Network for Research and Development in Africa

International Journal of Information, Technology & Innovation in Africa
ISSN: 2360-9772. Volume 11, Number 4
Pages 28-45 (September, 2019)
nrdajpapers@gmail.com

Design of Intelligent Vehicle Traffic Control System and Speed Management

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Abstract: *Through its use of information technology, ITS offers advantages that is not available in convent transportation systems. Basically, ITS provides two kind of benefits. One kind is the resolution of traffic problems, including traffic congestion, air pollution, and traffic accidents. The other kind is improved services for users and increased efficiency of the transportation system and its operators. The study designed an intelligent vehicle traffic control system and speed management. To produce the system; European ITS Framework Architecture (FRAME) Browsing Tool was used. The system is capable to manage traffic in all or part of the road network using a methodology that is appropriate for urban roads, e.g. using traffic lights at junctions and with the possibility of incorporating facilities for pedestrians to cross the road in a controlled manner. In addition, the system can be able to calculate recommended speed limits for given traffic and weather conditions, and road network characteristics. Furthermore, the system shall be able to detect and identify vehicles that exceed the maximum authorised speed limit on selected carriageways.*

Keywords: *Intelligent, Speed, System and Transport*

1.0 Introduction

Intelligent Transportation Systems is a global trend, attracting worldwide interest from transportation professionals, automotive industry, and political decision makers. 'ITS is related to advanced communication, information, and electronics technology to solve transportation problems such as traffic congestion, safety, transport 'efficiency and environmental conservation (Pallavi and Vilas-Kharat, 2018). According 'to Commission for Global Road Safety(June 2006), the global road deaths were between 750,000 to 880,000 in the year 1999 and estimated about 1.25 million deaths per year and the toll is increasing further. World health organization report, (1999) showed that in the year 1990 road accidents as a cause of death or disability were the ninth most significant cause of death or disability and predicted that by 2020 this will move to

sixth place. Without significant changes to the road transport systems, these dreadful figures are likely to increase significantly. Traditional driver training, infrastructure and safety improvements, may contribute to certain extent to reduce the number of accidents but not enough to combat this menace. Intelligent Transport Systems are the best solution to the problem. Safety is one of the principal driving forces behind the evolution, development, standardization, and implementation of ITS systems.

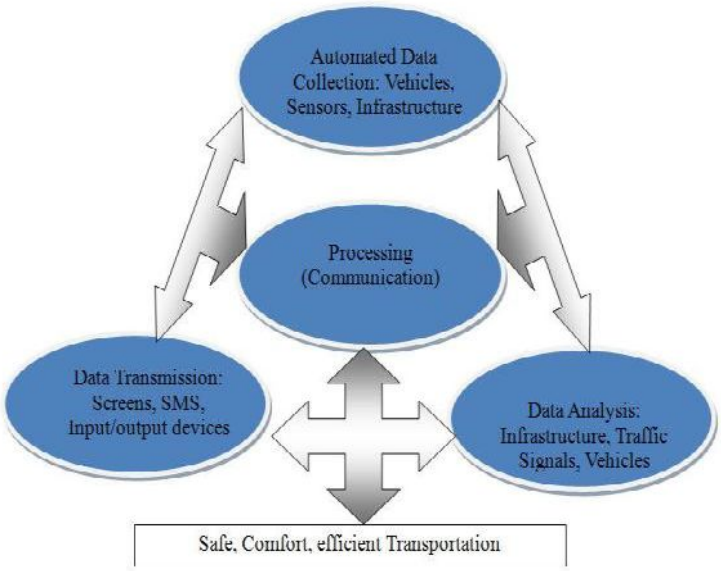

Figure1.1: Architecture / Overview Structure of ITS (Pallavi and Vilas Kharat, 2018)

According to figure 1.1; Automated Data Collection is needed for extensive and precise strategic planning through hardware and competent software. Automatic vehicle identification, GPS based vehicle locator; cameras, sensors etc. are the some of the hardware used for data collection. With this large amount of data the analysis can be done like traffic count, surveillance, travel speed, time, location, delay etc. In addition, Data Transmission is a key aspect of rapid and real-time information communication in ITS implementation. Information can be communicated by a traffic-related announcement to the traveller through SMS, internet, on-board units of vehicles etc. Furthermore, Data Analysis contains adaptive logical analysis, error rectification, data cleaning, and data syntheses. The processed data analysed further to forecast traffic scenario. Real-time information like travel time, delay, accidents on roads, change in route, work zone, diversions etc. is the gain after data analysis (Roor, 2016).

Intelligent Transportation System is a computerized system having diverse applications connected with Vehicle Transportation, which gets the live feeds from the sophisticated sensors of the smartphone and the equipment installed on the roadside or with camera mounted on the traffic light poles (Sen et al, 2009),. Smartphones consists of high-end processor and many sophisticated sensors in built. Sensors like GPS, Accelerometer, Proximity, Gyro meter, Microphone and Camera makes the smartphones different from other phones. ITS is being used and deployed in developed countries for real time navigation, traffic updates, lane discipline and predicting travel time. Its goal is to improve effectiveness, efficiency and safety of the road

transportation system. ITS had been successfully deployed in various developed countries like Japan, South Korea, Singapore, United States, Australia and United Kingdom. Deployment of ITS is different in different countries, but the motive is same i.e. to improve the transportation system performance including reduced congestion, increased safety and traveller convenience (Singh et al., 2014). ITS system is shown in figure 1.2.

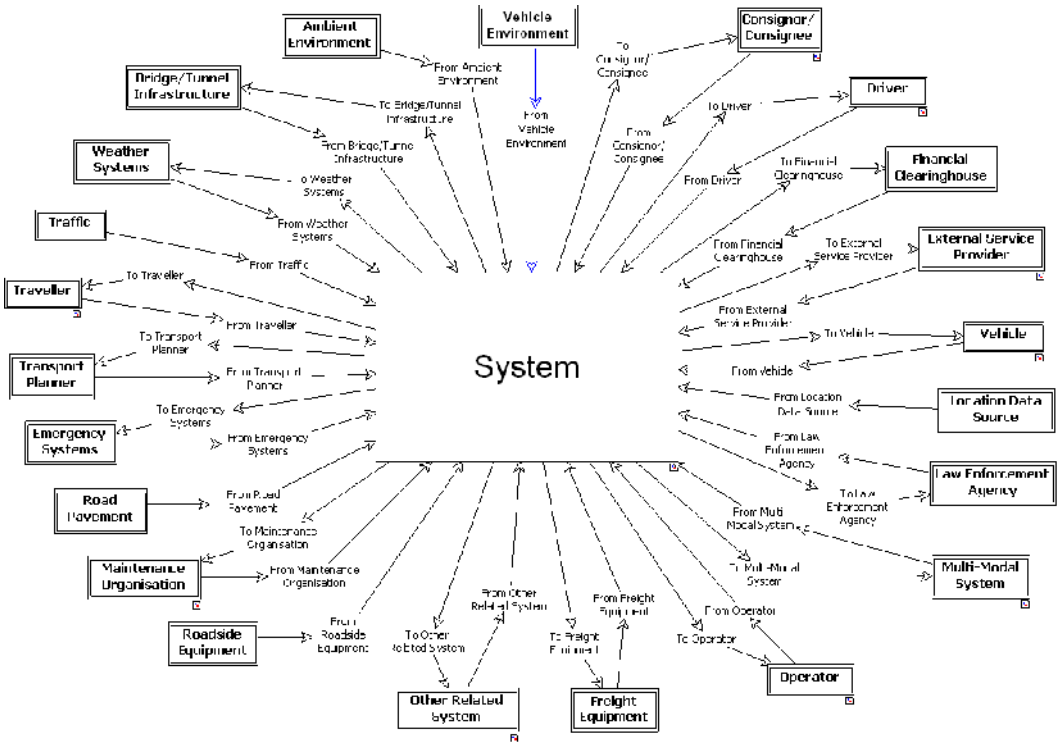

Figure 1.2: ITS System

2.0 Related Studies

2.1 Traffic Congestion

Traffic congestion is a serious problem in all parts of the world. The problem is growing fastest in developing countries where urbanization and the use of motorized vehicles is increasing most rapidly. Congestion causes delays and uncertainty, wastes fuel, results in greater air pollution, and produces a larger number of crashes. ITS can help to mitigate congestion by helping people plan travel better, by suggesting alternate routes and travel times, by keeping travellers well informed, by levelling traffic loads on roadways, and by helping to respond to and clear incidents more rapidly ITS for Developing Countries (ITSDC, 2004).

2.2 Intelligent speed adaptation

A standard speed limiter is a system that restricts the speed of the vehicle when the driver tries to exceed the maximum allowed driving speed. When the speed limiter incorporated with the intelligence to adjust the maximum driving speed, the speed limit specified by the roadside infrastructure or to the prevailing location-based on legal speed limit and to provide feedback to the driver; when that speed limit is exceeded, then technology called Intelligent Speed

Adaptation (ISA) (Bogenberger et al, 2000; Comte, 2000) ISA systems can be characterised based on the extent to which the driver is made aware of the situation.

Another characterisation for ISA systems can be made based on the speed limit itself as a fixed or a dynamic speed limit. In the fixed case, the driver is informed about the speed limit, which could be obtained from a static database. A dynamic speed limit system takes current road conditions such as bad weather, slippery roads, or major incidents into account before prescribing the speed limit. ISA can influence the traffic flow by limiting the maximum speed of the vehicles depending upon the actual traffic flow conditions. As such congestion can be delayed or alleviated by delaying vehicles so that by the time they arrive at a congested region the congestion has diminished or has already been dissolved.

3.0 Methodology

Using the European ITS Framework Architecture (FRAME) Browsing Tool, the study designed the following tasks.

3.1 Provide Planned Urban Traffic Management

3.1.1 Overview

i. This Function shall be capable of providing the following facilities: The ability to enable urban traffic management strategies to be implemented automatically by a timed sequence.
ii. The ability for the sequence mechanism to permit the implementation to be by any combination of time of day, day of week, day of month, or day of year.
iii. The ability for new sequences to be received from the functionality that provides the Road Network Operator interface.
iv. The ability to respond to requests received from the functionality that provides the Road Network Operator interface with details of the sequences that are currently available for use.
v. The ability to send requests for the implementation of traffic management strategies to the urban traffic management functionality.

3.1.2 Functional Requirements

i. When the first trigger input data flow is received the command that it contains shall be checked
ii. If the result of (a) is that the current available sequences are to be changed, then this shall be implemented
iii. Completion of (ii) shall be confirmed using the first trigger output data flow
iv. If the result of (i) is that details of the current sequences are to be output, this shall be sent to the urban traffic control Function using the first trigger output data flow
v. Periodically, the sequences shall be scanned and the next one to be implemented for the current day and time shall be determined
vi. When the day and time determined in (e) arrives, the control strategy (ies) requested in the sequence shall be sent to the urban traffic control Function using the second trigger output data flow
vii. When the second trigger input data flow is received the data for the new or revised urban traffic management strategy shall be checked for format and consistency

viii. If the result of (vii) is acceptable, the strategy shall be made available for selection when required

ix. If the result of (vii) is not acceptable, then details shall be output using the first trigger output data flow

x. The actions in (v) and (vi) shall take priority over all other actions carried out by this Function.

3.2 Implement Urban Traffic Strategies

3.2.1 Overview

l) This Function shall be capable of providing the following facilities: The provision of traffic management that enable Vehicles to make the most efficient use of the urban road network.

m) The automatic implementation of strategies for traffic management in a planned sequence according to the time of day and day of week.

n) The ability to output data for "stop & go" and/or "commands & information" messages directly to Vehicles so that their contents can be output to Drivers by an In-vehicle display mechanism.

o) The ability of the Road Network Operator to override the automatic implementation of one or more strategies using inputs made through the HMI provided by the Provide Urban Traffic Operator Interface Function.

p) The ability for the automatic strategy implementation to be temporarily overridden by inputs requiring green wave routes to be implemented for selected Vehicles.

q) The ability for the automatic strategy implementation to be overridden by requests for changes to the way that traffic is managed that are received from functionality in the Manage Incidents and Manage Demand High-level Functions in the Manage Traffic Functional Area.

r) The ability for the Road Network Operator to define the order of priority for the various inputs that can override the automatic strategy implementation.

s) The ability to adapt the traffic management strategies to suit the current and predicted traffic conditions using real-time data to identify the need for and content of the adaptations (adaptive traffic control).

t) The ability to apply traffic management strategies to some or all of the urban road network managed by the System.

u) The ability to monitor the results from the implementation of strategies so that if necessary corrective action can be taken if the content of strategies are not followed.

v) The provision of details of the current and previously implemented strategies on some or all parts of the urban road network to the Road Network Operator through the Provide Urban Traffic Operator Interface Function.

3.2.2 Functional Requirements

a) continuously monitor for receipt of the operator urban traffic management request, planned urban traffic management request, urban environmental inputs, urban demand management strategy and urban incident strategy request data flows

b) when any of the data flows in (a) is received, implement the traffic management commands that they contain using the contents of the data flow containing urban static

data to determine which are the appropriate section(s) if the urban road network to which the commands apply

c) the commands in (b) shall be implemented using some or all of the urban bridge inputs, urban tunnel inputs, urban lane management, urban speed setting, urban traffic management s&g request, urban traffic management msg requests and urban recommended routes data flows, plus data sent to the Traffic Simulation functionality in the urban strategies in use data flow and data sent directly to In-vehicle functionality using the s&g outputs for driver display and c&i outputs for driver display data flows

d) the commands being implemented in (b) shall be filtered for applicability and sent to any other adjacent urban traffic management systems in the urban traffic management strategies data flow and to any relevant inter-urban traffic management systems in the urban to inter-urban traffic commands data flow

e) if the urban zoning strategy data flow is received, whichever is necessary of the data flows in (c) shall be sent plus the urban zone access vehicle list data flow

f) it shall be possible for the data flows containing current urban traffic conditions, urban traffic flow management data, predicted urban network data, bridge urban inputs and tunnel urban inputs to be continuously monitored and for their contents to be used to revise the detail of the commands being implemented in (b) thus providing adaptive traffic control

g) if the operator urban traffic management request was received in (a) and had led to the implementation of (b) and (c) then the operator urban traffic management response data flow shall be sent to the Provide Operator Interface function

h) as a result of (c) the receipt of the urban traffic management s&g response, urban traffic management l&s response and urban traffic management c&i response data flows shall be monitored

i) when any of the data flows in (h) is received their contents shall be checked to see if the commands in (c) are being followed

j) if the result of (i) is that the commands are not being followed, this shall be communicated to the Provide Operator Interface function in the operator urban management response data flow and to the Maintenance Management functionality in the urban response fault data flow

k) if the requirement is included in the contents of the data flows in (b) the contents of the data flows in (i) shall be used to revise the commands being sent in (c)

l) if either the inter-urban to urban traffic commands or urban traffic management strategy data flows is received, their contents shall be analysed if necessary new commands implemented as in (c) with the addition that requests may be sent to any relevant multi-modal management systems in the urban crossing inhibit data flow

m) if any of the urban emergency route request, green wave request, vehicle priority request and request demand vehicle priority data flows is received, its contents shall be implemented as in (b) and (c) above and shall take priority over any of the other inputs received in (a), (l) and (m)

n) of the data flows in (m) the contents of the urban emergency route request shall take priority over all the others, with the contents of the vehicle priority request data flow

being the next highest in priority, followed by the contents of the demand vehicle priority data flow

o) if the inter-urban virtual coned area request data flow is received, implement the necessary lane closures and speed restrictions as in (b) and (c) above in order to prevent vehicles from entering the area around an accident

p) the commands in the operator urban traffic management request data flow received in (a) shall take precedence over all the inputs in (a) and (l) but not the inputs in (m) and (o)

q) the commands in the planned urban traffic management request data flow received in (a) shall take the lowest priority after all the other inputs in (a), (l), (m) and (o)

r) implementation of all the outputs in (c) shall be checked to ensure that the comments being implemented are consistent and coherent and do not contradict each other.

3.3 Collection of Urban Traffic Data

3.3.1 Overview

i. This Function shall be capable of providing the following facilities:
The collection of traffic flow data from sensors that are located within the urban road network managed by the System.

ii. The sensors shall be capable of detecting the presence of all types of road Vehicle, from Bicycles to Heavy Goods Vehicles.

iii. The processing of the raw input data provided by the sensors into actual traffic flow data, i.e. vehicle flow rates, vehicle speeds, etc.

iv. The supply of the processed raw input data to other functionality in the Manage Traffic Functional Area for collation and use.

Note that this Function shall not collect any data directly from Vehicles. It shall assume that all Vehicles are passive and not capable of providing data themselves.

3.3.2 Functional Requirements

a) the presence of the trigger input data flow shall be continuously monitored

b) the analogue data representing raw traffic flow data obtained in (a) shall be processed into digital data such as, but not limited to, flow, speed, occupancy, headway, vehicle classification, and queue

c) the data for each point in the urban road network at which it was produced shall be kept separate

d) the trigger output data flows, shall be used to send the data in (c) to the urban road network traffic control and data management Functions.

3.4 Collect Inter-urban Traffic Data

3.4.1 Overview

iv) This Function shall be capable of providing the following facilities:
The ability to collect traffic data from the inter-urban road network.

v) The ability for sensors within this Function to provide the data as raw input and for the sensors to be capable of detecting the presence of all types of road vehicle, from bicycles to heavy freight vehicles.

vi) The ability to process the raw input data provided by the sensors to provide actual traffic flow data, e.g. flow, speed, etc.

vii) The ability to pass this processed data to other functionality for collation and use in traffic control.

3.4.2 Functional Requirements

a) the presence of the trigger input data flow shall be continuously monitored
b) the analogue data representing raw traffic flow data obtained in (a) shall be processed into digital data such as, but not limited to, flow, speed, occupancy, headway, vehicle classification, and queue
c) the data for each point in the inter-urban road network at which it was produced shall be kept separate
d) the trigger output data flows, shall be used to send the data in (c) to the inter-urban road network traffic control and data management Functions.

3.5 Monitor Weather Conditions

3.5.1 Overview

i. This Function shall be capable of providing the following facilities: The ability to collect data about weather conditions that are relevant to the operation of the road network managed by the System.
ii. The ability for some or all of the data to come from Weather Systems or to be detected using sensors within the road network.
iii. The ability to forward the collected data to other functionality for storage.

3.5.2 Functional Requirements

a) when the first trigger data flow is received, the data that it contains shall be stored internally
b) the other input trigger data flow shall be continuously monitored for actual measured weather conditions
c) at periodic intervals the measured weather conditions shall be converted into digital data and collated with the data received in (a)
d) when (c) is complete, the data shall be sent to the Manage Environmental Conditions Data function using the trigger output data flow.

3.6 Manage Urban Road Network Lanes

3.6.1 Overview

i. This Function shall be capable of providing the following facilities: The ability to provide management of the lanes on roads in the urban network.
ii. The ability to enable the management of the lanes so that the most efficient use can be made of the road space available in the urban road network.
iii. The ability to enable the use of lanes to be changed in a way that is safe for vehicle operation and that causes the minimum disruption to all forms of urban road traffic.
iv. The ability to send commands that alter the use of lanes to the functionality that is responsible for the output of messages to Drivers, both at the roadside and in the Vehicle.

3.6.2 Functional Requirements

a) when either the first or second trigger input data flows is received, the commands shall be produced to change the use of the lanes as requested
b) the commands in (a) shall make the change of lane use in an orderly way such that the safety of vehicle and travellers is not reduced or compromised the commands in (a) and (b) shall be sent to the urban output actuation Function using the first trigger output data flow

c) implementation of the first trigger input data flow in (b) and (c) shall take priority over the second trigger input data flow
d) the new use of the lanes implemented in (c) shall also be sent to the Detect Urban Violation Function using the second trigger output data flow.

3.7 Detect Urban Traffic Violations

3.7.1 Overview

8. This Function shall be capable of providing the following facilities: The ability to detect violations of urban traffic management commands and report them to the law enforcement functionality.
9. The ability to only report a violation when it is detected that a vehicle does not follow the current urban traffic commands.
10. The ability for details of these commands to be provided by the urban traffic management functionality.

3.7.2 Functional Requirements

a) when the second or third trigger input data flows are received, the internal data describing the permitted vehicle movements within the urban road network shall be updated
b) the first trigger input data flow shall be continuously monitored and converted into vehicle presence and speed data
c) the positions of vehicles produced by (b) shall be compared against that required by (a)
d) if a vehicle is found in an illegal position by (c), details of the vehicle, the time, date. place and nature of the violation shall be sent to functionality in the Provide Support for Law Enforcement Area using the trigger output data flow
e) when the fourth trigger input data flow is received, the internal data describing the permitted vehicle speed shall be updated
f) if the vehicle speed obtained from (b) exceeds that specified in (e), details of the vehicle, the time, date. place plus allowed and actual speeds shall be sent to functionality in the Provide Support for Law Enforcement Area using the trigger output data flow.

3.8 Detect Violations on Inter-urban Roads

3.8.1 Overview

a) This Function shall be capable of providing the following facilities:
The ability to detect violations of inter-urban traffic control commands and report them to the law enforcement functionality.
b) The ability to only report a violation when it is detected that a Vehicle does not follow the current inter-urban traffic commands.
(3) The ability for details of these commands to be provided by the inter-urban traffic management functionality.

3.8.2 Functional Requirements

a) when the second or third trigger input data flows are received, the internal data describing the permitted vehicle movements within the inter-urban road network shall be updated
b) the first trigger input data flow shall be continuously monitored and converted into vehicle presence data
c) the positions of vehicles produced by (b) shall be compared against that required by (a)

d) if a vehicle is found in an illegal position by (c), details of the vehicle, the time, date. place and nature of the violation shall be sent to functionality in the Provide Support for Law Enforcement Area using the trigger output data flow
e) when the fourth trigger input data flow is received, the internal data describing the permitted vehicle speed shall be updated
f) if the vehicle speed obtained from (b) exceeds that specified in (e), details of the vehicle, the time, date. place plus allowed and actual speeds shall be sent to functionality in the Provide Support for Law Enforcement Area using the trigger output data flow.

3.9 Implement Urban Traffic Strategies

3.9.1 Overview

- This Function shall be capable of providing the following facilities:
  The provision of traffic management that enable Vehicles to make the most efficient use of the urban road network.
- The automatic implementation of strategies for traffic management in a planned sequence according to the time of day and day of week.
- The ability to output data for "stop & go" and/or "commands & information" messages directly to Vehicles so that their contents can be output to Drivers by an In-vehicle display mechanism.
- The ability of the Road Network Operator to override the automatic implementation of one or more strategies using inputs made through the HMI provided by the Provide Urban Traffic Operator Interface Function.
- The ability for the automatic strategy implementation to be temporarily overridden by inputs requiring green wave routes to be implemented for selected Vehicles.
- The ability for the automatic strategy implementation to be overridden by requests for changes to the way that traffic is managed that are received from functionality in the Manage Incidents and Manage Demand High-level Functions in the Manage Traffic Functional Area.
- The ability for the Road Network Operator to define the order of priority for the various inputs that can override the automatic strategy implementation.
- The ability to adapt the traffic management strategies to suit the current and predicted traffic conditions using real-time data to identify the need for and content of the adaptations (adaptive traffic control).
- The ability to apply traffic management strategies to some or the entire urban road network managed by the System.
- The ability to monitor the results from the implementation of strategies so that if necessary corrective action can be taken if the content of strategies are not followed.
- The provision of details of the current and previously implemented strategies on some or all parts of the urban road network to the Road Network Operator through the Provide Urban Traffic Operator Interface Function.

3.9.2 Functional Requirements

a) continuously monitor for receipt of the operator urban traffic management request, planned urban traffic management request, urban environmental inputs, urban demand management strategy and urban incident strategy request data flows

b) when any of the data flows in (a) is received, implement the traffic management commands that they contain using the contents of the data flow containing urban static data to determine which are the appropriate section(s) if the urban road network to which the commands apply
c) the commands in (b) shall be implemented using some or all of the urban bridge inputs, urban tunnel inputs, urban lane management, urban speed setting, urban traffic management s & g request, urban traffic management msg requests and urban recommended routes data flows, plus data sent to the Traffic Simulation functionality in the urban strategies in use data flow and data sent directly to In-vehicle functionality using the s & g outputs for driver display and c&i outputs for driver display data flows
d) the commands being implemented in (b) shall be filtered for applicability and sent to any other adjacent urban traffic management systems in the urban traffic management strategies data flow and to any relevant inter-urban traffic management systems in the urban to inter-urban traffic commands data flow
e) if the urban zoning strategy data flow is received, whichever is necessary of the data flows in (c) shall be sent plus the urban zone access vehicle list data flow
f) it shall be possible for the data flows containing current urban traffic conditions, urban traffic flow management data, predicted urban network data, bridge urban inputs and tunnel urban inputs to be continuously monitored and for their contents to be used to revise the detail of the commands being implemented in (b) thus providing adaptive traffic control
g) if the operator urban traffic management request was received in (a) and had led to the implementation of (b) and (c) then the operator urban traffic management response data flow shall be sent to the Provide Operator Interface function
h) as a result of (c) the receipt of the urban traffic management s&g response, urban traffic management l&s response and urban traffic management c&i response data flows shall be monitored
i) when any of the data flows in (h) is received their contents shall be checked to see if the commands in (c) are being followed
j) if the result of (i) is that the commands are not being followed, this shall be communicated to the Provide Operator Interface function in the operator urban management response data flow and to the Maintenance Management functionality in the urban response fault data flow
k) if the requirement is included in the contents of the data flows in (b) the contents of the data flows in (i) shall be used to revise the commands being sent in (c)
l) if either the inter-urban to urban traffic commands or urban traffic management strategy data flows is received, their contents shall be analysed if necessary new commands implemented as in (c) with the addition that requests may be sent to any relevant multi-modal management systems in the urban crossing inhibit data flow
m) if any of the urban emergency route request, green wave request, vehicle priority request and request demand vehicle priority data flows is received, its contents shall be implemented as in (b) and (c) above and shall take priority over any of the other inputs received in (a), (l) and (m)

n) of the data flows in (m) the contents of the urban emergency route request shall take priority over all the others, with the contents of the vehicle priority request data flow being the next highest in priority, followed by the contents of the demand vehicle priority data flow
o) if the inter-urban virtual coned area request data flow is received, implement the necessary lane closures and speed restrictions as in (b) and (c) above in order to prevent vehicles from entering the area around an accident
p) the commands in the operator urban traffic management request data flow received in (a) shall take precedence over all the inputs in (a) and (l) but not the inputs in (m) and (o)
q) the commands in the planned urban traffic management request data flow received in (a) shall take the lowest priority after all the other inputs in (a), (l), (m) and (o)
r) implementation of all the outputs in (c) shall be checked to ensure that the comments being implemented are consistent and coherent and do not contradict each other.
s)

Table 3.1: User need for Traffic Control System

Description	User Need Category	User Need
The system shall support the existing and new traffic management needs of authorities by providing a flexible yet comprehensive approach to determine traffic management strategies (including bridge and tunnel control).	7.1.0 Objectives	3.1.6.3 Create Traffic Predictions with Simulation Methods
		3.1.6.4 Manage Traffic Prediction Data Store
		3.1.6.5 Provide Traffic Predictions Operator Interface
		3.1.7.1 Assess Tunnel Status and Take Action
		3.1.7.3 Provide Tunnel Operator Interface
		3.1.8.1 Assess Bridge Status and Take Action
The system shall be able to manage traffic in all or part of the road network using a methodology that is appropriate for urban roads, e.g. using traffic lights at junctions and with the possibility of incorporating facilities for pedestrians to cross the road in a controlled	7.1.0 Objectives	3.1.1.5.10 Provide Urban Traffic Operator Interface Speeds and Headways Network Lanes
		3.1.1.5.18 Manage Urban Traffic
		3.1.1.5.19 Manage Urban Road
		3.1.1.5.2 Provide Planned Urban Traffic Management
		3.1.1.5.22 Output s&g Commands to Urban

manner.		Roads
		3.1.1.5.23 Output Urban Lane & Speed Commands
		3.1.1.5.24 Implement Urban Traffic Strategies
The system shall manage road traffic in such a way that congestion (travel time) may be reduced.	7.1.0 Objectives	3.1.1.5.20 Output c&i to Drivers using Urban Roads Commands & Messages urban Roads Inter-urban Roads
		3.1.1.5.22 Output s&g Commands to Urban Roads
		3.1.1.5.23 Output Urban Lane & Speed Commands
		3.1.1.5.24 Implement Urban Traffic Strategies
		3.1.2.13.5 Manage Inter-urban Traffic
		3.1.2.14.2 Output c&i to Drivers using Inter-
		3.1.2.14.3 Output Lane & Speed Messages to
		3.1.2.14.4 Output Inter-urban Traffic Commands & Messages

Table 3.2: User need for Speed Management

Description	User Need Category	User Need
The system shall be able to show the maximum authorised speed of vehicles on selected carriageways to be shown to drivers.	Speed Management	3.1.1.5.18 Manage Urban Traffic Speeds and Headways
		3.1.2.13.4 Manage Inter-urban Road Network Speeds & Headways
		3.1.2.14.2 Output C&I to Drivers using Inter-urban Roads
		3.1.2.14.3 Output Lane & Speed Messages to Inter-urban Roads
The system shall be able to	Speed	3.1.1.5.18 Manage Urban Traffic Speeds

set variable speed limits on parts of the road network	Management	and Headways
		3.1.2.13.4 Manage Inter-urban Road Network Speeds & Headways
		3.1.2.14.3 Output Lane & Speed Messages to Inter-urban Roads
The system shall be able to calculate recommended speed limits for given traffic and weather conditions, and road network characteristics	Speed Management	3.1.1.5.18 Manage Urban Traffic Speeds and Headways
		3.1.2.13.4 Manage Inter-urban Road Network Speeds & Headways
The system shall be able to support a database of all speed limits on the road network		3.1.1.5.18 Manage Urban Traffic Speeds and Headways
		3.1.2.13.4 Manage Inter-urban Road Network Speeds & Headways
The system shall be able to detect and identify vehicles that exceed the maximum authorised speed limit on selected carriageways	Speed Management	3.1.1.5.8 Detect Urban Traffic Violations
		3.1.2.14.5 Detect Violations on Inter-urban Roads
		7.3.4 Output Violator Identities to Inter-urban Roads
		7.3.5 Sort Fraud and Violation Notifications
		7.3.6 Create File for use in Prosecution
The system shall be able to support an in-vehicle database of road network data (e.g. speed limits, road hazards, junctions etc.).	Speed Management	3.1.1.5.18 Manage Urban Traffic Speeds and Headways
		3.1.2.13.4 Manage Inter-urban Road Network Speeds & Headways
		5.16.1 Manage Communication from Vehicle to Driver

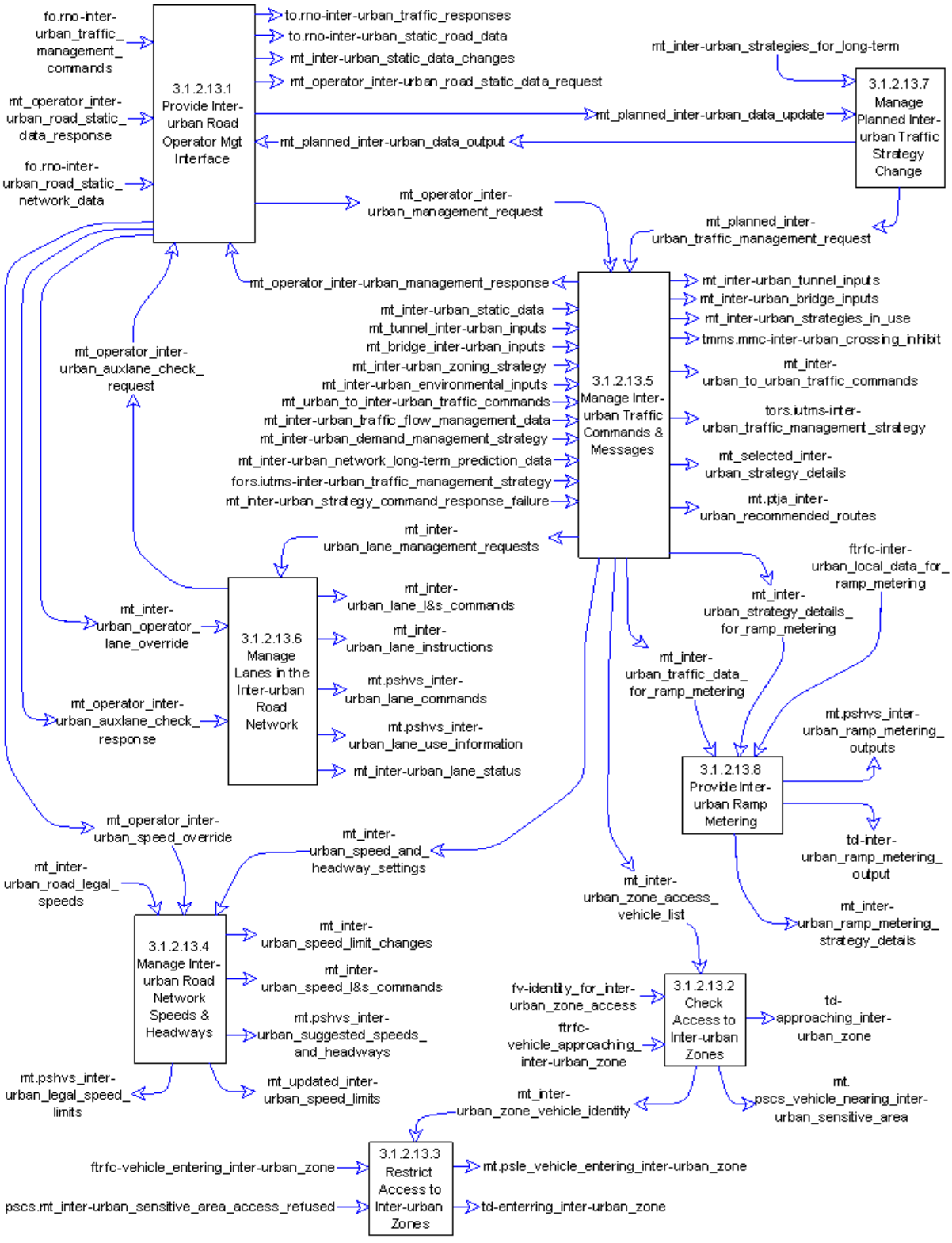

Figure 3.1: Traffic and Speed Management

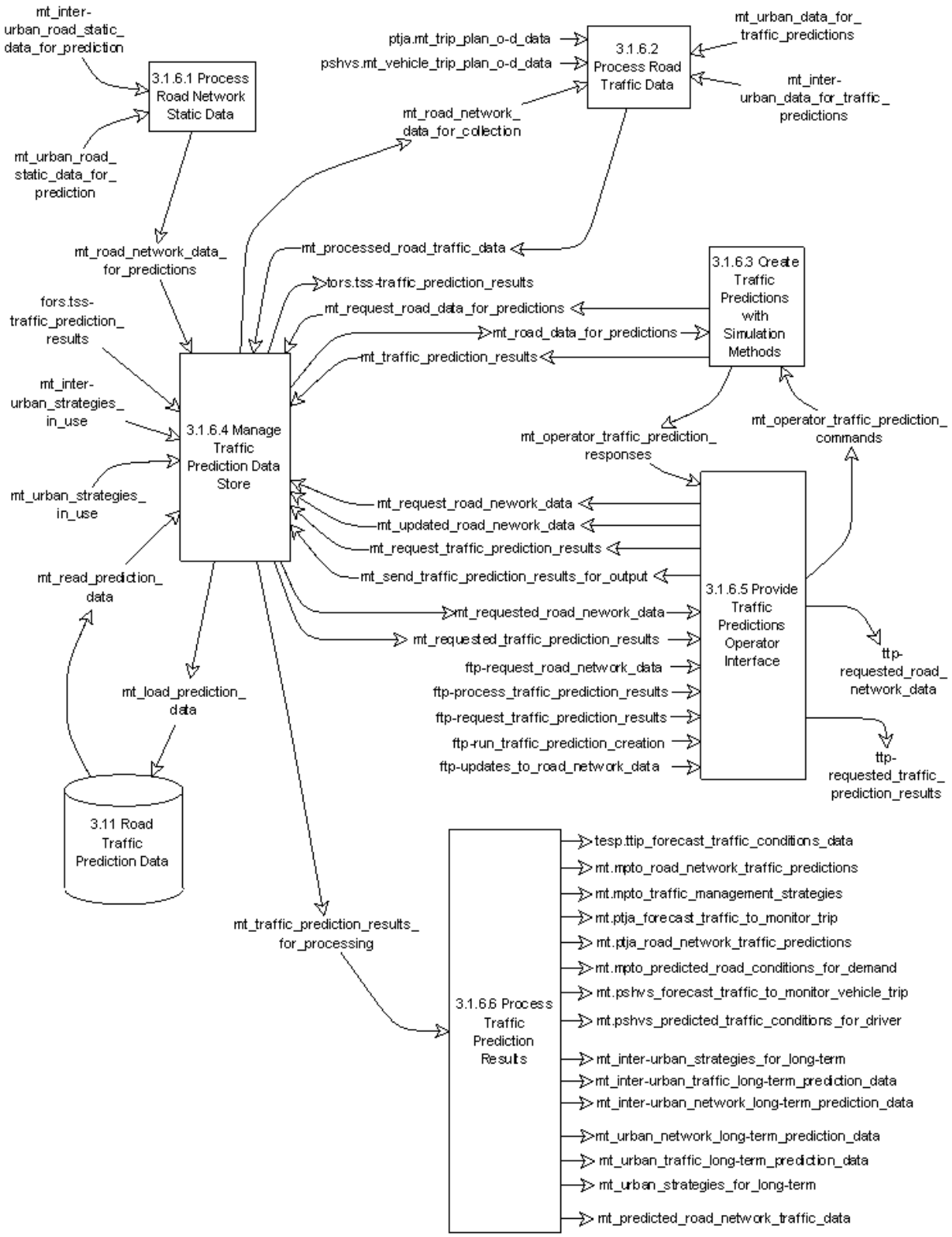

Figure 3.2: Traffic Prediction and Management

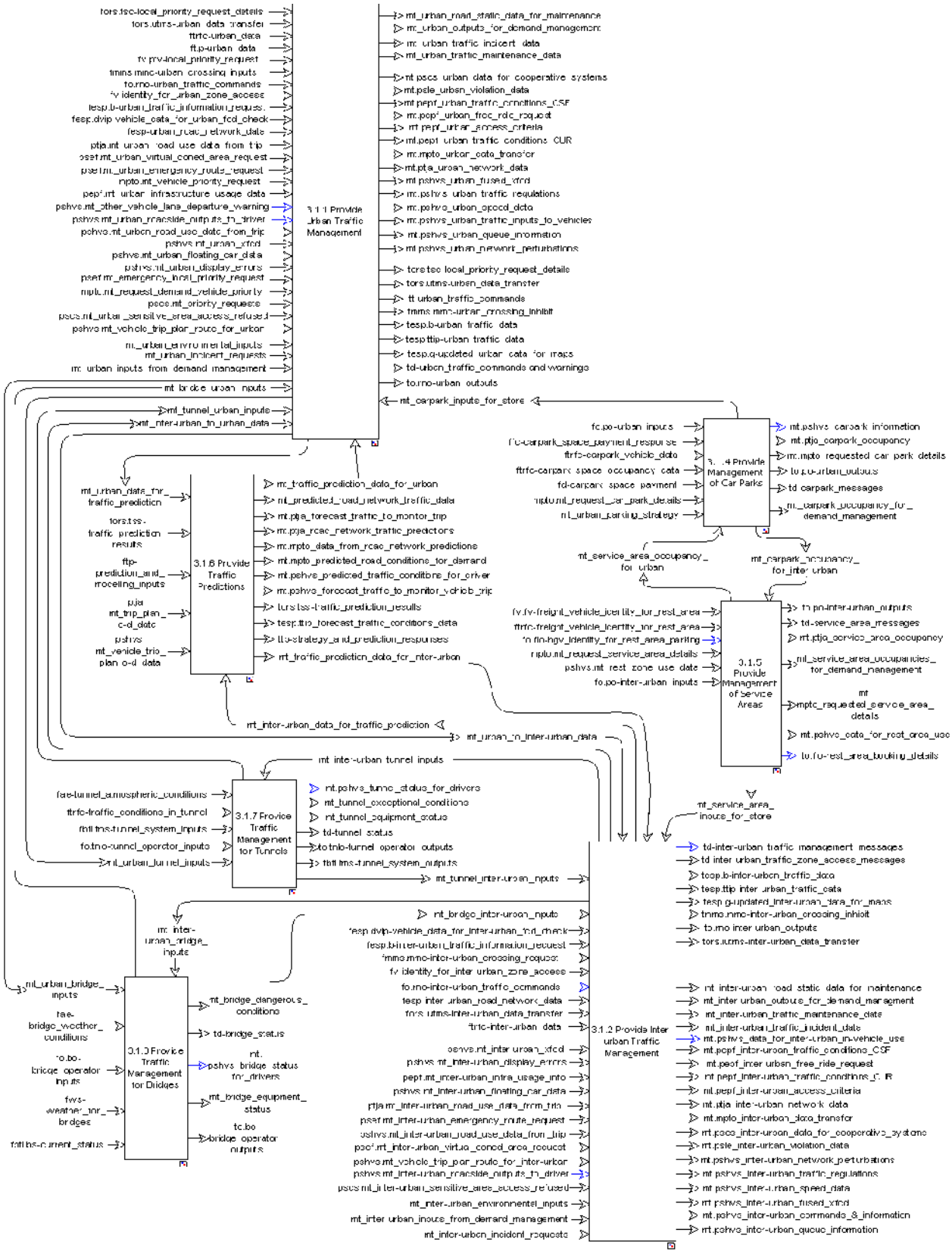
3.1.1 Provide Urban Traffic Management
3.1.6 Provide Traffic Predictions
3.1.4 Provide Management of Car Parks
3.1.5 Provide Management of Service Areas
3.1.7 Provice Traffic Management for Tunnels
3.1.3 Provice Traffic Management for Bridges
3.1.2 Provide Inter urban Traffic Management
mt_urban_road_static_data_for_maintenance
mt_urban_outputs_for_demand_management
mt_urban_traffic_incident_data
mt_urban_traffic_maintenance_data
mt.psce_urban_data_for_cooperative_systems
mt.psle_urban_violation_data
mt.pept_urban_traffic_conditions_CSF
mt.pept_urban_free_ride_request
mt.pept_urban_access_criteria
mt.pept_urban_traffic_conditions_CUR
mt.mpto_urban_data_transfer
mt.pta_urban_network_data
mt.pshvs_urban_fused_xfcd
mt.pshvs_urban_traffic_regulations
mt.pshvs_urban_speed_data
mt.pshvs_urban_traffic_inputs_to_vehicles
mt.pshvs_urban_queue_information
mt.pshvs_urban_network_perturbations
tors.tsc-local_priority_request_details
tors.utms-urban_data_transfer
ttfrtc-urban_data
ttfrtc_urban_traffic_commands
tmms.mmc-urban_crossing_inhibit
tesp.tb-urban_traffic_data
tesp.ttip-urban_traffic_data
tesp.tg-updated_urban_data_for_maps
td-urban_traffic_commands_and_warnings
to.mo-urban_outputs
mt_carpark_inputs_for_store
mt_bridge_urban_inputs
mt_tunnel_urban_inputs
mt_inter-urban_to_urban_data
mt_urban_data_for_traffic_prediction
tors.tss-traffic_prediction_results
ftp-prediction_and_modelling_inputs
pda mt_trip_plan_o-d_data
pshvs mt_vehicle_trip_plan_o-d_data
mt_traffic_prediction_data_for_urban
mt_predicted_road_network_traffic_data
mt.pta_forecast_traffic_to_monitor_trip
mt.pta_rcac_network_traffic_predictors
mt.mpto_data_from_rcac_network_predictions
mt.mpto_predicted_road_conditions_for_demand
mt.pshvs_predicted_traffic_conditions_for_driver
mt.pshvs_forecast_traffic_to_monitor_vehicle_trip
tors.tss-traffic_prediction_results
tesp.ttip_forecast_traffic_conditions_data
tto-strategy_and_prediction_responses
mt_traffic_prediction_data_for_inter-urban
fc.po-urban inputs
fd-carpark_space_payment_response
ttfrtc-carpark_vehicle_data
ttfrtc-carpark_space_occupancy_data
fd-carpark_space_payment
mpto.mt_request_car_park_details
mt_urban_parking_strategy
mt.pshvs_carpark_information
mt.ptjo_carpark_occupancy
mt.mpto_requested_car_park_details
to.po-urban_outputs
td_carpark_messages
mt_carpark_occupancy_for_demand_management
mt_service_area_occupancy_for_urban
mt_carpark_occupancy_for_inter urban
fv.fv-freight_vehicle_identity_for_rest_area
ttfrtc-freight_vehicle_identity_for_rest_area
tn.tn-hgv_identity_for_rest_area_parking
mpto.mt_request_service_area_details
pshvs.mt_rest_zone_use_data
fc.po-inter-urban_inputs
tn.po-inter-urban_outputs
td-service_area_messages
mt.ptjo_service_area_occupancy
mt_service_area_occupancies_for_demand_management
mt mptc_requested_service_area_details
mt.pshvs_data_for_rest_area_use
to.fc-rest_area_building_details
mt_inter-urban_data_for_traffic_prediction
mt_urban_to_inter-urban_data
mt inter-urban tunnel inputs
fare-tunnel_atmospheric_conditions
ttfrtc-traffic_conditions_in_tunnel
fmtl.tms-tunnel_system_inputs
fo.tno-tunnel_operator_inputs
mt_urban_tunnel_inputs
mt.pshvs_tunnel_status_for_drivers
mt_tunnel_exceptional_conditions
mt_tunnel_equipment_status
td-tunnel status
to.tnb-tunnel operator outputs
fmtl.tms-tunnel_system_outputs
mt_tunnel_inter-urban_inputs
mt_service_area_inputs_for_store
td-inter-urban traffic management messages
td inter urban_traffic_zone_access_messages
tesp.tb-inter-urban_traffic_data
tesp.ttip inter urban_traffic_data
tesp.tg-updated_inter-urban_data_for_maps
tmms.mmc-inter-urban_crossing_inhibit
to.mo inter urban_outputs
tors.utms-inter-urban_data_transfer
mt_inter-urban_bridge_inputs
mt_bridge_inter-urban_inputs
tesp.dvlp-vehicle_data_for_inter-urban_trnl_check
tesp.tb-inter-urban_traffic_information_request
tmms.mmc-inter-urban_crossing_request
fv.identity_for_inter urban_zone_access
fo.mo-inter-urban_traffic_commands
tesp.inter urban_road_network_data
tors.utms-inter-urban_data_transfer
ttfrtc-inter-urban_data
mt_urban_bridge_inputs
fae-bridge_weather_conditions
to.bo-bridge_operator_inputs
fws-weather_for_bridges
fmtl.tms-current_status
mt_bridge_dangerous_conditions
td-bridge_status
mt. pshvs_bridge_status for_drivers
mt_bridge_equipment_status
tc.bo bridge operator outputs
pshvs.mt_inter urban_xfcd
pshvs.mt_inter-urban_display_errors
pept.mt_inter-urban_intra_usage_info
pshvs.mt_inter-urban_floating_car_data
ptja.mt_inter-urban_road_use_data_from_trip
psce.mt_inter-urban_virtual_zoned_area_request
pshvs.mt_vehicle_trip_plan_route_for_inter-urban
pshvs.mt_inter-urban_roadside_outputs_to_driver
psce.mt_inter-urban_sensitive_area_access_refused
mt_inter-urban_environmental_inputs
mt_inter urban_inputs_from_demand_management
mt_inter-urban_incident_requests
mt.psce_inter-urban_data_for_cooperative_systems
mt.psle_inter-urban_violation_data
mt.pshvs_inter-urban_network_perturbations
mt.pshvs_inter-urban_traffic_regulations
mt.pshvs_inter-urban_speed_data
mt.pshvs_inter-urban_fused_xfcd
mt.pshvs_inter-urban_commands_&_information
mt.pshvs_inter-urban_queue_information

Figure 3.3: Urban Traffic Management Including Bridges and Tunnels

Conclusion

The study designed Intelligent vehicle traffic control system and speed management using European ITS Framework Architecture (FRAME) Browsing Tool and following conclusions were drawn.

1. The system is capable to indicate the maximum authorised speed of vehicles on selected carriageways to be shown to drivers.
2. The system can be able to set variable speed limits on parts of the road network.
3. The system is capable to calculate recommended speed limits for given traffic and weather conditions, and road network characteristics.
4. The system can able to detect and identify vehicles that exceed the maximum authorised speed limit on selected carriageways
5. The system can be able to minimise delays of all vehicles using adaptive signal control
6. The system is capable to grant priority to selected vehicles (e.g. Public Transport (PT), Emergency Vehicles) at an intersection controlled by some form of traffic signals
7. The system shall be able to give priority to PT in a manner that minimises the impact on other road users

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