# **Transport Stack**

### Powering innovation and impact with Digital Public Infrastructure & Goods

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Boston Consulting Group partners with leaders in business and society to tackle their most important challenges and capture their greatest opportunities. BCG was the pioneer in business strategy when it was founded in 1963. Today, we work closely with clients to embrace a transformational approach aimed at benefiting all stakeholders—empowering organizations to grow, build sustainable competitive advantage, and drive positive societal impact. JICA is an agency of the Government of Japan which extends Official Development Assistance (ODA) in 150+ partner countries over six decades. JICA DXLab, in a partnership with BCG, is a flagship initiative of JICA that spearheads digital transformation in its ODA programs for accelerating the socioeconomic impacts to thrive in the digital age.

One of the JICA DXLab focuses is Digital Public Infrastructure (DPI) and Digital Public Goods (DPGs). The Transport Stack that JICA DXLab has designed and built with various stakeholders showcases how mobility can be revolutionized through a data exchange DPI with DPGs.

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# Transformative Decade:

Catalyzing Digital Public Infrastructure (DPI) and Digital Public Goods (DPGs) Deployment

n a world driven by technological advancement, the need for a positive vision on technology resonates loudly among government officials, technologists, businesses and donors. The consensus is clear: **technology should strengthen societies by fostering innovation, human rights, inclusion and effective governance.** 

Digital Public Infrastructure (DPI) and Digital Public Goods (DPGs) mark a pivotal step in redefining how nations interact with technology. They focus on creating interoperable ecosystems through shared platforms, open protocols, and enabling policies, ensuring that economic opportunities and social services are delivered safely and efficiently.

This imperative for DPI transcends economic boundaries, uniting all the nations under a unified goal that demands collaboration between public and private entities. The acceleration of progress hinges on co-development, urging transformative approaches that can accelerate technological progress and integration.

JICA has played an instrumental role in redefining the mobility and infrastructure landscape by bringing metros to 17 cities across the world. Over the last few years with JICA DXLab (JICA's flagship initiative that spearheads digital transformation in its ODA programs) there is a pioneering push on the DPI-DPGs topic. In addition, data and digital will be a new asset category aimed at solving public issues and societal problems

#### Delhi's transport expanse, complexity, challenges and opportunities make it the perfect place for bringing DPI-led innovation

Delhi boasts an extensive public transport infrastructure that includes twelve Metro lines<sup>\*</sup>, Rapid Rail, more than eight thousand buses, and diverse micro-mobility players, all interconnected through an extensive network. However, despite the impressive scale of this transport network, **Delhi grapples with worsening traffic congestion,** adversely impacting both the economy and the environment.

### Delhi's congestion has worsened, harming economy and environment



## 2x

Delhi's population has doubled from 2000 to 2024 (currently ~20 Mn) and is expected to continue growing rapidly.



# 4<sup>th</sup> Rank

Delhi is ranked at 4<sup>th</sup> worst out of 68 cities in the world in Traffic Index 2024, indicating worsening traffic congestion.



# **\$10 Bn**

Delhi's annual economic loss due to traffic congestion amounted to \$10bn in 2018 (productivity loss and fuel wastage.)



## 12+ Mn

Total # of motor vehicles on road in Delhi (as of March 2021) is more than 12 million, With 3% growth from previous year.



## 42% time

Delhi citizens spend 42% of their annual travel time stuck in rush-hour traffic.



# 4th highest

Delhi's air pollution level is 4th highest among major cities in the world, with 'levels of health concern'.

\* Including NOIDA-Greater NOIDA Aqua Line, Rapid Metro Gurugram

Source: Economic Survey of Delhi 2022-23 & 2021-22, Traffic Index 2024, TomTom, Transforming India's Mobility- Niti Ayog, IQAir

DELHI AIMS TO BE A TOP 10 RANKED CITY IN THE GLOBAL TRANSPORT INDEX; CURRENTLY AT 40 IT IS THE ONLY INDIAN CITY IN THE RANKING

**Numerous initiatives** aimed at promoting multi-modal mobility (like Delhi Master Plan and Transit Oriented Development policy) have been implemented in the past, but the **focus has primarily been on physical infrastructure and connectivity.** 

- 1 In the **Delhi Master Plan 2041**, Delhi state government has planned initiatives to improve and mitigate the traffic conditions and congestions by reducing the use of private cars.
- 2 The Transit-Oriented Policy in Delhi aims to promote sustainable urban development by integrating transportation infrastructure with land-use planning, fostering accessibility, and reducing dependence on private vehicles.
- 3 12 transport hubs planned by Delhi Development Authority (including 3 multimodal hubs at Kashmere Gate, Anand Vihar and Sarai Kale Khan and 9 transit nodes).
- Promoting **last-mile connectivity** through:
  - Mohalla Buses by DTC 2,000 small electric buses that will run within 12 km vicinity to connect congested areas.
  - Dedicated spaces for e-auto/ rickshaws at metro stations.
- 5 The phased introduction of **new electric buses and the gradual replacement of existing CNG buses with electric ones** to promote sustainability.
- **6 Ease of access in mode transfer** through Foot-over bridges and Dedicated Skywalks.

### Digital initiatives exist but operate in silos, resulting in a fragmented system



Lack of comprehensive data for Delhi for seamless journey planning.



No defined mechanism to exchange real-time information between transport modes to optimize operations.



Heuristics driven network planning or route design; lack of data analytics.



Ticketing solution driven by Point-to-Point (P2P) integration.



Absence of connected network for integrated ticketing and revenue reconciliation.



# Introducing Transport Stack

Aimed at connecting multi-modes digitally and unlocking data at scale

ransport Stack distinguishes itself by addressing this critical gap in the existing landscape. It will enable next generation citizen mobility, service integration and future mobility services through an industry first Digital Public Infrastructure.

Transport Stack builds on a data hub model supported by standard data exchange protocol, and Mobility as a Service framework. It enables core transport services like metro, buses, rapid rail, and para-transit, as well as ancillary services such as parking and EV charging, and other 3rd party services to converge seamlessly.

### **Objectives of Transport Stack**



To **create a unified transport ecosystem covering** Metro, Bus, Rapid Rail and Micro-mobility through establishment of **secure data highways**.



To **foster innovation ecosystem** by providing open API access to transport and ancillary Services data, enabling businesses, startups, and app developers to create new services.



To **unlock and harness the transit data of citizens,** paving the way for effective urban management and evolvement into smart city.



To significantly **improve commuter mobility** for Delhi citizens by streamlining travel experiences across diverse transportation modes.

# Transport Stack shall enable multitude of benefits for Citizens, Transport operators, Businesses and Governments



<sup>1.</sup> Mobility as a Service



## **Impacts of Transport Stack**



#### Improved Commuter Experience

Citizens will enjoy a more convenient and efficient commuting experience with access to real time information to plan their journey (optimized for cost, time or convenience).



#### Increase in Public Transport Adoption

The Transport Stack is expected to increase public transport adoption from 67% to upwards of 90%, providing citizens with a more attractive alternative to private vehicles.



## Congestion Alleviation & Vehicular Emission Reduction

Increased adoption of Metros/EV buses/rikshas will reduce private vehicles, lower congestion-related issues and air pollution, thereby promoting environmental sustainability.



#### Dynamic Scheduling by Transport Operators

Transport operators can plan dynamic scheduling of public transport in alignment with the demand pattern of commuters to plan integrated services.



#### Enhanced Transport Planning by Government

Government agencies can leverage transit data from over 20 million people for effective public transport network planning.



#### **Contingency Planning and Response**

Government agencies will be enabled to plan contingencies efficiently by real-time transport network visibility, ensuring a rapid and coordinated response in the face of unexpected events.

#### 5 GUIDING KEY PRINCIPLES DRIVE THE TRANSPORT STACK TOGETHER; BLENDING INNOVATION AND SUSTENANCE

Interoperability, Privacy by Design, Open-source, Trust and Security and Agile & Scalability.

By adhering to these foundational principles, Transport Stack not only promises a transformative impact on urban mobility but also establishes a robust framework to build trust in transport ecosystem for adoption.

These principles hold together the success of Transport Stack, ensuring a resilient, adaptable, and secure foundation for redefining the way we navigate our cities.

# () ] Interoperability

Enabling interoperability in a system facilitates the efficient exchange and utilization of information among diverse digital systems.

## ()'2 Privacy by Design

Integrating privacy measures throughout the design and implementation stages to ensure adherence to privacy standards.

# 03

#### Open-source

Allowing widespread access and contribution of information on the platform.

# 04

### **Trust & Security**

Building a trusted and secure architecture ensures the protection of end-users against digital threats.

# 05

### Agile & Scalability

Flexible design to accommodate demand surges and expansion needs without altering the existing system.

# Transport stack will have data platform, APIs as underlying digital infrastructure, wherein services can be built on top by both stack and ecosystem partners



# Transport Stack in Action for Citizens

The Transport Stack is poised to revolutionize end-to-end journey planning, offering commuters a comprehensive view of available travel options, including metro, bus, rapid rail, and last-mile connectivity. With the ability to compare time and fare, users can easily select the most optimal option for their journey. The seamless integration allows users to book their entire journey through a single app, streamlining the process with a unified QR code. In case of service disruptions, it can provide alternate route recommendations, ensuring that commuters can adjust their travel plans smoothly without undue stress.

Beside the positive impact on farebox, many use cases related to non-farebox can be enabled on the Transport Stack. It can provide information on parking availability at or near metro stations. This feature empowers commuters to seamlessly transition from personal vehicles to public transport, promoting efficiency and enhancing the overall adoption of public transportation. It can enable locationbased notifications for deals and offers by their favorite outlets at Metro Stations, helping users save money on while commuting.

Transport Stack can promote green practices, by developing a carbon calculator showing commuters the emissions saved from using public transport, and potentially linking it to a city-wide program providing rewards and incentives to citizens for the emissions savings in form of carbon certificates, travel discounts or reward points that can be used for non-farebox activities. Users can receive insights and notifications when entering accident-prone areas, enhancing their safety.

These features collectively make the Transport Stack an invaluable tool for commuters, enhancing convenience, safety, and environmental sustainability.



# Transport Stack in Action for Transport Operators

GENERATE INSIGHTS AND ENHANCE OPERATIONAL PLANNING AND EFFICIENCY BY LEVERAGING DATA FROM DIVERSE TRANSPORT MODES

**Traffic Management & Optimization:** Integrated scheduling can be planned to match bus frequencies with metro ridership patterns, taking into account peak and off-peak hours. By analyzing traffic patterns, operators can redirect traffic to alternative transportation modes during service disruptions.

**Route Planning:** Identification of demand hotspots basis Origin-Destination Matrix of different transport modes and Mobile Location data to assess underserved areas by Public transport, for planning new routes and stations.

**Dynamic Fares:** AI-ML based models can be developed to adjust fares based on real-time commuter data such as vehicle occupancy, traffic conditions, and demand.

#### Transport for London (TfL) uses Big Data to plan transport services

Case study



#### Background

Transport for London (TfL) captures significant operational data from multiple systems: the iBus system tracks 9,200 vehicles; 20 million daily ticket 'taps' are recorded; traffic is managed through 6,000 signals and 1,400 cameras.

#### ০০০০০ ।ঊ০০ **Use of Big Data** ০০০ঊ০

TfL leverages data captured in Vehicle Location System, Fair Collection System, Sensors in Carriages, Intelligent Traffic Management System and Video Surveillance System to run analytics and generate insights for customer service and operation planning.



TfL uses extracted sensor data to visualize the crowd levelsin each train carriage to enhance capacity utilization. It uses ODX, a Big Data tool, to assess transport and traffic data sets for improving network planning and assessing the impacts of closures and diversions for better service level.



Source: Intelligenttransport.com, theodi.org

# Transport Stack in Action for Government

CRITICAL INSIGHTS FOR SMART CITY SOLUTIONS TO PAVE THE WAY FOR BETTER CITY MANAGEMENT AND ENHANCED GOVERNANCE

Analyzing Accident-prone Areas: Governments can analyze accident data to identify high-risk areas and implement interventions such as improved road design, better signage, and stricter traffic law enforcement.

**Gen-Al based Security Planning:** Governments can leverage generative- Al to simulate security threats

## and develop proactive measures and responses for safer and more resilient environments.

**Collaboration with Other DPI:** By combining transport data with other Digital Public Infrastructure (DPI) and smart city technologies, governments can enhance variety of urban aspects, from street lighting and energy consumption to public safety, and urban aesthetics.

#### SUMMIT Simulation Platform, Singapore

Case study



#### Background

SUMMIT (Singapore Urban Multi-Modal Integrated Transport Simulator), is a multi-modal agent-based simulation platform for public transport calibrated using real world mobility data sets from Singapore.



It involves the simulation of a full day of public transportation service at a full city-wide scale (e.g., entire Singapore bus/train/taxi systems). Real historical data is used to calibrate the journey plans/event parameters to ensure sufficient accuracy of simulation to reality.



SUMMIT can be used for scenario modelling and forecasting, such as modelling train disruptions for Singapore Mass Rapid Transit. Different scenarios are simulated, and KPIs are compared to help planners evaluate the efficacy of different mitigation measures.



Source: SSRN Papers

# Transport Stack in Action for Businesses

ACCESSIBILITY OF DATASETS VIA OPEN APIS TO REDUCE TIME AND COST TO MARKET FOR INNOVATIVE USE-CASES

**Hyper-personalized Offers:** A digital repository of deals and offers to send location-based notifications to users can be created, informing them of about promotions at their favorite retail outlets.

**Dynamic Advertisements:** Businesses can harness footfall data from Automatic Fare Collection (AFC) systems of

metro and buses to strategically select locations for placement of their advertisements for maximum impact.

**Insurance based on Travel Risk Profile:** Al-driven insurance premiums based on commuters' travel history and risk profiles can be developed to offer insurance tailored to individual travel behavior.

#### Accelerating Innovation in SG Transport Network

Case study



#### Background

Stellar Lifestyle is the largest managing agent of retail and advertising spaces in Singapore's rail network. It has launched an innovation program called 'STELLARATE' to promote the adoption of innovative solutions at MRT stations.



#### Startup Engagement

To identify suitable solutions, Stellar Lifestyle invited start-ups to present their ideas and technologies that address the challenges faced by commuters and working staff at MRT stations, and Waffle Technologies was selected.



Waffle Technologies offered a point-of-sale customer relationship management platform that streamlines the collection and analysis of customer data. This enhanced customer data analytics enabled tenants to select suitable retail spaces and service planning.



# Making this real: 8 elements will come together for successful enablement of Transport Stack and achieving outcomes laid out

# 01

Clear ownership and governance structure to own, build and support the stack, with defined roles of various parties

## 02

Use-cases to deliver on the value proposition, with feasibility assessment to ensure readiness for implementation.

# 03

Stakeholders consent and buy-in to come together and share their corresponding data for developing digital services.

# 04

Standardized data exchange protocols to ensure consistency and ease of integration across data sources.

## 05

Well-defined mechanism to onboard the data providers and users, with supporting procedures to ensure data quality and timely-update.

# 06

Adherence to evolving regulatory landscape, particularly with respect to privacy and data security to build ecosystem trust.

07

Suitable financial model to support the ongoing expenses to maintain and scale the stack, to ensure long-term sustainability.

## 80

Robust monitoring and evaluation framework to track the performance, and evolve the blueprint for system scaling and future use cases.



# Conclusion

he Transport Stack, an innovation advantage created under the umbrella of JICA DXLab, envisions a transformative path for mobility by creating a multimodal ecosystem. This elevates the data at play, promising improved efficiency, effectiveness, innovation and cultivating a sustainable cityscape.

The pilot in Delhi is **the beacon of innovation** for its mobility ecosystem. This initiative not only aids **Delhi in its ambition to become one of the top 10 cities** for public transport, but also creates valuable assets throughout its development lifecycle **that can be easily adapted and implemented in other cities around the world, tailored to their specific challenges.**  Thus, the imperative lies in expanding the influence of the Transport Stack beyond Delhi, encouraging the creation of similar solutions to mobility challenges in other cities within India and other developing countries. The DPI and DPGs approach enables such scalability with ease of replicable deployment in these regions.

This initiative is not just about addressing immediate issues but about setting the stage for a sustainable, interconnected future of mobility.

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