting vehicle speed based on the road layout ahead or according to prevailing speed limits.

Safety-based advanced driver assistance systems are increasingly becoming mandatory for light-duty passenger vehicles. From mid-2022, the Intelligent Speed Adaptation (ISA) function became mandatory for all new-design vehicles sold in Europe. From mid-2024, it will be required to be fitted to all new vehicles sold. This function

TechInsights expects growing automaker demand for ADAS features, like predictive powertrain control, ISA, and lane departure warnings, among others, to meet vehicle regulations and to increase driver safety.

needs to know the current speed limit, and both warn the driver and slow down the vehicle if the limit is exceeded. Most car makers continue to implement a multi-layered approach which on an on-board map of which speed limits apply to which road, a communications link to keep that map up-to-date, and a camera to detect speed limit signs by the roadside. Successful suppliers need to be able to offer, either directly or via ecosystem partners:

- An accurate speed limit map, which is regularly updated
- An efficient download-and-update mechanism to ensure the latest map data is always used. This needs to be in place for at least 7 years after the sale of the vehicle.
- A “virtual horizon” of what is ahead, so that suitable warnings can be given ahead of time
- The ability to help integrate this function into the wider ADAS and Driver Information systems on-board the vehicle

This mandate will further increase the penetration of windshield-mounted cameras, which are now expected to be fitted to 77% of all light-duty vehicles produced globally in 2025, rising to 92% by 2029. These cameras will thus themselves become important data sources, and mapping providers without access to user-generated camera data may struggle to offer a compelling solution in the future.

Autonomous Driving

Over the next five to ten years, fully autonomous vehicles will account for a negligible share of vehicles sold. TechInsights only expects the penetration of fully autonomous vehicles light-duty vehicles to start ramping up in the 2030s. However, the penetration rate of L2 capable vehicles (offering similar capabilities to today's autopilot-enabled Tesla models) will likely have hit 53% of annual production in 2030. By 2035 almost 80% of vehicles produced will offer at least L2 functionality. The maps that these vehicles need (which will almost certainly NOT be based on data gathered by high-precision survey vehicles) is thus a market that is worth fighting over. As such, TechInsights continues to see automakers seeking to partner with companies that they see as having the long-term vision and capabilities required for success in this space. The last year, perhaps unsurprisingly, has thus seen the emergence of Google as a stronger player in providing location-centric data and services to carmakers.

The penetration rate of L2 capable vehicles (offering similar capabilities to today's autopilot-enabled Tesla models) will likely have hit 53% of annual production in 2030, rising rapidly to 80% by 2035.

- It was noteworthy that in its February 2022 Strategy Update on the Mercedes-Benz Operating System (MB.OS), Mercedes announced what it described as a “long-term strategic partnership” with Google. This will bring the Google Maps platform into MB.OS-equipped vehicles for navigation and POI data.
- TechInsights is aware of at least one automaker which will source its ISA solution from Google. It will also share detected objects with Google and will reportedly be helping Google recruit other carmakers to share similar data.

Analysis and forecasts of key trends relating to autonomous driving are published in [TechInsights' Autonomous Vehicles service](#).

Enterprise (Non-Automotive)

Beyond the automotive industry demand for high quality location services continues to be driven by several key domains and horizontal use-cases, including:

- Transport & Logistics
- On-demand mobility services
- Asset tracking and supply chain
- Business intelligence
- Mobile apps and 5G networks

Across these industries location services such as navigation, routing, geolocation, and geofencing, among others, enables businesses to improve performance and to gain competitive advantage. For example, matrix routing enables fleet managers to plan optimal routes for their delivery fleets, while traffic enhanced navigation can enable companies across each of the above-mentioned sectors to share accurate ETAs with customers in real time. Direct benefits include greater fleet utilization, reduced fuel costs, and improved customer service, respectively.

The trend towards improved environmental sustainability is also driving demand for tools to enable enterprises to optimize their operations. Across the transportation and logistics sector, there is a growing imperative for businesses to measure and report their carbon footprint and environmental impact transparently. Location services

enable enterprises with fleets to optimize their operations by calculating the most fuel efficient, low emission routes and enabling businesses to make environmentally smart decisions on where to locate factories and premises. Location services also enable tools and parts in factories (or large premises) to be tracked, and the efficiency of processes to be better managed.

The growth of IoT in different verticals is generating waves of real-time data from connected objects. This data can be collected, merged with other data sources, and analyzed using geospatial tools to generate insights that improve decision making, and enhance accountability, efficiency, and business performance. For example, farmers can deploy sensors across their fields to measure water levels, acidity/ alkali levels in soil, and other metrics to guide when, and in which specific locations, targeted intervention is necessary to improve productivity.

Location Intelligence

Enterprises across different industries that are striving for greater efficiency and improved competitive performance are accelerating their efforts in digitalization, business intelligence, and location intelligence across their operations. Location intelligence also plays a key role in executing government policies, for example identifying which dwellings in urban areas remain [underserved by broadband coverage](#).

Location intelligence, which we define as the integration of first-party and third-party data with geospatial services (e.g. maps, routing, geocoding, search, etc.), is a benefit derived from the digitalization of business processes and the proliferation of IoT. Location intelligence provides enterprises with geospatial context to enhance decision making, optimize business processes and to better manage and track valuable assets. For example, when assessing suitable locations for a new store a retailer can use maps and probe data to identify which streets in town have superior footfall at different times of day. Factories can track the location of materials and parts across workshops to measure and improve process efficiency. Hospitals could also track assets, like medical equipment, to eliminate wasted time searching for equipment which could be in other departments.

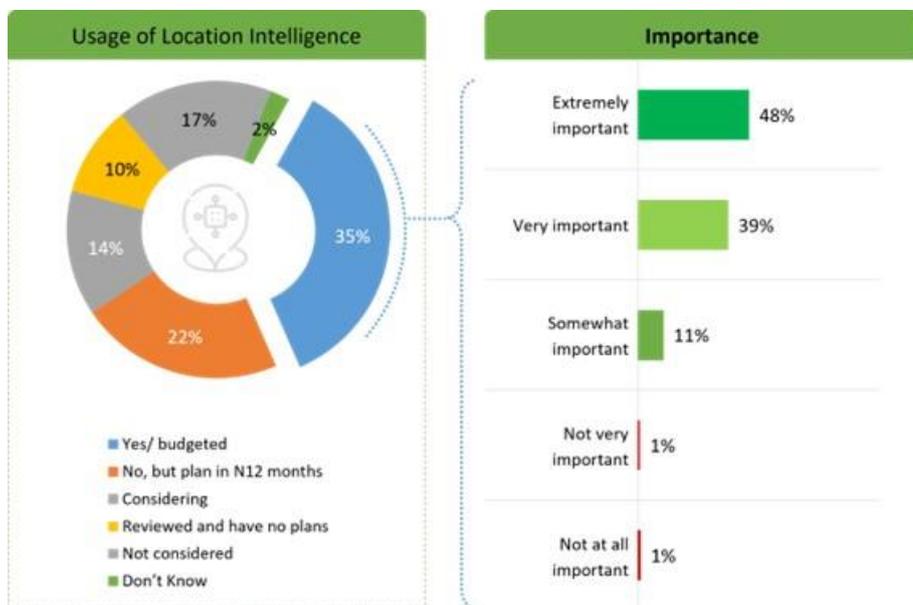
Location intelligence is increasingly being used in insurance, with

companies like Pula, Ibis Network, and Arbol, among others, using geodata sets to assist insurance underwriting and to assess insurance claims for industries like real estate and agriculture. Satellite imagery combined with other data sets (e.g. weather patterns, flood warnings, agricultural yields, etc.) enables insurance companies to improve their ability to assess risk and provide insurance more cheaply than previously possible. In relevant cases assessing satellite imagery of locations can provide insight into potential risks more cost effectively than surveying sights in person.

During 2021 TechInsights conducted a detailed survey among over 900 enterprise users across France (300+), Germany (300+), and the US (300+), across 10 vertical markets which [addressed IoT spending](#), IoT apps and deployments, IoT vendors and IoT solutions. The survey asked respondents whether their company budgeted for location intelligence. The results show that over a third (35%) had budgeted for the use of location intelligence, with a further 22% highlighting plans to do so in the next 12 months, and 14% considering doing so. Just 10% indicated they had reviewed location intelligence but had no plans, Exhibit 4.

Over a third of I.T. decision makers surveyed stated they had budgeted for location intelligence.

Exhibit 4 The Usage and Importance of Location Intelligence



Nearly 90% of businesses that have budgeted for location intelligence view it as either extremely or very important.

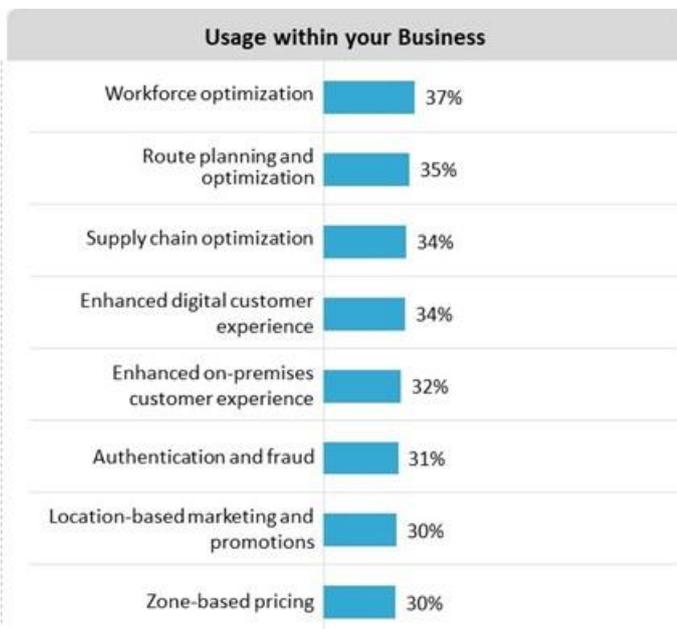
The survey also asked how important is location intelligence to your business? From the 35% of businesses that budgeted for location intelligence, 87% stated location intelligence as either extremely

important (48%) or very important (39%) to their businesses. Just 11% described location intelligence as somewhat important and only 2% not very important and not at all important.

Location intelligence is being deployed for a variety of use-cases in businesses which have already budgeted for these services. Exhibit 5 shows 37% of businesses surveyed are deploying location intelligence to support workforce optimization, followed by 35% for route planning/ optimization, 34% for supply-chain optimization, and 34% to enhance the digital customer experience. 30% are using location intelligence for authentication and fraud reduction while 30% claim to be engaging in location-based marketing and promotions and zone-based pricing.

Three quarters of fleet-based delivery or goods transport firms surveyed claimed to have budgeted for location intelligence or plan to do so in the next 12 months.

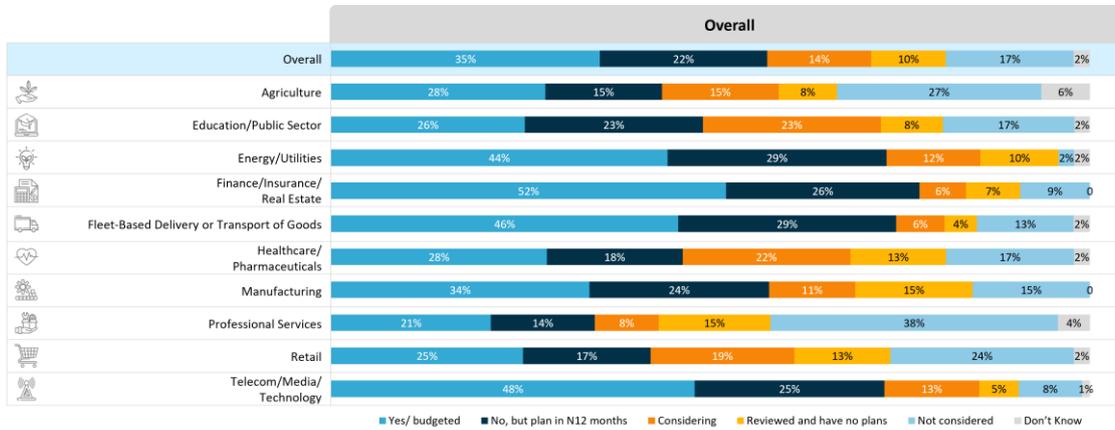
Exhibit 5 Location Intelligence Use Case Popularity



Notably, companies operating in industry verticals such as Finance, insurance, and real-estate (FIRE), Telecom, Media, and Technology (TMT), Fleet-Based Delivery of Transport of Goods, and Energy/ Utilities highlighted greater use of location intelligence than other sectors, Exhibit 6. 52% of FIRE companies claim to have budgeted for location intelligence versus 48% of TMT companies, 46% involved in fleet-based delivery or goods transport companies and 42% of energy and utility firms. Companies in this sector also demonstrated greater plans to budget for location intelligence in the next 12 months. 29% of companies involved in fleet-based delivery or goods transport, and in energy/ utilities claimed they will invest in location intelligence over

the next 12 months compared to 26% in FIRE and 25% in TMT.

Exhibit 6 Location Intelligence Usage by Industry Vertical



Base: Overall - 943, Agriculture - 78, Education/Public Sector - 98, Energy/Utilities - 97, Finance/Insurance/Real Estate - 98, Fleet-Based Delivery or Transport of Goods - 94, Healthcare/Pharmaceuticals - 95, Manufacturing - 97, Professional Services - 95, Retail - 95, Telecom/Media/Technology - 96
 GTI. Businesses today have budgeted for various technologies / solutions or are making plans for these technologies / solutions in the future. Has your company budgeted for the following technology / solution, or do you plan to budget for it in the future?

Transport and Logistics

Transport and logistics companies can leverage a variety of different location services to enhance their competitiveness, become efficient, and to assess and monitor driver performance. This includes (among others) driver navigation, complex route planning and optimization, asset tracking and post trip analysis.

- **Truck routing and navigation:** Specific truck navigation services takes into consideration road restrictions and specific regulations for heavy-duty vehicles (e.g. maximum vehicle height, weight and length suitable for roads or bridges, environmental zones, etc.) when calculating routes.
- **Complex route planning:** Scheduling and planning the most suitable routes for drivers is necessary where they have multiple deliveries and stops to make. Matrix and batch routing can help dispatchers to identify and plan the most optimal routes for their fleet of delivery vehicles.
- **Asset tracking and post trip analysis:** A variety of location tools (e.g. geolocation tracking, geofences, snap-to-roads and maps) can be deployed to tracking vehicles in real-time and for conducting post trip analysis. The increasing importance of asset tracking for supply chain management is covered in greater detail in section 2.2.3. Post trip analysis enables fleet managers to assess where improvements could be made (e.g. reducing excessive dwell time) and to monitor driver

performance.

Heavy-duty vehicles are also influenced by broader trends impacting the automotive sector including the electrification of trucks and fleets, the implementation of driver assistance and safety systems (ADAS), and increased automation. In terms of environmentally friendly goods transportation, transport and logistics companies are evaluating emission friendly alternatives to petrol and diesel, e.g. EV, hydrogen, and biofuels.

Consequently, TechInsights continues to expect strong and evolving demand for location services from companies involved in transport and logistics, and OEMs of heavy-duty vehicles. As highlighted in Exhibit 6, TechInsights' October 2021 enterprise survey identified that three-quarters of companies involved in fleet-based delivery, or the transport of goods had already budgeted for location intelligence usage or planned to do so in the next 12 months.

Location intelligence is also being used by producers to better understand their supply-chains, and to assess the sustainability and environmental footprint of their products and partners. For example, Unilever partnered with Orbital Insight to enhance supply-chain visibility of its palm oil-based products across factories, farms, suppliers, and stores.

Mobility Services

Mobility services encompass a broad range of transport modes and operators, including taxi (or ride) hailing, car-sharing, ridesharing, and micro-mobility options like bike- and scooter- sharing.

TechInsights' [Automotive Connected Mobility](#) channel estimates the number of active ride-hailing users at the end of 2022 was in the range of 450 million to 500 million, globally. Over the next 5 years we [expect continued growth](#) in the base of active ride-sharing users, which will translate to a greater volume of trips conducted via ride-hailing services.

Overall, demand for mobility services continues to grow strongly at a global level. Location services remain at the heart of modern mobility services, enabling users to share their pick-up location with drivers on a map, providing accurate journey ETAs to both drivers and

customers, providing real time traffic data to enhance routing, and providing accurate addressing.

Over the past 18 – 24 months mobility service providers like Uber, Lyft and Grab have been actively diversifying into last-mile food and package delivery and have also expanded beyond cars to other transport forms, as they look to leverage their investment in drivers.

TechInsights' [Automotive Connected Mobility](#) service predicts strong consumer demand and growth in other [mobility services](#), including car-sharing. [Membership numbers will rise 36% between 2022 and 2027 to approach 84.9 million globally.](#)

Asset Tracking and Supply Chain Management

Asset tracking involves monitoring the movement of valuable assets, such as vehicle fleets, equipment, parts, and raw materials across the supply chain. The tracking of assets enhances transparency, improves accountability, and enables optimization of supply chains for both suppliers and buyers. Importantly, asset tracking is enabled by location services including maps, geo-location, geofencing, and other location tools.

Vehicle tracking, traffic optimized multi-point routing, assessing driver behavior, and logging trip information offered by fleet management solution providers are all underpinned by maps and location services. Fleet telematic solution provider, Verizon Connect, surveyed 657 respondents from US fleet companies in mid-2022 for its [2023 Fleet Technology Trends Report](#) and noted that over 50% of highlighted improvements in customer service and productivity functions after implementing GPS fleet tracking. Furthermore, just under 50% highlighted a positive improvement in routing. The study also noted use of fleet management software delivered an average 10% improvement in average fuel cost reduction for respondents in the transportation sector, a 21% average boost in cost reduction, and an average 12% improvement in labor costs.

Maps and location services (e.g. geolocation, geocoding, routing, and navigation) are imperative for tracking products across the supply-chain, from within factories through to delivery to the customer. For example, as parts or assets move from inside to outside the factory, dispatchers can track the position of their vehicles in real time to

provide improved ETA guidance to internal and external customers. Dispatchers can also leverage information about traffic incidents to provide drivers with alternative routing. Furthermore, the digitization of the transport and logistics sector is enabling haulage companies to use location services and real-time information to optimize and maximize fleets of trucks and minimize underutilized capacity. The economic viability of cellular enabled asset management tags has improved due to a combination of lower priced cellular enabled RFID tags and low [mobile data prices](#). The battery performance (and therefore lifecycle) of cellular-enabled tags has increased significantly, which is also making them more viable.

Enterprises need to monitor the location and movement of assets to deliver greater accountability, enhance customer satisfaction, and to improve decision making.

IoT providers are offering location and tracking out of the box, not just around cellular, but also around unlicensed LPWA technology like LoRaWAN. Customers will increasingly have a choice beyond assisted GPS, depending on power consumption and the level of accuracy required for their solution. Some companies may just need to know where an asset is with basic geo-fencing. For example, warehouse assets like cable drums or the basic position of enterprise fleets to track those assets to a specific depot or location, which may not require a high level of accuracy. In those cases, even unlicensed LPWA technologies like LoRa may be sufficient, if the network knows what time a signal is picked up by any number of gateways, so that it is possible to triangulate that to a location with an accuracy of 40-50 meters, perhaps slightly less in dense urban environments.

For greater levels of accuracy, integrated AGPS/cellular/Wi-Fi sniffing will work very effectively, such as specific pallet locations or where in a storage rack an item is located. Some companies are also integrating these capabilities into unlicensed [LPWA solutions](#), such as Actility, which has some patented IP around low power GPS (through its acquisition of Abeeway), which is a LoRaWAN equivalent of AGPS (Assisted GPS). The network provides key information to the device preparing to make a fix, which means that the GPS can be active for a shorter period and acquire fewer satellite signals. The position calculations are then processed in the cloud, which reduces the battery impact, while still providing GPS levels of accuracy (in many cases sub-10 meters). If a standard GPS offering has a 1-year battery

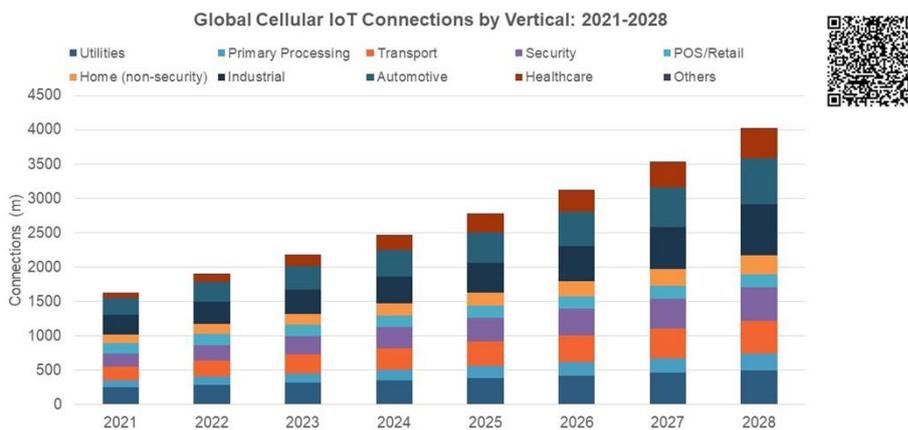
life and pure LoRaWAN has a 10-year battery life, this solution could give up to 9 years

Location services will also be used to enhance augmented reality (AR) which will create a more immersive experience. AR and real-time location services (RTLS) will be combined on a much bigger scale to provide value to businesses and customers. In fact, the trend has already begun with airports and hospitals using BLE Beacons, combined RTLS and Wi-Fi to help staff and passengers find their way through their complex and difficult to navigate spaces.

IoT presents a future growth opportunity for location platforms as the number of devices connected to the internet increases. TechInsights' [Enterprise IoT Strategies](#) service estimates the number of devices connected over the cellular network is set to grow at a 13% CAGR between 2023 and 2028 across a variety of industry verticals, Exhibit 8. IoT in Healthcare, is set to show the strongest growth, followed by Industrial, Automotive, and security. Cellular connectivity will enable enabled equipment to be tracked or monitored, although clearly not all these connected devices will need support from geospatial services e.g. geolocation, directions, or routing.

TechInsights expects a 13% CAGR in the number of cellular IoT connections between 2023 and 2028 to drive demand for location services.

Exhibit 7 Global Cellular IoT Connections: 2021-2028



TechInsights
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Fundamentally, where mobility is a core requirement e.g. automotive, or fleet or where assets need to be tracked e.g. in a factory, or across

a supply chain, the greater the need for geolocation services.

Traceability in the supply chain is becoming a very important element of compliance in many industries to guarantee the source of origin, as well as the integrity of any component. Examples include car parts shipped globally to different suppliers, where location tracking and identification of the origin is vital, especially in terms of liability should there be a safety recall on a particular vehicle component. The same is also true in terms of food processing, where traceability is vital in guaranteeing the integrity of a finished product, for example, if a fast-food chain guarantees customers that chicken nuggets contain 100% chicken breast meat, then suppliers need to ensure they can prove that the chicken nuggets they produce are sourced from chicken breast or risk a serious breach of an SLA (service level agreement) with a customer.

Data recorded by these connected objects will be able to provide contextual information via alerts and can be visualized. For example, a vending machine which is low on a certain product item, or which has become faulty is able to communicate its status to head office and can be restocked or fixed.

Mobile Applications

From a volume perspective, mobile phones, and in particular smartphones, remain the primary device through which consumers access location-enabled services, such as map apps, turn-by-turn navigation apps, local business search, taxi-hailing apps, and location-based games, among others.

While all-in-one travel applications depend on location services, many other apps are enabled with location awareness to provide contextual relevance. e.g. location sensitive weather and news, or to prevent content being viewed by users outside authorized geographies determined by content rights holders. More broadly, basic location services also include store locators which usually consists of a location input box, a map, markers, and results including travelling distance from the users' postal code.

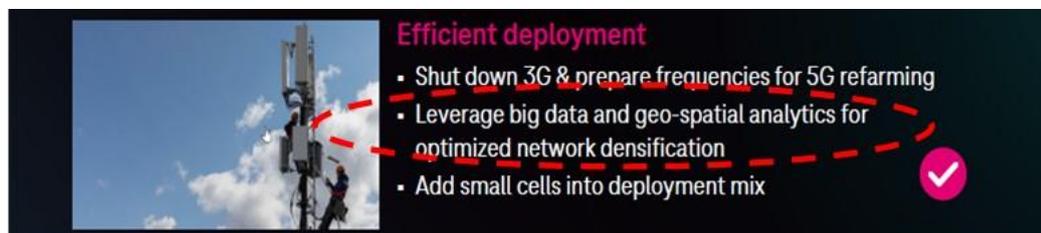
Over the next 5 years, the rising population of consumers with GPS handsets combined with a growing base of mobile data users and app-stores users will boost the addressable market for different types of consumer LBS.

- **Satellite navigation enabled handsets:** Annual sales of satellite navigation enabled smartphones, which support accurate geolocation, is set to rise from nearly [1.4 billion at the end of 2022 to nearly 1.6 billion by the end of 2026](#), according to TechInsights' Emerging Device Technologies service.
- **App-store users:** TechInsights estimates the population of users accessing app-stores to download apps and games will rise from just over [3.5 billion at the end of 2023 to nearly 3.8 billion at the end of 2027](#), thus increasing the addressable market of users able to download location-based applications.
- **Mobile data users:** Apps and services which rely on location-based services served in real-time are dependent on mobile data connectivity when they are out and about. The number of [mobile data users is set to exceed 4.6 billion by 2027](#).

5G Networks

Mobile operator network planners typically lean on maps, location services, and other segmentation data to plan the deployment of radio access networks (2G, 3G, 4G) at both a macro and micro level. However, with 5G more sophisticated and detailed 3D maps will be required, particularly in dense urban environments where service providers are aiming to deploy 5G using [mmWave](#). Although 5G mmWave offers higher bandwidth, its coverage range is limited and prone to interference from both hard and soft physical features, such as lamp posts and tree foliage, respectively. Consequently, maps providing accurate 3D models in tandem with RF propagation tools will enable mobile operators to optimize the positioning of their 5G RAN to provide the best possible signal and coverage. Exhibit 9 from a Deutsche Telekom Capital Market Day Presentation underlines the important role of geo-spatial analytics for efficient and optimized 5G network densification.

Exhibit 8 Deutsche Telekom Targets Geospatial Analytics 5G Deployment



Source: Deutsche Telekom, Capital Market Day Presentation, May 2021

[5G deployments are continuing to ramp up](#), which is reflected in 5G subscriber growth forecasts. TechInsights expects strong growth in 5G network deployment over the next 5-years as the number of [5G subscribers expands from 1.05 billion at the end of 2022 to nearly 3.4 billion by 2027](#).

5. Benchmark Update & Summary

TechInsights evaluates and scores the relative strengths, weaknesses, and capabilities of Google, HERE, Mapbox and TomTom across seven dimensions necessary to address current and emerging use-cases. These dimensions include map making and maintenance, automotive, non-automotive, developer community, map and data visualization, growth and leadership, and environmental sustainability. In last year's benchmark update TechInsights has replaced 'POI and search' and 'openness and flexibility' benchmark categories with 'non-automotive' and 'environmental sustainability', respectively. This change has been made to reflect priority areas for the evolving location sector.

Map making and maintenance: Providing reliable, fresh, and up-to-date maps and map content at scale has become table stakes and expected in the era of "on-demand" and autonomous services. Location platforms which have the capability to deliver near real-time map updates to meet a broad and evolving range of customer needs will score highly in this category. As will companies that apply a robust and holistic approach by conflating data sources and applying manual and automated quality checking and verification. Platforms that develop maps to meet current, emerging and future needs (e.g.

EV, ADAS, autonomous transportation, AR/XR, etc) will also score well.

Automotive: The automotive sector remains a critical source of revenue and demand for the location sector, and therefore the ability to service both current, emerging, and future needs of light and heavy-duty vehicle makers cannot be ignored. In this category we award higher scores to companies which have announced deals and partnerships to supply key players in the automotive space (e.g. OEMs and tier ones) with location services and solutions. Scores also reflect the ability of location companies to meet the strategic objectives of vehicle OEMs.

Non-Automotive: Non-automotive encompasses a broad range of horizontal and vertical use-cases for location services which extend beyond use by automotive companies. Non-automotive location services underpin mobility services, fleet transport and logistics management, asset tracking, consumer internet services, business/location intelligence and other areas. Providing specific products, services and solutions that address these different use-cases reflects well for location vendors in this category.

Developer community: Each location provider offers developers direct and indirect access to a broad set of location capabilities, including map tiles, geocoding, routing, place search, traffic data and more, through application programming interfaces (APIs) and software development kits (SDKs). A high score in this section is awarded to platforms that demonstrate they provide a broad range of location services for developers to deploy in their applications across multiple horizontal use-cases and different industry verticals. The relative size of developer community size provides a signal of how well platforms are addressing developer needs, to an extent, but is not the only criteria for a good score.

Map and data visualization: The need to support customized map views and visualization of location data varies by use-case, vertical and company. Some companies may seek a highly customized map for a specific use-case or want to integrate their own location data onto a map, or they may want to toggle between different visualization options for a specific dataset. In contrast, for other companies it will be less important to customize either map or data visualization. Companies offering both off-the-shelf and customizable data visualizations will score highly in this segment.

Industry vision and leadership: As highlighted in chapter 3 of the report the opportunities for future growth in the location sector will come from supporting autonomous vehicles, addressing the needs of the on-demand mobility sector, and meeting rising demand for location intelligence with respect to asset tracking, fleet management, and IoT as businesses embrace big data. Companies which communicate strong intent to address future needs and use cases in key location sectors, and other domains, either directly or through partnerships will score highly.

Environmental sustainability: It is increasingly important for companies to demonstrate to stakeholders, including investors and customers, that they are taking actions to reduce their environmental footprint. This means replacing energy from fossil fuels with those from renewable sources, finding ways to increase energy efficiency, and participating in a circular economy i.e., reducing and recycling waste, and using recycled materials. Companies which are measuring their environmental impact (e.g. GHG emissions, energy consumption, etc.), that have signed up to third-party disclosure frameworks, and made environmental sustainability part of their corporate structure will score well in this category.

Benchmark Results

Since the last report strong competition between Google, HERE, and TomTom, in map making and map maintenance, has placed this benchmark category into greater focus. Beyond the map making category, competition continues to be intense, with each company evolving their capabilities further; offering new products and solutions to address market needs and claiming customer wins. In this year's benchmark study, HERE once more maintains overall leadership, followed by Google and TomTom further closing the gap.

Google: Google has made progress in several areas over the past year, particularly in automotive. Google's strategic partnership with Mercedes, announced in February 2023, represents a significant shift in strategy for Google. Google unbundled its automotive services (GAS) to enable Mercedes greater control over implementation of GAS and the driver experience. Google also added BMW as an Android Automotive customer. Significantly, Google is evolving its location products beyond infotainment navigation towards supporting ADAS

use-cases. At CES 2023 Google announced its HD Map will be used by Volvo and Polestar. Google's lack of openness and the limitations it imposes on developers continues to weigh on its developer and overall score.

HERE: The introduction of UniMap at CES 2023 enables a step-up in HERE's map making and map maintenance capabilities, while its dominance in supporting OEMs meet the EU's intelligent speed assistance (ISA) laws remains unrivalled. Consequently, HERE remains a leader in map making and automotive categories. As HERE seeks new leadership, improving EV driving experiences, and supplying detailed road rules and regulations information, and supporting truck and fleet use cases remain its core focus. HERE's mapping-as-a-service capability remains unique among its competitors. HERE remains independent, open, flexible and provides developers and customers with highly customisable and off-the-shelf solutions. HERE's vision for growth remains largely unchanged, with a focus on supporting emerging and future enterprise and automotive-based use-cases.

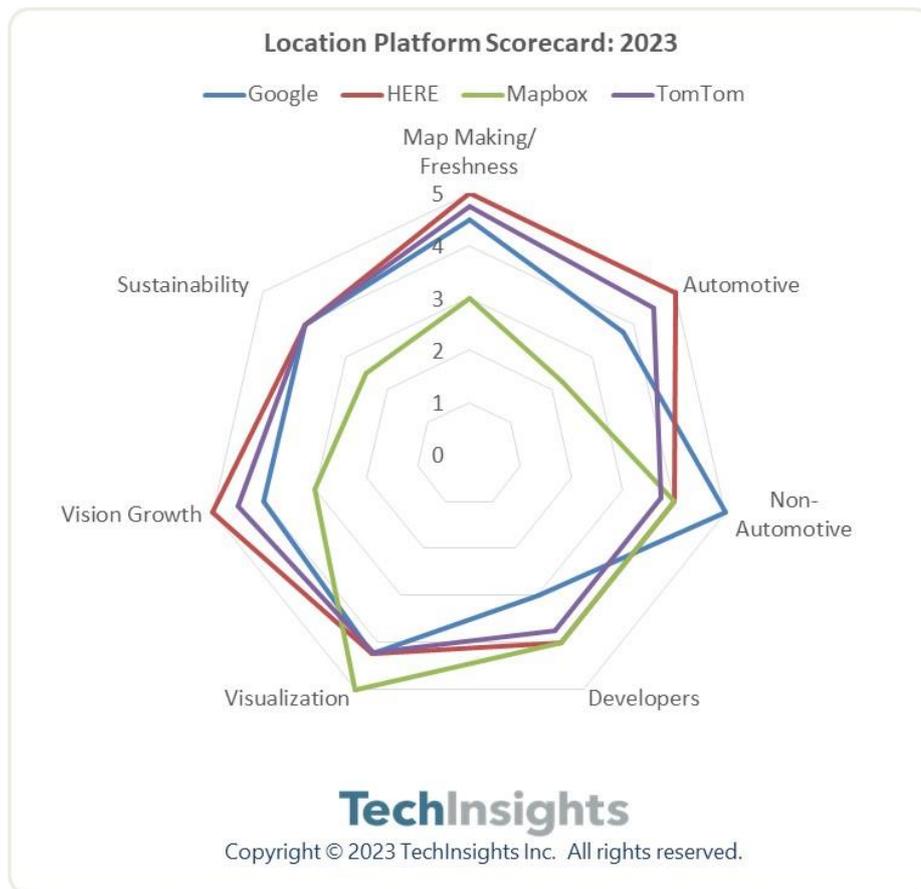
Mapbox: Mapbox continues to improve its location proposition since our last report, adding to its navigation capabilities, updating map imagery, and enhancing map rendering performance. Mapbox continues to be a leading player in map data visualization and location software and has scored notable wins in the automotive domain. It announced its navigation SDK has been deployed on GM, Toyota, and Rivian vehicles, but remains a marginal supplier of locations services to the automotive sector overall. Mapbox does not currently offer location products to support ADAS applications while its effort to support fleets through Mapbox Fleet is in its infancy. Mapbox has positioned its location services to support a variety of non-automotive use case e.g. last mile logistics, retail, business intelligence, and real-estate. Mapbox remains an open, independent, and flexible provider of location services. Mapbox's base map uses Online Street Maps (OSM) as a foundation, which remains open to inconsistent, erroneous or malicious edits.

TomTom: The creation of Overture Maps Foundation by TomTom, AWS, Meta, and Microsoft strengthens TomTom's map-making capability in a variety of dimensions, including addressing non-road-based use cases. Overture's open map standard will appeal to developers. TomTom reports strong traction for its ADAS products and its truck

navigation. TomTom’s partnership with VW subsidiary, CARIAD, and other automotive wins (Hyundai) demonstrates its strength in navigation software and traffic. TomTom score strongly for innovation and industry vision with its founding role in the creation of Overture, and remains an independent, open, and flexible supplier of location services to the location sector.

In Exhibit 10 below the scores in parenthesis are those awarded in last year’s benchmark report. Scores without parenthesis are for new benchmark categories.

Exhibit 9 Location Platform Scorecard: 2023



Benchmark Scores	Google	HERE	Mapbox	TomTom
Map Making/ Freshness	4.5(4)	5(5)	3(3)	4.75(4.5)
Automotive	3.75(3.75)	5(5)	2.25(2.25)	4.5(4.5)
Non-Automotive	5(4)	4(4)	4(4)	3.75(4)
Developers	3(5)	4(4)	4(4)	3.75(3.5)
Visualisation	4.25(4.25)	4.25(4.25)	5(5)	4.2(4)
Vision Growth	4(4)	5(5)	3(3)	4.5(3.75)
Sustainability	4(4)	4(3.75)	2.5(2.5)	4(4)

Map Making & Map Freshness

	Google	HERE	Mapbox	TomTom
Map Making	4.5(4)	5(5)	3(3)	4.75(4.5)

Except for Mapbox, which relies on OpenStreetMap (OSM) for its base map, the map-making and map maintenance capabilities of each location company are similar and Google, HERE and TomTom, with each scoring strongly in this category. Each location platform deploys a broadly similar multi-source approach to compiling data required to build and maintain its maps. We discuss these approaches in detail in section 2.2 of our [Location Platform Benchmarking Report: 2021](#) and briefly earlier in this report.

Since our last report Google, HERE and TomTom have each enhanced their map making and map maintenance approaches to shorten the map update cycle, provide greater levels of detail, and improve map coverage.

- Google:** Google now has a high-definition map product to complement its standard map, at least for North America. High definition typically means road attributes (e.g. lanes and road signs) and their measurements are captured in detail and to within decimetre accuracy in order to assist localisation of machines, e.g. vehicles. At CES 2023 Volvo announced its plans to use Google’s HD map in its Volvo EX90 and Polestar 3 cars. Google’s lane level and localisation data will facilitate ADAS features like lane change assistance, Volvo’s pilot assist technology, and in future, autonomous driving functionality. In December 2022 Google announced plans to combine teams working on Google Maps and Waze and it also highlighted the improved ability of its AI/ ML training models to continually improve its ability to accurately mine its street view imagery, in addition to its community of over 150 million Local Guides and over 10,000 local governments, transit agencies and organisations that provide updated location information to Google Maps.
- HERE:** HERE launched its new map platform, UniMap, at CES 2023. HERE claims UniMap is revolutionary in its ability to automatically ingest, processes, conflate and publish an

increasing volume of location data from a wide range of sources. UniMap aligns standard and high-definition map and integrates all map layers into a single map structure. HERE claims UniMap is an evolution of its HERE Live Map, which is built on conflating an array of sensor data perception, probe and other types of data) from leading automotive OEMs (Audi, BMW, Daimler, and others) UniMap uses AI to automate the processing of 500 million KM of probe and sensor data each hour to extract map features (e.g. 2D and 3D road sign positions), validate speed limits, and build missing road geometry. HERE gleans data from 300 million vehicle sensors from over 40 million connected vehicles, over 30 billion street level imagery (SLI) from HERE True vehicles and fleet partners. It takes less than 24 hours for updates from vehicles to be published. UniMap enables unified map making for both standard definition maps to support visual use-cases and high-definition supporting ADAS and autonomous driving. HERE claims UniMap will create a step-change in map freshness, with map updates meeting use-cases which demand real-time accuracy. UniMap is available on a trial basis to select HERE customers in 2023, before commercial roll-out in 2024.

- **TomTom:** After 3 years of investment and R&D TomTom announced a new TomTom map platform, and mapping strategy. TomTom is moving away from solely maintaining its own proprietary base map. Instead, it cofounded the Overture Foundation with internet giants, Amazon Web Services (AWS), Microsoft, and Meta, to create a base map based on open map data standards, and which leverages data from open map data sources, like OpenStreetMap. This base map will be called Overture Maps and will be maintained by founding members and partners. TomTom claims Overture Maps will enable it to improve its base-map offering for both road-based and non-road-based use cases where it has not prioritised its map building investment. TomTom expects the open and standard base map to enable it to focus investment in enhancing higher-value map layers, e.g. ADAS and HD Maps, and also to attract developers seeking to avoid being locked into proprietary map data formats. TechInsights expects Overture will enhance TomTom's base map coverage and depth, while enabling it to focus its investment on higher value layers.

- **Mapbox:** In August 2022, Mapbox announced its ADAS SDK product which supports ISA regulation for Europe. TechInsights believes Overture Maps has potential to benefit OSM, by checking the quality of OSM map data and fixing errors. Crowd sourced map edits in OSM will be quarantined in Overture Maps, before being standardised, quality checked, and published in Overture. The open nature of Overture means clean and checked data from Overture can also be made available in OSM, which is of benefit to Mapbox.

The Overture Maps initiative aims to create a widely adopted base map standard as an alternative to proprietary map data formats from Google and HERE. Instead of building and updating their own digital maps, members of Overture Maps (AWS, Meta, Microsoft, and TomTom) will each update and contribute to Overture. Overture Maps will leverage OpenStreetMap data, but apply quality checking, before making OSM data available through Overture Maps. As with all collaborations only time will tell if it delivers on its targets and attract a ground swell of developers. In April 2023 Overture Maps pre-released an example data set, consisting of 3D building footprints for major cities in the US. Since launch, ESRI, PTV Group, Nomoko have become foundation members. Despite the launch of pre-release map data, it remains to be seen how quickly Overture's effort can be scaled globally.

Each location company provides significant country coverage for their maps and map content, with Google, HERE, and TomTom remaining ahead of Mapbox. However, the depth of coverage, attributes and features available can vary by country for each location platform. Some countries are mapped in detail and underpin application which require high accuracy mapping (e.g. ADAS) while others are mapped in basic detail to support high-level use-cases.

Significantly, Google remains banned in China. Google coverage of South Korea also remains limited because mapping services in South Korea must (by law) reside within the country on national security grounds. To date Google has not complied. In China HERE and TomTom are engaged in joint ventures and partnerships with Chinese location companies enabling both to offer location services there. HERE has a joint venture with NavInfo. HERE and TomTom both provide detailed local map coverage of South Korea. Although the OneMap alliance is no longer in place, HERE states that it continues to

collaborate with map makers in Asia Pacific to develop a dynamic high-definition map with the ability to empower autonomous cars which is aligned with HD Live Map standards. Mapbox has created a JV with Softbank, one of its investors, to target digital map growth opportunities in Japan and across the Asian region.

Automotive Location Services

HERE continues to lead in automotive services, with TomTom and Google further closing the gap with HERE. HERE and TomTom have strong capabilities in supporting driver assistance systems (e.g. ADAS and hazard warnings), and supporting EV and hybrid navigation. However, both HERE and TomTom are facing strong competition from Google for infotainment navigation services, which is now extending to ADAS. Google's and Mercedes' strategic announcement in February 2023 signifies, for the first time, an unbundling of Google Automotive Services (GAS) which cedes user experience control to vehicle makers. It remains to be seen whether this approach becomes de facto for Google. Notably, during 2022, BMW announced BMW Operating System 8 in certain models and variants will integrate Android Automotive OS but will not use Google Automotive Services (GAS). Mapbox remains on the fringe of automation location, but its SDK has scored notable wins with GM and Toyota.

	Google	HERE	Mapbox	TomTom
Automotive	3.75(3.75)	5(5)	2.25(2)	4.5(4.5)

HERE and TomTom remain well positioned as providers of location services and location content to an automotive sector which continues to evolve towards an increasingly electrified, software defined, safety-led, and autonomous future. HERE, TomTom and Mapbox are independent and provide car makers with control over vehicle and driver data, and development of the overall navigation and infotainment experience. Google's newly announced deal with Mercedes, announced on 22nd Feb 2023, indicates Google is repositioning strategically to also allow OEMs greater control of vehicle data. The deal raises an important question about whether Google will extend its unbundling approach to other vehicle OEMs. HERE and TomTom report continued strong participation and growth in automotive.

- HERE's strength in automotive location services, spanning

location content and services, remains unrivalled. It claims over 180 million vehicles use its data and solutions on-board across 50 OEM brands, up from 170 million reported last year. HERE has maintained initial leadership in supplying car OEMs with location content to support EU ISA regulation, noting 17 ISA wins spanning more than 35 brands, up from 15 in last year's report. Its connected navigation solution, HERE Navigation is also gaining traction, with 6 OEM wins and others in the pipeline. As the fragmented EV ecosystem and infrastructure matures slowly HERE's EV product continues to evolve to address some of the early challenges that have emerged, with customers including Smart, Lotus and Vinfast. HERE's products are also being used for vehicle NCAP (New Car Assessment Programme) ratings, as they gain prominence in OEM marketing. 34 m vehicles have been shipped with HERE's Automated Driving Maps (up for 22 m in 2022). HERE's HD Map underpins the SAE L2+ capabilities of the BMW 7 Series, available in North America, and is also the HD map provider for Mercedes. It's new product Automated Driving Zones enables OEMs to define the operating conditions under which their automated driving systems can be activated. HERE's platform was used by Ford to support its BlueCruise product.

- TomTom has posted a strong year in automotive services, announcing an impressive 17% revenue growth from €223.1 million in 2021 to €260 million in 2022 and claims to serve around 50 automotive brands with its range of location services. It has doubled the number of vehicles with SAE level 1 and level 2 automation from 5 million to 10 million since our [last report](#), which spans 25 brands. TomTom claims it offers best-in-class ISA with both internal and external validation. TomTom has closed deals with multiple global top ten car maker groups for the supply of high-definition (HD) map, including 3 of the top 5, to support L2 and L2+ use cases. Notably, in 2022 TomTom announced it has become the navigation software partner of CARIAD, the software platform unit of VW Group. TomTom has also announced Nissan and Genesis as OEM customers. TomTom remains a leading provider of traffic service and navigation software. In September 2022, TomTom and Hyundai Motor Group announced a deepening of their partnership by deploying TomTom technology in all its vehicles across Europe, covering Genesis, Hyundai, and KIA vehicles.

HMG will also use TomTom's ADAS map to support its Highway Driving Assist.

Neither Google nor Mapbox report how many vehicles are enabled by their location services respectively. However, since our last report, both companies have reported traction for their navigation services and software.

- **Google:** Google's overall momentum in automotive continues to build. Increasing numbers of OEM brands are using Android Automotive to power their IVI systems and leaning on Google Automotive Services, including Google Maps, to provide the navigation experience. In February 2023, Mercedes-Benz and Google announced a strategic partnership to build Mercedes' own branded navigation experience based on in-car data and navigation capabilities from Google Maps Platform. The partnership is significant because Mercedes gains access to Google's navigation, places, and traffic data while maintaining control of the driver user interface, customer engagement and relationship. Separately, BMW announced it will integrate Android Auto OS (AAOS) on certain models and variants, although stopped short of using Google Automotive Services (GAS), like Google Maps. Other volume carmakers announcing use of AAOS includes Honda, Volvo, General Motors (GM), Ford, Stellantis, and Renault. Google's Android Auto smartphone mirroring solution remains a popular option for vehicle makers to include on their cars. At CES 2023 Google announced role in providing location services no longer remains limited to the vehicle infotainment system and it is now supporting ADAS and vehicle safety functions. Google's HD Maps is now available in select cars with Google built-in, beginning with the Volvo EX90 and Polestar 3.
- **Mapbox:** Since our last update Mapbox announced a partnership with Toyota Motors Europe to offer cloud navigation powered by Mapbox Dash, for European models, Yaris, Yaris Cross, and Aygo X. GM has elected to deploy Mapbox Dash, which Mapbox describes as a turnkey navigation application that runs on Android and Linux based infotainment systems. Mapbox also claims several vehicle makers launched products with Mapbox technology, including the Toyota Tundra and Rivian's R1T. It is working with Toyota Motors (North America and Europe) Rivian, General Motors (GM) and BMW. Mapbox claims

3D Live Navigation, which it launched in January 2023 supports ADAS hazard warnings.

Non-Automotive Location Services

	Google	HERE	Mapbox	TomTom
Non-automotive	5(4)	4(4)	4(4)	3.75(4)

TechInsights has reassessed this category to include non-road use cases, including a broader set of consumer digital mapping and location use cases, including asset tracing, fleet management, mobility, retail, fitness gaming and the entire breadth of applications. Both HERE's and TomTom's commercial focus understandably remains on higher-value market opportunities in transport and logistics, asset management, and mobility services, that are also centered on road-based map use-cases. In contrast Google and Mapbox have high penetration across the longtail of locations services and have also been successful in fleet management and mobility services. Despite growing traction non-automotive customers, from a revenue perspective HERE and TomTom continue to slowly grow beyond automotive, with non-automotive business growth in the low single digit range for both in 2022. While we believe HERE's non-automotive business to be stronger than TomTom's, TechInsights expects TomTom's score in this category will increase in future because Overture Maps will strengthen its ability to attract developers with monetization potential. As more developers begin use free Overture map data in their applications TomTom has potential to upsell higher value content layers and location services.

Google: Google is a leader in servicing a broad range of use cases. Google's non-automotive solutions are focused on transport and logistics (which includes on-demand and fleet), retail, financial services, real- estate and asset tracking. Google has a broad base of non-automotive customers which reflect its strength at servicing a broad range of sectors. Examples include delivery companies e.g. DPD, fleet management e.g. GO-JEK, ABAX, Fleetminder; insurance companies, e.g. Allianz, Allstate, Swiss Life; retail, e.g. The Home Depot, and Ikea, among others.

HERE: HERE's focus on non-automotive sectors remains targeted towards fleet management, supply-chain, mobility services, infrastructure planning, and public safety. HERE's solutions include

truck-optimized navigation. HERE has announced a range of non-automotive companies and use-cases as customers during 2022 and 2023, reinforcing momentum behind its transport and logistics division. It reports solid growth in software related deals from transport and logistics and strong usage of routing transactions from customers in this sector. HERE's platform approach has enabled it to capture a broad range of customers, distributors, and partners over the past 12 months. HERE claims its platform has over 40 partners and reaches over 2 million developers. Announced customers include traffic management solutions, Yunex Traffic, logistics provider, Hermes, last-mile solution provider, Bettermile. Customers include – mobility (Lyft, Cabonline, Iteris), logistics (AWS, PTV, Holcim, Glympse, Migros, Descartes), technology (Oracle, Cognizant, SAP), and telco (Verizon, Ericsson, Esri).

Mapbox: Logistics, outdoors, travel, business intelligence and real-estate are the five broad sectors Mapbox is targeting for growth outside of the automotive sectors. Mapbox has gained a broad base of companies in each of these industry segments, which reflect its strength in these domains. Mobility e.g. Curb, Va de Taxi, Cowboy; on-demand delivery e.g. Instacart; logistics e.g. Flybuy, Optym, Transfix; business intelligence e.g. Tableau, Power BI, sumlogic.

TomTom: TomTom's non-automotive use cases span fleet-management and logistics, mobility and on-demand, food delivery, and location intelligence. Like HERE, TomTom's focus has been on road-based use-cases. However, leveraging map data from OSM and other contributors to Overture will enable TomTom to better support a broader set of location use cases in future. TomTom continues to provide location services to companies in the transport and logistics sector, including Simacam, Descartes, Omnitrac, and Paragon, among others. In September 2022 it launched a truck version of its Go Navigation optimized for professional truck drivers. TomTom's solutions target other location sectors, with 'location intelligence' covering a broad range of use-cases. TomTom has announced customers across a broad range of sectors and uses, which reflect on its ability to service non-automotive customers. Examples include – mobility (Uber), logistics (Green Mile), business intelligence (Precisely), and insurance (Loop) among others.

Developer Community

	Google	HERE	Mapbox	TomTom
Developer	3(5)	4(4)	4(4)	3.75(3.5)

Developer platforms enable developers of all sizes to implement location capabilities into their applications and services, whether it is a simple vector map, providing routing and directions from A-to-B, through to geofencing and geolocation. Developer tools can be offered both directly via the platform’s portal, or indirectly via partners with established developer communities. Each of the location platforms has made improvements to aspects of their developer product, partnerships, and strategies. Overall, we have lowered Google’s score in this domain while raising TomTom’s relative score.

Google: Maps has a strong consumer brand and a large pool of developers. In June 2020 Google reported over 5 million projects from businesses of all sizes which use Google Map APIs. Despite its impressive developer traction, TechInsights has revised Google’s score down in the previous iteration of its benchmark report due to restrictions and limitations in how Google makes its location services available. First, Google is not independent due to its own consumer and business location services. This means developers are not able to use Google products to develop services which compete with Google’s own services. Second, developers using Google Maps can only use Google’s location services, and not integrate with third-party services. On one hand an integrated approach to location services offers a simplified and less complex experience. However, on the other hand differentiation is restricted. In March 2022 the US Justice Department is reported to have re-opened an investigation of Google Maps and these restrictive approaches in 2022 and the investigation remains ongoing. Google offers a broad range of location APIs, albeit fewer than both HERE and TomTom. During May 2022 Google has opened up ARCore Geospatial API to developers to encourage location-based AR experiences.

HERE: HERE reports over 2 million developers across its ecosystem of direct and indirect developers (which includes Amazon Location Service, Microsoft Azure, MuleSoft, and SAP, among other reselling channels). It has over half a million direct developers registered on its portal. Across both developer channels the number of API calls to its platform per month continues to grow. HERE continues to offer the

broadest range of APIs and SDKs to enable developers to build compelling apps. HERE's focus remains primarily on reaching enterprise developers seeking quality location services with longer tail developers a secondary target. HERE expects improved productization of its APIs and capabilities during 2023 will improve its ability to attract and monetize its customer base.

TomTom: TomTom has made improvements to its developer portal and TechInsights now views TomTom's location APIs and SDKs as on par with its competitors in terms of its core portfolio. It has also worked to improve the experience for developers. Like HERE, TomTom is focused on attracting active, enterprise developers, specifically in domains like fleet and logistics, ride-hailing, and food delivery. It is less concerned about attracting the long tail developer community. We estimate TomTom's direct developer base in the tens of thousands range, though it has potential to grow due to its new map platform and Overture Maps. TomTom continues to distribute and resell its location services via developer ecosystems, including, Microsoft Azure, Huawei, and Verizon. TomTom remains independent and therefore enables flexibility and openness to meet developer needs. TomTom's commitment to openness is reflected in its founding role in the Overture foundation and it has joined the OpenStreetMap Foundation as a platinum member.

Mapbox: Mapbox remains one of the leaders in developer community. Mapbox claims to have 3.9 million registered developers using its location SDKs and APIs, although its base of active developers is likely in the few hundreds of thousands range. These developers range from enterprise customers through to long tail developers. Since our last report Mapbox has enhanced its maps and navigation SDKs, which includes improvements to performance, visualization, and available functionality. Examples include, map internationalization, which enables products to dynamically adapt to different languages and world views, Globe View, and new APIs, respectively. Mapbox remains independent, open, and flexible for developers. Overall, Mapbox continues to offer the fewest location capabilities to developers of its competitors.

Map Data & Visualisation

	Google	HERE	Mapbox	TomTom
Visualization	4.25 (4.25)	4.25 (4.25)	5 (5)	4.2 (3.5)

Visualisation covers a broad range of capabilities and assets, including not just the ability to deliver customised and increasingly detailed map views, but also the analysis and manipulation of geospatial datasets which can be used by data scientists and non-developers alike. Vehicle OEMs are seeking rich visualisation options for screens in vehicles, including 3D and augmented reality representations of the world to enhance the driving experience. Demand for detailed and customisable visualisation of maps is also coming from other markets beyond automotive also looking to improve customer experiences.

Each location vendor has announced relative improvements and enhancements to the look, feel, range and performance of their digital maps. Mapbox remains a leader in this domain through further enhancements, while Google, HERE and TomTom, also improved. However, HERE remains a leader in how geospatial data can be interrogated and analysed with its augmented analytics approach.

Google: Google continues to score well in visualisation. It has improved its visualisation by adding features like 'search with Live View' which enables users to search for POIs by holding their smart phone camera up at buildings. Live View annotates the buildings with AR-based POI information. Immersive view provides immersive 3D views of major buildings in cities, and has been rolled out in London, Los Angeles, New York, San Francisco, and Tokyo.

HERE: HERE's visualisation capabilities meet various demands and needs from a range of customers segments. HERE Workspace enables non-developers and non-specialists to create cartographic based visualisations and some basic editing capabilities. However, tools like Data Inspector and its Data SDK for Python, combined with Workspace, are targeted at geo-specialists and computer scientist, and provides a deeper range of analytical and visual tools. HERE is aiming to differentiate in future from competitors by providing augmented analytics, which will enable the automation of data integration, analysis, and geospatial visualisation processes.

Mapbox: Mapbox remains a leader in providing map customisation and visualisation tools. Since our last report has added to its visualisation capabilities. In January 2023 it introduced Mapbox 3D Live Navigation, which combines its 3D lane models, sensor information, road sign data, environmental models, 3D buildings, and dynamic lighting conditions and weather.

TomTom: TomTom continues to move towards its goal to deliver best-in-class visualisation tools, which it stated last year as a strategic imperative. TomTom has demonstrated a clear improvement in the overall level of detail of its base maps by leveraging Overture Map data. TomTom has demonstrated enhancements to customisation and styling options and ease of use and is offering the ability for users to visualise imported data and customise map assets.

TomTom’s score has improved in this section by making a variety of visual improvements, including the addition of natural features to make its maps look closer to reality, and enhancing the look and feel with new colours and better labelling. TomTom is making detailed satellite imagery (30 cm resolution) available to catch up with its competitors. Moving forwards TomTom’s visualisation team is aims to provide a best-in-class visual experience for location data and is committed to driving further enhancement to current capabilities.

Vision and Growth Leadership

	Google	HERE	Mapbox	TomTom
Industry Vision	4(4)	5(5)	3(3)	4.5(3.75)

The vision of location companies are broadly similar and aligned with evolution across a number of industries, including automotive (e.g. connected cars, EV and autonomous driving), mobility (e.g. taxi-hailing, ridesharing, carpooling), fleet management and last mile delivery (e.g.) telematics, asset tracking, driver monitoring), and IoT (e.g. business/ location intelligence). However, noteworthy differences between location platforms remain worth highlighting.

Google: Through its strategic partnership with Mercedes, Google has demonstrated flexibility to address the needs of OEMs with a strong desire to retain control of vehicle user experience. Google is also offering OEMs HD maps which support advanced safety features. Google’s Waymo service is leading the way in enabling autonomous driving, and Google is actively developing Augmented Reality (AR) and

Virtual Reality (VR) capabilities that underpin the current 'metaverse' trend. Its recent launch of ARCore Geospatial API demonstrate its vision to enhance location services with AR experiences. Generally, Google continues to focus on improving its location products, including its Google Maps service, and making its Google Maps Platform developer friendly. While Google is clearly an innovative company which offers a best-in-class all-in-one map and navigation application, it is yet to communicate its vision to provide location services to support growing use-cases, like supporting ADAS capabilities in vehicles, enabling intelligent speed assist by providing comprehensive speed limit data, truck navigation and truck ADAS, transport and logistics or specific sectors beyond mobility and retail.

HERE: Despite the resignation of its CEO, Edzard Overbeek, HERE's interim leadership retain a clear vision for both platform evolution and industry growth across its target sectors of automotive, transport and logistics, mobility, and on-demand sectors. HERE remains committed to enhancing next-generation vehicle experiences, enabling automated driving, providing best-in-class EV services, and supporting both predictive logistics and private mapping. HERE's growth vision for the location sector reflects its broad ownership structure, which consists of vehicle OEMs (Audi, BMW, Mercedes), telecom provider (NTT), and chip suppliers (Intel), Continental, Mitsubishi Corp., and Pioneer. Ownership by Mitsubishi is opening a range of new use-cases for the company.

Mapbox: Overall, Mapbox remains focused on improving its overall location offering and has communicated a strategic focus of 'powering navigation for people, packages and vehicles everywhere.' According to Softbank's March 2020 presentation to announce its JV, Mapbox Japan, Mapbox Japan will also target innovative domains like automated driving, mobility-as-a-service, AI vehicle dispatch services, delivery services, robots and drones, and navigation. Mapbox was one of the first location platforms to enable AR-based driving navigation through its Vision SDK, leveraging the data to capture location content, like speed signs.

TomTom: We've increased TomTom's score due to its leading role in the creation of the Overture Foundation and Overture Maps initiative. Overture Maps will enable TomTom to deliver fresh and detailed maps cost efficiently by combining efforts with its partners and leveraging open map data standards. Overture Maps will enable TomTom to focus greater investment in acquiring higher value data sets which sit

above the base map data. TomTom remains focused on meeting the evolving requirements of the automotive sector other high value road-based use cases. Beyond automotive, TomTom is targeting companies engaged in the fleet and logistics, last mile delivery, ride-hailing and food deliver sectors. TomTom has stated its ambition to provide best-in-class map and data visualisation tools to address growing demand for rich map-based visuals across multiple sectors.

Environmental Sustainability

	Google	HERE	Mapbox	TomTom
Sustainability	4 (4)	4(3.75)	2.5(2.5)	4(4)

This new category, introduced in our 2022 benchmark, ranks location companies on the extent to which their businesses place environmental sustainability at the heart of their operations, and how they measure and verify their performance. By its nature the aim of location and location intelligence is to enhance and optimise business performance. For example:

- Identifying the most efficient, low-cost routes for transport and logistics companies.
- Locating infrastructure optimally to reduce costs and maximise performance.
- Tracking important assets to minimise wasted time, effort and resources either recovering or replacing lost assets.

Beyond these benefits, scoring in this category considers how well sustainability goals, strategy and governance are outwardly communicated via reports, recognised disclosure frameworks, press releases and new products. TechInsights expects the ability of firms to increase the sustainability of their businesses, including the products and solutions they sell, to play an increasingly important role in future success. Enterprise and businesses will seek out suppliers and partners that not only address commercial objectives, but that also fit with their own sustainability strategies.

Google, TomTom and HERE continue to show strong commitment to environmental sustainability by improving measurement and disclosing their environmental impact and targets, and by providing oversight over sustainability topics to their respective boards. TechInsights believes Mapbox is also committed to environmental

sustainability but does not score highly due to limited disclosure of its environmental impact and reliance on carbon offsets to achieve zero-carbon emissions. Google and TomTom are leaders in this category while HERE continued to close the gap during 2022.

- **Google:** Google's target for net-zero emissions across its operations and value chains is 2030, and to achieve a 50% reduction in absolute emissions versus its 2019 baseline, before 2030. Google has expanded the availability of 'eco routes' across Europe. Google estimates since launching in Canada and US, eco routes have helped remove over half a metric tons of carbon emissions. Google claims that since 2017 it matched 100% of annual electricity use with renewable energy sources. Google also provides a tool, called the Environmental Insights Explorer, designed to provide cities and regions with actionable data and insights to reduce global emissions, and project green light, an AI tool that delivers recommendations for city planners to optimise traffic light timing to reduce vehicles from stop starting.
- **HERE:** HERE made progress on environmental sustainability during 2022. It announced a commitment to reduce net-zero scope 1 and scope 2 carbon emissions 90% by 2035, using a 2019 baseline. It is also in the process of setting a science-based reduction target as defined by the Science-Based Target initiative (SBTi). HERE continued to focus on Environment, Health, and Safety (EHS) during the year. It has rolled out software to capture utility data from its offices. HERE continues to work towards ISO14001 and ISO45001 and has reviewed of the UN's Sustainable Development Goals (SDGs) to understand how its activities and products contribute to these efforts. During 2021 HERE embedded ESG into its corporate structure by forming a sustainability advisory committee and the appointment of an executive sponsor for HERE sustainability.
- **Mapbox:** Mapbox does not publish CSR or ESG reports, and neither has it outlined which disclosure framework it employs. However, it has outlined its sustainability targets in regular blogs and estimated the environmental benefit of its location technology. Mapbox claims it achieved carbon neutrality in 2016, which it achieved through purchasing carbon offsets and renewable energy credits. Mapbox also estimates its logistics

and fleet management tools reduce road freight emissions by 20%. TechInsights continues to award Mapbox a relatively low score in this category because it doesn't report key information including, how it measures, discloses, and verifies emissions across its business activities.

- TomTom:** TomTom has adopted the Greenhouse Gas (GHG) Protocol as the underlying framework for its emission reporting and has set 2030 as a target year to be carbon neutral. In 2022 TomTom achieved BREEAM (Building Research Establishment Environmental Assessment Method) In Use certifications of 'very good' for offices in Amsterdam and Eindhoven. TomTom has developed a high-level environmental policy, and its managements and supervisory boards are supporting initiatives for improving its reporting and defining KPIs. TomTom achieved external certification to ISO 14001 in 2015 and was recertified during 2021.

6. Strengths & Weaknesses

In the previous section TechInsights highlighted specific capabilities on which to benchmark and score the different location platform providers. However, enterprises of different types will have different needs and requirements for their location platform. In Exhibit 11 we summarise the relative strengths and weaknesses of each of the location platforms.

Exhibit 10 Strength & Weakness Analysis of Major Location Platforms

	Relative Strengths	Relative Weaknesses
Google	<ul style="list-style-type: none"> Very deep pockets (>US\$256 B in revenue in 2021) Strong consumer brand recognition - > Billion monthly active users of Google Maps worldwide Tuned to consumer trends due to dominance of search. Large base of GPS traces assist real time map changes Largest number of POIs and the most granular info 	<ul style="list-style-type: none"> Still perceived as a strategic threat by some carmakers No China presence Fake listings remain an ongoing challenge Concerns over privacy & use of data for advertising Its location services are behind a walled garden and less flexible vis-à-vis competitors Google is locked out of large developer ecosystems like Azure and Amazon Web Services (AWS)

	<ul style="list-style-type: none"> • > 150 M Local Guides (2023) contributing POI info • Millions of developers (>5 M apps and websites use Google Map APIs on a weekly basis) • Indoor venue maps – 10K locations • Leadership in AI/ML and cloud tech. 	
HERE	<ul style="list-style-type: none"> • Independent and open • Healthy annual revenue €946m in 2022 and a €4.5 b order book • Significant resources – >6K employees globally • Leading map provider in North America and Western Europe (claiming ~70% market share 2022) • Leader in Intelligent Speed Assist • Strong ADAS and HD Map momentum • Influential investors and partnerships in key LBS growth areas e.g. automotive, industrial Asia • Large addressable market through third-party developer platforms e.g. AWS, Azure, SAP, etc. • Global coverage, including China, Japan, and South Korea • Strong growth vision and product lines beyond automotive • Full range of map making tools, powered by UniMap • Large enterprise customers (e.g. Amazon, MSFT) • Hybrid navigation mode in absence of connectivity • Strong messages on privacy 	<ul style="list-style-type: none"> • Currently seeking a new CEO to replace Edzard Overbeek • Weak in long-tail developer v Google and Mapbox • Limited consumer brand
Mapbox	<ul style="list-style-type: none"> • >700 M monthly active location (GPS) probes/ users • Leader in map data visualization • Independent and based on open principles • Strong in software • 2.7 m customers using its navigation and location tools. • Large developer community 3.9 m registered developers 	<ul style="list-style-type: none"> • Fewest employees – 700 globally • Doesn't control its own map; OSM dependence • Susceptible to malicious map edits • Remains weak in automotive location content • Weak indoor/ venue coverage

	<ul style="list-style-type: none"> • Used in >45 K apps • Location leader in Business Intelligence (BI) sector • Investment from Softbank • Presence in China and Japan via JV 	
TomTom	<ul style="list-style-type: none"> • Well-resourced with 3.8k globally and €358 m spend in R&D • Combining its resources with AWS, Meta, and Microsoft to develop enhanced base maps leveraging checked OSM data. • TomTom remains a strong consumer navigation brand • Leader in navigation software with 15 OEM customers • Leader in traffic data (live and historic) in North America Western Europe • Focused on automotive and enterprise • Open and flexible for developers • Aggressive pricing of location services • >600 M active GPS probe points • Closing the gap on map and data visualisation. • Large addressable market through third-party developer platforms e.g. Azure, Huawei, Verizon, etc. 	<ul style="list-style-type: none"> • Less well-resourced versus Google and HERE • Reliance on Apple for probe data • Weak indoor/ venue coverage • Declining consumer business (PND) risks stability

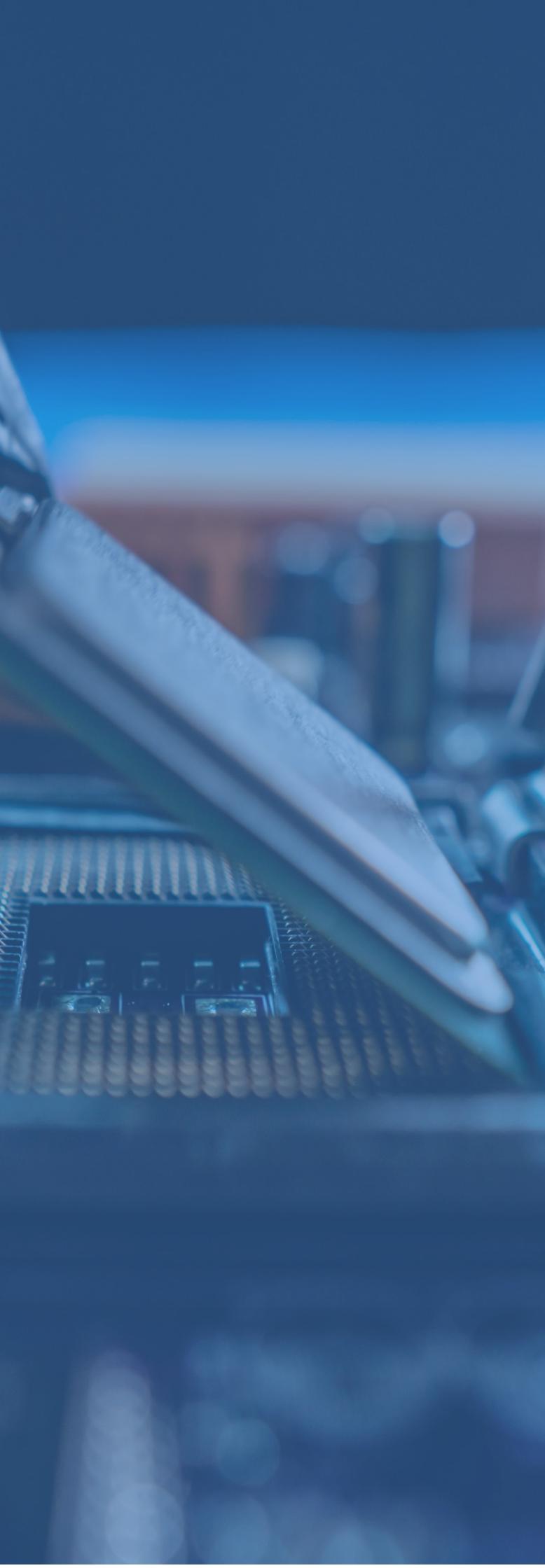
7. Related Reports

We recommend reading the following additional research for context (subscription may be required):

- [Navigation & Location-Based Services 2022 – The Value Layer Conundrum](#)
- [TomTom Pivots: Capital Markets Day Reaction](#)
- [xEV Systems Demand Outlook 2021-2030](#)
- [Global Annual IoT Revenues Forecast by Vertical: 2022-2030](#)

8. Analyst Contact

The authors of this Insight, **Nitesh Patel**, can be reached at nitesh.patel@techinsights.com or by using the following telephone number: **+44 1908 423 621**



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TechInsights

1891 Robertson Road
Suite 500
Ottawa, Ontario K2H 5B7 Canada

T 1-613-599-6500

F 1-613-599-6501

Web site : www.techinsights.com

E-Mail: support@techinsights.com