AYALON HIGHWAYS CO. LTD

METROPOLITAN TRAFFIC MANAGEMENT SYSTEM (MTMS)

System concept and scope

May 2021

V3.0

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1 Summary Overview

1.1 Project Background

The Ayalon Highways network of metropolitan freeways is undergoing preparations for the construction and operation of a new traffic management control center in the Tel-Aviv metropolitan area, known as MANTAM, designed to cover all aspects of the various highways, urban roadways, public transportation, and the like.

The new MANTAM will incorporate traffic management and control systems, security and technical support, and data services for communication with external systems and users' applications. Some exiting modules may remain as is, some may be replaced, and others may be gradually integrated into the MTMS (Metropolitan Traffic Management System).

This document describes the MANTAM's System (MTMS) concept and scope, components, and modules representing the system's key potential capabilities.

1.2 Document Goal

The purpose of the document is to enable bidders a deeper understanding of the scope, approach, needs and components of the metropolitan traffic management system. And to define a clear professional language for analyzing and comparing the bids.

At the same time the document is intended to assist Ayalon Highways in finalizing the design of the MTMS, its supporting systems, and interfaces. As part of the design phase, a review will be conducted of existing solutions and those under development, and a qualified bidder(s) will be selected to provide these solutions.

Therefore, the concept and scope, which are described in this document, are preliminary and liable to be updated until such time that the project is implemented. Any bidder that meets the threshold conditions detailed in the tender documents may suggest alternative solutions and additional content that address the requirements and specifications.

1.3 Mission Statement

Traffic management in the Tel Aviv metropolitan area is currently fragmented, with various responsible authorities, companies, and municipalities. There is an immediate need for a new centralized management system, known as the Metropolitan Traffic Management System or "MTMS", to manage and coordinate mobility, traffic flow, event management, and incident response, especially along major, frequently congested travel corridors across the region. Existing highway and traffic signal management systems should become interconnected to create a real-time traffic situation snapshot, process and display integrated data, and apply available state-of-the-art technology, including (among others) online analysis, forecasting, and simulation, towards intelligent transportation network management.

The attached document is intended to detail the concept, scope, and capabilities of the required MTMS modules and additional modules relevant to the MANTAM mission.

1.4 Metropolitan Traffic Management System (MTMS) Overview

The MTMS shall comprise at least the following functional components:

- Data Collection and Data Management
- Data Processing and Decision Support System (DSS)
- Integrated Traffic Control

As further detailed, each component consists of several modules.

The MTMS shall comply with general system requirements, including:

- System development requirements
- Infrastructure requirements
- Cyber-security

As detailed in this document, The MTMS should also support broader, more comprehensive, and direct region-wide traffic management.

The MTMS should consist of modular 'building block' designed and standard interfaces to enable the development and integration of future modules, either by the bidder or from a 3rd party supplier.

Future capabilities may include, but are not limited to:

- Field device management, including adaptive systems, direct communications between field devices, and edge processing capabilities.
- Public transportation routes, lines, and frequency planning and management
- Vehicle to Environment (V2E) communication, and autonomous vehicle support
- Integrated traffic demands management
- Advanced artificial intelligence and online simulations for prediction and planning

The MTMS is required to support interfaces with external traffic control systems, data sources and data suppliers, transportation management partners (i.e., other organizations involved in traffic management in the metropolitan area), systems and clients. Some of the interfaces are described in this document, and additional interfaces may be required at later phases. Such interfaces should be simple to implement and should not require significant software modifications or hardware updates.

The following scheme describes the MTMS functional modules (colored in green) and other modules with which the MTMS should interface. The bidder may elaborate about additional modules and interfaces provided in its proposal:

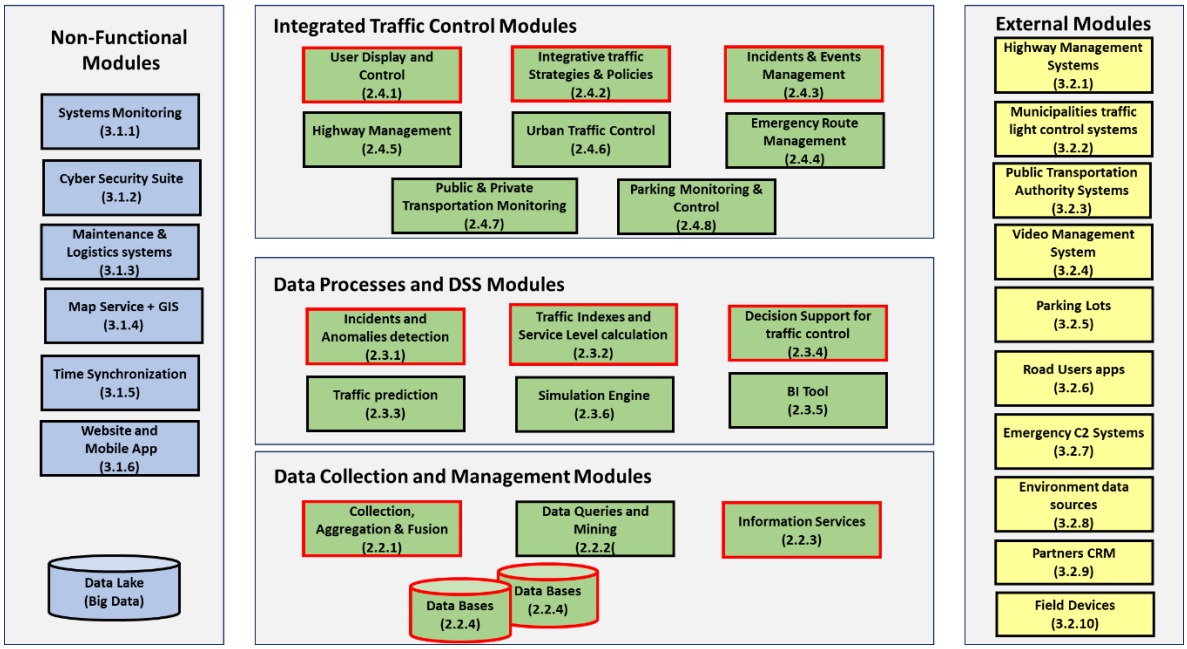

Fig. 1: MTMS Components and Interfaces

The numbers in parentheses represent the paragraph numbers in the document which describe the module content and requirements.

- Green modules represent the MTMS modules; highlighted in the red frame are the MTMS core modules.

- Blue components represent non-traffic functional modules, which will be provided by the customer – Ayalon Highways. The bidder will be required to develop interfaces with these modules.
- Yellow modules represent external systems or system's modules. These external systems are not part of the MTMS, some of these systems exist, and some will be added in the future. The bidder will be required to develop interfaces with these systems.

The terms "module" or "system's module" refer to functional capabilities implemented by software. System may consist of one or several modules. The above figure suggests a certain architecture of the system, but the bidder may suggest another architecture as long as these capabilities are implemented.

2 MTMS Modules' Requirements

2.1 Scope

This chapter details the main functional and technical requirements for the MTMS modules.
The bidder is encouraged to propose additional modules that can be relevant to the MANTAM mission.

2.2 Data Collection Component (DCC) Modules

The data collection component will collect available data, generate an integrated (traffic and traffic-related) real-time situation picture, arrange the data in the internal DB and disseminate it to other system's modules, users, external partners, and 3rd parties and road users.

The DCC might consist of the following modules:

2.2.1 Collection, Aggregation and Fusion Module (Core MTMS module)

- Collect available real-time traffic and traffic-related data from various external and internal sources. These sources include various types of sensors (which may collect raw or pre-processed data) such as magnetic road sensors, video analytics based on video from traffic cameras, and data from 3rd party applications such as Waze, autonomous car communication systems, etc.
  A set of base interface specifications described in Chapter **שגיאה! מקור ההפניה לא נמצא.**.
- The data collected will also include various traffic-related data types such as traffic status, incidents, system and devices' inventory and malfunctions, emergency and field teams' locations, traffic infrastructures status, and environment status.
- Aggregate, filter, and fuse all relevant real-time traffic data received through its interfaces and generate a real-time integrated traffic situation picture.
- Resolve relevant discrepancies between the data from various input sources
- Rearrange, combine and adjust the data model for abstraction, queries, and mining.
- Transfer the data for storage in either the internal DB, or to an external Ayalon DB, or both.

2.2.2 Data Query and Data Mining

- Enable large data queries and mining options based on schedules, time intervals, geographic regions, road sections, incidents and event types, and the like.

- The data query and mining shall support operators and traffic engineers in investigating anomalies and incidents, understand the consequences of specific traffic strategies, and design improved new strategies.

2.2.3 Information Services (MTMS Core module)

- Disseminate real-time data (raw data and processed data) in a coordinated manner through all the available channels to other MTMS modules, partners' traffic management systems, clients, and road users, including future clients, such as autonomous vehicles.
- Allow coordinated and supervised data queries.
- Employ interfaces with the Ayalon Highways' website, mobile application, and CRM.

2.2.4 Internal DB (MTMS Core module)

- The internal DB will be used primarily by MTMS.
- The internal DB will store various types of data, e.g., traffic data, technical data, operator actions, traffic planning decisions, data used for statistics, including raw and processed data from different sources.
- According to functional requirements, some of the data will be permanently stored, whereas some will be stored temporarily and later will be deleted and\or replaced by updated data.

2.3 Data Processing and Decision Support System (DSS) Component Modules

This functional component may include several modules:

2.3.1 Incidents and Anomalies Detection (MTMS Core module)

- Automatically detects incidents, congestion, or other issues of interest, based on rules and thresholds.
- Detects anomalies in received data (according to defined thresholds) and generates warnings.

2.3.2 Traffic Indexes Metering and Service Levels Calculation (MTMS core module)

- Estimates travel time and velocity, and other traffic indexes per road section, including travel time and velocity per lane wherever data is available.
- Calculates nominal traffic indexes per date and time.
- Compares calculated indexes to required service levels and nominal expected values and alert operators according to preset rules.

2.3.3 Traffic Prediction

- Predicts the future traffic status/condition, service levels, and incidents per specific road sections.
- Automatically detects early signs of possible congestion by comparing flows and journey times at various points along a route with "normal" existing values.
- Automatically issues alerts and traffic predictions useful for preventive actions to be performed before the actual traffic congestion occurs.
- Shall enable usage of a simulation engine as part of the prediction process. The bidder may also suggest other prediction tools.
- Shall be capable of integrating AI algorithms and methods from the system provider or 3rd parties.

2.3.4 Decision Support for Traffic Control (MTMS core module)

- Support or recommend coordinated responses for the MTMS and cooperating external parties via strategic actions and requests based on established rules and strategies.
- Such strategies shall focus on "cross-boundary" responses, for example, coordinating between road management and adjacent traffic signal management jurisdictions.

2.3.5 BI Tool

- BI Tools shall be used for various tasks mentioned above: statistics, level of service assessment, and the like. The BI Tools shall be chosen upon the market, best of breed.

2.3.6 Simulation Engine

- The simulation engine includes mesoscopic, macroscopic, and hybrid traffic simulation capabilities. Optionally it also includes microscopic traffic simulation capabilities.
- The simulation engine will be adequate for various tasks, such as traffic management planning and traffic control parameter calibration, assessment and comparison of traffic strategies and policies, traffic prediction, real-time assessment of predefined congestion management schemes, and\or traffic control parameters.
- The bidder shall describe its capabilities to integrate with 3rd party simulation engine to perform the above tasks.

2.4 Integrated Traffic Control (ITC) Modules

This functional component may include several modules:

2.4.1 User Display and Control (MTMS Core Module)

- Displays integrated relevant data via a Graphic User Interface (GUI) dashboard in a Geographic Information System (GIS)-type interface.
- Presents the relevant traffic information concerning traffic flow, congestion, and incidents in ergonomic ways on an interactive roadway map.
- The GUI shall also be compatible with a typical control center's video wall functionality.
- Allows the operator to manage and control connected systems or devices, as allowed by partner agencies' mutual agreements and business rules.
- Enables to display, manage and control connected traffic cameras.
- Displays connected systems, field devices, and their status on the operator dashboard, GUI, and/or GIS.
- Includes an incident manager dashboard that monitors the response to incidents and events according to predefined response plans.
- Ability to configure display setups for each user according to its functional operation and authorization.
- Allows the traffic control supervisor to manage the configuration of the data processing and DSS module settings and rules.

2.4.2 Integrated Traffic Strategies and Policies (MTMS core module)

- Definitions of integrative traffic management strategies and policies to be implemented.
- Enables individual definitions according to time of day, weather conditions, ordinary traffic events, traffic conditions, etc.
- Addresses traffic light control policies and rules, highway control including ramp metering, public transportation priorities, dedicated public transportation route management, freight transportation limitations, parking limitations, traffic toll payments, and the like.
- Enables establishment of standard operating procedures related to avoiding and managing traffic loads.
- The policies and strategies shall leverage and interface with traffic strategies of the connected systems.

- Implements and monitors the real-time implementation of the desired integrative Traffic Control Plan to ensure efficient traffic management measures.
- Offers a capability to approve, reject, override and manage DSS recommended actions, strategies, and cross-jurisdictional requests.
- Offers a manual management capability of cross-jurisdictional actions, strategies, and requests to manage regional mobility coordination directly.
- At later stages, should be capable of implementing AI methods – either from the system supplier or from 3rd parties.

2.4.3 Incidents and Events Management (MTMS Core Module)

- Supports management of planned and/or spontaneous/unforeseeable incidents and events.
- Can receive incidents and events information from the data processing component or external systems.
- Enables a manual setup and management of road incidents and events.
- Addresses and enables management of all the relevant aspects from detection and verification to the management of a coordinated response and until the stage of resolving and clearing of the incidents\events, followed by the restoration of normal traffic flow.
- Based on semi-automatic and automatic processes, which are displayed to the operators in a relevant manner.
- Includes a design tool for defining policies and rules to be implemented according to various incidents and events.
- The design tool will enable the following:
    - Define Standard Operation Procedures related to incident and event management, including policies regarding management and coordination between Traffic Center personnel, personnel of other subordinate traffic centers, other relevant parties, and organizations such as police, firefighters, emergency health services, and municipalities.
    - Address traffic light control policies and rules, highway control including ramp metering, public transportation priorities, dedicated public transportation route management, traffic information, and guidelines to the public.
    - Define rules according to time of day, weather conditions, and the like.
    - Define rules according to specific geographic locations, e.g., Rabin Square, and according to the event's general location, such as an event on a certain section of the Ayalon Highways.

2.4.4 Emergency Route Management

- Enables defining and monitoring emergency routes used by prioritized vehicles, such as ambulances, firefighting vehicles, and police vehicles during emergency events.
- Enables requests for traffic light control system adjustments from the UTC according to the emergency routes.
- Enables an adjustment of the emergency traffic route according to traffic conditions.
- Continuously monitors the status of the emergency routes.

2.4.5 Highway Traffic Management

- Monitors and manages highway traffic flow
- Collects, aggregates, and fuses data from highway detectors to create a highway traffic situation picture.
- Detects and manages incidents and events occurring on highways. Can use an external module that also serves the MTMS (e.g. Incidents and Events Management modules).
- Supports or recommends a course of action and coordinated response based on established rules and strategies.
- Calculates highway traffic indexes and service levels. Can use an external module that also serves the MTMS (e.g. Traffic Indexes Metering and Service Levels Calculation modules)).
- Automatic and manual control of the following field devices:
  - Variable Message Signs (VMS)
  - Lane Control Signs (LCS) and signals
  - Gates and barriers
- Compatible with a wide range of standards to ensure compatibility with different systems, devices, and applications. Specific standards requirements are described in the interfaces chapter.
- Supports the implementation of an HOV/HOT traffic lane next to other general purpose lanes.
- Supports the implementation of reversible traffic lanes on specific highway sections.

2.4.6 Urban Traffic Control System and Traffic Light Management Interface Module

- Monitors and manages urban road traffic flow.

- Collects, aggregates, and fuses data from urban detectors to create an urban roadway traffic status picture.
- Detects and manages incidents and events that occur on the urban roads. May use an external module, which also serves the MTMS (e.g. Incidents and Events Management modules).
- Supports or recommends a course of action and coordinated response based on established rules and strategies.
- Calculates urban traffic indexes and service levels. Can use an external module, which also serves the MTMS (e.g. Traffic Indexes Metering and Service Levels Calculation).
- Automatic and manual control of the following urban field devices
  - Intersection Traffic Lights
  - Variable Message Signs (VMS)
- Compatible with a wide range of standards to ensure compatibility with different systems, devices, and applications.

2.4.7 Integrative Public & Private Transportation Means Monitoring

- Collects, aggregates, and fuses all the available data from public & private modes of transportation, and direct operating, control, and monitoring systems used by the public & private transport providers and from the data systems of the Israeli Transport Ministry.
- Supports intermodal traffic management.

2.4.8 Parking Monitoring & Control

- Receives and records occupancy data, opening times, and the status of different parking facilities and parking spaces to provide a basis for efficient parking guidance adapted to the current situation.
- The integrated parking data is displayed on information boards, websites, and applications or through 3rd party applications.
- Assists in reducing traffic loads by integrative parking monitoring, control, and disseminating relevant parking information data.
- Capable of supporting dynamic pricing management processes.

3 MTMS Interfaces

3.1 Interfaces to Non-Functional Modules

The MANTAM non-functional modules represent all supporting modules related to technical monitoring, maintenance, cyber, customer relationships, etc. These modules may be provided by the bidder or client, Ayalon Highways. In either case, the MTMS modules should support and enable an interface with these modules.

3.1.1 Monitoring (System and Infrastructures)

- The MTMS functional modules shall send log files, including performance and faults, to the monitoring module; the log data shall refer to all layers:
  - Hardware
  - Operation system and applicative infrastructures (DB, drivers, management applications)
  - Applicative processes
  - Interfaces

3.1.2 Cybersecurity Suite

The cybersecurity suite shall include various control and monitoring components designed to prevent, detect, contain, and eliminate cyber-attacks. These controls shall include, but are not limited to, the following:

- Central Active Directory Repository - All MTMS users accessing MTMS modules shall be authenticated and authorized, based on a central active directory repository, before granted access.
- RBAC (Role-Based Access Control) management module - MTMS modules shall support the RBAC (Role-Based Access Control) model. All MTMS users will be granted access to view or manipulate data based on their authorization level.
- SIEM - All MTMS modules shall send logs to SIEM for auditing.

3.1.3 Maintenance and Logistic Support

- The maintenance and logistic support systems manages all of the traffic center inventory and maintenance procedures.

- The MTMS modules shall establish an interface with these systems to collect relevant data concerning planned maintenance, engineering events (road infrastructures, field devices), and systems installations. The collected data will include, as a minimum, the location and time frame of these events.

3.1.4 Map Service + GIS

- The MTMS modules shall integrate through a standard-based API with a dynamic ESRI Map Service + GIS data – to be supplied by Ayalon Highways.
- The MTMS bidder may create additional GIS data layers.
- Traffic data – real-time or non-real-time, such as events or alerts are displayed on the map, on different layers.
- The operating status of devices is also displayed as required on the map, in different layers.
- Each layer of data can be selected and displayed or hidden as required.

3.1.5 Time Synchronization

- All MTMS modules must be time-synchronized.
- The synchronization shall be based on the NTP (Network Time Protocol) server supplied by the client, Ayalon Highways.

3.1.6 Website and Mobile App

- The MTMS shall interface through a standard-based API to the Ayalon Highways Website and Mobile App.
- The supplier can detail which interfaces are already implemented by the system under consideration.

3.2 Interfaces with External Systems and Field Devices

The MTMS shall include interfaces with various external systems and field devices. These external systems and devices might use non-standard or unsupported protocols used by the proposed MTMS. Adaptations, if needed, will be applied by adding a middleware\gateway to provide a common protocol for connecting to the MTMS.

As a default, the prioritized protocol should be based upon Open API (REST) for all interfaces. Connection to traffic systems, C2C and C2F, should be based upon standard traffic ICDs such as TMDD\NTCIP (for C2C) and MODBUS\DVI 35\OPC (for C2F).

The following sections describe the primary expected interfaces; additional interfaces may be required throughout the system's life cycle

3.2.1 Highway Management Systems

In addition to the internal highway management module, the MTMS shall have a C2C interface with external highway management systems operated by external operators. This interface shall enable several TMDD dialogs to obtain maximal interoperability between the systems. Dialogs shall include, but not be limited to the following:

- Event Class Dialog
- Node, Link, Route Class Dialogs
- LCS (Lane Control) Class Dialog
- DMS Class Dialog
- Gate Class Dialog
- Ramp Meter Class Dialog
- Device Class Dialog
- Detector Class Dialog

3.2.2 Traffic Light Control Systems

In addition to the internal UTC module that controls traffic lights governed by the MANTAM, the MTMS shall also have a C2C interface with external traffic light control systems, usually operated by local municipalities. This interface shall enable several TMDD dialogs to obtain maximal interoperability between the systems. Dialogs shall include, but not be limited to the following:

- Event Class Dialog
- Node, Link, Route Class Dialogs
- Intersection Signal Class Dialogs
- DMS Class Dialog
- Gate Class Dialog
- Ramp Meter Class Dialog

- Device Class Dialog
- Detector Class Dialog

3.2.3 Public Transportation Authority Systems

Public Transportation Authority Systems provide interfaces between the following information:

- Public transportation routes and timeline – This information is published in GTFS (General Transit Feed Specification).
- Real-Time location of transportation lines – This information is published in SIRI (Standard Interface for Real-Time Information) protocol.

The MTMS shall connect with this interface to enrich the Traffic Situation Picture.

Additional interfaces between the MTMS and the public transportation authority systems are expected to be implemented in the future. The bidder is encouraged to describe potential interfaces between its system and public transportation systems.

3.2.4 Video Management System

- The MTMS shall integrate through standard-based API with a Video Management System provided by the customer.
- The interface shall enable automatic and/or manual retrieval of real-time or stored video recordings related to alerts, incidents, and events.
- The interface shall enable the transmission of control messages to the VMS to change the cameras' vision angles.

3.2.5 Parking Lots

Parking lots inventory and status (open\closed\occupancy) shall be collected from parking lots operators' systems and displayed as a layer in the traffic situation picture.

3.2.6 Road Users Applications

Road users' applications, such as WAZE, contribute significant information concerning traffic status on metropolitan roads. This data includes:

- Traffic volume, occupancy, and congestion
- Travel time
- Incidents

The MTMS shall establish an interface with such applications, WAZE, as a minimum.

3.2.7 Emergency Forces C2 Systems

Emergency forces such as police, firefighting services, and first-aid services play a major role in traffic management, especially in response to road incidents. Therefore, an interface is required between the MTMS and the emergency forces' C2 systems. This interface shall include gathering the following data:

- Incidents
- Self-location
- Chat

The MTMS shall also disseminate traffic information data to those systems.

3.2.8 Environment Data Sources

Environmental conditions, mainly weather, influence traffic flow. The MTMS shall connect to a weather service provider to obtain relevant data.

3.2.9 CRM Systems

Municipalities and traffic operators use CRM systems to document and manage events. The MTMS shall establish an interface with these systems to gather events' information and provide these organizations with data regarding events handled by the Metropolitan Traffic Center.

3.2.10 Field Devices

Most of the field devices are not connected directly to the MTMS modules but through road control systems such as the Highway Management System and the UTC.

Interfaces between the road control systems and field devices shall include:

- Detectors
- Traffic Lights (UTC)
- VMS
- LCS
- Ramp Meter (Highway Management System)
- Closure Gates
- Etc.

4 MTMS General System Requirements

4.1 Overview

This chapter describes the desired infrastructures, architecture, and development standards. These standards are based on modern systems utilizing open-architecture and cloud-native standards. The bidder shall suggest off-the-shelf solutions and therefore is not expected to meet all of these standards, only to describe whether or not the system complies with these standards.

Sections 4.2-4.7 describe the expected system standards:

4.2 User Experience

- Single sign-on to all system' modules.
- GUI, which enables the user to both visualize all location-based data and activate operation at specific locations.
- The GUI shall also enable the operator to perform basic geographic-based calculations, such as route measurements, objects summary in a polygon, and the like.
- Simple and intuitive operation with an integrated and consistent look and feel.

4.3 System Development Requirements

4.3.1 Modularity

- Modular system architecture
- Separation between the data layer, the application layer, and the client layer.
- Interfaces between layers are based on a standard API, REST as a default.
- Separation between functional modules, which are implemented as services, loosely coupled and leveraging standard interfaces.

4.3.2 Dynamic management

- Flexible configuration and setup changes with zero or minimal downtime.
- Versions updated with minimal downtime and only a degraded capability during the update.

4.3.3 Elastic Resources

- Elastic growth capability in computation resources and storage.
- The amount of data, processing capabilities, and users will grow gradually in the coming years, and the system is expected to enable this growth without major changes. Only computation resources and storage expansion are acceptable.

4.3.4 Clients

System clients are expected to be web clients without any unique software installation at the client station.

4.4 Interfaces and API

- Usage of international protocols.
- Default protocols are TMDD for C2C, REST (OpenAPI), and WebSocket for other systems and clients' interfaces.
- Protocols' transformation is applied by using an external gateway.

4.5 Backup and Restore

- Ability to back up and restore all the collected and manufactured data (data manufactured by the data processing modules) used for the MTMS operations.
- The data includes operational data, users' actions, technical data, all sorts of configurations (systems configurations, users' configurations), and hardware and software versions.
- Ability to restore any required backup, usually without the need to perform a system restart.

4.6 Configuration Management

- Applying a configuration management method and tools.
- Version changes of modules have API compatibility with previous versions.

4.7 Cyber Security

MTMS modules are expected to comply with the following cybersecurity requirements:

- Development based on a common SSDLC (secured software development lifecycle) model.

- Hardening to reduce the attack surface, i.e., using secured protocols over non-secure protocols, inactivating unused models.
- Support the RBAC (Role-Based Access Control) model. MTMS modules shall support the RBAC (Role-Based Access Control) model. All MTMS users shall be granted operational system functionalities based on their authorization level.
- Mutually authenticate other modules using secured cryptographic channels.
- MTMS modules, handling or communicating sensitive data with other modules, shall encrypt the data at rest and data in motion.
- Produce event logs containing operational status to detect any failures or anomalies caused by cyber-attacks.

4.8 Infrastructure Requirements

The MTMS will be hosted either in the Ayalon Highways Control Center, on the cloud, or in an on-site/cloud hybrid environment. The bidder shall describe the requirements from these different optional locations (Control Center, the cloud or hybrid environment) in order for them to host the MTMS.