Doc. TED 28 (21134) WC
November 2023

For Comments Only

BUREAU OF INDIAN STANDARDS

DRAFT FOR COMMENTS ONLY
(*Not to be reproduced without the permission of BIS or used as an Indian Standard*)

भारतीय मानक **मसौदा**

कुशल यातायात प्रबंधन पद्धति घटक - सामान्य विशिष्टि

Draft *Indian Standard*

INTELLIGENT TRAFFIC MANAGEMENT SYSTEM COMPONENTS — GENERAL SPECIFICATIONS

ICS: 03.220.20; 35.240.60

Intelligent Transport Systems Sectional Committee, TED 28	**Last date for receipt of comments is 19/01/2024**

FOREWORD
(*Formal Clause to be added later*)

The composition of the Committee responsible for the formulation of this standard is given at **Annex A (Will be added later).**

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of test or analysis, shall be rounded off in accordance with IS 2: 2022 'Rules for rounding off numerical values (*Second Revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Doc. TED 28 (21134) WC
IS XXXX:XXXX
November 2023

Draft *Indian Standard*

INTELLIGENT TRAFFIC MANAGEMENT SYSTEM COMPONENTS — GENERAL SPECIFICATIONS

1 SCOPE

This standard provides the details of the components of Intelligent Traffic Management System.

2 REFERENCES

This standard does not contain any cross reference.

3 TERMINOLOGY

For the purposes of this standard, the following terms and definitions shall apply.

3.1 All Red — A condition when only red aspects are displayed. The All Red is executed when an abrupt signal change is required (e.g. power up, flash-to-signal, manual-to-auto, hurry call-to-auto, etc).

3.2 Amber Time ─ Duration of the amber display for a phase or a movement.

3.3 Adaptive Traffic Control Systems (ATCS) — Adaptive Traffic Control Systems are traffic responsive systems that use data from vehicle detectors and optimize traffic signal settings in an area to reduce vehicle delays and stops.

3.4 Cable-less Linking Facility — A method of linking traffic signals along a corridor and / or in an area using timing information derived from their master time clock systems.

3.5 Central Computer — A computer system that is connected to all traffic signal controllers under the ATCS through the communication network. The network control software runs at the Central Computer.

3.6 Clearance Amber — Clearance Amber is the warning signal to traffic streams approaching the Stop Line, commenced at the change of a right of way.

3.7 Communication Network — A wired or wireless facility used to send and receive data between the Central Computer and the Traffic Signal Controller

3.8 Conflict Plan — Any competing phases that are not allowed simultaneously are defined as conflicting phases. The Conflict plan is a listing of all conflicting groups.

3.9 Corridor — An arterial road with several intersections.

3.10 Cycle Plan — Each signal switching schemes make a Cycle Plan. Change of a stage switching sequence or stage timings define a new cycle plan.

3.11 Cycle — Cycle is the total time period required for one complete sequence of signal switching scheme, in which all stages are given some fixed order.

3.12 Day Plan — Day Plan is the distribution of cycle plans for a particular day.

3.13 Decision Support — Reports, Graphs, Traffic Simulator interface.

3.14 Filter Green — The Filter Green provides signal for the turning traffic. When linked with a vehicle phase the termination of filter green is blackout; otherwise it flash for few seconds (equivalent to clearance amber time) before termination.

3.15 Fixed Time Operation — None of the stages are preempted

3.16 Full ATCS — The signal controllers shall accept stage timings from the ATCS application and report back the operational parameters to the central server

3.17 Full VA Cycle — Vehicle Actuated operation of signal controller with fixed cycle length

3.18 Full VA — Preemption enabled for all the stages

3.19 GPS (Global Positioning System) — A satellite-based radio navigation system developed and operated by the U.S. Department of Defense (DOD). GPS permits users to determine time, date and day of week 24 hours a day, in all weather, anywhere in the world with a precision and accuracy.

3.20 IRNSS (Indian Regional Navigation Satellite System) — The Indian Regional Navigation Satellite System, with an operational name of NavIC, is an autonomous regional satellite navigation system that provides accurate real-time positioning and timing services. It covers India and a region extending 1,500 km around it, with plans for further extension.

3.21 Green Running Period — Split time utilized for the stage.

3.22 Green Wave — A scheme that give right-of-way progressively at all intersections in a corridor.

3.23 Hurry Call — The Hurry Call mode will provide the means to force the controller to a defined stage, without violating safety clearances.

3.24 Indicative Green — The Indicative Green is a continuously flashing signal/steady signal, which provides signal for the free left turning traffic. The termination of indicative green is always blackout.

3.25 Inter Green — This is the time period between the end of the green signal for one stage and the beginning of the green signal for the following stage.

3.26 Loop — The sensor element of a vehicle detector.

3.27 Maximum Green Period — Maximum Green period is the maximum time period for which a green light can be in the ON state in a particular stage.

3.28 Minimum Green Period — This facility ensures that a phase looses right of way only after a minimum time period has elapsed. This minimum time is defined as Minimum Green Period. It will not be possible to terminate prematurely the minimum green period.

3.29 Network Control Software — ATCS application software that generate, monitor and manage the signal plan timings for all intersections under the ATCS.

3.30 Offset — Offset is defined as the difference between the start/termination of green time at the successive upstream and downstream signals.

3.31 Pedestrian Movements — The Pedestrian phase contains two signal aspects, viz. Red and Green. The termination of pedestrian phase can be either red flash or green flash.

3.32 Performance Index — A measure of effectiveness on the applied control strategy.

3.33 Phase — The sequence of conditions applied to one or more streams of vehicular or pedestrian traffic, which always receive identical signal light indications. The controller provides facilities for a number of phases, each phase provide control for one of the following:

3.34 Power Saving — Signal lamp intensity control based on ambient light during different time of the day.

3.35 Priority Route — A route in a corridor that carry maximum volume of traffic at a given point of time.

3.36 Priority Stage — A stage that is a part of the priority route

3.37 Red Extension — When a right of way is terminated with Clearance amber, opening of the next right of way is delayed by the Red Extension period. With no continuing phase this gives an effect of all red between stage changes.

3.38 Right-Of-Way — A visual signal to go-ahead.

3.39 Semi-Actuation — One or more stages are not preempted in vehicle actuated signal operation.

3.40 Special Day Plan — Holidays falling on normal weekdays can be treated as special days and can have a different day plan.

3.41 Split — A Split decides how long a Stage should remain; i.e. the duration of a given right of way.

3.42 Stage Preemption — A facility to terminate a Stage execution before it reaches the Green running time set for that Stage. The Stage preemption happens when there is no continuous vehicle demand on the corresponding approach.

3.43 Stage Skipping — Facility for a stage to appear only when demanded.

3.44 Stage — A stage can primarily be considered as a condition of signal lights during a period of the cycle, which gives right of way to one or more traffic movements. One or more phases form a Stage (Group). Stage is a group of non- conflicting phases.

3.45 Traffic Lane — A lane is part of a roadway (carriageway) that is designated for use by a single line of vehicles, to control and guide drivers and reduce traffic conflicts.

3.46 Traffic Management Centre (TMC) — Place where the Central Computer resides and all communication network links are aggregated.

3.47 Traffic Signal Controller — A microcontroller based equipment with solid state traffic signal lamp switching module.

3.48 Vehicle Detector — A device that detect the presence and passage of a vehicle.

3.49 Vehicular Movements — The Vehicle phase contains three signal aspects, viz. Red, Amber and Green. The termination of vehicle phase is always with clearance amber.

3.50 Week Plan — Week Plan is the distribution of available day plans for a week.

3.51 Zone — A small area with limited number of intersections in a city under ATCS.

4 ITMS COMPONENTS

The major components of ITMS are Adaptive Traffic Control System (ATCS), Emergency vehicle preemption system, pelican controller, Red light violation detection system, Intelligent parking management system etc. The general specification of this components are listed below

4.1 General Specifications of Adaptive Traffic Control System (ATCS)

The Adaptive Traffic Control System has the following building blocks.

a) Traffic Signal Controller;
b) Vehicle Detectors;
c) Communication Network;
d) ATCS Application Software; and
e) Traffic Management Centre

4.1.1 *Traffic Signal Controller*

The Traffic Signal Controller equipment is a microcontroller based controller with solid state traffic signal lamp switching module and a conflict monitoring facility to ensure that conflicting, dangerous or disallowed traffic signal displays are not shown.

Site specific configuration data shall be stored in a non-volatile memory device (FLASH memory) easily programmable at the site through keypad or laptop. Volatile memory shall not be used for storing the junction specific plans or signal timings.

All timings generated within a traffic signal controller shall be digitally derived from a crystal clock which shall be accurate to plus or minus 100 milliseconds.

The controller shall provide a real time clock (RTC) with battery backup that set and update the time, date and day of the week from the GPS/IRNSS. The RTC shall have minimum of 10 years battery backup with maximum time tolerance of 1 sec per day.

The controller shall have the facility to update the RTC time from ATCS server, GPS and through manual entry.

The controller shall be capable of communicating with the ATCS server through Ethernet on a managed leased line network or any other appropriate stable communication network.

4.1.1.1 *Police Panel*

The controller shall provide the following facilities in a separate panel with provision for lock and key arrangements for use by the Traffic Police.

a) *Four Hurry Call switches* — The Hurry Call mode will provide the means to force the controller to a defined stage, without violating safety clearances. A preemption input may be used to demand the Hurry Call mode to give right of way to emergency vehicles. It should be possible to configure the Hurry Call switches to any stage as per site requirements;

b) *One Forced Flash Switch* — Activation of this switch should force the signal to Flashing Amber / Flashing Red;

c) *One Auto / Manual Switch* — Activation of this switch should enable manual operation of the controller. Deactivation of the manual switch shall continue from the current stage without interruption;

d) *One Manual Advance Pushbutton Switch* — In manual operation mode, the stages appear in the sequence specified in the signal plan timetable. Activating the pushbutton switch shall terminate the currently running stage and start the next, without violating safety clearances; and

e) *One Junction OFF Switch* — Activating this switch should put OFF all signal lamps. On deactivation of the switch the traffic signal controller shall resume its normal operation without violating any safety clearances.

4.1.1.2 *Modes of Operation*

The traffic signal controller shall have the following modes of operation:

a) *Fixed Time* — In fixed time (pre-timed) mode the traffic signal controller shall execute stage timings according to the site-specific timetable maintained in the traffic signal controller FLASH memory. Inputs from vehicle detectors shall be ignored in this mode and no preemption shall be made on any stage. Cycle time remains constant in every cycle execution for a given time period;

b) *Vehicle Actuation with All Stages Preemption* — In the vehicle actuation with all stages preemption mode, the traffic signal controller shall execute stage timings as per demand from vehicle detectors within the constraints of Minimum Green; Maximum Green running period for the stage and Cycle time stored in the traffic signal controller FLASH memory. Preemption shall be possible for all demand actuated stages. Cycle time may vary in every cycle execution;

c) *Semi-Actuation* — In the semi-actuation mode, the traffic signal controller shall execute stage timings *in* the vehicle actuated stages as per demand from vehicle detectors within the constraints of Minimum Green, Maximum Green running period for the stage and Cycle time stored in the traffic signal controller FLASH memory. All other stages shall execute the Maximum green time configured for the stage. Preemption shall be possible for all demand actuated stages. Cycle time may vary in every cycle execution;

d) *Stage Skipping* — The traffic signal controller shall not execute the stage enabled for skipping when there is no vehicle demand registered for the stage till clearance amber time of the previous stage;

e) *Transit Signal Priority (TSP) for BRT buses* — The traffic signal controller shall provide transit signal priority for buses in dedicated lane to ensure minimum stop delay at the intersection, without violating safety clearances;

f) *Vehicle Actuation with Fixed Cycle length* — In vehicle actuation with fixed cycle length mode, the traffic signal controller shall execute stage timings as per demand from vehicle detectors within the constraints of Minimum Green, Maximum Green running period for the stage and Cycle time shall be maintained constant during a given timeslot. Preemption for all demand actuated stages except for Priority Stage shall be possible; and

g) *Full ATCS (FATCS)* — In FATCS mode, the traffic signal controller shall execute stage timings as per demand within the constraints of Minimum Green, Maximum Green running period for the stage and Cycle time specified by the Central Computer during every cycle switching. Preemption for all demand actuated stages except Priority Stage shall be possible in this mode.

   The traffic signal controller shall identify a communication failure with the central computer within a specified time period. In such an event the signal plan timings shall be executed from the local timetable stored in the traffic signal controller FLASH memory. Fallback mode of the traffic signal controller shall be vehicle actuated. On restoration of the communication with central computer the traffic signal controller shall automatically resort to FATCS mode.

   1) The traffic signal controller shall accept commands for remote selection / de-selection of the following from the Central Computer at TMC.

      i) Hurry Call;
      ii) Flashing Amber / Flashing Red; and
      iii) Junction Off.

   2) If not reverted to the normal operation within the time period listed below, the traffic signal controllers shall timeout the commands and operate normally

i) Hurry Call – 5 Minutes;
ii) Flashing Amber / Flashing Red – 30 Minutes; and
iii) Junction Off – 30 Minutes.

3) The traffic signal controller shall report the following to the Central Computer through the communication network every cycle or on an event as appropriate.

i) Green time actually exercised for each approach (stage preemption timing) against the Green running period set for the approach by the Central Computer;
ii) Mode of Operation;
iii) Lamp failure, if any;
iv) Output short circuit, if any; and
v) Detector failure, if any.

4.1.1.3 *Traffic Signal Controller Operating Parameters*

a) *Phases* — The controller shall have facility to configure 32 Phases either for vehicular movement, filter green, indicative green, pedestrian movement or a combination thereof.

It shall be possible to operate the filter green (turning right signal) along with a vehicular phase. The filter green signal shall flash for a time period equal to the clearance amber period at timeout when operated with a vehicular phase.

The pedestrian phase signal shall be configured for flashing red or flashing green aspect during pedestrian clearance. It shall be possible to configure any phase to the given lamp numbers at the site;

b) *Stages* — The controller shall have facility to configure 32 Stages;

c) *Cycle Plans* — The controller shall have facility to configure 24 Cycle Plans and the Amber Flashing / Red Flashing plan. It shall be possible to define different stage switching sequences in different cycle plans. The controller shall have the capability for a minimum of 32 cycle-switching per day in fixed mode of operation;

d) *Day Plans* — The controller shall have facility to configure each day of the week with different day plans. It shall also be possible to set any of the day plans to any day of the week. The controller shall have the capability to configure 20 day plans;

e) *Special Day Plans* — The controller shall have facility to configure a minimum of 20 days as special days in a calendar year;

f) *Starting Amber* — During power up the controller shall initially execute the Flashing Amber / Flashing Red plan for a time period of 3 Seconds to 10 Seconds. The default value of this Starting Amber is 5 Seconds. Facility shall be available to configure the time period of Starting Amber within the given limits at the site;

g) *Inter-green* — Normally the inter-green period formed by the clearance Amber and Red extension period will be common for all stages. However, the controller shall have a facility to program individual inter-green period from 3 Seconds to 10 Seconds;

h) *Minimum Green* — The controller shall allow programming the Minimum Green period from 5 *Seconds* to 10 Seconds without violating the safety clearances. It should not be possible to preempt the Minimum Green once the stage start commencing execution;

j) *All Red* — Immediately after the Starting Amber all the approaches should be given red signal for a few seconds before allowing any right of way, as a safety measure. The controller shall have programmability of 3 Seconds to 10 Seconds for All Red signal;

k) *Signal lamps monitoring* — The controller shall have inbuilt circuitry to monitor the lamp status;

m) *Green - Green Conflict Monitoring* — The controller shall have a facility to list all conflicting phases at an intersection. The controller should not allow programming of these conflicting phases in a Stage. A hardware failure leading to a conflict condition (due to faulty devices or short circuit in the output) shall force the signal into Flashing Amber / Flashing Red; and

n) *Cable less Synchronization* — It shall be possible to synchronize the traffic signal controllers installed in a corridor in the following modes of operation, without physically linking them and without communication network. GPS/IRNSS enabled RTC shall be the reference for the cable less synchronization.

    1) Fixed Time mode with fixed offsets; and
    2) Vehicle Actuated mode with fixed offsets.

4.1.1.4 *Input and Output facilities*

a) *Lamp Switching* — The controller shall have maximum 64 individual output for signal lamp switching, configurable from 16 to 64 lamps. The signal lamps shall be operable on 24VDC / 12VDC ±10%;

b) *Detector Interface* — A minimum of 16 vehicle detector inputs shall be available in the controller. All detector inputs shall be optically isolated and provided with LED indication for detection of vehicle;

c) *Communication Interface* — The traffic signal controller shall support Ethernet interface to communicate with the ATCS server;

d) *Power Saving* — The traffic signal controller shall have a facility to regulate the intensity of signal lamps during different ambient light conditions thereby saving energy. Pulse Width Modulation (PWM) based intensity control shall be used for the power saving;

e) *Real-time Clock (RTC)* — The GPS/IRNSS receiver for updating time, date and day of the week information of the traffic signal controller should be an integral part of the traffic signal controller.

    The traffic signal controller shall update the date, time and day of the week automatically from GPS during power ON and at scheduled intervals.

    Manual entry for date, time and day of week shall be provisioned for setting the traffic signal controller RTC (Real Time Clock).

    It shall be possible to set the RTC from the Central Server when networked;

f) *Keypad (optional)* — The traffic signal controller shall have a custom made keypad or should have provision for plan upload and download using PC/laptop/Central Server.

g) *Operator Display (optional)* — The traffic signal controller shall optionally have a LED backlit Liquid Crystal *Display* (LCD) as the operator interface.

4.1.2 *Vehicle Detector*

The detector equipment is a separate logic unit, which may be integrated into the controller, or alternatively mounted in its own housing. The outputs of the detectors indicate the presence of vehicles and are used to influence the operation of the traffic signal controller and shall generate demands and extensions for right-of-way. Means shall be provided so that a detector may be connected to demand and / or extend a phase movement as specified.

The contractor shall clearly specify the placement of the detector (upstream, downstream, stop-line, exit etc.) for independent straight and right turn signals and how the detector data is processed in non-lane based mixed traffic flow conditions.

The contractor shall give an estimate of the total number of vehicle presence detection zones and vehicle detectors required and the type of detection system recommended.

A detector that does not change its status at least once during a stage execution shall be notified to the Central Computer (in ATCS mode) at the termination of the associated stage.

4.1.3 *Communication Network*

Function of the Communication network is for remote monitoring of the intersection and its management. Real time data (like RTC time, stage timing, mode, events, etc) from the traffic signal controller is required to be sent to the Central Computer in Traffic Management Centre. Central Computer running the ATCS application shall calculate and send optimum signal timings to all intersections in the corridor. The contractor shall clearly specify the bandwidth requirements and the type of network recommended for the ATCS.

The contractor shall specify the networking hardware requirements at the Traffic Management Centre and remote intersections for establishing the communication network.

4.1.4 *ATCS Application Software*

Objective of the ATCS is to minimize the stops and delays in a road network to decrease the travel time with the help of state-of-the-art technology. The adaptive traffic control system shall operate in real time with the capacity to calculate the optimal cycle times, effective green time ratios, and change intervals for all system traffic signal controllers connected to it. These calculations will be based up on assessments carried out by the ATCS application software running on a Central Computer based on the data and information gathered by vehicle detectors at strategic locations at the intersections controlled by the system.

The ATCS application software shall run on LINUX platform and use open RDBMS as its database.

4.1.4.1 The ATCS application software shall do the following:

a) Identify the critical junction of a corridor based on maximum traffic demand and saturation;

b) The critical junction cycle time shall be used as the corridor cycle time i.e. cycle time common to all intersection in that corridor;

c) Stage optimization to the best level of service shall be carried out based on the traffic demand;

d) Cycle optimization shall be carried out by increasing or decreasing the common corridor cycle time based on the traffic demand within the constraints of Minimum and Maximum designed value of cycle time;

e) Offset correction shall be carried out to minimize number of stops and delays along the corridor for the priority route. Offset deviation measured using distance and speed between successive intersections shall be corrected within 5 cycles at a tolerance of +/- 5 seconds maximum;

f) The system shall have provision to configure priority for upstream signals as default. The ATCS software shall continuously check the traffic demand for upstream and downstream traffic and automatically assign the priority route to the higher demand direction;

g) Develop appropriate stage timing plans for each approach of every intersection under the ATCS, based on real time demand;

h) Propose timing plans to every intersection under the ATCS in every Cycle;

j) Verify the effectiveness of the proposed timing plans in every cycle;

k) Identify Priority routes;

m) Synchronize traffic in the Priority routes;

n) Manage and maintain communication with traffic signal controllers under ATCS;

p) Maintain database for time plan execution and system performance;

q) Maintain error logs and system logs;

r) Generate Reports on request;

s) Graphically present signal plan execution and traffic flow at the intersection on desktop;

t) Graphically present time-space diagram for selected corridors on desktop;

u) Graphically present network status on desktop; and

w) Make available the network status and report viewing on Web.

4.1.4.2 *Reports*

System shall generate Corridor based and Intersection based reports. The application software shall generate the following reports, but not limited to the below. All the reports shall be possible for selected dates.

4.1.4.2.1 *Intersection based reports*

a) *Stage Timing report* — The report shall give details of time at which every stage change has taken place. The report shall show the stage sequence, stage timings and stage saturation of all stages of all cycles for a day. The saturation is defined as the ratio between the available stage timings to the actual stage timing executed by the traffic signal controller for the stage (stage preemption time);

b) *Cycle Timing report* — *The* report shall give details of time at which every cycle has taken place. The report shall show the cycle sequence and cycle timings for all the cycles in a day;

c) *Stage switching report* — The report shall give details of time at which a stage switching has taken place. The report shall show the stage sequence, stage timings and stage saturation for a day;

d) *Cycle Time switching report* — The report shall give details of time at which a cycle switching has taken place. The report shall show the cycle sequence and cycle timings for the cycle in a day;

e) *Mode switching report* — The report shall give details of the mode switching taken place on a day;

f) *Event Report* — The report shall show events generated by the controller with date and time of event;

g) *Power on & down* — The report shall show time when the master is switched on, and last working time of the master controller;

h) *Intensity Change* — The report shall show the brightness of the signal lamp is changed according to the light intensity either manually through keypad or automatically by LDR with time stamp;

j) *Plan Change* — The report shall show the time of change of plan either through keypad or remotely through a PC or Server;

k) *RTC Failure* — The report shall show the time when RTC battery level goes below the threshold value;

m) *Time Update* — The report shall show the time when the Master controller updated its time either manually through keypad, automatically by GPS or through remote server;

n) *Mode Change* — The report shall show the time when Master controller's operating mode is changed either manually through keypad or a remote server. The typical modes are FIXED, FULL VA SPLIT, FULL VA CYCLE, FLASH, LAMP OFF and HURRY CALL;

p) *Lamp Status Report* — The report shall show lamp failure report with date and time of failure, colour of the lamp and associated phase;

q) *Loop Failure Report* — The report shall show the date and time of detector failure with detector number and associated phase;

r) *Conflict* — The report shall show the conflict between lamps (RED, AMBER, GREEN) in the same phase or conflict between lamps with other phase;

s) *Corridor Performance Report* — The report shall show the saturation of all the intersections in a corridor for every cycle executed for the corridor and the average corridor saturation for a day; and

t) *Corridor Cycle Time Report* — The report shall show the Corridor cycle time, Intersection cycle time, Mode of operation and degree of saturation of all the intersections in a corridor for every cycle for a day.

4.1.4.3 *Graphical User Interface*

The application software shall have the following Graphical User Interface (GUI) for user friendliness.

a) *User* login — Operator authentication shall be verified at this screen with login name and password;

b) *Network Status Display* — This online display shall indicate with appropriate colour coding on site map whether an intersection under the ATCS is online or off. On double clicking the intersection a link shall be activated for the traffic flow display for the intersection;

c) *Traffic Flow Display* — This online display shall indicate the current traffic flow with animated arrows, mode of operation, stage number being executed and elapsed stage time.

d) *Saturation Snapshot* — This display shall show the current saturation levels of all intersections in a corridor;

e) *Reports Printing / Viewing* — This link shall allow selection, viewing and printing of different reports available under ATCS; and

f) *Time-Space Diagram* — The time-space diagram shall display the current stages being executed at every intersection in a corridor with immediate previous history.

1) Junctions shall be plotted proportional to their distance on Y-axis and time elapsed for the stage in seconds on X-axis;
2) Junction names shall be identified with each plot;
3) Facility shall be available to plot the time-space diagram from history;
4) Currently running stage and completed stages shall be identified with different colours;
5) Stages identified for synchronization shall be shown in a different colour;

6) Speed lines shall be plotter for stages identified for synchronization to the nearest intersection in both directions;
7) It should be possible to freeze and resume online plotting of Time-Space diagram; and
8) The system shall have other graphical interfaces for configuring the ATCS, as appropriate.

4.1.4.4 *Special Mentions*

The contractor shall specify how the following are achieved by the ATCS application software supplied.

a) Optimizing delays in the corridor;
b) Handling locally generated / absorbed traffic due to parking lots and other facilities between intersections; and
c) Independent control of Filter Green (turning traffic) in non-lane based traffic with the detector placement appropriate for the software

4.1.5 *Central Control Room (CCR)*

The contractor shall specify the hardware and facilities required at the Central Control Room to manage the ATCS. The Central Computer where the ATCS application software runs and the data storage configuration used shall be a new generation server. Operator consoles as required shall be possible on LAN at the CCR

4.1.5.1 The following shall be possible from the CCR, using GUI

a) Switch OFF / ON an intersection;
b) Select / De-select Forced Flash at an intersection; and
c) Select / De-select Hurry Call at an intersection

4.1.5.2 *Decision Support*

a) The ATCS shall generate standard and custom reports for planning and analysis; and
b) It shall be possible to interface the ATCS with a popular microscopic traffic flow simulation software for pre and post implementation analysis and study of the proposed ATCS control strategy.

4.2 Emergency Vehicle Priority System

The emergency vehicle priority system gives priority green signal to emergency vehicles such as ambulances and fire engines and stops the conflicting vehicle movements. The system should have two modules:

a) A controller unit installed inside the traffic signal controller; and
b) The Vehicle Mount Unit kept near the windshield of the Emergency Service Vehicle.

It has to be implemented on a geo-fencing technique using GPS coordinates. During an emergency trip, the unit in the vehicle should broadcast GPS coordinates (latitude and longitude) of the vehicle and its headway in every one second using a transmitter. The controller should always be in listening mode waiting for the signal from the vehicle unit. Once it receives the coordinates of the vehicle the controller identifies the direction and location of the vehicle. It then gives a command to the traffic signal controller for a priority green signal for the direction of the approaching emergency vehicle. On detection of the signal, the Hooter installed at the traffic junction must generate an audio alarm to alert the drivers, pedestrians, and the police officer at the traffic junction about the arrival of the emergency service vehicle. The traffic signal will now terminate the currently running signal phase and opens right-of-way for the emergency vehicle. The signal sequence is resumed once the vehicle clears the junction; also the Hooter is switched off. All approaches to the traffic junction have to be geo-coded in the controller.

4.2.1 *Specifications*

4.2.1.1 *Controller Unit Specifications*

The specifications of Control Unit are given in Table 1.

Table 1 Specifications of Controller Unit
(*Clause* 4.2.1.1)

Sl No.		
(1)	(2)	(3)
i)	CPU	Minimum 32 bit Processor
ii)	Memory	i) Minimum 512MB or above DDR3 RAM ; and ii) Minimum 4GB Flash
iii)	External Memory	SD Card of minimum 2GB or more
iv)	Operating System	Any Embedded system OS
v)	Real-Time Clock (RTC)	On-board RTC with minimum 10 Year Battery Backup
vi)	RTC Update	Through GPS
vii)	Police Panel Interface	8 optically isolated inputs and 8 outputs
viii)	Hooter Interface	IP66 hooter with 90 to 105db sound level
ix)	Central Server Connectivity	Minimum 10/100Mbps using RJ45 Ethernet port or better alternate method
x)	Programming Facility	Using webserver
xi)	Firmware update	Through RJ45 Ethernet port
xii)	Data logging	As file format minimum 1MB file size
xiii)	Communication with VMU	Through radio communication in sub 1 GHz with a minimum of 500m range
xiv)	Compatibility Requirement	Should compatible with any signal traffic controller having Hurry Call Feature
xv)	Programmable Parameters	i) Junction ID; ii) Junction Name; iii) Number of Arms of the Junction; iv) Associated Hurry call number; v) Geo-Fencing Coordinates for each arm; vi) Minimum And Maximum Heading angles; and vii) Vehicle Authentication Details.

4.2.1.2 *Electrical & Mechanical Specifications*

The electrical and mechanical specifications are given in Table 2.

Table 2 Electrical and Mechanical Specifications
(*Clause* 4.2.1.2)

Sl No.		
(1)	(2)	(3)
i)	Operating Voltage	24 V DC +/- 10%
ii)	Controller Mounting	It must be mounted inside the Traffic controller Cabinet
iii)	Temperature	0°C to +55° C
iv)	Relative Humidity	95% RH Non- condensing at +40 degree C

4.2.1.3 *Vehicle Unit Specifications*

The specifications of Vehicle Unit are given in Table 3.

Table 3 Specifications of Vehicle Unit
(*Clause* 4.2.1.3)

Sl No.		
(1)	(2)	(3)
i)	CPU	Minimum 32 bit Micro Controller
ii)	Memory	Minimum 128 KB Flash and Minimum 32KB RAM
iii)	Operating System	Any embedded OS
iv)	Location Service	GNSS
v)	Positional Accuracy	Less than 2.5 m
vi)	Controller Unit Communication	Through RF wave in sub 1GHz with a minimum of 500m range
vii)	Status Indication LEDs	ON/OFF, Radio Transmission, GPS/IRNSS active
viii)	Programmable parameter	Vehicle ID
ix)	Supply Voltage	+5V DC +10% (Through USB) or +12V DC +10%
x)	Temperature	0°C to +55° C
xi)	Relative Humidity	95% RH Non- condensing at +40 °C
xii)	Mounting	Should be inside the vehicle

4.3 Physically Challenged Pedestrian Safety Controller Unit

Presently Pelican controller gives right of way green signal to the pedestrians upon pressing a push button. This green timings are fixed value irrespective of the class of pedestrian. But, these days, a considerable number of 'divyang' (people who are differently abled) also use the pedestrian crossing.. Crossing time available for normal pedestrians and divyang with different degree of disability will be different. The system should be capable of identifying pedestrian demands through various input devices such as Pushbutton Switch, RFID and Ultrasonic Sensor for providing them sufficient crossing time based on the input device detected. It should guide the pedestrians through different tones to:

a) Locate the pedestrian crossing;
b) Wait for green signal;
c) Walk through green signal; and
d) Do not enter the motorway when the green signal is about to terminate. The controller is most useful at mid-block crossings in front of hospitals, markets, schools etc.

4.3.1 *Specifications*

The specifications of Control Unit are given in Table 4.

Table 4 Specifications of Control Unit
(*Clause* 4.3.1)

Sl No.		
(1)	(2)	(3)
i)	CPU	Minimum 32 bit processor
ii)	Memory	a) Minimum 512MB DDR3 RAM; and b) Minimum 4GB Flash
iii)	External Memory	SD Card 2GB or more

iv)	Operating System	Linux
v)	Real Time Clock (RTC)	On-board RTC with minimum 10 Year Battery Backup
vi)	RTC Update	Through GPS/IRNSS
vii)	Categories of pedestrian supported	People carrying smart cane, RF ID Tag and others who uses the push button
viii)	Pedestrian Detection Inputs	Push Button Switch, RFID Reader and Ultrasonic Sensor
ix)	RF ID card Supported	125 KHz with EM4102 protocol
x)	Smart cane supported	Any smart cane with 40 KHz ultrasonic pulse
xi)	Pedestrian Tone Types	Locater, Wait, Safe Cross and Alert
xii)	Tone Base frequency	2 kHz
xiii)	Tone Volume Level	Variable from 0 to 5 dB
xiv)	Tone output device	Horn Speaker
xv)	Labelling for visually challenged	By Braille Labels
xvi)	Implementation scenarios	a) Midblock -2 Pedestrian Sensor Box (PSB); and b) Staggered crossing - 4 PSB
xvii)	PSB to PSB communication	Wireless 2.4GHz / CAN interface
xviii)	Central Server Connectivity	10/100 Mbps RJ45 Ethernet port or better alternate method
xix)	Programming Facility	Using webserver
xx)	Firmware update	RJ45 Ethernet port and JTAG or better alternate method
xxi)	Data logging	Local controller as file
xxii)	Programmable Parameters	a) Pedestrian categories Vs Walk time; b) RF ID card No Vs Pedestrian categories; c) Pedestrian Safe walk time; d) Start Amber, All Red and Amber time; and e) Phase, Cycle Plan, Day plan and Week Plan

4.3.2 *Operating Environment*

The operating environment conditions shall be as given in Table 5.

Table 5 Operating Environment Conditions
(*Clause* 4.3.2)

Sl No.		
(1)	(2)	(3)
i)	Operating Voltage	24 V DC +/- 10%
ii)	Controller Mounting	Pedestal / Pole
iii)	Temperature	0°C to +55° C
iv)	Relative Humidity	95% RH Non- condensing at +40 degree C

4.4 Red Light Violation Detection System

Red Light Violation Detection System capture and present evidence of the red light violation that helps smooth functioning of law enforcement. Violations are captured with the help of vehicle sensors, cameras, and the controller hardware installed at the road intersection. Images and video captured at the intersection have to be stored in hardware and sent to the central server in frequent intervals through an appropriate communication medium. The captured data should be processed at the control center to generate fine receipt, reports, etc.

4.4.1 *Specifications*

The specifications of Red Light Violation Detection System is given in Table 6.

Table 6 Specifications of Red Light Violation Detection System
(*Clause* 4.4.1)

Sl. No.			
(1)	(2)	(3)	(4)
i)	1)	Specifications	a) Evidence recording; b) Number plate image capture; c) IR illuminator for night operation; d) Server and storage; e) Communication Network; f) Remote RTO database connectivity; g) Optically isolated vehicle detector interface; h) Three second video & three progressive snapshots as evidence; j) Simultaneous monitoring of multiple lanes; k) Automatic recognition of standard number plates; m) Automatic ticket generation on violated vehicles; n) Compatible with all traffic controllers; p) Local storage on network failure; and q) Handle 4 arms simultaneously.
ii)	Controller Software		
iii)	2)	Client	a) Logs violation timestamps b) Local, remote camera and loop configuration c) Detects vehicle presence from loops d) Detects red light from traffic controller e) Captures video of full red light cycle f) Captures Image of violated vehicles
iv)	3)	File Transfer Client	a) Remote server configuration; b) File upload location configuration; c) File transfer interval configuration; and d) Transfer files to remote server.

v)	4)	Hardware	a) Industrial grade PC; b) Minimum 8 GB RAM; c) 8 isolated red light inputs; d) 32 isolated vehicle detector inputs; and e) 48 isolated vehicle detector inputs.
vi)	5)	Server	a) Windows platform; b) Open source database; c) Web based configuration tool; d) Web based operator interface; e) Automatic license plate recognition; f) Custom ALPR; and g) Third party ALPR.
vii)	6)	Reports	a) Violation reports i) Junction based; and ii) Approach based b) Repeated Violations i) Licence number; and ii) Number of violations

4.5 Parking Lot Management System

Parking lot Management System should help travelers to find parking spots quickly, thereby reducing frustration and enhancing their overall experience. It must incorporate elements ranging from traditional traveler information systems to quick and automated gate control systems, individual bay monitoring electronics, advanced parking management applications, pre-trip web-based information systems, display boards, driver guidance, and navigation systems that provide directions to an individual parking space.

4.5.1 *Specifications*

The specifications of Parking Lot Management System is given in Table 7.

Table 7 Specifications of Parking Lot Management System
(*Clause* 4.5.1)

Sl No.		
(1)	(2)	(3)
i)	Components	a) Entry gate system; b) Exit gate System; c) Bay Sensor; and d) Software Application
ii)	Operating Modes	a) Manual; and b) Automatic
iii)	Entry Gate System functions	a) Capture images of Driver and Vehicle Registration Number (both Day & Night);and b) Generate barcode based token c) Allow vehicles only when a parking space is available
iv)	Exit Gate System functions	i) Scan Entry tokens;

		ii) Display Entry and Exit information; and iii) Generate receipt and print bill
v)	Bay sensor specifications	
vi)	a) CPU b) Sensor c) Interface d) Power	a) Minimum 16 bit microcontroller b) Ultrasonic c) USB d) 12V DC
vii)	Web Application functions Configuration	
viii)	Real time information through mobile application	a) Pre-trip parking; b) Online Reservation; c) Bay status; and d) Level vacancy
ix)	Report generation	a) Entry/Exit vehicle information; b) Real time vacancy report; c) Daily and monthly revenue collection; and d) Parking load and efficiency at all time
x)	Payment Option	Through UPI/Credit card/debit card/cash etc.

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

INTELLIGENT TRANSPORT SYSTEMS SECTIONAL COMMITTEE, TED 28

Will be added later