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6

CREATING FRAMEWORK FOR MOBILITY AS A SERVICE (MaaS) IN INDIAN CITIES

SYSTEM ARCHITECTURE AND TECHNICAL REQUIREMENTS

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ABOUT THIS REPORT

This report has been prepared as a part of bilateral technical cooperation project “Integrated Sustainable Urban Transport Systems for Smart Cities (SMART-SUT)” commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ) and jointly implemented by Deutsche Gesellschaft fuer Internationale Zusammenarbeit (GIZ) GmbH and Ministry of Housing and Urban Affairs (MoHUA), Government of India. The objective of the project is to improve the planning and implementation of sustainable urban transport in selected Indian cities. The project also supports the Green Urban Mobility Partnership (GUMP) between the governments of India and Germany.

Indian cities selected under National Smart Cities Mission are planning, designing, developing, and implementing various urban mobility projects. All these projects, after implementation, produce a huge amount of data. Thus, the management of the mobility data is at centre of increasingly complex urban transport challenges in these cities. The mobility data generated from various sources and in various forms could be used for providing an integrated journey experience to the commuters which is known as ‘Mobility as a Service or MaaS’. Though providing such a service to commuters would require developing standard data collection and management protocols, strong institutional and regulatory framework, interventions related to urban mobility data policies and so on. With this objective in mind, SMART-SUT initiated the study titled “Creating Framework for MaaS in Indian Cities”.

The study aims to explore opportunities for implementing MaaS in Indian cities and identify a structured approach towards developing a smart mobility ecosystem which is required for developing such a solution by leveraging the real value of mobility data. The study outlines a stepwise approach and set of recommendations towards implementing a MaaS solution in the Indian context, a series of reports have been compiled as an output of this study covering various aspects of MaaS. The recommendations from these reports would assist Indian cities embarking on developing various data-driven mobility solutions like MaaS by integrating different transport modes.

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The team is hopeful of the study outcomes being a useful guide for deploying the MaaS ecosystem in Indian context.

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LIST OF ABBREVIATION

APIs	Application Programming Interface
I/O	Input/Output
OS	Operating System
MaaS	Mobility as a Service
SDK	Software Development Kit
SL	Security Level
SLA	Service Level Agreement
UI	User Interface

1 BACKGROUND

India is going through a rapid digital transformation in the transport and mobility sector. It is estimated that with the current pace of access to internet-enabled smartphones, the internet user base in the country will rise to 829 million people by 2022. Approximately, 97 percent of the internet users across India have access to internet through mobile devices. The user base for these smartphones is expected to cover almost 60% of the population [1].

Smartphones with high-speed internet and various sensor technologies can now generate, record and store a high volume of useful data in phones and applications that feed on personal information. While this data can help solve many mobility problems, it builds on a high potential to overlook privacy issues and personal data exploitation, for commercial purposes.

Hence, it is essential to comprehend how this 'smart' transport data is being generated and managed and decide as to which data can be used to develop mobility solutions. Further, mechanisms for data sharing by the government and mobility companies need to be established so that this could be leveraged to provide innovative travel solutions. In this process, it is critical that the privacy of the users must be ensured under the existing legal frameworks.

Mobility as a Service (MaaS) is an emerging smart mobility service that provides access to integrated journey options across different transport modes in a city using a single travel booking and payment platform to its users. With multimodal transport system in the city, MaaS provides commuters with seamless travel options, ascertaining a comfortable journey. The key aspect that enables this solution is the data sharing between different modes and service providers. The study titled "***Creating Framework for Mobility as a Service (MaaS) in Indian Cities***" aims to identify measures that are required for developing a MaaS solution. The objective of the study is :

- To develop a framework for an effective implementation of "Mobility as a Service (MaaS)" in Indian cities.
- To recommend the requisite data and system specifications for implementing MaaS in Indian cities.
- To design an effective policy and a regulatory framework by contextualizing issues related to data sharing in India.
- To develop a capacity-building toolkit for a better understanding of MaaS and facilitating the decision-making process for its successful implementation in Indian cities

Following reports have been compiled and documented* as an output of this study covering various aspects of MaaS :

i. Basics of MaaS and Learnings from Global Case Studies
ii. MaaS Readiness Tool
iii. Urban Mobility Data Policy
iv. Mobility Data Standards and Specifications
v. Legal and Regulatory Framework
vi. System Architecture and Technical Requirements.
vii. Reference 'Scope of Work' Document for MaaS Project

This report provides requisite system architecture and other technical support requirements including hardware and maintenance support associated with a typical MaaS platform. It offers guidance to the city authorities on the broad technical specifications required for MaaS projects, including those during the operations stage. This report describes various components of MaaS solution and provides the details and linkages of various systems and subsystems within the MaaS platform.

2 MaaS SYSTEM ARCHITECTURE

2.1 GENERAL

Data sharing and ownership are crucial aspects of the design of a MaaS platform, and the data is an asset as it facilitates the MaaS operator to integrate various transport services.

Two types of data sets exist in connection with

[1] https://icea.org.in/wp-content/uploads/2020/07/Contribution-of-Smartphones-to-Digital-Governance-in-India-09072020.pdf

*All the reports can be accessed via https://www.maastoolkit.org/ which has been developed as a web-based capacity building toolkit and an open source knowledge resource for all the stakeholders and government agencies planning to implement MaaS in Indian cities.

a MaaS platform- the data actively provided by the end-user and the data generated by the operation of the different transportation services. The data provided by the end-user includes personal information such as email addresses, phone numbers, the device used by the end user, and additional documentation that could include driver's licenses or passport pictures.

The data generated by the operation of services include origin and destination points of the user-generated trips, their preferred services, and the consequent cost. The cumulated information can be used to perform travel behaviour analysis with objectives to improve the efficiency and sustainability of a mobility network.

Therefore, it is imperative to consider the concerns related to data sharing, data ownership, data privacy, and data protection while designing and developing a MaaS platform.

Keeping the sensitive and valuable data within national borders in a secured server with all privacy tools implemented for maximum control ensures data security. It is vital to convey to the end-users that they are in control of their data. While personal data needs to be shared with the providers connected to the MaaS platform, sharing any personal data will require explicit consent by the end-user. Moreover, the data itself will not be owned by the MaaS operator but by authorities or the specialised third parties, the authority designates, who reserve the right to analyse or use the data. Access to the data by any other technical personnel involved in the operation and maintenance of the MaaS platform will be only on a need basis.

Accordingly, the MaaS system architecture, including the data storage hardware system, should comply with these requirements and hence, be standardised. This report would help the MaaS project stakeholders in providing high level guidance on this crucial requirement.

2.2 MaaS COMPONENTS

Typically, a MaaS solution comprises the following components:

i. A back end data management system

ii. A front end user interface application

Various system components based on the proposed MaaS solution details like routing, booking, payment, membership, revenue reconciliation, customer grievance redressal, etc

System architecture refers to placing various software components on physical machines. MaaS platform consists of several subsystems that include back end data services, hardware and system components, and multiple digital channels.

Figure 1 shows the details and linkages of various systems and subsystems of a typical MaaS platform:

3 PROPOSED HARDWARE REQUIREMENTS

Typically, the hardware requirement is categorised across the following three requirements:

i. Production Site: The production site is the actual live version of the site that the user can access.

ii. Disaster Recovery Site: A disaster recovery site, also known as a backup site, is where a company can temporarily relocate following a security breach or natural disaster.

iii. Staging Site: A staging site or staging environment is a near-exact replica of a production environment for software testing. Staging environments are made to test codes, builds, and updates to ensure quality in a production-like environment before application deployment.

Any typical MaaS solution should provide for the above-mentioned three key requirements. The MaaS hardware requirements depend on two critical decisions that a city needs to take-

i. On-Premise Hosting

ii. Cloud Hosting

Both the options have their share of advantages and disadvantages. The on-premise hosting allows sorting of all the hardware, operating systems, application, etc. on-premise and is controlled by the authority. Therefore, this setup is relatively secure. However, not all MaaS platform providers offer solutions flexible for hosted on-premise hosting.

On the other side, cloud hosting consists of a network of connected physical and virtual cloud servers and is not based on single server use. It is economical, and it allows for more flexibility and scalability with better efficiency.

A MaaS Platform will be made up of various systems and subsystems. Figure 1(a)represents the overall MaaS platform structure while figure 1(b) represents the flow of details and linkages within the platform :

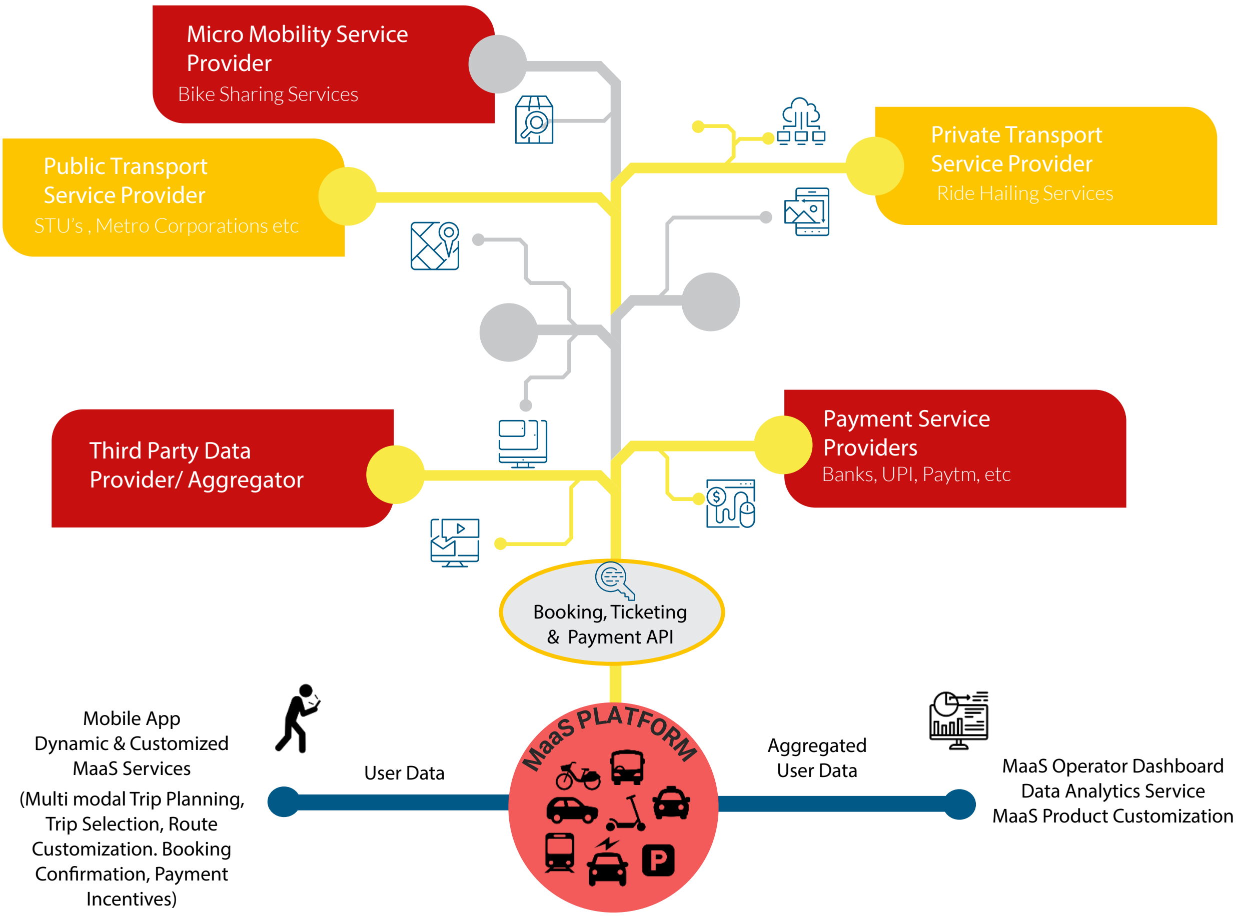


Figure 1(a) : MaaS Platform Details

Cities are recommended to opt for cloud hosting, provided the cloud server should be preferably located within the country.

3.1 HARDWARE SIZING FOR ON-PREMISE HOSTING

3.1.1 Production Site

The Production Site is the central infrastructure platform on which the MaaS system gets deployed. This needs to have complied with the specific systems requirements. Table 1 shows typical hardware requirements at the production site.

3.1.2 Disaster Recovery Site

Disaster recovery infrastructure is an important requirement for an application that runs on a real-time basis. Accordingly, a robust disaster recovery infrastructure is required for the MaaS project.

The hardware requirements at the disaster recovery site are presented in Table 2.

3.1.3 Staging Environment

A staging environment is used in the test phase before the go-live of an IT solution. The staging platform is an exact replica and can be housed in the developer's premise or cloud during the testing phase.

Table 3 presents the hardware requirements at the staging environment site:

3.2 HARDWARE SIZING FOR ON - CLOUD HOSTING

The salient features of cloud hosting are:

i. It minimises the risk of hardware installation and maintenance. The authority can use Microsoft Azure or Amazon Web Service, or any other local hosting platform.

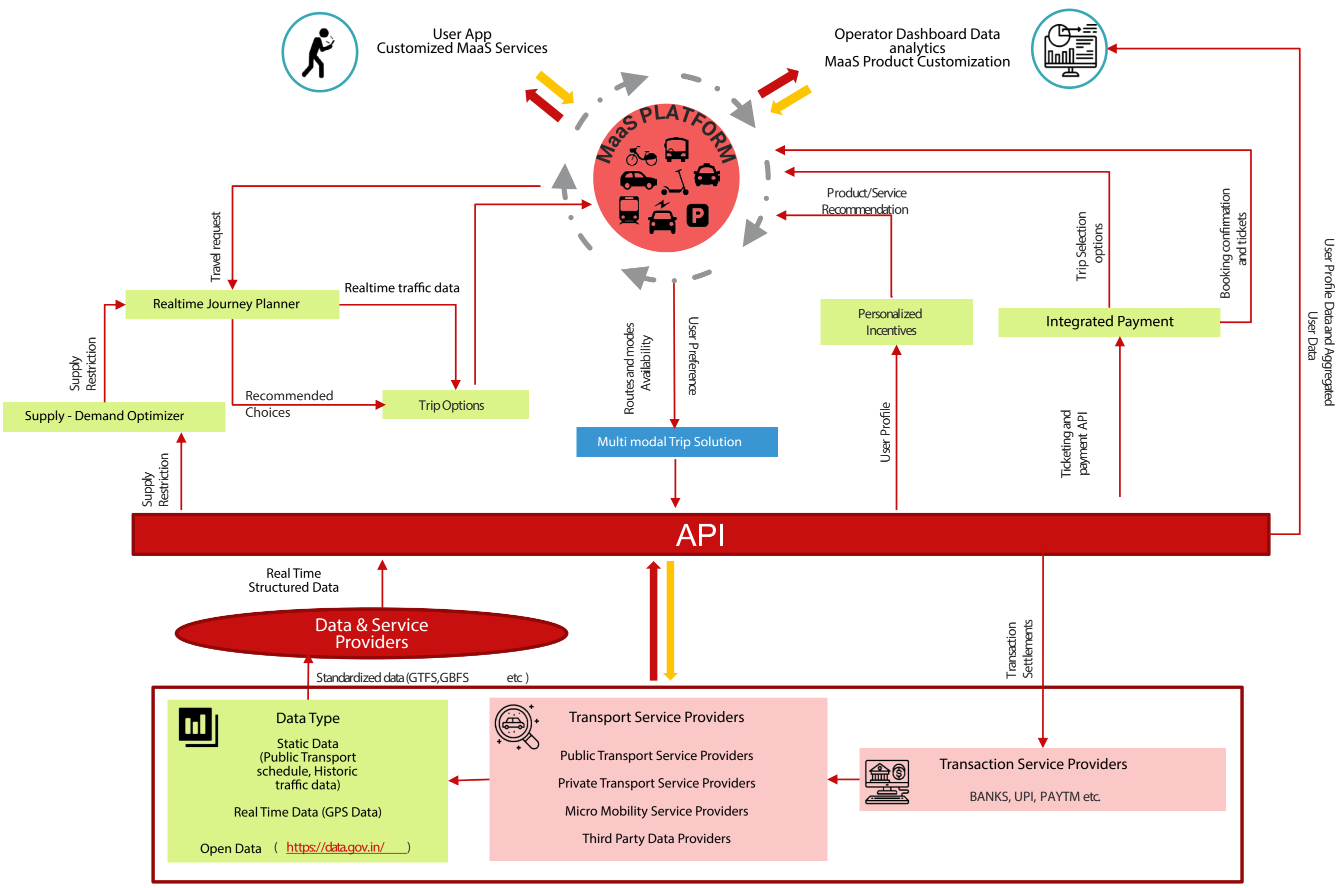


Figure 1(b): MaaS Platform Details

Table 1 Production Site Requirements

S. No.	Application / Service	Operating System	Database	Environment (Virtualized / Cloud)	Minimum Specs	P2V vCPU	Public IP	SSL Certificate	Storage in Total	Storage Scope in Years	Quantity
1	API, Web Server, Back end	Linux - Ubuntu 20.04 LTS	N/A	VMware	4 vCPU Cores, 16 GB RAM	1:3	Yes	Yes	100 GB	3	8
2	Tableau Server - Dashboard	Windows Server 2012 OS or higher	N/A	VMware	8 vCPU Cores, 128 GB RAM	1:3	No	Yes	1 TB	3	2
3	Database Server	Linux - Ubuntu 20.04 LTS	PostgreSQL 12	VMware	8 vCPU cores, 32 GB RAM	1:3	No	No	2TB	3	2
4	HA Proxy, etc, Airflow	Linux - Ubuntu 20.04 LTS	N/A	VMware	2 vCPU Cores, 8 GB RAM	1:3	Yes	No	50 GB	N/A	5
5	BI Datamart (Vertica 10.x)	Linux - Ubuntu 20.04 LTS	Vertica 10.x	VMware	24 vCPU Cores, 128 GB RAM	1:3	No	No	1 TB	3	3
6	MaaS Platform databases	Linux - Ubuntu 20.04 LTS	MySQL	VMware	16 vCPU cores, 128 GB RAM	1:3	No	No	8.5TB	3	1
7	MaaS Platform software	-	N/A	Kubernetes	16 vCPU cores, 128 GB RAM	1:1	Yes	Yes	2TB	3	TBD

Source: Based on Consultations with MaaS Platform Developers

Table 2 Disaster Recovery Site

S. No	Application / Service	Operating System	Database	Virtualized / Cloud	Minimum Specs	P2V vCPU	Public IP	SSL Cert.	Storage	Storage Scope in Years	Quantity
1	API, Web Server, Back end	Linux - Ubuntu 20.04 LTS	N/A	VMware	4 vCPU Cores, 16 GB RAM	1:3	Yes	Yes	100 GB	3	8
2	Tableau Server - Dashboard	Windows Server 2012 OS or higher	N/A	VMware	8 vCPU Cores, 128 GB RAM	1:3	No	Yes	1 TB	3	2
3	Database Server	Linux - Ubuntu 20.04 LTS	PostgreSQL 12	VMware	8 vCPU cores, 32 GB RAM	1:3	No	No	2TB	3	2
4	HA Proxy, etc, Airflow	Linux - Ubuntu 20.04 LTS	N/A	VMware	2 vCPU Cores, 8 GB RAM	1:3	Yes	No	50 GB	N/A	5
5	BI Datamart (Vertica 10.x)	Linux - Ubuntu 20.04 LTS	Vertica 10.x	VMware	24 vCPU Cores, 128 GB RAM	1:3	No	No	1 TB	3	3
6	MaaS Platform databases	Linux - Ubuntu 20.04 LTS	MySQL	VMware	16 vCPU cores, 128 GB RAM	1:3	No	No	8.5TB	3	1
7	MaaS Platform software	-	N/A	Kubernetes	16 vCPU cores, 128 GB RAM	1:1	Yes	Yes	2TB	1	TBD

Source: Based on Consultations with MaaS Platform Developers

Table 3 Staging Environment Site

S. No	Application / Service	Operating System	Databases	Virtualized / Cloud	Minimum Specs	P2V vCPU	Public IP	SSL Certificate	Storage in Total	Storage Scope in Years	Quantity
1	API, Web Server, Back end	Linux - Ubuntu 20.04 LTS	N/A	VMware	2 vCPU Cores, 8 GB RAM	1:3	Yes	Yes	100 GB	3	4
2	Tableau Server - Dashboard	Windows Server 2012 OS or higher	N/A	VMware	4 vCPU Cores, 64 GB RAM	1:3	No	Yes	1 TB	3	1
3	Database Server	Linux - Ubuntu 20.04 LTS	PostgreSQL 12	VMware	4 vCPU cores, 16 GB RAM	1:3	No	No	2 TB	3	1
4	BI Datamart (Vertica 10.x)	Linux - Ubuntu 20.04 LTS	Vertica 10.x	VMware	24 vCPU Cores, 128 GB RAM	1:3	No	No	1 TB	3	3
5	MaaS Platform databases	Linux - Ubuntu 20.04 LTS	MySQL	VMware	4 vCPU cores, 16 GB RAM	1:4	No	No	1 TB	1	1
6	MaaS Platform software	-	N/A	Kubernetes	16 vCPU cores, 128 GB RAM	1:4	No	No	2TB	1	TBD

Source: Based on Consultations with MaaS Platform Developers

ii. The cloud service is highly reliable, with relatively fewer resources required to manage the data.

iii. It requires less deployment effort as the service comes with plug and play functionality.

iv. It requires fewer integration efforts as the cloud services company manages the hardware linkages.

v. Lower cost compared to the on-premise hosting as there is no need for upfront hardware procurement and the cloud storage expands to meet the growing data storage requirements. Further, the maintenance is also being taken care of by the cloud storage provider.

4 MAINTENANCE AND SUPPORT

The MaaS solutions provider needs to provide a warranty of the provided solution, including the software and the hardware, for at least one year after handing over the complete solution.

During the warranty period, the solution provider shall carry out all the required remedial maintenance for software components and replace the hardware components covered under the warranty. The goal is to ensure that all the hardware and software parts are updated within the scope of the contract and per the contract specifications and performance measures.

4.1 MAINTENANCE REQUIREMENTS

Maintenance requirements are concerned with activities aimed at keeping the system usable and valuable for the organisation. The solution provider shall provide comprehensive maintenance services for the provided hardware and software during both the warranty period and support period.

The solution provider will carry out all the required preventive maintenance (scheduled upgrades), remedial maintenance (hotfixes and security patches), and required hardware replacements during the warranty period and support period.

The solutions provider can ensure the service provided by the Mobility as a Service (MaaS) platform is uninterrupted by applying the following practices as a part of the support and warranty services scope:

4.1.1 Systems Management

The proposed solution provides an integrated toolset to cover the day-to-day management of all MaaS systems and sub-systems

i. Database administrators will use specialist management tools for all database management.

ii. Application support will be covered by the use of administration tools built into the application products.

iii. Role-based access should be given to the database, e.g., booking functionality, revenue reconciliation functionality, customer relationship management functionality, etc.

4.1.2 Monitoring

The helpdesk team will monitor the status of all the systems and applications through the back office system. Monitoring will be done through the following -

i. Monitoring alerts ensure appropriate steps are taken to respond to the potential select function failure, diminished performance, or complete system failures.

ii. The call centre team shall be available to help with the issues regarding system disturbance.

Logging and Record-Keeping: Data logged from the system health monitoring will include:

i. Precise time and date.

ii. Component identification.

iii. Status message.

4.1.3 Preventive Maintenance

The objective of preventive maintenance is to mitigate the consequences of the system hardware or software components' failure. The responsibility for the same lies with the solution provider.

4.1.4 Corrective Maintenance

Corrective maintenance tasks shall be performed for the provided solution hardware and software during both the warranty and the support periods. It aims to identify, isolate, and rectify a fault so that the failed software and /or hardware components of the MaaS platform can be restored to an operational condition within the time limit established by the authority.

4.2 SUPPORT REQUIREMENTS

Stated below is the scope of the support service, which applies to the warranty and the support contract periods provided by the MaaS solution provider:

i. Provisioned and installed hardware;

ii. Application infrastructure of Maas platform, which includes server, operating systems, and database services;

iii. System management, including patch management and operating system administration.

iv. Database administration that includes the maintenance, updates, and database patch management activities;

v. Maas platform bug fixing and software updates;

vi. Application releases as per customers release management process;

vii. Application administration activities comprise the changes related to access management, permission management, and application rule management;

viii. End-user access management focuses on the application access to the user for various functions;

ix. User awareness and training to provide the necessary training to the users on the application functions;

x. Periodic application usage reporting;

Support will be carried out on three levels:

i. Helpdesk Support

ii. L1 Support (Onsite)

iii. L2 Support (Remote Local Support)

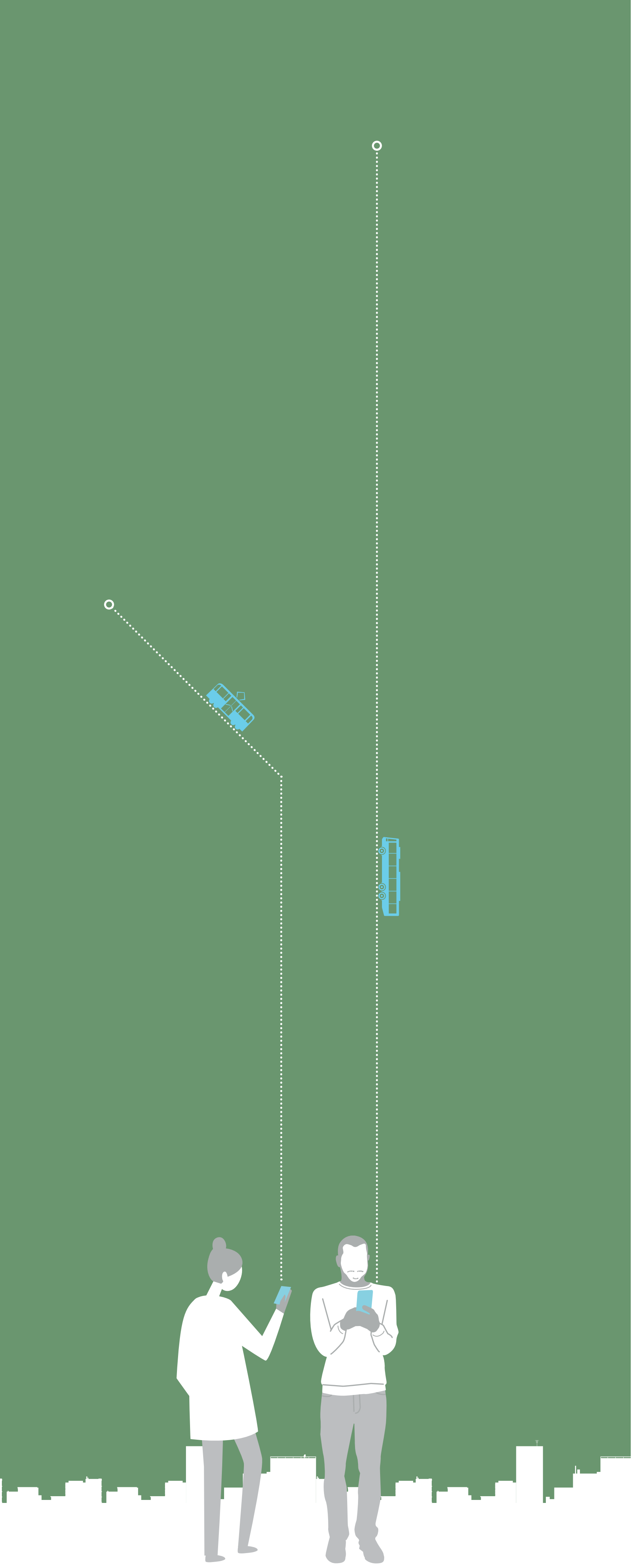
iv. L3 Support (Remote Overseas Support)

The suggested Service Level Agreement (SLA) Norms for MaaS platform base services is shown in Table 4.

The hardware requirements in this report outline the purpose of guidance and reference. It is recommended that the city authority finalise their requirements in advance and then incorporate the stated details in their scope of work for the MaaS platform provider. It is also advisable that specific key performance indicators should be mentioned rather than the specific hardware requirements.

Table 4 Service Level Agreement (SLA) Norms

Severity Level	Response Time	Resolution Time	SLA Definition
SL1 (Critical)	2 Hours	4 Hours	Any outage impacts on critical services in a live environment that results in complete system performance becoming inoperable.
SL2 (Urgent)	3 Hours	8 Hours	Any service degradation or slow system while responding to customer requests affecting partial services or a specific module like payment, membership reward, etc.
SL3 (Standard)	8 Hours	72 Hours	Any minor degradation of service that does not affect the quality of the service with minimal impact on the operations.



Ministry of Housing and Urban Affairs (MoHUA) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH are jointly implementing the technical cooperation project "Integrated Sustainable Urban Transport Systems for Smart Cities (SMART-SUT)", commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ). The project works with the three Smart Cities of Bhubaneshwar, Coimbatore, and Kochi and respective state governments of Odisha, Tamil Nadu, and Kerala to promote low carbon mobility planning, and to plan and implement sustainable urban transport projects.

As part of the Indo-German bilateral cooperation, both countries have also agreed upon a strategic partnership - Green Urban Mobility Partnership (GUMP) between Ministry of Housing and Urban Affairs (MoHUA) and Federal Ministry for Economic Cooperation and Development (BMZ). Within the framework of partnership's technical and financial cooperation, the German government will support improvements in green urban mobility infrastructure and services, strengthen capacities of national, state, and local institutions to design and implement sustainable, inclusive, and smart mobility solutions in Indian cities. As part of the GUMP partnership, Germany will also be supporting expansion of public transport infrastructure, multimodal integration, low-emission or zero-emission technologies, and promotion of non-motorised transport in India. Through this strategic partnership, India and Germany intend to jointly achieve effective international contributions to fight climate change.