



## MAPPING AN AUTONOMOUS DRIVING FUTURE

### Abstract

Autonomous cars have been a buzz word for quite some time now. But for the still-nascent technology to become a widespread reality requires developing high definition maps — also known as high precision maps — to provide accurate navigation details right down to the centimeter level. Towards this end, several firms specializing in hardware, software, product design, map-making, and research are coming together to develop maps specifically made for driverless cars and make safe, self-driven cars a reality.



## The evolution of maps

Maps have certainly evolved a great deal. The digital maps of today and the HD maps of tomorrow have significantly superior features when compared to yesteryears cartography and paper maps.



<ul style="list-style-type: none"><li>• Require physical space</li><li>• Can be accessed and used offline only</li><li>• Mostly use symbols to represent features</li><li>• Limited to specific areas based on the scale of the map</li><li>• Cannot be updated easily</li><li>• Cannot represent all features simultaneously</li></ul>	<ul style="list-style-type: none"><li>• Require digital storage space</li><li>• Can be accessed online</li><li>• Show all features including estimated travel time, information on traffic, and the actual asset</li><li>• Not limited to specific areas</li><li>• Good at showing area overlays from various angles</li><li>• Is dynamic and can be easily updated</li></ul>	<ul style="list-style-type: none"><li>• Built for self-driving cars</li><li>• Have extremely high-resolution with centimeter level accuracy</li><li>• Provide virtual assistance</li><li>• Can be easily updated on a daily basis</li><li>• Provide precise information about ground truth</li></ul>
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Autonomous vehicles need to adhere to extremely high safety standards as the failures can impact human lives. High definition maps with appropriate safety guidance for autonomous cars, other drivers, and pedestrians, will help in moving towards a new safety standard in autonomous driving.

High definition maps are built around three key objectives: navigation assistance, driver assistance, and automated driving. These maps have sufficiently precise road information to help self-driving cars identify the road signs with a centimeter accuracy. They also provide real-time traffic information on other cars on the road, pedestrians, and cyclists which can help avoid accidents in critical situations through quick response times.



### Navigation

- Standard navigation maps
- Map attributes used for drivers only
- Traffic alerts
- Annual map update



### Driver Assistance

- Standard navigation maps with advanced drive assistance systems (ADAS) attribute
- Online traffic alerts
- Frequent map updates



### Automated Driving

- Up to date information about speed limits
- High reliability of dedicated ADAS attributes
- Lane accurate positioning/localization





### Building HD maps: key factors, challenges, and players

Building a high definition map is a complex task with several aspects including sourcing data, collating the data to build the map, integrating artificial intelligence (AI) capabilities, provisioning for incorporating live road data, and ongoing maintenance.

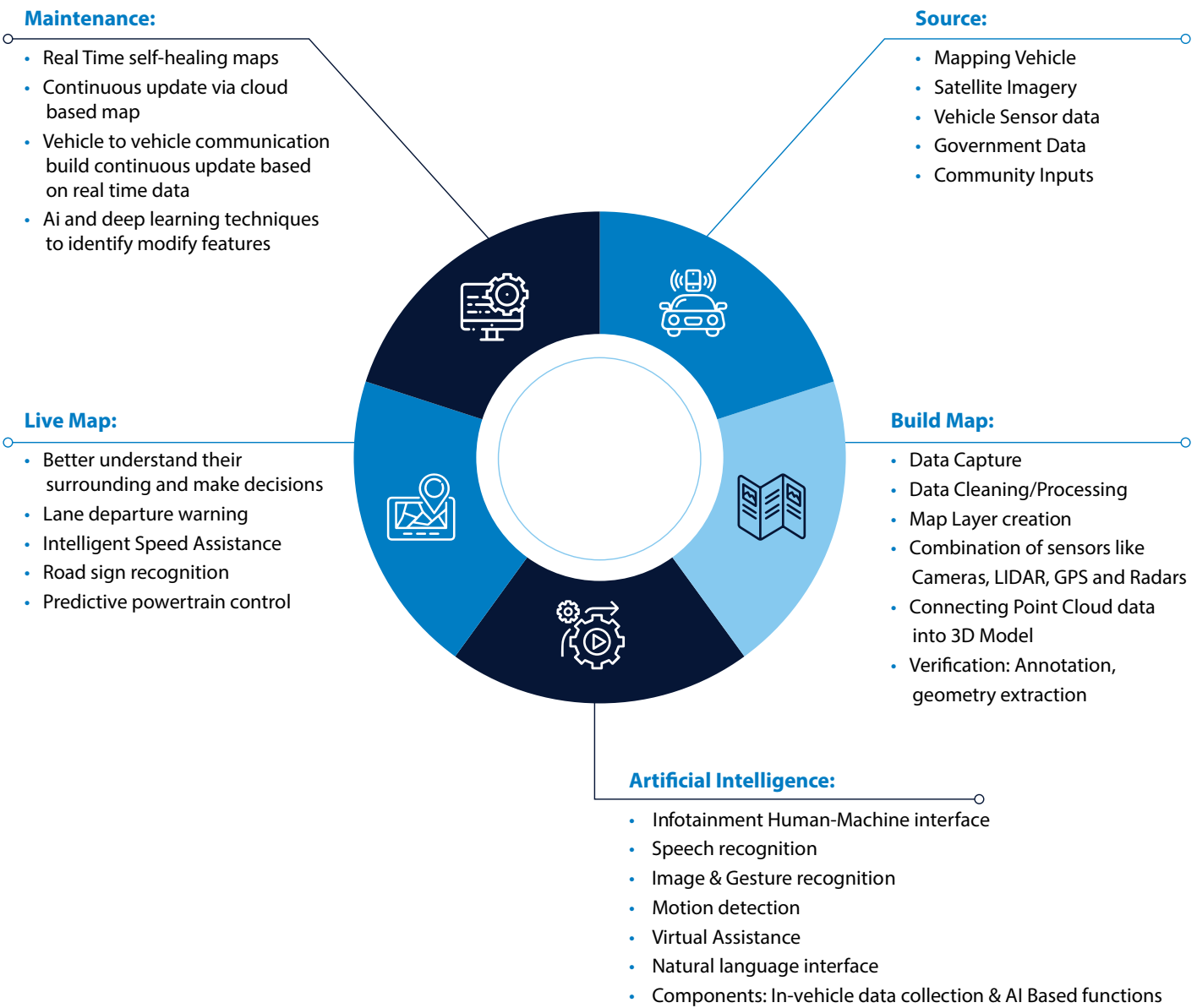


Fig: High level view of the HD Mapping Process



However, there are several challenges involved in building these maps and integrating them for autonomous driving:

- Project costs: Manual verification and requirements for fresh maps/data sourcing lead to high production costs because achieving higher efficiencies for map database creation remains difficult. The high costs of building autonomous vehicles also add to project costs
- Project architecture and circulation: Projects involve massive volume of data. Further, the data for complex driving challenges such as intersections, continue to be difficult for current levels of machine learning. Also, it is challenging to circulate and monetize standalone map datasets
- Quality control: It is difficult to produce error-free maps due to the high complexity of the road environment and its dynamic nature
- Regulatory permissions: Before driverless cars can be driven on the roads, regulatory body approvals are required. Proving safety can only be done through extended and expensive real-world driving simulations
- Limitations of AI tools: Generating automation maps remains problematic with manual verification based on local expertise and specialist knowledge acquired over many years. Most of the new entrants are making commercial maps with only limited datasets like vehicle sensor data or satellite imagery. This is not sufficient to build high-

accuracy, near-error-free maps

- Size of map datasets: Maps sizes have increased exponentially with higher accuracy requirements, especially in relation to HD 3D maps for driverless vehicles. This complicates sending map updates over the air in terms of time, bandwidth usage, and cost requirements. Today's available LTE (4G) allows data transmission at 100 Mbps, while at least 2.2 Gbps is required. However, 5G technology with transmission speeds of 5 Gbps and will be market-ready post 2020. Also, for real time execution, latency must be lower than 10ms which requires high performance computing onboarding the vehicle.



All of the above can be put into perspective through considering a live example of HD map creation:

Autonomous Vehicle Project	
Year of inception: 2015	Investments: \$3 Bn
Targeted year: 2025	Targeted investments: \$96 Bn
Average cost of creating HD maps:	\$5000/Km*
Cost-reduction techniques #1:	Crowd sourcing Service commercialization Payver-Uber drivers use dashboards to capture street data
Key problems:	Huge data-traffic Redundancy in captured data
Length of street network in US *	6.58* million km
Cost incurred for creating HD maps for the entire US	~\$32 Bn
Human intervention:	Human surveying is mandate
Cost-reduction technique #2:	Computer vision technology, can capture distance of lane marking too, however not that reliable when compared with Lidar.

\*Source: (DEEPMAP data)

Today, three key map makers are involved in advanced HD maps creation and research:

- Carmera: Invested ~\$27 Mn into a street intelligence platform to create HD Maps

for autonomous cars

- Mapper: Invested ~\$9.2 Mn into its software to convert the raw data from Lidar and camera into HD Maps with inch level accuracy.

- Here Maps & TomTom Maps: Are making HD Maps for autonomous vehicles and focusing on new mobility experiences such as adaptive cruise control and lane keep assistance.





## The need for greater integration

For developing HD maps, multiple products, sensors, and software are used to ensure that appropriate data is captured. Also, to ensure that autonomous vehicles are enabled to adequately handle real life issues using these maps, there is a need for close alignment of vehicle sensor installations, data capture mechanisms,

and system integration practices. Finally, machine learning and seamless data services are going to play critical roles in enabling usability and functionality of these vehicles.

Towards this end, automobile manufacturers have been closely

partnering with multiple software and map making firms to bring several ambitious projects to life. This high level of cross-industry collaboration is mandated by the need to bring down the high costs associated with these projects, and to bring in new developments in technology.



## The bottom-line

Several steps are underway to enhance the technology and street environment to enable a seamless experience for users of autonomous vehicles and provide appropriate safety. However, widespread rollout into real-world traffic scenarios has a high dependency on multiple stakeholders and government approvals. Cost is another factor, and in the current scenario, the costs associated with making these vehicles functional and safe are too high. As the auto industry integrates with

other industries towards workable and cost-effective solutions, there is a growing requirement for resources with newer skills to be able to handle the volume of data and technology involved.

Yet, in spite of these significant challenges, there are substantial opportunities as well. Within this evolving scenario, both service and product companies have opportunities to make a difference. ADAS have the potential to change the automotive sector and analyst firms estimate the current

market potential at annual revenues of between \$5 Bn to \$8 Bn. In recent times ADAS equipped car sales have increased significantly by ~ 87% to 89%, and the automobile industry is further expecting to see more than 10% annual increase by 2020.

Perhaps the day is not far away, when autonomous vehicles equipped with seemingly omniscient HD maps will be the rule rather than the exception.

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Yuvaraj is a GIS professional with over 9 years of experience in GIS domains such as telecom and navigation. Yuvaraj has expertise in ArcMap, QGIS, NE (Network Engineer - Telecordia), FME (Feature Manipulation Engine), and experienced in doing data ingestion from 3rd party vendors. He played a critical role in creation of GIS database for a telecom giant, and in the quality management and data delivery for multiple global clients.

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Sreepriya's strengths are in understanding client demands and transforming strategy to Optimized implemented solutions going the extra mile to create customer delight

At Infosys BPM, she is responsible for the setup, transition and delivery of projects in the digital and GIS space.

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