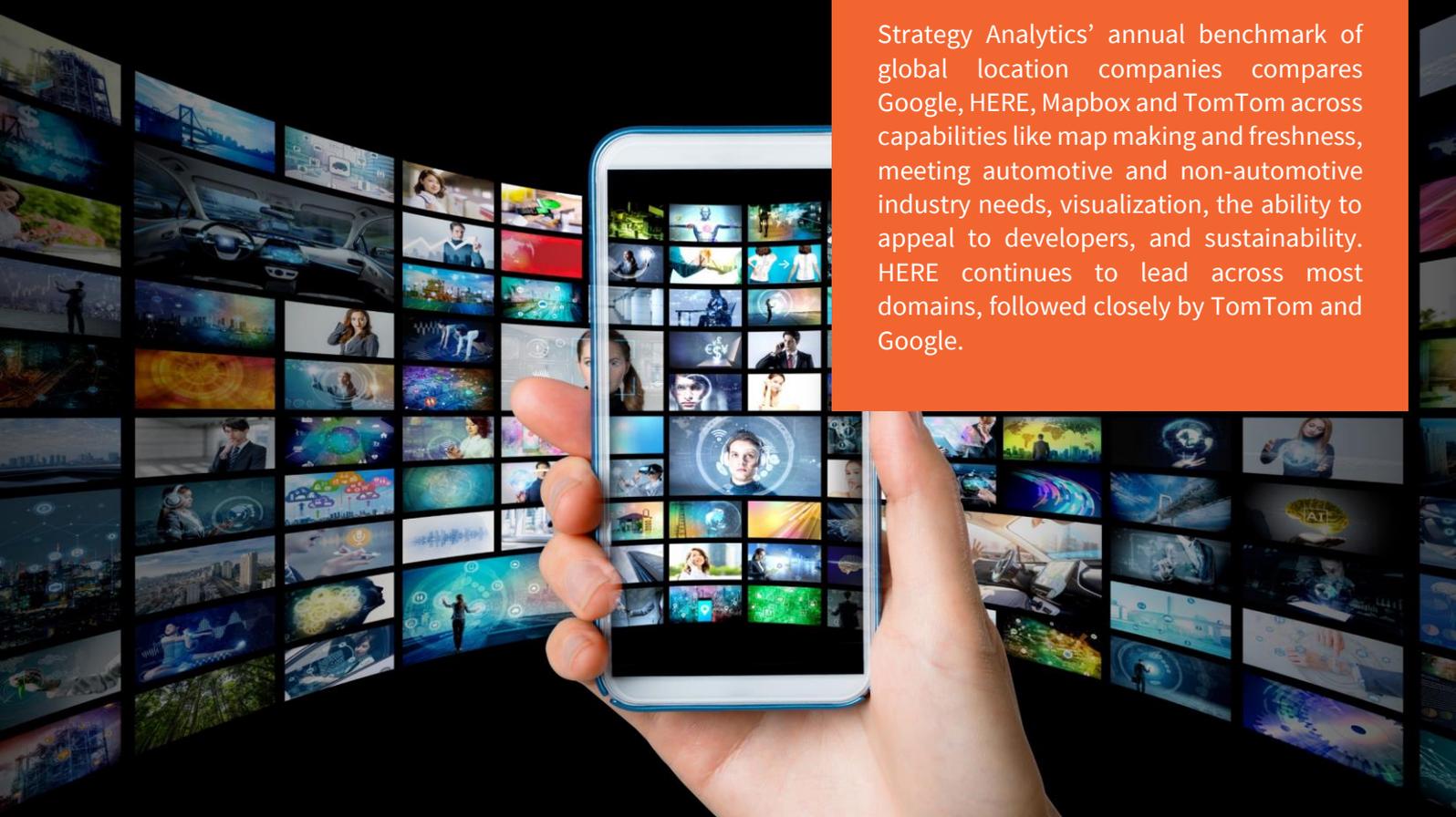


Location Benchmarking Report: 2022

25 May 2022

Report Snapshot

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



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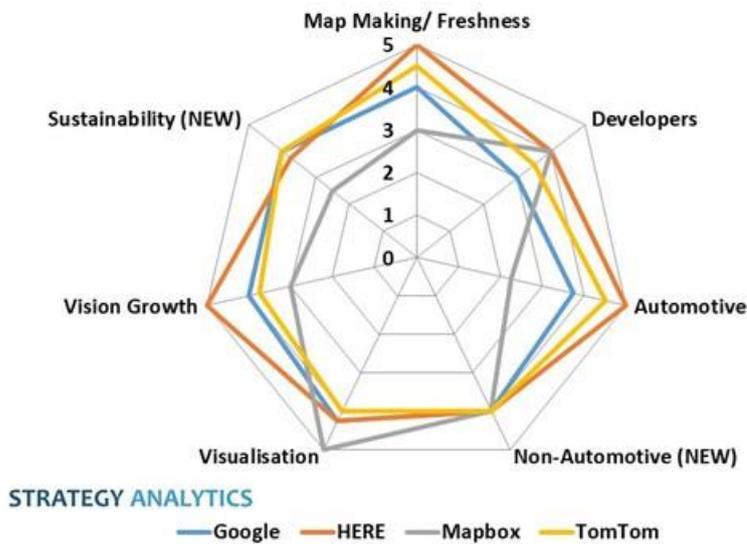
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1. Executive Summary

Competition in the location sector remains intense as use-cases for map and locations services and the nature of demand across key markets evolve. In the 2022 Strategy Analytics' location-platform benchmarking report HERE ranks as a leader and co-leader across many of our seven categories and is followed closely by TomTom and Google. Mapbox remains in final position.

- Strategy Analytics 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 is also a co-leader in non-automotive and developer community. HERE remains a leading provider of location content to the automotive sector, including ADAS and HD content. HERE's platform approach maintained its momentum with strong non-automotive growth across target sectors, e.g. transport and logistics, telecoms, media, and technology, among others. The key pillars of HERE's growth strategy remain partnerships, an open, multi-platform approach, industry vision 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. Lack of ADAS content combined with limited flexibility and independence has weighed on its mapping and developer scores. Google has significant resources, tech leadership, and a strong consumer and developer brand in location services as key strengths.
- TomTom has overtaken Google in map making and developer community and is a joint leader in servicing non-automotive needs, particularly transport and logistics. It is a joint leader in sustainability and is closing the gap in industry vision, visualisation, 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.



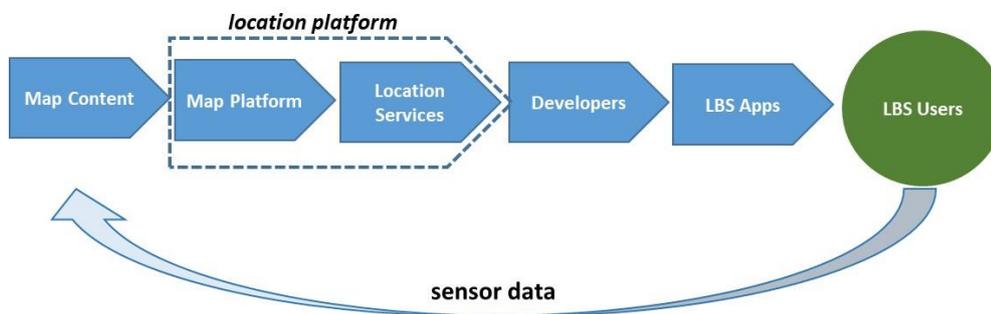
Source: Location Benchmarking Report: 2022, Strategy Analytics

2. Introduction

2.1 Location Platform Definition

Strategy Analytics defines a location platform as a company which provides customers with 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, organisations, 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 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 customized depending on customer needs.

2.2 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 a role in creating highly accurate maps with sub-meter precision and scale. So too is the falling cost associated with capturing high-definition imagery, lidar and other map data inputs. These highly detailed and attributed maps support a variety of increasingly sophisticated use cases, delivering precision 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 requires 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 Strategy Analytics notes that location platforms HERE and TomTom have indicated a significant step change increase in the volume of real time imagery captured by cameras installed on fleets. The combination of this imagery

3. Location Sector Demand Drivers

The growth outlook for location services and location intelligence remain 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 visualise and perform geospatial analysis on geotagged data to analyse performance and generate critical business insights.

However, for many of these industries the nature of demand for location services is evolving and creating growth opportunities for suppliers capable of addressing these expanding needs and uses. For example, the automotive industry is looking 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 different 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

3.1 The Automotive Industry

During 2021 the passenger vehicle market rebounded from the negative impact on sales caused by the 2020 COVID-19 pandemic and remains on an annual growth trajectory, despite supply-side challenges due to **semiconductor shortages** and **fallout from the war in Ukraine**.

The automotive sector remains a significant source of revenue for providers of location content and location services and will continue to do so as the nature of demand continues to evolve. The automotive industry includes light-duty vehicles e.g., passenger cars and vans, and heavy-duty vehicles, such as trucks, buses, and coaches.

Strategy Analytics expects that the increasing penetration of embedded navigation in mass market vehicles, growth in the ownership of **electrified vehicles**, mandates for **ADAS features like ISA**, and **vehicles with autonomous capabilities** to result in continued expansion of demand for automotive-grade location services. With vehicles becoming more software defined **displays are replacing traditional instrument clusters**, redefining infotainment and navigation visualisation.

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, providing information including the location of compatible charging points, the availability of those charge points, and supporting EV specific routing that calculates the optimal journey which takes charging times into consideration. Strategy Analytics 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 business model for road-based navigation systems continues to evolve as vehicles become connected and software defined. Historically, car OEMs have licensed location content and navigation software from location companies and tier one suppliers to build their embedded IVI navigation systems. However, rising vehicle connectivity means automakers are moving to hybrid navigation, which combines embedded map data to support offline navigation and incremental over-the-air (OTA) map updates. Fully online navigation solutions rely on data connectivity while hybrid systems fall back to embedded maps when coverage or signal is poor.

The approaches of different OEMs and brands can also vary. Some vehicle makers are keen to differentiate the overall driving experience by adopting the best-of-breed software and services and building the experience in-house. VW's subsidiary, CARIAD, and Toyota's Woven Planet are two examples when the carmaker has created a subsidiary specifically to address the increasing software-based needs of OEMs, including navigation, safety, and autonomous systems. In June 2021, Woven Planet, announced the acquisition of **CARMERA**, a US-based spatial AI company specialising in road-intelligence to bolster Woven Planet's Automated Mapping Platform. In April 2021 Toyota acquired Lfyf's self-driving unit for \$550 m. In contrast, some OEMs are seeking out-of-the-box solutions, or their own balance between customised needs.

3.1.1 The Continued Rise of In-Vehicle Navigation

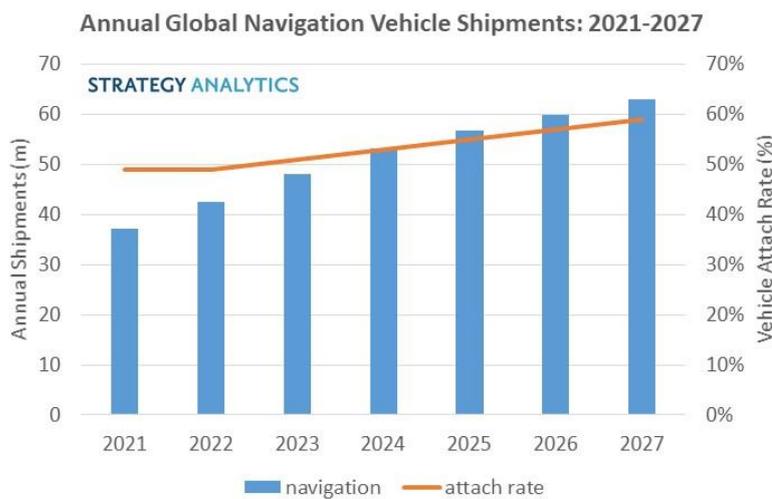
Navigation remains the primary use case for location services and software within the automotive sector, whether this is directly through embedded, or hybrid navigation software integrated with the in-vehicle infotainment (IVI) system, or indirectly through Portable Navigation Devices (PNDs), smartphone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

Embedded and hybrid navigation solutions were once available on luxury models or as an optional extra. However, they are now becoming table stakes in the volume car segment. Strategy Analytics forecasts volumes of embedded and hybrid IVI navigation systems will double globally from 31 m at the end of 2022 to 63 m by 2027, Exhibit 1. This equates to navigation penetration of shipped cars rising from just below 50% to nearly 60% across the period. This

Globally, in-vehicle navigation sales will double from 31 m at the end of 2022 to 63 m by 2027

growth in demand for navigation systems will provide continued growth opportunities for suppliers of location content and locations services.

Exhibit 2 Annual Global Navigation Shipments: 2022 – 2027



Source: Strategy Analytics, Infotainment & Telematics

3.1.1.1 Rising Electric Vehicle Production

An increasing proportion of the 63 m navigation enabled vehicles sold in 2027 (noted above) will be electric vehicles with EV-specific navigation features.

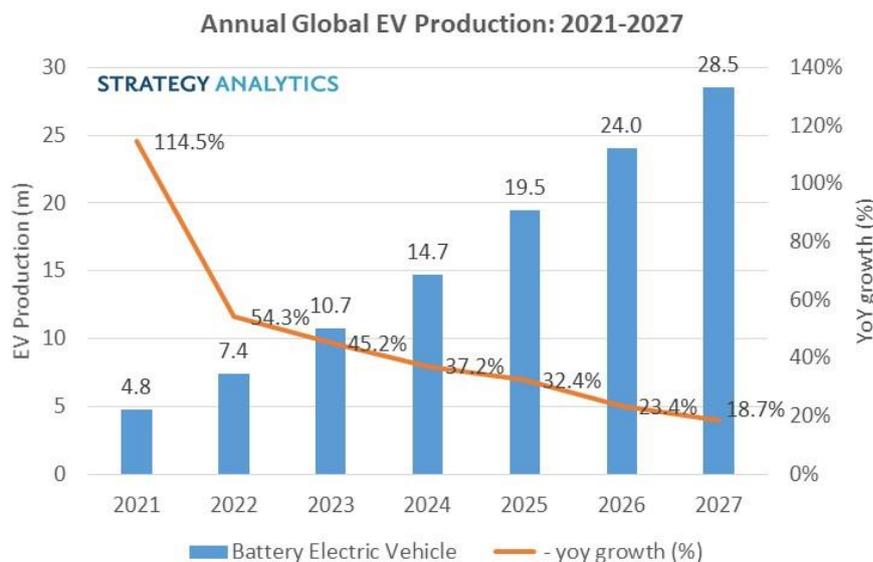
EV navigation services have evolved to address some of the early challenges facing EV drivers, including the limited range which EVs can travel before a recharge, and the limited numbers of EV charging stations. Fragmentation of EV charging connectors across vehicle brands and models introduces further complexity for drivers. Consequently, EV OEMs are introducing location-powered services that can ease ‘range anxiety’ for EV drivers and improve the EV driving experience. These EV navigation services include information, such as an estimate of the driving distance based on current vehicle charge, the location and availability of compatible EV charging stations, and EV specific routing, which is 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 visualisations, and building EV-optimised 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.

Strategy Analytics estimates global electric vehicle (EV) production will expand 286% to reach 28.5 m EV vehicles between 2022 and 2027, Exhibit 3. Across this period Strategy Analytics forecasts double digit growth year-on-year.

Exhibit 3 Annual EV Car Production Growth: 2021-2027



Source: Strategy Analytics, Powertrain, Body, Chassis and Safety

Annual production of EV vehicles will expand 286% to reach 28.5 m units between 2022 and 2027

3.1.2 Advance Driver Assistance Systems

Strategy Analytics expects growing automaker demand for advance driver assistance systems (ADAS) features, like predictive powertrain control, intelligent speed assist (ISA), and lane departure warnings, among others, to meet vehicle regulations and to increase driver safety.

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. One example of this is the speed limit assistance function which will become mandatory for all new-design vehicles sold in Europe from mid-2022, and for all new vehicles sold from mid-2024. This function needs to know the current speed limit to warn the driver and slow down the vehicle if the limit is exceeded. Most car makers are looking to a combination approach which relies both on an on-board map of which speed limits apply to which road as well as a camera to detect speed limit signs by the roadside. The ability to supply such a map, as well as create a “virtual horizon” of what is ahead is thus becoming very important, as is the ability to cost-effectively keep that map and horizon data up to date for at least 7 years after the sale of the vehicle.

This mandate will further increase the penetration of windshield-mounted cameras, which are now expected to be fitted to over 75% of all light-duty vehicles produced globally in 2025. These cameras will become important data sources, and mapping providers without access to user-generated camera data may struggle to offer a compelling solution in the future. Detailed coverage and forecasts of key trends relating to assisted and autonomous driving are published in [Strategy Analytics' Autonomous Vehicles service](#).

Strategy Analytics 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.

The penetration rate of L2 capable vehicles (offering similar capabilities to today's autopilot-enabled Tesla models) will likely have hit 45% of annual production in 2030, rising rapidly to 70% by 2035.

3.1.3 Autonomous Driving

Over the next five to ten years, fully autonomous vehicles will account for a negligible share of vehicles sold. Strategy Analytics only expects the penetration of fully autonomous, 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 45% of annual production in 2030, rising rapidly to 70% by 2035. The maps that these vehicles need (which may well not be based on data gathered by high-precision survey vehicles) is the market that is worth fighting over, and increasingly Strategy Analytics is seeing that automakers and suppliers want more control over the mapping ecosystem and are thus both partnering and making acquisitions to build up their own capabilities.

- One such example is the partnership between Mercedes-Benz and NVIDIA. Both companies are aiming to release a new platform for the future of a software-defined vehicle. NVIDIA's acquisition of the HD mapping start-up, **DeepMap** (June 2021) will help the company enhance its strength in localization and mapping for autonomous driving and provide more solutions to automakers, without the need of classical mapping providers e.g., HERE Technologies, TomTom, Zenrin and others.

Towards the end of 2021 Daimler's Mercedes Benz S-Class and EQS became the first commercially available SAE Level-3 capable autonomous vehicles in Germany, albeit restricted to speeds up to 60 km per hour. Notably, Daimler's DRIVE PILOT system is powered by HERE's HD map. Mercedes is also seeking regulatory approval to offer DRIVE PILOT in California and Nevada by end 2022.

Detailed coverage and forecasts of key trends relating to autonomous driving are published in [Strategy Analytics' Autonomous Vehicles service](#).

3.2 Enterprise (Non-Automotive)

Beyond the automotive industry demand for 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.

The trend towards improved sustainability is also driving demand for tools to enable enterprises to optimise 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 can help enable enterprises with fleets to optimise their operations by calculating the most emission friendly 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 buildings) to be tracked, and the efficiency of processes to be better managed.

Furthermore, 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 analysed 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 intervention is necessary improve conditions.

3.2.1 Location Intelligence

Enterprises across different industries that are striving for greater efficiency and improved competitive performance are accelerating their efforts in

Location services can help enable enterprises with fleets to optimise their operations by calculating the most emission friendly routes and enabling businesses to make environmentally smart decisions about where to locate factories and premises

digitalisation, business intelligence, and location intelligence across their operations.

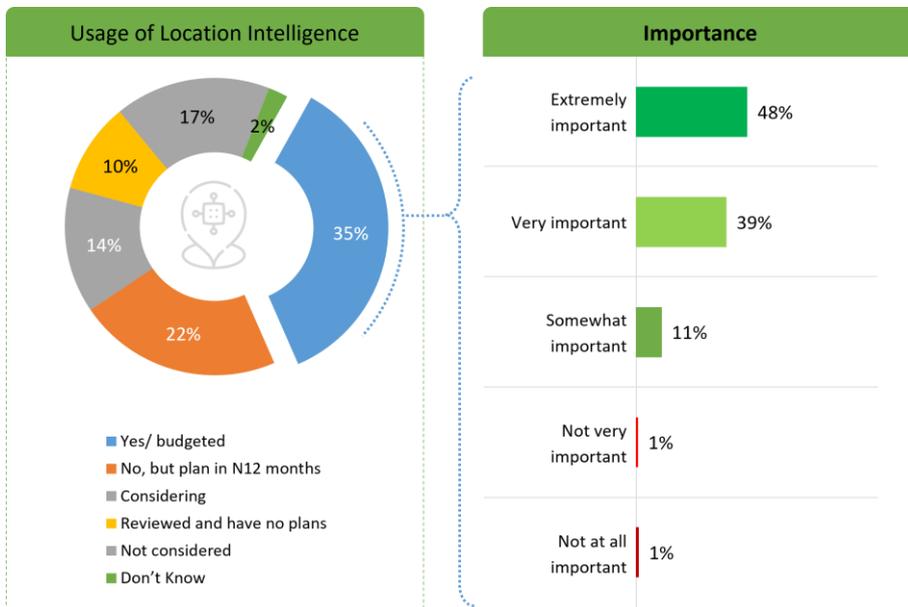
Location intelligence, which we define as the integration of first-party and third-party data with geospatial services (e.g. maps, routing, geocoding, search, etc.), is a benefit derived from the digitalisation of business processes and the proliferation of IoT. Location intelligence provides enterprises with geospatial context to enhance decision making, optimise 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 according to time 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 looking 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 Strategy Analytics 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 & Importance of Location Intelligence



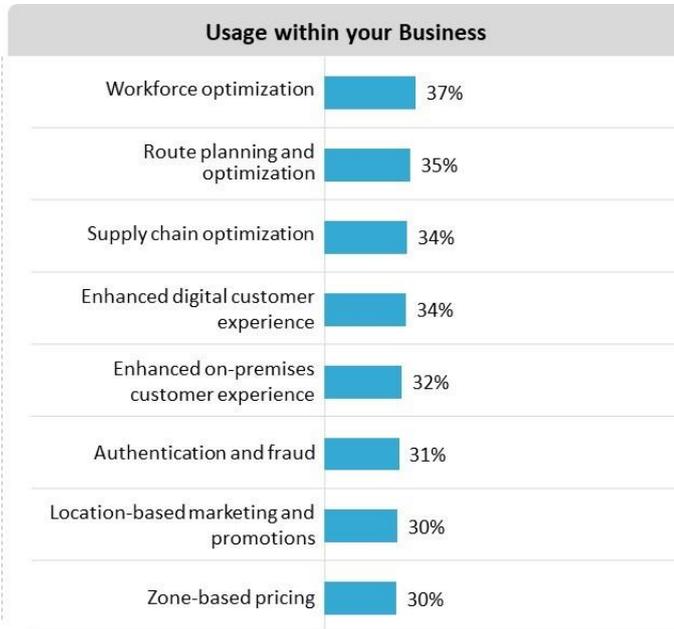
Source: Strategy Analytics

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 optimisation, followed by 35% for route planning/ optimisation, 34% for supply-chain optimisation, 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.

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

Exhibit 5 Location Intelligence Use Case Popularity

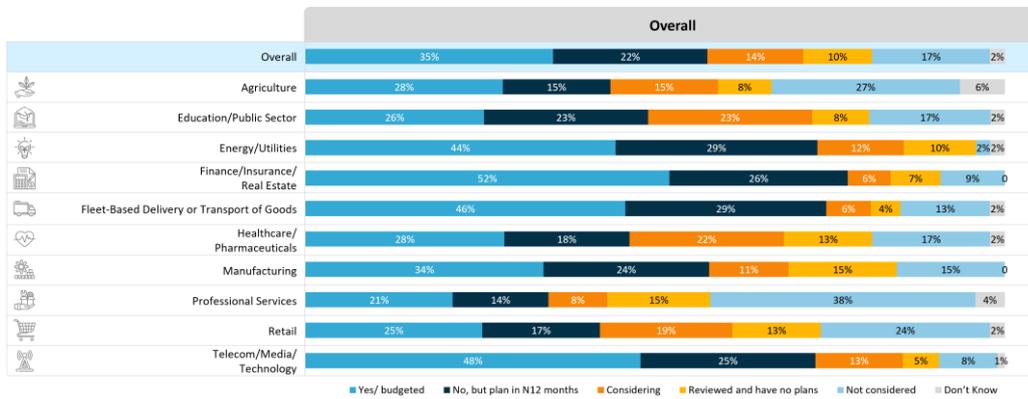


Source: Strategy Analytics

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.

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 - 76, 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?

Source: Strategy Analytics

3.2.2 Transport & 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 optimisation, 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, Strategy Analytics 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, Strategy Analytics' 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.

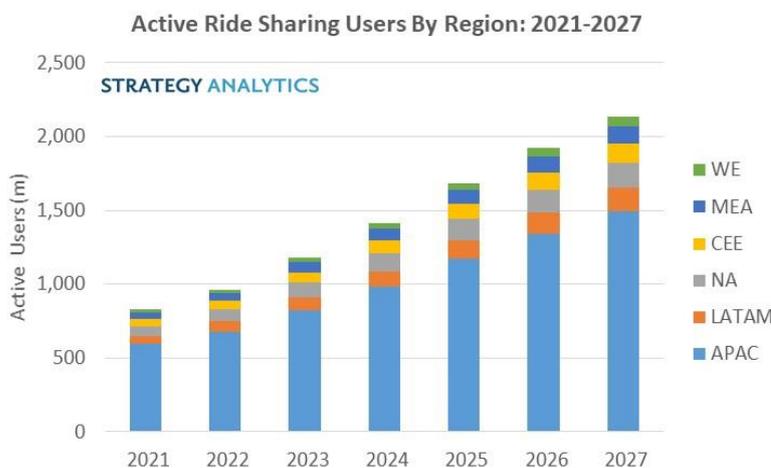
3.2.3 Mobility Services

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.

During 2021 the ride-hailing sector began its recovery from the **negative impact of the COVID-19 pandemic** and demonstrates strong signs of future growth. Strategy Analytics forecasts the number of active ride-hailing users to more than double globally and **exceed 2.1 B by the end of 2027**, Exhibit 7. The doubling in the base of active ride-sharing users 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. Therefore, rising numbers of users of mobility services globally will drive continued growth in location service usage.

Exhibit 7 Global Active Ride-Hailing User Forecasts: 2021-2027



Globally, active ride-hailing users will more than double and exceed 2.1 billion by 2027

Source: Strategy Analytics, Connected Mobility

Strategy Analytics' 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 m globally.

3.2.4 Asset Tracking & 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 optimisation 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 behaviour, 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 700 US fleet managers in its 2021 [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 a 41% improvement in vehicle maintenance for respondents in the transportation sector and a 53% decrease in fuel consumption for those in the services industry.

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 [falling 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 years¹

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.

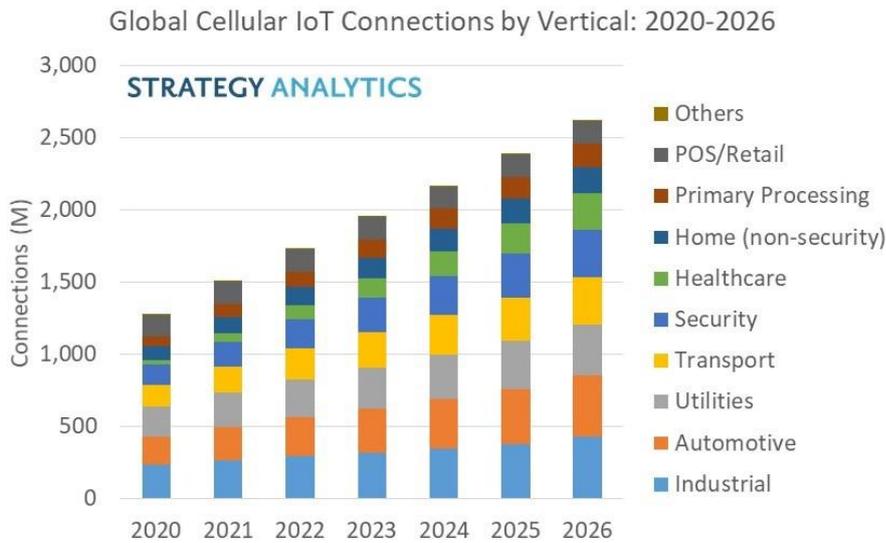
IoT presents a future growth opportunity for location platforms as the number of devices connected to the internet increases. Strategy Analytics' **Enterprise IoT Strategies** service estimates the number of devices connected over the cellular network is set to grow at a 12% CAGR between 2020 and 2026 across a variety of industry verticals, Exhibit 8. IoT in Healthcare, is set to show the strongest growth, followed by Security, Primary Processing and Automotive. Cellular connectivity will enable enabled equipment to be tracked or

Strategy Analytics expects a 12% CAGR in the number of cellular IoT connections between 2020 and 2026 to drive demand for location services.

¹ <https://www.actility.com/customer-stories/die-mobilier/>

monitored, although clearly not all these connected devices will need support from geospatial services e.g. geolocation, directions, or routing.

Exhibit 8 Global Cellular IoT Connections: 2020-2026



Source: Strategy Analytics, Enterprise IoT Strategies, Feb 2021

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.

3.2.5 Mobile Apps

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 authorised 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 just above 1.48 Billion at the end of 2022 to nearly 1.71 B by the end of 2026, according to Strategy Analytics' Emerging Device Technologies service.

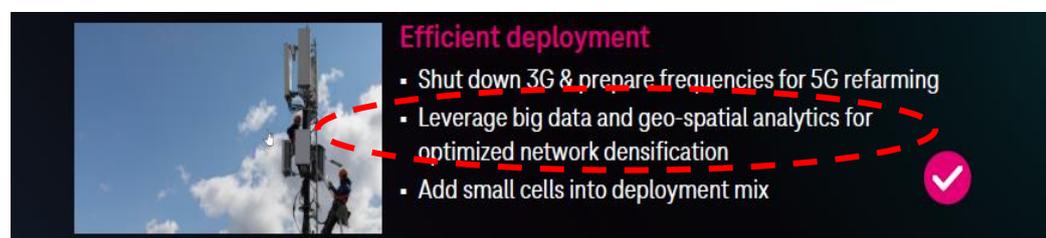
App-store users: Strategy Analytics estimates the population of users accessing app-stores to download apps and games will rise from nearly 3.4 B at the end of 2022 to over 3.8 B at the end of 2026, thus increasing the addressable market of users able to download location-based applications.

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 approach 4.8 B by 2026.

3.2.6 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 optimise 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 optimised 5G network densification.

Exhibit 9 Deutsche Telekom Targets Geo-spatial 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. Strategy Analytics expects strong growth in 5G network deployment over the next 5-years as the number of 5G subscribers expands from almost over 1.35 B at the end of 2022 to nearly 3.9 B by 2026.

4. Benchmark Update & Summary

Strategy Analytics 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, developer community, automotive, non-automotive, map and data visualization, growth and leadership, and environmental sustainability. In this year's benchmark update Strategy Analytics 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.

Developer community: Each location provider offers developers 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.

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 (NEW): 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.

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 growth 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 (NEW): 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.

4.1 Benchmark Results

Competition across each benchmark category remains fierce between Google, HERE, Mapbox and TomTom, with each evolving their capability set 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, closely followed by Google and TomTom, and then Mapbox.

Google: Google has made improvements in several areas over the past year, introducing some flexibility and customisation options for developers, enhancing overall map content layers, and improving visualisation options. It has introduced eco-friendly routing in Google Maps and overall Google is committed to minimising its environmental footprint. In automotive, Android Automotive OS continues to gain mass market OEM customers (e.g. Honda, Volvo, GM, Ford, Stellantis and Renault), while Android Auto is well penetrated. However, Google's focus remains on infotainment and it currently doesn't offer maps or location services to support vehicle performance and safety systems such as predictive power management, intelligent speed assistance, lane departure, and hazard warnings. Google continues to target a broad range of sectors like mobility, transportation and logistics, retail, and other domains with its location solutions. Google's lack of openness and the limitations it imposes on developers weighs on its developer and overall score.

HERE: HERE's activities over the past 12 months have focused on enabling OEMs to meet EU intelligent speed assistance (ISA) laws, improving EV driving experiences, providing comprehensive parking information (indoor and outdoor), supplying detailed road rules and regulations information, supporting truck and fleet use cases, and addressing non-automotive use cases

such as autonomous delivery, **metaverse/ AR**, and digital twins. Addressing a broad range of needs at scale positions HERE as a leader in map making. HERE remains a leader in servicing the automotive market with navigation and safety (ADAS) products, and its HD map powers SAE level 3 automated driving in Germany, and likely in the US before the end of 2022. HERE is committed to environmental sustainability across its operations and its partners. HERE's mapping-as-a-service capability is unique among its competitors while its marketplace continues to build momentum with growing numbers of companies making their location data assets available for monetization or exchange. HERE remains independent, open, flexible and provides developers and customers with highly customisable and off-the-shelf solutions. HERE is a leader in presenting a strong vision for its role in supporting emerging and future use-cases for location services across many sectors.

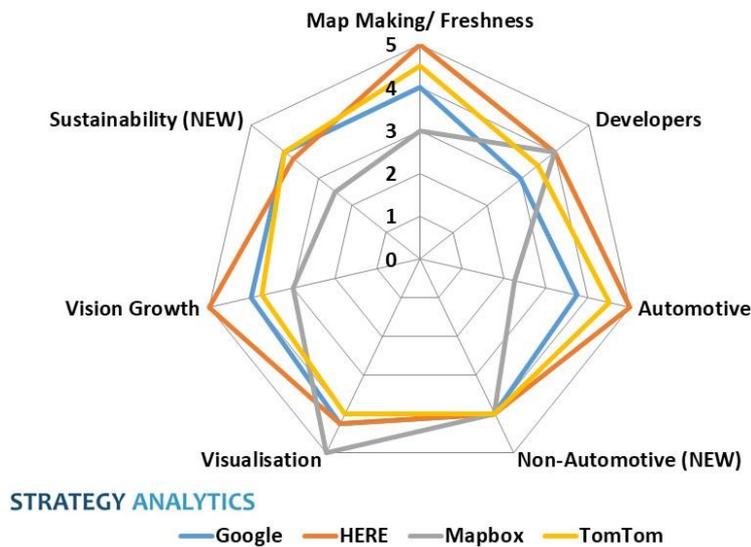
Mapbox: Mapbox continues to improve its location proposition since our last report, adding to its navigation capabilities, updating map imagery, and enhancing map rendering performance. It has also recently launched a preview of Mapbox Fleet, designed to meet the needs of road-based fleet companies. Mapbox remains 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: TomTom has strengthened its score across a variety of domains, including map-making and maintenance, automotive, non-automotive and visualisation. TomTom communicates strong traction for its ADAS products and has highlighted the strength of its ISA (speed limits) offering, truck navigation, and has launched its own infotainment software ecosystem, IndiGo, as it seeks to move up the infotainment value-chain and target OEM's evolving needs. TomTom's partnership with VW subsidiary, CARIAD, and other

announced automotive wins (Nissan and Genesis) demonstrates its strength in navigation software and traffic. TomTom has sought to improve its developer experience and notably it’s map and routing APIs have won developer awards while it has also announced updated APIs to support route analysis, matrix routing, and waypoint optimisation. TomTom improves its score for innovation and industry vision due to the launch of IndiGo 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 10 Location Platform Benchmark Score Summary



Source: Location Benchmarking Report: 2022, Strategy Analytics

Benchmark Scores	Google	HERE	Mapbox	TomTom
Map Making/ Freshness	4(5)	5(4.5)	3(3)	4.5(4)
Developers	3(5)	4(4)	4(4)	3.5(3)
Automotive	3.75(3.5)	5(5)	2.25(2)	4.5(4.5)
Non-Automotive (NEW)	4	4	4	4
Visualisation	4.25(4.25)	4.25(4.25)	5(5)	4(3.75)
Vision Growth	4(4)	5(5)	3(3)	3.75(3.5)
Sustainability (NEW)	4	3.75	2.5	4

Source: Strategy Analytics

4.1.1 Map Making & Map Freshness

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

Each location platform deploys a broadly similar multi-source approach to compiling data required to build and maintain its maps. We discussed these approaches in detail in section 2.2 of our previous [Location Platform Benchmarking Report: 2021](#).

At a high level, map maintenance requires continuously combining and conflating data captured from multiple sources, including authorities, mobile mapping survey vehicles, satellite and aerial imagery, crowd-sourced information, and sensor derived observations, e.g. anonymised GNSS probe data or front-facing cameras on vehicles. According to both HERE and TomTom the volume of street level imagery acquired from vehicle cameras on vehicles has exploded significantly over the past 12 months and will continue to rise as numbers of vehicles with front-facing cameras increases. Computer vision is routinely applied to imagery to identify, classify, and label features such as roads, road signs and buildings. AI performs quality checking to ensure any changes that have been detected are not erroneous and align with data present in other map layers. The updated map data is compiled and published incrementally, either in a matter of a few days, weeks, or over a period of a month, depending on the use-case or customer and subject to quality checking against other known map content features and attributes. AI is also used to capture relevant information published online by authoritative sources, such as planned road works, or building construction.

Both the range and nature of attributes collected by location companies continues to expand and evolve to better serve a variety of use-cases, including [mobility services](#), [EV](#), [ADAS](#), [autonomous vehicles](#) (including [drones](#)), [transport and logistics](#), and smart cities. For example, information about the location of bike/ scooter sharing hubs, EV charge points, accurate speed limit data, road rules and regulations, road elevation and curvature, public transit timetables, and both indoor and outdoor parking information is increasingly important for location companies to provide potential customers.

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 is 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. HERE remains part of the OneMap Alliance aimed at providing a single HD map globally. Mapbox has created a JV with Softbank, one of its investors, to target digital map growth opportunities in Japan and across the Asian region.

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 each score strongly in this category. HERE in particular stands out with its maps supporting a broad range of use-cases and its mapping-as-a-service proposition.

Google: Google deploys significant resources to build and maintain its map, while also relying on probe data inputs from a base of opted-in Android powered smartphones, and its community of over 120 m active local guides that provide their inputs. Google Maps covers over 200 countries and territories with navigable maps. During 2021 Google claims to have expanded the availability of more detailed street maps to over 50 cities. Despite these strengths Google is banned from providing its services in China, which represents a notable gap in country coverage. While Google collects map data at scale, it does not provide the levels of depth necessary to support growing OEM demand for features to support ADAS functions, like predictive powertrain control or speed limit assistance. Google provides indoor venue maps which remain important for navigating complex indoor locations like airports, exhibition halls, and large public and private buildings.

HERE: HERE claims to be a leader at mining a diverse range of location data including its own fleet of HERE True vehicles, tens of billions of daily probe data points, hundreds of thousands of community editors, satellite imagery and expanding volumes of street level imagery (SLI) from over 30 m connected vehicles. HERE offers maps for 200 countries and navigable maps for 164 countries. HERE is unique in providing enterprise customers with mapping-as-a-service offering. HERE offers comprehensive road rules and regulations data, including information about environmental zones, toll costs for passenger and commercial vehicles to assist both consumer and commercial automated driving. Supporting ISA and EV has been a priority during 2021 and will remain so in 2022. HERE's mapping is also focused on truck ADAS, and it continues to increase its parking database for on-street, off-street and indoor parking venues. Partners like Lyft, Didi (outside China) and others are also contributing to enhance HERE' geospatial content. HERE has increased the number of automatically dictated observations, community edits, probe point volumes and data acquisitions significantly. HERE's map content is supporting emerging non-automotive use-cases which include robotic delivery, multimedia use-cases such as the metaverse, and visual simulations.

TomTom: Like both Google and HERE, TomTom deploys significant resources acquiring relevant map data (GPS probe data, community and partner inputs, mobile mapping vehicles, satellite and aerial imagery and authoritative sources). TomTom highlights a significant increase in imagery captured by front facing cameras on vehicles over the past year. TomTom claims to cover 199 countries and territories with navigable maps, and 191 with its voice maps. From a crowd sourcing perspective, TomTom claims its map editing partnership (MEP) program, which enables certified employees of partners such as Microsoft, Uber, Huawei, Sygic, MAPIT and LocalKnowledge, has accumulated over 71 m edits during 2021 across 183 countries. TomTom claims leadership in ISA drive test performance and strong capabilities to support ADAS services. Indeed, in January 2022 TomTom announced over 5 m vehicles rely on TomTom's ADAS map. TomTom also collects and offers relevant data to support truck navigation, including road rules and prevailing regulations.

Mapbox: Mapbox uses OpenStreetMap (OSM) as one of several sources to build its map and relies heavily on anonymous, opted in, sensor data collected from over 650 m users that use apps integrated with Mapbox's map. Mapbox also

uses its Vision SDK to capture road related data, like traffic signs. Mapbox support of ADAS features remains limited, as does its support for truck navigation use-cases. Like all other location companies in our benchmark Mapbox supports EV routing, aimed at identifying optimal routes which include the best stops, if charging is required. Mapbox performs weakly in this category because it does not build its own map and is reliant on community edits to OSM. Relying on community contributions leaves OSM vulnerable to incomplete, erroneous and malicious edits, despite Mapbox introducing quality checking processes. OSM received around 4 m map edits per day during Q4 2021 from 1.75 m contributors.

4.1.2 Automotive Location Services

HERE continues to lead in automotive services, with TomTom 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. Both HERE and TomTom face strong competition from Google for infotainment navigation services but not for ADAS, currently. Increasing numbers of large 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. Mapbox remains on the fringe but has scored notable wins with GM and Toyota.

	Google	HERE	Mapbox	TomTom
Automotive	3.75(3.5)	5(5)	2.25(2)	4.5(4.5)

HERE and TomTom remain well positioned as suppliers of location services to an automotive sector which is evolving towards an increasingly software defined, safety-led, and autonomous future. From a strategic perspective, HERE, TomTom and Mapbox provide car makers with control over driver data, while Google limits access to this information. HERE and TomTom report continued strong participation and growth in automotive.

- HERE remains a leader in automotive by virtue of its strong location content market share in North America and Europe, early leadership in supporting ISA with accurate speed limit coverage in the EU, and strong EV capabilities.

HERE claims 150 m vehicles and 50 OEM brands use HERE technology and that its market share for navigation content licensing in the EU and North America is 70%. Furthermore, at the International Motor Show (IAA) in Germany, HERE announced its solutions were present in 39 of the 44 new vehicles announced at the show, spanning its navigation, ADAS, intelligent speed assistant (ISA), real-time traffic and hazard service. HERE has made strong claims it is winning an overwhelming majority of proposals from vehicle OEMs to support the ISA feature and reports over 22 m ADAS map vehicles shipped between 2017 and end 2021. In EV HERE is committed to acquiring content from a fragmented set of local EV information providers to offer an end-to-end and comprehensive solution. HERE's location service continues to underpin the only commercially available SAE L3 car, Mercedes Benz S-Class, in Germany, with availability in the US slated for launch in 2022. HERE has also announced deals from smaller OEMs like SAIC Motor's overseas division to support its connected IVI outside SAIC's home markets and Vietnam based EV maker, VinFast.

- TomTom has posted a strong year in automotive services, announcing that over 5 m SAE level 1 and level 2 automated vehicles sold by car makers in North America and Europe rely on TomTom's ADAS map; representing a 10-fold increase over the past few years. TomTom claims its ADAS map supports around a third of all (autonomous vehicles) AVs that are equipped with an ADAS map. Like HERE, TomTom claims it offers best-in-class ISA and notes strong internal validation. Additionally, TomTom claims it 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 their most advanced use cases. Notably, TomTom announced it has become the navigation 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.

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:** During October 2021 Google announced Honda as new customer for Android Auto OS (AAOS) and subsequently Google Automotive Services

(GMS). Honda adds further momentum behind AAOS, adding to a list of announced major carmakers, which includes, Volvo, General Motors (GM), Ford, Stellantis, and Renault. In addition to AAOS, Google’s Android Auto smartphone mirroring solution remains a popular option for vehicle makers to include on their cars, due to popularity with consumers. In January 2022, Google claimed Android Auto availability had reached nearly 150 m cars worldwide. Google’s role in providing location services remains limited to the vehicle infotainment system and is yet to support ADAS and vehicle safety functions. Google’s efforts in supporting autonomous driving remains a feature of its Waymo, self-driving company.

- **Mapbox:** Since our previous report Mapbox has made advances into automotive but continues to play at the fringe. Notably, 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, GM and BMW.

4.1.3 Non-Automotive Location Services

	Google	HERE	Mapbox	TomTom
Non-automotive	4	4	4	4

Each location provider demonstrates strong capabilities to service non-automotive location opportunities and enterprises, with services addressing mobility services, transport and logistics, asset management, and on-demand providers common across all. Both HERE and Google target a slightly broader range of industries and use-cases than both TomTom and Mapbox.

Google: 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 has been committed to broadening its base beyond servicing automotive customers and has defined solutions for fleet management, supply-chain, mobility services, infrastructure planning, and public safety. Within infrastructure planning HERE's solutions assist telcos in optimising their 5G RAN buildouts, in addition to supporting smart city projects. HERE has announced a range of non-automotive companies and use-cases as customers during 2021, including significant momentum in 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 m developers. Among announced customers are providers of fleet services (Goodyear), logistics company (Yojee), mobility service (Lyft), Swiss retailer (Migros), and telecom infrastructure vendor (Ericsson). HERE is also working with local authorities to enable cities to deploy smart and sustainable city services. Bridgestone Mobility Partners has made location data generated by its vehicle fleet of 1.2 m available for licensing via HERE's marketplace. Additionally, HERE has highlighted growing demand from logistics companies for location services and content to support robotic delivery, from entertainment and media companies to underpin AR/ VR experiences, and from other enterprises to help with simulations visualisations.

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. 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, asset tracking and location intelligence. Although TomTom sold TomTom Telematics to Bridgestone Europe in April 2019, its location services continue to underpin Webfleet's solutions and

TomTom continues to provide location services to companies in the transport and logistics sector, including Simacam, Descartes, Omnitrac, and Paragon, among others. 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.

4.1.4 Developer Community

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

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.

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 by virtue of that a large pool of developers. In June 2020 Google reported over 5 m projects from businesses of all sizes which use Google Map APIs. Despite its traction, Strategy Analytics has revised Google’s score down in this 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 approaches². 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 2.5 m developers across its ecosystem of direct and indirect developers (which includes Amazon Location Service, Microsoft Azure, MuleSoft, and SAP, among other reselling channels). We estimate the number of direct developers in the hundreds of thousands range. HERE continues to offer the broadest range of APIs and SDKs to enable developers to build compelling apps. HERE continues to focus primarily on reaching enterprise developers seeking quality location services with longer tail developers secondary.

TomTom: TomTom has made improvements to its developer program which sees it close the gap on competitors. Like HERE, TomTom is focused on attracting active, enterprise developers, and is less concerned in attracting the long tail developer community. Therefore, TomTom hasn't reported growth levels of its developer community, which we estimate in the tens of thousands range. TomTom has picked up awards³ for its developer experience, and during 2021 enhanced its map display API, traffic API, search, and routing APIs, in addition to launching new APIs for route analysis, matrix routing, and waypoint routing. 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.

Mapbox: Mapbox remains one of the leaders in developer community. Mapbox claims to have 3.5 m 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, map visualisation, and available functionality. Mapbox remains independent, open,

² U.S. Probe of Google Maps Picks Up Speed, Reuters

³ Best in automotive APIs for its routing API, The 2021 API Awards. Winner of Developer Week's 2021 Devies Awards for its routing API.

and flexible for developers. Overall, Mapbox offers the fewest location capabilities to developers of its competitors.

4.1.5 Map and Data Visualization

	Google	HERE	Mapbox	TomTom
Visualization	4.25 (4.25)	4.25 (4.25)	5 (5)	4 (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 is a leader in how geospatial data can be interrogated and analysed with its augmented analytics approach.

Google: Google has improved its visualisation through its implementation of WebGL through its Google Maps JavaScript API. In May 2021, Google announced a beta version of WebGL overview within its Google Map JavaScript API, which enables features including map tilt, rotation, and the ability to render both 2D and 3D objects onto Google Maps with occlusion. More recently, Google is offering a new ARCore Geospatial API, to enable developers to integrate capabilities like Google’s Live View (AR feature) in their own applications for free. It is also adding immersive views in major cities to enable visitor to view the city in various weather conditions and also to explore venues from within. It has also benefited in visualisation through some innovation from the location intelligence company, CARTO. BigQuery, Google’s cloud data

warehouse, supports the ingestion, storage, query, and analysis of a variety of geospatial formats. An extension from CARTO, called BigQuery Tiler, enables geospatial visualisation and analysis within the BigQuery warehouse. Google also partnered with CARTO to demonstrate visualisation of deck.gl using Google's Map JavaScript API.

HERE: HERE's visualisation tools meet various demands and needs from a range of customers segments. HERE Studio 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 Studio, 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. Mapbox has updated its satellite imagery to 50 cm across the US, 25 cm across the Netherlands, and 10 cm across Switzerland. Mapbox claims to have improved the transition from this satellite imagery to 3D terrains to create a seamless and realistic 3D experience. Mapbox Atlas enables developers to run Mapbox maps and other location services on their own server (including private cloud infrastructure) to enable data visualisation. Mapbox Studio enables users to customise map design, use existing map styles, animate, and extrude map and data layers to provide compelling visualisations.

TomTom: TomTom has made delivering best-in-class visualisation tools a strategic imperative to address rising demand from both automotive and non-automotive industries for richer, flexible, and customisable visualisation capabilities. 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.

4.1.6 Vision and Growth Leadership

	Google	HERE	Mapbox	TomTom
Industry Vision	4(4)	5(5)	3(3)	3.75(3.5)

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: 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: HERE remains a leader in vision and industry growth with its HERE Platform strategy. By providing a platform which enables enterprises to exchange and monetise their location datasets, Strategy Analytics believes HERE Marketplace positions it uniquely to tap into expanding demand for location intelligence. HERE’s mapping-as-a-service enables port authorities, factories, mining companies, and owners of large, complex venues to map these locations and optimise both customer and employee workflows. HERE’s

vision for the transport and logistics is to enable end-to-end traceability of product from the factory through to distribution, including last mile delivery, using a range of its solutions. This includes enabling established freight forwarders to compete with digital entrants by providing end-to-end supply-chain visibility. HERE remains focused on enabling the autonomous sector, including light and heavy-duty vehicles and drone delivery. Strategically, HERE has a strong history of encouraging OEMs to share data (e.g. traffic and road signs) to ensure OEMs remain at the centre of innovation and is leveraging data from 30 m connected vehicles to power its live services. 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.

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 have increased TomTom's score in the category to reflect its increasing scope beyond navigation software and desire to provide best-in-class visual experiences to address car OEM needs and other sectors. TomTom remains focused on meeting the evolving requirements of the automotive sector, and is positioning for future growth by **moving up the automotive software stack** through its IndiGO framework. IndiGO provides OEMs with an alternative Android Automotive OS (AAOS) ecosystem of apps, services and **UX** to power their digital cockpits. IndiGO enables OEMs to customise the look and feel of its cockpit using a modular approach. As noted in the automotive section of this report, TomTom expects customers of IndiGO to integrate other TomTom location services, like navigation and traffic, into their vehicles. 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.

4.1.7 Environmental Sustainability

	Google	HERE	Mapbox	TomTom
Sustainability	4	3.75	2.5	4

This new category seeks to rank 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. This means, identifying the most efficient and 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 this, scoring in this category considers how well sustainability goals, strategy and governance are outwardly communicated via reports, disclosure frameworks, press releases and new products. Strategy Analytics 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 also fit with their own sustainability strategies.

Google, TomTom and HERE have all made strong commitment to environmental sustainability by improving measurement and disclosure of their environmental impact and targets, and by providing oversight over sustainability topics to their respective boards. Strategy Analytics believes Mapbox is also committed to environmental sustainability but does not score highly due to limited disclosure and evidence. Google and TomTom are leaders in this category while HERE has made progress on closing the gap during 2021.

Google: Google announced three Google Map updates targeting the reduction in transport related CO2 emissions and providing users with greener choices. The first update is eco-friendly routing, which are routes provide the both the lowest fuel consumption and fuel cost. The second update is the introduction of a 'lite' mode, optimised to provide essential information to cyclists (e.g. trip progress, ETA update, and road elevation). Google claims to have seen a 98% rise in the use of biking directions on Google Maps in 2021 and is committed to supporting bike sharing. The third update involves expanding bike and scooter sharing information to over 300 cities globally.

HERE: During 2021 HERE improved how it addresses sustainability and has embedded ESG into its corporate structure by forming a sustainability advisory committee and the appointment of an executive sponsor for HERE sustainability. HERE is working towards external certification to ISO 14001 by the end of 2022. Beyond this, HERE is supporting a carbon footprint assessment and carbon reduction approach which it expects to be completed during 2022. All new facilities will be leased and operated at Leadership in Energy and Environmental Design (LEED) gold standards. HERE is capturing metrics on emissions related to power consumption, cooling, and heating, among other categories.

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. In 2018 it outlined its process for achieving carbon neutrality, which it achieved through purchasing carbon offsets and renewable energy credits. Mapbox also Strategy Analytics has awarded Mapbox a low score in this category because it hasn't reported key information including, how it will address, measure, disclose, and verify activities linked to reducing its environmental impact.

TomTom: TomTom is committed to supporting the UN's sustainable development goals (SDGs) and is focused specifically on SDG 4 (quality education), SDG 5 (gender equality) and SDG 11 (sustainable cities). During 2021 TomTom set operational targets to achieve these goals. For SDG 5 it is focusing on its Diversity and Inclusion (D&I) strategy. 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.

5. Strengths & Weaknesses

In the previous section Strategy Analytics 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 11 Strengths & 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 • > 120 M Local Guides (2020) 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. 	<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)
HERE	<ul style="list-style-type: none"> • Independent and open • Significant resources – >7K employees globally • Leading map provider in North America and Western Europe (claiming ~70% market share) • Strong ADAS and HD Map momentum 	<ul style="list-style-type: none"> • Weak in long-tail developer v Google and Mapbox • Limited consumer brand

	<ul style="list-style-type: none"> • 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 • Large enterprise customers (e.g. Amazon, MSFT) • Hybrid navigation mode in absence of connectivity • Strong indoor venue marketplace • Strong messages on privacy 	
Mapbox	<ul style="list-style-type: none"> • 650 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 > 175K monthly active • Used in >45 K apps • Location leader in Business Intelligence (BI) sector • Investment from Softbank • Presence in China and Japan via JV 	<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
TomTom	<ul style="list-style-type: none"> • Well resourced. • 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 • Moving up the stack in automotive infotainment through its IndiGo ecosystem • Open and flexible for developers • Aggressive pricing of location services • >600 M active GPS probe points 	<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

	<ul style="list-style-type: none">• Closing the gap on map and data visualisation.• Large addressable market through third-party developer platforms e.g. Azure, Huawei, Verizon, etc.	
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6. Analyst Contacts

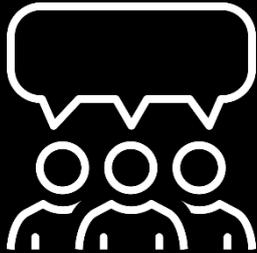
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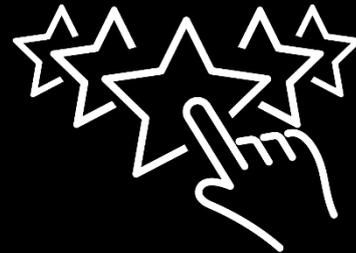
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