

INDIA'S TOLL TRANSFORMATION: HOW TECHNOLOGY IS STREAMLINING TRAFFIC FLOW

Abstract

India's highway network is the lifeline of its growing economy—but for years, toll plazas have experienced delays. Now, a technological revolution is transforming how tolls are collected, making travel faster, smarter, and greener. From the widespread adoption of FASTag to the upcoming satellite-based GNSS tolling, India is embracing cutting-edge solutions that promise seamless, contactless journeys. This article explores the innovations reshaping toll management—from RFID and video tolling to AI and Blockchain—and offers a glimpse into global trends. Discover how India is building the future of transportation, one toll at a time.

India's vast network of highways is a crucial artery for its booming economy. However, navigating this network can often be a frustrating experience, especially at toll plazas. Traditionally, cash transactions caused delays and congestion. Thankfully, technology is revolutionizing toll management in India, paving the way for a smoother and more efficient transportation system. This article explores the technological advancements transforming toll collection in India, with a glimpse into global trends.

From Manual Mayhem to Electronic Efficiency: A Technological Revolution

Manual cash collection at toll booths led to long queues and traffic bottlenecks. The introduction of Electronic Toll Collection (ETC) systems marked a turning point. Here's a breakdown of the prevalent technologies:

- ◎ **Manual Toll Collection:** Manual toll collection refers to the conventional approach



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wherein drivers make payments either in cash or through a card swipe machine stationed at toll booths. In this method, vehicles stop at designated toll plazas, where toll collectors manually accept cash payments or process card transactions before allowing vehicles to proceed. This method has been widely used for decades and relies on physical interaction between toll collectors and drivers to facilitate payment. While effective, manual toll collection can lead to delays, especially during peak traffic periods, and requires infrastructure and staffing at each toll plaza to manage transactions efficiently.

- Electronic Toll Collection (ETC) Lane:** Dedicated lanes equipped with ETC readers allow vehicles with FASTags to pass through seamlessly without stopping. This Radio Frequency Identification (RFID) tag, affixed to a vehicle's windshield, enables contactless toll payments. This significantly improves traffic flow, especially during peak hours.

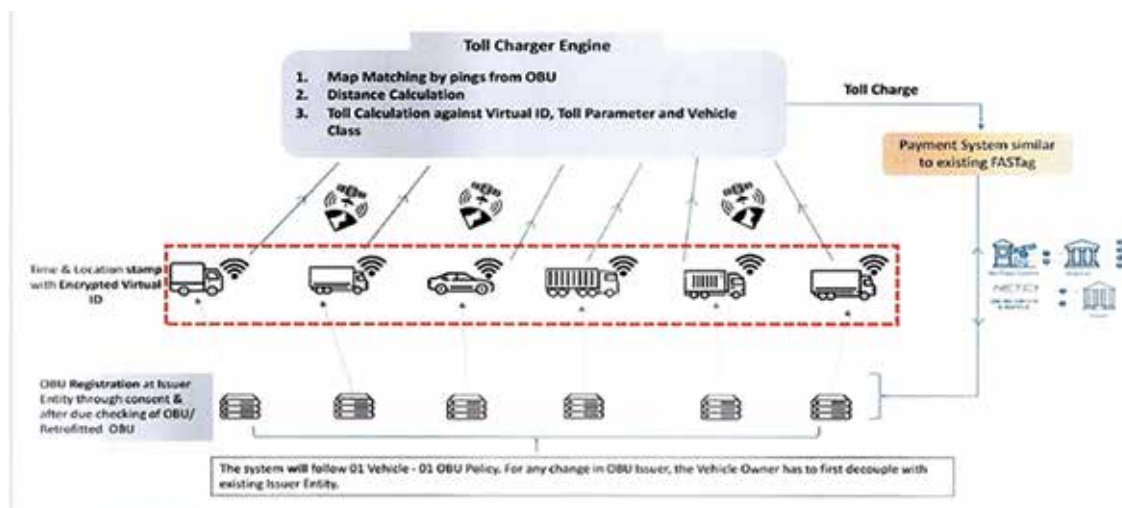
Future of Electronic Toll Collection:

- Video Tolling (VTOLL):** This system uses high-resolution cameras to capture license plates of vehicles passing through toll plazas without FASTags. The vehicle owner is then identified, and the toll is billed electronically or sent by mail for later payment. While VTOLL reduces congestion compared to cash lanes but it can be less efficient than FASTag due to potential delays in billing and processing.
- GNSS-Based Toll Collection:** India is set to introduce a new satellite-based toll collection system. Unlike traditional toll plazas, this

system charges vehicles based on the distance travelled, eliminating the need for physical barriers. Let's delve into the details:

I. How GNSS Works

- GNSS and GPS Integration:** The system utilizes GNSS and GPS technology to precisely track vehicle movement. GNSS provides accurate positioning data, while GPS ensures global coverage.
- Distance-Based Charging:** Instead of fixed toll amounts, vehicles are charged based on the actual distance travelled. This dynamic approach enhances fairness and efficiency.
- Barrier-Free Experience:** Say goodbye to long queues at toll booths. Equipped vehicles seamlessly pass through dedicated GNSS lanes without stopping.
- On Board Unit (OBU):** OBU is a compact device installed in all vehicles that communicates with satellites to determine the vehicle's exact location and calculate toll charges proportionately.



Source: NHAI; GNSS Mechanism

II. Toll Booth Showdown: GNSS vs. FASTag

Particulars	GNSS based tolling	FASTag based tolling
Billing method	Amount of distance travelled on the Road - fairer for short trips.	Fixed toll amount irrespective of distance travelled

Technology	GNSS relies on satellite signals for location tracking - creating "virtual" toll booths	FASTag uses RFID technology for automatic toll collection at specific toll plazas.
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Infrastructure	Vehicle must install a On Board Unit (OBU) and Highways have to be geo-fenced	Vehicle must have FASTag (RFID) and Toll plazas at Highways
Challenges	Privacy issues due to tracking of vehicle. Accurate toll calculation is contingent upon the precision of the GNSS system.	High cost of building and maintaining toll plazas, potential for congestion during peak hours.

Global Perspectives

While India's toll management system is undergoing a rapid technological transformation, it's valuable to consider global trends. Many European nations use DSRC (Dedicated Short Range Communications) or infrared beacons for toll collection. These systems facilitate seamless payments and reduce congestion. Countries currently using GNSS Tolling – Germany (2005), Slovakia (2010), Hungary (2013), Belgium (2016), Russia and Bulgaria.

Europe remains the only region with large-scale satellite-based tolling systems. The GNSS based road user charging in USA has been implemented in 3 states (Oregon, Utah & Virginia) currently.

- ⊙ **Open Road Tolling:** Some countries, like Norway and Singapore, have adopted open road tolling systems. This involves satellite-based or GPS technology to track vehicles and automatically deduct tolls without designated toll plazas.
- ⊙ **United States:** The U.S. employs various technologies, including electronic toll collection (ETC) and license plate recognition (LPR). States like California and Florida have embraced cashless tolling.

Results in Action: FASTag Transforming Indian Highways

- ⊙ The National Highways Authority of India (NHAI) has been instrumental in promoting FASTag adoption. FASTag penetration has surpassed 98% on national highways, a

remarkable achievement. This widespread adoption has demonstrably reduced congestion at toll plazas across the country.

- ⊙ India's shift towards automated toll collection has delivered significant time, economic, and environmental benefits. Annually, the system has saved an estimated 46.3 crore hours in vehicle travel time—translating to an economic value of approximately ₹34,000 crore.
- ⊙ One of the most notable improvements is the reduction in average vehicle waiting time, which has decreased by 47 seconds—from 714 seconds under manual tolling to just 667 seconds. This smoother traffic flow has contributed to considerable fuel savings across the country.
- ⊙ Toll revenue has also seen a substantial boost, rising by 29%, while the number of vehicle trips has increased—indicating both improved infrastructure efficiency and user adoption. Additionally, the digitization has effectively eliminated pilferage and revenue leakage.
- ⊙ Beyond the economic and operational gains, the move has had a positive environmental impact as well, with a significant reduction in carbon emissions due to decreased vehicle idling and congestion at toll plazas.

The Road Ahead: Future Role of Technology in Managing the Tolls

The Indian toll management landscape is poised for a revolution driven by continuous innovation. Here's how we can leverage emerging technologies to craft a future that is not only efficient but also environmentally responsible:

- ⊙ **Frictionless Payments with Mobile Wallets:** Imagine a world where toll payments seamlessly flow through your existing mobile wallet. Integrating FASTags with popular mobile wallets like Paytm or PhonePe can significantly enhance user convenience, encouraging wider adoption and reducing toll booth congestion.
- ⊙ **Blockchain: Building an Immutable Toll Ecosystem:** Blockchain technology,

renowned for its secure and transparent nature, holds immense promise for the future of toll collection. By establishing an immutable record of transactions, blockchain can streamline toll collection, minimize fraud and disputes, and ensure complete transparency for all stakeholders.

- ④ **AI-Powered Traffic Optimization:** Harnessing the power of Artificial Intelligence, we can create dynamic toll pricing systems. AI can analyze real-time traffic patterns and adjust tolls accordingly, optimizing traffic flow and significantly reducing congestion. This not only translates to faster commutes but also contributes to a greener environment by curbing emissions caused by stop-and-go traffic.
- ④ **Connected Vehicles: Paving the Way for a Tag-Free Future:** The rise of connected vehicles equipped with built-in communication capabilities presents a groundbreaking opportunity. Imagine a future where vehicles automatically interact with toll infrastructure, eliminating the need for physical tags altogether. This not only simplifies the user experience but also paves the way for a more sustainable future by minimizing resource consumption associated with physical tag production and distribution.

Beyond Efficiency: The Transformative Power of Electronic Toll Collection

Technology's impact extends far beyond mere efficiency. Consider the revolutionary potential of electronic toll collection, particularly GNSS-based tolling and FASTag lanes. These innovations offer a host of benefits:

1. **Reduced Traffic Congestion:** By expediting toll transactions, they significantly reduce wait times and promote smoother traffic flow. This not only leads to quicker commutes but also visibly decreases congestion on our roads.
2. **Increased Revenue Collection:** Electronic toll systems eliminate the inefficiencies associated with manual cash handling. As a result, revenue collection becomes nearly flawless, providing essential funds for

infrastructure development.

3. **Environmental Advantages:** The positive environmental impact cannot be overstated. With fewer vehicles idling at toll booths, emissions decrease, contributing to a cleaner and healthier atmosphere.
4. **Enhanced User Experience:** Ultimately, drivers enjoy a more convenient and time-saving experience. This technology's positive effects extend beyond efficiency alone.

By embracing these advancements, India's toll management system can become a model of efficiency, transparency, and sustainability, ensuring a smoother and greener journey for all.

A Brighter Future for Toll Management

India's toll management system is undergoing a significant transformation, driven by technological advancements. The widespread adoption of FASTags has demonstrably improved toll management. India's satellite-based toll collection system represents a significant leap forward. Challenges remain, such as infrastructure upgrades, but the potential benefits are immense.

Cost and Management Accountants (CMAs) can significantly contribute to the success of India's digital toll transformation by ensuring financial accountability and cost optimization in large-scale infrastructure projects. Their expertise in project evaluation, revenue assurance, and performance analysis helps maximize efficiency, minimize pilferage, and ensure that technology-driven toll systems deliver sustainable and transparent value to all stakeholders." MA

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