Report November, 2025

Smart Mobility Blueprint for India

A Roadmap for Intelligent Transport Systems

GEOSPATIAL WORLD
ADVANCING KNOWLEDGE FOR SUSTAINABILITY

ITS INDIA

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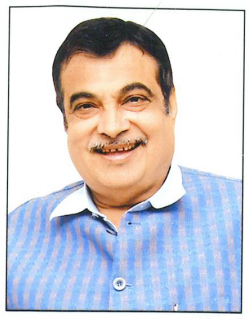
Abbreviations

ADAS	Advanced Driver Assistance System
ADC	Analog-to-Digital Converter
AI	Artificial Intelligence
AIS	Automotive Industry Standard
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
API	Application Programming Interface
ATCS	Adaptive Traffic Control System
ATIS	Advanced Traveler Information Systems
ATMS	Advanced Traffic Management System
AVCS	Advanced Vehicle Control Systems
BATCS	Bengaluru Adaptive Traffic Control System
BIS	Bureau of Indian Standards
BRT	Bus Rapid Transit
BS-VI	Bharat Stage VI Emission Norms
C-DAC	Centre for Development of Advanced Computing
C-V2X	Cellular Vehicle-to-Everything
CIAL	Cochin International Airport Limited
CMVR	Central Motor Vehicles Rules
COE	Centre of Excellence
CoAP	Constrained Application Protocol
ConOps	Concept of Operations
DAQ	Data Acquisition
DSRC	Dedicated Short-Range Communication
ERS	Electric Road System
ETL	Extract, Transform, Load
FAME	Faster Adoption and Manufacturing of Hybrid and Electric Vehicles
GHG	Greenhouse Gas
GIS	Geographic Information System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
ICCC	Integrated Command and Control Centre
INSPIRE	Infrastructure for Spatial Information in Europe
InvIT	Infrastructure Investment Trust
IoT	Internet of Things
IPPUC	– Instituto de Pesquisa e Planejamento Urbano de Curitiba (Urban Research and Planning Institute of Curitiba)
IRC	Indian Roads Congress
ISO	International Organization for Standardization
ITMS	Integrated Traffic Management System
IUT	Institute of Urban Transport
KMRL	Kochi Metro Rail Limited
LiDAR	Light Detection and Ranging

ML	Machine Learning
MLFF	Multi-Lane Free Flow
MoRTH	Ministry of Road Transport and Highways
MQTT	Message Queuing Telemetry Transport
NavIC	Navigation with Indian Constellation
NCAP	National Clean Air Programme
NCMC	National Common Mobility Card
NDCP	National Digital Communications Policy
NHAI	National Highways Authority of India
NIUA	National Institute of Urban Affairs
NIP	National Infrastructure Pipeline
NUTP	National Urban Transport Policy
O&M	Operations and Maintenance
OGC	Open Geospatial Consortium
PMP	Phased Manufacturing Programme
PLI	Production Linked Incentive
PMGSY	Pradhan Mantri Gram Sadak Yojana
PPP	Public–Private Partnership
PTMS	Public Transport Management System
PTP	Precision Time Protocol
RTK	Real-Time Kinematic (positioning system)
RTC	Real-Time Clock
SDG	Sustainable Development Goal
SEMP	Systems Engineering Management Plan
SIAM	Society of Indian Automobile Manufacturers
TEC	Telecommunication Engineering Centre
TOD	Transit-Oriented Development
UWB	Ultra-Wideband
ULIP	Unified Logistics Interface Platform
USDOT	United States Department of Transportation
V2I	Vehicle-to-Infrastructure
V2X	Vehicle-to-Everything
VIDES	Video Incident Detection and Enforcement System
VMS	Variable Message Sign
VRU	Vulnerable Road User

नितिन गडकरी
NITIN GADKARI



सत्यमेव जयते

मंत्री
सड़क परिवहन एवं राजमार्ग
भारत सरकार
Minister
Road Transport and Highways
Government of India

Message

I am glad to know that the Intelligent Transport Systems (ITS) India Forum, in partnership with IIT Hyderabad and OMI Foundation Trust, are convening the inaugural "ITS India Congress 2025 on Artificial Intelligence (AI) in Mobility" on 6-7 November, 2025, at the IIT Hyderabad, aimed at showcasing how AI could re-define road safety, urban efficiency, logistics competitiveness, and inclusive access.

2. The vision of the Ministry of Transport and Highways is not only to build world-class transport infrastructure, but also to make every kilometre of roads, safer, smarter, and more humane. From Bharat New Car Assessment Programme (Bharat NCAP), to data-driven interventions for black-spots identification, our efforts are rooted in evidence, empathy, and accountability.

3. I commend the organisers of the ITS Congress 2025 for advancing this important dialogue. Achieving safer roads requires the collective effort of policymakers, industry, academia, and citizens. Together, by leveraging technology with purpose and data driven decision making, we can create a future where every journey is safer, smarter, and more secure. I wish the conference a grand success.

(Nitin Gadkari)

New Delhi
27th October, 2025.

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Foreword

Shri Girdhar Aramane

IAS (Retd), Former Secretary, Ministry of Road Transport and Highways and Ministry of Defense

It is a privilege to extend my warm greetings to all participants of the ITS India Congress 2025, a landmark event that signifies a defining milestone in India's ongoing mobility transformation. As the nation advances confidently toward the vision of Viksit Bharat 2047, intelligent transportation systems (ITS) stand at the forefront of our development journey — shaping how people, goods, and information move in an increasingly digital and interconnected world.

India today is witnessing the convergence of artificial intelligence, intelligent infrastructure, and digital ecosystems, ushering in a new era of transportation that is not only safer and more efficient but also environmentally sustainable and socially inclusive. The ITS India Congress 2025 serves as a dynamic platform for dialogue, innovation, and collaboration among policymakers, technology leaders, academia, and industry pioneers — all committed to advancing this vision of a smarter mobility future. This Congress also reaffirms India's growing global leadership in harnessing technology to enable intelligent, data-driven, and citizen-centric transportation systems.

One of the key highlights of this year's Congress is the launch of the ITS India Roadmap, which represents a unified national vision for the deployment and scaling of intelligent transportation technologies across the country. Developed collaboratively by the nation's leading IITs, industry experts, policymakers, and ITS practitioners, this roadmap sets forth the strategic direction for integrating AI, IoT, data analytics, and connected vehicle technologies across highways, urban centers, and logistics corridors. It aligns closely with the Electronic Enforcement Policy and Standard Operating Procedures (2025) formulated by the Ministry of Road Transport and Highways (MoRTH) and the Supreme Court Committee on Road Safety (SCCoRS), emphasizing digital governance, automation, and interoperability as key enablers of safer and more accountable mobility systems.

Moving forward, the real transformation lies in institutionalizing intelligent systems across all infrastructure layers — seamlessly linking highways, smart cities, logistics hubs, and emergency response mechanisms into one cohesive digital mobility framework. This will require close collaboration between government, industry, and academia, underpinned by robust data-sharing standards, ethical AI frameworks, and an inclusive approach that ensures the benefits of technology reach every region and citizen of India.
The journey ahead will not only demand innovation but also policy consistency, capacity building, and public awareness, ensuring that technology adoption strengthens governance, transparency, and sustainability. With these collective efforts, India can set global benchmarks in mobility intelligence and create a model for developing nations worldwide.

The launch of the ITS India Roadmap is therefore not merely the unveiling of a document — it is the beginning of a national movement toward AI-driven, intelligent, and sustainable transportation. It symbolizes India's readiness to lead the global ITS revolution, where technology, governance, and human ingenuity come together to redefine how we move, connect, and live. Together, we are building the foundation for a smarter, safer, and truly connected India — driving forward toward the vision of Viksit Bharat 2047.

Foreword

Dr. R.S. Sharma

IAS, (Retd.), Former Chairman of the Telecom Regulatory Authority of India (TRAI)

It gives me great pleasure to extend my greetings to all participants of the ITS India Congress 2025, a momentous gathering that reflects India's growing commitment to building a digitally empowered and intelligent transportation ecosystem. This Congress arrives at a pivotal juncture in India's developmental journey — when digital transformation, data-driven decision-making, and smart infrastructure are becoming the bedrock of public governance and service delivery. Over the past decade, India has demonstrated how technology can transform governance at scale, from digital identity and financial inclusion to healthcare and public service delivery. The same spirit of innovation and reform now drives the evolution of our mobility and transport systems. As we move toward the vision of Viksit Bharat 2047, Intelligent Transportation Systems (ITS) are poised to play a defining role in shaping an integrated, safe, and sustainable mobility framework for the nation.

The ITS India Roadmap, launched at this Congress, is a landmark step toward realizing that vision. It represents a collaborative national effort — bringing together academia, policymakers, and industry experts — to chart the strategic direction for deploying AI, IoT, data analytics, and connected mobility solutions across India's transport corridors and urban centers. The roadmap outlines how technology can strengthen governance through automation, real-time monitoring, and interoperability, enabling transparency, safety, and efficiency on a national scale. What makes this initiative especially significant is its alignment with India's larger digital public infrastructure vision — one that emphasizes inclusivity, interoperability, and innovation. Just as platforms like Aadhaar, CoWIN, and the Ayushman Bharat Digital Mission have redefined the digital interface between citizens and the state, the ITS ecosystem holds the potential to redefine India's relationship with mobility — making it more intelligent, responsive, and citizen-centric.

The path ahead will demand collective will and cross-sectoral collaboration. Government institutions must work closely with technology innovators, academic researchers, and industry leaders to build robust data frameworks, ensure security and privacy, and create regulatory mechanisms that foster trust and scalability. The emphasis must remain on building systems that are not only technologically advanced but also equitable, accessible, and resilient. The launch of the ITS India Roadmap marks more than a technological milestone — it represents a national commitment to reimagining transport governance through digital intelligence. It symbolizes the next frontier in India's digital transformation journey — where innovation and public purpose converge to create an ecosystem that is smarter, safer, and more inclusive for all citizens.

As someone who has witnessed the transformative power of technology across multiple sectors, I am confident that India's leadership in intelligent transportation will set a global benchmark for how digital governance can drive sustainable development. The road ahead is both challenging and promising — but together, through vision, collaboration, and innovation, we can build a mobility ecosystem worthy of a Viksit Bharat.

Foreword

Shri Rohit Kumar Singh

IAS (Retd.) ,Former Secretary
to the Government of India,
Department of Consumer Affairs

India's transport and mobility landscape is undergoing a profound transformation. With the rapid expansion of infrastructure, increasing vehicle density, and the emergence of data-driven governance, the time has come to reimagine how technology and policy can together create a safer, more efficient, and inclusive mobility ecosystem. The launch of the ITS India Roadmap is a decisive step in this direction — one that reflects our collective resolve to embed intelligence, innovation, and integration into every layer of transportation planning and execution.

During my years of service in various capacities across the Government of India and the State of Rajasthan, I have witnessed how digital transformation and public-private collaboration can redefine outcomes. In the highways sector, initiatives such as the Hybrid Annuity Model (HAM) and the Toll Operate Transfer (TOT) framework demonstrated that sound policy design, risk-sharing, and transparent governance can unlock large-scale private participation and international investment. The same philosophy now needs to guide the evolution of India's Intelligent Transport Systems (ITS) — where strategic alignment between technology providers, regulators, and end users can accelerate implementation while ensuring long-term sustainability.

The ITS India Roadmap lays out a comprehensive vision for leveraging emerging technologies — from AI and IoT to advanced data analytics and connected mobility — to enhance efficiency, reduce congestion, and improve road safety. Beyond the technology, it emphasizes the importance of institutional frameworks, interoperable standards, and capacity-building mechanisms that ensure scalability and accountability. This systemic approach is critical for India to move from fragmented pilots to an integrated national mobility network. As India marches toward Viksit Bharat 2047, we must ensure that our transport modernization agenda is built on three pillars — innovation, inclusion, and integrity. The innovation to adopt cutting-edge ITS solutions; the inclusion to ensure these benefits reach every citizen, city, and rural region; and the integrity to implement with transparency, data ethics, and long-term vision.

I commend the ITS India Forum and its partners for their efforts in bringing together diverse stakeholders — from academia and government to industry and research organizations — to develop this roadmap. It stands as a guiding framework for policymakers and practitioners alike, offering not just technological direction but also strategic foresight for India's evolving mobility ecosystem. The future of transportation lies not merely in expanding physical infrastructure but in infusing intelligence into it. With sustained collaboration, India can lead the global shift toward connected, efficient, and sustainable mobility systems — setting new benchmarks for digital governance and public service delivery.

Foreword

Shri. Akhilesh Srivastava

President, ITS India Forum

India is entering a transformative era in transportation — one where physical infrastructure and digital intelligence must converge to redefine how mobility is designed, delivered, and governed. The "National ITS Roadmap" marks a major milestone in this journey. It is the culmination of months of dialogue, collaboration, and consensus-building among policymakers, technologists, industry experts, and research institutions — all united by the shared vision of creating a smarter, safer, and more sustainable transport ecosystem for India.

Intelligent Transport Systems (ITS) have the power to reshape our nation's mobility landscape by embedding data, automation, and connectivity into every layer of transport infrastructure. From improving traffic flow and road safety to enabling real-time public transport management and efficient logistics, ITS represents the backbone of a modern transport economy. Yet, realizing this vision requires a cohesive strategy that transcends silos, ensures interoperability, and promotes innovation at scale.

This report is not just a technical document — it is a vision blueprint. It identifies strategic priorities, governance frameworks, and implementation pathways that can guide both public and private stakeholders in accelerating ITS adoption across urban and intercity corridors. It also recognizes the critical role of digital platforms, indigenous R&D, and capacity building in ensuring that India's ITS ecosystem is not only world-class but also self-reliant and sustainable.

As President of the ITS India Forum, I am deeply encouraged by the collective enthusiasm and thought leadership that has shaped this initiative. The Forum has always envisioned itself as a bridge between government agencies, technology innovators, and academic institutions — fostering dialogue, disseminating best practices, and enabling collaboration that drives measurable impact on ground.

The Roadmap thus stands as both a reference document and a call to action. It seeks to empower all stakeholders — from policymakers and implementing agencies to start-ups and research bodies — to co-create solutions that address India's unique transport challenges while aligning with the broader goals of safety, sustainability, and inclusivity.

In the coming years, our goal is to ensure that ITS is no longer seen as an adjunct but as an integral component of every transport infrastructure project. We must build systems that communicate, cities that think, and networks that respond — intelligently, securely, and efficiently.

I invite all stakeholders to join us in this journey to make India's transport systems more resilient, data-driven, and people-centric. Together, we can turn this roadmap into reality and make India a global leader in Intelligent Transport Systems.

Foreword

Sanjay Kumar

Founder & CEO, Geospatial World

Mobility is the heartbeat of progress. As India moves steadily toward the vision of Viksit Bharat@2047, transport infrastructure must evolve beyond physical assets into intelligent, data-driven systems that anticipate needs, optimise movement, and safeguard lives. The convergence of infrastructure and digital intelligence is no longer a futuristic aspiration; it is the foundation of India's next growth decade.

Intelligent Transport Systems (ITS) represent this convergence. They transform highways into responsive networks, vehicles into data sources, and cities into ecosystems of connected mobility. When powered by geospatial data, IoT, and AI, our roads become living systems that communicate, adapt, and deliver enabling faster logistics, safer journeys, and cleaner air. The real promise of ITS lies not merely in technology adoption, but in institutionalising intelligence within every stage of planning, design, and governance.

This report, Smart Mobility Blueprint for India: A Roadmap for Intelligent Transport Systems, is both timely and transformative. It presents a cohesive national strategy to move India from fragmented pilots to an integrated, architecture led ITS ecosystem. It outlines the reforms needed to build unified data frameworks, strengthen institutional capacity, and enable interoperability across transport corridors and cities. The report's vision of embedding intelligence into infrastructure delivery aligns seamlessly with India's broader priorities under PM Gati Shakti, the National Infrastructure Pipeline, and the Digital India Mission.

At its core, this roadmap underscores that mobility is not only about movement, it is about empowerment. It calls for systems that are not just efficient but equitable; not just digital but sustainable. It emphasises indigenous innovation, data-driven policymaking, and capacity building pillars that will ensure India's ITS framework is both globally competitive and locally relevant. Geospatial World is proud to contribute to this collective effort to redefine India's transport future. We believe that by integrating spatial intelligence, real-time data, and digital governance, India can create mobility systems that are safer, cleaner, and profoundly human-centric.

As we stand at the cusp of a digital mobility revolution, this roadmap is more than a policy vision, it is a call to action. It urges every stakeholder to co-create a transport ecosystem that is intelligent by design and inclusive in impact.

Let us work together to build a future where every journey is smarter, every system is connected, and every kilometre of infrastructure contributes to a more sustainable, resilient, and prosperous India

Executive Summary

India's journey toward its objective of Viksit Bharat@2047 demands a transport ecosystem that is intelligent, inclusive, and sustainable. As cities expand and rural areas seek better access, Intelligent Transport Systems (ITS) have become central to achieving safer, cleaner, and more efficient mobility. This report presents a comprehensive national strategy to mainstream ITS across India's transport network integrating digital innovation with infrastructure delivery, social inclusion, and sustainable development.

The Case for ITS: Enabling Smarter, Safer, and Sustainable Mobility

India's growing motorisation, urban congestion, and limited rural access highlight the need for an intelligent such systems. While physical infrastructure has expanded rapidly, the absence of integrated, data-driven management limits safety, productivity, and user experience. By embedding intelligence into every layer of mobility planning, operations, and governance ITS can transform India's transport ecosystem into one that is safer, smarter, and more sustainable.

ITS integrates communication, control, and data technologies to make transport systems intelligent and responsive. From adaptive traffic signals and automated tolling to connected vehicle infrastructure, ITS enables real-time coordination, predictive management, and multimodal efficiency.

1. The Challenge

While India has made notable progress in deploying ITS across select cities and corridors, adoption remains fragmented, project-based, and uneven in impact. Most initiatives function in isolation limited by short-term funding, weak data integration, and lack of institutional ownership. As a result, critical information from tolling, enforcement, and traffic systems remains siloed, underused for real-time management or long-term planning.

Key gaps include:

- **No Unified Policy Direction:** Absence of a national framework defining roles, standards, and interoperability.
- **Data Silos:** Independent platforms for tolling, enforcement, and logistics restrict integration and analytics.
- **Short-Term Funding:** Limited fiscal continuity leads to under-maintenance and technology obsolescence.
- **Uneven Institutional Capacity:** Technical readiness and data literacy vary widely across states and cities.
- **Low Indigenous Development:** Dependence on imported technologies increases cost and limits adaptability.

2. Strategic Reform Levers

Transforming ITS from scattered pilots into a cohesive national ecosystem requires reforms across governance, data infrastructure, and institutional capacity. This roadmap identifies three interlinked levers to build India's ITS foundation.

- **Strengthening Policy and Institutional Frameworks:** A National ITS Policy and Architecture must define governance roles, interoperability standards, and data-sharing protocols. A Central ITS Mission, supported by state-level ITS Cells, will anchor implementation, planning, and oversight ensuring coordinated growth aligned with India's mobility and climate goals.
- **Building Data Integration and Indigenous Technology Capacity:** A Unified ITS Data Platform will integrate traffic, logistics, and enforcement data across agencies, enabling predictive management and policy insights. Simultaneously, domestic R&D and manufacturing ecosystems, supported through Make in India and PLI initiatives, will drive innovation and reduce dependence on foreign technology.
- **Ensuring Financial Sustainability and Capacity Building:** Dedicated financing via budgetary allocations, PPP models, and data monetisation mechanisms is essential for long-term viability. Parallelly, national certification and training programs for ITS professionals will build technical capacity across planning, integration, and maintenance functions.

Together, these reforms transform ITS from fragmented experimentation into a cohesive, data-driven mobility ecosystem enhancing safety, accessibility, and efficiency across India's urban and rural transport networks.

3. Key Recommendations: 10-Point Reform Agenda

To mainstream ITS across India's transport ecosystem, the nation must transition from fragmented, pilot-based deployments to a co-ordinated, architecture-driven approach. Incremental upgrades or city-specific projects cannot address systemic challenges of governance fragmentation, uneven standards, and limited data utilisation. A comprehensive reform strategy is essential one that embeds technology integration into infrastructure design, ensures fiscal sustainability, and builds institutional capacity for long-term delivery.

The following recommendations form the strategic blueprint for enabling large-scale, interoperable, and outcome driven ITS implementation across roads, highways, and urban networks.

Key recommendations include:

- **Notify a National ITS Policy and Architecture:** Formally adopt a unified policy framework defining technical standards, communication protocols, and interoperability requirements across national, state, and city levels ensuring consistency in design, data exchange, and system scalability.
- **Establish a Central ITS Mission:** Create a dedicated national mission with a clear mandate to plan, coordinate, and monitor ITS deployment. Regional ITS Cells should support implementation, capacity building, and compliance with the National ITS Architecture.
- **Mandate ITS Integration in All New Transport Projects:** Make ITS a core component of all new highway, urban, and multimodal projects to ensure data continuity, real-time monitoring, and lifecycle performance management.
- **Develop a Unified ITS Data Platform and Exchange Framework:** Build a secure, cloud-based data exchange integrating traffic, enforcement, and logistics information to enable analytics-driven policymaking, transparent monitoring, and regulated data monetisation.
- **Promote Indigenous Technology and R&D Ecosystem:** Strengthen domestic manufacturing and innovation in AI-based adaptive control, V2X communication, sensors, and analytics through Make in India, PLI, and startup accelerator programmes reducing import dependence and ensuring cost-effective scalability.
- **Institutionalise Capacity Building and Certification:** Launch national training and certification programmes through Centres of Excellence (CoEs) to develop a skilled ITS workforce capable of managing, maintaining, and expanding complex digital mobility systems.
- **Deploy Outcome-Linked Monitoring and Evaluation Frameworks:** Transition from input-based reporting to performance-driven metrics such as travel-time savings, emission reduction, safety improvement, and user satisfaction.

Additional elements from the framework:

- Establishing a National ITS Fund pooling public and private resources, supported by InvITs and green bonds for sustainable long-term financing.
- Deploying low-cost modular ITS solutions such as GNSS-based fleet management, digital maintenance dashboards, and emergency response systems to enhance safety and connectivity in rural India.
- Anchoring ITS deployment in principles of safety, accessibility, affordability, and sustainability, ensuring alignment with India's inclusive and low-carbon mobility agenda.
- Creating a national quality-assurance and integrator-certification framework to ensure transparency, interoperability, and accountability across agencies and vendors.
- Institutionalising continuous learning by linking post-deployment audits to national guidelines and publishing case-based lessons for replication across states.

4. Alignment with India's Development Vision

- Transport is not just about connectivity, it is central to economic growth, social inclusion, and environmental resilience. As India advances toward Viksit Bharat@2047, ITS will form the backbone of a safer, smarter, and low-carbon mobility ecosystem. This roadmap aligns ITS deployment with national priorities such as PM Gati Shakti, the National Infrastructure Pipeline (NIP), and the National Logistics Policy, ensuring every kilometre of infrastructure is supported by digital intelligence, data-driven planning, and real-time operations.

By embedding AI-enabled traffic control, vehicle connectivity, and geospatial integration, ITS reforms translate sustainability goals into measurable outcomes improving safety, reducing emissions, and expanding equitable access, especially across rural and remote areas. These measures also strengthen India's innovation and fiscal frameworks by promoting indigenous technology development, data monetisation, and public–private partnerships under Make in India and Digital India. Standardised architectures and interoperable data systems will position India as a global hub for intelligent mobility solutions.

5. Conclusion: A Call to Action

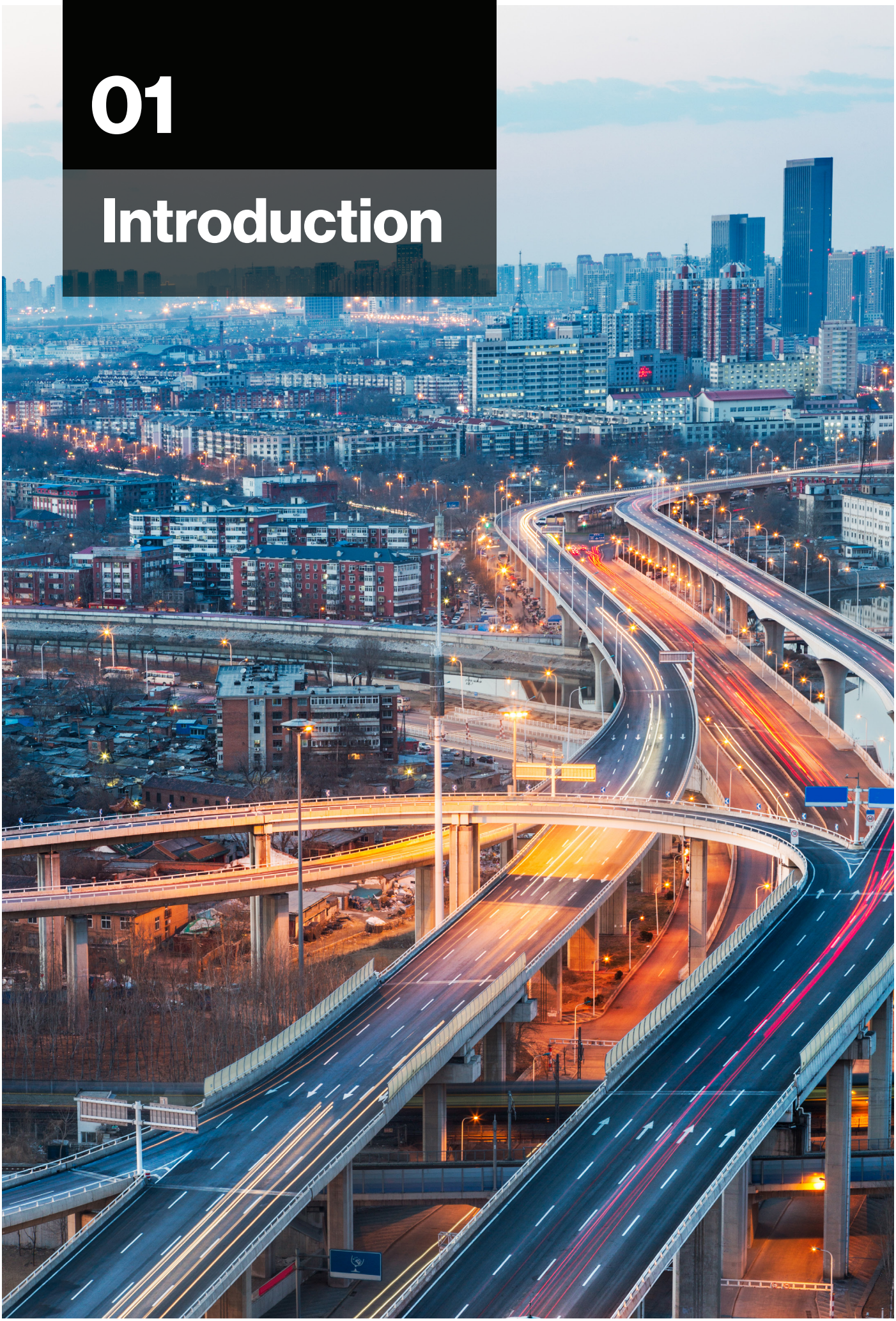
India's transport sector stands at a turning point. Continuing with fragmented, city-level pilots risks inefficiency and unequal access. The alternative—a cohesive, architecture-led transformation demands leadership, coordination, and sustained investment but promises safer roads, cleaner air, faster logistics, and empowered citizens.

- Achieving this vision depends on three critical levers:
- Establishing a National ITS Policy and Architecture for unified implementation.
- Building domestic innovation and capacity ecosystems for technology and data-driven mobility; and
- Implementing performance-linked monitoring and financing frameworks to ensure accountability and sustainability.

If implemented decisively, these reforms will create not just smarter transport systems but a digitally connected, inclusive, and climate-resilient mobility network realising the vision of Viksit Bharat@2047 and establishing India as a global benchmark in intelligent, sustainable transport.

01

Introduction



Introduction

India stands at the threshold of a new era in transport modernisation. With the world's third-largest construction market and one of the fastest-growing logistics networks, the country's next phase of infrastructure growth will be defined not just by how much is built, but by how intelligently it operates. Intelligent Transport Systems (ITS) form the digital nervous system of this transformation integrating technology, data, and automation across roads, railways, ports, airports, and urban mobility networks to make transport safer, faster, and more sustainable.

At its core, ITS refers to the application of information, communication, and sensing technologies to transport infrastructure, vehicles, and operations. It connects every element of mobility vehicles, roads, railways, metros, control centres, and users through real-time data exchange, enabling responsive traffic control, predictive maintenance, automated enforcement, and seamless multimodal connectivity. From adaptive traffic signals and electronic tolling to integrated passenger information systems and connected vehicle networks, ITS transforms static infrastructure into living, data-driven systems capable of learning and adapting to human and environmental needs. The case for ITS in India is both urgent and transformative. As the Indian economy accelerates toward its vision of Viksit Bharat, the pressures of freight congestion, logistics inefficiencies, and urban pollution continue to impose substantial economic and environmental costs. ITS offers a strategic solution to these challenges by enhancing traffic efficiency, enabling real-time enforcement, reducing emissions, and optimizing energy use across modes of transport. Beyond operational improvements, ITS ensures that the extensive physical infrastructure being developed under flagship national programs expressways, multimodal logistics parks, high-speed rail networks, and urban transit systems functions with greater efficiency, reliability, and accountability, forming the digital backbone of India's future mobility ecosystem.

The adoption of ITS is central to India's development agenda, aligning closely with PM Gati Shakti, Smart Cities Mission, Make in India, and Viksit Bharat 2047. By integrating real-time monitoring, predictive analytics, and multimodal coordination, ITS strengthens the backbone of India's expanding transport infrastructure. Under PM Gati Shakti, it enables data-driven connectivity across 44 ministries and 36 states, ensuring that infrastructure investments deliver greater efficiency and interoperability. Within the Smart Cities Mission, ITS powers integrated traffic management, smart parking, and command-and-control centres, enhancing urban mobility, safety, and service delivery. It also underpins India's clean mobility transition through FAME-II and the Electric Vehicle Policy, supporting intelligent charging networks, route optimisation, and energy-efficient fleet operations. At the industrial and economic level, initiatives such as Make in India, the Production Linked Incentive (PLI) Scheme, and the Phased Manufacturing Programme (PMP) are catalysing a domestic ITS ecosystem spanning sensors, controllers, communication modules, and telematics platforms. This convergence of digital innovation and manufacturing capability is advancing self-reliance, export competitiveness, and public private partnerships, positioning India as a hub for intelligent mobility solutions.

Beyond technology, ITS is a driver of social inclusion and environmental sustainability. By improving rural and peri-urban connectivity, it enhances access to markets, education, and healthcare, complementing programs like Pradhan Mantri Gram Sadak Yojana (PMGSY) and the Aspirational Districts Programme. Environmentally, ITS contributes to India's Net Zero 2070 and National Clean Air Programme (NCAP) goals by reducing congestion, curbing emissions, and optimizing energy use across transport modes. Together, these efforts make ITS a catalyst for inclusive, efficient, and climate-resilient growth, steering India toward a sustainable mobility future. Globally, countries such as Japan, South Korea, the United States, and members of the European Union have made ITS) a cornerstone of their mobility strategies, guided by frameworks like the EU ITS Directive and the US DOT ITS Strategic Plan. India now stands at a similar inflection point with its scale, diversity, and infrastructure investment momentum enabling it to leapfrog traditional models toward Digital-by-Design Infrastructure, where technology is embedded from project conception to operation.

With the rollout of 5G connectivity, Cellular Vehicle-to-Everything (C-V2X) networks, and NavIC-based localization, India is positioned to become a global hub for ITS innovation, manufacturing, and exports. As the nation advances toward Viksit Bharat 2047, ITS will be crucial to making every kilometre of infrastructure intelligent, every journey safer, and every transport system interconnected. This ITS India Roadmap comes at a pivotal moment offering a structured framework for national deployment, institutional alignment, standardization, and capacity building. It charts a path for India to move from fragmented implementation to a cohesive, future ready ITS ecosystem that supports smart, sustainable, and inclusive growth.

02

Current State of ITS in India

2.1. Foundations of Smart & Sustainable Transport

India's transport system is transitioning from fragmented, manual operations to integrated, technology-driven mobility. ITS are key to managing traffic, public transport, freight, safety, and the environment. Highways use ATMS for incident detection, while cities deploy ATCS with adaptive signals. ATIS provides real-time travel updates, and APTS supports tracking and e-ticketing. ITS deployment spans three levels: community (smart parking, shuttles), individual (apps, ride-sharing), and city (command centres, ITMS, multimodal hubs).

2.2. Key Principles of Intelligent Transport Systems (ITS) for India

The effective deployment of ITS in India requires adherence to a set of guiding principles that ensure scalability, inclusivity, resilience, and sustainability. These principles provide the foundation for policies, investments, and governance structures that will shape the future of smart mobility in the country.

Interoperability and Standardization

ITS deliver impact at scale if deployed systems across states, cities, and agencies communicate seamlessly. Interoperability requires common data standards, open APIs, and harmonized protocols.

User-Centricity and Accessibility

ITS should prioritize citizens, enhancing daily life beyond enforcement. Accessibility demands affordability, inclusivity for differently-abled users, and availability across urban and rural areas. A citizen-first approach builds trust and adoption.

Integration Across Modes and Agencies

India's transport modes metro, bus, rail, freight, and waterways operate in silos. Institutionalized integration through cross-agency governance at city, state, and national levels, with clear mandates for data sharing and joint operations, is essential.

Data-Driven Decision-Making

ITS generates vast real-time data from sensors, vehicles, and fare systems. Treating data as a public asset through open platforms with controlled access enables innovation and better decision-making.

Safety and Resilience

With India's high road fatality rates, ITS must deliver safer roads, faster emergency response, and resilient systems that withstand cyber threats and disasters to ensure mobility continuity

Sustainability and Environmental Impact

ITS should support eco-mobility through traffic optimization, public and shared transport promotion, EV adoption, and eco-driving tools to cut emissions and congestion.

Public–Private Collaboration

ITS success depends on collaboration: the private sector brings R&D, technology, and funding, while the public sector ensures regulation, equity, and reach.

Institutional Capacity and Governance

Technology alone is insufficient. Strengthening institutional capacity through training, transparent procurement, accountability, and continuous monitoring is vital for sustainable ITS implementation.

2.3. Core Components of ITS in India

ITS integrate a suite of advanced digital technologies that make transportation safer, faster, and more efficient. Modern vehicle innovations are redefining mobility by enabling smarter, more connected, and responsive systems that assist drivers, automate key functions, and enhance overall road safety. The next generation of ITS is further strengthened by high-speed communication and computing networks that connect vehicles, infrastructure, and control centres in real time creating an intelligent, data-driven ecosystem for transport management. Together, these technologies enable seamless coordination across roads, vehicles, and cities, paving the way for India's transition toward safe, connected, and autonomous mobility.

Table 1 Road ITS: Core and Emerging Technologies

Technology Focus	What it is	Current & Emerging Trends	Research & Innovation in India
Advanced Traffic Management Systems (ATMS) (Traffic Control and Management Systems)	ATMS focuses on real-time monitoring, control, and coordination of the overall traffic network. It integrates data from multiple sources to manage incidents, optimise traffic flow, and enhance road safety.	AI-based incident prediction, IoT-enabled surveillance, deep learning for anomaly detection, and Vehicle-to-Infrastructure (V2I) communication for coordinated responses.	Cities like Pune, Lucknow, and Kolkata are deploying integrated ATMS centres for traffic monitoring, analytics, and emergency coordination. Pilot studies also explore the fusion of IoT and AI for predictive traffic management and real-time congestion forecasting.
Adaptive Traffic Control Systems (ATCS) (Traffic Control and Management Systems)	ATCS focuses specifically on optimising signal timings and intersection performance based on live traffic conditions. It uses real-time sensor data to dynamically adjust signal phases, minimising delays and improving corridor efficiency.	AI-driven adaptive algorithms, Machine Learning-based congestion prediction, and Generative AI for multi-intersection optimisation.	Bengaluru's BATCS (C-DAC) optimises traffic flow across 165 intersections using AI-based adaptive control. Similar systems in Dehradun and Pune manage more than 50 junctions each, improving travel time reliability and reducing congestion.
Intelligent Parking Management Systems (User Charging Systems)	These systems use ground sensors and mobile apps to guide drivers to available parking spots and enable cashless payments, reducing unnecessary circling and urban traffic.	IoT-based space detection, AI-driven demand forecasting, LPR/RFID for automated entry and payment, EV charging integration, and robotic/ stacked parking for space optimisation.	Studies in major cities and airports use AI, IoT, and computer vision for real-time detection, digital payments, and EV-linked parking. Focus on multimodal and sustainable parking systems.
Intelligent Tolling Solutions (User Charging Systems)	These solutions such as FASTag, allow automatic toll collection through RFID or number-plate recognition, eliminating queues and ensuring transparent revenue management.	LIDAR and computer vision for vehicle detection, GNSS-based free-flow tolling, real-time pricing, and V2X-enabled contactless payments.	Pilots using NavIC-based GNSS tolling and FASTag show major time and fuel savings. Research advancing open-road, privacy-aware, barrierless tolling systems.
Incident Management Systems (Traffic Management Systems)	These systems detect crashes or breakdowns in real time through sensors or citizen alerts, triggering coordinated emergency responses and restoring normal flow faster	AI-based real-time incident detection, drone-assisted assessment, CAD-enabled coordination, and Standard Operating Procedure (SOP) based response.	Pilots on drone-based response and CAD integration for highways and urban corridors. Research focuses on AI analytics for faster detection and emergency activation.
Smart Transit and Bus Systems	These systems track public transport vehicles using GNSS , display live arrival times, and support e-ticketing and route optimisation, improving reliability and commuter convenience.	Edge cameras, predictive maintenance, automated fare collection, AI-driven scheduling, and multimodal integration through shared platforms.	Urban pilots under Smart Cities Mission, such as in Thiruvananthapuram, integrate bus tracking, digital ticketing, and real-time fleet co-ordination for efficient, connected transit systems.
Cross-Cutting and Emerging Technologies		5G, Edge AI, V2X, predictive ML, blockchain for secure transactions, and integration with EVs and micromobility for low-carbon mobility.	Research accelerates in AI-based analytics for safety, and multimodal integration. National expos showcase indigenous ITS prototypes and collaborations.

Source: Geospatial World Analysis

Table 2 Vehicle Intelligent Transport Systems (ITS): Core and Emerging Technologies

Technology Focus	What it is	Current & Emerging Trends	Research & Innovation in India
Advanced Driver Assistance Systems (ADAS)	These systems use sensors, cameras, and radar to help drivers with real-time functions such as lane keeping, adaptive cruise control, collision avoidance, and automatic braking, reducing accidents and improving road safety.	Adaptive cruise control, lane keeping, automatic braking, and pedestrian detection using integrated sensors (camera, radar, LiDAR, ultrasonic). AI and ML enable real-time environment interpretation and decision support.	ARAI developing ADAS hardware, electromagnetic testing, and embedded systems. Tata Elxsi & Mercedes-Benz R&D India collaborating on ADAS algorithms, AI-driven safety analytics, and digital twin simulations.
V2X (Vehicle-to-Everything) Communication	This communication enables vehicles to exchange information with other vehicles (V2V), roadside infrastructure (V2I), pedestrians (V2P), and networks (V2N), using 5G or C-V2X technology to prevent collisions, optimise traffic flow, and support autonomous driving.	Real-time connectivity among vehicles, infrastructure, pedestrians, and networks through DSRC, C-V2X, and 5G. Supports collision avoidance, traffic efficiency, and co-operative mobility.	Indigenous NavIC-based V2X sensor and on-board unit (OBU) development by Indian OEM–startup consortia. Research on secure, low-latency communication protocols and edge-AI processing for V2X data streams.
E-Call and Emergency Response Systems	These systems automatically notify emergency services during a severe crash, sharing the vehicle's location and critical data to ensure faster medical response and save lives.	Automated crash alerts transmit vehicle location and incident data to emergency services for rapid response. Integrated with telematics and voice modules for nationwide deployment.	Indian R&D centres developing AIS-140 compliant e-Call systems. Early deployments underway for emergency alert integration within fleet telematics and public transport vehicles.
Telematics and Connectivity Systems	These systems combine GNSS tracking, mobile communication, and onboard diagnostics to monitor vehicle performance, driver behaviour, and fleet operations, enhancing efficiency and enabling predictive maintenance.	Combines GNSS tracking, diagnostics, and data communication to monitor performance, driver behaviour, and maintenance. Enables predictive analytics and usage-based insurance models.	Indian firms building AIS-140 compliant telematics software and IoT devices for fleet tracking. Focus on analytics-driven dashboards, driver scoring, and predictive maintenance algorithms.
Vehicle Control & Management Units	These systems act as the vehicle's central brain integrating data from sensors, communication systems, and power units to coordinate functions like braking, acceleration, and steering in real time.	Centralized electronic control over powertrain, braking, and connectivity through Vehicle Control Units (VCUs) and Telematics Control Units (TCUs).	VRDE advancing indigenous VCUs and TCUs for both defence and commercial platforms. Focus on sensor fusion and safety-critical control systems.
Artificial Intelligence & Machine Learning Applications	These applications process vast amounts of transport data to predict congestion, detect anomalies, enable automated driving decisions, and improve infrastructure planning.	Enhances sensor fusion, driver behaviour prediction, maintenance forecasting, and autonomous decision-making.	Advanced AI-driven software being developed for adaptive driving, predictive maintenance, accident risk estimation and real-time perception tuned to Indian driving conditions.
Digital Twins	Digital Twins (DT) are virtual near-real-time representations of the transport network. DT for transport systems are essentially process models where demand, traffic flows and travel times are updated in near-real-time using real-world observations.	Transport modelling and traffic control tools are moving towards convergence. In such a scenario, the data obtained from traffic control systems are used to calibrate the DT while the DT is used by traffic control systems for optimisation and scenario analysis.	Several Smart Cities in India have implemented transport models that are tightly linked with ATCS systems. Some of the cities have started exploring extending this capability to that of a DT.

Source: Geospatial World Analysis

Table 3 Communication Technologies in ITS: Core and Emerging Technologies

Technology Focus	What it is	Current & Emerging Trends	Research & Innovation in India
5G Networks	5G form the backbone of modern ITS, providing ultra-fast, low-latency communication essential for real-time applications like autonomous driving, remote vehicle monitoring, and high-definition video surveillance.	5G enables ultra-reliable, low-latency communication (URLLC), high bandwidth, and massive device connectivity, supporting autonomous driving, remote control, and co-operative traffic management.	Research focuses on integrating 5G with ITS corridors and connected vehicle testbeds. Trials under DoT and C-DAC explore 5G-enabled V2N and V2X communication for real-time safety, platooning, and smart city traffic control.
Cellular Vehicle-to-Everything (C-V2X)	This builds on this by allowing vehicles to communicate directly with other vehicles (V2V), roadside units (V2I), pedestrians (V2P), and cloud networks (V2N), using cellular signals to enhance road safety and traffic efficiency.	C-V2X enables V2V, V2I, and V2P communication expanding use cases to co-operative driving, platooning, and remote operations with ultra-low latency and high reliability.	India is developing indigenous C-V2X and other related technologies led by C-DAC. Research focuses on adapting C-V2X protocols to Indian traffic density, interference conditions, and mixed fleet scenarios using NavIC-based localisation.
Dedicated Short-Range Communications (DSRC) / ITS-G5	These are specialised wireless technologies designed for vehicle-to-vehicle and vehicle-to-infrastructure exchanges over short distances, ensuring instant communication even without a mobile network.	DSRC and ITS-G5 enable low-latency safety message exchange such as Co-operative Awareness Messages (CAM) and Decentralised Environmental Notification Messages (DENM).	Indian R&D institutions are assessing interoperability between DSRC and C-V2X for hybrid ITS deployment. Studies explore DSRC based pilot zones in controlled environments for short-range communication.
Edge Computing and Multi-Access Edge Computing (MEC)	These bring data processing closer to where it's generated such as traffic cameras or roadside units reducing delay and enabling faster decision-making for applications like adaptive traffic control and automated braking.	Edge and MEC architectures process vehicular data close to the source, reducing latency and network load.	India's 5G testbeds and IIT research centres are implementing edge computing nodes along smart highways for real-time analytics, dynamic route guidance, and safety monitoring.
Ultra-Wideband (UWB) and Satellite Navigation	These technologies enhance location accuracy: UWB provides precise short-range positioning for vehicle guidance and parking systems, while satellite-based navigation ensures reliable, nationwide geolocation for all transport operations.	UWB enables centimetre-level positioning for pedestrian detection and short-range communication. GNSS constellations provide accurate localisation for ITS safety applications.	Research under ISRO and MoRTH focuses on integrating NavIC with GNSS and UWB to enhance location accuracy for fleet tracking, ADAS, and V2X communication.
AI-Driven Network Management (Digital Twin Systems)	This uses artificial intelligence to automatically monitor and optimize network performance, predict congestion, and allocate bandwidth dynamically across ITS services.	AI supports dynamic spectrum allocation, predictive load balancing, anomaly detection, and network self-healing for optimized ITS connectivity and resilience.	Academia and industry are developing AI-driven Digital Twins for real-time traffic prioritisation, signal optimization, scenario planning, demand management and secure vehicular data transfer in Indian networks.

Source: Geospatial World Analysis

2.4. Intelligent Transport System – Demand and Barriers

Exhibit 1 ITS – Demand and Supply Drivers

Intelligent Transport System
Driving India towards Safer, cleaner and Smarter Mobility

Demand Driver of ITS in India

- **Rapid Urbanisation and Population Pressure**

  India's urban population will reach 630 million by 2030, placing immense pressure on roads, public transport, and parking. Cities like Bengaluru already lose approximately 120 hours per commuter each year to congestion. ITS adoption is driven by the need for adaptive traffic management, smart parking, and integrated transit systems to manage growing mobility demand efficiently.

- **Rising Vehicle Ownership**

  Number of vehicles are projected to rise from 226 million in 2023 to nearly 494 million by 2050, with two-wheelers forming 70% of the total. Ownership levels will almost double to 309 vehicles per 1,000 people, intensifying congestion and emissions. ITS enables dynamic traffic control, congestion pricing, and parking management to keep cities moving.

- **Road Safety Imperatives**

  India records over 150,000 road deaths annually, costing about 3% of GDP. ITS-driven tools like automated enforcement, AI-based incident detection, and emergency response integration can significantly reduce crashes and enhance road safety nationwide.

- **Environmental Sustainability and Climate Goals**

  Transport contributes 14% of India's CO_2 emissions, with road transport responsible for 90%. ITS supports eco-driving, EV integration, and congestion management, helping India advance toward its net-zero 2070 goal and sustainable urban mobility targets.

- **Evolving Consumer Expectations**

  Commuters now seek seamless, on-demand mobility through ride-hailing, shared bikes, and real-time transit apps. ITS powers Mobility-as-a-Service (MaaS) platforms that unify travel across metro, bus, taxi, and shared modes, offering real-time updates and cashless payments for a smooth, connected journey.

Supply Drivers of ITS in India

- **Government Policy and Investment**

  National mandates such as ITMS integration, electronic enforcement, and AIS-140 compliance are pushing large-scale adoption. Programs like Bharatmala, Sagarmala, and Multi-Modal Logistics Parks embed ITS features (ATMS, e-tolling, multimodal hubs). Funding through Smart Cities Mission and PM Gati Shakti creates sustained demand.

- **Public–Private Partnerships (PPPs)**

  Innovative PPP models (BOT, BOOT, and Infrastructure Investment Trusts (InvITs)) are financing corridor digitisation. Examples include Delhi–Mumbai Expressway ITS and Delhi NDMC's Advanced Parking Management System (APMS) with mobile app integration. PPPs bridge the gap between public oversight and private-sector efficiency.

- **Technological Innovation**

  Domestic firms (Videonetics, Kent ITS, Vehant, ITSPE, CDAC) and global players (Bosch, Siemens, Qualcomm) are deploying AI-powered video analytics, adaptive signals, and V2X pilots. Emerging technologies like AI, ML, IoT, 5G, and edge computing enable predictive traffic management, faster incident response, and integrated multimodal solutions.

- **Digital Infrastructure Backbone**

  The expansion of cloud-based platforms and Integrated Command & Control Centres (ICCCs) is creating centralised data visibility for cities and states. India's 5G rollout in over 100 cities provides ultra-low latency, critical for V2X communication, ITMS efficiency, and autonomous vehicle testbeds.

Source: Geospatial World Analysis

Enablers of ITS Deployment in India

- **Policy & Governance Ecosystem**

  Strong backing from MoRTH, NHAI, NPCI, and NITI Aayog, with states aligning policies. Schemes like National Common Mobility Card (NCMC), Battery Swapping Policy, and PM eBus Sewa embed ITS into sustainable and inclusive transport goals.

- **Financial Innovation**

  Diverse funding channels (PPP, Special Purpose Vehicles (SPVs), Infrastructure Investment Trusts (InvITs), and green bonds) reduce dependence on budgetary allocations and accelerate ITS rollout.

- **Local Manufacturing & Make in India**

  Domestic production of GPS devices, onboard units (OBUs), EV chargers, and surveillance equipment cuts costs, enhances supply resilience, and scales deployments under the Make in India initiative.

- **Digital Transformation Momentum**

  Integrated Command & Control Centres (ICCCs) under Smart Cities Mission act as urban ITS hubs, while national platforms like Vahan, Sarathi, NETC FASTag, and NPCI's payment rails provide the backbone for interoperability, enforcement, and digital payments.

- **Private Sector Leadership**

  Auto and tech majors are spearheading pilots: Maruti Suzuki–IIT Hyderabad V2X trials, Intel–LTTS edge AI safety systems, Ola Electric telematics, and Bosch adaptive traffic solutions. These innovations showcase India's growing ITS innovation ecosystem.

Barriers to ITS Deployment in India

- **Infrastructure Deficits**

  India faces a funding gap of USD 2.2 trillion to achieve its USD 7 trillion economy target. ITS infrastructure is concentrated in metros; smaller towns and rural areas still depend on legacy, non-digital systems, limiting nationwide penetration.

- **Legacy Systems & Fragmentation**

  Absence of standardised protocols and data formats across vendors and states creates silos. Legacy infrastructure makes integration with modern ITS solutions costly and complex. Efforts are currently underway by Department of Telecommunications and IRC to develop standardised ITS protocols for India.

- **Regulatory & Policy Gaps**

  Lack of a National ITS Architecture hinders interoperability. Privacy and data protection concerns around surveillance and vehicle data remain unresolved. Spectrum allocation delays continue to stall large-scale connected vehicle and V2X pilots.

- **High Capital & Operational Costs**

  Deployment of ATCS (INR 25lakhs/km) is unaffordable for Tier-2/3 cities. Long-term maintenance of cameras, sensors, and command centres stretches state budgets, creating sustainability concerns.

- **Capacity Constraints**

  State transport departments and municipal bodies lack skilled manpower to design, implement, and operate ATCS/ITMS systems. Heavy reliance on external vendors undermines institutional capacity building.

2.5. ITS for Rural Areas

India's rural transport landscape faces unique challenges shaped by sparse populations, limited infrastructure, and constrained access to modern technology. These factors collectively restrict mobility options, reduce economic opportunities, and hinder access to essential services such as healthcare, education, and markets. Seasonal weather conditions, poor visibility, and unmonitored road networks further increase the risk of accidents and travel delays, emphasising the need for smarter, more connected transport systems tailored to rural realities. ITS offer a transformative solution to these challenges by improving the efficiency, reliability, and safety of rural mobility networks. Through the integration of real-time data, communication technologies, and automated systems, ITS can bridge the connectivity gap between rural and urban transport. Beyond enhancing mobility, ITS can also create new employment opportunities in system operations, maintenance, and data monitoring, while promoting skill development for rural youth in emerging areas such as control centre management, equipment servicing, and remote diagnostics.

Potential applications of ITS in rural areas are wide-ranging. Safety-focused systems such as animal detection, wrong-way driving alerts, and road–rail crossing warnings can significantly reduce accidents on highways and village roads. Automated visibility and weather warning systems can improve travel safety during monsoons or fog, while road-geometry and speed warning technologies can guide drivers in difficult terrains. ITS also supports tourism, logistics, and local enterprise development by providing reliable information on travel conditions, routes, and amenities. A strong set of supply-side enablers is propelling this transformation. National policies and government-led initiatives are prioritising infrastructure modernisation and rural digitalisation. The rapid expansion of 5G and future communication networks, coupled with extensive civil infrastructure development under flagship programs like Bharatmala and PM Gati Shakti, provides the digital and physical foundation for large-scale ITS deployment in rural areas.

Simultaneously, demand-side enablers are strengthening the case for rural ITS adoption. The increasing disposable income of rural households and a growing appetite for transport, delivery, and digital services are driving new expectations for safe, reliable, and connected mobility. As access to smartphones and digital payment platforms expands, rural populations are becoming more receptive to technology-enabled transport systems, creating a virtuous cycle of adoption and innovation.

2.6. ITS for Remote Areas

India's remote regions (mountainous terrains, deserts, forested zones, and border areas) face some of the harshest transport challenges in the world. These areas often lack physical infrastructure, have minimal human presence, and possess limited or no access to technology. Poor connectivity, extreme weather conditions, and delayed emergency response mechanisms make mobility in such regions difficult and, at times, life-threatening.

The application of ITS in remote areas goes beyond improving mobility. It is about enhancing human safety, ensuring early warning, and supporting emergency response. Through the deployment of sensors, automated monitoring, and satellite-linked communication systems, ITS can provide timely alerts on landslides, avalanches, and severe weather conditions.Systems such as automated landslide and avalanche warnings, weather stations, and real-time visibility alerts can help authorities plan and respond quickly, reducing casualties and ensuring continuity of essential movement in remote zones. Beyond their safety role, ITS initiatives can contribute to local employment generation by creating new opportunities in system setup, monitoring, and maintenance. The rapid development of supply-side enablers is making ITS deployment in remote India increasingly feasible. Government policies promoting adventure tourism, frontier infrastructure, and digital connectivity are expanding. The rollout of 5G and future-generation communication networks promises to connect even high-altitude and isolated terrains, while civil infrastructure development under Bharatmala, Border Roads Organisation (BRO), and Digital India initiatives ensures that these technologies can be integrated with on-ground road and emergency systems.

On the demand side, the rising popularity of adventure and eco-tourism in remote destinations has created a need for safer, better-connected travel routes and real-time communication systems. Travellers , logistics operators, and local administrations are increasingly seeking technology-based safety mechanisms and monitoring systems that can provide accurate situational awareness and immediate alerts during emergencies.

2.7. Integrating SDG 11.2 in India's ITS

Sustainable Development Goal 11.2 calls for "access to safe, affordable, accessible, and sustainable transport systems for all," a vision that sits at the heart of inclusive urban transformation. For India, where cities are expanding rapidly and urban travel demand continues to outpace the growth of public transport systems, the integration of SDG 11.2 into ITS provides an opportunity to align technology, governance, and social equity. Achieving this goal is not merely about adopting advanced infrastructure or digital tools, but about reorienting transport policy to serve accessibility, inclusion, and resilience which are central to India's transition toward sustainable urbanisation. Globally, cities such as Bogotá, Curitiba, and Guangzhou have shown how ITS-enabled public transport can reshape mobility when guided by strong governance, multimodal integration, and citizen-focused planning. Bogotá's TransMilenio achieved major mode shifts through dedicated corridors, off-board fare collection, and clear institutional accountability, while Curitiba linked transport planning with land use to sustain ridership and control sprawl. Guangzhou's BRT demonstrated that multimodal integration and real-time monitoring can enhance both efficiency and inclusivity.

Indian cities have made significant progress in advancing sustainable urban mobility through initiatives such as Ahmedabad's Janmarg, Surat BRT, and Pune's Rainbow BRT. These systems reflect India's growing commitment to inclusive and technology-enabled transport, introducing features like dedicated lanes, GPS-based tracking, off-board fare systems, and gender-sensitive designs. The experience gained through these projects provides a strong foundation for scaling and refining future ITS-based solutions. As these systems evolve, there is scope to enhance inter-agency coordination, enforcement consistency, and integration with land-use planning to ensure seamless, multimodal connectivity. Strengthening data-driven monitoring, expanding feeder services, and linking BRT corridors with metro and suburban networks can further improve accessibility, reliability, and last-mile inclusion—helping Indian cities move closer to the holistic vision of SDG 11.2. To bridge these gaps, India's ITS strategy must move from an infrastructure-centric to an "Intelligent Accessibility" approach - one that integrates physical networks with digital systems and inclusivity goals.

03

Market Potential of ITS in India

3.1. Overview

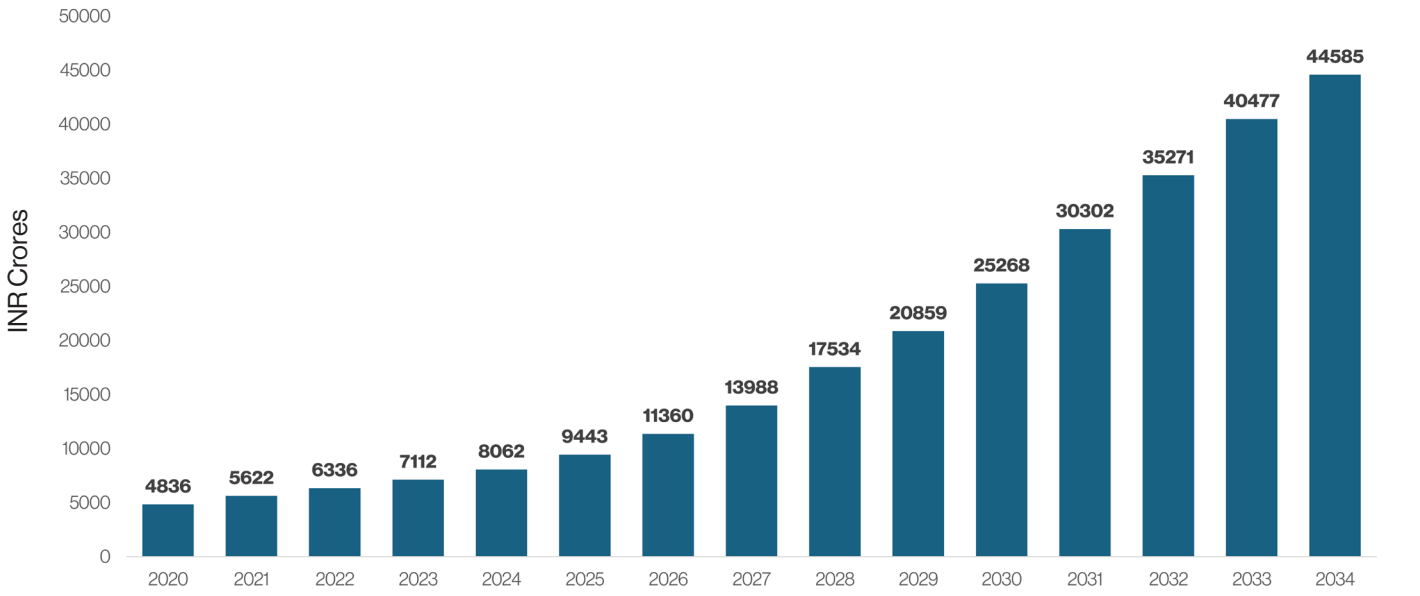
India's ITS market is on the cusp of rapid expansion, driven by escalating urban mobility challenges, ongoing technological innovation, and a strong government drive toward enhancing traffic efficiency and digital infrastructure. Valued at INR 8,062 crore in 2024, the ITS market is projected to surge to approximately INR 44,585 crore by 2034. This represents a robust CAGR of 18.7% over the decade. Notably, the period from 2025 to 2030 is expected to experience the fastest expansion, with an estimated CAGR of 21.8%, reflecting accelerated adoption during initial deployment and scaling phases.

Such sustained growth signals a structural transition in India's transport sector—from isolated traffic management projects to integrated, technology-led mobility ecosystems encompassing connected vehicles, automated tolling, and smart infrastructure.

3.2. Market Growth Trajectory – India

Between 2020 and 2024, the ITS market in India nearly doubled, marking the early adoption phase. From 2025 onwards, the sector is expected to witness an exponential rise, supported by digital public infrastructure, 5G rollout, and policy alignment under National ITS Blueprint and Vision@2047.

Exhibit 2 **India ITS Market Size and Forecast by Value INR (Crores)**



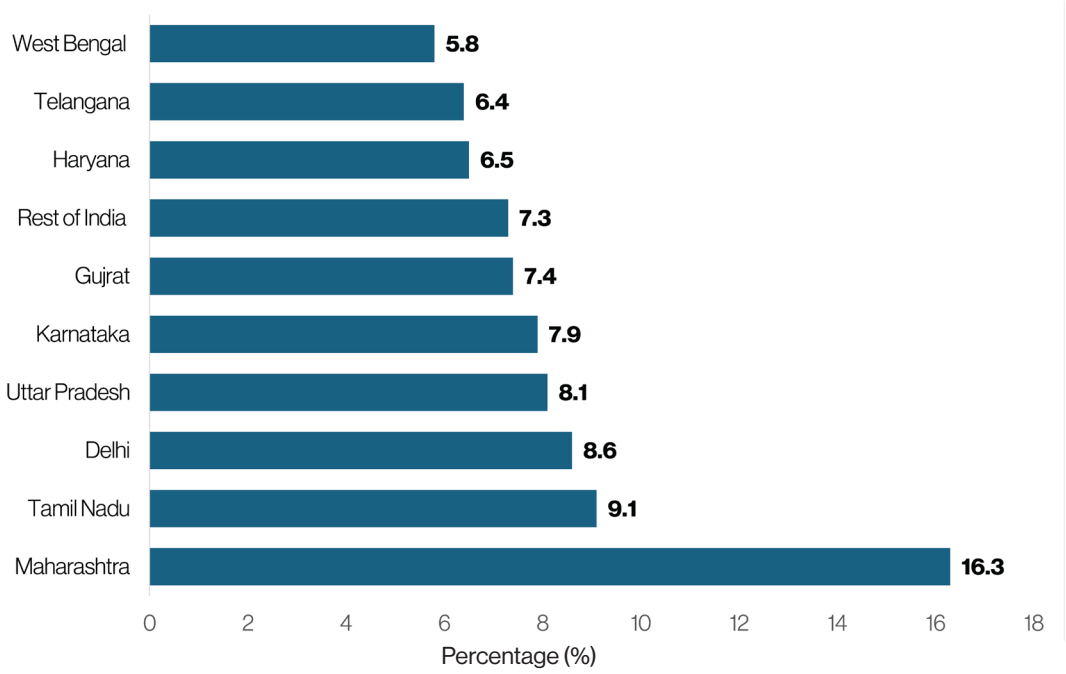
Source: Geospatial World Analysis, ITS Forum Analysis

3.3. Market Growth by States

The state-wise distribution of the ITS market in India reveals a concentrated pattern of growth, with a few industrially advanced states leading in adoption and investment.

Maharashtra, Tamil Nadu, and Delhi collectively account for nearly 34% of the total national market share, making them the top-performing ITS markets in the country. Maharashtra leads with 16.3%, driven by extensive infrastructure modernisation initiatives such as expressway ITS deployment, metro rail automation, and city command centre integration under the Mumbai Metropolitan Region Development Authority (MMRDA) and Pune Smart City projects. Tamil Nadu follows with 9.1%, benefitting from its strong automotive manufacturing ecosystem and progressive mobility policies in Chennai and Coimbatore. Delhi, with 8.6%, remains a frontrunner in implementing AI-enabled traffic management systems, public transport integration, and surveillance-based enforcement through the Delhi Integrated Multi-Modal Transit System (DIMTS).

Exhibit 3 Market Growth by States (%)



Source: Geospatial World Analysis, ITS Forum Analysis

Emerging states such as **Uttar Pradesh (8.1%)** and **Gujarat (7.4%)** are also showing accelerated ITS adoption, largely driven by greenfield expressway projects, logistics corridors, and smart city developments. Uttar Pradesh's network of expressways including Purvanchal, Bundelkhand, and Ganga Expressways is becoming a testbed for ATMS and digital tolling solutions, while Gujarat's industrial corridor development is fostering the deployment of freight management and vehicle tracking systems.

Other states such as **Karnataka (7.9%), Telangana (6.4%), and Haryana (6.5%)** are leveraging their strong IT ecosystems and industrial hubs to expand ITS infrastructure in cities like Bengaluru, Hyderabad, and Gurugram, respectively. Meanwhile, **West Bengal (5.8%)** and the Rest of India (7.3%) represent growing markets where ITS adoption is still at a nascent stage but expected to rise with upcoming urban mobility and national highway programs.

3.4. Market Segmentation Analysis

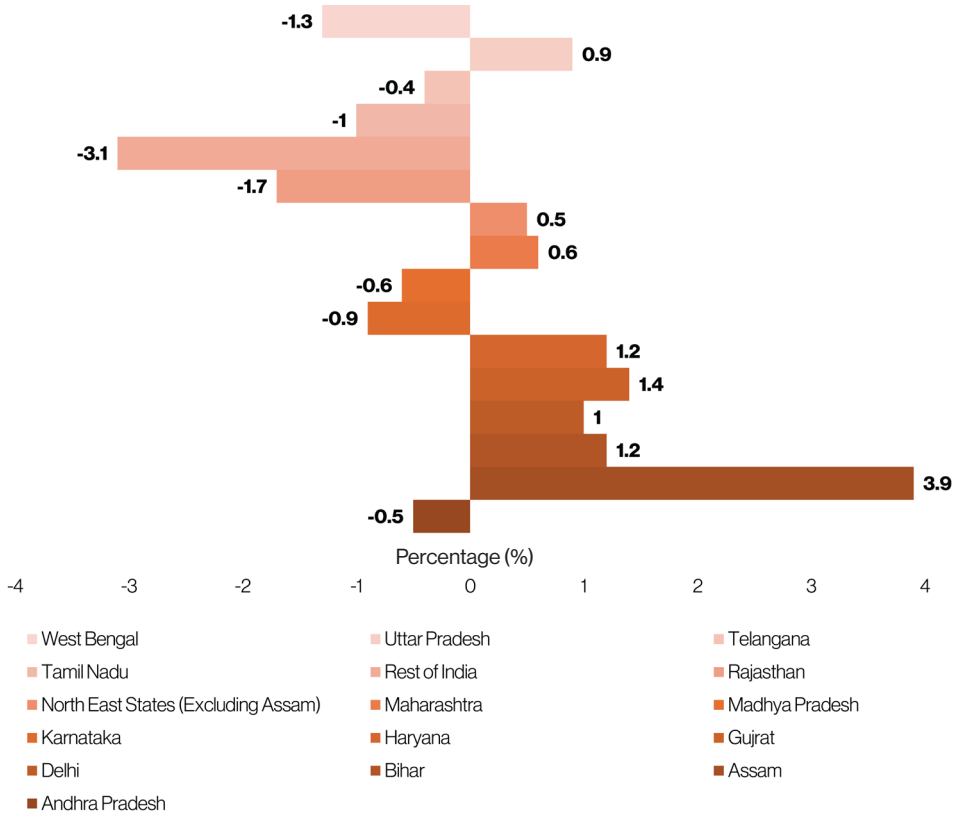
3.4.1. India CAGR Variance Analysis, By State (%)

The state-wise CAGR variance analysis of India's Intelligent Transportation System (ITS) market highlights regional disparities in adoption and growth momentum, reflecting varying levels of infrastructure readiness, policy focus, and investment capacity across the country. Among the high-growth states, Assam leads with a +3.9% variance, emerging as a strong performer in the Northeast due to its inclusion in digital highway and corridor connectivity projects under the Bharatmala and North-East Economic Corridor initiatives. The expansion of ITS infrastructure in Assam marks a significant step toward integrating remote and hilly regions into the national transport network.

- **Gujarat (+1.4%)** is witnessing steady traction supported by the deployment of ITS solutions across industrial corridors, ports, and logistics hubs, driven by the state's strong manufacturing and trade base. Similarly, **Haryana (+1.2%)** continues to benefit from the expansion of ITS-enabled logistics and freight management clusters around the Delhi-NCR region, strengthening its role as a key node in the national supply chain. **Delhi (+1.0%)** maintains moderate but consistent growth, led by incremental upgrades in ATMS and the integration of public transport operations through intelligent mobility platforms. **Uttar Pradesh (+0.9%)** also shows promising growth, powered by extensive expressway development (Purvanchal, Ganga, and Bundelkhand Expressways) and multimodal logistics hubs being developed under the Gati Shakti framework.

- In contrast, states such as **Maharashtra (+0.6%)** exhibit stable yet moderate growth as existing metro, highway, and city-level ITS systems reach saturation levels, with further expansion limited to upgrades and integration projects. On the declining side**, Tamil Nadu (-1.0%)** and **Rajasthan (-1.7%)** reflect reduced activity due to project consolidation and a lack of new large-scale ITS tenders, particularly beyond major urban centres like Chennai and Jaipur. **West Bengal (-1.3%)** continues to experience slow adoption, pending the rollout of ITS projects under its revised urban transport plan. The **Rest of India (-3.1%)**, encompassing smaller states and union territories, shows uneven deployment, largely due to limited institutional capacity and funding constraints.

Exhibit 4 India CAGR Variance Analysis, By State (%)

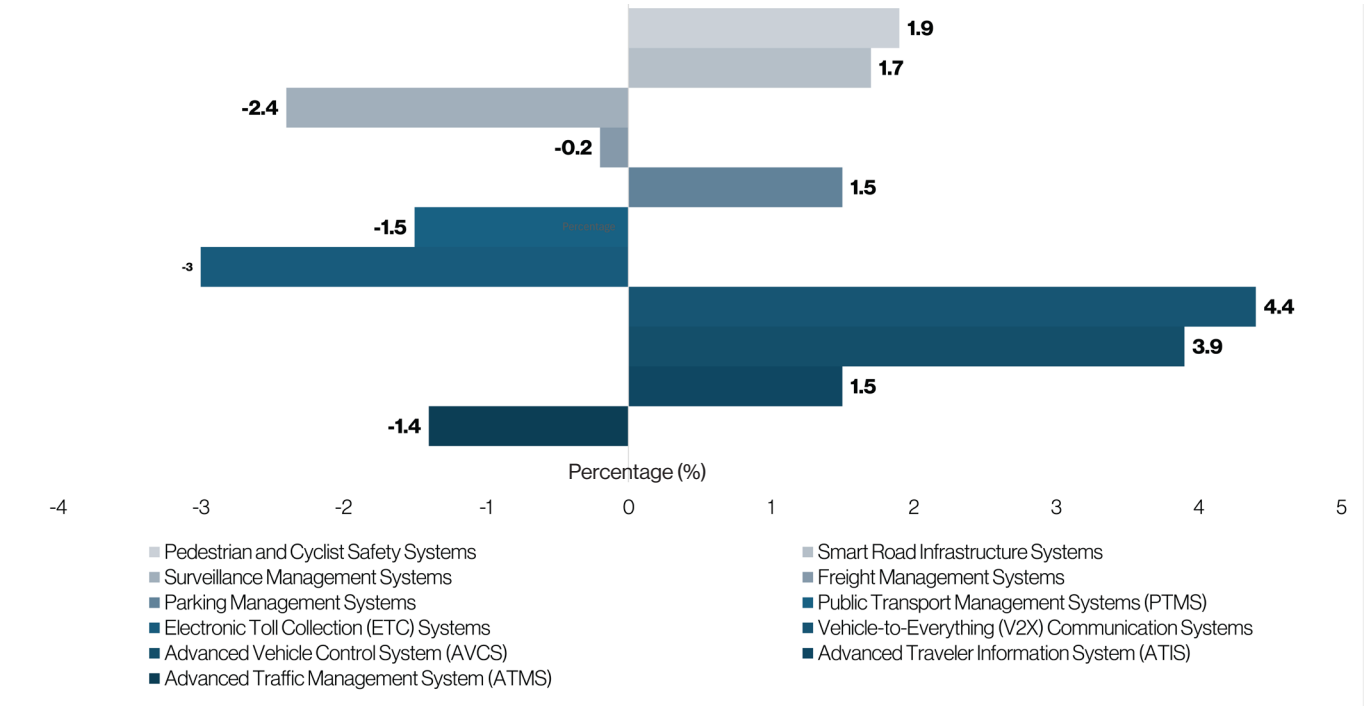


Source: Geospatial World Analysis, ITS Forum Analysis

3.4.2. India CAGR Variance Analysis, By Type (%)

The ITS market in India displays varying growth trends across its key sub-segments, reflecting both technological evolution and market maturity. Among these, V2X Systems have emerged as the fastest-growing segment, registering a +4.4% variance. This rapid growth is driven by the increasing adoption of 5G networks, connected vehicle pilots, and the integration of V2X solutions by automotive OEMs and telecom operators to enhance real-time communication between vehicles and infrastructure.

Exhibit 5 India CAGR Variance Analysis, By Type (%)



Source: Geospatial World Analysis, ITS Forum Analysis

Closely following is the AVCS segment, with a +3.9% variance, supported by rising demand for driver-assistance systems, telematics, and fleet automation. The growing emphasis on vehicle safety and automation has propelled this category as a major focus area for both commercial and passenger transport applications. Segments such as Pedestrian and Cyclist Safety Systems (+1.9%) and Smart Road Infrastructure Systems (+1.7%) are also witnessing healthy growth. This is largely attributed to the government's Vision Zero road safety initiatives and NHAI's digital highway programs, which promote the use of intelligent sensors, adaptive lighting, and AI-based infrastructure monitoring for safer mobility.

Meanwhile, ATIS and Parking Management Systems, both growing at +1.5%, are gaining traction through the expansion of multimodal transport information platforms and smart city automation projects. These solutions enhance user experience by providing real-time traffic data, parking availability, and travel optimisation services. On the other hand, traditional ITS domains are showing signs of saturation. Freight Management Systems (-0.2%) are witnessing slower growth due to the gradual pace of digital transformation in the logistics sector. Similarly, ATMS (-1.4%) have matured in major cities, limiting new deployment opportunities to expansion or upgrades. PTMS (-1.5%) have also plateaued, primarily due to consolidation among bus operators and limited fresh tenders.

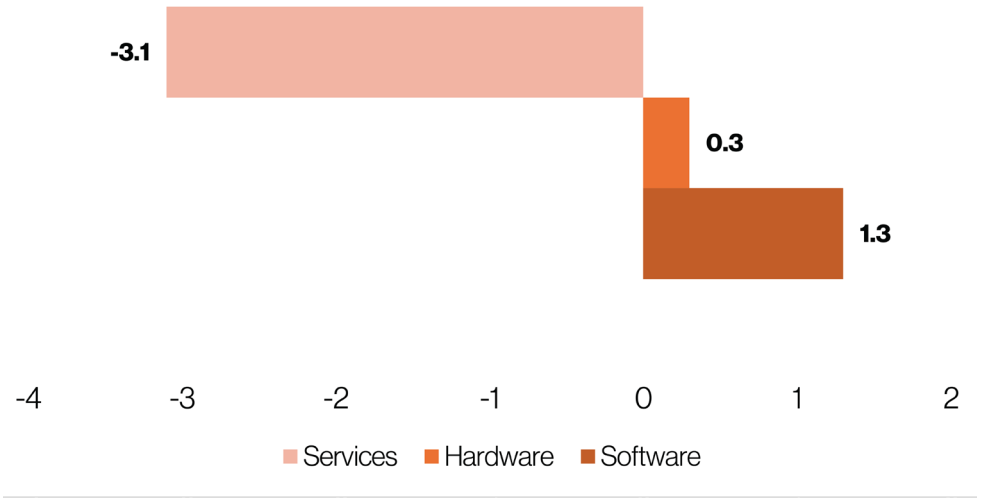
The Surveillance Management Systems segment shows the steepest decline (-2.4%), as conventional camera-based systems are increasingly being replaced by AI-integrated, citywide command and control centres that offer real-time analytics and cross-agency co-ordination.

3.4.3. India CAGR Variance Analysis, By Deployment (%)

The deployment pattern of ITS in India highlights a distinct shift toward centralised, city-scale implementations, driven by the government's push for digital urban infrastructure and integrated mobility platforms.

City-level deployments show the strongest performance with a CAGR variance of +0.3%, reflecting their dominance under the Smart Cities Mission, ICCCs, and urban mobility modernisation initiatives. These large-scale deployments enable unified management of traffic signals, surveillance, parking, and public transport systems through real-time data sharing and analytics. The increasing focus on AI-driven urban traffic management and multimodal transport integration further strengthens the city-level deployment model as the backbone of India's ITS expansion.

Exhibit 6 India CAGR Variance Analysis, By Deployment (%)



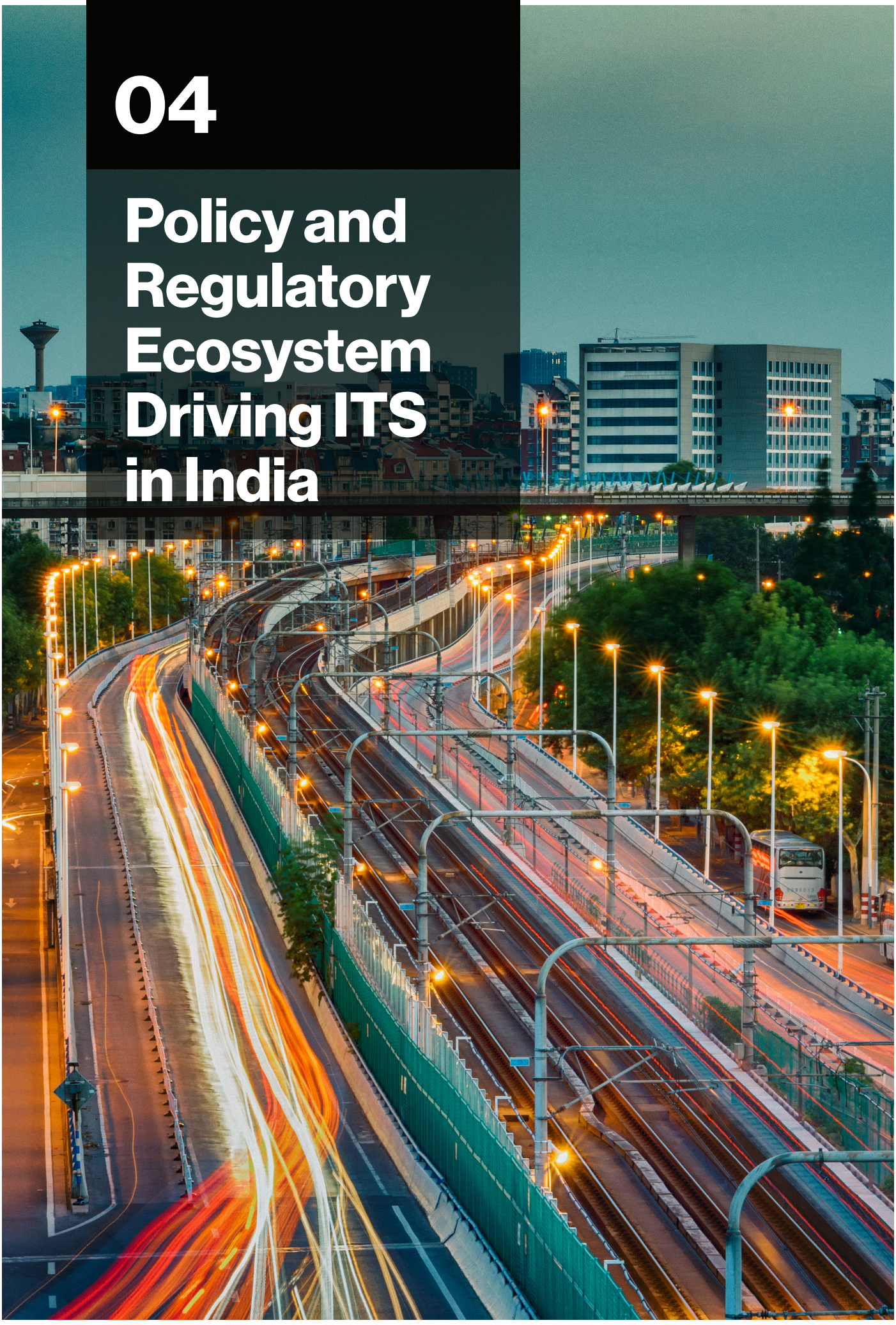
Source: Geospatial World Analysis, ITS Forum Analysis

In contrast, community-level deployments exhibit a decline of -0.6%, primarily due to their limited scalability and localized scope. These models are typically restricted to pilot projects, industrial zones, or specific transport corridors, serving as testbeds for evaluating new technologies rather than permanent infrastructure solutions. While they play a valuable role in innovation and R&D, their overall contribution to national ITS expansion remains modest.

Similarly, individual deployments with a CAGR variance of -0.7% are witnessing a decline as India transitions toward integrated and centrally managed citywide systems. Standalone ITS applications implemented by isolated agencies or departments are gradually being replaced by co-ordinated frameworks that ensure interoperability, data consistency, and cost efficiency.

04

Policy and Regulatory Ecosystem Driving ITS in India



India's approach to transportation policy has evolved from building physical infrastructure to developing intelligent, data-driven, and integrated mobility systems. Over the past decade, a series of national and state-level initiatives have positioned ITS as the backbone of modern mobility linking safety, sustainability, and digital governance into one cohesive framework.

4.1. National Policy Evolution

India's transport modernisation strategy places ITS at the heart of efforts to enhance road safety, congestion management, and digital mobility. **The National Urban Transport Policy (NUTP)** laid the foundation for technology-led traffic management, which evolved through Citywide Multimodal Transport Plans and the **Institute of Urban Transport (IUT)** Toolkit, introducing smart ticketing, integrated fare systems, and real-time passenger information services. The National Transport Policy and Road Safety Strategy (2018–2030) further institutionalised ITS adoption with mandates for adaptive traffic signals, automated challaning, and speed monitoring to reduce road fatalities and improve urban mobility. For highways, the Indian Roads Congress (IRC) SP:110-2017 and the NHAI ATMS Policy (2023) standardised ITS integration across national corridors covering FASTag-based tolling, automated enforcement, number plate recognition, and centralized traffic control centres for real-time monitoring and rapid emergency response.

At the urban level, the ITS as a core pillar of city mobility, financing ITMS, smart parking, and ICCCs to enhance efficiency and multimodal co-ordination. Cities like Hyderabad, Pune, and Ahmedabad have adopted AI-driven adaptive signalling and real-time transit management, reflecting India's steady transition toward data-driven, multimodal transport systems.

Together, these frameworks unify transport policy, industrial strategy, and digital infrastructure, positioning India as a regional leader in intelligent, self-reliant, and export-ready mobility technologies.

4.2. Regulatory Foundations and Data Ecosystem

India's ITS regulatory and data ecosystem connects transport, communication, and industrial frameworks to deliver safe, efficient, and technology-driven mobility. The Electronic Challan (eChallan) platform linked with Vahan (vehicle registration) and Sarathi (driver licensing) forms the backbone of nationwide automated enforcement. The Video Incident Detection and Enforcement System (VIDES) launched by NHAI in 2023 adds AI-based analytics for real-time incident and violation detection. Urban ITS implementation is supported through ICCCs, which serve as operational hubs integrating feeds from adaptive signals, cameras, and public transport tracking. The National Common Mobility Card (NCMC) enables interoperable payments across metro, bus, and toll systems, while Unified Logistics Interface Platform (ULIP) and Sagarmala extend ITS data visibility to freight and port logistics, creating a seamless national mobility data fabric.

Supporting this ecosystem, Automotive Industry Standards (AIS) under the Central Motor Vehicles Rules (CMVR) define norms for ADAS, V2X communication, and AIS-140 based GNSS tracking and emergency response. The Bureau of Indian Standards (BIS) ensures product quality, while the Society of Indian Automobile Manufacturers (SIAM) drives innovation in safety and performance. The Bharat Stage VI (BS-VI) emission norms further embed telematics and intelligent diagnostics into vehicle systems.

Together, these regulatory frameworks ensure standardisation, interoperability, and cybersecurity making ITS systems in India globally aligned yet locally optimised for diverse mobility environments.

4.3. Make in India, Production Linked Incentive (PLI) and Phased Manufacturing Programme (PMP)

India's ITS expansion is deeply aligned with the Make in India initiative, emphasising domestic manufacturing, innovation, and export readiness. Through the PLI and PMP schemes, the government promotes local production of 5G modules, V2X devices, sensors, and communication chipsets, reducing import dependency and building industrial self-reliance.

These schemes link ITS directly to national industrial policy encouraging partnerships among startups, academia, and R&D centres to design indigenous ITS hardware and software. Institutions like C-DAC, ARRI and Telecommunication Engineering Centre (TEC) support standard development, testing, and certification of locally built communication components. The focus on NavIC-based localisation, telecom–automotive convergence, and indigenous intellectual property creation ensures that India's ITS ecosystem is not only interoperable and secure but also globally competitive. Collectively, these initiatives position India as a regional hub for connected mobility technologies, exporting smart, affordable, and scalable ITS solutions

4.4. Intelligent Transport Systems across India

Indian states are increasingly embracing ITS to make mobility safer, smarter, and more sustainable. Each state has taken a slightly different path, guided by its policy priorities and transport challenges, but together they illustrate how digital tools, automation, and data-driven systems are reshaping the country's mobility landscape.

Maharashtra

Maharashtra has positioned itself as one of the leaders in this transformation. Through its logistics and electric vehicle policies, it has laid the foundation for freight digitalisation and sustainable urban mobility. On the ground, the Samruddhi Mahamarg expressway became the first large-scale project to deploy artificial intelligence-enabled traffic management with fibre-optic connectivity and integrated tolling. Similar rollouts on Pune-linked highways and the Mumbai–Pune Expressway reinforced road safety and enforcement through hundreds of intelligent cameras and automated number plate recognition. In cities, the Mumbai Metro Line 3 integrates smart ticketing and surveillance, while the state's logistics policy introduced an Intelligent Logistics Management System using predictive analytics and mapping. The Mumbai Trans-Harbour Sea Link capped these efforts with ITS-enabled tolling and monitoring, creating a layered ecosystem that blends road safety, multimodal transit, and digital freight solutions.

Karnataka

Karnataka has followed a structured roadmap by combining international collaboration with local innovation. The Japanese-supported ITS Plan laid the groundwork for automated signals, roadside sensors, toll systems, parking management, and a state-wide common mobility card. This was followed by projects such as the Safe City initiative in Bengaluru, which installed thousands of AI-enabled cameras to improve safety and surveillance. The Bengaluru Airport multi-modal hub became the first in India to seamlessly connect metro, buses, taxis, and private vehicles using smart scheduling systems. More recently, the Mysuru–Bengaluru highway introduced satellite-based tolling that charges drivers only for the distance travelled, while Bengaluru expanded adaptive traffic signals powered by artificial intelligence. Together, these projects show how Karnataka has blended early planning with advanced technology to modernise urban mobility and inter-city travel.

Tamil Nadu

Tamil Nadu has built a balanced ecosystem that spans metros, buses, and highways. The Chennai Unified Metropolitan Transport Authority provides a governance framework for co-ordinated planning and integration, including ITS features like smart signals and common ticketing. The Madurai Metro proposal seeks to extend smart fare systems and multimodal connectivity into tier-two cities, while Chennai's bus system has adopted AI-driven safety features such as panic buttons, surveillance cameras, and priority signalling at intersections. On highways, the Madurai–Kanyakumari corridor introduced one of India's most advanced surveillance systems, with smart cameras every 250 metres and automated accident alerts. Under the Tamil Nadu Road Sector Project, ITS tools such as road surveillance, detection systems, and command centres were linked with institutional capacity building for police, transport, and health departments. Tamil Nadu's example shows how ITS can strengthen urban transport, improve passenger safety, and modernise highway operations all at once.

Uttar Pradesh

Uttar Pradesh has emerged as a national leader in highway focused ITS deployments, backed by international collaborations. The Delhi Eastern Peripheral Expressway, developed with Japanese support, brought in advanced traffic and toll management systems that improved congestion management and safety. The Bundelkhand Expressway soon followed, becoming India's first solar-powered ITS expressway, while the Gorakhpur Link Expressway added features such as motion-detection cameras and real-time incident monitoring. In cities, Greater Noida's Integrated Smart Traffic Management System created a comprehensive model with hundreds of cameras, a command and control centre, and public information systems. The state also became one of the first to extend electronic tolling beyond national highways to state highways, while Varanasi's multi-modal terminal linked waterways and roads with potential for ITS in freight. Uttar Pradesh's dual focus on expressway systems and urban deployments shows its ambition to build a state-wide ITS backbone.

Gujarat

Gujarat has steadily built its reputation as a hub of ITS innovation. Starting with the addition of over 2,500 kilometres of highways in 2018, the state quickly moved to experimentation, hosting India's first connected vehicle demonstration in Ahmedabad in 2019, which allowed ambulances to communicate directly with traffic signals. Later projects such as the NH-47 elevated corridor opened space for AI surveillance and electronic tolling, while Smart City and AMRUT projects introduced command centres, automated challan systems, and more than 12,000 surveillance cameras across multiple cities. In 2024, Gujarat went a step further by piloting India's first unmanned toll plaza on the Dwarka Expressway using satellite and electronic tolling technology. The state today combines connected vehicle innovation with AI-based enforcement and smart city systems.

Delhi

Delhi has evolved into a national showcase for layered ITS adoption. Its electric vehicle policy targets a quarter of all new registrations as electric, with ITS enabling monitoring of charging networks and integration into the wider mobility system. The Delhi Metro and the Delhi–Ghaziabad–Meerut Regional Rapid Transit System highlight advanced ITS in transit, using digital ticketing, real-time passenger information, automated train control, predictive maintenance, and safety systems. Public transport safety was strengthened through a partnership with the National Informatics Centre to upgrade all vehicles with compliant tracking and emergency alert systems, while a bus management system now uses GNSSto optimise schedules (blocks) and charging for electric buses. On highways, Delhi has expanded artificial intelligence-driven traffic management with cameras, sensors, and automated enforcement, while also hosting early pilots of electric highways and vehicle-to-everything communication. Delhi's ITS model demonstrates how integration, safety, and enforcement can converge in a single metropolitan region.

Assam

Assam has led the way for ITS in the North-East by combining innovation with partnerships. Guwahati's integrated traffic management system introduced adaptive signals, violation detection cameras, and centralised monitoring, making it one of the most advanced in the region. In 2024, the state partnered with the national space agency to design a predictive ITS platform that uses satellite data and geographic information systems, a first-of-its-kind initiative in India. Assam also won recognition for its Road Asset Management System, which uses real-time data to improve road construction and maintenance, showing how ITS can extend beyond traffic to the full infrastructure lifecycle. Earlier, the Guwahati airport integrated passenger information systems and surveillance, marking the state's early embrace of ITS in transport hubs. Assam's approach highlights how regional states can pioneer smart mobility by combining urban systems, space technology, and infrastructure monitoring.

ITS Developments by State Road Transport operators

State Road Transport operators across India are progressively integrating ITS into planning, operations, and asset management. States are moving toward data-driven, predictive, and sustainable approaches to highway design and maintenance. In highway maintenance, ITS applications such as pavement and structural health monitoring, maintenance monitoring, and automated incident and weather management are improving safety and reducing lifecycle costs. Real-time data from sensors and control centres now enable preventive maintenance, timely alerts, and efficient work zone management. In highway design, ITS data inform safety oriented and sustainable design decisions through continuous traffic monitoring, crash analytics, and emissions tracking. Several states are also incorporating CAV readiness into new corridors by integrating communication infrastructure and smart roadside equipment.

Emerging technologies including digital twins, AI-based pavement distress detection, UAV-assisted inspections, and smart material sensors are transforming how highways are planned, maintained, and monitored. Blockchain-based asset tracking is further enhancing transparency in maintenance records. Collectively, these advancements mark India's shift from reactive management to intelligent, lifecycle-based infrastructure planning, aligning with national programmes such as PM Gati Shakti and Bharatmala while advancing the broader objectives of SDG 11.2 and Vision 2047.

05

Industry Ecosystem & Stakeholders

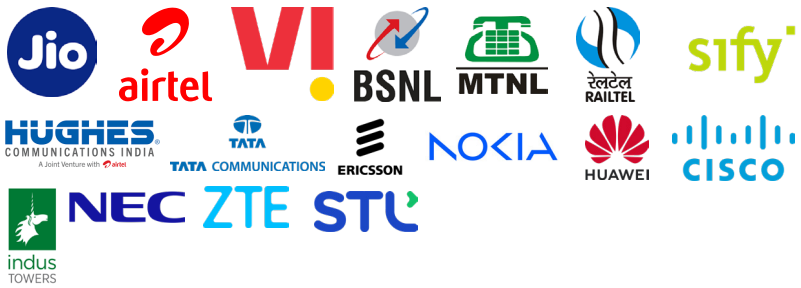
Industry Ecosystem & Stakeholders

The ITS market in India operates through a multi-layered ecosystem involving government bodies, technology providers, infrastructure developers, communication network operators, solution integrators, and end users. Each stakeholder segment plays a crucial role in developing, deploying, and maintaining smart mobility systems that support efficient, safe, and sustainable transport across the country.

The ecosystem functions as a collaborative value chain—where policy direction, technology innovation, infrastructure development, network connectivity, and system integration converge to deliver real-time transport intelligence and user services. This synergy is essential for achieving national ITS goals under Smart Cities, National Highways Development, and emerging initiatives aligned with Vision@2047.

Table 4 India's ITS Industry Ecosystem and Key Stakeholders

Ecosystem Layer	Role / Description	Key Stakeholders
Government & Regulatory Bodies	Frame ITS policies, standards, funding mechanisms, and compliance frameworks. Oversee large-scale national and state-level projects and facilitate public-private partnerships (PPPs).	सड़क परिवहन एवं राजमार्ग मंत्रालय MINISTRY OF ROAD TRANSPORT AND HIGHWAYS; NHAI; Ministry of Housing and Urban Affairs Government of India; इलेक्ट्रॉनिकी एवं सूचना प्रौद्योगिकी मंत्रालय MINISTRY OF ELECTRONICS AND INFORMATION TECHNOLOGY; दूरसंचार विभाग Department of Telecommunications; Smart City; CSIR; INDIAN ROADS CONGRESS; National Institute of Urban Affairs; ARAI Progress through Research; namma metro; एम एम आर डी ए MMRDA; Delhi Metro Rail Corporation Limited
Technology Providers	Supply hardware, software, and digital technologies enabling ITS solutions—such as sensors, AI-driven analytics, and data management systems. Their innovations power real-time monitoring, traffic control, and safety systems.	SIEMENS; BOSCH; IBM; CISCO; Trimble; HITACHI; NEC; Honeywell; Qualcomm; L&T Technology Services; MapmyIndia; सी डैक CDAC; ITS P&E; CMS SIMPLIFYING LIFE; ARCADIS; what3words; HEXAGON; esri
Infrastructure Providers	Build and maintain the physical backbone for ITS deployment, including smart highways, EV charging stations, signal infrastructure, and integrated transport hubs.	L&T; IRB INFRASTRUCTURE DEVELOPERS LTD; GMR; adani; RELIANCE Infrastructure; NCC NCC Limited; AFCONS; IL&FS; JMC PROJECTS (INDIA) LTD. (A Kalpataru Group Enterprise); Shapoorji Pallonji; TATA PROJECTS; ASHOKA Ashoka Buildcon Limited; DBL; HCC; KEC KEC INTERNATIONAL LIMITED; PATEL; GRIL; CUBE HIGHWAYS

Ecosystem Layer	Role / Description	Key Stakeholders
Communication Network Providers	Provide seamless connectivity for vehicle-to-infrastructure (V2X) and IoT communication using 4G/5G, fibre, and satellite networks, enabling real-time data transmission and control.	
Solution Integrators	Integrate hardware, software, and data systems into unified ITS platforms. They ensure interoperability, customization for city/state requirements, and seamless system operations.	
End Users	Represent the ultimate beneficiaries of ITS applications—ranging from government transport agencies to private logistics and daily commuters. Their adoption drives long-term success of ITS implementation.	

Source: Geospatial World Analysis

The ITS ecosystem in India thrives on synergistic collaboration between public authorities and private industry players.

- Policy and governance by MoRTH, NHAI, and MoHUA provide the strategic foundation for ITS adoption.
- Technology providers and system integrators enable innovation in AI, IoT, and automation, crucial for scaling smart mobility solutions.
- Infrastructure and communication providers ensure robust physical and digital connectivity to support end-to-end solutions.
- End users, both institutional and individual, act as catalysts by embracing ITS applications in day-to-day mobility, logistics, and operations.

Together, these stakeholders form a dynamic network that drives India's transition toward an intelligent, sustainable, and data-driven transportation system, aligned with the national vision for smart infrastructure and digital mobility under Vision@2047.

06

Technology & Infrastructure Backbone

ITS functions like the digital nervous system of modern mobility. It continuously senses traffic conditions, communicates information, analyses data, and enables real-time decisions. The goal is to move people and goods more safely, efficiently, and sustainably through an integrated network of vehicles, infrastructure, and control systems. At its core, an ITS transforms raw data from roads, vehicles, and the environment into actionable insights that support quick, informed decisions whether by a traffic manager, an automated signal, or an individual driver. This process follows a seamless information chain comprising six key stages.

6.1. The Information Chain in ITS

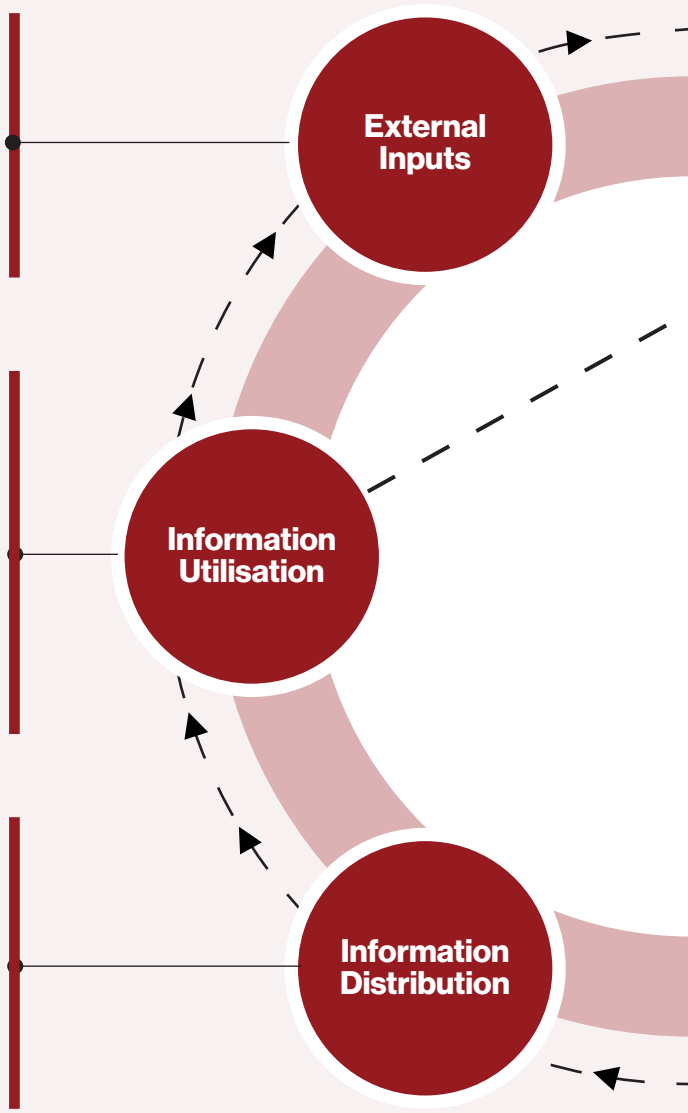
At the core of ITS lies an information chain, comprising sequential stages that enable collection, transmission, and use of transport -related data:

Exhibit 7 **Information Chain in ITS**

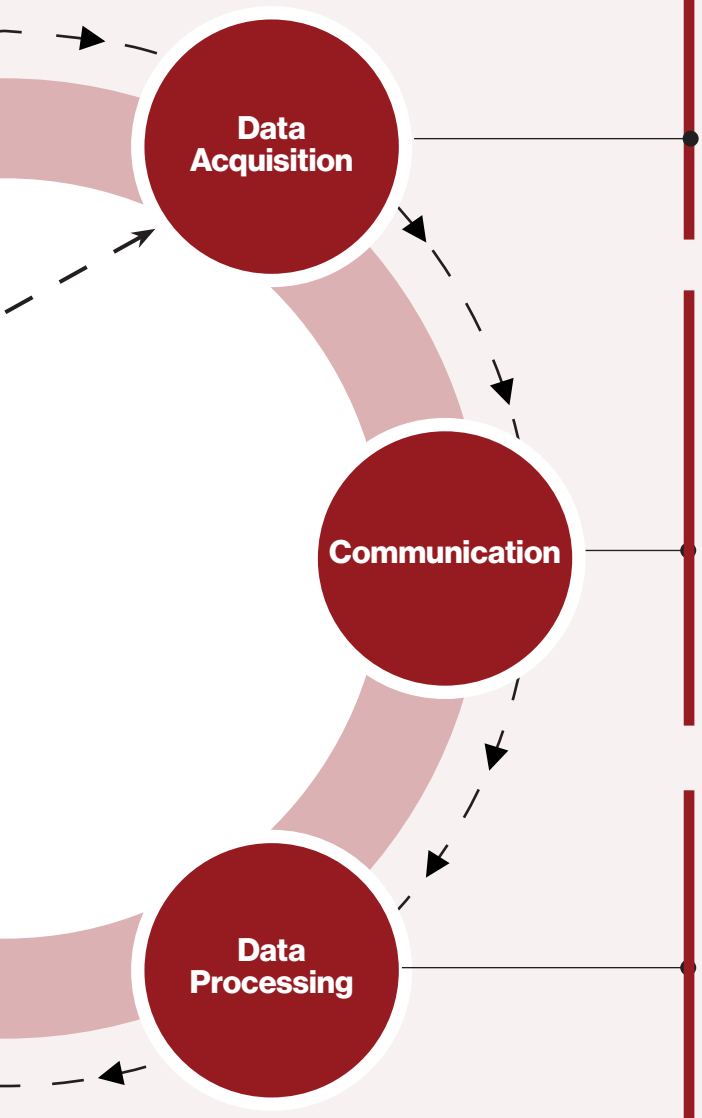
- Modern ITS does not operate in isolation. It connects with other digital systems to form a broader mobility network.
- Weather forecasts, financial systems, and logistics databases feed additional data into the ITS ecosystem.
- Such cross-sector integration expands ITS beyond traffic management — turning it into a comprehensive smart mobility framework.

- This is where ITS intelligence becomes operational.Traffic controllers modify signal timings, dispatch response units, or trigger speed regulations.
- Vehicles receive rerouting suggestions, and automated enforcement systems issue violation alerts. For public transport, fleet managers adjust schedules based on real-time passenger and traffic data.
- In essence, data-driven actions — from a green light for an ambulance to an adaptive signal at a busy intersection — ensure smoother, safer, and more efficient travel for everyone.

- ITS platforms distribute this data through multiple channels:
    - Dynamic Message Signs (DMS) display
    - Mobile apps and navigation systems guide travellers
    - Control centers and dashboards inform emergency responders.
- Through these channels, the right information reaches the right user at the right time — enabling informed decisions across the entire transport ecosystem.



Source: Geospatial World Analysis



- Every ITS begins with collecting information about the transport environment.
- Sensors embedded in roads, cameras at intersections, radars, and weather monitors constantly measure traffic flow, speed, vehicle type, and environmental conditions. Vehicles also serve as data sources through GPS, onboard diagnostics, and telematics units that transmit their position, velocity, and system health.
- Together, these elements create a live, high-resolution picture of the transport network — showing how traffic moves, where delays occur, and when conditions become unsafe.

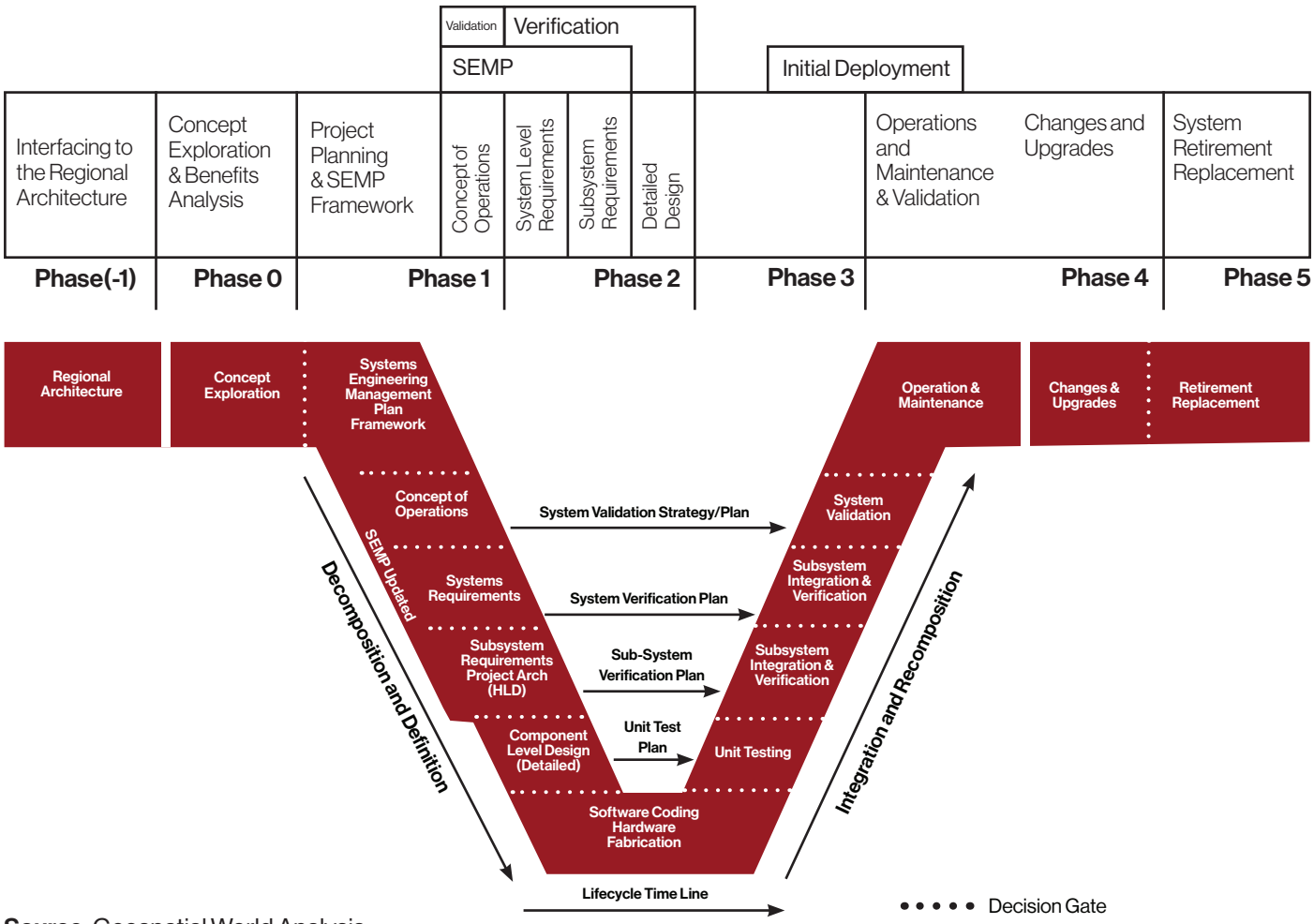
- Once collected, data needs to move quickly and reliably between devices and control centers.
- Communication networks serve as the circulatory system of ITS, using both wired and wireless technologies:
    - Fiber optic cables
    - Ethernet networks
    - Cellular networks (4G/5G)
    - Short-range communication DSRC or Wi-Fi
    - Satellite links
- This multi-layered connectivity ensures that real-time data flows uninterrupted across the transport system.

- Raw data is only useful when transformed into insight.
- In control centers, servers and analytics platforms receive massive data streams and process them using algorithms, artificial intelligence, and data fusion techniques.
    - This enables:
    - Detection of incidents or congestion.
    - Prediction of travel times and demand.
    - Optimization of traffic signals and routing.
- The system learns patterns over time, allowing it to forecast conditions before they occur. Instead of reacting to congestion, the network becomes proactive — adjusting to prevent it.

6.2. ITS Solution Development Process

Developing ITS solutions requires a structured, objective-driven, and iterative process that ensures technology deployment is aligned with actual mobility needs and operational goals. The development of an ITS solution should begin with a clear definition of objectives such as improving safety, reducing congestion, enhancing travel time reliability, or optimizing public transport operations and proceed through systematic stages of concept development, design, testing, and evaluation. Globally, system design approaches such as the Systems Engineering "V-Model" emphasise the importance of defining user needs and operational concepts before selecting or deploying technologies. While India does not yet have a formalized national framework for ITS system design, these principles provide a valuable foundation for developing an adaptable, context-specific process.

Exhibit 8 V-Model



Source: Geospatial World Analysis

At its core, the ITS Solution Development Process should follow three key stages:

1. **Defining Objectives and Concept of Operations (ConOps) -** The process begins with identifying stakeholder needs and establishing clear, measurable objectives linked to mobility, safety, sustainability, and user experience. A ConOps document should then outline how the system will function from the perspective of users, operators, and institutions. This stage ensures that the ITS deployment addresses real-world challenges and is aligned with broader transport and policy goals such as PM Gati Shakti, Smart Cities Mission, and Net Zero 2070.

2. **System Design and Integration -** Once objectives and operational concepts are defined, the system design stage focuses on detailing functional, technical, and data requirements. This includes defining architecture, interfaces, interoperability standards, and data flows to ensure seamless integration with existing infrastructure and digital platforms. The system should be designed for scalability, interoperability, and resilience, considering local constraints such as connectivity, terrain, and capacity.

3. **Testing, Validation, and Continuous Improvement -** Each component and subsystem should undergo rigorous testing and validation to confirm that the solution meets both technical specifications and operational needs. Post-deployment, performance must be continuously monitored using key indicators such as response time, reliability, and user satisfaction. Lessons learned from each deployment should feed back into future design improvements creating a continuous learning and refinement loop.

Cross-cutting enablers such as stakeholder coordination, project management, configuration control, risk assessment, and capacity building must operate throughout the process to ensure consistency and accountability. While India's ITS ecosystem is still evolving, adopting a principles-based Systems Engineering approach centered on clear objectives, well-defined operational concepts, and iterative validation will help ensure that ITS solutions are fit-for-purpose, sustainable, and future-ready. Such a framework will provide the foundation for developing a nationally adaptable ITS design and implementation methodology aligned with India's mobility and digital infrastructure vision.

6.3. Data Sourcing and Data Quality

Data acquisition forms the foundation of every ITS. It is the process through which real-world phenomena are captured, converted into digital signals, and transformed into actionable intelligence. This process connects the physical and digital layers of the transport ecosystem, allowing systems to sense, analyse, and respond in real time.

6.3.1. Basics of Data Acquisition in ITS

In simple terms, ITS data acquisition involves collecting information through sensors and devices installed on vehicles, roadways, and infrastructure, converting these physical measurements into digital data, and transmitting them for analysis.

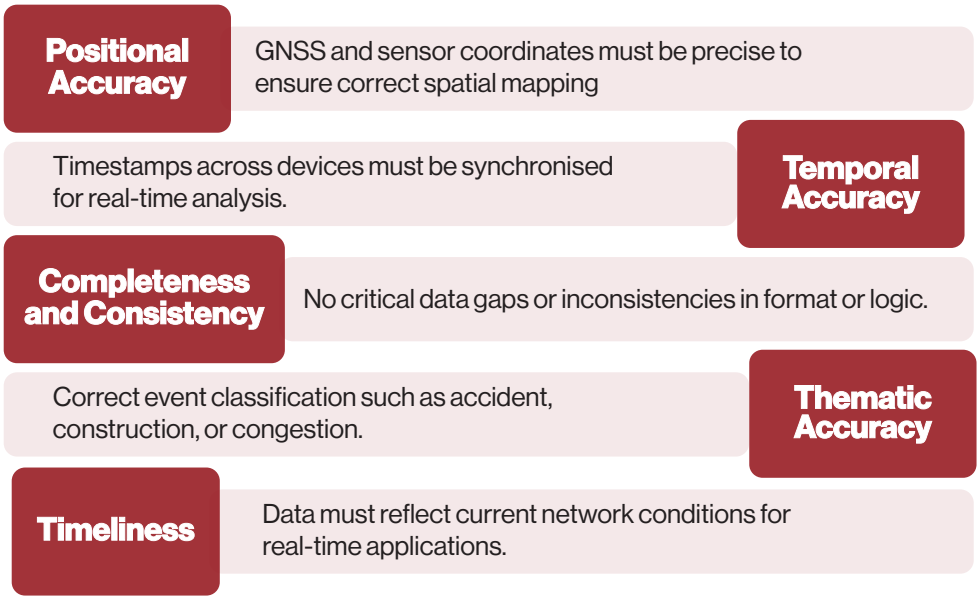
- Sensors like inductive loops, radar, LiDAR, and cameras record traffic parameters such as speed, flow, and occupancy.
- Environmental sensors monitor air quality, temperature, or precipitation.
- GNSS and telematics units provide continuous location and movement data.

This process includes several technical steps such as measurement, signal conditioning, analog-to-digital conversion, synchronisation, temporary storage, and transmission through communication

6.3.2. Data Quality and Reliability Requirements

Data acquisition is valuable only when the data are accurate, complete, timely, and consistent. ITS frameworks emphasize five key data quality dimensions:

Exhibit 9 **Key Data Quality Dimensions**



Source: Geospatial World Analysis

- Micro-level data are fine-grained, high frequency inputs from individual vehicles or sensors such as speed readings, vehicle trajectories, or ADAS outputs. They require high positional and temporal precision, enabling collision avoidance, incident detection, and driver behaviour analytics.
- Macro-level data represent aggregated, area-wide information like average corridor speeds, congestion levels, or emissions heatmaps. These datasets focus on representativeness and consistency, supporting urban planning, traffic forecasting, and infrastructure investment.
- Geospatial data integrate both scales, embedding every record within spatial co-ordinates or route segments. Adhering to standards such as ISO 19157 and Open Geospatial Consortium (OGC) norms, geospatial data enable map-matching, route optimisation, and spatial analytics in ITS dashboards and control centres.

Together, these layers ensure that ITS systems can both react instantly to traffic dynamics and strategically plan for long-term mobility improvements.

6.3.3. Live and Crowdsourced Data Acquisition

Modern ITS increasingly complement traditional sensor networks with crowdsourced data, turning drivers, passengers, and connected vehicles into mobile sensing nodes that continuously feed real-time information into the transport network.

Crowdsourced data provides three key categories of information critical for system operations and planning:

- **Travel Time and Speed Data -** Derived from continuous GNSS traces of moving vehicles and smartphones, enabling accurate estimation of link travel times, average speeds, and congestion levels across corridors.
- **Origin–Destination (OD) Information -** Aggregated from anonymised user trajectories, revealing travel demand patterns, route preferences, and inter-zonal connectivity. All are valuable for network optimisation and public transport planning.
- **Incident and Event Detection -** Captured through manual reports or abrupt changes in user speed or trajectory, identifying crashes, roadblocks, weather disruptions, or construction zones within seconds of occurrence.

Crowdsourcing operates through three main models:

- Active crowdsourcing allows users to manually report incidents or hazards through mobile applications.
- Passive crowdsourcing leverages smartphones or connected vehicle telemetry that automatically share speed, location, and travel-time data.
- Hybrid models combine both, ensuring continuous, user-validated updates.

To maintain live accuracy, systems employ continuous data streaming, auto-expiry of outdated records, and map-matching algorithms that correct GNSS deviations. Weighted data fusion prioritises fresh, high-density data while de-emphasising stale or inconsistent information.

This approach significantly enhances spatial coverage, responsiveness, and cost efficiency - detecting congestion, crashes, or network disruptions within seconds, often ahead of traditional sensor networks. However, it also introduces challenges such as verifying data authenticity, avoiding duplication, safeguarding user privacy, and addressing participation bias between urban and rural areas. Ensuring data validation, anonymisation, and equitable user representation will be critical for building a trustworthy, inclusive, and high-resolution crowdsourced ITS ecosystem in India.

6.3.4. The Central Role of Data in Advancing ITS

Data is the foundation of ITS, enabling real-time decision-making, predictive modelling, and automation across all modes of transport. Every function, from adaptive traffic control to autonomous navigation depends on the precision, diversity, and timeliness of the underlying data. As India builds its next generation of mobility infrastructure, establishing a robust, multimodal data ecosystem is essential for achieving efficiency, safety, and sustainability.

Multimodal sensing (combining cameras, LiDAR, radar, and connected vehicles) captures both the semantic and spatial dimensions of traffic environments. Datasets such as the IDS-JODHA multimodal collection and dedicated adverse weather datasets illustrate how integrated visual and spatial data improve perception, hazard detection, and behavioural modelling under varied Indian conditions. This rich data foundation enables systems to interpret complex road environments and operate reliably in real-world scenarios. Data analytics derived from these sources are transforming traffic management and safety planning. Insights into driver behaviour, lane discipline, and infrastructure condition now emerge from large-scale, real-time datasets. Fleet based initiatives such as Ather Energy's Pothole Alerts show how aggregated vehicle data can identify road defects, enhance safety, and guide maintenance, highlighting the value of industry–government collaboration in building a national data backbone for transport.

Geospatial intelligence further strengthens ITS by linking sensor data with high-definition maps and digital twins of road networks. This integration enables precise localisation, predictive routing, and energy-optimised operations, particularly for electric mobility. By combining live and spatial data, ITS evolves from reactive traffic management to proactive system-wide optimisation. The reliability of this ecosystem depends on data quality, interoperability, and weather-resilient sensing. Investments in localised datasets, adaptive perception algorithms, and unified standards will ensure that India's ITS is scalable, inclusive, and globally competitive.

6.3.5. Safeguarding Data Privacy in ITS

As transportation systems become increasingly data-driven, safeguarding privacy and cybersecurity has become as critical as improving efficiency and safety. The transportation sector, a key pillar of national infrastructure and economic security, now relies heavily on digital systems for automation, traffic optimization, and connected vehicle management. This growing digitisation also expands the sector's vulnerability to cyberattacks and privacy risks.

Transportation data, ranging from vehicle telemetry and passenger movement to operational analytics can reveal sensitive personal or commercial information. Without adequate protection, such datasets risk misuse or unauthorised access, leading to privacy violations and operational disruptions. Cyber threats including ransomware, denial-of-service, phishing, and malware attacks have the potential to cripple logistics networks, delay passenger services, and compromise navigation or payment systems, causing ripple effects across the economy and public safety. Addressing these vulnerabilities requires a strong and proactive cybersecurity framework. Key measures include network segmentation to isolate systems in case of compromise, endpoint anti-malware protection across all devices, and routine software patching to eliminate known vulnerabilities. Regular data backups ensure operational resilience against ransomware, while employee cybersecurity training builds awareness to prevent social-engineering attacks.

It is important that we embed privacy-by-design (PbD) principles into ITS architectures - ensuring data anonymisation, access controls, and compliance with evolving data protection regulations. As India expands its ITS infrastructure, a co-ordinated national approach to cybersecurity and privacy will be vital to protect data integrity, maintain public trust, and ensure that digital mobility advancements remain both secure and resilient.

6.4. Technical and Spatial Architecture of Intelligent Transport Systems (ITS)

Each component of ITS operates through three interlinked technological pillars that together make modern mobility intelligent, efficient, and adaptive:

- **Smart Infrastructure** refers to the physical and digital assets—sensors, cameras, adaptive signals, IoT devices, and connected networks—that collect and transmit real-time data across the transport ecosystem.
- **Data Intelligence** represents the analytical and decision-making layer. It uses AI, machine learning, and cloud platforms to transform raw data into insights, automate control, and support predictive management.
- **Geospatial Systems** provide the spatial context that anchors all ITS operations. Using GNSS, and remote sensing, they visualize, locate, and analyse transport networks to enable location-aware monitoring and response.

Together, these three layers create an interconnected system where infrastructure senses, data intelligence decides, and geospatial systems contextualize — forming the foundation of India's next-generation transport architecture.

Area Traffic Control System (ATCS)

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- **Geospatial Systems** provide the spatial context that anchors all ITS operations. Using GNSS, and remote sensing, they visualize, locate, and analyse transport networks to enable location-aware monitoring and response.

Advanced Traffic Management Systems (ATMS)

- **Smart Infrastructure:** Roadside sensors, cameras, adaptive signals, collect live traffic data, VMS and Vehicle Actuated Speed Signs display traveller information, and are linked via fibre and 5G networks.
- **Data Intelligence:** AI analytics detect incidents, adjust signal cycles, and predict congestion; edge devices enable instant local actions.
- **Geospatial Systems:** GNSS based dashboards visualise congestion, roadworks, and incidents spatially for faster, data-driven control.

Advanced Traveller Information Systems (ATIS)

- **Smart Infrastructure:** Aggregates feeds from sensors, tolls, and public transport through cellular and Wi-Fi networks.
- **Data Intelligence:** Cloud analytics deliver real-time updates, route guidance, journey planning and alerts on congestion and weather.
- **Geospatial Systems:** GNSS layers and LBS tools provide personalised, context-aware travel information.

Public Transport Management Systems (PTMS)

- **Smart Infrastructure:** Buses and metros equipped with AVL, PIS, and AFC systems linked to central command centres.
- **Data Intelligence:** Predictive analytics optimize schedules and reduce delays; edge processing updates passenger info instantly.
- **Geospatial Systems:** GNSS based maps enable route planning, transfer coordination, and service performance tracking.

Freight and Commercial Vehicle Operations (CVO)

- **Smart Infrastructure:** ITS-enabled corridors with weigh-in-motion, RFID, and GNSS tracking for fleet visibility.
- **Data Intelligence:** Dashboards monitor trips, driver behaviour, and route efficiency with AI-based alerts.
- **Geospatial Systems:** GNSS and geo-fencing enhance route optimisation and cargo compliance monitoring.

Advanced Parking Management Systems (APMS)

- **Smart Infrastructure:** Sensors, cameras, and digital displays detect and relay parking occupancy in real time.
- **Data Intelligence:** Cloud systems forecast demand, enable digital payments, and optimise pricing.
- **Geospatial Systems:** GNSS based mapping and navigation apps guide drivers to nearby available spaces.

Connected and Automated Vehicle Systems (V2X & AVCS)

- **Smart Infrastructure:** Roadside units and 5G/DSRC networks enable V2X communication between vehicles and infrastructure.
- **Data Intelligence:** Onboard AI interprets sensor and LiDAR data for driver assistance and automation, while ITS servers run algorithms to provide V2X functionality such as GLOSA and Emergency Vehicle Priority
- **Geospatial Systems:** HD maps and GNSS ensure lane-level accuracy and safe navigation.

6.5. Integration of CASE Mobility (Connected, Autonomous, Shared, and Electric)

The evolution of ITS aligns closely with global mobility trends summarized by the acronym CASE — Connected, Autonomous, Shared, and Electric. These four dimensions represent the future of smart, efficient, and sustainable transportation. ITS acts as the unifying layer that connects them through data, communication, and co-ordinated control.

Exhibit 10 **Integration of CASE Mobility**

C

Connected Mobility

Connected mobility involves vehicles and infrastructure communicating seamlessly in real time. Vehicles equipped with onboard sensors, telematics units, and internet connectivity act as moving data nodes—sending information such as speed, location, and incidents to control centres, while receiving live updates on traffic, hazards, or available parking.

ITS forms the digital ecosystem that enables this interaction. Roadside units, fibre networks, and cellular connectivity allow vehicles to exchange data. This connectivity enhances safety through collision warnings, improves efficiency by supporting adaptive traffic signals, and enables personalised driver information services.

A

Autonomous Mobility

Autonomous mobility builds on connected systems, adding intelligent automation for driving tasks. Autonomous or semi-autonomous vehicles rely on sensors, cameras, radar, and AI-driven decision systems to perceive their environment and respond safely.

ITS provides the essential foundation for autonomous vehicles (AVs) to operate offering precise digital maps, standardised lane markings, live signal information, and co-ordinated traffic management. Control centres can exchange data with AVs about road closures, weather alerts, or dynamic speed limits, while AVs contribute sensor data back to improve network intelligence.

S

Shared Mobility

Shared mobility includes ride-hailing, carpooling, bike-sharing, and on-demand shuttles offering more efficient use of vehicles and reducing congestion. Integration with ITS allows these services to function as part of a co-ordinated mobility ecosystem rather than isolated operators.

ITS enables shared mobility through open data, multimodal integration, and digital payment systems. Traffic management platforms can allocate curb space, optimise pick-up zones, and prioritise high-occupancy vehicles. Journey-planning and Mobility-as-a-Service (MaaS) applications combine metro, bus, and shared rides into one seamless trip plan.

E

Electric Mobility

Electric vehicles (EVs) mark a structural shift in transport energy systems, and ITS plays a crucial role in integrating charging infrastructure, grid management, and user services. Smart charging networks rely on real-time data from vehicles, power utilities, and traffic systems to ensure availability, reliability, and optimal energy use.

ITS platforms can manage EV charging loads dynamically—routing vehicles to the nearest available charger, predicting demand, and co-ordinating charging schedules to avoid grid stress. Data analytics also help identify ideal locations for new charging points based on travel patterns and land-use data.

Source: Geospatial World Analysis

Table 5 Interoperable framework for ITS Hardware and Software

Focus Area	Key Actions & Specifications	Expected Outcome

Define Core Interoperability Principles	• Adopt three-tier model:
	  • Format Interoperability (Syntactic) - Shared data structures and encoding standards.
	  • Semantic Interoperability - Common data meanings and code dictionaries.
	  • Operational Interoperability - Unified behaviour for timing, APIs, and updates
		Consistent interpretation and performance across vendors, systems, and states

Develop Data Standards (Syntactic Level)	• Specify data formats:
	  • JSON for modern systems
	  • XML for legacy systems
	  • ASN.1/Protocol Buffers/OneM2M/SNMP for real-time safety use.
	• Define standard message templates for each domain:
	  • Traffic, Tolling, Incident, Transit.
	• Enforce common units (km/h, m, °C, UTC) and coordinate systems (WGS-84).
		Uniform and machine-readable communication across devices and platforms.

Establish Semantic Consistency (Shared Meaning)	• Create a National ITS Data Dictionary specifying field names, units, and definitions. • Standardise code lists for vehicle classes, incident types, violations. • Include metadata such as timestamp, source, and confidence score with every dataset	Smooth upgrades without service disruption or data mismatch.
Version Control & Change Management	• Follow semantic versioning (Major, Minor, Patch). • Maintain 12-month co-existence between old and new standards. • Announce all updates with changelogs and backward compatibility notes. • Allow dual publishing (old + new) during transition periods.	Smooth upgrades without service disruption or data mismatch.
Certification & Compliance Framework	• Implement mandatory conformance testing for ITS hardware/software. • Authorize national test centres (ARAI, C-DAC, NIC). • Certification required for all government-funded deployments. • Publish compliance registry of certified products and vendors.	Verified, reliable, and secure ITS deployments that meet national standards.
Sectoral Interoperability Profiles	• V2X/Vehicle Safety: Standard message sets (BSM, SPaT, MAP, SRM, SSM, DENM/TIM), latency ≤100ms, PKI-based security. • Traffic Management: Common signal and detector data standards. • Incident Management: Unified lifecycle (detect–verify–resolve). • Tolling & Parking: Harmonised transaction and payment interfaces. • Transit: Common GNSS , schedule, and passenger info standards.	Domain-level harmonisation ensuring interoperability across all transport modes.
Security & Privacy Framework	• Enforce encryption (TLS), authentication, and digital signatures. • Apply role-based access controls and pseudonymised identifiers. • Implement secure OTA updates with signed firmware. • Conduct regular cyber audits under ISO/SAE 21434 & AIS-189/190.	Secure, privacy compliant ITS ecosystem maintaining public trust.

Source: Geospatial World Analysis

Exhibit 11 Testbeds and Pilot Projects in India

India has approached ITS implementation through testbeds and pilot projects that act as innovation sandboxes allowing new technologies to be trialed, localised, and scaled.

TiHAN	• India's first autonomous navigation testbed, TiHAN offers a controlled 2 km urban track and off-road facilities for drones and rovers. • Operational since 2022, it enables trials of driverless shuttles, V2X systems, and AI-based traffic detection tailored to Indian conditions. • Its collaboration with industry and NATRAX is shaping standards for autonomous and connected mobility.
NATRAX	• With Asia's longest high-speed test track (11.3 km) and diverse proving grounds, NATRAX is India's hub for testing ADAS, V2X, and high-speed safety systems. • Automakers use it for adaptive cruise control and lane-keeping trials, while its tie-up with TiHAN creates a complementary ecosystem for both city-level and highway-scale testing.

Source: Geospatial World Analysis

Exhibit 12 Smart City Mobility Pilots

Under the Smart Cities Mission, cities have trialled ITS modules

- **Indore** – AI-based red-light violation detection, now scaling citywide.
- **Bhopal** – bike-sharing integrated with MaaS apps.
- **Kochi** – launched the Kochi-1 integrated mobility card, model for NCMC.
- **Bhubaneswar** – adaptive signals reducing travel time by ~20%.
- **Dehradun** – adaptive signals reducing travel time and delays
- **Pune** – cyclist-priority signals on pilot corridors.

State-Level Pilots

- **Uttar Pradesh** – AI-driven road safety analytics, first of its kind in India.
- **Mumbai (Maharashtra)** – 100 AI-enabled traffic cameras for adaptive signals and violation detection.
- **Bengaluru (Karnataka)** – B-TRAC tested drone-based traffic monitoring during festivals.
- **Tamil Nadu** – ambulance-priority "Green Corridor" ITS pilot in Chennai cut response times by 30%.

Highway and National Pilots

- **Chandigarh–Parwanoo (NH-5)** - Early ITS deployment on hilly terrain, feeding into NHAI's national ITS toolkit.
- **FASTag Pilot** - Tested on Ahmedabad–Mumbai and Golden Quadrilateral corridors before national rollout, solving speed and interoperability issues.
- **Eastern Peripheral Expressway (Delhi)** - Served as a fully-fledged ITS highway model with incident detection, automated

Rail Pilot

- **Konkan Railway** - Trial of GNSS-based Anti-Collision Device ("Raksha Kavach") informed the nationwide rollout of TCAS for Indian Railways.

Source: Geospatial World Analysis

07

Case Studies

GLOBAL

CASE STUDY

Microsimulation Study of Cooperative ITS on the A22 Motorway, Italy

Project Overview

This study evaluated the potential impacts of Cooperative Intelligent Transport Systems (C-ITS) on the A22 motorway in Italy. Using microsimulation, the project mimicked roadworks warning messages and subsequent lane closures to analyze their effect on traffic performance. The scope was to provide evidence-based feedback for a planned C-ITS pilot deployment in 2020.

Problem Statement

Roadworks and lane closures on motorways frequently cause congestion, delays, and safety risks. There was a need to assess whether C-ITS solutions could provide drivers with early warnings and rerouting information to improve traffic flow and reduce bottlenecks

Solution Implemented

A microsimulation model of the A22 motorway was developed to simulate cooperative messages alerting drivers about lane closures and route changes. These messages differentiated between Connected Vehicles (CVs) and traditional vehicles.

Implementation Approach

- Developed a calibrated microsimulation traffic model using recorded data on driver behaviour and roadwork scenarios.
- Incorporated cooperative messages transmitted to CVs from a specific network link.
- Designed overlapping connectors for CVs (visible at 1500 m) and traditional vehicles (visible at 336 m).
- Tested scenarios with CV market penetration ranging from 10% to 100%.

Value Propositions [RoI]

Qualitative Benefits :

- Improved driver awareness and safety at work zones.
- Enhanced traffic efficiency and smoother flow near bottlenecks.
- Evidence base for C-Roads Italy pilot planning.

Quantitative Benefits :

- Reduction in traffic delays up to **8.66%.**
- Average speed increase of ~**10 km/h** at roadworks entrance.
- Queue time reduced by **60 seconds** on the open lane and **25 seconds** on the closing lane at highest CV penetration.
- Overall travel time savings of up to **65 seconds** at high market penetration (>40%).

GLOBAL

CASE STUDY

European Study on Safety Benefits of Cooperative Intelligent Transport Systems (C-ITS)

Project Overview

The study assessed the long-term safety impact of Cooperative Intelligent Transport Systems (C-ITS) across the European Union from 2015 to 2040. It focused on two high priority use cases identified by the European Commission:

- Red signal violation/intersection safety (V2I)
- Vulnerable Road User (VRU) protection

The objective was to quantify the reduction in fatalities and serious injuries under different technology deployment scenarios.

Problem Statement

The European Union faces persistent road safety challenges with thousands of fatalities annually. There is a need to evaluate whether large-scale adoption of C-ITS technologies can substantially reduce accident severity and fatality numbers.

Solution Implemented

The study modelled deployment scenarios of C-ITS communication technologies to project their potential safety benefits up to 2040.

Implementation Approach

Defined two high-priority C-ITS use cases involving vehicle-to-infrastructure (V2I) and pedestrian/cyclist to vehicle (V2P) communications for red signal violation/intersection safety, and Vulnerable Road User (VRU) protection.

Considered three communication technologies:

- **LTE-PC5:** Direct vehicle-to-vehicle and vehicle-to-infrastructure communication.
- **LTE-Uu:** Cellular network-based communications interface.
- **Wi-Fi:** Supporting V2V and V2I connectivity.

Inputs were incorporated stakeholder inputs from **5GAA members** and European C-ITS experts to develop assumptions and time-series modelling was applied to estimate avoided fatalities under both high- and low-deployment speed scenarios.

Value Propositions [RoI]

Qualitative Benefits :

- Strengthened evidence base for EU-wide adoption of C-ITS.
- Enhanced safety for vulnerable road users (pedestrians and cyclists).
- Technology-neutral comparison to guide policymakers and industry.

Quantitative Benefits :

- **3,932 to 8,774 lives could be saved** across the EU by 2040 (depending on scenario).
- **114,066 could be avoided fatalities and serious injuries** under the LTE-Uu high-deployment scenario.
- **90,380 could be avoided fatalities and serious injuries** under LTE-PC5.
- **27,144 could be avoided fatalities and serious injuries** under Wi-Fi.

GLOBAL

CASE STUDY

Simulation Study of Shared Autonomous Vehicles (SAVs) in Japan

Project Overview

This study by researchers at the University of Tokyo simulated the impacts of Shared Autonomous Vehicles (SAVs) on an urban road network. The objective was to evaluate changes in parking demand, congestion, and service levels in a scenario where the vehicle fleet consisted entirely of SAVs.

Problem Statement

Private vehicle ownership creates heavy parking demand in Japanese cities, while traffic congestion and emissions remain persistent challenges. Researchers sought to assess whether a fully shared, autonomous vehicle fleet could reduce parking needs while maintaining service levels.

Solution Implemented

Simulation of the was conducted using SOUND (Simulation of Urban road Networks with Dynamic route choice) to model SAV deployment and its impacts.

Implementation Approach

- Modelled City Road network with contemporary traffic conditions.
- Introduced a fully shared SAV fleet of 60,000 vehicles (less than 6% of registered private vehicles).
- Simulated SAV operations including empty vehicle travel for pickups.
- Compared outcomes with current (non-SAV) scenarios.

Value Propositions [RoI]

Qualitative Benefits :

- Massive reduction in parking demand, freeing urban land for other uses.
- Potential for repurposing office-dominated zones toward non-motorized and public uses

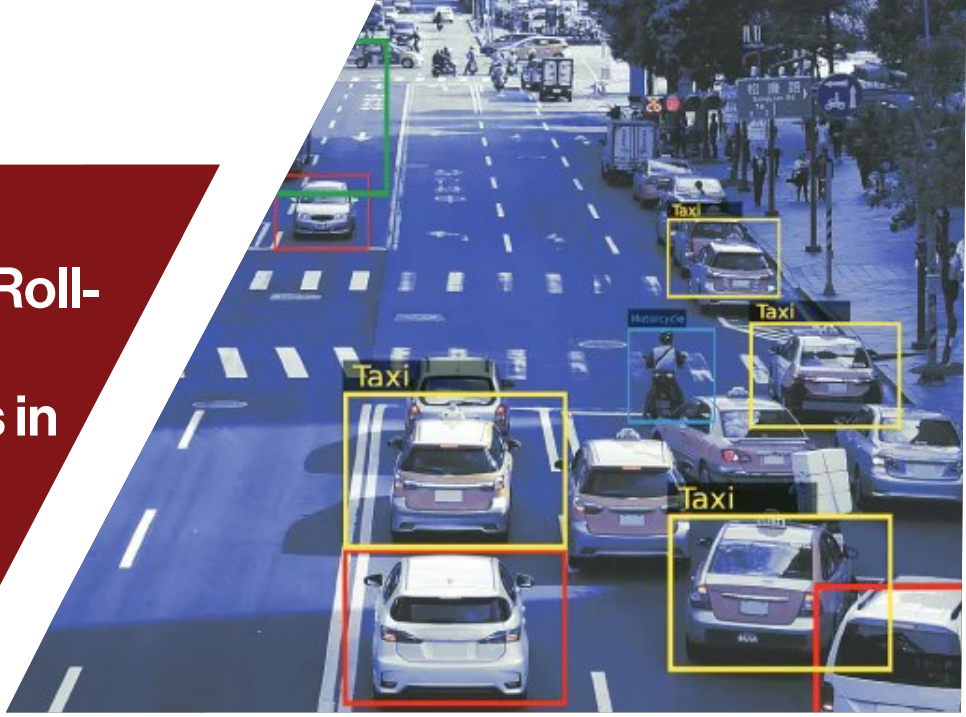
Quantitative Benefits :

- **94% reduction** in parking demand.
- SAV fleet of **60,000 vehicles** could provide equivalent service to existing demand with <6% of current private fleet size.

GLOBAL

CASE STUDY

Automatic Guided Vehicles (AGVs) for Roll-On/Roll-Off (RORO) Terminal Operations in South Korea



Project Overview

This study analysed the impact of introducing Automatic Guided Vehicles (AGVs) to automate operations at a Roll-On/Roll-Off (RORO) terminal in South Korea. The scope included evaluating improvements in productivity, cost efficiency, and environmental performance through simulation modelling and cost analysis.

Problem Statement

RORO terminal operations in South Korea are highly labour-intensive, with long loading times, higher operating costs, and significant carbon emissions. There was a need to evaluate whether automation through AGVs could improve efficiency and sustainability.

Solution Implemented

Simulation and cost models were developed to compare the current manual system against two AGV-based loading system scenarios.

Implementation Approach

- **Scenario 1 (One-way AGV system):** AGVs follow the same path as the current loading system, with one-way ramp movement.
- **Scenario 2 (Two-way AGV system):** AGVs can bypass each other on ramps, improving flow.
- The number of AGVs was varied (10–70) to measure productivity.
- A 15-year cost model was developed, factoring in capital costs, operating costs, and CO_2 emissions.

Value Propositions [RoI]

Productivity:

- 29 AGVs (Scenario 2) matched current productivity.
- 70 AGVs (Scenario 2) reduced loading time by **52%** (44,869 seconds vs. 93,099 seconds).
- 40 AGVs (Scenario 1) reduced loading time by **6%**.

Environmental Impact:

- CO_2 emissions reduced by nearly **65%** compared to current loading system (236,000 g vs. 664,340 g per loading process).

Cost Efficiency:

- Total 15-year operating cost of AGV system: **EUR 17,021,863.**
- Equivalent human-operated cost: **EUR 53,558,339.**
- Nearly **3x cost savings** despite high upfront AGV capital investment

GLOBAL

CASE STUDY

Exploration of Artificial Intelligence and Machine Learning Applications for Traffic Management in Texas, USA

Project Overview

This study, led by Texas Department of Transportation (TxDOT) and partners, explored the use of Artificial Intelligence (AI) and Machine Learning (ML) to enhance transportation management. Within the framework of **Integrated Corridor Management (ICM),** it developed and tested prototype ML models using Connected Vehicle (CV) data and traditional ITS sensor data. The scope included identification of safety hotspots, prediction of travel times, and optimization of signal timing for congestion management, with pilots in Texas.

Problem Statement

Non-recurring congestion caused by crashes, weather, and irregular events is a persistent challenge for traffic management centers. Traditional systems struggle to process large, diverse, real-time data streams to provide timely interventions.

Solution Implemented

Three prototype ML models were designed and tested:

- **Supervised learning models** for short-term travel time prediction.
- **Unsupervised learning and clustering models** for identifying crash hotspots and trip patterns.
- Reinforcement learning models for real-time signal optimization.

These models were trained on CV datasets and ITS traffic sensor data to inform Traffic Management Centers (TMCs).

Implementation Approach

- Surveyed 25 TxDOT employees to identify priority applications and data procurement strategies.
- Selected four use cases (safety hotspots, incident detection, signal timing optimization, and travel time prediction).
- Trained ML models on Connected Vehicle crash/trip data (I-35 in Austin).
- Field-tested models using new datasets from Austin and El Paso (segment-level travel times and traffic volume).
- Evaluated predictive accuracy against measured travel times.

Value Propositions [RoI]

Qualitative Benefits :

- Strengthened TxDOT capability in AI/ML-based traffic management.
- Improved real-time decision-making for TMCs.
- Enhanced coordination and staff training in handling emerging data-driven workflows.
- Enabled prioritization of high-impact applications: Safety Hotspot Detection and ICM.
- Signal optimization models improved corridor-level congestion management in simulations.

Quantitative Benefits :

- Travel time predictions accurate to within **1 minute (3%)** of observed times.

INDIAN

CASE STUDY

Kochi Metro and Kochi Water Metro Integrated Urban Mobility System

Project Overview

The Kochi Metro, operated by Kochi Metro Rail Limited (KMRL), is a mass rapid transit system launched in 2017, now expanded through multiple phases. Phase I spans 28 km from Aluva to Thripunithura with 25 stations, including recent extensions (Pettah–S.N. Junction and Thripunithura Terminal). Phase II (11.2 km "Pink Line") will connect JLN Stadium to Infopark via Kakkanad, while Phase III proposes an airport extension toward CIAL and Angamaly.

Complementing it, the Kochi Water Metro connects 10 islands over 75 km through 15 routes and 38 terminals using a fleet of 78 electric–hybrid ferries. It represents India's first fully integrated land–water intelligent transport system, providing eco-friendly, air-conditioned, and accessible services.

Problem Statement

Kochi's unique coastal geography and dispersed settlement pattern created mobility challenges between mainland and island communities, limiting access to jobs, trade, and essential services. A unified, sustainable, and multimodal transport system was needed to integrate waterways with land-based transit while minimising environmental impact.

Solution Implemented

Development of an integrated metro–water transport system with multimodal ticketing, hybrid electric ferries, and smart mobility features designed for inclusivity, sustainability, and last-mile connectivity.

Implementation Approach

- Constructed elevated metro corridors (Phase I–III) with modern stations and efficient operations.
- Deployed hybrid electric ferries with fast-charging infrastructure and floating terminals.
- Integrated ticketing, scheduling, and passenger information systems between metro and water metro.
- Partnered with Kudumbashree for women-led station management, housekeeping, and ticketing.
- Installed solar panels (57% power from solar) and rainwater harvesting at stations

Value Propositions [RoI]

Qualitative Benefits :

- Seamless land–water integration improving regional connectivity.
- Eco-friendly and energy-efficient mobility reducing emissions and congestion.
- Women empowerment through employment under Kudumbashree.
- Enhanced tourism and local trade via improved inter-island accessibility.

Quantitative Benefits :

- 78 ferries operating across 75 km network with 38 terminals.
- Solar energy meeting over half of total KMRL power demand

INDIAN

CASE STUDY

Bhubaneswar Smart City Surveillance and Traffic Monitoring Project

Project Overview

Honeywell Building Solutions developed and implemented a city-wide surveillance and monitoring system in Bhubaneswar, the capital of Odisha, as part of its Smart City initiatives. The system was designed to enhance urban security, prevent crime, and support traffic management.

Problem Statement

Bhubaneswar faced challenges with rising urban traffic, crime monitoring, and lack of centralized real-time surveillance. A unified smart city system was required to improve public safety and traffic control.

Solution Implemented

A multi-layered surveillance and monitoring solution combining fixed and mobile systems with central oversight:

- CCTV cameras at key junctions and public spaces.
- ANPR systems for traffic enforcement and vehicle tracking.
- Command and Control Center with video wall interface for city-wide monitoring.
- Vehicle-based mobile surveillance.

Implementation Approach

- Phase 1: Installation and expansion of CCTV cameras at various positions across the city
- Integration of feeds into a centralized command and control room for coordinated response.r

Value Propositions [RoI]

Qualitative Benefits :

- Improved citywide security and crime prevention.
- Enhanced traffic management through ANPR enforcement.
- Real-time monitoring enabling faster emergency response.

Quantitative Benefits :

- Phase 1 coverage: 114 cameras at 28 locations.
- Final system to cover 350+ cameras across 90 locations.

INDIAN

CASE STUDY

Bus Rapid Transit System (BRTS) – Amritsar, Punjab

Project Overview

The Government of Punjab, through the Punjab Bus Metro Society (PBMS), initiated the development of a Bus Rapid Transit System (BRTS) for Amritsar city to modernize and streamline urban mobility. Urban Mass Transit Company Limited (UMTC) was tasked with designing, securing approvals, tendering, and providing project management consultancy for the complete implementation of the project. The BRTS includes deployment of Public Transportation Management Systems (PTMS) covering passenger information, schedule communication, and integrated fare systems

Problem Statement

Amritsar faced growing challenges of traffic congestion, lack of efficient public transport, and limited integration of fares and schedules. A modern, technology-driven transit system was required to enhance urban mobility, accessibility, and sustainability.

Solution Implemented

A Bus Rapid Transit System (BRTS) supported by ITS-based PTMS including:

- Passenger Information Systems (PIS).
- Schedule communication for reliability.
- Fare integration with unified fare media.

Implementation Approach

- UMTC provided end-to-end consultancy including design, approvals, tendering, and project management.
- Funding structured through Government of Punjab and Government of India support.
- Implementation under PBMS with technical guidance from UMTC.

Value Propositions [RoI]

Qualitative Benefits :

- Improved public transport reliability and passenger convenience.
- Reduced congestion and improved traffic flow.
- Seamless ticketing and integrated fare systems.

Quantitative Benefits :

- INR 495 Crore investment enabling modern BRTS corridors.
- Increased capacity and speed of public transit relative to existing city bus systems.

INDIAN

CASE STUDY

Video Incident Detection and Enforcement System (VIDES) – Bengaluru–Mysuru Expressway

Project Overview

The Video Incident Detection and Enforcement System (VIDES) project on the Bengaluru–Mysuru Expressway marks India's first deployment of AI-based automated incident detection and enforcement at scale. Implemented by Tecsidel India, a leading global provider of Tolling and Intelligent Transport System (ITS) solutions with over 45 years of international experience, the project enhances highway safety and compliance through advanced video analytics.

The system comprises six M-type gantries covering 3+1 lanes on each carriageway, each equipped with high-speed cameras and connected to a centralized Control Centre for live monitoring and automated enforcement.

Problem Statement

The Bengaluru–Mysuru Expressway experienced recurring road safety challenges, including wrong-way driving, over-speeding, and improper lane discipline, leading to frequent accidents and fatalities. A reliable, automated system was required to detect and deter such violations in real time, reducing human dependency and improving enforcement efficiency.

Solution Implemented

- Installed at key sections along the corridor to capture vehicle movement and identify violations such as wrong-way entry and over-speeding.
- Artificial intelligence models were trained to detect incidents including wrong-way driving, over-speeding, average speed violations, and lane indiscipline.
- A central command facility receives real-time alerts from all gantries, enabling immediate enforcement and coordination with traffic authorities

Implementation Approach

- Gantries positioned at high-risk and high-traffic sections for maximum coverage and visibility.
- Cameras, sensors, and analytics modules integrated with a central server for seamless data transmission and event correlation.
- Automated incident detection triggers alerts in the control centre, enabling immediate verification and enforcement action.

Value Propositions [RoI]

Quantitative Benefits :

- Significant improvement in **road safety** through early detection and deterrence of violations.
- Improved **lane discipline and compliance** due to visible deterrence mechanisms.
- Reduced **human dependency**, enabling more consistent enforcement.
- **Real-time decision-making** capability for traffic management authorities.

INDIAN

CASE STUDY

Nehru Outer Ring Road (NORR) - Hyderabad

Project Overview

The Nehru Outer Ring Road (ORR) is a 158-kilometre, eight-lane, access-controlled expressway encircling Hyderabad, Telangana. Developed to enhance regional connectivity and reduce congestion within the city core, the ORR facilitates high-speed travel, efficient goods movement, and improved urban mobility.

To ensure seamless tolling operations and traffic management, IRB Golconda Expressway Private Limited engaged three Toll Management Software vendors—M/s. Kent ITES, M/s. VaaaN Infra, and M/s. Tecsidel India. Tecsidel India Private Limited serves as the Master System Integrator (MSI), overseeing unified transaction processing and real-time coordination across all toll plazas.

The project has successfully implemented FASTag-based electronic tolling in 226 lanes across 22 toll plazas, marking a significant step toward automated, cashless, and efficient toll management in India.

Problem Statement

Manual toll collection on high-volume access-controlled corridors led to operational inefficiencies, longer queue times, and inconsistent data reconciliation across plazas. To improve throughput, transparency, and user convenience, a unified and automated toll management system was required.

Solution Implemented

- FASTag integration across all 226 lanes, enabling automatic, contactless toll collection and seamless vehicle passage.
- Deployment of toll lane boosters in high-volume sections to enhance vehicle detection and transaction speed.
- Centralised coordination by the Master System Integrator (Tecsidel India) for unified data processing, monitoring, and control across all 22 plazas.

Implementation Approach

- FASTag-enabled lanes commissioned across the expressway to eliminate manual tolling and reduce congestion.
- Installation of lane boosters and upgraded toll software to ensure high transaction accuracy and real-time data synchronisation.
- Integration of all plaza systems under a single digital backbone managed by Tecsidel India for interoperability and performance monitoring.

Value Propositions [RoI]

Qualitative Benefits :

- Time savings and enhanced travel reliability for daily commuters and freight carriers.
- Better road quality and maintenance due to access-controlled design and continuous monitoring.
- Enhanced safety through regulated vehicle movement and faster emergency response mechanisms.
- Environmental benefits from reduced idling time and lower vehicular emissions.

08

Roadmap

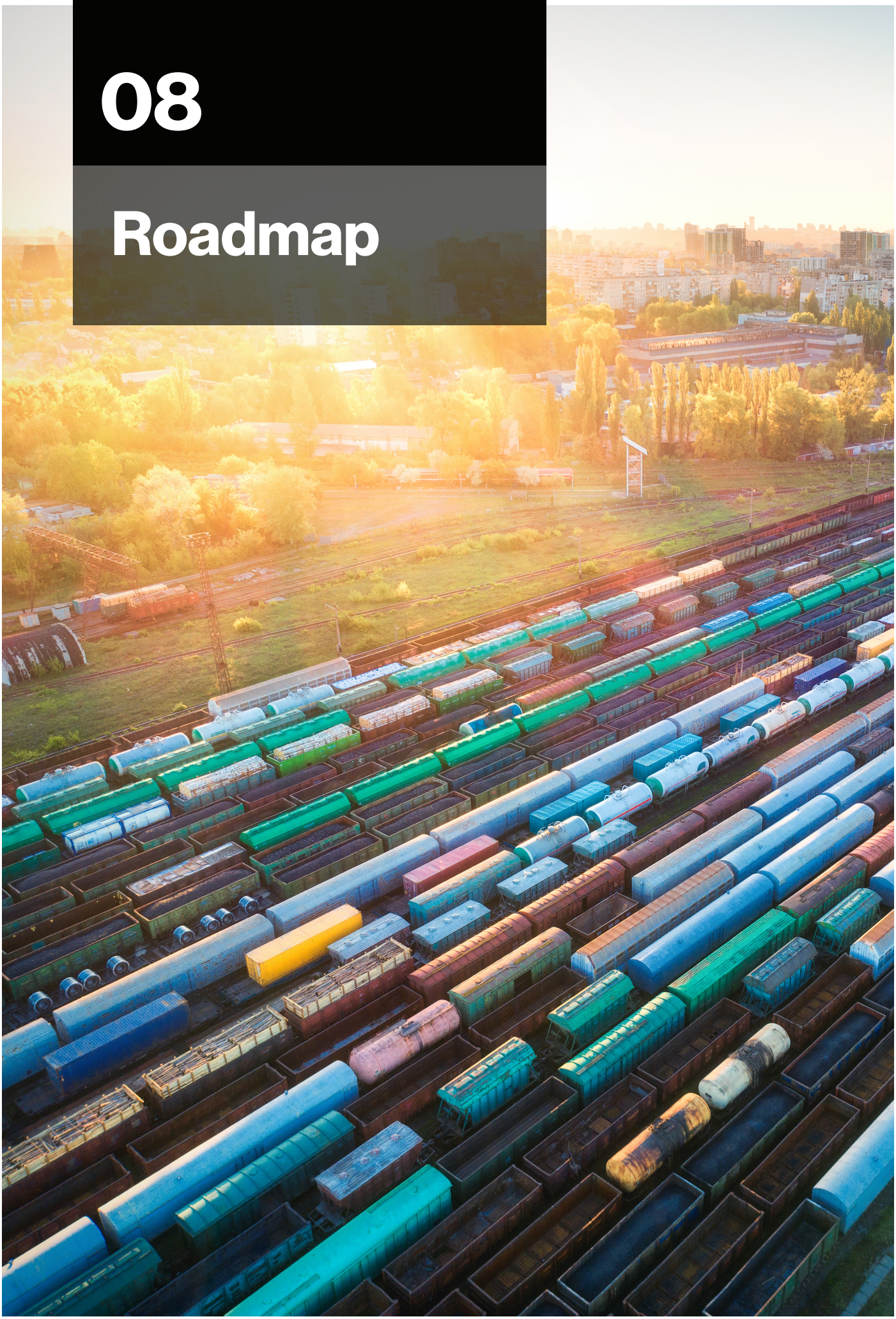


Table 6 Deployment Roadmap for ITS in India

	Inputs	Activities
National ITS Policy & Architecture	• National ITS Policy framework defining technology priorities and deployment standards. • Development of a National ITS Architecture	• Finalize and publish National ITS Architecture and interoperability standard. • Define phased rollout plan (urban, intercity, and rural ITS) • Establish monitoring framework
Technology Ecosystem & Standards	• Adoption of open ITS standards • R&D collab for indigenous tech development	• Develop indigenous technology and focus on standardizing APIs for communication • Create certification programs for ITS equipment and integrators.
Policy & Institutional Framework	• Create National ITS Financing framework and a National ITS Fund (NIF)	• Create a task force working to publish the financing framework and start pooling resources for National ITS Fund (NIF) • Define financial eligibility and co-financing criteria for ITS projects.
Public Budgetary Support	• Dedicated central and state government allocations • Budgeting within flagship programs	• Introduce dedicated ITS budget lines within the government • Allocate annual O&M budgets to sustain deployed ITS assets.
Revenue & Data Monetization Models	• Leveraging ITS-generated data for value-added services and creating partnerships	• Develop frameworks for regulated data monetization • Partner and pilot different revenue generating model
Institutional Setup	• Establish National ITS Authority and regional cells. • Create functional divisions for Planning, R&D & Management	• Operationalize National ITS Authority and COEs • Define roles, responsibilities and performance indicators. • Build inter-agency coordination mechanisms.
Digital & Physical Infrastructure	• Development of simulation labs, training centres, and online learning and training platforms.	• Set up COEs and ITS research parks. • Deploy online certification platforms with modular learning paths. • Create virtual simulation labs for ITS testing and prototyping.
Knowledge & Standards	• Access to global ITS standards, manuals, and guidelines. • Development of India-specific content and frameworks.	• Develop standardized training materials aligned with national and global ITS frameworks. • Publish manuals, toolkits, and technical handbooks. • Conduct periodic skill-gap assessments.
Institutional Coordination Frameworks	• Establishment of National ITS Council • State-level ITS steering committees	• Convene quarterly coordination meetings among national and state units • Develop a shared ITS project registry for tracking progress and duplication.
Academic and Research Partnerships	• Collaboration with universities • Joint R&D programs	• Develop joint research projects • Establish national fellowships • Create simulation labs and sandbox
International Cooperation	• Bilateral MoUs and partnerships • Knowledge-sharing and joint pilot programs	• Participate in regional ITS alliances and standard-setting bodies. • Facilitate knowledge exchange missions and global congress participation.
Citizen and Stakeholder Engagement	• Platforms for public participation and feedback • Awareness programs	• Build digital feedback dashboards integrated with ITS command centres. • Conduct outreach programs and awareness campaigns. • Implement participatory budgeting for local ITS initiatives.
Green Infrastructure Investments	• Dedicated funding for low emission ITS technologies	• Deploy ITS-enabled corridors. • Implement eco-friendly public transport management systems • Develop smart logistics hubs reducing idling and empty runs.
Inclusive and Sustainable Urban Mobility under SDG 11.2	• Develop pilots integrating ITS, safety, and accessibility. • Plan reforms in the existing BRT systems • Build SDG-aligned monitoring and data systems	• Launch regional ITS pilot corridors with Electric Road Systems (ERS), hydrogen buses, and feeder networks. • Conduct affordability and accessibility audits to align technology with user income and travel needs. • Operationalise the Dashboard

Policy, Technology and Funding

Capacity Building and Institutional Strengthening

Engagement and Collaboration Strategies

Climate and Sustainability

Source: Geospatial World Analysis

Outputs	Outcomes	Vision 2047 Target
• National ITS Architecture published by 2030. • 70% of projects aligned with standards by 2035; 100% by 2047.	• AI-enabled, real-time traffic management and connected vehicle systems reduce congestion, accidents, and travel time delivering faster, cashless, and interoperable journeys for citizens. • Public and private ITS agencies operate with certified professionals and aligned mandates, enabling streamlined decision-making, faster technology localization, and coordinated national-to-local implementation. • Collaborative R&D, indigenous design, and startup participation accelerate innovation and commercialization, positioning India as a regional hub for ITS patents, standards, and exports. • ITS integration in transport planning cuts GHG and pollutant emissions through real-time optimization, clean technology investments, and inclusion of ITS data in national climate monitoring. • Diversified funding models, public-private partnerships, and data monetization enhance investor confidence, enable cost recovery, and ensure efficient, accountable, and long-term ITS operations. • Urban transport systems redesigned to be inclusive, data-driven, and sustainable, achieving measurable gains in accessibility, affordability, and safety across cities.	• A seamless, intelligent transport system connects all national highways and major cities, reducing congestion, emissions, and accidents while supporting India's Net Zero and SDG goals. • India becomes a global hub for ITS R&D, exports, and standards development, recognized among the top three nations shaping global transport technologies. • A skilled, self-reliant workforce and multi-stakeholder ecosystem drive continuous innovation, with India serving as the regional anchor for ITS training, standards, and knowledge sharing. • ITS integration enables low-carbon, multimodal, and equitable transport systems, cutting emissions by 30% and making cities cleaner, safer, and more efficient. • Long-term reinvestment, innovative financing, and transparent governance ensure scalable, self-sustaining ITS infrastructure—making India a model for sustainable ITS financing globally. • India achieves universal access to safe, affordable, and low-emission transport, meeting SDG 11.2 goals through equitable, intelligent, and climate-resilient mobility for all citizens.
• Financing framework published by 2028 and fund operational by 2030.		
• INR 25,000 crore public funding committed by 2030. • 100 projects co-funded through Gati Shakti.		
• National ITS Data Marketplace launched by 2028 • 100 public–private data sharing agreements signed by 2030.		
• National ITS Authority operational by 2028. • 10 Centres of Excellence by 2035. • 5 ITS Research Parks by 2030.		
• 1 National ITS e-Learning Portal operational by 2027. • 10,000 annual online learners.		
• 25 training modules developed and adopted nationally. • 10 sector specific ITS handbooks published.		
• National and state ITS Council operational by 2028. • Unified ITS registry by 2027.		
• 50 joint research projects and 200 fellowships by 2030		
• India to host ITS Asia-Pacific Congress in India by 2030 and ITS World Congress in India by 2047.		
• 5 crore citizens reached through awareness campaigns by 2030. • 25% increase in ITS-enabled service usage.		
• Sustainable financing instruments used to finance 15% of ITS projects or mobilise INR 50,000 crore 2035		
• 10 ITS-based inclusive corridors operational by 2027. • Accessibility Dashboard launched by 2028. • 100 cities integrated with ITS-enabled, inclusive public transport by 2030.		

09

Milestones & Tracking Mechanism

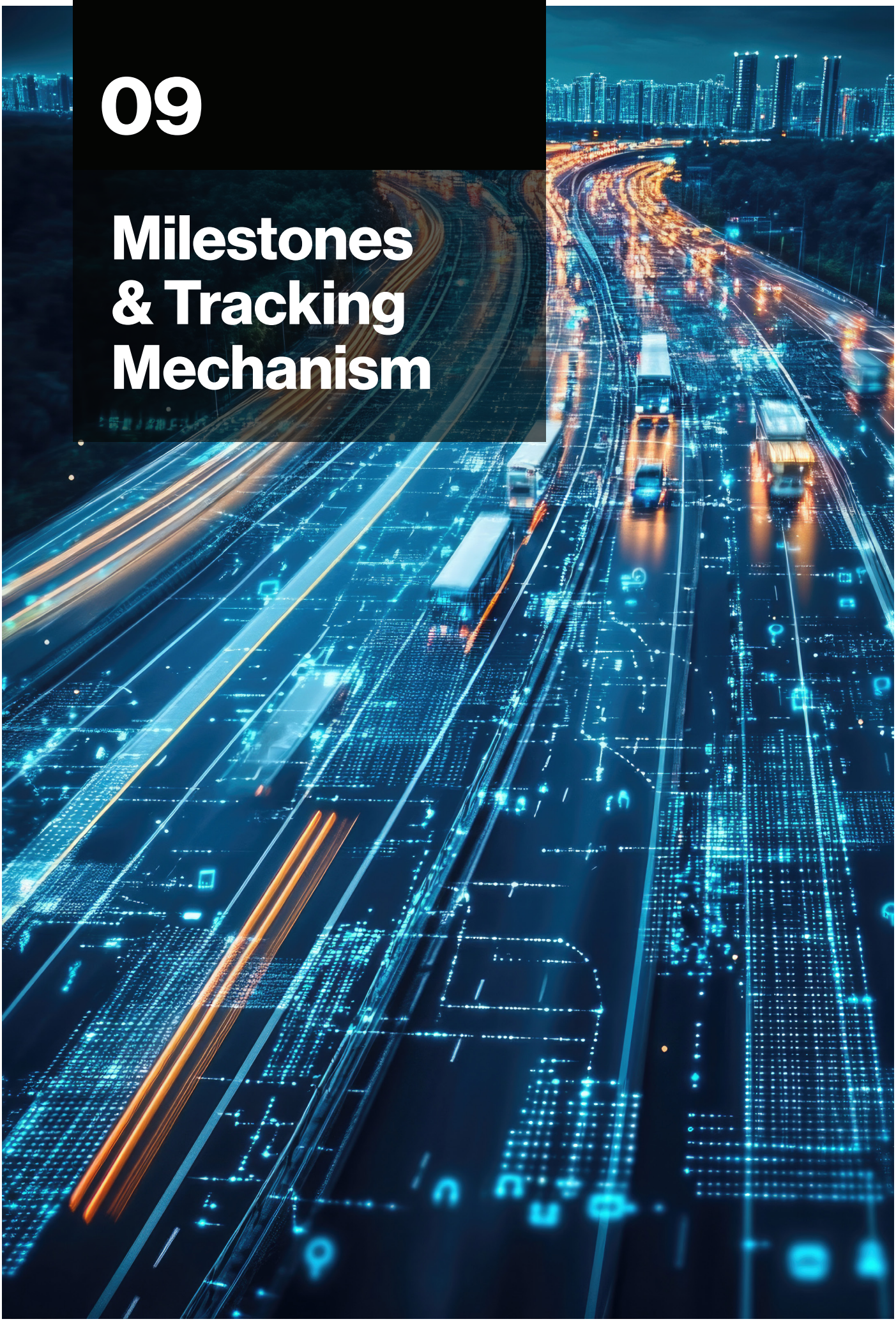


Table 7 Key Indicators (KPIs) Matrix

Component	Key Indicators (KPIs)	Target Milestones by 2035
National ITS Policy & Architecture	• National ITS Policy notified and operational. • % of projects conforming to National ITS Architecture and interoperability standards. • Centralised ITS Project Tracker deployed	• Policy notified by 2028 and operational by 2035 • 70% of new ITS projects aligned with national standards. • 100% public ITS projects digitally tracked.
Technology Ecosystem & Standards	• No. of standardised ITS APIs and data models published. • % of approved and certified locally made ITS devices/systems. • % of vehicles V2X-enabled.	• 20 ITS API/data standards adopted. • 80% ITS hardware certified by BIS/TEC. • 60% new vehicles V2X-enabled.
Infrastructure Deployment & Coverage	• % of highways and urban corridors under ATMS/ITMS coverage. • % of toll plazas integrated with MLFF (Multi-Lane Free Flow) system. • % of cities with ITS command centres.	• 75% national highways with ITS coverage. • MLFF (Multi-Lane Free-Flow) live on 25 major corridors. • ITS command centres in 100 cities.
Safety & Congestion Reduction	• % reduction in fatalities on ITS-covered corridors. • Average highway travel time improvement. • % intersections operating under adaptive signal control.	• 75% national highways with ITS coverage. • MLFF (Multi-Lane Free-Flow) live on 25 major corridors. • ITS command centres in 100 cities.
Emissions & Environmental Performance	• % reduction in CO_2 emissions from road transport. • % of ITS projects linked with green financing mechanisms. • No. of ITS-enabled eco-corridors operational.	• 15% GHG reduction through ITS optimisation. • 20% projects financed via green or climate-linked funds. • 25 ITS-enabled eco-corridors deployed.
Institutional Setup & Capacity Building	• National ITS Authority operational and functional divisions established. • No. of Centres of Excellence and trained professionals. • No. of standardised training programs launched.	• Authority and 5 regional cells functional. • 10,000 certified ITS professionals. • 10 national training modules operational.
Digital Connectivity & Data Infrastructure	• % of ITS command centres integrated with national cloud. • % of corridors with 5G or fibre connectivity. • System uptime and latency compliance.	• 80% integration with National ITS Cloud. • 60% corridors 5G/fibre enabled. • 99% uptime for command centres.
Financing & Investment Mobilization	• Total ITS funding mobilised (public + private). • % of projects financed via PPP/ Innovative mechanisms. • ITS Data Marketplace revenue generated.	• INR 75,000 crore mobilised. • 40% projects under PPP. • INR 500 crore annual data revenue.
Interoperability & Data Governance	• % systems interoperable across states/ vendors. • No. of certified interoperable APIs and data models. • % of projects with active data-sharing agreements.	• 80% interoperable systems. • 25 certified APIs/data models. • 200 data-sharing MoUs in force.

Source: Geospatial World Analysis

10

Strategic Recommendations

1 National ITS Policy & Architecture

India's ITS development remains fragmented across states, agencies, and sectors, with limited interoperability and absence of a unified framework guiding design, deployment, and evaluation. Establishing a **National ITS Policy and Architecture** will provide a cohesive direction, align technology standards, and ensure integration across urban, intercity, and rural networks.

Key Actions

- **Develop a Unified Policy and Architecture:** Finalize and publish the National ITS Policy and Architecture by 2030, defining standards for interoperability, communication protocols, and cybersecurity.
- **Define Phased Rollout:** Implement a phased deployment strategy urban ITS by 2030, intercity corridors by 2035, and rural integration by 2047.
- **Mandate Alignment with National Standards:** Require all central and state ITS projects to comply with the national architecture to ensure seamless data exchange and interoperability.
- **Establish a Monitoring and Compliance Framework:** Create a national digital registry to track ITS projects, monitor progress, and assess adherence to standards.

Institutional Implications

- Creates a clear governance and implementation structure, preventing duplication and technological silos.
- Enables interoperability across transport systems and regions, improving efficiency and data-driven decision-making.
- Strengthens India's global competitiveness by aligning national standards with international ITS frameworks.
- Positions India to achieve its Vision 2047 goal of seamless, intelligent, and sustainable mobility.

2 National ITS Authority & Governance Structure

India's ITS ecosystem currently spans multiple ministries, departments, and local agencies, resulting in overlapping mandates and inconsistent implementation. A dedicated National ITS Authority, supported by regional and state-level coordination cells, is essential to provide unified leadership, policy continuity, and effective inter-agency collaboration.

Key Actions

- **Establish the National ITS Authority:** Operationalize a statutory body under the Prime Minister's Office (PMO), Ministry of Road Transport and Highways (MoRTH) or Ministry of Electronics and Telecommunication (MeitY) by 2028 to oversee policy, standards, and national implementation.
- **Create Regional and State ITS Cells:** Form dedicated ITS divisions within state transport departments to ensure localised execution aligned with the national architecture.
- **Define Clear Roles and Accountability:** Develop an institutional charter specifying the authority's roles across policy formulation, project certification, R&D promotion, and funding coordination.

Institutional Implications

- Ensures unified governance and policy coherence across all ITS initiatives.
- Enhances coordination between central, state, and urban agencies, minimising duplication and delays.
- Facilitates streamlined decision-making, standardised project evaluation, and faster technology localisation.
- Strengthens accountability and transparency, enabling long-term program sustainability and private sector confidence.

3 Indigenous Technology Development & Open Standards

India's ITS landscape currently depends heavily on imported hardware, proprietary software, and vendor-specific platforms, limiting interoperability and cost efficiency. To build a self-reliant and globally competitive ITS ecosystem, India must promote indigenous technology development, open standards, and certification frameworks that ensure quality, compatibility, and scalability.

Key Actions

- **Promote Open Standards and Interoperability:** Develop and mandate open APIs, communication protocols, and data exchange standards to ensure seamless integration between different ITS systems and vendors.
- **Foster Indigenous R&D and Product Development:** Incentivise collaboration between industry, academia, and research institutions to design and commercialize Indian-made ITS hardware, sensors, and software platforms.
- **Establish National Certification Programs:** Launch a certification framework for ITS devices, integrators, and software vendors through BIS and TEC.
- **Encourage Startups and Innovation Clusters:** Create innovation zones and technology parks offering grants, sandbox environments, and incubation support for ITS startups developing localised solutions.

Institutional Implications

- Reduces import dependency and boosts domestic manufacturing aligned with the Make in India and Atmanirbhar Bharat missions.
- Enables global export of standardised, certified ITS technologies developed in India.
- Enhances national cybersecurity, data protection, and long-term maintainability of systems.
- Positions India as a regional hub for affordable, interoperable ITS technologies by 2047.

4 Digital Connectivity Backbone

A seamless and reliable digital communication network is the foundation of ITS. However, connectivity gaps, especially across rural and intercity corridors, hinder real-time monitoring, enforcement, and data exchange. Establishing a national digital connectivity backbone integrating fibre, satellite, and fifth generation (5G) networks is essential to enable real-time operations and future-ready mobility systems.

Key Actions

- **Integrate Multi-Layer Communication Networks:** Expand and interlink fibre-optic, 5G, and satellite networks to ensure continuous coverage across urban, highway, and rural corridors.
- **Develop Cloud-Based ITS Infrastructure:** Establish cloud and edge-computing platforms with geospatial dashboards for real-time data analytics, command, and control operations.
- **Implement Vehicle-to-Everything (V2X) Communication:** Accelerate pilots for Cellular V2X and satellite-enabled systems in 10 states by 2030, targeting full-scale national coverage by 2047.
- **Ensure Cybersecurity and Data Protection:** Introduce cybersecurity standards, encrypted communication protocols, and continuous monitoring frameworks for all ITS-connected systems.

Institutional Implications

- Enables real-time decision-making and predictive traffic management across all regions.
- Supports integration of connected vehicles, smart tolling, and automated enforcement.
- Strengthens resilience of transport infrastructure through redundancy and data-driven control.
- Provides the backbone for future innovations like autonomous driving and dynamic traffic optimisation.

5 Financing Framework & National ITS Fund (NIF)

India's ITS rollout needs predictable, blended financing—not one-off project grants. A National ITS Financing Framework and a National ITS Fund (NIF) will pool public allocations, multilateral lines, green capital, and private participation to de-risk projects, standardise procurement, and sustain O&M over the asset life.

Key Actions

- **Constitute NIF & publish the framework:** Define eligible ITS assets (ATMS/ITMS, MLFF, ICCC, V2X, data platforms), co-financing ratios, Viability Gap Funding norms, and O&M reserve rules.
- **Ring-fence public budgets:** Create dedicated ITS budget lines (central/state); align with Gati Shakti for co-funding and fast clearances.
- **Mobilize green & innovative capital:** Issue green ITS bonds, enable carbon credit monetisation for congestion/EV benefits, and float InvITs for revenue assets (tolling, parking, freight hubs).
- **Enable revenue & data monetization:** Stand up a regulated National ITS Data Marketplace; standardise data pricing, anonymisation, and revenue-sharing with ULBs/authorities.
- **Transparency & control:** Launch a National ITS Finance Dashboard for real-time capex/O&M tracking, disbursement triggers, and KPI-linked payouts across agencies.

Institutional Implications

- Stable, multi-year funding for scale, upgrades, and lifecycle O&M.
- Lower cost of capital via standardised risk, pooled issuances, and credit enhancement.
- Faster private participation with clear revenue models and predictable cash flows.
- Stronger accountability through live expenditure/KPI visibility across programs.

6 Innovative & Green Financing Mechanisms

Accelerating ITS deployment across India requires diversified and sustainable financing beyond traditional public budgets. Innovative and green financing mechanisms can attract private investors, support long-term asset maintenance, and align ITS expansion with India's sustainability and climate goals. By linking ITS investments with measurable environmental outcomes, India can tap into emerging carbon markets, green bonds, and infrastructure investment trusts to fund scalable, low-emission transport systems.

Key Actions

- **Issue Green ITS Bonds:** Develop a standardized framework for green-labelled ITS bonds tied to sustainable transport assets such as electric mobility management systems, adaptive traffic controls, and congestion-reducing technologies.
- **Enable Carbon Credit Monetisation:** Quantify emission reductions achieved through optimized traffic flow and reduced idling to generate tradable carbon credits within domestic and international markets.
- **Launch Infrastructure Investment Trusts (InvITs):** Package revenue-generating ITS assets like tolling networks, freight hubs, and parking systems into InvITs to attract institutional capital and long-term investors.

Institutional Implications

- Stable, multi-year funding for scale, upgrades, and lifecycle O&M.
- Lower cost of capital via standardised risk, pooled issuances, and credit enhancement.
- Faster private participation with clear revenue models and predictable cash flows.
- Stronger accountability through live expenditure/KPI visibility across programs.

7 Capacity Building & Human Resource Development

A skilled and future-ready workforce is essential for implementing and sustaining India's ITS vision. The rapid evolution of ITS technologies spanning data analytics, artificial intelligence, connected vehicles, and 5G-enabled infrastructure requires a structured capacity-building ecosystem that develops technical, managerial, and operational competencies across all levels of government and industry.

Key Actions

- **Establish a National ITS e-Learning Portal:** Develop an online learning and certification platform offering modular courses on system design, operations, maintenance, and data-driven decision-making.
- **Develop Specialised Training Curricula:** Partner with IITs, NITs, and leading transport institutes to design training modules aligned with global ITS standards and national deployment goals.
- **Create Centres of Excellence (CoEs) & Simulation Labs:** Set up virtual and physical labs to enable hands-on learning, real-world testing, and innovation in ITS technologies.
- **Introduce Certification & Accreditation Programs:** Certify ITS professionals, integrators, and equipment providers to ensure technical competence and standard compliance.

Institutional Implications

- Builds a self-reliant and technically competent ITS workforce capable of managing national deployments.
- Ensures operational consistency and quality across projects through standardised training and certifications.
- Strengthens India's R&D base by integrating academia, startups, and industry in continuous skill development.
- Positions India as a regional knowledge hub for ITS, exporting training, standards, and best practices to developing economies.

8 Research and Innovation Ecosystem

A strong research and innovation ecosystem is vital to sustain India's long-term ITS growth and reduce reliance on imported technologies. By fostering collaboration between academia, industry, and government, India can accelerate the development of indigenous ITS solutions tailored to its diverse mobility needs spanning connected vehicles, multimodal integration, and real-time analytics.

Key Actions

- **Establish ITS Research Parks and Innovation Hubs:** Set up dedicated research parks in partnership with IITs, NITs, and premier technical institutions to incubate startups, test new technologies, and support pilot deployments.
- **Create a National ITS R&D Program:** Fund multi-institutional projects focused on emerging domains such as Artificial Intelligence in traffic prediction, C-V2X communication, digital twins, and autonomous systems.
- **Launch Innovation Challenge Grants:** Provide annual competitive grants and hackathons to encourage entrepreneurs and students to solve real-world transport problems using indigenous technology.
- **Promote International Collaboration:** Partner with global ITS alliances and research institutions to exchange knowledge, co-develop standards, and enhance India's role in shaping global ITS innovation.

Institutional Implications

- Positions India as a global innovation hub for affordable and scalable ITS technologies.
- Drives indigenous product development, reducing technology imports and strengthening self-reliance.
- Builds long-term collaboration networks across academia, startups, and corporates for continuous innovation.
- Enables commercialisation of home-grown technologies through structured IP management and incubation support.

9 Data Monetization & Value-Added Services

As India's ITS ecosystem matures, the vast data generated through sensors, connected vehicles, tolling systems, and traffic management platforms can be transformed into a strategic national asset. By establishing regulated frameworks for data monetization and value-added services, the government can unlock new revenue streams, foster innovation, and enhance service delivery while ensuring data privacy, transparency, and interoperability.

Key Actions

- **Launch a National ITS Data Marketplace:** Develop a secure, government-regulated platform enabling public–private data exchange for research, logistics optimization, navigation, and urban mobility planning.
- **Establish Data Governance Frameworks:** Define standards for anonymisation, interoperability, and sharing of real-time data across agencies and industries, aligned with India's Digital Personal Data Protection Act.
- **Promote Value-Added Services:** Enable startups and enterprises to leverage ITS data for solutions such as predictive traffic analytics, road safety dashboards, and smart logistics routing.
- **Encourage Public–Private Data Partnerships:** Facilitate at least 100 agreements by 2030 between public agencies and private companies for co-developing ITS-driven services and applications.

Institutional Implications

- Creates sustainable, non-tax revenue streams to fund ITS operations and innovation.
- Encourages entrepreneurship and R&D in mobility analytics, logistics, and safety tech.
- Improves transparency and decision-making through open yet secure data ecosystems.
- Strengthens India's position as a leader in ethical, commercially viable ITS data governance.

10 Citizen and Stakeholder Engagement

For India's ITS to achieve widespread adoption and long-term impact, citizen participation and multi-stakeholder collaboration must become central to its governance model. Engaging the public, industry, academia, and local governments ensures that ITS deployments are responsive, inclusive, and sustainable bridging the gap between technology implementation and real-world mobility needs.

Key Actions

- **Establish Citizen Feedback Platforms:** Integrate real-time feedback and complaint modules within city-level Integrated Command and Control Centres (ICCCs) and highway operation centres to enhance responsiveness and trust.
- **Institutionalize Participatory Planning:** Involve citizens, civic bodies, and transport user groups in the design and prioritisation of ITS projects through public consultations and participatory budgeting frameworks.
- **Foster Industry and Academia Partnerships:** Establish regular multi-stakeholder forums for collaboration among government agencies, technology providers, research institutions, and civil society to ensure alignment on standards, innovation, and data ethics.

Institutional Implications

- Builds public trust and accelerates adoption of ITS-enabled services across urban and rural areas.
- Enhances accountability and transparency through participatory governance and open communication channels.
- Ensures solutions are user-centric, equitable, and aligned with on-ground transport realities.
- Fosters a shared ownership model, where government, industry, and citizens co-create India's intelligent mobility future.

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