

WHITEPAPER

How 5G Is Unlocking **Smarter, Safer, and More Sustainable** TRANSPORTATION



INTRODUCTION

As urban populations continue to grow, cities around the world are facing mounting challenges with traffic congestion, air pollution, inadequate public transit, and lack of accessibility in transportation systems. **Smart transportation, or smart mobility, offers a promising solution by integrating modern technologies like sensors, connectivity, data analytics, and automation into transportation infrastructure and vehicles.**

Smart transportation significantly improves city quality of life by optimizing mobility through intelligent traffic management, efficient routing, shared mobility options, and, eventually, autonomous vehicles. It reduces travel times, cuts emissions, enhances accessibility for disadvantaged

groups, and improves overall convenience and safety for citizens. With the rapid pace of global urbanization, embracing smart transportation is imperative for creating more livable, sustainable cities for current residents and future generations.

As an integral digital technology underlying many smart transportation use cases, high-speed 5G wireless networks provide the reliable, low-latency connectivity required to link vehicles, transport infrastructure, cloud platforms, and other components into an integrated mobility ecosystem. Smart transportation effects are seen on roadways, railways, airways, and the sea, as well as in fields such as traffic management, parking systems, vehicle communications, and more.



THE MARKET

The smart transportation market is experiencing rapid growth. According to Statista's projections from September 2023, the global smart transportation market is expected to more than double from an already impressive \$122 billion in 2023 to \$248 billion by 2028. This explosive market growth underscores the immense opportunities emerging from digitally transforming transportation systems.



Government Funding is Driving Adoption

Many countries and communities around the world are trying to improve the intelligence of their transportation systems. Leaders from the Philippines, Singapore, and the Netherlands have recently made smart transportation announcements.

In the U.S., the Bipartisan Infrastructure Law (BIL) created the Strengthening Mobility and Revolutionizing Transportation (SMART)

discretionary grant program, allocating **\$100 million per year from 2022 to 2026**.

The SMART program aims to fund demonstration projects by eligible public sector agencies. These projects aim to enhance transportation efficiency and safety by implementing advanced smart community technologies and systems. Eligible projects include:



Connected vehicles



Sensors



Coordinated automation



Smart grid



Traffic signals



Innovative aviation



Systems integration



Delivery/logistics



Market Segmentation by Transportation Mode



When examining the smart transportation market segmented by mode of travel, roadways constitute the largest segment due to the sheer scale of vehicle traffic and roadway infrastructure. Intelligent traffic systems, connected vehicle platforms, electric vehicle management and charging, and smart parking applications are driving roadway-related spending.



Railways represent the second largest and fastest-growing segment, as rail companies invest heavily in intelligent rail traffic management, preventive maintenance analytics, automated inspection drones, and more to digitize operations.



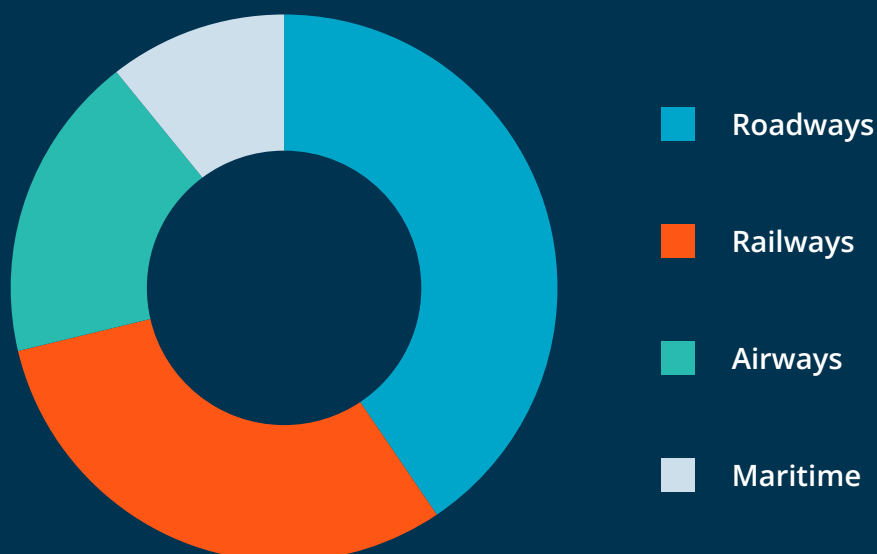
The airways segment also offers opportunities in areas like unmanned aircraft traffic management and intelligent [airport](#) logistics, though it is currently a smaller market.



Finally, the maritime segment is comparatively niche today but has potential for growth from smart port management, autonomous shipping, and other efficiency applications.

Smart Transportation Market

Share by Mode of Transportation



"Smart Transportation Market by Mode Of Transportation, Type, and Geography - Forecast and Analysis 2023-2027" Technavio, August 2023

Key Components and Technologies of **SMART TRANSPORTATION**

The realization of efficient, sustainable, and accessible smart transportation systems in urban environments relies on the integration of several critical technologies across infrastructure, vehicles, and data management platforms.



Transportation Infrastructure

Sophisticated sensors, high-resolution cameras, connected traffic signals, and intelligent transportation system (ITS) networks installed throughout roads, highways, bridges, tunnels, rail lines, ports, and even sidewalks form the basic infrastructure that enables comprehensive monitoring, analysis, and coordination of traffic activity. Features like adaptive traffic light timing, vehicle speed harmonization, and dynamic lane assignments allow intelligent infrastructure to optimize throughput safety and traffic flow in real-time.



Smart Vehicles

Connected vehicles equipped with navigation and advanced driver assistance systems receive and transmit data to other cars and transport infrastructure using onboard sensors and communication interfaces. This facilitates real-time coordination and automation among vehicles. Electric powertrains also characterize smart cars, as they offer sustainability benefits. Autonomous vehicle technology builds upon these connected and electric platforms to enable self-driving transport with little or no human operator input.



Data Management Platforms

Collecting and processing the deluge of data across expansive and numerous transportation network components requires big data analytics running on cloud computing platforms. Communication networks like cellular vehicle-to-everything (C-V2X) connectivity allow the insights to be coordinated securely among infrastructure control systems and vehicles with minimal latency. This data management ecosystem seamlessly integrates the physical and digital layers of smart transportation.

Main Goals and Benefits of 5G for SMART TRANSPORTATION



5G delivers key technological capabilities that empower smart transportation ecosystems.



Efficiency

By enabling real-time data transmission between vehicles, infrastructure, and computational platforms, 5G allows smart transportation systems to dynamically optimize traffic flow through measures like adjusting traffic light timings, updating vehicle routing, and modifying lane assignments to reduce congestion and travel times.

Drivers in the US lost an average of 51 hours due to traffic congestion.

2022 INRIX Global Traffic Scorecard



User Experience

The high-speed connectivity of 5G allows travelers to conveniently access real-time information on traffic conditions, transit arrival times, and routing options anywhere at any time. This keeps users better informed and makes navigation easier.



Quality of Life

By supporting the mass adoption of autonomous vehicles and intelligent transit systems, 5G enhances mobility and accessibility for all groups in society, regardless of age or ability. Fast, responsive mobility also facilitates improved urban planning around livable spaces instead of parking infrastructure.



Safety

The low latency of 5G allows critical vehicle-related data like emergency braking notifications to be near-instantaneously communicated, enabling collision avoidance systems to operate effectively and reduce accidents. Fast data speeds also assist first responders by providing rich details about emergency scenarios.



Sustainability

Connecting vehicles, charging stations, power grids, and traffic control systems through 5G enables intelligent optimization of electric vehicle charging and deployment to reduce fossil fuel usage. Efficient routing further improves sustainability by cutting unnecessary mileage and minimizing congestion-related emissions.

The Role of 5G Connectivity in **SMART TRANSPORTATION**

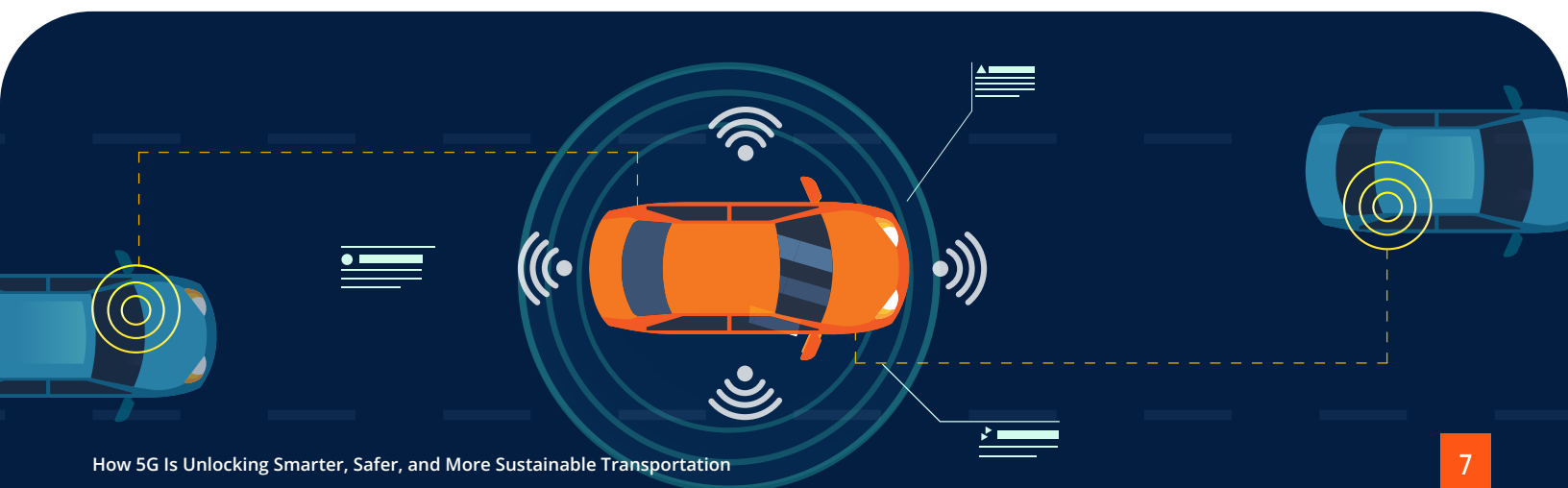
5G networks are uniquely equipped to address the connectivity requirements of complex smart transportation ecosystems. **With peak speeds up to 10 Gbps, 5G provides the high bandwidth needed to transmit the immense volumes of high-definition sensor data generated by connected vehicles and infrastructure in real-time.**

By reducing communication latency along with highly reliable links, 5G enables swift coordination between transportation components to support time-sensitive capabilities like traffic optimization and collision avoidance.

Additionally, the expected ability to support up to **1 million nodes per square km** allows 5G to quickly scale massive machine-type communications across expansive vehicles, infrastructure, and systems networks to collect ever-growing transportation data. Integrated edge computing further complements the high speeds by allowing near-real-time data analysis.

5G enables vastly more efficient data transmission and coordination to enhance operations across smart transportation systems. With the ability to track public transit vehicles in real-time using precise positioning data, transportation agencies are dynamically adjusting schedules and routes to accommodate demand and keep passengers better informed.

By rapidly aggregating and analyzing traffic flows from numerous video cameras, speed sensors, and connected vehicles, 5G-enabled traffic management systems identify developing congestion and implement optimizations like adjusting traffic light timings or recommending optimal vehicle rerouting to improve throughput. Quick and reliable vehicle-to-everything (V2X) connectivity allows direct high-bandwidth communication between vehicles (V2V), infrastructure nodes like traffic signals (V2I), pedestrians (V2P), networks (V2N), and more to exchange situational data continuously. This supports functionality like cooperative collision warning systems and transit signal priority to help vehicles navigate safely and efficiently.





Dense networks of internet-connected sensors on roads, bridges, rails, ports, and more will provide comprehensive, up-to-date transportation data to better coordinate infrastructure operations and maintenance.

In addition to public 5G networks, [private 5G networks](#) are crucial in enabling smart transportation systems. **Private 5G networks offer dedicated bandwidth, enhanced security, and customizable network configurations tailored to the specific needs of transportation infrastructure and vehicles.** These networks ensure reliable and secure connectivity for mission-critical applications, such as traffic management, autonomous vehicle communication, and real-time data processing.

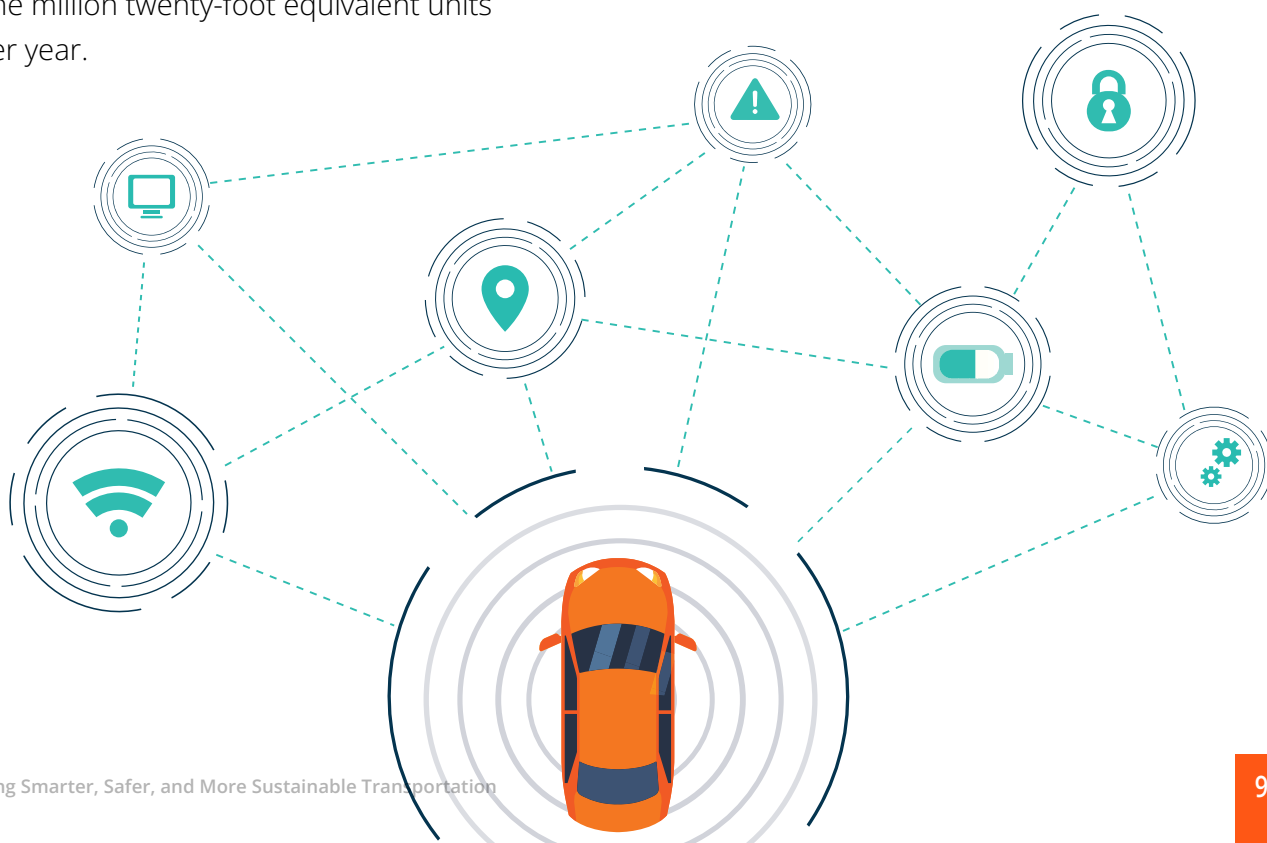
Finally, the ubiquity of high-bandwidth, low-latency 5G connectivity will catalyze innovative smart transportation applications powered by rich data. Autonomous vehicles equipped with cameras, LiDAR, radar, and other sensors share enormous high-definition sensor feeds with each other and smart infrastructure in real time to navigate environments collaboratively. Dense networks of internet-connected sensors on roads, bridges, rails, ports, and more will provide comprehensive, up-to-date transportation data to better coordinate infrastructure operations and maintenance. High-definition video feeds from high-resolution cameras across cities continuously upload imagery to inform traffic management systems. On the user level, the responsiveness of 5G will improve real-time transit and mapping mobile apps to provide faster route recommendations and travel updates.



Real World Smart TRANSPORTATION DEPLOYMENTS

A few examples of smart transportation deployments include:

- ✓ NEC and the Virginia Tech Transportation Institute (VTTI) have developed a [roadway warning system](#) using private 5G and AI to identify hazards and provide real-time warnings to drivers. The system, tested in Virginia, is expected to reduce traffic accidents and congestion.
- ✓ The East-West Gate (EWG) Intermodal Terminal in Hungary, Europe's largest and most advanced [intelligent railway logistics](#) terminal, has opened with a private 5G network implemented by Vodafone Hungary and Huawei Technologies Hungary. The terminal's technology includes fully automated cranes and green energy solutions, positioning Hungary as a key player in rail freight between Asia and Europe, with a capacity of handling up to one million twenty-foot equivalent units (TEU) per year.
- ✓ The Port of Tyne was the first in the UK to implement a site-wide private 4G and 5G network in partnership with BT and Ericsson, enabling [smart port applications](#) such as automatic number plate recognition and AI-driven container inspection. This technology is expected to streamline operations, improve safety and sustainability, and drive innovation in the maritime industry.
- ✓ Cellnex Telecom, Aena, and Nokia have operationalized the first 5G private network at [San Sebastian airport](#) in Spain, enabling use cases such as drone operations for security and advanced monitoring and environmental data collection and processing.



Challenges for 5G-based SMART TRANSPORTATION

While 5G connectivity promises to revolutionize intelligent mobility systems, several challenges around integration, infrastructure, policy, and security must be addressed.



The expansive connectivity between countless vehicles, devices, and networks raises valid **cybersecurity** concerns regarding hacking and unauthorized access to sensitive transportation data and control systems. Strict data encryption and endpoint authentication procedures are imperative.



Transitioning to 5G-based smart transportation represents substantial **financial and logistical hurdles** for cities, including upgrading physical network infrastructure and updating legacy IT systems. Public policy and regulatory frameworks will also need to evolve to govern advanced mobility tech applications enabled by 5G appropriately in areas like privacy and automation.



Realizing the full benefits of 5G for transportation requires significant upgrades to wireless **communication infrastructure** with the installation of numerous small cells throughout all aspects of a metro's transit networks. This necessitates substantial construction and capital investment.



Leveraging 5G's capabilities also relies on smooth **integration** with legacy transportation management systems and coordination frameworks - a complex challenge as new data sources, variables, and software must align with existing control infrastructure.



Deploying **private 5G networks** for smart transportation also presents challenges, such as spectrum allocation, network infrastructure investment, and integration with existing systems. Transportation agencies and private sector partners must collaborate closely to address these challenges and ensure the seamless implementation of private 5G networks in innovative transportation ecosystems.





CONCLUSION

While the potential of 5G-powered smart transportation is immense, realizing this vision will require concerted efforts from both the public and private sectors moving forward. Cities must prioritize investments in upgrading wireless infrastructure, such as dense 5G small cell networks blanketing transportation systems. Policymakers must also establish legal frameworks that proactively govern data privacy, cybersecurity, and vehicle automation standards, as these technologies see broader adoption.

At the same time, transportation agencies should actively pursue integration pilots where new 5G-connected infrastructure and vehicle platforms are deployed in tandem with existing systems.

An open collaboration between legacy providers and new smart mobility companies will ensure a smooth transition. Public education campaigns are also needed to raise awareness and facilitate user acceptance of smart transportation services.

The path toward realizing the smart transportation vision won't happen overnight. Still, the societal benefits of reduced congestion, improved accessibility, increased sustainability, and enhanced safety make it an imperative goal to pursue relentlessly. With strategic public-private collaboration and a solid commitment to innovation, our cities will eventually seamlessly integrate intelligent mobility fabric to power more vibrant, connected urban communities.



About PrivateLTEand5G.com



PrivateLTEand5G is the industry's only B2B media publication for everything related to Private Cellular Networks. The publication provides network operators, telecom vendors, service providers, and enterprises with critical insights to commercialize private LTE and 5G networks. It regularly shares significant enterprise private wireless deployments around the globe.

The publication hosts the podcast "Alynment" to have engaging discussions with industry leaders on the supply as well as demand side, revealing their thoughts and plans for wireless connectivity, as well as other diverse yet related topics, including IoT security, the distributed edge, CBRS, and navigating the myriad choices available for private networks.

PrivateLTEand5G.com is a division of KAIROS Pulse, a strategic consulting company specializing in aligning technology with business value for B2B technology companies.



About PrivateWirelessPRO



PrivateWirelessPro.com is dedicated to equipping system integrators with the expertise needed to excel in the rapidly evolving field of private 5G networking. Recognizing the gap in cellular solutions knowledge among system integrators, we offer comprehensive training, thought leadership, and expert guidance to empower them to meet their clients' growing demands for private 5G deployments. Our services cover every aspect of the industry, from identifying market opportunities and selling private 5G solutions to mastering installation, deployment, and providing tailored solution recommendations, ensuring integrators are well-prepared to lead in this cutting-edge technology space.

For more resources and guidance for system integrators and private cellular networks, visit us at: [PrivateWirelessPRO.com](https://www.PrivateWirelessPRO.com)

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