High-Definition Maps in Real Time : Powering the Future of Autonomous Mobility

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General Authority for Survey and Geospatial Information

Saudi Arabia's Vision for Smart Mobility

رؤية VISION 2030
المملكة العربية السعودية
KINGDOM OF SAUDI ARABIA

1st Phase

Completed	Served	Covered
+1,700	**+3,000**	**+30,000**
Trips	*Passengers*	*Kilometres*

Saudi Arabia has launched its first autonomous vehicle trials in Riyadh, representing a continuation of its efforts to develop autonomous mobility services, raise operational safety standards, and leverage modern technologies to achieve the goals of the National Transport and Logistics Strategy and Saudi Vision 2030, toward a smart and sustainable transport ecosystem.

Source: TGA (2026), www.tga.gov.sa

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Saudi Arabia’s Vision for Geospatial Insights

VISION رؤية 2030
المملكة العربية السعودية
KINGDOM OF SAUDI ARABIA

Based on what has been stated in Saudi Arabia’s Vision 2030:

> “We will expand the scope of electronic services provided to include other services such as **Geographic Information Systems**, health and applied services.”

The vision highlights the importance of geospatial information as a tool supporting developmental sectors and various digital fields through the integration of geospatial data, applications, and spatial solutions using location as a common reference framework. This contributes to increasing efficiency, improving the quality of services and operations, and supporting location-based decision-making.

“Everything happens somewhere”

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GEOSA: Executing the National Blueprint for Geospatial Sector

Vision

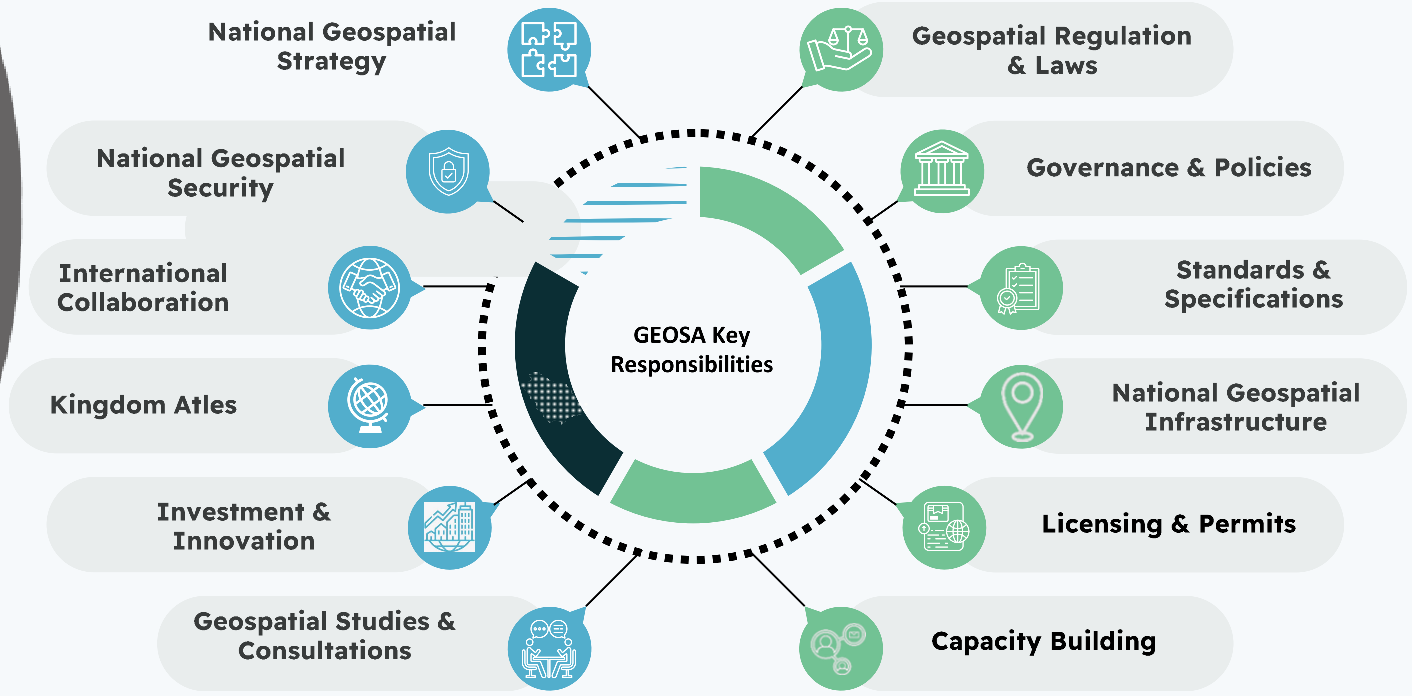
A vibrant, smart, and sustainable geospatial sector that achieves the efficiency of the geospatial infrastructure and contributes to the Kingdom's leadership in economic, social, and environmental sectors.

Mission

To provide a secure infrastructure and national geospatial data that is organized, effective, and reliable, supported by an innovative and investment-attractive environment. It is enhanced with qualified human capabilities and enables the participation of stakeholders and strategic partners and supports them in decision-making.

Strategic Direction

- Organizing, Supervising, and Overseeing the Geospatial Sector.
- Geospatial Infrastructure and enabling Investment
- Building National Capacities and Geospatial Innovation



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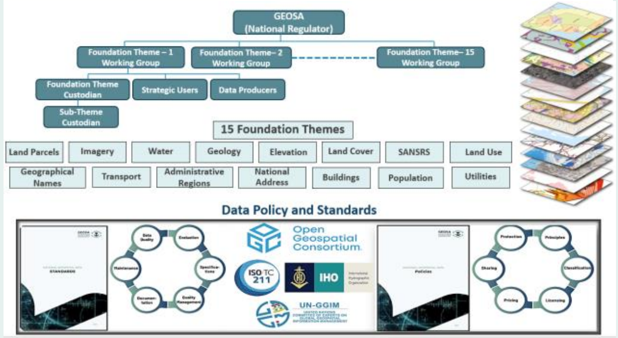
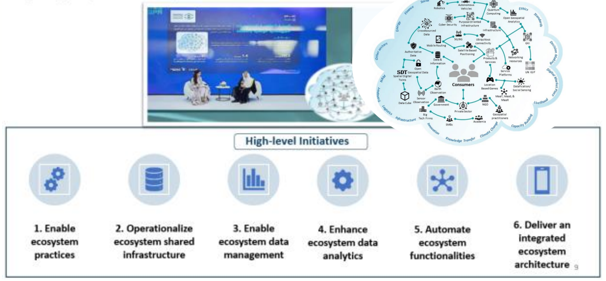
GEOSA Geospatial Infrastructure



National Geospatial Data Governance Framework

The National Geospatial Ecosystem is GEOSA's holistic framework to unify, enable, and evolve geospatial capabilities across Saudi Arabia. It supports smart governance, economic growth, and innovation by integrating data, infrastructure, and services.

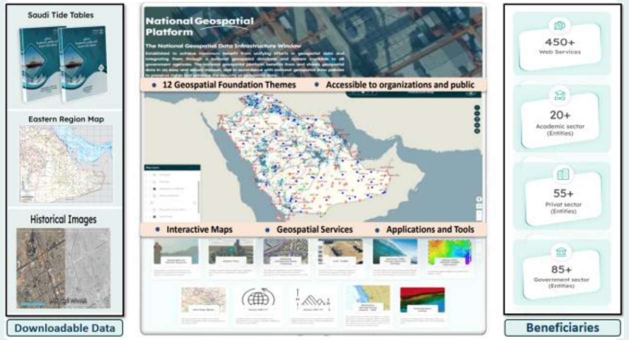


National Geospatial Ecosystem

National Geospatial Centre (NGC)

- The National Geospatial Center is a central body established by GEOSA to coordinate and enable the national geospatial ecosystem.
- It is responsible for the governance, integration, and quality assurance of geospatial data across sectors, supporting strategic decision-making and fostering innovation through access to reliable, standardized, and up-to-date geospatial information.

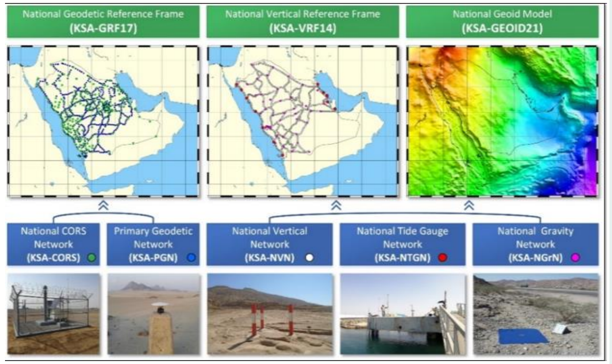
Saudi GEO-HUB



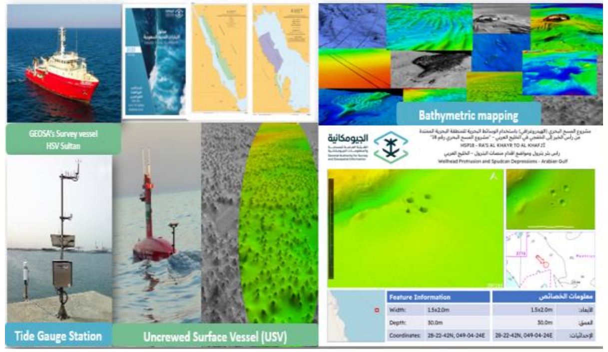
National Geospatial Platform

The National Remote Sensing Centre under GEOSA serves as the central hub for managing, coordinating, and advancing remote sensing activities across the Kingdom, supporting national development by leveraging satellite imagery, aerial surveys, and geospatial intelligence.

National Remote Sensing Centre



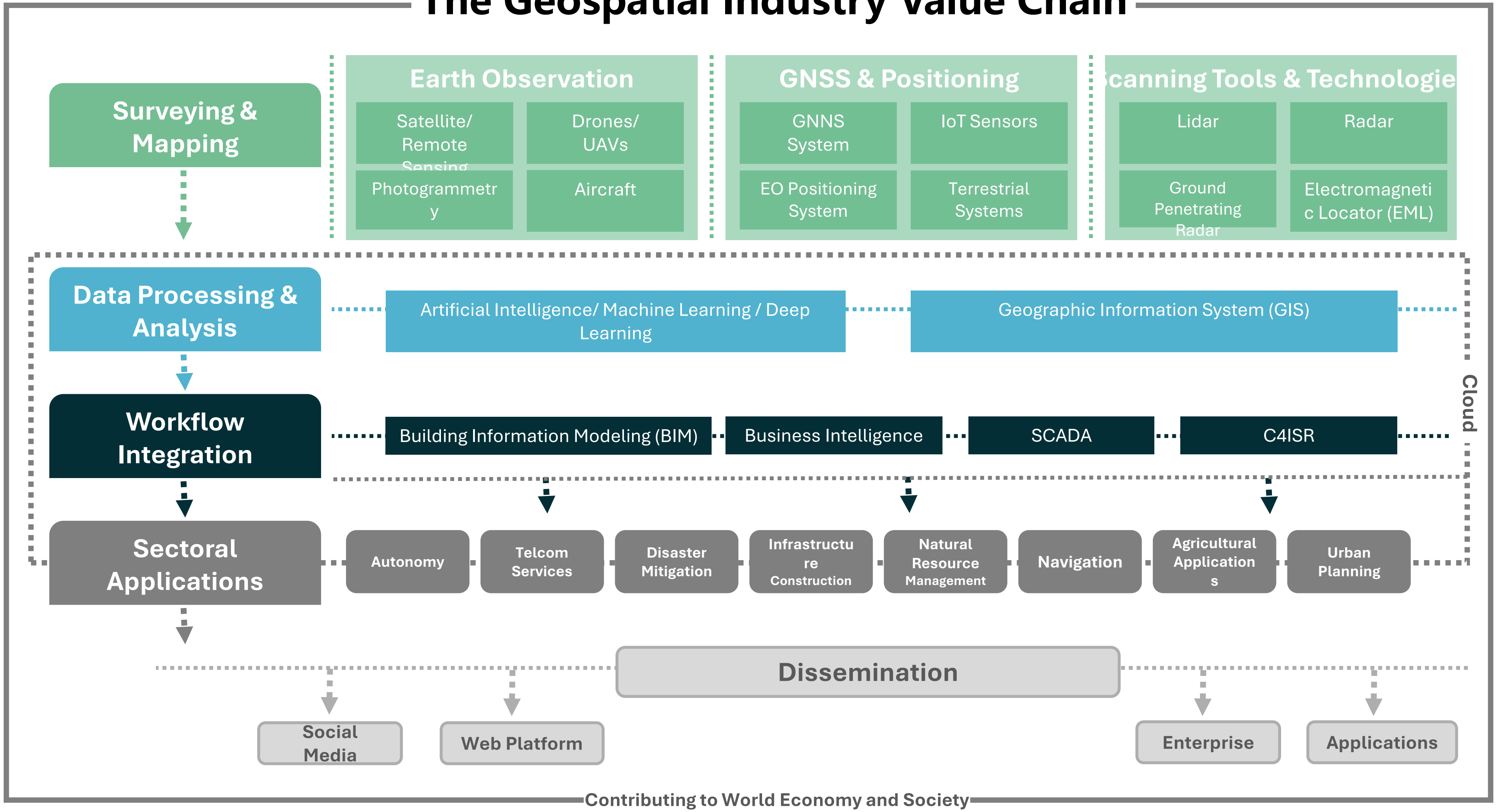
National Geodetic Infrastructure



National Hydrographic Infrastructure

Geospatial Permits & Licensing

The Geospatial Industry Value Chain



Source: Edited after Geospatial World Analysis

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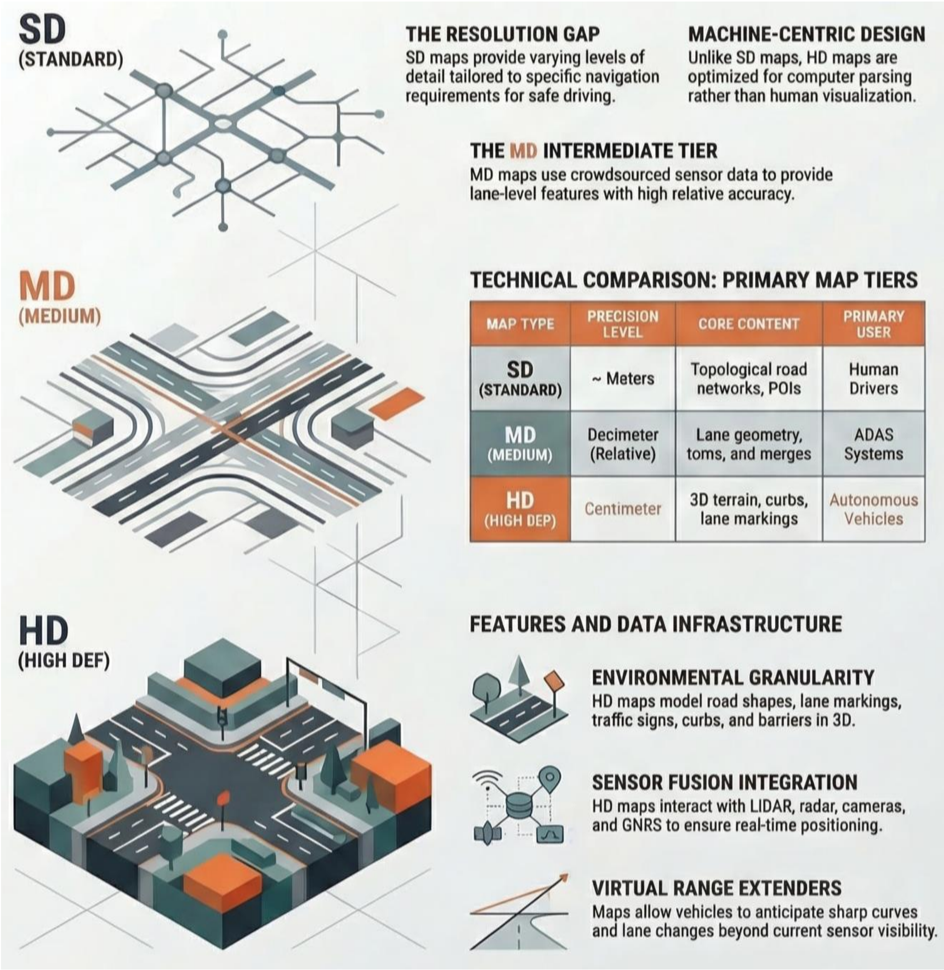
From SD to HD Maps : Key Concept



Shah, J.D. (2025) 'Cloud-orchestrated real-time HD map regeneration for Autonomous Vehicles', World Journal of Advanced Engineering Technology and Sciences, 17(3), pp. 001–011. doi:10.30574/wjaets.2025.17.3.1462.

SD Map (Standard Definition) :

A conventional navigation map designed primarily for human drivers, showing roads, routes, intersections, and points of interest at a meter-level accuracy. Used for basic navigation and route guidance, helping drivers move from one location to another efficiently.

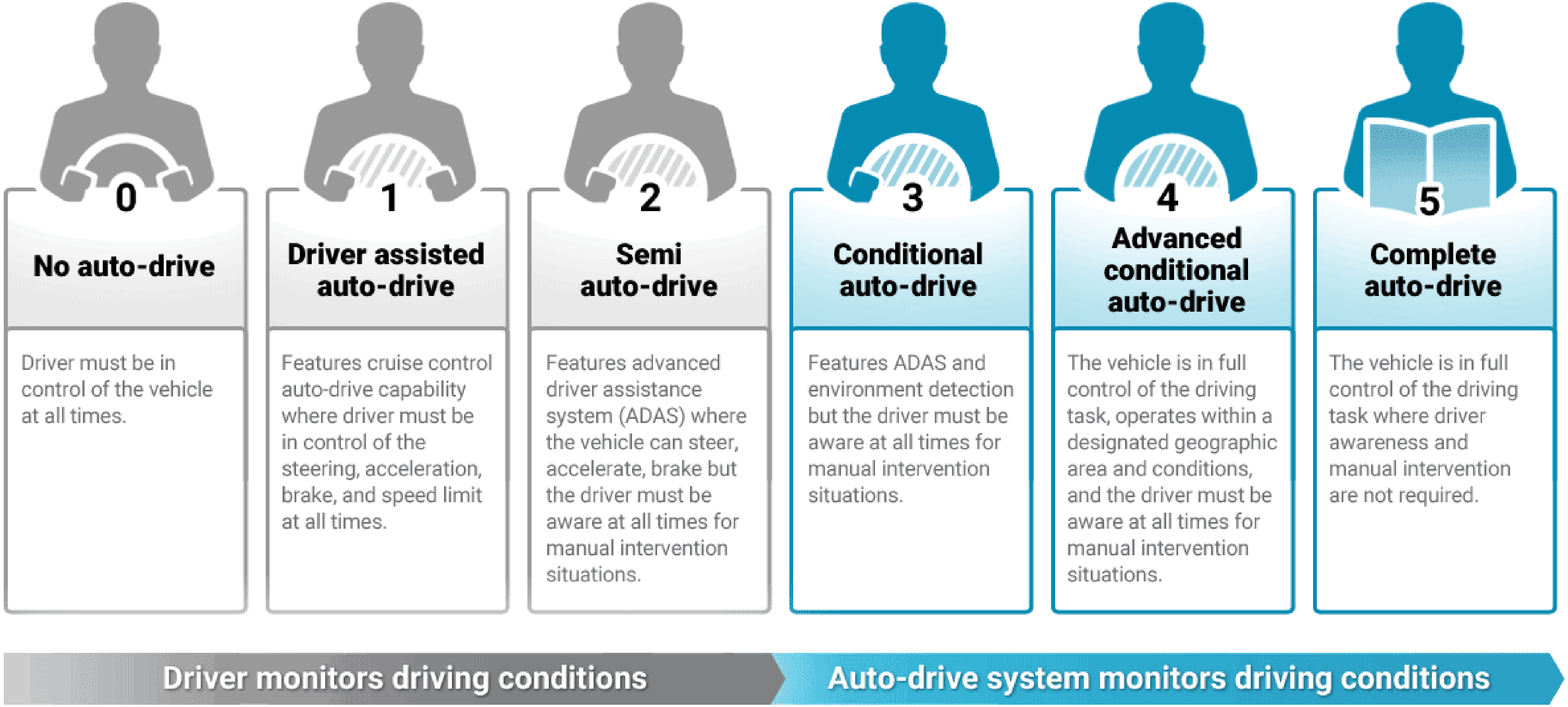
MD Map (Medium Definition) :

A more detailed digital map that adds lane-level road structure, such as lane geometry, road edges, and merges, with decimeter-level relative accuracy. Used to support Advanced Driver Assistance Systems (ADAS) by improving lane awareness, positioning, and assisted driving functions.

HD Map (High Definition) :

A highly precise, machine-readable map that represents the road environment in 3D with centimeter-level accuracy, including lanes, curbs, markings, traffic signs, barriers, and surrounding features. Used to enable autonomous vehicles to localize accurately, understand their environment, anticipate road conditions, and make safe driving decisions in real time.

Five Levels of Autonomous Driving



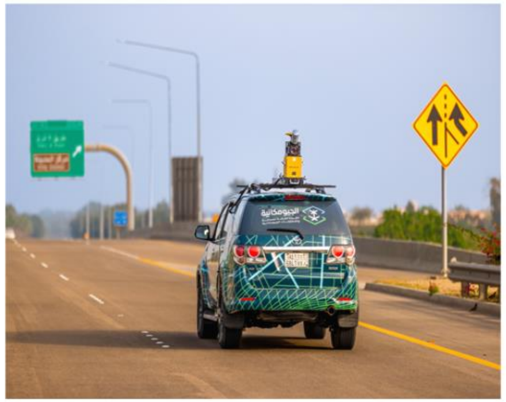
Dimitrakopoulos, G., Uden, L. and Varlamis, I. (2020) 'Autonomous driving levels and enablers', The Future of Intelligent Transport Systems, pp. 189–197. doi:10.1016/b978-0-12-818281-9.00017-6.

The HD Map Pipeline: from Sensor to Semantics

1. Select — **2. Collect** — **3. Align** — **4. Layer**

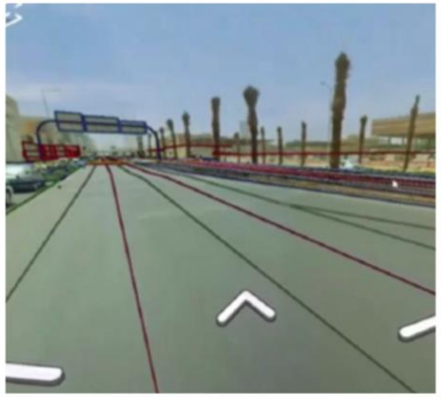
Operational Domain (OD) Selection

Use high-level topological maps to identify specific city segments or freight routes to be mapped.



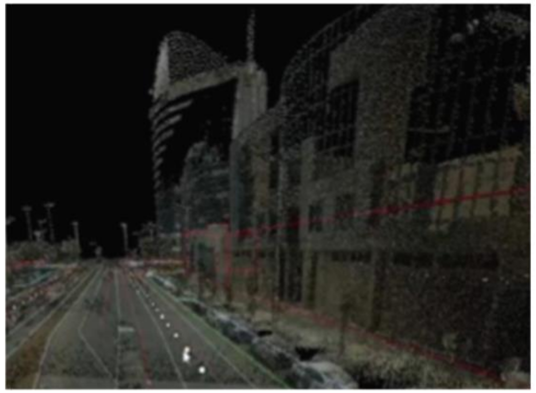
Raw Data Collection

Fleets equipped with LiDAR and cameras drive the area to capture raw geometric and visual observations.



Map Alignment (geometry)

Use Simultaneous Localization and Mapping (SLAM) to fuse sensor readings into a globally consistent 3D geometric model.



Layer Semantics (labeling)

AI and human annotators collaborate to add rich data like lane boundaries, traffic lights, and road associations.

The HD Map Gap in Autonomous Mobility

Konakanchi, S. (2024) 'Real-time processing in Autonomous Vehicle Networks: A distributed edge-cloud architecture for enhanced autonomous vehicle performance', INTERNATIONAL JOURNAL OF RESEARCH IN COMPUTER APPLICATIONS AND INFORMATION TECHNOLOGY, 7(2), pp. 2828–2841. doi:10.34218/ijrcait_07_02_217.

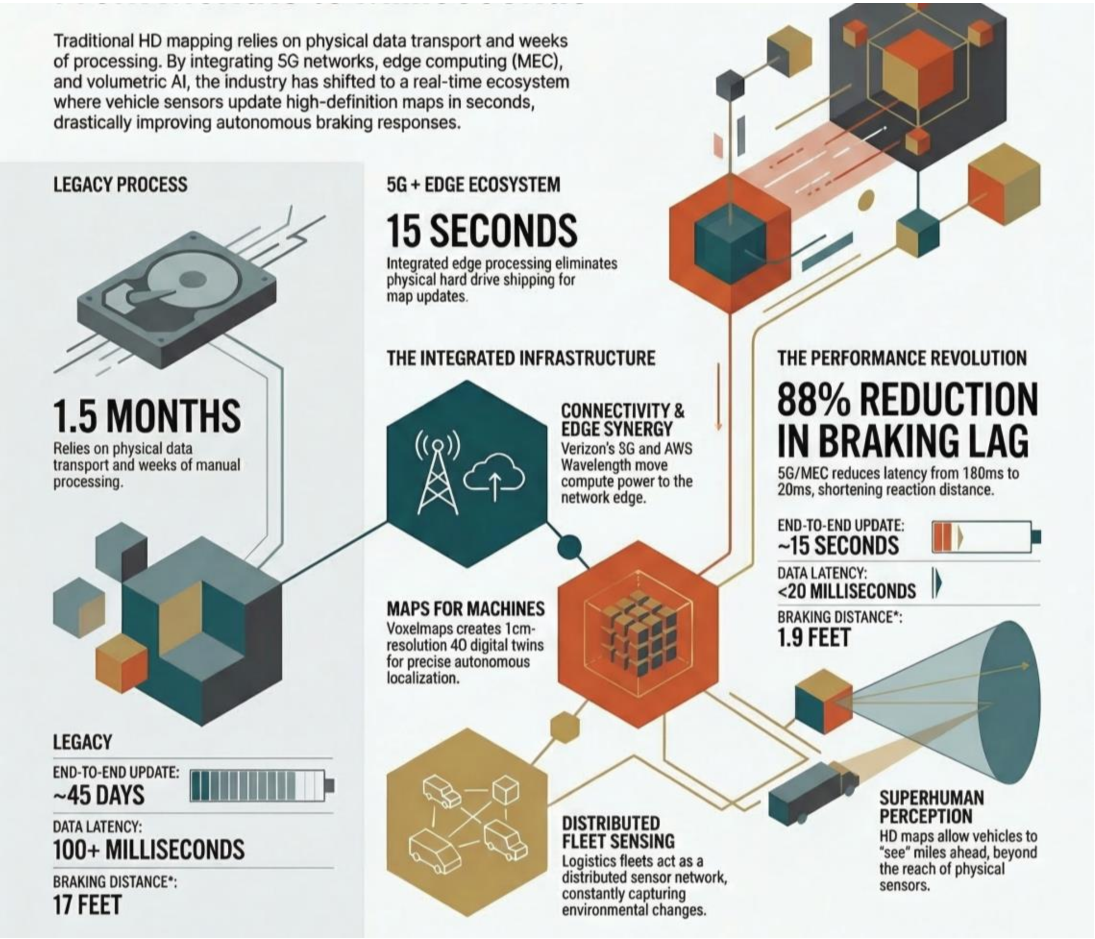
Current navigation systems are not sufficient for autonomous vehicles because traditional mapping is

- High cost of creation and maintenance
- Rapid road and infrastructure changes
- Need for continuous real-time updates
- Difficulty scaling across large geographies
- Heavy dependency for vehicle localization
- Integration and interoperability complexity

This creates major safety risks such as outdated route information, obstacle misalignment, and unreliable driving decisions.

The solution is real-time, AI-powered HD mapping that continuously updates the road environment for safer and smarter autonomous mobility.

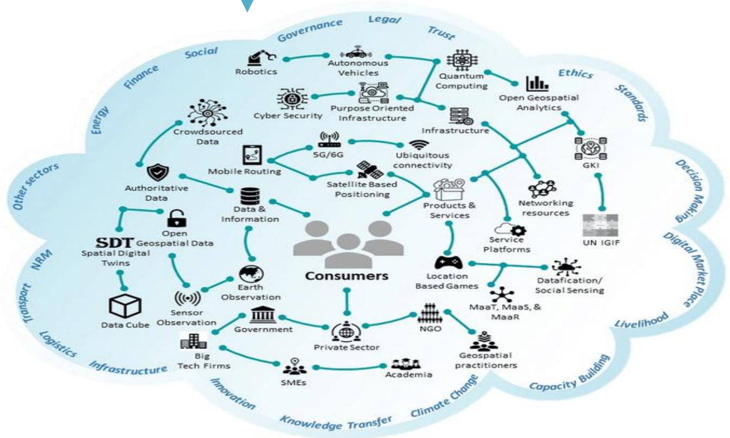
The Real-Time DH Mapping Ecosystem: From Months o Milliseconds



Voxelmaps. (2021, May 19). Real-time HD Maps for Autonomous Vehicles by Voxelmaps Powered by AWS & Verizon [Video]

A Powerful Collaboration

1. **Geospatial Industry** — Provides the AI, sensors and expertise to create HD Maps for machines.
2. **Logistics Fleets** — Act as a scalable data-gathering network to scan road conditions
3. **Telcom Providers** — Supply the high-bandwidth, low-latency 5G networks for real-time transmit
4. **Technology Enterprises** — Provide the critical edge computing, processing this maps locally for milliseconds



GEOSA Public

Coetzee, S., Gould, M., McCormack, B., Mohamed Ghouse, Z., Scott, G., Kmoch, A., Alameh, N., Strobl, J., Wytzisk, A., & Devarajan, T. (2021, August 5). Towards a sustainable geospatial ecosystem beyond SDIs.

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THANK YOU

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